8-2003

An Exploratory Research Study of Collection Management Tools for the Knoxville Botanical Gardens and Arboreta's Living Plant Collection

Kathryn Terese Steinhoff
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Kathryn Terese Steinhoff entitled "An Exploratory Research Study of Collection Management Tools for the Knoxville Botanical Gardens and Arboreta's Living Plant Collection." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Landscape Architecture.

Dr. Gary McDaniel, Major Professor

We have read this thesis and recommend its acceptance:

Dr. Susan Hamilton, Dr. Joanne Logan

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Accepted for the Council:

___Dr. Anne Mayhew____
Vice Provost and Dean of Graduate Studies

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An Exploratory Research Study of Collection Management Tools for the Knoxville Botanical Gardens and Arboreta's Living Plant Collection

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee

Kathryn Terese Steinhoff
August 2003

ACKNOWLEDGEMENTS

I would like to thank my major professor, Dr. Gary McDaniel, for allowing me to take on a project that did not fit the traditional research study model. I believe this study will benefit the Knoxville Botanical Gardens and Arboreta, the citizens of Tennessee and possibly other botanical institutions nation-wide. I would also like to thank the rest of my committee members, Dr. Susan Hamilton for her expertise in the public horticulture field and especially Dr. Joanne Logan for her support and for the use of the GPS receiver.

I would like to thank the board members of KBGA, especially Jim Cortese, Jenny Jukes and Sam Anderson. I thank Jim for his advice on tree management. I thank Jenny for sharing the history of the Howell Nurseries and for helping identify some of the plant material. I thank Sam, along with the City of Knoxville Department of Parks and Recreation for agreeing to support the project and to continue maintaining records on the plant collection.

I would like to express my gratitude to Angela Brown at the North Carolina Arboretum for sharing her knowledge about BG-BASE and BG-MAP. Thanks to Bob Brackman at Cheekwood Botanical Garden and Museum of Art and to Becky Sucher at the Missouri Botanical Garden for sharing their experience with using Microsoft Access to manage records for a plant collection.

I would like to acknowledge KGIS for allowing use of the orthophoto of the KBGA properties.

I owe a huge thanks to Jason Simms and Adam Fiscor for helping me trouble shoot through MS Access and ArcGIS.

Thanks to my family and friends for supporting me in everything I do. I hope I make you proud.

ABSTRACT

The Knoxville Botanical Gardens and Arboreta was formed in 2001 to purchase the C.B. Howell and Joe N. Howell Nurseries with the intent of forming botanical gardens and an arboretum in the Knoxville, Tennessee area. The two nurseries combined have a long history in the nursery industry and a collection of trees and shrubs worth preserving for the future gardens.

The board of directors instantly recognized that the nurseries had several unusual, specimen size plants, but they did not know exactly what they had or where it was located. The board felt that it was important to identify all the plant material on site and to create a record of the plant collection before they could start developing gardens. The records I have created will assist the master planner when deciding what plant material should be preserved.

A current trend in botanical institutions is to move from a card catalog record system to a computerized record system. There are two common software systems that have emerged for woody and non-woody plant collections. BG-BASE is a prefabricated software system with botanical information built-in, but is very expensive to purchase and maintain. Microsoft Access is the other most common computerized record option. MS Access is relatively inexpensive, but requires building the system yourself.

In this research study, I looked at what should be required in a living plant record system based on the garden's mission and built a plant record database in Microsoft Access and ArcMap in ArcGIS. Then, I tested the usefulness if the MS Access database using the data collected from KBGA's living plant collection. Using the database made in

MS Access, I was able to answer the board's questions – what plants do we have and where are they located?

Hopefully, by publishing the steps taken for creating a plant records database, other botanical institutions will have a guide to model their own plant system. Providing an alternative to BG-BASE could be especially helpful for botanical institutions with a limited financial budget. Botanical collections are the basis for having a garden, and being able to maintain adequate records about the collection is very important for establishing value of the collection and building a positive reputation.

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CHAPTER 1

INTRODUCTION

During the summer of 2001, The Knoxville Botanical Gardens and Arboretum (KBGA), a not-for-profit organization, was formed to purchase the Joe N. Howell and C. B. Howell Nurseries for the purpose of establishing a botanical garden and an arboretum in the Knoxville, Tennessee area. Their mission is: " for the benefit and enjoyment of the public, The Knoxville Botanical Gardens and Arboretum will feature trees, garden paths, and terraced gardens, as well as a variety of educational programs (McDonough, March 2002)."

It was by no coincidence that these properties were selected to support a botanical garden and arboretum. The C. B. Howell Nursery was established in 1786 when David Wessels Howell received a land grant from North Carolina. The land was put to use as an orchard and plant nursery and has been operating continuously in that capacity ever since. The property that once stretched to the Tennessee River from its current location is now a mere 28 acres. It's long, rich history in East Tennessee and the nursery industry and mature tree specimens make it a treasure worth preserving (McDonough, March 2002).

Joe N. Howell established the Joe N. Howell Nursery in 1942 on the eastern boundary of the C. B. Howell Nursery. Joe N. Howell was a landscape designer and avid collector of rare and unusual woody plant material. Both of these aspects of Joe Howell's life are evident in the 16-acre nursery he managed. There are literally thousands of linear feet of stonewalls, four charming round stone buildings, and a stone-sided greenhouse

that are very unique and are a testament to first-class craftsmanship (McDonough, March 2002).

Joe N. Howell passed away in 1980, and his daughter, Jenny Jukes has continued the family business as a landscape designer. Mrs. Jukes has no one to pass the family business along to, so she sold the Joe N. Howell Nursery to KBGA on February 6, 2002. Her uncle, Bryan Howell, who owns the C. B. Howell Nursery, is in similar circumstances and is in contract to sell his property to KBGA as soon as funds are available. As to date, KBGA has purchased 10 of the 28 acres from the C. B. Howell Nursery. The properties combined will total 44 acres (McDonough, March 2002).

These properties are less than five minutes from downtown, located off Boyd's Bridge Pike in East Knoxville. Mayor Victor Ashe envisions the botanical garden as a major hub for the Knoxville greenway system (McDonough, March 2002). The board members of KBGA anticipate that the botanical garden will function as a catalyst for revitalizing downtown and East Knoxville (O'Leary, 19 Mar 2002).

The board members of KBGA would like the garden to function as a community center; allowing for special musical and artistic events, private rentals, and educational opportunities for children and adults in history, urban forestry, bird watching, horticulture, and gardening. They envision it as being a destination attraction for garden and history enthusiasts in the southeast (O'Leary, 19 Mar 2002).

The board members have a great appreciation of the history and would like to continue Joe N. Howell's tradition of collecting rare plant specimens, while having a special interest in native plants. Ultimately, the board would like KBGA to be placed on the National Registry of Historic Places for its unusual architectural features, specimen

plants, and for its previous owners' contributions to the landscape industry in Tennessee. The board would also strive for accreditation as a botanical garden and be certified as an arboretum under the Tennessee Arboretum Certification Program. To be considered a candidate for any sort of registry, accreditation or certification, documentation of its features will be necessary (O'Leary, 19 Mar 2002). As the property switches hands, there is a sense of urgency that the historical nature of plants be documented before all known information is lost.

Research Questions

What plants are located on the KBGA property?

Where are these plants located?

How can all the data about the plant collection be managed in useful way?

Statement of Purpose

The purpose of this research is to explore how botanical gardens are managing the information about their living plant collections. In the review of literature, I will review current, computerized, living plant collection record systems and interview individuals from two botanical institutions in the area about their current plant record program. One institution that uses BG-BASE, and one institution that uses Microsoft Access will be selected for their expertise in using these different software packages. For KBGA's living plant collection I will collect general information such as correct botanical nomenclature, native range, size, the source of the plant material, general location, GPS coordinates for large trees, and any historical notes. Using the information gathered from these botanical institutions about their plant record system will aid in developing a tool for KBGA to

manage their plant records once I have collected it. The tool will be tested based on its ability to describe the living plant collection.

The limiting factors for this research relates to the board members' commitment to maintaining adequate records on its plant material. As there is currently no director, the board will have the final decision on how to organize the data on the plant collection. As the grounds stand today, there are garden-like settings of the former demonstration gardens. There are areas arranged in rows with small nursery stock that can easily be transplanted, or removed from the site. There is nursery stock that has grown so tall, the trees form virtual screens that may need to be thinned or removed. There are a few areas that are completely overgrown, and made impassible by the invasive plants: *Rosa muliflora, Ligustrum sinense, Lonicera maackii, Euonymus fortunei, Eleagnus pungens, Morus alba,* and *Celastrus scandens*. Also, the property is not entirely owned by KBGA, so only the areas that have been acquired before my deadline will be included in the collection for this paper. The site will likely undergo a change over the course of the next five or ten years as it readies itself for public use. As plants are shuffled from one location to another, or removed, records must reflect the change in order for the documentation to be useful.

For the scope of this research study, the collection will be defined as a) woody plants currently on site that may be retained based on their relative good health and habit; b) the plants' limited susceptibility to disease, and c) the limited possibility of the plant being a noxious plant either by its invasive nature in East TN or its toxicity to humans (e.g. poison ivy). Rare plants will be defined as plants that are either native or exotic to the eastern U.S. and are not commonly known or used in the southeast region. They may

include unusual cultivars of common species. Native plants will be defined as plants that are indigenous to the eastern U.S. prior to settlement of the area by Europeans. Plant records will refer to descriptive attributes that may be specific to a plant species or specific to an individual plant.

Significance of Study

The Knoxville Botanical Gardens and Arboreta is a relatively small, grassroots organization without a large operating budget. By looking at the alternative to expensive, ready-made living plant collection management software, the Knoxville Botanical Gardens and Arboreta should have a collection management tool that meets the needs of the organization with minimal financial costs.

By discussing the process of creating a plant record system in Microsoft Access and ArcMap in ArcGIS, other botanical institutions who currently do not have a computerized system, could use this information to help guide them with their software selection or for building their own database.

CHAPTER 2

REVIEW OF LITERATURE

The Knoxville Botanical Gardens and Arboreta are currently in the formative process of becoming a botanical garden. Botanical gardens are defined as institutions holding documented collections of living plants for the purposes of scientific research, conservation, display and education (Wyse-Jackson, 12).

A Brief History of the Howell Nurseries

The year was 1786, the United States had declared its independence from Great Britain 10 years earlier and North Carolina was awarding land west of the Appalachian Mountains to its dedicated soldiers of the Revolutionary War and selling land to cover war debts. David Wessels Howell was one of the individuals who were awarded a piece of land where he established a plant nursery and orchard in the area that would later be known as Knoxville, TN.

In 1786, the area was still controlled by the Indians. It was not until 1791 that William Blount signed a treaty with the Indians at James White Fort to open the area to white settlers. Blount named the area Knoxville after George Washington's secretary of war, General Knox. Land was divided into lots and auctioned off in 1792, and Knoxville was incorporated in 1815.

Meanwhile, the Howell's were establishing a plant nursery. The business began with an emphasis on growing fruit trees and other produce to sell as plants, and for selling the fruit at market. The Howell's had a specialty for growing strawberries. The fruits were described as being as big as large hen's eggs (Jukes).

The railroad reached Knoxville in 1855, and the Civil War (1861-1865) erupted a few years later. These combined events helped open the doors of industry to the South, moving Knoxville from essentially an agrarian society into an industrial one. The first industries of the area included textiles, furniture, marble and agricultural products. During Reconstruction, Knoxville served as a central location for shipping these products throughout the southeast.

By the 1880s, Knoxville began to see major changes in the landscape. People abandoned the farm to take a job in a factory or quarry and middle income families were purchasing and building homes for themselves. Housing developments sprang up in the areas today known as Fort Sanders, Old North Knoxville, and Fourth and Gill. The houses were stacked one after the other with very little yard space. This time frame coincides with what was known as the Victorian Era. It was marked by a renewed interest in beautiful things and nature, hence the explosion of popularity in ornamental plants. Despite the small yards, people wanted to dress-up their new homes with the latest and greatest plants. This was the time when the Howell's switched gears from growing plants for food to growing plants for enjoyment.

By the 1910s, The Howell's had a thriving corporation. Mr. S. R. Howell along with his four brothers, Carroll Sylvania, Bruce, Cole and Fletcher had branch operations in Charleston, S.C.; Charlotte and Hickory, N.C.; Leesburg, FL; Bristol, VA; and Chattanooga, Nashville, Sweetwater, Wolf Creek and Jefferson County in Tennessee. While most of these growing sites were sold to local nurserymen in their respective area, the Sweetwater operation played an integral part to the original Knoxville business (SNA, VII, 15-16). Mr. Bruce Howell was largely responsible for the Sweetwater operation. He

had strong horticultural interest and is responsible for introducing *Ligustrum sinensis pendula* (Weeping Privet)*, Cornus florida rubrum* 'Sweetwater' (Red-flowering Dogwood), *Cornus florida rubrum* 'Cherokee Chief'' (Red-flowering Dogwood), and *Ilex cornuta* 'Burfordi'(Burford's Chinese Holly) to the nursery industry (SNA, VII, 16). The Sweetwater Nursery was 1,100 acres in size and set-up right along the railroad where they could pull the rail car into the loading barn and ship plants all across the U.S. Eventually, the Sweetwater Nursery was sold to another nursery company, but they kept the original property in Knoxville (Jukes). When S. R. Howell passed away in 1944, his brother Cole took over the operation in Knoxville. Mr. Cole Howell maintained the Knoxville operation for several years and eventually passed the business to his son, Bryan Howell, who is the current owner of the original Howell Nursery (SNA, VII, 15). The original Howell Nursery eventually moved away from the wholesale nursery business and focused more on landscape design (Jukes).

From the 1930s – 1960s the popularity of the personal automobile allowed for housing to continue to move away from the center of the city of Knoxville. These suburbs today are known as Holston Hills, North Hills, Island Home and Sequoyah Hills. The lots in these areas are characterized by large lawn spaces with lot sizes ranging from ½ - 2 acres. With all the extra lawn space, people wanted to create a park-like setting around their home.

By 1942, Joe Howell, one of the heirs to the original Howell Nursery, recognized the need for landscape designers in Knoxville, and started a separate plant nursery/ landscape design business on the east end of the original Howell Nursery. Joe Howell was formally trained in horticulture and spent several years working under German and

Italian landscape architects in South Carolina before opening his own business (Jukes). Joe Howell had an immense interest in exotic and unusual plants, but contended that East Tennessee was the most beautiful place in the world. He never left the country to collect new and exciting plants, but did manage to acquire and propagate some unusual varieties of trees and shrubs (Jukes). The most striking features of the Joe Howell Nursery include the stonewalls and buildings surrounding the property and partitioning off separate plots of land. The walls were originally built as a selling tool to prospective clients to showcase the variety of stones available in East Tennessee. Some of the stones are from Crab Orchard, some from the Lambert Quarry in South Knoxville, some from English Mountain, some from Kentucky and a few other places where stone was available. The Joe N. Howell Nursery was set-up at one time as a 'Cash and Carry' retail nursery as well as a design firm, with demonstration gardens, but eventually he decided to devote all assets to the design business (Jukes).

In 2001, Jenny Jukes, Joe Howell's daughter who had been operating the Joe Howell Nursery since his death in 1980, was looking to sell the nursery. There was interest from one of the local churches to purchase the property for a housing development. As word of this got out that the stone walls and mature trees could be leveled for a housing development, Jim McDonough a building contractor with a great interest in history and architecture and Jim Cortese a tree specialist combined efforts to preserve the property. They assimilated a board of trustees, naming themselves the Knoxville Botanical Garden and Arboreta (KBGA). The board has managed to raise enough money to purchase the Joe Howell Nursery, which includes about 16 acres with a

6 bedroom stone house, 3 greenhouses, a storage building, smaller stone buildings and mature trees.

Ms. Jukes' uncle, Bryan Howell, owns the original Howell Nursery. Bryan has no one in the family to continue the nursery business and is in the process of selling the remaining 28-acre piece of property of the original Howell Nursery to the Knoxville Botanical Garden and Arboreta. The original Howell Nursery does not have the charm of the stonework at the Joe Howell Nursery, but has several mature specimen trees and space for KBGA to expand.

As of January 2003, KBGA has purchased the entire Joe Howell Nursery and 10 acres of the original Howell Nursery. Money has been raised almost entirely from local foundations, and individual contributions. The city of Knoxville and Knox County have also agreed to support the efforts by donating labor and equipment to clear out the overgrown areas.

The first major building project includes a stone bell tower and entrance garden area. The donor for this project wishes to remain anonymous. While there is currently no director of the Knoxville Botanical Gardens and Arboreta, the mission is to showcase native as well as exotic plant material that performs well in East Tennessee. The board envisions continuous educational programs for all ages, especially in arboriculture, and horticulture.

Describing a Botanical Garden

According to Dr. Shannon Smith, botanical gardens function in a large capacity for providing a beautiful setting, but also provide many services. The major purposes of a garden can be classified into five main categories: 1) Environmental Aesthetics, 2)

Information and Education, 3) Research, 4) Conservation and Preservation, and 5) Public service and Community Pride.

Aesthetics should be a high priority that combines the uses of plants, architectural and landscape construction features, green spaces, water, and forests. These features are what attracts members, tourists, residents, and provides an opportunity for public recognition. Support from these groups is vital for a garden's financial and political survival.

Gardens serve to educate and inform all types of audiences. Botanical gardens provide information in a printed format, in demonstrations, workshops, volunteer programs, films, and with herbarium collections. Information is provided on many levels from school children, to the elderly, amateur gardeners, garden clubs, and to professionals.

The research a botanical garden may conduct ranges from basic science experiments, to variety trials, to literature research and taxonomic studies. Botanical gardens commonly serve as a center for the preservation and conservation for plants and provide refuge for people, and wildlife. They hold collections of rare and exotic plant species and serve to manage urban landscapes and restore historical gardens.

A botanical garden should serve the public and be a source of community pride. It can attract locals and tourists, provide alternative learning experiences for school children, and offer a place for passive recreation (Smith, 14-15).

Collecting: Subject Definition and Justification

Human beings are natural collectors. Almost every human has spent time developing and managing collections for pleasure. Whether it is dolls, toys, or books as children, to stamps or coins as adults, it is a basic human activity (Robinson, Collecting).

Items that are considered collectable are generally an artifact that tells a story about past and present life. Scientific collections, such as in a botanical garden, are carefully documented, and are usually to learn more about the nature of an object (Robinson, Collecting).

The first step to developing a collection is to define the scope of the collection. This would take the shape as a list of major elements or themes that you intent to develop. Next, there should be justification for developing this collection. The collection should be value-added, by positively contributing to the quality of life in the community. You should develop a collection when "demand is likely to be long and steady." You should identify alternative information providers of similar material within the community. If someone already provides a service, there is no need to duplicate it (Robinson, Subject Definition and Justification).

Plant Records

The plants in a botanical collection are generally its greatest asset, and the basis for the garden's very existence (Sawyer, 41). It is important for organizations that function like a museum, such as a botanical institution, to maintain adequate documentation of their acquisitions. The nature of the organization's mission should help to determine the extent or scope of the records (Brown, 3). Unlike museums, botanical gardens are dealing with living acquisitions, which means they are constantly in a state of

change in terms of health, care, and possibly location in the garden. A system for keeping track of all the data about a plant is necessary for botanical gardens. The system for managing plant records must be able to record and retrieve data in a timely manner. Most importantly, the data collected must be accurate (Sawyer, 41).

At this day in age, institutions have a wide variety of sources of information at their fingertips. From staff experience, to reference books, and online databases, it is common practice to minimize the duplication of resources especially when deciding what to record in the plant records database (Brown, 4). With that in mind, specific information about how the plants were propagated, bloom time, fall color time, landscape or economic uses, and toxicity are typically not included in a plant records database.

When planning for a database, consider the roles served by the information recorded in the database. For example, if education is an important component to the organization's mission, the common name(s) should be a field in the database so that information can easily be pulled and presented on the display labels, brochures, and handouts (Brown, 5).

Relational Databases

A relational database is a computerized way for storing information in a collection of tables with each table relating to one subject. The advantage of a relational database is that it eliminates the need to enter repeated data (Murphy, A-5).

A computerized record system allows for sorting records, printing data, and for selecting specific records (Brown, 6). Under most circumstances, it is too difficult or time consuming to retrieve information, correlate data, and print information using a card catalog system (Brown, 8).

Documentation elements for preserving the history of the plants include recording the source, the nomenclature of the species, how it was received, and the date it was received (Brown, 8).

Geographic Information Systems (GIS) and Global Positioning System (GPS)

A GIS is a computer-based mapping and information retrieval system. By displaying data as it relates to a position on earth, it can facilitate the search for spatial patterns, or in a garden's case, to locate plants on the premises. A GIS consists of three primary components: a powerful computer graphics program, one or more external databases, and a set of analysis tools that can be used to graphically interpret the externally-stored data (BG-MAP, GIS).

Global Positioning System (GPS) is a method for accurately determining positions and elevations almost anywhere on earth. The system is comprised of 27 satellites with 24 working at one time, placed in orbit by the U.S. government. To determine a location using GPS, one would require a receiver that must make a signal contact to a minimum of four of the satellites in space (BG-MAP, Using GPS to Map Plants). The receiver picks up a high-frequency, low-power radio signal emitted from the satellites that calculates the receiver's location based on the distance between the receiver and the satellites (Brian, 2-3). This will receive Universal Transversal Mercator (UTM) coordinates, which may be converted to other coordinate systems.

Microsoft Access and ArcMap in ArcGIS

Microsoft Access is a PC-based, relational-database product that is widely used among businesses to manage and analyze data. Training for Microsoft Access can most likely be found at any major university, community college, or on Microsoft's web page.

Microsoft Access promotes itself as a simple and flexible, yet powerful database that can be used by anyone. It is equipped with wizards that can guide a user step-by-step in building their own database. The three main functions or aspects of Microsoft Access are tables, queries and forms. Microsoft Access is a comparatively inexpensive database system that retails for about $329 US for the Professional version, or $549 for the Developer version (http://www.mircosoft.com/office/access/howtobuy/default.asp).

Tables are the building block for the database. It is essentially a spreadsheet. The attribute, such as an ID number, name or address is listed in columns. The specific information about an individual is listed in rows (http://databases.about.com/library/weekly/ aa120300a.htm).

The query function allows you to request specific information and it will only retrieve what you are looking for. For example, if you wanted to know how many Japanese Maples exist in the Japanese Garden, you can query the database to pull-up only those records (http://databases.about.com/library/weekly/ aa120300b.htm).

The reports function allows you to produce attractive formatted summaries of the data that can be printed, or published on the web (http://databases.about.com/library/weekly/ aa120300c.htm).

Microsoft Access can be easily integrated with an SQL server. That means, if you have two or more computers managing information on the database, you can import and export data so the database is continuously updated (http://www.microsoft.com/sql/techinfo/officeintegration.htm).

The Missouri Botanical Garden has briefly discussed how they manage their living plant collection on their website. They have created a relational database with

many inter-related tables using Microsoft Access software. One table relates to the plant's taxa, and includes information such as its scientific name, native range, and author. The next table relates to the plant's accession with fields such as location in the garden, the source of the plant, or where it was collected, and the health of the plant. When plants are added to the plant collection, a unique, 8-digit accession number is assigned to the plant. The accession number is a key identifier for finding information specifically related to that plant.

Missouri Botanical Garden also describes the mapping system used on their website. The first step for them was acquiring an aerial photograph of all the garden's properties within the city. By placing satellite receivers in the garden, geographic coordinates could be collected from the garden. With the coordinates of points in the garden and the aerial photograph, an orthophoto was created. An orthophoto is an aerial photograph that is imbedded with a mapping coordinate system. In simpler terms, each pixel on the photograph is referenced to a point on the earth's surface. Now they can determine the plants' location by using a handheld GPS receiver next to the plant and loading those coordinates onto the orthophoto on the computer.

A further discussion with Missouri Botanical Garden's coordinator of plant records revealed that they link the plant records data base that was created in MS Access to ArcMap in ArcGIS using the SQL connect feature. ArcMap in ArcGIS software is a desktop GIS that can be loaded on to a computer and functions by linking a table or database to a geographically referenced image (Sucher, 2002).

To find out more about how a smaller garden uses MS Access to manage their living collections, I spoke with Bob Brackman about Cheekwood's record system.

Cheekwood Botanical Garden and Museum of Art in Nashville, TN has been chosen for its close proximity to Knoxville, TN, site of the Knoxville Botanical Garden and Arboreta. Cheekwood was a private-family estate that was opened to the public in 1960. The garden is relatively new, and is similar to KBGA in that it has great historical value from the previous owners. Cheekwood is 55 acres, which is similar in size to KBGA. Plant materials are very similar, with most of the collection outdoors, but some collections are located in greenhouses. Some of the grounds are completely wooded areas like KBGA, and they also maintain mature trees and special plant collections (http://www.cheekwood.org).

According to Mr. Brackman, Cheekwood just recently developed their record system, but it is somewhat in a state of flux since the last recorder left and the new plant recorder is coming in. Brackman is the director of the garden and did not have a personal, deep understanding of the database like a plant recorder might have. However, he tried to answer my questions. The MS Access database keeps track of the accessions by their location in the garden area. They keep track of only the woody plant material and do not keep track of the plants' nativity. For the future, they are working on a map and photograph gallery so visitors can locate plant material in the garden easier, and so they can look at images of the plant throughout the season.

BG-BASE and BG-MAP

BG-BASE is a PC-based software package that was designed to manage information on biological (especially botanical) collections. BG-BASE is being used by botanical gardens, arboreta, zoos, and universities (http://www.rbge.org.uk/BG-BASE/).

BG-BASE was developed by Kerry Walter to specifically address the plant curatorial needs of Arnold Arboretum at Harvard University and the Threatened Plants Unit (TPU) or the Conservation Monitoring Centre (now the UNEP – World Conservation Monitoring Centre). The primary objective for creating this plant management database was to create a system that could meet the demands of holding extensive amounts of data, but could also be used by smaller botanical gardens and would follow the International Transfer Format for Botanic Gardens Records (O'Neal, 22).

BG-BASE was originally created to manage living collections, but has expanded to manage herbaria, educational programs, membership functions, and special add-on modules for managing additional information on the living collection, such as for propagation and conservation. The system can link to embossers and engravers for creating labels for the plants in the field. It can receive information taken from barcode readers in the field. BG-BASE can be linked to mapping programs such as BG-MAP for locating plants by their latitude/ longitude position. This database can also be published to function on the Internet (O'Neal, 22).

BG-BASE is composed of a series of modules linked to other modules by shared fields. There are 6,000 data fields, spread across 250 database tables. BG-BASE was built using software from Revelation Software, Inc. This type of software was selected primarily for the special capabilities offered. Revelation Software allows for variable length fields and multi-value fields. A variable length field does not limit the number of characters in a field. This means, you never have to abbreviate, such as for a long botanical name, and you reduce the amount of wasted disk space by not having to reserve space that may or may not be used. The multi-value field allows for more than one value

to be held in a field. This is useful for plants that have more than one common name (O'Neal, 22).

BG-BASE was designed with the intent to be applicable to large and small botanical institutions. It can function on a single computer or be used in a multi-user/computer situation where the computers are all working together, and linked by a server. However, with 6,000 data fields, BG-BASE has recognized that it may be a bit overwhelming for some smaller gardens and no institution uses all of the data fields. The hope is that any garden would be able to grow into the database at their own pace (O'Neal, 22).

The price listing for BG-BASE as of July 2001 is as follows: $5,000 U.S. for the living collections module. Add-on modules for maintaining records on propagation or exporting the database on the web costs about $750 U.S. per module. Additional software to build reports ranges from $145 U.S. for 1 user to $660 for 5 users. For institutions that have more than one computer managing their records with no current network system, a network product for linking the computers costs about $1200 U.S. The annual support agreement ranges from $600 for one module to $875 for three or more modules. Additional services such as customization, data conservation or re-training costs $90 per hour or $600 per day (BG-BASE Pricing Sheet for new installations of BG-BASE version 6.0, July 2001). Refer to Table 2.1 to see how the cost of BG-BASE and BG-MAP compares with the cost of MS Access and ArcGIS. The price does not include the cost of a computer with Windows 98 or higher or at least 800 MHZ with 128-256 MB RAM. This would be the basic requirement for either plant records system.

Table 2.1 – Price Comparison Table for BG-BASE and BG-MAP to MS Access and ArcGIS

Software	Use	Includes	Retail Cost	Additional Requirements	Source
Prefabricated BG-BASE version 6.0	Database Management Software	Living Collection Module + single users install + OpenInsight DB Mgt. Software	$5,120	Travel and expenses for install and training	(Pricing Sheet for new installations of BG-BASE version 6.0)
Prefabricated BG-MAP	Mapping Software	Software, training, manual, 90 days support	$6,450	AutoCAD version 2000, 2002, 2004, BG-BASE 5.0 or higher	http://www.bg-map.com
Microsoft Access	Database Management Software		$329-$549		http://www.mircosoft.com/office/access/howtobuy/default.asp
ArcView 8.3 (ArcGIS)	Mapping Software	ArcMap, ArcCatalog, ArcToolbox	$1,290		(Diamond, 2003)

To learn more about BG-BASE's living collection module, I visited Angela Brown, plant records curator of the North Carolina Arboretum. The North Carolina Arboretum has been chosen for its close proximity to Knoxville. This arboretum is also quite young, as it was established in 1986 by the University of North Carolina. Their mission is to be, "a center for education, landscape and research that elevates the aesthetic, cultural, and economic quality of life in North Carolina." The arboretum is 426 acres, making it much larger than KBGA, but they face the same issues of similar plant material, mostly an outdoor living plant collection, and mature trees (http://www.ncarboretum.org).

The North Carolina Arboretum started their collection development program in 1991-1992. At that time, they looked at BG-BASE as an option for managing their plant collection records. Initially, they felt that the BG-BASE was too overwhelming and tried building their own record system using MS Access. Again, they were overwhelmed, this time by the challenges of creating a relational database that could be queried effectively.

So, in 1994 they applied for and received an IMLS (Institute of Museum and Library Services) grant to purchase the BG-BASE software and hardware to support it. While it was a struggle to learn how the database worked and how to navigate through all the data fields, Mrs. Brown took training classes that she found to be extremely helpful. The best feature about BG-BASE is the technical support provided with the annual support agreement. Questions can be answered and problems patched with the software in a very timely manner. The approximate $800/ year annual support agreement does not include any new updates in the software, but you do receive telephone support.

BG-BASE's living collection module consists of three main tables with several pages in each table. The NAMES table is spread across six pages of fields with most of the fields filled in with the full and correct botanical nomenclature. Because BG-BASE ships with the correct botanical name, it saves the data enterer from having to look up words and from spelling. The ACCESSIONS table is spread across 4 pages and relates to where a plant came from, how many were received and so on. The PLANTS table is spread across 5 pages and relates to the location, health, label type and size.

There are some weaknesses to BG-BASE that Mrs. Brown pointed out that cannot be overlooked. For one, the living collection module is full of fields that the North Carolina Arboretum does not use and these fields cannot be hidden. So, the data enterer has to wade through fields that are not used to get to the fields that are used. Another weakness is that if you want to have an image of the plant in the database, you have to purchase a separate image module. However, you can get around this if you also use BG-MAP, which can store images.

The North Carolina Arboretum's plant records database is mostly used by the horticulture staff, gardeners, and the production manager for determining plant locations. According to Mrs. Brown, they are happy with BG-BASE and BG-MAP and it satisfies their records' needs.

Accreditation and Certification

"The achievement of accreditation by the American Association of Museums is the field's primary vehicle for quality assurance and public accountability (AAM-Criteria and Characteristics)." A botanical garden classifies as a museum of living plants. The criteria for eligibility of accreditation require that an organization must fit into the

following definition of a museum. These include: being incorporated a not for profit or government entity; to be educational in nature; have a formally stated mission; have at least one full-time paid professional staff; present regularly scheduled programs; have a formal program for the documentation, care and use of collections; and have a maintenance program. Other general requirements include: they also must have been open to the public for at least two years; they must be open for a minimum of 1,000 hours per year; they must have a minimum-operating budget of $25,000/yr, and have accessioned 80% of the collection. The process requires matching certain organization culture characteristics, a self-study, and a peer institution review before accreditation is awarded.

The Tennessee Arboretum Certification program sets standards for what can be called an arboretum for public educational purposes. The general requirements to be considered for arboretum status include that the site must be open to the public; protective tree practices for landscape maintenance; newly planted trees must be mulched until they are well established; trees should be labeled with the common and botanical name, and be placed at a readable height, causing minimal damage to the tree and be maintained in good condition. Next, they will categorize the applicant into ranking levels. A level 1 has 30 different species of trees labeled. A level 2 has 60 different tree species labeled and a pamphlet for self-guided tours. A level 3 has 90 different species of trees labeled as well as a pamphlet for self-guided tours, as well as volunteers, part and full time personnel for special tours. The highest level is a level 4, which includes 120 different species of labeled trees, a pamphlet for self-guided tours, volunteers, part and full time personnel for special tours and must publish a newsletter at least twice a year.

In the review of literature, I have given a brief history of the Howell Nurseries, discussed the role of a botanical garden, the justification for a collection, how a collection might be managed and the technology used behind them, and the requirements for certification and accreditation of a botanical garden and arboreta.

CHAPTER 3

MATERIALS AND METHODS

Identifying Plants in the Field

To provide the plants in the field with an identifying marker; its genus, species, cultivar name, if known, and a six-digit accession number will be put on a label and attached to each plant. The accession number is unique to each plant or form. A plant form may be an area of ground cover, or a group of shrubs that can no longer be separated. Because of the unique nature of the accession number, it will be the primary key that will link the plant to its location in the garden and the data collected about the plant. The first two digits of the accession number relate to the last two numbers of the year, so all plants accessioned in the year 2002 AD will begin 02. The last four digits will be in a series running from 0001 – 9999. The probability that the garden will ever accession 10,000 or more plants in a year is unlikely.

For the initial labeling, the board of directors has chosen double-sided, aluminum nursery tags that can be engraved on both sides. The aluminum tag will have a life span of approximately five years. Machine-generated labels may replace the aluminum tags, as funds become available. The aluminum tags can be wrapped around the plants' branches, or the label will be attached to the tree trunk with a brass tack, four feet above the ground (Cortese, spring 2002).

With a pen and notebook in hand, I will record the botanical name and accession number assigned to each plant. The plant will be described by its approximate height in

feet if it is a shrub or small, transplantable tree, or by measuring the trunk's circumference at breast height in inches with a tape measure. The circumference will be converted to diameter at breast height to store in the database.

Walking through the grounds with the previous owners, propagators, and foremen if necessary and discussing where the plants came from will obtain the source of the plant material. This may also require reviewing old invoices.

Creating the Database using Microsoft Access

Getting Started:

1) **Open** MS Access
2) You will be prompted with a form asking if you would like a Blank Access database, Access database wizards, pages, & projects or Open an existing file.
3) Click **Blank Access database**.
4) Immediately, you are prompted to name your database. Select the folder where you would like to save your database. **Type** a name for the database in the File Name field and **select** Microsoft Access Databases in the Save as Type drop-down field.
5) When the Access file opens, you will see a database window with seven objects and 1 group. The objects are tables, queries, forms, reports, pages, macros, and modules. For this database, you will use tables, queries, forms and reports.

Creating a Table:

1) If it is not already highlighted, click on Tables from the Objects list.
2) Double-click Create table in Design View in the database window. The Table window opens in Design View.

3) Switch to Datasheet View.
4) You will see a split screen with a table on top for entering field name, data type and description with a folder for defining the fields' properties.
5) Fill in the specs:
6) Repeat steps 1-5 for all the tables needed for the database.

To start building the framework for the database, with the Tables tab selected under the objects menu, double-click on "Create table in design view". Here you can start writing in the field names to be included in a record. Next, click on the datasheet view icon on the upper left corner of the toolbar. This is where you define the characteristics of the data.

In Microsoft Access, you need to specify the type of data in each field. The choices for the data type include: number, text, memo, date/time, currency, yes/no, OLE object, AutoNumber, and Hyperlink. By setting the data type to a specific type a data type, you restrict the type of data you can enter in that field. The number data type is used for entering numbers used for calculations and is restricted to numbers, a decimal point, and a plus or minus sign. The text data type will store letters, numbers, and special characters, but is limited to 255 characters and is set to a default of 50 characters. The memo data type holds descriptive data and holds up to 64,000 characters. The date/time data type holds dates and times and can be used for calculations. The currency data type holds monetary values. The yes/no data type reads as a check box, so you can indicate a yes or no value. OLE objects store pictures, sounds or graphics. AutoNumber allows for MS Access to assign the next consecutive number. The Hyperlink data type can store a Web address (URL). Refer to Table 3.1 – Taxa Table to see the specifications that I used.

Table 3.1 – Taxa Table

Field Name	Type	Size
Taxon (primary key)	Text	75
Author	Text	15
Family	Text	30
Genus	Text	25
Species	Text	30
Subspecies	Text	40
Variety	Text	30
Forma	Text	30
Group	Text	30
Cultivar	Text	50
TradeName	Text	50
CommonName	Text	50
NativeRange	Text	100
Image	OLE Object	(none)

The field names have no spaces, hash or dash marks or unusual characters because that will not translate in ArcMap in ArcGIS.

The Taxa table is the table that carries information that will be true for all taxon, no matter its location in the garden or its source. This is the basic taxonomic information that will be necessary for analyzing the diversity of species in the garden. To briefly discuss what these fields mean, I will describe why it is located in the Taxa form in the database. The taxon is the botanical name in its simplest form. For example *Acer rubrum* 'October Glory' would be considered a taxon. This is a unique name with unique characteristics and that is why it is designated as the primary key. The family, genus, self-explanatory; they break up the complete scientific name into distinct groups. For example, if the KBGA would like to know how many families they have, or how many *Acers* they have, by breaking the information into different fields, it is easier to extract. The reason for keeping track of the author or authority of the plant name is for the ever-

changing, acceptable botanical nomenclature. Knowing who is the current acceptable authority will help to keep records current. Because KBGA has a distinct interest in native and exotic plants, it is important to identify the native range of the plant material. The Native Range field will not be so specific to name the counties in Tennessee where the species is indigenous, but to give an idea where the plant will be found in nature. For example *Acer rubrum* has a native range of eastern to central North America. The image field is simply to serve as a reference guide for the curator or plant recorder. The image should include identifying characteristics such as the leaf or bud. Refer to Table 3.2 – Accessions Table to see the specifications that I used.

The accession table maintains the information that is unique to each individual plant. For instance, there may be 25 *Magnolia grandiflora* in the garden. However, they are all unique based on their location, health, size, or source. The accession number, or ID is the unique identifier for the individual plants and serves as the primary key in this table. The accession number works much like the social security number works for U.S. citizens. It identifies a unique individual and the number has no numerical value. So, it is labeled as a text type field because there is no reason to solve mathematical formulas from the accession number. It is very important that the ID is a text type file especially when using the last two digits of the year to calculate the ID, or accession number. For example, during the years 2000 – 2009 the first digit is zero. If the ID number begins with a zero and the file type is a number, the zero will not appear. It will be important

Table 3.2 – Accessions Table

Field Name	Type	Size
ID (primary key)	Text	8
Taxon	Text	75
Deaccessioned	Yes/No	(none)
Sublocation	Text	20
Area	Text	20
Howreceived	Text	10
Plantcount	Number	(none)
Datereceived	Date/Time	(none)
Source	Text	100
Verifiedby	Text	50
Voucher	Number	(none)
Donor	Text	100
History	Memo	(none)
Condition	Text	10
DBH	Number	(none)
DBHdate	Date/Time	(none)
Height	Number	(none)
Heightdate	Date/Time	(none)
Cables	Yes/No	(none)
Lightningrod	Yes/No	(none)
Pruning	Memo	(none)
Fertilizer	Memo	(none)
Pestmgt	Memo	(none)

that the ID is a text type when joining the MS Access database with the GPS points in ArcMap in ArcGIS because they both need to be string data types, which would be text.

The taxon (the primary key in the Taxa table) is repeated in this table because it works as the foreign key that will allow the Accession table to relate to the Taxa table. The taxon is the botanical name in the simplest form consisting of the genus and species, and the variety and cultivar if it has one.

To keep living plants' records separate from plants that are dead or removed, there is a checkbox to designate if the plant is no longer part of the collection. The reason for not deleting a deaccessioned record all together is to keep track of plants that you once had and to see if there are trends in certain plants. If KBGA must replace a certain plant every 3-5 years because it dies, maybe they will no longer keep that particular species in the collection.

The location of the plant can be described in three different ways. The sublocation is a broad, general location. For example, the Demonstration Gardens, abbreviated DEMO in the database, is a sublocation. The area helps to pinpoint the plant a little closer to its actual location. For example, an area called WEST in the database under the sublocation of DEMO would be located on the west side of the gravel road in the Demonstration gardens. For an even closer description, some plants are identified by their GPS coordinates.

The source of the plant material is important for keeping track of reputable growers and for providing visitors with a source for plant material. Knowing when you received the plant will help keep track of the lifespan of the plant material. Knowing how

the plant was received, either by seed, cutting, bare root, or balled and burlapped serves to document the acquisition of a particular plant (Brown, 8).

There is a field for recording who verified the plant's botanical nomenclature and a voucher number field. Because there are several cultivars and several unusual plant species left over from the Howell Nurseries, it may be necessary to have the plant's identified by a professional, such as by a herbarium. To have a plant verified, I would take a leaf and stem sample to the University of Tennessee's Herbarium and tell them the genus where I think the plant belongs. They will look through the dried, mounted samples in their collection to see if it matches with something they have. If so, the voucher number on that dried sample will be recorded in the database.

As a fund-raising source, some trees or shrubs in the collection may be donated in memory of someone or the plant may have come from someone's private collection. The donor field should give the donor's full name. This field is a foreign key in the accession table that relates to an entirely different table that has more details about that person, such as the address and why the plant was donated.

KBGA has a distinct interest in the history of the property and the plants. Some plants may have an interesting story or history that should be recorded under the history field. For example, there is a row a pine trees between the borders of the former Joe N. Howell and C.B. Howell Nurseries. That row was planted by Joe Howell to prevent the weed seeds from C.B.'s property from blowing on to his property (Jukes, 2002). Knowing historical information about the plant material will help the master planner decide what plant material to keep and be useful in the garden's interpretation.

The maintenance records for the individual plant are an important aspect for the measuring the standards of the long-term arbor care. The condition field can describe the basic health of the plant such as good, fair, poor, or dead. Measuring the height and the DBH (diameter at breast height) and when it was measured could be important for identifying champion trees and for watching the growth of the plant. The database should acknowledge if there are cables or lightning rods on the plant so they can be inspected for safety reasons. The database also keeps track of the pruning, fertilizer, and pest management performed on each plant. This will help identify plants that are high maintenance, give evidence to why a plant may have died, or help identify when a plant may be due for a care. The accuracy of the maintenance records depend highly on the outdoor horticulturists documenting what they did to the plant material. Refer to Table 3.3 – Source Table to see the specifications that I used when designing the Source Information Table.

Table 3.3 – Source Table

Field Name	Type	Size
Source (Primary Key)	Text	100
Contact First Name	Text	15
Contact Last Name	Text	20
Title	Text	20
Phone	Text	15
Extension	Text	5
Fax	Text	15
Email	Text	50
WebsiteURL	Hyperlink	100
Address	Text	100
City	Text	25
State	Text	25
Zipcode	Text	10

"Source" is the primary key in this table, which allows it to relate to the accessions table because there is a source field in the accessions table. In order to extract the information easily, details about where a plant came from are broken into individual fields. Nothing is too surprising here; this is all the basic information you would expect to find in an address book. Refer to Table 3.4 – Donor Table to see the specifications that I used.

Because KBGA is a not-for-profit organization, it is important to identify supporters of the organization and document what and why they gave. For example, KBGA may want to use this information to help identify people who have donated trees as those who may be willing to support educational programs or for a capital fund drive. On the flip side, a donor who has a tree planted in memory of someone may want to know where that tree is planted and if it is still alive. The donor is the primary key in this table, which links to the foreign key, "donor" in the accessions table. An example of what

Table 3.4 – Donor Table

Field Name	Type	Size
Donor (primary key)	Text	50
Deceased	Yes/No	(none)
First Name	Text	15
Last Name	Text	20
Spouse Name	Text	50
Phone	Text	15
email address	Text	50
Address	Text	100
City	Text	25
State	Text	25
Zipcode	Text	10
Notes	Memo	(none)

should be in the donor field is: Dr. John T. Smith. Because it is possible that there is more than one Dr. John T. Smith that has donated a plant, numbers may be added after the name in the donor field and the subsequent information should distinguish one person from another.

Building Relationships Between Tables:

Now that the tables are set up to keep track of all the data, these tables must be linked so they can relate to one another. From the toolbar at the top of the screen, I clicked the "relationships" button to take me to a page showing all the tables with all the fields. Next, I dragged and dropped the primary key from the Taxa, Source and Donor table onto its foreign key in the accessions table. Figure 3.1- Table Relationships illustrates how the tables are linked so they can be queried together.

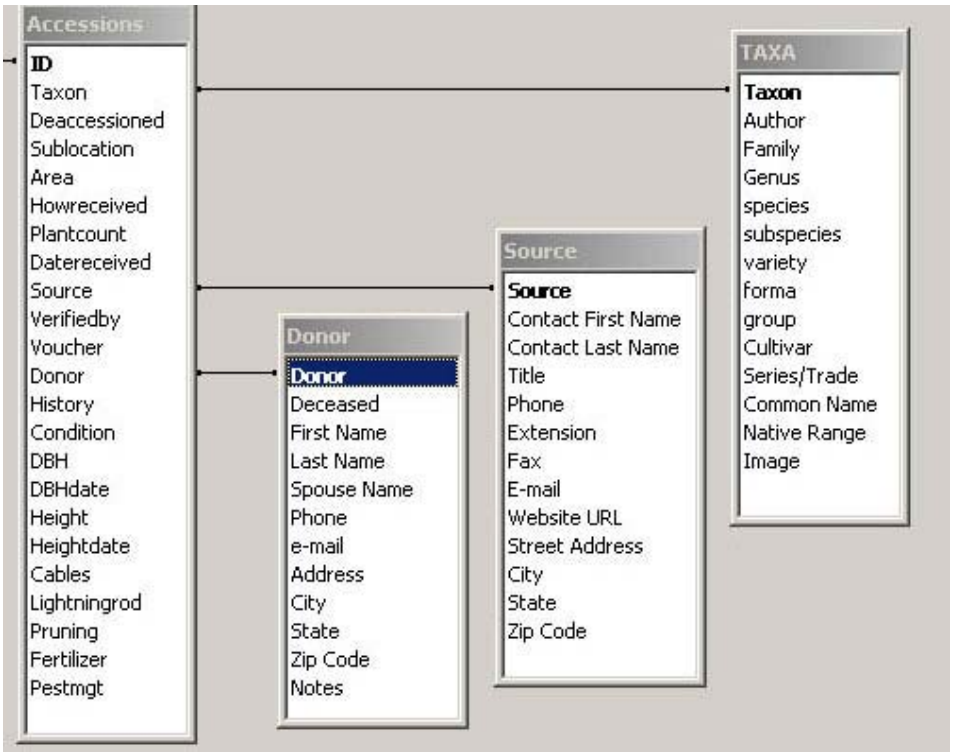

Figure 3.1 – Table Relationships

Creating a Form:

Creating the Taxa Form

1) Click on the **Forms** button under the Objects list.
2) Double-click **Create form** by using Wizard.
3) Select **Table: Taxa** from the drop down menu
4) Send over all the fields from the Taxa table
5) Select **Table: Accessions** from the drop down menu
6) Send over Accession #, sublocation, status
7) Select a columnar layout
8) Select standard style
9) Name the form TAXA

The TAXA form contains a subform of the plant accessions. The sub form will give a quick glance at how many times a plant has been accessioned in the garden, where it is located, and if it is living.

On the following page, Figure 3.2 shows how the TAXA form looks. There are fields for filling-in the information that is specific to that plant and a place to store an image for that plant. In addition to data fields, there is an accessions subform that is continuously updated to show how many you have of this plant, if it is still in the collection, and where it is located. Do not enter data in the accessions subform. If you have new accessions, fill out the complete accessions form. This subform is strictly used as a quick reference.

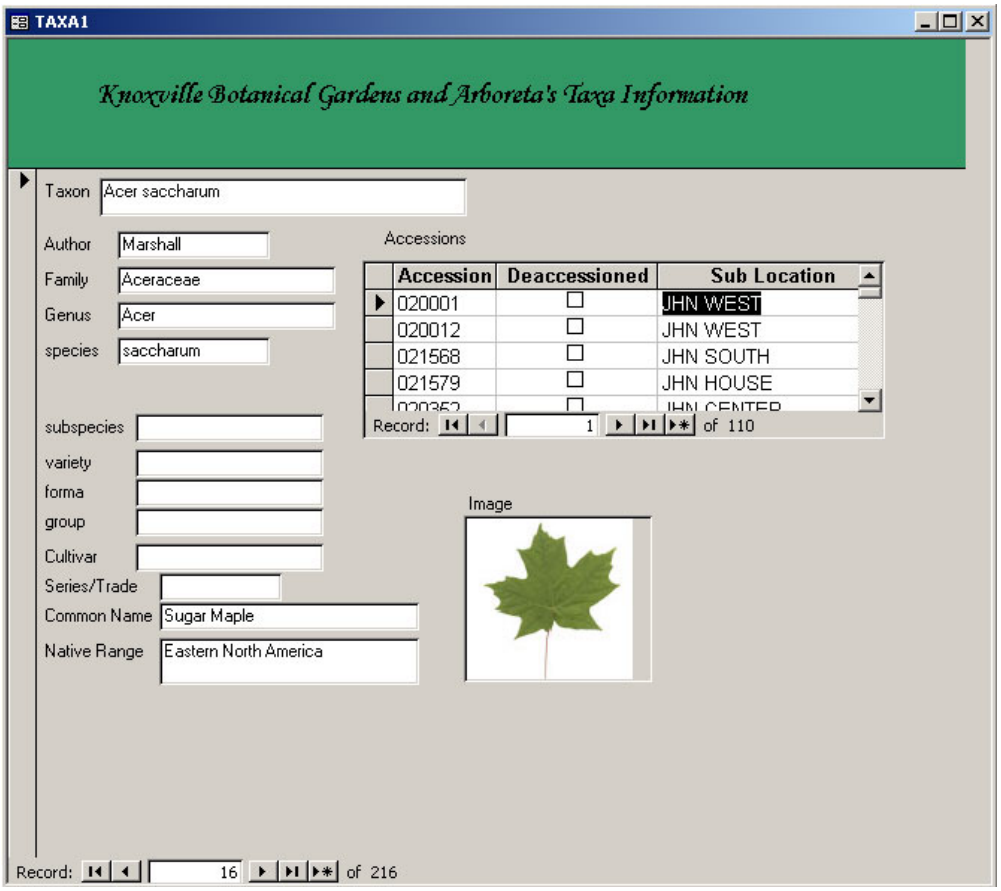

Figure 3.2 – Taxa Form

Creating the Accessions Form

1) repeat steps 1-2 from creating the taxa form
2) Select **Table: Accessions** from the drop down menu
3) Send over all fields EXCEPT taxa, source, donor, sublocation and area.
4) Select a columnar layout
5) Select a standard style
6) Name the form Accessions
7) Look at the form in Form View

Adding combo boxes

8) From the Toolbox, select Combo Box

9) Draw a box on the form to place the combo box

10) Select “I want the combo box to look up values in a table or query”

11) Select Taxa under view Tables as the source

12) Send over taxon from available fields to selected fields

13) Adjust the column width

14) Check “store that value in this field” and select “taxon”

15) Label the combo box TAXON

16) Create another combo box for the sublocation by repeating steps7-9.

17) Select “I will type the values that I want”

18) Select 1 for the number of columns

19) Type the possible values for the sublocation. I used JHN WEST, JHN CENTER, JHN EAST, JHN SOUTH, JHN DEMO, JHN HOUSE.

20) Select “store that value in this field and select sublocation”

21) Create another combo box for the area by repeating steps7-9.

22) Select “I will type the values that I want”

23) Select 1 for the number of columns

24) Type the possible values for the area. I used UPPER, UPPER1, UPPER2, UPPER3, MIDDLE 1, MIDDLE2, MIDDLE3, LOWER1, LOWER2, EAST LAWN, WEST LAWN, WEST TERRACE, BACK ALLEY, DRIVE, EAST WELL, EAST TERRACE, CRESCENT, EAST WING, WEST WING, WEST FRONT, WEST BACK, EAST FRONT, EAST BACK, AREA1, AREA2, AREA3, PLOT BARN.

25) Select “store that value in this field and select area.”

26) Create another combo box for the area by repeating steps 7-9.

27) Select “I want the combo box to look up values in a table or query”

28) Select “Source” under view Tables as the source

29) Send over “Source” from available fields to selected fields

30) Adjust the column width

31) Check “store that value in this field” and select “source”

32) Label the combo box “Source”

33) Create another combo box for the area by repeating steps 7-9.

34) Select “I want the combo box to look up values in a table or query”

35) Select “Donor” under view Tables as the source

36) Send over “Donor” from available fields to selected fields

37) Adjust the column width

38) Check “store that value in this field” and select “Donor”

39) Label the combo box “Donor”

Creating a Multiple Page Form in the Accessions Form

1) Adjust the length and width of the form while in design view.
2) Sort the text fields so the information specific to the accessions such as: Accession Number, deaccessioned, taxon, sublocation, area, source, how received, plant count date received, verified by, voucher, donor, and history is toward the top of the form. The maintenance information is at the bottom of the form and includes: condition, DBH (diameter at breast height), DBH date, height, height date, cables, lightning rod, pruning, fertilizer, and pest management.

3) Add a page break that is placed equally distant between the two pages. Do this by selecting the page break option from the toolbox and dragging a line where the page break should be placed.
4) Add two command buttons to navigate between the two pages. Do this by selecting the command button option from the toolbox and drawing a box to make a button. Click on the button to change the name. I used “Maintenance” for the name of the button on the first page to navigate to the maintenance section of the form. I used “Plants” for the name on the button on the second page to navigate to the section of the form, which is information specific to the individual plants.
5) Create a Macro to direct the path for the buttons. Do this by selecting a button and clicking the “Properties” button on the toolbar at the top of the page. This will bring up menu for all the properties about that button. With the “All” folder tab selected, scroll down to “On Click”. When you highlight that selection, a “...” button appears at the side. Click the “...” button to make a Macro for directing the buttons. A spreadsheet view should come up with the fields Macro Name, Action, and Comment across the top. Write “Attached to the accession form” under comment on the first line. Write “Attached to the Maintenance command button” under comment on the third line. Write “Maintenance” under Macro Name, select “GoToPage” under Action and write “2” in the Page Number field at the bottom of the page under Action Arguments and “Displays second page of the form” under Comment on the forth row. On the sixth row write “Attached to the Plant command button” under the Comment field. Write

"Plant" under Macro Name, select "GoToPage" under Action and write "1" under Page Number in the Action Arguments at the bottom of the table, and write "Displays the first page of the form" under Comment on the seventh line. On the ninth line write, "Attached to the After up date property of the form" under Comment. On the tenth line write "RequeryReportsTo" under Macro Name, "Requery" under Action and "Requery the ReportsTo combo box" under Comment. Name the Macro accession (page break) and close the macro window.

6) If the form operates like it is one page, you may need to turn off the vertical scroll bar. Do this by selecting the Form Selector which is the small box in the upper left corner of the form between the scroll bars. By double clicking on this box, it opens a properties menu, which allows you to change many properties about the form. With the All folder tab selected, scroll down to the Scroll bars option and select horizontal only. This will make navigation using the buttons more clear for the data entry person.

On the following page, Figure 3.3 and Figure 3.4 illustrate how the Accession Form looks. The first page, seen in Figure 3.3, relates to history about a particular plant or group of plants that share all the information in common. It has several drop-down menus to save time with typing and to keep spelling consistent. Almost all of the information on the first page will be filled out on the day that the plant arrives at the garden. The second page, seen in Figure 3.4 keeps maintenance history on the page. The horticulturist will be responsible for notifying the plant recorder of any changes about that plant's status.

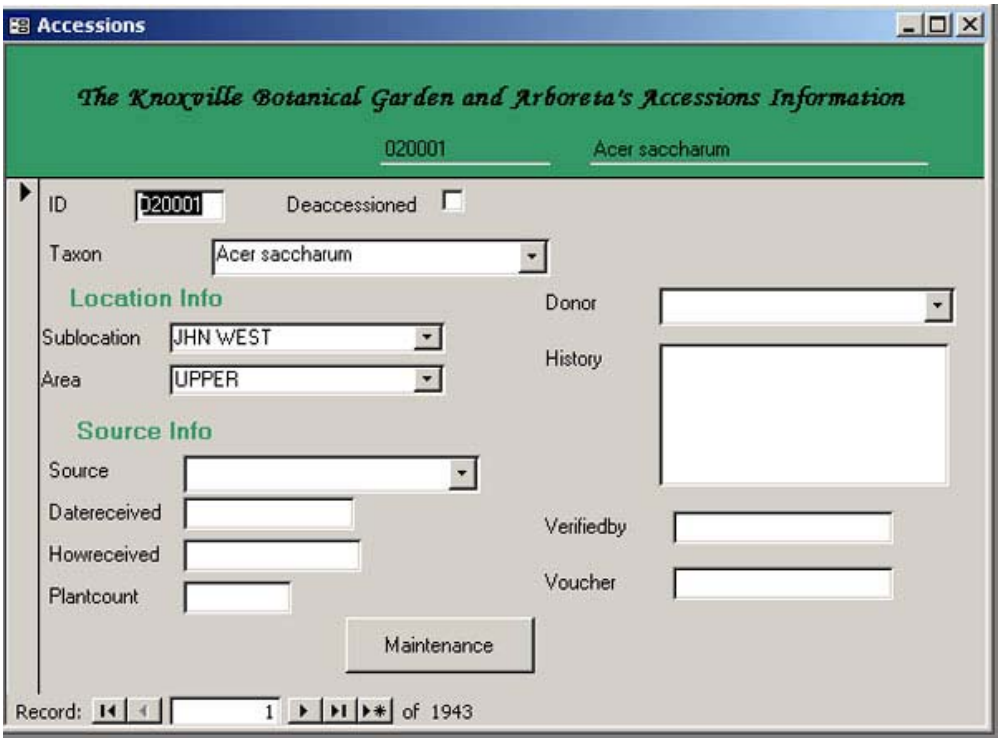

Figure 3.3 - Accessions Form 1

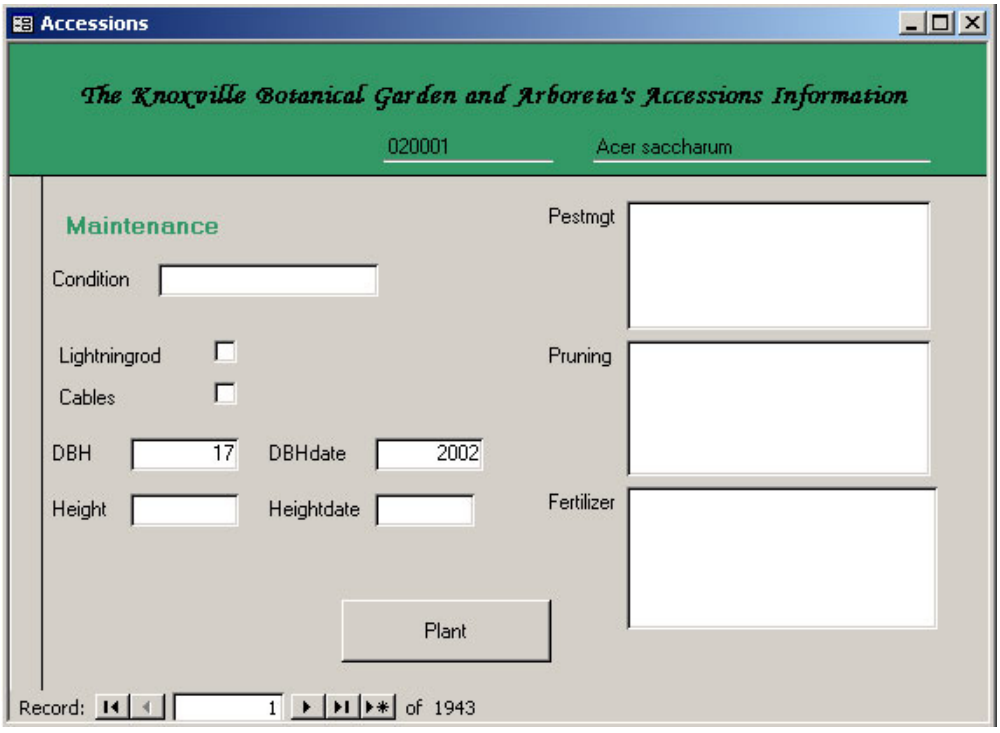

Figure 3.4 – Accessions Form 2

Creating the Source Form

1) Click on the “Forms” button under the “Objects” list.
2) Double-click “Create form by using Wizard.”
3) Select “Table: Source” from the drop down menu
4) Send over all the fields
5) Select a columnar layout
6) Select standard style
7) Name the form “Source”

In Figure 3.5, you will see how the Source Form appears. This form is to record the information about the source for the plant material placed in the garden. Keeping track of the source of plant material is important for the gardens’ records and helps support KBGA’s mission of supporting community interest. If you have a visitor who would like to know where they can purchase a plant you have in the garden, you should be able to tell the visitor where your plant came from and provide contact information.

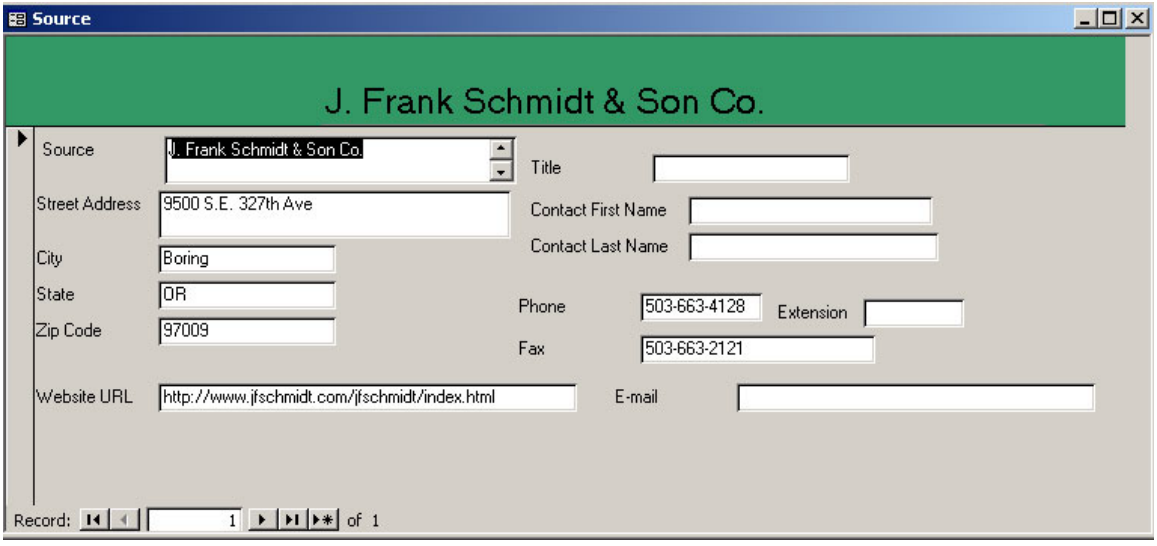

Figure 3.5 – Source Form

Creating the Donor Form

1) Click on the “Forms” button under the “Objects” list.
2) Double-click “Create form by using Wizard”.
3) Select “Table: Donor” from the drop down menu
4) Send over all the fields
5) Select a columnar layout
6) Select standard style
7) Name the form “Donor”

Refer to Figure 3.6 – Donor Form to see how the form appears in the database. The purpose of the Donor Form is to keep records on people who have donated to purchase a

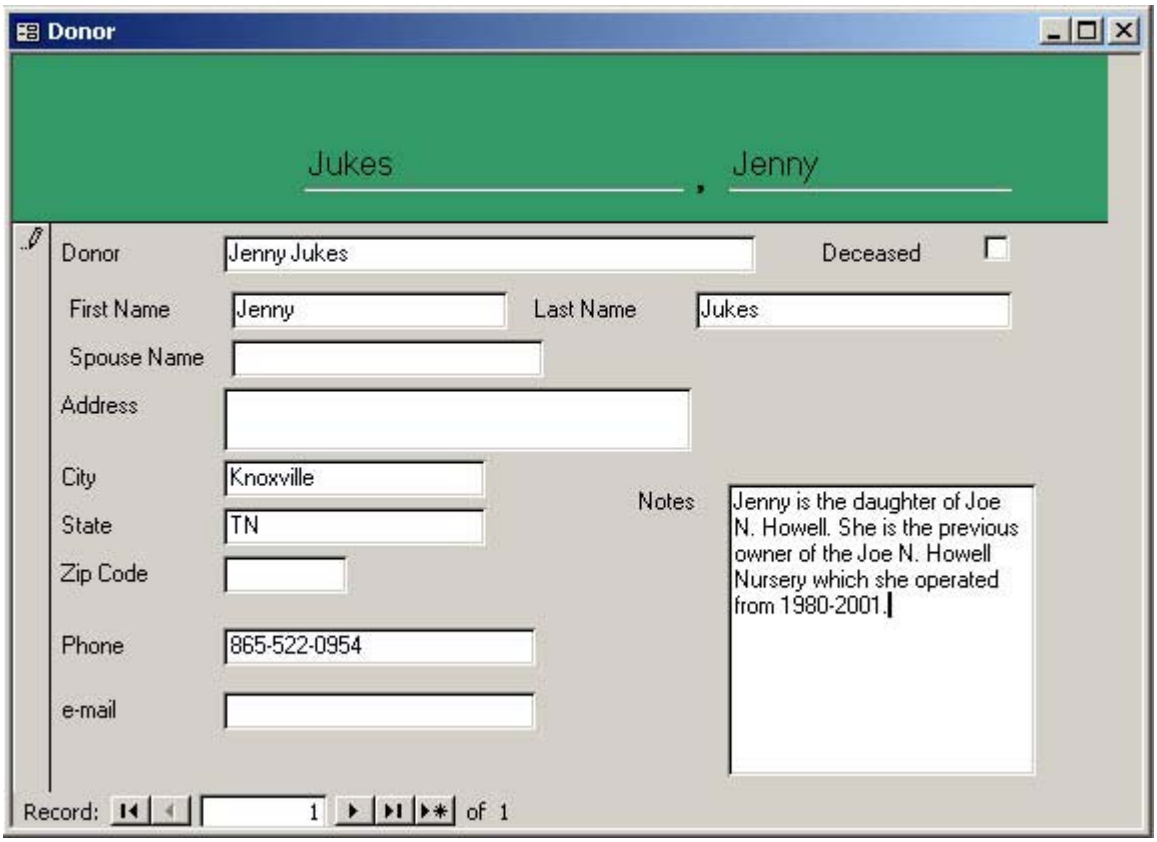

Figure 3.6 – Donor Form

plant for the garden to commemorate a person or event, the donor form has a contact name and a way to get in contact with this person. This person should be notified if something happens to the plant or the memorial plaque. Because KBGA insists that it be a place of community in its mission statement, maintaining a good rapport with its donors will be important.

Entering Data in the Database

With the database complete, I could enter all of the data that had been collected and recorded in a notebook in the database fields. Not all of the fields have a record for each plant because the existing plant material has incomplete records.

In order to fill in the TAXA form, I referred to The Manual of Woody Landscape Plants: Their identification, Ornamental Characteristics, Culture, Propagation and Uses fifth edition printed in 1998 by Michael Dirr. This comprehensive text was used for determining the current author of the plant name, the family name and the native range.

Collecting GPS Points in the Field

The GPS coordinates of the large trees will be gathered with a GPS receiver with a differential. The GPS receiver to be used is an eTrex Venture made by Garmin Ltd. This type of receiver currently costs between $125- 175 and can save a series of waypoints that can be downloaded to the computer. The activity of collecting GPS points of the trees requires standing next to a tree in the field with the GPS receiver and saving the coordinates. The receiver will be set to collect the points in decimal degrees.

When you use the waypoint marker on the GPS receiver to save points, it assigns the ID number 1, 2, 3... or you can type in the accession number for that plant. It was challenging to use the buttons on the receiver to type the accession number into the

receiver. I allowed the receiver to assign the ID number, and kept track of what number corresponds with the accession number, so the data recorded in the database would correspond with the GPS coordinates. I edited the ID field in MS Excel by changing the receivers' ID number to correspond with the respective accession number.

Locating Significant Trees on the Orthophoto

To visually locate the position of the large and/or significant trees based on location, size or rarity, an orthophoto of the properties will be obtained from KGIS. KGIS is an automated mapping and geographic information system created, owned, and funded by the city of Knoxville, Knox County, and the Knoxville Utilities Board. KGIS created this orthophoto with an aerial photograph embedded with coordinate code that can translate GPS points taken in decimal degrees. ArcMap in ArcGIS can translate decimal degrees, state plane coordinates or UTMs as long as the orthophoto has a known coordinate system. Using ArcMap in ArcGIS , the points will then be placed on the orthophoto, so data can be queried spatially.

Steps for Creating the GIS

1. Open the orthophoto in ArcMap in ArcGIS.
2. Bring in the X, Y data downloaded to the computer from the GPS receiver. The points will appear over the orthophoto. Do this under the Tools drop down menu, select "Add X, Y data" and find the file on your hard drive.
3. Save the X, Y data as a shape file. Do this under the File drop down menu, select Export Map and save it to the hard drive.
4. Refer to Figure 3.7 to see how the data is displayed. The waypoints taken with the GPS receiver can be seen as yellow dots over the orthophoto.

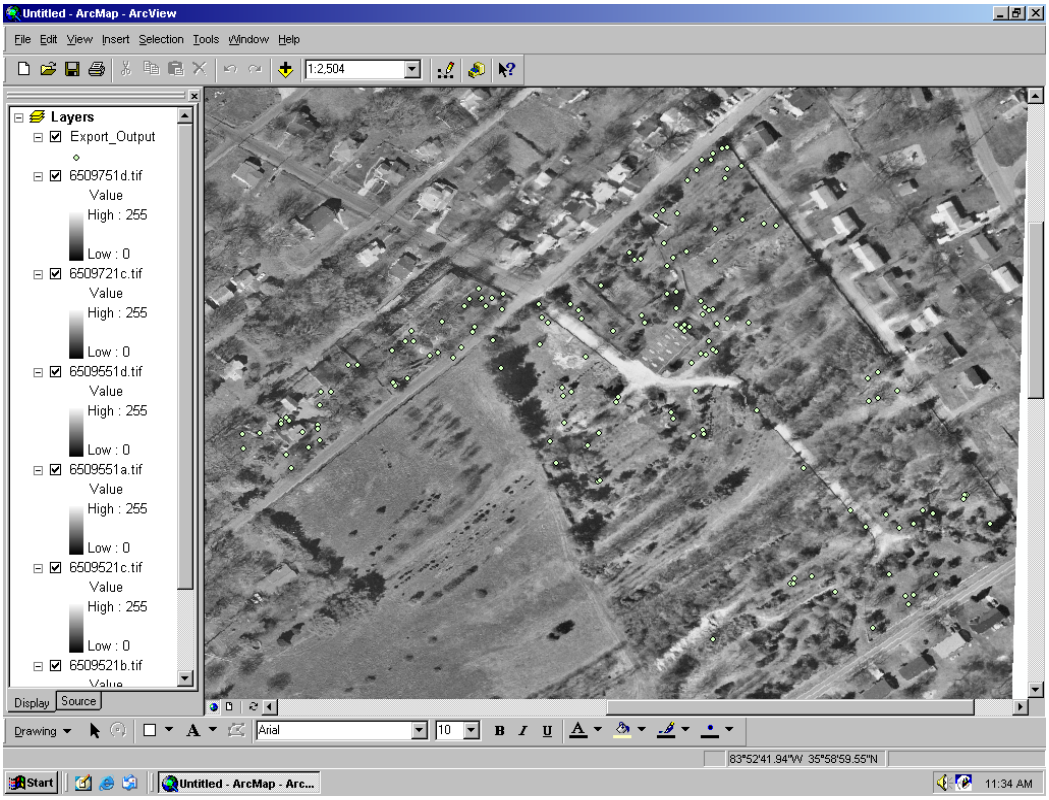

Figure 3.7 – Waypoints over the Orthophoto

5. Next, click the "add data" button to open the accessions table made in MS Access in ArcMap in ArcGIS.
6. Now, you want to join the shape file that contains the ID, latitude, and longitude with the accessions table.
7. Right click on the layer "Export-Output" in the Table of Content window on the left side of the screen. Select join tables and join the Export_Output ID with Accessions ID.
8. Refer to Figure 3.8 to see how to two tables joined appears. The Export-Output ID matches with the Accessions ID, so the two tables can work together to query information spatially.

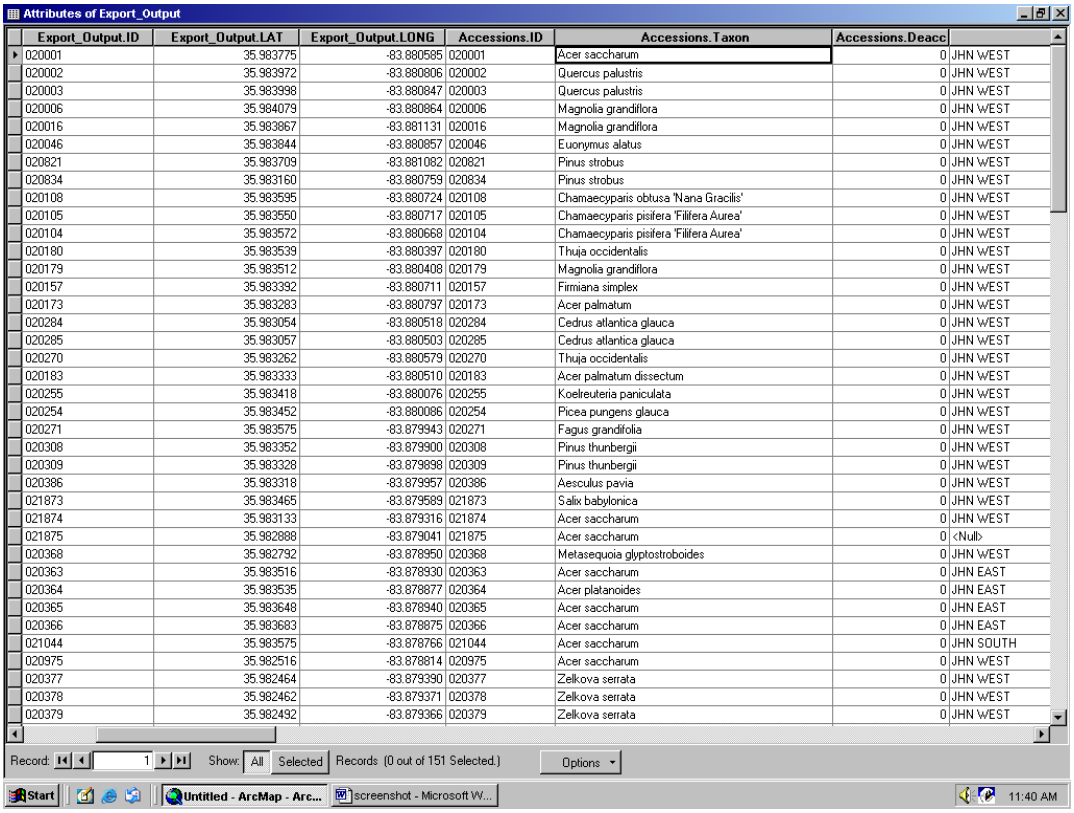

Figure 3.8 – Table Join in ArcMap in ArcGIS

9. To demonstrate how this works, I will write a query, asking where are all of the *Taxodium distichum* are located.
10. Click the "Selection" drop down menu and "Make Selection by Attributes."
11. Use the Wizard to help walk you through the process.
12. The image below shows the location of *Taxodium distichum* by highlighting all the plants in blue.

Refer to Figure 3.9 to see how you can write queries in MS Access or ArcMap in ArcGIS. The advantage of running queries in ArcMap is that the data can now be analyzed spatially. As more plants are identified by their GPS coordinates, they can be

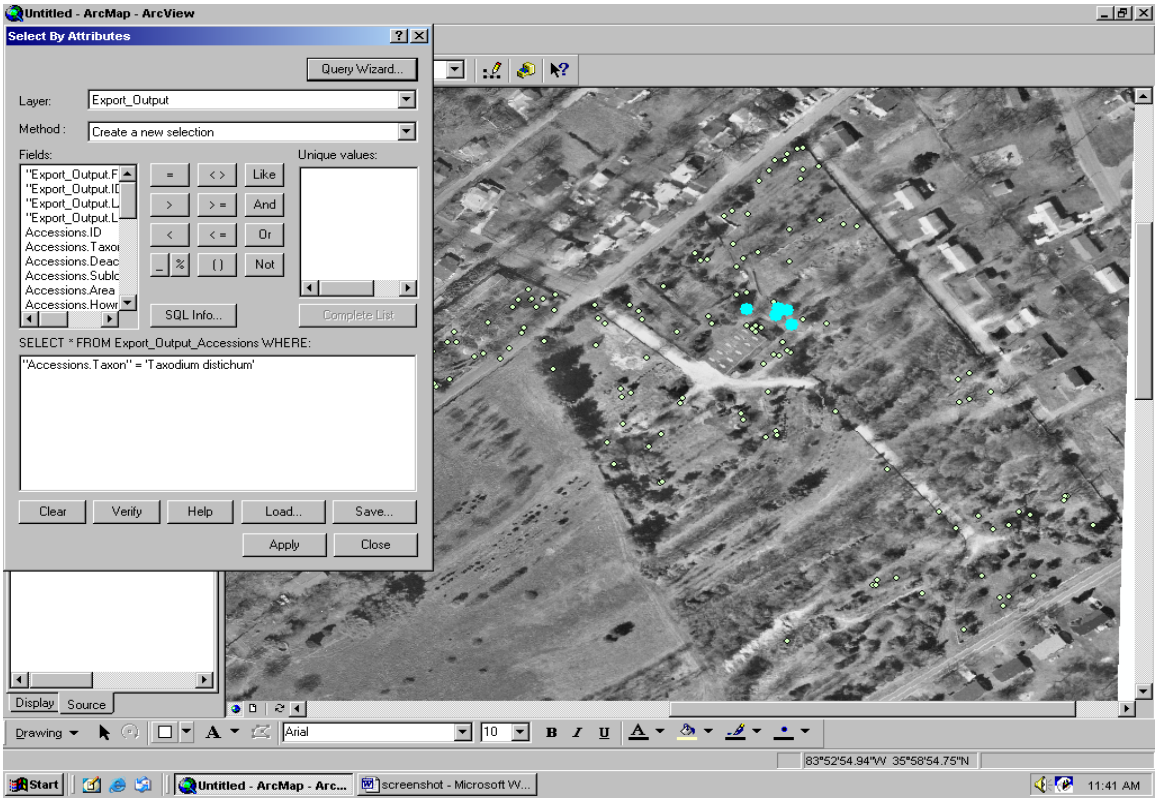

Figure 3.9 – Spatial Query in ArcMap

added to the table that was created to make the shape file or a new shape file can be added and joined with the accessions table from MS Access.

In summary, these are the materials and methods used. I collected data in the field and recorded it in a notebook and tagged each plant in the collection with an accession number and the botanical name. Next, I created a relational database in MS Access and entered the data. Then, I collected the GPS coordinates for significant trees in the field measured in decimal degrees with a GPS receiver. I brought the GPS points into ArcMap in ArcGIS and overlaid them on the orthophoto. I saved the points as a shape file. The table with the plant ID, Latitude, and Longitude were joined with the Accessions table in MS Access with no special script or connection being used. Now, numerous types of queries can be written and the answers will be highlighted over the orthophoto.

CHAPTER 4

FINDINGS AND DISCUSSION

After developing the database and entering the data, I was able to run some queries to determine specific information about the Knoxville Botanical Gardens and Arboreta's living plant collection.

For the scope of this study, I was able to determine that there are approximately 2,000 unique accessions. There are plants representing 43 families from 4 different continents. There are currently 216 different varieties of woody plant material including trees and shrubs.

One of the core values stated by KBGA is a strong use of native plants from North America. I wanted to see how the variety of plants broke down in terms of their native range. It was determined that 102 of 216 varieties come from Asia making up 47% of the collection. Plants native to North America were the next most abundant with 70 varieties represented, making up 32% of the collection. There are 19 varieties of garden hybrids making up 9% of the collection. There are 12 varieties of plants native to Europe and 12 varieties of plants with a wide native range that include more than one continent, each making up 6% of the collection. There was one variety native to Africa.

All of the plants in the collection were not recorded by their GPS coordinates. In order to give a general location for a plant, the property was divided into sublocations and areas. The property is physically divided by walls in most cases, and I used these barriers to define where plants are located. Refer to the drawing in the Appendix with the areas

defined below. I will describe the area by plants' botanical name, how many plants are in that area and if they are considered native to North America.

JHN WEST – Upper

JHN WEST – Upper is the flat area at the top of the hill, bordering Wimpole Ave. and across from the Plot Barn. This area is relatively weed-free with several transplantable size plants. There are a few specimen size *Magnolias, Pinus strobus, Quercus, Thuja occidentalis,* and *Chamaecyparis*.

Botanical Name – Plant Count

Native

Acer rubrum - 1
Acer saccharum - 2
Aesculus pavia - 9
Amelanchier arborea - 2
Celtis occidentalis - 3
Cercis canadensis - 1
Cercis canadensis 'Alba' - 1
Cercis canadensis 'Forest Pansy' - 3
Cladrastis kentuckea - 14
Clethra alnifolia 'Pink Spires' - 1
Cornus florida - 9
Magnolia grandiflora - 18
Picea pungens glauca - 1
Pinus strobus - 13
Quercus palustris - 2
Querus prinus - 2
Thuja occidentalis - 1
Tilia cordata - 9

Exotic

Acer griseum - 1
Acer palmatum - 20
Betula pendula 'Purpurea' - 2
Betula platyphylla japonica 'Whitespire' - 8
Buxus microphylla koreana - 5
Buxus sempervirens 'Vardar Valley' - 4

Chamaecyparis obtusa ‘Nana Gracilis’ - 1
Chamaecyparis pisifera ‘Filifera Aurea’ - 3
Chionanthus retusus - 2
Cotinus coggygria ‘Royal Purple’ - 3
Euonymus alatus - 1
Fagus sylvatica ‘Atropunica’ - 4
Fagus sylvatica ‘Pendula’ - 1
Firmiana simplex - 5
Ginkgo biloba - 4
Ginkgo biloba ‘Autumn Gold’ -1
Koelreuteria paniculata - 1
Lagerstroemia indica - 8
Lagerstroemia indica ‘Natchez’ - 4
Morus alba 'Chaparral' - 2
Parrotia persica - 4
Prunus subhirtella pendula ‘Pendula Plena Rosea’ - 10
Ulmus carpinifolia 'Cornubiensis' - 1
Vitex agnus-castus - 1

Garden Hybrids

X Cuppressocyparis leylandii - 2
Ilex x attenuata ‘Fosteri’ - 3
Ilex x ‘Nellie R. Stevens’ - 1
Laburnum x watereri ‘Vossii’ - 10
Malus x ‘Prairefire’ - 2
Viburnum x burkwoodii ‘Chenaultii’ - 1

Of the 48 varieties in this area, 18 are native, 24 are exotic, and 6 are garden hybrids. Of the 207 plants in this area 92 are native, and 115 are exotic or hybrids. There is a slightly higher concentration of exotic species and a higher plant count of exotic species.

JHN WEST – Middle 1

JHN WEST – Middle 1 is a gradually sloping area towards the top of the hill on the western border of the former Joe N. Howell Nursery. There are 36 varieties of plants in this area:

Native

Acer rubrum - 4

Acer saccharum - 32
Aesculus pavia - 1
Betula nigra - 9
Cornus florida - 22
Fagus grandifolia - 1
Gymnocladus dioicus - 1
Magnolia grandiflora - 4
Magnolia grandiflora 'Little Gem' - 1
Picea abies - 1
Picea pungens glauca - 4
Picea pungens glauca 'Fat Albert' - 16
Pinus strobus - 5
Quercus alba - 1
Quercus palustris - 1
Ouercus phellos - 1
Thuja occidentalis - 2

Exotic

Acer ginnala - 1
Acer griseum - 1
Acer palmatum - 10
Acer palmatum dissectum - 1
Acer platanoides 'Crimson King' - 3
Cedrus atlantica glauca - 3
Chaenomeles speciosa - 3
Cornus kousa - 6
Crataegus laevigata 'Crimson Cloud' - 1
Juniperus chinesis - 2
Koelreuteria paniculata - 1
Lagerstroemia indica - 1
Nandina domestica - 3
Pinus densiflora -1
Pinus thunbergii - 3
Prunus persica - 4
Syringa x persica - 2
Taxus cuspidata - 3

There are 18 native varieties and 18 exotic varieties; of the 165 plants in this area, 116 are native and 49 are exotic. While there is equal number of native and exotic species, there is a higher concentration of native plant material in this area.

JHN WEST - Middle 2

JHN WEST - Middle 2 is located between the two trench lines in the middle of the nursery. There is a well located in this area. Part of this area is still too overgrown to identify, but includes species such as: *Cornus florida, Cornus florida rubra, Malus* x *cvs., Viburnum rhytidophyllum, Koelreuteria paniculata, Forsythia* x *intermedia,* and *Betula nigra*. Plants that have been tagged in this area since March 2003 include:

Native

Cornus florida - 45
Magnolia grandiflora - 4
Magnolia grandiflora 'Little Gem' - 1
Picea glauca albertiana 'Conica' - 10

Exotic

Acer griseum - 1
Koelreuteria paniculata - 10
Pinus thunbergii – 2

JHN WEST - Middle 3

JHN WEST Middle 3 consists of a large number of 3" caliper oak trees. However, half of this area is too overgrown to tag at this time. In addition to the plant list below, other plants in this area include: *Cercis canadensis, Pyrus calleryana*, and more *Acer saccharum* and *Pinus strobus*. This is the plant list as of the plants that can be reached by March 2003:

Acer saccharum - 3
Chamaecyparis pisifera 'Filifera Aurea' - 1
Magnolia grandiflora - 11
Pinus strobus - 2
Quercus alba - 1
Quercus coccinea - 8
Quercus hemisphaerica 'Darlington' - 16
Quercus macrocarpa - 2

Ouercus phellos - 25
Ouercus prinus - 7
Quercus velutina - 3
Salix babylonica - 1

JHN WEST - Lower 1

JHN WEST Lower 1 is completely overgrown and virtually impassible. There are *Castanea, Quercus acutissima, Acer palmatum, Metasequoia glyptostroboides, Magnolia grandiflora, Prunus serrulata* 'Kwanzan'*, Prunus subhirtella, Chaenomeles speciosa, Cornus florida, Thuja occidentalis, Fagus grandifolia, Quercus robur, Viburnum rhytidophyllum* and possibly a few more plants of interest.

JHN WEST – Lower 2

JHN WEST – Lower 2 is a relatively flat, heavily shaded area near Boyds Bridge Pike. There are 13 varieties of plants:

Native

Acer saccharum - 6
Amerlancheir arborea - 1
Celtis occidentalis - 1
Gleditsia triacanthos inermis - 9
Gymnocladus dioicus - 1
Ilex opaca - 1
Magnolia grandiflora - 3

Exotic

Acer platanoides 'Crimson King' - 7
Chamaecyparis pisifera 'Filifera Aurea'- 1
Crataegus laevigata 'Crimson Cloud' - 5
Malus x cvs. - 7
Pyrus calleryana - 6
Zelkova serrata - 4

7 out of 13 of these plants are native to North America of these 52 plants 22 are native, there is a higher concentration of exotic plant material.

JHN CENTER - Area 1

JHN CENTER - Area 1 is on the north side of the Plot barn and is bordered by Wimpole Ave and the driveway that cuts through the nursery. There is a perennial border, and 4 square nursery stock areas marked off with railroad ties. Square 1 contains about 60 *Nandina domestica* 'Harbor Dwarf' that could be transplanted. Square 2 contains about 20 *Chamaecyparis pisifera* 'Filifera' that may be transplanted. Square 3 contains about 40 *Danae racemosa* that could be transplanted. Square 4 contains *Pinus strobus* 'Pendula', *Buxus microphylla, Chamaecyparis obtusa* 'Nana Gracilis'

Native

Acer saccharum - 5
Ilex opaca - 2
Magnolia grandiflora - 2
Quercus palustris - 2
Tsuga canadensis pendula 'Sargentii'-1

Exotic

Acer palmatum atropurpureum - 1
Acer platanoides - 1
Buxus sempervirens - 2
Chamaecyparis pisifera 'Squarrosa Cyano-viridis'- 2
Cunninghamia lanceolata 'Glauca' - 2
Lagerstroemia indica – 1

JHN CENTER – Area 2

JHN CENTER – Area 2 is bordered by 6' tall stone walls on 2 sides with Wimpole Ave. on the North side and the Plot Barn on the south side.

Native

Acer saccharum - 1
Cornus florida - 3
Ilex opaca - 2
Magnolia grandiflora - 5

Exotic

Acer platanoides - 2
Aesculus x carnea - 8
Betula platyphylla japonica 'Whitespire' - 47
Buxus microphylla koreana - 3
Chamaecyparis obtusa - 3
Cryptomeria japonica - 1
X Cuppressocyparis leylandii - 2
Euonymus kiautschovicus 'Manhattan' - 2
Magnolia stellata - 2
Pyrus calleryana - 1
Viburnum setigerum - 4

JHN CENTER – Area 3

JHN CENTER – Area 3 is located northeast to the plot barn, has a 6' tall stone wall on the west side, Wimpole Ave. to the north and is cut by a road on the east and south. Most of the plants in this area may be too large to transplant with exception of some *Ilex* species.

Native

Acer saccharum - 1
Cornus florida - 1
Magnolia grandiflora - 10
Quercus stellata - 1
Thuja occidentalis - 1

Exotic

Acer palmatum - 9
Buxus microphylla - 1
Buxus sempervirens - 1
Cedrus atlantica glauca - 1
Corylus avellana 'Contorta' - 1
Ilex aquifolium – 6
Ilex x *attenuata* 'Fosteri' - 5
Ilex cornuta - 4
Ilex cornuta 'Burfordi' - 1
Ilex x 'Nellie R. Stevens' - 2

Malus x ‘Snowcloud’ – 8
Photinia x *fraseri* - 1
Picea abies ‘Nidiformis’ - 2

Of the 18 varieties of plants in this area 5 are native and 13 are exotic. Of the 56 plants in this area 14 are native and 42 are exotic.

JHN CENTER – Plot Barn

JHN CENTER – Plot Barn includes the space surrounding the plot barn, but not contained by the stonewalls. Most of the plants in this area are mature size and will not be transplanted.

Native

Acer saccharum - 5
Celtis occidentalis - 2
Ilex vomitoria - 1
Magnolia grandiflora - 3
Picea glauca - 2
Picea pungens glauca - 1
Quercus phellos - 1
Taxodium distichum - 5
Thuja occidentalis - 1
Ulmus americana - 1

Exotic

Buxus sempervirens - 1
Cephalotaxus harringtonia - 2
X *Cupressocyparis leylandii* - 1
Cuppressus sempervirens - 3
Picea abies - 1
Picea abies pendula - 5
Pinus densiflora - 1

Of the 17 varieties of plants in this area 10 are native and 7 are exotic. Of the 36 plants in this area 22 are native and 14 are exotic.

JHN EAST – Upper 1

JHN EAST – Upper 1 is located in the upper northeast corner of the Joe N. Howell Nursery, bordering Wimpole Ave. and Paris St. This area is surrounded by stone walls on 3 sides and is predominated by large trees, probably too large to be transplanted.

Native

Acer rubrum - 6
Acer rubrum 'October Glory' - 1
Acer saccharinum - 2
Acer saccharum - 22
Aesculus flava - 3
Celtis occidentalis - 1
Gymnocladus dioicus - 1
Juglans nigra - 1
Magnolia grandiflora - 6

Exotic

Acer platanoides - 7
Acer platanoides 'Oregon Pride' - 7
Chamaecyparis obtusa 'Nana Gracilis' - 1
Cornus alba - 1
Malus x cvs. - 1
Malus x 'Prairiefire' - 2
Prunus serrulata 'Kwanzan'- 4
Pyrus calleryana 'Redspire'- 8
Sophora japonica - 2
Taxus x *media* - 2

Of the 19 different varieties, 9 are native, and 10 are exotic. Of the78 plants in this area, 43 are native and 35 are exotic.

JHN EAST – Upper 2

JHN EAST – Upper 2 has a large number of young, easily transplantable plant material. It is surrounded by walls on 2 sides, one on the exterior and one along the border of JHN EAST –upper 1 area.

Native

Acer rubrum - 20
Acer rubrum 'October Glory' - 10
Acer saccharum - 7
Acer saccharum 'Green Mountain' - 16
Crataegus viridis 'Winter King' - 6
Gleditsia triacanthos inermis - 2
Hamamelis virginiana - 1
Ilex verticillata - 5
Magnolia grandiflora - 11
Quercus palustris - 1
Tilia cordata - 2

Exotic

Callicarpa dichotoma - 5
Callicarpa japonica 'Leucocarpa' - 1
Fagus sylvatica 'Pendula' - 1
Ilex x 'Nellie R. Stevens' - 4
Magnolia stellata - 4
Malus x 'Prairefire' - 8
Prunus serrualata 'Kwanzan' - 9
Pyrus callerana 'Aristocrat' - 5
Viburnum carlesii - 6
Zelkova serrata - 2
Zelkova serrata 'Green Vase' - 10

Of the 22 varieties of plants in this area, 11 are native and 11 are exotic. Of the 136 plants in this area, 81 are native and 55 are exotic.

JHN EAST – Middle 1

JHN EAST – Middle 1 includes plants between the wall post down to the heavily overgrown Sweetgum area. Most of the trees appear to be 10-15 years old nursery stock, which may or may not be able to transplant.

Native

Acer rubrum - 28
Acer saccharum - 3
Cercis canadensis - 5

Fraxinus americana ‘Autumn Applause’ - 7
Ilex opaca - 1
Juniperus communis - 1
Liquidambar styraciflua - 2
Liriodendron tulipifera - 1
Magnolia grandiflora - 4
Pinus strobus - 11
Quercus coccinea - 3
Quercus phellos - 8
Taxodium distichum - 9

Exotic

Acer platanoides - 10
Fagus sylvatica - 1
Fagus sylvatica ‘Atropunicea’ - 1
Magnolia x *loebneri* - 3
Malus x cvs - 14
Nandina domestica - 6
Pinus thunbergii -13
Prunus cerasifera ‘Atropurpurea’ - 3
Prunus serrulata ‘Kwanzan’ - 15
Prunus subhirtella pendula - 5
Pyrus calleryana - 8
Viburnum rhytidophyllum - 1
Of the 25 varieties of plants, 13 are native and 12 are exotic. Of the 163 plants, 83 are native, and 80 are exotic.

JHN EAST – Middle 2

JHN EAST – Middle 2 consists of predominantly very tall, overgrown Sweetgums. It is surrounded by walls on 2 sides – the exterior wall and a border between JHN EAST – Middle 3.

JHN EAST – Middle 3

JHN EAST – Middle 3 would be described as an open field with a few, very large Maple specimens. There are stonewalls on 2 sides, but there is no exterior wall, only a chain-link fence along the property border.

Native

Acer saccharum – 5

Exotic

Acer platanoides – 1

JHN SOUTH – East Wing

JHN SOUTH – East Wing is located on the East side of the nursery bordering Paris St. and area JHN EAST – middle 3. Half of this area is still over grown but contains plants such as *Cercidiphyllum japonicum*, *Ginkgo biloba* 'Fastigiata', *Nyssa sylvatica*, *Quercus robur* and others from the list below.

Native

Acer saccharum - 9
Ilex opaca - 3
Juniperus communis - 1
Magnolia grandiflora - 6
Pinus strobus - 2
Pseudotsuga menziesii - 5
Quercus falcata - 1
Quercus palustris - 1
Quercus rubra - 3
Quercus velutina -1

Exotic

Ginkgo biloba - 1
Taxus cuspidata - 2

Because this area has not been completely inventoried, it would be unfair to do any type of analysis.

JHN SOUTH – Crescent

JHN SOUTH – Crescent is located at the bottom of the nursery facing Boyd's Bridge Pike. There is a burned-out shed at the crest of this area. It includes mostly large specimen trees.

Native

Acer saccharum - 4
Aesculus pavia - 10
Betula nigra - 5
Cercis canadensis - 2
Magnolia grandiflora - 4
Picea pungens glauca - 2
Quercus hemisphaerica 'Darlington' - 1
Thuja occidentalis - 2
Tsuga caroliniana - 1

Exotic

Acer platanoides - 5
Cephalotaxus harringtonia -1
Chamaecyparis pisifera 'Filifera Aurea' - 2
Koelreuteria paniculata - 1
Magnolia x *soulangiana* - 2
Malus x *cvs.* - 2
Taxus baccata - 8
Taxus x *media* - 1
Viburnum plicatum - 2
Viburnum rhytidophyllum - 1

Of the 19 varieties of plants in this area 9 are native and 10 are exotic. Of the 56 plants in the area 31 are native and 25 are exotic.

JHN SOUTH – West Wing

JHN SOUTH – West Wing is a bit overgrown, so not all the plants have been inventoried at this time. It contains species such as *Prunus subhirtella pendula, Picea*

abies, Taxus x *media, Pinus strobus, Magnolia grandflora, Tilia cordata, Crataegus laevigata, Betula nigra, Acer saccharum,* and *Tsuga canadensis*.

Native

Salix babylonica - 1
Taxodium distichum - 5

Exotic

Cunninghamia lanceolata 'Glauca' - 1

JHN HOUSE – East Terrace

JHN HOUSE – East Terrace is the terraced area behind greenhouse 3 and the red garage. It is surrounded by walls on 4 sides and has access by a side passage next to the red garage.

Native

Aesculus parviflora - 1
Aesculus pavia - 2
Celtis occidentalis - 1
Cornus florida - 1

Exotic

Danae racemosa - 1
Ficus carica - 1

Of the 6 plant varieties in this area 4 are native and 2 are exotic.

JHN HOUSE – East Well

JHN HOUSE – East Well is the curved area between the stock beds and the driveway. This area includes the remains of an old wishing well.

Native

Acer saccharum - 1
Celtis occidentalis - 1

Cornus florida - 5
Gymnocladus dioicus - 4
Magnolia grandiflora - 1
Pinus echinata - 1
Pinus virginiana - 1

Exotic

Acer platanoides - 1
Mahonia bealei - 9
Rhododendron cv. - 10

Of the 10 varieties of plants in this area, 7 are native and 3 are exotic. Of the 34 plants in this area, 14 are native and 20 are exotic.

JHN HOUSE – Drive

JHN HOUSE – Drive includes planting beds in the pea-gravel driveway.

Native

Cornus florida - 1
Magnolia virginiana - 1

Exotic

Acer palmatum dissectum - 1
Aucuba japonica 'Gold Spot' - 2
Aucuba japonica 'Rozannie' - 5
Aucuba japonica 'Variegata' - 4
Chamaecyparis obtusa 'Nana Gracilis' - 1
Firmiana simplex - 2
Mahonia bealei - 1
Sciadopitys verticillata - 1

Of the 10 varieties of plants in this area, 2 are native and 8 are exotic.

JHN HOUSE – East Lawn

JHN HOUSE – East Lawn includes the area between the driveway and sidewalk on the East end of the house.

Native

Cercis canadensis - 1
Cornus florida - 2
Ilex opaca - 1
Ilex vomitoria - 1
Quercus falcata - 1
Rhododendron catawbiense - 3

Exotic

Aucuba japonica - 15
Buxus microphylla - 1
Cephalataxus harringtonia - 1
Chamaecyparis obtusa 'Nana Gracilis' - 1
Ilex x 'Nellie R. Stevens' - 1
Mahonia bealei - 3
Nandina domestica - 6
Nandina domestica 'Aurea' - 12
Picea abies pendula - 1
Rhododendron cv. - 14
Taxus baccata - 1
Taxus x *media* - 1

Of the 18 varieties of plants, 6 are native and 12 are exotic. Of the 66 plants in the area, 9 are native and 57 are exotic.

JHN HOUSE – West Lawn

JHN HOUSE – West Lawn includes the front lawn area west of the side walk to the wall.

Native

Acer saccharum - 2
Aesculus parviflora - 1
Cornus florida - 1
Fagus grandifolia - 1
Hydrangea quercifolia - 4
Ilex opaca - 1
Ilex vomitoria - 1

Exotic

Acer palmatum - 2
Acer palmatum atropurpurea - 3
Aucuba japonica - 1
Berberis thunbergii atropurpurea 'Rose Glow' - 1
Cephalataxus harringtonia 'Fastigata' - 2
Danae racemosa - 9
Ilex crenata 'Helleri' - 2
Ilex cornuta 'Rotunda' - 5
Mahonia aquifolium - 13
Mahonia bealei - 5
Nandina domestica - 1
Pieris japonica - 1
Picea abies pendula - 1
Rhododendron cv. - 7
Taxus baccata - 1

Of the 22 varieties of plants in this area, 7 are native and 15 are exotic. Of the 65 plants in this area, 11 are native and 54 are exotic.

JHN HOUSE – West Terrace

JHN HOUSE – West Terrace includes the terraced patio area on the west side of the house.

Native

Aesculus parviflora - 2
Gymnocladus dioicus - 1
Ilex opaca - 1
Juglans nigra - 1
Liriodendron tulipifera - 2
Magnolia grandiflora - 2

Exotic

Aucuba japonica - 3
Buxus sempervirens - 1
Cephalotaxus harringtonia - 1
Danae racemosa - 1
Koelreuteria paniculata - 1
Loropetalum chinense - 1

Mahonia bealei - 3
Poncirus trifoliata - 3
Rhododendron cv. - 1
Taxus x *media* - 1
Viburnum rhytidophyllum - 1

Of the 17 varieties of plants in this area 6 are native and 11 are exotic. Of the 26 plants in this area 9 are native and 17 are exotic.

JHN HOUSE – Back Alley

JHN HOUSE – Back Alley includes the back alley behind the house. This area includes 3 exotic plants: *Rhododendron* cv., *Poncirus trifoliata*, and *Ilex* x 'Nellie R. Stevens'.

JHN DEMO – East Front

JHN DEMO – East Front is on the east side of the drive bordering Wimpole Ave. There are some exceptionally large *Quercus* and *Celtis* in this area, but most of the plants are still at a size that could be transplanted.

Native

Celtis occidentalis - 3
Cercis canadensis - 1
Cornus florida – 1
Ilex glabra - 3
Ilex opaca - 2
Ilex verticillata - 2
Quercus falcata - 2

Exotic

Aucuba japonica - 1
Buxus microphylla - 28
Buxus sempervirens - 7
Cedrus atlantica glauca - 1
Cephalotaxus harringtonia - 1
Cephalotaxus harringtonia 'Fastigiata' - 16
Chamaecyparis obtusa 'Crippsii' - 3

Cotoneaster adpressus -1
X *Cuppressocyparis leylandii* - 1
Hydrangea macrophylla - 2
Hydrangea paniculata 'Pee Gee' - 2
Ilex x *attenuata* 'Fosteri' - 1
Ilex cornuta - 1
Koelreuteria paniculata - 4
Lagerstroemia indica - 1
Mahonia bealei - 34
Prunus serrulata 'Amanogawa' - 1
Rhododendron cv. - 2
Spiraea x *bumalda* 'Anthony Waterer' - 6
Spiraea japonica 'Little Princess' - 7
Syringa laciniata - 1
Syringa pekinensis - 3
Taxus cuspidata - 6
Taxus x *media* - 2

Of the 31 varieties of plants in this area, 7 are native and 24 are exotic. Of the 145 plants in this area, 14 are native and 131 plants are exotic.

JHN DEMO – East Back

JHN DEMO – East Back is between the backdrop stone wall and Greenhouse 1 on the east side of the drive. It includes some large *Acer palmatum*, *Corylus avellana* 'Contorta' and *Quercus*.

Native

Acer saccharum - 1
Cornus florida - 1
Ilex opaca - 1
Itea virginica - 3
Picea glauca albertiana 'Conica' - 3
Quercus nigra - 1
Tsuga canadensis pendula 'Sargentii' - 1

Exotic

Acer palmatum - 1
Acer palmatum dissectum atropurpureum - 1

Acer palmatum dissectum ‘Viridis’ - 1
Acer palmatum atropurpureum - 8
Buxus microphylla - 1
Cephalotaxus harringtonia - 3
Cephalotaxus harrringtonia ‘Fastigiata’ - 12
Chamaecyparis obtusa - 3
Chamaecyparis obtusa ‘Nana Gracilis’ - 6
Chamaecyparis thyoides 'Ericoides' - 2
Fagus sylvatica ‘Atropunica’ - 1
Ilex x *attenuata* ‘Fosteri’ - 1
Ilex crenata ‘Helleri’ - 2
Ilex x ‘Nellie R. Stevens’ - 1
Koelreuteria paniculata - 1
Lagerstroemia indica - 1
Mahonia bealei - 5
Nandina domestica - 3
Nandina domestica ‘Firepower’ - 2
Picea abies - 1
Picea abies ‘Nidiformis’ - 1
Pinus mugo - 1
Prunus campanulata 'Okame' - 1
Prunus persica ‘Early Double Red’ - 1
Rhododendron cv. - 9
Sciadopitys verticillata - 3
Taxus x *media* - 3
Taxus cuspidata - 3
Viburnum carlesii - 1
Viburnum rhytidophyllum - 1

Of the 37 varieties of plants in this area, 7 are native and 30 are exotic. Of the 90 plants in this area, 11 are native and 79 are exotic.

JHN DEMO – West Front

JHN DEMO – West Front is the area west of the driveway adjacent to Wimpole Ave.

Native

Celtis occidentalis - 3
Pinus strobus - 1
Quercus hemisphaerica 'Darlington' - 1

Exotic

Acer ginnala ‘Red Rhapsody’ - 1
Aucuba japonica - 2
Berberis julianae - 1
Berberis thunbergii atropurpurea - 4
Cedrus atlantica glauca - 2
Chaenomeles speciosa ‘Texas Scarlet’ - 6
Chamaecyparis obtusa - 1
Chamaecyparis pisifera ‘Squarrosa Cyano-viridis’ - 18
Cunninghamia lanceolata ‘Glauca’ - 1
Fagus sylvatica ‘Pendula’ - 1
Lagerstroemia indica - 3
Mahonia bealei - 36
Nandina domestica - 12
Viburnum burkwoodii - 1
Viburnum carlesii - 1
Viburnum rhytidophyllum - 1

Of the 19 varieties of plants in this area 3 are native and 16 are exotic. Of the 96 plants, 5 are native and 91 are exotic.

JHN DEMO – West Back

JHN DEMO – West Back is the area west of the road, behind the wall from Wimpole Ave.

Native

Cornus florida - 1
Picea glauca albertiana 'Conica' - 1
Picea pungens glauca - 3

Exotic

Acer japonicum - 1
Acer palmatum - 2
Acer palmatum dissectum - 2
Buxus microphylla - 3
Camellia japonica - 1
Cedrus deodara - 1
Cephalotaxus harringtonia - 1
Cephalotaxus harringtonia ‘Fastigiata’ - 11

Chamaecyparis obtusa ‘Nana Gracilis’ - 4
Chamaecyparis pisifera ‘Filifera’ - 2
Corylus avellana ‘Contorta’ - 1
X *Cuppressocyparis leylandii* - 1
Danae racemosa - 6
Euonymus japonicus 'Latifolius Albomarginatus' - 2
Firmiana simplex - 1
Ilex aquifolium - 8
Ilex aquifolium 'Argenteomarginata' - 2
Ilex x *attenuata* ‘Fosteri’ - 3
Ilex cornuta ‘Burfordi’ - 2
Ilex crenata ‘Helleri’- 3
Ilex x ‘Nellie R. Stevens’ - 13
Loropetalum chinense - 1
Magnolia x *soulangiana* - 1
Nandina domestica - 6
Nandina domestica ‘Firepower’ - 1
Paeonia suffruticosa - 2
Picea abies ‘Nidiformis’ - 1
Pieris japonica - 5
Pinus thunbergii - 1
Rhododendron cv. - 26
Sciadopitys verticillata - 2
Taxus baccata - 2
Taxus x *media* - 2
Viburnum plicatum tomentosum - 1

Of the 37 varieties of plants in this area, 3 are native and 34 are exotic. Of the 126 plants in this are 5 are native and 121 are exotic.

As mentioned earlier, KBGA’s core values relate to the historic nature of the property and existing plant material, they have a distinct interest in native landscape plants and rare, exotic plants, and they demand a high level in the quality and appearance of the plant material. By describing what plants are located in each area, this should help guide the master plan with how they might develop gardens based on existing plant material.

The GPS coordinates taken for the trees thought to be significant for their size, rarity, or history will be helpful during the planning stage. The points appear to be fairly accurate, and should help the designer or architect when deciding where to develop gardens and put hardscapes. If KBGA continues to locate plants by their coordinates, they will eventually be able to create custom maps for their visitor to show where specific plants are located.

CHAPTER 5

CONCLUSIONS AND SUGGESTIONS

The question of what plants does the KBGA have, and where are these plants located will be constantly changing as plants die, are transplanted, or as new material is brought to the garden. However, the database I created supports the mission statement and can be maintained fairly inexpensively.

The design of the database is quite simple and should not require too much training for future plant recorders. The forms have a simple layout and are clearly marked for entering data. The use of the drop down menus in the Accessions form is a huge time saver, and helps maintain consistency in spelling and the names of the locations in the garden.

The board of directors must recognize the importance of their permanent living plant collection and make every attempt to keep records current and safe from damage by maintaining a current back-up system for the database.

As more property is acquired by KBGA and more property is cleared of weeds, someone with excellent plant identification skills will be required to verify the plant material, label the plants in the field with the scientific name and accession number, and add these new records to the database.

As stated in the introduction, KBGA would eventually like to pursue accreditation with the American Association of Museums and certification with the Tennessee Arboretum Certification Program. With the database and information within, KBGA has made a major step closer towards the criteria of maintaining adequate records about the

collection and is very close to 80% of the collection being accessioned. To take further steps toward the accreditation process, the information compiled in the database can be used to make interpretive labels with the botanical and common names for the visitor.

I hope that by publishing the steps taken in the process of creating a computerized, plant record system will help other botanical institutions. Whether the institution chooses to build their own database system or to purchase a ready-made version, this research study may help in making an informed decision about the types of software available for managing the information about their collection.

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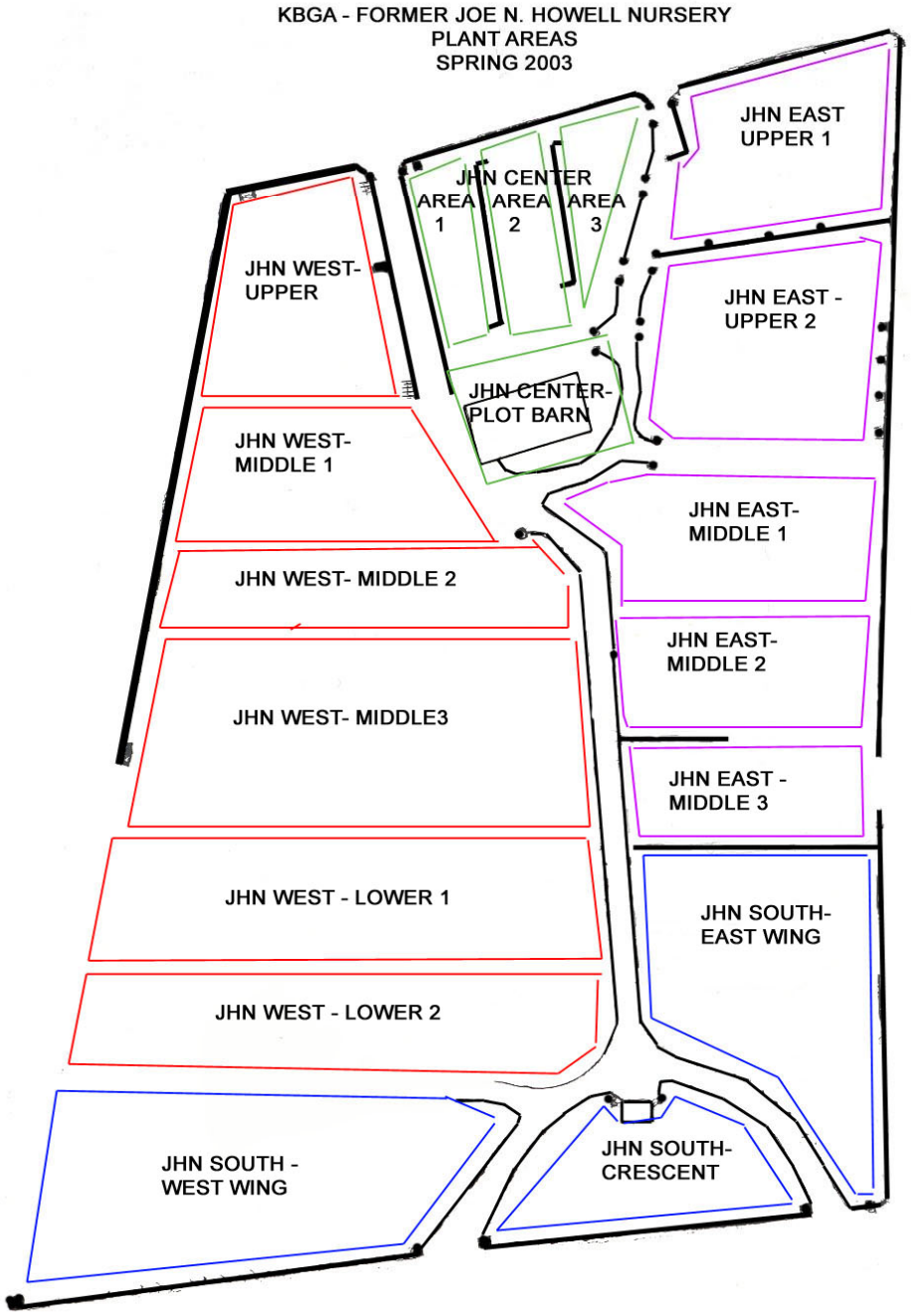
APPENDICES

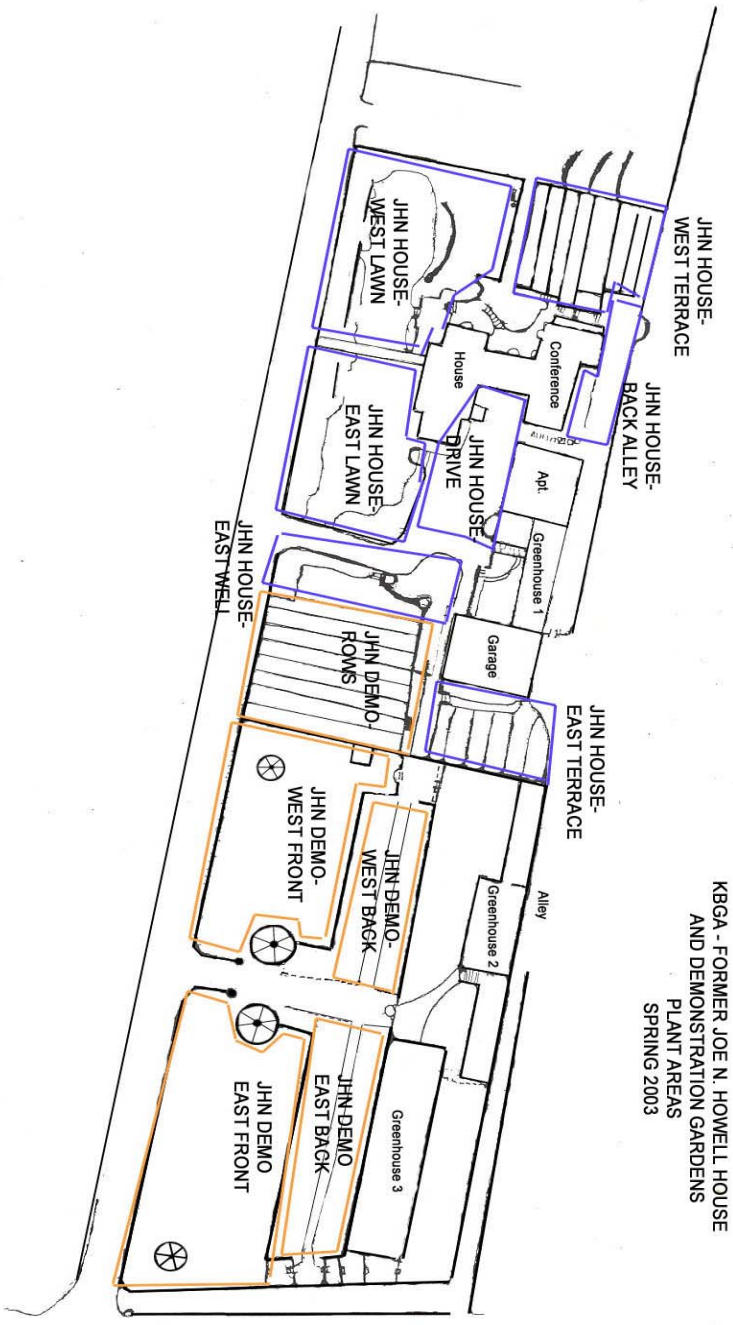
APPENDIX A

MAP OF THE FORMER JOE N. HOWELL NURSERY



APPENDIX B

MAP OF THE FORMER JOE N. HOWELL HOUSE AND DEMONSTRATION GARDENS



VITA

Kathryn Terese Steinhoff was born in Knoxville, TN on June 5, 1979. Being raised in the valley between the Southern Appalachian Mountains and the Cumberland Plateau, one of the most diverse places of species in North America, was very instrumental for developing her interest in plants.

Kathryn entered the Ornamental Horticulture and Landscape Design program at the University of Tennessee in Fall 1997 and graduated with her B.S. in Spring 2001. She decided to continue her education and enrolled in the Masters' program in Ornamental Horticulture and Landscape Design in Fall 2001. During her time at the University of Tennessee, she has had outstanding horticultural experiences and hopes to find full-time employment with a botanical institution in plant collection development or education.