Recommendations to Create a Fragment Habitat at Boston College

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Abstract

Conservation faces a steep challenge in the present day, with the rates of deforestation and habitat loss at an all time high. Animal extinction rates directly correlate with habitat loss, as already evident by the decline of several important species groups, including pollinators. With such a rapid decline in land available for plants and animals, along with a major increase in fragmentation of what remains, people must find space for wildlife. In an urban and developed environment, this means either saving land or building a new habitat fragment. For pollinators especially, a habitat fragment must maintain a high level of plant diversity in order to bring in higher numbers of varied animals. To conserve habitat near Boston College, we executed three main objectives. (1) We analyzed the green space on campus to choose an ideal spot to build a new fragment, (2) we then identified the current conditions and plants at the site and finally (3) we researched and chose species to build a renewed, native and biodiverse habitat, that held great aesthetic appeal. After our research, we discovered a site on Brighton Campus held the greatest potential for this proposed planting, and that the current species there varied, but were all in an unmaintained state. Finally, we found eight plants of varying heights, bloom times and colors that could diversify this area in appearance and ecological benefit. These eight species included American Witch Hazel, Silky Dogwood, Maryland Goldenaster, Redtop, Lowbush Blueberry, Common Boneset, Great Blue Lobelia, and Cardinal Flower. If planted, we believe this site could provide a beautiful fragment of native flowering plants for campus, as well as attract a variety of key pollinators, and most importantly, create a new, biodiverse habitat to aid in the conservation of wild spaces around the globe.

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Introduction

Habitat Loss and Fragmentation

With a rapidly growing population on a planet that has limited resources, humans directly compete with animals for land, food, and water. The largest threat facing the natural world in the fight against extinction remains habitat loss (Wilson 57). When 90% of a habitat disappears, half of the species that once thrived there fall victim to extinction. Biodiversity loss represents a huge problem closely linked to the decreasing natural habitat worldwide. A biodiverse environment stabilizes ecosystems, while protecting the environmental quality overall, proving a healthy planet requires intricate plant and animal diversity (Dwivedi, 2017). To ensure the current biodiversity of Earth continues, solutions across the globe, at federal, state, city or individual levels are required.

Conserving and restoring habitats remains an imperative part of climate change solutions, even in already developed areas. One problem with human sprawl is increased fragmentation of habitats. A landmark study found 70% of forested areas lie within just half a mile of their edges, and a further 20% has just 100 meters as a buffer from human development and agriculture (Bryce, 2016). Although the focus should lie in protecting larger swaths of forest to prevent further fragmentation and habitat loss, saving fragments that remain is hugely important, especially in developed areas such as the Northeast United States.

The factors that determine biotic response to an incident of habitat fragmentation include, "time since isolation, the distance between adjacent remnants and the connectivity between them" (Saunders et al., 1991). Essentially, when land breaks up into fragments due to human encroachment, animals can survive and move in between sections, as long as the distance and time are not too great. Another important factor to consider when attempting to design a workable fragment habitat are diversity indicators. Studies found differences in habitat heterogeneity lead to asymmetric movement between fragments (Gustafson, 1996; Kang, 2015). Thus, any landscaped sections attempting to function in a wildlife corridor for animals to move through urban areas must hold enough diversity to match or come close to natural habitats. For the purposes of this project, this means looking at wild and native plants found in similar soil and topography types of the chosen spot. It is a scientifically accepted fact that biodiversity stabilizes ecosystems, while protecting the environmental quality overall (Dwivedi, 2017).

Pollinator Loss

The increasing fragmentation and loss of native or biodiverse habitats has hugely impacted pollinators around the world. With fragments or reduced native habitat, pollinators and diversity both decline (Rathcke and Jules, 1993; Potts, 2010). Pollinators hold particular importance compared to other wildlife as they perform a double function. They facilitate plant reproduction, which not only provides a crucial ecological function for natural ecosystems, but also is vital for human food security (Ollerton, 2017). Just for worldwide coffee production, a commodity second only to oil in value, animals perform "22 trillion pollinator visits to flowers" (Klein et al., 2003). Pollinators, whether insects, birds or mammals, represent an integral part of food production worldwide. Thus, any habitat conservation should keep optimizing pollinator habitat in mind. Focus given to planting an array of flowers, or other plants that attract pollinators, is proven to improve pollinator abundance and diversity (Goulson et al., 2015).

Importance of Native Species

Native species hold particular importance as pollinators gravitate towards them in higher quantities compared with exotic varieties (Pardee, 2014). In Massachusetts there are 259 native plant species protected under the Endangered Species Act ("List of Endangered"). With habitat degradation, increased landscaping or complete removal of natural spaces, these plants and more fall further at risk. Thus, we focused on native plants, as increasingly they are in danger of disappearing, along with the bump in pollinators they can bring. However, some near-native or similar exotic species can be useful to increase diversity of an area while remaining in maintenance, habitat type and aesthetic guidelines (Salisbury, 2015). A previous research group found a percent of native species on BC's main campus of 41.43%, revealing room for percent nativity improvement with this proposal (Dangond and McKnight, 2017). Focusing on native plants, with others only recommended occasionally was the method to mitigate specific requirements with important biodiversity concerns.

Urban Examples

In Boston, the concept of creating a landscape corridor for wildlife already has a foothold. The Rose Fitzgerald Kennedy Greenway, a series of green spaces in the form of parks, wild meadows, bee hive areas and more, connects 1.5 miles of habitat patches from Chinatown

to the North End ("Plants & Landscapes"). This intricately designed series of spaces includes a "Pollinator Ribbon," which encompasses a series of garden spaces specifically designed in the corridor to promote and attract pollinator species to Boston. This greenway provides an excellent example of what a highly urbanized area can accomplish, while revealing the necessity for these corridors and patches to extend through the surrounding neighborhoods of Boston. With BC located just 5 miles outside of the city, the campus has a unique placement with both natural habitats and highly developed ones nearby.

Background on BC's Landscaping

This type of project already has traction within BC's landscaping department as a method of repurposing runoff or unkept/wild areas. As the campus relies heavily on its manicured appearance in the form of sod and constantly changing flowerbeds, implementation of a native species fragment would still need aesthetic appeal. Plant selection should rely on a variety of factors regarding their ecosystem benefits and biodiversity along with beauty and level of maintenance. With ¾ of plants on BC's main campus falling under a low maintenance category, plant upkeep represents a surprisingly important factor in designing a habitat patch on campus (Dangond and McKnight, 2017). Any plan must satisfy both the goals of conservation enthusiasts and Boston College's groundskeeping, to ensure it will be implementable.

Research Questions

Ultimately, habitat loss represents the greatest threat to species survival and biodiversity worldwide. Thus, people need to conserve land and native species, so fragment habitats should be either preserved or established in developed areas that lack large swaths of habitat. For Boston College to assist with habitat and biodiversity loss, they should utilize this report to implement a fragment habitat, with diverse, native plants to aid the survival of animal species in the northeast. Future projects or landscaping plans can utilize these suggestions and plans to improve habitat and species conservation on Boston College's campus, improving their overall plant biodiversity and appearance. This project questions 1) Where is a suitable location to create a habitat patch that exists on campus? 2) What are the characteristics and plants in the chosen area? and 3) Which species are recommended for the area based on both biodiversity and aesthetic factors?

Materials and Methods

Objective 1-Fragment Identification

The goal for the first objective was to: understand the fragment structure of campus, and to classify those fragments into predetermined categories. In order to properly analyze the amount of open space on Boston College's campus, we first needed to get an overview of campus. For this we relied on using Google Maps technology. It is easy to access, and also provides tools that are quite easy to use for tracking areas. Once we identified the proper area on the map, we began highlighting specific fragments on campus. For the highlights, we used black to cover any buildings, and used yellow to highlight the "Green/Open" areas on campus. After tracing, and naming all the locations; we gathered the data provided by Google Maps, which was the area based off of the acreage of the parcel. There is room for error in this method, due to the fact that the measuring tools may not be as accurate as if it were to be done by hand. Unfortunately, the application only allows the user to get so granular with the line placement.

This process could be easily repeated as long as the person conducting the experiment had access to the internet, and Google. There are no restrictions as to the type of parcel that these methods can be applied to; and Google Maps keeps the images updated within typically a year, making it accurate in the regard of what structures are physically standing. The fact that the application is accurate for the buildings is crucial in this analysis; due to the fact that we are trying to analyze the fragmented space; while defining which of these fragments may be considered "usable". After the fragments of "Green" space were identified, we sorted them by size; and then began inquiring with the landscape team on campus as to what areas may "need improvement." During the conversation, with Regina "Gina" Bellavia, she reiterated that without keeping aesthetics on the forefront of our mind, the school would not be willing to execute on any recommendations provided. This changed the course of the conversation, and brought us the definitions of the types of "Green" space we have on campus today. First, we have areas that are solely sod/grass, and will remain that due to outstanding circumstances. Secondly, we have semi-managed/maintained areas; these are highlighted by the flower beds, bush rows, and small tree populated areas throughout campus. Lastly we talked about the unmanaged areas, the specific places where there is opportunity for change. Criteria highlighted by the landscape management team was a "wild" fragment, with a unique habitat within it that we could focus on.

Objective 2-Current Area Survey

The materials required for the second objective, are a camera and computer. The first part of objective two is to use photos to identify species. Once the pictures were taken the identification was done using various resources including online field guides. The second part of objective two, where the wetland area is and how big it is, was determined using online mapping systems. To find a best estimate of the location and size of the wetland area google earth was utilized. The measuring tool on google earth was used to drag around the perimeter of the wetland area. A brief visit to the site in April was able to be done to describe the area.

Objective 3-Plant Species Research

For the third portion of this experiment, we researched a variety of plants native to Massachusetts in order to identify which plants would best thrive in the chosen fragment spot on Brighton campus. Then, we selected eight from the collated list that provided diverse variety in several factors. Plants were added to the large list if they were native to Massachusetts (Figure 5). Several key resources were utilized for plant selection, including the Audubon website, the Ladybird Johnson National Wildflower Center, and the MADEP stormwater handbook. The Audubon website in particular helped identify plants native to the zip code Boston College falls in, which meant they were more specific to the area than Massachusetts in general (“Massachusetts Native Plants”). After choosing plants, more in depth information was found with the National Wildflower Center (“Native Plants”).

Multiple characteristics were researched and recorded for every plant to ensure future development of the site could pick plants fitting to specific criteria. These various criteria included the plant’s nativity, form, lifespan, bloom time, color, average height, soil moisture requirement, soil type requirement, light preference, maintenance level, and benefits. This extremely wide range of factors was based on the key references, with a chart style modeled loosely off the stormwater handbook (“Massachusetts Stormwater”). To determine the plant’s importance to biodiversity, their varying bloom times, pollinators they attracted, and larval species they hosted were taken into account to choose the best variety of plants that provided a diverse habitat to bring in varied wildlife species. Finally, for aesthetic determination, multiple plants with colorful blooms were considered, taking into account the time they bloomed, and how tall, and thus obvious, any flowers or colorful portions would be.

The plants chosen from the overall list were picked to fit the spot chosen and provide variety for the fragment habitat. We examined the total list and chose several that did well in moist or wet soil, full sun or partial shade, neutral/slightly acidic soil (the assumed pH of the area), lower maintenance, perennial life cycle, differing bloom times, various colors and diverse benefits.

Results

Objective 1-Fragment Selection

Boston College has 35.655 acres of green space around it's Main, and Brighton campus. As shown from Figure One below much of this green space is fragmented. The largest of these fragmented green spaces are: Brighton Meadows at 11.4 acres, Brighton Woods at 7.37 acres, and the Plex Footprint at 3.65 acres. Boston College has 100.472 acres of land of which 64.817 of them are developed or unusable spaces. 35.48% of all of the Boston College land is "green." Encompassed in green is both the fully natural spaces and the partially maintained spaces. In order to further analyze the given fragments; the group worked alongside the landscape management team to identify which areas possessed the criteria to have a new biodiverse landscape. Certain areas were always going to be turf/sod, due to University requirements, yet we also defined semi-managed areas, and unmanaged areas. Figure 1 conveys the map that was put together for the analysis, with the yellow highlighted areas being specific fragments throughout Main, and Brighton Campus. The specific green spaces were labeled in order to keep track of the parcel's for dimensional analysis. Figure 2 takes the list of greenspace on campus, and evaluates each based on the 3 categories that defined the parcel best, both in the eyes of the University, and students. The table has highlighted boxes conveying what is found in the location; while the cells with the black border are the easiest for us to focus on, due to the fact they are un-managed. Brighton Meadow was the largest parcel, and it is also diverse. The fact that it has all the areas we categorized in one section pushed our efforts in this direction.

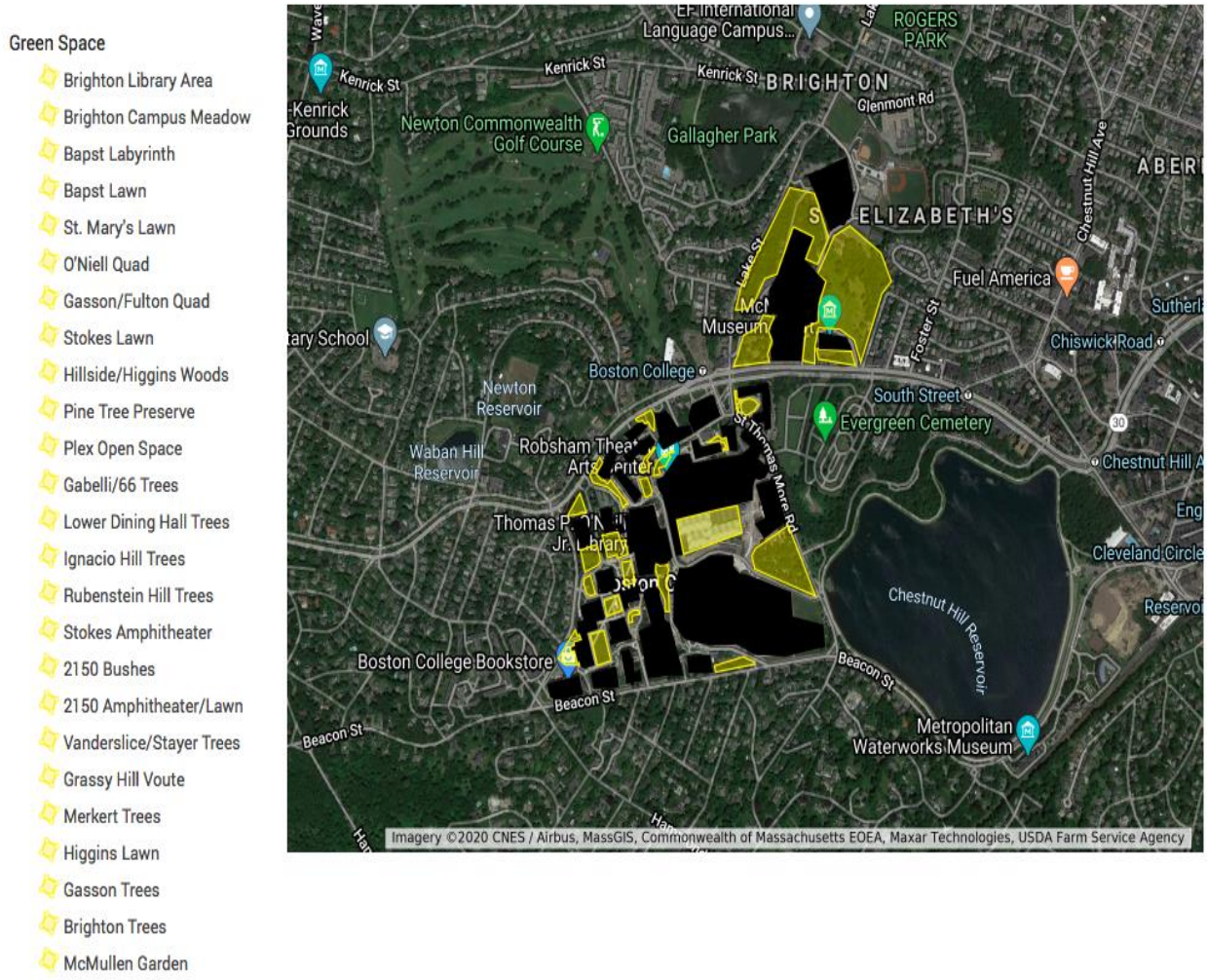

Figure 1: Map displaying Boston College and the surrounding areas. Yellow highlighted portions represent the significant green spaces found on both the Main and Brighton campuses, listed to the left of the map.

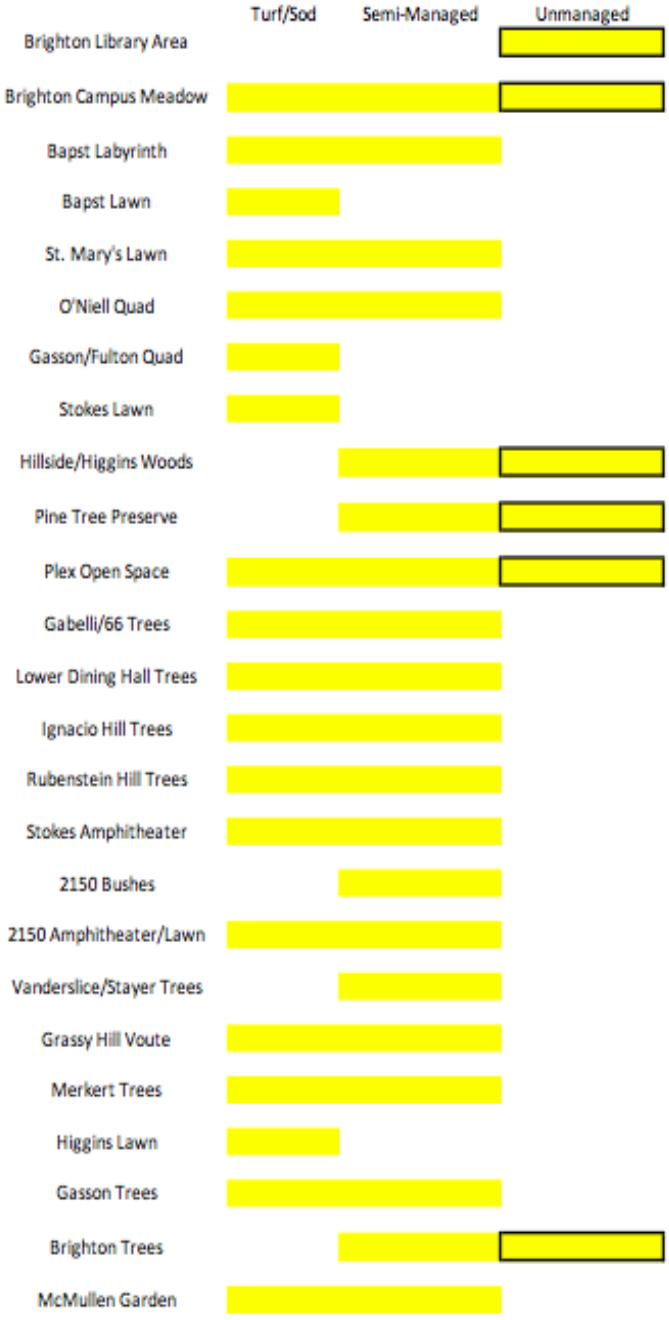

Figure 2: Classification of Open Space under determined categories including turf/sod, semi-managed and unmanaged.

Objective 2-Current Area Survey Results

The wetland area studied is located on Boston College property at approximately 42 degrees 20’30.49” N and 71 degrees 09’47.55” W in Brighton. The area is visible from the Boston College McMullen museum and the area directly surrounding the wetland area is not currently used for any official activity. The area was built by Boston College in 2015. Since 2015 there has been some construction around the area, however, all that construction and digging seems to have stopped as of 2017. Besides the addition of the wetland area, the surrounding field has been kept largely the same since at least the 1990’s according to the google earth imagery found as shown in figure 3. To our knowledge, the plants that have accumulated in the area, which are to be identified down below are natural in that no official gardening has been done in the wetlands. The grass present in the surrounding area is not tended except for some minimal grooming.

Figure 3: Google earth captures the history, size, and location of the wetland area. The pictures captured here are from 2003, 2007, 2013, 2015, 2017, and 2019. The 2019 image was used to approximate the size of the wetland area.

The actual wetland area is in an irregular somewhat circular shape that is approximately 79 meters around. The pond contains a drain and a number of exposed cylinders which are a part of the drainage system. The area sometimes is filled with water, but for most of the year it has wet soil, but no accumulated water according to google earth imagery. Within the wetland area there is mostly groundcover and weeds with a few shrubs and tall grasses. There is some trash in the pond which has not been cleaned out and the area is not currently maintained at all as can be seen in figure four.

Figure 4: These six images show the state of the wetland preserve. The site of the area in relation to the rest of the field and the McMullen museum can be seen. Additionally, the trash and man made objects in the field can be observed in these images.

To the best of ability, the plant species have been identified below. Due to COVID-19 and the inability to spend time at the site, identification was made with pictures only and are not certain. The pictures that these identifications were based off of can be found below in figure five. The plant species included an unknown *Phragmite* species, *Taraxacum officinale*, *Festuca rubra*, unknown *Polygonacae* species, unknown *Ranunculus* species, and *Andropogon gerardi.* These do not represent every single plant, but rather the plants that were most abundant.

Plant Species 1: Unknown *Phragmite* species

Plant Species 2: *Taraxacum officinale*

Plant Species 3: *Festuca rubra*

Plant Species #5: Unknown *Ranunculus* species

Plant Species #4: Unknown *Polygonaceae* species

Plant Species #6: *Andropogon gerardi*

Figure 5: These pictures show the identified species of plants at the site.

Objective 3-Plant Species Results

After examining multiple key resources for native plants, we produced a chart with the 12 characteristics we investigated for each plant (Table 2). In total, we researched and summarized these criteria for 37 plants. Of these, all of them were native, and almost 95% of them had a perennial lifespan. They were mostly herbs, with some shrubs and a few species of grass and trees. Their bloom times and colors varied quite a bit, but heights for most of the species looked at were under 6 feet, evident as the list of plants is sorted by height. A majority of the soil moisture requirements encompassed moist, or wet soils, with dry soils required only occasionally. The vast majority of the plants in table 2 required acidic or were growable in any soil. Sun requirements ranged from full sun to shade, but many either thrived in sun or sun/partial shade. Maintenance and comments (which includes listed benefits) were the two categories with the highest variene in response, as these were more specific to each plant, leading

to few repeated responses. This overarching table shows the variety of plants we identified throughout this study, which we then used to select the specific plants that would provide diversity and beauty to the area selected.

After identifying 37 native plants, we chose eight that provided different aspects to the chosen site, both in looks and ecological benefits. We also made sure each plant chosen fit the site's soil, sun and water characteristics, while being perennial and lower maintenance (Table 1).

Table 1: *Chart displaying the chosen eight plant species, the 12 categories considered listed above.*

Common Name	Scientific Name	Native?	Form	Lifespan	Bloom Time	Color	Height	Soil Moisture	Soil type
Maryland Goldenaster	*Chrysopsis mariana*	yes	herb	perennial	Aug-Oct	yellow flowers	0-1 ft.	wet	acidic/neutral
Lowbush Blueberry	*Vaccinium angustifolium*	yes	shrub	perennial	May-Jun	white flowers, blue fruit	1-3 ft	dry, moist	acidic
Redtop	*Agrostis Alba*	yes	grass	perennial	Apr-Nov	natural grass	2-3 ft	dry, moist, wet	all
Great Blue Lobelia	*Lobelia siphilitica*	yes	herb	perennial	Jul-Oct	blue/purple flowers	2-3 ft	moist, wet	all
Common Boneset	*Eupatorium perfoliatum*	yes	herb	perennial	Jun - Oct	white	2-4 ft	moist, wet	all
Cardinal Flower	*Lobelia cardinalis*	yes	herb	perennial	May-Oct	red flowers	3-6 ft	moist, wet	neutral - acidic
American Witch Hazel	*Hamamelis virginiana*	yes	shrub	perennial	Sept-Nov	yellow thin blooms	4-6 ft	moist	acidic
Silky Dogwood	*Cornus amomum*	yes	bush	perennial	Apr-Nov	white flowers, blue berries	6-12 ft	dry, moist, wet	all

Light Preference	Maintenance	comments
sun	remove dead heads	seems good in that it blooms in the fall, pretty, perennial
sun, part shade, shade	planting more than one beneficial for fruit production	attracts birds, fruit edible
part shade/shade	mowing	good for insects, grows in all conditions, native pasture/meadow grass
sun/partial shade/shade	remove dead heads	humming birds, bees
sun, part shade, shade	cut back in early spring to produce growth	it is butterfly food.
sun, pard shade, shade	might need water if a drought occurs	beneficial to insects
sun, part shade	pruning to shape as desire	does not flower until 6 years old
sun, part shade	possible trimming	good for wildlife, bank stablizer

Of the chosen plants for the new habitat fragment, all of them are native perennials that thrive in either dry/moist, moist, moist/wet or wet soils. They all live in slightly acidic, neutral or any soils and only one of them cannot handle full sun. Also, many of them have long bloom times, with a variance in when the blooms start and end. They range in height from 1-12 ft, with more shorter or midrange height plants than taller species.

The specific plants chosen include the Maryland Goldenaster, a short herb, which blooms from August until October with yellow flowers akin to daisies. This, along with the Lowbush Blueberry, a shrub with a short bloom of May until June, bearing blue fruit and white flowers represent the two shortest plants chosen (Figure 6).

Figure 6: Images of the two smallest plants selected for the fragment habitat. Left: the yellow bloom of the Maryland Goldenaster. Right: the petite blooms of the Lowbush Blueberries.

Three plants selected were in the height range of 2-4 ft. The first, called Redtop, is a grass that blooms for a long time, from April until November. The Great Blue Lobelia, an herb named for its blue and purple flowers, also bloom long, flowering from July through October. Longer still, the Common Boneset, an herb with white flowers, blooms June until October (Figure 7).

Figure 7: Images of the three long-blooming, medium/short height selected plants. From left to right: Redtop, The Great Blue Lobelia and the Common Boneset.

The final three species chosen were capable of reaching taller heights, with their peak growth potential ranging from 6-12 ft. The shortest of these last three, the Cardinal Flower, named after its red flowers, blooms from May until October. American Witch Hazel, flowering from September through November, is a type of shrub, with thin, yellow blooms. Finally, Silky

Dogwood, the only bush selected, has white flowers and blue berries, which bloom from April until November (Figure 8).

Figure 8: These images display the blossoms of the final three species selected, the tallest ones overall. The Cardinal Flower (left), American Witch Hazel (center) and Silky Dogwood (right).

Discussion

Fragmentation at BC

The degree of isolationism is directly related to the surrounding habitat (Harris, 1984). The more grassland we have, the more suitable habitat for some species. While buildings and roads may be an environment for some birds, and lichens; it is not suitable for most organisms. The less monoculture we have throughout campus, the more diversity we will attract. Where there is plant biodiversity, there will also be a larger amount of animal diversity. As we can see from the overlaid map of campus, it is speckled with buildings and small fragments consisting of plant species. It is natural in landscape design to break up areas with fragments of "nature" in between in order to increase the aesthetic, and make the buildings feel smaller, and less crowded. Campus's throughout the country have a similar fragmented landscape as Boston College's; when in an urban environment. Where there is space for larger quad's on campus, in the Midwest for example, those schools have larger fragments, but they are still fragments nonetheless (Iowa State). This fragment was important to us, because it helps to bridge the wooded area off of

Greycliff Rd., with the cemetery, which then connects to campus. If you look at the expanse that way, it is a fairly decent funnel for animals, yet when you begin moving west through campus, connecting the fragments becomes more of a challenge. As students get closer to the academic area, they will notice an increase in manicured areas, along with a denser building structure. Many fragments become unusable, due to the density factor, or other bureaucratic restrictions. It is hard to identify the degree of isolationism for specific fragments without physically being there and studying the interactions that happen between them. There may have been a better fragment choice based on interaction basis, yet without being physically on campus it seemed best to choose the fragment that was the largest, and belonged to the most categories of green space on campus.

Current Site Indicators

In results for objective two, the plant species present in the retention pond included an unknown *Phragmite* species, *Taraxacum officinale, Festuca rubra,* unknown *Polygonacae* species, unknown *Ranunculus* species, and *Andropogon gerardii.* Although a native species of *Phragmite* exists, it is rare, and likely this *Phragmite* species is not native. *Phragmite's* are usually an indication that the ecosystem is out of balance. *Taraxcum officinale* is also known as the common dandelion and is not native to the United States though it is now naturalized to the area. The Festuca rubra is native to New England. Polygonacae, known colloquially as Buckwheat, does have native species to New England, and it is possible that this species is native to the area. Rannunculus species, also known as buttercup are not native to America even though there are over 500 species in the genus. *Andropogon gerardi,* commonly known as Big BlueStem, is native to the region. There are no shrubs in this area nor are there any trees. The lack of diversity in height leads to birds and small mammals not being able to take refuge in the preserve. Many of the species found in the area are "weeds" meaning that they are low growing and take over the area. That takeover prevents native plants from coming in and being able to establish themselves which would be beneficial for pollinators and insects. For this reason, even though the area is "green" it is not a high quality habitat fragment as it lacks diversity. There are also not a variety of colors or bloom times represented in these species, which is what makes the area such an eyesore.

Although no tests were able to be performed on the soil in the area, based on the existing plants information can be gleaned. *Phragmite* species avoid poor and very acidic soils. *Taraxacum officinale* can grow in all types of soils though it prefers neutral to alkaline soils. *Ranunculus* species prefer slightly acidic soils. *Festuca rubra* can grow from acidic to slightly alkaline soils. *Polygonacae* species can tolerate almost all soil conditions. *Andropogon gerardii* can grow in all soil conditions. With this knowledge it can be known that the soil in the area is likely around neutral. It would not be possible for these plants to exist in very basic or in very acidic soils. Objective two helps to set up the recommendations in objective three. By knowing what plants are capable of growing in the area, it is not understood that plants requiring very acidic or very basic soils will not grow well in the area. The greatest limitation here is that identifications were not able to be done conclusively. Therefore, though it is likely that the soil is relatively neutral this report is unable to determine that conclusively.

Biodiversity

As shown in the results, the plants chosen for the area include American Witch Hazel, Silky Dogwood, Maryland Goldenaster, Redtop, Lowbush Blueberry, Common Boneset, Great Blue Lobelia, and Cardinal Flower. These plants all handle the sun well, will be okay in the soil in the area, and are native so we know that they can survive in the area. This combination of plants has been chosen for the area because of their diverse nature in color, height, flower, and bloom time. This diversity optimizes the habitat fragment to benefit a number of species. American Witch Hazel because of its size provides a habitat for a variety of birds to nest. Some birds also eat parts of the tree. According to the Missouri Native Foundation, American Witch Hazel is particularly beneficial to Noctuid Moths as they feed on the nectar of the tree. The Dune Noctuid moth is identified as endangered by the Massachusetts Department of Fish and Wildlife and so providing a food source for the Noctuid moth is of particular importance. Silky dogwood trees because of their size also provide a habitat for nesting birds and mammals. Various types of birds and mammals eat the blue fruits that come from the dogwoods. Though the Maryland Goldenaster is a small plant that cannot provide a shelter, it attracts native pollinators and in particular honey bees. The benefit for honeybees is particularly high because the Maryland Goldenaster blooms later than most other plants so the bees are provided with nectar at a time that it might normally be more difficult to find. According to the USDA, Redtop grass is used as

cover by small birds and mammals. Additionally, ducks use the grass for nesting and geese use the grass for both nesting and for grazing. Honeybees are the most common insect to pollinate the lowbush blueberry. In addition to helping the honeybee, the fruit of the blueberry makes a tasty snack for not only humans, but also turkeys, bluebirds, rabbits, foxes, and many more birds and mammals. Bees, wasps, butterflies, and moths are all attracted to the common Boneset as a food source. Caterpillar moths are some of the biggest consumers of the plants. The swamp sparrow also feeds on the Common Boneset. The shape of the flowers on the Great Blue Lobelia and on the Cardinal Flower provides food for hummingbirds when in bloom. Even though the wetland habitat is a small space in a fragmented area turning it from a mostly flat invasive species filled space to a space filled with plants of diverse heights, bloom times, and flowers brings in a broad spectrum of wildlife which helps conserve the fragmented area and increase beauty.

Aesthetic and Maintenance Requirements

The fragment we ended up choosing on Brighton campus, consists of a more wild, less manicured portion of Boston College's green spaces. Currently, this spot is regarded as somewhat of an eyesore, both to those working in the McMullen Museum, visitors walking by, and the landscaping department of BC. The plants there now are overgrown and trash among them. Thus, any new plants put into place needed to be maintained in a way that allowed those viewing it to enjoy the spot, along with some initial and occasional trash clean up. To this effect, as consistent with much of BC's landscaping, we chose more low maintenance plants, so that the spot could remain neat, without significant work. However, this presented a limitation for the work done in objective 3, in that it is hard to tell what plants truly are low maintenance, without surveying them in person, or cross comparing with the work done on campus by landscaping. We knew that BC kept work needed for plants low, by replacing them completely, constantly putting in new sod or replanting flower beds. What we did not know is how BC could adapt to a slightly different landscaping challenge, such as the plants suggested in this project. To remedy this slight uncertainty, we tried to choose species in the guidelines of the spot, that had limited, more optional care. The selected habitat site is part of a drainage site, so watering would be limited as the soil there is constantly damp. Some other maintenance needed by the plants chosen include removing dead flower heads, pruning, and cutting back extensive growth. All of these

mentioned activities represent by choice methods of maintaining a plant, essentially they can be completed depending on the aesthetic or growth rate landscaping desires. Finally, perhaps most important, all the plants chosen were perennials, which means they would not require replanting, essential for a spot that should be left relatively untouched, so wildlife can thrive there (Table 1).

Almost more important than the level of maintenance required from the plants chosen in the final objective, is the appearance of these plants. Boston College is known for possessing a beautiful, bright and colorful campus, and this habitat spot needs to meet those standards. To achieve the somewhat elusive BC aesthetic, we paid special attention to the color and bloom time of the plants and their flowers. Particularly, we ensured that those chosen in our recommendation for the habitat had differing bloom times, so something always looked bright and alive. Of course in winter, this objective can not completely be met, which is why we chose plants that bloomed into November, along with some that started blooming in April. In the cold temperatures of Massachusetts, these bloom schedules ensure the spot is colorful right up until snow might fall on campus (Table 1). The colors themselves were also carefully chosen, as we picked a fair portion of the rainbow. Species part of the chosen eight, bloom in a range of colors, including white, yellow, red, purple and blue (Figure 6; Figure 7; Figure 8). Some of the specimens also have fruits that they produce, providing another unique, pleasing visual for the area. Ultimately, we were able to find plants that met these aesthetic considerations, but still ensured biodiversity and met the criteria of the selected location.

Benefits to Campus

Overall, this spot represents a unique way for BC to diversify its plant specimens, while still bringing vibrancy and beauty to campus. Plants suggested in table 1, along with many of the others listed in table 2, spread across a wide range of characteristics. With their differences, comes a variety of benefits to the campus itself. Besides the biodiversity influx as already mentioned, some of these plants are edible, such as the Lowbush Blueberry, while others provide important stabilization for the landscape, such as the Silky Dogwood (Table 1). This habitat spot in particular could prove important for future classes at BC. Students could study the plants as they grow, or the animals that visit them. Wildlife visiting these plants, especially pollinators, could pass through the rest of BC's campus, aiding in the pollination and survival of other species on campus. Finally, this habitat could provide wellness benefits to the people at BC.

Although out of the scope of this study, people often want to connect with nature, especially as they see it losing ground against human development and global warming. The positives in this area in many ways are incalculable, but important all the same. As a beautiful, native, biodiverse habitat, it could provide an excellent starting point for students to begin or grow their appreciation or understanding of nature. The goal overall, to help with habitat conservation, could have greater success beyond this spot, if viewing this fragment inspires people to aid in other areas of conservation. Benefits, definable and otherwise, seem extensive, if this selected spot is planted and maintained for the entire community to enjoy, including both humans and nature.

Recommendations

The plants that we have chosen will help increase biodiversity in the area, and return some native species to the area. We also were sensitive to the aesthetic goals of campus, and attempted to choose plants that would continue to keep that ideal. The choice of plants included species that will be blooming from early Spring, to late Fall. These plants also all require a lesser amount of maintenance in comparison to some of the counterparts that we studied. In order for the landscape team to accept some of the suggested plants we had found, we knew they needed to be aesthetically pleasing, while also cost effective. It is assumed that McMullen would also be accepting of the proposed species as well, since the management team has requested a prettier retention area from landscaping in the past. We also recommend that another group try to implement these species in the future, and in conjunction conduct a study on biodiversity of the area in relation to other parts of campus. The plants may require upfront cost to install; but they would create a unique native wetland habitat that Boston College is currently lacking. If this were to be implemented it could be studied down the road, and used for an example in University Landscape Management; we believe if this were implemented it would help to further increase the University's sustainability rating as well.

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Appendix

Table 2 : *Cumulative plant chart with all of the plants considered, with all 12 plant criteria*

Common Name	Scientific Name	Native?	Form	Lifespan	Bloom Time	Color	Height	Soil Moisture	Soil type
Missouri Violet	*Viola sororia*	yes	herb	annual	Mar-May	white, pink, blue, purple flowers	0-1 ft	moist, wet	acidic
Maryland Goldenaster	*Chrysopsis mariana*	yes	herb	perennial	Aug-Oct	yellow flowers	0-1 ft.	wet	acidic/neutral
Birdfoot Violet	*Viola pedata*	yes	herb	perennial	Mar-Jun	purple flowers	0-1 ft.	Dry	acidic
Butterflyweed, Butterfly milkweed	*Asclepias tuberosa*	yes	herb	perennial	May-Sep	orange/yellow flowers	1-2 ft	dry, moist	acidic/slightly
Bluebell-of-Scotland	*Campanula rotundifolia*	yes	herb	perennial	Jun-Sep	blue/purple flowers	1-2 ft	dry	all
White Baneberry	*Actaea pachypoda*	yes	herb	perennial	Apr-Jun	White flowers, red or white fruit	1-3 ft	moist, wet	acidic
Wild Bergamot	*Monarda fistulosa*	yes	herb	perennial	May-Sep	white, pink, purple flowers	1-3 ft	dry, moist	acidic
Wild Lupine	*Lupinus perennis*	yes	herb	perennial	Aprl-Jul	blue, purple flowers	1-3 ft	dry, moist	acidic
Black-eyed Susan	*Rudbeckia hirta*	yes	herb	annual	Jun-Oct	yellow flowers	1-3 ft	dry, moist	acidic
Lowbush Blueberry	*Vaccinium angustifolium*	yes	shrub	perennial	May-Jun	white flowers, blue fruit	1-3 ft	dry, moist	acidic
Broomsedge	*Andropogon Virginicus*	yes	grass	perennial	Apr-Nov	brown tufts	1-3 ft	dry, moist, wet	all
Calico Aster	*Symphyotrichum lateriflorum*	yes	herb	perennial	Aug-Oct	small, pale, white and purple flowers	1-3 ft	moist, tolerates flooding	all
Jack-in-the-Pulpit	*Arisaema triphyllum*	yes	herb	perennial	Mar-Jun	green flowers with brown stripes, late summer bright red berries	1-3 ft	moist, wet	all
sensitive fern, beadfern	*Onoclea sensibilis*	yes	fern	perennial	Jun-Nov	green, lime green leaves	1-3.5 ft.	moist, wet	acidic
Spotted Geranium	*Geranium maculatum*	yes	herb	perennial	Mar-Jul	pink-purple flowers	1.5 ft	moist	acidic
Narrow-Leaf Mountain-Mint	*Pycnanthemum tenuifolium*	yes	herb	perennial	Jun-Sep	clusters of purple/white flowers	1.5-2.5 ft	dry, moist	acidic
Redtop	*Agrostis Alba*	yes	grass	perennial	Apr-Nov	natural grass	2-3 ft	dry, moist, wet	all
Tufted hairgrass	*Deschampsia cespitosa*	yes	grass	perennial	May-Sep	brown tufts	2-3 ft	dry, moist	all
Great Blue Lobelia	*Lobelia siphilitica*	yes	herb	perennial	Jul-Oct	blue/purple flowers	2-3 ft	moist, wet	all
Virginia Mountain-Mint	*Pycnanthemum virginianum*	yes	herb	perennial	Jul-Aug	white, purple spotted flowers	2-3 ft	moist	all
Common Boneset	*Eupatorium perfoliatum*	yes	herb	perennial	Jun - Oct	white	2-4 ft	moist, wet	all
Late Purple American-Aster	*Symphyotrichum patens*	yes	herb	perennial	Aug-Oct	daily-like flowers in purple/blue	2.5 ft	dry, moist	acidic
Wrinkle-Leaf Goldenrod	*Solidago rugosa*	yes	herb	perennial	Sept	yellow flower	3 -6 ft	wet	all
Canadian Golden Rod	*Solidago canadensis*	yes	herb	perennial	Sept-Nov	yellow flowers	3-6 ft	dry, moist	all
Canadian Lily	*Lilium canadense*	yes	herb	perennial	Jun-Jul	orange/yellow/red flowers	3-6 ft	moist, wet	neutral - acidic
Cardinal Flower	*Lobelia cardinalis*	yes	herb	perennial	May-Oct	red flowers	3-6 ft	moist, wet	neutral - acidic
Turk's Cap Lily	*Lilium superbum*	yes	herb	perennial	Jul-Sept	Red, orange, yellow flower	4 - 7 ft	moist	acidic
Anise-Scented Goldenrod	*Solidago odora*	yes	herb	perennial	Jul-Oct	golden/yellow flowers	4 ft	moist	acidic
Switchgrass	*Panicum virgatum*	yes	grass	perennial	May-Aug	red blooming strands	4-5 ft	dry, moist	all
American Witch Hazel	*Hamamelis virginiana*	yes	shrub	perennial	Sept-Nov	yellow thin blooms	4-6 ft	moist	acidic
Coastal Plain Trumpetweed	*Eupatorium fistulosum*	yes	herb	perennial	July-Oct	pink-purple flowers	5-10 ft	dry, moist, wet	neutral - mildly acidic
Red Osier	*Comus sericea*	yes	shrub	perennial	May - Jun	white flower	6 - 12 ft	moist	neutral
Red Chokeberry	*Aronia arbutifolia*	yes	shrub	perennial	May	white flowers, red ripe fruit	6 - 12 ft	moist	acidic
Highbush blueberry	*Vaccinium corymbosum*	yes	shrub	perennial	May - Jun	blueberries and white flowers	6-12 ft	dry, moist, wet	acidic
Silky Dogwood	*Comus amomum*	yes	bush	perennial	Apr-Nov	white flowers/ blue berries	6-12 ft	dry, moist, wet	all
Inkberry	*Ilex glabra*	yes	bush	perennial	evergreen	small white flowers	6-12 ft	dry, moist, wet	all
Spicebush	*Lindera Benzoin*	yes	bush	perennial	Apr-Jun	red berries/yellow flowers	6-12 ft	dry, moist, wet	all

Common Name	Light Preference	Maintenance	comments
Missouri Violet	sun, part shade	freely self-seeds, not as reliable	attracts birds, pretty
Maryland Goldenaster	sun	remove when dead? look into this	seems good in that it blooms in the fall, pretty, perennial
Birdfoot Violet	part shade, shade	susceptible to dry rot	pretty, nice it blooms in spring
Butterflyweed, Butterfly milkweed	sun	gets aphids, can be sprayed, or left	attracts butterflies and hummingbirds, hosts larval species, nectar source
Bluebell-of-Scotland	sun/partial shade/shade	germinates quickly, long-lasting	attracts hummingbirds
White Baneberry	part shade, shade	?	POISONOUS parts
Wild Bergamot	sun, part shade	Colonizes by rhizomes so lift and divide every 3 years to contain it, improve air circulation and improve plant vigor.	attracts birds, butterflies, hummingbirds and high heat tolerance
Wild Lupine	sun, part shade	very adaptable	brings in butterflies and hummingbirds, larval host for 2 species
Black-eyed Susan	sun	seeds have to be replatned, irrigation in dry year will improve flowering, don't mow until after mature seed cones formed	birds and butterflies, larval host for 2 species
Lowbush Blueberry	sun, part shade, shade	planting more than one beneficial for fruit production	attracts birds, fruit edible
Broomsedge	sun	non-intensive	good for wildlife
Calico Aster	sun/partial shade	?	attracts native bees, birds
Jack-in-the-Pulpit	sun	low	attracts birds and mammals (red berries)
sensitive fern, beadfern	part shade, shade	if in moist area, low	red fiddleheads in spring, nice feature, but spreads easily, might take over? Also does not tolerate frost, turns black,
Spotted Geranium	partial shade/shade	deheading prolongs bloom, spreads easily	attracts pollinators, birds
Narrow-Leaf Mountain-Mint	sun/partial shade	too keep from getting wide, divide it by roots occasionally	food to wildlife, mint, attracts bees and butterflies
Redtop	part shade/shade	mowing	good for insects, grows in all conditions, was once the native pasture/meadow grass
Tufted hairgrass	sun	trimming	good for insects
Great Blue Lobelia	sun/partial shade/shade	?	humming birds, bees
Virginia Mountain-Mint	partial shade	may need prevention from spreading, low otherwise	attracts bees and butterflies
Common Boneset	sun, part shade, shade	cut back in early spring to produce growth	it is butterfly food.
Late Purple American-Aster	sun/partial shade	?	attracts birds, drought tolerant
Wrinkle-Leaf Goldenrod	sun	not labor intensive	attracts birds, has unique flowers
Canadian Golden Rod	sun, part shade	might have problems with mildew	It can overtake an area if it does particularly well so that needs to be minitored
Canadian Lily	sun	needs watering if soil gets very dry during a drought	has many flowers that bloom in the summer
Cardinal Flower	sun, pard shade, shade	might need water if a drought occurs	beneficial to insects
Turk's Cap Lily	sun	needs well drained soil	beautiful flowers, attracts hummingbird
Anise-Scented Goldenrod	sun/partial shade	low watering required	special to native honeybees
Switchgrass	sun or shade	trimming	good for insects
American Witch Hazel	part shade, sun	pruning to shape as desire	does not flower until 6 years old
Coastal Plain Trumpetweed	full sun, partial sun	if clump widens too much, it may need to be seperated and replanted	attracts pollinators
Red Osier	part shade	pruning	beneficial for water fowl
Red Chokeberry	sun	splitting ocassionally required	immediate food source for birds.
Highbush blueberry	sun, part shade, shade	pruning	good for birds and mammells. Fruit is edible!
Silky Dogwood	sun/partial sun	possible trimming	good for wildlife
Inkberry	sun/partial sun	trimming	good for insects
Spicebush	sun	low	good for birds/insects