RHETORIC OF BEEKEEPING: SCIENCE, RESISTANCE & INNOVATION

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ABSTRACT

This paper analyzes the rhetoric surrounding the field of biodiversity conservation and suggests the rhetoric presented by online beekeeping communities as a model for a larger citizen science movement. In the advent of the Anthropocene, conservationists argue that we must move beyond traditional conservation paradigms and embrace a sustainability model marrying humans, nature, and technology as one unit rather than three dichotomous spheres. This paper researches rhetoric within online beekeeping forums and finds that three themes continue to dominate the discourse and can be identified as (1) participatory citizen science, (2) democratic political resistance, and (3) professional-amateur innovation. Finally, the paper expands into the importance of engaged scholarship as it presents recommendations for sustainability, scalability, and a digital online space for local DC beekeepers called LiveHive. Here DC beekeepers converse on an online forum about the use of digital sensors, citizen science, and political engagement. The research documents my own exploration into the making of digital sensors for beehive monitoring and further lays the groundwork for how Georgetown University can begin their own journey into the local beekeeping network.
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Many thanks,
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CHAPTER I

INTRODUCTION

As we bite into a crisp apple, our sensations come into contact with a multitude of complex systems from agricultural pollination to socio-political information exchanges. To think about the sheer volume of these systems as we continue to crunch could be overwhelming, but perhaps in that moment, we can adopt a gratefulness for one being that holds these systems together. At the very heart of these interconnected structures is the honeybee - *apis mellifera* - which sits as an unsung hero. These pollinators are responsible for both propagating the earth’s ecosystem with genetic variation and feeding the planet’s human population. Because honeybees contribute to these two large and vital life-giving systems (as well as a number of other sweet products), it is appropriate to study our relationship to them while searching for sustainable solutions for today’s environmental crises.

Rhetoric surrounding the current environmental crises is rapidly changing in response to evolving scientific, technical, and political spheres. Keen to accomplish their goals in biodiversity conservation, environmental NGOs have begun to refine their techniques of persuasion as well. In my paper, I argue that the field of 21st Century urban beekeeping - which proliferates on brick and mortar rooftops and online - is a site where both the natural and the rhetorical character of the hive are expressed. Through this process, I identify three vital aspects of contemporary urban beekeeping that are simultaneously authentic practices within the community and suggestive of their discursive strategies. Given certain characteristics of these communities, my belief is that
these honeybee advocates offer the current biodiversity conservation movement an appealing model for imitation.

This curiosity with honeybees has further generated a tradition of hobbyist beekeepers participating with citizen-engaged scientific inquiry surrounding pollinators. The emergence of similar layperson-involved science initiatives also began in fields of local weather monitoring and biodiversity cataloging in the second half of the 20th century. From these initiatives evolved the term “citizen science” which implied citizen-engaged scientific study. However, many citizen science projects vary by levels of engagement by citizens or scientific institutions with differing outcomes and motivations.

Literature suggests that an ideal citizen science project has citizens and scientific institutions equally engaged in the Scientific Method either collecting and sharing data or creating new forms of inquiry. This ideal project would equally aid in answering scientific questions and disrupting the current eco-political system. More recent literature evolving from 2000 - 2015 further suggests that the emergence of digital technology is a solution to finding this balance between citizens and scientists working with scientific institutions and disrupting the socio-political system. Finding this balance can be aided by digitality through the emergence of Web 2.0 as a digital communication space and the evolution of low-cost, open-source environmental sensor technology; these can lead to a future socio-technical space for citizen science to run sustainability.

Scholars have envisioned this space in the form of techno-sustainable cities as highly digitized innovative spaces interfacing positively with biodiversity and the ecosystem. Similar to citizen science initiatives, they promote a collaboration between local amateurs of engaged and scientifically literate communities with city governments
and technical enterprises. This shift specifically related to environmental ideology has also been called Conservation 3.0 by a number of environmental conservation organizations as it not only protects nature and provides for human communities but stimulates technological innovation to aid in that relationship.

Beekeepers, in fact, engage in the techno-positive Conservation 3.0 paradigm through online forums displaying rich digital communities of beekeeping knowledge exchange. This paper intends to analyze the discourse and arguments used within these digital spaces to explore the role of urban beekeepers as citizen scientists. The analysis asserts that the rhetoric used in beekeeping communities marries the three goals of Conservation 3.0 in that it protects the environment, engages human populations, and stimulates technological innovation to aid in that relationship. Each of these goals are addressed through three themes found in the forums including (1) participatory citizen science, (2) democratic political resistance, and (3) professional-amateur innovation.

Finally, on a personal note, I am further interested in this topic as an urban beekeeper, myself, living in Washington, DC. I first became a beekeeper as a student at American University as one of my professors ran the beekeeping society. Before I knew it, I was the President of the campus beekeeping society and needed to learn as much about bees as I possibly could. Throughout this process, I was surprised to find that I not only became fascinated with beehive behavior, but also with the entire culture of topics surrounding urban beekeeping including community meetings, beekeeper knowledge exchange, urban eco-politics, citizen science, sustainable development, biology, hive cameras, and food systems. With this fascination, I delve into this research looking to better understand that culture.
Beginning in 2006, a cultural phenomenon emerged known as the public rallying call to “Save the Bees.” The phenomenon took hold of news outlets, company marketing strategies, and internet memes. Suddenly, the well-being of this small insect was the concern of individuals with previous disinterest in the creature. This widespread public concern can be attributed to repeated media coverage of the emerging illusive and dramatic honeybee-killer known as Colony Collapse Disorder (CCD). In 2006, news outlets began to report that honeybees were falling prey to a mysterious affliction in which millions of bees would go missing from their hives. Moreover, the remaining Queen and few bees left displayed signs of immune system failure and would be unable to sustain the colony. For news outlets, CCD served as the perfect murder mystery observed Rowan Jacobson author of *Fruitless Fall*. There were missing creatures, a variety of physical maladies affecting the remaining bodies, and a flurry of fingers pointing in every direction in an attempt to pin down the culprit (Jacobson).

While the mystery has still gone unresolved, the public outcry has only intensified as companies have also expressed concern for the plight of the bees. General Mills removed Buzz, their honeybee mascot, from their Honey Nut Cheerios cereal boxes and left simply a white bee outline to talk about the missing honeybees. They then prompted consumers to plant more seeds to help save the bees and offered to send them a free package (General Mills). Additionally, Whole Foods Market ran a media campaign in one Rhode Island store displaying empty shelves missing such foods as apples, pears, and strawberries all pollinated by bees. In their online media campaign, they post two pictures
of the store with and without these products and write, “This is what your grocery store looks like without honeybees,” (Whole Foods Market). Both of these instances used blank space to convey the potential consequences missing bees with have on food resources.

These campaigns appropriately drew attention to the enormous role of honeybees in U.S. food systems. Because domesticated honeybees pollinate 1/3 of our agricultural system in the United States, the collapse of honeybees is a serious threat to food systems, economic structures, and widespread ecological management (Jacobson). Moreover, their pollination is essential to the continued genetic variation found across our biodiverse ecosystems and therefore the trouble with honeybees needs to also be at the center of discourse surrounding biodiversity conservation. “Conservation of biodiversity of honeybees and wild pollinators is important to realize the potential yields of several cross-pollinated crops, hybrid seed production, crops grown under poly-house conditions and in conservation of rare and endemic species in the country,” asserts the Central Potato Research Institute (CPRI). Having responsibility for both human food systems and propagating genetic biodiversity, bees have to sustain the health and security of an abundance of living things on the planet.

And while scientists have not been able to agree on a cause for CCD, the issue has prompted researchers to investigate our historical relationship with the honeybee. The honeybee evolved on the African continent but has since migrated to Europe, Asia, and Oceania. As these bees migrated north, they developed adaptation behaviors for a colder climate and started to seek shelters to build their hives. Capitalizing on this behavior, humans began to move these hives into man-made shelters of wicker or wood, thus
beginning the domestication of the insect by beekeepers. Using honey and wax in many religious institutions, European colonizers then brought the honeybees across the ocean to the New World. Notably, Native Americans reported that they had never encountered the honeybee before European colonizers arrived on their shores (Jacobsen).

As Europeans continued to migrate across the continent, a series of non-native plant species, such as the apple tree, traveled with them. When industrial-style agriculture and urbanism evolved to harvest both these non-native and native plants, the continent’s ecosystem dramatically transformed to reflect large spaces of concrete, lawn grass, and miles of monocrop species dominated by corn and soy. This has left the native pollinators, such as the bumble bee, with a lack of diversity of foliage and nutrients leading to a vast number of native pollinators now facing the threat of extinction. With this threat to native species, domesticated honeybees now residing in North America have been bred extensively in the last half century to fill to role of pollinators in our agricultural sector (Jacobsen).

However, when our hero honeybee began to face the threats of Colony Collapse Disorder, the scientific and political communities started to ask how we as a society were going to address the larger environmental crises. “When beekeepers in Florida are paid to load their ‘six-legged livestock’ onto flatbeds and truck them thousands of miles to pollinate California almonds in February, Washington apples in March, South Dakota sunflowers and canola in May, Maine blueberries in June, and Pennsylvania pumpkins in July, the system hovers on the edge of breakdown. Today there may no longer be enough bees to pollinate our crops no matter what the incentive,” (Jacobsen 16). Likewise, scientists have not been able to discover the cause of CCD and currently name it as a
possible combination of systemic problems including the effects of neonicotinoids in pesticides, climate change, monoculture, overworked bees, and hive pests. However, the explanation that the entire environmental system is nearing breakdown leaves the world with doubts of how to find solutions to a very complex problem (Jacobsen).

At the same time, this crisis has brought about an upswing in urban beekeeping in U.S. cities such as Seattle, DC, New York, and San Francisco for the last decade (Moore). Urban honeybees have been reported to survive the winter at a 62.5 percent rate while rural bees were reported to have a substantially lower 40 percent survival rate. This staggering difference has been attributed to the greater biodiversity of plant species found in cities as compared to the vast monocrops of rural areas. In addition, scholars suggest that urban spaces have distance from industrially-used pesticides which are thought to have large negative effects on bees (The Cornucopia Institute). With these benefits in mind, urban beekeeping told hold of small communities where these urban beekeepers typically supported their hives on the rooftops of apartment buildings in a similar vein to community rooftop gardening.

Urban beekeeper and ethnographer, Lisa Jean Moore described the rapid culture of New York urban beekeeping in Buzz: Urban Beekeeping and the Power of the Bee. She asserts that urban beekeepers gain cultural capital from the experience. The social networks created within beekeeping produced a beekeeping knowledge that then became a source of capital and exchanged. This knowledge enriched the experiences and environmental awareness of the urbanites. “It became clear to us that we had no clue as to how complicated the bees’ networks were – their relation to each other as members of a hive, to other hive colonies, to other species, to the local flora and fauna, from cherry
trees and milkweed, to mites and wasps and back to humans,” (Moore 17). As the beekeepers spent days in and out tending and watching these hives, they began to think about their surrounding environment as more than late trains, broken water pipes, or the emergence of a deli around the corner and instead became very aware of the surprising existence of non-human life that exists all around urban spaces.

As beekeeping led the urban beekeepers to an understanding of these complex environmental networks, Moore described this understanding as the buzz. “The buzz as a conceptual reverberation or an echo, is where the sound bounces back and forth between objects. It speaks to the exchange between organisms that is often obscured by humans and humanism and to the tendency toward preoccupation with the needs of our own species. Thinking about our multifaceted relationships with bees led us to question our own actions and choices, the problems that stem from our humanness,” (Moore 61). This buzz offers the idea that humans anthropocentric views were the cause of environmental degradation and if only we watched and listened more to other creatures would we be able to ameliorate the misunderstandings between humans and sustainable design.

Moore’s use of the buzz stands as a tool for academic persuasion and instilled my own curiosity of how environmental organizers and authors used rhetoric to communicate experiences, ideologies, or research findings. Using the term “rhetoric” may cause others to believe I’m implying that these authors are being disingenuous, non-factual, or manipulative in their use of persuasive tools, but in truth, rhetoric is found in all fields of communication and is under utilized in analyzing fields of science related to the environment. While a scientific fact is still factual, it will always be presented with given context, potentially a selection of visuals, or in light of a larger cultural political
statement. Moore’s buzz then draws from the physics of sound made by bees in flight in a way to conclude that understanding how humans are affecting the environment goes along with deciphering the meaning of sounds made by the bees - a similar statement to those calling for people to “Listen to the trees!”

Perhaps this bee buzz is seen as our door to the natural world and has been so alluring to humans because we see beehives as reflective of our own human society. Throughout history, honeybees have been heralded as master engineering and calculating communities by those working with emerging technology. Their hives are seen as exemplary of sustainable building feats and they demonstrate geometrical prowess for utilizing the hexagon shape. It is, of course, debated if the hexagon is an intentional choice of the honeybee or a sheer happenstance of the wax material combined with bee body heat. In more recent conversations, bees have been a topic of discourse related to machine automata, networked telecommunications, and the emergence of a globalized social information structures referencing swarm intelligence, (Parikka). “Insects are continuously distributed across a social field,” observes author of Insect Media, Jussi Parikka, “not merely as denotations of a special class of icky animals but as carriers of intensities (potentials) and modes of aesthetic, political, economic, and technological thought,” (xii).

Parikka further illuminates the role of bees in particular as carrying heavily into the political realm as western politics. Political rhetoric continuously used honeybees in discourse surrounding government structure ranging from monarchism, communism, and industrial capitalism. Honeybees were used extensively as symbolic decoration by Napoleon and his empire, adopted by the French worker unionists and communists in the
late 1800’s as symbols of collective socialist actions, and then even used in Tolstoy’s War and Peace to describe the collapse of Russia as a collapse of the honeybee hive of Moscow, (Parikka). Honeybee hives have repeatedly been seen as political creatures with a variety of governmental structures and they remain a subject of political discourse still today. In 2010, entomologist, Thomas Seeley described the hive as “a harmonious society, wherein tens of thousands of worker bees, through enlightened self-interest, cooperate to serve a ... common good,” (Seeley, 6).

Seeley’s *Honeybee Democracy* (2010) went on to describe the complex communication and decision-making habits between the individuals of the hive as democratic. This popularized the idea that honeybees demonstrate a productive politically democratic society, (Seeley). Even as an entomologist, Seeley looks to see the connections between humans and bees in his work and rhetorically draws on the philosophy in ethics known as enlightened self-interest as if its meaning within human societies could possibly be the same as in bee societies.

Following Seeley’s work, Bill McKibben, founder of environmental NGO, 350.org, published *Oil and Honey* (2013). McKibben’s book painted two opposing political futures: (1) Honey, which drew on the local democratic decision-making of beehives in support of a naturalized type of local agricultural movement and a symbiotic relationship with the earth and bees for resource generation, and (2) Oil, in which the U.S. political system continued to fund the sticky fossil-fuel industry and congress which remained influenced by what he characterized as the extractive, crude, and dirty corporatocracy of the oil industry. He applauds Seeley’s narrative in *Honeybee Democracy*, “Here is Seeley’s commonsense summation of what bees have to teach us
about decision making; interestingly, they are principles that dominate at town meetings,” he posits, “An exercise of consensual democracy,” (76-78). McKibben then calls for local communities to start engaging in civic actions to aid in the fight against Climate Change through demonstrating their democratic rights including contacting Congress, engaging in local community meetings, and marching against the KeyStone XL Pipeline.

And so, this buzz is more than just a reverberation of our relationships with the bee and other animals and rather, it is the reverberation and echo of the technical, cultural, and political outcomes and discourses surrounding human relations to the surrounding environment. Humans see themselves reflected in the honeybee over any other creature because of their seemingly political and technical structures. Beekeepers then also see themselves as further extensions of these entities engaging in these structures; after all, beekeeping is a symbiotic and sustainable model between humans and the environment which is spurred by the technical mediation of the man-made beehives.
CHAPTER III
CONSERVATION 3.0

As noted, the honeybee acts as an unsung hero to both our agricultural system and the fate of biodiversity on this planet which are both complex and interconnecting ecological systems. Biodiversity has been defined as “the variety of all forms of life, from genes to species, through to the broad scale of ecosystems,” (Stanford University). In simpler terms, biodiversity can be seen in the sheer volume and variety of butterflies, corals, or oak trees on this planet. As each species evolved on Earth, they developed specific adaptations for maximizing their survivorship while interacting with their surrounding environments and other species. While extinction is a natural occurrence in evolution, it typically occurs at about one to five extinctions a year. Scientists have estimated that today, biodiversity is experiencing 1,000 to 10,000 times that extinction rate. This disastrous situation has been termed the 6th Greatest Extinction of life on Earth - comparable to the loss of the dinosaurs. However, this extinction is human-induced from a number of factors: the growing human population, destruction of natural habitats, extraction of toxic resources, pollution, climate change, poaching, and invasive species (Chivian and Bernstein).

Indeed, so great are these declines that some have felt compelled to identify our era as especially significant calling it the Anthropocene. In 2000, Paul Crutzen and Eugene Stoermer proposed that the effects of human modification to the planet had so drastically changed the environment that the Holocene geological epoch had changed and would be renamed the Anthropocene. These planetary changes included such things as the creation of a new atmospheric chemistry far more dominated by CO2 from the
burning of fossil fuels, the creation of new geological forms including asphalt, concrete, and plastics, and the 6th Greatest Extinction of life on this planet. “A daunting task lies ahead for scientists and engineers to guide society toward environmentally sustainable management during the era of the Anthropocene,” (Crutzen and Stoermer 23). While Crutzen and Stoermer popularized this term, there was even mention of the age of a human dominated planet 140 years leading up to 2000 (Smith and Zeder).

**Conservation 1.0**

In the United States of America, signs of this dramatic environmental change were brought into the political discourse during the Presidential years of Theodore Roosevelt who popularized the role of environmental conservation. Roosevelt was good friends with famous environmentalist John Muir and together, they created a legacy of wilderness conservation in the West. According to the National Park Service, Roosevelt warned, “Here in the United States we turn our rivers and streams into sewers and dumping-grounds, we pollute the air, we destroy forests, and exterminate fishes, birds and mammals -- not to speak of vulgarizing charming landscapes with hideous advertisements. But at last it looks as if our people were awakening,” (National Park Service). In a similar stance, Muir also ignited this American preservationist perspective. This ideology spoke about the wilderness as embodying the sublime or a silent and peaceful nature exemplifying the work and spirit of God. However, this ideology often painted humans as the corrupting force to nature stating that if humans inhabited a space, it was no longer wild. "God never made an ugly landscape. All that the sun shines on is beautiful, so long as it is wild," wrote Muir in *The Scenery of California* (Sierra Club). Taking these environmental stances lead Muir and Roosevelt to set aside swaths of
protected nature that humans could not inhabit - what is now known as the National Park System in the United States.

Teddy Roosevelt’s and John Muir’s contributions to American environmentalism through the National Parks System have been heralded as potentially the only thing that maintained some of North America’s unique biodiversity in the last century. However, the preservationist ideology at times rested in forms of colonialism (Adams and Mulligan). As the Parks System continued, authorities removed native tribes from their lands - denoting that alongside Manifest Destiny, the land had divine significance. To have any humans inhabit this sacred land would taint its purity as wilderness. With the forceful removal of native populations, the legacy of National Parks went on to only preserve the wild land for the vacationing leisure class who looked to experience short moments of a divine and calm nature away from the chaos of social and urban life (Burnham).

These problematic practices have been coined as Conservation 1.0 by a number of environmental organizations. Jon Hoekstra, lead scientist at the World Wildlife Fund, defined Conservation 1.0 as the legacy of preserving National Parks or what some call “fortress conservation” in which humans are separated dramatically from nature without access to any resources in these designated areas. Hoekstra goes on to describe the new timeline of conservation development from Conservation 1.0, 2.0 and finally 3.0. In doing so, he draws parallels of this procession to that of software updates. Following Conservation 1.0, logically came Conservation 2.0 which looked to connect human rights (access to clean water, economic stability, and food security) into biodiversity conservation (Hoekstra).
Conservation 2.0

Conservation 2.0 engaged in the first step of an environmental paradigm shift in which conservation organizations gained a more nuanced perspective of the human-nature relationship. One such example emerged during the 1960’s as Dr. Jane Goodall began her work on Great Ape conservation in Tanzania, Uganda, and the DRC. At the 2016 International Union for Conservation of Nature, Dr. Goodall was asked to speak in the “Conservation 2.0: Empowering Next Generations” seminar about the role of sustainability conservation education (Pacific Islands Climate Change Cooperative.) Dr. Goodall started her environmental work solely working to protect endangered populations of Great Apes, specifically focusing on chimpanzees. While working in what is now Gombe National Park, she concluded there was no way to protect chimpanzees if the human citizens in rural Tanzania were not aided in their own lives and included in the scientific process (The Jane Goodall Institute).

While Dr. Goodall noted that over-logging and poaching caused the rapid decline in chimpanzee populations, she also observed that the surrounding villages were running out of resources of wood to build their houses and cook. With her deep empathy for both nature and humans, Dr. Goodall challenged the previous notions of pure land preservation. Today, the Jane Goodall Institute spends their energies building partnerships to aid human communities in both getting their needs met and protecting ecosystems. They invest in women’s healthcare, build education programs, and provide scientific ecosystem monitoring jobs to local citizens. The Jane Goodall Institute’s approach is promoted as, “Dr. Jane Goodall discovered that when we put local communities at the heart of conservation, we improve the lives of people, animals and the
environment.” Dr. Goodall uses this tag line throughout her global speeches to emphasize a holistic approach connecting humans and the natural world together (The Jane Goodall Institute).

While this sounds like the obvious, yet still complex solution to our environmental relationship, 2.0 still fails to meet demands. Hoekstra argues that due to the overwhelming extent of modifications the planet is facing from Climate Change and the exponential growth of human population, working towards basic human rights and biodiversity conservation, frankly, is “passive provisioning based on nature's current productivity.” He warns that this is simply not enough to combat the future environmental pressures on this planet in the expectant rapidly changing Anthropocene (Hoekstra). He takes a presentist perspective on the current state of conservation believing that all of this past work has been building to the current state. With this argument, Hoekstra proposes a Conservation 3.0 in which the human interaction with the environment is highly interactive and includes innovative management and engineering practices.

**Conservation 3.0**

“It's time to start developing Conservation 3.0,” Hoekstra proposes, “Like software, Conservation 1.0 and Conservation 2.0 are serving us well, but the challenges of the 21st century require some critical updates. Nature in the future will look different than it did in the past. So too must conservation.” Using language that is reflective of a software developing company, Hoekstra invokes the narrative of technological progress as the logical solution to working in a futuristic environment. By drawing this parallel, he implies the past two movements were necessary components of development but perhaps
were running too slow or the user-experience functionality lacked the seamlessness that consumers were looking for. With this language, the conservation movement looks to attract technology companies, engineers, and computer scientists that were previously unengaged in matters of biodiversity conservation.

This movement looks to build these partnerships to cultivate technological innovation in bioinformatics, engineered oyster reefs, synthetic biology, sustainable 3D printing, and emerging machine-learning for environmental decision-support systems. It embraces digital conservation governance and new forms of technology-enabled citizen science participation like satellite imagery, drones, mobile apps for cataloguing, and environmental sensing technologies (WildLabs.net). With such large technological expectations, it is unsurprising that conservation organizations are looking to appeal to the same language used by Microsoft, Apple, or Google.

With this goal in mind, the World Wildlife Fund partnered with a number of other non-profits and technology companies, including Google, to present WildLabs.net - an online network of conservation technologists looking to share current projects and connect to other innovators and citizen science initiatives (Wildlabs.net). The mission statement on the site reads, “Wildlabs.net is a community of conservationists, technologists, engineers, data scientists, entrepreneurs and change makers. Together, we share information, ideas, tools and resources to discover and implement technology-enabled solutions to some of the biggest conservation challenges facing our planet,” (Wildlabs.net). While Conservation 3.0 radiates with enthusiastic 21st century buzzwords, it also hints at technological determinism, a salesmanship for the newest product on the shelf, and a faith in the potential autonomy of machines to act as our
global savior. To avoid such determinism, it is crucial for Conservation 3.0 to continue to learn from the complicated history of conservation and observe the roles that politics, citizens, and technology played in achieving or failing in their goals. Previous instances privileged the elite over the majority or engaged in “passive provisioning” as Hoekstra claimed in a world that needs instead, to increase equality and stimulate new forms of knowledge for innovation.

While WildLabs.net was launched in 2015, the entire last decade has seen an increase in enthusiasm for citizen participation in environmental science through the use of digital communication technologies. The aforementioned Jane Goodall Institute recently adopted drone technology to observe chimpanzee nesting locations and supplied Android products to Tanzanian citizens who act as forest monitors to collect data. In the field of citizen science, there has been a particularly jubilant conversation about the future of the field from mobile apps designed for bird watching and cataloguing to online and mobile sites made for parking-lot astro-enthusiasts to identify new galaxies. With this movement, Conservation 3.0 looks to not only challenge our conceptions of nature as something that is corruptible by any human inhabitants as 1.0 did, but that nature, humans, and technology are not separate and opposing domains - they are relational entities constantly interfacing with each other.

**Future Craft of IoT in Biodiversity**

The rhetoric of Conservation 3.0 suggests a techno-futurist vision of our planet which has spurred authors and imagineers to engage in postulating about what this should look like. For example, writer of *Animal Internet* (2016), Alexander Pscebera, recently imagined a world embodying this radical rethinking of conservation and envisioned a
highly monitored natural environment interlaced with biodiversity technology where GPS tracking devices would send updates of animal migration journeys to online community members and each time humans step outside, augmented reality would provide them with a heightened sensory state from computer collected data of the ecosystem. He can only envision this under the idea that, “Humans can save the environment and animals from impending ruin only once they divorce themselves from the conception of technology and nature, civilization and wilderness, as competing or dichotomous spheres.” This statement aligns with the ideology of Conservation 3.0 as he continued to describe his envisioned world full of digital sensors and video data collecting devices sending constant animal and environment monitoring streams to our networked communication systems. He further imagined that every citizen would have access to this Internet of Things (IoT) space which he describes as the Animal Internet (Pscbera).

Creating an Internet of Things (IoT) system to monitor wildlife and the environment could allow humans to reflect on our impact on the environment and iterate our designed systems quickly. Pscbera calls his world with an Animal Internet an ecology of resilience. “Instead of reconstructing pre-human landscapes,” he writes, “an ecology of resilience must be measured against its success in revitalizing the awareness among city dwellers of the importance of nature and animals. Only then will it fulfill its critical goal of making the usefulness and beauty of nature approachable for humans, thereby motivating to become co-creators of this beauty. The ecology of resilience is an ecology without fences,” (Pscbera 168). His vision aligns with Hoekstra’s Conservation 3.0 ideology that to prepare for a rapidly changing climate, we can turn to innovative and engineered systems of resiliency.
Cities of Tomorrow

Psbera’s interest in cities as a location for this sustainable future is appropriate because as the human population has been increasing, more individuals now reside in cities than any other dwelling and cities now act as catalysts for social, technical, and sustainable change. With the dawn of the digital age, society was presented with the opportunity to eliminate space as information and communication could be spread at the speed of light to the opposite side of the globe. While theorist believed that this elimination of geographical and physical space would cause humans to remain distant from one another, the opposite has actually occurred. “Instead of flows replacing spaces and bits replacing atoms, cities are now a hybrid space at the intersection of the two. Physical and virtual are fused through a productive collision, where both propinquity and connectivity play an important role,” postulated Carlo Ratti and Matthew Claudel, writers of *The City of Tomorrow* and researchers at the MIT Senseable City Laboratory (20). They believe that the digital revolution prompted the move towards urban physically proximate living and see this as a merging of a socio-technical system.

The future of designed cities and socio-technical systems has also been a blooming topic in the field of sustainable design. As the human population exploded in the last century, those working in sustainability have noted that the most sustainable way for our large human population to live is within cities with more communal resource consumption and less waste. One such example of sustainable design is Songdo, South Korea - a city built and designed to have ecologically sustainable buildings, digital sensors and monitors for the transportation system, and an automated waste system that pulls trash from individual homes for sorting and processing. The highly digitized city
only began development in 2004 and was highly influenced and led by Cisco Systems, one of the world’s leading technology design firms (Claudel and Ratti 27).

Cities embedded with ubiquitous computing are becoming more prominent and causing urban planners to ask new questions about urban design. “Future cities are traditionally the domain of urban planners, architects, and social theorists, but today a new player is entering the arena, using new tools to chase the same ideal: multinational computing giants. Companies like IBM, Cisco, Siemens, HP, and Microsoft are jockeying to build (and program) the city of tomorrow, with the persistent goal of efficiency and well-being,” (Claudel and Ratti 26). Songdo, South Korea was designed in a complete top-down control manner in which the master city planners and Cisco considered urban problems on a macro level and looked to address the higher level of design before breaking it down into smaller parts. This style is opposed to a bottom-up approach (popularized by Jane Jacobs’ Greenwich Village) which looks to start in micro areas such as neighborhoods and grow up into more levels of complexity typically valuing high participation of citizens.

Throughout the history of urban design, the debate between top-down and bottom-up has caused significant strife and political tension. Ratti and Claudel argue that with the future of digitality, “A merger of top-down and bottom-up systems can invite wide-spread engagement and mean effective implementation of solutions, ideally resulting in livable urban spaces,” (35). These authors assert, “Just as ordinary people have hacked software, “citizen developers” can begin to hack their city,” (36). They believe that effective channels for networked communication of city planners, amateurs, artists, and experts spreading technological information will be crucial. “Our work is
meaningless unless it ignites imaginations and provokes debate: design by mutation is
intrinsically collective,” they declare, (9).

To find this type of citizen developer urban planners could look to the culture of
the “pro-am” or professional-amateur as Charles Leadbetter described in his 2006 Ted
Talk, *The Era of Open Innovation*. He asked, “Who invented the mountain bike?” and
then explained that the mountain bike was developed through a community of users (of
bikers) in northern California dissatisfied with the current status of either racing or
cruising bikes and worked together to find parts and build their ideal bike for the
California mountains. He described these bikers or any users that operate in these special
interest communities as pro-ams. “Pro-ams are amateurs. They do it for the love of it but
they want to do it to very high standards. They work at their leisure. They take their
leisure very seriously. They acquire skills, they invest time, they use technology that is
getting cheaper. It’s not just the internet - cameras, design technology,” (Leadbetter). He
further argues that pro-ams are the reason for radical technological innovation because
they have high vested interest in the future of their activity to begin with. “When the
internet combines these passionate pro-am consumers who are knowledgeable, they have
the incentive to innovate, they’ve got the tools, they want to - that you get this kind of
explosion of creative collaborative operation,” (Leadbetter). Pro-ams provide the passion
for radical innovation while the internet could potentially provide the effective channels
for networked communication to move them towards becoming networked citizen
developers.
A Space for Urban Beekeeping

One such community that could be defined as pro-ams would be urban beekeepers. Urban beekeepers are known to invest a vast amount of time, money, and energy into the craft of urban beekeeping simply for the generation of intrinsic value. Their leisure activity requires days of their lives hands deep in bees or nose deep in beekeeper guidebooks. They hold this craft to a high standard; they speak about it over dinner; they attend weekly local beekeeper meetings; they read every news article that comes out about bees; they invest in new hive tools; they experiment with new hive styles. While honey does provide a small economic incentive for beekeepers, the majority of capital exchange between urban beekeepers is social capital and the dissemination of ideas and knowledge (Moore and Koust 522).

Engagements with urban rooftop farms and urban beekeeping are “tied to larger cultural trends, personal lifestyles, and philosophical perspectives that involve cultivating and integrating eco-politics into everyday urban life,” (Moore and Koust 522). Bringing us back to Moore’s buzz, urban beekeeping suggests an ability to evaluate our relation to the environmental sustainability of the city through a growth of eco-political knowledge exchange. Such a behavior trend indicates the presence of a Knowledge City which is defined as “a response to the changing global environment by generating, distributing, and using knowledge in many ways to balance economic prosperity, human development, and socio-environmental sustainability,” (Dizdaroglu 1).

These designed Knowledge Cities have four development goals that look to stimulate the knowledge of our own system and unsurprisingly, beekeeping falls under all four development areas for Knowledge Cities. These areas include (1) providing a strong
local economy that can be integrated with the global economy through providing technical knowledge and skills for products and services, (2) provides education and skill building for quality of life, (3) aids in the development of long-term strategic policies, and (3) is ecologically sensitive and sustainable. These Knowledge Cities also champion sustainability assessment technology that can help decision-making through environmental monitoring using the affordances of cameras, sensors, GIS capabilities, videos, and networking ability (Dizdaroglu 4).

Washington, DC is qualified as a Knowledge City and its urban beekeeping community aligns with these four required development goals. Urban beekeeping communities in DC participate in selling their honey to local restaurants or breweries (George Washington University) as well as building an economy of breeding and caring for new hives around the city (DC Beekeepers Alliance). Furthermore, urban beekeeping groups host community meetings, teach-ins, mentorships, and social outings for skill building, (DC Beekeepers Alliance). While urban beekeeping was spreading across the city, Michelle and President Barack Obama helped approve a White House beekeeping initiative getting their own “First Hives.” Then in 2014, President Obama released a “Presidential Memorandum - Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators” to push a number of funded projects and policies to aid bees, (Obama). Finally, urban beekeeping has benefits on the urban environment as it contributes to pollination across the city. Moreover, the urban environment benefits the bees because urban spaces typically provide a greater diversity of plant species and therefore cause the honeybees to have stronger immune systems (Claußnitzer). With all of these development goals being reached through beekeeping, we then further ask
ourselves what can be the relationship between urban beekeeping and digital
technological tools? How could combining scientific institutions related to pollination
with citizen empowerment be affected by the advent of the digital?
CHAPTER IV
CITIZEN SCIENCE

Entomologist and well-known biodiversity conservationist E.O. Wilson has noted that the field of environmental conservation faces many obstacles in scientific predictive modeling due to the complexity of real world situations. He has observed that it is difficult to experiment in labs with ecological research because of the level of uncertainty that comes from the interactions that happen in the wild. Because of this, Wilson advocates for biodiversity and ecological scientists breaking into the interdisciplinary world of real-time field-based citizen science research in search of new ways of understanding and digitally collecting data, (Wilson). However, because the term citizen science has been adopted by so many initiatives, it is important to set out the definition and type of citizen science that this paper will be expanding upon.

Defining Citizen Science

Countless educators, academics, and community organizers use the term citizen science to define any and all citizen participation in the field of science. This can include taking pictures of local birds, public health advocacy work, donating swabbed cheek cells for DNA analysis, or spending hours combing through star images to categorize galaxies. In *The Rightful Place of Science: Citizen Science*, Drs. Caren Cooper and Bruce Lewenstein argue for two distinct meanings of a “citizen science:” 1) a Democratic Citizen Science and 2) a Contributory Citizen Science. Drawing on the term’s recent use among scholars and advocates, Cooper and Lewenstein argue that a clearer sense of what citizen science does, and how, may help the field of science better draw on this resource.
For Cooper and Lewenstein, Democratic Citizen Science is best defined by Alan Irwin, who writes in *Citizen Science* (1995) that citizen science is effectively a form of political action, one comparable to “activist science” and “public engagement.” Situating his argument along a trajectory pioneered by Dickens, Wordsworth, Habermas, and Marcuse, Irwin means to identify how members of a techno-scientific culture can adopt the means to see their culture, and themselves, clearly. Echoing a frequent chorus since the 18th Century, Irwin writes that we are at a point “where a rethink of the linkage between science and everyday life is urgently needed” (2). One part of that “rethink” consists of observing (as many had already done by this point) that knowledge would quickly displace manufactured goods as the coin of the realm: Science, as a source of endless knowledge production, must play a central role in any sensible organization of society. To that end, Irwin observes, Democratic Citizen Science can be understood along two complementary lines: First, “science should address the needs and concerns of citizens,” even as, second, the production of knowledge capable of meeting those needs “could be developed and enacted by citizens themselves,” (Cooper and Lewenstein 53).

But even as he sees science moved out of the private lab and into the public square, Irwin characterization of that square is hardly antiseptic or voided of culture. “People bring into science such things as local contextual knowledge and real-world geographic, political, and moral constraints generated outside of formal scientific institutions,” (Cooper and Lewenstein 53). From public health advocates rallying for ethics in AIDS research in the late 80’s to local landowners protesting against the myriad dangers of fracking, Irwin’s model responds to the urgent need to bring scientifically-
literate thought to bear on the complex techno-scientific problems of the polis (Cooper and Lewenstein 54).

Contributory Citizen Science, on the other hand, is defined through Rick Bonney from the Cornell Lab of Ornithology and focuses on citizens contributing observations and data to the Scientific Method. In regards to ornithology, it developed new bird cataloging efforts and engaged volunteers to collect bird spotting data for the lab. However, this was also first noted earlier than Bonney in an example cited by the Oxford English Dictionary as “the collection and analysis of data relating to the natural world by members of the general public, typically as part of a collaborative project with professional scientists,” (Cooper and Lewenstein 55). This definition then references the 1989 National Audubon Society using the term citizen science to describe their initiative for volunteers to collect and test the acidity levels in rainwater and send the samples to the Society’s headquarters.

Contributory Citizen Science is typically organized as a top-down project where an institution creates an established goal and reaches out to volunteers to collect data for their research. However, this contributory definition has also been transforming. “More recently, the term has been used to describe a wide variety of styles in which the public helps carry out any of the steps of the scientific method whether conceiving of the research questions, designing methods, collecting the data, or interpreting results.” Cooper and Lewenstein redefine this second meaning of citizen science as “participatory” rather than “contributory” since examples of this type of project allow citizens to have a greater collaborative relationship with the institution or scientists (Cooper and Lewenstein 55-59).
A combined use of both meanings of citizen science in which Irwin’s democratic model and Bonney’s contributory or participatory model would create the ideal version of a citizen science project according to Cooper and Lewenstein. “Practitioners seek a hybrid,” they explain, “a gold standard of citizen science practice in which people do more than contribute data and researchers do more than use the data. Citizen science strives for designs that will achieve what Irwin envisioned with his original use of the term: “scientists engaging with people in ways that deeply shape what we know about the world.” This hybrid would involve citizens collecting data and participating in the scientific process of determining questions and interpreting findings. Additionally, it would also move this scientific work into the public space of policy, advocacy, and the future discourse on science (Cooper and Lewenstein 59).

**Citizen Science: Co-creation**

Hybrid projects such as this have a *co-creation* agenda. Authors Teresa Schafer and Barbara Kieslinger support the co-creation model of citizen science and have created a figure to display the parameters of the co-creation model definition. This depiction is on an XY coordinate plane include the variables of knowledge producers and project focus. The knowledge production can come at one end, from the scientific researchers and the other end, from the citizens. The project focus can be at one side, answering scientific questions or at the other, creating interventions in socio-ecological systems which translates to policy action. Co-creation projects, however, lie equally in the middle of all of these factors (Keislinger and Schfer 4).
Figure 1. Schafer’s and Kieslinger’s model of co-created projects.

At the bottom left corner where researchers are the main producers of knowledge and the focus is on answering scientific questions, we have examples of citizen science like volunteer computing. This is where citizens offer their computers to larger processing servers to run complex computations. In the upper right corner where citizens produce most of the knowledge with a focus on creating interventions in socio-ecological systems would be political citizen initiated projects. An example might be community members collecting samples after the BP oil spill with potentially scientific organizations sending citizens materials to do so (Cavalier and Kennedy 5).

In the bottom right corner where researchers produce knowledge and the focus is to create interventions in socio-ecological systems are projects such as contracted education work. An instance of this may be an educational workshop on how to find and
identify fossils and this is typically in the form of science communication. In the upper left corner in which citizens provide most of the knowledge and the focus is on answering scientific questions lies collegial projects. These are projects in which the citizen collects data and can make their own hypotheses and inferences, but will have very little personal interaction with scientists and policy. An example like this is the extension of citizen science project GalaxyZoo where citizens collect data on space images, but volunteers can also define their own research questions to investigate (Cavalier and Kennedy 5).

In the middle of this matrix lies the co-creation goal praising an equal exchange of all four themes. In this citizen science project, there is a sharing of information and data which allows both citizens and researchers to produce knowledge based on the information. In addition, the project would be invested equally in answering scientific questions and working towards interventions in socio-ecological systems that would better the general public's interests and needs. Such a project would be both participatory and democratic as well (Cavalier and Kennedy 5). This type of model seems idealistic and elusive, however, the emerging role of digitality may aid in supporting this agenda.

**Digital Citizen Science**

While the term citizen science came into popular use in the last decade or so, James Wynn, author of *Citizen Science in the Digital Age*, depicts the history and changing dynamics of models of citizen science using technical instrumentation as they evolved from the mid-nineteenth century into the modern digital age. In the mid-nineteenth century, the Smithsonian Institute began their first project that could be considered citizen science through collecting public weather observations to aid the fledgling field of meteorology. This program began with newsletters mailed throughout
the United States asking for volunteer weather observers. After certain members of the public responded, they began to receive standardized forms from the Smithsonian for weather data observation. A portion of those who replied also had access to basic and inexpensive data recording equipment including barometers. These technologies act as an early forms of today’s inexpensive digital sensor tools (Wynn 13).

These standardized data collecting forms and the emergence of basic citizen-accessible technological instruments acted as important pieces of the historical framework for the future of digital citizen science. Wynn argued that with the advent of digital technology, citizen science grew exponentially within the academic sphere. He observed that in 2006, there was a sudden increase in the term citizen science being written in scientific academic papers and he believed, “This newfound recognition is not the result of the emergence of a new find of activity, but rather a consequence of the increase in the payoffs and a decrease in the obstacles of traditional lay data collection made possible by the development of digital technologies,” (Wynn 26).

Wynn points to a number of changes to citizen science that were caused by digitality. He cites the emergence of spaces for easy-use online communication and information exchange between citizens and scientific institutions, the power of the networked architecture of the web for outreach about projects, and the evolution of low-cost digital sensors that, like the early weather monitor barometers, democratize the information gathering phase of citizen science. He also extolled digitality for enhancing the speed and standardization of citizen-provided data on the web which allowed for participants to quickly receive feedback on their contribution. Immediately after the Cornell Lab of Ornithology implemented instantaneous feedback web features, they
reported that the number of individuals submitting information to their citizen science project tripled. Finally, “the internet has made the diversification of sources of funding citizen-science projects possible. Crowdfunding sites like Kickstarter, for example, allow scientists and even laypeople interested in doing citizen science to find financing for their research outside of traditional institutional sources like governments and foundations,” according to Wynn (25).

**Citizen Science for the Future**

As Conservation 3.0 moves forward, it is imperative that it highlights the guiding themes and lessons presented from the history of citizen science as participatory, democratic, and digital. If the movement hopes to argue for a new conservation paradigm interlacing nature, humans, and technology, it must evaluate the role of both participatory and democratic citizen science which address the challenges of protecting and learning about our ecosystems and strengthening the relationships between citizens and scientists to empower political action. To create these hybrid models of co-creation, digital technology can play a vital role in enhancing these participatory and democratic projects through offering spaces for networked information dispersal, democratizing information collecting instruments, standardizing information exchanges between citizens and scientist, and opening new possibilities for hypothesis building, project initiating, and fund gathering.

This model of participatory, democratic, and digital citizen science as the ideal co-creation project is similar to Ratti and Claudel's idea of a hybrid model for sustainable urban planning. Again, their model envisions a city of citizen developers emerging from bottom-up grassroots and working alongside top-down institutional models of urban
development. As honeybees are a popular topic of discussion in both scientific circles and urban citizen engagement, this paper asks in what position does urban beekeeping fall in terms of citizen science models? In what position could urban beekeepers take in the role of sustainable and urban technological development as citizen science participants and citizen developers?
CHAPTER V

METHOD: RHETORIC OF INQUIRY

Digital citizen science researcher James Wynn further explores the culture of these citizen-science initiatives through the lens of discursive social interactions as he argues, “Because this investigative space includes social, political, and epistemological dimensions, it invites exploration by fields broadly interested in this phenomena and with the available concepts and methods for describing them. The field of rhetoric has these qualifications.” He continues to make the case that the field of rhetoric acts as an appropriate method for studying citizen science as it examines the historical, linguistic, and social components of intellectual conversations (7). At the same time, Wynn cautions that conventional rhetoric - so deeply rooted in the Medieval academic tradition as the final third of a tripartite Trivium - comprising logic, grammar, and rhetoric -- is only one aspect of the versatile method. As he notes, one of the features that promises to enhance citizen science projects is the diffuse, democratic interface of Web 2.0: A loose set of principles that make users the chiefest source of content, allowing for digital citizens to engage more deeply with one another.

At first, Rhetoric of Inquiry may seem incompatible with digital research due to the perception that rhetoric is reserved for studying the medieval academy. Fields such as social network analysis, sentiment analysis, or semantic analysis might be called into use for digital sites. However, while advertisers are turning to large quantitative datasets of expression like this, the academy is facing a dilemma in which these uniform toolsets deployed to capture the numerical representation lacks nuance and causes an oversimplification of contexts within the complex discourse of humans. Because of this,
rhetoric as an older method may still be of some uses here. Nancy Streuver, offers a useful characterization of the potential for rhetoric as inquiry as she writes, “It is one thing to take a ‘linguistic turn’ and proclaim language as the core of politics,” Streever observes in her *Rhetoric, Modality, Modernity* (2009), but “it is another to proclaim the political core of language, for this generates a list of useful investigative priorities,” (91). She further speaks to her concern that we work to draw the moral from the civil, and not the other way round. This would reflect a rhetorical analysis that works to make sensible the character and quality of political exchange and track how we conjure our environment instead of a rhetorical facility that sees itself as the root of all things.

**Rhetoric of Inquiry in the Field**

Bearing more directly on the immediate needs of this project, rhetorician Carl Herndl’s interests are less in the resurrection of a long-abandoned intellectual role for rhetoric alongside philosophy than it is in arguing for rhetoric’s capacity to accommodate otherwise extra-disciplinary research. “Scientists often see a problem as having a technical solution,” he writes, “while scholars from the humanities look to critical thinking through social acts to bring critical thinking through social aspects to such issues,” (8). In his introduction to *The Symposium on Engaged Rhetoric of Science, Technology, Engineering and Medicine* (RSTEM), Herndl looks to make use of the tropes of rhetorical analysis in the space between the social sciences and STEM fields. Conventional disciplinary expectations make interdisciplinary solutions difficult to achieve by effectively stacking the deck against interdisciplinary inquiry, he suggests, novel methods drawn from other parts of campus can only be as effective as the solution
we expect to propose. If it is the discipline that defines a range of possible outcomes in rigidly disciplinary terms, no amount of interdisciplinarity can redeem that project.

As Herndl makes the case for the evidentiary value of research into the *rhetoric* in which science and technology discourses are grounded, he cautions that the outcome of this inquiry is best understood in novel terms. “Scholars in engaged RSTEM can help augment the analytic question in science projects,” he writes, “with ethical questions about why and democratic or deliberative questions about how that are often absent from these conversations,” (Herndl 7). Thus, for Herndl, this methodology yields outcomes that belong to a conceptual domain all its own; outcomes are diminished by the temptation to deploy this rhetoric of inquiry in conventionally scientific or humanistic terms. In this vein, it is imperative that those working in rhetorical methodologies understand what type of space that encompasses. Herndl sets a distinction of purpose for those working the the RSTEM field as he suggests “that the relationship between rhetorical theory, criticism and engaged practice presents at least two difficult challenges. I describe the first as the challenge of working with science rather than for science,” (Herndl 8). After this statement, he continues, “The second challenge in the relation of theory to practice is the issue of tool use. We need to turn the insights of rhetorical theory into strategies and tools for doing engaged work,” (Herndl 9). In these two thoughts, he outlines the fundamental problems that rhetoric of science and technology can be commandeered by the scientific field and that the rhetorical tools are encouraged to be simplified and banal.

In the first case, we can see that rhetorical analysis can find itself falling into the practice of working for the scientific institution it intended to critique. This form can
come as a communicative practice most commonly seen as institutional PR. One such example may be the communicative role of bioengineering or geophysical science-based companies. Herndl explains that to counter this, the field must remember, “We want to participate in mission-oriented science projects that often induce us to embrace the ethos and framing of science, but this often makes it difficult to maintain some critical and analytic difference and distance. That difference is, however, much of what makes us useful,” (Herndl 8). This distance helps the field remain free of obligation and defines itself as working with rather than for the STEM institution.

The second challenge can be expanded upon through Herndl’s belief, “The tension I see is between our commitment to sophisticated concepts and rhetorical practices that avoid reductive simplification and the demand for simple tools and utilitarian practice,” (Herndl 9). This is further applied to the concepts of “applied” and “useful” rhetorical scholarship. “Applied” would be increasing public education about scientific concepts such as a media explanation of global warming to the general public. “Useful” on the other hand would be “coming to understand a phenomenon or question and its rhetorical effects,” (Herndl 9). An example of this might be understanding how culture discusses how society should respond to global warming and how they envision a future notion of a sustainable planet. The challenge of modern day environmentalism may lie in the fact that global warming education exists, but without studying the societal rhetoric and response to the notion, we find ourselves faced with climate deniers occupying high government positions. Herndl finds that simplified versions of these applied tools are “of the sort that too often troubles science communication when it is
seen as merely an efficient conveyer of scientific truth or as a response to the deficit model of public understanding of science,” (Herndl 9).

Due in part to some of these challenges, rhetoric of science and technology often gets siloed into a single disciplinary space rarely acknowledged by the scientific community or relevant other disciplines. By perhaps being tossed into spaces of PR or science education, it is rarely engaged with on an academic level. However, Herndl acknowledges the work of John McGowan who notes that this literature is finding a different space to occupy as he writes, “‘Engaged work will, very likely, come in forms that are not peer-reviewed, are often digital, sometimes ephemeral, and at other times emphasize process over product’ (McGowan, 2010, 416),” (Herndl 9). To cross disciplinary boundaries, to be involved in community-based analysis, and not fall into the traps of PR or top-down science education tools, rhetorical methodology may utilize digital space to flourish.

The Digital

Emphasizing process over product is a key element that rhetorical analysis can use to avoid acting for disciplines and rather acting with them. This emphasis is crucial to the methodology despite the frequently indifferent reception it receives from academic grant programs. However, one such example of digital and ephemeral forms of research is the vast library of information that the internet provides on changing and evolving cultural standards and notions. In a sense, the open, accessible nature of digital space also can promote democratic forms of information exchange which allows for rhetoric to engage with real-time documented peer-to-peer discourse in varying disciplines. Herndl describes this proposal as, “Designing communication strategies among researchers and
between research teams and communities can facilitate just the sort of productive boundary work that helps members of large interdisciplinary teams escape their own disciplinary silos,” (Herndl 8).

In this sense, rhetoric of science and technology takes on a design challenge in which it must create a space to exist before productive analysis can take place. The advent of digital has allowed for fundamentally the creations of new spaces that have never been experienced before. Herndl could agree with this as he writes, “Developing strategies and digital spaces for cross-boundary communication is something engaged RSTEM scholars can do and that can be justified on grant proposals,” (Herndl 8). It seems logical that more rhetorically-minded scholars could be creating digital spaces to enact their engaged research.

This challenging academic work also remains rooted in civic engagement. Herndl calls it “cosmopolitan enough to support the range of scholarship and practice that is already emerging yet is substantive enough to champion a progressive intellectual and political project,” (11). This progressive political project is very much aligned with the need for cross-disciplinary work in the changing environmental paradigm. Just as the environmental crises is a calamity requiring high political participation in addition to technological innovation, the role of rhetoric of science and technology is ingrained with political participation in addition to the culture of creativity and innovation. “Reconstructivism probably should be defined not by any particular agenda, but by the more general intention of conducting forefront scholarship aimed in part at helping to inform and deepen public inquiries, deliberations and negotiations concerning the democratic shaping and reshaping of technologies’ (Woodhouse et al., 2002, 299),”
Given this political lens, rhetoric of science and technology must also foster spaces for democracy as it looks to open up and analyze channels of information sharing in addition to following political action.

Therefore, it is appropriate to draw on techniques from rhetoric of inquiry to research the operation of scientific and hobbyist beekeeping communities and their “devices of communication and socialization, their political structures, their reliance on aesthetics, and their rhetorical dependence on persuasion,” (Nelson, Megill, and McCloskey 12). As Herndl suggests, digital spaces provide a wealth of interdisciplinary communication opportunities and fortunately, urban beekeepers are active participants of online beekeeping forums. With this in mind, I decided for this project that I will review three online beekeeping forums were researched: Honeylove.com, Beesource.com, and Biobees.com. In their variety, complexity, and occasional poetry, the persuasive techniques used by the contributing members of these three spheres speak to the the character of the arguments made by urban beekeepers as they negotiate a place for themselves and their hobby in the world. At the same time, of course, these rhetorics frequently do double duty, as these citizen scientists advocate for much larger ideas and ideals that are typically expressed in terms consistent with their own local passions.

Process

The Honeylove forum held 511 topics, 1,328 posts, has be live from 2013 - 2017, and was created out of Los Angeles, California. Biobees had a much larger presence with 16,858 posts, 5615 users, 2,489 topics, had been live from 2005 - 2017, and was created in the United Kingdom. Finally, the third forum Beesource held 130,751 posts , 49 topic categories with subdivisions under each, had been live from 1999 - 2017, and was created
in Chicago, Illinois. While conducting my exploratory research, I limited my study to within the last five years of posts from 2012 - 2017. I searched through approximately 500 post titles and read approximately 250 full posts which may have included up to 10 user exchanges per post.

With these observations, I then categorized the recurring themes in the forums as demonstrating a rhetoric of science, a rhetoric of resistance, and a rhetoric of innovation. Within these three themes, I more specifically identified (1) participatory citizen science, (2) democratic political resistance, and (3) professional-amateur innovation. I draw out exemplary examples of this online discourse for all three themes to provide detailed context within each theme. These specific instances are analyzed for language, grammatical structure, tonality, and the use of visuals to make persuasive arguments. I further use the literature of citizen science in the digital age to process how the urban beekeeping forums display a model for co-creation projects and set a tone for the future of Conservation 3.0.
Throughout the three forums, beekeepers displayed high levels of scientific, political, and technical literacy. With this literacy, they were able to interact with a variety of other fields including other beekeepers, scientific institutions, universities, U.S. government, and the Cisco technology company. The topics on the forums ranged from technological hardware, pesticides, climate change, how to care for bees, and larger environmental systems. I identified three major themes of discourse within these forums: (1) participatory citizen science, (2) democratic political resistance, and (3) professional-amateur innovation. These three themes are seen within posts and beekeeper exchanges in a number of ways that align with the previous literature in these fields.

**Science: Participatory Citizen Science**

With a passion for the complex inner workings of the beehive, it came as no surprise that the beekeepers displayed a keen interest in all levels of science. They often used ecosystem science terminology, posted links to or copies of published scientific articles to the site, and engaged in citizen science initiatives. I observed that the digital forums held space for the beekeeping community to discuss their experiences working alongside the scientific community through citizen science initiatives as well as served as an environment for the beekeepers to conduct parts of their citizen science projects.

In one such example,

**JConnolly writes:**

"Those of you interested in instrumenting your hives may be interested in this NASA proposal for tracking data from honeybee hives."
“To help track and monitor these changes, we are proposing a Honey Bee Climate Network made up of volunteers monitoring of honey bee nectar flows & plant phenology via the Internet. Over time, we can help to preserve records for long-term archiving, and expand the network to include more users/contributors and to include satellite data to establish links to the timing of nectar flow.” - [NASA]

On further inspection of this project webpage, I found NASA stated that there were many ways in which volunteers (both beekeepers and non-beekeepers) could be involved in helping pollinators. They suggested that volunteers get involved in educational outreach, document seasonal plants, use observation hives to decode bee dances, or provide forage for native bees, (NASA). In this instance, the beekeeper JConnolly suggests that other participants use this resource to join a citizen science initiative started by NASA. Using NASA’s words, they appeal to potential beekeepers looking to join a collective project that will be preserved and protected throughout time. This project actively engages the beekeepers in contributory citizen science work.

With NASA’s list of potential options for both beekeepers and non-beekeepers to get involved in their project, they demonstrate that this project can be redefined as participatory rather than just contributory. The suggested options offer citizens opportunities to participate in multiple stages of scientific discovery through engaging in preliminary research of plants or bee dances, making their own studies of Observation hives, educating the public, or taking conclusive action to provide more bee foliage outside. Examples of these types of posts were common on the board, but I also observed
a number of beekeeper exchanges that reflected and mediated on their own role as citizen scientists.

One example of this follows as,

**Andrew Dewey writes:**

“There are numerous standards about how professional scientific research is done. Citizen science is not quite so stringent, and many researchers dismiss "citizen science" out of hand unless it is done under the supervision of a professional. What makes a professional? What kinds of things do backyard/hobby beekeepers need to know about bees and beekeeping that is not already known?"

**Lburou writes:**

“It seems to me that gov't/institutional control of the purse strings creates many unnecessary hurdles for Scientists to overcome. At the same time, those entities do NOT have a patent on the Scientific Method."

Andrew Dewey’s post suggests that beekeepers do not just engage in citizen science initiatives, but reflect on their participation in the process of the scientific system. Through the process of engaging with citizen science, Andrew Dewey may also question how the institution values the information gathering of citizen scientists, asking what types of trends are observed and further information that beekeepers like to learn. He questions how beekeepers can stay informed and represented in the established science community. Lburou advances this discussion by stating his socio-political observations of the institution but also asserting that others outside the institution (like citizens and beekeepers) still have access to utilizing the Scientific Method as a public good. The
beekeepers demonstrate a belief that there are avenues for them to operate within scientific projects and want to stay informed.

One exchange exemplifies this as,

**BioBee writes:**

*It has long been my ambition to help reinstate our native honeybee to her rightful inheritance, so I am launching a Crowdfunder to help make this possible. I would love to have support from all of you here to get this project off the ground.*

In reply,

**Jon writes:**

*There is a Phd student at Nuig (Galway) university looking for hygienic traits in our native bee stock. I gave him a dozen samples from some of my colonies last November and I am hoping to get some feedback shortly. One of the challenges with native bee projects is starting off with the best stock possible.*

In this Biobees exchange, multiple examples of Wynn’s stated advantages of digital citizen science can be observed. Biobees uses the forum as a place to both rapidly exchange information with other beekeepers and promote their own “ambition” - a citizen science initiative for raising the population of the native honeybee species. In the same thread, many individuals express enthusiasm for the project and Jon in particular responds narrating their own experience also working with native bee scientific studies. They expressed some of the hardships the projects will need to overcome and also offered information to Biobees about scientific institutions they can partner with.

Overall, the beekeepers rhetoric suggest that they support a model of collaborative participatory citizen science often demonstrating crowd support or team project
exchanges with scientific institutions. At the same time they encourage reflecting on their role as citizen scientists and insist that certain institutions do not have sole control over scientific findings. This rhetoric suggests that these beekeepers utilize this online forum space as well as the affordances of Web 2.0 including crowd sourcing and standardized information systems with scientific institutions like NASA to act in a participants in all steps of the Scientific Method.

Resistance: Democratic Political Resistance

The second theme noted in the online beekeeping communities was that of Democratic Political Resistance. The beekeepers politics were typically liberal leaning in regards to both pesticide regulation and climate change action and they were noticeably politically active outside of the forum. This was observed through localized political organization actively happening on the forum. Furthermore, they focus on both discussing the means of resistance in conceptual frameworks in addition to more concrete civic actions. Some of their political endorsements merge both these frameworks and action.

An instance of this type of political endorsement follows as,

Susan Rudnicki writes:

“Bill McKibben, of 350.org, the climate change fighting group, has written a new book featuring our Vermont beekeeping friend, Kirk Webster, drawing together the issues of local food and citizen action with the issues widely driving our Earth to chaotic climate instability.”
While there are a number of references to human-induced climate change on the forums, Susan’s post exemplifies a previously mentioned instance of the role of bees as symbols of democratic political rhetoric. Susan describes author Bill McKibben as part of a “climate change fighting group” instilling “citizen action.” As referenced earlier, McKibben’s book is a call to action for engaging in political organizing, participating in moderate civil disobedience, taking a strong resistance towards a fossil-fuel led corporatocracy, and calling for democratic decision-making. Beyond climate change, these beekeepers also engage in instances of pesticide regulation and often attach petitions regarding regulations to the forums for other beekeepers to sign. In defense against small numbers of hesitations about such petitions, the beekeepers often talk about the value of using the power of democratic decision-making in regards to pesticide regulation.

One such example,

*Wintering writes:*

> It is true that governments (and large corporation) will have difficulty abandoning pesticides, as chemical treatment is a foundational of modern industrial agriculture. This said, the call to abandon pesticides is not meant to all-of-a-sudden have everyone stop using pesticides, such an event is near impossible. It is a call to make voices heard and therefore better represent the community in the political sphere. When employed hand-in-hand with sustainable small scale farming, it can be one effective tool among many.

Most beekeepers take this precautionary perspective to pesticides. They explain their political purpose as “a call to make voices heard” suggesting that they must execute their democratic rights as citizens through the petition. Such a claim also suggests that
beekeepers want a greater power in the decision-making of agricultural technology and solutions. Throughout the forums, this anti-pesticide rhetoric repeats itself with the same level of nuance. The posts reference that the beekeepers must take action because the fate of food security and biodiversity are at a great risk if they do not. The beekeepers also demonstrate an opinion that their voices are not being heard because they do not have enough democratic power.

This is referenced in one instance as,

**Adam writes:**

“There are (at least) two ways of achieving that.

1. Revolution - against the owners of the wealth and power. The very fact of them having the wealth and power suggests they will succeed.

2. Evolution - slowly eroding their power by persuading those in authority to gradually change the way they do things.

I would love to see a swarm of bees help surround the Tory Party conference in Manchester in October, particularly since Cameron has just moved the word "swarm" to the centre of political debate.”

Adam’s rhetoric of resistance notes that both techniques of “revolution” and “evolution” involve taking power away from those with power and increasing their own power in the process. With a sense of absurdity, Adam paints a dream political action that would involve a swarm of bees surrounding the conservative party in their home country of the U.K. as the bees also standing alongside the beekeepers’ civil actions. They note that previous Prime Minister Cameron had been co-opting the word “swarm” in political debates and feel that in a sense of irony, the bees would join in political solidarity with
the beekeepers to resist the opposing political party. While Adam’s post is more ideological, other beekeepers utilize the online forums to engage in political organizing. One such example follows as,

**Chelsea McFarland writes:**

“The Pollinator Stewardship Council is deeply concerned about recent reports of U.S. Dept. of Agriculture scientists who have faced consequences or investigations when their work called into question the health and safety of agricultural chemicals. We believe USDA must maintain scientific integrity, and not allow harassment, censorship or suppression of science-based findings. We are concerned that tax-payer funded research is being withheld from the tax-payers due to suppression of USDA scientists. Beekeepers are tax-payers, and integral agricultural stakeholders who rely on the research of USDA scientists to protect the national resource of pollinators so vital to a nutritious diet. Speak up for honey bees; share the beekeepers voice. Send an email to your Congressional Representative and Senator today. I support USDA Scientists.”

In this final example, Honeylover participant Chelsea McFarland uses their online forum to express strong solidarity with the scientific community stating they “support USDA Scientist” and are “deeply concerned” about the scientists experiencing harassment, suppression, and censorship. This statement suggests that beekeepers hold their contributions to the larger scientific community in a high regard. In the last statement, “Speak up for honey bees; share the beekeepers voice. Send an email to your Congressional Representative and Senator today. I support USDA Scientists,” Chelsea expresses an interconnected solidarity between honeybees, beekeepers, and USDA
scientists because of this potential censorship of scientific research claiming that pesticides harm bees.

Posts like this are often accompanied by other photographs of beekeepers attending rallies for their causes. They often hold signs saying “Save the Bees!” or “We speak for the bees.” Moreover, these activists decide to dress in yellow and black to look like bees themselves. As the picture shows, some activists even wear bee antennas to clearly distinguish themselves as bees. This trend continues on the online blogs where underneath each of the participant forum names, they have a tagline which says what kind of bee they identify as: worker bee, forager bee, scout bee, nurse bee or guard bee. These are further examples of how humans see themselves reflected in bees through their political and social interactions.

Figure 2. Photo posted on Honeylove forums of beekeeper activists.

Overall, the beekeepers political rhetoric advocates for resistance of those they see in power subjecting the environment and scientists in the form of democratic civic engagement. They ally themselves closely to both honeybees and scientists through this
process by presenting themselves as the voice of bees and standing in solidarity with USDA scientists as they argue that to censor their information is a violation of democratic civil rights. These beekeepers demonstrate that this democratic form of citizen science resides in defending scientific facts within their field through civic engagement.

**Innovation: Professional-Amateur Innovation**

The third theme I observed in the online beekeeping communities was that of Professional-Amateur (Pro-Am) Innovation. On the beekeeping forums, a clear innovative spirit percolates the curious beekeepers. While I have already established beekeepers as pro-ams in their beekeeping practice, I sought to see how this culture influenced their opinions on emerging technology and digital literacy. The forums demonstrated that beekeepers were in fact very interested in emerging digital technologies. On each of the analyzed forums, beekeepers displayed rounds of conversations related to hive design and the possibility of data that digital sensors could offer them.

One exchange follows as,

**Dingbatca writes:**

“I have been a nerd for the better part of 25 years. I am a Linux Systems Administrator by day and an Arduino nerd by night. I am NOT a programmer, so any code I write will be simplistic at best. A few years back I got the bright idea of imbuing all my skills into my beehives. Time to talk about sensors, cost/infrastructure and commercialization…[Lists a number of different types of sensors and how they could be used in the hive.]”
Shinbone writes:

*I actually think humidity is a more sensitive winter-time indicator of hive health than temperature.*

Libhart writes:

*For me it's just fun to see if I can do it myself. Conquering the technology is really the reward.*

This exchange highlights a key element including a mixture of technical expertise with an embrace of creative amateurism. Dingbatca begins the thread stating their technical background, but they are still attempting to go on a journey with only simplistic code. The participants exchange ideas, cite code, and suggest a variety of sensor hardware products to each other even making their own hypotheses as to how certain technologies would aid them in preventing hive failure. They further demonstrate a pro-am ideology by expressing that this work is for fun and to challenge themselves with the technology would be the reward. Beekeepers are amateur innovators looking to learn, experiment, and enjoy the possibilities of emerging technology coupled with their beehives.

On the Honeylove forum, a short film was posted interviewing two members of the forum community: Sylvia and Kelton. The film focused on two aspects of beekeeping found on the forum. The first is Sylvia’s “natural” beekeeping practice which she describes as using no pesticides or chemicals inside the hive to prevent other insect pests from infiltrating it. The second story, told by Kelton, reveals that he is both a medical robotics engineer and a beekeeper. He designed a camera that operated with computer vision to monitor the entrance of the hive.
The following is the partial transcript of the video,

**Kelton says:**

*So Eyes on Hives is like a heart rate monitor for a beehive. A little like how you have a FitBit to measure your heart rate, the bees now have a Eyes on Hives to measure theirs.*”

**Journalist says:**

*“Sylvia is a farm girl at heart. At her Los Angeles home, she tends bees the old-fashion way. So when I asked if she wanted to go high-tech and use Eyes on Hives, her answer surprised me.*

**Sylvia says:**

*“Oh, that would be fun! That would be really fun!”*

This transcript and story format offers another perspective to urban beekeepers ideas surrounding technology. Being a clear pro-am, Kelton completes this project to a high standard simply for his own experimentation. With a strong push against pesticides, it may be assumed that urban beekeepers were hesitant about innovation - pesticides after all are an innovation. However, the journalist notes that in a “surprising” moment, she and the viewers learn of Sylvia’s keen support for new digital innovation that would allow her to learn more about her bees. This short video, however, reveals that urban beekeepers can still be highly innovative in areas of digital technology and design and reject another form of innovation that they view as problematic to the environment. This suggests that they resist technical determinism and that all technology acts as either a good or bad force. This can also be said for how they view the role of technology companies.

An example of this view is as follows,
Vladimir writes:

“Next Generation Beehive / Your opinion needed. The reason I’m writing this message is because the company I work for (Cisco systems B.V., worldwide leader in IT technologies, www.cisco.com) initiated the project related to bees and how to prevent them from becoming extinct. A group of volunteers (my colleagues) together with me decided to focus on how using the power of modern technology, we can help both apiarists and bees.”

Enjambres writes:

“If you really want to consider this issue, get some bees and put your hands in some hives. Just my two cents.”

Viesest writes:

“Weight sensors (for each hive) could be useful.”

Harley Craig writes:

“If you want to help bees, take that money and buy land and set it aside and plant native wild flowers, the biggest problem I see with bees is reduced diversified forage.”

This exchange speaks volumes for the relationship between beekeepers and the role of large technology companies. Similar to the situation in Songdo, South Korea, Cisco, a leader in technology infrastructure, is interested in working in sustainable development. The beekeeping communities’ responses communicate some hesitation to the large organization, but also a number of strong pieces of advice. They demonstrate values of what Claudel and Ratti would define as a “citizen developer” aiding in the process of working with Cisco. Enjambres is skeptical of Cisco and so, encourages the company to physically engage with the bees themselves. Harley Craig voices concerns
that too much emphasis might be placed on the honeybee rather than increasing native biodiversity. Vieset, on the other hand, responds to Cisco by explaining what sensors could be useful.

On recent inspection of the Cisco bee project, Cisco has indeed taken all of this advice. In one branch of Cisco located in Paris (which is a particularly dense city of urban beekeepers), 17 Cisco employees certainly put their hands in some hives as they took beekeeping training classes on the weekend and ordered 90,000 bees. This group created a Cisco network called Connected Bees and experimented with temperature, humidity, IP sensors, and cameras to monitor these hives and have since extended this data to the French National Science Foundation. The honey sales from their hives went on to fund native biodiversity preservation programs as Harley Craig suggested and then extended the project to Great Britain and the Netherlands and now has 500 active community members, (Cisco).

Altogether, these exchanges express a rhetoric of beekeepers as pro-ams in regards to both beekeeping and digital innovation of sensor technology. They exchange information with each other about their explorations in building their own sensors for the fun of it while giving and taking advice from one another. While they enjoy working with digital technology they do not abide by any ideals of technological determinism that technology as a notion is either a good or bad force as they will both resist the use of pesticides and happily obtain digital sensing technology. Similarly, when approached by technology companies, they retain these ideals by both offering technical advice as well as separate social action advice.
Analysis Conclusion

The analysis suggests that the discourse used in beekeeping communities marries the three goals of Conservation 3.0 in that it engages and protects the environment, includes political participation with both science institutions and citizens, and stimulates digital technological innovation to aid in that relationship. Each of these goals are addressed through three themes found in the forums including (1) participatory citizen science, (2) democratic political resistance, and (3) professional-amateur innovation.

Within the theme of participatory citizen science, the beekeepers show high levels of scientific literacy and the confidence to read and share scientific papers. Furthermore, they make their own hypothesis on their hives based on the information they receive from scientists. Additionally, citizens promote and express enjoyment out of sending data from their hives to scientific institutions such as NASA and scientific papers openly express the work of beekeeper citizen scientists in collecting portions of their data. Finally, they demonstrate an interest in funding their own scientific projects through crowdsourcing while still partnering with universities.

Beekeepers are also a highly politically active community with the fundamental belief that they act as the voice for the bees and assert that we all must “Save the Bees!” They politically lean left on topics including pesticide regulation and climate change action. With this belief they deploy a rhetoric of resistance throughout their political dialogues that champions the use of democratic civil action such as petition signing, emailing government officials, and rallying. In their resistance to those with power, the beekeepers feel that bees and scientists are being subjugated and therefore express a sense of solidarity and community.
Finally, the beekeeping forums displayed a keen interest in innovation surrounding digital sensor technology for hives. Beekeepers display a curious and experimental tone to the emergence of open-source Arduino technologies and exchange amateur stories with each other about the innovation process. These beekeepers display professional-amateur (pro-am) tendencies towards innovation in that they are invested in both beekeeping and learning about emerging technologies to a high standard and for the intrinsic of fun. While they utilize digital sensors, they do not prescribe to the idea that all of technology acts as a good or bad force as they resist pesticides but enjoy digital sensors. This behavior further shows itself as the beekeepers offer varying forms of advice to Cisco as they show an interest in sensors, but also an interest in Cisco engaging with social dimensions surrounding pollinators as well.

These three themes run parallel to the arguments made by the emerging field of Conservation 3.0 looking to protect natural environments, politically value human citizens, and utilize emerging technology to aid in the human-nature relationship. Taking the literature of citizen science, these three themes also align with citizen science’s idyllic co-creation based project that values the bidirectional relationship of knowledge between citizens and scientists, the balance of scientific endeavors and political agency, and finally, the emergence of digital technology and instrumentation to cultivate these spheres in the future.
CHAPTER VII

LIVEHIVE

The field of Rhetoric of Inquiry is a highly engaged academic domain whose work can complement the aims and efforts of contemporary scientific communities, platforms, and processes it studies. Indeed, for Herndl, there is a trend that requires that disciplines rethink how they relate to one another. The rhetoric of science and technology is evolving with the advent of new media and networked communication and has allowed for the creation of new environments which “develop strategies and digital spaces for cross-boundary communication,” (Herndl 8). This may also challenge our previous research paradigms of highly-disciplined sciences which communicate in specialized labs and narrowly-disciplined conferences. Herndl’s assertion served as inspiration for the creation of LiveHive as a process of my own research.

With this, it seemed appropriate that this paper would move beyond traditional models of strictly–disinterested inquiry and embrace instead an engaged scholarship at the intersection of emerging digital spaces, the environment, and conservation as a domain of research. To this end, I propose LiveHive, a digital online space for the beekeepers of Washington, DC to discuss the emerging sensing technologies for beehives in addition to engaging in citizen science and politically active spaces. As I have conceived of it, this project exists in three separate but deeply interrelated parts: A digital platform for communication and education (also the source of data for further research), a modest network of Arduino-based sensors, which I have custom-developed for use in a beehive, and finally, consulting with Georgetown University as it establishes its own beehive initiative and is looped into my LiveHive network of DC beekeepers.
The Site: LIVEHIVE

The LiveHive website ([http://livehivemind.com](http://livehivemind.com)) hosts a main landing page that is designed to draw participants in and highlight the affordances of digital space including multimedia presentation. In order to communicate my emphasis on providing a leveled playing field for the exchange of information, I wanted to create an aesthetically sophisticated site, as opposed to setting a overly sterile tone. The landing page features live video banners of bees flying in and out of the hive to captivate participants and demonstrate the data recording ability of new digital technologies. Following this, the page displays the Live Hive logo I designed and a description of the research project. Participants can read on about the history and relationship of urban beekeepers, scientists, and political action and see the first Internet of Things [IoT] project for LiveHive — an arduino-based temperature sensor.

Figure 3. Graphic image of LiveHive website logo
**Observations from Forum**

From the landing page, participants are then encouraged to click a button “The Conversation” which will take them to the second page with a forum. Using Muut, I was able to embed a forum onto the LiveHive site which allows participants to easily create an account and answer or pose questions on the forum and interact with each other. The first number of themes that I created included asking participants what type of sensors they would ideally want, how they can see receiving data from these sensors as having a problem, how they can see this data aiding in science, what they think about the future of urban spaces full of digital environmental sensors, and if they would be interested in learning to make sensors themselves. I then expanded the forum to have three channels marked as Participatory Citizen Science, Democratic Political Resistance, and Professional-Amateur Innovation moving all sensor questions into that last channel.

The link for the website was sent out through a DC beekeeping Google Group I am a part of with an email explaining that this is a space that they should feel comfortable debating and asking questions of each other. It was pressed that this space is not a survey questionnaire and does not require that all participants write their opinions on each topic question. Furthermore, I encouraged them to create their own topics and invite friends of theirs to join in on the forum as well. Before sending out the site, I created two staged accounts: ReighlyD and BeeKriss which I had answer some of the topics and ask further questions. This intended to set a tone for the forum as casual and already approachable. Since this launch, individuals ranging from bee scientists to techno-enthusiast beekeepers have begun using the site to answer questions stating that they would be interested in taking the challenge of learning to build their own hive sensors. They discussed the types
of sensors they would want to use and some posted links to their own beekeeping websites filled with their own hardware experiments. My research observations from this experience were that my site suggested that the research I conducted on the larger online sites was also relevant to the DC community and these three topics got beekeepers talking!

**The Sensors**

On the next page I have called “Process,” I display my own experimental journey of searching through working with beehive technology. At the top, I present a film I made about a beehive camera trap I helped install at American University in 2015. I began my journey alongside so many other beekeepers experimenting with Arduino technology. The site displays the process of developing three sensors for temperature, humidity, and motion. For this process, I felt that it is important to lay out the narrative of learning and working with the emerging technology the beekeepers were interested in.

Within the Communications, Culture & Technology coursework, there is an emphasis on theory and practice and I was fortunate enough to take Interaction Design working with Human-Computer Interaction expert, Dr. Evan Barba who walked our class through experimenting with circuits, breadboards, and Arduino technology. During this time, I began to develop the idea of LiveHive and researched the role of Arduino technology for environmental monitoring.

**Temperature Sensor**

While I read that a temperature sensor was one of the least complicated projects, I feel it is important to acknowledge the unexpected challenges that I had with the technology component of this project. In many ways, Arduino and low-cost open-source
technology is advertised as a high accessible and while I would completely agree with this experience, I discovered that I still needed to enhance my vocabulary and ability to troubleshoot even the most basic problems I was encountering.

I purchased a temperature sensor online and obtained an Adafruit Arduino data logger. The wiring configuration for the temperature was pretty simple. I was able to use the three wires that were already soldered into the data logger to run them from power (5v), Ground, and the 0 analog output into the three prongs on the temperature sensor.

Figure 4. Photo of Arduino for temperature sensor.

Figure 5. Photo of temperature readings.
Following this, I found several different code examples online for testing my temperature sensor. While one continuously gave me error messages, another worked great! I did learn how to convert the data into Fahrenheit, but I decided to stick with Celsius because that is the standard in science data collection. While I had the temperature sensor working fairly quickly, I hit a lot more trouble understanding the ins and outs of the data logger. My goals were to get the data logger to use the real time clock embedded in it to write the date and time in addition to the temperature. All of this data would ideally be saved to the SD card so that while I was collecting beehive data, I could simply go to the hives, remove the SD card and collect the data onto my computer.

My first challenge was programming the RTC (real time clock). RTC allows the plugged in Arduino to receive the time and date that your computer also operates off of. After you send the Arduino the code, the RTC continues to maintain the accurate time and date even when it has no power. Again, I researched several online codes for RTC. Both the temperature and RTC codes were very accessible. I had a couple of troubles with one of the codes because the Serial kept repeating an inaccurate time stamp, but after trying another, it worked appropriately.
At this point, I had both the temperature and RTC working, but none of my data was actually being saved to the data logger. I tried reformatting the card multiple times, but nothing was seeming to work. Finally, I found online codes for simply testing the data logger. At one point, I was able to get the phrase “Testing 1, 2, 3” to write to the card, but I struggled to get any of my code from the RTC and temperature sensor to write. I thought that it was a potential problem in my code, with my wiring configuration, or even with the SD card. With great help from Professor Barba, I was able to see that the problem was with my code. I had only written the temperature and RTC to the monitor. I could view it in my monitor on my computer, but not in my SD card. I made the obvious mistake of failing to write to MyFile and open and close the file. After we troubleshooted this, the SD card stored all of the time and temperature stamps.
Figure 7. Photo of computer displaying temperature and time/date.

Figure 8. Photo of soldered temperature sensor.

Now was time to finish the wiring. Professor Barba suggested that my temperature sensor should be detachable so I can more easily take it in and out of the beehive. I used clip/detachable wires from the studio to make my wires longer so that the temperature sensor could remain inside the hive and the arduino would sit on the outside
of the hive. Additionally, I needed to ensure that the wires were going to be waterproof outside. To do this, I experimented with the wire cover that shrinks with heat.

At first, I bunched all three wires together and used the heat gun, but after this, my computer kept rejecting its USB connection to the arduino because it was drawing too much power. I spent a long time trying to determine if the problem was that my wire was too long and cut down the original length of the wire significantly. Finally, after seeing that the length was not the problem, I decided to cut off all of the shrinking plastic. After the wires were separated, the computer stopped rejecting my arduino for drawing too much power.

![Figure 9. Photo of entire temperature sensor with mock beehive box.](image)

This is when I realized that my wires had been touching each other and short circuiting the entire system. I then decided to individually use the shrinking wire coater on the three different wires for each of my connections. The heat gun may have affected the temperature sensor a bit. After all of the work with the heat gun, the temperature
sensor, my readings would consistently vary up and down by three degrees. This is not too dramatic, but is worth noting for the rest of the project.

After collecting data, I opened my SD card on my computer and sorted the data into excel by commas. This separated the time, date, and temperature into different columns. I deleted the day because all of the data was from the same day and I only wanted to see what would happen if I blew hot air or wrapped my fingers around the temperature sensor for several second intervals. I was able to create a simple data collection table and graph for demonstration with this data.

**DHT11 Temperature and Humidity Sensor**

After experimenting with the temperature sensor, I then researched humidity sensors and bought a DHT11 Temperature/Humidity sensor. The DHT11 has an abundance of open resources online for setting up the schematics and writing the code for the arduino. Again, I found that the process of putting this sensor together was more complicated than I originally imagined. I found several schematics online displaying how to setup the sensor in the breadboard. I placed the 5V and Ground wires attached to the two far side pins of the sensor. Then, I hooked pin 7 to the signal pin so that information instructions from the Arduino could be sent to the sensor. Finally, a 10k ohm resistor was suggested to go in between the Ground and Signal pin. I found two 5.1k ohm resistors and twisted them together to get close to the 10k suggestion.
After setting the wires in the breadboard, I researched what type of code I would need to use for the project and found that I had to download the DHT library onto my computer. This required the open-source DHTLib.zip from https://github.com/adafruit/DHT-sensor-library. In the Arduino sketch, I had to include
this library. I opened the sketch, clicked Sketch at the top of the program bar then hovered over “Include Library” and clicked “Add .ZIP Library…” and selected DHTLib.zip file from my desktop. I made the mistake multiple times by clicking the DHTLib folder file instead of the zip and when I ran my code it would display an error message stating that the file could not be found.

I came across several snippets of open-source code for the DHT11 humidity reading, but found that some were overly complicated and included a lot of the code for a system including the data shield, RTC, and SD card. Because of this, the code would run on my Arduino, but the Serial would read that my device stopped because the SD card could not be written to. I also kept importing too many different DHT libraries like dht.U. I finally found a very simple code that would work with the breadboard setup:

```cpp
#include <dht.h>
dht DHT;
#define DHT11_PIN 7
void setup(){
  Serial.begin(9600);
}
void loop(){
  int chk = DHT.read11(DHT11_PIN);
  Serial.print("Temperature = ");
  Serial.println(DHT.temperature);
  Serial.print("Humidity = ");
  Serial.println(DHT.humidity);
  delay(1000);
}
```

Figure 12. Graphic of DHT11 code.
And I was happy to get a reading on my Serial:

![Image of DHT11 temperature and humidity readings]

**Figure 13. Photo of DHT11 temperature and humidity readings.**

**Photo Interrupter**

My next sensor was a photo interrupter. I envisioned using a photo interrupter to monitor the motion of bees moving in and out of the hive. The photo interrupter I purchased was Uxcell 10 Pieces PCB Photo Interrupter Optical Slotted Switch HY301A. This photo interrupter uses an infrared light beam that travels between the two arms. When interrupted, this beam is changed. When hooked into the Arduino, the Serial displays numerical readings when it is uninterrupted and changes numerical readings when it is interrupted. The size of this photo interrupter seemed ideal for a bee to fly in between the two arms of the interrupter and trigger the reading. Some challenges that
arose while working on this project came in finding a clear schematic for the Arduino hardware setup.

Several of the examples I found online used a 5 prong photo interrupter while I used a 4 prong one. I tried to use the schematics associated with the 5 prong pieces, but kept finding that I could not interpret it. However, I was able to finally find versions for the 4 pronged setup which would use the running ground and charged lines of the breadboard to hook the device together. To create the circuit, I needed to have charge going into the upper left prong of the device and come out and run back to charge on the lower right prong. The lower left prong and upper right prong served to ground the device and both ran to ground.

I also needed to send the information signal to the device, however. While the 5 prong photo interrupter often displayed online had a middle pin on the left side of the device that worked at the signal prong, I eventually discovered that for the 4 prong device, I had to both send charge and information through the upper left prong of the device. To do this, I ran a 560k ohm resistor from charge to the same line at the prong and then the A0 analog signal pin between that resistor and the upper left prong. This way both went to the device.
Again, I had trouble determining which code was going to work on my device and the levels of resistance I was going to need. I found another beekeeping group that had the same idea as me to use multiple photo interrupters to create a “photogate” for the hive. In a series of four blog posts over a month, the Bee Lab group described the process of working with photo interrupters in series. But again, their code included a lot of the intricate components of writing to their SD card and working with several photo interrupters at once. In my stage of the process, I was simply looking to send a simple code to the device and see a numerical change in the Serial. I tested about four different codes, but was not detecting any numerical changes when I placed objects in and out of
the two sensor arms. I attempted to change the resistance being used, but while this affected the numerical number being displayed on the Serial (at times 657, 319 or 0) when resistance was changed, this number would just run repeatedly even when the infrared light was being interrupted.

Eventually, I was able to find this code:

```c
int val;
void setup() {
  Serial.begin(9600);
}
void loop() {
  val = analogRead(A0);
  Serial.println(val);
  if (val<-200) {
    tone(9,600,100);
    delay(99);
    tone(9,400,100);
    delay(99);
  }
  delay(5);
}
```

Figure 15. Graphic of photo interrruper code.

While using this code, I was able to get noticeable differentiations in the numbers displayed in Serial when I interrupted the sensor. I changed the resistance multiple times and noticed that the number changes differentiated. I felt that using the 560k ohm showed the most noticeable change in the numbers. When there was no interruption the numbers read from between approximately 712-730 and when there was an interruption, the numbers jumped up to approximately 904-953.
This one interrupter is about the same size as a bee sized slot used in wintering the hive and I would want to implement this at first in the winter when fewer bees are travelling in and out of the hive and only using the small space. To scale up, I would want to set a number of these up in serial as they showed in the Bee Lab and set them along the wide hive opening at the bottom of the box.

![Figure 16. Photo of photo interrupter readings.](image)

**Reflections**

Overall, I felt that the process of attempting to engage in the same pro-am innovation process that the beekeepers I was researching were doing was very enlightening to my research experience. I discovered that this sensor equipment is certainly affordable and open-source, but I also discovered that it takes a lot of patience
and energy to learn the vocabulary and troubleshoot both hardware connection problems and coding bugs. I was comforted to find that while I worked on this project, I could find descriptions of other beekeepers working in this space which further clarified that my research of those three online forums was also applicable to the larger online beekeeping culture. Finally, I also began to understand just how complicated it would be to create sensors that would actually be implemented into a hive which would need portable power, weather protection, and potentially Wi-Fi configurations. With this realization, I could see the value in working with an established technology company for better hive sensors. However, I still greatly valued my own exploration into amateur developing and realized how the process made me think more like an engineer in some ways and a bee biologist in others as I had to consider every environmental factor happening in the hive.

Georgetown: Apis Saxa

The final section of the site titled “Georgetown University” discusses the role that the university can play in the future of urban beekeeping. I was fortunate enough to have news of my thesis research spread through the local D.C. beekeeping community. Several weeks into the project, I was contact by two students from GREEN (Georgetown’s student environmental club). The students, Austin and Angela, heard about my research interests through the White House beekeeper. Seemingly thrilled to meet a beekeeper, the team explained that they wanted to get a beehive for campus but needed to find a beekeeper to begin the process. Without a moment’s hesitation, I joined the team and we began attending administrator meetings and pitching our beehive project to sustainability initiatives hoping to receive funding. Through the hard work of my partners and our administration allies, most notably, Jennifer Eagleton, we have secured our funding.
From my experience, I have also co-created a beekeeping club handbook for the team to move forward with in which I named the club Apis Saxa to commemorate Georgetown’s motto Hoya Saxa. Roughly translating the Latin, the club means Bees Rock. As of the moment, we are proud and excited to say that we have raised a significant amount of the funds and plan to buy two nucs from local beekeeping aficionado Toni Burman. The hives will be placed next to the Weiss lab before the spring semester concludes and are excited to loop the Georgetown beekeepers into the LiveHive network and I look forward to training several students in beekeeping over the course of the summer.
CHAPTER VIII

SCALABILITY AND SUSTAINABILITY

This research demonstrates that urban beekeeping groups display ideal qualities of co-creation models of citizen science. With a highly participatory culture of data collection, hypothesis making, and research design in collaboration with scientific research institutions and with a focus on both researching scientific questions and engaging in democratic socio-ecological political interventions, beekeepers are poised perfectly in the center of Teresa Schafer and Barbara Kieslinger co-creation project model. These qualities lend themselves ideal for Conservation 2.0 which looked to create a balanced relationship between humans and the environment. However, beekeepers also utilize the affordances of emerging technologies to aid them with the relationships they have with bees, each other, and scientific institutions. They show a proclivity to pro-am behaviors looking to experiment and hack their way through open-source digital sensor technology and also engage with larger technology organizations by offering technology opinions and social action advice to them. These actions demonstrate that beekeepers can operate a model for Conservation 3.0.

**Scalability: Science, Resistance & Innovation**

As we journey further into Conservation 3.0, we should take the models of beekeepers into the larger global context. As we established, the honeybee is a vital resource for both the biodiversity of this planet in addition to maintaining food security globally. The research found in this project, suggests that localized knowledge exchanges regarding urban beekeepers in citizen science, political action, and digital technology are emerging in online spaces and in local geographical contingents of these online spaces as
well. To scale this to the national and global level, I suggest that online forums be created that use these three themes as the scaffolding of the communication platform with the themes listed under conservation topics. This platform could be built in collaboration with the American Beekeeping Federation which stand as the national group for beekeepers. It should also engage citizens as well as scientific institutions, political actors, and technology companies. In this way, Ratti and Claudel’s model of a hybrid urban development project could be formed where citizen beekeepers can serve as “citizen developers” alongside the larger system actors.

Science

Specifically in the field of pollinator science, there needs to be increased accessibility to citizen science initiatives across the nation that also encourage the non-beekeeping public to get engaged. The number of urban beekeepers may be growing, but there is a noticeable public interest by those who may not want to become beekeepers but have an desire to help and learn about honeybees. As a beekeeper myself, I have found that almost every individual I speak to about my practice or research lights up in awe at the idea of helping to “Save the Bees.” After speaking to me, a large number of individuals return back to me unprompted to report that they encountered honeybees on their walk or read a news article about pesticides and bees. Science institutions must utilize this untapped energy and reach out to all citizens asking them to contribute to botany and bee data collection with the affordances of cell phone capabilities and plant native pollinator flowers as NASA suggested, (NASA).

Furthermore, participatory pollinator citizen science initiatives should also further interdisciplinary research. As conservation science adopts a more interdisciplinary
approach seeking to engage in sustainable development and changing economic models, it can also allow for researchers of varying disciplines to act as citizen scientists engaging in research design. One such example of this currently happening is the recent emergence of instantiating rural beekeeping for communities in need of sustainable livelihoods. This practice has spread as a global trend and utilized by organizations such as the Jane Goodall Institute in Uganda and Tanzania, (The Jane Goodall Institute). Researchers working in the humanities and social sciences can then provide a wealth of research design objectives as well as data in conjunction with scientific organizations.

**Resistance**

Standing amongst the climate chaos of the Anthropocene, it is inevitable that political action will continue to be necessary in the coming years. As current institutions and governments continue to deny Climate Change or abuse and pollute natural resources, it is up to a politically and scientifically literate public to utilize their democratic rights to resist such problematic practices. The mobilizing spirit of the online beekeepers is inspiring to the entire public and beekeepers should continue to participate in civic actions to stand in solidarity with scientific institutions on a grand level. One example of such an action happening includes a contingent of beekeepers who will be taking to the streets in bee hats on April 22, 2017 for the national March for Science on Washington. Their platform calls for stricter pesticides regulations and stands in solidarity with scientific institutions.

Further acts of resistance garnered from the research include petitioning for pesticide regulation and championing for more of a partnership between large and small-scale farming in the country. To aid this agenda citizen beekeepers can join the scientific
organization in collaboration with Pennsylvania State University and the Ceres Foundation known as the Pesticide Action Network North America. Their stated goals are to “replace the use of hazardous pesticides with ecologically sound and socially just alternatives,” (Pialatic). Working with these established organizations, beekeepers can receive legitimate updated information on the science behind pesticides and how best to take action for change.

**Innovation**

The online beekeepers demonstrated two behaviors that should be scaled to the national level: experimental amateurism and offering knowledge and insight to a large technology company. First, beekeepers should continue to use Arduino products to explore and innovate, but as a large number of beekeepers are doing this, it might be wise to create a standardized model of sensors for beehives. In this light, Arduino actually showcases one maker’s “Beekeeping with Arduino” project with full code and schematics. However, this only shows how to make a hive scale. To scale this larger, beekeepers and Arduino should partner to create a larger standardize technology resource. This would allow beekeepers to learn how to build simply sensors quickly and potentially graduate to building more complex and innovative features (Arduino).

Secondly, the beekeepers in my case studies offered productive advice to Cisco, but could have engaged more with the company instead of receiving them with hesitation. A number of large technology companies have shown an increased interest in taking on a variety of biodiversity protection projects as tech challenges. Beekeepers nationally should partner with these organizations and provide their say in the discussion. While some of the beekeepers were dismissive of Cisco’s interests in learning how sensors
could help bees, those beekeepers did actually offer Cisco productive advice. Beekeepers should encourage others to join in these partnerships with large companies if they would like to see potentially impactful technology on a global scale (Valentin).

Beyond Cisco, Microsoft also started a technology of bees initiative in the form of a Beekeeper Hackathon with the tagline “project sweetens cross-pollination of tech and tradition.” This project brought Microsoft employees together - some of which were beekeepers - to build drones with pollinating brushes to aid the bees in pollination as monitor hive conditions like temperature and humidity. Then they also built larger drones to monitor agricultural landscapes and collect imaging data. “The drones would never replace real bees,” said Microsoft, “but they could complement the bees’ work,” (Chansanchai). Projects like this offer innovative solutions to the larger systemic issues honeybees face and both beekeepers and technology companies would do well to partner with each other.

**Sustainability of Urban Beekeeping Practice**

Urban universities serve as ideal locations for the sustainability of beekeeping initiatives. Washington, D.C. in particular is host to a number of academic spaces engaging in the political, scientific, and innovative discourses surrounding urban beekeeping. Rooftops of American University, University of Maryland, and George Washington University all serve as homes for a number of buzzing urban bees as well as generations of students and faculty members. American University’s original faculty advisor, Eve Bratman, provided a peer-to-peer learning structure for student beekeepers in which an experienced beekeeping student would train a new head beekeeper over the
period of a summer and these beekeepers even started experimenting with digital technology including a motion detection camera trap.

Additionally, Bratman then taught a sustainable development course on bees and their roles in local and global food economies in the School of International Service. Similarly, the University of Maryland and George Washington University engaged in beekeeping mentorships and would utilize their beehives as educational platforms having undergraduate and graduate students conduct biology lab reports about the hives. George Washington also entered into digital spaces of engagement as they used a live camera feed to keep the public updated on their website GUBuzz.com where they would respond to blog comments from the public.

This type of integrated scholarship then extends across urban spaces. As a beekeeper for American University, I was also asked to attend local urban conferences on both campus sustainability and schools K-12 sustainability in relation to expanding dialogues of urban plant biodiversity of food systems. Acting as a knowledge hub, urban Universities are perched in perfect positions to disseminate knowledge of biodiversity conscious sustainable methods to the surrounding urban community. Georgetown University prides itself on engaged community scholarship through the Center for Social Justice Research, Teaching & Service. Some courses including Environmental Peacebuilding already operate with a community engaged model by partnering with a number of urban community gardens in the city. Adding beehives to the university property must also allow for our academic conversations about urban biodiversity, innovative campus sustainability, and the eco-politics of food systems.
CHAPTER IX
CONCLUSION

This project uses the case study of online urban beekeeping communities to ultimately research how we can better prepare for an environmentally sustainable future uniting humans, the environment, and technology into one interfacing and resilient system. Living in the Anthropocene, we can no longer live in Conservation 2.0 as only it only enables “passive provisioning based on nature's current productivity,” (Hoekstra). The rhetoric of Conservation 3.0 now calls for a new engineered future advocating for a technological solution to the global climate crises. To be sure that Conservation 3.0 does not fall prey to the forays of technological determinism, the historical literature surrounding the role of citizen science must be evaluated. Citizen science serves as an appropriate tool due to its history of engaging the public in ecological matters and utilizing publically accessible technology to do so.

Ideal citizen science projects are a hybrid of Participatory and Democratic. Participatory projects engage citizens in any and all steps of the Scientific Method from data collecting to research design. Democratic projects engage citizens in political action related to the field of science they are engaging with. With these two types of citizen science, a co-creation project can be created valuing citizens and researchers equally as well as the aims of answering scientific questions and creating productive systemic socio-political change. A recent scholar have recently argued that digital innovation has allowed for a greater likelihood of a co-creation project to occur because it provides the many affordances of Web 2.0 and low-cost digital data-gathering sensors. This same scholar then argues that as citizen science and digital citizen science in particular utilizes
the interdisciplinary domains of epistemological thought including historical, social, technical, and political contexts, rhetoric serves as an appropriate cross-disciplinary approach to analyzing the motivations and arguments of a field.

Further scholars promote the use of Rhetoric of Inquiry which is also known as Rhetoric of Science, Technology, Engineering, and Math (RSTEM) as a method that “can help augment the analytic question in science projects with ethical questions about why and democratic or deliberative questions about how that are often absent from these conversations,” (Herndl). These scholars also advocate for the use of digital environments to conduct their cross-disciplinary research. With this in mind, analyzed three online urban beekeeping forums (Honeylove, Biobees, and Beesource) in search of illuminating themes.

I searched through approximately 500 post titles and read approximately 250 full posts which may have included up to 10 user exchanges per post. With these observations, I then categorized the recurring themes in the forums as demonstrating science, resistance, and innovation. Within these three themes, I more specifically identified (1) participatory citizen science, (2) democratic political resistance, and (3) professional-amateur innovation. I draw out exemplary examples of this online discourse for all three themes to provide detailed context within each theme. These specific instances are analyzed for language, grammatical structure, tonality, and the use of visuals to make persuasive arguments. I further use the literature of citizen science in the digital age to process how the urban beekeeping forums display a model for co-creation projects and set a tone for the future of Conservation 3.0.
The analysis suggested that the discourse used in beekeeping communities marries the three goals of Conservation 3.0 in that it engages and protects the environment, includes political participation with both science institutions and citizen, and stimulates digital technological innovation to aid in that relationship.

Overall, the beekeepers rhetoric suggest that they support a model of collaborative participatory citizen science often suggesting crowd support or team project exchanges with scientific institutions. At the same time they encourage reflecting on their role as citizen scientists and insist that certain institutions do not have sole control over scientific findings. This rhetoric suggests that these beekeepers utilize this online forum space as well as the affordances of Web 2.0 including crowd sourcing and standardized information systems with scientific institutions like NASA to act in a participants in all steps of the Scientific Method.

Altogether, the beekeepers political rhetoric advocates for resistance of those they see in power subjecting the environment and scientists in the form of democratic civic engagement. They ally themselves closely to both honeybees and scientists through this process by presenting themselves as the voice of bees and embodying bees in addition to standing in solidarity with USDA scientists arguing that to censor their information in a violation of democratic rights. These beekeepers demonstrate that this democratic form of citizen science resides in supporting scientific facts within their field and standing in solidarity with their community through civic engagement actions.

Conclusively, these exchanges express a rhetoric of beekeepers as pro-ams in regards to both beekeeping and digital innovation of sensor technology. They exchange information with each other about their explorations in building their own sensors for the
fun of it while giving and taking advice from one another. While they enjoy working with digital technology they do not abide by any ideals of technological determinism that technology as a notion is either a good or bad force as they will both resist the use of pesticides and happy obtain digital sensing technology. Similarly, when approached by technology companies, they retain these ideals by both offering technical advice as well as separate social action advice.

These three themes run parallel to the arguments made by the emerging field of Conservation 3.0 looking to protect natural environments, politically value human citizens, and utilize emerging technology to aid in the human-nature relationship. Taking the literature of citizen science, these three themes also align with citizen science’s idyllic co-creation based project that values the bidirectional relationship of knowledge between citizens and scientists, the balance of scientific endeavors and political agency, and finally, the emergence of digital technology and instrumentation to cultivate these spheres in the future.

With these observations, the study moves into an alternative field of research in which, I create a website (LiveHive) inspired to further engage D.C. beekeepers in the digital process. Participants can go to this site at livehivemind.com and engage on a forum with three channels for Participatory Citizen Science, Democratic Political Resistance, and Professional-Amateur Innovation. I also research, build, and document three arduino sensors to potentially put in beehives. Finally, I discuss the process of helping to start a bee initiative at Georgetown University. From this part of the research, I discovered found that engagement for those three topics were not solely found on the sites I researched, but also in Washington, D.C. and I also discovered that building these
simple sensors was accessible and affordable, but it presented many more challenges than I had anticipated. However, I found it helpful to have an online community of innovating beekeepers to help me along the way.

This highly localized research lends itself to the large size of Conservation 3.0 because it is scalable. I recommend that these three themes should be given more thought in the larger context as beekeepers begin to provide citizen science data at a national level and cross-disciplinary fields engage in global sustainability projects. In addition, the energy to engage in political actions of resistance and utilization of their democratic power demonstrated by the beekeepers is inspiring. This energy must extend beyond local actions and into larger demonstrations and national groups like the March for Science and Pesticide Action Network. Technologically, these beekeepers should create a standardized online guide for amateur sensor-making for beehives so that other beekeepers can easily join the process and start to innovate at a more complex level. Moreover, these beekeepers should also partner with large leaders in technology who are looking to engineer solutions for the environmental crises like Cisco and Microsoft.

Finally, this wave of engaged, politically active, and technically savvy urban beekeepers must sustain and build its presence. The urban university acts as the prime location for the sustainability of this movement. Integrating beekeeping with student mentoring generations and educational material in the classroom ensures that this movement is self-reflective as scholarly work should be. It is the role of the university to participate in engaged scholarship on a local and global level leading to understanding the role that the university plays in researching and impacting larger systems. Just as Moore’s “buzz” intended to reverberate from the surrounding environment and open
beekeepers to experiencing their own role in the environment, the “buzz” experienced by urban beekeepers residing at universities should reveal a conceptual reverberation of the university's relationships to these complex systems.
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