THESIS

INVASION OF THE KILLER BEE: AN HISTORICAL EXAMINATION OF GOVERNMENTAL, AGENCY, AND BEEKEEPER RESPONSE TO AFRICANIZED HONEYBEE COLONIZATION IN THE SOUTHERN UNITED STATES

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ABSTRACT

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This study is an exploration of the effects that the migration of Africanized honeybees has had on the beekeeping industry in the southern U.S. The Africanized honeybee has had a disruptive effect on agriculture and beekeeping during its long migration from Brazil where it was released in 1954 to most of the southern U.S. Utilizing both historical-comparative and qualitative interview methods, an applying a theoretical framework of food regimes, technological lock-in theory, and Bourdieu's concept pf Habitus, this study explores how this bee has impacted both beekeeping and agricultural systems, and why it is such a bad fit for U.S. farming. The findings from this study help to define not just how this bee is a bad fit for farming, but also illuminates why our farming practices may be incredibly detrimental to our managed honeybee colonies upon which we depend.

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CHAPTER 1

The "Invasion" and framing the "bee problem"

> *It is March of 1954, and a visiting beekeeper is inspecting the apiary of Dr. Warwick Kerr in Brazil. The remote apiary is a research station where Dr. Kerr is studying new breeds of honeybees that will be both productive and able to survive in the jungle of Brazil. The visiting beekeeper notices that someone has left queen excluder grates on the front doors of the hives and removes them. Later that day, unnoticed, several queen bees exit their hives with complements of workers, off to seek new homes in the rain forest…off to forever alter the ecosystem of the jungle. The Africanized "killer bee" has been born. We go forward in time, it is 2005 and a beekeeper in Florida is going about routine inspections of his hives. He has 450 hives to inspect today and there is little time to waste. He approaches a pallet of four hives, puffs a little smoke in the doorways, waits a few seconds and cracks the propolis seal between the brood box and a super above it, like he has done thousands of times in the past, but today something different happens. Today, as soon as the box is cracked, the hive erupts in fury; clouds of bees are flying around his head, dive bombing his mask, furiously stinging his protective suit. The other hives on the pallet soon join in the frenzy and the situation becomes overwhelming, even for him. He is a professional beekeeper, used to dealing with bees in large numbers, but these are hives like no other he has worked with. They do not relent when the hive is reassembled, they do not calm down after many minutes have passed. He knows right away what has happened. The hive has been superseded by Africanized honeybees, and perhaps more of his hives have as well. The beekeeper knows that he will have extra work to do this spring, and will have to spend additional money in order to put new queen bees in all of his hives.*

In 1954, there was an accidental release of a strain of honeybees from Africa that exhibit highly defensive behavior when they feel their nest under threat. The Africanized honeybee has both a competitive and genetic survival advantage over both native species and domestic European honeybees within its climactic range. Since 1954 the Africanized honeybee (AHB) has spread from Brazil, through Central America into southern states in the U.S. As it has migrated, the AHB has had negative impacts on both the honey industry and pollination programs in the countries it has colonized. In many Latin American countries such as Panama and Costa Rica, there has been a pattern of sharp drops in honey production after initial colonization, with a steady recovery after about five years. In some smaller countries such as El Salvador beekeepers

have never really recovered (Caron 2001). Honeybees don't just provide us with a little bit of sweetness, they provide a vital service to agriculture in the form of pollination. Modern monoculture of crops requiring insect pollination would indeed be impossible without these tiny laborers. Honeybees also gather a great number of substances from the surrounding environment and concentrate them within their hive (nectar becomes honey and wax, pollen becomes "bee bread"), which make them excellent indicators of environmental quality (Porrini, Sabatini, Girotti, Ghini, Medrzycki, Grllenzoni, Bortolloti, Gattavecchia, and Celli 2003).

It was Dr. Kerr's intention to bring this bee to Brazil and keep it in a quarantined apiary far from other beekeepers, where he could begin to work on creating a hybrid bee that would be less aggressive, yet retain most of the desirable properties that made it particularly suitable for the Brazilian environment. Dr. Kerr soon discovered that they task of hybridizing this bee would be a difficult one. While first generation hybrids (F1 Hybrids) tended to be more gentle than their pure African parents, subsequent generations quickly reverted towards the highly defensive behaviors of the original bee (Caron 2001). Dr. Kerr intended to keep them quarantined in this remote locale until he was able to successfully hybridize the bee, however, as the story goes, on a lovely spring afternoon, a visiting beekeeper decided to remove the queen excluders from the entrances to the hives, allowing 26 swarms to escape (Caron 2001). The escaped swarms quickly propagated in the lush, forage rich Brazilian jungle, establishing a large feral population. The African bee, upon arriving in the wilds of Brazil found an already well established feral population of *Apis melifera M.* – the western honeybee which soon became "Africanized" (*Apis melifera Scutellata*) as due to specific genetic and adaptive behaviors during mating the feral genome rapidly shifts towards that of the African bee (*Apis melifera Adansonii)* (Caron 2001; Fletcher 1978).

It took many years for the bee to reach the US, with the first swarms being discovered in Hidalgo, TX in October of 1990 (Caron, 2001). Since arrival the bee has spread to most of the southern US and is still on the move. For many southern beekeepers, the AHB is just another problem to throw onto the already large list of issues that they face in maintaining their charges. Africanized honeybees are best known for exhibiting highly defensive behavior when they sense a threat to their nest through visual or physical stimuli (Alauxa, Sinhac, Hasadsrid, Hunte, Guzma´n-Novoaf, Gloria DeGrandi-Hoffmang, Uribe-Rubioh, Southeyc, Rodriguez-Zasa, and Robinsona 2009; Winston 1991). While all honeybees will defend their nest from predation, AHB tends to do so much more quickly than European honeybees (EHB) and in greater numbers, and they tend to follow the offender for a greater distance from the hive than EHB (Winston 1992, 1991, Caron 2001). Another behavioral adaptation that the AHB exhibits also presents problems for beekeepers is that African bees tend to abscond from the nest more frequently, a behavioral adaptation to the harsher conditions under which they evolved in Africa (Caron 2001; Fletcher 1978; Winston 1992). These behaviors are problematic when inserted into U.S. Beekeeping and the highly industrialized modern food production system in the U.S.

This thesis will closely examine the situation surrounding the Africanized honeybee in the U.S. in order to accomplish three tasks: 1) provide groundwork for framing the AHB issue in the context of the US Agri-political system, 2) uncover the process through which farming and beekeeping developed in a sort of "lock-step" process, and why AHB prove to be so disruptive, 3) provide a meaningful theoretical foundation for studying the place of honeybees, and in particular Africanized Honeybees in larger agricultural and social systems. In order to accomplish the tasks specifically outlined here, several theoretical frameworks will be utilized, those of technological lock-in, food regimes, and Bourdieu's concept of habitus. .

To examine the ways that the development of beekeeping and modern agriculture has led to them being seemingly inextricably entwined, technological lock-in theory (Arthur 1989; Cowan 1990; Cowan 1991; David 1985; Liebowitz and Margolis 1990; Pollan 2009; Roberts 2009) will be utilized. The historical development of both agriculture and beekeeping has been strongly influenced by technological and capitalist development in general, leading to the current system in which modern beekeeping is entrenched. Framing the AHB situation in the context of the U.S. Agricultural system will require an in-depth examination of the historical place of bees in our agricultural system, of the biological services that honeybees provide, and understanding of the cultural and social influences that govern our choice to use specific types of bees for agricultural tasks.

Our modern industrialized agriculture system – the "Agricultural-Industrial Complex" (Pollan 2009; Roberts 2009) is a complex web of farmers, government, corporations, and foreign interests, and this is inclusive of beekeeping as well. In order to examine the complexity of this web, and the historical factors that have led to the current system, the concept of Food Regimes will be utilized. This theory examines the ways which particular strategies of organization around modes of accumulation have affected the control and distribution of food at a global level. Beekeeping and the production of hive products (honey, wax, propolis, royal jelly, etc.), foods that directly require pollination (fruits/vegetables/nuts), and those that require pollination indirectly (for example dairy which requires alfalfa hay as feed stock) are an overlooked element in this equation by the majority of social science literature. The future of beekeeping in the United States, rather than being dictated solely by the current state of beekeeping, declining numbers of beekeepers and catastrophic colony losses due to Colony Collapse Disorder (CCD), may also be shaped by the trajectory of the current food regime and its focus on global markets.

The profession of beekeeping has developed an extensive set of practices that are accepted as "good beekeeping" and "best management practices." In order to examine the ways that individual beekeepers ideals and practices influence the organization and definition of the field of beekeeping, Bourdieu's concepts of habitus and practice will be applied. Honeybees, like other types of livestock are no longer wild animals, they are animals that have been imbued with cultural value, and economic interest over time (Yarwood 2006). In this respect, the genetic and biological form of the honeybee and the beekeepers methods are both expressions of historically invested social, cultural and economic capital. Beekeeper practices and bee behaviors developed over time through interactions with technology and social institutions, which influenced the development of accepted "best management' practices. Understanding these processes will serve to illuminate the ways in which the AHB disrupts the system on its most basic level, and why it has been designated an "unwanted species" of bee in the U.S., but not in other countries in its path.

Beekeeping in the United States has become a highly mobile profession, with many hives traveling upwards of 8000 miles in a year (Agnew 2007), crossing both the Mason Dixon line and the Continental divide. While examining these issues, it is important to remember how the "popular" image of the AHB has been constructed, what this means in terms of regulation and control, litigation, and its designation as an "unwanted species" of bee. In the US, professional beekeepers expend a great deal of capital and labor in maintaining European stock. In an already overstressed system, these extra capital outlays that are required in addition to shortages of capable labor could have detrimental effects on beekeeping businesses, leading to an increased loss of sideliner and smaller beekeeping businesses, and the concentration of more and more

bees (and the responsibility for their wellbeing and pollination services) in the hands of fewer and fewer beekeepers.

Also investigated here are the ways that media coverage of the bee has historically focused on sensationalized news stories, where there have been massive stinging incidents. The bees are often anthropomorphized or demonized, taking on a supernatural quality as seen in such cinematic productions as *The Swarm*. Yet, while the bee is very defensive, it has never become the problem that was expected, or that was projected by these types of propaganda. However, the sensationalized image of AHB has influenced the beekeeping industry, and due to the highly mobile nature of beekeeping, not just in southern states.

In Chapter 2 of this thesis, I will explore the historical development of beekeeping as a profession. While beekeeping has been practiced in some form for thousands of years, its development into a modern "profession" is very recent, developing alongside modern agricultural practices and manufacturing technology. The rise of professional beekeeping, the development of beekeeping technology, and the organization of modern beekeeping provide an excellent example of how we become dependent upon certain technologies, and how this makes it difficult for us to change our current systems. Chapter 3 will examine the primary data for this study, detailing the findings from in depth personal interviews with beekeepers, bee scientists and extension and apiary inspectors. Chapter 3 will connect the information gathered from these in depth interviews with the theoretical foundations and historical developments that were detailed in Chapter 2, in order to begin building a foundation from which beekeeping can be viewed as a social phenomena; the product of a complex arrangement of economics, politics, biology, and symbolic meaning . Chapter 4 will conclude by linking the issues of beekeeping in the presence of AHB to larger issues surrounding our industrialized food system, and offer

suggestions as to how the issue of AHB might be framed more effectively to allow for more open dialog regarding the problems facing beekeepers within its climactic range.

The chosen theoretical concepts will help to pull together many of the issues that surround beekeeping in the U.S. to create a cohesive framework for understanding the place of honeybees in our agricultural system. The framework provides a systematic way to uncover the process by which we became so dependent upon EHB. Investigating the impact that the AHB has had on the industry helps to illuminate weaknesses within our agricultural system – as the AHB is in its natural function identical to the EHB, however it exhibits characteristic behaviors that make it very out of place within the system. These assumptions are well supported by Bourdieu's theories of habitus and practice and modern food regime theories, which help to build a deeper understanding of the ways that both beekeepers and governments have shaped the current systems through practice, ideology and regulations.

The individuals interviewed for this study universally expressed a deep concern over the ways that honeybees in our agricultural system suffer from ill health, poor nutrition, and outside invading forces, of which AHB is only one. Many expressed a great deal of apprehension over issues of disease, nutrition and invasive pests, with the Varroa mite topping the list of problems. Scientists, apiary inspection agents, extension agents and beekeepers alike all feel that bees are currently under a great deal of pressure from our agricultural systems and most feel that some amount of change is in order to protect the health of our pollinators. However some of the interviewees also expressed a sense of being "trapped" in this system, and that change seemed difficult or impossible.

It is the goal of this thesis to make a meaningful contribution to the sociological literature on rural and agricultural issues as well as to literature on beekeeping. The dialog between

sociologists, farmers and governments on a global scale could benefit from the inclusion of honeybees, beekeepers and the topic of beekeeping as this inclusion can provide a deeper insight into our agricultural practices and what they mean to both us, and the natural world. Rachel Carson considered honeybees to be a keystone species (Carson 1962), one which can serve as an indicator of the health of our environment. As such, it is important that social science turns its attention to this "canary in the coal mine" and other indicator species, and continue to discuss the ways that our choices about agriculture, made with our best intentions and scientific knowledge, are many times detrimental to not just the environment but to ourselves.

CHAPTER 2

History, Theoretical foundations and methods

Researcher rational and methods

My personal history was critically important to the development of this study. Before I returned to college, I spent 8 years working as a commercial/sideliner beekeeper, experiencing all the joys and hardships that go along with being "in business" with nature. I became familiar with honeybees as both a source of income, and as a source of personal fulfillment. I learned that keeping bees, much like other types of livelihoods that deal intimately with nature, can be enlightening and humbling experiences. One is constantly reminded – Mother Nature is in charge, not humans. My small business moved honeybees from the orange groves of south Florida in the early spring to central Florida for palmetto and gallberry honey, and then north to the upper reaches of Michigan for cherry pollination. I spent many hours driving them myself on a big old flatbed truck, ducking in and out of gas stations, stopping only after dark unless it was an emergency. I learned how to properly rob the bees of their honey, and how to properly extract and bottle it for sale. Because of the size of my business, which topped out at 400 hives, many of the tasks (such as honey extraction) which are trivial for hobbyists, or performed by a work crew for large beekeepers were done by my partner and I. I learned the physiology and lifecycle of the honeybee in great detail, raising queens by hand in order to maintain and build our stock. Keeping bees in this way immersed me in the rhythms of the bee's lives.

This background has helped shape my understandings of nature and agriculture in the U.S., and does influence the way I understand the situation surrounding our beekeeping industry. Often my heart will tell me to take the side of the bee, since they are innocent animals that we exploit for our own ends. The other part of my training - that founded within the framework of

academia - forces me to acknowledge that my experiences could be a source of bias, and that the way I see things may be very different from someone who has never worked with bees. I also understand that these experiences can help to provide a window into the world of beekeeping for those who have not had this intimate personal experience. Throughout this study I have tried to maintain objectivity and to think critically about how problems facing bees impact us all, which I believe essential as bees and other pollinators are fundamental to our own survival.

Methods

Beekeeping as a profession and honeybees as livestock in the agricultural system have received little to no attention by the social sciences. As this study represents an initial investigation of the situation of beekeeping and Africanized honeybees in the U.S. it includes a great deal of synthesis of historical information and theoretical analysis in an effort to help place honeybees and beekeeping within accepted sociological literature. The use of historical analysis "…is particularly useful for establishing a baseline or background prior to participant observation or interviewing" (Marshall and Rossman 2011). I felt it was necessary to provide this information in order to establish a basic understanding of what beekeeping is and what beekeepers do in our agricultural system in a way that was accessible to people who were non-beekeepers and who may never have read anything relating to beekeeping.

The primary data collection method involved the use of in-depth personal telephone interviews, using a standardized, open ended interview strategy. The goal of these interviews was to acquire a contemporary understanding of how various involved groups felt that the AHB had impacted the beekeeping industry, honeybees as livestock, beekeepers and the public. The sample consisted of individuals who work in the beekeeping industry in the U.S. as researchers and professors, beekeeping journal writers, apiary inspectors and extension scientists,

commercial beekeepers, beekeeping association leaders, and individuals involved in bee removal in the AHB area. Four different interview schedules were developed (See Appendix A), tailored to each group's specific roles and modes of involvement in beekeeping in the U.S. This resulted in 15 interviews that lasted from between 50 and 90 minutes in length. The interviews were transcribed and major and underlying themes were identified through an intensive coding process using the Nvivo software package. Data was analyzed using Nvivo to provide an understanding of which themes recurred in the majority of interviews and to rank issues in order of importance. While the most commonly occurring themes found in the data are given extensive attention in chapter 3, those that were least common were also explored in order to present the unique perspectives that each group held. Throughout the analysis, the theoretical framework established in chapter 2 is used to provide context and structure to the resultant data, providing a cohesive understanding of the major issues surrounding AHB and beekeeping in general in the U.S.

Historical Context

Beekeeping is a part of our agricultural heritage that has received very little attention until recent developments with bee colony die-off prompted a great deal of public sentiment towards honeybees (Benjamin 2009). Humans have a very long history of managing honeybees for the direct products of the hive such as wax and honey, and also for pollination of our agricultural crops. Some of the earliest records of beekeeping date to about 6000 years ago. Modern beekeeping has little in common with traditional beekeeping however, and it is the purpose of this chapter to examine the ways that technological innovation has impacted both beekeeping and the agricultural systems into both of which, bees are intricately entangled, and to provide a context for further investigation of the situation surrounding AHB. Additionally, this

chapter will build a theoretical foundation through which the current system of beekeeping and the effects of the AHB can be examined. Several theoretical ideas will be used to unpack the AHB situation in the southern US, in order to provide structure for a multi-leveled analysis. At the macro level, the concepts of technological lock-in and food regimes will be used in order to situate beekeeping within the context of modern agricultural and political systems. In order to situate beekeepers themselves within the larger context of agriculture, Bourdieu's concept of habitus will be applied to beekeepers. This section will explore how beliefs and dispositions regarding the keeping of bees and what constitutes good beekeeping have affected the trajectory of the development of the industry, and the place of AHB.

There are four main areas in which technological innovation has been important in changing the face of beekeeping from a small endeavor as part of a diversified farm system to that of a stand-alone profession. Innovations in protective clothing for beekeepers, including improved veils made from modern materials and suits made from improved textiles, were essential to working with very large numbers of beehives in an efficient manner. Improved hive design, and particularly the introduction of Langstroth type movable frame hives (with their modular, mass producible design, and easy portability) ushered in what was often called the era of "rational beekeeping" (Dziezron 1882; Langstroth 1853). Innovations in transportation made it increasingly possible for large numbers of bees, housed in these new improved highly portable hives to be moved over long distances. Enhancements in harvesting and processing of hive products such as beeswax and honey helped bolster this new fledgling enterprise by increasing the amount of honey that beekeepers were able to produce from their apiaries, and a global market for honey was established. All of these innovations played key roles in transforming

traditional systems of beekeeping, and indeed systems of cropping into the modern system that we are familiar with today.

Traditional Beekeeping

Traditional beekeeping practices and equipment are very far removed from their modern, mass produced counterparts. Modern beekeeping equipment is manufactured with a high degree of precision and uses many types of materials not readily available from nature. Modern beekeeping equipment is also designed for the convenience of the beekeeper and the efficiency of producing honey and other hive products. This is counter to the way that beekeeping had been practiced for thousands of years. Traditional beehives were (and in some places still are) generally produced from materials that were readily available from the natural environment. Efforts are made to create a place that bees would consider an attractive place to build a nest, and the bees generally determine the shape and configuration of their combs on their own (Crane 1999). Modern, rationalized beekeeping manipulates the interior dimensions of the bees' home to induce honeybees to build comb in a way that is to the beekeepers benefit. Bees are placed in hives with a queen who likely has had her wings clipped and so she is unable to leave the nest, and indeed, she may not have even mated naturally, and instead may be artificially inseminated. Down to the minutest details, the natural impulses of honeybees have been studied and, we are able to coerce bees to do our bidding (Jacobsen 2009). Indeed, even the purpose of keeping bees is no longer the same. Once bees were kept to provide that rare bit of sweetness that was impossible to get anywhere else, and today pollination is the major focus of much of the beekeeping industry (Crane 1999; Jacobsen 2009).

Log hives

Over the last several thousand years, humans have found ingenious ways to devise artificial nesting cavities for honeybees. Some of the most primitive hives on record were log

hives or “bee gums” (Crane 1999). A log hive can be constructed using a very minimal tool kit. In many cases what constitutes a beekeepers hive may just be a naturally hollow log that is further smoothed out and rubbed or smoked with pungent herbs and placed up in a tree or other location in the hopes that bees might find this an appropriate residence. A little beeswax or propolis (tree and plant resins that bees gather and use to seal small cracks in the hive) might be placed near the entry way or inside the cavity to give it a more “homelike” smell (Crane 1999). Traditional log hive beekeeping is still practiced in many areas of the world, particularly in China and Africa.

Figure 1. Log Hive **in Africa. Picture from http://www.mnh.si.edu/kakamega/honeyandsilk.html**

Skeps

A skep is a beehive that is woven out of straw or other flexible natural material such as willow or wicker. Skep-type hives have a long history in beekeeping, and have been used in many regions in various designs (Crane 1999). Often a skep is woven and then covered in mud or clay to provide additional insulating and temperature regulation capability to the hive (Crane 1999). Skeps were generally closed on one end, frequently conical in shape, with a single

entryway, and the open bottom was placed on a stool or woven mat that could easily be removed for harvesting honey (Crane 1999). In other places in the world, cylindrical hives were made of reeds or clay, had a stamped/molded front piece with an entrance that could be removed, or variably a removable back end for accessing honey combs(Crane 1999). While these traditional hives tended to be low tech, they were in no way unsophisticated, and traditional beekeeping is accompanied by a vast store of knowledge of the natural functioning of bees and beehives (Crane 1999).

Figure 2. Skep hives in a stone enclosure. Image from http://science.howstuffworks.com/environmental/life/zoology/insects-arachnids/bee7.htm

Traditional Protective clothing

The practice of wearing clothing to protect oneself from bee stings is something that is a relatively recent development in the history of beekeeping. Even modern day honey hunters often will remove any unnecessary articles of clothing to prevent a bee from becoming trapped in the folds and stinging. Often they opt for other means of subduing or calming bees such as the smoke of various herbs and plants, or rubbing their skin with a balm of pungent herbs (Crane 1999). Careful, slow movement in addition to these methods can minimize the number of stings that one would receive when stealing honey from a bees nest.

Stinging incidents can have an exponential cascading effect. When a honeybee stings something, the barbs of the sting become embedded in the skin, clothing or fur, resulting in the loss of the stinger, along with the bee's digestive tract. When this occur the bee releases an alarm pheromone which is detectable even by the human nose, smelling vaguely of bananas (Crane 1999; Winston 1991). This pheromone is a distress call to the other bees in the area that there is a predator, which puts the colony on alert status, increasing the likelihood that other bees in the colony will sting (Crane 1999; Winston 1991). In some types of bees, like Africanized Honeybees (AHB), who are highly sensitive to the alarm pheromone, this can begin a cascade of highly agitated behavior which can lead to large numbers of stings. This behavior can spread in an apiary, as more bees release alarm pheromone, other hives can become agitated as well(Caron 2001; Crane 1999; Winston 1991). It would seem then to come as no surprise that really significant improvements in protective clothing for beekeepers began in the late 1800's, along with the rise of professional beekeeping. Keeping larger numbers of bees in close proximity to one another necessitates increased protection for the beekeeper.

Some of the earliest types of protective gear were, like traditional hives, made from materials which were readily available and affordable to the beekeeper. Suits made of tightly woven linen or cotton were fairly common, and veils were often little more than a bit of cloth thrown over the head and shoulders which dramatically reduced visibility (Crane 1999). More advanced attempts at protecting the face from stings came in the form of woven cane or straw screens, and later woven wire screens that could be inserted into a cloth hood (Crane 1999). In the late 1800s, the development of bee masks that were comprised of black net or woven wire screen material, held onto a framework in the shape of a cylinder that stood away from the face

came more into use, eventually leading to the highly effective protective veils that are used today (Crane 1999).

Figure 3. Pieter Brueghel the Elder, "Beekeepers" circa 1650, picture from the Web Gallery of Art (http://www.wga.hu/index.html)

Traditional Migratory Beekeeping

As long as people have been tending bees, they have been migrating bees. Most often in traditional beekeeping, beehives were moved in order to secure an extra honey crop (Crane 1999). There is historical record of honeybees being migrated as early as 250 BC in Greece, with hives being strapped on the back of donkeys and moved several miles (Kritsky 2010). Pack animals were commonly used to move bees, including mules, donkeys and camels. It is possible that horses were more likely to become fearful and skittish when stung, while donkeys and mules were much more easy to control in these instances (Crane 1999). In areas where there was access to waterways, beehives might be loaded onto barges which were then moved fairly long distances up or downstream. The hives would be left upon the barges which served as "floating

apiaries", and when the barge began sinking into the water from the weight of honey they were taken back home and honey was harvested (Crane 1999).

Hives were very often moved in small numbers by hand, using a sling devised of two poles and cloth onto which two or three hives could be placed and then carried by two people (Crane 1999). In Slovenia, a special harness was devised that would allow a single man to carry four horizontal wooden hives on their back through the mountainous country. When hives were carried back in this manner usually only half the load that was originally carried to the new location could be moved back at once, necessitating more trips (Crane 1999). As recently as 1900 there is record of women in the Italian Alps carrying single hives on top of their heads. When bees were moved in this manner, it was often at night when they will usually avoid flying should they escape the hive (Crane 1999). Moving at night also prevented the temperature inside the hive from becoming warm enough to melt combs while the hive was closed off (Crane 1999).

Harvesting honey and wax

In traditional systems of beekeeping, it was very common for the bees to be killed in order to harvest the honey and wax. Various substances could be burned and the smoke used to either force the bees out of the combs or they were killed by burning brimstone, puffball or tobacco (Crane 1999). In high enough concentrations these substances would not just calm the bees but kill them. It was not until the mid 1700's in Europe that the practice of killing off the colony went out of vogue (Crane 1999).

There are references to some ancient methods of beekeeping where the colony was not killed in order to harvest honey. In many places that utilized horizontal hives such as Slovenia, Syria and Egypt, bees would be encouraged to build their nest towards the front part of the cylinder by means of an adjustable back board or divider, which could then be moved further

back or which had an opening in it for bees to pass through to build honey comb. When comb was harvested, it would be removed until there was evidence of brood and then they would close the hive back up (Crane 1999). This was beneficial to the bees obviously, but also benefitted the beekeeper as there was no need to replace the colony in subsequent seasons. This practice would have been most beneficial in those areas where the bees stayed active all year as killing off colonies would constitute a loss of income. It is not surprising that the maintenance of permanent colonies of bees developed in multiple places in Africa and the Middle East as there was less downtime for bees seasonally than in places such as Great Britain or Northern Europe (Crane 1999). In Syria in particular, colonies were not only kept stationary and were not killed to harvest honey, but they were also given permanent shelters. This practice was not uncommon globally, and there are records of a great variety of "bee houses" being constructed to protect colonies further from predation or climate (Crane 1999). Around the mid 1700's it became increasingly the practice in Northern and Eastern Europe to not euthanize bees to harvest honey, and with the invention of the bellows smoker, narcotizing bees using some of the substances previously mentioned became more the norm (Crane 1999).

Innovations in beekeeping and the rise of the "professional" beekeeper

Like many other artisan crafts formerly handled in the home, the Industrial Revolution brought sweeping changes to the way people were able to keep bees for profit. Along with the technical innovations that will be discussed in this section, larger developments in the fields of manufacturing and labor organization made it possible to mass produce woodenware and other implements for beekeepers. The development of motorized transport combined with modular hives led to beekeeping becoming an increasingly mobile endeavor (Crane 1999). All of these things combined led to the development of beekeeping as a "profession" rather than simply a

hobby, or sideline activity undertaken by farmers or woodsmen. Today the beekeeping industry in the U.S. is responsible for one out of every three bites of food that we eat, and over six billion dollars in agricultural profit (Agnew 2007; Benjamin 2009; Brown 2009).

One of the most critical innovations that led to the rise of professional beekeeping is the Langstroth movable frame hive. Scientific discovery of the 3/8" "beespace" – the space above which bees will fill an area with comb and under which they will fill with propolis, led to the current era of "rational" beekeeping. This is beekeeping based upon scientific principles, with foundations in biology and behavior(Crane 1999; Jacobsen 2009). These principal innovations ushered in by the era of the Langstroth hive allowed for tighter control over honeybees than earlier forms of bee housing. Keeping bees in movable frame hives allowed for the manipulation of the honeybee brood nest which was impossible to do with most traditional hives (Crane 1999). For example, if a hive of bees is new or weak, you can take a frame of brood from another hive and slide it into the nest box, instantly boosting the population of the colony by several thousand. It also makes propagation of hives much easier.

In early traditional types of beekeeping, a suitable dwelling was made and it was hoped that a wild swarm would find it a good home. In modern rationalized beekeeping, several frames of brood, a pound or two of bees and an un-hatched queen cell are placed into what is known as a "nuc" (nucleus) box – a smaller version of the normal hive box which holds 4-5 frames. This creates an environment in which the smaller number of bees can maintain the correct temperature for the queen to hatch out, and make her mating flight. The nest can then be easily transferred to a new box once the queen is mated and begins laying eggs of her own. A "natural" nest can even be simulated in this system by including brood of varying ages, from that which is just about to hatch, to newly laid eggs.

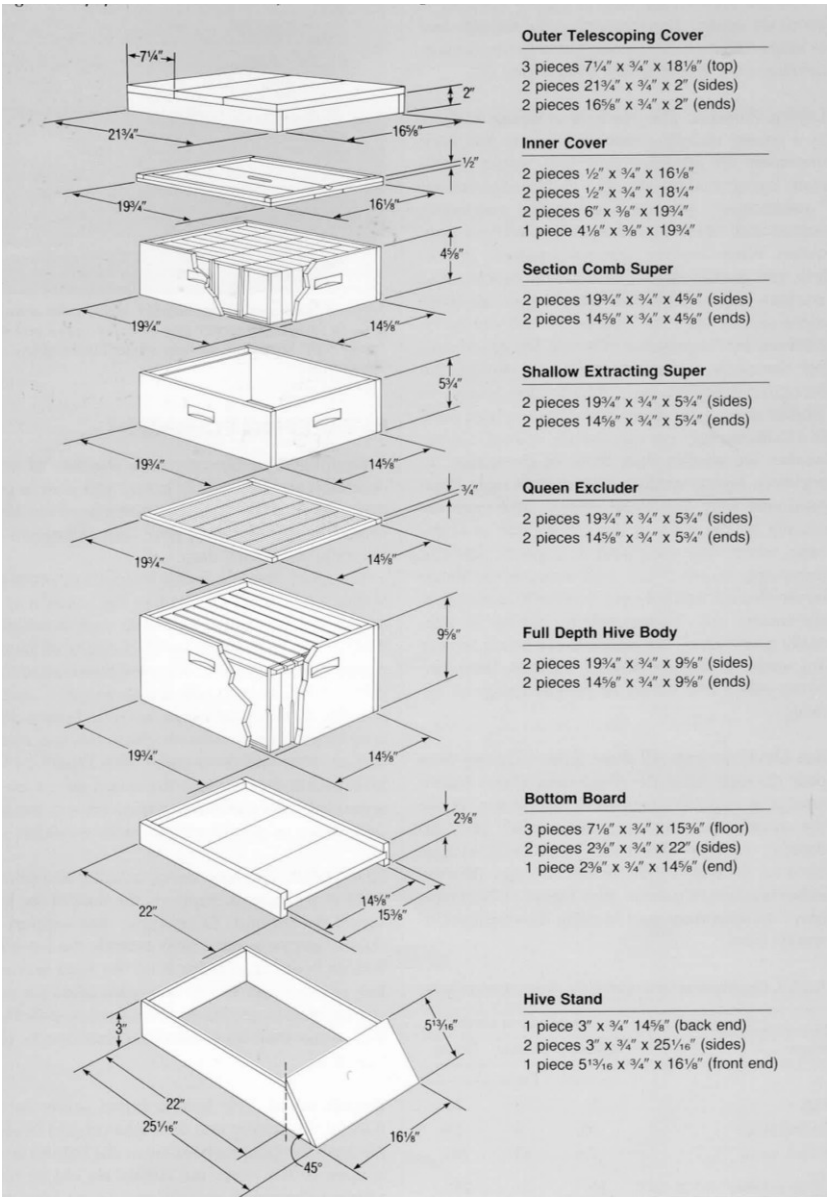

Figure 4. A diagram of a typical Langstroth style hive. Image from http://www.entomology.msstate.edu/resources/tips/beekeeping/beehives.php

This provides the right balance of bees of various ages to take care of all the jobs of the hive, just on a smaller scale. These innovations were very important to the modern beekeeping profession as it gave them extensive control over what their hives looked like, how the bees propagated and the size and strength of each colony which was previously impossible. This

invention in conjunction with the advent of modern manufacturing techniques led to the first commercial beekeepers (Crane 1999; Jacobsen 2009).

Another aspect of the Langstroth hive that led to its use in modern systems of beekeeping is its modularity. Even beyond the ability to manipulate the brood nest, the entire hive was composed of interchangeable modules in the form of boxes for the nest, and separate boxes for honey called "supers", called this because they are superimposed on top of the brood nest (Crane 1999). This innovation made it possible for beekeepers to dramatically increase the amount of honey that they could collect from a single blossom period by continually expanding the hive so that the bees could put up more nectar (Crane 1999). Often when a hive becomes full and there is no longer any room for either brood or nectar storage, colonies will begin to create new queen cells and prepare to send out a swarm (Crane 1999). This is the natural process used by bees to propagate new colonies and reduce crowded conditions in the current colony (Crane 1999). Not only could beekeepers give the colony more room for both brood and honey, but they could also individually inspect frames for these queen cells and eliminate them, preventing the colony from swarming. This was a highly desirable development from the point of the beekeeper because a hive that swarms is reduced in population and is lower in productivity as it has to go about raising a new queen from the queen cells adding a lag time until she starts laying new brood (Winston 1991).

The advent of modern motorized transportation has had a profound impact on the development of modern beekeeping. The ability to transport bees in large numbers over extremely long distances easily has allowed beekeepers to chase an "endless summer" in a sense, overwintering bees in southern Florida, and moving them to various places as needed for honey crops and pollination contracts. Global rapid transit had the additional effect of opening up world

markets for honey and beeswax. This has led to falling prices for honey and beeswax from domestic sources which have led more and more beekeepers to focus on pollination contracts as a means of income. This focus has been aided by the introduction of shared bottom board pallets that can hold four hives, which enable beehives to be loaded onto semi-trucks four at a time, stacked several deep and covered with large plastic nets that allow ventilation, however prevent the greater number of bees from escaping while in transit (Crane 1999).

Rapid air transportation has allowed for the development of new industries related to beekeeping as well. There is now a market for what are termed "package bees", which are 2-4lbs of bees, a queen in a special cage, all in a small screen sided wooden crate that has a built-in feeder can. These packages can be shipped through the standard U.S. mail system via next day air, and placed into an empty hive as an alternative method of adding colonies to an apiary. Mated queens can also be shipped in this manner, and it is not uncommon, particularly in areas where the AHB is prevalent for a beekeeper to re-queen his entire stock every spring in order to ensure that they remain European. In the 1960s through 1983, Steve Taber III a honeybee scientist who worked for the USDA, developed methods for transporting viable honeybee semen and artificial insemination techniques, which allowed for beekeepers the world over to share the genetic pools of their bee stock (Crane 1999).

The ability to transport bees, whether intentionally or unintentionally as stowaways on cargo ships has also had some negative impacts on honeybees in the U.S. Along with importations of bees and stowaway swarms we have had the introduction of several very detrimental bee pests and diseases. One of the most damaging invasive pests to ever be accidentally introduced to hives in the U.S. is the Varroa mite (*varroa destructor)* in 1987, which is a parasitic mite that originally lived on *Apis cerana*, the Asiatic honeybee. While bees in Asia evolved along with the

varroa mite, European bees had been isolated from them for millennia, and the impact that varroa had on bees in the U.S. when they were accidentally introduced here was devastating (Crane 1999). U.S. beekeepers suffered huge losses within the first five years of the varroa mite infestation, and they continue to be a serious threat to honeybee health in the U.S. (Benjamin 2009; Crane 1999; Jacobsen 2009; Winston 1991).

Improvements in protective clothing and equipment for the efficient removal and extraction of honey were essential to the professionalizing of beekeeping. The use of "queen excluders" – wire mesh divider between the brood boxes and honey boxes (see figure 6) – allows for the beekeeper to trap the queen in the lower levels of the hive, while allowing the smaller worker bees to travel upwards to store nectar. This allows for quick and efficient removal of honey boxes from the stacked hive without having to worry about the queen being removed at the same time. The use of a modified leaf blower to blow the bees out of boxes set up on a special frame also reduced the time it would take to move the honey from hive to the honey house. Other methods to remove bees from honey boxes include the use of Butyric Anhydride or blends of essential oils on a special "fume board" to chase bees out of the combs (Crane 1999).

Improved bee suits with good visibility, increased sting protection, and made from better, lighter, and cooler materials are important for beekeepers who manage large numbers of colonies. Tightly woven cotton, linen, or polyester blend materials, rip-stop nylon and Kevlar are all materials commonly used in modern day bee suits. Some bee suits for use in very hot areas where sting protection is a high priority, for example places in South and Central America that have been colonized by AHB are designed with special ventilation systems. Modern suits come in a great variety for various purposes; some may simply be a jacket with a hood and veil attached, or a full body suit designed for maximum protection. The ability to secure good sting

protection is not necessarily just to prevent the beekeeper from getting stung, as there is still a pretty high chance of this happening, but to increase the speed with which you can work through your hives. In particular when performing tasks that require manipulation of the brood nest or harvesting honey – activities that are likely to cause more disruption to the hives and agitate the bees, having a good suit allows the beekeeper to work faster and with less regard for the bees temperament while *minimizing* stings. The development of superior sting protection was a part of the apparatus that was necessary for beekeeping to become an efficient, professional, large scale operation that could be run successfully with a minimum of personnel (Crane 1999).

Honey processing innovation

Modern beekeeping with large numbers of hives requires highly efficient means of handling the products of the hive. The use of modular movable frame hives allows beekeepers to remove just those boxes or frames that are ready to be harvested in a quick and efficient manner. There are improved means of removing bees from combs quickly allowing the colony to remain intact. Honeycombs must be "uncapped" in order to extract the honey from the cells. This is typically done with a flexible sharp knife or heated electric knife which can cleanly remove the caps without disturbing the comb to a great degree.

Figure 5. Uncapping a frame of honey with a heated knife. Image from http://www.heathmonthoney.com.au/ProducingHoney/ProducingHoney-pg3.htm

These combs can then be loaded into a specialized machine that is akin to a washing machine that spins the combs at a very high velocity. This causes the honey to be flung out of the cells due to centrifugal force, where it runs down the sides of the drum and through a spout into a container before being sent for further processing. The cappings are then usually strained to remove as much honey as possible, washed and rendered into solid blocks of clean beeswax for sale.

The honeycomb frames used in a beehive had to undergo several iterations of innovation as the extracting equipment became more powerful and was able to spin at higher velocities (Crane 1999). Early attempts at spinning frames would often lead frames with a less sturdy layer of foundation wax in the center of the comb to collapse under their own weight when the machines would reach high velocity (Crane 1999).

Figure 6. A radial honey extractor. Image from http://greenroadfarm.com/beekeeping/?page_id=205

Solutions to this problem included embedding fine steel wires into the foundation wax before allowing the bees to draw the comb out, and also to use a rigid, honeycomb imprinted material such as porcelain or iron for the foundation (Crane 1999). Eventually the wired foundation, and rigid foundations made of plastic or cellulose, imprinted with a comb pattern and coated with wax were settled upon as the gold standards for frames used for liquid honey production (Crane 1999).

The ability to extract honey while leaving the combs almost entirely intact (uncapping only removes the very smallest layer of wax from the surface of the comb), was beneficial to the efficiency of the beekeepers operation. This allowed beekeepers to return the combs directly back to the hive which the bees could simply refill without having to redraw comb. This both served to shorten the time until combs could be extracted again, and also increased honey production as bees did not need to use part of the nectar they gathered to build new comb (Crane 1999). However, as is so often the case, what is good for the beekeeper and what increases the efficiency of the operation is often detrimental to honeybees in the end. The ability to reuse combs in this manner allows for the transmission of bee diseases much more easily, as combs almost never end up back on the same hive, particularly in very large operations. More recent findings also indicate that there is a build up of the medications used for treating varroa mites and agricultural pesticides within the wax in hives, with levels increasing the longer the frames are used (Sanford 1993; van Englesdorp 2009).

How the "rules of the regime" shaped beekeeping

All of these changes in beekeeping mirrored changes that were occurring in other areas of agriculture within the international food regime. An international food regime is defined as "a specific constellation of governments, corporations, collective organizations, and individuals that

allow for renewed accumulation of capital based on shared definition of social purpose by key actors" (Friedmann 2005). One shared social purpose around which a regime can be organized is food production. Because food is essential to human life, conflicts surrounding the production, accumulation and distribution of food can be highly political sites where power differentials become visceral and embodied through hunger or lack thereof. Friedman describes international food regimes as being, "sustained but nonetheless temporary constellations of interests and relationships" which, "even at their most stable…unfold through internal tensions that eventually lead to crisis" through which restructuring takes place, and new food regimes will arise (Friedmann 2005). John Ruggie (1982) stated that "regimes limit the discretion of their constituent units to decide and act on issues that fall within the regime's domain" (Ruggie 1982). In the case of agricultural practice, rules, regulations, laws and beliefs about what to produce, how much to produce, and how it will be distributed limit farmers' ability to make decisions Some of which include how much they will grow, what particular crops are acceptable, what types of equipment they will need to purchase and what types of practices they will use in their treatment of land and animals.

There has been a great deal of attention paid to the ways in which food regimes have determined what crops will be grown and how this has impacted farmers, but no attention has been paid to the ways in which beekeeping has been affected. Beekeepers, like other types of agricultural workers, are at the mercy of the organizing bodies and principles of food regimes. Beekeeping is an unusual case as, while bees have been "domesticated" to some degree, honeybees still maintain a great deal of their wildness, and in fact require it to be healthy. Bees can be put in a box, however when they fly out of the hive, they are out of our control and will go where they will. This is not the case with any other livestock which can be more tightly

controlled. Within highly organized systems of agriculture, honeybees are something of an anomaly, unlike a cow or a chicken which we can pen up and control their every move, beekeepers have to have some degree of faith that their bees will do the things that they want them to do.

Beekeeping and historical food regimes

Over the last 200 years researchers have identified two food regimes, the "colonial diasporic" and "mercantile-industrial" food regimes, each with very distinct configurations of institutions, rules and modes of operation. The first food regime (1870-1930) the colonial-diasporic food regime saw the birth of beekeeping as a professional pursuit. This regime is characterized by a system of colonialism (dominated by the British), importation of goods from tropical production points, of grains and basic staples from colonies (such as the U.S.) leading to the intensification and capitalization of farming (Friedmann 2005; McMichael 2009). The development of monoculture and larger scale cropping in the U.S. along with industrial development during this time period necessitated the elaboration of beekeeping from a small cottage industry into a larger scale, industrial endeavor. Prior to 1852, when L.L. Langstroth invented his particular incarnation of the movable frame hive, a beekeeper was someone who had a couple hives on their land as part of a diversified farm (Crane 1999; Kritsky 2010). The movable frame hive had two major characteristics that made it the ideal tool for beekeepers looking to expand to a more professional mode of beekeeping. First, the hive allowed control of the beehive at a scale not possible before. It allowed beekeepers to manipulate the individual honey combs in the brood nest of the hive, as well as allowing harvesting of honey without killing off the colony. The honey was then processed in a factory type setting. Second, the design of the hive was such that it could be mass produced by newly developed industrial carpentry

technology. The ingenious design both allowed for beekeepers to create a large number of hives via brood manipulation, while keeping the startup costs low enough so as not to be prohibitive (Crane 1999; Kritsky 2010).

During this time period, as larger acreages of pollination-dependent crops were being planted for expanding markets, beekeepers developed skill sets and business practices that allowed them to turn beekeeping into a viable, stand-alone professional and somewhat "industrialized" process that supported intensified farming operations. This is an example of what Goodman, Sorj and Wilkinson called "appropriation" of natural processes by capitalist markets (Goodman 1987). Julie Guthman explains that "Opportunities for more predictable profit making can be found in discrete activities that can be removed from the rural setting and put into factories, either at the input end or the processing/marketing end" (Guthman 2004). It was during this food regime that farms and the tasks that were accomplished on them were being transformed from small scale, cottage industries to full fledged industrial ventures. It is partially this tension between earlier ways of farming and the shift towards an emerging industrial farming and food processing system that predicated the crisis that demarcated the end of the first food regime and defined the second food regime – the Mercantile-Industrial food regime.

The development of improved farming methods were hallmarks of the earlier food regime and ultimately led to surpluses that the domestic market was unable to absorb. The first food regime was punctuated by the collapse caused by the Great Depression and the agricultural crisis of the Dust Bowl (Berlan 1991; McMichael 2009). During this same period, Berlan notes that there was a rather sharp increase in fresh fruit and milk consumption in the U.S. which he deemed to be rather unimportant, (Berlan 1991) however in terms of the development of beekeeping this is noteworthy. Increased domestic consumption of citrus (and later, international

consumption as preservation and transport technologies developed) and other fruits and vegetables were driving factors in the intensification of beekeeping during the second food regime.

This time period, which Friedmann labels the Mercantile-Industrial food regime in the U.S. was characterized by "Fordist" farm policy and development ideals (Berlan 1991; Kenney, Lobao, Curry, and Goe 1991). Fordist farm policies were centered on the ideas of intensification and accumulation of stockpiles of *durable foods*. The stockpiling of corn, wheat, and soybeans due to government subsidy programs have been the subject of scholarly attention, however honey was also a product that operated under a subsidy program during this food regime (Canada 2004). Established in 1949, the honey price support program was intended to create market price stability for honey, stimulating the beekeeping industry in an effort to maintain sufficient numbers of colonies for pollination of vital crops (Canada 2004). This program continued through the end of the second food regime, and the beekeeping industry continued to step up intensity of beekeeping operations. Beekeeping by this time was a fully developed professional commercial endeavor with industry interest groups, voluntary associations, and ancillary industry developments such as "bee supplies", with companies specializing in wooden ware, implements, and "hive treatments" (medications) (Crane 1999; Jacobsen 2009).

During this time period, the U.S. came to dominate the world food market through clever use of "food aid" in which surplus commodities were given to developing countries (McMichael 2009). This aid had a dual effect of fueling industrial development in these countries, while at the same time creating dependence upon imported food products in places that formerly were self-sufficient (McMichael 2009).

These dynamics increasingly set the stage for the liberalization of trade on an international scale and also encouraged developing countries to focus on export markets rather than diversified agriculture and food self-sufficiency (McMichael 2009). For the beekeeping industry this has had some rather disastrous results, and is likely the root cause of the current crises in beekeeping(Jacobsen 2009). Increasingly liberalized world markets have led to falling prices for domestic honey in the U.S., which led to the honey loan program being no longer considered viable (Canada 2004). As low cost imports of honey from Argentina and China flooded the market, honey producers began to increasingly default on the loans they received with their honey as collateral from the program (Canada 2004). As a result the program was closed for good in the mid 1990's, honey production became less of a focus in the U.S., and beekeepers have shifted increasingly to pollination as their major source of income (Canada 2004; Jacobsen 2009). This leads us to the present crisis in both beekeeping and agriculture which some scholars consider to be indicative of the collapse of the second food regime and possibly the rise of the third food regime – the "Green Capitalism" regime (McMichael 2009).

"Green Capitalism"

Food regimes are not permanent; they are generally predicated and punctuated by crises of one sort or another (Friedmann 2005). These times of crisis act as catalysts for social movements of either farmers, or workers, or as in the current moment, consumers (Friedmann 2005; McMichael 2009). There is some evidence that we are currently in the midst of a state of transition between the Mercantile-Industrial food regime and the rise of a new regime, which Friedmann has labeled as the "corporate-environmental" food regime, and which McMichael dubs "Green capitalist" (McMichael 2009). This period of transition is characterized by the development of movements that are in conflict with current systems built around durable foods

and “foods from nowhere” (Friedmann 2005). These are durable products, with ingredients from many geographic locations that have no certain point of origin, and no cultural rooting. The proliferation of these types of food products are contested by groups that focus on “foods from somewhere” such as the “local food” movements, fair trade, or origin labeling (McMichael 2009).

The world honey market has been embroiled in such conflicts in recent years as well. In particular there have been strict regulations on the importation of honey from China due to both incidents of “dumping” of cheap honey onto U.S. markets which threatened to cause the collapse of our domestic honey markets, but also because some Chinese honey was found to be adulterated with other sugars and contaminants not permitted by the FDA (White 1988). Even more recently it was found that the vast majority of honey products that are on U.S. grocery shelves do not meet FDA requirements for honey in that they have been so highly processed that they no longer contain pollen grains, which are considered a constituent part of honey as a natural food (Schneider 2011). These events, coupled with the phenomena of Colony Collapse Disorder (CCD), where bee colony numbers have been steeply declining to an as of yet unidentified pathogen or contaminant have led to the development of a movement to “Save the Bees”.

The movement to save the bees (like other food related movements of this time period) calls attentions to the ways in which our current industrialized food system is harmful to soils, animals and people. While movements such as fair trade call attention to the ways that large scale monocultures and corporate food production dominate markets and disempower smallholder farmers, the bee movement calls attention to the way that bees are exploited by modern farming to their detriment. There is evidence supporting the contention that modern

industrialized agricultural systems are inherently inhospitable to honeybees (Benjamin 2009). Bees are subjected to the deprivation of a natural healthy diet when they are placed in monoculture situations, where they also pass diseases back and forth among themselves (Agnew 2007; Jacobsen 2009). Industrial farming methods which use large quantities of pesticides, herbicides and fungicides are harmful to people and are also particularly to bees. There has been a growing recognition of the particular suspension of disbelief it takes among corporate interests to continue to promote insecticide use on crops that *must be pollinated by an insect* and then to further contend that they cause no harm to bees. The fact that we must truck insects in to perform this pollination in the first place is indicative that the natural balance is very out of kilter.

The current regime is dominated by large agricultural companies that frequently have higher incomes than some of the countries to which they sell their products (Held and McGrew 2007). These corporations have a great deal of power in deciding how agriculture will be done in both developed and developing countries, both simply by market power and their own internal R&D departments. They also exert this power through grants and funding of research external to their companies. By funding research in educational institutions and government agencies they are able to add an obfuscating layer that misdirects attention away from the corporation, while at the same time producing research that supports their corporate goals.

Of particularly relevance to beekeeping is government research into the cause of colony collapse disorder (CCD). In 2009 Army researchers announced that they had "found the cause" of CCD, and that it was caused by the combination of a virus that was carried by the Varroa destructor mite and Nosema – a type of bee "dysentery" (Bromenshenk 2010; Kluger 2010). This theory has yet to be confirmed by additional studies, but seems to absolve the involvement of agricultural chemicals in CCD. Another recent controversy surrounding CCD was brought to the

publics attention that Bayer Chemical, producers of pesticides, had funded a great deal of research that seemed to point to pathogens as the cause of CCD rather than pesticides (Ratnieks and Carreck 2010). It is speculated that this research was released in order to deflect attention away from pesticides produced by Bayer that had come into use in the year preceding the initial colony losses. These pesticides called "neonicotinoids" were being implicated in CCD in Europe, and were the subject of multiple bans in countries throughout Europe and the UK. (EURMC 2009). Since these pesticides were banned in the U.K. they have been reporting resurgence in their bee populations, indicating that these pesticides had some sort of effect on the bee deaths (EURMC 2009).

Another issue of importance to beekeepers that is indicative of the current crisis in our agricultural system is that bee health is also suffering from extensive monoculture in other ways. Aside from problems of pesticides, there is the problem of nutrition – monocultures present bees with a lack of diversity in their diets, and many crops do not provide even the bare minimum of nutrition for bees (Benjamin 2009). In many crop situations bees have to be fed a solution of sugar water in order for them to just survive through the 3-4 weeks of a pollination contract. Monocultures offer little in the way of natural forage for bees. Similar to the ways that standardized diets have had negative impacts on the health of humans, honeybees (as well as other livestock animals) have also suffered for this particular change (Pollan 2009). The lack of adequate natural forage and bee nutrition and health have been the focus of the save the bees movement in addition to issues surrounding research funding and pesticides.

Rachel Carson considered honeybees to be an "indicator" species. Because of the ways that honeybees forage from their surroundings and concentrate what they gather in their hives in the form of wax, pollen and honey, conditions inside the hive and health of bees tends to reflect

the overall health of the environment in which they live (Carson 1962). In much the same way that there are movements currently lobbying for healthier, safer, chemical free food and food production systems for humans, there is a growing body of people who are lobbying for improved nutrition and treatment standards for animals that are in our care as well. These movements are part of the social forces that will shape the next food regime.

"Lock-In" – why the honeybee?

The current modern system of beekeeping in the U.S. was originally developed using a particular phenotype of honeybee – the western honeybee, or "European Bee" *Apis melifera* (Ellis 2009; Winston 1991). The European bee is reputed for its relative docility, gentle nature and good honey production. European honeybees are much slower to become agitated than some other types of bees, such as AHB, they do not stay as agitated for as long, will not chase as far as AHB would, and tend to sting in much smaller numbers when they do (Caron 2001; Crane 1999; Ellis 2009; Sanford 1993). Because of this gentle nature, both the equipment used to keep and transport them, and the husbandry practices of beekeepers have developed in ways that are specific to this. According to Paul David (1985) there are three aspects of a system that are conducive to the production of a state of lock-in which are helpful in analyzing the situation with the use of honeybees in U.S. agriculture. The first of these, is *technical interrelatedness* which has to do with the actual physical equipment and interrelated industries that have a stake in the system (David 1985). Second is that of *economies of scale*, which has to do with the ways that the field of possible options can get narrowed down to often just one single option because it increases the efficiency of the system (David 1985). The third aspect is that of *quasi-irreversibility* which arises due to the store of human knowledge that surrounds a system – it is

much easier to change out a piece of hardware than the built up knowledge of generations of individuals – the "software" of the system (David 1985).

Technical interrelatedness

In beekeeping, technical interrelatedness is evident in various ways, from the way that the Langstroth hive is designed, to the ways that our monoculture is organized around the availability of bees to do pollination. In many ways the Langstroth hive is really tailor-made for use with European bees – with the use of a bellows smoker; you can keep a European beehive calm enough that cracking the propolis seal on the various modular components of a hive will not incite them to massive stinging(Crane 1999). They also do not generally get extremely upset at the entire top of the hive being open when a beekeeper is working inside the box(Crane 1999). European bees can take much more abuse and much less gentle treatment than a hive of AHB before they will get very agitated and begin stinging in large numbers. One has to actually drop a hive of European bees or kick the side repeatedly before they will react in a similar manner to that of AHB simply from cracking the lid to the hive. Throw on a set of modern protective clothing, and one can work hundreds of hives in quick succession in an apiary of European bees and maybe never even get a sting or have a hive get highly agitated. This is unlikely to be the case in an apiary of AHB, where agitated hives tend to alert other hives, particularly if they are in close proximity to each other.

The practice of keeping four Langstroth style hives on a shared bottom board which is easy to load with a fork-lift onto a truck is also less suited for use with AHB than European bees. AHB tend to pick up alarm signals from neighboring hives and become agitated much more quickly by thumps and vibrations that can carry through the shared bottom board when one hive on the pallet is being worked. In Central and South America where AHB are commonly used in

place of European bees, they are usually kept on individual hive stands, and also kept in smaller numbers in a particular apiary than we might with European bees(Caron 2001). The important thing to keep in mind here is that the AHB is simply another bee, and is morphologically identical in almost every way to their more gentle counterparts, the differences are behavioral (Caron 2001; Sanford 2007; Taylor 1985). These differences become very evident when the beekeeper and the system they are put into do not take those differences into account. Because of their highly defensive behavior and the ways that they tend to react to vibration and jostling, and manipulation of their hive box, AHB would be very difficult to load onto semi trucks the way we do with our European bees here in the U.S.

Many of our largest food crops in the U.S. and Canada are grown in extensive monoculture systems, which tend to be sterile places that provide little habitat for native pollinating species. Many of these crops require managed honeybees for pollination, some in order simply to set fruit, and others to boost yield to levels that make it the crop profitable. One crop in particular in the U.S. that represents an excellent example of lock-in to the use of European honeybees is almonds. California's acreage in almonds has increased dramatically over the last 50 years, and now sits at around 800,000 acres (Agnew 2007; Mendleson 2010). An almond grove that looks beautiful, is in truth a very sterile, barren place devoid of food for bees for most of the year, and as such is unable to support sufficient numbers of native bees and pollinating species to not require the services of honeybees for pollination. Every year approximately 75-80% *of all managed colonies in the U.S.* make their way to the almond groves of California in early spring for a two to three week long pollination contract (Agnew 2007). Over a million hives of bees are transported along interstate highways in order to make their operating capital for the season, and to provide millions of dollars in profit to the almond

growers (Agnew 2007; Benjamin 2009; Jacobsen 2009). These trips do not always end without incident, and there are accidents every year transporting bees across our highways. Often this can end in serious injury or death, and there is a great risk to emergency crews of being stung a great many times. Were this same situation to occur with AHB the situation could be even more dangerous. Simply pulling into a gas station to fill up with a truckload full of AHB could be a dangerous undertaking, and perhaps considered a public menace (as indeed a truck full of European bees can be as well).

Economies of scale

European honeybees have been selected out of a vast array of pollinating species in our world over thousands of years (Crane 1999). The lock-in to this singular choice out of the array of choices has been set in motion by various historical events and economic factors. European bees were brought along with the settlers from various places in Europe as part of their stock of plants and animals for use on their farms and plantations (Crane 1999). Because of their nature and the fact that humans in Europe, Africa and Asia had been keeping bees for agricultural purposes for thousands of years, they had in place systems for maintaining and moving bees around and were familiar with their care, they brought them along with them (Crane 1999). There were no honeybees in the Americas prior to their importation by early European settlers (Crane 1999; Winston 1991).

Honeybees proved to be the most efficiently and easily manipulated pollinator species, and over time these systems grew up around their use. Other types of bees and species have been used, such as native stingless bees in Central America which can produce about 2.5 lbs of honey in a season, and bumblebees which do a wonderful job pollinating but make no honey or wax (Crane 1999). In comparison, honeybees can produce up to 90lbs of honey from a single colony

in a season, in addition to wax, pollen and propolis which are all substances which humans have found uses for (Crane 1999). Humans tend to get the most value for the time spent caring for honeybees, and also tend to return more per dollar of capital investment than other types of pollinators. Many of the innovations discussed in this paper have made it possible for a small number of people to maintain a large number of colonies, and mechanized transport has made it possible to move them long distances.

Ultimately, the European bee was chosen, and it is a good bee, but it did not need to be the most economical or efficient choice for the system. It simply matters that a single option is selected and the system can organize itself around that choice. This makes the system more efficient even if the actual object of the system is not the "best" technology (Cowan 1990). W. Brian Arthur also proposes that once a technology has been adopted that there are two new properties that emerge:

> "…*inflexibility* in that once an outcome (a dominant technology) begins to emerge it becomes progressively more 'locked in'; and *non-ergodicity* in that historical 'small events' are not averaged away and 'forgotten' by the dynamics – they may decide the outcome" (Arthur 1989:117).

Arthur postulates that those technologies, which by fate or fortune, are adopted at earlier times, can have the additional benefit of having many more improvements to its design or method of use that other, competing technologies might not (Arthur 1989). Beekeeping is a special case in the development of rationalized systems and technologies in that a major component of the system is a living organism. In essence, the systems that humans have developed around the bee that constitute our system of commercial beekeeping are highly rationalized, and designed to work with the very particular behavior patterns of the European

honey bee. While it is true that we have hybridized this bee and bred it into docility, the scale of time in which such changes have occurred in honeybees is too long to have seen a great deal of change during the period in which industrialized agriculture was developed. We are not really able to change the bee a great deal, so we have created systems of husbandry that are able to exploit the most subtle biological and behavioral patterns of the EHB. In the formative years of commercial beekeeping in the U.S. and the U.K., the majority of the bees that were available to individuals wishing to become involved were of European stock. Since this was the bee that was available, the systems that were developed, and repeatedly improved upon really do work best with these bees.

Quasi-irreversibility

It is important as we think about this idea of quasi-irreversibility to remember that there is no biological factor that would prevent an Africanized honeybee from pollinating an almond tree. As far as pollination goes with this particular flower, the European and the Africanized honeybee behave exactly the same way. They perform the same biological function, picking up pollen with the small electrically charged hairs on their bodies, and transferring it to the pistils of flowers on other trees when they stick their proboscis into the flower to gather nectar. In this respect they function identically, and some studies of pollination rates by European and Africanized honeybees have shown that they tend to make almost identical numbers of trips to flowers (Crane 1999; Fletcher 1978).

In fact, in many places in Africa, and now in South and Central America and Mexico *they are the only bees used for agricultural pollination* (Crane 1999; Fletcher 1978). We have spent many years breeding honeybees for the very traits which make them fit the system – docility and high production, and the European honeybees are embedded with centuries of cultural and

economic capital, and endowed with the property of being "good bees". Beekeepers, who want to be "good beekeepers" work with "good bees" and use "best practices" with the "proper equipment" - a similar phenomena has been noted with sheep breeds in the UK (Yarwood 2006). These present an extensive store of knowledge – the "software" of the system, which is actually more difficult to dislodge than it is to change the physical aspects of the system. There are definitely options that would work identically from a biological perspective.

When Africanized bees colonized South and Central America, it was observed that many beekeepers went out of business and stopped keeping bees as they had difficulty adapting to the behavior of the bees (Caron 2001). After a lag time of about two to three years, it was observed that new people were picking up beekeeping as a profession, exploiting the opportunity for free bees (feral AHB are easily convinced to nest in empty boxes) and good income from honey and pollination contracts (Caron 2001). These new bees required significantly different care and handling, and also some variations in equipment that were unfamiliar to the older beekeepers that did not fit with their ideas of what "good beekeeping" was, or what a "good bee" was. AHB is notorious for its often times belligerent nature, and is almost universally labeled as a "bad bee" in places that are accustomed to using European bees (Caron 2001). Basically, the systems of knowledge and practice that these beekeepers had at their disposal did not work with the AHB (Caron 2001). It is possible that those who had not worked with EHB to start with did not have set ideas of how beekeepers *should work* with bees, or how bees *should behave* when worked in traditional ways.

Beekeeper habitus

Richard Yarwood and Nick Evans (2006) apply Bourdieu's concept of *habitus* to the raising of livestock within capitalist agricultural systems. They discuss the ways in which farm

animals are sites of the accumulation of capital in various forms, and how both farmers and farm animals embody a *habitus* – a set of dispositions and behaviors -related to the raising of livestock (Yarwood and Evans 2006). The concepts of habitus, practice and capital can be used to examine the relationship between humans and honeybees, and particularly what has occurred in areas where the introduction of Africanized bees alters the nature of that relationship.

As mentioned previously beekeeping as a large-scale agricultural profession is a relatively new pursuit compared to other forms of livestock husbandry, only developing over the last 150 years. Prior to the invention of the Langstroth hive, there were not "beekeepers" there were farmers who had a handful of colonies on their farm. As such, the profession of beekeeping has had less time to develop a repertoire of practices that constitute "good husbandry". Also, the field of beekeeping as a profession arose during a time of unprecedented industrial appropriation of agricultural practices and as such was very rapidly "industrialized".

The process of industrial appropriation inserts mechanistic, capitalistic centered practices into agricultural processes, disrupting traditional practices that farmers may have used to ensure the health of both animals and people (Goodman 1987; Mann 1978). Due to this unique development, the field of beekeeping in the U.S. has incorporated methods that were developed by capitalist interests into the set of practices that constitute "good" bee husbandry. This insertion of capitalist values and practices into the field of beekeeping has several implications for the health of beekeeping as an industry, some relating to the nature of the bee itself and some to the ways that beekeepers have developed a habitus in relation to beekeeping. These problems become amplified when dealing with AHB, as they require very different handling than does EHB.

Industrial livestock production works best when the animal being produced is easily manipulated to fit into the system, such as with chickens or cattle. Industrial agriculture has a tendency to take systems that work in one area, and superimpose them onto other areas of agriculture. Bees retain a great deal of their wildness compared to other forms of livestock, and actually require this wildness in order to remain in good health. This in part explains the late development of beekeeping as an industry; humans had to learn to adapt their equipment and behaviors in relation to the bee in order to incorporate it into the agricultural system on a large scale. Insects are also more delicate in general than the other forms of livestock we keep, and so some of the tactics used in the keeping of other types of livestock are inappropriate for honeybees.

In our efforts to keep bees "under control" we have developed methods that prevent them from using their natural defenses to overcome challenges from pests and diseases (by preventing absconding, natural mating, or simply dying off because they cannot resist pathogens) and substituted these defenses with chemicals and medications. Insect evolution happens on a different kind of timeframe than that of mammals however, and these methods lead to medication and chemical resistance in bee pests in a much shorter time frame than what occurs in cattle or sheep. So, while antibiotic resistance is a problem in the raising of mammals, it is even more troublesome in an organism whose life cycle is completed in just a few short weeks. Left to their own devices honeybees will evolve to deal with pests and disease (Sherman, Seely, and Reeve 1997), however the insects are not afforded this luxury in modern agricultural systems where they are required to be productive for the majority of the year. This coupled with the industrial practice of crowding large numbers of animals together in a single location, re-use of equipment, and movement of animals over long distances has been particularly harmful to bee

health, leading to the spread of pests and diseases that previously would have been inconceivable.

Institutional networks that are integral to the field of beekeeping have had different responses to the encroachment of Africanized bees. Some of these differences may be attributed to the extent to which the practices of beekeeping have been appropriated by industrial processes, they types of capital that are associated with beekeeping in the area, and also the nature of the habitus of the beekeepers who work within the field. Individual beekeepers develop a habitus in relation to accepted practices within the field of beekeeping that may be inadequate when faced with Africanized honeybees.

A beekeeper's habitus, defined as dispositions and behaviors that are performed on a somewhat unconscious level, that are learned and developed through their practice of keeping bees, can cause them a great deal of grief when their apiary is invaded by Africanized bees (Bourdieu 1990). These deeply ingrained behaviors relating to the ways in which beekeepers handle and manipulate their bee colonies can lead to stinging accidents, and a great deal of frustration for beekeepers and the people and animals that live near their yards. Practices which seem natural and normal to industrial beekeeping such as frequent, rapid inspection of colonies, keeping four hives on a shared bottom board, or even such innocuous methods of manipulation such as breaking the propolis seal on a hive top or loosening a frame that may be glued tightly to the box can be hazardous. The defensive reactions of the bees in an adjacent hive to vibrations from the inspections of a neighbor are likely to be attributed to the bees behavior, not farmer behavior.

Bourdieu posits that habitus is difficult to change as these are processes that occur on a subconscious level, that we are barely aware of (Bourdieu 1990). It has been the case that many

old-timer beekeepers in areas where Africanized bees have colonized have given up beekeeping as a business in frustration, unable to adapt to the new more defensive bee. In areas of South and Central America where AHB have colonized there has been a similar pattern of reductions in honey production for a period of several years, after which time honey production goes back up to near normal levels, and sometimes exceeds previous levels (Caron 2001). This trend has been attributed to older beekeepers that are used to keeping with EHB abandoning their businesses, leading to a greatly reduced number of colonies and beekeepers in an area. The uptrend begins when people new to the field of beekeeping start up businesses, frequently (and in some areas exclusively) utilizing Africanized bees (Caron 2001). The beekeepers that do stay in business say that the AHB is workable, but it takes a great deal of adaptation on the part of the beekeeper in order to do so. Beekeepers must not only adjust the numbers of hives they keep per apiary, the types of equipment they use (single hive stands rather than shared stands), but also must change those behaviors which may be sub-conscious *habitus.* Changing the time of day that they inspect hives (near dusk rather than in the morning or during daylight hours), being more cautious, and also being aware of which colonies are most defensive and inspecting those last are important behavioral changes on the part of the beekeeper which can make AHB more workable.

There are also shifts in the nature of capital that are associated with the field of beekeeping when AHB colonize an area. AHB do not have the same reputation for being gentle, industrious creatures that their European cousins do, and this alters the way that not only the bee, but beekeepers are valued. In areas of colonization beekeepers can be seen as both *protectors* of the public, when they remove colonies from places that are near human inhabitants, and also are seen as *villains* because they are the source of "problem bees". In areas of colonization it is important for institutional networks to help support the activities of beekeepers through

education of both beekeepers and the public as to proper responses to AHB. The social capital afforded beekeepers by these institutional supports can be more important than economic capital investments in keeping beekeepers in business, as the costs associated with keeping AHB can at times be less than keeping EHB (Caron 2001).

Our current system of beekeeping in the U.S. is extremely complex, and presents a great number of challenges to the health of both honeybees and humans. Honeybees in a natural state would determine the configurations of combs in their nests, and would build comb with various size cells for workers and brood. In our current system using pre-imprinted comb, they are forced into a standardized cell size which has been shown to have some negative impact on their ability to resist varroa mites. Some research has shown that bees allowed to build natural comb have lower levels of infestation by varroa mites than those that are built from standardized foundation (Piccirillo and Jong 2003). The reason for this may have to do with effects that varying size and depth of comb cells has on the timing of larva in cells being sealed over with wax, which occurs when larva reach a certain critical distance from the lip of the cell, in wider cells it takes longer for the larva to reach the cell lip (Piccirillo and Jong 2003). This study also found that varroa favored larger cells in all types of hives for propagation, not just those of AHB (Piccirillo and Jong 2003). Transporting bees for long distances, at times of the year when they should be resting or building up brood requires beekeepers to feed bees substitutes for their natural foods, including “pollen analogs” made from soy, and sugar syrups. These can act as temporary or emergency food, but there is growing concern that these substitutes are an inadequate diet and can have implications for the bee’s immune systems (Kluger 2010).

A great number of the crops which our use of honeybees allows us to grow in vast monocultures are now genetically modified – crops such as canola, soy and cotton are good

examples. Not only are large quantities of pesticides, herbicides and fungicides (of questionable safety for use with bees) used on these plants, but many are engineered to withstand greater quantities of certain pesticides, or they produce pesticides in every cell of the plant. This includes pollen which bees use for food for raising their young (Mendleson 2010; Ratnieks and Carreck 2010). Some of the newest pesticides in use, the neonicotinoids pesticides, are frequently used as a seed coating which then accumulates in the soil, and is taken up and excreted throughout the plant, and can be found in both pollen and nectar (EPA 2010; Kluger 2010).

The relation between the pesticide industry and the honeybee has always been a contentious one, as it is difficult to produce a product that is deadly to one invertebrate, which will not harm another. There is a growing body of knowledge that would contest that it is actually not possible to do so, and that most pesticides have implications in the health of bees (EURMC 2009; Kluger 2010; Mendleson 2010; PAN-EUROPE 2011; Schwartz 2010; van Englesdorp 2009).

Another issue of concern is that in our current system of keeping large numbers of bees in close proximity to one another there is an increased use of amendments such as antibiotics, fungicides and pesticides actually applied for use inside beehives to control diseases and pests (Crane 1999). This has a twofold effect on the ability of bees to resist these pests – first it interrupts the bees natural evolutionary means of controlling diseases and pests in the overall population by allowing weaker colonies that are less able to combat the pest to survive and reproduce, and secondly, by promoting resistance to the treatment in the organism being treated for (Forsman 2004; Sanford 1993). This combination of genetically weakened, stressed, malnourished, pesticide challenged bees with highly resistant pathological organisms; all brought together into the almond groves of California represents to many a sort of "perfect storm". Joe

Traynor, the largest bee broker in California, and a former beekeeper himself equates the almond groves to a "bee brothel", where they are exposed to every disease that they can possibly get (Agnew 2007). As this thesis has discussed, this situation has been created by the way we organized the beekeeping industry and our agricultural industry, in a complex web of interactions that makes it *appear* as if there is no alternative to the current system.

Beekeeping as a profession developed under the previous two food regimes , the colonial-diasporic and mercantile-industrial food regimes, to fit in as part of the systems of accumulation and production that were integral to them. Beekeepers developed practices that mirrored other industrial processes and turned beehives into mobile "pollination units" that are assaulted by a barrage of agricultural chemicals and treatments, hauled long distances, subjected to crowded living conditions, and often lack proper nutrition to be healthy. Bees are absolutely essential to our agricultural system, and appeals for their health and wellbeing are really appeals for our own survival. It is estimated that approximately 1 out of every 3 bites of food that we eat is the direct result of pollination by honeybees – the crisis of honeybee losses could rapidly turn into a human crisis (Benjamin 2009). By using the idea of food regimes it is possible to examine the underlying organization of agricultural systems under which beekeeping arose in concert with modern farming techniques. This understanding can help us forge a better system to replace our current regime, one that will be friendlier and healthier for both people and the animals that we share the earth with.

CHAPTER 3

"Killer Bees" – not so killer after all

> *"There was so much negativism about Africanized bees and how bad the bees are that we had a situation …that this person had a backhoe and he hit a small building….there were 3 Africanized feral nests in it. As soon as he hit it, he knew something was wrong. He backed off, turned the equipment off and was running to his supervisors truck…the supervisor said "African bees are deadly , you are a dead man - you got stung 20 times...he rolled the windows up, locked the doors and drove off and left him. At the time he ran to his supervisor he had less than 20 stings, the news media has played it up so negative…it's the whole killer bee thing".(Apiary Inspector)*

Africanized bees have had serious impacts in every place that they have colonized; of this there is no doubt. Many beekeepers have struggled to cope with the changes in the behavior of their insects, some have been successful, but even more have gone out of business. As discussed in chapter 2, the AHB does not dovetail well with commonly accepted beekeeping practices, or with the agricultural system that has grown up around these practices. In almost every country along their path, systems and people have had to adjust to a new way of keeping bees for agricultural purposes, but the U.S. has not necessarily followed suit. There are a number of reasons that U.S. beekeepers have had a different experience, from economic to political.

This chapter will be examining these issues in-depth, using information gathered from intensive personal interviews with professional and hobbyist beekeepers, extension and inspection agents, research scientists and regulatory officials who work with honeybees. The first part of the chapter will deal with the image of the AHB - that of the "killer bee", and also

with the reality of AHB. As the opening vignette for this chapter illustrates, there is a great deal of misinformation that surrounds this insect which can be problematic for those who keep bees, those who work in regulatory or enforcement types of positions, and also those who happen to stumble upon a nest of AHB. The next section will explore what it means to keep bees in AHB colonized zones, both in the US and elsewhere. The presence of AHB has serious implications for the management and care of bees for both honey production and pollination services. Problems associated with public interactions with bees, the rise of hobby beekeeping, and the struggles of current professional beekeeping are all amplified when AHB are in an area, and require a great deal of coordination between the public and various agencies. The chapter will then conclude with an investigation of how all these various issues might impact the future of beekeeping (and in turn, agricultural production and food security) in the U.S. The arrival of AHB has fundamentally changed the game for beekeepers, regulators, and farmers in colonized areas, and the impacts of these changes are likely to have far reaching effects.

Perceptions of the Africanized Honeybee

While the Africanized honeybee is more difficult to manage, and more likely to cause stinging incidents than their European counterparts, the reality of this bee often does not parallel the mental image that people have of the bee. The idea of the "killer bee" is still pervasive, particularly among non-beekeepers. A great number of people do not perceive the AHB as being a honeybee, but rather as some sort of mythical, dangerous creature (LeBas 2000). A friend of mine recently went to Ecuador for a trip, when she arrived back I asked her if she had seen any AHB in Ecuador and she said "I saw lots of honey bees but no African bees". However, if she saw bees on flowers in Ecuador, they were almost certainly Africanized bees - the perceptions of these two insects that are practically identical in form and function rarely overlap in peoples'

minds (LeBas 2000). In reality, the AHB often overlaps with the EHB in both natural and man-made settings.

The Media – the "myth" of killer bees

Many of the interviewees expressed concern over the way that the AHB has been demonized in the minds of the public through popular media. It would be impossible to have a conversation about AHB with a non-beekeeper without first spending some time to educate them about the "killer bee" mythology, how this mythology has been constructed, and where the myth and reality diverge. All of the individuals I interviewed referred to these bees as AHB, Africanized bee, or some similar terminology. They all expressed in some way that while the bees were defensive, difficult to deal with, and potentially dangerous, that the term "killer bee" was inappropriate. One of my interviewees refused to take part in the study until I explained to him that my use of the term "killer bee" in the title of my study was intended to call attention to this mythology, and that my true intentions were to attempt to present a realistic picture of the AHB in the U.S.

The media have a tendency to focus on those stories which are the most sensational, whether it is a natural disaster or some other event. The attention that they have given to the AHB has been no different, and to that end they have embraced and promoted the "killer bee" identity in the news and other popular media(Sanford 2006). The prevalence of this image makes it difficult for the non-beekeeper to get accurate information about the AHB, and perpetuates the stereotype of "killer" bees. As illustrated in the case of the foreman leaving his worker behind because he had been stung by a "killer" bee and was "going to die", this sensationalized image can have very real, and possibly detrimental implications, and not just in the ways in which we deal with the bee itself, but in the ways we understand the situations in

which human and bee cross paths. In almost all of the interviews I conducted, I found that one of the major issues that the respondents presented were issues of this "imaginary" killer bee and the need for there to be timely and accurate information disseminated to the public in regards to AHB. Their task of informing the public as to the real dangers of AHB and how to react in an AHB situation has been made more difficult by the widespread cultural adoption of the AHB stereotype and the perpetuation of the "killer bee" mythology by the media.

One interviewee who works as a state apiary official in an AHB colonized area, when asked what the most pressing issues regarding AHB responded that public awareness and rapid response were very important. His second most pressing issue related to concerns about the news media, and their propensity to "build up the negativism about bees", saying "like if you got three or four stings, they act like it's a massive stinging incident". He also states that "there is always a reason for why you have a severe stinging incident…..like one fellow who got over 500 stings….he ran over a beehive with a lawnmower. There was another incident where a man ran over a European bee nest with a lawnmower and that one resulted in a death". He said that the news people who interviewed him were skeptical of the validity of the genetic test results that said the hive was European and wanted him to run the test again, which again showed that they were European bees.

A more recent example, in September of 2011, there was an incident in which a 1000 lb hog was killed by honeybees; the CNN News blog headline read "Hives bigger, killer bees meaner this year, say experts after attacks". The article states that the bees stung the hog after their hive was disturbed in an outbuilding. It does not state if the hog had the ability to run away from the bees, or if it was penned and unable to escape. The headline refers to the incident as "attacks" however, had the bees nest not been disturbed they would not have reacted defensively,

all honeybees instinctively defend their nest, AHB just tends to do so in greater numbers than EHB.

An apiary inspector from an AHB colonized area said that there is a common misconception that these bees "attack" people. The use of this word elicits images of bees hunting people down and attacking them unawares. This is never the case, unless one happens to disturb the bees in some way, they don't seek one out. He stated that, "the minute you say killer bees people imagine bees with machine guns coming to shoot everyone down…it isn't like that – they don't come to you, you go to them". The headline also states that "experts" told them that the "killer bees" were meaner and bigger this year…however the article only has statements from one person, a beekeeper who specializes in AHB removal in the area where the incident took place. There is no indication that any other experts in the field of beekeeping or Africanized honey bees were consulted. This is fairly typical of media treatment of such AHB related incidents. It is also interesting to note that there was no mention in the article of the honeybees in question having been tested to see if they were AHB.

One of the apiary inspection agents interviewed stated that he never passes up the opportunity to talk to the media. He sees it as an opportunity to help dispel misinformation, and to educate people about the realities of AHB in their areas. Having dealt with the encroachment of AHB from the time it was first discovered in his state until the present, he understands that the media has the power to have either a positive or negative impact on the situation. He stated that "you have to learn to use the news media to your advantage, talk to them, educate them…because they can put you up or tear you down, its either one way or the other". An educated media reporter can be a beneficial ally, helping to allay fears in the public and can also help people learn what they need to know to prevent stinging incidents. As in the example of the

September 2011 incident, rather than spread fear about the bees being "bigger and meaner" this year, the reporter could have used the incident as an opportunity to educate people to make them safer. He could have pointed out that the bees were in an unused outbuilding, that this is one type of habitat that these insects find attractive, and that if you see bees coming and going from areas such as sheds, water meter boxes, or barbecue grills, don't attempt to open them up and have a look, call a pest control professional or beekeeper who specializes in AHB removal.

Another interviewee who has been working as an extension apiarist for almost 40 years stated his sentiments regarding the tendency of the media to "hype" up AHB incidents as follows:

> "What I see now is that there is an almost complete ignorance of these bees on the part of the general public …the only time they get involved is when there is some sensationalized press release or some incident. We have this African bee question just going on… bumping along below the surface somewhere and then boom there is some issue and it goes up and it carries some great degree of sensationalism and then it dies back down again and goes bumping along till the next incident…and it all really is driven by media".

A state apiary inspector related a story about a lady in his state who was stung over 1000 times by Africanized bees, of course, the media were all over the story and she got a lot of attention from them for the first few days. The woman did pull through thanks to receiving excellent medical care, and when the interviewee went back to see her 6 days later, her husband related that he was "the only person who cared to come back to see how she was"…the news media had chosen to report only the stinging incident, not that she recovered and was fine. The media perpetuates disinformation on bees in general as pointed out by one interviewee, a

professor in entomology, he used the example of "Bee Movie" – "All the bees doing any of the work in the movie, they are all male! It's just totally biologically ridiculous!"

According to Frank Furedi, most people in our society do not base their perceptions of risk or danger on scientific knowledge or evidence, but on their own cultural beliefs and assumptions about their safety (Furedi 2006). The media tends to amplify these already existing states of fear, but are not responsible for their creation. Furedi states that:

> "There exists a disposition towards the expectation of adverse outcomes, which is then engaged by the mass media. The result of this engagement is media which are continually warning of some danger. But the media's preoccupation with risk is a symptom of the problem and not its cause. It is unlikely that an otherwise placid and content public is influenced into a permanent state of panic through media manipulation" (Furedi 2006, pp. 60).

He further elaborates that in part, our accumulated scientific knowledge may actually heighten people's feelings of fear, as they become more aware of things that could constitute potential risks (Furedi 2006 pg 61). Many people already have a fear of insects (sometimes irrational, sometimes not) so amplifying fear of an insect that stings, and that has the potential to do so in great numbers is not a difficult task for media. The media manages to perpetuate this image of the "killer bee" despite the fact that AHB has never actually caused the intense problems that were predicted. According to Gary Glassner this type of focus on "rare but disturbing events can lead to expensive and ineffective public policy" in relation to the problem (Glassner 1999).

The reality of Africanized Honeybees

AHB are honeybees

While it is true that AHB are more difficult to work with, are highly defensive, and can be a public nuisance or hazard, the fact is that Africanized Honeybees are honeybees. They are identical in almost every respect to the common honeybees we have been keeping for pollination and honey for centuries. The major differences between the AHB and the EHB are largely behavioral. When you are out walking and see honeybees visiting flowers, minding their own business…if you are in an AHB zone they are almost certainly the dreaded "killer bee". As a bee removal specialist that I interviewed remarked, when they are in the field "they are just shopping, they don't care about you". When they are away from the hive foraging, and when they are a homeless swarm, they do not act defensively, this is a behavior that is almost always exclusive to nest protection - the bee equivalent of "homeland security". It is precisely this defensive behavior however, that makes it so difficult for this bee to fit into our modern highly industrialized agricultural system. As discussed in the previous chapter, our current system of food production is constrained by increasingly global market forces. The rules of the regime have been dictated by policy, economic interest, and are complimented by systems of knowledge that developed over time, a time when there were no Africanized honeybees in the U.S., and no crisis in beekeeping.

The real dangers of AHB

That the AHB can be dangerous and a public nuisance is not a question; undoubtedly they can be a hazard in public spaces or on private property. From the way that incidents are handled by the media, and the hype that surrounds the bee, one would think that there have been a large number of deaths due to stinging and that incidents happen frequently. The truth

according to information provided by Adkins Bee Removal Service, one of the largest bee removal services in the US is that since they arrived in the U.S. there have been 14 human deaths attributable to AHB stinging incidents. Included in this number however, were individuals who were allergic to bee sting (Adkins 2011). In a rather amusing graphic on their website they show that more people have died to coconuts falling from trees (20) since 1990 than have died at the stinger of AHB (Adkins 2011). There have been a much larger number of pet and livestock deaths (Kim 1999), however the risk of being stung to death by AHB is really rather small. As we saw from the opening vignette to this chapter, there is a great deal of confusion about this "killer bee" – the foreman thought that the worker was surely going to die because he had been stung 20 times. Chemically – the venom is identical to that of the European Honeybee, and in fact the venom from most members of the hymenoptera family is very similar, this family includes bees, wasps, and some types of ants (Waldbauer 2003). AHB stinging incidents tend to be dramatic due to the numbers of stings that individuals can receive, and this danger should not be downplayed. However, a well-informed public and beekeeping community will be able to minimize the impact that these bees have in an area.

Bees and the public

Africanized honeybees are much like any other honeybee – when a nest is left to itself, its members behave a great deal like European honeybees, they visit flowers, they gather nectar and pollen, and the queen lays eggs. A feral nest of bees in the wild is not necessarily a problem. It is when AHB and people cross paths that problems arise. Almost universally, respondents said that the most important thing that could be done to improve the AHB situation in their area was to improve public education. Several respondents felt that accurate, timely information could prevent a great number of AHB incidents. This is particularly the case in urban areas where AHB

can often nest in public facilities such as on power lines, in switch boxes, or other structures which may or may not be closely monitored. A modern city offers almost unlimited nesting areas for AHB which find small spaces like water meter boxes or unused barbecue grills very appealing sites. In Florida, they have created the "Bee Aware" program, which educates the public about possible nesting sites of AHB, and how to recognize if bees actually inhabit a location or are simply visiting. An interviewee who specializes in AHB removal states that he tells clients "if you see bees coming and going and there isn't something delicious to eat in there, then they are living there", and that they should call a specialist. Some of the most dangerous situations with AHB arise when people try to remove them from their property themselves rather than calling for help from a qualified professional.

As mentioned previously, the AHB has proven to be much less of a problem than originally was anticipated, and many of the interviewees were in agreement that this has been in large part due to preparedness and public awareness campaigns, and intensive efforts to remove them from public areas. As one professor specializing in beekeeping stated:

> "They have been here since 1991 and have not caused a problem because (as I keep saying) they are removed from public areas. I think they are not a problem! Beekeepers that keep these bees choose to; they know what they are getting into".

He, and several others felt that it is really only when these bees are in spaces that are commonly inhabited by humans that they present a problem, and that "only bees in public spaces should be eradicated". Several interviewees also related that AHB impact has been minimized by providing timely information and assistance to beekeepers in their area on how to prevent usurpation of their managed colonies by AHB.

Bee Removal Services

Often when people find AHB on their property they try to remove the bees themselves which can result in serious danger to themselves and others, or create hazards to livestock or pets. One theme that was almost universal in the interviews was that attempting to remove AHB on one's own is a very risky undertaking, and is one of the biggest public hazards related to AHB. The bee removal specialist said that it was not uncommon for him to receive a panicky call from a woman that started out with "my husband went out there…" to which he would ask "how many times did he get stung". He said he arrived at one location to find a lawnmower running in circles in the yard near a very upset nest of AHB. Recommendations on how the public should handle feral nests on their property vary from state to state, with some states recommending that they call a state inspector to come remove the nest, and others informing them of private eradication services that specialize in bee removal. "There is no "approved" method to kill a colony. We need to develop one… soapy water, gasoline" said a professor of entomology. Methods of removal span the spectrum from poisoning with dangerous chemicals (which can only be done by certified pest control operators) to live removal and relocation of the hive. The method used will vary based upon the skills and ideology of the person doing the removal. One large company that specializes in bee removal recommends that the focus on extermination should be shifted to live removal in light of CCD and concerns for dwindling honeybee populations (Adkins 2011).

The recent CNN article – "Killer bees meaner, hives bigger this year, say experts after attacks", the reporter details a stinging incident that resulted in the death of a 1000 lb hog (CNN 2011). He spoke with a bee removal expert that had responded to the incident who told him that it was unusual for bees to kill an animal that size, which is only partly true, cows and horses have

frequently been the victims of AHB mass stinging(Caron 2001). This bee removal expert also told him that the bees "seemed bigger and meaner" this year (CNN 2011). While interviewing a bee removal specialist, a possible explanation for this arose, that had nothing to do with the biology or behavior of the bees changing in any way. The interviewee related that since the housing crisis and the economic recession began in 2008, many people have been putting off having feral nests removed from their properties due to the cost of removal. This interviewee related that one of the first questions he asks when someone calls about a removal is "how long have they been there" – if it has been less than 6 months, the nest is likely to be more manageable, however, nests that have been in place for a year or more can be very large and extremely defensive.

In areas where AHB have colonized there is an increased need for training of emergency personnel, both first responders such as paramedics, fire, and police officers, but also emergency room staff and physicians. Dealing with a person who has had a massive number of stings is not the same as treating someone who is allergic to bee sting, or who has had a snake bite. One interviewee felt that we have had fewer fatalities to AHB in this country than has been the case in Central and South America because we have more highly trained medical personnel, and we have benefitted from the experiences of those other countries that were colonized by AHB before us. The U.S. also likely has *more* medical facilities in general, and bee sting victims may not need to travel as far or as long to receive care. Medical personnel need to be aware of the potential long term effects of large numbers of stings. Emergency care can manage the effects of venom on an immediate basis, however within a few days to a week later - muscle tissue breakdown from bee stings can start to stress kidneys. This condition, known as rhabdomyolysis, can be fatal if the patient is not given the proper supportive care, including fluids and dialysis in

very severe cases. In general when AHB moves into an area there is an increased need for training of emergency workers such as police, fire, and paramedics, as well as specific training for emergency room and hospital personnel on how to handle massive sting victims.

Keeping Bees in the AHB zone

Both professional and hobby beekeeping are impacted in areas where AHB have colonized, however the effects on these groups are quite different. This is a theme that came through in many of the interviews, some of the main reasons being access to transportation and locations outside of the AHB zone, access to knowledge and resources, and increased capital investment and need to maintain business as usual. Professional beekeepers are also more "locked in" to the current system of agriculture – there is an intense demand for their services. One interviewer who is a retired professor of entomology and a lifelong beekeeper stated the following concerning professional beekeepers:

> "That group have the means, have the knowledge and the means to continue to do selection, to select for the best, they have the means at least in south Texas and south Florida to move their colonies and leave them there for part of the year when there is not a lot of reproduction of Africanized honeybees, you can have bees in Tampa over the winter period through the citrus flow, then move them to almonds then rather than move them back to south Florida, to the Tampa area, the larger beekeepers now go to North Florida where there is less colonization, and do something else, go to do blueberries for example." (Retired professor)

This is also the case with what the industry would term "sideliner" beekeepers. These individuals typically have between 100 and 500 hives and do beekeeping as more of a seasonal or part-time venture. This group has some of the resources of the commercial beekeepers, but between the

commercial and sideliners and backyard/hobbyist beekeepers there is a sharp schism. Several of the interviewees brought this situation up, the retired professor having this to say:

> "So too with the sideliners, they have the capability and the knowledge to go ahead and do re-queening. This group also has an economic incentive, when the bees get a little bit hot, they have an incentive to do something to improve that whereas the backyarder, without the economic incentive kind of you know, just closes the door on it, turns their back and says well, ok, I enjoyed the bees but they are too hot now I will just leave them be, I won't do anything. The colonization in that colony continues on unabated and within a couple generations it's pretty purely AHB material." (Retired professor)

A long time professional queen breeder put it this way:

> "Hobbyists are naïve and do not realize until their package bees have grown considerably that they have a sincere issue. Since many hobbyists are in urban areas, there is considerable risk and concern for neighbors and pets, etc. Unfortunately for the newer beekeepers, they become frightened and then neglect the hive- which only exacerbates the situation and the AHB colonies then spit out swarms that can saturate an area. We are lucky in that our winters can help to curb their permanent establishment but it all depends on the season."

In all these cases there is the intertwining of economic concerns, access to resources, and ideas about how to keep bees that influence who will continue to keep bees once AHB arrives in an area, and how they will do it.

The recent bee crisis has also had an impact on the way hobbyist beekeepers perceive the AHB, which one interviewee, an extension scientist in the AHB zone said has had some frightening consequences:

> "It is a little scary the situation down in southern California with these people who want to "save the bees" whenever they see a swarm or get a swarm call, in someone's back yard, instead of coming and taking it away, they bring a hive box and say "hey this is cool, why don't you just establish this in your backyard" and that scares me a little bit because then you have a non-beekeeper who has no idea what they are putting in the box, that's not such a good idea" .

Many of the interviewees however felt that hobbyists could safely keep honeybees in colonized areas, provided that they were given good information and taught to recognize the danger signs that their hives may have been usurped, and how to re-queen a hive. Beekeepers who do not feel comfortable performing routine inspections or manipulating their colonies should be discouraged from keeping backyard bees in these areas. In general however, it was clear that there is a great need for the insinuation of new knowledge in order for a beekeeper to continue keeping bees in an area where AHB colonizes. Because hobbyists do not necessarily support big agricultural concerns they are likely to be the victims of regulations that make it more difficult for them to gain the needed knowledge and resources they need to continue keeping bees.

Professional Beekeeping in the AHB zone

One of the interviewers expressed doubt about our ability to continue to maintain European stock in our commercial beekeeping operations and his recommendation was that beekeepers learn to work with AHB and work towards creating more manageable populations of AHB. It is the case that in all other areas where the AHB has become established that they have had to incorporate them into their beekeeping practices, even in nearby Mexico where AHB hybrids are used in commercial production of fruits and vegetables and honey (Ratneiks and Visscher 1996; Sanford 2006). This is in part due to the development of habitus related to

beekeeping – those methods of working with bees that seem natural and normal, but that are aberrant when attempted with the AHB. A retired university researcher, when asked if it was the bee or the beekeeper that was the problem put it this way:

> " it's a bit of both...the old beekeepers have a hard time changing their habits, one of the most effective demonstrations… was to take a selection of older beekeepers into an apiary with Africanized honeybees and give them the smoker and the hive tool and say here open this colony and we had a cloud of bees immediately...then we would go into another colony using our management techniques of not jarring a colony, you know the way that we were looking and show them that we could do our inspection in a very quick time and get our information on a colony and get out of the colony without the cloud of bees, and they became believers almost instantly, but of course we couldn't show everyone that…"

Most commercial beekeepers become accustomed to working their bees a particular way and that is usually in ways that lend to efficiency and are supportive to the current food regime. When you have hundreds of hives to care for, taking extra time and being gentle is not always possible, and both of these are tactics that are needed when working with AHB. Many beekeepers go out of business when the AHB comes to town, for multiple reasons, a research scientist described the situation in this way:

> "…so a lot of beekeepers, older beekeepers but you know, beekeepers of all groups just didn't do the adaptation to keep these bees quickly enough and so it became either a risk, a burden, less profitable, more expensive because they were trying to re-queen with European bees and the bees just weren't productive....for all of those reasons it was simply a matter of beekeepers like all groups of farmers are set in their ways, they

have to be shown that there is a different way and then some adapt more quickly than others, and the adapters are called survivors and those are the ones that continued with bees, and those that didn't do the adapting or did not want to do the adapting…those were the ones that ended up giving up on it…"

He also mentioned that those who stayed in business ended up profiting from the collapsing of the beekeeping industry in their area:

"…the ones that stayed in it ended up getting some real good bargains, if that beekeeper that gave up who had 20 colonies had a nice new extractor it wasn't worth much of anything to him or her, so an established beekeeper was picking boxes up and extractors up...you know, fire sale bargains!"

There are a lot of differences between the management of AHB and EHB, and a great number of changes that a beekeeper would have to make in their practices if they were to want to move from keeping one type of bee to the other. One interviewee said "It starts with how one approaches a colony, when one approaches it, where you site them and a lot of aspects of management throughout the season…with AHB it is business, but it isn't business as usual, so they really have to learn to adjust". This is not always an easy process, and as Bourdieu noted, those aspects of behavior which we deem to be normal, natural and the "right way" of doing things can be hard to change because often we are not even aware that they are behaviors we can choose to change (Bourdieu 1990).

One difference between keeping EHB and AHB is in where bees are placed in relation to the crop they are pollinating. In our highly industrialized monoculture/factory style farming, bees are often placed directly in the crop area, between rows, along the edges of the field, and frequently where there is a chance of contact between bees and workers. This is an efficient

means of ensuring that bees can reach all the flowers – our large monocultures are often larger than bees placed along the edges of fields or orchards can pollinate. Bees will fly in a radius of two miles; however 100,000 acres of citrus or almonds may exceed this range so bees must be placed within the fields or orchards themselves. When working with AHB (with a few exceptions). In most cases when working with AHB the bees should be put inside what one interviewee called a "vegetative corral", which another interviewee said would "make them fly out above head level." By placing the AHB within a more enclosed space, with some sort of vegetation such as shrubs or bushes at about 5-6ft in height, the bees are forced to fly upwards over this vegetation on their way to the fields. This puts them at an elevation where they are less likely to be disturbed by farm workers or animals that come near to the enclosure. This also helps to prevent noise, movement and vibration from agitating the bees. One interviewee also said that AHB should be kept on single hive stands, rather than placing 4 hives on shared bottom boards which can transfer vibrations from one hive to another and result in all 4 becoming agitated. This has implications for moving beehives in large numbers. In many commercial beekeeping operations, honeybee hives are loaded onto trucks via shared bottom board pallets using a fork lift – individual hives require lifting and moving by hand rather than by mechanical means. Because our current food regime demands that farmers focus on high production and efficiency, these requirements for using AHB for pollination are problematic.

Due to their more defensive nature, AHB beekeeping tends to be more of a "leave-alone type of beekeeping" according to a retired professor of entomology. According to the professor, AHB hives are often placed in these vegetative corrals near the fields once, and then every year the numbers are amended if need be by replacing those hives that have died out rather than having the bees moved in and out on a seasonal basis. This would not only require a different

type of beekeeping, but a different business model from that used in the U.S. (and particularly in the case of almonds and other very large crops) in which contracts are decided upon directly before the season based upon fluctuating market demands and strength of bee colonies, and colonies moved many miles accordingly (Agnew 2007).

AHB can have the effect of reducing the efficiency of beekeeping operations due to their defensive behavior; however, as one interviewee related, defensive bees are not always a bad thing in the eyes of beekeepers. Defensive bees are better at keeping bears and other predators out of the hive, and also less likely to be stolen. Beehive theft has always been a problem, and many beekeepers brand their boxes with their initials or the name of their company. This interviewee said that in Mexico, in addition to purposely selecting for more defensive bees, often bee hives are placed in areas that are hard to get to such as busy highway medians in order to reduce the likelihood of theft. AHB can be more difficult to work with in the field, more trouble to load on trucks (particularly since they need to be kept on single bottom boards and loaded individually rather than as a 4 hive unit).

Finding workers who are willing to take the stings is also an issue with keeping AHB, resulting in high employee turnover rates for some beekeepers in areas that have been heavily colonized. As this interviewee related, in many Latin American countries there are an abundance of people who are desperate enough for the money that they will continue to work with the AHB, and this may not be the case in the U.S. From my own personal experience as a commercial beekeeper, finding reliable help that was not fearful of our gentle honeybees was a difficult task. Had they been AHB, we likely would not have had the workers that we did. In addition, as another interviewee mentioned, AHB are not really more dangerous in the event of a major highway accident involving spilling of beehives onto the road. He said that once a hive is

smashed on the road, they all pretty much behave the same way. He did state that they could be much more problematic should the truck need to stop for gasoline during daylight hours however.

In many cases in the colonized areas, the beekeepers who have managed to stay in business are the ones who have more isolated locations, and those who have learned how to work with the bee, and how to keep their undesirable behavior to a minimum while working with them, transporting them, and while extracting honey. The matter of shipping bees as packages or pollination units out of the AHB zone itself however is contentious, a long time queen breeder stated:

> "I would prohibit imports from all package producers in Texas and in AHB afflicted areas. Navasota isn't designated as AHB- but who are they kidding? They shouldn't be allowed to ship out bees- period."

One very important difference between these areas in Latin America and the U.S. that makes it easier for our beekeepers to continue working with the EHB rather than AHB is that of climate and geography. The U.S. is a very large country, and in addition to having a great deal more resources than many of the other countries that have been invaded, we also have multiple climatic zones that beekeepers can (and do) move between. Several of the interviewees mentioned that particularly the larger scale beekeepers have the ability to pick up their hives and move them to areas where the AHB has not colonized due to climatic restriction, moving hives in an out of the AHB zone according to season and breeding cycles. In these more southern countries, this is not an option, with the exception of Argentina, which has only been colonized by AHB in the more northern parts of the country. In some other cases, beekeepers have nowhere to go unless there are mountainous areas nearby. In some areas such as Costa Rica, they

have mountainous inland areas that are excellent habitat for beekeeping. It has been found that at higher elevations the AHB tend to tone down their defensive behavior (Caron 2001). In these areas AHB can more easily be used for honey production and pollination.

AHB effectiveness in pollination

In many AHB colonized areas the bees are used for pollination, however most of the interviewees expressed doubt as to our ability to integrate them into our agricultural system in the U.S. The main reason cited was that of the defensiveness of the bee and concern for the safety of non-beekeeper farm workers and the public.

> "we will try not to use AHB as the bees for pollination as long as we can get the mild mannered EHB, because people need to be working on the locations, they need to go through the fields to lay irrigating pipes, they may be working on weeds, they may be doing a whole lot of things and we can't have bees out there that wont behave themselves around the people who work there"

Modern farms can be busy, noisy places with a great deal of activity going on for much of the day. It is common in the U.S. for hives to be placed directly on the edges of fields or between rows (in the cases of orchards or very large monocultures), areas that are frequented by workers. Almost universal concern was given by interviewees as to the safety of agricultural workers in proximity to hives. It has been the case in some areas where AHB are used for agriculture such as Sinaloa, Mexico, which has a booming vegetable industry largely produced for American tables, that AHB hybrids are used, and placed in open areas, in fields or directly adjacent without any recorded deaths due to stinging (Ratneiks and Visscher 1996).

There are some methods that have been effective in colonized areas that make it possible to use AHB for pollination, which include both adaptations to apiary locations and construction,

and changes in the business model of renting pollination units. One interviewee who spent extensive time observing beekeeping in Latin America had the following to say about using these bees for pollination, using the example of melon pollination:

> "working with a melon grower you actually end up leaving the bees right there rather than trying to move them, then augmenting the numbers every year, in other words moving more in. More stationary, but they are getting paid for those colonies and to restock the colonies that have absconded and things and so you...you adapt, you learn quickly what you can do and can't do with this bee". (Retired entomology researcher)

Research on the effectiveness of AHB in pollination in Latin America has shown that they can be highly effective pollinators of commercial crops such as melons, even though the feral nests were quite a distance from the fields in comparison to the distance a managed hive would be placed (Veen, Arce, and Arias 2004). This would indicate that AHB hives that were placed in vegetative corrals at a minor distance from fields should still be highly effective at crop pollination. Additionally, the interviewee related that these locations needed to be "isolated, but not necessarily remote" in order to provide protection to agricultural workers.

Raising queens

The raising of queen bees for use in commercial beekeeping is an essential component of the modern agricultural system. Regularly re-queening hives helps to keep them strong, disease free, and makes them more effective as pollination units. Queens in the U.S. have traditionally been raised in areas that are now being colonized by AHB, as one interviewee remarked:

> "When we do the map overlay, of where the current queen breeding programs exist and the probability of Africanization is high - they all fall in areas where we show colonization will proceed" (retired entomology researcher)

Queen breeding programs are particularly vulnerable to the encroachment of AHB, as mentioned previously, AHB drones tend to have a mating advantage over EHB drones, so when one is attempting to raise queens in an AHB zone wild, natural mating is something that is questionable. This could serve to increase the cost of queens as artificial insemination methods would be one of the only ways to ensure that the stock is free of AHB genes. One interviewee was concerned that the genetic base for U.S. queen breeding operations was very narrow, and while the AHB could provide a much needed infusion of fresh genetic material for our bees, there would be little market for the bees produced. He said "incorporate Africanized bees and then become the ridicule of the industry and no one is buying their product because their bees are a little bit hotter". This sentiment was mirrored by a queen breeder whose area is currently free of AHB, but is on the edge of the climatic range, and who felt that regulatory intervention was needed to prevent loss of business - “Personally, as a breeder, I would appreciate legislation that inhibits importation of any bees from AHB areas.”

Some states, such as Florida offer best management practices for their beekeepers who are interested in raising queens for personal use; however several interviewees expressed concern about this practice. They felt that it was not possible to raise AHB free queens in an area where AHB has colonized, even if the breeder maintained high levels of drones, and they felt that “no one would actually purchase a queen from a Florida beekeeper anymore; this is a shift in the industry” (extension scientist). This trend has already been seen as another interviewee mentioned, in reference to the fact that the state of Maryland recently banned the importation of bees from Georgia because they “don’t want foreign stock with AHB” (extension agricultural agent), and will remedy the deficiency by focusing on local bee stock rather than the importation of bees. Another interviewee regards the situation as inevitable and says that his prediction is that

in the future there will be "no movement of bees from colonized areas to non-colonized areas" (retired university researcher). Should this actually come to pass it would require an intensive restructuring of the current system of beekeeping for pollination contracts in the U.S. It is important to note however, that all the choices that individuals feel they have in regards to how to deal with these issues are constrained by the systems of knowledge in which they are immersed, and that these systems of knowledge have been built around the productionist ideals of our current food regime.

Management of bees

The first colonizing wave of AHB tends to be the most disruptive in almost every area that they have saturated, and requires the most adaptation on the part of beekeepers (Caron 2009). It has been to date the general practice of state apiary inspection agencies, scientists and researchers and beekeeping associations to focus on maintaining the current system, through more intensive management practices. This has included better swarm management, re-queening of hives every 6 months, and more frequent inspections in order to assess the status of hives. There are conflicting opinions as to whether or not maintaining EHB in the AHB zones increases the workload or expense of beekeepers. One interviewee, a university extension researcher stated that these additional tasks "do not increase the workload of a *good beekeeper*, it's only one item beyond what they *should be doing anyways*, it's basically best management practices for beekeeping in general". He also stated that beekeepers complain the most re-queening every 6 months due to the increased cost.

Many beekeepers have traditionally raised their own queens; however this practice does not work in areas where AHB is present for reasons mentioned before, and while many would like to say that the cost is a tradeoff for the labor required to breed the queens in the past, many

beekeepers do not see things that way. As a retired university researcher stated, “a lot of beekeepers engage in practices that are really time consuming and there are ways they could do them quicker and more efficiently but they do them because that’s how they were taught to keep bees”. From personal experience I know that raising queens can be a very time consuming, but enjoyable task. Like many other small farmers, beekeepers often do time consuming tasks in order to cut corners on a tight budget, and queen bees can be a significant expense as shown in table 1.

***Table 1*:** 2011-2012 Single Queen and lowest wholesale price Queens*

2010-2012 Prices	single, price each	wholesale lowest price each
Olivarez Honey Bees Inc.	25	18
Ebert Honey Queens	18	N/A
Bostic Farms	16	N/A
Honey Rustlin' Farms	25	N/A
Draper Bee Farms	32	N/A
Wootens Golden Queens	22	18
Ohio Queen Bees	20	N/A
Noble Apiaries	24	15.5
Bush Bees	32	N/A
White Oak Apiary	35	N/A
Waldo Ohio Apiaries	22	N/A
Jersey Girl Queens	25	N/A
California Bee Company	25	18
R Weaver Apiaries	24	18
Daykel Apiaries	35	31
Cedar Glen Apiaries	23	N/A
Mike's Bees and Honey	25	N/A
Honey Run Apiaries	22	18
Parson's Gold Apiaries	32.75	28.75
Rossman Apiaries	23	18
Average price	25.29	21.58

*All prices are for mated queens, prices only include clipping/marking if it is standard, wholesale prices are given for the lowest cost/highest volume price offered by the breeder, not all breeders offer a volume discount.. Data was gathered from current prices listed on each company websites.

States that recommend clipped/marked[1] commercially produced queens that are free of AHB genetic material make this process of raising one's own queens less viable and appealing. One interviewer who worked for the extension agency in an AHB state said that it is easier for a beekeeper to get a permit to move bees out of the state if they adhere to the best management practices and have clipped/marked queens that are easy to identify as being AHB free.

As table 1 illustrates, it can be costly to re-queen hives with certified AHB free stock, and if you want clipped/marked queens there is often an additional cost. One benefit to paying more for the clipped/marked queens as mentioned by an extension apiarist is that if a queen is clipped and marked, and you can find her in a hive, there is no need to re-queen that hive unless the queen is weak or not laying eggs in sufficient numbers. The additional cost of frequently requeening hives is the major cost increase that beekeepers in areas that are colonized by AHB incur should they try to stay in business using EHB. That beekeepers and officials would recommend such a costly offensive against AHB as this is indicative of just how tightly entrenched beekeeping is in our current agricultural system. We must use the EHB, we must maintain the status quo within our beekeeping system, even if it means more expense and work for beekeepers, who often subsist on a marginal budget to begin with.

AHB and pests/disease

Bees have gotten a lot of press lately, and the public has become more acutely aware of the problems surrounding the beekeeping industry in the U.S., and globally. While this study calls attention to a great many problems that are present in the beekeeping industry, this should not be taken to mean that beekeepers themselves are doing a poor job. This sentiment was well put by one of the interviewees:

[1] clipped refers to clipping the wings of the queen so that it cannot fly, and marked means marking the queen with a small dot of paint or a sticker for easy identification

"I think beekeepers do the best job they can. People want to blame beekeepers and I find that misguided. Most beekeepers take very good care of their colonies." (University research scientist)

The vast majority of beekeepers genuinely want to take the best care of their bees that they can, however they find themselves beset by problems. As mentioned by several interviewees, managed honeybee colonies live in a soup of viruses, bacteria and parasites, one extension research scientist stated that "bees live with 22 named RNA viruses, iridescent virus, and more, all sorts of microbes - put all this together and bees are in trouble, it makes you wonder how any colony does survive to tell the truth". Add to this soup of pestilence the pressures of pollination, thousands of miles of travel under confinement, poor nutritive value of many pollination crops, lack of natural forage flowers, and the ever growing press of pesticides, herbicides and fungicides that bees are exposed to and one begins to understand the recipe for disaster that is brewing in your average managed bee colony. And it is a disaster that we have brought upon bees by injecting them into a system where they are inundated by the chemicals and products that make the system more efficient *for us* – with little regard to their wellbeing.

One extension scientist interviewed related that in the beehive, of almost all the chemicals and toxins that have been studied, that queens were best able to withstand the effects of these chemicals, followed by adult workers, but that baby bees and larva were very vulnerable, however pesticide studies are as a rule performed on adult bees. One hazard that he saw on the horizon for the future health of bee colonies was that one particular chemical substance, amitraz, which is actually quite toxic to queen bees may soon find it's way into hives as a mite treatment. Many beekeepers, desperate for a more effective treatment, are lobbying to have it approved for use against the destructive invasive varroa mite.

Varroa is "everything"

One of the most significant events in the history of beekeeping has been the accidental introduction of the varroa mite *varroa destructor* into global beekeeping populations. One interviewee, an extension apiarist in an AHB populated area said "everything is varroa; it's our biggest problem and will continue to be our biggest problem for a long time". The arrival of the varroa mite coincided with the advance of the AHB through Mexico, and resulted in the withdrawal of funding and the rollback of "bee barrier" programs (Caron 2009). Just as AHB was poised to enter the U.S., there was a fundamental shift in the direction of bee research, towards the control of the varroa epidemic on our managed European colonies.

AHB does not seem have the same issues with varroa mites that our managed colonies seem to have (Winston 1992). This is partially evidenced by the fact that feral colonies of AHB exist in such abundance without the intervention of beekeepers and mite control measures. As one extension scientist mentioned, the Varroa mite exists in the AHB population but does not seem to have the same virulent effect that they have in managed bee populations. The reasons for this could be genetic or behavioral, but another possibility is that their ability to resist could be due to the fact that feral AHB nests are not manipulated to the extent that our managed colonies are.

One study in particular found that in feral bee colonies, the mites themselves are not as virulent as they are in managed colonies (Seely 2007). He presented several reasons why there could be differences in the mite populations and survivability between managed colonies and feral colonies. One reason is that in managed colonies, beekeepers attempt to control mite populations, which negates the bees' natural ability to adapt through natural selection for resistance to the mites (Seely 2007). He also remarked that our manipulation of the brood nests

of managed bees when splitting off hives to create nucs or package bees, or to bolster weak hives, results in *horizontal transmission* of varroa mites. The study states the following "Virulence theory suggests that horizontal transmission, defined as infectious transfer among unrelated hosts, promotes the evolution of virulent parasites by favoring those that strongly (and thus harmfully) reproduce in current hosts before moving on to new hosts"(Seely 2007). Further, the study says that "Virulence theory suggests that the vertical transmission, in which parasites are passed from host parent to offspring, promotes the evolution of avirulent parasites because the reproduction of the parasites is linked to that of their hosts".

One of the interviewees, an extension scientist said of Seely's research:

> "…after some time the woods became repopulated, they had some mites, but they survived, he found that the mites in our commercial colonies are different – they are "super mites". There are less virulent mites in urban beekeeping colonies due to less commercial beekeepers in the areas bees and mites can live together". (Extension Scientist)

In his study, Seely looked at bees in the Arnot Forest preserve in New York, and relates that conditions for feral bee colonies are not conducive to drift (where bees "drift" from their own hive to nearby hives) due to the distance between the colonies, preventing horizontal transmission of *varroa destructor* (Seely 2007). He also noted that the feral bees in the Arnot forest swarmed more frequently, in which a portion of the nest leaves and establishes a new colony. This can serve to reduce mite populations because there is no brood production for several weeks in the new colony which interrupts the mite life cycle, however he admits that swarming alone does not explain the bees ability to coexist with the mite (Seely 2007). There is also the possibility that these bees ability to survive with varroa is linked to the fact that they are

not used in agricultural settings and thus are not exposed to the same kinds of chemical pesticides that managed colonies are. This research indicates some possible directions for research which could explain why AHB are able to survive in such incredible numbers as feral colonies with varroa mites. It may be the case that we don't necessarily need more miticides to control mite populations in our bees, but to change our management practices to allow the bees themselves to develop means of mite control. While not giving any hard answers as to why AHB survives with mites, this study does offer some compelling avenues for exploration.

A retired professor who was interviewed offered an additional explanation for AHB's ability to coexist with varroa (which has also been found in some research studies) (Piccirillo and Jong 2003). He related that AHB tends to have a shorter gestational period, with the brood emerging two days earlier than the brood of EHB. Varroa mites evolved in concert with honeybees and the gestational time period of the baby mites that are laid in the cells with the honeybee brood mature at the same rate. In AHB the shorter gestational time means that the bees hatch out when the mites are still likely to be in an immature state, and they either die or are removed by the housekeeping bees as they prepare the cells for new eggs. This interviewee felt that one possible direction for breeders was to focus on breeding bees that mimic the brood cycle of the AHB, creating a bee that goes through its pupal stage in fewer days than our current managed bees.

Several of the interviewees felt that these natural methods of controlling mites were unlikely to receive the amount of research funding that would be needed in order for them to be really viable. With one interviewee stating that "if we stopped using chemicals and meds on bees we would lose about 90% and the remainder would be great, but how can beekeepers have no income, no bees for pollination." The current need for honeybees for pollination has the effect of

keeping both beekeepers and bees on a treadmill of sorts, requiring them to invest more money in managing their bees, and also prevents them from allowing bees to naturally develop resistance to pests in the manner they have for millions of years. This same interviewee, a long time extension scientist said that “there is no way for us to get there with our current beekeeping operations, we just can’t”. With the degree of interrelatedness between our agricultural industries, it would be practically impossible to simple break honeybees out of the lock-in, even if it meant that we could “save the bees”.

Another interviewee, a state inspection agent who was working in his position when both the AHB and the varroa mites arrived in the U.S. had this to say about the situation with the use of pesticides inside beehives and varroa:

> "Varroa was bad enough on bees that most beekeepers decided that they wanted to do something about it so we went through our succession of chemicals, we are still putting chemicals in there to try to deal with varroa and I am pretty sure that that is the worst problem that we have had in a long time, but it didn't seem quite so severe at first, when I talk about at first, we began to have a problem around 1990, (that’s just when we first started to use the chemicals too) - in keeping queens in the colony for a full year"

He also stated that: “Negative things happening to bees began with this use of chemicals in the beehive that was 1990, we are now 20 years into varroa and things aren't any better with the queens”. Several of the interviewees related that they felt that the use of these chemicals in the treatment of varroa mites (and other medications used for various ailments) were really just the tip of the deadly iceberg for our bees. A university researcher related that of 171 possible environmental contaminants that we have tested wax, pollen, and bees for, 121 of these substances have been found in our managed hives.

There was a recent study that related the fact that bees were recently found to be engaging in an unusual behavior, that of "entombing pollen" – where pollen cells are sealed with a layer of wax (van Englesdorp 2009). The researchers found that the pollen in entombed cells contained high levels of agricultural chemicals when it was tested (van Englesdorp 2009). One interviewee, an extension scientist related that this was "not a new behavior, but certainly an unusual behavior for bees. We have been seeing bees do this on occasion since the 1970s". He said that when they found bees engaging in this behavior that in addition to the chemicals found in the pollen that was entombed, that any microbes they found in that pollen were dead, while nearby pollen that was not entombed (that was also contaminated) still had live microbes in it. Scientists are still attempting to uncover what the mechanism behind this behavior is, however it is noted that it is highly unusual behavior that only seems to occur with bees exposed to environmental contaminants (van Englesdorp 2009).

Our managed bees in the U.S live in a "chemical soup" that is very different from the natural setting in which honeybees evolved over millions of years. Our managed bees are also subject to a large number of pests and diseases, and medications and treatments used to "control" these problems. This has changed the way that honeybees are able to naturally adapt to their conditions, interrupting their ability to naturally select for resistance to mites and microbes. While not offering up a great deal of answers as to why AHB is able to survive without the help of humans in the wild, there are some clues such as lack of manipulation, lack of exposure to agricultural pesticides and chemicals, as well as some developmental adaptations which may explain their resilience. All of these could prove to be beneficial directions for research into increasing the survivability of our managed bee populations

AHB in other countries

For many of the reasons already discussed, the AHB colonization experience in other countries has been different than that in the U.S. Several respondents however had some specific things to say about the ways that AHB are kept in other places, and the importance of beekeeping for the people there. One respondent, currently working as a university researcher felt that in addition to the U.S. having more resources to combat the encroachment of AHB into our apiaries, that the bees unique characteristics are why it has taken over beekeeping industries in Latin America, stating that: "In areas where AHB thrives – the tropics and subtropics, there is no way to keep EHB there. AHB survives better in these areas and there is nothing we can do about that except select for the best, most gentle AHB". Another interviewee says that he encourages people in Latin America to take up beekeeping, despite the fact that AHB is prevalent there. Keeping bees can have great benefit to poor/rural people, who keep small numbers of hives for very different reasons than backyarders in the U.S.:

> "Beekeeping there is not people that are keeping bees in their backyard to have honey for their table or to give away as a Christmas present, it's not what we would call a hobbyist or "backyarder" - People there start beekeeping as a way, as an economic means of improving the family and also improving family health by now having access to honey and pollen - in the rest of the world beekeeping products are medicines, are things of health not of things for sweetening your tea or putting on toast as a novel food for example." (Retired university researcher)

He also related that beekeeping in these areas is different in scale than that in the U.S., and that in these areas people are able to significantly improve their lives with a smaller number of hives

than would be required in the U.S. This reduction in scale would make keeping AHB a less daunting task:

> "Among those people starting two or three colonies can significantly improve family finances. We have been able to demonstrate that it can significantly improve family health because they have access to the honey and the bee products, so that group in the US that we would typically call sideliners, in the U.S it takes more colonies to be able to do this, and secondly they are pretty much managing like the commercial beekeepers - the poor campesinos in Latin America and our sideliners in the U.S." (retired university researcher)

In both Latin American and Africa, these bees are used almost exclusively for beekeeping purposes, as they are really the only option available. They have increased fitness within their climatic range in the Americas (Caron 2001). In some parts of Africa, they are the native species and have been either kept by people, or had their nests pillaged for honey for millennia. It is in part the tradition of honey hunting in Africa, along with predatory pressures that is suspected of having led them to evolve their highly defensive behaviors (Crane 1999; Fletcher 1978; Sanford 2006). In some of the countries where these bees predominate such as Brazil, beekeeping is flourishing, however this is not the experience of all countries in the path of AHB (Caron 2001; Sanford 2006). Many countries still suffer hardships in their beekeeping industries (not strictly due to the AHB) however in many cases, after a few years of disarray, beekeeping begins to reform, albeit often with a number of different practices and revised economic models (Caron 2001; Sanford 2006). These various systems of keeping bees that have been developed in these countries could serve as exemplars for the U.S. also. While they are decidedly more "low-tech" than what we do in the U.S., they have less problems with bee die-off than the U.S. as well.

Legal issues

One of the biggest differences between the U.S. and other countries into which the AHB has migrated is the U.S. legal system. Several of the respondents regarded the propensity towards litigation in the U.S. to be a major issue preventing people who might be interested in maintaining AHB colonies from doing so.

> "…and I think the other huge issue is of course, that separates them from U.S. beekeeping is they are not as strongly litigation societies as our own - if your bees kill a horse you just pay for the horse...in the U.S. it's a court appearance and you know all the things that go on and on....even a dog or a chicken...what you end up going through.....yep that's your insurance, you just bought a dead horse". (Apiary Inspector)

Another respondent stated it in this way:

> "in the United States there are always lawyers somewhere who are ready to take on a case against almost anyone for anything and that's probably a little bit different here than in the foreign countries" (Extension scientist)

One respondent, a long-time apiary inspector in the AHB zone has seen regulations regarding AHB shift a great deal during his tenure. He remarked that people need to be aware of the fact that if there is a honeybee colony inhabiting their property it can be a liability if they do not do something about it. Currently they are not *required* to, but if someone gets stung they can be sued for negligence because it was on their property. He says that in his state there used to be laws regarding the keeping of AHB, however that when they realized that they were not going to be able to stop the spread of the bee they decided to deregulate. He also said that this did not mean that beekeepers in his state started keeping AHB hives:

"We deregulated around 2004-2005 because AHB was in over 75% of the state. Legally the beekeepers can keep them, but they don't want them…because it's a possible lawsuit". (Apiary inspector)

He also related that this was not the same as in other countries where you might simply be required to pay for damages, not involved in a full-blown lawsuit, here in the U.S. he said, it could end up costing you a great deal:

"That $50.00 beehive, if someone's kid gets stung could cost you a million dollars". (Apiary inspector)

The "lawmakers" and the "regulators"

The interviews revealed that there was a dichotomy within those who are responsible for creating and enforcing regulations and laws regarding bees and beekeeping. Two types of officials were identified, those who were "lawmakers" – mostly comprised of state and local governmental officials and city/county planners and the "regulators" – mostly made up of state apiary inspectors, university extension agents and others who work directly with bees and beekeepers. Each of these groups of individuals has very different ideas and approaches to dealing with the issues surrounding AHB. For the "regulators" the focus tended to be much more on issues dealing with agriculture, the viability of the beekeeping industry and with the dissemination of accurate public information. The "lawmakers" on the other hand, the focus has been largely on public safety and zoning regulations regarding beekeeping. These individuals are also constrained in their decision making ability by the rules of the current regime as well, just as beekeepers and farmers are.

That awmakers focus on zoning regulations and other similar solutions is understandable; most city mayors likely do not have degrees in biology or entomology, and are also unlikely to have experience as a beekeeper.

> "take your average mayor in any city and what do they know about beekeeping, I mean occasionally you will come across a beekeeping mayor but by and large, you know, in large cities and municipalities where agriculture doesn't exist in the city anyway there is a huge disconnect between those making the rules and bees".

They also have a responsibility to respond to the demands of their constituency, and certain realms of action in which they have the power to respond – if citizens complain to mayor or the county commissioner about the troublesome "killer bees" they will have to make some sort of effort to "fix" the problem.

> "…nothing against them it's just that they have other issues to think of, it makes sense for me to keep bees in a subdivision where we have African bees in the area as we need to dilute those genetics down as much as possible, but they have to think about things I don't have to think about – which are you know the possibility of the person on the other side of the fence suing you because it's not zoned agriculture, and the bees are drinking in their pool." (Extension research scientist)

Most lawmakers and the general public think of bees as stinging insects, insects that are a problem. Feral nests are often hard to spot, and the public are largely unaware of the numbers of feral nests that can be in an area that is thoroughly saturated by AHB. Even beyond the AHB issues, there is a disconnect between individuals and the realities of food production and beekeeping. If a neighbor has a beehive in their yard (even if it is purely European), and there is a stinging incident, there is a good likelihood that that beekeeper will be blamed. The presence of

AHB in an area can amplify negative feelings towards bees in general “you have this negative bee in the environment doing these negative things and beekeepers often get blamed for it”. With negative feelings about bees so prevalent, it does not take an extreme situation to elicit a public response:

> "…one single complaint or one accident, someone is stung such as an animal, animals are usually our early warning device, but it could be a person, as well. Their solution is often to ban bees, that actually biologically is the worst thing they can do, because by banning the keeping of bees, beekeepers keeping bees… that opens up the niche to further colonization - that basically takes away managed colonies with some control over the stock and allows the natural feral population to then take over an area.” (Research Professor).

The real problem with this type of approach to AHB is that it just doesn’t work. There is no hard data available on the number of feral hives that are removed/eradicated from residential and urban areas per year, however a bee removal specialist stated that “over 10,000 hives of bees are removed from Tucson alone in a single year”. Considering that the University of Florida African Honey Bee program reports that there can be anywhere between 100 to 200 feral colonies per square mile in areas where AHB have taken hold, it seems a credible number (UF-IFAS 2011). As of the last census, Tucson covered an area of 195.1 sq/miles (US Census 2010), there are likely well over 20,000 feral colonies of AHB in the city at any given time using a conservative estimate of 150 hives/sq mile. It is impossible to legislate the bees out of an area, but one can legislate beekeeping out of an area, and in the absence of an actual solution a solution that the public can relate to has to suffice.

> "So they are actually, although they are banning bees all they are doing is banning the sensible care of bees, that is bees in beehives, then of course they can't ban the bees from bee trees, from church steeples, from any of those other things, overturned flower pots...in all of the southwest of course, simply the water meters at ground level just a perfect nesting site for this bee...and so any of their efforts are actually very harmful, very counterproductive, and in most cases it is simply one resident or one accident that then sets off many of these officials to come up with "the solution" of the ban or a severe restriction of one sort or another" (retired research professor).

This sentiment seemed to be common among those who were interviewed that serve in a more "regulatory" capacity – the bee inspectors, extension scientists/researchers and beekeeping association leaders.

Many of the states that were colonized later attempted to learn from the regulatory and legislative trials and tribulations of those states that were colonized before.

> "so we listened to what Texas tried to do and we saw how that worked and we used some of their materials and put together some of our own and ran it through a combination of University cooperative extension plus the regulatory people, through the Ag commissioners offices and our programs and approaches are slightly different because it was Imperial and San Diego counties that we thought would get the AHB first and they did. Imperial county is very agricultural so that ag commissioner tends to lead more towards the Ags, when you come over to San Diego that commissioner is more a seer of weights and measures and deals with an urban population" (Extension scientist)

Almost all of the respondents had some negative sentiment regarding beekeeping bans, thinking it an ineffective solution to the problem. While one stated that he felt the biological

niche evidence was weak, he felt that the evidence that banning bees would keep citizens safe was equally weak. Another respondent felt that the AHB was really not that major a problem, in part because of the focus on eradication in public areas, but was neutral on the subject of beekeeping bans. Most respondents thought that education of lawmakers was just as important as education of the public regarding the issues surrounding the AHB, and that with proper education that many of these problems could be avoided without resorting to bans on beekeeping. Biologically, beekeeping bans may not be a good solution to the problems that municipalities have with the AHB, but they are something that "can be made into a law, easy to write and easy to come up with, gives appearance of doing something about the situation, and you can garner public support for this" (Apiary inspector).

In essence, many of the respondents felt that these areas are going to have AHB regardless of whether or not there are bans or tight regulations placed upon beekeeping, and that banning did not make the situation better. An inspector from Florida felt that this was particularly true in his state because of how thoroughly the bees had saturated the area. Some of the recommendations that were offered up by the interviewees were not to ban beekeeping outright, but to have limits on the number of bee hives individuals can keep on property. The majority also felt that the bees were not as significant a problem as had been originally expected, and that they attributed it to proper advance planning and education:

> "We didn't end up with a significant serious problem that we did not see coming or that we did not try to handle in advance"(Extension Scientist)

Another respondent stated when asked what they thought should be changed in the way we handle AHB:

> "I haven't heard any horror stories about African bees in the US since they arrived in 1991. So something is working right and I wouldn't change anything". (University researcher)

The Future of Beekeeping in the AHB zone

Most of the respondents felt optimistic about the future of beekeeping in the U.S. and globally. They all agreed that as far as the AHB is concerned, that, for better or worse, the AHB is not going to be eliminated from the U.S. Most also felt optimistic about the ability of U.S. beekeepers to be able to maintain their businesses and keep beekeeping the way that they have been. Some however expressed some concern about the future of our commercial beekeeping system, with reservations about the health of our honeybees and our ability to maintain European stock in the southernmost areas of the country. Three of the respondents similarly felt that there needed to be some regulation or restrictions placed on movement of bees into and out of areas that are heavily colonized with AHB. Most were however hopeful for the future of beekeeping overall. One, a research scientist stated the following:

> "Beekeeping will continue everywhere. Migratory beekeeping will change when beekeepers no longer move bees out of AHB areas (FL and parts of TX), but otherwise, beekeeping will continue. Hopefully, bees will be selected for resistance to disease and mites and more bee pastures will be planted, and pesticides reduced so bees can be healthier everywhere." (Bee Scientist)

Another expressed concern about the stability of beekeeping in the U.S. and the effect that the potential "offshoring" of beekeeping to places where labor is cheaper and people are more willing to work with AHB could have implications for our food security in the U.S.

Another concern that the majority of respondents had in terms of the future of beekeeping was that of the aging population of beekeepers. Some felt concerned that there would be a shortage of beekeepers as older beekeepers left the field, and their children moved into new types of professions rather than taking over the family business. Beekeeping has for most of its professional life existed as a master/apprentice or father/son type of business model, and a number of the respondents lamented that this system was breaking down. One respondent however, a beekeeping association leader noted that just because this system was breaking down did not mean it was a death sentence for beekeeping. He noted that there were different avenues to beekeeping as a profession today than existed for past generations, and that a great number of the newer beekeepers were people who came from university backgrounds rather than through a family business or apprenticeship situation.

What is clear from the interviews is that those involved with beekeeping are all dedicated and concerned individuals who feel that it is extremely important that collectively we continue to strive to improve the state of honeybee health. Most are terribly concerned with the conditions under which our commercial honeybees are kept, they are concerned about the levels of pesticides used, the nutritional status of bees, and they worry about invasive pests and loss of habitat and forage for bees. A particularly poignant theme that seems to infuse the interviews is the conflicting ideas of "vanishing bees" and "the problem AHB". It seems that our real bee disappearance problem is in our managed honeybee colonies and with European honeybees, and not necessarily simply a "honeybee problem". AHB are honeybees, and as mentioned, they are prolific in the areas in which they have colonized and somehow are managing to survive when our managed bees are dying out in droves. This has to mean something is amiss somewhere in our system. This study does not attempt to say that individuals should be keeping AHB instead

of EHB in our beekeeping operations, but that perhaps we can learn something from the survival of the AHB and their resilience under natural circumstances that would be relevant in our struggle to keep our managed bees from disappearing.

CHAPTER 4

The Future of Beekeeping – where will we still keep bees?

This thesis does not attempt to prescribe a "fix" for the problems surrounding beekeeping, it does however, attempt to put these issues into context, from which concerned individuals in both natural and social sciences can advance a dialog. The example of the Africanized honeybee provides an excellent contrast to our managed honeybees due to their persistent "wildness" and resilience. The AHB do not just survive, but thrive in areas where our managed bee colonies have suffered extreme losses, and it has been the goal of this thesis to call attention to some of the reasons for these varying outcomes. While not offering a total solution or fix, there are some things that could help to improve the health and survivability of our bees (and ourselves in turn) and those suggestions will be offered in this chapter.

Historically, the AHB and the EHB have had different trajectories in their expansion from their native areas, with the EHB arriving along with the colonists, and having a long history of "domestication" while the AHB in the Americas has been much less exploited. The EHB and its particular nature has been the focus of our creativity and inspiration over many centuries, resulting in a highly technical system of keeping bees for both honey and as pollination units that dovetails with modern agriculture. AHB on the other hand, since its release in Brazil has largely spread of its own volition due to its extreme fitness to the environment. The AHB did not necessarily need men with trucks, or special boxes in order to proliferate itself from Brazil into Argentina and Central America, through Mexico and into the U.S. It has been many years, since the arrival of the Varroa mite that any significant number of feral bees has thrived in the U.S. At least that is, until the arrival of the AHB. The AHB, in its natural trajectory has been incredibly prolific and resilient in every area that falls within its climactic range.

The real puzzle is to determine why this contrast exists, why the survival rates of these bees are so incredibly divergent from each other. The different ways in which these bees have been and are regarded by beekeepers and those involved in agricultural work is a good starting place. Differences in the ways that these bees are managed in areas where they use them for agriculture are a much more "hands off" type of beekeeping, allowing the bees to live a more natural existence. As some of the research presented in this thesis has shown this more natural kind of beekeeping could be part of the reason for the ability of the AHB to survive in an environment along with varroa mites and other pests and diseases. Because AHB demand less handling, less manipulation of brood, fewer colonies kept in a single apiary and less movement, they may be able to employ natural adaptive methods that all honeybees have to resist pests and problems.

Another possibility for the robustness of AHB could have to do with the environments in which they flourish. The less developed areas of Latin America where the bees are most abundant, some of the colonized areas in the U.S. such as the wilds of Florida and even urban areas, likely provide more diverse forage for bees than the monoculture our managed bees are frequently exposed to. Issues of bee nutrition, loss of wild forage and inferior feed substitutes are likely to be areas of continuing research for many years, and were an area of great concern to those interviewed. Our modern industrial agriculture, which many say provides inadequate nutrition and excessive empty calories for humans (Pollan 2009; Roberts 2009), may indeed do the same for honeybees (Jacobsen 2009). It may be the case that the health and survival of both honeybees and humans could be tied to a more holistic and natural way of producing food.

Issues of chemical exposure from many sources present challenges to honeybees, with our domestic bees bearing a much greater burden of exposure than feral AHB. Managed

honeybee colonies are routinely exposed to agricultural pesticides, as drift in the air, in the nectar and pollen of flowers via systemic applications, and in the water from canals and irrigation ditches that they frequent in agricultural settings. There have been high levels of these industrial chemicals found in honeybee hives, unsurprising as honeybees gather resources from a two-mile radius outward from the hive, and concentrate them in the hive (Porrini et al. 2003). While the debate still rages on as to whether concentrations of chemicals in animal and human adipose tissue directly causes cancer or not (Pollan 2009; Roberts 2009), most of the individuals interviewed for this study expressed concern that this concoction of chemicals was harmful for bees.

Whether we can continue to maintain honeybees for pollination in the U.S. will have both ethical implications and threatens our national food security. Some of the individuals interviewed felt that the future of beekeeping in the Americas might exist not in the U.S., but in Latin American countries. Some cited that in those countries, the people were willing to work with the AHB, and therefore would be able to maintain pollination stock to a greater degree than we would. The "willingness" of farmers in Latin America to work with the bee is frequently a matter of necessity and poverty. In much the same way that off-shoring our production of fruits and vegetables exposes many of Latin Americas poor to harmful chemicals; they additionally bear the burden of having to work with more defensive and potentially dangerous pollinators. Additionally, the movement of a great deal of our food production to other locales presents a threat to food security in the U.S. in the event of economic or natural crises.

Large agricultural product and chemical product companies in the U.S. have often dominated the areas of research and development, in areas from seed development, to soil amendments, and also to honeybees (Mann 1978; Pollan 2009; Roberts 2009; Schwartz 2010). In

many European countries, pesticide bans have had the effect of reversing bee losses, however in the U.S. our chemical giants are funding research that shows their chemicals are not the cause of colony die-off, but that it is due to pests and diseases that our bees have had for perhaps decades (EURMC 2009; Kluger 2010; Mendleson 2010; Ratnieks and Carreck 2010; Schwartz 2010). The large corporations and the institutional and economic, and governmental structures that have allowed them to so fully dominate the global food system, to the detriment of not just humans, but to honeybees, a critical link in our food system, warrant further investigation. The honeybee provides something of a "concrete entity" for movements to focus attention on, much as a great deal of attention has been given to the plight of polar bears and other endangered species. While many people are still afraid of being stung by honeybees, there is a growing understanding of the essential nature of honeybees to our own wellbeing among laypeople. While some of the individuals interviewed felt that there were some drawbacks to the phenomena surrounding the "save the bees" movement, most felt that this was a positive step. Applied, action oriented research on these grassroots efforts to improve the plight of the honeybee could have a real impact on the grip that big Agra holds on our food systems.

Many of the interviewees felt that the proliferation of information related to honeybees and the growth of hobby beekeeping to be something of a double edged sword. Hobbyist beekeepers can learn a great deal about nature and agriculture from keeping a backyard hive of bees, passing this knowledge on to neighbors and children, but if they are inexperienced or inattentive in AHB areas they can become a menace. In areas where individuals are required to register hives and submit to yearly inspections, the extents to which these issues can become matters of public safety are minimized. Those interviewed universally felt that banning beekeeping in AHB areas was an ineffective solution however, despite the fact that this could

prevent hobbyist's hives from becoming Africanized in more highly populated areas. Some felt that the bans would open up an environmental niche, while others felt that whether EHB was present in an area did not matter much and that AHB was going to be there regardless. Issues surrounding the banning of bees in urban/metro areas and the ability of hobbyists to continue to keep bees will continue to be points of contention for the foreseeable future.

One area where there could be a great deal of improvement in terms of public safety is in having more programs and regulations in terms of bee removal from private property. Removal from publicly owned spaces, while problematic, is likely not as big an issue as removal from individuals property. In most areas where the AHB lives individual homeowners are responsible for having bees removed themselves. As noted in the interview with the bee removal specialist, this has been a particularly problematic issue recently due to the economic recession. Many people who are on tight budgets may delay having bees removed from their property until the bees become a nuisance, perhaps killing a farm animal, or a neighbor's dog, or even causing a human stinging incident. In light of the financial crisis, states where AHB are located could do more to help make sure that bees that are on the properties of financially strapped citizens do not become a hazard to them or others. It could also be a fruitful research area to investigate further the ways that media has influenced perceptions of AHB, and how alternative ways of understanding this insect could prove valuable to both public safety and agricultural systems.

It is the spaces in which bees and people interface where the AHB becomes a problem. The majority of interviewees felt that Africanized honeybees in the wild were not a hazard to anyone, and that they provide the same important ecosystem benefits that other honeybees and pollinating insects provide. Honeybees, either AHB or EHB that are properly managed pose little danger to the public or to farm workers. AHB however cannot be managed in the same way we

manage our current bees, and the systems of beekeeping that have developed around them in other countries are quite different, both in the ways bees are kept, where they are kept, and the types of financial arrangements that surround the business of pollination or honey production. It may be of value to figure out ways that AHB can safely be incorporated into beekeeping in the U.S., taking some of the pressure off our currently overtaxed managed bees. Additionally research into native and alternative pollinators could be critical to our ability to maintain a secure food supply in the future.

In the last century we have seen unprecedented shifts in the way we grow food, with the responsibility for more and more food production falling into the hands of fewer and fewer farmers. This has been the case with beekeeping as well – increasingly technical systems of keeping bees have made it possible for beekeeping to metamorphose from a small endeavor with really widely varied methods, to a stand-alone profession with somewhat rigid standards of practice. Up until recently beekeeping has kept pace with the development of monoculture, and despite some adversity, beekeepers have managed to always pull through with sufficient pollinators for our needs. The advent of CCD has shown that this appearance of stability may be merely a veneer, and that underneath, the whole system is in danger of collapsing because of the problems facing a small, fuzzy, essential but often maligned insect.

Changes in the way that we produce food could have a positive impact on the health of both honeybees and native pollinating species. Shifting more production towards organics, or smarter use of pesticides and other chemicals than the current "scorched earth" policy that seems to be common would be beneficial. While there is no current scientific evidence that GMO crops are in themselves harmful to bees there is at least one significant way in which they can harm our pollinators. Crops that are designed to resist the effects of chemicals such as glycophosphate tend

to have large amounts of this poison dumped on them, much more than would be used if the crop itself were sensitive to the chemical itself. This can pollute soils and water, which inevitably find their way into beehives.

Another thing that could be done to help both honeybees and beekeepers alike would be to institute some sort of price support program for domestic honey production. Neo-liberal trade policy has had a devastating impact on beekeepers that is infrequently discussed. The loss of the honey loan program in 1996 led to the demise of many smaller beekeepers who kept bees for the purpose of producing honey, and increased concentration in the beekeeping industry. This change also helped swing the focus of beekeeping away from honey production to that of pollination services. Bees that are kept for honey production are usually moved less frequently, and for shorter distances when they are moved. They are not placed in industrial agricultural settings where they face a barren landscape filled with a single monoculture crop that is laden with pesticides. Bees for honey production are placed in areas where there is an abundant source of forage that they can make quality food from, that is not routinely sprayed with chemicals.

Promoting the production of honey would be unlikely to influence the number of beekeepers who still focus on pollination, there will continue to be demand for this, however it will provide a reservoir of healthier bees that could be called into use for pollination if they are needed. In terms of AHB – making honey production profitable again would also make it possible for those who are interested to keep AHB, and begin working out systems of beekeeping that fit with this bee. The AHB have many positive traits that could end up being a boon to beekeepers, and supporting honey production could stimulate action in this direction. In addition to government mandated price supports, beekeeping organizations, and beekeepers themselves could try to develop ways to increase the value of domestic honey. Focusing on things such as

organic honey, varietal or specialty honey or point of origin labeling honey could help increase honey prices.

It has been the goal of this thesis to provide an insight into the ways that the system of beekeeping may be running counter to the way nature intends bees to work. It may be that the rigidity of the system into which we inject bees and other types of animals and plants is not dynamic enough to accommodate for the ever changing processes of nature. It is equally likely that it is too rigid to accommodate for the strains we ourselves place upon it, whether it be from our use of chemicals, or our desire to use monocultures requiring a tremendous amount of natural resources. Beekeeping is just another aspect of a system that is under a great deal of stress, and that is essentially harmful to the environment and those creatures that live within it. As we work towards a future in which the resilience of our means of maintaining our societies, and our home planet, the place of this small insect may be of great significance. It is the hope of this researcher that the future for both honeybees and people is a bright one, a future where respect for the natural strengths of plants, animals, ecosystems and people can all work in concert.

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APPENDIX A. INTERVIEW SCHEDULES

Entomologists/honeybee scientists

1) What do you consider the most important or urgent issue related to Africanized Honeybees in the U.S.?
2) What types of recommendations would you make to beekeepers and regulatory officials who are managing the AHB situation?

    a. Do you think there is a disconnect between regulators and beekeepers on these issues?
    b. How do you think beekeepers could improve their management practices in the presence of AHB?
    c. How do you think regulators could improve their management practices in the presence of AHB?
    d. What do you feel is the role of research and scientists like yourself in the management of this issue?
    e. How do you think the public/average citizens should be involved in this issue?

3) How do you personally view the situation with AHB in the U.S.?

    a. Do you see the issues as being different in the U.S. than they are in other countries that have been colonized by AHB?
    b. If you were able to change things, how would you change them?

4) What are your views on the current management of European Honeybees in the U.S.?

    a. What are the most pressing problems with bees?
    b. Where do you think the greatest opportunity for improving the state of beekeeping in the U.S. exists? With whom?
    c. What do you feel you personally can do to improve the state of beekeeping in the U.S.?

5) What do you think should be done with Africanized Honeybees in the U.S.?

a. If eradication: How should this be handled?
b. If maintenance of European stock top priority: What do you feel is the best method to prevent apiaries from becoming AHB?
c. If work with AHB: What are some of the changes that you think are required to utilize AHB in (Florida/Texas)?

6) What do you foresee as the future of beekeeping in:

a. Florida/Texas?
b. The U.S.?
c. Globally?

Commercial Beekeepers and beekeeping association officials

1) What do you consider the most important or urgent issue related to Africanized Honeybees in your area?
2) How do beekeepers in your area manage the presence of Africanized Bees?

a. Do you think that most beekeepers comply with regulation closely?

i. If yes, why, if no why not

b. Do you think that most officials are sensitive to the needs of beekeepers when they are devising regulations?

ii. If yes how, if no how not

c. What do you think that beekeepers in your area could do to help improve the situation with AHB in your area?
d. Do you think that there are management practices that many beekeepers could change or improve that might help the situation with AHB in your area?
e. How do you think the public/average citizens should be involved in this issue?

3) How do you personally view the situation with AHB in your area?

f. If you were able to change things, how would you change them?

4) What are your views on the current management of European Honeybees in your area?

    a. What are the most pressing problems with bees?
    b. Where do you think the greatest opportunity for improving the state of beekeeping in your area exists? With whom?
    c. What do you feel you personally can do to improve the state of beekeeping in (Florida/Texas)

5) What do you think should be done with Africanized Honeybees in your area?

    a. If eradication: How should this be handled?
    b. If maintenance of European stock is top priority: What do you feel is the best method to prevent apiaries from becoming AHB?
    c. If work with AHB: What are some of the changes that you think are required to utilize AHB in (Florida/Texas)?

6) What do you foresee as the future of beekeeping in:

    a. Your state/region?
    b. The U.S.?
    c. Globally?

Government/regulatory officials

2) What do you consider the most important or urgent issue related to Africanized Honeybees in (Florida/Texas)?
3) How do beekeepers in (Florida/Texas) manage the presence of Africanized Bees?
    a. Is there a high level of beekeeper compliance with current regulations?
    b. Do you think there is a disconnect between regulators and beekeepers on these issues?
    c. How do you think <u>beekeepers</u> could improve their management practices in the presence of AHB?

    d. How do you think regulators could improve their management practices in the presence of AHB?
    e. How do you think the public/average citizens should be involved in this issue?
4) How do you personally view the situation with AHB in (Florida/Texas)
    a. If you were able to change things, how would you change them?
5) What are your views on the current management of European Honeybees in (Florida/Texas)
    a. What are the most pressing problems with bees?
    b. Where do you think the greatest opportunity for improving the state of beekeeping in (Florida/Texas) exists? With whom?
    c. What do you feel you personally can do to improve the state of beekeeping in (Florida/Texas)
6) What do you think should be done with Africanized Honeybees in (Florida/Texas)?
    a. If eradication: How should this be handled?
    b. If maintenance of European stock top priority: What do you feel is the best method to prevent apiaries from becoming AHB?
    c. If work with AHB: What are some of the changes that you think are required to utilize AHB in (Florida/Texas)?
7) What do you foresee as the future of beekeeping in:
    a. Florida/Texas?
    b. The U.S.?
    c. Globally?