ABSTRACT

Title of Thesis: TRANSFORMING ECOLOGICALLY DEFICIENT ROADSIDE GREENSPACE INTO QUALITY POLLINATOR HABITAT

Joshua W. Franklin, Master of Landscape Architecture, 2018

Thesis directed by: Professor Byoung-Suk Kweon
Department of Landscape Architecture

This paper discusses preeminent ecological issues attributable to human development which negatively affect pollinator population sizes and diversity, and suggests design solutions to mitigate them. Under particular scrutiny is the perpetuation of monoculture landscapes. The problems with this ubiquitous practice include increased pesticide and herbicide use, lack of habitat and forage for pollinators, and reduced soil quality. In an effort to attenuate these threats, this thesis proposes two redesigns of University of Maryland campus lawn spaces into designed native plant communities. In these designs, native plants have been arranged in ways that reduce maintenance and provide ecological benefits by considering the unique roles each of them fill in their natural environment. Other strategies, such as defining borders around the habitat and placing smaller plants near the edges, were also implemented in order to positively influence the public’s view of these more naturalized designed systems and encourage adoption.

TRANSFORMING ECOLOGICALLY DEFICIENT ROADSIDE GREENSPACE INTO QUALITY POLLINATOR HABITAT

by

Joshua W. Franklin

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Advisory Committee:

Professor Byoung-Suk Kweon, Chair
Professor David Myers
Professor Dennis vanEngelsdorp

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1.1 INTRODUCTION

Pollinators play a vital role in ecosystems all over the world. They have a special bond with flowering plants which feed them – and they, in return, enable these plant's reproduction. Today the importance of green spaces is well documented (Akpinar, Barbosa-Leiker, & Brooks, 2016; Ekkel & Vries, 2017; van den Berg, Maas, Verheij, & Groenewegen, 2010), and people all over benefit at the sight, or even the thought of, green landscapes. Different varieties of plants are placed around homes, and in parks. Their fruit is sold in grocery stores, and consumed for their varying tastes, juices, and health benefits. But the love of plants is indeed fostered, in very many cases, by the small animals who make their pollination and, thus, propagation possible in the first place. Any love of flowering plants must be accompanied by a love of (or at the very least, a profound appreciation for) the pollinators we share our planet with who make their continued existence possible.

Appreciation often begins with learning; to fully appreciate something, one must understand it. Universities are responsible, in large part, for instilling knowledge into soon-to-be professionals who will shape the world. Pollinators form such a critical ecological niche that on such campuses of higher learning, especially those such as the University of Maryland, which aim to be an example of sustainable achievement (University of Maryland, Office of Sustainability, n.d.), it is increasingly important that strategies be implemented to end the continuation of common facility practices which discourage pollinator success in urban spaces.

As a student in such an educational facility with a particular interest in this cause, I have focused my design thesis to suggest methods of creating pollinator friendly habitats alongside campus roads. Thinking of roadside space in terms of potential habitat encourages the creation of *connecting* networks of urban greenspace (as roads themselves are always connected). The benefits of implementing such a strategy could serve to better educate students and visitors about the importance of these creatures, help provide a greater area of forage and nesting, and stand at the forefront of ecologically guided design, letting go of long-held practices with little natural value in favor of ones which instead help to mitigate the loss of ecological diversity in the world which we live.

1.2 WHAT ARE POLLINATORS?

The term pollinator describes any organism which aids in the sexual reproduction of plants by conveying pollen from one specimen's flower to another flower of the same specimen. This interaction typically occurs through a symbiotic (mutually beneficial) interplay fostered over millions of years of evolution. The flower of a plant attracts organisms through smell, food, and/or coloration, encouraging them to come into contact with its pollen (the male gametes of the plant world). As the organism moves from flower to flower, accumulated pollen is haphazardly transferred to pistils (female parts of the flower). When pollen meets the pistil of a plant within the same species, the plant is able to reproduce using its genetic information. In this way, both the pollinating organism as well as the plant itself benefit. The organism typically receives food, and the plant, a chance at successful sexual reproduction.

Over time (millions of years), plants and their pollinators co-evolved to become more competitive and specialized at this process, leading to a plethora of adaptations. Many unique relationships exist today between specific plants and specific pollinators who are locked in reliance upon each other for existence.

1.3 ECONOMIC VALUE OF POLLINATORS

In 2014, The White House under former President Barack Obama issued a memorandum calling for a federal strategy to promote the health of the nation's pollinators. (The White House, 2014) Released at the same time, alongside the memorandum, was a fact sheet describing the roll of pollinator populations in the national and global economy (The White House, 2014). According to this document, honey bees enable the production of at least 90 commercially grown crops in North America, and of the leading 115 global food crops, 87 of them – 35% of global food production - are dependent on animal pollination. It should also be noted that crop yields are enhanced up to 75% through insect pollination, and in the last 50 years, agriculture reliant on insect pollinators has risen by 300% globally (Chadwick, Alton, Tennant, Fitzmaurice, & Earl, 2016).

Today, pollinators contribute more than 24 billion dollars to the United States Economy – 15 billion of that attributed to honey bees, and the other 9 billion to wild native pollinators (The White House, 2014).

1.4 COMMON INSECT POLLINATORS

Bees

Bees are perhaps one of the most publicly well-known pollinators in the animal kingdom. This is understandable as they are by far the dominant pollinator of crops, and, at least in temperate areas of the world, generally agreed to be the most important pollinator for plants of all kinds (Black, Borders, Fallon, Lee-Mäder, & Shepherd, 2016). While *Apis meliferra* (figure 4), the European Honey Bee, is the most widely known and cultivated species in the bee kingdom, over twenty thousand species of bees have been identified currently, with new ones being discovered every year (Black, Borders, Fallon, Lee-Mäder, & Shepherd, 2016). In the United States and Canada alone, more than four thousand species have been identified (Wilson & Carril, 2016). And while bees are often thought of as fuzzy dull-yellow and black striped insects of a certain size, bees actually come in a great range of colors and sizes. These differences help different bee species exist in varying types of environmental conditions, from deserts to tundra and almost everything in between. Here are some other bees compared to *Apis mellifera* (figure 4):

Figure 1. Bombus affinis queen, USGS BIML

Figure 2. Andrena weilesleyana, USGS BIML

Figure 3. Triepeolus distinctus, USGS BIML

Figure 4. Apis mellifera, Maciej A. Czyzewski, Wikimedia Commons (CC)

Bees are insects identifiable by their hairy bodies, two pairs of wings, a proboscis for extracting nectar, a stinger (sometimes), and in some cases a "pollen basket" on their hind legs which can hold onto pollen for easy transportation (Chadwick, Alton, Tennant, Fitzmaurice, & Earl, 2016). Other features that bees share with many other insects include six legs, two compound eyes, and three simple eyes (used to detect changes in light intensity) (Wilson & Carril, 2016).

Within these parameters, great diversity can be found between bees. They can be as small as *Perdita minima* at 1/16th of an inch, or as large as *Bombus dahlbombii* at 1 ½ inches (Chadwick, Alton, Tennant, Fitzmaurice, & Earl, 2016). And, as mentioned earlier, they even come in different colors. (Chadwick, Alton, Tennant, Fitzmaurice, & Earl, 2016)

Figure 5. The colorful *Augochloropsis anonyma, USGS BIML*

Though many people are familiar with the idea of the bee hive, over 90% of bee species are actually solitary, meaning that the female bee builds her own nest, and gathers food for only herself and her offspring (Chadwick, Alton, Tennant, Fitzmaurice, & Earl, 2016). How much interaction they have with other bees within their species varies, with some solitary bees living completely alone, some in aggregations near each other, and some even sharing a nest entrance but living in individual chambers – not unlike people in an apartment building (Wilson & Carril, 2016). Eusocial (or truly social) bees, like the ever familiar European Honey Bee (that's *Apis mellifera* again), share a nest, split up duties such as nest maintenance and reproductive responsibilities, and are comprised of a mother and all her daughters (Wilson & Carril, 2016). This is a rare distinction, relatively speaking, and only honey bees, bumble bees, and some kinds of sweat bees exhibit this behavior within the United States and Canada (with honey bees portraying the highest level of sociality). (Wilson & Carril, 2016)

Where bees live, and how they nest, depends on the species. Seventy percent of bees actually live in holes in the ground dug by a single female bee

(Wilson & Carril, 2016). Other bees find and use whatever pre-existing holes they can find, such as hollowed out twigs, holes in rocks, crevices, and even empty snail shells (Wilson & Carril, 2016). Some bees create their own nests on the surface of structures using small rocks and mud (Wilson & Carril, 2016).

The nutritional needs of bees are almost entirely met by flowers (the basis on the special relationship between bees and many flowering plants). Both pollen and nectar provide sustenance for them and their offspring. If there are no flowers, then there are no bees. Some bees are specialized to only feed from certain flowers and thus rely on them to exist. Over 400 species of bees have been documented in Maryland (Maryland Department of Natural Resources). Some of these include the following:

Figure 6. Leaf cutting bees, Megachile spp., USGS BIML

Figure 7. Bumble bees, Bombus spp., Kent McFarland, Flickr (CC)

Figure 8. Mining bees, Andrena spp., USGS BIML

Figure 9. Sweat bees, Halictidae spp., USGS BIML

Figure 10. Mason bees, Osmia spp., USGS BIML

Bees are so extremely diverse that there's no sound way to describe what kinds of plants attract bees. Some bees have long tongues, some have short tongues, some eat pollen, some don't, and some are specialists and only prefer certain flowers. The best way to feed a multitude of bees with a limited selection of plants is by choosing plants with different shapes and sizes (Wilson & Carril, 2016).

Butterflies

Colorful fairies of the meadow, butterflies hold a special place in the hearts of those who enjoy a spring promenade through the garden. They have long filled people with intrigue, appearing on Egyptian hieroglyphics as early as 1,500BC (Nazari & Evans, 2015). Today their likeness is featured widely in logos, art, jewelry, in frames and bottles, and on clothing and furnishings. Though not nearly as adept as their fellow bees, they too hold the beneficial distinction as a provider of natural pollination services. As such, much like the bee, butterflies are reliant upon sufficient flowering landscape for survival, and the flowering landscape, to a limited but existing extent, relies on them.

There are an estimated 20,000 species of butterfly globally, with about 800 of them found in North America (Black, Borders, Fallon, Lee-Mäder, & Shepherd, 2016). They come in a wide variety of shapes and colors, each suited to its own environmental niche. Like most insects, they require warm temperatures in order to fly. Sun-warmed bricks and stones allow them to warm up in the morning, and during the day they flit about in sunlit areas, visiting their favorite flowers (Mader, Shepherd, Vaughan, Black, & LeBuhn, 2011).

As adults, butterflies feed solely on nectar from flowers. The sugary substance gives them the energy they need to fly, find mates, and lay eggs. Flowers that are typically favored by butterflies bloom during the day, and provide nectar at the bottom of a long spur or tube. They have sweet odors, and provide enough room for butterflies to land on. The flower colors also tend to correspond to the butterflies field of vision, displaying red to violet, and often ultraviolet. Some flowers have even developed markings only visible (or relevant) to specific pollinators, guiding them to the nectar.

Unlike bees, butterflies do not create nests for their young – instead, they lay their eggs on specific groups of plants which will provide their offspring with the nutrition and habitat they will need to thrive (Black, Borders, Fallon, Lee-Mäder, & Shepherd, 2016). This specificity makes many butterfly species highly reliant on those species for their own continued existence.

Upon hatching, the offspring of butterflies begin a wondrous life of changes which many of us are familiar with, called metamorphosis. The newly hatched larvae, called caterpillars, begin feeding almost immediately on the plant on which they were laid, gorging themselves almost constantly, until they have significantly stored up enough energy to pupate. At this time, they select a location from which they attach themselves and restructure their own bodies into a hard casing known as a chrysalis. Inside this casing, their body is transformed into their final and adult stage – the butterfly. (Black, Borders, Fallon, Lee-Mäder, & Shepherd, 2016) These are just a few of the many species of butterfly which can be found in Maryland:

Figure 11. Viceroy butterfly, Thomas Barnes, USFWS

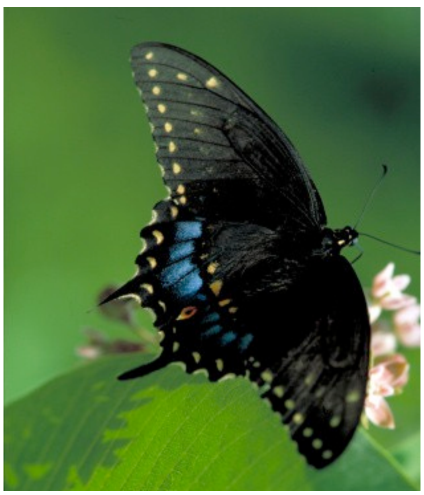


Figure 12. Black Swallowtail, Dr. Thomas Barnes, USFWS

Figure 13. Cabbage White, Dr. Thomas Barnes, USFWS

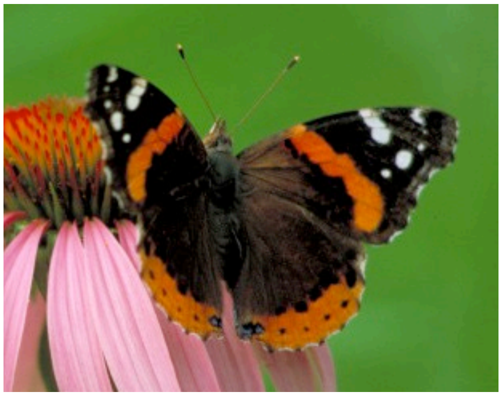


Figure 14. Red Admiral, Dr. Thomas Barnes, USFWS

Figure 15. Male Colias philodice, Megan McCarty, Wikimedia Commons (CC)

Figure 16. Strymon melinus, Anita Gould, Flickr (CC)

The Baltimore Checkerspot Butterfly

The Baltimore Checkerspot, *Euphydryas phaeton* (figure 17), has been Maryland's State Insect since 1973. Though the law which made it so does not give reason for the designation, the Maryland State Archives speculates that it was likely due to both the name and colors. (Maryland State Archives, n.d.)

Figure 17. Ventral View of a Freshly Emerged Female, Annette Allor, 2013

Like many other butterflies, the Baltimore Checkerspot has developed a preference for one specific host plant on which to lay its eggs and feed on during its larval stage. For the Checkerspot, that plant is *Chelone glabra*, the White Turtlehead.

Historically, the Baltimore Checkerspot had a range in Maryland spanning 15 counties, most with multiple breeding colonies. Today though, wild colonies in Maryland are only known to exist in 7 different counties. (Maryland Department of Natural Resources, n.d.) Currently in Maryland, it has a state conservation rank of S2, meaning that it is imperiled in Maryland because it is very rare. This decrease in numbers is likely due to loss and degradation of habitat, deer browse of its preferred host plant, and wetland succession.

Today, there are ongoing efforts being made to stabilize and reestablish the Checkerspot through restoring and protecting quality habitat, and capturing, breeding and rereleasing healthy specimens.

Wasps

While wasps are typically thought of as aggressive, the majority of them are gentle and rarely sting people (yellowjackets are one of the exceptions). Their larval stages are often carnivorous, feeding on protein-rich insect prey to funnel their growth, then switching to carbohydrate based diets when reaching adulthood (Mader, Shepherd, Vaughan, Black, & LeBuhn, 2011). The carnivorous larvae behavior can be useful in preventing an overabundance of plant-eating insects.

As adults, nectar feeding wasps rely on flowers whose nectar stores are shallower as their tongues are quite short in comparison to bees and butterflies. Many adult wasps will also feed on honeydew (aphid excrement) and/or rotting fruit. While not as effective as bees at pollination (their bodies are much smoother), their common interaction with plants still allow it to occur incidentally. (Mader, Shepherd, Vaughan, Black, & LeBuhn, 2011).

Flies

While this may come as a surprise to some, there are many species of flies which feed on flower nectar – sometimes crucial for specific plants, and occasionally for human food crops as well. Though flies don’t have stingers, many mimic the coloration of other insects like bees and wasps which do in order to deter predators. This often leads people to mistake certain flies for bees.

Adult flies do not nest. Instead they lay their eggs in places where the larvae will have food to eat upon hatching. Where that may be varies widely depending on the species. Because they do not expend time and energy on nesting, they can survive and reproduce using less energy than bees and wasps. This allows them to have much greater success in colder regions like tundra and alpine where they are more common pollinators than bees (Mader, Shepherd, Vaughan, Black, & LeBuhn, 2011).

Moths

There are more than 10,000 moth species in North America. Many of these species are specialist pollinators, and/or food for other wildlife like songbirds. Their lifecycle closely resembles that of butterflies, many requiring a specific host plant to reproduce successfully. Though many moth species lack mouth parts or digestive systems (carrying over energy from their larval forms), those that do have mouth parts often resemble those of butterflies, with long tongues that are capable of pollinating long tubular flowers.

One defining feature of moths is that many species are active at night. As most bees, wasps, flies, and butterflies remain inactive during these hours, moths become the most important pollinators for night-blooming plants. These will typically be white or light colored as to stand out to moths in the evening. This is not to say, however, that moths can’t be found pollinating during the day. Those which are active during the day typically prefer many of the same flowers that attract butterflies and other pollinators (Mader, Shepherd, Vaughan, Black, & LeBuhn, 2011).

Beetles

Like flies, beetles aren’t typically thought of as pollinating insects. What interesting though is that fossil records suggest that beetles and flies were actually the first insect pollinators of prehistoric flowering plants whose shapes were more bowl-like with many stamens and pistils. However, as many flowers evolved different shapes and characteristics over time, beetles seem to have guarded the same traits that attracted them to the prehistoric flowering plants in the first place. Thus, plants which continue to display these features (like Magnolias and Water Lilies) remain favorites for foraging beetles.

Like flies, beetles tend to lay their eggs in places near food sources for their offspring, in or on dead or dying tree bark. Upon hatching, many of the larvae tunnel into the bark or wood. Interestingly, many mason bees and leafcutter bees rely on abandoned beetle larvae tunnels to create their nests. (Mader, Shepherd, Vaughan, Black, & LeBuhn, 2011).

1.5 POLLINATOR THREATS

Across the globe, many pollinators are in decline. This places a stress on both the plants that rely on them to reproduce, and the animals that in turn rely on those plants for food. This includes humans. Over the last 10 years, the United States has lost 30-40% of its honey bee colonies, and in Europe that amount is up to 53%. Considering that 80% of insect crop pollination is carried out by honey bees, this is reason for great concern (Chadwick, Alton, Tennant, Fitzmaurice, & Earl, 2016). But honey bees aren't the only ones having trouble. In the US alone, at least five butterfly species have gone extinct since 1950, and an additional twenty-five species are listed as endangered nationwide. (Black, Borders, Fallon, Lee-Mäder, & Shepherd, 2016) Even species that are widespread have seen their numbers declining.

Animal endangerment is most often caused by loss or degradation of habitat, displacement of invasive species, and pollution. Today, the great majority of threats to pollinators originate from human activity (Mader, Shepherd, Vaughan, Black, & LeBuhn, 2011).

Habitat Destruction (biodiversity limitations & segmentation)

Like people, each pollinating insect has specific needs in order to thrive. These needs are typically met by the ecosystems in which the organism has evolved in and around. One of the major threats to the success of pollinators today is the loss or degradation of their habitats. Making room for agriculture alone has altered 36% of the earths land surface, turning forests and meadows into largely monoculture food crops (often coated in pesticides). The little habitat left, including field margins, hedgerows, roadside banks, and creeks with their limited plant diversity and proximity to pesticide drift become the only valuable habitat left in these areas.

Urban development is another significant cause of habitat loss for pollinators. Plots of land containing wild flora and fauna are often rapidly decimated and transformed into human structures and roads, with little resemblance to their predevelopment states. Envied waterfront property on coastlines, estuaries, and around lakes and rivers have etched away rare landscapes that specialized species rely on for habitat (Mader, Shepherd, Vaughan, Black, & LeBuhn, 2011). Even when small areas of habitat are left for wildlife, the fragmentation can result in minimized diversity and biological richness as the spread of certain plant genes stays relegated to a small area.

The human impact on organism transport has also had a profound effect on native habitats. Species that evolved far from each other, once limited by oceans, mountains, deserts, or other natural limiting factors are now being exposed to each other through human intervention. When exotic species are brought into native ecosystems, they can outcompete and crowd out native pollinators' preferred food and habitat sources. Bacteria and fungi from different areas of the world are sometimes transported (often accidentally) with detrimental effects upon native species (Mader, Shepherd, Vaughan, Black, & LeBuhn, 2011).

Pesticides

Pesticides pose one of the greatest risks to pollinators globally. These chemicals are often intended to discourage pest populations that negatively impact the quality and quantity of cultivated plants, often - but not limited to – food crops. Unfortunately, many other unintended organisms get caught in the crossfires of this chemical warfare – pollinators included.

Pesticides can make it to pollinators through ground-nest infiltration, poisoned nesting material like mud and leaves, and through contact with pollen and nectar from protected plants.

In urban areas where pesticides are applied, they are often applied at a much greater amount per acre than on agricultural lands where it is applied by licensed applicators. Altogether, millions of pounds of pesticides are applied in a variety of conditions every year, and for pollinators roaming around seeking food sources and habitat, the effects have been detrimental. After a significant kill – any great incidental contact with harmful pesticides – beekeepers may find thousands of dead honey bees in and around each hive. This doesn’t even account for wild native pollinators who are often effected equally (or more) by the same events, but who die out of sight away from cultivation, and undocumented (Mader, Shepherd, Vaughan, Black, & LeBuhn, 2011).

1.6 POLICY

International Policy Initiatives

In 2016 The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) released a press release delivering some interesting global statistics, concerns, and suggestions.

The report noted that while global insights on insect pollinator populations were not yet able to assemble an accurate percent of organisms at risk, many regional and national assessments painted a concerning picture for pollinators, particularly butterflies and bees, with often more than 40 percent if invertebrate species threatened locally. Pesticides were acknowledged as a definite threat to these species worldwide, along with changes in land use, intensive agricultural practices, alien invasive species, diseases, and climate change.

Several suggestions were given, encouraging behavior that might help turn the tide on our pollinators' troubling fate – the suggestions were as follows:

- Maintaining or creating greater diversity of pollinator habitats in agricultural and urban landscapes;
- Supporting traditional practices that manage habitat patchiness, crop rotation, and coproduction between science and indigenous local knowledge;
- Education and exchange of knowledge among farmers, scientists, industry, communities, and the general public;
- Decreasing exposure of pollinators to pesticides by reducing their usage, seeking alternative forms of pest control, and adopting a range of specific application practices, including technologies to reduce pesticide drift;
- Improving managed bee husbandry for pathogen control, coupled with better regulation of trade and use of commercial pollinators.

Lastly, the report noted that pollination stability and crop yields increased with a high diversity of wild pollinators, regardless of the presence or quantity of managed bees – again reminding us that native pollinators (not just managed honey bees) play a significant role in global agricultural production (IPBES, 2016).

While not a committed plan of action, international research initiatives such as this one are important because they bring valuable information to the table of policymakers worldwide – enabling them to make informed decisions based on collaborative scientific input.

National Policy Initiatives

In 2014, as mentioned in section 1.1.5, then President Barack Obama issued a presidential Memorandum calling for the creation of a federal strategy to promote the health of honey bees and other pollinators. This created an executive taskforce co-led by the Secretary of Agriculture, and the administrator of the Environmental Protection Agency with other members from many government agencies such as the Department of State, Defense, and Energy, among others. Together, this task force created The National Strategy to Promote the Health of Honey Bees and other Pollinators (The White House, 2015). The strategy places a heavy emphasis on public-private partnerships and addresses key stressors which impact pollinator health, including:

- Nutrition, with a focus on providing adequate forage resources for pollinators
- Land-use policies and practices to increase forage and nesting resources for a variety of pollinators
- Management of arthropod pests and disease pathogens
- Pesticides

- Rearing issues, including bee biology, genetics, and breeding

There are four components to the strategy under implementation which include the Pollinator Research Action Plan (PRAP), plans for expanding education and outreach, opportunities for public – private partnerships, and improving pollinator habitat. In order to provide the resources for government agencies to act, additional funding from the President's Budget was allocated for 2016 (an extra $34 million above the previous year).

"The overarching goals are to reduce overwintering honey bee colony mortality by 50% within ten years, increase the Eastern wintering population of the monarch butterfly to 225 million butterflies in five years, and restore/enhance 7 million acres of land for pollinators over the next 5 years through Federal actions and public/private partnerships" (The White House, 2015).

The 2014 memorandum fostered a lot of discourse, research, and public awareness. It is an excellent example of the effects of combining science and policy to stimulate action. Unfortunately, after 2016, federal initiatives regarding Pollinator protection seem to have slowed, with little to no sources on executive actions taken regarding the issue. This stresses the importance of activity on local levels that can persist despite changes in the federal government.

Maryland Initiatives

After the 2014 presidential memorandum by President Barack Obama, many states were encouraged by the EPA to develop their own plans to protect pollinators within their borders. Maryland followed suit and after much collaboration between state agencies, and local beekeepers, organizations, and scientists, a Maryland Pollinator Protection Plan was released in June 2016.

The plan is a voluntary outline of best management practices (BMPs) publicly accessible to all Marylanders with the intent of improving statewide pollinator health and mitigating the risks of pesticides (Maryland Department of Agriculture, 2016).

Maryland is also the first state in the United States to ban consumer use of a type of pesticide called neonicotinoids. These chemicals have been shown in research to decrease the chances of a honey bee colony's survival rate over winter (Lu, Warchol, & Callahan, 2014). After being passed, the bill went into effect January 2017 (State of Maryland, 2016).

1.7 REPURPOSING LAWN AS A DESIGN SOLUTION

<u>The Idea</u>

As mentioned in section 1.2.2, the clearing of land for agricultural or urban development is one of the leading causes of decline for pollinator species. One way to help native pollinators then, would be to provide them appropriate forage and habitat.

The University of Maryland Campus is itself designated as an arboretum & botanical garden, and for nine years has held the title of a Tree Campus USA by the National Arbor Day Foundation (UMD Right Now, 2017). The UMD Arboretum's mission states:

“Through exemplary practices of environmental stewardship, horticulture and urban forestry, the Arboretum and Botanical Garden will enhance the campus’ aesthetic and promote awareness of conservation and preservation of our natural environment for the enrichment of the university community, the citizens of Maryland and our visitors” (UMD Arboretum & Botanical Garden, n.d.).

As a part of this goal, the campus should consider implementing a plan to use the arboretum and botanical gardens as a means to provide forage and habitat for native pollinator species and honey bees. There is no doubt that the existing plantings already serve to benefit pollinators, however, the scale of this practice could be expanded to include underused areas of earth, particularly in an effort to diversify habitat and forage for these populations, and provide connections between the many gardens on campus.

Pollinators in Urban Spaces

While urban spaces are often considered to be wildlife “deserts,” this doesn’t necessarily need to be the case. Urban areas with adequate green space are capable of supporting native pollinator species. Their success can mean more productive urban ecosystems (as a food source for birds and other small animals), community and school gardens, and even urban agriculture centers. Because many densely urban areas contain less agricultural-scale pesticide use, these areas can actually act as a sort of haven for pollinators (Hall, 2017).

Aesthetics

Roadsides help to shape pedestrians' experience as they move through the outdoor urban environment. They provide an opportunity for shade and a distinct border separating them from the road. Because sidewalks (beside which they exist) serve as vital connections for pedestrians moving from place to place, few visitors will make it on and off of an institution without moving past one. This ubiquity makes them excellent areas for demonstrating ideas, showcasing pride, and exemplifying sustainable practices.

While a well curated and designed roadside has the ability to influence perceptions, so equally does a poorly designed one. Roadsides with struggling lawn or dying trees can paint a negative impression of an area. The lack of one entirely, directly exposing the pedestrian physically and psychologically to the adjacent street, lacks both excitement and inspiration – and can compromise feelings of safety.

Climate sustainability & Ecological Potential

Roadside verges are all over. In urban areas they compose a larger network of connected green spaces, but are often lawn (Ignatieva & Stewart, 2009). Lawn, being typically monoculture based and constantly mowed, does not fill much of an ecological role, specifically when compared to systems based on the success of a group of plant life allowed to bloom (Smith & Fellowes, 2015). By transforming road verges from these limited monoculture systems to thriving ecosystems, habitats are created and organisms can find areas to thrive in urban settings.

CHAPTER 2: ECOLOGICAL DESIGN CONSIDERATIONS

2.1 BIODIVERSITY

Biodiversity refers to the amount of species in an ecosystem. Research has linked higher levels of biodiversity to ecosystem function and stability (Darke & Tallamy, 2014). In 1955, Robert MacArthur predicted that the greater variety of species in a system, the more productive that system would be – productivity, being described at utilizing energy from the sun to generally support greater amounts of life (MacArthur, 1955).

Because many different flowering plants rely on different pollination strategies to successfully reproduce, and in turn many pollinators rely on specific types of flowering plants for food and habitat, these groups are codependent on each other for survival. One's biodiversity is linked to fate of the other's biodiversity; the failure of a specialized pollinator to thrive also affects any plant which relies on that organism to reproduce.

Biodiversity also creates a buffer. In ecosystems with high biodiversity, the negative effects of the failure of one species is more likely to be offset by the existence of other species which fill similar roles or provide similar ecosystem services.

One concern with pollinators is the idea of a “tipping point” once certain species come under enough stress, or once the buffer of biodiversity has been eroded significantly. One study published in 2014 created a theoretical mathematical simulation of stress on pollinator populations and found that while resilient to stressful conditions, an ecological collapse can occur very quickly past a certain limit (Lever, van Nes, Scheffer, & Bascompte, 2014).

Being aware of the already compromised health of pollinator populations worldwide as well as the potential consequences of reaching a tipping point should drive the adoption of initiatives aimed at buffering further population losses through the provision of habitat and food sources capable of safeguarding biodiversity among pollinators.

Monocultures

The term monoculture describes the repetitive use of one singular organism (typically plants), agriculturally or commercially, in a given space. In agriculture, it is common to see fields planted entirely with one genetically similar strain of crop. This makes is easier to care for the field, as all the individual plants’ needs are the same. The same practice is also commonplace in urban street trees, and lawns across the developed world, which favor homogenous displays. Unfortunately, biologically speaking, especially from a pollinator’s standpoint, this practice has its disadvantages.

Every organism fills some sort of ecological niche - often directly useful or useless to other organisms. Monoculture crops invite “pests” which can take advantage of the plant being grown (e.g., as a food source or host) and can increase their rate of reproduction due to the abundant resource (Wetzel, Kharouba, Robinson, Holyoak, & Karban, 2016). This often leads to greater applications of pest control which can unintendedly harm native pollinators.

Because monocultures are genetically similar, there is also a much higher risk that their populations are equally susceptible to any given stressor. This can more easily lead to a quick demise for an entire monoculture population, negatively affecting organisms (such as pollinators) that rely on that plant as a food source which must then leave to compete for habitat elsewhere. As the Harvard School of Public Health states in regards to monoculture susceptibility, "Pathogens spread more readily, and epidemics tend to be more severe…" (Harvard T.H. Chan School of Public Health, n.d.).

Because pollinators rely on flowers as a food source - and flowers are typically short lived, appearing often for just a few weeks of the year - it is important that they have access to a variety of flowering plants which bloom at different times of the year. In monoculture situations, this cannot be the case.

If a system is to be ideal for pollinators then it must contain a variety of plants which bloom at different periods throughout the year. This provides a consistent source of food, as well as extra stability should disease or other pests strike wherein only a few plants are ever effected at a time rather than an entire area.

2.2 PLANTING IN URBAN SPACES

Benefits of Green Space to Urban Society

The hypothesis that green space has a positive impact on humans has been around for a while now. In 1984, Edward Wilson, an American biologist, researcher, theorist, naturalist, and author, published the book Biophilia, which popularized the books title as a hypothesis – the biophilia hypothesis - describing "the urge to affiliate with other forms of life." The idea is that humans are genetically predisposed to preferring things in nature as a result of relying upon it during evolution. This is likened to the genetic disposition of humans to be attracted to baby mammals – willing to go out of their way to protect them, as well as the long standing practice of cultivating plants in and around the home. This interest, this love for life, helping to sustain life itself (Wilson E. O., 1984). It would make sense then, based on this hypothesis, that access to green space should uplift people's sense of wellbeing.

It turns out that further research does support Wilson's hypothesis. Green space in urban areas has been related to higher levels of well-being (Bertram & Rehdanz, 2015). A study published in 2016 found that access to maintained green urban areas, such as gardens and parks, is positively associated with life satisfaction. The opposite was also deduced, associating access to abandoned lots with less life satisfaction (Krekel, Kolbe, & Wustemann, 2016). Another study, published in 2013 in the Journal of Public Health, found that both access to observable green space as well as participation in useable green space within an urban area lowered the likelihood of one seeking treatment for anxiety/ mood disorders (Nutsford, Peason, & S., 2013).

Urban Limiting Factors

Growing plants in an urban environment is not a straightforward endeavor. Urban conditions can be far from ideal for most plants. Runoff in urban systems can be more concentrated, and contain hydrocarbons, plastics, and other chemicals. Past construction and frequent pedestrian traffic often leave urban soils highly compacted, unstructured, and altered by added waste materials over time. Buildings too pose a problem, often obscuring sunlight to plants, and their walls as well as the pavement around them absorb heat, creating warmer conditions than outside the city (Windhager, Simmons, & Blue, 2012).

At the University of Maryland, street-side conditions can include pedestrian traffic and compacted soils (leading to fewer ground air pockets, and thus less oxygen for plant roots), polluted runoff from buildings, salt runoff from sidewalk treatments, and soil heated year-round by underground pipes. Incredibly, this does not stop all plants from thriving, but plants for an urban area must be chosen carefully. Because there is great variation within these places, microclimate must be taken into account. For example, a brick wall with southern exposure will hold onto heat longer than one with northern exposure. Choosing which plants to place in a given area must be done with great consideration on many factors.

2.3 NATIVE PLANTS

Benefits of Native Planting

Native plants are those which evolved to occur in a place through their own natural (non-human) distribution. These plants are directly suited to those environments through adaptation and ecological connections formed with other organisms present in the same system. Because they are already adapted to native soils and climate, they typically require less added maintenance. This reduces the use of fertilizers and conserves water. In addition, native pollinators are typically better adapted to native plants, and generally prefer them over non-natives (Razanajatovo, Fohr, Fischer, Prati, & Kleunen, 2015).

"Restoring native plant habitat is vital to preserving biodiversity. By creating a native plant garden, each patch of habitat becomes part of a collective effort to nurture and sustain the living landscape for birds and other animals"
- National Audubon Society (National Audubon Society, n.d.).

Considering Non-Native Plants

One interesting viewpoint is that it is difficult to consider urban spaces as a "native habitat." That is – few, if any, species evolved specifically to thrive in urban landscapes. This raises the question then – can native-only plantings succeed and thrive in their native areas even if those native areas no longer resemble what they evolved to adapt to? In practice, the answer is sometimes.

Claudia West, a landscape designer and lecturer, and Thomas Rainer, a registered landscape architect and teacher, advocate the use of plants which fill specific ecological niches – native and non-native, while discouraging the use of non-native plants that may become invasive. The idea is to adopt plant palettes which are naturally adapted to specific sites. That being so, native plants are often the first ones to consider, and the most likely to succeed. Placing plants together which have long coexisted in natural settings means that there's a lower risk of their failure. However, they emphasize designing lasting plant communities based on ecological performance – not necessarily the origins of the plant material (West & Rainer, 2015).

2.4 PATCHES AND CORRIDORS

As humans continue to populate and develop over time, wildlife habitat is cleared to make space for agricultural and urban development – what is left for wildlife is considered a patch. Depending on the side of the patch as well as the distance of one patch from another, species can become trapped inside them, surrounded by inhospitable land. Furthermore, when populations are small and isolated, they become more vulnerable to extinction through a combination of demographic, environmental, and genetic factors (isolated organisms often begin to interbreed, limiting their own genetic diversity) (Gilpin & Soulé, 1986).

One solution to the issue of patch isolation is the creation (or protection of) wildlife corridors. When small populations are connected in some way, interchange of breeding individuals can occur. This can mean the difference between a local species' decline or viability. For this connection to occur however, the corridor must contain quality habitat and food source for the many species involved (DeStefano, 2009).

In the case of pollinators, their movement between patches also allows then to spread plants genetic material (pollen) more widely. A study published in 2017 found that pollen transfer by butterflies, bees, and wasps between patches connected by a corridor was significantly higher than between unconnected patches (Townsend & Levey, 2005).

Roadsides as a Corridor

Roadsides form an extensive network of linear habitat across all types of land, with an estimated 17 million acres of them managed by the US Department of Transportation. This is a lot of land with a lot of conservation potential as these areas often form links between fragmented habitats. The roadsides which benefit pollinators the most are the ones which are mown less frequently, left untreated by herbicides and pesticides, and not planted with introduced grasses (Hopwood, Black, & Fleury, 2015).

Interestingly, a roadside managed to best accommodate biodiversity is capable of supporting entire life cycles of some pollinators – from egg to adult. Their potential includes support for diverse communities including native bees, butterflies, wasps, flies, and other pollinating insects. One concern is that creating valuable pollinator habitat near roads could increase pollinator casualties, but some research has suggested the contrary. Such a European study found that frequency of mowing was linked to the proportion of butterflies killed on roads. Butterflies that had to disperse to find new habitat after roadsides were mowed were placed at a much higher risk of collision with vehicles. High quality roadside habitats instead retained a larger number of pollinators, leading to less casualties.

Figure 18. Plantings of wildflowers along roadside in North Carolina, NCDOT

2.5 CASE STUDY: POLLINATOR PATHWAY IN WASHINGTON STATE

The Pollinator Pathway is a mile-long, 12 foot wide, pollinator-friendly corridor in Washington State which connects the Seattle University Campus with a small area of forest known as Nora's Woods. The project is a collaboration between the designer Sarah Bergmann, and homeowners along the strip who "buy-in" to help fund the project in city owned verges in front of their homes.

There are 20 sites, or connecting gardens, along the corridor. Each one was individually planned and funded, but created in continuity with the larger corridor. Plants chosen were primarily native and researched for pollinator and human appeal, accordance with city requirements, drought tolerance, and ease of maintenance – which homeowners agreed to keep up.

The corridor has served as a living classroom for students of art, systems thinking, and design. It is also monitored in order to collect data about the small organisms visiting patterns (Pollinator Pathway, n.d.).

In 2016 Sarah Bergmann, in an interview with Atlas Obscura, clarified her purpose behind the creation of the project and moving forward. Though seemingly created for pollinators, the idea is actually much bigger. Bergmann, through her design, wishes to stress the importance of a purposeful, well-designed, world in the Anthropocene. While the honey bee, an important agricultural commodity, has received a lot of press attention in light of recent threats, Bergmann stresses that there are many other environmental issues of consequence, and that in order to meet these challenges, communities will need to adopt a design frame of thinking, considering the greater ecological system that we all live in, a global ecological design. The Pollinator Pathway not only provides forage for honeybees, but for a large number of other native pollinators as well who are often not designed for and lose habitat to urban development. The corridor also links two fragmented areas of land and engages the public and local government to work together. It’s the broader system of thinking in this human dominated era that Bergmann wishes to impart (Giaimo, 2016).

2.6 NATURE INSPIRED PLANT DESIGN

In order to create lasting, well-functioning pollinator habitat and forage, plantings must be selected purposefully and arranged with the greatest consideration to the ecological role that each specimen fulfills.

In nature, we see plants which thrive in a variety of conditions. They’re found in the arctic tundra as well all the way to Death Valley. There is often frustration when plants fail to survive in urban settings, and many variables are to blame for this mortality. However, even in the hostile urban environment, plants can be found spontaneously growing in sidewalk cracks and abandoned lots – and with absolutely no maintenance or care whatsoever. The key then is to choose plants which are appropriate for the site in which they are being placed, surrounded by other plants which together may form a successful plant community.

Vertical Plant Layers, Horizontal Distribution, and Maintenance

By understanding different plant communities which best thrive in certain conditions, specific species can be selected which are already adapted to the preexisting conditions of areas to be designed. Plants which thrive in the desert may excel in a sunny, dry urban location. Soggy downhill locations could be planted with wet meadow species. Choosing plants which will succeed in the existing conditions of a site mean that the finished landscape will require less maintenance and the plant will be more likely to survive.

One important concept to consider when planting a community is root and foliage layers, and growth habits. Different plant roots grow at different depths of soil, thus reducing competition for nutrients among the established community. Claudia West and Thomas Rainer describe thinking of plantings vertically in two separate categories – design, and function (West & Rainer, 2015). The design layer describes the tallest most visually dominant species. These are chosen to create an aesthetic for the site. In this layer designers consider color, shape, size, and texture. The other layer to consider is the functional layer, which describes a mix of typically low growing species which hold the ground (preventing erosion and encouraging water infiltration) and fill gaps to prevent weed invasion. Once the idea of function and design have been established, they can be broken further down into more specific layers.

The most visually dominant layer, layer 1, consists of structural and framework plants. These hold year-round form, defining the plantings overall shape and often include trees, shrubs, and/or tall perennials and grasses. It is important that plants in this layer live long and spread slowly (if at all). Because this layer serves as an anchor for the rest of the design and contains the smallest quantity of plants, placement of structural plants is of higher consequence and more exact than the other layers. Some examples include Prunus, Vaccinium, Cercis, Andropogon, and Quercus among many others.

Layer 2 consists of seasonal theme plants which visually dominate the planting for a short time during the year. As the seasons progress and change, so does the seasonal layer. Placement of these plants is best done in “strokes” or collections, dappling these plants across the site to create different visual effects. These plants should be chosen for their texture and color. Some examples include Rudbeckia, Echinacea, Aster, Solidago, and Agastache, among many others.

Layer 3 is the ground-covering layer, the layer made up of the functional plants. These plants may lack striking forms or brilliant colors, but they are plants which bond the community together, and prevent weeds from taking hold. Their roots help to hold soil in place, preventing erosion, and many of them also help to fix nitrogen into the soil. They are also typically the first to flower during the spring and early summer, providing forage for pollinators before the perennials return and shade their leaves. Some examples include species of Trifolium, Viola, Trillium, Carex, and Crocus, among many others.

Layer 4 is something of a “pseudo-layer” as its job is meant to cede space to plants in other layers. It is the filler species. They don’t live long, but they produce large amounts of seeds. They will often be outcompeted by other plants which are intended for the design, but not before they have had a chance to drop their seeds. These seeds act as an “insurance” should any die-off occur in the other layers. Once this occurs, the seeds of filler plants erupt out of the soil and fill the void until plants from other layers can once again outcompete them. Some examples include Erigeron, Lobelia, and Stylophorum, among others.

Designing plantings considering these roles can dramatically reduce maintenance needs by mimicking natural plant communities which already exist naturally without human intervention.

Ecological Design Aesthetics

One of the contemporary issues to ecological design is the more natural aesthetic which it often creates. Separated and defined plantings surrounded by mulch are hardly ecologically beneficial when compared to robust layered plant communities, but the latter is a significant change from the well-manicured and tightly controlled plantings which have come to define proper upkeep and maintenance. In order to successfully adopt more ecologically beneficial and diverse plantings in urban and suburban settings, strategies must be applied which still assure stakeholders that an area is well kept.

To begin, all unwanted species must be thoroughly removed before new plantings are introduced. Without this vital step, any unremoved weedy roots or fast growing seeds left in the soil will compete visually and physiologically with the intended plantings, and controlling a solidly established weed population mingling with the desired plantings is almost unrealistic. To avoid this, the desired site must be cleared completely, using techniques such as smothering, spraying, burning, or physically removing unwanted species – all before planting intended species.

Orderly frames are also important in maintaining legibility. Plantings should have a definite edge. This can be done by placing wider layers of smaller plants around the plant community, or even simply mowing around it. Plantings should never creep onto sidewalks or fall into walking space. By keeping frames familiar and legible, they convey a message of purposeful design rather than coming across as messy or unkept (Nassauer, 1995). In order to maximize the visual dimension, plantings should generally be lower around the outside and very gradually increase in size towards the middle.

Lastly, any species which are lost for any reason must be replaced quickly to prevent erosion, and stop weeds from getting a foothold.

Creating a thriving plant community takes time and planning. It is not as straightforward as selecting and placing attractive plants all in a day’s work. However, done properly, once these communities are established they require less overall maintenance than non-ecologically designed plantings, and support greater biodiversity (West & Rainer, 2015).

2.7 PLACE BASED LEARNING

Learning through Experience and Familiarity

It is one goal of this design project to help shape students to be aware of their surroundings, and of a contemporary and relevant issue of their time. This arguably begins by understanding the immediate surroundings. Experiences shape views and solidify understanding, thus motivating action. Robert Pyle, a writer, teacher and founder of the Xerces Society makes the case that extinction of experience (as he calls it) resulting from loss of local diversity results in a positive feedback loop of alienation, apathy, and inaction (Pyle, 2008).

By plating communities of plants, emphasizing natives, and providing habitat for native pollinators, they become more visible, and people become familiar with them. This familiarity leads to awareness and concern. It is important that as an institution which celebrates and strives for sustainability, the University of Maryland not only provide opportunity for students to learn about abstract concepts, theories, and affairs, but also the importance of protecting and cherishing natural Maryland ecosystems here and now.

CHAPTER 3: DESIGNING ROADSIDE POLLINATOR HABITAT THAT ACCOMMODATES POLLINATORS ON THE UNIVERSITY OF MARYLAND CAMPUS

3.1 PURPOSE

Above, I have made several arguments in favor or encouraging pollinators on the University of Maryland campus. In order to better illustrate my main points, I have redesigned two roadside sites on the university campus which can serve as examples of designed urban pollinator habitat. Both designs display practices encouraged in this thesis, but differ in the level of interactivity with people.

Before designing each site, I analyzed several important factors, which include climate, circulation (pedestrian and vehicular), topography and hydrology, utilities, vegetation, soil, and viewsheds.

3.2 CLIMATE

According to the University of Maryland Department of Atmospheric & Oceanic Science, the climate in College Park, MD is as follows:

"Summers are warm and sometimes humid and the winters are mild. Especially pleasant weather prevails in the spring and autumn. The coldest weather occurs in late January and early February, with an average daily maximum temperature of 7C (45F) and an average daily minimum of -2C (28F). The warmest weather occurs in late July, when daily high temperatures commonly exceed 30C (86F). There are no well-defined wet and dry seasons. Snowfall is not common, and averages only about 43cm (17in) per winter season. During the summer, showers are frequent. Thunderstorms occur on about one of every five days" (Universitiy of Maryland, Department of Atmospheric & Oceanic Science, n.d.).

According to the USDA, the University of Maryland, College Park campus is located in Hardiness zone 7a. This means that extreme winter lows are not expected to reach any lower than 0 to 5 degrees Fahrenheit.

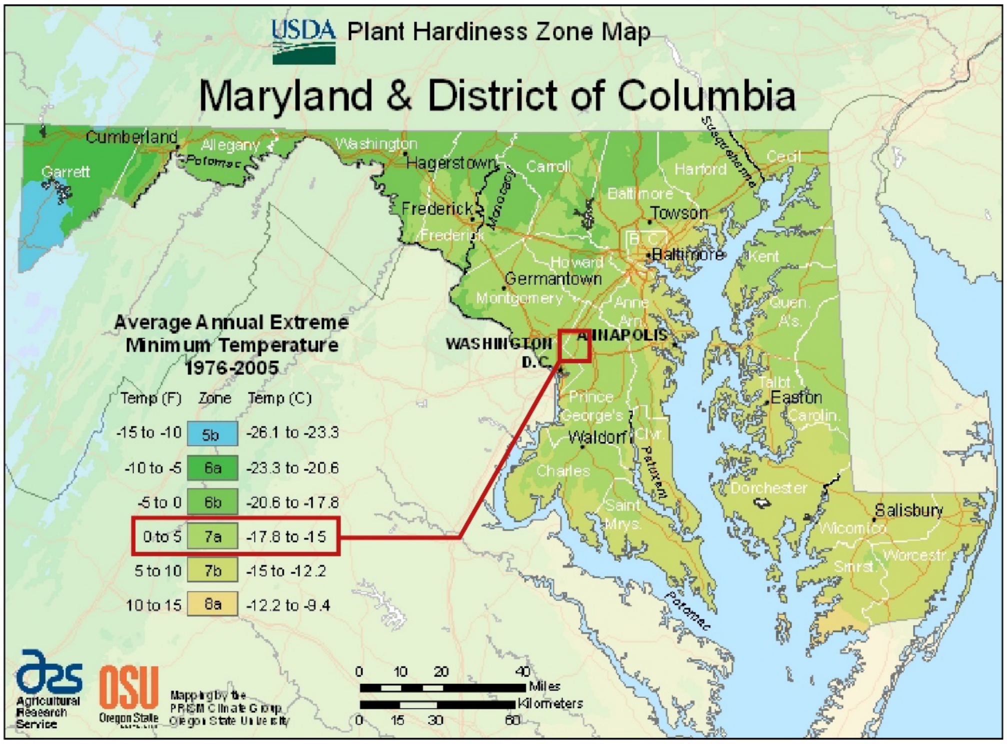


Figure 19. Maryland and District of Columbia Plant Hardiness Zone Map, USDA

3.3 SITE A: STADIUM DRIVE CAMPUS GATE

Reason for Redesign

The road median located at the northwest entrance of campus, in between Stadium Drive, serves as a focal point for visitors to the campus. One of its main features is the small gate house (figure 26 and 27) which can be found at several key campus entry points.

Currently, the area lacks in both ecological and visual diversity, and aside from lawn turf, there is just one tree. This area could benefit both the university, in terms of representation, as well as pollinators who would currently find little benefit in visiting this site. Below are my analyses of the site:

Location

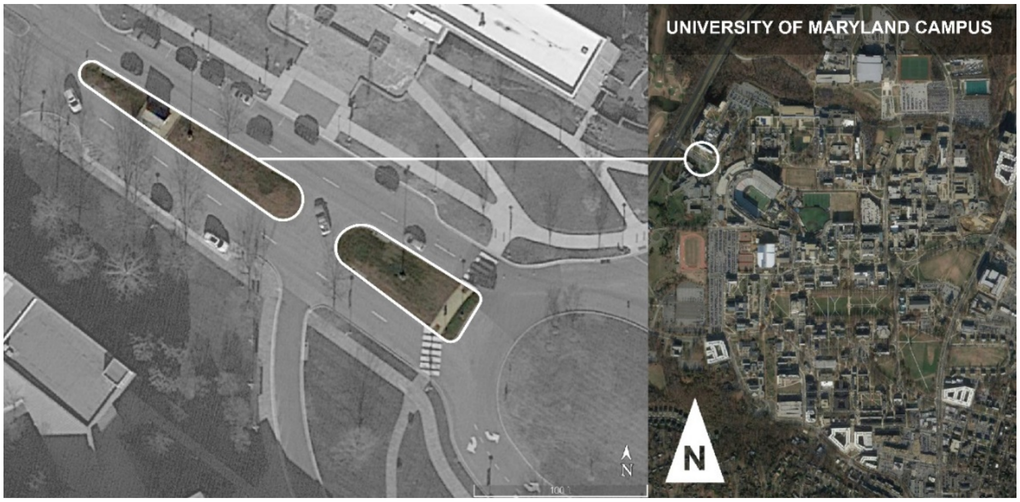


Figure 20. Location of Site A - Northwest Campus, by author

Site Analysis & Observations

Vehicular + Pedestrian Traffic

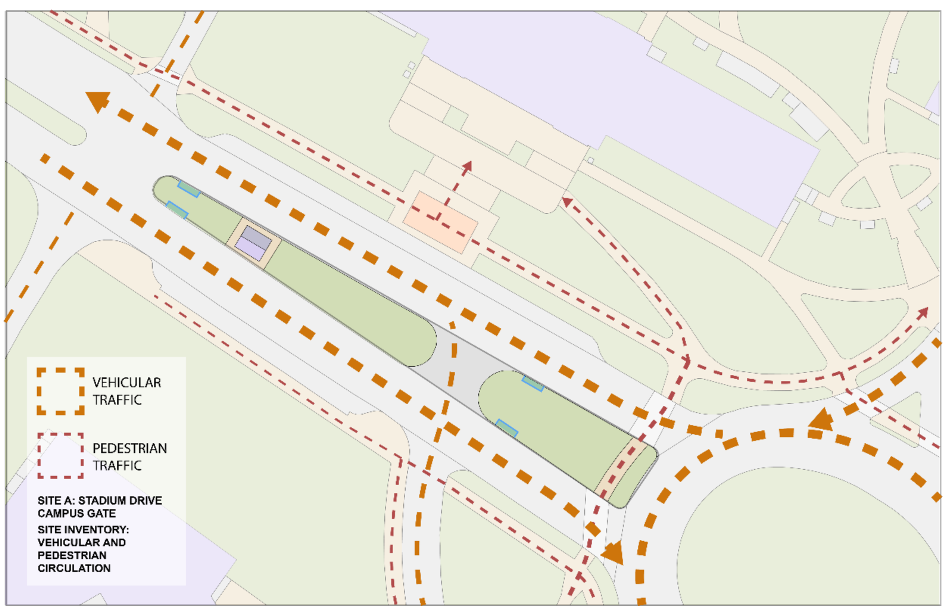


Figure 21. Site A: Vehicular and Pedestrian Traffic, by author

Topography + Water Movement

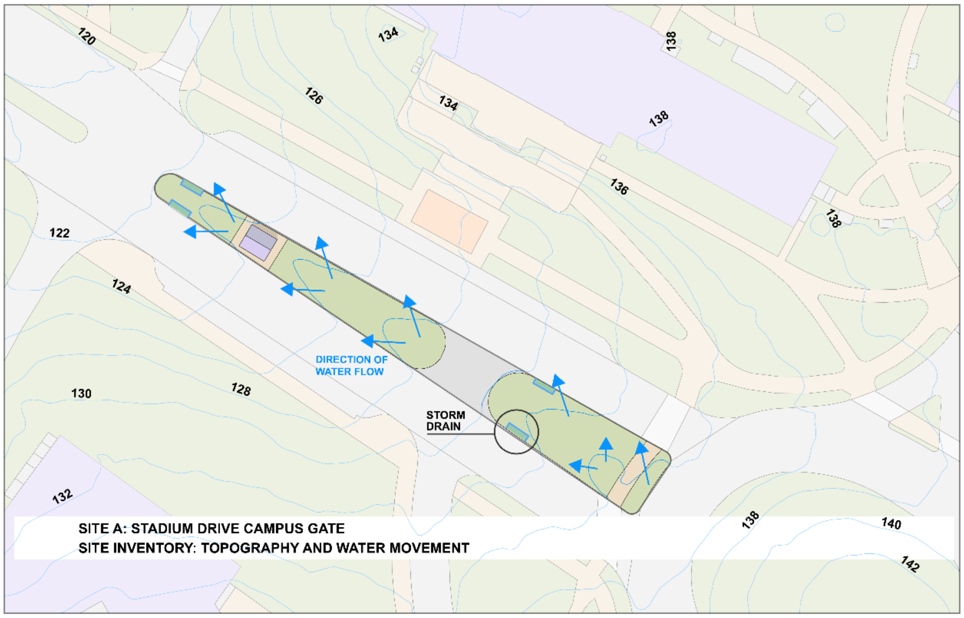


Figure 22. Site A: Topography and Water Movement, by author

Utilities

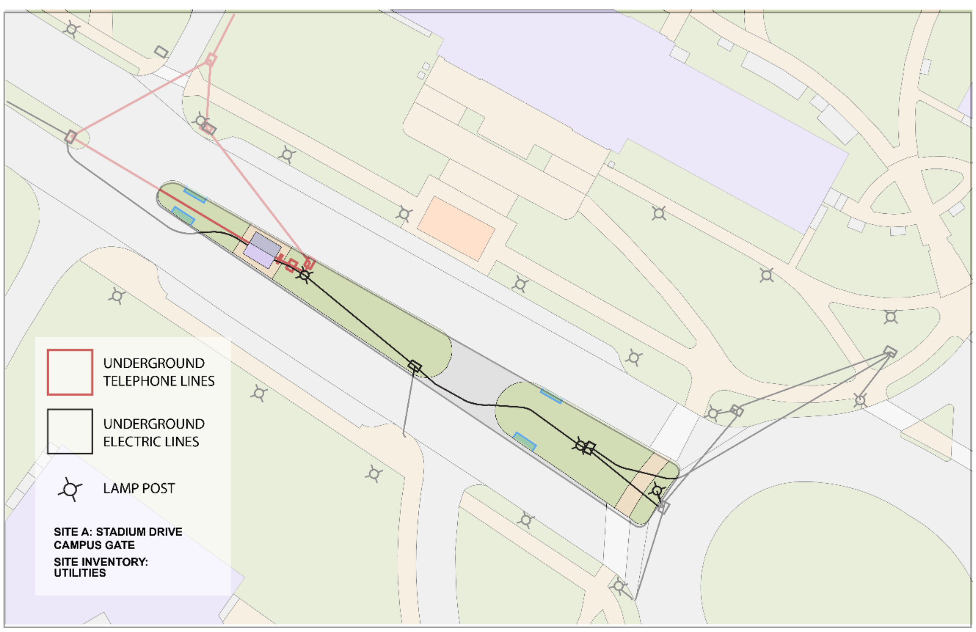
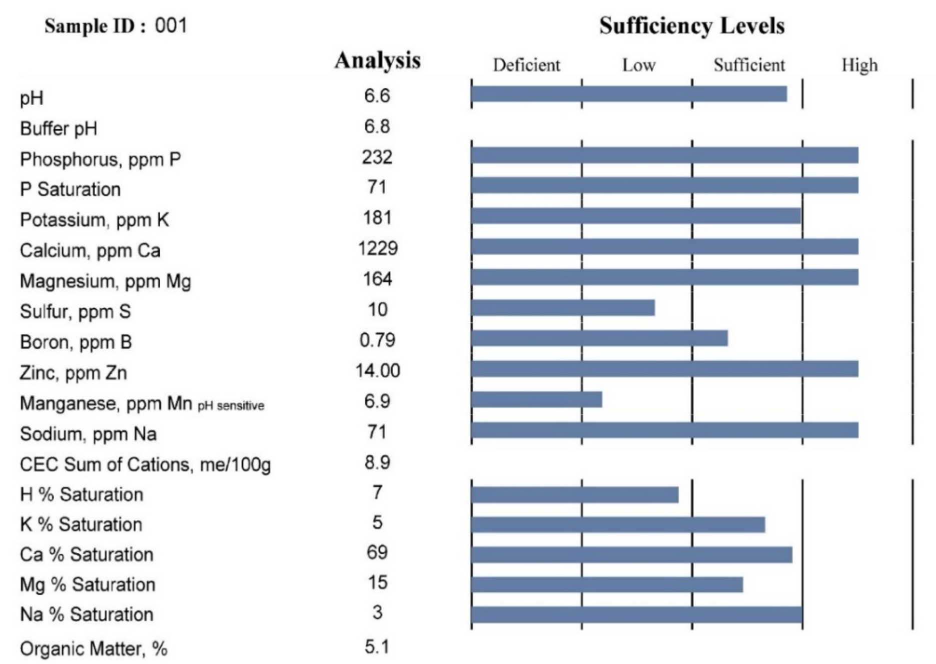


Figure 23. Site A: Utilities, by author

Vegetation

Figure 24. Site A: Vegetation, by author

Soil



Sample ID : 001

	Analysis
pH	6.6
Buffer pH	6.8
Phosphorus, ppm P	232
P Saturation	71
Potassium, ppm K	181
Calcium, ppm Ca	1229
Magnesium, ppm Mg	164
Sulfur, ppm S	10
Boron, ppm B	0.79
Zinc, ppm Zn	14.00
Manganese, ppm Mn pH sensitive	6.9
Sodium, ppm Na	71
CEC Sum of Cations, me/100g	8.9
H % Saturation	7
K % Saturation	5
Ca % Saturation	69
Mg % Saturation	15
Na % Saturation	3
Organic Matter, %	5.1

Figure 25. Site A: Soil Analysis provided by AgroLab, DE

In order to get the most accurate results for my soil composition, I used a cylindrical soil sampler tube to collect 4-6in deep samples at each site. These were taken from five different locations within each perimeter then mixed up and sent to AgroLab, an agricultural laboratory in Delaware, which tested the soil and sent back results specifying levels of various nutrients and minerals. The idea was to test for any outstanding composition which may prevent the success of any chosen plants. The main factor that I took from this soil sample was the generally high levels of minerals, especially sodium, which are very indicative of an urban setting. Based on these results I would need to be sure to avoid plants which were sensitive to high soil mineral content.

Visibility

Figure 26. Site A: View 1, by author

Figure 27. Site A: View 2, by author

Figure 28. Site A: View 3, by author

Figure 29. Site A: View 4, by author

Figure 30. Site A: View 5, by author

Site A Design & Graphics

Design Program

Site A currently lacks in both biodiversity and visual interest. Because it is located at a key entrance to the University of Maryland, it sets the stage for aesthetic expectations on campus. Therefore, I recommend using this area to highlight campus pride. Seasonal colors should represent school spirit and accentuate the importance of the entryway. This would also serve as a demonstration of the potential of designed plant communities to fill even highly visible urban spaces in a way that is attractive to many people.

Plan

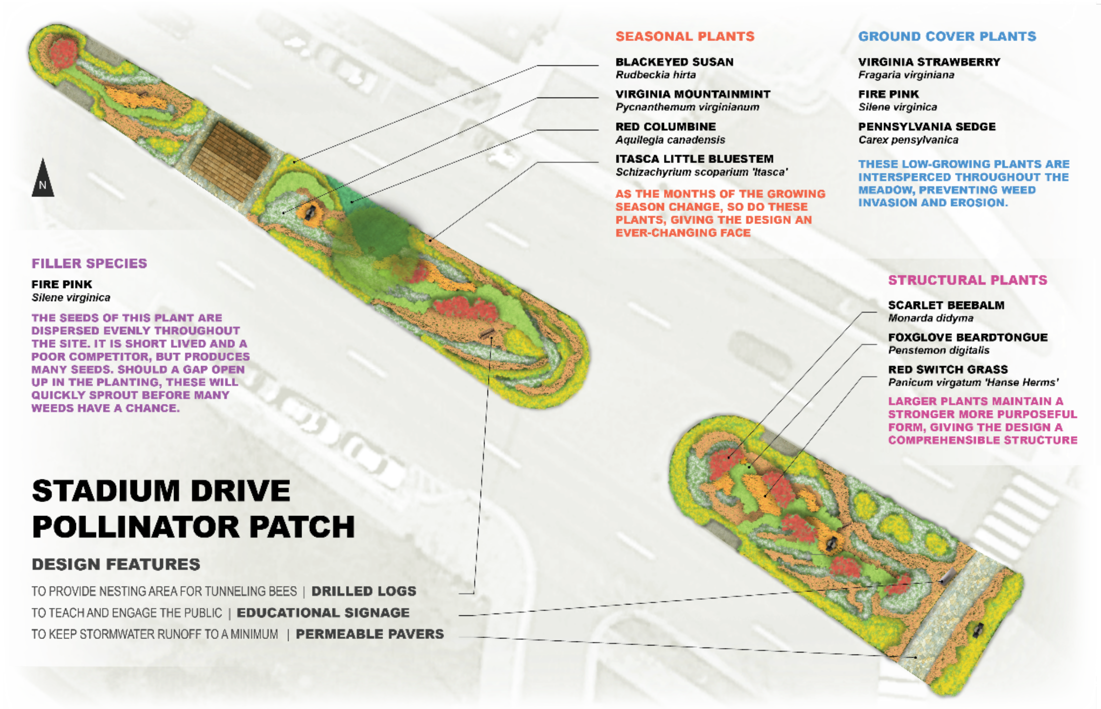


Figure 31. Site A: Plan, by author

Site A: The Stadium Drive Pollinator Patch redesign upgrades both the overall aesthetic of the site, as well as its ability to sustain a population of pollinators. Long, thin stretches of flower clusters are meant to provide the illusion of a non-designed naturalized area, while their clustered placement creates dramatic swaths of changing seasonal color. An educational signage board is placed beside the pedestrian walkway to educate the public about the importance of designed ecologically beneficial areas.

Plant Palette

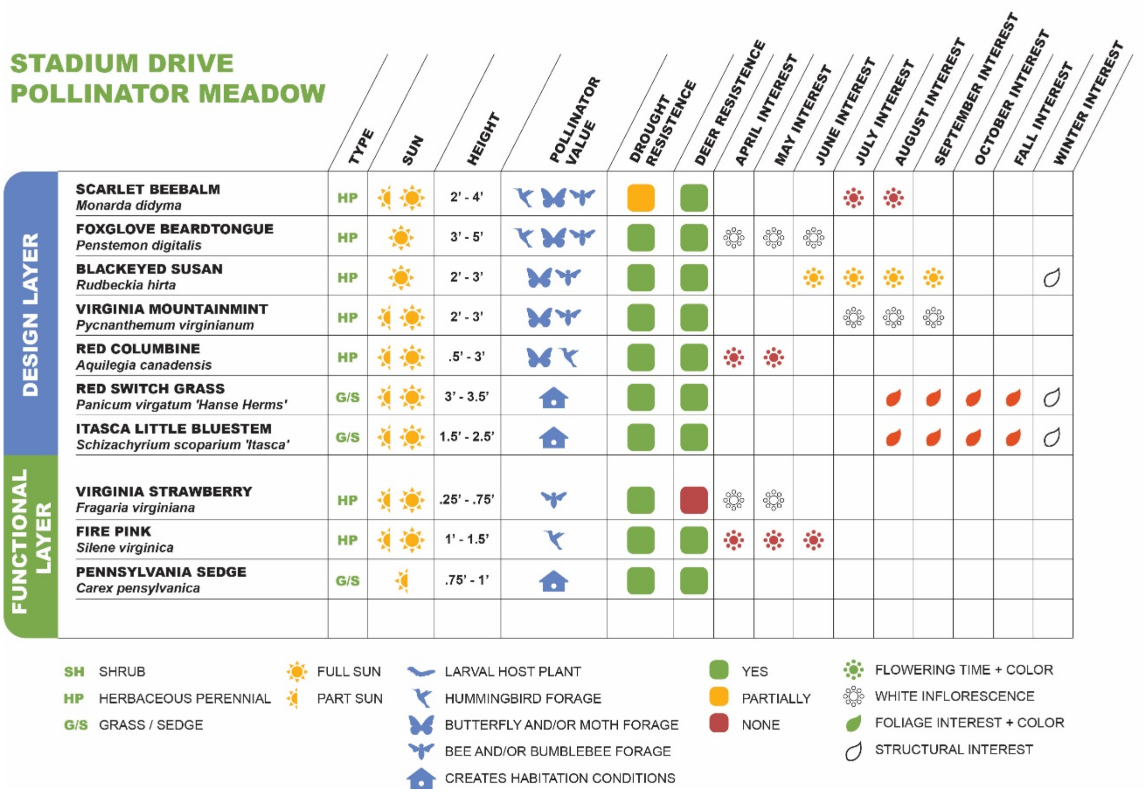


Figure 32. Site A: Plant Palette, by author

The plants chosen for this site all benefit native pollinators in some way. Important consideration was placed on plants which can resist deer browse and withstand occasional drought. Note that blooms were selected to exist throughout the summer growing season, while certain plants with structural interest in the non-growing season were considered as well. Note that plants within the functional layer rows are interspersed throughout the entire design.

Perspective of the Stadium Drive Pollinator Patch

Figure 33. Site A: Perspective, by author

In this perspective you can see the incredible visual difference that is made by densely planting native species instead of relying on lawn-space. As an entrance to the university, this site represents the institution well while boasting benefits to native wildlife. Because the curb and road serve as a natural boundary, choosing lower species to border the design sufficiently frame it without seeming messy or unkempt.

3.4 SITE B: REGENTS DRIVE ANIMAL SCIENCES BUIILDING

<u>Reason for Redesign</u>

The lawn area beside the Animal Sciences building on the University of Maryland Campus is currently extremely underused in terms of ecological potential. It is composed of seven young trees, and lawn. At best, some small spring ephemeral species can be found across the site in the spring.

Because of the size of this site, as well as pedestrian access, I chose to redesign it in a way that invites people to step into, learn about, and experience the introduced biological diversity. Below are my analyses of the site:

Location

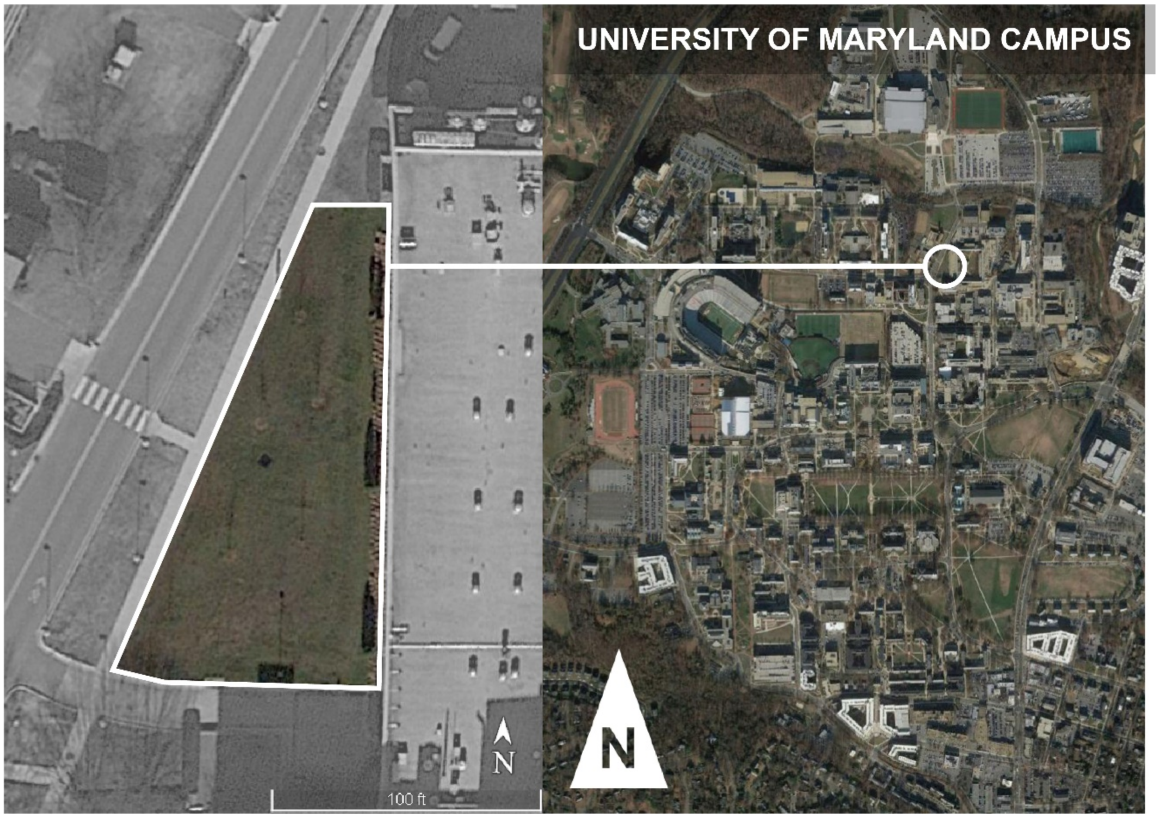


Figure 34. Location of Site B – North Campus, by author

Site Analysis & Observations

Vehicular + Pedestrian Traffic

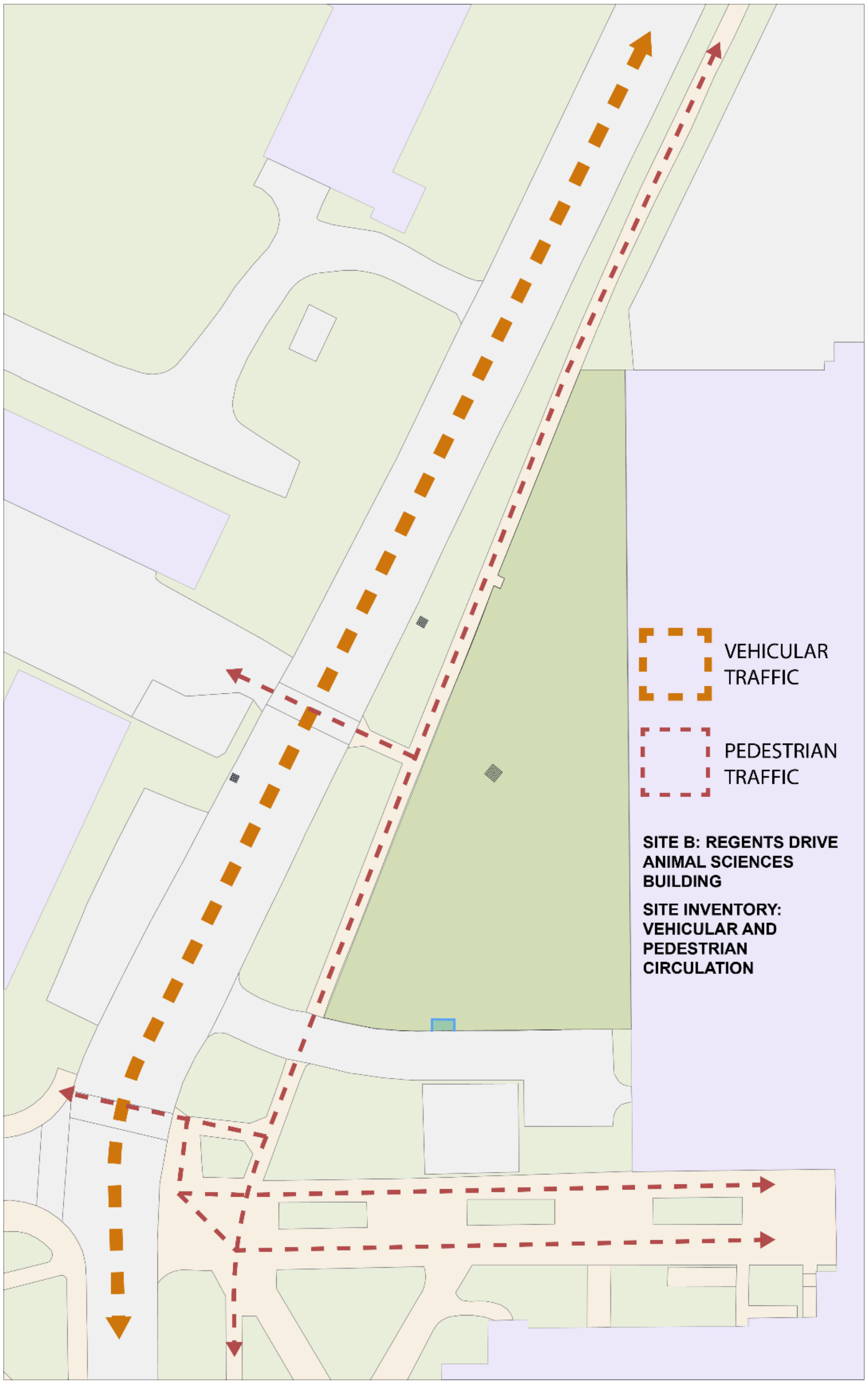


Figure 35. Site B: Vehicular and Pedestrian Traffic, by author

Topography + Water Movement

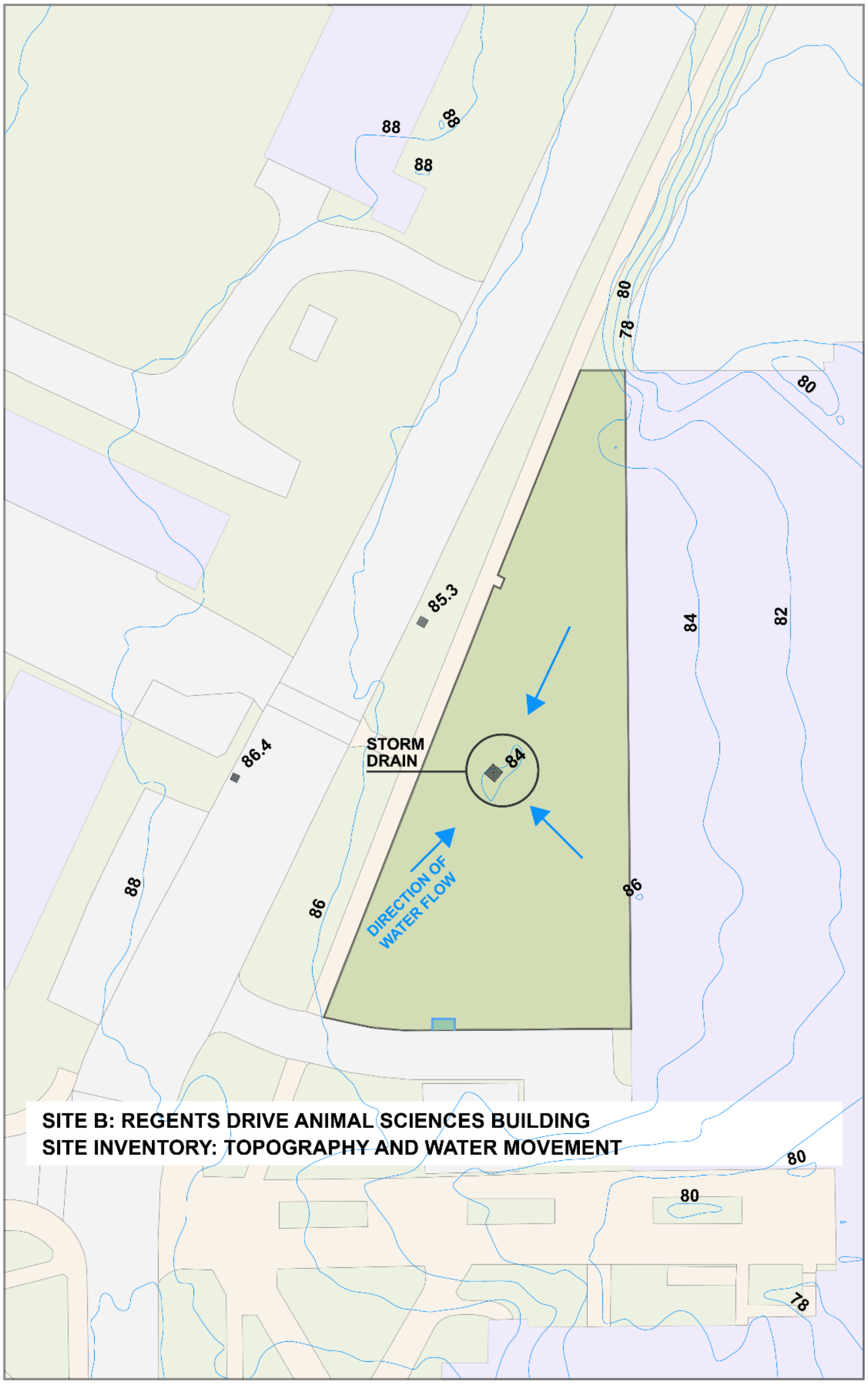


Figure 36. Site B: Topography and Water Movement, by author

Utilities

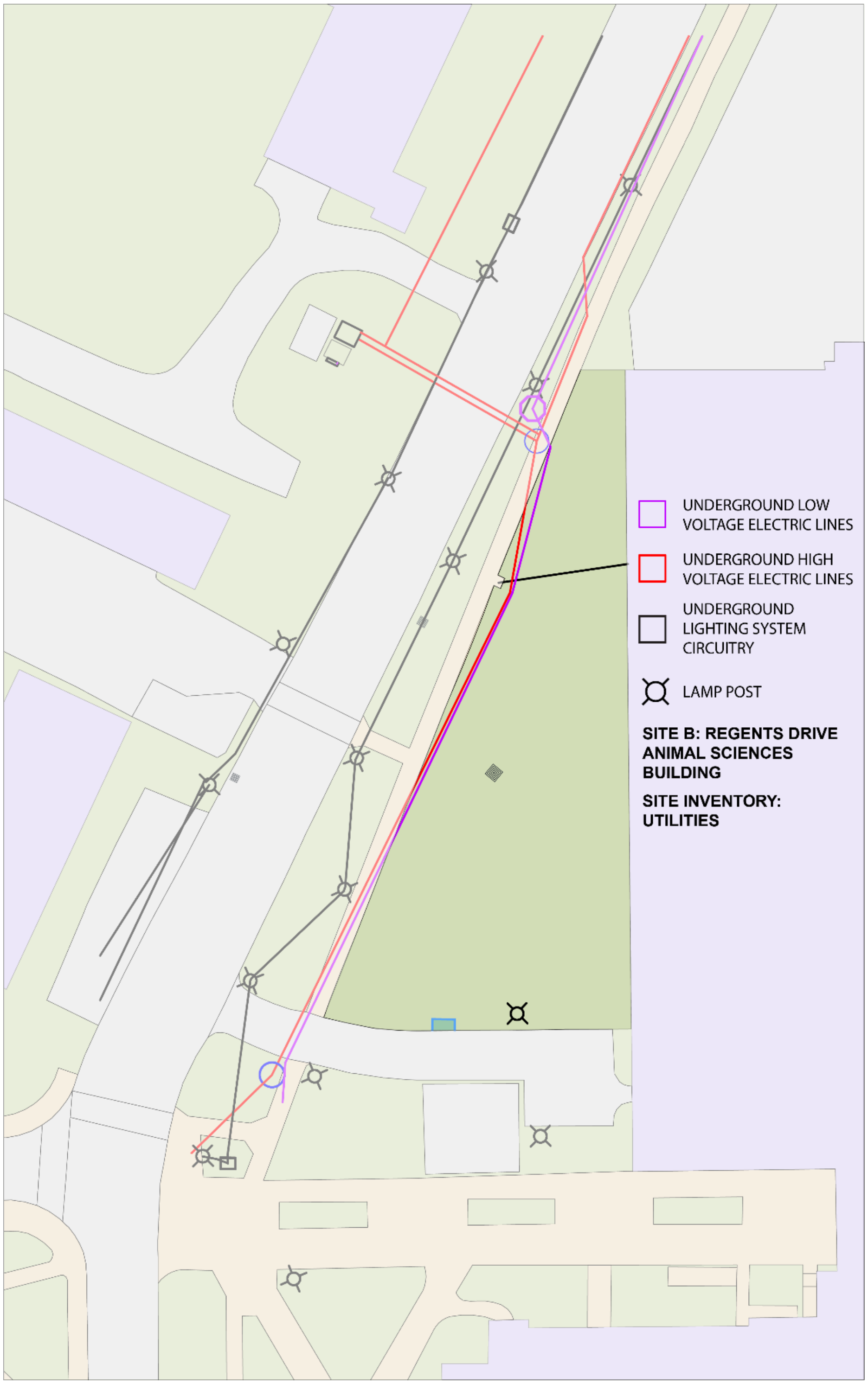


Figure 37. Site B: Utilities, by author

Vegetation

Figure 38. Site B: Vegetation, by author

Soil

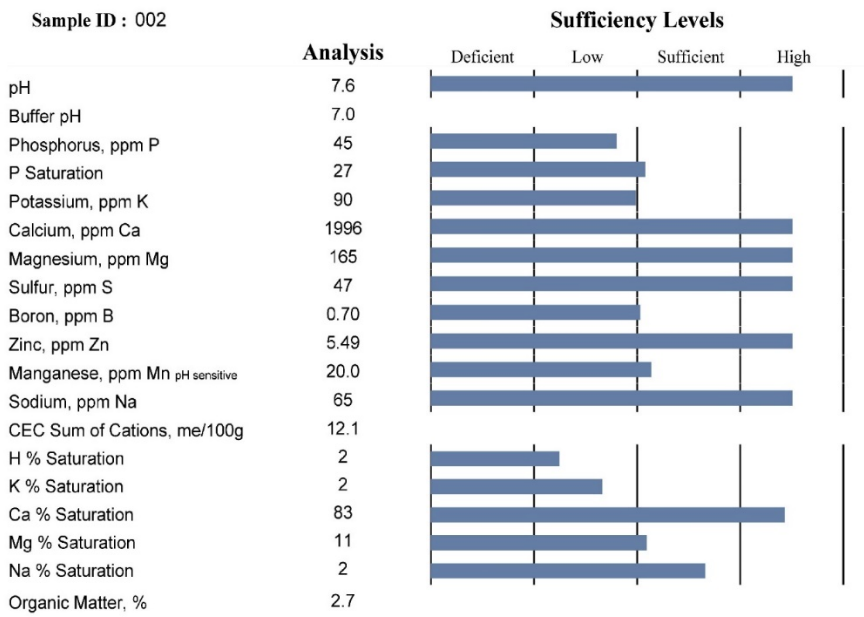


Figure 39. Site B: Soil Analysis results provided by AgroLab, DE

As was expected, the soil sample for this site was very similar to that of the last one. There are no deficiencies, but many high mineral contents. Being aware of this, I was sure to select plants that were not sensitive to high levels of minerals (especially sodium) in the soil.

Visibility

Figure 40. Site B: View 1, by author

Figure 41. Site B: View 2, by author

Figure 42. Site B: View 3, by author

Site B Design & Graphics

Design Program

The idea for this area is to create an accessible meadow-like plant community that gives passerbys the ability to enter and experience the redesigned site. As this location is closer to central campus than Site A and has continuous pedestrian access, it is an excellent opportunity to foster educational place-based experience.

Plan

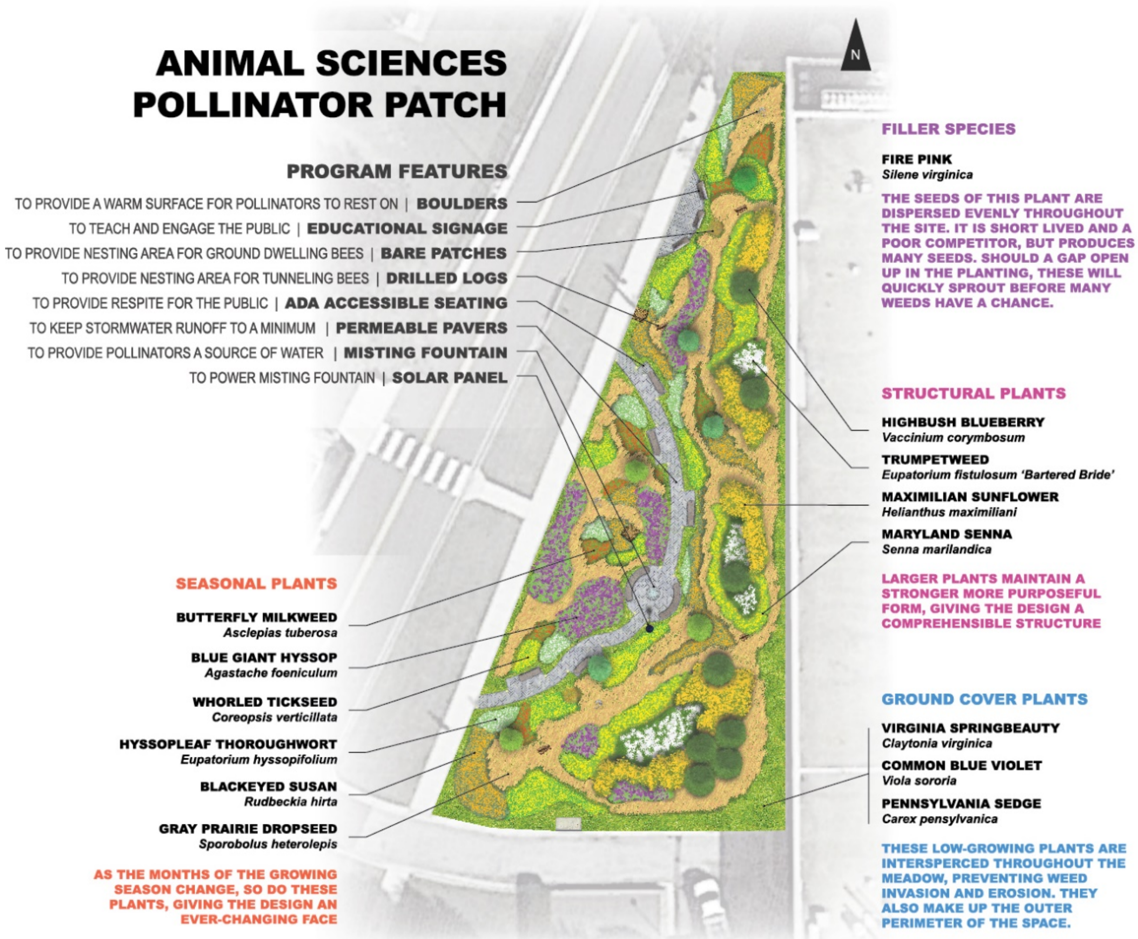


Figure 43. Site B: Plan, by author

The Animal Sciences Pollinator Patch incorporates both best practices for creating pollinator habitat, as well as introducing and encouraging people to walk into and experience the space. There is a walkway that goes through the site, with seating throughout. At the north end, there is a small inset where curious onlookers can read educational signage and spot the pollinators and nesting sites which it refers to.

Plant Palette

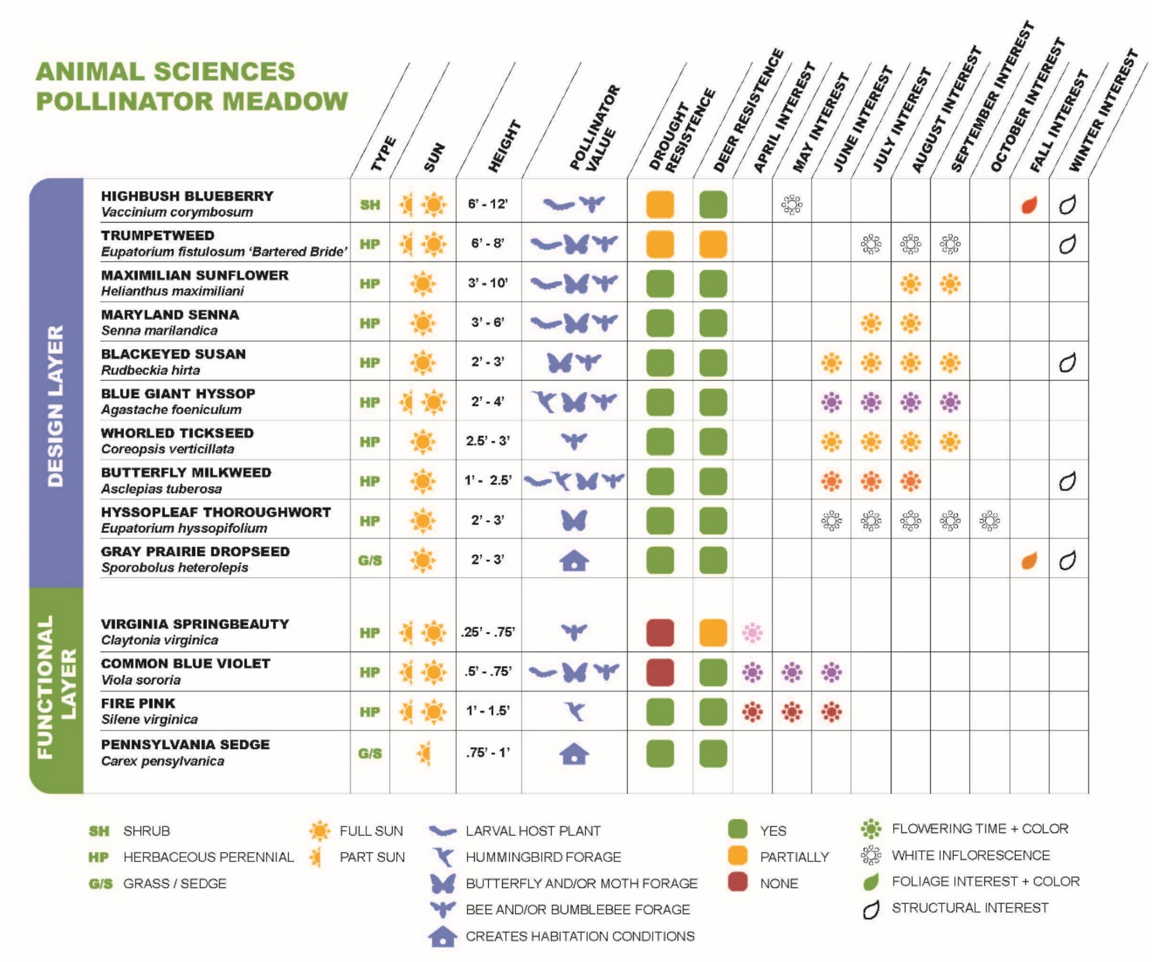


Figure 44. Site B: Plant Palette, by author

As with the previous site, the plants chosen for this site all benefit native pollinators in some way, and consideration was placed on plants which can resist deer browse and withstand occasional drought. Just as with site A, blooms were selected to exist throughout the summer growing season, while certain plants with structural interest during the non-growing season were also chosen strategically. Plants within the functional layer rows are interspersed throughout the entire design.

Perspective of the Animal Sciences Pollinator Patch

Figure 45. Site B: Perspective, by author

3.5 CONCLUSION

In conclusion, the two redesigned sites provide an alternative way of thinking about underused urban lawn spaces. By adapting these areas to the needs of local species, each site becomes part of a bigger ecological system. This provides resources and habitat for a diverse range of creatures which can move from site to site to access the resources they need to survive. Both proposed designs combined would add 15,000sq.ft. of excellent pollinator forage and habitat to the University of Maryland Campus, all converted from monoculture lawn space. This in turn would also support hundreds of other species like birds and bats which rely on some of these other plants and insects to survive – all while aesthetically enhancing each site, and inviting people to enjoy and experience them.

It is of vital importance that human development, not only considers, but necessitates, care for the needs of all the systems on which it relies. This includes human safety and wellbeing, functionality, economics, *and* environmental sustainability among others. Choosing to ignore any integral parts of this greater system leads to many of the imbalances we see today wherein too many native species become unable to find sufficient resources to thrive. Current human development has largely ignored the needs of environmental systems around it at great cost. Perhaps the recent panic over the sudden population decline of the honey bee was just a warning. If human development continues to expand at the expense of the health of surrounding ecosystems, scares like this could become more commonplace.

Instead, all designs for human settlement growth and expansion should be created to support all natural systems into which it comes into contact. When a bee creates its nest, then goes out into the world to forage, it plays its part within a system that is inclusive of all living things, and thus, supports its own success as well. It is this manner of thinking and behaving that a prudent society should aim to adopt, so that society may continue to develop without destroying the world around it, and as a result, human society itself.

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