Part 645 – National Range and Pasture Handbook

Subpart M – Pollinator Habitat Considerations for Range and Pasturelands

645.1301 General

A. Definition: Pollination is the transfer of pollen grains from a plant's anther (the pollen-producing part of the flower) to a stigma (the pollen-receiving part of a flower). In most plant species, pollination is required to produce fruit and seeds, and cross-pollination (pollination between two genetically different individuals) helps to enhance fruit and seed production. The three major types of pollination are:

(1) Self-pollination – Self-pollination occurs in some species of plants with perfect flowers, where there is proximity of the anther and stigma in the flower's morphology and when the plant is self-fertile (does not require cross-pollination). Cotton, soybeans, and tomatoes are examples of self-pollinating plants.

(2) Wind-pollination – Wind-pollinated plants produce pollen grains that are carried by the wind; they produce huge amounts of pollen to assure that some pollen grains, by random chance, to reach the stigmas of flowers growing on other individuals of their species. Most grasses (including rice, corn, and wheat) are wind-pollinated as are many nut trees (including pecans and walnuts) and conifers (pines, firs, cedars, etc.).

(3) Animal-pollination – For many species of plants, pollination is facilitated by animals transporting pollen from the anthers to the stigma. This reproductive strategy allows for less pollen production than wind-pollination. Approximately 85 percent of plant species (including almonds, blueberries, and apples) depend on animals for pollination. Pollinators are animals that transfer pollen from the anther to the stigma, usually while visiting flowers to consume nectar and/or pollen. Pollinators are essential for pollination of plants that do not self-pollinate or utilize wind-pollination. Some self-pollinating plants (e.g. cotton, soybeans, and tomatoes) are used as a nectar and/or pollen source by pollinators, allowing for cross-pollination of some of the seed. For those plants, pollinators provide value by increasing pollination rate (thus enhancing fruit and seed production) and by assuring increased genetic diversity of the offspring (seeds) – a critical characteristic for ecological adaptation.

B. Among the vertebrate animals, there are multiple hummingbird species that serve as pollinators, and some other vertebrate groups (e.g., bats, lizards) have at least a few species that are pollinators. However, insects including bees, butterflies, moths, flies, wasps, and beetles, make up the great majority of pollinator species. Insect pollinators such as managed honeybees and wild native bees not only play a critical role in our food production system, but also in the pollination of thousands of plant species in native and managed ecosystems. For the remainder of this chapter, the term "pollinator" and "pollinators" refers to insect pollinators, not vertebrate pollinators.

C. Federal Policies and Directives

(1) Over the past two decades, a significant decline in pollinators has been noted. In response, the federal government has made efforts to promote pollinator health and habitat. These efforts include a Presidential Memorandum (2014) and Federal Strategies (2015) to promote the health of honey bees and other pollinators as well as Farm Bill programs (particularly 2008, 2014, and 2018) that provide federal resources for creating and enhancing pollinator habitat on private lands. In support of the value of pollinators, NRCS provided specific policy regarding pollinators (Title 190, General Manual, Part 416, "Pollinators") that focuses on "preventing unnecessary harm to pollinators and their habitats and to enhance, whenever practical, the nesting and foraging habitats for pollinators."

(2) Some pollinator species, such as the rusty patched bumble bee (*Bombus affinis*), have decreased in abundance and extent and have been listed as threatened or endangered by the U.S. Fish and Wildlife Service. When threatened and endangered (T&E) species are of concern, NRCS will follow agency policies to assure that NRCS technical or financial assistance meets the mandates of the Endangered Species Act, 1973.

645.1302 Insect Pollinators on Range and Pasturelands

A. Value to Agriculture

Insect pollinators play a critical role in supporting agricultural production. Over 100 crops in the U.S. depend on pollinators to produce seeds, fruits, nuts, vegetables, and fiber, resulting in an estimated value of $30 billion annually (Jordan et al. 2021). These crops are often adjacent to rangelands and pasture. Pollinators and agriculture go hand-in-hand. Farmers and ranchers rely on pollinators to pollinate many of their crops, enhance on-farm biodiversity and support wildlife habitat, while pollinators rely on agricultural conservation practices and well-managed range and pasturelands for habitat and forage. Thriving populations of bees and other pollinators on rangelands and pasture pollinate native wildflowers (which often serve as nutritious forage to livestock) and exotic forage legumes. In doing so, they ensure that these plants remain present and abundant while also providing pollination services on other nearby crops.

B. Ecological Value and Linkage to Ecosystem Services

The benefits pollinators provide for ecosystems are wide-ranging and substantial. Pollinators play a critical role in range and pastureland ecosystem processes by increasing biodiversity and abundance of forbs, legumes, and flowering woody plants. They increase capacity of range and pasturelands for provisioning (animal feed, food, and fiber), regulating (carbon cycling), supporting (biodiversity and water and nutrient cycling), and providing cultural (recreational, spiritual, and aesthetic) services (Gibson 2006).

645.1303 Range and Pasturelands as Pollinator Habitat

A. North American rangelands, particularly those with a high diversity of native forbs, legumes, shrubs, grasses and grass-like species (graminoids) (figure M-1), are excellent habitat for thousands of species of insect pollinators. Rich and diverse native plant communities tend to increase ecosystem function and stability resulting in greater resilience and resistance to maintain ecosystem states and facilitating recovery from disturbances such as drought, grazing, and fire (Anderson 2006; Standish et al. 2014; Zuppinger-Dingley et al. 2016). On pasturelands, common seed mixes are often used and typically have only a few species of grasses and legumes (figure M-2); pasturelands with low plant species richness have been shown to have lower pollinator species richness (Orford et al. 2016). However, it is possible to create pasturelands with high plant diversity, by planting a diverse mix of native and non-native grasses, forbs, and legumes (figure M-3). If pasturelands are managed for high floral resource availability, they can support large populations of multiple pollinator species.

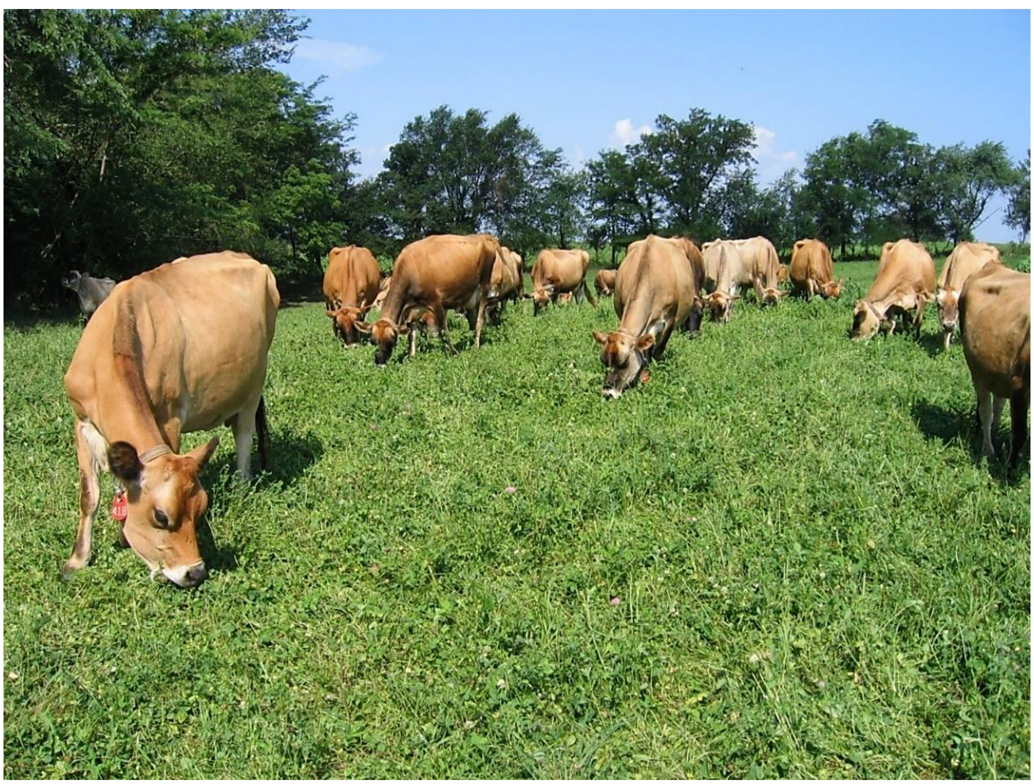
B. To meet the landowner's pollinator habitat objectives, the conservation planner should assist the client with setting realistic expectations. The establishment of rich and diverse plant communities requires different time, care, consideration, and maintenance, when compared to the management of grass-only communities (Gibson 2006, Symstad and Jonas 2011). For many grazing operations, particularly with improved pasture (e.g., Bermuda grass, bahia grass, fescue spp., timothy, orchard grass, and smooth brome), the establishment of a dedicated pollinator habitat area may be an additional alternative for the client.

Figure M-1. Rangeland grazed by cattle in Osage County, Oklahoma (Photo by Ray Moranz, Xerces Society and USDA-NRCS).

An example of the conservation practice standards (CPS) which may be utilized to promote dedicated pollinator habitat include Hedgerow Planting CPS 422A, Field Border CPS 386, Filter Strip CPS 393, Wildlife Habitat Planting CPS 420 or other conservation practice standards allowing for emphasis on pollinators (see Using 2018 Farm Bill Programs for Pollinator Conservation). Adding a mixture of clovers or diversifying with native species, particularly native legumes, are additional options for pasture overseeding and renovation. Herbicide options to control noxious or invasive plants may require the use of spot chemical treatments or mechanical removal. Planning and implementation of prescribed fire on rangeland may require additional considerations with regards to fire return interval and timing, if the objective is to maintain or increase the forb component. Additional monitoring and management may be required in managed grazing systems, as livestock often select preferred pollinator plants. Forage harvest management may require altering the timing and amount of harvest activities.

Figure M-2. Pastureland with cattle grazing in Maryland. Photo by Preston Keres, USDA.

Figure M-3. Legume-rich, diverse pastureland with cattle grazing in southeastern Iowa. Photo by Francis Thicke (Radiance Dairy).



645.1304 Major Pollinator Groups and their Biology

A. Overview

Among insects, the main groups that pollinate are the bees, butterflies, moths, flies, wasps, and beetles. Bees are considered to be the main pollinators. In addition to the European honey bee, there are close to 4,000 native bee species in the United States (Ascher and Pickering 2020; Moissett and Buchanan 2010), and they are efficient pollinators of flowers, including crops. All insect pollinators have multiple life stages (egg, larva, pupa, adult). To thrive, the needs of each life stage must be met. Biologists have identified four key habitat resources necessary to support diverse pollinator communities.

(i) Host plants – Provide vegetative forage needed for larval development of most butterfly and moth species, as well as for some flies and beetles. Insect species differ greatly in the host plants they require. Some pollinator species are host plant generalists (their larvae eat plant species from multiple plant families), but even these generalist species use only a small subset of the entire plant community. Other pollinators are host plant specialists, with their larvae eating plants from only one or two families. For instance, the monarch butterfly is a host plant specialist. In natural settings, its larvae feed only on milkweed plants (Family *Apocynaceae*). Rarely do two insect species have precisely the same host plant requirements. Therefore, having a diversity of plants is critical to provide for the larval needs of a diverse community of butterflies and moths. Many forb species serve as larval hosts, but so do many legumes, graminoids (grasses and grass-like plants such as sedges and rushes), and woody plants.

(ii) Nesting sites – Nesting sites are essential for bees and wasps to support their development from egg to larva to pupa to adult. Approximately 70 percent of native bee species nest underground. Bare areas between plants with crumbly textured, uncompacted (friable) soils are essential. Almost 30 percent of bee species nest in cavities in herbaceous or woody stems. Dead but standing stems from prior years are highly suitable for these cavity nesters. The 47 species of bumble bees in the U.S. nest in cavities such as abandoned rodent burrows or at the base of bunch-forming grasses (Michener 2007).

(iii) Overwintering sites – The great majority of insect pollinators do not migrate and are full-year residents. In most U.S. states, cold winter temperatures restrict insect activity, and those insects need somewhere to safely survive the winter while immobile. Some insect pollinators spend the winter underground, while others overwinter within leaf litter or within stems of forbs, legumes, graminoids and woody plants.

(iv) Floral resources – Flowers producing nectar and pollen, which serve as food for adult bees and butterflies, and some flies, beetles, wasps, and moths. Most pollinators feed on nectar from a diverse array of plant species, although many pollinators exhibit a strong preference for a few species. Pollen is consumed by bee larvae and adults, as well as some adult flies and beetles. Adult bees collect pollen to feed to their larvae, and many bee species are pollen generalists collecting pollen from plants from multiple plant families (polylactic). However, others specialize in pollen from a few plant species (oligolectic), and a handful of bee species specialize on pollen from a single species. A large percentage of forb, legume, and woody plant species produce nectar and edible pollen. Most graminoid species have wind-pollinated flowers that produce no nectar and produce pollen with limited nutritional value to most pollinators. Graminoid pollen may have incidental use particularly where forb pollen is lacking (Saunders 2018). More importantly, as mentioned above, graminoids can serve as host plants, nesting sites, and overwintering sites, and thus are important components of pollinator habitat.

645.1305 Characteristics of Suitable Pollinator Habitat

A. Suitable pollinator habitat usually has all four key resources in proximity (host plants, nesting sites, overwintering sites, and floral resources). Additionally, disturbance regimes (such as prescribed fire or grazing) are implemented so that they maintain habitat quality without causing excessive mortality to pollinator populations. If pesticides are used, their potential negative impacts on pollinators can be mitigated using Pest Management Conservation System (Conservation Practice 595) and other conservation practices.

B. In North American rangelands and pasturelands, maintaining or enhancing plant diversity is one of the central tasks of pollinator and grassland conservation (Gibson 2006; Zuppinger-Dingley et al. 2016). Diverse plant communities help to ensure that the key resources mentioned above are available, particularly host plants for a wide variety of butterflies and moths. Given that plant species flower at different times, high plant diversity also helps to ensure floral resources throughout the growing season. This is of great importance to pollinators, as numerous species are unlikely to persist if there are long periods with no nectar or pollen available.

C. Although there are exceptions (see Mack and Thompson 1982), a large number of North American grassland plant species are highly tolerant of grazing and can persist with moderate or high utilization rates. However, sometimes persistence of a diverse plant community is not enough. In some diverse grasslands, many of the forbs preferred by pollinators for their floral resources are grazed so low that they are unable to bloom or produce few flowers (Moranz et al. 2014). This is problematic because plants need to bloom to provide nectar and pollen to pollinators.

645.1306 Pollinator Habitat Management – Overview`

Ecologically diverse and well managed range and pasturelands provide many environmental benefits, including important habitat for pollinators. Managed grazing, prescribed burning, forage harvest management, and pest management conservation systems, either in combination or individually, can be important tools to increase plant and pollinator diversity on range and pasturelands (Jonas et al. 2015). Planners will need to consider how the timing, technique and scale of these practices may affect pollinators.

645.1307 Pollinator Habitat Management – Grazing

A. Grazing Effects on Pollinators

Few studies have been performed to assess the impacts of grazing on North American pollinators, and most studies performed to date have studied only a small subset of the pollinator community. Studies here and abroad show two main types of responses: (1) pollinators benefit from grazing when livestock forage selectively on grasses, allowing for an increase in forb abundance and diversity; and (2) pollinators are harmed by grazing when livestock feed heavily on forbs for a long duration (Hopwood et al. 2015). Below, we discuss variables to consider when the goals are to increase abundance and diversity of forbs and pollinators.

(i) Grazing Animal

Plants and pollinators in some North American grassland ecoregions, particularly tallgrass, mixedgrass, shortgrass prairies, evolved in with the presence of grazing by large ungulates such as bison and elk (Mack and Thompson 1982; Anderson 2006). Today, most rangelands and pasturelands are grazed by domesticated grazing animals from the old world (especially cattle, horses, sheep, and goats). In general, these livestock species differ from one another and from native grazers in their forage preferences and grazing behaviors. Additionally, different breeds, sexes, and age classes of grazers forage differently. When developing prescribed grazing or forage harvesting plans for landowners interested in pollinator conservation, NRCS planners should learn the feeding preferences and behaviors of the livestock on the ranch or farm, and if possible, should assess the effects of recent or current grazing by those animals on key resources for pollinators, particularly important floral resources and host plants.

(ii) Stocking Density

Stocking density impacts forage utilization, which in turn impacts pollinator habitat. High stocking rates can result in short-term and even long-term decrease in floral resources. On the other hand, if the grazing animals in question strongly prefer grasses over forbs, moderate and perhaps even high stocking rates can result in forb-dominant communities by releasing forbs from competition with grasses on native rangelands. Stocking density also can influence direct mortality of pollinators. Heavy stocking is likely to cause greater mortality of immobile eggs, pupae, and slow-moving larvae by trampling or incidental consumption. Regardless, the duration and timing of grazing events and rest and recovery periods are critical components of managed grazing that must be considered.

(iii) Duration, Timing and Rest Period

Regarding its effects on pollinator habitat, stocking density appears to interact strongly with the duration and timing of grazing. On most range and pasturelands, high stocking density for numerous consecutive months is likely to result in long-term depletion of floral resources and host plants, as well as greatly reduced grass biomass (Moranz et al 2014; DeBano 2016). High stocking density for a short period of time can cause short-term losses of pollinator resources; but if enough rest is provided to the grazing unit, these pollinator resources often send up new shoots that flower (from the ground or from leaf axils). In some regions of the U.S., moderate to high stocking density improves pollinator habitat by reducing the dominance of one or more exotic grasses (e.g., exotic Kentucky bluegrass in the Northern Plains). Regardless of grazing animal and stocking density, it is essential to plan for a rest period when plants can recover after a grazing event, so that the plant can regrow, replenish food reserves, and bloom.

B. Considerations for Managed Grazing (528)

NRCS field staff should consider the following when developing managed grazing plans for producers seeking to conserve pollinator populations.

(i) Determine if the site has any threatened and endangered (T&E) species or species of special interest to the producer, or if the producer’s pollinator habitat goal involves pollinators in general.

(ii) Identify the plant species that meet the needs of target pollinators.

(iii) Although grazing management that increases plant diversity and floral resource availability often benefits pollinators, it is important to remember that high plant diversity does not guarantee floral resource availability. When pollinator habitat is an objective, a managed grazing plan should aim to minimize impacts to flowering stems.

(iv) The grazing plan should consider the objective of assuring that target forbs be allowed to flower and set seed. This may require season-long deferment of some pastures. The length of rest period varies by region. Refer to State guidance for specific recommendations.

(v) If conservation of native bees is an objective, aim to minimize livestock concentrations causing excessive soil compaction and trampling of ground-nesting sites. This may require deferment of some pastures for weeks or months.

(vi) Riparian areas can support high diversity and abundance of native forbs and pollinators (DeBano et al. 2016). NRCS conservation practices such as Fence (382) and Watering Facility (614) can be used to divert livestock away from riparian areas, thus reducing harm to forbs. This is particularly important for riparian areas in the arid West.

645.1308 Pollinator Habitat Management – Prescribed Fire

A. Fire Effects

Overall, insect pollinator diversity and abundance are enhanced by restoration of ecological processes associated with reference conditions or other states in the ecological site description and state-and-transition models for an area (Standish et al. 2014; York et al. 2017). This includes restoration of prehistoric fire regimes through the implementation of prescribed fire. Fire frequency is dependent upon ecosystem characteristics, where range and pasture with higher moisture regimes generally exhibiting higher fire frequencies (and shorter fire return intervals) than more arid systems (Symstad and Jonas 2011). Restoring prehistoric fire regimes through the implementation of prescribed burning can accomplish this in the following ways:

(i) Fire can slow or reverse woody plant encroachment, creating improved microclimates (more sunlight, warmth) for most insect pollinators, while also improving habitat conditions that increase forb and legume diversity.

(ii) Fire can reinvigorate plant communities by burning up litter and standing dead vegetation. This results in improved nutrient cycling, greater light penetration, and increases in soil temperature, which in turn stimulates seed germination, production, and plant growth.

(iii) Fire stimulates increased flowering in many plant species, some of which are preferred sources of nectar and pollen.

B. NRCS planners should note that many insect pollinators are vulnerable to fire (Black et al. 2011)., This is particularly true of the immobile eggs and pupae, as well as the slow-moving larvae. All three of these life stages are likely to be incinerated if they are above ground during the prescribed burn. Fire can have negative indirect effects as well, by top-killing host plants and floral resources, and by destroying the pithy stems used by stem-nesting bees.

C. Different timing, frequency, and intensity of fire provides different outcomes. Fire can be used to benefit grass to the detriment of forbs. If pollinator habitat is an objective, prescribed burns require the consideration of the forb community.

D. In figure M-4a, pasture to the right of the burn boundary was burned with higher windspeed and lower relative humidity, whereas pasture to the left of the burn boundary (burned one day after the burn on the right) was burned with lower windspeed and higher relative humidity. Figure M-4b shows natural skips associated with higher frequency burns. Ecosystem response to fire must be carefully considered in conservation planning. Follow NRCS planning policy, standards, State specific protocols, and refer to Subpart J – Prescribed Burning in this handbook for additional information. The following parameters should be considered to address pollinator needs when implementing prescribed burns. These parameters promote a lighter and patchier spatial distribution of prescribed fire resulting in a natural mosaic structure and refugia for pollinators, as exemplified in figures M-5a and M-5b.

(1) Higher relative humidity results in a slower fire with a greater number of natural skips.

(2) Shorter fire return intervals reduce fuel load build up, creating less intense fires with greater number of natural skips, particularly in mesic systems.

(3) Burning during periods of lower wind speed can lead to lower intensity fires with a patchy spatial distribution, which can reduce direct mortality to pollinators.

(4) Consider varying the timing of prescribed burns to benefit a broader diversity of plant and pollinator species.

Figure M-4. Prescribed fire implemented in mesic pastureland in eastern Iowa. Photos by Christine Taliga, (USDA-NRCS).

(a)

(b)

Figure M-5. Prairie pasture showing refugia after prescribed fire implementation in eastern Iowa **(a)** and the following summer **(b)**. Photos by Christine Taliga (USDA-NRCS).

(a)

(b)

E. Considerations for Prescribed Burning (338)

Prescribed burn implementation may offer an important tool for landowners interested in improving pollinator habitat, plant diversity, and productivity, and reducing pest pressure. NRCS planners should consider the following during the prescribed burn planning process:

(i) Determine if the site has any T&E species or species of special interest to the producer, or if the producer's pollinator habitat goal involves pollinators in general.

(ii) Identify the plant species that meet the needs of target pollinators.

(iii) The burn plan should be designed to benefit the target plant community. However, the needs of the plant community need to be balanced with the need to mitigate mortality to pollinators. One way to achieve this balance might be to burn only a portion of the farm or ranch each year. This would reduce the likelihood of extirpating local pollinator populations that can occur when their entire habitat is burned at the same time. For example, in tallgrass prairie rangeland, some pollinator ecologists recommend burning no more than one third of the habitat per year.

(iv) Allow unburned skips to remain. Don't go back after the main fire to try to burn every square foot of the burn unit.

(v) If the producer is concerned about one or more imperiled pollinator species on their land, incorporate information about this pollinator's life cycle to modify the planned season of burn to minimize likelihood of causing significant species harm.

(vi) Burn at different times of year, rather than at the same time each year. Burning during the same season over time may shift community dynamics, favoring some plant species and pollinator species at the expense of others.

645.1309 Pollinator Habitat Management – Mowing and Haying

A. Mowing and Haying Effects

Although livestock grazing is the main land use of rangeland in the U.S., significant acreages of rangeland are hayed, particularly in the tallgrass prairie region of the central U.S. The effects of haying on rangeland pollinators have seldom been studied in the U.S. However, like other management activities, haying can have positive and negative effects. On the positive side, haying can help to maintain plant richness and abundance in native range (Kansas Natural Heritage Inventory 2010). This removal of above ground biomass increases light availability to seedlings and crowns of forbs, legumes, and grasses. Unfortunately, as with prescribed fire, haying can kill pollinators, particularly the immobile or nearly immobile immature forms. Haying also temporarily reduces availability of host plants, stems for stem-nesting bees, and floral resources used by most pollinator species.

B. Considerations for Forage Harvest Management (511)

Forage and harvest management may be utilized to enhance desirable species, reduce pest pressure, and increase wildlife habitat, while also benefitting pollinators. NRCS planners should consider the following techniques when the landowner's objectives include pollinator protection:

(i) Determine if the site has any T&E species or species of special interest to the producer, or if the producer's pollinator habitat goal involves pollinators in general.

(ii) Identify the plant species that meet the needs of target pollinators.

(iii) Consider two cuttings or fewer per growing season from each site. Multiple cuttings per year is suspected of causing greater direct mortality to pollinators and of limiting the availability of floral resources (McKnight 2018).

(iv) Consider adjusting the timing of haying to avoid impacts to pollinators. Stagger cutting and harvest to accommodate bloom time and allow for re-bloom, if practical, considering hay quality.

(v) If harvesting an entire field, harvest from one end of the field to another (or from the middle going outward) to allow insects an escape route, rather than harvesting from the perimeter inward.

(vi) Use a flushing bar on the mower and reduce mowing speeds to allow pollinators to escape.

(vii) Leave some unharvested areas each growing season for pollinator habitat.

645.1310 Pollinator Habitat Management – Herbaceous Weed Treatment (315)

Removal of herbaceous weeds including noxious, prohibited, and undesirable plant species not only enhances the quality of the forage for grazers, but also releases native or desired plant communities essential for pollinator habitat.

NRCS planners should consider the impacts to pollinator food supplies and habitat when planning the method and amount of herbaceous weed treatment when the landowner's objectives include pollinator protection along with the following:

- (i) Determine if the site has any T&E species or species of special interest to the producer, or if the producer's pollinator habitat goal involves pollinators in general.
- (ii) Identify the plant species that meet the needs of target pollinators.
- (iii) Adjust the timing of treatments to periods of the year that accommodate reproduction and other life cycle requirements of target pollinator species.
- (iv) Apply herbaceous weed treatments that protect the health and vigor of native or desired plant species to preserve and enhance habitat for pollinator insects.
- (v) Select treatments that maintain or enhance plant community composition and structure to meet the requirements of target pollinator species.
- (vi) When the herbaceous weed treatment of undesirable species results in the need to reestablish desired herbaceous species, follow details in the appropriate NRCS vegetation establishment practices and use native vegetation to preserve and enhance pollinator habitat.
- (vii) Consider selective herbicides with minimal impacts to desired plant species supporting pollinators.

645.1311 Pollinator Habitat Management – Pest Management Conservation System (595)

Pests, including noxious and invasive plant species, are of considerable concern in the maintenance of healthy range and pasturelands. By protecting pollinators during pest management activities, other beneficial insects and other wildlife may also benefit. In rare situations, the use of Pest Management Conservation System (Code 595) may be warranted on grasslands. In such situations, conservation planners can help producers prevent or mitigate pest management risks to pollinators by utilizing the principals of PAMS (prevent, avoid, monitor, suppress) in their integrated pest management (IPM) approach.

(1) Use the following techniques to reduce impacts to pollinators:

- (i) Determine if the site has any T&E species or species of special interest to the producer, or if the producer's pollinator habitat goal involves pollinators in general.
- (ii) Assess potential impacts to target pollinators from pest management activities.
- (iii) Prevent pest populations from infesting a field or site by reducing conditions favoring pest populations. This may be achieved by conducting regular soil analysis to prevent overapplication of nutrients and increasing species diversity (Zuppinger-Dingley et al. 2016). Clean equipment thoroughly and implement sanitation procedures to prevent introducing plant pests and pathogens.
- (iv) Avoid pest populations by choosing pest-resistant cultivars and native species.
- (v) Monitor for pests regularly by implementing a scouting program and keeping records of pest location and distribution. Also monitor pollinator types and species in the area to avoid potential impacts.
- (vi) Suppress pests with the most targeted and least damaging methods available to pollinators when economic thresholds are determined. Choose alternative active ingredients, formulations, or applications methods that offer less risk to pollinators. Adjust the timing of pesticide applications (an hour after sunset) to avoid periods when pollinators are more likely to be present and active.

(2) Refer to the following USDA resource when considering the impacts of pesticides on pollinators:

Agronomy Technical Note 9 (Title 190), “Preventing or Mitigating Potential Negative Impacts of Pesticides on Pollinators Using Integrated Pest Management and Other Conservation Practice.”

645.1312 Pollinator Habitat Management – Brush Management (314)

A. Livestock and many pollinator species benefit from brush management because high woody plant cover can reduce the abundance and diversity of herbaceous plants used by livestock and pollinators alike (Archer et al. 2017). Practices that reduce woody plant cover will usually have a net long-term benefit to grassland pollinator communities if the negative effects of the woody plant reduction are short-lived and do not eliminate a local population of a pollinator species. Determine the pollinators the producer aims to conserve and assess potential impact of brush management to those pollinators. Schedule implementation of brush management so that it is effective but also reduces impact to pollinators.

B. When implementing chemical treatments for woody management follow the Pest Management Conservation System standards (595) above.

645.1313 Pollinator Habitat Management: Planting and Stand Rejuvenation - Range Planting (550), and Pasture and Hay Planting (512)

A. Conservation Practice 550 (Range Planting) and Conservation Practice 512 (Pasture and Hay Planting) can involve seeding onto a clean soil bed or sowing seeds in already established range or pasture via the methods of overseeding, interseeding, or spot replanting. Regardless of the method, producers can improve pollinator habitat by including a diverse array of forb and legume species in their seed mix.

(1) Utilize the considerations below to enhance pollinator habitat.

- (i) Determine the pollinators that currently utilize the site.
- (ii) Determine the flowering resources currently available at the site.
- (iii) For native range, the site should have a diversity of native forbs, legumes, and shrubs blooming each month of the growing season so that they provide nectar, nesting sites, shelter, and larval host plants throughout the growing season.
- (iv) For pasture, increase the diversity of flowering legume and forbs species. Utilize a flowering cover crop when implementing long-term crop rotations that include rotation of pasture and hayland planting. Schedule cultural practices (mowing, fertilization, irrigation) to avoid or minimize prime foraging times for bees and breeding, egg, and larval stages for key butterflies. Implement Field Borders (386), Contour Buffer Strips (330), and Filter Strips (393), with abundant floral resources to provide additional plant diversity.
- (v) If the client is interested in pollinator habitat but also interested in maintaining “improved” pasture (e.g., Bermuda grass, bahia grass, fescue, etc.), consider informing the client of the alternative of establishing a dedicated pollinator habitat area that is excluded from grazing.

(2) If interseeding to improve pollinator habitat, consider the following:

- (i) Remove built-up thatch by conducting a Prescribed Burn (338) during the dormant season, followed by interseeding forbs, shrubs and subshrubs, and legumes with the use of a no-till drill or broadcast method. Ensure seed-to-soil contact and seeding depth is specific to seed type. Use native species whenever possible. Fall or dormant seeding of forb-rich seed mixes allows for natural winter stratification, necessary for the germination of many forb species.

(ii) Strategic livestock use or mowing may aid in the establishment of newly seeded vegetation. Implement the timing of these activities to allow for blooming of the newly seeded species if applicable.

(iii) Commence site preparation activities during the dormant season to minimize impacts to pollinators. Implement seeding with the use of a no-till drill to minimize ground nesting habitat, erosion, and weed growth. For bare seed beds, consider the use of mulch or cover crops to prevent erosion and protect ground nesting sites, while allowing for some bare ground where sites are least subject to erosion. If utilizing a blooming cover crop (340) allow for bloom completion before termination.

(iv) When selecting species for range and pasture planting, use adapted species and cultivars specific to the area. Use those species of high pollinator value (NRCS Plant Materials Pollinator Conservation Plants) and ensure high seed viability with current species-specific seed tests.

(v) For legumes, use pre-inoculated seed, inoculum-coated seed, or inoculate with the proper viable strain of rhizobia immediately before planting. Use native legumes when available and practical.

(vi) Interseeding on rangeland does not meet NRCS Standards and Specifications in all States. Therefore, please check with your State's guidance when considering this practice.

B. Post-seeding management is critical for plant establishment.

The following techniques may be used to foster plant establishment with pollinator considerations:

(i) Implement mowing techniques to minimize weed seed set while allowing early successional seeded species to flower below the mow line.

(ii) Follow livestock exclusion recommendations until plants are fully established (usually after the second year of seeding).

(iii) Use strategic and closely monitored prescribed grazing to eliminate competition from existing vegetation when interseeding, then implement livestock exclusion recommendations until plant establishment.

(iv) Implement PAMS as noted above.

645.1314 Additional Resources

A. Some Key USDA Resources on Pollinator Conservation

(1) USDA-NRCS Plant Materials Resources: Pollinator Value of NRCS Plant Releases Used in Conservation Plantings. Plant Materials Publications Relating to Insects and Pollinators.

(2) USDA 2014. Using 2014 Farm Bill Programs for Pollinator Conservation. Biology Technical Note NO. 78. 2nd ed. USDA; South San Francisco, CA, USA.

(3) Conservation Webinars: http://conservationwebinars.net

(4) USDA Plant Database: https://plants.usda.gov/home

B. Plant Identification

(1) Tools used to assess rangeland and pastureland health will help NRCS staff provide guidance to producers. However, additional resources exist that will help NRCS identify plants to assess pollinator habitat conditions, as well as information on how to manage for pollinators.

(2) To assess the availability of host plants and floral resources, it is necessary to be able to identify plants. In addition to working with local experts, extension services, and university staff, multiple tools exist to help with this.

(i) The USDA Plants website; https://plants.usda.gov/home. This website provides illustrations, tips on identification, and a range map for each species. For many plants, plant guides or fact sheets have been developed to provide NRCS field staff with information on the biology and management of these plants.

(ii) NRCS has developed plant guides to assist in the identification of preferred monarch butterfly plants. Most of these plants also have value of pollinators. These guides can be found at the NRCS Monarch Web Page https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/plantsanimals/pollinate/?cid=nrcseprd402207.

(iii) State-level NRCS online plant guides, such as California NRCS eVegGuide.

(iv) Websites of various botanical organizations, particularly:

- Your State's native plant society
- The Ladybird Johnson Wildflower Center: https://www.wildflower.org/plants/
- Calflora: calflora.org

(v) Online apps that identify the organism (plant, animal or fungus) in each photo that you submit to the app. These apps are not 100 percent accurate but are becoming more accurate as they incorporate more photos. Make sure you do not share any of the producer's personally identifiable information with these apps.

C. Evaluating Pollinator Habitat

Some State NRCS offices have developed Pollinator WHEGs (Wildlife Habitat Evaluation Guides). These WHEGs are typically available on each State's online Field Office Technical Guide. Some additional resources to help assess pollinator habitat conditions are:

(i) https://xerces.org/publications/hags/natural-areas-and-rangelands

(ii) https://xerces.org/publications/hags/pollinators-farms-and-agricultural-landscapes

D. Other General Guidance on Conserving Pollinators on Rangelands, Pasturelands, and Farms

(1) Bosworth, Sid. 2018. Developing a Bee-Friendly Pasture System. Forage Legume Pollinator Project, University of Vermont Extension, Burlington, VT. Available online at: http://pss.uvm.edu/beeclover/Articles/Pollinator_Pasture_UVMExt2018.pd

(2) Eric Mader, Matthew Shepherd, Mace Vaughan, Scott Hoffman Black, and Gretchen LeBuhn. 2011. The Xerces Society Guide: Attracting Native Pollinators (protecting North America's bees and butterflies). Storey Publishing, North Adams, MA.

(3) National Strategy to Promote the Health of Honey Bees and Other Pollinators. Available at https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/Pollinator%20Health%20Strategy%202015.pdf

(4) The Xerces Society. 2018. Best Management Practices for Pollinators on Western Rangelands: Guidelines Developed for the U.S. Forest Service. 126+vii pp. Portland, OR. The Xerces Society for Invertebrate Conservation. Available online at https://xerces.org/publications/guidelines/best-management-practices-for-pollinators-on-western-rangelands

(5) The Xerces Society. 2020. Rangeland Management and Pollinators: A Guide for Producers in the Great Plains. 6 pp. Portland, OR. The Xerces Society for Invertebrate Conservation. Available online at https://xerces.org/publications/fact-sheets/rangeland-management-and-pollinators.

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