Maintaining Diverse Stands of Wildflowers Planted for Pollinators

Ongoing Management of Pollinator Habitat

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XERCES SOCIETY
for Invertebrate Conservation

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The Xerces Society for Invertebrate Conservation

www.xerces.org

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Photographs & Artwork

Cover: Native pollinator planting featuring *Gilia*, *Phacelia*, *Clarkia*, and *Grindelia*, in a California almond orchard.

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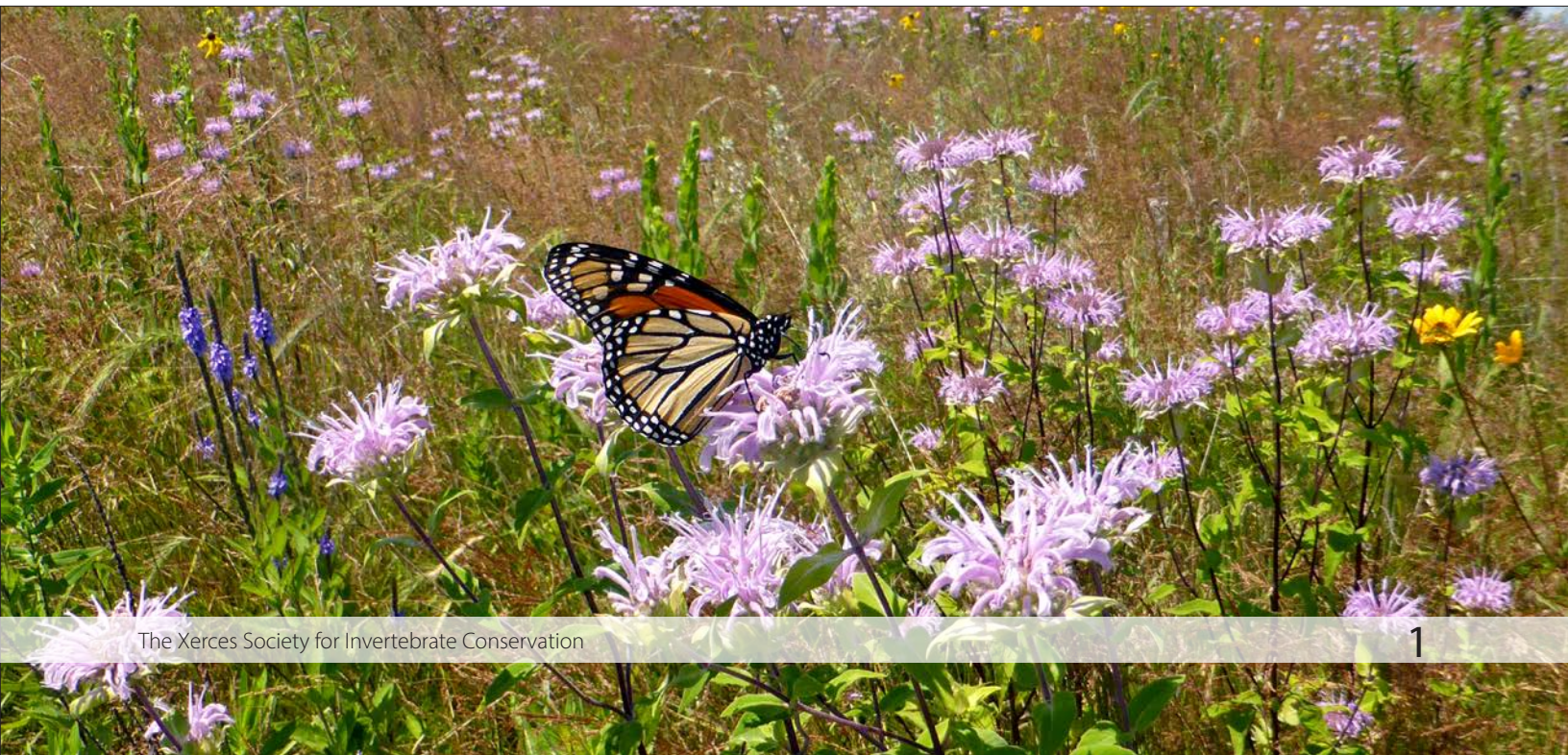
Importance of Long-term Management

Land managers, including farmers, are increasingly integrating pollinator habitat into farms to support pollinators and the crop pollination services they provide. These habitats, which typically consist of wildflower-rich meadows or field-borders, often require some level of ongoing management to maintain high flower diversity and abundance for foraging pollinators. Poor establishment, poor seed quality, effects of succession (e.g., woody plants begin to shade out wildflowers), overly vigorous native flowers, and invasion of weedy species can all degrade the plant community, requiring management action to improve the habitat for pollinators. When coupled with active monitoring, ongoing habitat management is an efficient use of time and resources, capable of detecting and preventing problems before they degrade plant communities and adversely affect the pollinator value of the habitat.

This guide is intended to facilitate management of wildflower habitat in the years after initial establishment. First, we discuss the characteristics that impact the pollinator value of planted wildflower habitat, and then we review the key steps in the management process. Next, we summarize the management tools most likely to sustain wildflower populations, which support bees and other pollinators, and finally, we provide diagnostic tools to help select appropriate management techniques for an array of potential habitat conditions. The management techniques described here are best suited to pollinator habitats in agricultural environments that range in size from 0.5–5 acres; they can be applied in other contexts, but additional factors, such as sensitive or rare species and regulatory requirements, should be considered in natural habitats that are not covered in this document.

Figure 1.1: It's important to include wildflowers with overlapping bloom times so there is continuous bloom from spring through fall in pollinator plantings in order to support diverse pollinators. For example, in the upper Midwest, an array of wildflowers provides nectar for monarch butterflies (*Danaus plexippus*).



2

Characteristics of Functional Pollinator Habitat

Before determining whether wildflower habitat requires management, it is helpful to know the conditions that best support pollinators. Functional pollinator habitat has multiple species of wildflowers that start blooming in early spring and continue through fall (exact timing depends on the region). Periods of bloom should overlap rather than leaving time periods when nothing is in bloom, also known as gaps in bloom. We define a gap in bloom as a two week period when there is less than 10% cover of blooming wildflower species. Different pollinators rely on different plant species; in order to support a robust pollinator community, wildflower habitat should contain a wide variety of native species present. Grasses (and flowering shrubs where regionally appropriate) are desired components in pollinator habitat. For example, grasses can provide vegetation structure, nesting or overwintering sites for pollinators and other wildlife, host plants for butterflies, fibrous root systems which diversify soil structure, help to buffer against weed invasion, and can be fuel for carrying prescribed burns which can benefit wildflowers. However, because some grasses can aggressively spread and eventually reduce wildflowers, the aim of managing for diversity is to limit their dominance.

Figure 2.1: This high value pollinator habitat in Minnesota provides diverse resources for bees, butterflies, and beneficial insects.

The key features of pollinator habitats that can support diverse, abundant populations of wild bees and other pollinators are:

- A diversity of desirable, pollinator-attractive plant species, with no single species dominant.
- Species that bloom in overlapping succession all season long (spring, summer, fall), with at least three species, ideally many more, blooming at any given time.
- Dominant plants are wildflowers (some weeds may be present, but they are not outcompeting wildflowers).
- Desired plant species persist over time.
- If unwanted weedy species are present, they are non-invasive and unlikely to compete with desirable species.

It can be helpful to set specific goals for the planting and refer back to them to ensure the planting is fulfilling its intended function. An example goal would be: wildflowers provide bloom throughout the growing season and weedy species cover is low

FIGURE 2.2: *Example* Pollinator Habitat Installation Plan

Example

POLLINATOR HABITAT INSTALLATION PLAN

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STEP 1—Habitat Installation Record

1. **Print a copy** of this form in advance (www.xerces.org/habitat-assessment-guides);
2. **Record all of the species** initially seeded into the site and any desirable native species remaining after site preparation BEFORE the first monitoring (i.e., during or immediately after planting); AND
3. **Save a copy** of your Plan to work from during each monitoring.

SITE NAME: Oregon Meadow **INSTALLATION DATE:** October 1, 2012

KEY SITE DETAILS that may impact wildflower establishment (e.g., weed pressure/species of concern, site history, soil characteristics, etc.):

Bindweed, plaintain, sorrel, and harding grass were removed from the site during using solarization, but will likely require additional management over time.

STEP 2—Site Preparation & Habitat Installation

Site preparation is **one of the most important** and often inadequately addressed components for project success. It is also a process that may require more than one season of effort to reduce competition from invasive, noxious, or undesirable plants prior to planting. *In particular, site preparation should focus on the removal of perennial weeds* (there are more options to address annual or biennial weeds after planting). For more information on recommended site preparation methods, see *Wildflower Establishment: Organic Site Preparation Methods* or other habitat installation guides available at: www.xerces.org/pollinator-habitat-installation-guides.

1 **Site Preparation Method(s):**	☑ Solarization	☐ Smother cropping	☐ Repeated shallow cultivation	☐ Sheet mulching
	☐ Soil inversion	☐ Organic herbicide applications	☐ Sod removal	
2 **Planting Method(s):**	☑ Broadcasting	☐ Drop-seeding	☐ Native seed drill	☐ Transplants
3 **Site Maintenance During Establishment:**	☐ Mowing		☑ Hand-weeding	☑ Spot-spraying
FOR DIVERSITY:		☐ *Seasonal mowing*	☐ Grass-selective herbicide	☑ Weed removal around site edges
		☐ *Rotational mowing*	☐ Conservation haying	☐ Irrigation
FOR WEED CONTROL:		☐ *Spot-mowing*	☐ Prescribed fire	☐ Grazing

STEP 3—Plant Selection

Individual species should be chosen to provide **consistent and abundant** floral resources throughout the year. In order to achieve this goal, **at least three species from each blooming period (early, mid, and late season), should be included. The best time for planting most species is in the late fall.** NOTE: *Transplants may be preferred when seed is not available, weed pressure is high, or when a particular species is difficult to establish by seed. Plugs are usually the most cost-effective container size for transplants.*

DESIRABLE SPECIES		IDENTIFYING CHARACTERISTICS				
# ✓	COMMON OR SCIENTIFIC NAME	DESCRIPTION (VARIETY/SUBSPECIES, COLOR, ETC.)	🔄	⚲	(Circle 1–3)	(Circle one)
1 ☐	California poppy (Eschscholzia californica)	4 petals, carrot-like leaves	A	A	🌱 ☀ 🍁	🌿 🌾 🌳
2 ☐	Globe gilia (Gilia capitata)	Purple, "ball"-like	A	C	🌱 ☀ 🍁	🌿 🌾 🌳
3 ☐	Farewell-to-spring (Clarkia amoena)	Pink, looks like a poppy	A	A	🌱 ☀ 🍁	🌿 🌾 🌳
4 ☐	Western yarrow (Achillea millefolium)	White, feathery leaves	P	C	🌱 ☀ 🍁	🌿 🌾 🌳
5 ☐	Bigleaf lupine (Lupinus polyphyllus)	Purple, legume, palmate leaves	P	C	🌱 ☀ 🍁	🌿 🌾 🌳
6 ☐	Oregon sunshine (Eriophyllum lanatum)	Yellow, daisy-like	P	C	🌱 ☀ 🍁	🌿 🌾 🌳
7 ☐	Douglas aster (Symphyotrichum subspicatum)	Purple, daisy-like	P	C	🌱 ☀ 🍁	🌿 🌾 🌳
8 ☐	Western goldentop (Euthamia occidentalis)	Yellow, small flowers	P	A/C	🌱 ☀ 🍁	🌿 🌾 🌳
9 ☑	Roemer's fescue (Festuca roemeri)	Cool season bunchgrass	P	R	🌱 ☀ 🍁	🌿 🌾 🌳
☐					🌱 ☀ 🍁	🌿 🌾 🌳
☐					🌱 ☀ 🍁	🌿 🌾 🌳
☐					🌱 ☀ 🍁	🌿 🌾 🌳

KEY: ✓ ANY ESTABLISHED desirable species not installed or part of the seed mix; 🔄 LIFE CYCLE: A (annual); B (biennial); P (perennial); ⚲ ABUNDANCE: A (abundant); C (common); R (rare); * (low performance/early successional); 🌸 BLOOM TIME: 🌱 (early/spring); ☀ (mid/summer); 🍁 (late summer/fall); FORM: 🌿 (forb/wildflower); 🌾 (native grass); 🌳 (woody tree/shrub)

Print copies of this and other forms at: www.xerces.org/habitat-assessment-guides. See Appendix B for a list of the available forms.

Overlapping Bloom

Many pollinators are only active during a portion of the growing season, while some forage throughout the entire growing season. During their flight periods, pollinators require a steady supply of pollen and nectar. A diverse community of pollinators is therefore best supported by wildflower habitat that contains numerous species with overlapping bloom periods. This is because gaps between bloom periods could force resident pollinators to abandon a site. We define a gap in bloom as a period of time when wildflower bloom is sparse or nonexistent (less than 10% cover of blooming wildflower species) for a two week period. Determining a gap in bloom can vary regionally. For example, wildflowers begin blooming as early as February in California, while bloom begins later in the spring—in March in the South/South Central states and around April/early May in the Midwest and East Coast. Some bloom expectations are consistent across regions: bloom should last until late October (under normal rainfall), when most of the pollinators have ceased activity in all regions.

(< 25%), with no problematic species present. It is also recommended to use the initial seed list to create a Pollinator Habitat Installation Plan (see Appendix B), which can later be used as a point of reference when monitoring and evaluating the habitat (see an example *Pollinator Habitat Installation Plan* on page 3). Ideally native species seeded into the site are well-adapted for the local site and weather conditions, and therefore expected to thrive. If so, then ask the following questions:

- Are all species planted present?
- Do wildflowers or weedy species dominate?
- Is a diversity of species present in each season?
- Are any problematic weed species present?

If answers to these questions indicate that wildflowers are not diverse and dominant in the habitat site, then management activities are likely necessary. The best way to determine if management activities are needed is through routine monitoring of the wildflower habitat.

3

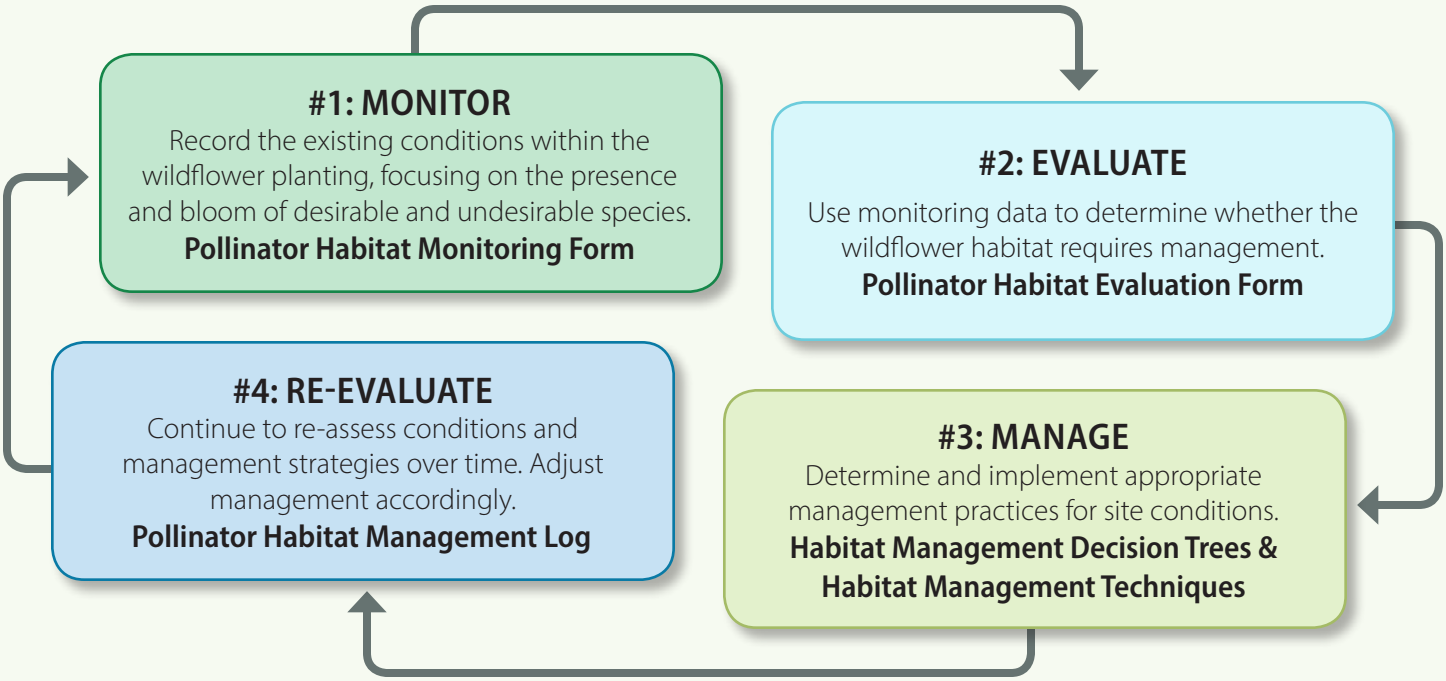
Management Process

In order to achieve the best management outcomes for the long term health of wildflower habitat and associated pollinators, we recommend taking an active management approach. Active management involves early identification of potential problems before they become major issues. For example, early detection and management of an incipient invasive weed is much easier than trying to control a large scale invasion. Active management can also help reduce costs, as re-starting a project is often more expensive than maintaining existing habitat. An active approach requires a low-level but consistent time commitment in which the land manager or land owner regularly monitors, evaluates, prescribes, and implements management activities to maintain their wildflower plantings.

Monitoring

It is important to routinely check wildflower habitat to ensure that the species planted are still present and providing abundant blooms. Monitoring at different times throughout the growing season is particularly important because it allows observation of conditions across different seasons and the

FIGURE 3.1: Procedure for Monitoring and Managing Habitat



detection of trends that can't be observed without repeat monitoring. For example, monitoring allows land managers to identify gaps in bloom and plan management actions to fill that gap (e.g., interseeding in subsequent years).

We recommend monitoring every 2–4 weeks from spring through fall. The timing and intensity of monitoring varies by region (for more information, see the *Regional Differences Table* on page 43). Many perennial species may not flower in the first year post-planting, while most annual species are early-successional species that disappear over time. Knowing which species should be present (consult the initial seed mix) can help with evaluation of whether the wildflower habitat is performing as expected. Over time, monitoring frequency can decrease, provided it is still possible to ensure that the habitat maintains its desired condition. We do recommend increasing monitoring intensity in the years following severe or unusual weather to ensure the community has not shifted towards undesirable conditions.

A few simple metrics can provide information on the status of the wildflower habitat and whether it is providing sufficient floral resources for pollinators throughout the year. These metrics include:

1. **Presence**—whether a specific species occupies a site, and at what density. We assign four categories that also denote the abundance of the species: Abundant, Common, Rare, Not present.
2. **Plant diversity**—the number of both planted (desired) and unwanted (weedy) species present.

Tracking each wildflower species over time can help to identify species that could potentially dominate the site or those in danger of disappearing. One easy way to do this is to use your original planting mix to keep track of the species planted within the site. It is also a good idea to note the presence and cover of unwanted weedy species to help determine when management is necessary. Use the *Pollinator Habitat Monitoring Form* (see example *Pollinator Habitat Monitoring Form* on pages 7–8) to record all species present. The plant diversity data can help identify if a variety and balance of species are providing pollen and nectar to bees, and will assist in the selection of specific management actions that can maintain conditions that foster wildflower diversity.

FIGURE 3.2: A red clover (*Trifolium pratense*) crop on both sides of the wildflower strip—outlined in white—provides additional food resources for pollinators, but also poses the risk of outcompeting native wildflowers over time. It is important to monitor the presence of red clover in the wildflower planting, evaluate if it is taking over, and prepare management actions to balance the plant community if diversity is a long term goal.

Figure 3.3: *Example* Pollinator Habitat Monitoring Form—Desirable Species

Example

POLLINATOR HABITAT MONITORING FORM

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STEP 1—Monitoring Record

1. **Print a copy** of this form in advance (www.xerces.org/habitat-assessment-guides);
2. **Record all of the species** initially seeded into the site on your Pollinator Habitat Installation Plan BEFORE first monitoring (i.e., during or immediately after planting); AND
3. **Bring a copy** of your Pollinator Habitat Installation Plan to refer to during each monitoring.

STEP 2—Site Details

SITE NAME: Oregon Meadow

CURRENT DATE: June 20, 2016

SEASON: ☐ Early (Spring) ☑ Middle (Summer) ☐ Late (Late summer/fall) ☐ Dormant (Winter)

DATE OF LAST MONITORING: May 28, 2016

STEP 3—Survey Desirable Species

We recommend monitoring once a month during the dormant season and every two weeks once the meadow starts blooming in spring. On sites with low maintenance needs—typically perennial plantings on established sites—we recommend monitoring at least 2× a year (in spring and late summer). For more information on suggested regional monitoring schedules, see Appendix A.

DESIRABLE SPECIES			SCORING				
#	Common or Scientific Name	Form (Circle one)	Blooming?*	×	Abundance†	=	Score
1	California poppy (Eschscholzia californica)	forb	blooming (1PT)	×	C (1PT)	=	1
2	Globe gilia (Gilia capitata)	forb	~~1PT / 0PT~~	×	N (0PT)	=	0
3	Clarkia (Clarkia spp.)	forb	blooming (1PT)	×	A (1PT)	=	1
4	Western yarrow (Achillea millefolium)	forb	blooming (1PT)	×	A (1PT)	=	1
5	Bigleaf lupine (Lupinus polyphyllus)	forb	blooming (1PT)	×	R (1PT)	=	1
6	Oregon sunshine (Eriophyllum lanatum)	forb	blooming (1PT)	×	R (1PT)	=	1
7	Douglas aster (Symphyotrichum subspicatum)	forb	blooming (1PT)	×	R (1PT)	=	0
8	Western goldentop (Euthamia occidentalis)	forb	vegetative (0PT)	×	A (1PT)	=	0
9	Roemer's fescue (Festuca roemeri)	native grass	vegetative (0PT)	×	R (1PT)	=	0
		forb / grass / woody	1PT / 0PT	×	A 1PT / C 1PT / R 1PT / N 0PT	=	
		forb / grass / woody	1PT / 0PT	×	A 1PT / C 1PT / R 1PT / N 0PT	=	
		forb / grass / woody	1PT / 0PT	×	A 1PT / C 1PT / R 1PT / N 0PT	=	
		forb / grass / woody	1PT / 0PT	×	A 1PT / C 1PT / R 1PT / N 0PT	=	
		forb / grass / woody	1PT / 0PT	×	A 1PT / C 1PT / R 1PT / N 0PT	=	
		forb / grass / woody	1PT / 0PT	×	A 1PT / C 1PT / R 1PT / N 0PT	=	
		forb / grass / woody	1PT / 0PT	×	A 1PT / C 1PT / R 1PT / N 0PT	=	
		forb / grass / woody	1PT / 0PT	×	A 1PT / C 1PT / R 1PT / N 0PT	=	
		forb / grass / woody	1PT / 0PT	×	A 1PT / C 1PT / R 1PT / N 0PT	=	
		forb / grass / woody	1PT / 0PT	×	A 1PT / C 1PT / R 1PT / N 0PT	=	
		forb / grass / woody	1PT / 0PT	×	A 1PT / C 1PT / R 1PT / N 0PT	=	
		forb / grass / woody	1PT / 0PT	×	A 1PT / C 1PT / R 1PT / N 0PT	=	
		forb / grass / woody	1PT / 0PT	×	A 1PT / C 1PT / R 1PT / N 0PT	=	
		forb / grass / woody	1PT / 0PT	×	A 1PT / C 1PT / R 1PT / N 0PT	=	
						Bloom Score TOTAL	5

KEY: FORM: (forb/wildflower); (native grass); (woody tree/shrub) · * BLOOMING: is the species CURRENTLY blooming or vegetative · † ABUNDANCE: A[1PT] (abundant ≈ 50%+); C[1PT] (common ≈ 10–50%); R[1PT] (rare ≈ <10%); N[0PT] (not present ≈ 0%) · SCORE: multiply BLOOM points by ABUNDANCE points

CONTINUED ON NEXT PAGE

Print copies of this and other forms at: www.xerces.org/habitat-assessment-guides. See Appendix B for a list of the available forms.

FIGURE 3.3: *Example* Pollinator Habitat Monitoring Form *continued*—Unwanted Species

Example

STEP 4—Survey Unwanted Species

#	UNWANTED SPECIES Common or Scientific Name	SCORING (Circle one)	(Circle one)		
1	Himalayan blackberry (Rubus armeniacus)	🌳	🌸	R	X
2	Bindweed (Convolvulus arvensis)	🌿	🌸	C	X
3	English plaintain (Plantago lanceolata)	🌿	🌸	R	
4	Giant foxtail (Setaria faberi)	🌾	🍃	R	
5	Wild oat (Avena fatua)	🌾	🍃	C	X
	TOTAL Unwanted Species				5

KEY — FORM: 🌿 (forb/wildflower); 🌾 (native grass); 🌳 (woody tree/shrub) • BLOOMING: is the species CURRENTLY blooming (🌸) or vegetative (🍃) • ABUNDANCE: A (abundant ≈ 50%+); C (common ≈ 10–50%); R (rare ≈ <10%); N (not present ≈ 0%) • ⚠ HIGHLY PROBLEMATIC SPECIES that requires immediate management action.

STEP 5—Calculate Species Diversity & Abundance

Tracking the levels of the desirable and unwanted species on a site over time will help to decide when management is necessary.

Desirable Species Total

STEP			A	C	R	TOTAL
1	PRESENT SPECIES	Tally present species by abundance (Calculate total number of species)	3	1	4	8
2	MISSING SPECIES	Count the number of species that are currently not present (Compare with *Pollinator Habitat Installation Plan*)				1
3	BLOOM SCORE	**CALCULATE TOTAL BLOOM SCORE (STEP 3)** (If the **TOTAL** Bloom Score is ≤2, record this date as a **GAP IN BLOOM** on the *Pollinator Habitat Evaluation Form*)				5

Unwanted Species Total

STEP			A	C	R	TOTAL
1	PRESENT SPECIES	Tally present species by abundance (Calculate total number of species)	0	2	3	5
2	MISSING SPECIES	Count the number of species that are currently not present but which were found on previous *Monitoring Forms*				1
3	BLOOM SCORE	**CALCULATE TOTAL HIGHLY PROBLEMATIC WEEDS (STEP 4)** (Highly Problematic species require immediate action—track actions taken on the *Pollinator Habitat Management Log*)				3

STEP 6—Repeat Monitoring

Regular monitoring is important during the establishment phase (years 1–5). Consistent data, collected every 2–4 weeks from spring through fall during the key establishment years (which varies regionally; see regional variation Appendix A), provides the best foundation for formulating management decisions. After the establishment time period, monitoring intervals can be increased. We do recommend periodic intensive monitoring every third year to ensure the habitat maintains desired conditions. Monitoring in years following severe or unusual weather can also help detect novel conditions that respond to the changing environment.

Notes:

Print copies of this and other forms at: www.xerces.org/habitat-assessment-guides. See Appendix B for a list of the available forms.

Figure 3.4: Wildflower bloom can shift rapidly in a short period of time, which is why it is it is important to monitor wildflower plantings regularly during the growing season—approximately every 2–4 weeks—in order to document species diversity and abundance over time.

Management

When deciding among management techniques, select practices that maintain the existing diversity while controlling weeds in the habitat. The Pollinator Habitat Decision Trees (pages 31–33) can help identify appropriate management technique for a variety of conditions commonly found in pollinator habitat. The timing of management actions is often critical to their success.

We recommend recording all management actions and outcomes in a *Pollinator Habitat Management Log* (see an example *Pollinator Habitat Management Log* on page 35). Recording information can help guide future management by logging whether a management action achieved the desired results and should be repeated in the future, or whether it needs to be altered in order to generate preferred outcomes.

Setting action thresholds for percent cover of weeds can help land managers determine when to take targeted management actions to reduce an unwanted species. Thresholds often vary by personal preference and by species of concern. For example, for a pernicious weed like musk thistle (*Carduus nutans*), a threshold of 5% cover may motivate management, whereas for a weedy species that is not particularly aggressive and likely to diminish over time—such as yellow foxtail (*Setaria pumila*)—a threshold may be higher, such as 25% cover, before action is warranted.

Re-evaluation

Habitat management is a long-term commitment and requires reassessment and adjustment in order to maximize success. Continued monitoring over time allows flexibility in adapting a management approach when new conditions arise or management actions do not have the intended effect. The data collected by monitoring provides a baseline for comparison of management strategies used (see example *Pollinator Habitat Management Log,* page 35). Repeated monitoring and review of past management actions will highlight potential problems quickly. For example, if targeted weed populations continue to increase, then different and/or more aggressive management is

Figure 3.5: This diverse wildflower prairie on an Oklahoma ranch is managed by annual mowing and an occasional prescribed burn to maintain wildflower diversity.

likely required. Remember that each site is different and may respond to techniques in a different way. Adaptive management can help to tailor habitat maintenance to the site's unique conditions.

Figure 3.6: Example Management Strategies Following Habitat Evaluation

Example Low Abundance Species Management

Consider interseeding bigleaf lupine into the site (Figure 3.6, #5). California poppy is declining, but because it is an annual, that can be expected and it can be allowed to drop out of the mix (#1). In the case of globe gilia (#2), we would recommend substituting a different species that blooms at the same time of year because it appears to be poorly suited to the site or doesn't compete well. For Douglas aster (#7), a perennial species, we would recommend interseeding and may even advise plug planting if multiple interseedings of Douglas aster are unsuccessful, as it offers great late-season pollen and nectar resources to pollinators and persists for several years.

Example Dominant Species Management

For native species with very high abundance, like western goldentop (Figure 3.6, #8), consider mowing a patch before it sets seed in order to reduce its abundance in the following year, providing the opportunity for other wildflowers to establish. It may be advisable to interseed following this management action if other wildflowers that bloom during the same time period are absent or present in very low numbers.

Example Gaps In Bloom

In this example, there are gaps in bloom in mid-March and in late September/ early October. We would recommend interseeding species whose bloom period would overlap the spring gap in bloom and others that help extend the season later in the year. Appropriate species will vary by region. See *Additional Resources* (page 41–42) for links to regional plant lists that can help with species selection.

Example Weed Management

When unwanted species reach a threshold level, in this case over 10% for all weedy species (Figure 3.6, circled), they should be aggressively targeted to reduce the potential that take over the site. This form also lets you see when management actions achieve their intended function. For example, management of non-native grasses in Year 3 led to decreased levels in subsequent years.

FIGURE 3.6: *Example* Pollinator Habitat Evaluation Form—Native Forbs

Example

POLLINATOR HABITAT EVALUATION FORM

XERCES SOCIETY for Invertebrate Conservation

Evaluating habitat monitoring results on a regular basis (e.g., annually) can help identify conditions and facilitate selection of management activities.

STEP 1— Organize Monitoring Records

1. **Print a copy** of this form in advance (www.xerces.org/habitat-assessment-guides).
2. **Gather all Monitoring Forms** from previous year.

STEP 2—Site Details

SITE NAME: Oregon Meadow

STEP 3—Desirable Species Persistance

Recording all the species initially seeded into the site and their abundance over time can help determine whether they are persisting, or are in danger of either disappearing or taking over the meadow. Use this information to determine when a management action is necessary.

NATIVE FORBS

Use the Pollinator Habitat Monitoring Forms to determine whether each native forb species is present year after year and estimate average abundance (use the record from the middle of the species' bloom period) in order to indicate if a species has low or high abundance and requires action:

1. **LOW ABUNDANCE Species Management**—Highlight species that are expected to be **A** (Abundant) or **C** (Common), but were found to be **R** (Rare) or **N** (Not Present) at least two years in a row or **R** species that were **N** for multiple years. Only wildflower species not present for more than three consecutive years should be considered to have disappeared (some may lie dormant for a brief period, then suddenly return). **NOTE:** in exceptionally diverse plantings (common in some regions like the Midwest), many species will be **R** for the lifetime of planting; **OR** some annual species that are early successional are expected to disappear over time and do not need to be re-seeded if other high value perennial species are present and abundant.
2. **HIGH ABUNDANCE Species Management**—Mark species that are **A** for multiple years in a row. If the abundance of a native species increases consistently over time and maintains high numbers, it may limit the presence of other species. Consider management actions to reduce its population (e.g., disking, hand-weeding, or spot-spraying herbicide).

BLOOM TIME—Circle the average bloom season of each species in your planting: (early/spring); (mid/summer); (late summer/fall).

DESIRABLE SPECIES			SPECIES ABUNDANCE BY YEAR				
#	Common or Scientific Name	(Circle 1–3)	2013	2014	2015	2016	20__
1	California poppy (Eschscholzia californica)		*A	C	C	C	
2	Globe gilia (Gilia capitata)		C	N	R	N	
3	Clarkia (Clarkia spp.)		A	C	C	A	
4	Western yarrow (Achillea millefolium)		C	C	C	C	
5	Bigleaf lupine (Lupinus polyphyllus)		C	C	R	R	
6	Oregon sunshine (Eriophyllum lanatum)		C	C	C	C	
7	Douglas aster (Symphyotrichum subspicatum)		C	C	C	R	
8	Western goldentop (Euthamia occidentalis)		*A	*A	*A	A–C	

GAPS IN BLOOM					
1. Record sampling dates with a TOTAL Bloom Score of ≤2 in the appropriate column by year (this information can be found in Step 3 or 5 of the *Pollinator Habitat Monitoring Forms*).			3/20	3/28	
2. Compare these dates with the average predicted Bloom Times to identify gaps in bloom greater than two weeks—potentially caused by low abundance or a lack of species diversity during certain times of year—that should trigger management actions.				9/29	

CONTINUED ON NEXT PAGE

Print copies of this and other forms at: www.xerces.org/habitat-assessment-guides. See Appendix B for a list of the available forms.

FIGURE 3.6: *Example* Pollinator Habitat Evaluation Form *continued*—Unwanted Species

Example

STEP 3—Desirable Species Persistance *continued*

NATIVE GRASSES

Native Grass Management—Using the *Pollinator Habitat Monitoring Forms*, determine whether each native grass species is present year after year, then estimate average abundance throughout the year in order to determine if a species requires management, and circle any species that have reached a threshold amount. Track these species to ensure that their populations remain under the levels you deem acceptable.

DESIRABLE SPECIES		SPECIES ABUNDANCE BY YEAR				
#	Common or Scientific Name	2013	2014	2015	2016	20__
1	Roemer's fescue (Festuca roemeri)	R	C	C	R	

STEP 4—Unwanted Species Persistance

Keeping track of the levels of weedy species present will help to decide when management is necessary. We recommend setting a threshold level that weed populations should not exceed. When weeds get to those levels, it should trigger a management action.

WEEDS, NON-NATIVES, INVASIVE SPECIES, ETC.

Weed Management—Using the *Pollinator Habitat Monitoring Forms*, determine which weedy species are present year after year and which species are Highly Problematic in order to determine if a species requires management. Circle any species that have reached a threshold amount or require immediate action. Track these species to ensure that their populations remain under the levels you deem acceptable. Many weed species are easy to control when their populations are low, but can quickly take over a site, necessitating re-starting when their numbers get too high.

UNWANTED SPECIES			SPECIES ABUNDANCE BY YEAR				
#	Common or Scientific Name	(Circle one)	2013	2014	2015	2016	20__
1	Himalayan blackberry (Rubus armeniacus)		R	R	N	R	
2	Bindweed (Convolvulus arvensis)		R	R	C	R	
3	English plaintain (Plantago lanceolata)		N	R	N	N	
4	Dock/sorrel (Rumex spp.)		R	R	R	N	
5	Giant foxtail (Setaria faberi)		R	C	C	R	
6	Wild oat (Avena fatua)		R	C	C	R	

KEY: FORM: (forb/herbaceous); (grass/sedge/brome); (woody tree/shrub) — ABUNDANCE: A (abundant); C (common); R (rare); N (not present)

Notes:

Print copies of this and other forms at: www.xerces.org/habitat-assessment-guides. See Appendix B for a list of the available forms.

4

Management Strategies

The goal of long-term management is to maintain a high diversity of bloom across seasons, with managable weed pressure. In order to maximize management effectiveness, it is important to use the appropriate tools, and to schedule management actions to be implemented at a time when they are likely to have the highest impact. Timing of techniques varies by region (see *Regional Differences Table*, page 43), but is often connected to growth stages of unwanted weedy plants, which may change annually given local weather conditions. Paying close attention to the critical time periods when weeds or other dominant species are growing, flowering, and setting seed will help guide the timing of management activities to best control problematic species.

Some management actions can negatively affect some wildlife, including pollinators. For example, mowing or haying during the bloom period of wildflower species can remove needed flowers and may also harm pollinators and other insects nesting and feeding in the habitat. It is best to spread ongoing management across several years, trying not to disturb more than one third of the managed area at any one time. Pollinator plantings are also excellent habitat for ground nesting birds; therefore, management should avoid disturbing nesting birds when possible. Nesting dates generally range from mid-late spring to late summer, depending on the region, and are available from state wildlife agencies or your USDA NRCS field office.

I. MOWING

Mowing is consistently rated as one of the most effective management tools for increasing or maintaining the diversity and density of forbs. Mowing can be also used to control weeds and limit the encroachment of unwanted woody plants. Timing of mow events determines whether mowing is more effective for maintaining wildflower diversity (Section A) or providing weed control (Section B).

FIGURE 4.1: Many desirable perennials are slow-growing and will tolerate mowing—like this gumweed (*Grindelia* sp.) seedling, shown here seven days after a mow event.

FIGURE 4.2: Pollinator habitat can be ideal nesting habitat for ground-nesting birds and other wildlife. In order to avoid disturbing ground-nesting wildlife, management should be timed to avoid nesting dates.

A. Mowing for Diversity

Mowing for diversity can involve: mowing seasonally (i), mowing rotationally across seasons and across different areas of the pollinator habitat (ii), or coupling these two mowing strategies.

i. *Seasonal Mowing*

In many cases a single mow event can help maintain wildflower diversity and persistence. Timing of mowing can be targeted to reduce abundance of a dominate species, or to reduce litter and aid wildflower seed dispersal. To reduce the cover of dominant species (either planted or unwanted), mow when the plant is most vulnerable, during active growth prior to bloom or before seed set. This action can help limit new growth the following year, and create space for other species to grow. A mow event in the fall can help break down senesced stems and leaves, and to spread wildflower seeds. Fall mowing also targets woody species that can invade pollinator habitats. Litter removal can complement mowing by removing build-up of materials that can limit wildflower germination and growth (see *Litter Removal*, sidebar).

Flail mowing is an effective mow method, as it results in small pieces of vegetation which typically break down quickly. Place the mow bar at a high setting (at least 12" above the soil) to avoid disturbing bumble bees that may be nesting in the area. Available equipment can affect mowing frequency, particularly when the goal of mowing is to reduce woody invaders in the habitat area (e.g., mow less frequently if using a brush hog and more frequently if using a weed-eater).

ii. *Rotational Mowing*

Mowing patches of habitat at different times of the 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, potentially increasing 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 the timing of mowing in each area 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 the time period that has the largest impact on the target species for several years until the target species has significantly decreased.

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-seed 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.

B. Mowing for Weed Control

Mowing can also be used to manage weedy vegetation growing in pollinator habitat. Establishment mowing, mowing to control weeds regularly during the first one to two years after intial seeding is common in regions where most wildflower species in pollinator habitats are perennials (e.g. Midwest, Northeast, Mid-Atlantic). Beyond establishment, mowing typically targets weedy species prior to seed set. By mowing weeds before they set seed, the weed seed bank can be greatly reduced. This technique is especially effective for eradicating annual weed species. When mowing to control a perennial weed species, mow events may need to occur multiple times during critical plant growth stages to reduce seed set and plant vigor. If an unwanted weed species is distributed throughout the habitat and the best time to target it is during the bloom period of planted wildflower species, we recommend only mowing ⅓–⅕ of the habitat at any given time or considering a different management strategy for the target weed species.

Mowing for weed control is easiest to implement either when weedy species have grown taller than wildflower species or when weeds only occur in specific areas. For example, in western regions, many cool season weeds grow significantly taller than wildflowers very early in the spring, so a carefully timed high-mow can manage weeds with minimal harm to wildflowers growing underneath. In cases where weeds are not taller than the wildflowers, focusing only on trouble-spots and/or avoiding mowing while wildflowers are blooming is recommended, except in regions where mowing during the first few years of establishment is recommended (see *Regional Differences Table*, page 43).

It is important to be familiar with the characteristics of target weeds. Like wildflowers, some weed species will set seed lower to the ground when mowed and may need to be eradicated through hand-weeding or other management methods. Other weed species—including bindweed (*Convolvulus* spp.) and mugwort (*Artemisia* spp.)—are stimulated by mowing, thus mowing is not advisable as a control method when they are present.

Litter Removal

Litter (undecomposed plant material) can reduce light penetration to the soil and limit the ability of new wildflower seeds to germinate and grow. Litter removal can favor wildflower communities by removing excess nutrients, especially in formerly cropped lands, because many native plant species thrive in nutrient-poor environments. High soil fertility can promote non-native species, especially during the early stages of habitat establishment. Mowing can help facilitate decomposition and reduce litter build up, although additional removal of litter with a rake is sometimes necessary. A hay rake, tedder tractor attachment, or hand rake can help clear the area. Conservation haying (Section VI) is another method that removes excess litter. If significant litter continually occurs in the site, consider a prescribed burn (See Section *VII. Prescribed Fire*).

Figure 4.3: Mowing can be an excellent way to encourage wildflower diversity and reduce cool season weeds when timed correctly—as in this site in California, which was mowed in early spring before the perennials had begun blooming.

When mowing non-native grasses, determining whether they are annual or perennial, and warm or cool season can help inform management timing. Target cool season perennials in the early spring and again in the fall if they resume active growth (typically triggered by a moist fall or cooler fall temperatures.). Cool season annuals need to be mowed before they set seed early in the spring. Many cool season annuals are considered winter annuals—they germinate in fall, overwinter as a rosette (low-lying leaves) and flower in the early spring. Mowing should target the flowering stems in the spring.

Warm season annual and perennial forbs can both be targeted in the late spring, with mowing timed before flowering. However, mowing is not particularly effective for eradicating warm season perennial grasses. Repeated mowing will generally favor grasses over forbs, therefore it is generally not an effective standalone method for perennial weed control. Instead, combine mowing with a grass-selective herbicide treatment. We recommend mowing, waiting for regrowth, then spraying the unwanted species.

FIGURE 4.4: Weed-eaters are effective for spot-mowing because they allow users to target small patches of weeds that are mixed in with desirable plants.

FIGURE 4.5: Hand-weeding is often the most effective way to remove weeds without harming desirable species, although it can be time-consuming in large sites.

i. *Spot-mowing*

When weeds are clumped together, spot mowing may be an option. A weed-eater (a.k.a. string-trimmer, 'weed whacker') is the recommended tool for spot mowing. A tri-blade is most effective at cutting thick stemmed weeds or small woody stems—e.g., invasive thistles or Himalayan blackberry (*Rubus armeniacus*)—while string is best for thin-stemmed weeds like annual grasses and mustard (*Brassica* spp.). Follow all safety guidelines when operating weed-eaters. Time spot-mowing so that unwanted plants are cut back before they set seed. Weed-eaters can also be used to mow around the site edges (*Section V*).

II. 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. We

recommend wearing gloves and long sleeves to protect 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 resprout 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.

III. SPOT-SPRAYING

Spot-spraying refers to 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. Spot-spraying can also result in bare patches; we recommend interseeding into large areas that were sprayed after the herbicide residues have dissipated. Information on residual periods of herbicide residue can usually be found on the product label.

It is important to follow the instructions on the label when applying herbicides. Most weedy species should be targeted during their active growth phase. We do not recommend using herbicides on weeds when they are in bloom, because weeds are least susceptible to herbicides during the flowering stage and because such spraying could expose pollinators to harmful chemicals. In addition, avoid any herbicide that is toxic to bees (e.g., paraquat and gramoxone). Sources of information about herbicide toxicity to pollinators are listed in the *Additional Resources* at the end of this document. Guidance on active ingredients that target non-native or invasive weeds and appropriate application timing is usually available from statewide Invasive Plant Councils (e.g., California Invasive Plant Council) or extension agencies. Certified Crop Advisors can also provide assistance with application rates and timing.

FIGURE 4.6: Many conservation programs spot-spray invasive or noxious weeds to avoid disturbing adjacent established native plants—like the Glacier Exotic Plant Team is targeting Canadian thistle and bindweed while avoiding milkweed and globemallow (left), or herbicides are applied as added insurance against invasive woody species in northern tallgrass prairie restoration (right).

IV. GRASS-SELECTIVE HERBICIDE

If non-native grasses are a major weed threat, then grass-selective herbicide may be an appropriate treatment option. Grass-selective herbicide treatments are most effective during the early plant growth phase—not during flowering—when grasses are small (typically <6" tall). It is often necessary to spray multiple times throughout the year to target both warm and cool season grass species. Be aware that grass-selective herbicides can damage forbs if they are applied at high rates or applied multiple times over a short period. Most forbs are able to recover, but may show signs of herbicide damage. If well-established native bunch grasses are present, grass-selective herbicides can still be used, as vigorous perennial native grass stands often recover from a single herbicide treatment. However, recently planted native grasses can be eradicated by the use of grass-selective herbicides. If non-native grasses are known to be a major issue at the site, consider seeding only forbs in the initial planting to allow the use of grass-selective herbicides. Native grasses can be interseeded in the future following successful grass-selective herbicide treatment. Be aware that some grass-weeds—like annual ryegrass, (*Lolium multiflorum*)—appear to be resistant to grass-selective herbicides; other removal strategies will be required when targeting those species. Make sure to follow all directions on the label when applying herbicides.

V. WEED REMOVAL AROUND SITE EDGES

When site preparation has been successful, weeds within pollinator habitat may be minimal, but weeds surrounding it could invade from the edges. To combat weeds around pollinator habitat we recommend managing site perimeters through mowing, herbicide application, mulching (best for smaller sites), or a buffer of native bunch grasses. It is likely that weed management will need to occur multiple times throughout the year to target weeds present in different seasons. When mowing outside the site, set the mower bar to the lowest level without it touching the ground. Time mowing to just before or immediately after flowering of unwanted forbs; annual grasses should be mowed prior to seed production. Perennial grasses can be regularly mowed throughout the year to prevent seed production, limit their spread, and reduce their vigor. If there are low-growing or creeping invasive plants on the edge—such as birdsfoot trefoil (*Lotus corniculatus*)—we do not recommend mowing. Instead, hand weeding or spot spraying may be appropriate.

If spraying herbicides to control weeds in the perimeter of a habitat area, take special care to ensure that herbicides do not drift off target and kill wildflowers. In addition, do not spray any weeds

FIGURE 4.7: Established sites may need weed management around the edges—outlined in white below—where undesirable plants can be removed by mowing or targeted herbicide applications.

that are in bloom, as this poses a risk to pollinators. If combating nearby weeds with herbicides, consider a long term strategy such as expanding the existing habitat to encompass the problem areas, if the adjacent area contains suitable conditions for wildflowers (e.g., flat terrain that is not frequently driven over). If mulching the borders of a planting, apply weed-free mulch (e.g., straw or wood chips) on an annual basis. If weeds penetrate the barrier, hand-weeding or herbicide applications may be needed. Another option is to plant a buffer of native bunch grasses around wildflower habitat that can be mowed or weeded regularly to help resist weed invasion from the outside edges. If space permits, mulch can also be applied around the native grass border to extend the width of the buffer around the habitat area.

VI. CONSERVATION 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 litter is removed from the site. As such, haying can be even more effective than mowing at promoting wildflowers because excess nutrients are removed, promoting soils that favor desired plant communities in place of 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) during daylight in order to give pollinators and other wildlife more time to disperse. Use of a flushing-bar on the mower may 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

Figure 4.8: Conservation haying reduces light competition from tall grasses by allowing spring-blooming flowers and other short-statured plants to thrive, and it may also help bees to more easily find these resources. Above, a strip of spring-blooming wildflowers is no different from the surrounding area except that it was hayed in the previous fall. The 85 ac site in Minnesota below shows conservation haying on a larger scale—a mosaic of 5–10 ac hayed and unhayed treatment plots has been established, such that only a portion of the site is hayed in any given year.

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 if the soil surface is visible. This will help mitigate the loss of natural seed drop by wildflowers that are cut during the haying process.

VII. PRESCRIBED FIRE

Prescribed fire can be used to manage 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 litter, suppress woody species, release nutrients, open space for new growth, stimulate germination of some seeds, enhance flowering, and reduce weedy competition. Fire can be an effective tool for combating invasive plants 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—examples include cogongrass (*Imperata cylindrica*), cheatgrass (*Bromus tectorum*), and Chinese bushclover/ sericea lespedeza (*Lespedeza cuneata*).

The timing of a prescribed burn influences its impact on the plant community. For example, burning during the late winter season can stimulate cool-season grasses and spring wildflowers. Spring burns tend to suppress cool-season grasses and invigorate warm-season grasses, while summer fires are most efficient at controlling woody species, such as red cedar (*Juniperus virginiana*). Fall burns can stimulate wildflowers the following growing season.

Many pollinators are vulnerable to the effects of fire. We recommend splitting the site into three to five sections, with the aim of burning one section per year. This ensures refuge for wildlife and supports quicker recolonization of previously burned areas. Refuge from fire also helps sustain healthy populations of pollinators and natural enemies of crop pests close to crop fields.

FIGURE 4.9: Prescribed fire can be highly effective for managing native plant populations to favor wildflowers over aggressive grasses and woody species—here the Michigan Department of Natural Resources and The Nature Conservancy conduct an annual burn to preserve habitat for the endangered Karner blue butterfly (*Plebejus melissa samuelis*).

Prescribed burns 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 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. These plant groups are green (less flammable) from spring through fall, during which most burns take place.

VIII. GRAZING

Selective grazing can be used to help suppress dominant grasses (native and non-native) and maintain wildflowers in pollinator habitat; however, improperly managed grazing also can reduce or eliminate wildflower cover. Grazing may not be right for every site; for example, balancing grazing requirements and appropriate stocking rates on small sites can be difficult, and sites with unprotected waterways or many steep slopes may be unsuitable for grazing. A light to moderate stocking rate—depending on the site—helps ensure that livestock are primarily eating grasses and not overgrazing a site. 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 adaptive management with light to moderate stocking rates.

Before choosing grazing as a management strategy, it is important to check the palatability of the species in your planting. If the wildflowers you want to promote are highly or moderately palatable, grazing may not be the most appropriate tool to increase their abundance. 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 (see *Additional Resources: Grazing*).

Cattle or bison are the preferred grazing livestock in pollinator habitat dominated by grasses

FIGURE 4:10: Cattle grazing around various native wildflowers—including boneset (*Eupatorium* spp.) and blue lobelia (*Lobelia siphilitica*).

FIGURE 4.11: When properly managed at a low stocking rate, cattle grazing is a highly efficient method for reducing grasses from pollinator habitat.

because, at low stocking rates, they generally prefer grasses over wildflowers. However, cattle especially find many wildflower species highly palatable—such as prairie clover (*Dalea* spp.). If your habitat has high wildflower density, cattle grazing may not be the preferred management tool to maintain diversity. Goats and sheep are less selective grazers and will consume both wanted and unwanted species; they are therefore less preferred grazers for pollinator plantings but may be used to graze for weed or brush control.

A. Rotational Grazing

There are many rotational grazing systems. When designing a rotational grazing system that will benefit pollinators, maintaining stocking rates and rest periods that allow wildflowers to bloom throughout the growing season is essential. Consider splitting the site into three to five segments that are grazed at different times and with varied intensity and duration across years. Create patchy vegetation structure by maintaining grazed areas, areas that are recovering from grazing, and refuge areas free from grazing for an entire season to provide a variety of habitats for pollinators and other invertebrates.

B. Patch-Burn Grazing

One method to utilize both prescribed fire and grazing is patch-burn grazing. Typically, ⅓ to ⅕ of the site is burned each year and no interior fencing is used to direct grazing. With a light to moderate stocking rate, this results in heavy grazing pressure in the most recently burned area, some grazing in areas burned the previous year and very little grazing pressure in areas burned two or more years ago. This variance in grazing pressure creates areas of differing vegetation height, litter cover, and bare ground on the same management site. Patch-burn grazing can increase abundance of any unpalatable wildflowers as livestock preferentially consume new growth. If livestock are grazing the most recently burned site to a uniform short height (there are not taller wildflowers standing among short grazed grasses), consider decreasing the stocking rate for the entire pasture.

C. Grazing for Broadleaf Weed Control

Grazing can be an effective tool to remove some populations of broadleaf invasive weeds. For example, goats are increasingly being used in the Midwest to manage invasive buckthorn (*Rhamnus* spp.) shrubs, as well as Canada goldenrod (*Solidago canadensis*), a native wildflower that often dominates wildflower plantings and can require management to set it back so that other species can thrive. Typically, areas with a high density of weedy species are fenced in and grazed intensely when the weed species is vulnerable (actively growing). Preventing weed seed set is important and multiple years of control or stacking methods of control (e.g., grazing followed by herbicide) may be necessary to exhaust the existing seed bank and to adequately eliminate perennial weeds in an area. Interseeding areas of previous dense weed populations may be necessary after control.

IX. REINTRODUCING WILDFLOWER DIVERSITY

A. Interseeding

Interseeding is the addition of seeds to a site while maintaining some or all of the existing vegetation. It is used to restore species that have been lost from the site, or introduce new species not originally

included. Interseeding can address the following issues: restore wildflowers to a grass dominant site, fill a gap in bloom, add a critical species (e.g., milkweed that support monarchs), or provide a seed bank to fill in after weed eradication leads to exposed or disturbed patches of soil.

In many landscapes, suppression of dominant vegetation and litter removal is necessary before interseeding. Grazing, mowing, haying, prescribed burning, chemical control, or a combination of these techniques prior to interseeding and again after interseeding, can maximize wildflower establishment and persistence. Time the vegetation suppression techniques to stress the dominant vegetation at its most vulnerable stage (i.e., actively growing and at, or near, flowering). For example, a site dominated by cool-season grasses should be disturbed in the spring and fall before a dormant interseeding and ongoing management should continue to emphasize disturbance during those periods.

Species selection for interseeding depends on the existing plant community. If the existing vegetation is missing one or multiple plant guilds typical of a healthy plant community in the region (e.g., warm- and cool-season grasses, sedges, wildflowers), aim to restore those guilds through interseeding. Native species that are easily established and will persist are the best choice for interseeding. Interseeding rates should be 25% higher than accepted seeding rates for restorations in the region. Many wildflower species require a period of cold and moist conditions to break dormancy and the best timing for interseeding is before or during periods of regional precipitation (e.g., during the monsoon season in the southwest or during the winter dormant season in the west). If the climate permits, snow seeding is another option (see *Snow Seeding*, sidebar). If site preparation has suppressed existing vegetation and removed litter, broadcast interseeding followed by rolling with a cultipacker is an effective approach. If some litter remains, or broadcast seeding isn't appropriate, an accurately calibrated and carefully operated native seed drill (planting no deeper than ¼") can also be used for interseeding.

In the first growing season following interseeding, new seedlings will emerge in and

Snow Seeding

Snow seeding is an option for interseeding during the dormant season in cold climates. Because seed is broadcast on top of snow, it easy to see seed coverage and achieve even distribution of seed across the site (Figure 4.12a). A light cover of snow of just a few inches is preferred to heavy snow since the seed must work its way through the snow to reach the soil. Before snow-seeding, check the weather to make sure that heavy rains are not expected in the near future—since rain or rapid snow melting could cause the seed to wash around (or off) the site before it has found its way to the soil. Snow seeding can be done by hand, with a belly crank, or a broadcaster (Figure 4.12b).

Figure 4.12a: Seed Distribution on Snow

Figure 4.12b: Broadcasting Seed on Snow

Figure 4.13: This California pollinator meadow features numerous native wildflower species with overlapping bloom times to support pollinators throughout the growing season. In order to maintain a diversity of bloom over time, the site was mowed and interseeded with additional high quality wildflowers in November 2015

amongst existing vegetation. This highly competitive environment can limit seedling establishment. Management to reduce this competition can promote the establishment of newly interseeded species. If established wildflower species won't be harmed, mowing vegetation to a height of 4–6" can increase sunlight to the seedlings and increase their success rates. If the existing vegetation is composed mostly of grasses (whether native or non-native), multiple cuts above the height of the seedlings will likely be needed.

B. Plug or Bare Root Planting

In small areas or in small, unique habitat areas (e.g., a wet slough among a larger grassland site), using plugs or bare roots plants to increase diversity is an option. Some plant species don't germinate reliably from seed in field settings when planted in a seed mix—such as vinegar weed (*Trichostema lanceolatum*). Other species have a better chance of survival when they are planted from a container than when planted from seed—such as some milkweed species (e.g., *Asclepias sullivantii*) or some blazing star species (e.g., *Liatris spicata*). Using transplants provides these difficult-to-establish species an opportunity to develop a strong root structure and compete with other species in diverse systems. Plugs are often the smallest size container available, making them the most affordable option. In arid climates, plugs are best planted in the fall with the rains; in other regions, they can be planted during the growing season, timed with rains, such as spring or fall (see *Regional Differences Table*, page 43). Avoid transplanting in summer during periods of extreme heat as this can lead to plant stress and limit successful establishment. It may be necessary to water for one to two years after planting plugs, depending on precipitation in your region.

X. IRRIGATION

We recommend planting native, locally adapted species that are drought-tolerant. Nevertheless, when areas experience severe drought, water scarcity can decrease the survival and establishment of drought-adapted species. Providing just enough water to mimic 'normal' rainfall patterns (i.e., winter in California, monsoons in the southwest) during drought years can greatly improve wildflower germination and persistence. Irrigation is most critical in drought-prone regions during the initial

establishment phase (typically one to three 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^2. 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.

Figure 4.14: Installing drip-tube irrigation to help establish plant plugs , which benefit from supplemental irrigation during establishment, in a Minnesota pollinator planting.

Figure 4.15: In some areas, such as California, irrigation may be necessary to establish new wildflower plantings from seed and should be included in the planning and installation phases of a project.

XI. STARTING OVER

Hopefully following the advice in this guide will help to avoid situations in which starting over is necessary. In some cases, such as when initial weed control at a site was inadequate, restarting the project by implementing intensive, non-selective weed control might be the best solution. If re-starting, it is a good

idea to complete a year of weed control prior to seeding, to control the major issues that led to the need to start over. We recommend initiating site preparation by May (at the latest) the year of intended re-planting. One growing season of intensive weed management using techniques such as chemical fallow or solarization is usually sufficient. If the mix is high in wildflowers that require stratification, then planting in the fall or winter (after October 15th) is generally more successful than a spring planting. For guidance on weed control prior to establishment of pollinator habitat, as well as habitat installation recommendations, see the Xerces Society/NRCS series of establishment guides (see *Additional Resources: Re-starting Habitat*).

If some wildflower species are thriving, consider saving their seeds the year prior to re-starting a project to reduce the cost of seeds when replanting. Different species need to be harvested at different times, and usually require cleaning prior to storing. Make sure to store them in a cool, dry place. Adding silica packets can help prevent buildup of excess moisture. Some seeds respond best to stratification, or storage in a cold environment, such as a fridge. If new seeds are purchased, they can be sown in fall prior to frosts, which provide natural stratification. Seed mixes with high percentages of seeds requiring stratification that are seeded in spring tend to perform less well than if seeded in fall, unless they are placed in cold storage before sowing. For information on seed saving, cleaning and storage, we recommend reviewing regionally available guides (see *Additional Resources: Seed Saving*).

XII. EXTREME WEATHER CONDITIONS

Extreme weather, including droughts and flooding, is becoming more prevalent. Extreme weather can test the ability of even the most proactive manager to maintain wildflower diversity and abundance within a site. We recommend increasing monitoring frequency in the years following an extreme event in order to track and manage novel undesirable conditions.

In multi-year droughts, seeds may lie dormant and their viability may be reduced over time (See *Section X. Irrigation*). Floods can scour a site, removing seed from the seed bank. When floods occur, it might be necessary to add seeds or plugs in subsequent years (See *IX. Reintroducing Wildflower Diversity*). Floods can also introduce seeds of weedy species, thus monitoring for new weedy species after a flood can help prevent new problems. If seasonal flooding is known to be a common occurrence, including flood-tolerant species in the initial seed mix can help habitat withstand inundated conditions. Installing erosion/ scour resistant materials over the seed bed can help retain seeds if flooding becomes a frequent occurrence.

While none of the sites we have worked on have been affected by wildfire, fires are becoming increasingly common, particularly in the arid west. As described above, fire can facilitate the germination of wildflowers. In the case of severe fire, however, it is important to monitor in the following year to observe changes in site conditions. Re-seeding or adopting different management techniques to address altered conditions may be necessary following a burn.

5

Deciding Which Management Technique to Use

Identifying Conditions

Data collected from routine monitoring will help to identify the conditions present in the pollinator habitat. See Table 5.1 for a list of the most common conditions we've observed in native wildflower meadows. Decision Trees 1–3 provide additional assistance for identifying the condition of your meadow and determining which management techniques to use over time. After initial establishment, planted pollinator habitat often follows one of these common trajectories:

High Diversity of Bloom

The goal of a pollinator habitat planting is a diversity of bloom across seasons with minimal/manageable weed pressure. Some plantings maintain their intended function and plant community structure without much intervention, while others may lose one or many species. Species losses can create gaps in bloom that need to be filled in order to attract and maintain pollinators throughout their foraging season, which can last 4–6 weeks for solitary species with a single generation and many consecutive months for social species or species with multiple generations per growing season. A less frequent condition occurs when one or a few desirable plants grow to dominate the habitat, such as native bunch grasses or a vigorous wildflower species, such as goldenrod (*Solidago* spp.). These dominant plant species will compete with other native species and can eventually prevent the habitat from supporting a diverse

Figure 5.1: This pollinator habitat in Virginia provides late-season bloom through the inclusion of long-blooming wildflowers, such as blanketflower (*Gaillardia* spp.) and black-eyed Susan (*Rudbeckia hirta*).

Figure 5.2: Weedy radish (*Raphanus* spp.), prickly lettuce (*Lactuca serriola*), and mallow (*Malva* spp.) are intermixed with desirable native wildflowers like lupine (*Lupinus* spp.) and baby blue eyes (*Nemophila menziesii*) in this pollinator planting, requiring targeted weed management.

array of flowering plants, as well as their associated pollinators. If vigorous native plants dominate the habitat, light management may facilitate conditions that foster a high diversity of native wildflower species.

Mixture of Desirable and Unwanted Plants

In some circumstances, unwanted species may co-exist with desirable planted species as a patchwork, with weeds dominating in some areas and wildflowers in others. Alternately, weeds may be intermixed with desirable species. These scenarios present different management challenges. In plantings with patchy areas, it is possible to manage weeds intensively without worrying about damaging adjacent wildflowers (i.e., spot-mowing). Interseeding with additional wildflower species is often necessary, however, to fill in the disturbed area after management and repel new unwanted species from taking hold. In plantings where weeds and wildflowers are interspersed, more targeted weed management (e.g., hand-weeding or spot-spraying) is often best.

Defining a Diversity of Bloom

A Diversity of Bloom is defined by overlapping bloom periods of at least 2–3 species during each season (spring, summer, and fall). The goal of long-term management strategies is a Diversity of Bloom across seasons with minimal/manageable weed pressure (see Decision Trees 1–3 on pages 31–33). We define dominance as the condition when one class of species (wildflowers or weeds) are more abundant that the other, with the consequence that they can potentially suppress the other.

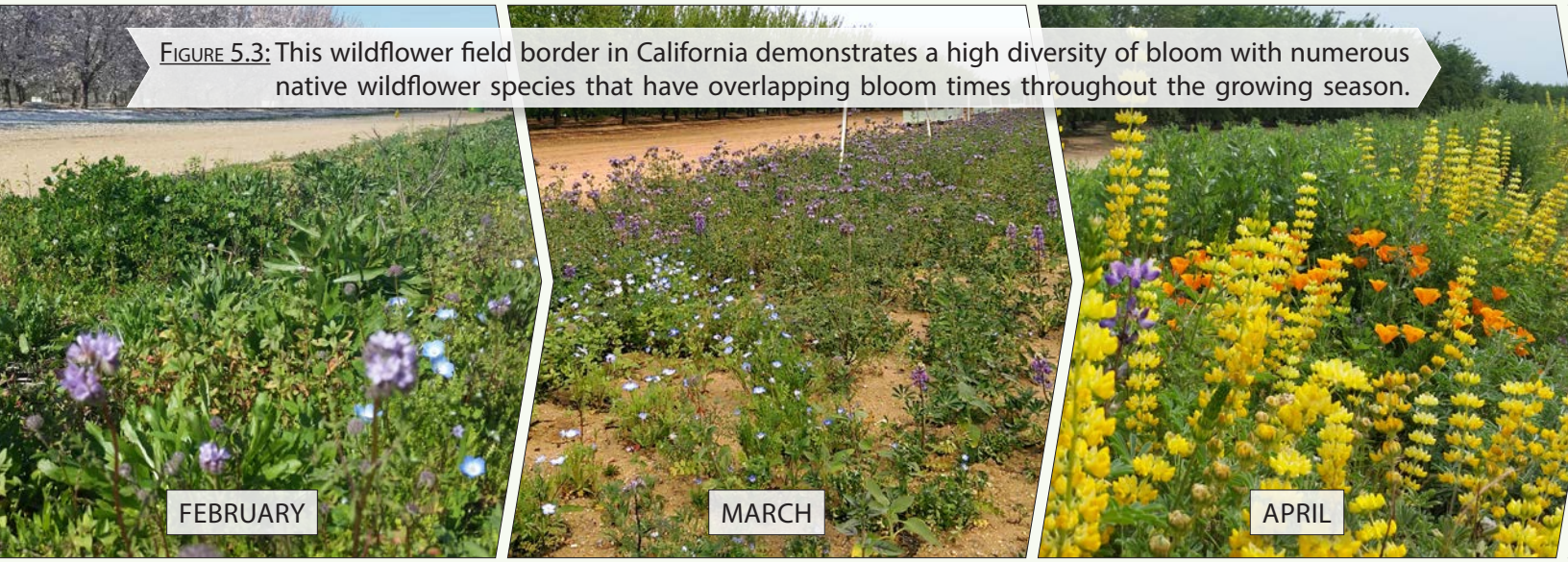


Figure 5.3: This wildflower field border in California demonstrates a high diversity of bloom with numerous native wildflower species that have overlapping bloom times throughout the growing season.

Table 5.1: Common Site Conditions

DOMINANT SPECIES	DESCRIPTION			EXAMPLES†
DESIRABLE SPECIES Native wildflower and grass species cover at least 75% of the site	**Diverse wildflower bloom with minimal weed cover**	Diversity of Bloom		At least three wildflower species in bloom in each season (except winter), with overlapping flowering periods
	Lacking one or more key species	Key planted species missing		One or more planted species did not germinate or failed to establish at site
		Gap(s) in bloom		Lacks early or late-blooming species
	Dominated by one or a few native species	Native grass		Native fescue (*Festuca* spp.) dominates
		High value pollinator plants		Goldenrod (*Solidago* spp.) dominates
		Low–moderate value pollinator plants		Yarrow (*Achillea millefolium*) dominates
MIXTURE Both weeds and wildflowers present	**Weeds are present in significant amounts in some—but not all—areas of the site**	Intermixed	» Mostly Woody	Weedy trees/shrubs are interspersed in both well-established and poorly-established areas
			» Mostly Forbs	Flowering weeds are interspersed in both well-established and poorly-established areas
			» Mostly Grasses	Weedy grass(es) are interspersed in both well-established and poorly-established areas
		Patches		Distinct patches where weeds dominate and distinct areas where wildflowers dominated
UNWANTED SPECIES Weeds—including non-native, invasive, and noxious species—cover 70% or more of the site	**Dominanted by one or a few weed types or species with few to no native species**	Grass(es)	» Warm-Season	Cheat grass (*Bromus tectorum*)
			» Cool season Annual	Medusahead (*Taeniatherum caput-medusae*)
			» Cool season Perennial	Harding grass (*Phalaris aquatica*)
		Forbs		Bindweed (*Convolvulus* spp.); Russian thistle (*Salsola tragus/S. kali*)
		Woody plants		Blackberry (*Rubus* spp.); Eastern redcedar (*Juniperus virginiana*)
	More than one form of weedy species present	Mixture		May include mixed weedy grasses, forbs, and woody species

Table 5.1 *Notes:*

† These are just a few representative examples of different native and weedy species—contact your local extension office for examples specific to your region.

Figure 5.4: A large patch of yellow star thistle (*Centaurea solstitialis*)—outlined in red—is pushing out native wildflowers that include gumweed (*Grindelia* spp.) and California poppies (*Eschscholzia californica*), allowing for intensive management practices like spot-mowing.

When to Use Interseeding

Interseeding is a tool that can help restore diversity lost from a site (see *Management Strategies: Interseeding*). It often is most successful when coupled with other forms of weed management, particularly if management is targeted at reducing abundance of dominant wildflowers or weeds and results in large areas of bare soil that could be colonized by unwanted species. Interseeding can be costly and may not always be necessary. We recommend waiting to determine whether management actions alone stimulate the habitat to move closer to the desirable conditions. If not, consider interseeding after completing other management actions in future years.

Dominated by Undesirable Species

Even a habitat that starts off with a robust wildflower population may succumb to weed invasion over time. On the one hand, weeds might co-exist with wildflowers, necessitating some light management. However, when one or many weeds species takes over, a more intensive approach is required.

Selecting Management Treatment

Once the condition of the planting has been identified (e.g., see Table 5.1), determine the appropriate management technique(s). We provide decision trees to facilitate this process (p. 31–33). A number of different management techniques can be utilized to address one or more conditions. We recommend trying first using familiar, known techniques, prioritizing those that also have the least negative impact on wildflowers.

Timing of implementation of a management technique is critical to its success. For example, mowing after seed set by a weedy species provides little weed control and may even exacerbate the invasion by distributing seeds throughout the site. Careful timing of a management action can help achieve different goals. For example, mowing in the spring can target many weeds (e.g., cool season grasses) during their active growth stage, whereas mowing in the fall targets late-flowering weeds that produce seeds in the fall. Late season mowing is also a good option for control of woody species. While many management strategies are effective throughout the U.S., implementation timing varies by region. For this reason, we recommend monitoring to ensure that actions occur during the optimal window.

Decision Tree #1: Sites Dominated by Desirable Species

The goal of long-term management strategies is to foster or maintain a Diversity of Bloom across seasons with minimal/manageable weed pressure (see *Notes* below). We define dominance as the condition when one or more species (wildflowers or weeds) are more abundant than the others, with the consequence that species diversity may be suppressed.

Dominance: Are desirable species dominant (i.e., most abundant)?

- **No** → *Go to Decision Tree #2*
- **Yes** → **Species Diversity: Are there at least 2–3* wildflower species present?**

Species Diversity: Are there at least 2–3* wildflower species present?

- **No** → **Pollinator Value: What is the value of the dominant species present to pollinators?**
- **Yes** → **Overlapping Bloom: Do species bloom continuously* throughout the growing season?**

Pollinator Value: What is the value of the dominant species present to pollinators?

- **Low value native grass(es)**

1. Selectively remove grass(es) by:
   - **Grass-selective herbicide‡** *OR*
   - **Hand-weeding** *OR*
2. Create space for forbs by:
   - **Conservation haying** *AND/OR* **litter removal** *OR* **grazing** *OR*

If necessary, consider reintroducing wildflower diversity by **interseeding**

- **Low–moderate value wildflower(s)**

Selectively remove patches of dominant low value species by:
- **Hand-weeding** *OR*
- **Spot-spraying herbicide‡** *OR*
- **Spot-mowing**

If necessary, consider reintroducing wildflower diversity by **interseeding** additional high value wildflower species

- **High value wildflower(s)**

Selectively remove patches of dominant species by:
- **Hand-weeding** *OR*
- **Spot-spraying herbicide‡** *OR*
- **Spot-mowing**

If necessary, consider reintroducing wildflower diversity by **interseeding**

Overlapping Bloom: Do species bloom continuously* throughout the growing season?

- **No** → **How is the site lacking species?**
- **Yes** → **IDEAL CONDITIONS: Diversity of Bloom***

How is the site lacking species?

- **Key species missing‡**

Reintroduce wildflower diversity by **plug-planting** *OR* **interseeding** wildflowers to fill in gaps

- **Gap(s) in bloom**

1. **Mow for diversity**; **AND**
2. Reintroduce wildflower diversity by **plug-planting** *OR* **interseeding** to fill in gaps

IDEAL CONDITIONS: Diversity of Bloom*

1. Manage to maintain this state by:
   - **Mowing for diversity** *OR*
   - **Conservation haying** *OR* **litter removal**; **AND**
2. Targeting aggressive weeds:
   - **Mowing for weed control**
   - **Hand-weeding**
   - **Weed removal along perimeter**

Decision Tree #1 *Notes:*

* A Diversity of Bloom is defined by overlapping bloom periods of at least 2–3 species during each season (spring, summer, and fall).
‡ During active growth phase.
† These are representative examples of native species—contact your local extension office for examples specific to your region.
‡ Some species don't establish well from seed and may require transplants.
See *When to Use Interseeding*, p. 30.

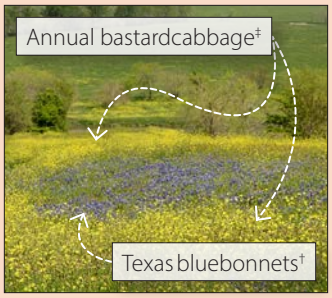
Decision Tree #2: Sites with a Mixture of Desirable & Unwanted Species

Dominance: Are desirable species *more* abundant than weed species?

- **No** → *Go to Decision Tree #3*
- **Yes** → **Distribution: How are wildflowers and weeds distributed throughout the site?**

Patches

1. Use technique(s) timed to selectively target weeds' vulnerable growth phase:
   - **Spot-mowing** *OR*
   - **Spot-spraying herbicide**ŝ *OR*
   - **Hand-weeding; AND**
2. Reintroducing wildflower diversity by **interseeding** wildflower species is recommended after clearing a large patch of weeds to help wildflowers re-colonize the area and compete with weed seeds that might germinate from the seed bank.



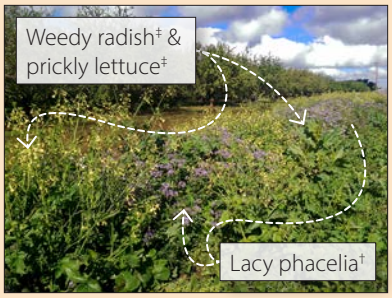
Intermixed

What types of weeds are present?

Mostly woody

Use technique(s) timed to selectively remove *OR* target the weeds' vulnerable growth phase:
- **Mowing for weed control** annually in fall *OR*
- **Hand-weeding** (with pulawskis or other tools) is often best for woody species like broom *OR*
- **Spot-spraying herbicide**⁂ *OR*
- **Grazing for weed control** *OR*
- **Prescribed fire**

Mostly forbs



Use technique(s) timed to the target weeds' vulnerable growth phase:
- **Hand-weeding** *OR*
- **Mowing for weed control** *OR*
- **Spot-spraying herbicide**⁂ *OR*
- **Grazing for weed control** *OR*
- **Prescribed fire**

Mostly grasses

Selectively remove grass(es) by:
- **Grass-selective herbicide**⁂ *OR*
- **Grazing for weed control** *OR*
- **Prescribed fire** (note: only for cool season grasses) or
- **Hand-weeding**

Decision Trees #2 & 3 *Notes:*

⁂ During active growth phase. Targeting weeds during the vulnerable stage is critical. This can include using control methods during the flowering of a monocarpic plant, spraying a perennial during phloem flow to the roots in the fall, etc. For more information on successfully targeting weedy species in your area, contact your local extension office.

† These are representative examples of native species—contact your local extension office for examples specific to your region.

‡ These are common widespread non-native weedy species—contact your local extension office for examples specific to your region.

Interseeding wildflower species is recommended after clearing a large patch of weeds to help wildflowers re-colonize the area and compete with weed seeds that might germinate from the seed bank. See *When to Use Interseeding* on p. 30 for details.

⚠ Note: Sites with high weed pressure—like the one pictured—will likely need multi-years of management before interseeding.

ⓘ Sandbar willow (*Salix exigua*) is a desirable species for streambank stabilization *in its native range*, but can become weedy without proper management.

DECISION TREE #3: Sites Dominated by Unwanted Species

DOMINANCE: What weed forms dominate the meadow?

Mixture

If a variety of species are present, use a combination of techniques timed to target weeds during their vulnerable growth phaseŝ, including:

- **Mowing for weed control** *OR*
- **Spot-mowing** *OR*
- **Spot-spraying herbicideŝ** *OR*
- **Hand-weeding**

If necessary, consider reintroducing wildflower diversity by **interseeding** wildflower species

⚠ Multi-year management may be required.

Mostly forbs

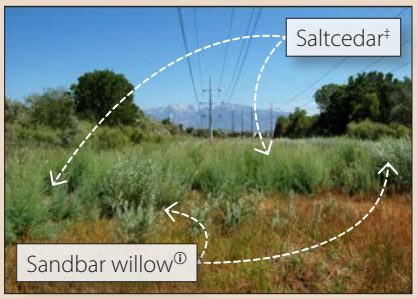
Use technique(s) timed to the target weeds' vulnerable growth phaseŝ, including:

- **Mowing for weed control** *OR*
- **Spot-mowing** *OR*
- **Spot-spraying herbicide*** *OR*
- **Hand-weeding**

If necessary, consider reintroducing wildflower diversity by **interseeding** wildflower species

⚠ Multi-year management may be required.

Mostly woody



Use techniques to target woody weeds (which are more vulnerable to disturbance):

- **Hand-weeding** *OR*
- **Spot-mowing frequently** *OR*
- **Spot-spraying** foliar herbicide frequently, cut and stump treatment *OR*
- **Prescribed fire**

Mostly grasses

Growing season?

Cool

Life cycle?

Perennial

Selectively remove perennial cool season grass(es) by:

- **Grass selective herbicideŝ** in early spring and again in fall *OR*
- **Seasonal mowing** in early spring and again in fall *OR*
- **Grazing for weed control** in early spring and again in fall *OR*
- **Prescribed fire**

If necessary, consider reintroducing wildflower diversity by **interseeding** wildflower species

Annual

Selectively remove annual cool season grass(es) by:

- **Seasonal mowing** in early-mid spring once grasses have bolted but before flowering *OR*
- **Grass selective herbicideŝ** in early spring *OR*
- **Grazing for weed control** in early-mid spring *OR*
- **Prescribed fire** in early-mid spring

If necessary, consider reintroducing wildflower diversity by **interseeding** wildflower species

Warm

Selectively remove warm season grass(es) by:

- **Seasonal mowing** in mid-late summer *OR*
- **Grass-selective herbicideŝ** in mid-late summer *OR*
- **Conservation haying**, in mid-late summer before seed set *OR*
- **Grazing for weed control** in mid-late summer *OR*
- **Prescribed fire** in late summer

If necessary, consider reintroducing wildflower diversity by **interseeding** wildflower species

FIGURE 5.5: Follow up monitoring and assessment is critical to successfully managing wildflower plantings over the long term.

Recording Management Practices

Each wildflower planting is different and therefore responds differently to management actions. It is important to track the success of the techniques used (see *Pollinator Habitat Management Log*). If undesirable conditions persist in spite of management, then we recommend re-evaluating the technique used and either altering the timing or trying a different method. Continued monitoring will inform management and assist in the decision-making process.

FIGURE 5.6: *Example* Pollinator Habitat Management Log

Example

POLLINATOR HABITAT MANAGEMENT LOG

XERCES SOCIETY for Invertebrate Conservation

Keeping track of management techniques helps assess effectiveness of timing and method, allowing for improved implementation in future years.

STEP 1—Print copies of this form in advance (www.xerces.org/habitat-assessment-guides)

STEP 2—Site Name: Oregon Meadow

STEP 3—Management Practices Record

Record all management techniques used. Be sure to include the timing of the action so if it is not effective management can be adjusted in the future. In addition, record the intended goal for the management (for example, "to reduce or eradicate Harding grass from the meadow").

NOTE: **Before implementing techniques the following year, be sure to evaluate whether the technique utilized met the intended goal.** If not, adapt the existing technique (e.g., different timing and/or frequency) or trial a new one.

BEFORE IMPLEMENTATION					AFTER IMPLEMENTATION			
#	MANAGEMENT TECHNIQUES LOG				EFFICACY ASSESSMENT			
1	YEAR:	2015	MONTH(S):	Jun + Nov	EVALUATION DATE(S):	02/15/16	TECHNIQUE SUCCESSFUL?	Y / (N)
	TECHNIQUE PLANNED:	Sprayed grass-selective herbicide			NOTES	Abundance of non-native grasses increased		
	INTENDED GOAL:	Decrease non-native grass cover, specfically harding grass + wild oat			SUGGESTED CHANGES/ NEXT STEPS:	Spot-spray more frequently, starting in early spring to target during active growth		
2	YEAR:	2016	MONTH(S):	Mar, Jun, Aug + Nov	EVALUATION DATE(S):	11/25/16	TECHNIQUE SUCCESSFUL?	(Y) / N
	TECHNIQUE PLANNED:	Repeatedly spot-spray grass-selective herbicide, starting in early spring			NOTES	Reduced non-native cover so both target species were Rare.		
	INTENDED GOAL:	Decrease non-native grass cover, specfically harding grass + wild oat			SUGGESTED CHANGES/ NEXT STEPS:	None		
3	YEAR:	2016	MONTH(S):	Oct + Nov	EVALUATION DATE(S):		TECHNIQUE SUCCESSFUL?	Y / N
	TECHNIQUE PLANNED:	Interseeded site in fall with globe gilia + bigleaf lupine			NOTES			
	INTENDED GOAL:	Increase abundance of declining spring/ early summer wildflower species			SUGGESTED CHANGES/ NEXT STEPS:			
	YEAR:		MONTH(S):		EVALUATION DATE(S):		TECHNIQUE SUCCESSFUL?	Y / N
	TECHNIQUE PLANNED:				NOTES			
	INTENDED GOAL:				SUGGESTED CHANGES/ NEXT STEPS:			

Print copies of this and other forms at: www.xerces.org/habitat-assessment-guides. See Appendix B for a list of the available forms.

6

Management is a Moving Target

Pollinator habitat is a dynamic living system that changes based on weather conditions and past management actions. Weed populations that have previously been controlled can re-emerge as issues in wet years or if management events were not properly timed (See *Case Study #2: Pennsylvania Apple Orchard*). Sometimes this requires re-evaluation of management techniques. As you learn the principles of habitat management described in this guide, you will become more comfortable adapting and modifying these practices to improve your pollinator habitat. The results may work well, or it may be time to go back to the drawing board. We continually fine-tune our management actions with the goal of achieving the best results. After a few years of monitoring and managing, it will likely get easier to fine tune timing and treatments, and ultimately increase the health and longevity of your pollinator habitat.

Remember that follow up monitoring and assessment it critical. Checking up on the impact of a management action, and the conditions it fosters, is key to maximizing planting success. It is easier and more cost-effective to do annual maintenance than to re-start an entire project every few years. After a year or two of monitoring, checking up on the status of the pollinator habitat will become a more rapid process as familiarity with desirable and unwanted species increases (See *Case Study #1: Oregon Blueberry Farm*). In addition, implementation of specific management techniques should also become easier. Once the desired conditions are created and wildflower species have a strong foothold (usually five years post-establishment), monitoring and management activities can decrease.

We recommend not only recording which management actions you use, but also whether they were successful. If the condition targeted was unaffected, alter the technique by changing timing, coupling it with another strategy, or taking an entirely new approach (see *Case Study #3: California Almond Orchard*). If new undesirable conditions arise, consider altering the technique or substituting it for a different one. When a management strategy is effective, however, implement it in the same way until conditions appear to change.

This guide represents a starting point for assessing and managing site conditions. Over time, a site and it's unique needs will become familiar, and it will become more intuitive and efficient to recognize shifting conditions and implement techniques to optimize pollinator habitat.

7

Case Studies

This section provides real world examples of management used in wildflower habitat in three different regions: the Pacific Northwest, California, and the Mid-Atlantic states. The case studies illustrate different techniques that can be implemented with varying intensities and combinations. All of these meadows contain a high diversity of bloom, indicating that management actions continue to be successful over time.

1 OREGON BLUEBERRY FARM: *Selectively Removing Non-Native Weeds*

This ½ acre wildflower planting was initiated in 2012 alongside a conventionally managed blueberry field. Weeds were managed chemically prior to seeding with native wildflowers. Not all weedy species were eradicated; therefore, some unwanted species have persisted over time. No native bunchgrasses were included in the seed mix because the farmer wanted to retain grass-selective herbicides as a treatment option to combat the non-native grasses prevalent throughout the farm, which posed a high threat of reinvasion.

Many native wildflower species have thrived in the site, including farewell-to-spring (*Clarkia amoena*) (Figures 7.1–2), an annual that vigorously re-seeds itself. Other species never established, necessitating interseeding in 2014 and 2015 to fill in gaps in bloom early and late in the year—including lupine (*Lupinus* spp.), California poppy (*Eschscholzia californica*), and gumplant (*Grindelia* spp.).

Figure 7.1: While some species, like California poppy and lupine, thrived in the planting early—shown in May 2013—additional interseeding was required to fill gaps in bloom where other species failed to establish (shown in August 2013).

Figure 7.2: Now a flourishing wildflower meadow, the planting supports abundant blooms year after year, thanks to a fall mow once a year, twice annual spraying with grass-selective herbicide, and targeted dead-heading to remove individual weeds, like salsify, invading a site otherwise dominated by farewell-to-spring (shown in July 2014).

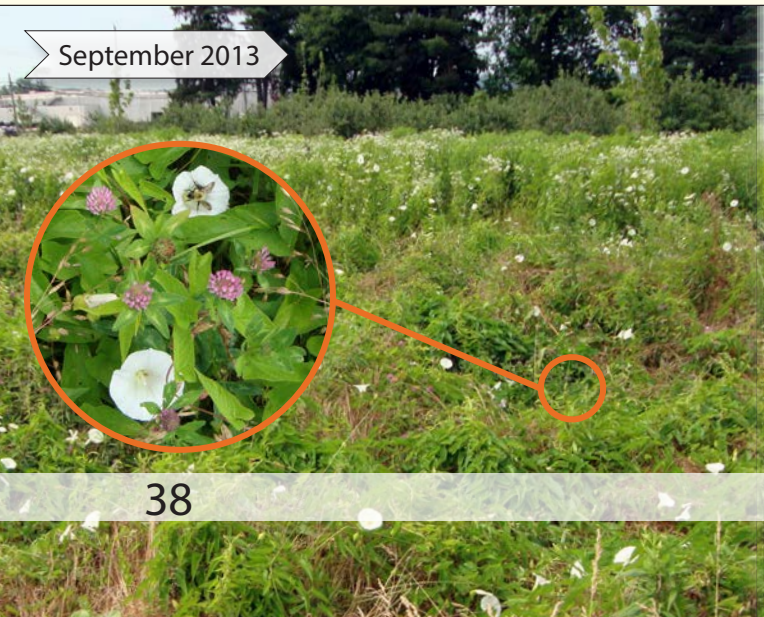
Non-native cool season grasses have continued to be a major problem, despite annual spraying with a grass-selective herbicide. Other persistent weeds including Western salsify (*Tragopogon dubius*) and Queen Anne's lace (*Daucus carota*)—circled in white—are hand-weeded or dead-headed once a year to prevent spread into crop fields. The site is mowed annually in the fall to prevent Himalayan blackberry (*Rubus armeniacus*) from establishing. Despite continued issues with weeds present at low levels, the management actions and interseeding have been highly successful and the habitat continues to contain high-performing wildflowers that re-seed year after year.

2 PENNSYLVANIA APPLE ORCHARD: *Managing Aggressive Weeds During Establisment*

This one-acre pollinator meadow, located adjacent to an apple orchard, was first seeded with perennial wildflowers in 2011. Prior to planting, the site had very high weed pressure, including field bindweed (*Convolvulus* spp.), knapweed (*Centaurea* spp.), and thistle (*Cirsium* spp.) (Figure 7.2—September 2013). These species tend to thrive in open, cultivated ground and soil rich in nitrogen (i.e., typical conditions found in gardens and farms). Although the site was mowed and tilled prior to seeding, weeds were not eradicated. In addition, perennial wildflowers are often slower to establish than annual weeds, even though perennials are persistent once established. This combination

Figure 7.3: Bindweed (circled) initially covered a large portion of the meadow, mounding up on top of other weedy species as well as desirable wildflower species like asters and goldenrod—which made managing the site without harming the wildflowers more difficult.

Figure 7.4: By April 2015, native wildflowers—including wild bergamot (*Monarda fistulosa*) and purple coneflower (*Echinacea purpurea*)—have rebounded in the site, thanks to a combination of aggressive weed control measures, monitoring, and interseeding.



of slow wildflower establishment and inadequate site preparation allowed weeds to outcompete the wildflower seedlings, quickly leading to a weed-dominated planting. Despite this high weed pressure, some desirable plants like goldenrod (*Solidago* spp.) and asters (*Symphyotrichum* spp.) were still found in high abundance. Because of this mix of desirable and undesirable plants, starting over did not seem necessary. As an important side note, we do not recommend mowing and tillage as adequate preparation for weedy sites.

To achieve the goal of restoring diversity and function, a combination of weed control and interseeding were used. The site was flail-mowed several times in 2013 to remove as much weedy vegetation and litter as possible to promote good seed-soil contact in preparation for a fall dormant seeding. Care was taken during site preparation to disturb the soil as little as possible to avoid bringing up dormant weed seeds, which would likely cause additional weed problems in the future. Due to an unusually early snowfall event, seeding was delayed until early spring 2014, as the planting area was not accessible to planting equipment due to wet soil conditions. Note: If fall dormant seeding is delayed until spring and the seed mix has already been obtained, be sure to store the seed in an airtight container in a cool location (e.g., unheated shed or barn). Another option is to consider snow seeding (see *Snow Seeding*, p. 26). The site was interseeded at a half rate of 30 seeds/ft^2 (compared to the typical recommended seeding rate for wildflower meadows of 60 seeds/ft^2).

Wildflowers slowly reestablished in small patches, but aggressive management was still required to continue to control weeds. Canada thistle was spot-treated with herbicide just as it was going to flower. Large patches of bindweed also received targeted spot-treatment with herbicides using a backpack sprayer. Smaller patches of bindweed required a different control method because some of the dense vines were tangled around desirable wildflowers that would also be killed if contacted by herbicide. For these smaller patches, bindweed was cut close to the ground by hand or by using a string trimmer so that the desirable plants were less disturbed. In addition, portions of the site containing poison ivy (*Toxicodendron radicans*), knapweed, fleabane (*Erigeron* spp.), plantain (*Plantago* spp.), and Queen Anne's lace were spot-mowed as needed. By April 2015, a diversity of wildflowers occupied a large portion of the site (Figure 7.2, right); however, the site will be monitored and managed to maintain a diversity of wildflower and bloom times to support apple pollinators before and after apple tree bloom.

3 CALIFORNIA ALMOND ORCHARD: *Balancing Wildflowers with Native Bunch Grasses*

This ½ acre pollinator habitat project was initiated in 2010. It is bordered by commercial almond orchards, partially restored native grasslands, chaparral, and degraded grasslands. Prior to the 2010 planting, the site was dominated by exotic annual grasses and invasive broadleaf weeds. The original planting consisted of both native forbs and native grasses. While native bunch grasses, such as purple needle grass (*Stipa pulchra*), thrived in the site (shown right, June 2013), wildflower establishment was poor. Therefore, in 2013, the landowners began managing the meadow to achieve a balance of native grasses and wildflower cover with a 50:50 ratio. The low initial wildflower establishment indicated that the existing seed bank

Figure 7.5: The site was mowed and shallowly disked (top) before wildflowers were planted using a native seed drill in Novemeber 2013 (bottom).

was likely insufficient to reach the desired condition through management alone, therefore, a decision was made to interseed the area with a diverse mix of native wildflowers.

To prepare for seeding, the area was mowed and shallowly disked in the fall of 2013. Seed was sown at a rate of approximately 50 seeds/ft^2, using a native seed drill on ½ the field (Figure 7.3) and a manual seed slinger on the other half, to test the the effectiveness of different seeding methods. A ring-roller was used to push the seed down into the soil on the portion of the field that was seeded using the seed-slinger. In the end, there was no noticeable difference in wildflower establishment between the sections seeded with different equipment.

Despite a multi-year drought that impeded seed germination, the current wildflower cover in the site has improved—approximately 30:70 forb:grass ratio (Figure 7.6). Management of the site since interseeding has consisted of mowing the perimeter to prevent weed encroachment and annual fall mowing to prevent litter build-up and open up areas for new wildflower germination. There has been some encroachment of cool-season, exotic, annual grasses. If these grasses persist, they will be managed with a high mow early in the spring, carefully timed to cut the grass before it goes to seed. Because the exotic grass germinates very early, it is usually taller than the native vegetation in early spring. This allows for the mower blade to be set so that it cuts the weedy grass species without harming the native grasses andwildflowers germinating underneath.

Figure 7.6: In June of 2013, the site was dominated by *Stipa pulchra,* with little wildflower cover (previous page). The interseeding successfully increased native wildflower cover without reducing the abundance of native bunch grasses (below).

8

Additional Resources

Seed Saving

Collecting and Seed Storage. (Ladybird Johnson Wildflower Center)
www.wildflower.org/howto/show.php?id=8&frontpage

Drying, Cleaning and Storing Prairie Seed. (Tallgrass Prairie Center)
www.tallgrassprairiecenter.org/sites/default/files/pictures/techguide2_dryingcleaning_2015_web.pdf

Eckberg, J., J. Hopwood, and E. Lee-Mader. 2016. *Expanding Pollinator Habitat on Farms: Collecting and Using Your Own Wildflower Seed*. 12 pp. Portland, OR: The Xerces Society for Invertebrate Conservation.
www.xerces.org/collecting-wildflower-seed

Seed Collecting from Tallgrass Prairies. (Tallgrass Prairie Center)
www.tallgrassprairiecenter.org/sites/default/files/pictures/techguide1_seedcollecting_2015_web.pdf

Tchida, C. *Collecting Wildflower and Prairie Seeds*. (University of Minnesota Extension: Sustainable Urban Landscape Information Series.)
www.extension.umn.edu/garden/landscaping/implement/wildflower.htm

Wall, M., and J. MacDonald (photographer). 2009. *Processing Seeds of California Native Plants for Conservation, Storage, and Restoration*. CD. Claremont: Rancho Santa Ana Botanic Garden
www.amazon.com/gp/product/0981971709

Prescribed Fire

Resource Center: Prescribed Fire (eXtension.org)
http://articles.extension.org/prescribed_fire

Prescribed Fire Equipment (eXtension.org)
http:tinyurl.com/RxFireEquip

Re-starting Habitat

Jordan, S. F., J. K. Cruz, K. Gill, J. Hopwood, J. Fowler, E. Lee-Mäder, and M. Vaughan. 2016. *Wildflower Establishment: Organic Site Preparation Methods*. 44 pp. Portland, OR: The Xerces Society for Invertebrate Conservation.
www.xerces.org/organic-wildflower-establishment

Habitat Installation Guides (The Xerces Society)
These regional installation guides provide in-depth guidance on installing and maintaining wildflower meadows or hedgerows as pollinator habitat, including example seed mixes and recommended plants.
www.xerces.org/pollinator-habitat-installation-guides

Interseeding

Williams, D., J. Eckberg, J. Hopwood, R. Powers, M. Vaughan, K. Jokela, S. Foltz Jordan, and E. Lee-Mader. 2018. *Interseeding Wildflowers to Diversify Grasslands for Pollinators: Guidance for the Great Plains and Midwest Regions*. 36 pp. Portland, OR: The Xerces Society for Invertebrate Conservation.
https://xerces.org/interseeding-grasslands-for-pollinators/

FIGURE 8.1: Collecting wild seeds—such as milkweed (*Asclepias* spp.)—can be a good way to obtain locally-adapted ecotypes..

Weed Management

DiTomaso, J. M., et al. 2013. *Weed Control in Natural Areas in the Western United States*. Davis: UC Weed Research and Information Center.

New Jersey Invasive Species Strike Team
Species List with Control Recommendations (Includes Target, Watch and Widespread Species): www.njisst.org/documents/SpeciesListandControlRecommendations15.xlsx

Radosevich, S., R., J. S. Holt, C. M. Ghersa. 2007. *Ecology of Weeds and Invasive Plants: Relationship to Agriculture and Natural Resource Management*. John Wiley and Sons.

Weed Research and Information Center. (UC Cooperative Extension and Agricultural Experiment Station)
http://wric.ucdavis.edu/

DiTomaso, J. M, G. B. Kyser, and M. J. Pitcairn. 2006. *Yellow starthistle management guide*. 78 pp. Berkeley: California Invasive Plant Council.
www.cal-ipc.org/ip/management/pdf/YSTMgmtweb.pdf

Grazing

Helzer, C. 2011. *Patch-Burn Grazing for Biological Diversity*. The Nature Conservancy.
https://prairienebraska.files.wordpress.com/2011/05/patch-burning-for-biodiversity.pdf

Weir, J.R., S.D. Fuhlendorf, D.M. Engle, T.G. Bidwell, D.C. Cummings, D. Elmore, R.F. Limb, B. W. Allred, J.D. Scasta, and S.L. Winter. 2013. *Patch Burning: Integrating Fire and Grazing to Promote Heterogeneity*. Oklahoma Cooperative Extension Service and Oklahoma State University.
http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-4677/E-998survey2013.pdf

Database of Plants Poisonous to Livestock (Cornell University)
http://poisonousplants.ansci.cornell.edu/php/plants.php

Range and Pasture Technical Resources (USDA–NRCS)
www.tinyurl.com/NRCS-Grazing-Lands

Resource value of plants in the Southern Plains (Oklahoma State University Extension Service)
www.okrangelandswest.okstate.edu/files/grazing%20management%20pdfs/F-2872.pdf

NRCS Field Offices
www.nrcs.usda.gov/wps/portal/nrcs/main/national/contact/local/
Visit your local field office to find more information on desirable species for grazing.

Weed Identification

Introduced, Invasive, and Noxious Plants
https://plants.usda.gov/java/noxiousDriver
Federal and state lists noxious, invasive, and introduced plants, with links to more information.

National Invasive Species Information Center (United States Department of Agriculture)
www.invasivespeciesinfo.gov/
This website has a compilation of fact sheets and identification guides for invasive plants.

New Jersey Invasive Species Strike Team
Info Center: www.njisst.org/index.asp

Weed Identification Tool. (University of Wisconsin–Madison Cooperative Extension)
www.weedid.wisc.edu/weedid.php

Weed Image Search. (Weed Science Society of America)
http://wssa.net/wssa/weed/weed-identification/

Weed Research and Information Center. (UC Cooperative Extension and Agricultural Experiment Station)
http://wric.ucdavis.edu/

Uva, R. H., J. C. Neal, and J. M. DiTomaso. 1997. *Weeds of the Northeast*. 408 pp. Ithaca, New York: Cornell University Press.

Stubbendieck, J., M. Coffin, and L. M. Landholt. 2003. *Weeds of the Great Plains*. 605 pp. Lincoln: Nebraska Department of Agriculture.

Parkinson, H., J. Mangold, and F. Menalled. 2015. *Weed Seedling Identification Guide for Montana and the Northern Great Plains*. 164 pp. Bozeman: Montana State University Extension.
http://store.msuextension.org/publications/AgandNaturalResources/EB0215.pdf

Whitson, T. D., L. C. Burrill, S. A. Dewey, D.W. Cudney, B.E. Nelson, R. D. Lee, and R. Parker. 2001. *Weeds of the West*. 630 pp. Laramie: University of Wyoming.

Herbicides

Best Management Practices for Wildlands Stewardship
www.cal-ipc.org/ip/management/BMPs/BMPHerbicide.pdf

Bee precaution pesticide rating (University of California Integrated Pest Management [UC–IPM])
www2.ipm.ucanr.edu/beeprecaution/#

Johansen, E., L. A. Hooven, and R. R. Sagili. 2013. *How to Reduce Bee Poisoning from Pesticides*. 35 pp. Corvallis: Oregon State University.
https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/pnw591.pdf

Appendix A: Regional Differences Table

There are regional differences in the management strategies used to maintain diverse stands of wildflowers. This table is meant to be a general guide to the timing and types of management strategies used within each region. There will be variation within a region based on elevation, local site conditions, and other factors.

REGION		CALIFORNIA	PACIFIC NORTHWEST
Technique	**Timing**		
VEGETATION MONITORING[1]	Every 2–3 wks	➤ JAN–JUN	➤ FEB–SEP
	Once a month	➤ JUL–DEC	⊗
MOWING FOR DIVERSITY	Seasonal	➤ OCT	➤ AUG / SEP (fall mow for woody plant control).
	Rotational	➤ OCT	➤ Can be used in areas without Himalayan blackberry (which should be mowed every fall).
MOWING FOR WEED CONTROL[2]	DURING ESTABLISHMENT AFTER ESTABLISHMENT	➤ EARLY SPRING: High mow to target early-germinating, tall weeds (e.g., annual grasses and malva/ mustard). MID-SUMMER: High mow to target warm season weeds (e.g., prickly lettuce).	⊗ Not commonly used in this region.
GRASS-SELECTIVE HERBICIDES[3]		➤ MID–DEC: Begin mid-month and continue throughout winter and spring as needed. Most commonly used to manage cool-season grasses; most effective when grasses are small (<6" tall); may need multiple treatments.	SPRING–SUMMER: Commonly applied a few times. MID- to LATE-AUG : Final spray ⚠ Aggressive species may need multiple applications.
CONSERVATION HAYING[4]		⊗ Not commonly used in this region.	
PRESCRIBED FIRE[5]		➤ FALL burn to clear litter. ➤ EARLY SPRING burn to manage cool-season weeds.	➤ AUG 15TH–OCT 15TH
GRAZING		➤ Defer grazing for first year to promote good establishment. After that, with appropriate stocking rates and / or rotation, grazing can be compatible with diversity in any season.	➤ Not very common in this region; cattle preferred in grassland habitats; goats for steep hillsides, particularly along waterways.
INTERSEEDING	Fall-seeded	OCT–NOV: Seed with fall rains.	SEP 15TH–OCT 15TH: After the rains and before a frost; or,
	Spring-seeded	⊗	MAR
PLUGS AND BARE ROOT PLANTING[6]		MID-OCT–MID-DEC, with irrigation available at the time of planting. MID-DEC–EARLY FEB	➤ SEP 15TH–OCT 15TH: Plant plugs or bare root transplants after the rains and before frosts; or, SPRING: Plugs usually require irrigation for the first season.
IRRIGATION		➤ APR–OCT for the first 2–3 years during normal rainfall years, or more frequently as as needed during drought years. ➤ Required for transplants; may be necessary in seeded areas during drought.	➤ Not required unless planting in the spring or during multi-year droughts.
STARTING OVER	BEGIN SITE PREP	➤ JAN (unless solarizing, which can be undertaken later in the spring).	➤ FEB / MAR
	Seed site	OCT–NOV: Plant with fall rains.	OCT–NOV: Dormant seed.

KEY:

- ⊗ Not applicable.
- **REMINDER:** Avoid using management technique during nesting season for ground-nesting birds.
- **REMINDER:** Avoid or postpone management technique when wet conditions are predicted, such as spraying herbicides—to avoid movement of herbicides off target—or seeding during excessively wet conditions.
- ⚠ **WARNING**—Additional acton may be needed.
- Seed (or interseed) site.

ADDITIONAL INFORMATION:

1. **VEGETATION MONITORING**—Add [MAR] APR and [NOV] OCT for invasive cool-season grass scouting; first several hard frosts.
2. **MOWING FOR WEED CONTROL**—During establishment (~years 1–2); after establishment (years 2–3+). **Reminder:** Keep fire safety guidelines in mind when mowing in arid regions.
3. **GRASS-SELECTIVE HERBICIDES**—Target applications during active growth of the dominant grass weeds on site: cool season grasses; warm-season grasses. **Reminder:** Avoid use or use carefully in plantings that contain desirable native grasses.
4. **CONSERVATION HAYING**—To support plant diversity, aim to hay at different times every year.
5. **PRESCRIBED FIRE**—When possible, avoid burning more than ⅓ of an area in a given year.
6. **PLUGS AND BARE ROOT PLANTING**—Plant plug transplants; plant bare root transplants.

Appendix A: Regional Differences Table *continued*

Technique	Timing	SOUTHWEST Low [High] Elevations	MOUNTAIN REGION
VEGETATION MONITORING[1]	EVERY 2–3 WKS	› FEB–JUN [APR–JUL]	› APR–SEP
	ONCE A MONTH	› JUL–JAN [AUG–MAR]	⊗
MOWING FOR DIVERSITY	SEASONAL	› NOV [SEP / OCT]	› OCT
	ROTATIONAL	› NOV [SEP / OCT]	› OCT
MOWING FOR WEED CONTROL[2]	DURING ESTABLISHMENT	⊗ Not a commonly used technique in this region.	› Mow to 6–8" when weeds are 12–15" to allow sunlight to reach seedlings, yet avoid smothering them.
	AFTER ESTABLISHMENT		› Mow one to several times when a significant amount of priority weeds are close to flowering (prior to seed set).
GRASS-SELECTIVE HERBICIDES[3]		WINTER [SPRING] and again in FALL, shortly before dormancy. MID-SUMMER	SPRING and again in FALL, shortly before dormancy. MID-SUMMER
		⚠ Aggressive species may need multiple applications.	
CONSERVATION HAYING[4]		⊗ Not commonly used in this region.	
PRESCRIBED FIRE[5]		› FALL burn to clear litter. › EARLY SPRING burn to manage weeds.	› YEAR-ROUND: Burn at various times throughout the year. › SUMMER or FALL burns may be better for maintaining wildflowers.
GRAZING		› Defer grazing for first year to promote good establishment. After that, with appropriate stocking rates and / or rotation, grazing can be compatible with diversity in any season.	› Defer grazing for first year to promote good establishment. After that, with appropriate stocking rates and / or rotation, grazing can be compatible with diversity in any season.
INTERSEEDING	FALL-SEEDED	NOV / DEC [SEP/OCT]: Sow seed with fall rains.	OCT / NOV; or,
	SPRING-SEEDED	⊗	FEB / MAR
PLUGS AND BARE ROOT PLANTING[6]		NOV / DEC [SEP / OCT], with irrigation available. DEC / JAN [OCT / NOV]	APR / MAY or late AUG / SEP: Plant as early as possible to catch spring rains. DORMANT SEASON › NOTE: May require irrigation for the first season.
IRRIGATION		› Irrigation is required for transplants for the first 2–3 years, and maybe be required for seeded areas during drought.	› Irrigation is required for transplants for the first 2–3 years.
STARTING OVER	BEGIN SITE PREP	› FEB [APR]	› APR
	SEED SITE	FALL or EARLY SPRING	DORMANT SEASON (fall) or in early spring to take advantage of spring rains.

KEY:

- ⊗ Not applicable.
- **REMINDER:** Avoid using management technique during nesting season for ground-nesting birds.
- **REMINDER:** Avoid or postpone management technique when wet conditions are predicted, such as spraying herbicides—to avoid movement of herbicides off target—or seeding during excessively wet conditions.
- ⚠ **WARNING**—Additional acton may be needed.
- Seed (or interseed) site.

ADDITIONAL INFORMATION:

1. **VEGETATION MONITORING**—Add [MAR] APR and [NOV] OCT for invasive cool-season grass scouting (); first several hard frosts ().
2. **MOWING FOR WEED CONTROL**—During establishment (~years 1–2); after establishment (years 2–3+). **Reminder:** Keep fire safety guidelines in mind when mowing in arid regions ().
3. **GRASS-SELECTIVE HERBICIDES**—Target applications during active growth of the dominant grass weeds on site: cool season grasses (); warm-season grasses (). **Reminder:** Avoid use or use carefully in plantings that contain desirable native grasses.
4. **CONSERVATION HAYING**—To support plant diversity, aim to hay at different times every year.
5. **PRESCRIBED FIRE**—When possible, avoid burning more than ⅓ of an area in a given year.
6. **PLUGS AND BARE ROOT PLANTING**—Plant plug transplants (); plant bare root transplants ().

GREAT PLAINS South [North]	MIDWEST
⊠	
APR–OCT [MAY–SEP]	MAY–SEP
➤ Rotational mowing preferred. ➤ If mowing annually is required: **NOV [OCT]**.	➤ **LATE JUN:** Mow to reduce dominance of native warm-season grasses. ➤ **AFTER OCT 1ST:** Mow to increase availability of sunlight for spring wildflowers.
➤ Avoid mowing site more than once every three years.	➤ Avoid mowing site more than once every three years; avoid periods of peak bloom (e.g., July 1ST–Sept. 30TH).
➤ **MAY–AUG [JUN–SEP]**: Mow to 6–8" when weeds are 12–15" to allow sunlight to reach seedlings.	➤ **JUN–SEP:** Mow to 6-8" when weeds are 12-15" to allow sunlight to reach seedlings and avoid thick litter accumulation.
➤ **SUMMER:** Mow one to several times when a significant amount of priority weeds are close to flowering (prior to seed set).	➤ **SUMMER:** Mow one to several times when a significant amount of priority weeds are close to flowering (prior to seed set).
SPRING and again in **FALL**, shortly before dormancy. **MID-SUMMER**	**SPRING:** Spray cool-season grasses in spring, or in **FALL** shortly before dormancy.
⚠ Aggressive species may need multiple applications.	
➤ **OCT:** Fall hay.	➤ **AFTER OCT 1ST** (ideally) or after peak bloom. However, haying may need to occur earlier if the nutritional quality of the hay is a concern.
➤ **YEAR-ROUND:** Burn at various times throughout the year. ➤ **SUMMER** or **FALL** burns may be better for maintaining wildflowers.	➤ **DORMANT SEASON:** In fall after vegetation has dried out; or, ➤ **SPRING:** Before significant green-up. Spring burns can help to control cool-season grasses. Hotter burns with longer duration will manage against tree and shrub weeds.
➤ With appropriate stocking rates, grazing is compatible with diversity in any season under a variety of grazing systems including patch burn, rotational, or continuous. When grazing during growing season, know the palatability of your wildflowers.	➤ With appropriate stocking rates, grazing is compatible with encouraging plant diversity by reducing litter build-up, reducing grass dominance through patch-burn grazing or keeping woody species under control. ➤ If grazing for weed control, graze during peak growth of target weed before it flowers.
DEC–FEB [NOV–FEB]: Dormant season interseed.	**FALL** or **DORMANT SEASON:** Fall or snow seed.
⊠	
➤ **OCT 15TH–JAN 1ST [SEP]**; or, ➤ **MAR 1ST–APR 15TH [APR / MAY]** ➤ Note: May require irrigation for the first season.	**EARLY FALL** or **SPRING:** Plugs may require irrigation if soils are dry and/or rain does not follow planting event.
➤ If dry or drought year, irrigate recent plug and bare root plantings.	➤ Generally not required unless plug planting is subjected to unusually dry conditions.
➤ **FEB–APR [MAR–MAY]:** Begin full season of site prep followed by **DORMANT** seeding. If existing vegetation is aggressive, sod-forming grasses, two growing seasons of site prep may be necessary.	➤ **MAY**
DORMANT SEASON (fall) or in early spring to take advantage of spring rains.	**OCT–NOV** (or **DORMANT SEASON**): Seed habitat; or, ➤ Put (back) into other production to manage weed seed bank (1+ years).

Notes:

Appendix A: Regional Differences Table *continued*

Technique	Timing	New England	Mid-Atlantic
Vegetation Monitoring[1]	Every 2–3 wks	⊗	➤ MAR–OCT
	Once a month	➤ MAY–OCT / NOV	⊗
Mowing for Diversity	Seasonal	➤ **OCT / NOV:** Mow after first several hard frosts, but before permanent snow cover.	➤ FEB–MAR ➤ SEP–OCT
	Rotational		Rotational patch mowing preferred. Do not mow vegetation shorter than 4".
Mowing for Weed Control[2]	**During** establishment	➤ Mow to 6–8" when weeds are 12–15" to allow sunlight to reach seedlings, kill annual weeds, halt weed seed dispersal, and avoid thick litter accumulation.	
	After establishment	Dependent on weed growth.	
Grass-Selective Herbicides[3]		**SPRING:** Spray cool-season grasses in spring, or in FALL shortly before dormancy.	**EARLY SPRING** or **MID-FALL:** Spray for cool-season grasses.
		⚠ Aggressive species may need multiple applications.	
Conservation Haying[4]		⊗ Not commonly used in this region.	
Prescribed Fire[5]		➤ **NOV:** Before snow cover; or, ➤ **MAR–MAY:** Before green-up, but after snowmelt (varies by year). **SPRING** burns can help to control cool-season grasses.	➤ FEB 15TH–MAR 15TH
Grazing		⊗ Not commonly used in this region.	
Interseeding	Fall-seeded	**OCT / NOV:** After first several hard frosts, but before permanent snow cover.	**NOV 15TH–DEC 15TH:** Before first hard-frost; or, MAR–APR
	Spring-seeded		
Plugs and Bare Root Planting[6]		➤ **MAY / JUN:** Plant as early as possible to catch spring rains. ➤ Additional irrigation may be required during the first year of establishment, especially during dry years.	**NOV 1ST–DEC 15TH** or **MAR 1ST–MAY 15TH** **OCT 15TH–DEC 15TH** or **MAR 1ST–MAY 31ST:** Plant in the fall before frost date or in spring after last hard frost. Planted plugs usually require irrigation for the first season.
Irrigation		➤ For spring seeded plots, irrigate during establishment year so that irrigation plus rainfall totals ~1" per week. Fall seeded plots should not require irrigation excepting very dry years, or excessively well drained soils.	➤ Plugs or bare roots may require supplemental irrigation until established. Wildflower habitat established by seed does not typically require irrigation in this region.
Starting Over	**Begin** site prep	➤ **SPRING:** As soon as soil can be worked (typically **MAY–JUN**).	➤ **SPRING:** As soon as soil can be worked.
	Seed site	**OCT / NOV:** After frost but before permanent snow cover.	**NOV / DEC:** Dormant seeding after frost but before ground freezes or permanent snow cover

KEY:

- ⊗ Not applicable.
- **REMINDER:** Avoid using management technique during nesting season for ground-nesting birds.
- **REMINDER:** Avoid or postpone management technique when wet conditions are predicted, such as spraying herbicides—to avoid movement of herbicides off target—or seeding during excessively wet conditions.
- ⚠ **WARNING**—Additional acton may be needed.
- Seed (or interseed) site.

ADDITIONAL INFORMATION:

1. **VEGETATION MONITORING**—Add **[MAR] APR** and **[NOV] OCT** for invasive cool-season grass scouting (); first several hard frosts ().
2. **MOWING FOR WEED CONTROL**—During establishment (~years 1–2); after establishment (years 2–3+). **Reminder:** Keep fire safety guidelines in mind when mowing in arid regions ().
3. **GRASS-SELECTIVE HERBICIDES**—Target applications during active growth of the dominant grass weeds on site: cool season grasses (); warm-season grasses (). **Reminder:** Avoid use or use carefully in plantings that contain desirable native grasses.
4. **CONSERVATION HAYING**—To support plant diversity, aim to hay at different times every year.
5. **PRESCRIBED FIRE**—When possible, avoid burning more than ⅓ of an area in a given year.
6. **PLUGS AND BARE ROOT PLANTING**—Plant plug transplants (); plant bare root transplants ().

SOUTHEAST

- JAN / FEB–NOV

⊠

- Rotational mowing preferred. **NOTE:** If mowing annually is required, break up area into three or more sections:

  1. SPRING / **2. MID-SUMMER** / **3. FALL** or **WINTER**

- Mow to 6–8" when weeds are 12–15" to allow sunlight to reach seedlings, kill annual weeds, halt weed seed dispersal, and avoid thick litter accumulation.

Dependent on weed growth.

EARLY SPRING or **MID-FALL:** Spray for cool-season grasses.

⚠ Aggressive species may need multiple applications.

- To support plant diversity over time, change up haying times.
- **YEAR-ROUND:** Can occur throughout the year.
- Cattle and other grazers like horses, goats, and sheep help maintain diversity in some areas, particularly balds and boggy sites.

DORMANT SEASON: After the first frost; or before the last frost.

⊠

DORMANT SEASON plantings are recommended, so that roots can develop when there is likely to be adequate moisture.
SPRING. Still may require irrigation.

- Plugs or bare roots may require supplemental irrigation until established. Wildflower habitat established by seed does not typically require irrigation in this region.

- **Smother cropping—SPRING:** begin site prep using tillage when plants have grown a few inches. **SUMMER–FALL:** smother crops for fall planting.
- **Solarization**—can be started in **SPRING** or **FALL**.

LATE FALL

Figure A1: Interseeding a site dominated with native grasses, using a native seed drill.

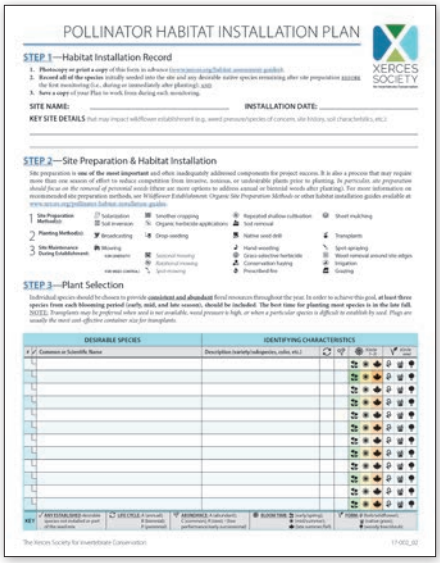
Notes:

Appendix B: Project Planning Forms

These forms were designed as tools to assist you with monitoring wildflower diversity and longevity on a site and planning habitat management. You can download them as printable PDFs at: **http://xerces.org/habitat-assessment-guides/**

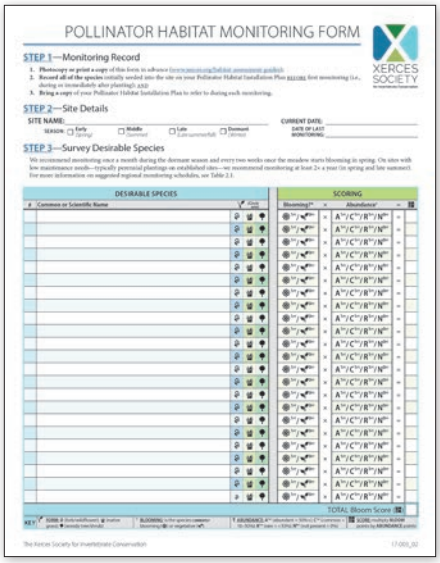
Installation Plan

Example on page 3.


POLLINATOR HABITAT INSTALLATION PLAN

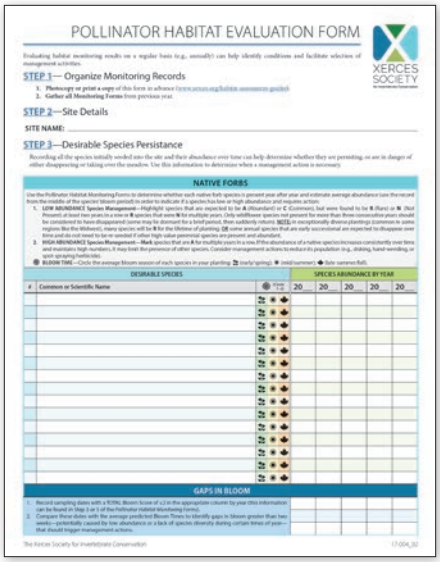
Monitoring Form

Example on page 7.


POLLINATOR HABITAT MONITORING FORM

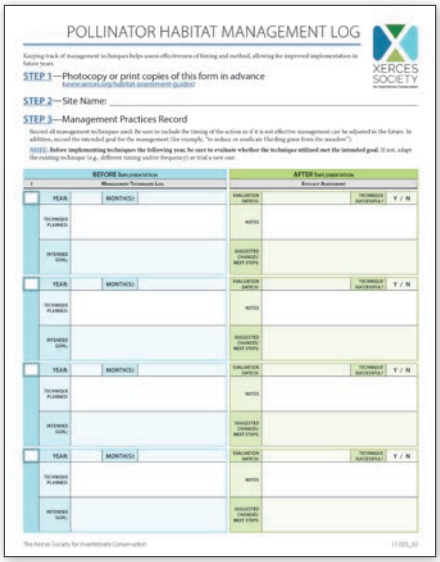
Evaluation Form

Example on page 11.


POLLINATOR HABITAT EVALUATION FORM

Management Log

Example on page 35.


POLLINATOR HABITAT MANAGEMENT LOG

Appendix C: Additional Acknowledgments

Photographs

We are grateful to the photographers for allowing us to use their wonderful photographs. The copyright for all photographs is retained by the photographers. None of the photographs may be reproduced without permission from the photographer:

Bear Paw Battlefield, National Parks Service [flickr.com/bearpaw]—Figure 4.6: Glacier Exotic Plant Team spot-spraying Canada thistle (*Cirsium arvense*) and bindweed (*Convolvulus* spp.).

Tony Frates [flickr.com/tonyfrates]—Decision Tree #3: saltcedar (*Tamarix chinensis*) and sandbar willow (*Salix exigua*) taking over a frequently-mowed site.

Kimberly Gallagher: Figure 7.4.

Chris Hoving [flickr.com/pcrucifer]—Figure 4.9: Prescribed burn in Newaygo county for Karner blue butterfly (*Plebejus melissa samuelis*) habitat.

Matt Lavin [flickr.com/plant_diversity]—Decision Tree #1: Low value native grass; Decision Tree #3: Cheat grass (*Bromus tectorum*).

Mark Mathosian [flickr.com/markgregory]—Figure 4.1: Florida burrowing owl (*Athene cunicularia floridana*).

Justin Meissen [flickr.com/40855483@N00]—Figure 4.6 (right): Spot-spraying herbicide on woody weeds.

Montana Fish, Wildlife, and Parks—Decision Tree #3: Hooked bristlegrass (*Setaria verticillata*).

Oregon State University [flickr.com/oregonstateuniversity]: Decision Tree #3: Medusahead (*Taeniatherum caput-medusae*).

Harry Rose [flickr.com/macleaygrassman]—Decision Tree #3: Harding grass (*Phalaris aquatica*).

Tina Shaw, USFWS Midwest Region [flickr.com/usfwsmidwest]—Figure 7.1: Collecting milkweed (*Asclepias* spp.) seeds.

Lan Shen, Houstan NPAT [flickr.com/hnpat]—Decision Tree #2: Mostly woody weeds.

Ken Slade [flickr.com/TexasEagle]—Decision Tree #2: Patchy weeds.

Claudia Street, Glenn County RCD—Figure 4.2: Tarweed (*Grindelia* spp.) seedlings seven days post-mowing.

Stephen Thomforde, Great River Greening—Figure 4.8: Conservation haying.

Sandor Weisz [flickr.com/santheo]—Figure 4.5: Hand-weeding at Meadowbrook Farm.

Dave Williams—Figure 4.4: Using a string-trimmer for targeting weeds between wildflowers.

The Xerces Society / Nancy Lee Adamson—Figure 5.1.

The Xerces Society / Jessa Kay Cruz—Cover (*front*); Figures 3.3, 4.3, 4.7, 4.13, 5.2, 5.3; Decision Tree #1: Lacy phacelia (*Phacelia tanacetifolia*), distinct patches, intermixed, key planted species missing, gaps in bloom; Decision Tree #2: Prickly lettuce (*Lactuca serriola*) & Radish (*Raphaenus* spp.); Figures 7.2–3; A1.

The Xerces Society / Sarah Foltz Jordan—Figures 1.1, 2.1, 3.4, 4.8, 4.10, 4.12A & 4.11B, 4.14, 4.15; Decision Tree #1: Common yarrow (*Achillea millefolium*), April 2015, May 2016; Decision Tree #3: Plumeless thistle (*Carduus acanthoides*).

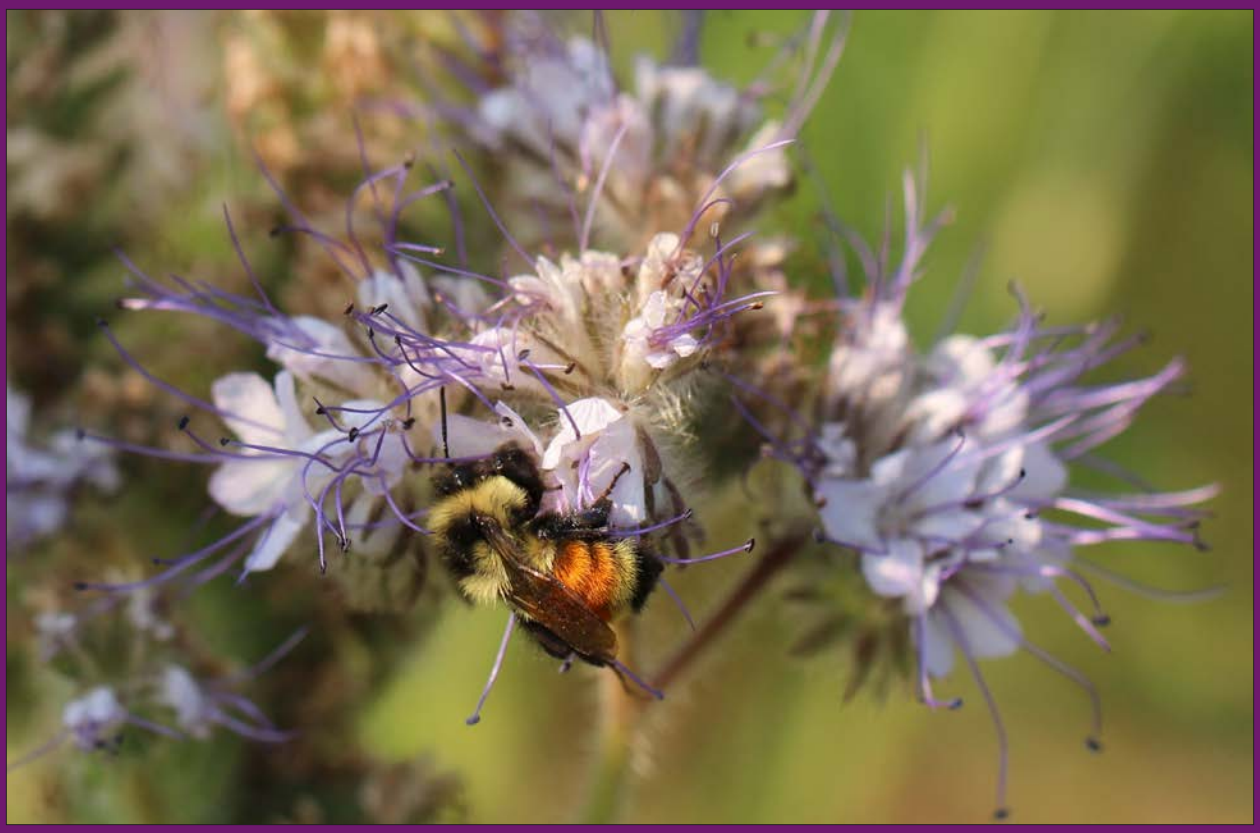
The Xerces Society / Kelly Gill— Decision Tree #2: Mostly Grasses; Figure 7.5–6.

The Xerces Society / Jennifer Hopwood—Cover (*back*); Figures 3.5, 4.11; Decision Tree #1): Low-moderate value wildflower.

The Xerces Society / Eric Lee-Mäder—Figure 7.1.

The Xerces Society / Hillary Sardiñas—Decision Tree #3: Mixed weedy forbs and grasses.

The Xerces Society / Mace Vaughan—Figure 6.1.



Hunt's bumble bee (*Bombus huntii*) on lacy phacelia (*Phacelia tanacetifolia*) in Montana pollinator planting. (Photograph by Jennifer Hopwood, The Xerces Society.)

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