Sustainable Landscaping Plan to Increase Biodiversity and Ecosystem Services at Villanova University

By

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Thesis
Submitted to the
College of Engineering
Villanova University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE SUSTAINABLE ENGINEERING

May 2020

Villanova, Pennsylvania

STATEMENT BY AUTHOR

This thesis has been submitted in partial fulfillment of requirements for an advanced degree at the Villanova University.

DEDICATION

For my late grandfather who loved the land and all its gifts and passed that love on to me.

For my grandmother who is too stubborn to let anything in this world stop her and made sure that I knew nothing could stop me either.

For my father who always reminds me that the most important place is here, the most important time is now, the most important person is the person you are with, and the most important thing to do is be kind.

For my mother who taught me to always leave a place better than I found it and to strive to create a better world.

For my little sister who, in her endless generosity, let me have all the common sense.

ACKNOWLEDGMENTS

I would like to thank Hugh Weldon for all the information, support, and enthusiasm he brought to our meetings and correspondence. I would like to thank Susan DiLoreto for her passion for biodiversity, support of this project, and for introducing me to, and letting me borrow her copy of, The Living Landscape.

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ABSTRACT

In the past half-billion years five mass extinctions have occurred each of which drastically reduced the diversity of life on earth. Now the earth is undergoing a sixth mass extinction and the cause of this extinction event is human activity. Thus far the majority of human activity has been increasing the rate of extinction and decreasing biodiversity, however, this means that human activity can also be used to decrease the rate of extinction and increase biodiversity. Villanova University has committed itself to a Sustainability plan that strives to meet the 17 United Nations Sustainability Goals. All of these goals are in some way tied to slowing the mass extinction, increasing biodiversity, and improving ecosystem services but the current campus landscape does not reflect these goals. To increase biodiversity and improve ecosystem services on the Villanova University campus a sustainable landscaping plan that changes landcover proportions, land use, and land maintenance must be developed, and a baseline biodiversity score must be determined. To accomplish this the biophysical characteristics. regionally and locally were assessed to determine the needs of the university and the feasibility of change. The principal results of this assessment showed that the university has a low Shannon's Index biodiversity score, .19 out of 1, on the campus core and a high percentage of ecologically unproductive areas, impervious surface and manicured lawn, which make up 72%. of the total campus area. Additionally, trends in temperature and rainfall indicate that both will be increasing in the future. The principal results from the analysis emphasized the major needs of the university and these needs shaped the goals and actions addressed in the sustainable landscaping plan. The sustainable landscaping plan was evaluated using the STEEP (Social, Technical, Environmental, Economic, Political) framework to emphasize its range of impacts on Villanova University.

1 INTRODUCTION

The Americas are an extremely diverse area that is home to a plethora of biodiverse ecosystems. These ecosystems are filled with natural capital which has been used to drive social, technical, economic, and political growth throughout American history. Natural capital is the stock of natural assets: soil, air, water, flora, and fauna, which work together synergistically to provide humans with ecosystem services: food, water, shelter, and other benefits that humans gain from nature. Historically, areas with higher natural capital and ecosystem services grant populations in those areas a higher quality of life: one such area is the Americas. Currently, 40% of the earth's capacity to produce nature-based materials is contained within the Americas though the continent only contains 13% of the global population. Furthermore, terrestrial ecosystems provide ecosystem services in the Americas that are estimated to be equivalent to at least $24.3 trillion per year, which is equivalent to the gross domestic product of the region. Despite the richness of natural capital in the America's current use of natural capital exceeds nature's ability to replenish itself and diminishes its ability to continue to provide the same services.

The Americas produce 22.8% of the earth's ecological footprint and North America accounts for 63% of that footprint or 14.3%. Over time, when ecosystems are abused natural capital becomes depleted, a series of positive feedback loops begin to exacerbate issues within ecosystems. These issues compound upon one another and reduce ecosystem services. This process has been occurring in the Americas since 1960 and has caused 65% of ecosystem services to decline where 21% are greatly declining. These declines negatively affect the overall health of ecosystems and weakens them over time. In conjunction with the decline of ecosystem services, a quarter of the species in the Americas are classified to be at high risk of extinction due to habitat conversion, fragmentation, and overexploitation. Human-induced climate change also plays a role in furthering the decline of natural capital, ecosystem services, and biodiversity as it causes changes in temperature, rainfall, and other environmental factors. The chart in Figure 1.1, created by the Netherlands Environmental agency, shows a quantification of the past, present, and future factors of human-induced changes on biodiversity, represented by mean species abundance [1].

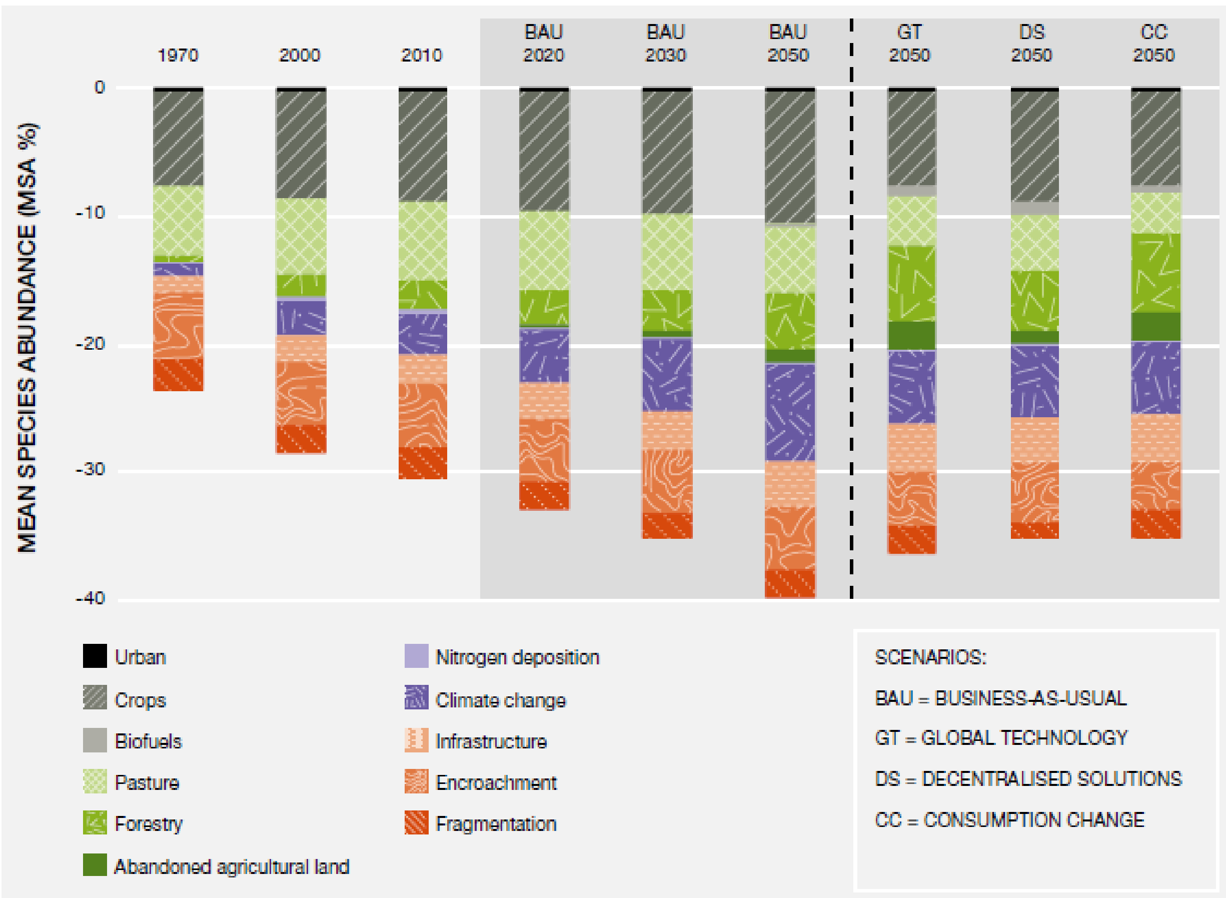

Figure 1.1: Pressures Driving Biodiversity Loss In the Americas [1]

Declining natural capital, ecosystem services, and biodiversity are directly linked. Biodiversity supports both natural capital and ecosystem services as diverse arrays of flora and fauna determine the health and productivity of an ecosystem. Biodiversity is defined by the Convention on Biological Diversity as “The variability among living organisms from all sources interalia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes, diversity within species, between species and of ecosystems”. In layman’s terms, this means that biodiversity is based on four factors: ecosystem diversity, the variety of physical environments and the biotic communities that live there, species composition, the density or frequency of a species in a community, species diversity, the number of different species in a community, and genetic diversity, the variation of genetic information within species in a community.

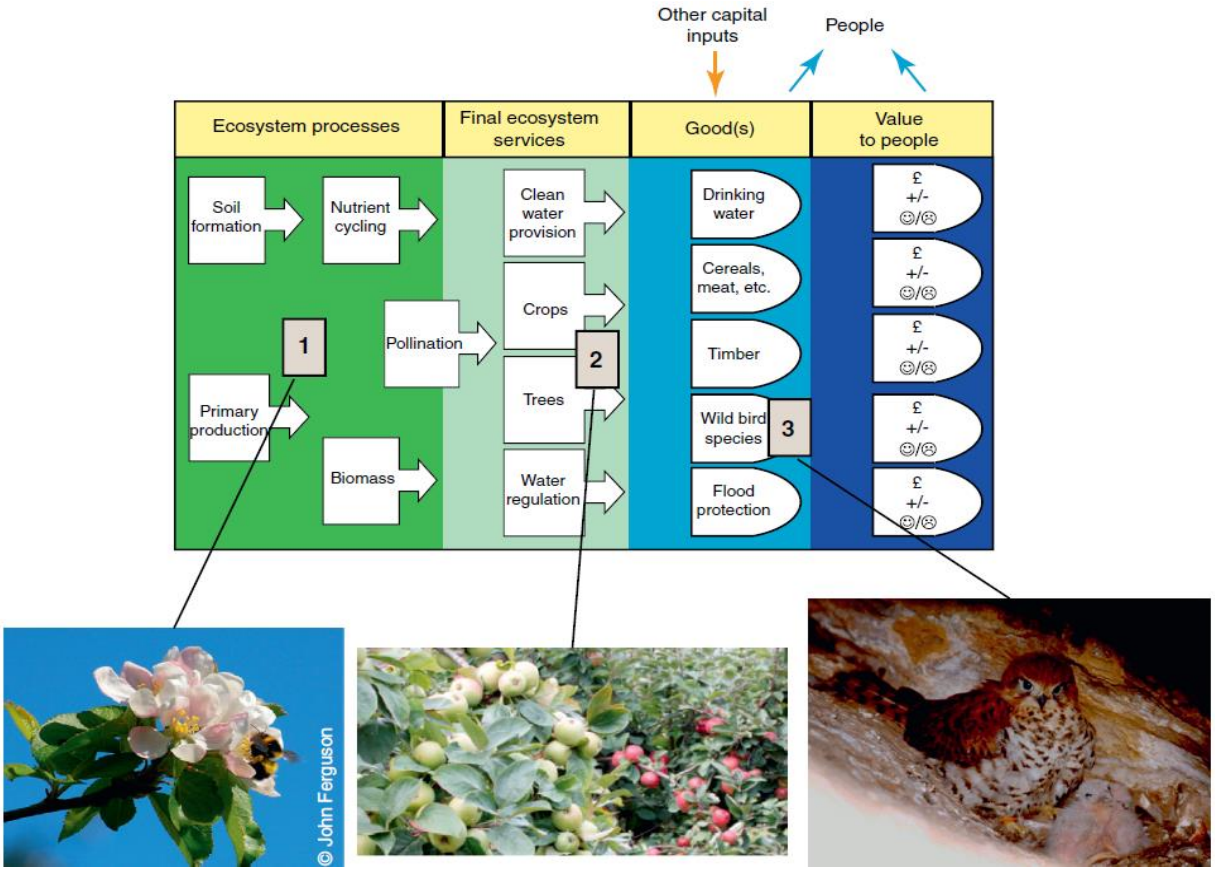

Figure 1.2: Example of the Benefits of Biodiversity and Their Relationship [2]

The benefits of biodiversity can be assessed in three different ways: as a regulator of ecosystem processes, an ecosystem service, and a good. Biodiversity is a major component in regulating ecosystem processes across trophic levels: microorganisms and fungi decompose detritus and facilitate nutrient cycling, primary producers sequester carbon and produce biomass, predators and parasites regulate populations, and pollinators facilitate the reproduction of producers and help to stabilize nonagricultural ecosystems. The right combination of biotic and abiotic components present in an ecosystem is what determines the functionality of the ecosystem. However, the variety or diversity of those components determines the health and resilience of the ecosystem. Ecosystems that have more biodiverse communities are more resilient to pests and environmental change and often function at a higher level than ecosystems that are less diverse. Biodiversity itself can also be considered an ecosystem service since flora and fauna can directly contribute to human needs, for example, organisms that contain useful compounds, pollinators which allow food crops to produce fruit, and wild crop and livestock relatives which provide genetic diversity increasing the resilience of food production systems. Biodiversity is a "good" where biodiversity itself is valued by humans this includes recreational, spiritual, educational, and religious values as well as the appreciation of scenic places and wildlife [2]. Figure 1.2: Example of the Benefits of Biodiversity and Their Relationship shows examples of benefits in each category and the relationship between these benefits and Figure 1.3: Benefits to Humans from Nature gives more specific examples for each category.

Regulating Contributions

- Habitat creation and maintenance – maintaining the ecosystem structures and processes that allow the other NCP to be provided
- Pollination and dispersal of seeds and other propagules – the ways that nature contributes to productivity of plants through fertilizing seeds and dispersing seeds and other vegetative propagules (IPBES, 2016a).
- Regulation of air quality – regulation of CO_2/O_2 balance, Ozone for ultraviolet-B absorption, polluting gases
- Regulation of climate – including regulating albedo, some aspects of greenhouse gas emissions, and carbon sequestration
- Regulation of ocean acidification – maintaining the pH of the ocean through buffering the increases and decreases of carbonic acid (caused mainly by uptake of atmospheric carbon dioxide in the oceans)
- Regulation of freshwater quantity, location and timing – for both direct uses by people and indirectly for use by biodiversity and natural habitats
- Regulation of freshwater and coastal water quality – capacity of healthy terrestrial and aquatic ecosystems to regulate water supply delivery and/or filter, retain nutrients, sediments and pathogens affecting water quality
- Formation, protection and decontamination of soils and sediments – sediment retention and erosion control, soil formation and maintenance of soil structure, decomposition and nutrient cycling
- Regulation of natural hazards and extreme events – preserved ecosystems' role in moderating the impact of floods, storms, landslides, droughts, heat waves, and fire
- Regulation of organisms detrimental to humans – pests, pathogens, predators, competitors

Material contributions

- Energy – biomass-based fuels
- Food and feed – wild and domesticated sources, feed for livestock and cultured fish
- Materials and assistance – production of materials derived from organisms in crops or wild ecosystems, for construction, clothing, printing, ornamental purposes and decoration
- Medicinal, biochemical and genetic resources – plants, animals and microorganisms that can be used to maintain or protect human health directly or through process of the organisms or their parts

Non-material contributions

- Learning and inspiration – opportunities from nature for the development of the capabilities that allow humans to prosper through education, acquisition of knowledge and development of skills
- Physical and psychological experiences – opportunities for physically and psychologically beneficial activities, healing, relaxation, recreation, leisure, tourism and aesthetic enjoyment
- Supporting identities - basis for religious, spiritual, and social-cohesion experiences, for narrative and story-telling and for sense of place, purpose, belonging, rootedness or connectedness
- Maintenance of options – continued existence of a wide variety of species, populations and genotypes, to allow yet unknown discoveries and unanticipated uses of nature, and on-going evolution

Figure 1.3: Benefits to Humans from Nature [1]

As stated above biodiversity can be assessed in three different ways: as a regulator of ecosystem processes, an ecosystem service, goods, and value to people. These benefits reflect the three pillars of sustainability: planet, prosperity, and people respectively. The impact that biodiversity has on each of these three pillars makes it a major influencer for creating a sustainable world. Villanova University is working towards a more sustainable campus through the Villanova Sustainability Initiative which uses the United Nations Sustainable Development Goals (UN SDGs) as a framework for its sustainability efforts. The UN SDGs are seventeen goals for the world that call on all nations for action on a myriad of topics to improve health and education, reduce inequalities, and help economic growth while addressing climate change and preserving natural areas. The 18 UN SDGs can be broken down into the three sustainability categories: people, planet, and prosperity, as shown in Figure 1.4 [3].

Figure 1.4: UN SDGs Categorized by The Three Pillars of Sustainability [4]

Biodiversity has an effect on each of these categories it also affects all seventeen of the UN SDGs at varying levels. In Figure 1.5 the chart depicts how experts believe biodiversity contributes the seventeen UN SDG's: "expert opinions were elicited from the Americas assessment authors to determine the level of consensus regarding the three most important nature's contributions to people for each Sustainable Development Goal*. Statistical methods were then used to identify clusters with similar relationships between nature's contributions to people and Sustainable

Development Goals. Blank cells indicate that no expert identified it as a priority, and the size of dots within cells illustrates the level of consensus among experts…” [1].

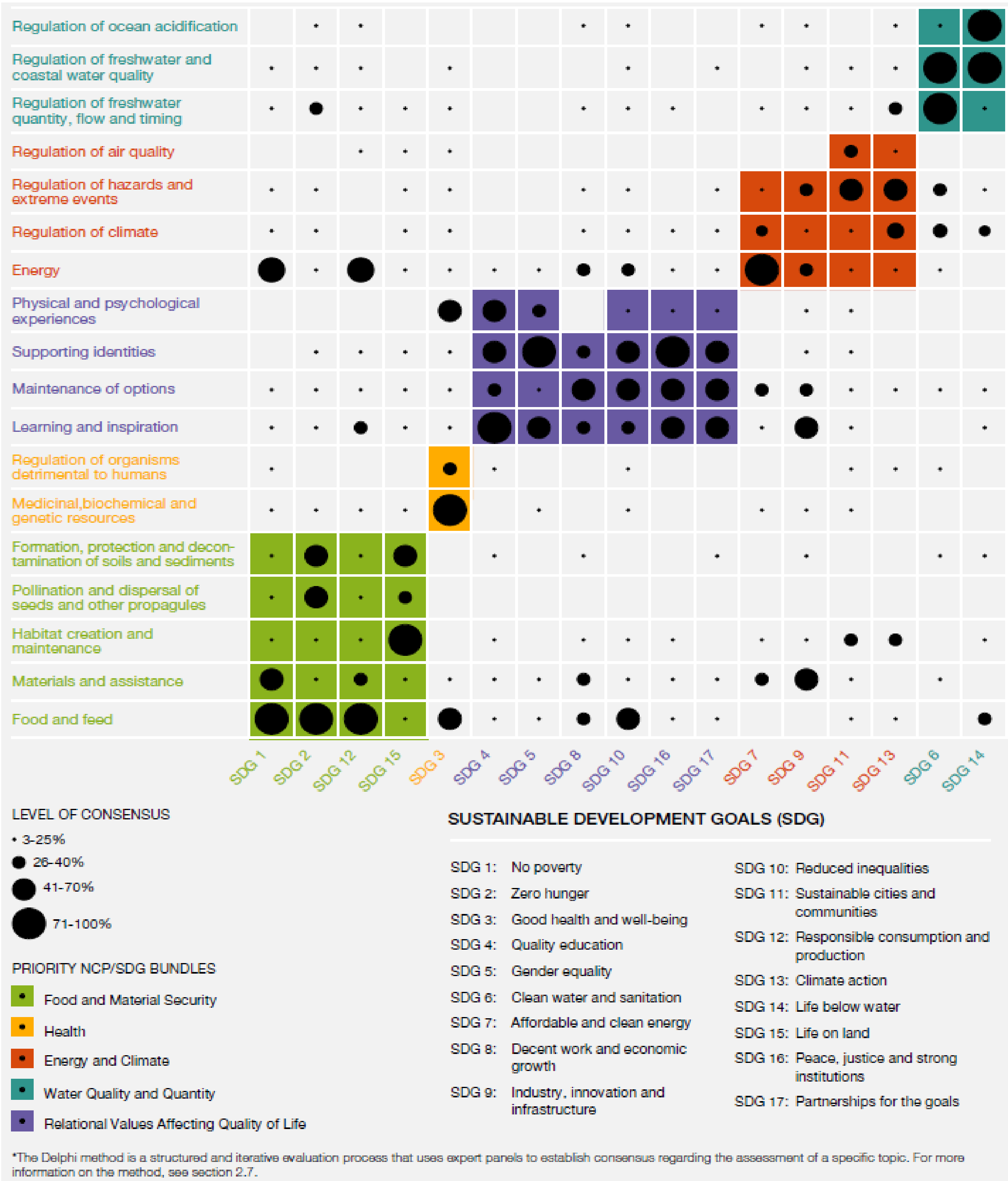

Figure 1.5: Natures Contributions to People Based on the UN SDGs [1]

The judgment of these experts shows that while there are many large areas of influence from biodiversity on physical systems and material contributions such as clean water, food, and health biodiversity also provides many non-material contributions that increase quality of life such as learning, cultural identity, and maintenance of options. The UN SDG’s were chosen to be the framework of the Villanova Sustainability Initiative because they give balanced weight to issues across the people, planet, and prosperity spectrum. The UN SDG’s will also be used in this paper to show the impact and importance of biodiversity on each of the UN SDGs.

2 LITERATURE REVIEW

2.1 Integrating Biodiversity and the UN SDGs

The Villanova University Sustainability Initiative uses the UN SDGs as a framework for its sustainability efforts so the effect of biodiversity on these goals is important to understand. In this section goals with greater correlation with biodiversity, based on rankings from Figure 1.5: Natures Contributions to People Based on the UN SDGs , will have more in-depth explanations in the following sections. While some of the goals are more focused towards developing nations, they can still be applicable to Villanova. This is because the University has positioned itself as a leader and influencer on an international scale due to its Augustinian roots and mission trips.

2.1.1 Goal 1: No Poverty

Biodiversity and healthy ecosystems are required to provide resources as well as ecosystem services to support various livelihoods such as agriculture, forestry, fisheries, and tourism. For many poor or rural households, ecosystem services can contribute 50% to 90% of their livelihoods. Without these resources and services, poor and rural populations are more vulnerable to disasters, poverty, and economic downturns which greatly reduce their quality of life. An article supporting these statements was published by Oxfords School of Geography and the Environment. For the article140 peer-reviewed publications were assessed and analyzed. A final list of 39 of those papers addressed the linkage between poverty alleviation and biodiversity, specifically ecosystem biodiversity, to determine if there was sufficient evidence that biodiversity alleviates poverty and the research yet to be done to determine the relationship between biodiversity and poverty alleviation. The ecosystem services considered in the papers were: wild species diversity, water supply, crops, livestock, and fish, hazard regulation, climate regulation, disease and pest regulation, detoxification, and purification in soils, air, and water, environmental settings, nutrient cycling, primary production, and water cycling. The poverty dimensions considered were: income and assets, food security and nutrition, employment, time, fuel and energy, health, education & skills, water, property rights, social capital, access to public goods, housing, and other. The results of this analysis were that while the above ecosystems services do not alleviate poverty, they do contribute to sustaining the livelihoods of the poor, and prevent them from falling further into economic distress, which reduces their vulnerability to poverty. The analysis also showed that there are specific linkages between pollination, food security, and nutrition; water supply and access to clean water and sanitation; and pest and disease regulation and health, the specifics of which will be covered later in this section. All of these findings support a strong correlation between ecosystem services from biodiversity and impacts on poverty [5].

2.1.2 Goal 2: No Hunger

Eliminating world hunger requires that agricultural productivity be adequate and sustainable, and assures that food is available from natural ecosystems. The first cannot be achieved without fertile soil and water to nourish the crops, pollinators to facilitate the creation of fruit, mast, and plant offspring, and genetic diversity among food plants to ensure that the species can adapt to changing environmental conditions, resist pests, and fight off disease. The focus of many campaigns to end hunger is to increase food production, however, currently, one-third of harvested food is thrown away where half, one-sixth, is lost before the food reaches the consumer and half, one-sixth, is lost at the retail and consumer levels. Furthermore, a third of the grains and cereals produced are fed to livestock. The issue is that food is not always available where the hungry live. To begin to tackle this problem food security, access, and sovereignty need to increase in these areas. "Eighty percent of the hungry live in developing countries where 50% are smallholders. Therefore, smallholders rather than large-scale commercial farmers are the backbone of global food security." [5].

Conventional larger scale farms practice monoculture planting with high-input agriculture, a process which allows for large scale, more consistent, production and requires heavy use of pesticides, herbicides, irrigation, and chemical fertilizers, however, this often comes at the expense of soil quality, eutrophication, pollinator health, and others. Most smallholders practice diverse planting with low-input agriculture, which makes them more reliant on biodiversity and ecosystem services to provide the conditions needed for healthy productive crops. It has been established that small diversified farms are more productive per area than larger monoculture farms, this is often referred to as the "paradox of scale" [6].

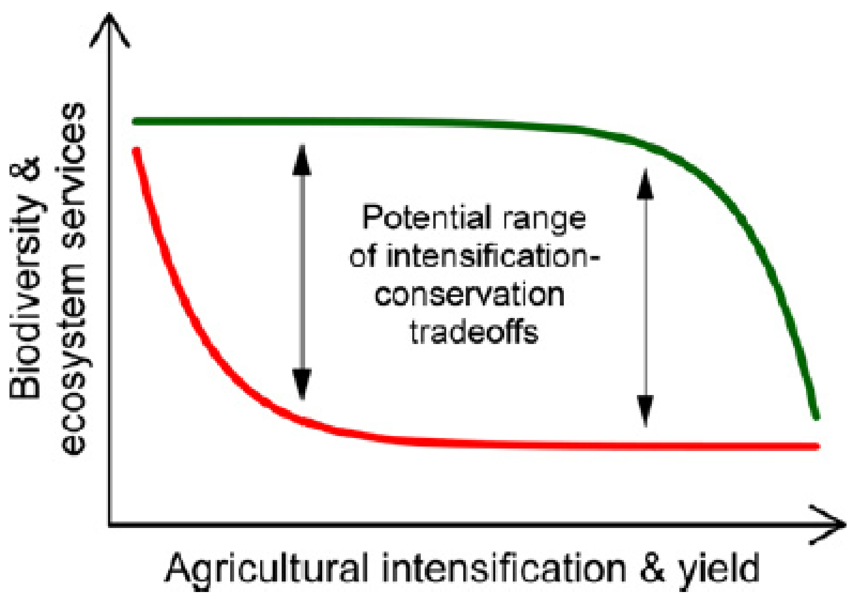

Figure 2.1: Farming Paradox of Scale [6]

Nutrition is also an important aspect of Goal 2 and is interconnected with Goal 3, good health and wellbeing. The food systems that supply people with calories and nutrients are dependent on culture, current markets, and biodiversity. Food culture has been changing since the mid to late 1900s when cereal production began to increase. While this change helped to rapidly decline the number of hungry people, primarily in developing countries, it also created new issues. Caloric needs were being met for more people but the simplifications of diets and lack of diversity in food choices resulted in a nutrient-poor diet concomitant with malnutrition, all the while ushering in health problems such as obesity and hypertension. Today maize, wheat, and rice supply the majority of caloric needs to the world, however, there are more than 80,000 plant species in the world available for human consumption. The three plants mentioned above have overshadowed many other species and caused developing communities, who often begin to adopt western diets as they become more developed, to neglect to cultivate and consume traditional plant species that have greater potential to supply calories and micro- and macronutrients to their diets [7]. Additionally, in the pursuit of higher yields and larger fruits, vegetables, and grains coupled with the depletion of topsoil, increased reliance on fertilizers, and increased CO_2 in the atmosphere, the nutritional content of these food produced at a large scale has begun to decrease. Recognition of these problems has spurred nutrition interventions that began as targeted one nutrient focused projects in developing nations and have evolved into movements to revitalize traditional foods all over the world. To achieve this revitalization a multifaceted approach that combines culture, current markets demand, and biodiversity is needed [7]. The figure below shows the positive relationships between nutrition, culture, current markets, and biodiversity when traditional food sources are reintroduced to people's diets. It was created for developing nations but is applicable to the revitalization of traditional foods anywhere, for example, the revitalization of traditional Native American cuisine in the United States.

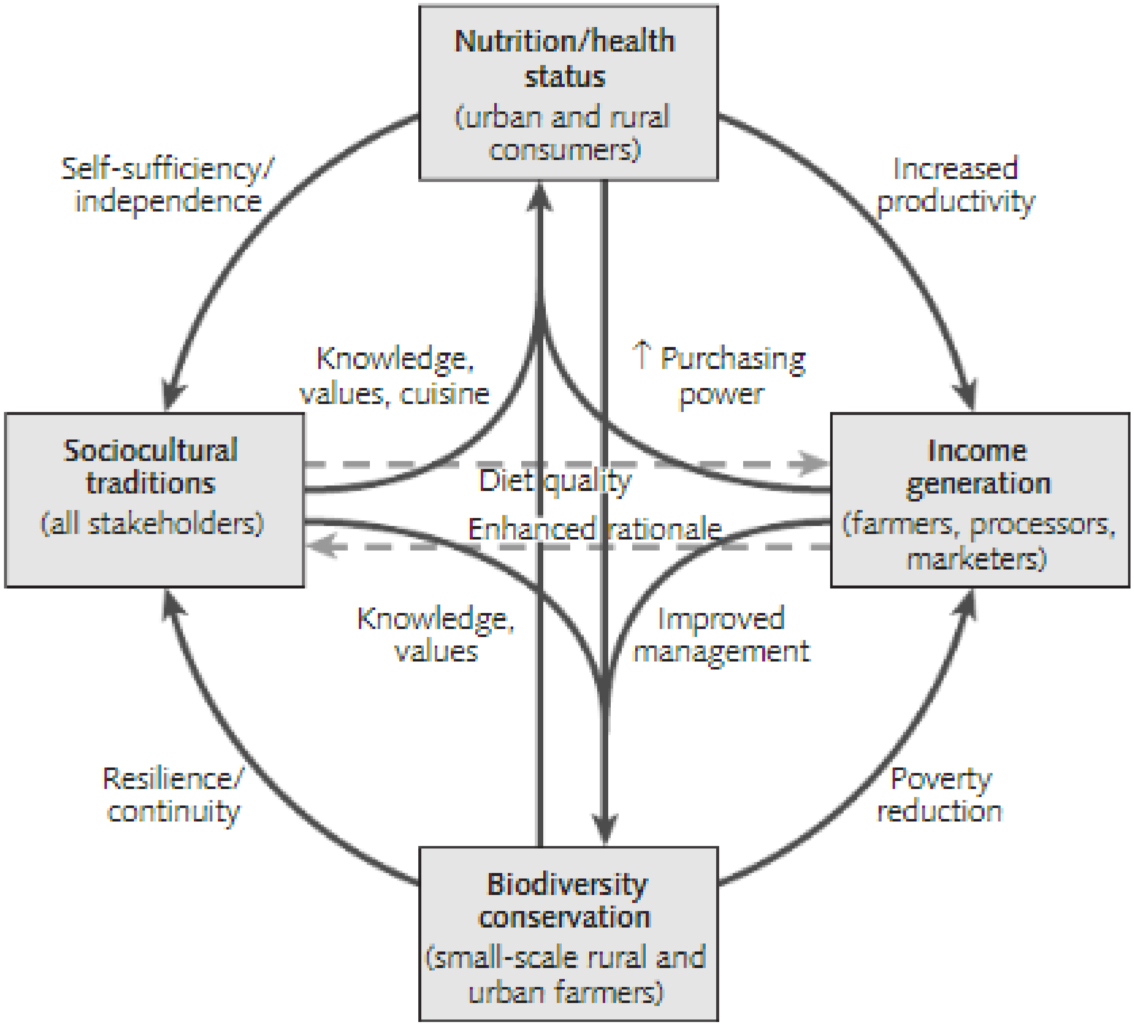

Figure 2.2: Population-level synergies linking agricultural biodiversity and human nutrition in developing countries [7].

This figure is also applicable to Villanova. The Villanova research and education garden run by The Villanova Consortium for Agricultural Research and Education (VCARE), as part of the Student Sustainability Committee (SSC), presents students with the opportunity to learn how to cultivate and grow their own gardens and foodstuff. By providing students with these skills Villanova University increases the chance that these students will grow a portion of their own food in the future and be less reliant on produce from supermarkets, which have traveled thousands of miles, from massive monoculture farms that harm biodiversity.

2.1.3 Goal 3: Good Health and Wellbeing

Human health is defined by the World Health Organization as "'a complete state of physical, mental and social well-being, and not merely the absence of disease or infirmity" there are two main facets that affect human health, direct pathways and indirect pathways. Direct pathways to human health include tangible stimuli from biodiversity, ecosystem services and goods, these are factors that are easy to identify, and subsequently, to measure their impacts on human health. These include impacts of biodiversity loss on the emergence and increased transmission of infectious diseases, health problems from loss of food and nutritional diversity, etc. One prime example of a primary pathway is the United States pharmaceutical industry, 118 of the top 150 prescription drugs are derived from living organisms where 74% are based on compounds from plants, 18% from fungi, 5% from bacteria, and 3% from vertebrates (such as snakes or frogs). Of these 9 of the top 10 drugs are based on natural plant products where sales from the active ingredients from the plants are around $1550 million. Globally, around 80% of the population relies on traditional medicine and about 85% of traditional medicine involves the use of plant extracts [8]. Drugs and traditional medicines help to extend the lives of patients as well as increase the quality of life of those who are chronically ill, biodiversity provides the means for the development of these drugs and ensures the survival of traditional medicinal plants.

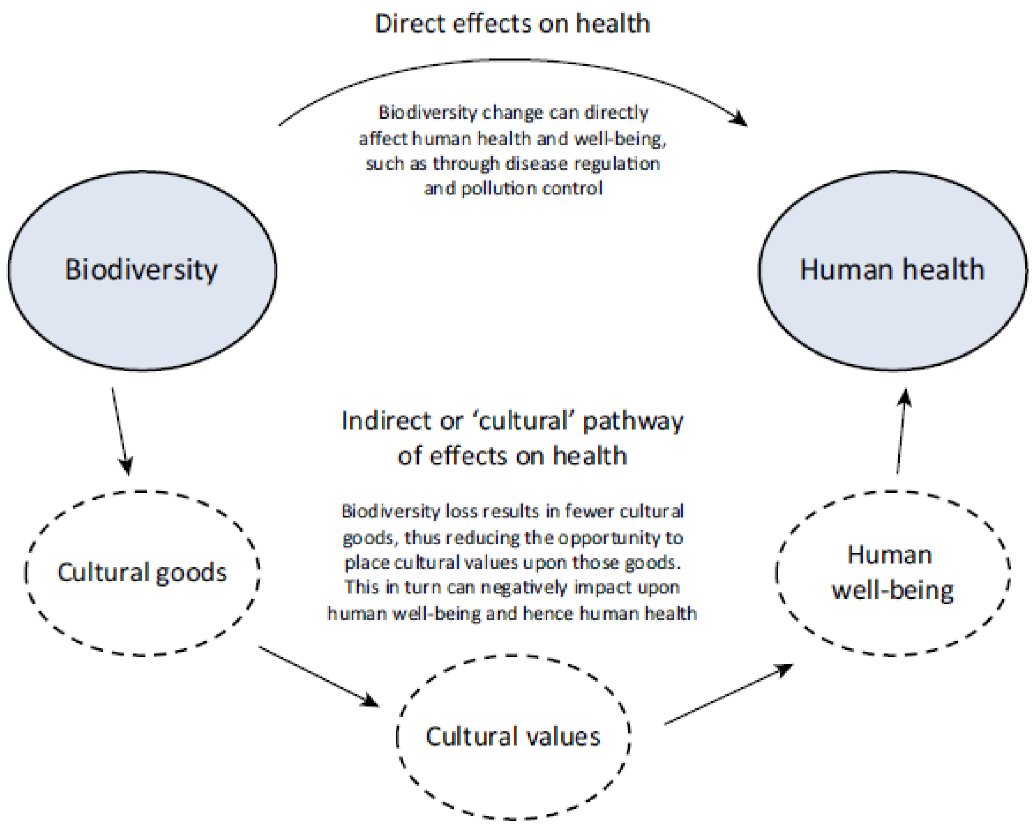

Figure 2.3: Direct and Indirect Pathways from Biodiversity to Human Health [9]

Indirect pathways are often intangible stimuli from biodiversity, value to people, these factors are more difficult to identify and do not have clear metrics for measurement but are none the less important. One of these intangibles is the cultural value that is placed on biodiversity and its effect on health. It has been proven that cultural associations cause individuals to react to, what would be considered insignificant, psychological stimuli. An example of this was a study done on the effects of the color of medication taken, for both placebo and active drugs, on reported health outcomes. Such a change is important because of its link to the cultural associations with various colors. This study sets up the argument for why biodiversity is so culturally important. Evidence suggests that mental health is negatively affected by the awareness of environmental degradation and positively affected by contact with "natural" spaces, examples of which are shown in the table below. [9]

Table 2.1: Health and Well-Being Benefits Found to Be Significantly Associated With Natural Space Experiences [9]

Exposure to Natural Space	Health or Well-Being Measured
Percentage of local green space	Increased perceived general health
Proportion of local green space	Decreased levels of inequality in mortality rates (related to income deprivation)
Proportion of local green space	Decreased stress events
Window view of natural space	Decreased postoperative hospital stay, negative evaluative nurse comments, and painkillers taken
Window view of natural space	Increased diverse aspects of well-being
Images of natural space	Faster recovery from stressed state, increased self-reported positive affect, and decreased self-reported anger and fear
Walk in natural space	Increased direction–attention abilities
Walk in natural space	Increased positive affect, relaxation, and fascination, and decreased negative affect
Visits made to urban green space	Decreased stress experiences
Images of general blue space	Increased positive affect and perceived restorativeness
Proximity to the coast	Increased self-reported general health
Window view of natural space	Increased performance on attentional measures
Proportion of local green space	Increased self-reported happiness
Time spent in forest environment	Decreased stress response, blood pressure, and pulse rate, and increased well-being

The evidence for relationships between interactions with natural spaces and benefits to health and well-being continues to increase but the reasoning behind these relationships is much less robust. A simple framework has been developed by Clark et al. to explain why biodiversity has these effects on human health. “Biodiversity change affects the provisions of cultural goods, which in turn affects the opportunities humans have to experiences these goods and to realize the values they place upon them; changes in these cultural values can then impact upon human well-being, which could consequently affect human health” [9].

While intangible biodiversity stimuli do not directly affect health, they increase quality of life and well-being, which reduces vulnerability to health problems. This is significant, especially on a college campus, because of the prevalence of mental health issues. In 2015 in the U.S around 31.1% of adults experienced an anxiety disorder and in 2014 6.7% of adults experienced at least one major depressive episode [10]; globally depression is predicted to be the leading cause of disease burden by 2030 [9]. The onsets of depression and anxiety are most likely to occur during college years, which has a largely negative impact on the health and academic performance of college students. Increasing support for biodiversity and biodiversity conservation could help to mitigate the impacts of negative metal health issues at Villanova University.

2.1.4 Goal 4: Quality Education

Providing inclusive and equitable quality education and promoting lifelong learning opportunities for all, from children to the elderly, on biodiversity creates interest, expands knowledge, and provides the necessary skills to solve biodiversity problems that can improve local communities and ecosystems. All of the benefits that can be gained from biodiversity rely on educating people on the importance and value of biodiversity as well as how to cultivate and maintain it.

At Villanova students have access to several classes that give classroom sessions as well as hands-on, and experimental education on ecology, biology, and biodiversity. Hugh Weldon, Villanova's Horticultural Supervisor, gives tree tours to anyone who is interested and educates them on the trees and plants of the campus. Villanova has the opportunity to use the biodiversity plan, detailed in this paper, to turn the main campus into a living laboratory for students, visitors, and the community, which provides examples of how to create biodiverse ecosystems in suburban areas. It also has the opportunity to ensure that students have adequate knowledge of the importance of biodiversity and ecosystem services so that when Villanova students become leaders, they understand the value of biodiversity and ecosystem services and will protect and cultivate these systems.

2.1.5 Goal 5: Gender Equality

In developing, nations women are largely in charge of managing biological resources and are more often affected by losses of biodiversity and ecosystem services. Loss of biodiversity and ecosystem services increases the about of time that women and children need to spend preforming tasks for the family such as collecting food, fuel, and water. This reduces the amount of time that women and children have for education and other activities that could generate income [11].

2.1.6 Goal 6: Clean Water and Sanitation

The health and biodiversity of ecosystems determines the quality, quantity, and delivery of water and also reduces the risk of water-related hazards and disasters. Wetlands, grasslands, and forests are all vital to maintaining the water system. Wetlands store water at the surface, subsurface, and ground levels which help to maintain river flows during dry seasons and reduce flooding risks during wet seasons. The myriad of plants in a healthy wetland purify water as it moves through the wetland so that it leaves cleaner than it entered. This is done by a dense network of roots that is created by wetland plants that capture, process, and dilute pollutants from water as well as capture sediment. Grasslands and Forests create ground cover and dense root systems that slow runoff, increase groundwater retention, and guard topsoil against erosion into waterways and the ocean. All of these systems also reduce the risk of eutrophication by halting and absorbing the excess nutrients before they can reach waterways. These processes increase water quality, reduce the need for certain purification measures in water treatment facilities, and maintain groundwater systems [11]. The loss of these systems reduces the overall amount of available freshwater due to increased runoff of fresh water into streams and rivers which carries it to the ocean, as well as reduced absorption of freshwater into the ground. The figure below shows the decline of renewable freshwater resources in the Americas since 1962.

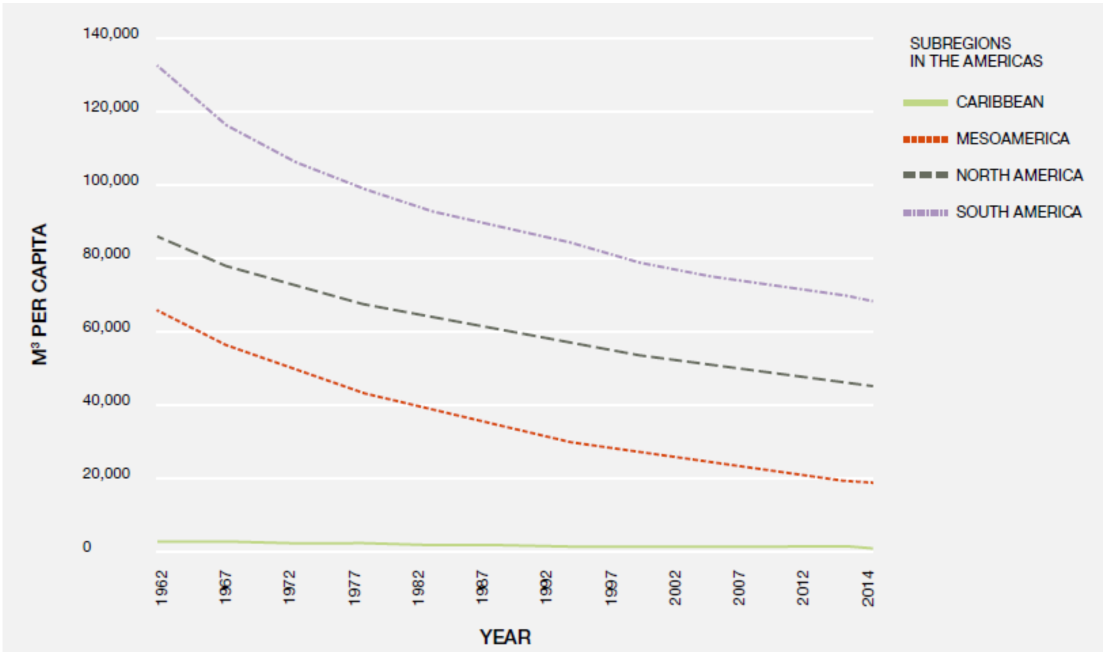

Figure 2.4: Renewable Internal Freshwater Resources in The Americas [1]

Villanova has several rain gardens designed to reduce runoff and increase absorption on the campus. However, when it rains, since the campus is situated on a hill, runoff tends to pool in certain areas because everything above is lawn and there is nothing to absorb it. This provides an opportunity for the pooling to be mitigated through the use of water-loving plants in or around these areas.

2.1.7 Goal 7: Affordable and Clean Energy

Over 3 billion people in the world rely on biological resources for cooking and heating; these resources include wood, charcoal, or animal waste [11]. Without these sources, people are more likely to turn to non-renewable resources to meet their energy needs since they are often more readily available than renewable energy sources in developing nations. Biodiversity education is important in this area so that communities learn that they need to help nature replenish energy resources since there is now a greater demand for those resources and nature can no longer provide them without being depleted. In the Americas, reliance on renewable sources of energy that rely on biodiversity such as algae and biofuels have increased. These methods of energy production increase energy security, as they reduce reliance on one singular energy sours as well as fossil fuels [1]. Examples of biofuels and their evolution can be seen in Figure 2.5.

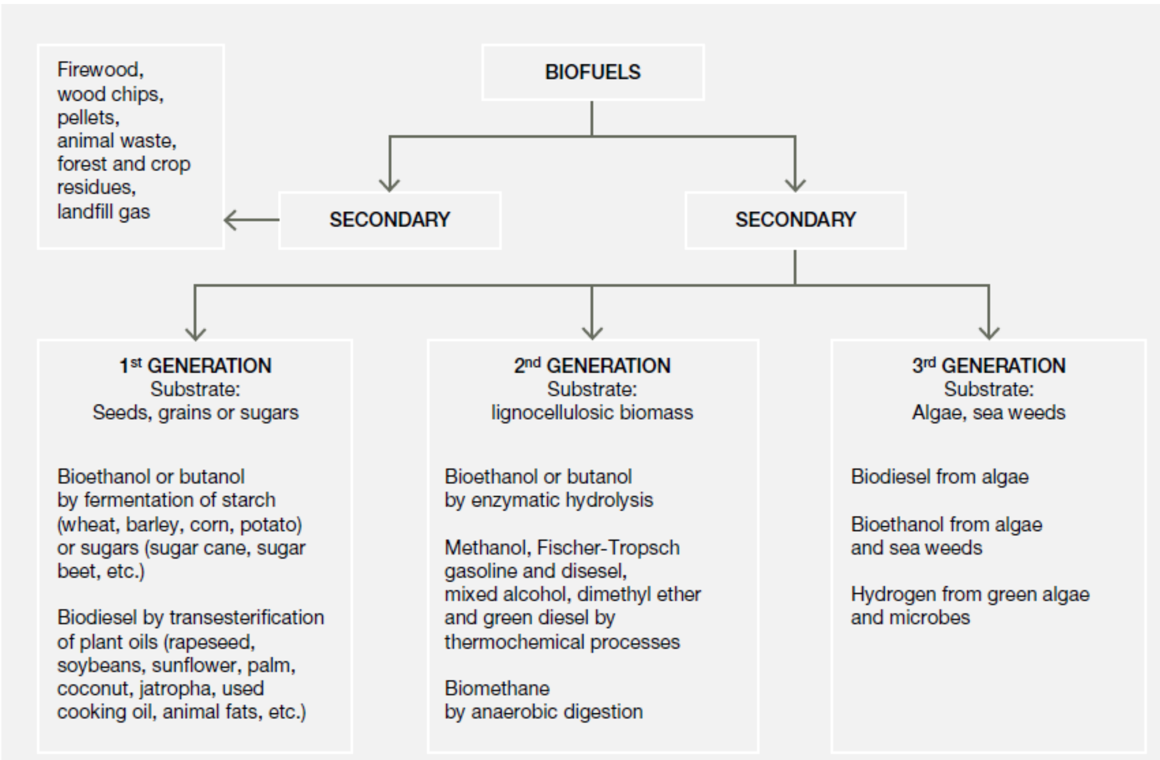

Figure 2.5: Biofuels and Their Evolution [1]

Furthermore, reliance on renewable resources that were inspired and improved by biological processes, flora, or fauna has also increased. These include solar panels that were inspired by plant photosynthesis and are in the process of being improved by combining nanotechnology and cyanobacteria to increase energy generation, wind turbines that use a similar design to humpback whale flippers to reduce drag and increase energy generation, etc. Biodiversity contributes efficient designs, that have been honed over thousands of years, to human inventions and allow for the creation of better more efficient systems that can generate more energy.

2.1.8 Goal 8: Decent Work and Economic Growth

As mentioned above biodiversity supports ecosystem services which are pivotal for many countries' economic activities and the employment of citizens; these activities include agriculture, forestry, fisheries, tourism, transportation, and trade. Biodiversity and healthy ecosystems enhance ecosystem services and, therefore, can lead to greater economic opportunities, higher productivity, and more efficient resource use [1]. Figure 2.6 shows the estimated economic values of ecosystems services in the Americas.

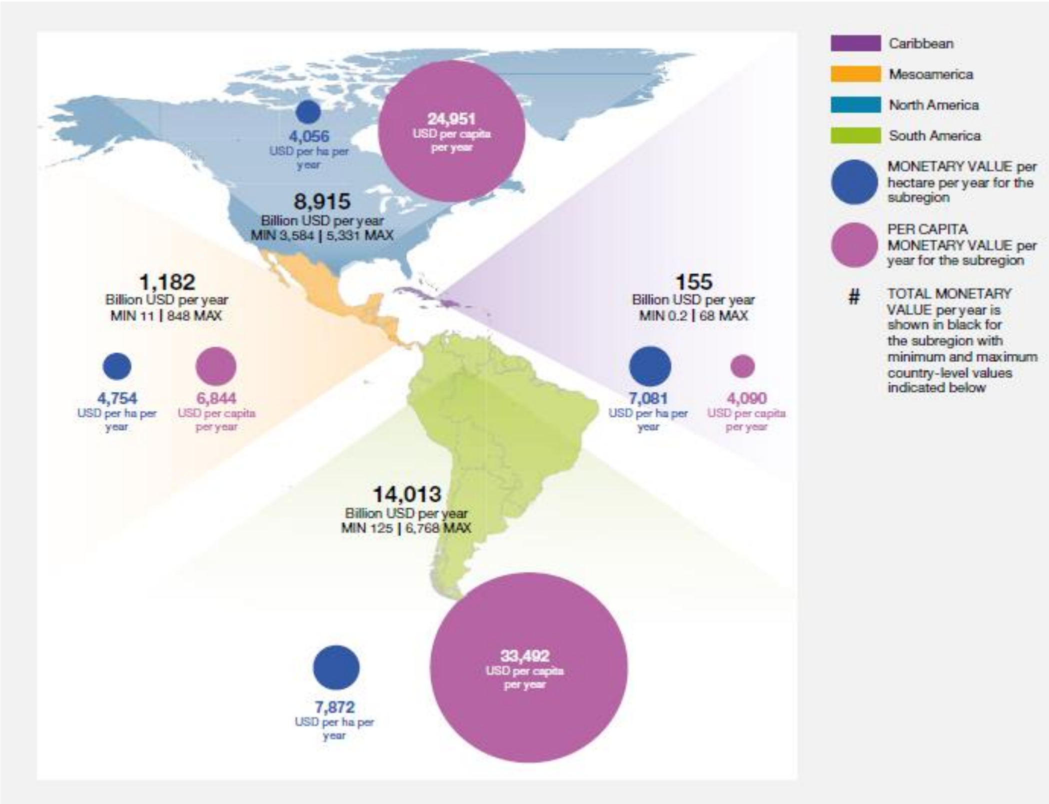

Figure 2.6: Estimated economic values of ecosystem services in the Americas [1]

For the university the benefits of biodiversity on tourism are most applicable, currently, tourism accounts for 10% of global GDP and one in eleven jobs. Many major tourist attractions encompass natural areas, protected landscapes, or protected areas such as beaches, volcanoes, mountains, wildlife, or plant life. Increasing biodiversity and pursuing the title of arboretum at Villanova university would give the university greater recognition and draw more visitors to the university increasing Villanova's economic opportunities.

2.1.9 Goal 9: Industry, Innovation, and Infrastructure

Biodiversity provides industry with raw materials or ecosystem services for products, inspires innovation, and can contribute to more reliable, lower risk, and lower cost infrastructure. Many industries rely on materials from nature, such as produce, livestock, cotton, wood, leather, bamboo, etc., to sell in their virgin form or to manufacture into other products. The availability of these products relies heavily on ecosystem services, such as fertile soil, clean water, pollination, etc. to provide these products for industry. Additionally, engineers and product designers used nature as a basis for their designs such as Velcro designed based on burrs as a fastener, bullet trains shaped like a kingfishers head to reduce drag and avoid noise when the train exits a tunnel and wind turbines with blade edges similar to the edges of whale fins which increase efficiency and reduce drag [12]. Nature has had millions of years to hone the traits of plants and animals to function as efficiently as possible and to create balanced, natural, zero waste, systems. This provides an opportunity for humans to observe, learn from, copy, and integrate these efficient traits and systems into man-made products and systems to improve them.

Biodiversity also has a large impact on human infrastructure. An increase or maintenance of biodiversity tends to have a positive effect on infrastructure, whereas, biodiversity loss tends to have more negative impacts on infrastructure. The impacts that biodiversity has on infrastructure can be indirect or direct. Some examples of the indirect benefits of biodiverse ecosystems would be mangroves protecting coasts from erosion, flooding, storm surges, and other weather events; wetlands purifying water, mitigating flooding, and accumulating topsoil; grasslands which reduce topsoil erosion, increase groundwater absorption; and forests which buffer wind, reduce erosion, increase groundwater absorption, to name a few. While none of these ecosystems directly contribute to infrastructure, they do mitigate the risks of serious damages to infrastructure systems that could have negative effects on humanity. Directly, biodiversity can benefit infrastructure through the use of green infrastructure, which helps with water management, living buildings that can keep buildings cooler as well as help with water management, and as algal-biofuels which contribute to increased energy security.

Using natural landscapes to provide ecosystem services such as groundwater retention, topsoil protection, shade, fauna habitat, and others on the Villanova University campus reduces some of the negative impacts of climate change on the campus. This, in turn, reduces the need for certain types of grounds maintenance, infrastructure, and energy use as well as the costs associated with these activities.

2.1.10 Goal 10: Reduce Inequalities in and Among Countries.

Globally biodiversity loss disproportionately affects those living in developing nations. Impoverish individuals in developing nations are more reliant on the direct benefits of biodiversity for their survival and livelihoods. Furthermore, developed nations often exploit developing nations for their natural resources and land. In most cases developing nations do not have as many laws and regulations protecting natural areas or manpower to strictly enforce the laws they do have. This allows companies and developed nations to extract their natural resources in irresponsible ways that destroy ecosystems, reduce biodiversity, reduce ecosystem services, and increase inequalities in the process without providing fair and just compensation for their actions.

In a similar fashion in the United States a great deal of environmental inequality occurs which most often negatively affects minorities and those of lower socioeconomic class and lowers biodiversity. This includes but is not limited to the destruction of natural areas to build of facilities that are, or can be, harmful to human health primarily in low income, minority, or indigenous areas, only providing affordable housing for low-income individuals around harmful facilities or high-risk areas with little to no green space, and gentrification. Protecting or increasing biodiversity in these situations can be complicated as green space increases the value of an area which can exacerbate gentrification and force out indigenous or long-time residents who can no longer afford to live there. However, as mentioned many times biodiversity increases quality of life and decreases risks associated with negative health outcomes.

Increasing biodiversity at Villanova would create a publicly accessible natural ecosystem for the campus community as well as any visitors. All people who visit the campus would have the opportunity to be exposed, educated, and/or have hands-on experience with native plants and ecosystems. This is especially important for students and visitors who may not have grown up with opportunities to explore natural outdoor areas.

2.1.11 Goal 11: Sustainable Cities and Communities.

While urban expansion is a threat to biodiversity it is also an opportunity for biodiversity conservation [1]. The majority of the world’s population lives in urban areas and as greater numbers of the population move into cities and urban sprawl increases, it becomes imperative that urban and suburban areas focus on increasing biodiversity and create unbroken swaths of biodiverse ecosystems. Accomplishing this will be crucial for mitigating global losses of biodiversity, increasing cultural awareness and significance of natural areas, and increasing quality of life for those who live in and around urban areas.

Lack of biodiversity in cities and communities causes many issues for humans and animals alike. Increases in human populations and the movement of these populations into urban areas cause increased in urbanization and urban sprawl. One of the primary problems with urbanization is a lack of vegetation resulting in biologically unproductive areas. The development of urban areas replaces productive natural ecosystems with impervious surfaces and lawns and scattered trees or shrubs which are highly unproductive. These areas then contribute to the urban heat island effect, stormwater overflow, poor air quality, habitat fragmentation, and decreased human and animal health and wellbeing.

An urban heat island is an urban area significantly warmer than the surrounding area due to the absorption and retention of heat from the sun on dark surfaces such as asphalt, roofing, buildings, etc., heat output from vehicles, heat output from HVAC systems, and lack of vegetation. The urban heat island effect impairs water quality by heating rainwater that comes into contact with the hot surfaces and deposits this hot water into water bodies, negatively affecting the health of the water body, causes increased energy consumption for cooling which elevates greenhouse gas emissions and air pollutants due to the increased burning of fossil fuels to provide the electricity required, and the elevated temperatures directly increase the rate of ground-level ozone formation which decreases air quality. The addition of green spaces and vegetation help to reduce temperatures in heat islands by cooling though the creation of shade by larger plants, reducing dark-colored heat-absorbing areas, and through evapotranspiration [13].

In the United states community, urban, and suburban green spaces are traditionally made up of large lawn areas dotted with lone trees and shrubs. These kinds of spaces are considered a cultural symbol for affluence and the American dream, which explains their popularity across the US. Laws in many communities reflect this and require lawns to be mowed to a certain height. Homeowners take great pride in the aesthetic quality of their grass, and spend large amounts of money, a record 47.8 Billion in 2018 for Lawns and Gardens [14], on water, herbicides, fertilizers, and other maintenance to improve and maintain the health of their grass. While lawn areas with scattered trees and shrubs preferable to impervious surfaces, they are highly unproductive compared to natural ecosystems. Manicured lawns lack plant biodiversity which makes the plants that are present in the area weaker because they do not have as many beneficial symbiotic relationships with other flora and fauna. Additionally, a lack of plant biodiversity prevents the landscape from being able to support a wide range of fauna. Landscaping in the absence of diversity creates biodiversity desserts and fragments productive habitats making it more difficult for flora and fauna to survive, creating an undesirable feedback loop of biodiversity loss. This, in turn, reduces the number of ecosystem services provided to humans in these areas.

Villanova is affected in some way by all of these issues due to current landscaping choices and practices. The plan in this paper will attempt to remedy some of these issues while meeting the needs of all of the users of Villanova University.

2.1.12 Goal 12: Responsible Production and Consumption

Population growth coupled with a culture of consumption has created dangerously unsustainable production and consumption systems that are highly detrimental to the earth, its ecosystems, and its residents. The fallout from the current production and consumption system of take, make, waste is decimating natural resource stocks, ecosystems, plant and animal populations, and human wellbeing and quality of life.

Biodiversity creates inspiration and opportunities for better, more efficient, product life cycles by providing examples of efficient zero-waste systems and products. Many companies are now attempting to create systems and products that mimic nature’s way of reusing and recycling all material involved in the system such as industrial ecology, closed-loop systems, and zero waste to landfill. Biodiversity also creates opportunities for more sustainable raw material choices as feedstock for products such as algae or mushrooms to be used as packaging instead of plastic, bamboo fibers for clothing instead of polyester, and many others. These kinds of changes not only positively affect economic growth and the environment, but they can also increase quality of life.

2.1.13 Goal 13: Climate Change

The number of trees and other plants in the world affects the global climate where greater numbers of these organisms decrease global temperatures and fewer of these organisms increase global temperatures. This is due to the ability of plants to sequester carbon and to cool themselves and the area around them. Plants absorb carbon dioxide (CO2) from the atmosphere to perform photosynthesis and create the glucose and carbohydrates they need to grow, sequestering the CO2 in the process. When CO2 is removed from the atmosphere it decreases the atmosphere's ability to trap heat subsequently cooling the planet. Additionally, plants cool the areas where they are situated through transpiration. As an area heats up plants release excess water into the atmosphere, similar to the way that humans sweat, which cools the plant as well as the surrounding environment. Large amounts of transpiration can significantly increase water vapor in the atmosphere which leads to precipitation and cloud cover in an area, enhancing the cooling effect [15].

2.1.14 Goal 14: Life Below Water.

The health of water systems such as wetlands, mangroves, coral reefs, and seagrass beds continue to decline throughout the Americas making the protection of these areas and their biodiversity more important than ever. Over 50% of wetlands in the United States, which filter and purify water of sediments and toxins and protect against flooding and drought, have been destroyed since it was settled by Europeans, with 90% of those losses for agricultural development [1]. Mangroves decreased by 10% in the Americas from 1996 to 2016. Mangroves provide habitat for many aquatic and terrestrial species as well as protecting coastlines against ocean swells and weather events

[16]. Ninety percent of coral reef cover was destroyed by 2003, since then coral bleaching, and disease have continued to reduce the remaining reef cover. Coral reefs support around 25% of all marine life and provide a buffer for coasts from storms and waves [1]. Seagrass beds have been declining by 7% per year since 1990. Seagrass beds provide habitat and hunting grounds for a number of creatures, processes wastes from seawater similar to wetlands, hold down sediment to prevent erosion. As the area of these ecosystems decreases so does the biodiversity, the resilience of these ecosystems, and the ecosystem services they provide.

As mentioned above Villanova has a number of rain gardens designed to reduce runoff and increase absorption on the campus. However, the campus is situated on a hill when it rains runoff tends to pool in certain areas because everything above is lawn and there is no flora to slow runoff and help with absorption. This creates an opportunity for runoff carrying fertilizers to move into waterways, which are part of the Chesapeake Bay watershed, which causes eutrophication. This risk should be reduced by increasing water-loving plants in and around these water catchment areas to absorb the excess water and nutrients.

2.1.15 Goal 15: Life on Land

The health of all life on land is linked to biodiversity but the way in which ecosystems and organisms are currently being used and exploited is not conducive to healthy terrestrial systems. In the Americas over 50% of habitats have been lost, leading to loss of biodiversity and ecosystem services. These losses have mainly been due to agriculture, urban expansion, timber, and now, climate change

Demand for agricultural products, the cost of farming, and loss of the cultural significance of agriculture have encouraged an evolution from many small local farms to a few massive national and international farms. This has encouraged the destruction of diverse ecosystems to create immense swaths of croplands where monocultures of annual crops are planted and cultivated. These monocultures do not provide the same, if any of the ecosystem services, food for pollinators, water retention, runoff mitigation, topsoil protection, etc., as the previous ecosystem that they replaced. Additionally, because many of the crop species planted are not native to the areas in which they are planted they are not accustomed to the soil composition or pests and require the addition of fertilizers, pesticides, herbicides, and water to survive and produce optimally. This has created wildly imbalanced ecosystems that rely heavily on human imputes and are continually depleting nutrients, topsoil, and water in the area which can lead to desertification, fires, drought, dust storms.

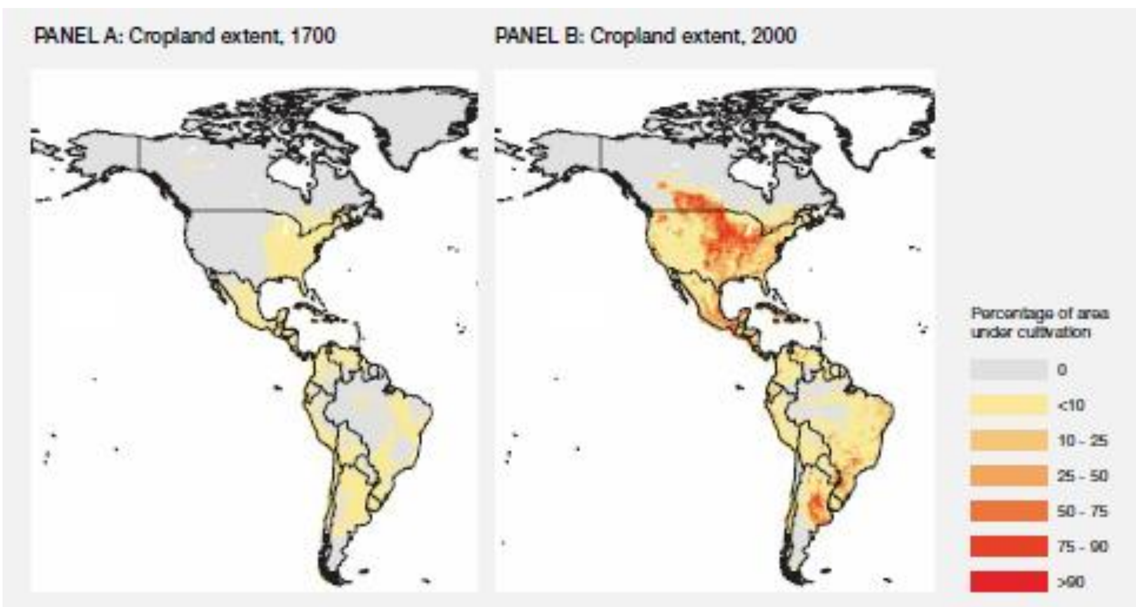

Figure 2.7: Changes in Crop Production in the Americas [1]

Some farmers and researchers have begun to question the practices of industrial agriculture and are attempting to move the sector towards more sustainable farming practices by using methods of farming based on natural systems, "Do nothing farming", and by using researching and experimenting with native perennial species as crops to increase crop and farmland resilience and decrease pesticide, herbicide, and fertilizer use, *The Land Institute*.

“Do nothing farming” is a method developed by Masanobu Fukuoka, a farmer and philosopher from southern Japan. His method has four main principals: avoid tilling, fertilizer, weeding, pesticides. He argued that these actions were only necessary because humans have created a detrimental feedback loop of “solutions” for problems created by previous “solutions”. Hard work is still involved in his method but it is hard work at the beginning, in the sowing of seeds, the determination of the crops that will thrive together and come back year after year, and learning what the plants need and how to provide that for them while adhering, as best as possible, to the four main principals once these tasks are accomplished much less work is involved for the farmer. Biodiversity is imperative for this farming method to work, as it relies heavily on the synergistic relationships of plants and animals to create healthy and bountiful crops. While this farming method was developed for family farms meant to feed families of 5-6 the significance of the four main principals is not lost when applied to industrial agriculture; however, it becomes much more difficult to execute.

Research by The Land Institute is aiming to help bridge the gap between “Do nothing farming” and industrial agriculture by creating seed mixes of high-yield, perennial grains, legumes, and oilseed crops, with supporting grasses and legumes to create scalable permaculture crops for large scale use. Annual crops account for 70% of the population’s calories and require farmers to till their fields every growing season to kill vegetation that would compete with the crops for resources. This process releases CO2 from the soil into the air, increases soil erosion, causes nutrient leakage, and changes soil microbiomes. By using perennials these problems can be avoided and the ecosystem services provided such as water retention, runoff reduction, topsoil protection, and soil microbiome health would increase greatly.

Figure 2.8: Annual vs. Perennial Crop Root Systems [17]

The impact of biodiversity on sustainable cities and communities were discussed above in goal 11. However, the way that land, specifically green space, in these areas is currently being used was not. Green space in cities and suburbs are most often neat orderly rows of trees and flowers and manicured turfgrass lawns. This type of greenspace reflects affluence in western culture where having a lawn was/is a crucial aspect of the “American Dream”. However, this type of landscape management creates poor biodiversity and stresses resources, especially in areas where lawn grasses do not take well to the soil and climate and reduces ecosystem service. An analogous approach to the agricultural interventions above should be recommended for green spaces in urban areas including the use of native perennial species while avoiding tilling, fertilizer, weeding, and pesticides as much as possible.

In the United States forests have always been sources of life and biodiversity for humans and animals alike. Forests makeup roughly 50% of the ecological regions in the United States and therefore, provide a great number of ecosystem services. North America is the largest producer of timber. The USA has one of the highest wood removal rates in North America. An integral practice of logging since its inception has been to take the biggest, best, and often oldest trees in a forest, essentially reversing natural selection. This process has removed the strongest and fittest trees, whose DNA has been shaped over millennia to survive drought, disease, pests, and weather changes, from the gene pool of future trees. This practice has made the forests of today weaker than those of the past in a time where the world is fraught with adversity for trees from invasive species, pests, disease, and climate change [18].

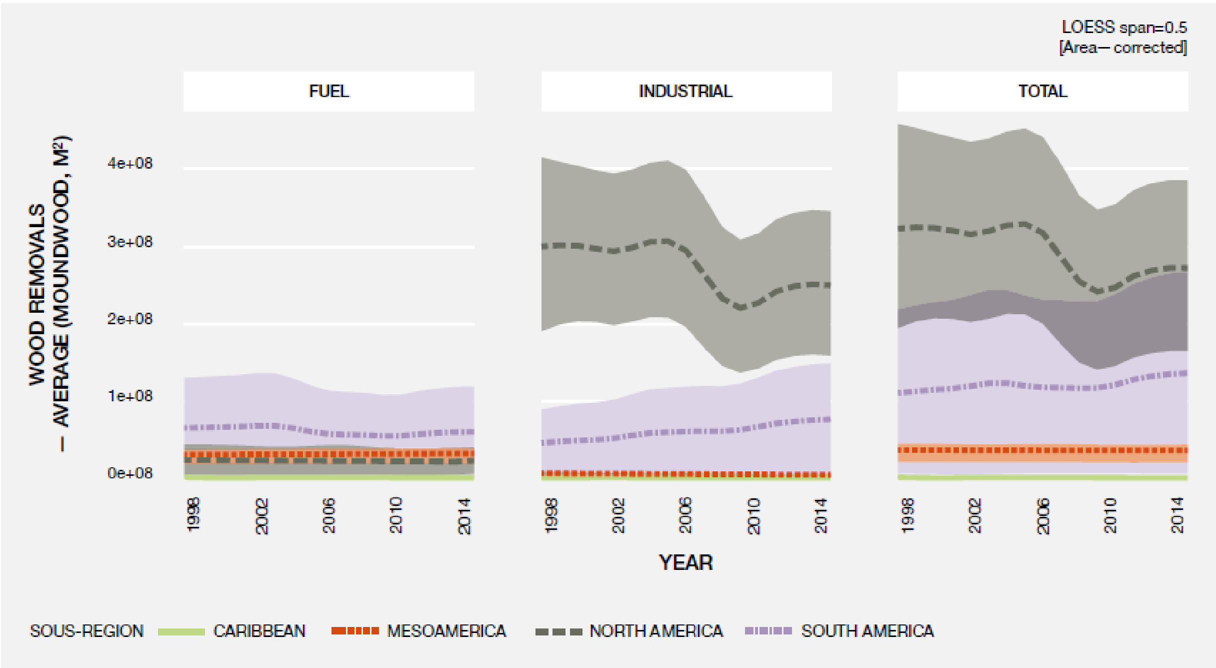

Figure 2.9: Wood Removal in the Americas by Industry Over Time [1]

The exploitation of life on land through poor management of agriculture, forests, landscapes, and other systems has created a detrimental feedback loop that is continually reducing the functionality of ecosystems, exacerbating issues associated with climate change, and negatively impacting human health. Without changing current systems the current and future health of the planet and everything that lives here will continue to decline.

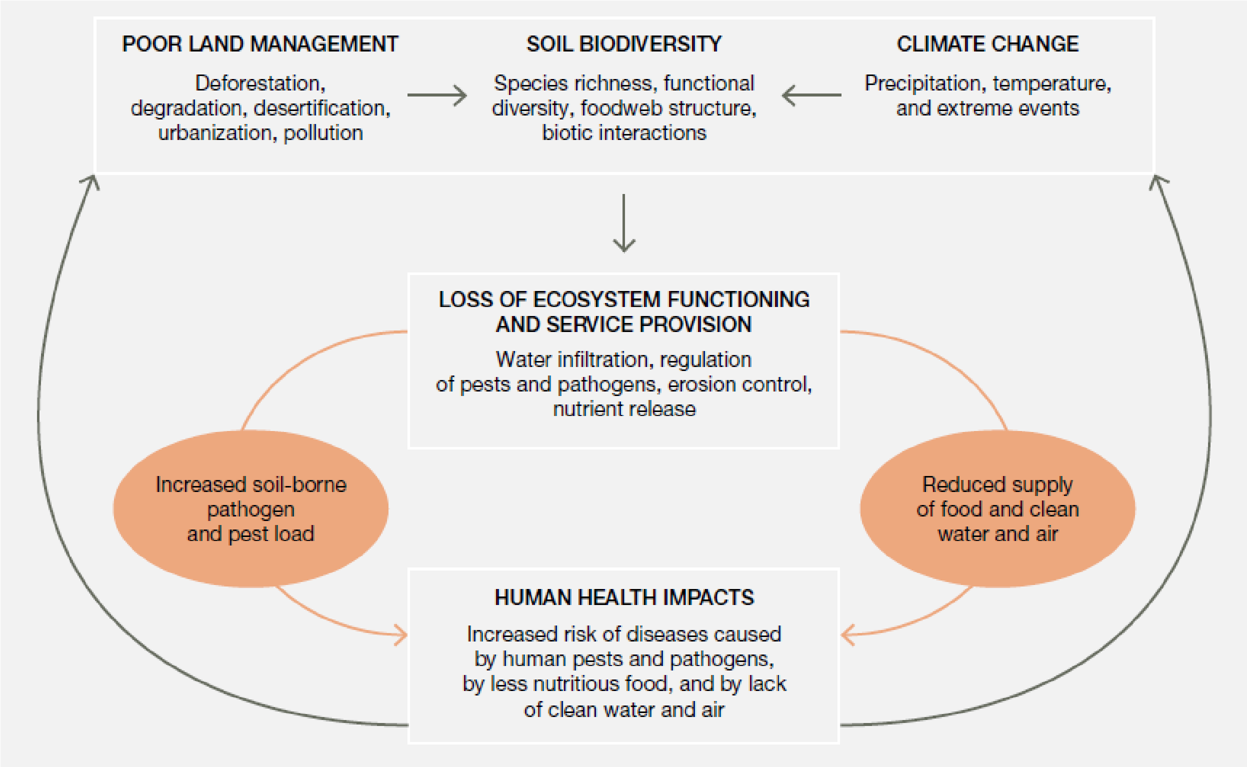

Figure 2.10: Poor Land Management Positive Feedback Loop [1]

Using more sustainable maintenance practices as well as increasing biodiversity on the Villanova University campus will begin to remediate some of these issues directly. Additionally by educating visitors and the community on the measures that have been taken, why they have been taken, and how providing an example of how homeowners, gardeners and small landholders can contribute to the mitigation of climate change, Villanova can have an impact greater than just its campus.

2.1.16 Goal 16: Peace, Justice, and Strong Institutions

Natural resources are the source of many threats to peace and injustice. In regions unable to protect natural resources and biodiversity, vital resources become scarce and infighting between citizens and among countries ensues. Borders between poorly managed and well-managed principalities are fraught with poaching and vandalism. Alternatively, large corporations and developed nations will often exploit developing nations for their natural resources and land. Developing nations can lack laws and regulations protecting their natural areas or manpower to strictly enforce the laws they do have. Companies and developed nations are then able to extract their natural resources in irresponsible ways that destroy ecosystems, reduce biodiversity, reduce ecosystem services without providing fair and just compensation for their actions. These circumstances lead to conflict within and among communities and keep powerful countries and corporations from being responsible for their impact and actions [11].

2.1.17 Goal 17: Partnerships for the Goals

The benefits of ecosystem services are shared by all people around the globe. The way that south America treats rainforests, the US obtains oil, trash is disposed of in the Philippines, or coal is burned in China affects the rest of the world. Partnering to protect shared ecosystem services benefits everyone and while some may argue that protecting biodiversity and ecosystem services will hamper economic growth these people do not understand the gravity of losing these services.

> *"When the last tree is cut, the last fish is caught, and the last river is polluted; when to breathe the air is sickening, you will realize, too late, that wealth is not in bank accounts and that you cannot eat money"* - Alanis Obomsawin [19]

2.2 Benchmarking: Sustainable Landscape Plans from Other Universities

The University of British Columbia was chosen because it is a leader in sustainability among universities and Haverford College was chosen due to the similarity of its location and size to Villanova and the measures it has taken to increase biodiversity and ecosystem services on the campus.

2.2.1 University of British Columbia

Figure 2.11: University of British Columbia Ariel Photo [20]

Figure 2.12: University of British Columbia Map [21]

The University of British Columbia (UBC) is one of the leading universities in sustainability research. The Campus Biodiversity Initiative: Research and Demonstration (CBIRD) at UBC is a campus-wide interdisciplinary collaborative effort that aims to "develop a platform of networks, projects, and research that supports biodiversity plan, policies, strategies, and actions…." [22] at the UBC campus. In its first year, 36 projects contributing to biodiversity have been completed, over 150 students have been engaged in various pertinent activities, 23 courses have involved projects, information, and results from CBIRD, 26 faculty members provided guidance, oversight, and expertise to the students, and over 30 staff and community partners were engaged in solving biodiversity issues using student research and findings on the UBC campus. CBIRD is integrated with the UBC sustainability plan, as well as the UBC strategic plan, all of which have interconnected goals and projects.

The overall mission of CBIRD is to "inform policy and practice that enhances biodiversity through research, education, campus and wider community engagement, and demonstration" [22]. Objectives for this mission are to "Cultivate biodiversity stewards by increasing public awareness and understanding of biodiversity issues and solutions" through the sustained engagement of stakeholders (students, faculty, staff, visitors, community partners, and researchers), "Advance policies and practices which address and respond to key biodiversity issues" by determining a baseline biodiversity assessment of the campus through pre-existing data, identification of areas lacking data, and creation of projects to fill data gaps followed by publicly sharing the data, and finally "Utilize the campus as a living laboratory" "advance student research that addresses the five strategic priority areas: baselining, demonstration, monitoring and evaluation, communication, and exploration of tools and mechanisms to support biodiversity on the Vancouver campus" [22].

The main focuses of CIBIRD in the first year were mainly focused on baselining. The projects pursued were advancing biodiversity, initiation of the creation of an urban forest management plan, green building plan, biodiversity strategy, and whole systems connection. Advancing biodiversity was done by connecting with the UBC community, through a biodiversity showcase, to make them aware of biodiversity issues and solutions and to provide opportunities for involvement with CBIRD. Additionally, a wide range of biodiversity data was collected by students to help determine the status of biodiversity on the UBC campus and by extension shape the development of other initiatives and projects as well as the emerging University Biodiversity Strategy. This data is also being used to create an open-source interactive map of the natural assets on campus.

CBIRD's strength is in its clear organizational structure of mission, objectives, and key actions which are backed by tremendous involvement of various university departments, students, professors, and community members. It also has a well-organized methodology for plan development represented by its strategic priority areas: baselining, demonstration, monitoring and evaluation, communication, and exploration of tools and mechanisms to support biodiversity.

2.2.2 Haverford College

Haverford is committed to sustainable landscaping and care of its campus and it shows. “We consider our campus a treasure and take seriously our responsibility to care for it”. The Arboretum and Grounds division is responsible for lawns, tree care, new plantings, and flower beds

The campus is split by grounds into different zones with the ground cover in each being maintained in different ways. At the heart of the college is center campus which is where the administrative offices are located and convocation occurs. In this area fine turf is planted and receives intense maintenance, it is aerified at least once a year, fertilized 4 times a year, overseeded annually, monitored for broadleaf weeds and sprayed when needed. Fine turf is present in other areas of campus but is minimized. The second section is the area of campus that radiates out from center campus where academic buildings and dorms are located. These areas are secondary turf areas and comprise 60% of all mown turf on the campus, these areas also require maintenance but it is much less rigorous, it is only aerified if the ground is extremely compacted, receives organic fertilizer 3-4 times a year, and broadleaf herbicides are only used in cases of large breakouts. The next area is athletic fields, of which there are two kinds, game fields, and practice fields. There are a total of 10 fields and each is aerified once a year, organic fertilizer is applied 4 times a year, and they are overseeded annually. Game fields may receive a second aerification, fungicides, monitored for broadleaf weeds which are spot sprayed, pesticides are applied when needed. Finally, there are minimally managed natural areas which are only mowed every six-to-eight weeks and meadows which are brush hogged once a year. Grass clippings from mowing in all areas are not collected and provide nitrogen to the soil, leaves are composed for the on-campus community garden, woody tree and bush clippings are chipped and recycled into mulch, and all trees that are removed are chipped and recycled unless they are too large in which case they are shipped to plywood plants or split for firewood.

The campus is also an arboretum and has a number of wooded areas in and surrounding the campus. The wooded areas on the outer edges of campus have a two-mile nature trail for visitors and community members to use. This area is left relatively wild and has the following layers: canopy, understory, trees, shrubs, and herbaceous vegetation. In this area, maintenance includes invasive remediation, trimming or tree removal in accordance with risk management, and replacement of dead trees with new saplings occurs dense tree canopy.

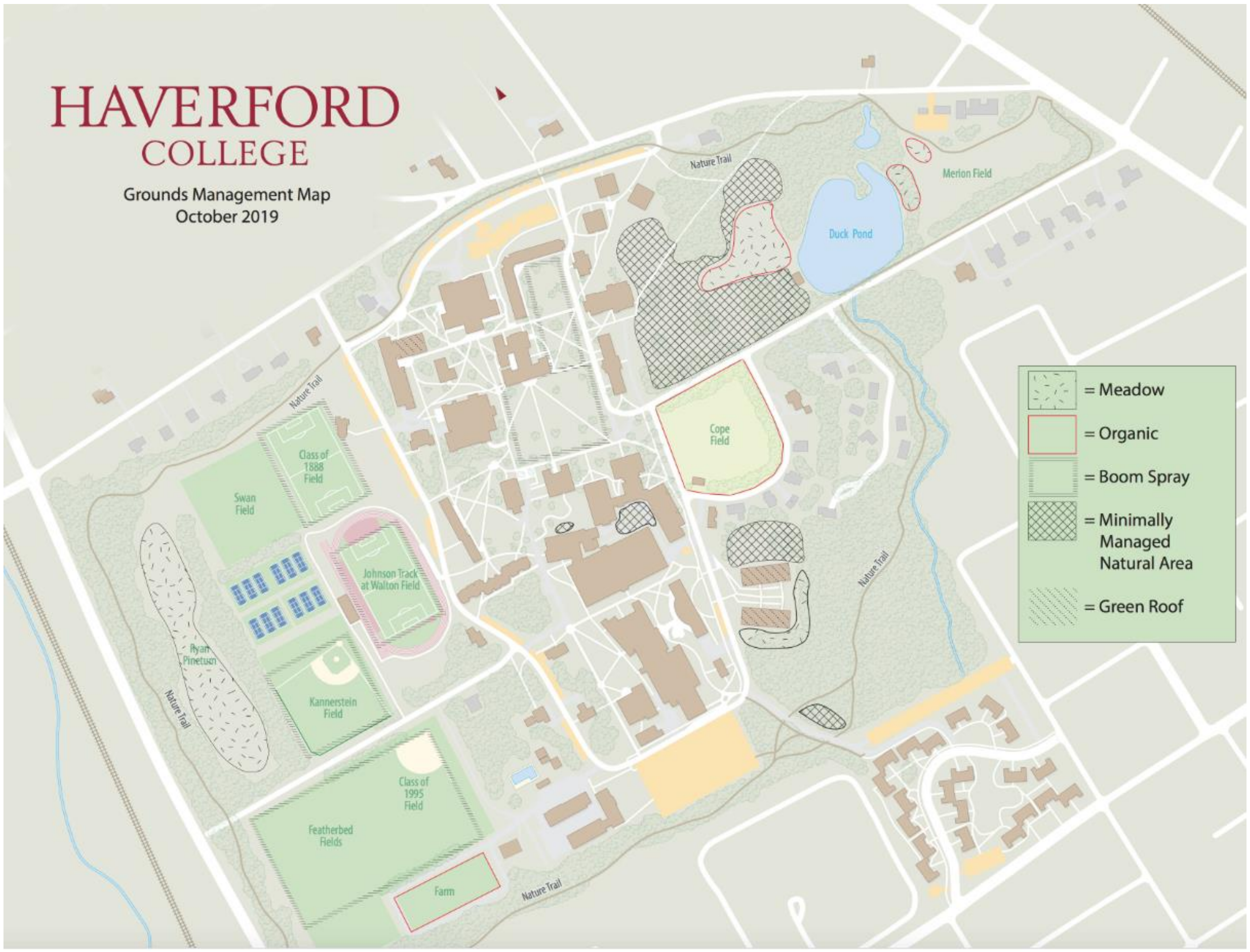

Figure 2.13: Haverford College Grounds Management Map [23]

2.3 Landscape Planning Concept

2.3.1 The Living Landscape

To provide the greatest benefits for all organisms (aesthetics, ecosystem services, food, habitat, recreational space, etc.) human landscaping should mimic the structure and composition of surrounding natural landscapes as much as possible, incorporating the needs of the human users as well as the needs of the native flora and fauna. Natural landscapes are made up of a number of horizontal and vertical layers where each layer contributes to the richness and diversity of the landscape. The landscape of Villanova and the surrounding suburbs should be that of a temperate forest [24], however, areal images from google earth, show that these human-created landscapes are much simpler than their natural counterparts and lack many of the layers needed to create healthy thriving ecosystems. While there are patches of woodlands, meadows, and wetlands they have been fragmented by the simplified landscapes, with fewer less diverse plantings, which make it difficult for diverse populations of wildlife to thrive. Reintroducing layers increases biodiversity of flora and fauna and helps to restore biological function to landscapes and contributes to increasing the number of ecosystem services [25].

> *"No matter how much any individual garden may seem like a separate place, a refuge, or an island, it is in truth part of the larger landscape, and that in turn is made of many layers…The richness of life in any given landscape is generally linked to the richness and intricacy in its layering"* – The Living Landscape

Natural landscapes are richly layered and can provide patterns and processes as to how human landscapes should be designed to create ecologically healthy areas. In Table 2.2 the layers found in natural landscapes of forests are listed.

Table 2.2: Layers of Natural Landscapes

Layers in a Landscape	
Vertical Layers	**Horizontal Layers**
Canopy	Dynamic Edge
Understory	Wet Edge
Shrubs	Wetlands
Herbaceous Plants	Meadows and Grasslands
Ground Layer	

Beginning with the vertical layers and starting at the top, the first layer is the canopy. The canopy is formed by the crowns of the tallest trees reaching up to the sky to absorb sunlight for photosynthesis. This layer receives the most sunlight and is the most photosynthetically productive so it is often responsible for providing the energy for flowering, fruiting, and seed production. The layers below only receive light that has been filtered by the canopy or light that passes through openings in the canopy which greatly influences the growth of the plants in the area below. Additionally, the canopy influences air quality and temperature. During colder seasons, late autumn, winter, and early spring deciduous trees do not keep their leaves which allows sunlight to pass through the canopy and reach the forest floor, the canopy also reduces air movement and protect against wind making air temperatures in a forest higher than those outside of it. During warm seasons, late spring, summer, and early autumn, the canopy is in full leaf, the leaves provide shade as well as respiration for the trees creating a cooling effect within forests. The canopy also provides habitat for a number of plants such as vines, epiphytes, and lichens, and animals such as birds, insects, and small mammals [25].

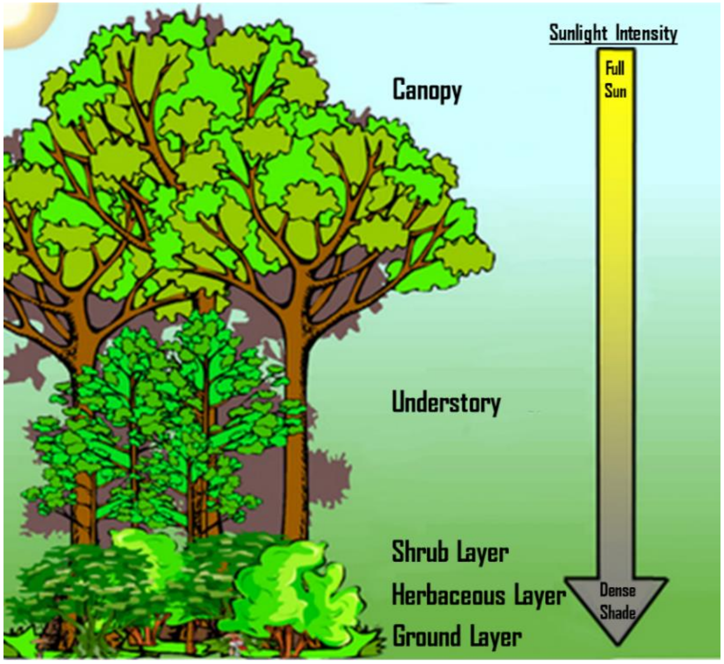

Figure 2.14: Vertical Layers in Natural Landscapes [26]

Below the canopy the tree understory which is made up of young trees that will eventually grow tall enough to become part of the canopy and shorter trees that will never reach canopy height. Young canopy trees are essential for the continual replacement of canopy trees as they die off and the shorter growing trees are essential for creating mid-story habitat. The majority of understory trees are able to grow in low light for extended periods this allows the canopy trees to survive until there is an opportunity for growth to the canopy layer and the shorter growing trees to survive indefinitely below the canopy [25].

The next layer is the shrub layer which is made up of woody multi-stemmed plants that are shorter than most trees. This layer occupies the space between the ground to 15 to 20 feet high. The shrub layer greatly contributes to habitat richness and diversity by providing shelter, seeds, berries, and fruits to sustain wildlife [25].

Below the shrub layer is the herbaceous layer, this is one of the most diverse layers and is comprised of fauna with non-woody stems such as wildflowers, ferns, and young seedlings. This layer occupies the area from the ground to around 4 feet high, the approximate height of most non-woody plants. Competition between plants for light in this layer is intense and the winners of these competitions shape the species composition and structure of the forest. Additionally, the interactions between herbaceous plants and animals in this layer also affect the future composition and functions of the forest [25].

The ground layer is the final vertical layer in a natural landscape and is where organic matter accumulates, decomposes, and nutrients are returned to the earth to be used again by plants. The accumulation of these materials on the forest floor conserve soil moisture, replenish nutrients through the transformation of organic materials facilitated by fungi, detritivores, and some mammals, and provide microhabitats for smaller organisms. The ground layer is stratified with large pieces of recognizable organic matter at the top and unrecognizable decomposed matter at the bottom [25].

Horizontally dynamic edges exist were two different habitats or ecosystems meet. The edge can be recognized by changes in biotic and/or abiotic elements from the two adjacent areas. Some edges can have stark differences making them easy to identify while others may have more subtle changes. With edges come ecotones, transitional zones between adjacent ecological systems. Edges and ecotones have ever-changing flows of resources and organisms making them areas of relatively high biodiversity, however, excessive edges with high levels of disturbances to the adjacent habitat can dramatically reduce diversity. Edges provide increased light and airflow to plants living there making them healthier and allowing them to produce more seeds and fruit [25]. A specific type of dynamic edge, where an ecosystem meets wetlands, lakes, streams, or consistently wet ground, is called a wet edge. Wet edges suppress tree growth and create areas where other plants can throve depending on their shade tolerance as well as their tolerance of wet and moist conditions. These plants protect edges against soil erosion into the water and create habitat for aquatic and terrestrial organisms.

Dynamic edges often horizontally separate forest from wetlands, meadows, or grasslands. Wetlands are not often found in residential areas, however, there are often areas of land where the ground is consistently wet and can benefit from being planted with water-loving species of plants to reduce runoff, increase water retention, mitigate flooding. Meadows and grasslands are highly biodiverse but in the northeastern United States most areas are predisposed towards woody plants and forests. Apart from some areas with consistently high moisture or soil composition that does not facilitate woody plant growth, almost all meadows and grasslands at present are a result of disturbances to the natural landscape caused by farming, logging, industry, etc. Meadows and grasslands are meant to be a transitional and, without intervention, will eventually be overtaken by woody vegetation.

The combination of these layers of native flora and their interactions with each other and the animals that live in and around them create complex communities that have evolved together over long periods of time. The members of these communities are genetically coded to work together, balance one another, and provide services to one another. While these tasks are unbeknownst to the organisms involved, they are essential to the survival of the organisms within the community. It comes as no surprise that these communities are more functional, productive, and stable the greater their biodiversity due to the complex relationships that have been forged between species to provide essential services to one another. Overlap does occur in the roles that species play in a community, however, even with this redundancy the loss of a species from a community causes reductions in functionality, productivity, and stability because some species are better or more specialized than others at certain roles [3].

3 METHODOLOGY AND DATA COLLECTION: PLANNING PROCESS

3.1 Methodology

An organizational framework is necessary for any landscape plan. It provides the planner with the information needed to provide their client with a comprehensive plan. The plan that will be created for Villanova needs to meet the goals and needs of the University, as well as, those of the environment. Because of this, the ecological planning method was chosen to provide the methodology framework for creating a landscaping plan to increase biodiversity. This process assesses biophysical and sociocultural information to provide solutions and constraints for decisions made about the landscape. Assessing these factors helps to determine how land should be allocated and used in a way that provides the most benefits to all, humans, animals, plants, and the environment, with the fewest drawbacks [27]. The ecological planning method has 11 steps interconnected steps, as shown in Figure 3.1. Arrow size represents the amount of influence each step has on one another.

- Step 1, a problem or issue that affects people, the environment, or the relationship between people and their environment is identified.
- Step 2, a goal is established to remedy this problem based on the wants and needs of the community.
- Steps 3 and 4, regional and local landscapes are analyzed and inventoried based on their biophysical (soil, water, etc.) and sociocultural (aesthetic, recreational, etc.) use.
- Step 5, studies are conducted linking the analysis to the established goals and problems.
- Step 6, Landscaping concepts, options, and choices are determined based on the studies and the goals that the community wishes to achieve.
- Step 7, A plan is created based on the best concepts, options, and choices presented.
- Step 8. The plan is presented to the community and relevant parties are involved. Step 9, detailed designs are explored based on the above factors.
- Step 10. The plan is implemented.
- Step 11 the plan is monitored and evaluated over time to ensure that it is meeting the set goals.

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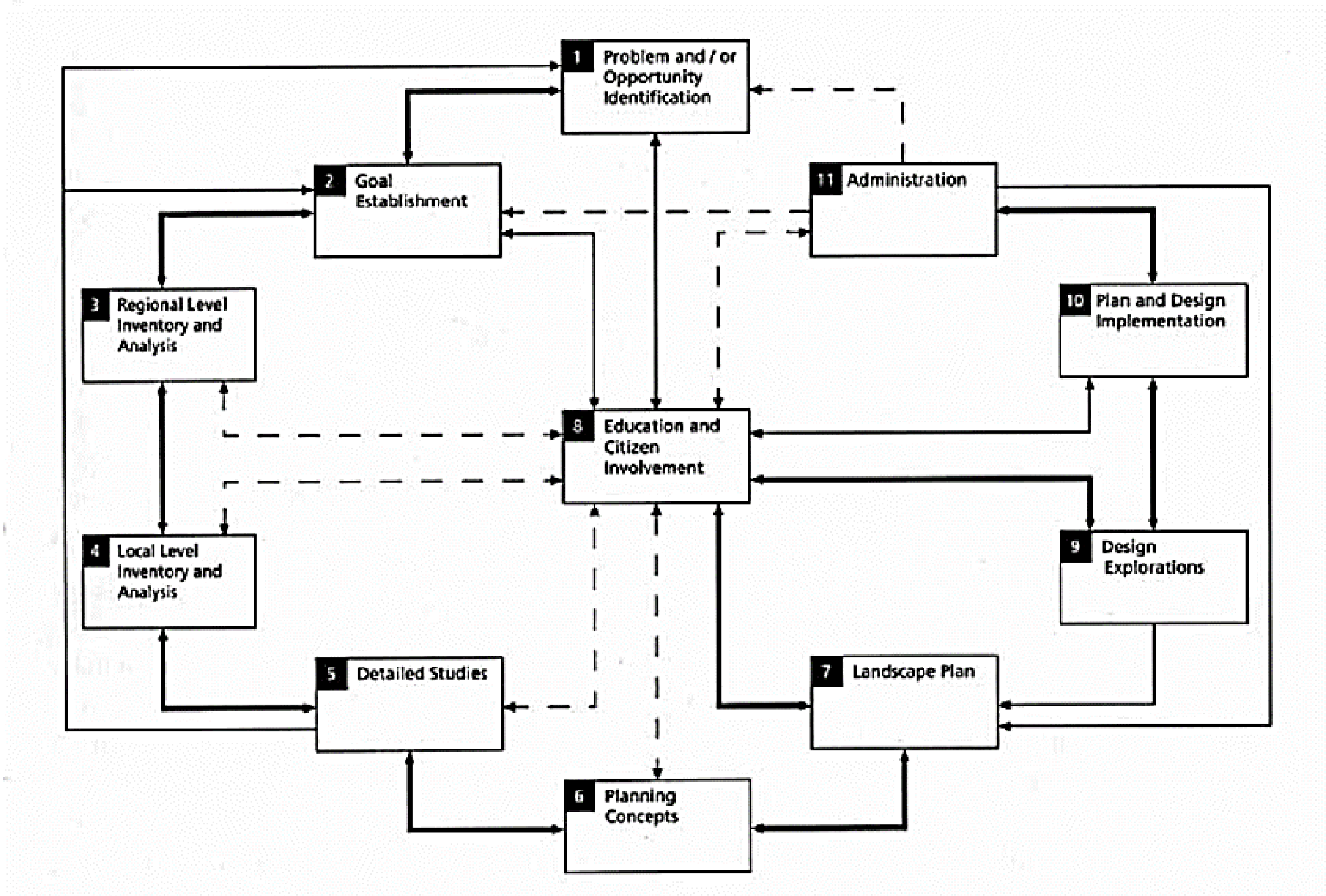


Figure 3.1: The Ecological Planning Method Flow Diagram [27]

Each of these steps has been addressed in the paper or will be addressed in great detail later in this chapter, however, they have been presented in a different order for better flow of information leading up to the plan.

4 DATA COLLECTION AND RESULTS: INVENTORY AND ANALYSIS OF THE BIOPHYSICAL ENVIRONMENT

Collecting and analyzing information on the physical and biological components of an area is crucial to creating a successful plan that holistically achieves its goals, benefits ecosystems, and satisfies the needs of all of the land users.

4.1 Landscape Analysis, Regional and Local

The region being assessed is southeastern Pennsylvania, as defined by the Forest Inventory and Analysis Program and shown in Figure 4.1, more specific analysis assesses the area within Delaware county, at the location of Villanova University when possible (location is indicated by the star on the map below). The assessment will take into account the historical and current biophysical landscape in the region, county, and university location which will include geological structure, climate, and ecosystems.

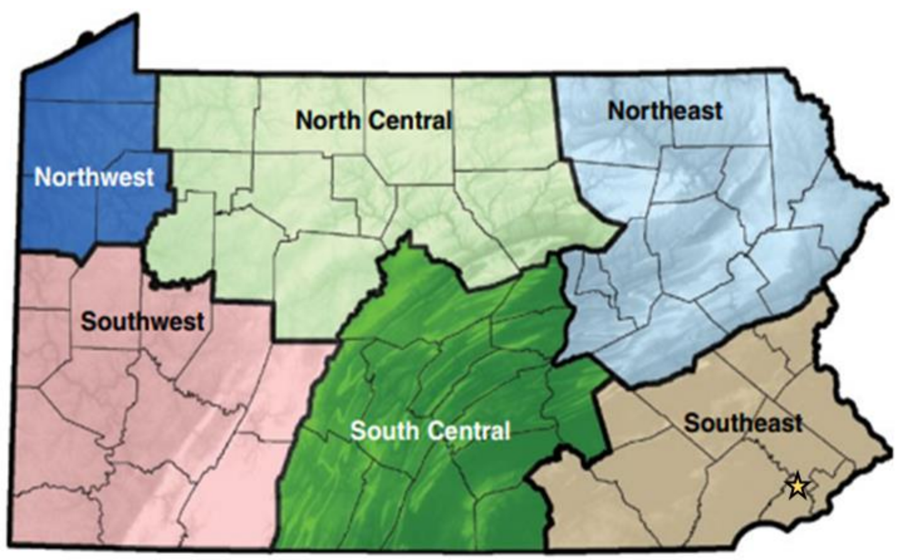


Figure 4.1: Regions of PA by Forest Inventory and Analysis Program [28]

4.2 Geological Structure

Southeastern Pennsylvania is made up of two major topographical sections, the Piedmont Plateau and the Coastal Plain. Villanova is located in the Upland Section of the Piedmont Provence [29] as shown in Figure 4.2: Physiographic Provinces of Pennsylvania . The dominant topographical form in this area is “broad, rounded to flat-topped hills and shallow valleys” with very low changes in elevation. The lack of large elevation changes in this terrain influences the drainage pattern of water to be dendritic, starting from the main source and branching out into smaller and smaller channels (similar to trees or human veins). The Geologic structure is extremely complex folded and faulted and the underlying rock types are schist, gneiss, and quartzite with some saprolite. [29]

The geological factors listed above create the landscape of Piedmont Provence, “Rolling or undulating uplands, low hills, fertile valleys, and well-drained soils.” [30]. These features coupled with the climate in the area have provided pastures, productive agricultural land, and short transportation of goods to markets in cities making the Piedmont Provence a leading agricultural location in Pennsylvania. “Some of the most popularly grown crops in this area are apples, peaches, and cigar leaf” [30].

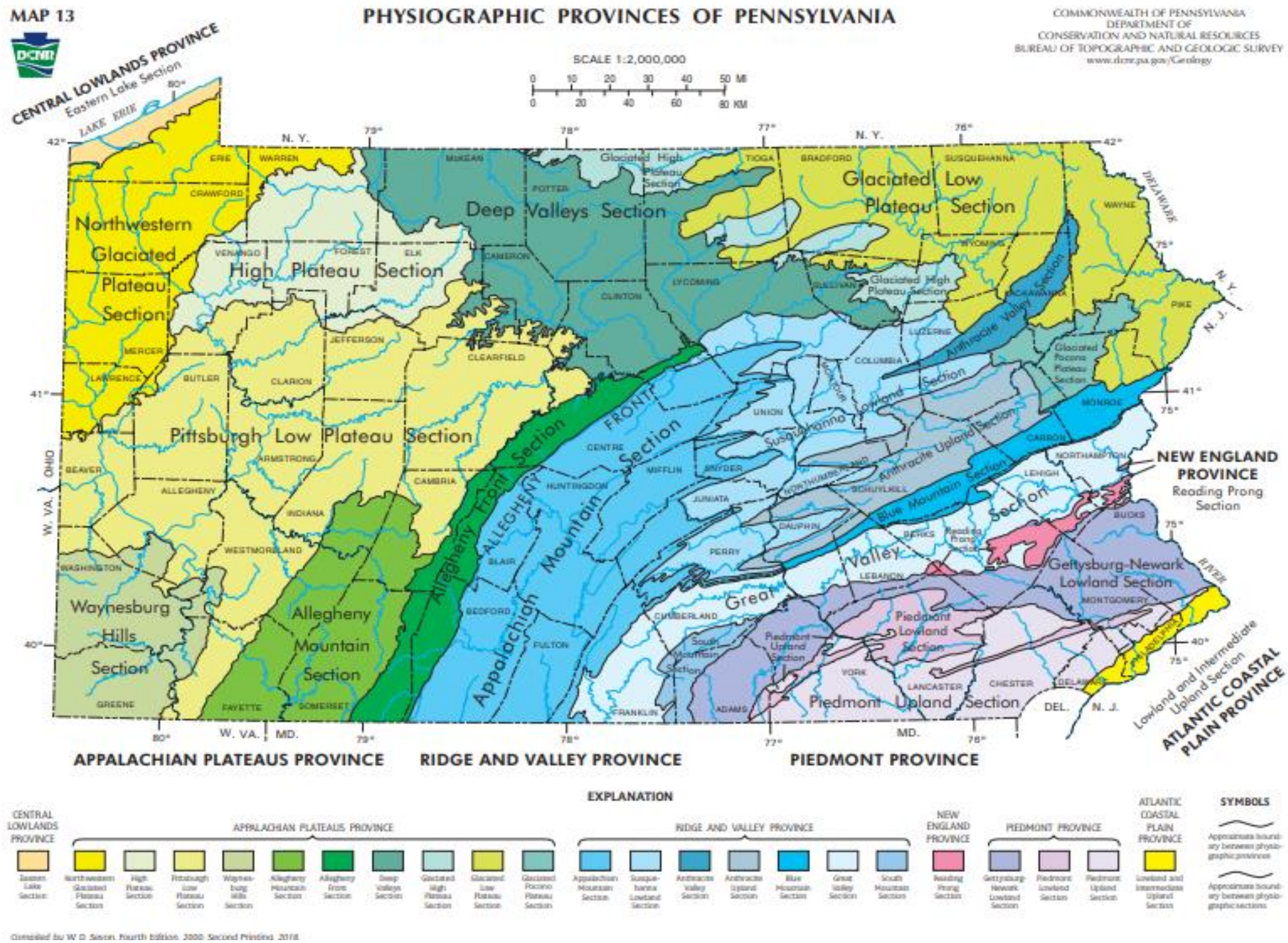


Figure 4.2: Physiographic Provinces of Pennsylvania [29]

4.2.1 Climate

Global climate change has spurred interest in the study of weather patterns due to the destructive pattern of major weather events. Droughts, floods, tornadoes, etc. all result in damage to human and natural landscapes, significant economic costs to individuals, communities, and municipalities, and, in worse case scenarios, can cause injury and loss of life. Local actions have been linked to global and regional weather patterns in a number of ways so the importance of understanding the regional climate is vital to creating a landscape that will not exacerbate weather-related issues in an area and help to mitigate issues that may be caused by climate change [27].

The regional climate, or macro-climate, comprises of the meteorological conditions of a large area over a long period of time. The macroclimate in an area is affected by the physical characteristics of a landscape such as mountains, water bodies, prevailing winds, and latitude. Conversely, the macroclimate affects physical characteristics through the weathering of terrain and ecological characteristics through the amount of precipitation. In this section, the Koppen Classification which takes into account average temperatures, average precipitation, prevailing winds, and relative humidity will be inventoried [27].

The Koppen climate classification was developed by the climatologist Wladimir Koppen based on his experience as a botanist. The system was meant to be used to analyze ecosystem conditions to identify types of vegetation present in different climate zones. The classification uses a series of three letters to categorize areas based on five main climate groups, precipitation, and seasonal temperatures respectively. The first letter in the classification represents one of the five main climate groups which are defined by temperature criteria (except group B) and are A: Tropical, B: Arid, C: Temperate, D: Continental, and E: Polar. The second letter subdivides each of the main climate groups based on the amount and seasonality of precipitation and the third letter represents the seasonal temperatures i.e. the warmth of the summer or the coldness of the winter [31]. Two tables (Table A.2: Detailed Koppen Classification Criteria of Major Climatic Types and Table A.3: Simplified Koppen Climate Classification Descriptions) detailing the Koppen Classification System are located in the appendix. The first shows the details of classification and the second shows simplified descriptions of each letter and what the letter means.

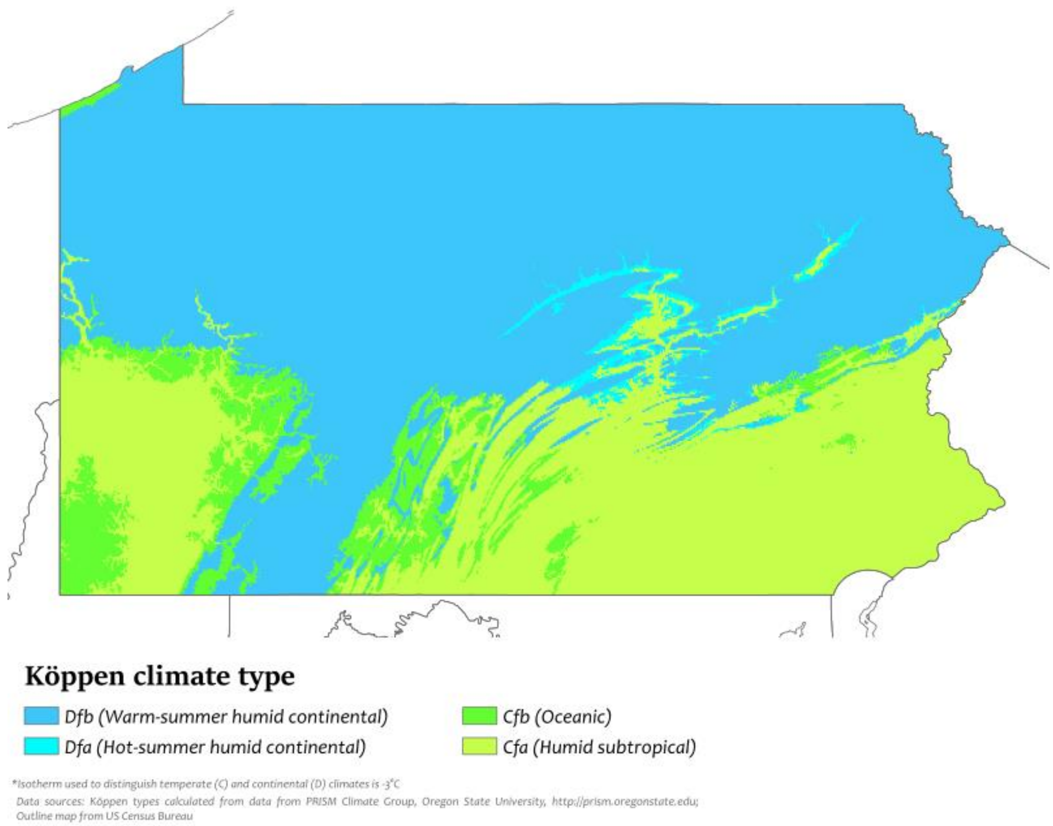


Figure 4.3: Koppen Climate Types of Pennsylvania [32]

The majority of Pennsylvania has a Kippen Climate of Dfa, moist-mid latitude climate with cold winters, while Southeastern Pennsylvania has a Koppen Climate of Cfa, moist-mid latitude climate with mild winters [33] [34]. To confirm this for Villanova data 2010 to 2020 weather data from NOAA on the maximum and minimum monthly average temperatures and average monthly rainfall in the Philadelphia Area were analyzed. The relevant data is shown in Figure 4.4 and Figure 4.5.

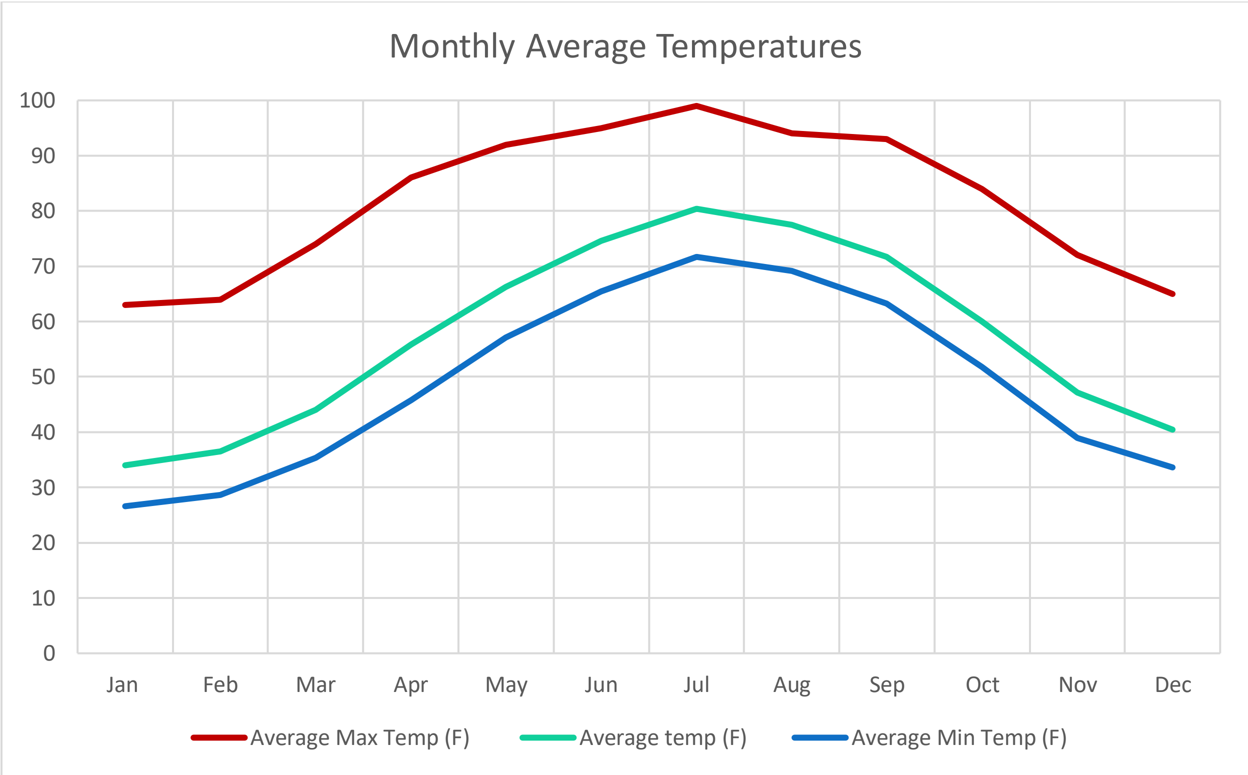


Figure 4.4: Monthly Average Temperatures in the Philadelphia Area

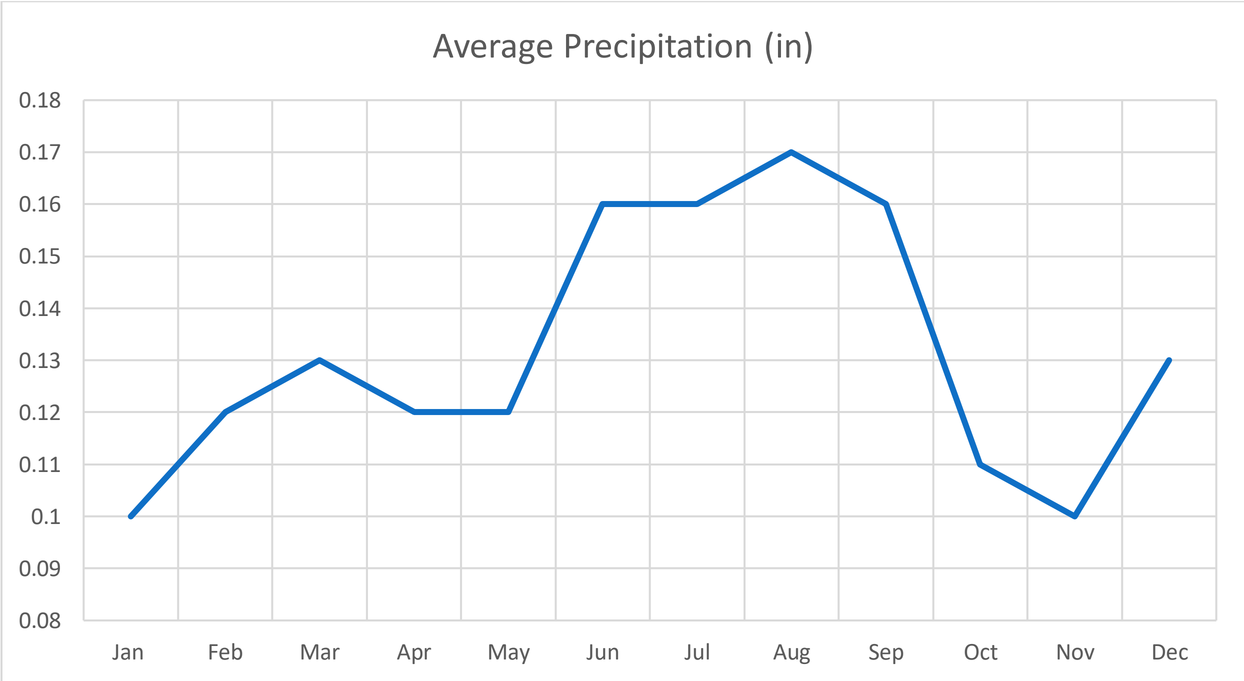


Figure 4.5: Average Precipitation in The Philadelphia Area

Figure 4.4: Monthly Average Temperatures in the Philadelphia Area depicts the monthly average maximum, average, and minimum monthly temperatures from 2010 to 2020. To be categorized as, C (Temperate), the first letter in the Koppen classification, the average temperature of the warmest month must greater than or equal to 50 °F and the temperature in the coldest month must be less than 64.4 °F but greater than 26.6 °F. In the Philadelphia area the average of the coldest month, 26.6 °F, and the average of the hottest month, 99 °F. For the categorization, f, precipitation is fairly evenly distributed throughout the year (no significant wet or dry season). Finally, for the categorization, the average temperature of the warmest month mist be greater than 71.6 °F.

Due to the onset of climate change, in addition to the assessment of historical conditions in the area, prospective future conditions have also been loosely assessed to show where temperature and precipitation will be heading in the future. This was done by assessing historical data on average temperature and precipitation from 1900-2019 and 1980-2019 using NOAA data. These two time periods were used to show changes over a long period of time as well as changes more recently that have occurred. The data sets were compiled into line charts and a linear trendline was added to each to show whether the values were increasing or decreasing over time. In both the 1900-2019 and 1980-2019 graphs the trendline showed positive temperature increase over time where the 1980-2019 graph's trendline line has a slope of .26 which is five times greater than that of the 1900-2019 graph, which is .02, indicating that average annual temperature is increasing more quickly than before and that annual average temperature will continue to increase in the future. This result was expected with the onset and progression of climate change. The trendlines for annual average precipitation also had positive slopes indicating a future increase in annual precipitation with the trendline for 1980-2019 having a slope that is twelve times greater than that of the 1900-2019 graph.

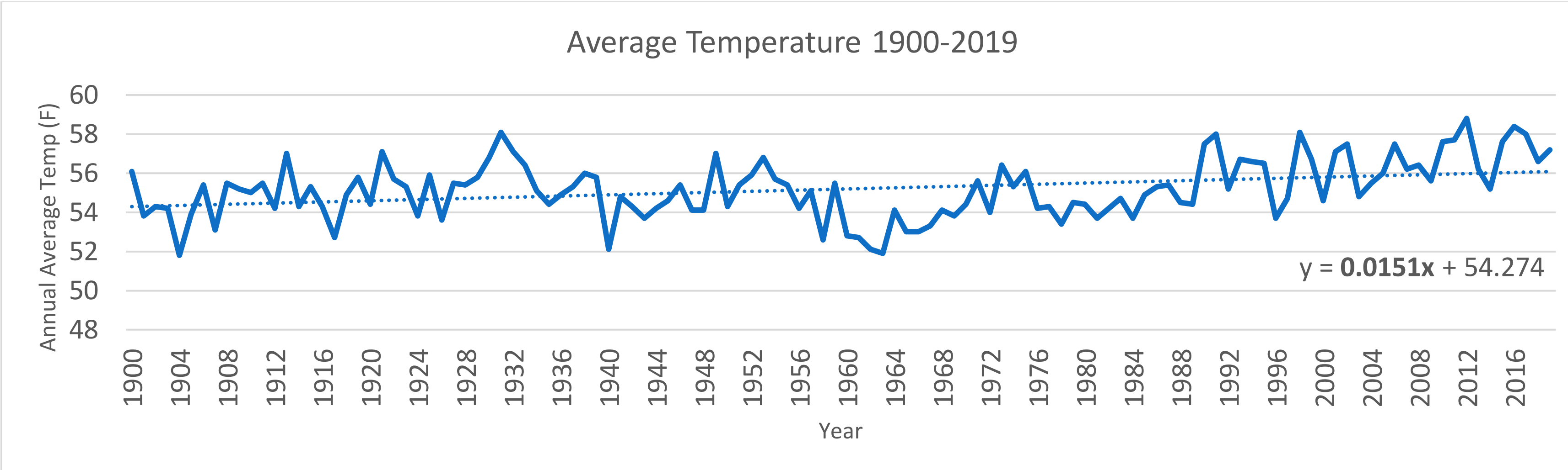


Figure 4.6: Average Annual Temperature Philadelphia Area 1900-2019

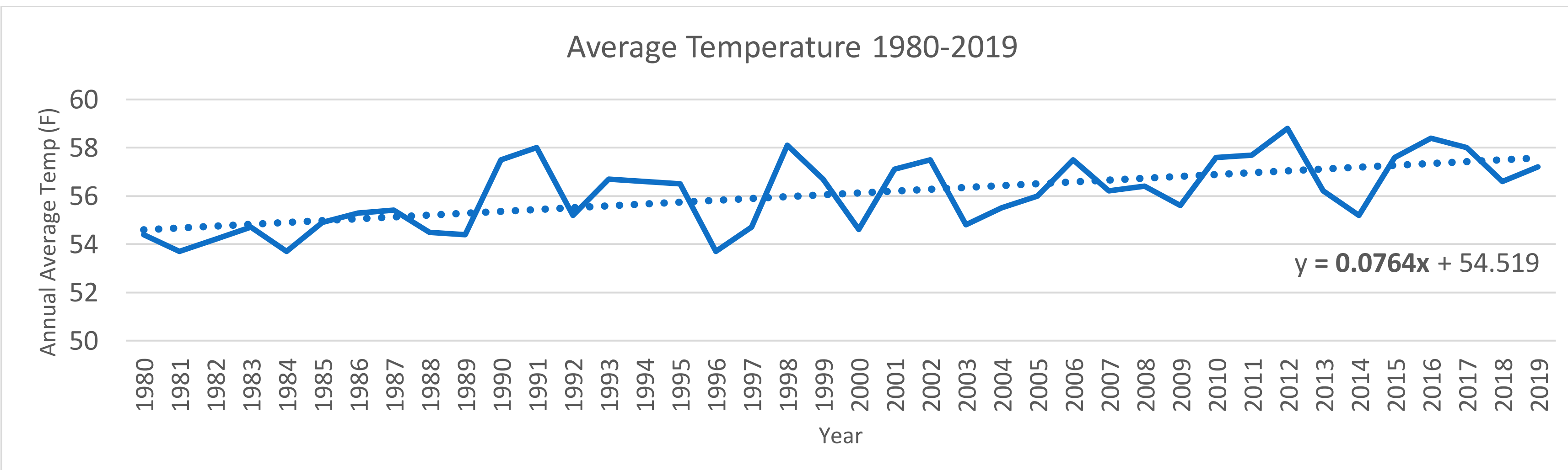


Figure 4.7: Average Annual Temperature Philadelphia Area 1980-2019

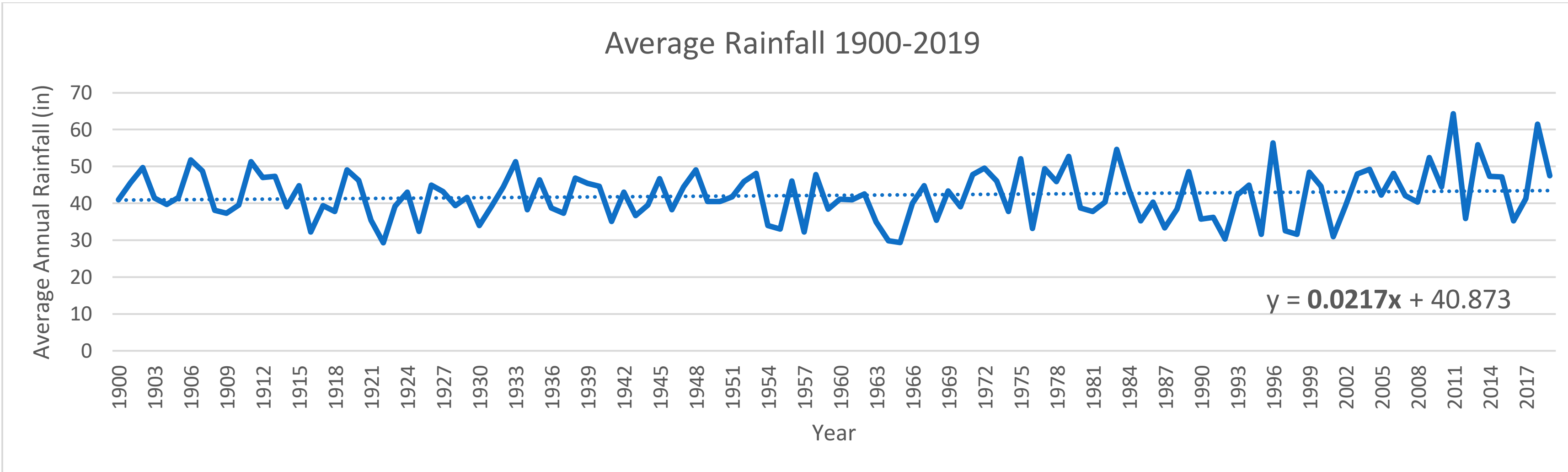


Figure 4.8: Average Annual Rainfall Philadelphia Area 1900-2019

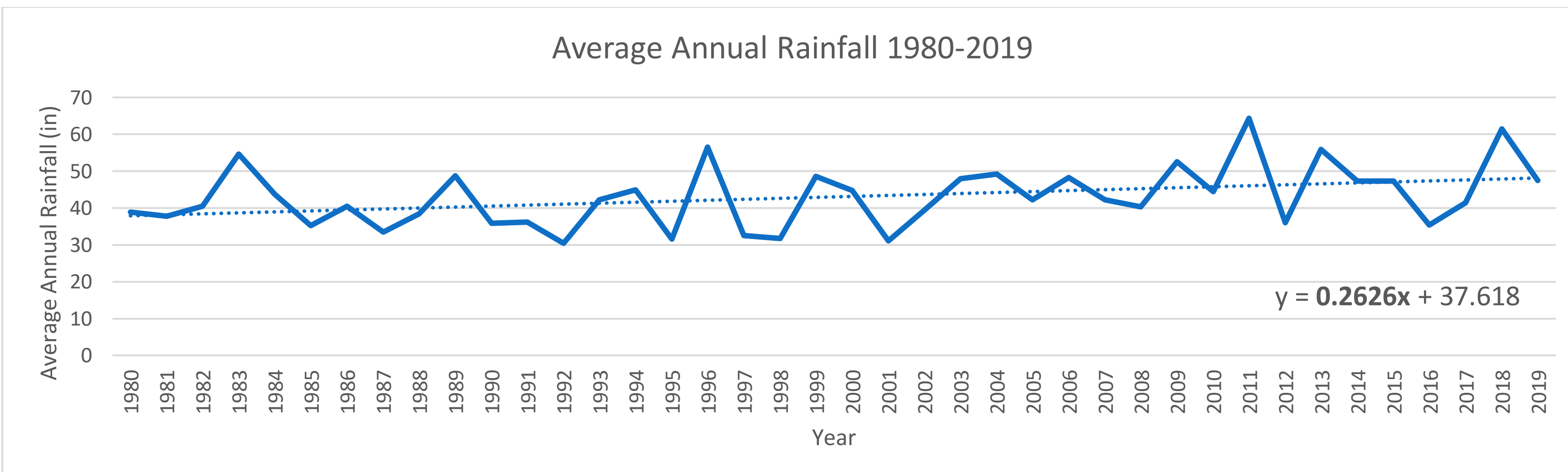


Figure 4.9: Average Annual Rainfall Philadelphia Area 1980-2019

Despite these changes in temperature and precipitation, the Koppen classification for the area will stay the same, however, the average temperature in the area is highly likely to continue to increase and the average precipitation is likely to increase as well. This information will be important in determining the type of plants that should be planted on the campus, heat and water-tolerant shade providers, as well as the types of plantings that should be added to the campus, rain gardens and wetlands.

Climate occurrences that are not taken into account for the Koppen classification but still important for developing a comprehensive plan are prevailing winds, sunny days, and humidity. Pennsylvania is located between 30°N and 60°N which is where westerly prevailing winds are found. The winds in Pennsylvania primarily come from the southwest during the summer and the northwest during the winter [35]. The average annual speed for these winds is 9.3 mph [36]. The average percent of sunny days is 55%. The average morning humidity is 76% and the average afternoon humidity is 54%.

Notable weather events that have not yet been addressed are flooding, thunderstorms, and tornadoes. Flooding can occur during any time of the year from heavy rainfall but flooding most often occur in the spring during March and April due to the combination of heavy rains and snowmelt. Flooding is expected at least once per year. Thunderstorms occur in the summer months and are responsible for the majority of summer rainfall. There are an average of 30-35 thunderstorms per year. Tornadoes occur most often in June followed by July and August. There are an average of 5-6 tornadoes observed annually in Pennsylvania, and at least one tornado has occurred in every country based on historical records. [30]

Table 4.1: Summary of Climate Information

Summary of Climate Information	
Koppen Climate Type [33]	Cfa, moist-mid latitude climate with mild winter
Average Annual Maximum Temp [37]	98 °F
Average Annual Temp (°F) [37]	53.2 °F
Average Annual Minimum Temp [37]	1 °F
Average Annual Rainfall (in) [37]	46.22 in
Prevailing Winds [35]	Westerly Prevailing Winds Summer: Southwest Winter: Northwest
Average Annual Windspeed [36] [38]	9.3 mph
Average Annual Sunny Days (%) [39] [38]	55%
Average Annual Number of Clear, Partly Cloudy, and Cloudy Days [40] [38]	Clear: 93 Partly Cloudy: 112 Cloudy: 160
Average Annual Humidity (%) [41] [38]	Morning: 76% Afternoon: 54%
Notable Weather Events	Flooding Thunderstorms Tornadoes

4.2.2 Regional Ecosystems

400 years ago, when early European settlers arrived in Pennsylvania the area was almost completely covered by forests. The land was slowly cleared by settlers for agriculture, fuel, housing, and manufacturing. As America grew so did the demand for resources, arable land, and shelter which increased the pace of land clearing. By the early 1900, the majority of Pennsylvania's forests had been cut down. The Department of Conservation and Natural Resources (DCNR), as well as other groups, have been carefully managing forests for the last century which has helped to restore forest cover to around 60% of Pennsylvania [42] where 96% of this forest area is timberland, land that has trees large enough to be harvested and that is capable to productivity over a long period of time [43]. There is very little forested area where Villanova is situated. Southeastern PA has the lowest percentage of forestland in the region (See appendix Table A.4:

Distribution of Forest Land in PA by Region), and the forest area that does exist is heavily fragmented by agriculture, residential, industrial, and other land use.

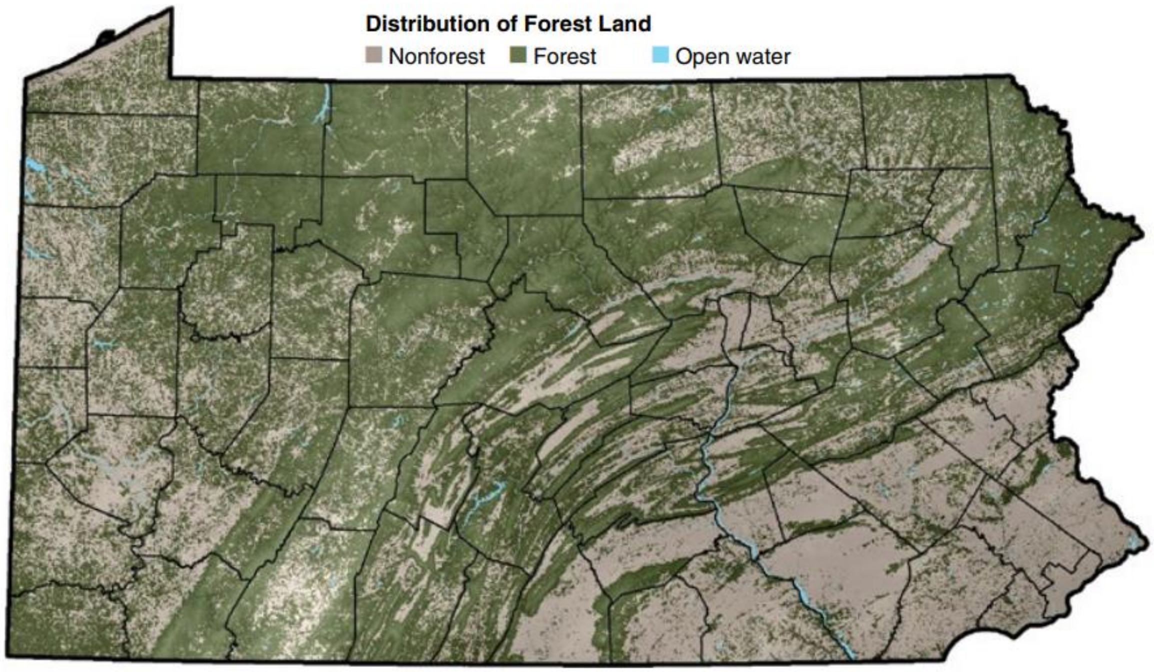


Figure 4.10: Distribution of Forest Land [28]

From 1965 to 2013 the area of forest land in Pennsylvania has been stable with only small fluctuations in the overall area. This is because losses of forestland due to development or other uses have been equal to the land being reverted to forests [44]. However, a downturn began in 2013 and from 2013 to 2018 forest area has been reduced by a quarter of a million acres [45]. Annual tree mortality increased 10% in 2016 and 18% in 2017 this continuing increase of mortality can be attributed to a number of different factors, invasive species such as the emerald ash borer, hemlock woody adelgid, spotted lanternfly, Japanese bittersweet, and others, climate change, increasing winter temperatures, overpopulations of white-tailed deer, disturbances (excessive and lack of), and fragmentation of forests [28].

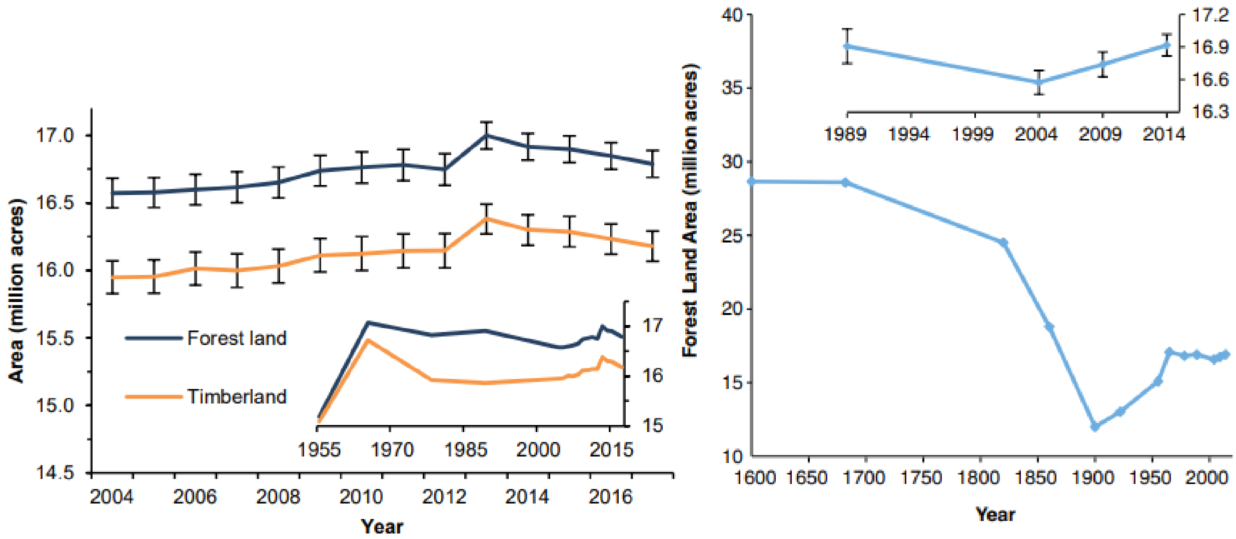


Figure 4.11: Area of Forest and Timberland by Year in Pennsylvania [43]

As mentioned above Villanova is found in the piedmont region. This region currently contains over 2,100 known native plant species which fall under eight categories: trees, shrubs, ferns, grasses, vines, perennials, annuals, and biennials. The forests of southeastern PA are currently primarily made up of oak-hickory habitat [46]. The area where Villanova is Located was historically an oak chestnut habitat and the forest in this area, as the name implies, was primarily made up of oak and chestnut species of trees. However, chestnut blight has killed most, if not all, American chestnut trees and now the forests in the area are primarily mixed oak forests.

The biodiversity plan for Villanova will draw inspiration from oak and hickory habitats and attempt to mimic the layers and flora found in these areas. The current composition of oak/hickory forests in Pennsylvania is shown in Figure 4.12: Current Species composition of oak/hickory habitats on forest land in PA and the ten most abundant tree species in southeastern PA are listed in Table 4.2: 10 Most Voluminous species of Tree in Southeastern PA.

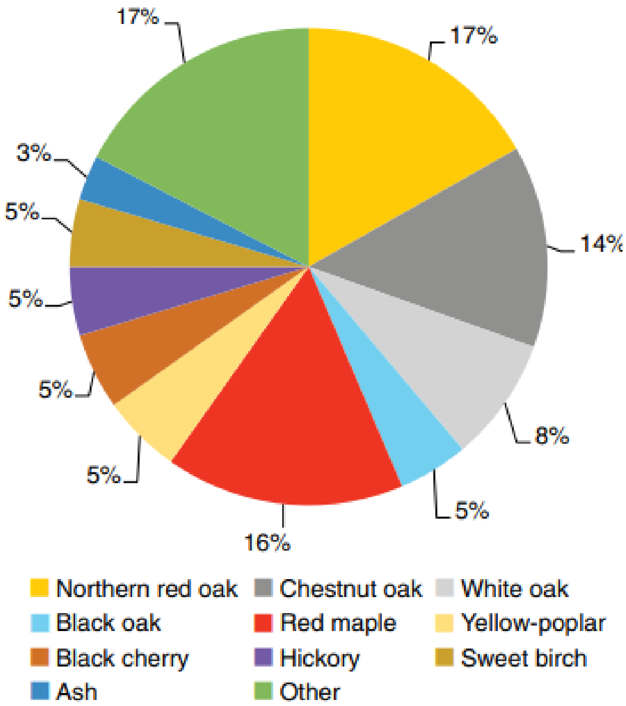


Figure 4.12: Current Species composition of oak/hickory habitats on forest land in PA [43]

Table 5.—*(Continued)* Ten most voluminous species by region, ranked by 2014 volume, and net volume by species, percentage of regional volume, and percent change in volume between 2004 and 2014, on timberland, Pennsylvania

Region		Volume in region, 2014 (million ft³)	Volume as a percentage of unit volume	Volume percent change, 2004 to 2014
Southeast	Yellow-poplar	552	22	52.8
	Ash	261	10	21.3
	Northern red oak	233	9	32.0
	Chestnut oak	204	8	36.8
	Red maple	179	7	14.6
	Black oak	174	7	10.4
	Hickory	153	6	30.8
	Black walnut	87	3	68.1
	Sweet birch	86	3	19.1
	Black cherry	83	3	24.0
	Regional total	**2,545**	**100**	**32.8**

Table 4.2: 10 Most Voluminous species of Tree in Southeastern PA [43]

4.3 Landscape Analysis, Campus Level

4.3.1 Existing Land and Land Users

Villanova is an academic institution, so its foremost land use is to provide areas that are used for the education of students. Other land uses on the Villanova campus are for residential, Augustinian, administrative, athletic, ceremonial, and facilities use. The main users of the campus are students whose goal is to receive a quality education, Augustinian friars encourage the four principles of catholic social teaching, human dignity, the common good, solidarity, and subsidiarity so that these values can be lived through the university community, faculty whose goal is providing an education to students and conducting research, and staff whose goal is to keep the University running smoothly at all levels. Villanova University's Campus is made up of five areas, each of which provides a combination of services to its users, the Central Campus (Campus Core), Athletic Campus, Lancaster Ave Campus, South Campus, and West Campus.

The central campus is made up of a combination of residential, dining, administrative, and academic buildings. This is where the majority of activity on the campus occurs during the day on weekdays and were scheduled activities occur on weeknights and weekends. Convocations are held on the front lawn of this area in addition to sports practices and games and ROTC training. The athletic campus is where the gym, track, football/soccer field, basketball stadium, and pool are located. As the name implies this area is majorly used for athletic activities, however, this area also houses facilities offices such as grounds management, the new performing arts center, and the main parking garage for the campus. Lancaster Ave Campus includes the new senior dorms, the new performing arts center a number of administrative buildings, and parking lots. South campus is majorly residential with a small amount of recreational area. West campus is a mix of academic, facilities, residential, recreational and administrative buildings.

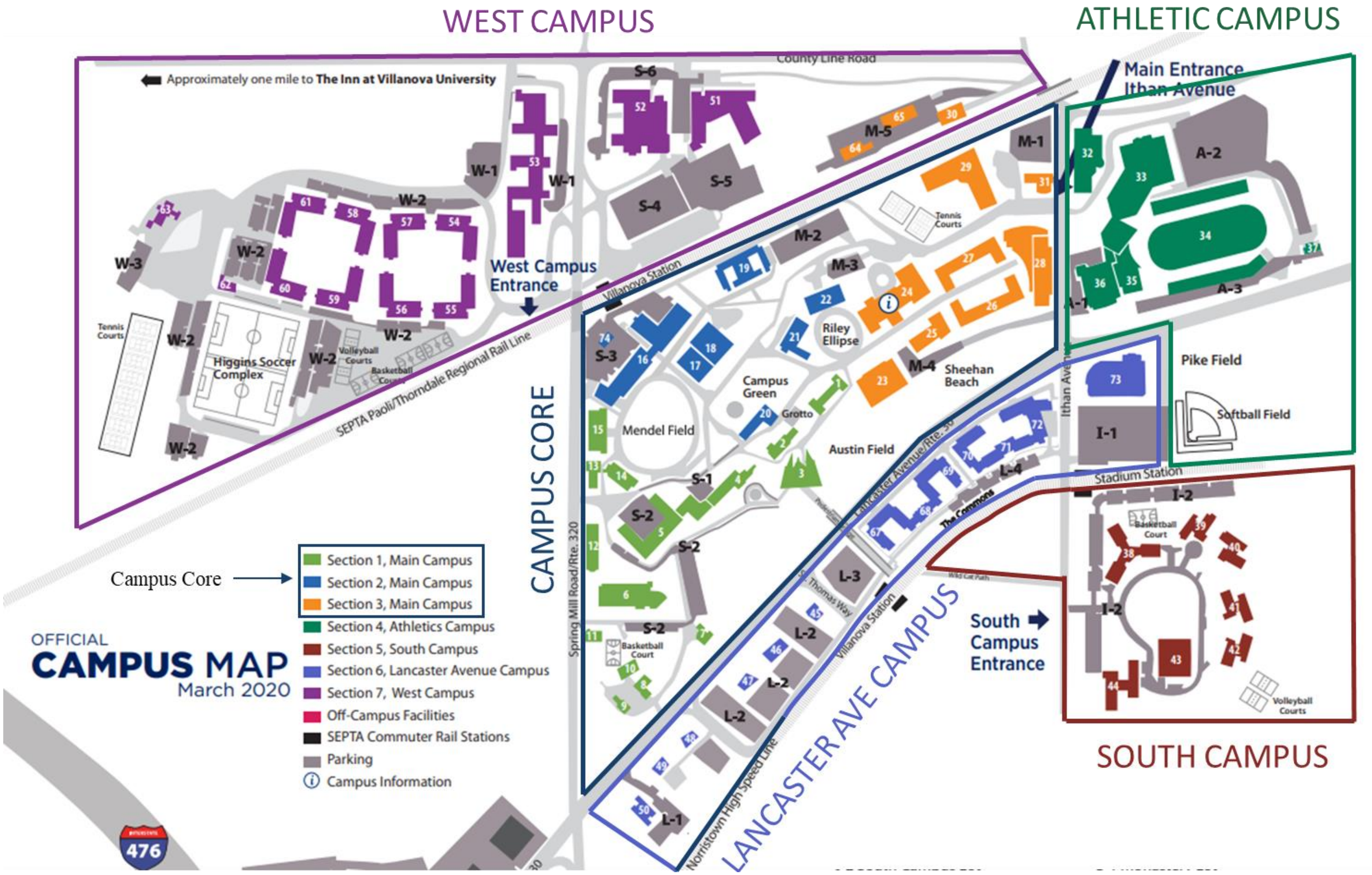


Figure 4.13: The Five Campus Areas [47]

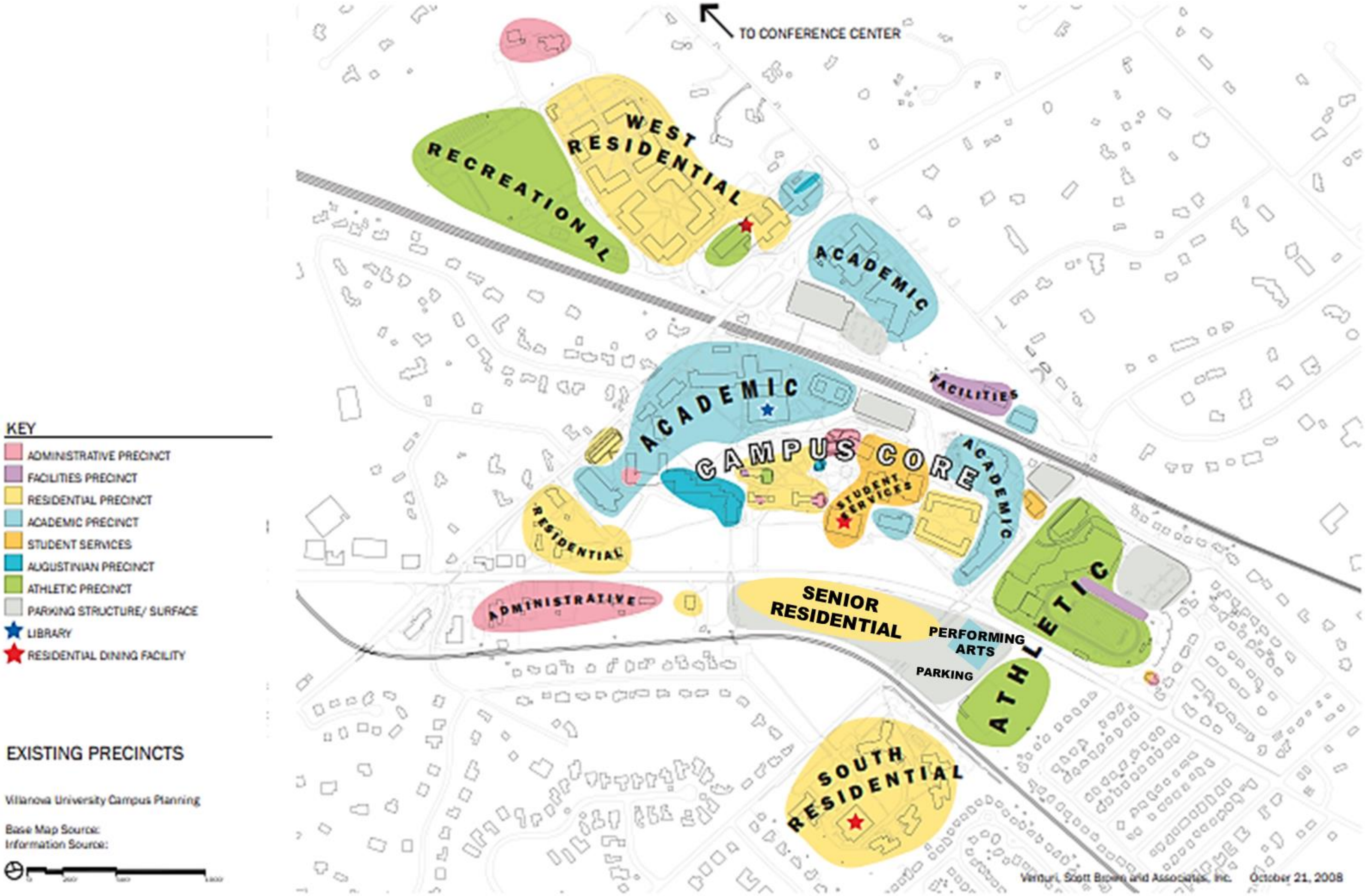


Figure 4.14: Campus Areas and Uses [48]

Figure 4.15: Vistas Landmarks and Iconic Green Spaces [48]

The current landscape of the campus is made up of lawns, rain gardens, flower beds, meadows, trees, shrubs, herbs, and vines. This landscape is created and maintained by the grounds department. The grounds department splits the campus into 9 zones with two to five staff members assigned to each zone. These staff members are encouraged to take ownership of these spaces and respect and improve the landscape taking care of litter, mowing grass, mulching, weeding, leaf removal, snow removal, ice melt application, seasonal flower plantings, pruning of trees and shrubs, and if needed small tree removal. They are also strongly encouraged to plant several trees in the spring and fall. Zoning to determine where, what size, and how many trees should be planted takes into account possible renovations or construction projects planned in or around the area, size of the area available, distance from buildings, sightlines. Once the size and general type of tree is determined, shade tree, small tree, or flowering tree, the species of tree is determined. Native species are the first choice but if they cannot be used naturalized or non-invasive species are considered instead [49]. General grounds maintenance differs for the meadow areas as well as the raingardens on campus compared to other areas. The meadow that is located to the east of Dundale mansion is mowed down annually and the meadow to the west Dundale mansion is mowed every other year. They are mowed with a brush hog in late winter before birds begin nesting and are monitored for invasive species in need of removal. There are around twenty-five rain gardens and other stormwater management areas are located on campus thanks to the Civil and Environmental department. Some are highly effective, and others are less so. Their location function and functionality determine the amount of maintenance they need. Most need to have their perennials cut back in the late fall, some need mulch to be cleaned out of the bottom to maintain depth, others need mulch added at the tops and sides of the banks. Additionally, plants may need to be added or removed based on the needs of the raingarden, this is normally done in the fall [49].

4.3.2 Terrain

The terrain in a small area, such as Villanova, is important for understanding surface water flow and distribution. This is especially important considering the steepening rainfall trendline from the climate data. The terrain present at Villanova is shown in the topographic map in Figure 4.5. Notably, the campus core is built on a small hill that has a maximum elevation slightly greater than 400 feet and the greatest sloping of this hill occurs on the northeast and southwest sides of the hill. The highest point in the campus core is the area between Alumni Hall and Corr Chapel and the lowest point is Middleton Hall and the area southwest from the building. South campus downhill from the campus core and is situated on a relatively level area. West campus is uphill from the campus core, at an elevation slightly greater than 450 feet, and situated on another small hill. Down the northwest slope of this hill is a small valley containing a pond and uphill from that pond on a southwest slope is Picotte Hall at Dundale (aka “The Mansion”). The Athletic campus is located downhill to the southeast from the campus core and is situated on flat ground.

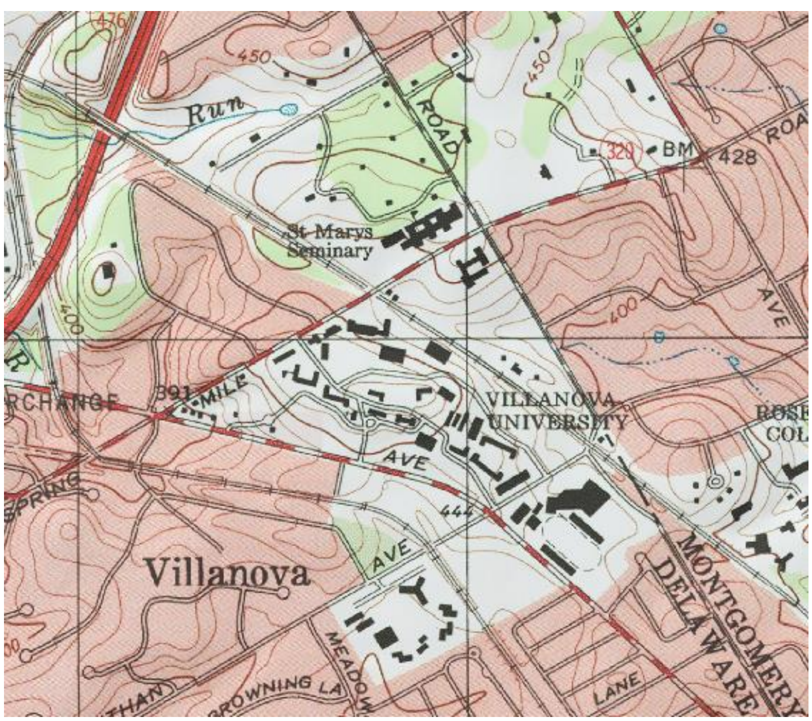


Figure 4.16: Topographic Map of Villanova University [50]

4.3.3 Water

The trendline in the climate analysis above showed a trend of 11x the rainfall in the area in the past 40 years compared to the last 120 years so this section will be focused on stormwater runoff on campus since that is likely to become one of the foremost issues on campus. Water flows downhill so the topographic map was used to determine where water will flow and collect on campus as shown in figure Figure 4.17. With the increase in rainfall, these areas are more likely to flood and cause costly damage to the campus, however, damage can be mitigated or prevented by creating appropriate natural features such as raingardens, wetlands, water-loving trees, and diverse groundcover. Figure 4.18 shows what kinds of measures have been taken to control stormwater and their locations on campus.

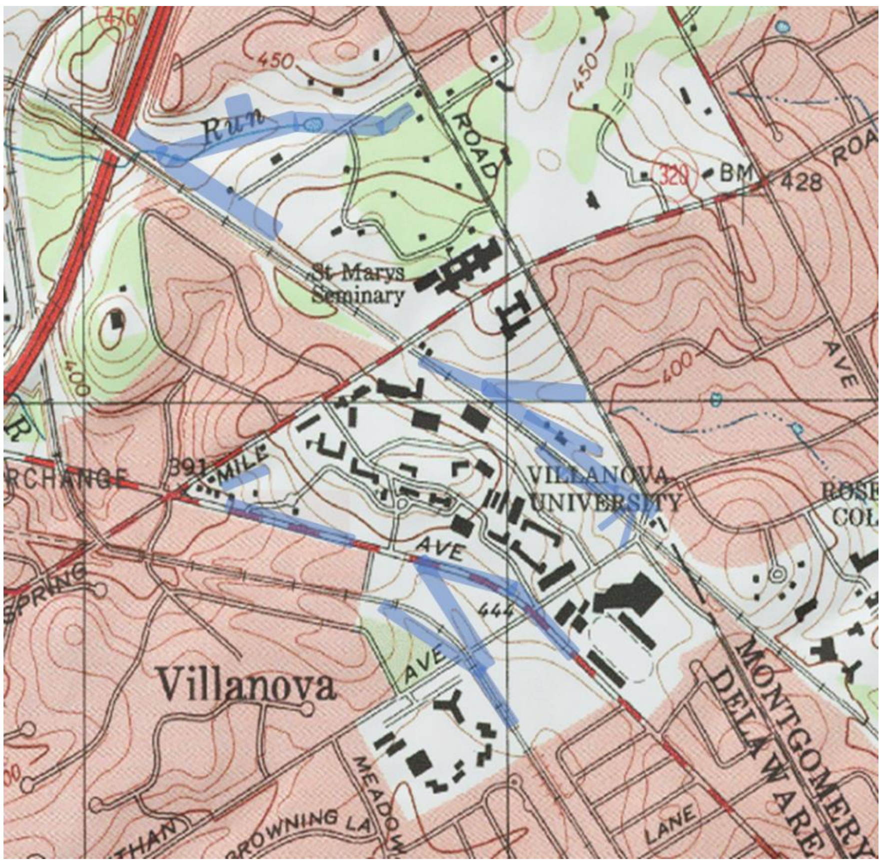


Figure 4.17: Campus Water Flow

Figure 4.18: Stormwater Control Measures on the Villanova University Campus [51]

When the two maps are overlaid, as shown in Figure 4.19, the relationship between the placement of stormwater control measures and campus water flow can be easily observed. Additionally, it also provides information on where the creation of natural stormwater control measures would be helpful to the University.

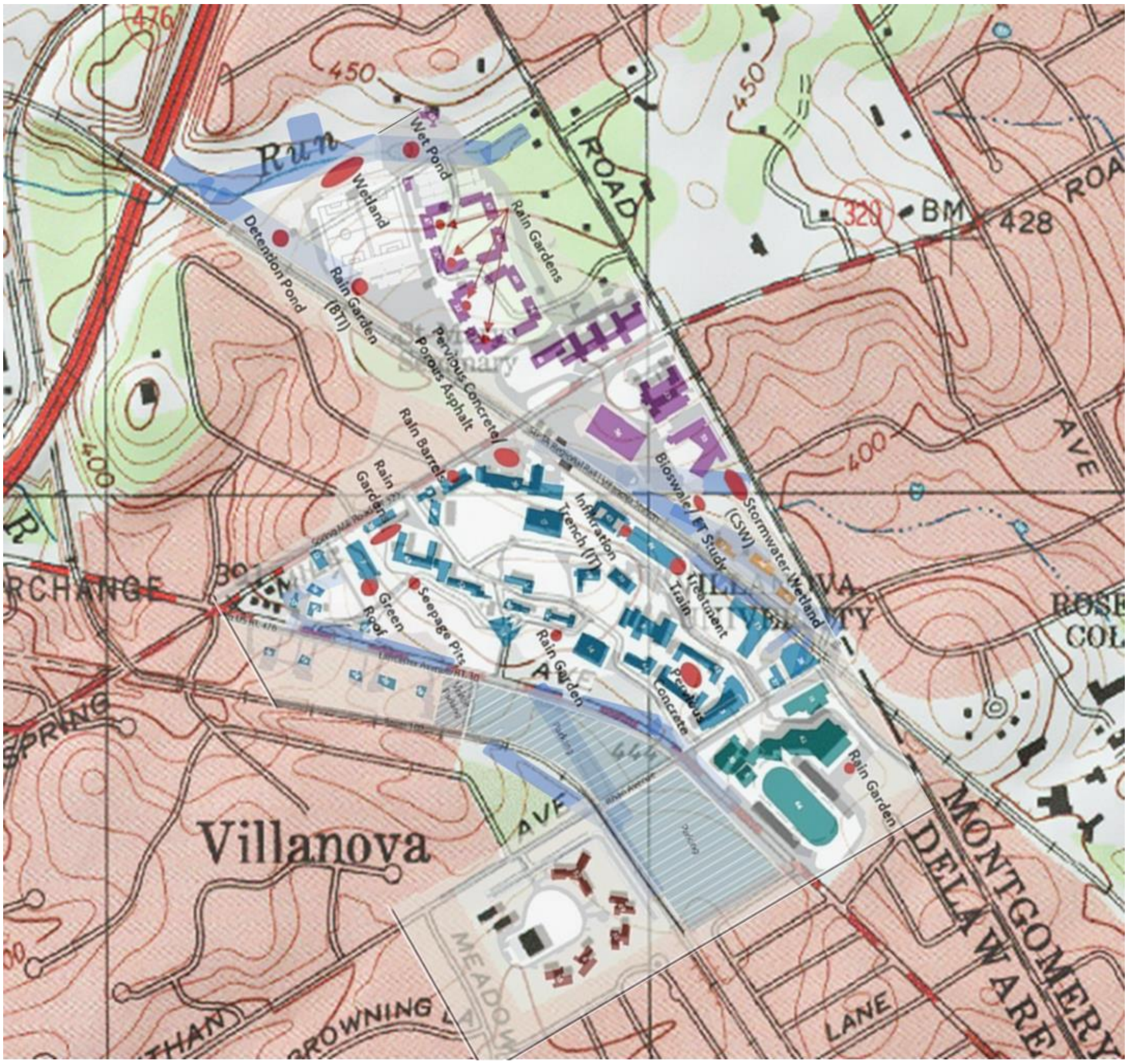


Figure 4.19: Campus Water Flow and Stormwater Control Measures

4.3.4 Soils

Soil is a vital natural resource for the growth of healthy productive plants and provides them with a number of fundamental building block for life including nutrients, water, microorganism relationships, and physical stability. Soil data and maps for the area of interest (AOI), the Villanova University area, was collected using the USDA Online Web Soil Survey Tool, specifically, data on organic matter depletion (OMD), soil pH, erosion factor, K (erosion factor), drainage class, depth to the water table, and pesticide runoff potential.

Soil organic matter is the basis for healthy and productive soils and is necessary for all soil functions, making it one of the most important indicators of soil health. It is made up of plant residue, living soil organisms, decomposing organic matter, and stable organic matter. This mixture increases the availability of nutrients to plants, helps to buffer acidity, increases moisture retention, available water capacity, and water infiltration, minimizes compaction, decomposes pesticides, and acts as a carbon sink [52]. 66.3% of the AOI has a moderately high potential for OMD and 19.9% has moderate potential for OMD.

Soil pH is a measure of acidity or alkalinity and it is measured on a scale of 0-14 where a pH of 7 or above indicates that the soil is more basic and a pH of below 7 indicates that the pH is more acidic [53]. The sweet spot for most crops a pH between 6-7.5 is optimal [53], however, the pH was provided so that plants who thrive at the indicated pH levels could be chosen. The pH of the majority of soil areas at Villanova is between 5.8-6.3.

Erosion factor, K, is a soil loss "index that quantifies the relative susceptibility of soil to sheet and rill erosion." [54]. Sheet erosion is the removal of soil from the force of raindrops hitting the ground and the flow of rainwater over the ground [55]. Rill erosion is the removal of soil from water that has formed rivulets, streamlets, or headcuts [56]. The values for the index range from

.02 for soils that are the least erodible to .64 for soils that are the most erodible [54]. The majority of the campus and the AOI has relatively high K values at .43.

Drainage class is the frequency and duration of wetness in soil. The majority of the campus is "Well Drained" meaning that water is removed from the soul readily leaving available water for plants during the majority of the growing season, however, there is not excessive wetness that would inhibit the growth of plant roots [57]. The exception to this is South Campus where the drainage class is "Somewhat Poorly Drained" meaning that water in this soil is removed slowly so the soil is wet at shallow depths for the majority of the growing season [57].

Pesticide runoff potential is the ability of the soil to transmit pesticides through surface runoff and the likelihood of those pesticides to reach surface water. This potential is based on the soils in their natural condition and does not consider present land use. The campus's rating class indicates that some runoff can be expected. However, since the campus has so many high maintenance lawns where it uses pesticides, with few buffers for runoff, pesticide runoff is more likely.

From the previous information in the climate section and the soil data collected in this section, the main areas of concern are due to rainfall and stormwater runoff. Both of these factors increase the potential for organic matter depletion, soil erosion, and pesticide runoff and will additionally be detrimental to the "Somewhat Poorly Drained" area located in South Campus. The landscaping plan will aim to preserve organic matter and soil while reducing pesticide runoff and poor drainage through the use of plants that are able to thrive in the indicated soil pH and drainage class.

Figure 4.20: Soil Type Map, Area of Interest Villanova University

Table 4.3: Soil Map Legend and Soil Information

Map Legend							
Map Symbol	**Map Unit Name**	**Percent of AOI**	**Organic Matter Depletion**	**pH**	**K**	**Drainage Class**	**Depth to Water Table**
CaA	Califon loam, 0 to 3 percent slopes	0.9%	Moderate	5.1	0.32	Moderately Well Drained	53 cm
CaaA	Califon loam, 0 to 3 percent slopes	2.2%	Moderate	5.6	0.32	Well Drained	46 cm
CdA	Chester silt loam, 0 to 3 percent slopes	0.9%	Moderately High	5.0	0.32	Well Drained	>200 cm
CdB	Chester silt loam, 3 to 8 percent slopes	4.9%	Moderately High	5.0	0.15	Well Drained	>200 cm
GdB	Gladstone gravelly loam, 3 to 8 percent slopes	12.1%	Moderately High	6.3	0.15	Well Drained	>200 cm
GeB	Glenelg channery loam, 3 to 8 percent slopes	6.7%	Moderately High	5.4	0.2	Well Drained	>200 cm
GeB3	Glenelg channery silt loam, 3 to 8 percent slopes, severely eroded	1.1%	Moderately High	5.4	0.2	Well Drained	>200 cm
GnA	Glenville silt loam 0 to 3 percent slopes	0.6%	Moderate	5.9	0.37	Moderately Well Drained	53 cm
GnB2	**Glenville silt loam, 3 to 8 percent slopes, moderately eroded**	**14.5%**	**Moderate**	**5.9**	**0.43**	**Somewhat Poorly Drained**	**53 cm**
Ha	Hatboro silt loam	1.3%	Moderate	5.9	0.37	Poorly Drained	8 cm
Me	**Made land, schist and gneiss materials**	**40.6%**	**Moderately High**	**5.8**	**0.43**	**Well Drained**	>200 cm
Mn	Melvin silt loam	0.4%	Moderate	6.7	0.43	Poorly Drained	15 cm
UrlB	Urban land-Gladstone complex, 0 to 8 percent slopes	3.2%	-	-	-	-	>200 cm
UrlD	Urban land-Gladstone complex, 8 to 25 percent slopes	1.8%	-	-		-	>200 cm

4.3.5 Wildlife

Observed large native Pennsylvania wildlife includes 63 mammal species, 414 bird species (285 regular denizens and 129 less frequent visitors) [58], 38 amphibian species, 13 turtles species, 26 native reptile species [59]. Locally a study was done by Villanova Universities Biology Department on the Stoneleigh property, which is owned and maintained by Natural Lands, that provided a look at what wildlife is present or is likely to be present in the area. There were 15 recorded mammal species where there is a possibility of seeing 35 different mammal species, 80 species of birds, 5 different species of reptiles, and three species of amphibians, a list of these species can be found in Table 4.4: Local Birds Table 4.4, Table 4.5, Table 4.6, and Table 4.7

Table 4.4: Local Birds [60]

Mallard	Red-eyed Vireo	Dark-Eyed Junco
Canada Goose	American Crow	Song Sparrow
Mourning Dove	Fish Crow	Field Sparrow
Chimney Swift	Blue Jay	White-throated Sparrow
Ruby-throated Hummingbird	Tree Swallow	Baltimore Oriole
Solitary sandpiper	Tufted Titmouse	Brown-headed Cowbird
Great Blue Heron	Carolina Chickadee	Common Yellowthroat
Turkey Vulture	Red-breasted Nuthatch	Black-and-white Warbler
Black Vulture	White-breasted Nuthatch	Ovenbird
Osprey	Brown Creeper	Northern Parula
Sharp-shinned Hawk	Carolina Wren	Black-throated Blue Warbler
Cooper’s Hawk	House Wren	Yellow-rumped Warbler
Red-shouldered Hawk	Ruby-crowned Kinglet	Palm Warbler
Red-tailed Hawk	Golden-crowned Kinglet	Chestnut-sided Warbler
Bald eagle	Swainson's Thrush	Yellow Warbler
Northern Flicker	Wood Thrush	Black-throated Green Warbler
Downy Woodpecker	American Robin	Northern Cardinal
Hairy Woodpecker	Gray Catbird	Indigo Bunting
Red-bellied Woodpecker	Brown Thrasher	Red-breasted Grosbeak
Yellow-bellied Sapsucker	Cedar Waxwing	Scarlet Tanger
American Kestrel	Purple Finch	
Warbling Vireo	Pine Siskin	
	American Goldfinch	

Table 4.5: Local Mammals [60]

Raccoon	Maryland Shrew	White-footed mouse
Gray Fox	Rock shrew	Southern bog lemming
Red Fox	Smoky shrew	Meadow jumping mouse
White-tailed Deer	Pygmy shrew	House mouse
Striped skunk	Water shrew	Norway rat
Short-tailed weasel	Star-nosed mole	Southern flying squirrel
Long-tailed weasel	Hairy-tailed mole	Groundhog
Mink	Eastern cottontail	Gray squirrel
Northern short-tailed shrew	Meadow vole	Fox squirrel
Least shrew	Woodland vole	Eastern Chipmunk
Masked Shrew	Red-backed vole	Red squirrel
	Muskrat	

Table 4.6: Local Reptiles [60]

Milksnake	Smooth green snake	Red-bellied snake
Common garter snake	Dekay's brown snake	

Table 4.7: Local Amphibians [60]

Spotted Salamander	Eastern newt	American toad

Observed pollinator species of Pennsylvania includes 406 bee species, 150 butterfly species, an estimated 1,500+ moths, an estimated 1,000+ beetles, and there are also an unknown number of flies (mostly in families Syrphidae and Bombyliidae) [61]. There is not specific local data on insects near Villanova, however, the importance of protecting insects as pollinators as well as food for larger animal species cannot be ignored.

4.3.6 Vegetation

4.3.6.1 Flora Biodiversity Inventory

4.3.6.1.1 Methodology

There are three components that can be studied to determine biodiversity: genetic diversity within a population or species, species diversity within a community, and ecosystem diversity of a landscape or region. When studying these components measures to quantify the number of, and difference in, traits, individuals, or species in a given area are used to determine biodiversity [62]. The component studied and measures used are dependent on the research done, the goals of the research and the size of the research area.

Figure 4.21: Three Components of Biodiversity [62]

For this study species, diversity within a community was most applicable due to the size of the area of the study and the goal of determining and increasing plant biodiversity. The measures that were chosen to determine biodiversity for this study are richness and evenness. Species richness represents the number of different species in an area, and species evenness represents the relative abundance of each species in the same area. As species richness and evenness increase, so does biodiversity. Figure 4.22 shows two images to help with the understanding of richness and evenness. Community 1 has high species richness and high species evenness, the second community has the same richness as Community 1 but low species evenness, therefore Community 1 is a more biodiverse community.

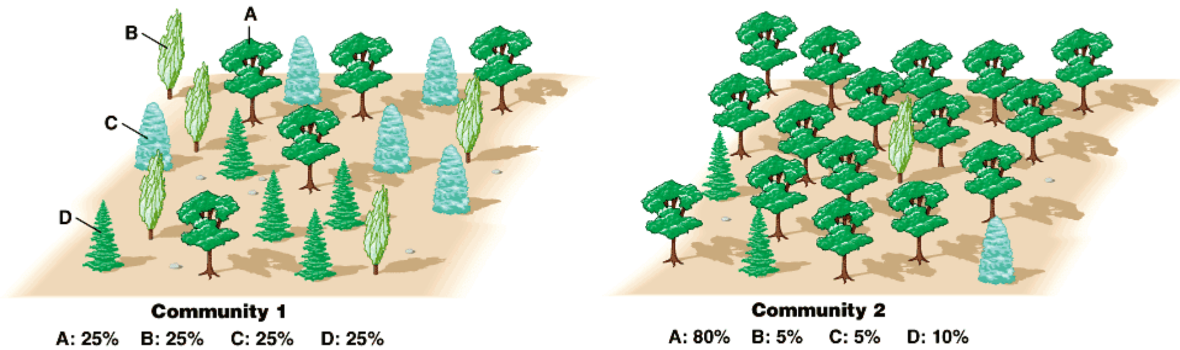


Figure 4.22: Communities Depicting Richness and Evenness [63]

To determine these metrics the most realistic collection techniques are a combination of quadrat sampling and observation. Quadrat sampling is most often used to determine the number and count of smaller species in a large area by sampling a small more manageable area. In quadrat sampling a quadrant, which is a frame that can vary in shape and size, is placed in a habitat of interest and the species within the quadrat are identified and counted, this can be done in person or by taking a photo for later analysis. The process is often repeated in sub-areas of the area of study where diversity may differ. The data can then be used to calculate the abundance of organisms in a sub-area by scaling the type and number of organisms found in a quadrant and the size of the quadrant to the size of the sub-area. Finally, the data from all of the sub-areas can be brought together to show the various types of species in an area and their counts [64]. Observation is used for larger organisms such as trees, bushes, shrubs, and those in flowerbeds and planted areas.

Once data on species type and count has been determined mathematical measures to determine species diversity can be used, the two most popular biodiversity indices are the Shannon Index and the Simpson Index; both focus on the species richness and evenness [65]. The Shannon index was originally developed for information theory and was used to determine the difficulty of predicting the next letter in a string of text, where the more different letters there are, and the more equal their proportions, the more difficult it is to predict the next letter. In terms of biodiversity, this means the more species there are, and the more equally those species are distributed, the more difficult predicting species chosen from the sample becomes, meaning biodiversity is higher. The equation for the Shannon Index (*H*) is shown below in equation (4-1) in which *s* is the number of species identified in the sample or the species richness, and *p* is the proportion (n/N), representing the relative abundance of species, where *n* is the total number of organisms of a species and *N* is the total number of organisms of all species in the sample.

$$H = -\sum_{i=1}^{s} p_i \ln p_i \tag{4-1}$$

H is a value greater than or equal to 0 where higher numbers represent greater diversity. *H'* can be normalized by dividing *H'* by ln(s), as shown in equation (4-2), so that the value outputted will be a number between 0 and 1, where numbers closer to 1 represent more biodiverse populations and numbers closer to zero represent less biodiverse populations [66].

$$H' = \frac{-\sum_{i=1}^{s} p_i \ln p_i}{\ln(s)} \tag{4-2}$$

The outputted number from this equation represents the probability of NOT being able to predict what a randomly chosen plant from the sample will be. Numbers closer to 1 indicate that it will be difficult to predict which plants are randomly chosen from the sample, denoting that the sample has high richness and evenness and therefore higher diversity. Numbers closer to 0 indicate that it will be easier to predict what plants may be randomly chosen from the sample, denoting that the sample has a low richness and/or low evenness, and therefore lower diversity [66].

There are two diversity indices and one evenness index for Simpsons: Simpson's Diversity (D_1) its inverse Simpsons Dominance (D_2), and Simpson's Evenness (E). The equations for each are shown below in equations (4-4) and (4-4).

$$D_1 = 1 - \sum_{i=1}^{s} p^2 \tag{4-3}$$

D_1 Is a value between 0 and 1 which represents the probability that two randomly chosen individuals from an area belong to different species. The closer the value is to 1 the more likely it is that two chosen individuals belong to different species. The closer the value is to 0 the more likely it is that two randomly chosen individuals will belong to the same species.

$$D_2 = \frac{1}{\sum_{i=1}^{s} {p_i}^2} \tag{4-4}$$

D_2 Is a value between 1 and *s*, the number of species, where a higher value indicates greater diversity. Both indices are meant to show the richness and abundance of species in an area.

$$E_D = \frac{D_2}{s} \tag{4-5}$$

E Is the degree to which individuals are split among species, where low values indicate dominance of one or a few species and high values indicate that there are equal numbers of individuals in each species. [67]

Table 4.8: Diversity Indicators and Equations

Metric	Description	Formula	Interpretation
Richness (s)	The number of species present	# of species	-
Evenness (p)	The relative abundance of each species	${}^{n}/_{N}$	-
Shannon's Diversity (H')	Richness and abundance of species	$-\sum_{i=1}^{s} p_i \ln p_i$	0-ln(s) The higher the value the greater the sample diversity
Shannon's Evenness (E_H)	Evenness of species	${}^{H}/_{\ln(s)}$	0-1 the greater the value the greater the species evenness
Simpsons Diversity (D_1)	Richness and evenness of species	$1-\sum_{i=1}^{s} p^2$	0-1 the greater the value the greater the sample diversity
Simpson's Dominance (D_2)	Richness of species	${}^{1}/_{\sum_{i=1}^{s} {p_i}^2}$	1-s the greater the value the greater the species diversity
Simpson's Evenness (E_D)	Evenness of species	${}^{D_2}/_{s}$	0-1 the greater the value the greater the species evenness

While all of these can show biodiversity levels "Simpson's index is particularly sensitive to changes in the relative abundances of the most important species. Shannon's index is particularly sensitive to the number of rare species in a community. Hence, Shannon's index is most suitable for plant, bird and mammal studies, whereas Simpson's is better suited for arthropods." [68]. From this information for this study Shannon's Diversity and Shannon's evenness will be used, however, the other values will be calculated as well for comparison.

4.3.6.1.2 Data Collection

The subject of interest for this biodiversity study was plants. Plants provide the foundation for almost all ecosystems and communities. They provide habitat, shelter, and food for most organisms which makes them imperative for organisms to survive and thrive. In this study, plants were put into one of five categories when being identified: herbs, shrubs, trees, vines, and grasses.

Table 4.9: Plant Categories and Descriptions

Plant Categories	Description
Herbs	Any seed-bearing plant which does not have a woody stem and dies down to the ground after flowering [69].
Shrubs	A woody plant which is smaller than a tree and has several main stems arising at or near the ground [70].
Trees	A woody perennial plant, typically having a single stem or trunk growing to a considerable height and bearing lateral branches at some distance from the ground [71].
Vines	A climbing or trailing woody-stemmed plant [72].
Grasses	Vegetation consisting of typically short plants with long, narrow leaves, growing wild or cultivated on lawns and pasture, and as a fodder crop [73].

The area of focus for the biodiversity study was the campus core, shown in the Figure 4.23. This area was chosen because provides the largest opportunity to make an impact by increasing biodiversity on a suburban campus as well as to showcase and educate visitors about the changes that have been made. The campus core is where the majority of lawns, landscaping, and plantings for the University occur, so changes in landscaping and planting practices in this area would have the largest effect on biodiversity. Furthermore, this is the only area that the majority of visitors see when they come to the Villanova University campus which provides Villanova with the opportunity to showcase and educate visitors on biodiversity issues and solutions.

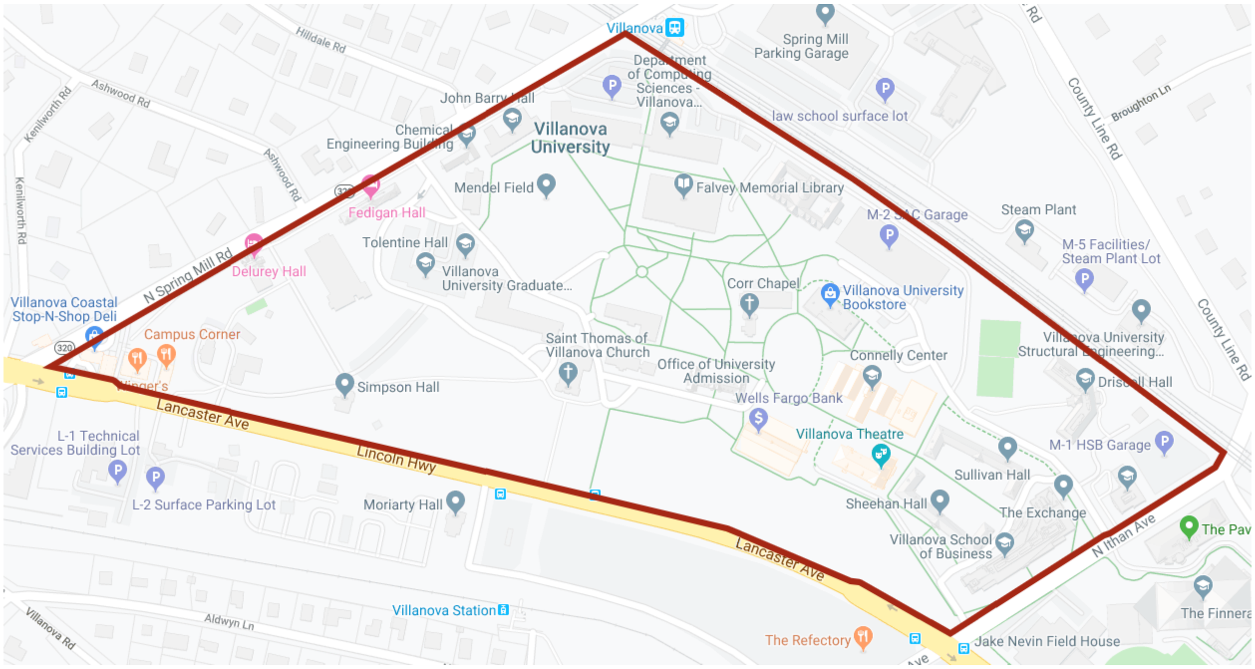


Figure 4.23: Area of Study, Campus Core

Once the subject of interest and the area of study was chosen the means of plant identification and logging plant locations could begin. There were two different areas for assessment within the campus core planted areas, which encompass flower beds and standalone trees and shrubs, and lawns, which are the grassy expanses on campus. For the first type of area, planted areas and standalone trees and shrubs, data collection started from the right half of the campus and moved left, each day a different area was assessed and the information from it logged, so that areas would not be double-counted. Plants were identified using PictureThis or Plant Net, plant identification apps. Once this information was determined the type of plant(s) (grass, herb, shrub, tree, or vine), the name of the plant(s), count of the plant(s), and location of the plant(s) were logged using the Collector app, as shown in the Figure 4.24.

The Collector app was created by ESRI to be used in tandem with ArcGIS online. All data collected in the field was transmitted to ArcGIS online, where locations and other data could be manipulated, where needed, to provide more accurate information. Shown in Figure 4.24 is a completed map of all of the data points collected on the plants on the campus core, color-coded by plant type. A list of all data points including latitude, longitude, plant common name, and count can be found in Appendix B.

For the second type of area, lawns, lawn area was broken into two categories iconic green spaces and lawns. Iconic green spaces are areas of lawn that are not likely to ever be changed due to their cultural, historic, athletic, and aesthetic value to Villanova, whereas, lawns have the potential to be converted into other kinds of natural areas. In Figure 4.25 iconic green spaces are shown in green and lawns are shown in yellow.

Polygons were drawn over each lawn area of campus to determine the area of the lawns in acres. This area was then converted into cubic inches and multiplied by the number of turfgrass plants per cubic inch, 6 plants per in^2 [74], to determine the total number of grass plants in the lawn. The Horticultural Supervisor, Hugh Weldon, then provided information on the grass mixes purchased by Villanova University in the last year, their weight, and seed composition of the mixes. The proportion of each type of grass in Villanova's lawns was estimated from this information. The proportion determined was used to estimate the number of grasses and grass types in the lawns instead of quadrat sampling because the University continually tries to maintain this proportion of grasses through the use of reseeding, overseeding, fertilizers, and pesticides. Using the area of the lawns, the proportion of grasses and the average size of a grass plant (well-maintained turf lawns have 6 turf plants per square inch [74]) the number of each type of grass plant in the Iconic Green Spaces and Lawns were determined.

Both the number of counted plants as well as the estimated number of grasses were used to calculate biodiversity. The calculations and interpretations will be detailed in the next section, results and discussion.

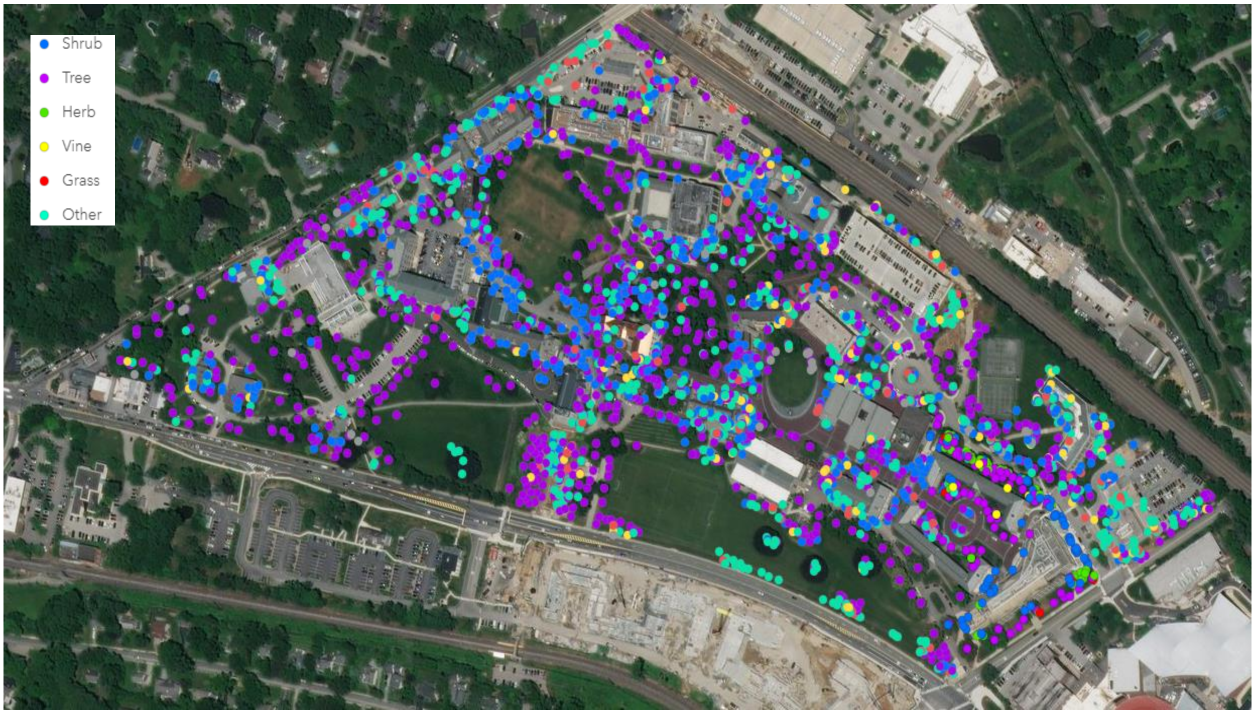


Figure 4.24: Plant Map Campus Core

Figure 4.25: Map of Iconic Green Spaces and Lawns

4.3.6.1.3 Results and Discussion

The total number of plants counted on the campus core, not including grasses in lawns, was **181,924**. The number of plants total on the campus core, including grasses in lawns, was **968,781,666**. Biodiversity was calculated using the normalized Shannon's index for the campus core excluding grasses in lawns to show the diversity of the planted areas of campus and then the entirety of the campus core including grasses and lawns to show the biodiversity of the entire campus core as well as to show the impact of lawns on the biodiversity score. For the Shannon's Index, the best score possible is 1, meaning that it would be very difficult to guess what a random plant chosen from the campus core would be which indicates high biodiversity and the worst possible score is 0, meaning that it would be very easy to guess what a randomly chosen plant from campus would be which indicates low biodiversity.

The first calculation, campus core excluding lawn grasses, included trees, flower beds, and other planted areas. The result for this area was a normalized Shannon's index of **.40**. This indicates that the current biodiversity of the campus core, excluding grasses, is medium-low and has decent room for improvement. The main influences for this score are English ivy followed by Japanese pachysandra. They are both used as groundcover and blanket the ground in a number of areas on campus and make up 45% and 11% of the counted plants respectively. Figure 4.26: Breakdown of Counted Plants by Type (Not Including Lawns) shows the breakdown of counted plants by their type and further shows the dominance of vines, majorly English ivy, on the campus core.

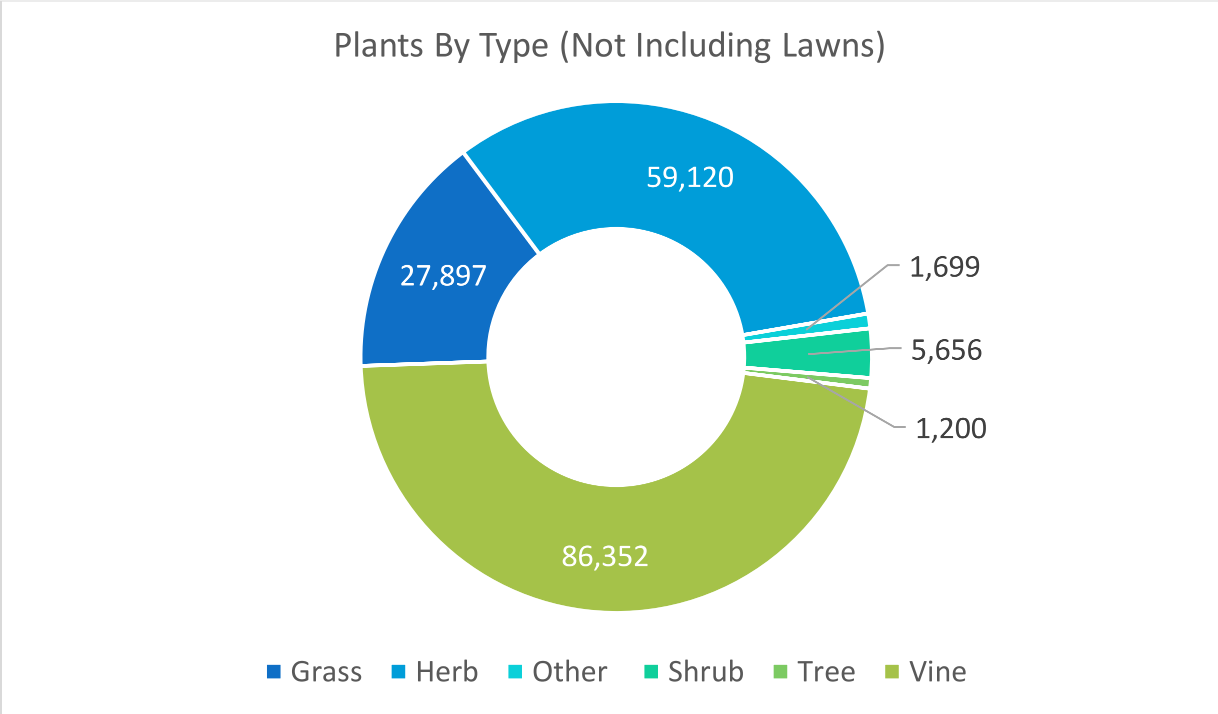


Figure 4.26: Breakdown of Counted Plants by Type (Not Including Lawns)

Lawns on the Villanova campus are primarily made up of turfgrass which tolerates high traffic and low mowing heights [75]. While breeders try to create more genetically resilient turfgrasses they are still often high maintenance and require additions of water, fertilizer, aeration, and herbicides. The inclusion of lawn grasses to the Shannon's Index equation resulted in a normalized Shannon's Index of **.19**, a reduction around half of the previous biodiversity score. The lawns that the University maintains are primarily made up of tall fescue, perennial ryegrass, Kentucky bluegrass, and fine fescues. A chart showing the estimated percentages of each type of these grasses in Villanova university lawns is shown in Figure 4.27: Lawn Grass Species Proportions. These proportions are an estimate based on the seed mixes that Villanova uses in its lawns. It is possible that other plants make up the lawn such as clovers and broadleaf grasses, however, since the university attempts to maintain lawns of purely turfgrass and actively tries to remove other species they were not included.

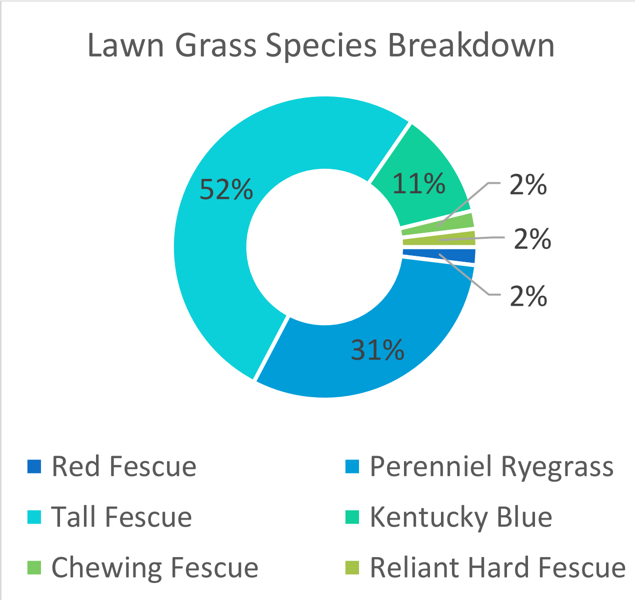


Figure 4.27: Lawn Grass Species Proportions

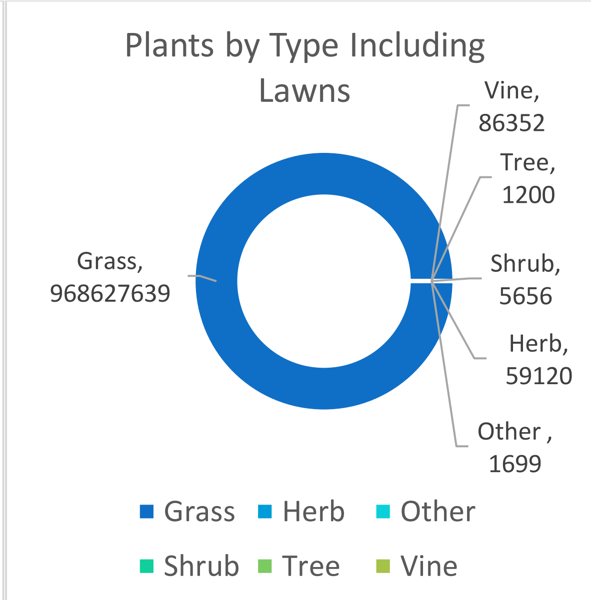


Figure 4.28: Breakdown of Counted Plants

Lawns made up of these six kinds of grass make up 99.98% of the plants counted on campus, shown in Figure 4.28: Breakdown of Counted Plants. This is why lawns have such a large negative impact on the biodiversity score and why it will be imperative that grass mixes, the amount of high maintenance lawn, and the areas of high maintenance lawn will need to be changed at the university.

The Shannon's Index scores show that the campus core is not currently doing well with its levels of biodiversity and that changes will need to be made in planting, land use, and maintenance of the campus core in order to increase biodiversity scores and become a more productive habitat. The largest changes can be made by reducing high maintenance lawn and changing lawn seeding and maintenance practices. Lawn areas that do not hold cultural or functional significance and lawns that are not used should be converted to more productive natural areas. Lawns that do not need to be rigorously maintained for sports or events should be lower maintenance and be seeded with a wider variety of species.

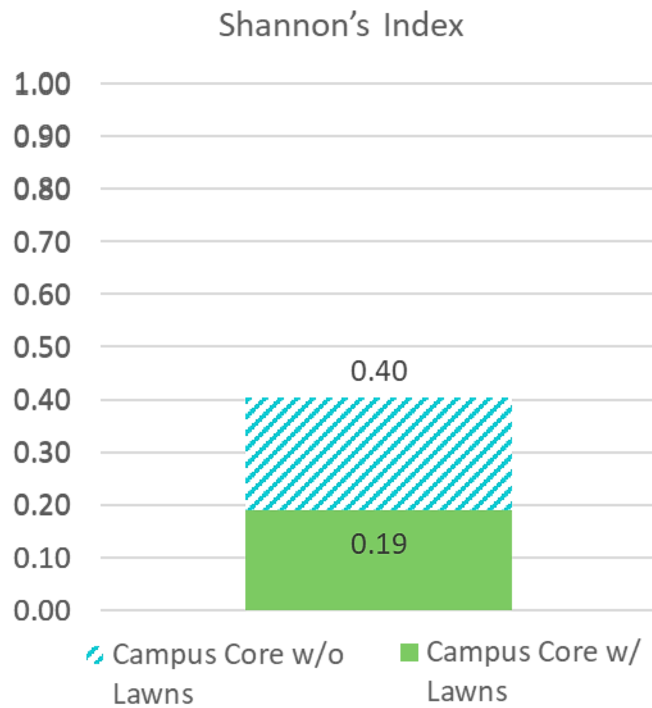


Figure 4.29: Shannon's Index Comparison

The most used areas of campus, the campus core, recreational areas, and residential areas are most often composed of lawns, trees, and flowerbeds which are maintained through mowing, trimming, weeding, and the application of pesticides, herbicides, fungicides, and fertilizers. Other maintained areas are assumed to have similar vegetation and maintenance practices. Additionally, there are manmade wetlands in the areas specified in Figure 4.18, a goldenrod meadow located at the very edge of west campus to the northwest, and some patches of forested area.

4.3.6.2 Land Cover and Benefits

Land cover for the entirety of Villanova University was assessed using the i-Tree Canopy tool which was developed through cooperation between the USDA Forest Service, Davey Tree Expert Company, The Arbor Day Foundation, Society of Municipal Arborists, International Society of Arboriculture, Casey Trees, and SUNY College of Environmental Science and Forestry. This tool uses random sampling in a user-specified area to determine an estimated percent of different cover categories that are also specified by the user. It does this by choosing a random point in the specified area and requiring the user to identify what cover category the point falls under. As more points are categorized the percentage of land in each cover category becomes more accurate. Once this is done the software assesses the percent tree cover of the area and uses multipliers from the EPA, which are based on population density and the social cost of carbon, (Table 4.10) to output the environmental, health, and monetary benefits of carbon monoxide removed annually, nitrogen dioxide removed annually, ozone removed annually, particulate matter less than 2.4 microns removed annually, particulate matter greater than 2.5 microns and less than 10 microns removed annually, carbon dioxide sequestered annually, and total carbon dioxide stored in the trees.

Table 4.10: EPA Tree Benefit Multipliers

	Benefit Description	Removal Rate (lbs/acre/yr)	Monetary Value ($/T/yr)
CO	Carbon Monoxide removed annually	0.857	$1,175.51
NO2	Nitrogen Dioxide removed annually	8.137	$478.44
O3	Ozone removed annually	44.164	$3,766.15
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	14.264	$5,503.43
PM2.5	Particulate Matter less than 2.5 microns removed annually	3.543	$160,537.39
SO2	Sulfur Dioxide removed annually	5.943	$153.23
CO2seq	Carbon Dioxide sequestered annually in trees	10,010.267	$46.51
CO2stor	TOTAL Carbon Dioxide stored in trees	251,395.359	$46.51

For this assessment, the user-specified area was the entirety of Villanova University, excluding public roads and railways, and the cover categories were impervious surface, trees, lawn, flower beds, meadows, natural stormwater measures (wetlands, rain gardens, etc.), and water. 1100 points were sampled within the polygon drawn to encompass the Villanova University area to provide an adequate sample size. The results for the estimated percent of cover and acreage can be found in Figure 4.30 and Table 4.11. These results show that impervious surfaces make up the majority of campus at 47%, followed by open lawns (lawn with no tree or other cover), 25% and tree cover, 21% (only 3% is fully forested area) (NOTE: Tree cover takes into account the full size of the canopy so if the tree was not from forested area underneath the tree there is often impervious surface, grass, or flowerbed). Impervious surface and lawns, especially turfgrass lawns, are both highly ecologically unproductive areas and they make up 72% or 187 acres of landcover at Villanova University. The University campus is 260 acres so it can be estimated from the percentages that 122 acres are covered by impervious surface and 64 acres are covered by lawn. To further break down the lawn cover 17.9 acres are iconic green space and 6.5 acres are athletic field totaling 24.4 acres, 9% of landcover. Because these areas are culturally significant or necessary for campus users this 9% of land cover will stay the same, however, the remaining 16% of landcover will be available for conversion into more productive ecosystems. Trees, meadows, natural stormwater measures, and some flower beds are more productive areas and make up 24% to 28% or 61 to 73 acres of campus. These areas can be increased as the lawn area is decreased.

The results of the monetization of tree cover show that annually trees provide around $32,000 worth of benefits and that total, through carbon sequestration of around 6,000 tons of carbon, the trees on campus provide $290,000 worth of benefits.

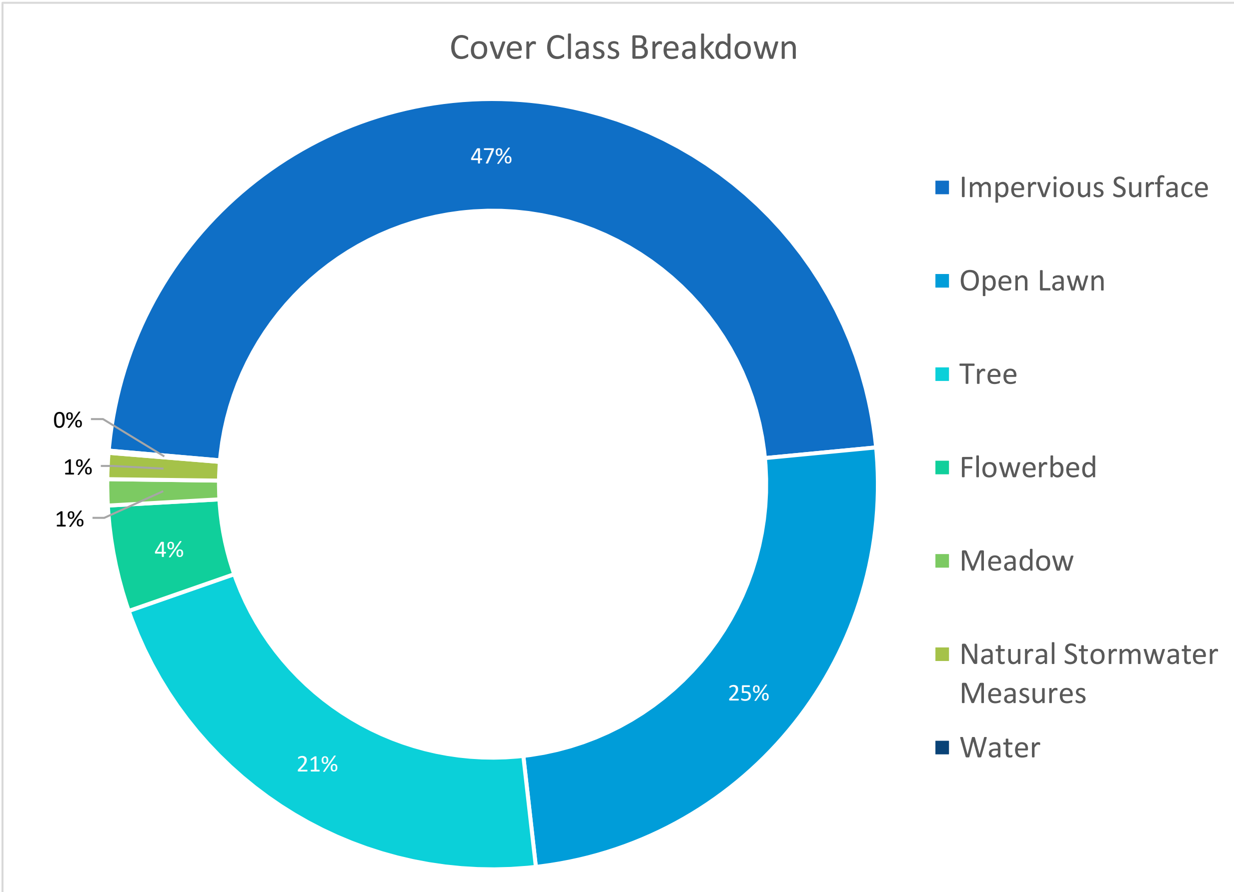


Figure 4.30: Estimated Landcover Type Breakdown

Table 4.11: Estimated Villanova Landcover Type Breakdown

Cover Class	Points	% Cover	Standard Error (SE)	Acres*
Impervious Surface	518	47%	±1.51%	122
Open Lawn	272	25%	±1.30%	64
Tree	235	21%	±1.24%	56
Flowerbed	49	4%	±0.62%	12
Meadow	12	1%	±0.31%	3
Natural Stormwater Measures	12	1%	±0.18%	3
Water	1	0%	±0.09%	0

*Assuming campus is roughly 260 acres

Table 4.12: Tree Benefit Estimates

Abbr.	Benefit Description	Value (USD)	±SE ($)	Amount	±SE (lb)
CO	Carbon Monoxide removed annually	$25.02	±1.43	42.72 lb	±2.44
NO2	Nitrogen Dioxide removed annually	$96.70	±5.53	405.66 lb	±23.21
O3	Ozone removed annually	$4,131.22	±236.39	1.10 T	±0.06
PM2.5	Particulate Matter less than 2.5 microns removed annually	$14,126.48	±808.32	176.61 lb	±10.11
SO2	Sulfur Dioxide removed annually	$22.62	±1.29	296.28 lb	±16.95
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$1,949.80	±111.57	711.08 lb	±40.69
CO2seq	Carbon Dioxide sequestered annually in trees	$11,564.24	±661.71	249.51 T	±14.28
CO2str	TOTAL Carbon Dioxide stored in trees	$290,421.47	±16,618.05	6,266.21 T	±358.56

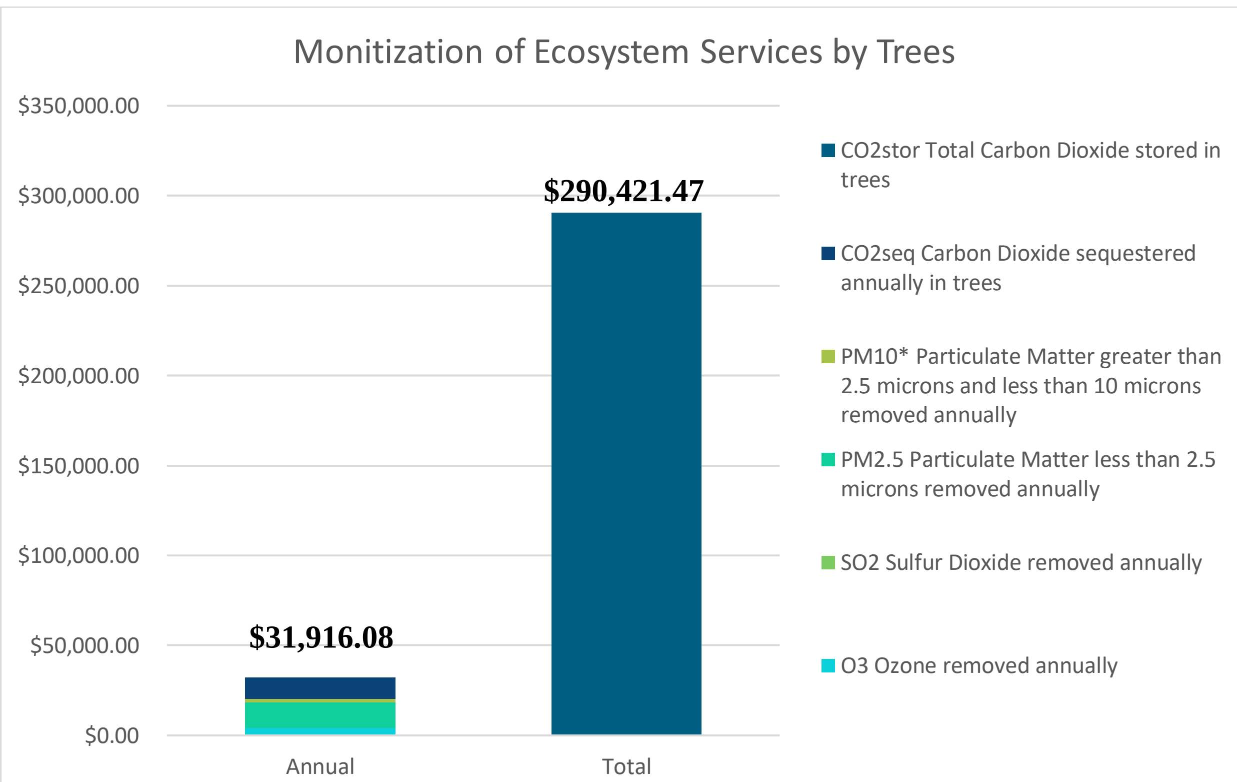


Figure 4.31: Monetary Benefits of Tree Cover

5 RECOMMENDATIONS: PLAN TO INCREASE FLORA BIODIVERSITY AND ECOSYSTEM SERVICES

5.1 Sustainable Planning Opportunities

Over half of the world's populations live in metropolitan areas and in the future, even more people will be moving into these areas. Global urban populations are expected to double by 2030 and by 2050 two-thirds of people in the world will be living in urban regions. Movement of people have, and will continue to, influence the transformation of spaces "from rural and natural to urban and suburban, the urbanization of the wild, the abandonment of the rural…" [27]. Because of these losses of natural lands and other negative human influences a 6^{th} mass extinction is currently occurring in the world. If species loss at this grand scale is allowed to continue vital benefits that biodiversity in nature provides humans such as air and water filtration, pollination, food production, regulation of climate, and others will be lost. Urbanization cannot be stopped but the way that the urban and suburban landscapes are managed can be changed so that these areas are beneficial, as opposed to detrimental, to natural habitats and ecosystem services. Villanova has to opportunity to ignite change and be an example of ecologically sound urban and suburban landscape planning that provides the community (humans, plants, and animals) the socio-cultural and biophysical systems they need to survive and thrive.

Villanova University does a beautiful job with their landscaping and plantings. The University won the Grand Award from the Professional Grounds Management Society in the 2018 Green Stars Awards Competition in the Urban University Grounds category for exceptional grounds maintenance. This award is meant to bring national recognition to grounds manicured with a high degree of excellence, efforts in high maintenance standards, high-quality appearance of the landscape, and promote well-maintained landscapes throughout the country. The university has also committed itself to be a sustainable steward to the campus that provides the university community with a number of benefits.

> *"Villanova's Grounds Department strives to be a sustainable steward of the University's 260-acre campus by making it a safe, functional and aesthetically pleasing environment. Its vision is to create a campus environment that preserves the historic beauty of Villanova's campus; educates the University community about the diversity, environmental benefits and aesthetic qualities of plant materials; provides a sense of direction and purpose in management of the campus landscape; and, generates a lasting impression upon prospective students, parents, alumni and all visitors to Villanova's campus."* [76]

The university must strike a balance between maintaining its grounds and being sustainable stewards, there are a number of conflicting ideologies between maintaining pristine grounds and letting there be productive natural areas in a landscape, however, both are beautiful and necessary aspects of sustainable human landscapes. Villanova University's mission is to "commit ourselves to academic excellence, to our values and traditions, and to our students, alumni, and the global community". The campus landscape, then, should reflect the Universities mission and further academic excellence among students by turning the campus into a living laboratory that contains a great diversity of flora and fauna for students to study and enjoy, protect the values and traditions of the University through "learning as a community ethos governed by love", a love of all God's creatures including flora and fauna, and serve students, alumni, and the global community using Villanova as an example of sustainable landscaping and sustainable land management.

5.2 Sustainable Landscape Plan Goals

The overarching goal of this plan is to **increase and maintain ecologically productive biodiverse landscapes on the Villanova University campus while satisfying the needs of all users**. This overarching goal encompasses changes that the campus needs to make, regarding their landscape and natural systems, to provide the greatest benefits to Villanova University. There are three sub-goals that the plan focuses on mitigating, that are deeply interconnected with biodiversity and ecological productivity, these sub-goals are: **create a campus that is a living laboratory, increase natural stormwater management measures, and increase natural heat mitigation measures**. The overarching goal and sub-goals were chosen based on assessments of current and historical data at the campus, local, and regional levels as well as how the plan can positively impact the triple bottom line people, planet, and prosperity at Villanova University.

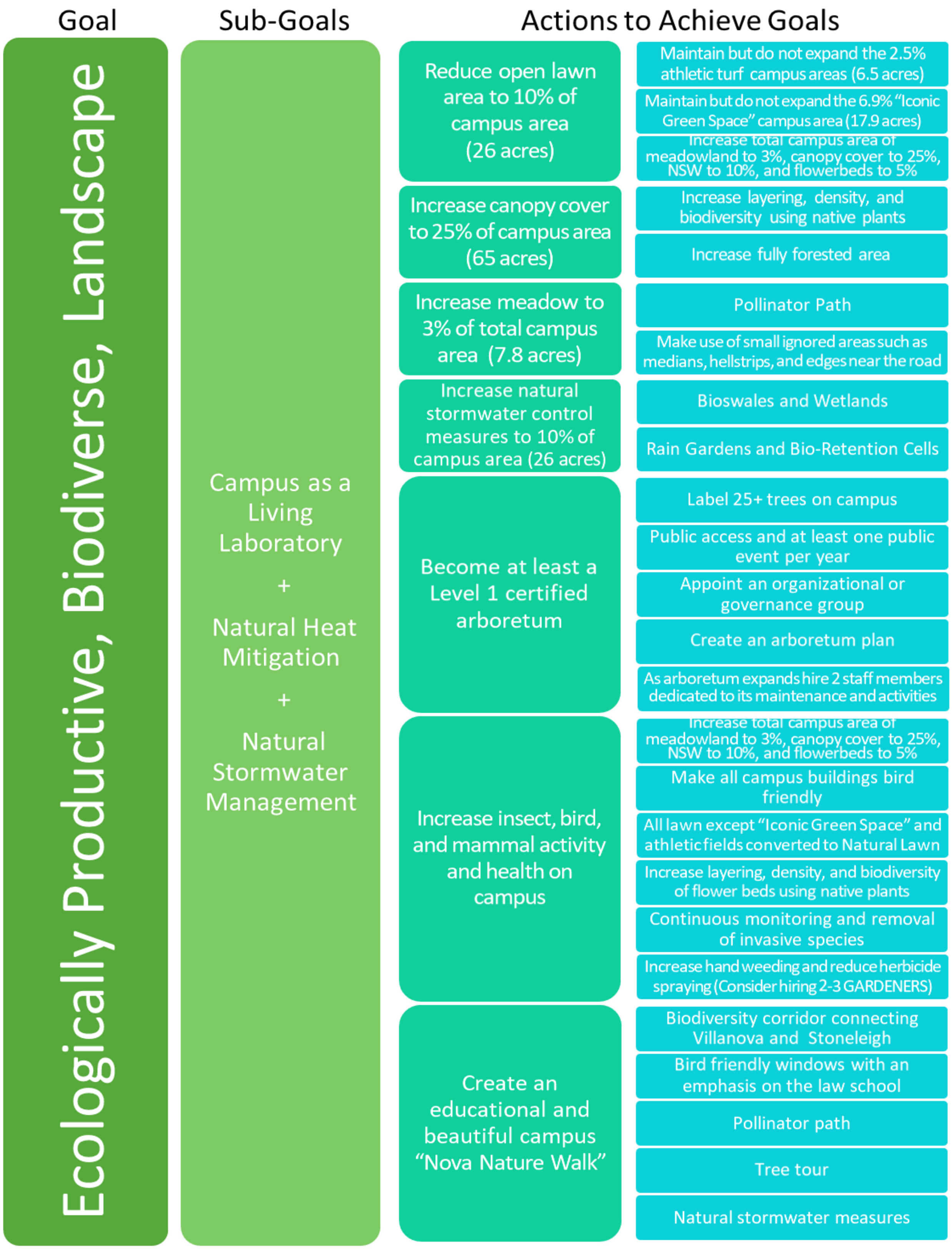
The Villanova University **campus is made up of 72% ecologically unproductive landcover**, 47% impervious surface and 25% open lawn, and the campus core has an overall Shannon's **biodiversity index score of .19 out of 1**, indicating overall low biodiversity, and a flower bed biodiversity of .40 out of 1, indicating medium-low biodiversity. Because of this, sites deemed suitable as **natural environmental study or educational sites only make up 10% of campus landcover.** These sites include meadow, natural stormwater measures, fully forested area, and trees specified in the campus tree tour, stormwater management studies being done by the civil and environmental department on new senior dormitories, and studies by the biology department on bird deaths caused by glass building collisions at the law school. Outside of these areas students and professors perform their studies, and community members educate themselves in other more biodiverse areas. The campus's high percentage of ecologically unproductive landcover also negatively influences the urban heat island effect as well as stormwater events. Local climate data shows trends for annual temperature and rainfall that indicate **increases in both annual temperature and rainfall in the future**, however, the trend for annual rainfall seems to be increasing more quickly. These future increases will exacerbate the urban heat island effect and its associated issues as well as issues associated with stormwater events on the Villanova University campus.

Table 5.1: Current Villanova Landcover and Future Targets

Landcover Type	Description	Current % cover	Target% cover	% Change
Impervious Surface	Surfaces that prevent rainwater from entering the soil such as roads, driveways, sidewalks, roofs, etc.	47%	Out of Scope	0%
Open Lawn	Single-layer lawn areas with no canopy cover	25%	10%	-15%
Tree Canopy	Areas where there is tree canopy cover such as forests or singular trees extending over lawns, parking lots, flower beds, etc.	21.5%	25%	+3.5%
Flower Beds	Planted areas made up of shrubs, herbs, vines, or other flora	4.5%	5%	+0.5%
Meadow	Open habitat made up of grasses and non-woody plants	1%	3%	+2%
Natural Stormwater Management	Rain gardens, wetlands, bio-retention ponds, bioswales, etc.	1%	10%	+9%
Water	Ponds, lakes, streams, etc.	0% (.09%)	0%	0%

To achieve the goals stated above changes in landcover proportions, as well as the management of the landcover types, must be made. Table 5.1 shows the proportions of landcover determined for the Villanova, as well as the proposed changes in landcover based on the needs of the university. The impervious surface makes up the majority of campus at 47% but changing this type of campus landcover is out of scope. The next most abundant landcover type is open lawn, which makes up 25% of the campus. The way that the reduction of open lawn was determined was by quantifying the amount of “Iconic Green Space” and real athletic turf. These areas will not be changed by the plan and were found to be around 9% of the campus area. Then the remaining lawn space on campus was evaluated and areas close to the entrances of buildings as well as areas where students are most likely to work or play outside were also taken into account, making up another 1%. So the total **open lawn space should be 10% of campus area** (NOTE: This may not seem like very much but there is and will be, lawn present under the canopy cover on-campus) which leaves 15% to be changed into other landcover types. Landcover pertaining to natural stormwater management was determined next due to the implications of increased rainfall from the climate data collected. It is recommended that the area of rain gardens and bio-retention cells is 20% to 30% of the impervious surface present, 21% was used so that there would still be area available for the other landcover types. Therefore, **10% of total campus area should be natural stormwater measures** of the total campus area. Areas where it would be beneficial, and possible, to plant grass or wildflower meadows for overall campus biodiversity as well as to create a biodiversity corridor between Villanova and Stoneleigh were assessed and showed that **meadows should cover 3% of total campus area**. Next, areas near buildings that are currently lawn but could become flowerbeds were assessed. From this, it was determined that **5% of total campus area should be flowerbeds**. However, the main focus for flowerbeds is to increase the density and layering within existing beds using native plants, more than creating new flower beds. Finally, the area remaining was dedicated to expanding the tree canopy thus **25% of total campus area should be covered by tree canopy.**

The following sections of this paper detail how to achieve the goals and meet the targets that have been set for Villanova University in this plan. Figure 5.1 summarizes this information.



*Acreage based on a 260-acre campus [77]

Figure 5.1: Goals and Actions to Achieve Goals

5.3 Planning Concepts

Planning concepts from both the book *The Living Landscape,* maintenance practices derived from "Do Nothing Farming", and traditional landscaping will be used in this plan depending on the land use, location, and users. The planning concepts are based on the stated goal and help to provide a general conceptual model for how decisions were made for the landscape plan and how landscaping decisions should be made in the future.

Concepts from *The Living Landscape* stem from the ideology of permaculture design which is a holistic framework that stresses the importance of "mimicking the diversity, functionality, and resilience of natural ecosystems…. that applies beyond landscaping to one's work life, social life, and community" [78]. *The Living Landscape* provides details on how to execute the creation and development of highly productive natural landscapes while still creating functional spaces for its users. The book emphasizes the use of native species, reduction of required maintenance, and the importance of mimicking or restoring natural landscape using horizontal and vertical layers. "Do Nothing Farming" stresses the importance of choosing the correct combination of plants when establishing a garden to bolster productivity as well as reduce maintenance. For the Villanova landscape choosing native plants that have been shown to grow well together, based on natural ecosystems in the area, will be crucial to reducing landscape maintenance over time at the university.

Traditional landscaping practices will be reduced and avoided where possible. The goal of traditional landscaping is most often to exert complete control over space to create a landscape that reflects current cultural values, which often does not create the most beneficial spaces for humans, flora, or fauna. Traditional landscaping encourages the creation of unnecessary lawn and planting of labor-intensive alien or invasive species, both of which require fertilizers, pesticides, herbicides, extra water, and other additions to survive because they have not evolved to create relationships with biotic and abiotic natural ecosystem. They do not provide the same if any, benefits and services to flora, fauna, and humans compared to the native species that they are replacing. The use of these practices over time has caused continuing declines in biodiversity which has weakened ecosystems making them susceptible to disease, pests, and weather events. However, traditional landscaping is beneficial in some areas such as athletic fields, recreational grounds, culturally significant areas, or areas with high foot traffic.

5.4 Sustainable Landscape Plan, Design, and Implementation

The following sections pertain to the different landcover categories: lawns and meadows, raingardens, bioswales, and wetlands, and trees, shrubs, herbs, and vines. They address **why** there needs to be a change, **how** to implement the changes, and **what** species are the best options for planting and suggestions for **where** on campus the changes should be made

5.4.1 Lawns and Meadows

On the Villanova university campus, lawns make up 25% of campus area and are the most negatively impactful area to biodiversity. This is because lawns at Villanova university are treated to remove clover and other flowering herbaceous plants from the lawn which leaves only turfgrass. This creates low plant biodiversity and additionally, it creates food deserts for pollinators and other insects who make up the base of the food pyramid for larger animals. To reduce this impact, firstly, open lawn, lawn that has no tree cover, will be reduced from 25% of campus area, 64.3 acres, to 10% of campus area, 26 acres. This is a reduction of 38.3 acres of open lawn where 5 acres will become meadow, 23.2 acres will become rain garden or bio-retention cells, and the remaining 9.2 acres will remain lawn but be covered by tree canopy. Secondly, instead of treating all lawns as high maintenance areas, a category system for lawn areas will be used to guide future maintenance.

Each lawn area on campus will be placed into one of four different categories fine turf, athletic turf, native lawn, or native meadow. These categories will correspond to what the type of ground cover is used, land use, users, and required maintenance level. Table 5.2: Lawn Area Categories summarizes this information for each of these categories and Figure 5.2 shows current law and meadow areas.

Table 5.2: Lawn Area Categories and Maintenance

					Maintenance								
	Plants	Use	Users	Maint-enance Level	Mowing Frequency	Mowing/Trimming Height (in)	Aerification (times/year)	Over-seeding (times/year)	Fertilizer	Herbicides	Fungicides	Watering
Fine Turf	Turfgrass	Cultural, aesthetic, recreation	Students, faculty, staff, visitors	High	As Needed	2.5”	1+	1	Organic 4/year	Spot treat as needed	As needed	As needed
Athletic Turf	Turfgrass	Athletic games, practices, and training	Athletes, students, community members	High	As Needed	2.5”	1+	1	Organic 4/year	Spot treat as needed	As needed	As needed
Native Lawn	Native grasses and legumes	Aesthetic, biodiversity, recreation	Pollinators, insects,	Medium-Low	As Needed	3.5”	-	-	Lawn Clippings	-	-	-
Native Meadows	Native grasses, legumes, and wild-flowers	Aesthetic, biodiversity, education,	Pollinators, insects, birds, small and medium-sized mammals, students, faculty	Low	Annual	-	-	-	-	Spot treat if hand cutting/ pulling is ineffect ive	-	-

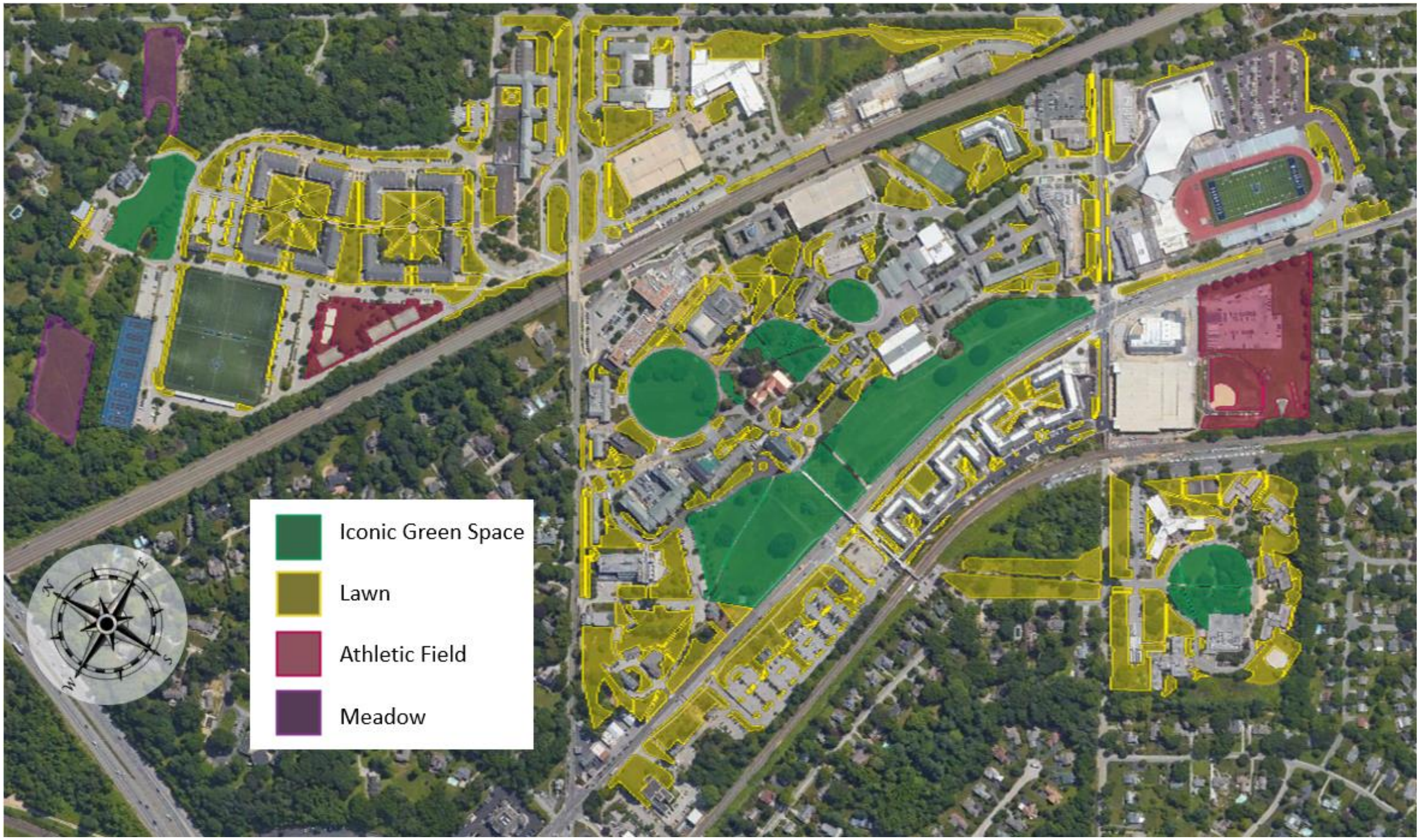


Figure 5.2: Current Lawn and Meadow Locations

5.4.1.1 Turf

The fine turf category will encompass high maintenance turfgrass lawns that are used for important campus events, such as convocation, or have cultural significance to the university, "Iconic Green Spaces". These areas make up 17.9 acres of campus and are used for recreation by students, faculty, and staff and their aesthetic qualities are enjoyed by visitors and passersby. The turfgrass used in these lawns would most like be the same as the current composition of grasses determined in Chapter 2, tall fescue, perennial ryegrass, Kentucky bluegrass, and fine fescues. Since these areas are meant to have higher traffic and still be aesthetically pleasing, they require overseeding, aeration, herbicides, fertilizer, and additional water. The use of these areas causes bald patches and compaction of soil which hurts grass growth. Overseeding helps to fill in thin areas and bald patches by adding additional grass plants and aeration helps to remediate compaction caused by user traffic. Since a certain aesthetic is trying to be maintained in these areas where problems arise herbicide and fungicides should be directly applied to the affected area. Water should be only be used when needed. In-ground sensors should be used to determine soil dryness to avoid water waste with inground and above ground sprinkler systems. Additionally, watering should be performed in the morning to avoid water wasted through evaporation, mildew, and fungal diseases.

The athletic turf category will also encompass high maintenance turfgrass lawns. These areas make up 6.5 acres of the campus and are fields used for athletic games, practices, and training. They are occasionally used for recreation by students, faculty, staff, and the community. The turfgrass in these lawns uses most of the same species as the fine turf: tall fescue, perennial ryegrass, and Kentucky Bluegrass but does not include fine fescues since they are from a shade mix. Since these areas are meant to be intensively used and still be beneficial to sports performance as well as aesthetically pleasing, they also require overseeding, aeration, herbicides, fertilizer, and additional water similar to the fine turf.

Each of the grasses that compose the fine turf and athletic turf lawn categories has slightly different maintenance needs, however, there is overlap so a happy medium for the maintenance of this combination of grasses can be found. Tall fescue has a suggested mowing height of 2.0 to 3.0 inches and performs best when fertilized with 2.3 to 3.0 lb N/1,000 sq ft per growing season. Perennial ryegrass has a suggested mowing height of 1.5 to 2.5 inches for turf use and responds best to 3.0 lb N/1,000 sq foot per growing season. Kentucky bluegrass should be maintained at 1.5 to 2.5 inches, during hot humid conditions the height should remain above 2.0 inches and requires higher amounts of nitrogen fertilizer 2.0 to 4.0 lb N/1,000 sq ft per growing season [75]. The DCNR planting guide lists Kentucky Bluegrass as “Potentially Invasive: Avoid planting except in special circumstances or situations” [79] so the use of this grass will not be included in this plan. Fine fescues perform best when mowed 2.0 inches or above and 1.0 to 2.0 lb N/1,000 sq ft per growing season is suggested [75].

5.4.1.2 Native Lawn

Native lawn will encompass all lawn areas that do not fall into the two categories above and should make up the majority of lawn type on campus. These lawns will be made up the naturally growing grasses and herbaceous plants native to the Villanova University area. This includes clover, broadleaf grasses, sorrel, etc. these plants are essential food sources for pollinators and other insects, who are essential food sources for birds and small mammals, so the presence of these flowering plants prevent biodiversity desserts and habitat fragmentation from occurring across campus. These areas will be used around buildings in place of current turfgrass lawns, for recreational activities by students, faculty, and staff, the education of students and visitors, to provide food for pollinators, and to contribute to biodiversity on the Villanova University campus. These areas will only require mowing and be otherwise left alone, other additions such as applications of herbicides, pesticides, or fungicides should only be done when necessary and organic pollinator-friendly chemicals should be used. This lawn should be cut at a height of 3.5 inches to maximize root depth. Grass clippings should be left to decompose in these areas which provides fertilization and decrease organic matter depletion of the soil.

5.4.1.3 Meadows

The meadow category will encompass areas that will be allowed to function in their natural state with minimal human interference. These areas will be used primarily by pollinators, insects, birds, small mammals for food and shelter and by students, faculty, and visitors as an educational opportunity. Meadows currently make up 2.6 acres of total campus area and the goal is to increase meadowland area to 7.6 acres or 3% of total campus area. The majority of areas that will populate this category will need to be converted from lawn into perennial meadow. This is an initially intensive process due to the importance of establishing a stable meadow ecosystem in the first years through planning, planting, and maintenance. Properly establishing a perennial meadow takes two to three years. In the first year the energy of these plants being directed towards their deep root systems, in the second year these root systems extend and growth above ground expands, and by the third year, the meadow is fully established.

To create a meadow area from what is currently lawn the area will need to be completely converted by killing off existing vegetation, re-seeding with native plants, and performing maintenance. To begin, the plants that will be used for reseeding must be chosen based on environmental factors and the goals of the University. Re-seeding will be done with a mix of native grass, legume, and wildflower species with local genetic material (PA ecotypes). The Pennsylvania DCNR provides a list of recommended native grasses and herbaceous species (this is not a complete list of all native grass and herbaceous species) which can be found in Table 5.3. as well as a recommended general native seed mix from the Bureau of Forestry (BOF) Table 5.4: BOF General Native Seed Mix Table 5.4). This includes a temporary cover crop, spring oats, that helps to improve the stabilization of soil and increase the chance of establishment for perennial plants. The BOF also provides optional additions to the general mix depending on the goal of the planter, in this case, pollinator-friendly wildflowers (Table 5.5). However, it is recommended that wildflowers should be left out of the initial seeding and added once meadow grasses have been established [80]. This is because the mowing heights required to control weeds during the first few years are detrimental to the establishment of the wildflowers and they would then need to be replanted.

The areas suggested for conversion to meadow are road medians, hellstrips (the strip of land between the road and the sidewalk [81]), parking lot medians, along the path that runs by operations and the law school, and small islands that may currently be mulched flower bed. Suggested areas for meadow planting can be found in Figure 5.3. For the areas near the road native, hardy perennials that are drought and salt tolerant will be necessary but the aesthetic and ecological benefits will provide beauty to the campus in normally ignored areas. For the area around the path that runs past operations and the law school wildflower meadow should be planted to create a pollinator path as a part of the campus green walk as well as a part of the biodiversity corridor between campus and Stoneleigh. Special care should be taken not to harm the trees and shrubs present in these areas when preparing the land, planting, and maintenance of the meadow. Additionally, shade resistant perennials or herbaceous ground cover should be concentrated under trees.

5.4.1.3.1 Meadow Construction

The existing lawn or herbaceous vegetation in the area where the meadow is to be planted must be eliminated removed. Planting can begin immediately in the spring if lawn is removed by hand or if the area is tilled. Smaller areas should have existing vegetation removed by hand and larger areas can be tilled. If done by hand sod should be cut into strips using a shovel, then undercut, and removed to a depth of 1 to 1.5 inches. Soil should be prepared and planted immediately after this [82]. Tilling works best for large areas of land. Soil should be tilled and a cover crop, such as spring oats or winter rye, should be planted to outcompete existing vegetation. The Mature crop should be harvested, and the land tilled again during hot dry weather to dry out to roots of any persistent weeds and grasses and planting can begin [82]. When using solarization or herbicides the DCNR recommends that vegetation be removed the fall before spring planting [79]. Solarization can be accomplished using black plastic, plywood, 6 inches of woodchips, newspaper (20 sheets thick with woodchips on top). Coverings should be applied in late spring or fall and be kept in place for at least two months. When the plants underneath the covering are dead and the soil is dry the dead thatch can be removed by tilling or raking. If the meadow is not planted immediately the area should be mulched with woodchips, shredded bark, or shredded leaves to prevent erosion and weeds. Herbicides should be applied in the fall before spring planting. Before planting any additional weeds should be removed by hand or, if there are a great number, through a second application of herbicide.

Planting should be done in late spring (April is ideal) when soil is warm, ideally with a no-till drill seeder, alternatively, seeds can be lightly worked into the soil using a rake or bedsprings or, if the soil has been plowed or tilled, hand seeding or broadcast seeders may be used. Straw should be used to shade out weed seedlings, provide erosion control, and help hold soil moisture.

During the first year of growth, carefully timed mowing is required to prevent weeds from developing seed heads while still allowing grasses to flourish. Regular mowing, every 4 to 6 weeks, at a height of 4” to 6” (mowing below 4” will harm the development of native grass seedlings), to prevent weeds from growing to 8” or taller, will keep weeds from flowering while allowing grasses to grow and mature. Large weeds should be cut off at ground height to prevent damage to young grass plants. Mowing should be avoided late in the season, late October/early November, as young grasses need to be allowed to grow before winter.

In the second spring, leftover vegetation from winter should be mowed to the ground before the start of the growing season (March or April). The areas should not be mowed after this time unless there are significant weed problems in which case the methodology form the first year should be used (EXCEPT: Mowing should not occur from early May to mid-July because this is grassland bird nesting season. During this time a weed trimmer can be used to target problem vegetation). The meadow should be monitored for invasive plants and noxious weeds all season long. These plants should be removed (from most preferred method to least preferred method) by cutting them off at ground level, pulling them out, or spot treating with herbicide (organic low risk preferred) [83] before they can develop flowers or seeds.

After the second year, the grasses in the meadow should be established and wildflowers can be seeded. The meadow should be mowed to the ground annually using a brush hog or a mower in late winter or early spring. Mowing should not occur between early May to mid-July because this is grassland bird nesting season. During this time a weed trimmer can be used to target problem vegetation. Every 3 to 4 years the meadow should be over-seeded with legumes.

Figure 5.3: Possible Meadow Locations

Table 5.3: DCNR Recommended Native Grasses and Herbaceous Species [79]

	Native Warm Season Grasses		
Big Bluestem	*Andropogon gerardii*	Switchgrass	*Panicum virgatum*
Indiangrass	*Sorgastrum nutans*	Purpletop	*Tridens flavus*
Deertongue grass	*Dicanthelium clandestinum*	Little bluestem	*Schizachyrium scoparium*
	Native Cool Season Grasses		
Virginia wildrye*	*Elymus virginicus*	Autumn bentgrass	*Agrostis perennans*
Canada wildrye*	*Elymus canadensis*	Povertygrass	*Danthonia compressa*
Riverbank wildrye*	*Elymus riparius*	Povertygrass	*Danthonia spicata*
	Native Legumes		
Partridge pea	*Chamaechrista fasciculata*	Showy tick-trefoil	*Desmodium canadense*
Senna	*Senna herbecarpa*		
	Native Wildflowers		
Black-eyed susan	*Rudbeckia hirta*	Tall white beardtongue	*Penstemon digitalis*
Cardinal flower	*Lobelia cardinalis*	Ox-eye sunflower	*Heliopsis helianthoides*
Common milkweed	*Asclepias syriaca*	Goldenrods	*Solidago spp.*
Butterfly milkweed	*Asclepias tuberosa*	Asters	*Symphyotrichum spp.*
Evening primrose	*Oenothera biennis*	Hoary mountain-mint	*Pycnathemum incanum*
Ironweed	*Veronia altissima*	Narrowleaf mountain-mint	*Pycnathemum tenuifolium*
Wild bergamot	*Monarda fistulosa*		

Table 5.4: BOF General Native Seed Mix [79]

Native Seed Mix		
Weight	**Common Name**	**Scientific Name**
3 lb PLS	Big bluestem	*(Andropogon gerardii)*
3 lb PLS	Little bluestem	*(Schizachyrium scoparium)*
2 lb PLS	Indiangrass	*(Sorghastrum nutans)*
2 lb PLS	Switchgrass	*(Panicum virgatum)*
2 lb PLS	Deertongue	*(Dicanthelium clandestinum)*
4 lb PLS	Virginia wildrye	*(Elymus virginicus)*
3 lb	Partridge pea	*(Chamaecrista fasciculata)*
0.5 lb	Showy tick-trefoil	*(Desmodium canadense)*
Total: 19.5 lb/acre		
Cover Crop: 30 lb/acre	Oats	(Avena fatua)

Table 5.5: DCNR Seed Mix Additions for Pollinators [79]

Wildflower Additions for Pollinators					
Weight	**Common Name**	**Scientific Name**	**Flower Color**	**Time of Bloom**	**Soil Conditions**
0.5-2 lb	Showy tick-trefoil	(*Desmodium canadense*)	Rose	Summer	Moist
0.5-1 lb	Tall white beardtongue	(*Penstemon digitalis*)	White	Spring and summer	Dry
0.5-2 lb	Grey goldenrod	(*Solidago nemoralis*)	Yellow	Summer and fall	Varies
0.5-2 lb	Common milkweed	(*Asclepias syriaca*)	Lavender	Summer	Dry to moist
0.5-2 lb	Wild bergamot	(*Monarda fistulosa)*	Pink	Summer	Dry
0.5-1 lb	Black-eyed susan	(*Rudbeckia hirta*)	Yellow	Summer and fall	Dry to moist
0.5-1 lb	Ox-eye sunflower	(*Heliopsis helianthoides*)	Yellow	Summer and fall	Dry
0.5-2 lb	Butterfly milkweed	*(Alclepias tuberosa*)	Orange	Summer	Dry
0.5-1 lb	New England aster	(*Symphiotrichum novae-angliae)*	Blue, rose, violet	Summer and fall	Damp
0.5-1 lb	Mountain-mints	(*Pycnathemum incanum* or *P. tenuifolium*)	White	Summer and fall	Dry to moist

Table 5.6: Other Native Wildflowers PSU [82]

Wildflowers for Pollinators

Common Name	**Scientific Name**	**Height**	**Flower color**	**Time of bloom**	**Soil conditions**
Black-eyed Susan	(*Rudbeckia hirta*)	1-3 ft	Yellow	Summer and fall	Dry to moist
Blazing-star	(*Liatris spicata*)	1-5 ft	Purple	Summer and fall	Moist
Butterfly milkweed	(*Asclepias tuberosa*)	1-3 ft	Orange	Summer	Dry
Canada anemone	(*Anemone canadensis*)	1-2 ft	White	Spring and summer	Damp
Cardinal flower	(*Lobelia cardinalis*)	2-4 ft	Red	Summer and fall	Moist
Common evening primrose	(*Oenothera biennis*)	1-5 ft	Yellow	Summer and fall	Dry
Common milkweed	(*Asclepias syriaca*)	3-5 ft	Lavender	Summer	Dry to moist
Common sneezeweed	(*Helenium autumnale*)	3-5 ft	Yellow to mahogany	Summer and fall	Moist
Goldenrod	(*Solidago* sp.)	1-5 ft	Yellow to golden	Summer and fall	Varies
Gray-headed coneflower	(*Ratibida pinnata*)	3-5 ft	Yellow	Summer and fall	Dry
Lanceleaf coreopsis	(*Coreopsis lanceolata*)	1-2 ft	Yellow	Summer	Dry to damp
New England aster	(*Aster novae-angliae*)	3-5 ft	Blue, rose, violet	Summer and fall	Damp
New York ironweed	(*Vernonia noveboracensis*)	3-10 ft	Purple	Summer and fall	Moist
Obedient plant	(*Vernonia noveboracensis*)	3-5 ft	Pink	Summer and fall	Moist
Pearly everlasting	(*Anaphilis margaritacea*)	1-3 ft	White	Summer and fall	Dry
Purple coneflower	(*Echinacea purpurea*)	2-4 ft	Purple-pink	Summer and fall	Moist
Queen-of-the-prarie	(*Filipendula rubra*)	2-9 ft	Pink	Summer	Moist
Sundrop	(*Oenothera fruticosa*)	1-3 ft	Yellow	Summer and fall	Dry
Wild bergamont	(*Monarda fistulosa*)	2-3 ft	Pink	Summer	Dry
Wild geranium	(*Geranium maculatum*)	1-2 ft	Rose-purple	Spring and summer	Moist
Wild lupine	(*Lupinus perennis*)	1-2 ft	Blue	Spring and summer	Dry, sandy

5.4.2 Rain Gardens, Bio-Retention Cells, Bioswales, and Wetlands

The trendline for average rainfall, found during the climate analysis in Chapter 2 page 57, indicates that the trendline for average rainfall has been increasing in the Philadelphia Area and will likely continue to do so in the future. For Villanova University this means that increased stormwater management measures should be taken to mitigate issues caused by stormwater runoff at the university as well as the surrounding community. While the university does have detention basins that are designed to manage stormwater, they do not treat stormwater for pollutants. Raingardens, bio-retention cells, bioswales, and wetlands mimic natural absorption and pollution removal ability of natural areas such as forests and meadows. These areas can help to increase rainwater absorption (30% to 40% more effectively that lawn areas), filter pollutants from runoff, remove standing water from lawns, increase habitat for pollinators, insects, and birds, and reduce flooding potential [84]. Because there is limited space available on campus for additional large natural stormwater measures such as bioswales and wetlands, this section will be focused on increasing the overall campus area of rain gardens and/or bioretention cells, as they are smaller and less difficult and expensive to build. However, this should not deter the construction of larger natural stormwater treatment measures if they are deemed feasible.

The most effective rain gardens and bio-retention cells (RGBC) are sized to accommodate for runoff from impervious surfaces that drain into the rain garden. This is determined by the soil type in the area and the amount of impervious surface draining into the RGBC. It is recommended that the area a rain garden or bioretention cell, for medium to well-drained soil, is between 20% and 30% of the amount of impervious surface they are treating. For Villanova University The area of all impervious surfaces (rooftops, driveways, sidewalks, parking lots, etc.) was estimated to be 122 acres for the campus in Chapter 2 page 91. However, 16 acres of this impervious surface is treated by the law school stormwater wetland, which makes up roughly 1.7 acres or .7% of campus landcover, bringing the number of acres needed to be treated down to 108 acres. Since the goal is to have 10% of the total campus area, or 26 acres, made up of natural stormwater measures then 24.3 more acres will need to be converted into natural stormwater measures. This area of natural stormwater measures falls into the 20% to 30% sweet spot at 22.5% of impervious surface area.

Raingardens and bio-retention cells should be built to take advantage of existing drainage patterns, which were assessed in Chapter 2 page 69, for example, low spots and areas where water collects, especially if these areas are away and downhill from building foundations. These areas should NOT be within 10 feet of a building, within 25 feet of a wellhead, or near underground utility lines. The best location for rain gardens or bio-retention cells is in partial to full sun and the water table must be at least 2 feet below the surface of the soil or instead of a rain garden, it will need to become a wetland garden [85].

5.4.2.1 Rain Garden Construction

To determine the specific size of a raingarden or bioswale that will accommodate runoff from impervious the soil type in the area and the amount of impervious surface draining into the wetland. The soil composition of the majority of campus, determined in Chapter 2 page 75, is made land which is well-drained and makes up the campus core and silt loam which is somewhat poorly drained and makes up West Campus. The soil composition determines which multiplier should be used, 20% to 30% for sandy, well-drained, soil and 60% for clay, poorly drained, soil. Additionally, the area of all impervious surfaces (rooftops, driveways, sidewalks, parking lots, etc.) must be calculated and multiplied by the appropriate multiplier to determine the RGBS area needed [86].

The depth of a rain garden should be four to eight inches deep to provide enough surface area for water storage during larger storms. Stormwater should spread evenly over the entire rain garden for best infiltration results. Once the location, area, and depth are determined the length and width of the garden can be chosen. Long thin rain gardens are recommended as they are easier to build and maintain. This shape allows for most work to be accomplished from outside of the rain garden, this helps to mitigate soil compaction which inhibits infiltration within the garden [87]. The first step in constructing a rain garden is to remove the vegetative cover from the surface area of the rain garden. If the topsoil is deep, more than 12 inches, create a depression that is 6 inches deep and begin planting. If the topsoil is shallow or soil is not of optimum quality sand or compost can be added to increase soil quality. When creating the depression, save the topsoil, and create a depression that is 12 to 18 inches deep. Fill the depression with a mix of 50% sand, 30% compost, and 20% topsoil (the saved topsoil) until the depression is about 6 inches deep. To determine the tonnage of sand and compost needed to fill the rain garden please refer to Equations (5-1)and (5-2). Plant selected native species of trees, shrubs, vines, grasses, and herbaceous plants to fill the space in the rain garden; a list of recommended options can be found in Table 5.7 below. Mulch the area with 2 inches of shredded mulch. Finally, water weekly unless there is regular rainfall occurring through the first year, weed, dead flower heads, and perform other needed maintenance. Remove and compost dead residue each spring [87].

L = Length of rain garden (ft)

W = width of a rain garden in feet (ft)

D = depth being filled (ft)

(5-1)

$$\left(\frac{[L*W*D]}{27\frac{ft^3}{yd^3}}\right)*0.50*1.5\frac{ton}{yd^2} = tons\ of\ sand$$

(5-2)

$$\frac{\left[\left(\frac{[L*W*D]}{27\frac{ft^3}{yd^3}}\right)*0.30*1200\frac{lb}{yd^2}\right]}{2000\frac{lb}{ton}} = tons\ of\ compost$$

5.4.2.2 Bioswale Construction

The first step in constructing a rain garden is to remove the vegetative cover from the surface area of the rain garden. Topsoil should be saved, and the surface area should be excavated 42 inches deep. The hole should then be backfilled with 12 inches of clean, washed, 1-inch aggregate. Next place 2 inches of 3/8 inches rock chip in the rock bed, if the surrounding soil is well-drained place the rock chip in the upper part of the rock bed and if the surrounding soil is poorly drained place the rock chip at the bottom of the rock bed [88]. Fill to within six to eight inches of the top with a mixture of 60% sand, 25% compost, and 15% topsoil (the saved topsoil). To determine the tonnage of rock, sand, and compost needed to fill the rain garden please refer to Equations (5-1), (5-2),

(5-3), (5-4), (5-5), (5-6), and (5-7).

L = Length of rain garden (ft)
W = width of a rain garden in feet (ft)
$\boldsymbol{D_a}$= depth being filled by aggregate (ft)
$\boldsymbol{D_c}$= depth being filled by rock chip (ft)
$\boldsymbol{D_m}$= depth being filled by soil mix (ft)

$$\left(\frac{[L * W * D_a]}{27\,\frac{ft^3}{yd^3}}\right) * 1.5\,\frac{ton}{yd^2} = tons\ of\ 1"\ aggregate \tag{5-3}$$

$$\left(\frac{[L * W * D_c]}{27\,\frac{ft^3}{yd^3}}\right) * 1.5\,\frac{ton}{yd^2} = tons\ of\ {}^{3}/_{8}"\ rock\ chip \tag{5-4}$$

$$\left(\frac{[L * W * D_m]}{27\,\frac{ft^3}{yd^3}}\right) * 0.60 * 1.5\,\frac{ton}{yd^2} = tons\ of\ sand \tag{5-5}$$

$$\frac{\left[\left(\frac{[L * W * D_m]}{27\,\frac{ft^3}{yd^3}}\right) * 0.25 * 1200\,\frac{lb}{yd^2}\right]}{2000\,\frac{lb}{ton}} = tons\ of\ compost \tag{5-6}$$

$$\frac{\left[\left(\frac{[L * W * D_m]}{27\,\frac{ft^3}{yd^3}}\right) * 0.15 * 1200\,\frac{lb}{yd^2}\right]}{2000\,\frac{lb}{ton}} = tons\ of\ topsoil \tag{5-7}$$

Plant selected native species of trees, shrubs, vines, grasses, and herbaceous plants to fill the space in the rain garden; a list of recommended options can be found in Table 5.7 below. Mulch the area with 2 inches of shredded mulch. Finally, water weekly unless there is regular rainfall occurring through the first year, weed, dead flower heads, and perform other needed maintenance. Remove and compost dead residue each spring [87].

Table 5.7: DCNR and PA DEP Recommended Native Grass, Herbaceous, and Tree Species for Riparian or Wetland Habitats

Native Grass and Herbaceous Species

Fox sedge	*Carex vulpinoidea*	Pennsylvania sedge	*Carex pensylvanica*
Woolgrass	*Scirpus cyperinus*	Bluejoint grass	*Calamagrostis candensis*
Soft rush	*Juncus 121ffuses*	Blue lobelia	*Lobelia siphilitica*
Joe-pye weed	*Eupatorium purpureum*	Turtle Head	*Chelone galbra*
Milkweed	*Asclepias incarnata*	Royal Fern	*Osmunda regalis*
Blue Flag Iris	*Iris versicolor*	Cardinal Flower	*Lobelia species*

Native Tree Species

Bigtooth aspen	*Populus grandidentata*	Black gum	*Nyssa sylvatica*
Quaking aspen	*Populus tremuloides*	Eastern hemlock	*Tsuga canadensis*
Pin oak	*Quercus palustris*	Red maple	*Acer rubrum*
Black willow	*Salix nigra*	Yellow birch	*Betula alleghaniensis*
Black cherry	*Prunus serotina*	American sycamore	*Platanus occidentalis*
Tulip poplar	*Liriodendron tulipifera*	Black spruce	*Picea mariana*
Eastern white pine	*Pinus strobus*	Silver maple	*Acer saccharinum*
Red spruce	*Picea rubens*		

Native Small Tree Species

Flowering dogwood	*Cornus florida*	Serviceberry	*Amelanchier arborea*
Staghorn sumac	*Rhus typhina*	Smooth serviceberry	*Amelanchier laevis*
Smooth sumac	*Rhus glabra*	Low serviceberry	*Amelanchier stolonifera*
Winged sumac	*Rhus aromatica*	Redbud	*Cercis canadensis*

Native Shrub Species

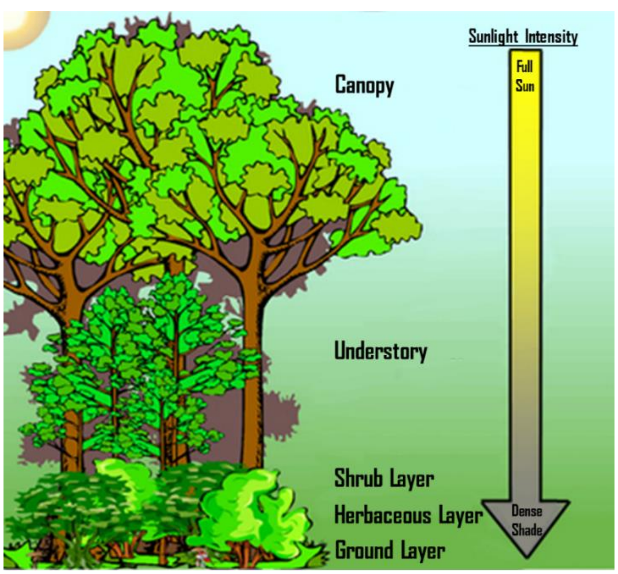
Alder	*Alnus spp.*	Winterberry holly	*Ilex verticilata*
Chokeberry	*Aronia melanocarpa*	Silky dogwood	*Cornus amomum*
Buttonbush	*Cephalanthus occidentalis*	Elderberry	*Sambucus canadensis*
Choke cherry	*Prunus virginiana*	Highbush blueberry	*Vaccinium corymbosum*
Gray dogwood	*Cornus racemosa*	Arrow-wood viburnum	*Viburnum dentatum*
Blackhaw	*Viburnum prunifolium*	Inkberry	*Ilex glabra*
Witch hazel	*Hamamelis virginiana*	Red-osier dogwood	*Cornus sericea*
Ninebark	*Physocarpus opulifolius*		

5.4.3 Trees, Shrubs, Herbs, Vines, and Flower Beds

> *"No matter how much any individual garden may seem like a separate place, a refuge, or an island, it is in truth part of the larger landscape, and that in turn is made of many layers…The richness of life in any given landscape is generally linked to the richness and intricacy in its layering"* – The Living Landscape

There are a number of patches of ecologically productive areas, woodlands, meadows, and wetlands, on and around the Villanova university campus. However, these areas have been fragmented by simplified lawn landscapes that lack biodiversity and functional layers. Villanova has an opportunity to enhance its already established planted areas by increasing biodiversity and functional layers as well as create new planted areas that have high biodiversity and functional layers using native plant species. This will increase the overall biodiversity of the campus as well as create biodiversity pathways for animals between woodlands, meadows, and wetlands on the campus, between the campus and Stoneleigh, and between the campus and the community.

Table 5.8: Layers of Natural Landscapes



Layers in a Landscape	
Vertical Layers	**Horizontal Layers**
Canopy	Dynamic Edge
Understory	Wet Edge
Shrubs	Wetlands
Herbaceous Plants	Meadows and Grasslands
Ground Layer	

For all planted areas, trees, shrubs, herbs, and vines Native species should be the primary choice for all plantings on the Villanova University campus. *The Living Landscape* pages 289-221 contain a list of suggested plants, their ecological function, their landscape function, and specific notes on the plan. It is suggested that this list is utilized when determining plant selection. The following sections provide suggestions for each of the horizontal layers.

5.4.3.1 Ground Layer

The ground layer at Villanova University currently primarily lawn, however, this plan already addresses the reduction of this kind of groundcover for other, more productive, groundcover on campus. The ground layer around trees is most often mulch, however, this should be replaced with native herbaceous groundcover in as many areas a possible. This provides an alternative for weed suppression and root protection that is less susceptible to runoff and less expensive in the long term.

5.4.3.2 Herbaceous Layer

The potential diversity of plants in the herbaceous layer is greater than that of any of the other layers listed due to the number of species of herbaceous plants. For humans, diversity in this layer provides color, texture, fragrance, seasonal changes, and helps to determine plants that are best adapted to local conditions. For wildlife, a higher variety of herbaceous species provides better shelter and cover and overlapping bloom sequences ensure that nectar, pollen, seeds, and fruits are continually available. There is, however, a balance that needs to be met. Grouping too many species that have distinctly different growing needs into areas that are too small will cause the planting to become difficult or impossible to maintain. The goal is to support the highest overall diversity but to avoid unsustainable variety in any one spot [25].

When choosing plants for the herbaceous layer healthy natural habitats in the area should be used as a model for what will thrive in the local ecosystem. When mixing and pairing herbaceous plants it is ideal to choose species with similar growth rates. “The key to a durable herbaceous layer is to rely primarily on a mix of clump-forming plants that are inherently long-lived, plants that regularly perpetuate themselves by self-sewing, and plants that have the capacity for self-repair.” [25]

Maintenance of these areas should include weeding, invasive species removal, and if needed mulching. Mulching can be reduced by pairing hearty herbaceous groundcover with the other chosen herbaceous species to suppress weed growth and reduce the need for mulch.

5.4.3.3 Shrub Layer

The shrub layer is not as diverse as the herbaceous layer but still provides vital services to both humans and animals. For humans, the shrub layer provides color, texture, fragrance, separates spaces, and can act as a block to unsightly areas. For animals, the shrub layer provides essential food and shelter.

5.4.3.4 Understory and Canopy

Tree canopy should make up 25% of the total campus area this canopy cover can be made up of both understory and canopy trees. The canopy cover includes trees planted in lawns and flower beds as well as forested areas on campus. Canopy cover will increase as younger trees grow and mature and with the planting of additional trees. A map depicting possible areas for complete canopy cover is shown in Figure 5.4. For singular trees planted in lawns, especially outside of the campus core, mulch should be replaced with native herbaceous groundcover. This provides an alternative for weed suppression and root protection that is less susceptible to runoff and less expensive in the long term.

5.4.3.4.1 Arboretum

The Villanova University campus has many impressive trees that have been lovingly cared for over the years. This health of these trees should be ensured by the university and their beauty should be shared with the community. To help achieve this the university should become a certified arboretum. The requirements for different levels of arboretum certifications are shown in Figure 5.5: Levels of Arboretum Accreditation [89]. The university already meets many of the qualifications to be a Level 1 certified arboretum all it needs is a written arboretum plan and an organizational or governance group. It is also recommended that as arboretum activities expand two dedicated staff members are hired to ensure tree health, perform maintenance, and plant additional trees needed to meet the tree canopy cover goal.

Figure 5.4:Potential Areas for Canopy Cover Increase

	LEVEL I	LEVEL II	LEVEL III	LEVEL IV
Arboretum plan	■	■	■	■
Organizational or governance group	■	■	■	■
Labeled tree and woody plant taxa				
25+	■			
100+		■		
500+			■	■
Staff or volunteer support				
Volunteer or paid	■			
Paid management		■	■	■
Curator			■	■
Scientific or conservation staff				■
Public dimension				
Public access and at least one event per year	■	■	■	■
Enhanced public and educational programs		■	■	■
Substantial educational programming			■	■
Collections policy		■	■	■
Collaboration with other arboreta			■	■
Collections data sharing with networked collections			■	■
Agenda for tree science, planting, and conservation			■	■
Collections conservation				■
Conservation role in Global Trees Campaign				■

Figure 5.5: Levels of Arboretum Accreditation [89]

5.4.3.4.2 Fully Forested Areas

In addition to planted trees and those that make up the arboretum Villanova has a number of areas that would be appropriate, and beneficial, to cultivate as fully forested area. There would be little to no human intervention in the forested areas once they are established, with the exception of invasive species removal and pest control. Suggested fully forested areas are shown in Figure 5.6.

Figure 5.6: Potential Areas to be Fully Forested

Area 1 encompasses the area directly beside St. Mary's Hall, four medians, and the area near the road intoWwest Campus. The area beside St. Mary's Hall is fondly referred to by the grounds department as Chuck's enchanted forest. This area was planted by the previous horticultural supervisor, Chuck Leeds, and was meant to replace forest that had been lost during construction on West Campus. However, this area is currently more of a large flower bed than a forest. This due to a lack of layers, low plant density, and heavy mulching of the entire area to prevent weed growth. This area provides a wonderful opportunity for conversion to a forested area since that was the area's intended land use. In terms of layers, there are already established trees and shrubs, so moving forward cultivation of an understory, herbaceous layer, and native ground cover will be required to turn this into forest area.

The larger medians, which contain lawn, trees, and flower beds, are impractical for all campus users and should be converted to fully forested areas. Human campus users do not utilize these areas for activities such as studying, picnicking, playing, etc. since they are inconveniently located between to roads; Animal campus users do not benefit significantly from these areas since the groundcover is majorly made up of turfgrass lawn though there are some pollinator benefits from the flower beds, and the campus minimally benefits from the heat mitigation from the trees as well as a small contribution to stormwater management. Since this area does not provide significant services for human users, animal users, or the campus they are impractical and should be converted to a more productive landscape, in this case, forest, to increase their benefits to the entire community.

The smaller medians contain flower beds with some trees, herbs, and shrubs. This area is also difficult to access and is providing minimal if any benefits and should be converted to a more productive landscape. More productive landscape, in this case, could be forested with layers of trees, shrubs, herbs, and groundcover or if the area is too small it could be planted with the same mix of perennial plants as recommended for meadows around the existing plants.

The area along to road into West Campus contains lawn and flowerbeds. As mentioned with the other areas the lawn here does not provide significant benefits to the campus users. The flower beds provide some benefits to pollinators, however, this benefit is small compared to the benefits of allowing this area to become forest.

Areas 2, 3, and 4 are all located on campus edges that border residential neighborhoods. **Area 2** encompasses the wooded area beside East County Line Road and the wooded area that borders the parking lot beside the steam plant. In the area along the road, there are mature trees and some flower beds. Allowing this area to become fully forested will benefit the university’s relationship with the community by ensuring that the steam plant, operations buildings, and law school are obscured by trees. **Area 3** is located along the edges of the athletic campus and encompasses the wooded area beside County Line Road and the lawn and flower beds bordering the parking lot. Allowing these areas to become fully forested will also benefit the university's relationship with the community by reducing sound and light pollution from the athletic campus into the surrounding communities. Finally, **Area 4** is located beside the NHSL Villanova Station this area contains mature trees that shade manicured lawn, benches, and a paved path. This area is often traversed by Villanova students traveling between the main campus and the South campus dorms. This area is being recommended due to complaints from the community about the visual impacts of the new senior dorms along Lancaster Ave. Cultivating this area to be fully forested will reduce the visual impacts of the senior dorms on the community and positively benefit the relationship between the community and Villanova University.

5.4.3.5 Flowerbeds

Flowerbeds should make up 5% of the total campus area. In flowerbeds, the focus should be on increasing the density and layering of plants. There should be at least three vertical layers present in flowerbeds, most beds currently have at least 2. Additionally, mulching, especially outside of the campus core, should be minimized and replaced with quick-growing native ground cover, dense herbaceous plants, or dense shrubbery. This will reduce costs for the university and increase ecological productivity. Weeding of flower beds and around trees should be done by hand to reduce herbicide use and reduce the possibility of accidentally killing beneficial plant species. This will increase manual labor required to control weeds, so it is suggested that 2-3 more staff members, specifically gardeners not landscapers, are hired to handle the additional workload.

5.5 Nova Nature Walk

The nova nature walk is intended to be a walk around the campus that showcases the sustainability efforts taken across the university, educates people on these efforts, provides a pleasurable and beautiful walk, and connects the campus to Stoneleigh. However, the nature walk cannot become a reality until the landscape of campus begins to change. Figure 5.7 shows the breakdown of the current campus landscape and Figure 5.8: Possible Campus Landscape shows a possible campus landscape that has begun to meets the goals of the sustainable landscaping plan (NOTE: the keys for these two maps are different). Figure 5.9 then shows the path that the nature trail would take through the campus and showcasing the main areas of interest along the trail based on the landscape in Figure 5.8: Possible Campus Landscape. The areas of interest include a pollinator path, the constructed stormwater wetland, bird-friendly windows on the law school, west campus forest AKA “Chuck’s Forest”, a campus core arboretum tree tour, the CEER green roof, Villanova Consortium for Agricultural Research and Education (VCARE) Garden, and the south camps forest. Areas that are already established are the constructed stormwater wetland, the CEER green roof, and the VCARE garden. Visuals on how current landscape could be changed into the remaining areas of interest are depicted in Figure 5.10, Figure 5.11, Figure 5.12, Figure 5.13, Figure 5.14, and Figure 5.15 These areas were chosen because they embody solutions to several issues facing urban and suburban areas all over the world. Each of these areas of interest and their locations are explained in greater detail in the sections below. Additional areas of interest on this trail can be added over time as more sustainable landscaping projects are completed.

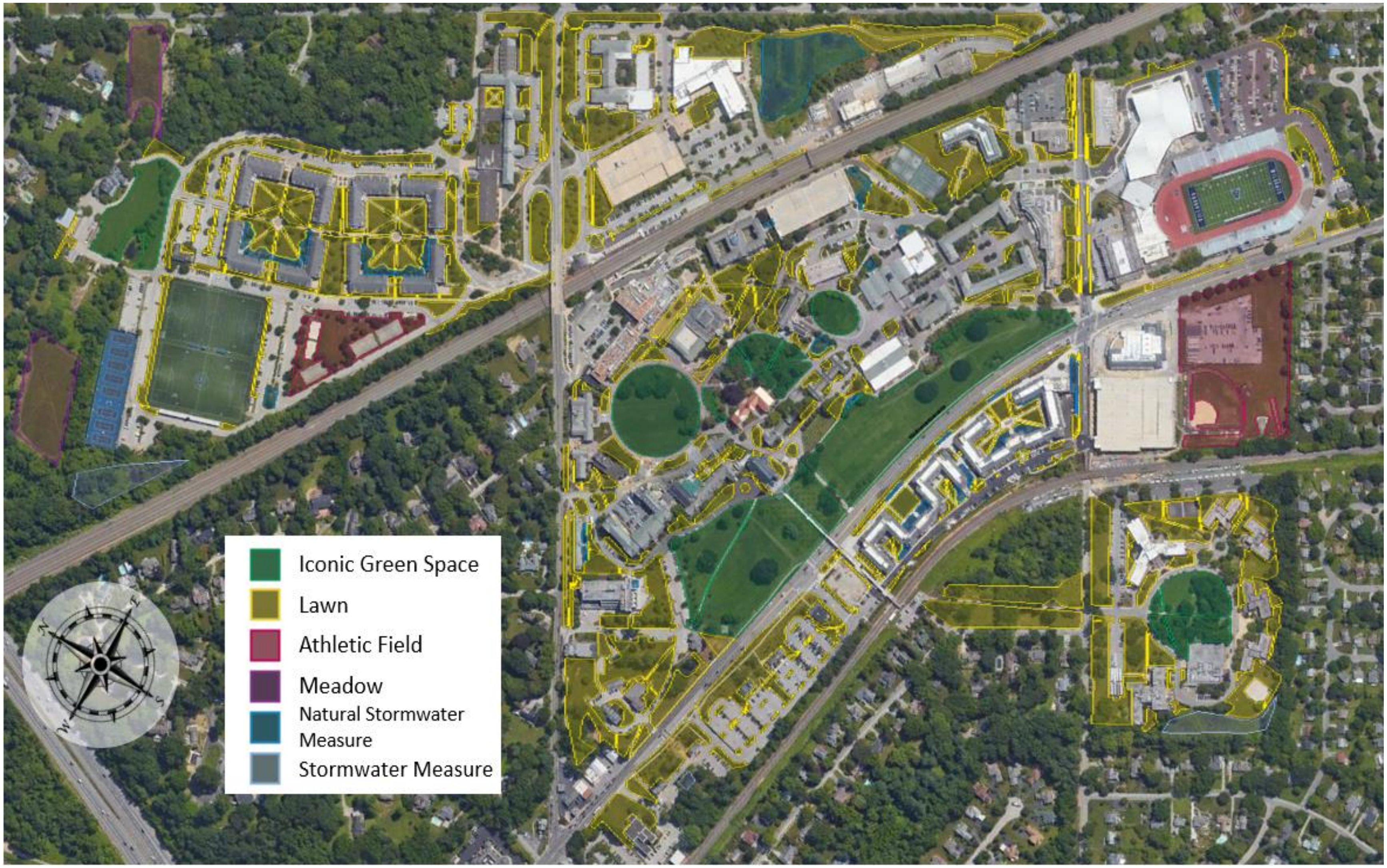


Figure 5.7: Current Campus Landscape

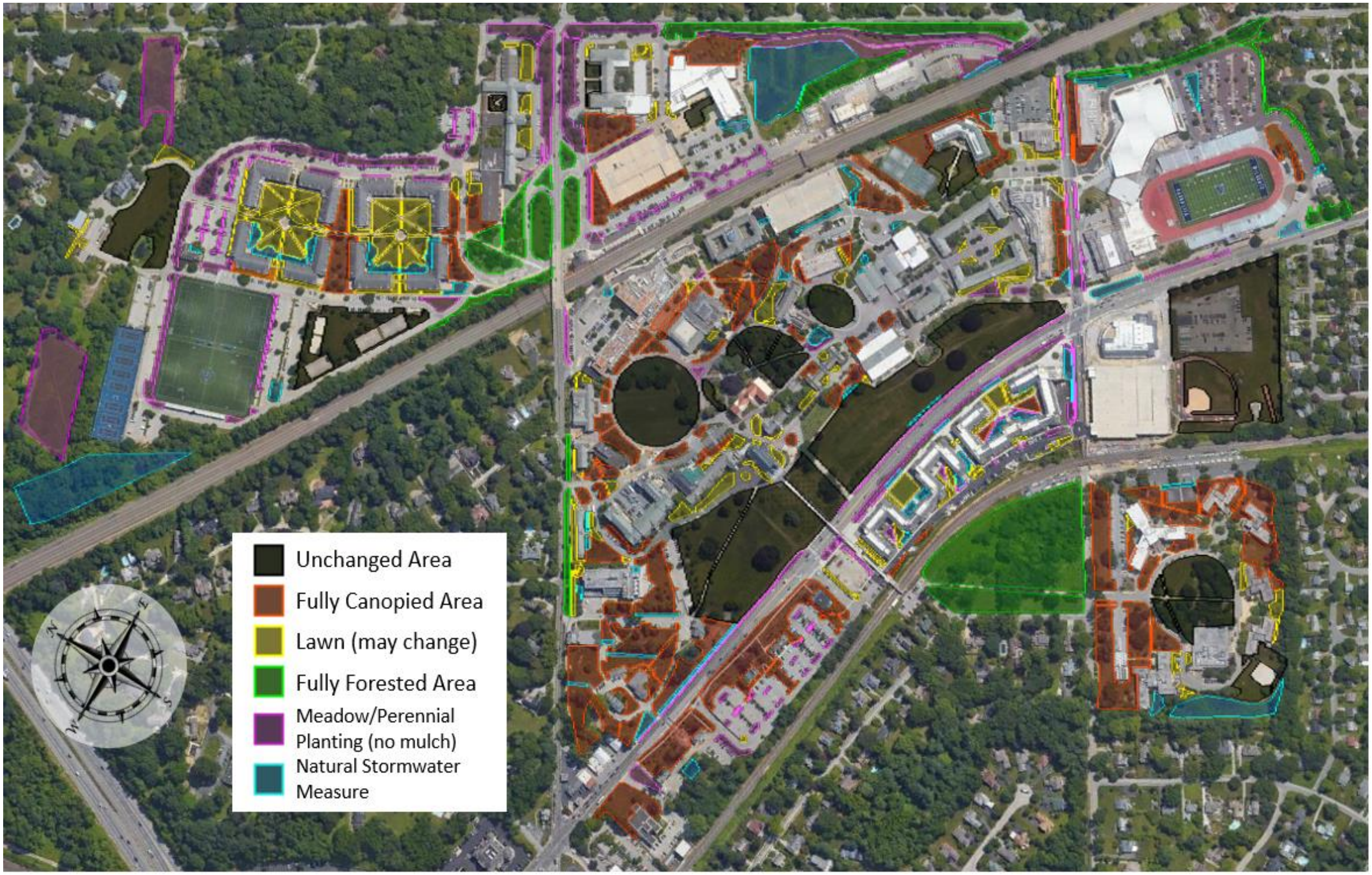


Figure 5.8: Possible Campus Landscape

Figure 5.9: Nova Nature Walk Path and Areas of Interest

Urban Land Use for Pollinators

Figure 5.10: Visual of Current Landscape and Possible Hellstrip Planting [90] [91]

Urban Land Use for Pollinators

Figure 5.11: Visual of Current Landscape and Possible Parking Lot Median or Road Median Plantings

Native Perennial Meadow

Figure 5.12: Visual of Current Landscape and Possible Pollinator Path Planting [92] [93]

*single bird of prey decals DO NOT WORK [94]

Figure 5.13: Visual of Law School and Future Bird-Friendly Windows [94] [95]

West Campus Forest Entrance

Figure 5.14: Visual of Current Landscape and Possible Future West Campus Forest Gate [96] [97]

South Campus Forest Path

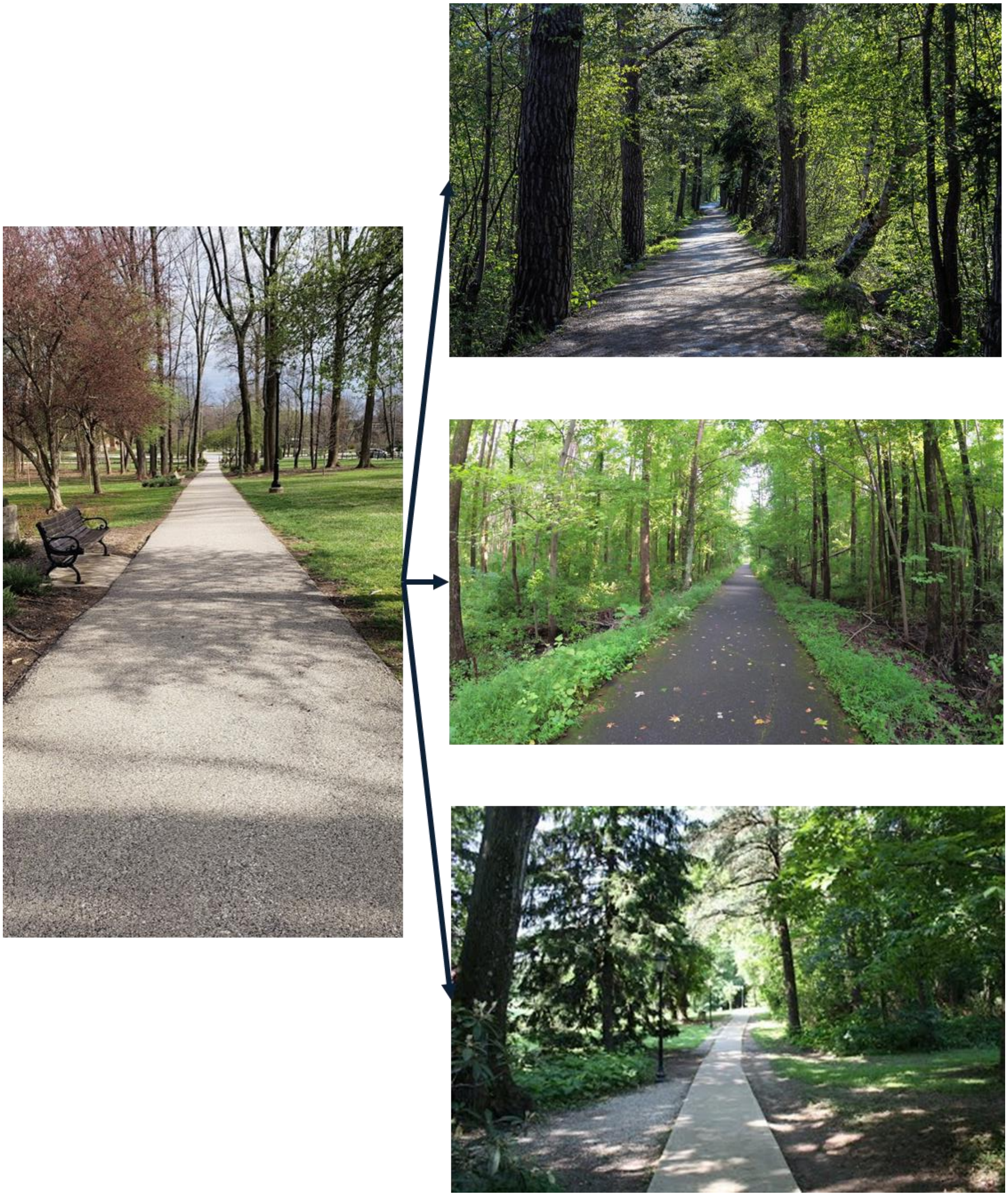


Figure 5.15: Visual Current Landscape and Possible Future South Campus Woods [98] [99]

5.6 Community Involvement and Education

Information on the changes being made to land cover, land use, and land maintenance and their benefits should be provided to the campus community. Details of this information, the how, what, why, and where should be available on the University website so that it can be accessed by anyone who is interested.

Once locations for meadows, natural stormwater measures, and trees are determined, activities involved with construction, planting, establishment, invasive species removal, and others can be included as activities for Villanova's day of service.

The Nova Nature Walk should be advertised on the University website with linked information on the benefits of the various areas included on the walk. Additionally, these areas should have signage at the location describing the changes made, the functions of the new area, and the benefits of the changes.

5.7 Administration

This plan is a part of the Villanova Sustainable Initiative so it will be overseen by the Sustainability Leadership council. However, the plan will require expertise and collaboration between the Grounds Department, Operations, Biology Department, Civil and Environmental Department, Geography and the Environment Department, the Center for Biodiversity and Ecosystem Stewardship (CBEST), and Natural Lands through Stoneleigh so these parties MUST remain involved in the continued design and execution of this plan.

Table 5.9: Key Contacts for The Sustainable Landscaping Plan

Group	Area of Expertise	Contact Name	Contact Info
Sustainable Leadership Council	Villanova Sustainability Initiative	William Lorenz	william.lorenz@villanova.edu
Grounds Department	Trees and Plant Selections	Hugh Weldon	hugh.weldon@villanova.edu
Operations	Operations	Robert Morro	robert.morro@villanova.edu
Center for Biodiversity and Ecosystem Stewardship	Biodiversity and ecosystem Services	Dr. Samantha Chapman	samantha.chapman@villanova.edu
Civil and Environmental Engineering Department	Natural stormwater measures	Dr. Robert Traver	robert.traver@villanova.edu
Operations	University sustainability and community involvement	Liesel Schwarz	liesel.schwarz@villanova.edu
Biology Department	Insect heath and diversity	Dr. Vikram Iyengar	vikram.iyengar@villanova.edu
Biology Department	Bird health and diversity	Dr. Robert Curry	robert.curry@villanova.edu
Natural Lands (Local Manager)	Meadow and forest design and establishment	Luke Hamilton	lhamilton@natlands.org
Natural Lands (Regional Manager)	Meadow and forest design and establishment	Gary Gimbert	ggimbert@natlands.org

6 CONCLUSION

Villanova University needs to increase biodiversity and ecosystem services on its campus to solve core issues that are affecting the campus and will continue to affect the campus in the future. Currently, biodiversity on the campus core is low, .19 out of 1, and ecologically unproductive landscape is high, 72% of total campus area. By achieving the goals and performing the actions shown in Figure 5.1: Goals and Actions to Achieve Goals, on page 100, Villanova University will be able to reduce ecologically unproductive landscape to 57% of total campus landscape and increase overall campus biodiversity, which will create a campus that is a living laboratory for research and education, increase natural stormwater management measures which will mitigate stormwater-related issues caused by future increases in average rainfall, increase natural heat mitigation measures which will help to lower temperatures on the campus caused by future increases in temperature, and increase the health of the flora, fauna, and humans of the Villanova University Campus.

7 IDEAS FOR FUTURE RESEARCH

Research in this area will be continued by Jessica Vairo. Suggested future areas of study are a full campus biodiversity score, determining the specifics of implementation and landscape design for the plan, and deeper integration with the Villanova Sustainability Plan. This study only assessed the biodiversity of the campus core so an additional study should be done to determine the biodiversity of the rest of the campus. Additionally, the Sustainable Landscaping Plan has the general actions that need to be taken to meet the goals and suggested areas for change. However, research and collaboration to determine detailed locations, specific plant selection, and feasibility will need to be done to further the plan. Working closely with the parties listed in the administration section to achieve this is recommended. Once that is completed a timeline and budget can be developed for the plan and implementation can begin. The goals of this plan should be established as metrics in the Villanova Sustainability Plan when it is reviewed for the 2022-2024 period. Currently, campus carbon sequestration is included but a metric specifically pertaining to biodiversity and ecosystem services should also be included.

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A. APPENDIX A

Table A.1: Raking of Goals based on Natures Contributions to People

Goals ordered by Correlation with Biodiversity	Description	Category
Goal 2	Zero Hunger	People
Goal 10	Reduce Inequalities	Prosperity
Goal 1	No Poverty	People
Goal 3	Good Health and Well-Being	People
Goal 9	Industry Innovation and Infrastructure	Prosperity
Goal 15	Life on Land	Planet
Goal 12	Responsible Consumption and Production	Prosperity
Goal 6	Clean Water and Sanitation	Planet
Goal 14	Life Below Water	Planet
Goal 4	Quality Education	People
Goal 8	Decent Work and Economic Growth	People
Goal 11	Sustainable Cities and Communities	People
Goal 16	Peace, Justice, and Strong Institutions	People
Goal 17	Partnerships for The Goals	Prosperity
Goal 7	Affordable and Clean Energy	People
Goal 13	Climate Action	Planet
Goal 5	Gender Equality	People

Table A.2: Detailed Koppen Classification Criteria of Major Climatic Types [31]

letter symbol			
1st	**2nd**	**3rd**	**criterion**
A			temperature of coolest month 18 °C or higher
	f		precipitation in driest month at least 60 mm
	m		precipitation in driest month less than 60 mm but equal to or greater than 100 – (r/25)[1]
	w		precipitation in driest month less than 60 mm and less than 100 – (r/25)
B[2]			70% or more of annual precipitation falls in the summer half of the year and r less than 20t + 280, or 70% or more of annual precipitation falls in the winter half of the year and r less than 20t, or neither half of the year has 70% or more of annual precipitation and r less than 20t + 140[3]
	W		r is less than one-half of the upper limit for classification as a B type (see above)
	S		r is less than the upper limit for classification as a B type but is more than one-half of that amount
		h	t equal to or greater than 18 °C

		k	t less than 18 °C
C			temperature of warmest month greater than or equal to 10 °C, and temperature of coldest month less than 18 °C but greater than –3 °C
	s		precipitation in driest month of summer half of the year is less than 30 mm and less than one-third of the wettest month of the winter half
	w		precipitation in driest month of the winter half of the year less than one-tenth of the amount in the wettest month of the summer half
	f		precipitation more evenly distributed throughout year; criteria for neither s nor w satisfied
		a	temperature of warmest month 22 °C or above
		b	temperature of each of four warmest months 10 °C or above but warmest month less than 22 °C
		c	temperature of one to three months 10 °C or above but warmest month less than 22 °C
D			temperature of warmest month greater than or equal to 10 °C, and temperature of coldest month –3 °C or lower
	s		same as for type C
	w		same as for type C
	f		same as for type C
		a	same as for type C
		b	same as for type C
		c	same as for type C
		d	temperature of coldest month less than –38 °C (d designation then used instead of a, b, or c)
E			temperature of warmest month less than 10 °C
	T		temperature of warmest month greater than 0 °C but less than 10 °C
	F		temperature of warmest month 0 °C or below
H[4]			temperature and precipitation characteristics highly dependent on traits of adjacent zones and overall elevation—highland climates may occur at any latitude

[1]In the formulas above, r is average annual precipitation total (mm), and t is average annual temperature (°C). All other temperatures are monthly means (°C), and all other precipitation amounts are mean monthly totals (mm).

[2]Any climate that satisfies the criteria for designation as a B type is classified as such, irrespective of its other characteristics.

[3]The summer half of the year is defined as the months April–September for the Northern Hemisphere and October–March for the Southern Hemisphere.

[4]Most modern climate schemes consider the role of altitude. The highland zone has been taken from G.T. Trewartha, An Introduction to Climate, 4th ed. (1968).

Data Sources: Adapted from Howard J. Critchfield, General Climatology, 4th ed. (1983), and M.C. Peel, B.L. Finlayson, and T.A. McMahon, "Updated World Map of the Köppen-Geiger Climate Classification," Hydrology and Earth System Sciences, 11:1633–44 (2007).

Table A.3: Simplified Koppen Climate Classification Descriptions [34] [100]

1st: Main Climate Groups	2nd: Seasonality Precipitation	3rd: Seasonal Temp
A (Tropical) Tropical Moist Climates: all months have average temperatures above 18 degrees Celsius	f (Rainforest)	
	m (Monsoon)	
	w (Savanna, Dry winter)	
	s (Savanna, Dry summer)	
B (Arid) Dry Climates: with deficient precipitation during most of the year	W (Desert)	
	S (Steppe)	
		h (Hot)
		k (Cold)
C (Temperate) Moist Mid-latitude Climates with Mild Winters	s (Dry summer)	
	w (Dry winter)	
	f (Without dry season)	
		a (Hot summer)
		b (Warm summer)
		c (Cold summer)
D (Continental) Moist Mid-Latitude Climates with Cold Winters	s (Dry summer)	
	w (Dry winter)	
	f (Without dry season)	
		a (Hot summer)
		b (Warm summer)
		c (Cold summer)
		d (Very cold winter)
E (Polar) Polar Climates: with extremely cold winters and summers	T (Tundra)	
	F (Eternal frost (ice cap))	

Table A.4: Distribution of Forest Land in PA by Region [28]

Table 4.—Distribution of forest land with respect to several urbanization and fragmentation factors, expressed as a percentage of the forest land in each region, Pennsylvania

Region	Forest land as a percentage of total land in region[a]	Percentage of forest land in wildland-urban intermix[b]	Percentage of forest land <650 feet from a road[c]
North Central	77	19	39
Northeast	68	40	45
Northwest	56	42	43
South Central	62	31	42
Southeast	29	52	67
Southwest	62	49	55
State total	**62**	**35**	**46**

[a] Percent forest estimate based on NLCD 2011 (includes woody wetland). Values are generally higher than estimates from FIA plot data.
[b] Approximating the forest land potentially affected by underlying or nearby development. Data source: U.S. Census (2011).
[c] Approximating the forest land potentially affected by roads. Data source: U.S. Census (2000).

Figure A.1: Type of forested area by PA region

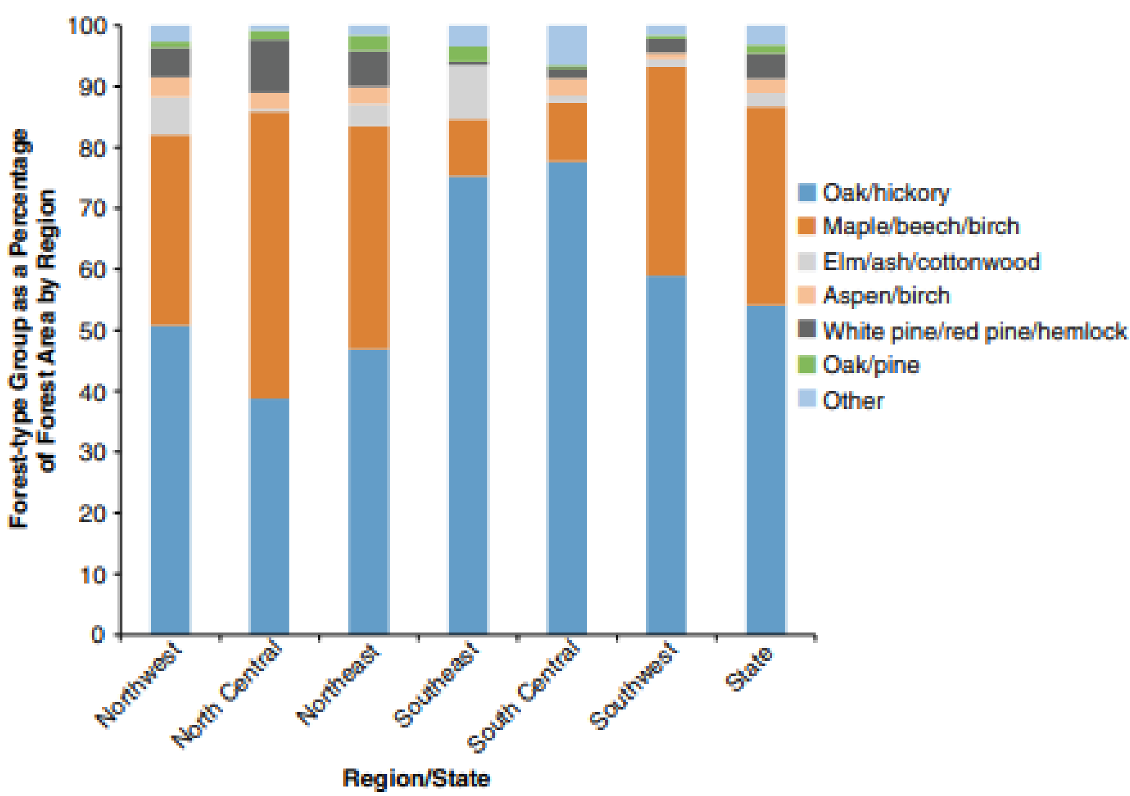

Table A.5: Raw Soil Data [101]

Delaware County, Pennsylvania (PA045)								
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**	**pH**	**Available Water Capacity**	**Drainage Class**	**K Factor**	**OMD**
CaaA	Califon loam, 0 to 3 percent slopes	12.8	2.2%	5.6	0.20	Moderately Well Drained	.32	Moderate
CdA	Chester silt loam, 0 to 3 percent slopes	5.2	0.9%	5.0	0.18	Well Drained	.32	Moderately High
CdB	Chester silt loam, 3 to 8 percent slopes	27.8	4.9%	5.0	0.18	Well Drained	.32	Moderately High
GdB	Gladstone gravelly loam, 3 to 8 percent slopes	21.1	3.7%	6.3	0.14	Well Drained	.15	Moderately High
GdC	Gladstone gravelly loam, 8 to 15 percent slopes	6.0	1.1%	6.3	0.13	Well Drained	.15	Moderately High
GeB	Glenelg channery loam, 3 to 8 percent slopes	38.2	6.7%	5.4	0.19	Well Drained	.20	Moderately High
GeB3	Glenelg channery silt loam, 3 to 8 percent slopes, severely eroded	6.1	1.1%	5.4	0.16	Well Drained	.20	Moderately High

GeD2	Glenelg channery silt loam, 15 to 25 percent slopes, moderately eroded	2.0	0.4%	5.4	0.16	Well Drained	.20	Moderately High
GeD3	Glenelg channery silt loam, 15 to 25 percent slopes, severely eroded	0.0	0.0%	5.4	0.16	Well Drained	.20	Moderately High
GeE	Glenelg channery silt loam, 25 to 35 percent slopes	1.5	0.3%	5.4	0.16	Well Drained	.20	Moderately High
GnA	Glenville silt loam 0 to 3 percent slopes	3.7	0.6%	5.9	0.18	Moderately Well Drained	.37	Moderate
GnB2	Glenville silt loam, 3 to 8 percent slopes, moderately eroded	82.5	14.5%	5.9	0.18	Somewhat Poorly Drained	.43	Moderate
Ha	Hatboro silt loam	1.1	0.2%	5.9	0.19	Poorly Drained	.37	Moderate
Me	Made land, schist and gneiss materials	231.9	40.6%	5.8	0.16	Well Drained	.43	Moderately High
MgC	Manor loam, 8 to 15 percent slopes	0.0	0.0%	5.3	0.19	Well Drained	.28	Moderate

Mn	Melvin silt loam	2.3	0.4%	6.7	0.21	Poorly Drained	.43	Moderate
UrlB	Urban land-Gladstone complex, 0 to 8 percent slopes	18.0	3.2%					
UrlD	Urban land-Gladstone complex, 8 to 25 percent slopes	10.6	1.8%					
Subtotals for Soil Survey Area		**470.8**	**82.5%**					
Collapse Montgomery County, Pennsylvania (PA091) Montgomery County, Pennsylvania (PA091)								
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**	**pH**	**Available Water Capacity**	**Drainage Class**		
CaA	Califon loam, 0 to 3 percent slopes	5.1	0.9%	5.6	0.20	Moderately Well Drained	.32	Moderate
CaB	Califon loam, 3 to 8 percent slopes	0.5	0.1%	5.6	0.20	Moderately Well Drained	.32	Moderate
GdB	Gladstone gravelly loam, 3 to 8 percent slopes	47.8	8.4%	6.3	0.14	Well Drained	.15	Moderately High
GdC	Gladstone gravelly loam, 8 to 15 percent slopes	0.2	0.0%	6.3	0.13	Well Drained	.15	Moderately High

Ha	Hatboro silt loam	8.5	1.5%	5.9	0.19	Poorly Drained	.37	Moderate
UrlB	Urban land-Gladstone complex, 0 to 8 percent slopes	6.4	1.1%					
UrlD	Urban land-Gladstone complex, 8 to 25 percent slopes	31.1	5.5%					
Subtotals for Soil Survey Area		**99.7**	**17.5%**					
Totals for Area of Interest		**570.5**	**100.0%**					

*Available water capacity
*pH is a 0-14 scale where a score of 7+ considered basic and a score below 7 is acidic. Values between 6-7.5 are optimal for crops.
*Erosion factor, K, ranges from .02-.69 where higher numbers indicate greater susceptibility to sheet and rill erosion by water.

B. APPENDIX B: POTENTIAL OUTCOMES

The potential outcomes from this plan will be evaluated using the STEEP framework. The framework is a holistic method to assess the results of a plan from a social, technical, environmental, economic, and political perspective.

Social

Increasing biodiversity and ecosystem services on the Villanova University campus will increase the research and educational opportunities showing the values of these landscapes to students, faculty, staff, community members, and visitors. It can also increase the health and wellbeing of the campus community through the filtering of chemicals from the environment, carbon capture and sequestration, and increasing enjoyment of the outdoors. Ensuring that all buildings on campus are bird-friendly and have bird-friendly windows will reduce bird deaths due to building collisions as well as reduce the negative views associated with these deaths by the campus community. Becoming a certified arboretum will show Villanova University is committed to the stewardship of its grounds. Creating a Nova Nature Walk that connects Villanova and Stoneleigh will showcase the measures that Villanova University has taken to become a more sustainable and environmentally responsible campus to students, faculty, staff, visitors, and the surrounding community. Partnering with Stoneleigh and increasing canopy cover around the campus, especially edge areas, can help to improve Villanova's relationship with the community.

There will likely be some backlash on the reduction of lawn space and proposed management of the remaining lawns as well as the application of adhesive film for bird-friendly windows, however, it must be stressed that the health of life on land should not be jeopardized in exchange for current aesthetic preferences.

Technical

From a technical perspective decreasing lawn area and increasing meadowland, tree cover, and natural stormwater measures will reduce stress on combines sewer systems during rain events as well as reduce pollutants in the runoff that does reach the combined sewer systems. It will also reduce the use of lawnmowers and other machinery used to maintain lawn areas. Increased canopy cover can provide shading, which dampens daily temperature variations for buildings, reducing energy needs for cooling by 39kWh/tree of electricity and 1,567,000 Btu/tree of Natural Gas [102]. Increased canopy over parking lots can reduce internal car temperatures as well as GAS THING

Environmental

Increasing the canopy cover helps with the reduction of the urban heat island effect, stormwater management, carbon sequestration, and food and habitat for fauna. Trees reduce heat through a combination of evapotranspiration and shading the branches and leaves that make up the tree canopy only allow 10% to 30% of the sun's energy to reach the area below the tree which affects air temperatures around the tree. In tree groves peak air temperatures are 9ºF cooler than open areas, suburban areas with mature trees are 4ºF to 6ºF cooler than suburbs without trees, and temperature over grass fields are 2 ºF to 4ºF cooler that open lawn areas. The cooling and shade created helping to reduce building energy use as well as reduces evaporative emissions from parked cars [103]. The impacts of stormwater are also reduced by trees. Branches and leaves intercept and absorb rainfall reducing the amount and impact of rainfall that reaches the ground which can lessen runoff and by extension topsoil loss from rainfall. Trees also absorb perform phytoremediation, when plants remove, transfer, stabilize, and/or destroy contaminants in the soil and groundwater [104]. Both canopy and understory trees are essential for providing food for insects, birds, and mammals as well as providing shelter for insects, birds, and small mammals. Increasing canopy cover will also increase carbon sequestration on campus by an estimated 92,000 tons of carbon per year and the total amount of carbon stored in trees on campus will increase by an estimated 2,300,000 tons of carbon.

Natural stormwater measures increase the absorption of runoff into the soil, treat remove harmful pollutants from runoff, provide food and habitat for fauna, and reduce eutrophication potential. Rain gardens absorb runoff 30% to 40% more effectively that lawn areas and can and due to the increased absorption, they can take up harmful pollutants present in the runoff [105]. This helps to prevent flooding as well as eutrophication. Plants in natural stormwater measures provide food for birds, insects, and other animals and larger NSW such as wetlands provide important habitat for amphibious species.

Reducing the overall lawn area will reduce the amount of mowing that needs to occur, reducing the need for gasoline, and in turn reducing overall carbon emissions. Increasing meadowland will help to decrease stormwater runoff, increase pollinator activity and health, and increase overall biodiversity.

Nova Nature Walk will create as well as expand viable habitat and create corridors to improve animal mobility, habitat, and food between Stoneleigh, Villanova, and other areas of the community.

Economic

Canopy cover currently provides an estimated $73,910 of annual benefits to the university through the removal of pollutants from the air as well as carbon sequestration. If the plan is completed the annual benefits from trees will increase to $86,124 of annual benefits an increase of $12,214.

Natural Stormwater Measures can provide cost reductions by reducing the amount of water that needs to be treated after rain events. While specific cost information could not be found the graph in Figure B. shows a comparison between the cost of green infrastructure vs the cost of infrastructure and treatment of the avoided gray water in Lancaster County nearby.

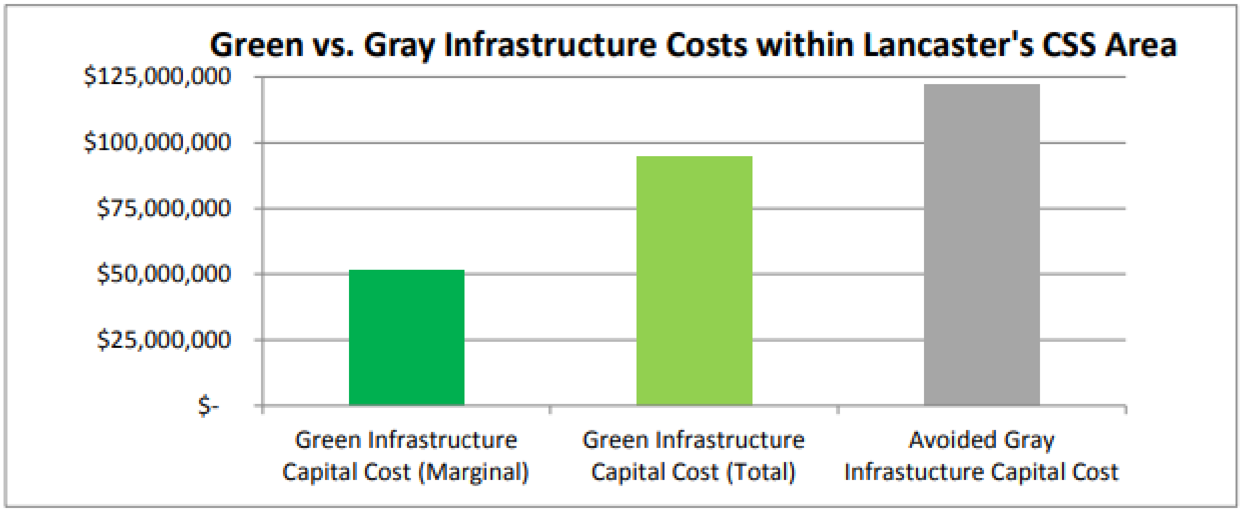

Figure B.1: Comparison of avoided gray infrastructure costs to green infrastructure costs within Lancaster's CSS area.

In 2003, EPA transformed two acres of lawn into a sustainable habitat for wildlife by planting hundreds of native plants and sowing seeds. EPA estimated by using this approach, the financial savings per year was $3,000 [106]. These savings were based on a reduction in the costs of lawn mowing labor, equipment wear and tear, and fuel consumption. This plan encourages Villanova to increase its meadowland by 5 acres, based on the information from the EPA, if the changes are made the university can save an estimated $7,500 a year.

Political

Achieving the goals sent in this plan will help Villanova University to meet the Sustainability goals set by the United Nations. The changes in this plan will also provide a way for the university to create positive relationships within the campus community as well as the local community.

C. APPENDIX C: BIODIVERSITY INVENTORY

Table C.1: Biodiversity Count for Campus Core Used in Shannon's Index Equations

Common Name	Total Count
American Hazelnut	1
American Hophornbeam	1
Ashe's Juniper	1
Asiatic Wheel Tree	1
Atlas Cedar	1
Austrian Pine	1
Barnyard Millet	1
Big flower Tellima	1
Black Crowberry	1
Black Haw	1
Black Maple	1
Black Nightshade	1
Black Oak	1
Blue Atlas Cedar	1
Border Privet	1
Burdock	1
Butterfly Bush	1
Cedar of Lebanon	1
Chinese Pistache	1
Common Lillac	1
Douglass Fir	1
Dwarf Mountain Pine	1
English Oak	1
European Copper Beech	1
European Spindletree	1
European Weeping Beech	1
False Sunflower	1
Franklin Tree	1
Garden Cucumber	1
Golden Larch	1
Grey Downy Balsam	1
Halka Zelkova	1
Hardy Fuchsia	1
Hickory	1
Hosta	1
Ironwood	1
Japanese Cedar	1
Japanese Cutleaf Maple	1
Kaido Crabapple	1
Lily Magnolia	1
Lingonberry	1
Loebner Magnolia	1
Maple (sprout)	1
Mexican Orange Blossom	1
Mock Orange	1
Muscadine	1
Nimblewill	1
Oak	1
Pakeweed	1
Persian Silk Tree	1
Poorjoe	1
Prickly Ash	1
Princess Tree	1
Purple Loosetrife	1
Ragweed	1
Red Oak	1
Redosier Dogwood	1
Saucer Magnolia	1
Scarlet Pimpernel	1
Sequoyah	1
Seven Suns	1
Shrubby Cinquefoil	1
Silver Birch	1
Southern Catalpa	1
Swamp Chestnut Oak	1
Sweet Azalea	1
Sweet Violet	1
tea	1
Tree of Life	1
Tricolor Beech	1
Unknown	1
Viburnum	1
Virginia Creeper	1
Virginia Three Seed Mercury	1

Weeping Beech	1
White Ash	1
White Dogwood	1
White Pine	1
White Swamp Oak	1
White Turtlehead	1
Wild Carrot	1
Wine Raspberry	1
Alaska Cedar	2
American Linden	2
Bigleaf Hydrangea + sprouts	3
Black Pine	2
Boxelder Maple	2
Butterfly Milkweed	2
Canada Hemlock	2
Canada Lettuce	2
Carolina Silverbell	2
Chestnut Oak + sprout	3
Common Sourwood	2
Cucumber Tree	2
Eastern Red Cedar (sprout)	2
European Larch	2
Great Laurel	2
Hairy Bittercress	2
Hinoki False Cypress	2
Indian Mint	2
Jimsonweed	2
Lacebark Pine	2
London Planetree	2
Northern Bush Honeysuckle	2
Pale Persicaria	2
Prairie Fleabane	2
Purple Woodsage	2
Rougosa Rose	2
Salt Cedar	2
Scarlet Firethorn	2
Sweet Bay	2
Water Fir + Sprouts	5
White Mulberry + Sprouts	8
Yellow Bluestem	2
Yellow Senna	2

Zebra Grass	2
American Bittersweet	3
American Larch	3
Black Cherry	3
Blisterwort	3
Boneset	3
Bottlebrush Buckeye	3
Canada Thistle	3
Chinese Peony	3
Common Myrtle	3
Curlytop Knotweed	3
Devil's Beggarticks	3
European Privet	3
Forsythia	3
Hairy Oldfield Aster	3
Holly Olive	3
Katsura Tree	3
Linden Arrowood	3
Mountain Laurel	3
Mulberry Weed	3
Old Fashioned Weigela	3
Pawpaw	3
Pignut Hickory	3
Pompano Grass	3
Rose Meadowsweet	3
Roughleaf Dogwood + Sprouts	5
Shrubby St. John's Wort	3
Silver Fir	3
Southern Bayberry	3
Summer Ragwort	3
Sweet osmanthus	3
Unknown 1	3
American Beech	6
Chinese Fir	4
Dawn Redwood	4
Longwood Blue	4
Pokeweed	4
Red flower Ragleaf	4
Shingle Oak	4
Southern Magnolia	4
Straw-Colored Flatsedge	4

White Sweetclover	4
American Black Nightshade	5
American Blue Vervain	5
American Wisteria	5
Anise Hyssop	5
Bigtooth Maple	5
Boxleaf	5
Bur Oak	5
Deodar Cedar	5
Hairy Crabgrass	5
Japanese Pieris	5
Limber Pine	5
Mulberry	7
Okome Cherry	5
Pin Oak	5
Sawtooth Oak	5
Shining Geranium	5
Silver Maple	5
Tulip Poplar	5
Tumble Mmustard	5
Western Azalea	5
Yellowood	5
Blue Wild Indigo	6
California Privet	6
Climbing Nightshade	6
Coastal Sweet Pepperbush	6
Garden Pink	6
Ginkgo	6
Hairy Beard Tongue	6
Japanese Holly	6
Nightshade	6
Orange Daylily	6
Oregon ash + Sprouts	7
Paperbark Maple	6
Scarlet Oak	6
Sensitive Fern	6
Spreading English Yew	6
Amur Maple	7
Arrowleaf Ragwort	7
California Lilac	7
Common Barnyard Grass	7

Common Buttonbush	7
European Goatseed	7
Japanese Boxwood	7
Japanese Stewartia + Sprout	11
Northern Spicebush	7
Oriental Bittersweet	7
Red Chokeberry	7
Redflower Ragleaf	7
Shasta Daisy	7
Stiff Dogwood	7
Zinnia	7
Aizoon Stonecrop	8
Black Chokeberry	8
Camellia	8
Common Sewthistle	8
Eastern Red Cedar + Sprouts	10
Chinese Chestnut	8
Field Thistle	8
Great Laurel	8
Horse Chestnut	8
Purple Chokeberry	8
Balsam Fir	9
Burning Bush	9
Chinese Trumpet Vine	9
European Smoketree	9
Foxtail	9
Japanese Bristlegrass	9
Japanese Snowball	9
Lateflowering Thoroughwort	9
Meadow Sage	9
Norway Spruce	9
Pagoda Dogwood	9
Reeves' Meadowsweet	9
Virginia Creeper	9
White Oak	9
Yellow Coneflower	9
American Sycamore	10
Black Locust	10
Blue Spruce	10
Common Gloldentop	10
Eastern Hemlock	10

Golden Ragwort	10
Greenstem Forsythia	10
Japanese Maple	10
Northern Red Oak + sprouts	12
Northern White Cedar	10
Norway Maple	10
Prickly Lettuce	10
Sweetbay Magnolia	10
Yew Plum Pine	10
Canada Wild Rye	11
Cinnamon Fern	11
Large White Petunia	11
Pampas Grass	11
False Aster	12
River Birch	13
Spreading Dogbane	12
Swamp White Oak	12
Tassel Tree (White Fringetree)	12
Tree of Heaven	12
Blue False Indigo	13
Butterweed	13
Creeping Cedar	13
Creeping Juniper	13
Flame Azalea	13
Foxglove Beardtongue	13
Inkberry	13
Japanese Flowering Cherry	13
Little Bittercress	13
Rocky Mountain Juniper	13
Sneezeweed	13
Tiger Lily	13
Waxy Privet	13
White Meadowsweet	13
Wild Senna	13
Yucca	13
Buttercup	14
Sugar Maple	14
American Elm + Sprouts	116
European Beech	15
Queen Anne's Lace	15
Winter Jasmine	15

Bearded Barley	16
Dovesfoot Geranium	16
Lily Magnolia	16
Tiny Vetch	16
Yucca	16
Blackgum	17
Rocky Mountain Pentstemon	17
Chinese Holly	18
Oliander	18
Perennial Salvia	18
Summer Lilac	18
Wild Bergamot	18
Bitter Panicgrass	19
Common Oliander	19
False Buck's Beard	19
Hairy White Oldfield Aster	19
Japanese Red Cedar	19
Pink Evening Primrose	19
Blue Plantain Lily	20
Florist's Spiraea	20
Green Ash	20
Villous Lilac	20
American Sweetgum + Sprouts	22
Angular Solomons Seal	21
Common Holly	21
Frost Aster	21
Partridge Pea	21
American Yew + Sprouts	23
Asiatic Dayflower	22
Lanceleaf Tickseed	22
Willow Oak	22
American Alumroot	23
Common Ninebark	23
Eastern Sweetshrub	23
Red Turtlehead	23
Wild Senna	23
Flowering Dogwood	24
Kousa Dogwood	24
Coleus	25
Jack In The Bush	25
New Jersey Tea	25

Redshank	25
Niger	26
Obedient Plant	26
Scotch Rose	26
Ajania Pallasiana	27
Azalea	27
Bottlebrush Buckeye	27
Common Grass	27
Milkweed	27
New York Aster	27
Alpine Rose	28
American Basswood	28
Catawba Rosebay	28
Common Yarrow	28
Thornless Honey Locust + sprouts	118
Shadblow Serviceberry	29
Star Magnolia	29
Leatherleaf Mahonia	30
Wreath Goldenrod	30
Big leaf Hydrangea	31
Crepe Myrtle + Sprouts	38
Martagon Lily	31
Smooth Blue Aster	31
Japanese Laurel	32
Russian Sage	32
Eastern White Pine	33
Feathertop Grass	33
Sawgrass	33
New England Aster	34
Red Daylily	34
American Arborvitae	35
Blue Lobelia	35
Goose Grass	35
Feather Reed Grass	36
Feverfew	36
Wild Rye	37
Dandelion	39
Solomon's Seal	39
Blue Mistflower	41
Blister Sedge	42
Salal	42

False Blue Indigo	43
Nutgrass	43
Common Mugwort	46
Juniper	47
Mugwort	47
American Witch Hazel	48
Devil's Tongue	50
Purple Beautyberry	50
Red Azalea	50
Blue Wood Aster	51
Chameleon Plant	52
Cutleaf Coneflower	52
Fleabane	52
Fragrant Sweet Box	52
Fuzzy Pride of Rochester	52
Redroot Flatsedge	52
Arrowwood Viburnum	54
Cat Tail	55
Green Carpetweed	55
Plantain Lily	55
Silky Dogwood	56
Garden Rose	57
Leatherleaf Arrowwood	57
Possumhaw Viburnum	57
Tibetan Hellebore	58
Birdeye Speedwell	59
Creeping Jenny	60
Chinese Silvergrass	61
Sugar Tyme Crabapple	68
Canada Yew	69
Red Maple	828
Wrinkleleaf Goldenrod	70
Cape Leadwort	71
Common Fern	72
Mission Grass	77
Japanese Yew	81
Creeping Myrtle	82
Indian Hemp	82
American Holly	86
Purple Fountain Grass	84
White Snakeroot	85

Unknown Grass 1	87
Spiny Sowthistle	90
Needle Stonecrop	93
Wayfaring Tree	96
Lambs Ear	101
Wild Sage	101
Blackroot	103
Hairy Alumroot	103
Sweet Joe-Pye-weed	105
Jerusalem Artichoke	106
Garden Stonecrop	107
Lily of the Valley	107
Miniature Rose (Tea Rose)	108
Indian Woodoats	109
Bearded Beggarticks	116
Heavenly Bamboo	116
Woodland Bittercress	118
White Panicle Aster	121
Common Winterberry	134
Virginia Sweetspire	138
American Pokeweed	139
Panicle Hydranga	139
Dense Blazing Star	142
Japanese Meadowsweet	143
Sensitive Fern	147
Oakleaf Hydrangea	150
St. John's Wort + Sprouts	155
Mountain Witch Alder	153
Eastern Redbud + Sprouts	316
Common Blue Violet	159
Spotted Joe-Pye-weed	165
Virginia Anemone	166
Switchgrass	168
Chinese Plum Yew	180
Whorled Tickseed	188
Bonica Rose	190
Sweet Box	192
Pigweed	197
Little Bluestem	201

Ladies Thumb	220
Threeseed Mercury	228
Nepalese Browntop	260
Spotted Spurge	261
Chinese Privet	286
Petunia	287
Crabgrass	292
Bush Bindweed	303
Spinulose wood fern	303
Hubricht's Bluestar	319
Black Eyed Susan	327
Allegheny Spurge	340
Gypsy Weed	346
Wedelia	380
Fragrant Sumac	402
Porcelain Berry	457
Blue Fescue	466
Cherry Laurel	469
Goldenrod	480
Bishop's Cap	481
Common Boxwood	485
Yellow Daylily	600
Purple Coneflower	652
Yellow Woodsorrel	668
Siberian Flag Iris	693
Wax Begonia	696
Garden Snapdragon	699
Tufted Knotweed	768
Blue Iris	923
Fragrant Plantain Lily	923
Spearmint	971
Rock Harlequin	1000
Blue Leadwood	3280
Common Liverwort	3408
Big Blue Lilyturf	5463
Winter Creeper	8906
Purplestem Aster	17366
Japanese Pachysandra	17431
English Ivy	69494

Table C.2: GIS Biodiversity Inventory for Campus Core

OBJECTID	Latitude	Longitude	Common Name
1275	40.036594	-75.33944	Aizoon Stonecrop
816	40.034771	-75.337274	Ajania Pallasiana
824	40.034775	-75.337266	Ajania Pallasiana
1980	40.037571	-75.345115	Alaska Cedar
2408	40.03765856	-75.34480208	Alaska Cedar
2616	40.034045	-75.33906	Allegheny Chinquapin
2617	40.034213	-75.339365	Allegheny Chinquapin
76	40.035572	-75.339914	Allegheny Spurge
81	40.035628	-75.340066	Allegheny Spurge
175	40.036078	-75.340485	Allegheny Spurge
212	40.035847	-75.33943	Allegheny Spurge
722	40.034581	-75.341163	Allegheny Spurge
725	40.034669	-75.341487	Allegheny Spurge
732	40.034683	-75.341627	Allegheny Spurge
885	40.036038	-75.342103	Allegheny Spurge
888	40.036059	-75.342067	Allegheny Spurge
2329	40.03645255	-75.34299401	Allegheny Spurge
2618	40.035291	-75.338472	Allegheny Spurge
2619	40.035347	-75.33864	Allegheny Spurge
2620	40.035381	-75.338854	Allegheny Spurge
2621	40.035369	-75.338705	Allegheny Spurge
2514	40.03643118	-75.344234	Alpine Rose
2517	40.03633535	-75.34401746	Alpine Rose
2522	40.03626922	-75.34378725	Alpine Rose
2534	40.03617405	-75.34338496	Alpine Rose
2279	40.03684266	-75.34262621	American Alumroot
1578	40.038299	-75.341962	American Arborvitae
1807	40.036254	-75.346208	American Arborvitae
1815	40.035925	-75.347517	American Arborvitae
1920	40.037207	-75.345988	American Arborvitae
1994	40.037421	-75.345518	American Arborvitae
2058	40.03757172	-75.34213487	American Arborvitae
800	40.034734	-75.337158	American Basswood
801	40.034709	-75.337206	American Basswood
970	40.036324	-75.341647	American Basswood
1069	40.036849	-75.340576	American Basswood
1284	40.036389	-75.339513	American Basswood
1285	40.036315	-75.339471	American Basswood

1287	40.036256	-75.339455	American Basswood
1288	40.036199	-75.339385	American Basswood
1290	40.036146	-75.339391	American Basswood
1292	40.036079	-75.339342	American Basswood
1293	40.036016	-75.339292	American Basswood
1294	40.035982	-75.339203	American Basswood
1329	40.036465	-75.339817	American Basswood
1330	40.036511	-75.339883	American Basswood
1331	40.036561	-75.339968	American Basswood
1332	40.036576	-75.339686	American Basswood
1333	40.036605	-75.339837	American Basswood
1334	40.036648	-75.339921	American Basswood
1335	40.036687	-75.34003	American Basswood
1336	40.036806	-75.340233	American Basswood
1337	40.036831	-75.340336	American Basswood
1338	40.036903	-75.340515	American Basswood
1339	40.036926	-75.340705	American Basswood
1343	40.03692	-75.340841	American Basswood
1418	40.036903	-75.341777	American Basswood
1642	40.038611	-75.342586	American Basswood
1759	40.035481	-75.345782	American Basswood
2029	40.03843105	-75.34244613	American Basswood
962	40.036245	-75.341851	American Beech
1471	40.036718	-75.342266	American Beech
2151	40.03814578	-75.34390008	American Beech
2157	40.03801203	-75.34427304	American Beech
2308	40.03655605	-75.34229411	American Beech (sprout)
1023	40.036624	-75.341101	American Bittersweet
916	40.036001	-75.342722	American Black Nightshade
1031	40.036728	-75.341247	American Blue Vervain
20	40.034889	-75.339375	American Elm
21	40.034953	-75.339399	American Elm
22	40.035007	-75.33943	American Elm
251	40.036148	-75.340715	American Elm
254	40.036207	-75.34072	American Elm
256	40.036276	-75.34075	American Elm
262	40.036276	-75.341123	American Elm
264	40.036212	-75.341167	American Elm
266	40.03613	-75.341179	American Elm
497	40.035255	-75.341512	American Elm
498	40.035169	-75.341335	American Elm

499	40.035114	-75.341198	American Elm
500	40.035034	-75.341025	American Elm
1364	40.037108	-75.340462	American Elm
1740	40.036211	-75.345603	American Elm
2622	40.034788	-75.338904	American Elm
2623	40.034792	-75.339001	American Elm
2624	40.03496	-75.338762	American Elm
2625	40.035023	-75.33881	American Elm
2626	40.035083	-75.338845	American Elm
2627	40.035139	-75.338871	American Elm
2628	40.03519	-75.339249	American Elm
2629	40.035208	-75.339165	American Elm
2630	40.035223	-75.339086	American Elm
2631	40.034784	-75.339066	American Elm
101	40.03532	-75.340151	American Elm (Sprout)
253	40.036151	-75.340689	American Elm (Sprout)
255	40.036194	-75.340706	American Elm (Sprout)
258	40.03626	-75.340763	American Elm (Sprout)
2302	40.03662	-75.34240413	American Elm (Sprout)
2632	40.035056	-75.338744	American Elm (Sprout)
2633	40.035214	-75.339223	American Elm (Sprout)
1403	40.037134	-75.341139	American Hazelnut
562	40.035859	-75.34142	American Holly
612	40.036247	-75.341459	American Holly
649	40.03573	-75.341578	American Holly
664	40.035834	-75.341902	American Holly
665	40.035793	-75.341972	American Holly
851	40.034979	-75.337495	American Holly
907	40.035942	-75.342603	American Holly
983	40.036316	-75.34124	American Holly
987	40.036139	-75.341386	American Holly
1093	40.035477	-75.33772	American Holly
1094	40.0355	-75.337756	American Holly
1099	40.035341	-75.337922	American Holly
1220	40.036142	-75.338175	American Holly
1374	40.037189	-75.340867	American Holly
1387	40.037324	-75.341143	American Holly
1415	40.036998	-75.341955	American Holly
1547	40.037612	-75.34148	American Holly
1579	40.038185	-75.341829	American Holly
1773	40.035766	-75.346174	American Holly

1813	40.035828	-75.347327	American Holly
1851	40.035973	-75.347106	American Holly
2020	40.03830446	-75.34239201	American Holly
2041	40.03792158	-75.34337088	American Holly
2048	40.03783853	-75.34263058	American Holly
2049	40.03780711	-75.34254836	American Holly
2050	40.03778891	-75.34250361	American Holly
2051	40.03775365	-75.34247147	American Holly
2105	40.0373622	-75.34425593	American Holly
2119	40.03771721	-75.344151	American Holly
2129	40.03792555	-75.34347991	American Holly
2134	40.03792961	-75.34361013	American Holly
2212	40.03714491	-75.34237793	American Holly
2235	40.03704156	-75.34205696	American Holly
2347	40.03622298	-75.34324586	American Holly
2376	40.0364415	-75.34378956	American Holly
2525	40.03622175	-75.34364058	American Holly
2528	40.0361743	-75.34353016	American Holly
2585	40.03622101	-75.34140596	American Holly
2634	40.034196	-75.338725	American Holly
2635	40.035186	-75.338305	American Holly
2205	40.0371553	-75.3422743	American Holly (Sprout)
2158	40.03811097	-75.34407238	American Hophornbeam
963	40.03629	-75.342039	American Larch
1981	40.037582	-75.344955	American Larch
2409	40.03762321	-75.34486698	American Larch
892	40.035961	-75.342352	American Linden
2273	40.03676338	-75.34308653	American Linden
506	40.034823	-75.341113	American Pokeweed
4	40.03512	-75.33952	American Sweetgum
981	40.036435	-75.341175	American Sweetgum
1258	40.035853	-75.338934	American Sweetgum
1259	40.035901	-75.339033	American Sweetgum
1261	40.036091	-75.338998	American Sweetgum
1265	40.036303	-75.339045	American Sweetgum
1266	40.03634	-75.338987	American Sweetgum
1267	40.036396	-75.338944	American Sweetgum
1269	40.036472	-75.338931	American Sweetgum
1295	40.035996	-75.339201	American Sweetgum
1296	40.036014	-75.339198	American Sweetgum
1320	40.036546	-75.340225	American Sweetgum

1733	40.036512	-75.344977	American Sweetgum
2106	40.03743345	-75.34417953	American Sweetgum
2244	40.03694581	-75.34259523	American Sweetgum
2271	40.03666235	-75.34300906	American Sweetgum
2272	40.03674083	-75.34298436	American Sweetgum
2275	40.03680705	-75.34298193	American Sweetgum
2276	40.03689386	-75.34287488	American Sweetgum
2277	40.03696025	-75.34282031	American Sweetgum
2278	40.03697163	-75.34277821	American Sweetgum
2636	40.035226	-75.339426	American Sweetgum
190	40.036019	-75.340311	American Sweetgum (sprout)
331	40.034876	-75.34015	American Sycamore
332	40.034922	-75.340276	American Sycamore
333	40.034983	-75.340444	American Sycamore
334	40.03504	-75.340629	American Sycamore
1034	40.036786	-75.341548	American Sycamore
1037	40.03677	-75.341245	American Sycamore
1820	40.036187	-75.347832	American Sycamore
1823	40.036177	-75.347958	American Sycamore
1833	40.036268	-75.347375	American Sycamore
2087	40.03684076	-75.34330246	American Sycamore
873	40.035069	-75.337544	American Wisteria
6	40.035009	-75.3395	American Witch Hazel
37	40.035311	-75.339548	American Witch Hazel
38	40.035365	-75.339514	American Witch Hazel
39	40.035417	-75.339475	American Witch Hazel
40	40.035456	-75.339448	American Witch Hazel
52	40.035411	-75.339639	American Witch Hazel
158	40.036057	-75.340473	American Witch Hazel
369	40.034846	-75.340807	American Witch Hazel
931	40.036186	-75.34288	American Witch Hazel
1322	40.036454	-75.340174	American Witch Hazel
2031	40.03821195	-75.34238303	American Witch Hazel
2165	40.03815926	-75.34405231	American Witch Hazel
2172	40.03806166	-75.34416348	American Witch Hazel
2247	40.03690476	-75.34264207	American Witch Hazel
2260	40.03685446	-75.34261935	American Witch Hazel
2283	40.03662285	-75.34286108	American Witch Hazel
2297	40.03666816	-75.34249436	American Witch Hazel
2309	40.03660295	-75.34228937	American Witch Hazel
2424	40.037635	-75.34449636	American Witch Hazel

2472	40.03681082	-75.34531107	American Witch Hazel
2587	40.036173	-75.34154248	American Witch Hazel
2637	40.035247	-75.338537	American Witch Hazel
2638	40.035463	-75.339036	American Witch Hazel
2639	40.035214	-75.339223	American Witch Hazel
2640	40.035056	-75.338744	American Witch Hazel
2641	40.034725	-75.339012	American Witch Hazel
2642	40.034213	-75.339265	American Yew
23	40.034917	-75.339402	American Yew (sprouts)
1805	40.036175	-75.346116	Amur Maple
1809	40.036419	-75.346277	Amur Maple
73	40.035411	-75.339851	Angular Solomons Seal
2418	40.03732616	-75.3447301	Anise Hyssop
756	40.034965	-75.336855	Arrowleaf Ragwort
799	40.035119	-75.337452	Arrowleaf Ragwort
1252	40.035765	-75.339091	Arrowleaf Ragwort
1451	40.037468	-75.341386	Arrowleaf Ragwort
232	40.035985	-75.340142	Arrowwood Viburnum
368	40.034861	-75.340654	Arrowwood Viburnum
881	40.035977	-75.342085	Arrowwood Viburnum
925	40.03603	-75.343017	Arrowwood Viburnum
1298	40.035909	-75.339414	Arrowwood Viburnum
1314	40.036305	-75.33983	Arrowwood Viburnum
1316	40.036215	-75.340012	Arrowwood Viburnum
2018	40.03830531	-75.34220402	Arrowwood Viburnum
2179	40.03804096	-75.34422006	Ashe's Juniper
913	40.035987	-75.342657	Asiatic Dayflower
1036	40.036664	-75.341155	Asiatic Dayflower
1041	40.036551	-75.340901	Asiatic Dayflower
2643	40.034725	-75.339012	Asiatic Dayflower
490	40.035413	-75.343776	Atlas Cedar
1924	40.037153	-75.34592	Austrian Pine
1008	40.036472	-75.342276	Azalea
1282	40.036442	-75.339561	Azalea
1417	40.037011	-75.341937	Azalea
1765	40.035634	-75.345956	Azalea
1843	40.035999	-75.347329	Azalea
1848	40.035991	-75.347174	Azalea
1880	40.036849	-75.346577	Azalea
1996	40.037351	-75.345684	Azalea
2292	40.0367177	-75.34268701	Azalea

2523	40.03630631	-75.34376371	Azalea
371	40.034983	-75.340947	Balsam Fir
372	40.034921	-75.340913	Balsam Fir
373	40.034909	-75.340842	Balsam Fir
374	40.034902	-75.340792	Balsam Fir
375	40.034876	-75.340727	Balsam Fir
376	40.034841	-75.340732	Balsam Fir
377	40.034889	-75.340696	Balsam Fir
378	40.03491	-75.340665	Balsam Fir
379	40.034962	-75.340655	Balsam Fir
407	40.035199	-75.343392	Barnyard Millet
1605	40.036703	-75.339157	Bearded Barley
290	40.035583	-75.343463	Bearded Beggarticks
295	40.035467	-75.34349	Bearded Beggarticks
25	40.034987	-75.339414	Big Blue Lilyturf
48	40.035183	-75.339618	Big Blue Lilyturf
94	40.035351	-75.340054	Big Blue Lilyturf
146	40.03535	-75.340431	Big Blue Lilyturf
161	40.035822	-75.340647	Big Blue Lilyturf
216	40.035899	-75.339657	Big Blue Lilyturf
221	40.035961	-75.339888	Big Blue Lilyturf
300	40.033856	-75.339231	Big Blue Lilyturf
306	40.033889	-75.339365	Big Blue Lilyturf
535	40.03557	-75.341454	Big Blue Lilyturf
552	40.035829	-75.341349	Big Blue Lilyturf
564	40.035922	-75.341424	Big Blue Lilyturf
573	40.035916	-75.341602	Big Blue Lilyturf
595	40.035988	-75.341776	Big Blue Lilyturf
633	40.03576	-75.341415	Big Blue Lilyturf
668	40.035781	-75.341957	Big Blue Lilyturf
854	40.035022	-75.337797	Big Blue Lilyturf
889	40.035956	-75.342123	Big Blue Lilyturf
893	40.035987	-75.342274	Big Blue Lilyturf
909	40.036028	-75.342569	Big Blue Lilyturf
920	40.035939	-75.342858	Big Blue Lilyturf
980	40.036443	-75.341158	Big Blue Lilyturf
982	40.036339	-75.34128	Big Blue Lilyturf
1033	40.036693	-75.341277	Big Blue Lilyturf
1043	40.036586	-75.340935	Big Blue Lilyturf
1084	40.035626	-75.337637	Big Blue Lilyturf
1086	40.035607	-75.33764	Big Blue Lilyturf

1092	40.03549	-75.337615	Big Blue Lilyturf
1100	40.035325	-75.337972	Big Blue Lilyturf
1104	40.035401	-75.33814	Big Blue Lilyturf
1107	40.035436	-75.338216	Big Blue Lilyturf
1112	40.035601	-75.337967	Big Blue Lilyturf
1193	40.035782	-75.337979	Big Blue Lilyturf
1200	40.035845	-75.338134	Big Blue Lilyturf
1205	40.035876	-75.33799	Big Blue Lilyturf
1209	40.035917	-75.338146	Big Blue Lilyturf
1211	40.035897	-75.338318	Big Blue Lilyturf
1227	40.035776	-75.337604	Big Blue Lilyturf
1304	40.035921	-75.339474	Big Blue Lilyturf
1312	40.036152	-75.339931	Big Blue Lilyturf
1355	40.037064	-75.340612	Big Blue Lilyturf
1378	40.037197	-75.340947	Big Blue Lilyturf
1381	40.037245	-75.341085	Big Blue Lilyturf
1396	40.037641	-75.340982	Big Blue Lilyturf
1472	40.036683	-75.342301	Big Blue Lilyturf
1482	40.036428	-75.342523	Big Blue Lilyturf
1691	40.038152	-75.342777	Big Blue Lilyturf
1729	40.035514	-75.344498	Big Blue Lilyturf
2213	40.03714896	-75.34243188	Big Blue Lilyturf
2239	40.03696673	-75.34232881	Big Blue Lilyturf
2242	40.03679121	-75.34268366	Big Blue Lilyturf
2250	40.03687998	-75.34260342	Big Blue Lilyturf
2252	40.03693038	-75.34275461	Big Blue Lilyturf
2285	40.03665723	-75.34283036	Big Blue Lilyturf
2320	40.03658183	-75.3427505	Big Blue Lilyturf
2322	40.03657447	-75.34281365	Big Blue Lilyturf
2451	40.03731626	-75.34485253	Big Blue Lilyturf
2454	40.03733776	-75.34495613	Big Blue Lilyturf
2477	40.03673515	-75.34529486	Big Blue Lilyturf
2479	40.03673628	-75.34518698	Big Blue Lilyturf
2484	40.0365911	-75.34501131	Big Blue Lilyturf
2491	40.03654461	-75.34471275	Big Blue Lilyturf
2498	40.03657327	-75.34452255	Big Blue Lilyturf
2502	40.03659066	-75.34438758	Big Blue Lilyturf
2508	40.03648363	-75.34444511	Big Blue Lilyturf
2559	40.03607171	-75.34143303	Big Blue Lilyturf
2565	40.03598878	-75.34134101	Big Blue Lilyturf
2581	40.03616266	-75.34126428	Big Blue Lilyturf

2644	40.03457	-75.33797	Big Blue Lilyturf
2645	40.035633	-75.339263	Big Blue Lilyturf
2646	40.034725	-75.339012	Big Blue Lilyturf
2647	40.035056	-75.338744	Big Blue Lilyturf
2648	40.035214	-75.339223	Big Blue Lilyturf
2404	40.03778391	-75.3445887	Big flower Tellima
2040	40.03818603	-75.34244166	Big leaf Hydrangea
2380	40.03663241	-75.34386728	Big leaf Hydrangea
2381	40.0366711	-75.34384581	Big leaf Hydrangea
2386	40.03666893	-75.34394856	Big leaf Hydrangea
2388	40.03671846	-75.34395392	Big leaf Hydrangea
1694	40.038142	-75.34273	Bigleaf Hydrangea
772	40.034979	-75.337039	Bigleaf Hydrangea (sprout)
692	40.035759	-75.342155	Bigtooth Maple
693	40.035789	-75.342213	Bigtooth Maple
694	40.035797	-75.342328	Bigtooth Maple
695	40.035816	-75.34242	Bigtooth Maple
696	40.035834	-75.342463	Bigtooth Maple
1516	40.035124	-75.341336	Birdeye Speedwell
363	40.034624	-75.340152	Bishop's Cap
366	40.03468	-75.340674	Bishop's Cap
2440	40.03748726	-75.34453245	Bishop's Cap
2649	40.035572	-75.339264	Bishop's Cap
2650	40.035463	-75.339036	Bishop's Cap
2651	40.035439	-75.338877	Bishop's Cap
1609	40.036626	-75.339181	Bitter Panicgrass
1627	40.036517	-75.339223	Bitter Panicgrass
1749	40.036559	-75.346179	Black Cherry
1774	40.035622	-75.346261	Black Cherry
1835	40.036446	-75.347328	Black Cherry
1444	40.03755	-75.341301	Black Chokeberry
2335	40.0361602	-75.34311961	Black Crowberry
621	40.035487	-75.341776	Black Eyed Susan
652	40.035737	-75.341637	Black Eyed Susan
662	40.035816	-75.34187	Black Eyed Susan
672	40.035658	-75.341675	Black Eyed Susan
681	40.035697	-75.34188	Black Eyed Susan
684	40.03574	-75.341959	Black Eyed Susan
863	40.035046	-75.33748	Black Eyed Susan
1882	40.036805	-75.346569	Black Eyed Susan
1953	40.037184	-75.345544	Black Eyed Susan

950	40.036117	-75.342511	Black Haw
1704	40.03626	-75.344842	Black Locust
1705	40.036214	-75.34494	Black Locust
1708	40.036121	-75.345004	Black Locust
1709	40.036078	-75.345112	Black Locust
1710	40.036007	-75.345172	Black Locust
1711	40.035948	-75.345251	Black Locust
1714	40.035904	-75.345317	Black Locust
1737	40.036276	-75.345556	Black Locust
1738	40.036237	-75.345521	Black Locust
1739	40.036161	-75.345567	Black Locust
1264	40.03626	-75.33899	Black Maple
2652	40.034897	-75.338667	Black Maple
571	40.035942	-75.341526	Black Nightshade
2457	40.03726275	-75.34469555	Black Oak
2088	40.03710796	-75.34421468	Black Pine
2605	40.03693316	-75.34394466	Black Pine
70	40.035036	-75.339888	Blackgum
313	40.034018	-75.339282	Blackgum
315	40.034001	-75.339516	Blackgum
316	40.034053	-75.339298	Blackgum
326	40.034447	-75.339648	Blackgum
346	40.034387	-75.340192	Blackgum
350	40.034439	-75.340405	Blackgum
705	40.035032	-75.342974	Blackgum
708	40.034961	-75.342806	Blackgum
710	40.034959	-75.342633	Blackgum
712	40.034921	-75.342548	Blackgum
994	40.036492	-75.342047	Blackgum
1779	40.035705	-75.346908	Blackgum
2073	40.03775656	-75.34330183	Blackgum
2078	40.03762393	-75.34286248	Blackgum
2082	40.03717293	-75.34279263	Blackgum
2083	40.03705058	-75.34288246	Blackgum
973	40.036394	-75.341492	Blackroot
1142	40.035274	-75.338043	Blackroot
1222	40.036108	-75.338161	Blackroot
1688	40.038039	-75.343034	Blackroot
1947	40.037245	-75.345465	Blackroot
1960	40.037307	-75.34538	Blackroot
2539	40.03574415	-75.3431469	Blackroot

526	40.035051	-75.340315	Blister Sedge
860	40.035041	-75.337471	Blisterwort
2104	40.03726055	-75.34417781	Blue Atlas Cedar
538	40.035599	-75.341403	Blue False Indigo
675	40.035647	-75.341697	Blue False Indigo
845	40.034841	-75.337593	Blue False Indigo
869	40.035045	-75.337483	Blue False Indigo
1077	40.035298	-75.337622	Blue Fescue
2015	40.0382538	-75.34226471	Blue Fescue
2019	40.03829768	-75.34235183	Blue Fescue
2026	40.03836416	-75.34244165	Blue Fescue
2653	40.034573	-75.337721	Blue Fescue
1297	40.036008	-75.339204	Blue Iris
247	40.036073	-75.33964	Blue Leadwood
1618	40.03654	-75.339227	Blue Lobelia
1954	40.037268	-75.345528	Blue Lobelia
1967	40.037315	-75.345285	Blue Lobelia
1613	40.036562	-75.339212	Blue Mistflower
1628	40.036492	-75.339235	Blue Mistflower
1888	40.036851	-75.346526	Blue Mistflower
1946	40.037281	-75.345553	Blue Mistflower
179	40.036131	-75.340466	Blue Plantain Lily
1837	40.036254	-75.347258	Blue Plantain Lily
149	40.035732	-75.340545	Blue Spruce
1286	40.036404	-75.339461	Blue Spruce
1566	40.037736	-75.341301	Blue Spruce
1572	40.037846	-75.34162	Blue Spruce
1816	40.036003	-75.347557	Blue Spruce
1496	40.036125	-75.342455	Blue Wild Indigo
1506	40.036372	-75.342894	Blue Wild Indigo
2654	40.035633	-75.339263	Blue Wild Indigo
1897	40.036722	-75.346485	Blue Wood Aster
1948	40.037217	-75.345466	Blue Wood Aster
1955	40.037235	-75.345313	Blue Wood Aster
2066	40.0375115	-75.3426483	Blue Wood Aster
1607	40.036686	-75.33921	Boneset
53	40.035365	-75.33959	Bonica Rose
111	40.035377	-75.34025	Bonica Rose
113	40.035467	-75.340177	Bonica Rose
116	40.035455	-75.340356	Bonica Rose
120	40.03546	-75.340476	Bonica Rose

152	40.035852	-75.340631	Bonica Rose
155	40.035961	-75.340558	Bonica Rose
157	40.036029	-75.340504	Bonica Rose
244	40.036098	-75.339616	Bonica Rose
1767	40.035542	-75.346	Border Privet
1053	40.036611	-75.34077	Bottlebrush Buckeye
1446	40.037541	-75.341299	Bottlebrush Buckeye
1769	40.035697	-75.34599	Bottlebrush Buckeye
2147	40.03819361	-75.34376438	Bottlebrush Buckeye
2164	40.03810306	-75.34401296	Bottlebrush Buckeye
2169	40.03806145	-75.34417268	Bottlebrush Buckeye
2185	40.03806376	-75.34420113	Bottlebrush Buckeye
2187	40.0379993	-75.34426983	Bottlebrush Buckeye
783	40.035481	-75.337474	Boxelder Maple
1009	40.036634	-75.341438	Boxelder Maple
1180	40.035443	-75.338259	Boxleaf
1181	40.035683	-75.338311	Boxleaf
2655	40.035329	-75.338765	Buckthorn
964	40.036432	-75.342141	Bur Oak
966	40.036353	-75.34193	Bur Oak
2075	40.03750311	-75.34314233	Bur Oak
2079	40.03741316	-75.34302476	Bur Oak
2086	40.03699848	-75.34320253	Bur Oak
870	40.035037	-75.337476	Burdock
944	40.036129	-75.342568	Burning Bush
988	40.036202	-75.341369	Burning Bush
118	40.035421	-75.340332	Bush Bindweed
136	40.035372	-75.340578	Bush Bindweed
237	40.036076	-75.340196	Bush Bindweed
360	40.034348	-75.340307	Bush Bindweed
415	40.035461	-75.34334	Bush Bindweed
417	40.035523	-75.343303	Bush Bindweed
447	40.035356	-75.343169	Bush Bindweed
483	40.035329	-75.343701	Bush Bindweed
569	40.0359	-75.341452	Bush Bindweed
715	40.034892	-75.342671	Bush Bindweed
1048	40.036475	-75.341073	Bush Bindweed
1118	40.035594	-75.337967	Bush Bindweed
42	40.035439	-75.339536	Bush Bindweed
2656	40.034318	-75.338291	Bush Penstemon
1614	40.036581	-75.339197	Buttercup

1589	40.037255	-75.339887	Butterfly Bush
248	40.036072	-75.339648	Butterfly Milkweed
2657	40.034667	-75.337839	Butterfly Milkweed
122	40.035422	-75.340505	Butterweed
2398	40.03686018	-75.3440754	California Lilac
1453	40.037535	-75.341302	California Privet
1280	40.036456	-75.339531	Camellia
2138	40.03798476	-75.34363143	Canada Hemlock
778	40.03499	-75.337088	Canada Lettuce
106	40.035308	-75.340129	Canada Thistle
1742	40.036065	-75.345606	Canada Thistle
239	40.036088	-75.340137	Canada Wild Rye
304	40.033921	-75.339297	Canada Yew
743	40.035083	-75.336603	Canada Yew
746	40.035112	-75.336696	Canada Yew
749	40.035048	-75.336829	Canada Yew
1758	40.035541	-75.345753	Canada Yew
1762	40.035603	-75.345731	Canada Yew
1763	40.035594	-75.345803	Canada Yew
1780	40.036003	-75.34698	Canada Yew
1782	40.035843	-75.346823	Canada Yew
1795	40.035991	-75.346612	Canada Yew
1798	40.036133	-75.346706	Canada Yew
1839	40.036135	-75.34729	Canada Yew
1840	40.036097	-75.347301	Canada Yew
2017	40.03830945	-75.34216106	Canada Yew
2140	40.03810216	-75.34364601	Canada Yew
2142	40.03820075	-75.34362836	Canada Yew
2199	40.03710841	-75.34212218	Canada Yew
2234	40.03696955	-75.34205786	Canada Yew
2334	40.03612561	-75.34309883	Canada Yew
2416	40.0375958	-75.34470691	Canada Yew
524	40.035165	-75.340363	Cape Leadwort
496	40.035736	-75.343731	Carolina Silverbell
1401	40.037285	-75.341274	Carolina Silverbell
1619	40.036517	-75.339211	Cat Tail
953	40.036162	-75.342403	Catawba Rosebay
1369	40.037409	-75.340654	Catawba Rosebay
1787	40.035893	-75.346808	Catawba Rosebay
1793	40.035945	-75.346633	Catawba Rosebay
1883	40.036795	-75.34651	Catawba Rosebay

1911	40.037073	-75.346105	Catawba Rosebay
2133	40.03786941	-75.34352848	Catawba Rosebay
2137	40.0379268	-75.34364305	Catawba Rosebay
2262	40.03674977	-75.34276515	Catawba Rosebay
2294	40.03673425	-75.34258041	Catawba Rosebay
2295	40.03666603	-75.34250903	Catawba Rosebay
2403	40.03781123	-75.34458178	Catawba Rosebay
2518	40.03632831	-75.34395906	Catawba Rosebay
2658	40.035186	-75.338305	Catawba Rosebay
2659	40.035439	-75.338877	Catawba Rosebay
1273	40.03656	-75.339256	Cedar of Lebanon
153	40.035865	-75.340634	Chameleon Plant
5	40.034966	-75.339505	Cherry Laurel
61	40.035214	-75.339734	Cherry Laurel
98	40.035309	-75.340181	Cherry Laurel
147	40.035361	-75.340449	Cherry Laurel
222	40.035955	-75.339871	Cherry Laurel
243	40.036098	-75.339651	Cherry Laurel
302	40.033899	-75.339214	Cherry Laurel
307	40.033906	-75.339286	Cherry Laurel
386	40.034988	-75.340032	Cherry Laurel
534	40.035505	-75.341444	Cherry Laurel
849	40.034958	-75.337532	Cherry Laurel
902	40.035921	-75.342486	Cherry Laurel
912	40.035985	-75.342686	Cherry Laurel
989	40.036233	-75.341332	Cherry Laurel
1049	40.036513	-75.341056	Cherry Laurel
1085	40.035619	-75.337644	Cherry Laurel
1114	40.035525	-75.338028	Cherry Laurel
1218	40.035985	-75.338199	Cherry Laurel
1225	40.03578	-75.337701	Cherry Laurel
1474	40.036643	-75.342385	Cherry Laurel
1518	40.037052	-75.341912	Cherry Laurel
1846	40.036014	-75.347294	Cherry Laurel
2130	40.03788807	-75.34346844	Cherry Laurel
2255	40.03693191	-75.34273176	Cherry Laurel
2259	40.03687536	-75.34265466	Cherry Laurel
2288	40.03668946	-75.34275295	Cherry Laurel
2304	40.03659661	-75.34235396	Cherry Laurel
2325	40.03651687	-75.34299086	Cherry Laurel
2660	40.034456	-75.338767	Cherry Laurel

2661	40.034725	-75.339012	Cherry Laurel
2662	40.035214	-75.339223	Cherry Laurel
2663	40.035056	-75.338744	Cherry Laurel
1000	40.036642	-75.341762	Chestnut Oak
1002	40.036699	-75.341862	Chestnut Oak
716	40.034892	-75.342823	Chestnut Oak (sprout)
44	40.034651	-75.339577	Chinese Chestnut
317	40.03415	-75.33941	Chinese Chestnut
325	40.034384	-75.33955	Chinese Chestnut
327	40.034554	-75.339771	Chinese Chestnut
328	40.034692	-75.339864	Chinese Chestnut
329	40.034793	-75.339952	Chinese Chestnut
2052	40.03769981	-75.34244421	Chinese Chestnut
2054	40.03768038	-75.34214213	Chinese Chestnut
1455	40.037626	-75.341258	Chinese Fir
1456	40.037672	-75.3412	Chinese Fir
1459	40.037665	-75.341163	Chinese Fir
2361	40.03639671	-75.34324755	Chinese Fir
54	40.035492	-75.339832	Chinese Holly
2529	40.03607207	-75.34359706	Chinese Holly
72	40.035441	-75.339925	Chinese Peony
2664	40.03457	-75.33797	Chinese Photinia
174	40.036083	-75.340392	Chinese Pistache
137	40.035281	-75.340484	Chinese Plum Yew
690	40.03559	-75.342055	Chinese Privet
691	40.035776	-75.3423	Chinese Privet
643	40.035694	-75.341475	Chinese Silvergrass
1645	40.038577	-75.342876	Chinese Silvergrass
1661	40.03846	-75.343228	Chinese Silvergrass
1665	40.038415	-75.34344	Chinese Silvergrass
1671	40.0383	-75.343514	Chinese Silvergrass
1679	40.038272	-75.34323	Chinese Silvergrass
1979	40.037588	-75.345092	Chinese Silvergrass
2152	40.0381023	-75.34390078	Chinese Silvergrass
2406	40.03761015	-75.34475995	Chinese Silvergrass
2414	40.03759621	-75.34471271	Chinese Silvergrass
1582	40.037489	-75.340349	Chinese Trumpet Vine
1584	40.037377	-75.340022	Chinese Trumpet Vine
1597	40.037002	-75.339383	Chinese Trumpet Vine
233	40.035977	-75.340107	Cinnamon Fern
752	40.035078	-75.336716	Climbing Nightshade

761	40.034966	-75.336947	Climbing Nightshade
687	40.035731	-75.342046	Coastal Sweet Pepperbush
1246	40.035691	-75.339089	Coastal Sweet Pepperbush
1690	40.038057	-75.342829	Coastal Sweet Pepperbush
2139	40.03805406	-75.34361471	Coastal Sweet Pepperbush
828	40.034712	-75.337354	Coleus
2665	40.035056	-75.338744	Coltsfoot
2666	40.034725	-75.339012	Coltsfoot
1951	40.037269	-75.345566	Common Barnyard Grass
100	40.035319	-75.340195	Common Blue Violet
507	40.034844	-75.341093	Common Blue Violet
576	40.035917	-75.341593	Common Blue Violet
891	40.035943	-75.342087	Common Blue Violet
894	40.035951	-75.342329	Common Blue Violet
1028	40.036765	-75.341168	Common Blue Violet
1038	40.036722	-75.341194	Common Blue Violet
1695	40.038151	-75.342722	Common Blue Violet
1722	40.035418	-75.345369	Common Blue Violet
1949	40.037217	-75.345588	Common Blue Violet
2065	40.03753641	-75.34247838	Common Blue Violet
2174	40.03807293	-75.34416908	Common Blue Violet
1021	40.036642	-75.341274	Common Boxwood
1171	40.035602	-75.338384	Common Boxwood
1182	40.035691	-75.338327	Common Boxwood
1439	40.037559	-75.341207	Common Boxwood
1520	40.037048	-75.341928	Common Boxwood
1528	40.037064	-75.341774	Common Boxwood
1533	40.037116	-75.341742	Common Boxwood
1686	40.038059	-75.343104	Common Boxwood
1754	40.035641	-75.345631	Common Boxwood
1761	40.035589	-75.34572	Common Boxwood
1764	40.035596	-75.345821	Common Boxwood
1781	40.03598	-75.34698	Common Boxwood
1818	40.03609	-75.347762	Common Boxwood
1819	40.036334	-75.347997	Common Boxwood
2143	40.0381951	-75.34379328	Common Boxwood
2153	40.03789325	-75.34451831	Common Boxwood
2156	40.03787848	-75.34459438	Common Boxwood
2197	40.03708625	-75.34210453	Common Boxwood
2336	40.0361769	-75.34316405	Common Boxwood
2340	40.0362614	-75.34307133	Common Boxwood

2378	40.03659075	-75.34386676	Common Boxwood
2382	40.0366688	-75.3438202	Common Boxwood
2385	40.03668655	-75.34390646	Common Boxwood
2389	40.03673065	-75.34395541	Common Boxwood
2402	40.03807752	-75.34418016	Common Boxwood
2465	40.03706896	-75.34518696	Common Boxwood
2588	40.03646215	-75.34312078	Common Boxwood
2593	40.03660171	-75.34313458	Common Boxwood
2667	40.03457	-75.33797	Common Boxwood
2668	40.034807	-75.337898	Common Boxwood
2669	40.034667	-75.337839	Common Boxwood
231	40.035979	-75.340122	Common Buttonbush
1972	40.037425	-75.345171	Common Buttonbush
2566	40.03607305	-75.34135441	Common Buttonbush
188	40.036016	-75.340304	Common Fern
946	40.036138	-75.342534	Common Fern
2208	40.03714078	-75.34225498	Common Fern
2287	40.03660758	-75.34259182	Common Fern
2670	40.034908	-75.338387	Common Flowering Quince
1879	40.036854	-75.346566	Common Gloldentop
396	40.035336	-75.343423	Common Grass
411	40.035357	-75.343368	Common Grass
1467	40.037666	-75.341347	Common Holly
2059	40.03758563	-75.34229822	Common Holly
2370	40.03643525	-75.34352788	Common Holly
2671	40.035051	-75.338126	Common Holly
1783	40.035857	-75.34682	Common Lillac
1871	40.036871	-75.346872	Common Liverwort
2574	40.03614008	-75.34141568	Common Mugwort
1784	40.035924	-75.346847	Common Myrtle
197	40.036266	-75.340293	Common Ninebark
811	40.034768	-75.337342	Common Ninebark
1448	40.037463	-75.341251	Common Ninebark
1525	40.037074	-75.341791	Common Ninebark
1541	40.037471	-75.341602	Common Ninebark
2425	40.03764458	-75.34449156	Common Ninebark
1277	40.03641	-75.339519	Common Oliander
2672	40.034908	-75.338387	Common Privet
1838	40.036201	-75.347288	Common Sewthistle
2571	40.03611651	-75.34138403	Common Sewthistle
1760	40.035542	-75.345896	Common Sourwood

2346	40.03624136	-75.34321816	Common Sourwood
46	40.035165	-75.339683	Common Winterberry
622	40.035515	-75.341792	Common Winterberry
641	40.035692	-75.341537	Common Winterberry
1025	40.036706	-75.341137	Common Winterberry
1072	40.035311	-75.337522	Common Winterberry
1098	40.035377	-75.337863	Common Winterberry
1127	40.035246	-75.337762	Common Winterberry
1147	40.035415	-75.338394	Common Winterberry
1159	40.035482	-75.338632	Common Winterberry
1394	40.037585	-75.340943	Common Winterberry
1447	40.037525	-75.341294	Common Winterberry
1458	40.037704	-75.341148	Common Winterberry
1687	40.038066	-75.343063	Common Winterberry
1887	40.036812	-75.346499	Common Winterberry
1941	40.037205	-75.345601	Common Winterberry
1961	40.037283	-75.345336	Common Winterberry
2091	40.03710538	-75.34404903	Common Winterberry
2097	40.03718751	-75.34436606	Common Winterberry
2343	40.03626735	-75.34320161	Common Winterberry
2401	40.03672905	-75.34410703	Common Winterberry
2564	40.03601782	-75.34133177	Common Winterberry
2586	40.03617141	-75.34148893	Common Winterberry
2608	40.03694357	-75.34427155	Common Winterberry
280	40.035486	-75.343411	Common Yarrow
294	40.035489	-75.343487	Common Yarrow
202	40.036289	-75.340263	Crabgrass
225	40.035958	-75.339902	Crabgrass
321	40.034024	-75.339544	Crabgrass
323	40.034043	-75.339455	Crabgrass
343	40.034299	-75.340256	Crabgrass
353	40.034322	-75.340276	Crabgrass
394	40.035301	-75.343388	Crabgrass
408	40.035203	-75.343403	Crabgrass
410	40.035318	-75.343407	Crabgrass
419	40.035566	-75.343258	Crabgrass
421	40.035513	-75.343311	Crabgrass
423	40.035394	-75.343302	Crabgrass
426	40.035299	-75.343304	Crabgrass
470	40.035399	-75.343607	Crabgrass
501	40.035017	-75.341039	Crabgrass

566	40.035931	-75.341516	Crabgrass
619	40.035492	-75.341781	Crabgrass
717	40.034967	-75.342815	Crabgrass
728	40.034637	-75.341376	Crabgrass
731	40.034703	-75.341645	Crabgrass
758	40.034984	-75.336855	Crabgrass
790	40.035136	-75.337418	Crabgrass
806	40.034767	-75.337257	Crabgrass
821	40.034782	-75.337229	Crabgrass
841	40.034827	-75.33754	Crabgrass
998	40.036614	-75.342094	Crabgrass
1016	40.036638	-75.341343	Crabgrass
1044	40.036626	-75.340933	Crabgrass
1060	40.036735	-75.340692	Crabgrass
1097	40.035363	-75.337841	Crabgrass
1119	40.035597	-75.337968	Crabgrass
1167	40.035623	-75.338795	Crabgrass
1196	40.035736	-75.338045	Crabgrass
1215	40.03594	-75.338219	Crabgrass
1513	40.035101	-75.341118	Crabgrass
2563	40.03605683	-75.34148633	Crabgrass
1683	40.038383	-75.342974	Creeping Cedar
296	40.035371	-75.343511	Creeping Jenny
297	40.035361	-75.343447	Creeping Jenny
298	40.03564	-75.343371	Creeping Jenny
299	40.035652	-75.343436	Creeping Jenny
1750	40.036346	-75.346035	Creeping Juniper
1886	40.036832	-75.346523	Creeping Juniper
172	40.036034	-75.340316	Creeping Myrtle
59	40.035319	-75.339618	Crepe Myrtle
60	40.035228	-75.339686	Crepe Myrtle
110	40.035382	-75.340242	Crepe Myrtle
112	40.035479	-75.340176	Crepe Myrtle
119	40.035491	-75.340391	Crepe Myrtle
539	40.035617	-75.341389	Crepe Myrtle
540	40.035614	-75.341407	Crepe Myrtle
541	40.035631	-75.341426	Crepe Myrtle
542	40.035639	-75.341406	Crepe Myrtle
543	40.035643	-75.341349	Crepe Myrtle
544	40.0357	-75.341358	Crepe Myrtle
882	40.036014	-75.342095	Crepe Myrtle

883	40.036043	-75.342086	Crepe Myrtle
884	40.036082	-75.342079	Crepe Myrtle
896	40.036025	-75.342353	Crepe Myrtle
897	40.036022	-75.342346	Crepe Myrtle
898	40.036033	-75.342351	Crepe Myrtle
899	40.036051	-75.342358	Crepe Myrtle
900	40.03606	-75.342343	Crepe Myrtle
922	40.035942	-75.343005	Crepe Myrtle
932	40.036218	-75.342849	Crepe Myrtle
1510	40.036337	-75.342974	Crepe Myrtle
1567	40.037737	-75.341392	Crepe Myrtle
1569	40.037777	-75.341605	Crepe Myrtle
1641	40.038562	-75.342474	Crepe Myrtle
1785	40.035903	-75.346818	Crepe Myrtle
2238	40.03694738	-75.34232628	Crepe Myrtle
2246	40.03688253	-75.34263038	Crepe Myrtle
2256	40.03690326	-75.34270318	Crepe Myrtle
2673	40.034808	-75.339226	Crepe Myrtle
2674	40.034859	-75.33931	Crepe Myrtle
2675	40.035159	-75.338934	Crepe Myrtle
2676	40.035196	-75.339023	Crepe Myrtle
2251	40.03686465	-75.34260593	Crepe Myrtle (sprout)
2258	40.03689741	-75.34267196	Crepe Myrtle (sprout)
2677	40.035381	-75.338854	Crested Iris
1561	40.037663	-75.341471	Cucumber Tree
1936	40.036861	-75.345515	Cucumber Tree
1010	40.036655	-75.341565	Curlytop Knotweed
769	40.034919	-75.337135	Cutleaf Coneflower
803	40.034853	-75.33728	Cutleaf Coneflower
1615	40.036575	-75.339193	Cutleaf Coneflower
1629	40.03649	-75.339301	Cutleaf Coneflower
18	40.034969	-75.339494	Dandelion
217	40.035903	-75.339665	Dandelion
384	40.034922	-75.340859	Dandelion
401	40.035233	-75.343447	Dandelion
674	40.035648	-75.341642	Dandelion
1018	40.036622	-75.341302	Dandelion
1156	40.035544	-75.338607	Dandelion
1229	40.035724	-75.337694	Dandelion
1243	40.035714	-75.338843	Dandelion
2280	40.03670768	-75.34280946	Dandelion

2678	40.035214	-75.339223	Dandelion
2679	40.034725	-75.339012	Dandelion
3	40.03606	-75.344146	Dawn Redwood
210	40.035559	-75.340724	Dawn Redwood
235	40.036026	-75.340173	Dawn Redwood
879	40.035903	-75.342187	Dawn Redwood
274	40.035388	-75.343435	Dense Blazing Star
286	40.035597	-75.343384	Dense Blazing Star
1132	40.03523	-75.337851	Dense Blazing Star
1319	40.036511	-75.340264	Dense Blazing Star
1327	40.036537	-75.340363	Dense Blazing Star
512	40.035153	-75.340848	Deodar Cedar
1701	40.036003	-75.344067	Deodar Cedar
1898	40.036612	-75.346545	Deodar Cedar
1899	40.036596	-75.34656	Deodar Cedar
2241	40.03690685	-75.34239138	Deodar Cedar
2680	40.03447	-75.33806	Deodar Cedar
1653	40.038558	-75.343143	Devil's Beggarticks
2681	40.034725	-75.339012	Devil's Beggarticks
776	40.034989	-75.337069	Devil's Tongue
781	40.035371	-75.337352	Devil's Tongue
1647	40.038645	-75.343055	Devil's Tongue
1651	40.038554	-75.343123	Devil's Tongue
1667	40.038385	-75.34337	Devil's Tongue
1682	40.038405	-75.342977	Devil's Tongue
1233	40.035691	-75.338633	Douglass Fir
2231	40.03679266	-75.34229478	Dovesfoot Geranium
2405	40.03776608	-75.34461365	Dovesfoot Geranium
2397	40.0369428	-75.34406721	Dwarf Mountain Pine
2682	40.034147	-75.338883	Eastern Blue Star
613	40.036238	-75.341403	Eastern Hemlock
614	40.036248	-75.341368	Eastern Hemlock
1799	40.036153	-75.346674	Eastern Hemlock
1987	40.037446	-75.345453	Eastern Hemlock
1989	40.037391	-75.345611	Eastern Hemlock
1993	40.03734	-75.345724	Eastern Hemlock
2463	40.03722415	-75.34523741	Eastern Hemlock
2468	40.03691621	-75.34521111	Eastern Hemlock
2470	40.03684741	-75.34530209	Eastern Hemlock
2495	40.03659488	-75.34457111	Eastern Hemlock
740	40.035194	-75.336528	Eastern Red Cedar

954	40.03607	-75.342403	Eastern Red Cedar
955	40.036076	-75.342454	Eastern Red Cedar
1362	40.037068	-75.340482	Eastern Red Cedar
1436	40.037426	-75.341217	Eastern Red Cedar
1397	40.037597	-75.340952	Eastern Red Cedar (sprout)
1442	40.03761	-75.341158	Eastern Red Cedar (sprout)
7	40.035042	-75.339455	Eastern Redbud
8	40.034989	-75.339546	Eastern Redbud
13	40.034945	-75.33949	Eastern Redbud
14	40.034929	-75.339453	Eastern Redbud
193	40.036213	-75.340283	Eastern Redbud
204	40.036276	-75.340223	Eastern Redbud
205	40.036323	-75.340215	Eastern Redbud
830	40.034788	-75.337471	Eastern Redbud
875	40.035768	-75.342824	Eastern Redbud
876	40.035833	-75.342787	Eastern Redbud
877	40.035862	-75.342868	Eastern Redbud
1165	40.035601	-75.33879	Eastern Redbud
1236	40.035718	-75.338775	Eastern Redbud
1239	40.03574	-75.338809	Eastern Redbud
1240	40.035747	-75.338885	Eastern Redbud
1255	40.035814	-75.33902	Eastern Redbud
1268	40.036407	-75.338925	Eastern Redbud
1283	40.036498	-75.339537	Eastern Redbud
1321	40.03648	-75.340201	Eastern Redbud
1349	40.037127	-75.3406	Eastern Redbud
1350	40.037052	-75.340625	Eastern Redbud
1351	40.037052	-75.340532	Eastern Redbud
1352	40.037032	-75.340523	Eastern Redbud
1363	40.037098	-75.340456	Eastern Redbud
1400	40.037332	-75.341358	Eastern Redbud
1473	40.036619	-75.342338	Eastern Redbud
1476	40.036716	-75.342441	Eastern Redbud
1531	40.037099	-75.341819	Eastern Redbud
2022	40.0382536	-75.34230608	Eastern Redbud
2024	40.03831231	-75.34234332	Eastern Redbud
2266	40.03677797	-75.34280866	Eastern Redbud
2286	40.03660348	-75.34272279	Eastern Redbud
2289	40.03671661	-75.34269646	Eastern Redbud
2293	40.03673646	-75.34262356	Eastern Redbud
2300	40.03663558	-75.34236265	Eastern Redbud

2321	40.03658899	-75.34282158	Eastern Redbud
2324	40.03658662	-75.34294323	Eastern Redbud
2551	40.03584303	-75.34319406	Eastern Redbud
2552	40.03586835	-75.3432101	Eastern Redbud
2554	40.03597133	-75.34316796	Eastern Redbud
2683	40.034663	-75.338992	Eastern Redbud
2684	40.034692	-75.339015	Eastern Redbud
2685	40.034695	-75.338954	Eastern Redbud
2686	40.03527	-75.339294	Eastern Redbud
2687	40.03527	-75.339237	Eastern Redbud
2688	40.035027	-75.338729	Eastern Redbud
2689	40.035078	-75.33875	Eastern Redbud
2690	40.035246	-75.339181	Eastern Redbud
2691	40.035276	-75.339161	Eastern Redbud
2692	40.035295	-75.339206	Eastern Redbud
15	40.034959	-75.339443	Eastern Redbud (sprout)
198	40.036235	-75.340301	Eastern Redbud (sprout)
818	40.034778	-75.337363	Eastern Redbud (sprout)
840	40.034835	-75.337505	Eastern Redbud (sprout)
1062	40.03667	-75.340702	Eastern Redbud (sprout)
1161	40.035514	-75.338684	Eastern Redbud (sprout)
1164	40.035554	-75.338772	Eastern Redbud (sprout)
1247	40.03569	-75.339038	Eastern Redbud (sprout)
1485	40.036467	-75.342358	Eastern Redbud (sprout)
2317	40.03677615	-75.3423802	Eastern Redbud (sprout)
2693	40.034725	-75.339012	Eastern Redbud (sprout)
2694	40.035056	-75.338744	Eastern Redbud (sprout)
2695	40.035214	-75.339223	Eastern Redbud (sprout)
75	40.035572	-75.339948	Eastern Sweetshrub
79	40.035618	-75.340096	Eastern Sweetshrub
975	40.036319	-75.341427	Eastern Sweetshrub
1450	40.037452	-75.341351	Eastern Sweetshrub
2696	40.03512	-75.338182	Eastern Sweetshrub
382	40.034962	-75.340901	Eastern White Pine
1270	40.036448	-75.338859	Eastern White Pine
1412	40.037187	-75.341503	Eastern White Pine
1413	40.037156	-75.341614	Eastern White Pine
1718	40.035631	-75.345467	Eastern White Pine
1755	40.035646	-75.34561	Eastern White Pine
1766	40.035603	-75.345974	Eastern White Pine
1776	40.035691	-75.346455	Eastern White Pine

1803	40.036077	-75.346289	Eastern White Pine
1806	40.036227	-75.346132	Eastern White Pine
1862	40.036598	-75.347373	Eastern White Pine
1865	40.036704	-75.347199	Eastern White Pine
1905	40.036934	-75.346383	Eastern White Pine
1906	40.036978	-75.346339	Eastern White Pine
1907	40.036998	-75.346301	Eastern White Pine
1908	40.037045	-75.346264	Eastern White Pine
1909	40.037065	-75.346233	Eastern White Pine
1912	40.037035	-75.346136	Eastern White Pine
1913	40.037098	-75.346189	Eastern White Pine
1914	40.037103	-75.346137	Eastern White Pine
1915	40.037134	-75.346038	Eastern White Pine
1916	40.036985	-75.346245	Eastern White Pine
1922	40.037184	-75.345904	Eastern White Pine
2442	40.03732196	-75.34453365	Eastern White Pine
2459	40.03721555	-75.34502261	Eastern White Pine
103	40.035328	-75.340174	English Ivy
135	40.035382	-75.340552	English Ivy
141	40.035284	-75.340535	English Ivy
203	40.036257	-75.340287	English Ivy
359	40.034354	-75.340331	English Ivy
362	40.034643	-75.340166	English Ivy
383	40.034921	-75.340907	English Ivy
575	40.035914	-75.341616	English Ivy
597	40.035935	-75.341751	English Ivy
634	40.035762	-75.341439	English Ivy
741	40.035092	-75.336509	English Ivy
809	40.034787	-75.337299	English Ivy
853	40.035009	-75.337705	English Ivy
940	40.036074	-75.342684	English Ivy
1091	40.03551	-75.337616	English Ivy
1177	40.035575	-75.338376	English Ivy
1361	40.037078	-75.340587	English Ivy
1395	40.037576	-75.340987	English Ivy
1441	40.037604	-75.341247	English Ivy
1460	40.037677	-75.34115	English Ivy
1548	40.037208	-75.341682	English Ivy
1638	40.038469	-75.342307	English Ivy
1756	40.035603	-75.345535	English Ivy
1789	40.035927	-75.346688	English Ivy

1810	40.036262	-75.346246	English Ivy
1826	40.036203	-75.347985	English Ivy
1830	40.036105	-75.347912	English Ivy
1844	40.035998	-75.34733	English Ivy
1863	40.036574	-75.347407	English Ivy
1901	40.036804	-75.346571	English Ivy
1910	40.036826	-75.346043	English Ivy
1917	40.037088	-75.34608	English Ivy
1923	40.037204	-75.345876	English Ivy
1986	40.037435	-75.345478	English Ivy
2034	40.03808835	-75.3424718	English Ivy
2155	40.03794948	-75.34443791	English Ivy
2237	40.03715609	-75.34223615	English Ivy
2240	40.03691388	-75.34237356	English Ivy
2444	40.03738879	-75.34456806	English Ivy
2466	40.03701243	-75.34517991	English Ivy
2467	40.03718566	-75.34518569	English Ivy
2496	40.03661858	-75.34459771	English Ivy
2521	40.03627083	-75.34384483	English Ivy
2697	40.035633	-75.339263	English Ivy
2698	40.035291	-75.338472	English Ivy
2699	40.035439	-75.338877	English Ivy
2700	40.035056	-75.338744	English Ivy
2306	40.03659714	-75.34240226	English Oak
45	40.034778	-75.339684	European Beech
163	40.036198	-75.34052	European Beech
245	40.0361	-75.339649	European Beech
330	40.034706	-75.340133	European Beech
335	40.034652	-75.340689	European Beech
503	40.034846	-75.341084	European Beech
530	40.035565	-75.341585	European Beech
1291	40.036134	-75.339241	European Beech
1700	40.036021	-75.343918	European Beech
1703	40.036361	-75.344811	European Beech
1717	40.035756	-75.345343	European Beech
1724	40.035801	-75.345131	European Beech
2318	40.03664675	-75.34265428	European Beech
2536	40.03585512	-75.34351666	European Beech
2550	40.03584835	-75.34317346	European Beech
1725	40.035522	-75.344491	European Copper Beech
974	40.036333	-75.341497	European Goatseed

977	40.036309	-75.341556	European Larch
1771	40.035711	-75.345848	European Larch
1796	40.036006	-75.346636	European Privet
1885	40.03683	-75.346554	European Privet
1492	40.036269	-75.342372	European Smoketree
1494	40.036185	-75.342376	European Smoketree
1497	40.036189	-75.342457	European Smoketree
1501	40.036217	-75.342569	European Smoketree
1507	40.036394	-75.342884	European Smoketree
919	40.035936	-75.342872	European Spindletree
1777	40.035671	-75.34645	European Weeping Beech
1135	40.035222	-75.338015	False Aster
1586	40.037355	-75.340024	False Blue Indigo
1593	40.037115	-75.339629	False Blue Indigo
1652	40.038561	-75.343138	False Blue Indigo
2144	40.03819166	-75.34383428	False Blue Indigo
2427	40.03759655	-75.34447501	False Blue Indigo
2538	40.03573212	-75.34318098	False Blue Indigo
2227	40.03705053	-75.34216326	False Buck's Beard
2701	40.035439	-75.338877	False Solomon's Seal
2702	40.035463	-75.339036	False Solomon's Seal
2181	40.03805516	-75.34423098	False Sunflower
1503	40.036332	-75.342732	Feather Reed Grass
2703	40.034318	-75.338291	Feather Reed Grass
827	40.034733	-75.3374	Feathertop Grass
1674	40.038196	-75.343625	Feathertop Grass
2493	40.0365345	-75.34470471	Feathertop Grass
2497	40.03656	-75.3445171	Feathertop Grass
494	40.035247	-75.343923	Fernleaf Beech
2537	40.0357372	-75.34326163	Feverfew
82	40.035631	-75.340084	Field Thistle
2704	40.034725	-75.339012	Field Thistle
2535	40.03612596	-75.34339878	Fine Line Buckthorn
2845	40.034202	-75.339083	Fine Line Buckthorn
2846	40.034246	-75.339117	Fine Line Buckthorn
2847	40.035051	-75.338126	Fine Line Buckthorn
2204	40.0371425	-75.34225113	Flame Azalea
2249	40.03686045	-75.34261398	Flame Azalea
2269	40.03671705	-75.34288921	Fleabane
1328	40.036538	-75.340335	Florist's Spiraea
1357	40.037109	-75.340577	Florist's Spiraea

631	40.035778	-75.341416	Flowering Dogwood
704	40.034979	-75.343005	Flowering Dogwood
984	40.036307	-75.341151	Flowering Dogwood
1052	40.036608	-75.34086	Flowering Dogwood
1260	40.035914	-75.338999	Flowering Dogwood
1342	40.036928	-75.340819	Flowering Dogwood
1422	40.036949	-75.341525	Flowering Dogwood
1424	40.036962	-75.341487	Flowering Dogwood
1469	40.036784	-75.342162	Flowering Dogwood
1644	40.038702	-75.342764	Flowering Dogwood
1757	40.035511	-75.345653	Flowering Dogwood
1768	40.0356	-75.346009	Flowering Dogwood
1786	40.035932	-75.346792	Flowering Dogwood
1831	40.036528	-75.34769	Flowering Dogwood
1856	40.036123	-75.347045	Flowering Dogwood
2071	40.03758283	-75.34276027	Flowering Dogwood
2085	40.03707237	-75.34304451	Flowering Dogwood
2201	40.03711125	-75.34219183	Flowering Dogwood
2226	40.03700278	-75.34221578	Flowering Dogwood
2314	40.03654565	-75.34243413	Flowering Dogwood
2455	40.03729731	-75.34484963	Flowering Dogwood
2456	40.03738398	-75.34477353	Flowering Dogwood
2583	40.03622456	-75.34129685	Flowering Dogwood
2705	40.035346	-75.338767	Flowering Dogwood
1849	40.036014	-75.347154	Forsythia
837	40.034809	-75.337595	Foxglove Beardtongue
2548	40.03574225	-75.34315196	Foxtail
19	40.034975	-75.339402	Fragrant Plantain Lily
85	40.0354	-75.33982	Fragrant Plantain Lily
182	40.036028	-75.34028	Fragrant Plantain Lily
228	40.035963	-75.340073	Fragrant Plantain Lily
536	40.035594	-75.341393	Fragrant Plantain Lily
572	40.035916	-75.341536	Fragrant Plantain Lily
599	40.035958	-75.341842	Fragrant Plantain Lily
914	40.036034	-75.342652	Fragrant Plantain Lily
923	40.036017	-75.342917	Fragrant Plantain Lily
928	40.036185	-75.342981	Fragrant Plantain Lily
948	40.036158	-75.342511	Fragrant Plantain Lily
961	40.036253	-75.341861	Fragrant Plantain Lily
968	40.036413	-75.341766	Fragrant Plantain Lily
971	40.036281	-75.341731	Fragrant Plantain Lily

995	40.036508	-75.3421	Fragrant Plantain Lily
1356	40.037101	-75.340571	Fragrant Plantain Lily
1367	40.037323	-75.34061	Fragrant Plantain Lily
1390	40.037491	-75.34093	Fragrant Plantain Lily
1408	40.037128	-75.341379	Fragrant Plantain Lily
1480	40.036751	-75.342509	Fragrant Plantain Lily
1677	40.03816	-75.343465	Fragrant Plantain Lily
1693	40.038157	-75.342733	Fragrant Plantain Lily
1821	40.036132	-75.347676	Fragrant Plantain Lily
1825	40.03619	-75.347938	Fragrant Plantain Lily
1834	40.03622	-75.347364	Fragrant Plantain Lily
1836	40.036431	-75.347368	Fragrant Plantain Lily
1854	40.036101	-75.347135	Fragrant Plantain Lily
1930	40.037	-75.345664	Fragrant Plantain Lily
1935	40.036721	-75.345498	Fragrant Plantain Lily
2094	40.03718973	-75.34415866	Fragrant Plantain Lily
2102	40.03723591	-75.34429416	Fragrant Plantain Lily
2107	40.03743663	-75.34420846	Fragrant Plantain Lily
2109	40.03754173	-75.34417291	Fragrant Plantain Lily
2136	40.03791855	-75.34364963	Fragrant Plantain Lily
2214	40.03717405	-75.34247063	Fragrant Plantain Lily
2274	40.03674851	-75.34310291	Fragrant Plantain Lily
2281	40.03668025	-75.34276911	Fragrant Plantain Lily
2316	40.03690166	-75.34220547	Fragrant Plantain Lily
2417	40.03757986	-75.34472101	Fragrant Plantain Lily
2435	40.03764971	-75.34449636	Fragrant Plantain Lily
2446	40.03743106	-75.34484623	Fragrant Plantain Lily
2506	40.03652615	-75.34439846	Fragrant Plantain Lily
2510	40.03644495	-75.34440681	Fragrant Plantain Lily
2706	40.034725	-75.339012	Fragrant Plantain Lily
2707	40.035056	-75.338744	Fragrant Plantain Lily
2708	40.035214	-75.339223	Fragrant Plantain Lily
41	40.035391	-75.339491	Fragrant Sumac
50	40.035415	-75.339545	Fragrant Sumac
62	40.03519	-75.339716	Fragrant Sumac
66	40.035145	-75.339813	Fragrant Sumac
69	40.035001	-75.339904	Fragrant Sumac
159	40.035853	-75.340618	Fragrant Sumac
272	40.035406	-75.343508	Fragrant Sumac
289	40.035538	-75.343402	Fragrant Sumac
1011	40.036664	-75.341571	Fragrant Sumac

1035	40.036685	-75.341327	Fragrant Sumac
1040	40.036638	-75.340947	Fragrant Sumac
1047	40.036478	-75.34105	Fragrant Sumac
1064	40.036791	-75.340647	Fragrant Sumac
1066	40.036757	-75.340552	Fragrant Sumac
1079	40.035327	-75.337597	Fragrant Sumac
1487	40.036436	-75.342328	Fragrant Sumac
2016	40.03825545	-75.34221301	Fragrant Sumac
2025	40.03832231	-75.34234238	Fragrant Sumac
2310	40.03657716	-75.34228673	Fragrant Sumac
388	40.034958	-75.340112	Fragrant Sweet Box
514	40.035181	-75.340467	Fragrant Sweet Box
2203	40.03711801	-75.34222871	Fragrant Sweet Box
2614	40.03759086	-75.34455982	Franklin Tree
2709	40.03457	-75.33797	French Hydranga
2710	40.034883	-75.337951	French Hydranga
2711	40.034667	-75.337839	French Hydranga
2712	40.03498	-75.33803	French Hydranga
2713	40.034807	-75.337898	French Hydranga
2714	40.03512	-75.338182	French Hydranga
2715	40.034486	-75.338899	French Rose
2716	40.034523	-75.33887	French Rose
2717	40.034548	-75.338846	French Rose
2718	40.034574	-75.338822	French Rose
2719	40.034638	-75.338756	French Rose
2720	40.034989	-75.338471	French Rose
1617	40.036564	-75.3392	Frost Aster
1631	40.036501	-75.339385	Frost Aster
2170	40.03807096	-75.3441001	Frost Aster
10	40.034949	-75.33947	Fuzzy Pride of Rochester
55	40.035473	-75.339915	Fuzzy Pride of Rochester
1204	40.035836	-75.338101	Fuzzy Pride of Rochester
1449	40.037457	-75.341301	Fuzzy Pride of Rochester
1549	40.037579	-75.34156	Fuzzy Pride of Rochester
2264	40.03676265	-75.34268983	Fuzzy Pride of Rochester
2326	40.03653398	-75.34303703	Fuzzy Pride of Rochester
2530	40.03607608	-75.34360228	Fuzzy Pride of Rochester
2721	40.035572	-75.339264	Fuzzy Pride of Rochester
2722	40.03457	-75.33797	Fuzzy Pride of Rochester
2723	40.034883	-75.337951	Fuzzy Pride of Rochester
2724	40.034807	-75.337898	Fuzzy Pride of Rochester

2725	40.034667	-75.337839	Fuzzy Pride of Rochester
186	40.036026	-75.340309	Garden Cucumber
1404	40.037209	-75.341184	Garden Pink
832	40.034797	-75.337414	Garden Rose
857	40.035047	-75.337481	Garden Rose
1197	40.035747	-75.338052	Garden Rose
1203	40.035817	-75.338115	Garden Rose
1208	40.035928	-75.338121	Garden Rose
1543	40.03762	-75.341599	Garden Rose
1544	40.037587	-75.341527	Garden Rose
1557	40.037633	-75.341447	Garden Rose
1797	40.036019	-75.346592	Garden Rose
2410	40.0376211	-75.34484338	Garden Rose
2531	40.03605803	-75.34355228	Garden Rose
270	40.035358	-75.343437	Garden Snapdragon
271	40.035374	-75.343522	Garden Snapdragon
287	40.035638	-75.343363	Garden Snapdragon
288	40.035653	-75.34345	Garden Snapdragon
1523	40.03711	-75.341848	Garden Snapdragon
1527	40.037049	-75.341796	Garden Snapdragon
1532	40.037109	-75.34174	Garden Snapdragon
1668	40.038335	-75.343501	Garden Snapdragon
1673	40.038238	-75.343671	Garden Snapdragon
1751	40.035803	-75.34569	Garden Snapdragon
1791	40.035866	-75.346677	Garden Snapdragon
2384	40.0366926	-75.34379285	Garden Snapdragon
2445	40.03743225	-75.34485036	Garden Snapdragon
2453	40.03732963	-75.34495048	Garden Snapdragon
282	40.03551	-75.343409	Garden Stonecrop
293	40.035563	-75.343467	Garden Stonecrop
1504	40.036439	-75.342811	Garden Stonecrop
1889	40.036762	-75.346551	Garden Stonecrop
2726	40.03457	-75.33797	Garden Stonecrop
2727	40.034667	-75.337839	Garden Stonecrop
688	40.035689	-75.342077	Ginkgo
924	40.036046	-75.342984	Ginkgo
1800	40.036198	-75.346863	Ginkgo
1900	40.036624	-75.34635	Ginkgo
2474	40.03674512	-75.34531628	Ginkgo
2480	40.0366559	-75.34518048	Ginkgo
495	40.035781	-75.343655	Golden Larch

2191	40.03796273	-75.34438803	Golden Ragwort
522	40.035043	-75.340169	Goldenrod
771	40.034966	-75.337061	Goldenrod
785	40.03544	-75.337409	Goldenrod
793	40.035131	-75.337416	Goldenrod
874	40.035147	-75.33751	Goldenrod
1133	40.035198	-75.337908	Goldenrod
1155	40.03552	-75.338624	Goldenrod
1178	40.035581	-75.338362	Goldenrod
1585	40.037336	-75.340009	Goldenrod
1594	40.037098	-75.339602	Goldenrod
1603	40.036677	-75.339202	Goldenrod
1616	40.036564	-75.339194	Goldenrod
1625	40.036481	-75.339209	Goldenrod
1639	40.038468	-75.342339	Goldenrod
1655	40.038497	-75.343176	Goldenrod
1659	40.038479	-75.343259	Goldenrod
1664	40.038414	-75.343419	Goldenrod
1939	40.037185	-75.345622	Goldenrod
1964	40.037278	-75.345271	Goldenrod
2163	40.03816463	-75.34400236	Goldenrod
2171	40.03806376	-75.34411808	Goldenrod
2190	40.0379897	-75.34437988	Goldenrod
2426	40.03760728	-75.34447871	Goldenrod
525	40.035085	-75.340307	Goose Grass
199	40.03625	-75.340302	Great Laurel
1995	40.037361	-75.345655	Great Laurel
2323	40.03656316	-75.34282644	Great Laurel
2349	40.0362822	-75.34328851	Great Laurel
1984	40.037481	-75.345355	Great Laurel (catawba Rosebay?)
1344	40.037027	-75.340886	Green Ash
1346	40.036985	-75.341133	Green Ash
1347	40.03685	-75.341057	Green Ash
1426	40.037022	-75.341429	Green Ash
1804	40.036277	-75.346431	Green Ash
1822	40.036154	-75.347724	Green Ash
1824	40.036205	-75.348068	Green Ash
1828	40.036416	-75.347659	Green Ash
1829	40.036439	-75.347899	Green Ash
1998	40.03814	-75.343131	Green Ash
1999	40.038135	-75.343042	Green Ash

2000	40.038238	-75.343007	Green Ash
2001	40.0381	-75.342758	Green Ash
2002	40.038202	-75.34263	Green Ash
2003	40.038062	-75.34254	Green Ash
2004	40.038206	-75.342537	Green Ash
2005	40.038502	-75.34233	Green Ash
2006	40.03857	-75.342521	Green Ash
2225	40.03706136	-75.34232018	Green Ash
2561	40.03606873	-75.34149303	Green Carpetweed
2577	40.03611886	-75.34140581	Green Carpetweed
901	40.035966	-75.342335	Greenstem Forsythia
381	40.034922	-75.340826	Grey Downy Balsam
242	40.036027	-75.340021	Gypsy Weed
12	40.034971	-75.339487	Hairy Alumroot
1366	40.037302	-75.340585	Hairy Alumroot
1392	40.037583	-75.340946	Hairy Alumroot
1562	40.037653	-75.341457	Hairy Alumroot
1753	40.035834	-75.345713	Hairy Alumroot
1841	40.036073	-75.347303	Hairy Alumroot
2438	40.03754726	-75.34449186	Hairy Alumroot
2728	40.035214	-75.339223	Hairy Alumroot
2729	40.034725	-75.339012	Hairy Alumroot
2730	40.035056	-75.338744	Hairy Alumroot
862	40.03504	-75.33748	Hairy Beard Tongue
784	40.035471	-75.337448	Hairy Bittercress
797	40.035178	-75.337424	Hairy Crabgrass
812	40.034752	-75.337319	Hairy Crabgrass
185	40.036021	-75.340301	Hairy Oldfield Aster
124	40.035435	-75.340525	Hairy White Oldfield Aster
240	40.036083	-75.3401	Hairy White Oldfield Aster
1345	40.037069	-75.341041	Halka Zelkova
2731	40.035463	-75.339036	Hamilton's spindletree
1461	40.037725	-75.341075	Hardy Fuchsia
582	40.035956	-75.341637	Heavenly Bamboo
598	40.035939	-75.341774	Heavenly Bamboo
942	40.036128	-75.342566	Heavenly Bamboo
943	40.03611	-75.342553	Heavenly Bamboo
1370	40.037328	-75.340679	Heavenly Bamboo
1391	40.03754	-75.340987	Heavenly Bamboo
2030	40.03819861	-75.34240894	Heavenly Bamboo
2035	40.03802623	-75.34255025	Heavenly Bamboo

2062	40.03754741	-75.34253313	Heavenly Bamboo
2110	40.03764524	-75.34420458	Heavenly Bamboo
2113	40.03768618	-75.34434661	Heavenly Bamboo
2116	40.0376826	-75.34415471	Heavenly Bamboo
2124	40.03782928	-75.34386471	Heavenly Bamboo
2217	40.03725631	-75.34255861	Heavenly Bamboo
2546	40.0358	-75.34313338	Heavenly Bamboo
992	40.036167	-75.341709	Hickory
2732	40.03457	-75.33797	Himilaian Balsam
1872	40.036918	-75.346607	Hinoki False Cypress
2036	40.03801336	-75.34248896	Hinoki False Cypress
1065	40.036744	-75.340697	Holly Olive
2733	40.034807	-75.337898	Holly Olive
2734	40.034883	-75.337951	Holly Olive
2735	40.03498	-75.33803	Holly Olive
2736	40.034725	-75.339012	Hop Clover
1716	40.035816	-75.345497	Horse Chestnut
1719	40.035526	-75.345315	Horse Chestnut
1723	40.03546	-75.345214	Horse Chestnut
1741	40.036085	-75.345658	Horse Chestnut
1743	40.036154	-75.345721	Horse Chestnut
1745	40.036215	-75.345771	Horse Chestnut
1746	40.036359	-75.345974	Horse Chestnut
1748	40.036513	-75.346034	Horse Chestnut
2737	40.035572	-75.339264	Horseweed
1692	40.038149	-75.342764	Hosta
84	40.035362	-75.33961	Hubricht's Bluestar
162	40.036085	-75.340532	Hubricht's Bluestar
1309	40.036293	-75.339784	Hubricht's Bluestar
1310	40.036178	-75.340041	Hubricht's Bluestar
1433	40.037409	-75.341256	Hubricht's Bluestar
1893	40.036749	-75.346402	Hubricht's Bluestar
2021	40.0382952	-75.34226711	Hubricht's Bluestar
2027	40.03825171	-75.34243436	Hubricht's Bluestar
2481	40.03668741	-75.34514596	Hubricht's Bluestar
2738	40.035633	-75.339263	Hubricht's Bluestar
16	40.034959	-75.339488	Indian Hemp
517	40.035193	-75.340434	Indian Hemp
2739	40.034667	-75.337839	Indian Hemp
1875	40.036938	-75.346596	Indian Mint
1891	40.036845	-75.346482	Indian Woodoats

1895	40.036734	-75.346346	Indian Woodoats
558	40.03513	-75.341415	Inkberry
765	40.034943	-75.337022	Inkberry
1559	40.037614	-75.341447	Inkberry
1600	40.0367	-75.339166	Inkberry
1969	40.037403	-75.345258	Inkberry
561	40.035892	-75.341394	Ironwood
529	40.035111	-75.340176	Jack In The Bush
798	40.035143	-75.337324	Jack In The Bush
815	40.034776	-75.33731	Jack In The Bush
2145	40.03819375	-75.34380451	Jack In The Bush
1521	40.03706	-75.341926	Japanese Boxwood
1790	40.035916	-75.346646	Japanese Boxwood
1845	40.036034	-75.347296	Japanese Boxwood
1847	40.035993	-75.347184	Japanese Boxwood
1855	40.036089	-75.347144	Japanese Boxwood
1858	40.036211	-75.347135	Japanese Boxwood
2198	40.03710596	-75.34211363	Japanese Boxwood
680	40.035656	-75.341722	Japanese Bristlegrass
1624	40.03649	-75.33925	Japanese Bristlegrass
49	40.035468	-75.33953	Japanese Cedar
1435	40.037451	-75.34123	Japanese Cutleaf Maple
303	40.033875	-75.339214	Japanese Flowering Cherry
745	40.035098	-75.336646	Japanese Flowering Cherry
750	40.035021	-75.336803	Japanese Flowering Cherry
760	40.034947	-75.336954	Japanese Flowering Cherry
1055	40.036744	-75.340717	Japanese Flowering Cherry
1056	40.036765	-75.340569	Japanese Flowering Cherry
1073	40.035307	-75.337559	Japanese Flowering Cherry
1375	40.037184	-75.340885	Japanese Flowering Cherry
1379	40.037194	-75.340979	Japanese Flowering Cherry
1696	40.038041	-75.342617	Japanese Flowering Cherry
2223	40.03710341	-75.34244588	Japanese Flowering Cherry
1175	40.035609	-75.338367	Japanese Holly
1788	40.036004	-75.346705	Japanese Holly
1869	40.036835	-75.346872	Japanese Laurel
2090	40.03713381	-75.34416551	Japanese Laurel
2096	40.0372152	-75.3442863	Japanese Laurel
2399	40.03683326	-75.34411658	Japanese Laurel
2601	40.03703365	-75.34405903	Japanese Laurel
2606	40.03691926	-75.34416993	Japanese Laurel

957	40.03626	-75.34227	Japanese Maple
965	40.036438	-75.342038	Japanese Maple
972	40.036408	-75.34154	Japanese Maple
990	40.036532	-75.341518	Japanese Maple
1827	40.036403	-75.347894	Japanese Maple
1832	40.036621	-75.347542	Japanese Maple
1866	40.036734	-75.347213	Japanese Maple
1868	40.036822	-75.346865	Japanese Maple
2154	40.03795141	-75.34452634	Japanese Maple
804	40.034728	-75.337258	Japanese Meadowsweet
1026	40.036734	-75.341193	Japanese Meadowsweet
1117	40.035702	-75.337988	Japanese Meadowsweet
1190	40.035734	-75.338017	Japanese Meadowsweet
1191	40.03561	-75.338414	Japanese Meadowsweet
1405	40.03711	-75.34109	Japanese Meadowsweet
1604	40.036682	-75.339168	Japanese Meadowsweet
1959	40.037324	-75.345447	Japanese Meadowsweet
2369	40.0364456	-75.34336215	Japanese Meadowsweet
2373	40.0364972	-75.34368616	Japanese Meadowsweet
2448	40.03741783	-75.3448609	Japanese Meadowsweet
2452	40.03732978	-75.34488043	Japanese Meadowsweet
2604	40.03699268	-75.34404076	Japanese Meadowsweet
1517	40.037059	-75.341919	Japanese Pachysandra
1573	40.037721	-75.34158	Japanese Pachysandra
2194	40.03700234	-75.34183914	Japanese Pachysandra
2196	40.03704846	-75.34210157	Japanese Pachysandra
1857	40.036184	-75.34709	Japanese Pieris
1870	40.036909	-75.346822	Japanese Pieris
2131	40.03788611	-75.34347981	Japanese Pieris
734	40.035193	-75.336494	Japanese Red Cedar
735	40.035182	-75.336458	Japanese Red Cedar
736	40.035201	-75.33648	Japanese Red Cedar
737	40.035204	-75.336495	Japanese Red Cedar
738	40.035207	-75.336497	Japanese Red Cedar
739	40.035172	-75.336511	Japanese Red Cedar
748	40.035098	-75.336726	Japanese Red Cedar
763	40.03496	-75.336975	Japanese Red Cedar
1068	40.036703	-75.340471	Japanese Red Cedar
2485	40.03664728	-75.34495633	Japanese Red Cedar
2486	40.0366427	-75.34501721	Japanese Red Cedar
2487	40.0365865	-75.34491713	Japanese Red Cedar

2488	40.03657775	-75.34478108	Japanese Red Cedar
2489	40.03658361	-75.34477448	Japanese Red Cedar
2490	40.03659423	-75.34477446	Japanese Red Cedar
1365	40.037152	-75.340475	Japanese Snowball
1878	40.036887	-75.346548	Japanese Snowball
2516	40.0363279	-75.34412158	Japanese Snowball
2519	40.03628195	-75.34385741	Japanese Snowball
1323	40.036472	-75.340215	Japanese Stewartia
1324	40.036536	-75.340322	Japanese Stewartia
1483	40.036398	-75.342525	Japanese Stewartia
1550	40.037539	-75.341457	Japanese Stewartia
2327	40.036461	-75.34304218	Japanese Stewartia
2328	40.03645396	-75.34296151	Japanese Stewartia
2330	40.03640348	-75.34298511	Japanese Stewartia
1484	40.036445	-75.342465	Japanese Stewartia (sprout)
629	40.035616	-75.34149	Japanese Yew
689	40.035736	-75.342106	Japanese Yew
1019	40.036636	-75.341332	Japanese Yew
1080	40.03533	-75.337484	Japanese Yew
1111	40.035482	-75.338091	Japanese Yew
1189	40.035768	-75.338037	Japanese Yew
1198	40.035832	-75.338095	Japanese Yew
1212	40.035906	-75.338321	Japanese Yew
1416	40.036979	-75.341843	Japanese Yew
2464	40.03712468	-75.34527245	Japanese Yew
1136	40.035228	-75.338047	Jerusalem Artichoke
1149	40.035364	-75.338364	Jerusalem Artichoke
1163	40.035557	-75.338731	Jerusalem Artichoke
1463	40.037635	-75.341401	Jerusalem Artichoke
1552	40.037552	-75.34143	Jerusalem Artichoke
1556	40.037612	-75.341392	Jerusalem Artichoke
399	40.035298	-75.343397	Jimsonweed
425	40.035313	-75.343301	Jimsonweed
276	40.035414	-75.343427	Juniper
277	40.03549	-75.343407	Juniper
283	40.035511	-75.34348	Juniper
292	40.035596	-75.343459	Juniper
1860	40.036249	-75.347111	Juniper
1706	40.036207	-75.345071	Kaido Crabapple
1272	40.03661	-75.339394	Katsura Tree
1938	40.037169	-75.345523	Katsura Tree

2221	40.0370317	-75.3426339	Katsura Tree
2740	40.035733	-75.33938	Kentucky Yellowwood
2741	40.035783	-75.339359	Kentucky Yellowwood
156	40.035878	-75.34062	Kousa Dogwood
250	40.036063	-75.340274	Kousa Dogwood
929	40.036067	-75.342961	Kousa Dogwood
933	40.036281	-75.342846	Kousa Dogwood
936	40.03619	-75.34295	Kousa Dogwood
1242	40.035707	-75.338885	Kousa Dogwood
1253	40.035708	-75.3389	Kousa Dogwood
1481	40.03642	-75.342502	Kousa Dogwood
1736	40.036252	-75.345443	Kousa Dogwood
1926	40.037162	-75.345717	Kousa Dogwood
2069	40.03754027	-75.34273586	Kousa Dogwood
2121	40.0377463	-75.34402761	Kousa Dogwood
2123	40.0378381	-75.3438686	Kousa Dogwood
2128	40.03789208	-75.34371543	Kousa Dogwood
2263	40.0368265	-75.34269184	Kousa Dogwood
2315	40.03659025	-75.34247988	Kousa Dogwood
2319	40.03654316	-75.34274836	Kousa Dogwood
2437	40.03753431	-75.34446136	Kousa Dogwood
2511	40.0363613	-75.34434716	Kousa Dogwood
2526	40.0361812	-75.34362881	Kousa Dogwood
2527	40.03615136	-75.34354745	Kousa Dogwood
2533	40.03620748	-75.34344913	Kousa Dogwood
2742	40.035484	-75.339091	Kousa Dogwood
2743	40.03549	-75.339133	Kousa Dogwood
2744	40.035517	-75.339093	Kousa Dogwood
2745	40.035359	-75.338763	Kousa Dogwood
2746	40.035265	-75.338573	Kousa Dogwood
2747	40.034725	-75.339012	Kunth's Maiden Fern
1232	40.035716	-75.338508	Lacebark Pine
1235	40.035675	-75.338745	Lacebark Pine
1726	40.035559	-75.344542	Ladies Thumb
581	40.035991	-75.341632	Lambs Ear
594	40.035997	-75.341793	Lambs Ear
2542	40.03576468	-75.34304381	Lanceleaf Tickseed
165	40.036277	-75.340484	Large White Petunia
1635	40.036528	-75.339173	Lateflowering Thoroughwort
2748	40.034331	-75.338442	Laurustinus
2749	40.034368	-75.338378	Laurustinus

2750	40.034883	-75.337951	Laurustinus
2751	40.035051	-75.338126	Laurustinus
2752	40.034807	-75.337898	Laurustinus
2753	40.03457	-75.33797	Laurustinus
2754	40.034667	-75.337839	Laurustinus
370	40.034988	-75.340991	Leatherleaf Arrowwood
1013	40.036644	-75.341368	Leatherleaf Arrowwood
1014	40.036663	-75.341318	Leatherleaf Arrowwood
1015	40.036621	-75.341305	Leatherleaf Arrowwood
1081	40.035576	-75.337288	Leatherleaf Arrowwood
1564	40.037665	-75.341382	Leatherleaf Arrowwood
2337	40.03621606	-75.34316008	Leatherleaf Arrowwood
2342	40.0362634	-75.34319301	Leatherleaf Arrowwood
2354	40.03637565	-75.34320066	Leatherleaf Arrowwood
2357	40.03643718	-75.34322943	Leatherleaf Arrowwood
2360	40.03656498	-75.3432187	Leatherleaf Arrowwood
2362	40.0366547	-75.34324918	Leatherleaf Arrowwood
2367	40.0366739	-75.34334731	Leatherleaf Arrowwood
2391	40.0367808	-75.34384663	Leatherleaf Arrowwood
2394	40.03681675	-75.34395071	Leatherleaf Arrowwood
2512	40.03636291	-75.34433021	Leatherleaf Arrowwood
2524	40.0362468	-75.34365476	Leatherleaf Arrowwood
2589	40.03646671	-75.34312085	Leatherleaf Arrowwood
583	40.035907	-75.341694	Leatherleaf Mahonia
590	40.035945	-75.341805	Leatherleaf Mahonia
637	40.035775	-75.341478	Leatherleaf Mahonia
938	40.036148	-75.342702	Leatherleaf Mahonia
947	40.036121	-75.342532	Leatherleaf Mahonia
1576	40.037828	-75.341608	Leatherleaf Mahonia
2350	40.03627728	-75.34328631	Leatherleaf Mahonia
2755	40.03521	-75.338416	Leatherleaf Mahonia
36	40.035275	-75.339519	Lily Magnolia
47	40.035191	-75.339638	Lily Magnolia
200	40.036225	-75.34033	Lily Magnolia
829	40.034752	-75.337383	Lily Magnolia
918	40.03602	-75.342877	Lily Magnolia
927	40.036137	-75.342961	Lily Magnolia
1131	40.035218	-75.3379	Lily Magnolia
1139	40.03521	-75.338025	Lily Magnolia
1140	40.035236	-75.337882	Lily Magnolia
1158	40.035478	-75.33861	Lily Magnolia

1540	40.037466	-75.341627	Lily Magnolia
1861	40.036513	-75.347087	Lily Magnolia
2222	40.03712481	-75.34259148	Lily Magnolia
2351	40.03628941	-75.34331026	Lily Magnolia
2483	40.036672	-75.34505856	Lily Magnolia
2494	40.03658416	-75.34468701	Lily Magnolia
2756	40.034573	-75.337721	Lily Magnolia
2230	40.03698685	-75.34211425	Lily Magnolia (Possible Handkerchief Tree)
945	40.036123	-75.342565	Lily of the Valley
2439	40.03754	-75.34448065	Lily of the Valley
2441	40.03744351	-75.34464066	Limber Pine
2443	40.0373197	-75.34458336	Limber Pine
1150	40.035447	-75.338405	Linden Arrowood
2757	40.035291	-75.338472	Linden Arrowood
810	40.034748	-75.337323	Lingonberry
2573	40.03612945	-75.34143151	Little Bittercress
2023	40.03826133	-75.34224141	Little Bluestem
2028	40.03836471	-75.3424332	Little Bluestem
2202	40.0371277	-75.34224075	Loebner Magnolia
1199	40.03584	-75.33816	London Planetree
1210	40.035935	-75.338308	London Planetree
1434	40.037422	-75.341304	Longwood Blue
1493	40.036237	-75.342367	Longwood Blue
2758	40.03521	-75.338416	Lovage
2759	40.035572	-75.339264	Lovage
762	40.034966	-75.336935	Maple (sprout)
733	40.035464	-75.339038	Martagon Lily
1143	40.035267	-75.338035	Martagon Lily
2473	40.03678541	-75.34531074	Meadow Sage
917	40.036015	-75.342793	Mexican Orange Blossom
234	40.036034	-75.340197	Milkweed
650	40.035706	-75.341603	Milkweed
1032	40.036687	-75.341274	Milkweed
1958	40.037283	-75.345398	Milkweed
978	40.036281	-75.341479	Mimosa
886	40.036111	-75.342224	Miniature Rose (Tea Rose)
887	40.036094	-75.342059	Miniature Rose (Tea Rose)
895	40.036016	-75.342312	Miniature Rose (Tea Rose)
1106	40.03543	-75.3382	Miniature Rose (Tea Rose)
1974	40.037584	-75.344974	Miniature Rose (Tea Rose)
1977	40.037671	-75.345104	Miniature Rose (Tea Rose)

2333	40.03607267	-75.34307653	Miniature Rose (Tea Rose)
275	40.035444	-75.343424	Mission Grass
278	40.03553	-75.343475	Mission Grass
291	40.03561	-75.343457	Mission Grass
1526	40.037082	-75.341808	Mock Orange
1027	40.036722	-75.341164	Mountain Laurel
2422	40.03760503	-75.34459318	Mountain Laurel
74	40.035572	-75.339967	Mountain Witch Alder
117	40.035449	-75.340355	Mountain Witch Alder
192	40.035218	-75.340522	Mountain Witch Alder
215	40.03589	-75.339628	Mountain Witch Alder
387	40.035008	-75.340065	Mountain Witch Alder
389	40.034983	-75.340169	Mountain Witch Alder
516	40.035187	-75.340434	Mountain Witch Alder
519	40.03511	-75.340351	Mountain Witch Alder
545	40.035728	-75.341304	Mountain Witch Alder
549	40.03579	-75.34134	Mountain Witch Alder
911	40.035986	-75.342698	Mountain Witch Alder
921	40.036052	-75.342903	Mountain Witch Alder
926	40.036053	-75.342983	Mountain Witch Alder
976	40.036322	-75.341473	Mountain Witch Alder
1020	40.036675	-75.341098	Mountain Witch Alder
1128	40.035188	-75.33788	Mountain Witch Alder
1248	40.035726	-75.339092	Mountain Witch Alder
1438	40.037532	-75.341232	Mountain Witch Alder
1443	40.03765	-75.341213	Mountain Witch Alder
1454	40.037522	-75.341323	Mountain Witch Alder
1475	40.036669	-75.342438	Mountain Witch Alder
1486	40.036463	-75.342363	Mountain Witch Alder
1489	40.036275	-75.342351	Mountain Witch Alder
1505	40.036334	-75.342753	Mountain Witch Alder
1535	40.03717	-75.341787	Mountain Witch Alder
1551	40.03756	-75.341423	Mountain Witch Alder
2291	40.03673298	-75.34267728	Mountain Witch Alder
2299	40.03668101	-75.34245656	Mountain Witch Alder
2303	40.0365963	-75.34238325	Mountain Witch Alder
2307	40.03662468	-75.34232067	Mountain Witch Alder
2345	40.03624945	-75.34323558	Mountain Witch Alder
2471	40.03680314	-75.34531553	Mountain Witch Alder
2560	40.03609285	-75.34155228	Mountain Witch Alder
2760	40.035186	-75.338305	Mountain Witch Alder

2761	40.034154	-75.338889	Mountain Witch Alder
2762	40.035633	-75.339263	Mountain Witch Alder
2763	40.035639	-75.33945	Mountain Witch Alder
2764	40.035439	-75.338877	Mountain Witch Alder
412	40.035322	-75.343403	Mugwort
429	40.03514	-75.343351	Mugwort
1046	40.036615	-75.340968	Mulberry
1160	40.035492	-75.338626	Mulberry
1187	40.035662	-75.338419	Mulberry (sprout)
144	40.035253	-75.340548	Mulberry Weed
438	40.035286	-75.343285	Mulberry Weed
445	40.035448	-75.343157	Mulberry Weed
405	40.035122	-75.343424	Muscadine
28	40.034907	-75.339124	Needle Stonecrop
32	40.035073	-75.339049	Needle Stonecrop
1730	40.03535	-75.344431	Nepalese Browntop
1602	40.036687	-75.339211	New England Aster
1610	40.036612	-75.33921	New England Aster
1621	40.036519	-75.339194	New England Aster
2162	40.03813094	-75.34403494	New England Aster
2182	40.0380589	-75.34423865	New England Aster
2602	40.03699781	-75.34408361	New Jersey Tea
2609	40.03695561	-75.34427995	New Jersey Tea
2612	40.03709625	-75.3444041	New Jersey Tea
1601	40.036553	-75.339176	New York Aster
1611	40.036635	-75.339191	New York Aster
1620	40.036493	-75.339218	New York Aster
1630	40.036498	-75.339413	New York Aster
2148	40.038244	-75.34380698	New York Aster
2175	40.03807763	-75.34416348	New York Aster
2180	40.03804805	-75.34423106	New York Aster
2228	40.03699438	-75.34215802	New York Aster
508	40.034874	-75.341184	Niger
819	40.034769	-75.337307	Nightshade
850	40.034972	-75.337494	Nightshade
770	40.034945	-75.337056	Nimblewill
1850	40.036006	-75.347095	Northern Bush Honeysuckle
453	40.035143	-75.343127	Northern Red Oak
454	40.035246	-75.343098	Northern Red Oak
457	40.035497	-75.343013	Northern Red Oak
458	40.035584	-75.342996	Northern Red Oak

697	40.035589	-75.342801	Northern Red Oak
698	40.035244	-75.342916	Northern Red Oak
699	40.035459	-75.342856	Northern Red Oak
700	40.035404	-75.342862	Northern Red Oak
701	40.035341	-75.342868	Northern Red Oak
702	40.035136	-75.342934	Northern Red Oak
2558	40.03614211	-75.34159291	Northern Spicebush
2582	40.03616366	-75.34135323	Northern Spicebush
99	40.035317	-75.340221	Northern White Cedar
125	40.035432	-75.340536	Northern White Cedar
126	40.035405	-75.340557	Northern White Cedar
127	40.03538	-75.340569	Northern White Cedar
128	40.035351	-75.340586	Northern White Cedar
129	40.035316	-75.340558	Northern White Cedar
130	40.035292	-75.340573	Northern White Cedar
131	40.03526	-75.340594	Northern White Cedar
132	40.035286	-75.340608	Northern White Cedar
133	40.035295	-75.340595	Northern White Cedar
1005	40.0368	-75.342031	Norway Maple
1468	40.036893	-75.342138	Norway Maple
1479	40.03679	-75.342485	Norway Maple
2007	40.03862794	-75.34263454	Norway Maple
2011	40.03864264	-75.34264939	Norway Maple
2012	40.03865626	-75.34267155	Norway Maple
2013	40.03868187	-75.34269001	Norway Maple
2014	40.03867814	-75.34273331	Norway Maple
2192	40.03779696	-75.34470363	Norway Maple
2193	40.03771771	-75.34485315	Norway Maple
903	40.035901	-75.342544	Norway Spruce
904	40.035917	-75.342574	Norway Spruce
905	40.035932	-75.342624	Norway Spruce
1411	40.037179	-75.34144	Norway Spruce
1770	40.035621	-75.346024	Norway Spruce
1792	40.035814	-75.346692	Norway Spruce
1814	40.035812	-75.347507	Norway Spruce
1867	40.036842	-75.346926	Norway Spruce
2270	40.03666425	-75.3429473	Norway Spruce
794	40.035151	-75.337408	Nutgrass
835	40.034791	-75.337473	Nutgrass
1051	40.036488	-75.340952	Nutgrass
1063	40.036762	-75.340743	Nutgrass

2430	40.03763768	-75.34483481	Nutgrass
2431	40.03628733	-75.34322263	Nutgrass
2615	40.03740082	-75.34160851	Nutgrass
43	40.034436	-75.339123	Oak
104	40.035364	-75.340212	Oakleaf Hydrangea
145	40.035404	-75.340404	Oakleaf Hydrangea
154	40.035897	-75.34061	Oakleaf Hydrangea
171	40.036098	-75.340353	Oakleaf Hydrangea
178	40.036142	-75.340457	Oakleaf Hydrangea
249	40.03605	-75.340256	Oakleaf Hydrangea
647	40.035765	-75.341606	Oakleaf Hydrangea
654	40.035787	-75.341668	Oakleaf Hydrangea
661	40.035815	-75.341788	Oakleaf Hydrangea
1466	40.037641	-75.341371	Oakleaf Hydrangea
1478	40.036803	-75.342448	Oakleaf Hydrangea
1490	40.036316	-75.342349	Oakleaf Hydrangea
1499	40.036224	-75.342528	Oakleaf Hydrangea
1508	40.036396	-75.342882	Oakleaf Hydrangea
1563	40.037604	-75.341526	Oakleaf Hydrangea
1568	40.037742	-75.341421	Oakleaf Hydrangea
1640	40.038564	-75.342528	Oakleaf Hydrangea
2061	40.03757936	-75.34250378	Oakleaf Hydrangea
2089	40.03706056	-75.34409266	Oakleaf Hydrangea
2111	40.03763621	-75.34421713	Oakleaf Hydrangea
2114	40.0377175	-75.34419306	Oakleaf Hydrangea
2117	40.0377253	-75.34414418	Oakleaf Hydrangea
2125	40.0378544	-75.34383335	Oakleaf Hydrangea
2149	40.03818724	-75.34392268	Oakleaf Hydrangea
2167	40.03810945	-75.34403176	Oakleaf Hydrangea
2173	40.03806791	-75.34418678	Oakleaf Hydrangea
2183	40.03806091	-75.3442266	Oakleaf Hydrangea
2188	40.0379917	-75.34433631	Oakleaf Hydrangea
2218	40.03725771	-75.34254641	Oakleaf Hydrangea
2245	40.03689844	-75.34254761	Oakleaf Hydrangea
2267	40.03671091	-75.34280738	Oakleaf Hydrangea
2284	40.03666996	-75.3427647	Oakleaf Hydrangea
2765	40.034261	-75.339105	Oakleaf Hydrangea
2766	40.034287	-75.339048	Oakleaf Hydrangea
2767	40.034456	-75.338767	Oakleaf Hydrangea
2768	40.034639	-75.338567	Oakleaf Hydrangea
2769	40.034774	-75.338456	Oakleaf Hydrangea

2770	40.034667	-75.337839	Oakleaf Hydrangea
2429	40.03763351	-75.34445821	Obedient Plant
2499	40.03657308	-75.34449553	Obedient Plant
2500	40.03657308	-75.34449553	Obedient Plant
1120	40.035544	-75.338112	Okome Cherry
1121	40.035524	-75.338136	Okome Cherry
1122	40.035465	-75.338197	Okome Cherry
1123	40.035424	-75.338196	Okome Cherry
1124	40.035396	-75.338182	Okome Cherry
2233	40.03699042	-75.34208617	Old Fashioned Weigela
1599	40.036871	-75.339187	Oliander
1666	40.038411	-75.343447	Oliander
1892	40.03679	-75.346393	Oliander
2541	40.03575714	-75.34305699	Oliander
339	40.034155	-75.339849	Orange Daylily
357	40.034313	-75.340293	Orange Daylily
2771	40.034134	-75.338967	Orange Daylily
2772	40.035633	-75.339263	Oregon Ash
1022	40.03663	-75.341144	Oregon ash (sprout)
1061	40.036712	-75.340686	Oregon ash (sprout)
645	40.035741	-75.341605	Oriental Bittersweet
1925	40.037132	-75.345898	Pagoda Dogwood
1927	40.037066	-75.345794	Pagoda Dogwood
1928	40.037066	-75.345716	Pagoda Dogwood
1929	40.037014	-75.345646	Pagoda Dogwood
1931	40.036972	-75.345879	Pagoda Dogwood
1932	40.036842	-75.345626	Pagoda Dogwood
1933	40.036831	-75.345555	Pagoda Dogwood
1934	40.036789	-75.345571	Pagoda Dogwood
2460	40.0372312	-75.34509811	Pagoda Dogwood
766	40.034915	-75.337036	Pakeweed
2579	40.03612905	-75.34141551	Pale Persicaria
1583	40.037324	-75.340004	Pampas Grass
26	40.034939	-75.339143	Panicle Hydranga
33	40.035067	-75.339056	Panicle Hydranga
148	40.035712	-75.340539	Panicle Hydranga
548	40.035635	-75.341448	Panicle Hydranga
864	40.035043	-75.337486	Panicle Hydranga
1078	40.035341	-75.337525	Panicle Hydranga
1244	40.035724	-75.339041	Panicle Hydranga
2095	40.0372283	-75.34424598	Panicle Hydranga

2219	40.03725885	-75.34256181	Panicle Hydranga
2229	40.03700775	-75.34213661	Panicle Hydranga
2341	40.03626645	-75.3431808	Panicle Hydranga
2353	40.03635055	-75.34321208	Panicle Hydranga
2356	40.03640745	-75.34324643	Panicle Hydranga
2359	40.0365695	-75.34323403	Panicle Hydranga
2364	40.03664871	-75.34331555	Panicle Hydranga
2393	40.03677658	-75.34386708	Panicle Hydranga
2395	40.03685573	-75.34402411	Panicle Hydranga
2603	40.0370138	-75.34405076	Panicle Hydranga
580	40.035952	-75.341577	Paperbark Maple
586	40.036	-75.341858	Paperbark Maple
1808	40.036418	-75.346308	Paperbark Maple
2331	40.03642947	-75.34308378	Paperbark Maple
2332	40.03656759	-75.34301783	Paperbark Maple
430	40.035234	-75.343445	Partridge Pea
1188	40.035743	-75.338091	Partridge Pea
1201	40.035801	-75.338107	Partridge Pea
1206	40.035892	-75.337963	Partridge Pea
2423	40.0376165	-75.34453691	Pawpaw
2462	40.03717713	-75.34520673	Pawpaw
2584	40.0362252	-75.34139085	Pawpaw
2773	40.03457	-75.33797	Pepperweed
2774	40.034667	-75.337839	Pepperweed
1245	40.035742	-75.339059	Perennial Salvia
1279	40.03645	-75.339585	Perennial Salvia
151	40.035727	-75.340543	Petunia
164	40.0363	-75.340514	Petunia
301	40.033848	-75.339201	Petunia
1113	40.035657	-75.337946	Petunia
1195	40.035742	-75.338059	Petunia
1744	40.036381	-75.345763	Pignut Hickory
1778	40.035684	-75.346809	Pignut Hickory
2268	40.0366294	-75.3428704	Pignut Hickory
322	40.034014	-75.33956	Pigweed
341	40.034291	-75.340226	Pigweed
354	40.034345	-75.340347	Pigweed
395	40.035329	-75.34342	Pigweed
502	40.035021	-75.341064	Pigweed
721	40.034556	-75.341063	Pigweed
724	40.034664	-75.341525	Pigweed

730	40.034719	-75.341618	Pigweed
787	40.035192	-75.337378	Pigweed
822	40.034774	-75.337269	Pigweed
842	40.034839	-75.337561	Pigweed
1059	40.036746	-75.340779	Pigweed
1166	40.035608	-75.338802	Pigweed
1512	40.035079	-75.341122	Pigweed
1622	40.036521	-75.339259	Pigweed
1632	40.03649	-75.339394	Pigweed
751	40.034985	-75.336753	Pin Oak
759	40.034912	-75.336887	Pin Oak
878	40.035869	-75.34278	Pin Oak
952	40.036155	-75.342468	Pin Oak
1812	40.035733	-75.347337	Pin Oak
868	40.035029	-75.337475	Pink Evening Primrose
1997	40.037321	-75.345761	Plant on the corner that I didn't get to ID near ceer
2436	40.0375413	-75.3444767	Plantain Lily
2469	40.03685658	-75.34535148	Plantain Lily
2505	40.03654335	-75.34438635	Plantain Lily
2509	40.03646806	-75.34440156	Plantain Lily
2775	40.035633	-75.339263	Poison Sumac
754	40.035061	-75.336661	Pokeweed
789	40.035141	-75.33741	Pokeweed
2776	40.035439	-75.338877	Pokeweed
1598	40.036916	-75.339318	Pompano Grass
439	40.035291	-75.343293	Poorjoe
83	40.035616	-75.34008	Porcelain Berry
181	40.036069	-75.340407	Porcelain Berry
183	40.036019	-75.340279	Porcelain Berry
189	40.036032	-75.340303	Porcelain Berry
510	40.034846	-75.341181	Porcelain Berry
528	40.035075	-75.34023	Porcelain Berry
531	40.035506	-75.341548	Porcelain Berry
554	40.035832	-75.34138	Porcelain Berry
563	40.035848	-75.341371	Porcelain Berry
570	40.03592	-75.3415	Porcelain Berry
584	40.035939	-75.341625	Porcelain Berry
600	40.035944	-75.341878	Porcelain Berry
617	40.035472	-75.34172	Porcelain Berry
635	40.035757	-75.341415	Porcelain Berry
646	40.035717	-75.341572	Porcelain Berry

714	40.034924	-75.342816	Porcelain Berry
753	40.035056	-75.336641	Porcelain Berry
773	40.034961	-75.337066	Porcelain Berry
820	40.034761	-75.337295	Porcelain Berry
833	40.034752	-75.337463	Porcelain Berry
930	40.036152	-75.342911	Porcelain Berry
941	40.036099	-75.342617	Porcelain Berry
1012	40.03667	-75.341371	Porcelain Berry
1017	40.036626	-75.34132	Porcelain Berry
1029	40.03677	-75.341173	Porcelain Berry
1045	40.036601	-75.340967	Porcelain Berry
1050	40.036504	-75.341012	Porcelain Berry
1076	40.035329	-75.337548	Porcelain Berry
1090	40.03552	-75.337624	Porcelain Berry
1110	40.035474	-75.338185	Porcelain Berry
1116	40.035511	-75.338036	Porcelain Berry
1129	40.03514	-75.337935	Porcelain Berry
1169	40.035633	-75.338927	Porcelain Berry
1207	40.035922	-75.337953	Porcelain Berry
1213	40.03592	-75.338314	Porcelain Berry
1219	40.03603	-75.338161	Porcelain Berry
1223	40.036116	-75.338149	Porcelain Berry
1228	40.035715	-75.337586	Porcelain Berry
1249	40.035753	-75.339109	Porcelain Berry
1303	40.035907	-75.339513	Porcelain Berry
1315	40.036315	-75.339802	Porcelain Berry
1457	40.037769	-75.341191	Porcelain Berry
1500	40.036212	-75.342539	Porcelain Berry
1587	40.037348	-75.340049	Porcelain Berry
1634	40.036512	-75.339343	Porcelain Berry
1636	40.036555	-75.339127	Porcelain Berry
2132	40.03791133	-75.34346578	Porcelain Berry
2253	40.0369225	-75.34272123	Porcelain Berry
2254	40.03692379	-75.34253745	Porcelain Berry
2476	40.03673035	-75.34530813	Porcelain Berry
2520	40.03627016	-75.34384305	Porcelain Berry
2575	40.03612898	-75.34139588	Porcelain Berry
2777	40.035056	-75.338744	Porcelain Berry
2778	40.035214	-75.339223	Porcelain Berry
2779	40.035439	-75.338877	Porcelain Berry
51	40.035454	-75.339566	Possumhaw Viburnum

68	40.035071	-75.339834	Possumhaw Viburnum
2064	40.03758726	-75.34251976	Possumhaw Viburnum
2098	40.03723126	-75.34434138	Possumhaw Viburnum
2112	40.03764125	-75.34423906	Possumhaw Viburnum
2118	40.0377252	-75.34415351	Possumhaw Viburnum
2400	40.03676078	-75.34406933	Possumhaw Viburnum
2607	40.03688241	-75.34424916	Possumhaw Viburnum
2610	40.03704716	-75.34431561	Possumhaw Viburnum
2611	40.03709965	-75.34438801	Possumhaw Viburnum
2780	40.034164	-75.3389	Possumhaw Viburnum
2781	40.035291	-75.338472	Possumhaw Viburnum
1606	40.036705	-75.339213	Prairie Fleabane
2434	40.03758545	-75.34441286	Prickly Ash
520	40.034904	-75.340195	Prickly Lettuce
780	40.035098	-75.337176	Princess Tree
871	40.035052	-75.337479	Purple Beautyberry
1591	40.037204	-75.339779	Purple Beautyberry
2146	40.038207	-75.34382485	Purple Beautyberry
2161	40.03813573	-75.34397933	Purple Beautyberry
2352	40.03637315	-75.34321503	Purple Beautyberry
2355	40.03641405	-75.34324048	Purple Beautyberry
2358	40.03655405	-75.34320543	Purple Beautyberry
2363	40.03665421	-75.34331721	Purple Beautyberry
2392	40.03680589	-75.34387103	Purple Beautyberry
2396	40.03681076	-75.34392026	Purple Beautyberry
2420	40.03756826	-75.3446055	Purple Beautyberry
2461	40.03716861	-75.34523611	Purple Beautyberry
2478	40.03673148	-75.34522315	Purple Beautyberry
1389	40.037354	-75.341117	Purple Chokeberry
1542	40.037498	-75.341609	Purple Chokeberry
1944	40.037219	-75.345575	Purple Chokeberry
1956	40.037284	-75.345348	Purple Chokeberry
191	40.035232	-75.340543	Purple Coneflower
194	40.03625	-75.34026	Purple Coneflower
273	40.035429	-75.343503	Purple Coneflower
284	40.035559	-75.343396	Purple Coneflower
385	40.034973	-75.340011	Purple Coneflower
513	40.035172	-75.340499	Purple Coneflower
523	40.035141	-75.34032	Purple Coneflower
620	40.035523	-75.341811	Purple Coneflower
642	40.035702	-75.341509	Purple Coneflower

651	40.03572	-75.341606	Purple Coneflower
667	40.035816	-75.341861	Purple Coneflower
673	40.035644	-75.341655	Purple Coneflower
677	40.035658	-75.34174	Purple Coneflower
683	40.035709	-75.341895	Purple Coneflower
685	40.035748	-75.341925	Purple Coneflower
802	40.034836	-75.337274	Purple Coneflower
834	40.0348	-75.337471	Purple Coneflower
856	40.035035	-75.337472	Purple Coneflower
1108	40.035442	-75.338147	Purple Coneflower
1192	40.03578	-75.337974	Purple Coneflower
1251	40.035752	-75.339078	Purple Coneflower
1376	40.03715	-75.340894	Purple Coneflower
1382	40.037235	-75.341048	Purple Coneflower
1519	40.036781	-75.341855	Purple Coneflower
1529	40.037071	-75.341781	Purple Coneflower
1663	40.038403	-75.343397	Purple Coneflower
1859	40.036247	-75.347115	Purple Coneflower
1890	40.036842	-75.346476	Purple Coneflower
2039	40.03817546	-75.34246488	Purple Coneflower
2160	40.03814418	-75.34398426	Purple Coneflower
2782	40.035537	-75.33907	Purple Coneflower
2783	40.03512	-75.338182	Purple Coneflower
2784	40.034153	-75.33893	Purple Coneflower
2785	40.035633	-75.339263	Purple Coneflower
2786	40.035186	-75.338305	Purple Coneflower
1058	40.036744	-75.340801	Purple Fountain Grass
1067	40.036734	-75.340471	Purple Fountain Grass
1495	40.036203	-75.342352	Purple Fountain Grass
1502	40.03624	-75.34258	Purple Fountain Grass
1662	40.038452	-75.343305	Purple Fountain Grass
1678	40.038281	-75.343213	Purple Fountain Grass
1680	40.038245	-75.343025	Purple Fountain Grass
1681	40.038419	-75.343004	Purple Fountain Grass
2407	40.03764031	-75.34476583	Purple Fountain Grass
2415	40.03762285	-75.34471901	Purple Fountain Grass
1612	40.036642	-75.339167	Purple Loosetrife
846	40.034869	-75.337541	Purple Woodsage
865	40.035024	-75.337472	Purple Woodsage
196	40.036233	-75.340245	Purplestem Aster
207	40.036345	-75.340184	Purplestem Aster

236	40.036068	-75.340103	Purplestem Aster
105	40.035339	-75.340174	Queen Anne's Lace
397	40.035345	-75.343403	Queen Anne's Lace
1656	40.038532	-75.343199	Queen Anne's Lace
1194	40.035788	-75.337991	Ragweed
939	40.03613	-75.342593	Red Azalea
1477	40.036688	-75.342437	Red Azalea
1522	40.037074	-75.341913	Red Azalea
2200	40.03711	-75.34213083	Red Azalea
2236	40.03702695	-75.34208013	Red Azalea
2248	40.0368881	-75.34262658	Red Azalea
2257	40.03688856	-75.34268308	Red Azalea
2265	40.03673233	-75.3427733	Red Azalea
2296	40.03668538	-75.34251753	Red Azalea
2298	40.0366572	-75.34247461	Red Azalea
2301	40.03658326	-75.34236673	Red Azalea
2348	40.03625538	-75.34324723	Red Azalea
2513	40.03639973	-75.34431793	Red Azalea
1752	40.035819	-75.34574	Red Chokeberry
1794	40.03596	-75.346637	Red Chokeberry
2532	40.03615726	-75.34344295	Red Chokeberry
338	40.034279	-75.340189	Red Daylily
356	40.034366	-75.340439	Red Daylily
102	40.035312	-75.340155	Red flower Ragleaf
211	40.035841	-75.33941	Red Maple
213	40.035908	-75.33958	Red Maple
218	40.035916	-75.339744	Red Maple
220	40.035952	-75.339843	Red Maple
223	40.036001	-75.339882	Red Maple
226	40.03605	-75.340007	Red Maple
227	40.035993	-75.340035	Red Maple
309	40.033974	-75.339268	Red Maple
310	40.033956	-75.339426	Red Maple
311	40.034003	-75.33935	Red Maple
344	40.034324	-75.34022	Red Maple
347	40.034379	-75.340277	Red Maple
511	40.035096	-75.340712	Red Maple
604	40.036036	-75.34154	Red Maple
609	40.03609	-75.341577	Red Maple
610	40.03615	-75.341608	Red Maple
706	40.035009	-75.342898	Red Maple

709	40.03499	-75.342747	Red Maple
711	40.034927	-75.342592	Red Maple
747	40.035044	-75.336618	Red Maple
764	40.034842	-75.337009	Red Maple
767	40.034931	-75.337015	Red Maple
935	40.036258	-75.342996	Red Maple
967	40.0364	-75.341801	Red Maple
969	40.036409	-75.341761	Red Maple
991	40.036494	-75.341773	Red Maple
1024	40.036719	-75.341092	Red Maple
1039	40.03664	-75.340997	Red Maple
1057	40.036706	-75.340808	Red Maple
1088	40.035507	-75.337646	Red Maple
1237	40.035652	-75.338796	Red Maple
1238	40.035676	-75.338836	Red Maple
1241	40.035744	-75.338885	Red Maple
1254	40.0358	-75.339012	Red Maple
1256	40.035833	-75.339016	Red Maple
1257	40.035878	-75.339041	Red Maple
1262	40.036115	-75.339002	Red Maple
1271	40.036634	-75.339082	Red Maple
1274	40.036446	-75.339395	Red Maple
1302	40.035893	-75.339536	Red Maple
1305	40.036317	-75.339678	Red Maple
1306	40.036298	-75.339741	Red Maple
1307	40.03627	-75.339806	Red Maple
1308	40.03624	-75.339865	Red Maple
1311	40.03616	-75.339938	Red Maple
1313	40.036314	-75.340007	Red Maple
1340	40.037063	-75.340731	Red Maple
1341	40.036988	-75.340754	Red Maple
1348	40.037018	-75.340568	Red Maple
1399	40.03738	-75.341327	Red Maple
1407	40.037222	-75.341369	Red Maple
1409	40.037167	-75.341348	Red Maple
1410	40.037273	-75.341422	Red Maple
1414	40.037131	-75.341453	Red Maple
1699	40.036314	-75.34453	Red Maple
1731	40.036567	-75.345271	Red Maple
1732	40.036527	-75.345145	Red Maple
1734	40.036517	-75.345007	Red Maple

1811	40.035752	-75.347125	Red Maple
1817	40.035992	-75.347526	Red Maple
2008	40.03858053	-75.34253942	Red Maple
2070	40.03768052	-75.34284309	Red Maple
2074	40.03759989	-75.34330533	Red Maple
2081	40.03736893	-75.34276628	Red Maple
2224	40.03702946	-75.34237408	Red Maple
2447	40.03741508	-75.34481006	Red Maple
2449	40.03734733	-75.34486036	Red Maple
2787	40.03416	-75.33859	Red Maple
2788	40.03443	-75.33803	Red Maple
214	40.035891	-75.339581	Red Maple (sprout)
219	40.035886	-75.339721	Red Maple (sprout)
224	40.035976	-75.339908	Red Maple (sprout)
230	40.036019	-75.340022	Red Maple (sprout)
1179	40.035595	-75.338363	Red Maple (sprout)
1202	40.035807	-75.338106	Red Maple (sprout)
956	40.036206	-75.342259	Red Oak
1685	40.038063	-75.343155	Red Oak (sprout)
624	40.035534	-75.341862	Red Turtlehead
114	40.035494	-75.340185	Redflower Ragleaf
115	40.035457	-75.340352	Redflower Ragleaf
123	40.035445	-75.34052	Redosier Dogwood
246	40.036105	-75.339684	Redroot Flatsedge
168	40.036233	-75.340439	Redshank
527	40.035071	-75.340244	Redshank
550	40.035709	-75.341353	Reeves' Meadowsweet
1217	40.036032	-75.338282	River Birch
1462	40.037779	-75.341066	River Birch
1575	40.037744	-75.341591	River Birch
2503	40.0366373	-75.34433416	River Birch
2504	40.0365686	-75.34437698	River Birch
2507	40.03649263	-75.34441676	River Birch
2568	40.03609408	-75.34153786	River Birch
2789	40.034115	-75.338763	River Birch
2790	40.034211	-75.338509	River Birch
2791	40.034271	-75.338458	River Birch
2792	40.034337	-75.338316	River Birch
2793	40.034389	-75.33813	River Birch
768	40.034938	-75.337031	River Birch (sprout)
1536	40.037162	-75.341836	Rock Harlequin

1537	40.037162	-75.341836	Rock Harlequin
1580	40.038004	-75.34141	Rocky Mountain Juniper
1278	40.036442	-75.339543	Rocky Mountain Pentstemon
177	40.036139	-75.340457	Rose Meadowsweet
1152	40.035456	-75.338508	Roughleaf Dogwood
1162	40.035536	-75.338722	Roughleaf Dogwood
1170	40.035653	-75.338986	Roughleaf Dogwood
1186	40.035677	-75.338427	Roughleaf Dogwood (sprout)
825	40.034704	-75.337439	Rougosa Rose
150	40.035731	-75.340564	Russian Sage
1877	40.036891	-75.346579	Russian Sage
2338	40.0362138	-75.3431478	Salal
2339	40.03625485	-75.34312963	Salal
2590	40.03644826	-75.34310356	Salal
2592	40.03657121	-75.34314255	Salal
979	40.036243	-75.34151	Salt Cedar
1902	40.036373	-75.346628	Salt Cedar
2077	40.03748218	-75.34288675	Saucer Magnolia
1658	40.03847	-75.343237	Sawgrass
2042	40.03789196	-75.34335211	Sawtooth Oak
2047	40.03778618	-75.34262323	Sawtooth Oak
2076	40.03745446	-75.34309055	Sawtooth Oak
2080	40.03736771	-75.34296018	Sawtooth Oak
2120	40.03760726	-75.34400983	Sawtooth Oak
2794	40.03444	-75.33796	Sawtooth Oak
2795	40.034499	-75.337865	Sawtooth Oak
2099	40.03723213	-75.34431335	Scarlet Firethorn
2093	40.03719221	-75.3442021	Scarlet Oak
2108	40.03755363	-75.34419948	Scarlet Oak
2594	40.03672691	-75.34330811	Scarlet Oak
2595	40.03675407	-75.34339878	Scarlet Oak
2596	40.036784	-75.34372151	Scarlet Oak
2597	40.03682446	-75.34380488	Scarlet Oak
872	40.035055	-75.337502	Scarlet Pimpernel
2365	40.0367305	-75.34336273	Scotch Rose
2366	40.03663026	-75.34321573	Scotch Rose
2379	40.03661436	-75.34389711	Scotch Rose
2383	40.03671185	-75.34381846	Scotch Rose
2387	40.03672252	-75.34396844	Scotch Rose
2390	40.03678941	-75.34384313	Scotch Rose
184	40.036012	-75.340286	Sensitive Fern

1398	40.037635	-75.34094	Sensitive Fern
2195	40.0370759	-75.34205183	Sensitive Fern
1684	40.038079	-75.343134	Sensitive Fern
308	40.033983	-75.339327	Sequoyah
1488	40.036431	-75.342304	Seven Suns
67	40.035088	-75.339821	Shadblow Serviceberry
77	40.035585	-75.339969	Shadblow Serviceberry
95	40.035258	-75.340115	Shadblow Serviceberry
96	40.035306	-75.340167	Shadblow Serviceberry
97	40.035307	-75.340209	Shadblow Serviceberry
138	40.035321	-75.34049	Shadblow Serviceberry
139	40.035308	-75.340524	Shadblow Serviceberry
140	40.035273	-75.340541	Shadblow Serviceberry
229	40.035942	-75.340108	Shadblow Serviceberry
658	40.035761	-75.341644	Shadblow Serviceberry
663	40.035797	-75.341858	Shadblow Serviceberry
671	40.035645	-75.341683	Shadblow Serviceberry
679	40.035659	-75.341716	Shadblow Serviceberry
682	40.035696	-75.341887	Shadblow Serviceberry
686	40.035735	-75.34192	Shadblow Serviceberry
1082	40.035544	-75.337566	Shadblow Serviceberry
1083	40.035652	-75.337562	Shadblow Serviceberry
1172	40.035613	-75.338369	Shadblow Serviceberry
1173	40.035611	-75.338332	Shadblow Serviceberry
1174	40.035646	-75.338316	Shadblow Serviceberry
1183	40.035704	-75.338322	Shadblow Serviceberry
1184	40.03572	-75.338395	Shadblow Serviceberry
1185	40.035729	-75.338432	Shadblow Serviceberry
1712	40.035998	-75.345329	Shadblow Serviceberry
1715	40.035891	-75.345512	Shadblow Serviceberry
2371	40.03646413	-75.34358195	Shadblow Serviceberry
2372	40.0365225	-75.34367343	Shadblow Serviceberry
2375	40.0364658	-75.34373641	Shadblow Serviceberry
2377	40.03646786	-75.34383603	Shadblow Serviceberry
2796	40.035572	-75.339264	Shadblow Serviceberry
2797	40.035426	-75.338964	Shadblow Serviceberry
1530	40.037064	-75.341767	Shasta Daisy
2060	40.03759295	-75.34253377	Shingle Oak
2068	40.03760076	-75.34267133	Shingle Oak
2555	40.0357699	-75.34279581	Shingle Oak
2556	40.0358553	-75.34294031	Shingle Oak

1669	40.038321	-75.343592	Shining Geranium
1534	40.037122	-75.341764	Shrubby Cinquefoil
1431	40.037416	-75.341249	Shrubby St. John's Wort
238	40.036078	-75.340151	Siberian Flag Iris
653	40.035776	-75.34164	Siberian Flag Iris
670	40.035804	-75.341999	Siberian Flag Iris
1300	40.035919	-75.339438	Siberian Flag Iris
1377	40.037164	-75.340897	Siberian Flag Iris
1383	40.037237	-75.341021	Siberian Flag Iris
1385	40.037279	-75.341144	Siberian Flag Iris
1428	40.037348	-75.341205	Siberian Flag Iris
1646	40.038659	-75.342883	Siberian Flag Iris
1660	40.03848	-75.343244	Siberian Flag Iris
2798	40.034667	-75.337839	Siberian Flag Iris
2799	40.03457	-75.33797	Siberian Flag Iris
241	40.036023	-75.340059	Silky Dogwood
1299	40.035936	-75.339351	Silky Dogwood
1881	40.03684	-75.34654	Silky Dogwood
2313	40.03663956	-75.34236793	Silky Dogwood
2557	40.03607928	-75.34153079	Silky Dogwood
2570	40.03610348	-75.34138607	Silky Dogwood
2580	40.0361156	-75.34129283	Silky Dogwood
1720	40.035421	-75.345349	Silver Birch
1565	40.0377	-75.341354	Silver Fir
1571	40.037796	-75.341684	Silver Fir
1918	40.037208	-75.346077	Silver Maple
1983	40.037533	-75.345416	Silver Maple
1988	40.037495	-75.345478	Silver Maple
1990	40.037459	-75.345577	Silver Maple
2368	40.03645535	-75.34337673	Silver Maple
836	40.034829	-75.337514	Smooth Blue Aster
855	40.035032	-75.337493	Smooth Blue Aster
1963	40.037285	-75.34538	Smooth Blue Aster
838	40.03484	-75.337501	Sneezeweed
2176	40.038076	-75.34414055	Sneezeweed
1281	40.036497	-75.339577	Solomon's Seal
1368	40.037304	-75.340569	Solomon's Seal
1393	40.037604	-75.340864	Solomon's Seal
1596	40.036969	-75.339377	Solomon's Seal
2101	40.0372463	-75.34428588	Solomon's Seal
1406	40.037119	-75.341035	Southern Bayberry

996	40.0366	-75.342109	Southern Catalpa
567	40.035925	-75.341487	Southern Magnolia
568	40.0359	-75.341446	Southern Magnolia
592	40.035996	-75.341905	Southern Magnolia
593	40.036022	-75.341939	Southern Magnolia
2800	40.03512	-75.338182	Southern Magnolia
1511	40.03512	-75.341018	Spearmint
1470	40.036778	-75.342146	Spinulose wood fern
775	40.035006	-75.337095	Spiny Sowthistle
791	40.035142	-75.337403	Spiny Sowthistle
808	40.034756	-75.337209	Spiny Sowthistle
813	40.034756	-75.337306	Spiny Sowthistle
844	40.034844	-75.337576	Spiny Sowthistle
852	40.034989	-75.337571	Spiny Sowthistle
1075	40.035273	-75.337625	Spiny Sowthistle
1224	40.036131	-75.338108	Spiny Sowthistle
1554	40.037574	-75.341421	Spiny Sowthistle
1623	40.036536	-75.339273	Spiny Sowthistle
1970	40.037388	-75.34524	Spiny Sowthistle
553	40.035833	-75.341378	Spotted Joe-Pye-weed
623	40.035452	-75.341839	Spotted Joe-Pye-weed
630	40.03575	-75.341395	Spotted Joe-Pye-weed
949	40.036118	-75.342499	Spotted Joe-Pye-weed
1141	40.03526	-75.33803	Spotted Joe-Pye-weed
1359	40.03713	-75.34055	Spotted Joe-Pye-weed
1430	40.037382	-75.341253	Spotted Joe-Pye-weed
1491	40.036286	-75.342366	Spotted Joe-Pye-weed
1498	40.036211	-75.34246	Spotted Joe-Pye-weed
1509	40.036373	-75.342881	Spotted Joe-Pye-weed
1648	40.038589	-75.343012	Spotted Joe-Pye-weed
1654	40.038554	-75.34315	Spotted Joe-Pye-weed
1873	40.036928	-75.346636	Spotted Joe-Pye-weed
1942	40.037188	-75.345581	Spotted Joe-Pye-weed
1971	40.037399	-75.34521	Spotted Joe-Pye-weed
2311	40.0364808	-75.34232563	Spotted Joe-Pye-weed
281	40.035445	-75.34342	Spotted Spurge
319	40.034096	-75.339492	Spotted Spurge
320	40.034024	-75.339512	Spotted Spurge
324	40.034077	-75.339494	Spotted Spurge
342	40.034141	-75.339818	Spotted Spurge
358	40.034408	-75.340414	Spotted Spurge

585	40.035942	-75.341624	Spotted Spurge
666	40.035812	-75.34185	Spotted Spurge
718	40.034908	-75.342602	Spotted Spurge
720	40.034411	-75.340591	Spotted Spurge
723	40.034616	-75.341244	Spotted Spurge
742	40.035146	-75.336587	Spotted Spurge
755	40.035039	-75.336741	Spotted Spurge
779	40.03515	-75.33718	Spotted Spurge
795	40.035122	-75.337437	Spotted Spurge
805	40.034761	-75.337244	Spotted Spurge
823	40.034776	-75.337272	Spotted Spurge
843	40.03484	-75.337583	Spotted Spurge
908	40.035975	-75.342601	Spotted Spurge
986	40.036152	-75.341376	Spotted Spurge
1087	40.035585	-75.337668	Spotted Spurge
1105	40.035404	-75.338182	Spotted Spurge
1176	40.035589	-75.338401	Spotted Spurge
1250	40.03575	-75.339085	Spotted Spurge
1301	40.035908	-75.339507	Spotted Spurge
1514	40.035105	-75.341293	Spotted Spurge
1721	40.035436	-75.34536	Spotted Spurge
2543	40.03579301	-75.34306148	Spotted Spurge
2562	40.03606906	-75.34155327	Spotted Spurge
2576	40.03612221	-75.34140352	Spotted Spurge
518	40.035141	-75.340441	Spreading Dogbane
9	40.034911	-75.339474	Spreading English Yew
2801	40.035056	-75.338744	Spreading English Yew
2802	40.035214	-75.339223	Spreading English Yew
2803	40.035633	-75.339263	Spreading Pellitory
632	40.035775	-75.34142	St. John's Wort
644	40.035726	-75.341455	St. John's Wort
861	40.035036	-75.337488	St. John's Wort
1096	40.035408	-75.337842	St. John's Wort
1318	40.036467	-75.340215	St. John's Wort
1326	40.036552	-75.34029	St. John's Wort
1452	40.037448	-75.341405	St. John's Wort
1894	40.036734	-75.346367	St. John's Wort
2312	40.0364809	-75.3423202	St. John's Wort
638	40.03576	-75.341457	St. John's Wort (sprout)
209	40.036221	-75.340101	Star Magnolia
345	40.034351	-75.34022	Star Magnolia

348	40.034367	-75.340306	Star Magnolia
349	40.034422	-75.340376	Star Magnolia
556	40.035842	-75.341395	Star Magnolia
559	40.035868	-75.341398	Star Magnolia
577	40.035918	-75.341602	Star Magnolia
578	40.035908	-75.341661	Star Magnolia
579	40.035938	-75.341647	Star Magnolia
588	40.035967	-75.341832	Star Magnolia
589	40.035958	-75.341831	Star Magnolia
591	40.035939	-75.341894	Star Magnolia
611	40.036106	-75.34174	Star Magnolia
639	40.035735	-75.341448	Star Magnolia
937	40.036234	-75.342768	Star Magnolia
960	40.036127	-75.341755	Star Magnolia
1070	40.035062	-75.337629	Star Magnolia
1071	40.035089	-75.33761	Star Magnolia
1130	40.035169	-75.337909	Star Magnolia
2209	40.0371443	-75.34232453	Star Magnolia
2211	40.03714571	-75.3423425	Star Magnolia
2215	40.0372023	-75.34249286	Star Magnolia
2220	40.0370785	-75.34268956	Star Magnolia
2804	40.035186	-75.338305	Star Magnolia
2805	40.035498	-75.33914	Star Magnolia
78	40.035545	-75.340029	Stiff Dogwood
336	40.034126	-75.339788	Straw-Colored Flatsedge
727	40.034708	-75.341543	Straw-Colored Flatsedge
1697	40.036444	-75.344728	Sugar Maple
1698	40.036377	-75.344626	Sugar Maple
1747	40.036324	-75.345966	Sugar Maple
1802	40.035858	-75.34618	Sugar Maple
1919	40.037236	-75.346049	Sugar Maple
1921	40.037273	-75.345913	Sugar Maple
1965	40.037165	-75.345393	Sugar Maple
1966	40.037303	-75.345256	Sugar Maple
1992	40.037408	-75.345695	Sugar Maple
2009	40.0385948	-75.34256666	Sugar Maple
2010	40.03862178	-75.34260846	Sugar Maple
2141	40.0381237	-75.34369881	Sugar Maple
2261	40.03687425	-75.34266951	Sugar Maple
2450	40.03734733	-75.34486036	Sugar Maple
180	40.036109	-75.340395	Sugar Tyme Crabapple

391	40.035591	-75.343352	Sugar Tyme Crabapple
392	40.035484	-75.343362	Sugar Tyme Crabapple
393	40.035405	-75.343382	Sugar Tyme Crabapple
398	40.035335	-75.34341	Sugar Tyme Crabapple
400	40.035232	-75.343449	Sugar Tyme Crabapple
402	40.035191	-75.343457	Sugar Tyme Crabapple
403	40.035128	-75.343415	Sugar Tyme Crabapple
406	40.0352	-75.3434	Sugar Tyme Crabapple
409	40.035303	-75.343395	Sugar Tyme Crabapple
413	40.035355	-75.343375	Sugar Tyme Crabapple
414	40.035458	-75.343351	Sugar Tyme Crabapple
416	40.03552	-75.343316	Sugar Tyme Crabapple
418	40.035558	-75.343251	Sugar Tyme Crabapple
420	40.035559	-75.343266	Sugar Tyme Crabapple
422	40.035389	-75.343296	Sugar Tyme Crabapple
424	40.035316	-75.343314	Sugar Tyme Crabapple
427	40.035227	-75.343321	Sugar Tyme Crabapple
428	40.035145	-75.343348	Sugar Tyme Crabapple
433	40.035071	-75.343389	Sugar Tyme Crabapple
434	40.035088	-75.343333	Sugar Tyme Crabapple
435	40.035175	-75.343304	Sugar Tyme Crabapple
437	40.035268	-75.343276	Sugar Tyme Crabapple
440	40.035344	-75.343253	Sugar Tyme Crabapple
441	40.035421	-75.343235	Sugar Tyme Crabapple
442	40.0355	-75.343225	Sugar Tyme Crabapple
443	40.035528	-75.34314	Sugar Tyme Crabapple
444	40.035453	-75.343163	Sugar Tyme Crabapple
446	40.035358	-75.343171	Sugar Tyme Crabapple
448	40.035273	-75.343188	Sugar Tyme Crabapple
449	40.035189	-75.343208	Sugar Tyme Crabapple
451	40.035101	-75.343243	Sugar Tyme Crabapple
452	40.035036	-75.343268	Sugar Tyme Crabapple
459	40.035628	-75.343554	Sugar Tyme Crabapple
460	40.035535	-75.343529	Sugar Tyme Crabapple
461	40.035432	-75.343537	Sugar Tyme Crabapple
462	40.035351	-75.343546	Sugar Tyme Crabapple
463	40.035268	-75.343573	Sugar Tyme Crabapple
464	40.035183	-75.343582	Sugar Tyme Crabapple
465	40.035136	-75.343655	Sugar Tyme Crabapple
466	40.035212	-75.343636	Sugar Tyme Crabapple
467	40.035312	-75.343626	Sugar Tyme Crabapple

468	40.035404	-75.343617	Sugar Tyme Crabapple
471	40.035491	-75.3436	Sugar Tyme Crabapple
472	40.035572	-75.343571	Sugar Tyme Crabapple
473	40.035607	-75.343619	Sugar Tyme Crabapple
474	40.035547	-75.343614	Sugar Tyme Crabapple
475	40.03546	-75.343616	Sugar Tyme Crabapple
476	40.035372	-75.343649	Sugar Tyme Crabapple
477	40.035297	-75.34367	Sugar Tyme Crabapple
478	40.035211	-75.343696	Sugar Tyme Crabapple
479	40.035133	-75.343716	Sugar Tyme Crabapple
480	40.035175	-75.343756	Sugar Tyme Crabapple
481	40.035262	-75.343746	Sugar Tyme Crabapple
482	40.035323	-75.343697	Sugar Tyme Crabapple
484	40.035413	-75.343676	Sugar Tyme Crabapple
485	40.03551	-75.343656	Sugar Tyme Crabapple
486	40.035592	-75.343637	Sugar Tyme Crabapple
487	40.035625	-75.343676	Sugar Tyme Crabapple
488	40.035539	-75.343701	Sugar Tyme Crabapple
489	40.035484	-75.343738	Sugar Tyme Crabapple
491	40.035304	-75.34376	Sugar Tyme Crabapple
492	40.035196	-75.343783	Sugar Tyme Crabapple
493	40.035137	-75.34382	Sugar Tyme Crabapple
616	40.035455	-75.341735	Sugar Tyme Crabapple
625	40.035504	-75.341934	Sugar Tyme Crabapple
627	40.035629	-75.341878	Sugar Tyme Crabapple
628	40.035592	-75.341748	Sugar Tyme Crabapple
27	40.034936	-75.339176	Summer Lilac
34	40.03506	-75.339032	Summer Lilac
71	40.035384	-75.339776	Summer Lilac
1676	40.03817	-75.343422	Summer Ragwort
999	40.036642	-75.341946	Swamp Chestnut Oak
626	40.035497	-75.341983	Swamp White Oak
1588	40.037355	-75.340045	Swamp White Oak
1592	40.03718	-75.33973	Swamp White Oak
1772	40.03582	-75.346036	Swamp White Oak
2084	40.03712145	-75.34297031	Swamp White Oak
2092	40.03712706	-75.34413836	Swamp White Oak
2599	40.03697971	-75.34392928	Swamp White Oak
2600	40.03704196	-75.34410046	Swamp White Oak
2806	40.034868	-75.338556	Swamp White Oak
1985	40.037478	-75.345368	Sweet Azalea

515	40.035191	-75.340424	Sweet Bay
1054	40.036684	-75.340671	Sweet Bay
56	40.035386	-75.339704	Sweet Box
80	40.035605	-75.34008	Sweet Box
602	40.035922	-75.341858	Sweet Box
648	40.035757	-75.341622	Sweet Box
655	40.035793	-75.341696	Sweet Box
660	40.035815	-75.341835	Sweet Box
669	40.035808	-75.341972	Sweet Box
906	40.035935	-75.342612	Sweet Box
910	40.035943	-75.342654	Sweet Box
2103	40.0372977	-75.34428386	Sweet Box
2282	40.03662498	-75.34272591	Sweet Box
2290	40.03670626	-75.34268486	Sweet Box
533	40.035582	-75.341419	Sweet Joe-Pye-weed
390	40.0351	-75.340335	Sweet osmanthus
796	40.035193	-75.337452	Sweet Violet
560	40.035892	-75.341395	Sweetbay Magnolia
1101	40.035356	-75.338033	Sweetbay Magnolia
1103	40.035409	-75.338123	Sweetbay Magnolia
1109	40.035481	-75.338133	Sweetbay Magnolia
1115	40.035627	-75.33809	Sweetbay Magnolia
1672	40.03821	-75.343718	Sweetbay Magnolia
2043	40.03786536	-75.34325331	Sweetbay Magnolia
2046	40.03783343	-75.34280598	Sweetbay Magnolia
2807	40.03521	-75.338416	Switch Ivy
1577	40.038096	-75.341548	Switchgrass
2038	40.03824156	-75.34249373	Switchgrass
206	40.03636	-75.340186	Tassel Tree (White Fringetree)
521	40.035075	-75.340165	Tassel Tree (White Fringetree)
1230	40.035714	-75.337654	Tassel Tree (White Fringetree)
2055	40.03765716	-75.3419619	Tassel Tree (White Fringetree)
2056	40.03764771	-75.3419249	Tassel Tree (White Fringetree)
2067	40.03750051	-75.34269108	Tassel Tree (White Fringetree)
2428	40.03759836	-75.34447731	Tassel Tree (White Fringetree)
2492	40.03653696	-75.34469711	Tassel Tree (White Fringetree)
934	40.03624	-75.343009	tea
29	40.034971	-75.339189	Thornless Honey Locust
30	40.034931	-75.339104	Thornless Honey Locust
31	40.035057	-75.339019	Thornless Honey Locust
35	40.035088	-75.339095	Thornless Honey Locust

63	40.035348	-75.339786	Thornless Honey Locust
64	40.035397	-75.339815	Thornless Honey Locust
65	40.035425	-75.339877	Thornless Honey Locust
87	40.03545	-75.339968	Thornless Honey Locust
88	40.035482	-75.340016	Thornless Honey Locust
89	40.035502	-75.340073	Thornless Honey Locust
90	40.035528	-75.34006	Thornless Honey Locust
91	40.035524	-75.33999	Thornless Honey Locust
92	40.03538	-75.340031	Thornless Honey Locust
93	40.035406	-75.340117	Thornless Honey Locust
259	40.036333	-75.340967	Thornless Honey Locust
267	40.035658	-75.341048	Thornless Honey Locust
268	40.035639	-75.340924	Thornless Honey Locust
269	40.035634	-75.340878	Thornless Honey Locust
546	40.035788	-75.341273	Thornless Honey Locust
547	40.035733	-75.341222	Thornless Honey Locust
606	40.035996	-75.341273	Thornless Honey Locust
607	40.036056	-75.341394	Thornless Honey Locust
608	40.036113	-75.341441	Thornless Honey Locust
1004	40.036731	-75.342053	Thornless Honey Locust
1707	40.036199	-75.345139	Thornless Honey Locust
1713	40.035984	-75.345357	Thornless Honey Locust
1735	40.036307	-75.345208	Thornless Honey Locust
1775	40.035676	-75.346324	Thornless Honey Locust
959	40.036203	-75.34208	Thornless Honey Locust
167	40.036203	-75.34042	Thornless Honey Locust (sprout)
252	40.036135	-75.340712	Thornless Honey Locust (sprout)
257	40.036264	-75.340736	Thornless Honey Locust (sprout)
260	40.036294	-75.340956	Thornless Honey Locust (sprout)
263	40.036275	-75.341088	Thornless Honey Locust (sprout)
265	40.036208	-75.341146	Thornless Honey Locust (sprout)
551	40.035708	-75.341261	Thornless Honey Locust (sprout)
432	40.035194	-75.343392	Threeseed Mercury
436	40.035186	-75.343295	Threeseed Mercury
450	40.035178	-75.343199	Threeseed Mercury
676	40.035652	-75.341713	Threeseed Mercury
890	40.035951	-75.342086	Threeseed Mercury
1030	40.036758	-75.341226	Threeseed Mercury
1216	40.035893	-75.338293	Threeseed Mercury
1728	40.03553	-75.344461	Threeseed Mercury
2808	40.034725	-75.339012	Threeseed Mercury

574	40.035874	-75.341564	Tibetan Hellebore
603	40.035986	-75.341875	Tibetan Hellebore
2207	40.03715249	-75.34229436	Tibetan Hellebore
1650	40.038587	-75.343064	Tiger Lily
1675	40.038197	-75.343611	Tiger Lily
2809	40.035439	-75.338877	Tiger Lily
2810	40.035463	-75.339036	Tiger Lily
866	40.035032	-75.337463	Tiny Vetch
86	40.035367	-75.339743	Tree of Heaven
557	40.035808	-75.341411	Tree of Heaven
587	40.035987	-75.34185	Tree of Heaven
951	40.036136	-75.342505	Tree of Heaven
2811	40.035214	-75.339223	Tree of Heaven
2812	40.035056	-75.338744	Tree of Heaven
380	40.034935	-75.340788	Tree of Life
703	40.035569	-75.342574	Tricolor Beech
2813	40.034375	-75.338873	Tsutsusi Azalia
364	40.034662	-75.340172	Tufted Knotweed
365	40.034619	-75.340688	Tufted Knotweed
504	40.034839	-75.341105	Tufted Knotweed
958	40.036288	-75.342225	Tulip Poplar
993	40.036406	-75.341909	Tulip Poplar
1001	40.036704	-75.341788	Tulip Poplar
1006	40.036798	-75.341956	Tulip Poplar
1007	40.036746	-75.341866	Tulip Poplar
2814	40.03457	-75.33797	Tulip Poplar
1952	40.037195	-75.345535	Tumblemustard
160	40.035846	-75.340633	Unknown Grass 1
1524	40.037097	-75.34189	Viburnum
1538	40.037195	-75.341773	Villous Lilac
1545	40.037586	-75.341526	Villous Lilac
1558	40.037617	-75.341448	Villous Lilac
1581	40.037693	-75.340771	Villous Lilac
2100	40.03731985	-75.3443688	Villous Lilac
2135	40.03793016	-75.34363938	Villous Lilac
2432	40.03761876	-75.34444638	Villous Lilac
2591	40.03649181	-75.34315671	Villous Lilac
2815	40.034456	-75.338767	Villous Lilac
142	40.035264	-75.340554	Virgina Creeper
404	40.035119	-75.343422	Virgina Three Seed Mercury
173	40.036069	-75.340465	Virginia Anemone

187	40.036026	-75.340298	Virginia Anemone
2540	40.03574026	-75.34317553	Virginia Anemone
2544	40.03569962	-75.34317123	Virginia Anemone
2816	40.035347	-75.33864	Virginia Anemone
176	40.036077	-75.340426	Virginia Creeper
195	40.03624	-75.340249	Virginia Creeper
285	40.035577	-75.343392	Virginia Creeper
814	40.03478	-75.337347	Virginia Sweetspire
1102	40.035411	-75.338125	Virginia Sweetspire
1214	40.035907	-75.338298	Virginia Sweetspire
1226	40.035722	-75.337531	Virginia Sweetspire
1354	40.037301	-75.340685	Virginia Sweetspire
1372	40.037114	-75.340618	Virginia Sweetspire
1373	40.037146	-75.340802	Virginia Sweetspire
1386	40.037307	-75.341132	Virginia Sweetspire
1402	40.037133	-75.341109	Virginia Sweetspire
1432	40.037391	-75.341264	Virginia Sweetspire
1440	40.037597	-75.341212	Virginia Sweetspire
1445	40.037538	-75.341286	Virginia Sweetspire
1546	40.037602	-75.34153	Virginia Sweetspire
1574	40.037732	-75.341584	Virginia Sweetspire
1884	40.03684	-75.346536	Virginia Sweetspire
1943	40.037173	-75.345611	Virginia Sweetspire
2032	40.03808747	-75.34243368	Virginia Sweetspire
2344	40.03626047	-75.34321333	Virginia Sweetspire
2567	40.03611325	-75.34141137	Virginia Sweetspire
2817	40.035291	-75.338472	Virginia Sweetspire
2818	40.035439	-75.338877	Virginia Sweetspire
2819	40.034725	-75.339012	Virginia Sweetspire
605	40.036039	-75.341438	Water Fir
1801	40.035904	-75.346374	Water Fir
107	40.035216	-75.340082	Water Fir (sprout)
134	40.035307	-75.340518	Water Fir (sprout)
636	40.035763	-75.341453	Water Fir (sprout)
656	40.035782	-75.341694	Wax Begonia
659	40.035784	-75.341783	Wax Begonia
826	40.034723	-75.337403	Wax Begonia
1419	40.03691	-75.341745	Wax Begonia
1421	40.037037	-75.341648	Wax Begonia
1423	40.036954	-75.341536	Wax Begonia
1425	40.036945	-75.341444	Wax Begonia

1427	40.037046	-75.341356	Wax Begonia
1670	40.0383	-75.343559	Wax Begonia
1853	40.036052	-75.347139	Wax Begonia
1975	40.037573	-75.344931	Wax Begonia
1976	40.037666	-75.345071	Wax Begonia
2232	40.03701056	-75.34212354	Wax Begonia
2374	40.03650105	-75.3437108	Wax Begonia
2411	40.03765336	-75.34485416	Wax Begonia
2413	40.03773311	-75.34490635	Wax Begonia
2458	40.03726756	-75.34494641	Wax Begonia
2613	40.03730255	-75.34449663	Wax Begonia
2820	40.034573	-75.337721	Wax Begonia
1637	40.038455	-75.342314	Waxy Privet
305	40.033887	-75.339332	Wayfaring Tree
1231	40.035833	-75.338531	Wayfaring Tree
1234	40.03572	-75.338627	Wayfaring Tree
1353	40.037131	-75.340634	Wayfaring Tree
1358	40.037127	-75.340509	Wayfaring Tree
1371	40.03715	-75.340783	Wayfaring Tree
1384	40.037259	-75.341048	Wayfaring Tree
1388	40.037351	-75.341118	Wayfaring Tree
1429	40.03735	-75.341215	Wayfaring Tree
1465	40.037614	-75.341409	Wayfaring Tree
1852	40.036075	-75.34705	Wayfaring Tree
2063	40.03758743	-75.34248158	Wayfaring Tree
2115	40.03777793	-75.34424271	Wayfaring Tree
2126	40.03782116	-75.34390351	Wayfaring Tree
2216	40.03723908	-75.34257623	Wayfaring Tree
2821	40.03498	-75.33803	Wayfaring Tree
2822	40.03512	-75.338182	Wayfaring Tree
121	40.035441	-75.340478	Wedelia
1702	40.036035	-75.344716	Weeping Beech
2823	40.034725	-75.339012	Western Azalea
11	40.034981	-75.339441	Western Azalea
985	40.036142	-75.34132	Wheel Tree
1003	40.03666	-75.342003	White Ash
1904	40.036951	-75.346507	White Dogwood
2824	40.034667	-75.337839	White Gaura
1074	40.035269	-75.337597	White Meadowsweet
2569	40.0361059	-75.3413713	White Meadowsweet
17	40.034981	-75.339467	White Mulberry

537	40.035598	-75.341429	White Mulberry
2210	40.0372279	-75.34235696	White Mulberry (sprout)
2547	40.03578673	-75.34313825	White Mulberry (sprout)
312	40.033905	-75.339345	White Oak
455	40.035305	-75.343069	White Oak
456	40.035378	-75.343038	White Oak
615	40.035454	-75.341696	White Oak
1420	40.037006	-75.341647	White Oak
1937	40.036928	-75.345482	White Oak
2057	40.0375893	-75.34173548	White Oak
2515	40.03635981	-75.3441631	White Oak
2598	40.03686191	-75.34385936	White Oak
1134	40.035284	-75.337924	White Panicle Aster
1570	40.037798	-75.34156	White Pine
792	40.035154	-75.33743	White Snakeroot
817	40.034796	-75.337318	White Snakeroot
859	40.035049	-75.337492	White Snakeroot
1437	40.037476	-75.34124	White Snakeroot
1553	40.037571	-75.341427	White Snakeroot
1608	40.036615	-75.339158	White Snakeroot
1633	40.036502	-75.339405	White Snakeroot
1940	40.037185	-75.34556	White Snakeroot
1962	40.037302	-75.34534	White Snakeroot
2419	40.03755406	-75.34465436	White Snakeroot
2501	40.03657385	-75.34447076	White Snakeroot
2545	40.03588088	-75.34306766	White Snakeroot
2578	40.03612165	-75.34140667	White Snakeroot
2825	40.035439	-75.338877	White Snakeroot
1263	40.03618	-75.339057	White Swamp Oak
2159	40.03815445	-75.34396276	White Sweetclover
2178	40.0380567	-75.3442018	White Sweetclover
2189	40.03798601	-75.34434093	White Sweetclover
867	40.035027	-75.337476	White Turtlehead
1276	40.03654	-75.339465	Whorled Tickseed
1317	40.03642	-75.340133	Whorled Tickseed
1325	40.036515	-75.340334	Whorled Tickseed
1657	40.038531	-75.343184	Whorled Tickseed
1842	40.035747	-75.347472	Whorled Tickseed
2421	40.0375624	-75.34455431	Whorled Tickseed
2433	40.03756035	-75.34444866	Whorled Tickseed
2475	40.03671843	-75.34529698	Whorled Tickseed

2482	40.03670268	-75.34509576	Whorled Tickseed
1626	40.036515	-75.339241	Wild Bergamot
1968	40.037396	-75.345262	Wild Bergamot
786	40.035442	-75.337437	Wild Carrot
1950	40.037228	-75.345587	Wild Rye
1957	40.037366	-75.345433	Wild Rye
166	40.036263	-75.340478	Wild Sage
1464	40.037594	-75.341394	Wild Senna
1555	40.037553	-75.341443	Wild Senna
744	40.035087	-75.336482	Willow Oak
1125	40.035187	-75.337742	Willow Oak
1126	40.035165	-75.337847	Willow Oak
1137	40.035246	-75.337946	Willow Oak
1138	40.035312	-75.338031	Willow Oak
1144	40.035318	-75.338173	Willow Oak
1145	40.035344	-75.338235	Willow Oak
1146	40.035398	-75.338343	Willow Oak
1148	40.03545	-75.338461	Willow Oak
1151	40.035459	-75.338518	Willow Oak
1153	40.03552	-75.338613	Willow Oak
1154	40.035574	-75.338638	Willow Oak
1157	40.035574	-75.338669	Willow Oak
1168	40.035643	-75.338919	Willow Oak
1289	40.036252	-75.339243	Willow Oak
2044	40.03777945	-75.34308276	Willow Oak
2045	40.03779121	-75.34287568	Willow Oak
2053	40.03767646	-75.34229913	Willow Oak
2072	40.03775371	-75.34335281	Willow Oak
2122	40.03771071	-75.34394158	Willow Oak
2127	40.03783991	-75.34372268	Willow Oak
2553	40.0359174	-75.34311766	Willow Oak
2826	40.035439	-75.338877	Willow Oak
2827	40.035572	-75.339264	Willow Oak
2828	40.035585	-75.339175	Willow Oak
2829	40.035633	-75.339263	Willow Oak
2830	40.035186	-75.338305	Willow Oak
2831	40.03521	-75.338416	Willow Oak
2832	40.035291	-75.338472	Willow Oak
2833	40.035301	-75.338685	Willow Oak
2834	40.035347	-75.33864	Willow Oak
2835	40.035369	-75.338705	Willow Oak

2836	40.035381	-75.338854	Willow Oak
2837	40.035463	-75.339036	Willow Oak
509	40.034859	-75.341175	Wine Raspberry
1360	40.037031	-75.340566	Winter Creeper
1864	40.036591	-75.34738	Winter Creeper
1095	40.035432	-75.337733	Winter Jasmine
108	40.035313	-75.340107	Woodland Bittercress
1945	40.03725	-75.345542	Wreath Goldenrod
2150	40.03815285	-75.34392263	Wreath Goldenrod
2166	40.03815976	-75.34404658	Wreath Goldenrod
2177	40.03803618	-75.34420716	Wreath Goldenrod
2184	40.03805405	-75.34420706	Wreath Goldenrod
2186	40.03802811	-75.34425686	Wreath Goldenrod
170	40.036248	-75.340478	Wrinkleleaf Goldenrod
1896	40.036662	-75.346432	Wrinkleleaf Goldenrod
2838	40.035639	-75.33945	Yaupon
2168	40.03806896	-75.344118	Yellow Bluestem
678	40.035665	-75.341746	Yellow Coneflower
24	40.034859	-75.339293	Yellow Daylily
337	40.034285	-75.34021	Yellow Daylily
355	40.034383	-75.340482	Yellow Daylily
555	40.03582	-75.341367	Yellow Daylily
565	40.03592	-75.341457	Yellow Daylily
596	40.035978	-75.341882	Yellow Daylily
640	40.035702	-75.341503	Yellow Daylily
713	40.03492	-75.342757	Yellow Daylily
719	40.034771	-75.341693	Yellow Daylily
757	40.035013	-75.336865	Yellow Daylily
831	40.034789	-75.337437	Yellow Daylily
847	40.034894	-75.337639	Yellow Daylily
848	40.034913	-75.337589	Yellow Daylily
858	40.035053	-75.337488	Yellow Daylily
1539	40.037277	-75.341751	Yellow Daylily
1590	40.037278	-75.339864	Yellow Daylily
1874	40.036893	-75.346622	Yellow Daylily
1903	40.036902	-75.346439	Yellow Daylily
1973	40.03759	-75.344946	Yellow Daylily
1978	40.037599	-75.345077	Yellow Daylily
1982	40.03762	-75.345267	Yellow Daylily
2033	40.0381299	-75.34244601	Yellow Daylily
2037	40.03820578	-75.34248603	Yellow Daylily

2412	40.0376774	-75.34486778	Yellow Daylily
2839	40.034667	-75.337839	Yellow Daylily
2840	40.03457	-75.33797	Yellow Daylily
2841	40.034362	-75.338923	Yellow Daylily
1560	40.037661	-75.341456	Yellow Senna
57	40.035436	-75.33981	Yellow Woodsorrel
58	40.034877	-75.339432	Yellow Woodsorrel
109	40.035272	-75.340189	Yellow Woodsorrel
143	40.035264	-75.340563	Yellow Woodsorrel
169	40.03627	-75.340484	Yellow Woodsorrel
201	40.036269	-75.340272	Yellow Woodsorrel
208	40.036337	-75.340193	Yellow Woodsorrel
261	40.036319	-75.340949	Yellow Woodsorrel
279	40.035469	-75.343409	Yellow Woodsorrel
318	40.034096	-75.339548	Yellow Woodsorrel
340	40.034322	-75.340319	Yellow Woodsorrel
352	40.034378	-75.340345	Yellow Woodsorrel
361	40.034665	-75.340095	Yellow Woodsorrel
367	40.034644	-75.340648	Yellow Woodsorrel
431	40.035196	-75.343402	Yellow Woodsorrel
469	40.0354	-75.343606	Yellow Woodsorrel
505	40.034853	-75.341105	Yellow Woodsorrel
532	40.035514	-75.341543	Yellow Woodsorrel
601	40.03594	-75.341883	Yellow Woodsorrel
618	40.035489	-75.341782	Yellow Woodsorrel
657	40.035787	-75.341702	Yellow Woodsorrel
726	40.034681	-75.34147	Yellow Woodsorrel
729	40.034651	-75.341434	Yellow Woodsorrel
777	40.034999	-75.337058	Yellow Woodsorrel
788	40.035116	-75.337415	Yellow Woodsorrel
807	40.034772	-75.337243	Yellow Woodsorrel
915	40.035988	-75.342746	Yellow Woodsorrel
997	40.036649	-75.342038	Yellow Woodsorrel
1042	40.036575	-75.340934	Yellow Woodsorrel
1089	40.035525	-75.337681	Yellow Woodsorrel
1221	40.036146	-75.338186	Yellow Woodsorrel
1515	40.035123	-75.341362	Yellow Woodsorrel
1727	40.035453	-75.344416	Yellow Woodsorrel
2206	40.03716308	-75.34232123	Yellow Woodsorrel
2549	40.0357955	-75.3431559	Yellow Woodsorrel
2572	40.03611315	-75.34137287	Yellow Woodsorrel

2842	40.03457	-75.33797	Yellow Woodsorrel
2843	40.034725	-75.339012	Yellow Woodsorrel
2844	40.034667	-75.337839	Yellow Woodsorrel
314	40.034005	-75.339444	Yellowood
351	40.034381	-75.340386	Yellowood
707	40.035011	-75.342842	Yellowood
1380	40.037234	-75.341016	Yellowood
2305	40.03660703	-75.34236386	Yellowood
880	40.035977	-75.342045	Yew Plum Pine
782	40.03543	-75.337349	Yucca
1649	40.038587	-75.343044	Yucca
774	40.035029	-75.337122	Yucca
1595	40.037	-75.339429	Zebra Grass
839	40.034764	-75.337686	Zinnia