TO BEE OR NOT TO BEE: ROBOBEES AND THE ISSUES THEY PRESENT FOR UNITED STATES LAW AND POLICY

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I. INTRODUCTION

Approximately one in every three mouthfuls of the American diet benefits from honeybee pollination in some form or another, either directly or indirectly.[1] Not only that, bee pollination is responsible for over $15 billion in increased crop value each year, and commercial production of many specialty

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1. *Honey Bees and Colony Collapse Disorder*, USDA, [thereinafter *Honey Bees*] www.ars.usda.gov/News/docs.htm?docid=15572 (last visited Mar. 2, 2016).

crops depends on pollination by honeybees.[2] In short, the continued existence of honeybees, or at the very least the continued pollination of crops by honeybees, is incredibly important with respect to both our agricultural industry and our day-to-day lives. It is for this reason that it is so alarming that honeybees have recently begun to disappear in large numbers, as losses continuing at this level "could threaten the economic viability of the bee pollination industry."[3] Faced with such a serious threat, the need for a solution of any kind is enormous.

While preserving the honeybee population is of course viewed as the best means of carrying on, there is seemingly another solution that has surfaced: coordinated, agile robotic insects that emulate the body, brain, and colony aspects of honeybees.[4] Whether replacing honeybees with these "RoboBees" would be wise from a public policy perspective, whether they would constitute drones for legal purposes, the implications of both governmental and private use for personal privacy laws, and the potential effect on current land use regulations are all issues to be dealt with in this Note.

Part II of this Note will examine the history and background of the honeybee disappearance and the subsequent development of RoboBees in order to provide the context in which this issue arises. Part III will analyze the policy implications of RoboBees as permanent replacements for honeybees should they become extinct, classifications of the RoboBees for legal purposes, the potential implications for personal privacy violations stemming from public and private use of RoboBees, and the potential effects that the development and widespread use of RoboBees could have on current land use regulation. Part IV makes a recommendation as to where RoboBees should fit within the solution to the honeybee disappearance problem, how they should be classified, and how they should be regulated with respect to privacy laws.

II. BACKGROUND AND HISTORY

A. Colony Collapse Disorder and the Threat to Honeybees

In October 2006, beekeepers began reporting losses of thirty to ninety percent of their hives, which is an unusually high magnitude of loss.[5] This phenomenon has been labeled "Colony Collapse Disorder" (CCD). CCD's main symptom is a very low number of adult honeybees present in the hive, or in some cases no adult honeybees present at all.[6] In addition to the low numbers of adult honeybees, hives affected by CCD have a live queen and no dead honeybee bodies within the hive, often with honey and immature bees still present.[7] Frequently, though not always, hives hit by CCD are also found

2. *Id.*
3. *Id.*
4. *Robobees*, HARVARD UNIV., http://robobees.seas.harvard.edu (last visited Mar. 2, 2016).
5. *Honey Bees*, *supra* note 1.
6. *Id.*
7. *Id.*

to contain a virus-transmitting parasite of honeybees known as varroa mites.[8]

There are four general categories being looked into as possible causes of CCD: pathogens, parasites, management stressors, and environmental stressors.[9] Additionally, there have been several mentions of honeybee disappearances in the 1880s, 1920s, and 1960s, all with descriptions that sound similar to CCD, though there is no way to know for sure that these disappearances were in fact caused by CCD.[10] A workshop of scientists and stakeholders was co-chaired by the Agricultural Research Service and the National Institute of Food and Agriculture in June 2007 to develop a CCD Action Plan, but the exact cause of CCD and how exactly to combat it still remain a mystery.[11] Thus, it seems both prudent and potentially necessary to have other available and viable solutions to honeybee disappearance at the ready.

One such solution is the banning of particular uses of pesticides, a route which the European Union has recently taken.[12] The EU ban is on a class of pesticides known as "neonicotinoids," exposure to which is thought to have a wide range of negative effects on honeybees, including scrambling their ability to navigate.[13] However, the United Kingdom has since temporarily lifted the ban, allowing farmers to use the pesticides despite the potential detrimental effects on the bee population.[14] The effects of this ban elsewhere in Europe, which is set to last for two years, should be illuminating as to whether decrease in pesticide use will be an effective means of combating CCD.

Another solution focuses on the aforementioned varroa mite found in hives affected by CCD. These mites enter the hive by clinging to the backs of foraging worker bees.[15] Australian scientist Denis Anderson has been attempting to discover a chemical switch that would turn off the mite's breeding cycle, but has been unsuccessful up to this point because of a lack of funding for his work.[16] The thinking is that if such a switch is discovered, it could be used as a sort of poison coating on the entrance of commercial hives that the bees would come into contact with upon entering, targeting mites in the same way that a flea collar does fleas.[17]

A third possibility for solving CCD is to halt and reverse the destruction of the bees' source of food, as hungry bees are more vulnerable to illness and disease.[18] Between 2006 and 2011, 1.3 million acres of grassland and wetland

8. *Id.*
9. *Id.*
10. *Id.*
11. *Id.*
12. Roxanne Palmer, *How Can We Save Bees? 3 Possible Solutions to Combat Honeybee Decline*, INT'L BUS. TIMES (Jan. 22, 2014, 11:38 PM), http://www.ibtimes.com/how-can-we-save-bees-3-possible-solutions-combat-honeybee-decline-1546190.
13. *Id.*
14. Damian Carrington, *UK Suspends Ban on Pesticides Linked to Serious Harm in Bees*, GUARDIAN (July 24, 2015), http://www.theguardian.com/environment/2015/jul/23/uk-suspends-ban-pesticides-linked-serious-harm-bees.
15. Palmer, *supra* note 12.
16. *Id.*
17. *Id.*
18. *Id.*

were converted to cropland in the Dakotas, Nebraska, and parts of Minnesota and Iowa "at a rate not seen since before the Dust Bowl."[19] Stopping this practice and preserving more grassland and wetland would help bees to avoid hunger, which should in turn help them to avoid diseases such as CCD.[20] To this effect, "[t]he U.S. Department of Agriculture (USDA) announced the availability of $4 million in assistance for farmers, ranchers, and forest landowners working to improve food sources for honeybees on private lands in Midwestern and Northern Plains states.[21] This effort is aimed at improving the health of bees "in a region where more than two-thirds of the nation's honeybee population spends the summer months, pollinating crops and building strength to survive winter."[22]

Against this backdrop of different possible solutions being investigated, one particularly interesting and promising alternative method of combating CCD has emerged, the RoboBee Project.

B. The RoboBee Project

Enter RoboBees: the small, coordinated, agile robotic insects being designed at Harvard which will seek to emulate a honeybee's body, brain, and colony behavior.[23] Among the potential uses for these robotic insects are the autonomous pollination of crop fields, search and rescue, hazardous environment exploration, military surveillance, traffic monitoring, and high-resolution weather and climate mapping.[24] The robotic insects would emulate a bee's body by achieving autonomous flight through the use of compact energy power sources and associated electronics integrated into the RoboBee's "body," and would emulate the brain through the creation of artificial "smart" sensors which would act similar to a bee's eyes and antennae. RoboBees would also emulate colony behavior through the development of sophisticated coordination algorithms, communication methods, and global to local programming tools in order to simulate the sophisticated behavior of a real colony of insects.[25]

In order to allow for the RoboBee's flight, a series of artificial muscles must be custom designed out of piezoelectric materials, and the muscle system would have to use separate "muscles" for power and control during flight.[26] To achieve this, a relatively large power actuator oscillates the wing-thorax mechanism in order to power the wing stroke, while smaller control actuators

19. *Id.*

20. *See id.* (describing how saving the habitats of bees would help keep the population healthy).

21. Justin Fritscher, *USDA to Invest $4 million for Honey Bee Food Sources on Private Lands*, USDA (Oct. 6, 2015), http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/releases/?cid=nrcseprd405226.

22. *Id.*

23. *Robobees*, *supra* note 4.

24. *Id.*

25. *Id.*

26. Colin Schultz, *These Little Robot Bees Could Pollinate the Fields of the Future*, SMITHSONIAN (Mar. 12, 2013), http://www.smithsonianmag.com/smart-news/these-little-robot-bees-could-pollinate-the-fields-of-the-future-1824486/.

fine-tune the wing motions to generate torque for the purposes of control and maneuvering.[27] Piezoelectricity refers to the ability of certain materials to generate an electric charge in response to applied mechanical stress, the effect of which is reversible (electricity is generated when stress is applied, and stress is generated when an electric field is applied).[28] Essentially, how it works is that the placing of mechanical stress shifts positive and negative charge centers in the piezoelectric material, which results in an external electrical field.[29] When reversed, this outer electrical field either stretches or compresses the piezoelectric material.[30] The piezoelectric effect allows the muscles to contract when a voltage is applied across their thickness.[31]

There have been a variety of estimates as to when RoboBees could actually begin artificially pollinating crops. Some say that we should expect to see these robotic bees in the wild within five to ten years.[32] Other researchers believe that RoboBees could artificially pollinate a field of crops in as soon as ten years.[33] Still others insist that we are at least twenty years away from the possibility of robotic bees being able to conduct this artificial crop pollination.[34] One way or another, however, there seems to be consensus that at some point in the future, RoboBees will be able to perform the crop pollination function that honeybees currently perform.[35] However, it should also be noted that the lead researcher in charge of the RoboBee Project has stated that even if RoboBees were used for pollination, it would only be a stopgap measure while a solution to CCD was discovered and implemented, and should not be viewed as a permanent solution or replacement for honeybees.[36]

One of the chief obstacles facing the RoboBees is that the batteries needed to power them are currently too heavy for them to carry while still being able to sustain flight, and so they must be tethered in order to fly (meaning they have to be connected directly to the power source).[37] To overcome this obstacle, larger versions are being built so that they will be able to carry the battery, electronic centers, and all other necessities for autonomous flight.[38] This process does seem to be advancing at a fairly rapid pace, however. One Harvard graduate student and mechanical engineer working on the project pointed out that "their team is currently 'on the eve of the next big development' for the RoboBees, as the robots are now able to take on more

27. *Id.*
28. *The Piezoelectric Effect*, NANOMOTION, http://www.nanomotion.com/piezo-ceramic-motor-technology/piezoelectric-effect/ (last visited Mar. 2, 2016).
29. *Id.*
30. *Id.*
31. Schultz, *supra* note 26.
32. *Id.*
33. Dina Spector, *Tiny Flying Robots Are Being Built to Pollinate Crops Instead of Real Bees*, BUS. INSIDER (July 7, 2014), www.businessinsider.com/harvard-robobees-closer-to-pollinating-crops-2014-6.
34. *Robobees*, *supra* note 4.
35. Schultz, *supra* note 26; Spector, *supra* note 33; *Robobees* , *supra* note 4.
36. *Id.*
37. Spector, *supra* note 33.
38. *Id.*

weight while in flight."[39] Other developments that need to occur are smart sensors to allow the RoboBees to detect flowers and wireless communication devices that will be needed in order for the RoboBees to communicate with one another within a colony in the field.[40] The power sources must also power the RoboBees for long periods of time, while being small and portable enough to attach to the robotic insects without compromising their ability to achieve autonomous flight.[41] After all this is accomplished, the RoboBees should be able to perform honeybee tasks such as flower pollination without having to collect nectar, and in theory would only have to come back to some power source or charging station to recharge their batteries periodically.[42]

In summary, there is the potential for RoboBees to serve as either a temporary or permanent solution to CCD. However, there are still significant obstacles that stand between them and the autonomous flight functions required for crop pollination, as well as questions regarding the wisdom of using them to replace natural honeybees.

III. ANALYSIS

A. Does Public Policy Favor Using RoboBees?

The first issue that warrants examination with respect to replacing natural honeybees with RoboBees is whether or not it would be wise to do so from a public policy perspective. There are a significant number of potential upsides and downsides to doing so that must be balanced against each other when making this determination.

One benefit of using RoboBees to replace honeybees is that the new robotic bees would obviously be immune from phenomena such as CCD, as all of the suspected general categories mentioned before (pathogens, parasites, management stressors, and environmental stressors) are issues that only affect living organisms, not robots.[43] This means that there is no risk of running into the same CCD-related problems in the future. Additionally, as mentioned previously, there have been several mentions of honeybee disappearances throughout history, which may or may not have been caused by CCD.[44] So, while relying on natural honeybees leaves us potentially vulnerable to future disappearances, which seem to occur semi–frequently and may not be solved by a solution to CCD, using RoboBees could allow us security from future disappearances which would otherwise have the potential to devastate the agriculture industry.

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39. Aaron Mamiit, *RoboBees Might Be Pollinating Our Crops Within 10 Years*, TECH TIMES (Aug. 4, 2014, 8:54 AM), www.techtimes.com/articles/12019/20140804/robobees-might-be-pollinating-our-crops-within-10-years.htm.

40. Dominic Basulto, *New RoboBees Show That the Future of Robotics Is Very, Very Small*, WASH. POST (Aug. 7, 2014), www.washingtonpost.com/blogs/innovations/wp/2014/08/07/new-robobees-show-that-the-future-of-robotics-is-very-very-small/.

41. *Id.*

42. Spector, *supra* note 33.

43. *See Honey Bees*, *supra* note 1 (describing the four general categories suspected of causing CCD).

44. *Id.*

Additionally, RoboBees would be entirely pesticide-proof, as they are completely mechanical.[45] Thus, society could continue to reap the agricultural benefits of pesticides without worrying about harming the creatures that are necessary for certain necessary agricultural functions. Another advantage of using RoboBees as permanent replacements for honeybees is that the RoboBees could simply not be equipped with stingers and would obviously not have any venom stored within them.[46] This would virtually eliminate allergic reactions resulting from bee stings and the deaths associated with them. Approximately two million Americans have allergies to the venom of stinging insects, and many of them are at risk for life-threatening allergic reactions.[47] Additionally, approximately fifty deaths each year are caused by insect sting allergies in the United States.[48] Both of these numbers could be reduced if bee stings were to be taken out of the equation entirely.

Finally, because RoboBees would only be transmitting pollen, they would not have to collect nectar like real honeybees.[49] Honeybees, like other types of bees, need both the nectar and pollen from plants, and they take nectar that they gather during the process back to their hive.[50] RoboBees, however, would not require nectar and therefore would be able to forego the step of returning nectar back to a hive. This is because honeybees gather the pollenated nectar as food to bring back to their hive, something the RoboBees would not be required to do as they are inorganic and do not need to eat.[51] So in this regard, RoboBees would actually be more efficient than natural honeybees at pollinating crops, as they would not need to bring back nectar or pollen for food and could focus exclusively on cross-pollinating.[52]

There are of course several downsides to the notion of using RoboBees as permanent replacements for honeybees. The first is the emotional argument that we would essentially be allowing a species to die out that we otherwise might be able to save. Not only this, but some have argued that the creation of the pesticide-proof RoboBee would be rewarding big agricultural companies such as Monsanto, Bayer, and Syngenta, who manufacture the pesticides that some point to as a potential cause of natural honeybees dying out in the first place.[53] Indeed, Greenpeace created a cautionary, fictional video to play off of this desire to keep natural honeybees from extinction.[54] The video looks at the

45. Bill Talen, *The Promised Land of the RoboBee, Monsanto and DARPA*, HUFFINGTON POST (June 4, 2014), http://www.huffingtonpost.com/reverend-billy/the-promised-land-of-the-_b_5441190.html.

46. *Bee Venom*, WEBMD, http://www.webmd.com/vitamins-supplements/ingredientmono-972-bee%20venom.aspx (last visited Mar. 2, 2016).

47. *Allergies to Insect Stings*, WEBMD, www.webmd.com/allergies/guide/insect-stings (last visited Mar. 2, 2016).

48. *Id.*

49. Spector, *supra* note 33.

50. *Why Do Bees Need Nectar and Pollen?*, BUZZ ABOUT BEES, http://www.buzzaboutbees.net/why-do-bees-need-nectar-and-pollen.html (last visited Mar. 2, 2016).

51. *The Benefits of Insect Pollination*, UNIV. GA. COLL. AGRIC. & ENVTL. SCI., http://www.ent.uga.edu/bees/pollination/background.html (last updated May 29, 2015).

52. *Robobee—Robotic Pollinators to Replace Dying Bees*, BEFORE IT'S NEWS (Apr. 17, 2013), http://beforeitsnews.com/alternative/2013/04/robobee-robotic-pollinators-to-replace-dying-bees-2622928.html.

53. Talen, *supra* note 45.

54. GreenpeaceVideo, *NewBees*, YOUTUBE (Apr. 28, 2014), http://www.youtube.com/watch?v=

development of fictional "NewBees" (which are for all intents and purposes RoboBees), and ends with the line "should we create a new world or save our own?"[55]

Additionally, developing too heavy a reliance on robotic insects to conduct such an important function as pollination could leave us susceptible to widespread malfunctions, which could be just as catastrophic as natural bee extinction.[56] Also, while robotic pollination would be more efficient in the sense that RoboBees would have no need to collect nectar like real honeybees, they also would theoretically have to come back to something to recharge their batteries, which may offset that efficiency advantage.[57]

There is also another set of potential downsides to RoboBee replacement of natural bees that deal with potential uses other than crop pollination. For one, privacy concerns could arise, as individuals will almost inevitably use the tiny bee robots to spy on other individuals.[58] This concern is especially relevant given the availability of commercial drones and other unmanned aircraft, some of which are available as kits for citizens to buy and make on their own.[59] This privacy concern is no doubt more than trivial to most Americans, who value their privacy fiercely. There is also a concern that the small robots could be used in warfare to function as virtually undetectable unmanned drones.[60] Those who take issue with the use of unmanned drones currently being used in warfare and tactical strikes would no doubt be even more upset and unnerved by the use of RoboBees for such purposes, which would be insect-sized and virtually undetectable.[61]

In summary, there are several potential benefits and drawbacks to be taken into consideration when making the determination whether or not RoboBees replacing natural honeybees permanently would be a wise policy decision. However, policy considerations are not the only factor that must be considered when analyzing this issue.

B. Are RoboBees Drones?

Even if it would be a wise public policy decision to use RoboBees for the purposes of crop pollination on a permanent basis, how would these tiny robotic insects be regulated, and what would the legal ramifications be? One very reasonable possibility is that the RoboBees would fall under the classification of drones.[62] Drones, more accurately labeled unmanned aerial

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55. *Id.*

56. Spector, *supra* note 33.

57. *Id.*

58. Basulto, *supra* note 40.

59. Michael J. Sheehan, *U.S. Citizens' Fourth Amendment Rights & Unmanned Aerial Vehicles: An Appeal for Bright-Line Legislative Action*, 32 TEMP. ENVTL. L. & TECH. J. 255, 260 (2013) (citing *Arducopter: Adruino-based Autopilot for Multirotor Craft*, ARDUPILOT, http://copter.ardupilot.com).

60. *Id.*

61. *Id; see also* GLOBAL DRONES WATCH, http://droneswatch.org (last visited Feb. 8, 2016) (providing information about drones).

62. Qassim A. Abdullah, PENN. ST. DEP'T GEOGRAPHY, *1.4 Classification of the Unmanned Ariel*

vehicles (UAVs), are essentially aircraft that can fly without an onboard human pilot, and may operate under remote control or autonomous programming.[63] Given the relative novelty of UAV technology, legal policy addressing the proper use of UAVs is rather underdeveloped, particularly with regard to privacy concerns.[64] To address this, President Obama in February 2015 issued an executive order creating standards for how the Federal Government will address the privacy issues associated with drones.[65] The order requires federal agencies to examine their drone policies prior to adopting new drone technology as well as every three years thereafter, and creates new requirements for the collection of information by drones.[66] Namely, agencies may only collect information "to the extent that such collection or use is consistent with and relevant to an authorized purpose."[67] The president also directed the Department of Commerce's National Telecommunications & Information Administration to initiate a process to create privacy, accountability, and transparency rules for commercial and private uses of drones.[68] Should these robotic insects be deemed to fall under the UAV classification (and it would certainly appear rational for them to, given the definition), they will be governed by whatever privacy guidelines are developed as a result of this process.

The Federal Aviation Administration (FAA) had also been tasked with creating regulations for government and civilian drone use by September 2015.[69] Despite this deadline, however, the FAA instead said it would issue a rule on small commercial drone use by the end of 2015.[70] It has put forth a "Small UAS Registration Rule" which requires owners of Unmanned Aerial Systems (UAS) which weigh over .55 pounds and under 55 pounds to register their aircraft no later than February 19, 2016.[71] However, this registration is aimed at those using their small UAS as a "model aircraft," meaning it would need to be used for hobby or recreational purposes, whereas the RoboBees are intended for commercial purposes such as pollination.[72] FAA regulations would seem to be pertinent, as the agency predicts that 30,000 drones could be

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Systems, https://www.e-education.psu.edu/geog892/node/5 (last visited Mar. 2, 2016).

63. Sheehan, *supra* note 59 (citing Richard M. Thompson II, Cong. Research Serv., Drones in Domestic Surveillance Operations: Fourth Amendment Implications and Legislative Responses 2 (Apr. 3, 2013).

64. *Id.* at 260.

65. Gregory S. McNeal, *What You Need to Know About the Federal Government's Drone Privacy Rules*, FORBES (Feb. 15, 2015).

66. *Id.*

67. *Id.*

68. *Id.*

69. Melanie Reid, *Grounding Drones: Big Brother's Tool Box Needs Regulation Not Elimination*, 20 RICH. J.L. & TECH. 9, 12 (2014) (citing Bart Jansen, *FAA Has Plan for Drones, But is Behind Schedule*, USA TODAY (Dec. 2, 2013, 11:03 PM), http://www.usatoday.com/story/travel/flights/2013/12/02/faa-drones/3805447).

70. Kevin Robillard & Erin Mershon, *Obama to Issue Drone Privacy Order*, POLITICO (July 23, 2014, 7:01 PM), http://www.politico.com/story/2014/07/executive-order-drone-privacy-barack-obama-109303.

71. Press Release, Fed. Aviation Admin., FAA Announces Small UAS Registration Rule (Dec. 14, 2015).

72. *Id.*

airborne in United States airspace within twenty years.[73] However, the Congressional Act tasking the FAA with this responsibility focuses on regulations to alleviate safety concerns, and the Federal Government has yet to pass any legislation arising from privacy concerns with the increase in drone use by civilians and the government.[74] While there are of course some safety concerns associated with RoboBees, their extremely small size and potential for surveillance make privacy a much more pervasive potential issue.[75] One likely reason for the lack of focus on privacy concerns is the fact that the industry hopes to have 100,000 people working in "drone-related" jobs by the year 2025, and too stringently addressing privacy concerns could serve to undermine the burgeoning industry.[76]

Another problem arising from the future FAA regulations pertains to the issue of whether such regulations would even be applicable with respect to RoboBees.[77] The FAA in February released its proposal for rules governing small commercial drone use, and for the most part it seems that RoboBees would fall squarely under its category of "small commercial drones" (weighing up to 55 pounds, staying below 500 feet in the air, and flying less than 100 miles per hour).[78] However, the proposed rules also require that the aircraft "fly within sight of their remote pilots during daylight hours."[79] Given that the RoboBees are meant to behave on their own as real colonies of bees, they would not have a remote pilot.[80] Therefore, even when the FAA issues its regulations, if they retain this requirement, they would be entirely inapplicable to RoboBees.

The United States Department of Defense defines UAVs as "powered aerial vehicles sustained in flight by aerodynamic lift over most of their flight path and guided without an onboard crew."[81] Given that RoboBees seem to fall within this definition and therefore will likely be considered "drones," they too would appear to create jobs. However, like other drones, the chief concern with RoboBees being utilized as tiny robotic drones in ways other than as crop pollinators is the potential invasions of privacy. As discussed earlier, one of the potential uses for the tiny robots is surveillance.[82] The RoboBee's tiny and lightweight body has been noted as being suitable for "potentially carrying . . .

73. Ben Jenkins, *Watching the Watchmen: Drone Privacy and the Need for Oversight*, 102 KY. L.J. 161 (2013–14) (citing FED. AVIATION ADMIN., FAA AEROSPACE FORECAST: FISCAL YEARS 2010–2030, at 48 (2010), http:faa.gov/data_research/aviation/aerospace_forecasts/2010-20130/media/2010%20Forecast%20Doc.pdf).

74. Reid, *supra* note 69.

75. Basulto, *supra* note 40.

76. Jenkins, *supra* note 73, at 161–62 (citing Victor Luckerson, *Where Will the Drone Jobs Go? States Balance Economic Opportunity with Privacy Concerns*, TIME (May 1, 2013), http://business.time.com/2013/05/01/where-will-the-drone-jobs-go-states-balance-economic-opportunity-with-privacy-concerns/).

77. Mary Beth Albright, *Could Robot Bees Help Save Our Crops?*, NAT'L GEOGRAPHIC (Aug. 21, 2014), www.theplate.nationalgeographic.com/2014/08/21/could-robot-bees-help-save-crops/.

78. Bart Jansen, *FAA Unveils Drone Rules; Obama Orders Policy for Agencies*, USA TODAY (Feb. 16, 2015, 8:12 AM), www.usatoday.com/story/news/2015/02/15/faa-drone-rule/23440469/.

79. *Id.*

80. *Robobees*, *supra* note 4.

81. *Introduction of the Unmanned Aerial Vehicles*, U.S. DEP'T DEF., http://archive.defense.gov/specials/uav2002/uavpage01.html (last visited Mar. 2, 2016).

82. *Robobees*, *supra* note 4.

items like video cameras."[83] New innovations such as this have created problems for courts in determining whether or not a breach of the right to privacy has occurred, as "[n]ew technologies create new opportunities for an invasion of privacy by the government . . . ."[84] Drone technology is fairly unique in the threat that it presents to individual privacy, as it eliminates the practical safeguards against Fourth Amendment searches.[85] One unique element of drone technology particularly relevant to RoboBees is that drones can be significantly smaller in size than more traditional aircraft, which can make them all but invisible at heights from which other aircraft such as airplanes or helicopters are easily spotted.[86]

C. Potential Privacy Issues Regarding RoboBees

Until privacy guidelines for commercial drones are further developed in the United States, we must look to case law regarding privacy issues in the context of similar aircraft. More specifically, cases addressing privacy concerns with respect to manned aircraft, while not an entirely identical situation, can be helpful in deciphering what sort of limits would be imposed on the RoboBees for surveillance purposes. For example, the legality of an aircraft's position is not sufficient to evaluate the constitutionality of any surveillance conducted aboard it.[87] So, even if RoboBees were legally permitted to roam crop fields or other areas for the purposes of pollination, surveillance conducted by them would not necessarily be constitutional. While technology creates many varied means of observation and surveillance, "the fact that something can be done does not make the doing of it constitutional."[88]

When looking at case law regarding any sort of technology-assisted surveillance, *Kyllo v. United States* is a good starting point.[89] In this case, the Supreme Court examined the issue of whether a thermal imaging device aimed at a private home from a public street amounted to a "search" within the meaning of the Fourth Amendment.[90] Considering that drones today can be equipped with similar technology and should soon be able to see through the walls of buildings, the case is especially significant for purposes of drone surveillance.[91] The Court in *Kyllo* held that obtaining information regarding the interior of a home that could not otherwise be obtained through the use of "sense-enhancing technology" constituted a search when "the technology in question is not in general public use."[92] So the question for purposes of *Kyllo*

83. Albright, *supra* note 77.

84. Sheehan, *supra* note 59 (citing Olmstead v. United States, 277 U.S. 438 (1967)).

85. Jenkins, *supra* note 73, at 171.

86. *Id.* (citing Travis Dunlap, *We've Got Our Eyes on You: When Surveillance by Unmanned Aircraft Systems Constitutes a Fourth Amendment Search*, 51 S. TEX. L. REV. 173, 201 (2009)).

87. State v. Bryant, 950 A.2d 467, 478 (Vt. 2008).

88. *Id.* at 479.

89. Kyllo v. United States, 533 U.S. 27 (2001).

90. *Id.* at 34–35.

91. Jenkins, *supra* note 73, at 172 (citing RICHARD M. THOMPSON II, CONG. RESEARCH SERV., R42701, DRONES IN DOMESTIC SURVEILLANCE OPERATIONS: FOURTH AMENDMENT IMPLICATIONS AND LEGISLATIVE RESPONSES 13 (2013), http://www.fas.org/sgp/crs/natsec/R42701.pdf.

92. *Kyllo*, 533 U.S. at 34.

thus becomes: will RoboBees be considered to be "in general public use" when they are finally created?

The answer appears to be yes. In 2012, Congress passed the FAA Modernization and Reform Act (FMRA), which stated, in part, that the FAA was to publish a rule allowing for "civil operation" of small "Unmanned Aerial Systems" (UAS) by August 13, 2013.[93] While the FAA missed all of the deadlines under the FMRA that have come and gone to date, it has at least (tardily) published an "Unmanned Aircraft Systems Comprehensive Plan" (Comprehensive Plan) and "Integration of Civil Unmanned Aircraft Systems in the National Airspace System Roadmap" (Roadmap).[94] The Comprehensive Plan and the Roadmap both indicate that the FAA is planning to slowly integrate civilian UAS into the National Airspace system "over a period of years."[95] With that being said, "it is also equally evident that the demands of agriculture, first responders, and commercial vendors to deploy the technology at a quicker pace will be hard for [the] FAA to continue to ignore."[96] Interestingly enough, though, the FAA explained in both its Roadmap and Comprehensive Plan that it would not be promulgating any specific rules with regards to privacy, "but rather would leave privacy to others."[97] These "others" are likely the states, as many states already have specific privacy protections in place, and of those that do not, many are considering adopting them in anticipation of the inevitable UAS integration.[98]

A variety of privacy rules and strategies are being considered with respect to UAS, with one such idea involving a defined "fence" allowing a UAS operator to fly the UAS in a defined route "with specific camera, microphone, and other parameters."[99] If the UAS should stray outside of these parameters, an automated program kills its power and it is forced to land.[100] This idea is intriguing and does seem to protect individual privacy interests, but may not be totally applicable to a drone such as a RoboBee. As aforementioned, the RoboBee is designed to behave like a real life honeybee, and as such will presumably search for crops that need to be pollinated and then proceed to pollinate them.[101] This sort of natural behavior may be difficult to contain within a specific area or "fence," which would be detrimental to the performance of the RoboBee as a crop pollinator. It could lead to a number of instances in which RoboBees trigger the automated kill program simply because they identify something that needs to be pollinated that lies beyond the invisible fence which they are not supposed to cross. Other suggestions include "requirements of height and distance from objects, places, and people

93. Wendie L. Kellington & Michael Berger, *Why Land Use Lawyers Care About the Law of Unmanned Systems*, ZONING & PLANNING LAW REPORT 4 (June 2014) (citing FAA Modernization and Reform Act of 2012 (FMRA), Pub. L. No. 112-95, §332(b)(1), 126 Stat. 11, 74 (2012)).

94. *Id.*

95. *Id.* at 5.

96. *Id.*

97. *Id.* at 9.

98. *Id.*

99. *Id.*

100. *Id.*

101. *Robobees*, *supra* note 4.

not involved in operations or consenting . . . ."[102] This strategy, of course, suffers from the same deficiency that plagues the "fence" solution: given that RoboBees are designed to emulate the body, brain, and colony aspects of a real bee, any significant distance requirement would no doubt interfere with their ability to carry out the function for which they were created.[103]

One potentially useful strategy is to require UAS owners and operators to enter into agreements with the Federal Government about how the UAS would be operated under their control and how they plan on dealing with private information should it be obtained by their UAS.[104] This idea actually has some potential with regard to RoboBees, as owners could enter into agreements stating that their UAS are being used strictly for agricultural or pollination purposes and will not be used to obtain private information at all. The agreements would include specified consequences for a party should it breach the contract, which would include license revocation, among other things.[105] Seeing as how RoboBees would presumably be vital to the continuation of the owner's livelihood should they be implemented to replace natural honeybees, the potential consequences included in the agreement would certainly be enough to deter them from breaking the agreement.[106]

One way or another, however, it does appear that UAS (which would of course include RoboBees) will be available for civilian use. While there does not appear to be any direct statement or suggestion that RoboBees will be available to private citizens, given that their primary purpose would be crop pollination, it would certainly stand to reason that individuals needing their fields pollinated would not be precluded from purchasing them for that purpose. Whether or not this civilian use will equate to the "general use" required under *Kyllo* is an issue that remains to be seen, but if it does, then government and law enforcement use of RoboBees for surveillance purposes will not constitute a search requiring a warrant under the Fourth Amendment.[107] Some "[s]cholars have expressed doubt that the Court's ruling in *Kyllo* will encompass the most common drone surveillance tools—cameras and video recorders—due to the fact that these tools are in general public use."[108] They predict that drone surveillance would probably only constitute a search under *Kyllo* if the drone were to use some sort of thermal-imaging device or other scanner not generally available to the public.[109] However, "other scholars have asserted that drone surveillance generally falls within *Kyllo*'s prohibition because drones themselves are 'sense-enhancing' devices

102. Kellington & Berger, *supra* note 93, at 9.
103. *Robobees*, *supra* note 4.
104. Kellington & Berger, *supra* note 93, at 9.
105. *Id.*
106. *Id.*
107. Jonathan Olivito, *Beyond the Fourth Amendment: Limiting Drone Surveillance Through the Constitutional Right to Informational Privacy*, 74 OHIO ST. L.J. 669, 687 (2013) (citing Joseph J. Vacek, *Big Brother Will Soon Be Watching—Or Will He? Constitutional, Regulatory, and Operational Issues Surrounding the Use of Unmanned Aerial Vehicles in Law Enforcement*, 85 N.D. L. REV. 673, 679–84 (2009); Dunlap, *supra* note 86, at 201–04).
108. *Id.*
109. *Id.*

that are not in general public use."[110] But even if one takes this view of *Kyllo*'s applicability, the fact that drones are becoming increasingly available to the public for domestic use makes it questionable whether the courts would consider this argument compelling for any significant period of time.[111]

Additionally, FAA regulation is likely to leave room for state and local governments to regulate the potential privacy violations arising from UAS usage through "protection and enforcement of privacy, including the kind, and circumstances of, personal information collected . . . ."[112] However, until these regulations are passed, case law will continue to provide the most guidance for determining how RoboBees' likely impact on privacy rights should be handled.

In another case, an investigating officer circled twice over an individual's property at 400 feet to see the contents of a greenhouse through openings in its roof and the sides, which allowed him to identify what he thought was marijuana and obtain a warrant based on his observations.[113] The Supreme Court found that the fact that a helicopter was flying at an altitude of 400 feet "made no difference for Fourth Amendment purposes."[114] In reaching this conclusion, the Court reasoned that there was nothing to suggest that helicopters flying at such an altitude were sufficiently rare or that they interfered with the normal use of the property or other parts of its curtilage.[115] Specifically, the Court noted that the record revealed no undue noise, as well as "no wind, dust, or threat of injury."[116] Should RoboBees become common in the wild (and as noted above, it has been suggested by some that this could occur as early as in five years), there would not be anything "sufficiently rare" about them and thus it is hard to imagine them interfering with the normal use of any property.[117] After all, "[a] Robobee measures about half the size of a paperclip" and "weighs less than a tenth of a gram . . . ."[118] This makes it extremely unlikely that they would cause any wind, dust, or threat of injury. Therefore, the RoboBees would seem to fall into the category of craft that does not require a warrant to observe what would be visible to the naked eye.

One significant issue with comparing case law regarding manned aircraft and RoboBees is the difference in altitude at which both would presumably operate. Courts have allowed aerial surveillance from navigable airspace "where civilian planes or helicopters routinely fly, although they have prohibited such surveillance if it occurred from unusually low altitudes."[119]

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110. *Id.* (citing Paul McBride, *Beyond Orwell: The Application of Unmanned Aircraft Systems in Domestic Surveillance Operations*, 74 J. AIR L. & COM. 627, 651–61 (2009)).

111. *Id.* (citing Mary G. Leary, *The Missed Opportunity of United States v. Jones: Commercial Erosion of Fourth Amendment Protection in a Post-Google Earth World*, 15 U. PA. J. CONST. L. 331, 344–51 (2012)).

112. *Id.* at 8.

113. Florida v. Riley, 488 U.S. 445, 448 (1989).

114. *Id.* at 451.

115. *Id.* at 445–46.

116. *Id.* at 452.

117. *Id.* at 446.

118. *Autonomous Flying Microrobots (Robobees)*, WYSS INST., http://www.wyss.harvard.edu/viewpage/457 (last visited Feb. 8, 2016).

119. Robert Molko, *THE DRONES ARE COMING! Will the Fourth Amendment Stop Their Threat to Our Privacy*, 78 BROOK. L. REV. 1279, 1281 (2013) (citing Pew v. Scopino, 904 F. Supp. 18, 27 (D. Me. 1995)).

However, what constitutes an "unusually low altitude" would without a doubt be different for planes and helicopters than it would be for tiny insect-sized robots. As mentioned earlier, the Supreme Court found that a helicopter flying 400 feet above the ground was not sufficiently rare.[120] In another case involving a private plane, the Court held that the police did not need a warrant to observe marijuana plants in an individual's backyard from an altitude of 1000 feet.[121] However, a RoboBee would have to be flying at a sufficiently low altitude so as to be able to conduct its crop pollination functions, much lower than the aforementioned 400 feet.[122]

The Constitution also limits the amount of technological assistance the police may use without a warrant.[123] It has been stated by the courts that "[a]bsent a warrant, it is impermissible for police to use artificial aids to observe activities within an individual's home because that act intrudes upon an individual's privacy, triggering a Fourth Amendment 'search.'"[124] Clearly a small insect-sized robot outfitted with a camera would be considered an "artificial aid," and therefore would require a warrant. However, the above quotation only seems to apply to observations made of activities occurring within an individual's home, leaving other activity more easily observable by RoboBees without any need for a warrant.

To date, drones have actually been used in surveillance related to the arrest of a United States citizen on domestic soil.[125] A predator drone was used to reconnoiter a ranch during a standoff between armed suspects and police, and when its sensors located the suspects and determined that they were unarmed, the police rushed in, "and made the first known arrests of U.S. citizens [on U.S. soil] with help from a Predator."[126] So while much of the case law centers on manned aerial vehicle surveillance not falling within the classification of "drones," the concept of UAVs being used for surveillance purposes on domestic soil is not only not an unreasonable one, but one that has been implemented in certain situations.

One way or another, it appears that development of RoboBees would at least in some way alter the means by which individuals may be observed in their private lives. "Drone technology, when carried to its extreme, threatens to destroy whatever vestiges of privacy remain in modern society, even in areas like a secluded, fenced-in backyard or private estate."[127] While this is the worst-case scenario, it is possible that the mere possibility of this conclusion resulting from the use of technology like RoboBees for surveillance purposes could restore our "mental model of a privacy violation [by acting as] the

120. *Florida v. Riley*, 488 U.S. 445, 445-46 (1989).

121. California v. Ciraolo, 476 U.S. 207, 215 (1986).

122. *See* Spector, *supra* note 33 (explaining that the Robobees would go flower to flower in order to put down pollen).

123. Timothy T. Takahashi, *Drones and Privacy*, 14 COLUM. SCI. & TECH. L. REV. 72, 104 (2013).

124. *Id.* (citing United States v. Ki, 415 F. Supp. 1252, 1256 (D. Haw. 1976)).

125. *Id.* at 74 (citing Brian Bennett, *Police Employ Predator Drone Spy Planes on Home Front*, L.A. TIMES, Dec. 10, 2011, at Nation).

126. *Id.*

127. Molko, *supra* note 119, at 1281.

visceral jolt society needs to drag privacy law into the twenty-first century."[128]

D. Federal and State Privacy Protections from Drone Use

There is currently an absence of uniform federal law on drone use and privacy. Recently, Congress attempted to pass the Preserving American Privacy Act of 2013, which would have essentially "require[d] a warrant before a drone could be used."[129] Specifically, the 2012 version of the proposed Act provided that "[n]o Federal agency may authorize the domestic use of an unmanned aircraft . . . for law enforcement purposes or for surveillance of a United States national or real property owned by that national, including by any State or local government, except pursuant to warrant and in the investigation of a felony."[130] In addition, the Act provided that, "[n]o Federal agency may authorize the domestic use, including granting a permit to use, of an unmanned aircraft . . . to permit any private person to conduct surveillance on any other private person without the consent of that other private person or the owner of any real property on which that other private person is present."[131] Taken together, these two sections of the proposed legislation would have seriously alleviated concerns about the use of RoboBees in ways that would infringe on individual privacy, as a warrant would have been required for law enforcement purposes and it would have been impermissible for other private individuals to use them to spy on other private individuals. However, the bill ultimately died in Congress, as it was introduced in a previous session and was not enacted.[132] Therefore, the country remains without federal law governing the use of drones.

Even in the absence of federal legislation or case law limiting the government's use of drones for seemingly invasive surveillance purposes, state actors have moved to take certain precautions ensuring their citizens' privacy to some extent.[133] Twelve states have already passed legislation significantly limiting government drone flights, and twenty-one other states currently have legislation pending on the same matter.[134] State regulatory schemes regarding privacy protection from drone use have involved controlling both public and private use, and the means by which they seek to control these uses vary from state to state.[135]

In regulating public (meaning law enforcement and government) use of drones, some states require a warrant for any enforcement entity to operate a drone, though many of these statutes allow for, "exceptions in certain defined

128. Takahashi, *supra* note 123, at 113 (citing M. Ryan Calo, *The Drone as Privacy Catalyst*, 64 STAN. L. REV. ONLINE 29 (2011), www.stanfordlawreview.org/online/droneprivacycatalyst).

129. Reid, *supra* note 69, at 4.

130. Preserving American Privacy Act of 2012, H.R. 6199, 112th Cong. § 2 (2012).

131. *Id.* § 5.

132. *H.R. 637 (113th): Preserving American Privacy Act of 2013*, GOVTRACK.US www.govtrack.us/congress/bills/113/hr637 (last visited Feb. 9, 2016).

133. Reid, *supra* note 69, at 3.

134. *Id.*

135. Robert A. Heverly, *The State of Drones: State Authority to Regulate Drones*, 8 ALB. GOV'T L. REV. 29, 49–54 (2015).

circumstances."[136] For example, Indiana law provides that "a law enforcement officer must obtain a search warrant in order to use an unmanned aerial vehicle,"[137] but also provides that an unmanned aerial vehicle may be used without first obtaining a warrant so long as certain criteria are met.[138] Other states like Texas require reporting on drone use by public entities,[139] while states such as Alaska and Utah regulate the retention of drone-collected information in order to control public use.[140] Still other states have special administrative agency procedures set up especially for authorizing government and law enforcement to use drones or "training and licensing procedures applicable to public use of drones."[141] Some states even go as far as to prohibit all use by public entities, though these can be limited in their application to uses for specific types of surveillance or enforcement.[142] However restrictive the states choose to be, it is nevertheless unlikely that federal operations will be affected whatsoever by state regulation.[143]

With regard to the regulation of private drone use, some state schemes that have been established regulate private drone use generally, but most have "more specific objectives" and are "aimed at specific activities."[144] An example of the former is Idaho, which has enacted law stating that:

> Absent a warrant, and except for emergency response for safety, search and rescue or controlled substance investigations, no person, entity or state agency shall use an unmanned aircraft system to intentionally conduct surveillance of, gather evidence or collect information about, or photographically or electronically record specifically targeted persons or specifically targeted private property . . . .[145]

An example of the latter is Illinois, which specifically prohibits drone use in a manner that interferes with another individual's hunting or fishing.[146] There are also state prohibitions on photographing individuals through the use of UAVs without their consent "for the purpose of publishing or otherwise publicly disseminating the photograph," with exceptions for "newsgathering, newsworthy events, or events or places to which the general public is invited."[147]

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136. *Id.* at 51.

137. IND. CODE ANN. § 35-33-5-9(a) (West, Westlaw through the 2016 Second Sess.).

138. *Id.* § 35-33-5-9(b).

139. TEX. GOV'T CODE ANN. § 423.008 (West, Westlaw through the end of the 2015 Sess.).

140. ALASKA STAT. ANN. § 18.65.903 (West, Westlaw through the 2015 First Sess.); UTAH CODE ANN. §63G-18-104 (West, Westlaw through 2015 First Special Sess.).

141. Heverly, *supra* note 135, at 51.

142. *See* IOWA CODE ANN. § 321.492B (West, Westlaw, through the 2016 Reg. Sess.) (providing that "[t]he state or a political subdivision of the state shall not use an unmanned aerial vehicle for traffic law enforcement.").

143. Heverly, *supra* note 135, at 52 (citing Seth P. Waxman & Trevor W. Morrison, *What Kind of Immunity? Federal Officers, State Criminal Law, and the Supremacy Clause*, 112 YALE L.J. 2195, 2206 (2003)).

144. *Id.*

145. IDAHO CODE ANN. § 21-213(2)(a) (West, Westlaw, through the 2016 Reg. Sess.).

146. *See* 720 ILL. COMP. STAT. 5/48-3(b)(10) (West, Westlaw, through the 2016 Reg. Sess.) (prohibiting one who "uses a drone in a way that interferes with another person's lawful taking of wildlife or aquatic life.").

147. N.C. GEN. STAT. §15A-300.1(b)(2) (West, Westlaw, through the 2016 Reg. Sess.).

While many of these state responses to drone use do differ in a number of ways, they can at the very least serve as a resource for the Federal Government to draw upon in attempting to enact its own law covering the issue. There is not one particular statute or provision that is perfect in and of itself, but taken together, an effective federal law option should be achievable through crafting a patchwork of the best portions of select states' laws.

E. Potential Land Use Issues Regarding RoboBees

In addition to potential privacy issues, the widespread use of RoboBees could also have serious land use implications, which may be problematic. A number of local codes currently regulate where certain types of aircraft may be located, "and the definitions of 'airport' or 'heliport' will likely also cover areas where UAS take off and land vertically or laterally."[148] This means that the FAA would have to decide whether or not to allow such rules to apply to UAS, and would require a determination as to whether or not land use authorities will be able to regulate the places of launch, land, and recharge.[149] As stated above, we know that RoboBees are going to need to recharge their batteries periodically, so the question of who will be able to regulate such places of recharge is a real issue pertaining to their use.[150]

The question of who is truly in charge of regulating UAS is still not entirely clear, particularly with regard to the regulatory framework for "sUAS" (meaning "small", classified as UAS weighing less than fifty-five pounds, a category RoboBees would most certainly fall under).[151] In one particular case in March 2014, an administrative law judge for the National Transportation Safety Board dismissed an FAA complaint involving a civilian's use of a sUAS on the grounds that it was not an "aircraft," but rather a "model aircraft," a separate class of aerial machines that the FAA had treated as outside the scope of its authority and therefore waived its right to regulate.[152] This decision appears to indicate that sUAS fall outside of the regulation of the FAA. However, it is important to note as well that the events around which the decision revolved all occurred before passage of the FMRA, and so while it is not entirely clear, it is likely that the FAA's rules will be applied to sUAS users.[153]

Another wrinkle in the regulation issue arises when looking at potential zoning regulations, which could affect RoboBees. Traditionally, state and local governments have been given authority and responsibility for airport and heliport siting in order "to ensure compatible land uses around airports."[154] So long as the state and local regulations do not interfere with safe aircraft

148. Kellington & Berger, *supra* note 93, at 5.
149. *Id.*
150. Spector, *supra* note 33.
151. Kellington & Berger, *supra* note 93, at 6.
152. *Id.* at 7 (citing Huerta v. Pirker, N.T.S.B., Docket CP-217 (Mar. 6, 2014), http://02b954f.netsolhost.com/docs/211088332-Pirker-Decision.pdf).
153. *Id.*
154. *Id.*

operations or air traffic flow, they have successfully regulated the places where these establishments can be sited.[155] The relevant FAA rule defines "Airport" as "any airport, heliport, helistop, vertiport, gliderport, seaplane base, ultralight flightpark, manned balloon launching facility, or other aircraft landing or takeoff area," while defining "Heliport" as "any landing or takeoff area intended for use by helicopters or other rotary wing type aircraft capable of vertical takeoff and landing profiles."[156] While there are no doubt many differences between UAS and more traditional aircraft such as airplanes and helicopters, without any federal rules specific to UAS, the places from which they take off and where they land certainly would seem to fall under the FAA definition of "Airport."[157] However, because of the differences between UAS and traditional craft, it is expected that when the FAA does get around to its UAS-specific rulemaking, it will "leave room for state and local regulatory controls to affect the UAS experience including . . . authorization of some land use controls over places where certain types of UAS take off, land, recharge, and fly . . . ."[158]

State and local governments will not have free rein in their regulation of UAS, however. As currently written, the Federal Airline Deregulation Act of 1978 (FADA) "will limit state or local controls over UAS in the absence of specific FAA rule clarification."[159] The statute provides that "a State may not enact or enforce a law, regulation, or other provision having the force and effect of law related to price, route or service of any air carrier that may provide air transportation under this subpart."[160] The term "Air Carrier" is defined as "a person who undertakes directly by lease, or other arrangement, to engage in air transportation. This includes an individual, firm, partnership, corporation, company, association, joint-stock association, governmental entity, and a trustee, receiver, assignee, or similar representative of such entities."[161] Given the incredibly small size of RoboBees, however, they would not fall under this definition of "Air Carrier," and therefore state and local governments would not be so limited in their regulation of them.[162]

One way or another, in the end it appears that when it comes to land use control and regulations, both the FAA and state and local governments will wind up having a hand in the development of rules regarding UAS, at least some of which would appear to cover RoboBees when they are in use.

IV. RECOMMENDATION

Given the seriousness of the threat facing natural honeybees and the

155. *Id.* at 8 (citing Am. Airlines, Inc., v. Town of Hempstead, 398 F.2d 369 (2d Cir. 1968); United States v. City of New Haven, 367 F. Supp 1338 (D. Conn. 1973); Garden State Farms v. Bay, 390 A.2d 1177 (N.J. 1978)).

156. 14 C.F.R. § 157.2 (2016).

157. Kellington & Berger, *supra* note 93, at 8.

158. *Id.*

159. *Id.*

160. 49 U.S.C. § 41713(b) (2012).

161. 14 C.F.R. § 139 (2016).

162. *Autonomous Flying Microrobots*, *supra* note 118.

potential benefits of robotic pollination, RoboBees should be considered a viable option not only as a temporary stopgap measure to combat CCD until a permanent solution is found, but also as a potential permanent solution to replace natural honeybees in their role as pollinators. If successful, utilizing the RoboBees in this role would leave us less susceptible to CCD or other natural honeybee disappearances that have surfaced from time to time throughout history. Furthermore, while there is the potential for malfunctions of the RoboBees, which could open us up to similar problems as CCD and natural bee disappearances, we are in control of the ability to fix those malfunctions. The same cannot necessarily be said for natural bee disappearances for which we do not always have an explanation and for which a solution may be far more difficult to discover and then implement. Additionally, the RoboBees would likely be more efficient at pollination as they would not need to collect nectar in the same way that real bees do, namely by simply transmitting pollen from place to place.

After they have been fully developed and are present in the wild, RoboBees should be considered UAVs or drones and should be governed by the same rules and regulations that are promulgated with regards to the executive order issued by the president on privacy guidelines for commercial drones, or alternatively by the guidelines he has put forth for federal agency drone use.[163] Additionally, it will be important to fit the RoboBees into the case law dealing with surveillance by aerial manned and unmanned aircraft for further guidance on how to treat them and to fill in any gaps left by regulations or guidelines.[164]

As to the regulation of government use of RoboBees and of drones generally, it is clear that uniform federal legislation is needed with regards to both privacy and land use issues, and equally clear that the courts are not equipped to develop common law doctrines of privacy to account for the use of drones. For privacy purposes, that legislation may be in the form of an act structured in a way similar to the Preserving American Privacy Act.[165] Whether it comes in this form or in another form that is less clear, there have to be predictable rules for government drone use nationwide. State legislatures have already made clear by passing and proposing their own legislation that they believe privacy regulation, in addition to safety regulation, is needed for these government drones, and having various states providing different requirements for government drone use can only serve to stymie the predictability that the law so favors.[166] For these reasons, national legislation must be passed either setting uniform guidelines for government drone use or tasking the FAA or another appropriate regulatory agency to do so.

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163. *See generally* Jenkins, *supra* note 73, at 175–76 (describing a proposed law to regulate the use of UAVs to protect private citizens).

164. *See generally* Florida v. Riley, 488 U.S. 445, 451–52 (1989) (considering the implication of law enforcements' use of aerial surveillance); State v. Bryant, 950 A.2d 471 (Vt. 2008) (illuminating one instance of UAV surveillance resulting private citizens being prosecuted for marijuana cultivation).

165. Preserving American Privacy Act, H.R. 637, 113th Cong. § 3 (2013).

166. *See* N.C. GEN. STAT. §15A-300.1(b)(2) (West, Westlaw, through the 2016 Reg. Sess.) (detailing the precautions the North Carolina legislature enacted to protect privacy).

Fortunately, a large number of states have already provided the government with a blueprint for crafting such national legislation by way of enacting their own drone regulating laws.[167] Ideally, there would be separate legislation, or at the very least separate sections of the same act, for prohibitions on private and public drone use. The law addressing the government and law enforcement use of drones should track the language of a state like Indiana, providing a general prohibition on their use without a warrant, but then providing exemptions from that general prohibition by enumerating an exhaustive list of circumstances that would allow for warrantless drone use.[168] The law concerning private use of drones should follow a less generalized approach, enumerating the impermissible uses of drones by private citizens and leaving the rest to be lawful. Such specific provisions as Illinois' prohibition of interfering with hunting and North Carolina's photography for purpose of public dissemination, for example, should be included on the list.[169] This way private citizens would not be deterred from using recreational drones for fear of incidentally invading the privacy of another outside of an enumerated list of situations, and the burgeoning industry of commercial drone sales will not by stymied. This concern becomes even more important when one considers the economic impact that such a chilling effect could cause, as lower demand for drones would injure states, which are depending on the drone industry to create jobs for their citizens.[170]

With regards to land use regulation, it appears fairly certain that the FAA will have authority to promulgate and enforce its rules as applied to users of sUAS in the future. While the deadlines of the FMRA are continually not being met, it at the very least seems that eventually there will be predictable and uniform rules governing their use.

One can imagine a number of different applications RoboBees have, whether it be merely replacing natural honeybees as pollinators, conducting surveillance or reconnaissance for search and rescue, or being deployed to aid the military. Regardless of which of these possibilities come to fruition, there needs to be uniform federal regulation to govern their use.

V. CONCLUSION

In summary, the prospect of utilizing RoboBees as permanent replacements for natural honeybees in the role of crop pollination has both pros and cons. However, the potential benefits of utilizing RoboBees in such a role as opposed to merely stopgap replacements outweigh the potential downsides to such utilization. Therefore, they should be considered as viable alternatives to honeybees in the long run should efforts to eradicate CCD fail. After they

167. Heverly, *supra* note 135, at 49–54.

168. IND. CODE. § 35-33-5-9(a)–(b) (West, Westlaw, through the 2016 Reg. Sess.).

169. 720 ILL. COMP. STAT. 5/48-3(b)(10) (West, Westlaw, through the 2016 Reg. Sess.); N.C. GEN. STAT. § 15A-300.1(b)(2) (West, Westlaw, through the 2016 Reg. Sess.).

170. Jenkins, *supra* note 73, at 161–62.

have been fully developed, the tiny robots appear to fall squarely within the category of UAVs or "drones," and therefore should be governed by whatever privacy guidelines are created for commercial drones to the extent applicable to those drones.

How they should be governed when serving governmental or private purposes is far less clear given the current lack of federal guidance on the matter. While drones have been used in the past to aid police in making arrests, the case law centers mostly on factors such as altitude and interference with property that deal with manned aircraft, and would be inapplicable to small insect-like robots.[171] However, given the possibility of these RoboBees being used as government surveillance equipment, it is highly likely that there will be public demand for some sort of specification as to what extent they can be used for surveillance purposes, or at least some case law which will illuminate to a certain extent what can and cannot be done. Additionally, the increased private use of drones raises concerns about potential intrusion upon individual privacy. Until then, the case law governing other forms of heightened surveillance and technologically advanced methods will have to also govern RoboBees employed for non-commercial purposes, unless state legislatures have already acted to limit or otherwise define the scope of government drone use. However, this should serve only as a stopgap while Congress creates federal standards for government drone use, after which case law and state legislation should fall in line with the new uniform regulations. The federal legislation should be based upon certain state laws already currently in effect, and should resemble the hybrid model proposed by this Note.

The development and implementation of the RoboBee project has many implications, some exciting and some unnerving. But one way or another, it appears almost certain that in some capacity these small insect-like robots are going to be flying in our skies, and we have to be prepared for the day when they are, whether that preparedness means knowing who or what is going to be able to regulate them or having safeguards in place to ensure that any encroachment on the privacy of American citizens is carefully and uniformly circumscribed.

171. Florida v. Riley, 488 U.S. 445, 451–52 (1989); California v. Ciraolo, 476 U.S. 207, 215 (1986); State v. Bryant, 950 A.2d 467, 471 (Vt. 2008).