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A Review on Bees

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Bees are great. They pollinate our delicious crops, the plants we use to feed livestock, and beautiful wildflowers that create not only scenery for us, but habitat for wildlife. Their contribution to the ecosystem and to humans is immense.

Bees are in trouble. Many species of bees are declining. Scientists suggest this decline is due to the rapid environmental changes in the last three decades.

Bees need our help. This handout provides an overview of bee ecology and behavior, and following will be a discussion on what people can do to help. The reader will find planting recommendations based on what the author observed our most common native bees foraging on.
Telling the difference between flies, wasps, and bees is not as easy as it sounds. These groups of insects are quite similar, and even experts get it wrong sometimes.

Bees have two pairs of wings, their antennae tend to be longer than flies, and most have more hair and fatter legs than flies and wasps.

Flies have triangular heads from above, short thick antennae, large forward facing eyes, and only one wing on each side of their body.

Wasps are mostly hairless, thin, have two pairs of wings, and have narrow waists. When flying, many wasps have two thin long legs that hang down.

“All bees sting.” There are many species of stingless bees, and male bees do not sting.

“All bees are aggressive.” Bees often warn before they sting, bumping into the annoyance with their bodies. Bees are more aggressive to humans if they are standing near the colony or the bee gets stuck in hair or clothing.

“Honey bees sting multiple times.” Honey bees are the only species of bee with a barbed stinger. The stinger often gets lodged in skin and rips from the bee’s abdomen, causing its death. Other species do not have barbed stingers, so the same individual can sting multiple times.

“All bees live in colonies.” Honey bees, bumble bees, and some species of sweat bees are eusocial. Eusocial bees share a nest and perform duties that help one another. However, many other species of bee are solitary or semisocial.

“All bees make honey.” In North America, only honey bees make honey. Other bees, like bumble bees, store nectar but the resulting substance is different from the stored nectar of honey bees.
Types of Native Bees in Massachusetts

**Carpenter bees**
Giant carpenter bees resemble bumble bees but are solitary insects that nest in wood. One can identify giant carpenter bees by their large size and shiny black abdomen. Giant carpenter bees (*Xylocopa virginica*) are the most common carpenter bee in Massachusetts.

Carpenter bees hibernate in the winter and mate in the spring. The mated females lay their eggs in 6-8 chambers in tunnels they create in wood. New adults emerge in August, forage to prepare for winter, and hibernate in tunnels.

**Sweat bees (*Halictidae*)**
Bees in the family *Halictidae* are sometimes called sweat bees because some species are attracted to human sweat. Sweat bees are sometimes metallic in color and many nest in the ground, though some nest in wood. Some species are **social**, having one queen that lays eggs and workers that help each other. Some species are **cleptoparasites**, meaning they steal resources from other bees. The rest are **solitary**, meaning each female lays and rears her own young.

Genera with common species in MA include: *Specodes* (cleptoparasites), *Lasioglossum*, *Nomia*, *Agapostemon*, *Augochloropsis*, *Augochlorella*, and *Halictus*. In some subfamilies in Halictidae both sexes overwinter, but in others only mated females overwinter. In the spring or summer the bees emerge and mate (if not already mated) and begin foraging, digging nests, and laying eggs.
Mining bees
Mining bees build their nests in the ground. They create tunnels with chambers for each egg the female will lay. Mining bees are solitary. Females will lay eggs onto a mixture of pollen and nectar within a chamber of the tunnel. When the egg develops into an adult it will overwinter in the tunnel until the following spring or summer.

Calliopsis andreniformis  Andrena carlini

Mason bees (*Osmia*)
Bees in the genus *Osmia* are referred to as mason bees. These bees make their nests in hollow twigs or existing holes in wood. They use mud to make compartments between each laid egg. They fill up the tunnel with compartments and eggs and seal the end with mud. These bees can be metallic green or blue, or black in color. Like mining bees, these bees are also solitary and make their own nests. Males are the first to emerge and they wait for females to mate with. Once females have mated, they look for a nest site and start gathering pollen and nectar to feed her young. The new bees develop into adults and overwinter until the following spring or summer.

Osmia virga  Osmia pumila

Photo by blueberrytalk
**Mellitta Americana**

*Mellitta americana* is one of the only cranberry specialists. It specializes on pollen from cranberry and blueberry. It is one of the most common small bee pollinator of cranberry in the North East. These bees are solitary and nest in the ground.

**Leafcutter bees in Megachilidae**

Leafcutter bees cut circular shapes out of leaves and use the pieces to build their nests. Most species build their nests in wood, but some build nests in the ground or in any cavity they find (like holes in concrete or snail shells). Leafcutter bees collect pollen on the underside of their abdomens instead of on their legs like other bees. Most species are solitary and each female makes her own nest. Each egg has a separate chamber with food for the developing bee. In most species the eggs develop into adult bees and overwinter until the following spring or summer.

There is potential for *Megachile addenda* to be an effective managed pollinator of cranberry. A relative of this species, the alfalfa leafcutter bee, is already being managed to pollinate alfalfa, carrots, and some other fruits and vegetables. This species nests in the ground near or on cranberry bogs. Learn more by reading Cane, 1996.

**Leafcutter Bee Nest Making**
Massachusetts Bumble Bee Identification

Female Bumble bee Identification

*Bombus impatiens*

*Bombus griseocollis*

*Bombus bimaculatus*

*Bombus vagans*

*Bombus fervidus*

*Bombus perplexus*

Male bumble bees look similar to females, but have yellow hairs on their faces.

Female bumble bee identification reprinted with permission:
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Many species of bees nest in holes in the ground.

Some species dig their own holes or use rocks and mud to build nests.

Some use existing holes in twigs, rocks, beetle burrows, etc.

Hive building bees typically nest between rocks, hollow tree stumps, or abandoned rodent or rabbit holes.
Bee Ecology

Life cycle
A gravid female lays her eggs in nest cells. The unfertilized eggs become males and the fertilized eggs become females. The egg-laying female can choose whether to lay female or male eggs. When the larvae hatch, they eat pollen until they are large enough to pupate. After the pupation period, they become adult bees. Depending on the species of native bee, they will emerge anytime between February and September.

Foraging temperature
Different species of bees forage at different temperatures. Based on information taken from a study in Oregon (Broussard et al, 2011) bumble bees were seen foraging most often at around 68°F, while honey bees foraged most often at around 76°F.

Buzz pollination
Plants in the potato family (Solanaceae) like tomatoes, potatoes, chili peppers, and eggplants need to be sonicated in order to release pollen. Some plants get pollinated more efficiently with buzz pollination like blueberry and cranberry. This is done by a behavior known as buzz pollination. Only some bees do this, like bumble bees, but honey bees are not one of them. Bees that buzz pollinate move their flight muscles rapidly, causing the flower and anthers to vibrate, dislodging pollen.

Tongue lengths and body size
Different species of bees have different tongue lengths. Short-tongued bees usually visit shallow flowers and longer tongued bees visit flowers with long corollas. Body size also plays a role in what flowers bees visit. Heavier bees usually visit stronger stemmed flowers and lighter bees visit weak stemmed flowers.

Bumble bee Lifecycle
Bumble bee queens emerge in early Spring. They feed themselves on early blooming plants, then look for a nest, usually a rodent hole. Queens make a ball from pollen and nectar and lay eggs into the mixture. Queens incubate the eggs for a couple of weeks.

Once those eggs develop into adults, they collect pollen and nectar to bring back to the nest to feed one another. The queen’s only job is to lay more eggs. The workers take advantage of used cells to store pollen or nectar.

Near the end of the colony cycle, the queen lays unfertilized eggs that become future queens. Both males and new queens leave the nest and generally do not return. The males wait on flowers for queens to mate with. New queens fill up on reserves to prepare for hibernation.

When winter comes, new queens are hibernating and all others expire.
Bee Food

**Nectar** provides carbohydrates and a water source to bees. Bees are more picky about the plants they collect pollen from than nectar.

**Pollen** is the main source of protein and essential amino acids for most species of bee. Different plants have different protein contents and amino acids.

It has been shown that the species of plants around a colony can impact larval growth. Therefore, the more plant variety the better. It has been demonstrated that pollen is necessary for proper ovarian development in bees. It is essential for queens to find plants with high protein content. On each foraging trip some bees forage exclusively for nectar, others for pollen, and some bees forage for both.

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**What does this mean for us?**

Install or do not mow plants with high protein content in their pollen, and have several species of plant available whenever possible.

Plants high in protein include those in the family Fabaceae- the pea, bean, or legume family.¹

Bumble bees frequently visit plants in the family Asteracea (like heath aster or New England aster) and Lamiaceae (like garden sage, catmints, or lavender), but they rarely collect pollen from these plants.

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**Fabaceae Examples**

<table>
<thead>
<tr>
<th>Bird's Foot Trefoil</th>
<th>Red Clover</th>
<th>Wisteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Bird's Foot Trefoil" /></td>
<td><img src="image2" alt="Red Clover" /></td>
<td><img src="image3" alt="Wisteria" /></td>
</tr>
</tbody>
</table>

¹ Photo by Max Westby is licensed under CC BY 2.0.
² Photo by peupleloup is licensed under CC BY 2.0.
³ Photo by Qwrtl is licensed under CC BY 2.0.
**Foraging strategies**

**Specialists and Generalists**

Some species of bees inherently favor certain species of flower. The bee species that preferentially collect floral resources from only a few species of flower are known as specialists. The bee species that are less picky about the species of flower they collect floral resources from are known as generalists. These terms apply not to the individual bee but to the species as a whole.

**Flower constancy**

Individual bees vary on how picky they are when collecting floral resources. Some bees will go out and collect pollen or nectar from a variety of flower species, and some bees will go out and collect pollen or nectar from mainly one species of flower. The picky bees are called flower constant.

There are consequences to being flower constant. It extends foraging time, since bees are skipping over rewarding flowers in search of the species they are foraging on. Farmers of crops want their pollinators to be flower constant. Bees that are flower constant make better pollinators because they stay on the monoculture and do not clog up the stigma of the crop with pollen from other plants.

The benefits to bees are currently not so clear to scientists. There are two mainstream hypotheses as to why a bee would choose to be flower constant. The first has to do with a theory that bees might have a limited memory capacity and therefore learning to manipulate one flower at a time might be advantageous. The other hypothesis has to do bees using a “search image” to pick out flowers from the surrounding environment.²

**Forage distance**

It is difficult to study foraging range, thus little is known about foraging range for many species of bee. Honey bees have been the most intensively studied. They usually forage 0.6-3.7 miles from their nest, but have been seen flying up to 12.4 miles when no other forage is available.
Predators, Parasites, and Parasitoids

Predators

Predators of bees include robber flies, wasps, assassin bugs, spiders, mammals, lizards, and birds.

Wax moths are serious predators of social bees. The gregarious larvae of the wax moth eat away at the nest and the immature bees inside it. In northern US and Canada wax moths do not survive the cold winters.

Parasites

Viruses are implicated in Colony Collapse Disorder for honey bees and so have received increased attention. There is evidence that honey bee viruses can spread between honey bees and bumble bees but little is known with respect to other native bees.

There are at least twelve viruses currently being studied in honey bees. Some of them being acute bee paralysis, deformed wing virus, sacbrood virus, and black queen cell virus.

Bacteria like those that cause American and European foulbrood in honey bees can cause substantial mortality. Bacteria are less studied in other bees.

Spiroplasmataceae is a group of prokaryotes that can cause mortality in honey bees. It has been identified in other bees like bumble bees, Osmia, and Anthophora, but little is known how the prokaryote affects these bees.

Chalkbrood

Chalkbrood is a fungus that infests the gut of infected honey bee larvae and cause the larvae to eventually starve. Similar diseases are also found in Megachile and Osmia. Stonebrood is another fungus that infects honey bees and causes the stone-like mummification of infected larvae in the colony.
Predators, Parasites, and Parasitoids (cont.)

At least three species of the microsporidian *Nosema* are known to infect bees. *N. apis* and *N. ceranae* are mostly found in honey bees and *N. bombi* is mostly found in bumble bees.

*N. apis* is associated with colony mortality in the winter and reduced build up in the spring. Honey bees are especially susceptible to *Nosema* in the winter when they are unable to defecate outside the hive. *N. bombi* infections often make bumble bees less productive and can reduce their lifespan.

*Nosema bombi* is interesting to some researchers because it is found more frequently in declining bumble bee populations than stable ones.

*Crithidia bombi* is a common trypanosome of bumble bees. It can increase mortality in stressed workers. It can also induce behavioral changes that make bumble bees forage slower and have trouble learning to exploit new rewards.

*Apicystis bombi* is a neogregarine that is mostly found in bumble bees, but can spread to honey bees. The effects are very harmful and include reducing reproductive success and reducing the lifespan of queen bumble bees.

*Nematodes* are rarely found in honey bees. In bumble bees, the nematode *Sphaerularia bombi* infects overwintering queens. Infected bumble bee queens often do not start their own colonies, and instead spend time in an overwintering site until expiration.

In 1963 a study found that the yeast *Candida* may be a component of overwinter mortality in bumble bee queens, causing them to emerge early from hibernation.
Predators, Parasites, and Parasitoids (cont.)

Parasitic mites are ectoparasites but can be found in cavities like the trachea. Some mites seen on bees are phoretic, meaning that they use the bees as transport. Parasitic mites are associated with social bees. Some of these species include the Varroa mite, *Locustacaracus buchneri*, and *Acarapis woodi*.

The Varroa mite can cause substantial loss in honey yield, shortened lifespan, and reduced sperm count in drones. It is the parasite with the most impact on the honey bee industry, likely because Varroa mite parasitism is positively correlated with some honey bee viruses. Varroa mites develop and feed on bee brood in their cells, and then they attach to adult honeybees in order to move to other bees to parasitize.\(^4\)

Parasitoids

The following parasitoids inject their eggs into the abdomens of bees. The egg grows and feeds on the internal structures of the bee, eventually causing the bee’s death.

Conopid fly infections are fairly common and can reach peaks of up to 73% of worker bumble bees at one point in time.

A species of phorid fly, *Apocephalus borealis*, is known to infect bumble bees and honey bees. Currently, the infections are only documented in certain parts of North America.

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Syntretus spp. is a genus of brachonid wasp that is known to parasitize bees. Some species of this wasp parasitize stingless bees. Other species, like *Syntretus splendidus*, has been found to parasitize bumble bees.
Crop pollination

Honey bees
People love honey bees. They tolerate a variety of environmental conditions, are relatively easy to manage, and produce tasty honey. Despite how convenient and practical they are, it is necessary that we do not solely rely on one species of bee for pollination. This is true for many reasons. One is that native bees work with honeybees to increase yield (see box). Another is to have a backup plan in case something happens to the honey bee pollinator industry.

Wild Bees (Unmanaged Native Bees)
Understanding the role that wild native bees play in crop pollination can motivate bee conservation efforts and inform agricultural management. This is important since its estimated that 1/3 of the human diet can be traced back to pollination by bees. The majority of what we eat is wind-pollinated cereals, but without bees our diets would be considerably less tasty. Bees pollinate crops like potato, onion, broccoli, cucumbers, lemon, strawberry, apples, mangos, avocados, and many more. Wild bees currently play a significant role in crop pollination and are estimated to provide 150 billion dollars in pollination services. Wild bees can also offer insurance against changes in the availability of managed bees.

Occasionally native bees are better pollinators of certain crops, like bumble bees to cranberry, because of their “buzz pollination” and toleration of inclement weather.

A meta-analysis is the review of findings from several studies. One meta-analysis of 29 studies conducted around the world found that fruit set increased significantly with visitation rates and diversity of wild pollinators. The meta-analysis found that farms produce higher yield if they have higher numbers and more diversity of wild bees regardless of how many honey bees are imported. Visits by wild pollinators increased fruit set even where substantial quantities of managed bees were present, suggesting that the pollination service of wild bees is unique and additive to that of managed bees.

Wild Bee Species Common on Cranberry

Melitta Americana
top: female
bottom: male

Megachile addenda
top: female
bottom: male
Wild Bee Diversity on Crops

Having higher numbers (abundance) of wild bees is thought to increase yield by having more bees visiting flowers and pollinating. Having more species (diversity) of bees present on a crop may increase yield in many ways. It’s been shown that different species of bee can affect one another’s behavior while foraging. These changes can increase the effectiveness of the bee’s pollination or make the species pollinate more frequently.

Having multiple species of native bees on a crop can help with having pollinators all season long since different species are active at different times of year. It can also help with having pollinators on all parts of the crop or on different crops since species differ in where they prefer to forage and on the plants they prefer to forage on.

Diversity provides essential overlap in services bees provide. This is important so that if one species is in decline at some point in time, a species with overlapping functions can still provide that service.

Identifying the bees on the poster “Join the Conversation about Native Bees”
Written by Stephen Buchmann, Ph.D., Interim NAPPC Coordinator, Pollinator Partnership
Cranberry pollination

Cranberries can become pollinated without pollinators, but for optimal fruit set insect pollinators are needed.

Cross-pollination is the transfer of pollen from one plant to another. Cross-pollination provided by bees can increase the size of the fruit, the number of seeds, and the consistency in the shape of the fruit.

Cranberries are native to the United States, but honey bees are not. Cranberry is likely adapted to be optimally pollinated by native bee species.

It is difficult to make recommendations about how many honey bee or bumble bee colonies cranberry growers need for pollination. Different varieties of cranberry may need more or fewer pollinators depending on the number of berries that variety of upright can hold. Another reason is that native bees are more or less pervasive at certain bogs and they often provide pollination.

Honey bees prefer to forage on wildflowers because they produce more nectar than cranberries.

There are some varieties of cranberry that produce more nectar than others (Stevens vs. Ben Lear and Early Black). This suggests that genes may be partially responsible for nectar production and can be selectively bred for increased nectar production. The hope is that if nectar production is increased then honey bees would be attracted back to cranberry.

The questions are:
Could cranberry produce competitive amounts of nectar?
How would reallocating plant resources to nectar production affect fruit production?

One might think that monocultures would improve pollination; bees in the area have no choice but to pollinate cranberry flowers. However, vast fields of a single crop are not appealing to native bees because they need varied habitats, varied nutrition, and consistent food sources. As mentioned above: wild bees play an important role in increasing yield, regardless of how many honey bees are present.

There are factors other than pollination that limits the amount of berries an upright can produce. Not all flowers on an upright will produce berries even with optimal pollination. It is likely that some flowers only serve the purpose of insurance in case others are lost to insects, disease, or receive insufficient pollination.

Photo by Tatiana Bulyonkova is licensed under CC BY 2.0
Many studies have concluded that bumble bees are superior pollinators of cranberry, particularly short-tongued bumble bees.

Bumble bees deposit more pollen on cranberry stigmas than other cranberry pollinators. More pollen on the stigma often leads to increased fruit set, fruit mass, and number of seeds.

Bumble bees and other wild native bees may be particularly important if weather conditions are poor through much of cranberry bloom. Inclement weather can dramatically reduce the pollination efficacy of honey bees, but bumble bees still forage in inclement weather.

Few options have been presented to cranberry growers in regard to increasing the presence of bumble bees on the bog. And none are proven to be effective in increasing or diversifying the population on cranberry bogs.

The current most popular options are to import commercial hives or to increase native populations with pollinator gardens.

Commercial Bumblebee Hives

Commercial bumble bees have been available since 1988. When commercial bumble bee hives were first produced they were shipped all over the world without careful inspection for parasites. Today there are regulations in place that require producers to be more diligent about screening for diseases. However, one study in the UK has found that 77% of the commercially produced colonies they inspected contained microbial parasites. Some of the parasites found are known to spread to honey bees and possibly other species as well.\(^3\)

Pollinator Gardens

One reason pollinator gardens are speculated to be effective is because crop yield is dramatically increased for farms located near natural or semi-natural environments. There is a positive relationship between proximity to natural habitats and increased pollinator abundance. There is some evidence that properly managed pollinator gardens can increase richness and abundance in surrounding habitat and perhaps increase crop yield (see Garibaldi et al, 2014).
The Decline of Native Pollinators

Bumble bees as a whole are declining worldwide; this is measured as decreased abundance and range restrictions. Not all species of bees are declining and some scientists have suggested that generalist bee species are doing better than those that are pickier about what they eat.

Some research findings suggest that the decline in native bee populations is due to rapid environmental changes in the last 25-30 years. This includes the following:

**Habitat loss**
A meta-analysis, which is the review of findings from several studies, assessing the threats to abundance and diversity of wild bees found that habitat loss is the most destructive human activity to wild bees. Habitat loss can be the destruction or fragmenting of habitat.

**Insecticide**
Neonicotinoids are persistent in the environment and systemic, meaning they become part of the plant and get into the nectar and pollen. Experiments in field and lab conditions have demonstrated that neonicotinoids have negative impacts on bumble bees. With that said, bees started declining before the registration and widespread use of neonicotinoids.

**Pathogen spillover**
As honey bees and bumble bees are being transported around the world they run the risk of spreading disease to new populations that do not have defenses against these parasites, viruses, bacteria and parasitoids. (See “Commercial bumble bees”)

**Invasive species**
Honey bees are a nonnative species (introduced somewhere in the 1600s) and we keep producing more and more honey bees to pollinate our crops. There are a finite number of bees that can live in certain habitats based on the number of flowers. It is speculated that native bees are being pushed out of their natural habitats because honey bees are taking up resources.

**Climate Change**
There is consensus among scientists that the Earth’s climate is warming. The changes that occur due to a warming climate, like rising sea levels, more intense storms, and more frequent heat waves can directly destroy animals and habitat or make it more difficult for them to survive.

These factors may be more or less impact in different geographic locations. It is likely that these factors interact with each other, so it is not just habitat loss, or just invasive species, but a combination of things.
Helping Bees

Bees pollinate 16% of the flowering plant species in the world. They pollinate plants that control erosion, that beautify landscapes, and provide habitat and food for wildlife.

The simplest and most obvious way to help bees is to install habitat and floral resources. Planting flowers also has the benefit of helping other surrounding wildlife.

Besides planting, another way to provide habitat and floral resources is to let naturally occurring native plants grow. Many of us like manicured landscapes, but letting plants get untidy in some places is beneficial to wildlife.

Providing habitat
Gardens in urban areas are not only good for us, but they are awesome for the bees! Neighborhoods with more backyard gardens have been shown to have higher bee diversity than neighborhoods with fewer backyard gardens. This is correlation not causation, but it makes intuitive sense that more food means healthier and more abundant bees.

A majority of the author’s research is on our most abundant native pollinators, and therefore the following recommendations are targeted to helping bumble bees.

Some of the following recommended plants have invasive varieties or species. Check with local nurseries or online resources before planting or letting it grow.

Plants for queen bumble bees:
- Pussy willow
- Dogwood
- American holly
- Black cherry
- Winterberry
- Black willow
- Honeysuckle
- Beach plum
- Purple coneflower
- Common yarrow
- Swamp azalea
- Beard tongue
- Southern arrowwood
- Swamp rose
- Blueberry
- Lupine
- Crabapple

See page 18 for ornamentals
Helping Bees (cont.)

Installing New Pollinator Habitat

When choosing flowers to install as part of a pollinator habitat, native species are often better choices. This is because they are adapted to thrive in the environment and have evolved with the native pollinators. When native plants are not an option, certain non-native plants are also attractive to bees (see following page).

Sun exposure and soil characteristics should be considered when selecting a site for a pollinator habitat. Many plants in pollinator habitats prefer full sun. Drainage, pH, salinity, and other characteristics of soil should be determined before planting. For example, rhododendrons prefer well-drained soils and acidic soils. If the site has poor drainage and low acidity, steps must be taken to correct this before planting. In this case, a raised bed and wettable sulfur is one possible solution.

Larger pollinator habitats attract more pollinators. At least one half acre should be devoted to pollinator habitats. When deciding where to plant within the pollinator habitat, research has shown that keeping plant species clustered together is more attractive to pollinators.

Diversity is important for the success of a pollinator habitat. Different plant species provide different nutritional components that are essential for bee health. Diversity in plant species also allows for plants to bloom at different points in the season. When selecting plants, keep in mind bloom times and try to incorporate plants that bloom early season, mid season, and late season. At least three plants should be in bloom early, mid, and late season. The following link is a great resource to discover when plant species are in bloom: http://www.wildflower.org/

There are two ways to install plants in pollinator habitats: seed mixes and transplants. For the highest chance of success, seed mixes should be purchased from local sources that harvest their seeds nearby. Transplants are often used because they provide resources to pollinators quickly, but they are more expensive. If a transplant is not used, it may be several seasons before plants begin flowering.

Existing Habitat

As mentioned above, most of us like the aesthetic of manicured landscapes. However, to get manicured landscapes it requires the removal of wildflowers and debris that bees utilize. Many of the plants we consider weeds (like dandelions) are great resources for native bees. Dead wood and twigs are also great resources for native bees as nesting habitat. Consider allowing some wildflowers and debris to remain around the landscape. For farmers, consider allowing some wildflowers to grow around the crop after bloom.
Alien plants
A large proportion of bees are using alien and invasive plants. It is common to see native bees using spotted knapweed, autumn olive, Japanese knotweed, Japanese honeysuckle, and other invasive species to MA. We do not recommend planting invasive plants. However, some ornamental plants can attract and provide resources to bees without much harm to the environment.

While it is always better to plant native plants (see above), non-invasive alien plants do offer floral resources to bees and we recommend planting them. These include: Russian sage, Japanese spirea, rose of Sharon, catmint, autumn joy, and rhododendrons.

Artificial Nesting Habitat
The success rate of providing artificial nests is low. Most researchers do not recommend installing artificial nests. One reason is that invasive wasps have been found to use them in high numbers.
References


Footnotes

1. You can find the protein contents of other plant families in Hanley et al, 2008. Check here for more information for Fabaceae in MA.


2. Learn more about search image in bees (and a wealth of other things about bumble bees) by reading Dave Goulson’s book *Bumblebees: Behaviour, Ecology, and Conservation*.

3. Commercial bumblebee hives have been implicated in the decline of some native bee populations by way of pathogen spillover (see section on “bee decline”). This disease spillover from introduced populations to native populations can bring new species of disease, new disease strains, and/or increase the number of infected individuals. In Argentina, commercial bumblebees are blamed for the decline of their native *Bombus Dahlbomi*, one of the largest bumblebee species in the world. Read more about it here:


4. For a detailed summary on *Varroa* mites check here:

http://entnemdept.ufl.edu/creatures/misc/bees/varroa_mite.htm
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REFERENCES

For references please see the UMass Cranberry Station website:
http://ag.umass.edu/cranberry

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For further reading see:
http://articles.extension.org/bee_health