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A Plan for Pollinator Landscape Management on the Ursinus Campus

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Abstract

This document proposes a plan for managing pollinator landscapes on the Ursinus campus. The goals of this project were to research existing pollinator management plans and studies about pollinator health to provide a background on which to build an Ursinus-specific plan. Other schools' pollinator protection plans were used as inspiration for a document that would address the needs of pollinators on the Ursinus campus while keeping the communities goals and restrictions in mind. Recommendations for campus include creating a pollinator-friendly landscape in the Musser garden. The plan for Musser garden includes for the creation of pollinator foraging and nesting sites. Using this planting plan as a guide, faculty, students, and staff can work together to create plantings across campus that provide quality habitat for local pollinators.

Introduction

Due to the documented recent and drastic declines of native and domesticated honey bees in North America it is imperative that communities help preserve pollinator populations. Ursinus College's commitment to sustainability and stewardship sets a precedent for creating a campus environment where pollinators can both be free from dangerous toxins and find suitable foraging and nesting habitats. Ursinus College is located north of Philadelphia in a mix of land types including suburban, urban forest, commercial, and agricultural land. Ursinus' campus has the opportunity to serve as a refuge for pollinators in the area that encounter environmental stressors from the surrounding industrial and residential areas.

Goals of the Project

The goals of this project are to investigate the land management practices at Ursinus to determine where improvement is needed and to create a plan that benefits local pollinators. With 170 acres of managed land, Ursinus has an opportunity to make an impact on the surrounding areas that benefit from pollinators. Changes made on the campus that positively impact pollinator health could provide pollination benefits for a large area around campus. We seek to make recommendations that have both the human Ursinus community and the ecological health of the campus in mind. Using

other universities and colleges with pollinator protection plans as templates, I will propose here detailed and easily implementable recommendations for campus.

The Facilities Services Department at Ursinus College already takes steps to make the campus a greener and safer space for local wildlife. Their efforts include reducing pesticide and herbicide use whenever possible and planting a variety of native species. However, the Department has only a few full time staff members who care for the grounds, which makes hand weeding and other time-intensive land management practices challenging. My goal is to provide recommendations that have a clear course of action. This is an important step for Ursinus as it would be an opportunity to revitalize the appearance of the campus, while recognizing that pollinator health is an increasingly important issue.

Pollinator Decline and Efforts to Protect Pollinators

Why Bees?

Pollinators include a wide variety of species that aid in the reproduction of plants by transporting pollen between flowers. Species of pollinators include mostly flying insect species such as bees, wasps, flies, butterflies, beetles, and moths but also include other insect species and mammalian species such as bats (Mader, 2011, p. 21).

For the purposes of this document the term pollinator refers to winged insect pollinator species. Pollinator species aid in the fertilization of flowering plant species as they search for pollen and nectar. Their contributions are responsible directly or indirectly for pollinating as much as one-third of the fruits, vegetables, and other food that people consume globally. (Mader, 2011, p. 5). While all pollinators contribute to plant reproduction, species of bees are among the most prolific pollinators both nationally and globally. As a result, they are well studied due to their significance in food production. In particular, I focus heavily on both native bees and European honey bees because of their significant pollination contributions.

Native bee species are often forgotten when discussing pollinator decline. Before honey bee species were brought from Europe, native bee species provided pollination for the varied ecosystems all over North America. With 4,000 species of native bees found in the United States, these native bees are prolific pollinators and contribute to both natural and commercial landscapes (Buchmann & Moisset, 2011, p. 1). Native bees can be social, such as bumble bees that live in nests and raise young communally, though most native bees are solitary insects that lay their own eggs and raise them seasonally without a hive (Buchmann & Moisset, 2011, p. 3). Native bees are usually more docile than their European counterparts and rarely sting people; this makes them appealing pollinators for public spaces with high human population density.

Colony Collapse Disorder

Domesticated species of bees – those that are kept and managed for pollination services and the production of honey, have faced startling decline in the last decade. This decline was primarily a result of colony collapse disorder (CCD) which was first noticed in 2006 when U.S. beekeepers experienced an unusually high colony loss rate with unusual symptoms (Environmental Protection Agency, 2016). In 2006, and in the years to follow, beekeepers reported colony loss between 30% and 90% when loss rates less than 30% had been common previously (Ellis, Evans, & Pettis, 2010, p. 134). Hives suspected of succumbing to CCD display symptoms not typical of hives that merely fail to overwinter. These hives did not die due to starvation or disease. In colonies suffering from CCD there is a sudden loss of worker bees but no apparent shortage of honey or pollen (Environmental Protection Agency, 2016). Worker bees are the portion of the population responsible for gathering pollen, producing food, and maintaining the hive. The queen and young are abandoned and the colony dies. The unusual symptoms of CCD coupled with its sudden appearance in the last decade left beekeepers unsure of what caused such a drastic decline.

Current research suggests that CCD is the result of a combination of multiple factors including known pathogens that attack bees, lack of genetic diversity of the queens/colonies, effects of exposure to pesticides, lack of access to abundant and diverse

food sources, and degraded habitat (Ellis, Evans, & Pettis, 2010, p. 134). In the 2013-15 growing seasons beekeepers and researchers noted that colony loss percentages were returning to sustainable levels below 30% (Environmental Protection Agency, 2016). However, with CCD emerging as a threat only in the last decade it would be unwise to assume that this two year interval marks the end of pollinator decline.

CCD refers specifically to losses of domesticated European bee species from managed hives, but native bee populations face the same combinations of threats that lead to CCD. Native species occupy the same foraging areas as honey bees and are exposed to the same man-made environmental hazards like pesticides and loss of habitat. Removing human threats such as habitat destruction, pesticide poisoning, and loss of bio-diverse foraging habitat allows colonies and solitary bees to be more resilient when facing non-human threats such as predators and pathogens (Di Pasquale et al., 2013). While stressors such as pathogens and genetic quality of the colony are difficult to mitigate from a community standpoint, land owners can help pollinators providing quality habitat and removing harmful pesticides from their maintenance practices.

Threats to Pollinators

The effects of climate change will undoubtedly have an impact on pollinator populations as temperatures rise and affect local species composition and habitat

health. There is already evidence of climate zones shifting. As the planet warms, plant composition will be effected as species are able to migrate farther north with shifting temperatures. Shifts in temperature can affect the abundance of blooms as well as the quality of the pollen they provide (Hegland, 2008) Pollinator species will have to follow the changing climate zones or adapt to a different region of plant species (Vanbergen et al., 2013, p. 6). Shifts in seasonal weather could also pose a threat for pollinators. As North America warms spring bloom times may shift away from their normal patterns (Hegland et Al., 2008). Pollinator species may not adjust to the changing weather and miss crucial bloom times at the beginning of spring leaving them without food. (Vanbergen et al., 2013, p. 6). Pollinators have evolved with certain species diversity and climate patterns and shifts in spring and fall bloom times could be deadly for some species

Climate change alone would be a formidable challenge for pollinator species, but combined with other threats these issues become more pressing. Habitat loss, particularly when coupled with shifting species composition, leaves pollinator species with even fewer foraging and nesting sites (Vanbergen et al., 2013, p. 6). Shifting climate zones may force populations into more developed areas where bees cannot access adequate amounts of food or shelter. Changing zones may leave populations facing new pathogens and diseases that were not present in their native regions. These stresses

combined with other human and non-human threats could leave pollinators fighting for survival.

Pathogens and parasites that attack colonies, particularly European honey bees, are another example of threats to bee populations. One of the most troubling bee parasites is the varroa mite, a small tick-like parasite that attaches itself to individual bees and reproduces throughout a colony. These mites are quite aggressive and contribute to weakening hives, especially when coupled with other stressors. A 2010 study showed colonies that succumbed to CCD had higher numbers of varroa mites present than hives not experiencing other environmental stressors (Le Conte, Ellis, & Titter, 2010, p. 345). With treatment from beekeepers, the presence of varroa mites is not a death sentence for most hives. However, the presence of the mites provides added stress to already fragile colonies and can contribute to CCD. Successfully treating the mites may be a way to help colonies combat other effects of CCD.

Bee populations are at risk for pesticide poisoning as they visit flowering plants that have been sprayed with the harmful chemicals. When landowners spray plants for pests that harm their plants, such as aphids, they may not consider other insect traffic on their property and inadvertently contribute to pollinator decline. These non-target poisonings can greatly affect colony health as worker bees can be killed from exposure to toxins in the field or bring contaminated pollen back to the hive. Pesticide use is not

contained to any one land use type. Pollinators can come into contact with pesticides on agricultural, residential, institutional, and commercial properties making pesticide poisoning a frequent and dangerous encounter for bee populations.

Neonicotinoid pesticides have been found to be extremely harmful to bee populations. Doses of this chemical have been shown to "cause a wide range of adverse sub lethal effects in honeybee and bumblebee colonies, affecting colony performance through impairment of foraging success, brood and larval development, memory and learning, damage to the central nervous system, susceptibility to diseases, hive hygiene etc." (Van der Sluijs et al., 2012). All of these symptoms can contribute to CCD and severely reduce the success rate of the hives. These pesticides should be avoided whenever possible, and if pesticides are required they should be applied in a way that causes the least harm to surrounding pollinator populations. Spraying downwind of hives whenever possible, spraying late at night when bees are inactive and not spraying flowering plants are some of the ways to avoid pesticide contamination for the bees.

In suburban areas, such as the residential areas surrounding Ursinus, lawns and gardens are sprayed for a variety of aesthetic purposes and for pest management. Homeowners are not subject to the same kinds of pesticide regulations that agricultural lands are and often are not educated on ways to prevent pollinator harm (Mader, 2011, p.5). Suburban landscapes include pristine chemically treated lawns and well-

manicured gardens full of cultivar species; plant species bred for looks and hardiness, not necessarily pollen and nectar quality or quantity. Flowering lawn species such as dandelions and clover are seen as weeds and may be treated with pesticides, even though these plants are frequented by pollinators. Gardens full of nonnative cultivar plants offer insufficient foraging space as native pollinators haven't evolved with these species (Mader, 2011, p.77). Simple modifications, such as changing how households used pesticides and creating pollinator friendly gardens in residential and public areas, could make suburban communities much more pollinator friendly.

Agricultural land, which is also found close to Ursinus's campus, poses its own threats to pollinator health. European honey bees and native bee species contribute substantially to the agricultural industry in America. Their domestic pollination services are valued at $15 billion dollars annually, making pollinator populations important members of the U.S. agricultural economy (Pollinator Health Task Force, 2015, p. 5). Even though pollinators are key members of this industry, agricultural areas are often damaging to bee health. Agricultural fields are often sprayed with harmful chemicals, but in higher volume than residential areas. In agricultural habitats, pollinators attracted to the flowering plants encounter vast stretches of poisoned vegetation creating miles of pollinator food deserts.

Low biodiversity in monoculture agriculture is harmful to pollinator species. Bees forage on diverse pollen and nectar sources in uncompromised environments, and receive nutrients from the various species they visit. Colonies who only have access to areas of monoculture or low biodiversity may not be receiving essential nutrients needed for colony success (Brodschneider & Crailsheim, 2010). A French study showed that access to more diverse and better quality pollen helped hives combat other stressors such as exposure to varroa mites (Di Pasquale et al., 2013). The results suggest that bees located near agricultural grounds had a lower success rate than those that had access to a more diverse diet. The quality and diversity of pollen sources is more beneficial than an abundance of poor quality pollen (Brodschneider & Crailsheim, 2010). Introducing a more complex diet of native species could be a means of combating population decline. By installing strips of native plants in and around agricultural lands farmers could benefit from pollination services while investing in the health of pollinators who help their crops.

Pollinator Management for College and University Campuses

Pollinator protection plans are often designed for certain land use types as to address the specific needs of the area in question. Plans for wetlands, suburban homes, and golf courses are examples of the kinds of specific plans in existence. Pollinator

protection plans for these land types highlight the specific challenges and benefits of each site. For example, plans for golf courses recommend that the grass not be treated with harmful pesticides and that out of play areas be used as pollinator habitat. Making use of these out of bounds areas allows golf courses to provide useful pollinator habitat in otherwise scarce landscapes (Shepard, 2002). The absence of college campuses from these tailored plans could be attributed to the unique land use type that schools occupy.

A typical rural or suburban school campus has elements of numerous different land types. Large lawns in common space mimic elements of golf courses or industrial parks with mowed front entrances. Large parking lots for faculty staff and students act similarly to those found at shopping centers in commercial areas. Campuses are both institutional and residential as buildings share duty as homes and classrooms. Sections of the grounds may be forested and main areas of campus can function similarly to public parks with paved paths and open spaces. Smaller planted areas resemble private gardens but can be disturbed by high foot traffic. University and college campuses are usually cared for by one landscaping crew who must be made aware of the potential challenges and benefits each of these land types pose for pollinators. Because of this mix, universities can benefit from using elements of many parts of more specific plans but they would benefit more from a singular plan designed specifically for the diverse uses of college campuses.

Pollinator Protection Plans

In response to these threats described above, colleges and universities have begun to change their land management practices. Prior to making recommendations for the Ursinus campus, I looked for schools and universities that may already have a pollinator protection plan in place that Ursinus could use as a template. Many schools and businesses have sustainability statements about environmental commitment, thought there were few who had, or were choosing to publish, a pollinator specific management plan. Schools that have published documents concerning pollinators were often vague in their goals, opting to create general statements pledging to "increase" habitat and "reduce" pesticide use. Instead of focusing on schools who published empty plans, the following universities were chosen as inspiration for the Ursinus management plan.

Emory University published an article in 2014 announcing that they were banning neonicotinoids from being used on campus and banning plants purchased from nurseries that use neonicotinoids (Williams, 2014). The article also mentioned that the school planned to increase and maintain pollinator landscapes on campus as well as provide outreach programs about pollinator health for community members (Williams, 2014). In an update to this article, a representative from Emory University detailed the efforts the school has taken to protect pollinators since the pesticide ban (Pierce, 2015).

Emory has increased pollinator habitat on campus and in the surrounding area with volunteer based habitat restorations and has focused on invasive species removal along with restoring and adding native plant gardens on campus (Pierce, 2015). Emory is a good example of a college making concrete changes to their campus. Banning harmful chemicals and running volunteer based plantings are examples of ways Ursinus could create better pollinator landscapes.

Bee Campus USA certifications are awarded to colleges that display extraordinary efforts in protecting bee species and helping to prevent pollinator decline. (Bee Campus USA, 2015). Bee Campus USA is a continuation of Bee City USA, a certification program that works with communities to create sustainable pollinator habitats. Bee Campus USA requires universities to create a committee of local government, faculty and staff, and student members who work to create a better pollinator environment on their campus (Bee Campus USA, 2015). Colleges and universities are required to create pollinator protection plans and pest management plans as part of the certification. They must also host educational sessions and pollinator centered events throughout the year. This certification process, while being more detailed than many self-initiated pollinator protection plans from other schools, requires institutions to set their own goals and management plans and does not have a set standard for what level of commitment is required.

The newest college to join the ranks of Bee Campus USA is the University of North Carolina Asheville which received its certification in April of 2016. UNC Ashville received the certification based on their efforts over the last few years to help support pollinator habitat and pollinator research (Allen, 2016). Students, faculty, staff, and community volunteers at UNC Ashville have added pollinator meadows and native plants to the campus landscape in an effort to increase habitat on campus. They have worked with their landscaping crew to designate areas of campus that are not mown as pollinator habitat and provide nesting material such as downed trees and lawn clippings for native pollinators. UNC Ashville stands out from other Bee Campus USA schools because of how well they have documented changes to their campus. The school has a section of its website dedicated to pollinators and the pollinator gardens found on campus. Some of the resources available on their site include a map of pollinator habitats on the campus and links pollinator research conducted by students (Allen, 2016). UNC Ashville helps promote education about pollinator issues and provides examples of pollinator protection efforts for other institutions by having materials available to the public.

Penn State's Center for Pollinator Research produced a pollinator garden certification that provides easy to understand instructions for creating pollinator habitat. *The Application for Pollinator Friendly Gardens* asks participants to assess their gardens based on standardized lists of plants and makes recommendations of how to

increase pollinator habitat and provide adequate foraging material. The application contains lists of required elements for the gardens to pass inspection, laying them out in one organized and easily implementable document. The first and arguably most important element of this certification is to provide food for the pollinators (p. 1-2). Participants' gardens must provide food throughout the growing season, early spring through late fall, and the certification places high importance on the presence of native plants.

The certification requires participants' yards to contain a set number of plants from a list of specific species. The Application requires at least four tree and shrub species from a list of 17 trees and 23 shrubs to provide habitat for pollinators (p. 1-2). At least six species of flowering native perennials must be present on the property with two species present in each flowering season. Gardeners may choose between 15 early bloom, 20 mid-season bloom, and 7 late season bloom species to fill their gardens. This list provides an extensive guide for creating substantial foraging space for pollinators on residential properties.

In addition to foraging areas within gardens, the Pollinator Friendly Garden Certification specifies other required elements of healthy pollinator habitat. At least two host plants for pollinator caterpillars are required on the property. At least one source of water must be provided on the property; for example birdbaths, ponds, and streams

are acceptable sources (p. 3). Shelter in the form of open ground, bee boxes, and piles of brush or leaves must also be provided for native pollinator nests. This certification requires gardeners to be committed to pollinator health on all levels, not just including certain plants in their gardens. Sections of this certification ask participants to look critically at the way they use pesticides and to work towards removing invasive species from their property.

The only challenge of this certification is that it is designed for residential areas. While the certification takes size of property into consideration, the largest option for garden size on the Application is 10 acres which is nowhere near the 170 acres that the Facilities Services Department cares for (p. 4). Requirements for specific numbers of species would need to be adapted for use on Ursinus's campus.

Current Land Management Practices at Ursinus College

Pollinators on Ursinus Campus

The issue of pollinator loss hits close to home on Ursinus campus as we have lost colonies from the apiary at the college farm over the last few years. Over the 2015-16 winter, Ursinus students and staff worked to keep the two active hives healthy until spring. Both hives were located at the college farm and fed sugar water about once a

week over the fall. Both hives looked relatively strong heading into winter, but varroa mites were found in both hives. One hive did not survive the winter. The stronger hive is doing well and is being cared for by Ursinus students and staff with the help of a local bee expert. Adding more foraging area on campus would benefit these hives, as they are located near suburban housing with non-native plants as well as agricultural fields. Adding more are for foraging also benefit native species such as bumblebees which can be seen around the flowering plants on campus in the spring and summer.

Ursinus is currently committed to sustainability in a number of ways related to pollinator health. The Office of Sustainability (OS) employs several students who facilitate positive change on campus in regards to environmental health and sustainability. One of these positions is the Land Stewardship Fellow- a position I held in 2015-20016. Future fellows could adopt a role in overseeing the suggestions in this document and help to implement the changes suggested below. OS could create a formal agreement with the Facilities Services Department and the Environmental Studies Department to help with the funding and implementation of pollinator friendly projects. With the support of Ursinus faculty members, future OS Fellows, honors students, or capstone classes could conduct research on and study changes in pollinator presence on campus as these projects are implemented over time. With the cooperation of the Facilities Services Department and the students of Environmental Studies there are many opportunities for collaborative change on campus.

Facilities Services Department Procedures

I met with Dave Bennett, Grounds Supervisor for the Ursinus Facilities Services Department, several times over the course of the 2015-2016 academic year to discuss how campus is managed and ways that the Facilities Services Department could support pollinator health. Bennett is a long standing member of the Ursinus community and has been supportive of the efforts I proposed to protect campus pollinators. During our meetings we discussed how his grounds crew takes care of campus plants and some of the efforts they have made to make Ursinus more pollinator friendly.

According to Bennett, there is already attention being given to greening the campus to support pollinator habitat. According to Bennett, Facilities already focuses on planting as many natives as possible when it fits within the aesthetic goals of the look for campus. Ursinus generally leans towards a "landscaped look" with frequently maintained sprawling lawns and tidy plant beds. In beds with annual plants, flowers are changed out one to three times a season in an effort to keep plants in bloom for as much of the year as possible. Providing a variety of multi-season blooms is already a positive step towards increasing forageable space on campus, though attention should also be given to the variety of annuals planted as some non-native species are not bred for producing pollen and nectar, the essential elements of pollinator diets. Future planting schedules should select species that have preferable bloom times within the

goals of the landscaping crew as well as plants that produce food for pollinators in the area.

Changes could be made to the lawn mowing schedule, though there are several circumstances that make changing mowing schedules more difficult on college campuses. Bennett reported that mowing practices change depending on the season and public events being held on campus. The campus is broken up into zones and, depending on how active the campus is, several zones could be mowed throughout the 5 day mowing schedule. Summer mowing tends to run on a slower schedule as the growth rate reduces and campus activity becomes less frequent. Fall mowing schedule stays on a slower schedule, though fall leaves are mulched by zone as needed as events require it.

To improve current mowing practices in regards to pollinators the Facilities Services Department could change their mowing times and frequency so as to avoid unnecessary pollinator casualties from machinery. Mowing in the early morning or evening is one practice that could help reduce casualties as bees and other pollinators tend not to fly earlier in the morning. Because of obvious conflicts with mowing at early hours on a residential campus these considerations would not be popular and will probably not be implemented. Mowing early in the morning, when the grass is wet with dew, can also leave clumps of wet grass behind that would have to be removed

which creates more work for Facilities staff. Reducing the frequency of mowing is another way that the department could reduce its impact. Ground nesting native pollinators use dead leaves or plant stems for overwinter nesting sites, so coordinating leaf mulching efforts could help to promote pollinator health (Mader, 2011). The main areas of campus that see high human traffic could continue to be mulched but leaving unmulched lesser-traveled areas of campus, such as off season fields and areas around the backs of buildings, could be beneficial for supporting pollinator habitat.

One of the biggest concerns that arose was the lack of time to devote to caring for garden beds. Weeding work done on campus is minimal due to the small crew size. Because the landscaping crew has only 5 members and additional help crews often only work in the summers, the department relies heavily on Round Up to keep weeds out of the manicured beds. According to Bennett the crew uses about 10-15 gallons of the herbicide a season, which goes to managing weeds on campus and along pathways on campus and along Main Street. Weeds could be combated without pesticides with the addition of student volunteer crews who could do weekly weeding inspection. Such a program could be implemented though the OS or the Ursinus Center for Advocacy, Responsibility and Engagement (UCARE) as the addition of additional weeding and gardening support would lead to the reduced use of pesticide and herbicides on campus.

When more native plants are introduced to campus there is more competition for bed space and less area for weeds to pop up (Mader, 2011). Especially with the introduction of hardy perennials and the concentrated removal of invasive species, there could be a noticeable difference in weed presence. The introduction of more native species would also encourage more native predators to arrive on campus (Mader, 2011). Native host plants would foster a larger population of native predatory species that could help reduce the amount of pest infestations in the area, helping to reduce the need for pesticides.

Another way to help promote less pesticide and herbicide use on campus would be to create a group of students to volunteer to help tend plant beds. With a small number of students on campus receiving training about what weeds and pests are undesirable on campus, they could meet a few times a month to help weed plant beds and discourage pest presence by learning safe ways to help treat infested plants. This volunteer group could be sourced from existing clubs such as Ursinus College Environmental Action, The Outdoors Club, Bonner, and various fraternities and sororities looking to meet their community service quotas. Because this would be a seasonally available crew, there would be opportunity to look at summer fellows who may be interested in helping to cover summer months when campus is quieter. Even the addition of a handful of students could help the short staffed grounds crew with maintenance of better habitat practices.

Recommendations for Ursinus College

The main goal of this plan is to facilitate burdens on campus that will positively impact pollinator health without placing undue burdens on the people who care for this campus. One of the best ways to battle CCD and pollinator decline is to reduce controllable stressors, particularly providing adequate foraging cites for all pollinators. As other environmental stressors are reduced, such as loss of habitat and exposure to pesticides, colonies have a better chance of fighting and recovering from non-human threats like the varroa mites that contribute to colony loss. The most important thing Ursinus can do is ensure that our 170 acres of land is safe for pollinators and free from dangerous pesticides. Utilizing low traffic areas of campus for nesting sites helps provide important habitat space without impacting the aesthetics of valued public spaces.

Musser Garden

Musser Dorm sits on 6th Avenue in Collegeville, tucked behind other houses on Main Street, with a large garden occupying the space in front of the house. During our walks around campus, Dave Bennett identified this garden as a space to begin implementing planting changes to campus. The garden was donated as a class gift but has since fallen into disrepair with large patches of bare ground and several overgrown bushes. Because Musser is located behind the other student houses on Main Street this

garden area is more sheltered from car and foot traffic. This provides pollinators with fewer disturbances when foraging and nesting as opposed to beds on campus near frequent human traffic. This location also allows for more freedom in designing a plan as it is less visible to the public and restoration work will not detract from campus activities. For these reasons, this area has been chosen as an example garden for the changes that could be implemented in other existing beds on campus.

The Musser Garden is located between two residential houses but receives mostly direct sunlight throughout the day. Paved paths separate sections of the garden next to the house, along the sidewalk, and in the main grassy area of the yard. Two large pine trees that are currently within the plant bed will be removed soon as they are too close to the Main Street dorms. Lilac bushes and Korean boxwoods will be removed from the garden as they are overgrown and unhealthy. In addition to these removals, there is a large patch of several Red Twig Dogwood plants that require intensive pruning.

To prepare this planting plan for the garden Bennett and I met at Musser and evaluated the plants already on the property. He gave suggestions about the state of the present plants and we determined which plants would be removed from the garden. After determining which plants were healthy enough to stay, we referred to the suggested plant list provided by the Application for Pollinator Friendly Gardens. The

following plants were chosen to replace plants that will be removed from the garden and to fill the bare ground in the Musser beds.

Musser Garden Planting List

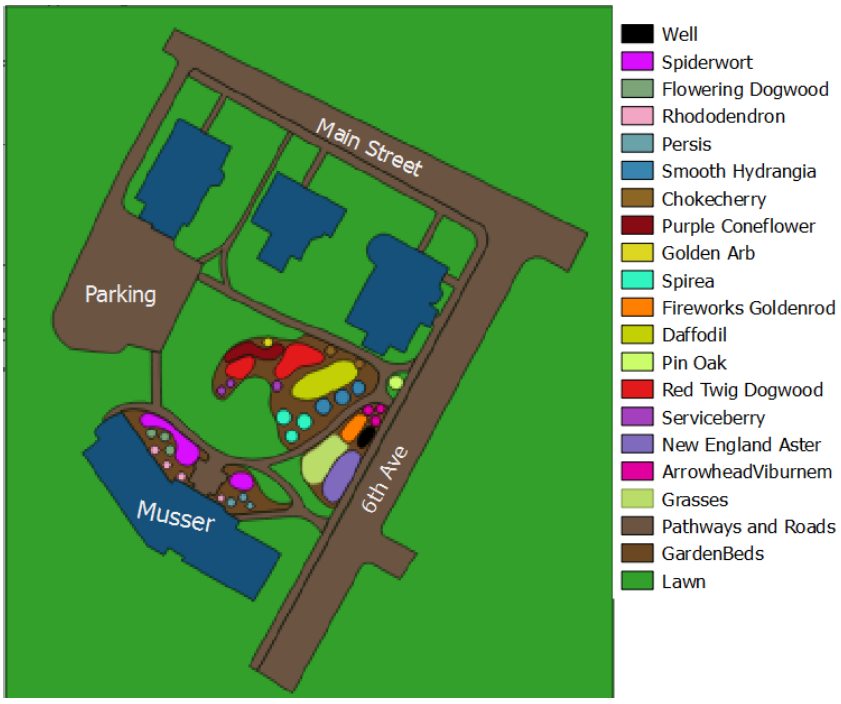
	Botanical Name	Common Name
1	Amelanchier spp.	Serviceberry
2	Cornus florida	Flowering Dogwood
3	Cornus sericea	Red Twig Dogwood
4	Echinacea purpurea	Purple cones
5	Hydrangea arborescens	Smooth hydrangea
6	Narcissus pseudonarcissus	Daffodil
7	Pieris japonica	Japanese Pieris
8	Prunus virginiana L.	Chokecherry
9	Quercus palustris	Pin Oak
10	Solidago rugosa 'fireworks'	Fireworks Goldenrod
11	Spirea ssp.	Spirea
12	Symphyotrichum novae-angliae	New England aster
13	Thuja occidentalis 'Golden Globe'	Golden Arborvitae
14	Tradescantia ohioensis, T. Virginiana	Spiderwort
15	Viburnum dentatum	Arrowhead viburnum

Table created based on recommendations from Penn State's Center for Pollinator Research and Dave Bennett, Grounds Supervisor at Ursinus College.

The Penn Pollinator Garden Certification asks for at least four species of trees and shrubs that support pollinators. The Musser Garden already had pin oak trees along the street and red twig dogwood in the garden bed. Serviceberry, flowering dogwood, smooth hydrangea, chokecherry, and arrowhead viburnum were selected as trees and shrubs to add for this first planting of the garden. Chokecherry and

serviceberry are also both host plants for butterfly caterpillars, fulfilling another element the certification recommends.

The certification requires 6 species of native perennial flowers, two from each season. Spiderwort and purple coneflower were chosen from the mid-season bloom time. Some species of milkweed should also be considered for planting in this area, as they are host plants for endangered butterflies. Fireworks goldenrod and New England aster were chosen as additions for the late season bloom. This list does not have to be the end for this garden however. More natives should be added from the recommended species list in subsequent years as planting schedules allow.



Map of Musser Garden created using suggestions from the Application for Pollinator Friendly Gardens and from Grounds Supervisor Dave Bennett

Application for Other Areas of Campus

The suggestions made for the Musser garden are an example of the kinds of changes that could be made all over Ursinus Campus. Because this garden was in disrepair and offered a large space for adding new plants it was a good choice for the first official pollinator friendly additions to campus. The same process could take place for other established beds on campus. Small sections of campus should be focused on one at a time so that this process does not overwhelm the grounds crew's schedule. By picking small areas to focus on, such as the beds around one building at a time, the process can be repeated.

Those who are organizing a planting should choose a section of campus, for example the plant beds in front of North/Richter dorm. They should assess what plants are in these beds already and determine if they are healthy. Planners should remove any invasive species in the area along with plants that aren't healthy or do not fit within the vision for the pollinator habitat. For this I referred to Dave Bennett's knowledge of the campus and what plants thrive at Ursinus. With the remaining space, faculty, staff and students involved should make a plan to add species that are beneficial to pollinators using the Application for Pollinator Friendly Gardens as a guide. By assessing small sections at a time the campus is broken up into smaller parcels more similar to a home garden. This helps provide a gradual transition on campus that could

be tailored to the schedule of Facilities staff and student volunteers making implementation easier.

These suggestions are specifically for existing beds on the main campus, particularly around academic buildings and residential halls. Treating each academic building as individual projects allows for a higher density of pollinator friendly plants on campus and provides more habitats in existing plant beds. Main Street houses could go through a similar process, treating each house as its own property and replicating the assessment and planning process for each garden. Areas not addressed in these suggestions include the naturalized storm water basin, the college farm, and the Whittaker Environmental Research Station (WERS). The storm water basin requires different consideration than the gardens on campus. The original planting document should be referenced before any changes are made as the plants in the basin require different conditions to thrive. That being said, this area is a naturalized undisturbed area of land on campus and already serves as habitat and foraging grounds. As planting conditions allow, native pollinator friendly plants could be added to the basin to strengthen this habitat.

The college farm is already home to the Ursinus apiary and is an area of forageable material not treated with pesticides. While the farm's size and lack of harmful chemicals already make it a safe place for pollinators on campus, strips of

pollinator meadow could be added on the edges of the field to further support native bees and our own honey bees who may not receive enough nutrients from agricultural land. Similarly, faculty and staff members in charge of WERS should look into creating strips of pollinator habitat within the agricultural fields as WERS is currently an agricultural monoculture.

Low Traffic Nesting Sites

Ursinus campus is maintained purposefully as a public space, and thus the grounds need to look good in all seasons. Gardens in the high traffic areas of campus are not the best place to foster nesting sites for pollinators or host plants for caterpillars. These areas are frequently disturbed by community members walking by and by Facilities Services staff who maintain the beds. Host plants are nesting and food sources for pollinators and their young and the leaves are often heavily chewed by these pollinators. These plants may not be suitable for high traffic areas as they would not fit into the Ursinus aesthetic. To support pollinators on campus space should be made in low traffic areas where neither the pollinators nor the people are impacted by the location. The vegetated area next to the gravel parking lots behind New Dorm are a good example. There is a large space that is not heavily manicured and this area is not usually disturbed by students. Other low traffic areas could include the space behind the Wellness Center and Thomas and areas behind residential houses on Main Street.

By utilizing these areas for nesting habitat Ursinus can provide space for pollinators to breed without impacting the look of campus.

Providing nesting and caterpillar habitat is a low-maintenance practice that can create a big impact. Host plants, plants that provide food for caterpillars and shelter for pollinator nests such as milkweed and spicebush, are important to different pollinator species. Because nesting sites are not always aesthetically pleasing, they are often overlooked. Wood piles, fallen leaves, patches of bare ground, and man-made pollinator boxes are all examples of native pollinator shelter. While piles of brush don't have a place in the well-traveled areas of campus they could find a home in low-traffic areas. Lawn clippings and mulched leaves could be left on the ground out of the way to provide shelter for pollinators. Downed limbs could be brought back into the forest or left out of the way for nesting sites and over-winter shelter. Installing bee boxes would provide additional shelter space and students would be able to study population health on campus over several years.

Care of Ursinus Bees

Ursinus had one hive successfully overwinter in 2015-16. These bees were cared for by Environmental professor Leah Joseph, Facilities staff member Jeffery Williams, and environmental studies and OS students. While the bees were fed weekly and the Environmental Studies Department brought in an outside expert to give advice on the

health of the hive, there is currently a lack of student leadership in caring for the bees. Caring for the bees has been a part of the Farm Fellows position through OS in years past. While this makes sense for some students, farm work and bee keeping are not always co-interests for students excited to work on the farm. This year helping feed the bees became a part of the Land Stewardship Fellow's weekly work. This should continue in future years with an emphasis on training the fellow to learn to care for bees on their own. This position would be great for someone interested in pursuing pollinator research or with past experience with bee hives. Having this fellow take a step further into understanding how to keep bees will help them to feel more confident in the health of the hive. Fellows should also help train younger students interested in the hive to help keep someone knowledgeable about the bees on campus at all times.

To help promote the hive's presence on campus it would be nice to have Open Hive days where interested students could come visit the college farm and learn about the bees on campus. "Pollinator walks" could also be events run by fellows where they lead groups around campus and talk about how different land types affect pollinators around Ursinus. These and other events would serve as education opportunities so that the changes made to campus do not go unrecognized. Students conducting research on campus could also host similar events either on COSA or throughout the semester to help show to the campus how pollinator landscapes are studied at Ursinus.

Pesticides & Herbicides

Ursinus's Facilities Services Department currently relies on herbicides in the plant beds because they do not have the time in their work weeks to dedicate hours to weeding. The grounds crew is already careful with their use of pesticides and herbicides on campus, but further reduction of pesticide and herbicide use would help the pollinator populations.

Ursinus should ban the use of neonicotinoid pesticides on campus formally. We should follow Emory University's plan to ban the chemical on the grounds and also work with nurseries that supply Ursinus to ensure that neonicotinoids pesticides are not applied to the plants brought to campus. Other pesticides should be applied only to plants not in bloom, and only to the affected areas. Spraying when pollinators are not active such as in the early morning or late afternoon is also a practice that could help to further avoid pollinator poisoning.

In an effort to reduce herbicide use on campus a student crew of volunteers should be trained to help take care of the beds. This volunteer work could be organized by the Office of Sustainability in partnership with UCARE, Bonner Leaders, and Scholars in Service. Bonner Leaders are required to complete 300 hours of volunteer work a year, about 10 hours a week, and are a source of organized, consistent, and

quality service. Bonner Leaders are currently in charge of other service projects on campus including Wismer on Wheels, Sustainable Move In, and facilitating work days on the college farm. Working with UCARE and a Bonner Leader as a site manager a small crew of students could be trained to know what kinds of work would help the Facilities Services Department transition to more pollinator friendly practices. Classes held once a semester, or as needed if specific projects arise, could be run by OS Fellows and Bonner leaders to ensure that the work on campus was done correctly. These students could help with weeding, identifying areas of improvement on campus, and facilitating installations of new pollinator friendly plantings on campus. With several permanent student members to oversee the work that is delegated to this crew other student organizations could get involved. Sororities and fraternities on campus, Scholars in Service, and student-run clubs who want to volunteer could complete hours working on Ursinus property creating change close to home.

Student Projects, Research, Volunteer work

Implementing these changes on campus provides Ursinus with a unique opportunity to conduct student research about pollinator health in the surrounding area. Over the next few years studies could be conducted about the extent of forageable material on campus and monitor pollinator presence as changes are made to the landscape of the campus. Studies of abundance, biodiversity, and overall health of

pollinators could foster cooperative research between many departments including Environmental Studies, Biology, and Mathematics and offer valuable data to a growing research field. Chemistry students could test soil chemistry in the gardens on campus and conduct research on how pesticides and herbicides affect plant and insect life on campus as well as how new pollinator friendly paintings affect soil chemistry.

Courses in the Environmental Studies Department frequently feature volunteer work as part of their curriculum. Students in environmental courses often have opportunities to travel to local reforestation projects, stream cleanups with local watersheds, and other environmentally minded service projects. Students in the 2015 capstone course designed and ran a tree planting event in Hunsberger woods that continued reforestation efforts started two years before in another environmental course, Forests and People. Future capstone classes could adopt the suggestions made in this document and create planting plans for other areas of campus. Students from all levels of the Environmental Studies Department could be trained to volunteer time for weeding and bed maintenance and individual classes could decide to run a garden planting. In partnership with the proposed volunteer schedule run by the Office of Sustainability and Bonner Leaders, classes could fulfill community engagement requirements working with Ursinus staff and students. In an effort to bring the positive changes to the surrounding area local schools and community groups could be invited to Ursinus to learn about what we are doing here and bring these practices back to their

homes and communities. These sessions could be led by the students and classes who work on campus.

Conclusion

This document was developed to help provide a safe space for pollinators on the Ursinus Campus. Our goals are to use Ursinus's land as an area that is free from harmful chemicals and provides much needed habitat for local bees and other pollinators. Starting with the Musser garden we have created a planting strategy for campus using existing management plans and planting guides as templates. This plan is meant to be easily replicated so that future Ursinus students, faculty, and staff can have a clear idea of what they can do to continue improving pollinator habitat on campus. We suggest that Ursinus students interested in pollinators and land stewardship work with Facilities Services staff to help design, implement, and manage pollinator habitat restoration on campus. These students can monitor the success of the plantings and provide further advice to keep this project alive for years to come. The Facilities Services Department should continue to exercise caution when using pesticides and herbicides on campus and create a formal agreement that no neonicotinoids will be used at ursinus. Following the implementation of these suggestions, all changes made to Ursinus campus should be documented on the Office of Sustainability website in a manner that is easy to follow so that other schools

interested in pollinator management can replicate and improve on our efforts. These changes will help to support our local pollinators and keep Ursinus campus safe for community members, both people and pollinators.

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