Martha's Vineyard Pollinator Pathways:

Farm Pollinators and Pollinator Plants

2023 Annual Report

Prepared by Matt Pelikan
Director, Martha's Vineyard Atlas of Life Project
BiodiversityWorks, Inc.
Vineyard Haven, Massachusetts
mpelikan@biodiversityworksmv.org

Executive Summary

1. 2023 was the second year of fieldwork for this project, which is coordinated by the Betsy and Jesse Fink Family Foundation. Eight Martha's Vineyard farms participated in 2023, and data collection and analysis was performed by BiodiversityWorks.

2. A total of 91 site visits were made across the eight farms and the full growing season. Data collected included photographs entered into the iNaturalist online database, bee specimens collected, and narrative accounts capturing conditions and observations during each visit.

3. Especially when combined with 2022 data, this year's observations highlighted the enormous diversity of insect species making use, in one way or another, of flowers on farms. Flowers in specially prepared project plots, in waste areas of the farms, in dedicated pollinator rows, and even on crop plants were observed supporting insects in eight taxonomic orders.

4. The most frequently observed order was Hymenoptera, which includes bees and wasps. The prominence of this order in our data may partly reflect allocation of observer effort, but it also highlights the close association bees and wasps have with flowers and the ecological importance of this association.

5. While a wide range of flowers were shown to offer meaningful support for flower-visiting insects, native late-season composite species (goldenrods and asters), whether within the project plots or growing wild on farms, supported the greatest number and diversity of insects, and also supported the most oligolectic (pollen specialist) bees, which are a particular focus of this study.

6. One first Vineyard record for a bee species, *Megachile inimica*, was established during the 2023 field season. Observations this year also suggest that the locally uncommon bumble bee *Bombus vagans* may have a particular association with agricultural land on Martha's Vineyard.

7. Observations from our two field seasons show that relative minor augmentation of floral resources on farms can reliable enhance the numbers and variety of insects that a farm supports, and in particular can attract some specialized insects that would likely not be detected if their favored plant species were not present. If you build it, they will come!

Thanks to all eight of the farms participating in this project! 2023 was the second year of fieldwork for this project, assessing the importance of Vineyard farm habitat to pollinators and develop recommendations for methods farms can use to enhance resources for pollinators. The project was developed by the Betsy and Jesse Fink Family Foundation with assistance from BiodiversityWorks and various entomologists and ecologists. The Fink Foundation has had primary responsibility for managing the experimental flower parts we installed on participating farms; BiodiversityWorks has handled the data collection and analysis for the project and prepared this end-of-the-year report.

Across both field seasons, the project has been a fun and interesting one. We've enjoyed getting to know the participating farms, each of which has its own personality, and we've been fascinated to watch the seasons (both natural and agricultural) unfold. We've documented a huge diversity of insects (plus a few other kinds of animals) making use of flowers on farms. And some of the observations this project has produced have turned out to be of considerable significance.

BiodiversityWorks was very fortunate to have Vineyard native Jennifer Sepanara as our field assistant for this project in 2023. Jennifer has extensive and varied experience with biological fieldwork, and much of that previous work transferred very readily to finding and photographing insects. She brought a strong work ethic and a great deal of intelligence to her work on this project, and we're grateful for her contributions.

Season Summary

Weather on Martha's Vineyard is famously variable and unpredictable, but the weather during the 2023 field season was often unusual even by Vineyard standards. While the Vineyard is generally considered to past the risk of frost by mid-May, the second half of May 2023 featured a number of nights cold enough to produce localized frost. Overnight lows flirted with freezing as late as the overnight of May 30-31. Farms and other locations were affected unevenly by these events, with impacts on plants largely depending on the local microclimate. But in some locations, these unusual frost events set back vegetation considerably, killing leaves and flower buds on less hardy species. The summer that followed was generally warm but not hot, with a lot of overcast days that may have somewhat constrained the results of our insect sampling. Surprisingly, considering the moderate conditions through the summer, many late-flowering plants concluded their bloom periods earlier than we expected (and earlier than they did in 2022). By about the middle of October, most of the flowers in our project plots had shut down.

With generally moderate conditions through the summer, plants of all kinds seemed to grow fairly well. The perennial plants in our project plots, which were mostly planted during the spring of 2022 and so were fully mature during the 2023 field season, exhibited very strong vegetative growth and, in most cases, vigorous flowering. Wild vegetation growing on field edges and other unmanaged areas of farms likewise seemed to have a good season. Within the plots, we began to see instances of competition, with one growing in coverage at the expense of another; we'll

discuss our observations on this phenomenon later on. But generally, the species (both native and introduced) that we selected for our plots proved to be hardy and resilient.

Activity Measures

In 2023, project staff made a total of 91 site visits at participating farms, the earliest on May 6 and the latest on October 19. These visits were distributed roughly evenly among the eight farms participating in this project. Visits lasted anywhere from about half an hour to about 90 minutes, depending on how much insect activity there was. During each visit, photographs were taken of as many animals as possible visiting flowers both inside and outside the project plots. In addition, notes on sightings and conditions were kept on paper field sheets during the visits, with this information later transcribed and expanded into Google document “site visit narratives” which we compiled. These narratives often captured observations for which we were unable to obtain any concrete documentation (a specimen or a photograph). Original paper field sheets were retained in case they were needed to correct errors or resolve ambiguities.

Goldenrod, smooth aster, *Monarda*, and sunflower in the Whippoorwill Farm project plot

Over the course of the season, 72 bee specimens were collected across the eight participating farms, to allow precise identification and to add to a collection of voucher specimens for the project. All bees were identified to genus, species, or subspecies level by project staff, using a dissecting microscope and identification keys on the Discover Life website (discoverlife.org). Some specimens were photographed through the microscope to facilitate getting expert input on the ID; in addition, some specimens were reviewed by pollinator ecologist Molly Jacobson during a visit she made to the Vineyard in mid-August.

Using photographs taken during site visits and microscope photos taken in the lab, we created 926 iNaturalist observations reflecting 159 species in 2023. 514 of this year's observations were from the "general areas" of participating farms (that is, areas outside our project plots). These observations documented 119 species. The remaining 412 of this year's observations were from the project plots, with 105 species represented.

Across two field seasons, we've made a total of 1,466 iNaturalist observations documenting 215 species. This includes 845 observations of 174 species for general areas on farms and 621 observations reflecting 125 species for project plots.

In analyzing all this data, we've looked for patterns of use by insects — flowers that are used copiously by a wide range of insect species, or flowers that appear to be strongly preferred over other flowers by particular insects. We think the volume of data we collected is ample to support meaningful conclusions about such patterns. But it doesn't hurt to emphasize that this is pilot project, not an experiment, and our methodology was not designed for and cannot support any kind of rigorous, quantitative analysis. We made an effort to spend ample time both inside and outside the project plots, and we made sure to examine every kind of flower we observed for insect activity. But our effort was not distributed in any sort of controlled way.

It's also important to point out that we observed was insect visitation at flowers — which is not the same thing as pollination. In general, if an insect visits one flower and then visits another flower of the same species, there is at least some chance that the insect is performing pollination by transferring pollen. But we had no means to determine which of the insects we observed were successfully transferring pollen, and so it's better to think of the subject of this project as "insects that visit flowers (for any of a range of reasons, and with any of a range of outcomes)" rather than just "pollinators."

Bees

While this project looks at pollinators of all kinds, we place special emphasis on bees for a couple of reasons. First, because their biology is so interrelated with flowers, bees have evolved into powerful and ecologically important pollinators. Their activity is crucial for a huge range of plants, crop species and wild species alike. Moreover, the stage has been well set for intensive study of bees on the Vineyard: a major survey done in 2010-2012 (Goldstein and Ascher 2016) provided a great base of knowledge but, like any single study, raised as many questions as it answered. Work conducted by BiodiversityWorks over the last couple of years — including data collection for this project — has built substantially on the results of that study and helped solidify the Vineyard's value to bee conservation and, especially, the support of rare and uncommon, highly specialized bees. The Vineyard's bee checklist, overall, currently stands at 197 species, a remarkable number for our region of the world and the island's relatively small land area. So far, results of this project have already demonstrated an important role played by island farms in supporting this valuable ecological diversity.

2023 brought the total number of bee species observed in this project up to 57. In 2023, we added 12 species that we did not find in 2022; 15 bee species were observed in 2022 but not in 2023. Bee diversity was roughly the same in the two years, with 45 species found in 2022 and 42 in 2023. This pattern — a significantly different mix of species being observed each year — is a familiar one for naturalists who have worked much with insects: insect populations can vary hugely from year to year, with particular species often going from undetectably rare in one year to rather common the next. This is one reason it's important for insect surveys to extend across multiple seasons.

This year's fieldwork yielded a lot of interesting results concerning bees, including insights on bee ecology, the status of particular species, and even the addition of one new species to the Vineyard checklist. Here is a look at some of the bee highlights from 2023.

Andrena melanochroa and ***Andrena miserabilis***: One of the new species added to the overall project bee list in 2023, *Andrena melanochroa* is a tiny bee, averaging about 7 mm long. *A. miserabilis*, which was also found in 2022 and appears to be considerably more common and widespread on the Vineyard, is similar in size. Despite their small proportions, though, both of these species are fairly easy to identify (by bee standards, at least), with distinctive facial geometry and/or coloration in both sexes. Interesting to observe in 2023 was their apparent fondness for strawberries. Several of the participating farms grew strawberries (*Fragaria* x *ananassa*) in sections of the farms that we surveyed. Bloom period for strawberries in 2023 fell mainly in the middle of May (our records of pollinators on strawberries span roughly from May 8 to May 20), and during this rather chilly month, strawberry blossoms ranked among the most heavily visited flowers. Prominent among the insects foraging on strawberry blossoms were these two small *Andrena* bees.

Andrena melanchroa (left) and Andrena miserabilis (right) specimens, photographed through a dissecting microscope.

Curious about the interactions between pollinators and strawberries, we did some research. Most helpful was a 2019 article from the *Journal of Applied Ecology* (MacInnis and Forrest 2019). We learned that while strawberry flowers are capable of self-pollination, the largest, best-shaped, and most marketable fruits are produced by cross-pollination. An elegant study by MacInnis and Forest examined how bees of various sizes physically interact with strawberry flowers, and how pollination by various species affected the quality of the fruit produced. Larger bees (such as the honey bee, *Apis mellifera*, which we also observed on strawberry flowers) often dislodge pollen as the forage, resulting in self-pollination and hence lower-quality fruit. But smaller bees, like *Andrena melanchroa* and *A. miserabilis*, disturb the flowers they visit less than larger bees do, while still being effective at picking up and carrying pollen. The result is that strawberries pollinated by small, native bees typically produce the best strawberries! You'd still get a crop without native bees, through either self-fertilization or pollination by honey bees. But yields would be much lower and the fruits would be inferior. This is a fine example of the mutually beneficial relationship between native bees and agriculture.

Andrena asteris: In late 2021, as our study of Vineyard bees was starting to take shape and this farm pollintor project was in development, we believed *Andrena asteris* to be a rare or at best uncommon insect on Martha's Vineyard. Our basis for this assessment was mainly the small number of this bee (one male and one female) that were detected by a major study of bees conducted in 2010-2012 (Goldstein and Ascher 2016). The discovery of a female *Andrena asteris* at Thimble Farm in September 2021 seemed at the time to be an important find and was one of the first observations that got us intrigued by the possibilities of farms as habitat for specialized bees.

A female *Andrena asteris* takes pollen from a smooth aster blossom in one of our project plots.

With two more full seasons of fieldwork to rely on, though, we now know that this species is quite common here — probably the most numerous of our late-season composite flower specialists. Most of the individuals of this species that we have observed have been associated with Asteraceae, though the fact that *A. asteris* freely visits both goldenrods and asters makes it

somewhat less fussy than most of our other specialized bees. It has been detected at four of the eight farms participating in this project. While numbers observed in 2022 were modest, 2023 appeared to be a "big year" for the species, with notable counts including 11 at Thimble Farm on October 12; of 31 *Andrena* individuals observed at Slough Farm on September 21, most were probably *A. asteris* (though conditions prevented species-level ID of most of these bees).

Most or all of the *Andrena asteris* we've observed, whether as part of this project or in the course of other fieldwork, were found during the second half of September or the first half of October. This late-season flight period affects the flower choices of this bee. Most records, as noted above, involve visits to either goldenrod or asters. But we have few if any records of this bee visiting *Euthamia* (which generally blooms earlier than our other goldenrod genus, *Solidago*, and tends not be available during the flight period of this bee). While we have plenty of records of *A. asteris* visiting *Solidago nemoralis* and *Symphyotrichum laeve* in our project plots, the greatest concentrations we've found of this bee (both in working on this project and more generally) have been on two white-flowered asters, *S. ericoides* and *S. pilosum*. We've come to regret that neither of these asters could be included in our project plots. With rather weedy appearance and small, white-rayed flowers, neither is popular as an ornamental species and hence they don't seem to be available in the commercial native plant market. But both asters are plentiful in the wild on Martha's Vineyard, and one or the other occur in margins and waste areas at several of the project farms. Since it's not just *Andrena asteris* that prefers these unprepossessing plants, we think *S. ericoides* and/or *S. pilosum* are worth encouraging wherever found and would be great choices for any plan to propagate native flowers for encouraging pollinators.

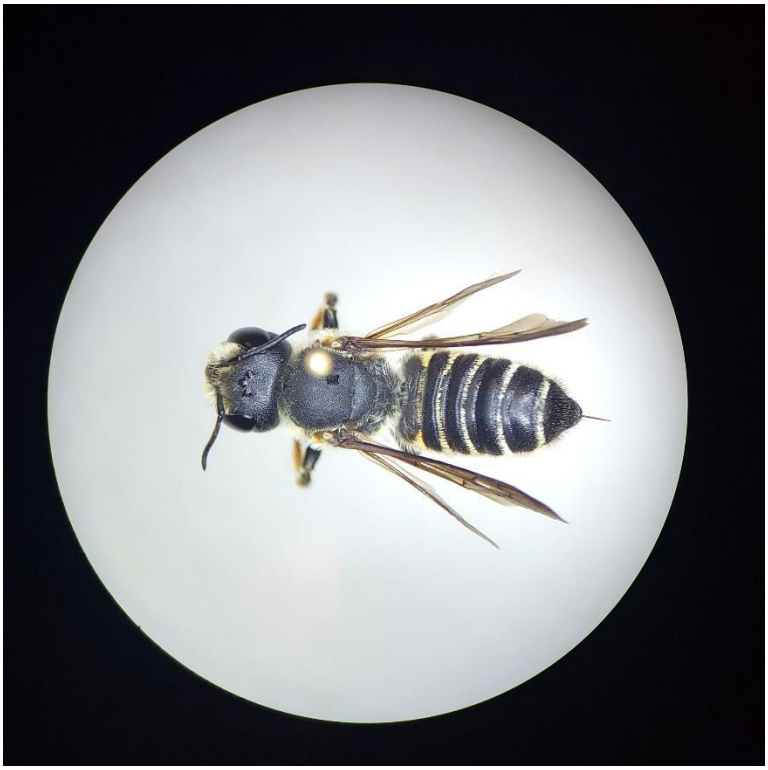
Interestingly, there is some evidence that male *Andrena asteri*s are much less finicky about flowers than females are: for example, about 10 males were observed patrolling around marigold flowers at Slough Farm on September 21, 2023. A few landed briefly and seemed to take (or attempt to take) nectar from marigold flowers, but mainly these bees skimmed low over the marigold patch, presumably hoping to find a female conspecific to mate with. We presume that marigold flowers (an orange-yellow variety) looked enough like *Solidago* blossoms to fool these male bees. But females, which collect pollen to provision their nests, have to be much more discriminating since their offspring have evolved to grow best on a diet of native composite pollen.

Megachile inimica: On September 22, we collected a distinctive bee off of a black-eyed Susan flower (*Rudbeckia hirta*) in the community garden at Thimble Farm. At 16 mm overall length, this female bee was about the length of a large bumble bee; under the microscope, she showed an unusually large, blocky head and massive, sharp-edged mandibles. The bee keyed out readily as *Megachile inimica*, a species of leaf-cutter bee, and photographs of the specimen, posted as an observation in iNaturalist, allowed several experts to confirm this identification:

https://www.inaturalist.org/observations/184545593

(The location and various anatomical details allowed this bee to be identified all the way to the subspecies level, *M. i. sayi*).

Based on a definitive state checklist of bees published in 2021 (Veit, M.F., *et al*. 2021), this represented a first Vineyard record (indeed, a first record for the tri-county Cape and Islands region) for this species. As such, it was probably the single most significant find of this year's fieldwork for this project.



Specimen of the Vineyard's first *Megachile inimica*, photographed through a dissecting microscope.

Relatively little seems to be known about the species, though several on-line sources suggest that it is a pollen specialist on members of the aster family (which includes *Rudbeckia*). Within the family Asteraceae, it has been documented taking pollen from a fairly wide range of species. Like other leaf-cutter bees, females presumably lay their eggs in pre-existing holes in wood, using round disks cut from leaves to separate a series of egg-containing cells within each tunnel. The fact that such a large and distinctive bee had evaded previous detection on the Vineyard suggests that this species is uncommon here. We can't rule out the possibility that this individual was accidentally imported to the Vineyard, though there is no evidence that specifically suggests that, and bees, in general, don't seem to be particularly susceptible to accidental transport. On balance we think it most likely that *Megachile imica* is an established part of the island's insect fauna, albeit scarce and/or with very limited distribution. The fact that

this species was discovered on a farm serves as reminder that farms, characterized by high floral diversity, can be very good habitat for insects, even specialized ones.

Colletes solidaginis: One of the bee species added to the project bee list in 2023, this beautiful insect is, as its name suggests, strongly associated with *Solidago*. It flies earlier in the season than most of our other late-season composite-specialist bees: in 2023, records ranged from July 22 to August 20. Most of the records we have for this species come from sweet goldenrod, *Solidago odora*, a very common wildflower with an early bloom period for its genus. But while its preferred pollen/nectar plant is abundant on the Vineyard, *C. solidaginis* is rather scarce here, occupying a very small percentage of what seems like suitable habitat. We have no idea why this might be; perhaps this ground-nesting bee has very specific soil type requirements. Interestingly, the presence of large quantities of *Solidago* doesn't seem to be a requirement for his species; in August 2023, we found this bee at Long Point Wildlife Refuge on patches of just a few stems of *S. odora*.

Colored to match her favorite flower, a female *Colletes solidaginis* forages on a goldenrod blossom at West Chop Woods, Vineyard Haven.

Our only record of this species from this project was a single individual observed on August 9 at Whip-poor-will Farm. No specimen was taken and no photograph was possible, but this is a distinctive bee species and we were confident of the identification. This is an unusual record for *C. solidaginis* in that the bee was visiting *Euthamia* in the project plot. But the *Solidago nemoralis* in the project plot, a relatively late-blooming species, was not flowering significantly at this date, and the bee was presumably making the best of the resources that were available at this location. The episode illustrates the value of having multiple floral choices, with a range of bloom periods, available for pollinators.

Bombus vagans: Perhaps the most interesting set of observations were the multiple observations we had of the bumblebee *Bombus vagans*, believed to be one of the less common Bombus species on the Vineyard and an example of the kind of bee that this project is seeking

ways to support. (Technically, we mean *Bombus vagans* and/or *Bombus sandersoni*. The two are very closely related, generally not distinguishable based on photographs taken in the field, and sometimes not even separable when working from specimens because most of the differences between the two species are, in our experience, subtle and subjective. Existing information suggests that *sandersoni* is truly rare in our region, though, and while we might have photographed this species, it seems safer and easier to use "*Bombus vagans*" as shorthand for "the *Bombus vagans*/*Bombus sandersoni* complex.")

A female *Bombus vagans/sandersoni*, held temporarily in a plastic vial for photographs.

In 2022, we managed only two iNaturalist observations of *B. vagans*: a female found foraging on kale flowers and photographed at The Farm Institute in late May, and a large female, probably a queen, found on clover right next to the Farm Institute project plot in early July. Both individuals were captured, photographed in vials, and released, and both of these observations (somewhat surprisingly) were confirmed to become "research-grade" observations. A male was collected off of lavendar at Beetlebung Farm on July 14 and ID to species level by Matt Pelikan. Interestingly, despite a very active bee-hunting schedule, we did not record B. vagans at any other location in 2022, and based on that pattern, we tentatively surmised that farms, for some reason, offer particularly good habitat for this bee.

Then, in 2023, we compiled 19 iNaturalist records of *B. vagans*, with at least one record from all eight participating farms. None of these obseravations has been confirmed to the species level (see our comments above on the ID difficulties of this species). But we're confident that all are referrable to the "*B. vagans*/*B. sandersoni*" complex. In addition, Jennifer collected specimens at Whippoorwill Farm on August 10 (a female observed foraging on clover and chicory); at the Farm Institute project plot on August 17 (a female feeding on clover); at Thimble Farm on August 24 (a female feeding, unusually for a bee, on zinnia); and at the North Tabor Farm

project plot on August 23 (a female feeding on sunflower). Our best assessment of these specimens is that all represent *Bombus vagans* in the strict sense. While the bees in the 19 2023 iNaturalist records were observed on a plants including *Monarda didyma*, teasel, bachelor's button, motherwort, sunflower, and zinnia, suggesting generalist foraging habits, 10 (more than half) were observed on purple clover, which is consistent with other accounts that suggest *B. vagans* has a fondness for this common plant.

Most strikingly, we can find no 2022 or 2023 Vineyard records of *Bombus vagans/Bombus sandersoni* that aren't associated with one of the project farms! This is in spite of a very active bee-watching schedule.

Especially given the challenges of identifying this bee, we caution against placing too much weight on this limited data set. But available information suggests that *Bombus vagans* associates very strongly with farms on Martha's Vineyard, and that while it makes use of a wide range of flowers, it has a particular fondness for clover. That foraging preference may go far toward explaining this bee's fondness for farm: clovers of various species are generally common on farms, whether growing wild or deliberately planted as a cover crop. The overall abundance and variety of floral resources on farms probably plays a role, too, and while we don't have any specific information about the nesting habits of this species, it may be that some kind of resource found mainly on farms (compost piles? old hay bales? areas under landscape fabric?) is favored by this bee for nesting.

In any case, the story of *Bombus vagans* can be considered an early success for this project. It appears to be an insect that, for any of several reasons, depends largely on farms; vegetation typically found on farms appears to satisfy this bee's needs; and by ensuring a plentiful supply of clovers, farms can probably improve their ability to support this uncommon insect. And while we can't say for sure, it is very possible that the much more rare *Bombus sandersoni* is likewise a beneficiary of farm habitat and floral patterns.

Competition: One goal for this project is to assess the extent to which honey bees (*Apis mellifera*) compete against native solitary bees. *A. mellifera* is an introduced species in North America, and on the Vineyard this bee lives almost exclusively in curated hives. (In effect, it is managed as a livestock species, just like sheep, cattle and goats.) A substantial and steadily growing body of scientific literature shows that, under some conditions at least, competition from honey bees can harm native bee populations, sometimes seriously.

We are fully persuaded by these studies and feel certain that the presence of honey bees on Martha's Vineyard does nothing good for native bees. Furthermore, while we know that honey bees are effective pollinators of many crop plants, there are much less effective with some other species. And many native bee species appear to be good pollinators for crop plants, as well, in addition to effectively pollinating some native species that honey bees tend not even to visit. So our informed guess is that an intact native bee fauna would provide perfectly adequate pollination services on Vineyard farms, and that therefore keeping honey bees for pollination purposes is not necessary.

However, we also understand that honey bees produce a valuable commodity in the form of honey (Matt cannot get his day started without a cup of tea with honey in it). And we recognize that this species is interesting enough so that some people may enjoy having it around just because honey bees are fun to watch and get acquainted with. So we have made a deliberate effort in the course of this project to get a feel for whether and to what extent honey bees compete with local native bee populations, so that current and potential bee-keepers can make an informed decision on whether to raise this non-native insect.

Female honey bee (*Apis mellifera*) foraging on a crab apple blossom in early May 2023. Many *Andrena* bees were present on the same tree.

It's important to note that our observations are really just anecdotal observations, and we've made no effort at any kind of formal, quantitative study of the effects of honey bee competition. But across the two years of fieldwork we've conducted, we've noted many instances in which honey bees and native bee species were foraging in close proximity to each other. Based on these observations, we think that the specific context of any interspecies interaction can have a major effect on how much honey bees are interfering with native species. It is clear that, especially with respect to the smaller, solitary bee species in the families Andrenidae, Colletidae, and Halictidae, honey bees are socially dominant and displace the native bees from blossoms much more often than the native bees displace honey bees. And sometimes the sheer numbers of honey bees may mean that this one species is able to collect most of the pollen or nectar from the available floral resources, leaving little for other species. But in situations where lots of flowers (and, just as importantly, a good variety of flowers) are present, the interruptions in foraging that honey bees cause are brief and probably not of much consequence.

For example, on October 12, Matt tallied 198 honey bees in the community garden portion of Thimble Farm, along with 82 (!) common eastern bumble bees (*Bombus impatiens*) and at least 11 A*ndrena asteris*. Almost all of these bees were concentrated on a few *Symphyotrichum*

pilosum plants that were in full bloom. Matt noted that “with everything concentrated on one species and honeybees so numerous, [he] was not surprised to see multiple instances of *Apis* bumping other species off of blossoms. There were plenty of blossoms, though, and the disturbed bees simply landed on another nearby flower.” Most of the *Andrena* bees were pollen-laden females, suggesting that adequate pollen was present in the flowers and that these bees were collecting it effectively. We’ve also noted, across the two years of the project so far, instances in which different bee species concentrate on different flower species, so that the bees do not directly compete with each other.

Our best assessment, then, is that honey bees are kind like a persistent headwind for smaller native bee species. It’s possible for this headwind to be strong, but in many cases it may be trivial. The presence of this species is unlikely ever to benefit native bees, and even the quick displacement of native bee from one flower to another surely represents an undesirable waste of energy and loss of foraging time for the displaced bee. But in situations where lots of flowers are available, the disturbed bee may only fly a few inches and is foraging again in a couple of seconds, and it is hard to argue that these negative impacts are likely to add up to any significant harm.

There is more to the story, of course. For one thing, in addition to foraging on farms, honey bees may disperse long distances to forage in native habitats in which floral diversity and abundance may be much lower. In such situations, the negative effects of honey bees on native bees may be much greater that we hypothesize they are on farms. But we are not in a position to make any assessment of such situations.

In our view, then, the best course of action from the perspective of native been conservation is to not keep honey bees. But if you do decide to keep bees, we believe you can greatly mitigate any negative impacts by ensuring the presence of varied and abundant floral resources are available throughout the growing season. The presence of such resources will not alter the social dominance that honey bees exhibit over small native bees. But the presence of ample floral resources will generally reduce the local negative impacts of honey bees to a low, likely negligible level.

Other Pollinators

In 2023, we documented members of eight insect orders visiting flowers on farms. This includes observations from within the project plots as well as within other portions of participating farms. A few of these orders were represented by only a few observations, and the individuals observed were likely using flowers simply as random perches (scorpionflies in the order Mecoptera) or as perches from which to hunt other insects (e.g., dragonflies and damselflies in the order Odonata and ambush bugs in the order Hemiptera). Even in these case, though, the flowers being used are serving an ecological purpose, and it’s possible for any insect visiting a flower to serve as a pollinator if it happens to carry pollen grains from one plant to another.

It would probably be overkill to go into detail on all the insect orders we observed, but the following paragraphs take a look at a few groups and observations that seemed particularly important.

Wasps: A large and diverse group, “wasps” essentially means all of the order Hymenoptera except ants and bees. While wasps exhibit a wide range of life histories, many are either predatory or parasitic and hence play important roles in controlling populations of other arthropods. In most cases, it is the larval stage that consumes animal prey, which is brought back to the nest by adults that feed mainly on pollen. A conservative species count from the project plots taken all together runs to about 30 species; the actual species count is higher because individuals not identified to species level have to be lumped at genus or family level even if, visually, they appear to be distinct species.

A relatively small number of species account for the bulk of our wasp observations: paper wasps (*Polistes fuscatus* and the non-native *P. dominula*); “potter wasps in the subfamily Eumeninae (the genera *Euodynerus*, *Ancistrocerus*, which was represented by at least four species, and *Monobia* were all common); large wasps in the family Sphecidae (e.g., *Sphex ichneumoneus*, *S. pensylvanicus*, *Ammophila* spp., *Eremnophila aureonotata*, and “grass-carrying wasps” in the genus *Isodontia*); and “square-headed wasps” in the family Crabronidae (inculding the two-banded stink bug hunter *Bicyrtes quadrifasciatus*, members of the difficult genus *Ectemnius*, and especially the very common “bee wolf” species *Philanthus gibbosus*). 2023 produced the project’s (and, apparently, the Vineyard’s) first records of the colorful sawfly *Tenthredo basilaris.* Also notable was the project’s (and, again, apparently the Vineyard’s) second record of a “carrot fly” in the genus *Gasteruption* (the individual observed this year was clearly a different species from the one observed in 2022, though we are not able to identify either one to the species level).

The “bee wolf” wasp *Philanthus gibbosus*.

It was seem surprising that we were pleased by the large number of “bee wolves” (*Philanthus* spp.) that we observed this year, since we like bees so much and the females of this genus

provision their nests with paralyzed bees! But the natural world is a web on incredibly complex interactions, and like any other kind of predator, bee wolves have an important role to play in regulating bee population sizes and providing selective pressure on the species they hunt. Many of the other wasps we've mentioned are more evidently beneficial: members of the genus Ammophila, for example, prey on caterpillars, many of them pest species that any farmer would be happy to see controlled. Overall, we think that the wasp fauna is one of the real bright spots highlighted by this project: farms support a diverse and interesting mix of wasps, and in return, the farms reap the ecological benefits of a rich wasp fauna. Wasps can be assumed to play a powerful role in maintaining the ecological health of farms.

One of the Vineyard's first records for the sawfly *Tenthredo basilaris*, feeding on goldenrod.

As we note elsewhere, adult wasps can be found on nearly any type of flower, but goldenrod, *Monarda punctata*, and members of the family Apiaceae emerge as flowers that seem especially important wasps.

Flies: In contrast to the wasp fauna we observed, flies (the order Diptera) found on farms appear to be dominated by introduced species. In 2023, we documented members of nine fly families. The most numerous family was Syrphidae, also known as "flower flies" or "hover flies," which constituted about half of all our fly records in 2023. The lion's share of our 2023 Syrphid records were in the genus Eristalis, including few records of the native *E. dimidiata* and *E. transversa*, all visting native composites, and a lot more records for the introduced *E. tenax* and especially *E. arbustorum*, with the latter visiting an unusually broad range of flowers, both native and exotic. The introduced *Syritta pipiens* also produced a fair number of records, though this species seemed less prominent in 2023 than it was in 2022. As far as we know, the larvae of all of these species are detritivores - that is, feeding on decaying organic matter - and it is not surprising to find them common on farms, where compost piles and tilled-in plants produce ample opportunities for detritivores to breed. While feeding on decaying matter is an

unglamorous lifestyle, detritivores are ecologically important because they help promote the recycling of nutrients through the food web.

Other prominent Syrphids in our results include the colorful wasp mimics *Spilomyia longicornis* and *Sericomyia chrysotoxoides*, native species that have aquatic larvae, and members of the genus *Toxomerus*, with predatory larvae that feed on aphids. Adults of all of these species visit flowers, apparently with very little preference as to type, and while they are probably not as efficient pollinators as bees are, they may still play a significant role in overall pollination services.

Spilomyia longicornis foraging on *Symphyotrichum pilosum*.

The family Tachinidae was well presented in our 2023 data, though most individuals in this difficult family could not be identified with any precision from the photographs we obtained. All Tachinids have larvae that are (generally lethal) parasites on other arthoropods, so Tachinids are important for regulating the populations of other species. One of the few Tachinids we were able to identify this year was *Trichopoda pennipes*. The larvae of this colorful fly parasitize true bugs (Hemiptera), with squash bug, *Anasa tristis*, generally regarded as an agricultural pest, reportedly a favorite host.

Finally, it's worth mentioning *Physocephala tibialis*, in the family Conopidae, which was well represented in our observations this year. Most of these observations were of flies visiting goldenrod, though in a couple of cases, the flower visited was oregano. *P. tibialis* are parasites on bees; as note in our discussion of "bee wolves" above, we regard species like this one as beneficial in spite of their lethal effects on bees. They are native species engaged in the ecological relationships that they evolved to participate in.

The fly fauna of farms appears to be both diverse and distinctive. It includes many non-native species, which presumably made it to North America through importation along with soil or agicultural products. We regard these introduced flies as adventive rather than invasive - that is, we don't think they are having harmful effects on native populations - though this assessment is

necessarily speculative since we know nothing at all about what the Vineyard fly fauna may have looked like prior to European settlement. But it is clear that many non-native fly species exist in the company of native species that are ecologically similar, which suggests that harmful competition is not a problem.

Trichopoda pennipes, a Tachinid fly, foraging on goldenrod. This fly parasitizes true bugs, including several agricultural pest species.

Butterflies and moths: Both the project plots and surrounding areas of participating farms were quite productive of the order Lepidoptera in 2024. Observations from our project plots documented 21 Lepidopteran species visiting flowers, including the butterflies sachem (*Atalopedes huron*, which has recently colonized the Vineyard), juniper hairstreak (*Callophrys gryneus*, an uncommon species here), and common buckeye (*Junonia coenia*, a rare to uncommon, but fairly regular, immigrant). Observations outside the project plots documented 27 Lepidoptera species in the general areas, including sachem, red-banded hairstreak (*Calycopis cecrops*, in the process of becoming established on Martha's Vineyard), and painted lady, *Vanessa cardui*, an irregular immigrant that was rather scarce in 2023. Several butterflies were quite common, including American copper (*Lycaena hypophlaeas*), pearl crescent (*Phyciodes tharos*), monarch (*Danaus plexippus*), and cabbage white (Pieris rapae). With the exception of this last species, which is non-native and has cabbage-eating larvae that can become pests, all the butterflies were observed are native species and can be considered beneficial insects.

Several of the moths we observed, however, may be less welcome on farms. The beet webworm moth, *Spoladea recurvalis*, was a fairly common visitor to a range of flowers and is probably at least a potential pest species on farms, since its larvae eat the leaves of beets and related crops. And *Helicoverpa zea*, the corn earworm moth, is notorious as a pest species. Fortunately, we only recorded one individual of this species in 2023.

One of our most distinctive and beautiful butterflies, a juniper hairstreak (*Callophrus gryneus*) takes nectar from a goldenrod flower.

While butterflies and moths were observed visiting a bewildering array of flowers in 2023, one particular flower association is worth pointing out. Butterflies and moths were just about the only insects we observed visiting zinnia flowers, which are commonly included in pollinator plantings on farms, or are grown for the cut flower market. Because zinnias (especially varieties with highly doubled flowers) attract relatively few pollinators, we don't recommend them for inclusion in pollinator plantings. But their ability to attract butterflies means they have at least some value in this role.

Beetles: While members of the order Coleoptera are not often thought of as pollinators, many species of beetles do forage on flowers, and some of these species appear to transport pollen pretty efficiently. In 2023, one of the most prominent flower-loving groups of beetles, the so-called "flower longhorns" of the subfamily Lepturinae, was surprisingly scarce in our observations: we did note *Brachyleptura vagans* feeding on cilantro flowers and an unidentified member of the genus *Typocerus* on oregano, suggesting that mint-family herbs may be important for supporting these somewhat specialized beegtles. While not strictly a flower longhorn, the locust borer longhorn beetle Megacyllene robiniae is definitely a longhorn beetle that loves flowers (all our observations involved goldenrod), and this colorful beetle accounted for the majority of our longhorn beetle (family Cerambycidae) observations. And the red milkweed beetle, *Tetraopes tetrophthalmus*, a longhorn beetle in the subfamily Lamiinae, was observed several times on its favored host plant, common milkweed (*Asclepias syriaca*).

The solder beetle (Cantharidae) *Chauligonauthus pensylvanicus* was recorded several times late in the season, visiting (like Megacyllene) native composite flowers, often ones in our project plots. This is a very common beetle on the Vineyard and we find it almost everywhere we find goldenrods.

Larvae of *Megacyllene robiniae* live in the wood of locust trees, but the adults of this longhorn beetle are almost always found on goldenrod flowers.

Some of the beetles we observed, including the Japanese beetle *Popillia japonica* and the striped cucumber beetle *Acallyma vittatum*, are regarded as pest species. Some of these, like the Japanese beetle, are non-natives, and their presence of farms is the negative, flip side of the added diversity that comes from the many naturalized (exotic but not invasive) insects that are so common in agricultural settings.

Beetles were not an especially prominent part of the insect live we observed in 2023. But their occasional presence of flowers, both in our project plots and in the general area of farms, is a reminder of how many types of insects rely on flowers for parts of their life cycles.

Hemiptera: Like the beetles, true bugs were observed in significant but not large numbers in 2023. The small milkweed bug, *Lygaeus kalmii*, was our most frequently observed Hemipteran; while some individuals were observed on common milkweed, this bug's favored host, *L. kalmii* visited a surprisingly wide range of flowers. The scentless plant bug (Rhopalidae) *Harmostes refluxus* was also recorded fairly regularly, showing a modest preference (like so many insects!) for goldenrod flowers. And predatory ambush bugs (Reduviidae) in the genus *Phymata* were also recorded a number of times, lurking for prey on the blossoms of goldenrod and, in one instance, sunflower.

As is the case with beetles, introduced species figure prominently in our list of Hemiptera, and some of the true bugs we observed can probably be regarded as agricultural pests. As such, their presence in our project plots or surrounding areas is not really welcome. But if you have a productive and diverse ecosystem, it's inevitable that some species humans deem undesirable will figure in the mix. So the presence of pest species at the relatively low levels of abundance we observed is yet one more indicator of the biological productivity of farm habitats. And it bears noting that generalist predatory insects like *Phymata* can be thought of as beneficial: they take a mix of prey that includes beneficial species, such as bees, as well as harmful ones, like

cucumber beetles, and overall they perform a valuable role in reducing the number of any flower-visiting species that starts to become excessively common.

Small milkweed bug, *Lygaeus kalmii*, on goldenrod blossoms.

Project Plots

With generally moderate growing conditions through most of the late spring and summer, plants in our project plots generally grew well and flowered robustly. The toughness of native species was well illustrated when the smooth aster (*Symphyotrichum laeve*) in the project plots at a couple of farms were browsed almost to the ground by deer. While little top growth was left in these instances, affected plants rebounded vigorously; by the end of the growing season, the browsing episodes were basically evident only in slightly delayed bloom periods in the affected plants.

In general, the performance of the project plots in 2023 echoed what we observed in 2022. Our three native composites — the goldenrod species, *Euthamia tenuifolia* and *Solidago nemoralis*, combined with smooth aster (*Symphyotrichum laeve*) — accounted for 30% or nearly a third of all our iNaturalist observations, both inside and outside the project plots, in 2023.

Competition between plant species: In designing our project plots back in early 2022, we were certainly aware that planting a bunch of different plant species close to each other raised the possibility of one species interfering with the other. But having no idea at all which of our species might turn out to be the most aggressive, we designed the project plots mainly with an eye toward making them as attractive as possible to pollinators, and then learn what we could about competition based on the results. In general, we planted our plugs in blocks, on the assumption that masses of one species, or two closely related species plants would be easier for pollinators to find. So our two goldenrod species were often interplanted in dual-species “goldenrod” blocks, and a similar plan was used for the two species of *Monarda*.

During the 2022 growing season, the initial spacing of the plugs we put gave all the plants ample room to grow to maturity. As the 2023 season progressed, though, we started to get a feel for which species were most aggressive. This year, narrow-leaved goldenrod (*Euthamia tenuifolia*) formed steadily growing multi-stemmed bunches and appeared to spread outward via rhizomes. The species proved quite dominant over its relative, *Solidago nemoralis*, which in a few of the project plots barely bloomed and was nearly eliminated by the end of the season. Since *Euthamia* is one of the earliest-blooming of our goldenrod species, the effect of this one-sided battle was to curtail the bloom period for goldenrods, collectively, in the project plots. By the time of the late-season activity periods of many of our goldenrod-loving *Andrena* bees, *Euthamia* (and therefore goldenrod in general) had mostly finished blooming. We saw the effects of this as we observed reduced numbers, or even a complete lack of observations, of some of these bees in 2023 relative to 2022. (The absence of any 2023 records of either *Colletes simulans* or *Colletes compactus* probably furnishes the best example.)

Found in our project plots in 2022 but not in 2023, the late-season bee *Colletes compactus* may have been affected by plant competition and a shortened growing season in 2023.

A similar process played out between the two *Monarda* species in our project plots, *M. didyma* and *M. punctata*. In 2022, the former species was still maturing and bloomed only sparingly, which the latter species bloomed heavily and across a long time period. In 2023, though, *M. didyma* spread aggressively, and its tall habit allowed it to out-compete its shorter relative. In 2022, we identified *M. punctata* as one of our most powerful pollinator species, being especially attractive to wasps and the larger bees (bumble, carpenter, and honey bees). In 2023, there weren't enough *M. punctata* flowers in some of our plots to attract much (though where it occurred, this species seemed to perform about as it did in 2022). Meanwhile, *M. didyma* proved be something of a disappointment in terms of its pollinator performance. We did see a few bees on it, mostly smaller sweat bees (Halictidae) that often foraged by walking entirely inside the long, tubular *M. didyma* blooms. But probably because of the length of the calyx of these flowers, relatively few species seemed to be able to forage on *M. didyma*. So the competition between these two species resulted in a significant net loss in the resources the project plots offered to pollinators.

Other pollinator plants

A high percentage of our insect observations came from the specially chosen pollinator plants in the project plots: as we've noted, goldenrods (*Solidago nemoralis* and *Euthamia tenuifolia*), smooth aster, (*Symphyotrichum laeve*), *Monarda punctata*, and sunflowers (*Helianthus annuus*) all performed well in both field seasons to date, attracting large numbers of pollinators, a high diversity of insects, and the lion's share of the uncommon or specialized bees we detected. Goldenrods, asters, and milkweeds performed equally well outside the project plots, growing in edge and waste areas on farms. But other types of plants were consistently attractive to pollinators and some, we feel, worth including in pollinator plantings.

Apiaceae: This large and important plant family, contains plants with umbel-shaped flower heads such as carrot, fennel, Queen Anne's lace, and golden Alexander. Flowers of these plants are almost all attractive to pollinators, especially wasps, small bees (especially ones in the genus *Hylaeus*), and flies.

Herbs: A functional and not a taxonomic category; most of the plants we're thinking of, though, fall in the mint family (Lamiaceae): oregano, thyme, mints of various kinds, motherwort, cat mint, and the like. Many plants in this category can be marketed for culinary and medicinal purposes, and most or all of the farms participating in this project grow herbs for one purpose or another.

Interim Recommendations

Our observations and experiences in 2023 definitely helped us refine our sense of what pollinators are supported by farms, and what flowers are best at supporting them (and, especially, best at supporting our target suite of specialized bees). The following is a synopsis of what we'd currently recommend for pollinator plantings aimed at attracting and supporting high pollinator diversity and helping a farm provided benefits for the pollinators that appear to be most in need of help on Martha's Vineyard.

1. Goldenrod, goldenrod, goldenrod! If one conclusion stands out after two years of fieldwork on this project, it is that goldenrod is a precious and irreplaceable pollinator plant on Martha's Vineyard. It is the preferred pollen and nectar source for a large number of late-season specialist bees, mainly in the genera *Andrena* and *Colletes*; while some of these bees are fairly common on the Vineyard, others appear to be uncommon or rare. A wide range of other pollinators enthusiastically visit goldenrods. And goldenrods, collectively, bloom from mid-July into the second half of October, spanning much of the Vineyard's peak season for pollinators.

While our project plots contain two species of goldenrod, *Euthamia tenuifolia* and *Solidago nemoralis*, we emphasize that we selected these species more because they were commercially available than because we expected them to perform particularly well. Any of our native goldenrods would be a useful addition to a farm pollinator patch. *Solidago odora*, *S. rugosa*, and

S. sempervirens (primarly a plant of dunes and upper beaches in the wild, but a surprising versatile species in cultivation) are among the species that seem to attract the most activity in the wild. Ideally, a pollinator patch would incude multiple species with different bloom periods, and our observations suggest that plants in the genus *Solidago* attract a slightly different mix of insects than ones in the genus *Euthamia* (so included at least one species in each genus is desirable). But if you want to help Vineyard pollinators, we don't think you can go wrong by encouraging goldenrods of any and all kinds. It is as useful growing wild in unmanaged areas as it is in deliberately established pollinator plots, so encouraging naturally occurring goldenrod is every bit as useful as intentionally planting it.

2. Native asters: Our project plots contain only one species of aster: *Symphyotrichum laeve*, or smooth aster. Native to the Vineyard, though not very common here, this species also has fairly large, blue-rayed flowers that we expected would be attractive to a wid range of pollinators. Across the project's two years, this attractive species has performed quite well, growing vigorously, resprouting readily after being browsed by deer, and proving popular with bees and other pollinators. At the project's start in early 2022, we tried to source some other species, including New England aster (*S. novae angliae*). But this species is available mainly as horticultural cultivars, selectively bred and quite different from "wild type" New England aster. So we opted not include it. We also wanted to include at least one white-rayed aster, but we had no luck sourcing any of these from southern New England commercial sources. Apparently white-rayed species are deemed less ornamental that blue-rayed ones and hence are much less frequently grown in cultivation. A more recent web search suggests that the commercial supply of white-rayed aster may be improving.

While smooth aster has worked well in the project plots, our observations on farms outside the project plots and more broadly around the Vineyard have suggested that it as actually a couple of small-flowered species with white rays that are the most effective asters for supporting pollinators, and in particular specialized bees: *S. pilosum* (hairy white old field aster) and *S.ericoides* (white heath aster). Both are common in wild or waste habitats on Martha's Vineyard, with substantial populations of one or both in waste portions of several of the farms participating in this project. And both are highly attractive to bees, flies, and sometimes other types of pollinators. In particular, *Andrena asteris* flocks to either of these species when they are available. Both of these asters are vigorous, even aggressive perennials well adapted to dry, sandy soils. They both are rather weedy in appearance, with small leaves and sprawling habit, which probably explains their limited presence in the commercial market. Either of these asters would be a great addition to a pollinator plot, and if a farm wanted to begin production of native Vineyard pollinator plant, we would love to see more of both of these species in bloom around the island!

3. *Monarda*: We have had mixed results with this genus, many members of which are well known as pollinator resources. We think that the low-growing and free-flowering *Monarda punctata* would be an excellent addition to any pollinator plot. It reliable attracts large numbers of bumblebees, large carpenter bees, and honey bees, all of which are useful pollinators in a farm context. And *M. punctata* is magically attractive to larger wasp species, including social

wasps in the genus *Polistes* (paper wasps), yellowjackets in the genera *Vespula* and *Dolichovespula*; solitary “potter wasps” in the subfamily Eumeninae; and solitary wasps in the family Sphecidae. Importantly, all of these wasps are predators or parasites of other arthropods; if you practice Integrated Pest Management, these wasps rank among your best friends.

Monarda didyma, on the other hand, grew aggressively once established in our project plots but attracted relatively little pollinator activity. While we don’t feel it does any harm (unless it outcompetes more desirable plants), we don’t feel that this species is a priority for inclusion in pollinator plantings.

While we didn’t include it in this project and have no experience growing it on the Vineyard, *M. fistulosa* is a regional native that might be worth experimenting with. Its flowers are tubular like those of *M. didyma*, but much shorter, making them accessible to a much larger range of insects. Reports from elsewhere in New England suggest that this species is widely adaptable and favored by a nice mix of bees, butterflies, and other insects.

4. Clover: Clover of any species has proven to be a good pollinator resource in this project. The two very common species purple and white clover (*Trifolium pratense* and *T. repens*, respectively) showed real resilience in our project plots, nearly dying during the drought conditions of 2022 but bouncing back and blooming strongly in most project plots in 2023. A wide range of pollinators visit clover, and as we noted above, clover is a favorite of *Bombus vagans*, one of the target bees of this project. While it didn’t seem to get much use as a cover crop in 2023, crimson clover (*T. incarnatum*) attracted a lot of pollinator activity in 2022 when it was allowed to reach flowering stage as a cover crop.

In part because clovers are often included in cover crop mixes, and in part because these introduced plants are well established as adventive species on most farms, we do not think clovers need to be a high priority in typical pollinator plantings (though their inclusion would still be a fine thing). But encouraging clover where it occurs growing wild on farms, or including it in cover crops in contexts where it can be allowed to bloom, are measures we can confidently recommend for any farm that wants to help pollinators out.

5. Sunflowers: *Helinathus annuus* has long been a favorite of gardeners and plant breeders alike: a huge diversity of this fast-growing annual is readily available on the commercial market, varying is height, habit, and flower size, form, and color. From the perspective of this project, sunflowers are a bit tricky because they are annuals, requiring ongoing work if they are to be included in pollinator patches. But most varieties grow readily from seed and, once established, are bulletproof in terms of drought and heat resistance. (We do note that unprotected sunflowers are vulnerable to deer browse, at least until the plants are mature enough to become tough.)

Our main reason for including sunflower in our project plot mix was that several bees in the genus *Melissodes* specialize in using *Helianthus*. So far, *M. trinodis* and *M. asteris* have proven to be common on project plot sunflowers, and this association appears to be very, very close:

we've rarely observed either of these bees on any other kind of flower, and one or both of these specialized bees have been found on sunflowers at seven of the eight farms participating in the project. (We do have a few records of *Melissodes* visiting *Rudbeckia*, or black-eyed Susan, which of course is a fairly close relative of *Helianthus*.) If you plant a reasonable quantity of the right sunflower varieties, we can virtually guarantee that you will attract *Melissodes*. Other bees incuding honey bees (*Apis mellifera*), common eastern bumblebees (*Bombus impatiens*), and sweat bees in the genera *Halictus* and *Agapostemon* are also frequent visitors to sunflowers. So *Helianthus* is highly recommended as a late summer pollinator plant.

A female *Melissodes*, either *M. trinodis* or *M. agilis*, takes pollen from sunflower blossom. These two closely related bees are strongly associated with sunflowers.

Observations in 2023, though, reinforced the impression we got in 2022 that all sunflowers are not alike. Sunflowers with very small flowers appear to attract less activity than ones with medium or large flowers. Varieties with dark ("mahogany") petals seem to be less attractive than ones with yellow petals. Sunflowers with highly doubled blossoms ("pom-poms") are rarely visited by bees. And pollen-free varieties, now commonly grown for the cut-flower industry because they do not drop pollen on indoor surfaces when included in floral arrangements, have very limited appeal.

On this last point, Matt Pelikan and visiting pollinator ecologist Molly Jacobson observed a striking illustration on a visit to one project farm in mid-August of this past summer. Only a handful of sunflower blossoms were open in the project plot, but we quickly tallied five *Melissodes* visiting them, including a male and four females actively collecting pollen to provision their nests. When we searched an adjacent sunflower field with many hundreds of open blossoms, we could find no *Melissodes* at all. The only bees present were bumble bees and honey bees which appeared to be taking nectar - but all of these bees had empty corbicula

("pollen baskets"), indicating that they were unable to collect pollen from these flowers. We believe that these commercial sunflowers were all pollen-free varieties which offered nectar (to support adult bees) but not pollen (necessary for provisioning nests). Pollen-free sunflowers, in other words, do not support the full life cycle of bees and are of little interest to the sunflower specialist bees in the genus *Melissodes*.

Pollen-free sunflowers may of course be an excellent choice for the cut-flower market, and they do provide food (nectar) for adult bees. But if you are planting sunflowers specifically to support pollinators, we strongly recommend the use of only traditional varieties with pollen-producing, medium- or large-sized flowers with yellow petals. The value of such sunflowers and their superiority as pollinator plants over other types is one of strongest conclusions we have drawn to date.

6. Milkweeds: Following the loss of to an unknown pathogen of almost all the butterfly weed (*Asclepias tuberosa*) we planted in 2022, this legendary pollinator plant was almost absent from our pollinator plots in 2024. But this species and common milkweed, *A. syriaca*, are common in waste areas of several of the participating farms, and in 2024, this important genus once again showed its enormous appeal to pollinators.

7. Plot preparation and maintenance: As we noted earlier, competition among species can be a problem in pollinator plots, sometimes reducing floral diversity over the long term as taller and more aggressive species crowd out shorter and less aggressive ones. We think, therefore, that single-species patches make the most sense when you are planning a pollinator resource.

In 2023, our established project plots generally flourished with relatively little maintenance work needed. (As noted elsewhere, a couple of species flourished a bit too much, choking out less aggressive relatives.) Most of the plants we experimented with are widely adaptable, at least moderately drought-resistant, and suited to a range of soil types (including the lean, sandy soils that are so prevalent of the Vineyard). With the exception of sunflowers, which have annual life-histories, we expect that our recommended pollinator plants will persist with little maintenance for many years once they are established. Elisabeth Sheldon, who provided most of the plant care in the project plots in 2022 and 2023, noted that sunflowers were much easier to get established in 2022, when most of the project plots had irrigation installed, than in 2023, when irrigation was not used. But even in 2024, sunflowers reached maturity and flowered in good numbers in the plots. Goldenrods, asters, and *Monarda* no doubt benefitted from irrigation as they got established in 2022. But all of these grew prodigiously without supplemental water in 2023.

As with any horticultural project, though, establishing a pollinator plot necessarily requires at least a little up-front effort. Thanks to the cooperation of participating farms, all of our project plots were tilled in early spring 2022, before being planted. While we don't have any untilled plots for comparison, we feel that tilling as an initial step is worth the effort. Our experiment in 2022 of spreading a thin layer of wood chips on newly established project plots was generally successful as a weed suppression method that reduces the labor of getting plugs established. In

2022, plots generally received at least a light weeding every week or two. The benefit of this approach was evident in 2023, when little maintenance was needed and the pollinator plants had only each other as competition!

8. Honey bees: As discussed above, we don't think that the presence of honey bees is likely to benefit native bee populations under any circumstances. And we suspect that native bees can provide adequate pollination services on farms, without help from honey bees. We recognize, though, the value of honey bees as domesticated animals, and for farms that choose to support honey bees either for pollination or honey production, we strongly urge that special attention be paid to maintaining rich and diverse floral resources throughout the growing season, which we believe will reduce or eliminate harmful effects from competition between honey bees and small native bee species.

Conclusion

2023 was an active and interesting field season for this project. This year's observations generalized clarified and reinforced the most important conclusions we drew base on last season's data. It's clear that Vineyard farms, with diverse and dynamic habitats, support a wide variety of insect life. That insect life, in turn supplies a wide range of ecological services for the farms: pollinating crops and other flowers, cycling nutrients, controlling pest populations. While many of those insects are generalists in terms of their flower usage, others are highly specialized, interested mainly in flowers belonging to one genus or family. Our observations suggest that even modest plantings of the right pollinator plants can attract (and presumably help support) some of those specialized insects, enhancing diversity on farms and increasing the ecological benefits that farms offer to the landscape as a whole.

We hope this report will assure farmers participating in this project that their farms represent valuable habitat integrated with the larger Vineyard ecosystem. We also hope that some of the suggestions we offer for improving pollinator resources on farms will prove to be appealing and manageable enough to be adopted. And we would encourage farms to continue experimenting with pollinator plantings of all kinds, from dedicated pollinator rows and plots to cover crop schemes that include clovers and other flowering plants to the embrace of the biological potential of untidy, unmanaged edges and waste areas on farms. Perhaps one of more farms will even take on the challenge of developing commercial-scale propagation of some of our most highly recommended native pollinator plants!

In any event, BiodiversityWorks, the Martha's Vineyard Atlas of Life project, and the Betsy and Jesse Fink Family Foundation deeply appreciate your cooperation on this project, and we value the food you produce for the Vineyard community in such ecologically beneficial ways. If you have questions about this report or about supporting wildlife in general, please direct them to the report's author, Matt Pelikan, at mpelikan@bidiversityworksmv.org.

References:

Goldstein, P. Z., and J. S. Ascher. 2016. Taxonomic and behavioral composition of an island fauna: a survey of bees (Hymenoptera: Apoidea: Anthophila) on Martha's Vineyard, Massachusetts. Proceedings of the Entomological Society of Washington, 118(1), 2016, pp. 37-92.

MacInnis, G., and J.R.K. Forrest. 2019. Pollination by native bees yields larger strawberries than pollination by honey bees. Journal of Applied Ecology 56:824-832. https://doi.org/10.1111/1365-2664.13344

Viet, M. F., J. S. Ascher, J. Milam, F. R. Morrison, and P. Z. Goldstein. 2021. A checklist of the bees of Massachusetts (Hymenoptera: Apoidea: Anthophila). Journal of the Kansas Entomological Society, 94(2), pp. 81-157.