SARE FARM ASSESSMENT 2008

Wilmington, DE

A native bee visiting blueberry blossoms at Farm. Wild bees are important pollinators of blueberry.

Delaware DEPARTMENT of AGRICULTURE
Serving Agriculture and Protecting Consumers

Northeast Region SARE
Sustainable Agriculture Research & Education Program

Executive Summary

Why farm for native bees? Most people are familiar with honey bees, yet unaware of North America's resource of native bees. There are 49 species of bumble bees, and more than 3,500 species of solitary bees in North America. Long-term population trends for several wild, native bee species, most notably bumble bees, are demonstrably moving downward (National Research Council 2007). For many native bee species, the scarcity of long-term population data and the incomplete knowledge of basic taxonomy and ecology make definitive assessment of their status very difficult to determine.

Recent research has shown that native bees can play a major role in the pollination of agricultural crops (Kremen et. al. 2004 and Shuler et. al. 2005). For example, watermelon crops in California can expect 100% pollination from native bees if farms have sufficient natural areas surrounding them. *Ceratina* sp., a widespread cavity-nesting native bee, has been documented as a robust pollinator of melons on the eastern shore of Maryland (Norden 1985). Several studies have demonstrated that native bees pollinate apples, squash, blueberries, cherries and other farm crops more effectively than honey bees, on a bee-per-bee basis. Even crops that use managed honey bees as their main pollinators benefit as much as five-fold yield increase when they interact with native bees, primarily by causing them to move more frequently between male and female flowers (Vaughan et. al. 2007).

Bees can take advantage of often-patchy habitats and farms with little surrounding natural area. Growers can manage low productivity land onsite to increase native bee abundance. Holzschuh et. al. (2007) and Hopwood (2006) showed that bee diversity is related to the cover and diversity of flowering plants. These studies suggest that farm management practices that provide additional native flowering plants in and around fallow areas and encourage native bee populations may provide "pollination insurance" to supplement honeybees.

In Delaware, agricultural statistics value cucurbit crops specifically, between $16 and $21 million/year. This is an important segment of the state's agricultural economy. Cucurbits are highly dependent upon insect pollination and benefit from a diverse bee and pollinator community.

TABLE OF CONTENTS

I. INTRODUCTION

Crop-pollinating native bees have three basic needs: access to a diversity of native plants, places to rest and/or nest, and protection from pesticides. Native bees come in a range of sizes and it is important to provide flowers that are of various sizes, shapes and colors in order to support a diverse community of bees. Most native bees are solitary and nest in small tunnels and cells they construct underground. Others nest in dead wood or the soft pith of some plants (i.e., Joe-pye weed, blackberries and sumac). The purpose of this report is to provide information about the native bees detected on your farm and their habitat requirements so that you can better manage your land to provide the greatest advantage for these important crop pollinators.

Planning for the pollinators on your farm is easy. We will focus on three easy steps:

1. recognizing the native bees and bee habitats on your farm;
2. adapting existing farm and land management practices to avoid negative impacts on these bees;
3. providing habitat for native bees on and around the farm.

II. SITE OVERVIEW

A. Past and Current Farm Practices

Farm is a property steeped in history. The land on Foulk Road outside of Wilmington, Delaware, was purchased in 1832, by Clark Webster. In 1835, Clark's son, Isaac, began clearing the ground of the multitude of rocks, and thus began the Webster family farming traditions. In 1940, the farm was officially named Farm, when John registered his Guernsey milking herd, but most still referred to the farm as "Webster's".

Now, 176 years later, the property at Foulk road remains a working farm and orchard harvesting and selling their produce, including some peaches from trees planted by John Webster thirty years ago, to the local community. They also maintain a small nursery of ornamental plants and cut flowers, produce and sell honey, have a bakery on-site providing fresh pies, cookies and breads and have a number of farm animals that provide compost, consume raw waste, attract children and complete the farm agritourism business. Farm is a unique and valuable farm fragment that has been enveloped by an urban landscape.

Farm is committed to following USDA regulations for organic farming. They do not use synthetic chemicals, genetically modified seeds, irradiation, or hormones to speed growth. They do use beneficial insects, aged compost (produced on-site), plant-based sprays, crop rotation, mulches, and heirloom varieties. A diversity of crops are managed for commercial and personal use including; apples, blackberries, blueberries, cherries, grapes, peaches and nectarines, pears, plums, raspberries, rhubarb, strawberries, cucumbers, peppers, pumpkins, spinach, squash, sweet corn and tomatoes.

Farm does utilize honey bees for pollination. Their management strategies include; no-till areas, all pesticide free areas, buffer strips, no mow areas, and supplemental floral resources for nectar and pollen. They are not currently involved in any conservation programs.

B. Land Use

The Farm property is a small parcel (~5.6 acres) that is heavily planted for agricultural and orchard production. The property includes several small tilled areas within a matrix of grassy, untilled borders and orchard.

Table 1. Landcover Estimates for Farm

Land Cover Type	Estimated Area
Crop Fields	% (1.5 acres)
Untilled Farm Space	(3.0 acres)
Buildings / Greenhouses	(1.0 acres)

Figure 1. Overview infrared aerial photograph of Farm (property **outlined in yellow).**

The habitat surrounding the farm is also important to consider when managing for native bees. We identified the habitat surrounding the farm based on state GIS archive data. We mechanically drew a 1 km radius buffer around the property and estimated percent (%) cover for each dominant habitat type.

Farm is a small agricultural site surrounded by residential development (85%). Within 1 km of the site are also a small assortment of additional habitats including some commercial or industrial sites, a conservation area, patches of hardwood forest, and other crop fields (**Table 2**). There is little high quality habitat for pollinators, but the forest patches and residential yards should provide some habitat.

Table 2: Habitat types within 1 km of Farm

Habitat Type	Percent Cover within 1 km
Residential	84.6
Commercial / Industrial	7.9
Conservation Area	3.9
Hardwood Forest	3.3
Crop Field	0.3
Stream / Tax Ditch	<0.1

Figure 2. A 1-km buffer around Farm delineates surrounding habitat types and land use.

C. Soils

Soil data for the area of Farm is not available via the NRCS web soil survey. Well-drained, sunny soils with limited clay content are most suitable for ground-nesting bees.

D. Plant Diversity and Invasive Species

Flowering plant diversity at the site is relatively low (see **Appendix 1**). The small size of the parcel limits the amount of space available for native perennial vegetation. No invasive species problems were noted at the site.

Figure 3. The untilled areas beneath fruit trees can support some species useful for native bee forage. Here, Indian Strawberry (*Duchesnea indica*) blooms amidst leave of clovers (*Trifolium* sp.) (Photo: Matt Sarver)

III. BEE SAMPLING RESULTS

From 2006-2008, bee transects were established to sample pollinators in and near your cucurbit crops. Bees were sampled during the months of March through October (**Appendix 4, Figure 7**). 80 individual bees have been collected and identified.

These bees can be categorized into 2 distinct categories that are important for management; solitary nest building bees and social nest building bees. Solitary bees include all except bumble bees and honey bees. A solitary bee is one in which a female constructs a nest and gathers food for her offspring completely on her own and she normally dies before her young reach maturity. The many solitary bee species exhibit a range of nesting behaviors. Nests can be found in the ground, in holes in wood and within the hollow stem of certain types of plants. Although individual female solitary bees each build their own nest, the nests of many individuals may be clustered together in areas of ideal habitat, sometimes creating dense aggregations.

Social nest building bees include our best-known pollinators, the bumble bees and the honey bees. Bumble bees are native to the United States. They live in annual colonies founded by a queen and her worker daughters who share the work of constructing the nest and provisioning the young. They prefer to nest in abandoned rodent nests underground or in tussocks of vegetation. The honey bee, while not native to the United States, is a cavity nester with colonies consisting of a queen and her workers living together in perennial hives that may last several years. Honey bees are the most highly managed pollinator. Domestic honey bees are housed in man-made hives and are moved throughout the United States to pollinate a variety of crops.

There were 21 different species collected at Farm between 2006 and 2008 (**Appendix 4**). Of these, the abundances of 7 species or groups known to pollinate cucurbit crops are given in **Table 3** below. At this site, these species occur in small numbers and with little overlap through the growing season. For this reason, it will be important to consider a techniques to improve and supplement nesting sites and provide plants that can serve as sources of pollen and nectar throughout the growing season.

Table 3. Native bees known to pollinate cucurbit crops (2006-2008 Farm).

Genus species	**Common name**	**Total # of bees on transect**	**Crop[1]**	**Month(s) present**	**Month(s) projected (goal)**
Ceratina species	Green sweat bee	5	C	*June & Sept*	June-Sept
Peponapis pruinosa	Squash bee	4	P	Aug	July-Sept
Lasioglossum species	Sweat bee	1	WC	June	Mar-Sept
Augochlora pura	Green sweat bee	1	WP	Sept	May-Sept
Bombus species	Bumble bee	1	WCP	Aug	Mar & June-Sept
Agapostemon splendens	Green sweat bee	0	P	-	June-Aug
Melissodes bimaculata	Digger bee	0	WC	-	July-Aug

[1] = **W**atermelon, **C**ucumber and **P**umpkin

IV. CURRENT CONDITIONS and RECOMMENDATIONS

A. CROP RECOMMENDATIONS

APPLE, CHERRY, and PLUM

Pollination Needs: Cross-pollination by a compatible pollenizer variety is required for most types of apples, sweet cherries, and plums; and this cross-pollination is accomplished by insects. Honey bees are important pollinators of apple, but they are relatively inefficient, and it can be difficult to have strong colonies early enough for apple bloom. Orchard mason bees (*Osmia* spp.) are efficient apple pollinators and may be managed using artificial nest sites.

Current Conditions: No orchard mason bees were collected at the property, and there is little nesting habitat available.

Recommendations: Consider establishing orchard mason bees in artificial nests on the property. Studies indicate that these bees can improve fruit-set and shape of some apple varieties, even when

PEACH, NECTARINE, and PEAR

Pollination Needs: Most peach varieties grown today are self-fertile, but benefit from inset visitation (increased fruit set). Pears range from self-fertile to self-sterile, but also benefit from insect visitation. Honey bees are the most important pollinators of these fruits. Pear blossoms are not very attractive to bees, and large numbers of honey bees are required.

Current Conditions: Honey bees are present at the farm.

Recommendations: Continue to provide honey bees for pollination, since few native pollinators are known to visit these flowers enough to provide significant pollination.

BLACKBERRY and RASPBERRY

Pollination Needs: Both self-fertile and self-sterile varieties of blackberry and raspberry benefit from insect pollination, which results in improved fruit size and shape. While honey bees visit the flowers, bumble bees are more efficient pollinators, active in colder weather, depositing more pollen per visit, and preferentially visiting younger flowers.

Current Conditions: Potential bumble bee habitat at the site is very limited. One species of pollinating bumble bee was found at your property. The trapping methods employed,

however, do not catch large numbers of bumble bees, so there may be more bees visiting the site.

Recommendations: Improve bumble bee nesting habitat by creating areas of dense vegetation that are not mowed, raked, or otherwise disturbed. Since bumble bees nest at high densities in edges, creating a small hedgerow bordered by native wildflowers and grasses may provide a nesting area for bumble bees. While the rate of artificial nest box occupancy is low, your site may be a good candidate for nest box deployment because of the lack of natural nesting sites.

BLUEBERRY

Pollination Need: Blueberries (lowbush, highbush, and rabbit-eye) in general realize increased fruit set from bee pollination. Honey bees are useful pollinators, but because they do not buzz-pollinate (see Tomato for a description of this process), and because they often have difficulty reaching into the long flower tubes, they are less efficient than bumble bees as blueberry pollinators. Other native bees, including digger bees (*Andrena* spp.), mason bees (*Osmia* spp.) and leaf-cutter bees (*Megachile* spp.) are potential pollinators, if populations are sufficient.

Current Conditions: None of the native bee blueberry pollinators were captured in any numbers at your site. This reflects the lack of habitat for native bees in the surrounding landscape due to suburban development.

Recommendations: Improve nesting opportunities for bumble bees, ground-nesting solitary bees, and cavity-nesting bees on the farm. Artificial nest sites may prove beneficial. Increase the amount of mid to late season floral resources. Continue to provide honey bees for blueberry pollination, since the populations of native pollinators are likely to be highly variable.

CUCUMBER

Pollination Needs: Most cucumbers require insect pollination for proper fruit set and quality. Honey bees and bumble bees are both good cucumber pollinators, with fewer bumble bee visits required to prevent fruit abortion, indicating that bumble bees may be more efficient pollinators. Some other native bees are known to visit cucumber flowers in Delaware, including small carpenter bees (*Ceratina* spp.), long-horned bees (*Melissodes bimaculata*), and sweat bees (*Lasioglossum* spp.).

Current Conditions: Honey bees are present at the site. One species of pollinating bumble bee was found at your property. The trapping methods employed, however, do not catch large numbers of bumble bees, so there may be more bees visiting the site. Small numbers of small carpenter bees were captured at the site, but no long-horned bees

Recommendations: Improved bumble bee habitat might increase numbers of foraging bumble bees that visit the flowers. Protecting untilled farm space may encourage ground-nesting solitary bees that may contribute to pollination.

PUMPKIN and SQUASH

Pollination Needs: Pumpkins and other gourds are most efficiently pollinated by the squash bee, *Peponapis pruinosa*.

Current Conditions: Squash bees were found in small numbers at your farm during the bee survey. These are soil-nesting bees that specialize on squash and pumpkin pollen and depend on these plants for the pollen they feed to their young. Bumble bees (one species present at your farm) also pollinate squash effectively. The long-horned bee *Melissodes bimaculata* and the metallic green sweat bees *Augochlora pura* and *Agapostemon splendens* are also pumpkin and squash pollinators. Of these, only a single specimen of *Augochlora pura* was captured at your farm.

Recommendations: Avoid tilling the areas near which you grow pumpkins and gourds to prevent damage to ground-nesting squash bee nests, long-horned bee nests, and sweat bee nests. Plant some pumpkins or gourds each year in order to maintain your squash bee population. If you stop planting these crops, the bees will move elsewhere because they depend upon squash pollen and cannot use the pollen of other species of plants. Improving habitat for bumble bees should also benefit your squash. See Blackberry and Raspberry for these recommendations.

TOMATO

Pollination Needs: Tomatoes are dependent on vibration for fruit set. This can be accomplished by wind, or by buzz-pollination (also known as sonication), a special type of pollination used by bumble bees, in which the flower is vibrated to force release of pollen from the anthers.

Current Conditions: See Blackberry and Raspberry

Recommendations: See Blackberry and Raspberry

PEPPER

Pollination Needs: Peppers are generally self-pollinating, but cross-pollination is common, and because bee pollination can increase fruit-set and yield even in self-pollinating varieties, bee visitation is beneficial. Peppers are visited by a variety of bees,

although the relative attractiveness of the flower is low. Pollination by bumble bees and syrphid flies is known to increase fruit quality.

Current Conditions: See Blackberry and Raspberry

Recommendations: See Blackberry and Raspberry

STRAWBERRY

Pollination Needs: While modern Strawberry cultivars are capable of partial self-pollination, not all pistils of the flower are pollinated. Incomplete pollination leads to smaller berries with irregular shapes. Wind increases the degree of pollination somewhat, but only with insect visitation do the plants realize close to full pollination. Bee pollination ensures larger, well-shaped fruits. Honeybees are reportedly not very strongly attracted to strawberry blossoms, so heavy saturation with colonies is required to achieve good pollination, especially for small plantations surrounded by more attractive nectar sources. Such saturation, while it may provide effective pollination, depletes other nectar sources nearby, potentially depriving native bees of needed resources. Therefore, managing nearby areas for native bees may be a good alternative.

Current Conditions: Mason bees (*Osmia* spp.) are frequent visitors to strawberry, and these bees require cavities in which to nest. Sweat bees (*Halictus* spp.), mining bees (*Andrena* spp.) and hover flies (*Eristalis* and other syrphid flies) all contribute to strawberry pollination. A variety of bee visitors is best for optimal fruit production and quality.

Recommendations: Provide artificial mason bee nesting sites near strawberry beds, or plant appropriate nesting vegetation nearby.

Figure 4. Honey bee pollinating strawberry at Farm. (Photo: Matt Sarver)

SUNFLOWER

Pollination Needs: Sunflower, especially hybrid varieties, can self-pollinate, but yields and seed oil content are increased with bee pollination. Nectar-foraging bees are effective pollinators because they visit both male-fertile and male-sterile flowers. Honeybees are very valuable for sunflower pollination, and many native bees visit the crop as well, contributing to pollen transfer.

Current Conditions: Honey bees are present on the property, and should visit the sunflowers in season, along with a variety of solitary bees.

Recommendations: Continue to provide honey bees for effective sunflower pollination. Practices that increase solitary bee populations should also have a beneficial effect on sunflower yields.

B. SPECIFIC LAND USE CONDITIONS AND RECOMMENDATIONS

1. Cropped Areas

Current Conditions: Cropped beds consist of both tilled vegetable beds and untilled rows of berries.

Recommendations:

Limit tillage and mulch depth where feasible in cropped areas to improve ground-nesting bee habitat.

Figure 5. Crop bed at Farm. (Photo: Matt Sarver)

2. Non-cropped Areas

Mowed grass

Current Conditions: There is a good deal of grassy habitat at the property, kept short by rotational grazing by livestock. While short grass is not as beneficial to bees as native perennial vegetation, a number of species of plants important to bees can inhabit mown lawns. Foremost among these are the clovers (*Trifolium* sp.) and dandelions (*Taraxacum officinale*), which are of high forage value to both bumble bees and honeybees.

Figure 6. Dandelions and other lawn "weeds" are valuable forage for bees. Here, a honeybee feeds on dandelion at Farm. (Photo: Matt Sarver)

Recommendations: Design mowing/grazing schedules around the bloom of the lawn wildflowers that bees make use of.

Marginal Areas

Current Conditions: The marginal areas around farm buildings and equipment storage areas may provide habitat for bees on your farm. While the plant communities in these areas are primarily weedy annuals, some perennial vegetation is present, including clovers and violets. The untilled soils may be used by some species of ground-nesting bees.

Recommendations: Less frequent mowing will encourage more perennial vegetation that is of use to bees.

Figure 7. Marginal areas are of value to bees, and may be enhanced through active management. (Photo: Matt Sarver)

Orchard

Current Conditions: The area beneath your fruit trees harbors some useful bee forage plants including violets, clovers, and dandelions.

Recommendations: Less frequent mowing will encourage more perennial vegetation that is of use to bees. Consider seeding this area in desired bee forage ground covers, and placing artificial nest sites for orchard mason bees.

Figure 8. The southern corner of the property might be an ideal location for a native wildflower planting that would help provide supplemental forage for native bee species. (Photo: Matt Sarver)

V. SUMMARY of RECOMMENDATIONS

Tier 1 – Changes in Management Practices

- The squash bee, *Peponapis pruinosa*, depends entirely on cucurbit flowers to survive. They also nest underground and mostly occur on farms consistently growing squash year after year. If you anticipate growing pumpkins or squash in future years, plant these crops every year and leave open soils nearby for nesting sites.
- Protect untilled areas that may serve as nesting sites for solitary, ground-nesting bees.

Tier 2 – Basic, Low Cost or Do-it-yourself Improvements

- Provide artificial nest sites for cavity-nesting bees such as mason bees (*Osmia* spp.) and small carpenter bees (*Ceratina* spp.). These should be placed among fruit trees and near the strawberries. Placing boxes in other areas around the farm may generally increase the numbers of these pollinators.
- Experiment with wooden bumble bee nest boxes to see if they are occupied by bumble bee colonies.

Tier 3 – Higher Investment Improvements

- Develop a Conservation Plan with your local NRCS office. Technical and financial assistance may be available to select and implement conservation practices to benefit pollinators and pollination services (see next section).
- Seed a mix of clovers and other low-growing forage plants beneath fruit trees.
- Plant borders of native shrubs and/or wildflowers along the fence and in other marginal areas to provide supplemental forage for native bees and potential nest sites for bumble bees.

VI. NRCS Assistance Available for Pollinator Habitat Management

In June of 2008, Congress passed revisions to the Food, Conservation, and Energy Act of 2008 otherwise known as the Farm Bill. The 'new' Farm Bill recognizes the vital role that pollinators play in the U.S. agricultural landscape by proposing significant increases in research funding for honey bees and native bees, and by mandating that conservation programs support habitat restoration and management for pollinators (Xerces: 2008 Farm Bill, Benefits to Crop Pollinators).

Odd areas and idle fields on farms can be used to create habitat for pollinators. Promoting pollinator habitat on and near the farm will increase pollinator diversity and be a benefit to your crops. Through the Wildlife Habitat Incentives Program (WHIP) and the Environmental Quality Incentives Program (EQIP) landowners can receive technical and financial assistance to help restore and/or improve pollinator habitat on their farm. New language in the 2008 Farm Bill makes pollinators and their habitat a priority for land managers and conservationists. The new Farm Bill authorizes special consideration when determining payments for practices that promote pollinator habitat during program implementation. It requires that native and managed pollinators be considered during the review or development of Farm Bill conservation practice standards. Congress has recognized that pollinators are a crucial part of the healthy landscape panorama and NRCS participation will be vital to this effort (Xerces Society, Using Farm Bill Programs for Pollinator Conservation).

The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for private landowners to develop and improve high quality habitat that supports wildlife populations of National, State, Tribal, and local significance. Through WHIP, NRCS provides technical and financial assistance to help landowners implement wildlife habitat practices. WHIP agreements generally last from 5 to 10 years.

The Environmental Quality Incentives Program provides technical, educational, and financial assistance to eligible farmers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program is funded through the Commodity Credit Corporation. The purposes of the program are achieved through the implementation of a conservation plan. Two (2) to Ten (10) year contracts are made with producers and cost-share payments may be made to implement eligible conservation practices including animal waste management systems, buffer strips, and nutrient management.

VII. Timetables and Credits

Date(s) of surveys:

2006: 29 June, 12 July, 28 July, 13 September
2007: 25 April, 23 May, 19 June, 17 July, 13 August, 30 August, 20 September

Field Assessments and reports:

Sarver Ecological Consulting, Matthew Sarver, (724) 689-5845
Bonnie MacCulloch Consulting Services, (302) 353-6243

Bee data:

Delaware Department of Agriculture, Plant Industries, Heather Harmon, Entomologist, (302) 698-4588

Principal Investigator and Plant Industries Administrator:

Dr. Faith Kuehn
Delaware Department of Agriculture
Plant Industries
2320 So. DuPont Hwy
Dover, DE 19901
(302) 698-4587

Appendix 1. List of Flowering Plants found During Site Visit

Growth Form	Common Name	Genus	Species	Native?	Annual/Perennial
Forb	Star-of-Bethlehem	*Ornithogalum*	*umbellatum*	Non-native	**P**
Forb	Small-flower Crane's-bill	*Geranium*	*pusillum*	Non-native	**A**
Forb	Plantain	*Plantago*	*sp.*	Non-native	**P**
Forb	Purple Deadnettle	*Lamium*	*purpureum*	Non-native	**A**
Forb	Common Starwort	*Stellaria*	*media*	Non-native	**A**
Forb	Gill-over-the-ground	*Glechoma*	*hederacea*	Non-native	**P**
Forb	Purslane Speedwell	*Veronica*	*peregrina*	Non-native	**A**
Forb	**Yellow Wood-sorrel**	*Oxalis*	stricta	Non-native	**P**
Forb	Broad-leaved Plantain	*Plantago*	*major*	Non-native	**P**
Forb	**Lady's Thumb**	*Polygonum*	*persicaria*	Non-native	**A**
Forb	Lambs Quarters	*Chenopodium*	*sp.*	Non-native	**A**
Forb	Perscians' Speedwell	*Veronica*	*persica*	Non-native	**A**
Forb	Shepherd's Purse	*Capsella*	*bursa-pastoris*	Non-native	**A**
Forb	Dwarf Cheeseweed	*Malva*	*neglecta*	Non-native	**A**
Forb	Bulbous Buttercup	*Ranunculus*	bulbosus	Non-native	**P**
Forb	Old-man-in-the-spring	*Senecio*	*vulgaris*	Non-native	**A**
Forb	Dock	*Rumex*	*sp.*	Non-native	**P**
Forb	**White Clover**	*Trifolium*	*repens*	Non-native	**P**
Forb	**Dandelion**	*Taraxacum*	*officinale*	Non-native	**P**
Forb	Indian Mock-strawberry	*Duchesnea*	*indica*	Non-native	**P**
Forb	Violet	*Viola*	*sp.*	Native	**P**

BOLD = Species important for bee forage
***** = Component of planted seed mix

Appendix 2: Bees collected at Farm between 2006 and 2008.

Genus species	Common	Total	Genus species	Common	Total
Agapostemon virescens	Green sweat bee	2	*Halictus ligatus/poeyi*	Sweat bee	2
Anthidium manicatum	Leafcutter bee	1	*Lasioglossum admirandum*	Sweat bee	5
Apis mellifera	Honey bee	4	*Lasioglossum bruneri*	Sweat bee	1
Augochlora pura	Sweat bee	1	*Lasioglossum rohweri*	Sweat bee	2
Augochlorella aurata	Sweat bee	1	*Lasioglossum tegulare*	Sweat bee	1
Bombus citrinus	Bumble bee	1	*Lasioglossum versatum*	Sweat bee	2
Bombus fervidus	Bumble bee	1	*Melissodes desponsa*	Digger bee	1
Calliopsis andreniformis	Andrenid bee	2	*Melissodes trinodis*	Digger bee	39
Ceratina calcarata	Small carpenter bee	2	*Peponapis pruinosa*	Squash bee	4
Ceratina dupla	Small carpenter bee	1	*Xylocopa virginica*	Large carpenter bee	Observed
Ceratina strenua	Small carpenter bee	2	**TOTAL**		**80**
Halictus confusus	Sweat bee	5			

Figure 9. The total number of native, wild bee species caught each month from Mar - Sep at Farm.

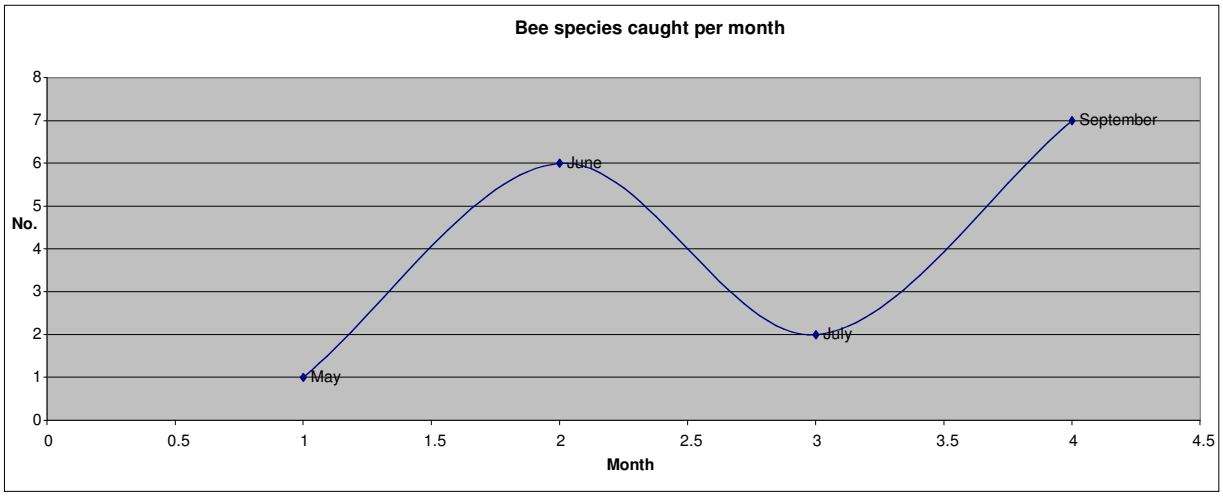
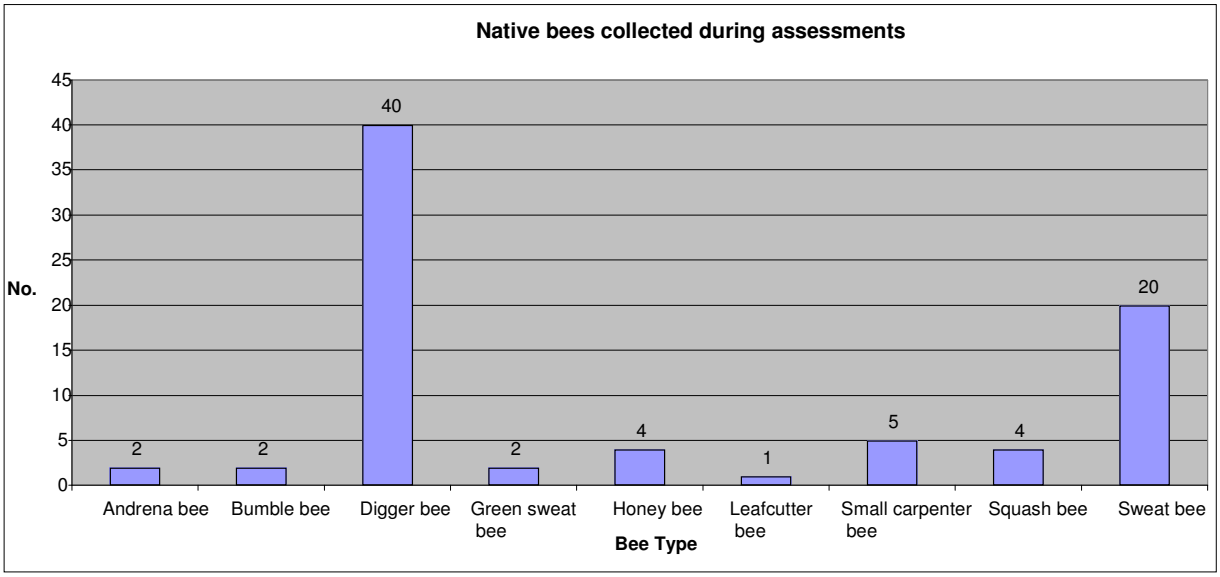


Figure 10. The number of native, wild bee individuals caught at Farm, by group.



Appendix 3: NRCS Contact Information

Kent County Agriculture Center
800 Bay Road, Suite #2
Dover, Delaware 19901-4667
Phone: 302-741-2600
Fax: 302-741-0341

Georgetown Agriculture Center
21315 Berlin Road, Unit #3
Georgetown, Delaware 19947
Phone: 302-856-3990
Fax: 302-856-4381

New Castle Agriculture Center
2430 Old County Road
Newark, DE 19791
Phone: 302-832-3100
Fax: 302-834-0783

REFERENCES:

Holzschuh, A., I. Steffan-Dewenter, D. Kleijn, and T. Tscharntke (2007): Diversity of flower-visiting bees in cereal fields: effects of farming system, landscape composition and regional context. J. Applied Ecology 44:41-49.

Hopwood, Jennifer L. (2006): The value of roadside prairie restorations in the conservation of native bees. Poster presented at the 2006 Annual Meeting, Entomological Society of America.

Kremen, C., N. Williams, R. Bugg, J.P. Fay and R. Thorp (2004): The area requirements of an ecosystem service: crop pollination by native bee communities in California. Ecology Letters 7:1109-1119.

Kremen, C. N. Williams, S. Greenleaf and R. Thorp. Native Bee Pollination of Watermelon. Factsheet prepared by Xerces based on research by Kremen et al.

National Research Council (2007): Status of Pollinators in North America. National Academies Press, Washington, D.C.

Norden, B.M.B (1985): The comparative importance of small carpenter bees (*Ceratina* spp.) and other insects to pollination of melon (*Cucumis melo l.*) in the eastern United States. in, Steve Buchmann ed., Experimental Studies of Pollination and Foraging Efficiency. University of Arizona Press.

Sheffield, C.S., P.Kevan, S. Westby and R.Smith (2008). Diversity of cavity-nesting bees (Hymenoptera: Apoidea) within apple orchards and wild habitats in the Annapolis Valley, Nova Scotia, Canada. Can. Entomol. 140: 235-249.

Shuler, R. E., Th. H. Roulston and G.E. Farris (2005): Farm practices influence wild pollinator populations on squash and pumpkins. Journal of Economic Entomology 98:790-795.

Vaughan, M., M. Shepherd, C. Kremen, and S.H. Black (2007): Farming for bees, Guidelines for providing native bee habitat on farms. Xerces Society.

www.xerces.org: Farm Bill: Benefits to Crop Pollinators

Commercial Vegetable Production Recommendations. 2008. University of Delaware Cooperative Extension.
How to Reduce Bee Poisoning from Pesticides. H. Riedl, E. Johansen, L. Brewer and J. Barbour. 2006. Oregon State University, Corvallis, OR. PNW-59d1.

How to Reduce Bee Poisoning From Pesticides. H. Riedl, E. Johansen, L. Brewer and J. Barbour. 2006. Oregon State University, Corvallis, OR. PNW 591.
http://extension.oregonstate.edu/catalog/pdf/pnw/pnw591.pdf

Protecting Honey Bees from Chemical Pesticides. M. Frazier. Penn State.

University of Georgia Honey Bee Program
http://www.ent.uga.edu/bees/Pollination/Table_Insecticides_Miticides.htm
Pollinator Habitat Planting. Michigan CRP – SAFE CP – 38E Pollinator. USDA NRCS. July 2008.