Central Campus and the
Sarah P. Duke Gardens Expansion

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Abstract

With the development of Central Campus at Duke University the opportunity may exist for one hundred acres of hollows between East and West campus and a greenway swath to be assigned to Sarah P. Duke Gardens for oversight. This Masters project examines one possible scenario for the future of the Central Campus hollows. The Gardens welcomes the opportunity for this addition to the garden footprint and the possible connection that may exist to develop an academic connection to the University. This Central Campus Master Plan is to be developed over the next twenty to fifty years with possible initial construction to begin the summer of 2008.

The Gardens would like the opportunity to restore the hollows back to a pine-hardwood forest. This addition would tie in to the current mission of the Gardens – to create and nurture an environment for learning, inspiration and enjoyment. Through a concentrated effort on the removal of invasive plants and the addition of native species the Gardens education programs would be enriched and a new connection to University academics would be established. With the establishment of new partnerships with various Duke Departments within campus service and the academic areas, the development of the hollows will improve Central Campus.

The Gardens already functions as storm water control. With the increase of impervious surfaces that Central Campus could add, the amount of storm water runoff that will impact the Gardens and the hollows will increase. The one hundred acres of hollows of pine-hardwood would not only provide opportunities for education and research, but it would provide a mechanism to manage storm water runoff and water quality.
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Introduction

Duke University is currently reviewing options for developing the area located between East and West campus known as Central Campus. Located in the Central Campus, called “a jewel in the crown” by President Keohane, the Sarah P. Duke Gardens (SPDG) may have the good fortune to inherit one hundred acres of wooded hollows, and gain a “greenway” swath from the northern corner of the W. L. Culberson Asiatic Arboretum along Flowers drive to Erwin Road.

Among new opportunities for the Gardens are a new classroom and teaching greenhouse space located in our horticultural support complex. The possibility of having an academic connection with the Gardens is welcomed. The ability to expose the Gardens to the Duke students is very exciting to the staff. Expansion of our educational classes in both the adult and children’s areas offers the ability to broaden the appeal of the Gardens to the University and community is a wonderful opportunity.

The Gardens opportunity for the hollows has been discussed between the Central Administration and the Executive Director of the Gardens. The University is currently working on a Central Campus Master Plan that will affect development on over 200 acres of land. This development would upgrade many facilities located on Central Campus over a 20-50 year period. The aim of the plan is to create a graduate student campus, flanked by East and West undergraduate campuses, and to develop an area that would attract the entire Duke community. Part of this Master Plan is an estimated 100 acres of hollows that will not be developed and has the potential of coming under the leadership of the Gardens.
The Question that the Executive Director and Board of Advisors should ask is how might the hollows be restored and developed in a method that would meet the goals of the master plan while enhancing the mission of the SPDG? This project will start with a comparison of the development of SPDG and each mission statement mirroring the times. I will discuss the opportunities that may present themselves to the Gardens with the development of Central Campus and the 100 acre hollows. I will explain why the proposed addition should be part of the Gardens and how this addition will complement the mission. Then detail my proposal of one action plan for the additional areas that will have direct impact on the Gardens. I will conclude with a vision of how to achieve success in relation to the additional land from Central Campus into the mission of the Gardens.

Sarah P. Duke Gardens Background

Duke Gardens is located at 426 Anderson Street, Durham, North Carolina. The Gardens is a 55-acre botanical display garden open to the public free of charge 365 days a year. (Figure 1) Campus Drive borders the Gardens on the South, Flowers Drive to the West, Anderson Street on the East and Lewis and Yearby Streets on the North. The Gardens consists of four major areas, the original Historic Terraces, the H.L. Blomquist Garden of Native Plants, the W.L. Culberson Asiatic Arboretum and the Doris Duke Center and its surrounding gardens.

Today, the SPDG is recognized as one of the premier public Gardens in the United States. The SPDG has an estimated 300,000 visitors annually from all over the world (Gardens 1995). The Gardens are located on Duke University’s Central Campus and is an integral part of the University in the space it occupies, its mission, and the funding that receives from the University. By virtue of its location and mission, the Gardens has taken on the role of ambassador for the
University through its mission to serve the public. The Gardens is open from eight AM until dusk for people of all ages, ethnic, and financial backgrounds to come to learn, for inspiration and enjoyment.

Figure 1 - Sarah P. Duke Gardens Map (Gardens 1995)
Mission Statements over the Years

Like many organizations the mission statement of the Gardens provides a guide for staff and administration on its reason for being and its core objectives. This was not always so. In the beginning, SPDG did not have a mission statement. The Gardens started as just a passion for plants by Dr. Frederick M. Hanes M.D. (Semans 1992). The valley that would eventually become the SPDG was on the original Duke University master plan as a lake. Dr. Hanes proposed that the site be developed as a garden. So, in 1934, what is now the South Lawn became the first site of Duke Gardens with an estimated 75,000 plants, especially irises (Durden 2001). Owing to a sequence of major rain storms the original iris gardens were washed away regularly. Undaunted by this, Dr. Hanes proposed relocating the plants to higher ground. Ellen Shipman, a prominent woman landscape architect, set forth on the task of designing a more formal garden than that of the iris garden (Durden 2001). This led to the creation of the Terraces on a nearby slope and they became the second site for the Gardens.

The Terraces were dedicated in 1939 as a memorial to Sarah P. Duke. Over the next several years, still being guided by a love for plants, the historic core developed and grew to include the terraced gardens, a rock garden and an English style South Lawn. In 1968, the Blomquist Garden of Native Plants was opened to the public. Known as one of the finest botanical collections of native southeastern United States plants, the six and one half acre garden was dedicated in honor of Duke Professor Hugo L. Blomquist, founding chair of the Department of Botany and authority on the flora of the southeast. The site sits on agricultural land which was abandoned soon after the Civil War. It now contains more than 900 species and varieties of native plants, a fern grotto and natural spring (Steffek 1997).
In 1982 a large retention pond was designed and installed to help deal with the constant flooding of the Gardens after heavy rains. Even though it has never formally been part of the Gardens mission, the work of storm water management is still being done today within the Gardens walls. Beginning in 1984 the twenty acres North of the Terraces and surrounding the new pond has become home to more than 550 species and cultivars of Asian flora (Gardens 1995). The botanical objective of creating the W. L. Culberson Asiatic Arboretum was to show the unique relationship between many plants of the eastern Unites States and eastern Asia. These groups are referred to as vicariates or disjunctive species.

The first reference to a mission statement for the Gardens comes from a Gardens brochure; the date is unknown and it was found in a scrapbook at the Gardens library, but it is believed to be from the early eighty’s. This mission statement, believed to be the work of Dr. William Culberson, Executive Director SPDG 1978-98, explained that the gardens had two functions. The first is aesthetic: to provide a superb example of the ornamental garden as a fine art (Semans 1992). The second function: to be an educational resource for the University (Semans 1992).

**First Mission Statement**

The Mission of the Sarah P. Duke Gardens of Duke University is to be an example of the gardens as fine art, providing enjoyment, education and inspiration for all people who enter.

Dr. Culberson felt that the goal was achieved by acquainting the public with the kinds of plants suitable for culture in this area. This was accomplished through the Blomquist garden
with its labeled collection of 900 wildflowers of the southeastern United States, the introduction of trees and shrubs from a foreign flora in the Asiatic Arboretum and the Terrace plantings (Semans 1992). The second mission statement approved in 1992, expanded on the first statement. Bullet points were added because it became necessary to include the contribution the Gardens made to the community, both the University and its surroundings.

Mission Statement 1992

The Mission of the Sarah P. Duke Gardens of Duke University is to be an example of the gardens as fine art, providing enjoyment, education and inspiration for all people who enter.

*to promote an appreciation of the gardens as fine art through excellence in landscape design, preservation, plantings, ornament, and horticultural practices;
*to encourage knowledge of the plants of the southeastern United States and their use as landscape subjects;
*to further the understanding of the plants of eastern Asia and their relationship to their counterparts in the eastern United States;
*to develop, display, and maintain documented collections of seasonal and perennial garden-worthy plants for use in comparable climatic regions;
*to provide aesthetic enjoyment and an appreciation of the garden as a place for pleasure, relaxation, and renewal

For the next ten years, the Gardens staff focused on the mission of the Gardens by developing the space into a setting for memorable and enriching experiences, quiet
contemplation, relaxation, and renewal. Knowing that the Gardens’ mission was twofold and that development had leaned heavily on the Gardens as a fine art, it was time to concentrate on developing the educational component of the mission. The existing educational programs were at their maximum because no indoor public space for programming was available for inclement weather. In 2001 the Doris Duke Center was dedicated and this led to the revision of the mission statement which was approved in 2002.

**Mission Statement 2002**

The mission of Sarah P. Duke Gardens of Duke University is to be an example of the garden as fine art, providing visitors aesthetic pleasure and a setting for spiritual renewal. It is to introduce children to the discovery of nature and adults an appreciation of plant life. It is also to educate by: demonstrating excellence in landscape design and horticulture, including the selection of the most garden-worthy plants for its climatic zone; familiarizing the public with the native flora of the southeastern United States, including indigenous plants for landscape use; and illustrating the closely related and horticulturally rich flora of eastern Asia.

The Doris Duke Center facility hosts a variety of events from adult and children classes to weddings, meetings, and theatrical performances. The Center is surrounded by a number of new gardens including the serpentine, white garden, pond and amphitheatre. East of the Center is the horticultural support area with equipment storage, offices, twin greenhouse and the head house. These areas are necessary for the support, maintenance and upkeep of the Gardens. These additions highlighted the new SPDG mission by reinforcing the ability to create an
environment for learning and settings for memorable experiences. After the Center was opened and operational for a couple of years the staff revisited the mission statement. With a few changes in key leadership roles over the last couple of years the mission statement was modified to reflect a more succinct mission and was adopted in 2003.

**Mission Statement 2003**

The Mission of the Sarah P. Duke Gardens is to create and nurture an environment for learning, inspiration, and enjoyment;

- Demonstrate, as a living museum, excellence in garden design, horticulture, and plant collections;
- Present diverse learning opportunities to further understanding and appreciation of the natural world, plant life, and conservation;
- Provide settings for memorable and enriching experiences, quiet contemplation, relaxation, and renewal;
- Respect Duke Gardens' heritage.

Working with this version for the next four years, the staff set forth on a vision of the future of the Gardens. With the recently completed master plan in 2005, a guide for the Gardens next twenty five years was developed. The staff, along with members of the Board of Advisors, the Master Planning Task Force Committee, and guidance from landscape architects Marshall Tyler and Rausch, detailed several goals for future development and growth of the Gardens including:
• Improve circulation, legibility, and accessibility for all visitors
• Expand the Gardens’ presence at its edges, creating links to its surroundings and responding to future development as identified in the Duke University Master Plan
• Improve the welcome experience for visitors
• Preserve and enhance the existing gardens and improve their visibility and function
• Preserve the Gardens’ forest setting and historic character
• Create new gardens and facilities that serve the Gardens’ mission and that logically connect its existing gardens and facilities
• Increase opportunities for earned income
• Identify short- and long-term development objectives

(Marshall 2004)

Part of this plan included the development of “garden fingers” that would sprawl out into the campus and surrounding urban areas to help expand the presence of the Gardens outside of the confines of the existing rock wall (Marshall 2004). With a master plan in hand and the changing environmental emphasis by the University and beyond, the Gardens again reworked its mission statement to reflect the times.

Mission Statement 2007

The Mission of the Sarah P. Duke Gardens is to create and nurture an environment for learning, inspiration, and enjoyment;

* Demonstrate, as a living museum, excellence in garden design, horticulture, and plant collections;
*Complement Duke University’s role in research and education as a premier institution of higher learning;

* Present diverse learning opportunities to further understanding and appreciation of the natural world, plant life, and conservation;

* Strive to be recognized as a model for environmental stewardship and sustainability;

* Provide settings for memorable and enriching experiences, quiet contemplation, relaxation, and renewal;

* Respect Duke Gardens' heritage.

The Master Plan suggests extending the Gardens out into the University with “garden fingers”. Both the hollows and greenway extend Gardens presence beyond the rock walls. Then, from the mission statement, complementing the educational role within the University and being a model for environmental sustainability the land could be developed in order to create new partnerships with University departments and academia. By creating partnerships directly with the School of the Environment or even individual instructors to develop classes or research sites within the hollows the Gardens could complement Duke University’s role in research and education as a premier institution of higher learning. As the Gardens strive to be recognized as a model for environmental stewardship and sustainability, the Gardens could begin joint projects with Duke Recycles by locating recycling facilities around the hollows. Many of these partnerships will help present a diverse learning opportunity as well as an understanding of the natural world.
Central Campus Planning: an environmental approach

Duke University, in 2000, adopted a new overall Campus Master Plan. There are eight principles that will guide the University’s planning decisions into the 21st century.

- Duke is a historic and dynamic campus
- Duke is a premier University
- Duke includes an internationally recognized health system
- Duke is a University in the forest
- Duke is a collection of memorable places
- Duke should be a walkable campus supported by an understandable circulation system
- Duke is a community of communities
- Duke is a citizen of Durham and the region

(Architect 2004)

The Duke University Campus is unique (Figure 2). A large amount of the campus is less than a 100 years old and is both historical and full of life (Architect 2004). The challenge faced by many departments at the University is to preserve, enhance, and maximize the campus resources in support of Duke’s mission of research, health care and education (Architect 2004).
The Central Campus redevelopment is currently in the design phase within the University Master Plan. The Master Plan goal for the area is to develop the central part of the campus as an academic hub which would join and complement both East and West Campus (Figure 3).
Figure 3 - *Central Campus Master Plan* (Biohabitats 2005)

This proposed acquisition of 100 acres of hollows for the Gardens could complement the University’s overall commitment to increase their environmental sustainability and reduce the campus ecological footprint. The University made its environmental sustainability commitment known in 2005 by adopting an Environmental Policy which states:

“Duke University seeks to attain and maintain a place of leadership in all that we do. This includes leadership in environmental stewardship and sustainability on our campus, in our medical institutions, and in the larger community of which we are a part. We will bring vision, intellect, and high ethical standards to our pursuit of environmental leadership in research and teaching, institutional operations, and our relationship with the community.

**Academics**

Duke University will continue to be in the forefront of environmental research and education and will continue to use our institutional capability to constructively affect environmental policy throughout the world. We are committed to supporting interdisciplinary environmental scholarship and research, disseminating information
about environmental research and policy, increasing faculty and student awareness of environmental issues, and enhancing environmental educational offerings.

Operations

Duke University will comply with all relevant environmental laws and regulations and go beyond compliance by integrating the values of sustainability, stewardship, and resource conservation into our activities and services. We will make decisions to improve the long-term quality and regenerative capacity of the environmental, social, and economic systems that support the University’s activities and needs. We will engage in pollution prevention activities and develop and promote practices that maximize beneficial effects and minimize harmful effects of operations, research, and activities on the surrounding environment. We are committed to assessment of the environmental impacts associated with our activities and services, and we will develop and track measures of our progress.

Community

Duke University is committed to playing a constructive and collaborative role as a responsible environmental citizen in the life of the surrounding community. We will maintain a positive and proactive role in communicating with the surrounding community, especially the Durham community, regarding our environmental activities and performance.”

(Biohabitats 2006)

The University has also taken a leadership role in the area of environmental stewardship (Biohabitats 2006). In 2003 the University dedicated to require that all new construction and renovations be LEED certified (Biohabitats 2006).

“The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ is the nationally accepted benchmark for the design, construction, and operation of high performance green buildings. LEED gives building owners and operators the tools they need to have an immediate and measurable impact on their buildings’ performance. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.” (Council 2007)

Starting with the West Edens Link, Duke has included LEED certification in the planning process of all new construction and renovations (McDaniel 2006). The University commitment is
to obtain a silver or higher rating for all its buildings. Keeping this in mind, there are a number of environmental issues that the Central Campus development will be facing.

One goal due to the size of the Central Campus project is to minimize the amount of site disturbance during any phase of construction (Biohabitats 2006). This minimization could be enhanced by conserving present natural areas. This would include protecting existing trees, encouraging biodiversity, lessening the impact of soil compaction, and controlling erosion and sediment impacts to the surrounding areas especially the hollows (Biohabitats 2006). To accomplish this, control measures will be implemented which conform to the U.S. EPA document # EPA 832/R-92-005. This is the Storm Water Management for Construction Actives standards which include the redirecting of the solid and construction waste to a recycling or reuse center (Biohabitats 2006).

**Sarah P. Duke Gardens Planning: development of the hollows**

Duke’s commitment to the environment is consistent with the Gardens’ current mission statement: to strive to be recognized as a model for environmental stewardship and sustainability and provide settings for memorable and enriching experiences, quiet contemplation, relaxation, and renewal. At present, the horticultural staff is working towards sustainable practice throughout the Gardens. These practices include controlling invasive species, composting, drip irrigation, mulching and rain water collection. The horticulturists could build upon these practices by using the hollows to demonstrate, a living museum, garden design, horticulture, and plant collections as well as sustainable ecological practices. The incorporation of native plants to bring the hollows back to a more natural state would be an extension of the Gardens mission and would complement the existing Blomquist garden.
The adult and children’s educational programs are commitment to presenting learning opportunities to understand and appreciate the natural world, plant life and conservation through environmental workshops, classes and symposiums dealing with horticultural and sustainable practices. One way the Gardens’ education program would use the hollows would be to identify the native species and in turn give the University an outdoor extension of the more traditional classroom. Labeling of the species in the hollows by the Gardens staff would complement the labeling Duke has started of many of the large specimen trees found on campus.

The hollows by virtue of their topography were undeveloped. Like much of Duke University campus, the wooded areas and hollows were cut and used as farmland or abandoned. Ultimately the land was purchased by the school, the nutrients needed for a healthy environment were depleted from this land by over use, wind and rain erosion (University 2007). This neglect left much of the area weather beaten and gully marked and the hollows are now in different stages of succession.

The time frame that I am proposing for restoration is in the later stage of the young pine forest succession. This is between the 25th and 35th year of succession in the piedmont (University 2007). This state is highlighted yellow in figure four. (Figure 4) However based on what vegetation is currently on the various sites and the potential resources available to develop the hollows, the opportunity exists to demonstrate later stages of the hardwood transition in some areas of the hollows (Edeburn 2007).
<table>
<thead>
<tr>
<th>Year Range</th>
<th>Vegetation Description</th>
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<tbody>
<tr>
<td>1st Year</td>
<td>Horseweed dominant; crabgrass, pigweed</td>
</tr>
<tr>
<td>2nd Year</td>
<td>Asters dominant; crabgrass</td>
</tr>
<tr>
<td>3rd to 18th Year</td>
<td>Grass scrub community; broomsedge grass, pines coming in during this stage</td>
</tr>
<tr>
<td>19th to 30th Year</td>
<td>Young pine forest</td>
</tr>
<tr>
<td>30th to 70th Year</td>
<td>Mature pine forest; understory of young hardwoods</td>
</tr>
<tr>
<td>71st to 100th Year</td>
<td>Pine to hardwood transition</td>
</tr>
<tr>
<td>100th Year plus</td>
<td>Climax oak-hickory forest</td>
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**Figure 4 - North Carolina Succession** (University 2007)

The vegetation in the hollows is consistent with the succession patterns of re-growth, but invasive species have begun to take over many areas of the hollows. The Central Campus area is located in the Piedmont of North Carolina and land in this area is known to be affected by disturbances, ranging from farming, hurricanes and fire but overtime the vegetation will eventually return to a mixed hardwood climax forest (University 2007).

The 100 acres or the hollows are in relatively good condition (Edeburn 2007). The hollows seemed to have “bookends” at either side of the ravines. Starting from the bottom of the ravines moving upward there is an estimated 75’ zone that is heavily overgrown with invasive
species. Working up the side it returns to a healthier stand of forest. Once at the top, again there is a 75’ zone of invasive species that is choking out the existing forest. The age of the forested areas, trees above 25’, is a range from 25 years to 70+ years (Edeburn 2007). Here it would be necessary to do a more extensive evaluation, possibly using a core sampling or cruiser stick, to get a more accurate assessment to gauge what stage of succession would be best suited for the area. There was a natural movement from one succession zone to the next perpendicular to the creek in the west hollow (Edeburn 2007). It moves across in almost a visually perfect succession, from a young pine forest to a pine-hardwood mix to a mature hardwood stand.

A recent walk through of the area confirmed the presence of over 90 species of existing flora. (Appendix A) The hollows were walked at low, middle and high ravine elevation. With the visual inspection of the hollows, an estimation of 75% of the herbaceous and shrubs in the lower section were invasive (Holmes 2007). But as we moved up the slope we found that the make up of the tree layer was about 97% native in relation to the way the Gardens classifies its trees (Holmes 2007). Dead and fallen trees, especially pine, are a major challenge for the Gardens. Southern pine bark beetle has been an important cause of pine mortality (Jenkins 2007). As we walked through the areas under consideration, there were a number of trees that should be removed to lessen the possible spread of the pine beetle to other healthy trees.

The 100 acres of hollows are currently an urban watershed and would need to continue that function (Figure 5). A 300’ wide corridor has been suggested to maintain the streams that drain the hollows to Sandy Creek (Biohabitats 2006). These hollows also support wildlife habitat corridors. If the land acquisition takes place, SPDG would plan for the restoration of the land, the elimination of invasive species and the protection of the hollows as a buffer to benefit
wildlife habitat, water quality, and stream stability (Biohabitats, 2006). In addition the plan would need to incorporate the Gardens mission and develop additional opportunities for education and research.

![Study site of Central Campus, in red](image)

**Figure 5 - Study site of Central Campus, in red** (Biohabitats 2006)

The planned care provided to the hollows by SPDG would further develop the commitment the University has undertaken already with the Sandy Creek restoration project. With the Sandy Creek restoration in 2004, Duke transformed an eight acre wetland off of highway 751 to help control storm water runoff (Lucas 2004). The project restored a silt clogged, heavily eroded stretch of the creek (Lucas 2004). Over time, storm water runoff from the Central Campus hollows will directly affect Sandy Creek if the hollows are not enhanced. Similar to that project, the hollows would be used to help with storm water runoff from the Central Campus
development. In addition this land would be used in the master plan as a buffer for green space. Successful restoration would recreate the natural habitat that would have been found in the area around thirty years ago.

The area under consideration is now re-forested land that was abandoned following the Civil War. The North Carolina landscape prior to this period was mixed pine-hardwood forests which covered much of northeastern part of the state. The mix included species such as loblolly pine, oak, hickory, with dogwood, cedar and magnolia (Gary B. Blank 2001). The loblolly pine (\textit{Pinus taeda} Mill.) forest dominated the eastern North Carolina landscape prior to the settlement by the Europeans (Carolina 2007). With over two hundred years of clearing for agricultural purpose the loblolly pine has been reduced to a vestige in the forest landscape. There are an estimated sixteen varieties of oak (\textit{Quercus}) native to North Carolina (Carolina 2007). Among the varieties that would be found in the Piedmont region are post oak (\textit{Quercus stellata Wangenh}), swamp red oak (\textit{Quercus pagoda} Raf), swamp chestnut oak (\textit{Quercus michauxii} Nutt.) and willow oak (\textit{Quercus phellos} L.) to name a few (Carolina 2007). Within this pine-hardwood mix the hickory (Carya) would make up the third major dominate hardwood. One that is common along streams and hillsides throughout the state is the shagbark hickory (\textit{Carya Ovata (MUL) K Koch.}) (Carolina 2007). The minor species that would add diversity to the mix would be the flowering dogwood (\textit{Cornus florida} L) which adds the white waft of flowers under the canopy of larger forest trees (Carolina 2007). The most commonly found tree in the Piedmont is the Eastern red cedar (\textit{Juniperus virginiana} L.) which can thrive from acidic wetlands to dry rocky soils (Carolina 2007). Finally the Southern magnolia (\textit{Magnolia grandiflora} L.) would round out the diversity of trees, native to the central and southern Coastal Plain found in many of the well drained soil conditions (Carolina 2007). Biohabitats, the Central Campus Plan
environmental consultant, has recommended a number of native plants that will enhance the soil conditions of the hollows. (Appendix B)

I recommend that the hollows be restored back to a pine-hardwood forest. The zone where these hollows are located will be directly affected by the surrounding development. Much of the area within Central Campus will contain land that is being developed as impervious surfaces which will increase the amount of water run off into the hollows. The pine-hardwood forest would enhance the areas natural function as a watershed from surrounding areas. The swath and other parts of Central Campus could also increase the runoff into the existing Gardens.

**Vision of Project and Sarah P Duke Gardens**

The opportunity to obtain additional land for the Gardens is a wonderful prospect. This acquisition could help the Gardens accomplish and further develop its current mission. The acquisition would create the opportunity to revisit the mission statement. The issue of restoration and related research is not discussed in the current mission or bullet points of the SPDG.

The Gardens will be able to claim success for this project by setting a number of benchmarks and targets in conjunction with this project. First, the horticultural staff will be able to demonstrate the transformation from a ravine to a living museum. The University will be able to measure this with not only a visual change but with the improved quality of water moving through the campus. With the partnerships that the staff will make to develop this site into a model for environmental sustainability, the University will see a stronger presence of Gardens staff involved with academic programs and University committees dealing with environmental
issues on campus. Learning opportunities will open up for not only Gardens staff, but also for
the University community and campus visitors offering a better understanding of the natural
world, plant life and conservation.

The Gardens’ education programs, children and adult, will develop these opportunities by
increased programs in the new outdoor classroom “extension”. This will be measurable by the
current bench mark that has been set with the number of educational activities the Gardens offers
today. The addition of the hollows will open new connections for research opportunities
involving the Gardens and leading educators of Duke University. Having the ability to offer a
range of different settings from the original Gardens including a greenhouse and classroom, to
the greenway swath and hollows, this will also offer the School of the Environment an extension
to their choices of teaching sites. The development of individual opportunities for master’s
projects and independent study projects will provide enriching experiences for the Duke student,
at both the graduate and undergraduate levels.

Vision in context of Gardens Mission

There are two extremes that Central Administration has expressed for the possible
development of the area. The first is to do nothing and let it continue on its current course of
being overtaken by invasive species. (Figure 6) The other extreme for the area is a mesh of
walking and bike trails throughout the hollows. I believe that the Gardens approach should fall
in the middle of those extremes. This would be accomplished by utilizing the horticultural and
educational staff as well as our Garden internship program. The approach I am recommending
would start with the removal of the invasive species. This could take three to five years. During
that time planting and converting the landscape to the healthy pine-hardwood forest would be
taking place as nonnative species were removed. (Figure 7) The restoration would incorporate an educational component. The teaching-by-doing method with the interns would supply additional labor to complement the Gardens staff in the restoration process. The Gardens would, in accordance with their mission provide settings for memorable and enriching experiences, quiet contemplation, relaxation, and renewal by developing visitor trails and pathways through the site while being sensitive to the environmental surroundings. This would give visitors the ability to view the restored hollows after the “clean-up”.

![Figure 6 – Existing conditions (photo by Author)](image1)

![Figure 7 – Healthy pine-hardwood forest (Lea 2006)](image2)

If the Gardens were not given the opportunity to oversee the hollows or the greenway swath other possible oversight would include Facility Management Department (FMD) and Duke Forest. The aim of FMD is to make every effort to create and maintain a campus that is clean, safe, ecologically sound and aesthetically pleasing (Department 2005). Under their guidelines there is no mention of an educational element to tie the project back to environmental
education. They strive for an aesthetically pleasing environment but do not plan for interaction between the environment and visitors or the University community. Examples of FMD’s oversight are the wooded areas behind the Bryan Center and the section between the rear of the Chapel and Science Drive.

The second department that could manage the area is the Duke Forest. The focus that Duke Forest has on forestry education and research has expanded to include ecological and environmental sciences (University 2007). This land use could easily fall under an urban forest management configuration. Even though this project has some research components, it may not be a large enough sampling for their purpose. The hollows are a collection of woods with an estimated 100 acre footprint that will be surrounded by housing, classrooms and University related facilities. Here I see that the aesthetic surroundings and the interaction for visitors and the University community are left out.

I feel that the space is positioned in a location that the only fully encompassing managing department could be the SPDG. The Gardens is a place for people, education, relaxation, and reflection. These components will be needed in the overall plan for the Central Campus development. The proposed sites are also in need of the Gardens and its ability to take an existing overgrown, debris filled ravine and turn it into a wonderful addition to the “jewel in the crown”.

**Action Plan**

This project will by no means be a sole proprietorship by the Gardens. The development of the hollows and greenway swath will include a multitude of campus service departments and
academic guidance. I believe that the Gardens staff will be a wonderful resource for many of the developmental aspects of the sites. Still there are resources across the campus such as the School of the Environment, FMD, Duke Forest, Duke Recycles, and for the Gardens not to pursue these will result in a project not fully developed.

I understand that there will be a financial component to the restoration of which the Gardens will not be able to meet. Here Central Administration will need to come forth with funds to implement many facets of the operation, both the hollows and the greenway swath. There will be time lines for the implementation of the greenway swath. This will need assistance from FMD and sub-contractors to complete in a timely fashion. This swath will also need collaboration between the Gardens and the Architects Office to develop an attractive and functional “garden finger”.

On the academic side the Gardens would benefit from the inclusion of the School of the Environment. I feel this project will complement the School of the Environment and benefit the Gardens by offering an outdoor laboratory and demonstration site which is closer to campus than the Duke Forest. Within the School of the Environment are people with the knowledge to make the hollows not only an aesthetic place but an environmentally sustainable site. I would recommend partnering professors with Gardens staff to develop classes or masters projects that could contribute to and benefit the hollows. This would not only benefit the restoration of the site but would add a level of academic interaction that the Gardens seeks through its mission.

I recommend joining forces with Duke Forest for evaluation of the hollows beyond my initial walk through with Jud Edeburn, Resource Manager Duke Forest to look at the health and time line of the forested areas. I would also recommend that a more extensive ecological
evaluation be done of the flora found in the hollows which would go beyond the initial walk thru that was done with Jason Holmes, Assistant Horticulturist and Harry Jenkins, Superintendent SPDG. I am suggesting here that the assessment should take place along the bottom of the hollow working outwards in a perpendicular direction towards the top of the hollows. I feel that the Central Campus master Plan buffer of 100’ of riparian buffers, is a good start (Biohabitats 2006). A more extensive survey should be conducted by the Gardens staff in all three hollows which connect to the South. The dark area on the topographic map, I feel is relatively small and research could be done with assistance of summer interns with guidance from Gardens staff. (Figure 8) This sampling will be one that indicates a simple tally of species presence or absence. During this evaluation a visual inspection of how well the area has adapted to dealing with the runoff will be needed. A documentation of debris and areas that need landscape modification will also be done at this time. The inspection will look for any wash-outs or areas that ‘rip rap’ has been placed to control soil erosion.
The Gardens will use the sampling data collected to look at species value. The information gathered will help the Gardens staff to determine if there is any existence of pine-hardwood forest in addition to revealing the type of invasive species to be removed. The analysis of the plant variety would need to be in line with the Gardens ‘Plant Collection Plan’. The two main points of the analysis would be to identify the existing flora and the desired flora. The Gardens staff will assemble a catalog of the hollows invasive flora, which will be slated for removal. They will also assemble a catalog of native southeastern flora to be saved. Duke Gardens will incorporate the use of its summer interns annually to collect data of changes over time in the vegetation of the three hollows.
I feel the establishment of a joint partnership with Duke University Wetland Center Nicholas School of the Environment (DUWC) would be a good first step due to the experience they have in stream restoration. I feel that from the 100’ riparian buffer moving up the ravines would be the place where the Gardens could make its most significant contributions. The Gardens staff, in conjunction with the DUWC, will develop a possible seven monitoring sites to observe the health of the watershed with the possibility of four long term monitoring sites after weeding out any redundant sites (Richardson 2007). I would recommend that a series of samples be taken over several months before restoration begins. The first sampling will give us a benchmark of the present environmental conditions of water quality in the hollows. A recommendation that the Gardens start quarterly water quality testing of the ponds located in the Gardens to create a benchmark for the Gardens water quality.

According to Dr. Richardson the hollows are considered phase five in the Duke Forest Stormwater Improvement and Wetlands Restoration Project (Richardson 2007). Phase one of this project has many similarities to the proposed hollows project as seen here in a before and after photograph of restoration of a section of the Sandy Creek. (Figure 9) For comparison figure ten is a recent photograph of a stream in one of the hollows. (Figure 10) The hollows are up stream from the existing restoration project. If the hollows are not dealt with and left to their own demise then over time the restoration that has been accomplished by the first few phases of the Sandy Creek project will be affected and much of the headway that has been accomplished will be destroyed (Richardson 2007).
Conclusion

I feel that the acquisition of the hollows and greenway swath would be in accordance with the most current mission statement and the Master Plan of Duke Gardens. The opportunity that is at the doorstep of the Gardens, both figuratively and literally, has all the components to move the Gardens to a new level. In line with the mission statement, the addition of the hollows can create and nurture an environment for learning, inspiration and enjoyment. The maintenance
and future development of the 100 acre hollows is not only an environmental issue but a significant financial issue. The need for increased staffing, the need to purchase plant material to restore the hollows are some of the questions now on the table. The Gardens 2005 Master Plan sets forth the addition of creating “garden fingers” to extend its presence further into the campus. This land acquisition would help make that a reality – albeit a challenging one. In the past, the Gardens accepted the challenge of creating an exquisite garden known around the world from a debris filled ravine and succeeded. The Gardens history proves it has the ability to take a vision and make it a reality that benefits Duke University, the surrounding community and visitors from around the world.
## Appendix A

(Holmes 2007)

<table>
<thead>
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<th>Common Name</th>
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<th>Native</th>
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</thead>
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<td>Oriental Bittersweet</td>
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<td>Periwinkle</td>
<td>Vinca minor</td>
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<td>Viburnum</td>
<td><em>Viburnum rafinesqueianum</em></td>
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<td>Winter Creeper</td>
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<tr>
<td>Yellow Passionflower</td>
<td><em>Passiflora lutea</em></td>
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</tbody>
</table>
Appendix B
(Biohabitats 2006)

**hydric:** wet, plants periodically or often inundated by water

**mesic:** moist, adequate soil moisture retention year-round

**sub-xeric:** moist to dry, seasonally moist, periodically dry

**xeric:** dry and drought resistant, little moisture retention, excessively drained

**Small Trees** (up to 25 ft)
Serviceberry, (*Amelanchier arborea*) deciduous, full/part-sun, mesic/sub-xeric
*Devil’s-walkingstick, (*Aralia spinosa*) deciduous, full/part-sun, hydric/xeric
Paw paw, (*Asimina triloba*) deciduous, part-sun/shade, mesic/sub-xeric
American hornbeam, (*Carpinus Carolina*) deciduous, part-sun/shade, mesic/sub-xeric
Chinquapin, (*Castanea pumila*) deciduous, full-sun/shade, sub-xeric/xeric
Eastern Redbud, (*Cercis Canadensis*) deciduous, full-sun/shade, mesic/xeric
Fringetree, (*Chionanthus virginicus*) deciduous, full-sun/part-sun, mesic/xeric
Pagoda dogwood, (*Cornus alternifolia*) deciduous, part-sun/shade, mesic/sub-xeric
Flowering dogwood, (*Cornus florida*) deciduous, sun/shade, mesic/xeric
Washington hawthorn, (*Crataegus phaenopyrum*) deciduous, full-sun/part-sun, mesic/xeric
Persimmon, (*Diospyros virginiana*) deciduous, full-sun/part-sun, mesic/sub-xeric
Carolina silverbell, (*Halesia carolina*) deciduous, full-sun/shade, mesic/sub-xeric
Common witch-hazel, (*Hamamelis virginiana*) deciduous, full-sun/shade, mesic/sub-xeric
American holly, (*Ilex opaca*) evergreen, full-sun/shade, mesic/sub-xeric
Red cedar, (*Juniperus virginiana*) evergreen, full-sun/part-sun, sub-xeric/xeric
Umbrella tree, (*Magnolia tripetela*) deciduous, full-sun/part-sun, mesic/sub-xeric
Hop-hornbeam, (*Ostrya virginiana*) deciduous, part-sun/shade, mesic/sub-xeric
Sourwood, (*Oxydendrum arboreum*) deciduous, full-sun/shade, sub-xeric/xeric
Hoptree, (*Ptelea trifoliata*) deciduous, full-sun/shade, mesic/sub-xeric
American plum, (*Prunus Americana*) deciduous, full-sun/part-sun, sub-xeric/xeric
Pin cherry, (*Prunus pensylvanica*) deciduous, full-sun/part-sun, mesic/sub-xeric
*Common Sassafras, (*Sassafras albidum*) deciduous, full-sun/part-sun, mesic/sub-xeric
Blackhaw Viburnum, (*Viburnum rufidulum*) deciduous, full-sun/shade, mesic/xeric

**Large Trees** (over 25 feet)
Red maple, (*Acer rubrum*) deciduous, full-sun/shade, hydric/xeric
Sugar maple, (*Acer saccharum*) deciduous, full-sun/shade, mesic/sub-xeric
Yellow buckeye, (*Aesculus flava*) deciduous, part-sun/shade, mesic/sub-xeric
Yellow birch, (*Betula alleghaniensis*) deciduous, full-sun/part-sun, mesic/sub-xeric
Sweet birch, (*Betula lenta*) deciduous, full-sun/shade, mesic/sub-xeric
River birch, (*Betula nigra*) deciduous, full-sun/part-sun, hydric/sub-xeric
Bitternut hickory, (*Carya cordiformis*) deciduous, full-sun/shade, mesic/sub-xeric
Pignut hickory, (*Carya glabra*) deciduous, full-sun/shade, sub-xeric/xeric
Yellowwood, (*Cladrastis kentuckea*) deciduous, full-sun/part-sun, mesic/sub-xeric
Beech, (*Fagus grandifolia*) deciduous, full-sun/shade, mesic/sub-xeric
Tulip tree, (*Liriodendron tulipifera*) deciduous, full-sun/part-sun, mesic/sub-xeric
Cucumber tree, (*Magnolia acuminata*) deciduous, part-sun/shade, mesic/sub-xeric
Black tupelo, (*Nyssa sylvatica*) deciduous, full-sun/shade, mesic/xeric
Sycamore, (*Platanus occidentalis*) deciduous, full-sun/part-sun, hydric/mesic
Red spruce, (*Picea rubens*) evergreen, full-sun/shade, mesic/sub-xeric
*Black cherry, (*Prunus serotina*) deciduous, full-sun/part-sun, mesic/xeric
White oak, (*Quercus alba*) deciduous, full-sun/part-sun, mesic/xeric
Chestnut oak, (*Quercus montana*) deciduous, full-sun/part-sun, mesic/xeric
Red oak, (*Quercus rubra*) deciduous, full-sun/part-sun, mesic/sub-xeric
Post oak, (*Quercus stellata*) deciduous, full-sun/part-sun, sub-xeric/xeric
American linden, (*Tilia americana*) deciduous, full-sun/shade, mesic/sub-xeric
Canadian hemlock, (*Tsuga canadensis*) evergreen, full-sun/shade, mesic/sub-xeric
Carolina hemlock, (*Tsuga caroliniana*) evergreen, full-sun/shade, mesic/sub-xeric

**Low Shrubs** (under 4 feet)
New Jersey tea, (*Ceanothus americanus*) deciduous, full-sun/part-sun, mesic/xeric
Sweetfern, (*Comptonia peregrina*) deciduous, full-sun/part-sun, sub-xeric/xeric
Snowhill Hydrangea, (*Hydrangea aborescens*) deciduous, part-sun/shade, mesic/sub-xeric
Shrubby St. John’s Wort, (*Hypericum prolificum*) deciduous, full-sun/part-sun, hydric/xeric
Drooping leucothoe, (*Leucothoe fontanesiana*) evergreen, part-sun/shade, mesic/sub-xeric
Carolina rose, (*Rosa carolina*) deciduous, full-sun/part-sun, mesic/sub-xeric
Swamp rose, (*Rosa palustris*) deciduous, full-sun/part-sun, hydric/mesic
Cranberry, (*Vaccinium macrocarpon*) evergreen, full-sun/part-sun, hydric/mesic
Lowbush blueberry, (*Vaccinium pallidum*) deciduous, full-sun/part-sun, mesic/xeric
Maple-leaf Viburnum, (*Viburnum acerifolium*) deciduous, full-sun/part-sun, mesic/xeric

**Mid-size Shrubs** (4-10 feet)
Red chokeberry, (*Aronia arbutifolia*) deciduous, full-sun/part-sun, hydric/sub-xeric
Black chokeberry, (*Aronia melanocarpa*) deciduous, full-sun/part-sun, hydric/sub-xeric
Sweetshrub, (*Calycanthus floridus*) deciduous, part-sun/shade, hydric/sub-xeric
Cinnamonbark, (*Clethra acuminata*) deciduous, full-sun/part-sun, sub-xeric/xeric
Silky dogwood, (*Cornus amomum*) deciduous, full-sun/part-sun, hydric/sub-xeric
Hazelnut, (*Corylus americana*) deciduous, full-sun/shade, mesic/sub-xeric
Bush-honeysuckle, (*Diervilla sessilifolia*) deciduous, full-sun/shade, mesic/xeric
Hearts-a-bustin, (*Euonymus americanus*) deciduous, part-sun/shade, mesic/sub-xeric
Large Fothergilla, (*Fothergilla major*) deciduous, full-sun/part-sun, mesic/sub-xeric
Dense Hypericum, (*Hypericum densiflorum*) deciduous, full-sun/part-sun, mesic/xeric
Common winterberry, (*Ilex verticillata*) deciduous, full-sun/shade, hydric/mesic
Virginia sweetspire, (*Itea virginica*) deciduous, full-sun/shade, hydric/sub-xeric
Mountain laurel, (*Kalmia latifolia*) evergreen, full-sun/part-sun, sub-xeric/xeric
Spicebush, (*Lindera benzoin*) deciduous, part-sun/shade, mesic
Sweet azalea, (*Rhododendron aborescens*) deciduous, full-sun/shade, hydric/mesic
Flame azalea, (*Rhododendron calendulaceum*) deciduous, part-sun/shade, mesic/sub-xeric
Carolina Rhododendron, (*Rhododendron carolinianum*) evergreen, part-sun/shade, mesic/sub-xeric
Mountain rosebay, (*Rhododendron catawbiense*) evergreen, full-sun/shade, mesic/sub-xeric
Wild or Pinxter azalea, (*Rhododendron periclymenoides*) deciduous, part-sun/shade, hydric/sub-xeric
Pinkshell azalea, (*Rhododendron vaseyi*) evergreen, full-sun/part-sun, mesic/sub-xeric
*Elderberry, (*Sambucus canadensis*) deciduous, full-sun/shade, mesic
*Coral berry, (*Symphoricarpus orbiculatus*) deciduous, full-sun/shade, mesic/xeric
Hobblebush, (*Viburnum alnifolium*) deciduous, part-sun/shade, mesic
*Highbush blueberry, (*Vaccinium corymbosum*) deciduous, full-sun/part-sun, sub-xeric/xeric
Deerberry, (*Vaccinium stamineum*) deciduous, full-sun/part-sun, mesic/xeric
Witherod Viburnum, (*Viburnum cassinoides*) deciduous, full-sun/shade, mesic/sub-xeric

**Large shrubs** (over 10 feet)
*Tag alder, (*Alnum serrulata*) deciduous, full-sun/part-sun, hydric/mesic
Mountain winterberry, (*Ilex montana*) deciduous, full-sun/part-sun, mesic/sub-xeric
Mock orange, (*Philadelphus inodorus*) deciduous, full-sun/part-sun, mesic/sub-xeric
Rosebay Rhododendron, (*Rhododendron maximum*) evergreen, part-sun/shade, mesic/sub-xeric
*Smooth sumac, (*Rhus glabra*) deciduous, full-sun/part-sun, mesic/sub-xeric
*Silky willow, (*Salix sericea*) deciduous, full-sun/shade, hydric/sub-xeric
*Arrowwood, (*Viburnum dentatum*) deciduous, full-sun/part-sun, mesic/sub-xeric

**Vines**
Dutchman’s pipe, (*Aristolochia macrophylla*) deciduous, part-sun/shade, mesic/xeric
Crossvine, (*Bignonia capreolata*) evergreen, full-sun/shade, hydric/sub-xeric
Trumpet creeper, (*Campsis radicans*) deciduous, full-sun/part-sun, sub-xeric/xeric
Virgin’s bower, (*Clematis virginiana*) deciduous, full-sun/shade, mesic/xeric
Climbing hydrangea, (*Decumaria barbara*) deciduous, full-sun/part-sun, mesic/sub-xeric
Coral honeysuckle, (*Lonicera sempervirens*) deciduous, full-sun/part-sun, mesic/sub-xeric
*Virginia creeper, (*Parthenocissus quinquefolia*) deciduous, full-sun/shade, mesic/xeric
Passion flower, (*Passivlora incarnate*) deciduous, full-sun/part-sun, mesic/xeric
Fox grape, (*Vitis labrusca*) deciduous, full-sun/part-sun, mesic/sub-xeric

**Ferns**
Maidenhair fern, (*Adiantum pedatum*)
Ebony spleenwort, (*Asplenium platyneuron*)
Lady fern, (*Athyrium felix-femina ssp.asplenoides*)
Hay-scented fern, (*Dennstaedtia punctiloba*)
Wood fern, (*Dryopteris marginalis*)
Sensitive fern, (*Onoclea sensibilis*)
Cinnamon fern, (*Osmunda cinnamomea*)
Interrupted fern, (*Osmunda claytoniana*)
Royal fern, (*Osmunch regalis*)
Christmas fern, (*Polystichum acrostichoides*)
New York fern, (*Thelypteris novaboracensis*)
Chain fern, (*Woodwardia areolata*)
Common woodsia, (*Woodsia obtuse*)
Grasses and Sedges
Big bluestem, \textit{(Andropogon gerardii)}
Broomsedge, \textit{(Andropogon virginicus)}
River cane, \textit{(Arundinaria gigantea ssp. gigantea)}
Pennsylvania sedge, \textit{(Carex pennsylvanica)}
Plantain-leaved sedge, \textit{(Carex plantaginea)}
River oats, \textit{(Chasmanthium latifolium)}
Oat grass, \textit{(Danthonia compressa)}
Bottle brush, \textit{(Elymus bystrix)}
Switch-grass, \textit{(Panicum virgatum)}
Little bluestem, \textit{(Schizachyrium scoparium)}
Indian grass, \textit{(Sorghastrum nutans)}
Eastern gamma grass, \textit{(Tripsacum dactyloides)}

Mesic for full sun
Butterfly weed, \textit{(Asclepias tuberosa)}
New England aster, \textit{(Aster novea angliae)}
Curtis aster, \textit{(Aster curtisii)}
Hairy coreopsis, \textit{(Coreopsis pubescens)}
Joe-Pye weed, \textit{(Eupatorium fistulosum)}
Blazing star, \textit{(Liatris spicata)}
Cardinal flower, \textit{(Lobelia cardinalis)}
Bee balm, \textit{(Monarda didyma)}
Wild blue phlox, \textit{(Phlox Carolina)}
Blackeyed susan, \textit{(Rudbeckia hirta)}

Mesic for shade
Jack-in-the-pulpit, \textit{(Arisaema triphyllum)}
Wild ginger, \textit{(Asarum canadense)}
Trout lily, \textit{(Erythronium americanum)}
Sharp-lobed hepatica, \textit{(Hepatica acutiloba)}
Alumroot, \textit{(Heuchera americana)}
Partridge berry, \textit{(Mitchella repens)}
Cinnamon fern, \textit{(Osmunda cinnamomea)}
Solomon’s seal, \textit{(Polygonatum biflorum)}
Christmas fern, \textit{(Polystichum acrostichoides)}
Oconee bells, \textit{(Shortia galactifolia)}
Foamflower, \textit{(Tiarella cordifolia)}

Ground Covers
Pussy’s toes, \textit{(Antennaria plantaginifolia)}
Wild ginger, \textit{(Asarum canadense)}
Green-and-gold, \textit{(Chrysogonum virginianum)}
Mouse-eared coreopsis, \textit{(Coreopsis auriculata)}
Wild strawberry, \textit{(Fragaria virginiana)}
Wintergreen, \textit{(Baultheria procumbens)}
Little brown jugs, (*Hexastylis arifolia*)
Dwarf crested iris, (*Iris cristata*)
Partridge berry, (*Mitchella repens*)
Allegheny spurge, (*Pachysandra procumbens*)
Phacelia, (*Phacelia bipinnatifida*)
Chalice Phlox, (*Phlox amoena*)
Wild blue phlox, (*Phlox divaricata*)
Creeping phlox, (*Phlox stolonifera*)
Golden aster, (*Pityopis graminifolia*)
Christmas fern, (*Polystichum acrostichoides*)
Oconee bells, (*Shortia galacifolia*)
Blue-eyed grass, (*Sisyrinchium mucronatum*)
Foamflower, (*Tiarella cordifolia*)
Yellow-root, (*Xanthorhiza simplicissima*)

**Wildflowers**
Doll’s eyes, (*Actaea Pachypoda*)
Carolina phlox, (*Phlox carolina*)
Blue star, (*Amsonia tabernaemontana*)
Thimbleweed, (*Anemone virginiana*)
Wild columbine, (*Aquilegia canadensis*)
Green dragon, (*Arisaema dracontium*)
Jack-in-the-pulpit, (*Arisaema triphyllum*)
Goat’s-beard, (*Aruncus dioicus*)
Swamp milkweed, (*Asclepias incarnate*)
Butterfly-weed, (*Asclepias tuberosa*)
White wood aster, (*Aster divaricatus*)
Late purple aster, (*Aster patens*)
False goatsbeard, (*Aristolba biternata*)
Wild indigo, (*Baptisia tinctoria*)
Blue cohosh, (*Caulophyllum thalictroides*)
Pink turtlehead, (*Chelone lyonii*)
Black cohosh, (*Cimicifuga racemosa*)
Coreopsis, (*Coreopsis pubescens*)
Bleeding heart, (*Dicentra eximia*)
Shooting star, (*Dodecatheon meadia*)
Joe-Pye weed, (*Eupatorium fistulosum*)
Wild geranium, (*Geranium maculatum*)
Sunflower, (*Helianthus resinosus*)
Sharp-lobed hepatica, (*Hepatica acutiloba*)
Alumroot, (*Heuchera Americana*)
Jewelweed, (*Impatiens capensis*)
Blazing star, (*Liatris spicata*)
Turks-cap lily, (*Lilium superbum*)
Cardinal flower, (*Lobelia cardinalis*)
Lobelia, (*Lobelia puberula*)
Great lobelia, (*Lobelia siphilitica*)
Fringed loostrife, (*Lysimachia ciliate*)
Bishop’s cap, (*Mitella diphylla*)
Bee balm, (*Monarda didyma*)
Carolina phlox, (*Phlox Carolina*)
Garden phlox, (*Phlox paniculata*)
Solomon’s seal, (*Ploygonatum biflorum*)
Blackeyed susan, (*Rudbeckia hirta*)
Bloodroot, (*Sanguinaria canadensis*)
Fire pink, (*Silene virginica*)
Winkle-leaf goldenrod, (*Solidago rugosa*)
Bush pea, (*Thermopsis villosa*)
New York ironweed, (*Vernonia noveboracensis*)
Cited Literature


