WHAT'S IN YOUR GARDEN? ASSESSING THE "ECO-FRIENDLINESS" OF PLANT CHOICES OF DENTON, TEXAS GARDENERS

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Urbanization is seen as a threat to biodiversity within urban ecosystems, which are largely reliant on humans for their composition. Two types of extremes exist in the spectrum of urban domestic gardens; on one end, the typical urban garden which is planted by landscapers at the time the house is built and is generally left unchanged, and, at the other, a "wild" landscape planted entirely with native plants which provides habitat for native fauna and pollinators. This study assesses the plant choices made by members of organized gardening groups-the Denton County Master Gardeners (DCMG), the Elm Fork Master Naturalists (EFMN), the Trinity Forks Native Plant Society (TFNPS), and Keep Denton Beautiful (KDB)-and toward which extreme these choices put these gardens on the psectrum. TFNPS and EFMN both fall closer to the wild garden extreme, with TFNPS the closest to a "wild garden." DCMG was almost directly between the two extremes, but fell closer to the typical urban garden. By looking at how these groups manage their gardens, we begin to understand the ways in which gardeners can mitigate and soften the harsh changes between wild landscapes and urban environments. Collaboration between groups could have the potential to encourage more people to use native plants which provide habitat for native fauna and pollinators if those in the typical urban garden spectrum could find in the "wild" gardens of those on the opposite end of the spectrum.

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CHAPTER 1

INTRODUCTION AND BACKGROUND INTRODUCTION

Urbanization has been called one of the greatest threats to biodiversity in the modern age (Lerman and Warren 2010). Yet urban ecosystems have been shown to have a great capacity for supporting and maintaining high levels of biodiversity, sometimes even more diverse than their wild or semi-wild counterparts (Goddard et al. 2009; Vergnes et al. 2011). Still, urban ecosystems are unlike their correlating natural spaces. The urban landscape is a complex socio-ecological system formed by a number of competing anthropogenic forces (Daniels and Kirkpatrick 2006; Goddard et al. 2013; Savard 1999; Vergnes et al. 2011). As urbanization continues to grow in intensity around the world, shifts in ideology about composition and uses of green space in cities is shaping how humans approach the idea of green space maintenance in general (Freeman et al. 2012). The post-modern urban landscape has moved away from the "control and exploit" paradigm (Freeman et al. 2012) and towards a relationship which includes human beings as part of nature, rather than outside of it. Gardening allows humans to enter into a relationship with nature that is complex and challenging, wherein humans seek to commodify and shape green space, often towards specific species like birds or butterflies, which are pleasing to people (Freeman et al. 2012). These relationships are rarely static, and constantly evolve based on cultural perceptions and land-use requirements (Freeman et al. 2012).

Within these relationships, the product of human intervention on the urban landscape has important implications for biodiversity in urban green space (Kermath 2007). The composition, configuration and management of domestic gardens has an enormous impact on the overall biodiversity of an urban ecosystem (Goddard et al. 2013; Smith et al. 2005), and are chiefly the products of decisions made by a small number of individuals for personal enjoyment, rather than

being focused at a large, diverse group of citizens or consumers, as would a municipal or commercial landscape. This aspect of individuality causes much diversification in the results of gardening activities, as one of the main components of gardening is that of personal expression and identity (Bhatti and Church 2004; Clayton 2007; Freeman et al. 2012; Kiesling et al. 2010). Making up such a significant portion of the urban landscape, these domestic gardens carry much potential for helping to increase the amount of wildlife-friendly and native-dominated habitats within the urban ecosystem (Van Heezik et al. 2012). In order to achieve this increase in available ecological services, homeowners and gardeners must have access to knowledge and products which will encourage them to participate in gardening activities which promote and sustain biodiversity (Van Heezik et al. 2012).

Despite their size and potential to substantially affect the urban ecosystem, these domestic gardens remain largely unstudied in the context of maintaining and promoting biodiversity (Cameron et al. 2012; Daniels and Kirkpatrick 2006; Davies et al. 2008; Goddard et al. 2009; Goddard et al. 2013; Kowarik 2011; Mathiu et al. 2006; Smith et al. 2005; Vergnes et al. 2011). Most of the research to date has focused on the nature/wildlife or leisure/culture binary (Freeman et al. 2012) and most often from the social science or natural science viewpoint, and few have focused directly on composition (Smith et al. 2005).

Domestic gardens generally fit into two extremes; a typical urban garden which contains plants that were planted by landscapers at the time the house was built and remains largely unchanged and a “wild” landscape in which all available growing space is planted with native plants that provide habitat for native fauna and pollinators. This study aims to discover how the plant choices of urban domestic gardeners fall on this spectrum and thus mitigates the sometimes harsh changes between a wild area and an urban environment.

Urban Landscapes and Domestic Gardens

The nature of the urban landscape is unique, created by fragmented and isolated islands of vegetation. This fragmentation has a dramatic effect on the overall structure of urban landscapes as it limits the availability of resources, creating unique selection pressures on urban organisms (Lundholm 2006; Vergnes et al. 2011). Fragmentation limits the dispersal of species in the urban ecosystem and composition is largely based on human intervention (Goddard et al. 2009; Vergnes et al. 2011). Anthropogenic manipulation is responsible for much of the appearance of the urban landscape (Goddard et al. 2013).

While the influence of the efforts of humans on urban green space is apparent in nearly all parts of the urban ecosystem, it is seen most intensively in the context of domestic gardens (Goddard et al. 2009). Accounting for up to 50% of the total green space in a city (Goddard et al. 2013), domestic gardens are a substantial part of the urban landscape and generally the most intensively managed. In the United States, more than 90 million homes have a domestic garden of some kind (Kiesling et al. 2010), totaling 69 million acres of land. Kiesling et al. (2010) identify conventional (orthodox) gardening methods as those which require frequent human intervention in the form of watering, fertilizing, and applications of pesticides. The general trend of American gardening is industrial (Kermath 2007), meaning that most Americans use some kind of chemical treatment when tending their gardens, including fertilizers and pesticides. Any big box store in the United States contains multiple chemical options for increasing production in domestic gardens, and most gardeners admit to using conventional gardening methods (Kiesling et al. 2010). Kermath (2007) estimates that more synthetic fertilizer is used on American lawns than India uses in its entire agricultural system. As a whole, the US spends more maintaining one acre of lawn than it does producing the same amount of corn (Kermath 2007). Over $75

million dollars are spent annually on pesticides, and it is estimated that ten times more pesticide is used on domestic grass than in agriculture (Kermath 2007). This kind of ideology towards gardening results in the idea that humans can grow any plant as long as they have access to the proper amendments (Kiesling et al. 2010). This is perhaps one of the main reasons that urban domestic gardens are the main producers of exotic and invasive species (Kermath 2007; Smith et al. 2005). Alien species account for anywhere between 66-70% of the total vegetation in domestic gardens (Kermath 2007; Smith et al. 2005). As composition plays an integral role in the kind of species pools an ecosystem can support (Smith et al. 2005), the overabundance of non-native flora is seen to have detrimental effects on the populations of native flora and fauna (Smith et al. 2005) as they cannot replace native species in regards to their functionality within a given ecosystem (Kowarik 2011). Many herbivores and nectarvores thrive better in the presence of native plants, as native flora often produce more abundant and potent resources than their exotic brethren (Daniels and Kirkpatrick 2006; French et al. 2004; Van Heezik et al. 2012).

Exotics are also tied to about half the endangered and threatened species in the world, owing to the ability of alien plants to genetically swamp closely related natives through hybridization (Kermath 2007). Social contagion is thought to have a cumulative effect on gardening, with keeping neighborhood standards and social identity accounting for some of the most prevalent reasons for maintaining a domestic garden (Clayton 2007; Hunter and Brown 2011; Kiesling et al. 2010). Hunter and Brown (2011) found that domestic gardens appeared most frequently in urban areas where residents could see their neighbor's domestic garden; the most intense clusters of domestic gardens appeared in areas where the nearest neighbors (within 91 meters) also had a domestic garden. Understanding the underlying values that lead to choices made in the modern domestic garden, both in the methods of gardening used and the plants

present in the garden, is a necessary step in determining the best ways to institute change within the gardening community (Van Heezik et al. 2012).

Despite the troubling figures mentioned above, domestic gardens have the potential to be bastions for native species, both flora and fauna, while also improving the biodiversity of the urban ecosystem and mitigating the adverse effects of urbanization (Daniels and Kirkpatrick 2011; de Ridder et al. 2004; Goddard et al. 2009; Mathieu et al. 2006; Savard 1999; Smith et al. 2005; Vergnes et al. 2011). Domestic gardens are often the main point of contact between humans and nature (Bhatti and Church 2004; Freeman et al. 2012; Gross and Lane 2007; Kiesling et al. 2010; Lerman and Warren 2010). This connection between humans and nature is highly personal and often a result of the individual's cultural history and self-identity (Clayton 2007; Kermath 2007; Mazumdar and Mazumdar 2012; Van Heezik et al. 2012). Clayton (2007), Freeman et al (2102), and Kiesling et al (2010) completed studies on motivations in gardening, identifying seven main themes: creative expression/personal identity, health promotion, production, skill-building and knowledge enhancement, connection to nature, social identity and expression of faith. Kiesling et al (2010) found that a growing number of gardeners self-identify as ecologically or environmentally pro-active in relation to their attitudes about gardening. Even in those individuals who self-identify as pro-environmental there is a noticeable gap between possessing environmental knowledge and awareness and demonstrating ecologically positive behaviors and practices in the domestic setting (Van Heezik et al. 2012). In Kiesling's study (2010), most domestic gardeners fell somewhere in between conventional and unorthodox or ecologically-focused gardening methods. Ecological gardening methods are those that lean towards sustainability and natural methods of production (Kiesling et al. 2010), including selecting plants which can grow within the parameters of the local environment and using

methods which conserve resources such as rainwater harvesting, avoidance of soil amendments or pesticides, increasing biodiversity, and minimizing the use of non-renewable resources like peat moss (Kiesling et al. 2010). Van Heezik et al (2012) found that lifestyle and aesthetics have a greater impact on gardening choices than ecology for most people. Similarly, they discovered a gap between possessing knowledge of environmentally friendly gardening practices and the application of that knowledge on domestic gardens (Van Heezik et al. 2012). Attitudes and belief systems have a significant impact on the choices made in home gardening (Clayton 2007; Van Heezik et al. 2012). In order to implement pro-environmental gardening practices into the behaviors of gardeners, it is necessary to add knowledge of the positive aspects of native and environmentally-friendly gardens to the belief systems of modern gardeners (Van Heezik et al. 2012). However, finding ways of doing so has proven challenging (Van Heezik et al. 2012). Few studies have directly sought to understand how to change the belief systems of people and facilitate tangible change within the gardening society (Daniels and Kirkpatrick 2011; Van Heezik et al. 2012). Clayton (2007) found that the internet, commercial garden centers, government entities and university horticulture groups, and libraries were the most common sources of gardening knowledge. Gross and Lane (2007) found that 22% of their respondents take ideas from the television when making choices relating to their gardens.

By observing individual gardens and the plant choices and methods used in those gardens, a baseline of what gardeners are doing in the Denton ecosystem can be created so that improvements can be made in the ways native and eco-friendly plants are encouraged and utilized in local domestic gardens. Few studies have looked directly at how lifestyle and personal ideology relate to the selection of gardening or nature related hobby groups and/or the selection of educational materials. If, as previous research suggests, gardeners seek ideas for

their gardens from outside sources, understanding what drives them to choose particular avenues of study or to join particular hobby groups could give insight into ways in which biodiversity and ecologically-friendly gardening methods can be both presented to interested hobby gardeners and subsequently translated into the domestic garden, thus closing the gap between possessing and implementing knowledge.

The Denton County Ecosystem

Denton County, located in North Central Texas, sits on the edge of two diverse ecological regions; the Blackland Prairie to the east and the East Cross Timbers to the west (TPWD 2016). The Texas Parks and Wildlife Department (TPWD) estimate that the East Cross Timbers region is one of the most fragmented vegetative regions in Texas. Characterized by acidic, sandy, or sandy loam soils, the Cross Timbers ecoregion has historically been dominated by tress including post oak, blackjack oak, cedar elm, hickory, mesquite and hawthorn (TPWD 2016). Clearing for tame-grass pastures and ranches changed much of the landscape in the twentieth century and rapid urbanization has made vast changes to the appearance of the region in modern times.

Growing vegetation and managing wildlife in this ecoregion is described as "challenging" by the TPWD, due to the inhospitable soils and widespread fragmentation (TPWD 2016). The Blackland prairie presents an entirely different landscape and potential for growing vegetation. Dominated by heavy, alkaline clay soils created from the abundance of chalk, limestone, shale, and marls, the Blackland Prairie is much more fertile than its Cross Timbers neighbor. Fragmentation in this ecoregion is characterized by the World Wildlife Foundation (WWF) as "extreme" (WWF 2016). Most of the fertile land is privately owned and only 4 hectacres in Denton County are currently under voluntary protection (WWF 2016).

Because both of these ecoregions and their environmental characteristics are present in the area, growing plants in the domestic garden can be a challenging experience, depending on what part of the city your garden lies. New construction has seen an uptick in the last 20 years (Clower and Henderson 2011), meaning that soil has been trucked in and put down on newly built lots, often poor soil that is low in the organic substances necessary to support plant life, and gardening in Denton, therefore, means using amendments.

Growth in both Denton County and the City of Denton has been skyrocketing in the past 40 years. The population of Denton County in 1970 was 75,633 (Denton County 2016). By 1980, it had jumped to 143,126, a change of 59.46%; in 1990, it had nearly doubled to 273,525 (91.11% change). While growth slowed somewhat in the early 21st century (432,976 in 2000 and 662,614 in 2010), Denton County is now the 9th most populated county in Texas (Denton County 2016) and shows no signs of stopping. Within the City of Denton, new business has contributed to the continued population growth. Attracting new corporate headquarters and large corporations such as Sally Beauty Company, Peterbilt Motors, Target, Fastenal, Tetrapak, and United Copper Industries and preparing to build new shopping centers like Unicorn Lake and Rayzor Ranch, Denton is quickly developing available land to accommodate an influx of new residents and businesses (Clower and Henderson 2011). Denton is also home to two state universities, Texas Woman's University (TWU) and the University of North Texas (UNT), the latter of which is the largest university in the Dallas/Ft. Worth region. Between 2000 and 2010, the population of Denton rose from 80,537 to 131,044, a change of more than 28%. In the last 5 years, the population has increased 18% to 131,044. This does not include the students of TWU and UNT who do not live in Denton full-time. Since the student population of both universities

tops 50,000, there are a considerable number of transient residents who have no permanent ties to their homes.

Study Group: Denton Hobby Gardeners

Within in Denton, Texas, there are several organized gardening groups who assist hobby gardeners in improving their knowledge of local environmental restoration and gardening through education and outreach. For the purposes of this study, "gardens" refers to any space immediately adjacent to a dwelling or space for which a single family is responsible for the upkeep and maintenance of said space, and where flora are regularly planted and tended. This may include what many Texans refer to as "yards," raised beds, containers, window boxes, or farmland. "Hobby gardener" (hereafter referred to as "gardeners") refers to any person whose gardening work is unpaid or casual, but who spends a dedicated amount of his or her free time on the upkeep and maintenance of a garden space, regularly does independent research on topic related to plant selection or growing plants, and/or participates in an organized gardening group. "Organized gardening group" includes any official (i.e. requires dues and has stated membership requirements which must be satisfied to participate) organization with a stated interest in environmental restoration or gardening. The Trinity Forks Native Plant Society (NPS) and Elm Fork Master Naturalists (EFMN) each advocate for the use of native plants in natural areas and domestic gardens as part of their education programs and promote the restoration of the local environment using native and ecologically friendly plants. The Denton County Master Gardener (DCMG) have a horticultural focus to their program, but also teach the use of organic gardening methods and use of native plants, although it is not their focus. Keep Denton Beautiful is a local program which, among other things, promotes the beautification of the City of Denton, including

environmental restoration in the form of gardening and native tree planting on both private and public land.

The Master Naturalists are a state sponsored group of volunteers organized by the Texas A&M Agrilife Extension Office who are interested in spreading conservation information to their local communities through presentations, demonstrations, and community service. In order to become a certified Master Naturalist, "trainees" must complete 40 hours of at-home classroom training which includes topics on forest management, flora, fauna, geology, archaeology, ecological concepts and urban systems (EFMN 2016). Continuing members must also complete 8 hours of advanced training and 40 hours of chapter approved community service each year to retain their certification. Members pay a fee of anywhere from $50-160 per year to remain active in their respective chapter. While not specifically focused on gardening, they provide knowledge base that can easily be translated into the domestic garden. Additionally, the group is very involved in the Lake Lewisville Education Learning Area (LLELA) which works to restore native Texas ecosystems (LLELA 2016), further exposing them to native plants which grow in the area.

The Native Plant Society was started in 1981 in Denton, Texas in order to conserve and promote the use of native plants in Texas. Annual dues are $35 for each member. Three levels of training certification are available to both members and non-members and include in their curriculum identifying native plants and invasive plants to avoid, designing with native plants, differences in soil types, the value of native plants, and understanding differences between sustainable and conventional development (Turnbull 2016). Completion of training courses is not required to begin or maintain a membership. While the group is not specifically related to gardening, they offer have a high level of personal training related to conservation and

management of natural resources in the state of Texas and are directly involved in disseminating ecological information to the general public.

Conversely, the Master Gardeners are specifically trained in methods relating to gardening in the home. Initial training requires an application and interview before being accepted into the training program. Classes are held in-person each Tuesday for seven hours from February to May, with topics including general botany, soil composition, lawn care, water conservation, vegetable and herb gardening, insects, and landscape horticulture. After passing a final exam, successful applicants are given the status of intern, during which time they must complete seventy hours of community service for their chapter. At the end of the internship, full membership is granted. Certified Master Gardeners must complete twelve hours of advanced training and twelve hours of community service in order to retain their active status (DCMG 2016).

Keep Denton Beautiful is a community organization focused on improving the aesthetic beauty of the City of Denton. They sponsor volunteer events that focus on keeping the neighborhoods and business of Denton clean and attractive for residents and visitors. Programs they organize include a tree planting, neighborhood and business cleaning, beautification projects, and youth programs. The organization sends out a monthly newsletter with information and activities and sponsors a tree giveaway which gives native trees free to charge to Denton residents (KDB 2016).

All of these groups have a vested interest in promoting the use of plants in the home environment, although with varying levels of focus on the ecological benefits. While KDB is mostly attuned to aesthetic beauty, the Master Naturalists, Native Plant Society, and Master Gardeners have a stronger focus on the biological and ecological aspects of the North Texas

ecosystem. Members of these groups have different ideologies and means of expressing their knowledge within the home environment. Assessing what kind of methods are used in plant selection and garden maintenance will show how these gardeners are mitigating the changes in land use between wild landscape areas and urban environments, thus increasing the habitat for native fauna and pollinators (and therefore its "eco-friendliness") and softening the transitions between urban and wild ecosystems.

In Chapter 2, we see how plants in gardens in the area in and around Denton, Texas are chosen and by what methods gardens are tended. As the study group consists of people who are most likely to make changes to their garden, thus changing the "typical" urban garden landscape into something different, we will see how each gardening group moves away from the "typical" urban garden and towards the "wild" garden landscape. "Wild" garden landscapes are considered to be "eco-friendly" in the sense that they provide habitat for native fauna and pollinators (food and shelter) and thus encourage the propagation of these species in the urban ecosystem. The closer a garden falls on the spectrum towards the "wild" garden end, the more eco-friendly it is considered to be.

In Chapter 3, I discuss the implication of the plant choices made by gardeners and where it puts them on the spectrum towards eco-friendliness. Other factors including soil, personal knowledge and philosophy, exposure to native plants, and water conservation are tied in to the overall results of Chapter 2 and suggest further research which could benefit the continued "softening" of the transition between wild and urban landscapes.

CHAPTER 2

METHODS AND RESULTS

Methods

Nineteen garden walks (i.e. walking through the garden space with a participant) were conducted in order to ascertain what kinds of plants are being planted in gardens in and around the city of Denton, Texas, as well as how these plants, and the associated gardening methods, are impacting our local environments. Walks lasted anywhere from 45 minutes to 2.5 hours and were conducted at homes located both in and around the city of Denton, Texas, including outlying areas of Pilot Point and Double Oak. All plants named during the garden walks were tallied and entered onto a master spreadsheet. Where possible, scientific names were located and plants were given one of six statuses: native, non-native, hybrid, exotic, spice, or unknown.

These categories were chosen based on use (in the case of food or spice), native range (in the case of native, non-native, exotic), or hybrid status. In the case where only a general name of the plant was given (i.e. "holly"), the genus was used to classify the plant into one of these categories; in these cases, some plants may be improperly categorized due to lack of identification by the gardener. "Native" in this case means inclusion on the Lady Bird Johnson Wildlife Center (LBJ 2016) list of native plants. "Non-native" refers to plants which do not appear on either of these lists but are native to other parts of the continental United States according to the Missouri Botanical Garden Website (MBG 2016a). "Hybrid" refers to any plant which has been hybridized, regardless of the status of the crossed plants. "Exotic" refers to any plant native to countries or states outside the continental US according to the Missouri Botanical Garden Plant Finder or Tropicos (MBG 2016b). "Food" indicates plants which are grown specifically for human consumption. "Spice" indicates a plant which is commonly used in

cooking but is not necessarily classified with other food plants. "Unknown" refers to plants which could not be identified with confidence as any of these categories, generally because they were referred to in a broad category (i.e. palm tree) for which a single genus could not be ascertained. Where varieties of the plant were not known by the gardeners, these plants fell into the category of "possible native," wherein a native variety of the plant exists but the plant present in the garden cannot be confirmed as the native variety with confidence; "possible hybrid" wherein it is possible the variety in the garden is a hybrid; and "possible non-native" meaning it is possible that the variety in the garden is a non-native. In the event that any of the websites used for identification indicated that the plant was invasive, the status of "exotic invasive" or "non-native invasive" were used. The total number of "native" and "possible native" plants in each garden was divided by the total number of plants appearing in each garden, giving a percentage of native plants per garden.

Plant lists were then evaluated for their potential to offer habitat (i.e. food and shelter) for native fauna or pollinators. The percentage of native plants and eco-friendly plants per garden are used as a metric for determining how likely a garden is to provide food and shelter for native pollinators, thus making it "eco-friendly," or contributing to the improvement of the native environment of Denton County. Plants were evaluated using plant characteristics listed in the Lady Bird Johnson lists of Special Collections, Texas Department of Wildlife website, Native Plant Information Network, and the Missouri Botanical Garden Plant Finder. Plants were categorized into "bee friendly," indicating that these plants offer food and shelter for bees; "butterfly nectar," indicating that butterflies use these plants to obtain nectar; "butterfly host," meaning these plants are suitable for butterfly larvae; "hummingbird nectar," indicating that hummingbirds are attracted to these plants; "insect nectar," which indicates the plant offers

nectar to a variety of insects; “food source,” which means that the plant offers food for native mammals; “bird friendly,” indicating the plant offers food and nesting materials for a variety of birds; “shelter,” meaning the plant provides either a place to live or nesting materials for a variety of fauna; “pollinator friendly,” meaning the plant attracts and offers nectar for a variety of pollinators; “moth nectar,” which indicates that moths are attracted to these plants; and “biological controls,” indicating that these plants attract native insects which feed on pest populations of insects. The total number of these plants appearing in each garden were divided by the total number of plants in each garden to obtain a percentage of “eco-friendly” plants per garden.

Interview transcripts were reviewed to create a picture of each study group’s ideologies and methods in the garden, plant selection process, amendments, feelings towards native fauna and other animals, provision of ground cover and water for native fauna, and avenues used to research gardening questions were reviewed for relevant themes. Keywords were created to highlight important themes which were present within and between groups of participants.

Gardeners were randomly selected through emails distributed to all current (at the time of the study) members of the Denton County Master Gardeners, Elm Fork Master Naturalists, Trinity Forks Native Plant Society, and Keep Denton Beautiful. Gardeners were self-selected to participate in the study in response to those emails by directly contacting the author.

Additionally, two subjects were recruited through an article in the Denton Record Chronicle about the research project. Given that there were a small number of responses per group, all those who contacted the author prior to August 1, 2015 were evaluated as part of the study (21 in total). Two participants’ data were excluded due to the fact that they did not know the majority of the plants in their gardens and therefore could not be used as part of the data set.

Participants were given a written and verbal explanation of the project and gave written consent to participate (IRB #15-201).

Interviews took place at the home of each participant between June and August of 2015. The subject walked the author through his or her respective garden and named as many plants as he or she knew by common or scientific name. Photographs were taken by the author for review along with the interview notes. During and after the tour, participants were asked a series of open-ended questions about their reasons for joining the particular group to which they belong (with the exception of Keep Denton Beautiful, which has no official membership requirements), the types of amendments used on the soil and for pest control, where they obtain plants, what the word "native" means, their knowledge of pollinators, and their process for researching any questions they have about gardening or gardening methods.

Results

Plant Diversity

Native and Eco-friendly Biodiversity by Group

In total, 508 distinct taxa of plants were identified by gardeners. This number is probably low due to the fact that many of the plants were not named by variety but by genus only, and could not be established as a distinct variety. If we assume that those plants classified as possible native are in fact native, there more native plants present across these nineteen garden spaces than non-native or exotic. Of these 508 plants taxa, 199 are considered to be native or possibly native, 22 as non-native, 185 as exotic, 29 as hybrid, 55 as food, 9 as invasive (7 exotic, 2 non-native), 10 as spice, and 8 as unknown. These numbers do not account for the possibility that some of these plants have been classified incorrectly due to the identification by the gardener,

or the fact that some groups may use different criteria for the classifications of native, non-native, or exotic. Adapted plants were not considered as part of the study due to the complexity of attempting to categorize plants as adapted versus native, non-native, or exotic based on the criteria set forth by the various groups studied. The category of adapted, however, may change the understanding of the plant's status to the gardener and therefore promote the use of a plant that is considered adapted for their purpose, but considered exotic or non-native in reference to this study.

Two additional categories were studied to evaluate the potential of each garden to contribute to the "eco-friendliness"— that is, the ability of each garden to provide food and shelter for native fauna and the total number of native plants present—of each garden and thereby improving the "eco-friendliness" of the city of Denton. Native Plant Society had the highest percentage of native plants (over 70%) and the highest percentage of eco-friendly plants (over 68%) of all studied groups. Master Naturalists came in just under the Native Plant Society with percentages of native plants between 53% and 71% and ecofriendly plant percentages between 55% and 75%. Master Gardeners had the lowest percentages of the gardening groups studied, with native plant percentages between 28% and 48% and eco-friendly plant percentages between 33% and 51%. Keep Denton Beautiful and Denton Record Chronicle gardeners varied the most in terms of native plants (between 16% and 57%) and eco-friendly plants (between 18% and 52%). The KDB participant who is also a Master Gardener in another state (KDB3) was in range of other Master Gardeners, with native plant percentages of 47% and eco-friendly plant percentages of 47%. It is important to note that the list of "eco-friendly plants" is not exhaustive and that some plants not included on the list for this study may in fact contribute to the "eco-friendliness" of the city of Denton in currently unknown ways.

Similarly, Master Naturalists and Native Plant Society members had the highest proportion of natives in comparison with exotics (158 native/36 exotic and 116 native/26 exotic, respectively). Master Gardeners and the KDB/DRC group were nearly equal in proportion to native plants and exotic plants, although Master Gardeners had more natives (136 native/129 exotic), while KDB/DRC had 171 natives and 196 exotics. KDB/DRC had the most non-natives and food plants (18 non-native/71 food), while Master Naturalists and Master Gardeners had similar numbers of food plants (31 and 29, respectively). Neither Native Plant Society member interviewed grew food plants, although the Master Naturalist who is also a member of the Native Plant Society does grow food in her garden. Master Gardeners had 16 non-native plants, significantly higher than either Master Naturalists (5) and Native Plant Society members (1).

The vast majority of individual species appeared in fewer than 4 gardens. The most common plants found in gardens were *Iris* (exotic, 14 gardens), *Yucca* (native, 11 gardens), flame acanthus (*Anisacanthus quadrifidus*, native, 11 gardens), Turks cap (*Malavaviscus arboreus*, native, 11 gardens), rosemary (*Rosmarinus officinalis*, pest control, 11 gardens), redbud tree (*Cercis*, possibly native, 11 gardens), basil (hybrid, 11 gardens), *Lantana* (native, 10 gardens), daylily (*Hemerocallis*, exotic, 10 gardens), tomatoes (*Solanum*, various varieties, food, 9 gardens), hearty hibiscus (*Hibiscus coccineus*, native, 9 gardens), Mexican feathergrass (*Nassella tenuissima*, native, 9 gardens), butterfly weed (*Asclepias tuberosa*, native, 9 gardens), mealy blue sage (*Salvia farinaecea*, native, 9 gardens), coral honeysuckle (*Lonicera sempervirens*, native, 9 gardens), mint (*Mentha*, spice, 9 gardens), beautyberry (*Callicarpa Americana*, native, 8 gardens), *Zinnias* (native, 8 gardens), and black-eyed Susan (*Rudbeckia hirta*, native, 8 gardens).

The average number of named plants in a single garden is 65, with the highest number of

named plants in a single garden being 162. Master Gardeners have an average of 70 plants in their gardens, Master Naturalists have an average of 60 plants, Native Plant Society members have 75 plants, and Keep Denton Beautiful and Denton Record Chronicle gardeners have an average of 61.

Total Native Biodiversity vs. Total Biodiversity

Overall biodiversity across groups is high, with 508 distinct taxa of plants being accounted for across 19 gardens, which are spread in and around the city limits of Denton. An average of 65 different species, 15 native plants, and 20 exotic plants appear in each garden, making the average number of exotic plants per garden higher than that of native. Conversely, an average of 31 eco-friendly plants appear in each yard studied, making the average number of eco-friendly plants higher than that of either native or exotic plants. Since the vast majority of gardeners interviewed professed a desire to attract native fauna and pollinators, it is expected that there would be more eco-friendly plants than any other category.

Even so, overall, only 47% of the 508 plants identified are considered native or possibly native and 48% are considered eco-friendly. The majority (53%) are considered exotic, non-native, hybrid, spice, or food. In this case, food and spice plants are generally not considered to be native plants but they may provide some services to native fauna and pollinators. For example, parsley can act as a host for butterflies and rosemary attracts both native and bumblebees. It is worth noting that a number of plants considered "exotic" or "non-native" by these standards may have become adapted to the area and do in fact provide services to the local ecosystem. However, as previously stated, adapted is a category fraught with complications and highly debated and could not be considered in the purview of this study. Despite this, there is a

chance that so-called “native” biodiversity is actually higher than presented here.

Gardening Groups and Their Impact on Plant Diversity

Masters Gardeners: Control Over the Environment

Five members of the Denton County Master Gardeners volunteered to participate in the study and were interviewed as part of this study. Three were retired, one works full-time as a medical professional, and the fifth does not work. The income level of the participants all ranged in the mid to upper middle class. All were university educated and two had advanced degrees (doctoral level). All participants were female.

The participants cited varying reasons for joining the Master Gardeners, but all expressed that becoming a Master Gardener was a goal they had desired for a long time. The time constraints involved in being a member of the Master Gardeners was the biggest reason that the two retired members cited for waiting to become a member until retirement and it was suggested that many Master Gardeners are retired before joining due to the commitments involved. Not only must “trainees” attend all day classes at least once a week during normal working hours, but they also must complete 40 hours of service to the organization per year. One participant stated that it was difficult to do the training while working full-time, but she felt that it was worth it.

All participants had a family history of gardening, with either a parent and/or grandparent involved in gardening. Additionally, there was a feeling that being part of the Master Gardeners made one respected within the gardening community. Of the four groups studied, the Master Gardeners were by far the most selective in choosing trainees. One participant had been involved in the selection process of trainees and admitted that the selection committee was very mindful of people’s motivations to join the group and that interests must be aligned with the

overall goal of the Master Gardener's chapter. There is a clear spirit of sharing amongst members. All participants stated that Master Gardeners willingly share knowledge and plants with each other and the community; one participant takes great pride in being part of the annual Garden Tour, during which other Master Gardeners tour the gardens of selected members for ideas and knowledge sharing. Members are also able to teach classes to each other and the community, thus further sharing their knowledge. One participant lamented that she wished more people knew about the help available to them through the Master Gardeners when beginning gardening projects or running into problems.

All five participants in this group mentioned a fondness for wildlife in general and all planted specifically to attract certain birds, butterflies, and other native fauna. At least one admits to actively discouraging animals such as cats from the yard, using orange peels, in order to make her yard more inviting to local wildlife. Most had water features to attract animals and some sort of cover, either in the form of decorative housing or plants. The most common animals actively deterred from gardens include poisonous snakes and purple martins, which these participants consider to be pests.

Much of the plant choice within this group focuses on personal expression. As the Master Gardeners were created by horticulturalists from Texas A&M University, there is heavy concentration on how plants grow and what is necessary to make them grow properly. Members tend to have a high knowledge of soil composition, water conservation, and sunlight requirements of plants. Plant knowledge among the participants varied, with two knowing all the plants in their garden and two knowing only certain plants. Most of the plants are purchased from local, non-commercial nurseries, or traded with other Master Gardeners. One gardener in this group admitted that she never purchased plants but got all her plants from fellow Master

Gardeners. Participants in the group mentioned that they enjoy adding new plants to their gardens and will often look specifically for plants they have never grown before. While there was concern from all participants about implementing native plants and plants which grow well in the local environment, there was an overarching sense that this was secondary to the most important point mentioned, which was that gardening is "art". Use of varying colors, textures, and heights in the landscape was often more important that having mostly native plants. These participants expressed a desire to control their environment and make it look the way they wanted it to look. This group in particular is prone to experimentation, not only with plants but also with methods of pest control and soil amendments. There is a sense that with the right knowledge and proper amendments, anything can be grown. The use of containers is popular among Master Gardeners, particularly for growing more exotic plants. This allows the gardener to grow non-native plants in a more controlled environment without disrupting the local natural landscape. Some participants believe that container gardening helps use less water for plants that typically have a higher water requirement, but they had no discernable proof for such beliefs.

While these gardeners recognize the benefit of organic pest control and organic soil amendments, they may or may not use them in the garden, depending on the kind of landscape they are trying to achieve. Master Gardeners in this study had the most manicured gardens of any other and were most likely to utilize non-utilitarian garden art pieces, such as statues or figures which served no purpose other than to improve the aesthetic appearance of the space. One participant believes that a so-called "native landscapes" look "messy," "untended," and that HOA groups are not particularly fond of them. This ideology may or may not contribute to plant choice, but it certainly affects how these gardeners exert their power over their environments.

While education is important to these gardeners, they tend to be limited in the kinds of sources they cite when looking for answers. Because of the nature of sharing among members, other Master Gardeners are one of the main sources used by these participants. Additionally, many members use the resources produced by the Texas A&M Extension Office, the group which oversees the Master Gardeners. All participants interviewed use Neil Sperry as a reference and various kinds of books. However, these participants were less likely to do independent research and rarely used media sources for inspiration or answers. As previously seen, personal choice is apparent even within the kinds of resources consulted. Whether or not age is a mitigating factor in the choice of books and radio programs over online resources is not clear, but two of the participants interviewed did mention a dislike of using the computer.

Master Naturalists: Working in Harmony with Nature

Four Master Naturalists volunteered to participate and were interviewed as part of this study; one is a member of the Native Plant Society and another is also a member of the Master Gardeners. All interviewees were female. At least three were university educated, one was working on a doctoral degree at the time of interview, and the remaining one did not divulge her level of education. One is retired, two work full-time, and one does not work. Their income levels ranged from lower middle to upper middle class.

Various reasons were cited for joining the Master Naturalists, although most stated a love of the outdoors and nature. Several mentioned that it was easier to find volunteer hours with the Master Naturalists in comparison to the Master Gardeners because of the Master Naturalists' connection to the Lewisville Lake Education Learning Area (LLELA), which provides them with ample opportunities for completing their volunteer hour requirements. Master Naturalist training

can be completed online and although there is a rather intense training period, it is better suited to those who are working due to the flexibility of online education. Gardeners in this category also stated more frequently that they were interested in "organic" gardening methods, that is, methods which use non-chemical or non-commercially produced methods of pest control and amendments in their garden. One gardener also used companion planting as part of her efforts to control pests in lieu of any kind of intervention.

The greatest overarching theme among the Master Naturalists interviewed was the idea of working in harmony with what already exists. All of the participants stated that if a plant was growing in their garden space and wasn't invasive or toxic to the environment, they were happy to let it grow where it was and in some cases, even toxic or invasive plants were left because they were part of the existing landscape. Several gardeners in this group had natural or semi-natural prairie spaces where they threw wildflower seeds and waited to see what grew. One participant had an entire natural prairie that she had not touched, clearing only a small plot for growing vegetables, although she left a number of the naturally growing plants where they were in order to encourage native fauna and pollinators to visit her vegetable garden. During her interview, a number of birds and pollinators were seen, including butterfly caterpillars on the Black-eyed Susans. Interviewees did not express an aversion to "natural" landscapes, that is, allowing plants to grow where they germinate rather than configuring a garden space which matches the desires of the gardener. While several of the interviewees did have somewhat landscaped garden spaces, they were more likely to enjoy landscapes which were less controlled. Like the Master Gardeners, these gardeners enjoyed native fauna and pollinators visiting their gardens and tried to create garden spaces which provide cover and water to encourage nesting. However, these gardeners were more likely to provide natural habitats for fauna rather than human constructed

houses or other decorative items.

Plant choice varied widely among Master Naturalists, but focused mostly on creating a garden space which exists in harmony with the surrounding environment. Of the groups studied, the Master Naturalist gardeners had the highest ratio of native plants in relation to exotic and non-native plants, and had the fewest number of invasive species. Master Naturalists are also more likely to plant seeds rather than grown plants. These gardeners were less likely to add plants for aesthetic value, although several did mention enjoying the challenge of growing new plants. One participant stated that she only replaced dead plants in her garden, while another replaced all the exotic and/or invasive plants in her garden with native varieties when possible.

Only one Master Naturalist in this case was subject to an HOA restriction and she stated that she felt her garden was a good example to others in the area of what could be done with native plants rather than the potentially exotic or non-native plants that were often planted by the neighborhood developer. Her HOA was less restrictive and she found very little problem being able to plant natives in her garden space. Other participants lived in remote areas where they had more options for choosing plants. Even in these situations, Master Naturalists often changed only part of the landscape to plant food crops or replace plants that were disturbed during the building process of the home. All participants stated a preference for native plants and were likely to get their plants from plant sales run by the Master Gardeners, Native Plant Society, or LLELA, small, family run nurseries, or native/organic nurseries. One participant did admit to going to big box stores like Lowes or Home Depot to ask for native plants in order to help establish a need to carry more native plants in these kinds of stores.

Education among these participants varied widely and included internet searches, TAMU Extension publications, Native Plant Society publications, various unnamed blogs, Neil Sperry,

and books. Due to the nature of their volunteer work, many members of this group are also able to see firsthand the kinds of plants that grow in wild areas; whether this affects the plant choices of these participants is unclear.

Native Plant Society: Return to "Native" Lands

Two members of the Native Plant Society volunteered to participate and were interviewed as part of this study. One member of the Master Naturalists is also a member of the Native Plant Society. All participants in this group were female, college educated, and in the mid to upper middle class income range. One was a university professor, one was retired, and one worked full-time.

Amongst the members of the Native Plant Society interviewed, the greatest overall concern was returning, both in their own home gardens and others' gardens, to a use of almost exclusively native plants. One gardener stated that her garden was 90-95% native plants. In this case, native seems to refer to plants that are utilitarian for native fauna and pollinators, are adapted to the local environment (both in water use and ability to withstand seasonal change), and grows naturally without intervention (i.e. amendments or pest control). In contrast to the Master Naturalists, members of the Native Plant Society were more likely to replace exotic or invasive plants with native plants, rather than leaving them to grow if they were not causing harm to fauna or flora. Interviewees in this group professed a desire to help others restore native gardens in their own homes. Denton's chapter of the Native Plant Society is one of the lead chapters in the state, encouraging other chapter to be more active and participate in propagating the use of native plants instead of exotics and non-natives. New species are added generally to increase diversity in home gardens and therefore improve the ability of these gardens to provide

for native fauna, rather than for personal or aesthetic reasons, although these factors could still be in play. Like previous groups, members of the Native Plant Society expressed a fondness for native fauna. One interviewee even stated that for her, native fauna were free entertainment. The Native Plant Society works closely with members of the Master Naturalists and this may have an effect on the plant choices of Master Naturalists, although this was not entirely clear from the data. The time commitment of the Native Plant Society is also much less consuming and therefore more convenient for working people.

Plant choices in this group were varied, but seemed to focus mainly on native plants. Two interviewees expressed that they chose plants specifically to attract native fauna and pollinators, thus helping to increase the presence of these fauna and pollinators in the local area. While all gardens surveyed included exotics or non-natives, Native Plant Society had a high level of native in comparison to exotic and non-native and were the least likely to have food crops. Whether or not this is because there are few food crops native to the North Texas area is unclear; none of the interviewed gardeners expressed any such reasoning. While the level of native plants to exotic/non-native plants is not quite so high as that of the Master Naturalists, this may be due to the smaller sample size of the Native Plant Society. Members of this group also had a stronger idea of what "native" means for them and were the most likely to use media and educational material only provided by the Native Plant Society, which carries its own list of native plants that varies from the sources used for identification in this study. While members of this group do not believe that other sources are "wrong" per se, they are more likely to go with the more stringent description of "native" as described by their society than other groups interviewed.

Similarly, members of this group were most likely to use the smallest number of sources for their instruction and generally only those produced by the Native Plant Society. These

gardeners are also least likely to use non-natural amendments and pest control. Plants are generally purchased from local nurseries known to carry native plants or Native Plant Society plant sales.

Keep Denton Beautiful and Denton Record Chronicle: Untapped Potential

Eight gardeners volunteered and were interviewed who are not members of any of the previously mentioned groups. Six were involved in projects with Keep Denton Beautiful and two were recruited from an article in the Denton Record Chronicle about the project. One person in this group was a Master Gardener in another state, but was not a member of the local Master Gardeners chapter. Another gardener was familiar with the Master Naturalists but was not a member due to time constraints. Two additional people volunteered and were interviewed, but could not be considered as part of the data set because they could not name the majority of the plants in their garden. Education levels in this group varied from high school graduate to doctoral level studies, as did income levels, ranging from lower middle class to upper middle class. Three men and five women were interviewed as part of this group.

Reasons for gardening amongst this group were diverse, but most included a family member who gardened in the past or gardening for a connection to another place or family member. One interviewee started gardening as a way of grieving for his grandfather and another grew plants which reminded him of his childhood in Puerto Rico. When asked why they had not joined one of the three groups studied, most cited a lack of time, but a few mentioned feeling intimidated at meetings, particularly in reference to the Master Gardeners. Several gardeners in this group also participated in the Denton Organic Society, which offers free classes in living an organic lifestyle, including organic gardening, free of charge. Members of this group were most

likely to experiment with different ways of growing plants, including hugelkultur (mounds created by dead logs, kitchen scraps, grass clippings, leaves, and soil to grow plants), lasagna gardening (creating more fertile soil with layers of newspaper, cardboard, leaves, grass clippings, and kitchen scraps), keyhole gardening (raised beds in the shape of a keyhole which use less water and are popular in arid environments like Africa), and raised beds. While there is knowledge of native flora, fauna, and pollinators amongst all members of this group, their devotion to planting for or attracting these fauna or pollinators was less than that of those in the other three groups. By far, this group had the highest ratio of native plants to exotic and non-native plants, with a nearly equal one to one ratio. Members of this group also grew the most food crops of any of the three groups, although that may be due to the size of the sample. Plants were purchased for a number of sources, including big box stores. Some interviewees expressed a need to buy less expensive plants, while others said they never shopped at big box stores.

These gardeners were the most likely to use commercial or chemical amendments and pesticides in their gardens.

Plant choices among these participants were the most varied of all the groups. Personal choice was by far the most important factor expressed by these gardeners. Growing "clean" (i.e. pesticide free) food, memory gardening, and improving the environment were the most frequently stated objectives in choosing plants for the garden.

Education also varies widely amongst participants in this group. Two gardeners interviewed had completed a horticulture course at North Central Texas College and used this knowledge when choosing plants and making decisions about amendments and pest control. Wide ranges of sources were used to research plant choices and potential problems in the garden, including TAMU Extension Office materials, Native Plant Society materials, Lady Bird Johnson

website, blogs, websites, and Google searches, although most of the interviewees mentioned that finding "legitimate" (i.e. from a trustworthy source such as a government or university website) information could be frustrating and sometimes searches took a lot of time. Several gardeners interviewed participated in classes offered by the City of Denton.

Common Themes

Know Your Soil to Know Your Amendments

Being aware of what kind of soil is present in the garden was another common theme among gardeners in all groups. Knowing what kind of soil one has makes it easier to choose plants, amendments, and watering requirements. The most common soil amendment used was a product called Dino Dirt, which is made by the City of Denton from grass clippings, leaves, and branches that were picked up from city homeowners. Many gardeners also used products such as MiracleGro soil, especially in containers.

Most gardeners in all categories used kitchen scraps in their gardens for various reasons. One Master Gardener threw orange and banana peels, cantaloupe rinds and seeds, and other vegetable and fruit scraps directly in the garden, while a Master Naturalist saved all her kitchen scraps and poured them into freshly dug holes when planting seeds and new plants for fresh fertilizer. These scraps served both as natural compost and as food for native fauna.

Other soil amendments included grass clippings, leaves, mulch, peat moss, cardboard, newspaper and chicken manure. One Master Gardener used pieces of broken pots in the bottom of potted plants to facilitate soil drainage. The same gardener also used broken egg shells to prevent insects from attacking her plants.

Emotional Benefits of Gardening

Most of the gardeners in this study mentioned some kind of stress relief or therapeutic benefits of gardening. Being outside, connecting with nature, being in the dirt, successfully growing plants and connecting with fauna were all mentioned in this context. Gardeners stated that they were able to disconnect from the stresses and problems they experienced in their daily lives by channeling that stress into caring for their garden. They also cited the joy and accomplishment they felt in creating a beautiful space, adding new plants, or growing plants in general. Most gardeners enjoyed sharing their gardening skills with others. Many also enjoyed having others admire their garden space or even inspiring neighbors to improve their own garden space.

This feeling of joy and accomplishment is not dampened by failures in the garden. During the study period, a long unseasonable wet period had plagued the growing season. All gardeners interviewed stated that losing plants was just part of being a gardener and that they simply replanted what was lost. Some gardeners did admit to giving up on certain plants when they failed to thrive over multiple seasons, but not on gardening all together.

Carrying on the Gardening Tradition

All participants in this study mentioned a family member who gardened as part of their reason for gardening. Some had multiple family members who had previously gardened and some had only a parent or grandparent. Those who grew food often had a family member who had participated in farming and had a desire to grow their own produce. Several gardeners also enjoyed passing the gardening tradition on to their children and grandchildren. Two gardeners had fairy gardens to entice their grandchildren into visiting the garden and thereby being able to

teach them the names of the plants. One mother-daughter team had created their garden to save money on buying produce and utilizing the large amount of land they had to work with.

Gardening for memory was another common theme. At least one gardener in each category had a specific plant grown in memory of a loved one. Several gardeners had planted potted plants they had received at their parent's funeral and one gardener had planted species he had enjoyed during his childhood in Puerto Rico. These plants brought up happy memories for them and gave them a way of connecting with family who had passed way.

Pollinators, Fauna, and Pests

All participants had some knowledge of pollinators and their importance to the local environment, although no group seemed to have a higher level of knowledge than another. One Master Gardener allowed insects to set up hives as long as they were not near doors or windows in her home; she had a hive of paper wasps hanging from a tree in her yard during the interview. Most subjects knew the importance of bees and butterflies and at least two-thirds of the participants choose plants specifically to attract such pollinators to their yard. One Master Naturalist hosted a hive of bees on her property in order to encourage them to establish themselves in the local environment.

Similarly, all subjects expressed a desire to attract native fauna, particularly birds, possums, armadillos, and raccoons. While they generally considered squirrels to be pests, none actively discouraged them from their gardens. Some birds were also considered to be pests, but again, they were not actively discouraged. Instead, most gardeners attempted to attract less pesky birds by planting flowers that would attract them. The most commonly cited pest species were poisonous snakes, generally because of the danger they posed to household pets, feral cats,

and various types of insects that caused damage to plants. Several participants in different groups used chickens and/or chicken manure as amendments or pest control. One gardener from the Denton Record Chronicle group kept chickens in a coop next to the garden, moving the coop every few weeks so that the chickens would fertilize the ground. They also allowed the chickens to forage for worms and insects amongst their food crops to keep them naturally free of pests.

Another gardener had a neighbor with turkeys and chickens, whom she allowed to freely visit her garden to help minimize the number of pests in her garden as well as to naturally fertilize the ground.

Increased Habitat

Amongst all groups, there was more than one subject who was interested in increasing the available habitat for native fauna and insects. One Master Gardener had her garden certified as a Wildlife Sanctuary, meaning that her garden provided all the necessities for native fauna and pollinators, including water, shelter, and food. While Master Gardeners were more likely to use man made items to provide this habitat, other groups were equally likely to have such provisions available in natural form (i.e. plant cover or fallen logs). Additionally, most gardeners had a desire to increase the diversity of the local environment by planting many different species of plants, thus creating more habitat.

	DCMG1	DCMG2	DCMG3	DCMG4	DCMG5	EFMN1/NPS 4	EFMN2/MG6	EFMN3	EFMN4	NPS2	NPS3	KDB1	KDB2	KDB3	KDB4	KDB5	KDB6	DRC1	DRC2
Total Exotic	27	23	16	34	29	2	12	3	19	14	12	5	9	23	10	29	79	39	2
Total Food	0	17	3	7	2	7	8	8	8	0	0	0	12	21	8	4	12	1	13
Total Hybrid	4	1	4	8	5	0	4	0	4	2	1	1	1	3	0	2	8	0	0
Total Native	12	19	24	52	16	21	31	14	73	49	57	10	6	40	3	24	42	16	2
Total Possible Native	5	2	2	3	1	1	4	2	12	5	5	1	1	6	1	6	6	4	3
Total Non-native	2	4	4	4	2	0	1	1	3	0	1	1	2	2	1	0	7	5	0
Total Spices	3	3	0	3	3	0	0	2	0	0	2	1	2	2	0	3	5	2	1
Total Unknown	4	2	2	0	1	0	0	0	0	1	1	0	0	1	1	0	3	1	1
Total Taxa	57	71	55	111	59	31	60	30	119	71	79	19	33	98	24	68	162	68	22
Total Eco-Friendly	19	24	27	57	25	22	33	18	90	48	54	10	9	46	6	34	47	17	4
Percent Native	29.82%	29.58%	47.27%	49.55%	28.81%	70.97%	58.33%	53.33%	71.43%	76.06%	78.48%	57.89%	21.21%	46.94%	16.67%	44.12%	29.63%	29.41%	22.73%
Percent Eco-friendly	33.33%	33.80%	49.09%	51.35%	42.37%	70.97%	55.00%	60.00%	75.63%	67.61%	68.35%	52.63%	27.27%	46.94%	25.00%	50.00%	29.01%	25.00%	18.18%

Table 1. Plant taxa totals per garden with native and eco-friendly percentages.

	Denton County Master Gardeners (DCMG)	Denton County Master Naturalists (DCMN)	Elm Fork Native Plant Society (EFNPS)	Non-Affiliated (KDB/DRC)
Conservation	Lowest level of environmental concern of the three groups. Water conservation is the highest concern.	Mid-high level of environmental concern. "Native" is not as important. Water conservation is a high concern.	High level of environmental concern, but mostly in relation to returning the North Texas environment to a "natural" state. What this means is not clear. Water conservation is important.	Varying levels of environmental concern, but generally mid-high. Water conservation is important.
Education	Large time commitment- not condicive for working people (generally). Focus on gardening, not so much environmental concern. Course material comes from Texas A&M.	Coursework can be done online-better for working people. Volunteer commitment is easier to fulfill because of LLELA. Focus on environmental preservation, not so much native plants. Course material comes from Texas A&M.	No formal training required, but available. Focus on replacing "non-natives" with native plants.	Education generally through coursework (at community college) or personal interest. No affiliation either because the time commitment is too great or the values of the groups do not match personal beliefs.
Space	View outdoor space as a canvas-gardening is an art form. Less focus on "natural" or "native" in relation to texture, color, memories etc.	Outdoor space should generally be left alone. Some "control" needs to be asserted (personal preference), but if it's not causing environmental harm, there's no reason to make major changes.	"Non-native" plants should be replaced with "native" plants. "Native" generally refers to the beliefs espoused by the EFNPS.	More likely to experiment with different methods; plant choice related to education or preference. More emphasis on control of the environment.
Background	Tend to have relatives (parents, grandparents) who gardened.	Tend to consider themselves "outdoorsy" people. More concern for environmental stability, but not necessarily native plants.	May have relatives who garden, but also have (through education or other means) developed a concern for the environment, particularly in regards to native plants.	May have relatives who gardened, but also developed an interest in gardening through education (i.e. horticulture courses at community college or on the job training)

Table 2. Interview results by group.

CHAPTER 3

DISCUSSION

Denton gardeners are in fact contributing to the overall "eco-friendliness" of the ecosystem in and around the city limits, albeit in varying degrees of prominence. All gardeners in this study had some native and eco-friendly plants in their gardens, but the difference in percentages between groups was sometimes significant. A number of factors, not limited to group affiliation, are impacting the choices made by individual gardeners in their home environment. As this study group is made up of men and women who have a professed interest in gardening and regularly attend their gardens, they provide a good baseline for determining where Denton is in terms of "eco-friendliness" and in what direction it needs to go to improve its status.

Plant Selection of Denton Gardeners

Plant Choice and Education

Organized Education: Master Gardeners, Master Naturalists, and Native Plant Society

Plant choice seems to be directly influenced by education, either personal or from an organized gardening group. Gardeners who belong to an organized gardening group in this study did less independent research on the whole and tend to focus the majority of their research on information produced or endorsed by their chosen group(s). Knowledge sharing is also more common among these groups and, though individual plant choice is varied, the proportions of natives and eco-friendly plants are within a similar range for each group, indicating that gardeners are making similar choices in the types of plants they are putting in their personal garden space. The proportion of native and eco-friendly plants changes across the groups, with

Native Plant Society members having the highest levels of native (75% of all plants) and eco-friendly plants (68% of plants), Master Naturalists following closely behind with an average of 63% native plants and 65% eco-friendly plants, and Master Gardeners with an average of 39% native plants and 41% eco-friendly plants.

Even those who did not currently belong to an organized gardening group but had previous affiliations fell within the ranges of their training group. KDB3 had been a Master Gardener in another state and planted 46.94% natives and 46.94% eco-friendly plants, which falls within range of other Master Gardeners, but lower than either Master Naturalists or Native Plant Society members. While her percentages were higher than most Master Gardeners in this study, she relied mostly on what she had learned over the years, including that which she gained from the Master Gardeners, rather than doing much independent research. The independent research she did was more targeted, as she already generally knew what she was looking for when beginning a search.

Similarly, EFMN2 is a member of both the Master Naturalists and the Master Gardeners and her percentages were on the lower end of the Master Naturalists and only slightly higher than those of the Master Gardeners (58% native/55% eco-friendly). As she expressed viewpoints relating to both groups, this mid-range level of native and eco-friendly plants seems to make sense. EFMN1 is a member of both the Master Naturalists and the Native Plant Society. She had equally high numbers of 70.97% native and eco-friendly plants. Her viewpoints contributed these percentages, as most of her land was a native prairie and she only cleared space to grow non-native vegetables; she felt that the land should be left untouched, as many Master Naturalists do, and she only cleared a small space to grow vegetables. However, her gardening methods were decidedly organic and more in line with the Native Plant Society; she left the native plants

in place to encourage pollinators and fauna to visit her garden.

Independent Research: Keep Denton Beautiful and the Denton Record Chronicle

This group likely represents what "average" (i.e. the average homeowner/gardener in Denton) gardener chooses to put in their gardens and how they make those choices. Gardeners not associated with an organized gardening group on the whole did more independent research and expressed more frustration with finding pertinent information than those who belonged to organized gardening groups. A notable exception to this were the two participants in the KDB group (KDB2 and KDB4) who were students of the Horticulture program at the North Central Texas College in Gainesville, Texas. They relied more on the knowledge obtained from their studies when making decisions about plants and gardening methods, similar to the way member of organized gardening groups made their choices.

Gardeners in this category had a broader range of "education" that was self-obtained from attending workshops run by the City of Denton and the Denton Organic Society, web searches, blogs, books, and radio programs like Neil Sperry. Several gardeners in this category expressed that they had trouble sifting through all the results obtained from web searches and finding information that was credible, i.e. comes from a legitimate source such as a university, government entity, or the TAMU Extension Office, which operates both the Master Gardeners and the Master Naturalists. This falls in line with studies done by Clayton (2007) who found that gardeners most often use internet, government or university based gardening groups, and commercial garden centers for gathering information on plant choices and gardening methods.

Contrary to Gross and Lane (2007), who found that 22% of gardeners used television as inspiration for gardening products, no gardeners in this groups used television as a means of

educating themselves. Master Gardeners, while considered knowledgeable by most members of this group, were also portrayed as seeing themselves as "superior" gardeners, which was off-putting to several gardeners in this group and may have caused them to shun some of the information available to them through the Master Gardeners. Similarly, most members of this group had not heard of the Native Plant Society or the Master Naturalists and therefore had most likely no used any of their publications (or been unaware that they had used them).

Two gardeners in this group form the high end of eco-friendly gardens in this category. KDB1 works closely with the Master Naturalists through his job and has percentages of native and eco-friendly plants more in line with that group (58% native, 53% eco-friendly). KDB5 is a self-professed organic gardener who regularly attends City of Denton gardening classes and classes offered by the Denton Organic Society. While she does not feel her gardening goals align with that of the Master Gardeners, she did express interest in the Master Naturalists. She had higher percentages of native and eco-friendly plants that others in this category (44% native and 50% eco-friendly), putting her well above most other gardeners in this group.

At the other end of the spectrum are KDB2, KDB4, KDB6, DRC1, and DRC2, who had the lowest percentages of native plants and eco-friendly plants (21%/27%, 17%/25%, 30%/29%, 30%/25%, 23%/18%, respectively) of any participants in this study. These participants are more indicative of the kinds of percentages that can be expected in most yards in Denton.

Gardeners in this group are also more likely to buy plants from big box stores such as Lowes and Home Depot. Some do shop at independent nurseries or plant sales, but the majority buy plants from commercial outlets. Their exposure to native plants, therefore, may be less than gardeners in organized gardening groups, which may have an impact on plant choice. Gardeners in this category also have the highest number of food crops grown and were more likely to

garden so that they could grow their own produce, which limited the kinds of plants they have in their garden space. At least two participants were relatively new to gardening (KDB4 and DRC2), which may also limit the number of plants they felt prepared to grow.

Potential for Improving the Local Ecosystem

More than just having a beautiful yard, most gardeners in this study expressed a desire to improve the local ecosystem. However, more factors than just having a variety of plants growing in a garden impact the local environment. Total biodiversity in Denton gardens is high, with 508 distinct taxa being found in 19 gardens. As stated by a number of other studies, gardens in Denton are in fact providing a high level of biodiversity in and around the city (see Goddard et al. 2009; Vergnes et al. 2011). Other factors such as percentage of natives, "eco-friendly" plants which provide services (i.e. food and shelter) to native fauna and pollinators, xeric plants, soil quality and amendments, and pesticide use all impact the ecosystem and its ability to sustain life.

Personal Philosophy vs. Knowledge

Van Heezik (2012) found that exposure to education about environmentally friendly plants and gardening methods improve the use of such plants and methods in gardens. Members of organized gardening groups tend to shop at the same independent nurseries and plant sales, therefore being exposed to similar numbers of native and eco-friendly plants for sale. In spite of this, there is a wide discrepancy between percentages of native plants appearing in gardens of each group. Ties to personal philosophy, and that of the education and philosophy of the gardening group affiliation, seems to have an impact on plant choice even when exposed to the

same kinds of plants. Indeed, as Van Heezik (2012) showed, possessing knowledge of environmentally friendly plants or natives does not necessarily translate to gardeners using this knowledge when making choices about plants. Van Heezik (2012) also found that personal preference and lifestyle had greater influence on plant choices and gardening methods than knowledge. Master Gardeners, who profess a love of "art" and using varieties of colors and textures, have the lowest percentage of natives and eco-friendly plants of the three organized groups, but are trained as part of their education with the Master Gardeners in the use of native plants. Native Plant Society members and Master Naturalists, whose personal choices and lifestyle often sway towards the organic and "eco-friendly," have greater numbers of natives and eco-friendly plants. Their affinity toward natural spaces may increase their desire to plant native and eco-friendly plants as this ideology generally supersedes a desire for color and texture.

Native Plant Society members and Master Naturalists also have less objection to somewhat "messy" landscapes, which impacts the kinds of plants they will buy and plant in their gardens.

Of all the groups, Master Gardeners seemed to be the least interested in converting to all native plants. This is due in part to an ideology that native gardens are not visually appealing because they can be less structured and are looked down upon by HOAs and neighbors. Master Gardeners, of all the groups studied, had the most strongly held ideology of "control and exploit" (Freeman et al. 2012) and drew the most pleasure from having most of the control over the composition, configuration, and management of their garden space (Goddard et al. 2013; Smith et al. 2005). As this group holds individual creativity and personal expression (Bhatti and Church 2004; Clayton 2007; Freeman et al. 2012; Kiesling et al. 2010) and the ability to grow plants that may be challenging in the present environment (Kiesling et al. 2010) as the main reasons for

gardening in the first place, convincing them to give up on what they consider to be more visually stimulating exotics could be the greatest issue faced in this case. Master Gardeners love the challenge of growing difficult or exotic plants and natural beauty above all else in their own gardens. While they may understand and respect native and eco-friendly plants, personal vision seems to override such feelings. A solution to this problem may be in collaboration with other groups. Tearing down the idea that native gardens have to be ugly would go a long way to convincing Master Gardeners, and other gardeners with the same opinion, to implement more native plants into their landscapes. North Texas previously had both prairie and woodland landscapes (TWPD 2016; WWF 2016), landscapes that are still present in native areas of Denton County. This could perhaps promote the idea that native landscapes are messy or colorless, as these landscapes often are made up of mostly wild grasses and undergrowth species and lack color for much of the year. That is not necessarily the case. Challenging the Master Gardeners to work with Master Naturalists and Native Plant Society members to create more visually stimulating and "cleaner" garden landscapes with native plants could help increase the number of natives and eco-friendly plants present in the Denton environment. This could be particularly important as the Master Gardeners give garden tours which expose a number of gardeners to various plants in their gardens.

Number of Exotics vs. Exposure to Natives

Members not affiliated with a particular group have the highest number of exotics and non-natives of any group. Kermath (2007) and Smith et al. (2005) found that exotics account for 66-70% of plants in urban gardens. The KDB/DRC group's numbers fall into that range and in some cases, the percentage of exotics is closer to 80%. These gardeners tend to shop at big box

or commercial stores to obtain plants and may have less exposure to native plants depending on how each store visited chooses to display and advertise native and eco-friendly plants. These big box and commercial stores are also more likely to carry hybrid plants which are bred to withstand the often harsh growing conditions of the Texas summer. Gardeners in this category were less aware of what kinds of plants are native and eco-friendly and tend to buy things that will grow in the local climate without using too much water. This lack of targeted exposure to native and eco-friendly plants, combined with a lack of knowledge about native and eco-friendly plants, may have an impact on the number of native and eco-friendly plants which are chosen for these garden spaces.

It is also important to note that Master Naturalists and Native Plant Society members are more often exposed to targeted information on native and eco-friendly plants. By design, the Elm Fork chapter of the Master Naturalists participate in the upkeep and restoration of LLELA, thereby exposing them on a regular basis to naturally occurring plants in the North Texas ecosystem. LLELA is also home to a nursery which sells native plants to the general public, further exposing members to native and eco-friendly plants. Master Naturalists work closely with the Native Plant Society, who by design are focused on obtaining and planting native plants in their garden spaces. As these groups have the highest percentages of native and eco-friendly plants, their exposure to such plants may have an impact on their plant choice.

Water Conservation

While it does not contribute a service to the environment, and therefore is not considered in the overall "eco-friendliness" of a garden, water conservation was the single most mentioned concern in choosing plants. Water conservation affected plant choice, amendments, and

watering methods, and six of the nineteen subjects in this study had rain barrels which they used for watering plants. One Master Naturalist had a 13,000 gallon tank which she used to water her plants and grass. One participant from the KDB group used her phlox flowers as a guide for watering; when the phlox started to wilt, she knew it was time to water the plants. Various methods of conserving water were used by participants across the groups. One Master Gardener created "jackets" for her potted plants which provided insulation to keep soil cooler, therefore allowing for less evaporation. Another Master Gardener used pots for her exotic plants so that she could control the amount of water used in the majority of her garden, thereby using less water overall while still being able to grow the plants she liked. A participant from the KDB group and the Native Plant Society group each mentioned that their water bills had not changed or had been lowered by changing the types of plants in their gardens.

Knowledge Gaining and Personal Philosophy

Gardeners in this study who do not belong to organized gardening groups often expressed a desire to improve their knowledge of native and eco-friendly plants. However, most had limitations in their personal lives that prevented them from joining organized gardening groups and were forced to do research on their own. Many were frustrated with the difficulty of trying to find pertinent information when doing web searches. Regardless, all gardeners in the KDB/DRC group showed a willingness and eagerness to learn more about plants and gardening. If given the proper information about what kind of plants to grow and where to find them, these gardeners would most likely be willing to plant more natives in their garden spaces. But lack of available and readily accessible information on such plants makes it currently a daunting task for most untrained gardeners, especially those who have other time commitments with family and

work. As in the case with the Master Gardeners, some gardeners in this case also have personal philosophies that could prevent them from planting natives. DRC1 chooses plants that remind him of his childhood in Puerto Rico and might therefore not be swayed into exchanging those memories for native plants.

Social Contagion and Native Plants

Imitation is another way in which gardeners in these groups can influence the number of native and eco-friendly plants occurring in Denton. At least one participant in each organized gardening group studied mentioned that they enjoyed having a "one-off" garden in the neighborhood to serve as inspiration for their neighbors. These same gardeners mentioned that neighbors started asking questions about the gardens and that their immediate neighbors had started to do more yard work because of the appealing nature of the gardener's work. Like Clayton (2007), Hunter and Brown (2011), and Kiesling et al. (2010) found in their studies, Denton gardeners are showing that social contagion, a phenomenon where neighbors within short distances (91 m) of a house with a garden are more likely to garden themselves, is alive and well. HOAs did not seem to be as much of a deterrent as personal opinion. Two participants stated that they would plant whatever they wanted in their yards and the HOA would have to deal with it; one stated that if the HOA were to mow down her plants (as they had once threatened to do), she would plant even more the next time until they gave up. One participant was a new homeowner who was replacing all the plants that had been put in by her landscaper with native alternatives. Her HOA was more lenient and allowed the use of more native plants without penalty. Even so, most natives in the gardens observed appeared in the backyard, with the front yard remaining largely grass and trees. Increasing the number of natives in the front yard may

influence other homeowners to plant natives and eco-friendly plants in their gardens due to the nature of imitation observed by these gardeners.

Water Conservation

Equally important to all gardeners is planting water wise plants. Since native and eco-friendly plants are generally adapted to the native landscape, planting with these plants could increase the chances of homeowners choosing native and eco-friendly plants over exotics and hybrids sold by commercial nurseries. Those who use a high number of native plants often choose to do so because they need so little water or can go longer periods without water than exotics or hybrids. While some gardeners have invented their own methods of conserving water, such as using "jackets" on potted plants to keep soil cool or gardening with raised beds, it may be just as easy to plant native plants without such extra efforts, therefore saving time and money for those who may be short on both. The problem becomes exposing gardeners and homeowners to these plants in nurseries, either commercial or independent, rather than pushing hybrid or exotic plants which may not perform as well. Not all gardeners have the time or desire to learn which plants are water wise and which plants are not, so advertising is key to increasing the number of natives present in the local ecosystem.

Organic vs. Conventional Methods

The choice between organic and conventional gardening methods is often related to personal lifestyle and ideology, but also to convenience. Kermath (2007) and Kiesling et al. (2010) both found that the majority of Americans admit to using industrial (i.e. chemical or commercially produced) methods of fertilizing and pest control. In the case of Denton

gardeners, that statistic generally holds true. While those who profess a more "organic" lifestyle, such as those involved in Master Naturalists and Native Plant Society, used far fewer chemicals than those in the KDB/DRC group. The Master Gardeners fell under the category of mixed-use, similar to findings by Kiesling et al. (2010). While many used some organic methods of fertilizing and pest control, they were also far more likely to use products like MiracleGro and Roundup than those in the Master Naturalists and Native Plant Society. Master Gardeners more often tried organic methods and then switched to chemical methods if the organic methods did not produce the desired results, whereas Master Naturalists and Native Plant Society members were more likely to use solely organic methods. The KDB/DRC group were far more likely to rely solely on chemical methods in comparison to the organized gardening groups, which is more indicative of what the majority of Denton residents use on their gardens.

Amendments and gardening methods also come into play when purchasing a new home. New homes are being built within and around the city of Denton to keep up with the rise in population (Clower and Hendershot 2011; Denton County 2016). During construction, these home sites are often filled in with soil that has been trucked in from other areas, also called "fill dirt". Fill dirt is soil which has been has been cleared from farmland, forests, old roadbeds, or construction sites and contains a mix of topsoil, rocky substrate, and any other material present during clearing, which includes both organic and non-organic materials (Braen 2013). "Clean fill" is generally used for leveling landscapes, which should have no organic material, as organic material can cause problems with foundations over time (Braen 2013). Fill dirt used on new home constructions sites is often devoid of organic material, which is essential for growing plants. Therefore, in order to grow plants on new home sites, amendments are generally necessary to improve the soil enough that it can support plant life. Commercially available

amendments used by new home builders most often include generic topsoil or chemical fertilizers in order to establish new plants. It is not always known where the topsoil originates from or if it is nutrient rich. The City of Denton offers a product called Dyno Dirt, which is made from the yard refuse picked up from homes within the city limits (or within the service area of the city). This nutrient rich product can be used as mulch, soil conditioner, and fertilizer. Many gardeners in this study use this product as it is part of the city's recycling program and is locally sourced. Members of organized gardening groups were twice as likely to use Dyno Dirt than those in the KDB/DRC group. Since most new homes will require amendments to make them suitable for growing, promoting the use of a local product like Dyno Dirt could be combined with efforts of local organized gardening groups to increase the use of native and eco- friendly plants. Partnering with the city officials during plant sales of the organized gardening groups could increase both the knowledge of locally sourced garden products and native and eco-friendly plants.

The Problem with Defining "Native," "Invasive," and "Weeds"

As this study focuses on the number of "native" and "eco-friendly" plants present in each garden, gardeners were asked how they define the term "native" and what plants are considered "weeds" or "invasive". "Weeds" had a much more ubiquitous consensus as to a definition, with the overall feeling that weeds are anything that is growing where a gardener doesn't want it.

Several Master Gardeners and Master Naturalists admitted that they don't pull up plants until they know what they are and can decide if they want it in that spot or not. One Master Gardener said that it wasn't always easy to identify leaves of new plants and so it was necessary to allow plants to bloom before removing them. As noble as this sounds, there is always the

potential that a "native" or "eco-friendly" plant may be removed from a garden simply because it is in the wrong place at the wrong time. Particularly with those gardeners concerned with how their garden looks or with having a more controlled environment, removing potentially native plants is probably often a reality. Since these same gardeners profess a dislike of "messy" or "scruffy" looking gardens, they may be removing potentially ecologically positive plants in favor of exotics or non-natives.

"Invasive" is also a difficult to define term and may cause confusion among gardeners. Each gardener has a different idea as to what an invasive plant may be and often it depends on the willingness of the gardener to work on controlling potentially invasive plants. If the plant can be controlled, the gardener may not consider it "invasive". For example, plants used for ground cover or to fill in larger spaces, like ajuga, mondo grass, ivy, nandina (bamboo), vines, and creeping plants, are often listed in scientific databases as "invasive" species because of their natural aptitude for covering large spaces quickly and the likelihood that, if introduced to a natural, untended environment, they could quickly eclipse a native landscape. But if the goal of the gardener is to cover a large space and he or she has the wherewithal to work on limiting said species to a certain area, it may no longer be considered as a detrimental to the garden space. If that is the case, the gardener may no longer consider that species to be invasive, because it now serves a purpose and is not considered unwelcome. But if the gardener feels in constant "battle" with a particular species, then a plant that was not previously considered invasive may be termed as such due to the gardener's personal feelings towards such a plant. Like a weed, the term invasive rests in the eye of the gardener and his vision for the garden space. This also leads to the potential for exotic plants to be introduced into an otherwise native environment because a particular gardener wants a so-called exotic for his or her landscape.

As previously discussed, defining a native plant is also fraught with problems. Even the scientific community cannot seem to agree on a single definition for what constitutes a native plant. The nature of human movement means that plants will be introduced, and have been introduced, by people. It is unclear at what point an "introduced" species become "adapted" and if, then, the "adapted" plant can be considered "native". Even the database used for determining native plants in this study, the Native Plant Information Network (NPIN), which is run by the Lady Bird Johnson Wildflower Center at the University of Texas at Austin (LBJWC 2016), lists 9 different definitions of native that have been compiled from various sources. While they all differ, the one thing they have in common is that they agree that plants must be present in the environment without human intervention and evolve naturally in the ecosystem. Therefore, introduced species, under this definition, would not be considered a "native" plant. However, it is always possible that a plant that has been adapted for as long as recorded history, or as long as the memory of the gardener, but technically does not originate in the region, could be considered a "native" plant due to the fact that it has become so ubiquitous in the region that it is part of the natural landscape. Some gardeners believe that if a plant is providing services to the environment, such as providing food or shelter for fauna and insects, it is considered "adapted" and, in their minds, "native". If this is the case, the number of "native" plants in a garden could be higher than what is presented here, depending on the views of the individual gardener.

Implementing Change: Challenges and Possibilities

Gardeners in Denton, Texas are in fact improving the biodiversity of the local ecosystem by planting a large number of unique plants. Those who are members of organized gardening groups are also planting anywhere from 30% to 79% native plants in their gardens spaces and up

to 70% eco-friendly plants, making even the low end of the spectrum up almost 50% natives and eco-friendly plants. Since these organized gardening groups represent those with high levels of knowledge about gardening and the importance of native plants, if all residents were to follow this trend, native and eco-friendly plants present in the local ecosystem could reach upwards of 50% of the total vegetation of garden space.

As seen from the KDB/DRC group, not all residents reach the high levels of native diversity as that of organized gardening groups. One roadblock in the implementation of natives is the lack of easily accessible information about gardening with natives and eco-friendly plants. Members of this group expressed frustration with trying to find pertinent information relating to the use of natives in the home garden. This information is scattered broadly among a number of sources and can sometimes be difficult to track down without a targeted idea of exactly what is needed. Lack of time to do such broad searches and sift through this information is a concern for most gardeners, the same reason they often do not join organized gardening groups. If a single or small number of sources could be created with easily accessible information on using natives in the local environment, it is possible that gardeners and homeowners like those in this group would be willing to use this knowledge when choosing plants and gardening methods. Local libraries, Keep Denton Beautiful, and the City of Denton could all help to provide residents with localized information about gardening with natives and avenues for help. Both the Master Naturalists and the Master Gardeners have volunteers willing to assist local gardeners with their gardening problems, but no gardeners in the KDB/DRC group knew that such help existed.

Since Master Gardeners and Master Naturalists both require volunteer service hours as a condition of membership, partnering with local organizations like KDB could increase the number of people who were aware that help was available to them and thus could help increase

the number of natives being planted within the city.

However, even if such a database were available or if more people knew about the help available to them by the Master Naturalists and Master Gardeners, there is no guarantee that all residents would be interested in using it. The time factor, coupled with a lack of desire, could still be a deterrent to planting natives in the home garden. Those with the ability to hire landscapers to do their gardening for them may be unlikely to utilize such a service. Landscape services often use exotic or hybrid plants even when homeowners request natives. DCMG3 and EFMN2-MG6 both hired landscapers to plant natives in the gardens at their new homes. Both expressed frustration with the number of exotics that were planted in place of the requested natives. EFMN2-MG6 was in the process of replacing her exotics with native counterparts at the time of interview and had hired a second landscaper to do the work. If someone less interested in gardening was given exotics instead of natives, he or she might be less likely to try and fix the problem, preferring to leave things as they are. Encouraging landscapers to switch from exotic to native plants could be a daunting task, as they are often bound to the suppliers that they use.

KDB2 is a landscaper who buys her plants from a local nursery and often plants with natives when requested because they are more water wise. She feels that she is in the minority, however, as her colleagues often go for commercial nurseries where prices are cheaper and the plants tend to be hybrid or exotic. Further research on the use of landscapers and the potential for landscapers to switch to using natives is necessary.

Personal choice is also a great deterrent to using native plants. As seen in the case of Master Gardeners, aesthetics and desires often outweigh environmental sustainability. This is not limited to Master Gardeners. DRC1 chose plants that reminded him of his childhood in Puerto Rico. Convincing someone who gardens for memory to switch to native plants could be

difficult, as it essentially changes the reason that the person gardens in the first place. If other gardeners' reasons for choosing plants are personal, emotional, or deep seeded, forcing change upon them could be futile.

Determining the ability of garden plants to sustain native fauna and pollinators, especially those which fall under the category of "adapted," could also be helpful in promoting the use of eco-friendly plants. As the definition of "native" is highly disputed, encouraging any plants which offer services to the local ecosystem could be beneficial. Further study into the role of "adapted" and "native" plants could help gardeners understand which plants would be most beneficial for both their own personal garden and the larger ecosystem.

CHAPTER 4

CONCLUSION

Domestic gardens can be bastions for biodiversity of both flora and fauna. Studies have shown that domestic gardens can have higher levels of biodiversity than wild or semi-wild landscapes. Unlike wild and semi-wild landscapes, the composition of domestic gardens is largely controlled by anthropogenic forces. Choices made by the individual, therefore, have a large impact on the overall biodiversity of a given landscape. Discovering what kind of choices are being made in gardens in and around the city of Denton, Texas could be helpful in determining how organized gardening groups and those interested in environmental restoration can go about improving the utilization of native and eco-friendly plants.

Understanding how gardeners who belong to organized gardening groups with a focus on environmental restoration and/or general gardening choose plants and gardening methods helps to provide a baseline of what is possible in terms of implementing native plants into home gardens. Members of these groups show high percentages of native and eco-friendly plants (those that provide habitat like food and shelter for native fauna or pollinators). Even at the low end of the spectrum, nearly half of all plants in these gardens are native or eco-friendly. If all gardeners in Denton were to plant in a similar fashion, the number of natives and/or eco-friendly plants would nearly double.

Not all gardeners will reach this level. Those not affiliated with an organized gardening group had a far lower percentage of natives and eco-friendly plants, often half of that of members of organize gardening groups. Lack of easily accessible knowledge and exposure to native and eco-friendly plants means that these gardeners are choosing exotic and non-native plants with a higher frequency. Organized gardening group members are exposed to native and

eco-friendly plants more often than those not in such groups, due to both the nature of the groups to which they belong, as in the case of the Master Naturalists who volunteer at LLELA and are exposed to native and eco-friendly plants growing wild on a regular basis, and because they are promoted through education and knowledge sharing, as in the case of Native Plant Society members and Master Gardeners.

Even with such knowledge and exposure, implementation of natives and eco-friendly plants is not guaranteed. Master Gardeners who possess knowledge about natives and eco-friendly plants may choose exotics due to personal desire for a particular color or texture when designing and creating a garden. Their feelings of control over the landscape and desire to express themselves through their garden space supersedes their desire to plant with natives.

While they are still more likely than non-members to use natives, their use of natives is based on personal ideology rather than a desire to improve the environment.

The need for expression is also a deterrent for planting with exotics and natives. Memory gardening was cited in multiple cases, meaning that gardeners chose plants that reminded them of family members or places they had lived. These plants, more often than not, were exotic.

Convincing gardeners who garden for this reason to switch from exotics to natives could prove problematic, as their interest in gardening may be entirely tied to exotic plants as a way of connection with the past.

The choice of gardening methods is similar to that of plant choice. As the soil in Denton County is often naturally low in nutrients, coupled with the high volume of new homes being built and poor quality fill dirt being used in garden spaces, amendments are necessary to support plant life in most parts of Denton County. Gardeners who are more likely to choose high percentages of native and eco-friendly plants are also more likely to implement organic and non-

chemical gardening methods and choose organic products and amendments. Many gardeners in this category experiment with natural methods such as keyhole gardening, hugelkultur, and lasagna gardening, all of which naturally improve soil by breaking down yard and kitchen waste and turning it into nutrient rich compost. Conversely, those who plant with more exotics are more likely to use commercial or chemical gardening methods like applying commercial topsoil and fertilizer to their gardens or using raised beds filled with commercial garden soil like MiracleGro.

Identifying plants as "native" can also be challenging. No singular definition for the term "native" can be established, so different ideas about which plants are native can mean that some gardeners are planting "exotic" or "non-native" plants with the understanding that they are in fact "native." This happens most often in the case of "adapted" plants. While "adapted" plants were established in the ecosystem by humans, they have been part of the larger ecosystem for so long that they may now be providing habitat to local flora, fauna, and pollinators. If this is the case, they could be considered "eco-friendly" even if they are not technically "native" under most definitions. Therefore, the actual percentage of "native" or "eco-friendly" plants could be much higher than presented here due to differences in the understanding of a particular plant's role in the ecosystem.

Despite all these potential challenges, Denton gardeners are improving the overall biodiversity of Denton County. A total of 520 distinct varieties of plants were identified, with an average of 65 species and varieties in each garden. Eco-friendly plants were the highest average category (17 plants per garden), higher than both exotic (16) and native (14), and a nearly equal ratio of exotics to native plants on average. Those who belong to organized gardening groups had a higher average number of natives and eco-friendly plants than those who did not belong to an

organized gardening group. Master Naturalists and Native Plant Society members had the highest percentage of natives and ecofriendly plants, while Master Gardeners percentages of both plant types were slightly lower. Even so, Master Gardeners generally had twice the number of natives and eco-friendly plants in comparison to non-members.

Education was an important factor in plant choice, second to using water wise plants. Water conservation was the highest concern for all gardeners in the study. Those groups who advocate for the use of and expose members to native and eco-friendly plants with frequency had higher levels of native and eco-friendly plants in their home gardens and were more likely to choose organic gardening methods. Those groups who encourage a "control and exploit" paradigm, as understated as it might appear, were more likely to use exotics and resort to chemical methods of gardening when organic methods failed to produce the results needed. Still, those who received their education in these more formal circumstances were almost twice as likely to plant with natives and eco-friendly plants as those who did not. Gardeners who were not members of an organized gardening group more often expressed frustration with trying to locate information about gardening in the local environment and wished there was a single source where they could get advice on choosing plants for the local environment. Many gardeners in this category were unaware of the resources available to them through organized gardening groups and therefore did not utilize them often.

In spite of the encouraging findings that average gardeners are interested and willing to research gardening in the local environment, challenges to increasing the number of natives and eco-friendly plants in Denton County gardens remain. Many gardeners find native landscapes "messy" and "ugly." Changing this perception is an important factor in improving the use of natives in the home garden. Another problem arises in that even if a single source of information

were available to residents, there would still be those opposed to using such a resource. The strong influence of personal choice and personal motivation can be a deterrent to using native and eco-friendly plants in the garden, even if the knowledge is available or known. Additionally, those with a lack of desire to garden may hire landscapers who have no vested interest in using native plants and therefore will use cheaper exotics or non-natives.

Discovering what prevents homeowners from participating in gardening and how landscapers factor in to the number of exotics in the local ecosystem could be an important next step in improving the overall number of native and eco-friendly plants. Collaboration between organized gardening groups to improve the perception of native gardens by learning to design desired landscapes using a higher percentage of native and eco-friendly plants could be beneficial to local residents. Organized gardening groups need to improve their advertisement of their services so that more residents are aware of the help available to them when wanting to start a gardening project.

Denton, Texas has the potential to improve the local ecosystem by increasing the number of natives and eco-friendly plants utilized in home gardens and thus mitigating the land use changes between wild landscapes and urban environments. With time and effort from organized gardening groups and other organizations committed to environmental restoration, gardeners could play a key role in the future of the urban ecosystem.

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