2015

A Botanical Survey of Native and Non-Native Species Along the Three Rivers Greenway in Columbia, South Carolina

Rebecca L. Givens
University of South Carolina - Columbia

A Botanical Survey of Native and Non-native Species along the Three Rivers Greenway in Columbia, South Carolina

by

Rebecca L. Givens

Bachelor of Science
University of South Carolina, 2010

Submitted in Partial Fulfillment of the Requirements

For the Degree of Master of Earth and Environmental Resources Management in

Earth and Environmental Resources Management

College of Arts and Sciences

University of South Carolina

2015

Accepted by:

Jill Anderson, Director of Thesis

John Nelson, Reader

John Kupfer, Reader

Lacy Ford, Vice Provost and Dean of Graduate Studies

DEDICATION

To Jesse Crooks, without whom I would be lost. Thanks for loving me and keeping me grounded and focused. Also, to Edgar-what would life be without an adorably, crazy cat?

Acknowledgements

I would like to express my sincere appreciation and thanks to my committee member, Dr. John Nelson, for his patient guidance, mentorship, and inspiration on my road to becoming a botanist. His classes opened a new world for me and a passion for plants that I did not realize lay dormant. I am fortunate to have experienced his enthusiasm for field trips, plant jokes, and lunch time pep talks, which pushed me to make the most of my education in a career I love. I would also like to thank my committee member, Dr. John Kupfer, for his guidance and keeping me on point throughout this study, and my advisor, Dr. Jill Anderson for counting me as one of her graduate students.

I would also like to recognize my fiancé, Jesse Crooks, and my father, Michael Givens, for their many trips and constant companionship while completing my field work for the survey. Similarly, I want to give many thanks to my sister, Dr. Carrie Givens, for her unwavering support, endless proof-reading, and fount of knowledge concerning any aspect about research and writing a thesis. I would like to acknowledge Marvin Brown for his assistance with GIS mapping and fun at the USCH and Herrick Brown for all of his knowledge about plants and the USCH database. Finally I would like to thank my mom, Vickie Givens, and my friend and co-worker, April South, for their support.

Abstract

Baseline surveys are important tools in establishing the present flora located within an area for future monitoring. In addition, knowledge of invasive species presence is essential to help maintain native ecosystem biodiversity. This study aimed to establish a baseline inventory of plant species found along a portion of the Three Rivers Greenway in Columbia, South Carolina, and to create a comprehensive list of native and invasive plant species within this area. In addition, a geographic information system (GIS) was employed to show the spread of a particular known invasive plant species, *Hedera helix* within the area. Specimens were collected in the study area from July 2013 to April 2015 with a focus on the fruiting or flowering status of each species gathered. This field study yielded a total of 178 specimens, with 53 of the specimens being duplicate species. Of the 125 identified species, 99 were dicots, 23 were monocots, and 3 were gymnosperms. The three largest dicot and monocot families found in the study area were that of Asteraceae, Fabaceae, and Rosaceae with 38%, 20%, and 18% and Poaceae, Commelinaceae, and Cyperaceae with 31%, 18%, and 18%, respectively. Of the species collected, 73% were native and 27% were non-native. Maps of the spread of *H. helix* showed a large portion of the southern area of interest (AOI) and 54% of the total AOI as inundated with this invasive species. Specimens were archived with identification labels at the University of South Carolina Herbarium in Columbia, South Carolina.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

List of Abbreviations

GIS .... Geographic Information System

AOI .... Area of Interest

EU .... European Union

CAP .... Common Agricultural Policy

IPPC .... International Plant Prevention Convention

RSPMs .... Regional Standards for Phytosanitary Measures

USDA .... United States Department of Agriculture

NISC .... National Invasive Species Council

ESA .... Endangered Species Act

USCH .... University of South Carolina Herbarium

FERC .... Federal Energy Regulatory Commission

GPS .... Global Positioning System

ITIS .... Integrated Taxonomic Information System

SC-EPPC .... South Carolina Exotic Pest Plant Council

CHAPTER 1: **Introduction and Literature Review**

Considered a modern instigator of worldwide changes in ecosystems, invasive plant species adapt from harmless plants to noxious ones with deleterious repercussions for conservation, primary production, and ecosystem services (Petanidou et al. 2011). An invasive plant species is classified as any species, which is non-native and upon introduction does or has the ability to inflict harm on the environment, the economy, or to human health (Martin and Blossey 2012). Conservationists, decision makers, managers, and the public typically distrust new species introductions because these species have the potential to become invasive species and threaten native biodiversity (Chauvenet et al. 2012). In addition, the introduction of new species can disrupt nutrient cycling, productivity, biotic interactions, and dispersal patterns (Kreyling et al. 2011). The possibility of introducing an invasive species to a new habitat is worrisome because an invasive species could have a large, negative impact on biodiversity (Chauvenet et al. 2012).

Global trade provides opportunities for new forms of dispersal of potential invasive species. For example, present reductions in European Union (EU) restrictions to transport and trade, along with increased tourism and support for agricultural modernization through the EU Common Agricultural Policy (CAP), have altered control measures allowing for an increased probability of invasive species spread (Bardsley and Edwards-Jones 2007. Ironically, travel from England (Great Britain) to America and then

France first highlighted the potential dangers associated with invasive species and international travel and trade.

The concept of international plant protection was originally conceived after the devastation of European grape vineyards by the North American invasive aphid *Daktulosphaira vitifoliae* (grape phylloxera) in the late 1800s ("History of the IPPC" 2014). The International Plant Prevention Convention (IPPC) is a legally binding international agreement developed in 1929 that creates standards for addressing world phytosanitary concerns (Lindgren 2012). The IPPC first began addressing invasive species in 1951, and defines a "pest" as any species, strain, or biotype of plant, animal, or pathogenic agent injurious to plants or plant products. Subsequently, a "quarantine pest" is a pest of potential economic importance to the area, endangered and not yet present, or present but not widely distributed and being officially controlled (FAO 2007). The IPPC includes pests, such as invasive plants, that may directly or indirectly adversely affect agriculture or the environment (Hedley 2004). At a regional level, the IPPC allows for the development of Regional Standards for Phytosanitary Measures (RSPMs), providing guidelines for screening plants prior to import (Lindgren 2012). RSPMs are significant because they suggest modeling as a tool that should be used in pest risk analysis, such as with invasive plant species (Lindgren 2012). However, to model an area appropriately for future monitoring it must first be surveyed to the fullest extent.

Global leaders in importing and exporting with comparable ecosystems, the United States and China have become both suppliers and victims of the international transport of invasive plant species (Jenkins and Mooney 2006). Extensive trade and travel between these two countries and worldwide has only exacerbated invasive species spread. For example, approximately 40% of U.S. total imports are from China and China's imports from the U.S. have doubled in the past 10 years, while their exports worldwide have increased 400% (Jenkins and Mooney 2006). With a similar biogeography, the native biodiversity of both nations will likely suffer as the flora and fauna merges (Jenkins and Mooney 2006). As evidenced in the early 1900s with the destruction of the population of *Castanea dentata* (American chestnut), pests, competitors, and pathogens can be stressors negatively affecting the fitness of forests resulting in mass mortalities of some native plant species in North American forests (Jenkins and Mooney 2006).

An increasing body of scientific literature has explored the environmental concerns associated with plant species' introductions and invasions and there are many resources and studies documenting the effects of invasive plant species. Baker and Murray (2012) addressed the effects of seasonal litter-fall from non-native *Pinus radiata* on local primary production ecosystem services in Australia's native woodland vegetation over a two-year period. Results showed that in autumn and winter large amounts of needles from invasive pines fell up to three times more than the number of native leaves (Baker and Murray 2012). The pine needles, which were of lesser quality than native leaves, contained fewer carbon (C) and nitrogen (N) molecules, but with a higher ratio of C to N (Baker and Murray 2012). Though inputs of C and N were higher because of the pine needles, the results indicated that the pine needles decomposed slowly and immobilized N, limiting availability of N for native plant growth in the long term (Baker and Murray 2012).

Furthermore, the intrusion of large amounts of pine needles to native eucalyptus woodland ground cover could lead to both short and long term detrimental effects on the native biodiversity, such as alteration of leaf-litter invertebrate communities, changes to microclimate, and increased fire intensity (Baker and Murray 2012). It was suggested that the influx of *P. radiata* needles be controlled through the use of buffer zones, addition of plant strips composed of native trees that could cushion the native vegetation from the pine microclimate, the replacement of *P. radiata* with mixes of two or more species (polycultures), or the effective management of planting *P. radiata* on lower elevations and in areas not exposed to strong winds where litter can be carried to nearby woodlands (Baker and Murray 2012). These mechanisms could help limit the intrusion of pine needle litter in adjacent woodlands and aid to keep the primary productivity at an optimal level.

While *P. radiata* behaves as an invasive species to native eucalyptus woodlands, *Eucalyptus globulus* (Tasmanian blue gum eucalyptus) is an invasive plant species in California where oak woodlands are native. Imported as an ornamental from Australia in the 1850s, *E. globulus* was recently classified as a "limited" invasive plant species by the California Invasive Plant Council (Cal-IPC) in a 2015 assessment of the tree's ecological impacts (Wolf et al. 2015). The species is most notable for being fire-intensive and altering groundwater availability, which results in interesting circumstances when *E. globulus* is planted or grows at a high density in California, where drought and fires are prominent. Furthermore, *E. globulus* has parameters for greater fuel loads than the native oak woodlands and can survive prolonged dry summers by tapping into deep water reservoirs with their far-reaching root systems (Wolf et al. 2015). Anthropogenic disturbance is crucial to establishing new populations of the species; however, established stands of *E. globulus* are already expanding, especially along the coast of California. In addition, a 50-400% increase in the size of *E. globulus* stands has been documented between 1930 and 2001 across six sites along the coastline (Wolf et al. 2015). Such impacts on the native habitats of the California coastline should factor into future management decisions.

Economic impacts caused by invasive species are being researched extensively, and many conservation organizations have expanded their budget to include management of invasive species, especially invasive plant species (Martin and Blossey 2012). In 2006, the federal budget for invasive species control in the United States was $466 million, $400 million more than the 2002 budget (Martin and Blossey 2012). The U.S. Fish and Wildlife Service reports species of nutria, zebra mussels, lionfish, Asian carp, Burmese pythons, and two species of plants, Eurasian watermilfoil and *Tamarisk* spp. (salt cedar) as current invasive species that cost the most in damage, management, and control (U.S. Fish & Wildlife Service 2012). Models can be extrapolated to determine how the presence of invasive plant species can influence the appeal of land for conservation procurement and help to reframe the economic impact of invasive plants in terms of trade-offs that are relevant to conservation specialists (Martin and Blossey 2012).

Martin and Blossey (2012) studied the ecological and economic effects invasive plant species have on the desirability of lands for conservation acquisition. Using a web-based survey, public and private land owners were asked to choose between plots of hypothetical land that varied in area, plant species composition, and maintenance cost

(Martin and Blossey 2012). Of the 285 responses received, rare plant species richness had the strongest effect on land parcel desirability, seconded by invasive plant abundance, area, and lastly maintenance cost (Martin and Blossey 2012). It was noted that federal land managers were most sensitive to invasive plant species cover (Martin and Blossey 2012). Results showed that species richness was highly valued and an increase of one rare plant species was worth a 4.31% reduction to non-native invasive plant species cover (Martin and Blossey 2012). Furthermore, responses favored invasive plant control that cost less than $142.72 acre per year to maintain (Martin and Blossey 2012). Organizations participating in this survey spend a combined total of approximately $35 million a year to manage invasive plant species; thus it is imperative that the cost of management not be excessive. Control programs costing more than $142.72 acre per year would not be economically efficient (Martin and Blossey 2012). Because money is a chief concern of management, programs that restrict the movement of invasive plant species should be enacted early to prevent a rise in cost later on when the invasive species becomes unmanageable.

On an economic level, invasive species can cause harm to farming through the take-over of croplands (Bartz et al. 2010). Farmers can suffer from tradeoffs in the fitness of species invading croplands leading to diversification in populations across habitats. In Lee's review (2002) the invasive species *Malus pumila* (paradise apple), which ripens prior to *Crataegus* spp. (native hawthorn), has higher internal temperatures, allowing for a divergence in the phenology and physiology of *Rhagoletis pomonella* (apple-maggot fly). *R. pomonella* can develop 3-4 weeks earlier in the year due to an adaptation to higher temperatures and thus disperse themselves sooner to more apple crops (Lee 2002). *R. pomonella* evolved as a new species in the process of sympatric speciation from a group of flies that fed on hawthorn species after the arrival of apples to North America in the 1800s. Due to their evolution, *R. pomonella* only feeds on species of apples, whereas hawthorn flies still feed on only hawthorn species (Lee 2002). Experiments have shown that warmer conditions during development of larvae select for alleles seen in populations of *R. pomonella* and cooler conditions select for alleles common in hawthorn fly populations (Lee 2002). Distinct physiological species can exist because of fitness tradeoffs when invasive species disrupt croplands. The development of *R. pomonella* earlier in the growing season of apple crops can greatly harm apple harvests for farmers (Lee 2002).

Furthermore, species have evolved responses in plasticity to irregular conditions. Introduced to the U.S. from Southeast Asia before 1700, *Abutilon theophrasti* (velvetleaf) has become a hostile invasive species in croplands in the Midwestern U.S. over the past century (Lee 2002). *A. theophrasti* has evolved as a response to interspecific competition for light with soybean, allowing it to outcompete soybean crops and harm harvests in invaded cultivated fields (Lee 2002).

Invasive plant species also affect human health with the introduction of new allergenic pollens that can cause medical outbreaks in communities (Bartz et al. 2010). Pests and vectors, such as mosquitos and *R. pomonella* can also contribute to issues of human health when their development is effectively sustained by an influx of invasive species to a habitat. Mack and Smith (2011) discussed potential risks of different vectors of human parasites supported by the catalyst of invasive plant species growth and spread. The aquatic, invasive plant *Eichhornia crassipes* (water hyacinth) creates dense, floating areas of foliage above and below the water line in tropical South America. It is commonly known as “the world’s worst weed” as it is a serial invader in the tropics and naturalized in temperate latitudes, requiring only that the temperature of its freshwater habitat be above 5°C (41°F) (Mack and Smith 2011). The damage wrought by *E. crassipes* is massive to aquatic ecosystems and nearby humans dependent on food, transportation, and clean water from such ecosystems (Mack and Smith 2011). This monoculture species with short stolons, dense, large foliage, and fibrous roots impedes the water current resulting in stagnant water and creating an optimal habitat for the incubation of parasite larvae (Mack and Smith 2011). For decades there has been a definitive link between *E. crassipes* and cases of malaria as *Anopheles* female mosquitos, which carry the instrumental agents for malaria (*Plasmodium* spp.), frequently deposit their eggs on the mats of *E. crassipes*.

In Africa, the terrestrial invasive plant *Lantana camara* (largeleaf lantana) is a notorious escapee from its original horticultural and ornamental status (Mack and Smith 2011). Native to the tropics of America, its aggressive growth as an invasive species allows it to form dense thickets of sprawling, entangled, and spiny stems in disturbed areas. By creating these habitats, *L. camara* facilitates the growth of *Glossina* ssp. (the tsetse fly) which carries trypanosomiasis commonly known as African sleeping sickness, a fatal illness if not treated (Mack and Smith 2011). Although a beautiful, flowering shrub, *L. camara* is a driver of disease that humans are unwittingly aiding by promoting sites for tsetse flies with shrubbery alongside their homes and throughout their villages (Mack and Smith 2011).

In North America's temperate environment, contracting Lyme disease caused by the tick-borne spirochete, *Borrelia burgdorferi*, is emerging as a more serious threat being exacerbated by the growth and spread of *Berberis thunbergii* and *Lonicera* spp., two types of terrestrially invasive shrubs (Mack and Smith 2011). Originally introduced for ornamental uses, *B. thunbergii* and *Lonicera* spp. have spread into North American forests and compete with native species. As both the plants' coverage and the concentration of deer populations has increased simultaneously, though exclusive of one another, the number of ticks has also increased (Mack and Smith 2011). Attaching to the deer population and thereby traveling with them, the ticks and deer form a dual role in the spread of Lyme disease. Tick populations have increased as a response to the surge in growth of these shrub species because these invasive plants provide places for the ticks to conceal themselves and breed, as well as preserve a high humidity favorable to tick survival (Mack and Smith 2011). *B. thunbergii* and *Lonicera* spp. are aggressive invasive species that can be transported to similar ranges and ecosystems with similar climates and biogeography, similarly to their introduction to North America as they originate in the East. As easily spread invasive species, they have a higher ability to promote circulations of disease as vectors that harbor parasites (Mack and Smith 2011).

In addition, damage to ecosystem biodiversity can further occur in the genetic modification of native flora. For example, genetically modified crops and ornamental plants that escape from their designated sites where they were planted and maintained can alter the genotypes of wild species via hybridization, which may result in abundance loss of a species and a degradation of the biodiversity in the ecosystem (Bartz et al. 2010).

Invasive species notably cause long-term ecosystem change, such as altering the composition and function of ecosystems and reducing species biodiversity (Bardsley and Edwards-Jones 2007). Alterations in the most basic of ecosystem functions have injurious effects on other environmental components. Ecosystem functions are crucial to maintaining biodiversity because they regulate change and stability, which is visible in the effects of deforestation on climate change and climate change on coral bleaching (Sekercioglu 2010). However, invasive species can potentially offer ecosystem benefits by providing habitat and food resources to rare and endangered species, filling voids left by extinct species and even supplying some ecosystem functions (Schlaepfer et al. 2011).

Schlaepfer et al. (2011) studied the benefits of invasive species on areas where conservation efforts are focused. The study noted that in ecosystems where non-native tree species were introduced into pastures that were no longer employed for grazing and could not be recolonized by native species of trees, the non-native species were successful. The introduced species thrived and created a new habitat bolstering native animal and plant populations. The new, non-native species provided shelter, food, and nutrients, ultimately creating a new microclimate of species. Not only did the introduced species facilitate restoration and recolonization, but they filled a niche left bare by the native species that could no longer survive in the altered pasture conditions (Schlaepfer et al. 2011).

Raghubanshi et al. (2005) conducted an experiment on the effects of invasive plant species on biodiversity in India. The experiment looked at several South American species which had been introduced. *Ageratum conyzoides* is a fast growing weed that has become a major problem in agroecosystems (Raghubanshi et al. 2005). In marine ecosystems, several species were noted as nuisances with adverse effects to biodiversity by outcompeting other native marine plant species. However, some invasive species were noted as being economically beneficial and helpful to maintain biodiversity. For example, the use of invasive species for phytoremediation to repair ecosystems with metalliferous soils via the ability to accumulate or exclude and store essential elements and metal deposits was proposed as a form of therapy for ecosystems (Raghubanshi et al. 2005). Although many invasive plant species pose problems to ecosystems, when researched and managed properly they can provide ecosystem functions in a degraded ecosystem and aid the economy and biodiversity when native species cannot sustain their niches.

The increasing importance of studying climate change is vital to understanding and preventing the spread of invasive plants. Changing climatic conditions provide opportunities for invasive species to expand their distribution and establish themselves in new ecosystems (Bardsley and Edwards-Jones 2007). Hellmann et al. (2008) led a study to predict how climate change influences invasive species movement. Because invasive species are distributed in qualitatively predictable behaviors and respond differently from native species, climate change has the potential, depending on the habitat, to alter those behaviors. For example, invasive plant species behaviors are noted to follow the common "invasion pathway" (Hellmann et al. 2008). The pathway was utilized to identify five consequences to invasive species by climate change including 1) altered transport and introduction mechanisms, 2) establishment of new invasive species, 3) altered impact of existing invasive species, 4) altered distribution of existing invasive species, and 5) altered effectiveness of control strategies (Hellmann et al. 2008).

These consequences provide suggestions for invasive species management plans and stress a need for greater environmental monitoring and management coordination (Hellmann et al. 2008). Such environmental changes provide challenges for policy planning and management strategies for natural, agricultural, and urban areas (Bardsley and Edwards-Jones 2007).

Invasive species display characteristics of increased competitive ability, and thus increase the susceptibility of habitats to being invaded by other non-native species (Colautti and Richardson 2009). Currently in some countries, the floral composition of non-native species is one third of all plant species, and in the United States, there are more than 4,300 naturalized non-native species (Martin and Blossey 2012). For example, *Nandina domestica* (sacred bamboo) and *Elaeagnus umbellata* (autumn olive) were introduced to the U.S. from Asia in the 1800s as ornamental species ("Invasive Plants" 2014), and *E. umbellata* was also later cultivated to attract wildlife in habitats and to aid in erosion control (Fordham et al. 2003). Both *N. domestica* and *E. umbellata* appear on the United States Department of Agriculture (USDA) and National Invasive Species Council (NISC) list of invasive plant species and are noted to cause impact by displacing native species ("Invasive Plants" 2014). It is unfortunately common for non-native, ornamental plant species to escape cultivation and become invasive species. There are approximately 17,000 native plant species in the U.S. and an additional 5,000 plant species in the U.S. that have escaped and thrive in their non-native ecosystems (Pimental et al. 2004).

In addition to habitat loss and climate change, invasive species are believed to be a serious threat to endangered species (Martin and Blossey 2012). Of the 958 species listed as threatened or endangered within the Endangered Species Act (ESA), approximately 400 are deemed in jeopardy because of competition or predation by non-native species (Pimental et al. 2004). Worldwide almost 80% of endangered species are at risk as a consequence of invasive species stress (Pimental et al. 2004). For example, *Arundo donax* (giant reed), is an introduced plant that is an aggressive invasive species originally brought from the Mediterranean to Los Angeles, California in the 1800s to be used as both an ornamental plant and for erosion control in drainage canals ("Fire Effects Information" 2014). As it desiccates waterways, *A. donax* eliminates native waterway flora that provide habitats for four endangered species: *Vireo bellii pusillus* (least bell's vireo), *Empidonax traillii extimus* (southwestern willow flycatcher), *Rana draytonii* (California red-legged frog), and *Gasterosteus aculeatus* (three-spine stickleback) (Invasive Species 1999).

Known as one of the most prevalent invasive species in the United States, *Lythrum salicaria* (purple loosestrife) is an escaped ornamental introduced in the early 1800s that destroys invaded riparian habitats (Invasive Species 1999). The U.S. Fish and Wildlife Service cites this species as occurring in all U.S. states except Florida. Roadside maintenance, such as mowing and the construction of roads and ditches, allows *L. salicaria* to easily spread from exposed meadows and old pastures to unexposed wetlands ("Purple Loosestrife" 2014). It is known to invade a myriad of wetland habitats including freshwater wet meadows, river banks, marshes, pond edges, reservoirs, and ditches ("Purple Loosestrife" 2014). By overcrowding upwards of 44 native grasses, *L. salicaria* limits wetland plant species, such as federally endangered orchids and *Hibiscus moscheutos* (swamp rose mallow) ("Purple Loosestrife" 2014). With an annual control cost of more than $45 million *L. salicaria* is both ecologically and economically damaging (“Purple Loosestrife” 2014).

Commonly seen on roadsides along the Atlantic coast, north to Illinois and Massachusetts, west to Texas and Oklahoma, and south to Alabama, Georgia and Mississippi, *Pueraria montana* var. *lobata* (kudzu) and *Arundo donax* (giant reed), which have spread from the East to West coast throughout the southern United States, are two noticeable invasive plant species. Other less common, but still prevalent invasive plant species in the United States are *Hydrilla verticillata* (hydrilla), *Lygodium japonicum* (Japanese climbing fern*)*, *Ligustrum japonicum* (Japanese privet), *Nandina domestica* (sacred bamboo), *Ailanthus altissima* (tree of heaven), *Albizia julibrissin* (mimosa tree), *Vinca major* (big leaf periwinkle), and *Wisteria sinense* (Chinese wisteria). Common invasive plant species in South Carolina are *Ligustrum sinense* (Chinese privet), *Hedera helix* (English ivy), *Microstegium vimineum* (Japanese stiltgrass), and *Morus alba* (white mulberry), to name a few.

Schierenbeck et al. (1994) completed a study in the Upper Coastal Plain of South Carolina to document the spread of *Lonicera* species, specifically *L. japonica* and *L. sempervirens*, common invasive vines throughout the state. The biomass and growth patterns of these species were monitored and measured to determine their adaptation abilities for survival and spread. Measurements of spread during seasonal and growth changes showed there was no single explanation for the spread of these invasive vines; rather, multiple plant advantages combined with wider distribution ranges increased competitive abilities (Schierenbeck et al. 1994). For example, *L. japonica* thrived because it escaped herbivory, but it also sprouted leaves in two different seasons, allowing for higher photosynthetic capabilities and growth. Studying such growth patterns in invasive and native plants in the same habitat could provide opportunities to identify invasive species competitive adaptations before they expand and establish new distributions (Schierenbeck et al. 1994).

CHAPTER 2: **Surveying the Riverfront Park**

Considered a modern instigator of worldwide changes in ecosystems, invasive plant species adapt from harmless plants to noxious ones with deleterious repercussions for conservation, primary production, and ecosystem services (Petanidou et al. 2011). An invasive plant species is classified as any species, which is non-native and upon introduction does or has the ability to inflict harm on the environment, the economy, or to human health (Martin and Blossey 2012). Conservationists, decision makers, managers, and the public typically distrust new species introductions because these species have the potential to become invasive species and threaten native biodiversity (Chauvenet et al. 2012). In addition, the introduction of new species can disrupt nutrient cycling, productivity, biotic interactions, and dispersal patterns (Kreyling et al. 2011). The possibility of introducing an invasive species to a new habitat is worrisome because an invasive species could have a large, negative impact on biodiversity (Chauvenet et al. 2012).

Global leaders in importing and exporting with comparable ecosystems, the United States and China have become both suppliers and victims of the distribution of invasive plant species (Jenkins and Mooney 2006). Extensive trade and travel between these two countries and worldwide has only exacerbated invasive species spread. For example, approximately 40% of U.S. total imports are from China, and China's imports from the U.S. have doubled in the past 10 years, while their exports worldwide have increased 400% (Jenkins and Mooney 2006). With a similar biogeography, the native biodiversity of both nations will likely suffer as the flora and fauna merges (Jenkins and Mooney 2006). As evidenced in the early 1900s with the destruction of the population of *Castanea dentata* (American chestnut), pests, competitors, and pathogens can be stressors negatively affecting the fitness of forests resulting in mass mortalities of some native plant species in North American forests (Jenkins and Mooney 2006).

Economic impacts caused by invasive species are being researched extensively, and many conservation organizations have expanded their budget to include management of invasive species, especially invasive plant species (Martin and Blossey 2012). In 2006, the federal budget for invasive species control in the United States was $466 million, $400 million more than the 2002 budget (Martin and Blossey 2012). The U.S. Fish and Wildlife Service reports species of nutria, zebra mussels, lionfish, Asian carp, Burmese pythons, and two species of plants, Eurasian watermilfoil and *Tamarisk* spp. (salt cedar) as current invasive species that cost the most in damage, management, and control (U.S. Fish & Wildlife Service 2012). Models can be extrapolated to determine how the presence of invasive plant species can influence the appeal of land for conservation procurement and help to reframe the economic impact of invasive plants in terms of trade-offs that are relevant to conservation specialists (Martin and Blossey 2012). However, to model an area appropriately for future monitoring it must first be surveyed to the fullest extent.

Invasive plant species also affect human health with the introduction of allergenic pollens that can cause medical outbreaks in communities (Bartz et al. 2010). Pests and vectors, such as mosquitos can also contribute to issues of human health when their populations are bolstered by an influx of invasive species to a habitat. Mack and Smith

(2011) discussed potential risks of different vectors of human parasites supported by the catalyst of invasive plant species growth and spread. The aquatic, invasive plant *Eichhornia crassipes* (water hyacinth) creates dense, floating areas of foliage above and below the water line in tropical South America. It is commonly known as "the world's worst weed" as it is a serial invader in the tropics and naturalized in temperate latitudes, requiring only that the temperature of its freshwater habitat be above 5°C (41°F) (Mack and Smith 2011). The damage wrought by *E. crassipes* is massive to aquatic ecosystems and nearby humans dependent on food, transportation, and clean water from such ecosystems (Mack and Smith 2011). This monoculture species with short stolons, dense, large foliage, and fibrous roots impedes the water current resulting in stagnant water, creating an optimal habitat for the incubation of parasite larvae (Mack and Smith 2011). For decades there has been a definitive link between *E. crassipes* and cases of malaria as *Anopheles* female mosquitos, which carry the instrumental agents for malaria (*Plasmodium* spp.), frequently deposit their eggs on the mats of *E. crassipes*.

In North America's temperate environment, contracting Lyme disease caused by the tick-borne spirochete, *Borrelia burgdorferi*, is an emerging disease being exacerbated by the growth and spread of *Berberis thunbergii* and *Lonicera* spp., two types of terrestrially invasive shrubs (Mack and Smith 2011). Originally introduced for ornamental uses, *B. thunbergii* and *Lonicera* spp. have spread into North American forests and compete with native species. As both the plants' coverage and the concentration of deer populations has increased simultaneously, though exclusive of one another, the number of ticks has also increased (Mack and Smith 2011). Attaching to the deer population and thereby traveling with them, the ticks and deer form a dual role in the spread of Lyme disease. Tick populations have increased as a response to the surge in growth of these shrub species because these invasive plants provide places for the ticks to conceal themselves and breed, as well as preserve a high humidity favorable to tick survival (Mack and Smith 2011). *B. thunbergii* and *Lonicera* spp. are aggressive invasive species originating in the East that can be transported to similar ranges and ecosystems with similar climates and biogeography, similarly to their introduction to North America. As easily spread invasive species they have a higher ability to promote circulations of disease as vectors that harbor parasites (Mack and Smith 2011).

In addition, damage to ecosystem biodiversity can occur with the genetic modification of native flora. For example, genetically modified crops and ornamental plants that escape from their designated sites where they were planted and maintained can alter the genotypes of wild species via hybridization. This may result in reduced species' abundance and ecosystem biodiversity (Bartz et al. 2010).

Invasive species notably cause long-term ecosystem change, such as altering the composition and function of ecosystems and reducing species biodiversity (Bardsley and Edwards-Jones 2007). Alterations in the most basic of ecosystem functions have injurious effects on other environmental components. Ecosystem functions are crucial to maintaining biodiversity because they regulate change and stability, which is visible in the effects of deforestation on climate change and climate change on coral bleaching (Sekercioglu 2010). However, invasive species can potentially offer ecosystem benefits by providing habitat and food resources to rare and endangered species, filling voids left by extinct species and even supplying some ecosystem functions (Schlaepfer et al. 2011).

An an increasing body of scientific literature has explored the environmental concerns associated with plant species' introductions and invasions and there are many resources and studies documenting the effects of invasive plant species. Schlaepfer et al. (2011) studied the benefits of invasive species on areas where conservation efforts are focused. The study noted that in ecosystems where non-native tree species were introduced into pastures that were no longer employed for grazing and could not be recolonized by native species of trees, the non-native species were successful. The introduced species thrived and created a new habitat bolstering native animal and plant populations. The new, non-native species provided shelter, food, and nutrients, ultimately creating and new microclimate of species. Not only did the introduced species facilitate restoration and recolonization, but they filled a niche left bare by the native species that could no longer survive in the altered pasture conditions (Schlaepfer et al. 2011).

The increasing importance of studying climate change is vital to understanding and preventing the spread of invasive plants. Changing climatic conditions provide opportunities for invasive species to expand their distribution and establish themselves in new ecosystems (Bardsley and Edwards-Jones 2007). Hellmann et al. (2008) led a study to predict how climate change influences invasive species movement. Because invasive species are distributed in qualitatively predictable behaviors and respond differently from native species, climate change has the potential, depending on the habitat, to alter those behaviors. For example, invasive plant species behaviors are noted to follow the common "invasion pathway" (Hellmann et al. 2008). The pathway was utilized to identify five consequences to invasive species by climate change including 1) altered transport and introduction mechanisms, 2) establishment of new invasive species, 3) altered impact of existing invasive species, 4) altered distribution of existing invasive species, and 5) altered effectiveness of control strategies (Hellmann et al. 2008).

These consequences provide suggestions for invasive species management plans and stress a need for greater environmental monitoring and management coordination (Hellmann et al. 2008). Such environmental changes provide challenges for policy planning and management strategies for natural, agricultural, and urban areas (Bardsley and Edwards-Jones 2007).

Invasive species display characteristics of increased competitive ability, and thus increase the susceptibility of habitats to being invaded by other non-native species (Colautti and Richardson 2009). Currently in some countries, the floral composition of non-native species is one third of all plant species, and in the United States, there are more than 4,300 naturalized non-native species (Martin and Blossey 2012). For example, *Nandina domestica* (sacred bamboo) and *Elaeagnus umbellata* (autumn olive) were introduced to the U.S. from Asia in the 1800s as ornamental species ("Invasive Plants" 2014), and *E. umbellata* was also later cultivated to attract wildlife in habitats and to aid in erosion control (Fordham et al. 2003). Both *N. domestica* and *E. umbellata* appear on the United States Department of Agriculture (USDA) and National Invasive Species Council (NISC) list of invasive plant species and are noted to displace native species ("Invasive Plants" 2014). It is unfortunately common for non-native, ornamental plant species to escape cultivation and become invasive species. There are approximately 17,000 native plant species in the U.S. and an additional 5,000 plant species in the U.S. that have escaped and thrive in their non-native ecosystems (Pimental et al. 2004).

In addition to habitat loss and climate change, invasive species are believed to be a serious threat to endangered species (Martin and Blossey 2012). Of the 958 species listed as threatened or endangered within the Endangered Species Act (ESA), approximately 400 are deemed in jeopardy because of competition or predation by non-native species (Pimental et al. 2004). Worldwide almost 80% of endangered species are at risk as a consequence of invasive species stress (Pimental et al. 2004). For example, *Arundo donax* (giant reed), is an introduced plant that is an aggressive invasive species originally brought from the Mediterranean to Los Angeles, California in the 1800s to be used as both an ornamental plant and for erosion control in drainage canals ("Fire Effects Information" 2014). As it desiccates waterways, *A. donax* eliminates native waterway flora that provide habitats for four endangered species: *Vireo bellii pusillus* (least bell's vireo), *Empidonax traillii extimus* (southwestern willow flycatcher), *Rana draytonii* (California red-legged frog), and *Gasterosteus aculeatus* (three-spine stickleback) (*Invasive Species* 1999).

Known as one of the most prevalent invasive species in the United States, *Lythrum salicaria* (purple loosestrife) is an escaped ornamental introduced in the early 1800s that destroys invaded riparian habitats (*Invasive Species* 1999). The U.S. Fish and Wildlife Service cites this species as occurring in all U.S. states except Florida. Roadside maintenance, such as mowing and the construction of roads and ditches, allows *L. salicaria* to easily spread from exposed meadows and old pastures to unexposed wetlands ("Purple Loosestrife" 2014). It is known to invade myriad wetland habitats including freshwater wet meadows, river banks, marshes, pond edges, reservoirs, and ditches ("Purple Loosestrife" 2014). By overcrowding upwards of 44 native grasses, *L. salicaria* limits wetland plant species, such as federally endangered orchids and *Hibiscus moscheutos* (swamp rose mallow) ("Purple Loosestrife" 2014). With an annual control cost of more than $45 million *L. salicaria* is both ecologically and economically damaging ("Purple Loosestrife" 2014).

Commonly seen on roadsides along the Atlantic coast, north to Illinois and Massachusetts, west to Texas and Oklahoma, and south to Alabama, Georgia and Mississippi, *Pueraria montana* var. *lobata* (kudzu) and *Arundo donax* (giant reed), which has spread to from the East to West coast throughout the southern United States, are two noticeable invasive plant species. Other less common, but still prevalent invasive plant species in the United States are *Hydrilla verticillata* (hydrilla), *Lygodium japonicum* (Japanese climbing fern), *Ligustrum japonicum* (Japanese privet), *Nandina domestica* (sacred bamboo), *Ailanthus altissima* (tree of heaven), *Albizia julibrissin* (mimosa tree), *Vinca major* (big leaf periwinkle), and *Wisteria sinense* (Chinese wisteria). Common invasive plant species in South Carolina are *Ligustrum sinense* (Chinese privet), *Hedera helix* (English ivy), *Microstegium vimineum* (Japanese stiltgrass), and *Morus alba* (white mulberry), to name a few.

Schierenbeck et al. (1994) completed a study in the Upper Coastal Plain of South Carolina to document the spread of *Lonicera* species, specifically *L. japonica* and *L. sempervirens*, common invasive vines throughout the state. The biomass and growth patterns of these species were monitored and measured to determine their adaptation abilities for survival and spread. Measurements of spread during seasonal and growth changes showed there was no single explanation for the spread of these invasive vines; rather, multiple plant advantages combined with wider distribution ranges increased competitive abilities (Schierenbeck et al. 1994). For example, *L. japonica* thrived because it escaped herbivory, but it also sprouted leaves in two different seasons, allowing for higher photosynthetic capabilities and growth. Studying such growth patterns in invasive and native plants in the same habitat could provide opportunities to identify invasive species competitive adaptations before they expand and establish new distributions (Schierenbeck et al. 1994).

2.1 *Hedera helix*: Invasive Plant Species of Interest

Hedera helix is an evergreen dicot member of the plant family Araliaceae. Derived from the Greek 'helisso,' meaning 'to turn around' (Paulsen et al. 2010), it is a liana that specializes in spread via climbing with adventitious roots that allow the plant to maneuver along a wide range of organic and non-organic substances (Melzer et al. 2011). A popular ornamental plant species in the New World (Americas), *H. helix* behaves as an invasive species, whereas in the Old World (Europe, Africa, and Asia) its native habitat, it grows naturally in gallery forests or riparian zones. The root system of *H. helix* is adaptable in its method of attachment, tolerating myriad substrates such as rocks, tree bark, and mortar, enabling it to climb up to 30 meters with appropriate moisture, light, and attachment conditions (Melzer et al. 2011). Unbranched adventitious roots specialized in attachment develop at the side of its shoots nearest to the climbing substance, and when in contact with soil, shoots will develop beneficial underground roots that are branched (Melzer et al. 2011).

Melzer et al. (2011) studied the ability of *H. helix*'s adventitious roots to attach to different host species and non-organic substances. The tensile strength of the roots was also tested. *H. helix* was found to be able to easily attach to wood, cork, and mortar; however, attachment was not achieved on smooth surfaces, such as glass and aluminum.

In addition, results showed that *H. helix* grows on a wide variety of bark types and the root attachment system is adapted to function on most vertical areas that might be encountered during growth (Melzer et al. 2011). When testing the tensile strength of the attachment roots, it was found they were stiffer, had a higher breaking stress than plants with radicles, and a higher maximum strain overall. The ability of the attachment roots to maintain their grip and not break easily allows *H. helix* to move quickly, attach to many surfaces, and withstand weather conditions in non-native ecosystems as a hardy invasive.

While the adventitious roots of *H. helix* are adapted to function for attachment specializing in anchoring to surfaces and climbing to allow the plant growth space, they offer little nourishment unlike the subterranean roots of the plant (Melzer et al. 2011). This high level of adaptation gives *H. helix* the great ability to easily become an invasive species where any such vertical spaces are present in non-native habitats. Such a species bears importance in considering the management of habitats where invasive plant species are present; therefore in this study, *H. helix* was chosen to study its current spatial extent in the area of interest (AOI).

2.2 Study Objective

South Carolina has a long history of botanical exploration. The University of South Carolina Herbarium (USCH) or A.C. Moore Herbarium shares in that history as it was established in 1907 by botanist Dr. Andrew Charles Moore. With over 100,000 specimens, it is the largest collection in the state of South Carolina. Herbariums are fundamental in documenting current and historical patterns of plant diversity, which is indispensable for understanding human and natural influences on plant community structure (Kristensen 2009). This study contributes to the specimen database at the USCH with its baseline survey of the AOI.

A 9 ½ mile linear park located in the cities of Columbia, West Columbia, and Cayce, the Three Rivers Greenway is the convergence site of the Saluda, Broad, and Congaree rivers, as seen in Figure 2.1. The Three Rivers Greenway was created and is managed by The River Alliance which is a non-profit organization in Columbia, SC. This study aimed to understand the presence of all species and the prevalence of a particular invasive plant species in a portion of the Three Rivers Greenway in Columbia, South Carolina. This was to be accomplished by: 1) surveying the existing flora found at the site, 2) scientifically identifying collected specimens of species at the site, 3) cataloging the specimens by their native or non-native status, including whether or not they were invasive, 4) researching the USCH database for specimens already found in and around the AOI, and 5) using GIS to map the spread of *H. helix*, a noted invasive vine along the greenway as well as, the presence of all other identified specimens.

Important definitions to know for this study are found in Table 2.1. Both angiosperms and gymnosperms were collected in the AOI. Angiosperms have flowers and seeds borne in fruiting structures, whereas gymnosperms do not produce flowers and bear “naked seeds” so termed because they are unenclosed (Weakley 2012). Introduced plants in this study are harmless currently, but may or may not have the potential to become invasive if brought to an area lacking co-evolved competitors and natural enemies (“Introduced, Invasive, and Noxious Plants” 2014). To be considered noxious, a plant must appear on a noxious weed list maintained by a regulatory agency, wherein it can be banned, quarantined, or eradicated depending on its impact (UC-IPM 2014). In this study, plants termed “noxious” are listed on South Carolina noxious weed lists.

Confusion can arise when discussing the terminology of naturalized, invasive, and native plants. Some species, such as *Lonicera japonica*, which is a common invasive plant species, is also a considered a naturalized species to the AOI. It has existed so long in the AOI that it has come to be considered native as it behaves like a native species in this habitat despite its typical invasive tendencies. However, the species is technically invasive because it not original to the New World and is difficult to manage as it spreads rapidly and aggressively, displacing native plants. In this study, a plant species’ origin will be considered to determine its status as native or non-native. For example, *L. japonica* is termed both ‘non-native’ and ‘invasive’ to the AOI because its native range is in eastern Asia.

The City of Columbia recently employed the engineering firm Chao and Associates, Inc. to monitor seepages, animal burrowing, fallen trees, live and dead standing trees, and slope instability by observing the west or river side of the canal embankment (Chao and Associates, Inc. 2011). The firm also measured the cross section of the embankment along the length of the canal to catalogue the area in sections based on the probability of failure risk. Sections were grouped as ‘A’, ‘B’, ‘C’, and ‘D’ (Chao and Associates, Inc. 2011). The City of Columbia cited maintenance of the embankment and public safety, as well as the continued operation of the hydroelectric power generation station and the City of Columbia’s drinking water supply as reasons for conducting these surveys (Chao and Associates, Inc. 2011). Sensitivity to the environment and people who use the Riverfront Park were noted as goals. This examined area is the same as that of the AOI surveyed.

Chao and Associates, Inc. decided during Phase I evaluations that large portions of the embankment should be maintained as they were currently (Grego 2012). Furthermore, in the Columbia Canal West Embankment-Phase II plan prepared for FERC (Federal Energy Regulatory Commission) from early 2012, references were made to protect the riparian zone. However, it was eventually decided that environmental and water quality issues should be tabled in favor of embankment safety and that vegetation down to the water's edge should be removed (Grego 2012).

The ultimate plan advised that all trees on the embankment be removed as they block observation procedures, disrupt embankment stability, and generate habitats for burrowing animals (all proposed management actions in this paragraph are from: Chao and Associates, Inc. 2011). All trees and woody vegetation, except for trees that were of great size and age, were advised to be removed in portions of sections 'B', 'C', and 'D'. Older, larger trees were to be monitored for disease or storm damage, and no new trees should be planted or allowed to grow in the areas. The main goals of the firm for each section was as follows: 1) sections 'C' and 'D' were to be stabilized with no trees on the embankment and only mowable ground cover remaining, 2) section 'B' was to have all understory trees removed, leaving canopy trees, and removing all trees when damaged or diseased with no replanting, and 3) section 'A' needed no vegetation removal besides what is currently done, which is the periodic removal of snags and fallen trees.

While the durability of the embankment for utility operations and the City of Columbia's water supply is important to the community, the disturbance of a riparian zone can cause more problems. Degraded riparian zones as a result of vegetation loss can lead to riverbed erosion, an increase in water temperature, a reduction in dissolved oxygen in the water, and loss of property or land value (US-NRCS 2006). Disturbance is defined as the disruption of functions or services within an ecosystem that maintain and benefit the ecosystem's viability (Villnäs et al. 2013). While natural disturbances such as drought, flooding, and fire can cause devastation, such situations are temporary and ecosystems can recover with time if not disturbed further. However, human disturbances such as clear-cutting, habitat fragmentation, and pollution are permanent and place more difficult pressures on ecosystems and species (Villnäs et al. 2013). Without time to adjust to one stressor before another stressor creates change, ecosystems cannot recover and natural cycles of disturbance including growth, dieback, and regrowth do not occur. Continued disturbance without recovery allows new species to move into and establish themselves in the area (Villnäs et al. 2013).

The study area is located in Richland County, South Carolina. The climate is humid subtropical climate with hot, long summers and short, mild winters. Spring and fall are mild intermediate periods between summer and winter (Newcome 2003). Temperatures average 26.9 °C (80.5 °F) in the summer and 9.2 °C (48.6 °F) in the winter, rarely exceeding 37.8 °C (100 °F) or falling below -6.7 °C (20 °F). The hottest and wettest month is July (14.1 cm (5.54 inches) rainfall) and the coldest month is January; however, October is the driest month (6.5 cm (2.56 inches) rainfall) (Newcome 2003). The growing season lasts for 8 months and snow is uncommon and short in duration if it does occur. Hurricanes from the Atlantic Ocean and the Gulf of Mexico contribute to rainfall and windy conditions during hurricane season (June 1st-November 30th)

(Newcome 2003). For ecosystems, hurricanes can mean a partial to complete loss of hardwood trees and native species, which in turn clears habitats for the invasion and establishment of invasive plant species.

The specific area of interest (AOI) included 52.9 acres on the east bank of the Three Rivers Greenway in a portion called Riverfront Park, comprising a distance of approximately 2 miles from the Diversion Dam (34° 2' 0.06"N, 81° 4' 9.63"W) south to the Interstate 126 overpass (34° 0' 32.84"N, 81° 3' 30.42"W). The area is highlighted by the red triangles in the map of South Carolina in Figure 2 and includes sections 'A' and 'B' from the City of Columbia's embankment plan. The Broad River, which flows along the area of study is approximately 150 miles long flowing through North and South Carolina, and is a primary tributary of the Congaree River. In Columbia, SC, the Broad River is crossed by two interstates (Interstates 20 and 126) and one major road (River Drive).

The habitat along the river in the study area was that of a riparian zone, which is defined as lands contiguous to streams or rivers and inundated with hydrophilic vegetation (US-NRCS 2006). These buffers are vital to improving water quality and preventing the runoff of pollutants, such as nitrogen, phosphorus, and pesticides, or sediments (US-NRCS 2006). A large source of nutrients and energy for aquatic communities, riparian zones contribute to energy input with woody debris and leaf litter and by offering shade, sustenance, and travel passages for both aquatic and terrestrial wildlife (US-NRCS 2006). Vegetation in riparian zones is characterized by native trees, shrubs, and grasses that aid to slow water from flooding and consequently stabilize and preserve riverbeds and banks allowing time for the water to penetrate the soil and recharge groundwater (US-NRCS 2006). As areas of sediment deposition, riparian zones build river banks and prevent erosion by trapping sediments (US-NRCS 2006). The soil type in the AOI was 100% Toccoa loam, which is located in flood plains, has low runoff, occasional flooding, and is moderately well drained (*Custom Soil Resource Report* 2014).

River travel was a primary mode of transportation in the late 1700s and Columbia, the capital of South Carolina was strategically placed along the confluence of these rivers to maximize their conveyance capabilities. A major thoroughfare for the exporting of goods, the canal dates back to 1820 and ran from the Midlands to the Atlantic Ocean via the Port of Charleston. The portion of the greenway studied began in the recently disturbed northern section of the Riverfront Park at the Diversion Dam, which was constructed in 1891. This is also known as the Canal Embankment or the headwaters of the Old Columbia Canal.

Today these rivers are popular for recreation, development, and boating sites. Considering historical and ongoing changes to the ecosystem along the greenway, invasive species have had frequent opportunities to invade, establish, and thrive. With the growing need to calculate biodiversity loss, interest in botanical surveys has increased (Buckland et al. 2007). Collection and identification of invasive plant species in herbariums, as well as management of such species in varying habitats is a principal concern for conservation of native species and ecosystems (Evans 2013).

Knowledge of invasive species dispersal and spread is important to maintain native ecosystem biodiversity and help create preventative measures which can be applied to deter invasive species introductions. In disturbed ecosystems, invasive species that have previously established niches have modified ecosystem functions to an alternative, degraded condition. Removing such species cannot guarantee the ecosystem will be restored, but it is worth investigation because ecosystem functions are crucial to maintaining biodiversity by regulating natural change and stability (Khanna et al. 2012). Therefore, comprehending invasive species interactions can be helpful in predicting potential community shifts (Khanna et al. 2012).

2.3 Methods

A botanical survey was conducted of the overall species variability along the west bank consisting of approximately 2 miles from the Diversion Dam (34° 2' 0.06"N, 81° 4' 9.63"W) south to the Interstate 126 overpass (34°0'32.84"N, 81°3'30.42"W) from July 2013 to April 2015. The total area of the AOI was calculated to be 52.9 acres (214,078.7 m^2). Because disturbance is credited as an influence on the structure of plant communities and is associated with the spread of invasive plant species, the spatial extent of *H. helix*, an invasive plant, was calculated and quantified in the AOI (Larson 2002). The northern portion of the AOI, from the Diversion Dam (34° 2' 0.06"N, 81° 4' 9.63"W) to the Broad River Road overpass (34° 1' 35.22"N, 81° 4' 6.25"W), has been disturbed in the past but has been left undisturbed for many years, only receiving some partial removal of snags and fallen trees occasionally. The second area is the southern portion of the AOI from the Broad River Road overpass (34° 1' 33.30"N, 81° 4' 5.22"W) to the Interstate 126 overpass (34° 0' 32.84"N, 81° 3' 30.42"W), which was disturbed approximately two years ago as part of the City of Columbia's embankment plan. The southern portion of the AOI was disturbed similar to section 'B' of the embankment plan, where understory trees, woody vegetation, snags, fallen trees, and any diseased or damaged trees were removed, leaving only canopy trees.

The study area began at the edge of the Broad River and spread east to the main sidewalk lining the canal. Plants between the main sidewalk and canal embankment were not included in this study as the area is frequently mowed and maintained by the local park rangers. Concrete and man-made trails were used to transverse the study areas, although more often specimens and GIS data were collected off the main trails.

The survey began at the Diversion Dam. A Garmin *etrex* 20 (Figure 2.3) global positioning system (GPS) was used to determine latitude and longitude, as well as elevation for location of the species identified. Transects (ca. 8 m in length) were created using a meter measuring tape (Figure 2.3). Once measured, transects were numbered and labeled with their associated number on nearby trees with Presco Pink Glo flagging tape (Figure 2.3). Some transects were a few meters longer because of a lack of trees able to be labeled due to the circumference of the tree trunk. For example, trees trunks were individually determined visually to be too large in circumference or too thin for tagging. This was done to conserve materials with larger trees and to not potentially lose labels on thinner trees during heavy rains when flooding would occur in the area and thinner trees were damaged.

As the purpose of this survey was to identify different species in the area and create a baseline survey, one or more specimens of all plant species found were collected. Specimens were selected by status of fruiting or flowering, two important identifiers when keying flora. Furthermore, specimens collected were defined by type of plant, the area in which they were collected, the season, the weather, and the date. Notes were taken during the survey to list these observances, as well as the latitudinal and longitudinal coordinates and elevations of each plant from which a specimen was gathered placement. The specimens were pressed together in a dryer for periods of one to three weeks depending on the potential moisture levels determined to be in their floral or fruiting portions.

Once dried, specimens were keyed or identified. Specimen keys, listed below, and the University of South Carolina Herbarium (USCH) were employed as resources. Already recorded data for the Riverfront Park area, including the AOI, was researched at the USCH with the assistance of Herrick Brown, the Assistant Curator. Using multiple database queries, including "Richland County", "South Carolina", and "Riverfront Park" in Specify 6 (2014), data was accessed on March 18, 2015. The queries returned multiple results for the area, which were organized into Table 2.2 using the specimen's binomial nomenclature, family, and official USCH number.

Using both the *Manual of the Vascular Flora of the Carolinas* (1968) and *Flora of the Southern and Mid-Atlantic States* (2012), specimens were keyed to determine their genus and specific epithet. Of the literature Radford et al. (1968) contains full keys, whereas Weakley (2012) is lacking in some plant families. However, Radford, et al. (1968) has not been revised since 1968 and some binomial nomenclature has since been altered. Weakley (2012) is the more current version and uses the latest binomial nomenclature for identifying flora; thus, all specific names keyed are associated with that information. In addition, all identified specimens using the Weakley (2012) key were cross-referenced with the Integrated Taxonomic Information System (ITIS) (2014). Information on specimen families, genera, species, and common names was retrieved December 8, 2014, from the Integrated Taxonomic Information System on-line database, http://www.itis.gov. ITIS (2014) was used to decide the final version of the identified specimen's taxonomic information so as to be as current as possible. Dr. John Nelson, curator of the University of South Carolina Herbarium in the Department of the Biological Sciences, assisted greatly with identification verification of the specimens, as well as, solely identified many of the specimens.

Once identified, information including the binominal nomenclature, family, latitude and longitude, elevation, and transect number (T1 to T131) and status as a monocot, dicot, or gymnosperm for each specimen was compiled into Table 2.3. Details concerning the native or non-native status for each specimen were compiled into a different table (Table 2.4). If a specimen was native, it was also designated as rare or common in SC. If a specimen was non-native, it was also designated as introduced, naturalized, or invasive, and if invasive, whether or not it is labeled as a state and/or federally noxious weed. Furthermore if invasive, the severity of invasiveness and known locations within South Carolina where indicated within Table 2.4.

Each specimen was also classified by the areas in SC in which it is found. Three sections of the state of SC were used to group locations of specimens: M=mountains, P=piedmont, and CP=coastal plain. If a specimen was designated as being found in "all of SC", then the plant is represented in all three regions across the state. These regional separations are borrowed from the South Carolina Exotic Pest Plant Council's list (2014) of invasive, terrestrial plant species. The 2014 Terrestrial Exotic Invasive Species List created by the South Carolina Exotic Pest Plant Council (SC-EPPC) was also referenced to solely identify invasive species in Table 2.4. The United States Department of Agriculture (USDA) Plants (2014) website, Invasive.org: Center for Invasive Species and Ecosystem Health (2014), Radford et al. (1968), and Weakley (2012) were all referenced to identify each specimen's status as native or introduced, if the specimen was not referenced in the SC-EPPC invasive species list. Some information for species locations was difficult to find; therefore, some species received designations of "not enough data."

Labels for each specimen acquired were created listing the specimen number, binomial nomenclature, associated floral family, date acquired, environmental factors, notes on the specimen itself, latitude, longitude, and elevation of the specimen, and the county and state in which the specimen was found. Number assignations for individual specimens as seen in Table 2.3 and 2.4 are not the actual specimen numbers for the USCH. Specimens in bold in Table 2.3 are duplicate specimens. Duplicate specimens have been removed from Table 2.4 as native or non-native status is indicative of the species' binomial nomenclature, not of the number of specimens for each species.

Maps throughout this paper were created using ArcGIS® software by ESRI. The GPS data was used to map individual specimens by providing a point and linking each specimen's location, name, and familial status data to each point. A second map was created using the Area Calculation feature on the *eTrex* to show the spread of the invasive species *H. helix*. With the *eTrex*, spread of *H. helix* was able to be calculated by walking the entire perimeter of an area where the species was found.

Due to the restriction of the landscape and an inability to access vertical growth of *H. helix* with the area calculation function of the *eTrex,* the spatial extent of *H. helix* is measured as only ground cover growth. Because there was no historical data for comparison, this is the first known map showing the spatial distribution of such a species in the study area. This map was studied to see potential patterns in the spread and utilized to calculate a percentage of coverage of *H. helix* in the AOI.

Information of the soil type of the AOI was garnered from the United States Department of Agriculture (USDA) Web Soil Survey website at http://websoilsurvey.nrcs.usda.gov/ on November 18, 2014. Marvin Brown is attributed with producing the *Custom Soil Source Report for Richland County, South Carolina* and for creating Figure 2.9 with ArcMap.

2.4 Results

This study yielded 178 total specimens, 53 which were duplicates of species already identified from the AOI in this study. There were 125 different species found, including 23 monocots, 99 dicots, and 3 gymnosperms (Figure 2.4). Duplicate specimens, though found in different locations of the study area from specimens of the same name, are not included in any graphical representations, which are to display the different species collected. Information on duplicate specimens is addressed later. Comparing the 125 non-duplicated specimens from this study to the USCH database specimen records (Table 2.2), there are 33 specimens from this study that have already been recorded in the database. Dicots composed 79%, monocots 18%, and gymnosperms 3% of the 125 non-duplicated specimens.

The three largest dicot families found in the study area were Asteraceae, Fabaceae, and Rosaceae, with 38%, 20%, and 18% of the 79% of dicot specimens, respectively (Figure 2.5). Three other families had at least three or more specimens. Families not included in Figure 2.5 because only one species was present were: Adoxaceae, Altingiaceae, Amaranthaceae, Anacardiaceae, Annonaceae, Apiaceae, Araliaceae, Betulaceae, Bignoniaceae, Boraginaceae, Campanulaceae, Caprifoliaceae, Convolvulaceae, Cornaceae, Elaeagnaceae, Ericaceae, Gelsemiaceae, Geraniaceae, Hypericaceae, Juglandaceae, Linderniaceae, Malvaceae, Menispermaceae, Oxalidaceae, Papaveraceae, Phytolaccaceae, Platanaceae, Ranunculaceae, Santalaceae, Styracaceae, and Urticaceae. In addition, families not included in Figure 2.5 because only two species were present were: Acanthaceae, Berberidaceae, Brassicaceae, Caryophyllaceae, Fagaceae, Lamiaceae, Oleaceae, Polygonaceae, Rubiaceae, Sapindaceae, Solanaceae, Ulmaceae, Verbenaceae, and Violaceae.

Of the monocots collected in the study area, the families Poaceae, Commelinaceae, and Cyperaceae included the most non-duplicated monocot species with 31%, 18%, and 18% respectively (Figure 2.6). Specimens were collected for six additional monocot families. All monocot families are represented in Figure 2.6. The three gymnosperms collected during field work were *Asplenium platyneuron*, *Polystichum acrostichoides*, and *Pinus taeda*, which are in the families Aspleniaceae, Dryopteridaceae, and Pinaceae, respectively.

Of the 125 non-duplicated specimens, 91 (73%) were native species and 34 (27%) were non-native species (Figure 2.7). All native species were identified as common. Of the 34 non-native species identified, 17 (50%) were introduced, 10 (29%) were invasive, and 7 (21%) were naturalized (Figure 2.8).

Individual locations for each of the 178 specimens collected are shown in Figure 2.9. The overall survey documents the species present in the area. Data in this map includes duplicate specimens. The specimen data points appear in Figure 2.9 in clumps and spread out along the AOI. This occurred because it was not the intention of the survey to collect many duplicates of species, but rather to gather specimens of different species. After the beginning of the survey and toward the middle of the AOI mostly duplicate species of those already found were present. As seen in the map, this changed toward the end of the AOI where more new specimens were located.

Data was also acquired to calculate the spatial extent of the invasive species, *H. helix*. Because there was only one specimen of *H. helix* found in the USCH database records, no historical spatial extent could be determined to compare to the data collected during this survey. The current spread of *H. helix* within the AOI as calculated with the area perimeter function of the Garmin *eTrex* utilized during the survey process is indicated in Figure 2.10, with polygons showing the area covered and colors indicating ranges of spatial extent. Based on the total area of the AOI, 52.9 acres (21.4 ha) and the total area of *H. helix* coverage (11.65 ha), the percent of the AOI covered by *H. helix* growth was 54%. Comparing the disturbed habitats of the northern and southern portions of the AOI, *H. helix* is more abundant in the southern section than the northern portion (Figure 2.10). Though the northern portion contains less acreage, the southern section contains a greater total coverage of *H. helix*.

Red represents the smallest area covered in square meters of *H. helix*, ranging from 8.4 to 74 m^2. Following red, orange shows a range of 74 to 245 m^2. Next is yellow with 245 to 1267 m^2. Lime green displays 1267 to 2251 m^2. Furthermore, green shows a range of 2251 to 4752 m^2. Light blue contains 4752 to 8071 m^2. Lastly, blue represents the largest tracks of coverage with 8071 to 29800 m^2.

2.5 Discussion

The humid, subtropical climate of Columbia, South Carolina provides thriving habitats for monocots, dicots, and gymnosperms; therefore, the variety of specimens acquired (as seen in Figures 2.4, 2.5, and 2.6) was anticipated. It is important to take a baseline species survey of the biodiversity of the flora in an area to monitor future effects of non-native species spread on an ecosystem. Results of this survey found a majority (73%) of the non-duplicated identified specimens to be native species, all of which were common to the area. Of the non-native species, 17 (50%) were introduced, 10 (29%) were invasive, and 7 (21%) were naturalized species. Although these numbers were not high, it is important to realize that a plant species currently categorized as 'introduced' or 'naturalized' can become invasive if the non-native habitat it is thriving in lacks competition or predators.

This survey found 10 individual invasive plant species in the AOI, which is only 8% of the total non-duplicated identified species. While this is not a large amount of invasive species presence, these numbers only represent individual plant species found in the area and not a spatial extent or count of individual plant specimens of these species. This was a population survey that intended to take representative specimens of species in the AOI. It is important to calculate the invasive species percentage to monitor any new species that may encroach upon the area with the disturbance from the City of Columbia's embankment plan.

Disturbance of ecosystems by invasive species can negatively affect biodiversity and ecosystem functions, as well as influence the economics and human health of nearby communities. The measure of disturbance is critical and even a little disturbance can lead to substantial changes, such as fragmentation and changes in available nutrients (Huennekee and Thomson 1995). For example, Larson (2003) conducted a study on invasive and native plant species in disturbed habitats and found that disturbance led to an earlier stage of plant succession, which allowed for the movement of invasive weeds into the habitat. Furthermore, she indicated that disturbed habitats display a disruption in ecosystem structure and alterations in resources (e.g., the availability of nutrients and food) (Larson 2003). Human disturbances, such as building infrastructure, large-scale agriculture, and digging for resources in quarries are known as exogenous disturbances (Larson 2003). It was proposed that the presence of exogenous disturbances in habitats should be expected to result in the movement of plant species that are evolutionarily adapted to exploit such circumstances into the environment (Larson 2003).

Invasive plant species, such as *H. helix* are known for their abilities to take advantage of disturbances. Paulsen et al. (2010) studied the ability of *H. helix* to affect human health via contact dermatitis. *H. helix* has been reported as a cause of contact dermatitis since 1899, and it is believed that allergies from contact dermatitis are under-diagnosed because of a lack in viable patch test allergens. The common allergen in *H. helix*, falcarinol, was studied with patch testing over 16 years (Paulsen et al. 2010). Falcarinol is largely found in the ivy family Apiaceae and is detected in *H. helix* on the stalks, leaves, and roots. With more than 1% of falcarinol contained in the leaves, pruning plants in this family or handling them in any setting can result in sensitization in both children and adults. As a strong irritant, *H. helix* contains heredin, which aggravates mucosal surfaces in the nose and throat (Paulsen et al. 2010). Hands and/or forearms were recorded as the most common site of irritation. Because plants containing falcarinol are abundant and there was a large response of positive reactions during the patch testing, the authors suggested it be the next commercially available plant allergen to require further testing (Paulsen et al. 2010).

H. helix was chosen in this study to be a focus for a specific invasive plant species of concern to create a database of spatial extent. It inhabits a great expanse of the AOI as seen in Figure 2.10; 54% to be exact. While found in both large and small clumps on the ground, it also climbs mature trees (*Platanus occidentalis*, *Pinus* spp., *Quercus* spp., *Juglans nigra*) in the AOI and is located along major and minor pathways, whether the path is a paved sidewalk or trails throughout the wooded area.

During the field portion of this study it was particularly noticeable that *H. helix* grew densely in shaded areas. Comparing the disturbed habitats of the northern and southern portions of the AOI, *H. helix* was more abundant in the southern section where disturbance recently occurred approximately two years ago (Figure 2.10). This disturbance was part of the City of Columbia embankment plan and included the removal of all understory trees, woody vegetation, snags above six inches in diameter including the root ball, fallen trees, and diseased or damaged trees to leave only canopy trees. The northern portion, where disturbance occurred in the past and has been left undisturbed except for the occasional removal of snags and fallen trees, is greatly overwhelmed with *H. helix*. However, it is a smaller area than the southern section and the total *H. helix* is less profuse. The abundance of *H. helix* is a concern to the native plant population as it blankets large sections of the forest floor and stifles growth of herbaceous and shrub flora.

Procedures such as those enacted by the City of Columbia's plan to stabilize the canal embankment by removing species on the riverside embankment qualify as disturbances which allow for invasive plant species to exploit the circumstances of the cleared area. Without historical data, one cannot discern that these disturbances caused the movement and growth of *H. helix* to expand into and throughout the AOI; however, it can be inferred from knowledge gleaned from studies like Larson (2003).

Because of its allergenic properties *H. helix* is also a human health issue. Many people frequently use the different pathways along and within the forest for exercise and fun with their children and pets. With such heavy traffic and the prevalence of *H. helix* throughout the AOI and along many pathways, as well as its known invasive ability to spread efficiently, the plant presents a problem of increased contact dermatitis to the human population. Therefore, it is critical that management of this invasive is a high priority for the City of Columbia as it adversely affects both plant and human populations.

Management of invasive species is critical to maintain proper ecosystem structure, which is composed of primary productivity, ecosystem services, predator/prey relationships, and food webs. According to the National Invasive Species Council (NISC) the first line of defense and primary focus is prevention by ensuring invasive species do not establish themselves in new habitats. Site managers and conservationists like to study potential conflicts between particular invasive and native species, especially species endemic to certain areas and ecosystems to allow for preventative measures to occur before biodiversity is threatened (Huennekee and Thomson 1995). Baker and Murray's (2012) study suggests that knowledge of invasive species locations and proper placement of barriers against invasive species spread can prevent the encroachment of such species into new habitats. However, Schlaepfer et al. (2011) creates an argument that all invasive species are not injurious to ecosystems.

Whether invasive species are damaging or beneficial to an ecosystem was not the question of this study. This study focused on creating a baseline survey of the species represented in the AOI and identifying each species as native or non-native, determining the distribution of *H. helix*, and visualizing comparisons between two varying levels of disturbed habitats in a portion of the Three Rivers Greenway. As a result, further study can be attributed to determining if the species interact well or if the flora of the area should be reestablished with a focus on native plant species as a restoration process that reduces, but does not eliminate non-native species and the planting of rare species, which is suggested to have a positive impact on utility (Martin and Blossey 2012).

This study highlighted the need for curated references for native and non-native species records. When researching individual specimens for division of native or non-native and the further subcategories of rare or common and invasive, naturalized, or introduced, it was obvious that there was a disconnect between available references that could provide information of the taxonomic levels of a species and whether or not a species was native or non-native, when it might have been introduced to a new area, or how long a species might have existed in an area without harming native flora and should in turn be termed naturalized. While it was easier to determine the native status of certain specimens, whether a specimen was just introduced or was indeed invasive or naturalized was harder to define. More plant surveys and further study of the specimens already housed in herbariums globally could help establish historical records of native species representation and the status of species not native to areas in which they are currently located.

By maintaining, improving, and augmenting specimens to herbariums like USCH, resources can be improved. With enhanced resources, studying the changing species in an area can provide insight on the management, evolution, and ecology of plant species and their habitats (Primack and Miller-Rushing 2009). In addition, studying changes in plant phenology, such as differences in flowering in the past and present years, through herbarium specimens can show alterations in climatic conditions (Primack and Miller-Rushing 2009). Herbaria house preserved taxonomic representations of species from their local area and globally. Evaluating such specimens can improve predications of species alteration in response to climate change, helping to identify species that will survive or face crises which is a chief conservation priority (Primack and Miller-Rushing 2009). Furthermore, herbaria are important teaching tools for informing the public about their local biodiversity and the effects of climate change on their environment and can combine scientific research and education by using native and invasive specimens in exhibitions and presentations (Primack and Miller-Rushing 2009).

Table 2.1. Important Terms. Definitions to help understand the terminology used in this study.

Important Terms		
Term	**Definition**	**Example (as seen in Table 2.2)**
dicot	an angiosperm plant with net-like leaf venation and reproductive parts in groups of four or five (Weakley 2012)	*Liquidambar styraciflua*
introduced	plants that are not native to the area where they are found ("Introduced, Invasive, and Noxious Plants" 2014)	*Youngia japonica*
invasive	any species, which is non-native and when introduced to an area does or has the ability to inflict harm on the environment, the economy, or to human health (Martin and Blossey 2012).	*Lonicera japonica*
monocot	an angiosperm plant with parallel leaf venation and reproductive parts in groups of three (Weakley 2012)	*Smilax glauca*
native	plants that grow naturally and are indigenous to the area where they are found	*Cornus stricta*
naturalized	plants that are not native to the area where they are found, but behave like native species, have existed in a non-native habitat for some time, and do not exhibit invasive characteristics (UC-IPM 2014)	*Viola arvensis*
noxious	a legal term used by federal/state regulatory agencies for plants that can or do cause threatening/harmful actions to agriculture or wildlands (UC-IPM 2014)	*Clematis terniflora*

Table 2.2. USCH Database Specimen Records. Database records acquired from Specify 6 and USCH for the Riverfront Park area. This table is 4 pages long.

USCH Number	Family	Genus	Species	Subspecies
107945	Poaceae	*Elymus*	*virginicus*	
107946	Verbenaceae	*Verbena*	*brasiliensis*	
107947	Bignoniaceae	*Catalpa*	*bignonioides*	
108001	Asteraceae	*Mikania*	*scandens*	
108002	Caprifoliaceae	*Sambucus*	*canadensis*	
108003	Fabaceae	*Mimosa*	*microphylla*	
108004	Fabaceae	*Sesbania*	*punicea*	
108005	Fabaceae	*Albizia*	*julibrissin*	
108006	Passifloraceae	*Passiflora*	*incarnata*	
108007	Cornaceae	*Cornus*	*stricta*	
111215	Potamogetonaceae	*Potamogeton*	*spp.*	
111216	Amaranthaceae	*Amaranthus*	*tuberculatus*	
111217	Ulmaceae	*Ulmus*	*americana*	
112751	Fagaceae	*Castanea*	*dentata*	
112936	Fabaceae	*Apios*	*americana*	
68275	Asteraceae	*Helianthus*	*tuberosus*	
69489	Apiaceae	*Ptilimnium*	*capillaceum*	
78357	Urticaceae	*Boehmeria*	*cylindrica*	
78358	Cyperaceae	*Carex*	*gigantea*	
78399	Asteraceae	*Pluchea*	*camphorata*	
78400	Rubiaceae	*Cephalanthus*	*occidentalis*	
78401	Poaceae	*Pennisetum*	*glaucum*	
78403	Onagraceae	*Ludwigia*	*virgata*	
78404	Onagraceae	*Ludwigia*	*alterniflora*	
78405	Poaceae	*Panicum*	*rigidulum*	var. *rigidulum*
78406	Onagraceae	*Ludwigia*	*decurrens*	
79353	Anacardiaceae	*Toxicodendron*	*radicans*	
79354	Vitaceae	*Ampelopsis*	*cordata*	
79355	Nyssaceae	*Nyssa*	*biflora*	
79356	Fagaceae	*Quercus*	*nigra*	
79357	Vitaceae	*Ampelopsis*	*arborea*	
79358	Fabaceae	*Lespedeza*	*cuneata*	
79359	Clusiaceae	*Hypericum*	*gentianoides*	
79360	Fagaceae	*Quercus*	*lyrata*	
79361	Scrophulariaceae	*Lindernia*	*dubia*	var. *anagallidea*
79362	Asteraceae	*Rudbeckia*	*laciniata*	
79364	Campanulaceae	*Lobelia*	*cardinalis*	
79365	Fabaceae	*Apios*	*americana*	
79366	Ranunculaceae	*Clematis*	*terniflora*	

USCH Number	Family	Genus	Species	Subspecies
79367	Violaceae	*Viola*	*affinis*	
79368	Poaceae	*Setaria*	*pumila*	ssp. *pallidifusca*
79369	Asteraceae	*Elephantopus*	*tomentosus*	
79371	Vitaceae	*Vitis*	*rotundifolia*	
79372	Caprifoliaceae	*Lonicera*	*japonica*	
79373	Passifloraceae	*Passiflora*	*lutea*	
79376	Grossulariaceae	*Itea*	*virginica*	
79384	Anacardiaceae	*Toxicodendron*	*radicans*	
79408	Campanulaceae	*Lobelia*	*elongata*	
79581	Asteraceae	*Elephantopus*	*tomentosus*	
79583	Asteraceae	*Symphyotrichum*	*pilosum*	var. *pilosum*
79585	Fabaceae	*Apios*	*americana*	
79586	Asteraceae	*Vernonia*	*noveboracensis*	
79588	Asteraceae	*Boltonia*	*caroliniana*	
79589	Hydrophyllaceae	*Hydrolea*	*quadrivalvis*	
79590	Pontederiaceae	*Pontederia*	*cordata*	
79591	Apiaceae	*Hydrocotyle*	*umbellata*	
79593	Caprifoliaceae	*Sambucus*	*canadensis*	
79594	Scrophulariaceae	*Mimulus*	*ringens*	
79595	Ulmaceae	*Ulmus*	*alata*	
79598	Magnoliaceae	*Magnolia*	*grandiflora*	
79623	Cyperaceae	*Scirpus*	*cyperinus*	
79624	Commelinaceae	*Commelina*	*virginica*	
79625	Cyperaceae	*Rhynchospora*	*corniculata*	
79626	Cornaceae	*Cornus*	*stricta*	
79627	Bignoniaceae	*Bignonia*	*capreolata*	
79628	Poaceae	*Elymus*	*virginicus*	
79629	Oleaceae	*Ligustrum*	*sinense*	
79630	Araliaceae	*Hedera*	*helix*	
79631	Aquifoliaceae	*Ilex*	*cornuta*	
79632	Poaceae	*Dichanthelium*	*dichotomum*	
79633	Hamamelidaceae	*Liquidambar*	*styraciflua*	
79634	Asteraceae	*Elephantopus*	*tomentosus*	
79636	Rosaceae	*Prunus*	*caroliniana*	
79637	Bromeliaceae	*Tillandsia*	*usneoides*	
79902	Ulmaceae	*Ulmus*	*americana*	
79903	Rosaceae	*Aphanes*	*australis*	
80128	Cuscutaceae	*Cuscuta*	*compacta*	
80129	Amaranthaceae	*Alternanthera*	*philoxeroides*	

USCH Number	Family	Genus	Species	Subspecies
80130	Clusiaceae	*Hypericum*	*mutilum*	
80132	Pontederiaceae	*Pontederia*	*cordata*	
80133	Amaranthaceae	*Alternanthera*	*philoxeroides*	
80134	Brassicaceae	*Lepidium*	*virginicum*	
80135	Platanaceae	*Platanus*	*occidentalis*	
80136	Betulaceae	*Betula*	*nigra*	
80137	Acanthaceae	*Justicia*	*americana*	
80443	Cyperaceae	*Carex*	*vulpinoidea*	
80464	Poaceae	*Echinochloa*	*crus-galli*	
80465	Equisetaceae	*Equisetum*	*hyemale*	
80466	Acanthaceae	*Ruellia*	*caroliniensis*	
80468	Cornaceae	*Cornus*	*stricta*	
80554	Scrophulariaceae	*Mimulus*	*ringens*	
80555	Ranunculaceae	*Clematis*	*virginiana*	
80556	Caprifoliaceae	*Viburnum*	*dentatum*	
80558	Fabaceae	*Strophostyles*	*helvula*	
80559	Buddlejaceae	*Polypremum*	*procumbens*	
80560	Poaceae	*Panicum*	*rigidulum*	
80561	Plantaginaceae	*Plantago*	*lanceolata*	
80562	Chenopodiaceae	*Dysphania*	*ambrosioides*	
80564	Scrophulariaceae	*Mecardonia*	*acuminata*	
80565	Euphorbiaceae	*Acalypha*	*rhomboidea*	
80566	Cucurbitaceae	*Sicyos*	*angulatus*	
80568	Asteraceae	*Conyza*	*canadensis*	
80569	Platanaceae	*Platanus*	*occidentalis*	
80585	Cyperaceae	*Rhynchospora*	*spp.*	
80587	Typhaceae	*Typha*	*latifolia*	
80588	Apiaceae	*Ptilimnium*	*capillaceum*	
80588	Apiaceae	*Ptilimnium*	*capillaceum*	
80589	Hydrocharitaceae	*Egeria*	*densa*	
80646	Potamogetonaceae	*Potamogeton*	*diversifolius*	
81074	Poaceae	*Echinochloa*	*crus-galli*	
81122	Onagraceae	*Oenothera*	*perennis*	
81123	Cucurbitaceae	*Cucumis*	*sativus*	
81124	Asteraceae	*Smallanthus*	*uvedalius*	
81125	Convolvulaceae	*Calystegia*	*sepium*	
81126	Poaceae	*Tripsacum*	*dactyloides*	
81127	Asteraceae	*Eupatorium*	*serotinum*	
81128	Smilacaceae	*Smilax*	*smallii*	

USCH Number	Family	Genus	Species	Subspecies
81130	Vitaceae	*Ampelopsis*	*cordata*	
81131	Asteraceae	*Conyza*	*bonariensis*	
81132	Aceraceae	*Acer*	*negundo*	
81133	Oleaceae	*Fraxinus*	*americana*	
81134	Campanulaceae	*Lobelia*	*cardinalis*	
81135	Commelinaceae	*Commelina*	*communis*	
81136	Fabaceae	*Amorpha*	*fruticosa*	
81137	Cornaceae	*Cornus*	*stricta*	
81138	Clusiaceae	*Hypericum*	*mutilum*	
81184	Onagraceae	*Ludwigia*	*palustris*	
81185	Brassicaceae	*Cardamine*	*pensylvanica*	
81607	Liliaceae	*Hymenocallis*	*caroliniana*	
82784	Magnoliaceae	*Liriodendron*	*tulipifera*	
85382	Rosaceae	*Rosa*	*spp.*	
89208	Betulaceae	*Betula*	*nigra*	
89733	Caryophyllaceae	*Arenaria*	*serpyllifolia*	
89735	Brassicaceae	*Draba*	*brachycarpa*	
89736	Caryophyllaceae	*Cerastium*	*glomeratum*	
89737	Poaceae	*Poa*	*annua*	
96334	Asclepiadaceae	*Matelea*	*gonocarpos*	

Table 2.3. Specimen Identifications and Localities. Information identifying each individual specimen, their status as a monocot, dicot, or gymnosperm, their latitude/longitude, associated transect number, and elevation. Species in bold are duplicates from this study. This table is 6 pages long.

	Genus	Species	Subspecies	Common Name	Family	Monocot	Dicot	Gymnosperm	Transect	Latitude	Longitude	Elevation
1	*Platanus*	*occidentalis*		Sycamore	Platanaceae		✓		T1	N 34°01.987'	W 081°04.174'	153 ft
2	*Cephalanthus*	*occidentalis*		Common buttonbush	Rubiaceae		✓		T1	N 34°01.986'	W 081°04.178'	168 ft
3	*Dichanthelium*	*polyanthes*		Small-fruited witch grass	Poaceae	✓			T1	N 34°01.983'	W 081°04.174'	158 ft
4	*Sambucus*	*nigra*	ssp. *canadensis*	American black elderberry	Adoxaceae		✓		T1	N 34°01.986'	W 081°04.178'	156 ft
5	*Chasmanthium*	*latifolium*		Indian woodoats	Poaceae	✓			T1	N 34°01.984'	W 081°04.173'	162 ft
6	***Dichanthelium***	***polyanthes***		Small-fruited witch grass	Poaceae	✓			T1	N 34°01.984'	W 081°04.168'	183 ft
7	*Cocculus*	*carolinus*		Carolina coralbead	Menispermaceae		✓		T1	N 34°01.994'	W 081°04.151'	210 ft
8	*Sida*	*rhombifolia*		Cuban jute	Malvaceae		✓		T1	N 34°01.997'	W 081°04.155'	201 ft
9	*Ligustrum*	*sinense*		Chinese Privet	Oleaceae		✓		T1	N 34°01.988'	W 081°04.155'	218 ft
10	*Ligustrum*	*japonicum*		Japonese Privet	Oleaceae		✓		T1	N 34°01.991'	W 081°04.155'	205 ft
11	*Liquidambar*	*styraciflua*		Sweetgum	Altingiaceae		✓		T1	N 34°01.991'	W 081°04.155'	205 ft
12	*Youngia*	*japonica*		Oriental false hawksbeard	Asteraceae		✓		T1	N 34°01.986'	W 081°04.156'	212 ft
13	*Callicarpa*	*americana*		American beautyberry	Lamiaceae		✓		T18	N 34°01.904'	W 081°04.150'	100 ft
14	*Smallanthus*	*uvedalia*		Hairy leafcup	Asteraceae		✓		T15	N 34°01.917'	W 081°04.156'	171 ft
15	*Albizia*	*julibrissin*		Mimosa	Fabaceae		✓		T9	N 34°01.947'	W 081°04.154'	191 ft
16	*Clematis*	*terniflora*		Sweet autumn virginsbower	Ranunculaceae		✓		T1	N 34°01.982'	W 081°04.156'	176 ft
17	*Ampelopsis*	*arborea*		Peppervine	Vitaceae		✓		T1	N 34°01.987'	W 081°04.158'	150 ft
18	*Ampelopsis*	*cordata*		Heartleaf peppervine	Vitaceae		✓		T1	N 34°01.987'	W 081°04.158'	150 ft
19	*Juncus*	*bufonius*		Toad rush	Juncaceae	✓			T1	N 34°01.991'	W 081°04.177'	149 ft
20	***Cocculus***	***carolinus***		Carolina coralbead	Menispermaceae		✓		T2	N 34°01.979'	W 081°04.155'	175 ft
21	***Clematis***	***terniflora***		Sweet autumn virginsbower	Ranunculaceae		✓		T3	N 34°01.977'	W 081°04.156'	180 ft
22	*Lonicera*	*japonica*		Japanese honeysuckle	Caprifoliaceae		✓		T3	N 34°01.977'	W 081°04.155'	171 ft
23	*Juglans*	*nigra*		Black walnut	Juglandaceae		✓		T9	N 34°01.949'	W 081°04.166'	171 ft
24	*Cornus*	*foemina*		Swamp dogwood	Cornaceae		✓		T15	N 34°01.916'	W 081°04.173'	168 ft
25	*Ilex*	*decidua*		Possumhaw	Aquifoliaceae		✓		T12	N 34°01.930'	W 081°04.175'	144 ft
26	*Acer*	*negundo*		Boxelder	Sapindaceae		✓		T10	N 34°01.939'	W 081°04.179'	131 ft
27	*Smilax*	*glauca*		Cat greenbrier	Smilacaceae	✓			T10	N 34°01.941'	W 081°04.175'	142 ft
28	*Carpinus*	*caroliniana*		American hornbeam	Betulaceae		✓		T6	N 34°01.963'	W 081°04.164'	136 ft
29	*Commelina*	*virginica*		Virginia dayflower	Commelinaceae	✓			T3	N 34°01.975'	W 081°04.169'	156 ft
30	*Persicaria*	*setacea*		Bog smartweed	Polygonaceae		✓		T1	N 34°01.991'	W 081°04.177'	149 ft

	Genus	Species	Subspecies	Common Name	Family	Monocot	Dicot	Gymnosperm	Transect	Latitude	Longitude	Elevation
31	*Cyperus*	*drummondii*		Drummond's sedge	Cyperaceae	✓			T1	N 34°01.991'	W 081°04.177'	149 ft
32	*Lindernia*	*dubia*		Yellow-seed false pimpernel	Linderniaceae		✓		T1	N 34°01.991'	W 081°04.177'	149 ft
33	*Verbesina*	*occidentalis*		Yellow crownbeard	Asteraceae		✓		T1	N 34°01.999'	W 081°04.165'	173 ft
34	***Clematis***	***terniflora***		Sweet autumn virginsbower	Ranunculaceae		✓		T5	N 34°01.967'	W 081°04.156'	168 ft
35	*Elephantopus*	*tomentosus*		Hairy elephant foot	Asteraceae		✓		T19	N 34°01.896'	W 081°04.155'	193 ft
36	***Verbesina***	***occidentalis***		Yellow crownbeard	Asteraceae		✓		T23	N 34°01.872'	W 081°04.155'	181 ft
37	*Vitis*	*rotundifolia*		Muscadine	Vitaceae		✓		T25	N 34°01.864'	W 081°04.151'	199 ft
38	*Laportea*	*canadensis*		Canadian woodnettle	Urticaceae		✓		T24	N 34°01.866'	W 081°04.150'	211 ft
39	*Tradescantia*	*hirsuticaulis*		Hairystem spiderwort	Commelinaceae	✓			T26	N 34°01.858'	W 081°04.150'	149 ft
40	***Clematis***	***terniflora***		Sweet autumn virginsbower	Ranunculaceae		✓		T3	N 34°01.977'	W 081°04.156'	180 ft
41	***Verbesina***	***occidentalis***		Yellow crownbeard	Asteraceae		✓		T25	N 34°01.864'	W 081°04.151'	175 ft
42	*Dicliptera*	*brachiata*		Branched foldwing	Acanthaceae		✓		T29	N 34°01.830'	W 081°04.140'	200 ft
43	***Laportea***	***canadensis***		Canadian woodnettle	Urticaceae		✓		T30	N 34°01.823'	W 081°04.139'	159 ft
44	*Hedera*	*helix*		English ivy	Araliaceae		✓		T31	N 34°01.815'	W 081°04.144'	175 ft
45	***Callicarpa***	***americana***		American beautyberry	Lamiaceae		✓		T34	N 34°01.790'	W 081°04.139'	170 ft
46	*Solidago*	*leavenworthii*		Leavenworth's goldenrod	Asteraceae		✓		T39	N 34°01.731'	W 081°04.110'	191 ft
47	*Tillandsia*	*usneoides*		Spanish moss	Bromeliaceae	✓			T53	N 34°01.610'	W 081°04.129'	145 ft
48	*Asimina*	*triloba*		Pawpaw	Annonaceae		✓		T56	N 34°01.596'	W 081°04.125'	137 ft
49	*Viola*	*arvensis*		European field pansy	Violaceae		✓		T43	N 34°01.712'	W 081°04.120'	278 ft
50	*Vicia*	*sativa*	ssp. *nigra*	Garden vetch	Fabaceae		✓		T14	N 34°01.919'	W 081°04.151'	214 ft
51	***Ligustrum***	***japonicum***		Japanese Privet	Oleaceae		✓		T8	N 34°01.950'	W 081°04.159'	177 ft
52	*Trifolium*	*campestre*		Low hop clover	Fabaceae		✓		T8	N 34°01.950'	W 081°04.155'	180 ft
53	*Poa*	*chapmaniana*		Chapman's bluegrass	Poaceae	✓			T8	N 34°01.951'	W 081°04.157'	174 ft
54	*Gamochaeta*	*purpurea*		Spoon-leaf purple everlasting	Asteraceae		✓		T8	N 34°01.951'	W 081°04.157'	174 ft
55	*Sonchus*	*asper*		Spiny sowthistle	Asteraceae		✓		T8	N 34°01.951'	W 081°04.157'	174 ft
56	*Taraxacum*	*erythrospermum*		Rock dandelion	Asteraceae		✓		T10	N 34°01.944'	W 081°04.153'	176 ft
57	*Cercis*	*canadensis*	var. *canadensis*	Eastern redbud	Fabaceae		✓		T9	N 34°01.948'	W 081°04.162'	177 ft
58	*Quercus*	*nigra*		Water oak	Fagaceae		✓		T11	N 34°01.932'	W 081°04.156'	163 ft
59	*Vicia*	*caroliniana*		Carolina vetch	Fabaceae		✓		T11	N 34°01.932'	W 081°04.154'	171 ft
60	*Galium*	*aparine*		Stickywilly	Rubiaceae		✓		T11	N 34°01.932'	W 081°04.154'	171 ft

	Genus	Species	Subspecies	Common Name	Family	Monocot	Dicot	Gymnosperm	Transect	Latitude	Longitude	Elevation
61	***Vicia***	***sativa***	**ssp. *nigra***	Garden vetch	Fabaceae		✓		T11	N 34°01.932'	W 081°04.154'	171 ft
62	***Liquidambar***	***styraciflua***		Sweetgum	Altingiaceae		✓		T10	N 34°01.939'	W 081°04.154'	163 ft
63	*Prunus*	*serotina*		Black cherry	Rosaceae		✓		T14	N 34°01.923'	W 081°04.151'	169 ft
64	*Geranium*	*carolinianum*		Carolina geranium	Geraniaceae		✓		T14	N 34°01.923'	W 081°04.151'	169 ft
65	*Lamium*	*amplexicaule*		Henbit deadnettle	Lamiaceae		✓		T14	N 34°01.923'	W 081°04.151'	169 ft
66	*Veronica*	*hederifolia*		Ivyleaf speedwell	Plantaginaceae		✓		T14	N 34°01.923'	W 081°04.151'	169 ft
67	*Cardamine*	*hirsuta*		Hairy bittercress	Brassicaceae		✓		T22	N 34°01.878'	W 081°04.133'	171 ft
68	*Nemophila*	*aphylla*		Smallflower baby blue eyes	Boraginaceae		✓		T22	N 34°01.879'	W 081°04.133'	170 ft
69	*Rubus*	*argutus*		Sawtooth blackberry	Rosaceae		✓		T22	N 34°01.879'	W 081°04.133'	170 ft
70	*Duchesnea*	*indica*		Indian strawberry	Rosaceae		✓		T24	N 34°01.871'	W 081°04.129'	168 ft
71	*Carex*	*festucacea*		Fescue sedge	Cyperaceae	✓			T24	N 34°01.871'	W 081°04.129'	168 ft
72	*Carex*	*amphibola*		Eastern narrowleaf sedge	Cyperaceae	✓			T24	N 34°01.870'	W 081°04.126'	176 ft
73	***Rumex***	***crispus***		Curly dock	Polygonaceae		✓		T24	N 34°01.870'	W 081°04.126'	176 ft
74	*Carex*	*flaccosperma*		Thinfruit sedge	Cyperaceae	✓			T24	N 34°01.870'	W 081°04.126'	176 ft
75	***Youngia***	***japonica***		Oriental false hawksbeard	Asteraceae		✓		T1	N 34°01.981'	W 081°04.154'	176 ft
76	***Geranium***	***carolinianum***		Carolina geranium	Geraniaceae		✓		T1	N 34°01.981'	W 081°04.154'	176 ft
77	*Rubus*	*trivialis*		Southern dewberry	Rosaceae		✓		T1	N 34°01.981'	W 081°04.154'	176 ft
78	*Veronica*	*peregrina*		Purslane speedwell	Plantaginaceae		✓		T1	N 34°01.981'	W 081°04.154'	176 ft
79	*Oxalis*	*stricta*		Common yellow oxalis	Oxalidaceae		✓		T8	N 34°01.951'	W 081°04.156'	194 ft
80	*Hypochaeris*	*glabra*		Smooth cat's ear	Asteraceae		✓		T10	N 34°01.944'	W 081°04.154'	185 ft
81	***Duchesnea***	***indica***		Indian strawberry	Rosaceae		✓		T26	N 34°01.859'	W 081°04.124'	184 ft
82	***Rubus***	***trivialis***		Southern dewberry	Rosaceae		✓		T26	N 34°01.860'	W 081°04.125'	205 ft
83	*Krigia*	*dandelion*		Potato dwarf dandelion	Asteraceae		✓		T29	N 34°01.835'	W 081°04.118'	213 ft
84	***Youngia***	***japonica***		Oriental false hawksbeard	Asteraceae		✓		T29	N 34°01.830'	W 081°04.118'	213 ft
85	***Veronica***	***hederifolia***		Ivyleaf speedwell	Plantaginaceae		✓		T34	N 34°01.789'	W 081°04.116'	183 ft
86	*Prunus*	*caroliniana*		Carolina laurel cherry	Rosaceae		✓		T50	N 34°01.641'	W 081°04.097'	179 ft
87	*Halesia*	*carolina*		Carolina silverbell	Styracaceae		✓		T20	N 34°01.889'	W 081°04.152'	163 ft
88	***Nemophila***	***aphylla***		Smallflower baby blue eyes	Boraginaceae		✓		T34	N 34°01.796'	W 081°04.140'	163 ft
89	*Osmorhiza*	*longistylis*		Longstyle sweetroot	Apiaceae		✓		T35	N 34°01.783'	W 081°04.139'	136 ft
90	***Cornus***	***foemina***		Stiff dogwood	Cornaceae		✓		T21	N 34°01.883'	W 081°04.152'	165 ft

	Genus	Species	Subspecies	Common Name	Family	Monocot	Dicot	Gymnosperm	Transect	Latitude	Longitude	Elevation
91	*Podophyllum*	*peltatum*		Mayapple	Berberidaceae		✓		T42	N 34°01.715'	W 081°04.129'	178 ft
92	*Elymus*	*virginicus*	var. *virginicus*	Virginia wildrye	Poaceae	✓			T1	N 34°01.991'	W 081°04.177'	149 ft
93	***Youngia***	***japonica***		Oriental false hawksbeard	Asteraceae		✓		T44	N 34°01.699'	W 081°04.135'	159 ft
94	***Oxalis***	***stricta***		Common yellow oxalis	Oxalidaceae		✓		T39	N 34°01.735'	W 081°04.113'	150 ft
95	*Plantago*	*virginica*		Virginia plantain	Plantaginaceae		✓		T39	N 34°01.735'	W 081°04.113'	150 ft
96	*Elaeagnus*	*umbellata*	var. *parvifolia*	Autumn olive	Elaeagnaceae		✓		T12	N 34°01.930'	W 081°04.169'	161 ft
97	*Poa*	*autumnalis*		Autumn bluegrass	Poaceae	✓			T18	N 34°01.907'	W 081°04.156'	168 ft
98	*Sparganium*	*americanum*		American bur-reed	Typhaceae	✓			T26	N 34°01.854'	W 081°04.147'	205 ft
99	*Bignonia*	*capreolata*		Crossvine	Bignoniaceae		✓		T29	N 34°01.831'	W 081°04.144'	174 ft
100	*Packera*	*glabella*		Butterweed	Asteraceae		✓		T29	N 34°01.831'	W 081°04.144'	174 ft
101	*Chenopodium*	*album*		Lambsquarters	Amaranthaceae		✓		T117	N 34°00.743'	W 081°03.531'	176 ft
102	***Osmorhiza***	***longistylis***		Longstyle sweetroot	Apiaceae		✓		T35	N 34°01.785'	W 081°04.116'	179 ft
103	***Lonicera***	***japonica***		Japanese honeysuckle	Caprifoliaceae		✓		T55	N 34°01.603'	W 081°04.125'	203 ft
104	*Hypericum*	*hypericoides*	ssp. *hypericoides*	St. Andrew's cross	Hypericaceae		✓		T105	N 34°00.922'	W 081°03.617'	155 ft
105	*Trifolium*	*incarnatum*		Crimson clover	Fabaceae		✓		T35	N 34°01.785'	W 081°04.116'	179 ft
106	***Trifolium***	***campestre***		Low hop clover	Fabaceae		✓		T35	N 34°01.785'	W 081°04.125'	179 ft
107	***Geranium***	***carolinianum***		Carolina geranium	Geraniaceae		✓		T35	N 34°01.785'	W 081°04.125'	179 ft
108	***Duchesnea***	***indica***		Indian strawberry	Rosaceae		✓		T35	N 34°01.785'	W 081°04.125'	179 ft
109	***Ligustrum***	***sinense***		Chinese Privet	Oleaceae		✓		T9	N 34°01.948'	W 081°04.162'	178 ft
110	*Nuttallanthus*	*canadensis*		Canada toadflax	Plantaginaceae		✓		T35	N 34°01.785'	W 081°04.125'	179 ft
111	***Cercis***	***canadensis***	**var. *canadensis***	Eastern redbud	Fabaceae		✓		T9	N 34°01.948'	W 081°04.162'	177 ft
112	*Symphyotrichum*	*pilosum*	var. *pilosum*	Hairy white oldfield aster	Asteraceae		✓		T131	N 34°00.585'	W 081°03.502'	174 ft
113	*Triodanis*	*perfoliata*		Clasping Venus' looking-glass	Campanulaceae		✓		T35	N 34°01.783'	W 081°04.118'	156 ft
114	***Veronica***	***hederifolia***		Ivyleaf speedwell	Plantaginaceae		✓		T35	N 34°01.783'	W 081°04.118'	156 ft
115	*Rumex*	*crispus*		Curly dock	Polygonaceae		✓		T39	N 34°01.740'	W 081°04.113'	156 ft
116	*Sisyrinchium*	*atlanticum*		Eastern blue-eyed grass	Iridaceae	✓			T24	N 34°01.866'	W 081°04.124'	201 ft
117	*Vicia*	*cracca*		Bird vetch	Fabaceae		✓		T48	N 34°01.664'	W 081°04.104'	146 ft
118	*Solanum*	*pseudocapsicum*		Jerusalem cherry	Solanaceae		✓		T61	N 34°01.511'	W 081°04.104'	153 ft
119	*Nandina*	*domestica*		Sacred bamboo	Berberidaceae		✓		T86	N 34°01.317'	W 081°03.984'	162 ft
120	***Sambucus***	***nigra***	ssp. *canadensis*	American black elderberry	Adoxaceae		✓		T91	N 34°01.257'	W 081°03.791'	157 ft

	Genus	Species	Subspecies	Common Name	Family	Monocot	Dicot	Gymnosperm	Transect	Latitude	Longitude	Elevation
121	***Sida***	***rhombifolia***		Cuban jute	Malvaceae		✓		T24	N 34°01.866'	W 081°04.124'	207 ft
122	*Commelina*	*communis*		Asiatic dayflower	Commelinaceae	✓			T24	N 34°01.866'	W 081°04.124'	201 ft
123	*Solanum*	*carolinense*		Carolina horsenettle	Solanaceae		✓		T91	N 34°01.244'	W 081°04.772'	155 ft
124	*Verbena*	*bonariensis*		Purpletop vervain	Verbenaceae		✓		T37	N 34°01.767'	W 081°04.113'	180 ft
125	*Lactuca*	*biennis*		Tall blue lettuce	Asteraceae		✓		T34	N 34°01.791'	W 081°04.113'	180 ft
126	***Vitis***	***rotundifolia***		Muscadine	Vitaceae		✓		T14	N 34°01.920'	W 081°04.145'	240 ft
127	***Ligustrum***	***japonicum***		Japanese Privet	Oleaceae		✓		T14	N 34°01.920'	W 081°04.145'	240 ft
128	*Lespedeza*	*cuneata*		Sericea lespedeza	Fabaceae		✓		T130	N 34°00.586'	W 081°03.504'	179 ft
129	*Vaccinium*	*corymbosum*		Highbush blueberry	Ericaceae		✓		T129	N 34°00.598'	W 081°03.503'	166 ft
130	*Ilex*	*verticillata*		Common winterberry	Aquifoliaceae		✓		T129	N 34°00.607'	W 081°03.499'	166 ft
131	*Toxicodendron*	*radicans*		Poison ivy	Anacardiaceae		✓		T128	N 34°00.620'	W 081°03.499'	149 ft
132	***Halesia***	***carolina***		Carolina silverbell	Styracaceae		✓		T126	N 34°00.637'	W 081°03.502'	155 ft
133	***Elaeagnus***	***umbellata***	**var. *parvifolia***	Autumn olive	Elaeagnaceae		✓		T125	N 34°00.644'	W 081°03.505'	144 ft
134	***Commelina***	***virginica***		Virginia dayflower	Commelinaceae	✓			T25	N 34°01.861'	W 081°04.123'	222 ft
135	*Smilax*	*smallii*		Lanceleaf greenbrier	Smilacaceae	✓			T131	N 34°00.580'	W 081°03.497'	199 ft
136	*Lepidium*	*virginicum*		Virginia pepperweed	Brassicaceae		✓		T31	N 34°01.810'	W 081°04.118'	197 ft
137	***Duchesnea***	***indica***		Indian strawberry	Rosaceae		✓		T31	N 34°01.810'	W 081°04.118'	197 ft
138	*Tradescantia*	*hirsuticaulis*		Hairystem spiderwort	Commelinaceae	✓			T117	N 34°00.744'	W 081°03.538'	162 ft
139	*Asplenium*	*platyneuron*		Ebony spleenwort	Aspleniaceae			✓	T116	N 34°00.759'	W 081°03.540'	153 ft
140	*Polystichum*	*acrostichoides*		Christmas fern	Dryopteridaceae			✓	T114	N 34°00.781'	W 081°03.556'	170 ft
141	***Nandina***	***domestica***		Sacred bamboo	Berberidaceae		✓		T111	N 34°00.820'	W 081°03.571'	124 ft
142	*Ilex*	*cornuta*		Chinese holly	Aquifoliaceae		✓		T108	N 34°00.862'	W 081°03.587'	132 ft
143	*Ipomoea*	*purpurea*		Common morning-glory	Convolvulaceae		✓		T105	N 34°00.910'	W 081°03.610'	132 ft
144	*Phytolacca*	*americana*		American pokeweed	Phytolaccaceae		✓		T103	N 34°00.955'	W 081°03.620'	137 ft
145	*Ruellia*	*caroliniensis*		Carolina wild petunia	Acanthaceae		✓		T100	N 34°01.041'	W 081°03.642'	150 ft
146	*Conoclinium*	*coelestinum*		Blue mistflower	Asteraceae		✓		T105	N 34°00.922'	W 081°03.617'	155 ft
147	***Lonicera***	***japonica***		Japanese honeysuckle	Caprifoliaceae		✓		T103	N 34°00.953'	W 081°03.619'	157 ft
148	*Andropogon*	*virginicus*		Broomsedge bluestem	Poaceae	✓			T104	N 34°00.952'	W 081°03.620'	159 ft
149	***Asimina***	***triloba***		Pawpaw	Annonaceae		✓		T53	N 34°01.611'	W 081°04.132'	179 ft
150	***Clematis***	***terniflora***		Sweet autumn virginsbower	Ranunculaceae		✓		T55	N 34°01.603'	W 081°04.085'	170 ft

	Genus	Species	Subspecies	Common Name	Family	Monocot	Dicot	Gymnosperm	Transect	Latitude	Longitude	Elevation
151	*Pinus*	*taeda*		Loblolly pine	Pinaceae			✓	T48	N 34°01.665'	W 081°04.138'	226 ft
152	*Phoradendron*	*serotinum*		Oak mistletoe	Santalaceae		✓		T53	N 34°01.619'	W 081°04.128'	188 ft
153	*Stellaria*	*media*		Chickweed	Caryophyllaceae		✓		T1	N 34°01.998'	W 081°04.162'	142 ft
154	*Cerastium*	*semidecandrum*		Five-stamen chickweed	Caryophyllaceae		✓		T1	N 34°01.998'	W 081°04.162'	142 ft
155	***Pinus***	***taeda***		Loblolly pine	Pinaceae		✓	✓	T1	N 34°01.997'	W 081°04.158'	154 ft
156	*Ulmus*	*americana*		American elm	Ulmaceae		✓		T1	N 34°01.993'	W 081°04.164'	155 ft
157	*Verbena*	*brasiliensis*		Brazilian vervain	Verbenaceae		✓		T1	N 34°01.996'	W 081°04.176'	156 ft
158	***Packera***	***glabella***		Butterweed	Asteraceae		✓		T3	N 34°01.975'	W 081°04.171'	170 ft
159	***Carpinus***	***caroliniana***		American hornbeam	Betulaceae		✓		T4	N 34°01.973'	W 081°04.170'	157 ft
160	*Acer*	*rubrum*		Red Maple	Sapindaceae		✓		T7	N 34°01.957'	W 081°04.172'	151 ft
161	*Planera*	*aquatica*		Water-elm	Ulmaceae		✓		T7	N 34°01.956'	W 081°04.178'	155 ft
162	*Arundinaria*	*gigantea*		Giant cane	Poaceae	✓			T13	N 34°01.925'	W 081°04.169'	185 ft
163	*Corydalis*	*flavula*		Yellow fumewort	Papaveraceae		✓		T35	N 34°01.781'	W 081°04.140'	220 ft
164	***Pinus***	***taeda***		Loblolly pine	Pinaceae			✓	T36	N 34°01.773'	W 081°04.134'	171 ft
165	*Viola*	*sororia*		Common blue violet	Violaceae		✓		T61	N 34°01.511'	W 081°04.103'	159 ft
166	***Prunus***	***caroliniana***		Carolina laurel cherry	Rosaceae		✓		T63	N 34°01.494'	W 081°04.091'	188 ft
167	***Vaccinium***	***corymbosum***		Highbush blueberry	Ericaceae		✓		T56	N 34°00.588'	W 081°03.500'	214 ft
168	***Carpinus***	***caroliniana***		American hornbeam	Betulaceae		✓		T56	N 34°00.593'	W 081°03.497'	156 ft
169	*Amelanchier*	*arborea*		Common serviceberry	Rosaceae		✓		T50	N 34°00.639'	W 081°03.504'	159 ft
170	*Fagus*	*grandifolia*		American beech	Fagaceae		✓		T49	N 34°00.647'	W 081°03.506'	171 ft
171	***Bignonia***	***capreolata***		Crossvine	Bignoniaceae		✓		T48	N 34°00.658'	W 081°03.511'	154 ft
172	*Smilax*	*rotundifolia*		Roundleaf greenbriar	Smilacaceae	✓			T48	N 34°00.662'	W 081°03.517'	152 ft
173	*Yucca*	*filamentosa*		Adam's needle	Asparagaceae	✓			T45	N 34°00.684'	W 081°03.524'	162 ft
174	***Liquidambar***	***styraciflua***		Sweetgum	Altingiaceae		✓		T39	N 34°00.742'	W 081°03.533'	169 ft
175	*Photinia*	*serratifolia*		Taiwanese photinia	Rosaceae		✓		T29	N 34°00.836'	W 081°03.576'	180 ft
176	*Senecio*	*vulgaris*		Old-man-in-the-spring	Asteraceae		✓		T17	N 34°00.910'	W 081°03.604'	175 ft
177	***Acer***	***negundo***		Boxelder	Sapindaceae		✓		T34	N 34°00.796'	W 081°03.553'	157 ft
178	*Gelsemium*	*sempervirens*		Carolina jessamine	Gelsemiaceae		✓		T53	N 34°00.617'	W 081°03.493'	168 ft

Table 2.4. Species Conservation Status. Designations of each non-duplicated individual species collected as native or non-native and known locations within South Carolina. This table is 4 pages long.

	Genus	Species	Subspecies	Native	Common	Rare (state/fed tracked)	Non-native	Introduced	Naturalized	Invasive (state/fed noxious)	Severity	Known Locations
1	*Platanus*	*occidentalis*		✓	✓							all of SC
2	*Cephalanthus*	*occidentalis*		✓	✓							all of SC
3	*Dichanthelium*	*polyanthes*		✓	✓							M, P
4	*Sambucus*	*nigra*	ssp. *canadensis*	✓	✓							all of SC
5	*Chasmanthium*	*latifolium*		✓	✓							all of SC
6	*Cocculus*	*carolinus*		✓	✓							all of SC
7	*Sida*	*rhombifolia*		✓	✓							all of SC
8	*Ligustrum*	*sinense*					✓			✓ (state)	severe threat	all of SC
9	*Ligustrum*	*japonicum*					✓			✓	significant threat	all of SC
10	*Liquidambar*	*styraciflua*		✓	✓							all of SC
11	*Youngia*	*japonica*					✓	✓				not enough data/P
12	*Callicarpa*	*americana*		✓	✓							all of SC
13	*Smallanthus*	*uvedalia*		✓	✓							all of SC
14	*Albizia*	*julibrissin*					✓			✓ (state)	significant threat	all of SC
15	*Clematis*	*terniflora*					✓			✓ (state)	significant threat	all of SC
16	*Ampelopsis*	*arborea*		✓	✓							P, CP
17	*Ampelopsis*	*cordata*		✓	✓							P, CP
18	*Juncus*	*bufonius*		✓	✓							all of SC
19	*Lonicera*	*japonica*					✓			✓ (state)	severe threat	all of SC
20	*Juglans*	*nigra*		✓	✓							all of SC
21	*Cornus*	*foemina*		✓	✓							all of SC
22	*Ilex*	*decidua*		✓	✓							all of SC
23	*Acer*	*negundo*		✓	✓							all of SC
24	*Smilax*	*glauca*		✓	✓							all of SC
25	*Carpinus*	*caroliniana*		✓	✓							all of SC
26	*Commelina*	*virginica*		✓	✓							all of SC
27	*Persicaria*	*setacea*		✓	✓							all of SC
28	*Cyperus*	*drummondii*		✓	✓							not enough data/P, CP
29	*Lindernia*	*dubia*		✓	✓							all of SC
30	*Verbesina*	*occidentalis*		✓	✓							all of SC

	Genus	Species	Subspecies	Native	Common	Rare (state/fed tracked)	Non-native	Introduced	Naturalized	Invasive (state/fed noxious)	Severity	Known Locations
31	*Elephantopus*	*tomentosus*		✓	✓							all of SC
32	*Vitis*	*rotundifolia*		✓	✓							all of SC
33	*Laportea*	*canadensis*		✓	✓							M, P
34	*Tradescantia*	*hirsuticaulis*		✓	✓							M, P
35	*Dicliptera*	*brachiata*		✓	✓							P, CP
36	*Hedera*	*helix*					✓			✓ (state)	severe threat	all of SC
37	*Solidago*	*leavenworthii*		✓	✓							P, CP
38	*Tillandsia*	*usneoides*		✓	✓							P, CP
39	*Asimina*	*triloba*		✓	✓							M, P
40	*Viola*	*arvensis*					✓		✓			M, P
41	*Vicia*	*sativa*	ssp. *nigra*				✓	✓				all of SC
42	*Trifolium*	*campestre*					✓	✓				all of SC
43	*Poa*	*chapmaniana*		✓	✓							M, P
44	*Gamochaeta*	*purpurea*		✓	✓							all of SC
45	*Sonchus*	*asper*					✓		✓			all of SC
46	*Taraxacum*	*erythrospermum*					✓	✓				all of SC
47	*Cercis*	*canadensis*	var. *canadensis*	✓	✓							all of SC
48	*Quercus*	*nigra*		✓	✓							all of SC
49	*Vicia*	*caroliniana*		✓	✓							all of SC
50	*Galium*	*aparine*		✓	✓							all of SC
51	*Prunus*	*serotina*		✓	✓							all of SC
52	*Geranium*	*carolinianum*		✓	✓							all of SC
53	*Lamium*	*amplexicaule*					✓		✓			all of SC
54	*Veronica*	*hederifolia*					✓	✓				M, P
55	*Cardamine*	*hirsuta*					✓		✓			all of SC
56	*Nemophila*	*aphylla*		✓	✓							M, P
57	*Rubus*	*argutus*		✓	✓							all of SC
58	*Duchesnea*	*indica*					✓		✓			all of SC
59	*Carex*	*festucacea*		✓	✓							all of SC
60	*Carex*	*amphibola*		✓	✓							all of SC

	Genus	Species	Subspecies	Native	Common	Rare (state/fed tracked)	Non-native	Introduced	Naturalized	Invasive (state/fed noxious)	Severity	Known Locations
61	*Carex*	*flaccosperma*		✓	✓							all of SC
62	*Rubus*	*trivialis*		✓	✓							all of SC
63	*Veronica*	*peregrina*		✓	✓							all of SC
64	*Oxalis*	*stricta*		✓	✓							all of SC
65	*Hypochaeris*	*glabra*					✓		✓			all of SC
66	*Krigia*	*dandelion*		✓	✓							all of SC
67	*Prunus*	*caroliniana*		✓	✓							P, CP
68	*Halesia*	*carolina*		✓	✓							all of SC
69	*Osmorhiza*	*longistylis*		✓	✓							P
70	*Podophyllum*	*peltatum*		✓	✓							all of SC
71	*Elymus*	*virginicus*	var. *virginicus*	✓	✓							all of SC
72	*Plantago*	*virginica*		✓	✓							all of SC
73	*Elaeagnus*	*umbellata*	var. *parvifolia*				✓			✓ (state)	alert	M, P
74	*Poa*	*autumnalis*		✓	✓							all of SC
75	*Sparganium*	*americanum*		✓	✓							all of SC
76	*Bignonia*	*capreolata*		✓	✓							all of SC
77	*Packera*	*glabella*		✓	✓							all of SC
78	*Chenopodium*	*album*		✓	✓							all of SC
79	*Hypericum*	*hypericoides*	ssp. *hypericoides*	✓	✓							all of SC
80	*Trifolium*	*incarnatum*					✓	✓				all of SC
81	*Nuttallanthus*	*canadensis*		✓	✓							all of SC
82	*Symphyotrichum*	*pilosum*	var. *pilosum*	✓	✓							all of SC
83	*Triodanis*	*perfoliata*		✓	✓							all of SC
84	*Rumex*	*crispus*					✓	✓				all of SC
85	*Sisyrinchium*	*atlanticum*		✓	✓							all of SC
86	*Vicia*	*cracca*					✓	✓				P (only found in Richland Cty)
87	*Solanum*	*pseudocapsicum*					✓			✓ (state)	emerging threat	not enough data (only in 4 counties)/all of SC
88	*Nandina*	*domestica*					✓			✓ (state)	significant threat	all of SC
89	*Commelina*	*communis*					✓	✓				all of SC
90	*Solanum*	*carolinense*		✓	✓							all of SC

	Genus	Species	Subspecies	Native	Common	Rare (state/fed tracked)	Non-native	Introduced	Naturalized	Invasive (state/fed noxious)	Severity	Known Locations
91	*Verbena*	*bonariensis*					✓	✓				all of SC
92	*Lactuca*	*biennis*					✓	✓				not enough data/possible shift in range due to climate change?
93	*Lespedeza*	*cuneata*					✓			✓ (state)	severe threat	all of SC
94	*Vaccinium*	*corymbosum*		✓	✓							all of SC
95	*Ilex*	*verticillata*		✓	✓							all of SC
96	*Toxicodendron*	*radicans*		✓	✓							all of SC
97	*Smilax*	*smallii*		✓	✓							P, CP
98	*Lepidium*	*virginicum*		✓	✓							all of SC
99	*Tradescantia*	*hirsuticaulis*		✓	✓							M, P
100	*Asplenium*	*platyneuron*		✓	✓							all of SC
101	*Polystichum*	*acrostichoides*		✓	✓							all of SC
102	*Ilex*	*cornuta*					✓	✓				P (only found in Richland Cty)/not enough data
103	*Ipomoea*	*purpurea*					✓	✓				all of SC
104	*Phytolacca*	*americana*		✓	✓							all of SC
105	*Ruellia*	*caroliniensis*		✓	✓							all of SC
106	*Conoclinium*	*coelestinum*		✓	✓							all of SC
107	*Andropogon*	*virginicus*		✓	✓							all of SC
108	*Pinus*	*taeda*		✓	✓							all of SC
109	*Phoradendron*	*serotinum*		✓	✓							all of SC
110	*Stellaria*	*media*					✓	✓				all of SC
111	*Cerastium*	*semidecandrum*					✓	✓				not enough data
112	*Ulmus*	*americana*		✓	✓							all of SC
113	*Verbena*	*brasiliensis*					✓	✓				all of SC
114	*Acer*	*rubrum*		✓	✓							all of SC
115	*Planera*	*aquatica*		✓	✓							P, C
116	*Arundinaria*	*gigantea*		✓	✓							all of SC
117	*Corydalis*	*flavula*		✓	✓							P
118	*Viola*	*sororia*		✓	✓							all of SC
119	*Amelanchier*	*arborea*		✓	✓							all of SC
120	*Fagus*	*grandifolia*		✓	✓							all of SC
121	*Smilax*	*rotundifolia*		✓	✓							all of SC
122	*Yucca*	*filamentosa*		✓	✓							all of SC
123	*Photinia*	*serratifolia*					✓	✓				not enough data
124	*Senecio*	*vulgaris*					✓		✓			M, P
125	*Gelsemium*	*sempervirens*		✓	✓							all of SC

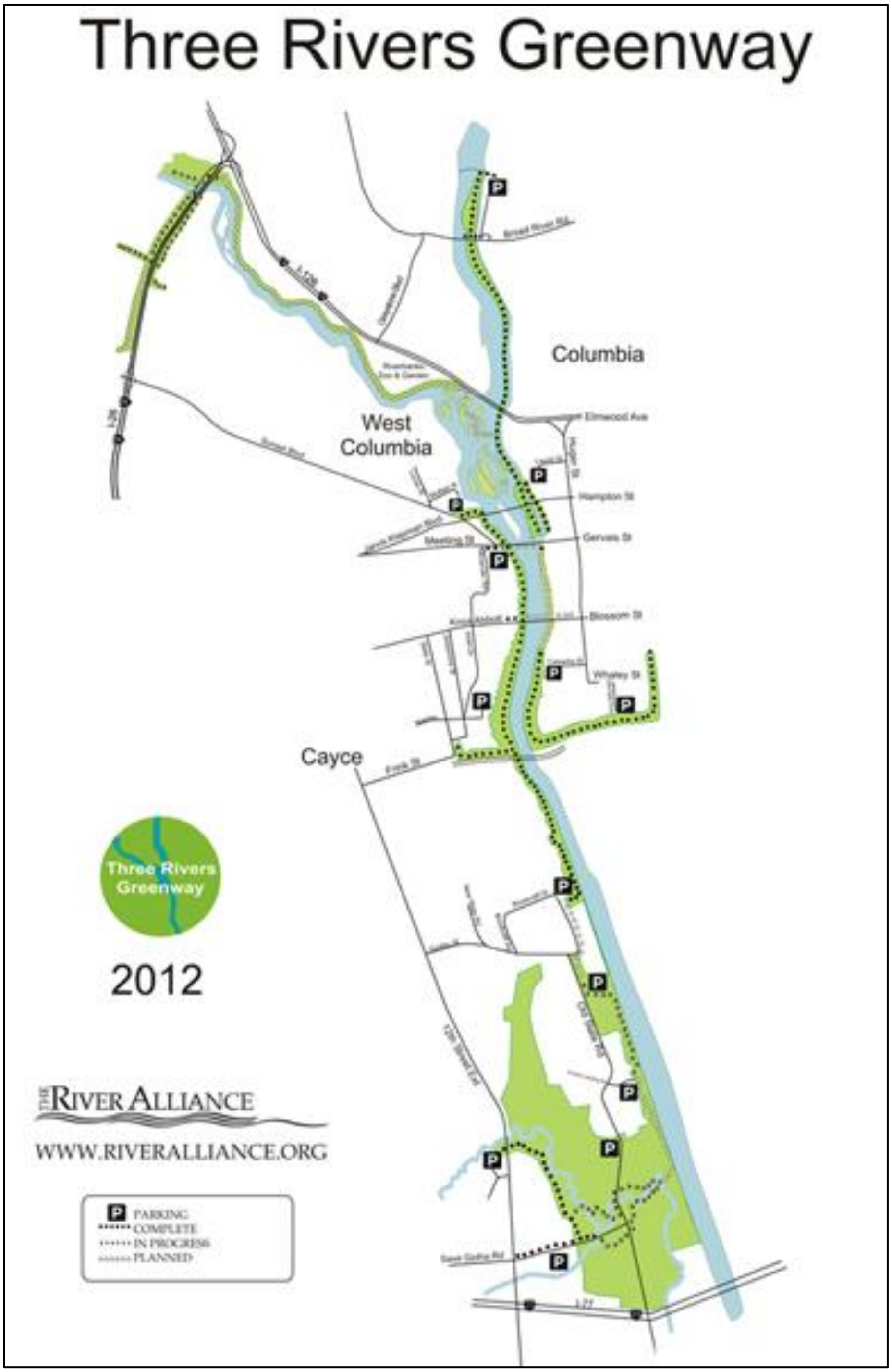

Figure 2.1. Three Rivers Greenway Map. A map of the 9½ mile Three Rivers Greenway, which includes the AOI. (The River Alliance 2012).

Figure 2.2. Map of South Carolina Lakes and Rivers. Reference map showing major waterways and bodies in South Carolina with the study area highlighted by a red triangle. (South Carolina Film Commission 2010).

Figure 2.3. Surveying the AOI. A) Field Work Materials. Clockwise from the top left: notebook for recording field info. and Garmin *eTrex* 20, Stanley 8m measuring tape, a tagged tree, field plant press, Presco PinkGlo flagging tape, and measuring tape. B) Landscape of the AOI. This picture is representative of the area surveyed.

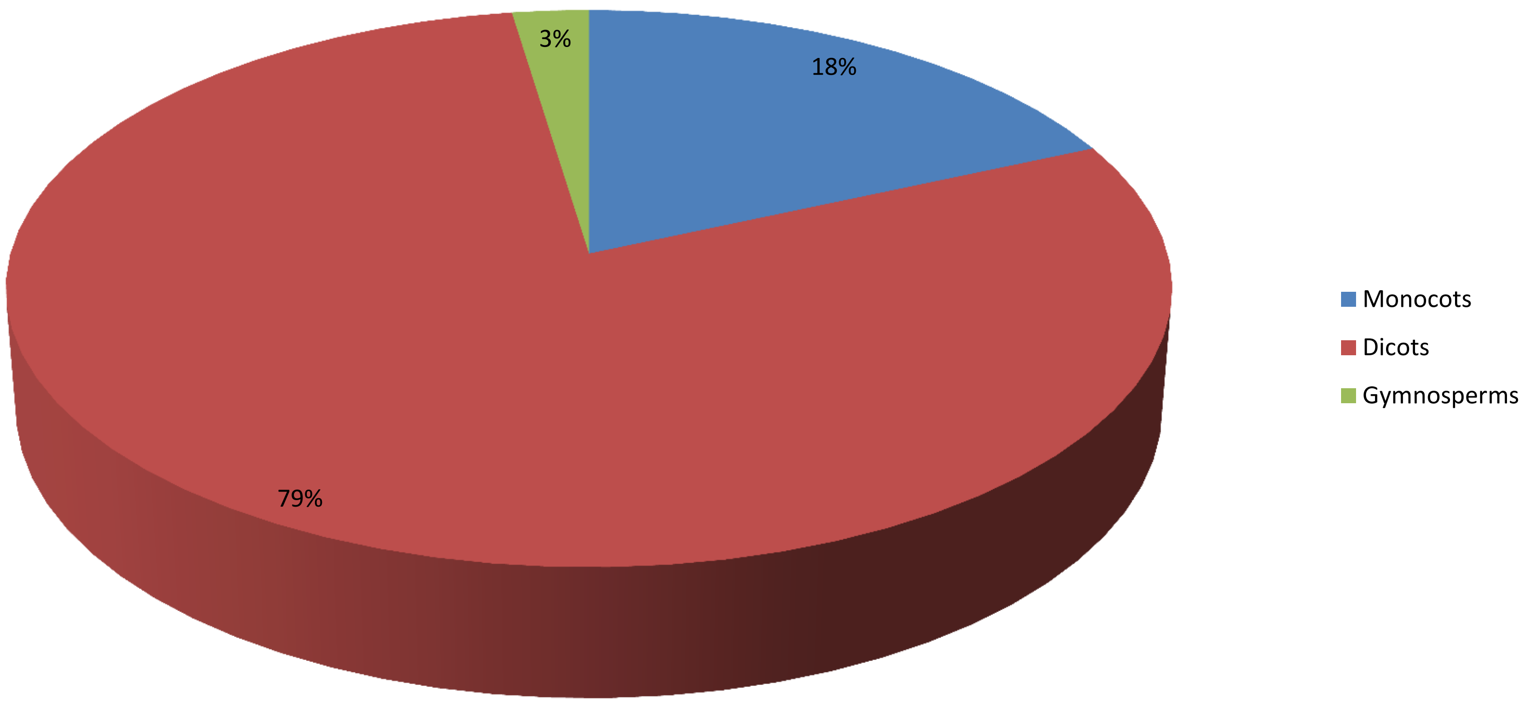

Figure 2.4. Breakdown of plant types. Separation of plants into monocots, dicots, and gymnosperms by percentage.

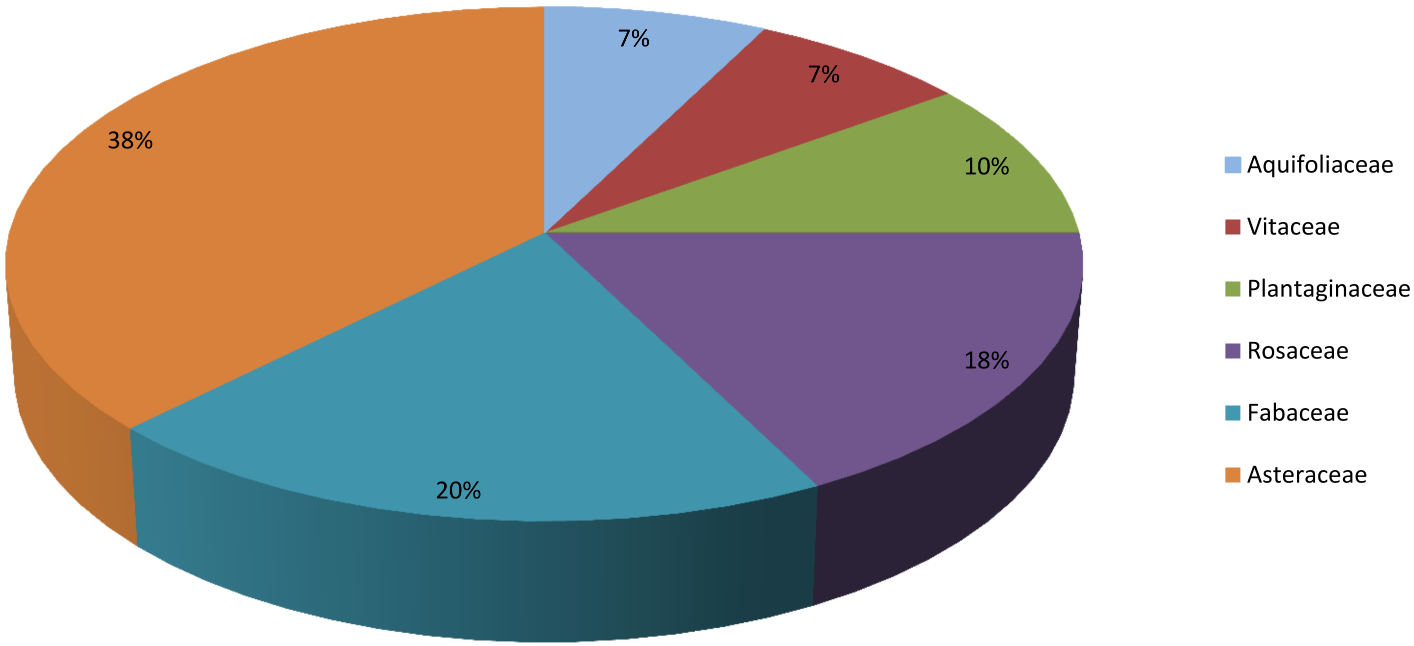

Figure 2.5. Dicot Families. Legend is arranged from smallest to largest by percentage of species per family. Only plants with 3 or more specimens are displayed in this pie chart.

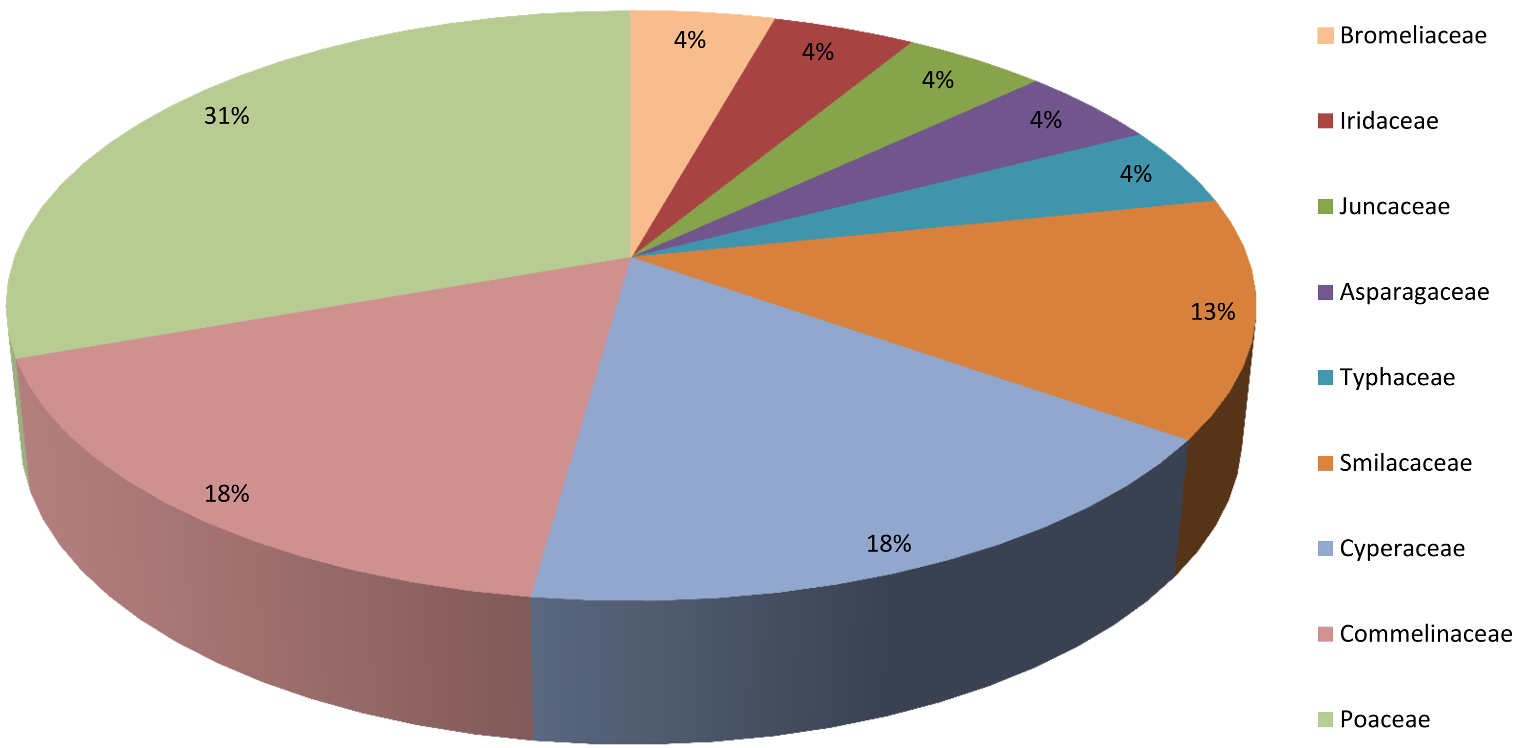

Figure 2.6. Monocot Families. Legend is arranged from smallest to largest by percentage of species per family. All plants belonging to monocot families are represented in this pie chart.

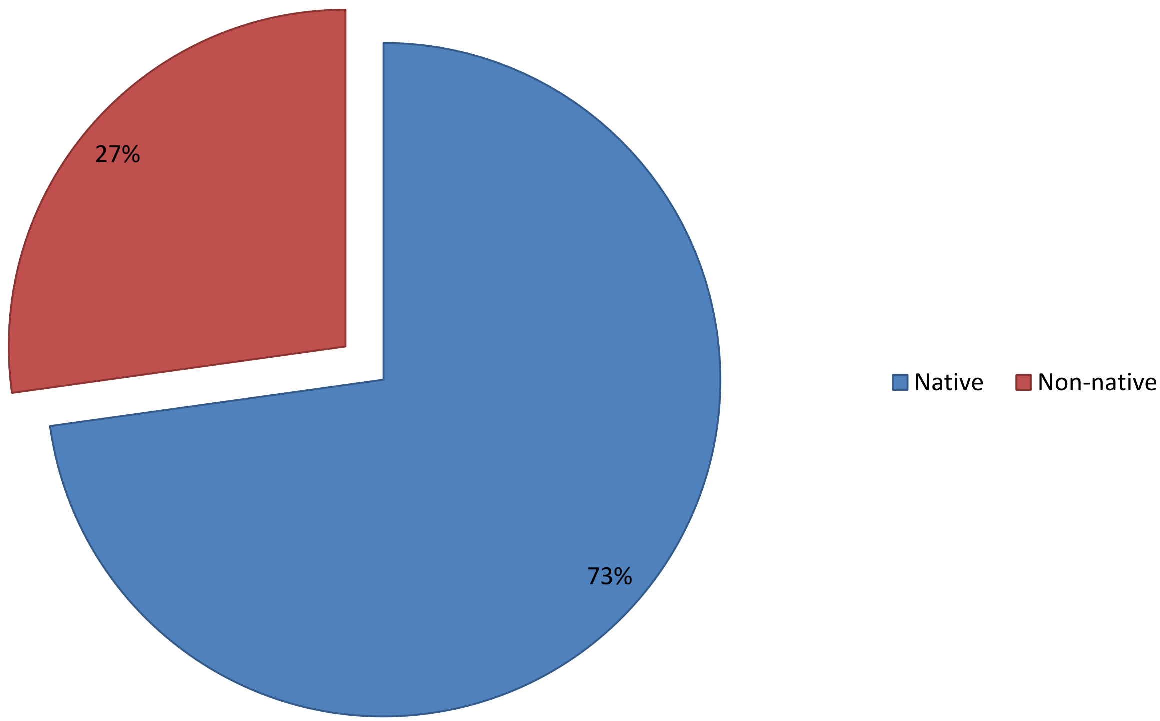

Figure 2.7. Native vs. non-native plants. Percentage of non-duplicated native species compared to the percentage of non-native species found in the AOI.

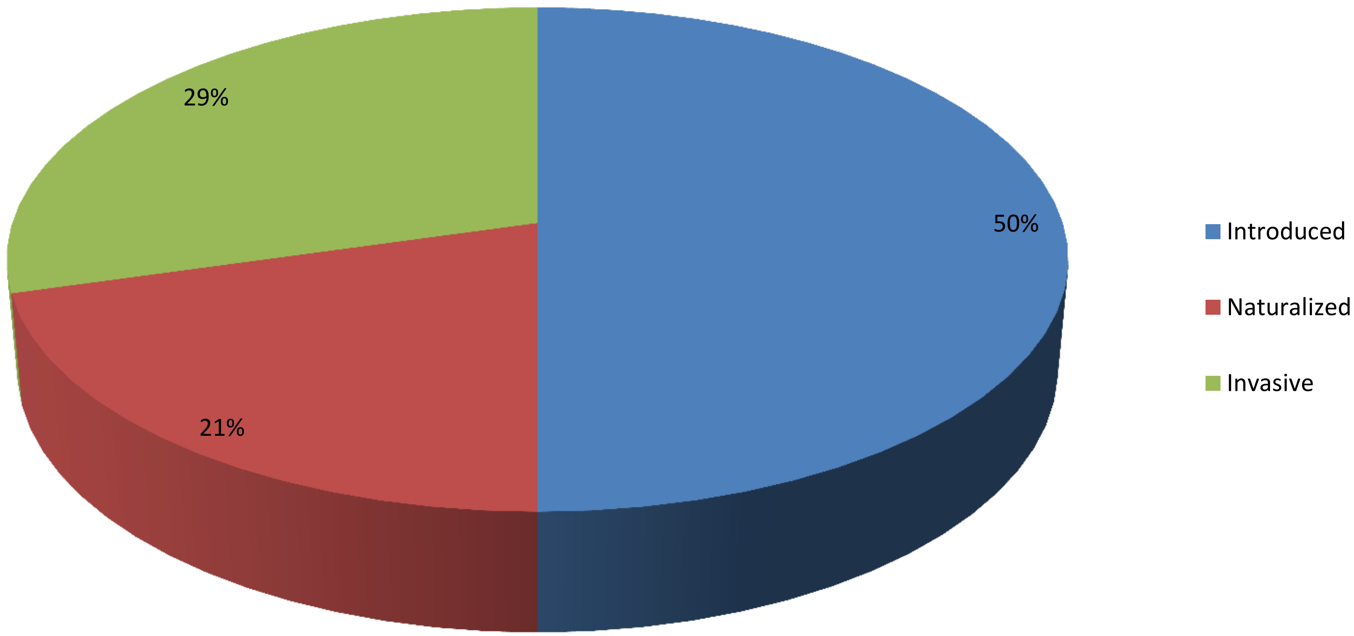

Figure 2.8. Breakdown of non-native species. Visual representation of the classification of the non-native species into the groupings of introduced, naturalized, and invasive species.

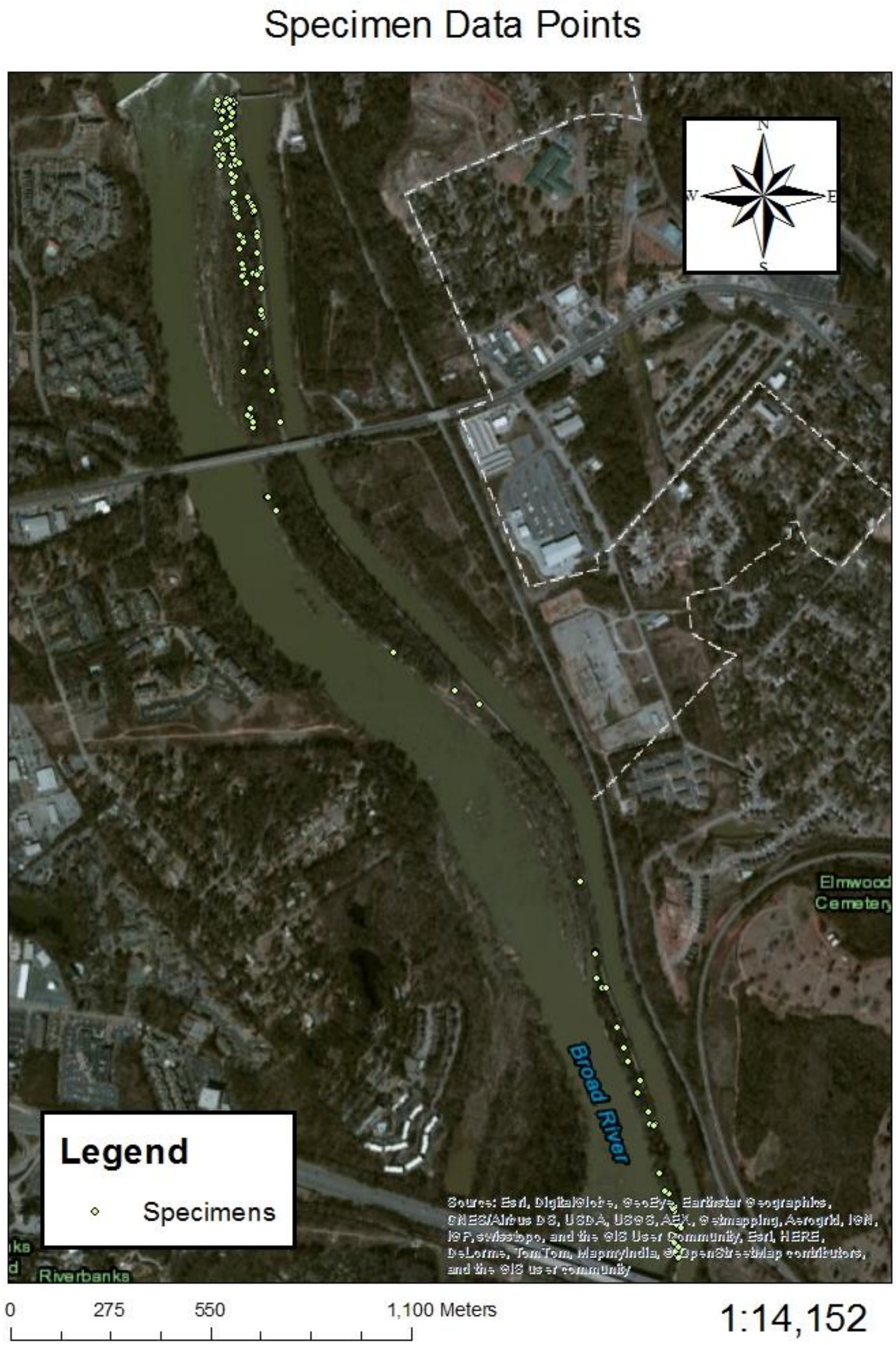

Figure 2.9. Specimen data points. Locations of all 178 specimens collected in the AOI.

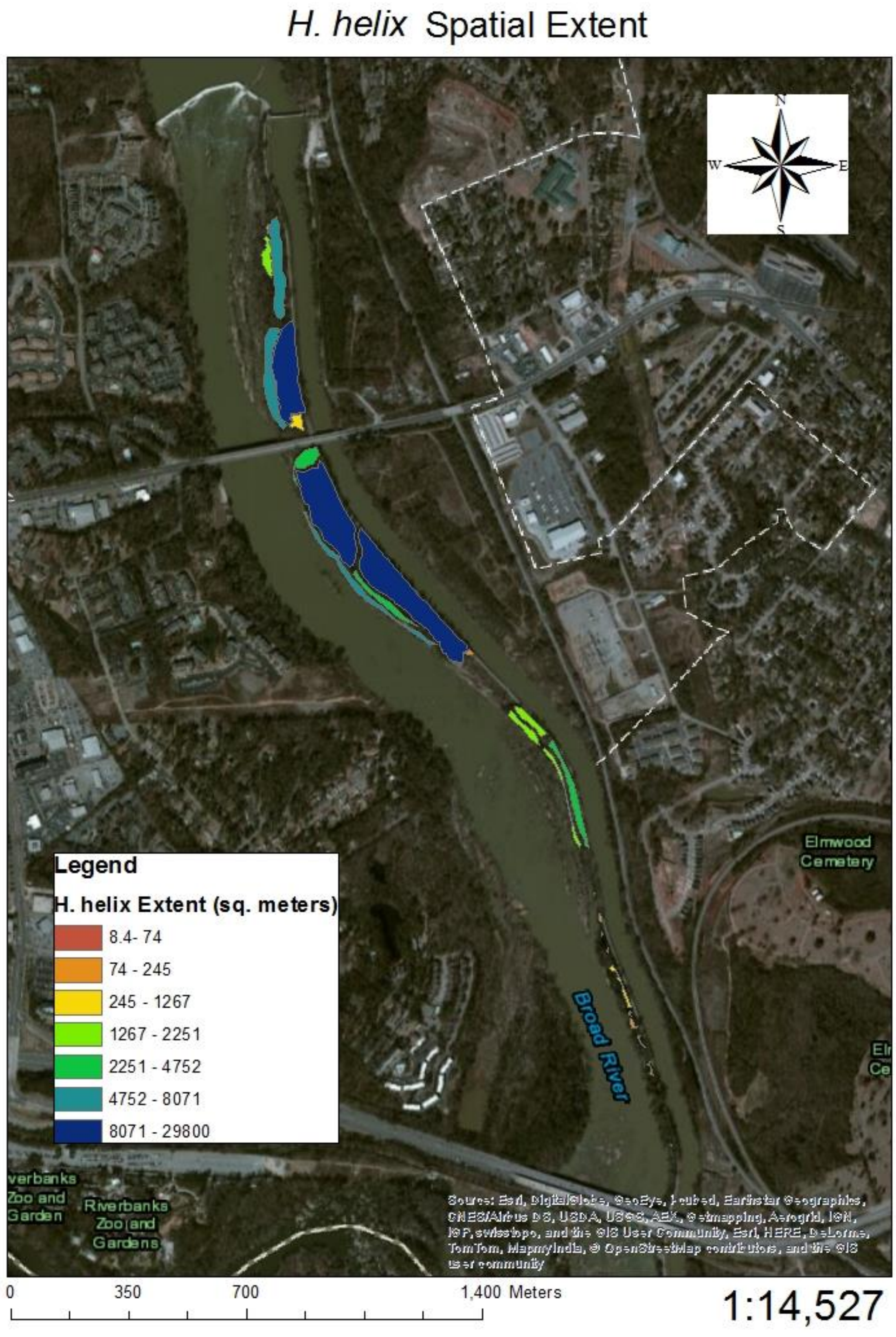

Figure 2.10. Spatial extent of *H. helix*. GIS map displaying polygon data of all *H. helix* presence in the AOI in square meters.

WORKS CITED

Baker, Andrew C., and Brad R. Murray. "Seasonal Intrusion of Litterfall from Non-native Pine Plantations into Surrounding Native Woodland: Implications for Management of an Invasive Plantation Species." Forest Ecology and Management 277 (2012): 25-37. Print.

Bardsley, Douglas K., and Gareth Edwards-Jones. "Invasive Species Policy and Climate Change: Social Perceptions of Environmental Change in the Mediterranean." Environmental Science & Policy 10.3 (2007): 230-42. Print.

"Base Reference Map of South Carolina." South Carolina Base Map. Yellow Maps World Atlas, 2010. Web. 03 Nov. 2014.

Bartz, Robert, Ulrich Heink, and Ingo Kowarik. "Proposed Definition of Environmental Damage Illustrated by the Cases of Genetically Modified Crops and Invasive Species." Conservation Biology 24.3 (2010): 675-81. Print.

Buckland, S. T., D. L. Borchers, A. Johnston, P. A. Henrys, and T. A. Marques. "Line Transect Methods for Plant Surveys." Biometrics 63.4 (2007): 989-98. Print.

Chao and Associates, Inc. CEII Columbia Canal West Embankment-Phase II. Rep. Columbia: n.p., 2011. Print.

Chauvenet, A.L.M., J. G. Ewen, D. P. Armstrong, T. M. Blackburn, and N. Pettorelli. "Maximizing the Success of Assisted Colonizations." Animal Conservation (2012): 1-9. Print.

Colautti, Robert I., and David M. Richardson. "Subjectivity and Flexibility in Invasion

Terminology: Too Much of a Good Thing?" Biological Invasions 11.6 (2009): 1225-229. Print.

Custom Soil Resource Report for Richland County, South Carolina. Rep. USDA Natural Resources Conservation Service, 18 Nov. 2014. Web. 12 Dec. 2014.

ESRI (Environmental Systems Resource Institute). 2013. ArcMap 10.2. ESRI, Redlands, California.

Evans, Jason M. "Pistia Stratiotes L. in the Florida Peninsula: Biogeographic Evidence and Conservation Implications of Native Tenure for an ′Invasive′ Aquatic Plant." Conservation and Society 11.3 (2013): 233. Web. 2 Nov. 2014.

"Fire Effects Information." Plant Species Life Form-Graminoid-ARUDON. USDA Forest Service, 29 Apr. 2014. Web. 11 Dec. 2014.

Fordham, Ingrid M., Richard H. Zimmerman, Brent L. Black, Beverly M. Clevidence, and Eugene R. Wiley. "Autumn Olive: A Potential Alternative Crop." Berry Crop Breeding, Production and Utilization for a New Century: A Proceedings of the XXVI International Horticultural Congress, Toronto, Canada, 11 - 17 August, 2002. Ed. P. Hicklenton and J. Maas. Leuven: ISHS, 2003. 437-39. Print.

Grego, John. "Optimism about Canal Foliage Premature." Ed. Sharon H. Kelly. Friends of the Congaree Swamp News (Spring 2012): 4. Newsletters from Friends of the Congaree Swamp. Friends of the Congaree Swamp, Spring 2012. Web. 12 Dec. 2014.

Hellmann, Jessica J., James E. Byers, Britta G. Bierwagen, and Jeffrey S. Dukes. "Five Potential Consequences of Climate Change for Invasive Species." Conservation Biology 22.3 (2008): 534-43. Print.

"History of the IPPC." International Plant Protection Convention (IPPC). Food and Agriculture Organization (FAO), 2014. Web. 6 Dec. 2014.

Huenneke, Laura Foster, and James K. Thomson. "Potential Interference Between a Threatened Endemic Thistle and an Invasive Nonnative Plant." Conservation Biology 9.2 (1995): 416-25. Print.

"Introduced, Invasive, and Noxious Plants." USDA Plants Database. USDA Natural Resources Conservation Service, 12 Dec. 2014. Web. 13 Dec. 2014.

"Invasive Plants." National Invasive Species Information Center (NISIC). United States Department of Agriculture (USDA), 23 Sept. 2014. Web. 5 Dec. 2014.

Invasive Species. Riverdale, Md.: U.S. Dept. of Agriculture, Animal and Plant Health Inspection Service, 1999. Invasive Species, Pests, and Disease. USDA Forest Service, 1999. Web. 11 Dec. 2014.

Jenkins, Peter T., and Harold A. Mooney. "The United States, China, and Invasive Species: Present Status and Future Prospects." Biological Invasions 8.7 (2006): 1589-593. Springer. Web. 03 Dec. 2014.

Khanna, Shruti, Maria J. Santos, Erin L. Hestir, and Susan L. Ustin. "Plant Community Dynamics Relative to the Changing Distribution of a Highly Invasive Species, Eichhornia Crassipes: A Remote Sensing Perspective." Biological Invasions 14 (2012): 717-33. SpringerLink, 5 Oct. 2011. Web. 15 Sept. 2012.

Kreyling, Juergen, Torsten Bittner, Anja Jaeschke, Anke Jentsch, Manuel Jonas Steinbauer, Daniel Thiel, and Carl Beierkuhnlein. "Assisted Colonization: A Question of Focal Units and Recipient Localities." Restoration Ecology 19.4 (2011): 433-40. Print.

Kristensen, Dale. "The Fowler Herbarium." Queen's University Dept. of Biology. Queen's University, 01 Sept. 2009. Web. 11 Dec. 2014.

Larson, Diane L. "Native Weeds and Exotic Plants: Relationships to Disturbance in Mixed Grass Prairie." Plant Ecology 169 (2003): 317-33. Print.

Lee, Carol Eunmi. "Evolutionary Genetics of Invasive Species." Trends in Ecology & Evolution 17.8 (2002): 386-91. Elsevier. Web. 4 Dec. 2014.

Lindgren, Cory J. "Biosecurity Policy and the Use of Geospatial Predictive Tools to Address Invasive Plants: Updating the Risk Analysis Toolbox." Risk Analysis 32.1 (2012): 9-15. Web. 17 Sept. 2012.

Mack, Richard N., and Melissa C. Smith. "Invasive Plants as Catalysts for the Spread of Human Parasites." NeoBiota 9.0 (2011): 13-29. Pensoft.net. Web. 7 Dec. 2014.

Martin, Laura J., and Bernd Blossey. "Invasive Plant Cover Impacts the Desirability of Lands for Conservation Acquisition." Biodiversity Conservation 21 (2012): 1987-996. Print

Melzer, B., R. Seidel, T. Steinbrecher, and T. Speck. "Structure, Attachment Properties, and Ecological Importance of the Attachment System of English Ivy (*Hedera helix*)." Journal of Experimental Botany 63.1 (2011): 191-201. Web. 17 Nov. 2014.

Newcome, Roy, Jr. Ground-Water Resources of Richland County, South Carolina. Rep. no. 30. N.p.: Department of Natural Resources (DNR), 2003. Print.

Paulsen, Evy, Lars P. Christensen, and Klaus E. Andersen. "Dermatitis from Common Ivy (Hedera Helix L. Subsp. Helix) in Europe: Past, Present, and Future." Contact Dermatitis 62.4 (2010): 201-09. Web. 17 Nov. 2014.

Petanidou, Theodora, Robert C. Godfree, Daniel S. Song, Aphrodite Kantsa, Yoko L. Dupont, and Nickolas M. Waser. "Self-compatibility and Plant Invasiveness: Comparing Species in Native and Invasive Ranges." Perpectives in Plant Ecology, Evolution and Systematics 14 (2012): 3-12. Web. 12 Sept. 2012.

Pimentel, David, Rodolfo Zuniga, and Doug Morrison. "Update on the Environmental and Economic Costs Associated with Alien-invasive Species in the United States." Ecological Economics 52.3 (2005): 273-88. Print.

Primack, Richard B., and Abraham J. Miller-Rushing. "The Role of Botanical Gardens in Climate Change Research." New Phytologist 182.2 (2009): 303-13. Wiley Online Library. Web. 12 Oct. 2013.

"Purple Loosestrife." Refuge Issues-Invasive Species. National Wildlife Refuge Federation, 2014. Web. 10 Dec. 2014.

Radford, Albert E., Harry E. Ahles, and C. Ritchie Bell. Manual of the Vascular Flora of the Carolinas. Chapel Hill: U of North Carolina, 1968. Print.

Raghubanshi, A. S., L. C. Rai, J. P. Gaur, and J. S. Singh. "Invasive Alien Species and Biodiversity in India." Current Science 88.4 (2005): 539-40. Print.

"SC-EPPC - Terrestrial Exotic Invasive Plant List." SC-EPPC - South Carolina Exotic Pest Plant Council. N.p., 23 Oct. 2014. Web. 29 Oct. 2014.

Schierenbeck, Kristina A., Richard N. Mack, and Rebecca R. Sharitz. "Effects of Herbivory on Growth and Biomass Allocation in Native and Introduced Species of Lonicera." Ecology 76.6 (1994): 1661-672. Print.

Schlaepfer, Martin A., Dov F. Sax, and Julian D. Olden. "The Potential Conservation Value of Non-Native Species." Conservation Biology (2011): n. pag. Print.

Sekercioglu, Cagan H. "Ecosystem Functions and Services." Conservation Biology for All. Ed. Navjot S. Sodhi and Paul R. Ehrlich. Oxford: Oxford UP, 2010. 45-72. Science & Publications: Conservation Biology for All. Society for Conservation Biology, Jan. 2011. Web. 03 Dec. 2014.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed November 18, 2014.

"South Carolina Film Commission." Lakes & Rivers. South Carolina Film Commission, 2010. Web. 03 Nov. 2014.

Specify. Computer software. *Specify Software Project*. Vers. 6. Biodiversity Institute-University of Kansas, 2014. Web. 18 Mar. 2015.

"Three Rivers Greenway." River Alliance. The River Alliance, 2012. Web. 17 Jan. 2013.

UC-IPM. "Invasive Plants." How to Manage Pests. University of California Agriculture and Natural Resources-Integrated Pest Management (UC-IPM), 10 July 2014. Web. 13 Dec. 2014.

USDA, NRCS. 2014. The PLANTS Database (http://plants.usda.gov, 12 December 2014). National Plant Data Team, Greensboro, NC 27401-4901 USA.

U.S. Fish & Wildlife Service. (2012). "The Cost of Invasive Species." January 2012.

U.S. Natural Resources Conservation Service (NRCS). (2006). "National Conservation Practice Standard: Riparian Forest Buffer." Code 391. January 2006.

Villnäs, Anna, Joanna Norkko, Susanna Hietanen, Alf B. Josefson, Kaarina Lukkari, and

Alf Norkko. "The Role of Recurrent Disturbances for Ecosystem Multifunctionality." Ecology 94.10 (2013): 2275-287. Ecological Society of America. Web. 6 Dec. 2014.

Weakley, Alan S. Flora of the Southern and Mid-Atlantic States, Working Draft of 30 November 2012. N.p.: n.p., n.d. The University of North Carolina Herbarium (NCU). 30 Nov. 2012. Web. 15 Apr. 2014.

"Web Soil Survey." Web Soil Survey (WSS). USDA Natural Resources Conservation Service, 06 Dec. 2013. Web. 10 Dec. 2014.

Wolf, Kristina, Joseph DiTomaso, Dean Kelch, Ramona Robison, Elizabeth Brusati, and Doug Johnson. *Assessment of Tasmanian Blue Gum (Eucalyptus Globulus)*. Tech. California Invasive Plant Council (Cal-IPC), Mar. 2015. Web. 16 Mar. 2015.

Appendix A: List of Vascular Plant Taxa

Gymnosperms

Aspleniaceae

Asplenium platyneuron (L.) Britton, Sterns & Poggenb., Ebony spleenwort

Dryopteridaceae

Polystichum acrostichoides (Michx.) Schott, Christmas fern

Pinaceae

Pinus taeda L., Loblolly pine

Angiosperms

Acanthaceae

Dicliptera brachiata (Pursh) Spreng., Branched foldwing

Ruellia caroliniensis (J.F. Gmel.) Steud., Carolina wild petunia

Adoxaceae

Sambucus nigra ssp. *canadensis* (L.) R. Bolli, American black elderberry [ITIS]; (*Sambucus canadensis* Linneaus, Common elderberry)

Altingiaceae

Liquidambar styraciflua L., Sweetgum

Amaranthaceae

Chenopodium album L., Lambsquarters

Anacardiaceae

Toxicodendron radicans (L.) Kuntze, Poison ivy

Annonaceae

Asimina triloba (L.) Dunal, Pawpaw

Apiaceae

Osmorhiza longistylis (Torr.) DC., Longstyle sweetroot

Aquifoliaceae

Ilex cornuta Lindl. & Paxton, Chinese holly

Ilex decidua Walter, Possumhaw

Ilex verticillata (L.) A. Gray, Common winterberry

Araliaceae

Hedera helix L., English ivy

Asparagaceae

Yucca filamentosa L., Adam's needle

Asteraceae

Conoclinium coelestinum (L.) DC, Blue mistflower

Elephantpus tomentosus L., Hairy elephant foot

Gamochaeta purpurea (L.) Cabrera, Spoon-leaf purple everlasting

Hypochaeris glabra L., Smooth cat's ear

Krigia dandelion (L.) Nutt., Potato dwarf dandelion

Lactuca biennis (Moench) Fernald, Tall blue lettuce

Packera glabella (Poir.) C. Jeffrey, Butterweed

Senecio vulgaris L., Old-man-in-the-spring

Smallanthus uvedalia (L.) Mack. ex Small, Hairy leafcup

Solidago leavenworthii Torr. & A. Gray, Leavenworth's goldenrod

Sonchus asper (L.) Hill, Spiny sowthistle

Symphyotrichum pilosum var. *pilosum* (Willd.) G.L. Nesom, Hairy while oldfield aster

Taraxacum erythrospermum Andrz. ex Besser, Rock dandelion

Verbesina occidentalis (L.) Walker, Yellow crownbeard

Youngia japonica (L.) DC, Oriental false hawksbeard

Berberidaceae

Nandina domestica Thunb., Sacred bamboo

Podophyllum peltatum L., Mayapple

Betulaceae

Carpinus caroliniana Walter, American hornbeam

Bignoniaceae

Bignonia capreolata L., Crossvine

Boraginaceae

Nemophila aphylla (L.) Brummitt, Smallflower baby blue eyes

Brassicaceae

Cardamine hirsuta L., Hairy bittercress

Lepidium virginicum L., Virginia pepperweed

Bromeliaceae

Tillandsia usneoides (L.) L., Spanish moss

Campanulaceae

Triodanis perfoliata (L.) Nieuwl., Clasping Venus' looking-glass

Caprifoliaceae

Lonicera japonica Thunb., Japanese honeysuckle

Caryophyllaceae

Cerastium semidecandrum L., Five-stamen chickweed

Stellaria media (L.) Vill., Chickweed

Commelinaceae

Commelina communis L., Asiatic dayflower

Commelina virginica L., Virginia dayflower

Tradescantia hirsuticaulis Small, Hairystem spiderwort

Convolvulaceae

Ipomoea purpurea (L.) Roth, Common morning-glory

Cornaceae

Cornus foemina Mill., Swamp dogwood

Cyperaceae

Carex amphibola Steud., Eastern narrowleaf sedge

Carex festucacea Schkuhr ex Willd., Fescue sedge

Carex flaccosperma Dewey, Thinfruit sedge

Cyperus drummondii Torr. & Hook., Drummond's sedge

Elaeagnaceae

Elaeagnus umbellata var. *parvifolia* (Wall. ex Royle) C.K. Schneid., Autumn olive

Ericaceae

Vaccinium corymbosum L., Highbush blueberry

Fabaceae

Albizia julibrissin Durazz., Mimosa

Cercis canadensis var. *canadensis* L., Eastern redbud

Lespedeza cuneata (Dum. Cours.) G. Don, Sericea lespedeza

Trifolium campestre Schreb., Low hop clover

Trifolium incarnatum L., Crimson clover

Vicia caroliniana Walter, Carolina vetch

Vicia cracca L., Bird vetch

Vicia sativa ssp. *nigra* (L.) Ehrh., Garden vetch

Fagaceae

Fagus grandifolia Ehrh., American beech

Quercus nigra L., Water oak

Gelsemiaceae

Gelsemium sempervirens (L.) J. St.-Hil., Carolina jessamine

Geraniaceae

Geranium carolinianum L., Carolina geranium

Hypericaceae

Hypericum hypericoides ssp. *hypericoides* (L.) Crantz, St. Andrew's cross

Iridaceae

Sisyrinchium atlanticum E.P. Bicknell, Eastern blue-eyed grass

Juglandaceae

Juglans nigra L., Black walnut

Juncaceae

Juncus bufonius L., Toad rush

Lamiaceae

Callicarpa americana L., American beautyberry

Lamium amplexicaule L., Henbit deadnettle

Linderniaceae

Lindernia dubia (L.) Pennell, Yellow-seed false pimpernel

Malvaceae

Sida rhombifolia L., Cuban jute

Menispermaceae

Cocculus carolinus (L.) DC., Carolina coralbead

Oleaceae

Ligustrum japonicum Thunb., Japanese privet

Ligustrum sinense Lour., Chinese privet

Oxalis stricta L., Common yellow oxalis

Papaveraceae

Corydalis flavula (Raf.) DC., Yellow fumewort

Phytolaccaceae

Phytolacca americana L., American pokeweed

Plantaginaceae

Nuttallanthus canadensis (L.) D.A. Sutton, Canada toadflax

Plantago virginica L., Virginia plantain

Veronica hederifolia L., Ivyleaf speedwell

Veronica peregrina L., Purslane speedwell

Platanaceae

Platanus occidentalis L., Sycamore

Poaceae

Andropogon virginicus L., Broomsedge bluestem

Arundinaria gigantea (Walter) Muhl., Giant cane

Chasmanthium latifolium (Michx.) H.O. Yates, Indian woodoats

Dichanthelium polyanthes (Schult.) Mohlenbr., Small-fruited witch grass

Elymus virgnicus var. *virginicus* L., Virginia wildrye

Poa autumnalis Muhl. ex Elliott, Autumn bluegrass

Poa chapmaniana Scribn., Chapman's bluegrass

Polygonaceae

Persicaria setacea (Baldwin) Small, Bog smartweed

Rumex crispus L., Curly dock

Ranunculaceae

Clematis terniflora DC., Sweet autumn virginsbower

Rosaceae

Amelanchier arborea (F. Michx.) Fernald, Common serviceberry

Duchesnea indica (Andrews) Focke, Indian strawberry-ITIS (2014), [*Potentilla indica* (Andrews) T. Wolf- (Weakley 2012)]

Photinia serratifolia (Desf.) Kalkm., Taiwanese photinia

Prunus caroliniana (Mill.) Aiton, Carolina laurel cherry

Prunus serotina Ehrh., Black cherry

Rubus argutus Link, Sawtooth blackberry

Rubus trivialis Michx., Southern dewberry

Rubiaceae

Cephalanthus occidentalis L., Common buttonbush

Galium aparine L., Stickywilly

Santalaceae

Phoradendron serotinum (Raf.) M.C. Johnst., Oak mistletoe

Sapindaceae

Acer negundo L., Boxelder

Acer rubrum L., Red maple

Smilacaceae

Smilax glauca Walter, Cat greenbrier

Smilax rotundifolia L., Roundleaf greenbrier

Smilax smallii Morong, Lanceleaf greenbrier

Solanaceae

Solanum carolinense L., Carolina horsenettle

Solanum pseudocapsicum L., Jerusalem cherry

Styracaceae

Halesia carolina L., Carolina silverbell

Typhaceae

Sparganium americanum Nutt., American bur-reed

Ulmaceae

Planera aquatica J.F. Gmel., Water-elm

Ulmus americana L., American elm

Urticaceae

Laportea canadensis (L.) Wedd., Canadian woodnettle

Verbenaceae

Verbena bonariensis L., Purpletop vervain

Violaceae

Viola arvensis Murray, European field pansy

Viola sororia Willd., Common blue violet

Vitaceae

Ampelopsis arborea (L.) Koehne, Peppervine

Ampelopsis cordata Michx., Heartleaf peppervine

Vitis rotundifolia Michx., Muscadine

Appendix B: Additional Vascular Plant Taxa From Riverfront Park

Information in this appendix is from an undergraduate research study at the University of South Carolina of the flora of the Three-Rivers Waterfront (Saluda, Broad, and Congaree rivers) on the west edge of Columbia, SC and Richland County. While located at the USCH, these specimens are not currently documented in the database. These specimens have been identified by Dr. John Nelson. Labels similar to those created for the specimens in this study have been created for each specimen in this appendix as an additional part of this thesis.

The specimens in this appendix were gathered between 2008 and 2009. Though the area these specimens were collected in includes some of the AOI from this thesis, it was a larger study area around the approximate coordinates, 34.0019°N, -81.0552°W. Specimens in this appendix cannot be included in this thesis' data as these specimens pertain to the flora of a larger area that faces different parameters of disturbance than those in this thesis. However, some of the specimens in this appendix are the same as those from this study. The table below includes all specimens identified by binomial nomenclature, family, and zone location. Zone locations were not formally set with bounds of latitude and longitude, but are near the above coordinates and along the Three Rivers Greenway waterfront. Numbers do not pertain to the USCH database and are solely for this appendix order. This data is presented here for future explorations and research in this thesis' AOI and the surrounding area.

Table A.1. Appendix B: Additional vascular plant taxa from Riverfront Park. This appendix table is 7 pages long and includes species from a separate study.

	Genus	Species	Subspecies	Family	Zone
1	*Polypogon*	*monspeliensis*		Poaceae	1
2	*Cardamine*	*hirsuta*		Brassicaceae	1
3	*Ranunculus*	*abortivus*		Ranunculaceae	1
4	*Salvia*	*lyrata*		Lamiaceae	1
5	*Oenothera*	*laciniata*		Onagraceae	1
6	*Vicia*	*sativa*	*ssp. nigra*	Fabaceae	1
7	*Galium*	*aparine*		Rubiaceae	1
8	*Juncus*	*marginatus*		Juncaceae	1
9	*Nuttalanthus*	*canadensis*		Plantaginaceae	1
10	*Liriope*	*spicata*		Asparagaceae	1
11	*Podostemum*	*ceratophyllum*		Podostemaceae	1
12	*Rubus*	*pensilvanicus*		Rosaceae	1
13	*Glyceria*	*striata*		Poaceae	1
14	*Heliotropium*	*amplexicaule*		Heliotropiaceae	1
15	*Poa*	*chapmaniana*		Poaceae	1
16	*Justicia*	*americana*		Acanthaceae	1
17	*Glyceria*	*striata*		Poaceae	1
18	*Carex*	*typhina*		Cyperaceae	1
19	*Sorghum*	*halepense*		Poaceae	1
20	*Smallanthus*	*uvedalia*		Asteraceae	1
21	*Hydrocotyle*	*verticillata*		Araliaceae	1
22	*Juncus*	*marginatus*		Juncaceae	1
23	*Dichanthelium*	*scoparium*		Poaceae	1
24	*Scirpus*	*cyperinus*		Cyperaceae	1
25	*Erigeron*	*strigosus*		Asteraceae	1
26	*Bidens*	*frondosa*		Asteraceae	1
27	*Viola*	*sororia*		Violaceae	1
28	*Quercus*	*laurifolia*		Fagaceae	1
29	*Toxicodendron*	*radicans*		Anacardiaceae	1
30	*Fraxinus*	*pennsylvanica*		Oleaceae	1
31	*Acalypha*	*rhomboidea*		Euphorbiaceae	1
32	*Eupatorium*	*capillifolium*		Asteraceae	1
33	*Solidago*	*leavenworthii*		Asteraceae	1
34	*Maclura*	*pomifera*		Moraceae	1
35	*Symphyotrichum*	*dumosum*		Asteraceae	1
36	*Carya*	*cordiformis*		Juglandaceae	1
37	*Cocculus*	*carolinus*		Menispermaceae	1
38	*Dichanthelium*	*acuminatum*	*var. acuminatum*	Poaceae	1
39	*Verbesina*	*alternifolia*		Asteraceae	1
40	*Mollugo*	*verticillata*		Molluginaceae	1

	Genus	*Species*	*Subspecies*	Family	Zone
41	*Mimulus*	*ringens*		Phrymaceae	1
42	*Egeria*	*densa*		Hydrocharitaceae	1
43	*Podostemum*	*ceratophyllum*		Podostemaceae	1
44	*Cyperus*	*strigosus*		Cyperaceae	1
45	*Packera*	*glabella*		Asteraceae	1
46	*Ligustrum*	*japonicum*		Oleaceae	1
47	*Phytolacca*	*americana*		Phytolaccaceae	1
48	*Prunus*	*caroliniana*		Rosaceae	1
49	*Trianthema*	*portulacastrum*		Aizoaceae	1
50	*Lepidium*	*virginicum*		Brassicaceae	1
51	*Ligustrum*	*sinense*		Oleaceae	1
52	*Clematis*	*terniflora*		Ranunculaceae	1
53	*Quercus*	*nigra*		Fagaceae	1
54	*Liriope*	*muscari*		Asparagaceae	1
55	*Commelina*	*virginica*		Commelinaceae	1
56	*Duchesnea*	*indica*		Rosaceae	1
57	*Trifolium*	*incarnatum*		Fabaceae	1
58	*Rumex*	*acetosella*		Polygonaceae	1
59	*Dichanthelium*	*ensifolium*	*var. ensifolium*	Poaceae	1
60	*Diodia*	*virginiana*		Rubiaceae	1
61	*Conyza*	*bonariensis*		Asteraceae	1
62	*Rumex*	*crispus*		Polygonaceae	1
63	*Tillandsia*	*usneoides*		Bromeliaceae	1
64	*Bromus*	*catharticus*		Poaceae	1
65	*Hypochaeris*	*radicata*		Asteraceae	1
66	*Hypochaeris*	*radicata*		Asteraceae	1
67	*Pontedaria*	*cordata*		Pontederiaceae	1
68	*Persicaria*	*longiseta*		Polygonaceae	1
69	*Oxalis*	*dillenii*		Oxalidaceae	1
70	*Oxalis*	*dillenii*		Oxalidaceae	1
71	*Pinus*	*taeda*		Pinaceae	1
72	*Ostrya*	*virginiana*		Betulaceae	1
73	*Cercis*	*canadensis*		Fabaceae	1
74	*Sida*	*rhombifolia*		Malvaceae	1
75	*Halesia*	*carolina*		Styracaceae	1
76	*Halesia*	*carolina*		Styracaceae	1
77	*Vernonia*	*gigantea*		Asteraceae	1
78	*Solidago*	*puberula*	*ssp. pulverulenta*	Asteraceae	1
79	*Elephantopus*	*carolinianus*		Asteraceae	1
80	*Elephantopus*	*carolinianus*		Asteraceae	1

	Genus	*Species*	*Subspecies*	Family	Zone
81	*Hypericum*	*hypericoides*		Hypericaceae	1
82	*Modiola*	*caroliniana*		Malvaceae	1a
83	*Plantago*	*lanceolata*		Plantaginaceae	1a
84	*Sanicula*	*marilandica*		Apiaceae	1a
85	*Allium*	*canadense*		Amaryllidaceae	1a
86	*Potentilla*	*canadensis*		Rosaceae	1a
87	*Asplenium*	*platyneuron*		Aspleniaceae	1a
88	*Rubus*	*bifrons*		Rosaceae	1a
89	*Vicia*	*cracca*		Fabaceae	1a
90	*Bromus*	*secalinus*		Poaceae	1a
91	*Hordeum*	*pusillum*		Poaceae	1a
92	*Stachys*	*floridana*		Lamiaceae	1a
93	*Triodanis*	*perfoliata*		Campanulaceae	1a
94	*Sonchus*	*oleraceus*		Asteraceae	1a
95	*Ranunculus*	*sardous*		Ranunculaceae	1a
96	*Lespedeza*	*virginica*		Fabaceae	
97	*Persicaria*	*punctata*		Polygonaceae	
98	*Samolus*	*valerandi*		Primulaceae	
99	*Ptilimnium*	*nodosum*		Apiaceae	
100	*Cyclospermum*	*leptophyllum*		Apiaceae	2
101	*Carex*	*vulpinoidea*		Cyperaceae	2
102	*Carex*	*vulpinoidea*		Cyperaceae	2
103	*Phalaris*	*arundinacea*		Poaceae	2
104	*Phalaris*	*arundinacea*		Poaceae	2
105	*Carex*	*vulpinoidea*		Cyperaceae	2
106	*Elephantopus*	*carolinianus*		Asteraceae	2
107	*Clematis*	*terniflora*		Ranunculaceae	2
108	*Hibiscus*	*syriacus*		Malvaceae	2
109	*Eleusine*	*indica*		Poaceae	2
110	*Conoclinium*	*coelestinum*		Asteraceae	2
111	*Tradescantia*	*hirsuticaulis*		Commelinaceae	2
112	*Alternanthera*	*sessilis*		Amaranthaceae	2
113	*Solanum*	*pseudocapsicum*		Solanaceae	2
114	*Trifolium*	*dubium*		Fabaceae	2
115	*Ilex*	*cornuta*		Aquifoliaceae	2
116	*Packera*	*glabella*		Asteraceae	2
117	*Carex*	*scoparia*		Cyperaceae	2
118	*Juncus*	*debilis*		Juncaceae	2
119	*Lepidium*	*virginicum*		Brassicaceae	2
120	*Carex*	*vulpinoidea*		Cyperaceae	2

	Genus	*Species*	*Subspecies*	Family	Zone
121	*Solanum*	*carolinense*		Solanaceae	2
122	*Youngia*	*japonica*		Asteraceae	2
123	*Gamochaeta*	*purpurea*		Asteraceae	2
124	*Cyperus*	*strigosus*		Cyperaceae	2
125	*Acer*	*negundo*		Sapindaceae	2
126	*Triodanis*	*perfoliata*	*ssp. biflora*	Campanulaceae	2
127	*Cephalanthus*	*occidentalis*		Rubiaceae	2
128	*Pyrrhopappus*	*carolinianus*		Asteraceae	2
129	*Conyza*	*bonariensis*		Asteraceae	2
130	*Oxalis*	*stricta*		Oxalidaceae	2
131	*Solanum*	*ptychanthum*		Solanaceae	2
132	*Ligustrum*	*japonicum*		Oleaceae	2
133	*Solidago*	*canadensis*		Asteraceae	2
134	*Vicia*	*sativa*	*ssp. nigra*	Fabaceae	2
135	*Solidago*	*canadensis*		Asteraceae	2
136	*Clytoria*	*mariana*		Fabaceae	2
137	*Lactuca*	*floridana*		Asteraceae	2
138	*Erigeron*	*strigosus*		Asteraceae	2
139	*Persicaria*	*hydropiperoides*		Polygonaceae	2
140	*Elymus*	*riparius*		Poaceae	2
141	*Oxalis*	*violacea*		Oxalidaceae	2
142	*Diodia*	*virginiana*		Rubiaceae	2
143	*Carya*	*illinoinensis*		Juglandaceae	2
144	*Elaeagnus*	*umbellata*	*var. parviflora*	Elaeagnaceae	2
145	*Ipomoea*	*purpurea*		Convolvulaceae	2
146	*Apocynum*	*androsaemifolium*		Apocynaceae	2
147	*Rhus*	*glabra*		Anacardiaceae	2
148	*Callicarpa*	*americana*		Lamiaceae	2
149	*Staphylea*	*trifolia*		Staphyleaceae	2
150	*Steinchisma*	*hians*		Poaceae	2
151	*Steinchisma*	*hians*		Poaceae	2
152	*Cryptotaenia*	*canadensis*		Apiaceae	2
153	*Campsis*	*radicans*		Bignoniaceae	2
154	*Smilax*	*rotundifolia*		Smilacaceae	2
155	*Stellaria*	*media*		Caryophyllaceae	3
156	*Hypochaeris*	*glabra*		Asteraceae	3
157	*Allium*	*neapolitanum*		Amaryllidaceae	3
158	*Veronica*	*hederifolia*		Plantaginaceae	3
159	*Ludwigia*	*alternifolia*		Onagraceae	3
160	*Polystichum*	*acrostichoides*		Dryopteridaceae	3

	Genus	Species	Subspecies	Family	Zone
161	*Hydrocotyle*	*bonariensis*		Araliaceae	3
162	*Boehmeria*	*cylindrica*		Urticaceae	3
163	*Boehmeria*	*cylindrica*		Urticaceae	3
164	*Ludwigia*	*glandulosa*		Onagraceae	3
165	*Panicum*	*dichotomiflorum*		Poaceae	3
166	*Lygodium*	*japonicum*		Lygodiaceae	3
167	*Hydrocotyle*	*bonariensis*		Araliaceae	3
168	*Ludwigia*	*repens*		Onagraceae	3
169	*Viburnum*	*nudum*		Adoxaceae	3
170	*Viburnum*	*nudum*		Adoxaceae	3
171	*Hydrolea*	*quadrivalvis*		Hydroleaceae	3
172	*Ludwigia*	*decurrens*		Onagraceae	3
173	*Lemna*	*valdiviana*		Araceae	3
174	*Viburnum*	*recognitum*		Adoxaceae	3
175	*Viburnum*	*recognitum*		Adoxaceae	3
176	*Mollugo*	*verticillata*		Molluginaceae	3
177	*Sabal*	*minor*		Arecaceae	3
178	*Halesia*	*carolina*		Styracaceae	3
179	*Trifolium*	*campestre*		Fabaceae	3
180	*Smilax*	*smallii*		Smilacaceae	3
181	*Smilax*	*smallii*		Smilacaceae	3
182	*Ampelopsis*	*arborea*		Vitaceae	3
183	*Hypericum*	*mutilum*		Hypericaceae	3
184	*Toxicodendron*	*radicans*		Anacardiaceae	3
185	*Typha*	*latifolia*		Typhaceae	3
186	*Saururus*	*cernuus*		Saururaceae	3
187	*Hydrolea*	*quadrivalvis*		Hydroleaceae	3
188	*Hibiscus*	*moscheutos*		Malvaceae	3
189	*Prunus*	*caroliniana*		Rosaceae	3
190	*Prunus*	*serotina*		Rosaceae	3
191	*Toxicodendron*	*radicans*		Anacardiaceae	3
192	*Carex*	*typhina*		Cyperaceae	3
193	*Alnus*	*serrulata*		Betulaceae	3
194	*Alnus*	*serrulata*		Betulaceae	3
195	*Tradescantia*	*subaspera*		Commelinaceae	3
196	*Sida*	*rhombifolia*		Malvaceae	3
197	*Tripsacum*	*dactyloides*		Poaceae	3
198	*Equisetum*	*hyemale*		Equisetaceae	3
199	*Passiflora*	*lutea*		Passifloraceae	3
200	*Passiflora*	*lutea*		Passifloraceae	3

	Genus	Species	Subspecies	Family	Zone
201	*Ludwigia*	*glandulosa*		Onagraceae	3
202	*Callicarpa*	*americana*		Lamiaceae	3
203	*Elodea*	*canadensis*		Hydrocharitaceae	4
204	*Diospyros*	*virginiana*		Ebenaceae	4
205	*Ligustrum*	*sinense*		Oleaceae	4
206	*Ampelopsis*	*arborea*		Vitaceae	4
207	*Eupatorium*	*serotinum*		Asteraceae	4
208	*Ludwigia*	*decurrens*		Onagraceae	4
209	*Diodia*	*virginiana*		Rubiaceae	4
210	*Eragrostis*	*hypnoides*		Poaceae	4
211	*Cicuta*	*maculata*		Apiaceae	4
212	*Cicuta*	*maculata*		Apiaceae	4
213	*Digitaria*	*serotina*		Poaceae	4
214	*Lactuca*	*floridana*		Asteraceae	4
215	*Lactuca*	*canadensis*		Asteraceae	4
216	*Pennisetum*	*glaucum*		Poaceae	4
217	*Cyperus*	*iria*		Cyperaceae	4
218	*Sacciolepis*	*striata*		Poaceae	4
219	*Cyperus*	*iria*		Cyperaceae	4
220	*Mikania*	*scandens*		Asteraceae	4
221	*Mikania*	*scandens*		Asteraceae	4
222	*Echinochloa*	*crus-galli*		Poaceae	4
223	*Lobelia*	*cardinalis*		Campanulaceae	4
224	*Apios*	*americana*		Fabaceae	4
225	*Apios*	*americana*		Fabaceae	4
226	*Cyperus*	*strigosus*		Cyperaceae	4
227	*Podostemum*	*ceratophyllum*		Podostemaceae	4
228	*Acalypha*	*rhomboidea*		Euphorbiaceae	4
229	*Setaria*	*viridis*		Poaceae	4
230	*Hypericum*	*hypericoides*		Hypericaceae	4
231	*Magnolia*	*grandiflora*		Magnoliaceae	4
232	*Ligustrum*	*japonicum*		Oleaceae	4
233	*Carex*	*lurida*		Cyperaceae	4
234	*Cocculus*	*carolinus*		Menispermaceae	4
235	*Hypericum*	*mutilum*		Hypericaceae	4
236	*Rhubus*	*trivialis*		Rosaceae	4
237	*Ampelopsis*	*cordata*		Vitaceae	4
238	*Platanus*	*occidentalis*		Platanaceae	4
239	*Alternanthera*	*philoxeroides*		Amaranthaceae	4
240	*Egeria*	*densa*		Hydrocharitaceae	4

	Genus	*Species*	*Subspecies*	Family	Zone
241	*Podostemum*	*ceratophyllum*		Podostemaceae	4
242	*Podostemum*	*ceratophyllum*		Podostemaceae	4
243	*Podostemum*	*ceratophyllum*		Podostemaceae	4
244	*Paspalum*	*dilatatum*		Poaceae	4
245	*Paspalum*	*dilatatum*		Poaceae	4
246	*Solanum*	*sarrachoides*		Solanaceae	4
247	*Solanum*	*sarrachoides*		Solanaceae	4
248	*Cynodon*	*dactylon*		Poaceae	4
249	*Carex*	*lupulina*		Cyperaceae	4
250	*Podostemum*	*ceratophyllum*		Podostemaceae	4
251	*Cyperus*	*pseudovegetus*		Cyperaceae	4
252	*Clethra*	*alnifolia*		Clethraceae	4
253	*Nandina*	*domestica*		Berberidaceae	4
254	*Nandina*	*domestica*		Berberidaceae	4
255	*Rubus*	*trivialis*		Rosaceae	5
256	*Cercis*	*canadensis*		Fabaceae	5
257	*Prunus*	*serotina*		Rosaceae	5
258	*Carpinus*	*caroliniana*		Betulaceae	5
259	*Prunus*	*angustifolia*		Rosaceae	5
260	*Viola*	*sororea*		Violaceae	5
261	*Corydalis*	*flavula*		Papaveraceae	5
262	*Helenium*	*amarum*		Asteraceae	5a
263	*Euphorbia*	*commutata*		Euphorbiaceae	5b
264	*Clematis*	*viorna*		Ranunculaceae	5b
265	*Wahlenbergia*	*marginata*		Campanulaceae	5b
266	*Ruellia*	*caroliniensis*		Acanthaceae	5b
267	*Smilax*	*smallii*		Smilacaceae	5b
268	*Verbascum*	*thapsus*		Scrophulariaceae	5b
269	*Gamochaeta*	*purpurea*		Asteraceae	5b
270	*Quercus*	*nigra*		Fagaceae	5b
271	*Crataegus*	*aestivalis*		Rosaceae	5b

Appendix C: Complete List of Vascular Plant Taxa From Riverfront Park and the Three Rivers Greenway

Appendix C is a complete, combined list of all vascular plant taxa found in the Riverfront Park and Three Rivers Greenway areas from the data in this thesis and the data in Appendix B. This succinct list will be an easy guide to the flora along the Congaree, Saluda, and Broad rivers in Columbia, South Carolina. Numbers in this appendix are solely for numbering the species in this list and do not pertain to USCH database numbers. Species are listed alphabetically by familial status, then binomial nomenclature.

Table A.2. Appendix C: Complete list of vascular plant taxa. A combined list of all species from this thesis and Appendix B. Organized alphabetically by familial status, then binomial nomenclature. This appendix table is 7 pages long and does not include duplicate species.

	Genus	Species	Subspecies	Family
1	*Dicliptera*	*brachiata*		Acanthaceae
2	*Justicia*	*americana*		Acanthaceae
3	*Ruellia*	*caroliniensis*		Acanthaceae
4	*Sambucus*	*nigra*	ssp. *canadensis*	Adoxaceae
5	*Viburnum*	*nudum*		Adoxaceae
6	*Viburnum*	*recognitum*		Adoxaceae
7	*Trianthema*	*portulacastrum*		Aizoaceae
8	*Liquidambar*	*styraciflua*		Altingiaceae
9	*Alternanthera*	*philoxeroides*		Amaranthaceae
10	*Alternanthera*	*sessilis*		Amaranthaceae
11	*Chenopodium*	*album*		Amaranthaceae
12	*Allium*	*canadense*		Amaryllidaceae
13	*Allium*	*neapolitanum*		Amaryllidaceae
14	*Rhus*	*glabra*		Anacardiaceae
15	*Toxicodendron*	*radicans*		Anacardiaceae

	Genus	Species	Subspecies	Family
16	*Asimina*	*triloba*		Annonaceae
17	*Cicuta*	*maculata*		Apiaceae
18	*Cryptotaenia*	*canadensis*		Apiaceae
19	*Cyclospermum*	*leptophyllum*		Apiaceae
20	*Osmorhiza*	*longistylis*		Apiaceae
21	*Ptilimnium*	*nodosum*		Apiaceae
22	*Sanicula*	*marilandica*		Apiaceae
23	*Apocynum*	*androsaemifolium*		Apocynaceae
24	*Ilex*	*cornuta*		Aquifoliaceae
25	*Ilex*	*decidua*		Aquifoliaceae
26	*Ilex*	*verticillata*		Aquifoliaceae
27	*Lemna*	*valdiviana*		Araceae
28	*Hedera*	*helix*		Araliaceae
29	*Hydrocotyle*	*bonariensis*		Araliaceae
30	*Hydrocotyle*	*verticillata*		Araliaceae
31	*Sabal*	*minor*		Arecaceae
32	*Liriope*	*muscari*		Asparagaceae
33	*Liriope*	*spicata*		Asparagaceae
34	*Yucca*	*filamentosa*		Asparagaceae
35	*Asplenium*	*platyneuron*		Aspleniaceae
36	*Bidens*	*frondosa*		Asteraceae
37	*Conoclinium*	*coelestinum*		Asteraceae
38	*Conyza*	*bonariensis*		Asteraceae
39	*Elephantopus*	*carolinianus*		Asteraceae
40	*Elephantopus*	*tomentosus*		Asteraceae
41	*Erigeron*	*strigosus*		Asteraceae
42	*Eupatorium*	*capillifolium*		Asteraceae
43	*Eupatorium*	*serotinum*		Asteraceae
44	*Gamochaeta*	*purpurea*		Asteraceae
45	*Helenium*	*amarum*		Asteraceae
46	*Hypochaeris*	*glabra*		Asteraceae
47	*Hypochaeris*	*radicata*		Asteraceae
48	*Krigia*	*dandelion*		Asteraceae
49	*Lactuca*	*biennis*		Asteraceae
50	*Lactuca*	*canadensis*		Asteraceae
51	*Lactuca*	*floridana*		Asteraceae
52	*Mikania*	*scandens*		Asteraceae
53	*Packera*	*glabella*		Asteraceae
54	*Pyrrhopappus*	*carolinianus*		Asteraceae
55	*Senecio*	*vulgaris*		Asteraceae
56	*Smallanthus*	*uvedalia*		Asteraceae
57	*Solidago*	*canadensis*		Asteraceae
58	*Solidago*	*leavenworthii*		Asteraceae
59	*Solidago*	*puberula*	*ssp. pulverulenta*	Asteraceae
60	*Sonchus*	*asper*		Asteraceae
61	*Sonchus*	*oleraceus*		Asteraceae

	Genus	Species	Subspecies	Family
62	*Symphyotrichum*	*dumosum*		Asteraceae
63	*Symphyotrichum*	*pilosum*	var. *pilosum*	Asteraceae
64	*Taraxacum*	*erythrospermum*		Asteraceae
65	*Verbesina*	*alternifolia*		Asteraceae
66	*Verbesina*	*occidentalis*		Asteraceae
67	*Vernonia*	*gigantea*		Asteraceae
68	*Youngia*	*japonica*		Asteraceae
69	*Nandina*	*domestica*		Berberidaceae
70	*Podophyllum*	*peltatum*		Berberidaceae
71	*Alnus*	*serrulata*		Betulaceae
72	*Carpinus*	*caroliniana*		Betulaceae
73	*Ostrya*	*virginiana*		Betulaceae
74	*Bignonia*	*capreolata*		Bignoniaceae
75	*Campsis*	*radicans*		Bignoniaceae
76	*Nemophila*	*aphylla*		Boraginaceae
77	*Cardamine*	*hirsuta*		Brassicaceae
78	*Lepidium*	*virginicum*		Brassicaceae
79	*Tillandsia*	*usneoides*		Bromeliaceae
80	*Lobelia*	*cardinalis*		Campanulaceae
82	*Triodanis*	*perfoliata*		Campanulaceae
83	*Wahlenbergia*	*marginata*		Campanulaceae
84	*Lonicera*	*japonica*		Caprifoliaceae
85	*Cerastium*	*semidecandrum*		Caryophyllaceae
86	*Stellaria*	*media*		Caryophyllaceae
87	*Clethra*	*alnifolia*		Clethraceae
88	*Commelina*	*communis*		Commelinaceae
89	*Commelina*	*virginica*		Commelinaceae
90	*Tradescantia*	*hirsuticaulis*		Commelinaceae
91	*Tradescantia*	*subaspera*		Commelinaceae
92	*Ipomoea*	*purpurea*		Convolvulaceae
93	*Cornus*	*foemina*		Cornaceae
94	*Carex*	*amphibola*		Cyperaceae
95	*Carex*	*festucacea*		Cyperaceae
96	*Carex*	*flaccosperma*		Cyperaceae
97	*Carex*	*lupulina*		Cyperaceae
98	*Carex*	*lurida*		Cyperaceae
99	*Carex*	*scoparia*		Cyperaceae
100	*Carex*	*typhina*		Cyperaceae
101	*Carex*	*vulpinoidea*		Cyperaceae
102	*Cyperus*	*drummondii*		Cyperaceae
103	*Cyperus*	*iria*		Cyperaceae
104	*Cyperus*	*pseudovegetus*		Cyperaceae
105	*Cyperus*	*strigosus*		Cyperaceae

	Genus	Species	Subspecies	Family
106	*Scirpus*	*cyperinus*		Cyperaceae
107	*Polystichum*	*acrostichoides*		Dryopteridaceae
108	*Diospyros*	*virginiana*		Ebenaceae
109	*Elaeagnus*	*umbellata*	*var. parviflora*	Elaeagnaceae
110	*Equisetum*	*hyemale*		Equisetaceae
111	*Vaccinium*	*corymbosum*		Ericaceae
112	*Acalypha*	*rhomboidea*		Euphorbiaceae
113	*Euphorbia*	*commutata*		Euphorbiaceae
114	*Albizia*	*julibrissin*		Fabaceae
115	*Apios*	*americana*		Fabaceae
116	*Cercis*	*canadensis*		Fabaceae
117	*Clytoria*	*mariana*		Fabaceae
118	*Lespedeza*	*cuneata*		Fabaceae
119	*Lespedeza*	*virginica*		Fabaceae
120	*Trifolium*	*campestre*		Fabaceae
121	*Trifolium*	*dubium*		Fabaceae
122	*Trifolium*	*incarnatum*		Fabaceae
123	*Vicia*	*caroliniana*		Fabaceae
124	*Vicia*	*cracca*		Fabaceae
125	*Vicia*	*sativa*	*ssp. nigra*	Fabaceae
126	*Fagus*	*grandifolia*		Fagaceae
127	*Quercus*	*laurifolia*		Fagaceae
128	*Quercus*	*nigra*		Fagaceae
129	*Gelsemium*	*sempervirens*		Gelsemiaceae
130	*Geranium*	*carolinianum*		Geraniaceae
131	*Heliotropium*	*amplexicaule*		Heliotropiaceae
132	*Egeria*	*densa*		Hydrocharitaceae
133	*Elodea*	*canadensis*		Hydrocharitaceae
134	*Hydrolea*	*quadrivalvis*		Hydroleaceae
135	*Hypericum*	*hypericoides*	ssp. *hypericoides*	Hypericaceae
136	*Hypericum*	*mutilum*		Hypericaceae
137	*Sisyrinchium*	*atlanticum*		Iridaceae
138	*Carya*	*cordiformis*		Juglandaceae
139	*Carya*	*illinoinensis*		Juglandaceae
140	*Juglans*	*nigra*		Juglandaceae
141	*Juncus*	*bufonius*		Juncaceae
142	*Juncus*	*debilis*		Juncaceae
143	*Juncus*	*marginatus*		Juncaceae
144	*Callicarpa*	*americana*		Lamiaceae
145	*Lamium*	*amplexicaule*		Lamiaceae
146	*Salvia*	*lyrata*		Lamiaceae
147	*Stachys*	*floridana*		Lamiaceae
148	*Lindernia*	*dubia*		Linderniaceae
149	*Lygodium*	*japonicum*		Lygodiaceae

	Genus	Species	Subspecies	Family
150	*Magnolia*	*grandiflora*		Magnoliaceae
151	*Hibiscus*	*moscheutos*		Malvaceae
152	*Hibiscus*	*syriacus*		Malvaceae
153	*Modiola*	*caroliniana*		Malvaceae
154	*Sida*	*rhombifolia*		Malvaceae
155	*Cocculus*	*carolinus*		Menispermaceae
156	*Mollugo*	*verticillata*		Molluginaceae
157	*Maclura*	*pomifera*		Moraceae
158	*Fraxinus*	*pennsylvanica*		Oleaceae
159	*Ligustrum*	*japonicum*		Oleaceae
160	*Ligustrum*	*sinense*		Oleaceae
161	*Ludwigia*	*alternifolia*		Onagraceae
162	*Ludwigia*	*decurrens*		Onagraceae
163	*Ludwigia*	*glandulosa*		Onagraceae
164	*Ludwigia*	*repens*		Onagraceae
165	*Oenothera*	*laciniata*		Onagraceae
166	*Oxalis*	*dillenii*		Oxalidaceae
167	*Oxalis*	*stricta*		Oxalidaceae
168	*Oxalis*	*violacea*		Oxalidaceae
169	*Corydalis*	*flavula*		Papaveraceae
170	*Passiflora*	*lutea*		Passifloraceae
171	*Mimulus*	*ringens*		Phrymaceae
172	*Phytolacca*	*americana*		Phytolaccaceae
173	*Pinus*	*taeda*		Pinaceae
174	*Nuttallanthus*	*canadensis*		Plantaginaceae
175	*Plantago*	*lanceolata*		Plantaginaceae
176	*Plantago*	*virginica*		Plantaginaceae
177	*Veronica*	*hederifolia*		Plantaginaceae
178	*Veronica*	*peregrina*		Plantaginaceae
179	*Platanus*	*occidentalis*		Platanaceae
180	*Andropogon*	*virginicus*		Poaceae
181	*Arundinaria*	*gigantea*		Poaceae
182	*Bromus*	*catharticus*		Poaceae
183	*Bromus*	*secalinus*		Poaceae
184	*Chasmanthium*	*latifolium*		Poaceae
185	*Cynodon*	*dactylon*		Poaceae
186	*Dichanthelium*	*acuminatum*	*var. acuminatum*	Poaceae
187	*Dichanthelium*	*ensifolium*	*var. ensifolium*	Poaceae
188	*Dichanthelium*	*polyanthes*		Poaceae
189	*Dichanthelium*	*scoparium*		Poaceae
190	*Digitaria*	*serotina*		Poaceae
191	*Echinochloa*	*crus-galli*		Poaceae
192	*Eleusine*	*indica*		Poaceae
193	*Elymus*	*riparius*		Poaceae
194	*Elymus*	*virginicus*	var. *virginicus*	Poaceae

	Genus	Species	Subspecies	Family
195	*Eragrostis*	*hypnoides*		Poaceae
196	*Glyceria*	*striata*		Poaceae
197	*Hordeum*	*pusillum*		Poaceae
198	*Panicum*	*dichotomiflorum*		Poaceae
199	*Paspalum*	*dilatatum*		Poaceae
200	*Pennisetum*	*glaucum*		Poaceae
201	*Phalaris*	*arundinacea*		Poaceae
202	*Poa*	*autumnalis*		Poaceae
203	*Poa*	*chapmaniana*		Poaceae
204	*Polypogon*	*monspeliensis*		Poaceae
205	*Sacciolepis*	*striata*		Poaceae
206	*Setaria*	*viridis*		Poaceae
207	*Sorghum*	*halepense*		Poaceae
208	*Steinchisma*	*hians*		Poaceae
209	*Tripsacum*	*dactyloides*		Poaceae
210	*Podostemum*	*ceratophyllum*		Podostemaceae
211	*Persicaria*	*hydropiperoides*		Polygonaceae
212	*Persicaria*	*longiseta*		Polygonaceae
213	*Persicaria*	*punctata*		Polygonaceae
214	*Persicaria*	*setacea*		Polygonaceae
215	*Rumex*	*acetosella*		Polygonaceae
216	*Rumex*	*crispus*		Polygonaceae
217	*Pontedaria*	*cordata*		Pontederiaceae
218	*Samolus*	*valerandi*		Primulaceae
219	*Clematis*	*terniflora*		Ranunculaceae
220	*Clematis*	*viorna*		Ranunculaceae
221	*Ranunculus*	*abortivus*		Ranunculaceae
222	*Ranunculus*	*sardous*		Ranunculaceae
223	*Amelanchier*	*arborea*		Rosaceae
224	*Crataegus*	*aestivalis*		Rosaceae
225	*Duchesnea*	*indica*		Rosaceae
226	*Photinia*	*serratifolia*		Rosaceae
227	*Potentilla*	*canadensis*		Rosaceae
228	*Prunus*	*angustifolia*		Rosaceae
229	*Prunus*	*caroliniana*		Rosaceae
230	*Prunus*	*serotina*		Rosaceae
232	*Rubus*	*argutus*		Rosaceae
233	*Rubus*	*bifrons*		Rosaceae
234	*Rubus*	*pensilvanicus*		Rosaceae
231	*Rubus*	*trivialis*		Rosaceae
235	*Cephalanthus*	*occidentalis*		Rubiaceae
236	*Diodia*	*virginiana*		Rubiaceae
237	*Galium*	*aparine*		Rubiaceae
238	*Phoradendron*	*serotinum*		Santalaceae
239	*Acer*	*negundo*		Sapindaceae
240	*Acer*	*rubrum*		Sapindaceae

	Genus	Species	Subspecies	Family
241	*Saururus*	*cernuus*		Saururaceae
242	*Verbascum*	*thapsus*		Scrophulariaceae
243	*Smilax*	*glauca*		Smilacaceae
244	*Smilax*	*rotundifolia*		Smilacaceae
245	*Smilax*	*smallii*		Smilacaceae
246	*Solanum*	*carolinense*		Solanaceae
247	*Solanum*	*pseudocapsicum*		Solanaceae
248	*Solanum*	*ptychanthum*		Solanaceae
249	*Solanum*	*sarrachoides*		Solanaceae
250	*Staphylea*	*trifolia*		Staphyleaceae
251	*Halesia*	*carolina*		Styracaceae
252	*Sparganium*	*americanum*		Typhaceae
253	*Typha*	*latifolia*		Typhaceae
254	*Planera*	*aquatica*		Ulmaceae
255	*Ulmus*	*americana*		Ulmaceae
256	*Boehmeria*	*cylindrica*		Urticaceae
257	*Laportea*	*canadensis*		Urticaceae
258	*Verbena*	*bonariensis*		Verbenaceae
259	*Verbena*	*brasiliensis*		Verbenaceae
260	*Viola*	*arvensis*		Violaceae
261	*Viola*	*sororia*		Violaceae
262	*Ampelopsis*	*arborea*		Vitaceae
263	*Ampelopsis*	*cordata*		Vitaceae
264	*Vitis*	*rotundifolia*		Vitaceae