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Term Project Proposal: Bee Forage in NYC

Recent headlines in the news state that the bees are officially on the endangered species list. The species added to the list are seven native Hawaiian bee species that are not responsible for pollinating the numerous crops that feed people around the world.[6] These seven rare bee species are found only on the tiny islands of Hawaii and responsible for pollinating numerous rare, native flowers. The steep decline in these indigenous bees has also caused the decline of local endangered fauna that are indigenous to the Hawaiian islands.[7] The threat that these honey bees are facing in Hawaii: fire, invasive species, habitat alteration and loss from human development, is the same as honey bees all over the continental U.S.. The threatening decline native Hawaiian honey bees is a signal of what may also happen to continental honey bee. Honey bees in the United States contribute over $14 billion to the value of American crop production every year, make up one out of every three bites of food we eat,[11] and therefore play an essential role in feeding people around the globe.

Like the rare native species of Hawaii, bee colonies in the US, and worldwide, have been in mysterious decline in recent decades, which is a cause for concern in the scientific and agricultural communities. This increasing drop in honeybee population has gained enough attention to be labeled Colony Collapse Disorder (CCD)[11]. Scientists hypothesize that the aggressive use of insecticides on crops damages the nervous systems of pollinating honey bees, causing them to become confused and abandon their hives, with some beekeepers have reported up to a 90% loss of their hives. Unfortunately, research has been inconclusive in finding a direct cause to CCD, and scientists continue to explore possible causes such as malnutrition, disease, genetics, habitat loss and fragmentation, and other stress factors.[8] The loss of bees and hives across the country is also adding to the increasing risk of genetic diversity loss in bee species. The fewer types of bees there are, the more at risk the remaining species are to being wiped out by diseases and natural catastrophes.

Several studies have shown the widespread decline of wild bumble bees across America since the early 1990s.[1] While very few bumble bee populations have grown in numbers, the majority of them have fallen to a borderline catastrophic level, with little hope of bouncing back without major human action.

Bees around the world are responsible for a crucially important ecosystem service: plant pollination. Their ability to fly and their velcro like, fuzzy hair make them perfect organisms for carrying pollen from flower to flower for plant reproduction. Flowers have actually co-evolved

with bees and other flying insects to be colorful and fragrant to specifically attract bees and literally spread their seeds. Because of the bees' indispensable role in food production, we have taken advantage of these "domesticated" bees to pollinate major crops around the world. We have taken control of beehives, transport them via trucks around the country during blooming season, and release them in agricultural fields. Some crops such as almond trees, rely entirely on bees for pollination.[11] If bees continue to abandon their hives, if populations continue to decline and lose genetic diversity, there will be severe repercussions. The ongoing decline and potential extinction of both wild and domesticated bees will lead to a global decline in food production, and drastically change the world's agriculture systems.

In a seemingly unrelated world, New York City is a forever bustling and expanding city, with a population of well over 8 million people. According to the UN Habitat Human Settlements Programme, at least 50% of Americans live in urban or urbanized areas. That number is estimated to grow to 70% by 2050. This number will rise as a result of people moving from rural areas to urban ones, but more importantly, because of the expanding sprawl of cities and suburbs around the United States. New York City is already a billboard advertisement for traffic, pollution, human altered urban landscapes and all the environmental impacts that follow. When looking down on the five boroughs from the sky, one may not be overwhelmed by how much green they see, but rather, by how much of the city's surface is unused, tar-covered rooftops.

Beekeeping has now been legal in New York City for six years, with over 200 reported beehives in 2012, and many more not reported.[17] However, the population of urban bees has not proliferated in the way that the city expected, leading urban ecologists to raise questions about the growth potential urban hives. Andrew Cote, a beekeeper who tends to dozens of hives in the city, thinks that the bees of New York City may be unhappy because they do not have enough forage to sustain them, and become malnourished by eating garbage. However, other beekeepers argue that malnourishment is not the issue, as bees often travel up to five miles to find proper pollen.[17] Instead, they think that the quality of the plants in New York City is not sufficient to sustain larger bee populations, and the bees are leaving the city in search of better forage. Anthony Planakis, who has cared for bees since 1977 says that for one beehive, there should be at least one acre of foraging land to sustain the colony. However, public space in NYC that is capable of sustaining plants and bees is very limited, and shrinking. This is when the lack of bee foraging becomes a design issue.

Industrial design reaches far beyond the realm of product design and home furnishings. In fact, industrial design has proven to be an essential tool in projects that range from green architecture, to urban planning, to environmentally conscious design systems. As an industrial

designer in training, I want to incorporate the strategies that I've learned in my industrial design classes and apply them to this growing ecological problem. My aim is to design a standard for urban rooftops that will incorporate all the necessities that bees need to thrive in an urban environment like New York City. Through research on what bees need: shelter (a hive), water, forage and comfortable living conditions, I plan to incorporate the types of plants that bees like best for urban rooftops. Some of these plants are already being grown, such as sedums, in New York City's parks and rooftops. The sedums provide food for urban bees, but also provide other services for the city by trapping escaping heat and gases.[17]

My plan will include painting rooftops white in cities, as to reduce the amount of heat absorbed into the city's many buildings. This will cool the temperature of rooftops and allow bee colonies to be more comfortable on the city's rooftops. Other necessary aspects will include a sustainable and consistent water source, as dehydration can be a real issue for bees in urban areas. The collection of rainwater on rooftops could be a suitable solution for providing bees with water and not using more treated tap water. The other main component of my project will include plants that can survive and thrive in a city, where resources like rain, sunlight, and soil are very different. I will implement plants that must be easy to maintain, can survive in New York City, and most importantly sustain large bee populations.

My intention for this project is to create a design for greener roofs will also help solve non bee related issues such as urban air pollution, heat absorption by buildings, waste management, and water filtration in New York City. The United States EPA has documented a phenomenon known as the heat island effect, which is when an urban area is significantly warmer than its surrounding areas due to higher levels of human activity. Plants have the power of capturing and storing CO_2, the molecule responsible for the warming of the earth's atmosphere. The burning of fossil fuels for heating, cooling, and transportation has caused a large imbalance of the carbon cycle. More plants in urban areas will help to absorb this excess carbon to help balance out the cycle, even if a little bit.

Another large issue that humans face today is the pollution of water through excessive amounts of nitrogen. Nitrogen is a key element in the successful growth of plants, and can thus be apart of my solution. The city's many iconic water towers already do the job of storing water on rooftops as a pressure and pumping mechanism. Letting the water filter through a layer of plants and soil will help to absorb pollutants such as nitrogen to benefit urban plants, bees, and people.

In order to incorporate all of these urban issues together into one solution, I want to design a modular planter for habitat restoration to benefit urban bees. This module will include a group of plants that can thrive in large urban centers, a shelter for the urban bees, and a filtering water layer that re-pumps into the buildings' waterways. The modular aspect of this design will allow individuals to incorporate as many or as few planters as they can or want on their rooftops. I want this design to also be suitable and accessible for suburban dwellers, who face many of the same ecological issues as city dwellers.

Some people may wonder why they should care about bees in New York City. The reason all people should care about New York bees is that New York has the potential to set an unprecedented example for the future of the "urban environment." As cities and suburbs continue to expand outwards, people need to be simultaneously expanding in their ability to work for the planet, rather than against it. Urban expansion will only continue to threaten the survival of wild bees, so we need to be planning and design with them in mind. The larger implementation of well designed rooftops gardens could have real and immediate benefits to the city of New York. Creating a better, healthier environment for bees to live in would create a spark in city greenery. This biomass could better sustain local food gardens and provide better local produce for the people living in New York. In addition to busier, happier bees, New York City would have a better regulated temperature and cleaner air due to a large increase in biomass on the city's many rooftops. These many plants could also help to capture and filter water, absorb pollutants such as phosphorus and nitrogen, for human consumption.

There is a significant social and mental benefit that city dwellers would receive from a larger amount of greenery in New York City.[16] A higher exposure to plants has proven to improve mental, cardiovascular, and respiratory health.[19] In New York City, people are trapped in canyons of buildings that block natural sunlight and fresh air. Greener rooftops would definitely encourage people to get outside more and tend to their rooftop gardens, and thus get more sunlight, exercise, and be exposed to a little bit more nature every day, which is something every New Yorker desperately needs.

I choose to focus on urban bees because I believe that by finding a solution for the flora and fauna that we, as New Yorkers, interact with daily will motivate us more to create change within our communities. Unfortunately, scientists still do not know why wild bees continue to disappear, but it is becoming more clear that human activity plays a large role in the decline of wild bees. I believe that in order to help wild bee populations, countries as a whole need to be making more informed decisions about habitat restoration and sustainable agriculture, but we as individuals can also do our part to help. While scientists continue to search for ways to stabilize wild bee populations, I believe that by taking better care of the bees living in our urban environment, we are taking positive steps towards helping wild bees as well.

Annotated Bibliography:

1. **Patterns of Widespread Decline in North American Bumble Bees**

   This source is an academic study of the decline in bee populations across North America. It documents the historical distribution of eight different bee species and their distribution today. This study also analyses pathogenic infections in bumbles bees and the impact that human systems are having on the major decline of bees.

Cameron, S. A., J. D. Lozier, J. P. Strange, J. B. Koch, N. Cordes, L. F. Solter, and T. L. Griswold. "Patterns of Widespread Decline in North American Bumble Bees." *Proceedings of the National Academy of Sciences* 108.2 (2011): 662-67. PNAS. Web.

2. Can Green Roofs Provide Habitat for Urban Bees

This scientific journal explores the correlation between the growth of urbanization and the impact it has had on wildlife, and in particular: pollinators. Furthermore this journal explores the potential for green roofs in urban centers to be a strategy for improving the the population and lifestyles of urban bees.

Colla, Sheila R., Erin Willis, and Laurence Packer. "Can Green Roofs Provide Habitat for Urban Bees (Hymenoptera: Apidae)?" *Cities and the Environment CATE* 2.1 (2009): 1-12. *Digital Commons at Loyola Marymount University*. Web.

3. Integrating the Environment in Urban Planning and Management: Key Principles and Approaches for Cities in the 21st Century

This article from UNEP is a a full body analysis of the interactions of urban areas and the environment. This article explores the integration of urban planning with the environment and approaches to that goal. This source considers climate change, urban design, and even economic and political influences.

Dodman, David, Gordon McGranahan, and D. B. Dalal-Clayton. *Integrating the Environment in Urban Planning and Management: Key Principles and Approaches for Cities in the 21st Century*. N.p.: United Nations Environment Programme, 2013. Print.

4. Living Cover

This source is a great source of information on the green roofs that have already been established in the United States. This source includes materials and methods that have been used in theses urban gardens to maximize efficiency and harmony between plants and the buildings they reside on.

Fischetti, Mark. "Living Cover." *Scientific American* 298.5 (2008): 104-05. Web.

5. Product Design for the Environment: Concepts

This online source explores the potential for industrial product design to work for the environment. This website explores sustainable design and the life cycle of product design.

This will be useful to merge the data of bee population loss and design that can aid that issue, without causing other sustainability issues.

Giudice, Fabio. "Product Design for the Environment: Concepts." *Product Design for the Environment: Concepts*. Department of Industrial and Mechanical Engineering, University of Catania, n.d. Web. 29 Sept. 2016. <http://www.productdesignenvironment.info/concepts1.htm>.

6. Seven Bee Species Have Been Added to the Endangered Species List

This is one of the many articles that have been publish online about the recent addition of bees to the endangered species list. This example of tertiary literature is a useful tool in informing the people in a quick, understandable way.

Hrala, Josh. "7 Bee Species Have Been Added to the US Endangered Species List." *ScienceAlert*. N.p., 30 Oct. 2016. Web. 12 Nov. 2016. <http://www.sciencealert.com/seven-species-of-bees-have-been-added-to-the-endangered-species-list>.

7. Seven Hawaii Bee Species Are Endangered

Like the Sciencealert article, this is also a news article that headlined about the recent addition of bees to the endangered species list.

Jones, Caleb. "Feds List 7 Hawaii Bee Species as Endangered, a First in US." Feds List 7 Hawaii Bee Species as Endangered, a First in US. Phys.org, 30 Sept. 2016. Web. 11 Nov. 2016. <http://phys.org/news/2016-09-feds-hawaii-bee-species-endangered.html>.

8. Assessing Insecticide Hazard to Bumble Bees Foraging on Flowering Weeds in Treated Lawns

This scientific article focuses on the effect that pesticides and insecticides have had on the foraging of bumble bees in cities and suburban areas. Studies have shown that residue from insecticides on flowering plants has adverse effects on the life and lifestyle of urban bees. What is crucial about this study is that it shows that insecticides have long lasting effects, that last beyond the time that bees are exposed to the toxin.

Larson, Jonathan L., Carl T. Redmond, and Daniel A. Potter. "Assessing Insecticide Hazard to Bumble Bees Foraging on Flowering Weeds in Treated Lawns." *PLoS ONE* 8.6 (2013): 1-7. Web.

9. Green Roofs as Urban Ecosystems

This sources analyses urban rooftops as potential urban ecosystems. This article defines many terms regarding rooftops and their potential are viable ecosystems in cities.

Oberndorfer, Erica, Jeremy Lundholm, Brad Bass, Reid R. Coffman, Hitesh Doshi, Nigel Dunnett, Stuart Gaffin, Manfred Köhler, Karen K. Y. Liu, and Bradley Rowe. "Green Roofs as Urban Ecosystems: Ecological Structures, Functions, and Services." *BioScience* 57.10 (2007): 823. Web.

10. Structure in Nature Is a Strategy for Design

This book is an inspiration for industrial design because it illustrates many structures found in nature such as the honeycomb. Natural structures are often the way they are because the form is the most effective and best evolved in many cases. Structures in nature are a great source of help to designers for creating forms.

Pearce, Peter. *Structure in Nature Is a Strategy for Design*. Cambridge: MIT, 1978. Print.

11. Pollination Facts

This source from the American Beekeeping Federation has many facts about bees, their lifestyles, and the ecological issues that they are facing today.

"Pollination Facts." - American Beekeeping Federation. ABF, 2015. Web. 14 Oct. 2016. <http://www.abfnet.org/?page=14>.

12. Ready to Late Sedum Green Roofs and Walls

This sources is exclusively about the importance of sedums as plants for green roofs. In recent years, research on sedums has shown that they are beneficial plants to have on urban rooftops and are a good source of forage for bees.

"Ready to Lay Sedum Green Roofs and Walls." *Sedum Green Roof*. N.p., n.d. Web. 12 Nov. 2016. <http://www.sedumgreenroof.co.uk/benefits-of-green-roofs.php>.

13. Worker Bees on a Rooftop, Ignoring Urban Pleasures

This New York Times article explores the benefits of green roofs in New York City. This article gives a very novel point of view on New York City, the birds eye view. This article looks into the other benefits that green roof tops have on air and water filtration, in addition to aiding bee species.

Satow, Julie. "Worker Bees on a Rooftop, Ignoring Urban Pleasures." *The New York Times*. The New York Times, 06 Aug. 2013. Web. 19 Oct. 2016. <http://www.nytimes.com/2013/08/07/realestate/commercial/worker-bees-on-a-rooftop-ignoring-bryant-parks-pleasures.html>.

14. Impact of Different Green Roof Layering on Plant Water Status and Drought Survival

This is a scientific study that analysed the different types of green roof layerings and their ability to absorb water in the Mediterranean region. This source gives great insight into the design of soil, retention, and filtration layers for the optimal survival of the Salvia plants.

Savi, Tadeja, Sergio Andri, and Andrea Nardini. "Impact of Different Green Roof Layering on Plant Water Status and Drought Survival." *Ecological Engineering* 57 (2013): 188-96. Web.

15. Making a Bee-Friendly Garden

This source is a less data intensive source of how to create bee friendly gardens. This source is important in describing what kind of flora bees need to thrive and carry out

Sydney Cameron, Terry Harrison, Michael McKelvey, and May Berenbaum "*Making a Bee-Friendly Garden.*" Making a Bee-Friendly Garden. Bee Spotter, University of Illinois, n.d. Web. 29 Sept. 2016. <https://beespotter.org/topics/beegarden/>.

16. Ecological Design and Planning

This book explores the possibilities of landscape ecological planning. Although this source is not exclusively about urban ecological development, it is enlightening about the general practice of ecological planning in landscape design.

Thompson, George F., and Frederick R. Steiner. *Ecological Design and Planning*. New York: John Wiley, 1997. Print.

17. Two Years After Legalized Beekeeping, City May Be Running Short on Forage

This WNYC podcast and article focuses on the rising numbers of beehives in urban areas, yet are still facing major issues. Beehive numbers have risen in urban areas, but there is a concern by city ecologists that there isn't enough forage to sustain them all.

"Two Years After Legalized Beekeeping, City May Be Running Short on Forage." *WNYC*. N.p., 25 June 2012. Web. 19 Oct. 2016. <http://www.wnyc.org/story/218358-urban-bees-may-be-running-out-foraging-ground/>.

18. The Nature of Urban Design: A New York Perspective on Resilience

This book is great resource because it focuses specifically on the ecological resilience of New York City. The premise of the book urge city dwellers to be in charge of the development of the cities they live in and create their communities. The author explores more social impacts of urban design and how urban ecology takes a role in those impacts.

Washburn, Alexandros. The Nature of Urban Design: A New York Perspective on Resilience. N.p.: Island, 2013. Print.

19. Natural Environments and Human Health

This article focuses on the health benefits that humans have from being exposed to the natural environment. This source is valuable because it evaluates numerous types of people in varying environments.

Wells, Nancy. "Natural Environments and Human Health." *How Natural and Built Environments Impact Human Health* (2014): n. pag. *Design & Environmental Analysis*. Cornell University, 2014. Web. <http://www.human.cornell.edu/outreach/upload/CHE_DEA_NaturalEnvironments.pdf>.

20. Stackable Urban Beehive Is Perfect for Beginner Beekeepers

This online source is a great source of design inspiration by showing beehive designs that have already been created for human environments. Precedent in design is a very useful tool to analyze what has already been done and how effective it was, which gives designers a point to build off of.

Zimmer, Lori. "Stackable Urban Beehive Is Perfect for Beginner Beekeepers." *Inhabitat Green Design Innovation Architecture Green Building*. Inhabitat, 30 Jan. 2013. Web. 19 Oct. 2016. <http://inhabitat.com/stackable-urban-beehive-is-perfect-for-beginner-beekeepers/>.