Natural Resources and Environmental Sciences Project

POLLINATOR HABITAT INSTILLATION AT MARION COUNTY LAKE

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EXECUTIVE SUMMARY

Marion County Lake has provided its community with a lake that they are proud of. The lake offers a host of recreational activities for its citizens to participate in, including boating, fishing, hiking, camping, swimming, frisbee golf, and several others. However, the lake currently lacks a management plan that clearly defines goals and management regulations. As a capstone project for the Natural Resources and Environmental Sciences Secondary Major, students were given the task of researching a component of a lake management plan to better inform Marion County Lake on what to include in theirs. The part of the management plan addressed in this report is a biodiversity and conservation plan for pollinators.

In early February, four objectives for the project were developed and include: 1) provide site recommendations and a list of appropriate plants to use for pollinator habitat, 2) outline the best management strategies to optimize the habitat health, 3) analyze different funding opportunities related to pollinators, and 4) develop an outreach and educational plan pertaining to pollinators for Marion County Lake visitors.

To achieve these objectives, several methods were deployed: 1) research pollinator ecology native to Kansas and the tallgrass prairie, 2) critically analyze different management strategies used to maintain pollinator habitat and optimize pollinator visits, 3) review different outreach and educational opportunities available, and 4) research different funding and government programs that aid in the creation of pollinator habitat.

CONCLUSIONS

After evaluating the research and project conclusions, several key conclusions have been developed with a complete list on page 30.

1) The instillation of pollinator habitats creates homes for pollinators while also providing a host of ecosystem services including increased infiltration of rainwater, homes for other wildlife, preventing invasive species from dominating, supporting agricultural systems, and creating a beautiful space for people to learn about and enjoy nature.
2) Prescribed burning is an effective method for managing pollinator habitat. It should only be burned every 2-5 years and only 25-50% of the habitat should be burned at a time.

RECOMMENDATIONS

It is recommended that Marion County Lake install pollinator habitat surrounding the lake. The pollinator habitat should include a variety of native grasses and flowering plants that can be managed with a 2-year burn cycle. On-site interpretive signs and pamphlets can also be utilized to inform the public about pollinators and why the pollinator habitat was installed.

DISCUSSION

BACKGROUND

Marion County Lake is located in Marion County, Kansas, approximately 4 miles southeast of the town of Marion. The lake is about 153 acres of water but covers 300 acres of land (Figure 1). The area surrounding the lake is mainly composed of silt loams and silt clay loams (see Appendix A). The three-soil series that surround the lake are Clime-Sogn complex with 3-20% slopes, Sogn silty clay loam with 0-10% slopes, and Labette-Sogn silty clay loam with 0-8% slopes. The land cover surrounding the lake is mostly grassland and herbaceous along with developed, open space, low intensity, and medium intensity. Elevation ranges from 430 to 393 m above sea level. The average yearly precipitation for the area is about 30-35 inches (Goodin et al., 2004). The average mean annual temperature is 54-56° F with an average high of 91° F and an average low of 19° F. As for the flora and fauna present at the lake, a site visit determined that are 11 woody plant species and 2 invasive plant species at the lake (Tables 1 and 2). According to the Kansas Department of Wildlife Parks and Tourism, there are 5 threatened species in Marion County and 3 endangered species (Tables 3 and 4). Of these threatened or endangered species, 4 are birds, which are important for pollination.

Figure 1. Aerial photograph of Marion County Lake (Taken from Google Earth, 2018).

Table 1. A list of woody plant inventory at Marion County Lake

Common Name	**Latin Name**
Roughleaf Dogwood	*Cornus drummondii*
Willows	*Salix spp.*
Smooth Sumac	*Rhus glabra*
Kentucky Coffee Tree	*Gymnocladus dioicus*
Eastern Cottonwood	*Populus deltoides*
Red Mulberry	*Morus rubra*
Button Bush	*Cephalanthus occidentalis*
Bur Oak	*Quercus macrocarpa*
American Elm	*Ulmus americana*
Honey Locust	*Gleditsia triacanthos*
Black Locust	*Robinia pseudoacacia*

Table 2. A list invasive species at Marion County Lake

Common Name	**Latin Name**
Eastern Red Cedar	*Juniperus virginiana*
Japanese Honeysuckle	*Lonicera japonica*

Table 3. A list of threatened species in Marion County (Kansas Department of Wildlife, Parks, and Tourism)

Common Name	**Latin Name**
Topeka Shiner	*Notropis topeka*
Flutedshell Mussel	*Lasmigona costata*
Piping Plover	*Charadrius melodus*
Snowy Plover	*Charadrius alexandrinus*
Eastern Spotted Skunk	*Spilogale putorius*

Table 4. A list of endangered species in Marion County (Kansas Department of Wildlife, Parks, and Tourism)

Common Name	**Latin Name**
Whooping Crane	*Grus americana*
Least Tern	*Sterna antillarium*
American Burying Beetle	*Nicrophorus americana*

The lake was a product of the New Deal when the Civilian Conservation Corps sent World War I veterans to build the lake in 1936 (Marion County Park & Lake). Since then, the lake has mainly been used for boating, fishing, and water recreation. There are several camping sites around the lake along with a frisbee golf course located near the southeast portion of the lake. There is also a shelter house, picnic areas, a museum, children's playground, and boating and fishing docks.

BIODIVERSITY MANAGEMENT

At present, Marion County Lake lacks a lake management plan to provide specificity for management policies, including those relevant to wildlife present at the lake. It is recommended that Marion County Lake include a biodiversity management clause within their lake management plan.

The U.S. Fish and Wildlife Service suggests that state fish and wildlife agencies:

- Include pollinators in their state wildlife action plans as species of greatest conservation need
- Add pollinator-friendly habitat as part of projects for other target species
- Review management practices to make them more pollinator friendly

In accordance with this, Marion County Lake should include within its lake management plan policies that seek to increase the diversity and number of rare, threatened, or endangered local pollinator species (including honey bees and monarch and Regal Fritillary butterflies). This can be done by creating or enhancing habitats and natural areas that support these species. Enhancing pollinator diversity helps to maximize ecosystem resiliency while conservation that focuses on pollinator services may only work to protect dominant pollinator species of economic importance and disregards benefits provided by lesser (and most likely more threatened) pollinator species (Senpathi et al. 2015). Management decisions that promote general biodiversity tend to have positive effects on ecosystem services, while the reverse is not always true. Focusing management policies on enhancing conservation efforts for all local pollinator species, with an emphasis on promoting biodiversity, will accomplish the same objectives as the ecosystem services approach, while harnessing the additional benefits of increased ecosystem resiliency and protection of more pollinator species. The economic benefit of services provided by dominant pollinator species is clear, particularly in the agriculture sector, but additional benefits of maintaining biodiversity across landscapes are more difficult to quantify. The following document summarizes the importance of pollinators to local ecosystems and ways in which Marion County Lake can implement and support pollinator habitat conservation and biodiversity efforts.

CURRENT VALUE AND STATE OF POLLINATOR POPULATIONS

Pollinators have played a vital role in plant reproduction and diversity for at least 170 million years, making them key components of natural ecosystems and agricultural production systems around the world (Ollerton, 2017). Bees and butterflies are the most commonly known pollinators, but there are several other invertebrate species such as moths and beetles, as well as vertebrates such as birds and bats, that play vital roles in plant pollination. The promotion of plant abundance and diversity by animal pollinators greatly influences global biodiversity by positively affecting essential pathways such as food webs and nutrient cycles. Ollerton (2017) suggests that "as many as 1 in 10 terrestrial animals" are pollinators and estimates that there are more than 350,000 pollinator species worldwide. Although drastically different species of pollinators and plants are involved in interactions in different parts of the world, the basic structure of many of these networks seems to be relatively similar (Rhodes, 2018).

Pollinators are of importance to humanity and the biosphere as a whole. They play essential roles in agriculture, economics, food security, and overall biodiversity, but throughout recent years, pollinator populations have been declining. In 2016, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) released an assessment that "confirmed evidence of large-scale wild pollinator declines" and strongly encouraged pollinator preservation (Dicks et al., 2016). Ollerton (2017) stated that these declines are reflected at "local, regional, and global scales" and most likely due to anthropogenic causes such as climate change, pesticide use, and land use change. Natural causes, which could also arguably be influenced by human action, such as weather patterns and resource availability also affect changes in pollinator distributions (Ollerton, 2017).

The consequences of this decline, as well as the likelihood of further decline, pose great threats to global sustainability. Public awareness about these issues is on the rise. As a result, increased public action, government intervention, technological innovations, and mitigation strategies are being implemented to promote and conserve pollinator populations.

POLLINATOR BENEFITS & COSTS

When considering the benefits and costs of changes in the environment, one approach that can be taken is looking at ecosystem services. This is because humans, like all other living beings, depend on their environment for survival and a holistic point of view, one that considers multiple species and system interactions, must be considered when attempting to quantify services provided to humans by the environment (Saunders 2017). Pollination is one of the most important and widely studied services provided to our ecosystem, and pollinators play an essential role in promoting plant biodiversity and agricultural stability across the globe (Kevan and Phillips, 2001; Saunders, 2017).

Animal pollinators are critical to sustaining the United States and global food security. According to the U.S. Department of Agriculture, pollinating species – including butterflies, bees, wasps, and moths – are essential for the production of 87 out of 115 major food crops produced domestically ("Fact Sheet" 2014) and 65 percent of wild plants are dependent on pollinators (Ritten et al., 2017). In addition to crop production, pollinators also promote diverse and reliable fruit, seed, and nut supplies (Potts et al., 2016). According to Potts et al. (2016), bees alone visit over 90 percent of the 107 leading global crops, making them the most important group of animal pollinators. In the United States, the honeybee population alone is valued at $14.6 billion annually (Kevan and Phillips, 2001), while entire pollinator population contributions total $24 billion (Ritten et al., 2017).

Even though pollinators have shown to be of great benefit to agricultural production, pollinator habitat near the crop fields is not a widely used practice by farmers. Two reasons for this include that it is difficult to link the instillation of pollinator habitat adjacent to crop fields with increased yields and there is an initial loss of capital to change farming practices (Table 5; Wratten et al., 2012). But there are additional benefits that come with having pollinators and their habitats in agricultural fields other than just higher crop yields (Figure 2). These benefits include biodiversity conservation, conservation biological control, soil, and water quality protection, rural prosperity and aesthetics, weed suppression, and weed control savings.

Table 5. Obvious and less obvious costs and benefits of enhancing pollinator habitat in cropland areas (adapted from Wratten et al., 2012)

Costs	Benefits
<u>Obvious Factors:</u> · Loss of cultivated land and corresponding crop yields · The potential loss of yield due to the variability of wild pollinators · Costs of restoring non-crop vegetation (flower seeds, specialized machinery) · Labor	· Small savings in production costs by reducing the size of cultivated land · Savings in honeybee hive rental fees · Potential subsidies from agri-environment schemes or price premiums for organic or 'environmentally friendly' products
<u>Less Obvious, Delayed, or Non-monetary Factors:</u> · Training of habit enhancement techniques · Monitoring enhancement areas for the successful establishment of flowers and beneficial insect populations · Maintenance costs of new habitats · Increase in pests attracted to wildflowers · Increase in weeds · Increase in diseases · Possible lack of spill-over (pollinators are attracted to wildflower margins and do not enter crop)	· Increases in biological control-reduction in pesticide use · Reduced pesticide decreases the likelihood of resistance developing · Landscape manipulation helps other ecosystem services · Increased soil fertility · Suppression of weeds · Alternative crop potential- sale of wildflower seeds or timber · The aesthetic value of improved landscape · Improved water quality · Improved plant and insect conservation · Other wildlife benefits · Community benefits beyond the farm boundary

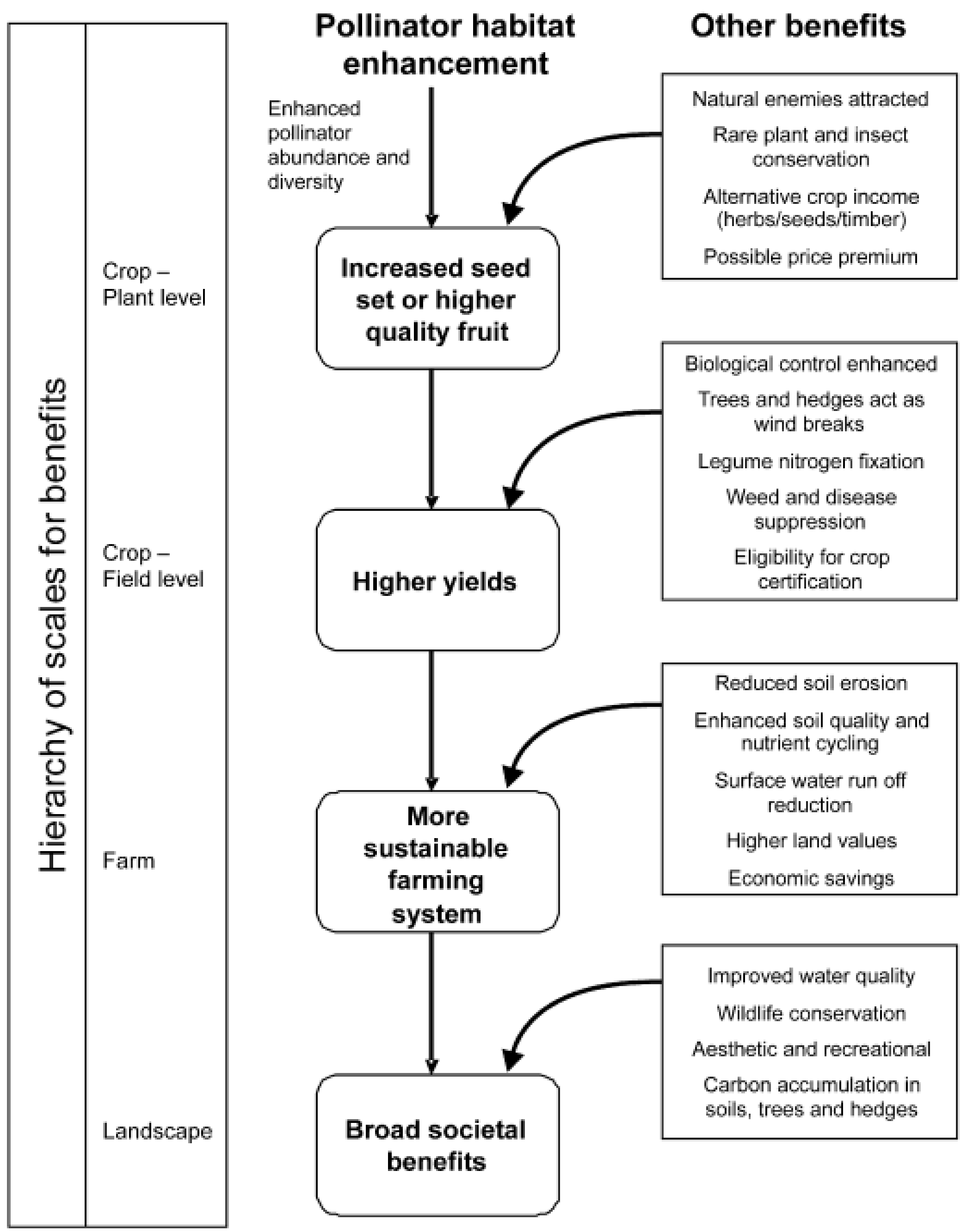


Figure 2. Diagram of the potential benefits of pollinator habitat enhancement (taken from Wratten et al., 2012).

In addition to pollinators providing agricultural benefits, biofuel and medicine production depends heavily on pollinator-dependent plants (Potts et al., 2016). The production of honey also affects several economic, medical, and cultural areas of human life. Beekeeping and honey hunting, as well as the anti-bacterial and anti-fungal properties associated with honey, have provided benefits for several rural and developing communities around the globe (Potts et al., 2016). This shows that the instillation of pollinator habitats creates homes for pollinators while also providing a host of ecosystem services including increased infiltration of rainwater, providing habitat for other wildlife species, preventing invasive species from taking over, supporting agricultural systems, and creating a beautiful space for people to learn and enjoy nature. This provides Marion County Lake with an opportunity to enhance biodiversity, aesthetics, and educational activities at the lake.

POLLINATOR ECOLOGY

At Marion County Lake, there is no evidence of existing pollinator habitat, therefore it would require the installation of pollinator habitat near and around the lake for pollinators to visit the area. To better advise Marion County Lake about attracting and supporting pollinators around the lake, the preferred habitat attributes in relation to feeding plants, nesting sites, and geographic characteristics such as land cover, soil type, and elevation are provided. There are three main types of pollinators that are highlighted below: bees, monarchs, and the Regal Fritillary. These species were chosen because of their popularity, the location of their natural habitat in Kansas and the tallgrass prairie, conservation needs, and their potential benefits to the environment and the lake.

BEE POLLINATORS

There are an estimated 20,000 bee species worldwide, 3,500 bee species in the United States, and greater than 200 bee species in Kansas. Over the years, bees have been subject to a decrease in the abundance and diversity of flowers, exposure to agricultural chemicals and parasites spread by humans, and climate change (Goulson et al., 2015). All of these have put stress on bee populations, causing a decrease in their abundance and distribution. The honey bee decreased in population by 59% in North America from 1947 to 2005. This decline has resulted in increased costs for commercial pollination, valued at $150-$175 per hive in 2009, tripling the value of commercial pollination from just $50 per hive in 2003 ("Fact Sheet" 2014). This has led some to believe that there is a 'pollination crisis' because 75% of the world's crop species benefits from insect pollinators and this provides a global service worth $215 billion to food production. To better support the agroecosystem, it is important to provide for a diverse group of bee pollinators so that they can survive impacts of climate change better than a single species. Some key factors that can do this are to increase abundance, diversity, and continuity of floral resources, provide nest sites, reduce exposure to pesticides, prevent further introductions of non-native bees, parasites, and pathogens, and develop monitoring programs (Goulson et al., 2015).

Habitat Characteristics and Requirements

There are three groups of plants that bees use including, legumes, mints, and composites (Pollinator Prairie, 2011). Bees tend to prefer flowers in which 20-40% of the nectar consists of dissolved sugars. Appendix B provides examples of these flowers that are native to Kansas, including the White Wild and Blue Wild Indigo, New Jersey Tea, Purple Prairie Clover, Pale Purple Coneflower, Eastern Purple Coneflower, Prairie Blazing Star, Rosemallow, and Great Blue Lobelia (Figure 3). It is important to be selective in the origin of the plants that are installed for pollinator habitat because the presence of the invasive species has been shown to decrease pollinator visits of the native species in the tallgrass prairie (Woods et al., 2012). Many bees also build nesting sites in twigs with pithy stems, while others nest in holes of dead trees (Pollinator Prairie, 2011). Another option to provide a nesting site for bees is to install nesting boxes for the bees to make a home in (Figure 4).

Figure 3. Photographs of nine native wildflowers to Kansas that bees use as nectar sources are A) Blue Wild Indigo, B) Pale Purple Coneflower, C) Great Blue Lobelia, D) Purple Prairie Clover, E) Prairie Blazing Star, F) White Wild Indigo, G) Eastern Purple Coneflower, H) Rosemallow, and I) New Jersey Tea (taken from Pollinator Prairie, 2011).

Figure 4. A photograph of a bee nesting box that could be installed at Marion County Lake (taken from Nurturing Nature)

MONARCH BUTTERFLY

Each fall, monarchs migrate to central Mexico where they overwinter in large clusters on trees in the mountains. They return in the spring with the females laying eggs on milkweeds. The range of monarchs extends across North America, but the historical extent of the monarchs (pre-European) is thought to coincide with prairies through the Great Plains (Figure 5; Cutting & Tallamy, 2015). The monarch butterfly populations were at its lowest level in 2014, which presents serious domestic and international concerns, as their annual migration from Mexico into the U.S. provides several billion dollars of ecosystem service benefits and ecotourism revenues to the U.S. economy (Ritten et al., 2017). One reason for this is decline is the loss of more than 1.3 billion stems of milkweed in the United States, the monarchs breeding ground (Thogmartin et al., 2017). Approximately 98% of this loss is attributed to the loss of milkweed with conversion to corn and soy fields (which averages 3.9 times more monarch eggs than other agricultural fields) as the Great Plains and other areas are turned into agricultural land.

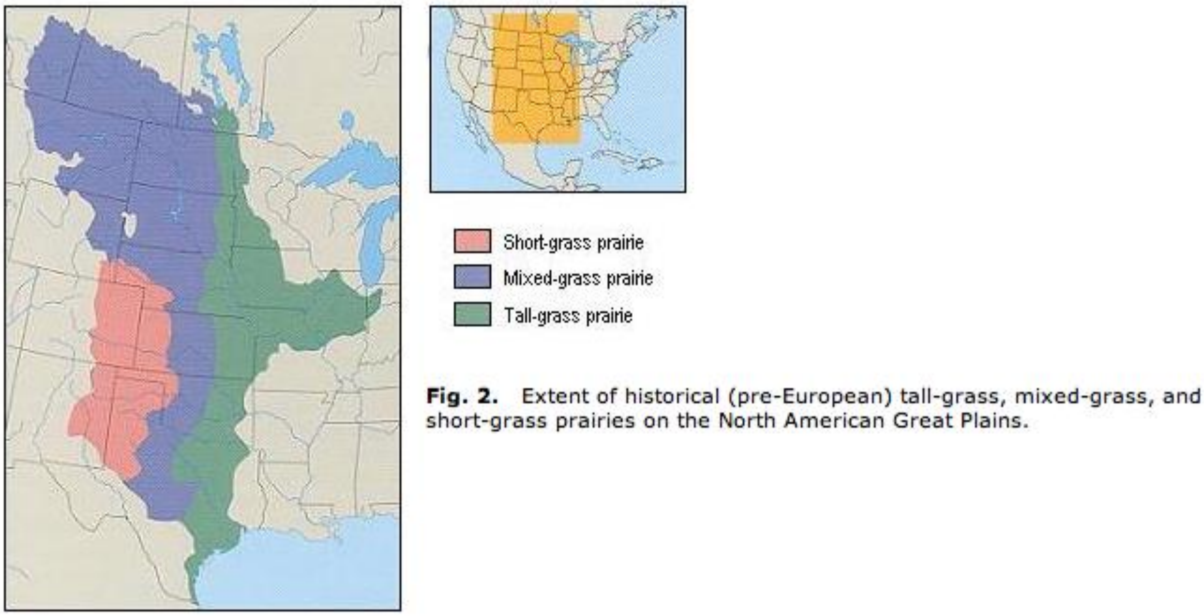


Figure 5. A map of the historical (pre-European) tall-grass, mixed-grass, and short-grass prairies on the North American Great plains that was home to the monarch (taken from Cutting & Tallamy, 2015).

Habitat Characteristics and Requirements

Monarch habit needs to include host plants for larvae such as milkweed, adult nectar sources like asters, coneflowers, and Joe Pye weed shown in Figure 6 with a complete list in Appendix B (Cutting and Tallamy, 2015). They also need sites for roosting, thermoregulation, mating, hibernation, and predator escape. Monarchs are host-plant dependent, meaning that without milkweeds there will not be monarchs in that area. The distribution of milkweed across the landscape also influences monarch productivity. This includes the time that a female spends searching for a host plant, the number of eggs laid in a given area, and degree of parasitism and predation. Monarchs tend to lay more eggs per plant on milkweeds that occur in smaller milkweed patches. Also, it is thought that females may prefer agricultural milkweeds because of the increase in nitrogen content contained within the plant.

Figure 6. Four photographs of plants the monarch pollinates. A) milkweed, B) Joe Pye, C) Coneflower, and D) Aster (Taken from Pollinator Prairie, 2011).

In addition to milkweeds, Monarchs also need trees for roosting, which have correlated to areas near large bodies of water such as lakes (Cutting and Tallamy, 2015). Similar to the bee, the monarch will also nest in a Monarch Box (Figure 7). In relation to climate, they tend to need a habitat that is protected from wind and storms, the absence of freezing temperatures, exposure to some sunlight, and areas of high humidity.

Figure 7. A photograph of a Monarch butterfly nesting house (taken from Joyful Butterfly, 2014)

REGAL FRITILLARY

The Regal Fritillary, shown in figure 8, is a univoltine butterfly meaning that they reproduce once per year with eggs that overwinter (Caven et al., 2017). They also feed on the violet species as larvae and do not lay eggs directly on host plants, but somewhere hidden within their prairie home.

Over the past two decades, the Regal has declined in population by 75-95%. The reasons for the decline are not clear but some believe it is due to the decreased habitat as the prairie landscape is getting converted to agriculture and urban areas.

Figure 8. Photograph of the Regal Fritillary, *Spyeria idalia;* a native species to the tall-grass prairie (Taken from Pollinator Prairie, 2011).

Habitat Characteristics and Requirements

The Regal Fritillary is specific to the tall-grass prairie and requires this ecosystem for survival. Drier areas with well-drained soils, such as silty clay loams, have shown to be favorable conditions for the Regal (Caven et al., 2017). Other important landscape characteristics to consider is elevation, slope, hill shade, slope position, land cover type, and average fire frequency (McCullough, 2016). These characteristics are important because it is the favorable conditions for the prairie violet to grow in, and without the violet, the Regal Fritillary cannot survive in that area (Figure 9). Of those variables, the elevation is the most important one when looking at the presence of the prairie violet. The preferred elevation range for maximum violet density is 380-420 m above sea level. The prairie violet is also exclusively found in grassland cover type with 0-10% slope that faces north or north-east.

Figure 9. Photograph of the prairie violet, the feeding plant of the Regal Fritillary (Taken from Haddock, 2007).

OTHER POLLINATORS

Three types of pollinators habitat have been described this far, but there are many other types of pollinators such as bats, birds, beetles, moths, and flies. These pollinators are helpful and essential to the environment, especially a prairie ecosystem. Grasses in the prairie are wind pollinated while the wildflowers are pollinated by bees, beetles, flies, butterflies, moths, and hummingbirds, creating an ecosystem maintained by pollinators. Thus, pollinator habitat is not just home to one specific pollinator, but a variety of different pollinators will exist in the area, creating a more biodiverse system. When creating pollinator habitat, it is important to choose plants that allow for adequate food, shelter, and water sources. These preferred pollinator plants overlap between different pollinator species in terms of preference. For example, milkweed is an essential plant for the Monarch, but some bees and beetles will also pollinate the plant. Table 6 characterizes the preferred plant traits for the different pollinators.

Table 6. Different types of pollinators and their preferred plant traits (adapted from Ley, 2007)

PLANT TRAITS	Bats	Bees	Beetles	Butterflies	Birds	Flies	Moths
Color	Dull white, green, or purple	Bright white, yellow, blue, or UV	Dull white or green	Bright, including red and purple	Scarlet, orange, red, or white	Pale and dull to dark brown; flecked with translucent patches	Pale and dull red, purple, pink, or white
Nectar Guides	Absent	Present	Absent	Present	Absent	Absent	Absent
Odor	Strong must; emitted at night	Fresh, mild, pleasant	None to strongly fruity or fetid	Faint but fresh	None	Putrid	Strong sweet; emitted at night
Nectar	Abundant; somewhat hidden	Usually present	Sometimes present; not hidden	Ample; deeply hidden	Ample; deeply hidden	Usually absent	Ample; deeply hidden
Pollen	Ample	Limited: often sticky and scented	Ample	Limited	Modest	Modest	Limited
Flower Shape	Regular; bowl shaped- closed during the day	Shallow; have a landing platform; tubular	Large bowl-like, magnolia	A narrow tube with spur; wide landing pad	Large funnel like; strong perch support	Shallow; funnel like or complex and trap-like	Regular; tubular without a lip

HABITAT IMPLEMENTATION STEPS

Steps that are important to follow when implementing pollinator habitat are as follows (Figure 10). The first step of the process is to recognize a pollination problem (Bosch and Kemp, 2002). One factor that can affect pollinator productivity and decreased plant yields is the weather; for example, insufficient sunlight hours in the 10-day period immediately after flowering can reduce the likelihood of fruiting. Methods used to determine whether there is a pollination problem includes the comparison of yields in open-pollinated flowers versus flowers pollinated with abundant pollen. The second step of the process is to select your pollinator species based on the target crop. This can be done by field and literature surveys. The third step is to obtain populations of the species to study its biology and potential for management. This includes understanding its life cycle, how the species develops, foraging behavior, nesting behavior, population dynamics, its predators, and its susceptibility to disease. The fourth step is to combine all the information learned from the previous studies into the development of management systems that results in both appropriate pollination levels and sustainable reproduction. A complete management system should address: 1) rearing methods, 2) releasing methods, 3) pollinator density, 4) nesting materials, 5) pollinator supply, and 6) control methods against enemies. Once the management plan has been developed, a pilot test can be conducted to ensure that the goals of the project can be met based on pollination and bee return. The last step in the process is to establish new pollinator new pollinator habitat in the desired area.

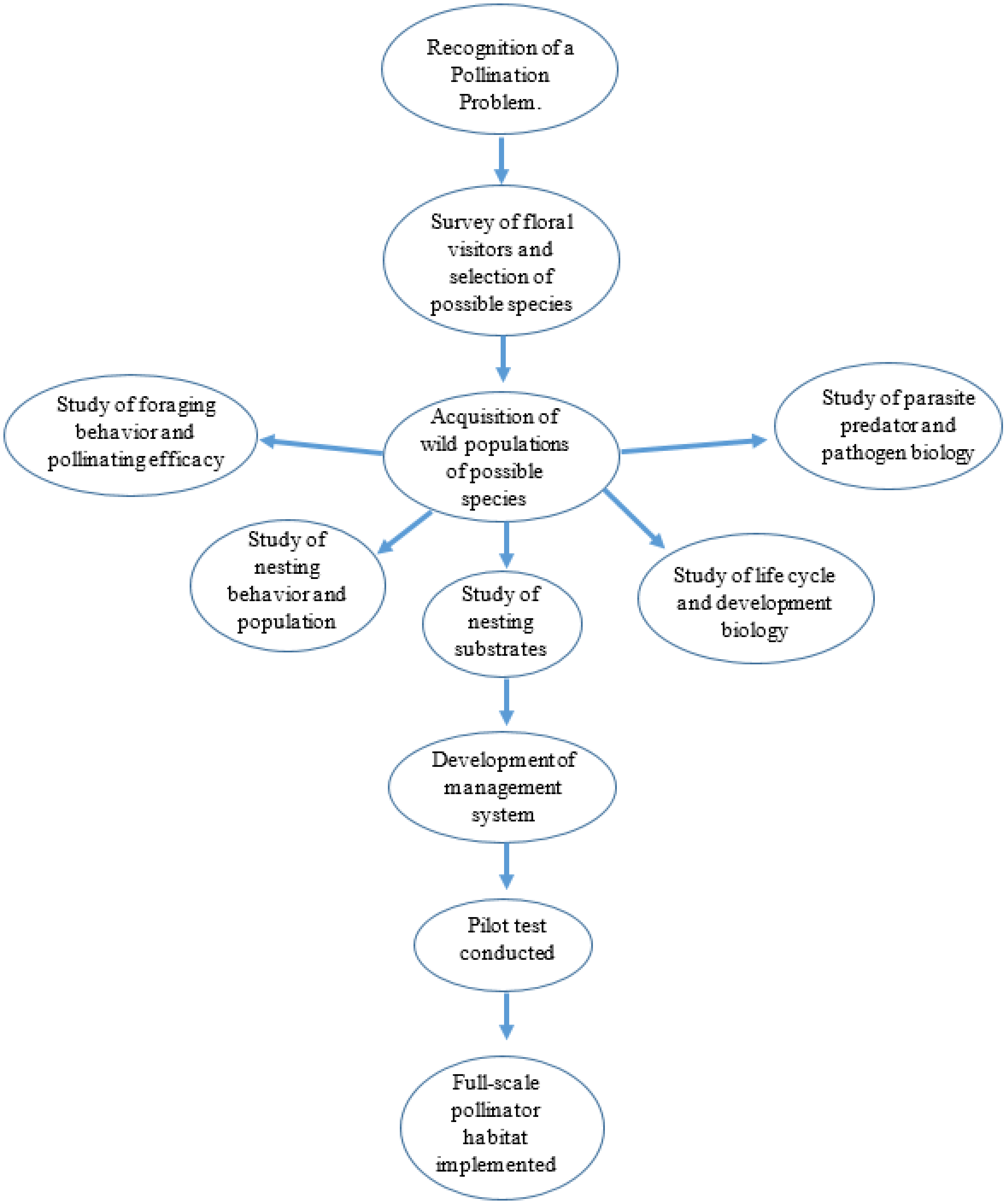


Figure 10. Diagram of the process involved in the development of a pollinator species into an area (adapted from Bosch & Kemp, 2002).

The above sections detailed that native pollinators to Kansas have seen a major reduction in available habitat as their natural prairie habitats are being converted to urban and agricultural landscapes, resulting in a decline in the species' population. It also described the preferred habitat for pollinators and what steps to take to implement the habitat in the desired area. The following section will better describe what management practices can be used to maintain pollinator habitat at Marion County Lake.

POLLINATOR MANAGEMENT STRATEGIES

Pollinator management strategies have been implemented at every level of government. There is disagreement on which practices work best. The following strategies on how to install pollinator habitat and manage that habitat into the future are described and compared to each other below.

SEEDING: SEED DRILL

Minimum-till drill seeding can be an effective way to establish pollinator habitat, reduce the number of weeds in planting, and conserve ground nesting bee habitat (USFS, 2015). No-till drills can sow seed into already existing vegetation, but it is advised the vegetation be eight inches or less to prevent clogging the drill (Hutchins, 2016). Use a drill with small seed boxes able to deliver forb seeds and plant them in the fall to allow for emergence after overwintering (USFS, 2015). Seed drilling can be an effective way to plant seeds over a large area but if this is not available there are other methods to plant seeds. An example of a no-till seed drill is shown below:

Figure 11. A photograph of a no-till seed drill used to plant seeds for pollinator habitat (taken from Great Plains Ag).

Seed can also be spread by hand and lightly raked into the soil in the fall (MBWSR, n.d.). Using a compactor or roller after the seed has been spread will also help with soil contact (Hutchins, 2016). Containerized plantings should be reserved for species that do not do well from seeds such as milkweed. Forbs tend to do better with broadcast seeding and grasses do better when drilled into the ground. Broadcast seeding is an easy inexpensive way to spread seed over a small area. The problem with this method is that it may take a substantial amount of manpower to perform.

GARDEN PRACTICES USED FOR MANAGING POLLINATOR HABITAT

Garden practices are a management practice that allows for the creation of pollinator habitat in close proximity to humans and can be used to revamp landscape gardens around buildings. Most gardens contain a variety of flowering plants native and exotic that may be used by pollinators

(Altizer and Majewska, 2019). Many gardens are often managed by weeding, but this practice can decrease the diversity of the garden, for example, dandelions are considered a weed but provide a source of nectar for pollinators (Altizer and Majewska, 2019). Mulching may also have negative effects on ground nesting bees because it creates a barrier to the soil (Altizer & Majewska, 2019). The USFS (2015) suggests that if mulching cannot be avoided then leave barren patches, 6-12 inches, around the base of plants to make the soil available for nesting habitat. Another suggestion is to place pots of barren soil, which are 8-10 inches deep, in the mulched area to provide pollinator habitat. The removal of dead vegetation and debris should take place later in the growing season to allow for the emergence of overwintering pollinators (Altizer and Majewska, 2019). Brush piles or stumps can also be included in a garden habitat to provide overwintering sites for pollinators.

MOWING: WHAT EQUIPMENT TO USE AND BEST PRACTICES

Mowing can be an effective way to manage pollinator habitat if that habitat is smaller in size. In general, some management plans have suggested that mowing is not an effective management strategy in the long term (Warriner, Hutchins, Nongame, and Rare Species Program, & Texas Parks and Wildlife Department, 2016). Mowing should only be used to remove undesirable species, in conjunction with prescribed burning, and prepare an area for light disking. There are, however, management plans that incorporate mowing practices. While mowing, the speed of the tractor or mower should not exceed eight miles per hour, mowing should be done in patches and/or mow at a height of eight to twelve inches, mowing should not be conducted during the blooming season, and a flushing bar should be used (USFS, 2015). The flushing bar is intended to allow pollinators to escape before the mower reaches them. An example of a flushing bar is shown below:

Figure 12. A photograph of flushing bar on a mower used in pollinator habitat (taken from Biodiversity Management Guide).

Mowing in patches and at a higher height allows for some habitat to be retained. A more specific type of mower is suggested by the Minnesota Bureau of Water and Soil Resources which is a flail type mower (Figure 13). It is also suggested to mow annual and biennial weeds to 5-8 inches with a Flail-type mower as needed during the first 1-2 years of establishment is important to provide sunlight and decreases competition for seedlings (MBWSR, n.d.). A flail mower is only recommended for the first years of a pollinator planting so it may not be in the best interest of a park to purchase. Furthermore, the task done by this mowing could be accomplished by a combination of brush hog mowing and hand removal at smaller pollinator plantings.

Figure 13. A photograph of a flail mower used for managing pollinator habitat (taken from WoodMax Power Equipment)

WHAT AREAS TO MOW

Another consideration when it comes to mowing is where not to mow. More specifically should a park mow secondary roads? According to Killian (2016) "Secondary road ditches often contain several species of plants that provide forage for pollinators". Limiting the mowing of ditches can provide forage and shelter for pollinators and could potentially save agency money. In some cases, these areas already include food species for pollinators as well as the pollinator species themselves, so adopting "no-mow" practices is sufficient to create edge habitat (MDNR, 2017). Mowing secondary ditches in patches or when forage is at a minimum would be another option. If it is necessary to mow near roads, initially mow closely, and possibly couple with light soil disturbance, prepare a seedbed and expose soil for seed germination and seedling growth (USFS, 2015). This implies that the areas of road have already been identified to have sufficient pollinator habitat. If a road does not have significant forage, follow the United States Forest Service's example of preparing roadsides for seeding and habitat.

In most parks, there are general use areas that are mowed much shorter than the native grass around them. Some flowers may persist in these areas and can serve as a source of forage for pollinators. According to the USFS (2015) "Flowers provide pollen and nectar sources for pollinators in urban and intensively managed areas". It is clear that to some pollinators in certain areas these flowers may be their only option. Mowing should be conducted every two weeks in high traffic areas and every three weeks low traffic areas

(USFS, 2015). Rotate the mowing schedule to ensure flowers persist throughout the growing season (USFS, 2015). It has also been found that in combination with raising the mowing height to 2.5 inches and minimizing pesticide use, mowing only every 2 or 3 weeks has the potential to increase flower abundance by 70–300%. These simple mowing practices will increase the number of flowers substantially benefitting pollinators.

PRESCRIBED BURNING PRACTICES FOR MANAGING POLLINATOR HABITAT

While fire may seem destructive and harmful to pollinators it can be used to construct and maintain quality pollinator habitat. Many agencies and organizations do have prescribed burning as a practice in their management plans. Prescribed burning can be used to prepare a site for a pollinator planting as well as remove invasive species (USFS, 2015). It is important to prepare a site to eliminate competition from other undesirable species (MBWSR, n.d.). Woody plants may to some degree offer pollinators habitat and forage but if left unchecked may spread throughout a site. To prevent this from happening prescribed burning is used to prevent the succession of native prairies into woodlands (Hutchins, 2016). Burning can also be used to speed the recovery of native plants that are essential to pollinators.

INTENSITY AND FREQUENCY OF PRESCRIBED BURNING

Once pollinator planting is established, burning takes on a different role other than succession, which is maintaining a quality habitat. Low intensity burning should be used to limit the damage to pollinator populations (USFS, 2015). Low intensity burning suggests that there is not a significant amount of fuel available for the fire. To keep fuel loads to a minimum and allow for areas to recover from previous burnings, an area should only be burned every two to five years (MBWSR, n.d.). Rotating areas that are burned will help increase the likelihood that they eventually will be recolonized (Hutchins, 2016). In areas that have not been burned for long periods of time thatch will form providing habitat preferred by ground nesting bees (Hutchins, 2016). If areas are subjected to frequent burnings it is possible the native insect population may be eliminated (Hutchins, 2016). Overall a burning schedule and record should be developed in order to produce the most beneficial burns.

AREA AND TIME FRAME FOR PRESCRIBED BURNING

Prescribed burning of a pollinator habitat should not be burned all at once (Hutchins et al., 2016). It is suggested that pollinator habitats can have areas burned anywhere from 25-50% (MBWSR, n.d.). The only time an area should be burned all at once is before pollinator habitat has been planted. According to Hutchins (2016), the unburned areas eventually allow for the burned areas to be recolonized as the vegetation recovers. The USFS (2015) suggests leaving patches of unburned vegetation in the burned areas to further help recovery and provide important wintering habitat for pollinators. The time of burning also affects pollinators. It is important not to burn during the flowering seasons or during the winter months because it may destroy pollinators that are wintering in leaf litter or hollow stems (Hutchins, 2016). Instead, spring and fall are the preferred times to burn. But some believe it is important to burn areas in the summer to allow milkweeds to regrow for migrating monarchs to use, but thi, in turn, destroys other pollinator forage and host plants, which negatively affected those pollinators. Therefore, the area burned and the time an area is burned may depend on which pollinators are being managed. In order to promote biodiversity, a general approach should be taken.

HERBICIDE USE FOR MANAGING POLLINATOR HABITAT

Herbicide application may be used in a management strategy as it does not actively target insects like insecticides or other pesticides. There are certain considerations to keep in mind including that indiscriminate spraying of native plants will lead to a loss in habitat (Landis, 2014). Thus, herbicide might be detrimental to native plants, but it can be used to eliminate undesirable grasses and invasive species (USFS, 2015). Biodegradable broad spectrum herbicide can be applied repeatedly during spring and the site should be immediately planted after the final application (Hutchins, 2016). Essentially, if an area was designated for conversion to pollinator habitat, herbicide can be used to kill off almost all the plants in the area to make way for the desirable species. Once a pollinator planting has been established, it is important to spot treat weeds or invasive species with herbicide to prevent unwanted damage (MBWSR, n.d.). The only time to treat such species is when they are not in bloom. An alternative to herbicide application is hand weeding and should be conducted after rains to make it easier.

PESTICIDE USE FOR MANAGING POLLINATOR HABITAT

In general, pesticide use is not advised but it is recognized that not everyone can avoid using pesticides with their management plans. According to Landis (2014), all monarch way stations should be managed organically, pest species can be brushed or washed off, or insecticidal soap can be applied to individual milkweeds. The MBWSR (n.d.) suggests using trees or other woody plants as a buffer for pesticide drift and run-off. Pesticides that list hazards to honey bees often do not list hazards to native bees, which are affected at lower doses (Hutchins, 2016). Applying pesticide when flowers are not in bloom or pollinators are not active is a way to minimize the risk of application (USFS, 2015). Use only the amount of pesticide necessary to carry out the job and follow the label instructions. In any pollinator management plan, it is best to eliminate or minimize pesticide use and provide a buffer against pesticide drift.

This management section did not include all of the possible management techniques associated with pollinator plantings and some may benefit specific situations more than the practices outlined. Marion County Lake should take these techniques mentioned, and if required, adapt them to their own needs. The well-being of pollinators should always be at the forefront of a pollinator management plan and by using these techniques both humans and pollinators can benefit from each other at the lake.

COMMUNITY OUTREACH AND EDUCATION

Educating local communities about pollinator contributions to the environment can greatly influence pollinator health, abundance, and diversity. Sharing knowledge with the public regarding pollinator benefits, increased population declines, the importance of habitat preservation, and ways in which one can help can initiate community efforts to advertently improve local agriculture and biodiversity. Interpretive signs posted near pollinator habitats, as well as the use of fliers, local newspapers, websites, and social media outlets can all be used to generate awareness and support for native and installed pollinator habitats. Reaching out to local schools and youth programs such as 4H, FFA, Girl Scouts, and Boy Scouts, and encouraging them to join in on pollinator habitat installation, data collection, and preservation can provide excellent educational opportunities for children. Hosting Citizen Science projects such as butterfly catches, the building of butterfly and bee boxes, and the monitoring of various pollinator species are also great ways to bring about community involvement, education, and tourism for all ages. Several websites, listed in (Table 7) below, provide access to national public education and awareness programs and provide information on a wide variety of pollinator-related issues.

Table 7. A list of pollinator education information and national programs

Sources for Pollinator Educational Information and National Programs	
Xerces Society for Invertebrate Conservation	https://xerces.org/citizen-science/
Pollinator Partnership	https://pollinator.org
Great Pollinator Project	http://greatpollinatorproject.org/education
U.S. Fish and Wildlife Service - Pollinator Outreach and Education Materials	https://www.fws.gov/pollinators/pollinatorpages/outreach.html
National Pollinator Garden Network	http://millionpollinatorgardens.org

The Pollinator Partnership website, in particular, Pollinator.org, offers an abundance of free educational opportunities for people of all ages. Planting guides, gardening tips, lesson plans, webinars, children's activities, printable posters and fliers, and helpful links for further research and funding opportunities are easily accessible on the site. The non-profit organization also highly encourages state participation in National Pollinator Week, an "international celebration of the valuable ecosystem services provided by bees, birds, butterflies, bats, and beetles," held this year June 17th-23rd. Participation in National Pollinator Week at Marion County Lake could provide ample opportunities for community involvement, education, data collection, and tourism.

INTERPRETIVE SIGNS

Most parks and organizations seek to inform the public about current environmental issues. Interpretation is one way to connect people to a resource and defined as a mission-based communication process that forges emotional and intellectual connections between the interests of the audience and meanings inherent in the resource (Beck, Cable, and Knudsen, 2018:6). Just stating facts is not interpretation, forging an emotional connection with the visitor is a must for successful interpretation.

Interpretation can be an effective management tool when it is done correctly and can control how people interact with the resource. Once way to do this is through interpretive signs. Examples of interpretive signs are to explain to the public why they are no longer mowing certain areas of the park or asking the public to not spray pesticide and herbicide in an area (Figure 14).

Figure 14. Two examples of an interpretive sign addressing pollinator management practices (taken from Maryland Park Service, 2017 and BWSR).

A good sign should have less than fifty words, get the main point across in less than thirty seconds, and use the large font (Beck et al., 2018:268).

Signs do an excellent job at attempting to manage for desired behaviors. A URL can also be provided for visitors to get more information for a specific site or region. These examples show that signs are a practical way of managing people's interaction with pollinator plantings at Marion County Lake, though it would be ideal to add an interpretive program too.

POLLINATOR TOURISM

The overall goal of tourism from a management-based perspective is to attract visitors to your area, provide education on the conservation of your resource and potentially make a profit. There is one group of pollinators that the public usually has positive views on which can be used to attract people to pollinator plantings; that is, butterflies. Using butterflies as a flagship species for pollinator conservation gets the public more interested in pollinator conservation, and not only benefits butterflies, but many other species as well. With public interest about pollinators rising it is likely the message of the conservation efforts for pollinators will spread (Lemelin, 2013:198). Having a rare species at a pollinator planting, like the Regal Fritillary, can also bring people in from all over the world and further drive up interest in the conservation of the species. Managers of pollinator plantings should do everything in their power to attract outside visitors to not only spread a conservation message but to bring in outside capital to a community.

ECONOMIC SOLUTIONS

There are three ways to integrate ecology and economics to achieve conservation goals: (1) through technical integration of models; (2) the policy integration of methods; and (3) the political integration of mindsets to better design incentive programs to meet biological goals and accommodate private landowner preferences (Shogran, Parkhurst, and Settle, 2003). To integrate models, economists must identify "pragmatic positive links between systems rather than the ethereal normative decisions of morals and policy" by identifying feedback loops between economics and the environment (Shogran, Parkhurst, and Settle, 2003). To integrate methods, interest groups must agree on a common goal, such as maximum species protection at minimum cost. The integration of mindsets requires that economists identify "correctly why the market failed (e.g., public good, open access, jointness, asymmetric information), recognize the key feedback loops, and then define the appropriate strategy to correct the failure, either through new rules, new institutions, or new price incentives." Recognizing cultural and social values is another important component of mindset integration because many private landowners do not welcome mandate-driven conservation programs and typically regard private land choices as subject to their personal prerogative. But voluntary participation by private landowners is critical to successful pollinator restoration because pollinators operate best in landscapes of mixed agricultural land and native habitat.

Throughout recent years, the government has taken steps to protect pollinators from declining populations. Out of 31 bills proposed about pollinator-related issues from 2000-2017, 4 were passed by Congress (Figure 15; Hall and Steiner, 2019). In addition, 36 states passed 110 policies relevant to pollinator health, agricultural pesticide pieces of training, as well as pesticide disposal and application restrictions have been enforced in several states (Figure 16). In 2006, the US Congress declared that a week in June will be "National Pollinator Week." This week is for the celebration of pollinators and to spread the word about what people can do to help protect pollinators (Pollinator.org).

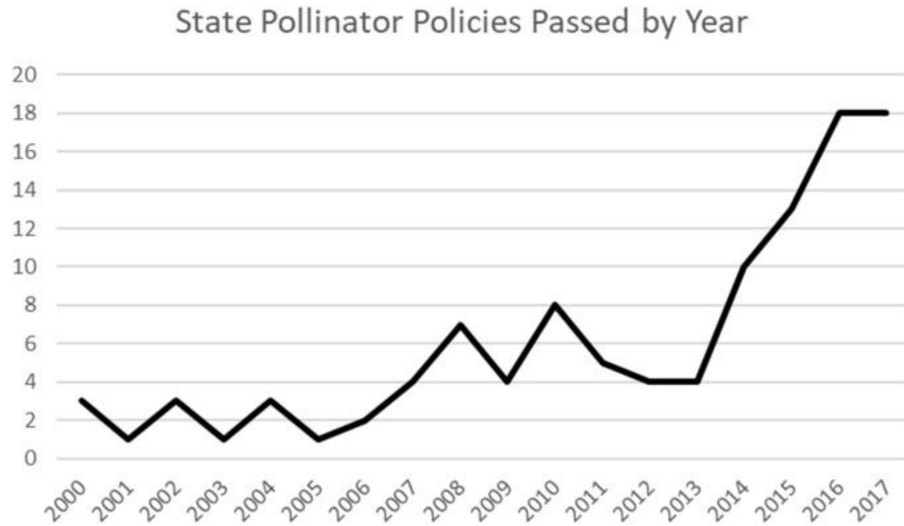
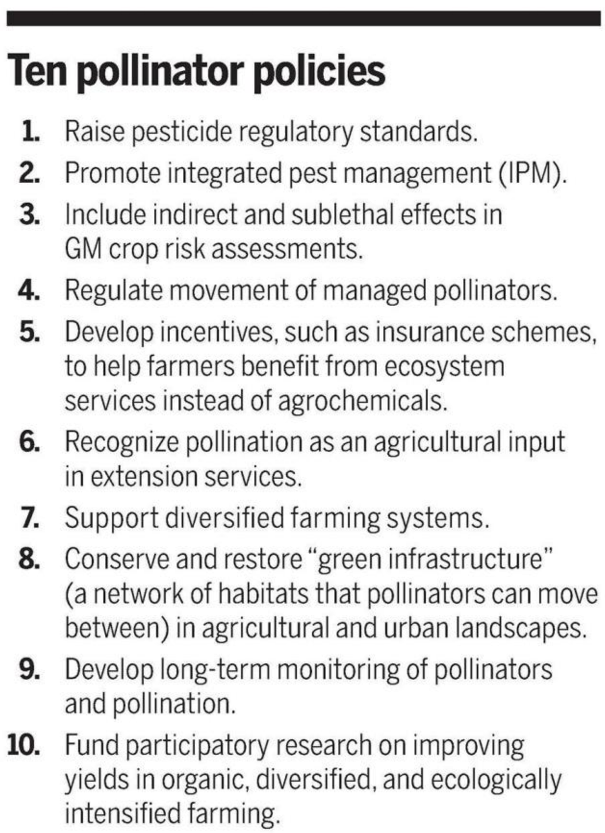


Figure 15. The number of pollinator-related policies proposed in the United States from 2000 to 2017 (Hall and Steiner 2019)



Ten pollinator policies

1. Raise pesticide regulatory standards.
2. Promote integrated pest management (IPM).
3. Include indirect and sublethal effects in GM crop risk assessments.
4. Regulate movement of managed pollinators.
5. Develop incentives, such as insurance schemes, to help farmers benefit from ecosystem services instead of agrochemicals.
6. Recognize pollination as an agricultural input in extension services.
7. Support diversified farming systems.
8. Conserve and restore "green infrastructure" (a network of habitats that pollinators can move between) in agricultural and urban landscapes.
9. Develop long-term monitoring of pollinators and pollination.
10. Fund participatory research on improving yields in organic, diversified, and ecologically intensified farming.

Figure 16. Ten pollinator-relevant policies for both national and international government consideration (taken from, Dicks et al., 2016).

Pollinating services are a public good and thus subject to under-investment in the private sector. This is particularly problematic as a large majority of pollinator habitat is located on private land. Pollinator habitat protection and enhancement, therefore, require policy intervention and incentive programs to sustain successful conservation efforts.

Incentive-based policy programs are preferred by economists because they encourage innovation and allow for flexibility of implementation. Incentive programs may help to mitigate the problem of free riders or holdouts, which are common challenges for cooperative conservation programs. Greater than 80% of habitat for endangered pollinator species is located on privately owned land (Parkhurst et al., 2002), so cooperation among landowners and government agencies is critical for successful pollinator habitat restoration and conservation on a landscape scale.

An example of a type of incentive-based policy program is the Pollinator Habitat Initiative (CP-42), which is operated by the U.S. Department of Agriculture through the Conservation Reserve Program (CRP). CRP allows private landowners to retire land from agricultural production in exchange for an initial $150 per acre payment and up to a 50 percent cost-share payment over a 10-year contract ("Pollinator Habitat Planting"). Farmers base enrollment decisions on the projected productivity of the land and the opportunity cost of lost revenues. All agricultural land uses with annual revenues per acre less than the value of CRP should be enrolled and converted to pollinator habitat. There are several million acres of land enrolled in CRP throughout the country and the average rental rate in 2017 was $76.73 per acre (USDA Farm Service Agency, 2017). The goal of the Pollinator Habitat Initiative is to restore habitat for honeybees and native pollinator species by promoting the growth of native flowering plants and installing beneficial wildflowers to increase pollination for commercial crops. Our team recommends that Marion County Lake make information about CRP available to private landowners near the lake and encourage pollinator habitat conservation in the surrounding lake area.

CRP ENROLLMENT INFORMATION

To be eligible for CRP enrollment, a farmer must have owned or operated the land for at least 12 months prior to the previous CRP sign-up period. Exceptions to this rule include:

- Land acquired by the new owner due to the previous owner's death;
- Change in ownership due to foreclosure; or
- Land that was purchased by the new owner without the sole intention of placing it in CRP.

To be eligible for placement in CRP, land must be either: Cropland (including field margins) that is planted to an agricultural commodity 4 of the previous 6 crop years from 2008 to 2013, and which is physically and legally capable of being planted in a normal manner to an agricultural commodity; or certain marginal pastureland that is suitable for use as a riparian buffer or for similar water quality purposes.

There are two ways to enroll in CRP. The first is through a competitive process known as CRP General Sign-up. General CRP sign-ups are announced on a periodic basis by the Secretary of Agriculture; they do not occur according to any fixed schedule. The second way to enroll is through

CRP Continuous Sign-up, which offers on a continuous basis. All enrollment offers are processed through your local FSA office (Figure 17).

FSA SERVICE CENTER OFFICE
MARION COUNTY FARM SERVICE AGENCY
301 EISENHOWER DR
MARION, KS 66861-1376

(620) 382-3714
(855) 784-3420 Fax

Mailing Address:
301 EISENHOWER DRIVE
MARION, KS 66861-1376

FSA State Web Site

Sara Morey
County Executive Director
(620) 382-3714 ext 22
(855) 784-3420 fax
sara.morey@ks.usda.gov

KURT F SCHWEINLER
Farm Loan Manager
(620) 343-2812
Kurt.Schweinler@ks.usda.gov

Street Map
Driving Directions

Site: 1278
Office:62018

Figure 17. Contact information for the Marion County FSA office

AGGLOMERATION BONUS

There are two key features to managing pollinator services: landscape composition and configuration. The landscape to be conserved must include site and pollinator-specific floral resources and promote heterogeneity between cropland and native habitat. Three incentive programs designed to enhance cooperation among landowners and achieve optimal spatial configuration for ecosystems services include the *cooperation bonus*, the *entrepreneur*, and the *ecosystem service district* (Goldman, Thompson, and Daily, 2007). The cooperation, or agglomeration bonus, builds on the existing USDA Conservation Reserve Program (CRP) design and provides an additional payment to landowners that retire land for conservation that borders existing conservation land, creating a contiguous reserve (Figure 18). This incentive mechanism can help to coordinate the conservation of private land and avoid habitat fragmentation and is ideal for areas with many small farms, where neighbors are likely to know and trust one another and maintain a high level of communication, thus ideal for Marion County Lake.

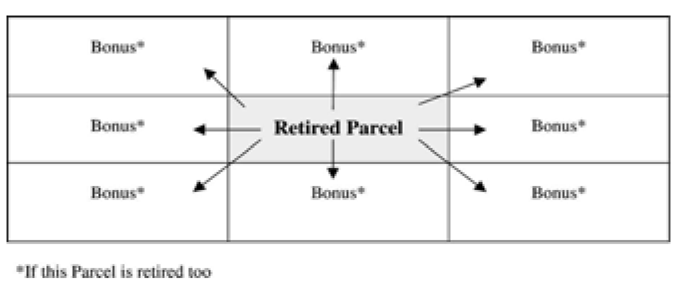


Figure 18. Diagram of how an agglomeration bonus distributes payment to retired land (taken from Goldman, Thompson, and Daily (2007).

ADDITIONAL FUNDING OPPORTUNITIES

The table below includes a summary of organizations that Marion County Lake may apply to for pollinator habitat installation or maintenance grants. Grant applications may be accessed online through the links provided, or by contacting program administrators. It is recommended that Marion County Lake apply for as many funding opportunities as possible. Funding is available for seed mixes, milkweed plugs, habitat installation, and site maintenance.

Table 8. A list of potential funding opportunities

National Fish and Wildlife Foundation	Monarchs, other pollinators	Pre-proposal: May 9th, 2019 Full proposal: July 18th, 2019	Grants available for habitat improvement. State government agencies eligible. Priority for the state of Kansas.
Monarch Watch	Monarchs	No deadline	Priority for projects with a clear educational focus and administrative support.
Feed a Bee	Honey bees	No deadline	Inquiries: feedabee@bayer.com
U.S. Fish and Wildlife	Monarchs, other pollinators	No deadline	Federal grant search engine. Email pollinator inquiries to: christina_milloy@fws.gov
Pollination Project	General	No deadline	Preliminary application screening. Funding to "support projects in their early stage of development"
Bee and Butterfly Habitat Fund	Honey bee, butterfly	Applications accepted year-round, fall 2019 decisions will be made September 1, 2019	Questions about application or site preparation can be directed to info@beeandbutterflyfund.org or by calling 800-407-5337
Monarch Joint Venture	Monarchs		Use this directory to find and order native milkweed seeds for the area. You may also order milkweed plugs grown by volunteers that are ready for planting.
Conservation Reserve Program	General		See the section titled "CRP Enrollment Information"

Local Milkweed Market Vendors

Name: Kansas Native Plants
Website: http://kansasnativeplants.com
Phone Number: 785-806 6917
Address: 6800 SW Fountaindale Rd
City: Topeka
State: KS
Zip: 66614
Country: US

Name: Monarch Watch
Email: milkweed@monarchwatch.org
Website: http://monarchwatch.org
Phone Number: 785-864-4441

Address: Foley Hall, University of Kansas
City: Lawrence
State: KS
Zip: 66047
Country: US

Name: Vinland Valley Nursery
Email: info@vinlandvalleynursery.com
Website: http://vinlandvalleynursery.com

Phone Number: 785-594-2966
Address: 1606 N 600 Rd
City: Baldwin City
State: KS
Zip: 66006
Country: US

SITE VISIT

Potential habitat installation sites were identified during a group site visit to Marion County Lake. Three such sites were identified by the group and are highlighted in Figure 19. These sites were chosen based on their proximity to community activities (disc golf, picnic areas), existing plant life, size of contiguous habitat, and ease of conversion into native pollinator plant communities. The areas chosen are large enough to support a diverse floral and pollinator ecosystem and their proximity to recreational areas will help to enhance community knowledge and enjoyment of pollinators. Locations were chosen on both the north and south end of the lake, allowing for pollinator stopover on both sides of Marion County Lake.

Figure 19. Photographs of potential pollinator habitat sites near the disk golf course on the south side of the lake (left) and near the community picnic area on the north shore (right)

CONCLUSIONS

This report comprises the cumulation of three months of research into the feasibility of pollinator habitat at Marion County Lake. The report examines the need for pollinators and the cost and benefits that go along with installing pollinator habitat in an area. It outlines what type of pollinator habitat is necessary for bees, monarch butterfly, and the Regal Fritillary to exist in an area. It also includes how to install pollinator habitat at the lake and compares different management strategies for taking care of the habitat. The report then outlines different outreach and educational opportunities for Marion County Lake personnel to teach the public about pollinators. This report also reviews different funding opportunities available to use to install the pollinator habitat. From this, the following conclusions were made:

1) Pollinator species and abundance has declined due to a reduction in the species habitat as it is being converted to urban and agricultural landscapes. This includes bees, monarch butterfly, and the Regal Fritillary.

2) Pollinator habitat should be restored to natural areas, including in specified areas surrounding Marion County Lake, with an interest in increasing pollinator abundance and diversity.

3) The installation of pollinator habitats creates homes for pollinators while also providing a host of ecosystem services including increased infiltration of rainwater, homes for other wildlife, preventing invasive species from taking over, supporting agricultural systems, and creating a beautiful space for people to learn and enjoy nature.

4) Pollinator habitat needs to allow for adequate food, shelter, and water sources for the pollinators.

5) Milkweed and prairie violet must be present at Marion County Lake for the monarch butterfly and Regal Fritillary to visit the area.

6) Pollinator habitat should include only native species to the area because the presence of invasive species decreases pollinator visits of the native species in the tallgrass prairie.

7) Prescribed burning is an effective method for managing pollinator habitat. It should only be burned every 2-5 years and only 25-50% of the habitat should be burned at a time.

8) Mowing is not an effective management strategy in the long term.

9) The pollinator management plan should eliminate or minimize pesticide use and provide a buffer against pesticide drift. In addition, herbicide application may be used in a management plan as it does not actively target insects like pesticide.

10) Minimum-till drill seeding is an effective strategy to plant pollinator habitat.

11) Interpretive signs and informational pamphlets are a practical way of enhancing community interaction with pollinator plantings at Marion County Lake.

RECOMMENDATIONS

It is recommended that Marion County Lake install pollinator habitat surrounding the lake. This is because of the decline in pollinator species and abundance, the high value that pollinators can add to the area, and increase biodiversity at the lake. To do this, Marion County Lake should apply for funding opportunities listed above in the section “Economic Solutions.” Habitat should then be installed in the areas shown in Figure 20. The pollinator habitat can include a variety of native grasses and flowering plants to increase pollinator visits and aesthetics of the lake (Appendix B).

Near the habitat, interpretive signs can be added, along with pamphlets available in the lake office and information posted on the Marion County Lake website and Facebook page to inform the public about pollinators and why the pollinator habitat was installed (Appendix C). To care for the site, it is highly recommended that mowing and pesticide use be limited; instead, prescribed burning every 2 years can be used to get rid of unwanted vegetation and maintain the health of native plants.

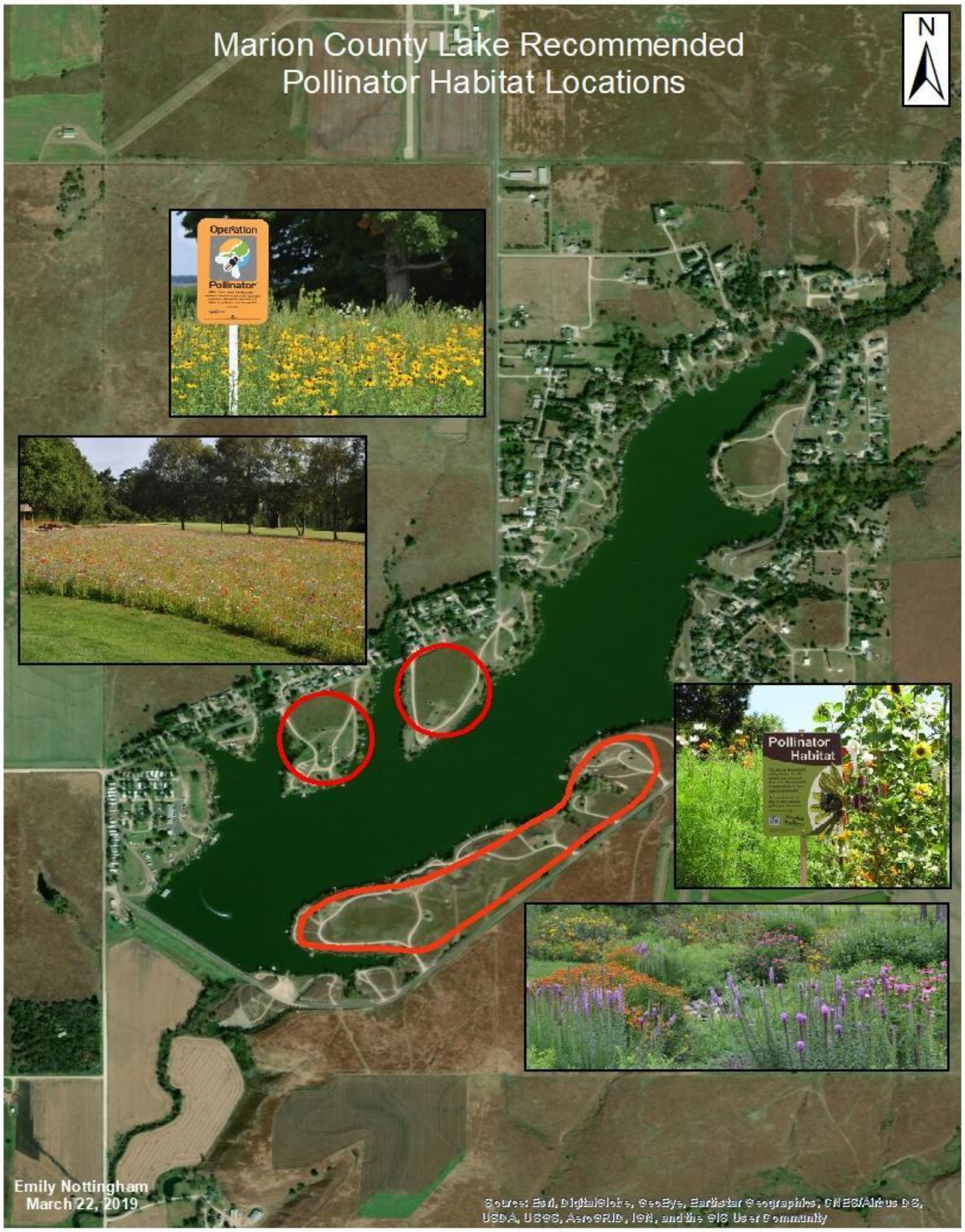


Figure 20. A map of the recommended locations of pollinator habitat at Marion County Lake and examples of what that habitat could look like.

STEPS TO IMPLEMENT POLLINATOR HABITAT AT MARION COUNTY LAKE

A basic plan to implement and maintain pollinator habitat at Marion County Lake is as follows:

1. Apply for funding opportunities during the summer months leading up to site installation.

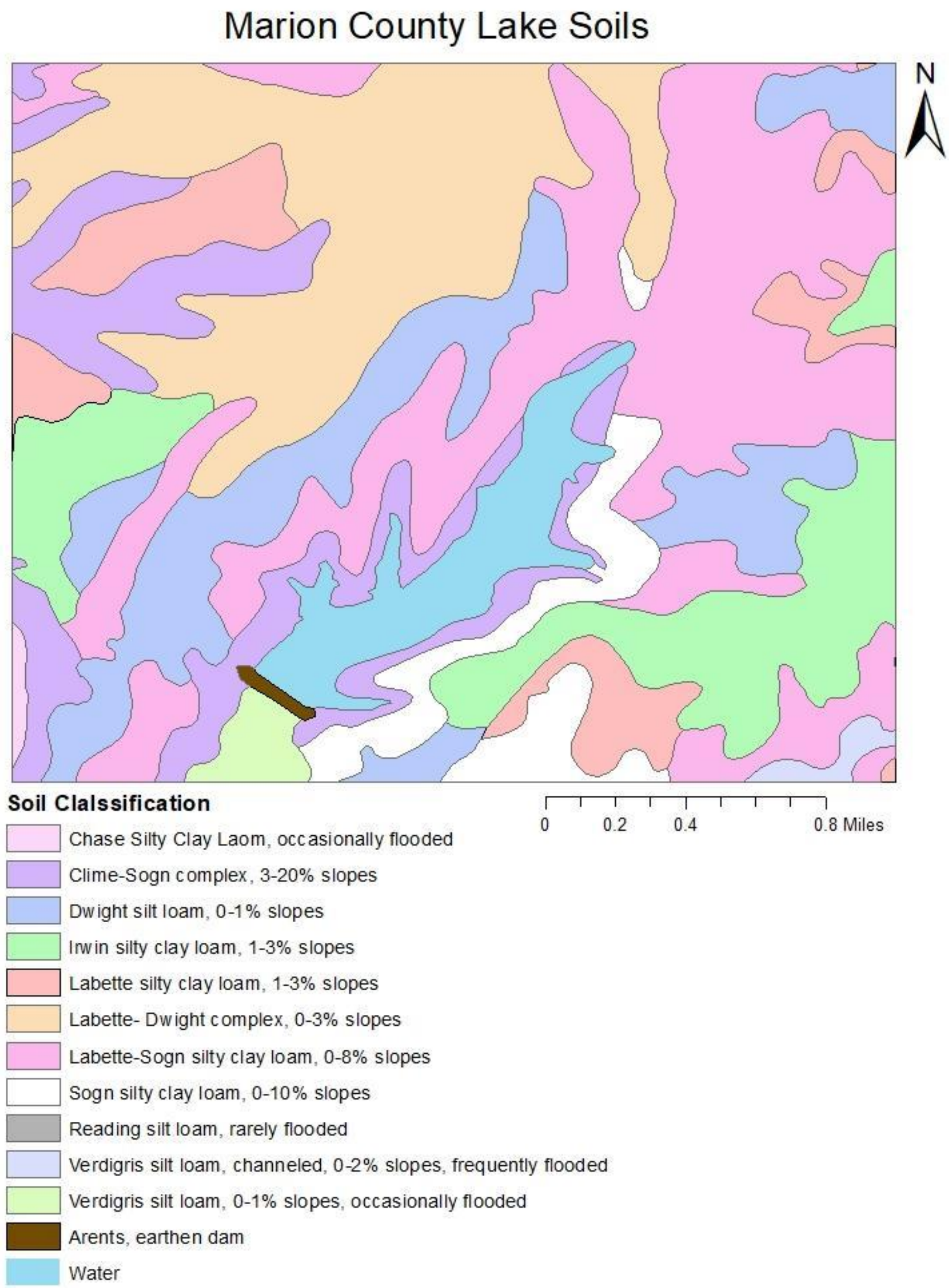
2. Prepare the site for habitat installation by burning the fall before the habitat is to be installed.

3. Plant grass and flowering plant mix in the spring in the areas identified in Figure 20.

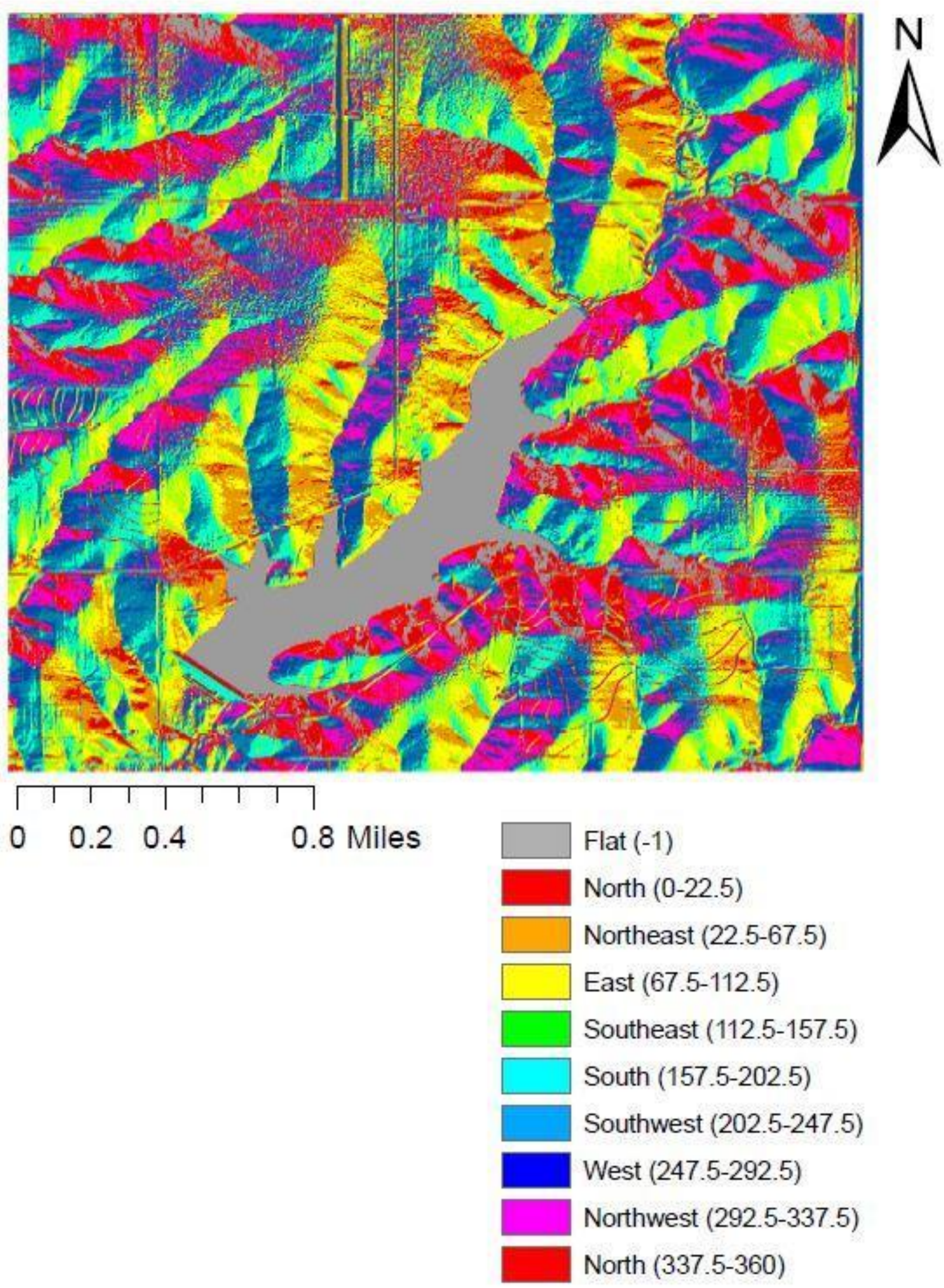
4. Install interpretive signage and utilize media outlets to make public aware of the project. Print informational fliers provided in Appendix C and make available in community areas.

5. Follow the long-term maintenance plan that includes burning every 2 years in the spring.

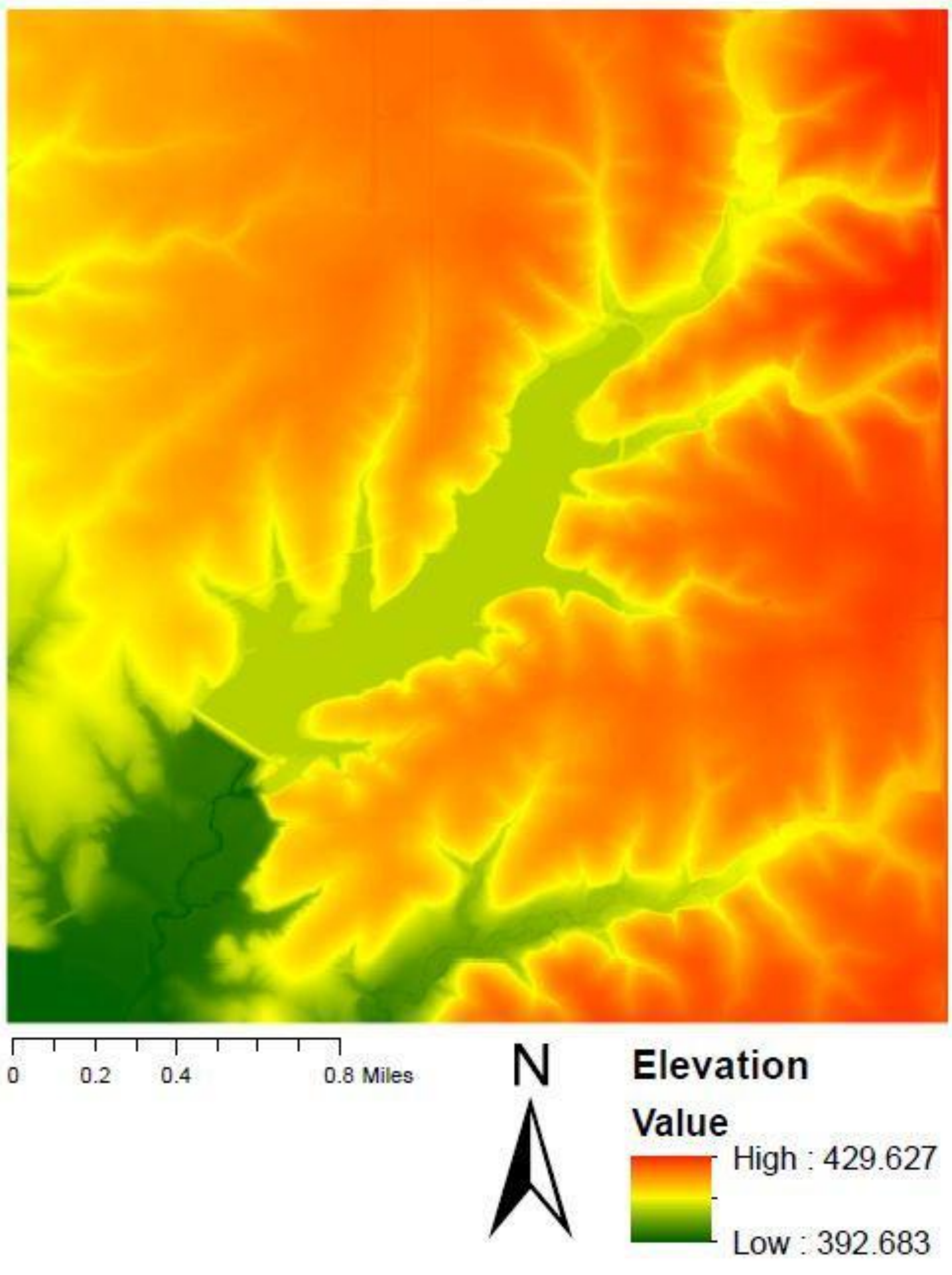
APPENDIX A: MARION COUNTY LAKE LAND CHARACTERISTIC

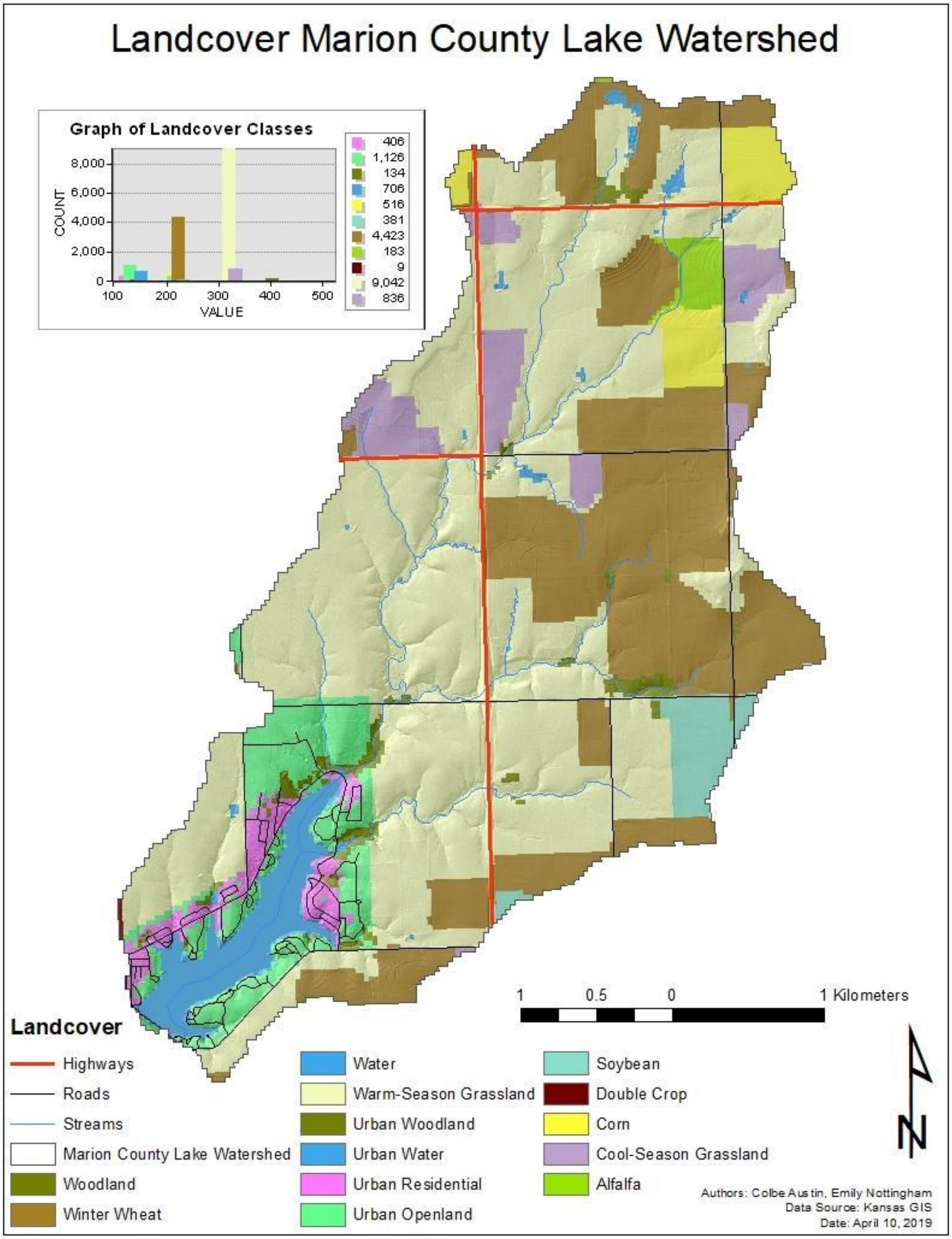


Marion County Lake Aspect



Marion County Lake Elevation




Landcover Marion County Lake Watershed
Graph of Landcover Classes
COUNT
8,000
6,000
4,000
2,000
0
100
200
300
400
500
VALUE
406
1,126
134
706
516
381
4,423
183
9
9,042
836
1
0.5
0
1 Kilometers
Landcover
Highways
Roads
Streams
Marion County Lake Watershed
Woodland
Winter Wheat
Water
Warm-Season Grassland
Urban Woodland
Urban Water
Urban Residential
Urban Openland
Soybean
Double Crop
Corn
Cool-Season Grassland
Alfalfa
N
Authors: Colbe Austin, Emily Nottingham
Data Source: Kansas GIS
Date: April 10, 2019

APPENDIX B: POLLINATOR PLANT LIST

LIST OF FLOWERS (adapted from Pollinator Prairie, 2017)

Asclepias incarnata
Common Name: Swamp Milkweed
Pollinators: Hummingbirds, Butterflies
Bloom Color(s): Pink, Purple
Height: 3-6 ft.
Bloom Period: June-October
Sun: Sun, Partial Shade
Soil: Moist

Asclepias sullivantii
Common Name: Prairie Milkweed
Pollinators: Butterflies
Bloom Color(s): Pink
Height: 2-3 ft.
Bloom Period: June-August
Sun: Sun
Soil: Moist

Asclepias syriaca
Common Name: Common Milkweed
Pollinators: Butterflies, Bees, Beetles
Bloom Color(s): Purple
Height: 2-6.5 ft.
Bloom Period: May-August
Sun: Full Sun
Soil: Dry, Moist

Asclepias tuberosa
Common Name: Butterfly Milkweed
Pollinators: Butterflies, Bees, Beetles, Hummingbirds
Bloom Color(s): Orange, Yellow, Red
Height: 1-2.5 ft.
Bloom Period: May-September
Sun: Sun, Partial Shade
Soil: Dry, Moist, Well-Drained

Asclepias viridis
Common Name: Green Milkweed
Pollinators: Butterflies, Bees
Bloom Color(s): White, Green
Height: 1-2 ft.
Bloom Period: April-September

Sun: Sun
Soil: Dry, Moist, Well-Drained

Baptisia alba
Common Name: White Wild Indigo
Pollinators: Butterflies, Bees
Bloom Color(s): White
Height: 2-5 ft.
Bloom Period: April-July
Sun: Sun, Partial Shade
Soil: Dry, Moist

Baptisia australis
Common Name: Blue Wild Indigo
Pollinators: Butterflies, Bees
Bloom Color(s): Purple, Blue
Height: 3-5 ft.
Bloom Period: April-August
Sun: Sun, Partial Shade
Soil: Well-Drained, Moist

Baptisia bracteata var. leucophaea
Common Name: Longbract Wild Indigo
Pollinators: Bees
Bloom Color(s): Yellow
Height: 1-4.5 ft.
Bloom Period: March-June
Sun: Sun, Partial Shade
Soil: Well-Drained, Moist

Ceanothus americanus
Common Name: New Jersey Tea
Pollinators: Bees, Butterflies, Moths, Flies, Beetles, Wasps
Bloom Color(s): White
Height: 3-5 Ft.
Bloom Period: May-July
Sun: Sun, Partial Shade
Soil: Dry, Well-Drained, Moist

Coreopsis lanceolata
Common Name: Lanceleaf Tickseed
Pollinators: Butterflies, Beetles
Bloom Color(s): Yellow
Height: 1-2 ft.
Bloom Period: May-July
Sun: Sun, Partial Shade, Shade
Soil: Dry, Moist

Delea purpurea
Common Name: Purple Prairie Clover
Pollinators: Butterflies, Flies, Beetles, Wasps
Bloom Color(s): Purple
Height: 1-3 ft.
Bloom Period: June-August
Sun: Sun
Soil: Dry

Echinacea pallida
Common Name: Pale Purple Coneflower
Pollinators: Bees, Butterflies, Birds
Bloom Color(s): Pink, Purple
Height: 2-4 ft.
Bloom Period: June-August
Sun: Sun
Soil: Dry, Moist

Eupatorium perfoliatum
Common Name: Common Boneset
Pollinators: Bees, Butterflies, Wasps
Bloom Color(s): White
Height: 2-6 ft.
Bloom Period: June-October
Sun: Sun, Partial Shade, Shade
Soil: Moist

Echinacea purpurea
Common Name: Eastern Purple Coneflower
Pollinators: Bees, Butterflies, Hummingbirds, Beetles
Bloom Color(s): Pink, Purple
Height: 2-5 ft.
Bloom Period: April-September
Sun: Sun, Partial Shade
Soil: Dry

Eupatorium purpureum
Common Name: Sweet scented Joe Pye Weed
Pollinators: Bees, Butterflies, Moths
Bloom Color(s): Pink, Purple
Height: 4-7 ft.
Bloom Period: July-September
Sun: Sun, Partial Shade
Soil: Moist

Helenium autunale
Common Name: Common Sneezeweed
Pollinators: Butterflies
Bloom Color(s): Yellow
Height: 2-5 ft.
Bloom Period: July-October
Sun: Sun
Soil: Moist

Helianthus pauciflorus
Common Name: Stiff Sunflower
Pollinators: Butterflies, Bees
Bloom Color(s): Yellow
Height: 2-4 ft.
Bloom Period: July-September
Sun: Sun
Soil: Dry

Hibiscus lasiocarpos
Common Name: Rosemallow
Pollinators: Butterflies
Bloom Color(s): White, Pink
Height: 3-7 ft.
Bloom Period: April-October
Sun: Sun
Soil: Moist

Liatris aspera
Common Name: Tall Blazing Star
Pollinators: Butterflies, Bees
Bloom Color(s): Purple
Height: 2-5 ft.
Bloom Period: July-October
Sun: Sun
Soil: Moist

Liatris punctata
Common Name: Dotted Blazing Star
Pollinators: Butterflies, Bees
Bloom Color(s): Purple
Height: 6-30 in.
Bloom Period: August-October
Sun: Sun
Soil: Dry

Liatris pycnostachya
Common Name: Prairie Blazing Star
Pollinators: Butterflies, Bees
Bloom Color(s): Pink, Purple
Height: 2-5 ft.
Bloom Period: May-December
Sun: Sun
Soil: Moist, Dry

Liatris spicata
Common Name: Dense Blazing Star
Pollinators: Butterflies, Bees, Moths, hummingbirds
Bloom Color(s): Purple
Height: 3-5 ft.
Bloom Period: July-August
Sun: Sun, Partial Shade
Soil: Moist, Dry

Lobelia siphilitica
Common Name: Great Blue Lobelia
Pollinators: Bees, Hummingbirds
Bloom Color(s): Purple
Height: 2-3 ft.
Bloom Period: July-October

Sun: Sun, Partial Shade, Shade
Soil: Moist

Monarda fistulosa
Common Name: Wild Bergamot
Pollinators: Bees, Hummingbirds, Butterflies, Moths, Flies
Bloom Color(s): Purple, White, Pink
Height: 2-5 ft.
Bloom Period: May-September
Sun: Sun, Partial Shade
Soil: Moist, Dry

Salvia azurea
Common Name: Azure Blue Sage
Pollinators: Bees
Bloom Color(s): Blue
Height: 3-5 ft.
Bloom Period: July-October
Sun: Sun, Partial Shade
Soil: Dry

Symphyotrichum cordifolium
Common Name: Common Blue Wood Aster
Pollinators: Bees, Butterflies
Bloom Color(s): Blue, Purple
Height: 2-5 ft.
Bloom Period: September-October
Sun: Sun, Partial Shade
Soil: Dry

Symphyotrichum lanceolatum
Common Name: White Panicle Aster
Pollinators: Butterflies
Bloom Color(s): White
Height: 2-5 ft.
Bloom Period: July-November
Sun: Sun
Soil: Moist

Symphyotrichum novae-angliae
Common Name: New England Aster
Pollinators: Bees
Bloom Color(s): Pink, Purple
Height: 1.5-6 ft.
Bloom Period: August-October
Sun: Sun
Soil: Moist

Vernonia fasciculata
Common Name: Prairie Ironweed
Pollinators: Bees, Butterflies, Moths
Bloom Color(s): Purple, Pink
Height: 2-6 ft.
Bloom Period: July-September
Sun: Sun
Soil: Moist

Viburnum prunifolium
Common Name: Blackhaw
Pollinators: Bees
Bloom Color(s): White
Height: 12-15 ft.
Bloom Period: April-June
Sun: Sun
Soil: Dry

Zizia aurea
Common Name: Golden Zizia
Pollinators: Bees, Butterflies
Bloom Color(s): Yellow
Height: 1-3 ft.
Bloom Period: April-August
Sun: Sun, Partial Shade
Soil: Moist

LIST OF GRASSES (adapted from Dyck Arboretum of the Plains, 2019 and Lady Bird Johnson Wildflower Center, 2012)

Andropogon gerardii
Common Name: Big bluestem
Pollinators: Butterflies
Bloom Color(s): Red, blue, brown
Height: 4-8 ft
Bloom Period: August-November
Sun: Sun, Part shade
Soil: Moist

Bouteloua dactyloides
Common Name: Buffalograss
Pollinators: Butterflies
Bloom Color(s): Yellow
Height: 3-12 in.
Bloom Period: April-December
Sun: Sun
Soil: Dry

Panicum virgatum
Common Name: Switchgrass
Pollinators: Butterflies, Bees
Bloom Color(s): Greed, brown
Height: 3-6 ft
Bloom Period: August-November
Sun: Sun, part shade
Soil: Dry, moist

Schizachyrium scoparium
Common Name: Little Bluestem
Pollinators: Butterflies, moths
Bloom Color(s): White, green, brown
Height: 3-6 ft
Bloom Period: June-December
Sun: Sun, Part shade
Soil: Dry

Sorghastrum nutans
Common Name: Indiangrass
Pollinators: Butterflies
Bloom Color(s): Yellow
Height: 3-6 ft
Bloom Period: August-October
Sun: Sun, part shade, shade
Soil: Dry, Moist

Sporobolus heterolepis
Common Name: Prairie Dropseed
Pollinators: Bees
Bloom Color(s): Pink, Yellow, Green, Brown
Height: 1-3 ft
Bloom Period: June-August
Sun: Sun
Soil: Dry

APPENDIX C: OUTREACH MATERIAL

POLLINATORS

AT MARION COUNTY LAKE

REGAL FRITILLARY

Habitat: native tallgrass prairie
Host plant: prairie violet

MONARCH BUTTERFLY

Migrate across north America each fall from central Mexico to Canada
Host plant: milkweed
Nectar sources: aster, coneflowers, Joe Pye weed

BEES

Habitat needs: legumes, mints, a variety of native wildflowers
Threatened by chemical insecticide use and climate change

WHY CREATE POLLINATOR HABITAT?

Pollinator habitats are continually threatened by habitat conversion and degradation, climate change, exposure to agricultural chemicals, and decreases in the abundance and availability of floral resources. Pollinators promote plant biodiversity, increase soil and water quality protection, and are essential for food production.

MONARCH JOINT VENTURE

Partnering across the U.S. to conserve the monarch migration

www.monarchjointventure.org

The Monarch Joint Venture is a partnership of federal and state agencies, non-governmental organizations, and academic programs that are working together to protect the monarch migration across the lower 48 United States.

MISSION

Recognizing that North American monarch (*Danaus plexippus*) conservation is a responsibility of Mexico, Canada and the U.S., as identified in the North American Monarch Conservation Plan, this Joint Venture will coordinate efforts throughout the U.S. to conserve and protect monarch populations and their migratory phenomena by developing and implementing science-based habitat conservation and restoration measures in collaboration with multiple stakeholders.

Our mission will be achieved by coordinating and facilitating partnerships and communications in the U.S. and North America to deliver a combination of habitat conservation, education, and research and monitoring.

VISION

The vision of this Joint Venture is abundant monarch populations to sustain the monarch migratory phenomena into perpetuity, and more broadly to promote monarchs as a flagship species whose conservation will sustain habitats for pollinators and other plants and animals.

Monarch Joint Venture
University of Minnesota
monarchs@monarchjointventure.org

Gardening for Monarchs:

Creating habitat for monarch butterflies and other pollinators

Habitat needs

Good monarch habitat must meet the needs of all four monarch life stages, and ideally, multiple parts of the monarch migratory cycle. Female monarchs lay eggs on milkweed host plants because their caterpillars only eat milkweed leaves. Once the caterpillar is fully developed, it often leaves the host plant to find a safe place to pupate, or form its chrysalis. After the adult butterfly emerges, it uses its long straw-like mouth, or proboscis, to consume nectar from a variety of different flowering plants. Thus, monarchs need both milkweed and nectar plants during the breeding part of their annual migratory cycle. As they migrate, they need nectar plants to fuel their long flight. Because monarch-friendly gardens are usually focused on breeding and migrating, the information here targets milkweed and nectar plants. More information on overwintering habitat requirements for monarchs in the western U.S. can be found on our website.

Increasing use of herbicides, habitat loss due to real estate and agricultural development, and climate change are all factors in a declining monarch population. However, conservation efforts can start in your backyard. Plant a butterfly garden, and provide a safe haven for monarch eggs and caterpillars, and help fuel adults during their migration!

First steps

Start by replacing a patch of lawn or bare ground, or simply add native plants to an existing garden. Planning and creating a butterfly garden is a great way to increase the amount of time you spend outdoors and connect with nature.

1. Choose a sunny site for your garden. Butterflies need the sun's energy to warm up and most nectar and milkweed plants grow best in sunny spots. Adding flat rocks can help create basking zones for butterflies to regulate their temperature.
2. Include windbreaks. Butterflies prefer to feed in areas sheltered from wind. A fence, shrub, or a wall can serve as a windbreak, and can also be a good place for pupation. If your site does not have a wind break, consider planting a shrub.
3. Testing garden soil can determine whether the area is suitable for growing plants, or if it needs amendments. Sand, clay or wet soils may be difficult to plant in, and may require specialized techniques.
4. Prepare the soil by removing lawn or other plant cover, and raking the soil. Additional soil can be brought in as needed.
5. In difficult areas, or if space is limited, consider planting in containers.

The Importance of Monarch Conservation

The monarch butterfly is a flagship species for conservation. As a national partnership organization, the Monarch Joint Venture utilizes the social and cultural presence of monarchs to promote conservation for more than just monarchs.

With a tremendous geographic range and amazing migration, monarchs draw attention from all over North America. Many other pollinators benefit from monarch conservation efforts, as people throughout the entire breeding, migration, and overwintering range work to preserve and create habitat. Adding native milkweed to an area provides food for monarch caterpillars, and nectar for a diversity of other pollinators.

Planting the habitat

1. Whenever possible, use native plants for your garden. Plants that are native to your area are hardy, suited to live in the region, and usually require less maintenance. The Pollinator Partnership's Eco-regional Planting Guides[1] can help you find a list of plants that are suitable to your area, and determine the time of year that they flower.
2. Find a nursery that sells native plants. You may find a native plant nursery in your area at the Plant Native website[2] or by contacting your local Wild Ones chapter. Most nurseries provide a list of native plants that they have in stock. Choose plants that have not been treated with systemic pesticides, meant to deter insects, as these can affect pollinators, including monarchs, and their caterpillars.
3. Using potted plants or plant plugs (plants that have germinated and are ready for planting) may be the easiest choice for small garden areas. Seed mixes may also be used, and may be more cost-effective in larger areas.
4. Planting perennial plants will ensure that your garden comes up year after year. You can supplement these with annuals if needed, to add color once perennials are done blooming.
5. Choose a diverse array of plants that flower at different times to attract butterflies throughout the growing season. Plants that bloom early are critical for monarchs during the spring migration. Late blooming plants, such as goldenrod, many asters, and blazing stars, are critical during the monarch's long migration each fall.
6. If using potted plants, plan your garden and prepare the bed before purchasing plants. Group plants by color and type. Butterflies are attracted to large splashes of color in the landscape, especially red, orange, yellow and purple. Place short plants in front of tall ones.
7. Whenever possible, avoid hybrids and cultivars that are bred for their size, as they usually have less nectar in their flowers.
8. Include larval host plants. Monarchs need milkweed, so include species of milkweed native to your area. For a list of native milkweed, see the Monarch Joint Venture Milkweed Information Sheet[3]. Milkweeds are also a good source of nectar for butterflies and other pollinators.
9. Keep plants well-watered after purchase but prior to planting.
10. When you are ready to plant, dig a hole just large enough for the plug's roots. Use soil to cover the roots so that only the leaves and stem of the plant are above ground. Add straw or grass mulch around the plants to retain water in the soil and prevent weed growth. Water newly planted plugs.
11. If seed is used, prepare the area by removing lawn and invasive plants. Seed can be spread manually, or for larger areas, use a broadcaster to get an even spread. Frost seeding, or the application of seed in the late winter, when snow is starting to melt, may also help the seed settle into the soil. Add mulch to conserve moisture.

MONARCH JOINT VENTURE

Photo credits: Janet Allen, Candy Sarikonda, Teal Johannsen

Maintenance

1. Water plants until they are well established. Follow the vendor's directions on watering, and keep in mind that additional water may be needed during warm dry spells or if the plants appear to be drooping. Once established, native plants typically do not need additional water.
2. Butterfly requirements vary from site to site. Don't be surprised if a plant that is touted as being a butterfly magnet does not attract any butterflies to your garden. Watch your habitat over time and determine which flowering plants are most popular to butterflies in your area.
3. Weed by hand as needed. Avoid using herbicides and insecticides to rid your garden of unwanted plants and insects, as they may also be harmful to beneficial organisms.
4. Remember that host plants are meant to serve as food for caterpillars, so chewed leaves are a sign that they are doing their job!

Additional features of a good butterfly habitat

1. Keep dead trees and wood piles to serve as winter shelters. While monarchs migrate in the fall, many other butterflies and pollinators may overwinter in the area and use these features as shelter.
2. Consider other wildlife friendly practices. Bird feeders and a heated bird bath can help resident birds in the winter months. Bee nesting boxes can help native bees overwinter. Having bare ground can help ground nesting pollinators find a spot for the winter.
3. Register your monarch habitat online with the Monarch Joint Venture as a "Success Story" to share with others!

Resources:

1. **Pollinator Partnership Eco-Regional Planting Guides** - http://www.pollinator.org/guides.htm
2. **Plant Native Website** - http://www.plantnative.org/
3. **MJV Milkweed Information Sheet** - http://monarchjointventure.org/images/uploads/documents/MilkweedFactSheetFINAL.pdf

www.monarchjointventure.org

POLLINATOR PLANTS

Midwest Region

Showy goldenrod, field thistle, and swamp milkweed

In the Midwestern states of Iowa, Missouri, Illinois, and Indiana, a wealth of plant diversity grows in lush tallgrass prairies, as well as in oak savannas, windswept lakeshore dunes, shallow soils and rocky slopes of glades, and within deciduous forests.

The native plants of the Midwest support a diverse range of pollinators including thousands of species of native bees, butterflies, beetles, flies, wasps, and moths. The Midwest region is an important breeding area for the monarch butterfly (*Danaus plexippus*) and is also home to several imperiled species of bumble bees and butterflies, including the endangered rusty patched bumble bee (*Bombus affinis*). Pollinators in the Midwest maintain healthy, productive plant communities, provide food that sustains wildlife, and play an essential role in crop production.

Providing wildflower-rich habitat is the most significant action you can take to support pollinators. Adult bees, butterflies, and other pollinators require nectar as their primary food source. Female bees also collect pollen as food for their offspring. Native plants, which are adapted to local soils and climates, are usually the best sources of nectar and pollen for native pollinators. Incorporating native wildflowers, shrubs, and trees into any landscape promotes local biological diversity by providing shelter and food for wildlife. Native plants are better adapted to regional climate cycles, do not need fertilizers, and are less likely to become weedy.

This guide features plants native to the Midwest that are highly attractive to pollinators and are well-suited for small-scale plantings in gardens, on business and school campuses, in urban greenspaces, and in farm field borders. In addition to supporting native bees and honey bees, many of these plants attract nectar-seeking butterflies, moths, and hummingbirds, and some are host plants for butterfly and moth caterpillars. Most of these species can be purchased as seed or transplants, and are adaptable to growing conditions found across the Midwest. Please consult regional Floras, the Biota of North America's North American Plant Atlas (http://bonap.net/napa), or the USDA's PLANTS database (http://plants.usda.gov) for details on species's distributions in your area.

Our **Bring Back the Pollinators** campaign is based on four principles:

1. **Grow** a variety of pollinator-friendly flowers;
2. **Protect and provide** bee nest sites and caterpillar host plants;
3. **Avoid** using pesticides, especially insecticides: *and*
4. **Spread** the word!

You can participate by taking the **Pollinator Protection Pledge** and registering your habitat on our nationwide map at: www.bringbackthepollinators.org.

BRING BACK THE POLLINATORS
A Xerces Society Conservation Campaign

XERCES SOCIETY
for Invertebrate Conservation

Planting for Success

Sun Exposure

Most pollinator-friendly plants prefer sites that receive full sun throughout most of the day and are mostly open, with few large trees. A southern exposure can provide the warmest habitat, but is not required.

Plant Diversity

Choosing a variety of plants with overlapping and sequential bloom periods will provide food for pollinators throughout the seasons.

Habitat Size and Shape

Habitat patches that are bigger and closer to other patches are generally better than those that are smaller and more isolated from one another. However, even a small container garden can attract and support pollinators!

Planting Layout

Flowers clustered into clumps of one species will attract more pollinators than individual plants scattered through a habitat patch. Where space allows, plant clumps of the same species within a few feet of one another.

Seeds or Transplants

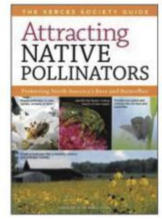
It is usually cheaper to establish large habitat areas from seed; however, seeding native wildflowers on a large-scale is an art unto itself. For step-by-step instructions, see *Establishing Pollinator Meadows from Seed* and the Pollinator Habitat Installation Guides listed in the Additional Resources section. For smaller areas like gardens, transplants are usually easier to use and will bloom faster than plants started from seed.

Protect Pollinators from Insecticides

Although dependent on timing, rate, and method of application, all insecticides have the potential to poison or kill pollinators. Systemic insecticides in particular have received significant attention for their potential role in pollinator declines (imidacloprid, dinotefuran, clothianidin, and thiamethoxam are examples of systemic insecticides now found in various farm and garden products). Because plants absorb systemic insecticides as they grow, the chemicals become distributed throughout plant tissues and are sometimes present in pollen and nectar. You can help protect pollinators by avoiding the use of these and other insecticides. Before purchasing plants from nurseries and garden centers, be sure to ask whether they have been treated with insecticides. To read more about threats to pollinators from pesticides, please visit: www.xerces.org/pesticides.

Additional Resources

Attracting Native Pollinators



Our best-selling book highlights the role of native pollinators in natural ecosystems, gardens, and farms. This comprehensive guide includes information about pollinator ecology, detailed profiles of over 30 common bee genera, and habitat designs for multiple landscapes with over 50 pages of fully illustrated regional plant lists. Available in bookstores everywhere, and through www.xerces.org/books.

The Xerces Pollinator Conservation Resource Center

Our Pollinator Conservation Resource Center includes regional information on pollinator plants, habitat conservation guides, nest management instructions, bee identification and monitoring resources, and directories of native pollinator plant nurseries.
www.xerces.org/pollinator-resource-center

Lady Bird Johnson Wildflower Center

The Xerces Society has collaborated with the Lady Bird Johnson Wildflower Center to create lists of plants that are attractive to native bees, bumble bees, honey bees, and other beneficial insects, as well as plant lists with value as nesting materials for native bees. These lists can be narrowed down with additional criteria such as state, soil moisture, bloom time, and sunlight requirements. The Center's website also features image galleries, how-to articles on native plant gardening, and more.
www.wildflower.org/conservation_pollinators

Establishing Pollinator Meadows from Seed

These guidelines provide step-by-step instructions for establishing pollinator meadows from seed in areas that range in size from a small backyard garden up to an acre. Topics include: site selection, site preparation, plant selection, planting techniques, and ongoing management.
www.xerces.org/establishing-pollinator-meadows-from-seed

Pollinator Habitat Installation Guides

These regional guidelines, developed in collaboration with the USDA's Natural Resources Conservation Service, provide in-depth practical guidance on how to install nectar and pollen habitat for bees in the form of wildflower meadow plantings or linear rows of native flowering shrubs. Region-specific seed mixes and plant recommendations are included in the appendices of each guide.
www.xerces.org/pollinator-habitat-installation-guides

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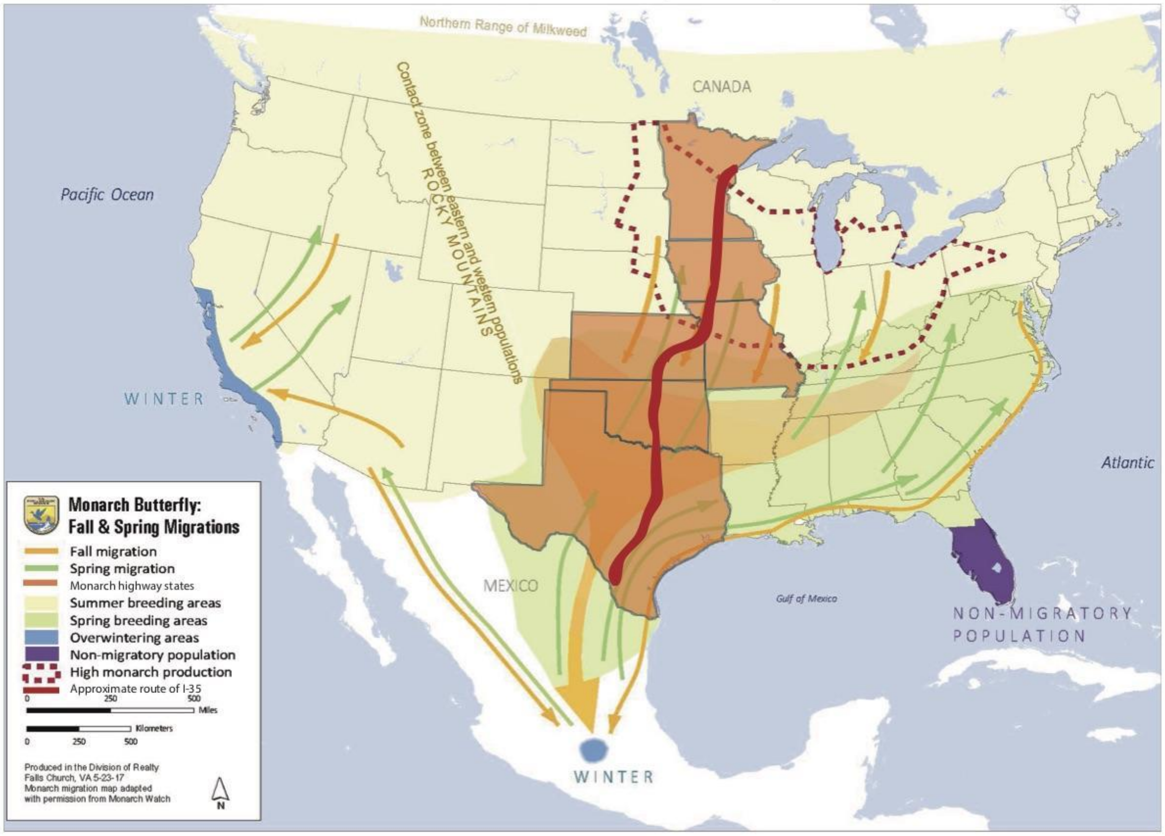
2017-050

The Monarch Highway

WWW.MONARCHHIGHWAY.ORG

What is the Monarch Highway and how did it come to be?

The "Monarch Highway" is a symbolic migration corridor that follows Interstate-35 (I-35) from Laredo, Texas, to Duluth, Minnesota, aligning with the central flyway of the eastern migratory population of the monarch butterfly. The symbolic highway is a partnership effort bringing people together to catalyze conservation actions throughout the central flyway where monarchs need it most! However, in order to bring back the monarchs from their dramatic decline, conservation efforts are needed from everyone throughout the entire monarch range.



Who is Involved with the Monarch Highway?

In 2016, I-35 was identified the "Monarch Highway" by the State Departments of Transportation in the central flyway, including Minnesota, Iowa, Missouri, Kansas, Oklahoma, and Texas. However, the effort to conserve monarch butterfly habitat in this corridor extends beyond the roadsides managed by these DOTs. The conservation activities of the agencies, companies, non-profits, and individuals who own and manage land within the corridor can contribute to a network of connected habitat across the landscape for monarchs. Recognizing that restoring habitat across North America is important in supporting monarch butterflies, the Monarch Highway runs through the central part of the nation encompassing extremely important breeding habitat as well as the area through which both spring and fall migrations funnel.

Looking for more information? Visit www.monarchhighway.org to learn more and get involved!

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