#BeeSouthwestern:

Bee Campus USA Certification & Pollinator Protection at Southwestern University

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SOUTHWESTERN UNIVERSITY

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1. Introduction

Ecological biodiversity is the cornerstone of sustainability. The complex relationships between organisms within an ecosystem are responsible for the health and regulation of their environment. Without this intricate web of predation, pollination, and resource partitioning, life itself would be impossible to maintain. This is due to the reliance of ecosystem services on the diversity of the ecosystem's inhabitants — these vital services include the removal of waste products, the creation of clean soil, air, and water, and the production of food for both human beings and other organisms. Pollinator diversity in particular is a major driver of human agriculture. Globally, pollinators are responsible for the production of 87 of the most consumed food crops, including tomatoes, grapes and apples, affecting roughly a third of all agricultural land (FAO, 2018). Diversity in agroecosystems is equally important, as soil biota and the genetic resources of the crops themselves contribute to greater system resilience to disruption (FAO, n.d.).

The protection of pollinator species is doubly important considering the ongoing Holocene extinction, characterized by the endangerment and disappearance of countless species worldwide (Ceballos & Ehrlich, 2018). In fact, since 1970, 76% of freshwater wildlife, 39% of marine wildlife, and 39% of terrestrial wildlife have been lost due to climate change, habitat disruption, and over-consumption (WWF, 2014), and in North America, over the past two decades alone, many species of native bumblebees (genus *Bombus*) have experienced up to a 96% population decline due to introduced pathogens and competition from non-native bees, and have seen up to an 87% reduction in their foraging ranges (Cameron et al., 2011).

Institutions of higher education provide excellent settings for taking action on pollinator and biodiversity loss. In a physical sense, college campuses provide hundreds of thousands of acres of green space to experiment with the implementation of sustainable landscaping and gardening practices, with the ten largest campuses in the U.S. owning over 113,625 acres (Egan, 2019). In terms of intellectual resources, universities have historically and continue to serve as sites for the proliferation of social activism, and in recent decades various organizations and agreements have been focused specifically on promoting universities as drivers of ecological sustainability and social equity. When Southwestern University (SU) signed the American College and University Presidents' Climate Commitment, then-President Jake B. Schrum said that "colleges and universities like Southwestern … have an obligation to be models for their students' support for sustainability, which is absolutely crucial to saving our planet" (SU, n.d.b).

This group affirms President Schrum's assertion that college campuses will play a crucial role in devising and practicing the solutions to humanity's greatest ecological threats. It is upon this conviction that we aim to realize our goal of improving the resilience and efficacy of our local environment by promoting biodiversity and pollinator protection on our college campus. It is our hope to preserve the physical and spiritual resources the natural world provides for future generations of students, faculty, and staff, as well as for the city community at large.

The literature review will also discuss our decision to engage in environmental activism in a university setting, which is due to the complex and large-scale challenges of climate change, and because of the nature of college campuses themselves. Universities, suggests Kermath (2007), have historically been the primary breeding grounds for social movements, and their prestige allows them the capacity to impact both policy formation and public sentiment. By serving as media for interdisciplinary research and discourse, as well as producers of innovative technologies, institutions of higher education are uniquely equipped to help combat and mitigate the negative impacts of climate change. From the management of surrounding wild spaces to the meticulous maintenance of sports fields and lawns, the practical solutions to climate change and biodiversity loss will likely be initiated at a university

The following section of the paper details the history of activism and the contemporary practices of SU in Georgetown, Texas. This history affirms that SU is an apt site for conducting such types of initiatives. The final portion discusses the primary avenue we have decided to pursue in our efforts to improve campus biodiversity: the acquisition of certification by the Bee Campus USA program. In addition to protecting local native wildlife, we expect our project to bring esteem to the college and to lengthen its impressive list of environmentally conscious enterprises.

2. Literature Review

2.1. Biodiversity and its Importance

Terms such as biological diversity, natural diversity, and species richness have a recorded history dating back to the early twentieth century, most of which referred to the variety of plant and animal

species within a given boundary. The word biodiversity was first introduced to the scientific community by biologist Walter Rosen during the National Forum on BioDiversity in 1986 (Wilson, 1988). Its usage has most often been within the context of habitat alteration and species decline, and the concept of ecological diversity is therefore inextricably linked with the field of conservation biology, which seeks to manage the Earth's natural resources in such a way as to protect its species, habitats, and ecosystems (Soulé, 1986).

The definition agreed on by the United Nations (UN) during the 1992 Earth Summit continued this common understanding of the term biodiversity. However, a notable development in our conceptualization of diversity is the inclusion of variation not just between species (interspecific diversity) but within them as well (intraspecific or genetic diversity). Therefore, within a given location, biodiversity can encompass:

1. Species diversity, based on the number of taxonomically unique species, usually those which are endemic and found nowhere else;
2. Ecological diversity, based on the number of unique ecosystems and/or habitats; and
3. Genetic diversity, based on the variation of genetic material between members of a single species (DeLong, 1996).

Biological diversity can be found wherever life flourishes on Earth, although the regions with the highest levels of diversity are typically situated in the tropics. This has led to an unequal latitudinal distribution, with a noticeable decline in biodiversity as latitudes increase. It is believed that the abundant warmth and sunlight found along the equator increase available biomass, reduce competition for resources, and therefore promote the greatest array of organisms, whereas the temperate zones produce a higher degree of speciation as organisms compete for limited ecological niches (Willig, Kaufman, & Stevens, 2003).

The importance of biodiversity becomes evident through the study of *ecosystem services*, a term coined in the 1970s to describe the various benefits that humans enjoy from healthy ecosystems. Per the Millennium Ecosystem Assessment (2005), functioning ecosystems are responsible for maintaining conditions suitable for both humans and the rest of the biosphere, including the provision of food, the regulation of climate, as well as non-material benefits such as recreation and spiritual value. While scientists, environmentalists, and economists have sought to place a monetary value on these services, others have asserted that because the human economy is

situated within these vital ecosystem processes and is wholly dependent on them, quantifying their worth is pointless (Salles, 2011). While the relationship between biological diversity and ecosystem services is still being uncovered, Harrison et al. (2014) concluded in their review of over 500 studies that the interactions between a wider array of organisms was associated with more robust ecosystem services. Therefore, biodiversity is likely directly connected with the provision of crucial ecosystem services.

Just as biodiversity varies across the globe, its stability over time fluctuates immensely, as can be seen in the Earth's history of mass extinction events, during which the vast majority of living species disappeared from the fossil record. In modern times, anthropogenic climate change as well as habitat disruption, overexploitation, and pollution have led to what is now termed the Holocene extinction, an ongoing loss of species that includes the disappearance of American megafauna following the last Ice Age and the present-day endangerment of countless species worldwide (Ceballos & Ehrlich, 2018). The impacts of these losses will be felt around the world, as the ecosystem services all living things depend on begin to erode. Unfortunately, the negative effects may also compound one another in a positive feedback loop, in which the loss of one species results in the greater likelihood of another, and the consequence of that loss worsens an environmental issue. For example, the loss of diversity amongst animals which act as natural pest controls will likely result in a rise in the populations of disease-bearing insects such as mosquitos, a very serious implication for the mitigation of the spread of tropical infectious diseases (Cardinale et al., 2012).

Biological diversity is not, therefore, simply a matter of having an array of butterflies to look at or a vast field of flowers to smell, but rather a crucial component of our existence on this planet. The efforts of conservation biologists are therefore paramount in the struggle to combat climate change and its impacts on humans and the biosphere. Soon the things which are in many places taken for granted — breathable air, potable water, a tolerable climate — may become quite scarce, should we fail to mobilize against our loss of biodiversity.

As the human population continues to grow and urbanize, urban landscapes, characterized by high populations at a high density, will continue to grow, which raises the question of how biodiversity can be included in these landscapes and how it can benefit an urban space (Dearborn & Kark, 2010). Motivations for biodiversity in urban spaces are those that will primarily benefit nature and humans: ecosystem services. These services within an urban space may take the form

of building green spaces within urban landscapes, thereby enhancing local biodiversity, reducing the heating and cooling costs of buildings (in the case of vegetated rooftops or walls), and slowing runoff during rainstorms (Dearborn & Kark, 2010). Another form would be leaving already existing ecosystems undisturbed. This has many benefits, as in the U.S., urban trees annually remove 711,000 tons of air pollutants, prevent soil erosion, and provide cooling shade (Dearborn & Kark, 2010, p. 436).

Supporting biodiversity in urban spaces also allows for environmental education and a reconnection of people to their environment. For example, in Austin, Texas, the reconstruction of the Ann W. Richards Congress Avenue Bridge unintentionally resulted in the ideal bat roost (BCI, n.d.). Instead of exterminating the bats, thousands of tourists now gather downtown to watch up to 1.5 million Mexican free-tailed bats (Dearborn & Kark, 2010, p. 436). Besides generating revenue, this event provides an opportunity for the public to be informed about the Mexican free-tailed bat and how to protect it, and can also encourage an overall appreciation for and desire to protect biodiversity.

Environmental education is also important to disseminate the problems associated with non-native species. Non-native species are introduced at higher rates in suburban areas and can be less edible to herbivores or unattractive to pollinators (Bouma, Huizenga, & Warners, 2013). Invasive species introduced during suburban horticulture can also crowd out native plant species, leading to lower biodiversity of animal and insect species that are adapted to native species. Reintroduction of native species areas can invite native pollinators and animals which can benefit healthy ecosystems.

2.2. Pollinators and their Importance

Pollination is the transference of pollen grains from the male anther of a flower to the female stigma, which is how plants reproduce (USDA, n.d.). Pollinators, therefore, are species that enable this transference. There are insect pollinators such as bees and butterflies as well as vertebrate pollinators such as bats and birds; within each of these groups there is a diversity of species. Across North America alone, there are more than 4,000 wild bee species (NSF, n.d.), and worldwide there are more than 28,000 species of butterflies (Nair, Mitra, Bandyopadhyay, 2014).

In order to protect biodiversity, it is necessary to protect pollinators. Protecting a native pollinator population in itself supports diversity. Pollinators also provide different services, the

main one being pollination of many different plant species (NSF, n.d.). The increase of native pollinators will support the growth of native plant species through pollination. Supporting native plant growth creates a positive feedback loop; as the presence of native plants increase, biodiversity in native animals that require those native plants for survival will increase as well.

As pollination is a necessary part of plant reproduction, crop monocultures worldwide require a reliable pollinator. Managed honey bee hives are often used to ensure crop pollination; however, honey bees are not always the most effective pollinator on a per flower basis, and managed honey bee populations have been declining due to the spread of pests and disease, as well as improper pesticide and herbicide use (Klein et al., 2006). This highlights how having a diverse group of pollinators is also essential to food production, as researchers estimate that wild pollinators provide half of global crop pollination services (NSF, n.d.).

Pollinators also support plant reproduction on a local level. This has the benefit of stimulating local plant nurseries as well as improving local food production (Xerces, n.d.b). Butterflies act as pollinators and are excellent ecological indicators, meaning that they communicate information about their ecosystems. This is because they are easily observable, and they are sensitive towards environmental and climatic changes (Saha, Sarkar, Barik, Das, & Dey, 2015). For example, a decrease in butterfly species population and diversity can indicate a larger issue of habitat loss or a decrease in native plants. Pollinators such as birds and bats also act as pest control by eating insects like mosquitoes, flies, and beetles (Kunz, Torrez, Bauer, Lobova, & Fleming, 2011). Through acting as pest control, there is less need for the use of pesticides, which can be detrimental to many different populations of animals and insects, whether or not they are the target (Xerces, n.d.b). This also supports biodiversity by controlling an insect population that would otherwise become overpopulated, which is when the population of a species within an area exceeds the carrying capacity of its ecological niche. The overpopulation of insects could lead to the spread of disease and overconsumption of plants, both native and agricultural.

2.2.1. Bee Species Controversies

For many, the pervading image of a bee is one that is small, has black and yellow stripes, lives in a hive with thousands of other bees, and, above all, produces honey. This perception is based largely off of the western honey bee, *Apis mellifera*, which was introduced to North America in the seventeenth century by Europeans for the production of honey (A&M, 2006). Since then, the

honey bee has become an instrumental component of the U.S. agricultural industry, producing profit not only from the sale of its honey but also being responsible for the pollination of billions of dollars worth of fruits and vegetables every year (Losey & Vaughan, 2006).

The negative ecological effects of the introduction of European honey bees in North America occur in two related but distinct ways. The first concerns the impacts of competition for resources between *A. mellifera* and its native counterparts. Whereas most North American bee species are solitary, forage a limited number of plant species, and generally travel no more than two-hundred yards from their nest, honey bees are able to forage more efficiently as colonies, visit a much larger variety of flowers, and can travel up to six miles from their hives to forage (Burtz Huryn, 1997; Schwarz & Hurst, 1997; Gathmann & Tscharntke, 2002; Thomson, 2004; TPWD, 2016).

Secondly, the relationship between pollinators and plant communities is being investigated with a focus on *A. mellifera* and invasive plants. Because many North American bees are specialized foragers, they are unable to pollinate introduced species of plants. Honey bees, however, contribute to the creation of invasive mutualisms by pollinating and thus contributing to the spread of introduced plant species (Barthell, Randall, Thorp, & Wenner, 2001; Goulson & Derwent, 2004).

The Texas Parks and Wildlife Department (TPWD) issued an internal briefing on the issue of placing honey bee hives on state property, stating that "the placement of managed honey bee colonies on TPWD lands managed wholly or in part for native biodiversity is incompatible with the protection of native biodiversity and should be avoided" (TPWD, 2017). It is for these reasons — the protection of threatened local pollinators and the prevention of the spread of invasive plant species — that our capstone group strongly discourages the further purchase, establishment and/or maintenance of honey bee (*Apis mellifera*) hives on SU campus grounds, of which there are currently three, located just north of the athletic fields.

2.3. Universities as the Forefront of Social Change and Strategies to Protect Biodiversity

At the forefront of social change, modern "entrepreneurial universit[ies]" have a strong connection to their local communities and have a heavy focus on innovation, resulting in experimental spaces where innovative new ideas and social movements can propagate (Colding & Barthel, 2017, p. 2). Universities shape the minds of generations of youth, provide footholds for new innovations that

would otherwise fail due to market competition, and contribute research to all levels of government and industry. Kermath (2007) argues that universities are also the start of many social movements — public perception and policy regarding immigration, psychology, equal rights, gender rights, environmental movements, etc. have all been influenced by universities (Brown & Hamburger, 2012; Pappas, 2012; Colding & Barthel, 2017).

Due to the widespread concern of climate change and its negative impact on biodiversity (and thus its potential to lead to an imbalance in ecosystems worldwide), universities are seeking ways to contribute research to the mitigation of these problems as well as via practical programs implemented on campus (Brown & Hamburger, 2012). In the process, American universities are faced with the dilemma of having to re-evaluate their traditional values in order to stay relevant to such topics. For example, universities are starting to shift away from manicured grass and non-native or adapted trees towards planting native plants and grass while still trying to maintain the aesthetic value on campus (Clifford & Petrescu, 2012). Despite this dilemma, Pappas (2012) asserts that universities need to take responsibility for the impact they can have on social change; by instating more environmentally sustainable strategies and programs at universities, such as the reintegration of native flora species on campus land, universities can begin to weave environmentalism and desire for habitat protection into the culture of a community (Kermath, 2007).

2.3.1. Case Studies

In this section, we offer case studies from other universities in order to exemplify best practices in biodiversity promotion on college campuses. Both Valley Forge Christian College in Phoenixville, Pennsylvania, and Calvin University in Grand Rapids, Michigan, implemented ecosystem restoration initiatives, although the first highlights the importance of student-led initiatives and community engagement, while the latter's program shows the merits of a university-led approach. Additionally, the Florida Native Landscape Project replaced non-native plants on Stetson University's campus in DeLand, Florida with native plants, showing, again, the benefits of university-led approaches. Finally, numerous universities take part in Tree Campus USA, which focuses on the protection of trees on college campuses.

For sustainable endeavors to be undertaken at universities, it is important to involve the community and get key campus figures and administrators on board; this can be seen in Valley

Forge Christian College's initiative to restore a native species ecosystem. Mitton and Guevin (2003) document the process of Valley Forge's commitment to sustainability through the first year of the "habitat action to change hearts" (HATCH) initiative and programs following. The Creation Club was formed in order to get HATCH started and they received a Campus Ecology grant to pursue their efforts. This student organization hosted events such as student-led tours, raised awareness through brochures, and hosted a seminar about the importance of native species landscaping and habitat restoration in order to educate the campus and community, as well as monitor the species while maintaining an inviting habitat to attract various species. To ensure success, the authors' recommendation is to select an initiative that matches campus goals; they suggest starting with a small, non-costly project that aligns with the interests of the environmental advocacy group and with the college's ability to support the project (Mitton & Guevin, 2003). Other important steps are creating connections with groups that will have greater technical knowledge that pertains to the project, such as local Audubon Society chapters, and being open about struggles and successes, since an engaged community will want to assist in the struggles and expand the successes (Mitton & Guevin, 2003).

Calvin University in Grand Rapids, Michigan provides one such example of a specific strategy to protect, and in this case increase, biodiversity on campus. This university introduced a forest restoration project that sought to find the best trees, nurse trees, and landscape to reintroduce forested areas. It is important to restore forest in unused areas with maintained, often non-native grass, also known as turfgrass, as these areas require a large amount of pesticides, herbicides, irrigation, and fossil fuels due to mowing and fertilizer use to maintain, in comparison to forests (DeJong, Warners, & Warners, 2017). Forests are highly beneficial, as they support biodiversity and can act as carbon reservoirs. Interestingly, Bouma, Huizenga and Warners (2013) found that intact forest habitats have lower biodiversity than restored habitats, encouraging the reintroduction of native species into university grounds maintenance, particularly in campuses located in suburban areas. Determining the trees and grasses for Calvin University's forest restoration initiative involved taking into account the native species' ability to support animal and insect life as well as whether the species would fit in well with the campus. Survivorship and spread of the forested area were affected by planting arrangements but not soil differences, and within seven years the previously turfgrass landscape had been restored to a diverse forested area. This

restoration is best performed in a turfgrass area that is unused but expansive, as these areas offer low biodiversity and are not frequented by people (DeJong, Warners, & Warners 2017).

Kermath's study (2007) used Stetson University to illustrate the connection between biodiversity and human lives, and as an encouragement tool for other universities to re-evaluate their campus landscapes. Stetson University is located in DeLand, Florida, where exotic plants are seen as more preferable to native plants. Given the tolerable weather that provide residents in Florida with an abundance of sunshine, the growing season is longer compared to the majority of other states in the U.S. The long growing season has enabled Florida residents to plant many varieties of exotic plants such as non-native, albeit naturalized, tropical plants in urban landscaping. Because of this preference for exotic plants, landscaping in Florida is crowded with naturalized and invasive exotic plants and soil that is heavily fertilized, with nearly 14% of naturalized exotic plants deemed problematic by the Florida Exotic Pest Plant Council (Kermath, 2007, p. 215). However, some universities in Florida continued to maintain the status quo in terms of campus landscaping which included well-manicured grass, shrubs and trees. Kermath argues that universities have a duty to champion environmental sustainability on their campuses due to the large role that they play as examples in the larger communities they inhabit (Kermath 2007).

In 1995, Stetson University had started to challenge the campus status quo slowly by incorporating native plants into their landscape. Despite the lack of resources since the university did not have programs in landscape architecture or urban forestry, the Florida Native Landscape Project launched by Stetson University was a success. This project aimed to remove non-native plants and replace them with native plants, shrubs, and grasses around the Gillespie Museum of Minerals and the Department of Geography and Environmental Science. The project's objectives were to begin a Green Movement at the university, help the community to reshape their value of landscape, and to show appreciation to the "natural heritage" of native plants (Kermath, 2007, p. 216). Five years later, the project received the Florida Native Plant Society award for second place, but the success of this project goes beyond the award. The continuation of the project over the span of five years gave Stetson's community a better understanding of the benefits of biodiversity, improved their understanding of ecological sustainability, and started the conversation of native plants amongst the landscape designer community in Florida (Kermath, 2007).

Universities have also turned to recreating forest habitats for native wildlife as a means of not only improving biodiversity but also for the myriad advantages that come with having a

certified tree-friendly campus, such as Tree Campus USA certification. The state of Texas alone is home to thirty campuses that have proven their commitment to promoting campus-wide biodiversity by adhering to the standards laid out by the Arbor Day Foundation (ADF, n.d.):

1. Formation of a Campus Tree Advisory Committee made up of students, faculty, and administration
2. Creation of a Campus Tree Care Plan with clear goals and responsibilities
3. Allocation of annual funds to the upkeep of campus trees
4. Observance of Arbor Day, typically celebrated the last Friday of April
5. Implementation of Service-Learning Project to educate and involve the wider community

The environmental and economic benefits of tree cover on university campuses have been found to include the removal of harmful gases from the air, including the storage of carbon, as well as the reduction in costs associated with heating and cooling buildings (Bassett, 2015). Reaping these benefits, however, requires years of planning, cooperation and commitment, and before planting and landscaping can begin there must be clear and practical expectations from the various individuals and institutions that will play a role in the campus's growth and maintenance (Roman et al., 2017).

2.4. Universities and Campus Green Spaces

One particularly controversial topic when it comes to biodiversity, nature, and universities is the near universal presence of heavily manicured landscapes, with trimmed trees and fields of turfgrass. These landscapes require the majority of university water to be put towards landscaping and are detrimental to the biodiversity of the region, as many native species are unable to survive on perfectly manicured, non-native college landscapes. These landscapes are not sustainable, as water is a scarce resource whose future is unpredictable (UN, 2006). While the use of these lawns can certainly be criticized, there are benefits to their existence on university campuses.

Gray (2013) provides supportive evidence that suggests that lawns can be valuable in social, economic, and environmental ways. Socially, native-focused as well as turfgrass lawns are sustainable and of great importance to universities as they provide students, faculty, and staff a place to engage outside for studies, recreation, and socializing. This aspect of large lawns on university campuses provides evidence for the importance of maintaining a central lawn, while

other, less frequented green spaces of the campus can be utilized for greater biodiversity and habitat restoration. There is evidence that suggests that turfgrass lawns and native plantings require similarly high levels of maintenance; however, native species typically require manual maintenance in terms of trimming overgrowth and removal of dead species, whereas turfgrass lawns require high resource use (Gray, 2013). Environmentally, lawns that are focused around native species are much more sustainable than turfgrass lawns, as non-native turfgrass can come with negative side effects such as higher water use, which can exceed demands of drought prone regions and result in higher prices for maintenance. The most important aspect of these lawns is the university's practice and maintenance of the space. Utilizing sustainable practices, combining lawns and native species, and maintaining lawns for use by pedestrians as well as important ecosystem functions are all ways that universities can ensure that they are encouraging a sustainable green space suitable for the area (Gray, 2013). However, despite the importance and sustainability of including native species in campus green spaces, this is often contrary to the actual preferences of many.

Johnson and Castleden (2011) showcase this discrepancy in their case study of the University of Victoria in British Columbia, Canada. They conducted a survey of geography students who identified themselves as "environmentally concerned" and "environmentally conscious;" of the sample, a high percentage agreed that replacing grass with native plants was beneficial and an efficient way to conserve water usage. The participants were presented photographs of different landscape scenarios with no descriptive words and asked to rank them based on aesthetic. Despite the participants' supposed preferences for native plants, images with turfgrass scored the highest. Johnson and Castleden (2011) suggest that the results may have been different if there were words on each photograph describing the types of plants present, and/or the amount of water needed for each landscape. Based solely on aesthetics, students preferred well-groomed landscapes, despite their inherent environmental implications.

This preference for manicured landscapes was studied at Liverpool Hope University as well. Speake, Edmonson, and Nawaz (2013) used a questionnaire to gather both qualitative and quantitative data to look at how students of the school view, understand, and utilize green spaces on campus. They did so by using free response for feelings and emotions and close-ended questions for data to gather demographics of responders and their perceptions. The analysis of question responses and data concluded that many students favored manicured green spaces over naturalistic.

In fact, none of the students responded with favoring naturalistic areas (Speake, Edmondson, & Nawaz, 2013). Whether or not the student body, as well as faculty and staff, see green spaces as a beneficial part of campus could determine their influence on campus culture. However, this influence may not matter if the university does not consider community desires regarding natural spaces, such as through hosting community forums to hear community input.

2.5. University Decision-Making over Natural Spaces

The Association for the Advancement of Sustainability in Higher Education (AASHE) has recognized that human health and well-being are in large part associated with nature, and that universities should broaden their focus on the integration of biodiversity on campus such as through sustainable landscaping, community gardening, raising awareness, and promoting on-campus engagement (Krasny & Delia, 2014). In an attempt to diversify in line with this recommendation, many universities have included sustainability-related topics into their curriculum in both social science and natural science disciplines to engage their students (Brown & Hamburger, 2012).

Despite being such major stakeholders on campus due to their tuition expenses and amount of time spent on campus, students are often left out of the loop when it comes to programs and decisions regarding sustainability on campus. Johnson and Castleden (2011) describe how students are often unable to participate in university decisions on issues that impact their lives, such as re-designing/remodeling landscaping. While necessary, including students and other diverse voices in sustainability endeavors can be difficult for universities, as they are faced with the need to create a specific position or a body of government such as a committee in order to encourage sustainability and engage the campus and local community, and must also tackle funding issues associated with such endeavors (Brown & Hamburger, 2012).

This research discussed the global and local importance of biodiversity, pollinators and the ways they play into the success of biodiversity, and the incredible importance of sustainable initiatives at universities. As a primary catalyst of societal change, universities must take responsibility and implement strategies for the protection of pollinators and biodiversity; this can be done by implementing specific initiatives such as the restoration of forest habitat or including native flowering plants in green spaces, as well as by engaging with both the campus and local communities. However, as noted, the prevalence of manicured turfgrass on college campuses, as

well as in the green spaces of many developed areas, has shaped the preferences of many regarding aesthetics of these spaces. By planting native plants and educating the community, universities can alter these perceptions and encourage people to see the inherent beauty and sustainability of native landscapes.

More than just implementing native landscaping on their campuses, however, universities must engage with and listen to the campus community, especially students. By giving students more agency regarding native landscaping and other sustainability initiatives on campus, the university will better be able to keep up with innovative new sustainability ideas and encourage student involvement in these endeavors. This will foster a mindset of sustainability in youth, which they will carry with them into the workforce, where these ideas can propagate into many different fields and communities. Eventually, sustainability could be more than just a way for universities and companies to gain prestige; it could be the lifestyle of society.

The next section of this research will discuss the history of sustainability initiatives at SU and the ways in which the university supports pollinators and biodiversity. Following this, we explain and discuss the purpose and certification requirements of Bee Campus USA, in what ways the university is already meeting these goals, and what this capstone has done — and what still needs to be done — in order for SU to become certified as a Bee Campus USA affiliate and better support and protect pollinators and biodiversity on campus.

3. Southwestern University: Sustainability and Biodiversity Protection

3.1 History of Sustainability at Southwestern

SU lists one of its core values as "encouraging activism in the pursuit of justice and the common good," and this can be shown in the history at SU of environmental activism leading to sustainable initiatives. The 2018 environmental studies capstone documented the history of student, faculty and staff commitments to environmental sustainability, and defined environmental activism as "a specific form of activism which aims to change public attitudes and policies pertaining to the environment" (Bressette et al., 2018, p. 7). Environmental activism can lead to instituting

sustainable initiatives, projects, and policies to reduce an ecological footprint, and environmental activism and the creation of environmental activist groups has directly led to sustainable initiatives that differentiate SU from other institutions. This section will review SU's history of environmental activism and sustainable initiatives in order to show that Bee Campus USA certification would align with the university's commitment to sustainability.

In the 1960s, activism began increasing in Austin and surrounding universities, including SU. Activism at SU at this time was focused on social activism, specifically women's issues, discrimination on campus, and political issues (Bressette et al., 2018). This broader social activism provided a foundation for environmental activism at SU. Earth Day was celebrated at on campus for the first time in 1970, which consisted of teach-ins, letter writing, guest speakers, and live music (Bressette et al., 2018). Environmental activism significantly increased starting with the creation of the Environmental Studies program and the SU Environment Awareness Klub, now called Students for Environmental Activism and Knowledge (SEAK), in 1999 (Bressette et al., 2018). Throughout the 2000s, SEAK organized events focused on environmentalism, such as Earth Day in 2000, and raised awareness for energy consumption, recycling, and water usage, creating an atmosphere that supported conversations focused on environmental issues on campus (Bressette et al., 2018). Also, faculty in the Environmental Studies program have actively facilitated and participated in student-led activism, as well as teach a variety of classes requiring activism-related projects.

Sustainable initiatives have primarily been a result of student activism. In 1971, a recycling program began on campus thanks to an ecology task force (Bressette et al., 2018), and throughout the 1990s there was a focus on more sustainable construction on campus, in particular new soccer and baseball fields that are more environmentally conscientious (Newton, 1999). SEAK took a lead in campaigning for sustainable initiatives, such as the installation of new water-efficient showerheads, removing trays and adding compost bins to the commons (Bressette et al., 2018), picking up litter around campus, and providing reusable dishware for events on campus (D. Rosario, personal communication, November 7, 2019). SEAK also petitioned then-President Schrum to sign the Talloires Declaration and the American College and University Presidents Climate Commitment, which lead to the creation of the Talloires Committee (Bressette et al., 2018), which later became the Sustainability Committee. In addition, environmental studies students, faculty, and capstone projects have led to sustainable initiatives such as switching SU to

100% renewable electricity in 2010, updating the lighting in the Walzel gym in 2016, Tree Campus USA certification in 2018, and the hire of a Sustainability Coordinator position in 2019 (Bressette et al., 2018).

In early 2009, around the same time as the signing of the Talloires Declaration and the beginning stages of the transition to renewable electricity, the SU Community Garden was established with a huge initial push. It began as a mostly SEAK and Environmental Studies project, with goals of producing food for local food banks and even for the dining hall on campus. "It was exciting… we had major aspirations right at first. We figured it could be a really big community garden for other people who live around here, not just for SU folks, but you still have to have someone who spearheads it, who's here — on the faculty or staff who can continue to carry over between students" (L. Hobgood, personal communication, November 12, 2019). This lack of a point person will be returned to in a later section.

The Sustainability Committee has played a significant role in making decisions regarding sustainable initiatives, as they provide money from the Green/S.A.F.E. Fund (henceforth referred to as Green Fund) to support projects that will promote sustainability at SU, with a focus on student projects. The recent creation of the position of Sustainability Coordinator started as a Green Fund proposal, and half of the salary still comes from the Green Fund (V. Johnson, personal communication, November 4, 2019). The purpose of the Sustainability Coordinator is to work collaboratively with administration, faculty, staff, and students to develop, coordinate, and promote effective sustainability initiatives to reduce the university's impact on the environment (V. Johnson, personal communication, November 4, 2019). The current Sustainability Coordinator, Veronica Johnson, has led initiatives such as the EcoRep program, an on-campus thrift store, "bag-the-bag" bins, a trash buddy program, and a recycling education program. Among future goals for SU, Johnson lists becoming a zero-waste and carbon-neutral campus, as well as developing an Office of Sustainability. Additionally, Johnson submitted a Green Fund for the purchase of three BatBnB houses for placement around Southwestern, locations to be determined. Bats are incredibly beneficial for their local environments and ecosystems; they are pollinators (although and seed-carriers, and also help to maintain pest and insect populations, which reduces the need for pesticide use. In fact, in the Texas Hill Country alone, it is estimated that bats save $1.4 billion annually in avoided pesticide use. Johnson plans to host a Bat House Reveal Ceremony in the spring of 2020 (V. Johnson, personal communication, December 4, 2019).

SU's certification as a Bee Campus USA affiliate would not only follow in this tradition of student-led sustainable initiatives — it would support SU's commitment to maintaining a sustainable campus, as well as align with SU's core values.

3.2 Biodiversity and Pollinators at Southwestern

3.2.1 *Programs Supporting Biodiversity and Sustainability at Southwestern*

Organization / Program Name	Classification	Role on Campus / Mission Statement / Purpose
Students for Environmental Activism and Knowledge (SEAK)	Student Organization	"To improve sustainability policies on Southwestern's campus, state-wide, and nationally. We strive to educate and involve the Southwestern community in environmental, energy, and conservation issues. We believe in thinking ahead by acting now to create a cleaner and more sustainable Southwestern"
Human Environmental Animal Team (HEAT)	Student Organization	"To educate students on and improve situations for human rights, animal welfare, and environmental preservation and conservation."
Southwestern Community Garden/Garden Club	Student Organization	"To foster community through sustainable food cultivation."
SU Cat Partners	Student Organization	"To protect and maintain the welfare of the campus cats, to address any problems created by strays coming on to Southwestern's campus, and to foster a relationship between the campus community and campus cats."
Coalition for Diversity and Social Justice (CDSJ)	Student Umbrella Organization	"To foster an inclusive and supportive community of student organizations that promotes and celebrates diversity. The CDSJ is a united voice dedicated to empowering the SU community to challenge the oppression of any individual or group."
Environmental Studies Program	University Department	"Encourages students to analyze a local or regional environmental issue from multiple perspectives, and notably, encourages some element of environmental activism or community engagement. The hope is that students will engage in a research project that will allow them to gain experience, research skills, and communication skills necessary to succeed in a professional or academic field"

Sustainability Committee	Faculty / Staff / Student Committee	"The Sustainability Committee is charged with the promotion of practices and programs that support the principles of social, financial, and environmental sustainability of Southwestern University as outlined in the Talloires Declaration and the American College and University Presidents Climate Commitment."
Facilities Management	University Department	"To provide and maintain an environment that fosters learning and the betterment of humanity by creating a safe, sustainable and aesthetically pleasing environment for the community while preserving the historical character of the campus."

3.2.2. Landscaping

SU's grounds are similar to the general look of most universities: fields of manicured turfgrass, managed trees, and beds near and around buildings with a variety of plants. The university is dedicated to sustainability and campus stewardship, especially in recent years, and this can be seen in the university's landscaping decisions. One such decision, while not well-known by the campus community, is the production of mulch from campus trees that are removed for health or safety reasons and is used campus wide. Another is the university's efforts to conserve water; controlled by a computerized weather station, the irrigation system at SU is designed to only water when necessary. Additionally, the sports complex is irrigated using greywater, household wastewater from all streams without fecal contamination, from the City of Georgetown; in fact, SU was the first entity to use greywater in Georgetown (Johnson, n.d.). Despite these efforts, and even though around 90% of landscaping on campus is native or drought tolerant, SU is still Georgetown's largest water user (L. Roberson, personal communication, November 10, 2019). In order to combat this, an environmental studies capstone group proposed the use of a 19,000-gallon rainwater collection system for irrigation in fall 2018, which has yet to come to fruition (Johnson, n.d.).

Many of the plants on SU's campus are not native or best suited for the droughts that Texas is often and increasingly faced with. However, as these less-suited plants deteriorate, they are replaced with plants that are native or otherwise adapted for drought-tolerance (R. Erben, personal communication, November 10, 2019). There are two primary examples of this on SU's campus. In 2018, the landscaping surrounding the Hugh Roy and Lillie Cullen Building, the primary administrative building on campus, was redone to include a multitude of native and adapted plants such as Texas mountain laurel and asparagus ferns, as well as rocks for ground cover to limit the

need for water. In fall 2019, renovations to the Fondren-Jones Science Center were completed, and native and adapted plants such as sage and cenizo were added in beds surrounding the building, and the St. Augustine grass surrounding the area was replaced with *Zoysia japonica*, "Palisades," an adapted grass species developed at Texas A&M that is drought-tolerant and both shade and full-sun tolerant (R. Erben, personal communication, November 10, 2019). Additionally, in the summer of 2019, wildflower seeds were spread across a large triangular area of grass near the Corbin J. Robertson Center, the campus athletic center. Unfortunately, there have not been any wildflowers yet due to very little rain in the months since (L. Roberson, personal communication, November 10, 2019). These are larger-scale examples, but this replacement of non-native and/or non-adapted plants with native and/or adapted plants is now a staple of Facilities Management (Facilities)' groundskeeping practices, and is not the only way in which SU's landscaping is sustainable.

3.2.3. Pest Management

Facilities Management are committed to an informal Integrated Pest Management (IPM) plan designed to counter problems in the least harmful ways possible. The plan includes five crucial aspects, with the first the most important: *inspection*. Every day, Facilities staff inspect the campus grounds in an attempt to catch problems before major management such as pesticide application is needed. Inspection is a constant, ongoing, necessary process for the prevention of pest problems and harmful corrective action. Second is *preventative action*, in which the root cause of the potential problem is identified, and action is taken, such as altering watering levels, to prevent the problem from spreading. Third is *monitoring*, similar to inspection — once a problem is discovered, it is continually monitored at each and every step of the process. After any action is taken, Facilities returns to this stage. If the initial preventative action did not fix the problem, an *overall analysis* takes place: What is the problem? What led to the problem? What needs to be done to correct the problem that has not already been attempted? Why did previous attempts fail? Finally, *reevaluation* occurs, next steps are outlined, and the problem returns to the monitoring stage. It is a long, multistep, cyclical process, and lasts about a month in most cases (L. Roberson, personal communication, November 10, 2019). Working with Facilities, this philosophy was written up in more detail by our capstone and is available on the Bee Campus USA page on SU's website.

There are two interesting aspects of pest management at SU, one of which falls outside of Facilities' IPM plan and into the hands of a student organization: Cat Partners. Cat Partners of SU (CPSU) was founded officially as an organization in 2011 as a result of Alex Brown's sociology capstone project in the fall of 2010, which focused on the Trap, Neuter, Return (TNR) of feral cats that had been living around or on campus (A. Brown, personal communication, September 21, 2016). When feral cat populations are left unchecked, they can become overpopulated. By trapping, spaying/neutering, and returning the cats to the colony, populations will no longer increase, and established colonies will repel other feral cats from their territory. Thanks to the efforts of CPSU, there are now nine campus feral cats, all spayed/neutered, and at least three of which allow (or even, in the case of Mister Socks, adore) human contact. These campus cats help to keep other feral cats from establishing themselves on campus and becoming a nuisance, and also help to keep bugs and other critter populations such as mice small. Feral cats are also known for decimating bird populations, but because SU's cat community is managed and fed at feeding stations, this is not as much of an issue. It does, however, bring up the second interesting aspect of pest management at SU: bird calls.

Back in 2000-2001, SU's campus was experiencing a major grackle problem, to the extent that there were concerns for the safety and health of students, faculty, and staff due to the noise, waste, feathers, and odors from the birds. Facilities attempted to rid the campus of the birds numerous times; they tried clapper boards, starter pistols, laser lights, airhorns, smoke, and even fireworks, but nothing worked. Facilities even spent over $30,000 in overtime during the summer trying to keep the grackles away from campus. Finally, a solution was discovered, and it remains today: "Bird Gard Pro," a unit that projects predatory bird calls to keep grackles and other pest birds away. A few units were installed around campus, and now for nearly two decades, there have been no issues with birds (R. Erben, personal communication, November 4, 2019).

These bird calls are both socially sustainable in their protection of the campus community's health and safety and economically sustainable in the low maintenance required of the units and their effectiveness. They are also environmentally sustainable, as the bird calls effectively and efficiently stave off any possibility of overpopulation of pest birds on campus; while birds provide valuable ecosystem services such as maintaining insect populations, when they overwhelm an area they can drastically reduce these populations. In the years following the installation of the calls, Facilities noted no noticeable change in insect populations, as bugs are not a primary food source

for grackles (R. Erben, personal communication, November 4, 2019). Additionally, even without the grackles on campus, there are many bird species to perform ecosystem services, such as mockingbirds, multiple dove species, owls, nighthawks and other hawk species, sparrows, wrens, etc. (J. Long, personal communication, November 8, 2019), as they are not affected by the calls.

3.2.4 Green Spaces

Well-groomed, primarily turfgrass landscapes are not the only green spaces available to the SU community. One such area is the SU Community Garden, founded in early 2009 and managed by the Garden Club, a student organization, starting in 2014 (S. Brackmann, personal communication, November 4, 2019). Equipped with an aquaponic growing system and raised wicking beds (each a product of student Green Fund grants), the campus garden helps to conserve water during the warmer months and often supplies organic produce such as cabbage, lettuce, broccoli, spinach, chard, eggplant, peppers, tomatoes, strawberries, etc. to community organizations. In fact, in the early 2010s, fifty pounds of food was produced in one harvest and donated to a local food bank (L. Hobgood, personal communication, November 12, 2019). Additionally, with the planting of low-maintenance pollinator plants such as Yellow Columbines and Guajillo, part of the garden was designed specifically to attract bees, butterflies, and other pollinator species (Johnson, n.d.). At one point, this pollinator garden was around 15,000 square feet with over 30 varieties of pollinator plant species (L. Roberson, personal communication, November 10, 2019). In years past, there was also a Texas native wildflower hillside, as well as a butterfly garden (L. Hobgood, personal communication, November 12, 2019).

Due to the nature of SU, with students coming and going, the garden has ebbed and flowed with the varied passions of its overseers. In a meeting on November 4th, 2019, Dr. Sarah Brackmann, the Senior Director of Integrative and Community-Engaged Learning, described how she was heavily involved with the garden around 2013-2014 and noted that "…nobody was really taking ownership of the garden… not sustainable. And I said for many years, it will not be sustainable until someone takes ownership because there's so much work that goes [into it]." This has been true for much of the garden's existence, even with the Garden Club as the primary owner. "Every year, a new group of students become very passionate and engaged… but I can give you names of alumni who just got burnt out… the garden just kills their soul." Dr. Laura Hobgood also noticed this: "It's gone through various iterations… It's gone up and down like that the whole

time, [with] 2 or 3 year chunks where for some reason there was a bunch of activity and then it sort of goes [downhill gesture]… cause it's a lot of work" (L. Hobgood, personal communication, November 12, 2019).

With the hire of a Greenhouse Technician, Lance Roberson, in fall 2018, there is now a primary manager for the garden, someone that can ensure the sustainability of the garden as students come and go. Having a point person is also important for the success of student-learning projects, which have been ongoing in the garden through varied courses, such as a plethora of Community Engaged Learning courses once taught by Dr. Molly Jensen in the 2010s (S. Brackmann, personal communication, November 4, 2019), Dr. Joshua Long's Sustainable Food and Agriculture course, a First Year Seminar (FYS) course titled From Farm to Table: Food in our Changing Environment, etc.

The Community Garden is not the only service-learning green space available to SU students: located about one mile east of main campus, Ecolab is owned by SU and utilized by students of the Ecolab program, a "student-driven environmental field studies program for learning and research in Ecology, Geographic Information Systems (GIS), and Environmental Studies" (SU, n.d.a), established in 2014. The area is untouched by mowers or any other sort of managed maintenance, and access is only allowed for those within the program, or otherwise granted permission for service-learning projects. Water analysis, surveys of animal and plant species, and GIS mapping are projects which often occur in Ecolab, as well as restoration projects, including trash removal, trail creation and maintenance, and replacement of invasive species with native species (SU, n.d.a).

This section has discussed the long and rich history of sustainability at SU — from social issues such as gender equality to environmentally sustainable endeavors, student-led activism at SU has paved the way for the many sustainable initiatives SU prides itself on, such as the transition to renewable electricity and the establishment of the Sustainability Committee. However, this culture of sustainability is not enough; landscaping decisions are critical for environmental sustainability, and thankfully the Facilities Management team at SU also subscribes to a mindset of sustainability. With their focus on native and adapted plants and their previously unofficial least-toxic IPM plan, Facilities staff aim to preserve and further establish native habitat on SU's campus. With the management of local feral cat communities and the installation of bird calls to keep grackles from invading campus, SU has also shown its more interesting aspects of pest

management. Finally, green spaces on campus that allow greater student oversight include the SU Community Garden, with its own history of ups and downs, and Ecolab, a primarily academic space. Each of these aspects of sustainability at SU come together to create the socially- and environmentally-conscious atmosphere needed for SU to subscribe to sustainable initiatives and programs beyond what the university already does, such as the primary aim of our capstone project: the certification of SU as a Bee Campus USA affiliate.

4. Bee Campus USA

4.1 Requirements and Certification

After the collapse of bee colonies was being reported at an alarming rate in the U.S. in the mid-2000s (USDA, 2019), a small group of conservationists came together to come up with a solution. Instead of pointing fingers, this group decided to set forth the Bees City USA program in 2012 in order to raise awareness and start a dialogue about protecting our pollinators. Three years later, Bees Campus USA launched to bring this discussion to universities as well (AASHE, 2018). Bee Campus USA is an initiative of the Xerces Society for Invertebrate Conservation that aims to recruit universities to engage in sustainable practices that promote pollinator habitats and native landscaping. By doing so, Bee Campus USA certifies a campus as a "Bee Campus," a label achieved through a set of application requirements that include a campus management plan that includes a native, pollinator-friendly plant list (NPL) and an IPM plan, a bee campus committee, and engaged student service-learning projects focused around pollinator education. Listed below, these requirements (Xerces, n.d.a.) help the university unite what they are already doing as well as continue to promote sustainable practices within the faculty, staff, and student body:

1. Establish a committee and develop a habitat plan
2. Host awareness event(s)
3. Sponsor and track student service-learning projects
4. Offer pollinator focused courses and/or workshops
5. Post signage to educate your campus and broader community
6. Maintain a web presence to share your Bee Campus USA news and activities
7. Reapply annually for renewal

The first requirement is to establish a committee and a habitat plan. The committee must be made up of the landscape director, faculty, staff, and students (Xerces, n.d.a). This committee oversees the annual renewal of the campus' certification by producing a full report that details that year's events, projects, pollinator curricula, and the campus habitat plan. The committee must also update the university's webpage with the relevant information pertaining to their Bee Campus USA efforts, as listed in the above application renewal requirements. The first step that the committee takes in applying for Bee Campus USA certification is the habitat plan. This plan is made up of the IPM plan and the NPL, the latter of which includes regional sources for the plants (Xerces, n.d.a). The IPM plan is a description of current university policies for managing pests and which pesticides are being used in the case of infestations, if any. The IPM plan will be analyzed to make sure that the university is using the least toxic options for pest management and does not have a severe effect on pollinator populations. The NPL is a list of native, pollinator-friendly plants that the university may use. This acts as a way to categorize the landscaping the campus is engaging in that might influence pollinator patterns. Providing a regional source for native plants on campus allows Bee Campus USA to recognize that the university is actively working to create a sustainable habitat that matches the campus' ecological region. The IPM plan and NPL must be publicized on the university Bee Campus USA webpage for other local landscapes to access and use as a model.

Several of the following steps in applying for Bee Campus USA certification are focused on community and student engagement and learning. These include awareness events, student learning projects, and pollinator-focused courses. The first of these is hosting awareness events which enable the community to learn more about the importance of pollinators and their role in ecosystem services. The event also acts as a way of recognizing the campus' certification. Events can be as large as workshops or as small garden tours; it is only necessary to make the overall community aware of the certification and pollinator's importance. Some themes that should be covered in the awareness event are the role of pollinators in our food source, ecosystem food webs, and the spread of native plants. Awareness events should be held every year and can be open to the campus community or the city community and can involve national observance days like Earth Day, National Pollinator Week, and Garden for Wildlife Month (Xerces, n.d.a). Following awareness events is the focus on student involvement by tracking and sponsoring student learning projects. These projects can be on- or off-campus and should enhance habitats, which allows garden planting days or invasive species removal events to count towards this requirement (Xerces,

n.d.a). Biennially, a course with a pollinator-focused curriculum must be offered for students. Workshops that focus on pollinator ecology, integrated pest management, landscaping for pollinators, and/or native plants also count towards this requirement. It is possible to host a workshop that covers all three of the above requirements, allowing for each campus to create a unique approach towards Bee Campus USA certification. These different paths also allow for universities to integrate learning through their unique ecoregions and raise awareness for pollinator protection.

Finally, advertising that brings attention to the campus' efforts towards Bee Campus USA certification must be accessible and easily available for the campus community. This must be in the form of signage and an active web presence that tracks the different ways the campus has worked towards certification. Signage on campus should include information that focuses on the importance of native landscaping and pollinator roles in the greater ecosystem. These help the community to acknowledge the importance of Bee Campus USA certification and the university's commitment to sustainability. The active web presence allows anyone to read about the details of the university's dedication to their Bee Campus USA certification. It should be updated with current news of sustainable practices, pollinator-focused events happening on the campus, and outline the IPM plan and NPL for those interested. It should be used as an important source of information for future and current students as well as for the annual reapplication process.

4.2 Benefits to Universities

Joining Bee Campus USA provides universities numerous benefits directly and indirectly through the application process. The first benefit is a direct benefit to the school in the form of rating and marketing materials with Bees Campus USA certification. Universities are actively engaged in current issues in order for them to race amongst their peers to attract like-minded students. Environmentally conscious universities can keep score of their sustainability achievements through the Sustainability Tracking Assessment and Rating System (STARS), which is used to compete amongst one another (Northland, 2018). Bee Campus USA certification has created a ripple effect on universities and their local communities; during the process of applying for certification, universities must go through the seven steps for certification, ranging from forming a committee to creating pollinator-focused courses. Forming a committee brings together staff, faculty, and students, the three essential stakeholders who represent the campus population.

The certification also requires universities to raise awareness and to start pollinator conversations through awareness events, various student-learning projects, and courses/workshops, which will spark interest and enables participants to continue to stay plugged into the issue of pollinator protection. Students who are involved in the such projects gain extensive knowledge on pollinators, enabling them to put it into real-world practice. The projects allow students to use campus grounds as an extension of the classroom. For example, the University of North Carolina, Asheville, Bee Campus USA affiliate, has implemented additional learning opportunities to students from different disciplines such as internships, independent studies, and courses related to pollinators (Salvia, 2018). On top of this, students are continuously involved and learned about university decision-making regarding landscaping and least toxic integrated pest management.

4.3 What Texas Schools are Doing

Currently there are six Bee Campus USA certified institutions in Texas, including Abilene Christian University (ACU) in Abilene, Coastal Bend College (CBC) in Beeville, Tarrant County College Southeast Campus in Arlington, University of North Texas (UNT) in Denton, University of Texas at Dallas in Richardson, and University of Texas Rio Grande Valley in Brownsville (Xerces, n.d.c). Based on the Annual Report of Accomplishments in 2018, there were only three that submitted annual reports for 2018 that are available: ACU, CBC, and UNT (Xerces, n.d.c). There were similarities and differences in the ways each campus approached their awareness events, created habitats, and instituted policies. Each university had a different approach when it came to raising awareness due to the university's core values and geography, as well. For example, CBC is located in Beeville, TX. The coincidence of the city's name has allowed CBC to expand its education and outreach programs beyond the campus to the City of Beeville. The CBC has partnerships with the City of Beeville to host the Annual Bee Jamboree event, intended to educate the community about the benefits of bees and pollinators through live music, farmer's markets, and vendors (CBC, n.d.).

In the meantime, UNT has a substantial focus on creating habitat and extensive programs for service-learning and various curriculums that are related to pollinators; their slogan, “Mean Green,” is not just about the color. There were ten significant events and service-learning projects such as BioBlitz events in the spring and fall, assessments of plants on campus, cleaning up

invasive species, and the Big Event, a nationally recognized day of service. UNT has also added pollinator-related curriculum into different classes such as Biology, Biodiversity, Conservation of Animals, and more (UNT, n.d.). Despite the different approaches each campus uses to educate its community, there is a consensus; all three schools have utilized their community garden as a starting point for pollinator habitat protection. ACU has utilized its two big community gardens to test out which native plants work in which seasons and are the best for the area while requiring the least maintenance and attracting more pollinators (ACU, n.d.), UNT hosted garden workdays twice a year that brought students, faculty, and staff members to help pull weeds, lay and remove mulch, and plant (UNT, n.d.), and CBC hosted the Annual Bee Jamboree at the college's Conservation Garden (CBC, n.d.).

4.4 What Southwestern Already Does

SU's dedication to sustainability allowed for many of the requirements to be filled without active changes in already existing policies and practices. Meetings with Facilities, individuals on staff and faculty, the Sustainability Committee, and garden students brought awareness to the current practices by the campus and that the capstone group only needed to catalog this information into an application. The first meeting with Facilities allowed us to start on the NPL and IPM plan. Members of Facilities, including Lance Roberson, Richard Dabbs, Randy Erben, Randy Damron, and Ben Nava, provided valuable information regarding the IPM plan, particularly that SU's Facilities management use a five-step program to analyze a situation and use proper management techniques (personal communication, October 10, 2019). This allowed the group to write out an official IPM plan that details each step that SU takes towards safe and sustainable pest management. Randy Erben then shared a plant list of all plants being utilized in SU's landscaping (R. Erben, personal communication, October 10, 2019). SU includes a majority native plants into its aesthetics, allowing for us to cross list with a public access list provided by the City of Austin. This source contained information about whether a species was native to blacklands prairie and/or Edwards Plateau, native to a Texas ecoregion that was not blacklands prairie or Edwards Plateau, or a hybrid species with native parentage. Lance Roberson also provided information on the regional source, Native Texas Nursery, where SU purchases their native landscaping plants (L. Roberson, personal communication, October 10, 2019). The information provided by the Facilities

Management staff allowed the group to write out the information needed for the Bee Campus USA application and fulfill the habitat plan requirement.

An important meeting with Dr. Romi Burks gave the group insight to allow the Sustainability Committee to absorb the Bee Campus USA committee as it already had the required student, faculty, and staff makeup (R. Burks, personal communication, September 26, 2019). The Sustainability Committee would then take the responsibilities of renewing SU's certification and overseeing the fulfillment of Bee Campus USA requirements. It was necessary however for this absorption to be voted on and accepted by the current members of the Sustainability Committee. Dr. Burks also gave recommendations on our Green Fund proposal which included a five-year renewal plan that detailed each year's costs, the annual renewal fee, and signage costs (R. Burks, personal communication, September 26, 2019). This provided the group with insight on what to focus on to get financial funding to meet requirements and ensure Bee Campus USA certification.

Email correspondence with Dr. Emily Niemeyer provided information about a current First Year Seminar that taught a pollinator-focused curriculum based around Community-Engaged Learning Projects (CELP). This class, a First Year Seminar (FYS), named From Farm to Table: Food in our Changing Environment, focuses on climate change and how it has and will impact food sources. The CELP that Dr. Niemeyer gave students included a pollinator focused project that led to a presentation on what the group did in the campus garden, what they learned, and supporting resources on the importance of pollinators in food sources (E. Niemeyer, personal communication, October 16, 2019). This class, which will be offered in the fall semester for first-year students, provides the opportunity for students to take a class that includes pollinator education, fulfilling the pollinator curriculum requirement of Bee Campus USA. The CELP of Dr. Niemeyer's FYS also counts towards sponsoring and tracking student service-learning projects, thereby doubling as both a service-learning project and as a pollinator-focused course.

A majority of Bee Campus USA application requirements were already completed as the capstone group met and communicated with various members of the SU community. However, it was still necessary for the group to get approval for the Sustainability Committee to absorb Bee Campus USA duties, install signage on campus, and create an SU Bee Campus USA webpage. These aspects of the application have been fulfilled with work by the group. The group has also sought to look beyond these requirements and create a Protected Native Habitat on campus, located in a field northeast of the maintained campus near the sports facilities.

4.5 What Southwestern Needs to Do

The first requirement of Bee Campus USA certification is to form a committee, which we proposed to the Sustainability Committee in their October 18, 2019 meeting. The proposal included a five-year project continuation plan that outlined the future responsibilities of the committee, the details and requirements of maintaining Bee Campus USA certification, and future pollinator awareness event ideas. The first year required the formation of the committee and the creation of the Bee Campus USA webpage and the second would require the annual public awareness event. The third year would see the signage designed and placed on campus grounds. By the fourth, the committee would need to have fully integrated a pollinator class or workshop and the fifth would see the completion of all necessary steps, allowing the committee to simply record the previous steps and submit for reapplication. While this was the proposal we offered in the meeting, we decided to instead finalize our application to Bee Campus USA within the 2019-2020 school year rather than extend the application. The proposal for the Sustainability Committee to absorb the Bee Campus USA committee was approved in the meeting and allowed for the capstone group to move forward in attaining certification.

Another part of the Bee Campus USA application required endorsement from the highest official on campus, which for Southwestern is our president, Dr. Edward Burger. The group emailed Dr. Burger a brief outline of our proposal and why Southwestern should seek Bee Campus USA certification along with the endorsement of members of facilities and staff. On November 11, 2019, Dr. Burger conveyed his endorsement of the Bee Campus USA certification and application (P. Witt, personal communication, November 11, 2019). With his endorsement and the rest of the application prepared, we submitted the official application to Bee Campus USA on Thursday, November 21, 2019.

The group found it necessary to obtain funding for the application fee, signage, and the Protected Native Habitat. To do so, we applied for the Green Fund, which would allocate money to the project. In the proposal for funding, we outlined several important items. Most expensive of the proposal was funding for seasonal bug releases, requested by Facilities. The minimum that they could work with was $500 per year, so we requested $1500, either as a budget for a $500 release per year for three years or $1500 for one, however Lance Roberson and Facilities see fit. A portion of the budget will go to signage, which would cost $150 for ten temporary signs and $150 for one permanent sign. Seeds, starter plants, and soil for the campus Community Garden

and the courtyard inside the library, with approval from Amy Anderson, came to around $350. We seek to spread seeds, plant starter plants, and install signage on campus in the spring semester. The complete cost of our proposal was $2,150, which was approved for the full amount on November 22nd, 2019 (V. Johnson, personal communication, November 25, 2019). The Sustainability Coordinator, Veronica Johnson, has agreed to take on the annual renewal fee of $100 as part of her budget. Use of this money will help SU exceed in expanding biodiversity on campus and allow it to be a more outstanding bee campus by dedicating the school to greater efforts of protecting pollinator populations.

On December 3, 2019, SU was officially certified as a Bee Campus USA affiliate, the first among our peer institutions. While certainly an accomplishment our group is proud of, many of the capstone group's plans are to expand on what SU already does so that the university has a greater level of commitment than simply what is required by Bee Campus USA. Including the pollinator habitat, greater native species within the library courtyard, and planting native species in the campus garden are not required for certification, but reflect SU's desire and dedication to going beyond in sustainability, and support from Facilities, staff, faculty, and students mirrors this fundamental belief on SU's campus.

5. Conclusion

This paper has discussed the vitality of biodiversity and pollinator protection, and the ways in which universities can and should take part in the global fight against climate change and widespread habitat and species loss. While humanity has the capacity to adapt to these changes, the billions of organisms we share this planet with do not. Ecosystem services necessary for life on this planet rely heavily on biodiversity, conservation of which is paramount to the survival of life as we know it. In order to protect biodiversity, it is necessary to protect pollinators, as they make possible the propagation of numerous plant species, including our food crops. There are many avenues for the preservation of biodiversity and pollinators aside from habitat protection and conservation, such as including green, natural spaces in urban areas; this capstone stresses the importance of incorporating biodiversity protection into the core values of universities.

At the forefront of social change, universities encourage interdisciplinary research and discourse and the creation of innovative technologies, shape the minds of youth, possess abundant acreage to practice sustainable land use, and often have a heavy influence over their local communities. Although the general aesthetic of college campuses comprises sweeping lawns for socialization and activities, with manicured and often non-native grasses, shrubs, and trees, numerous colleges nation-wide are beginning to practice biodiversity protection, as our case studies show. Student-led initiatives and community engagement, university-led approaches, and certification programs such as Tree Campus USA and Bee Campus USA are primary avenues for biodiversity and pollinator conservation at college campuses.

Our paper has also reviewed the rich history of sustainability and environmental activism at SU, in an effort to highlight the ways in which Bee Campus USA fits directly into SU's core values. The university's switch to fully renewable electricity, the recent creation of the Sustainability Coordinator position, and certification as a Tree Campus USA institution, as well as many other sustainable endeavors, have paved the way for Bee Campus USA certification. This program is an excellent way for SU to show its continued commitment to sustainable practices, specifically through the protection of pollinators, and thus biodiversity. With certification on December 3rd, 2019, SU has become the seventh Bee Campus USA certified affiliate in the state of Texas, and the first among our peer institutions.

Throughout the course of our capstone project, as described above, we found that SU already meets a majority of the requirements for Bee Campus USA. With the absorption of Bee Campus USA duties into the Sustainability Committee, the installation of signage and planting of seeds and starter plants by our capstone group, and the creation of a Bee Campus USA webpage on the SU website, the requirements of certification will be met, and certification will be renewed annually by the Sustainability Committee. However, our group seeks to look beyond these baseline requirements, such as through our work to establish a Protected Native Habitat on campus property, east of the sports fields.

We also suggest further recommendations for actions on campus to support biodiversity protection and Bee Campus USA. One would be the establishment of Charlie's Grove, a largely unused space just east of Joe S. Mundy Hall, which houses Facilities Management, as a pollinator garden. With its pre-existing beds for plants and a cobblestone walkway, as well as its location near the Fountainwood Observatory and a parking lot, this area has excellent ecological,

engagement, and marketing potential. Similarly, the newly established Protected Native Habitat is a prime location for pollinator protection; the area has not been mowed or irrigated in decades, resulting in native, dense vegetation. While this can make plantings difficult, with a large volunteer effort, such as the Big Event, projects there would be feasible. We also suggest the installation of homes for solitary bees; while beehives already exist on our campus, providing habitat for solitary bees would greatly benefit local populations of bees as well as plants on SU's campus. Additionally, the inclusion of a permanent fund for seasonal bug releases into the budget for Facilities would be ideal; these releases would increase pollinator populations on campus, reduce the need for pesticide use, and could even engage the community by making them into Awareness Events as per Bee Campus USA requirements. In sum, this project not only seeks to highlight Southwestern University's ongoing commitment to sustainability, but also offers further opportunities to engage the campus community in initiatives to preserve our local biodiversity.

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