Effects on Boston's Urban Biodiversity

Author: Kelly John Holland

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Effects on Boston’s Urban Biodiversity
Kelly John Holland
Advisor: Dr. David Krauss Boston College Biology Department

Abstract

In an attempt to better understand the biodiversity of an urban ecosystem, we have conducted plant and bird biodiversity assessments of 10 sites in the Greater Boston area from September 2002-April 2003. These sites have been identified by the Urban Ecology Institute as important green areas through the Natural Cities Program. The purpose of this program is to create a greater body of knowledge of urban green spaces and the greater urban ecosystem of Boston. Our objective was to quantify plant and bird biodiversity by focusing on species richness. We then compared this biodiversity information to various factors such as area of impervious surface, and area of maintained lawn. Our analysis did not demonstrate statistically significant relationships between these factors.

Introduction

As the Earth’s population continues to grow, a study of cities and urban ecosystems becomes increasingly important. Biodiversity is a critical area of study within urban areas and the conservation of species richness is no longer a strictly rural issue (Harrison and Davies, 2002). Plant and avian biodiversity in cities can improve the quality of urban life, provide educational opportunities, and increase the awareness of residents to other environmental issues (Savard et al., 2000).

Many people believe that human beings have a responsibility to protect the Earth’s biodiversity for future generations. Continued human connection to the natural world is dependent on the protection of this diversity of life. In addition to a given species’ right to exist, species and ecosystems also provide valuable services to humans. The Rosy Periwinkle (Catharanthus roseus) of Madagascar is a flower that contains chemicals used to treat childhood leukemia and Hodgkin’s disease by reducing cancer cell growth (Campbell et al., 1999). Every lost species is a loss of potentially beneficial genes. Entire ecosystems can also provide services. For example, natural wetland communities function
to control floods, oxygen production, sequestering of harmful pollutants, and water recharge. These examples demonstrate the value of studying ecosystems around the world. In order to better understand the urban ecosystem we must study and value it in the same way.

Ecosystems function best when there is a greater number of species present (Stiling, 2002). Experiments have been done linking plant productivity to the number of species present (Nameem et al., 1994). In these studies controlled artificial chambers containing high, medium, and low diversity of species at all trophic levels were examined. The chambers with the highest diversity had the highest productivity as measured by percentage vegetative cover. Other researchers (Tilman and Downing, 1994) have found grassland areas with higher diversity more resistant to drought than areas of lower diversity. This experiment by Tilman and Downing demonstrated some of the benefits of communities with high plant species diversity. Our study seeks to understand what factors affect biodiversity in the urban setting. Once more is learned, urban planners and community groups can take steps to preserve the biodiversity that offers these benefits.

The term biodiversity refers to the great variety of life present in the natural world (Campbell et al., 1999). It can be applied at all levels of organization from genes and species to entire ecosystems. Alpha diversity is used to describe the number of species within an ecosystem; beta diversity is used to compare the differences between various habitats (Stiling, 2002). There have been many models used to study biodiversity in different ways. Species richness is a term meaning the number of species or alpha diversity in a given area. This indicator is informative because it can be used as an effective descriptor for areas with many species or biodiversity hotspots (Campbell et al., 1999).
However, this measure does not account for the number of individuals present for each species. Researchers have created biodiversity indices that account for the dominance of one species over others. The Shannon and Brillouin Indices (Stiling, 2002) are examples that incorporate the abundance of species within the ecosystem as well as the species richness. In these measures a community that has a more even distribution of individuals has a higher level of diversity than a habitat dominated by a few species.

The two greatest threats to biodiversity are habitat destruction and introduction of invasive exotic species (Campbell et al., 1999). Both factors are anthropogenic and preventable with long term planning and sustainable development practices. A community’s resistance to invasion by exotics has been seen to be a function of its species richness (Knops et al., 1999). In their experiments they found these areas of low diversity more susceptible to invasion than those with higher diversity.

Since biodiversity is of a great importance to an ecosystem, research needs to continue in all areas including urban settings. The flow of energy, nutrient cycling, and biodiversity are all important to natural systems as well as urban systems. In the great majority of urban areas the natural plants and animals are found in patches. In order to grasp the diversity of an entire urban area the ecology of these small patches must be studied. Previous work in urban areas have used a variety of biodiversity indicators such as green space, habitat heterogeneity, vegetative cover, and connectivity between green space areas to better understand the diversity of these ecosystems (Maurer et al., 2002). Maurer et al. (2002) used these techniques as part of a long-term study of the ecology of Berlin. Other studies have focused on the ecological importance of abandoned industrial areas called brownfields (Harrison and Davies, 2002).
Preserved areas, reservations, parks, and other green space within the urban setting are relevant starting locations for understanding biodiversity in the city because they contain the majority of plant and wildlife. Biodiversity is also important to the understanding of urban ecosystems because concepts such as species value, fragmentation, hierarchy, and differing scales (Savard et al., 2000) can be used to understand an individual site, and they can be applied to the entire system. In addition to planned green spaces, these brownfields are also important to the ecology of a city. Plant and bird communities move in to reclaim such sites creating urban wilderness. Heavy development pressure on these areas can threaten renewed biodiversity. Improved strategies and practices for evaluating and defending brownfield wilderness have been successful in the United Kingdom to bring conservation to equal levels with other social and economic concerns (Harrison and Davies, 2002).

Studies of birds have been used in cities because birds are highly mobile and avian species richness is easily monitored. This ease of study is due to their high visibility. Bird groups are also sensitive to habitat changes and shifts in composition. For example, by studying birds of prey one can learn about the health of lower trophic levels (Savard, 2000). In the mosaic habitat of urban parks the number of breeding birds is also related to the number of years a site has been populated by natural plant species (Hermy and Cornelis, 2000). Shrub abundance and tree cover affect bird diversity by providing cover, nest areas, and feeding sites (Savard et al., 2000). Increases in bird abundance and diversity have been found to be related to diversity and volume of vegetation (Savard et al., 2000). Surounding areas are also of importance to site richness and abundance. It has been found that open water increases the occurrence of gulls and open lawn areas increase the
occurrence of the European Starling (*Sturnus vulgaris*) in the urban setting (Savard *et al.*, 2000).

In order to maintain and improve diversity in urban ecosystems, specific, unique, high diversity communities need to be identified and preserved to continually support this diversity (Rockwood, 1995). These specific local preservation pockets contribute to the health and richness of the city as a whole because most of the plants and animals are found within them. The creation of hierarchies of important conservation sites has been used in London to protect urban wildlife (Harrison and Davies, 2002). In a study at the University of Minnesota (Galatowitsch *et al.*, 2000), the researchers shifted from the individual site scale to taking into account the surrounding areas. This shift was important to understand the relationship between wetlands and avian diversity. Larger patches have higher species richness and in patches of similar size areas with higher spatial heterogeneity have greater richness (Savard *et al.*, 2000). Successful long-term urban development plans can serve as a connection between ecological and political realms of municipalities and improve the understanding of the urban ecosystem (Rockwood, 1995). In the United Kingdom, city planning now includes plans for protecting sites for natural conservation and planners use the input of the public, private, and volunteer groups (Ennos, 2001). The importance of preserving the biodiversity of a city becomes clearer as research continues in and around urban ecosystems.

**Methods**

Research was conducted at 10 sites in the greater Boston area.
- Assembly Square Mall Waterfront: a small strip of land also located on the Mystic River south of the Mystic River Reservation (Figure 1). It borders a heavily traveled shopping area and is located in Somerville.

- Belle Isle Reservation: a salt marsh area park located on the border of Revere, East Boston, and Winthrop (Figure 2).

- Boston Regional Medical Center: a site found in Stoneham (Figure 3). It includes the Medical Center grounds and stretches down to Spot Pond.

- Burlington Forest Site: an unmanaged forest community located in Burlington (Figure 4). It borders industrial developments, private residences, and a power line right of way.

- Cranberry Bog: located along the Aberjona River in Woburn (Figure 5). It is a marsh area surrounded by scattered upland hardwood and White Pine (Pinus alba) plant communities.

- Horn Pond: another conservation area in Woburn (Figure 6). It is a pond with surrounding marsh and upland forest communities.

- Mystic River Reservation: located in Medford, MA near the junction of the Mystic and Malden Rivers (Figure 7). It is a park with maintained lawns and paved trails surrounded by wild vegetated areas. The park follows the path of the Mystic River north to the Main Street Bridge.

- Parkway Plaza: located along Mill Creek (Figure 8). It is a tidal marsh bordered by a shopping center. The site is divided by chain-link fences and has patches of impervious surface.
• Woburn Landfill Site: located in North Woburn (Figure 9). This area includes the landfill and the surrounding hardwood forest.

• Mary O’Malley Park: an area of land in Chelsea bordering the harbor (Figure 10). It is a park consisting of a large grass area and patches of native vegetation.

With the many ways biodiversity can be analyzed we chose to study species richness. We felt that comprehensive species counts would be the most informative and have the strongest links to the abiotic factors. We hypothesized that the number of species present would be affected by site composition and these abiotic factors. The team wanted to generate a comprehensive species listing for each site. In future studies these data can be compared to transect analyses measuring species abundance (Krauss, 2001). Researchers recorded all vascular plant species (Hermy and Cornelis, 2000) because these plants make up the habitat structure and create niches for animal species. These plant species were recorded to generate the species richness counts for each site. The research team consisted of the author and Colleen Ford another environmental scholar at Boston College. Together we assembled these plant diversity data by walking a series of transects across each site. Beginning at one end of a site the team walked in a line identifying all plant species encountered along the way. After reaching the opposite boundary of a given site, researchers began a new parallel transect approximately 5 meters from the previous transect. In this manner the entire site area was surveyed and the majority of species counted. However it is important to acknowledge the difficulty in encountering and identifying all plant species (Hermy and Cornelis, 2000). Impassable sections were visually surveyed from a distance using binoculars. Plants were identified using the field guides Petrides (1986), Brown (1979), and Peterson and McKenny (1968). For all unknowns
encountered in the field, a sample was taken and identified in the lab. Any unknown that could not be identified was counted as a single separate species. Ornamental plants and exotics (Hermy and Cornelis, 2000) were also included in the total plant species richness data for each site because they contribute to the structure and productivity of the ecosystem.

Bird species richness data were obtained by visual and auditory identification of the birds during site transects. Team members used the Peterson (2002) to identify species. Migratory birds present were included in counts because migration corridors are important benefits of these patches (Savard et al., 2000). Researchers created bird species richness listings for each site.

Many of the sites included areas of mowed lawn and impervious surface. The size of these sections was hypothesized to have an effect on the species diversity for each site. To measure the percentage of each site that was mowed lawn the team cut out these areas from a map of the site and weighed them on a sensitive balance. The mass of the marked sections was compared to the total mass generating the percentage of lawn area in each site. The percentage of impervious surface will be measured with the same procedure.

Using Stat View 5.0 statistical analysis software, Simple Regression tests were run for plant and bird richness data. Plant and bird richness data were compared in regression analyses with number of bird species as the dependent variable. The plant data was also compared to the percentage of lawn and impervious surface using the same type of test.
Figure 1 – Assembly Square Mall Waterfront Site along the Mystic River in Somerville.
Figure 2 – Belle Isle Marsh Site found in the communities of East Boston, Winthrop, and Revere.
Figure 3 – Boston Regional Medical Center Site located in Stoneham.
Figure 4 – Burlington Forest Site located in Burlington along Route 128.
Figure 5 – Cranberry Bog Site found along the Aberjona River in Woburn.
Figure 6 – Horn Pond Site and surrounding woodland located in Woburn.
Figure 7 – Mystic River Reservation Site found in Malden.
Figure 8 – Parkway Plaza Site along Mill Creek in Chelsea.
Figure 9 – Woburn Landfill Site found in North Woburn.
Figure 10 – Mary O’Malley Park Site located in Chelsea
Results

All of the species richness counts, lawn area, and soil quality data have been recorded in Table 1. This table serves as a summary for all of the data. Using a simple regression analysis the total number of plant species recorded was compared to the total bird species encountered (Figure 12). Looking at this graph we see that the results are not statistically significant (P value > .5). There are no single outliers that can account for this result; all of the data points are very different from each other. Hypothesizing that ornamental species were affecting the relationship, an additional regression was run without these ornamentals incorporated into the total plant richness counts (Figure 13). This relationship was also found not to be significant and the P-value remained >.5 for the test. Tree and shrub totals were compared to the number of bird species without ornamental species, wildflowers, and grasses (Figure 14). This relationship was also not significant (P-value >.5).

Looking at the relationship between plant species richness and percentage of mowed lawn on the regression plot (Figure 15), we see this relationship is also not statistically significant. The percentage of impervious surface tests were not informative because all sites contained amounts in the category of 0-10%.
Data Summary

Table 1 – The listing of species richness counts, lawn area, and impervious surface for each of the 10 study sites in the Boston area.

<table>
<thead>
<tr>
<th>Site</th>
<th>Tree/Shrub</th>
<th>Wildflower/Grasses</th>
<th>Ornamental</th>
<th>Total Plant</th>
<th>Bird</th>
<th>Lawn</th>
<th>Impervious Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parkway Plaza</td>
<td>15</td>
<td>5</td>
<td>1</td>
<td>21</td>
<td>5</td>
<td>0</td>
<td>4</td>
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<td>10</td>
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<td>4</td>
<td>23</td>
<td>8</td>
<td>0</td>
<td>3</td>
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<td>25</td>
<td>14</td>
<td>5</td>
<td>44</td>
<td>2</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Mary O'Malley Park</td>
<td>31</td>
<td>16</td>
<td>2</td>
<td>49</td>
<td>1</td>
<td>60</td>
<td>4</td>
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<tr>
<td>Boston Regional Medical Center</td>
<td>35</td>
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<td>12</td>
<td>67</td>
<td>7</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Mystic River Reservation</td>
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<td>14</td>
<td>8</td>
<td>43</td>
<td>6</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>Woburn Landfill</td>
<td>9</td>
<td>8</td>
<td>0</td>
<td>17</td>
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<td>0</td>
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<tr>
<td>Horn Pond</td>
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<td>23</td>
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<td>0</td>
<td>0</td>
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<td>68</td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Burlington Forest</td>
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<td>0</td>
<td>31</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Total Plant and Bird Species

Figure 12 – This regression plot shows the total plant species as the independent variable and the bird species as the dependent. The graph shows that the relationship between these two species richness is not significant (P value > .5).
Plant (without ornamental) and Bird Species

![Regression Plot](image)

\[ Y = 4.314 + 0.028 \times X; \ R^2 = 0.025 \]

Figure 13 – The above graph shows the relationship between the plants without ornamental species included and total bird species. This relation is not significant (P value >.5).

Tree / Shrub and Bird Species

![Regression Plot](image)

\[ Y = 4.884 + 0.019 \times X; \ R^2 = 0.004 \]

Figure 14 – Tree and Shrub species richness count was compared to bird diversity data in this regression graph. The above relationship is not significant (P-value >.5).
**Total Plant and Percentage of Mowed Lawn**

![Regression Plot](image)

\[ Y = 36.381 + 0.171 \times X; \quad R^2 = 0.032 \]

Figure 15 – This graph examines the relationship between total number of plant species and percentage of site that was mowed lawn. Graph also shows correlation is not significant.

**Discussion**

Based on the lack of statistically significant evidence, the direct relationship between plant species richness and bird species richness cannot be demonstrated. The number of plant species on a site was also not found to be correlated to the percentage of the site that was maintained lawn surface. This study did however add to our knowledge of site composition. The team now has comprehensive listings of identified plant and bird species found in each location. These lists can be a valuable educational tool for students and community groups wishing to learn more about the urban ecosystems in their area.

Knowing the different species present at a site is also important in long-term studies and site monitoring. We hope that research will continue at each of these areas. This study’s data can be used as a starting point to measure whether or not species richness
increases or decreases in any of these sites. During the proposed long term monitoring process, as the community experiences change, the factors that contribute to this change both positive and negative can be observed. Over a period of time we hope students will better understand these factors. This proposed long-term study could then give insight into what affects urban biodiversity.

As this long-term research continues, the team suggest the following changes to the protocol. First, plant and bird surveys should be conducted in the summer. We repeatedly experienced cold spells that affected which bird species were visible. This lead us to conclude that accurate bird species counts for each site need to be recorded during late spring and summer. Also winter plant identification is more time consuming and can often lead to confused results. Studying each of the sites in the summer would make identification much easier and more accurate. Because birds show different activities at different times of day (Savard, 2000), we recommend that researchers conduct bird transects at the same time of day and during the same basic weather conditions for the different sites. This will reduce the variability of conditions for the different sites. This will reduce the variability of conditions and give more informative data about the birds of each location. Future work could also include the effect of dominant species in an area. Teams would find different biodiversity indices that account for dominance useful in this type of work.

The focus of future research can be shifted by the results of this study. Instead of investigating just the individual sites, teams could incorporate the surrounding areas. Whether an area is bordered by noisy highway, industrial plants, residential areas could be an important factor. We also believe that the history of the site and the amount of time it
has been in existence as a preserved area are important. Sites could be experiencing different stages of succession and colonization, which would affect the types of species present. Due to the patchy nature of urban green space, future work could look at the connectivity and exchange between areas. The presence of green corridors may be very important to the types of birds found on a site and should be examined. A future study could also look at whether or not larger sites serve as sources for smaller areas in close proximity. The interplay between patches will be important to understanding the functioning of the entire urban landscape. The species richness lists of this study can serve as a starting point for specific plant and bird distribution studies. Thinking specifically about birds, certain species may prefer specific plant types in their site selection. Future examinations should record the types of plant communities in which specific birds are found.

This study is only a starting point to what we hope will be long term commitment to understanding the many components of an urban ecosystem. Using the species richness counts of this study (Appendix A), continued monitoring of changes in biodiversity can be conducted. This information can be used to learn about what is causing the change and help the work to minimize the loss of urban biodiversity. This research falls in with the global need to preserve biodiversity and to use natural ecosystems as an educational tool. We hope our work will be a foundation for continued long term study and monitoring of urban biodiversity.
Literature Cited


Appendix A

39.1 Parkway Plaza Mill Creek

**Plant Biodiversity**

- Grape: *Vitis sp.*
- Tree of Heaven: *Ailanthus altissima*
- Japanese Knotweed: *Polygonum cuspidatum*
- Norway Maple: *Acer platanoides*
- Honey Locust: *Gleitsia tricanothis*
- Smooth Summac: *Rhus glabra*
- Staghorn Summac: *Rhus typhina*
- American White Birch: *Betula papyrifera*
- Wild Rose: *Rosa sp.*
- Wild Carrot: *Daucus carota*
- Bitter Nightshade: *Solanum dulcamara*
- Giant Reed: *Phragmites communis*
- Milkweed: *Asclepias syriaca*

**Birds**

- Black Duck
- Mallard
- Gull
- Red tail Hawk
- House Sparrow

40.1 Belle Isle Marsh

**Plant Biodiversity**

- Gray Birch: *Betula populifolia*
- Scrub Pine: *Pinus virginiana*
- White Pine: *Pinus strobes*
- Weeping Willow: *Salix babylonica*
- Red Pine: *Pinus resinosa*

**Bird**

- Robin
- Common Crow
- Gull
- Meadow Lark
37.2 Assembly Square Mall Riverfront

Plant Biodiversity

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway Maple</td>
<td>Acer platanoides</td>
</tr>
<tr>
<td>Tree of Heaven</td>
<td>Ailanthus altissima</td>
</tr>
<tr>
<td>Speckled Alder</td>
<td>Alnus rugosa</td>
</tr>
<tr>
<td>Balsam Poplar</td>
<td>Populus balsamifera</td>
</tr>
<tr>
<td>Honey Locust</td>
<td>Geitsia tricenthanos</td>
</tr>
<tr>
<td>White Pine</td>
<td>Pinus strobus</td>
</tr>
<tr>
<td>Hornbeam</td>
<td>Ostrya virginiana</td>
</tr>
<tr>
<td>Pin Oak</td>
<td>Quercus palustris</td>
</tr>
<tr>
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<tr>
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<td>Alnus serrulata</td>
</tr>
<tr>
<td>Red Pine</td>
<td>Pinus resinosa</td>
</tr>
<tr>
<td>American Bittersweet</td>
<td>Celastrus scandens</td>
</tr>
<tr>
<td>Japanese Knotweed</td>
<td>Polygonum cuspidatum</td>
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<td>American Basswood</td>
<td>Tilia americana</td>
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<td>Softleaf Arrowood</td>
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</tr>
<tr>
<td>Buckthorn</td>
<td>Rhanbys sp</td>
</tr>
<tr>
<td>Ironwood</td>
<td>Carpinus caroliniana</td>
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<tr>
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</tr>
<tr>
<td>Prunus</td>
<td>Prunus sp.</td>
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<td>Cranberry Viburnum</td>
<td>Viburnum trilobum</td>
</tr>
<tr>
<td>Common Cattail</td>
<td>Typha latifolia</td>
</tr>
</tbody>
</table>

Bird Diversity

Common Grackle
Gull
38.1 Mary O'Malley Park

Plant Biodiversity

Honey Locust
Scarlet Oak
Pin Oak
Norway Maple
Peach Leaf Willow
White Mulberry
Japanese Knotweed
Black Birch
Staghorn Sumac
Tree of Heaven
Alder
American Bittersweet
Red Pine
Gray Birch
Mountain Laurel
Choke Cherry
American Basswood
Smooth Sumac
Black Locust
Narrowleaf Spirea
Washington Hawthorn
Red Mulberry
American Elm
Common Cottonwood
Common Dandelion
Milkweed
Wild Carrot
Ironwood
Cranberry Viburnum
Bitter Nightshade
Wild Rose
Poison Ivy

Gleitsia tricanthos
Quercus coccinea
Quercus palustris
Acer platanoides
Salix amygdaloides
Morus alba
Polygonum cuspidatum
Betula lenta
Rhus typhina
Ailanthus altissima
Alnus sp.
Celastrus scandens
Pinus resinosa
Betula populifolia
Kalmia latifolia
Prunus virginiana
Tilia americana
Rhus glabra
Robinia pseudoacacia
Spirea alba
Crategus phaenopyrum
Morus rubia
Ulmus americana
Populus grandidentata
Taraxacum officinale
Ailanthus altissima
Daucus carota
Carpinus caroliniana
Viburnum trilobum
Solanum dulcamara
Rosa sp.
Rhus radicans

Bird Diversity

Gull
16.3 Boston Regional Medical Center

**Plant Biodiversity**

Norway Spruce  
Red Maple  
Arrowwood  
Eastern Hemlock  
White Pine  
Crab Apple  
White Spruce  
Staghorn Summac  
Pin Oak  
Rhododendron  
Gray Birch  
Coastal Pepperbush  
Cat Grape  
Giant Reed  
Poison Ivy  
Common Dandelion  
Common Cattail  
Purple Loosestrife  
Wild Carrot (Queen Anne's)  
Speckled Alder rose  
June berry  
Buckthorn  
Ironwood  
Cherry  
American Bittersweet  
Blue Ash  
Peachleaf Willow  
Northern White Cedar  
Honey Locust  
Yellowwood  
Scarlet Oak  
Leather wood  
Sourgum  

**Bird Diversity**

Morning Dove  
Sparrow  
Canada Goose  
House Finch  
Crow  
Cardinal
### 36.1 Mystic River Reservation

#### Plant Biodiversity

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>Scientific Name</th>
</tr>
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<tbody>
<tr>
<td>Pin Oak</td>
<td><em>Quercus palustris</em></td>
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<td>Black Locust</td>
<td><em>Robinia pseudoacacia</em></td>
</tr>
<tr>
<td>American White Birch</td>
<td><em>Betula papyrifera</em></td>
</tr>
<tr>
<td>Tree of Heaven</td>
<td><em>Ailanthus altissima</em></td>
</tr>
<tr>
<td>Weeping Willow</td>
<td><em>Salix babylonica</em></td>
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<td><em>Polygonum cuspidatum</em></td>
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<tr>
<td>Staghorn Sumac</td>
<td><em>Rhus typhina</em></td>
</tr>
<tr>
<td>American Bittersweet</td>
<td><em>Celastrus scandens</em></td>
</tr>
<tr>
<td>Poplar</td>
<td><em>Populus sp.</em></td>
</tr>
<tr>
<td>Gray Birch</td>
<td><em>Betula populifolia</em></td>
</tr>
<tr>
<td>Scarlet Oak</td>
<td><em>Quercus coccinea</em></td>
</tr>
<tr>
<td>Milkweed</td>
<td><em>Ailanthus altissima</em></td>
</tr>
<tr>
<td>Atlantic White Cedar</td>
<td><em>Chamaecyparis thyoides</em></td>
</tr>
<tr>
<td>Balsalm Poplar</td>
<td><em>Populus balsamifera</em></td>
</tr>
<tr>
<td>Northern Arrowwood</td>
<td><em>Viburnum recognitum</em></td>
</tr>
<tr>
<td>Dogwood</td>
<td><em>Cornus sp.</em></td>
</tr>
<tr>
<td>Prunus</td>
<td><em>Prunus sp.</em></td>
</tr>
<tr>
<td>Wild Carrot</td>
<td><em>Daucus carota</em></td>
</tr>
<tr>
<td>Smooth Alder</td>
<td><em>Alnus serrulata</em></td>
</tr>
<tr>
<td>Bitter Nightshade</td>
<td><em>Solanum dulcamara</em></td>
</tr>
<tr>
<td>Purple Loosestrife</td>
<td><em>Lythrum salicaria</em></td>
</tr>
<tr>
<td>Wild Rose</td>
<td><em>Rosa sp</em></td>
</tr>
<tr>
<td>Giant Reed</td>
<td><em>Phragmites communis</em></td>
</tr>
</tbody>
</table>

#### Bird Diversity

- Mallard
- Common Grackle
- American Robin
- House Sparrow
- American Goldfinch
- Red wing blackbird
5.6 Woburn Landfill

**Plant Biodiversity**

<table>
<thead>
<tr>
<th>Species</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giant Reed</td>
<td><em>Phragmites communis</em></td>
</tr>
<tr>
<td>Wild Rose</td>
<td><em>Rosa sp.</em></td>
</tr>
<tr>
<td>American White Birch</td>
<td><em>Betula papyrifera</em></td>
</tr>
<tr>
<td>Red Oak</td>
<td><em>Quercus rubra</em></td>
</tr>
<tr>
<td>Gray Birch</td>
<td><em>Betula populifolia</em></td>
</tr>
<tr>
<td>Red Pine</td>
<td><em>Pinus resinosa</em></td>
</tr>
</tbody>
</table>

**Birds**

- Morning Dove
- Red Tail Hawk

8.1 Burlington Forest

**Plant Biodiversity**

<table>
<thead>
<tr>
<th>Species</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staghorn Sumac</td>
<td><em>Rhus typhina</em></td>
</tr>
<tr>
<td>Poison Ivy</td>
<td><em>Rhus radicans</em></td>
</tr>
<tr>
<td>Red Maple</td>
<td><em>Acer rubrum</em></td>
</tr>
<tr>
<td>Red Oak</td>
<td><em>Quercus rubra</em></td>
</tr>
<tr>
<td>American Elm</td>
<td><em>Ulmus americana</em></td>
</tr>
<tr>
<td>White Pine</td>
<td><em>Pinus alba</em></td>
</tr>
<tr>
<td>White Oak</td>
<td><em>Quercus alba</em></td>
</tr>
<tr>
<td>Pin Oak</td>
<td><em>Quercus palustris</em></td>
</tr>
<tr>
<td>Sassafras</td>
<td><em>Sassafras albidum</em></td>
</tr>
<tr>
<td>Northern Arrowwood</td>
<td><em>Viburnum recognitum</em></td>
</tr>
<tr>
<td>Atlantic White Cedar</td>
<td><em>Thuja occidentalis</em></td>
</tr>
</tbody>
</table>
Horn Pond

Red Oak  Quercus rubra  
Weeping Willow  Salix babylonica  
Wild Rose  Rosa sp.  
Tree of Heaven  Ailanthus altissima  
Staghorn Sumac  Rhus typhina  
Common Cattail  Typha latifolia  
Knotweed  Polygonum cuspidatum  
Purple Loosestrife  Lythrum salicaria  
White Pine  Pinus alba  
Red Maple  Acer rubrum  
Balsalm Poplar  Populus balsamifera  
Common Cottonwood  Populus deltoids  
American Bittersweet  Celastrus scandens  
American White Birch  Betula papyrifera  

Bird diversity

Mallard  
Red Wing Blackbird  
Gull  
Swan  
Chickadee  
House Sparrow  
American Gold Finch  

10.3 Cranberry Bog

Plant Biodiversity

White Pine  Pinus alba  
Red Maple  Acer rubrum  
Norway Maple  Acer platanoides  
American White Birch  Betula papyrifera  
Staghorn Sumac  Rhus typhina  
Spirea  Spirea sp.  
Swamp Cottonwood  Populus heterophylla  
Buckthorn  Rhamnus sp.  
Hickory  Carya sp.  
Japanese Knotweed  Polygonum cuspidatum  
Horse Chestnut  Aesculus hippocastanum  
Grape  Vitis sp.  
American Elm  Ulmus americana  
Sugar Maple  Acer saccharum  
Red Oak  Quercus rubra  
White Oak  Quercus alba  

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Bittersweet</td>
<td>Celastrus scandens</td>
</tr>
<tr>
<td>Wild Carrot</td>
<td>Daucus carota</td>
</tr>
<tr>
<td>European Buckthorn</td>
<td>Rhamnus cathartica</td>
</tr>
<tr>
<td>Honeysuckle</td>
<td>Viburnum sp.</td>
</tr>
<tr>
<td>Poison Ivy</td>
<td>Rhus radicans</td>
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<tr>
<td>Buckthorn</td>
<td>Rhamnus sp.</td>
</tr>
<tr>
<td>Pussy Willow</td>
<td>Salix discolor</td>
</tr>
<tr>
<td>Alder</td>
<td>Alnus sp.</td>
</tr>
<tr>
<td>Cucumber Magnolia</td>
<td>Magnolia acuminata</td>
</tr>
<tr>
<td>Shortstock Arrowwood</td>
<td>Viburnum dentatum</td>
</tr>
<tr>
<td>Giant Reed</td>
<td>Phragmites communis</td>
</tr>
<tr>
<td>Purple Loosestrife</td>
<td>Lythrum salicaria</td>
</tr>
<tr>
<td>Smooth Alder</td>
<td>Alnus sp.</td>
</tr>
<tr>
<td>Common Cattail</td>
<td>Typha latifolia</td>
</tr>
<tr>
<td>Wild Rose</td>
<td>Rosa sp.</td>
</tr>
</tbody>
</table>

**Bird Diversity**

- American Robin
- Morning Dove
- Cardinal
- Red wind Blackbird
- Hawk
- Canada Geese
- Mallard