CONSERVATION STRATEGY FOR MONARCHS (*DANAUS PLEXIPPUS*) AND AT-RISK POLLINATORS IN NEBRASKA

Nebraska Monarch and Pollinator Initiative

NEBRASKA GAME PARKS

"*The largest habitat recovery initiative in American history is needed to plant new and enhance existing populations of milkweeds and other native wildflowers for the recovery of monarch butterflies*"
(Nabhan et al. 2015).

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Purpose: The purpose of this plan is to work collaboratively with stakeholders to support populations of monarchs and other at-risk pollinators, as well as their ecological services, in Nebraska.

PART I: Need for Pollinator Conservation

Monarch butterflies (*Danaus plexippus*) are struggling. Estimates indicate that the eastern population of these butterflies has dropped as much as 90% over the last two decades, and during winter 2013–2014 the lowest numbers of monarchs recorded to date were congregated on a limited area where they overwinter in Mexico (Jepsen et al. 2015). Monarchs were petitioned for listing as an endangered species in 2014 (Center for Biological Diversity 2014). The International Union for Conservation of Nature (IUCN) World Heritage Outlook has assessed the monarchs' migration to be a threatened phenomenon (IUCN 2016). Counts of monarch eggs during surveys from 1999 to 2010 in the Midwest showed an 81% decline (Pleasants and Oberhauser 2013). And, fewer monarch larvae were found in Nebraska in 2016 than in prior years (S. Spomer and T. Weissling, pers. commun.).

Insect pollinators as a guild are declining in North America (Cameron et al. 2011; U.S. Fish and Wildlife Service 2012; Xerces Society 2016a,b). The Nebraska Natural Legacy Project has identified at-risk (i.e., threatened, endangered, or vulnerable to such status) pollinators in the state (Schneider et al. 2011). And, there are at least 15 pollinator species including butterflies, moths, and bumble bees in greatest need of conservation in Nebraska. These pollinators are at-risk in Nebraska under current conditions or because of emerging threats to their populations. Actions that Nebraskans take will be very important to halting the decline of monarch butterflies and many other pollinators. Proactive conservation measures have the potential to prevent the need for a threatened or endangered listing of the monarch butterfly and other pollinators in Nebraska.

PART II: Conservation Goals for Monarchs and Other Pollinators

In 2014, the National Pollinator Health Task Force was created. The task force is an interagency organization charged with coordinating federal efforts to promote pollinator health through research, public education, and public-private partnerships to create habitat (Obama 2014). In May 2015, the Pollinator Health Task Force released a national strategy that included increasing the eastern population of monarch butterflies to 225 million individuals occupying an

area of 6 ha (~15 acres) of wintering habitat in Mexico by the year 2020, and enhancing or restoring 7 million acres for pollinators over the next 5 years (Pollinator Health Task Force 2015). The task force is employing domestic/international actions and public-private partnerships to work toward meeting their objectives.

In order to develop an effective conservation strategy for monarchs and other insect pollinators in Nebraska, a regional team of concerned individuals (Table 2) reached out to stakeholders to discuss the magnitude of the problem, gain perspectives, receive input regarding conservation actions, and request collaborative participation. Input received from the stakeholders was weaved into this state plan, representing conservation practitioners, government organizations, non-government organizations, agricultural groups, businesses, and educators who met to express their ideas and concerns at a summit in Lincoln, Nebraska in February 2016 (Table 3). This group of nearly 100 individuals formed the Nebraska Monarch and Pollinator Conservation Initiative. With partners communicating and in many cases working collaboratively, we may be able to conserve migration and breeding of monarch butterflies by growing population levels to a stable size, and avoid a need for listing under the Endangered Species Act.

International goals to restore monarchs currently comprise efforts in 9 Canadian provinces, 2 Mexican states, and over a dozen states in the U.S., including Nebraska given the continuity the state can provide to monarch migration flight paths. In 2015, wildlife managers from the U.S., Canada, and Mexico held Trilateral Committee meetings to support a recommendation given by the U.S.G.S. Monarch Conservation Science Partnership whose analyses set a goal of 1–1.5 billion new milkweed stems (e.g., *Asclepias* spp.) in the central flyway, a high priority area for monarchs, by the year 2020 (Nabhan et al. 2015). The basis for this target number of milkweeds largely came from research by Pleasants and Oberhauser (2013) and Flockhart et al. (2015), and numerical objectives for recovery of monarchs have since been further supported by Semmens et al. (2016).

There are twelve U.S. states in this central flyway. Therefore, Nebraska's contribution toward the goal should likely be at least one-twelfth of the total (i.e., 125 million milkweed stems). Stakeholders discussed and voted on multiple potential goals for number of milkweed stems during the summit in 2016. Based on these discussions, input, and voting results, the Nebraska Monarch and Pollinator Initiative believed that a goal of 125 million new milkweed stems in the state was a solid target.

Additionally, supporters of this conservation strategy aim to establish milkweeds within high-diversity, forb-rich areas, with a focus on native plantings. Land in Nebraska can offer both migration and breeding habitat to monarchs. Diverse sources available for foraging in spring, summer, and fall will help ensure that the state is meeting nectar, pollen, and foliage needs of

monarchs, and other pollinators, during their different life stages. For the purposes of this document, it is estimated that ~100–300 stems of milkweed per acre are needed in forb-rich habitat for monarchs. This estimate takes into account that one milkweed plant can produce several stems.

Concerns for the monarch shaped the advancement of a conservation plan in Nebraska for the butterfly, but also for other native pollinators such as moths, bumble bees, and additional butterflies that biologists have identified to be in greatest need of conservation in the state. Many actions that benefit monarchs can be adjusted easily to benefit multiple declining pollinators. While conserving monarch habitat, the state wildlife agency also has the goal of sustaining at-risk pollinators: Bucholz black dash (*Euphyes conspicua bucholzi*), Colorado Rita Dotted-blue (*Euphilotes rita coloradensis*), Iowa skipper (*Atrytone arogos iowa*), mottled duskywing (*Erynnis martialis*), Ottoe skipper (*Hesperia ottoe*), regal fritillary (*Speyeria idalia*), Two-spotted skipper (*Euphyes bimacula*), married underwing (*Catocala nuptialis*), Whitney underwing (*C. whitneyi*), American bumble bee (*B. pensylvanicus*), Hunt bumble bee (*B. huntii*), Morrison bumble bee (*B. morrisoni*), yellow bumble bee (*B. fervidus*), Suckley's cuckoo bumble bee (*B. suckleyi*), and variable cuckoo bumble bee (*B. variabilis*).

Stakeholders recognize that goals for pollinator habitat conservation are not achievable in the absence of education and outreach to the people who can take interest, offer support, and make on-the-ground work possible. Given the multitude and diversity of stakeholders engaged, communication is imperative. The Nebraska Monarch and Pollinator Initiative identified the following educational and outreach goals: 1) Create a clearinghouse for information, 2) Develop and share best management practices with all interested parties, 3) Engage approximately 50 citizens or more in an active volunteer network over the next 3 years, 4) Reach out to involve schools and school lands, and 5) Hold a combination of a minimum of three pollinator meetings, public events, or workshops per year.

A multi-state committee composed of state and federal agencies and non-government organizations has formed for monarchs, and they will be drafting a regional conservation strategy that has potential to help refine goals in Nebraska over time. Goals in Nebraska's document for monarchs and other pollinators have potential for revision as new information, research, and conservation models become available.

Conservation Goals for Monarchs and At-risk Pollinators in Nebraska*

- Increase habitat for breeding and migrating monarchs
- Increase habitat for other at-risk pollinators
- Plant 125 million milkweed stems (count from 2015 to 2020)
- Establish milkweeds within high-diversity, forb-rich acres, with a focus on native plantings
- Create clearinghouse for information
- Develop and share best management practices
- Engage stakeholders including agribusiness, landowners, educators, agencies, organizations, and citizens in pollinator efforts
- Engage 50 citizens or more in an active volunteer network over the next 3 years
- Involve schools and school lands
- Hold a minimum of three pollinator meetings, public events, or workshops per year
- Support pollinator programs offered by USDA and others
- Address research gaps
- Support research objectives and increase capacity for pollinator work
- Monitor and evaluate impacts of pollinator conservation efforts

*Goals may be adjusted later according to regional and national guidelines.

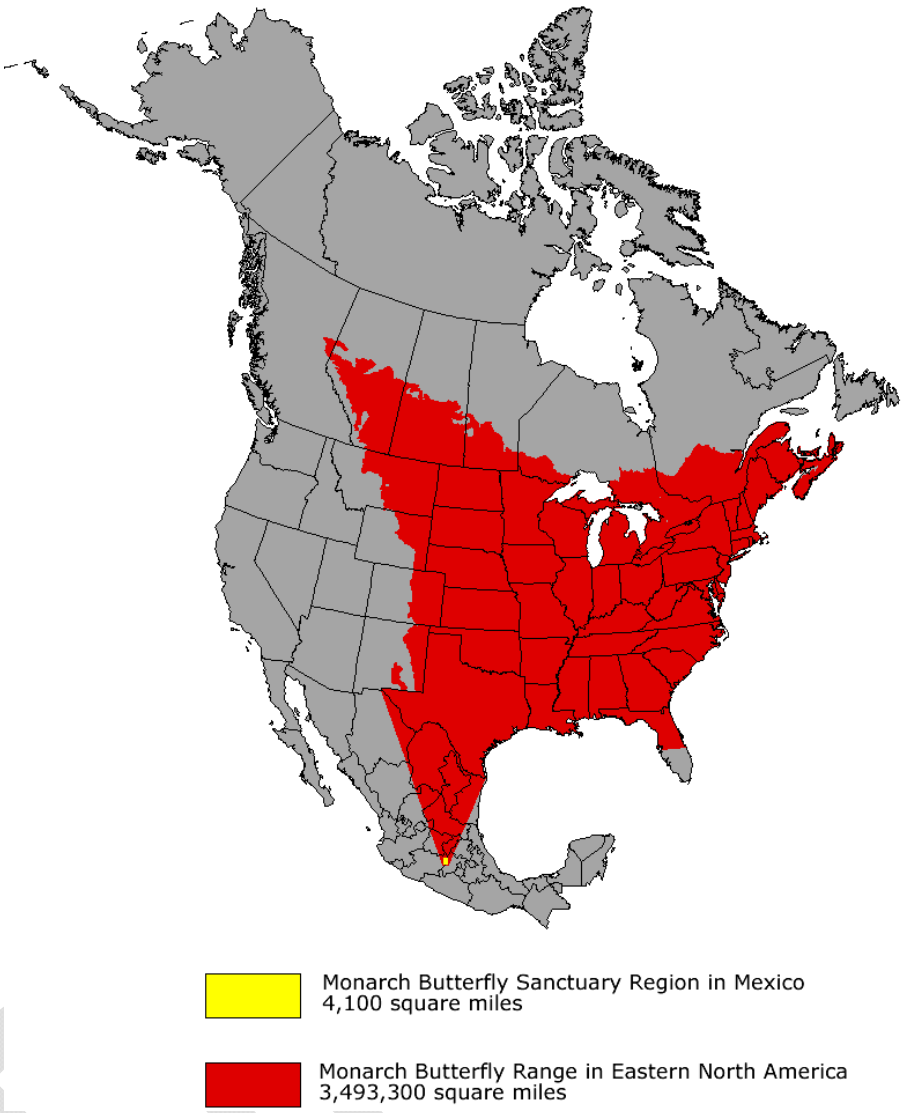
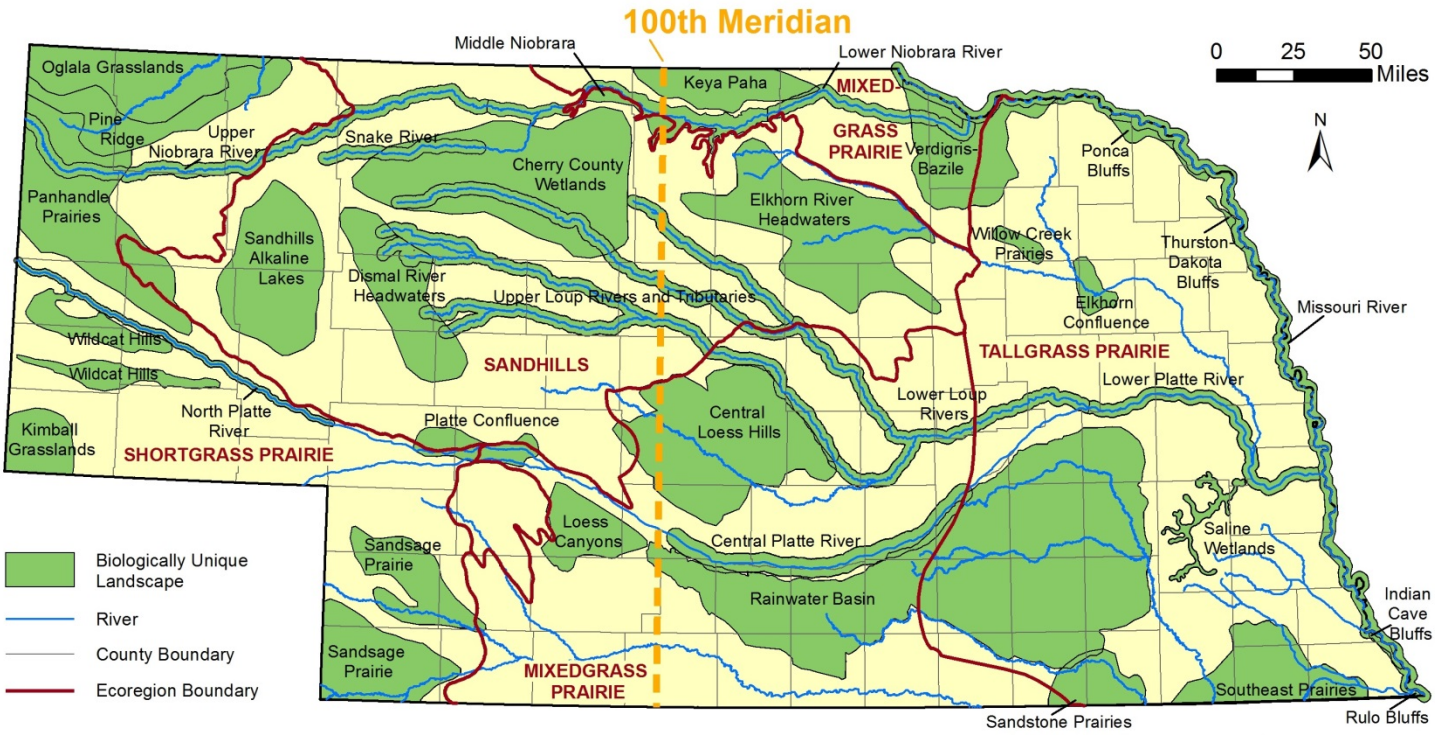


FIG. 1. Distribution of the eastern population of monarch butterflies (*Danaus plexippus*) is shown in red, and limited overwintering range in Mexico is shown in yellow. The distribution of this population includes the state of Nebraska in its entirety. Map produced by Journey North, Monarch Butterfly (2016).



Map by the Nebraska Natural Heritage Program of the Nebraska Game and Parks Commission

FIG. 2. While current data suggest that monarchs in Nebraska are most prevalent east of the 100th meridian, on-the-ground conservation actions statewide can benefit the species and other pollinators. Biologically Unique Landscapes (BULs) offer some of the best opportunities for conservation of species (Schneider et al. 2011), including monarchs and many other pollinators. Map produced by the Natural Heritage Program, Nebraska Game and Parks Commission (2017).

PART III: Background and Life History Notes

Importance of Animal-assisted Pollination to Agriculture and Business

In Nebraska, pollination from the animal kingdom can be credited to species of hummingbirds, butterflies, moths, bees, beetles, ants, and flies. Pollination is important to ecosystems and businesses and critical to our way of life. Globally, an estimated 85% of the world's flowering plants depend on animals, mostly insects, for pollination (Tallamy 2009, Ollerton et al. 2011). Eighty-seven of the world's 124 most common cultivated crops (i.e., 70%) are reliant on animal pollinators, and insect-pollinated forage plants such as alfalfa and clover

provide feed for livestock (Klein et al. 2007). Many producers recognize bumble bees as nature's most efficient pollinators, and prefer their "buzz" pollination for crops such as blueberries, raspberries, kiwis, cranberries, and tomatoes (C. N. Park, pers. commun.).

The number of produce growers in Nebraska has been increasing. Nebraska offers ~100 farmers' markets, ~240 roadside stands, and ~40 pick-your-own farms (NE Department of Agriculture 2017). Numerous specialty crops grown by farmers in the state benefit from or rely on pollinators. In Nebraska, examples of specialty crops that use pollinators include sunflowers (~9426 ha [~23,292 ac.], National Agricultural Statistics Service 2016), tree fruits, melons, cucumbers, tomatoes, berries, pumpkins, squash, eggplant, coriander, prickly pear cactus, and many more.

In the U.S., we can thank pollinators for ~25–33% of every bite of food we take because of their role in enabling or enhancing crop production or pollinating plants that are used as livestock feed (McGregor 1976). Pollinators are essential to grazing lands as well, because of their role in rangeland food production and help with nutrient cycling (Kevan 1999, Black et al. 2011). In all, about 1000 different kinds of plants that humans use for items such as food, spices, medicines, and fabrics are pollinated by animals (Pollinator Partnership 2016). Pollinators annually provide an impressive amount of added crop value, ~$20 billion in the United States alone (Morse and Calderone 2000, Calderone 2012).

Life Cycle of the Monarch

Monarchs, like all Lepidopterans (butterflies and moths) undergo complete four-stage metamorphosis (egg, caterpillar, pupa, and adult; Gullan and Cranston 2014). Adult female monarchs will lay their greenish-white to cream, conical eggs singly on the underside of leaves, stems, and inflorescences of a variety of species of milkweed, the host plant that will be needed by the caterpillars (Opler and Krizek 1984, Scott 1986). Once the larvae (caterpillars) hatch out of the fertilized eggs within only 3–5 days during the summer or early fall, they feed on the milkweed leaves and flowers, which are the host food source for them (Monarch Watch 2016). As a larva feeds and grows, it develops through stages known as instars. During the fifth and final instar, the larva prepares to transform into a hardened pupa known as a chrysalis. A newly developed butterfly will emerge from its chrysalis within 10–14 days during the breeding season (Monarch Watch 2016). The entire development process may take as little as 4 weeks (McCormac 2016) or as many as 6 weeks per brood (Opler and Krizek 1984). The number of broods per growing season can depend on weather conditions (McCormac 2016).

Migration of Monarch Butterflies

Monarchs inhabiting lands east of the Rocky Mountains will migrate as far as ~4800 km (~3000 mi; Monarch Watch 2016) in the fall to survive winter in southern areas with milder temperatures (Opler and Krizek 1984). The monarchs that have emerged in late summer or early fall are capable of delaying reproduction and living longer (i.e., ~6 months versus ~1 month; Opler and Krizek 1984) and are part of the only generation that will migrate (Monarch Watch 2016). Migration begins in mid-August and lasts through October (Opler and Krizek 1984). Monarchs are not very strong fliers (J. R. S. Waldman, pers. commun.) but are excellent gliders on air currents (Scott 1986).

During southerly migration, the monarchs must find areas to drink nectar from fall blooms such as goldenrods (*Solidago* spp.), asters (*Symphyotrichum* spp.), ironweed (*Vernonia* spp.), joe pye weed (*Eutrochium* spp.), and bonesets (*Eupatorium* spp.) (Opler and Krizek 1984, Inamine et al. 2016). The majority of the monarchs from the Great Plains overwinter in the highlands of Mexico, mostly on southwest slopes in trees where they can maintain adequate body temperatures (i.e., clearings are too cold and freezing temperatures can kill adults; Scott 1986). On wintering grounds, monarchs congregate in large numbers on trees and make for a remarkable sight (McCormac 2016)! Many monarchs mate during late winter in Mexico (mating also occurs on northern breeding grounds, most often in the afternoon), and then begin the return flight north in March and April (Opler and Krizek 1984, Scott 1986). Females may lay eggs during northward migration (Scott 1986). Opler and Krizek (1984) report that only a very small percentage of monarchs may be able to survive the northward migration in a given year.

Habitat Requirements of Monarchs

For successful conservation of monarch butterflies, it is important to understand the habitat needs of the species throughout its life cycle. Monarchs have a reliance on milkweed for their larvae. Milkweeds may grow naturally most often in prairies, crop fields, pastures, roadsides, and marshes (Opler and Krizek 1984). Adult monarchs use other flowers for nectar depending on seasonal availability, such as unrelated plants including but not limited to dogbane (*Apocynum* spp.) and lilac (*Syringa* spp.) in spring and composites in the fall (Opler and Krizek 1984).

Significance of Milkweed

Wild monarch caterpillars must feed on the foliage and flowers of milkweeds for survival. During feeding on the host plants, the monarch caterpillars ingest chemicals known as cardiac glycosides that are toxic to most organisms (Monarch Watch 2016). These toxins, which

remain in the insects through metamorphosis from larva to pupa to adult, provide a natural defense for monarchs against would-be predators that have evolved to avoid the warning of poison signaled by the brightly contrasting bands of monarch caterpillars and the striking wing colors of the adult butterflies.

There are many native species of milkweed for monarchs in Nebraska. Milkweeds such as common, swamp, broadleaf, whorled (*A. syriaca*, *A. incarnata, A. latifolia*, *A. verticillata*, respectively), and several others are known to be well suited to growing conditions within ecoregions of the state (See Appendix S-1 for complete list of native milkweeds). It is generally accepted that people should prioritize planting native milkweeds (Monarch Joint Venture 2016). Local Coordinating Wildlife Biologists and other experts (Table 4) are available to consult for planting suggestions.

Numerous insect pollinators other than monarch butterflies will visit, use, and even specialize on milkweeds as well (Borders and Lee-Mader 2014). Examples of species that benefit from milkweeds in Nebraska include regal fritillary, Iowa skipper, Bucholz black dash, Southern Plains bumble bee, Morrison bumble bee, large milkweed bug (*Oncopeltus fasciatus*), great golden digger wasp (*Sphex ichneumoneus*), and others. Milkweeds are an important component of ecosystems in Nebraska, as in much of the U.S.

Significance of Diverse Floral Resources

Adult monarch butterflies are habitat generalists. In spring and summer, monarchs inhabit a variety of open habitats with diverse nectar sources. Nebraska is a breeding area for multiple generations of monarchs and provides habitat during the species' migration. Therefore, foraging habitat for monarchs must be available from late May to October each year. Habitat with diverse floral resources provides for multiple pollinators, as well as many other species of wildlife.

Threats to Monarchs

Habitat Loss

Open habitats with milkweed and other native flowering plants are being reduced or lost to increased cropland, developments, and other uses. A staggering 53 million acres of grassland in the Great Plains, an area roughly the size of the state of Kansas, have been converted to cropland since 2009 (World Wildlife Fund 2016). Monarch Watch estimates that at least 6,000 acres per day account to 2.2 million acres of monarch habitat lost each year in the United States (Monarch Watch 2016). In parts of the United States, and especially within the Corn Belt, there has been a long-standing culture of removing milkweeds from the landscape, and it continues to

be a challenge to affect a change in this practice. Further, in winter, monarchs are vulnerable to loss of Mexican forests of oyamel fir (*Abies religiosa*), which the butterflies rely on for shelter, from illegal and unsustainable logging and invasive bark beetle infestations, and even possibly from increased air pollution (Jepsen et al. 2015).

Invasive plant species can also reduce the amount and quality of habitat available to monarchs. Louise's swallow-wort (*Cynanchum louiseae*) and European swallow-wort (*C. rossicum*) were both introduced into the U.S. and have become possible population sinks for monarchs (Casagrande and Dacey 2007). Casagrande and Dacey (2007) reported that monarchs would oviposit on the non-native swallow-worts, but the hatched larvae could not get nourishment from the plants and died within just a few days. However, not all *Cynanchum* species are detrimental to monarchs. Monarchs can be quite successful on the native honeyvine (*C. leave*; Bartholomew and Yeargan 2001), but it is an aggressive plant that may not be the best choice for people who desire a manicured garden.

Extreme Weather Events

Monarchs are vulnerable to weather events. Hail, freeze, and strong winds threaten monarchs during seasonal movements and overwintering. Mortality of the butterflies can often be attributed to freezing temperatures and precipitation events on their wintering grounds (Oberhauser and Peterson 2003). In 1981, freezing temperatures in Mexico killed 2.5 million adult monarchs (Scott 1986). Strong winds can push monarchs off course during migration (Scott 1986). In 2010, mortality of half the eastern population of monarchs was attributed to storm events (McCormac 2016).

High heat and drought are threats to monarchs. In Texas where migratory monarchs funnel through the state, dry conditions in 2011 coupled with heat and wildfires in 2012 took their toll on plants for foraging monarchs. Milkweeds for larvae were drastically diminished, and wildflower nectar for adults was lost, leading to subsequent decline in the winter counts of monarchs in Mexico (Rice 2013). Further habitat loss is projected to occur at already restricted overwintering sites because of changing climate that could render current wintering ground uninhabitable for monarchs (Oberhauser and Peterson 2003).

Exposure to Chemicals and Biological Pesticides

Herbicides have been developed to be extremely effective at eliminating undesirable plants that are not considered traditional crops or landscape plants. Unfortunately, many plants that are culturally considered to be weeds are in fact host plants and necessary for pollinator

survival. Milkweeds are a genus of plants that have declined in Nebraska. There are numerous scientific publications about herbicidal control of milkweeds (e.g., McCarty and Scifres 1968, Bhowmik 1982, Martin and Burnside 1984), whereas recognition of the importance of maintaining milkweeds in ecosystems is relatively young in the scientific literature (e.g., Withgott 1999, Brower et al. 2006).

Fewer milkweeds on the landscape result in fewer breeding locations for monarchs and can lead to declines in their populations, as well as for additional pollinators that would otherwise use the plants (Pleasants and Oberhauser 2013, Jepsen et al. 2015). Research by Pleasants and Oberhauser (2013) suggested the reduction in numbers of milkweeds coincided with the increased use of glyphosate herbicide and genetically modified corn and soybean. Genetically-modified herbicide resistant crops have contributed to more pervasive and widespread use of herbicides, thereby possibly removing milkweeds and reducing floral abundance and diversity of nectar-providing plants for migrating adult monarchs (J. Wu-Smart, pers. commun.). Complexities exist in trying to understand what variables have caused declines in milkweeds. Perhaps chemical applications, in conjunction with changes in tillage practices, crop rotations, or other factors have led to the decline (C. Romary, pers. commun.).

Exposure to insecticides can cause lethal or sublethal (i.e, reduced health and fertility) effects on monarchs and other wildlife. Crops engineered to have toxic properties, specifically against insects that may cause damage, can have significant ecological and even long-term economic costs (Obrycki et al. 2001). Losey et al. (1999) found that pollen transferred from *Bacillus thuringiensis* (*Bt*; a biological pesticide) crops (e.g., corn pollen) to milkweed increased mortality of monarchs exposed to the substance by 44% in only 4 days. However, it was unclear from Losey et al. (1999) how much treated pollen was dusted onto the milkweeds to cause negative effects (see Helmich and Siegfried 2001). In toxicity studies, B. D. Siegfried found that monarch larvae are only highly sensitive to certain *Bt* toxins, with less response to Cry9C and Cry1F varieties (Helmich and Siegfried 2001). Because milkweeds may grow in close proximity to crops like corn whose pollen spreads by wind up to 60 m (~200 ft; Raynor et al. 1972), it is important to have a greater understanding of exposure risks to pollinators. Additionally, chemical applications inconsistent with label directions are problematic and can be the source of long-term damages, with the potential to cause extirpations of non-target organisms. Biopesticides are subject to federal oversight and approval (U.S. Environmental Protection Agency 2010).

Pollinators may be exposed also to "natural" pesticides, but it is unclear of the risks involved. A common misconception is that organic farming is completely pesticide- and

chemical-free. While that may be true for many organic farms, it is not true for all. Various criteria, including no use of synthetic pesticides, during the planting and growth of crops must be met in order for them to receive organic certification; however, natural chemicals are allowed in organic operations. Many plants produce natural toxins that serve pesticide functions (Ames et al. 1990). The toxins are often less persistent than synthetic chemicals but may have to be applied much more heavily than synthetics in order to receive the same level of control (K. Bailey, pers. commun.). The Xerces Society for Invertebrate Conservation prepared a list of common organic pesticides and the toxicity level of each to bees (Xerces 2012). There has been relatively little research on the full extent of the effects of natural pesticides on monarchs. Nevertheless, most organic farming is likely an asset to pollinators, because these farms have potential to increase species richness of native plants and butterflies (Jonason et al. 2011).

Neonicotinoids are insecticides including acetamiprid, clothianidin, imidacloprid, nitenpyram, nithiazine, thiacloprid, and thiamethoxam. They are a class of insecticides toxic to bees, even in very small quantities (Hopwood et al. 2012), and are also poisonous to other non-target organisms such as predators of crop pests, aquatic invertebrates, and birds (Mineau and Palmer 2013, Gibbons et al. 2015, Hopwood et al. 2013, Morrisey et al. 2015). Research shows that monarch butterfly larvae are susceptible to reduced growth and mortality from neonicotinoids when they consume milkweed tissues contaminated with the chemical (Pecenka and Lundgren 2015, Krischik et al. 2015). Milkweeds can become polluted when neonicotinoids move offsite from farm fields (Pacenka and Lundgren 2015), or when they are treated directly with the insecticides as nursery plants (Krischik et al. 2015). These chemicals are being used widely on crops, gardens, lawns, parks, and municipal lands. Neonicotinoids are frequently applied as seed coatings to many row crops (e.g., corn, soybean, sunflower), and as much as 90% of all conventional corn seed may be treated with the chemical prior to planting (Douglas and Tooker 2015). Neonicotinoids can leach into soil and pollute water to have a greater impact on the environment beyond intended use (Hallmann et al. 2014). The EPA conducts regular risk assessments of neonicotinoids and establishes regulations regarding usage (U.S. EPA 2017).

Pollinators can be exposed to chemicals used on lawns and gardens (as well as on other urban landscapes). Homeowners spend over $9 billion for ~78 million pounds of pesticides per year (U.S. EPA 2011). While yards can offer so much potential for pollinator habitat, there is also the potential for misuse of chemicals when the average homeowner has had no opportunity to receive specialized training in application.

Illness in Monarchs and Host Plants

Illness in monarch butterflies can be caused by a number of factors. Transmission of a protozoan parasite (*Ophryocystis elektroscirrha* [OE]) among monarchs can be lethal (Bartel et al. 2011). Larvae become infected after ingesting spores on contaminated milkweed plants (de Roode et al. 2008). The parasite tends to increase in prevalence as the monarchs' breeding season progresses and then decline in a phenomenon known as "migratory culling" as southward migration of the monarchs occurs (Bartel et al. 2011). Some monarchs can develop greater tolerance to OE, largely based on the availability of milkweeds in their diet with intermediate levels of cardiac glycosides (Sternberg et al. 2012). Known illnesses and mortality can also be caused by parasitic eggs laid on larvae by tachinid flies, nuclear polyhedrosis virus (NPV) that affects larvae and chrysalides, trichogramma wasp eggs laid inside a monarch's egg, and dehydration (Gomez 2014).

Road salt run-off can increase sodium levels in milkweeds growing along roads (Snell-Rood et al. 2014). Snell-Rood et al. found that roadside milkweeds had 1.5–30 times more sodium than milkweeds growing in prairie, and survival of monarch larvae was decreased nearly 20% if they foraged on a host plant with elevated sodium (2014). The sodium bioaccumulates in the tissues of a monarch, to affect neural and muscle development (Snell-Rood et al. 2014).

Diseases and pests of milkweeds can negatively impact monarch butterflies by reducing availability of host plants. Common diseases of milkweeds include fungi causing leaf spot, root rot, and verticillium wilt (The Monarch Program 2016). Aphids, whiteflies, scale insects, spider mites, thrips, leaf miners, snails, and slugs are all pests on milkweeds (The Monarch Program 2016). Unfortunately, measures used to control infestation of milkweed pests have the potential to kill monarch butterflies as well.

Predation

Monarch butterflies have a natural defense against predation because of their toxicity, but this protection is not infallible. Despite the typical monarch's protection from being unpalatable and even toxic to many predators, an individual butterfly is only poisonous if as a larva, it had the opportunity to obtain cardiac glycosides from plants (Scott 1986). Poisons accumulate in the wings and abdomen of monarchs (Brower and Glazier 1975), but some birds such as Black-backed Orioles (*Icterus abeillei*) and jays (*Gymnorhinus cyanocephalus* and *Aphelocoma* spp.) have learned to discard the most toxic portions, typically the cuticle (outer layer) (Petersen 1964, Monarch Watch 2016). Further, Black-headed Grosbeaks (*Pheucticus melanocephalus*) are immune to the toxins and prey on the butterflies on wintering grounds in

Mexico (Scott 1986). The black-eared mouse *Peromyscus melanotis* is also capable of feeding successfully on overwintering monarchs (Glendinning and Brower 1990). The most common predators of monarchs are other insects (K. S. Oberhauser, pers. commun).

Competition

Monarchs will compete inter- or intra-specifically when resources are scarce. In Florida, Brower (1962) documented interspecific competition between monarch and queen butterflies and found if only one species of host plant is abundant, numbers of monarchs declined, although they still maintained a breeding population (Brower 1962). However on an island in the Caribbean, monarchs out-competed milkweed bugs (Blakley and Dingle 1978). Online forums about raising butterflies sometimes comment on witnessing monarch caterpillars consume monarch eggs on milkweed. This type of cannibalism is not unheard of, particularly if there is not enough host plant material. Nail et al. (2015a) suggest that monarchs exhibit density dependence through a negative effect on survival based on measures of per plant egg density, and a minimum of 29 milkweed plants may be needed to produce an adult monarch ready for fall migration. How wild monarchs in Nebraska may compete for foraging and breeding resources with one another or among other species is not fully understood.

At-risk Pollinators in Nebraska

Fifteen species of insect pollinators including butterflies, moths, and bumble bees are either currently labeled as at-risk by the Nebraska Natural Legacy Project or have been identified by experts as likely meeting the criteria to be so designated. The Natural Legacy Project's list of at-risk species is scheduled to be revised in 2017, and each of the 15 species not currently designated with such status will be evaluated for inclusion on the list.

Criteria for Selecting Tier I At-risk Species in the Nebraska Natural Legacy Project

Species were included in the Tier I list that met one or more of the following criteria (from Schneider et al. 2011):

State and Federally Listed Species: Species listed as Threatened or Endangered under the federal Endangered Species Act or the Nebraska Non-game and Endangered Species Conservation Act. Recovery and delisting of these species is a goal of the plan.

Heritage Ranked Species: Species ranked by NatureServe and the Natural Heritage Network as globally critically imperiled (G1), imperiled (G2) or vulnerable (G3). Or, species ranked as either state critically imperiled (S1), imperiled (S2) or vulnerable (S3) in all or nearly all states in their range.

Declining species: Species whose abundance and/or distribution has been declining across much of their entire range.

Endemic Species (or nearly so): Species whose entire range of distribution occurs within or primarily within Nebraska. Conservation actions in Nebraska would be critical to the conservation of the species.

Disjunct Species: Species whose populations in Nebraska are widely disjunct (≥200 mi) from the species' main range of distribution. Such populations may contain genetic variations that could be important to the long-term survival of the species. Species must be ranked as critically imperiled (S1) or imperiled (S2) within Nebraska.

Criteria for Selecting Tier II At-risk Species in the Nebraska Natural Legacy Project

Tier II species were those that did not meet the Tier I criteria but were ranked by the Nebraska Natural Heritage Program as either State Critically Imperiled (S1), State Imperiled (S2) or State Vulnerable (S3) (from Schneider et al. 2011).

Butterflies

A brief life history description is given for each of the butterfly species, besides the monarch, included in this pollinator plan. At-risk status, host plants, and conservation actions are listed in Table 1.

- Tawny Crescent (*Phyciodes batesii*)

  Life cycle: Lays eggs in groups under the leaves of the aster host plant. Larvae feed on the leaves, and first- and second-stage caterpillars live together in webs on the host plant (Butterflies and Moths of North America 2017). Has one flight period from 24 May–22 June in Nebraska. Third stage, partially-grown caterpillar hibernates. (Dankert et al. 2005).

- Regal Fritillary (*Speyeria idalia*)

  Life cycle: Lays eggs throughout habitat and not necessarily on or next to host plants that larvae need to eat. May lay up to 2,400 eggs. Eggs hatch before winter. Larvae overwinter and begin feeding in spring. Caterpillars are black and yellow with short branching spiny hairs. Adults emerge in early summer and may be seen through September (as described in Panella 2010).

- Colorado Rita Dotted-blue (*Euphilotes rita coloradensis*)

  Life cycle: Stay in close proximity to host plants. Males look for females near host plants. Individual eggs laid on flowers. Caterpillars feed on flowers and fruits of host plant. Ants tend to the larvae, giving them protection from parasites and predators in exchange for the caterpillars' secretion of a sugary substance (Allen et al. 2005). Pupae overwinter. Flight period from mid to late summer (Dankert et al. 2005).

- Iowa Skipper (*Atrytone arogos iowa*)

  Life cycle: While waiting in the afternoon for receptive females, males perch on low vegetation near host plants. Females deposit eggs singly under host plant leaves. Larval stage occurs most of the year. Caterpillars hibernate, complete their feeding the next spring, and pupate in a leaf cocoon in vegetation <1 m (~3 ft) above the ground. Females emerge later than males. In Nebraska, adults begin to fly in late June–July (as described in Panella 2010).

- Mottled Duskywing (*Erynnis martialis*)

  Life cycle: Males perch and patrol for females. Eggs deposited singly on host plants (Butterflies and Moths of North America 2016c). Fully grown caterpillar overwinters. Has two broods annually. Flight periods April–May and June–July (Dankert et al. 2005).

- Two-spotted Skipper (*Euphyes bimacula*)

  Life cycle: Males perch in sedges waiting for females. Females lay eggs singly. Caterpillars feed on leaves and form a shelter of tied leaves (Butterflies and Moths of North America 2016d). The partially grown caterpillar overwinters. Flight period during mid-summer. In Nebraska, records from 17 June–9 July, but the species likely occurs later in the year as well (Dankert et al. 2005).

- Bucholz Black Dash (*Euphyes conspicua bucholzi*)

  Life cycle: Little information is known about the egg, larva, and pupa of this species. Flight period is from July–August (Walton 2016).

- Ottoe Skipper (*Hesperia ottoe*)

  Life cycle: Eggs are creamy white (Montana Field Guide 2016). Larvae construct shelters in grass leaf blades by fastening two or more blades of grass together with silk. Larvae feed on the ends of leaves and overwinter in shelters. Flight occurs from June–early August (as described in Panella 2010, Butterflies and Moths of North America 2016c).

Moths

A brief life history description is given for each moth species included in this plan. At-risk status, host plants, and conservation actions are listed in Table 1.

- Married Underwing (*Catocala nuptialis*)

  Life cycle: Females emit pheromone that attracts males (Oehlke 2016). In fall, eggs are laid under cracked or loose tree bark to hatch in the spring (Gall 1990). Emergence from pupae occurs at the soil surface (Oehlke 2016). Flight period from July–August (Butterflies and Moths of North America 2016a). All life stages are above-ground (NatureServe 2015).

- Whitney Underwing (*Catocala whitneyi*)

  Life cycle: *Catocala* species deposit eggs under shaggy or cracked tree bark (Gall 1990). When range overlaps with *Catocala nuptialis*, *C. whitneyi* emerges later (Butterflies and Moths of North America 2016b). All life-stages are above-ground (NatureServe 2015).

Bees

Bees are broadly categorized based on their lifestyle of being social or solitary (Ogg 2016, Xerces Society 2016c). Bumble bee colonies die off at the end of each season, but new colonies are formed the following season (Williams et al. 2014). Bumble bee queens need to have habitat for overwintering and access to suitable nesting sites in order to be able to found a colony the following spring and go through a complete colony cycle. Some bee species require a nest host for their survival; these are collectively known as cuckoo bees. Cuckoo bumble bees do not build their own nests but rather utilize the nest of a specific host bumble bee where cuckoo eggs may be deposited, and then host worker bumble bees unintentionally raise the brood

Bees are very important pollinators (U. S. Forest Service 2016). They have high energy requirements, including nectar, pollen, and various micro-nutrients obtained from water sources. Bumble bees will seek out efficient foraging routes, only traveling as far from their nest as necessary, typically <2 mi, to find sustenance (Rau 1924, Lihoreau et al. 2012). More detailed requirements for Nebraska's native bumble bees are given in Table 1.

Bumble bees can be distinguished from other types of bees by their robust, fluffy appearance. Of the 20 known species of social bumble bees that live in Nebraska reported by Douglas Golick of the University of Nebraska–Lincolns' entomology department (Bergin 2014), at least six may be at-risk and are included in this planning effort: American bumble bee (*B. pensylvanicus*), Hunt bumble bee (*B. huntii*), Morrison bumble bee (*B. morrisoni*), yellow bumble bee (*B. fervidus*), Suckley's cuckoo bumble bee (*B. suckleyi*), and variable cuckoo bumble bee (*B. variabilis*).

TABLE 1. Insect pollinators including butterflies (Dankert et al. 2005), moths, and bumble bees (IUCN 2015) in greatest need of conservation in Nebraska are shown with their basic habitat and host plant requirements, as well as specific management recommendations (Schneider et al. 2011; D. A. Golick, pers. commun.; J. L. Hopwood, pers. commun.).

Pollinator Insect	Status	Host Plant(s) and Habitat	Specific Management Recommendations
Butterflies			
Monarch (*Danaus plexippus*)	Under review	Larvae feed on milkweeds (*Asclepias* spp. and honeyvine [*Cynanchum laeve*]). Adults nectar on a variety of flowers throughout the growing season. Statewide but most common east of the 100th meridian.	- Plant milkweeds (refer to Appendix S-1 for a list of species native to Nebraska) - Ensure flowers are available for adults to nectar on throughout the growing season - Avoid mowing habitat during the breeding season: mow before Apr 15, between Jul 1–15, and after Sept 20
Tawny Crescent (*Phyciodes batesii*)	Tier I at-risk	Larvae feed on smooth blue aster (*Symphyotrichum laeve*). Adults drink nectar. Very rare in northern panhandle of Nebraska.	N/A
Regal Fritillary (*Speyeria idalia*)	Tier I at-risk	Caterpillars feed on violets: common blue (*Viola sororia*), birdfoot (*V. pedata*), prairie (*V. pedatifida*), and Nuttall's (*V. nuttallii*). Adults drink nectar from milkweeds, native thistles (*Cirsium* spp.), prairie clovers (*Dalea* spp.), ironweeds (*Vernonia* spp.), blazing stars (*Liatris* spp.), and purple coneflowers (*Echinacea* spp.). Mostly in wet meadows and sometimes upland prairies throughout Nebraska.	- Plant *Viola* spp. - Ensure flowers are available for adults to nectar on during flight season (Jun–Jul) - Offer overwintering habitat of leaf litter - Limit prescribed burning to 1/3 or less of a site per year

TABLE 1 (cont.)

Pollinator Insect	Status	Host Plant(s) and Habitat	Specific Management Recommendations
Butterflies			
Mottled Duskywing (*Erynnis martialis*)	Tier I at-risk	Host plant is New Jersey tea (*Ceanothus americanus*). Scattered across state.	- Plant New Jersey tea
Two-spotted Skipper (*Euphyes bimacula*)	Under review	Larvae feed on sedges such as upright sedge (*Carex stricta*) in Nebraska. Associated with wetlands but can also occur on adjacent uplands with flowers. Uncommon local resident. North of the Platte River in Nebraska.	- Plant *Carex* spp.
Bucholz Black Dash (*Euphyes conspicua bucholzi*)	Tier I at-risk	Larvae feed on wide-leaved sedges (*Carex* spp). Adults drink nectar from milkweeds. In wet meadows and marshes. Very rare. Endemic to Nebraska. Recorded presently in only two counties in the state: Stanton and Boone.	- Plant *Carex* spp. and milkweeds
Ottoe Skipper (*Hesperia ottoe*)	Tier I at-risk	Caterpillars feed on grasses, especially bluestems and gramas (*Bouteloua* spp). Adults drink nectar from plants such as purple coneflower and hoary verbena (*Verbena stricta*). Statewide.	- Plant big and little bluestems, gramas, purple coneflowers, and hoary verbenas
Moths			
Married Underwing (*Catocala nuptialis*)	Tier I at-risk	Larvae feed on leadplant (*Amorpha canescens*), possibly honeylocust (*Gleditsia triacanthos*) and oak (*Quercus* spp.). Primarily in eastern half of state.	- Plant leadplants, honeylocusts, and oaks - Note, species is vulnerable to fire because all life stages are above-ground (NatureServe 2015)
Whitney Underwing (*C. whitneyi*)	Tier I at-risk	Larvae feed on leadplant, possibly oak and honeylocust. Primarily eastern half of state.	- Plant leadplants, honeylocusts, and oaks - Note, species is vulnerable to fire because all life stages are above-ground (NatureServe 2015)

TABLE 1 (cont.)

Pollinator Insect	Status	Host Plant(s) and Habitat	Specific Management Recommendations
Bumble Bees			
Hunt Bumble Bee (*B. huntii*)	Under review	Plants for nectar and pollen foraging include but are not limited to sunflowers (*Helianthus* spp.), coneflowers, rabbitbrushes (*Chrysothamnus* and *Ericameria* spp.), native thistles, penstemons (*Penstemon* spp.), phacelias (*Phacelia* spp.), currants (*Ribes* spp.), and clovers (adapted from Williams et al. 2014). Prairies and meadows in the panhandle of Nebraska. Nest underground.	- Use nitrogen-fixing fallow ag. management - Protect species from exposure to disease from managed bees (i.e., commercially-reared bumble bees or hives of European honey bees; see Cameron et al. 2016)
American Bumble Bee (*B. pensylvanicus*)[a]	Under review	Use a variety of plants such as native milkvetches (*Astragalus* spp.), native thistles, dogwoods (*Cornus* spp.), prairie clovers, purple coneflowers, sunflowers, blazing stars, rosinweeds (*Silphium* spp.), nightshades (*Circaea* spp.), and prairie clovers (adapted from Williams et al. 2014). Found mostly in open farmland and grasslands. Primarily nest on the surface of the ground, among tall grasses.	- Offer areas with long grass suitable for nesting above ground - Avoid mowing during nesting season (May–Sept); however if some mowing is necessary, leave undisturbed patches or mow at the highest cutting height possible to prevent disturbance of nests - Stock grazers for short periods followed by extended recovery to reduce trampling of nesting and overwintering sites - Determine effects of pathogens - Use nitrogen-fixing fallow ag. management - Avoid pesticide use in prime foraging locations - Protect species from exposure to disease from managed bees (i.e., commercially-reared bumble bees or hives of European honey bees)

[a] Serves as nest host to *B. variabilis*.

TABLE 1 (cont.)

Pollinator Insect	Status	Host Plant(s) and Habitat	Specific Management Recommendations
Bumble Bees			
Yellow Bumble Bee (*B. fervidus*)[b]	Under review	Long tongue allows for nectaring from flowers of legumes. Examples of plants used include milkvetches, sunflowers, thistles, limber honeysuckle (*Lonicera dioica*), beebalms and bergamots (*Monarda* spp.), louseworts (*Pedicularis* spp.), penstemons, and clovers (adapted from Williams et al. 2014). Queens may build nests underground in old rodent burrows, or above ground in tree cavities, grass tufts, rock piles, and inactive bird nests. Found in tallgrass prairies, parks, farm fields, and gardens. Widespread range in Nebraska.	- Plant native legumes and other plants as indicated, particularly in tallgrass prairie - Use nitrogen-fixing fallow ag. management - Avoid mowing during nesting season (May–Sept); however, if some mowing is necessary, leave undisturbed patches or mow at the highest cutting height possible to prevent disturbance of nests - Protect species from exposure to disease from managed bees (i.e., commercially-reared bumble bees or hives of European honey bees) - Stock grazers for short periods followed by extended recovery to reduce trampling of nesting and overwintering sites
Morrison Bumble Bee (*B. morrisoni*)	Under review	Uses open scrubland. Nests underground, in tufts of grasses, or in structures. The bees use plants such as sunflowers, milkweeds, milkvetch, rabbitbrushes, thistles, yellow spiderflower (*Cleome lutea*), Rocky Mountain bee plant (*Cleome serrulata*), narrowleaf rhombopod (*Cleomella angustifolia*), desert princesplume (*Stanleya pinnata*), lambstongue ragwort, Riddell's ragwort, and broom-like ragwort. Range includes southwest portion of Nebraska's panhandle.	- Use nitrogen-fixing fallow ag. management - Protect species from exposure to disease from managed bees (i.e., commercially-reared bumble bees or hives of honey bees)

[b] Serves as nest host to *B. suckleyi*

TABLE 1 (cont.)

Pollinator Insect	Status	Host Plant(s) and Habitat	Specific Management Recommendations
Cuckoo Bumble Bees			
Suckley's Cuckoo Bumble Bee (*B. suckleyi*)	Under review	Shares habitat requirements with *B. fervidus*.	See specific management recommendations given for *B. fervidus*, because it is an expected brood host (Williams et al. 2014). Actions for *B. fervidus* will likely benefit *B. suckleyi*.
Variable Cuckoo Bumble Bee (*B. variabilis*)	Under review	Shares habitat requirements with *B. pensylvanicus*.	See specific management recommendations given for *B. pensylvanicus*, because it is used as a brood host. Actions for B. *pensylvanicus* can benefit *B. variabilis*.

PART IV: Habitat Conservation

Conservation Actions and Management Recommendations

While specific habitat management recommendations are given in Table 1, statewide on-the-ground conservation actions that can benefit at-risk pollinators include, but are not limited to:

1) restoration, enhancement, and management of native, forb-rich habitat
2) planting of host species for larval and adult life stages
3) planting of a variety of floral resources that will provide nectar and pollen throughout the growing season (typically a minimum of three plant species with blooms per season)
4) maintaining a clean, reliable water source
5) increased use of prescribed fire to promote floral diversity, with a rotation of burns so that a specific area is not burned in consecutive years (generally for disturbances, when a treatment is applied, do not treat more than one-third of the site per year, so that areas of refuge from fire and other management practices are available to pollinators)
6) grazing strategies that promote plant diversity,
7) leaving areas of bare ground and dead tree trunks for nesting, and
8) judicious application of herbicides and pesticides in habitats otherwise suitable for pollinators

Habitat conservation for monarchs and at-risk pollinators in Nebraska has many facets. After identifying the threats and challenges to pollinator conservation, the planning team proposed that the best approach to address the threats to monarchs and other pollinators is to recognize opportunities and take action on state-owned properties, on other public lands, and on private lands where landowners and land managers are interested in cooperation. By including options for conservation strategies on all of these lands under various ownership types, the goal of establishment of at least 125 million new milkweed stems, as well as thousands of acres with diverse floral resources, in the state is more attainable. All actions identified in this conservation plan are voluntary.

While habitat conservation actions are grouped to more specifically articulate potential conservation actions by ownership, there is often overlap among the identified strategies for the three categories of land we are addressing. This list of actions for pollinators has been

thoroughly vetted as the most important among a large constituency, but does not include every action that may benefit pollinators. While tribal lands are not specifically identified in this plan, participation and conservation actions of tribes are welcomed and would further contribute to goals for monarchs and other at-risk pollinators.

Actions and Opportunities on State-owned Properties

- Plant and maintain milkweed and floral resources in grasslands and on other managed lands.
- Provide and maintain floral resources for breeding and migrating pollinators.
- Establish best management practices that include recommendations for seed mixes, establishment of milkweed and prairie plants, mowing, prescribed burning, pesticide mitigation, and other specific guidelines.
- Implement best management practices to maintain, enhance, and restore grassland habitat with milkweeds and high-diversity native forb-rich plantings.
- Seed milkweed in open spots (e.g., after cedar removal). Use diverse pollinator plant mix and milkweed plugs.
- Promote propagation of milkweed (e.g., breaking up rhizomes and transplanting).
- Prevent spread of disease in existing milkweed stands by removing sick leaves and plants and using other treatment methods such as burning and mowing.
- Set up demonstration sites to portray use of monarch and pollinator habitats.
- Document commitments for number of milkweed stems and acreages.
- Maintain a database of state lands and habitat management practices.

Actions and Opportunities on Other Public Lands

- Maintain, enhance, and restore grassland habitat with milkweeds and high-diversity native forb-rich plantings.
- Seed milkweed in open spots (e.g., after cedar removal). Use diverse pollinator plant mix and milkweed plugs.
- Promote propagation of milkweed (e.g., breaking up rhizomes and transplanting).
- Establish best management practices with guidelines compatible to an agency or organization's multiple responsibilities to the public.
- Manage roads and rights of way (e.g., roads, utility companies) in a manner compatible with pollinator habitat.
- Develop guidelines for pollinator-friendly management of municipal and county lands.

- Engage partners such as the state Board of Educational Lands and Funds to include school trust lands in habitat restoration activities.
- Plant and maintain milkweed and floral resources in grasslands and on other managed lands (e.g., parks, trail systems, golf courses).
- Set up demonstration sites to portray use of monarch and pollinator habitats.
- Seek opportunities to provide resources for school groups that focus on milkweed habitats (e.g., pod collection).
- Document commitments for number of milkweed stems and acreages from public agencies holding lands.
- Prevent spread of disease in existing milkweed stands by removing sick leaves and plants and using other treatment methods such as burning and mowing.
- Provide and maintain floral resources for breeding and migrating pollinators.
- Develop a network and database of public lands.

Actions and Opportunities on Privately-owned Lands

- Work collaboratively with agricultural producers to find compatible solutions for their business and pollinators.
- Maintain, enhance, and restore grassland habitat with milkweeds and high-diversity native forb-rich plantings where landowners voluntarily participate (e.g., business lands, golf courses, yards).
- Seed milkweed in open spots (e.g., after cedar removal). Use diverse pollinator plant mix and milkweed plugs.
- Promote propagation of milkweeds.
- Seek opportunities to promote growth of milkweed within marginal and "odd" areas that have not been profitable as agricultural lands.
- Consider alternative uses that are compatible with pollinators on working lands.
- Provide technical assistance to producers and ranchers to improve or create habitat for pollinators.
- Offer information about best management practices to landowners and arrange support for them when possible.
- Encourage integrated pest management where it can minimize risks to the environment
- Promote state and local incentives to production farmers who incorporate milkweed and habitat into their operations.

- Utilize funding opportunities and priority rankings within the Farm Bill and programs such as Environmental Quality Incentives Program (EQIP) to develop and maintain milkweed and pollinator habitat.
- Use existing Conservation Reserve Program (CRP) and Conservation Practices (CP) to deliver pollinator habitat.
- Encourage the implementation of pollinator habitat in the Conservation Stewardship Program (CSP).
- Promote conservation of monarchs, a new national priority species, under Working Lands for Wildlife (WLFW), a partnership between the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) and the U.S. Fish and Wildlife Service (USFWS).
- Appoint spokespersons (e.g., 4-H groups) to get information to larger agriculture sector.
- Promote the economic benefits of pollinator gardens for businesses and homeowners.
- Replace sections of lawn with native flowerbeds and offer water and other resources to pollinators.
- Seek partnership opportunities with organic growers (sustainable ag. groups and the market for non-modified crops).
- Prevent spread of disease in existing milkweed stands by removing sick leaves and plants and using other treatment methods such as burning and mowing.
- Provide and maintain floral resources for breeding and migrating pollinators.

Technical support, and in some cases financial assistance, is available for habitat improvements. Persons interested in improving habitat for pollinators may want to contact Coordinating Wildlife Biologists, who work in partnership positions with the Nebraska Game and Parks Commission (NGPC) regionally across the state, NGPC Field Staff, Farm Bill Biologists, the Natural Resources Conservation Service, the U.S. Fish and Wildlife Service, the Xerces Society, or Pheasants Forever, Inc. for additional ideas, support, and site-specific consultation. A contact list of natural resource professionals is available in Table 4.

PART V: Education and Outreach in Support of Pollinator Conservation

The Nebraska Monarch and Pollinator Initiative designated the following action items relating to Education and Outreach in support of pollinator conservation as most important:

- Share best management practices for pollinators through trainings, workshops, brochures, and other methods.
- Develop a pollinator curriculum, with a focus on life-science concepts, for grades K-12.
- Produce informational sessions and/or videos for school district principals, to help them understand the importance of pollination and encourage their support for pollinator gardens.
- Offer signage and environmental interpretation at pollinator demonstration sites (e.g., parks, rest areas).
- Appoint spokespersons such as UNL ag. Extension and other ag.-based outlets to get information to larger agriculture sector.
- Target outreach campaign on the social services to benefit agricultural producers
- Promote the economic and ecological benefits of milkweed and pollinator gardens for businesses and homeowners.
- Encourage tolerance for growth of milkweeds in agricultural lands. Provide materials designed specifically for landowners that inform them of pollinator needs and provide multiple potential actions.
- Work with nurseries to promote different pesticide options and labeling of plants.
- Work with greenhouse growers that buy bumble bees to provide recommendations on limiting release of reared bumble bees into the wild.
- Integrate citizen science and outdoor activities.
- Host pollinator events for the public.
- Offer resources for school groups that focus on milkweed and native floral diversity.
- Reach out to organic growers and local farmers' markets (sustainable ag. groups and the market for non-modified crops).
- Create or obtain evaluation tools for assessing educational and behavioral impacts of various programs.
- Develop a speaker's bureau and resource center that is available to schools and community members (bureau may include Master Gardeners, academics, etc.).

- Work with service project organizations to enhance habitat and promote pollinator conservation (e.g., Boy Scouts, Eagle Scouts, Girl Scouts, youth groups).
- Develop after-school and/or summer programs pertaining to pollinators.
- Create a clearinghouse for information such as an e-mail list of individuals involved in pollinator conservation, networking and communication opportunities, and a website with presentations, videos, and information.

PART VI: Adaptation of Policy to Positively Impact Pollinators

The Nebraska Monarch and Pollinator Initiative advocated that the following policy-related action items were most important to pollinator conservation:

- Identify state and local policy requirements that influence pollinators, and promote policies that create opportunities and flexibility for their conservation (e.g. promotion of prescribed burning as a conservation tool).
- Remove barriers in state laws that limit pollinator-friendly management of county road rights of way.
- Develop guidelines for pollinator-friendly management of municipal and county land.
- Include milkweed and pollinator habitat in Environmental Quality Incentives Program (EQIP) priority rankings.
- Develop tax incentives for providers of pollinator habitat.
- Provide state and local incentives to production farmers that incorporate milkweed and habitat into their operations.
- Include pollinator practices in the 2018 Farm Bill.
- Establish guidelines, taking into consideration pollinator life stages and blooming periods, regarding the use of pesticides in or immediately adjacent to pollinator habitat.
- Establish regulations and/or incentives to limit the use of neonicotinoids to those times when pests are present and prevent non-target impacts.
- Establish a screening system to ensure that managed bees do not carry parasites or pathogens.

PART VII: Research and Monitoring to Inform Decision-Making

Researchers and other individuals familiar with the science of monarchs and pollinators were in favor of the following action items to address concerns and fill information gaps:

- Identify key research needs.
- Develop best management practices for existing milkweed populations in each of the major land uses (rangeland, hay meadows, cropland, roadsides, etc.), specifically in Nebraska.
- Discover which floral resources and planting densities are preferred in Nebraska by monarchs and other pollinators.
- Learn how to manage floral resources in each of the major land uses (rangeland, hay meadows, cropland, roadsides, etc.).
- Investigate monarchs' use of sand milkweed (*Asclepias arenaria*).
- Determine if sites restored with a combination of native grasses and forbs are more sustainable for pollinators than sites with only milkweed or milkweeds and other floral resources.
- Determine if the effects of certain grassland management methods are impacting or excluding specific plants and pollinators.
- Develop a monitoring protocol to evaluate sites for season-long nectar availability.
- Target at-risk pollinator surveys to areas that have been underrepresented.
- Measure Nebraska's contribution to the eastern monarch population (early Jun and early Aug sampling to detect breeders rather than migrators).

Additionally, the group identified the following action items to support research objectives and increase the capacity for pollinator work:

- Construct a database for storing monitoring information.
- Integrate citizen science and outdoor activities.
- Engage citizens in monitoring for monarchs and at-risk pollinators.
- Develop a list of volunteers.
- Create or obtain evaluation tools for assessing educational and behavioral impacts of various programs.
- Obtain funds to support monitoring.

PART VIII: Impacts of Changing Climate on Pollinators

When global climate change threatens species, they often need to adapt and sometimes even move to new locations if they are to survive. For example in Nebraska, the Tawny Crescent (*Phyciodes batesii*) was once seemingly secure in the state but recent surveys have revealed a paucity of specimens, even though its larval host plant, smooth blue aster (*Symphyotrichum laeve*), is common in the butterfly's expected range (M. L. Brust, pers. comm.). The leading hypothesis as to why Tawny Crescents are nearly extirpated from the state is that climate change has made conditions unsuitable for their needs and they have moved to or only persisted in more suitable environments (R. E. Schneider, pers. comm.). The case of the Tawny Crescent reminds us that there are circumstances beyond what good-intentioned biologists and land managers may be able to control with focused on-the-ground habitat management.

Researchers in the Department of Agronomy and Horticulture at the University of Nebraska–Lincoln have begun developing conservation models to describe how climatic conditions in the state may impact plant communities at the end of the century. Their models demonstrate that tallgrass prairie, central mixed-grass prairie, and western Great Plains prairie were all highly vulnerable to climate change (C. L. Wonkka, person. commun.). These affected plant communities could have serious consequences for pollinators in the state.

Climate change can impact pollinator distributions, timing of annual life-cycle events, and the seasonal coordination of when flowers bloom and availability of nectar sources for pollinators. Synchronization of ecological events including leaf-out, flowering, insect emergence, and migration is vital. Schneider (2014) states that some invertebrates may have difficulty relocating to more northerly climes or higher latitudes when climate change renders their current habitats inhospitable. The frequency of severe precipitation events is predicted to increase in Nebraska (Munoz-Arriola et al. 2014), and long droughts could impact pollinators.

Climate change has potential to impact monarch butterflies in breeding, migratory, and wintering habitats. Milkweed species that monarchs rely on for breeding and migration can be sensitive to increasing ozone exposure and experience foliar damage (Kline et al. 2008, Davis 2011). Batalden et al. (2007) project a northward shift in areas that can be inhabited by breeding monarchs, thus the monarchs could lose breeding locations. For monarchs, high temperatures can lead to lipid depletion, early migratory departure, and a premature end to reproductive diapause (Nail et al. 2015b, Nail and Oberhauser 2015). Oberhauser and Peterson (2003) found that hotter, drier climates would be unsuitable for oyamel firs, which currently provide monarchs with overwintering habitat.

Management strategies for pollinators should be "climate-smart." One of the most important aspects of being smart in conservation with limited resources is to know when to act and when to refrain from acting. Stein and others (2014) describe this as "recognizing the limits of adaptation" to climate impacts. Those limits may include ecological, technological, financial, and sometimes even social thresholds that must be considered in the face of climate change (Adger et al. 2009). For pollinators, conservation actions may include climate change mitigation (i.e., slowing emissions), and adaptation measures such as controlling invasive species, protecting and expanding habitats, and facilitating movements of wildlife (K. R. Nail, person. commun). Pockets of habitat can help ensure that monarchs and pollinators can move among locations and find resources, especially as suitability of sites can vary from year to year (J. Wu-Smart, pers. commun.).

Successful management is adaptive to changing conditions. Climate-smart adaptation avoids or reduces harm to species and ecosystems, and whenever possible seizes the beneficial opportunities. In order to have a prepared response to looming crises, it is helpful for managers to think ahead and plan for various scenarios within an uncertain future. An adaptive framework can align goals with actions on a timeline. This framework can later be adjusted as conditions change, because in conservation, there is rarely a one-size-fits-all solution.

PART IX: Native Plants to Attract Pollinators

In addition to the planting of milkweeds to support the reproduction and migration of monarchs, there are a plethora of plants to consider for pollinator conservation. Whether planting a backyard butterfly garden, rain garden, or enhancing large areas of land or wetland, there are multiple factors to consider. Giving some thought to plant selections will increase the chances of a successful planting. Several important considerations to make include:

1) sun exposure levels,
2) soil characteristics, including moisture levels,
3) habitat type (e.g., grassland, woodland, wetland),
4) blooming period (flower availability for pollinators throughout the growing season),
5) floral resource (pollen vs. nectar) and floral attractiveness to pollinators (height, color, access to resource)
6) commercial availability of plants and associated costs,
7) seed bed preparation before planting,
8) reduction in competition with invasives,

9) ability to conduct periodic maintenance,
10) usage of the land (e.g., pasture, recreation), and
11) desired aesthetic

Some sites already have sufficient plants for pollinators. Quality sites abundant with pollinator-friendly plants may only need periodic maintenance and disturbances to persist. Disturbances may include prescribed fire, grazing, and/or mowing planned for select times and specific intensities. In other cases such as when dealing with sites dominated by exotic brome grasses (*Bromus* spp.), it will be necessary to aggressively combat invasive species before attempting any sort of planting. Control methods should be implemented over successive seasons before new plants for restoration are put in the earth. Additionally, these sites should be on a regular rotation for monitoring and additional control measures. Otherwise the work and investment in planting may only have short-term gains or none at all. Plants that are native to Nebraska will normally be best suited to local growing conditions and better able to compete with non-desirables. See Appendix S-1 for a list of plants native to Nebraska that are recommended for pollinator conservation.

PART X: Agency Responsibilities

In 2014, a presidential memorandum was drafted to create a federal strategy to promote the health of honey bees and other pollinators (Obama 2014). The Pollinator Health Task Force was formed with a clear directive to improve pollinator habitat with specific objectives. All federal heads of executive departments and agencies are called to meet this challenge.

The Nebraska Game and Parks Commission and the Nebraska Department of Agriculture are legally responsible for proper management of insects in the state. Additionally, the U.S. Fish and Wildlife Service (USFWS) has authority over any insect that is a federally listed species and its "unauthorized taking, possession, sale, and transport" is prohibited; any management actions or manipulative research methods implemented are subject to policies of the Endangered Species Act of 1973 - ESA (16 U.S.C. 1531-1544, 87 Stat. 844), as amended – Public Law 93-20. ESA - Section 7 requires that "any action authorized, funded or carried out…is not likely to jeopardize the continued existence of listed species or modify their critical habitat" (ESA 1973). Furthermore, the Nebraska Game and Parks Commission has responsibility for protecting endangered and threatened species under authority of the Nongame and Endangered Species Conservation Act (NESCA),(Neb. Rev. Stat. § 37-801 to 37-811) (NESCA 1975). Nebraska Game and Parks Commission has entered into a Programmatic

Agreement (PA) with the USFWS to conserve threatened and endangered species (NGPC and USFWS 2008). In some cases, other agencies have developed PAs with the Commission for these species as well. Habitat work for the species must be in compliance with the most current PA, as amended. Any management actions outside the parameters of the PA that directly impact threatened and endangered species require environmental review and approval from the Commission's Environmental Analyst. Refer to the PA and obtain appropriate approval and permits as necessary for management actions that may impact listed species.

PART XI: Partnerships for Large-Scale Pollinator Conservation

Participation by many groups may be the only way to conserve migration and breeding habitat for monarchs, avert a threatened or endangered listing of the species, and prevent decline of other pollinators. The Nebraska Monarch and Pollinator Conservation Team (Table 2) brought 55 organizations and businesses (Table 3) together to begin addressing the issues facing pollinators in the state. See addenda for an inventory and commitment of partner-based actions for conservation of monarchs and other at-risk pollinators in Nebraska.

TABLE 2. The Nebraska Monarch and Pollinator Conservation Team formed in order to plan how to address the threats facing monarch butterflies in the state, in hopes of preventing a threatened or endangered listing of the species in Nebraska.

Team Member	Affiliation
Peter Berthelsen	Nebraska Pheasants Forever, Inc.
Natalia Bjorklund	University of Nebraska Extension
Carolyn Butler	Nebraska Wildlife Federation
Jennifer Duerr	Save Our Monarchs Foundation
Mike Fritz	Nebraska Game and Parks Commission
Randall Gilbert	Save Our Monarchs Foundation
Jennifer Hopwood	Xerces Society for Invertebrate Conservation
Duane Hovorka	Nebraska Wildlife Federation
Ritch Nelson	U.S. Department of Agriculture, Natural Resources Conservation Service
Melissa Panella	Nebraska Game and Parks Commission
Kirk Schroeder	U.S. Fish and Wildlife Service
Gerald Steinauer	Nebraska Game and Parks Commission
Kristal Stoner	Nebraska Game and Parks Commission
J. Scott Taylor	Current: Midwest Association of Fish and Wildlife Agencies
Rosemary Thornton	Friends of the Niobrara

TABLE 3. Fifty-five organizations and businesses contributed representation at Nebraska's Monarch and Pollinator Conservation Summit in 2016. Additional entities not listed here were invited but unable to provide an attendee. After the summit in 2016, representatives from additional groups provided input relevant to the monarch and pollinator conservation strategy.

Participating Entity
Center for Rural Affairs
City Sprouts
Congressman Jeff Fortenberry's Office
Crane Trust
Creighton University
Federated Garden Clubs of Iowa, Inc.
Friends of the Niobrara, Inc.
Glacier Creek Preserve
Great Plains Nursery
Green Bellevue
Homestead National Monument
Lancaster County Engineer
Lincoln Parks and Recreation
Lincoln Public Schools
Loveland Garden Club
Metropolitan Community College
Monarch Flyway
Monarch Gardens
Monarch Watch
Monsanto
National Park Service
Nebraska Association of Resource Districts
Nebraska Corn Board
Nebraska Department of Agriculture
Nebraska Department of Roads
Nebraska Ducks Unlimited
Nebraska Environmental Trust
Nebraska Extension, Lancaster County
Nebraska Farm Bureau
Nebraska Farm Service Agency

TABLE 3 (cont.)

Participating Entity
Nebraska Game and Parks Commission
Nebraska Land Trust
Nebraska Nursery and Landscape Association
Nebraska Pheasants Forever, Inc.
Nebraska Soybean Association
Nebraska Statewide Arboretum
Nebraska Sustainable Agriculture Society
Nebraska Weed Control Association
Nebraska Wildlife Federation
Northern Prairies Land Trust
Omaha Public Schools
Omaha's Henry Doorly Zoo and Aquarium
Prairie Plains Resource Institute
Sandhills Task Force
Save Our Monarchs Foundation
Spring Creek Prairie Audubon
Syngenta
The Nature Conservancy
University of Nebraska–Lincoln
University of Nebraska–Omaha
U.S. Army Corps of Engineers
U.S. Department of Agriculture, Natural Resources Conservation Service
U.S. Fish and Wildlife Service
Wachiska Audubon Society
Xerces Society for Invertebrate Conservation

TABLE 4. Several organizations can provide consultation regarding conservation actions for pollinators.

Contacts for Pollinator Conservation	Contact Information
Nebraska Game and Parks Commission	402-471-0641 www.outdoornebraska.org
Nebraska Pheasants Forever, Inc.	402-621-0744 nebraskapf.com/habitat-programs/pollinator/
Nebraska Wildlife Federation	402-477-1008 NebraskaWildlife@Windstream.net www.nebraskawildlife.org/
Save Our Monarchs Foundation	Info@SaveOurMonarchs.org www.saveourmonarchs.org/
University of Nebraska Extension	402-472-2966 unlextension@unl.edu extension.unl.edu/community-environment/
Natural Resources Conservation Service, USDA	402-437-4100 www.nrcs.usda.gov/wps/portal/nrcs/site/ne/home/
Nebraska Partners for Fish and Wildlife, USFWS	308-382-6468 www.fws.gov/refuge/North_Platte/what_we_do/Partnerships/Partners_Program.html
Xerces Society for Invertebrate Conservation	855-232-6639 www.xerces.org/

Acknowledgments

The Editor of this document would like to thank members of the Monarch and Pollinator Planning Team for recognizing the need for development of a pollinator conservation plan in Nebraska and assembling the resources to bring stakeholders together to make it happen. Nebraska Wildlife Federation provided staff and organizational support for the effort. Entities that funded the Monarch and Pollinator Conservation Summit included Nebraska Pheasants Forever, Inc.; U.S. Fish and Wildlife Service; Friends of the Niobrara, Inc.; and Nebraska Game and Parks Commission. Thank you to Timothy McCoy, Peter Berthelsen, Theodore Burk, and O. R. "Chip" Taylor for delivering informative presentations to explain the problems facing monarchs and pollinators and sharing ideas about conservation strategies at the 2016 summit. Carolyn Butler, Natalia Bjorklund, Duane Hovorka, and Ritch Nelson led engaging breakout sessions at the summit. Additional record keepers included Regan Gilmore, Mia Keady, Ted LaGrange, and Louise Lynch. Bethany Teeters provided very helpful background information on many of Nebraska's native bees. Chris Helzer, Jennifer Hopwood, Ritch Nelson, Kirk Schroeder, Rachel Simpson, Kristal Stoner, Judy Wu-Smart, Randall Gilbert, Craig Romary, Eric Zach, Nebraska Game and Parks Commission Wildlife staff, and numerous individuals offered helpful editorial comments on the many draft versions of this document. J. Hopwood also provided excellent technical guidance for pollinators. Kay Kottas, as a representative for Nebraska Native Plant and Seed Producers, Gerry Steinauer, and Jon Morgenson provided information that formed the bulk of the content of the native plant list for pollinators in Nebraska. Kristal Stoner, Jeff Hoffman, Alicia Hardin, Kirk Nelson, and Jason Smith helped estimate the Nebraska Game and Parks Commission's capacity for pollinator work in Nebraska. Lindsay Rogers has been working tirelessly to share pollinator information with students, educators, and anyone else who wants to learn more. Last but certainly not least, gratitude is expressed to the many individuals who represented their organizations at the Monarch and Pollinator Conservation Summit to contribute valuable input during the planning process. Numerous people offered to be part of action teams to carry out the plans described in this document. See Table 3 for a list of participating organizations.

ADDENDA: **Commitments to Pollinator Conservation**

Numerous partners are involved or otherwise willing to take action in support of monarch and pollinator conservation. The following partners demonstrate commitments to conservation actions to benefit monarchs and other pollinators.

ADDENDUM 1. **Crane Trust**

Habitat Conservation

The Crane Trust protects and maintains habitat for migratory birds along the Platte River. This habitat is a vital extension of the tallgrass prairie into the west that provides many resources for migratory birds and pollinators. Additionally, the Trust protects wet meadow habitat that is vital for Whooping and Sandhill cranes and houses some very unique pollinators. We hope to protect this region from development for human use into the future. When we conduct restorations, milkweeds are always included in the seed mixes, along with many native flowers that pollinators enjoy.

Challenges

The largest challenge that faces the Crane Trust is funding. Without extra funds, the Trust would not be able to participate widely outside of the owned acreages. However, we have many facilities that can be used by interested parties. Grant-finding is a constant effort put on by Crane Trust employees to try and solve this issue, as well as focusing on some aspects of donations to the efforts of this non-profit.

Education and Outreach

The Crane Trust would love to promote and offer pollinator-related topics through classes, trainings, social media, and brochures. We already have a fact sheet on native pollinators, and are beginning a citizen science project to monitor butterflies.

Policy

Policy changes involving roadside mowing could allow more milkweeds to grow along roads leading to our properties, as well as a policy change limiting the amount of pesticide use in Nebraska. Pesticide drift is surely a huge issue, and in a rural area we are surrounded by farms that have the potential to poison the beneficial prairie insects, not just their pest insects.

Research and Monitoring

The Crane Trust completes vegetation surveys across our properties, and we are beginning to do formal butterfly surveys, noting the location and general density of butterflies of concern like the monarch and regal fritillary. The hope is that we can provide a detailed picture of how land management and habitat interact to produce the butterfly community that we see.

Collaborations with Partners

Nebraska Master Naturalists assist with our butterfly monitoring. Roots and Shoots also visits to aid in butterfly identification for the Fourth of July Butterfly count. Additionally, the Crane Trust hosted the Roots and Shoots citizen science festival that showcased projects on pollinator study and production.

ADDENDUM 2. **Ducks Unlimited, Inc.**

Habitat Conservation

Ducks Unlimited, Inc. strives to permanently protect and restore wetlands and associated upland habitat. Ducks Unlimited promotes early successional habitat that not only benefits waterbirds but also benefits many upland bird and insect species. When completing a wetland restoration project, we always restore associated upland habitat as well by planting a high-diversity seed mixture, which includes grasses, forbs, and milkweed. Ducks Unlimited will continue pursuing our mission of conserving wetland acres, and in doing so will protect and provide thousands of acres of upland habitat across the state for monarchs, pollinators, and numerous other wildlife species.

Ducks Unlimited protects and restores thousands of acres (circa 5000 a.) of wetland and upland habitat a year all across the state of Nebraska. Although we do work across the entire state, our primary focus is in the Rainwater Basin and along the Platte River. Our work is perpetuating pollinators in the uplands and wetlands on our projects through our high-diversity seed planting and moist soil management. Our plan is to continue with our successful mission to restore waterfowl habitat, but we have already begun including more milkweed seed in our seed mixtures to increase the benefit of our projects to target species like monarchs.

Collaborations with Partners

Ducks Unlimited partners with many conservation organizations throughout the state in pursuing our mission of protecting and restoring wetland and upland habitat for waterfowl and other wildlife species. Organizations such as Nebraska Game and Parks Commission, U. S. Fish and Wildlife Service, Audubon Society, Pheasants Forever, Platte River Basin Environments, various state Natural Resource Districts, and the Crane Trust are just a few of the organizations that we often partner with on many conservation projects. Collaborating with multiple partners on a single project allows each organization to bring its expertise to the table, which often results in a project with added benefit to a plethora of wildlife and pollinator species.

ADDENDUM 3. **Farm Service Agency**

Habitat Conservation

Monarch butterflies and pollinators are a high environmental priority with U.S. Department of Agriculture (USDA). Farm Service Agency administers the Conservation Reserve Program (CRP) on behalf of USDA. One of the primary focuses of CRP is targeted to wildlife habitat which would include pollinator habitat. Agriculture productivity relies on pollinators to pollinate more than one-third of our food crops. CRP has a practice CP-42, Pollinator Habitat, available to increase resources needed for pollinators. CRP provides farmers and landowners with practices like this to achieve many farming and conservation goals. While Farm Service agency (FSA) does not have a focal area in Nebraska, over 23,000 acres of Nebraska cropland have been enrolled to CP-42, Pollinator Habitat.

Challenges

Another name for challenges is opportunities. FSA pays landowners to enroll land into CRP. CP-42 participants are guaranteed:

- 10 years of annual rental payments.
- Payments covering 50% of eligible costs to establishing pollinator habitat.
- Sign-up incentive payment (SIP) up to $150 per acre on new land enrolled in CRP.
- 50% cost-share payments for mid-contract management.

Possible challenges include outreach to inform people about CRP benefits and competition with agricultural production. Economically, CRP must compete financially with farm income given up to enroll.

Education and Outreach

Farm Service Agency has CP-42, Pollinator Habitat, fact sheets available to provide information to any conservation or pollinator partners. FSA works very closely with Natural Resources Conservation Service (NRCS), Nebraska Game and Parks Commission (NGPC), Pheasants Forever, Inc. (PF) and others to provide program information to the potential participants through their outreach efforts. FSA representatives would be available for any outreach events promoting CRP and its programs that would benefit pollinator habitat. The FSA website also contains information about all the practices of the CRP program, including pollinator habitat. FSA also provides a monthly GOVdelivery newsletter to interest operators

and land owners in pollinator habitat. Information on CRP opportunities are routinely included in these newsletters. FSA newsletter would be available to advertise pollinator events that FSA is involved with.

GovDelivery goes directly to ~26,000 e-mail addresses. FSA periodically sends a hard copy newsletter to ~80,000 through the mail. FSA conducts outreach at some state-level and county-level agricultural shows, where various FSA programs are promoted, including CRP and CP-42, to farmers and landowners.

Policy

The opportunities are great with a concerted effort to raise awareness of the need for pollinators in our food supply and ecosystem. FSA is likely one of the few partners that can provide rental payments, cost share, and incentive to enroll.

Some of the limitations include the size of CRP under the 2014 Farm Bill. CRP authorized acres were reduced from 32 million to 24 million acres. Demand for CRP is currently very high with the current reduced commodity prices. CRP is very close to the 24 million acre cap.

Research and Monitoring

FSA relies on conservation partners to provide the necessary research and monitoring to provide the best pollinator habitat available.

Collaborations with Partners

In Nebraska, FSA works closely with conservation partners NRCS, NGPC, PF, and the NRCS State Technical Committee to find those opportunities to benefit a number of conservation goals.

ADDENDUM 4. **Friends of the Niobrara, Inc.**

Friends of Niobrara, Inc. was created by citizens across the state of Nebraska who cooperate with local and federal government, as well as other groups, to offer education and outreach about the importance of protecting the Niobrara watershed. The mission of Friends of Niobrara, Inc. is to preserve the natural, historic, and scenic qualities of the Niobrara River and Valley.

Habitat Conservation

Common milkweed (*Asclepis syriaca*) has regularly been planted on property in Lincoln, Nebraska. Diversified plantings of milkweed will take place in Lincoln to include more species of milkweeds.

Education and Outreach

Friends of Niobrara encourages its members to plant for butterflies and other pollinators.

Research and Monitoring

Rosemary Thornton of Friends of Niobrara will continue to monitor milkweeds on property she owns located in Lincoln and Valentine where she raises larvae from eggs. Additionally, there are plans to sign up for the Monarch Larvae Monitoring Project, keep track of individual larva, including the growth and health of each, and report to the Monarch Joint Venture (MJV). Adult monarchs can be tested for the *Ophryocystis elektroscirrha* (OE) parasite under a microscope.

Collaborations with Partners

Friends of Niobrara is happy to work with the Nebraska Game and Parks Commission, Nebraska Department of Roads, and other groups to further the mission for conservation of monarch butterflies.

ADDENDUM 5. **GreenBellevue**

Green Bellevue is a grass-roots 501(c)(3), founded in 2009. Green Bellevue's vision includes …"educating and empowering people to undertake programs that beautify our community, preserve our natural resources, and honor our environment." From the beginning, we have had a focus on wildlife habitat and organic gardening as two of our main initiatives. We have conducted some educational meetings on similar topics and have invested funds and elbow grease in Bellevue public gardens that are appropriate to the topic.

Green Bellevue has also worked with other local partners to provide guidance and consulting to groups that have asked for assistance or guidance on their own garden projects.

We collaborate on projects and funding opportunities with the Bellevue Tree Board, a citizen advisory group that includes community volunteers and certified arborists.

The gardens have been designated as a Monarch Waystation, associated with the University of Kansas. This is a unique appointment and puts Bellevue "on the map" for a citizen science project that appeals to all ages for environmental appreciation and education. Special signage is in place for that.

The leadership volunteers of Green Bellevue's Wildlife Habitat Initiative are the primary drivers of this proposal. Additional support also is derived from the Sustainable Gardening and Youth Outreach Initiative Leaders.

Green Bellevue does not currently have specific goals for monarchs and pollinators, but is willing to make it a specific theme for 2017 and beyond. Green Bellevue can be nimble in its objectives from year to year.

Habitat Conservation

Habitat conservation efforts could be incorporated into our long-range plans. We have focused on small, community -based projects to date. We can identify locations for possible milkweed planting in our community and seek cooperation from others as needed. Bellevue is the third largest city in Nebraska.

Challenges

Challenges include: 1) getting others to agree not to spray pesticides that would jeopardize the program, and 2) adequate volunteers to monitor new plantings and assure success (e.g., weeding).

Education and Outreach

We have a history of working with our local schools. We have involved students from grade school through high school. One of our volunteers is currently working with a graduate student from the University of Nebraska–Omaha who is researching monarchs. Our website, local newspaper, general meetings, and farmer's market are used to educate and get others involved. Green Bellevue has an extensive email list for e-letters and a broad network of partners and supporting organizations. We meet monthly to conduct educational meetings, which are free and open to the public.

Policy

The local school system is receptive to our values and plans. We have considerable support from the City of Bellevue. There are many local residents that support our organization as well. Our local Parks Department has tended to ignore our requests for limited chemical spraying. Green Bellevue influences policies effectively, and there are certainly policy changes that could be made to help in implementation of actions for pollinators.

Research and Monitoring

Research and monitoring activities described earlier in sections above.

Collaborations with Partners

Green Bellevue partners with numerous organizations in efforts that can help pollinators. These groups include neighborhood associations, schools, churches, University of Nebraska–Lincoln Extension, Nebraska Master Naturalists, Bellevue Tree Board, and many more.

ADDENDUM 6. **Lincoln Public Schools, Science Curriculum Department**

Education and Outreach

Butterflies provide an engaging context for teaching life science concepts in the Lincoln Public Schools (LPS) science curriculum K–12. At this point, we do not use monarchs and other pollinators in the classroom, but there is interest in exploring connections to using them with the curriculum.

ADDENDUM 7. **Loveland Garden Club (a club member of the Garden Club of America [GCA])**

The Garden Club of America (GCA) is 200 club members strong with four main thrusts of interest: conservation, flower arranging, horticulture, and garden history and design. The GCA celebrated its 100th anniversary in 2011 and has held the annual National Affairs and Legislation (NAL) Conference in Washington D. C. since 1983. Loveland Garden Club (LGC), the only GCA club in Nebraska, is in Region XI which has 18 clubs in the Midwest.

For the last 5 years, pollinators have been a focus of all 200 GCA clubs with an interest in native plants. Currently, no specific goals have been set specifically for monarchs and pollinators, but we have recruited speakers on bees and monarchs, LGC has supported the Milkweed for Monarchs project at the National Parks Regional Offices in Omaha, and we are beginning a project at Glacier Creek Preserve (GCP). The cover of our quarterly magazine is a picture of a prescribed burn at GCP. LGC is hosting the GCA Shirley Meneice Conservation Meeting in Omaha in 2017 which will focus on prairies. More than 250 attendees are expected at this annual event held in different venues all over the United States. *Symphjyotrichum oblongiforlium* var. *angustatus* "Raydon's Favorite" was awarded the Freeman Medal in 2016.

Habitat Conservation

LGC members are from the Omaha area, were instrumental in starting the Lauritzen Gardens and support the LGC Endowed Lecture which is held every other year.

Challenges

LGC is just starting to look at the challenges and solutions of pollinators. Our club is a 501(c)3 organization.

Education and Outreach

Educating our members is one of our main goals.

Policy

LGC is limited to 50 active members.

Research and Monitoring

We are just beginning to advocate for pollinators with the University of Nebraska–Omaha (UNO) Masters Project of Emily Geest who is studying monarchs and milkweed in Omaha gardens.

Collaborations with Partners

LGC is just starting a project in conjunction with UNO's Glacier Creek Preserve with the GCA Partners for Plants project. Seeds from plants native to Nebraska will be used.

ADDENDUM 8. **Monarch Gardens (monarchgard.com)**

As a native plant garden design firm specializing in stylized urban wildlife habitat, we include as many host plants and nectar plants in our client landscapes as possible – within the limitations of a pleasing aesthetic design and the ecosystem function going on underground, too. We also work with some acreage owners to create a synthesis of habitat that bridges foundation beds and the wildness just beyond the lawn or fenceline. While we do not have a specific goal of milkweed numbers in mind, our general goal is to include as much diversity in our designed spaces as possible using straight species native plants adapted to the climate and wildlife (especially pollinators). We also plant on 12" centers – this allows more plants and a stronger ecosystem requiring less maintenance; the typical landscape design firm plants much wider and relies on mulch as a design element over plants. More plants, more planet.

Habitat Conservation

We primarily design gardens in and around Lincoln and Omaha. This year we have already designed ~5,000' of gardens – a modest number we expect to double this year, then quadruple next year. Our garden plans and consults we provide to clients also include information on the wildlife benefits of plants used, as well as resources to learn more about pollinator and wildlife-friendly landscape design and management.

Challenges

City ordinances, Homeowner Association (HOA) rules, and the like can present challenges. The typical idea of a "pretty" landscape is often incongruent to how wildlife see pretty, not to mention how our landscapes need to do a better job at carbon sequestration, stormwater runoff mitigation, etc. We work hard to ensure our gardens do triple duty. And while many folks find "wild" plant pretty in the wild, we are still learning how to adapt these plants to a more designed space while ensuring they still function similarly as to how they do in the wild (ecologically speaking). How can we design resilent native plant communities in an urban area that benefit wildlife, help with infrastructure issues, and are found gorgeous (accepted) by the public? When we have people complaining about "weeds" greater than 6", or HOAs that expect home landscapes to look like business campuses, it makes our goals harder to implement.

Education and Outreach

We offer regional and national speaking engagements on native plant garden design for wildlife many times each year and are willing to schedule more upon request. We also offer six mini pollinator garden plans on our website for various site conditions, as well as four online lectures/classes that people can take to learn about specific pollinators and the plants they require, how to garden for wildlife year round, how to design a sustainable space, etc. Also, a monthly newsletter is available.

Policy

This topic was mostly addressed in our response to the "Challenges" section. The best we can do is carefully and smartly design spaces using some elements of traditional garden design – tiered levels, masses and drifts, elements that welcome humans into the space (benches, paths, art, etc).

Research and Monitoring

We are currently building a 2,500' monarch/pollinator garden for the Cornhusker Council of the Boy Scouts of America headquarters in Lincoln. This space will be monitored for monarch adults and larvae by Boy Scouts.

Collaborations with Partners

In addition to the enterprises mentioned previously, we are trying to partner with any business open to an element of social advocacy/activism in their landscapes, as well as nonprofits who promote pollinator health.

ADDENDUM 9. **National Park Service**

Habitat Conservation

The National Park Service (NPS) has seven sites in Nebraska, five of which have land that is managed to conserve natural biodiversity. The NPS feels strongly that all pollinators must be preserved and strives to ensure that the needs of all creatures are taken into account when making management decisions. The NPS environmental education programs that promote conservation of natural and historic objects and wildlife within the parks are recognized globally. Each of the NPS sites in Nebraska – Missouri National Recreational River, Niobrara National Scenic River, Scottsbluff National Monument, Agate Fossil Beds National Monument, and Homestead National Monument of America have specific goals related to native vegetation and promoting and maintaining biodiversity.

Homestead National Monument of America has just over 100 acres of restored tallgrass prairie and 60 acres of lowland bur oak woodland. The management of the natural areas at the monument focuses on presenting the visitors a glimpse of what the first Homesteaders would have encountered while promoting biodiversity. The NPS does not have current estimates on the number of milkweed stems per acre; however, we are looking at monitoring data to see if we can determine an estimate. NPS has not specifically developed a numeric goal of milkweed for monarchs to our knowledge mostly because of the large national scale of our operations but would work locally with groups such as the state wildlife agency to adopt local goals for consistency and provide assistance.

NPS as a whole would like to utilize its venues to serve as patch habitat for pollinators as appropriate and serve as demonstration sites to communicate the importance of pollinators to visitors and the community. The NPS actively manages their lands ensuring invasive and exotic species are controlled and that natural processes such as fire continue to travel over the landscape. Besides managing the land for biodiversity, the NPS also has a very active environment education program. The program that is developed specifically for insects has reached several hundred students each summer.

Challenges

The main challenge that the NPS has is that most of the land under our management is already very diverse supporting a fair number of milkweeds. Opportunities to work the soil and plant more milkweeds will be limited. NPS does have very active education and outreach

abilities and can make a contribution through development of programs targeting the community and visitors.

Education and Outreach

Homestead National Monument of America has an active environment education program during the summers – Kids in Parks. During these events, kids explore the tallgrass prairie and woodland learning about the biodiversity of the monument. Several hundred students participate in these hands-on activities each summer. In addition, we have several events each year that focus on the importance of the prairie, woodland, and creek. NPS can expand programming in other park units in Nebraska, each of which have similar programs to that described for Homestead.

NPS has a website established to communicate resources that are available: www.nps.gov/subjects/pollinators/index.htm

Policy:

NPS is responsive to the Presidential Memorandum -- Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators. We as an agency have interest in partnering with other agencies and non-governmental organizations interested in promoting this agenda. Many of our policies and initiatives can be viewed on the web link provided earlier.

Research and Monitoring

NPS has a science/research support funding program, but programming research support must be planned 3 years out. We compete for these funds nationally and work with other partners. We would be interested in partnering on research needs through this program as appropriate.

Collaborations with Partners

Homestead National Monument of America has worked with agencies such as the Natural Resources Conservation Service and Pheasants Forever, Inc. for many years to help promote buffer strip and other conservation programs. Most of the time, our main contributions are related to providing meeting locations; however in the past, the NPS has hired interns to help promote conservation programs in the local watershed. Homestead National

Monument of America has long been monitoring the vegetation of the monument, but no specific pollinator research has been completed.

Throughout the NPS region, we have other examples of partnerships we could take advantage of. We also have involvement in the larger picture and participate in national/international forums such as the Commission for Environmental Cooperation projects including the Monarch Butterfly Flyway, etc. We are also involved in using the Landscape Conservation Cooperatives (LCC) as a tool to communicate across agencies and coordinate efforts. We would recommend involvement of this monarch and pollinator group with LCCs to communicate needs that might be able to be taken forward beyond Nebraska.

ADDENDUM 10. **Nebraska Corn Board**

Habitat Conservation

The Nebraska Corn Board has not set specific goals in regard to monarchs and pollinators. The Board recognizes that even though corn does not rely on pollinators, they are critical to agriculture and food production as a whole. As stewards of the land and Nebraska's natural resources, corn farmers can play a role in promoting the health and vitality of the state's pollinators.

Challenges

The greatest challenge the Corn Board may face in contributing to statewide pollinator goals is finding and promoting programs or practices that are not only beneficial to pollinators but also offer benefit to corn growers and can be feasibly implemented on their fields or into their operations. The hope is that the Board's involvement with statewide pollinator efforts will lead to solutions to this challenge.

Education and Outreach

Using the Nebraska Corn Board's established channels for outreach and education (social media, newsletters, publications), there is opportunity to help educate on the role pollinators play in agriculture as well as promote and inform Nebraska corn producers of programs or best management practices that facilitate healthy pollinator populations and conservation of their habitat.

Policy

As a state checkoff organization, the Nebraska Corn Board is prohibited from lobbying at the state level and is restricted in our ability to influence policy at a national level.

Research and Monitoring

The Nebraska Corn Board does not currently fund any pollinator related research but would consider funding research that demonstrates a benefit to both corn producers and pollinators.

Collaborations with Partners

The Nebraska Corn Board is not currently partnered with any groups focused exclusively on pollinator conservation. The National Corn Growers Association is a cooperator of the Nebraska Corn Board, and they are members of two pollinator focused efforts, the Keystone Monarch Collaborative and the Honey Bee Health Coalition.

ADDENDUM 11. **Nebraska Department of Roads**

Interest: Nebraska Department of Roads (NDOR) includes Environmental Stewardship as a goal within its Mission Statement. Roadside right-of-way (ROW) serves as pollinator habitat, and as appropriate, may be developed to improve its value to pollinating organisms.

Goals: 1) To consider development of pollinator habitat during development of construction projects, implementing habitat development where feasible and appropriate. 2) Reduce roadside mowing, where reduction will not affect safety and other NDOR goals. We look to specialized pollinator conservation groups to recommend dates when mowing is least damaging to pollinating organisms.

Habitat Conservation

NDOR owns rights-of-way statewide.

1) NDOR has a funded research project with University of Nebraska–Lincoln to study roadside wildflower islands' effect on pollinating species.

2) We are a partner with Nebraska Game and Parks Commission's (NGPC) Pollinator and Monarch Butterfly Habitat Restoration on the Cowboy Trail effort.

3) NDOR seed mixtures (for areas apart from shoulders) contain native flowers. Milkweed species are included in selected NDOR mixtures.

4) NDOR is working toward revising policy and guidance documents to emphasize conservation and development of pollinator habitats within its rights-of-way.

Challenges

Relevant challenges that NDOR faces include:

1) Maintenance of NDOR pollinator habitat development areas.
2) Measuring results of NDOR's efforts.
3) Funding for habitat development.

Education and Outreach

NDOR is considering development of a webpage and a brochure that would outline our efforts in pollinator conservation. NDOR's Communication Division would be asked to participate in developing these items.

Policy

NDOR staff is developing policy documents that will need Department approval. Staff anticipates that once approved, the policies will favorably adjust NDOR's guidance documents for roadside management and for project construction.

Research and Monitoring

NDOR is supportive of research efforts as described in the "Habitat Conservation" section above.

Collaborations with Partners

NDOR is a partner with NGPC's Pollinator and Monarch Butterfly Habitat Restoration on the Cowboy Trail effort. NDOR may be interested in partnering with local monarch butterfly/pollinator enthusiast groups near habitat development sites for maintenance, mowing, and weed control needs. More will be known after our policy documents are approved.

ADDENDUM 12. **Nebraska Game and Parks Commission, Planning and Programming, Parks, and Wildlife divisions**

Nebraska Game and Parks Commission (NGPC) is charged with the protection and management of Nebraska's natural resources. NGPC has broad general goals for the conservation of monarch butterflies and pollinators interwoven in our responsibilities for all species of wildlife. With the decline of monarchs and regal fritillaries, there has been a recent flurry of positive activity among multiple divisions of the Nebraska Game and Parks Commission (NGPC). However, we have been asked to do more from the public, administration, and the U.S. Fish and Wildlife Service (USFWS) to address national conservation goals for pollinators.

Habitat Conservation

Habitat practices (e.g., invasive tree removal, grass planting, prescribed burning, grazing management) that NGPC conducts on public lands have the potential to improve nearly 70,000 acres of pollinator habitat per year at the current rate of implementation. This acreage estimate includes practices on grasslands, wetlands, and woodlands and grows substantially when support of partner programs and technical support and access programs on private lands are included in the estimate. Impact can increase to well over 500,000 acres per year with landowner involvement and participation in programs.

Two grants recently received from the National Fish and Wildlife Federation and Nebraska Environmental Trust over the next 3 years will enable the Planning and Programming and Parks divisions to restore and create >300 acres of new high diversity prairie plantings spread across the monarchs' flyway in Nebraska. New pollinator habitat will be added to the Cowboy Trail and at a minimum of 15 parks in eastern Nebraska. Approximately 30 acres of NGPC's park property will be ready for pollinator seeding during fall 2016 by a contract vendor. And, hopefully at least another 30 or more acres will be added each of the next 2 years. We plan to plant over 25,000 milkweed seedlings during this same time period using funding from these two grants.

Challenges

The challenges facing NGPC with regards to contributing to the enhancement of habitat for monarchs and other pollinators revolves around available funding and adequate numbers of personnel and collaborators to accomplish the goals.

Education and Outreach

While quality land management and in-depth research are extremely important to conservation, we also need more education and outreach for all citizens in order to advance the monarch and pollinator initiative. In addition to the drafting of the *Conservation Strategy for Monarchs (*Danaus plexippus*) and at-risk Pollinators in Nebraska*, NGPC personnel have taken leading roles in hosting monarch and pollinator informational meetings and workshops. Informational webinars are also being held.

"Monarchs on a Mission" aims to educate Nebraskans about monarchs and milkweed by inviting them to color a monarch of their own. The colored monarchs will be collected and used in an exhibit at the Nebraska State Capitol during Pollinator Week 2017. Teachers, program leaders, education staff, or anyone working with students are invited to request an Educator Packet filled with three monarch and pollinator related educational activities, 30 paper monarch butterflies to be colored, and a return envelope to send in the monarchs once they are colored. Information will be made available on NGPC's website. Monarch and pollinator information is also being shared at the Nebraska State Fair.

Additionally, an organized "volunteer" pollinator habitat creation and monitoring program will be implemented with many of the 20 local communities and/or school groups along the Cowboy Trail, a multi-use recreational rail-trail in northern Nebraska, and in a number of state parks utilizing restoration projects to engage and involve up to 200 people in volunteer prairie restoration efforts. We also plan to present several educational programs with the Boy Scouts through the mid-America Council. The Nebraska Natural Legacy Project, state wildlife action plan, will be used as a guide to accomplish these goals.

Policy

NGPC' s role in the state is to provide policy makers with information, so that they can make better informed decisions. For example, roadside haying policy on state highways allows anyone to cut or mow the right-of-way (ROW) anytime without any limitations. The Nebraska Department of Roads (NDOR) would be able to better regulate pollinator habitat given more control over timing of roadside haying practices. NGPC is also able to interface with federal policy makers by providing information as well as through its membership in the Association of Fish and Wildlife Agencies.

Research and Monitoring

Plots planted with milkweeds only, or milkweeds and additional forbs and grasses, are being evaluated for their growth and overall success. But, the Monarch and Pollinator Initiative also recognizes that while formal scientific data are highly informative, there is also a benefit to being able to rely on citizen scientists for additional data collection. NGPC is promoting citizen science projects to document sightings of regal fritillaries and monarchs (or lack thereof along transects), as well as milkweed plantings in the state. Some basic data on pollinators and host plants are being collected at the local level and records are sent to NGPC and/or public websites such as inaturalist.

Collaborations with Partners

Nebraska Game and Parks Commission is pleased to work with numerous partners, many recognized in the Addendums of this document, in pollinator conservation efforts, whether it is through on-the-ground actions or sharing of information. The Nebraska Natural Legacy Project has been involved with the University of Nebraska's beneficial insect discussions. And, habitat quality is significantly improved with the Nebraska Department of Roads as a partner to restore and enhance 200 miles of Highway ROW adjacent to the Cowboy Trail to high quality pollinator habitat and to participate in the evaluation and monitoring efforts with local community volunteers. Many upland terrestrial wildlife and plant species are expected to benefit from these proposed improvements to the ROW grasslands and parklands which are mostly intended to assist in the recovery of pollinator species of insects such as the monarch butterfly.

ADDENDUM 13. **Nebraska Soybean Association**

Education and Outreach

Topics related to pollinators and monarchs to educate producers would be distributed in our quarterly Soybean Nebraska Magazine. We have social media outlets through the Nebraska Soybean Board.

Policy

The Nebraska Soybean Board is not allowed by law to engage in policy efforts. The Nebraska Soybean Association handles soybean policy work.

Collaborations with Partners

The Nebraska Soybean Association is a state affiliate of the American Soybean Association, and ASA is a member of the pollinator focused efforts of the Keystone Monarch Collaborative and the Honey Bee Health Coalition. Such, information is shared with the many cooperating soybean states and their members.

ADDENDUM 14. **Nebraska Statewide Arboretum (Nebraska Forest Service)**

Habitat Conservation

The Nebraska Statewide Arboretum (NSA), with the tagline mission of "Sustainable Landscapes for Healthy Homes and Communities" assists people and communities across the state in developing sustainable landscaping including improved habitat for beneficial insects and other wildlife. We do that through three program areas: a network of over 100 affiliate sites across the state that trial and display plants and landscaping for local education; a horticulture program that collects and grows native plant for use in community projects and are made available for purchase by the public; and via a community green infrastructure program that provides funding and technical assistance for landscape projects. NSA is also a membership organization that does extensive education and outreach on sustainable landscaping.

We have two active initiatives aimed at improving pollinators: Greener Nebraska Towns and Community as Habitat, a cooperative initiative with the UNL Dept. of Entomology. Through those two initiatives we are hoping to help establish up to 100 total acres of pollinator-friendly landscaping spread across 40–50 communities across the state. Project sites are at parks, schools, college campuses, fairgrounds and other public places. We have also written a proposal to the Monarch Butterfly Conservation Fund to support native plant collecting and growing for planting in communities to improve monarch and pollinator habitat.

Challenges

The challenges are many, but the most problematic to us is the general apathy most people have toward doing meaningful work in sustaining or improving the natural world around us. We are not aware of many people that do not want to help pollinators and monarchs, but there does not seem to be enough people willing to work hard for habitat improvement. We need to change that somehow. Education and inspiration is critical to this endeavor.

Education and Outreach

We work hard at education already and will be doing a significant amount of that through our existing outreach programs. This will include efforts such as newsletters, website material, brochures, etc. We would be excited to work with other entities in a more coordinated effort.

Policy

Nebraska Statewide Arboretum does not believe there are any policies currently limiting the scope of our work for pollinators.

Research and Monitoring

Our funding and outreach initiatives all have a research/evaluation and monitoring component. We will be evaluating habitat function as well as the impact on local citizens to help us learn more about the important best management practices that lead to success of habitat projects and local awareness and support.

Collaborations with Partners

We work with affiliated arboretum sites across the state that are locally managed including parks, schools, and campuses. We have strong ties with several UNL departments/groups including the Department of Entomology, the Department of Agronomy and Horticulture, Institute of Agriculture and Natural Resources, the Nebraska Forest Service and University of Nebraska–Lincoln Extension. We also have collaborative relationships with many of the Natural Resources Districts. We would like to strengthen ties with groups like Prairie Plains Resource Institute and Pheasants Forever.

ADDENDUM 15. **Nebraska Sustainable Agriculture Society**

The Nebraska Sustainable Agriculture Society (NSAS) has as a priority, education and outreach to Nebraska farmers on the importance of farming practices that are beneficial to monarchs and other pollinators. We hold an annual conference that includes sessions on monarchs and other pollinators. Additionally, we hold farm tours throughout the growing season to showcase different farming practices that are beneficial.

Challenges

At NSAS, our biggest challenge is to educate farmers on different practices that are beneficial for monarchs and other pollinators. This also includes educating the next generation of farmers.

Education and Outreach

NSAS provides educational opportunities about monarchs and other pollinators for farmers and aspiring farmers. These include hands-on sessions during the growing season around sustainable and organic farming practices that provide a direct benefit to these pollinators.

Policy

NSAS participates in the National Sustainable Agriculture Coalition and their work on policy. Our focus is on education and outreach however.

Research and Monitoring

NSAS has farmers that participate in government programs and university research projects.

Collaborations with Partners

We have partnered with the University of the Nebraska Organic Program, SARE, and Farm Aid to provide opportunities for farmers to participate.

ADDENDUM 16. **Nebraska Weed Control Association**

The Nebraska Weed Control Association is making it a priority to educate our members on the importance of milkweed and other beneficial plants to Nebraska's landscape. We hold four trainings per year and will be covering pollinators and monarchs at three of the four trainings.

Challenges

Our biggest challenge is to educate landowners on the importance of habitats for monarchs and other pollinators in each of our counties.

Education and Outreach

We will bring in experts to share about monarchs and other pollinators at our training sessions.

Policy

Education efforts at the county level are needed for landowners and our Board of Directors.

Research and Monitoring

Some in our organization have mentioned they would be willing to help with monitoring, since we are working in rural areas every day.

Collaborations with Partners

The Nebraska Weed Control Association has not yet collaborated with partners for monarch and pollinator conservation efforts, but may have opportunities to do so in the future.

ADDENDUM 17. **Nebraska Wildlife Federation**

Nebraska Wildlife Federation has a backyard wildlife program that has been teaching people how to make a place for wildlife, including monarchs and other pollinators, in their backyard. The Federation has also been working to create (and identify existing) monarch and pollinator model gardens across Nebraska, to help educate Nebraskans about monarch, pollinators, and their habitat. Several of these gardens are in development, primarily in the Lincoln area, and others are in the works.

Challenges

Funding is a constant challenge, to fund the staff time, travel, and other costs of carrying on outreach, education, and conservation. In general, our workshop participants have been very interested and willing to provide or improve monarch and pollinator habitat.

Education and Outreach

Nebraska Wildlife Federation is part of the Monarch and Pollinators Education and Outreach Committee that emerged from the Monarch Summit. With Nebraska Environmental Trust Fund support, we are providing 15 backyard habitat workshops, and 5 regional schoolyard habitat workshops, to teach people how to make a place for monarchs and other pollinators in their backyards and schoolyards. Nebraska Wildlife Federation is also partnering with the National Wildlife Federation to provide additional outreach and education via web sites and other means.

Policy

The Federation has been involved in state legislation that would change the current requirements that landowners mow county road ditches at least twice a year; to date that has been unsuccessful but we are working on new legislation for 2017.

The Federation takes an active role in the USDA Natural Resources Conservation Service State Technical Committee, providing advice to the USDA on implementing conservation programs, including some that provide incentives for planting and maintaining pollinator-friendly habitat and adopting pollinator-friendly practices (like integrated pest management versus whole-field pesticide spraying). The Federation is active in the Legislature on agency funding issues, and we will be looking for opportunities to support additional funding for monarch and pollinator conservation activities.

Research and Monitoring

We are not involved directly in research related to monarch and pollinators, but we provide information on volunteer monarch and pollinator monitoring programs, like Monarch Watch and Milkweed Watch, in our workshops and presentations.

Collaborations with Partners

The Federation helped organize initial partner meetings in 2015 which led to the Monarch Summit. We also collaborated with Game & Parks, the Fish & Wildlife Service, Pheasants Forever, the University of Nebraska, Monarch Watch and others to organize the Monarch Summit in February, 2016. We are actively collaborating with the University of Nebraska–Lincoln, Omaha Public Schools, Nebraska Game and Parks Commission, Cornhusker Council of the Boy Scouts of America, Community Crops in Lincoln, City Sprouts in Omaha, Pioneers Park Nature Center in Lincoln, Milkweed Watch, National Wildlife Federation, and other agencies and organizations.

ADDENDUM 18. **Northern Prairies Land Trust**

Habitat Conservation

Northern Prairies Land Trust (NPLT) biologists will work with private ranchers and farmers to implement native prairie enhancement projects. We will also provide $200,000 in cash match (Nebraska Environmental Trust Grant) over the next 2 years to monarch and pollinator conservation by Prairie Plains Resource Institute (PPRI). Other partners include Nebraska Game and Parks Commission (NGPC), the U. S. Fish and Wildlife Service (USFWS), and the National Fish and Wildlife Foundation (NFWF). This conservation work will occur throughout the eastern half of Nebraska, an area designated by the USFWS as high priority for monarch conservation.

Specific project objectives of this partnership include:

- Enhance a minimum of 12,550 acres of higher-quality, native tall and mixed-grass prairies as habitat for monarchs and other pollinators through the actions of invasive tree clearing, planned grazing, and prescribed fire.
- Restore a minimum of 200 acres of cropland to milkweed rich, high-diversity (~100 species), local-ecotype prairie as monarch habitat.
- On a minimum of 475 acres, restore cropland or inter-seed existing grasslands using a milkweed-rich, moderate-diversity (20–40 species) local ecotype seed mix.
- When the above mentioned plantings are mature (in 3–5 years), use volunteers and cooperating partners to collect milkweed and other wildflower seed from the plantings for use (free of charge) in plantings of other monarch habitat projects (prairie restorations and butterfly gardens).

Challenges

To help meet challenges, NPLT will work with PPRI and their existing organizational infrastructure to achieve goals.

Research and Monitoring

Monitoring of monarch and milkweed populations in Nebraska will primarily be conducted by our project partners. NPLT will contribute to tracking the impact of our restoration and management activities via such metrics as:

- Acres of existing prairie enhanced through prescribed burning.

- Acres of existing prairie enhanced through grazing/grassland management plans.
- Acres of existing prairie enhanced through invasive shrub and tree removal.

Collaborations with Partners

Northern Prairies Land Trust is partnering with Prairie Plains Resource Institute, Nebraska Game and Parks Commission, the U. S. Fish and Wildlife Service, and the National Fish and Wildlife Foundation as described.

ADDENDUM 19. **Pheasants Forever, Inc.**

Habitat Conservation

Through its ability to design conservation program seeding mixtures, the selling of seed mixtures, and promoting a "Habitat Standard," Pheasants Forever, Inc. (PF) designs, sells, and plants ~50 million milkweed seeds in the state each year. On an annual basis, PF impacts 190,000 acres of grasslands (planting high quality habitat and managing existing grasslands with prescribed fire and other practices). PF works toward the development of a 'High Quality Habitat Standard' that is promoted and applied to habitat projects in the state. PF has many conservation programs that establish and manage high quality grasslands:

- Honey Bee and Monarch Butterfly Partnership
- Corners For Wildlife
- Habitat Share
- Grassland Improvement Program
- Prescribed Fire Management Program
- No-till Grass Drill program (>65 drills in the state)
- Seed sale program (10–25 thousand grass/wildflower acres per year)
- Farm Bill Wildlife Biologist Partnership
- Coordinating Wildlife Biologist Partnership
- Local chapter projects (65 chapters working across the state)
- Plant ~50 million milkweed PLS seeds per year in Nebraska (primarily common, butterfly, and swamp milkweeds, in that order). This number has been increasing every year with the development and use of our 'high quality habitat standard.'
- There is currently no way to estimate the number of stems established.

Education and Outreach

- Pheasants Forever, Inc. has a youth pollinator program in which we are working with 3rd and 4th grade classrooms to establish pollinator habitat projects across the state. Typically, these are 1-acre projects that are established on public lands.
- Regular production of monthly video habitat tips that feature pollinator habitat objectives, management suggestions, outcomes, etc. Sample: https://www.youtube.com/watch?v=4uGZ_C6EmEI
- Pollinator training events with Monarch Joint Venture for PF staff in the state and around the country.

- Social media posts about pollinators (Facebook, website, etc.). Nebraska Monarch and Pollinator Initiative is now on facebook @nebraskaMPI
- Many presentations at conferences and meetings across the country related to pollinators and pollinator habitat.
- Presentations and training to chapter leaders and the public at the annual State Habitat Meeting (>250 attendees).

Policy

- Pheasants Forever, Inc. is actively involved in several national committees related to pollinators and monarch butterflies.
- Pheasants Forever, Inc. is actively involved with USDA and USFWS to improve conservation program seeding mixtures and habitat outcomes.

Collaborations with Partners

Pheasants Forever, Inc. has been actively working on pollinator conservation efforts with the following organizations:

- Monarch Joint Venture
- Monarch Collaboration Committee
- Honey Bee Health Coalition
- Iowa Monarch Conservation Consortium
- American Beekeeping Federation
- Honey Bee and Monarch Butterfly Partnership
- National Fish and Wildlife Foundation
- U.S. Fish and Wildlife Service
- U.S. Department of Agriculture
- Nebraska Game and Parks Commission
- Save Our Monarchs

ADDENDUM 20. **Prairie Plains Resource Institute**

Habitat Conservation

Through high diversity prairie restoration work and appropriate land management practices, Prairie Plains Resource Institute has and will continue to have a positive impact on monarch and pollinator conservation in Nebraska. We are interested in continuing with these efforts as well as enhancing other efforts to assist with monarch and pollinator conservation in the state. Our typical high diversity seed mixes have included an abundance of milkweed and other forbs that are key pollinator plants. We plan to place even more focus on harvesting milkweeds (mostly common milkweed; *Asclepias syriaca*) and other key pollinator forbs in the coming years. We plan to include more of this seed in certain plantings to ensure even more pollinator rich restored habitat. These restoration efforts will also be complimented by greenhouse grown plugs. We plan to expand our greenhouse operation, specifically for growing more milkweeds and key pollinator plants for the purpose of supplying restoration and enhancement projects with local ecotype plants. Our other goals deal with land management. As a land trust, Prairie Plains owns and manages a number of properties across the state. Our land management techniques (e.g., fire, grazing, invasive tree removal) have always revolved around enhancing the diversity of the prairies. We are interested in continuing these best management practices with extra attention to managing for milkweed stands and other important pollinator plants.

We have started by discussing management and restoration goals/plans with other agencies in Nebraska and hope to secure National Fish and Wildlife Foundation (NFWF) grant funding from the Monarch Butterfly Conservation Fund 2016 to put these plans in action. Prairie Plains has written a NFWF grant proposal for the Monarch Butterfly Conservation Fund 2016. This collaboration is among Prairie Plains, the Partners in Fish and Wildlife program under U. S. Fish and Wildlife Service (USFWS), the Southeast Prairies with Northern Prairies Land Trust, Nebraska Game and Parks Commission, Lower Platte South Natural Resource District (NRD), and the National Wildlife Refuge System - Rainwater Basin Wetland Management District. The collaborators on this project plan to use funding to work with 12,550 acres for tree clearing and grazing programs. High diversity prairie plantings would be done on >200 acres, and moderate diversity prairie plantings would be done on >225 acres. An additional 200+ acres of restoration would be completed on USFWS's refuge areas in the Rainwater Basin. An expansion of the Prairie Plains' greenhouse would allow us to grow >20,000 seedlings over a

2-yr project. This includes milkweeds and other key pollinator forbs for restoration and enhancement projects.

The habitat conservation work that Prairie Plains plans to do will mostly take place in the eastern half of Nebraska. The restoration work (seeding and plugs) will occur various places in the eastern half of the state. Most of the land management work (tree clearing, grazing, prescribed burning, etc.) would take place in the eastern half as well (working with other collaborators involved with the grant proposal). However, Prairie Plains' specific focus will be on prairie lands in Hamilton County, Nebraska.

Challenges

The main challenge to monarch and pollinator conservation will be obtaining enough funding. We will need financial assistance to be able to expand our greenhouse, provide restoration services, and perform other land stewardship tasks. The NFWF grant proposal is a good start. If funding is secured, Prairie Plains and the other collaborators will be able to meet the goals they have laid out as a part of the proposal. Continued funding for these efforts will also be a challenge for almost all organizations involved.

Education and Outreach

Prairie Plains would be interested in contributing knowledge and expertise on high diversity, local ecotype habitat restoration and land management techniques to benefit pollinators as part of classes or trainings. We could provide presentations on either habitat restoration or land management. We would be happy to provide sites for restoration and management tours on the land.

Policy

We are not as involved in the policy realm. We would be happy to perhaps provide some input on what is needed as far as restoration or plug growing efforts go. That is, any information that would relate to other agencies that are looking at influencing policy to increase restored acres from cropland, etc.

Research and Monitoring

We plan to have a role in monitoring, albeit likely small. In 2016, we will be setting up some transects on ~5 different properties to count regal fritillaries and monarchs. We plan to continue this into the future, and we also plan to work with other agencies that are doing more

specific monitoring and research. We can provide sites for monitoring or provide input on monitoring plant communities. We typically get to observe a number of different prairie sites and their plant communities throughout the growing season. Going forward, we plan to keep better records of our observations about both plant and insect communities on our properties.

Collaborations with Partners

As mentioned above, our NFWF grant proposal is a collaboration among Prairie Plains, the Partners in Fish and Wildlife program under the U. S. Fish and Wildlife Service, the Southeast Prairies with Northern Prairies Land Trust, Nebraska Game and Parks Commission, Lower Platte South NRD, and the National Wildlife Refuge System - Rainwater Basin Wetland Management District.

ADDENDUM 21. **Syngenta Crop Protection, LLC**

Habitat Conservation

Syngenta has an interest in pollinator conservation as described on our website explaining the work we are doing including Operation Pollinator. For an overview, see www.syngenta-us.com/beehealth/. We also try to have pollinator plots at our sites. In Nebraska, we plan to plant 1 acre for monarch butterflies at our site in Waterloo.

Research and Monitoring

Operation Pollination is a research-based program that uses specially selected wildflowers to attract a variety of pollinators and increase biodiversity.

Collaborations with Partners

Currently, our key collaborators for pollinator conservation are Pheasants Forever, Trees Forever, Project Apis m, Honey Bee and Monarch Butterfly Partnership, Delta FARM, and Sand County Foundation.

ADDENDUM 22. **The Save Our Monarchs Foundation**

Habitat Conservation

Our organization is dedicated to procuring and distributing milkweed and other native forb seeds. Last year, we distributed 1,000,000 seed packets across the U.S. We hope to distribute more in 2016. In Nebraska, we have a joint project with Nebraska Public Power District (NPPD) to restore their properties and rights-of-way to pollinator habitat as resources allow. By the end of 2017, we intend to have restored or enhanced > 3,000 acres of this land. Our current restoration project sites are in Gage, Nemaha, Phelps, and Dawson counties.

Challenges

Our biggest challenge to restore or enhance the amount of acres at our disposal is funding for seeds and/or starter plants. If funding allows, we would like to open a greenhouse in Nebraska in which to cultivate different milkweed varieties and other native forbs in order to provide our projects ourselves, with a greater likelihood for success. We have noticed on other restored parcels that direct seeding has not been very effective in terms of germination and establishment rates of medium-diversity seedings. We believe that focusing our efforts, using milkweed and forb plugs, on pollinator/forb islands in larger enhanced areas will provide a greater rate of establishment.

Education and Outreach

We currently give presentations to community groups regarding the situation of monarchs and other pollinators. If given other opportunities, we are willing to provide presentations, trainings, produce media, etc.

Policy

We are researching the possibility of more prescribed burn-friendly policies.

Research and Monitoring

We monitor our sites and track species counts (plant and pollinator) over time.

Collaborations with Partners

Currently, we have an agreement in place with NPPD to restore pollinator habitat on their properties and right-of-ways. We hope to extend our agreements to other utilities and right-of-way holders in Nebraska.

ADDENDUM 23. **Twin Valley Weed Management Area**

Twin Valley Weed Management Area (TVWMA) was organized in 2004 with a vast array of committee members, including Corp of Engineers, Extension Educators, NE Game and Parks Commission (NGPC), District Foresters, Natural Resource Districts (NRD), Natural Resources Conservation Service (NRCS), County Weed superintendents, Resource Conservation and Development (RC&D) representatives, and local landowners. Although our primary focus is on removal of invaders and noxious weeds, we are all conservationists and want to see the best use of our riparian areas. Pollinator plantings are new to all of us on this committee, and we are certainly aware of how important they are in our ecosystem. We feel that we can contribute significantly because of the number of acres that we have access to, the landowner contacts who would be willing to participate, and funding is available.

Habitat Conservation

On an annual basis TVWMA is thinning and removing undesirable trees and vegetation. In addition, we are either deep disking or burning an additional 200–300 acres of islands (or sandbars) which may provide sites for seedbeds if not too sandy. Some of these areas have been seeded back to recommended mixtures at landowner request. These areas are usually somewhat primitive and set idle basically for wildlife purposes. We administer 145 miles of the Republican River from Cambridge to Superior, Nebraska, so we do have access to a large number of acres (and landowners). It is a matter of determining what soil types and existing vegetation will conform to these types of pollinator plantings. My estimate is that we may have up to 600 acres on 20 different sites of potential property access for these plantings.

Challenges

The primary challenge we see is that many of our potential seeding sites may be too sandy for typical pollinator plantings. The sites we work on within the riparian area are from sandy to silty loam – a wide contrast. We do think that with the funding that we have received (and future funding) through Nebraska Environmental Trust, that we can financially meet all challenges head on. In addition, we have funding provided by the local NRD and several other sources.

Education and Outreach

Pollinator plantings are a relatively new topic to me and members of our committee. We do get excellent exposure from the press with all the endeavors that we encounter. We have made videos of various projects we get involved with. The Lower Republican NRD puts out a quarterly newsletter to all households in their district and often times discusses our ongoing activities. We contribute articles to *Weed Watch*, which is a statewide biennial newspaper insert. We have two extension educators on our committee who are very interested in these plantings and will take the opportunity to share the success stories once achieved.

Policy

As of right now, there are no policies that would negatively impact the plantings that we would like to make. We have numerous acres to plant and landowner support to do so. We have talked to Mark Brohman, executive Director of Nebraska Environmental Trust, and he too assured us that these plantings would be a wise use of Trust Funds. We have talked to NRCS personnel about the Environmental Quality Incentives Program (EQIP). They informed us that they were not aware of any funds available for plantings in riparian areas. They said funds only apply to upland site plantings. It would be nice if this policy could change!

Research and Monitoring

TVWMA personnel will be keeping a close eye on the plantings and checking on germination of the seedings. Other members of our committee, i.e. Extension personnel and NRD will be watching closely as well.

Collaboration with Partners

As mentioned previously, we have a strong and diversified committee involved. The Corp of Engineers at Harlan Reservoir has also obtained some funding, and they too will be making several plantings on upland sites. We also want to work with NGPC on property they own south of Red Cloud for some pollinator plantings as well.

ADDENDUM 24. **U.S. Fish and Wildlife Service, Partners for Fish and Wildlife Program**

Habitat Conservation

The Nebraska Partners for Fish and Wildlife Program (NE PFW) focuses its efforts in ecosystems or landscapes where our efforts will accomplish the greatest biological benefits per conservation dollar expended. We focus our efforts on restoring and maintaining the functionality of natural communities and ecological systems. Our main emphasis continues to be to restore wetland, grassland, riverine, and riparian habitat on private lands; and working with private landowners and other partners to restore and protect priority habitats to increase and maintain federal trust species population. Projects are prioritized, planned, and designed to address current stresses (e.g., invasive species, habitat fragmentation, lack of fire, changes in hydrologic regimes, and grassland conversion). The NE PFW continues to work with our partners to provide high quality prairie, wetland, and riparian habitats for monarchs and other pollinators, grassland nesting birds, migratory waterbirds (e.g., waterbirds, waterfowl, shorebirds, wading birds), federal listed species, and the numerous other species of plants and animals that depend on these systems for their survival.

NE PFW restores important riverine, stream, and riparian habitat for numerous federal trust species by removing invasive species such as Russian olive, eastern red cedars, and phragmites. These types of projects will help restore and maintain migratory corridors and reduce additional stresses and pressure that may occur and cause further increases in habitat fragmentation and the distribution of undesirable invasive species. The NE PFW program also conducts projects to improve wetlands by restoring their natural hydrology. These types of projects help restore the hydrology and contribute toward the restoration and enhancement of important wetland habitats. These projects also restore and maintain native habitats and migration corridors and reduce stresses that affect the plant composition of these critical important wetlands.

Undesirable invasive woody tree species are invading native grasslands throughout Nebraska at an alarming rate. Native prairie restoration projects reduce stresses to monarchs and other pollinators by: (a) restoring important prairie habitat by removing and suppressing invasive vegetation; (b) enhancing the native qualities of native grasslands by increasing plant diversity; and, (c) restoring and maintaining habitat and migratory corridors for monarchs, pollinators, avian species and other federal trust species.

Challenges

There are numerous challenges that our organization faces when it comes to restoring habitats for fish and wildlife, including habitats for monarchs and other pollinators on private lands. A few challenges that affect our ability to put monarch and other pollinator habitat on the ground in Nebraska include:

- Funding and capacity
- Cost of seed and availably of seed and plant material
- Economic incentives for producers to plant cropland back to grassland/prairie
- Eastern red cedar invasion and habitat fragmentation
- Landowner perception of compatibility of milkweed in grazing systems

A solution to the above challenges involves continuing to work with private landowners and other partners to develop and maintain successful voluntary partnerships to restore wetland, grassland, riverine, and riparian habitat on private lands for the benefit of monarchs and other pollinators. The success of our conservation efforts on private lands is dependent on our ability to develop and maintain partnerships throughout Nebraska to collectively address the challenges that we all face.

Education and Outreach

An overarching objective of the NE PFW program is to maintain and enhance communication and collaboration with our diverse group of internal and external Partners. Information sharing and communication is an essential part of conservation and NE PFW program staff will continue to inform the public and make efforts to increase awareness of the importance of conserving species and habitats on private lands, including the restoration and enhancement of habitat for monarchs and other pollinators.

The NE PFW program staff would be interested in participating in landowner meetings, project site visits, field tours, outdoor educational activities, conferences and/or workshops to promote monarch and other pollinator conservation efforts throughout various landscapes of Nebraska.

Policy

A national, regional, and state priority for the U.S. Fish and Wildlife Service is to "Reverse the declining trend for monarchs and other endemic pollinators." The large intact native prairies and grasslands located throughout the Service's Mountain-Prairie Region (Region 6) provide a variety of native flowering plants that have overlapping blooming times,

are adapted to local soils and climate, and provide the nectar and pollen producing habitats that are required by monarchs and other pollinators. Conservation actions are being focused in key geographic areas which are important for summer breeding and migrating monarchs, and these efforts are occurring in eastern North and South Dakota, Kansas, and Nebraska in Region 6. National and regional priorities help guide Service activities and allow the NE PFW to assist in implementation of habitat projects that benefit monarchs and other pollinators.

Research and Monitoring

The Strategic Habitat Conservation (SHC) framework has been embraced by the NE PFW program and its partners to help guide planning and conservation delivery in Nebraska. The process has been applied more in some conservation Focus Areas where technical and financial resources have been secured through larger formalized partnerships (e.g., Joint Ventures, Landscape Conservation Cooperatives, and Cooperative Recovery Initiatives). The SHC framework is being applied in Nebraska to guide conservation delivery to benefit Federal trust species, including migratory birds, grassland nesting birds, federally listed species, and other federal trust species (i.e., monarchs and other pollinators). The four basic elements of the SHC framework include: (a) biological planning, (b) conservation design, (c) program delivery, and (d) monitoring and research. The program delivery element of the SHC framework has been and will continue to be the emphasis of the NE PFW program. Implementation of on-the-ground habitat restoration projects that restore and protect priority habitats to increase and maintain Federal trust species populations is the primary goal of the PFW program.

However, to increase accountability and to measure, assess, and report on effectiveness, efficiency, and fiscal integrity of our habitat conservation practices/projects/program, different levels of monitoring have been identified/developed. The purpose and goal of our monitoring efforts is to contribute toward the successful delivery of habitat restoration projects throughout Nebraska and contribute towards meeting the goals, objectives, and targets for the NE PFW program as identified in the PFW Mountain-Prairie Region Strategic Plan 2012–2016.

To ensure that the on-the-ground habitat restoration practices identified within Landowner Agreements are completed and functioning per the scope of work identified, site visits are conducted at the time of project completion and will be repeated periodic throughout the life of the agreement. During site visits, projects are evaluated to determine if the vegetative composition and fish and wildlife use of the project is meeting anticipated goals and to document the response of the flora and fauna to the practices that were implemented as a result of the implementation of the habitat project.

Metrics that will be tracked for projects that benefit monarchs and other pollinators include:

- Acres of existing prairie enhanced through prescribed management (e.g., fire, grazing/grassland management plans).
- Acres of existing prairie enhanced through invasive shrub and tree removal.
- Acres and number of sites of prairie restored/enhanced through the planting of high diversity, milkweed/pollinator plant-rich seeding/plantings.
- Acres and number of sites of prairie restored to moderate diversity, milkweed-pollinator plant rich seeding/planting.

Collaborations with Partners

One of the main goals of the PFW program is to "Broaden and Strengthen Partnerships." Community-based partnerships are the foundation for success of the PFW program. Our goal is to develop successful voluntary partnerships; to restore wetland, grassland, riverine, and riparian habitat on private lands; and to work with private landowners and other partners to help prevent the need for further listings of species as endangered or threatened. The NE PFW program works with a diverse group of partners to provide high quality prairie, wetland, and riparian habitats for monarchs and other pollinators and the numerous other species of plants and animals that depend on these systems for their survival. The success of the PFW program is dependent on our ability to develop and maintain partnerships throughout Nebraska.

ADDENDUM 25. **Wachiska Audubon Society**

Habitat Conservation

Wachiska is focused on preserving remnants of native prairie ecosystem in the 17-counties of southeastern Nebraska. The eight prairies we own contain ~ 150 acres of native prairie. We own an additional ~200 acres of former cropland that are in various stages of native prairie restoration. We also hold a number of conservation easements on additional prairies. Our mission is to foster the healthy survival of our native prairies.

Challenges

Our members have always been involved and dedicated to our mission. We see the state plan and project for monarchs and pollinators not so much as a challenge for us but rather an opportunity to become involved.

Education and Outreach

This is the core of why we are committed to conserving our native prairies. Annually, we conduct outings to our prairies for area school groups and others. The importance of pollinators is a main part of the prairie story and is what we try to instill in our young audiences.

Policy

We closely monitor, through concerned Wachiska members and others, what the state legislature has on its upcoming agenda. Our members are sensitive to environmental, land use, and other issues and are ready to promote or oppose legislation.

Research and Monitoring

We closely monitor the health of our prairies as to the need for a burn, haying, removal of invasive species, or regeneration. We are in a position to provide research opportunities for others to assess and monitor the monarch host plants and plants visited by pollinators. We believe that assessing the outcome of a campaign to plant milkweed plugs needs to be evaluated to improve the success of future plantings. We also have some small areas that could be planted for pollinators.

Collaboration with Partners

Wachiska Audubon has worked with USDA-Natural Resources Conservation Service (NRCS) in doing prairie restoration seeding. In the Spring of 2015, a 30-acre seeding was done with ~4,000 seeds per acre of native milkweed with assistance from NRCS.

ADDENDUM 26. **Xerces Society for Invertebrate Conservation**

Habitat Conservation

The Xerces Society is a nonprofit conservation organization that works to protect invertebrates and their habitat. Our staff works with farmers, gardeners, agency staff, land managers, departments of transportation, and others to create habitat for monarch butterflies and other pollinators. We work to conserve all pollinators through restoration, education, research, advocacy, policy, and communication and outreach. We hope to bring monarchs back to a stable population and to support a healthy migration.

We work directly with private land owners to help them install and manage pollinator habitat, and we work with agricultural educators and others that engage with private landowners. Through a formal partnership with the USDA Natural Resources Conservation Service, we support efforts to create habitat specifically for monarchs as well as honey bees and other pollinators. We also work with public land agencies, providing best management practices to manage existing habitat and restore habitat. We do not have a focal area in the state, but our regional office is based in Omaha.

Challenges

One challenge will be finding partners and communicating with other stakeholders about the expertise Xerces can provide and the way in which we might collaborate with other stakeholders. We are hopeful this process will help to create a network that continues long after the plan is drafted.

Education and Outreach

In our outreach efforts, we translate the best available science into practical conservation policy and practice. We can provide programs that include 1-hr talks, field days, pollinator monitoring training, and a day-long pollinator conservation short course that takes the audience through pollinator biology, identification, pollinator-friendly management practices, and restoration guidelines. We will be happy to work with others in Nebraska on classes, trainings, newsletters, websites, videos, and more.

Policy

We look to influence policies at all levels (local, state, federal) that can protect pollinators through habitat management and creation, or protection from the misuse of pesticides. The

governor of Nebraska has declared a week in June for pollinators. Although it is not policy, it would be amazing to have a mandate from the governor of Nebraska directing state agencies to find ways to support pollinator health. Although there are many agencies in Nebraska already engaged in this process of finding ways to support monarchs, a mandate might bring other agencies to the table and engage new audiences.

Research and Monitoring

Xerces has a monitoring program for milkweeds and monarchs in the western states. In the east, we are working with the Natural Resources Conservation Service to monitor the effects of their Monarch Butterfly Habitat Development Project. We also have a citizen science pollinator monitoring guide that can be adapted and used by different audiences for different purposes.

Collaborations with Partners

Xerces partners with many different organizations and individuals, including agencies at the local, state, and federal level, conservation groups, landowners, educational institutions, businesses, and more. We are open to new collaborations with other stakeholders or nontraditional pollinator conservation stakeholders.

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SUPPLEMENTARY APPENDIX 1: List of Plants Native to Nebraska for Pollinators

A highly diverse planting will provide numerous nectar, pollen, foraging, and shelter sources for pollinators during multiple seasons. While not inclusive of every plant that pollinators may use, this list of flowering herbaceous perennials and annuals, shrubs, trees, grasses, ferns, sedges, rushes, and bulrushes offers some useful suggestions for native plants that will attract pollinators to gardens and restorations in Nebraska. Choose plants appropriate to ecosystems. Common and scientific names are listed as given in the U. S. Department of Agriculture's PLANTS database (USDA 2016). Additional information about growth habits was derived from the Natural Resources Conservation Service (2017a,b), Lady Bird Johnson Wildflower Center (2016), Wisconsin State Herbarium (2016), Hilty (2015), Müller (2009), and experts as given in the acknowledgments section. Plants are listed in alphabetical order by Family and scientific name under growth habit (i.e., herbs/forbs, graminoids, shrubs, trees). Although all of the plants in this table are native to Nebraska, a very limited number of species may be listed as invasive by county; it is advisable to compare your plans for pollinator plots with your county noxious weed list to avoid violations. Also, some plants have mechanical and/or chemical defenses against herbivory that can cause reactions in people or animals. Make your selections accordingly if you think you, young children, pets, or livestock will be highly susceptible to plant defenses or if you have other concerns.

Herbs/forbs:
Arum Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
Jack in the pulpit	*Arisaema triphyllum*	S–P	A–W	sand, loam, clay	1–2	Mar–Jun	Pulpit-like flower provides red berries in late summer; woodland plant
bearded beggarticks	*Bidens aristosa*	P–F	A–W	various soils except very sandy	1–4	Jul–Sept	Flowers yellow; 2-pronged bur

APPENDIX S-1. (cont.)

Herbs/forbs:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
bearded beggarticks	*Bidens aristosa*	P–F	A–W	various soils except very sandy	1–4	Jul–Sept	Flowers yellow; 2-pronged bur
white doll's daisy	*Boltonia asteroides*	F	A	clay-tolerant	3–5	late Jul–Oct	Flowers are white rays with yellow center; rays sometimes tinged pink to purple; tolerates standing water for short periods of time
false boneset	*Brickellia eupatorioides*	F	D	tolerates poor soil; limestone, clay, sand, gravel	1–3	Sept–Nov	White, yellow, or red flowerheads
tall thistle	*Cirsium altissimum*	F–P	A–W	fertile loam, clay-loam, sandy-loam	4–5	late Jul–Oct	Flower light to dark purple, occasionally white florets

APPENDIX S-1. (cont.)

Herbs/forbs:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
prairie thistle	*Cirsium canescens*	F	A–D	sand, gravel, disturbed sites	1–3	May–Aug	Flower cream, occasionally pale lavender
Flodman's thistle	*Cirsium flodmanii*	F	A–D	disturbed sites	1–3	late Jun–Sept	Flowers dark purple, sometimes pink, rarely white
yellowspine thistle	*Cirsium ochrocentrum*	F	D	sand, gravel, disturbed sites	1–4	Jul–Aug	Flowers purple to rose-colored, rarely white
wavyleaf thistle	*Cirsium undulatum*	F	A–D	sand, loam, clay; disturbed sites	1–3	Jun–Jul	Flowers purple to pinkish-purple or white
blue mistflower	*Conoclinium coelestinum*	F–P	M	moist loam, sand, or clay; disturbed sites	1–3	Jul–Nov	Flowers blue to purple; may become weedy

APPENDIX S-1. (cont.)

Herbs/forbs:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
stiff tickseed	*Coreopsis palmata*	F	D–A	loam, clay-loam, sandy loam, or some gravel	1–3	May–Sept	Medium-large yellow flower heads
parasol whitetop	*Doellingeria umbellata*	F–P	W–A	calcareous, sandy-loam, slightly acidic	2–4	Aug–early Oct	Flower heads with white rays and yellow center, clustered inflorescence flat- topped
blacksamson echinacea	*Echinacea angustifolia*	F	A–D	clay loam, med. loam, sandy loam, clay, sandy	1–2	Jun–Jul	Flower is a pinkish ray that droops from a dark cone-shaped center
pale purple coneflower	*Echinacea pallida*	F–P	A–D	sand, loam	3–5	Jun–Jul	Narrow drooping flower petals; pale purple

APPENDIX S-1. (cont.)

Herbs/forbs:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
tall thoroughwort	*Eupatorium altissimum*	F–P	D–A	loam, clay, or gravel; high pH tolerated; disturbed sites	2–5	late Jul–Sept	Flowers in branching clusters, white, star-shaped with 5 triangular petal-like lobes
common boneset	*Eupatorium perfoliatum*	F–S	W–A	sand, loam, clay	3–6	Jun–Oct	Flowers pure white
lateflowering thoroughwort	*Eupatorium serotinum*	P	A	sandy, sandy loam, med. loam, clay loam, clay; disturbed sites	2–5	late Aug–early Oct	Small white flowers form larger heads
spotted joe pye weed	*Eutrochium maculatum*	F–P	W–A	mineral rich, silty or sandy loam	3–6	Aug–Sept	large, purple, dome--shaped inflorescences; tolerates water-logged conditions, sandy wetlands

APPENDIX S-1. (cont.)

Herbs/forbs:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
sweetscented joe pye weed	*Eutrochium purpureum*	F–S	A	sand, loam, clay	2–6	Jun–Sept	Pale pinkish-lavender florets
Indian blanket	*Gaillardia pulchella*	F–P	A	sandy or calcareous; often disturbed sites	1–2	May–Aug	Flowers magenta to red with yellow border and reddish center
Spanish gold	*Grindelia papposa*	F	A–D	disturbed sites	2–5	Aug–Sept	Yellow flower head
curlycup gumweed	*Grindelia squarrosa*	F	D	disturbed sites	1–3	Jul–Oct	Flowers yellow; plant that is researched for its use as biofuel

APPENDIX S-1. (cont.)

Herbs/forbs:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
sneezeweed	*Helenium amarum*	P	D	acid-based, calcareous, limestone-based, sand, sandy loam, med. loam, clay loam, clay; disturbed sites	1–3	Apr–Sept	Flowers yellow, occasionally with purple center, aromatic
common sneezeweed	*Helenium autumnale*	F–P	A–W	moist clay	2–5	late Jul–early Oct	Flowers yellow; despite its name, causes very few allergies because not wind-pollinated
common sunflower	*Helianthus annuus*	F–P	D–A	sand, loam, clay	1–9	Jul–Oct	Large, showy flower heads

APPENDIX S-1. (cont.)

Herbs/forbs:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
sawtooth sunflower	*Helianthus grosseserratus*	F	A	Prefers fertile loamy soil but tolerant of other soil types	3–12	Aug–Nov	Large yellow flowers with saw-toothed petals
cheerful sunflower	*Helianthus ×laetiflorus*	F	D	sand, loam, clay	3–6	Aug–early Oct	Flowers yellow; naturally occurring hybrid
Maximilian sunflower	*Helianthus maximiliani*	F	D–A	various soils; clay-like but tolerant of limestone-based, sandy, sandy loam, med. loam, clay loam, clay	3–10	Aug–Nov	Numerous yellow flowers; enjoyed by livestock

APPENDIX S-1. (cont.)

Herbs/forbs:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
stiff sunflower	*Helianthus pauciflorus*	F	A–D	loam, clay loam, sand, or gravel	2–6	late Jul–Sept	Flower yellow; leaves mostly opposite, nearly stalkless, gray-green, mostly on lower half of plant
Jerusalem artichoke	*Helianthus tuberosus*	F	D–A	well-drained, sand, loam, clay	3–6	late Jul–Oct	Flower heads are large, golden yellow
smooth oxeye	*Heliopsis helianthoides*	F	A	sandy	3–5	late Jun–Oct	Flowers yellow with golden center
tall blazing star	*Liatris aspera*	F–P	A–D	sand, loam	1–4	Jul–Sept	Flowers in spike-like cluster of purple to pink; long style emerges from center of flower

APPENDIX S-1. (cont.)

Herbs/forbs:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
dotted blazing star	*Liatris punctata*	F	A–D	well-drained, sandy, calcareous	1–2	Aug–Oct	Flowers pink to purple
prairie blazing star	*Liatris pycnostachya*	F	A–W	rich loam or clay loam, rocky	2–5	Aug–early Oct	Flowers pink to purple, cylindrical
stiff goldenrod	*Oligoneuron rigidum*	F	D–W	various; tolerates nutrient poor, acidic, or neutral soil	1–5	Aug–Oct	Dark yellow, bell-shaped flower-heads in terminal cluster

APPENDIX S-1. (cont.)

Herbs/forbs:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
upright prairie coneflower	*Ratibida columnifera*	F	A	various well-drained, often calcareous; limestone-based, caliche type, clay, clay loam, med. loam, sandy loam, sandy	1–3	May–Oct	Red or yellow petals droop from red-brown central disk
pinnate prairie coneflower	*Ratibida pinnata*	F–P	A	various; sandy to clay and calcareous	3–5	late May–Sept	Yellow flower petals droop from center grayish-brown cone
blackeyed Susan	*Rudbeckia hirta*	F–P	A–D	clay, loam, peat, sand	1–3	late Jun–Sept	Flowers bright yellow with dark center; typically easy to grow

APPENDIX S-1. (cont.)

Herbs/forbs:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
lambstongue ragwort	*Senecio integerrimus*	P–F	W–A	fine to coarse-textured	1–2	late Mar–late May	Flowers yellow; grows well in riparian areas; drought-intolerant
Riddell's ragwort	*Senecio riddellii*	F–P	D	sand	1–3	late Jun–late Sept; or spring	Flowers yellow; sub-shrub
broom-like ragwort	*Senecio spartioides*	F	D	rocky, disturbed sites	<3	Jun–late Sept	Flowers pale yellow; drought-tolerant but also tolerates poor drainage; sub-shrub
wholeleaf rosinweed	*Silphium integrifolium*	F	A	well-drained; sand, loam, clay	2–6	Jul–Sept	Flowers bright yellow

APPENDIX S-1. (cont.)

Herbs/forbs:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
compassplant	*Silphium laciniatum*	F	D–A	various; well-drained; sand, loam, clay	3–12	Jul–early Sept	Name refers to the deeply incised leaves, which tend to orient in a north-south direction
cup plant	*Silphium perfoliatum*	F–P	D–W	sand, loam, tolerates clay	3–6	Jul–Sept	clasping leaves around stem form a rain-catching cup that provides a water source for wildlife
Canada goldenrod	*Solidago canadensis*	F–P	A	caliche type, sandy, sandy loam, med. loam, clay loam, clay	3–6	late Aug–early Nov	Showy yellow flowers

APPENDIX S-1. (cont.)

Herbs/forbs:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
gray goldenrod	*Solidago nemoralis*	F–S	A	sandy, sandy loam, med. loam, clay loam, clay, caliche, rocky	1–2	Aug–Sept	Arching spikes of small yellow flowers
downy ragged goldenrod	*Solidago petiolaris*	F–P	A–D	sandy to rocky, slightly acidic soil	3–4	Aug–early Nov	Flowers golden yellow rays; flower heads have a floral bract
showy goldenrod	*Solidago speciosa*	F–P	A–D	sand, loam, clayey, rocky	1–5	Aug–Sept	Small yellow flowers form showy spikes up to 1' long
common blue wood aster	*Symphyotrichum cordifolium*	F	W	sand, loam, clay	2–4	Jul–Oct	Ray flowers light blue to purple, sometimes white, yellow center

APPENDIX S-1. (cont.)

Herbs/forbs:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
white heath aster	*Symphyotrichum ericoides*	F	A–D	disturbed sites	2–3	late Aug–early Oct	Flower heads white rays with yellow center
smooth blue aster	*Symphyotrichum laeve*	F	D–A	loam, clay-loam, sandy loam, some rock	2–4	mid Sept–Oct	Showy ray flowers, violet to purple with yellow centers
skyblue aster	*Symphyotrichum oolentangiense*	F–S	A	well-drained, dry, sandy or rocky sites	1–3	late Aug–early Nov	Flowers deep-blue to lavender around center yellow disk
New England aster	*Symphyotrichum novae-angliae*	F–P	A	sand, loam, clay	2–6	Aug–Oct	Pink, purple, or blue flowers in a ray with yellow-orange centers; clustered stems
hairy white oldfield aster	*Symphyotrichum pilosum*	F	A	sandy	1–3	Aug–early Nov	White showy ray flowers surround yellow center

APPENDIX S-1. (cont.)

<u>Herbs/forbs</u>:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
willowleaf aster	*Symphyotrichum praealtum*	F–S	A	loamy	3–5	late Aug–Oct	Flowers light blue with yellow center
golden crownbeard	*Verbesina encelioides*	F	D	sandy, gravelly areas, disturbed sites	2–3	Apr–Oct	Flower heads yellow with 3-toothed rays
Baldwin's ironweed	*Vernonia baldwinii*	F	A	rocky, sandy, clay, clay loam, med. loam, sandy loam, sandy, limestone-based, caliche type	3–5	Jul–Nov	Flowers pink to purple; spreads by rhizomes

APPENDIX S-1. (cont.)

<u>Herbs/forbs</u>:
Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
prairie ironweed	*Vernonia fasciculata*	F–P	A–W	fertile; loam, peat, sand	3–6	Jul–Sept	Densely clustered, rose-purple flowers on sturdy stems

APPENDIX S-1. (cont.)

<u>Herbs/forbs</u>:
Bellflower Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
cardinalflower	*Lobelia cardinalis*	F–S	A–W	humus-rich; med. loam, clay loam, limestone-based, sandy, sandy loam, clay	1–6	May–Oct	Showy flowers red in terminal spikes; good choice for riparian areas
great blue lobelia	*Lobelia siphilitica*	F–S	W–A	sand, loam, clay	2–3	late Jul–early Oct	Tubular flowers, lavender-blue; upper lip of flower has two segments and lower lip has three

APPENDIX S-1. (cont.)

Herbs/forbs:
Borage Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
hoary puccoon	*Lithospermum canescens*	F–S	D–A	well-drained soils; disturbed sites	2	Mar–Jun	Tubular flowers yellow-orange to orange
soft-hair marbleseed	*Onosmodium bejariense*	S	D	sandy or rocky, well-drained	1–3	late May–Aug	Tubular, white, cream, or yellowish-green

APPENDIX S-1. (cont.)

Herbs/forbs:
Buckwheat Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
water knotweed	*Polygonum amphibium*	F	W	hydric, muddy	1–2	Jun–Sept	Flowers bright pink in spike; can grow in water or on land
swamp smartweed	*Polygonum hydropiperoides*	F–P	W–A	hydric, muddy	<3	Jun–late Oct	Flowers white; in shallow water or on moist soils
Pennsylvania smartweed	*Polygonum pensylvanicum*	F–P	A	dark, moist, loamy	1–4	Mar–Oct	Flowers pinkish-red in dense cluster

APPENDIX S-1. (cont.)

Herbs/forbs:
Buttercup Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
yellow marsh marigold	*Caltha palustris*	P–S	A–W	muddy, humus-rich	1–2	Apr–May	Flowers shiny yellow; good choice for riparian areas
Carolina larkspur	*Delphinium carolinianum virescens*	F–P	A–D	sandy, sand loam, med. loam, clay loam, clay; acid-based, calcareous	1–2	Apr–Jul	Flowers with spur, white to blue-violet in spike-like cluster
dwarf larkspur	*Delphinium tricorne*	P	A	rich, moist soil	1–3	Apr–May	Flowers spurred, blue or white
purple meadow-rue	*Thalictrum dasycarpum*	P	A	rich, sandy or calcareous loams; sandy, sandy loam, med. loam, clay loam, acid-based, calcareous	3–7	Apr–Jul	White, yellow, green, or purple flowers occur in loose delicate, terminal clusters

APPENDIX S-1. (cont.)

Herbs/forbs:
Calamus Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
sweetflag	*Acorus americanus*	F–P	A–W	mucky, silty	2–3	May–Jul	Grows best in water depth <1'; good for soil stabilization and preventing bank erosion; cinnamon-like aroma

APPENDIX S-1. (cont.)

Herbs/forbs:

Caper Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
yellow spiderflower	*Cleome lutea*	F	A–D	sandy, rocky	1–3	May–Aug	Showy, 4-petaled yellow flowers
Rocky Mountain beeplant	*Cleome serrulata*	F–P	D	well-drained, sandy	4–5	Jul–Sept	Flowers pink to reddish-purple, rarely white
narrowleaf rhombopod	*Cleomella angustifolia*	F	A	heavy alkaline clay or sand	2–7	Jun–Sept	Flowers yellow orange and fragrant

APPENDIX S-1. (cont.)

Herbs/forbs:
Carrot Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
button eryngo	*Eryngium yuccifolium*	F	A–D	sandy, loamy	4–6	Jun–Aug	Flowers turn purplish in the fall; yucca-like foliage
hemlock waterparsnip	*Sium suave*	F–P	A–W	sandy or mucky	2–6	Jul–Sept	Clusters of tiny white flowers, fragrant; semi-aquatic plant
golden zizia	*Zizia aurea*	P–S	A–W	sandy, sandy-clay, loam	1–2	May–Jul	Leaves are food source for swallowtail larvae

APPENDIX S-1. (cont.)

Herbs/forbs:

Cat-tail Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
broadleaf cattail	*Typha latifolia*	F–P	W	hydric, rich, mud, saline	4–8	Apr–Jun	Spike of small male flowers above cylindrical brown female flowers

APPENDIX S-1. (cont.)

Herbs/forbs:
Dogbane Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
spreading dogbane	*Apocynum androsaemifolium*	F–S	D	sand, gravel	2–5	Jun–Aug	Relative of milkweed; small groups of tiny pink, bell-shaped flowers near branch tips; flowers striped with darker pink inside bell; lilac-like scent; important nectar source for adult monarchs
Indianhemp	*Apocynum cannabinum*	P–F	A	various	3–5	May–Aug	Relative of milkweed; small tubular flowers white; fibers can be used to make rope

APPENDIX S-1. (cont.)

Herbs/forbs:

Evening Primrose Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
broadleaf enchanter's nightshade	*Circaea lutetiana*	P–S	A–W	sand, loam, clay	1–2	late May–Aug	Flowers white, sometimes faded pink; two stamens project from center of flower
common evening primrose	*Oenothera biennis*	F	A–D	well-drained; disturbed sites	2–6	Jul–Oct	Lemon-scented yellow flowers open at dusk and close mid-day; blooms may open on shady days as well
fourpoint evening primrose	*Oenothera rhombipetala*	F	A–D	sandy	1–4	Jul–Sept	Lemon-scented yellow flowers open at dusk and close mid-day; may bloom on shady days as well

APPENDIX S-1. (cont.)

<u>Herbs/forbs</u>:
Figwort Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
Canadian lousewort	*Pedicularis canadensis*	P–S	A	limey	1–3	late Apr–Jun	Tubular, 2-lipped flowers yellow and red; gets some nourishment from other plant roots
meadow lousewort	*Pedicularis crenulata*	P–F	A–W	requires continually moist soil	1	May–Jul	Flowers usually purple; often grows near streams
swamp lousewort	*Pedicularis lanceolata*	P–F	W	limey	1–3	Aug–Oct	Long creamy white to light yellow flowers

APPENDIX S-1. (cont.)

Herbs/forbs:
Figwort Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
foxglove beardtongue	*Penstemon digitalis*	F–P	A–D	fertile, well-drained loams, clay loams, and sand; prefers acidic but tolerates lime	2–5	May–Jul	Stalked clusters of white, tubular, unevenly five-lobed flowers which rise in pairs from upper leaf axils; purple lines inside flowers attract bees
large beardtongue	*Penstemon grandiflorus*	F	D	sandy, rocky	2–3	May–Jun	Tubular flowers pink to purple
Culver's root	*Veronicastrum virginicum*	F–P	A–W	moist, rich	3–6	Jul–Sept	Small white to cream-colored elongate inflorescences

APPENDIX S-1. (cont.)

Herbs/forbs:

Fumitory Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
dutchman's breeches	*Dicentra cucullaria*	F–S	A–W	humus-rich, acidic to neutral; tolerates limestone	1	Mar–May	Distinctive flowers white, double-spurred; leaves fern-like

APPENDIX S-1. (cont.)

<u>Herbs/forbs</u>:
Geranium Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
Carolina geranium	*Geranium carolinianum*	F–P	A–D	gravel, clay	usually <1, up to 2’	Apr–Aug	Flowers white to pink
spotted geranium	*Geranium maculatum*	F–S	A	rich, acidic, but may tolerate poorer soil	1–3	Mar–Jul	Flowers range in color from white to lavender-purple

APPENDIX S-1. (cont.)

Herbs/forbs:

Iris Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
prairie blue-eyed grass	*Sisyrinchium campestre*	F–P	D–A	sandy	1–2	May–Jun	Dainty member of the iris family with white to blue flowers; named for its slender grass-like leaves

APPENDIX S-1. (cont.)

Herbs/forbs:
Lily Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
meadow garlic	*Allium canadense*	F	A	moderately rich, neutral soils	1–2	late Apr–early Jul	Flowers star-shaped, pink or whitish; emits onion-like scent; edible bulb
Michigan lily	*Lilium michiganense*	F–P	W–A	loamy, sandy loam	2–5	Jun–early Aug	Dangling orange to red-orange flowers with light spots
smooth Solomon's seal	*Polygonatum biflorum*	P–S	A–D	rich, acid soils, but also calcareous; prefers high humus; sandy, sandy loam, med. loam, clay loam, clay	1–5, usually 2'	Mar–Jun	Flowers typically pale green to white

APPENDIX S-1. (cont.)

Herbs/forbs:

Mallow Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
light poppymallow	*Callirhoe alcaeoides*	F	A	dry, sandy or clayey; calcareous	2	late Apr–Jul	Flowers white, pink, or magenta

APPENDIX S-1. (cont.)

Herbs/forbs:

Mangosteen Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
great St. Johnswort	*Hypericum ascyron*	F–S	A–W	loam, clay-loam, rocky	2–6	late Jun–Aug	Flowers with 5 yellow petals and very bushy stamens; leaves dark green

APPENDIX S-1. (cont.)

Herbs/forbs:

Milkweed Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
clasping milkweed	*Asclepias amplexicaulis*	F	D	sandy	2–3	May–Jul	Flowers variable in color: green, pink, to purple; extremely fragrant; leaves typically clasp stem
sand milkweed	*Asclepias arenaria*	F	D	sandy	1–3	May–Aug	Greenish-white flowers
spider milkweed	*Asclepias asperula*	F	D–W	rocky, sandy	1–2	Mar–Oct	Flowers white and green
Engelmann's milkweed	*Asclepias engelmanniana*	F	A–D	sandy, calcareous	1–4	Jun–Sept	Flowers green, tinged purple

APPENDIX S-1. (cont.)

Herbs/forbs:

Milkweed Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
swamp milkweed[c]	*Asclepias incarnata*	F–P	W–A	rich, wet, muddy; mucky clay soils; prefers neutral to slightly acidic soil, tolerates heavy clay	2–4	late Jun–early Sept	Pink to purple-colored flowers; white variants; good choice for riparian areas
sidecluster milkweed	*Asclepias lanuginosa*	F	D	sandy, gravelly, rocky	1	late May–Aug	Flowers white and green
broadleaf milkweed	*Asclepias latifolia*	F–P	D–A	sandy, well-drained	2–3	Jul–Oct	Numerous large leaves lack branches; flowers yellowish, pale-green

APPENDIX S-1. (cont.)

Herbs/forbs:
Milkweed Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
plains milkweed	*Asclepias pumila*	F–P	D–A	sandy, clayey, or rocky calcareous or gypseous soil	<1	Jul–Aug	Flowers in white or pink umbel
purple milkweed	*Asclepias purpurascens*	F	D	sandy	2–3	May–Jul	Flowers deep magenta; associated with oak-hickory savanna
showy milkweed[c]	*Asclepias speciosa*	F	D–W	sand, loam, clay	2–4	May–Sept	Flowers in rose-colored cluster
slimleaf milkweed	*Asclepias stenophylla*	F	D–A	rocky or sandy limestone	1–3	Jun–early Aug	Flowers showy; pale greenish-white to pale yellowish, sometimes tinged with purple

APPENDIX S-1. (cont.)

Herbs/forbs:
Milkweed Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
horsetail milkweed	*Asclepias subverticillata*	F–P	D	sandy	2–4	May–Sept	Star-like flowers greenish-white, sometimes tips are tinted purple
prairie milkweed[c]	*Asclepias sullivantii*	F	A–W	variable	2–3	Jun–Aug	Clusters of pink or pinkish-white flowers; also known as Sullivant's milkweed
common milkweed[c]	*Asclepias syriaca*	F	A	med. to fine sandy, clayey, or rocky calcareous; also well-drained loamy soil	3–5, up to 8	Jun–Aug	White to purple-colored blooms; not shade-tolerant; needs plenty of light
butterfly milkweed[c]	*Asclepias tuberosa*	F	D–A	sand, loam	2–3	Jun–Aug	Brilliant orange blooms

APPENDIX S-1. (cont.)

Herbs/forbs:

Milkweed Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
whorled milkweed[c]	*Asclepias verticillata*	F–P	D	sandy, clayey, or rocky	1–3	Jun–early Sept	Flowers small, greenish-white; narrow leaves whorl around stem
green comet milkweed	*Asclepias viridiflora*	F	D	sandy	1–3	Jun–Aug	Flowers greenish-white; thinly oblong (comet-shaped)
green antelopehorn[c]	*Asclepias viridis*	F	A–W	disturbed ground, limestone soils	1–3	Apr–Sept	Flowers greenish to yellow-white, with slight reddish purple center, clustered in umbel; named for horn shape of seed pods

APPENDIX S-1. (cont.)

<u>Herbs/forbs</u>:
Milkweed Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
honeyvine	*Cynanchum laeve*	F–P	D–W	prefers fertile, moist soil	stems 10' at maturity	Jun–Sept	Honeyvine can easily spread and is very difficult to eliminate; carefully evaluate your landscape plans before planting; extremely valuable plant to monarchs; sweet scent

APPENDIX S-1. (cont.)

Herbs/forbs:
Mint Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
blue giant hyssop	*Agastache foeniculum*	F–S	A	well-drained, sandy	2–4	Jul–Aug	Native mint; showy bluish-purple flowers in terminal spike
yellow giant hyssop	*Agastache nepetoides*	F–P	A	med., well-drained	4–6	Jul–Sept	Showy flowers creamy yellow in terminal spike
purple giant hyssop	*Agastache scrophulariifolia*	F–S	A	rich, moist	2–5	Jul–Sept	Flowers purplish-red in terminal spike
hairy pagoda-plant	*Blephilia hirsuta*	F–P	A	well-drained	2–3	May–Sept	Flowers blue to purple
wild bergamot	*Monarda fistulosa*	F–P	D–W	sand, loam, clay	2–5	Jul–early Sept	Cluster of lavender flowers, rarely white

APPENDIX S-1. (cont.)

Herbs/forbs:
Mint Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
obedient plant	*Physostegia virginiana*	F–P	A	humus-rich; loam, sand	2–4	Aug–Nov	Flowers snapdragon-like, but square stem typical of mints; pink to purple blooms; tolerates drought and poor drainage; easily moved
Virginia mountainmint	*Pycnanthemum virginianum*	P	A–W	moist, calcareous soils	2–3	Jul–Aug	Clusters of white flowers; mint aroma; can grow prolifically but less so in drier soils
pitcher sage (azure blue sage)	*Salvia azurea*	F–P	A–D	limestone-based, sandy, sandy loam, med. loam, clay loam, clay	3–5	Jul–Oct	Two-lipped, blue or white flowers, whorl around square stem and form a terminal spike-like cluster

APPENDIX S-1. (cont.)

Herbs/forbs:

Pea Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
groundplum milkvetch	*Astragalus crassicarpus*	F–S	D–A	any but clay	1–3	late Apr–Jun	White, blue, and purple flowers
partridge pea	*Chamaecrista fasciculata*	F–P	D–A	deep, sandy, well-drained; clay, clay loam, med. loam, sandy loam, sandy, acid-based, calcareous	1–3	Jun–Oct	Flowers showy yellow with red center
white prairie clover	*Dalea candida*	F	A–D	sandy or rocky	1–2	May–Sept	Dense, white cylindrical flowers
roundhead prairie clover	*Dalea multiflora*	F	D	limestone, calcareous clays	1–3	Jun–Jul	Flowers white

APPENDIX S-1. (cont.)

Herbs/forbs:

Pea Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
purple prairie clover	*Dalea purpurea*	F	A–D	sand, loam, clay	1–2	May–early Sept	Dense, bright purple cylindrical flower spikes
silky prairie clover	*Dalea villosa*	F	D	sandy	1–2	Jul–Aug	Flowers pink to pale purple
showy ticktrefoil	*Desmodium canadense*	F	A–D	pH adaptable; sand, loam, clay, rocky	2–6	late Jun–early Sept	Showy flowers pink to purple; good for nitrogen fixation
roundhead lespedeza	*Lespedeza capitata*	F–P	A–D	sandy, loamy, or gravelly	2–4	Jun–Aug	Flowers cream with a pinkish throat
Great Basin lupine	*Lupinus ×alpestris*	F–P	D	well-drained	1–3	Apr–Jul	Slender flowers purple and white in clusters and spikes; good for nitrogen fixation
Nuttall's sensitive-briar	*Mimosa nuttallii*	F	A–D	various	vine may grow 4’	Jun–Sept	Flowers form pink globes

APPENDIX S-1. (cont.)

Herbs/forbs:
Phlox Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
prairie phlox	*Phlox andicola*	F	A–D	dry, sandy or gravelly	<2	Apr–Jun	Flowers star-shaped, white, or faintly bluish; dense growth under ideal conditions
wild blue phlox	*Phlox divaricata*	P–S	A	rich, moist, acidic, but also calcareous; sandy, sandy loam, med. loam, clay loam, clay	<2	Apr–Jun	Flower with 5 petals fused at base; pale blue to blue-violet to reddish purple, occasionally white
fall phlox	*Phlox paniculata*	F	A–W	organic, loam	2–4	Jun– early Sept	Showy flower clumps of pink to lavender, rarely white

APPENDIX S-1. (cont.)

Herbs/forbs:

Pondweed Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
largeleaf pondweed	*Potamogeton amplifolius*	F	W	hydric	2–3	Jul–Sept	Flowers green; aquatic plant
waterthread pondweed	*Potamogeton diversifolius*	F	W	hydric	2–3	Apr–May	Flowers red; aquatic plant
leafy pondweed	*Potamogeton foliosus*	F	W	hydric	<3	Jun–Aug	Flowers green; aquatic plant
Fries' pondweed	*Potamogeton friesii*	F	W	hydric	<1	Jul–Aug	Flowers green and brown; aquatic plant
variableleaf pondweed	*Potamogeton gramineus*	F	W	hydric	<3	Apr–May	Flowers green; aquatic plant

APPENDIX S-1. (cont.)

Herbs/forbs:

Rose Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
Virginia strawberry	*Fragaria virginiana*	F–P	A–D	various; tolerates moderately acidic soil	<1, ground-hugging	mid Apr–Jun	Flowers white; edible berries; red fall color

APPENDIX S-1. (cont.)

Herbs/forbs:
Spiderwort Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
longbract spiderwort	*Tradescantia bracteata*	F–P	A–D	sandy	<2	May–early Jul	Flowers bluish-purple with 3 petals and bright yellow anthers

APPENDIX S-1. (cont.)

Herbs/forbs:
Spurge Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
flowering spurge	*Euphorbia corollata*	F–P	A–D	various; loam, clay, sand, gravel, rocky; tolerates poor soil	1–3	late Jun–Aug	Flowers white with green or yellow center

APPENDIX S-1. (cont.)

Herbs/forbs:
Verbena Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
Dakota mock vervain	*Glandularia bipinnatifida*	P	A	well-drained sand, loam, clay, caliche, limestone	2	Mar–Oct	Flower clusters in shades of pink to purple
swamp verbena	*Verbena hastata*	F–S	A–W	moist, moderately acidic	2–5	Jun–Sept	Flowers small tubular, blue-violet clusters; good choice for riparian areas
hoary verbena	*Verbena stricta*	F	A–D	sand, loam	2–4	May–Sept	Flowers purple, lavender

APPENDIX S-1. (cont.)

Herbs/forbs:
Violet Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
Nuttall's violet	*Viola nuttallii*	F	D–A	well-drained; sand, gravel	<1	Apr–Sept	Flowers yellow with back of upper petals often tinged with purple; lance-shaped leaves
birdfoot violet	*Viola pedata*	F–S	D–A	well-drained; shallow, sandy, rocky	<1	Mar–Jun	Large showy flowers pale to dark violet with deep orange anthers; named for leaf shape; tolerates drought
prairie violet	*Viola pedatifida*	F–P	A–D	well-drained; sand, loam	<1	mid Apr–early Jun	Flowers purple to blue-violet, 2 of the 5 petals have white hair-like tufts (bearded)

APPENDIX S-1. (cont.)

Herbs/forbs:

Violet Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
common blue violet	*Viola sororia*	F–P	W–A	moist, rich	<1	Mar–May	Flowers purple with white throat; leaves heart-shaped

APPENDIX S-1. (cont.)

Herbs/forbs:
Waterleaf Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
eastern waterleaf	*Hydrophyllum virginianum*	P–S	A–W	rich soils but may tolerate shallow soils and gravel	1–2	May–Jun	Flowers range in color from white to pale violet
silverleaf phacelia	*Phacelia hastata*	P	D–A	rocky	1–3	May–Jul	Flowers small white or pale purple in tight coiled cluster

APPENDIX S-1. (cont.)

Herbs/forbs:

Water-plantain Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
broadleaf arrowhead	*Sagittaria latifolia*	F–P	W	hydric, mud	3	Jul–Sept	Three-petaled flowers white with yellow center, arrowhead-shaped leaves

APPENDIX S-1. (cont.)

<u>Herbs/forbs</u>:
Wood Fern Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
ostrich fern	*Matteuccia struthiopteris*	P–S	A	moist, cool, sandy	2–8	N/A	Larval food source well-suited in riparian areas

APPENDIX S-1. (cont.)

Graminoids:
Grass Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
big bluestem	*Andropogon gerardii*	F–P	A–D	sand, loam, clay; acid or calcareous	4–8	Aug–Nov	Tan to maroon color in fall; drought-tolerant; can survive periodic flooding
sideoats grama	*Bouteloua curtipendula*	F–P	A–D	med. textured, well-drained; disturbed sites, igneous, limestone-based sand, loam, clay	2–3, rarely taller	Jun–Nov	Flowers hang from only one side of stem; drought-tolerant

APPENDIX S-1. (cont.)

Graminoids:
Grass Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
American mannagrass	*Glyceria grandis*	F	W	cannot tolerate high alkalinity	3–5	late May–early Sept	Cool-season grass; flowers purple; good choice for riparian areas and increasing soil stability; grows rapidly in spring and fall
little bluestem	*Schizachyrium scoparium*	F	A–D	well-drained; sandy, sandy loam, med. loam, clay loam, clay, limestone-based	2–3	Aug–Oct	Blue-green bunchgrass turns bronze and red in fall; larval food source
prairie dropseed	*Sporobolus heterolepis*	F	D	dry, sand, loam	2–4	Jul–Sept	Blooms of pink, yellow, green , or brown; fine-textured bunchgrass

APPENDIX S-1. (cont.)

Graminoids:
Sedge Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
river bulrush	*Bolboschoenus fluviatilis*	F–P	W–A	hydric, sand, loam, clay	5–7	late Jul–mid Aug	Yellowish-brown nodding flowers in spikelet
cosmopolitan bulrush	*Bolboschoenus maritimus*	F–S	W–A	hydric, fine clay, silt loam, sand, clay; tolerates pH up to 9.0	4–5	late Jul–Sept	Good choice for wetland erosion control
upright sedge	*Carex stricta*	F–P	A–W	sand, loam, peat	1–3	late May–Jul	Greenish or brownish spikes of inconspicuous flowers; actively grows when soil is cool during spring and fall

APPENDIX S-1. (cont.)

Graminoids:
Sedge Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
needle spikerush	*Eleocharis acicularis*	F	W–A	silt, sand, mud	<1	Apr–Sept, fruit	Small spikerush; grows in shallow water or wet ground
purple spikerush	*Eleocharis atropurpurea*	F	W	silt, sand, mud	<1	Jun–Oct, fruit	Small spikerush
flatstem spikerush	*Eleocharis compressa*	F	W	mucky, sandy, peaty, gravelly, rocky	1	Jun–Aug, fruit	Suitable for wetlands but may also grow in degraded sites
Engelmann's spikerush	*Eleocharis engelmannii*	F	W	sandy, peaty, muddy	1	Jun–Sept, fruit	Suitable for wetlands
bald spikerush	*Eleocharis erythropoda*	F	W–A	calcareous, alkaline pH of 7 to 8	<3	early Jun–Aug, fruit	Suitable for wetlands
pale spikerush	*Eleocharis macrostachya*	F–P	W	sand, loam, clay	1–3	Jun–Aug, fruit	Suitable for wetlands

APPENDIX S-1. (cont.)

Graminoids:
Sedge Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
blunt spikerush	*Eleocharis obtusa*	F–P	A–W	various; average, clay, sand, gravel, rock, acid, neutral, alkaline	<2	Jun–Oct, fruit	Suitable for wetlands
common spikerush	*Eleocharis palustris*	P	W	organic, silty clay, fine loam, often alkaline	1–3	Jun–Aug, fruit	Suitable for wetlands
fewflower spikerush	*Eleocharis quinqueflora*	F	W	sand, peat	<1	May–Aug, fruit	Suitable for wetlands
slender spikerush	*Eleocharis tenuis*	F	A–W	limestone; disturbed-sites	1–3	May–Jul, fruit	Suitable for wetlands
Wolf's spikerush[d]	*Eleocharis wolfii*	F	A–W	sand, silt, loam, clay, rock	<2	late May–Jul	Suitable for wetlands, wet prairies

APPENDIX S-1. (cont.)

Graminoids:
Sedge Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
Hall's bulrush[d]	*Schoenoplectiella hallii*	F	W–A	fluctuating moisture, sandy, peaty	<2	Sept–Oct (fruit)	Flower clusters with 1–6 oval spikelets
hardstem bulrush	*Schoenoplectus acutus*	F	W	peat, coarse	5	Jun–Aug	Reddish-brown flowers; good choice for wetland soil stabilization
softstem bulrush	*Schoenoplectus tabernaemontani*	F–P	W	hydric	4–9	late May–Jul	Flowers nodding orange-brown spikelets
green bulrush	*Scirpus atrovirens*	F–P	W–A	hydric, clay, gravel, sand, organic material	2–4	Jun–Aug	Inflorescence dark brown, nearly black

APPENDIX S-1. (cont.)

Graminoids:
Rush Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
common rush	*Juncus effusus*	F–P	W	hydric, clay, loam, sand	2–4	Jul–Sept	Good choice for rain gardens and wetland soil stabilization
Torrey's rush	*Juncus torreyi*	F	W–A	sand, mud, clay	2–3	Jun-Aug	Yellowish-red flowers in starburst shape

APPENDIX S-1. (cont.)

Shrubs and sub-shrubs:

Aster Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
yellow rabbitbrush	*Chrysothamnus viscidiflorus*	F	A–D	well-drained med. to course soil types	<4, 3' typical	Aug–Oct	Flowers golden; good food source for bees in fall; drought-tolerant
rubber rabbitbrush	*Ericameria nauseosa*	F	D	tolerates coarse, alkaline soils; disturbed sites	2–5, rarely 7	Aug–Oct	Flowers small yellow heads in dense cluster at end of stem; foliage white-gray; valuable food source for pollinators in fall

APPENDIX S-1. (cont.)

<u>Shrubs and sub-shrubs</u>:
Birch Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
American hazelnut	*Corylus americana*	P	A–D	variable; moist to dry, well-drained soils	6–12	Apr–Jun	Edible nuts; suckering

APPENDIX S-1. (cont.)

<u>Shrubs and sub-shrubs</u>:
Buckthorn Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
New Jersey tea	*Ceanothus americanus*	P–S	D–A	well-drained, mesic sand, loam, or limey; sandy, sandy loam, med. loam, limestone-based	3', up to 5'	late Apr–May	Flowers white

APPENDIX S-1. (cont.)

<u>Shrubs and sub-shrubs</u>:
Buckwheat Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
spreading buckwheat	*Eriogonum effusum*	F	D	well-drained; sandy, rocky	1–3	Jul–Sept	Flowers small white
alpine golden buckwheat	*Eriogonum flavum*	F	D	well-drained; sandy, rocky	1–2	Jun–Aug	Flowers bright yellow; can grow well in rock gardens

APPENDIX S-1. (cont.)

<u>Shrubs and sub-shrubs</u>:
Dogwood Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
roughleaf dogwood	*Cornus drummondii*	P–S	D–A	limestone-based, sandy, sandy loam, med. loam, clay loam, clay, acid-based, calcareous	up to 16’	Apr–Jun	Flowers creamy-yellow
silky dogwood	*Cornus obliqua*	F–P	W–A	clay, loam, sand	8–10	Jun	Greenish-white flower clusters; berries transform from white to blue

APPENDIX S-1. (cont.)

Shrubs and sub-shrubs:
Honeysuckle Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
limber honeysuckle	*Lonicera dioica*	P–S	D–A	various	5–10	May–Jun	Flowers arranged in whorl and reddish tubular with long yellow stamens; climbing vine-like shrub
American black elderberry	*Sambucus nigra canadensis*	S–F	A	prefers rich, moist, slightly acidic soil; tolerant	10–12	May–Jun	Showy white flowers in summer; edible fruit in Sept
coralberry	*Symphoricarpos orbiculatus*	F	A–D	well-drained sand, loam, clay	4–6	Apr–Jul	Large coral-pink to purple berries ripen in fall and persist through spring

APPENDIX S-1. (cont.)

<u>Shrubs and sub-shrubs</u>:

Madder Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
common buttonbush	*Cephalanthus occidentalis*	P–S	A–W	limestone-based, sandy, sandy loam, med. loam, clay loam, clay	6–12	Jun–Sept	Good choice for riparian areas; quick-rooting for soil stabilization

APPENDIX S-1. (cont.)

Shrubs and sub-shrubs:

Mustard Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
desert princesplume	*Stanleya pinnata*	F	D–A	sand, stone; thrives on selenium-rich soil	1–6	Apr–Aug	Flowers lemon yellow racemes

APPENDIX S-1. (cont.)

Shrubs and sub-shrubs:

Pea Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
leadplant	*Amorpha canescens*	F–P	D–A	sand, loam	2–3	Jun–Jul	Spikes of iridescent purple flowers; drought-tolerant and long-lived
false indigo bush	*Amorpha fruticosa*	F–P	A	acid-based, calcareous, pH adaptable; sandy, sandy loam, med. loam, clay loam, clay	5–12	May–Jul	Tubular-looking flowers small, purple to dark blue with long yellow stamens
dwarf false indigo	*Amorpha nana*	F	A–D	rocky or sandy soil	1–3	May–Jul	Dense tufts of fragrant purple flowers in late spring

APPENDIX S-1. (cont.)

Shrubs and sub-shrubs:
Rose Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
common serviceberry	*Amelanchier arborea*	S–F	A	moist, well-drained, acid soil	15–30	Apr–May	White flowers in spring; yellow, orange, and red-colored leaves in fall
common ninebark	*Physocarpus opulifolius*	F–S	A	clay, loam	3–10	May–Jun	White and pink flowers
chokecherry	*Prunus virginiana*	F–S	A	rich, moist soil; limestone-based, sandy, sandy loam, med. loam, clay loam, clay	20–30	May	White flowers become edible fruit with strong bitter flavor but rich in antioxidants

APPENDIX S-1. (cont.)

Shrubs and sub-shrubs:
Rose Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
prairie rose	*Rosa arkansana*	P–F	A–D	prefers well-drained; sandy, loamy, and heavy soils; tolerates heavy clay; acid, neutral, and basic (alkaline) soils	1–3	late May–Jul	Flowers white to deep pink
smooth rose	*Rosa blanda*	F	D	rocky	2–5	Jun–Aug	Pink to white flowers; few thorns
Allegheny blackberry	*Rubus allegheniensis*	F–P	A	various; well-drained, sand, loam, clay	3–6	late May–Jul	Flowers white; edible fruit

APPENDIX S-1. (cont.)

<u>Shrubs and sub-shrubs</u>:
Rose Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
northern dewberry	*Rubus flagellaris*	F–S	W–D	various; loam, clay-loam, sandy or rocky	1 or up to 4 if erect	May–Jun	Flowers white, vine-like

APPENDIX S-1. (cont.)

Shrubs and sub-shrubs:

Sumac Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
smooth sumac	*Rhus glabra*	F	D	dry, sandy, sandy loam med. loam, clay loam, clay, caliche	10–20	May–Aug	Velvety red fruit on female plants persist into winter

APPENDIX S-1. (cont.)

Trees:
Beech Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
white oak	*Quercus alba*	F	A–D	deep, moist, well-drained, loam, sand, med. loam, clay loam, clay, acid-based	80 to >100	Mar–May	Brown to red wine-colored leaves in the fall
bur oak	*Quercus macrocarpa*	F	A–D	variable soils	80–100	Mar–May	Mild yellow-brown leaves in the fall
Northern red oak	*Quercus rubra*	S–P	A	well-drained, loamy sand	75–100	Mar–May	Russet to bright red color in the fall; grows rapidly

APPENDIX S-1. (cont.)

Trees:
Birch Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
hophornbeam	*Ostrya virginiana*	S–P	A	well-drained; variable, tolerates rocky soil	30–50	Apr	Cream-colored fruit looks like hops; yellow color in fall

APPENDIX S-1. (cont.)

Trees:

Elm Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
common hackberry	*Celtis occidentalis*	F	A	rich, moist soil	60–100	Feb–Apr	Yellowish in fall

APPENDIX S-1. (cont.)

Trees:

Horse-chestnut Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
Ohio Buckeye	*Aesculus glabra*	F–P	A	rich, deep soil	50–100	Mar–May	Greenish-yellow flowers in spring, yellow to orange flowers in fall

APPENDIX S-1. (cont.)

Trees:

Linden Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
American basswood	*Tilia americana*	P	A	moist, rich, well-drained, loamy soil	60–80	Apr–Jul	Fruit is round and hangs in cluster, ripening in the fall; attracts bees that use the flowers to make strongly-flavored honey

APPENDIX S-1. (cont.)

Trees:

Maple Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
silver maple	*Acer saccharinum*	F–P	W–A	alluvial deposits	75–100	Mar–Apr	Delicate maple-leaf foliage; first of the maples in North America to bloom

APPENDIX S-1. (cont.)

Trees:

Olive Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
white ash	*Fraxinus americana*	F–P	A	any deep, moist soil	75–120	Apr–May	Produces yellow, deep purple, and maroon fall color
green ash	*Fraxinus pennsylvanica*	F	A	sand, loamy to clayey	50–75	Apr–Jun	Yellow fall color; grows rapidly

APPENDIX S-1. (cont.)

Trees:
Pea Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
eastern redbud	*Cercis canadensis*	S–P	A–D	moist, fertile, well-drained	15–30	Mar–May	Clusters of rosy-pink flowers in spring
Kentucky coffeetree	*Gymnocladus dioicus*	F	A	deep, rich, moist sandy loams or silty clays	75–100	late May–Jun	Greenish-white flowers are fragrant on the female plant; drought-resistant

APPENDIX S-1. (cont.)

Trees:

Plane-tree Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
American sycamore	*Platanus occidentalis*	F–P	W–A	moist, sandy loam or silty clay	60–100	Mar–Apr	Produces round, brown 1" fruit; mottled white bark; leaves drop throughout summer

APPENDIX S-1. (cont.)

Trees:
Rose Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
downy hawthorn	*Crataegus mollis*	F–P	A–D	variable	35–50	May–Jun	White spring flowers become orange-red fruit
prairie crab apple	*Malus ioensis*	F	A–D	well-drained loam	20–35	May–Jun	Fragrant white to pink flowers become very tart fruit; suckering
American plum	*Prunus americana*	F–P	A–D	moist, rich, well-drained loam	20–35	Apr–May	Fragrant white flowers in spring; yellow to red fruit in summer
black cherry	*Prunus serotina*	F–P	A	well-drained, variable	25–110; variable size classes	Mar–Jun	Small edible berries in summer

APPENDIX S-1. (cont.)

Trees:

Walnut Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
shagbark hickory	*Carya ovata*	F–P	A	any well-drained fertile soil	60–80	Mar–Jun	Yellow to golden-brown in fall
black walnut	*Juglans nigra*	F–P	A	moist, rich soils; sandy loam, med. loam, clay loam, acid-based, calcareous	50–75, up to 150	Apr–May	Fruit consists of three layers; tree produces chemical that can be toxic to other plant species if planted too close

APPENDIX S-1. (cont.)

Trees:

Willow Family

Common name	Scientific name	Sun exposure[a]	Soil moisture[b]	Soil description	Height (ft)	Bloom period	Notes
eastern cottonwood	*Populus deltoides*	F	W–A	moist soils; sandy, sandy loam, med. loam, clay loam, clay	80–100	Feb–Apr	Cottony ¼ ”-long seeds mature over summer; leaves are dark green in summer and fade in fall to shades of light green, yellow, and brown
Missouri River willow	*Salix eriocephala*	F	A–W	sandy	<20	Feb–Mar	Good choice for riparian areas; quick rooting for soil stabilization

[a] Sun exposure: F = full sun, P = part sun, and S = shade.

[b] Soil moisture: W = wet, A = average, and D = dry.

[c] Species of milkweed recommended because of local occurrence, availability for planting, and appeal to monarchs.

[d] Tier I at-risk species in the Nebraska Natural Legacy Project (Schneider et al. 2011).