ABSTRACT

An Environmental History: William Cameron Park, Waco, Texas

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Cameron Park is a 416-acre municipal park located at the confluence of the Brazos and Bosque Rivers near downtown Waco, Texas. The results of this project suggest first that the park's ridge-top was completely cleared for grazing during the late 1800s and early 1900s and secondly that release of the pastures led to differential regeneration of forest cover, first in *Juniperus* species and then with deciduous species. This release event took place eighty to ninety years ago, coinciding almost exactly with the dedication of Cameron Park in May 1910. Additionally, regeneration of deciduous species was concentrated initially along historic fence-lines so that delayed succession has been occurring as broadleaf species just now begin to move into the interior of former pastures. The result is that regeneration of *Juniperus* and broadleaf species has led to a significant increase in forest cover along the ridge-top since the abandonment of the pastures.

An Environmental History: William Cameron Park, Waco, Texas

by

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A Thesis

Approved by the Department of Environmental Studies

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DEDICATION

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CHAPTER ONE

Introduction

Cameron Park is a municipal park located at the confluence of the Brazos and Bosque Rivers near downtown Waco, Texas. The park, named for William Cameron—a Waco businessman and civic leader who died suddenly in 1899, was dedicated on May 27, 1910 (Tolson 1920, [467]). According to a 1975 article in the Waco Tribune-Herald, Cameron Park is 410 acres by deed and 416.72 to 418.51 acres by instrument computation, placing it among the largest civic parks in the United States (Cameron Park Vertical File). Little has been written on the park, however, so information on its history and vegetation remains unknown even to many Waco residents.

The purpose of this project is to write a general environmental history of Cameron Park (focusing on local settlement patterns) and a detailed history of the park's ridge-top (focusing on the impact of grazing on the ridge-top's tree species). Principal research questions include:

1. Has there been a quantifiable change in the forest cover of Cameron Park since the park's dedication?
2. Has there been a change in which species are present in Cameron Park since the park's dedication?
3. How were the ridge-top tree species affected by the abandonment of pastures?

Ideally, the information from this history will be used in future studies of the park that look specifically and in great detail at the impact of exotic species, the regeneration of native tree species, the impact on floodplain species of dam-construction, etc.

Chapter Two describes both the historic and scientific methodologies used in this project to address the above research questions. Chapter Three establishes a timeline of settlement patterns in Waco because different cultural groups interact with the landscape in different ways. It is important to highlight this “dynamic and changing relationship between environment and culture” because human activity permanently alters the landscape (Russell 1997, 41; Ward and others, 2002, 37; Wu and Hobbs 2002, 359; Cronon 2003, 13; Turner and others, 2003, 450). This section also emphasizes major events—tornadoes, floods, road-construction, etc.—which might have triggered periods of change in the park.

Chapter Four uses the results of the personal interviews and anthropogenic disturbance mapping to produce the general environmental history of Cameron Park. The information in this chapter provides a context within which the results of the detailed environmental history can be better understood. Chapter Five uses the results of the scientific fieldwork to create this detailed history, which discusses the impact of pasture release on the ridge-top tree species. Fieldwork is important because it can be used to establish “patterns of past landscapes” and to reveal “the variety of uses that have shaped the present and the interactions over time between changing uses and changing cultures” (Russell 1997, 36). Chapter Six is a discussion of the results, including an examination of the significance of the findings.

CHAPTER TWO

Historic Methodology

Review of Environmental History Literature

Environmental histories are studies of long-term ecological change in a specific area. This history uses both unwritten sources—interviews, scientific fieldwork—and printed sources—books, surveys, photographs, letters, maps—to extract information about the impact of grazing on the park's tree species (Russell 1997, 30 – 31; Cronon 2003, 6 – 8). More specifically, this project focuses on the locations of fence-lines because they denote former pastures (i.e. former grazing sites) and facilitate initial regeneration of tree species. Prior to beginning the detailed history of Cameron Park, it is helpful to review the common themes found in other environmental histories.

One of the most basic themes found throughout the environmental history literature is the idea that fieldwork is an essential component of any environmental history. Scientific fieldwork has long been used as a way to verify the accuracy of historic sources, which may be ambiguous, biased or incomplete. Each of the sources was written within a unique setting, and "both general and local contexts color what is written and how it is expressed" (Russell 1997, 26). Some common ways in which ecologists use fieldwork to verify sources include: searching for abandoned roads to validate maps, tracing vegetative boundaries to verify logging records, performing photographic comparisons to confirm descriptions of the vegetation, etc. (Russell 1997, 37; de Blois et al. 2001, 422; Huggard and Gomez 2001, xvii). Validation of historic sources is especially essential in areas like Cameron Park where little research has been performed and only a handful of sources exist.

At the same time, historic research is used to establish the location of research sites. Using historic sources to determine field locations is helpful because "Prior land use can leave a distinctive legacy in composition of terrestrial and aquatic communities, even when the vegetation appears to have recovered" (Turner and others, 2003, 450). Without the information gleaned from deeds, aerial photographs, memoirs, etc., ecologists are in danger of overlooking subtle changes and anthropogenic impacts.

In other words, both historic research and scientific fieldwork are vital components of an environmental history. Fieldwork authenticates the documentary record, and historic research in turn lays the foundation for fieldwork:

> The evidence gleaned from written sources comes to life for ecologists when they apply it to specific landscapes and their component ecosystems. They can then evaluate the importance of historical factors in affecting the structure and functioning of these systems. (Russell 1997, 36)

Without historic research, environmental historians are less able to ascertain if they have chosen the best study site, and without fieldwork, environmental historians are basing research on what may be nothing more than interesting stories. In response to this idea, I used five types of fieldwork to validate historic sources, to identify former pastures and to determine my general study locations.

The second idea found in the literature is that culture shapes environment: as cultures have evolved, the human-environment interaction has evolved as well. At various times, Americans have feared nature for its native peoples, exploited nature for its resources, sought nature for its divinity and interacted with nature in countless other ways:

> As early as 1653, the historian Edward Johnson could count it as one of God's providences that a 'remote, rocky, barren, bushy, wild-woody wilderness' had been transformed in a generation into 'a second England for fertileness.' (Cronon 2003, 5)

Anthropogenic shaping of the environment is more than a modern phenomenon: human settlement has always been accompanied by some degree of harm to the landscape.

Different cultural groups interact with the landscape in different ways. For example, "agriculturally oriented immigrants wielded their axes as soon as they arrived in America," but "native peoples lived in, on, and from the forests" (Pena 1981, 44; Russell 1997, 131; Huggard and Gomez 2001, xvii). Even within larger cultural groups, there is variation in how people view the land; despite common beliefs to the contrary, there were Native Americans who exploited the land's resources and Euro-Americans who respected the land's resources. Because the human-environment interaction varies between and within people groups, the modern landscape is a mosaic of systems at different levels of disturbance (Russell 1997, 7; Wu and Hobbs 2002, 358; Turner and others, 2003, 458; Worrall 2005, 178). Accordingly, changes in culture must be studied alongside changes in vegetation.

This changing relationship between man and nature can be seen in Cameron Park. In the mid-1800s, despite the proximity of Waco Village to the park, initial settlers drew on the land for timber and food but otherwise avoided settling in the area. As the town's population grew exponentially during the late-1800s, people began settling in what would become the park, yet by the early-1900s, people began to value the area's natural beauty and set aside the land for park use. Because culture shapes environment, I used anthropogenic disturbance mapping and oral memoirs to determine how the view of Wacoans towards Cameron Park changed over time.

A third theme in the literature emphasizes the importance of distinguishing between natural and anthropogenic change. Ecosystems are dynamic: not all ecosystem change is a result of human activity, and some systems are dependent on change associated with natural disturbance events (Pogue and Schnell 2001, 295; Ward and others, 2002, 42). Improper regulation of disturbance-dependent systems can even hinder the change that maintains the environment: "In highly regulated river segments, landscape patterns may be 'frozen in time' by dams and artificial levees (Ward and others, 2002, 37). Both fire and flooding played a role in Cameron Park; minor floods historically occurred on the Brazos River on a yearly basis, and while there is no data on frequency of fires, the ridge-tops in Cameron Park are typical of fire-dependent ecosystems.

It is possible if difficult to distinguish between natural and unnatural changes. Linear boundaries and even-aged stands generally indicate an anthropogenic disturbance while irregular boundaries with trees of varying age point to a natural disturbance (Russell 1997, 41; Pogue and Schnell 2001, 295; Turner and others, 2003, 449; Taverna et al. 2004, 690). Human-induced change is not an acceptable substitution for natural ecological processes because ecologists do not fully understand how natural systems function.

I discriminated between anthropogenic and natural change using vegetative plot studies and photographic comparisons, a visual means of identifying changes. The Texas Collection at Baylor University has gathered still photographs of Cameron Park dating to the early 1900s, and other photographs can be found in books or pamphlets tangentially addressing the park (Figure 2.1). As the photographic comparisons in Appendix D show, there has been growth both in the park's canopy cover and understory. In some of the photographs, the cliffs, individual trees are identifiable; in other photographs—such as those taken at Proctor Springs, tree regeneration is obvious.

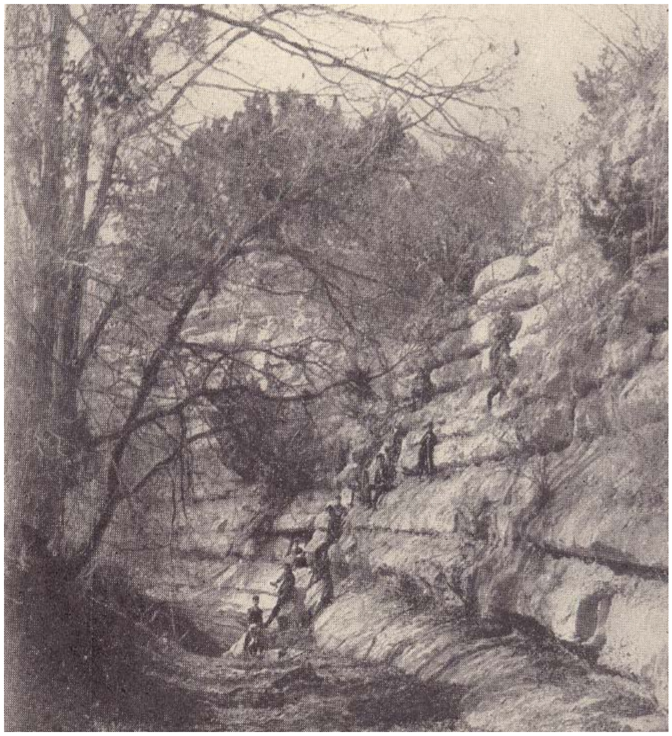


Figure 2.1. 'Lover's Leap' 3 miles north of Waco in 1901. Land for the park had not yet been donated (Prather 1901, plate 1).

The final idea found throughout the literature is that human factors (e.g. agriculture, construction, road-building, dam-building) currently have a much greater impact on the landscape than do environmental factors (e.g. geology, hydrology, soil, topography, etc.) (de Blois, Domon and Bouchard 2001, 434; Huggard and Gomez 2001, 111; Pan and others, 2001, 100; Pogue and Schnell 2001, 296; Ward, Malard, and Tockner 2002, 37). The influence of human versus environmental factors can be seen clearly in forests (like those in New England or here in Cameron Park) where the pre-settlement landscape reflected soil types and climate while the current landscape reflects recreational, residential and commercial use (de Blois and others, 2001, 421).

Forest stands have been especially prone to human disturbances because both the land and the trees are valuable. The anthropogenic impacts, however, are diverse and not limited to the clearing of forests:

> In addition to directly altering the type of forest patches and their spatial pattern, such as by plantation and clear-cutting, land use can also trigger secondary succession through field abandonment, or modify the natural forest succession processes, such as by grazing or selective cutting. (Pan and others, 2001, 100)

As a result, management of forests must both minimize human factors and restore the environmental factors that shaped the land in the first place.

Most of the land in Cameron Park has been directly affected by human activity—be it logging, grazing or settlement. This high level of human activity in the park was one of the catalysts behind the anthropogenic disturbance mapping. Maps such as the Bird's-Eye View Maps and Sanborn Fire Insurance Maps were also particularly useful because they offered extremely detailed views of the city. Digital and hard copies of the Sanborn Maps are found in the libraries at Baylor University in Waco, Texas, and the Bird's-Eye View Maps can be accessed through the Amon Carter Museum in Fort Worth, Texas.

Historic Methodology

This project studied historic maps, surveys, deeds, speeches, etc. to trace the early vegetation and development in Waco. Some sources explicitly addressed the vegetation while others focused on the culture and only indirectly mentioned the vegetation. Historic documents are one of the richest sources of information about the relationship between man and nature because they provide a temporal context for the research. Primary sources are especially valuable because they provide information on historic landscape pressures and cultural attitudes.

Because the historic documents dealt largely with local and regional history, they provided general background information rather than detailed, formative information about the park. As a result, information from the historic research has been included with the methodology of the historic research. It is important to remember, however, that historic documents may be inaccurate, biased or exaggerated. In an effort to cope with any possible bias or inaccuracy in my sources, I compared the results of my historic research against the results of my fieldwork, checked the information found in historic sources with other sources and refrained from taking the information as absolute.

Maps

Maps are important because they possess a temporal context which provides easily-interpreted visual information and calls attention to change (Pan et al. 2001, 101; Ward, Malard, and Tockner 2002, 36). In particular, maps provide valuable information on settlement pattern changes and the evolving cultural awareness of the local landscape:

> Maps depict selected abstractions of real geographic space, reflecting conscious or subconscious selections made by the mapmaker. These choices can be analyzed to understand general attitudes held by the mapmaker about that geographic space and about the people who lived in it. (Lape 2002, 43 - 45)

Maps are drawn for particular purposes—thematic, historic, geologic, etc.—so understanding the motives of the mapmakers is crucial to interpreting the map itself.

I accessed historic and thematic maps in collections such as the Perry-Castañeda Library at the University of Texas at Austin, the Texas Collection at Baylor University, or the State Archives in Austin, Texas. During March 2006, I made two trips to Austin, Texas, to visit the Perry-Castañeda Library and the State Archives to study the maps, and I visited the Texas Collection in Waco several times to look through the maps.

The criteria I used to analyze the maps differed depending on the type of map used. For geologic maps, I looked for maps which included the Cameron Park area, were sufficiently detailed and had been updated or drawn recently. Criteria applied to historic maps and thematic maps varied depending on the publication date and theme of the map. Sanborn Fire Insurance Maps, for example, provided detailed information on building outlines; heights and function of structures; street names; street and sidewalk widths; property boundaries; and house and block numbers (Digital Sanborn Maps 1867 - 1970). There are no sheets specifically addressing Cameron Park in 1926, but the Sanborn Map index shows that Cameron Park was bordered by development on all sides and that a road network crisscrossed the park. For both historic and thematic maps, it was imperative that I be able to locate accurately the City of Waco on the map.

For maps dating to exploration in Texas, I looked for descriptive labels (e.g. denoting prairie, buffalo, wild horses, etc.); specifically, I looked for the Brazos and Bosque Rivers so I could pinpoint the location of Waco. Changing labels often provided formative data about an area. For example, Alexander de Humboldt's "Map of New Spain" (1803) showed only the Brazos River and "fertile savannahs" yet Stephen F. Austin's "Map of Texas with parts of the Adjoining States" (1835) showed the Cross Timbers, Brazos River, Waco Village, buffalo, cattle and wild horses (Texas Maps: 1800 – 1829; Texas Maps: 1830 – 1839). "Map No.2: Colonial Texas: 1822 – 1834" (1847), "Mapa geografico de la Provincia de TX" (1822), "Mapa original de TX por el cuidadano" (1829) and "Map of Spanish Texas" (1856?) noted the Cross Timbers, Rio de los Brazos, Pueblo de los Huecos, *llanos, Ganado vacuno en gran numero*, Comanches, Tonkawas and Apaches near Waco (Texas Maps: 1820 – 1829; Texas Maps: 1850 – 1859).

For maps dating to the settlement of Waco, I tracked development: roadways, urban development, rail lines, etc. Bird's-Eye View maps provided valuable information about development in Waco. Some have questioned the reliability of the maps, but "in terms of what you see in the landscape, they're really pretty reliable with a few exceptions;" artists were more likely to have left out structures or elaborated on the appearance of buildings than to have added structures (Hafertepe 2006). Bird's-Eye Views exist for Waco for 1873, 1886 and 1892, and though Cameron Park does not appear on the maps until 1892 (when Proctor Springs, the historic picnicking area donated by the Cameron family to the City of Waco, appears), the maps reveal that roads approached the park as early as 1873 (Texas Bird's-Eye Views). In fact, what appears to be a streetcar is apparent in the 1892 map, running from downtown Waco along Herring Avenue to Cameron Park (Bird's-Eye View Collection).

Records

Historic records provide detailed information about specific events: environmental concerns, land transactions, births, deaths and war-time needs. Records offer "a temporal context for studying the history of human impact on the landscape" because they address what people believed to be the pressing issues of the day (Russell 1997, 20). Because records tend to be very specific and to address exact events, they are typically used in conjunction with other sources, such as aerial photographs, digitized maps and fieldwork (de Blois and others, 2001, 423; Ward and others, 2002, 36; Cronon 2003, 6 – 8).

I visited the McLennan County Clerk's office to access deeds recording local land grants, and in searching these deeds, I looked for the names of known grantors (W.W. Cameron, J.J. Riddle, M.H. Proctor, etc.). In addition to the May 10, 1910 donation, deeds from the Cameron Family to the City of Waco date to May 19, 1920; September 9, 1920; March 16, 1921 and February 14, 1922; the Wm. Cameron Company deeded land to the city on December 28, 1942 (McLennan County Deeds). Archived collections of family papers are found in the Texas Collection, and a series of deeds reveals that by 1850 the 11-league Tómas de la Vega grant across the river from Cameron Park had been broken into smaller grants—the Hays, Barton, Spenser and Curhill Surveys (Hays family papers). Data on agricultural and wartime production is found chiefly in government publications.

Memoirs

Memoirs are tremendously important because they are personal accounts of how people viewed the environment in which they lived. Fortunately for historians, the historic emphasis on leaving a legacy prompted many people to keep memoirs, especially during times of change or interest, and often, these memoirs were reproduced in speeches and newsletters. These reproductions are especially valuable when, as is often the case, the original accounts have been lost. The Texas Collection at Baylor University houses an extensive collection of memoirs compiled by the Institute for Oral History, which I pored over looking for references to historic tree species, development, etc. It was not possible to search all of the memoirs so I looked specifically for keywords such as: Cameron Park, Proctor Springs, flooding, development, picnic, horses, etc.

Memoirs are most helpful for the general historical information that they provide. For example, Rachel Plummer, a captive of Comanche Indians, described the Cross Timbers in her memoirs, noting “small prairies, skirted with timber of various kinds—oak, of every description, ash, elm, hickory, walnut and mulberry” (Plummer 1968, 5).

Moreover, memoirs are oftentimes reproduced in speeches and newsletters. The 1959 Texas State Historical Association meeting discussed the memoirs of George Erath and his comments on the Waco Indians, the creation of McLennan County, the founding of Waco Village and other moments in Waco history.

Anthropogenic Disturbance Mapping

Anthropogenic disturbance mapping is a descriptive form of fieldwork that involves identifying and mapping historic fence-lines, house sites, recreational sites and roads. Disturbance mapping is especially crucial in Cameron Park because development has been occurring within three miles of the park since 1849. Isolating sites of anthropogenic activity is essential to understanding the current tree composition because “Land use and land cover predominantly determine the structure, functioning, and dynamics of most landscapes throughout the world” (Wu and Hobbs 2002, 359). For example, the presence of fence-lines or outhouses in a *Juniperus* canopy can offer information on whether the canopy is natural or a result of grazing.

Mapping was completed during the summer of 2006 and involved noting the locations of concrete slabs, concrete pieces (e.g. bricks, steps, cinder blocks), structures (e.g. outhouses, archways), trash, wire piles, fence-lines, fence-posts and miscellaneous items of interest. Because I wanted the results to reflect historic anthropogenic pressures, I did not note the locations of fence-posts, trash piles and concrete slabs which obviously had been put in place recently. In lieu of using GPS to note the location of the above artifacts (it was not practical given the five meter accuracy of my equipment), I hand-drew locations onto a trail map provided by the City of Waco. Disturbance mapping was conducted along all of the trails in Cameron Park and within some of the park’s interior.

Personal Interviews

Interviews are advantageous because the interviewer can ask specific questions about species composition, regeneration rates, land use, etc. For this history, fifteen people were interviewed during the summer of 2006; Catherine Guinn, an undergraduate at Baylor University, conducted four of the interviews as part of an anthropological field school. The informants were people with extensive knowledge of the park—former and current park employees, long-time park-users, long-time Waco residents, etc. The results of the interviews were used to validate historic sources, to fill informational gaps and to elaborate on information inferred from photographs, maps and fieldwork.

With the informants' permission, the interviews were recorded and transcribed, and copies of the tapes and transcriptions were given to the Baylor University Texas Collection. Transcription was completed in January 2007. Dr. Kenneth Hafertepe, Interim Chair of the Department of Museum Studies at Baylor University, was the only informant whose interview was not captured on tape, but notes were kept during the meeting and checked by Dr. Hafertepe. For all other informants, there were times during the transcription process when words were unclear (due to microphone issues, flipping of tapes, mumbling, etc.); these words were marked as unintelligible.

CHAPTER THREE

Scientific Methodology

Review of Scientific Fieldwork

Digital Analyses

Geographic Information Systems (GIS) and Remote Sensing programs display and manipulate data visually, providing a dynamic view of an area. This project used ArcGIS and ERDAS Imagine to study changes in Cameron Park's tree species. The analyses were conducted in January and February 2007. ArcGIS was used to digitize the data collected during disturbance mapping, and the result was a series of maps displaying the locations of all anthropogenic artifacts. Areas with high concentrations of artifacts almost certainly represent areas of historic anthropogenic use.

ERDAS Imagine was used to track changes in canopy cover by performing supervised classifications on aerial photographs. Once the photographs were imported into ERDAS and georectified, supervised classifications were performed on each of the photographs. Ideally, spectral classes would have been broken down very specifically—infrastructure, roads, grassland, barren land, agricultural land, cedar brakes, deciduous corridors, etc., but this specificity was not possible in Cameron Park because the quality of the aerial data was limited (de Blois et al. 2001, 424; Pan et al. 2001, 101; Pogue and Schnell 2001, 290; Narumalani et al. 2004, 481; Bai et al. 2005, 95; Sivanpillai et al. 2005, 346). Landcover was very generally categorized as forest cover, grassland, water and non-vegetative cover.

Incremental Tree Coring

Incremental tree coring is used in areas with even-aged stands, systemized patterns or decreased diversity to verify data about how the tree species have changed. The tree cores taken during the process are remarkably informative: "a cross-section of a tree trunk reveals age, episodes of suppression and release, nutrient status, climate, fires and other disturbances such as defoliation, and other information" (Russell 1997, 46). Natural systems should be "a patchwork of diverse communities arranged almost randomly" so simplified landscapes suggest human impacts (Cronon 2003, 32 – 33).

Coring was conducted in three ridge-top locations showing successional growth. Fifteen cores were taken between the three locations for two species—cedar elm (*Ulmus crassifolia*) and durand's white oak (*Quercus sinuata var. sinuata*), and ten cores were taken for live oak (*Quercus virginiana*) and Texas ash (*Fraxinus texensis*). Eastern red cedar (*Juniperus virginiana*) and ashe juniper (*Juniperus ashei*), despite being important species, were not cored since false rings make their cores difficult to read. The cores were mounted on blocks; sanded using 220, 400, 600, 800, 1000 and 1200 grit paper; and analyzed with a linear-encoder measurement stage. The aim was to determine rough age-DBH (diameter at breast height) relationships for each species. Raw coring data is in Appendix A. All Latin names were derived from Shinners and Mahler's *Flora of North Central Texas* and fieldwork conducted using the smaller Stahl and McElvaney's *Trees of Texas: An Easy Guide to Leaf Identification*.

Vegetative Plot Studies

Vegetative plot studies are valuable because they provide detailed information about test areas of varying size, and scientists can extrapolate from these microcosmic sites to larger study areas. Moreover, plot studies are indispensable in patchy forest stands because "Even areas that remain predominantly forested may be changed considerably by human alteration of historical disturbance regimes" (Wimberly 2004, 631). This project used plot studies to understand how release of former pastures affected regeneration rates of deciduous and *Juniperus* species in Cameron Park's ridge-top locations. This type of general plot study is a form of vegetative census, focusing primarily on identifying the species, age and diameter at breast height (DBH) of each tree (Horvitz et al. 1998, 459).

Plot studies were conducted during the winter of 2006. For the study, three 10 by 10 meter plots were set up at 10 meter intervals to form a line running perpendicular to a known fence-line; a replicate line of plots was set up nearby (Figure 3.1). The result was five sets of replicated lines within three ridge-top locations. Ideally, pairs would have been spaced further apart and each site would have included more than three plots, but this was not possible in Cameron Park because of the density of the trails, the probability of intersection a second fence-line and the variability of the terrain. Plot sizes were kept small to accommodate fence-lines and the terrain. GPS coordinates for the plots are in Appendix B, and the results of the plot studies are in Appendix C. Multi-stemmed trees are shown with hyphens between individual stems and brackets at the first and last stems.

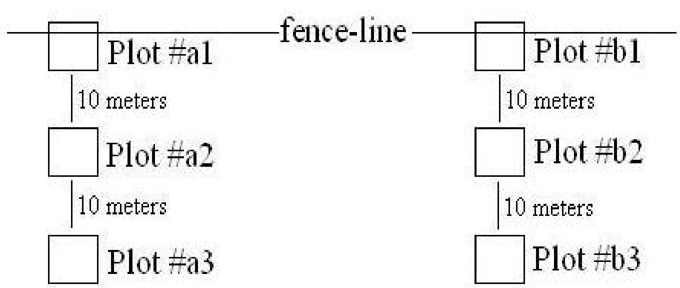


Fig 3.1. A diagram showing the layout of plots. It is important to remember, however, that individual plots might be offset to avoid interfering terrain and hiking/biking trails.

Four sets of plots (sets one and two near the trails *Colorado, Erect* and *Slinky* and sets four and five near the trails *Baseball and Cedars*) were used for a statistical analysis of the regeneration rates of cedar and broadleaf species within the ridge-top. Set three near the trail *Outback* was used solely for descriptive purposes and not included in the statistical analysis. Data from the plot studies were analyzed in SPSS and Microsoft Excel. Pearson chi-squared tests and standard t-tests were run in SPSS to determine the statistical significance of the data based on the means; Microsoft Excel was used to create graphs based on number of individuals and total summation of the data.

There were a few difficulties which must be discussed. First, there were several large, open-crowned broadleaf trees scattered throughout the park. These trees most likely date to the time when the park's ridge-tops were grazed, and the presence of these trees affected the regeneration rates of the saplings: clusters of seedlings were often found both directly beneath the parent tree and in patches within ten to twenty meters of the parent tree. I did not account for this variable statistically as the statistical analyses were already complex. I did, however, note when these trees were found in or near any of the plots, and this information can be found in the notes section of the data sheets in Appendix C.

Secondly, differentiating species in the understory was extremely difficult for two reasons. On one hand, several species have hybridized to the point of being nearly indistinguishable even in the canopy. The problem species in the park were ashe juniper (*Juniperus ashei*) and eastern red cedar, buckley oak (*Quercus buckleyi*) and shumard's oak (*Quercus shumardii*). In both cases, hybridization has formed something resembling a gradient so that the species and the hybrid were classified under one heading—'eastern red cedar' and 'shumard's oak.' Some of the shumard's oaks had retained leaves at the time I conducted the plot studies, but it was still not possible to key the trees.

On the other hand, several understory species could not be distinguished. *Crataegus* species have not been examined in-depth in this area by taxonomists so it was not possible to key them with certainty, though there were at least three or four species in the plots. Shrubby *Prunus* species have been identified in this area, and at least two or three species were found in the various plots, and I did identify canopy *Prunus* species such as laurel cherry. Since the plot studies were conducted during the winter months, I thought it best not to key the species in the absence of flowers and leaves, but keying the *Prunus* and *Crataegus* species would have been difficult even during the spring or fall. Latin names were again derived from Shinners and Mahler's *Flora of North Central Texas*.

Photographic Analyses

Still photographs can be studied separately to understand what an area looked like at a particular time or compared with photographs taken at the same vantage point at different times to reveal how the area has changed (Ward, Malard, and Tockner 2002, 36). Still photographs are open to interpretation so they should be viewed as a way to support rather than prove hypotheses. The most valuable source of historic still photographs of the park is the Texas Collection's Cameron Park Photo Collection, which includes photographs dating to the early-1900s and also includes postcards based on early-1900s watercolors of the park. Formal photographic comparisons of historic and modern still photographs were carried out during the winter of 2005, see Appendix D.

Studying aerial photographs provides an even more dynamic model. Aerials highlight subtle changes in texture (how rough or how smooth objects appear), pattern (the density and arrangement of the objects) and spectral reflectance (how light or how dark objects in the photograph appear). Because texture, pattern and reflectance are unique to different land-types, aerial photographs offer information about vegetation, boundaries, land uses, physical structures and terrain and are essential to pulling together detailed information from still photographs, written records, maps, etc. into a coherent, larger picture (de Blois, Domon and Bouchard 2001, 423; Pan et al. 2001, 101).

This project used aerial photographs from 1941, 1951, 1958, 1964, 1972, 1981, 1995 and 2004 to confirm changes in canopy cover and development seen in still photographs. Specific changes from year to year were more easily understood when studied using ArcGIS and ERDAS Imagine. Aerial photographs were also studied, however, using a stereoscope to gain a three-dimensional view of the relationship between topography and land-use. The 1941 aerial photograph was purchased from the National Archives at College Park, Maryland; the 1958, 1964, 1972, 1981 and 1995 aerial photographs were purchased from the Soil Conservation Service in Waco, Texas; the 1951 photograph was loaned to me by Dr. Joseph White at Baylor University and the 2004 aerial photograph was given to me by Mr. Jake Krall in the City of Waco GIS Department.

Site Description

Topography

The topography of Cameron Park is diverse and includes cliffs, hills, valleys, meadows and ravines. The cliffs are a product of the Balcones Fault, “thousands of breaks all allowing movement in the same direction,” which runs across Texas from the southwest to the northeast and dips to the southeast at a rate of twenty to ninety feet per mile (Poage 1981, 2; Wallace 1983, 10; Kibler and Gibbs 2004, 1). The topography in Cameron Park varies because McLennan County is at the juncture of several systems. Near Waco, the grasses of the Black and Grand Prairies, the forests of the Cross Timbers and the cliffs of the White Rock Escarpment meet, "the sinuous line of contact between woodland and prairie" (Tharp 1939, 31; Templin 1958, 6; Leach 1978, 40; Wallace 1983, 11; Hayward et al. 1992, 16; Kibler and Gibbs 2004, 1). In the park, this results in slopes leading from the cliffs to the Brazos River (Fraps 1916, 27; Kibler and Gibbs 2004, 1).

Soils

According to the "Geologic Atlas of Texas – Waco Sheet" (1954) and the "General Soil Map of McLennan County, Texas" (1974), the soils of Cameron Park are part of the Austin-Stephen-Eddy, Trinity-Frio and Asa-Yahola associations and are chiefly Austin Chalk (type *Kau*) with lesser amounts of Alluvium and Fluviatile terrace deposits (types *Qal* and *Qtc*) (Map Collection). The soils in the park have a mean pH of 6.6, are moderately permeable and are clayey or loamy; the chalk underlying these soils is 150 to 300 feet deep and is microgranular calcite (Francaviglia 1992, 21; Map Collection).

Austin chalk is "the geological 'backbone' of McLennan County," forming deposits four to six miles wide from Eddy through Waco to West (Poage 1981, 8). The chalk is "a massive stratified limestone with white and blue layers of different thicknesses," and it weathers easily so "often the whole surface of a hill is covered with loose pieces, some very finely divided" (Prather 1901, 1 - 2). It is this breaking and weathering that is responsible for the cliffs, known locally as the Devil's Backbone, found in the park.

Both Gulfian (Upper Cretaceous) and Comanchean (Lower Cretaceous) limestone weathers into the black soils which are found in the Waco area and gave the Blackland

Prairie its name (Pope 1890, 16; Bray 1906, 86; Poage 1981, 6). The black soils, usually found with lesser amounts of sands and clays, are extremely productive. Early settlers took advantage of the fertility and cultivated most of the land in the Blackland Prairie; the soils of the Grand Prairie, in contrast, are shallow, stony and best used for grazing (Pope 1890, 16; Templin 1958, 13; Wallace 1983, 11).

Hydrology

The principal surface waters in Waco are the Brazos and Bosque Rivers. There are, however, six drainage basins in the downtown Waco area: Barron's Branch, Waco Creek, Wilson's Creek, Primrose Creek, the Business District and East Waco (Spencer 1966, 9). Before the construction of Lake Waco Dam on the Bosque River and Whitney Dam on the Brazos River, the Brazos and Bosque Rivers flooded regularly ("Lake Waco," "Whitney Dam and Reservoir"). The lateral water flows associated with these floods shaped the vegetation in Cameron Park along the floodplain (Malanson 1995, 12).

The subsurface waters in Waco are primarily part of the Cretaceous Trinity Aquifer (Rupp 1976, 12). However, the Brazos River floodplain (and to a lesser extent the Bosque River floodplain) also generate groundwater as they collect rainfall:

> The highly permeable sand and gravel of the Brazos alluvium produce large quantities of ground water suitable for agricultural and domestic use. This shallow ground water is recharged by normal seepage from the Brazos River and rainfall on the flood plain. . .Although the Bosque alluvial sediments are generally less permeable than those of the Brazos alluvium, they transmit fluids in considerable quantity, primarily in rainy seasons. (Rupp 1976, 17)

Groundwater in Waco is primarily used for irrigation purposes (Rupp 1976, 17).

Natural springs are also an important component of Waco's hydrological regime. These springs are a result of faulting and breaking associated with the Balcones Fault, which draws water up through cracks in the underlying limestone (Poage 1981, 2 – 4; Hayward et al. 1992, 15; Hayward and Yelderman 1995, 18; Wallace 1999, 13). Throughout the mid- to late-1800s and early-1900s, Waco was known as the “Geyser City” in recognition of its numerous artesian springs (Pope 1890, 29; Wallace 1983, 44).

People traveled from all over the state to bathe in the waters and drink from the wells, believing the water to possess healing powers. Diseases believed to be cured by the waters included dyspepsia, rheumatism, syphilis, eczema and chronic blood, skin, liver and kidney troubles (Pope 1890, 3; Wallace 1983, 44). Copies of historic letters noting the healing nature of the water are included in Appendix E. Historically, artesian wells produced cool water around 1,200 feet and hot water around 1,800 feet, and the water temperature averaged around 103°F (Pope 1890, 1; Rupp 1976, 7).

The first water company, formed in 1872, depended on artesian wells (Rupp 1976, 7). By 1891, Waco had eleven flowing wells; by 1894, twenty wells operated in the city, and by 1897, Waco had twenty-seven operational wells (Rupp 1976, 7 - 9). Artesian well water (pumped from the Trinity Aquifer) provided most of the city’s water until 1912 when the demand of 28,500 city inhabitants finally outpaced supply (Rupp 1976, 7 - 9). While many of the natural springs have dried, some of the springs which catalyzed early development of the city, such as Proctor Springs and Barron Springs, still flow.

Climate

On one hand, the climate of Waco closely resembles that of east Texas. It is a humid, subtropical climate and averages thirty to forty inches of rain each year (Tharp 1939, 39; Templin 1958, 9; Spencer 1966, 11; Kibler and Gibbs 2004, 1). On the other hand, the climate also resembles that of west Texas. The climate is dry and hot, and though the warmest weather generally occurs in June, temperatures can top 100°F from May through September (Spencer 1966, 9; Leach 1978, 21). The climate can also occasionally reach surprisingly low temperatures—in 1899, temperatures fell to ten below zero, and the Brazos River froze over completely (Heritage Society of Waco 1999, 28). The result is a climate that is fairly moderate but can see substantial fluctuations in temperature, rainfall and humidity (Pope 1890, 18). The cliffs of the Balcones Escarpment mark the dividing line between the eastern and western climates (Wallace 1983, 11).

Vegetation Zones

The interaction of geologic variables shaped the vegetation in Cameron Park; the vegetation varies as the topography, soils, hydrology and climate vary. Waco developed along the interface of grassland and forest. The “Vegetation Type Map of the Southern Cross Timbers – Waco” (1974) shows grassland and a band of trees (Oak/Mesquite/Juniper/Mixed Woods with lesser amounts of Pecan/Elm/Live Oak Forest) indicative of the Eastern Cross Timbers, a strip of woodland extending from southeastern Kansas to central Texas (Map Collection). Historically, cities developed along prairie–forest edges because the prairie provided easily-cultivated land and the forests provided lumber.

Early explores in central Texas repeatedly commented on the prairie-forest boundary. Mary Austin Holley, cousin of Stephen F. Austin, documented the Central Texas landscape during an 1831 tour of the state:

> The surface is beautifully, and often fancifully, diversified with prairie and woodland; presenting to the enterprising farmer, large and fertile fields already cleared by the hands of nature, and waiting, as it were, to receive the plough. The woods which encircle the prairies afford the best of oak, cedar, ash, and other timber valuable for fencing and building. (Holley 1836)

Early explorers and settlers focused on this Cross Timbers-Black and Grand Prairies junction because it stood out in such stark contrast to the surrounding land (Bray 1906, 71; Roemer 1935, 3 - 5; Plummer 1968, 5; Jordan 1973, 235; Hayward et al. 1992, 7).

The dominant trees of the Eastern Cross Timbers are various species of oak, black walnut (*Juglans nigra)*, Texas ash, American elm, black hickory (*Carya texana*) and pecan (*Carya illinoinensis*) (Bray 1906, 70; Gregg 1933, 19; Tharp 1939, 31 – 33; Francaviglia 1998, 8). There is some debate, however, as to whether the Cross Timbers extend into Waco. South of Oklahoma, the Cross Timbers are increasingly relegated to riparian corridors so it may be more accurate to think of Waco as part of the 'False Cross Timbers,' a riparian extension of the Eastern Cross Timbers (Jordan 1973, 235; Hayward and Yelderman 1995, 12; Francaviglia 1998, 24).

The dominant grasses of the Grand Prairie and Blackland Prairie are little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii subsp. gerardii*) and yellow Indian grass (*Sorghastrum nutans*) (Kibler and Gibbs 2004, 3). Though the Grand and Black Prairies certainly reached the Waco area, it is unknown as to how near the Blackland Prairie came to Cameron Park. Some ecologists believe the cliff-tops in the park were historically part of the prairie ecosystem while others believe the park's grassland was not in fact part of the prairie.

CHAPTER FOUR

Historical Timeline

Review of Settlement Patterns

It is important to study an area's cultural history because as humans settle in an area, they permanently alter the land (Cronon 2003, 32). At the same time, the land influences settlement. The rough terrain in Cameron Park, for example, initially discouraged land brokers from surveying the area, but the fertile bottomlands of the Brazos River were cultivated immediately (Templin 1958, 13; Poage 1981, 81). Periods of settlement relevant to this study are: Native American, Spanish, Anglo-American frontiersmen, the railroad years, the cattle years, the park's dedication and the twentieth century.

Native Americans

The Wichitas, Tonkawas, Comanches, Caddos and Apaches all occupied the Waco area at different times (Newcomb 1961, 250; Watt 1969, 199; Kibler and Gibbs 2004, 5). The most influential of these groups, however, was a sub-tribe of the Wichitas and relative of the Caddos known as the Waco Indians, who migrated southward into Waco in 1700 and occupied the area longer than any other tribe (Newcomb 1961, 23; Wallace 1983, 13; Hayward et al. 1992, 16). Ellis Bean was the first to use the word 'Waco' when he wrote a letter to Stephen F. Austin from Waco Indian Village in 1827 (Wallace 1999, 12).

The Waco Indians founded two villages in the Waco area. The head village, El Quiscat, was on the west bank of the Brazos River south of Barron's Branch (near the current site of the Waco suspension bridge) while Flechazos was near Waco Creek in the vicinity of Baylor University (Watt 1969, 208 - 209; Wallace 1983, 13; Waco Indians Vertical File). The Wacos occupied these villages until 1835, when they began moving into present-day Palo Pinto County (Watt 1969, 209). As Anglo-Americans settled in central Texas, the Wacos migrated northward on the Brazos River away from the encroaching settlement (Figure 4.1).

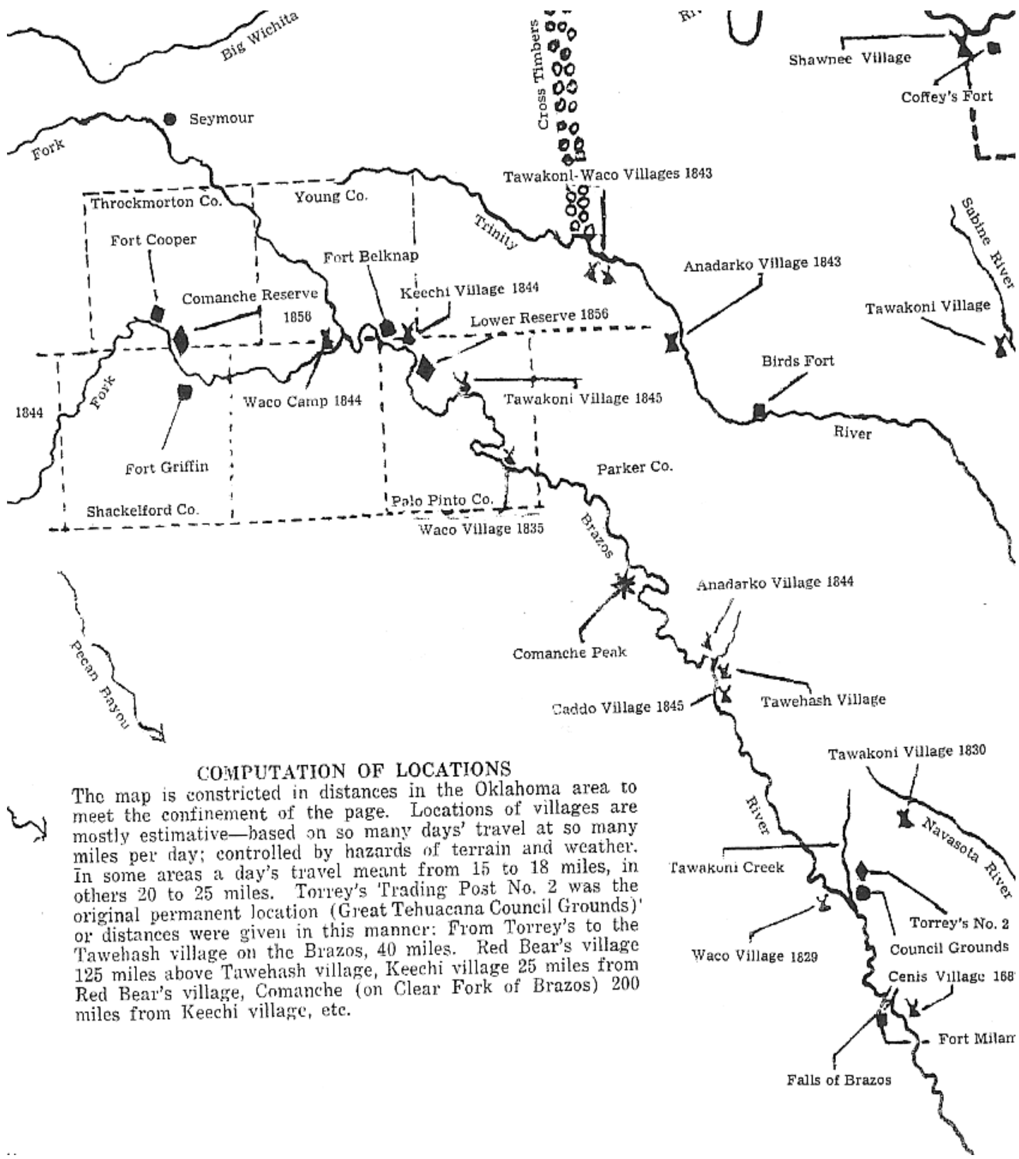


Figure 4.1. Movement of the Waco Indians north along the Brazos River to avoid encroaching white settlements (Watt 1969, figure 2, plate 2])

The Waco Indians were agriculturalists. At the head village, the Wacos cultivated over four hundred acres: growing corn, squash, beans, peaches and watermelons (Watt 1969, 203; Poage 1981, 15; Wallace 1983, 13; Wallace 1999, 13). After the Wacos acquired horses, they began to rely on bison and turkey as well and to leave their villages for months at a time in pursuit of game; however, "bison and other wild game remained supplementary to the produce of the gardens" (Newcomb 1961, 253).

The Wacos frequently interacted with other tribes. They allied themselves with the Tawakonis, who had settled at Tehuacana Creek by 1772 and were also members of the Wichita Confederacy (Wallace 1999, 14). In contrast, they constantly warred with the Cherokees, who attacked Waco Indian Village in 1829 and then set up camp across the Brazos River from the Wacos in 1830 (Watt 1969, 224; Poage 1981, 14; Wallace 1983, 13 – 14; Wallace 1999, 15; Waco Indians Vertical File). There were also Tonkawas to the east, Apaches to the west and Comanches in the area; a Comanche Trail passed by the Brazos-Bosque Junction (Texas Maps: 1820 – 1829; Texas Maps: 1850 – 1859).

The Wacos also interacted with Anglo-American settlers, but there is some debate as to the nature of the Native American-Anglo American interaction. Some early settlers accused the Waco Indians of being thieves and murderers. Stephen F. Austin accused the Wacos of a number of atrocities and sent Thomas Duke and Aylett Buckner to Waco Village in 1824 to ascertain the strength of the tribe and to learn whether attacking the village was an option (Watt 1969, 214; Wallace 1999, 12 – 15). In reality, while the Waco Indians likely participated in or instigated acts of violence, they were certainly not guilty of all of which they were accused (Roemer 1935, 13 – 14). The Anglo American-Native American relationship was more complicated than what is sometimes assumed.

The Wacos had a limited impact on the landscape—they only numbered between six hundred to nine hundred villagers and lived in Waco for sixty-three years (Watt 1969, 199 - 200). The Wacos' greatest environmental impact was cutting down trees for use in their huts—the Wacos used cedar from a sacred grove on the east bank of the Brazos, clearing land for agriculture and setting fires to round up game (Erath 1923, 85; Newcomb 1961, 255; Watt 1969, 204; Wallace 1983, 15; Wallace 1999, 13; Waco Indians Vertical File). The above activities kept the land cleared so that successional growth would have occurred after the tribe left Waco and the lands were released; this release would have occurred, however, prior to the founding of Waco Village.

Spanish

In 1540, the Spanish arrived in Texas, bringing horses, cattle and sheep: animals which would dramatically shape the lives of Indians and Europeans alike (Poage 1981, 64; Wallace 1983, 13; Francaviglia 1998, 54). In 1716, Capitán don Domingo Ramón crossed north-central Texas, and on June 14, 1721, the Marquis de Aguayo camped in Waco near the junction of the Brazos and Bosque Rivers while touring the region for the Spanish monarchs (Peña 1981, 43 – 45; Poage 1981, 25; Hayward and others, 1992, 17; Chipman and Joseph 1999, 90). Francisco Vásquez de Coronado, Fray Jose de Solis and Anthanase De Mezieres also traversed the area in the mid-1700s (Coronado 1904, 214; Francaviglia 1998, 59 – 63). In short, the Spanish presence in Texas was extensive.

The map, "Spanish Missions, Presidios, and Roads in the 17th and 18th Centuries" (1976), shows that the Spanish presence in Texas was concentrated on the coast (Atlas of Texas). More specifically, "A few missions, some military posts along the shore, and the settlements . . . made up the entire Spanish occupation until 1818" (Maissin 1961, 149).

The Spanish, however, eventually explored the state in its entirety. Stephen F. Austin's "Mapa Original de Texas" (1840), which was used by the Spanish in their exploration, included the 'Rio de los Brazos de Dios' (Brazos River) and the 'Pueblo de los Huecos' (Waco Village) (Texas Maps: 1800 – 1829). Other maps describe the Cross Timbers, surrounding plains and wild cattle, horses and bison (Chipman and Joseph 1999, 89).

The arrival of the Spanish in Central Texas marked a shift in the relationship between man and nature. Native Americans interacted with the land like any other group, but they generally showed greater respect for the land than the newly-arriving Europeans; Waco Indians, for example, viewed the landscape in mystical terms, referring to the Brazos River as the 'Great Tohomoho' or 'Woman Having Powers in the Water;' Europeans tended to value the land for what it could provide: timber, fuel and food (Wallace 1983, 13; Huggard and Gomez 2001, xviii). The Spanish killed buffalo (*Bison bison*), cut down trees to ford rivers, cleared land for agriculture, etc. to a greater extent than the Native Americans (Peña 1981, 44; Chipman and Joseph 1999, 90). Consequently, the ecological footprint of the Spanish was more extensive and permanent than that of the French or Indians and was the result of explorers passing through the area.

Early Settlers

The departure of the Native Americans and Spanish coincided with the arrival of the European settlers. McLennan County was part of Robertson's Colony (also known as the Nashville Colony or Leftwich Grant), granted in 1825 by the Republic of Mexico to Robert Leftwich, a land agent acting for a group of Nashville businessmen under the direction of Sterling C. Robertson (Gaines 1963, 3; Kibler and Gibbs 2004, 5). The contractual boundaries of the colony were defined as "beginning where the San Antonio road crosses the Trinity, thence following said road westward to the ridge dividing the waters of the Brazos and Colorado, thence following that ridge to the Cross Timbers, thence a northeasterly course to the Trinity, thence down the Trinity to the beginning;" the northern border was indefinite: nobody could determine the boundary of the Cross Timbers themselves (Erath 1923, 20; Poage 1981, 29). Robertson colony was not, however, immediately parceled to individual owners.

Private ownership began in Waco on April 26, 1832, with a two-league grant to Thomas Jefferson Chambers by the State of Coahuila and Texas (Templin 1958, 11; Francaviglia 1998, 111; Wallace 1999, 19). Tómas de la Vega received an eleven-league grant from the Mexican government on June 14, 1830, which was broken into smaller grants and sold to individual families; the Hays family, for example, owned 640 acres of the de la Vega grant (Conger 1958, 2 – 5; Hays Family Papers). Figure 4.2 shows a simplified map of early land grants; a more complete grant map is found in Appendix F.

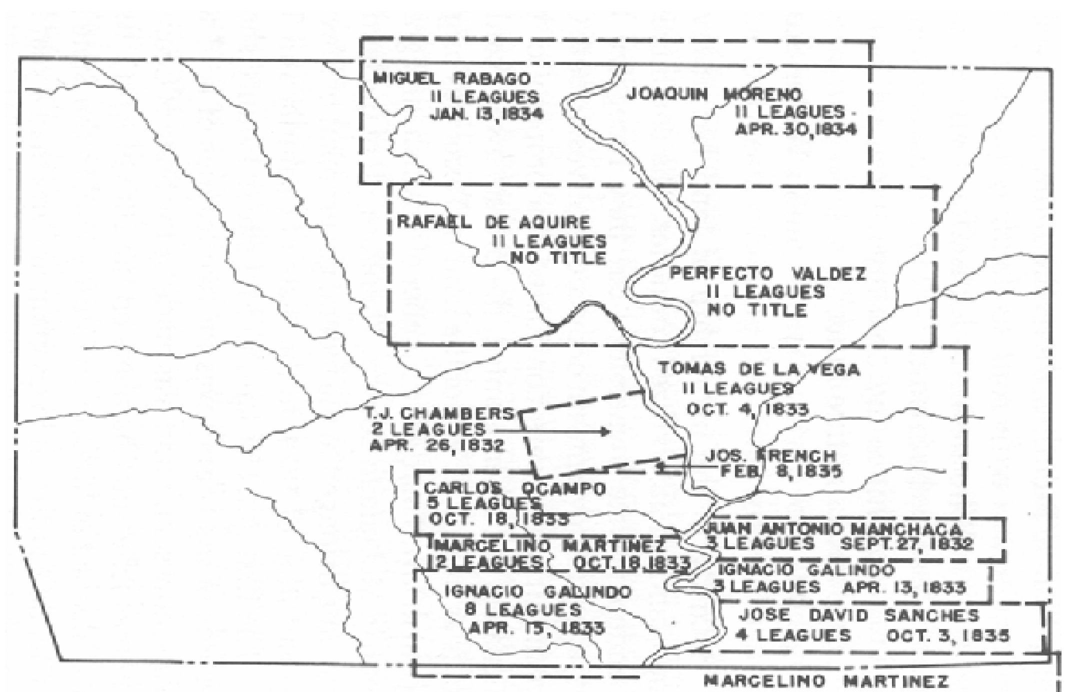


Figure 4.2. Early land grants along the Brazos River in Waco, Texas (Poage 1980, 79)

By 1836, all of the land in McLennan County along the Brazos River had been claimed, except for the land in Cameron Park:

> This land was evidently too rough to attract early land speculators. The land along the Bosque and the west side of the Brazos is at this point a series of limestone cliffs—Lover's Leap, Emmons cliff, Brazos Bluff. Farther back are cedarbrakes for some distance. (Poage 1981, 81)

What is today Cameron Park was part of the Stephens survey, which had been deeded to John B. Earle and J.S. Houser by J.Y. and J.J. Riddle in the 1850s; the area encompassing Proctor Springs was deeded by the widow of J.S. Houser, Mrs. Martha Houser Proctor, to John Walton in 1885 ("Cameron Park Research Collection"; Cameron Park Vertical File; McLennan County Deeds).

During the early-1800s, present-day Waco was beyond the edge of settlement in Texas; few people chose to settle in the area and isolate themselves from other frontiersmen. The first Anglo-American settler in the area was John Boyd, who in 1834 built a crude cabin four miles outside of Waco but left shortly thereafter; Torrey Brothers Trading House, opened in 1842 near Tehuacana Creek, was the first business in the area (Simpson 1963, 3; Poage 1981, 43 – 44; Wallace 1983, 15; Wallace 1999, 17). In 1837, the Texas Rangers built Fort Fisher in response to a Comanche raid on nearby Fort Parker; this region of Texas was so isolated and uninhabited, however, that the Rangers were ordered to pull out of the area only a few months later (Maissin 1961, 188; Poage 1981, 43; Wallace 1999, 17).

Settlement of Waco began in earnest during the early years of Texas statehood. In 1846, Jesse Sutton opened a blacksmith shop across the Brazos River from the Waco Indian Village; in 1847, Thomas Barron built the first home west of the Brazos, and in 1848, Neil McLennan built the first permanent home in McLennan County (Erath 1923, 84; Poage 1981, 52; Wallace 1983, 18 – 19). This influx of settlers prompted surveyors George Bernard Erath and John McLennan to lay out Waco Village on March 1, 1849, on the T.J. Chambers grant; Chambers had sold the land in 1848 to John Sydnor, who used land agent Jacob de Cordova to sell the land for a dollar an acre (City of Waco 1914, 9; Erath 1923, 85; Simpson 1963, 7).

Erath and McLennan were forward thinking when they laid out Waco's town square on March 1, 1849. At the time, only twenty families lived in what is McLennan County, but Erath and McLennan maintained adamantly that the area would one day become a crucial transportation corridor since it sat in the center of the state on several natural boundaries (Erath 1923, 85). Erath and McLennan were correct: people quickly moved to Waco Village. Shapley Prince Ross built the first log cabin in town in 1849, and by 1852, three hundred people lived in the 'city limits' (Erath 1923, 85; Wallace 1999, 22).

Early settlers took note of the landscape's dominant species: mesquite, ash, walnut, pecan, hackberry, elm and oaks (Bray 1906, 71; Gregg 1933, 19; Templin 1958, 9). It is important to remember, however, that some species may have been present that were not mentioned in early documents and that other species may not have been present even though they were noted in historic records. People usually noted only the species they considered valuable—such as ash, walnut or pecan, and early settlers frequently confused species (e.g. eastern red cedar and ashe juniper) (Poage 1981, 6). Photographs of the park taken in the early 1900s can be found in Appendix D as part of the formal photographic comparison.

The settlers shaped the vegetation in Waco. Settlers made use of Cameron Park to supply lumber for their construction needs. According to early records, the first church was built in 1850 of cottonwood planks with boards laid over cedar stumps for pews (Wallace 1983, 25). Post oak (*Quercus stellata*) and eastern red cedar were used for slaves' cabins, and walnut was frequently used for furniture (Wallace 1999, 20 – 23). The Earle-Harrison House was built of post oak gathered from a thicket near the house, and early businesses were constructed using rawhide lumber cut from eastern cottonwood (*Populus deltoides subsp.. deltoides*), oaks, elms and gum trees (Conger 1954, [5]; Wallace 1983, 27). In reality, what the early settlers referred to as post oak (*Quercus stellata*) was likely durand's white oak (*Quercus sinuata var. sinuata*)—the species share appearances and range, but durand's white oak is more common in this area.

Early settlers also cut down trees for other purposes. During construction of the Waco Suspension Bridge in 1870, red cedar (*Juniperus virginiana*) from the cliff-tops was "floated down the Brazos for use in the foundation," and early Wacoans also cleared land for agriculture, roads and grazing (Holley 1836, 32; Bray 1906, 71; Roemer 1935, 192; Poage 1981, 64; Wallace 1999, 20 – 23; Scrapbook of Mary Bayly Wilkes; "Waco Suspension Bridge"). As the population of Waco increased exponentially, settlement moved closer to the Cameron Park area.

Cattle Drives

Construction of the Waco Suspension Bridge will be discussed later, but "The Chisholm Trail was as significant as the suspension ridge in establishing Waco as the crossroads of Texas and bringing the great cattle drives through town on their way to northern railheads and eastern markets" (Wallace 1983, 34). It could be argued that the City of Waco owes its existence to the cattle drives which passed through town during the mid-1800s. As early as 1846, the first cattle passed through Waco on the Shawnee

Trail (Wallace 1983, 34; Hayward et al. 1992, 14; Pace and Frazier 2004, 78). Beginning in 1868, however, cattlemen began to follow the Chisholm Trail through Waco:

> For its first few hundred miles, the drivers actually followed the old Shawnee Trail from San Antonio through Austin to Waco. From there the new route split off and headed through Fort Worth, passing east of Decatur, and on into Indian Territory at Red River Station. Once in Indian Territory it headed north to Abilene. (Pace and Frazier 2004, 196)

Both trails crossed the Brazos River near Barron's Branch at the current site of the suspension bridge (Poage 1981, 67; Pace and Frazier 2004, 196).

Cattle played a crucial role in the Waco economy. Over five million steers passed through Waco on the Chisholm Trail, and both the sale of cattle in the city and visits to saloons, brothels and stores by cowboys fueled development of the city (Poage 1981, 66; Wallace 1999, 45). W.A. Poage recalled having seen thousands of cattle driven down Washington Street and across the bridge during the 1860s and 1870s (Heritage Society of Waco 1999, 12). Additionally, some cattle drives originated in Waco, making local stockmen wealthy. In 1854, for example, Captain Sul Ross drove five hundred steers from Waco to Missouri, and in 1855, Peter Ross drove a herd from Waco to Chicago (Poage 1981, 66; Wallace 1983, 34; Hayward and others, 1992, 14; Hayward and Yelderman 1995, 19). Though most drives originated south of Waco, nearly all drives passing through the city stopped in Cameron Park, ideal both for watering and resting the herds.

By the 1890s, cattle drives had ceased to pass through Waco. Prolific use of barbed wire had ended the open range and hindered the ability of cowboys to feed and move their cattle (Kibler and Gibbs 2004, 6). Additionally, emphasis shifted to cotton with the invention of the steel plow and advent of the railroad (Wallace 1999, 46; Kibler and

Gibbs 2004, 6). Farmers could not only produce cotton at a quicker pace but also transport that cotton to distant regions. Lastly, urban growth along what would become the I-35 corridor made the trails impractical as land was increasingly converted to residential and commercial use (Kibler and Gibbs 2004, 6; Pace and Frazier 2004, 203; "Chisholm Trail").

Despite the fairly short amount of time that cattle passed through Waco, the cattle era shaped the local landscape. Proctor Springs served as a watering hole for cattle, and Cameron Park served as an unofficial feeding ground for cattle—the Suspension Bridge—and before that, the ford in the same site—was the only place in the region at which the Brazos River could be forded and was thus a natural stopping point for cattle drives (Memoirs of Roger Conger 1979, 251; Cameron Park Vertical File). However, the greatest impact of the cattle drives is undoubtedly the development it spurred in the city.

Railroads

The arrival of the railroad spurred development in Waco because it linked the isolated city with the rest of the state. In 1858, Waco was the terminal stop on a stage line running from Houston, but the city was more than one hundred miles from the nearest railroad (Simpson 1963, 16). The first railroad to reach Waco was the 'Waco Tap.' The Tap, later renamed the Waco and Northwestern Railroad, connected with the Houston and Texas Central Railroad in Bremond, Texas, and arrived in Waco on September 18, 1872 (Poage 1981, 89; Hayward and Yelderman 1995, 19; Wallace 1999, 46). Three railroads reached Waco by 1882 (Pope 1890, 32; Heritage Society of Waco 1999, 21).

By the early 1900s, nine lines reached Waco (Figure 4.3), including the Missouri-Kansas-Texas, Cotton Belt, Santa Fe, Southern Pacific, Texas Central and Missouri

Pacific (Templin 1958, 12; Poage 1981, 88; Atlas of Texas). However, the rapid increase in railroads, which ushered in the cotton era, also brought about the end of the cattle era:

> The cotton era and the railroad era were one and the same. Before the railroad, cotton production was limited to local and nearby regional mills. After the railroad, Blackland cotton supplied a world. (Hayward and Yelderman 1995, 17)

The cotton economy was a prosperous one, and Waco quickly became a city of wealth, refinement and culture rather than a city of pioneers, rebels and cattle (Wallace 1999, 67).

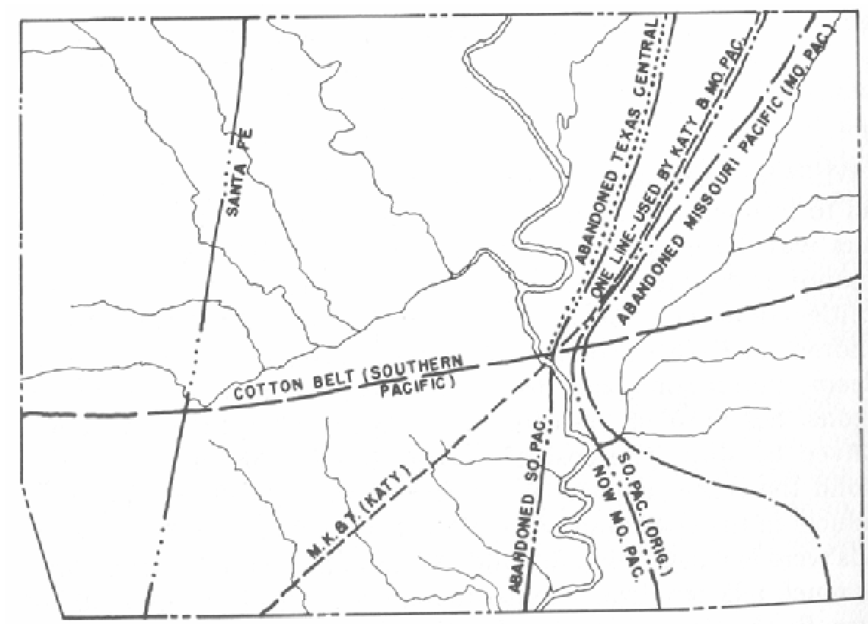


Figure 4.3. Railroad lines in Waco, Texas during the late nineteenth-century (Poage 1980, 88)

The same man responsible for bringing the Waco Tap into the city, Joseph Speight, was also responsible for building the Waco Suspension Bridge (Hayward and others, 1992, 15; Wallace 1999, 46; "Waco Suspension Bridge"). It took nearly two years and $130,000 to build the bridge, but the bridge (opened on January 7th, 1870) brought in revenue in the form of tolls and linked either side of the Brazos River, not only for locals but for regional passersby as well ("Waco Suspension Bridge"). Completion of the 475-foot suspension bridge was as important as a symbol, however, as it was important as a networking tool: "In a community isolated, thinly populated, without railroads or telegraphs, close on the border of a hostile frontier, just after a devastating war, with no surplus capital, this great monument of internal improvement had been reared" (Wallace 1983, 33). The Waco Suspension Bridge remains a proud symbol of Waco today.

Dedication of Cameron Park

One hundred twenty-five acres of land and a check for maintenance and development of the park was given on May 19, 1910, to the City of Waco "in memory of Wm. Cameron, and for the pleasure of the people" by Mrs. Flora B. Cameron, widow of William Cameron, and their children: W.W. Cameron, Mrs. Flora M. Baird and Mrs. Margaret C. Bolton (Tolson 1920, [467] ; Cameron Park Vertical File; Scrapbook of Mary Bayly Wilkes). Later donations would bring the park to its current size. In 1911, Mrs. Edward Rotan donated Rotan Riverside Drive (modern-day University Parks); in 1920, the Cameron Family donated several hundred acres to the city and during the 1920s, the City of Waco purchased forty-eight acres for the park (Tolson 1920, [467]; Cameron Park Vertical File; Scrapbook of Mary Bayly Wilkes).

The park's dedication on May 27, 1910, was a gala affair. Waco citizens dressed in their finest and gathered downtown; businesses closed; Mayor H.D. Mistrot gave a speech from Proctor Springs and hundreds of photographs were taken (Scrapbook of Mary Bayly Wilkes). A copy of the Mayor's speech can be found in Appendix G. Many of the photos survive, providing irreplaceable information about the park's vegetation at the time. These photos show Proctor Springs, Lover's Leap and other locations throughout the park. Newspaper articles on Cameron Park discuss the vegetation of the park at the time of the dedication, mentioning cedar and plum along the cliff tops, oaks and pecan throughout the park, and a variety of wildflowers: bluebonnets, violets, poppies, etc., which implies open fields (Cameron Park Vertical File).

The Brazos still flooded regularly, and groundwater was stable enough that Wacoans could boast: "never has the main spring and the four feeder springs been known to go dry" (Cameron Park Vertical File). As a result, floodplain species like pecan, eastern cottonwood, American elm (*Ulmus americana*) and oaks were likely present as well. Early Waco citizens most frequently used the park for picnicking, hunting for violets, picture-taking expeditions and visiting the park's playground (Olenbush 1977, 12, 104; Moen 1989, 130; Cameron Park Vertical File). R.J. Tolson's *A history of Wm. Cameron & Co., Inc.* is an especially valuable source because it explicitly discusses the park.

Twentieth Century

The scientific fieldwork focuses on the environmental changes and pressures of the last century. The period between 1929 and 1938 was a time of intense change in Waco. Lake Waco Dam was completed in 1929. The dam, which sits on the Bosque River 4.6 river miles upstream of the Brazos-Bosque confluence, strongly impacted the park's vegetation because construction of the dam altered the hydrological regime of not only the Bosque but the Brazos River as well. (Army Corps of Engineers 1970, 9; Heritage Society of Waco 1999, 53; "Lake Waco"). Changing hydrologic regimes are injurious to floodplain species like eastern cottonwood, which depend on periodic floods for reproduction.

In addition, 1936 saw "the greatest flood known to have occurred on the Brazos and Bosque Rivers" (Army Corps of Engineers 1970, 1; "Lake Waco"). During the flood, the gage on the Brazos River topped 40.9 feet, and the gage on the Bosque River topped 44.5

feet (Army Corps of Engineers 1970, 1 – 2). In Cameron Park, floodplain species would have been inundated because the water reached the bottom of the cliffs. In fact, the flood destroyed the South Bottoms area of Cameron Park (Cameron Park Vertical File). Furthermore, development intensified throughout the park. In 1910, there was little more than a mile of paved street in Waco; by 1936, there were nine miles of hard-surfaced roads in the park alone (City of Waco 1914, 41; Cameron Park Vertical File). Water had also covered East Waco in 1907, becoming as deep as ten feet, and covered West Waco in 1913 (Heritage Society of Waco 1999, 33, 39).

From 1939 to 1945, the United States was involved in WWII, and Waco was a center of war-related activity. Manufacturing and agricultural production had dropped off in Waco during the Depression, but the war saw rapid construction of military plants and bases and renewed demand for cotton, cotton products and canvas ("Waco"). Waco was central to the war effort, and "by 1942 Waco was the armed forces' leading manufacturer of cots, tents, mattresses and barracks;" Waco Army Flying School, Blackland Army Air Field and Bluebonnet Ordnance Plant were all located near Waco ("Waco"). Such a shift in the economy and culture of the city impacted the vegetation as manufacturing and development increased exponentially and land was put back into agriculture. In 1939, 310,857 acres in McLennan County were devoted to crops—139,885 acres in cotton, 90,720 acres in corn and the remaining acreage devoted to oats, sorghums and hay crops; livestock and livestock products accounted for 30% of farm product value in McLennan County (Bureau of Labor Statistics 1944, 7). As agricultural production increased, irrigation needs grew, putting pressure on Waco's water resources.

In addition to war-related activities, Waco experienced large floods in 1944 and 1945. Both of the floods registered between 36.4 and 36.7 at the Washington Avenue gage on the Brazos River so once again the park's floodplain vegetation was inundated (Army Corps of Engineers 1970, 2). These floods were less severe, however, than the 1936 flood, and no articles have surfaced suggesting that any part of the park was destroyed.

The first major event of the 1950s was the completion of the Whitney Dam and Reservoir, which is two miles south of Whitney, Texas, on the Brazos River, in April 1951. The reservoir has a capacity of 379,100 acre-feet and a surface area of 23,500 acres ("Whitney Dam and Reservoir"). Like the Lake Waco Dam, the Whitney Dam shifted the hydrological regime of the Brazos River. Construction of the dam prevented regular flooding of the Brazos River, which in turn prevented the seeds of floodplain species from dispersing, allowed litter and organic matter to accumulate on the forest floor and increased the ability of non-native species to survive.

The most influential event of the 1950s was the tornado of 1953. Until the tornado hit, Waco citizens believed the Waco Indian adage that the city was protected from "the great winds" because it sat in a gently-sloping valley, protected by the goddess of the Brazos River, 'Great Tohomoho' (Wallace 1983, 13; Waco Tornado: 1953 Vertical File). However, at 4:45 pm on May 11, 1953, a tornado put to rest this idea. According to an article in the May 25, 1953, issue of *Life*, "sixty seconds after the storm struck, 113 people were dead, hundreds were injured, and buildings along a path five blocks wide and five miles long lay in ruins," see figure 4.4 (Waco Tornado: 1953 Vertical File). The tornado side-swept the City of Hewitt, approximately seven miles southwest of Waco, passed directly by the Alico Building in downtown Waco and crossed the Brazos into East Waco near Waco Drive (Weems 1977, 61). Cameron Park is within blocks of the tornado's path so it is possible that the tornado's high winds uprooted trees or damaged the vegetation. Cameron Park may have also experienced logging during the 1950s. Aerial photographs of the park taken in 1951 show open areas indicative of logging in the park's cedar brakes, but this information has not been validated in written sources (Aerial Photographs).

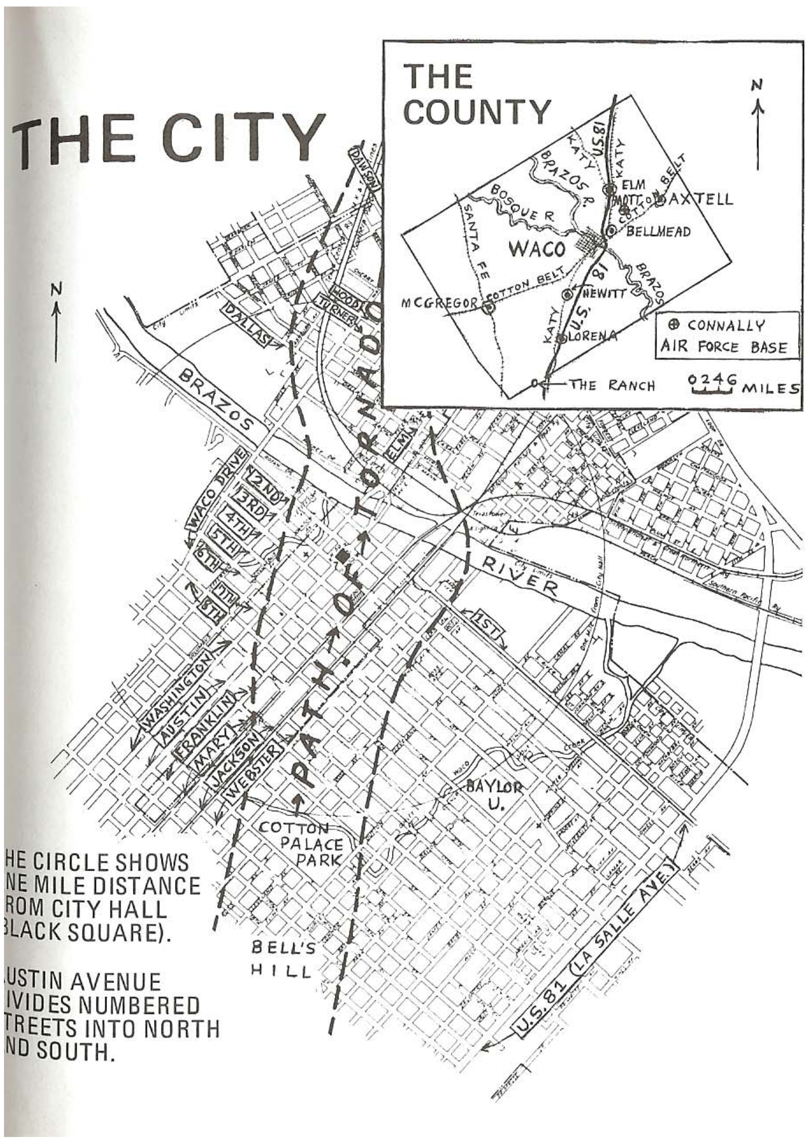


Figure 4.4. Path of the 1953 tornado through downtown Waco, Texas (Weems 1991, figure 11, plate 5)

In 1965, the second Lake Waco Dam was completed, completely submerging the first Lake Waco Dam (“Lake Waco”). The 1928 Lake Waco had a surface area of 2,742 acres; the second Lake Waco had a surface area of 19,440 acres (“Lake Waco”). Construction of this dam again shifted the hydrologic regime of the Brazos and Bosque Rivers, but the net impact on the river was almost certainly less than that of the first Lake Waco Dam because the hydrological regime was not shifted as severely.

Lydia Blair conducted a study in 1965 which compared the vegetation of Cameron Park with the vegetation of Woodway, TX. The study sampled four points at fifty foot intervals on one hundred fifty foot transects, studying species, distribution, diameter, height, etc. (Blair 1965, 13). Blair found the most common trees in Cameron Park to be Texas ash (*Fraxinus texensis*), shin oak (*Quercus sinuata var. breviloba*), eastern red cedar (*Juniperus virginiana*), cedar elm (*Ulmus crassifolia*), shumard’s oak (*Quercus shumardii*) and *Juniperus* hybrids (Blair 1965, 16 – 17, 45). What Blair refers to as shin oak, however, is more likely durand’s white oak, which is far more common throughout the park.

In 1969, Cameron Park was significantly impacted by the extension of Herring Avenue across the Brazos River into Cameron Park. The City of Waco argued that “the bridge would provide greater access to the park,” but extension of the bridge meant splitting the forest along the Pecan Bottoms (Cameron Park Vertical File). A walk-through of Proctor Springs reveals that Cameron Park had the 1969 Champion durand white oak (*Quercus sinuata var. sinuata*) in Texas. The presence of this tree suggests that other white oaks were present historically in Proctor Springs because oaks are rarely found in isolation and this particular tree is open-canopied.

Photographs taken of Cameron Park in 1980 by Baylor University student Laura McCurley provide visual evidence of the park's vegetation during the 1980s. The photographs show the line of cliffs (taken from Cameron Park East), vegetation along the roads, Proctor Springs, the old Proctor Springs playground, Lawson's Point, etc. (Cameron Park Vertical File). These photographs are especially valuable because historic photos are available for some of the same areas, allowing for formal photographic comparisons.

Walk-throughs of the park show that eastern red cedar and honey mesquite (*Prosopis glandulosa*) dominate the cliffs; pecan (*Carya illinoinensis*), eastern cottonwood (*Populus deltoides subsp. deltoides*), black walnut (*Juglans nigra*), American elm (*Ulmus americana*), and oaks are common on the floodplain; eastern red cedar, live oak (*Quercus virginiana*), cedar elm (*Ulmus crassifolia*) and durand's white oak dominate the ridge-tops; and elm, sugar hackberry (*Celtis laevigata*), ash and oaks are common in the stream valleys. In addition, several areas within the park show distinct vegetative boundaries and age differences between neighboring tree stands, which suggests that these stands are successional.

CHAPTER FIVE

General Environmental History

Results of Personal Interviews

Geology

There seems to be a general consensus among the informants that the ridge-top was most likely in pastures or farmlands during the late 1800s and early 1900s—"I think that a lot of it was in farms. . . especially up around the Cameron Park Clubhouse. . .and, actually out at Lover's Leap too, the area out in there" (Stemm 2006). First, the topography of the ridge-top is comparatively flat. The park is an otherwise cliff-dominated landscape so the flat terrain would have been an obvious and ideal location for houses, barns, pastures, etc. (Gehlbach 2006; Hayward 2006; Mangum 2006; Seibel 2006; Stringer 2006).

Secondly, the ridge-top vegetation is suggestive of former pastures-lands. The handful of very large, open-crowned broadleaf trees (which implies low-density forest cover during initial years of growth), the high percentage of multi-stemmed deciduous and *Juniperus* trees (which suggests logging or grazing) and the ratio of old *Juniperus* species to young deciduous species (which signals recent successional growth) indicate that the land along the ridge-tops was open in the recent past (Gehlbach 2006; Hayward 2006; Mangum 2006; Seibel 2006). Moreover, part of the rural culture in the late 19th century and early 20th century was that most families kept some amount of cattle (Mangum 2006). It would thus have been likely that open land was used for grazing.

There is some debate in the literature about whether Waco and the Cameron Park area were historically part of the Blackland Prairie, and this debate was in no way resolved with the interviews. Dr. O.T. Hayward, former Professor of Geology at Baylor University, placed the park squarely in the Blackland Prairie (Hayward 2006). In contrast, Dr. Fred Gehlbach, Research Professor of Ecology and Emeritus Professor of Biology and Environmental Studies at Baylor University, believes the park was never part of a prairie ecosystem but was Balcones Escarpment (Gehlbach 2006). Both professors agree, however, that the cliff-tops were most likely in grasslands for some while, and this was verified by the results of my plot studies, incremental coring and disturbance mapping (Gehlbach 2006; Hayward 2006).

Exotic Species

Exotic species are one of the biggest problems in Cameron Park today, yet the informants knew comparatively little about the subject. Of the many exotic species present in the park, informants were most familiar with common privet (*Ligustrum vulgare*) and golden bamboo (*Phyllostachys aurea*); less familiar with nandina (*Nandina domestica*), vinca (*Vinca major* and *Vinca minor*) and English-ivy (*Hedera helix*); and almost completely unfamiliar with chaste tree (*Vitex agnus-castus*) or chinaberry (*Melia azedarach*). What the above suggests is that the informants were aware only of the species they were likely to find in their own yards (e.g. privet, nandina, etc.) or to recognize immediately (e.g. bamboo).

Because the informants were not looking at the vegetation when they were children, they remember little about whether the above exotics were present in the park during their childhoods. Nonetheless, there was a general agreement among the informants that nandina, privet, vinca and English-ivy were either not present in the park during the early- and mid- twentieth century or were present in smaller amounts (Jud 2006; Mangum 2006; Powell 2006; Stemm 2006). Alva Stemm, Director of Parks and Recreation from 1955 to the late 1970s, is an exception, however, believing that vinca was always present in the park. During his tenure as Director, students at Baylor University would cut vinca from Cameron Park for use in their Ring-Out Ceremonies (Stemm 2006). Alva Stemm is probably correct since there were house-sites within the park, and vinca is frequently found near house-sites but does not otherwise spread through dense forests.

Because bamboo is readily identifiable, the informants had more to say on this exotic. The informants all passionately believed that the bamboo had increased over the last half-century (Hayward 2006; Johnson 2006; Mathias 2006; Stemm 2006). This is due in part to a City of Waco Parks Department policy during the 1950s which encouraged intentional planting of golden bamboo as an erosion control measure (Gehlbach 2006; Stem 2006). The informants also agree that bamboo is probably the greatest exotic problem in the park because it is so difficult to remove once it is started (Johnson 2006; Mangum 2006; Mathias 2006; Seibel 2006; Stemm 2006; Stringer 2006). At Proctor Springs, for example, the city has actually sent volunteers into the field with machetes to cut down the bamboo (Schell 2006).

The informants did not agree, however, about when the bamboo arrived in the park. Roughly half of the informants do not remember the bamboo from their childhoods (Jud 2006; Johnson 2006; Mangum 2006; Powell 2006). Dorothea Mangum argues that she would have remembered the bamboo (and the vines as well) because she rode her horse through the park for years (Mangum 2006). In contrast, half of informants believe the bamboo has been in the park for the last century, though it might have been present only in scattered patches (Gehlbach 2006; Hayward 2006; Mathias 2006; Stemm 2006; Stringer 2006). "I remember it when I first visited the park when I was five or six years old, and it was there then. . .so that was seventy years ago" (Stringer 2006).

Native Vegetation

The interviews seemed to suggest that the tree species have not changed in the park at over the last century. The informants agreed that pecan (*Carya illinoensis*), eastern cottonwood (*Populus deltoides subsp. deltoides*), black walnut (*Juglans nigra*) and various species of ash, elm and oak have been and continue to be the dominant species along the floodplain and stream valleys and that eastern red cedar (*Juniperus virginiana*), cedar elm (*Ulmus crassifolia*) and various species of oak and ash dominate the uplands (Gehlbach 2006; Jennings 2006; Jud 2006; Mangum 2006; Mathias 2006; Schell 2006; Seibel 2006; Stemm 2006; Stringer 2006). Alva Stemm and his wife made particular mention of the grove of cedar near Lake Shore Drive which the Waco Indians were rumored to use for the center poles in their huts (Stemm 2006). Several informants also mentioned wild plum (*Prunus mexicana*) (Seibel 2006; Stemm 2006; Stringer 2006).

Informants disagree, however, about whether or not the ratio of cedar to deciduous trees is shifting within the park. Cedar has always been present in large numbers in the park, forming cedar brakes (Gehlbach 2006; Hayward 2006; Jennings 2006; Johnson 2006; Mangum 2006; Stemm 2006). Most of the informants do not believe a shift is occurring in the deciduous- cedar ratio (Jud 2006; Mangum 2006; Mathias 2006; Schell 2006; Stemm 2006). In contrast, Dr. Fred Gehlbach and Dr. O.T. Hayward believe that eastern red cedar is invading abandoned pasture-land in Cameron Park, which is classic cedar behavior, and affecting the ratio of cedar-to-deciduous trees (Gehlbach 2006; Hayward 2006).

The city has taken some measures to increase the number of native species. For example, in the park's open areas (e.g. Pecan Bottoms or near Cameron Park Clubhouse), the Parks Department has from time to time planted species such as pecan, plum or crepe myrtle (Schell 2006; Seibel 2006; Stemm 2006). As a general rule, the city plants trees only when they are worried about regeneration of that species (Fuller 2006; Schell 2006; Seibel 2006). The park has also seeded herbaceous species. During the 1950s, the city seeded the road from Wilson's Creek to the clubhouse with poppies and bluebonnets. Part of the city's long-term plan for the park involves artificial seeding of native plants (Fuller 2006).

As a general rule, most of the informants believed that the tree species in Cameron Park had not changed, an idea which is contradicted by the scientific fieldwork. The likely reason for this discrepancy is two-fold. First, the change in forest cover has occurred slowly and thus subtly—this change could have been merely overlooked by the informants. Secondly, the informants who were actual residents of Cameron Park lived along the periphery of the park away from the ridge-top. As a result, these informants may not have been aware of a change in forest cover along the ridge-top simply because they spent most of their time along the stream valleys and floodplain.

Changing Land-Use

According to the informants, the biggest change in the park has been how and to what extent the land is used recreationally (Falco 2006; Mathias 2006; Schell 2006).

Historically, people used the park primarily for picnicking, hiking and horseback-riding (Falco 2006; Jud 2006; Mangum 2006; Powell 2006; Schell 2006). Picnicking was an especially popular activity for local schools: elementary schools from as far as Tokio, West, Ross, Gholson, Riesel, etc. would drive in to picnic, and local high schools frequently held graduation picnics in the park (Johnson 2006; Jud 2006; Powell 2006). On holidays like Easter or the Fourth of July, the park would be so crowded with families who were kodaking (picture-taking), picnicking or picking plums to make jelly that it was sometimes difficult to drive through the park (Jud 2006; Stemm 2006; Stringer 2006).

At the time, hiking was done only informally as there were no formal, organized trails (Stemm 2006). The most popular stops on hiking and driving tours were Lover's Leap, Emmons Cliff and the Mouth of the Bosque (Jud 2006; Stemm 2006; Stringer 2006). People also visited Cameron Park for Jacob's Ladder, which was originally made of cedar but replaced in the 50s with a permanent concrete structure (Jud 2006; Powell 2006; Stemm 2006). In the late 1800s and early 1900s, children from nearby neighborhoods occasionally camped in the park (Johnson 2006). Hiking, however, was never as popular a pastime as picnicking because local residents had been picnicking in the Cameron Park area since long before the land was deeded to the city.

During the early 1900s, people also visited the park for more organized activities. Visitors could rent horses from the stables near the McCulloch House [a historic home on the periphery of the park] and race across the sandbars of the Brazos River or gallop in the park's meadows (Johnson 2006; Jud 2006; Mangum 2006). The stream at Proctor Springs used to be much more accessible, and people would bathe or swim in the springs and pools (Mangum 2006; Powell 2006; Stemm 2006; Stringer 2006). For a short time, there was a small zoo on the hillside above Proctor Springs, and people traveled far distances to visit the talking crow, which "could cuss worse than any person you ever saw" (Johnson 2006; Stemm 2006). There was also little train near Pecan Bottoms, housed now at Lion's Park, which was hand-built and run by local railroad engineer A.H. "Smokey" Garland (Jud 2006; Stemm 2006).

What the informants emphasized most passionately, however, was that the park is used much more today than it had been in the recent past. During the 1960s, 70s and 80s, recreational use was almost non-existent because people were afraid to use the park (Gehlbach 2006; Jennings 2006; Schell 2006; Seibel 2006; Stemm 2006). When people thought of Cameron Park, they thought of murder, drug-dealing and prostitution (Falco 2006; Schell 2006). Former Park Ranger Nora Schell admits that the most common uses for the park during this time were drug-dealing, prostitution and gambling; "it was used very, very infrequently by picnickers" (Schell 2006).

Public use of the park increased during the early 1990s for two reasons: first, the newly-established Park Rangers began to clear out the more unsavory characters (Falco 2006; Jud 2006; Schell 2006; Seibel 2006). The Park Rangers patrolled the park on motorcycles and horses and "were specifically hired as a safety concern for the public as they visited Cameron Park" (Falco 2006; Jennings 2006; Jud 2006; Schell 2006; Seibel 2006). The Park Rangers encouraged positive park use—mountain biking, hiking, running, disc golfing, etc.—because "The more people that you have in the park that you want in the park. . .the less of those that you don't want" (Seibel 2006).

Secondly, people returned to the park because the city began funding much-needed repairs. The City has deliberately worked on improving infrastructure: playgrounds, streets, restrooms facilities and trails because many of the park's structures date to the Works Progress Administration of the Great Depression and are in such disrepair that city officials are wary of scaring off visitors (Falco 2006; Fuller 2006; Jennings 2006; Seibel 2006). At the same time, however, city officials want to avoid overly commercializing the park: "Even when you're doing functional things like building shelters, doing parking lots or whatever in certain areas that you respect the natural beauty and the history of the park" (Falco 2006).

Currently, the most popular recreational uses of the park are disc golf, mountain biking, hiking and visiting the spray park at Herring Avenue Bridge (Jennings 2006; Mathias 2006; Powell 2006; Seibel 2006). During the week, people predominantly use the park for running, mountain biking and playing disc golf; during weekends, families and slightly larger groups tend to dominate the park—picnicking and literally swarming the spray park (Jennings 2006). Todd Harbour, Head Track & Field/Cross Country Coach at Baylor University, has on at least one occasion recruited students to run for him using Cameron Park as a training facility, and, perhaps most encouraging, local schools have once again begun to picnic in Cameron Park, and there are often school busses lined up along the road. Cameron Park Zoo, Anniversary Park and Miss Nellie's Pretty Place also have brought people into the park (Falco 2006; Schell 2006).

As an interesting note, Cameron Park has become known nationally for its mountain biking. The park's terrain attracted the attention of the National Off-Road Mountain Biking Association, and Cameron Park was chosen as one of only eight sites in the nation for the 2004 racing circuit (Jennings 2006; Schell 2006). Biking started becoming popular in the early 1990s, and early Waco bike-enthusiasts actually helped to build and maintain a lot of the trails that park visitors now enjoy (Jennings 2006; Schell 2006). Informants pointed out, however, that bikers frequently like to make their own trails, which can cause serious erosion problems (Jennings 2006; Mangum 2006; Schell 2006).

The informants all emphasized that as land use continues to pick up, the emphasis should not just be on reacquainting people with Cameron Park but on getting people out to the park for the first time. To this end, the city has created summer "outdoor adventure series" that include mountain biking, hiking, kayaking, and canoeing (Jennings 2006). Hopefully, with increased recreational use will come greater appreciation of the park (Falco 2006; Mangum 2006; Mathias 2006).

Residential Development

The informants were particularly helpful in providing information on residential development in and near the park. Most of the modern residential development is on the periphery of the park, where the houses and the forest weave in and out. A bit surprisingly, the relationship between park and neighborhoods was generally seen as a positive (Falco 2006; Jud 2006; Mangum 2006; Mathias 2006). In fact, in the more than twenty years that the Mathias Family has lived on Baker Lane, only three of their neighbors have moved (Mathias 2006).

Historic residential development was also centered on the park's borders. The Cameron Family owned a home near present-day McLennan Community College (MCC) (the college's Art Center is their old house), and the Duke Family lived 100 to 200 yards from the park's entrance (Mangum 2006; Stemm 2006; Stringer 2006). The Aynesworths built a house near Miss Nellie's Pretty Place, and Dr. Wilson Crossway, Nell Pape and Bobbie Barnes each lived near the park in houses built during the 40s

(Johnson 2006; Mangum 2006). The Mathias house on Baker Lane was built in the 1920s by the Rogers Family (Johnson 2006; Mangum 2006; Mathias 2006). Though it is likely that turn-of-the-century Wacoans kept summer homes in the park, the informants knew of only one site actually within the park—a rock house at Emmons Cliff built by the Weatherbee family (Gehlbach 2006; Johnson 2006).

Herring Avenue Bridge

The extension of Herring Avenue into Cameron Park in 1969 was a controversy that literally divided public opinion. The debate, "a thorn in the flesh for a long time," caused people to fear losing the friendship of people they knew who lined up on the other side of the debate (Jud 2006; Stemm 2006; Stringer 2006). Supporters of the proposal generally pointed out that building Herring Avenue Bridge would open up the park and increase access for people living in East Waco (Stemm 2006; Stringer 2006).

Many Wacoans initially opposed construction of Herring Avenue Bridge. First, some people opposed construction of the bridge because it was a violation of the covenant with the Cameron Family (Mangum 2006). The Cameron Family's deeding Cameron Park to the City of Waco was essentially contingent on the city's maintaining the park in a natural state, and the Herring Avenue Bridge bisected the park (Mangum 2006; Stringer 2006). At one point, there was talk of the Cameron Family moving Cameron Park to another location (Mangum 2006).

Other people opposed extending the bridge because there were worries that increasing access to the park would bring less desirable people into the park. In other words, this was partly a racial and economic issue—the people in East Waco tended to be poorer minorities where the people in West Waco were historically wealthier, Caucasian and long-time Waco families (Gehlbach 2006, interview). Racial and economic issues, however, were generally addressed as safety concerns.

Lastly, a few people argued that extending the bridge would diminish the natural beauty of the park (Gehlbach 2006; Stemm 2006). The idea was that:

> . . .the bigger the size, the smaller the surrounding area or surface area, the better you are going to maintain a relatively natural environment. . .the longer and thinner, with the longer and thinner edge, more border you produce, less chance you got of maintaining that. (Gehlbach 2006)

The national environmental movement, however, had just begun so ecological issues were not readily accepted or understood by the public at large.

Flooding

Interviews confirmed that the Brazos River historically flooded regularly. Even a thunderstorm could leave East Waco under a few feet of water (Jud 2006). Floods in the 1930s and 1940s washed out University Parks Drive, then known as Riverside or Rotan Drive, and the road remained that way until Wilbur Crawford undertook it upon himself to fix the road (Stemm 2006). During the flood of 1936, Proctor Springs flooded, and in some places the water was eight feet, deep enough for kids to dive off of the top of the shelter into the water below; Proctor Springs also flooded in 1944 and 1945 (Stemm 2006). The flood was severe enough that several of the informants remember looking out upon the flooded Gholson Valley from Emmons Cliff or Lover’s Leap (Johnson 2006; Jud 2006; Stringer 2006).

Logging

I found no written sources to corroborate the idea that logging took place in Cameron Park. However, Dr. Gehlbach insisted otherwise:

> You probably have run across, but if you haven't you will run across, information on the fact that in the late 1800s and even the. . .first quarter of the 20^{th} century, uh. . .there was a lot of timber-cutting still going on for construction purposes. (Gehlbach 2006)

Dr. Gehlbach gathered his information from books and various old-time Wacoans and ranchers but, unfortunately, has no written records of the information.

Despite whether formal logging took place in Cameron Park, it is almost certain that logging of an informal nature did occur. There are tree stumps present throughout the park, and additionally, we know that from time to time people used the trees in Cameron Park in construction of early Waco structures—some of Waco's early streets were paved with wood blocks (Gehlbach 2006). As late as the 1950s, city officials used cedar from the park in the construction of park facilities: "It wouldn't hurt anything because you were just thinning out part of the forest out of there" (Stemm 2006). During the next few decades, however, even this informal logging method would become less common. During the 1980s, "people were used to just going into the park and just picking up wood to start barbeque fires and things like that. And, at the time, I wouldn't put it past anybody cutting down a tree just to have the wood, but that hasn't happened in a long time" (Schell 2006). In other words, selective wood-cutting probably took place in Cameron Park.

Results of Disturbance Mapping

The results of the anthropogenic disturbance mapping were not unexpected, see Appendix H. Throughout the park, there are wire piles, cedar fence-posts and intact fence-lines marking what appear to be former pastures. Most of these fence-lines are concentrated on the ridge-top, forming large, open spaces suitable for larger animals such as cattle and also smaller spaces suitable for smaller animals: chickens, hogs, goats, etc. There were also extensive standing fence-lines in the stream valleys near the trails *Hale Bopp* and *Highlander*. One of the fence-lines extends from the top of the stream valley near the main road in Cameron Park down to the floodplain of the Bosque River.

Throughout the park, I occasionally came across seemingly random clusters of fence-posts. For example, at Emmon’s Cliff, there are cedar posts forming the shape of an ‘L’ in one of the clearings, and along Cameron Park Drive near Lawson’s Point, there are cedar fence-posts lining either side of the road. Near Circle Point on the trail *Tar Hill*, there is a series of metal posts. What the above suggest is that there might have been scattered pens or pastures throughout the park or that early Wacoans might have used both cedar and metal fence-posts to cordon off roadways and gateways.

Concrete rubble piles were also generally found on the ridge-tops. There were roughly twenty slabs which were large enough to have been some sort of a foundation—for a house, barn or shed, for example. The slabs were clustered into seven or eight sites, but it was nonetheless difficult to determine if the slabs were from related or distinct structures. The park is also littered with countless smaller piles. For simplicity sake, I lumped brick, cinder blocks and concrete into this group; however, it is worth noting that this group includes sites with kitchen tiles, shingles, broken dishes, etc. These concrete piles, though scattered throughout the entirety of the park, are most common in those same ridge-top locations. Trash piles were generally found near these concrete piles.

The disturbance maps also outline any potential historic roadbeds. There were two types of roadbeds in Cameron Park—vegetational beds (i.e. where the vegetation boundaries and patterns suggest an historic roadway) and evidentiary beds (i.e. where the remains of tar or asphalt suggest an historic roadway). In most cases, these possible roadbeds were found alongside fence-lines and gateways, further substantiating the possibility that they were in fact roads. I found evidentiary roadbeds near Emmon's Cliff and along *Tar Hill* (whose name itself might be suggestive). I found vegetational roadbeds along the trails *Baseball, Slinky* (which is bordered on either side by fence-lines which end at a still-standing gateway) and off of Park Lake Drive.

Lastly, there are various miscellaneous items of interest. There is a No Parking Sign near *Slinky* in a thick cover of trees. Along *Outback* near the baseball fields, there is part of a clay septic line; because the land was abandoned sometime before the 1920s, these septic lines are nearly one hundred years old. Throughout the park, there are also numerous bedsprings, which tend to be found near concrete piles and occasionally near general trash piles so it is not possible to determine with absolute certainty whether these bedsprings were dumped in that particular area or were a remnant of a former house. Finally, there are three locations in the park (near the double fence-line/roadway at *Slinky*, along the edge of a pasture on *Powder Monkey* and along the fence-lines in *Hale Bopp)* with what appear to be outhouses (concrete cylinders mounted on concrete slabs).

It is important to remember, however, that the map is not a perfectly accurate representation of the anthropogenic impact in the park. Because of the park's size and variable terrain, I only documented the wire piles, fence-posts, concrete piles, etc. along trails or in areas where I knew there to be a pile of some sort. Additionally, various ravines or cliffs prevented me from tracing all fence-lines. The results of the mapping were important because they provided an idea of the extent and sites of anthropogenic activity and not because they provided precise locations of wire, concrete, trash, etc.

CHAPTER SIX

Detailed Environmental History of Cameron Park's Ridge-top

Results of Scientific Fieldwork

Increment Coring

The results of the incremental tree coring were illustrative as to the arrival dates of various species on the transects. The r^2 value for Texas ash (*Fraxinus texensis*) was 0.605 with an age range of 17 to 75 and a DBH range of 6 to 20.9 (Figure 6.1). What this suggests is that Texas ash regeneration is fairly recent along the ridge-top. Eight of the ten cores were taken from trees which were less than fifty years old. Forty percent of the samples had a DBH below ten, and fifty percent of the samples had a DBH between ten and twenty; only one of the samples had a DBH above twenty.

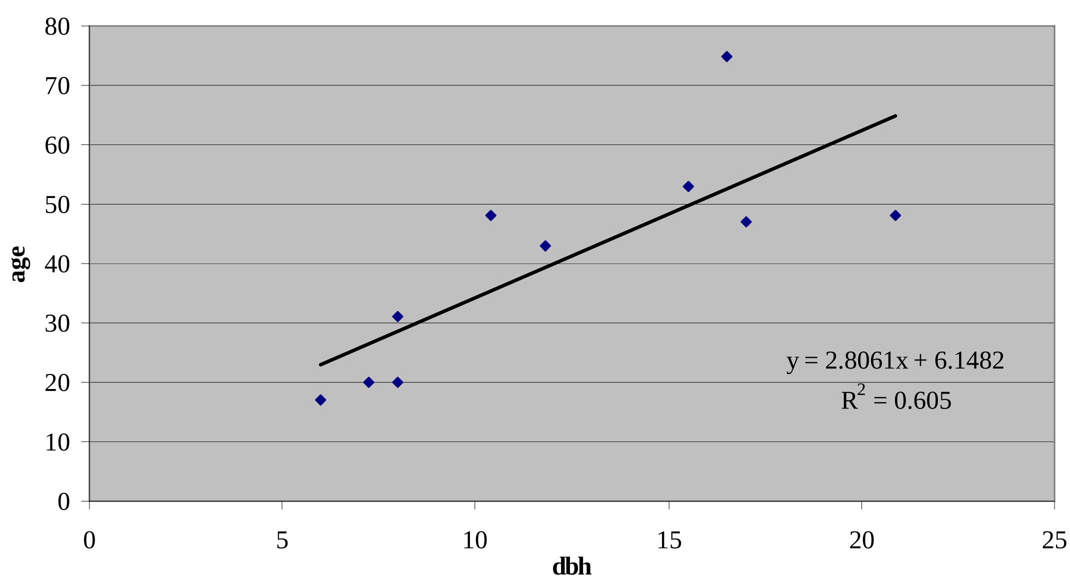


Figure 6.1. Age -DBH relationship of Texas ash along the Cameron Park ridge-top

The r^2 value for live oak (*Quercus virginiana*) was 0.8409; the strong correlation between age and relationship suggests to me that live oaks are less influenced than some of the other species by competition and external or geologic variables. Ages ranged from 27 to 171, and DBH ranged from 7.1 to 37.5, see figure 6.2. Live oak trees were most frequently found in the medium size range: Seventy percent of the samples had a DBH between 14.9 and 23.5. One of the samples had a DBH below ten, and two of the samples had a DBH above twenty-five. This representation is not completely accurate, however, as the larger live oaks were generally extremely large, pre-pasture trees with evidence of heart rot so that it was not possible to core them. The implication is that many of the older live oak trees date to the period of Waco settlement.

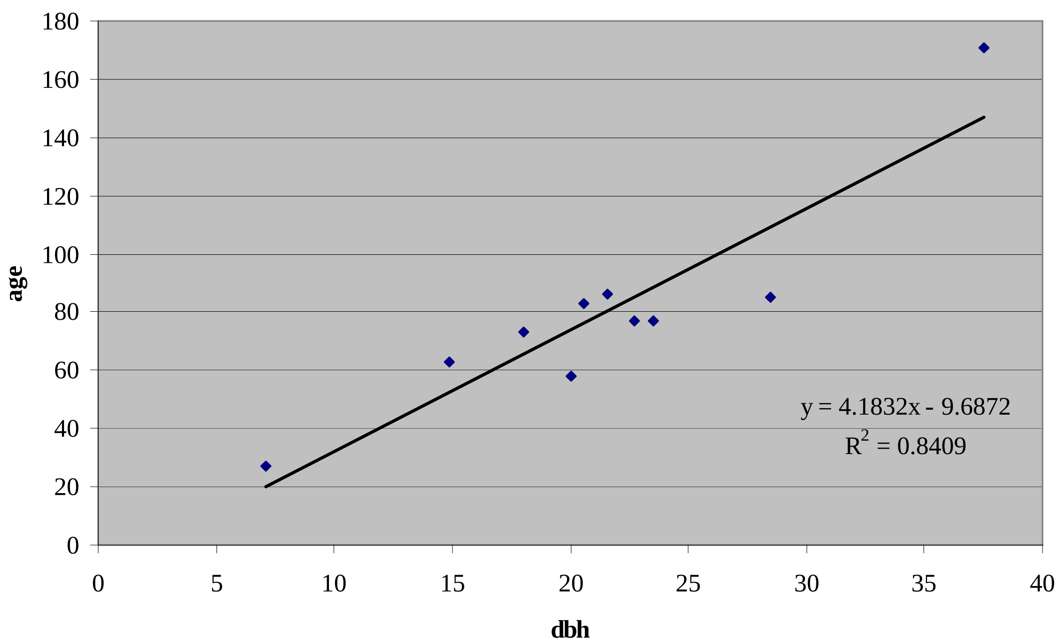


Figure 6.2. Age-DBH relationship of live oak along the Cameron Park ridge-top

Cedar elms (*Ulmus crassifolia*) also had a fairly high r^2 value of 0.6. The DBH range was 8.5 to 38.9, and the age range was 24 to 122, see figure 6.3. Cedar elms were dominant throughout the ridge-top but were especially prevalent near site 3 along the *Outback* trail. Regeneration of cedar elms has obviously been occurring for several decades as there were not only several pre-pasture, open-canopied cedar elms but also individual trees spread along the age continuum.

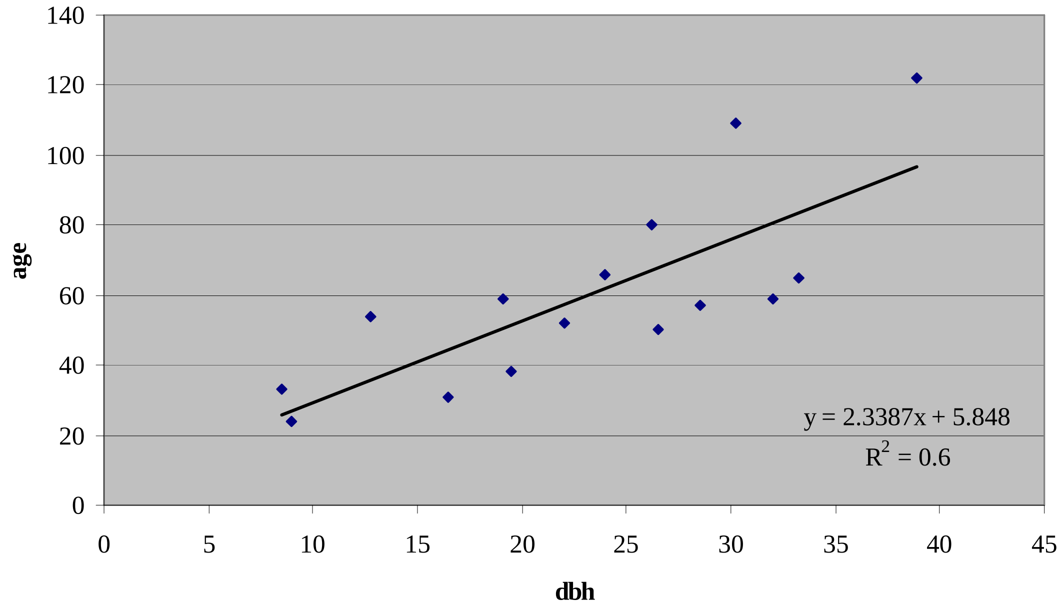


Figure 6.3. Age-DBH relationship of cedar elm along the Cameron Park ridge-top

The R^2 value was weakest for durand's white oak (*Quercus sinuata var. sinuata*) at .4964 (Figure 6.4). The low R^2 value is due in part to sample #14, which measured a 33.5 DBH; I was unable to core into the tree's center because of heart rot issues. I chose to keep the core, however, because of the size of the tree and because I missed the center by only an inch; it is my belief that twenty to thirty years could safely be added to the age I attributed to it in my calculations. The range of ages for this species was 29 to 121, and the range of DBH was 11.5 to 36.75. Like cedar elms, durand's white oaks were common along the ridge-top and most likely had been present for more than half a century as there were individuals of varying sizes and closed- and open-canopied plants.

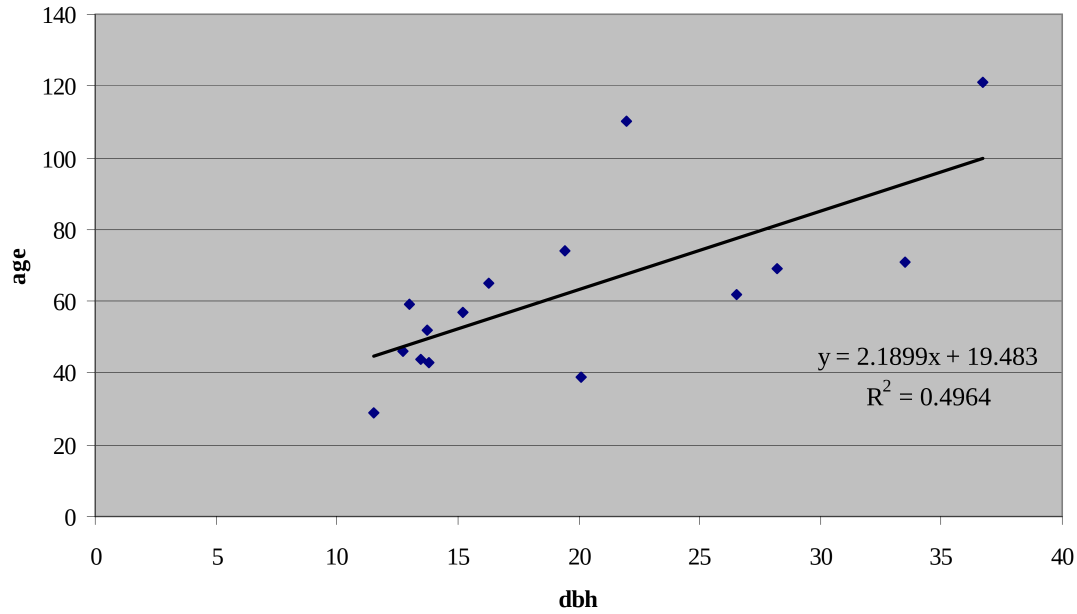


Figure 6.4. Age-DBH relationship of durand's white oak along the Cameron Park ridge-top

To gain an idea of the accuracy of the aging method, I aged each tree core twice and then compared the ages to obtain a standard error of the estimate for each species. The average error for cedar elm was 8.067 years. The standard error for Texas ash was 8.417 years. The average error for live oak was exactly 5 years, and the average error for durand's white oak was 5.5 years. Calculating a standard error of the estimate for the aging method helped to account for variables such as missing the center of the tree, mistaking rings and artifacts, etc.

Combining the coring data for all four species, it becomes evident that there was in fact a surge in regeneration of the ridge-top tree species beginning around eighty to ninety years ago, see figure 6.5. What is also evident in this graph are the handful of pasture trees which were most likely left as shade trees during the late 1800s and early 1900s. It is important to note, however, that this sample is not an accurate representation of the park. There were many trees that have regenerated during the last twenty years which were not studied simply because it was not possible to take a core from such a narrow stem. Additionally, within the park's ridge-top, there is a higher percentage of trees dating to the mid-1900s; the ratio is skewed towards the older trees because my goal was to obtain a range of ages for each species rather than a representative sample for each species. Nonetheless, a surge in regeneration after the pasture release is evident.

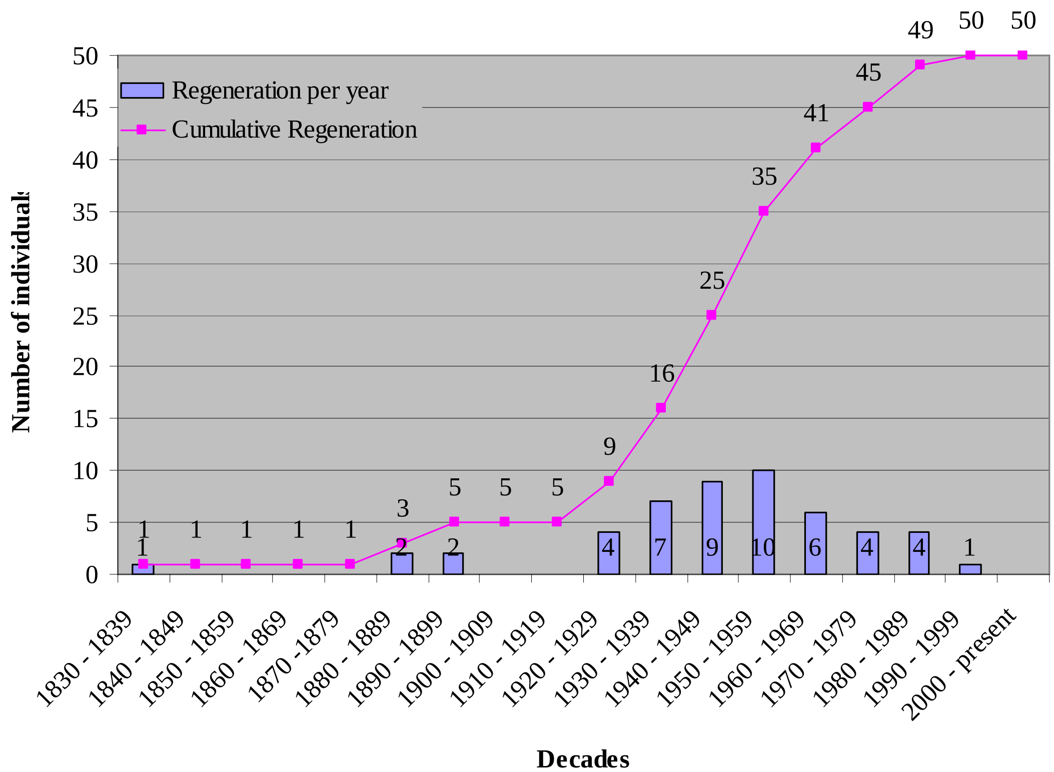


Figure 6.5. Combined age data for all four species. Note the increased regeneration rates beginning in the mid 1900s and the resulting surge in cumulative regeneration of ridge-top tree species.

Vegetative Plot Studies

Before analyzing the results of the plot studies, it is important to note particulars about the data collection. First, because the terrain in the park is exceptionally variable and because there are more than twenty miles of trails in the park, plot lines did not always follow a straight line and were not always set exactly ten meters off. All plots were set off ten meters from man-made trails, interfering terrain and other plots; notes were kept on all such instances and can be found in Appendix C.

Secondly, because the data was collected during the winter season when trees were leaf-off and because many of the species in the park have hybridized, some species have been lumped together. ‘Cedar’ refers to eastern red cedar (*Juniperus virginiana*), ashe juniper (*Juniperus ashei*) and cedar-juniper hybrids. ‘Shumard’ refers to shumard’s oak (*Quercus shumardii*), buckley oak (*Quercus buckleyi*) and shumard’s-buckley hybrids. However, families and genera are correct, and many of the species have hybridized to the point of being indistinguishable even when they are flowering.

The data collected on the lines from Site 3 were studied independently from the data collected at Sites 1, 2, 4 and 5 because they share no similarities with the data from the other plots. The plots were dominated by privet (*Ligustrum vulgare*), large cedar elms in the canopy and exotic species in the understory. The high concentration of exotic species is an important indicator of a disturbed habitat. Interestingly, there were scattered patches of young broadleaf species which were not dominated by any particular species and were more diverse than other stands along the ridge-top. The only conclusion I could draw was that the intense disturbance was due to the proximity of the road.

Data on the lines at Sites 1, 2, 4 and 5 demonstrate clear regeneration patterns for the trees in Cameron Park’s ridge-top. As the graphs show, within the canopy, cedar is far more common than broadleaf species in all of the plots; however, there is less cedar and more broadleaf in series 1 plots than in series 2 plots and series 3 plots (ranging from a ratio of 2.2:1 to 4.6:1) (figure 6.6). This same pattern holds true when broadleaf species are broken down into red oaks, white oaks, ashes and live oaks (figure 6.7). There is also evidence to suggest that oak species were among the first broadleaf species to appear along the ridge-tops. The information about regeneration of canopy species is based on basal area, which refers to the actual basal area of the tree's trunk(s) at DBH.

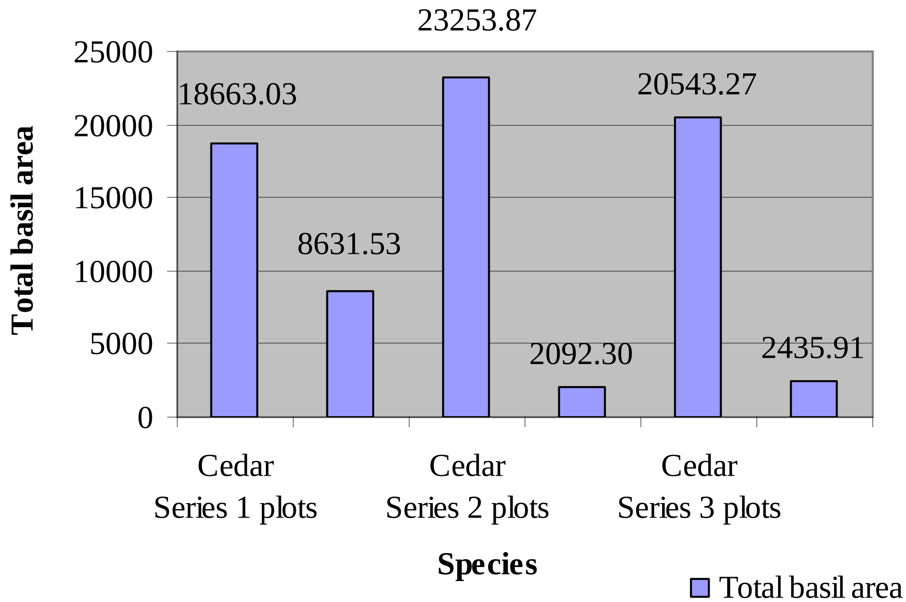


Figure 6.6. Comparison of cedar and broadleaf basal area in the canopy

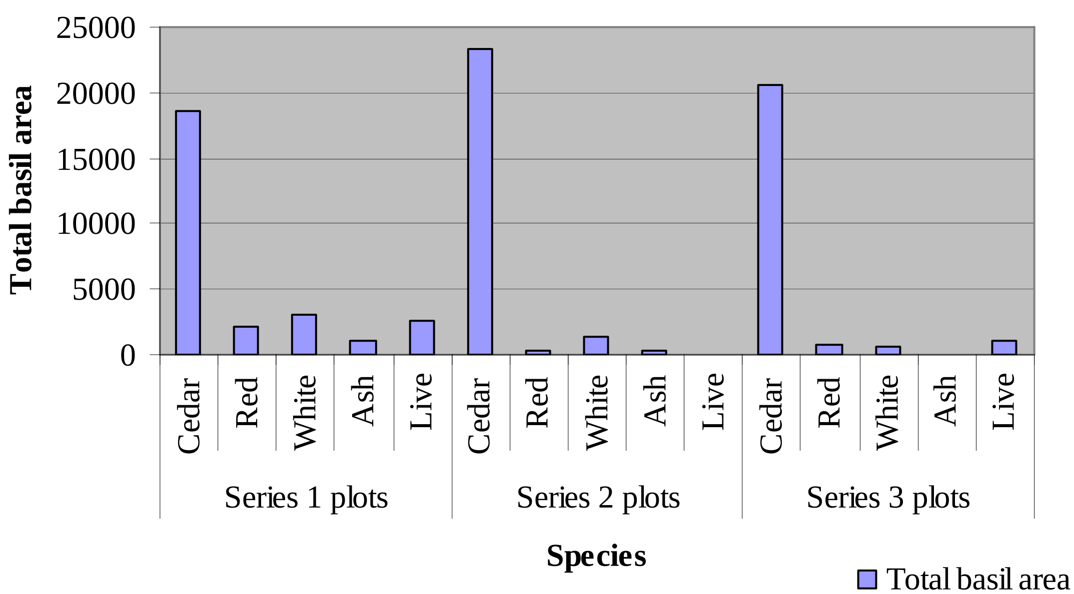


Figure 6.7. Comparison of basal area for canopy species by species rather than larger grouping

There is no statistical significance in the canopy when considering total basal area and running a one-way ANOVA. This is probably for one of two reasons. First, the sample size for deciduous species was fairly low since some plots did not contain any deciduous species. Deciduous trees were much more common in series 1 plots (8631.526 total basal area) than series 2 plots (2092.301 total basal area) or series 3 plots (2435.913 total basal area). Secondly, the terrain in Cameron Park is exceptionally patchy, and while this variable undeniably influenced the uniformity (or lack thereof) of the ridge-top vegetation, it was not accounted for statistically.

There is statistical significance, however, when considering number of individuals. As figure 6.8 shows, the number of individual cedar trees far surpasses the number of individual broadleaf trees. Additionally, the number of cedar trees increases as you move away from the fence-line, and the number of broadleaf trees decreases dramatically as you move away from the fence-line, decreasing by more than half. An SPSS crosstabs analysis shows the relationship to be statistically significant (Table 6.1). The contingency coefficient for the number of plants by broad grouping in the plots is 0.234.

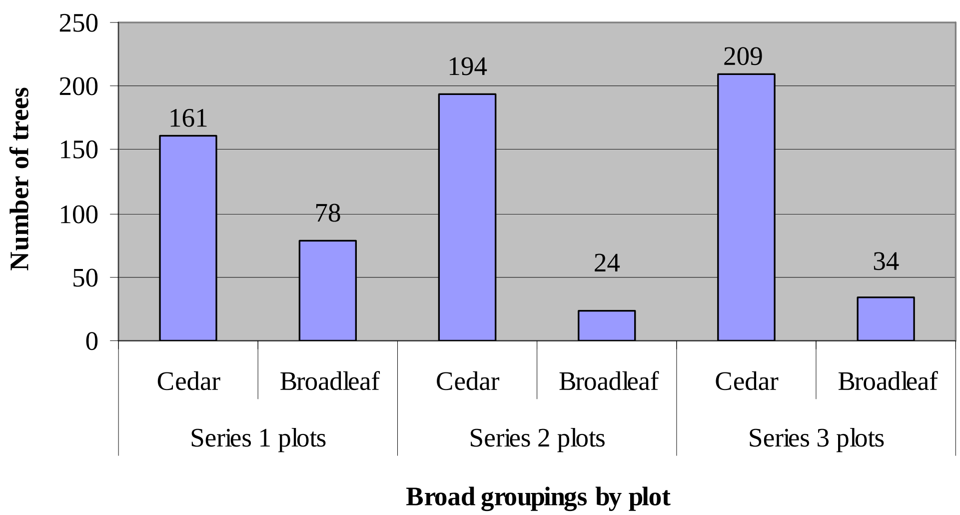


Figure 6.8. Comparison of cedar and broadleaf canopy species by number of individuals

Table 6.1. Crosstabs Analysis Comparing the Number of Individuals in the Canopy for Eastern Red Cedar and Combined Broadleaf Species

Statistical Test	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	28.390	2	< 0.0001
Likelihood Ratio	28.442	2	< 0.0001

Within the understory, the pattern is different. Regeneration of broadleaf species is highest in series 1 plots (651 seedlings among all sizes) and lowest in series 3 plots (301 seedlings among all sizes); in all of the plots, the most common size class for seedlings was the 20 to 50 cm range (Figure 6.9). Regeneration of cedar was highest in series 3 size class broken up into plot series. The strongest relationship is in this second Chi-Squared test, which supports the idea that regeneration is influenced by fence-lines.

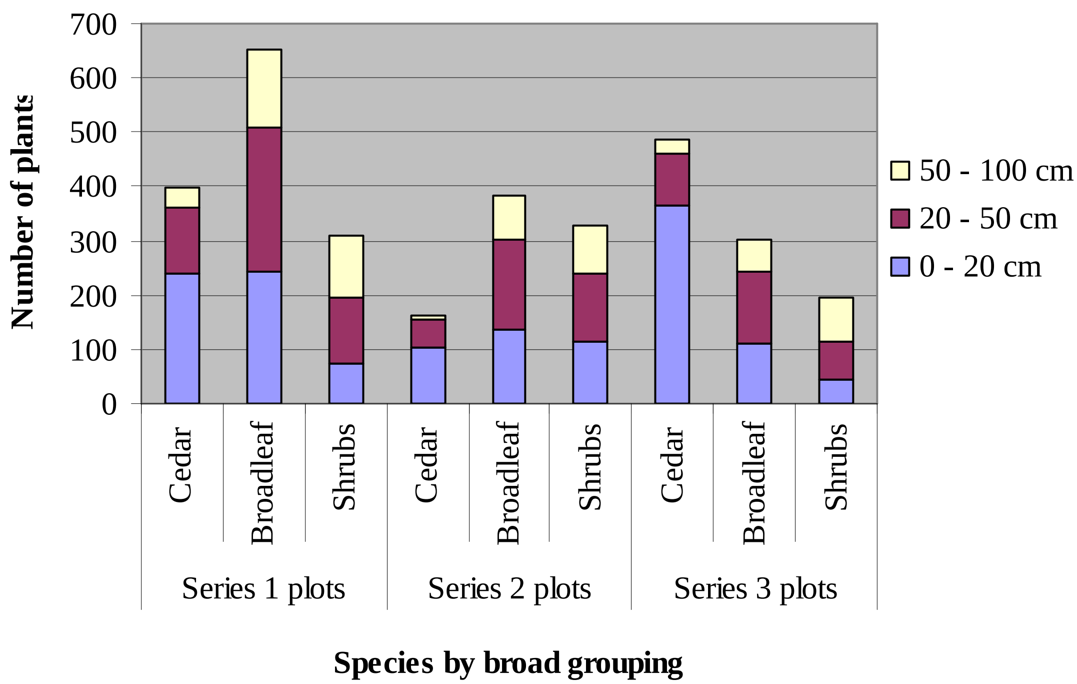


Figure 6.9. Comparison of cedar, broadleaf and shrub regeneration rates in the understory

plots (488 seedlings among all sizes) and lowest in series 2 plots (161 seedlings among all sizes), and the most common size class was 0 to 20 cm. Broadleafs outnumbered cedar by a 3:2 ratio in series 1 plots and more than a 2:1 ratio in series 2 plots, but cedar outnumbered broadleafs by a 5:3 ratio in series 3 plots. No patterns emerge when broadleaf species are broken into specific groups (Figure 6.10). What the data suggest is that cedar is being out-competed along fence-lines: where broadleafs are most prevalent.

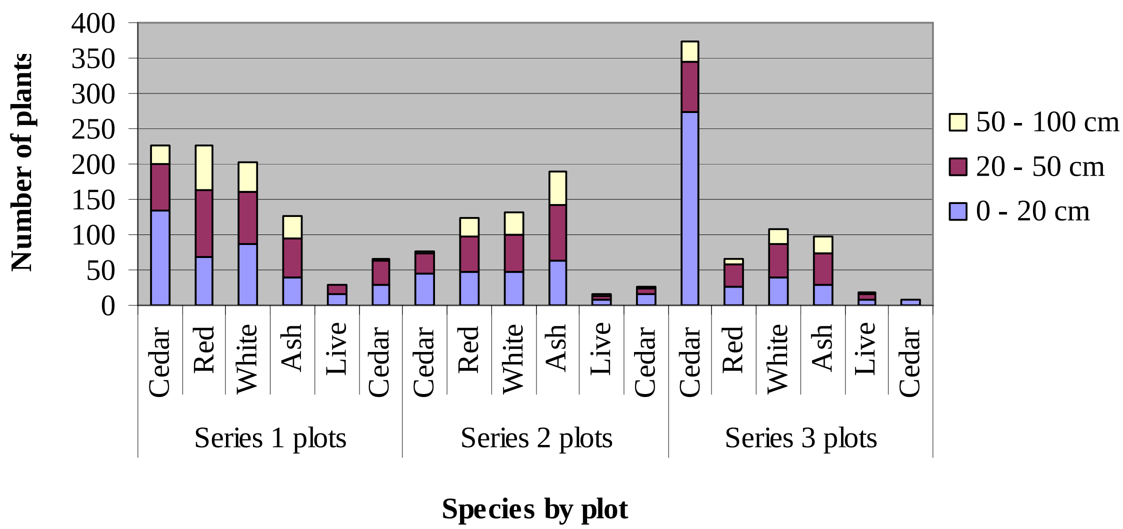


Figure 6.10. Regeneration rates by species in the understory

Data on the understory are statistically significant. Comparing cedar to broadleaf to shrubs is significant when looking at the ratio in each plot per size class (Table 6.2). Data are also significant when I compared cedar to broadleaf to shrubs by size class per plot series (Table 6.3). What this means is that there is a statistically significant pattern in the regeneration rates of understory species in two cases: 1) when studying species in plot series broken into size classes, and 2) when studying species by size class per plot.

When comparing the plot series with the size classes for each species, there is a statistically significant pattern for cedar species and for shrub species; there is not a statistically significant patter for deciduous species. In fact, the Chi-Square value for deciduous species has a very poor significance (0.749). It is important to note, however, that deciduous species might exhibit significant patterns if a larger sample size was used.

Table 6.2. Crosstabs Analysis of the Ridge-top Understory Comparing the Species and Plot Series (Location in Comparison to the Fence-line) Tiered by Size Class

Size Class		Value	Df	Asymp. Sig (2-sided)
0 – 20 cm	Pearson Chi-Square	194.901	4	< 0.0001
	Likelihood-Ratio	198.134	4	< 0.0001
20 - 50 cm	Pearson Chi-Square	41.136	4	< 0.0001
	Likelihood-Ratio	44.012	4	< 0.0001
50 – 100 cm	Pearson Chi-Square	25.588	4	< 0.0001
	Likelihood-Ratio	28.955	4	< 0.0001

Table 6.3. Crosstabs Analysis of the Ridge-top Understory Comparing the Species and Size Class Tiered by Plot Series (Location in Comparison to the Fence-line)

Plot Series		Value	df	Asymp. Sig (2-sided)
Series 1 Plots	Pearson Chi-Square	130.439	4	< 0.0001
	Likelihood-Ratio	134.310	4	< 0.0001
Series 2 Plots	Pearson Chi-Square	57.103	4	< 0.0001
	Likelihood-Ratio	63.724	4	< 0.0001
Series 3 Plots	Pearson Chi-Square	236.649	4	< 0.0001
	Likelihood-Ratio	236.411	4	< 0.0001

Table 6.4. Crosstabs Analysis of the Understory Comparing the Size Class and Plot Series (Location in Comparison to the Fence-line) Tiered by Species

Cedar v. Deciduous v. Shrub		Value	df	Asymp. Sig (2-sided)
Cedar	Pearson Chi-Square	30.102	4	< 0.0001
	Likelihood-Ratio	30.570	4	< 0.0001
Deciduous	Pearson Chi-Square	1.930	4	.749
	Likelihood-Ratio	1.949	4	.745
Shrub	Pearson Chi-Square	19.906	4	.001
	Likelihood-Ratio	19.887	4	.001

Data on shrub regeneration in the understory follow another pattern (Figure 6.9). Overall, there were the same number of plants in series 1 plots (313) and series 2 plots (323). However, while the 20 to 50 cm class size was nearly identical for series 1 (122) and series 2 (125) plots, the 0 to 20 and 50 to 100 cm size classes were not. For series 1 plots, seventy-five shrubs fell within the 0 to 20 range, and one-hundred sixteen shrubs well within the 50 to 100 range; for series 2 plots, one-hundred eleven shrubs fell within the 0 to 20 range, and eighty-seven shrubs well within the 50 to 100 range. Series 3 plots had the lowest totals for all size classes: 0 to 20 (43), 20 to 50 (68) and 50 – 100 (79).

Combining canopy data with coring data is illustrative. I found five individuals with the largest DBH for each canopy species and categorized this information by plot (Table 6.5). Broadleaf species decrease in size as distance from the fence-line increases: Texas ash, durand’s white oak and buckley oak noticeably decrease in DBH as distance from the fence increases, and live oak and shumard’s oak also show a decrease in DBH, but the DBH is greater in series 3 plots than in series 2 plots. The results for eastern red cedar suggest that there is no difference in the DBH of cedar as one moves away from the fence-line.

Table 6.5. DBH Values for Six Common Ridge-top Canopy Species in Cameron Park

	durand's white oak	live oak	Texas Ash	shumard's oak	buckley oak	eastern red cedar
plot 1	29.5	34.5	18.5	25	30	31
	22	22	12	18	1	30
	21	22	11	12	-	29
	20	21	11	11	-	28.5
	20	20	10.5	8	-	28
plot 2	25	1	12.5	7	19	33
	21.5	-	10	4	3	31
	14	-	8	2.5	-	30
	14	-	7	1	-	29
	11	-	5	1	-	28
plot 3	12.5	28.5	7.5	19	-	33
	11	23.5	4	18	-	30
	10.5	-	3	13	-	27
	10	-	2	6	-	27
	8	-	2	5.5	-	25.5

Using the DBH values and regression lines for durand's white oak, live oak and Texas ash, one gains an even clearer picture of deciduous regeneration along fence-lines (Table 6.6). Lacking age data for buckley oak (*Quercus buckleyi*) and shumard's oak, it is impossible to follow this same methodology, but the results would be similar since DBH values followed a similar pattern. What these values demonstrate is a trend for broadleaf species to decrease in age as one moves away from the fence-line.

Table 6.6. Examination of Coring and Plot Study Data to Determine DBH-Age Relationships for Three Common Broadleaf Canopy Species in Cameron Park's Ridge-top

	durand's white oak		live oak		Texas ash	
	DBH	Age	DBH	Age	DBH	Age
plot 1	29.5	84.0851	34.5	134.633	18.5	58.0611
	22	67.6608	22	82.3432	12	39.8215
	21	65.4709	22	82.343	11	37.0155
	20	63.281	21	78.16	11	37.016
	20	63.281	20	73.9768	10.5	35.6127
plot 2	25	74.2305	1	-5.504	12.5	41.2251
	21.5	66.5659	-	-	10	34.2099
	14	50.1416	-	-	8	28.5978
	14	50.1416	-	-	7	25.7918
	11	43.5719	-	-	5	20.1797
plot 3	12.5	46.8568	28.5	109.534	7.5	27.1952
	11	43.5719	23.5	88.618	4	17.3739
	10.5	42.477	-	-	3	14.5679
	10	41.382	-	-	2	11.7619
	8	37.0022	-	-	2	11.762

Digital Analyses

It is difficult to determine how or to what extent forest cover has changed in Cameron Park because the quality of the classifications was so poor. Landscape studies frequently use post-classification change detection algorithms, ground truthing data and landscape matrices to verify differences in vegetative cover over time (Narumalani et al. 2004, 481 - 482; Bai et al. 2005, 97; Sivanpillai et al. 2005, 347). However, accuracy assessments were not useful in this Cameron Park study because the aerial photographs were of overall poor quality (a common concern in these types of analyses) so the landcover maps were of low accuracy. For these supervised classifications, dark green symbolizes forest cover, tan symbolizes urban cover and beige symbolizes grassland or barren land.

Based on the classifications, forest cover appears to have increased slightly in Cameron Park between 1941 and 2004, see figures 6.11 to 6.18. Even with these less-than-perfect classifications, the more permanent sites of forest cover and no forest cover within the park are obvious. In all of the classifications, the barren land along Lover's Leap, Emmon's Cliff and Lawson's Point is obvious, and the concentration of trees

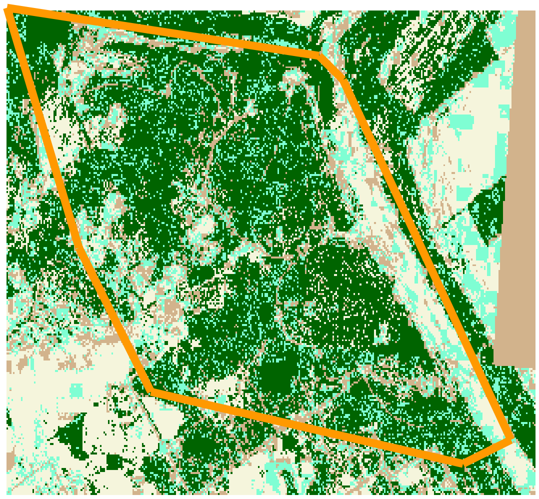


Figure 6.11. Supervised classification of the 1941 aerial photograph; the park is outlined in orange

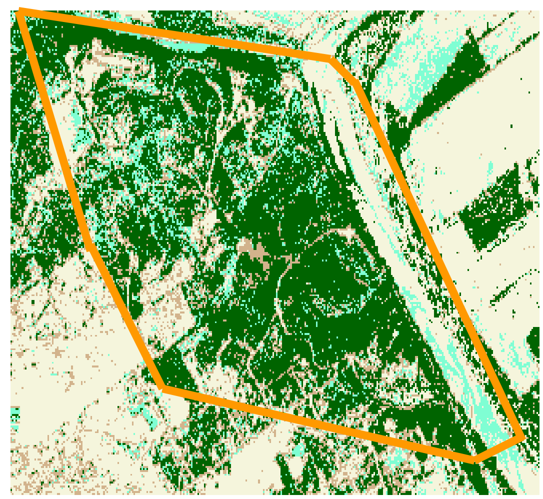


Figure 6.12. Supervised classification of the 1951 aerial photograph; the park is outlined in orange

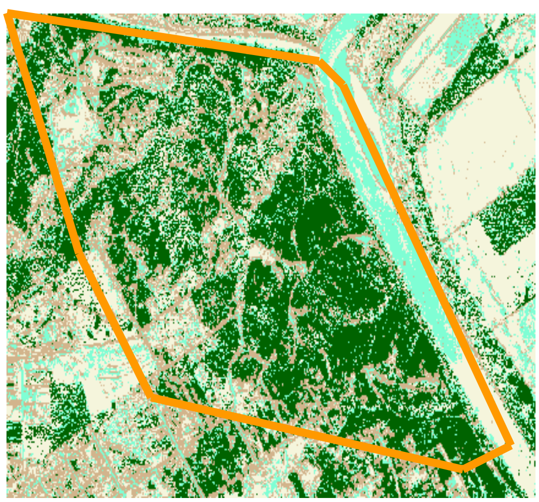


Figure 6.13. Supervised classification of the 1958 aerial photograph; the park is outlined in orange

Figure 6.14. Supervised classification of the 1964 aerial photograph; the park is outlined in orange

Figure 6.15. Supervised classification of the 1972 aerial photograph; the park is outlined in orange

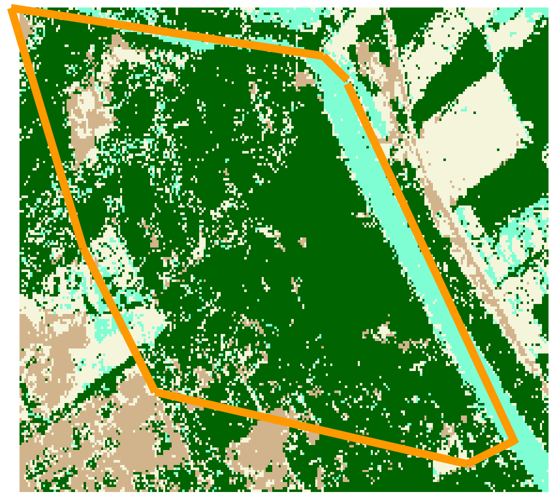


Figure 6.16. Supervised classification of the 1981 aerial photograph; the park is outlined in orange

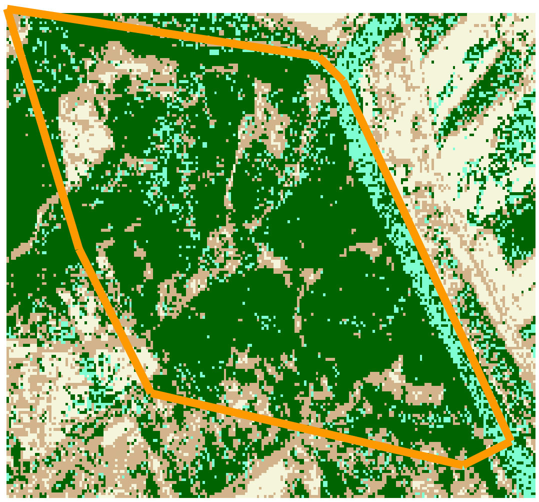


Figure 6.17. Supervised classification of the 1995 aerial photograph; the park is outlined in orange

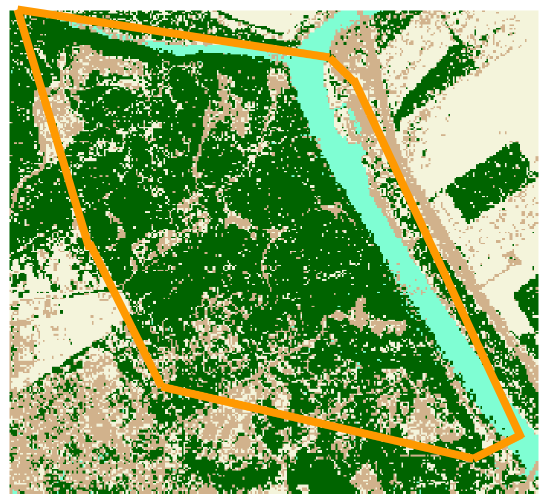


Figure 6.18. Supervised lassification of the 2004 aerial photograph; the park is outlined in orange

within Cameron Park East and near hiking trails is also obvious. Again, classifications performed on better resolution photographs could provide more detailed, accurate data on how the forest cover has changed and whether these landcover maps are correct.

In an effort to better understand the relationship between vegetation and topography, I draped the 2004 supervised classification onto a 30 meter DEM including the Cameron Park area. In general, forest cover appears to be densest along the floodplain, slightly less dense throughout the mid-slopes and significantly less dense along the steep cliffs and ravines (see figures 6.19 to 6.22). This pattern stems from the geology of the different areas. The geology of the park operates along a gradient, with the deepest, wettest soils on the floodplain and the shallowest, rockiest soils on the cliff-tops.

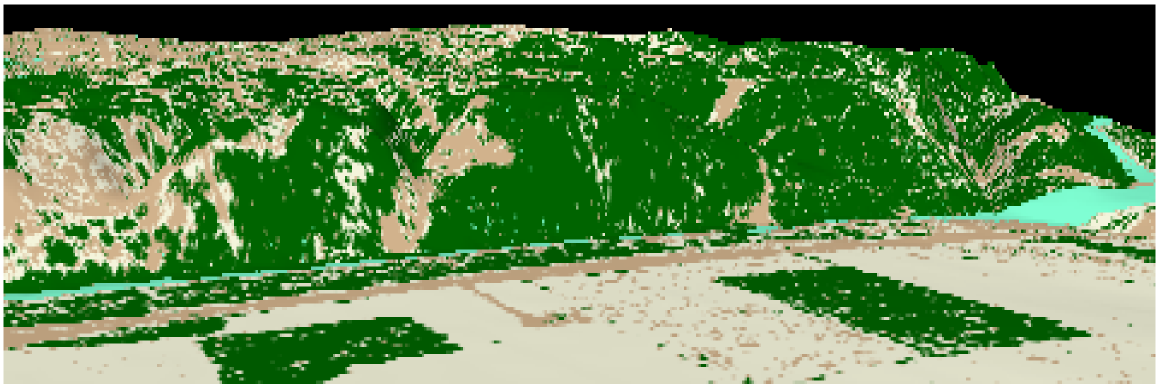


Figure 6.19. The grassland/forest of Cameron Park West is elevated along the White Rock Escarpment.

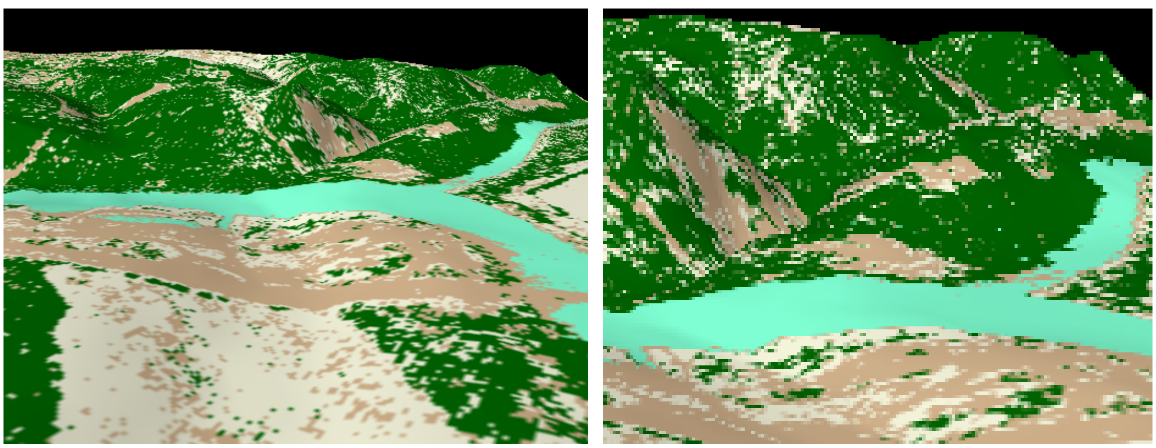


Figure 6.20. Confluence of the Brazos and Bosque: note the range of topography in this location

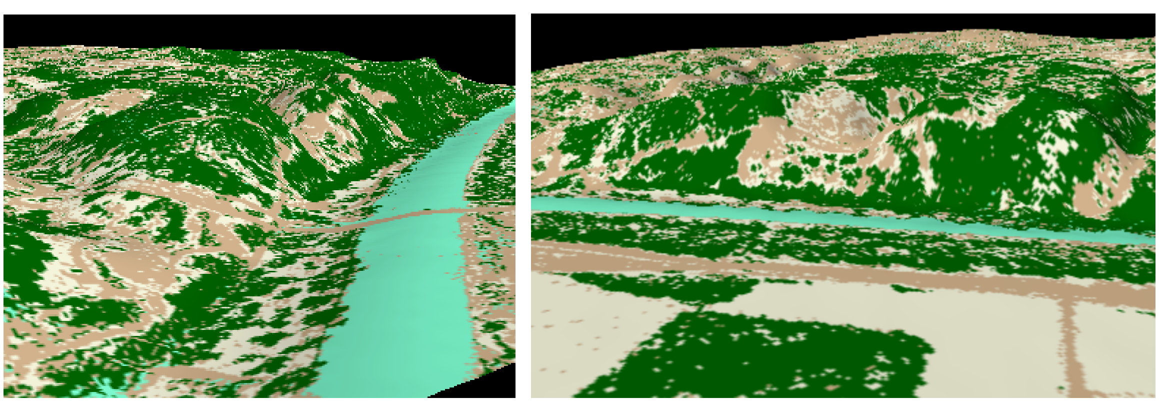


Figure 6.21. Riparian corridor in Cameron Park: on the left, the floodplain is evident; on the right, note the barren area in the ravine (a product of crumbling associated with the limestone underlying the park)

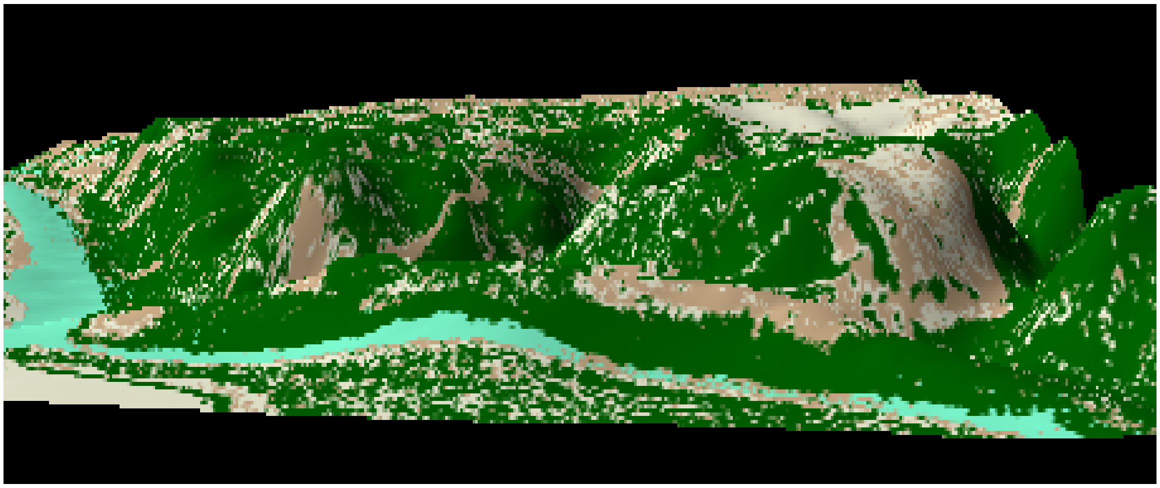


Figure 6.22. Limestone cliffs along the Bosque: the floodplain is evident but there is no sloping gradient between floodplain and cliffs; vegetation is surprisingly dense along the cliffs with the exception of Lovers Leap (far right of the image); note also that the tops of the cliffs have little to no forest cover

Interestingly, there does not appear to be as strong of a relationship between vegetation and topography as might be expected. Barren land or sparse forest cover is not limited to the cliff-tops, and dense cover is not limited to the floodplain and mid-slopes so one of the most surprising elements of the images was the barren land along the mid-slopes. It is important to remember, however, that much of the non-vegetative cover around the park's boundary has been developed residentially or commercially so the area is not naturally tree-less.

To gain an idea of the accuracy of the classification method, I constructed an error matrix based on a randomly-generated stratified sample of points in Cameron Park and calculated the user's and producer's accuracy (Tables 6.7 and 6.8). Table 6.7 is an error matrix in which numbers along the diagonal represent correctly-classified landcovers and numbers off of the diagonal represent incorrectly-classified landcovers. Table 6.8 clearly demonstrates that the classification method was very accurate in identifying forest cover, which is of utmost importance since this history is a study of changes in forest cover. The overall accuracy of the classification method was 82.67%, meaning that the quality of the maps depends more on the quality of the aerial photographs than the method of study.

Table 6.7. Supervised Classification Error Matrix Based on the 2004 Aerial Photograph of Cameron Park

ERDAS Data	Realworld Data			
	forest	grassland	Non-vegetative	Total
forest	28	2	2	32
grassland	3	8	0	11
Non-vegetative	2	4	26	32
Total	33	14	28	75

Table 6.8. User’s and Producer’s Accuracy for the Supervised Classification Methodology Based on the Error Matrix in Table 6.7

User's Accuracy		Producer's Accuracy	
Forest=	87.50%	Forest=	84.84%
Grassland=	72.72%	Grassland=	57.14%
Non-vegetative=	81.25%	Non-vegetative=	92.86%

CHAPTER SEVEN

Discussion

Discussion of the Historical and Scientific Results

Review of Purpose and Research Questions

As I stated in the Introduction, the general purpose of this project was to create an environmental history of Cameron Park and thereby to expand the amount of information available on the park for future studies. More specifically, the objective was to determine the impact of fence-lines on the park's ridge-top tree species. No study of this nature has been conducted in either the central Texas region or the state as whole, and the most comparable studies were those conducted in general oak-forest ecosystems in New England or Texas, studies such as Russell's *People and the land through time: linking ecology and history* (1997), Francaviglia's *Cast Iron Forest* (1998) and Cronon's *Changes in the Land: Indians, Colonists, and the Ecology of New England* (2003).

The research questions for this thesis focused on changes in the park's tree species:

1. Has there been a quantifiable change in the forest cover of Cameron Park since the settlement of Waco?

2. Has there been a change in which species are present in Cameron Park since the settlement of Waco?

3. How were the ridge-top species affected by the abandonment of pastures?

At the outset, my hypotheses were that:

1. There had been an increase in forest cover—particularly along the ridge-tops.

2. The same species are present today as were present during early settlement.

3. The abandonment of pasture-land led to an increase in forest cover, with live oak (*Quercus virginiana*) dominating the pre-pasture landscape and eastern red cedar (*Juniperus virginiana*) and cedar elm (*Ulmus crassifolia*) dominating the post-pasture landscape.

After completing my research and compiling the results from the historical research, interviews and scientific research, I accept all three of the hypotheses.

Discussion of Results

The first research question was: has there been a change in forest cover? The results of the supervised classifications in ERDAS Imagine were inconclusive, suggesting an increase in canopy cover but not providing any quantitative evidence of an increase. Even a quick comparison of the 1941 and 1951 aerial photographs with the later aerials, however, reveals conclusively that forest cover has increased, particularly in the ridge-top locations. This increase in canopy cover was confirmed during tree-coring, plot studies and disturbance mapping.

Calculations performed in Microsoft Excel on the coring data revealed that thirty-six percent of the trees were fewer than fifty years old, forty percent were between fifty to seventy-five years old, fourteen percent were between seventy-five to one hundred years old, and ten percent of the samples were greater than one hundred years old. In other words, twenty-five percent of the fifty trees date to the period before the park, and seventy-five percent of the trees have regenerated during the last seventy-five years. While this does not conclusively prove that there has been a change in forest cover, it strongly supports the idea that forest cover has rapidly increased (and regenerated) since the ridge-top land was donated to the city in the 1920s. What this suggests is a major release approximately eighty to ninety years ago, around the time of the park's creation.

Walking through the park as part of the plot studies and disturbance mapping revealed very clear vegetative boundaries that followed historic fence-lines and an older cedar canopy with a younger deciduous canopy. The mean basal area for cedar species along the ridge-top was 115.9194 in series 1 plots, 119.8653 in series 2 plots and 98.2931 in series 3 plots; mean basal area for broadleaf species was 110.6606 in series 1 plots, 87.1792 in series 2 plots and 71.6445 in series 3 plots. What this suggests is that forest cover increased along the ridge-tops in Cameron Park as eastern red cedar and ashe juniper (*Juniperus ashei*) invaded the abandoned pastures and broadleaf species began to move in thereafter.

Additionally, mean basal area is lowest for cedar in series 3 plots, where the total number of individuals is highest, and mean basal area for deciduous species is higher in series 2 plots than series 3 plots even though total number of individuals is higher in series 3 plots. This suggests that a large number of young cedar trees can be found in series 3 plots while fewer, older cedars are found in series 1 and 2 plots. This could very likely be the result of ranchers' tendency in Cameron Park to make use of standing cedar trees along fence-lines as fence-posts. What the above highlights for deciduous species is the presence of large, open-canopied pre-pasture trees and the delayed and differential successional growth. Delayed succession occurred as *Juniperus* species invaded the abandoned pastures before deciduous species; differential succession occurred as deciduous species regenerated first along fence-lines before moving into the park's interior.

The second question focused on whether or not there had been a change in which tree species were present within Cameron Park. I answered this question based primarily on qualitative rather than quantitative data—interviews, historic sources, etc. Early sources mention various species of oak, walnut, ash, elm, hickory, pecan, plum, cedar and mesquite (Bray 1906, 70; Gregg 1933, 19; Tharp 1939, 31 – 33). Personal interviews and walk-throughs of the park confirm that these same species are dominant in the park today. Additionally, various artifacts in the park confirm the presence of these species—Cameron Park was home to the 1969 Champion durand's white oak (*Quercus sinuata var. sinuata*), and fence-lines were frequently made of barbed wire wrapped around cedar stumps. Historic photographs taken during the early 1900s reveal these same species.

I do not, however, have any sort of quantitative information to validate the idea that the same species are present in the park today as were present a century earlier. Early settlers and geologists left no sources which included specific numbers (early geologic surveys, such as those conducted by Robert Hill, do not include the park area), and my thesis was not focused on the park's tree species as a whole. All we know is that there has been some artificial planting of native tree species and that most of the informants agreed that—with the exception of exotic species—there had been no change in species composition (Fuller 2006; Stemm 2006; Seibel 2006; Schell 2006). There has been, however, some degree of change in the composition of broadleaf to cedar species, which is discussed below.

The third question focused on how the ridge-top tree species were affected by the abandonment of historic pastures. I did not find any written evidence to support the idea that the ridge-tops in Cameron Park were grazed (though Dr. Fred Gehlbach at one time or another came across this information in printed sources), but I know with absolute certainty that grazing took place in the park. For example, an 1874 vote by Waco Village held that hogs were no longer allowed to run at large through the city (Heritage Society of Waco 1999, 16). The ridge-top would have been an ideal location for pastures because of the flat terrain, proximity to town and access to natural springs. Moreover, numerous informants confirmed that the ridge-top would have been an ideal site for families keeping cattle, and the anthropogenic disturbance mapping revealed the presence of fence-lines, wire piles, outhouses, etc. throughout the ridge-top sites. In fact, fence-lines are found everywhere in the park in large numbers

The vegetative plot studies statistically supported the finding that after the pastures were released and the land abandoned, *Juniperus* species were the first to move into the area. This invasive behavior is seen on the 1941 and 1951 aerial photographs as well; reviewing the aerial photographs in succession clearly illustrates, for example, the movement of forest cover onto the ridge-top at the Lover's Leap ballfields. In addition, invasion of abandoned pastures by eastern red cedar or ashe juniper is classic cedar-juniper behavior (Gehlbach 2006; Hayward 2006).

Broadleaf species began to regenerate in the area after cedar species had been established. Broadleaf species moved into the area along the fence-lines and then spread within the park's interior. Of the broadleaf species which I studied, both the plot studies and the incremental tree coring suggested that cedar elm, shumard's oak and buckley oak were the first species to move in, followed by Texas ash. The average basal area (and thus age) was lower for Texas ash (133.69) than for any of the other three species (cedar elm -241.89, live oak – 406.32, durand's white oak – 353.79).

Live oaks did not show any regenerative pattern other than that live oak seedlings were rare and present most frequently near large, multi-stemmed, open-canopied live oaks. This is validated by walk-throughs of the park which reveal that cedar, shumard's, buckley and cedar elm were older, multi-stemmed and open-canopied; Texas ash were rarely multi-stemmed or broad-canopied. What the above suggests is that regeneration of shumard's oak, buckley oak and ash is closely related to the presence of fence-lines while live oak regeneration results from pre-pasture individuals which were left as shade trees.

The above results are significant for a number of reasons. First, individual hardwood trees are older along the fence-line than they are within the interior of the park away from pasture borders. This suggests both that broadleafs demonstrated delayed succession compared to cedar species and that broadleafs demonstrated differential succession: regenerating first along fence-lines and then moving into the interior.

Secondly, the results of the fieldwork point to a large release event approximately ninety years ago, which closely matches the time of the park's dedication. The park is missing, with the exception of fewer than two dozen pre-pasture parent trees, trees dating to before the park's dedication. The importance of this is it supports the idea that between the founding of Waco in 1850 and the creation of Cameron Park during the 1910s and 1920s, intense grazing was taking place in the park, culminating in a sudden onset event approximately eighty to ninety years ago.

This finding is further supported by the disturbance mapping, which revealed the presence of fence-posts, wire piles and intact fence-lines throughout the park, especially along the ridge-top. The amount of fence-lines in the park shows conclusively that animals (most likely cattle and smaller animals judging by the varying size of wire) were either being penned in or kept out of the ridge-top. Either way, grazing animals were in the ridge-top area so grazing was taking place. Because the location of the fence-lines matches the location of pastures in the aerial photographs, it is almost certain that at least some of the animals were being kept within Cameron Park.

Based on all of the results, I would say there was likely almost complete clearing of Cameron Park’s ridge-top and that regeneration of the canopy tree species began approximately eighty to ninety years ago when the park was created and the land abandoned (if it had not already been abandoned some time prior to its being donated to the city). Moreover, broadleaf species exhibited both differential and delayed succession when compared with cedar succession. It is important to note, however, that the cedar species will likely continue to flourish along the ridge-top so it may not be entirely appropriate to call this successional growth.

APPENDICES

APPENDIX A

Raw Data - Incremental Tree Coring

Table A.1 – Raw Data for Incremental Tree Coring

Sample	DBH	Age	Trunk	Location	Notes
Cedar Elm					
1	22	52	1	31.58485 N, 097.16746 W	concrete, trash, shed
2	8.5	33	2	31.58529 N, 097.16651 W	
3	9	24	1	31.58481 N, 097.16748 W	
4	19.5	38	2	31.58466 N, 097.16748 W	
5	24	66	1	31.58472 N, 097.16744 W	
6	28.5	57	1	31.58551 N, 097.16649 W	
7	30.2	109	1	31.58399 N, 097.16741 W	
8	26.5	50	2	31.58466 N, 097.16747 W	wire
9	38.9	122	1	31.58539 N, 097.16674 W	cans
10	32	59	2	31.58475 N, 097.16741 W	
11	26.2	80	2	31.58469 N, 097.16751 W	fence-lines
12	12.8	54	7	31.58542 N, 097.16659 W	stems: different levels
13	16.5	31	2	31.58386 N, 097.16793 W	
14	33.3	65	1	31.58418 N, 097.16782 W	
15	19.1	59	2	31.58422 N, 097.16783 W	
Live Oak					
1	21.6	86	4	31.58656 N, 097.16072 W	
2	14.9	63	1	31.58607 N, 097.16503 W	
3	28.5	85	1	31.58713 N, 097.16393 W	
4	37.5	171	2	31.58460 N, 097.16730 W	wire
5	20.6	83	3	31.58606 N, 097.16058 W	
6	23.5	77	1	31.58705 N, 097.16399 W	
7	22.7	77	3	31.58520 N, 097.16096 W	
8	20	58	3	31.58609 N, 097.16063 W	
9	18	73	1	31.58539 N, 097.16095 W	
10	7.1	27	1	31.58542 N, 097.16092 W	

Table A.1 - Continued

Sample	DBH	Age	Trunk	Location	Notes
Durand's white oak					
1	28.2	69	2	31.58393 N, 097.16723 W	
2	13.5	44	1	31.58381 N, 097.16129 W	
3	12.8	46	1	31.58584 N, 097.16056 W	
4	15.2	57	1	31.58406 N, 097.16740 W	wire, post nearby
5	13.8	52	1	31.58587 N, 097.16034 W	
6	11.5	29	2	31.58661 N, 097.16072 W	
7	26.5	62	3	31.58668 N, 097.16083 W	
8	22	110	4	31.58659 N, 097.16077 W	
9	20.1	39	1	31.58665 N, 097.16104 W	
10	13	59	1	31.58672 N, 097.16122 W	
11	13.8	43	1	31.58522 N, 097.16088 W	
12	36.8	121	1	31.58380 N, 097.16738 W	
13	19.4	74	1	31.58554 N, 097.16136 W	
14	33.5	71	1	31.58722 N, 097.16370 W	missed center, heart rot
15	16.3	65	1	31.58712 N, 097.16032 W	
Texas Ash					
1	16.5	75	1	31.58696 N, 097.16117 W	
2	6	17	1	31.58425 N, 097.16762 W	trash
3	10.4	48	1	31.58564 N, 097.16042 W	
4	15.5	53	1	31.58747 N, 097.16380 W	
5	8	31	1	31.58701 N, 097.16396 W	
6	7.3	20	1	31.58420 N, 097.16762 W	
7	11.8	43	1	31.58375 N, 097.16806 W	
8	20.9	48	1	31.58381 N, 097.16808 W	wire, concrete, trash
9	17	47	1	31.58726 N, 097.16375 W	
10	8	20	1	31.58659 N, 097.16074 W	

APPENDIX B

Starting GPS Coordinates for the Vegetative Plots

1a1 (31.58880 N, 97.16052 W)

1a2 (31.58576 N, 97.16067 W)

1a3 (31.58563 N, 97.16096 W)

1b1 (31.58600 N, 97.16069 W)

1b2 (31.58582 N, 97.16043 W)

1b3 (31.58579 N, 97.16115 W)

2a1 (31.5866 N, 97.16700 W)

2a2 (31.58655 N, 97.16092 W)

2a3 (31.58661 N, 97.16121 W)

2b1 (31.58684 N, 97.16049 W)

2b2 (31.58690 N, 97.16060 W)

2b3 (31.58704 N, 97.16083 W)

3a1 (31.58482 N, 97.16745 W)

3a2 (31.58473 N, 97.16737 W)

3a3 (31.58459 N, 97.16717 W)

3b1 (31.58218 N, 97.16720 W)

3b2 (31.58270 N, 97.16718 W)

3b3 (31.58280 N, 97.16732 W)

4a1 (31.58741 N, 97.16408 W)

4a2 (31.58713 N, 97.16403 W)

4a3 (31.58706 N, 97.16401 W)

4b1 (31.58471 N, 97.16369 W)

4b2 (31.58733 N, 97.16367 W)

4b3 (31.58715 N, 97.16368 W)

5a1 (31.58687 N, 97.16368 W)

5a2 (31.58698 N, 97.16370 W)

5a3 (31.58706 N, 97.16398 W)

5b1 (31.58690 N, 97.16384 W)

5b2 (31.58693 N, 97.16400 W)

5b3 (31.58703 N, 97.16419 W).

APPENDIX C

Results of the plot studies

Table C.1 - Raw Data – Site Description

Plot	1a1	1a2	1a3
Slope	6	4	2
Aspect	none	310	none
GPS	31.58880, 097.16052	31.58576, 097.16067	31.58563, 097.16096
notes	double-fence thru center of plot		uphill - 1a1/1a2
Plot	1b1	1b2	1b3
Slope	9	4	11
Aspect	190	175	290
GPS	31.58600, 097.16069	31.58582, 097.16043	31.58579, 097.16115
notes	offset 1m to avoid trail, burrows, trash	burrows, wire piles, 2 durand oaks nearby, dead cedar	uphill - 1b1/1b2, probably cleared
Plot	2a1	2a2	2a3
Slope	2	12	4
Aspect	310	290	270
GPS	31.5866, 097.16700	31.58655, 097.16092	31.58661, 097.16121
notes	trash, burrows, 30m from power line, wire piles	downhill - 2a1, wire, dead trees	offset 5m to avoid trail
Plot	2b1	2b2	2b3
Slope	3	4	10
Aspect	none	290	10
GPS	31.58684, 097.16049	31.58690, 097.16060	31.58704, 097.16083
notes	unnatural mounds	wire piles, dead cedars	dead cedars, downhill - 2b1/2b2

Table C.1 - Continued

Plot	3a1	3a2	3a3
Slope	10	3	14
Aspect	110	none	140
GPS	31.58482, 097.16745	31.58473, 097.16737	31.58459, 097.16717
notes	dead trees, trash, wire, open area	burrows, trash dump, wire	trash, downhill - 3a1 & 3a2,
Plot	3b1	3b2	3b3
Slope	2	4	9
Aspect	none	85	170
GPS	31.58218, 97.16720	31.58270, 097.16718	31.58280, 097.16732
notes	Fence, concrete, trash, dead trees	Dead trees, trash: dump, metal	downhill from 3b1 & 3b2, offset
Plot	4a1	4a2	4a3
Slope	none	none	none
Aspect	none	none	none
GPS	31.58741, 097.16408	31.58713, 097.16403	31.58706, 097.16401
notes	concrete, wire, on roadbed, mounds,	cedar near, trash, dead trees, wire,	live oak near, offset 10m to avoid
Plot	4b1	4b2	4b3
Slope	none	3	none
Aspect	none	80	none
GPS	31.58471, 097.16369	31.58733, 097.16367	31.58715, 097.16368
notes	burrow, concrete	open durand oaks	pocket - buckthorn,
Plot	5a1	5a2	5a3
Slope	6	none	none
Aspect	150	none	none
GPS	31.58687, 097.16368	31.58698, 097.16370	31.58706, 097.16398
notes	burrows, wire	uphill - 5a1, wire	trash
Plot	5b1	5b2	5b3
Slope	10	3	none
Aspect	120	160	none
GPS	open cedar, offset		bedsprings, trash,
notes			unnatural mounds

Table C.2 - Raw Data – DBH Totals for Canopy Species

Plot 1a1

Cedar	Shumard	Privet	Durand
14	1	1	8
1	1	1	14
[23 -	1		
- 11 -	1		
- 12.5]			
[14 -			
- 6 -			
- 10]			
[18 -			
- 4]			
[9 -			
- 10 -			
- 19 -			
- 12 -			
- 7]			
10			
[1 -			
- 1]			
[14 -			
- 7]			
2			
[7 -			
- 9 -			
- 21]			
1			
3			
14			
2			
3			
3			
2			
15			
1			
1			
1			
[11 -			
- 5 -			
- 7]			

Table C.2 – Continued

[3 -	
- 4]	
8	
11	
Plot 1a2	
Cedar	Privet
[17 -	[1 -
- 21]	- 1]
16	2
16	1
25	3
11	[2 -
4	- 2]
4	1
[12 -	
- 7 -	
- 7 -	
- 7 -	
- 4 -	
- 3]	
[16 -	
- 6]	
[6 -	
- 12 -	
- 2 -	
- 3]	
[14 -	
- 13 -	
- 3]	
[2 -	
- 8 -	
- 4]	
11	
10	
18	
5	
16	
[18 -	
- 6 -	
- 3]	
12	

Table C.2 – Continued

8
1
[15 -
- 26 -
- 13 -
- 11]
[11 -
- 5]
16
Plot 1a3
Cedar
[8 -
- 5 -
- 9 -
- 6 -
- 7 -
- 15]
[10 -
- 8 -
- 13]
12
9
8
12
12
8
[12 -
- 18]
1
[10 -
- 7]
11
1
21
2
[16 -
- 11]
[7 -
- 8 -
- 2]
[6 -

Table C.2 – Continued

- 1]						
[9 -						
- 12 -						
- 16 -						
- 11 -						
- 10 -						
- 8 -						
- 11]						
Plot 1b1						
Cedar	Live oak	Shumard	Durand	Buckthorn	Texas red	Nandina
[3 -	[20 -	[11 -	[21 -	1	30	11
- 25]	-15 -	- 25]	- 20]		1	
6	- 21]	8				
13						
[1 -						
- 2 -						
- 3]						
[12 -						
- 10 -						
- 30 -						
- 4 -						
- 10]						
7						
[4 -						
- 3 -						
- 4 -						
- 2]						
25						
2						
4						
1						
9						
2						
[13 -						
- 2]						
14						
10						
4						
31						
11						
26						

Table C.2 – Continued

7		
14		
9		
Plot 1b2		
Cedar	Durand	Texas red
[12 -	14	3
- 25 -		
- 15 -		
- 5]		
8		
17		
[16 -		
- 9]		
25		
14		
[3 -		
- 13]		
12		
[16 -		
- 29 -		
- 11]		
10		
10		
9		
12		
9		
[18 -		
- 6]		
5		
23		
[5 -		
- 5 -		
- 4]		
13		
2		
Plot 1b3		
Cedar		
15		
[9 -		
- 4 -		
- 4 -		

Table C.2 – Continued

- 10 -
- 13 -
- 9 -
- 9 -
- 10]
[13 -
- 5 -
- 5]
[9 -
- 10 -
- 18]
[1 -
- 8]
[10 -
- 14 -
- 9 -
- 7]
[6 -
- 5 -
- 9 -
- 4]
[13 -
- 12 -
- 10 -
- 8 -
- 14]
[7 -
- 1]
[8 -
- 22]
[13 -
- 6]
[9 -
- 12]

Plot 2a1

Cedar	Live oak	Durand	Privet	Chinaberry	Shumard
22	34.5	11	1	1	3
16	22	20		1	4
16	22	14			1
13.5		20			1

Table C.2 – Continued

13					
12.5					
11.5	Texas ash	Buckthorn	Redbud	Rosacea	
11	9.5	2	3	5	
11	18.5	2			
10	8				
9.5	2				
8	2				
8	1				
6	5				
5	4.5				
5					
5					
5					
4					
3.5					
2					
Plot 2a2					
Cedar	Durand	Buckthorn			
27.5	25	1			
9		1			
9		2			
22.5		2			
[4 -		2			
- 7.5]		4			
9		1			
8					
9					
3.5					
10					
8					
7.5					
15					
1					
1					
7					
31					
Plot 2a3					
Cedar	Durand	Shumard	Privet	Buckthorn	Chinaberry
16.5	[12.5 -	[19 -	1	1	2
7	- 11]	- 13]		1	3

Table C.2 – Continued

19		18		1
30		5		2
2		1		1
21				
[13 -				
- 25.5 -				
- 7 -				
- 9 -				
- 6]				
6				
5				
4				
2				
2				
2				
4				
3				
Plot 2b1				
Cedar	Shumard	Durand	Redbud	
17.5	3	1	2	
1				
1				
19				
[13 -				
- 10]				
[6 -				
- 27 -				
- 12 -				
- 28.5 -				
- 17.5 -				
- 11]				
1				
1				
3				
21				
[13 -				
- 9.5]				
Plot 2b2				
Cedar	Durand	Buckthorn		
10.5	[14 -	1		
13	- 21.5 -	1		

Table C.2 – Continued

2	- 9]
8	11
4.5	
10	
10	
5	
13	
12	
26	
[25.5 -	
- 12]	
7.5	
8	
9	
3	
6	
Plot 2b3	
Cedar	
5	
1	
3	
3	
7	
10	
20	
3.5	
5	
9	
17	
[12 -	
- 13]	
15.5	
[6 -	
- 12]	
7	
9	
13	
[6.5 -	
- 7.5 -	
- 8.5]	
Plot 3a1	

Table C.2 – Continued

Cedar elm	Privet	Coral berry
7	1	1
33	[1 -	1
[11 -	- 1 -	
- 19]	- 3 -	
26	- 1 -	
	- 1 -	
	- 1 -	
	- 1 -	
	- 3 -	
	- 2]	
	2	
	[3 -	
	- 2 -	
	- 4 -	
	- 4 -	
	- 8]	
	[4 -	
	- 3 -	
	- 2]	
	4	
	[3 -	
	- 2 -	
	- 2 -	
	- 1]	
	[1 -	
	- 1 -	
	- 1]	
	[4 -	
	- 3 -	
	- 1]	
	[4 -	
	- 2 -	
	- 2 -	
	- 1 -	
	- 1 -	
	- 1]	
	[1 -	
	- 2]	
	[1 -	
	- 1]	

Table C.2 – Continued

	3				
	[2 -				
	- 2 -				
	- 1]				
	5				
	[3 -				
	- 1]				
	2				
	1				
	3				
	[1 -				
	- 1]				
	2				
	3				
	[2 -				
	- 4]				
	[6 -				
	- 5 -				
	- 5 -				
	- 4]				
Plot 3a2					
Privet	Cedar	Hackberry	Texas ash	Chinaberry	Nandina
[7 -	[17 -	15	3	[3 -	1
- 6 -	- 19]	22		- 7 -	1
- 6 -	20			- 14]	1
- 5 -					[1 -
- 9 -					- 1]
- 1 -					1
- 15]					
[2 -					
- 1]	Coral berry				
[1 -	[1 -				
- 1]	- 1]				
[3 -	1				
- 2 -	[1 -				
- 1]	- 1 -				
4	- 1]				
[9 -	1				
- 8 -	[1 -				
- 8 -	- 1 -				
- 1 -	- 1]				

Table C.2 – Continued

- 1 -	[1 -			
- 4 -	- 1]			
- 3 -	1			
- 2 -	1			
- 11]				
[4 -				
- 6 -				
- 5 -				
- 8 -				
- 2 -				
- 9 -				
- 1 -				
- 2 -				
- 4 -				
- 6 -				
- 4 -				
- 6]				
2				
3				
Plot 3a3				
Privet	Chinaberry	Cedar	Hackberry	Coral berry
1	2	39	[11 -	[1 -
1			- 18 -	- 1 -
2			- 21 -	- 2 -
1			- 26 -	- 2]
[3 -			- 16]	[-2
- 7 -				- 2 -
- 4 -				- 1 -
- 2 -				- 1 -
- 4]				- 1 -
1				- 1]
[3 -				[1 -
- 2 -				- 1]
- 2]				[1 -
[1 -				- 2 -
- 1]				- 1]
[1 -				1
- 2 -				1
- 1 -				1
- 1]				[1 -
				- 1 -

Table C.2 – Continued

				- 1]
				[1 -
				- 1]
				1
				1
				[1 -
				- 1]
				[1 -
				- 1]
				[1 -
				- 1 -
				- 1 -
				- 1]
				[1 -
				- 1 -
				- 1]
				[1 -
				- 1]
				[1 -
				- 1]
				[1 -
				- 1 -
				- 1 -
				- 1 -
				- 1 -
				- 1]
				[1 -
				- 1]
				[1 -
				- 1 -
				- 2 -
				- 2 -
				- 1 -
				- 1]
Plot 3b1				
Privet	Cedar elm	Cedar	Coral berry	
[6.5 -	[10.5 -	[14 -	3	
- 1 -	- 6]	- 18 -	2	
- 1 -	[31 -	- 13]	3	
- 1 -	- 16]	[26.5 -	3	
- 3 -	26	- 21.5 -	2	

Table C.2 – Continued

- 3.5]		- 21.5]	1
1			1
2			1
[7 -			3
- 4]			[2 -
4			- 1 -
[1 -			- 1 -
- 4 -			- 1 -
- 3 -			- 1]
- 5.5 -			1
- 2.5 -			1
- 4.5 -			1
- 3]			1
1			2
3			1
1			[1 -
2			- 1]
Plot 3b2			
Privet	Soapberry	Cedar elm	
[5 -	14	13	
- 1 -	16	5	
- 7 -		5	
- 8]			
[1 -			
- 1 -			
- 2 -			
- 2]			
[1 -			
- 4 -			
- 3 -			
- 3]			
[1 -			
- 1]			
[2 -			
- 2]			
3			
[8 -			
- 5 -			
- 2.5 -			
- 15 -			
- 14.5 -			

Table C.2 – Continued

- 21 -					
- 2 -					
- 6 -					
- 5]					
[3 -					
- 3 -					
- 9.5 -					
- 4 -					
- 6 -					
- 5 -					
- 3 -					
- 7.5 -					
- 7.5 -					
- 5.5 -					
- 8]					
[3 -					
- 3.5 -					
- 4 -					
- 4 -					
- 5 -					
- 8 -					
- 1 -					
- 1 -					
- 2 -					
- 3]					
[5 -					
- 1 -					
- 2 -					
- 6 -					
- 1 -					
- 7 -					
- 3 -					
- 4 -					
- 5.5 -					
- 6 -					
- 7 -					
- 8.5]					
Plot 3b3					
Privet	Cedar	Texas ash	Buckthorn	Nandina	Coral berry
[1 -	[35.5 -	4	1	1	1
- 1 -	- 13]			1	2

Table C.2 – Continued

- 1 -	1
- 2 -	1
- 3 -	2
- 3.5 -	1
- 5 -	3
- 3]	[3 -
1	- 2 -
[2 -	- 1 -
- 3]	- 1]
[5 -	[1 -
- 2 -	- 1 -
- 3 -	- 1 -
- 3 -	- 1 -
- 4]	- 1 -
[1 -	- 3]
- 5 -	3
- 3 -	2
- 2.5]	2
[1 -	1
- 4]	1
2	1
[7 -	2
- 5 -	2
- 3 -	[2 -
- 3]	- 1]
[3.5 -	1
- 7 -	[2 -
- 3.5 -	- 1 -
- 3 -	- 1 -
- 5 -	- 2 -
- 5.5 -	- 2]
- 7 -	
- 7 -	
- 6 -	
- 4]	
3	
[4 -	
- 4]	
4	
2	
Plot 4a1	

Table C.2 – Continued

Cedar	Durand	Shumard	Privet	Texas ash	Chinaberry
1	2	4	1	6	1
19		1	2		1
2		2	2		
9		1	2		
1		1	2		
1		[4 -	[3.5 -		
2		- 3.5 -	- 1]		
6		- 3 -	1		
3.5		- 4 -	1		
14		- 7 -	3.5		
17		- 11 -	[1 -		
10		- 12]	- 5]		
[11 -		3	[2 -		
- 11.5 -		2	- 2.5]		
- 10]		4	1		
3					
4					
Plot 4a2					
Cedar	Shumard	Privet	Durand	Red oak	
[3 -	4	1	[3 -	19	
- 4 -	1	[3 -	- 9 -		
- 4]		- 3]	- 5]		
33		[1 -			
[5 -		- 1 -			
- 4 -		- 2 -			
- 4 -		- 3]			
- 3 -		1			
- 2 -		1			
- 6 -		[1 -			
- 7]		- 1 -			
21		- 2]			
3		[2 -			
		- 2]			
		1			
		1			
		1			
Plot 4a3					
Cedar	Texas ash	Durand			
[14 -	[1 -	[10 -			
- 14]	- 1 -	- 6]			

Table C.2 – Continued

[2.5 -	- 4]	1
- 7 -	1	5
- 4 -	2	
- 4]	7.5	
[7.5 -	1	
- 7.5 -	2	
- 5.5]	3	
9		
[12 -		
- 13]		
10		
18		
[10 -		
- 27 -		
- 6 -		
- 7]		
[20 -		
- 10.5 -		
- 3.5 -		
- 4]		
5.5		
5		
6		
3		
17		
[9 -		
- 11]		
18		
12		
[11 -		
- 2 -		
- 5]		
8		
Plot 4b1		
Cedar	Shumard	Texas ash
4.5	5	11
12	[6 -	12
14.5	- 7]	7.5
7.5	[18 -	6
13	- 7]	11
26	1	

Table C.2 – Continued

4	1			
14	3			
8	3.5			
Plot 4b2				
Cedar	Texas ash	Buckthorn	Privet	Shumard
2	3	1	2	1
[11 -	10			7
- 12 -	[12.5 -			
- 14.5 -	- 8]			
- 25 -				
- 17 -				
- 8]				
11.5				
9				
14				
9				
6				
8				
8				
1				
5.5				
15				
9.5				
7.5				
13				
16				
9				
1				
Plot 4b3				
Cedar	Durand	Shumard	Privet	
3.5	1	5.5	1	
7	2	6	3	
3	3			
19	4			
16	10.5			
14.5	6			
16				
16				
4				
10				
2				

Table C.2 – Continued

4					
3					
2					
2					
1					
1					
1					
2					
6					
Plot 5a1					
Cedar	Buckthorn	Durand	Texas ash	Privet	Hackberry
29	2	[22 -	8	1	15
3	1	- 6.5]	6	2	
[20 -		8.5	4		
- 9 -		10		Red Bud	Cedar elm
- 18]		29.5		1	[4 -
7					- 2]
28					2
Plot 5a2					
Cedar	Texas ash	Privet	Shumard	Durand	
[13 -	5	1	2.5	4.5	
- 11 -		2			
- 11]		3			
[30 -		2			
- 13]					
6					
[10 -					
- 14.5]					
10					
[7 -					
- 8.5 -					
- 16 -					
- 28 -					
- 19 -					
- 18]					
13					
4					
3					
1					
22					
22.5					

Table C.2 – Continued

Plot 5a3			
Cedar	Live oak	Durand	Shumard
8	23.5	1	1
[8 -	28.5	8	
- 18 -			
- 33 -			
- 8 -			
- 7]			
9			
10.5			
1			
5.5			
[11 -			
- 11 -			
- 27]			
[19 -			
- 2 -			
- 6]			
[5 -			
- 22 -			
- 7]			
[11.5 -			
- 6]			
[12.5 -			
- 2.5 -			
- 7 -			
- 11.5]			
Plot 5b1			
Privet	Texas ash	Cedar	
1	10.5	[11 -	
	2.5	- 11 -	
		- 22]	
		4	
		3.5	
		20.5	
		[24.5 -	
		- 13]	
		4	
		18	
		11	
		2	

Table C.2 – Continued

		4	
Plot 5b2			
Cedar	Texas ash	Privet	Live oak
[4 -	7	2	1
- 10.5]		3	
[19.5 -		2	
- 4 -			
- 6]			
7			
2			
8			
1			
2			
1			
2			
1			
2			
2			
[7 -			
- 7 -			
- 11 -			
- 15]			
16			
16			
20			
2			
3			
3			
1			
1			
Plot 5b3			
Cedar	Privet	Shumard	
[14 -	3	4	
- 18]	[2 -		
6	- 2]		
18	1		
16	[4 -		
[11 -	- 1]		
- 15 -	3		
- 20]	[4 -		
23	- 3 -		

Table C.2 – Continued

14	- 3 -
[9 -	- 1]

Table C.3 - Raw Data – Understory Totals per Size Class

Plot	0 – 20	20 – 50	50 – 100
Plot 1a1			
Cedar	57	5	4
Durand	23	5	5
Live oak	5	0	0
Shumard	9	7	10
Privet	3	2	0
Nandina	1	0	0
Post oak	0	1	0
Ilex vomitoria	2	1	1
Plot 1a2			
Cedar	11	2	0
Durand	1	0	0
Live oak	1	0	1
Texas ash	7	5	3
Privet	6	6	5
Ilex vomitoria	1	1	2
Nandina	7	0	0
Shumard	1	0	0
Rosacea	0	1	0
Wafer ash	0	2	4
Plot 1a3			
Cedar	105	13	3
Buckthorn	2	0	0
Bush cherry	0	3	14
Live oak	2	0	0
Nandina	1	0	0
Texas ash	4	3	3
Plot 1b1			
Cedar	1	0	1
Rosacea	0	0	1
Nandina	2	3	3
Privet	0	1	1
Durand	1	1	3
Shumard	2	8	3
Live oak	1	0	0
Cedar elm	1	2	0
Crataegus	0	5	0
Red bud	0	4	0
Chinaberry	0	0	1
Buckthorn	0	0	2

Table C.3 – Continued

Plot	0 – 20	20 – 50	50 – 100
Plot 1b2			
Cedar	6	1	0
Eve's Necklace	1	0	0
Shumard	8	2	0
Privet	0	0	2
Durand	11	6	2
Texas ash	14	4	2
Rosacea	5	4	2
Buckthorn	1	2	1
Crataegus	1	2	0
Red bud	1	2	0
Cedar elm	8	2	0
Live oak	3	0	0
Prunus	6	0	1
Plot 1b3			
Cedar	94	7	5
Texas ash	7	9	4
Durand	4	1	2
Shumard	2	3	0
Bush cherry	0	2	1
Rosacea	0	1	0
Prunus	0	0	1
Plot 2a1			
Cedar elm	10	23	2
Sumac	1	0	0
Live oak	2	6	1
Ilex vomitoria	0	0	2
Privet	0	1	0
Prunus - plum	2	7	2
Crataegus	3	10	7
Cedar	11	7	2
Nandina	0	0	3
Wafer ash	0	1	0
Durand	13	15	13
Shumard	0	3	2
Red bud	0	1	2
Texas red	15	13	8
Texas ash	6	6	5

Table C.3 – Continued

Plot	0 – 20	20 – 50	50 – 100
Buckthorn	0	0	2
Bush cherry	0	3	1
Plot 2a2			
Cedar	2	2	0
Cedar elm	1	3	0
Privet	2	1	5
Texas ash	7	12	9
Rosacea	3	5	0
Chinaberry	2	1	0
Durand	3	5	3
Nandina	7	7	4
Sumac	1	1	0
Bush cherry	0	1	0
Buckthorn	7	2	3
Red bud	1	2	3
Shumard	2	3	2
Plot 2a3			
Cedar	4	3	2
Wafer ash	0	4	1
Nandina	0	2	2
Buckthorn	0	0	5
Texas red	3	2	0
Texas ash	0	2	1
Red bud	0	0	1
Crataegus	0	8	6
Prunus	0	1	0
Privet	0	0	1
Cedar elm	1	0	0
Shumard	1	3	1
Live oak	1	1	0
Viburnum	6	3	2
Durand	0	6	4
Plot 2b1			
Texas ash	20	12	10
Cedar	41	33	9
Durand	12	6	5
Shumard	4	18	7

Table C.3 – Continued

Plot	0 – 20	20 – 50	50 – 100
Red bud	2	2	2
Nandina	0	0	1
Cedar elm	12	4	2
Live oak	2	3	1
Privet	4	4	2
Crataegus	1	3	7
Prunus	0	2	4
Buckthorn	0	0	2
Plot 2b2			
Cedar	1	2	0
Texas ash	2	2	2
Prunus	4	0	1
Buckthorn	4	1	4
Crataegus	2	3	1
Texas red	0	1	1
Privet	0	1	2
Nandina	0	1	1
Red bud	0	2	0
Plot 2b3			
Cedar	8	6	2
Texas ash	0	0	2
Prunus - plum	0	3	1
Crataegus	0	3	0
Texas red	1	1	0
Nandina	0	1	1
Buckthorn	0	0	1
Privet	0	0	1
Plot 3a1			
Live oak	0	1	0
Privet	1	1	3
Rhubas	1	0	0
Prunus	2	0	1
Coral berry	0	0	2
Plot 3a2			
Privet	2	1	4
Nandina	1	0	6

Table C.3 – Continued

Plot	0 – 20	20 – 50	50 – 100
Coral berry	0	3	4
Ilex decidua	2	0	0
Plot 3a3			
Privet	28	26	16
Cedar elm	0	3	1
Live oak	0	0	1
Coral berry	4	7	9
Nandina	1	0	0
Eve's necklace	0	1	0
Plot 3b1			
Privet	5	4	4
Nandina	5	2	3
Cedar	4	2	2
Prunus	3	4	3
Coral berry	15	17	21
Plot 3b2			
Privet	7	5	5
Nandina	11	5	4
Coral berry	5	2	3
Ilex decidua	2	1	1
Bush cherry	4	3	2
Plot 3b3			
Privet	4	7	8
Nandina	7	1	2
Coral berry	13	24	22
Durand	1	0	0
Prunus	2	0	0
Cedar elm	0	1	0
Plot 4a1			
Cedar	13	4	5
Cedar elm	3	0	0
Shumard	5	13	10
Red bud	0	0	2
Privet	2	0	2
Live oak	1	0	0

Table C.3 – Continued

Plot	0 – 20	20 – 50	50 – 100
Bush cherry	0	1	2
Durand	4	5	2
Nandina	0	1	1
Rosacea	0	1	1
Texas ash	5	11	8
Buckthorn	0	0	1
Prunus	0	2	4
Plot 4a2			
Privet	3	3	6
Bush cherry	0	2	3
Cedar	26	17	1
Texas red	1	1	0
Red bud	5	9	5
Shumard	12	20	10
Texas ash	22	37	16
Nandina	1	6	0
Live oak	2	1	0
Cedar elm	3	3	1
Ilex vomitoria	1	1	0
Wafer ash	2	6	2
Buckthorn	0	0	3
Durand	3	11	3
Prunus	1	6	4
Crataegus	5	3	0
Plot 4a3			
Cedar	47	36	3
Cedar elm	3	2	0
Shin oak	2	3	0
Durand	3	5	3
Red bud	0	1	2
Shumard	4	7	3
Texas ash	7	13	6
Live oak	2	3	2
Buckthorn	0	1	3
Privet	3	7	11
Ilex vomitoria	2	1	0
Nandina	1	2	0
Rosacea	0	1	0

Table C.3 – Continued

Plot	0 – 20	20 – 50	50 – 100
Bush cherry	0	2	1
Prunus	2	4	1
Crataegus	2	1	0
Plot 4b1			
Buckthorn	0	0	1
Cedar	17	15	6
Ilex vomitoria	3	3	2
Shumard	2	3	10
Crataegus	1	1	0
Texas ash	3	9	3
Live oak	1	1	0
Cedar elm	2	2	0
Bush cherry	3	3	0
Privet	2	0	3
Red bud	1	1	0
Nandina	0	2	1
Durand	4	3	0
Wafer ash	0	3	1
Plot 4b2			
Privet	3	5	3
Nandina	0	2	0
Cedar	0	3	2
Ilex vomitoria	1	0	0
Buckthorn	0	1	4
Cedar elm	2	1	0
Shumard	5	9	4
Texas ash	3	6	2
Durand	14	18	13
Bush cherry	0	1	0
Live oak	1	2	1
Red bud	3	2	0
Rosacea	0	2	2
Prunus	1	3	0
Plot 4b3			
Cedar	16	6	13
Privet	2	1	4
Durand	14	18	11
Buckthorn	6	6	2
Shumard	2	5	3
Wafer ash	0	1	1
Redbud	1	0	0
Texas ash	2	3	1

Table C.3 – Continued

Plot	0 – 20	20 – 50	50 – 100
Ilex vomitoria	2	0	0
Crataegus	0	0	1
Nandina	1	0	0
Live oak	1	1	0
Prunus	0	1	0
Plot 5a1			
Cedar	56	48	3
Nandina	5	4	2
Privet	8	20	21
Redbud	4	10	7
Durand	14	29	10
Shumard	16	23	6
Buckthorn	1	1	1
Texas ash	3	9	3
Prunus	5	2	0
Bush cherry	1	4	4
Shin oak	2	1	0
Live oak	2	1	0
Plot 5a2			
Cedar	26	10	1
Durand	12	12	8
Live oak	0	1	1
Bush cherry	0	2	2
Buckthorn	2	0	0
Redbud	8	8	8
Privet	1	4	1
Red oak	4	2	0
Shumard	13	8	7
Ilex vomitoria	4	3	3
Prunus	1	1	2
Texas ash	4	4	8
Nandina	3	0	0
Plot 5a3			
Buckthorn	2	3	4
Privet	0	0	1
Cedar	51	8	0
Live oak	1	1	2
Redbud	2	3	2
Nandina	1	0	0
Texas ash	1	1	2
Shumard	6	3	2
Durand	8	8	1

Table C.3 – Continued

Plot	0 – 20	20 – 50	50 – 100
Bush cherry	0	2	1
Ilex vomitoria	4	0	0
Prunus	0	1	0
Red oak	2	2	0
Cedar elm	2	0	0
Plot 5b1			
Cedar	45	9	5
Privet	0	5	10
Shumard	16	6	7
Bush cherry	1	2	1
Durand	14	8	4
Cedar elm	2	1	0
Texas ash	3	4	1
Nandina	6	2	0
Buckthorn	2	0	1
Redbud	5	2	3
Live oak	2	1	0
Ilex vomitoria	2	4	0
Prunus	1	1	0
Plot 5b2			
Cedar	33	12	3
Privet	1	3	4
Bush cherry	0	1	0
Durand	4	1	1
Texas ash	1	1	0
Cedar elm	2	0	0
Shumard	2	4	2
Redbud	3	4	1
Nandina	4	4	0
Ilex vomitoria	2	2	0
Live oak	1	1	0
Prunus	1	1	0
Buckthorn	2	1	0
Plot 5b3			
Cedar	38	17	1
Durand	8	6	1
Privet	0	3	4
Shumard	6	4	1
Nandina	1	4	4
Cedar elm	1	0	0
Texas ash	8	10	2
Bush cherry	0	1	1

Table C.3 – Continued

Plot	0 – 20	20 – 50	50 – 100
Live oak	1	1	0
Redbud	1	2	3
Rosacea	0	0	1
Ilex vomitoria	1	0	0
Prunus	0	0	1

APPENDIX D

Formal Photographic Comparison and Historic Still Photographs

Photograph of the Bosque River taken from Lover's Leap by
Fred Gildersleeve in 1909 (Cameron Park Photos)

Taken by the author from the same vantage point; it was not possible to
obtain the exact angle—in 1909, the wall was not up around the cliffs

Photograph taken at Proctor Springs by an unknown artist, presumably in the 1900s judging by the rock-work (Cameron Park Photos)

Photo taken from the same vantage point by the author; note the change in the rock-work and the addition of trees in the small stream valley (between the camera and the subject) and the loss of trees along the hill

Succession of photographs taken by 2 unknown artists and the author (lower photo); note the shifting forest cover, addition of the wooden bridge and changing understory cover (Cameron Park Photos)

View of the Bosque River from Lover's Leap taken by an unknown artist sometime after the Great Depression; note that the Brazos is flooded, which makes the most likely date for this photograph before the construction of the Second Lake Waco Dam between 1958 – 1965 (Cameron Park Photos)

Photograph taken from the same vantage point by the author; it was difficult to match the photograph because of the overgrowth of honey mesquite and eastern red cedar

Photograph of Lindsey Hollow taken by an unknown artist
(Cameron Park Photos)


Photograph taken from the same vantage point by the author;
note the heavy understory growth since the top photo

Photographs taken by Fred Gildersleeve and the author of the playground at Proctor Springs; the top two were probably taken around the turn-of-the-century (note the horse-drawn carriage in the background (Cameron Park Photos)

Photograph taken sometime after the Great Depression
by an unknown artist; note the complete absence of
trees in the horizon (Cameron Park Photos)

Photograph taken by the author from the same vantage
point; note the growth of trees across the river

Photograph of Lover’s Leap taken by an unknown artist sometime after the Great Depression; note the hole in the wall (Cameron Park Photos)

Photograph of Lover’s Leap taken from the same vantage point by the author

Photograph of Emmon’s Cliff taken by Fred Gildersleeve
sometime during the mid-1900s (Cameron Park Photos)

Photograph taken from the same vantage photo by the author;
note the growth of trees since the first picture

APPENDIX E

Letters Supporting the Healing Properties of Waco's Artesian Water (Pope 1890, 3)

To the Bell Water Co., Waco, Tex.: Sirs – You ask me for my professional opinion of the character of the water furnished by your company from the artesian wells. In reply, I would say, that I have watched with interest the effects of these waters upon the health of this community during the past year and found them, without exception, beneficial. From observation of the effects upon those who have used the waters, and also from analysis made, I believe they are equal in all respects to those of Hot Springs, Arkansas, and I feel confident that in the near future hundreds of strangers will come here to avail themselves of the benefits to be derived from both drinking and bathing in them. Dyspepsia, constipation, chronic blood diseases and many other ailments may be prevented and cured by these waters as certainly as by any of the thermal springs in the United States.

Yours, truly, R.W. Park, M.D.

We concur in the above.

W.W. Wilkes, M.D.

J.H. Caldwell, M.D.

C.T. Young, M.D.

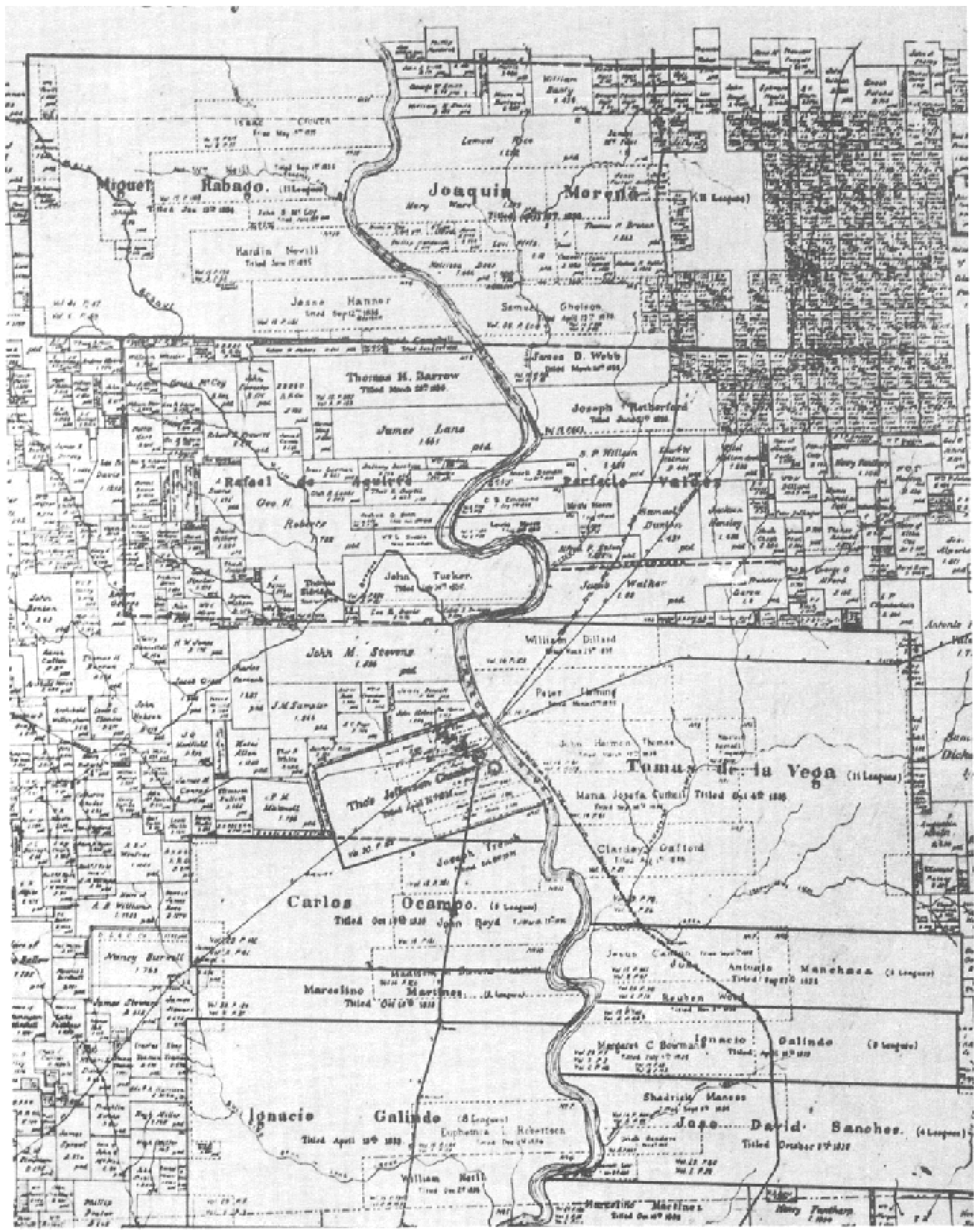
J.F. McKennon, Analytical Chemist and Pharmacist

I fully endorse the above, and from observation and experience of the use of the water extending over a period of nearly twelve months, the above endorsements are hardly strong enough.

F.W. Burger, M.D.

APPENDIX F

Map of Early Waco Land Grants (Conger 1958, plate 1)



APPENDIX G

Mayor Mistrot's Dedicatory Speech in Cameron Park (Cameron Park Vertical File)

"LOVERS OF THE BEAUTIFUL, THE GENEROUS AND THE TRUE:

During the time intervening between the death and the burial of William Cameron, I gladly seized an opportunity to stand in the legislative halls of the state and pay to his honored memory a merited tribute. I sang not of those who had trodden the perilous peaks of power. I thought not of those whose trophies were captured kings and conquered empires. I spoke of him who walked the private pathways of life, wearing the fadeless flower of a good name and enjoying everywhere the comradeship and the confidence of his countrymen. I spoke then in memory of the dead. In his name we gather here today in unnumbered thousands and, at your kindly bidding, I lift my voice to honor with you a sentiment loftier than is possible to blossom forth in human speech, but which links together at this hour in fond memory both the living and the dead. If it be true that the sainted spirits of the departed behold the heavenly acts of the living, then we cherish the happy thought that William Cameron from his castle in the skies looks down on this swelling throng with as genial and gladsome a glow as lighted the face of Moses fresh from Sinai's heavenly heights.

It is a beautiful thought of the scientific world that when a sound has been once uttered it never dies. The shouts of victory at Balaklava and the words of Webster at Bunker Hill are echoing still in the auditoriums of time. Still truer and still nobler is the thought that no generous act and no philanthropic deed ever dies. They possess the elements of immortality and inspire the hearts of men to noble action long after the hands that wrought them are folded above a pulseless breast. Some people are only worth the money they own, while others who preach and practice aright the gospel of wealth are worth more than it will ever be possible for them to possess. Service is the law of life as well as the standard by which a person's worth to the world is measured. The pyramids were built beneath the lash of a master to glorify Egyptian kings. They render no service. They stand as monuments of misguided ambition. The service, however, that this park will render for the glory and uplift of humanity will cause the Cameron name to remain sweet in the mouths of men as long as yonder river flowing by it seeks the sea, and as long as yonder sun circling the earth and looking down on it, calls back to faded cheeks the rosy tints of life.

No man has a right to be absorbed and satisfied with himself. No man can separate himself from the throbbing world about him. When the apostles became angry as they discussed who was to be the greatest in the Kingdom, the Savior declared unto them for all times: "Let him who would be chiefest among you be the servant of all."

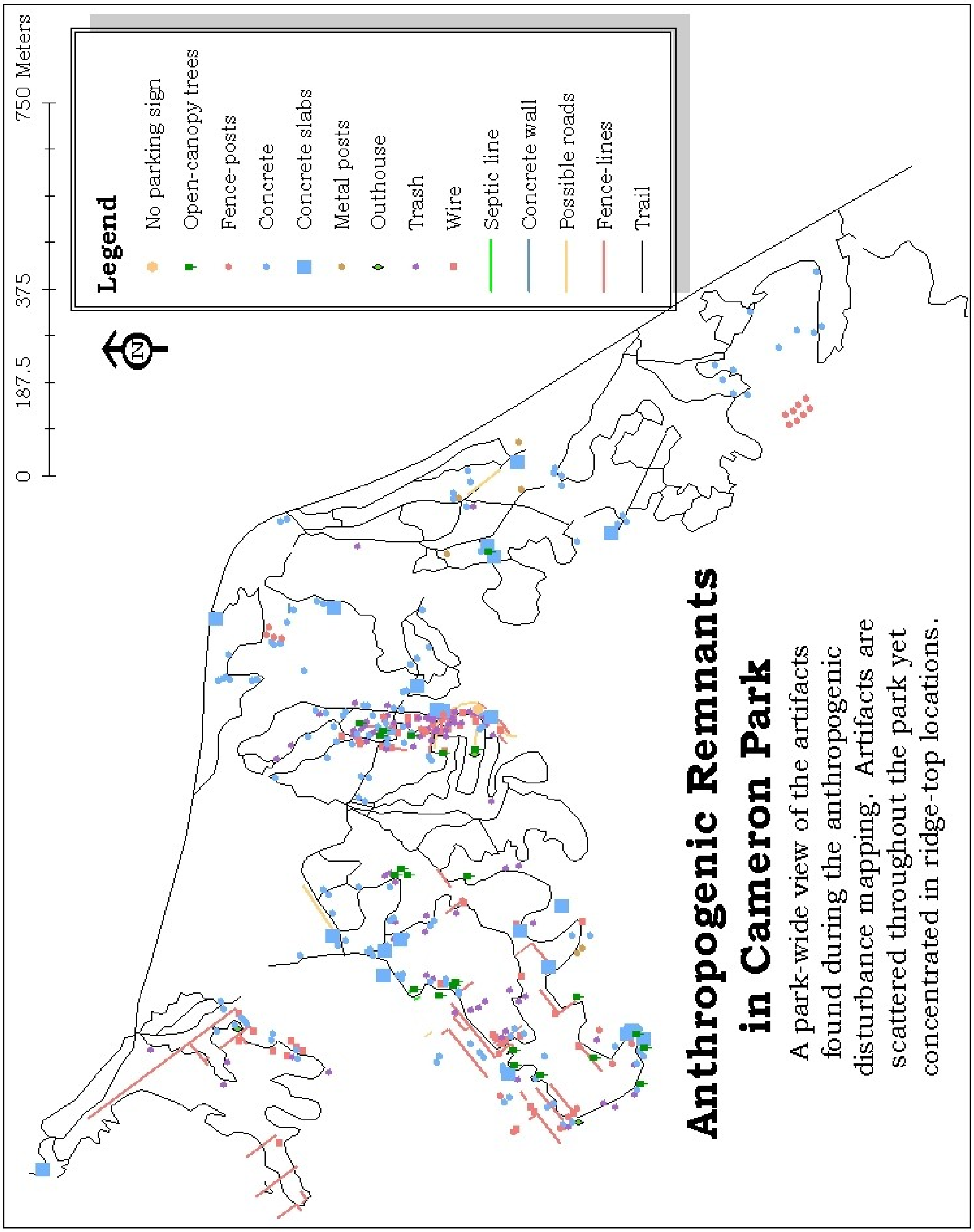
> 'He who serves self alone,
>   Serves neither God nor man.
> He who serves self alone,
>   Services the meanest mortal known.'

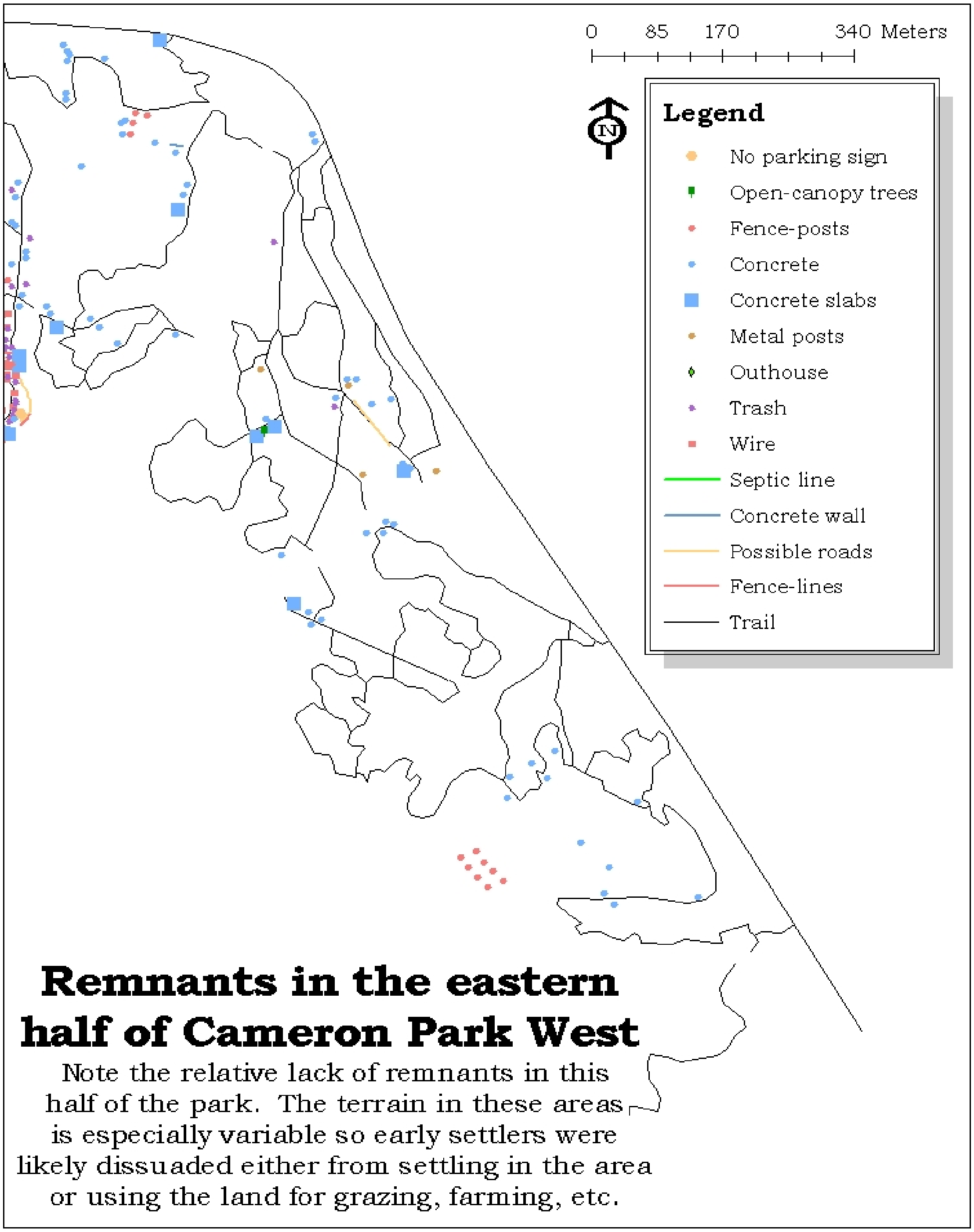
Service is the law of life. The rose of Sharon and the lily of the valley, that neither toil nor spin, perform their services in the world about them. The diamond-studded dew drop that glistens in the morning light and the aureole of the setting sun, that neither sow nor reap, have their allotted work in the universe of God. No man can live a selfish segregated life. He who toils for himself alone will 'reap from the hopes which around him he sows a harvest of barren regrets.' Every man owes a duty to every other man. Man is his brother's keeper. Talents that are hid in napkins never enrich the holder nor bless the world. The most valuable cargo that ever floated from Colchian shores are not the fleeces of commerce that bear the cold mark of trade, but the sweet spices of service, whose fragrance herald their coming, and whose rich perfumes attend their stay. A man's greatness is measured not by the number who serve him, but by the number whom he serves.

This is the most glorious gift ever made to the people of Waco. Jesus in the upper chamber bathing the disciples' dusty feet rendered not a more beautiful service and set not a nobler example than did the donors of this beautiful park. By this splendid donation the generous givers did more for the cause of humanity than if they had girdled the earth with a railroad track and an ocean liner. It is impossible to estimate a country's civilization by the constant click of countless factories and the busy buzz of whirling wheels. When Stephenson built his light-house on the storm-swept English Channel to preserve the lives of men, he erected a structure more valuable than all the towering smokestacks that line the ocean channel. All wealth does not bear the dollar mark; nor is it horded gold and cattle herding on a thousand hills. The man who paints a picture or produces a poem is as great a power in the civilization of the world as the man who plants a potato or the man who clips a coupon. This beautiful park with its vines and trees, its springs and rivulets, its cliffs and everglades, its valleys and mountains, is as much a part of our civilization as the finished fabric of the field of the factory. From out the city's busy throng, during all the years to come, will gather, on this playground and breathing spot, our people, to commune with nature and with Nature's God. Coming as it does from white souls and generous hands this act of philanthropy will ring the chiming bells of hope, health and happiness in human hearts long after the cold towering monuments of the Goulds and Vanderbilts have crumbled into unremembered dust. It will inspire the heart and nerve the arm for noble efforts when the silver and the gold of the Rothschilds is heard of no more. It will be a help, a hope, and an inspiration to the children of men when Xenophone and his ten thousand sleep in the tongueless tomb of oblivion. About us each day men of wealth mindful of self have gone to unremembered graves, while others forgetful of self have made immortal names, around which, each day, will cling and cluster a paeon of praise until the lips of our language have been sealed and the heart-throb of our people has been stilled. It is said that Themistocles while looking on the magnificent monument erected in honor of Miltiades declared: 'That monument will not let me sleep until I, too, have done some noble deed for my country.' Let us in this honored and historic hour, weighted and freighted with the gracious gratitude of a proud people, indulge in the fond and happy hope that this towering monument of love and philanthropy will so fill and thrill our lives that every man among us will say: 'The generous and gracious gift of the Camerons will not let me as a citizen of Waco sleep until I, too, have done some philanthropic deed for my people.'"

APPENDIX H

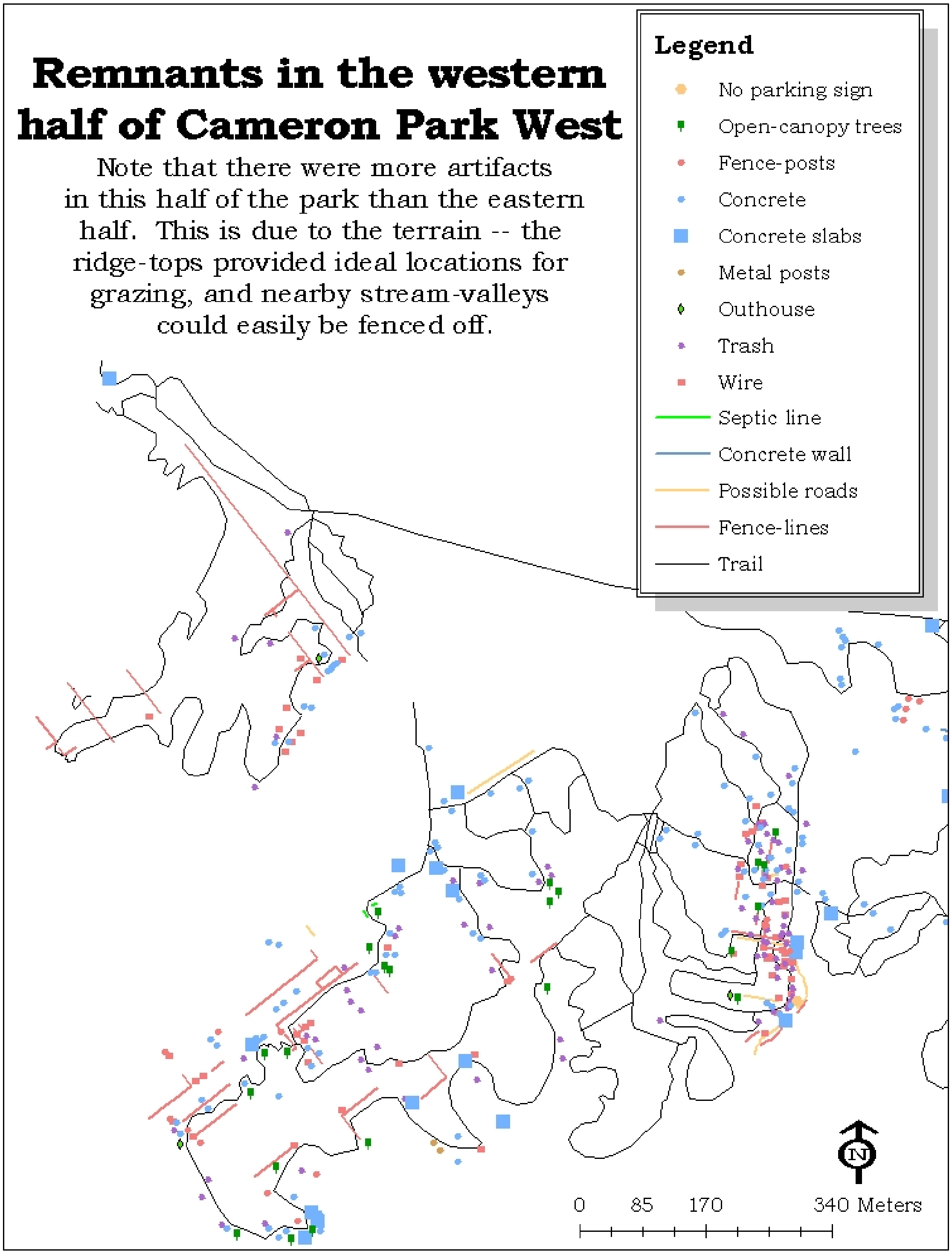
Results of Anthropogenic Disturbance Mapping –Maps Produced in ArcGIS 9.1

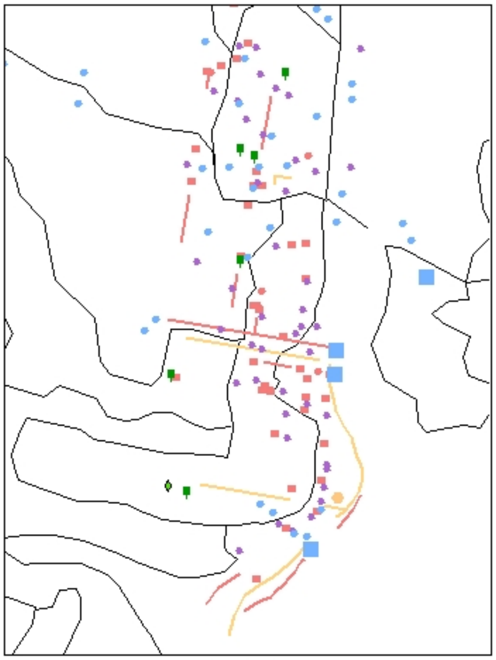




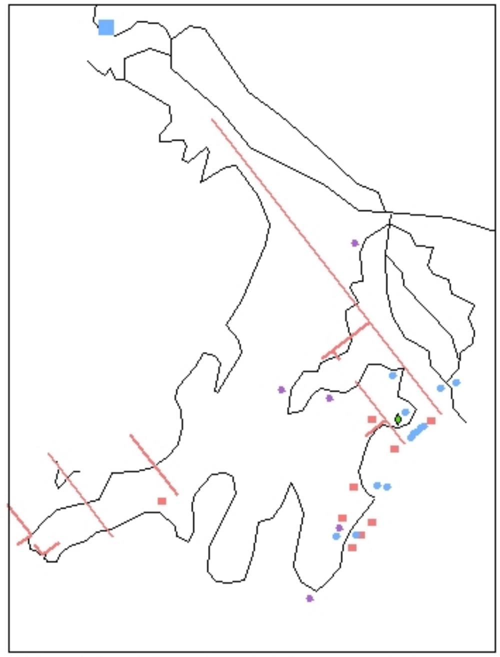
Remnants in the eastern half of Cameron Park West

Note the relative lack of remnants in this half of the park. The terrain in these areas is especially variable so early settlers were likely dissuaded either from settling in the area or using the land for grazing, farming, etc.

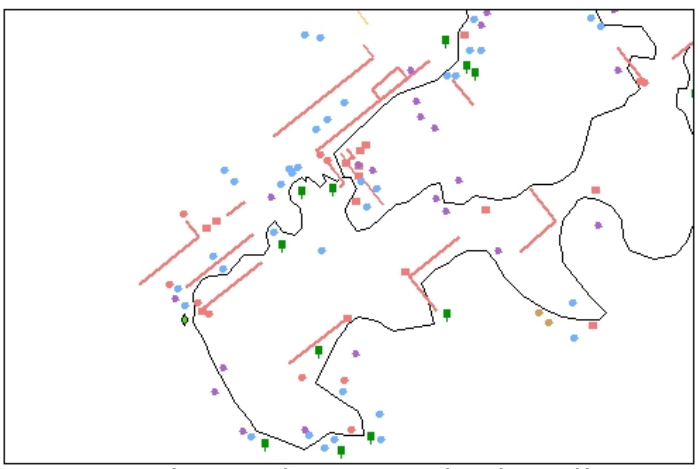

Remnants in the western half of Cameron Park West
Note that there were more artifacts in this half of the park than the eastern half. This is due to the terrain -- the ridge-tops provided ideal locations for grazing, and nearby stream-valleys could easily be fenced off.
Legend
No parking sign
Open-canopy trees
Fence-posts
Concrete
Concrete slabs
Metal posts
Outhouse
Trash
Wire
Septic line
Concrete wall
Possible roads
Fence-lines
Trail
N
0
85
170
340 Meters



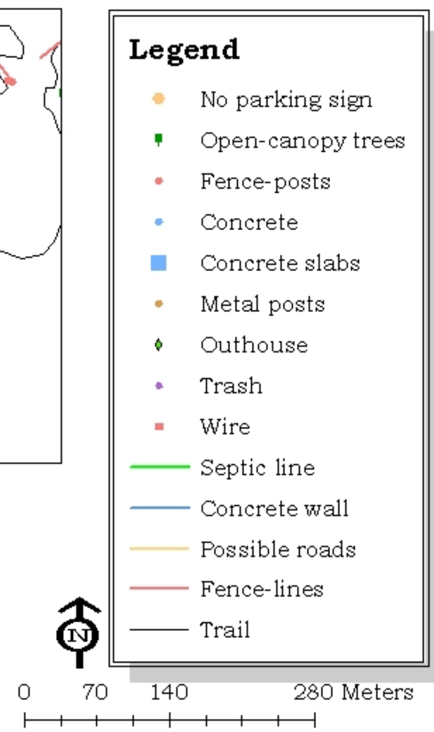
'Erect,' 'Slinky' & 'Colorado' trails



'Highlander' & 'Hale Bopp' trails

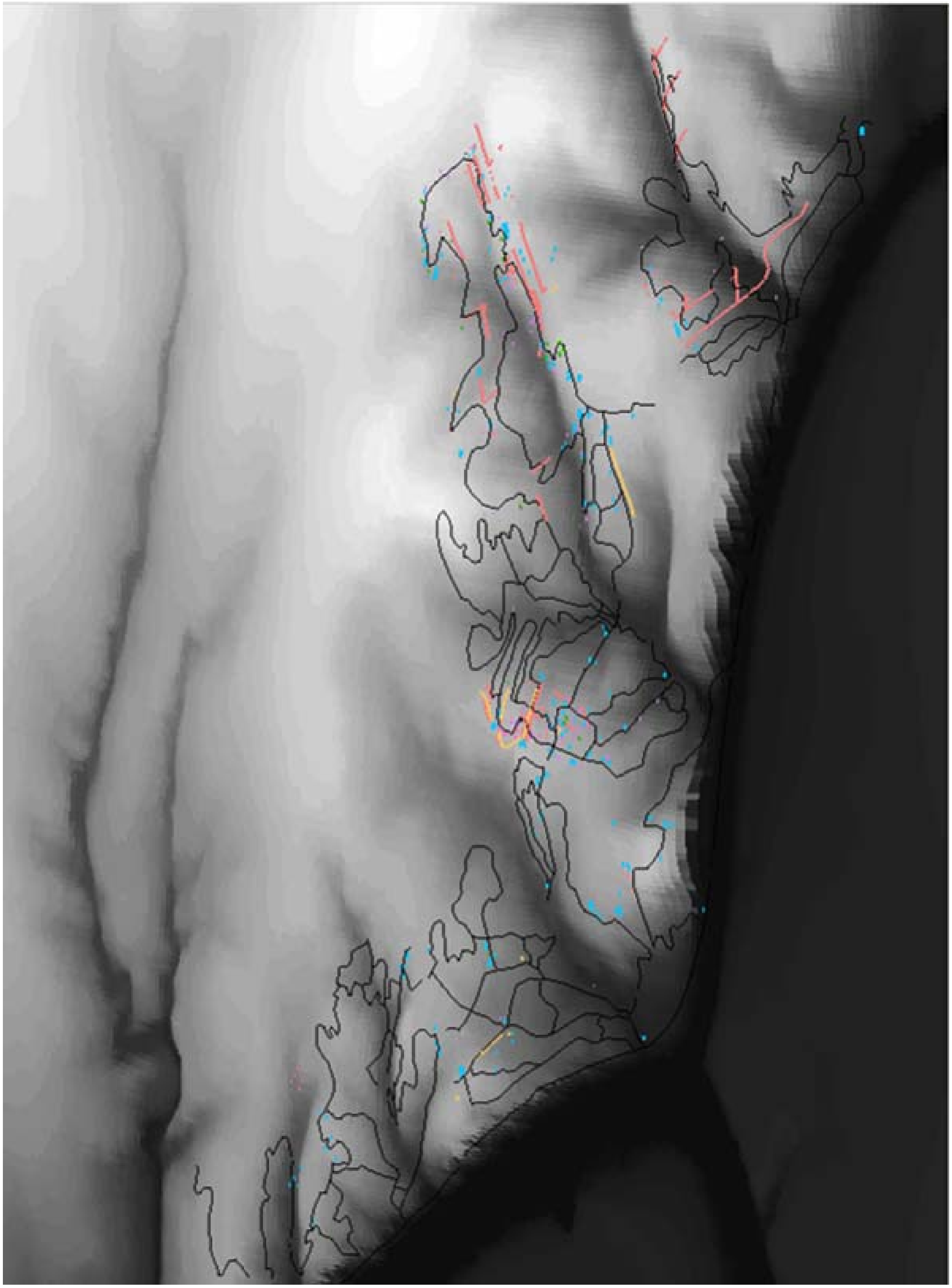


'Powder Monkey' & 'Outback' trails



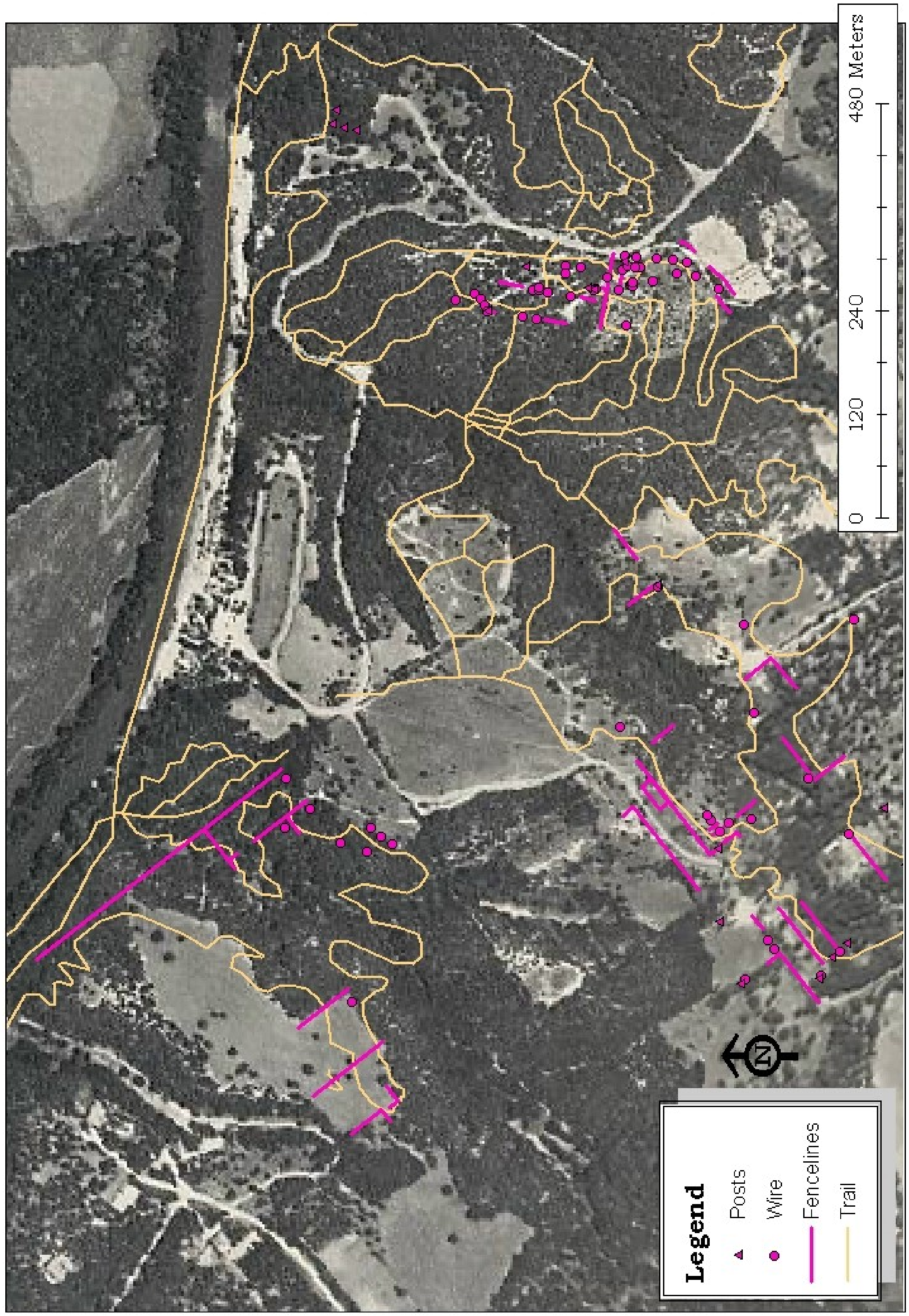
Areas of Interest

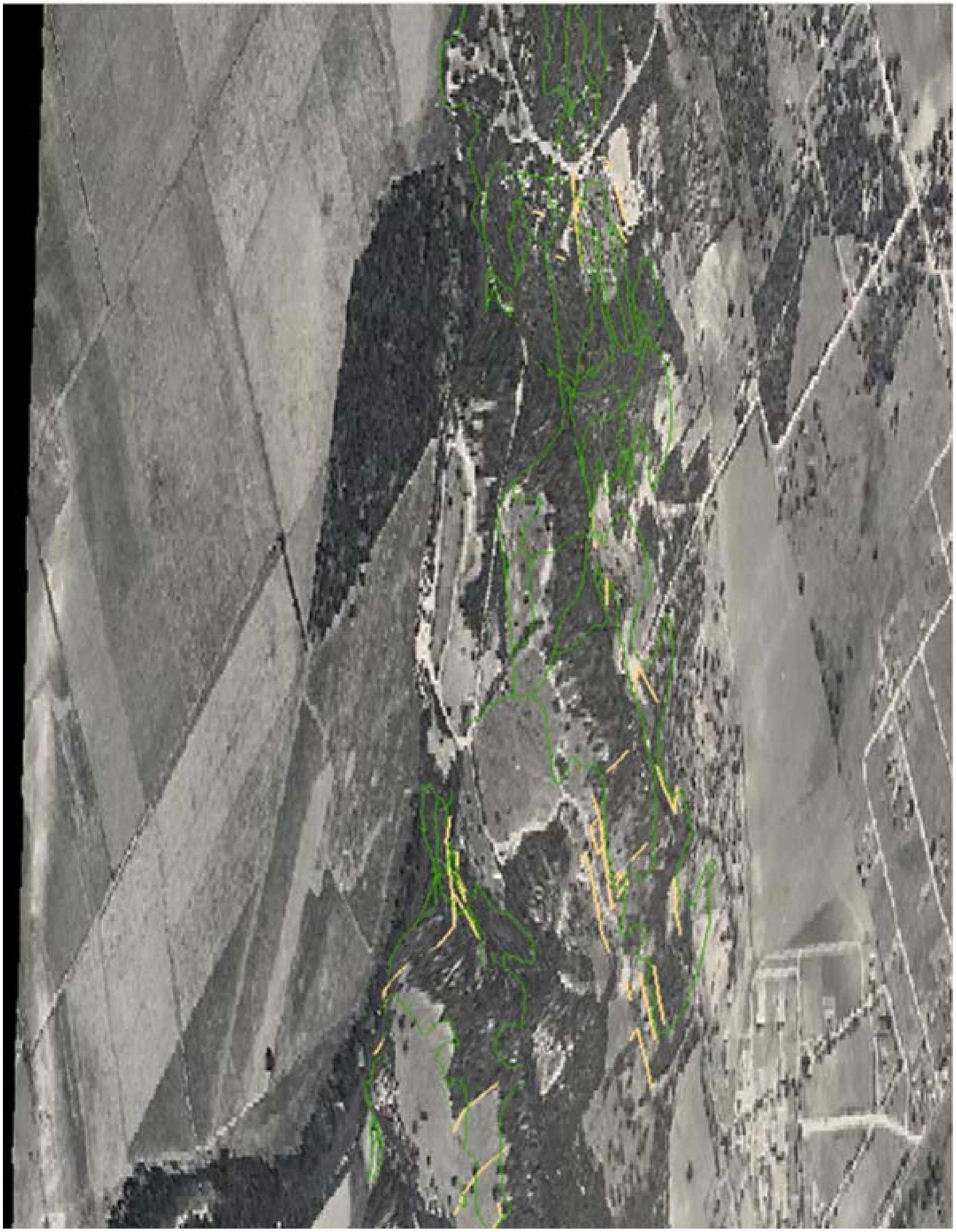
Remnants were concentrated in areas ideal for grazing and settlement. The areas of greatest interest are highlighted above.



Three-dimensional view of the anthropogenic remnants (using the same symbology as the above maps) using ArcScene

Overlay of historic fence-lines on a 1941 aerial photo





Three-dimensional view of the fence-lines and trails using ArcScene

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