NC Project Station Report Content:

1. Impact Nugget: A concise statement of advancements, accomplishments and impacts. (Limit to 1-2 sentences)

AR: Examined the occurrence of *Nosema apis* and *N. ceranae* in feral and Africanized honey bee populations in southwestern United States, as well as *N. bombi* in *Bombus* queens in Kansas. Studied mitochondrial DNA genetic diversity of feral honey bees in the United States.

CT: Demonstrated the importance of non-Apis bees to pollination of pumpkin and winter squash, showing that honey bees accounted for only about15% of bee visits to these crop plants, while the native bees *Bombus impatiens* and *Peponapis pruinosa* accounted for over 60% and 20%, respectively.

IN: Purdue University developed honey bee stocks that have an increased tendency to bite Varroa mites and to remove them from their bodies, which could eliminate the need for other mite controls.

ME: A change in knowledge has occurred in the Maine blueberry grower community regarding neonicotinoid insecticides and also with the fungicide, propiconazole. A change in action has occurred by some wild blueberry growers in that applications of fungicide are made more cautiously and only near bloom when mummyberry infection periods warrant control.

MN: Found measures of individual honey bees and of colonies that both reflect the nutritional quality of the floral landscape surrounding an apiary and predict colony survivorship over the winter. These findings could lead to a "bee blood test" to indicate colony health and predict survivorship.

MT: Monitored honey bee colony health before, during, and after the 2013-2014 almond pollination season and utilized pathogen-specific PCR in order to evaluate influence of pathogens on colony health. We determined that a recently described group of honey bee infecting viruses, the Lake Sinai viruses (LSV1-5) are very prevalent and abundant in both Montana and California-based beekeeping operations.

NJ: Measured the effectiveness of native pollinator habitat restoration protocols, identified the wild bee species that are the most important crop pollinators, and identified the plant species that the crop pollinators use for forage.

NY: Determined that pollination services provided by native bees and feral honey bees to commercial pumpkin production in New York is typically sufficient and that supplementing pumpkin fields with managed bees is not necessary in most situations. Consequently, some pumpkin growers are either reducing the quantity of honey bee hives or are no longer placing honey bee hives in their pumpkin fields.

OR: Developed nutrition management recommendations for commercial honey bee colonies based on their studies related to bee nutrition in Oregon that could potentially reduce honey bee colony losses by 15%. Also demonstrated the potential of honey bee brood pheromone to enhance honey bee foraging in hard to pollinate crops which could potentially increase crop yields up to 18%.

PA: Found that honey bees are 'poisoned' by widespread co-formulants used in agrochemicals, particularly organosilicone surfactants and the co-solvent N-methyl-2-pyrrolidone. Honey bees reveal that the formulation and not just the dose makes the poison.

2. New Facilities and Equipment. Include production areas, sensors, instruments, and control systems purchased/installed.

ME: Currently working with two electrical engineers to develop a portable Doppler radar for assessing colony strength

MN: Include production areas, sensors, instruments, and control systems purchased/installed.

OR: A new Tissue Lyser was purchased in 2014 for the Oregon State University Honey Bee Lab.

3. Unique Project Related Findings. List anything noteworthy and unique learned this year.

CT: We have continued our long term monitoring of pesticides in pollen brought back to honey bee hives. By monitoring the same location over a number of years, trends in pesticide exposure may be elucidated.

IN: Found that mite-biting behavior of honey bees significantly decreased Varroa levels in their breeding population.

ME: conducted a honeybee health survey of nine hive locations in the Maine blueberry barrens and found that unhealthy colonies were associated more with Varroa infestation then pathogens or insecticide residues in trapped pollen.

NJ: Only a small number (<20) of the ~400 wild bee species in our study system are important crop pollinators.

4. Accomplishment Summaries. Draft one to three short paragraphs (2 to 5 sentences each) that summarize research or outreach accomplishments that relate to the project objectives. Please use language that the general public can readily comprehend.

AR: *Nosema apis*, is a microsporidian pathogen of honey bees in the United States, while another Nosema species, *N. ceranae* has been more recently introduced to the United States *Nosema ceranae* is highly pathogenic in honey bees and is associated with reduced honey production and increased winter mortality. A molecular diagnostic technique involving PCR for *Nosema apis* and *N. ceranae* was conducted on Africanized, feral, swarms, and managed honey bee populations from Arkansas, Mississippi, Texas, Utah, Missouri, and Louisiana. A total of 446 samples were analyzed representing 327 feral, 17 swarms, and 102 managed honey bee colonies. Molecular diagnostic analysis revealed that 8% of the *Nosema* positive samples were *N. ceranae*, and 1.2% were *N. apis*.

Among the factors that are likely contributing to bumble bee decline, such as habitat loss, habitat fragmentation, and pesticide use, pathogens have also been implicated in *Bombus* decline. One of these pathogens is *Nosema bombi*, which infects multiple *Bombus* species worldwide. Surveys were conducted in multiple field sites located in three counties in Kansas. A total of 142 queens were collected from the sites described above. *Bombus auricomus* (44%, n = 63), *B. pensylvanicus* (24%, n = 34) and *B. griseocollis* (17%, n = 24) were most commonly collected bumble bee species. Molecular diagnostics revealed that 12% of *Bombus* queens (n = 17) were positive for *N. bombi.*

Although genetic variation studies on unmanaged (feral) honey bees have been conducted in the United States, none have extensively used mitochondrial DNA (mtDNA) sequencing analysis. Adult worker honey bees were collected from 203 feral colonies and 44 swarms from 12 states and subjected to DNA sequencing of a portion of the mtDNA cytochrome oxidase I and II genes. From the 247 honey bee samples in this study, 24 haplotypes belonging to three honey bee lineages (C, M and O) were observed. We identified distinct lineages in unmanaged colonies of honey bees in the United States that were not observed in previous studies on managed colonies.

CT: Dr. Kimberly Stoner attended an intensive week long pollen analysis course. Having taken this course we can now identify pollen so that we can start determining which plant species the honey bees we are monitoring have been visiting and collecting pollen and potentially pesticides from.

IN: Objective 2. We continued selection for “mite-biting” bees and obtained data showing that this trait, which is correlated with grooming behavior is effective in lowering mite populations in our breeding population. We also hosted the first meeting of the Heartland Honey Bee Breeders Cooperative and performed instrumental inseminations to share germplasm, and distributed inseminated queens to participants in PA, OH, WV, IN and MI.

Objective 3. We supervised undergraduate directly and graduate research through a collaborator to investigate effects of neonicotinoids on honey bees and other bee species. Preliminary evidence indicates that the talc used in planting pesticide-treated corn seeds becomes contaminated

with the fungicides as well as the clothianidin in the seed treatment and that it is much more toxic to honey bees than just talc with an equivalent dose of clothianidin.

Objective 6. We gave presentations directly to over a thousand beekeepers describing our breeding program for mite resistance. We conducted two queen-rearing classes to teach beekeepers to raise their own queens and perform selection for resistance. The HHBBC mentioned in objective 2 is conducting queen rearing courses in 5 states and distributing mite tolerant breeder queens.

ME: I focused my efforts on goal 4: to determine the effects of pesticides and other environmental chemicals on honey bee colony health. The major activities completed were research determining the effects of exposure to the insecticides imidacloprid and acetamiprid and the fungicide propiconazole to honey bees foraging during blueberry bloom. Extension/outreach objectives were also completed. These involved making presentations to blueberry growers and beekeepers on the risks honey bees experience when they experience pesticide residues during bloom. In addition, these findings were put in the insecticide recommendations for Maine blueberry growers. The results obtained were that no colony level effects were found in honey bees when exposed to the neonicotinoids during bloom and then moved to non-agricultural bee pasture after bloom. The effects of propiconazol were different. Small effects on young nurse bee longevity and their hypopharyngeal development.

However, no adverse effects were measured after three years on colony strength (as measured by adult and sealed brood densities), colony overwintering survival, queen performance, and disease levels in the colony. A change in knowledge has occured in the Maine blueberry grower community regarding neonicotinoid insecticides and also with the fungicide, propiconazole. A change in action has occurred by some wild blueberry growers in that applications of fungicide are made more cautiously and only near bloom when mummyberry infection periods warrant control.

MN: The University of Minnesota (PhD student Katie Lee) collected data from 15 migratory beekeeping operations as part of the Tech Team program, funded through the Bee Informed Partnership, with the aim of determining the treatment threshold for *Varroa destructor* mites in these operations, and to assess progress in selection for hygienic behavior (a behavioral mechanism of defense against mites and diseases) in honey bee queen breeding operations.

The University of Minnesota (Dr. Matthew Smart, PhD defended February 2015) determined the factors that predicted annual survival (over three years) of honey bee colonies located in North Dakota during the summer and transported to California for almond pollination over the winter. The factors that had a significant positive impact on survival included: the area of uncultivated land (including CRP lands, pasture, grassland, flowering trees and shrubs, fallow land, hayland, and ditches), the amount of brood (pupae) in September, the mean pollen (g) collected per day over the summer, the expression level of vitellogenin in September and abdominal lipid stores in August. Factors that negatively impacted survival included: higher *Varroa destructor* mite infestation levels in September and the expression level of lysozyme-2 in September. This is the first study to quantify the impact and importance of pollen nutrition; i.e., “pollen flow” from the level of landscape to the individual-bee, to the health and survivorship of colonies.

The University of Minnesota (PhD candidate Judy Wu-Smart) determined the impact of sublethal doses of imidacloprid insecticide on the fecundity and behavior of queen honey bees and queen bumblebees (*Bombus impatiens).* For honey bee colonies treated with as low as 10ppb in sugar syrup, the egg-laying rate of the queens decreased and the colonies collected significantly less pollen. For bumble bees, the queens delayed nest initiation (building wax cells and laying eggs) at concentrations as low as 2ppm, and did not initiate nests at all at concentrations of 20ppb and 50ppb.

MT: The Flenniken lab was involved in three longitudinal monitoring projects in 2013. This data includes colony health, and pathogen incidence and abundance data. In addition, laboratory based experiments aimed at determining the mechanisms of honey bee antiviral defense, particularly those triggered by double-stranded RNA (dsRNA). In addition, we performed laboratory-based experiments aimed at understanding virus infection, in the context of agrochemical exposure. We are currently analyzing this data, and plan to publish it next year.

Projects in the lab focus on five principal aspects of honey bee biology: (1) determining the mechanisms and contributions of RNA-triggered pathways in honey bee antiviral defense, (2) honey bee pathogen monitoring, detection and discovery with an emphasis on candidate etiologic agents of Colony Collapse Disorder, (3) investigating the pathogenesis of the recently discovered Lake Sinai viruses, (4) understanding the influence of the individual bee microbiome, metabolome, and transcriptome on the immune response and outcome of infections, and (5) examining the sublethal effects of agrochemicals on honey bee health. While at MSU, I established an active research program that supports one Ph.D. student, one Masters student, five undergraduates, and one senior scientist. In 2014, I submitted 11 grant proposals, and obtained over $500,000 dollars from 2012-2015, including a $150,000 fellowship awarded to Laura Brutscher, a PhD student in my lab, to support my research program at MSU. In 2014, I published one peer-reviewed journal article describing the genome and transcriptome on a honey bee infecting trypanosomatid, and one invited commentary on a new honey bee infecting virus. I am currently writing and invited review, and research manuscripts describing our findings regarding honey bee host pathogen interactions.

NJ: Rutgers University established 16 study sites where data on pollinator species visiting all the flowering plant species present within transects were collected from June through September 2014. Each 'treatment' study site was a pollinator habitat restoration planting, and each of these 8 sites was paired with a 'control' located in a nearby old field habitat. Thus analyses will be able to determine the extent to which active pollinator restorations support more and different native bee species as compared with passive successional regeneration.

Through analysis of previously collected data, Rutgers University has determined that a small set of native bee species (<20 species across 5 crops) are responsible for most of the crop pollination services from native bees that we have recorded thus far in our New Jersey and Pennsylvania study region. Rutgers University analyzed an additional data set, which has been collected under 4 previous grant years, that showed which of 17 native plant species suitable for pollinator restorations these crop pollinating bee species preferred.

NY: Through a series of statistical analyses, two features in the landscape were identified that impact wild bumble bee, *Bombus impatiens* (Cresson), and honey bee, *Apis melifera* L., visits to pumpkin flowers and led to greater fruit yield. The first feature was the level of diversity in land-use types across the landscape. High diversity landscapes (many different land-use types and approximately even parcel sizes) had more bumble bees and greater pumpkin yield compared with landscapes that had low diversity. The second feature was the amount of grassland in the landscape (i.e., semi-natural, open-canopy habitats such as fallows, shrubland, weedy ditches and nature preserves). A landscape with greater than 20 percent grassland was considered sufficient to sustain an adequate population of honey bees for pumpkin pollination.

Pollen foraging fidelity by two of the most common pollinators of pumpkin was explored in the Finger Lakes region of New York. Honey bee, *Apis mellifera*, and bumble bee, *Bombus impatiens*, hives were placed in each of five commercial pumpkin fields. Pollen brought back to these hives was examined in order to determine foraging fidelity. Pollen was collected from the corbicula of ten individuals returning to each hive in each of three sampling events from each field, and identified to the lowest possible taxonomic classification using a pollen reference library. Pollen from asteraceous plants (37%) was most commonly collected by honey bees, while pollen from fabaceous plants (34%) was most commonly collected by bumble bees. Pumpkin pollen collected by honey bees and bumble bees comprised only 1% and 0.7% of pollen brought back to the hive, respectively. These results suggest that factors other than proximity, such as nutrient content, pollen depletion by competing pollinators, or both, influence the decisions where bees forage for pollen.

OR: Oregon State University examined and compared the effects of consumption of various single source pollens from important cropping systems such as almond, blueberry and meadowfoam versus multiple-source pollens on honey bee physiology, immunocompetence and colony growth. The study results suggest that single-source pollen treatments reared significantly less brood, had significantly

lower hypopharyngeal gland protein content and immunocompetence compared to multi-source pollen treatments.

Determining the role of pollen nutrition on Nosema ceranae infection: Oregon State University evaluated role of pollen quality on *Nosema ceranae* infection by providing pollen in different concentrations to bees in experimental cages. The bees from experimental colonies that received highest pollen concentration were found to have significantly higher *Nosema* intensities and interestingly significantly higher survival when compared to other treatments.

Enhancing honey bee pollination using brood pheromone: Oregon State University also tested the potential of synthetic honey bee larval pheromone to increase pollination in hard to pollinate crops such as blueberry and hybrid carrot seed. The results from this study suggest that honey bee brood pheromone has the potential to increase honey bee foraging and seed yield in hybrid carrot seed crop.

PA: Pennsylvania State University is evaluating the role of 'inerts' in pollinator decline. Effects include learning impairment for adult bees and oral toxicity for larvae and adults. We have found 100% of co-formulants analyzed for in beehive samples, while only 70% of pesticide active ingredients searched for have been detected. We have focused our risk assessment efforts for pollinators on investigation of the newer inerts, the organosilicone surfactants and the co-solvent N-methyl-2-pyrrolidone (NMP).

Methods for analysis of organosiloxane, nonylphenol and octylphenol polyethoxylate surfactants in beehive matrices were developed. Trisiloxane surfactants were detected in every beeswax and 60% of the pollen samples. Total trisiloxane surfactant concentrations were up to 390 and 39 ng/g in wax and pollen. Nonylphenol polyethoxylates were detected in every hive sample with concentrations ranging from 26 ng/g to 10,239 ng/g. Highest residues were in wax followed by pollen than honey; octylphenol polyethoxylates concentrations were more than 10 times lower.

A larval rearing method was adapted to assess the chronic oral toxicity to honey bee larvae of the four most common pesticides detected in pollen and wax - fluvalinate, coumaphos, chlorothalonil, and chloropyrifos - tested alone and in all combinations. Among these four pesticides, honey bee larvae were most sensitive to chlorothalonil compared to adults. Synergistic toxicity was observed in binary mixtures of dietary chlorothalonil at 34 mg/L with fluvalinate at 3 mg/L or coumaphos at 8 mg/L. We also documented the high toxicity of NMP to larval bees at down to 0.01% (100 mg/L) in their diet.

5. Impact Statements. Please draft 2 or 3 impact statement summaries related to the project objectives. Statements should be quantitative when possible and be oriented towards the general public. This is perhaps the most difficult yet most important part of the report.

AR: No significant difference was observed in the occurrence of *N. ceranae* between 177 feral Africanized and 101 European honey bee samples from Utah and Texas. This is one of the first studies to document the occurrence of *Nosema ceranae* and *N. apis* from feral and Africanized honey bees in the United States.

This study is the first to examine the prevalence of *N. bombi* pathogen in colony-founding, spring queens in the United States. In addition to finding *N. bombi* at higher levels in *B. pensylvanicus* queens, we also show that *B. auricomus* queens are commonly infected with *N. bombi* in Kansas.

Mitochondrial DNA sequence analysis of feral honey bee colonies revealed that based on maternal inheritance, some populations of feral honey bees in the United States are not recent descendants from managed honey bee populations, and that they have been surviving as feral populations for a period of time.

CT: We have learned that bees other than honey bees are of importance in the pollination of pumpkin and squash. These non-honey bees account for over 80% of bee visits to these crops.

IN: We have selected for a novel resistance mechanism in our breeding program, mite-biting behavior. The average proportion of chewed mites sampled from our breeding population has increased from 3 to 44% in seven years and this grooming behavior was found to correlate with lower mite populations.

In 2014, a queen breeder cooperative was formed to share breeding stocks and to evaluate them. 74 artificially inseminated breeder queens were distributed to five cooperating states. In addition, a study involving many beekeepers was initiated to compare the survival and productivity of "mite-biter" bees to other stocks of bees.

ME: An impact in Maine has been for blueberry growers to adopt a proactive position about protecting honeybees. Several growers will begin in 2015 to monitor health of colonies in their blueberry fields during bloom. They are discussing the development of an independent scout(s) to perform this task for a fee in the future.

MN: We found measures of individual honey bees and of colonies that both reflect the nutritional quality of the floral landscape surrounding an apiary and predict colony survivorship over the winter. These findings could lead to a "bee blood test," whereby a beekeeper could send in samples of bees to a lab for analysis that would indicate colony health and predict survivorship.

The EPA is undergoing a review of neonicotinoid insecticides. Data collected by the University of Minnesota on sublethal effects of imidacloprid on queen honey bees and queen bumblebees will be used for EPA's upcoming risk assessments.

MT: The Flenniken Lab has obtained data on honey bee colony health and the prevalence of pathogens in Montana-basedhoney bee colonies involved in almond pollination. We collected over 170 samples, and performed ~ 2000 pathogen specific PCR reactions to analyzed those samples. We will use quantitative-PCR to assess pathogen abundance in the next phase of this project, which is also supported by the Montana Department of Agriculture – Specialty Crop Block Grant Program.

NJ: Agricultural growers can use the findings from Rutgers University to better manage their farms and provide a back-up of wild be pollination, should health problems with honey bees continue. Specifically, growers can restore plants attractive to the key crop pollinators, using marginal areas around the farm without having to take land out of production. Natural resource professionals (e.g. NRCS staffers) can use this same information in implementing federally-funded pollinator habitat plantings.

NY: A cost-benefit analysis was conducted to determine approximately how much money would be saved by reducing the pumpkin acreage supplemented with managed honey bees in New York. We conservatively estimated that seventy-five percent of the pumpkin fields likely do not benefit from supplementation (2,371 acres) If New York pumpkin growers would adopt our recommendations to not supplement with honey bees, this industry would save more than $75,000 annually in pollination services costs (2,371 acres x 1 hive per 2.5 acres = 948 hives x $80 per hive = $75,872).

OR: Recommendations based on our honey bee nutrition studies have helped Oregon commercial beekeepers reduce colony losses while pollinating nutrition deficient risk crops. In our 2013 survey of Oregon beekeepers that followed our recommendation of feeding protein supplement during carrot seed and blueberry pollination reported 10-15% decrease in colony losses. This translates to $ 3 million worth savings to the beekeepers.

Enhanced pollination in hard to pollinate crops (blueberry and hybrid carrot seed) using brood pheromone tool is expected to contribute about additional $ 5 million to Oregon farm income.

PA: Most inerts are generally recognized as safe, have no mandated tolerances, and their residues are unmonitored. Formulations are generally more toxic than respective active ingredients, particularly fungicides, by up to 26,000-fold based on published literature. Pesticide effects on terrestrial non-

targets like honey bee are performed without the formulation or other relevant spray adjuvant components used to environmentally apply the toxicant.

6. Published Written Works. Include scientific publications, trade magazine articles, books, posters, websites developed, and any other relevant printed works produced. Please use the formatting in the examples below.

1. Benjamin, F E, J R Reilly and R Winfree. 2014. Pollinator body size mediates the scale at which land use drives crop pollination services. J Applied Ecology 51: 440-449
2. Benjamin, F E, and R Winfree. 2014. Lack of pollinators limits fruit production in commercial blueberry (*Vaccinium corymbosum*). Environmental Entomology 43: 1574-1583.
3. Cariveau, D P, J E Powell, H Koche, R Winfree, and N A Moran. 2014. Variation in gut microbial communities and its association with pathogen infection in wild bumble bees (Bombus). ISME Journal 8: 2369-2379
4. Chen, J. and C.A. Mullin. 2014. Determination of nonylphenol ethoxylate and octylphenol ethoxylate surfactants in beehive samples by high performance liquid chromatography coupled to mass spectrometry. Food Chem. 158:473-479.
5. Chen, Y.P., J. S. Pettis, M. Corona, C. Ping, M. Spivak, P. K. Visscher, G. DeGrandi-Hoffman, H. Boncristiani, Y. Zhao, D. van Engelsdorp, K. Delaplane, L. Solter, F.A. Drummond, M. Kramer, W. Ian Lipkin, G. Palacios, M. C. Hamilton, B. Smith, S. K. Huang, H. Q. Zheng, J. L. Li, X. Zhang, J. Z. Zhou, L. Y. Wu, A. F. Zhou, M.-L. Lee, E. W. Teixeira, Z. G. Li, J. D. Evans. 2014. Israeli Acute Paralysis Virus: Epidemiology, Pathogenesis and Implications for Honey Bee Health. PLoS Pathog 10(7): e1004261. doi:10.1371/journal.ppat.1004261
6. Drummond, F. K. Collum, S. Hanes, M. Wilson, J. Skinner, and J. Collins. *In Press*. A pollination toolbox for wild blueberry growers. Rutgers Archived Publications.
7. Flenniken, M.L. Honey Bee Infecting "Plant Virus" with Implications on Honey Bee Colony Health (2014)*, invited commentary on Li et. al. [mBio 5(1):e00898-13, 2013, doi:10.1128/mBio.00898-13, mBio*.5(2):e00877-14.
8. Flenniken, M.L. and Andino R. Non-specific dsRNA-Mediated Innate Immune Response in the Honey Bee (2013)*, PLoS ONE* 8(10): e77263.
9. Garibaldi, L A, L G Carvalheiro, S D Leonhardt, M A Aizen, B R Blaauw, R Isaacs, M Kuhlmann, D Kleijn, A M Klein, C Kremen, L Morandin, J Scheper, and R Winfree. 2014. From research to action: practices to enhance crop yield through wild pollinators. Frontiers in Ecology and the Environment 12: 439-447
10. Magus, R.M., A.D. Tripodi, and A.L. Szalanski. 2014. Mitochondrial DNA genetic variation of honey bees (*Apis mellifera* L.) from unmanaged colonies and swarms in the United States. Biochemical Genetics. 52: 245-257. DOI: 10.1007/s10528-014-9644-y
11. Petersen, J. D., A. S. Huseth, and B. A. Nault. 2014. Evaluating pollination deficits in pumpkin production in New York. Environ. Entomol. 43(5): 1247-1253.
12. Petersen, J. D., and B. A. Nault. 2014. Landscape diversity moderates the effects of bee visitation frequency to flowers on crop production. J. Appl. Ecol. 51: 1347-1356.
13. Petersen, J. D., and B.A. Nault. 2014. Landscape a factor when assessing pollination needs. Vegetable Grower News 48(3): 25-26.
14. Tripodi, A.D., X. Cibils-Stewart, B.P. McCornack, and A.L. Szalanski. 2014. *Nosema bombi* (Microsporidia: Nosematidae) and trypanosomatid prevalence in spring bumble bee queens (Hymenoptera: Apidae: *Bombus*) in Kansas. Journal of the Kansas Entomological Society 87:(2) 225-233. DOI: 10.2317/JKES130730.1
15. Runckel, C., DeRisi, J.L., and Flenniken, M.L. A draft genome of the honey bee trypanosomatid parasite *Crithidia mellificae* (2014)*, PLoS ONE* 9(4): e95057.
16. Stoner, K. A. Fact sheet: "Protecting Pollinators from Pesticides" http://www.ct.gov/caes/lib/caes/documents/publications/fact_sheets/entomology/protecting_pollinators_from_pesticides_pdfr.pdf

17. Szalanski, A.L., A.D. Tripodi, and C.E. Trammel. 2014. Molecular detection of *Nosema apis* and *N. ceranae* from southwest USA feral Africanized and European honey bees, *Apis mellifera*. Florida Entomologist 92:(2) 585-589. DOI: 10.1653/024.097.0233
18. Zhu, W., D.R. Schmehl, C.A. Mullin, and J.L. Frazier. 2014. Four common pesticides, their mixtures and a formulation solvent in the hive environment have high oral toxicity to honey bee larvae. PLoS ONE 9(1): e77547.

7. Scientific and Outreach Oral Presentations. Include workshops, colloquia, conferences, symposia, and industry meetings in which you presented and/or organized. See below for formatting.

1. Bartomeus, I, D Cariveau, G Nayak, J Zientek, and R Winfree. 2014. The allometry of bee tongue length and its uses in ecology. Ecological Society of America, Sacramento, CA
2. Breece, C., R.R. Sagili 2014. Potential of Brood Pheromone in Beekeeping, Florida State Beekeepers Association, West Palm Beach, FL
3. Cariveau, D, M MacLeod, F Benjamin, and R Winfree. 2014. Pollination services versus biodiversity conservation on agro-ecosystems: Compatible or conflicting objectives? Entomological Society of America, Portland, OR
4. Cariveau, D, M Macleod, R Winfree. 2014. Can pollinator habitat plantings restore both biodiversity and ecosystem services? Ecological Society of America, Sacramento, CA
5. Cariveau, D, M Roswell, and J Zientek. 2014. Pollinator habitat assessment training for state resource management professionals, Duke Farms, Hillsborough, NJ
6. Cariveau, D. 2014. Cranberry pollination: The importance and management of wild bees, Ocean Spray Growers Meeting, Marucci Center for Blueberry and Cranberry Research and Extension, Chatsworth, NJ
7. Dibble, A. and F. A. Drummond. 2014. Behavior of bees. Ann. Meeting of the Maine Entomological Society, Augusta, ME.
8. Dibble, A., F.A. Drummond, and L. Stack. 2014. What do bees want? Flowers for Maine farms and gardens. Maine Agricultural Trade Show, Augusta, ME.
9. Drummond, F.A. 2014. Pollinator research in Maine, Neonicotinoids and fungicides. NRCS/ Extension in-service training program, Bangor, ME.
10. Drummond, F.A. 2014. Pollinators and neonicotinoids. Annual Maine Potato Growers Meeting, Caribou, ME.
11. Drummond, F.A. 2014. Honeybee colony collapse—Why This is Important ?. Ann. Maine Potato Conference, Caribou, ME.
12. Drummond, F.A. 2014. Honeybee colony collapse—Effects of Insecticides and Fungicides on Honey bees. USDA/NCS and EXTENSION meeting. Bangor, ME.
13. Drummond, F.A. 2014. Pollination in blueberry. Annual Maine Blueberry School, Waldoboro, ME.
14. Drummond, F.A. 2014. Pollination in blueberry. Annual Maine Blueberry School, Ellsworth, ME.
15. Drummond, F.A. 2014. Colony collapse disorder: update on health of bees - . Crop Advisors In service Training Workshop. Portsmouth, NH.
16. Drummond, F.A. 2014. Biology of bees and the Maine research program. Ann. Meeting of the Maine Entomological Society, Augusta, ME.
17. Drummond, F.A. 2014. Effect of propiconazole exposure to honeybees. NABREW Annual Meeting, Atlantic City, NJ.
18. Drummond, F.A. 2014. Pollination in blueberry. Annual Maine Blueberry School, Machias, ME.
19. Drummond, F.A. 2014. Threats to native and managed pollinators. Maine Pesticide Applicators Training Seminar, Presque Isle, ME.
20. Drummond, F.A. 2014. Threats to native and managed pollinators. Maine Pesticide Applicators Training Seminar, Brewer, ME.
21. Drummond, F.A. 2014. Threats to native and managed pollinators. Maine Pesticide Applicators Training Seminar, Augusta, ME.

22. Drummond, F.A. 2014. Threats to native and managed pollinators. Maine Pesticide Applicators Training Seminar, Portland, ME.
23. Drummond, F.A. 2014. Wild bees and tame bees...BUT are they healthy bees ? Blue Hill Library, Blue Hill, ME.
24. Drummond, F.A. 2014. Colony collapse disorder, the causes. The Skeptics Society, Orono, ME.
25. Drummond, F.A. 2015. Pollinator protection. Maine Agricultural Trade Show, Jan 14, Augusta, ME.
26. Drummond, F.A. 2015. Pollinator protection. Maine Agricultural Trade Show, Jan 15, Augusta, ME.
27. Drummond, F.A. 2015. Effects on the honeybee of sterol inhibiting fungicide resiudes on blueberry flowers. Canadian National Beekeepers Meeting, Jan 30, Moncton, N.B., Canada.
28. Drummond, F. K. Collum, S. Hanes, M. Wilson, J. Skinner, and J. Collins. 2014. A pollination toolbox for wild blueberry growers. NABREW Annual Meeting, Atlantic City, NJ.
29. Drummond, F., B. Eitzer, J. Evans, and L. Leblanc. 2015. Effect of exposure in honeybees to the sterol inhibiting fungicide, propiconazole, on flowers of lowbush blueberry. ABRC Annual Meeting, Tucson, AZ.
30. Drummond, F.A. and G. Fish. 2014. Neonicotinoid insecticides and bees. Maine Agricultural Trade Show, Augusta, ME.
31. Du Clos, B., Hanes, S.P., Loftin, C.S., and F.A. Drummond. 2014. A landscape-level pollinator habitat assessment tool for wild blueberry growers. Wild Blueberry Commission Advisory Board Meeting, Brunswick, ME.
32. Eitzer, B.D. 2014 "Analysis of Pesticides in Planter Exhaust Dust and Dosimeters Surrounding FieldsDuring Planting" American Bee Research Conference, San Antonio TX.
33. Eitzer B.D. 2014 Organized Symposium on "The Analysis of Pesticides in Bees and Bee Related Matrixes" at the North American Chemical Residue Workshop in St. Petersburg Beach, FL
34. Fine, J., C. Mullin, and J. Chen. 2014. Determination of N-methyl-2-pyrrolidone and metabolites in honey bees by LC-ESI-MS. Entomological Society of America National Meeting, Portland, OR. (poster presentation)
35. Flenniken M.L.. 2014. Animal and Range Science Departmen, Montana State University, Invited Speaker, "Honey Bee Host Pathogen Interactions", November 2014, Bozeman, MT.
36. Flenniken M.L.. 2014. Departments of Plant Pathology, Iowa State University, Invited Speaker, "Honey Bee Pathogen and Pathway Discovery", April 2014, Ames, Iowa.
37. Flenniken M.L.. 2014. Departments of Microbiology and Biology, University of Alabama at Birmingham, Invited Speaker, "Honey Bee Pathogen and Pathway Discovery", February 2014, Birmingham, Alabama.
38. Frazier, J., C. Mullin, and M. Frazier. 2014. Pesticides and pollinators: From subtle to substantial. American Honey Producers Association 45th Annual Meeting, San Antonio, TX.
39. Frazier, M., J. Frazier, and C. Mullin. 2014. Toxic house: Pesticide exposure and impacts on honey bee (*Apis mellifera*) colonies used for commercial pollination. Buzz-kills: The Genomics and Ecology of Stress in Pollinators Symposium, Entomological Society of America National Meeting, Portland, OR.
40. Frazier, M., J. Frazier, C. Mullin, W. Zhu, T. Ciarlo, and S. Ashcraft. 2014. Pesticide conundrum - Pesticides, neonicotinoids and pollinator protection. Turf and Ornamental Conference, Kutztown, PA.
41. Frazier, M., C. Mullin and J. Frazier. 2014. Can there be honey still for tea? NY Metro Bee Conference, New York, NY.
42. Genung, M, J Fox and R Winfree. 2014. Using the Price equation to predict ecosystem services in natural systems. British Ecological Society, Lille, France
43. Harrison, T and R Winfree. 2014. Biotic homogenization of bee communities across spatial scales, Entomological Society of America, Portland, OR
44. Harrison, T and R Winfree. 2014. Land use interacts with seasonal phenology in pollinator communities. Ecological Society of America, Sacramento, CA
45. Hunt G.J. 2014. Genetics of honey bee mite grooming behavior and attempts to breed resistant bees. The Varroa Summit, USDA-APHIS, Riverdale MD.

46. Hunt, G.J., 2014. Breeding mite biters at Purdue University. North American Beekeeping Conference and Trade Show, Baton Rouge, LA.
47. Hunt, G.J., Given K., Tsuruda J.M. and M. Arechavaleta-Velasco. 2014. Progress towards breeding for increased mite grooming behavior in honey bees. American Bee Research Congress, San Antonio, TX.
48. Jack, C., S. Uppala and R.R. Sagili 2014. Colony Level Prevalence and Intensity of Gut Parasite, *Nosema ceranae* and Investigating Effects of Colony Nutrition on *Nosema* Infection Persistence. Oregon State Beekeepers Association Conference, Seaside, OR.
49. Kenney, S.R., Du Clos, B. and F.A. Drummond. 2014. A Comparative Study of Urban and Forested Roadsides as Potential Bee Habitat. 2014 Maine EPSCoR High School Research Internship Poster Session. Orono, ME. Poster.
50. Lee, K. 2014. Tech-Transfer Teams: Working for Beekeepers" and "Research at the University of Minnesota Bee Lab. Colorado State Beekeepers Association, Boulder, CO.
51. Lee, K. 2014. Tech-Transfer Teams: Working for Beekeepers. North Dakota Beekeepers Association, Mandan, ND.
52. Lee, K. 2014. Tech-Transfer Teams: Working for Beekeepers. South Dakota Beekeepers Association, Aberdeen, SD.
53. Lee, K. 2014. Tech-Transfer Teams: Working for Beekeepers. Geneva New York Winter Symposium, Geneva, NY.
54. Lee, K. 2014. Importance of the Honey Bee. Galaxie Library, Apple Valley, MN.
55. Lee, K. 2014. Tech-Transfer Teams: Working for Beekeepers. Eastern Missouri Beekeepers Association Workshop, St. Louis, MO.
56. Looze, B.E., Loftin, C.S., and F.A. Drummond. 2014. landscape and pollinator ecology of wild blueberry fields. Ann. Meeting of the Maine Entomological Society, Augusta, ME.
57. MacLeod, M and R Winfree. 2014. Do rare and ecosystem-service providing bees prefer the same plant species? Ecological Society of America, Sacramento, CA
58. Mullin, C. and M. Frazier. 2014. What influences bee health? How do these factors interact? Pesticides (inerts). Pollinator and Pollination In-Service for Extension Educators, Penn State University, University Park, PA.
59. Mullin, C. A. 2014. Honey bee as a prime bioindicator of agrochemical pollution. Fifty Years of Research and Mentoring: Symposium in Honor of the Life and Career of Professor Fumio Matsumura, AGRO 5, 13th IUPAC International Congress of Pesticide Chemistry and 248th ACS National Meeting, San Francisco, CA. p. 79.
60. Mullin C.A., J. Chen, J. D. Fine, M. T. Frazier and J. L. Frazier. 2014. Determination of pesticide co-formulants and adjuvants in honey bee related matrices by LC-ESI-MS. Pesticides and Bees, Analysis Tools and Toxicological Effects Session, 51st NACRW-North American Chemical Residue Workshop, St. Pete Beach, FL. p. 43.
61. Nault, B. A., and J. D. Petersen. 2014. Supplementing pumpkins with bee hives: Is it worth it? Empire State Producers EXPO, Syracuse, NY.
62. Petersen, J.D., and B.A. Nault. 2014. Effects of landscape features on foraging by honey bees (Apis melifera) and bumble bees (Bombus impatiens) in pumpkin fields. Entomological Society of America Annual Meeting, Portland,OR.
63. Reilly, J, I Bartomeus, D Cariveau, F Benjamin, and R Winfree. 2014. More pollinator species are required for pollination function at larger spatial scales, but high regional dominance can suppress this effect. Ecological Society of America, Sacramento, CA
64. Roswell, M, D Cariveau, and R Winfree. 2014. How much sampling is necessary for pollinator biodiversity assessment? (poster) Ecological Society of America, Sacramento, CA
65. Smart, M.D., and M.S. Spivak. 2014. Effects of protein feeding on the nutritional and immunological systems of the worker honey bee (*Apis mellifera*). Entomological Society of America national meeting, Portland, OR.
66. Smart, M.D. 2014. Honey bee pollen utilization in agricultural lands: implications for colony health and survival. USDA honey bee forage and nutrition summit invited speaker, Washington, DC.

67. Smart, M.D. 2014. Influence of agricultural land use on the health and survival of honey bees. USGS Northern Prairie Wildlife Research Center invited speaker. Jamestown, ND.
68. Smart, M.D. and E.C. Evans. 2014. 2014. Bee healthy landscapes: Impacts of agricultural land use on the diversity and abundance or wild bees and the health and survival of commercial honey bees. University of Minnesota Conservation Biology Seminar invited speaker, Saint Paul, MN.
69. Smart, M.D. 2014. Agricultural land use and the survival of honey bee colonies. Saint Croix Riverway Speaker Series invited speaker, St. Croix Falls, WI.
70. Smart, M.D. 2014. Impacts of agricultural land use on the health and survival of commercial honey bees. Entomological Society of America North Central Branch pollinator symposium invited speaker, Des Moines, IA.
71. Spivak, M. 2014. Honey Bee Health Care. St Croix Watershed Research Station Friends Event, Stillwater, MN."
72. Spivak, M. 2014. Protecting Pollinators. Policy Forum on Creating Habitat for MN Pollinators. Keynote Address
73. Spivak, M. 2014. Keeping Bees Healthy. Tri-County Beekeepers Association, St Cloud, MN.
74. Spivak, M. The Bees' Perspective. Entomological Society of America, Portland, OR. Symposium How Cool is Entomology.
75. Spivak, M. Research Update. Iowa Beekeeping Association Annual meeting, Marshalltown, IA.
76. Spivak, M. Resin to Propolis: Plant Sources and Role in Honey Bee Health. Oregon Beekeeping Association Annual meeting, Seaside, OR.
77. Spivak, M. Research Update. North Dakota Beekeeping Association Annual meeting, Bismarck, ND.
78. Spivak, M. Helping Bee Pollinators. St Anthony Park Garden Club, St Paul, MN.
79. Spivak, M. Resin to Propolis: Plant Sources and Role in Honey Bee Health. British Columbia Honey Producers Association Annual Meeting, Vancouver, Canada.
80. Spivak M. Protecting Pollinators. National Caucus of State Legislators, Marquette Hotel, Minneapolis.
81. Spivak M. Can Pesticides and Pollinators Co-Exist? MN Nursery and Landscape Association, Pollinator Symposium, Wilder Foundation Bldg. St Paul, MN.
82. Spivak, M. Good News for Bees in MN. Bachmann's Nursery, Lyndale Store.
83. Spivak M. Apiary Management Practices and Pollinator Health. Agricultural and Applied Economics Association (AAEA) meeting on Pollinator Health, Hyatt Regency, Minneapolis
84. Spivak, M. Research Update. MN Honey Producers Association Annual meeting, St. Cloud, MN.
85. Spivak M. Protecting Pollinators. Midwest Agriculture Legislators Meeting, Omaha, NE.
86. Spivak M. Protecting Pollinators. South Dakota Beekeeping Association, Aberdeen, SD.
87. Spivak, M. Protecting Pollinators. Governmental Affairs Division, Target Corp, Target Headquarters, Minneapolis.
88. Spivak M. Bees and Trees. MN Dept Natural Resources Webinar.
89. Spivak M. Saving our Bees. Town Hall, Seattle, WA.
90. Spivak, M. Good News for Bees and Other Pollinators. The Seminar (top PR and communications people from 200 organizations), North Carolina,
91. Spivak, M. State of the Bees. Southeast MN Beekeeping Association, Rochester, MN
92. Spivak M. Responding to an S.O.S. from the Beekeeping Industry. Webinar for North Central Regional Center for Rural Development, Michigan State University,
93. Spivak M. Pollinators in your Garden. Hennepin County Master Gardeners, Southdale Library
94. Spivak M. Protecting Pollinators. Minneapolis Shade Tree Short Course, Bethel College
95. Stoner K. A. 2014 interviewed by Patrick Skahill of Connecticut Public Radio about honey bee health and proposals to ban neonicotinoid insecticides.
96. Stoner K. 2014 "The Future of Honey Bees, Wild Bees, and Pollination, and What You Can Do" CT NOFA Winter Conference, Dabury, CT (10 similar presentations also given at local libraries, clubs and schools)
97. Topitzhofer, E., G. Jones and R.R. Sagili 2014. You are what you eat: a look at diet diversity for honey bees, Idaho Honey Industry Annual Conference, Boise, ID

98. Tripodi, A.D., and A.L. Szalanski. 2014. Convergent morphology and divergent phenology: Competition avoidance in two long-tongued bumble bee species (Hymenoptera: Apidae: *Bombus*). Annual meeting of the Kansas (Central States) Entomological Society, Emporia, KS.
99. Tripodi, A.D., and Allen L. Szalanski. 2014. Convergent morphology and divergent phenology: Competition avoidance in two long-tongued bumble bee species (Hymenoptera: Apidae: *Bombus*). Presented at the annual meeting of the Entomological Society of America, Portland, OR.
100. Tsuruda J.M., Subramanyam S., Williams C.E., Hamiduzzaman M., Emsen B., Guzman-Novoa E. and G.J. Hunt. 2014. Behavioral resistance to Varroa mites – grooming and neurexin gene expression. American Bee Research Congress, San Antonio, TX.
101. Venturini, E. and F. Drummond. 2014. Farming for pollinators and other beneficial insects. Maine Agricultural Trade Show, Augusta, ME.
102. Winfree, R. 2014. Global change, pollinator biodiversity and ecosystem services. Dept of Entomology, University of Idaho and Washington State University
103. Winfree, R. 2014. Global change, pollinator biodiversity and ecosystem services. Dept of Biology, University of Pittsburgh
104. Wu-Smart, J., Krischik, V. and Spivak, M. 2014. Evaluation of laboratory bioassays using oral exposure of the neonicotinyl insecticide imidacloprid on honey bees (*Apis mellifera*) and bumble bees (*Bombus impatiens*). National Entomological Society of America, Portland OR (poster presentation).
105. Wu-Smart, J. and Spivak, M. 2014. Sub-lethal effects of neonicotinoid insecticides on honey bee queen behavior and colony development. University of Minnesota Community of Scholars Program Symposium, Saint Paul MN (poster presentation).
106. Wu-Smart, J. 2014. Pesticides and Pollinators. Univ. of MN College of Agriculture and Natural Sciences Course (CFANS 3333: Plants, Insects and Microbes), St. Paul, MN.
107. Wu-Smart, J. and Spivak, M. 2014. Sub-lethal effects of imidacloprid on honey bee queens and colony development. Wisconsin Honey Producer Association Conference, Trego WI.
108. Wu-Smart, J. 2014. Protecting bees from pesticides. St. Thomas University, Theology & Environment Course (THEO459: Theology and the Environment), St. Paul MN.
109. Wu-Smart, J. and Spivak, M. 2014. Sub-lethal effects of imidacloprid on honey bee queens and colony development. Minnesota Honey Producers Association Conference, St. Cloud MN.
110. Wu-Smart, J. and Spivak, M. 2014. Neonicotinoid insecticide effects on bees. Café Scientifiqué, Minneapolis MN.
111. Wu-Smart, J. 2014. Pesticides and Pollinators. Univ. of MN Horticulture Course (HORT 4850: Pollinator protection in managed landscapes), Saint Paul, MN.
112. Wu-Smart, J. 2014. Pollinator Plants, Habitat, and Pesticides Q&A. Pollinator Party, Minneapolis, MN.
113. Wooten, S. and K. Lee. 2014. Bee Informed - Bee Tech Team with Shannon Wooten. American Beekeeping Federation North American Beekeeping Conference, Baton Rouge, LA.
114. Zientek, J, D Cariveau, and R Winfree. 2014. The effect of pollinator restorations on bee community composition (poster). Ecological Society of America, Sacramento, CA

8. Fund leveraging, specifically, collaborative grants between stations and members.

- Dr. Brian Eitzer was awarded a **$35,000** cooperative agreement with the USDA to assist in the research of Steven Cook by conducting chemical analysis honey bees and related matrixes.
- Dr. Kimberly Stoner, Dr. Brian Eitzer, and Dr. Richard Cowles of the CAES were recently notified that they will receive **$145,000** from the Connecticut Department of Energy and Environmental Protection to study the exposure of bees to neonicotinoids occurring at ornamental nurseries.
- Honeybee Exposure to Pesticides in Maine – The question about Neonicotinoids. 2014-2015. PI: F. Drummond, Co-PI: J. Dill, submitted to and funded by Maine/SCRI for **$25,355**.

- Increasing Parameter Accuracy of an Agriculturally-focused, Spatially-explicit Bee Abundance Model. 2014. PIs: B. DuClos, C. Loftin, F. Drummond, submitted to and funded by USDA Northeast Sustainable Agricultural Research and Education Program for **$14,652**.
- Toward Pollinator Habitat on a Large Scale. 2014-2015. PI: A. Dibble, Co-PI: F. Drummond, submitted to and funded by USDA/NRCS for **$69,902**.
- Honeybee health in Wild Blueberry. 2014. PI: F. Drummond, submitted to and funded by Wymans & Sons, Inc. for **$15,000**.
- Sustainable pollination in the Northeast. 2012-2016. PI: A. Averill, Co-PIs: F. Drummond, B. Danforth, K. Stoner, B. Eitzer, J. Skinner and J. Burand, submitted to and funded by USDA/AFRI for **$3,570,000**.

9. Other relevant accomplishments and activities.

- Panelist in CSIRO Varroa mite workshop, Cairns, Australia.
- Presentation at ISBA spring meeting (200 attendees)
- Keynote for North Carolina State Beekeepers Assoc. spring meeting (Five presentations: 2 talks, 3 workshops, 200 attendees)
- West Central Beekeepers at Purdue for field day (40 attendees)
- Presentation at first Heartland Honey Bee Breeders Cooperative (HHBBC) meeting/instrumental insemination fest at Purdue
- Queen rearing class at Purdue (35 attendees)
- Queen rearing class at Heartland Apiculture Society conference in IL (45 attendees)
- ISBA summer meeting (100 attendees)
- Seed Treatment Workshop, Columbia City, IN, June 25 (50)
- Seed treatment talk to 100 farmers in Covington, IN, Dec 5
- ISBA fall meeting (100)
- IBA fall meeting (200)
- Yarborough, D., and F.A. Drummond. 2014. Insect control guide for wild blueberries. Univ. Maine Coop. Ext. Fact Sheet (includes cautions for pesticide selection during bloom). 243. 4 pp.
- Cote, J., D.E. Yarborough, and F. Drummond. 2014. Maine Wild blueberry pesticide chart. http://umaine.edu/blueberries/files/2010/05/2014-ME-Wild-Blueberry-Pesticide-Chart-Insecticides_Revised-on-5-7-2014.pdf (lists all pesticides for blueberry production and their risks to honeybees).
- Five videos on wild blueberry pollination. The videos was shot in June 2013 by Dr. John Skinner and Mr. Michael Wilson of the University of Tennessee.
    - Skinner, J., M. Wilson, E. Asare, A. Bajcz, K. Bickerman, S. Chapin, A. Dibble, B. Du Clos, K. Kollum, S. Hanes, A. Hoshide, C. Loftin, D. Yarborough, F. Drummond. 2013. Part 1: Commercial Blueberry Pollination in Maine's Blueberry Barrens.
    - http://www.extension.org/pages/70119/pollination-security-for-fruit-and-vegetable-crops-in-the-northeast - .Uv0UAf3XpyJ
    - Skinner, J., M. Wilson, E. Asare, A. Bajcz, K. Bickerman, S. Chapin, A. Dibble, B. Du Clos, K. Collum, S. Hanes, A. Hoshide, C. Loftin, D. Yarborough, F. Drummond. 2014. Part 2: Lowbush Blueberry in Maine, Native Plants and Native Bees in a Modern System. http://www.extension.org/pages/70119/pollination-security-for-fruit-and-vegetable-crops-in-the-northeast - .Uv0UAf3XpyJ
    - Skinner, J., M. Wilson, E. Asare, A. Bajcz, K. Bickerman, S. Chapin, A. Dibble, B. Du Clos, K. Collum, S. Hanes, A. Hoshide, C. Loftin, D. Yarborough, F. Drummond. 2014. Part 3: Pollinator Plantings (The Bee Module) for Maine Lowbush Blueberry.
    - http://www.extension.org/pages/70119/pollination-security-for-fruit-and-vegetable-crops-in-the-northeast - .Uv0UAf3XpyJ

    - Skinner, J., M. Wilson, E. Asare, A. Bajcz, K. Bickerman, S. Chapin, A. Dibble, B. Du Clos, K. Collum, S. Hanes, A. Hoshide, C. Loftin, D. Yarborough, F. Drummond. 2014. Part 4. Landscape Ecology in Maine's Blueberry Growing Region.
    - http://www.extension.org/pages/70119/pollination-security-for-fruit-and-vegetable-crops-in-the-northeast - .Uv0UAf3XpyJ
    - Skinner, J., M. Wilson, E. Asare, A. Bajcz, K. Bickerman, S. Chapin, A. Dibble, B. Du Clos, K. Collum, S. Hanes, A. Hoshide, C. Loftin, D. Yarborough, F. Drummond. 2014. Part 5. How to Estimate Native Bee Abundance in the Field.
    - http://www.extension.org/pages/70119/pollination-security-for-fruit-and-vegetable-crops-in-the-northeast - .Uv0UAf3XpyJ
- Michelle Flenniken is involved in teaching K-12 students about the importance of honey bees. In June 2014, she taught a class for Peaks and Potentials (Honey Bee Investigators, 20 students), and participated in the Gallatin Valley Farm Fair where ~ 400 4th grade students learned about honey bees and other important topics in agriculture.
- Honey Bee Investigators (H.B.I.), Instructor. I developed and taught this one-week molecular biology course for 5-6th graders in the Peaks and Potentials Summer Programs at MSU**,** June 2013 and 2014.
- Petersen, J., S. Reiners and B. Nault. 2014. Decision-making guide for bee supplementation of pumpkin fields. Cornell University. http://nysipm.cornell.edu/factsheets/vegetables/cucu/bees_pumpkins.pdf