

# SUPPORTING POLLINATORS IN AGRICULTURAL LANDSCAPES

A TECHNICAL GUIDE FOR SPECIALTY CROP  
FARMERS IN THE U.S. MIDWEST



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## SECTION 1:

# INTRODUCTION

## WHO SHOULD USE THIS GUIDE?

This Guide is designed for specialty crop farmers in the U.S. Midwest who want to protect and support pollinators on their land. While it's not a comprehensive manual for pollinator management, this Guide offers practical ideas for getting started and aims to spark further learning. Actions that support pollinators improve farm productivity as well as the resiliency of farm operations and the environment.

Specialty crops considered within this guide include fruits, vegetables, tree nuts, and horticulture crops, such as floriculture and nursery crops.<sup>1</sup> Unlike row crops which are wind- or self-pollinated, many fruits and vegetables rely on insect pollination to improve fruit set, yield and quality<sup>2,3</sup>. For this reason, growers often rent honey bees and/or invest in wild pollinator habitat to promote successful pollination of their crops.

The Midwest region is defined in accordance with the U.S. Census Bureau (2020) as: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin (Figure 1). Growing seasons, which can vary by state and crop, are defined as the period between the last frost date in the spring and the first frost date in the fall that can kill a crop. These dates are determined based on minimum temperature values which the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) identifies as follows<sup>4</sup>:

- 32 to 29 °F is a light freeze: Tender plants killed, with little destructive effect on other vegetation.
- 28 to 25 °F is a moderate freeze: Widely destructive effect on most vegetation with heavy damage to fruit blossoms, tender and semi-hardy plants.
- 24 °F and less is a severe freeze: Heavy damage to most non-woody, non-hardy plants. At these temperatures, the ground freezes solid, with the depth of the frozen ground dependent on the duration and severity of the freeze, soil moisture, and soil type.

1. U.S. Department of Agriculture, Agricultural Marketing Service. (n.d.). Specialty crop block grant program. <https://www.ams.usda.gov/services/grants/scbgp/specialty-crop>

2. Garibaldi LA, Steffan-Dewenter I, Winfree R, Aizen MA, Bommarco R, Cunningham SA, Kremen C, Carvalheiro LG, Harder LD, Afik O, Bartomeus I, Benjamin F, Boreux V, Cariveau D, Chacoff NP, Dudenhöffer JH, Freitas BM, Ghazoul J, Greenleaf S, Hipólito J, Holzschuh A, Howlett B, Isaacs R, Javorek SK, Kennedy CM, Krewenka KM, Krishnan S, Mandelik Y, Mayfield MM, Motzke I, Munyuli T, Nault BA, Otieno M, Petersen J, Pisanty G, Potts SG, Rader R, Ricketts TH, Rundlöf M, Seymour CL, Schüepp C, Szentgyörgyi H, Taki H, Tscharntke T, Vergara CH, Viana BF, Wanger TC, Westphal C, Williams N, Klein AM. Wild pollinators enhance fruit set of crops regardless of honey bee abundance. *Science*. 2013 Mar 29;339(6127):1608-11. doi: 10.1126/science.1230200. Epub 2013 Feb 28. Erratum in: *Science*. 2014 May 23;344(6186):816. PMID: 23449997.

3. McGregor, S.E. (1976) Insect Pollination of Cultivated Crop Plants. USDA Agriculture Handbook, 496, 93-98

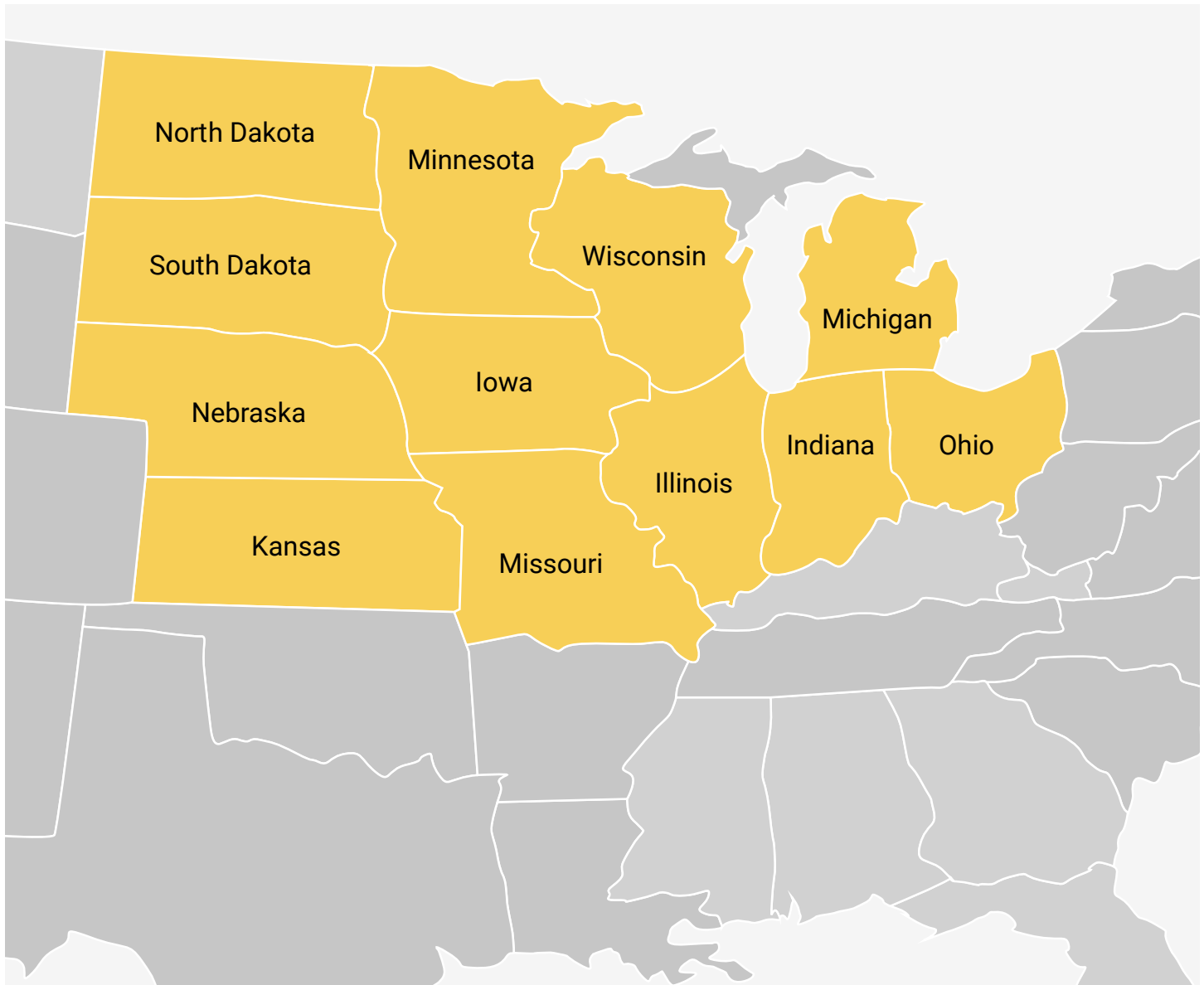
4. U.S. Department of Agriculture, Natural Resources Conservation Service. (n.d.). Growing season dates and length. <https://www.nrcs.usda.gov/wps/portal/wcc/home/climateSupport/wetlandsClimateTables/growingSeasonDatesLength>



For the most accurate depiction of the growing season in your area, consult the NRCS Wetlands Climate Table that corresponds to your location and conditions.

Another resource that may be consulted to better understand climate and growing conditions is the USDA Plant Hardiness Zone map.

**FIGURE 1.**  
**MAP OF MIDWEST STATES**



5. U.S. Department of Agriculture, Natural Resources Conservation Service. (n.d.). Wetlands climate tables. <https://www.nrcs.usda.gov/programs-initiatives/sswsf-snow-survey-and-water-supply-forecasting-program/wetlands-climate-tables>
6. U.S. Department of Agriculture, Agricultural Research Service. (n.d.). USDA plant hardiness zone map. <https://planthardiness.ars.usda.gov/>

# HOW TO USE THIS GUIDE

Use this Guide as a quick reference for specific topics or read it in full for a deeper dive into each subject. It offers practical guidance on how to support and protect pollinators and other beneficial organisms that are essential to resilient productive farms.

**Section 2:** Supporting and Protecting Pollinators in Your Operation covers four important activities that help support pollinators and minimize the negative impacts of pesticides: 1) integrated pest management (IPM); 2) habitat creation and maintenance; 3) communication between beekeepers and farmers; and 4) pesticide product selection and use. This Guide uses the term "pesticide" broadly to encompass a variety of chemical tools utilized in pest management. This includes not only insecticides but also miticides, fungicides (chemicals used to prevent or treat fungal diseases), and herbicides (chemicals used to manage weeds). Each type of pesticide serves a specific purpose in mitigating and managing unwanted organisms, and understanding their distinctions is crucial for effective and responsible usage.

**Section 3:** Identifying Marketing Opportunities discusses marketing opportunities, such as product labeling, price premiums and agritourism related to pollinator management.

**Section 4:** Creating a Pollinator Management Plan presents a pollinator management plan template that can be used to pull your pollinator support strategies together and budget for any implementation expenses. Look for a pencil icon (✎) throughout this Guide to highlight key considerations for developing an effective Pollinator Management Plan. This icon calls out important insights, tips, and best practices essential for fostering a healthy pollinator population on your farm. Each time you see the ✎ icon, we encourage you to pause and reflect on the recommendations.

**Section 5:** Resources contains information resources and provides important links to organizations, publications, and websites that make recommendations for specific pollinator practices and strategies.

**Section 6:** Case Studies: Pollinator Management In Action presents examples of two Pollinator Management Plans that have been implemented on Midwest farms.

**Important features:** Research highlights are integrated throughout the Guide and offer additional insights into specific topics covered.

# A QUICK OVERVIEW OF TERMINOLOGY

This Guide uses certain terms a number of times throughout the document. The following table (Table 1) defines some of the more commonly used terms.

TABLE 1. GLOSSARY

| TERM              | DESCRIPTION                                                                                                                                                                                                                                |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Drift             | The movement of pesticide dust or droplets through the air at the time of application or soon after, to any site other than the area intended.‡                                                                                            |
| Forage            | To search for food or provisions.                                                                                                                                                                                                          |
| Fungicide         | Chemicals used to prevent or treat fungal diseases.                                                                                                                                                                                        |
| Invasive species  | Non-native organisms that cause harm to the environment, the economy, or human health.†                                                                                                                                                    |
| IPM               | Integrated Pest Management. Pest management utilizing a combination of biological, cultural, mechanical, and chemical tools.                                                                                                               |
| Managed bees      | Bees that are managed by beekeepers, often for the purpose of honey production and/or crop pollination.                                                                                                                                    |
| Native pollinator | Animals that have co-evolved with the local plants and environment to form symbiotic relationships with each other.                                                                                                                        |
| Pesticide         | Chemical tools utilized in pest management. This includes not only insecticides but also miticides, fungicides (chemicals used to prevent or treat fungal diseases), and herbicides (chemicals used to manage weeds).                      |
| Pollinator        | Birds, bats, butterflies, moths, flies, beetles, wasps, small mammals, and most importantly, bees are pollinators. They visit flowers to drink nectar or feed off of pollen and transport pollen grains as they move from plant to plant.* |
| Wild pollinator   | Managed and native pollinators.                                                                                                                                                                                                            |

‡ <https://www.epa.gov/reducing-pesticide-drift/introduction-pesticide-drift>  
† <https://extension.umn.edu/invasive-species/terrestrial-invasive-species-participatory-science-tips-projects>  
\* <https://www.pollinator.org/pollinators>



## WHO ARE THE POLLINATORS?

Bees are the primary pollinators for most crops (Table 2), with honey bees (*Apis mellifera*), bumble bees (*Bombus* spp.), and other wild and managed bees all being important to crop production.<sup>7</sup> Honey bees are not native to North America<sup>8</sup> but have become widely used in commercial agriculture due to their willingness to visit a wide range of crop flowers and their ability to work in large numbers. Bumble bees, native to North America, are social insects that form colonies with a single queen and have the ability to pollinate in cooler conditions compared to honey bees. Bumble bees are considered more efficient pollinators of crops with partially closed flowers, or flowers with narrow openings like blueberries. Long-horned bees (*Eucera* spp., *Melissodes* spp., *Xenoglossa* spp.) are a group of solitary wild bees that play a crucial role in Midwest specialty crop agriculture by effectively pollinating a variety of crops, including squash, cucumbers, and sunflowers. Mason bees (*Osmia* spp.) and mining bees (*Andrena* spp.) emerge early in the spring and effectively pollinate apples and other spring-blooming fruits.

Many other bees, such as small carpenter bees (*Ceratina* spp.) and sweat bees (*Halictidae* spp.), can be abundant in agricultural areas and may play a vital role in crop pollination by visiting flowers and transferring pollen. Butterflies, moths, and hoverflies also contribute significantly to the pollination of a wide range of fruit and vegetable crops. Effective pollination by these insects is essential for the successful production of many crops, ensuring food security, agricultural biodiversity, and crop quality.

Different pollinator species vary in how well they pollinate certain crops. These differences come down to things like size, behavior, and how they gather food. That's why having a variety of pollinators on the farm can lead to better, more reliable pollination across many types of crops.

7. K. Ullmann, R. Isaacs, M. Vaughan, E. May, J. Ellis, N. Williams, T. Pitts-Singer, N. Boyle, J. Cane, K. Ward, J. Gibbs, N. Joshi, & D. Biddinger. 2017. Guide to Integrated Crop Pollination. Portland, OR. Integrated Crop Pollination Project. Available online: [https://icpbees.org/wp-content/uploads/2014/05/Guide\\_to\\_ICP\\_book-FINAL\\_August2017.pdf](https://icpbees.org/wp-content/uploads/2014/05/Guide_to_ICP_book-FINAL_August2017.pdf)

8. U.S. Geological Survey. (n.d.). Are honey bees native to North America? U.S. Department of the Interior. <https://www.usgs.gov/faqs/are-honey-bees-native-north-america>



To achieve sufficient levels of pollination in pollinator-dependent crops, many farmers rent honey bee hives or other managed pollinators, often at significant cost. However, habitat can be managed to increase wild pollinator populations that will contribute “free” pollination services to agricultural crops. The United States is home to more than 4,000 native bee species and hundreds of other pollinating insects, with over 800 bee species found in the U.S. Midwest. These beneficial insects require habitat to pollinate nearby crops. Wild bees live in one location year-round and require flowers, nesting sites, and overwintering sites for success. There is evidence that increasing the quality of nearby habitat can lead to increased pollination of key crops like apple, blueberry, and squash from this wild pollinating force.

Honey bees have populous colonies, and their hives can be moved from one crop to another. Bumble bees can buzz pollinate (vibrate their bodies to release pollen from a flower’s anthers), making them well suited for crops like tomatoes and blueberries, and they can work effectively inside greenhouses. Bumble bees and mason bees can fly in colder and wetter weather than honey bees, making them ideal pollinators for early blooming crops such as certain apple cultivars and blueberries. This has led to a specialized industry of raising and deploying bumble bees and mason bees across the country. Note that managed bumble bees and mason bees can pose risks to wild bees. Use local best management practices to reduce the chances of passing pathogens to wild bees if introducing managed bees.

## MANAGED POLLINATORS

While some pollinators will naturally exist in a given region and growing environment, some pollinators require active support to manage their populations and ensure their ability to survive and successfully pollinate crops. Support strategies vary by pollinator type and species, and may include the production of artificial nesting, or colony structures, or enhancing the natural landscape.

In the U.S. Midwest, honey bees are the most common managed bee. Beyond these, several other bee species are managed for crop pollination using species-specific techniques. Non-native alfalfa leafcutter bees (*Megachile rotundata*), for example, have been widely used since the mid-20th century for alfalfa seed production, with farmers providing artificial nesting blocks to support reproduction.

Bumble bees (*Bombus impatiens* and other species) have been commercially reared since the early 1990s for greenhouse tomato pollination, where their buzz pollination enhances fruit set. *Bombus impatiens*, the most widely reared species of bumble bee, is native to eastern North America, but it is used in areas both within and beyond its native range. More recently, reared bumble bee colonies are also deployed in open fields for crops including blueberries and cranberries.

Mason bees (*Osmia* spp.), such as the blue orchard bee (*Osmia lignaria*), are managed using nesting tubes to aid in pollinating orchard crops such as apple and cherry. Squash bees (*Xenoglossa* (*Peponapis*) *pruinosa*) are not commercially reared but are encouraged through conservation practices to support pumpkin and squash production. Each of these species plays a vital role in diversified pollination strategies, improving crop yields when and where honey bees may be less effective.

**TABLE 2.**  
COMMON BEES THAT POLLINATE PREDOMINANT MIDWEST FRUIT AND VEGETABLE CROPS <sup>9-18</sup>

| BEE                                                 | TYPE OF BEE                                                                                            | EXAMPLES OF CROPS POLLINATED                                     |
|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| Mason Bees ( <i>Osmia</i> spp.)                     | Wild. Many species. Nest in cavities.                                                                  | Apples, blueberries, tart cherries, strawberries, raspberry      |
| Bumble Bees ( <i>Bombus</i> spp.)                   | Wild and Managed. Many species, including one managed. Social. Nest in below or above ground cavities. | Apples, blueberries, melons, cucumbers, pumpkins, tomatoes       |
| Cellophane Bees ( <i>Colletes</i> spp.)             | Wild. Solitary. Ground nesting.                                                                        | Apples, blueberries                                              |
| Eastern Cucurbit Bees ( <i>Peponapis pruinosa</i> ) | Wild. Solitary. Ground nesting.                                                                        | Pumpkin, winter squash, zucchini                                 |
| European Honey Bees ( <i>Apis mellifera</i> )       | Managed. Social.                                                                                       | Apples, blueberries, tart cherries, cucumbers, pumpkins, squash  |
| Longhorn Bees                                       | Wild. Many species. Solitary. Ground nesting.                                                          | Pumpkin, winter squash, watermelon, zucchini                     |
| Mining Bees ( <i>Andrena</i> spp.)                  | Wild. Many species. Solitary. Ground nesting.                                                          | Apples, blueberries, tart cherries                               |
| Sweat Bees ( <i>Halictidae</i> )                    | Wild. Many species. Some solitary, others somewhat social. Ground nesting.                             | Apples, blueberries, tart cherries, squash, tomatoes, watermelon |

9. Purdue University, Department of Entomology, Purdue Extension. (n.d.). POL-12: Understanding the pollinating services of native bees [Purdue Extension publication]. <https://extension.entm.purdue.edu/publications/POL-12/POL-12.html>
10. Mader, E., Spivak, M., & Evans, E. (2010). Managing Alternative Pollinators: A handbook for beekeepers, growers, and conservationists (SARE Handbook No. 11; NRAES Publication No. 186). Sustainable Agriculture Research and Education & Natural Resource, Agriculture, and Engineering Service. <https://www.sare.org/wp-content/uploads/Managing-Alternative-Pollinators.pdf>
11. Michigan State University Extension. (n.d.). Pollination of pickling cucumbers [PDF]. Michigan State University. [https://pollinators.msu.edu/sites/\\_pollinators/assets/File/PollinationPicklingCucumbers.pdf](https://pollinators.msu.edu/sites/_pollinators/assets/File/PollinationPicklingCucumbers.pdf)
12. Integrated Crop Pollination Project. (2016, July). Michigan blueberry pollination factsheet [PDF]. <https://icpbees.org/wp-content/uploads/2016/07/MI-Blueberry-Pollination-Factsheet-FINAL.pdf>
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15. Seeds of Diversity Canada. (2012, October). Pollinator best practices. <https://seeds.ca/pollinator/bestpractices/index.html>
16. Ullmann, K., Cane, J., Fleischer, S., Treanore, E., & McGrady, C. (2017). Integrated crop pollination for squashes, pumpkins, and gourds [PDF]. Project Integrated Crop Pollination. <https://icpbees.org/wp-content/uploads/2014/05/Integrated-Crop-Pollination-for-Cucurbita-crops.pdf>
17. Rader, R., Cunningham, S. A., Howlett, B. G., & Inouye, D. W. (2020). Non-bee insects as visitors and pollinators of crops: Biology, ecology, and management. Annual Review of Entomology, 65, 391–407. <https://doi.org/10.1146/annurev-ento-011019-025055>
18. U.S. Department of Agriculture. (2018, January 3). Attractiveness of agricultural crops to pollinating bees [PDF]. <https://www.usda.gov/sites/default/files/documents/Attractiveness-of-Agriculture-Crops-to-Pollinating-Bees-Report-FINAL-Web-Version-Jan-3-2018.pdf>

# WHY SHOULD YOU SUPPORT POLLINATORS?

Pollinators, especially bees, play a crucial role in the pollination and subsequent production of fruit and seeds by crops and non-crop plants around the world (Figures 2 through 5). About 75% of all crop types and 35% of food crops produced rely on or benefit from the action of pollinators. Pollinator health is important to the long-term sustainability of crop production and to the broader environment. Attention to pollinators is more important than ever, as many pollinator populations are known to be in decline globally<sup>19</sup>.

Pollinated crops are among the most valuable agricultural products in the U.S. Midwest. Many crops grown in this region benefit greatly from insect pollination (Figure 6), including iconic crops such as Michigan cherries and Minnesota-bred Honeycrisp apples, which are exported across the country and world<sup>20</sup>. At almost \$800 million annually, apples account for 16% of regional agricultural revenues, making them one of the most valuable agricultural products in the U.S. Midwest. Because they play such an important role in the region's economy, it's essential to support a wide range of pollinators near fields and orchards - especially when managed pollinators, like honey bees, are declining in population numbers and may not be available<sup>21</sup>.



**FIGURE 2. HONEY BEE ON APPLE**



**FIGURE 3. HONEY BEE ON WILD PLUM**



**FIGURE 4. SQUASH BEE ON PUMPKIN**



**FIGURE 5. BEE ON EGGPLANT**

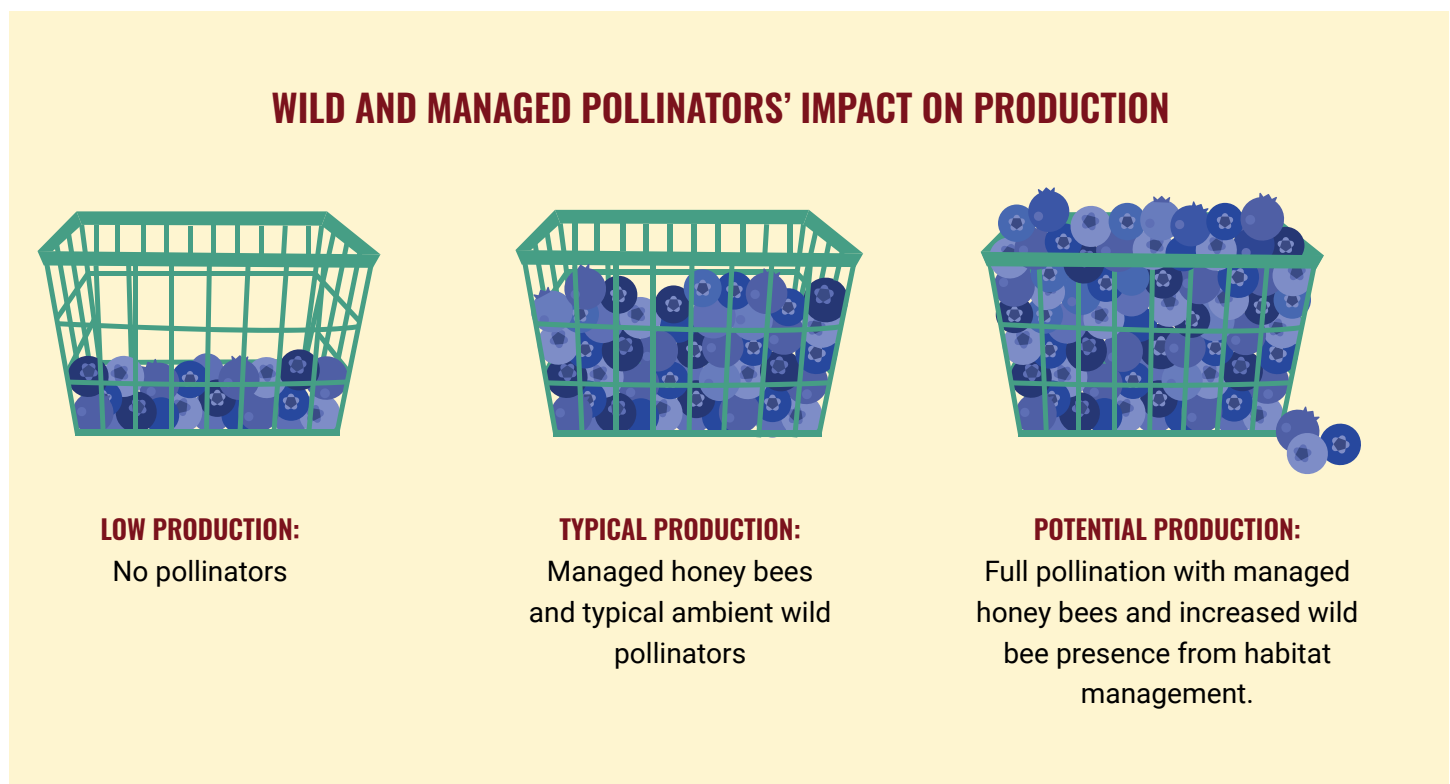
19. Mader, E., Spivak, M., and Evans, E. 2010. Managing alternative pollinators: A handbook for beekeepers, growers and conservationists. SARE Handbook 11, NRAES-186. <https://www.sare.org/wp-content/uploads/Managing-Alternative-Pollinators.pdf>.

20. Ullmann, K., Cane, J., Fleischer, S., Treanore, E., & McGrady, C. (2017). Integrated crop pollination for squashes, pumpkins, and gourds [PDF]. Project Integrated Crop Pollination. <https://icpbees.org/wp-content/uploads/2014/05/Integrated-Crop-Pollination-for-Cucurbita-crops.pdf>

21. U.S. Department of Agriculture. (2018, January 3). Attractiveness of agricultural crops to pollinating bees [PDF]. <https://www.usda.gov/sites/default/files/documents/Attractiveness-of-Agriculture-Crops-to-Pollinating-Bees-Report-FINAL-Web-Version-Jan-3-2018.pdf>.

There is growing concern over the health and status of both managed and wild pollinator populations. Wild pollinators throughout the U.S. are in decline, with the populations of some bumble bee species declining up to 96%. For example, once found throughout the Northeastern and Midwest regions of the United States, the rusty patched bumble bee (*Bombus affinis*) is now federally endangered (listed 2017) and is primarily only found in small pockets of the U.S. Midwest region. Some major stressors contributing to this decline include land use change and loss of habitat, diseases and parasites, invasive species, and pesticide exposure. Studies have found that those areas with intense agricultural production in the United States have the lowest wild bee abundance<sup>22</sup>. Butterfly species are also in decline, including the endangered Karner blue butterfly (*Plebejus samuelis*) (listed 1992) and the monarch butterfly (*Danaus plexippus*), which has seen significant population declines.

Climate change and drought are leading to unpredictable temperatures and rainfall, further compounding these pollinator stressors. Research shows that having more biodiversity in nearby habitats can help stabilize the timing of pollination and blooming between pollinators and crops, even as the climate warms<sup>23</sup>.



**FIGURE 6. WILD AND MANAGED POLLINATORS' IMPACT ON PRODUCTION**

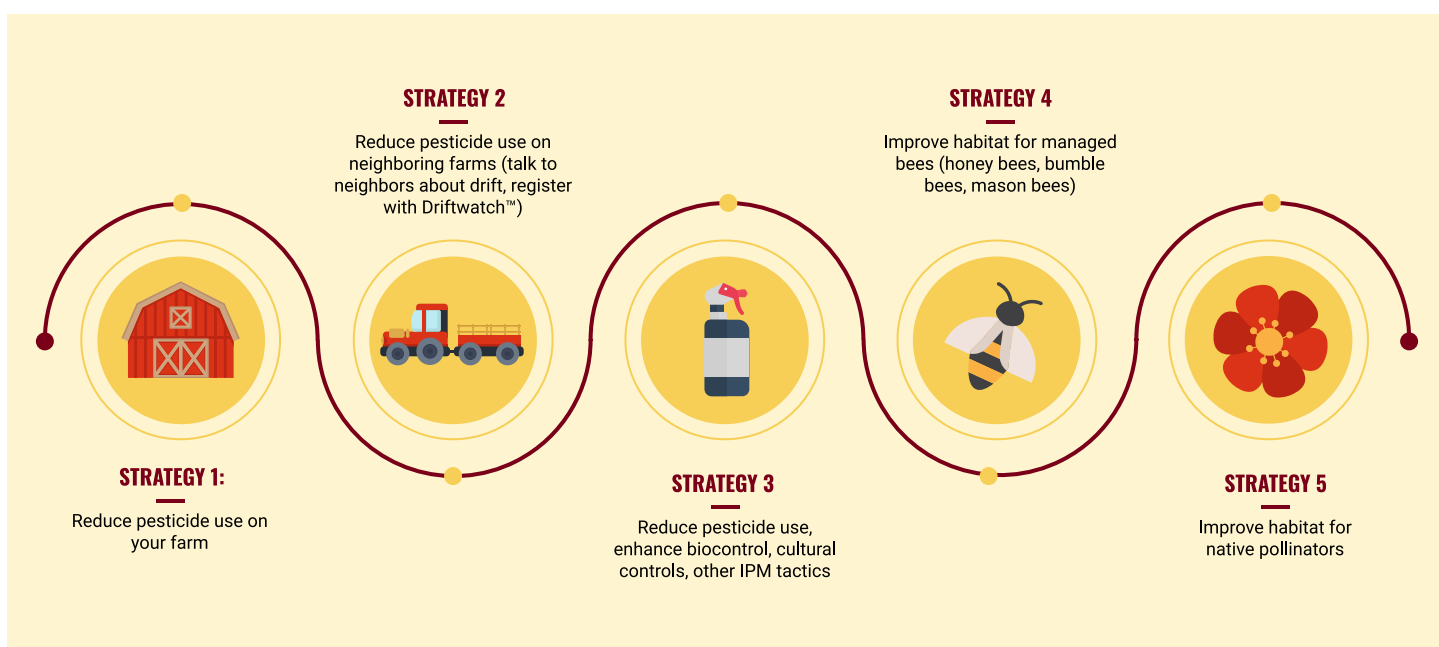
22. Koh, I., Lonsdorf, E. V., Williams, N. M., Brittain, C., Isaacs, R., Gibbs, J., & Ricketts, T. H. (2016). Modeling the status, trends, and impacts of wild bee abundance in the United States. *Proceedings of the National Academy of Sciences*, 113(1), 140-145.

23. Bartomeus I, Park MG, Gibbs J, Danforth BN, Lakso AN, Winfree R. Biodiversity ensures plant-pollinator phenological synchrony against climate change. *Ecol Lett*. 2013 Nov;16(11):1331-8. doi: 10.1111/ele.12170. Epub 2013 Aug 22. PMID: 23968

## SECTION 2:

# SUPPORTING AND PROTECTING POLLINATORS IN YOUR OPERATION

Balancing crop protection with pollinator health requires a thoughtful combination of practices that support both productivity and ecological resilience. This guide outlines strategies to help farmers and land stewards safeguard pollinators while maintaining robust agricultural production (Figure 7).



**FIGURE 7.**  
STRATEGIES FOR PROTECTING POLLINATORS WHILE MAINTAINING PRODUCTION

24. <https://driftwatch.org/>



# INTEGRATED PEST MANAGEMENT (IPM)

Using Integrated Pest Management (IPM) can help you save money and time, reduce pesticide use, limit negative impacts to pollinators, and enhance crop pollination. IPM is a pest management strategy based on ecosystem function and long-term mitigation of pest damage. It combines techniques such as:

- Habitat manipulation
- Use of pest-resistant varieties
- A range of cultural practices (e.g., crop rotation)
- Physical exclusion (e.g., fine-mesh netting)
- Mechanical strategies (e.g., chopping corn stalks with flail mower to destroy overwintering pest larvae)
- Biological control by beneficial insects and pest natural enemies
- Pest scouting and insect damage monitoring
- Pesticide application only when pests exceed economic thresholds

The strength of IPM lies in the combination of feasible complementary methods to create sustainable pest management programs.

## THE KEY PRINCIPLES OF IPM INCLUDE:



Insect pest identification



Monitoring, thresholds, observations, and predictive models influence decision making



A multi-faceted approach that combines cultural, physical, biological, and chemical methods



Prevention and avoidance of economically damaging pest populations



Continuous evaluation and improvement of management strategies



Pesticide-resistance management



Reducing pesticide risk to beneficial insects with product selection and application techniques

# PRINCIPLES OF IPM



## Insect pest identification

Proper identification of pests is vital to understanding the potential mitigation of pest infestations specific to your situation. Regular scouting for pests, signs of damage, and beneficial insects that may be providing natural control are critical components of a successful IPM strategy. Take the time to positively identify pest and pollinator larvae, as pollinator larvae can sometimes be miscategorized as pests (or pests miscategorized as beneficial insects) if not identified correctly.

Seek crop-specific monitoring schedules and guides that include pest and damage identification, monitoring protocols, and thresholds for treatment. For the U.S. Midwest region, IPM guides for fruit<sup>25</sup> and vegetable crops<sup>26</sup> are available. Resources for pesticide applicator certification can be found online from the American Association of Pesticide Control Officials<sup>27</sup> and U.S. Environmental Protection Agency<sup>28</sup>.



## Monitoring, thresholds, observations, and predictive models influence decision making

Traditionally, many farmers relied on calendar-based schedules when deciding when to spray insecticides and treat for other pests. However, most experienced growers know that pests have specific life cycles based on their biology and environmental conditions, rather than exact calendar dates. Therefore, it's best to monitor for pests proactively based on predictive models, historical incidences of pest outbreaks at a given site, and best practices, rather than relying solely on fixed dates or calendar-based schedules for management. As climate variability continues, insect pest emergence and activity, monitoring and adaptive measures will be needed to maintain an effective pest management program.

Monitoring tools help with trapping and scouting for insect pests out in the field. There are many tools that are publicly available and accessible. Examples include pheromone lure-based traps, sweep netting, and panel traps. Lure-pheromone traps are baited with a pheromone lure that mimics female insects' pheromones to attract males, or other attractive bait (e.g., yeast or fruit-mimicking scents). They are often used to discover the main flight of adult insects to determine when management tactics will be most effective. Extension educators or state departments of agriculture may have trapping networks that provide valuable data for farmers. Sweep netting is an active monitoring technique used to understand insect populations utilizing a net, often in fields. Panel traps are plastic or cardboard panels with a sticky glue coating. Panel traps can be used to detect the initial presence of pest populations.

25. Purdue University Department of Horticulture and Landscape Architecture. (n.d.). Fruit crops. Purdue University. <https://ag.purdue.edu/departments/hla/extension/fruit-crops.html>

26. <https://mwvegguide.org/>

27. Association of American Pesticide Control Officials. (2015, July 28). Resources. <https://aapco.org/2015/07/28/resources-2/>

28. U.S. Environmental Protection Agency. (n.d.). Pesticide Safety Education Programs. <https://www.epa.gov/pesticide-worker-safety/pesticide-safety-education-programs-0>

Economic thresholds are another important feature of pest monitoring that influences when pest management begins. Briefly, economic thresholds are research-based, and account for the level of pest damage that causes crop yield loss, declines in crop quality, and weighs these against the cost of pest control treatments (typically the amount of insecticide product plus application cost). When the cost of insect damage exceeds the cost of pest management, it is recommended to apply control treatments. Sampling thresholds are another type of action threshold based on empirical field research that only requires a knowledge of pest infestation levels. For example, in vining vegetables, cucumber beetles have a threshold of 0.5 to 5 beetles per plant depending on the crop and growth stage. Thresholds for specific crops and pests are available at most U.S. Midwest region Extension websites.

Predictive models, such as degree-day forecasts<sup>29</sup> are commonly used to help make decisions about the timing of management practices. Predictive models may use knowledge about pest biology, behavior, and life cycles, as well as weather data to help forecast pest emergence and improve timing of pesticide applications. This is important because it helps avoid unnecessary pesticide applications, saving money, and reducing pollinator exposure to pesticides.



A multi-faceted approach that combines cultural, physical, biological, and chemical methods

A combination of cultural, physical, biological, and chemical control methods creates a strong IPM program. Best practices include approaching rotating pesticide products with different modes of action, for instance, while taking advantage of physiological, ecological, and behavioral characteristics of the target pests. Non-chemical approaches can reduce the use of pollinator-toxic pesticides, and rotating pesticide products will decrease the chance for pests to become resistant to the control treatments.

**Cultural control methods** address how a site is planned out and managed. This includes crop and variety selection, planting layout, as well as practices that maintain healthy plants, which are more tolerant or resistant to pests. Crop rotation, following plant density and planting date recommendations, and planting cover crops can reduce pest pressure.

Other cultural practices may include thinning, training and trellising, soil-water management and modifying crop canopies for perennial fruit crops. The overall canopy size and shape, along with the position and distribution of stems, branches, and fruit can improve airflow, sunlight, and pesticide coverage, improving pest manageability and creating a less favorable environment for pests. Sanitation is another cultural control method and involves practices that remove and destroy previous season leaves, fruits, and other pest-harboring structures.

29. Herms, D. A. (2022, June). Using degree-days and plant phenology to predict pest activity [PDF]. University of Minnesota Extension. <https://pesticidecert.cfans.umn.edu/sites/pesticidecert.cfans.umn.edu/files/2022-06/049DegreeDays.pdf>



**Physical control methods**, otherwise known as mechanical controls, remove or destroy a target pest directly or modify a given environment such that it becomes unfavorable for target pests. Physical controls often address vegetation, such as using tillage for weed management. Fine-mesh netting over fruit crops is also a physical exclusion method that minimizes insect feeding damage to vegetation and fruit. Physical or mechanical removal of pests, the use of barriers or traps (e.g., “attract and kill”), or the use of heat treatments, and properly timed mowing regimens are examples of physical management techniques that can reduce target pest populations.

**Biological control methods** often use natural enemies or pest biology to suppress or prevent target pests. This may include the introduction or support of predators, parasitoids, or pathogens that limit pest reproduction or increase pest mortality. For example, natural enemies are encouraged by planting pollen/nectar producing landscape features like hedgerows on marginal land or field edges, which take little or no land out of production. These hedgerows as well as field windbreaks, or secondary agroforestry sites producing low-input products can also help to serve as overwintering sites for both pollinators and pest predators. Where possible, hedgerows should be at least 100 feet from field edges to minimize the risk of pesticide drift.

Another biologically based approach is the use of commercially available synthetic sex pheromones for insect pests (e.g., codling moth), released at high rates – a field dose much higher than that of female moths. Thus, synthetic pheromone plumes throughout the orchard work to confuse incoming male moths searching for females, which reduces successful mating, and thus the number of eggs that are laid and larvae that can infect the fruit.

**Chemical control methods** should be used responsibly and in accordance with the law. Take the time to learn about required certifications, pesticide manuals, and follow the direction of crop consultants or advisors when preparing to apply pesticides. There are many types of chemicals available, and they may or may not be compatible with your pest and pollinator management program. Chemical control is best used as a last resort with IPM, and in coordination with other compatible control methods. This method of pest control includes both organic and conventional pesticides. Different products and application techniques have different exposure routes and risks to pollinators.



## Prevention and avoidance of economically damaging pest populations

**Prevention** is the practice of keeping a pest population from entering a field or site and should be the first line of defense. For example, high-tunnels and the use of fine-mesh netting as forms of physical exclusion are gaining popularity because they can exclude insect pests in several specialty crops such as apples, blueberries, raspberries, and some vegetable crops.

**Avoidance** may be practiced when pest populations exist in a field or site, but the impact of the pest on the crop can be minimized through some cultural practice, such as mulching, or when a crop's unique life or other attributes allow it to escape infestation.

Consider the following techniques to defend against pest infestations:

- Grow pest-resistant crop varieties
- Rotate crops
- Clean and sanitize equipment
- Remove or till damaged fruits, vegetables, debris and infested material from site
- Eliminate alternate hosts or sites for pests and disease
- Create beetle banks<sup>30</sup> for beneficial insects
- Utilize conservation cover to improve soil health, among other benefits
- Intercrop
- Manage crop canopies to discourage favorable pest conditions
- Manipulate or disrupt certain biological processes, such as mating



## Continuous evaluation and improvement of management strategies

Management strategies should be evaluated and adjusted throughout the year according to results from monitoring, damage assessments at harvest, yields, changing weather patterns, or new and emerging pests. Evaluation of IPM programs should also consider opportunities to incorporate new farming practices and methods into an existing IPM system. New practices are essential to developing impactful IPM programs that are based on current science and established best practices. Lastly, while farms can adapt throughout the year, it is important to evaluate an IPM program year-to-year and make improvements annually. This can be done during the postharvest season and is often more feasible than adapting within the same year or growing season.

30. Xerces Society for Invertebrate Conservation. (n.d.). Beetle banks for beneficial insects: Conservation biocontrol on farms in the Upper Midwest. <https://xerces.org/publications/fact-sheets/beetle-banks-for-beneficial-insects>





## Pesticide-resistance management

Pest populations can develop resistance to specific pesticides through continued use of the same Mode of Action (MoA). Alternating MoAs, making applications at appropriate rates and timings, calibrating spray equipment, and many other techniques can help prevent resistance evolution. Resistance management techniques can be found at the Insecticide Resistance Action Committee (IRAC)<sup>31</sup>, Fungicide Resistance Action Committee (FRAC)<sup>32</sup>, Herbicide Resistance Action Committee (HRAC)<sup>33</sup> and Weed Science Society of America (WSSA)<sup>34</sup>.



## Reducing pesticide risk to beneficial insects with product selection and application techniques

Biorational products are low-toxicity pest controls, often derived from natural sources or microbes, that selectively target pests while sparing beneficial organisms and minimizing ecological impact<sup>35</sup>. Different biorational products (e.g., neem oil) may be used to manage crop stress, promote plant health, and enhance root growth. Biorational products can help mitigate pesticide risk and reduce exposure to humans and the environment, including protecting pollinators and other beneficial organisms. To reduce these types of risk, use low impact biorational products. These products can be used for managing crop stress, promoting root growth, and more. Some other ways to manage risk include:

- Read and comply with product labels
- Never apply during bloom
- Spray around dawn or dusk to avoid peak pollinator activity windows
- Avoid tank mixing to minimize risk of physical or chemical incompatibility of products, and to avoid undue harm to crops or pollinators
- Reduce or eliminate use of dust, wettable, or soluble powder formulations
- Use low toxicity rapidly degradable chemicals
- Do not spray on windy days or near water sources
- Never apply when unusually low temperatures or dew are forecast following treatment
- Inform neighboring beekeepers of possible pesticide use in adjacent crops
- Inform neighboring growers and applicators of hive locations

As an example, IPM can be integrated into apple production to manage Codling moth (*Cydia pomonella*), one of the most economically damaging insect pests of apple in the U.S. Midwest region. The Minnesota Department of Agriculture presents an IPM framework<sup>36</sup> for IPM tactics to manage the pest, by using pheromone traps for monitoring, and to implement insecticide sprays only when moth numbers exceed the action threshold (more than 5 moths/trap/week). This approach is known to reduce insecticide use without harming fruit yield or quality. Use the Minnesota Department of Agriculture IPM framework as the basis of pest control until you reach the economic threshold, after which fungicide application may be warranted.

31. <https://irac-online.org/>

32. <https://www.frac.info/>

33. <https://www.hracglobal.com/>

34. <https://wssa.net/>

35. University of Massachusetts Amherst. (n.d.). Biorational disease control. Center for Agriculture, Food, and the Environment. <https://www.umass.edu/agriculture-food-environment/fruit/ne-small-fruit-management-guide/general-information/biorational-disease-control>

36. Page 48: McCamant, T. (Ed.). (2007). Integrated pest management manual for Minnesota apple orchards: A scouting and management guide for key apple pests (2nd ed.). Minnesota Department of Agriculture. <https://fruitedge.umn.edu/sites/fruitedge-dl9.umn.edu/files/2023-07/IPM%20Manual-2007-MDA.pdf>

# ENHANCING AND CREATING HABITAT FOR POLLINATORS AND OTHER BENEFICIAL INSECTS

Enhancing and creating habitat on your farm can go a long way toward supporting healthy honey bees, increasing the abundance of wild bees, and adding to overall pollinator resilience against other stressors. Additionally, pollinator habitat areas support other beneficial insects and can reduce the need for pesticide inputs. In the past, non-crop areas were not believed to contribute to farm production. However, there is now an abundance of evidence that leaving or adding wildflowers and other habitat patches around pollinator-dependent crops can increase pollination, pest control, and crop production.

Farms with pollinator habitat can greatly benefit from wild bee crop pollination. Some studies show substantial benefits if 20 to 30 percent or more of land is managed for pollinators. In some scenarios, even smaller amounts of dedicated pollinator habitat can make a big difference<sup>37,38,39</sup>. Pollinator habitat may include cover crops, permanent wildflower areas, forests, riparian buffers, or hedgerows on the farm or in the immediate surrounding landscape. In general, providing habitat can enhance pollinator abundance, while removing features like hedgerows can lead to declines in their populations.

Some farmers worry that floral resources outside of the main crop might draw honey bees or other pollinators away from the crop itself. But research shows the opposite can be true. Non-crop floral resources help honey bees by giving them access to a wider variety of pollen, which is important for their health. These areas also support wild bees, helping build stronger pollinator populations overall - without reducing their presence in the crop.

Loss of habitat in agricultural lands threatens pollination in crops. Large and small actions taken to increase habitat can make a significant positive impact on pollinator populations.

## Key actions that a farmer can take to support pollinator habitat:

### Reduce

- Maintenance of wilder land areas
- Impact of mowing, such as increasing mowing height or reducing frequency
- Pesticide use by incorporating IPM practices

### Encourage

- Building pollinator nesting and overwintering habitat construction
- Communication with beekeepers about pesticide applications

- Planting cover crops in between rows or as a rotational crop
- Establishing buffer strips or habitat near fields and orchards
- Introducing or maintaining high quality nectar and pollen resources in non-production areas
- Managing pest species using best practices
- Registering bee hives on BeeCheck<sup>40</sup> for hive owners

37. Kremen, C., Williams, N. M., & Thorp, R. W. (2002). Crop pollination from native bees at risk from agricultural intensification. *Proceedings of the National Academy of Sciences*, 99(26), 16812-16816.

38. Morandin, L. A., Long, R. F., & Kremen, C. (2016). Pest control and pollination cost-benefit analysis of hedgerow restoration in a simplified agricultural landscape. *Journal of Economic Entomology*, 109(3), 1020-1027.

39. Morandin, L. A., & Winston, M. L. (2006). Pollinators provide economic incentive to preserve natural land in agroecosystems. *Agriculture, Ecosystems & Environment*, 116(3-4), 289-292.

40. <https://beecheck.org/>

## RESEARCH HIGHLIGHT

# IMPLEMENTING A MULTI-FACETED FRAMEWORK TO SUPPORT CROP POLLINATION

### STUDY

Isaacs, R., Williams, N., Ellis, J., Pitts-Singer, T.L., Bommarco, R. and Vaughan, M., 2017. Integrated crop pollination: combining strategies to ensure stable and sustainable yields of pollination-dependent crops. *Basic and Applied Ecology*, 22, pp.44-60.



The study by Isaacs et al. (2017) introduces the Integrated Crop Pollination (ICP) framework, a comprehensive approach to maintaining a stable and healthy pollinator population for reliable, effective crop pollination. Recognizing that farms have unique conditions and varying needs, the ICP approach is defined as “the use of managed pollinator species in combination with farm management practices that support, augment, and protect pollinator populations to provide reliable and economical pollination of crops.”

The authors focus specifically on bees—as they are most important for crop pollination—although other pollinators contribute. The framework integrates managed and wild bee species with strategies such as habitat enhancement, pesticide stewardship, and plant management practices to ensure consistent, effective pollination. It emphasizes the importance of supporting diverse pollinator species to adapt to weather variability, farm environments, and various crop pollination needs as wild bees can be the most effective pollinators for many specialty crop<sup>41</sup>.

To understand possible implementation of the ICP framework, the authors provide examples for how two types of specialty crop farms might approach bee pollinator choice:

41. Garibaldi et al. 2013 “Wild Pollinators Enhance Fruit Set of Crops Regardless of Honey Bee Abundance”



Small, diversified farms can support wild bees as pollinators: In a diverse landscape with on-farm bee habitat and minimal pesticide use, the environment is likely to support a stable population of wild pollinators. The ICP framework authors suggest that these farms can more heavily rely on wild bees for crop pollination, as both on- and off-farm conditions help sustain pollinator populations over time.



Large, high-production farms benefit from bringing in managed pollinators: In a landscape with less natural area and limited bee habitat and higher pesticide usage, there may be large fields of a mass-blooming crop with many flowers. Wild bee populations may be insufficient to pollinate all the crop's flowers, especially toward the field center. In this context, the ICP authors recommend bringing in managed pollinators to ensure adequate pollination and working towards creating a bee-friendly setting to support managed and wild pollinators.

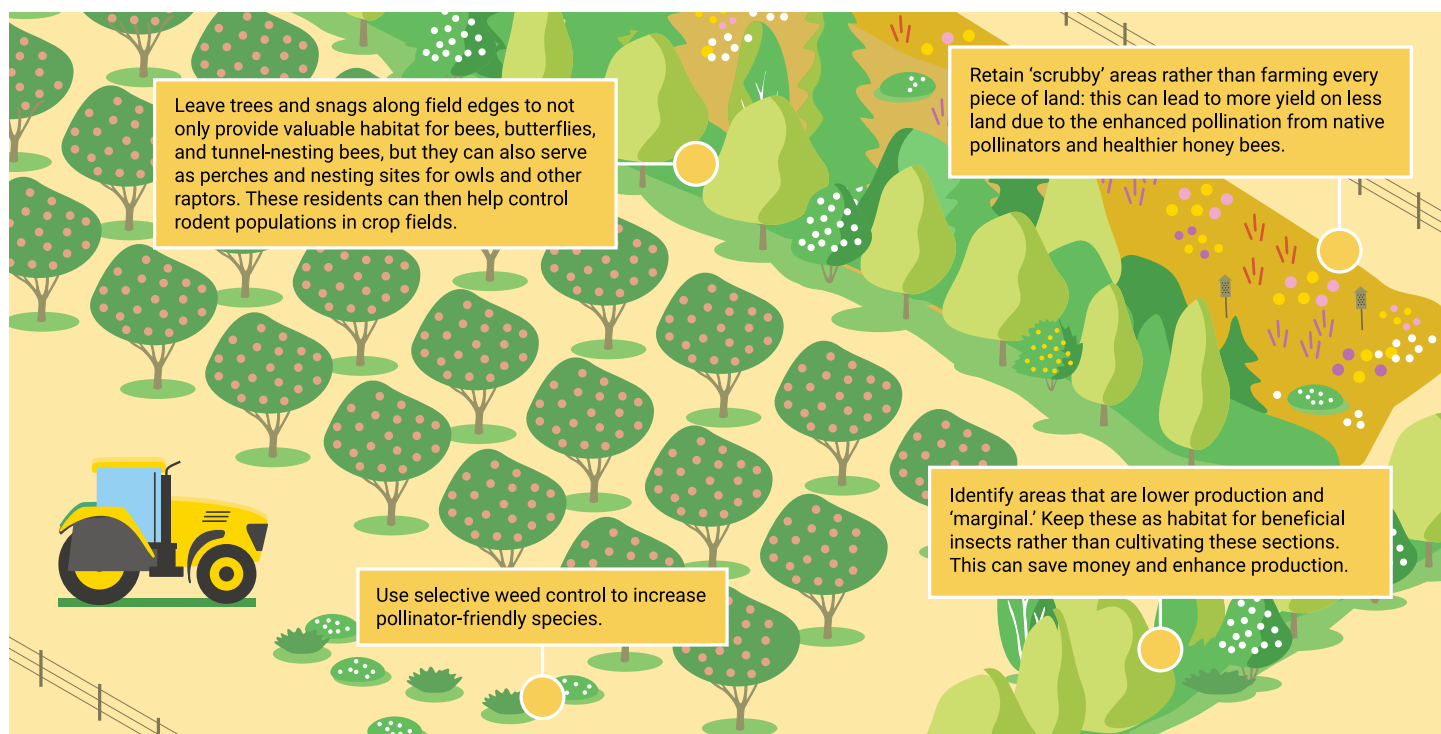
**FIGURE 8.**

Most farms fall somewhere between these examples. No matter where a farm falls, the authors encourage farmers to consider opportunities on their farms to support pollinator health and crop yields through practices that enhance pollinator health and pollination, fostering a more resilient and sustainable agricultural system.

# ENHANCING EXISTING AGRICULTURAL HABITAT FOR POLLINATORS

One of the most effective actions you can take for pollinators is to preserve and enhance the existing habitat on your farm. This starts with recognizing areas that might already be providing pollinator resources (Figure 8). Quality pollinator habitat consists of diverse plant communities (types of plants, blooming times, and flower shapes); provides pollen, nectar, and host plant resources; contains a mix of open or bare ground, areas with leaf litter, plant stems, and dead logs for nesting and overwintering; and supports protection from harsh environmental conditions. Pollinator resources can be found in the semi-natural and natural areas on the farm and in the wider landscape. Conservation areas, wetlands, and woodlots are natural habitats that offer essential resources for pollinators. The USDA Conservation Reserve Program (CRP)<sup>42</sup> and similar initiatives serve a comparable purpose by helping farmers and other land stewards to restore and maintain habitats that support pollinator populations, by providing financial incentives for planting native vegetation and pollinator-friendly habitat.

Fence lines, riparian buffers, unfarmed marginal lands, pastures, and roadsides are considered semi-natural areas because they are often mowed or managed and contain mixes of native and non-native vegetation, yet they too are known to provide valuable pollinator resources. They can also present a risk to pollinators if they are sprayed with pesticides or mowed without consideration for pollinator activity and use of resources.



**FIGURE 9. DIFFERENT AREAS ON FARM THAT CAN SUPPORT POLLINATORS.**

42. U.S. Department of Agriculture, Farm Service Agency. (n.d.). Conservation Reserve Program. <https://www.fsa.usda.gov/resources/programs/conservation-reserve-program>



Providing habitat to support honey bees and native pollinators can be as simple as reducing maintenance in unmanaged or wilder areas. This approach not only benefits pollinators but can also lower labor, fuel and other costs.

Enhance wild habitat with the following activities:

- Use selective weed control to decrease non-native invasive plants and increase pollinator-friendly plants
- Retain existing 'scrubby' areas rather than farming every piece of land: this can lead to more yield on less land due to the enhanced pollination from native pollinators and healthier honey bees
- Identify areas that are low production and do not farm them. Often it is not worth the cost of farming marginal land. Keep or convert these areas as habitat for beneficial insects to save money and enhance production
- Leave trees and snags along field edges to provide valuable habitat for bees, butterflies, and serve as perches and nesting sites for owls and other raptors. These birds can help control rodent populations in crop fields

## CREATING NEW HABITAT

Proactively enhancing and creating pollinator habitat can help attract and support larger pollinator populations on your farm, potentially leading to improved pollination and higher crop yields. Whether your goal is to ensure crop pollination, enhance beneficial biocontrol insects, or simply to increase the stewardship value of your land, the principles for creating or enhancing habitat for pollinators and other wildlife are relatively simple: provide food, water and shelter through wildflowers, native grasses, trees, and shrubs, and protect these areas from pesticide exposure.

Ideal habitat for bees includes the elements listed below. Keep in mind that creating habitat with just some of these elements can still significantly improve bee health and abundance.





**A mixture of flowering plants** (native plants, cover crops, non-invasive non-native plants, shrubs, trees, or ornamental plants) that bloom from early spring through fall. Cover crops are discussed in more detail in the Site Preparation section of this guide.

**Nesting and overwintering habitat** in the form of undisturbed soil, including bare soil that is free of mulch or other ground cover, provides nesting access for some ground nesting bees

- Other ground nesting bees prefer soil that is covered with leaf litter or dried grass. Some bees prefer nesting in disturbed soils
- Tunnel nesting species make use of standing plant material such as brambles, sticks, twigs, and holes in wood from boring beetles
- Species such as bumble bees can make use of brush piles, compost, rotten logs, and existing cavities like abandoned rodent burrows for nesting
- Most bees will use their nests for overwintering. Bumble bees overwinter away from their nests, typically in wooded areas or areas with loose soils, moss and leaf litter
- While natural habitat is best, artificial bee houses used by wild bees such as mason and leafcutter bees can be made or purchased. Just be sure to clean the houses out each year to prevent disease and parasite issues

**Protection from pesticide application** and drift through pesticide-free buffers and thoughtful management, especially around nesting aggregations. Once established, habitat plants can displace many of the sources of undesirable weed seeds that were once growing in that location. The displacement of the weed seed bank will reduce the time, resources, and chemicals needed to maintain these areas.

Enhancing habitat can involve costs related to land use and plant materials. To reduce expenses and streamline efforts, consider integrating pollinator habitat into other farm stewardship projects. For example, include native flowering shrubs and flowers in a riparian buffer. Not only will the buffer help reduce sediment runoff, but the deep root systems of native flowers and grasses will also take up excess nutrients while providing food and shelter to pollinators.

# EFFECTS OF FLORAL PLANTINGS ON PEST CONTROL AND POLLINATION SERVICES

### STUDY

Albrecht, M., Kleijn, D., Williams, N., Tschumi, M., Blaauw, B., Bommarco, R., Campbell, A., Dainese, M., Drummond, F., Entling, M., Ganser, D., de Groot, G., Goulson, D., Grab, H., Hamilton, H., Herzog, F., Isaacs, R., Jacot, K., Jeanneret, P., Jonsson, M., Knop, E., Kremen, C., Landis, D., Loeb, G., Marini, L., McKerchar, M., Morandin, L., Pfister, S., Potts, S., Rundlöf, M., Sardiñas, H., Sciligo, A., Thies, C., Tscharntke, T., Venturini, E., Veromann, E., Vollhardt, I., Wäckers, F., Ward, K., Westbury, D., Wilby, A., Woltz, M., Wratten, S., Sutter, L., 2020. The effectiveness of flower strips and hedgerows on pest control, pollination services and crop yield: a quantitative synthesis. *Ecology letters*, 23(10), pp.1488-1498.

Albrecht et al. (2020) analyzed data from 35 studies across North America, Europe, and New Zealand to examine how floral plantings—flower strips and hedgerows—affect pest control and pollination services. Pollination services were defined as the seed set, fruit set, pollen deposition, and flower visitation rate. The authors assessed the impact of these plantings on bee abundance and diversity, pollination of nearby crops, and crop yield. Key factors considered were the amount of natural area in the surrounding landscape, distance between the crop and the planting, time since planting (floral strips only), and plant diversity (floral strips only). Their findings include the following:

- Flower strips significantly enhanced pest control services in adjacent crops. While hedgerows did not significantly impact pest control, hedgerows could potentially be tailored to support specific beneficial natural enemies suited to a crop. One example of tailoring floral planting to natural enemies and pollinators is the inclusion of candy mint and spearmint to attract spider mite predators<sup>43</sup>.
- Floral plantings significantly increased both pollinator abundance and diversity.
- Floral strips did not significantly increase crop yields, suggesting that the potential impact of floral plantings on yield likely depends on the specific conditions of a farm and surrounding area. This result points to a need for further research on how to optimize plantings to maximize benefits to crop yield.
- Crop yield was similar in fields with and without a floral planting, indicating that non-crop floral resources do not ‘pull’ pollinators away from the crop.

The authors found that the effectiveness of floral strips on crop pollination services improved with:

- Time since planting. Crop pollination services tended to increase with the age of the plot. The authors suggest that this may be due to pollinators needing time to populate the planting, including finding nesting and overwintering sites.
- Diversity of plants in the planting. Higher plant diversity led to increased pollination services in adjacent crops.
- A smaller distance between the planting and the crop. A larger distance led to less pollination when modeled. This outcome, however, can be problematic if there is pesticide drift. Growers must be careful to minimize drift to avoid contaminating flowers.
- A more natural area in the landscape.

43. Togashi et al. 2019 “Mint companion plants attract the predatory mite *Phytoseiulus persimilis*”

# SITE SELECTION FOR CREATING OR ENHANCING POLLINATOR HABITAT

There are several considerations when selecting an appropriate site to install pollinator habitat such as slope, existing vegetation, soil, and sunlight. Evaluating these criteria carefully when selecting a site will ensure that your habitat planting is successful.

Using the Site Evaluation Rubric at the end of the Guide, you can begin evaluating potential project sites. The rubric is intended to help objectively evaluate each site's suitability for pollinator habitat. No answer is 'wrong;' rather, they are just factual statements to help you determine the best site for your habitat project.

Site selection can be influenced by the potential partnerships that may be formed at a specific site. For example, if a piece of land is adjacent to an engaged neighbor or is in the jurisdiction of a conservation authority, these parties may be willing to collaborate toward a common goal. On-farm pollinator habitat can also serve as an outreach or demonstration site, helping to showcase pollinator-friendly practices to neighbors and the broader community. If your farm is more accessible to the public or if you offer farm tours and Community Supported Agriculture programs, consider these additional opportunities to feature your pollinators and sustainable practices.

Keep in mind that even well-chosen sites may be located near land uses that conflict with your goals. For example, you may encounter unwanted pesticide drift from a neighboring property. When addressing concerns like drift or potential habitat expansion, begin with a respectful, open conversation. Offer practical, collaborative solutions and highlight the mutual benefits of supporting pollinator health. If challenges arise, be prepared to offer assistance or explore mediation to reach a positive outcome.

If the site is a known habitat for a sensitive species, review all laws, regulations, and guidelines. Consult with the U.S. Fish and Wildlife Service<sup>44</sup> or state and county conservation officials (such as the Department of Natural Resources or Department of Agriculture) for additional guidance. Even slight changes in sensitive habitat may have negative effects on rare, threatened, and endangered species. However, with careful planning, a habitat enhancement project could benefit both the species at risk and pollinators in general.

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44. U.S. Fish and Wildlife Service. (n.d.). Midwest. <https://www.fws.gov/about/region/midwest>

## PLANTING TYPES

There are various options for implementing pollinator habitats in agricultural settings that provide multiple ecological services. These include cover crops for soil health, prairie buffer strips for erosion control, hedgerows for wildlife habitat, bee lawns for pollination, and more. Each planting type offers unique benefits, enhancing biodiversity and landscape functionality and is often guided by the amount of room and location determined by site selection. By incorporating diverse plantings, land managers can improve ecological health, support wildlife, and create vibrant pollinator habitats.



**Cover Crops/Intercropping:** Cover crops are plants primarily grown to enhance soil health and provide environmental benefits, including support for beneficial insects. Their root systems stabilize the soil, prevent erosion, and improve ecosystem health. Legume cover crops fix nitrogen, and others are used to increase soil organic matter, enriching the soil for future crops while also offering vital food for pollinators. By suppressing weeds with their dense canopy, cover crops help to create habitats that allow flowering plants to thrive, attracting beneficial insects. Cover crops like buckwheat are particularly valuable, as their flowers produce nectar and pollen that support pollinator populations. Depending on the species, cover crop nitrogen content may peak just before or at flowering. As a result, growers must balance multiple factors: pollinator benefits, nitrogen contributions, and field operation timing. In some cases, this means terminating a cover crop while it's still in full bloom. Ideally, growers would maintain nearby refuge areas with flowering plants to provide alternative forage for pollinators when cover crops are terminated.



**Prairie/Buffer Strips:** Buffer strips, areas of native vegetation, may be planted between agricultural fields and near water bodies for the purpose of erosion control, filtering runoff, and improving water quality while simultaneously providing habitat for wildlife including pollinators like bees and butterflies. When buffer strips are composed of diverse native grasses and wildflowers, they can create a rich foraging environment, offering a continuous source of nectar and pollen throughout the growing season. By supporting and enhancing populations of a variety of pollinators, prairie buffers increase local biodiversity and contribute significantly to ecosystem health, making them invaluable in agricultural landscapes.





**Hedgerows:** Hedgerows consist of various woody plants and perennial vegetation planted along field borders. They act as windbreaks to protect crops and livestock, and can also provide important corridors for wildlife, including bees and butterflies. If the right plant species are incorporated into hedgerows, these areas can offer abundant sources of nectar and pollen, attracting and supporting beneficial insects and serving as larval host plants for certain pollinator species. Additionally, hedgerows enhance aesthetic value and can also be used to produce secondary, low-input crops like chokecherries, service berries, or tree nuts.



**Bee Lawns:** Bee lawns are purposefully designed spaces that incorporate low-growing flowering plants into traditional lawns, directly benefiting pollinators. Bee lawns<sup>45</sup> can provide nectar and pollen for native bees and other pollinators throughout the growing season if planted with a diversity of plants and maintained with mowings timed to enhance flowering. By minimizing the need for chemical fertilizers and pesticides, bee lawns promote a healthier environment that supports a diverse range of beneficial insects. The vibrant colors and varied textures of flowering plants attract various pollinators, fostering biodiversity while creating a sustainable and visually appealing landscape. Strategically planting bee lawns in areas away from direct insecticide spray zones, such as field margins or between rows, reduces the risk of pesticide exposure. This ensures pollinator habitats thrive while minimizing conflicts with pesticide applications. If planting bee lawns next to or between crop rows, be sure to mow down the flowers before applying any pesticides.



What will planting cost? Consider the expense of machinery use, labor, and material inputs such as smothering materials, herbicides, seeds and plants. If you don't know what to budget for time or materials, talk to another grower who has been through the process or reach out to your local county conservation officer. Also consider that plantings such as hedgerows can have monetary benefits over time, reducing the need for chemical pesticides in the crop and increasing pollination. In one study, a hedgerow planting paid for itself within about 5 years of installation and provided continued economic benefit to the grower for decades<sup>46</sup>.

45. University of Minnesota Extension. (n.d.). Planting and maintaining a bee lawn. <https://extension.umn.edu/landscape-design/planting-and-maintaining-bee-lawn>

46. Morandin, L. A., Long, R. F., & Kremen, C. (2016). Pest control and pollination cost-benefit analysis of hedgerow restoration in a simplified agricultural landscape. *Journal of Economic Entomology*,

# SELECTING PLANTS

Consider which pollinators you aim to support and attract to your landscape, as well as the habitat type you wish to establish (e.g., buffer strip, hedgerow, meadow, etc.). Plant diversity is a key element of successful pollinator habitat. Incorporating species with a variety of bloom times, colors, and forms will ensure there is a continuous source of food for pollinators from early spring to late fall. This diversity will also help provide nesting and overwintering sites all year. It is important to choose plants that are well adapted to the conditions at the site. Reach out to a local seed vendor, environmental consultant, or restorationist for assistance and check out the resources section of this Guide for plant selection materials.

Plants used to create habitat can include native plants that have evolved in your region or non-native species (if appropriate) that are non-invasive, adapted to the local climate, and provide valuable resources for pollinators. Though using native plants can involve larger up-front costs, in the long-term there can be savings due to reduced maintenance needs (for example, less maintenance and fewer inputs). There are many other benefits to native plants, and their use in agricultural landscapes can serve multiple goals: financial, environmental, agricultural, and aesthetic. Additionally, creating diverse, healthy ecosystems can improve soil quality and water retention, leading to more sustainable farming practices and potentially lower operating costs over time.

When creating a pollinator habitat seed mix, the ideal ratio is 75% native flowering broadleaf plants seed to 25% native grass seed. A ratio closer to 70/30 can be used to reduce costs. Including native grasses and sedges can help reduce costs while maintaining plant diversity. Grasses can also be quick to establish, easing weed pressure during the early phase of establishment. Including annual plants in your mix can be helpful in occupying the area and offering more immediate blooms while your perennial plants take time to establish roots. Reference Pollinator Partnership's Ecoregional planting guide series, *Selecting Plants for Pollinators*<sup>47</sup>, to find lists of native plants suitable for your location. State-specific recommendations are available from local Board of Water and Soil Resources (BWSR) offices or similar organizations.

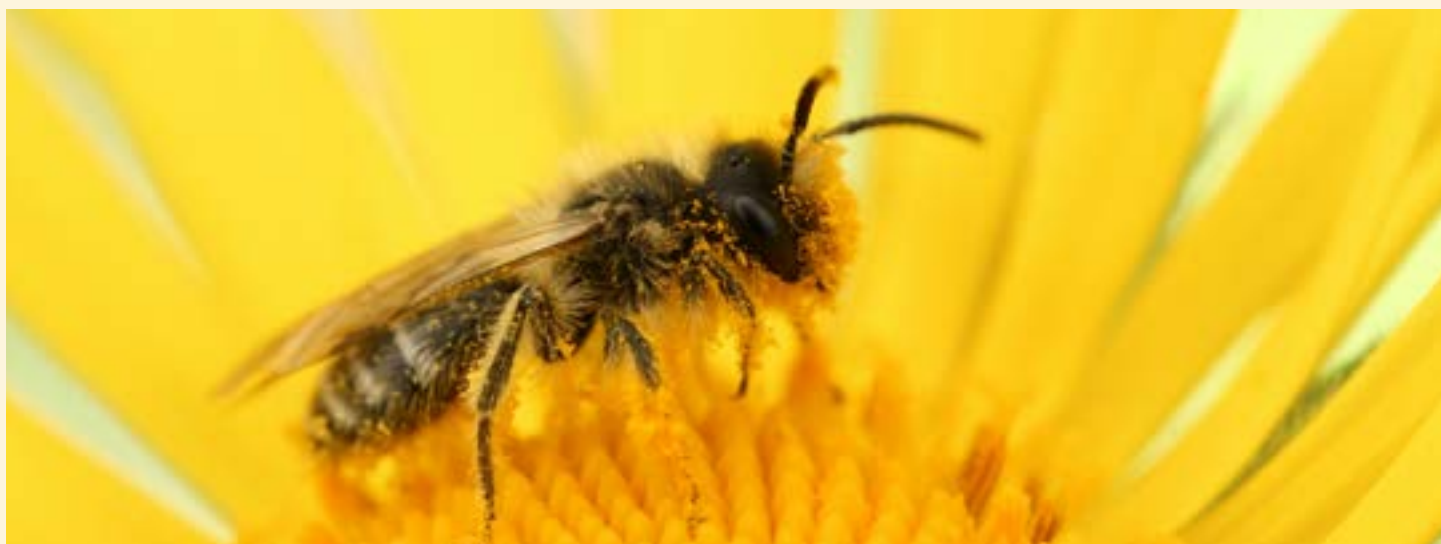
When planning a pollinator hedgerow, focus on selecting native trees and shrubs that are well-suited to the local conditions. Choose species with staggered bloom times to provide a continuous food source for pollinators throughout the season. Incorporate plants of varying heights and structures to create a diverse habitat, while also considering the mature size of the plants to ensure proper spacing. Native species are typically the best choice for long-term sustainability, though non-invasive non-native plants can be used where appropriate.

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47. Pollinator Partnership. (n.d.). Ecoregional planting guides. <https://www.pollinator.org/guides>

## RESEARCH HIGHLIGHT

# THE HABITAT CRISIS #2 - DR. ANDONY MELATHOPOULOS (300)



Supporting wild bees and honey bees in agricultural landscapes requires distinct deliberate approaches. Honey bees thrive with simple, low-cost plantings such as legumes and brassicas, which provide steady forage and are relatively easy and affordable for growers to establish. Wild bees, on the other hand, benefit greatly from plantings that include diverse native species. While establishing this tailored habitat may involve higher initial costs, it can be long-lasting and offers significant benefits when informed by knowledge of the local native plant and bee community. Attempting to meet the needs of both groups with a single approach risks inefficient use of resources. Instead, tailor the seed mix to the types of bees that you are most interested in supporting.

For more information, listen to Dr. Andony Melathopoulos' interview on the Beekeeping Today Podcast, Episode 300<sup>48</sup> from October 14, 2024. Or read the 2021 research article by Simanonok, Otto, and Buhl "Floral resource selection by wild bees and honey bees in the Midwest United States: Implications for designing pollinator habitat"<sup>49</sup>.

48. Beekeeping Today Podcast. (2024, October 14). The Habitat Crisis #2 – Dr. Andony Melathopoulos (Episode 300). <https://www.beekeepingtodaypodcast.com/the-habitat-crisis-2-dr-andony-melathopoulos-300/>

49. Simanonok, S. C., Otto, C. R., & Buhl, D. A. (2021). Floral resource selection by wild bees and honey bees in the Midwest United States: Implications for designing pollinator habitat. *Restoration Ecology*, 29(8), e13456.

# SITE PREPARATION AND CONDITIONING

Proper site and seedbed preparation is a crucial step that is often overlooked but is necessary to create successful pollinator habitat. Before conducting any site preparation, it is essential to recognize the specific preparation needs of your site. Common sites for larger areas of pollinator habitat will be pasture, idle or brushy fields, lawn grass, and soybean or corn stubble. Sites that were planted with soybeans provide the added benefit of additional nitrogen in the soil, supporting improved establishment. Field borders and nearby roadsides are ideal spots for hedgerow and buffer strip habitats. Sites with existing vegetation should have significant site preparation for one year before planting or seeding. If you are trying to remove invasive or noxious plant species, sites will require two years of site prep.

Consider the pesticide history of the site. Be mindful when planting in areas that housed crops that were treated with systemic pesticides or long-term herbicides. Systemic pesticides can persist in the soil for several years, depending on the type of insecticide and the environmental conditions, and may negatively impact pollinators feeding on flowers grown in that soil. Some herbicides can last for years. Planting into a site with one of these herbicides can lead to failed establishment of your habitat.

Weed removal is one of the most important steps to successful habitat creation. Whether there is heavy weed pressure on your site or simply turf grass, removing this vegetation is key to preparing your site for planting. Choose the method(s) below that best suits your needs.

## **SOLARIZATION:**

This process involves placing a clear UV-stabilized plastic sheet over the site, which has been wetted to a depth of 8 to 10 inches. Apply the sheet in the spring or early summer, then remove it the following fall, just before seeding or planting. The process can be completed in as little as two to three weeks, depending on weather and seed types. Heat generated from the sun will become trapped under the plastic sheet, and the high temperatures will kill the vegetation and dormant weed seeds. Solarization is an appropriate method for sites one acre in size or smaller. Plastic solarization films can lead to contamination of soil with microplastics but biodegradable options are available.

## **OCCULTATION:**

Occultation is similar to solarization, in that it involves covering the soil with UV-stabilized plastic sheet, except here the plastic is black and opaque. The black plastic absorbs light and does not become as hot as the clear plastic; therefore, this technique takes longer. Occultation typically requires at least four weeks to be effective; however, the longer the black plastic sheet is left in place, the more effective it will be (up to six weeks). As with solarization, plastic films can lead to contamination of soil with microplastics, but biodegradable options are available.

## SMOTHERING:

Like solarization and occultation, smothering is a non-chemical preparation method suitable for smaller sites, especially hedgerows. Prior to the growing season, cover the area with compostable material such as cardboard. Overlap the material to ensure that there is no open, bare ground. Cover the material with soil amendment, compost, or a similar material that will naturally break down. The area should be left to smother for an entire growing season before installing habitat. When using cardboard for smothering, especially if on a site that will be used to grow food, it is important to be aware of per- and polyfluoroalkyl substances (PFAs) and the type of cardboard that is used. Research is limited on this topic, however there are concerns that the PFAs in the cardboard are considered “forever chemicals” and could leach into the soil and groundwater with the potential for uptake by plants at the site.

## SMOTHER CROPPING:

Smother cropping, or smothering, is a method of site preparation using temporary cover crops such as clover (*Trifolium* spp.), phacelia (*Phacelia* sp.), sorghum sudangrass (*Sorghum bicolor* x *S. bicolor* var. Sudanese) and buckwheat (*Fagopyrum* spp.) to out compete existing weeds before the habitat is planted. Cover crops grow quickly and suppress unwanted weeds. This method of site preparation also provides pollinator forage while in bloom, and it improves soil moisture retention and soil stability relative to open ground. Cover crops are then easy to remove from the site when they are ready for seeding or planting. Some cover crops can become weeds themselves if they go to seed before removal, however these volunteer plants can be controlled with standard weed-management practices. Smother cropping may be used in larger areas with weed pressure that is low to moderate, though it is important to adapt management according to the specific weeds that persist on the site.

## TILLING:

Tilling the site is a good option when weed pressure is low or multiple tills are possible to eliminate the seedbed. Conduct a survey of existing plant material and consider past weed problems before tilling. Oftentimes, a till will work well in the short term but can bring weed seeds to the surface from the soil bed, continuing the weed problem. If you want to till, consider combining it with herbicide application. When tilling to exhaust the weed seedbank, first till, then irrigate to germinate the weed seeds, till to eliminate the plants, and repeat until the seedbed is exhausted.



## HERBICIDE APPLICATION:

Carefully time and repeat herbicide applications in preparation for seeding and planting. Begin by mowing the site. To be effective, herbicide usually needs to be applied a few times throughout the growing season as dormant seeds germinate. A fall application will be necessary if there is an abundance of cool season grasses and other, more aggressive noxious weeds. To ensure adequate seed-to-soil contact, brown and dead vegetation should be removed by burning, mowing, or raking. When using glyphosate herbicide, wait at least two weeks after the last treatment before planting or seeding. Other herbicides have different periods of time needed to wait before planting. Consult the label for notes on weed size and efficacy, as well as potential limits to the amount of product that can be used in a year.

## PRESCRIBED FIRE:

Prescribed fire/prescribed burning is the intentional and thoughtful application of fire to a site that accomplishes predetermined management objectives. It can be used to manage the spread of invasive weeds and aggressive plants, remove litter to improve seed to soil contact, stimulate germination of certain desired plant species, release nutrients, and more. Prescribed fire can and should be used in coordination with other site preparation techniques. When properly planned and implemented, prescribed fire can be cost effective and safe.



### WHAT WILL SITE PREPARATION COST?

Consider the cost of machinery, labor, and inputs such as smothering materials and herbicides. If you don't know what to budget for time or materials, talk to another grower who has been through the process or reach out to your local county conservation officer.

# SOIL AMENDMENTS

Creating pollinator habitat may require a comprehensive approach to soil amendment and management. In some cases, no amendments are necessary, as certain native plants can thrive in existing conditions. However, other species may require adjustments to soil composition or fertility to ensure successful establishment and long-term growth. The first step in the process is to compare specific plant requirements of selected pollinator plantings (e.g., preferred soil type, pH, and nutrient requirements) to your current soil conditions. Aspects like soil pH, organic matter levels, and nutrient content can be determined by conducting a soil test at the planting site. This baseline data will enable you to make informed decisions about any amendments needed. Adjusting soil pH may be necessary based on test results - lime can be used to raise acidity, while elemental sulfur can be applied to reduce alkalinity. Make sure to follow proper application rates (if applicable) for amendments to avoid nutrient overload and potential environmental harm. For some amendments, such as increasing or decreasing soil pH, a longer time period may be required to achieve the desired results. For more information about soil amendment rates for various situations, refer to your state's Extension nutrient recommendations, such as the University of Minnesota's Nutrient Management Guide for Commercial Fruit and Vegetable Crops in Minnesota<sup>50</sup>.

## SOIL NUTRIENTS:

Soil nutrients play a crucial role in pollinator habitats by supporting the growth and health of plants that provide food and shelter for pollinators. While healthy nutrient-rich soil can promote strong plant growth and abundant nectar and pollen production, it's important to maintain a balance. Many native species and wildflowers, which are often keystone species for pollinator habitat, thrive in low to moderate fertility soils, as overly fertile conditions can encourage the growth of weeds that may outcompete native species. To support pollinators, it's beneficial to focus on creating soil conditions that align with the needs of these adapted plants. Additionally, practices like planting cover crops, such as legumes, can naturally enrich the soil by fixing nitrogen and improving soil fertility without disrupting the balance necessary for native wildflowers to flourish.

## ORGANIC MATTER:

Adding organic matter may help to improve soil health on a small or larger scale. Incorporating well-aged compost manure or using organic mulches can enhance soil structure, increase fertility, and improve moisture retention, all while suppressing weeds. These practices can be integrated into existing crop rotations or fallow periods to maximize benefits.

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50. Rosen, C. J., & Eliason, R. (2005). Nutrient management for commercial fruit & vegetable crops in Minnesota. University of Minnesota Extension. <https://conservancy.umn.edu/server/api/core/bitstreams/5ec79b89-2ee9-4e35-9af6-2292ca155b25/content>



## SOIL TEXTURE:

In larger fields, improving soil structure can be achieved by strategically adding organic materials in heavy clay soils to enhance drainage, while clay amendments can help retain moisture in sandy areas. Biochar (a stable, carbon-rich form of charcoal) can be used as a soil amendment (in a variety of soil types, but especially in sandy or poorly drained soils) to improve soil fertility while also providing an efficient way to sequester carbon. Some cover crops like tillage radishes (*Raphanus sativus*) can also be planted to help loosen heavy soils. Additionally, incorporating mycorrhizal fungi into the soil can significantly enhance nutrient uptake for both native plants and surrounding crops. With this in mind, the selection of native plants for pollinator habitats is vital; so, choosing species adapted to the local climate and soil conditions will promote ecosystem resilience and biodiversity.

## MAINTAINING SOIL HEALTH:

Implementing regular maintenance and focusing on soil health is crucial for pollinator habitats on farms because it ensures that the plants providing nectar, pollen, and habitat remain healthy and productive. Regular maintenance helps control invasive species that can outcompete native plants, ensuring that pollinator-friendly species continue to thrive. Healthy soils improve plant growth by supporting strong root systems, enhancing resilience to pests and diseases, and optimizing nutrient availability, which is essential for maintaining a consistent food source for pollinators. Additionally, good soil health promotes biodiversity, helps with water retention, and reduces the need for chemical inputs, creating a more sustainable and supportive environment for both pollinators and crops. Effective water management strategies, including contour planting or swales, can optimize irrigation and reduce erosion. By minimizing soil compaction through careful machinery use, sustainable reduced tillage, or no till practices, and managing foot traffic, you can preserve soil integrity and, ultimately, the health of pollinator habitat.

# PLANTING WITH SEED

To properly establish habitat that will be valuable to you and the pollinators, consult technical guides for creating habitat on farms and orchards in your ecoregion (see Resources section). Pollinator seed mixes are generally planted in the fall or spring, timed with snowpack insulation or natural rains. The time of year that works best often varies with site conditions and latitude. Seeding onto frozen ground can be beneficial, as it helps to improve germination rates for some species. The freeze/thaw cycle in late winter can also help aid in working seeds into the soil, improving seed-to-soil contact and supporting germination. Before dispersing seeds, a site must have a clean seedbed and adequate bare soil. Common options for planting include drill seeding, broadcast seeding, and hydroseeding.

It is important to remain patient when planting native perennial flowers and grasses from seed as plants will usually not appear or be noticeable on your site the first year. It is helpful to remember the phrase “Sleep, creep, and leap!” when monitoring the growth and success of your planting. The process appears slow because native grass and flowering plant species allocate most of their resources to roots and very little to above ground growth during establishment.



# PLANTING FROM PLUGS AND POTS

Planting from plugs or containerized plants can be beneficial in that the plants have had time to grow in a greenhouse before they go into the ground. This allows them to develop a robust root system and above ground growth so that they are less susceptible to pressures like excessive heat or low moisture that might kill newly germinated seed. Potted plants also compete better against undesired grasses and other encroaching vegetation; however, transplanting is generally more expensive than seeding.

Planning a hedgerow or other planting using mature plant materials requires proper spacing. Plants must be placed where they will have sufficient room to grow without becoming crowded. Large shrubs should be planted at a 15- to 20-foot spacing and smaller shrubs at a 7.5-foot spacing. Depending on the species, trees need 20 to 30 feet. Overall, pay attention to individual species/variety height and width specifics when planning hedgerow spacing, as there can be wide ranges in sizes between varieties.

The best time to transplant from containers is the spring, after the danger of the last frost has passed and soils have warmed to a minimum of approximately 40°F. Depending on location, April and May are best, although microclimate factors, such as proximity to water, elevation, or even soil type can make a difference on when to plant. Trees and shrubs can also be planted in the fall (late September/early October) after the summer heat has lessened.



## WHAT WILL SEEDS AND PLANTS COST?

What will seed and plant materials cost? The material expenses associated with planting are usually the easiest to estimate using planting rates. Seed, plug or pot costs are readily available online or through your local conservation office. When estimating planting costs, however, be sure not to overlook the cost of planting itself - remember it will take time to get your seeds and plants in the ground and labor can be expensive. Field workers in Midwest (Lakes) states were paid \$18.36/hour on average in spring 2024<sup>51</sup>.

51. U.S. Department of Agriculture, National Agricultural Statistics Service. (2024, May 22). Farm labor (FMLA 05-24). <https://downloads.usda.library.cornell.edu/usda-esmis/files/x920fw89s/4j03fp044/d217sc75x/fmla0524.pdf>





# MAINTAINING HABITAT FOR POLLINATORS

This section provides a brief overview of how to maintain habitat for pollinators once planted.

## HABITAT PLANTED FROM SEED

If planting your site from seed, remember that it can take a few years for plants to fully establish. After seeding, one can expect a gradual but rewarding ecological transformation. Germination may occur slowly, with annual species dominating the landscape initially. However, the establishment of perennial species may take three years or more. Patience is vital during this period, as perennials will gradually develop their root systems and begin to dominate. Ultimately, with appropriate management and favorable conditions, this evolving landscape will foster a sustainable and diverse habitat, offering both aesthetic appeal and ecological benefits over time.

Before seeding, ensure the soil is moist but not waterlogged to create ideal conditions for germination. During seeding, water lightly and frequently to keep the topsoil consistently moist, avoiding displacement of seeds. After germination, gradually reduce watering frequency, allowing the plants to establish deep roots. Once established, water only as necessary based on local precipitation, ensuring soil remains moist but not overly soggy, to support long-term growth without encouraging weeds. In the first growing season of your planting, it is advisable to mow your site twice to set back any annual grasses or broadleaf weeds that may appear. Mow at a height of about six to eight inches whenever weeds reach 10 to 12 inches. Ensure that the last mow of the season in late summer or early fall maintains at least six to eight inches of vegetation height for overwintering.

Weed competition and invasive species should be continually monitored for the first several years. Spot mowing or targeted herbicide application should be conducted to control seed production and spread. If feasible, consider organizing a team of employees or partnering with a local non-profit to organize volunteers to hand pull weeds or target spray herbicides once a week or once a month during the first two years. Perfection is not necessary but prioritizing weeding of the most aggressive species is essential.

## MAINTAINING HABITAT CREATED FROM POTTED PLANTS/PLUGS

When planting perennials from plugs or pots, it is important to water thoroughly the day of planting and as needed in the following days. Look for wilted leaves as a sign they need additional water. Water the plants at least once a week for four to six weeks post-planting. If conditions are particularly dry, supplemental watering may be necessary. After this initial planting period, watering every one to two weeks is optimal, especially if planting occurred later in the winter or early spring. This watering schedule still holds true until the ground freezes if plants are installed in the fall, as plants still transpire if they have leaves in cooler weather.

A cost-effective method of controlling weeds and conserving soil moisture in an area where potted plants were installed is to use a mulch like wood chips or straw. Weed mat or landscaping fabric can be used, but this removes habitat for ground-nesting bees. Preemergence herbicides may be used to control weeds but doing so may reduce competition for weeds not affected by these chemicals, thereby replacing one weed with another. Glyphosate may offer better broad-spectrum weed control, but it is crucial that drift during spraying is prevented from reaching nearby beneficial plants. In general, potted plants will help shade out competing weed species once they become well-established.



We recommend estimating expenses required for the maintenance of your newly planted pollinator habitat. As with the other activities described in this section, be sure to include labor, input, and equipment-related expenses in your maintenance budget. It will be important to know these costs before you begin installing new pollinator habitat so you can plan ahead for them and make adjustments if necessary. All expenses can be recorded in your Pollinator Management Plan (PMP) budget.

## SELECTING AND USING PESTICIDES

Pesticides (either conventional or USDA Organic approved pesticides via OMRI)<sup>52</sup> have become an integral part of some farm management systems. However, there are risks to pollinators, other beneficial insects, the environment, and humans associated with their use, especially if label directions are not followed. The term ‘pesticide’ refers to all substances that are meant to control pests, including insecticides, fungicides, nematicides, miticides, and herbicides. Exposure to certain pesticides can kill bees or can cause effects that negatively impact foraging, learning, reproduction, or the long-term health of pollinator populations (these effects are referred to as sublethal). By using pesticides within an Integrated Pest Management (IPM) framework, following label directions, and selecting products that have low toxicity to bees, healthy bee populations can be maintained. If insecticide treatments are needed to control insect pests in crops, it’s recommended that you rotate between pesticide classes (a) within the growing season, and from year to year in the same crop to avoid the development of pest resistance and (b) in the same location, even if a different crop is grown, to avoid accumulation of pesticide residues in the soil. It is important to remember that wild bees and other beneficial insects may be visiting crop flowers even if honey bees have been moved during pesticide application. The practices below outline ways to control exposure to pesticides, so the risk is acceptable to pollinators while maintaining crop production and quality.

### SELECTING LEAST TOXIC PESTICIDE PRODUCTS: UNDERSTANDING PESTICIDE RISKS

Bee poisonings are related to exposure amount, exposure time, and the toxicity of the pesticide. The highest risk is from pesticide products that:

- Are highly toxic to bees
- Have residual toxicity longer than eight hours
- Can be found as residues in pollen, nectar, water, or soil where bees can be exposed to them
- Are sprayed on the crop during bloom when bees are present

Risks are reduced by following pesticide labels closely and paying attention to changes in use restrictions.

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52. Organic Materials Review Institute. (n.d.). OMRI Lists. <https://www.omri.org/omri-lists>

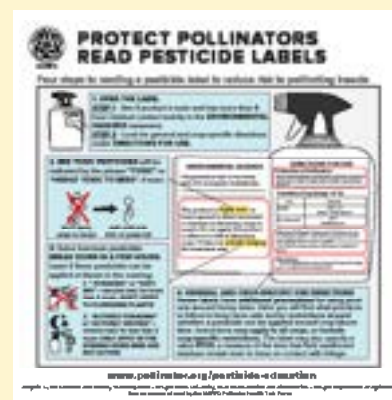
**FIGURE 10.**

AN EXAMPLE OF AN INSECTICIDE AND CROP ROTATION SYSTEM THAT AVOIDS BUILDUP OF PESTICIDE RESIDUES IN SOIL. TREATED FIELDS ARE INDICATED WITH A GREEN “CHECK MARK”, AND UNTREATED FIELDS ARE INDICATED WITH A RED “X”. EACH FIELD IS TREATED WITH PESTICIDES EVERY OTHER YEAR.





## PROTECT POLLINATORS, READ PESTICIDE LABELS



<https://www.pollinator.org/pollinator-org/assets/generalFiles/Reading-Pesticide-Labels-NAPPC-with-mitigation-2022v.final>

Pesticides can be useful in agricultural production (see Figure 9), but it is important to understand the consequences of using these chemicals. Insecticides are formulated to kill insects, which generally makes them toxic to non-target insects. There are limitations to the information provided by pesticide testing and labels in relation to pollinators, including the following:

- Most testing focuses on how deadly pesticides are to adult honey bees. However, honey bees do not represent all bee species, and pesticide recommendations that are not lethal for honey bees may be lethal to other bee species.
- Current assessments often overlook “sub-lethal” effects, which are impacts on bee health and behavior that do not cause immediate death.
- Tank mixes can produce synergistic effects that further increase toxicity to bees.
- Herbicides and fungicides are generally less toxic than insecticides, but they too can present risks to pollinators.

These gaps in understanding underscore the need for more comprehensive pesticide testing that considers the broader implications for all pollinators at various stages of development.

Since it is important to rotate pesticides, using only the absolute safest product for pollinators may not always be possible. A comprehensive Pesticide Risk Tool (PRT)<sup>53</sup> is available to assess the impact of insecticides and other pesticides for 15 environmental risk factors, including pollinators.<sup>54</sup>

53. <https://pesticiderisk.org/>

54. Meys, E.L., P. Mineau, P. Werts, S.G.A. Nelson, A. Larson, & W.D. Hutchison. 2024. Assessment of insecticide risk quantification methods: Introducing the Pesticide Risk Tool and its improvements over the Environmental Impact Quotient. *J. of Integ. Pest Management*, 15 (1), 9, <https://doi.org/10.1093/jipm/pmad032>



## FOLLOW LABEL DIRECTIONS

Pesticide labels are legal documents. Product registration, toxicity testing, and product regulation are in place to protect honey bees and other pollinators from the negative effects of pesticides. **It is illegal to use a pesticide in any way other than for the purpose and in the manner stated on the label.**

In addition, properly following pesticide labels is important from an economic perspective, from a human health perspective, and from an environmental perspective. Applying too much of one pesticide or one class of pesticide, applying it repeatedly in the same place, or applying it outside of label use could cost more money and could increase product risk to visiting bees.

Bee exposure to pesticides can occur when:

- Beekeepers and farmers do not adequately communicate.
- Pesticides are applied when bees are visiting flowers.
- Pesticides are applied to crops, weeds in the field, or field margins during bloom or to neighboring fields.
- Pesticides drift onto blooming plants adjacent to the crop.
- Systemic insecticides (like neonicotinoids) are translocated into the nectar and pollen of crop and non-crop flowering plants because of their movement through soil and water.
- Bees collect insecticide-contaminated nesting materials, such as leaf pieces collected by alfalfa leafcutter bees (*Megachile rotundata*), or are exposed to soil contaminated with pesticide residues as they build their ground nests.
- Bees collect pesticide-contaminated water in or near treated fields.
- Wild bees develop or overwinter in soil contaminated with pesticides.





## REDUCING POLLINATOR EXPOSURE TO PESTICIDES

When using pesticides, in addition to following label directions and maintaining clear communications with beekeepers and other stakeholders, other ways of minimizing managed and wild bee exposure include:

- Ensure that pesticide drift is minimized to reduce contact with adjacent habitat. Maintain a buffer area between crops that will receive pesticide treatment and bee habitat.
- Since fine droplets tend to drift farther, apply spray at lower pressures or choose low-drift nozzles that produce medium to coarse droplet size. Turn off sprayers near water sources (ponds, irrigation ditches, or leaking irrigation pipes), when making turns, and at the ends of fields.
- To minimize drift, do not spray in windy conditions or during temperature inversions.
- Avoid applying pesticides that can drift onto honey bee hives or wild bee nesting sites.
- Avoid applying pesticides (especially insecticides that have known toxicity to bees) to any flowers in bloom, even weeds; pollinators may be using these resources.
- Apply insecticides with long residual toxicity when bees are inactive or not present. Bees generally forage during daylight hours and when temperatures exceed 55°F. When abnormally high temperatures result in foraging activity earlier or later in the day, adjust application times accordingly to avoid bee exposure.
- Note: Some important pollinator species such as squash bees (*Peponapis pruinosa*) and bumble bees forage at lower temperatures and light levels and may be present on crop flowers in the early morning.
- Be aware that pesticides can be absorbed in soil, potentially impacting ground nesting bees or taken up by non-crop plants that bees use for forage and nesting habitat.
- Look for bees on flowering crops and adjacent areas with flowers. Nesting areas are difficult to locate, even with close inspection, but if you see bees entering and exiting holes in the ground, wood, or plant stems, protect these nesting areas from any exposure to insecticides wherever possible.

## RESEARCH HIGHLIGHT

# FLORAL PLANTINGS: PESTICIDE REFUGE OR RISK FOR POLLINATORS?

### STUDY

Graham, K.K., McArt, S. and Isaacs, R., 2024. High pesticide exposure and risk to bees in pollinator plantings adjacent to conventionally managed blueberry fields. *Science of The Total Environment*, 922, p.171248.

Pollinator plantings in agricultural settings are often designed to provide an alternative food source and habitat for wild pollinators when crops are not in bloom and up until this point, there was some evidence that these plantings could mitigate pesticide risks to beneficial insects. However, these plantings are often placed near fields where chemical pest control is used. This raises a question for growers: do these floral plantings serve as a refuge for pollinators or a potential zone of pesticide exposure?

The study by Graham et al. (2024) investigated pesticide risk (exposure and toxicity) to bees in pollinator plantings next to highbush blueberry fields. They conducted research on 12 farms in Michigan, comparing eight conventional farms and four unsprayed farms, some with pollinator plantings. The project evaluated pesticide residues in flowers, soil, and pollen collected by bumble bees. The authors found that bees faced similar pesticide exposure risks on farms with and without a pollinator planting. In addition, pesticide risk from wild

flowers located at the center or edge of a field was not higher than flowers in the plantings. Unsprayed farms had lower risk than farms that were sprayed, but pollen sampled from bumble bees indicated that exposure can also occur off-farm. Overall, they found that pollinator plantings do not act as a refuge for pollinators from pesticide exposure, highlighting the need to implement integrated pest management practices that combine reduced pesticide spray programs with pollinator plantings. To protect pollinators, Graham et al. suggest taking a few mitigation measures to reduce pesticide exposure that may occur in the floral planting, including:

- Reduce drift by installing a wind break between the pollinator planting and any crops that may be sprayed.
- Mow to remove bee-attractive blooming flowers in and around any crops prior to a pesticide application.

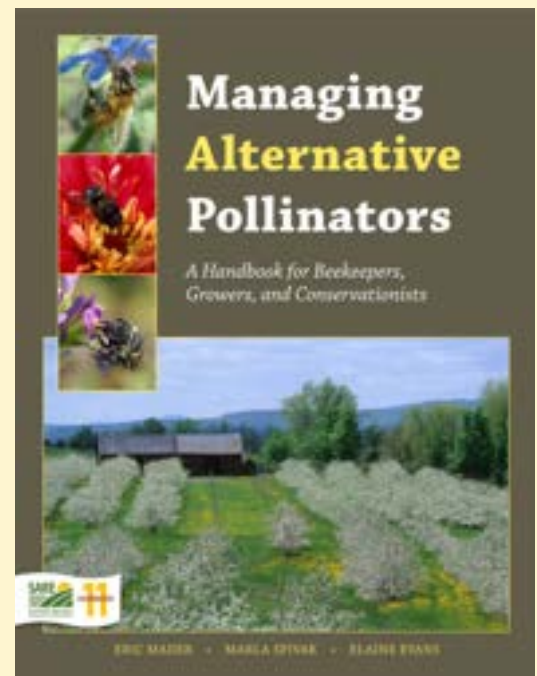
# COMMUNICATION WITH BEEKEEPERS, FARMERS, AND APPLICATORS

## WHAT IS IMPORTANT WHEN DISCUSSING CONTRACTS?

The need for communication and cooperation between beekeepers and farmers cannot be overstated and is the most effective way to reduce honey bee pesticide exposure risk in crops where managed honey bees are used for pollination. Both beekeepers and farmers benefit from developing positive working relationships and familiarizing themselves with one another's management practices.



### EXAMPLE CONTRACT



<https://www.sare.org/publications/managing-alternative-pollinators/chapter-one-the-business-of-pollination/pollination-contracts/>



## **DISCUSSIONS AND CONTRACTS BETWEEN FARMERS AND BEEKEEPERS SHOULD INCLUDE:**

- Rental fee, timing of payment, and relevant payment information.
- Preferred method of communication and emergency contact plan in the case of a disaster or pesticide issue.
- Coordination of crop timing with dates of colony arrival and departure.
- Where colonies are to be placed and access to the location(s), including a map or diagram and how the beekeeper can access their colonies when needed.
- Details of the beekeeper's responsibility to provide strong, effective colonies for crop pollination.
- A clear designation of responsibility for providing supplemental water when needed.
- Risks and responsibility of stinging incidents, theft or vandalism to hives, flooding or other risks depending on the location.
- A clear description of pesticide risks to the colonies and mitigation tactics. This may include:
  - o Details of the farmer's responsibility to safeguard bees from poisoning.
  - o A description of pest management practices in the cropping system before colonies are delivered and while colonies are present in the crop. Consider multiple routes of pesticide exposure like drift onto flowering weeds and water contamination.
  - o A description of buffers to be placed between treated areas and apiaries.
  - o A communication plan for informing neighboring farmers and applicators of apiary locations.
  - o A description of possible pesticide use in adjacent crops.
  - o Reference to state and regional information on crop pests and spraying schedule where available.

## **WORKING TOGETHER, BEEKEEPERS, FARMERS, AND APPLICATORS CAN HELP PROTECT HONEY BEES, WILD BEES, AND OTHER POLLINATORS.**





## WHAT FARMERS AND APPLICATORS CAN DO:

Learn the pollination requirements of your crops, and if (and when) they are attractive to bees. Plan your pest control operations with bee hazards in mind. Know where honey bee colonies are located to reduce pesticide exposure during applications.

- Identify hive locations. Check with your State Department of Agriculture for a hive registry program that can alert you to hives that might be in your area.
- Keep in mind that there are likely more honey bee colonies in the area than you are currently aware of. Honey bees have a large foraging range, and bees can be present in the crop even if hives are located a few miles away.
- Maintain appropriate buffers between treated areas and pollinator habitat.
- Consider your spray schedule and the establishment of no-spray buffers when coordinating hive placement with beekeepers.

Reduce the pesticide risk to bees.

- Use IPM methods to reduce the need for chemical applications
- Reduce bee contact with pesticides:
  - Avoid spraying blooming flowers during daylight hours when bees are flying.
  - Mow blooming weeds in orchard cover crops to remove their flowers before applying pesticides.
  - Be aware of other blooming crops or flowering weeds in the immediate vicinity when applying pesticides to a crop.
  - Inspect chemigation systems to verify that bees cannot access chemigation water and mitigate puddles that occur near spraying equipment and tanks, as bees frequently obtain water from muddy puddles.
- Select pesticides that are less toxic to bees when possible.
  - Select pesticides with the lowest pollinator precaution levels.
  - Choose a product with a short residual toxicity.
  - Do not apply pesticides rated for long residual toxicity to bees onto blooming plants, or in the case of raspberries, as some pollinators use the fruit as a sugar source.
  - Apply pesticides with longer residual toxicity when bees are not present or inactive.
  - Do not apply pesticides when unusually low temperatures or dew are forecast following treatment, as these conditions can extend residual times.
- Reduce pesticide drift:
  - Keep track of weather patterns including wind, precipitation, humidity, and daily temperatures to avoid unintentional pesticide drift to bee foraging areas nearby.
  - Verify that wind will not carry products in the direction of beehives, flowering plants including weeds, adjacent habitat, or non-target crops. Turn off sprayers near water sources (ponds, irrigation ditches, or leaking irrigation pipes), when making turns, and at the ends of fields.
  - Less drift occurs during ground application than aerial application. During aerial application, do not turn the aircraft back and forth across hives, blooming fields, or water sources.
  - Stay on the side of caution and avoid spraying any pesticide near bee colonies or on flowering plants, whether or not the pesticide has a bee caution on the label.

## WHAT BEEKEEPERS CAN DO:

- Do not leave unmarked hives near orchards or fields. Post your name, address, and phone number in large enough font to be read at a distance.
- Check with your State Department of Agriculture for a hive registration program. Your state may have its own program, it may use BeeCheck<sup>55</sup>, or it may not have a registration program. Non-agricultural applicators may also need to know the location of your hives (e.g., mosquito abatement programs).
- Communicate clearly to the farmer and/or applicator where your colonies are located, when they will arrive, and when you will remove them.
- Ask the farmer what pesticides, if any, will be applied while bees are in the field, and whether the label includes precautionary statements for bees.
- Learn about pest control problems and programs to develop mutually beneficial agreements with farmers concerning pollination services and prudent use of insecticides.
- Seek information on major crop pests and treatment options for your region.
- Miticides, such as those used for *Varroa destructor* control, are pesticides too. Use care when controlling pests in and around beehives and storing pesticides. Use pesticides for their intended use and follow all label directions carefully. Regularly replace brood comb to reduce exposure to residual miticides and other pesticides.



Before entering into a contract with a beekeeper, make sure you understand the rental fees, payment schedule, and any associated terms. Add this information to your Pollinator Management Plan (PMP) budget.

55. <https://beecheck.org/>

## SITE EVALUATION RUBRIC

This rubric is intended to help you identify potential areas on your land that are suitable for adding pollinator habitat. Generally, a higher score on the rubric indicates a better outcome. The rubric is not intended to be a comprehensive assessment or address all possible habitat types or environments. Long-term habitat maintenance is also necessary on a site to ensure its continued value to pollinators. Choose sites where you can effectively reduce non-desirable plant species and maintain the habitat, and look for detailed guides on site preparation and maintenance for your habitat type and region (see Resources section of this guide).

| SITE NAME                                                                |                                                           | DATE                                      |                                               |                                                   | SCORE |
|--------------------------------------------------------------------------|-----------------------------------------------------------|-------------------------------------------|-----------------------------------------------|---------------------------------------------------|-------|
| Score                                                                    | 0<br>(Do not proceed with site)                           | 1                                         | 2                                             | 3                                                 |       |
| Value as Crop Land                                                       | n/a                                                       | Site has high economic value as crop land | Site has moderate economic value as crop land | Site has little to no economic value as crop land |       |
| Distance from Pollinator Benefited Crops*                                | n/a                                                       | Approximately 0.5 to 0.75 miles away      | 2,500 ft. to 650 ft.                          | Less than 650 ft.                                 |       |
| Sunlight                                                                 | n/a                                                       | Full Shade                                | Partial Sun                                   | Full Sun                                          |       |
| Water Availability<br>(Needed for Establishment of Containerized Plants) | n/a                                                       | No water available                        | No water on site, but ability to bring it in  | Accessible water source on site                   |       |
| Slope                                                                    | 45° to 90° slope (inaccessible)                           | 11° to 45° steep slope                    | 5° to 10° moderate slope                      | 0° to 4° gentle slope                             |       |
| Soil Texture                                                             | n/a                                                       | Compacted                                 | Gravel, clay, sandy                           | Well-drained loam to permeable clay               |       |
| Soil pH                                                                  | Alkaline soil, pH above 7.5<br>or Acidic soil, pH below 4 | Acidic soil, pH between 4 and 5.5         | Slightly acidic soil, pH between 5.5 and 6.5  | Neutral soil, pH between 6.5 and 7                |       |
| Accessibility                                                            | Site is inaccessible                                      | Site is difficult to access               | Site is moderately accessible                 | Site is easily accessible                         |       |
|                                                                          |                                                           |                                           |                                               | <b>TOTAL SCORE</b>                                |       |

\*Habitat closer to a pollinator-benefited crop will help increase pollination more than distant habitat. Habitat for pollinators should also always be protected from pesticide applications. If the crop is treated with pesticides, have at least a 20-foot buffer between the crop and habitat and use practices that help reduce pesticide drift.

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## SECTION 3:

# IDENTIFYING MARKETING OPPORTUNITIES



Consumer interest in and support for pollinators has created new marketing opportunities for specialty crop growers on and off the farm. Opportunities include:

- Becoming certified as a business that supports Bee Friendly Farming® practices.
- Advertising as a Bee Friendly Farming® business.
- Capturing additional sales and price premiums for certified pollinator-friendly crops.
- Educating consumers about pollinator practices and environmental benefits.
- Establishing agritourism classes and other experiential opportunities around pollinator support.

More and more consumers are looking to support eco-friendly farming, especially when it comes to buying fruits, vegetables, herbs, and flowers. This growing interest can help farmers offset some - or even all - of the costs of creating and maintaining pollinator habitat, especially when those practices are certified by a third party for pollinator benefits.

Researchers in Michigan, for example, found that consumers were willing to pay up to 12 times more for potted plants coming from farms that followed bee-friendly practices.<sup>56</sup>

Two third-party pollinator-friendly certification programs are available in the United States:

- Bee Friendly Farming® (BFF) from Pollinator Partnership<sup>57</sup>
- Bee Better Certified from The Xerces Society for Invertebrate Conservation<sup>58</sup>

Programs like these offer certification for a nominal fee and provide marketing tools such as branded labels and signage (Figure 10). For more information contact Pollinator Partnership and the Xerces Society for Invertebrate Conservation listed in the Resources section of this guide.

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56. Heidi M. Wollaeger, Kristin L. Getter, and Bridget K. Behe. 2015. Consumer preferences for traditional Neonicotinoid-free, bee-friendly, or biological control pest management practices on floriculture crops. *HortScience* 50(5): 721-732.

57. <https://www.pollinator.org/bff>

58. <https://beebettercertified.org/>



Agritourism and events centered around pollinators can also create marketing opportunities for farms to educate the public, support conservation, and generate additional income while highlighting the important role pollinators play in agriculture. Pollinator agritourism invites visitors to farms to learn about bees, butterflies, and other pollinators in fun, hands-on ways. It blends education, conservation, and recreation with income-generating opportunities. These experiences, as well as on farm tasting-related events, often highlight the connection between pollinators and food production. Examples of popular pollinator-related agritourism activities and offerings:

- Guided pollinator tours – Walk visitors through pollinator gardens or wildflower meadows and talk about native bees, honey bees, butterflies, and their importance to crops.
- Pick-your-own flowers – Let guests cut fresh blooms from pollinator plots, especially native or pollinator-attracting plants.
- Beekeeping demonstrations – Offer safe, behind-the-scenes views of beekeeping practices, including honey extraction or hive maintenance.
- Pollinator workshops – Host activities like making bee hotels, seed bombs, or native plant container gardens.
- Photo spots – Create scenic areas in wildflower fields or near hives for visitors to take and share photos.
- Farm-to-table picnics or events – Offer pollinator-themed tastings or meals featuring fruits, veggies, and herbs that rely on pollination.



**FIGURE 11.**  
BEE FRIENDLY FARMING® FROM  
POLLINATOR PARTNERSHIP



## RESEARCH HIGHLIGHT

# CONSUMER WILLINGNESS TO PAY FOR POLLINATOR SERVICES

### STUDY

Wollaeger, H.M., Getter, K.L., and Behe, B.K. 2015. Consumer preferences for traditional Neonicotinoid-free, bee-friendly, or biological control pest management practices on floriculture crops. *HortScience*, 50(5): 721-732.



Researchers at Michigan State University conducted a nationwide Internet survey of more than 3,000 consumers about their “likelihood-to-buy” or “willingness-to-pay” for floriculture products that were produced using “bee friendly” practices. Bee-friendly practices were defined as neonicotinoid-free and/or the use of biological pest control practices. The study authors also tested the use of different terms indicating the use of “bee-friendly” practices to identify which term(s) resonated positively with consumers and elicited the greatest economic value.

The term “bee friendly” was valued most among survey respondents (compared to “neonicotinoid-free”) and was worth up to five times more to consumers who had purchased hanging flower baskets in the previous 12 months than those who had not. Similarly, the phrase “use of beneficial insects” was viewed positively by consumers compared to the term “traditional insect control.” The authors used a Likert scale in the survey (1-7) asking consumers to rate the importance of additional production attributes. Their findings are consistent with a previous study in Kansas where 93% of consumers were willing to pay 20% more for a carving pumpkin that was free of insecticides.<sup>59</sup>

Study authors concluded that the “importance of labeling extrinsic characteristics, such as “bee-friendly” to all survey respondents may provide the possibility of capturing premium prices with some demographic segments.”

59. Olson, D., Nechols, J.R., and Marr, C.W. 1995. Consumers’ preference for insecticide-free pumpkins in Eastern Kansas. *HortTechnology*, 5(3) 274-276.

## SECTION 4:

# CREATING A POLLINATOR MANAGEMENT PLAN

After much thought and research about the potential pollinator management strategies described in Sections 1-3, you may be left wondering “what next” or even feeling a bit overwhelmed by the options and opportunities. We suggest creating a written pollinator management plan (PMP) for your farm to map out goals, strategies, expenses and an implementation timeline.

A PMP is a customized site-specific document that takes into account the needs of your agricultural business and balances it with the needs of your ecosystem and pollinators.

A well-written PMP is one that remains flexible and dynamic enough to change over time as you adjust cropping schedules, budgets and goals, and, importantly, as you develop your pollinator knowledge and aspirations.

A simple PMP template is shown below to help get you started. The template is organized to provide space for your:

- Vision
- Goals
- Resource inventory
- Management strategies
- Implementation timeline
- Pollinator budget

An example PMP from Phil Stowe of Walking Plants Orchard in Minnesota is presented in Section 6: Case Studies so you can see how this U.S. Midwest grower of honeyberries plans to add wild pollinator resources to his farm.

## POLLINATOR MANAGEMENT PLAN: TEMPLATE (QUICK REFERENCE)

This section begins with a Quick Reference for developing a Pollinator Management Plan, followed by an example blank template to help you create your own plan.



# Pollinator Management Plan

Create a plan for supporting pollinators on your farm



*Sweat bee (Halictidae)* Photo: iNaturalist

This guide is meant to serve as a tool to help you develop and document goals, strategies, and budgets for use in a pollinator management plan (PMP) on your farm.

A PMP is a written document that outlines intentional strategies and best practices for managing and supporting pollinator populations at a site. PMPs are customized and site-specific, taking into account the needs of the agricultural and farming activity in balance with the needs of the target pollinators.

Specialty crop growers, farmers, and ranchers should use the PMP Template contained within this guide as a starting point for their farm. Each PMP should be tailored to the unique conditions and management goals for your farm.

The PMP can be as short or as long as you like, but the idea is to create a document that can serve as a helpful reference when implementing, sharing and monitoring your pollinator goals. The PMP can act as a roadmap for immediate and long-term pollinator management on your farm. A well-written PMP is one that remains flexible and dynamic enough to change over time as you adjust cropping schedules, budgets and goals, and, importantly, as you develop your pollinator knowledge.

## ABOUT

The idea for the Pollinator Management Plan (PMP) guide and template was borne out of conversations with specialty crop growers from across the Midwest during a series of focus groups conducted in winter 2024 as part of a pollinator project coordinated by the University of Minnesota.

Many focus group participants showed a strong interest in pollinators and pollinator management but simply didn't know "where to begin" when researching and developing strategies to support pollinators on their farm. With this in mind, the PMP template was developed to supply Midwestern specialty crop growers with location-relevant information to support developing cropping schedules, budgets, goals, and pollinator knowledge to best manage pollinator populations. .

**Funding:** This project was supported by funds from the State of Minnesota Pollinator Research Account, administered by the University of Minnesota College of Food, Agricultural and Natural Resource Sciences on behalf of the Board of Regents. Grant # 1806-11033-FAPOL-1377051.

**Project partners:** University of Minnesota, CFANS; University of Minnesota, CARL; University of Minnesota Bee Lab; and Pollinator Partnership



## USING THE POLLINATOR MANAGEMENT PLAN GUIDE & TEMPLATE

Prompts in this guide have been developed to help you with the process of brainstorming and planning (look for the pencil emoji ✎). Answers to the prompts will provide the basis for your plan. Example planning statements from specialty crop growers are included throughout the guide (look for the bee emoji 🐝). A blank template is provided at the end of this document where you can record your own PMP.

If you are new to pollinator management, we suggest creating a vision and goals that begin with the first 3 years (e.g., building knowledge and testing plantings), 4-5 years (e.g., observations in hand, consider larger plantings) and 6-10-years (e.g., demonstrating and sharing new knowledge). Start small and build from there as your knowledge, resources, and interests grow! Whether or not you are new to pollinator management and the benefits it can offer, you'll find that having a written PMP will serve as a helpful reference. Let's get started!

### VISION

This first planning task should be rewarding as you dream a bit about what your farm will look like, how pollinators might be integrated into your landscape, and the benefits they will bring over time. In the next planning task, you will use this vision to create specific PMP goals.

✎ Prompt: Why are you interested in supporting pollinators? What is your vision for pollinator management on your farm in 5-10 years? If you prefer, write a story or draw a map to communicate your vision!

Examples:

- "I strive to be a good steward of the land, and the land includes pollinators. My vision is to farm in harmony with nature while earning a living wage."
- "I envision having multiple fruit crops in production (e.g., honeyberries, apples, fall-bearing raspberries) and other plantings that support pollinators year-round."



*Squash Bee (Peponapis pruinosa)* Photo: iNaturalist

### GOALS

Goal setting is important - clearly defined goals that are SMART (specific, measurable, achievable, relevant and time-bound) not only motivate and inspire, but also help direct limited resources (time and money) toward vision-driven priorities. Goals reflect the "what" and "who" portion of your PMP, and strategies describe the "how".

It's often best to break up goals into shorter and longer-term time blocks such as 1 year, 2-5 years, and 6-10 years. Remember, "Rome wasn't built in a day," and neither will your pollinator habitat!

✎ Prompt: What will you do to support pollinators on your farm? What PMP long-term benefits do you hope to generate? What new knowledge and/or funding will be needed to achieve your long-term vision? Who will help with installation of your PMP?

Examples:

- Establish 2 acres of land in permanent prairie by year 3 as a source of pollinator habitat with financial assistance from a cost-share program.
- Identify flower and fruit pesticides that have minimal impact on pollinators in year 1 and adopt on at least 25% of crop land.
- Become certified as a "Bee Friendly Farm" in year 1 and immediately add to marketing materials.
- Explore ways to reduce harm to honey bee health using Integrated Pest Management (IPM). Identify at least one new practice to implement in year 2.
- Reduce pesticide drift contamination from neighboring farms in years 1-3.



## LOCATION & CURRENT MANAGEMENT PRACTICES

Inventory your land and plantings to identify any current habitat, food, and water resources for managed (e.g., honey bees) and wild pollinators. An easy way to get started is by using an aerial photo or a hand-drawn map to identify crop areas, edges, hedgerows, forest areas, conservation land, water sources, and homestead perimeters that can be adapted to support pollinators. A photo or map will help you visualize existing pockets of pollinator habitat and opportunities for new habitat that can be filled over time. Next, inventory other, non-physical resources that may be useful as you plan, install, and maintain pollinator habitat. These resources can include expertise or knowledge, time, and funding.

- Physical resources (tillable acres, pasture, forest, water, soil types)
- Expertise/access to knowledge (local NRCS office, Soil & Water Conservation District offices, seed companies, Extension educators, pollinator experts)
- Time (your time + volunteers, interns, and hired help)
- Funding (income, cost share, grants, loans)

 Prompt: Where is your farm located? What wild and managed pollinator resources do you already have in place on your farm? Remember, resources include summer and winter habitat, nectar and pollen for food, and water. What opportunities do you have to create new habitat?

Examples: Take a look at the map created below by Phil Stowe from Walking Plants Orchard in Osakis, Minnesota. Notice how he identified existing cropland, water sources, and CRP areas as well as areas where he plans to install new native pollinator habitat (🌸).



## POLLINATOR MANAGEMENT STRATEGIES

Strategies are defined as plans of action; they address the "how" pieces of your PMP, such as "how you will achieve your vision and goals." As you develop your PMP, let your vision, goals, habitat resources, and any future opportunities guide you. Look back at your current resource inventory. What are your soil type(s), water availability, insect-pollinated crops, and existing pollinator habitat? Think about the seasons and pollinator needs for flowering plants during different times of the year. Check out the keystone practices described in the **Midwest Technical Guide to Pollinator Management** for ideas.

Some of the most common pollinator management strategies are listed below and further explained in the yellow sidebar on page 4.

- **Protect** habitat, forbs, shrubs, water resources (IPM, pesticide reduction)
- **Conserve** habitat, forbs, water resources
- **Restore** habitat, forbs, water resources
- **Establish** habitat, forbs, shrubs, water resources
  - In field
  - Between crops (cover crops)
  - Edges (field, forest, road)
  - Near home
- **Maintain** habitat, forbs, water resources

 Prompt: How will you achieve your PMP goals? What actions will you need to take in the short- and long-term?

Examples:

- "Retain natural nesting habitat by leaving piles of sticks around hedge or tree rows."
- "Research and apply for "Bee Friendly Farming" (BFF) certification from Pollinator Partnership in years 1-2."
- "Restore small wetland on NE corner of farm to create water for pollinators over the next five years."
- "Protect existing hives and habitat by talking to neighbors about spray drift and registering my hives on [Beecheck](#) in year 1."
- "Host CSA volunteer events in fall to help with maintenance of existing native prairie strips and bee identification."
- "Establish 200 feet of new native pollinator habitat along perennial fruit crop field edge in year 2"



## IMPLEMENTATION TIMELINE

Get ready to put your plan into action! Most pollinator habitat is installed gradually with adjustments made as plants mature, cropping systems change, and goals evolve. Create a short and long-term timeline for implementing your PMP strategies. Note plantings that may be needed to fill flowering gaps and/or to attract crop-specific pollinators. Simply create a list or use a calendar for more detailed planning.

 Prompt: What is your timeline for implementation? What will happen each month or season or year? What will you plant and when?

Example: "Prepare site at least 12 months prior to seeding. Plan to seed pollinator seed mix in fall."

## BUDGET

Given your goals, strategies, and timeline, estimate the costs associated with your PMP. Think about what expenses will be necessary as you first implement a strategy and for on-going maintenance each season or annually. Be sure to capture labor costs (installation, maintenance); material expenses (seeds, plants, signs, mulch), equipment, fuel, and utility (water) needs.

Next, research added "income" that may result from your PMP. Income in this case refers to market premiums for pollinator-friendly farming services, gross sales generated from pollinator farm tours or educational events, as well as cost-share or grant opportunities that may be available to help you pay for the pollination services on your farm (e.g., USDA Natural Resources Conservation Service or state Board of Water and Soil Resources). Lastly, calculate the net annual investment needed to implement your PMP:  
 $(\text{costs} - [\text{grants or cost share} + \text{market premiums}]) = \text{net annual investment}$   
Based on your final budget numbers, are there any changes needed to your goals and strategies? If so, revise these now and create an updated budget.

 Prompt: What will your PMP cost annually over the next 1 year, 2 years, and 5 years?

Example: See PMP budget created by Phil Stowe of Walking Plants Orchard on page 5.



*Honey Bee (Apis mellifera)* Photo: iNaturalist

### Key actions to support pollinator habitat on your farm:

- Provide buffer strips or habitat near fields or orchards
- Increase flower abundance and diversity; aim for continuous bloom throughout the season
- Provide nesting habitat
- Reduce impact of mowing
- Communicate with beekeepers about pesticide applications
- Reduce pesticide use and follow IPM
- Maintain riparian buffers that provide pollinator habitat
- Plant cover crops in between rows or as a rotational crop
- Create or maintain water sources for pollinators
- Introduce or maintain quality nectar and pollen resources
- Keep an eye out for native pollinators to see the positive impact you are having.

## Example: Pollinator Management Plan Budget for Walking Plants Orchard, Osakis, MN

| YEAR                                 | UNIT    | # UNITS (a) | PRICE/UNIT (b) | COST \$ (a*b) |
|--------------------------------------|---------|-------------|----------------|---------------|
| <b>YR 1: Establishment (2025)</b>    |         |             |                |               |
| Labor                                | hour    | 20          | 20             | 400           |
| Seed starting mix                    | package | 1           | 50             | 50            |
| Forb plants                          |         | 1           | 250            | 250           |
| Bushes (haskap)                      | bush    | 682         | 7              | 4,774         |
| Soil amendments                      | acre    | 1           | 400            | 400           |
| Equipment charge                     | day     | 1           | 500            | 500           |
| Landscape fabric                     | foot    | 3,300       | 1              | 3,300         |
| Year 1 Subtotal (c)                  |         |             |                | 9,874         |
| Year 1 Income (incl. cost share) (d) |         |             |                | 0             |
| Year 1 Total Cost (c-d)              |         |             |                | 9,874         |
| <b>Year 2: Maintenance (2026)</b>    |         |             |                |               |
| Labor                                | hour    | 100         | 20             | 2,000         |
| Fencing wire                         | bale    | 1           | 200            | 200           |
| Fencing t-posts                      | post    | 132         | 6              | 792           |
| Year 2 Subtotal (e)                  |         |             |                | 2,992         |
| Year 2 Income (incl. cost share) (f) |         |             |                | 0             |
| Year 2 Total (e-f)                   |         |             |                | 2,992         |
| <b>Years 1 + 2 Total</b>             |         |             |                | <b>12,866</b> |

### Budget Notes & Assumptions

- All overhead expenses are attributed to Haskap enterprise and CRP.
- Owner labor and management is not charged. Only hired labor is included in labor estimate and is assumed to be 20 hours total during the first establishment year and then 5 hours/week for 20 weeks (May-August) to maintain new plants in year 2.
- Existing irrigation supplies will be used so no cost has been attributed for these or for water which is pumped from well.
- We assume no opportunity costs for land that will be planted with flowering perennials and Linden trees as the land does not otherwise support crop production.

Use the template and prompts below as a guide for creating your own pollinator plan using a word processing program. Feel free to adjust or include different information as you see fit. The PMP should be unique to your farm. Be sure to revisit your PMP often as your vision, knowledge, resources, and interests grow! For more information about pollinator management on farms visit [www.EXTENSION WEBSITE](http://www.EXTENSION WEBSITE) and the **Midwest Technical Guide to Pollinator Management** found there.

## **POLLINATOR MANAGEMENT PLAN TEMPLATE**

**Farm name:**

**Date created:**

### **VISION**

Why are you interested in supporting pollinators? What benefits do you hope to generate? In what ways would having a strong pollinator community strengthen your farm/orchard/etc.? What is your vision for pollinator management on your farm in 5-10 years? If preferred, write a story or draw a map to communicate your vision!

### **GOALS**

What will you do to support pollinators on your farm? What new knowledge and/or funding will be needed to achieve your long-term vision? Who will help with implementation of your PMP? (Make sure your goals are SMART: specific, measurable, achievable, relevant and time-bound.)

### **LOCATION & CURRENT MANAGEMENT PRACTICES**

Where is your farm located? What native and managed pollinator resources do you already have in place on your farm? Remember, resources include summer and winter habitat, nectar for food, and water. What opportunities do you have to create new habitat? For ideas, visit <https://beelab.umn.edu/create-nesting-habitat>.

### **POLLINATOR MANAGEMENT STRATEGY**

How will you achieve your PMP goals? What constructive and/or protective actions will you need to take in the short term and long term? What will you need to achieve your goals (labor, materials, equipment, financing, etc.)?

### **IMPLEMENTATION TIMELINE**

What is your timeline for implementation of strategies? What will happen each month or season or year? How will you prepare the land for planting, what will you plant, and when will you plant?

### **BUDGET**

What will your PMP cost annually over the next 1 year, 2 years, and 5 years? Create your own spreadsheet or simply itemize expenses, cost share funds, and new income or cost savings generated by implementing your PMP using the example in this guide.

# POLLINATOR MANAGEMENT PLAN: TEMPLATE

|                                         |                                |
|-----------------------------------------|--------------------------------|
| FARM NAME                               |                                |
|                                         |                                |
| FARM LOCATION                           |                                |
|                                         |                                |
| DATE                                    | CREATED BY                     |
|                                         |                                |
| VISION                                  |                                |
|                                         |                                |
| GOALS                                   |                                |
|                                         |                                |
| LOCATION & CURRENT MANAGEMENT PRACTICES | POLLINATOR MANAGEMENT STRATEGY |
|                                         |                                |
| IMPLEMENTATION TIMELINE                 | BUDGET                         |
|                                         |                                |

## POLLINATOR MANAGEMENT PLAN BUDGET

| YEAR 1 EXPENSES                                                                                         | PRICE/UNIT (\$) | NUMBER UNITS | COUNT | TOTAL COST (\$) |
|---------------------------------------------------------------------------------------------------------|-----------------|--------------|-------|-----------------|
| <b>Year 1, Establishment:</b><br>Labor<br>Seed/plants<br>Soil amendments<br>Fencing<br>Signage<br>Other |                 |              |       |                 |
| Year 1 total                                                                                            |                 |              |       |                 |
| Cost-share                                                                                              |                 |              |       |                 |
| My total costs, Year 1<br>[Year 1 total - Cost-share]                                                   |                 |              |       |                 |
| YEAR 2-5 EXPENSES                                                                                       | PRICE/UNIT (\$) | NUMBER UNITS | COUNT | TOTAL COST (\$) |
| As needed                                                                                               |                 |              |       |                 |
| Annual                                                                                                  |                 |              |       |                 |
| Years 2-5 total                                                                                         |                 |              |       |                 |
| Cost-share                                                                                              |                 |              |       |                 |
| My total costs, Years 2-5<br>[Years 2-5 total - cost-share]                                             |                 |              |       |                 |
| YEAR 6-10 EXPENSES                                                                                      | PRICE/UNIT (\$) | NUMBER UNITS | COUNT | TOTAL COST (\$) |
| As needed                                                                                               |                 |              |       |                 |
| Annual                                                                                                  |                 |              |       |                 |
| Years 6-10 total                                                                                        |                 |              |       |                 |
| Cost-share                                                                                              |                 |              |       |                 |
| My total costs, Years 6-10<br>[Years 6-10 total - cost share]                                           |                 |              |       |                 |



## SECTION 5:

# RESOURCES

Your State Department of Agriculture is a great place to look for additional resources, innovative programs, technical notes, pilot programs, financial incentives and other support for promoting and protecting pollinators on your farm. State University Extension Service contacts are also valuable sources of pollinator conservation and IPM information.

### GENERAL RESOURCES

#### INTERACTIVE MIDWEST VEGETABLE GUIDE

<https://mwveguide.org/>



#### MIDWEST FRUIT PEST MANAGEMENT GUIDE (PURDUE)

[https://ag.purdue.edu/departments/hla/extension/\\_docs/id-465.pdf](https://ag.purdue.edu/departments/hla/extension/_docs/id-465.pdf)



#### USDA/FOREST SERVICE FIRE EFFECTS INFORMATION SYSTEM (FOR PLANT- SPECIFIC GROWTH REQUIREMENTS)

<https://www.feis-crs.org/feis/>



#### NORTH CENTRAL, SUSTAINABLE AGRICULTURE, RESEARCH & EDUCATION PROGRAM

<https://northcentral.sare.org/resources/>



#### NORTH CENTRAL, INTEGRATED PEST MANAGEMENT CENTER (LINKS TO ALL STATES)

<https://www.ncipmc.org/>



#### UNIVERSITY OF MINNESOTA EXTENSION FRUIT AND VEGETABLE FARMING

<https://extension.umn.edu/fruit-and-vegetable-farming>



#### UNIVERSITY OF MINNESOTA BEE LAB

<https://beelab.umn.edu/>



## STATE DEPARTMENTS OF AGRICULTURE

This guide is intended to be a broad and brief overview of the ways specialty crop growers may support and protect pollinators on their landscapes. The topics included are complicated and have more details to be understood once you are ready to implement ideas. See the list of resources below for more information and reach out to technical assistance providers for on-the-ground support. There are many factors to consider when successfully adopting best management practices for pollinators.

### IA

<https://www.iowadnr.gov/Conservation/Iowas-Wildlife/Pollinators>



### IL

<https://dnr.illinois.gov/pollinatorresources.html>



### IN

<https://www.in.gov/isda/programs-and-initiatives/pollinator-habitat/>



### KS

<https://pollinatorpartners.ksdot.gov/>



### MO

<https://mdc.mo.gov/your-property/improve-your-property/wildlife-management/pollinators>



### MI

<https://www.michigan.gov/mdard/plant-pest/pesticides/managed-pollinator-protection-plan>



### MN

<https://www.mda.state.mn.us/plants-insects/pollinators>



### NE

<https://nda.nebraska.gov/plant/entomology/bee1.html>



### ND

<https://gf.nd.gov/pollinators>



### OH

<https://agri.ohio.gov/divisions/plant-health/apiary-program/apiary-program>



### SD

<https://habitat.sd.gov/resources/pollinator-habitat.aspx>



### WI

[https://datcp.wi.gov/pages/programs\\_services/pollinatorprotection.aspx](https://datcp.wi.gov/pages/programs_services/pollinatorprotection.aspx)



# FREQUENTLY ASKED QUESTIONS

## **Q. HOW WILL MY ACTIONS BE AFFECTED IF POLLINATOR SPECIES ARE LISTED UNDER THE ENDANGERED SPECIES ACT OR OTHER STATE LISTINGS?**

There are differences between species listed federally and those listed throughout the various states in the U.S. Midwest. There are existing programs and agreements that can be utilized to help protect farmers who have adopted voluntary conservation measures prior to and/or after a species is listed. Some actions are designed in the hope of preventing decline of the species to the point where listing is prudent, while others are designed to support the recovery of the species. For example, a Conservation Benefit Agreement (CBA) is a voluntary agreement between private or non-federal property owners, aimed at supporting the conservation or recovery of specific species. These species may include those listed as endangered or threatened under the Endangered Species Act (ESA) and/or at-risk species that are not listed. More information is available at <https://www.fws.gov/program/endangered-species> and <https://www.fws.gov/library/collections/tools-conservation-partnerships>

## **Q. AM I BETTER OFF MANAGING FOR NATIVE POLLINATORS, OR FOR HONEY BEES AND BUMBLE BEES SPECIFICALLY?**

The choice between managing for native pollinators versus honey bees and bumble bees depends on various factors, including the specific crops being cultivated, local environmental conditions, and conservation goals. Diversifying pollinator management to include a mix of native bees and managed bees can provide a more stable and effective pollination service. It also supports broader biodiversity and resilience in agricultural ecosystems.

## **Q. WILL MY WATER USE INCREASE WITH THE INSTALLATION OF HABITAT?**

Native plants are adapted for their local climate and are therefore well-suited to the various environmental stresses of each region, including drought. As a result, installing native habitats can reduce water use over time. The addition of habitat elements such as cover crops can help retain moisture in soil, reducing the need for supplemental water. Additional water is usually needed when potted plants are used to create habitat, but after about 1 to 3 years, the plants will have formed a deep root system and will not require watering.

## Q. SHOULD I CONSIDER ENROLLING IN CERTIFICATION PROGRAMS THAT RECOGNIZE MY POLLINATOR-FRIENDLY PRACTICES?

Certification programs can help show others what you are doing to support pollinators and conservation. Consumers are seeking out products that are produced in ways that help the environment and sustainability. Additionally, being part of a certification program gives you access to resources and community. Check out the Pollinator Partnership Bee Friendly Farming Program as one example.

## Q. WHERE CAN I SOURCE SEED AND PLANT MATERIAL FOR MY HABITAT PROJECTS?

Native plant material and nursery resources:

### POLLINATOR PARTNERSHIP

<https://www.pollinator.org/guides#vendors>



### CALSCAPE

[https://calscape.org/plant\\_nursery.php](https://calscape.org/plant_nursery.php)



### PLANT NATIVE

<https://www.plantnative.org/>



### MNL NATIVE SEED AND PLANT PRODUCTS

<https://mnlcorp.com/native-seeds-and-plants/>



### MONARCH JOINT VENTURE

<https://monarchjointventure.org/mjvprograms/habitat/milkweed-vendor-map>



### XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

[https://www.xerces.org/milkweed/milkweed-seed-finder#mwf\\_tool](https://www.xerces.org/milkweed/milkweed-seed-finder#mwf_tool)



### RIGHTS-OF-WAY AS HABITAT WORKING GROUP

<https://rightofway.erc.uic.edu/resources/seed-expert-map/>



## Q. WHERE CAN I GET TECHNICAL ASSISTANCE AND FUNDING TO IMPLEMENT POLLINATOR-FRIENDLY PRACTICES?

In addition, to the resources presented in the Resources chapter, review the following links for support:

### USDA NRCS FINANCIAL ASSISTANCE

<https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/>



### POLLINATOR PARTNERSHIP CONSULTING

<https://www.pollinator.org/consulting>



### NATIONAL ASSOCIATION OF CONSERVATION DISTRICTS TECHNICAL ASSISTANCE GRANTS

<https://www.nacdnet.org/technical-assistance-grants/>



## Q. AM I MORE LIKELY TO GET STUNG WITH MORE BEES ON MY FARM?

Unlike cartoons and Hollywood movies, bees are not flying around looking for people and pets to sting. You can safely observe bees visiting flowers from just inches away without the risk of being stung. Stings typically occur when bees are disturbed at their nests, accidentally stepped on or pinched, or become trapped in clothing. To avoid stings, steer clear of social bee nests, which may be located underground (as with bumble bees) or in tree cavities (as with honey bees). Be aware that wasps, such as yellow jackets, also nest in the ground and are frequently mistaken for bees.





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## SECTION 6:

# CASE STUDIES: POLLINATOR MANAGEMENT IN ACTION

### PROFILE #1

## WALKING PLANTS ORCHARD, PHILLIP STOWE, OSAKIS, MN



Walking Plants Orchard (WPO) is a small fruit farm in Osakis, MN that has been owned by Phillip Stowe since 2003. Stowe originally purchased the land, 55 acres enrolled in the Conservation Reserve Program (CRP), with plans to gradually establish a fruit farm and retire from his full-time software job. Fast forward to 2024 and you'll find Stowe proudly managing 1.5 acres of haskap, also called "honeyberries," two acres of fruiting trees (cherries, aronia berries, apples, apricots and peaches), and 20 acres of CRP. Much of the remaining land is leased to another grower who sustainably produces a prairie plant called Indiangrass (*Sorghastrum nutans*) for use in CRP seed mixes. A large honey producer also places approximately 20 hives on Stowe's land every year during summer. The haskap are Stowe's "cash crop" yielding 3,000 pounds of fruit (3 lbs. per plant) annually and are marketed wholesale to four wineries and two meaderies in Minnesota. In fall of 2024, Stowe began marketing a portion of his harvest frozen and as processed haskap jams and vinegars for direct sale to consumers on his newly created website.<sup>60</sup>

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60. <https://www.walkingplantsorchard.com/>

When asked about pollinators on his land, Stowe discussed his goal of managing in ways that would support pollinators and other beneficial insects. “I want to learn what not to do - to make sure that I am not harming the bees on the farm,” he said. After a careful inventory of Stowe’s management practices and natural resources, we learned that he was, in fact, doing everything right.

Stowe has and continues to manage his fruit trees and the 1,000 haskap plants primarily by applying organic practices, including the use of fabric mulch between rows to prevent weeds (in lieu of using herbicides) and netting to cover the haskap during fruiting to exclude damaging insects (instead of spraying insecticides). In addition, Stowe employs what are called “keystone pollinator practices” such as the planting of nectar-rich Dutch white clover around the perimeter of his haskap and tree fruit plots, allowing weedy areas to flower, maintaining a small pond to provide water, and encouraging nesting areas by providing undisturbed ground, hedgerows, buffer strips, tree snags, and bee nesting boxes.

After learning more about Stowe’s current management practices, we worked with him to create a pollinator management plan (PMP) that focused on: 1) filling flowering gaps on the farm to provide additional nectar and pollen sources for wild pollinators; 2) registering his land on BeeCheck™<sup>61</sup> to prevent pesticide drift from neighboring farms; 3) becoming Bee Friendly Farm (BFF)<sup>62</sup> certified to help brand his product; and 4) including information on his website about pollinator practices at WPO to educate consumers.

Stowe created a PMP in the fall of 2024 to address his new pollinator goals which include planting another 682 bushes of haskap and a new section of Dutch white clover. The haskap varieties were selected to take advantage of different bloom times - from April to June. Stowe will also plant Linden trees along the northern edge of the CRP acreage as well as a variety of native perennials with staggered bloom times in pocket areas around the farm to increase nectar and pollen availability throughout the seasons. Stowe estimates that the cost of planting and maintaining the new haskap, clover, trees and perennials during the first two years will be \$12,866. These direct costs include labor, seeds, plants, trees, soil amendments, landscape fabric, equipment rental, and fencing.

The future vision for WPO, written by Stowe as part of his new PMP, reads: “As organic producers of haskap berries with honey bee hives and approximately 20 acres of additional CRP, we strive to produce a marketable crop with the help of native pollinators ... We would like to extend our ‘pollinator season’ to include late summer and fall while introducing our customers to pollinator practices. The habitat needed to support this vision requires observing, maintaining and enhancing our landscape to allow native pollinators to thrive in abundance.”

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61. <https://beecheck.org/>

62. <https://www.pollinator.org/bff>

# POLLINATOR MANAGEMENT PLAN: WALKING PLANTS ORCHARD

OSAKIS, MN | <https://www.walkingplantsorchard.com/about>

**Owner:** Phil Stowe

**Date created:** September 2, 2024



## POLLINATOR VISION FOR WALKING PLANTS ORCHARD (WPO)

As organic producers of Haskap berries with honey bee hives and approximately 20 acres of additional Conservation Reserve Program (CRP) land, we strive to produce a marketable crop with the help of native pollinators. In spring and early summer, we enjoy walking throughout the orchard, next to flowering plants, while hearing the buzzing of pollinator activity. We would like to extend our “pollinator season” to include late summer and fall while introducing our customers to pollinator practices. The habitat needed to support this vision requires observing, maintaining and enhancing our landscape to allow native pollinators to thrive in abundance.





## POLLINATOR GOALS

### SHORT-TERM (2024 - 2026):

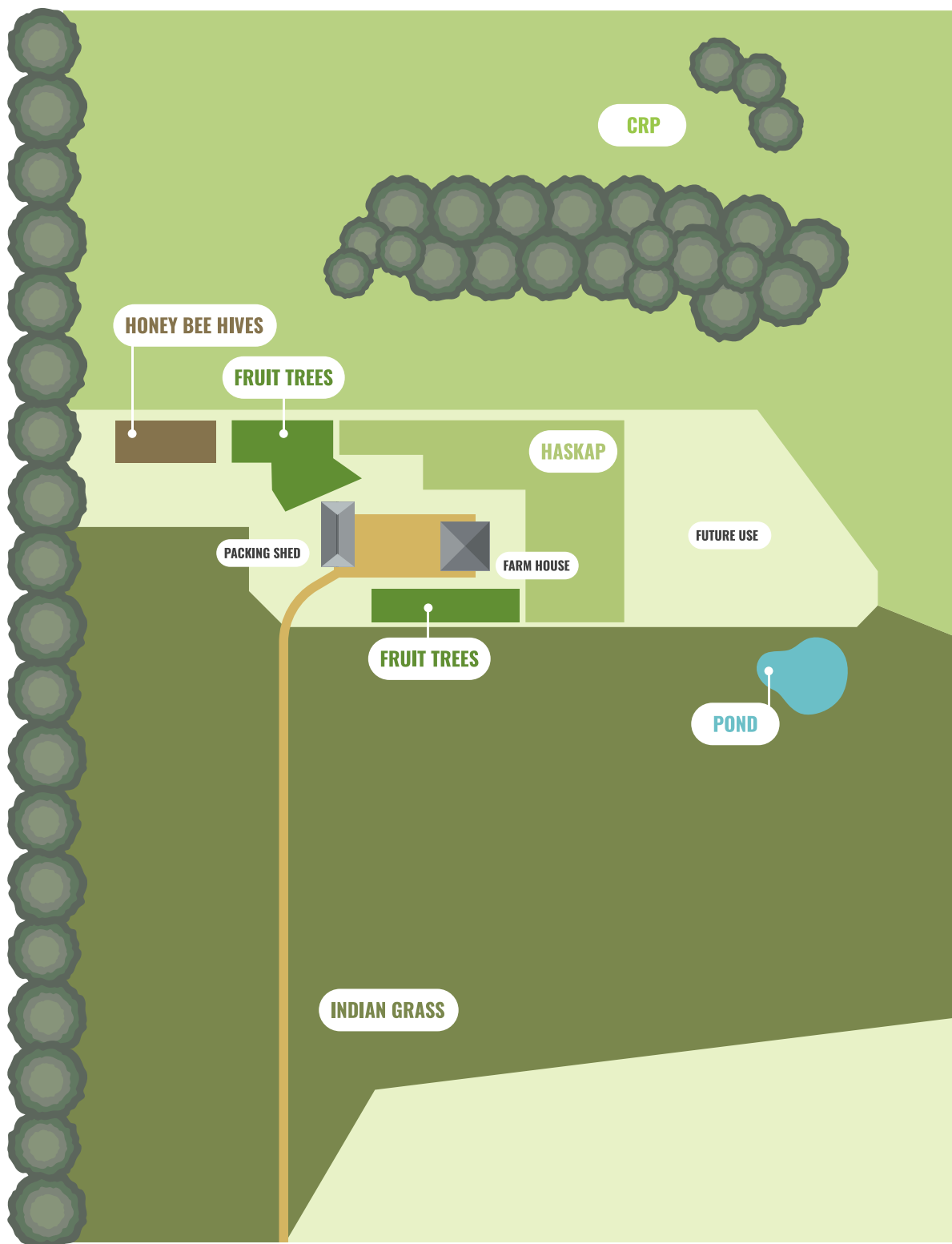
- 1 Encourage and protect pollinators, especially native species (e.g. bumble bees, mason bees, miner bees, sweat bees) that emerge before honey bees as we rely on these for the pollination of our early-flowering haskap varieties.
- 2 Remove wild parsnip from CRP and surrounding areas using control measures that are safe for native pollinators and honey bees; and
- 3 Educate consumers and other growers about pollinator-friendly practices on the farm through the WPO

### LONG-TERM (2027 +):

- 1 Learn more about native pollinator ecology and habitat so I can do a better job of supporting them on the farm; and
- 2 Supplement habitat for native pollinators on land that is coming out of CRP in 2029 with plantings that complement the existing habitat..

## LOCATION AND CURRENT MANAGEMENT PRACTICES

Our 55-acre farm is located in Douglas County. The soil is mainly clay-loam. By the end of 2025 we will manage three acres of haskap or “honeyberries” as well as two acres of other fruiting trees and shrubs. Of the original 55 acres that were originally in CRP when purchasing the farm in 2003, we renewed the CRP lease on 20 acres. The CRP contract will expire in 2029. The remainder of our land is leased to another grower who produces Indian Grass to sell as seed for use in CRP mixes.





## WALKING PLANTS ORCHARD FARM: 2024

WPO, minus the leased Indian grass land, is managed organically, but we are not certified. Keystone pollinator management practices are already in use:

- Approximately 20 acres of CRP planted in grass mix
- Perennial flowering crops such as (white clover) within the orchard rows and around the haskap perimeters
- Flowering weedy areas
- Flowering trees and perennials
- Ponds and potholes
- Undisturbed ground, hedgerows, and buffer strips
- Dead trees/snags
- Bee nesting boxes
- No pesticide applications on crops (use netting to exclude birds and harmful insects)

We are surrounded by mostly conventional commodity crop farmers who use insecticides and herbicides. The majority of neighboring farmers have the farmer's cooperative creamery association custom spray.

## POLLINATOR STRATEGIES

### SHORT-TERM (2024 - 2026):

- Register honey bee hives on BeeCheck™ to ensure nearby crop growers and pesticide applicators have the stewardship information needed before spraying.
- Plant new flowering trees along fence lines to attract pollinators.
- Plant flowering native perennials that will support pollinators in late summer and fall.
- Become Bee Friendly Farming certified through Pollinator Partnership.
- Incorporate information about pollinators and pollinator-friendly farming practices on website.
- Manage wild parsnip on CRP land based on recommendations from Douglas County SWCD.
- Become certified organic and market Haskap as "organically certified"

### LONG-TERM (2027 +):

- Plant formerly CRP land in a new mix that is both pollinator-friendly and a sustainable farm use.

## POLLINATOR STRATEGIES

- Minnesota-California Honey Farm, 721 Wells St., Eagle Bend, MN 56446.
- CRP contact, Douglas County FSA Farm Program Staff
- Native seed contact (Indian Grass), S-Enterprises, Inc.
- MN Bee Lab, Associate Extension Professor, Elaine Evans

## POLLINATOR PLANT SPECIES



### WHITE DUTCH CLOVER: *TRIFOLIUM*

The Haskap orchard will be expanded with Aurora, Beauty, Beast, and Indigo Gem varieties. White Dutch clover will be planted around new rows.

White clover (*Trifolium repens*), also known as Dutch white clover, is a member of the Fabaceae family (legumes) that grows low to the ground. It forms perennial mats that spread 1 to 2 feet and grow from 3 to 12 inches tall. White clover has poor traffic tolerance and does not grow well in shade. White clover (Dutch white clover) is an introduced plant that can be a weed in lawns but is also grown in many bee lawns to attract pollinators.



### AMERICAN LINDEN: *TILIA AMERICANA*

American Linden tree seedlings will be planted along the northern edge of the CRP.

A large deciduous tree often used as an ornamental or shade tree. It grows naturally in well-drained soils in both dry upland areas as well as coves, lower slopes, and river bottoms. Tolerates some drought. Grows to 50 to 80 feet tall.

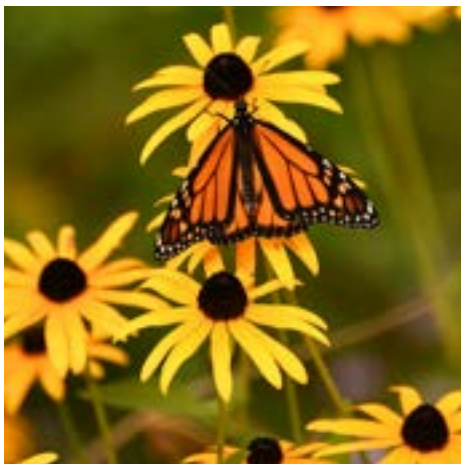
Tiny fragrant, yellow-white flowers that bloom in May-June are prolific nectar producers, and when in full bloom, they attract enough bees that you can hear the buzzing from several feet away.



### BLUE VERVAIN: *VERBENA HASTATA*

Wildflower seeds will be started and the sprouted plants will be transplanted to select locations near the CRP acreage. The seed varieties will be Blue Vervain, Black-eyed Susan, and Yellow Coneflower as described below.

Native perennial which commonly occurs in wet meadows, wet river bottomlands, stream banks, slough peripherals, fields, and waste areas. It is a rough, clump-forming perennial with a stiff, upright habit which typically grows 2 to 4 feet tall. Characteristics distinguishing blue vervain are its lance-shaped leaves, blue flowers, compact spikes, and fruits packed so tightly on the stem that they frequently overlap.



#### **BLACK EYED SUSAN: *RUDBECKIA HIRTA***

Black-eyed Susan, biennial or perennial, is a highly adaptable species found on a wide range of soil types. It has low to moderate water requirements and adapts well in full sun to partial shade. Yellow sunflower-like blossoms are found May to October in fields, prairies or open woods.



#### **YELLOW CONEFLOWER: *RATIBIDA COLUMNIFERA***

The beginning of summer coincides well with the blooming of coneflower. This plant can be found throughout the Great Plains states. Coneflower prospers best on light and moderately grazed prairie.

## SHORT-TERM IMPLEMENTATION AND MAINTENANCE TIMELINE

### 2024

- August: Meet with Douglas County SWCD to discuss wild parsnip management on CRP.
- October: Meet with UMN native bee specialist to identify native pollinators and plan for managing habitat in early May.

### 2025

- January: Register honey bee hives on BeeCheck™
- April: Start wildflower seeds. Linden trees arrive.
- May: Till soil for pocket plantings and expanded Haskap orchard. Transplant wildflower seedlings to select locations near Haskap. Plant Linden trees nursery along the northern edge of the CRP.
- Take soil samples for long-term Haskap plantings and amend soil as needed.
- June: Haskap plants arrive and installed. Landscape fabric laid after planting Haskap. White clover seeded between plants in orchard after landscape fabric installed. Wildflowers planted.

### 2026

- January: Apply for Bee Friendly Farming certification through Pollinator Partnership.
- January: Explore organic certification for farm.
- February: Add information about pollinators and pollinator-friendly farming practices to the “about” page on website.
- November: Apply for organic certification for farm.





## WPO POLLINATOR MANAGEMENT PLAN BUDGET

| 2024-2025 DIRECT EXPENSES                                        | PRICE/UNIT (\$) | NUMBER UNITS      | TOTAL COST (\$)<br>(\$/UNIT) X (NUMBER UNITS) |
|------------------------------------------------------------------|-----------------|-------------------|-----------------------------------------------|
| Labor                                                            | 20/hr.          | 20 hrs.           | 400                                           |
| Seed starting mix                                                | 50              | 1                 | 50                                            |
| Seed/plants                                                      | 250             | 1                 | 250                                           |
| Bushes                                                           | 7.00            | 682 haskap bushes | 4,774                                         |
| Trees                                                            | 4.00            | 50 linden trees   | 200                                           |
| Soil amendments                                                  | 400/acre        | 1 acre            | 400                                           |
| Landscape fabric                                                 | 1/foot          | 3300 ft           | 3,300                                         |
| Equipment rental                                                 | 500/day         | 1 day             | 500                                           |
| <b>Subtotal</b>                                                  |                 |                   | <b>9,874</b>                                  |
| 2026 DIRECT EXPENSES                                             | PRICE/UNIT (\$) | NUMBER UNITS      | TOTAL COST (\$)<br>(\$/UNIT) X (NUMBER UNITS) |
| Labor to maintain plants                                         | 20/hr.          | 100 hrs.          | 2,000                                         |
| Fencing wire                                                     | 200/bale        | 1                 | 200                                           |
| Fencing t-posts                                                  | 6               | 132               | 792                                           |
| <b>Subtotal</b>                                                  |                 |                   | <b>2,992</b>                                  |
| <b>Total for pollinator plantings<br/>and management (2 yrs)</b> |                 |                   | <b>12,866</b>                                 |

## WPO POLLINATOR MANAGEMENT PLAN BUDGET

- All overhead expenses are attributed to Haskap enterprise and CRP.
- Owner labor and management is not charged. Only hired labor is included in the labor estimate and is assumed to be 20 hours total during the first establishment year and then 5 hours/week for 20 weeks (May-August) to maintain new plants in year 2.
- Existing irrigation supplies will be used so no cost has been attributed to these or to water which is pumped from a well.
- We assume no opportunity costs for land that will be planted with flowering perennials and Linden trees as the land does not otherwise support crop production.



## PROFILE #2

# EVAN MOLIN, MOLIN MEADOWS FARM, CAMBRIDGE, MN.



## EVAN MOLIN OF MOLIN MEADOWS FARM

Evan and Jessica Molin run a mixed vegetable and cut flower operation that also offers “agri-tainment” in the fall to as many as 1,200 visitors each weekend. Located two miles north of the Anoka Sand Plain in Isanti County Minnesota, Molin Meadows Farm sits on 25 acres of former pasture and is surrounded by traditional corn and soybean operations.

The Molins purchased their farm seven years ago (2018) and spent the first year clearing brush and establishing plots for planting on three acres. Crop plantings include a rotation of tomatoes, peppers, green beans, zucchini, pumpkins, and sweet corn among other things. Since day one, the Molins have managed their land using strictly organic practices with an eye toward building pollinator habitat. Plantings of zinnia (*Zinnia asteraceae*) are interspersed between vegetable rows to attract bees, moths and butterflies. “We planted two rows of zinnias for every eight rows of produce beginning that first season,” explains Evan.

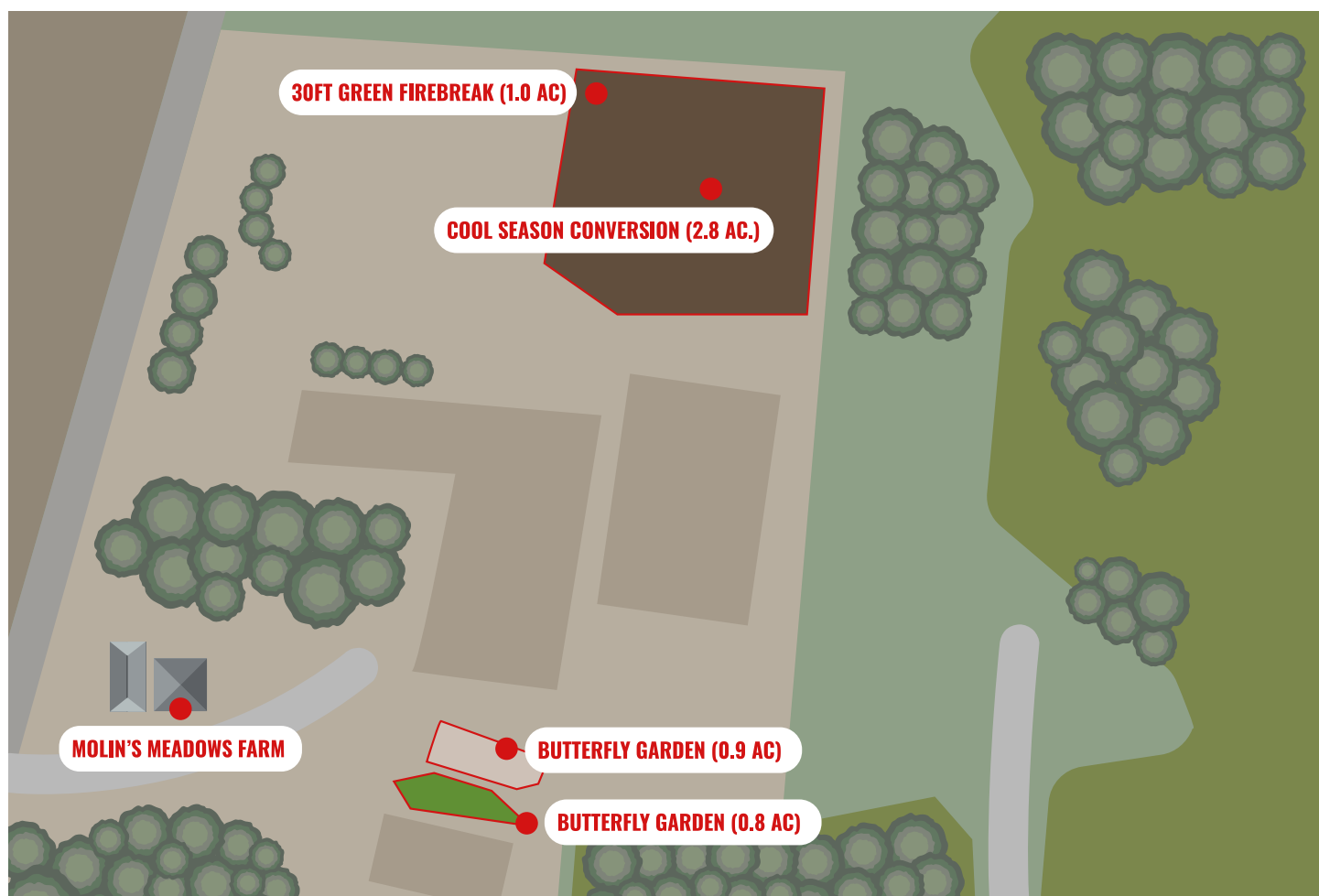
Pollinator habitat has gradually been expanded over the years to improve crop pollination and yield as well as biodiversity. “Biodiversity improves disease resistance,” Evan explains. “This is important when you don’t spray [pesticides or fungicides].” In addition to avoiding sprays to comply with organic recommendations, the Molin’s plant winter rye and clover as cover crops each fall to improve soil fertility and help with weed control. “Sometimes we let the cover crops flower before tilling to benefit the pollinators,” Evan says. “But we always terminate the cover before it goes to seed.”

The Molin’s sell their produce and cut flowers via a self-serve farm stand, the Cambridge Farmers Market, on-farm events, U-Pick, and Community Support Agriculture (CSA) subscriptions. Flower shares for the CSA come from 1/8th acre of peony (*Paeonia* spp.) plantings and another 1/8th acre of flowers planted annually including: ageratum (*Ageratum asteraceae*), gomphrena (*Gomphrena amaranthaceous*), Celosia (*Celosia amaranthaceous*), cosmos (*Cosmos asteraceae*), amaranth (*Amaranthus*), salvia (*Salvia officinalis*), bee balm (*Monarda didyma*), African marigolds (*Tagetes erecta*), lizianthus/prairie gentian (*Eustoma gentianaceae*), sunflowers (*Helianthus* spp.), and Redbor kale (*Brassica oleracea* ‘Redbor’).

"Pollinators fit in well with our farm. We are very cognizant of how pollinators are needed to do what we do," says Evan. With this philosophy and an interest in expanding cut flower offerings, the Molins met with Jason Beckler, a conservationist who works for the Minnesota Board of Water and Soil Resources (BWSR), in fall 2024 to develop a formal pollinator management plan for the farm. Together Jason and Evan created a 2-year plan to:

- (A) Surround the new pollinator plantings with a "green firebreak" planted with a clover mix (1 acre).
- (B) Install new pollinator-friendly perennial plantings in place of brome on what was formerly horse pasture (2.8 acres).
- (C&D) Install 1.7 acres of native flowers and grasses that support butterflies (market as a butterfly garden for farm visitors).
- (E) Add a 100-foot hedgerow of native spring-flowering shrubs, such as red-osier dogwood and pussywillow, along the south border of the farm to provide a spring source of nectar for pollinators and a cash crop that can be marketed.

The pollinator management plan outlined above is depicted in the map with letters corresponding to each management practice. Evan estimates that the new 5.5 acres of pollinator plantings will cost approximately \$13,900 to install. He plans to apply for a cost-share program to help offset the costs. Without assistance, Evan says he likely will not complete all of the project.



**MAP. NEW POLLINATOR INSTALLATIONS PLANNED FOR 2025.**



CURRENT CUT-FLOWER PLANTING AREA IN FALL AFTER TERMINATION AND CLEAN-UP.



ONE OF SEVERAL CURRENT VEGETABLE PLANTING BEDS IN FALL AFTER HARVEST.



FUTURE SITE OF BUTTERFLY GARDEN (SITES C AND D)



CURRENT CUT FLOWER PLOT (SOUTH OF BUTTERFLY GARDENS D & E)





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