

Native Populations of Bees in North Texas

Roughly one-third of the North American diet comes from fruits, vegetables, seeds, and nuts that rely on animal pollinators (Holden, 2006). The majority of these foods are pollinated by the European honeybee. Most of the work that is done by these little pollinators today is from commercial hives called apiaries that manage the European honeybee. These apiaries can be rented and trucked across the country where farmers will pay for the bees to pollinate their crops. This relationship is good for the farmer and the bees. The farmer will get a good crop, and the bees get food to produce more bees and honey. Since the 1990's the commercial bee industry has been in decline, especially so these past few years (Jacobsen, 2008). Several reasons exist from parasitic mites to diseases, and the fairly new Colony Collapse Disorder (CCD), which causes bees to fly out from the hive but not return (Jacobsen, 2008). Many theories exist on what causes CCD, but none have been confirmed. It is fairly easy to assess the strength and health of commercial apiaries since their keepers keep close watch over them, but who is watching the native population of bees? There is evidence of a decline, but no one knows to what extent (National Research Council, 2007). The real problem is that we have very little data on native populations of bees and how these factors may be affecting their population (National Research Council, 2007). Without this knowledge we could be losing native species and not even be aware of how much or why. Losses in native species could also result in a significant loss of native plants that the bees pollinate (Potential, 1998).

The research that will be proposed here is to conduct a series of surveys of

native bee populations across three different environments (grassland, woodland, and riparian) in North Texas to determine the diversity of bee species in each environment and if they vary across environments. Looking at the results we will have a better understanding of whether the native bees in our area are specialists or generalists in the types of areas they inhabit. Using this information we can better assess what steps to take in order to protect our native populations of bees as well as native plant species. The information can also be used to see if native bee populations are diminishing over time as further surveys are taken.

Background:

The European honeybee is not a species that is native to the United States. Some of the first known records of their arrival in North America date back to the early 1600's (Jacobsen, 2008). Although since that time these bees have grown and spread across the United States. There are now wild populations of the honeybee in addition to native bee populations. When discussing populations of native bees these will generally be bumblebees, sweat bees, or leaf cutting bees. According to the National Research Council there is little known about the abundance and the diversity of native populations of bees (National Research Council, 2007). This is one of the reasons this project is important to our understanding of wild pollinators.

According to Tepedino (1980), at least 67% of flowering plant species depend on pollination by insects, mostly bees. The honeybee is generally a highly productive pollinator, but there are many native plant species in the United States that do not attract the honeybee. Several reasons exist, such as the amount of nectar is too small,

the bees are too small or large, they cannot vibrate the pollen from the flower, or the plant has mechanisms to deter the honeybee. Plants such as these need to be pollinated by native bees that fit the plants specific requirements (Kearns, 1997). If they are not pollinated then the plants' genes cannot be spread and reproduction rates drop resulting in a loss of diversity (Kearnes, 1997). This will also affect the other organisms that depend on that plant for food, shelter, or other reasons. These effects could be far reaching.

By conducting these surveys we hope to learn if the bees in that area are specialists or generalists. If they are specialists this means that the plants in that area require native bees to pollinate them, or that the bees have a special environmental requirement that is met by the area (water, trees, flowering plants, etc). If it is found that there are similar bee species and similar numbers of individuals per species across each survey area, then it will appear that the bees are more generalists, and that they can exist in several different environments. It is hoped that the bees surveyed in North Texas are generalists since they will be more likely to survive difficulties and changes that might be affecting bee populations.

Right now there is very little information that has been gathered on the diversity of native bee populations of Texas. With the growing population of North Texas new developments have occurred that are changing undeveloped land for residential, retail, and other uses. With these developments we could be losing native species and not even be aware. It has been shown that bees that are smaller (sweat bee) and larger (bumble and carpenter) in body size are more at risk with habitat loss and

fragmentation (McKinney, 2007). It has also been shown that bees with habitat specialization may also be at high risk when their habitat is disturbed (McKinney, 2007).

The North Texas areas that will be included in this study are Denton and Wise Counties. They contain several cities, suburban/residential areas, several large bodies of water, and many undeveloped areas with native vegetation. The reason this area was chosen was for the different environments it contains. I will be looking at grassland/meadows, forests, and riparian areas. Denton and Wise counties provide many different locations that fit the criteria for this research.

Methods:

To assess the populations of native bees in North Texas there are three variables that the surveys conducted will collect data on; the number of bee species, the number of bees per species, and the type of vegetation at each sampling site. Each of these categories will be kept separate for each location for a later comparison. The number of species, or species richness, is a factor that will be used to determine how even the species are present in each environment. The number of bees per species will be important to the research because we are trying to assess the native population. In order to do so we need to see their numbers and how many bees are found per species in each area. The first two variables are particularly important to this research because they will show whether the bees are specialists or generalists depending on the vegetation.

There will be two surveys conducted in each of the three different environments based on the native plant vegetation. The first survey will be conducted in a

grassland/meadow, another in a forested area, and the last will be in an area near a body of water. An example for the grassland/meadow site will be the Clear Creek Natural Heritage Center located just northeast of the intersection of University Dr. and Loop 288. This area is open to the public and contains grasses and meadows. Another example of a site for where the forest survey could be conducted is on the Caddo-LBJ National Grasslands outside of Decatur. This area is also open to the public and has many different areas that would be suitable for forest sampling. The third example of a proposed site would be a mixture of forested and grassland/meadow close to a water source, referred to as riparian. This site is near Old Alton Bridge. There is public access to suitable sites there that offer grassland/meadow, forest, a creek, and Lake Lewisville. Visual inspections of each site will need to be conducted in order to determine the most suitable site at each general area to conduct the sampling. Each site needs to be at least 10km from the next nearest site, which the proposed sites are because that is roughly the maximum foraging area for most bees, and this will reduce the chance of sampling the same populations multiple times (Beekman, 2000).

The area of each plot will be one hectare (roughly two and a half acres). Each site will be sampled once a week from April through October since this is the peak time that bees are active (Jacobsen, 2008). Sampling will only take place on days that are sunny or partly cloudy, and above 60 degrees Fahrenheit, because this is when most bees will be active (Cane, 2000).

Two types of collecting methods will be used at each survey site. The first is active net collecting by a survey participant, and the other is passive bowl trapping. The

reason that both of these collection methods will be used is to reduce the chances of collecting bias. Some studies have shown that bowl trapping, while easier does not always fully represent bee diversity and abundance since all bees are not attracted to the bowls (Cane, 2000). The reasons for this are still unclear. Most studies on bee populations use both methods (Winfree, 2007).

The first collecting method, active netting will be performed by two participants for thirty minutes two times each sampling day. The first will be at 11am and the other at 3pm. Some bees have different foraging and behavioral schedules which is why it is important that the netting be done at different times of the day (Winfree, 2007). The participants will split the survey site in half and each will sample on only their half. After the first fifteen minutes of each netting period the collectors will switch sides of the survey area. This will be done to reduce collector bias if one collector is more skilled than another.

After bees are netted they will be euthanized to be identified later in a lab. A small amount of ethyl acetate will be infused into plaster of paris within a jar. Afterwards a crumpled paper towel will be placed in the jar to keep the bees from touching the solution and the lid will be fastened. When a bee is captured it will be placed in the jar, quickly killing it due to the fumes produced by the ethyl acetate. It may then be removed and placed in a holding container until it can be identified.

The next collection method will use bowl traps. This is a standard collection method used in many studies that simply fill a bowl with a water and soap solution to collect bees (Winfree, 2007; National Research Council, 2007). The soap serves as a

surfactant which reduces the surface tension of the water causing the bee to sink immediately when they land on the water (Cane, 2000). The advantages of this method include long collecting periods with minimal work and it can also be easily carried out by one or two collectors. The disadvantage is that it does not always yield a representative result when this is the sole means of sampling (Cane, 2000). That is why netting and bowl trapping will both be used to gain a more representative sample of the population.

The bowls that will be used for this method will be Solo brand, 6 oz., disposable bowls of fluorescent blue, yellow, and white (Winfree, 2007). The different colors are to reduce bias in case certain bees are more attracted to one color than another. There will be 30 bowls, 10 of each color. The bowls will be placed in one 'x' formation across the entire site (National Research Council, 2007).

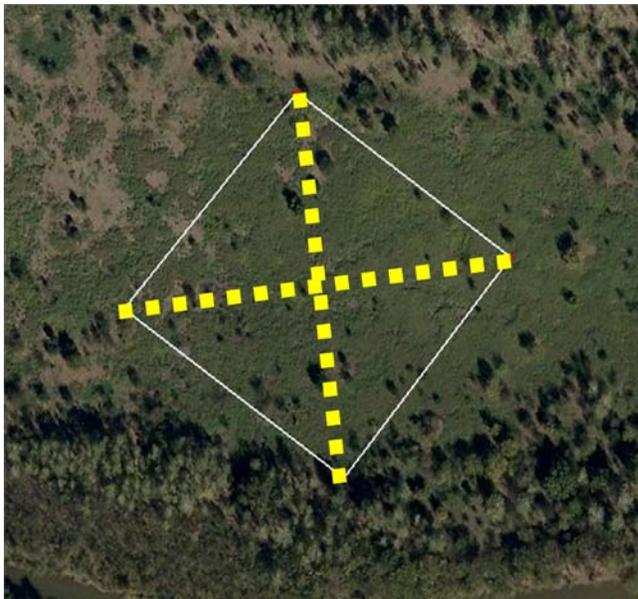


Figure 1. This is an example of what the 100m x 100m plot showing the placement of the bowls would look like.

Each bowl will be placed 10m apart so that each end of the line touches a corner of the

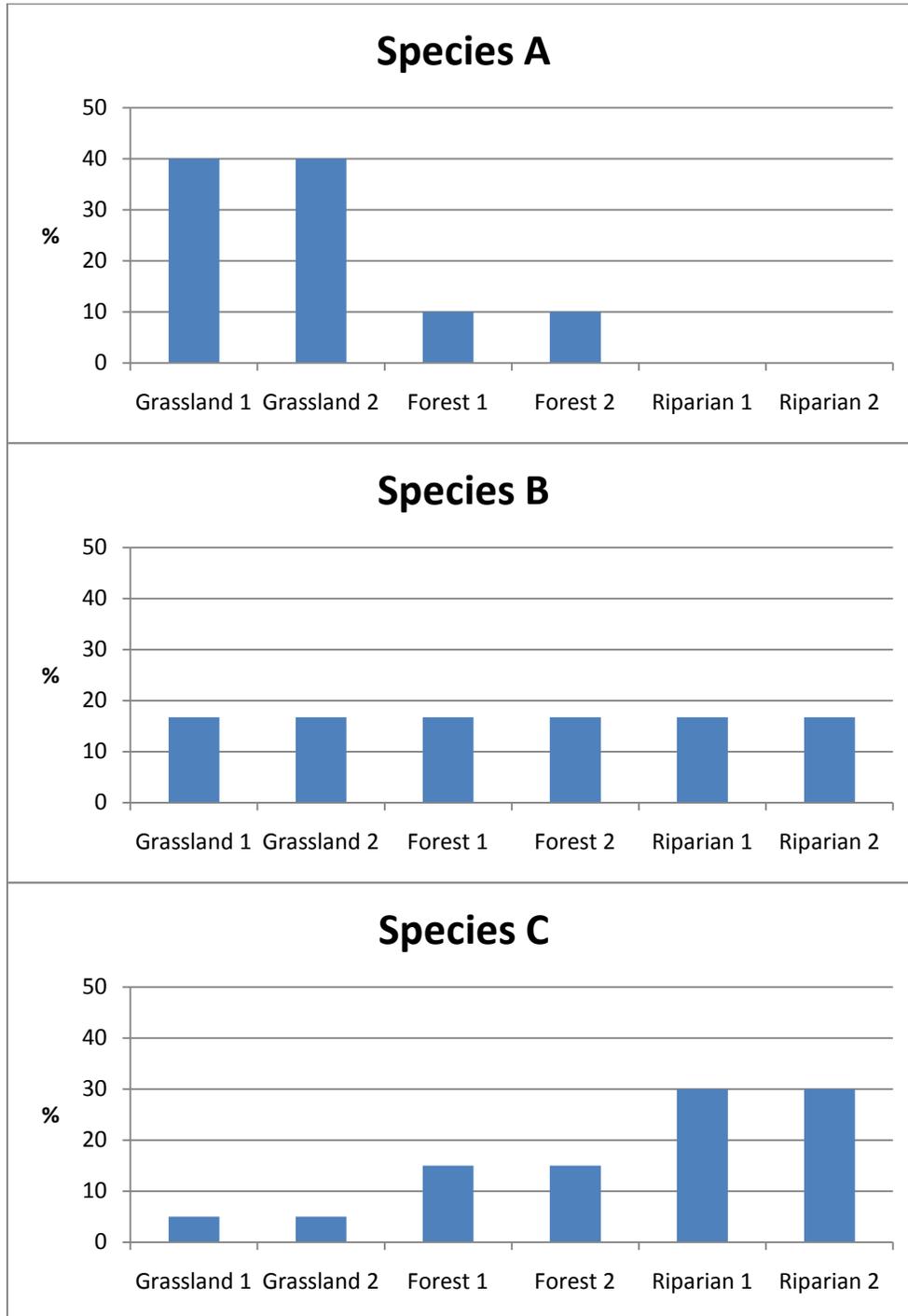
plot (National Research Council, 2007). The bowls will also be placed in random order for color to reduce any sampling bias. The bowls will be filled with a water and soap solution that causes any bee landing in it to sink and drown (Cane, 2000). This solution will be made by mixing one gallon of water with one teaspoon of Dawn brand blue soap (National Research Council, 2007). The bowls will be placed in each area in this manner from 9am to 5pm on the same days that the area is being sampled by netting. The samples will then be collected at 5pm and the bowls removed.

During each sampling day there is other important information that should be recorded. These variables will not be used in this research but could prove important to anyone who might do a study in the future or wishes to compare data. The other information that will be recorded on collection days should include the date, collection times, weather conditions, temperature, and wind speed.

After each collection day the samples will be dried and placed in holding containers displaying the date and location they were collected. Then the bees will be identified and the results of each day recorded. Once the sampling period is over and all the results have been recorded the data will be analyzed.

Analysis will consist of calculating an evenness index and creating a series of graphs that will represent each species and each survey site. The reason for creating a graph of species' richness and abundance of each species is to see if there are any species that are more abundant than others given a particular type of environment. If there is one species that has high abundance in grassy areas, but low abundance in forested areas or areas near water, then there might be something in the grassy

environment that this species relies on. It could also be said that they are specialists residing in that environment. The graphs below represent an example of what could be found during the surveys.

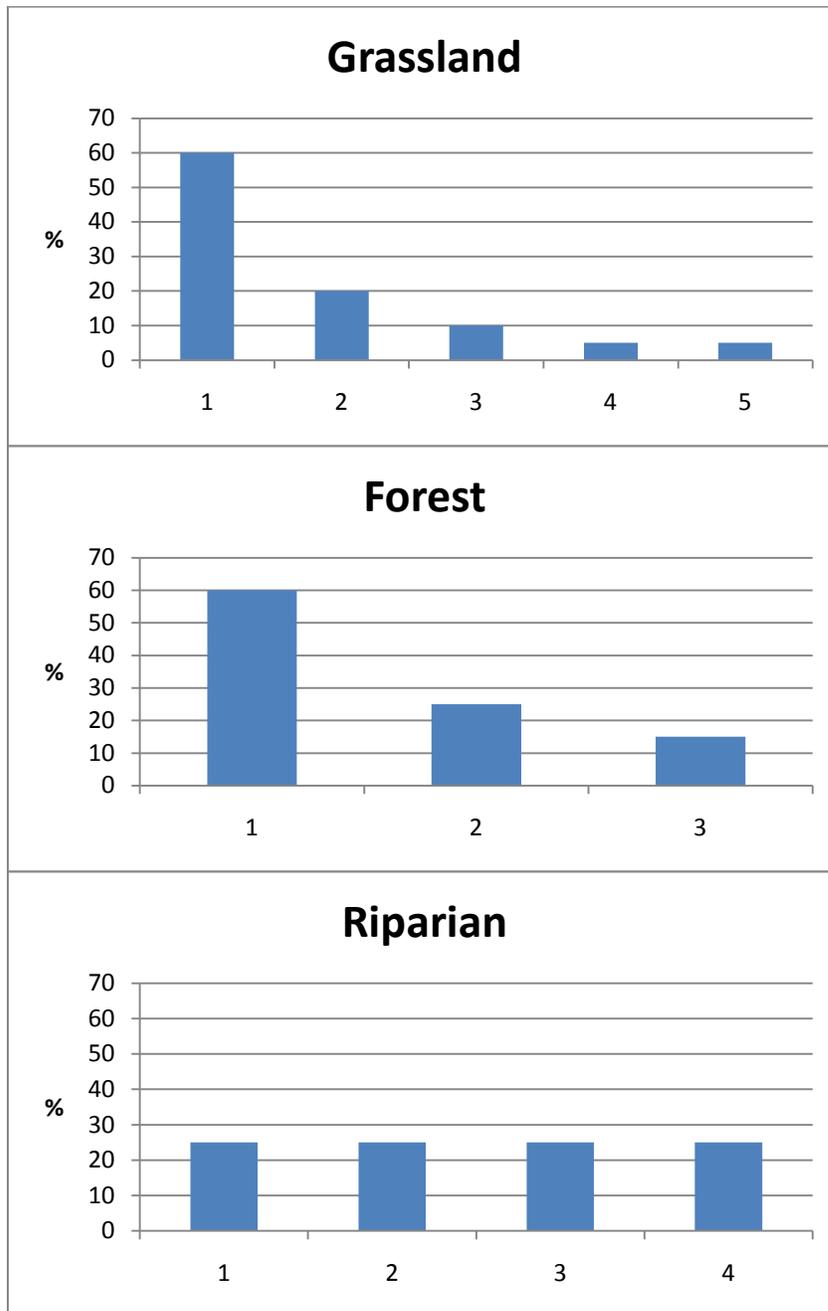


Figures: 2, 3, 4. In this example, species A is a grassland specialist, B is a generalist, and C is more of a specialist in riparian, but is found in all three environments.

Graphing the results of each environment will visually display the species richness and

evenness. If there are many species in an environment then it is said to have high

richness. If the species present are of equal abundance then they are even.



Figures: 5, 6, and 7. In this set of graphs, the grassland has the highest richness and is

very uneven, meaning that one species is dominating the assemblage. In the forest environment is low in richness but high in evenness with one species being the most common. In the riparian environment, there are fewer species and they are found in equal abundance. Here it is important to note that that species #1 may not be the same on each graph. These graphs order the taxa according to rank. For example, species A may be number one in the grassland, while species C is number one in the forest with species A ranked number 2. In evenness or diversity graphs the shape of the curve is important, not the species composition.

After the results are graphed then an evenness index will be calculated. The evenness will give the relative abundance of a species (Dogan, 2006). The equation that will be used is: $H' = (-\sum P_i(\ln P_i))/(\ln(\# \text{ of species}))$ (Smith, 1996). In this equation P_i is the proportion of each species in the sample. The reason this equation is to be calculated is to statistically show how even the abundance of individuals per species found in an area are. It is based on a scale from zero to one, zero being the most uneven and one being completely even. This is good tool to see if an area has high single species dominance and to compare the differences between two habitats (Stirling, 2001).

Conclusion:

This research will conduct a series of surveys of the populations of native bees of North Texas. By collecting samples of their populations we will then be able to identify which species we have in North Texas, how many species, and their relative abundance in grassland/meadows, forests, and riparian.

This research is important in our understanding of the native populations of pollinators in our region. It will help us to better understand the population densities of areas and the species richness. Knowing whether the species in our area are specialists or generalists is important in many ways. If we lose a particular environment that is inhabited by a specialist species, we could stand to lose significant numbers of that

species in that area. This could also cause serious losses in the plants that were pollinated by that species (Kearns, 1997). This study may also help us to better assess what areas are more suited for native bees and ways that we can help conserve them.

This research will also serve as a baseline study for future comparisons. When further information is gathered at later dates they will be able to compare their findings with this research to see if there is a decline for the native bee populations in our area. There is little information gathered on the native populations of bees and even less on whether some of the factors that are causing managed honeybees to die are spilling over to native species. This information will better enable future researchers to conduct their own research on the subject and compare their findings to this study.

There is so much that can be lost by our lack of knowledge on the native pollinators of our area. As of now we have almost no information on where the bees in our area reside, what species are present, and if they depend on a particular environment for their survival, or if they can thrive in several different environments. By not completing this study we stand to lose significantly in economics, food security, and biodiversity.

References:

- Allen-Wardell, G., P. Bernhardt, R. Bitner, A. Burquez, S. Buchmann, J. Cane, P. A. Cox, V. Dalton, P. Feinsinger, M. Ingram, D. Inouye, C. E. Jones, K. Kennedy, P. Kevan, H. Koopowitz, R. Medellin, S. Medellin-Morales, G. P. Nabhan, B. Pavlik, V. Tepedino, P. Torchio, and S. Walker. 1998. The Potential Consequences of Pollinator Declines on the Conservation of Biodiversity and Stability of Food Crop Yields. *Conservation Biology* 12: 8-17.
- Beekman, M., and F. L. W. Ratnieks. 2000. Long-range foraging by the honey-bee, *Apis mellifera* L. *Functional Ecology* 14: 490.

- Cane, J. H., R. L. Minckley, and L. J. Kervin. 2000. Sampling Bees (Hymenoptera: Apiformes) for Pollinator Community Studies: Pitfalls of Pan-Trapping. *Journal of the Kansas Entomological Society* 73:225-231.
- Cane, J. H., R. L. Minckley, L. J. Kervin, T. H. Roulston, and N. M. Williams. 2006. Complex Responses within a Desert Bee Guild (Hymenoptera: Apiformes) to Urban Habitat Fragmentation. *Ecological Applications* 16:632-644.
- Cockerell, T. D. A. 1933. The Excessive Abundance of Certain Bees. *The American Naturalist* 67:286-288.
- Colin, M. E., J. M. Bonmatin, I. Moineau, C. Gaimon, S. Brun, and J. P. Vermandere. 2004. A Method to Quantify and Analyze the Foraging Activity of Honey Bees: Relevance to the Sublethal Effects Induced by Systemic Insecticides. *ARCHIVES OF ENVIRONMENTAL CONTAMINATION AND TOXICOLOGY* 47:387-395.
- Coulson, R. N., M. A. Pinto, M. D. Tchakerian, K. A. Baum, W. L. Rubink, and J. S. Johnston. 2005. Feral honey bees in pine forest landscapes of east Texas. *Forest Ecology and Management* 215:91-102.
- Desneux, N., A. Decourtye, and J. Delpuech. 2007. The Sublethal Effects of Pesticides on Beneficial Arthropods. *Annual Review of Entomology* 52:81-106.
- Dogan H. M., Dogan M. 2006. A new approach to diversity indices - modeling and mapping plant biodiversity of Nallihan (A3-Ankara/Turkey) forest ecosystem in frame of geographic information systems. *BIODIVERSITY AND CONSERVATION* 15:3:855-878.
- DROEGE, S., V. J. TEPEDINO, G. LEBUHN, W. LINK, R. L. MINCKLEY, Q. CHEN, and C. CONRAD. 2010. Spatial patterns of bee captures in North American bowl trapping surveys. *Insect Conservation & Diversity* 3:15-23.
- Frazier, M. 2008.
What Have Pesticides Got To Do With It? *American Bee Journal* 521-523.
- Galen, C., and M. E. A. Newport. 1987. Bumble Bee Behavior and Selection on Flower Size in the Sky Pilot, *Polemonium viscosum*. *Oecologia* 74:20-23.
- Greenleaf, S. S., N. M. Williams, R. Winfree, and C. Kremen. 2007. Bee foraging ranges and their relationship to body size. *Oecologia* 153:589-596.
- Holden, C. 2006. Report Warns of Looming Pollination Crisis in North America. *Science* 314:397-397.
- Hury, V. M. B. 1997. Ecological Impacts of Introduced Honey Bees. *The Quarterly review of biology* 72:275-297.
- Jacobsen, R. 2008. *Fruitless fall : the collapse of the honey bee and the coming agricultural crisis*. New York: Bloomsbury.
- Johnson, R. 2010.
Honey Bee Colony Collapse Disorder. Congressional Research Service, Report Number, RL33938.

- Kearns, C. A., D. W. Inouye, and N. M. Waser. 1998. Endangered Mutualisms: The Conservation of Plant-Pollinator Interactions. *Annual Review of Ecology and Systematics* 29:83-112.
- Kearns, C. A., and D. W. Inouye. 1997. Pollinators, Flowering Plants, and Conservation Biology. *Bioscience* 47:297-307.
- Kevan, P. G. 1999. Pollinators as bioindicators of the state of the environment: species, activity and diversity. *Agriculture, Ecosystems & Environment* 74:373-393.
- Kremen, C., N. M. Williams, R. L. Bugg, J. P. Fay, and R. W. 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. M. Williams, and R. W. Thorp. 2002. Crop Pollination from Native Bees at Risk from Agricultural Intensification. *Proceedings of the National Academy of Sciences of the United States of America* 99:16812-16816.
- Losey, J. E., and M. Vaughan. 2006. The Economic Value of Ecological Services Provided by Insects. *Bioscience* 56:311-323.
- McKinney, M. L. 1997. Extinction Vulnerability and Selectivity: Combining Ecological and Paleontological Views. *Annual Review of Ecology and Systematics* 28:495-516.
- Michener, C. D. 1979. Biogeography of the Bees. *Annals of the Missouri Botanical Garden* 66:277-347.
- Minckley, R. L., J. H. Cane, L. Kervin, and D. Yanega. 2003. Biological Impediments to Measures of Competition among Introduced Honey Bees and Desert Bees (Hymenoptera: Apiformes). *Journal of the Kansas Entomological Society* 76:306-319.
- National Research Council (U.S.). Committee on the Status of Pollinators in North America, and National Academies Press. 2007. *Status of pollinators in North America*. Washington, D.C.: National Academies Press.
- Osborne, J. L., S. J. Clark, R. J. Morris, I. H. Williams, J. R. Riley, A. D. Smith, D. R. Reynolds, and A. S. Edwards. 1999. A Landscape-Scale Study of Bumble Bee Foraging Range and Constancy, Using Harmonic Radar. *Journal of Applied Ecology* 36:519-533.
- Shinners, L. H. 1957. Scarcity of Wild Bees and Wasps (Hymenoptera Aculeata) in North Central Texas in 1957. *The Southwestern Naturalist* 2:129-131.
- Smith, B., and J. B. Wilson. 1996. A Consumer's Guide to Evenness Indices. *Oikos* 76:70-82.
- Stirling, G., and B. Wilsey. 2001. Empirical Relationships between Species Richness, Evenness, and Proportional Diversity. *The American Naturalist* 158:286-299.
- Tepedino, V. 1980. The importance of bees and other insect pollinators in maintaining floral species composition. *Great Basin Naturalist Memoirs* 0: .
- Thomson, D. 2004. Competitive Interactions between the Invasive European Honey Bee and Native Bumble Bees. *Ecology* 85:458-470.

- Tuell, J. K., and R. Isaacs. 2009. Elevated pan traps to monitor bees in flowering crop canopies. *Entomologia Experimentalis et Applicata* 131:93-98.
- Walther-Hellwig, K., and R. Frankl. 2000. Foraging habitats and foraging distances of bumblebees, *Bombus* spp. (Hym., apidae), in an agricultural landscape. *JOURNAL OF APPLIED ENTOMOLOGY* 124:299-306.
- Walther-Hellwig, K., G. Fokul, R. Frankl, R. Büchler, K. Ekschmitt, and V. Wolters. 2006. Increased density of honeybee colonies affects foraging bumblebees. *APIDOLOGIE* 37:517-532.
- Westphal, C., R. Bommarco, G. Carre, E. Lamborn, N. Morison, T. Petanidou, S. G. Potts, S. P. M. Roberts, H. Szentgyorgyi, T. Tscheulin, B. E. Vaissiere, M. Woyciechowski, J. C. Biesmeijer, W. E. Kunin, J. Settele, and I. Steffan-Dewenter. 2008. MEASURING BEE DIVERSITY IN DIFFERENT EUROPEAN HABITATS AND BIOGEOGRAPHICAL REGIONS. *Ecological Monographs* 78:653-671.
- Williams, C. S. 1995. Conserving Europe's bees: why all the buzz? *Trends in Ecology & Evolution* 10:309-310.
- WINFREE, R., T. GRISWOLD, and C. KREMEN. 2007. Effect of Human Disturbance on Bee Communities in a Forested Ecosystem. *Conservation Biology* 21:213-223.
- Winfree, R., N. M. Williams, J. Dushoff, and C. Kremen. 2007. Native bees provide insurance against ongoing honey bee losses. *Ecology Letters* 10:1105-1113.