UBC Social Ecological Economic Development Studies (SEEDS) Student Report

UBC Food System Project: The Importance of Bees for Global and Local Food Security

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ABSTRACT

Over the past few years the world's agriculture and food systems have become increasingly industrialized with the goal of greater efficiency. Since 2004 scientists and farmers alike have begun to see a decline in bee populations, a phenomenon which has been given the name Colony Collapse Disorder (CCD). At the same time, many scientists and farmers have come to recognize the important role that pollinators such as bees play in our ecosystems and agroecosystems and how the processes of intensification of agriculture (including the use of pesticides, changes in land use and monocropping) are affecting bee populations all over the world. The UBC Farm at the University of British Columbia is home to 7 colonies of honeybees which contribute to the agroecosystem and ecosystem by pollinating both crop plants and wild plants. It has been discovered that one of the best ways to prevent Colony Collapse Disorder is to limit stresses on the hive. The apiculturists and employees at the UBC Farm have assured a good home for the hives, however they have acknowledged that the number of bees is limited by the availability of food for the bees, and therefore it is recommended that the UBC Farm plant crops and plants that would provide more diverse food sources for their honeybees. This report investigates how bees as pollinators in the farm landscape can help the UBC Farm achieve its goals of proving climate-friendly food.

1.0 INTRODUCTION

The Centre for Sustainable Food Systems at UBC Farm (hereafter referred to as UBC Farm) is a 24 hectare student-driven teaching and research farm at the University of British Columbia (UBC) Vancouver campus. Half of the land base of the UBC Farm (~12 hectares) is forested; the other half of is made up of approximately 8 hectares of cultivated fields and about 4 hectares with buildings, roads and grassy areas that are not currently cultivated. The UBC Farm holds a weekly summer market, the profits from which support its programs and operations. Produce from the market garden as well as other products, such as honey and eggs, are sold at the summer markets.

Apiculture at the UBC Farm holds the potential to provide increased benefit to the UBC farm; bees are a keystone species and are necessary for the pollination of one-third of all crops. Apiculture also presents educational benefit for UBC by providing more study opportunities to students; through the Farm's volunteer and internship programs, as well as UBC classes and directed studies projects. Additionally, the development of apiculture and bee research at the UBC Farm could contribute to general academic and public knowledge about why bees as pollinators are so integral to our food and agriculture systems. This report will prove that providing a habitat for bees is very important to the sustainability of our food systems and ecosystems, and that the UBC Farm at its current size and operation is providing such a habitat which would be jeopardized if the Farm were to be moved or down-sized.

This project can be viewed as a pilot, the intent of which is to lay the foundation for future projects on mixed livestock farming practices at the UBC farm; specifically, projects focused on apiculture. Our project looks into the value of bees in the farm landscape, and how bees as pollinators can help the UBC Farm achieve its goals of growing climate-friendly food. We researched some of the most pertinent challenges facing apiculture today on a global scale and then turned our focus to challenges to apiculture expansion at the UBC Farm.

1.1 PROBLEM DEFINITION

In both production and research projects, students and UBC Farm staff are working on the *Changing the Food System to Change the Climate Project*. One of the objectives of this project is to look at how incorporating livestock in a mixed farming system, specifically bees, will create a healthier agroecosystem. The UBC Farm has the goal of working against climate change by using their soils as a carbon to decrease the amount of atmospheric carbon without jeopardizing productive capacity. We were asked to investigate how bees as pollinators in the farm landscape can help the UBC Farm achieve its goals.

With a lot of research recently on Colony Collapse Disorder (CCD) and the dire need to protect and preserve bee populations, our group wanted to know how apiculture practices at the UBC Farm could work to mitigate the possible destruction of bee populations in this region and in the province. This report will focus on the importance of bees in a mixed farming system, the specific causes and symptoms of CCD and finally how these issues are seen in BC's Lower Mainland and more specifically at the UBC Farm and around our campus. Our main research questions that lead us to write this report were: what variables affect the success of bee populations? How would diverse landscape farming affect bee populations and associated crops? How do bees contribute to food security? How does intensification of agriculture affect bees?

1.3 OUR VALUE ASSUMPTIONS AND REFLECTIONS ON VISION STATEMENT

Our group value assumptions are framed by an Ecological paradigm. We believe that the pollination service that bees provide cannot be underestimated but that in our current food system people are largely disconnected from their food sources and subsequently are susceptible to overlooking the necessity of bees in food security. Bees are integral to the sustainability of all food that enters the UBC food system, whether grown on campus at the UBC Farm, within BC, or around the world. Our research about the importance of bees in agriculture has helped to shape our Ecological paradigm value assumptions about food and agriculture. Additionally, developments in scientific understanding of the combination of abiotic and biotic variables that contribute to bee disappearances and population declines, serve to further critique what we believe to be flaws in the Productionist paradigm, which seeks to find the most efficient means to any end, in this case the end being food production. We now see the need and value of bees when discussing the sustainability of agriculture and food systems. With the goal of protecting and enhancing the diversity of our ecosystems, we must take into account the role and importance of other organisms within the ecosystem that are integral to its sustainability. Therefore, we would add this component to the Vision Statement of the UBC Food System Project:

> 8. The unique work of non-human beings (i.e. wildlife, insects and microorganisms) is valued and recognized as processes that are less efficient when replicated by humans.

2. METHODOLOGY

Since our project was aimed at addressing a global issue on a local scale, we adopted the UBC Farm as our community of focus. Our methodology was centred around the three components of Community Service Learning: head, heart and hands, as mentioned in AGSC 350. The head component represents knowledge; it involves the process of research to gather information and data. The heart is our thoughts, perceptions, and values of what our research should project. It represents the group's personal paradigm. The final component is the hands; it involves planning, evaluating, drawing conclusions, and community service.

HEAD – Literature reviews, peer reviewed journals, interviews, surveys and academic websites were the driving force behind the framework of our project. They provided key elements in our understanding of the importance of bees, Colony Collapse Disorder (CCD), and the general view of the current status of bee colonies in agriculture. Interviewing key players such as Allan Garr (apiculturist at the UBC Farm) and Paul van Westendrop (apiculturist of the BC Ministry of Agriculture and Lands) provided insight into the possibilities and limitations of apiculture at the UBC Farm. Appendix A provides a further detailed interview with Allen Garr.

HEART – Our heated debates, discussions, and ideas regarding the project were shaped by our individual experiences that eventually created our personal paradigm. As a group we value the significance of our environment and the health of members of the ecosystem such as bees. This approach reflected our concern for the integrity and health of apiculture. We feel that a community has obligations and duties to protect their resources and environment; therefore an ecocentric/ non-anthropocentric point of view (to give highest priority to the integrity of the biosphere), explained in our value assumptions section of the paper, is sufficient in thoroughly explaining our concerns for apiculture and its role in food security.

HANDS – A major component of our project was our community service. Although we did not have the opportunity to work with bees; our work with chickens at the UBC Farm enriched our research experience. We believe that it was an opportunity to work as a team and learn things that are not necessarily covered in our paper.

3.0 FINDINGS

3.1 IMPORTANCE OF BEES FOR FARM LANDSCAPE: WHAT DO BEES DO?

Bees are important for a variety of reasons worldwide. Their most vital role is as pollinators, responsible for 15-30% of the world's food production (Kremen, Williams & Thorp, 2002). According to Kremen et al. (2002), bees pollinate more than 66% of the world's 1,500 crop species, which indicates a heavy reliance on bees by food producers. Bee pollination is a natural process that is vital for the sustainability and profits of agriculture as it can determine the yield and quality of crops (Delaplane & Mayer, 2000) Not only do bees pollinate crops that humans eat but they pollinate plants that animals eat and are therefore crucial members of the ecosystem that help sustain biodiversity (Delaplane & Mayer, 2000).

Pollination is a complex and essential component to the reproduction of flowering plants. A bee pollinates flowers by picking up pollen from the anther and brushing the pollen onto the stigma of the female part of the plant. The more pollen transferred, the more seeds develop, and the larger the fruit will be (Delaplane & Mayer, 2000). Some plants do not require insect pollination, while others are heavily reliant upon it to reproduce.

A large number of crop plants (see Appendix B) rely on bees for pollination, which has huge implications for farmers. Not only would it take more time and labor to replace bees with hand pollination but it would cost more than $90 billion per year (Shultz, 2007). One hive of bees can pollinate 3 million flowers a day, whereas a human being can only pollinate 30 trees (Shultz, 2007). Without bees many plants, including the fruits, vegetables, nuts, and seeds that make our diets healthful and varied, would disappear. Even though we can survive on eating wind-pollinated plants such as grain products, without bee-pollinated plants it would be increasingly difficult to obtain the micronutrients required for good health.

Although 20-30,000 bee species exist, farmers rely on only about 10 species for pollination. In North America, these species can be categorized as either native or managed pollinators. Native bees, also known as wild bees, have been declining over the years. This can be attributed to: the intensification of farming practices, the use of pesticides, the increasing homogeneity of landscapes, the increased isolation of bees from nesting and feeding resources, and the many diseases that plague bee populations. This decline in native bees has resulted in an increased demand for foreign bee species such as the European honeybee, *Apis mellifera*, which alone contributes between $5 and $14 billion per year in crop value. Although this is a large contribution, foreign bees are not nearly as effective pollinators as native species.

3.2 IMPORTANCE OF NATIVE BEES

There are approximately 4,000 species of native bees in North America. Native bees are a wonderful alternative to imported European honeybees which provide free pollination services and can act as buffer to current honeybee losses (The Xerces Society, 2009). With the focus on honeybees, native bees are often forgotten as important pollinators. In fact, on a bee-per-bee basis, native honeybees are more effective than honeybees at pollinating (The Xerces Society, 2009). This is due to the diverse range of foraging behaviours of native bees, for examples some native bee species, such as mason bees and bumble bees, are able to forage during colder or wetter conditions. In addition, they specialize in one type of flower and perform buzz pollination. Buzz pollination is when the bee grabs onto a flower's stamens and vibrates its flight muscles which release pollen from deep inside the anthers of certain flowers (The Xerces Society, 2009). This results in efficient pollination and larger and more abundant fruits. If adequate natural habitat is nearby, they can provide much of the pollination necessary for many crops.

Regardless of whether they are foreign or native, bees are considered a keystone species, suggesting that without them, our ecosystem would be largely at risk of collapsing (Shultz,2007). Fortunately, there are ways to prevent further bee population declines, which can be implemented on any sized landscape.

Over the years, changing landscapes through fragmentation, degradation and destruction of natural habitats has dramatically affected pollinators. Bee abundance and species richness are directly related to the abundance and diversity of flowering plants. Loss of habitat could lead to a decline in gene flow and re-colonization rates, causing lowered populations. In addition, agricultural intensification with the use of pesticides and the destruction of bee nesting sites can change the availability of floral resources and lead to mortality or altered foraging behaviors of wild pollinators. On the other hand, landscapes, such as that seen at the UBC Farm, which favour habitat heterogeneity within the foraging range of bees, can have a positive effect on bee communities. Farm landscapes with small field sizes growing a variety of crops with patches of non-crop vegetation (such as hedgerows, fallow fields, meadows and semi-natural wood or shrublands) are best suited for bee populations (Kremen et al, 2007).

3.3 DEFINITION OF COLONY COLLAPSE DISORDER (CCD)

Colony Collapse Disorder (CCD) is an event affecting bee colonies, which results in adult populations being rapidly decimated (Cox-Foster, *et al*, 2007). In the past ten years, we have seen dramatic losses of honey bees around the world in countries such as France, Germany, Belgium, and the U.K (Jacobsen, 2008). CCD is different from other colony collapse events in that no corpses are found in or surrounding the hive, as they would be if they had died from a parasitic attack for example (Cox-Foster *et al*, 2007). Bees vanishing in record numbers from colonies are noted as early as 2004; however, the epidemic hit hard over the winter of 2006/2007, when over 23% of American beekeeping operations were reportedly affected, resulting in an estimated loss of over 45% of bees within those operations (Cox-Foster, *et al*, 2007). Currently, the exact cause of CCD is under investigation by scientists. Researchers agree that a combination of factors are likely causing CCD and investigations are focused on understanding some of the possible pathogenic and viral sources, as well as how pesticide use and nutritional deficiency from commercial bees traveling long distances to pollinate monocrops is contributing to the CCD epidemic.

3.4 VIRAL COMPONENT OF CCD

Reports of bee disappearances in B.C. in 2004 caused scientists to search for a possible viral explanation after the apiculture inspector discovered records of the Kashmir Bee Virus (KBV) being found in colonies in B.C. for the first time in the early 1980’s (P. van Westendorp, personal communication, March 19, 2009). In 2004, KBV virus was again found in sick colonies as well as healthy ones. In 2007, when CCD was wreaking havoc in American commercial colonies, a protocol was established to look for Israeli Acute Paralysis Virus (IAVP) in struggling and healthy colonies in B.C. and again was found in both, confounding the claim made by scientists in the U.S. that IAPV was a significant marker for CCD (van Westendorp and Jacobsen, 2008).

Mr. van Westendorp was quick to point out that most researchers studying the disappearance of bees in B.C. are loathe to describe it as CCD due to the lack of definitive answers regarding the phenomenon (personal communication, March 19, 2009). Varroa mites, which were first detected in B.C. in 1990, compromise the bees’ immune system making them susceptible to viruses. The mites themselves are also vectors for viruses and can transmit KBV; however, this virus alone was discovered in B.C. almost a decade before the mites were found in colonies. This illustrates the lack of an obvious triangular relationship between the mites, the prominent viruses, and CCD because some colonies in the process of collapse have not been found to have mites in them, whereas others have. Mr. van Westendorp came to the conclusion that the weakening of colonies and the eventual collapse are due to a combination of factors that are both biotic and abiotic (personal communication, March 19, 2009). He stated that what bee experts in B.C. believe is that viruses like KBV and IAPV play a role in collapse events but alone are not powerful enough to cause collapse; conditions must go from being benign to virulent.

Additionally, the North American honeybee is not native to America and this may have genetic consequences. In the past fifty years in the United States, the Carolinas and California have been the principle rearing areas for queens that are sold to keepers throughout North America. Reproduction companies request the best queens from clients every year so that they can be bred and sold; this process is effectively narrowing the genetic pool. In light of this, Mr. van Westendorp raised an interesting question in need of investigation: “have we been breeding productive bee stock that is highly susceptible to viruses?” (personal communication, March 19, 2009).

3.5 PESTICIDES

CCD has been partially blamed on neonicotinoids), a new synthetic pesticide with the active ingredient imidacloprid which in the early 1990’s became the dominant pesticide used on crops (Jacobsen, 2008). This group of pesticides is a synthetic form of nicotine, which in its natural form is an insect repellent produced by tomato plants, green peppers, potatoes and nicotine plants (Jacobsen, 2008). This insecticide works as a nerve poison in insects, causing them to suffer side effects such as appetite loss, dementia, spasms, paralysis, and in the end, death (Jacobsen, 2008).

This pesticide has become popular because it is a systematic insecticide – crop seeds can be soaked in neonicotinoids, like imidacloprid and successfully repel insects as they grow. Due to the systemic nature of the insecticide, it is detectable in every part of the plant's tissue (Jacobsen, 2008). This is meant to be an improvement on noxious insecticides that are sprayed repeatedly on crops from above. Nevertheless, bees being insects themselves are not immune to its effects despite claims from its manufacturer, Bayer Corporation. Bayer Corporation believes that the amount of insecticide that bees return to the hive with (1-2 parts per billion) is not significant enough to do damage (Jacobsen, 2008). However, Bayer Corporation fails to recognize that most fields are exposed to more than one pesticide. Synergism, the mixing of agents such that the total effect is greater than the sum of the individual agent, explains why some colonies might display symptoms of CCD while others might not at the same dose. The toxic or sub-lethal threshold can be lowered by synergism (Quarles, 2008). Pesticide usage plays a powerful role in CCD, however the evidence is only suggestive and it would take an extensive monitoring program to either confirm or deny the role of pesticides in CCD.

3.6 NUTRIENT DEFICIENCIES AND INCREASED STRESS

Urbanization along with intensive agricultural practices has led to a decrease of natural habitats of animal species, as well as the weakening of the entire agricultural system (Shultz, 2007). The decrease of pollinators in natural areas has increased the demand for commercial bees to pollinate farms that lack the wild bees they once had (Shultz, 2007). Commercial beekeepers transport their bee hives 5500 miles a year to supply the demand of pollinators that are needed in diverse locations (Shultz, 2007). The beekeepers stop for a few weeks at a time, release the commercial honey bees to pollinate on one type of crop, and proceed to continue this cycle throughout the pollinating season (Jacobsen, 2008).

Nutritional deficiency is a contributor to CCD often associated with commercial honeybees (Oldroyd, 2007). An indicator of a well-nourished colony can be measured by the amount of honey a colony produces. Bees with CCD often produce lower honey yields (Shultz, 2007). Colonies producing higher amounts of honey yields feed on an adequate diet of protein from diverse pollen sources (Oldroyd, 2007). When bees are transported from one mono-crop field to the next, they feed on a single source which may or may not contain the high quality proteins they need to survive (Oldroyd, 2007). Additionally, traveling bees are fed a glucose mixture to make up for energy losses; however, this is only a short term solution that is incapable of sustaining their long term nutritional needs (Jacobsen, 2008). When protein sources are limited, honeybees have higher levels of stress and immune deficiency which lead to shortened life spans (Jacobsen, 2008).

Commercial bees are overworked, fed glucose syrup, transported long distances, medicated with antibiotics, and sprayed with pesticides to deal with viruses and bacteria in the hive (Jacobsen, 2008). These actions cause an imbalance in the agricultural system that stresses the honeybees, rendering them weak and immunosuppressed, making colony collapse more probable.

3.7 BEEKEEPING IN BRITISH COLUMBIA

Beekeeping has been practiced in British Columbia for nearly 150 years (Ministry of Agriculture and Lands, 2003). Today, honeybee colonies are kept virtually everywhere throughout the province with 2,300 registered beekeepers operating 47,000 colonies. A small number of beekeepers breed bees and queens, which are sold to other beekeepers in areas where it is difficult or costly to winter bees. Apiculturists also move bee hives into orchards or vegetable fields to provide pollination services for those crops. Despite its size, beekeeping in BC is critically important to the annual production of over $100 million of crops (Honey, n.d.).

Many of the large commercial bee operators registered with the BCHPA (BC Certified Honey Producer Association) and the BC Bee Breeders Association keep their bees on farms. Many of the beekeepers use no pesticides or mitacides, however some drugs and chemicals are used to deal with mites but in B.C those that are allowed in beekeeping are heavily regulated.

BC's agriculture is limited by its topography and climate which in turn limits the development of BC's apiculture (Honey, n.d.). Beekeeping is highly dependent on the seasonal availability of nectar and pollen which is dictated by not only the plants but also influenced by the weather conditions during the time of bloom (Ministry of Agriculture and Lands, 2003). In many areas of BC, the natural vegetation offers limited nectar floral sources although the introduction of crops and weeds has improved local beekeeping conditions (Ministry of Agriculture and Lands, 2003). Other influencing factors include quality of management, presence of disease and pests and the genetic quality of the bee stock (Ministry of Agriculture and Lands, 2003).

3.8 BEEKEEPING IN GREATER VANCOUVER

The original by-law referring to urban apiculture was a Health by-law from the 1970's that banned all livestock, including bees, within the city limits (Bradley, 2005, p.2). In 2005, the section regarding apiaries was removed by the City of Vancouver, in recognition of honeybees' importance to the sustainability of urban food systems. In April of 2002, the Vancouver adopted a position and definition of sustainability: that economic, ecological and social impact would be considered in integrated decision-making (Bradley, 2005, p.2).

Provincially, honeybee colonies are regulated by the Provincial Bee Act and all apiaries must be registered with the BC Ministry of Agriculture and Lands (BCMAL). If an apiary does not comply with the regulations put in place by the Ministry, the Ministry has the right to destroy or dispose of the bees and beekeeping equipment. BCMAL is in charge of responding to complaints, inspecting apiaries and controlling bee diseases (Bradley, 2005, p.2).

Although beekeeping was prohibited within the Vancouver City limits until 2005, many apiculturists kept backyard hives. In 2005, it was estimated that there were 36-46 beekeepers in the City, 26 of which were officially registered with the BCMAL (Bradley, 2005, p.4). The 2005 report also mentioned that “Science World, VanDusen Gardens, Strathcona Community Garden and the UBC Farm have demonstration hives and provide educational programs” (Bradley, 2005, p.5) demonstrating the obvious need to amend the by-law. Backyard beekeepers must now adhere to regulations: they are limited to 2 – 4 hives, they must manage them well to prevent swarming and aggressive behavior and assure adequate water supply to prevent bees going elsewhere (Chan, 2005).

3.9 BEEKEEPING AT THE UBC FARM

The UBC Farm is currently home to seven colonies of European honeybees (*Apis malifera*). The number of bees varies throughout the year with the lowest numbers during the winter and up to 50-60,000 bees during the summer. In addition to the UBC Farm, there are also a few colonies located at the UBC Botanical Gardens which belong to Allen Garr. Although those working on the UBC Farm claim that the hives have not been affected by CCD, in 2006 all the colonies died off; however this may have been due to poor management of the bee colonies (A. Garr, personal communication, March 20, 2009).

According to Amy Frye, Marketing Coordinator at the UBC Farm, the 2008 market season saw the sale of seventy-five 500g jars of honey, which at $10 each generated $75 of profit (personal communication, April 10, 2009). Amy said that there was a very high demand for this product and they could have sold more, however it sold out very quickly. In 2007 there was no honey, since the colonies died however in 2006 the Farm sold 96 jars for $594 of revenue. The high demand allowed the UBC Farm to raise the price of honey (yet still maintain competitive pricing for their artisanal local product) from about $6 per jar in 2006 to the $10 per jar in 2007 and thus increase revenues from honey sales. It is clear that there is a demand for this product; therefore if the Farm were to have more colonies producing more honey, there would definitely be a market for honey and bee products (A. Frye, personal communication, April 10, 2009).

Beekeeping is directly dependant on the crops that are available at the Farm. Currently, the UBC Farm only has field crops like squash and wild crops such as blackberries and dandelions as nectar and pollen sources for the bees. As a result currently, only seven colonies can be sustained. If the bees travel a little further, there are some apple and cherry trees but many are infertile and thus produce no fruit. In order to house more bees, the UBC Farm would need to plant more crops from which the bees are able to feed.

4.0 DISCUSSION

Almost all agriculture to some extent is dependant on bees, without their work as pollinators the system would crumble (Jacobsen, 2008, p 203). Even the cattle industry is reliant on bees because without them the alfalfa that they eat would not exist; therefore, neither would steaks or dairy products (Shultz, 2007). With growing populations and climate change, bees as pollinators are integral to sustainable agriculture and in maintaining food security.

The prevalence of CCD illuminates the increasing decline of bee species and draws attention to the factors believed to be contributing to CCD's decimation of hives. The experience of apiculturists who have lost their colonies, as well as the research gathered to date by scientists studying the disorder points to the need for conservation and protection efforts of insect pollinators (Otterstatter, M.C., and Thomson, J.D., 2008). Although CCD appears to be more prevalent in some countries it is a global problem that with increasing population and demands for food affects the food security of the entire world.

In his book "Fruitless Fall", Rowan Jacobsen states that "trying to find a single cause of CCD misses the point. CCD […] is a symptom of a larger disease – a disease of fossil fuels and chemical shortcuts, of billion-bee slums and the speed of the modern world" (1994, p. 181). He recognizes that viruses like IAVP, imidacloprid pesticides, and stressed bees are the most blatant signs of CCD but asserts that "until local agriculture replaces global agriculture, there will always be another parasite, another virus, another mysterious collapse" (1994, p. 181). We need to stop degrading our environment in the name of efficiency and perfection.

The phenomenon of recent bee disappearances reflects what George Ritzer describes as the irrationalities that are born from the process of hyper rationalization in societies that are organized to emphasize the most "optimum means to any given end" (1994, p. 372). These irrationalities are the paradoxical consequences of rational systems; they include: unpredictabilities and inefficiencies as is seen with unpredictable loss of bees and inefficient use of fuels to truck bees around to monocrops. The perceived advantage of efficiency that large scale breeding programs and mobile bee colonies belies the "grave dangers posed by progressive rationalization" (Ritzer, 1994, p. 378).

Colony Collapse Disorder is much more than the disappearance of bees and the threat it holds on our world wide food production. Rather, it is a *signal* that our whole agricultural system, all parts included, is steadily weakening. To suffice our human desires, we have pushed our earth's natural limits in many ways. "Efficiency" has been replaced by a weakened agricultural system. At the cost of speed today, there is more than a fair share of trouble in the long run. It is evident that we need to find solutions sooner rather than later because "[i]f bees continue to disappear at the current rate, honeybee populations in the United States will cease to exist by the year 2035" (Shultz, 2007).

Focusing away from efficiency and towards resilience is more sustainable. Resilience is the ability to recover after disturbances. The lack of interconnectivity between divisions within our agricultural system is what has weakened the system. The stronger our system holds together in unison, the greater potential it has to succeed in the long run. Resilience calls for group rather than individual efforts. Currently, the explored causes of CCD form a dichotomy between farmers who primarily believe it is caused by pesticides and researchers who believe it is caused by viruses. Our research indicates that CCD is caused by a multiplicity of events. The specialization of farmers and researchers bring depth to adequate problem solving skills and these individuals must to work together to find solutions that enhance systems resilience and sustainability.

5.0 RECOMMENDATIONS

5.1 STRATEGIES TO INCREASE NATIVE BEE POPULATIONS AT THE UBC FARM:

(Source: The Xerces Society, 2007)

1) Use local native plants. It has been suggested that native plants are four times more attractive to native pollinators than exotic plants

2) Chose several colors of flowers. Blue, purple, violet, white and yellow are particularly attractive to bees.

3) Plant flowers in clumps. Flowers clustered together attracts more pollinators compared to individual plants scattered throughout.

4) Include flowers of different shapes. Bees come in many different shapes and sizes. As a result, they have different tongue lengths and feed on different shaped flowers.

5) Include a diverse array of plants flowering all season. By having several plant species flowering at the same time and throughout the year, it will support a greater range of bee species that pollinate at different times of the seasons.

6) Provide appropriate nesting sites. Include patches of bare ground with soils of different textures; holes of different sizes drilled into boards, fences or dead trees; stranding dead trees and fallen branches; and fields where tillage and flood irrigation are avoided (Kremen et al, 2007).

7) Diversify the landscape.

8) Restore the natural habitat.

9) Choose to grow more crops and plants that can provide food for bees. Plants that A. Garr specifically recommended growing were sweet clover, Cecilia, alfalfa, and borage (personal communication, March 20, 2009). Appendix C provides a list of crops that require or benefit from bee pollination and can provide food for bees. This is a list that can be referred to when making considerations about what to plant for the next growing season. However, we acknowledge that the growth of certain crops is limited by the topography, soil, and climate at the UBC farm and therefore, not all of the crops on this list can be feasibly grown at UBC.

5.2 MANAGEMENT PRACTICES TO SUPPORT BEE HABITAT

(The Xerces Society, 2007).

Limit grazing. Unmanaged grazing can damage ecosystems, harming pollinators by reducing floral and structural diversity of the land. A diverse pollinator population requires adequate pollen and nectar sources from early spring to early fall. The best time to graze depends on each site but generally is after a majority of the flowers have withered or when the pollinators are in dormant or have laid eggs. This is usually in late summer and fall.

Control mowing. Try to limit mowing to only patches of weeds and during dormant periods such as in the fall or winter. Like grazing, mowing can alter species composition and may destroy smaller topographical features which provide structural diversity to the habitat and are potential nesting sites for bees. In general, mowing should not be conducted when flowers are in bloom.

Limit use of herbicides and insecticides. Avoid broadcast spraying or pellet dispersal as they may destroy a wide range of plants unintentionally and avoid treatment of areas where there are flowers in bloom.

5.3 RECOMMENDATIONS TO THE PUBLIC

1) Recognize that fruits and vegetables with some insect damage is natural: reduce demand for perfect fruits, veggies, flowers and lawns and that will reduce producers need to use insecticides (PBS podcast)

2) Take a bee keeping course and get involved in apiculture

3) Support sustainable agricultural systems

4) Backyard beekeeping

5.4 RECOMMENDATIONS FOR FUTURE AGSC 450 STUDENTS

1) Extend research on crops that are beneficial to bees and how to incorporate them into the farm.

2) The application of enhanced nesting practices onto the UBC Farm.

3) Keep up with the current data on CCD and its possible effects to BC and the UBC farm.

4) Educate farmers on the benefits using of native bees versus imported bees.

5) Promote the diverse genetic makeup of bees versus consistently breeding decedents of one type of bee.

6.0 CONCLUSION

We cannot afford to be divorced from the natural processes that govern the production of the food we eat. Bees, however small, are a crucial keystone species, responsible for buttressing a significant portion of our food system. One of the first steps in improving our food system at UBC as it relates to apiculture is to understand the challenges bees face and the possibilities available for increasing their populations. Our recommendations for increasing crop and tree species at the UBC Farm, as well as for students to get involved in backyard beekeeping are derived from our understanding of the biotic and abiotic challenges and possibilities that face bees.

7.0 FIELD WORK COMPONENT

We arrived at the UBC Farm at 10am Saturday morning to help move the chickens. We started by taking down the fence and rolling it up. Then Tim used the tractor to move the chicken house over to the other side of the farm. We then moved the shelters, fence, and feeders to the same area. We lined up the fence around the new plot and set it into the ground. The feeds were filled with food and we finally let the chickens out into their new home. Through this experience, we were given very little instructions and communication was limited. We felt that it would have been more beneficial if there was an explanation to why we were doing the activities that we were assigned. This would enable us to learn more about mixed farming and the impacts that it had on the farm.

8.0 GROUP REFLECTION

Most of our information for our group project came from outside sources, however we did learn from some important members of the UBC community. When it comes to our research paper and writing our report, our Teaching Assistant was very helpful during the course of our project. In terms of where we got our information about bees and the UBC Farm, Allan Garr, Paul van Westendorp and Amy Frye were all very helpful and provided a lot of information. We feel that there was a disconnection between our experience of writing this research paper and our experience of participating in field work at the UBC Farm. Our field work experience was dedicated to providing labour to the Farm by moving the chickens, and did not coincide with the focus of our paper.

From our literature review, we all learned a lot about bees, and now are more aware of their importance in agroecosystems. After completing our field work, we do not necessarily feel that we learned any new information that pertains to bees; however we enjoyed the opportunity to work on the Farm and the exposure to field work. Our field work enhanced our understanding of how a mixed landscape farm system works, however we would have appreciated more specific information about the importance of our work for the specific farm system.

Our understanding of overall food security was definitely changed by our research for our group project – we now have a collective realization of how important bees are as pollinators and we have more knowledge about the problems that bee populations are facing worldwide. While we felt that we could have learned more or been more involved in our field work experience, it brought our group together and we did enjoy ourselves. We faced some challenges during our field work, many of us felt uncomfortable outside of our element, not being used to farm work and it was especially difficult during such cold and rainy weather. After we set up the new fence we were very happy to watch the chickens run out of their home and be excited about their new location. Seeing the finished product of our work was rewarding.

Our group would recommend that the field work component of this project be more involved and more engaging. We would recommend that the field work be directly correlated with the topic of focus for the project. Our work at the Farm would have been more influential if we had a greater understanding of the importance of our work and how it affects the farm landscape. We feel that Community Service Learning is a very useful pedagogical tool when it is designed with concrete goals in mind.

It has been our experience that Community-Based Research Projects often result in a more engaged final product, because the researchers have an obligation to a community to produce useful information. We feel that when collaborating with the UBC Farm on future

Agricultural Sciences 450 projects, the teaching team must make sure that the scenario and field work be very relevant and that there are clear objectives for research that are identified by the staff and/or volunteers of the UBC Farm.

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APPENDIX

APPENDIX A: TELEPHONE INTERVIEW WITH A. GARR - MARCH 20, 2009

1. How many colonies? 7

2. What kind? Apis malifera - European honey bees

3. How many? Depends on time of year – 50-60 thousand by the summer and lowest numbers in winter. Some colonies are over at botanical gardens (belong to A. Garr)

4. Have we experienced any losses? We claim that we do not get CCD here but 3 three years ago all colonies died off possibly due to bad management (cannot be left alone). Moving around just creates more work for beekeepers (bees have wings anyways and can move long distances).

5. Do we grow a lot of bee pollinated crops/ a variety of food bees can feed on? It is debatable as to if there is enough food on the farm for them (we have root crops and they can feed from squash but no fields of clover or buckwheat). We should be planting more (only currently have blackberries, dandelions and we do not plant them either; they're just there). There are no big Maples or Chestnuts or Linden trees and low volumes of cherry and apples. The plant Cecelia has no economic benefit but is a good source of nectar and pollen for bees. Just because you put have a big stretch of land does not mean you can keep bees. Roses do not generate much food. There are cherry trees downtown but they are infertile so they have no fruit. Plant crops that bees can benefit from are sweet clover, Cecilia, alfalfa, and borage.

APPENDIX B: EXAMPLES OF BEE POLLINATED CROPS (KLEIN ET AL, 2007)

Essential (production decreases by ≥ 90% without bees):

Melons, squash, kiwi, passion fruit, brazil nut, macadamia, cacao, vanilla.

Great (production decreases 40- <90% without bees):

Cucumber, buckwheat, starfruit, durian, apple, mango, avocado, stone fruits, pear, berries, almonds, cashew, turnip, cola nut, coriander, cardamom, fennel seed, allspice.

Modest (Production decreases 10 - <40% without bees)

Okra, eggplant, strawberry, prickly pear, guava, pomegranate, black and red currant, chestnut, mustard seeds, rapeseed, coconut, soybean, seedcotton, sunflower seeds, sesame, coffee, caraway.

Little (Production decreases >0 - 10% without bees)

Chile peppers, bell pepper, tomato, various legumes, string bean, cowpea, papaya, kumquat, citrus fruits, longan, persimmon, lychee, peanut, flaxseeds, safflower.

APPENDIX C: CROPS THAT CAN PROVIDE FOOD FOR BEES (AVITABILE & SAMMATARO, 1998)

Alfalfa	Brazil nut	Celeriac	Clove
Allspice	Broad beans	Celery	Clovers, minor
Almonds	Broccoli	Chayote	Coconut
Alsike clover	Brussels sprouts	Cherimoya	Coffee
Anise	Buckwheat	Cherries	Collards
Apples	Cabbage	Chervil	Coriander
Apricots	Cocao	Chestnut	Cotton
Artichoke	Cantaloupe	Chicory	Cowpeas
Asparagus	Carambolo	Chinese gooseberry	Cranberries
Asparagus	Caraway	Kiwi	Crenshaw
Avocado	Cardamom	Cherry	Crimson clover
Berseem	Carrots	Chives	Crownvetch
Blackberries	Casaba	Cicer milkvetch	Cucumbers
Blueberries	Cashew	Cinnamon	Currants
Borage	Cauliflower	Citron	Cut flower seeds

Dewberry
Dill
Eggplants
Endive
Feijoa
Fennel
Flax
Garlic
Green bean
Gooseberries
Grapefruit
Guava
Herbs (spices)
Honeyball
Honeydew
Huckleberry
Jujube
Kale
Kapok
Kenaf
Kohlrabi
Kola nut
Lavender
Leek
Lemon
Lespedeza
Lima beans
Lychee
Longan
Loquat
Lotus
Macadamia
Mandarin
Mango
Mangosteen
Mustard
Nectarines
Niger
Nutmeg
Oil palm
Okra
Onion and Leek
Opium poppy
Orange
Papaya
Parsley
Parsnip
Passion fruit
Peaches & nectarines
Pears
Peppers
Persian melon
Persimmon
Pimenta
Plums & prunes
Pomegranate
Pomelo
Pumpkin & squash
Pyrethrum
Quinine
Radish
Rapeseed
Raspberries
Red clover
Rutabagas
Safflower
Sainfoin
Sapote
Scarlet runner beans
Sesame
Strawberry
Sunflower
Sweet clovers
Sweetvetch
Tangelo
Tangerine
Tea
Tendergreens
Tephrosia
Tomatoes
Trefoils
Tung
Turnips
Vanilla
Vetch (hairy)
Watermelon
Welsh onion
White clover
Zucchini