Mitigating Bioiversity Loss of Native Plants

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Native Plant Gardening and Strategies for Mitigating Plant Biodiversity Loss at the NYBG

Jamie Grigonis
Abstract:

Growing up harvesting from my own vegetable garden and going from nursery to nursery with my mother, it has been extremely evident that plant biodiversity is more than just privet along driveways and carnations in window boxes. Plant biodiversity is often overlooked but crucial to having a healthy and thriving environment. Without certain plants, our ecosystems will crumble and this needs to be addressed now while it’s still at a level we can grow from. In my internship I am working alongside the director of the Thain Family Forest at the New York Botanical Gardens in order to get a better understanding on what it means to conserve endangered species and the importance of reestablishing native plants in areas where invasive species have overrun them or where human activities have impeded on their environment. With this internship I have been able to study the ecology of native plant restoration and invasive species management, which has further proven why it is so important to sustain plant biodiversity and planting natives for your area in your garden. The disciplines, which my internship will mainly focus on, are the environmental history of plant loss and garden design. The environmental history of plant loss will show how climate change and human exploitation affected biodiversity in the Thain Family Forest and how the New York Botanical Garden has worked to restore the forest to it’s original glory. Garden design will show how it is possible to use native plants and non-invasive species in gardens to restore ecosystems to their nature level and reduce biodiversity loss.

Keywords: plant biodiversity loss, native plant gardening, environmental history, old growth forest, invasive species, garden design

Grigonis
Table of Contents

Abstract

Introduction

Section One: How Many Species Have We Lost, and Why Have We Lost Them?
  Part I: Decline of native species gardening
  Part II: How invasive species pushed out natives

Section Two: Religion and Native Plants – How Religion Affect Our Views of Climate Change
  Part I: Basics of the Food Chain
  Part II: Applying Modern Religion
  Part III: Natives and Climate

Section Three: The History of the Thain Family Forest and the Example It is to Restoring Native Species
  Part I: The Forest as a Park
  Part II: The Forest as a Lesson
  Part III: The Forest as a Lab

Section Four: Designing Gardens and Using Native Species in the Place of Invasive Species
  Part I: Annuals are Okay
  Part II: Plant for your Climate
  Part III: Maintenance … Or Lack Thereof
Section Five: Laws to Regulate Invasive Species and Help Protect Natives Can Improve Plant Biodiversity

Part I: “Liberal” Laws

Part II: Modern Application

Conclusion

Appendices

Bibliography
Old Growth and Regrowth: The Restoration of Native Plants and Management of Invasive Species in the Thain Family Forest. The Thain Family Forest is the largest old growth forest in New York. This means it is the largest portion of forest that hasn’t been lived on by humans. This gives it a mysterious appeal being surrounded by the Bronx yet still holding so much natural, untouched history. I am lucky enough to be able to work alongside the director of the Thain Family Forest, Jessica Schuler, to research the effects of the restoration of native plants and the management of invasive species. In my internship I will be specifically looking at how restoring native plants to the Thain Family Forest has improved the ecosystem and how managing the invasive species has allowed for plant biodiversity to return to the Thain Family Forest. An important thing to remember when looking at the Thain Family Forest is the history behind it.

The first chapter will show how there are many reasons why ecosystems lose plant biodiversity, native plants become scarce, and invasive species are introduced. Since the Thain Family Forest is an old growth forest, invasive species weren’t necessarily brought in directly by humans, but by animals that had to feed off of the invasive species when they overran the native species. The importance of managing invasive species is that it helps the entire ecosystem balance out because invasive species are brought in and have no natural competitors, making them have an immediate advantage over the native species. I will also discuss the reasons behind the loss of certain species within the Thain Family Forest.
This leads us into the second chapter, which will highlight religion and how religion plays a role in climate change – which is the greatest threat to native plants. Since the Paris Climate talks, religious leaders have spoken out about the affects of climate change and how this shapes how people interact with the environment, their personal lifestyle choices, and what this means for environmental protection. Beginning with introducing the food chain as the first foundational system in science schools teach, I will use that to build upon what that means to humans and what our role is. Using religious teachings as the transition into climate change, this will connect how our very fundamental teachings shape how we view climate change and why this needs to change in order to protect the environment and mitigate biodiversity loss even on the lowest levels.

In the third section I will talk about how the importance of restoring native species in the midst of climate change and how this goes hand in hand with the Thain Family Forest because different areas require different native plants to be restored. In this section I will look at how native plants help to rebuild ecosystems and how garden design is an important part of restoring biodiversity through the use of native plants and removing invasive plants. Most of this knowledge will come from my mother, who is a landscape designer and garden consultant who specializes in native plants and will be working at the NYBG soon as their garden designer. I will use the forest as my main organizational tool, in which it is a park, a lesson, and a lab.
In my fourth section I will introduce how garden design and using native in place of annuals and invasive species is actually much more low maintenance besides being equally as good for the environment. By showing how to properly use annuals, which annuals to avoid, and how to plant for your climate it will allow people to understand the importance of sustainable gardening and using native species in place of non native species. Native species are much more manageable and low maintenance in contrast to other species that are more aesthetically pleasing and commonly used. By educating on native species and how important they are to ecosystems, it will show how gardening and designing with them is so much more beneficial for the environment.

Lastly, I will show in my final section how adopting new policies and regulations on invasive species will help mitigate biodiversity loss, and by establishing incentives or some sort of way to have native plants used more in habitat restoration can improve ecosystems and help to reduce the amount of biodiversity loss that we have suffered since the 1950s. Again a vast majority of this knowledge will come from my mother since her job is partially to make garden and landscape designs when developers over-clear land and natives need to be replanted. I will also include my own personal experience of working at a preserve in high school to remove mile-a-minute vine from the premises and how this impacted my decision to make this my project. I will refer to the importance of laws and regulations already in place that have helped put the Thain Family Forest back on the right track.
I. How Many Species Have We Lost, and Why Have We Lost Them?

Biodiversity is a key factor to how we are able to survive on Earth. A main problem that we face is that extinction and biodiversity loss isn’t noticed on a small level, and only on a global level. According to the Millennial Ecosystem Assessment “Loss of ecosystem functions, and the services derived from them, however, occurs long before global extinction. Often, when the functioning of a local ecosystem has been pushed beyond a certain limit by direct or indirect biodiversity alterations, the ecosystem-service losses may persist for a very long time.”³ If we more closely understood the impacts of biodiversity loss, and how even on the small level of the Thain Family Forest, it would help the overall understanding of global biodiversity loss.

By starting on a small scale such as the Thain Family Forest to begin the study of native plant restoration to improve biodiversity it will allow us to see things on a more localized level and be able to make assumptions based upon the research done in a controlled area. In *The Root Causes of Biodiversity Loss* they identify that “The Paradox of biodiversity loss is that it is considered a global problem but that its actual occurrence is a highly localized phenomenon. The conservation of biodiversity therefore needs to be an undertaking that occurs simultaneously at a variety of scales.”⁴ This quote sums up the majority of my focus for my internship project, which is that working in small scale areas to restore native plant biodiversity will have a lasting affect on science and the surrounding areas.

Grigonis
Part I: Decline of native species gardening. The loss of any species can be extremely detrimental to the ecosystem and overall biodiversity. According to the 2016 Forest Plan made by Director Jessica Schuler there are 118 extirpated species no longer growing in the Thain Family Forest. Although this is an extensive list of extirpated species from the Thain Family Forest, I focused on a few I found the most interesting. *Oligadago flexicaulis*, or “broadleaf goldenrod”, is currently a part of the Native Plant Garden, which was established in 2012, but not found in the Thain Family Forest. The importance of this is that if a plant can thrive in the Native Plant Garden, which borders the Thain Family Forest, it will most likely be able to thrive when placed in one of the control areas in the Thain Family Forest. *Dryopteris goldiana* is a native fern to New York, which can be found in some areas of Long Island but is no longer found in the Thain Family Forest. One of the main reasons that I see for this fern to die out is that it requires very moist soil, and with some of the more severe droughts we’ve had for the past fifteen years in the Bronx it has created a different climate that doesn’t allow for the growth of this plant. *Pogonia ophioglossoides* is another wetland plant known as the snakemouth orchid. Again, I see that a main problem could be the droughts but also since woodland orchids tend to be so low growing it’s very likely that trampling and over-collection caused the extirpation of this orchid.

These latter two plants show just how important maintaining a proper ecosystem and maintaining overall global health is to having healthy ecosystems. When climates change as much as they have recently, we will see increased
changes in native habitats like we have in the Thain Family Forest. Other plants that became relevant towards the end of my data collection were the native sanguinaria and trillium.

*Part II: How invasive species pushed out natives.*
As well as the Thain Family Forest we have other areas in the metro area of Fordham that also have seen native plant losses. The Bronx River Parkway has a preserved area running between the Northbound and Southbound lanes, which are where my field research was conducted. These areas have bike paths and bridges in the parks in order to allow people to enjoy them. They also have many of the native plants that the Thain Family Forest doesn’t have, so this is a key area in which plants and seeds can be harvested in order to propagate them in the greenhouses, move them to the Native Plant...
Garden, and then eventually find places for them in the Thain Family Forest. While collecting data in the field one of the major obstacles were the patches of mile-a-minute vine that had taken over areas of the forest. Mile-a-minute vine is an invasive from Eastern Asia, which comes over on other small plants when they’re being transported to the United States for sale. This vine very literally grows a mile a minute, and overnight can make it’s way up a hundred year old tree and absolutely devastate it within a month because of how deep it’s roots go and how it takes the nutrients from the soil. Invasive species are a major issue because they are so hard to manage and track, being that their original infiltration of ecosystems is hard to pinpoint in large areas along parks and in the wilderness.

The mile-a-minute vine is invasive across all of the United States and in Cutchogue, NY the Downs Farm preserve has been battling an overgrowth of the

Grigonis
vine, which has taken over a large area of the forest that was part of the preserve. In the image above you can see that all of the leaves that look like natural greenery are actually mile-a-minute vine attached to every stick and branch.

Another common invasive is the invasive wisteria vine, which looks very similar to the native except the invasive has a light, lavender purple colored flower while the native has a much deeper violet colored flower. This can be seen growing on trees along roadways, in many cases those trees will be dead if you look close enough. It can also be seen growing on buildings, which on 72\textsuperscript{nd} between Columbus Avenue and Amsterdam it has ravaged several rows of buildings and fences. Although it’s very beautiful, it’s very harmful for the same reasons the mile-a-minute vine is. It grows very quickly and because of that absorbs all of the nutrients necessary for native plants to thrive in their natural ecosystems.
The image above is another area on the North Fork of Long Island where invasive have taken over the forest, in this case wisteria. As appealing as it may be, this destroys ecosystems and pushes natives to extinction.

The mile-a-minute vine doesn’t have many climate limiters, which allows it to grow wherever it can find a small patch of soil and plant to climb on. This makes it one of the most dangerous invasive because it’s not going to die if it finds roots in a sandy or marshy area, it will still manage to grow and take over where native species are thriving. This pushes out native species

Areas of the Bronx River Parkway preserve in Scarsdale are currently being assessed as areas for new bike paths, which means that the plants in those areas will be destroyed if not harvested. This gives the New York Botanical Garden a great opportunity to take the data collected from the field research done to find the necessary natives that the Thain Family Forest no longer has

Grigonis
and harvest them, along with any others that may be destroyed, to mitigate the
tbiodiversity loss and bring plants such as sanguinaria to the Thain Family Forest.

The trillium above is very common near Scarsdale parks, which is also
one of the smaller old growth areas we have in the Bronx Westchester area. The
trillium is a gorgeous native plant that can also be used in ornamental gardening
and landscape design. This is a main reason it’s no longer found in the Thain
Family Forest because it’s such a beautiful flower that is native and hardy, but
people walking through the gardens before it became a protected area often
picked it. Trilliums are very easy to transplant and harvest because their root
systems don’t go down deep and they have an easily harvested seedpod.

**Section Two:** Religion and Native Plants – How Religion Affect Our Views
of Climate Change. But why does native gardening and maintaining native
ecosystems cause such an issue when it comes to environmental health? Given
the above introduction on native species and invasive species, we see that native
species are extremely vulnerable to changes in the ecosystem and how invasive
species quickly can change the face of an entire ecosystem in days. Native
species are the bottom of the food chain, which is the most important part
because the rest of food chains can’t survive without the lowest. As climate
change becomes more and more of a tangible aspect of our daily lives, this also
affects ecosystems but unfortunately isn’t affecting invasive species the same
way it affects native species. As wildlife has to shift their diets from whatever
native species they are genetically engineered to consume, they help the spread
of invasive species. This is why native species make a difference, and why protecting them is all that more important to mitigating plant biodiversity loss.

A strong motivating factor for society in all aspects of life is religion. This encompasses how we see ourselves in relation to other beings, how we see ourselves in relation to the ecosystem, and how we see ourselves in relation to the environment as a whole. Religion has the capability to influence people and give them a set of rules to live by in order to live a peaceful and sustainable life in accordance to their governing religious body. In order to understand this and it’s relation to climate change, which gravely affects native plants, we must look at the food chain as a primary level of knowledge and how even the lowest levels are affected, and then at how religious leaders are shaping their addresses to the world on how to lower our footprint on the world to stop the avalanche of climate change.

Part I: Basics of the Food Chain. The food chain is taught in elementary schools as one of the first true scientific fundamentals we learn about our environment. The lowest part of the food chain, the primary-level producers, is where the focus will be for this research. As the Audubon Society gravely states “The continental U.S. lost a staggering 150 million acres of habitat and farmland to urban sprawl, and that trend isn’t slowing. The modern obsession with highly manicured “perfect” lawns alone has created a green, monoculture carpet across the country that covers over 40 million acres. The human-dominated landscape no longer supports functioning ecosystems, and the remaining isolated natural
areas are not large enough to support wildlife.”\(^1\) Human destruction of wildlife areas is a huge issue. Our obsession with the aesthetics in nature rather than the health of nature truly creates the most destructive pattern of behavior found in any species.

As stewards of the environment it’s our job to take care of every level, and not just for our own good. Using the food chain as a primary level to base our perspectives of how we need to treat the environment allows us to look at how religions and religious leaders accept their highly influential role during the Paris Climate talks and how they use their power to influence their followers to be more conscious of the environment and how humanity affects it.

**Part II: Applying Modern Religion.** All religions have some basis on how we should treat the world around us and how that affects our lives and afterlives. This can be seen in Christianity and Buddhism. Many of these are questionable considering the fact that religion puts humans first rather than the environment first.

It seems that for Christianity that this is one of the first times the Pope himself has openly called upon followers to protect the Earth that their God created for them. On the other hand, Buddhism has always put the needs of the Earth and environment first and foremost, and they are known for their minimalistic and low impact lifestyle (often being vegetarian or vegan). Christianity uses the justification that doing these things to please God will allow them forgiveness for their sins and heaven after death. This is also what many

\(^1\) Audubon Society

Grigonis
Native Plant Gardening and Strategies for Mitigating Plant Biodiversity Loss at the NYBG

monotheistic religions base their addresses on climate change off of. Buddhism greatly relies upon the idea of interconnectivity and the need to leave as little of an impact on the earth in order to live a properly fulfilled and just lifestyle.

When religion is called in to play you have to understand the ethical boundaries there are to this, being that religion and faith are things people often rely on to guarantee their sins are forgiven and they won’t burn in hell for eternity. With climate change this is already begun to happen, so maybe they realized hell would be quite uncomfortable with the early signs of global warming, but again their only reason is their comfort. Where does this suddenly become a religious need when it’s been happening for hundreds of years? If you haven’t been living an environmentally friendly life until your religious leader told you it’s necessary, what makes you any different than the average person or a sinner?

Lower impact religions have been more conscious of the necessity to be environmentally friendly for so long it’s engrained in their religion, like Buddhism, but these beliefs are being put second to more popular religions now that those religions have released statements.

Pope Francis boldly quotes that “Any harm done to the environment, therefore, is harm done to humanity.” in his address to the UN. This is the first time in modern history we see the Pope address climate change as a social issue to his followers and put it’s destruction in the context of a sin against humanity. This is a very broad context considering that most teaching in Christianity regard the Golden Rule, how to live your life to please God, and ways to repent personal sins. Pope Francis's modernity and forward thinking has

Grigonis
brought climate change to the table, thankfully, but is this really what we’re looking for in his wording? To Christians, it might be the right justification but the moral reasoning behind this seems to be lacking because it all circles back to humanity and how God created it for humanity.

_We Christians, together with the other monotheistic religions, believe that the universe is the fruit of a loving decision by the Creator, who permits man respectfully to use creation for the good of his fellow men and for the glory of the Creator; he is not authorized to abuse it, much less to destroy it. In all religions, the environment is a fundamental good._

Here it clearly shows that in this talk he puts monotheistic religions under the word of God to use what they need in a respectful manner, but this has not always been the case.

Lynn White has a very critical perspective on religious influences on the environment out in his essay showing how religion doesn’t quite help climate change in this observation:

_“The newly elected Governor of California, like myself a churchman but less troubled than I, spoke for the Christian tradition when he said (as is alleged), ”when you’ve seen one red-wood tree, you’ve seen them all.” To a Christian a tree can be no more than a physical fact. The whole concept of the sacred grove is alien to Christianity and to the ethos of the West. For nearly 2 millennia Christian missionaries have been chopping_
down sacred groves, which are idolatrous because they assume spirit in nature."²

Here we see how clearly the idea of a single entity encompasses solely that entity, and doesn’t entitle it to the spirituality behind the environment – regardless of religion or religious context – that comes with being in nature and protecting nature. As early as 1967 scholars had recognized the lack of necessity for religion to even try to influence climate change because of their lack of understanding for the environment and the world it entails unto itself. Now more recently than White’s observations of Christian leaders speaking out about climate change and nature, the Pope has also shown a different perspective here where he says:

“Consequently, the defense of the environment and the fight against exclusion demand that we recognize a moral law written into human nature itself, one which includes the natural difference between man and woman, and absolute respect for life in all its stages and dimensions.”³

Very, very clearly you can see that he is supporting the classical pro-life mindset of Christianity, when this could be a case for an argument towards population control and though respecting life, also respecting nature and the carrying capacity of our fragile ecosystem.

² White
³ Kirchgaessner

Grigonis
Throughout his statement Pope Francis never allows Christianity to take full responsibility for climate change, but Lynn White pointed out over 50 years ago that Christianity is the most Anthropocentric when he very boldly states:

“Christianity is the most anthropocentric religion the world has seen. As early as the 2nd century both Tertullian and Saint Irenaeus of Lyons were insisting that when God shaped Adam he was foreshadowing the image of the incarnate Christ, the Second Adam. Man shares, in great measure, God's transcendence of nature. Christianity, in absolute contrast to ancient paganism and Asia's religions (except, perhaps, Zoroastrianism), not only established a dualism of man and nature but also insisted that it is God's will that man exploit nature for his proper ends.”

This closely relates to Mark Graham’s criticism of Laudato Si’ when he says “The stewardship paradigm almost invariably results in an anthropocentrism that regards something as valuable insofar as it benefits humans in some way.” Graham shows here how the Christian point of view still tends to be selfish, lacking the morality of recognizing the need for interconnectivity and coexistence with nature, not solely being a caretaker to better our own lives. From both Graham’s criticism and Lynn's foreshadowing of where Christianity would come into play with climate change we see how though Pope Francis does address climate change, the lack of responsibility and lack of full dedication to help the environment without the ulterior motive of doing it because God gave you the

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4 White
5 Graham

Grigonis
land just doesn’t do enough to show how Christianity and the Pope’s statements will do much to help climate change.

Regardless, it is a step forward. In chapter four of the Laudato Si’ we see how Pope Francis clearly outlines the importance of ecology by breaking it down into terms that sound with spirituality such as the moral reasons, justice, and the common good that every generation should seek for the following. These terms commonly used in Catholic teachings are now applied to why we should be more focused on ecology and the environment as a part of the religion, not something that can be used at the whim of humans. Pope Francis uses the spirituality of Catholicism to implement greater measures of protecting the environment, clearly showing that he intends his encyclical to become a method of spiritually motivated environmentalism. This is extremely important in the realm of climate change because it allows Christianity to take a new perspective, and a whole new meaning to faith, because it puts the environment first which is a huge step forward for such a largely practiced monotheistic religion.

Buddhism is well known for it’s simplistic lifestyle and relation to the earth as the source of self-awareness and following the Eight Fold Path. A major problem of climate change is our inability to consciously be aware of how we impact the environment and how we choose to live in relation to our environment. As a part of Buddhism it is taught to live as peacefully with the environment and to rid oneself of suffering by leading a very low impact life in terms of the environment. This can be done very simply and have a huge positive impact on the environment simply by changing one’s diet and following a plant-based diet.
Siddhartha Gautama, the founder of Buddhism, teaches that “Consume less and consume only those things which are necessary for living; Live in harmony with nature, other people, and other creatures, as well as understanding the natural laws of the cycle of birth, old age, sickness, and death; Use nature wisely, and learn from nature to help improve their minds and behaviors.” These are declarations that don’t stand true to the majority of the population in our modern society. We live in a fast paced, throwaway culture in which we have little respect for the world around us where all of our commodities come from. In Buddhism, this is the exact opposite of what the Lord Buddha teaches. Buddhism wants followers to be aware of their part in the ecosystem and the consequences of taking advantage of the natural order of the world. In retrospect we are very small organisms to have such an impact on the environment. Being that we have such cognitive abilities that allow us to be the most intelligent organism on the Earth, we have lost our sense of connection to the environment due to our desire to manipulate it for our own needs.

In Buddhism, one must live as simply as possible in harmony with nature. This often means giving up high-value material things and sustaining one’s life on a plant-based diet, because the suffering of animals will result in self-suffering in the teachings of Buddhism. In Tibetan Buddhism there once was a culture that sacrificed an animal once a year to please the Gods, but this has been eliminated in hopes to live a more peaceful life. They believe in not just one

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6 Thathong

Grigonis
universe, but a matrix of universes that all coherently influence one’s life and the universes connected.

Graham applauds Pope Francis for criticizing consumption levels of affluent nations⁷, yet in his critique we see no mention of food consumption. Food waste is one of the many horrible diseases affluent societies are infected with, and it’s such a simple thing that can be fixed as easily as turning off a light. The production of food is extremely wasteful, and in meat production there is the most repulsive amount of suffering that the animals go through before they reach the plate of insatiable people. For nearly a year I have personally followed a vegan diet and have never felt closer to the environment or more in tuned with my body. In parallel to Buddhist teachings, by alleviating the suffering of organisms around you, you in return alleviate some of your own suffering. Many arguments against veganism focus on not the consumption of animals but the production, yet if more people followed a plant based diet these farms would be put out of business and there would be no need to grossly produce so much meat for consumption. Buddhist teachings guide one to a path of less suffering and therefore a path of less suffering for the environment as a whole. The connection between mind, body, and the universe is extremely important to maintain a balance and to follow the Eight Fold Path. These are also important revelations one must seek in order to follow a more environmentally sustainable lifestyle, because it’s the definition of simplicity to just not eat animals.

⁷ Graham Grigonis
Contrary to the Christian statement on climate change, Buddhism takes the path of showing how it’s more important to protect the Earth based upon the reasoning that interconnectivity or the need to take care of everything in order to limit the effects of climate change. In their statement to the UN they said “Our concern is founded on the Buddha’s realization of dependent co-arising, which interconnects all things in the universe.” This is what is most important to maintain balance, not just that a god has given this world to us and if we ruin it we’re going against him. Not only does it bring this new perspective to the table, but it calls on all humanity not just their religion – this shows they’re clearly looking for a further reaching platform than just one group of religious followers.

“Recognize both our dependence on one another as well as on the natural world. Together, humanity must act on the root causes of this environmental crisis, which is driven by our use of fossil fuels, unsustainable consumption patterns, lack of awareness, and lack of concern about the consequences of our actions.”

The Global Buddhist Climate Change Collective (GBCCC) uses the following values to promote interdependence among the Buddhist community to set an example for the rest of the world to promote the steps towards ending climate change. Buddhist leaders believe the lack of insight of our actions and how that has now affected the climate in means of survival is another perspective Buddhism shows, but not necessarily using some sort of ‘god’ or religious text to back it up. Buddhism purely acts upon morals and ethics of protecting earth and

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8 GBCCC

Grigonis
coexisting with nature, not acting to please a higher power – calls upon all people, not just those of their faith. When they do refer to anyone, it’s Buddha or Siddhartha Gautama who was a very real person who founded Buddhism, who had this set of beliefs and was able to conjure so many followers to found his own religion which is based upon love, interconnectivity, and living a low impact lifestyle in order to carry on to the afterlife. Yes, there is a way to reach Nirvana through following the Four Noble Truths and relying on good karma, but this again relates to the interconnectivity of all beings and not placing oneself higher than another being. This allows followers to put into perspective our place in the world and in the ecosystem, rather than put humanity first and the earth as our feeding grounds to take care of for our own good.

Religions have the capability to create an entire movement and show people why something is right or wrong based upon religious texts and teachings which people put their full trust and faith into. This is not only slightly skewed because of the motivations, but causes humans to put themselves first rather than last. In contrast, religions such as Buddhism teach the importance of interconnectivity which directly relates to the concepts of the food chain, the concepts of ecology, and how humanity isn’t meant to be all consuming and powerful over the earth. Regardless, religion has the opportunity to make a step in the right direction and show people that this earth is for us to conserve and not to waste.

*Part III: Natives and Climate.* Native plants are made for their climates and ecosystems just as humans adapt to live in different ecosystems. In the midst of
climate change, though this could call for an entirely separate research project, native species are at risk. It is important to mention the necessity of maintaining overall environmental health because of the state our climate is in today. As the temperature rises we are at more risk for losing land and losing valuable native flora on islands and coastal areas.

Temperature rise has been studied as a part of the Anthropocene, which is the geologic epoch in which humans have caused irreversible damage to the atmosphere and environment. This is what has sparked so much talk on climate change, because it is heavily studied by scientists and is slowly being proven.

The Falklands have been an area of research for the reason of their abundance of native flora and their vulnerability to climate change due to sea levels rising. What small island climates show us is how plants react in a controlled, single area and it allows us to get a basis of numbers and a sample of how it could affect larger areas. What the Falklands have proven is that as plants move to higher, cooler grounds, they are also facing boundaries that are pushing them to extinction. The native plants were also found to be moving more slowly into higher altitudes than their invasive counterparts, one in four of which were found to be spreading uphill. As the planet warms, ideal climatic conditions for different species of wildlife tend to shift to higher latitudes and greater altitudes. Not all species are expected to be able to keep pace with the changes underway. Of those that do, some will encounter mountaintops, shorelines and freeways that prevent them from going any further. As this happens, it also pushes wildlife to move into those areas, causing even more issues because as native plants

Grigonis
the wildlife feeds on become less available, they become larger issues to communities.

Another issue with climate change is that many of the weeds and invasive species that take over actually thrive on higher levels of carbon dioxide in the environment. When higher levels of carbon dioxide in the atmosphere affect the climate, native plants have trouble establishing themselves. Invasive species as well as weeds actually flourish which further pushes out the native species.

When exposed to higher parts per million of carbon dioxide, areas where native species were reintroduced didn’t show any growth⁹. This greatly allows invasive which thrive in atmospheres with higher concentrations of carbon dioxide to thrive.

Climate change and the staggering acceleration of carbon dioxide being released into our environment is killing native plants and ruining ecosystems. This is something that many people find hard to grasp, being that faith and religion tells people that this world was made for our use. Since the Paris Climate talks we have seen an increase in the role of religion as a promoter of environmentalism, which may help people realize our role in the ecosystem and our need to stop climate change before it’s too late.

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⁹ Duke

Grigonis
Section Three: The History of the Thain Family Forest and the Example It is to Restoring Native Species

The Thain Family Forest is the largest uncut portion left of New York’s original forests. The forest is currently fifty acres, which is amazing considering it’s in one of the five boroughs of New York City. This area was selected in 1895 and later donated do the New York Botanical Gardens by the Thain Family which is the family of Henry Hudson’s wife. Although there still are some thriving native species in the forest, there have been dramatic changes since the original installment of the forest as preserved land in the nineteenth century. More than one hundred species of native wildflowers have been extirpated from the forest as a result of over-collection, trampling by visitors, and an increasing volume of invasive species.
This obviously poses problems considering native plants are the backbone to an ecosystem and this has resulted in the loss of some animals that were once found in the forest as well. The main wildflowers still left in the forest are “trout-lily, Canada mayflower, false Solomon’s seal, hairy Solomon’s seal, and white wood aster.” These species have survived through hurricanes and droughts but the most detrimental factor that caused the loss of native wildflowers has been the invasive species introduced into the area.

**Part I: The Forest as a Park.** Being that the Thain Family Forest is part of a botanical garden, there is the factor of bringing in ornamental and exotic species as well. A majority of these species were brought in from other countries and not much care was taken to the fact that they aren’t native in earlier years before native biodiversity conservation was a thinking point of botanical gardens. The problem with the introduction of non-native species is that you also bring their predators, which can quickly wipe out native species. This happened with the native dogwood when a non-native viburnum was introduced, and the natural insect predator of the viburnum also began to eat away at the dogwood population nearly extirpating it. All of these issues leading up to this current project show how the diverse history of the Thain Family Forest makes it the perfect sample to attempt to restore completely extirpated wildflowers or wildflowers that are very scarce.

**Part III: The Forest as a Lesson.** In more recent years the problem with invasive species has been dramatically decreasing due to the heavier focus on restoring the Thain Forest to it’s natural state with as little as possible invasive
species and disturbances as possible. The map below compares the amount of invasive species found in the Thain Family Forest from 2006 to 2011.

*Part III: The Forest as a Lab.* The Thain Family Forest is the largest old growth forest left in New York State. This takes a minute to absorb because old growth means never touched by man, and with the Adirondacks as part of New York State that means we have destroyed so much of the beautiful native wildlife we have just for our own pleasure. Many people don’t realize how valuable these areas are. Native ecosystems create natural, healthy areas in which the environment can fully sustain itself and provide areas of recreation with no needs for other devices or destruction. For the 180 species known, the study showed that there would be a decrease upwards up 95% in all species by the year 2080\(^\text{10}\). This terrifying number is one of the very harsh realities climate change brings native species because of human pollution and destruction of the environment.

Although this is the worst-case scenario, many factors come into play that create this likely outcome. Plants can ‘migrate’ to a higher elevation, but higher elevations means different climates and potentially non-optimal conditions for prolonged survival. Grasslands will also creep up into high grounds, which was already observed on Marion Island\(^\text{11}\). With all of the information they gathered, they also set up an experimental warming ground to test the vulnerability of the native species of the Falklands to global warming.

\(^{10}\) Upson
\(^{11}\) Upson

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Native Plant Gardening and Strategies for Mitigating Plant Biodiversity Loss at the NYBG

This is a very important and relevant research project to my own because as temperatures rise, especially in areas near larger cities which naturally draw more heat than surrounding areas, native plants must adapt to the climate. By measuring the moisture content of the soil and temperature of the soil during data collection we are able to see the surrounding climates the plants are thriving under and monitor how they change and how this impacts the native plants in the areas where data was collected. This will allow any further mitigation of biodiversity loss to support how climate affects species, truly creating a lab out of the Thain Family Forest which is where any species we collect will grow and will be able to be monitored.

In an ideal world, this would be a lifelong journey of monitoring the plants and monitoring global temperature rises to educate the public on the importance of maintaining ecosystems and lessening our impact as a species on the environment. It was considered to create a citizen science research element for this, but the amount of research to be done to consider that, and organize how it could be done, still is in the works and potentially wouldn’t be able to be completed for another two to three years minimum.

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As an intern at the New York Botanical Gardens there are many different resources available. In a conference call with Dr. Gregory McGee at SUNY ESF the director of the Thain Family Forest and I collaboratively began to build a plan for the restoration process of the Thain Family Forest. One of the main problems
the project at SUNY ESF faced was that they made it is civilian science project and left it in the hands of volunteers after the first day. In order to maintain the most precise records it will be necessary to designate a specific plot, measure it into grid squares, and assign certain native wildflowers to each grid square. Dr. McGee at SUNY ESF used this in his plan but since there wasn’t much oversight of the collection of data it slowly faded off. For the plan at the Thain Family Forest Director Jessica Schuler and I will work along with volunteers that are established at the botanical gardens to maintain a closely maintained record of data, like the examples given above that SUNY ESF created. The plan for how plants are grown in the forest will be based mainly off of the same grid square proposal that SUNY ESF used, as seen in Appendix I.

To start, we need to do a thorough survey of the forest and what is currently there. This will include measuring the heights, leaf area, overall size, and amount of flowers of every plant in order to determine its reproductive capabilities. We also will be working with the director of the Native Plant Garden to see what thrives the most in the garden so we can divide those plants and assign them to plots within the Thain Family Forest. One plant that we have in the Native Plant Garden but not in the Thain Family Forest is *Crocus sieberi* or ‘Spring Beauty Crocus’ which is relatively easy to plant considering they are hardy bulbs, and this will most likely be the plant I study the most over this research project. A detailed description of each plot will be kept of what is put in the ground within that plot, how many plants are put in that plot, and what plants are relocated or moved from the Native Plant Garden. A problem that was found

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at SUNY ESF was that when they propagated plants in the greenhouses it skewed their results because of the consistent environment compared to the unpredictable climate in the forest. Since we have the Native Plant Garden right next to the Thain Family Forest, we will do our best to not have to propagate any divisions in the greenhouses so we can achieve more realistic and accurate results. We plan to use a planting data sheet similar to that used at SUNY ESF as seen in Appendix II.

In addition to the restoration of extirpated wildflowers that we have available to us at the New York Botanical Gardens, I will also be working on a way to determine the minimal threshold for the division of rhizomes in *Maianthemum racemosum*, False Solomon’s Seal, which are abundant in the Thain Family Forest right now. The purpose of this "side" experiment is so for future plantings we can have a general idea of how small we can divide a plant before it won’t reproduce.

*Part I: Annuals are Okay.* A main source of spring and summer plantings at Fordham is often annuals. In most cases, annuals can be natives and don’t have as large of an impact on ecosystems as invasive hardy species. Annuals such as impatiens and petunias, as well as many vegetables and fruits such as tomatoes, corn, watermelon and strawberries are common to plant in gardens come warmer months. These are all healthy alternatives to fill up garden space over invasive commonly sold at garden centers such as vinca vines, Bradford pears, and especially bamboo.
Vinca vines are commonly used as a groundcover to cover large areas of garden spaces, but often push out native species because of their elaborate root systems. Although vinca vines may look dead in the winter as they act like a typical annual, their root systems survive and they grow back everywhere they were during warmer months, and more, when they come back from hibernation. White clematis, sold as sweet autumn clematis, is another climbing vine many people buy to plant along fences that can grow into trees and absorb all of the nutrients from the surrounding ground, very literally sucking the life out of trees and starving any native plants that may be in the path of it’s root systems. Bradford pears are by far the worst invasive species and susceptible to many diseases that can spread to native trees. Bradford pears were introduced in 1954 as an ornamental tree and are commonly planted among streets for beautification. They were assumed to be sterile, but in fact are not because although they cannot cross pollinate among other Bradford pears, they can cross pollinate with any other pear tree and are a dominate genetic structure so more Bradford pears will grow. What happens after this is that slowly they revert to Chinese pears which are even far more invasive and resemble more of a prickly, multi-trunked, bush like structure. Again, they outcompete natives and their root systems take up all of the necessary nutrients, destroying ecosystems and biodiversity.

Annuals such as tomatoes, watermelons, impatiens, and petunias are indeed native to the United States and can be planted safely because they aren’t hardly, most cannot survive winters under a Zone 11, which is a average low of 40-50 degrees Fahrenheit which is not a majority of the United States.
Part II: Plant for your Climate. When designing gardens, many people see annuals as regular plants and expect them to act like year round plants. The other option people want is evergreens like yews, which stay green year round, but are nowhere near native or sustainable. Despite the aesthetic looks, they’re also unsustainable for the ecosystem. Yews are basically the weed of the shrub world and will continue to grow unless they’re meticulously and consistently groomed and trimmed. But this isn’t the main issue. These are often looked for because they don’t react as strongly to climate changes as natives do. Native species tend to move away from these areas, because they are pushed out form climate change and need to move to cooler areas. This is seen in upstate New York. Studies done by Columbia show “as some tree species in the Northeast move north or to higher elevations, New York is expected to lose its spruce-fir forests in the Catskills and Adirondack Mountains by 2100…Besides the spruce and fir trees, sugar maple, beech and birch forests as well as elm, ash and cottonwood forests are moving north, while hardwoods like oak and hickory, as well as invasive plants, are moving in.” This shows that because our climate is changing, were losing the native plants that create stable ecosystems and passively allowing invasive species to take over.

By choosing to allow climate change and use plants that are necessarily more aesthetically pleasing or that grow more consistently throughout the year we aren’t giving native species the chance and respect they deserve. This is a complete human fault because of our lack of education on how truly easy it is to

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give up easy species and maintain a healthy climate, which would allow native species to flourish the way they truly can.

Part III: Maintenance … Or Lack Thereof. False Solomon’s Seal may indeed be one of the most easy to replant and reintroduce into an environment due to its hardiness and how it reacted under my personal experiments. The smallest sprout can be placed on top of dirt, with no extra water or covering, and still manage to get roots into the ground and grow. The seeds themselves, which I harvested and left in a small plastic bag to dry out over the winter, have now sprouted and are almost gotten to a point where I can transplant them. Below is an image of how far they’ve grown since I threw the seeds on the ground in late March (now it is early May).

The importance of this experiment is mainly to show how native plants thrive in their natural environments and how given their natural climate and

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ecosystem they will thrive regardless of what situation their put in. Trilliums are very similar in the sense that they can be easily replanted and seeded, but they don’t spread as much as False Solomon’s Seal. Sanguinaria is similar as well because their seedpods hold anywhere from 3-10 seeds and those will drop and spread and create new seedlings that can be easily moved before the root system becomes fully developed.

Native plants and native gardening is becoming more popular especially for revegetation plans when constructions sites clear too much of the surrounding area for a building or complex and they need a landscape architect and designer to create a plan to mitigate the loss of native species due to their negligence. This is very common on coastal areas because of how dangerous it is to over clear beach grasses and native beach plants because of the fact that they very literally hold the ground together and prevent erosion and washouts during storms and help slow natural erosion. My mother, who is a landscape architect, has found that using this as a strategy to introduce homeowners to native plant gardening often works to educate the public on the importance of native plants in the ecosystem. Besides being essential to the food chain, reducing erosion, and maintaining healthy ecosystems, they can be quite beautiful and allow for the natural, undone, low maintenance look that many people strive for in gardening and when creating model homes. Beach homes on the coast of the Hamptons on Long Island often showcase tall grasses, low flowering native flora, and native trees that blend seamlessly into the surroundings because it’s very well what would’ve been there if homes and streets hadn’t been built.

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Another strategy that allows the low maintenance characteristics of native plants is the natural beauty of them, which was regarded during the signing of the Highway Beautification Act of 1965:

“The President signed the Highway Beautification Act on October 22, 1965. The signing ceremony took place 2 weeks after the President had surgery to remove his gall bladder and a kidney stone at Bethesda Naval Hospital. Although he had returned to the White House only the day before, President Johnson seemed to be in an expansive mood as he recalled the drive from the hospital to the White House along the George Washington Memorial Parkway:

I saw Nature at its purest. The dogwoods had turned red. The maple leaves were scarlet and gold . . . And not one foot of it was marred by a single unsightly man-made obstruction—no advertising signs, no junkyards. Well, doctors could prescribe no better medicine for me.

He added:
We have placed a wall of civilization between us and the beauty of our countryside. In our eagerness to expand and improve, we have relegated nature to a weekend role, banishing it from our daily lives. I think we are a poorer nation as a result. I do not choose to preside over the destiny of this country and to hide from view what God has gladly given.
After saying, "Beauty belongs to all the people," he signed the bill and gave the first pen to Lady Bird, along with a kiss on the cheek. ⑩

This act allows for the push back of industrial sites one thousand feet from main highways and the reduction of pollution to allow for native plants to flourish along highways. This is considered one of the biggest ‘broken laws' because of how many loopholes have been created allowing billboards and the lack of pollution monitoring. On a recent road trip from South Carolina to Eastern Long Island I witnessed miles of wildflowers and wild dogwoods blooming along the Interstate 95. Immediately this act came to mind because it shows just how low maintenance native wildflowers are and how big of an impact they can have on mood and energy. During those stretches of the highway where the states had gone the extra mile to plant native annual wildflowers along the roadways it woke up the surrounding forest and made the monotonous drive north more enjoyable. The entire highway is surrounded by forests on either side, despite the times it runs near capital cities and larger cities, and President Johnson was extremely spot on when he said we have created an industrial wall between humans and nature, because that’s exactly what we’ve done. The low maintenance aspect of native gardening can be shown on a road trip like this, driving hundreds of monotonous miles which are only broken up by the bright colors and tall branches surrounding the highway reminding us of the beauty of nature.

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⑩ Weingroff

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Section Five: Laws to Regulate Invasive Species and Help Protect Natives Can Improve Plant Biodiversity. Without federal and state laws and regulations none of this could be possible. Up until 1973 there was no such written concept of an endangered species until the Endangered Species Act was passed. This act allows us to monitor plants for the first time on an endangered species list, which is extremely important to the restoration of native wildflowers. With an endangered species list for plants there are many more opportunities to reduce the rate of species extinction. One of the major parts of this act is that it protects endangered and threatened plant private lands from being disrupted by agriculture and industry.² This is what has allowed protected forests, like the Thain Family Forest, to remain intact and not be disturbed so that we have some idea of what natural growth looks like.

In 2002 the Environmental Protection Agency released a promotion for beneficial landscaping in which “The rationale for practicing beneficial landscaping includes, among other reasons, the possibility of reversing biodiversity loss due to ‘clearing of native habitats and the introduction of invasive exotic plants. The general principle of beneficial landscaping is that it is possible for people to meet their ‘needs and sense of beauty, while maintaining or restoring a healthy, natural ecosystem’.⁵ Myers and Bazely use this example to show how it’s important to promote the use of native species rather than exotic species which can become invasive because it will maintain a healthy ecosystem, which is becoming more and more relevant in today’s world.
Part I: ‘Liberal Laws’. Beginning in 1970 was what is regarded by many environmentalists as the ‘Great Environmental Movement’ for environmental protection and regulation. Though this is where we see the greatest spike in government activity, it began long before that. A common argument for political conservative people who don’t believe the government should access as much funding as they do for environmental protection is that it’s not regulated properly. This is anything but wrong. For over a century the government has been regulating the environment in different ways that we don’t necessarily see as environmental action, but they have become a part of our lives that we couldn’t live without.

Earth Day 1970 achieved a rare political alignment: support from both Republicans and Democrats. As a result, Congress passed the Clean Air Act and Clean Water Act in 1970 and 1972. Not sitting on its environmental laurels, Congress followed up by passing the Endangered Species Act of 1973, the Safe Drinking Water Act of 1974, the Resource Conservation and Recovery Act of 1976, and the Toxic Substances Control Act of 1976. This sharp increase in government interest and of new legislation culminated with the enactment in 1980 of the Superfund law shows that the government has a grip on how to regulate how humans impact the environment.

There are many things the government has done and continues to do which have immensely enhanced our lives, but it is a common misconception that the government puts the environment aside compared to other concerns. Romantics such as Ansel Adams and John Muir inspired people to enjoy the
wilderness, leading to the protection of it by the National Parks Service and eventually the creation of the Wilderness Act of 1964. Fast forward a couple of decades and we also see the United States Government become a leader of the Montreal Protocol which aims to end the use of chlorofluorocarbons (CFCs) and halons which have rapidly depleted our vital ozone layer. These aren’t common household names, besides the National Parks Service thanks to Amy Poehler, but I’ll explain them a bit for you so you understand that it’s more than just bears, it’s for our own good.

The National Parks Services has been one of the most important parts of preserving land since it’s creation in 1916. You probably think about how Parks and Recreation is a funny show to binge watch when you should be writing your next quarterly report from your cubicle, but it does shed light on the importance of creating parks for people to enjoy. To name some of the things the government very well regulates and preserves the parks under the National Parks Service contain nearly 250 species of endangered animals, more than 75,000 archaeological sites, and the longest known system of caves in the world -- Mammoth Cave National Park -- with over 400 miles of caves. Over 44 million acres of wilderness are in 47 parks, totaling for about 53% of all of the parks. This means that just over half of the national parks we go to are untouched land maintained by the government so we can enjoy it. Beyond enjoyment there’s potential for advances in science and history that can be discovered any day at any moment -- all regulated and preserved by the government.
After the success of the National Parks Service, in 1964 the government made major strides to protect land from human destruction. The Wilderness Act of 1964 is one of the most important pieces of environmental legislature. It set aside millions of acres of land designated as wilderness which is different than other government protected lands such as preserves. When the land is protected under the Wilderness Act prohibits permanent roads and commercial enterprises.

Although this seems strict, it does allow for the National Parks Service to maintain and preserve certain areas of land that can be used for recreation, but these wilderness areas do not allow for motorized vehicles, temporary roads, or permanent structures. This allows for the public to see the beauty of nature within regulations that the government strictly upholds in order to maintain the beauty of these designated wilderness areas. It’s not just about the bears, the growing 106 million acres of land protected by the government under this act allows for people to escape from their office cubicles and embrace the beauty of our country and the natural, untouched land that we have left. If this isn’t convincing enough that the government cares that we see the beauty that our country has to offer, there’s also some things the government has done that you can’t visit, but it does directly impact your life.

The Montreal Protocol is one of the most important global agreements that the United States is a part of (in my opinion). The United States ratified the Montreal in 1988; a year after it was internationally recognized, and since has become a leader on the phasing out of ODS such as chlorofluorocarbons (CFCs) and halons. These are things once found in hairspray and light bulbs that have a
tremendously devastating affect on the ozone layer. It’s also the first treaty to be ratified and recognized globally, so having the United States as a leading force in it is proof that our government handles and regulates things very well. It’s estimated that by 2035 the participating parties will have eliminated a majority of the ozone depleting chemicals that are listed under the protocol. As soon as 2030 this protocol has the potential to prevent as many as 2 million cases of skin cancer. It is said that by mid century the protocol could lead to the ozone layer returning to it’s pre-industrial revolution state as well.

Not only does the government protect the bears, but it regulates these amazing areas for us to enjoy, and for our children and grandchildren to enjoy. Our ozone layer is something we cannot survive without, so living in the country that is a leading force of the Montreal Protocol is an honor because we are so much closer to it’s original state. The importance of these parks cannot be put into words but if you’re back in the New York area any time soon, I’ll take you to my lake house in the Adirondacks and you can see for yourself that without parks we might go a little bit crazy. This is why it’s important to protect these laws because they are more relevant today more than ever, and are applied more now than they were before.

But why is this important for native plants? Government regulation over the environment creates a baseline for how much further damage we can do to the climate, and the climate is what controls how ecosystems function. Without ecosystems performing and functioning at their optimal point, native wildflowers won’t be able to flourish and will eventually die out. This is constantly forgotten

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because we don’t consider a few flowers in the woods or a certain type of moss so vital to our environment, but they are the primary producers and the foundation of every food chain. Enough disruption has already happened due to human interaction, enough land has been destroyed. Our personal greed and lack of hindsight into what are actions will do to future generations is what has destroyed our environment. Without these regulations native plants won’t stand a chance against global warming and overall climate change that we are currently seeing the affects of already.

**Part II: Modern Application.** Flint, Michigan. Keystone Pipeline. BP Oil Spill. Bees. 400ppm. 3.6 degrees Fahrenheit. Balloons. Plastic particles. Mars? If you look up ‘environment’ in any search engine these are very common terms that pop up within the first few articles of what’s going wrong today and what our government is trying to fix to prevent any further environmental damage. What past laws have done is create a foundation in which new environmental laws can come into place. All of these search terms above are examples of environmental concerns and disasters which legislation has been put forward in order to mitigate the remaining detrimental impacts on the environment. What’s hard to find is how exactly the government wants to mitigate biodiversity loss by protecting native plants, because most are centered upon state run endangered and protected species lists rather than country wide regulations to stop deforestation and mitigate biodiversity loss.

Recently, the United Nations released 17 Sustainable Development Goals in which the 15th Development goal directly relates to mitigating biodiversity loss.
This goal states that it aims to “Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss”\(^\text{13}\) and uses the evidence that “Deforestation and desertification – caused by human activities and climate change – pose major challenges to sustainable development and have affected the lives and livelihoods of millions of people in the fight against poverty. Efforts are being made to manage forests and combat desertification.”\(^\text{14}\) These together will shape how members of the United Nations shape their governing bodies to challenge climate change and protect native flora in order to promote healthy ecosystems and an overall healthier global environment. This proves that with the foundations of past laws along with present laws and statements, there is more than enough pressure to protect native species and apply laws to the modern challenges we have accepted with climate change.

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**Conclusion of Research and Final Thoughts.** Throughout my research time at the New York Botanical Gardens and along with my personal studies at school, it became evident that society doesn’t do enough to teach on the importance of preserving native lands and native plants, and why old growth forests are so important for a healthy ecosystem. By using multiple disciplines along with my research it has allowed me to fully develop on a new stream of conscious thought in which I am more aware of my actions and how they impact the environment even on a primary producer level. Native species are the backbone of every ecosystem, but they are harder and harder to find because of people harvesting them and planting them in the wrong climates, invasive species pushing them out by taking their nutrients and growing over them, and urban sprawl leading to less natural land for native species to grow on. Every aspect of humanity affects native plant species from our over consumption of fossil fuels releasing carbon dioxide into the environment to clearing lands for agriculture and industry. By learning how people are influence and motivated throughout my education it has allowed me to shape my thought process on how people need to learn about native species and what will make people more conscious of their ecological footprint and how that impacts their surrounding ecosystems. When measuring plants and collecting data of species still found in old growth forests of preserved areas it was found that regardless of how protected a species is, humanity will find a way to encroach on forests and create new paths and structures that devastate populations of native plants. In just one potential bike path there was an entire colony of native sanguinaria, which
pictures are shown in Appendix III. These plants are vital to native ecosystems and without our protection, religious leaders using their power to influence society to live more sustainable lives, and knowledge of their role in ecosystems in food chains, we will break the foundation of our ecosystems and cause a dramatic amount of collateral damage.

The research done to see where native plants still could be used in New York City Parks and the New York Botanical Gardens still hasn’t shown that it’s a feasible project to take on. In the year I collected data and worked on my project I didn’t see a noticeable difference in the spread of native wildflowers because it takes so much time to actually collect that data. To supplement that my extensive research into how people’s thoughts are shaped towards native plants, the climate, and ecology has helped me understand how to make this project a reality in the future and to educate on the importance of mitigating biodiversity loss of native plants.
Appendix I: Grid Planting Example used at SUNY ESF

FIGURE 3. Study site containing twelve blocks. Each grid square represents a distance of 1 meter. Block centers are separated from one another by a distance of 20 meters. Treatment types alternate so that they are spread out across the entire study site. In this example three blocks run East to West and four blocks run North to South. Your layout may differ depending on the available area of secondary growth forest.
Appendix II: Native Wildflower Data Collection Sheets Example used at SUNY ESF

Wildflower Planting Data

<table>
<thead>
<tr>
<th>Species Name</th>
<th>Scientific</th>
<th>Common</th>
<th>Date Planted</th>
<th># of roots or seeds</th>
<th>Root Size (S, M, or L)</th>
<th>Quadrant (a, b, c, or d)</th>
<th># of roots or seeds</th>
<th>Root Size (S, M, or L)</th>
<th>Quadrant (a, b, c, or d)</th>
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<th>Quadrant (a, b, c, or d)</th>
<th># of roots or seeds</th>
<th>Root Size (S, M, or L)</th>
<th>Quadrant (a, b, c, or d)</th>
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<tbody>
<tr>
<td>1. Actaea pachypoda</td>
<td>Actaea pachypoda</td>
<td>white baneberry</td>
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<td>2. Actaea rubra</td>
<td>Actaea rubra</td>
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<td>3. Allium tricoccum</td>
<td>Allium tricoccum</td>
<td>wild leek</td>
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<td>4. Aralia nudicaulis</td>
<td>Aralia nudicaulis</td>
<td>wild sarsaparilla</td>
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<td>5. Asarum canadense</td>
<td>Asarum canadense</td>
<td>wild ginger</td>
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<td>6. Cardamine concatenata</td>
<td>Cardamine concatenata</td>
<td>cut-leaf toothwort</td>
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<tr>
<td>7. Cardamine (Dentaria) diphylla</td>
<td>Cardamine (Dentaria) diphylla</td>
<td>two-leaf toothwort</td>
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<td>8. Caulophyllum thalictroides</td>
<td>Caulophyllum thalictroides</td>
<td>blue cohosh</td>
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Note: The column “Root Size” is not applicable to seed blocks.

It may be easier to first diagram your block, and then fill in the data table. You can use this diagram to record the wildflowers planted in each plot. Then, transfer this data into the data table.

Grigonis
Appendix III. Photos from Field Research of Native Sanguinaria in an Old Growth Forest
Bibliography


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https://www.audubon.org/content/why-native-plants-matter.


*Note: Although not all references above were mentioned in the research, they were read and will be applied at a further date. Due to the nature of my internship being a very long project I can only provide what I have completed and planned to do up to this point.*

*Note: All images were taken by me or used from the sources cited above.*