Landscape Ecology of Florida Dry Prairie in the Kissimmee River Region

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ABSTRACT

Florida dry prairie is a rare natural community restricted to south-central peninsular Florida. Rather than being an artifact of clearcutting of pine flatwoods, dry prairie is a well-defined natural community distinguished and delineated on many of the presettlement land surveys of the region. These surveys were conducted before any extensive alteration of the landscape by logging and drainage, and therefore represent a close approximation of natural conditions. The presettlement land surveys were examined to determine the extent and characteristics of the Florida dry prairie landscape in the region centered on the Kissimmee River. Other historical maps and descriptions of vegetation characteristics were used to provide additional data concerning the boundaries of the region and its vegetation. The presettlement plat maps were examined for seventy townships, following the extent of mapped dry prairie, and the presettlement survey notes were examined for selected townships. The Kissimmee River dry prairie region was defined as being the extent of relatively contiguous dry prairie on predominantly upland soils, extending to the boundary of relatively continuous pinelands on its northern, western, and eastern borders. The presettlement extent of the Kissimmee River dry prairie region was determined to be about 786.6 mi^2 (503,428 ac; 2037 km^2). To the south, the Kissimmee River dry prairie region is bordered mostly by marshland, along the lower Kissimmee River, the north shore of Lake Okeechobee, along Lake Istokpoga, and in the "Indian Prairie" region, mostly a marshland region, centered on Glades County. The largest extent of the Kissimmee River dry prairie region is in southern Osceola and western Okeechobee counties, with one contiguous area of the dry prairie landscape covering 540 mi^2. The region is of smaller extent in Polk, Highlands, and perhaps northern Glades counties. The vegetation types present within the region based on the presettlement data are described, with additional interpretation based on field surveys of extant examples. The edaphic and landscape-level features of the pineland/prairie boundary are contrasted. There is no single factor or combination of factors that can define all borders of the Florida dry prairie region. In some cases, there is a correlation of dry prairie with developed clay subsoils, in contrast to the predominantly spodic subsoils of pinelands. However, the extent of the dry prairie region can better be related to differences in landform, specifically in topographic dissection and degree of homogeneity of soil moisture and vegetation types. Dry prairie is mostly found in relatively flat landscapes, with few patches of drier, sandier areas and few forested wetlands. Pinelands near the dry prairie border, particularly on the eastern border, are often found in more dissected landscapes, with more area of drier, sandy communities and dissected by forested wetland strands. This greater degree of landscape dissection may have served as a partial barrier to landscape-level fires, thus allowing more time between extreme burn events for pines to become established. It is possible that some areas along the dry prairie border have little correlation with edaphic factors because the pinelands were slowly expanding into prairie at the time of the presettlement surveys. Pinelands may have been expanding for the past few thousand years, since the time of a more arid climate in the region. If so, this may explain the lack of edaphic correlations with the border in some places. There is much more to be gleaned from examination of presettlement surveys and historical records, which can be utilized in ecological restoration and in making ecosystem management decisions.

INTRODUCTION

The purposes of this study are to describe the Florida dry prairie landscape within the Kissimmee River region based on original public land survey maps and notes, determine the landscape-level ecological factors that can be related to the extent of historical dry prairie, and develop hypotheses on the causes and factors maintaining the dry prairie landscape. These issues are important in determining how to treat dry prairie in an ecosystem management context. In particular, this project may provide more clarification of which areas of the landscape are more appropriately managed as pine savannas than dry prairies.

This study builds on, but significantly expands, previous work on the presettlement vegetation of Avon Park Air Force Range (APAFR) (Bridges 2000a), and elaborates on the geographical distribution and ecological factors of dry prairies in Florida, as outlined in recent reports on aspects of dry prairie ecology and management (Bridges 1997, Bridges and Reese 1999, Orzell and Bridges 1999, Bridges 2000b, 2001).

The Public Land Survey in Central Florida

The rectangular system of land surveying was authorized by Congress in 1785, and formalized as the standard for the United States by the creation of the office of Surveyor General in 1796 (Bourdo 1956, Hutchinson 1988). Before this date surveying was conducted by various methods, usually a "metes and bounds" method, with the result that areas surveyed and settled before 1796 do not

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conform to the standard method of rectangular surveys. No rectangular surveys exist for the original thirteen colonies, nor for the states of Kentucky, Tennessee, and Texas. Surveys which predate the establishment of the rectangular system of land survey are also prevalent in the earliest settled areas of Florida and Louisiana, and to a lesser extent in other states. Many of these surveys represent land grants by the Spanish or French, particularly along the coastline and major rivers, and are recognized by their irregular shapes.

The rectangular system of surveying divided the newly acquired territories of the United States by north to south lines run according to the true meridian, with other lines crossing these at right angles in order to form townships of six miles square. Each township was then subdivided into sections of one square mile each, by running parallel lines at one mile intervals. The exact method of determining these lines varied over time, and according to the lay of the land being surveyed. In general, the first areas subject to the rectangular survey were the "Northwest Territories" of Ohio, Indiana, and Illinois, where the methods of the surveys were further refined, and by 1815 a written detailed list of "Instructions for Deputy Surveyors" had been prepared in order to standardize survey methods. These instructions were periodically updated from 1815 until the present day (Hutchinson 1988). A good description of the history and methods of the public land survey can be found in Galatowitsch (1990).

The northern boundary of Florida was established as being the southern limit of lands ceded from Great Britain to the United States by treaty in 1783. In 1819 Spain ceded the lands which make up the state of Florida to the United States. After Florida became part of the United States, the system of rectangular land survey began to be applied to the state. By the 1850s, the area of central Florida including Avon Park AFR began to be surveyed. This was still rather early in the settlement of this region, when there were few settlers; the major presence of white man in the area consisted only of a series of forts crossing the peninsula. Among these was Fort Kissimmee, along the banks of the Kissimmee River on the east edge of Avon Park AFR, which was established in 1849. Fort Kissimmee was built as part of a string of eight forts across the state, spaced about fifteen miles apart, and with a roadway established between them. It was only a few years after the establishment of Fort Kissimmee that the public land surveys reached this part of the state (DeVane 1983, Morey 1996). Some areas in the southern part of the Kissimmee River dry prairie region, mostly near the border of Highlands and Glades counties, were not surveyed until the 1870s. These mostly marshy townships were still basically unsettled and undisturbed by white man at the time of the surveys.

By the time of the land surveys in the region of central Florida, the instructions to surveyors had evolved into a rather detailed set of methods to be followed, including the types of vegetation descriptions to be recorded in the surveyor's field notes. The relevant set of instructions for the surveys in the Kissimmee River region and most of the surrounding area are the General Instructions - Surveyor General's Office - Florida, 1850 (Putnam 1850).

The general location of the area for which presettlement plat maps were examined is given in Figure 1. On this figure, the township lines of the public land survey

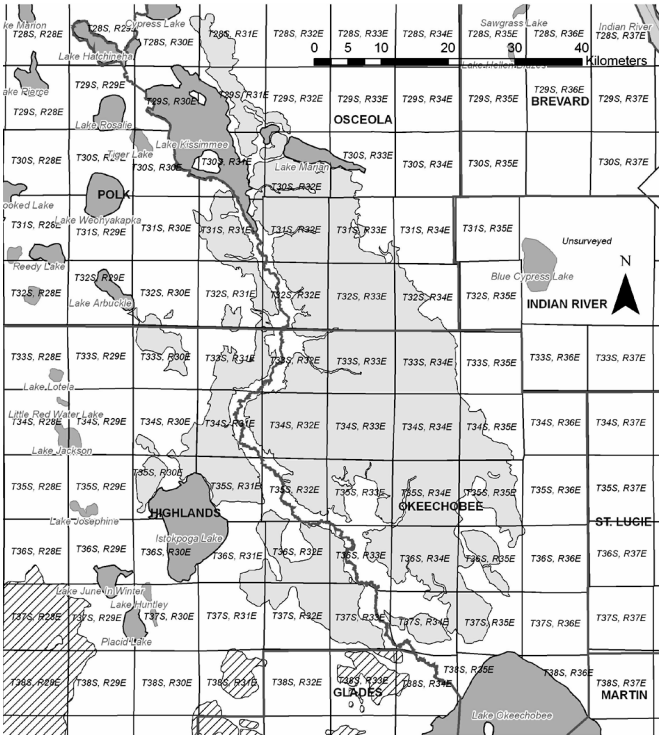

Figure 1. Index to township public land survey plats examined for presence of presettlement dry prairie landscape. Townships outlined (thin lines) and labeled, county boundaries (thick lines) and names, major water bodies in dark gray. The presettlement extent of the Kissimmee River region dry prairie landscape is in light gray, and of the Desoto-Glades region dry prairie landscape is crosshatched.

are mapped, and the township and range numbers given in italics. The area for which township plat maps were examined includes most of the southern half of Osceola County, the southeastern part of Polk County, the eastern half of Highlands County, the northeastern part of Glades County, and all of Okeechobee County.

Table 1 gives the dates and surveyors on record for some of the townships included within the Kissimmee River dry prairie region, particularly those near APAFR. The surveyor names listed with a question mark are interpreted by the author based on similarity of handwriting to pages of survey notes that do have their signature. Although some of the surveyors of the township boundaries did not sign any of the pages seen during this project, they were referenced on the surveys of the interior lines.

The Use of Public Land Surveys (PLS) and Historical Accounts for Vegetation Description and Mapping

Relatively few ecologists used public land survey records before the latter half of the twentieth century. The few studies before this period were mostly concerned with using public land survey notes as a tool for vegetation mapping of large areas. Some of the earlier studies using public land surveys are cited in reviews by Cottam (1949) and Bourdo (1956).

A major shift in the use of public land survey records for vegetation study occurred around 1950, and is tied to major changes in methodology for vegetation study in general. One of the first studies to exploit the potential of

Table 1. Dates and surveyors of selected townships within the Kissimmee River Dry Prairie Region.

Township/Range	Surveyor	Date
T28S, R32E, N boundary	H. Washington	1843
T28S, R32E, W, E, and S boundaries and interior lines	Charles F. Hopkins	Dec. 1852
T28S, R33E, N boundary	H. Washington	Apr. 1843
T28S, R33E, S and E boundaries and interior lines	Henry H. Floyd	Dec. 1852
T29S, R31E, W boundary	M. A. Williams	first quarter 1852
T29S, R31E, E, N, S boundary	M. A. Williams	fourth quarter 1852
T29S, R31E, interior lines	M. A. Williams	fourth quarter 1852
T29S, R32E, W boundary	M. A. Williams	1852
T29S, R32E, E and S boundaries and interior lines	Charles F. Hopkins	Jan. 1853
T29S, R33E, E and S boundaries and interior lines	Henry H. Floyd	Jan. 1853
T30S, R29E, N boundary	M. A. Williams	1852
T30S, R29E, E, W, and S boundaries	John Jackson	1854
T30S, R29E, interior lines	J. J. Daniel	Nov. 1855
T30S, R30E, N boundary	M. A, Williams	1852
T30S, R30E, E, W, and S boundaries	John Jackson	1854
T30S, R30E, interior lines	J. J. Daniel	May 1855
T30S, R31E, N, E boundary	M. A. Williams	1852
T30S, R31E, S, W boundary	John Jackson	1855
T30S, R31E, interior lines	J. J. Daniels	May 1855
T30S, R32E, W, E, and S boundaries and interior lines	Marcellus A. Williams	Dec. 1852 and Jan. 1853
T30S, R33E, W, E, and S boundaries and interior lines	Marcellus A. Williams	Jan. 1853
T31S, R29E, S boundary	John Jackson	Oct. 1854
T31S, R29E, E boundary	John Jackson	Oct. 1854
T31S, R30E, S boundary	John Jackson	Oct. 1854
T31S, R31E, S boundary	John Jackson	Oct. 1854
T31S, R32E, E, W, and S boundaries	John Jackson	1854
T31S, R32E, interior lines	J. J. Daniel	Apr. 1855
T31S, R33E, E, S boundary	John Jackson	1854
T31S, R33E, interior lines	J. J. Daniel	Mar. and Apr. 1855
T32S, R32E, S boundary	John Jackson	Oct. 1854 / May 1855
T32S, R31E, E boundary	John Jackson	Oct. 1854
T31S, R30E, E boundary	John Jackson	Feb. 1855
T32S, R29E, E boundary	William J. Reyes	May 1855
T32S, R30E, S boundary	William J. Reyes	May 1855
T32S, R30E, E boundary	William J. Reyes	May 1855
T32S, R31E, S boundary	William J. Reyes	May 1855
T33S, R30E, E boundary	William J. Reyes	May 1855
T33S, R30E, S boundary	William J. Reyes	May 1855
T33S, R31E, S boundary	William J. Reyes	May 1855
T33S, R31E, E boundary	William J. Reyes	May 1855
T34S, R30E, E boundary	J. J. Daniel (?)	May 1855
T34S, R31E, E boundary	J. J. Daniel (?)	June 1855
T31S, R30E, interior lines	J. J. Daniel	June 1855
T31S, R29E, interior lines	J. J. Daniel	Nov. 1855
T31S, R31E, interior lines	J. J. Daniel	Nov.-Dec. 1855
T32S, R31E, interior lines	J. J. Daniel	Dec. 1855
T33S, R31E, interior lines	J. J. Daniel	Dec. 1855
T32S, R30E, interior lines	J. J. Daniel	Dec. 1858
T33S, R32E, interior lines	William S. Harris	Dec. 1858
T32S, R29E, interior lines	William Mickler	March 1859
T33S, R30E, interior lines	William Mickler	March 1859
T33S, R33E, all exterior boundaries	William J. Reyes	1855
T33S, R33E, interior lines	William S. Harris	1859
T34S, R30E, interior lines	S. E. Hope	March 1859
T34S, R31E, interior lines	S. E. Hope	March 1859
T34S, R32E, all exterior boundaries	William J. Reyes	1855
T34S, R32E, interior lines	William S. Harris	Dec. 1858
T34S, R33E, all exterior boundaries	William J. Reyes	1855
T34S, R33E, interior lines	William S. Harris	Dec. 1858

Table 1. (Continued) Dates and surveyors of selected townships within the Kissimmee River Dry Prairie Region.

Township/Range	Surveyor	Date
T34S, R34E, all exterior boundaries	William J. Reyes	1855
T34S, R34E, interior lines	William S. Harris	Dec. 1858
T38S, R32E, S and E boundaries	John Jackson	Feb. 1859
T38S, R32E, interior lines	J. D. Stansbury	March 1870
T39S, R31E, S and E boundaries	John Jackson	Feb. 1859
T39S, R31E, interior lines	J. D. Stansbury	March 1870

public land survey records in quantitative reconstruction of the characteristics of presettlement vegetation was a study of Stewart's Woods, Wisconsin (Cottam 1949). In this paper the "random pairs" method of forest sampling was first tested and applied to the witness tree data to determine density and dominance (basal area) by species for the presettlement forest. This was compared to current forest composition to detect changes in the intervening period, which were quite dramatic due to reduction in fire frequency since settlement. This is among the first studies utilizing public land survey tree distances and diameters to reconstruct stand density, not just to produce a qualitative vegetation map, which has been a more common use of these data before this date.

These "distance-based" techniques for vegetation sampling, first pioneered in conjunction with the analysis of public land survey records, became one of the standard methods of forest sampling in subsequent decades. The procedure was expanded and described, including the "point-centered quarter" method used for analysis of the four witness trees at a section corner, by Cottam and Curtis (1956).

To help determine the adequacy of public land survey data for quantitative studies of presettlement forests, Bourdo (1956) analyzed potential sources of bias or inaccuracy in the data for a portion of the upper peninsula of Michigan. He found only minor bias in the data, mostly restricted to discrimination against tree species that seldom attained large size as witness trees, estimation rather than actual measurement of diameters, and perhaps distances that were estimated rather than chained. However, all of these are relatively minor concerns in most cases, and the public land survey records were supported as a useful source of vegetation data.

Many studies of presettlement vegetation have used public land survey records over the past 40 years. Most of these were conducted in the midwestern states, particularly Illinois (Hanson 1981, Hutchinson 1988, Bowles and McBride 1998), Wisconsin (Stearns 1949, Ward 1956), Missouri (Howell and Kucera 1956, Wuenscher and Valiunas 1967, Schroeder 1981, 1983), Minnesota (Grimm 1984), and Michigan (Whitney 1986, Silbernagel et al. 1997, Loope and Anderton 1998). A particular emphasis of many of these studies has been to determine the boundaries between prairie, savanna, and forest because of the current rarity of intact prairies and savannas in this region, and the need to identify their historical distribution for conservation and restoration purposes.

Some studies have synthesized public land survey, historical documents, historical floristic information, and edaphic data to estimate the extent and location of presettlement prairies and savannas (Goodban et al. 1999). Unfortunately, at Avon Park AFR there is little detailed site-specific historical vegetation or floristic accounts to use in corroboration or refinement of the data from the presettlement land surveys. Other studies that integrated public land survey data with other historical data to reconstruct presettlement vegetation conditions include a detailed study in the Sacramento Mountains of New Mexico (Kaufmann et al. 1998), determination of presettlement riparian and grassland conditions in Colorado and New Mexico (Galatowitsch 1990), and an environmental history of Inland Northwest USA forests (Hessburg and Agee 2003).

Public land survey records also were utilized to reconstruct the presettlement natural disturbance cycle of forests in Maine (Lorimer 1977), where information on windfalls and fire in the land survey records was analyzed in conjunction with species composition data. A study using presettlement data in the Georgia Piedmont indicated a landscape where the uplands were dominated by pines and fire-tolerant oak species, in contrast to the much more mesophytic species composition of today's forests in the region (Cowell 1998).

A few recent studies quantified the differences between prairie, woodland or savanna, and forest by use of presettlement tree density. Among these is a study of the presettlement vegetation of Lawrence County, Illinois, in which points with a tree density between 0.5 and 46.9 trees/ha were considered open woodland (Edgin 1999). The quantitative aspect of most studies has been concerned with the relative importance values of various tree species in the presettlement forest types, rather than the structural characteristics of forest types with a single dominant species, such as longleaf pine flatwoods/savannas.

Very few studies have been conducted within the southeastern United States utilizing presettlement data. Among the first was a study by Delcourt and Delcourt (1974) producing a map of the presettlement forest types and species composition in West Feliciana Parish, Louisiana, and determining that the selection of witness trees in this area was not biased by the surveyor. In a similar study by the same authors in the Florida panhandle (Delcourt and Delcourt 1977), the "Upland Pine Forest" community had a mean distance to the pine witness trees of 7.8 m, which would indicate a much denser forest on these sandhill upland sites than in the APAFR witness tree data (Bridges 2000a). Recently, Bragg (2002, 2003) has used land survey data in conjunction with other historical and edaphic data to describe presettlement landscapes in southern Arkansas, a region which like central Florida has many pineland/prairie borders. Small prairies in northwestern Louisiana also have been studied utilizing presettlement data (MacRoberts and MacRoberts 2004).

Only two other vegetation studies using public land survey records have been conducted in Florida, to our knowledge. The first of these compiled data on 127,653 witness trees from 48,831 sample points in northern Florida, from Gainesville northward and westward (Schwartz 1994, Schwartz and Travis 1995). This study was mostly concerned with broad differences between pine, upland hardwood, and wetland forest types and their regional distribution. Witness tree distances and diameters were not used in this study, just the presence and species of each witness tree.

Other than Bragg (2003), the only study in the southeastern United States known to combine qualitative and quantitative analysis of presettlement land surveys for a region to produce both mapped vegetation types and statistical analysis of presettlement tree density was done on APAFR (Bridges 2000a). This study resulted in a map of presettlement boundaries of major vegetation types with minor adjustments to conform to edaphic boundaries and make the resulting map more useful, and in estimates of the presettlement diameter distribution and ranges of density values for pine trees within APAFR.

Two studies have used witness tree data to reconstruct presettlement vegetation boundaries of the longleaf pine region of the West Gulf Coastal Plain. These two studies and their implications have been reviewed in Harcombe et al. (1993). Schafale and Harcombe (1983) used witness tree data to reconstruct and map eleven presettlement vegetation types in Hardin County, Texas, including types at the prairie/savanna/forest borders. Some of the quantitative data from this study are discussed under the pine density section of Bridges (2006). Another study was conducted by Delcourt (1976) in northeast Louisiana, mostly for the purpose of mapping the major vegetation types. One of the few relevant quantitative statistics from this study is that the "upland pine forest" type in this region had an average density of 46 trees (of all species combined) per acre, of which slightly over half (relative frequency = 54.7%) were pine trees in this region of mixed pine/hardwood forest dominance.

Limitations of Public Land Survey data for Vegetation Description and Mapping

Although it is an extremely valuable early source for vegetation data, the usefulness of Public Land Survey data for vegetation mapping is limited by the broad scale of the survey and mapping. Vegetation descriptions were made only along section lines, spaced one mile apart, and therefore represent only the major changes in vegetation types which were intersected by these lines. Boundaries of vegetation types between the section lines were only interpolated. The boundaries between section lines can be considered only as rough approximations. It would have been difficult, if not impossible, for the surveyors to have seen and accurately mapped the boundaries between different herbaceous-dominated vegetation types (for example, the boundary between prairie and marsh) except very near where this boundary crossed section lines. The boundaries between forest and savanna types and herbaceous-dominated types would have been more obvious, and could be considered more likely to be mapped in roughly the correct location. Since the mapping of these boundaries was not the main purpose of the surveys, these accuracy of the boundaries may vary depending on the skill and level of detail provided by each surveyor.

There were no set definitions in place at the time of the presettlement surveys, nor in many cases even at present, for determining the vegetation type present at any given point, or of how to determine the boundary between vegetation types. Many of these changes are really long ecotones, with a mixing of vegetation type characteristics extending over a zone of several hundred meters at the boundary between types. Other boundaries are sharper, such as the edge of a depression marsh or hardwood hammock within the prairie landscape. Two sets of type definitions and boundaries are most problematic in the region—the distinction between very open pinelands and prairies, and the distinction between prairies and shallow marshes. These seem to have been interpreted differently between surveyors. There is no easy way of rectifying the pineland/prairie boundary discrepancies between townships. However, since the boundary between prairie and shallow marsh can be defined in many cases as an edaphic boundary (change in topography, mapped soil type, and hydrology), some of the prairie/marsh definitions and boundaries can be adjusted based on other available data sources. The effects of drainage were considered in making these adjustments, so as not to include areas of original shallow marsh which are now dry due to drainage as part of the original extent of dry prairie.

There are several possible sources of error or bias in presettlement survey data (Bourdo 1956). The principal problem is of possible bias in selection of witness trees. Trees below a certain convenient marking size would likely be ignored, in favor of nearby larger trees. This is most apparent in the almost complete lack of trees less than 4-in diameter as witness trees. However, it could also have been important in selection of trees of differing diameters at some points. A second major problem is the discrimination against short-lived trees, or those not expected to last as witness trees. This may not have been a major problem in south-central Florida, since at most points there did not seem to be much choice of witness trees. This could have been a problem in vegetation types such as hardwood hammocks or swamps, but in the monotypic canopy pinelands it is not an issue. It is possible that some hollow or partially decayed pine trees, perhaps also being older and larger trees, may have been discriminated against in favor of younger, healthier trees.

Other possible sources of error include mislocation of corners, misidentification of trees, or complete fabrication of witness tree data for surveys that were never conducted. This has been documented for some survey areas, but is not known to have occurred in south-central Florida.

Because relatively few tree species were encountered in the surveys of south-central Florida, there is only a small chance of major errors in species identification. One problem is that longleaf pine and slash pine were almost never distinguished to species level in the survey data. This makes it impossible to determine which of these species was definitely present at a given point. In only a few instances the term "short-leaf pine" was used, which in the geographical context of south-central Florida must refer to slash pine. This is consistent with the low, wet landscape position at which these trees were noted to

occur at APAFR. It cannot be assumed that all of the unspecified pine witness trees in the region are longleaf pine, and current composition indicates that although most of the continuous pinelands at the borders of the dry prairie region are of longleaf pine, most of the "pine islands" present within the dry prairie region are composed entirely of slash pine.

There are a few other tree names that cannot be definitely attributed to a single species; however, all of these are of minor occurrence, and do not affect the determination of the major vegetation type at any point.

It became obvious in transcribing some of the survey notes that the distances given in the original notes were not consistent with the vegetation type mapped or the survey methodology. For example, it is highly unlikely that a surveyor would use a tree over 5 chains (100 m) distant as a witness tree; therefore, a distance given as "65 chains" to a tree would more likely be "0.65 chains" with the decimal left out. This interpretation was done very carefully, and distances given were changed from the literal reading of the survey notes only when there was strong evidence that a transcription error had likely occurred. This evidence was most often based on distances given for nearby points in the same vegetation type, the writing style and method of giving distances used by the same surveyor for other points (such as giving distances in either links or decimal chains), and the reasonability of the surveyor having traversed the particular landscape for that distance to reach a witness tree. When such an interpretation was made which differed from the literal reading of the survey notes, indications to this effect were made in the spreadsheet transcription of the witness trees.

In many cases, the handwritten notes of surveyors are not clear enough to be unambiguously transcribed. This can be particularly frustrating in the case of handwritten numerals that were not always clearly readable. In these cases, a best estimate was made of the intended numerical value, based on context and the handwriting style of the particular surveyor. It should be noted that there may be some small misinterpretations of these ambiguous numbers.

The Value of PLS Data for Vegetation Description and Mapping

The land survey witness trees and accompanying plat maps and vegetation descriptions represent the earliest available vegetation data set which was collected with systematic and replicable methods. Although it was not the primary purpose of the survey, the result is an invaluable record of the vegetation pattern, at least along the section lines and particularly at the section corners and section line midpoints. This systematic data collection, with sample points at standard intervals and clearly described methodology, was not generally a part of vegetation data collection, even by scientists, until after 1900.

Because the section corners and midpoints established during the presettlement surveys are part of the standard system of land survey to the current day, their locations have been well-established, and are often now marked with monuments. GIS and GPS technology make it possible to relocate any of these points in the field with a fairly high degree of accuracy. As such, it would be possible to replicate the methods of the original surveyors by choosing what would be appropriate witness trees for each point if the survey was conducted at the present day. By analyzing how the results of a present-day "resurvey" differed from the presettlement surveys, it is possible to determine the direction and magnitude of vegetation change, particularly in tree density, that may have occurred since the original surveys.

There are few, if any, reasons why the surveyors would have been inconsistent in the selection of witness trees and descriptions of vegetation type boundaries. The closest tree in each quarter, as long as it was at least 4 in in diameter, would likely have been utilized in almost all cases. There would have been no logical reason to select a more distant tree unless the closest tree was nearly dead or too small to blaze. Since there was usually no choice between trees of different species at survey points within the Kissimmee River region, there would not be a preferential bias for one species over another. Within the surveys done by a single surveyor, there would likely have been a standard, if intuitive, method of determining when vegetation type boundaries (such as pineland to pond or prairie) were being crossed, and these methods would likely be fairly consistent. These methods could have differed between surveyors, resulting in vegetation type boundaries that do not edge-match between adjacent townships. It is also possible that different surveyors varied in the amount of detail they used in delineating vegetation type changes. Differences in inclusion of minor types (hammocks, ponds) between townships should be interpreted with this in mind.

Almost all of the presettlement survey data for south-central Florida dates from between 1840 and 1870. A few changes to the "natural" land condition may have occurred before these dates, but they are relatively minor for our purposes. American Indian inhabitants of the region (Calusa, and later the Seminole tribe) likely set fires, which may have increased the fire frequency of some areas. There is no way of documenting whether this significantly changed the fire regime from what would have naturally occurred. There has been a long history of Indian burning, and later burning by early cattle ranchers, in the South, particularly in central Florida (Pyne 1982). This burning by Native Americans may have been sufficiently frequent and intense to have altered vegetation types, as has been hypothesized in a study relating fossil pollen and charcoal in peat deposits and pond sediments in the Southern Appalachians (Delcourt and Delcourt 1998). The disturbances associated with Indian habitation were likely minor, and concentrated near waterways and hardwood hammocks. The Seminoles grazed cattle over the region, and although this grazing may have had some effect on groundcover vegetation, it would likely not have been intense enough to cause major changes in vegetation pattern.

One of the first Americans to cross this region was Colonel (later President) Zachary Taylor, who passed through the area during the Second Seminole War in 1837. It was not until 1859 (about the time the presettlement surveys were completed) that the first settler arrived at APAFR, William Willingham, who used the area for cattle ranching. Cattle ranching by Willingham and a few other settlers is essentially the only known land use for

the area now comprising APAFR until about 1918. Although specific historical information is not available for all areas, it is unlikely that the pattern of settlement and land use differed greatly from that described for APAFR through the period of the presettlement land surveys. It was not until most of the lands comprising APAFR were sold to the Consolidated Naval Stores Company in 1918 that any substantive timbering occurred on the area. The pine islands within the Kissimmee River dry prairie region may have at least been partially spared from the wave of extensive logging in the 1920s, since it would not have been economical to extend roads or railroad lines to reach small isolated stands of timber. At APAFR, turpentine extraction, followed by logging, began in 1919 and was essentially complete by 1930 (DeVane 1983).

The most significant fact in this history of early land use at APAFR (and presumably in most of the surrounding region) is that little timber was cut before 1918, long after the presettlement survey records which recorded the diameters and distance to the nearest trees at reference points, and the boundaries between pinelands and prairies. Therefore, the presettlement surveys give a documented record of the major features of the vegetation and landscape before alteration of the vegetation pattern by western settler occupation and resource extraction.

METHODS

The first step in this process is to determine the historical extent of the Florida dry prairie landscape within the Kissimmee River dry prairie region. Although the general extent of prairie in the region was known, there had never been a detailed compilation of the presettlement public land surveys in this region, and therefore no precisely defined boundary compiled for the historical Florida dry prairie landscape. The determination of an accurate presettlement dry prairie boundary is critical to the analysis of ecological factors which may distinguish prairie from pine flatwoods/savanna landscapes.

Public land survey plat maps were downloaded in digital form from the LABINS web site of the State of Florida (http://www.labins.org). To determine the relevant townships which were to be included, the boundary of prairie vegetation was followed onto adjacent township plat maps until the far boundary of contiguous prairie was reached. This process resulted in a total of 70 township plat maps determined to have prairie vegetation types that may be a part of the contiguous Kissimmee River dry prairie region. The extent of this region ranges from the south end of Lake Tohopekaliga southward to the north end of Lake Okeechobee, and generally from the eastern slope of Lake Wales Ridge eastward into the St. Johns River watershed. This area is mostly within Osceola, Okeechobee, Polk, and Highlands counties, but also includes small parts of Brevard, Indian River, St. Lucie, and Glades counties at its outer borders.

Each of the 70 township plat maps were cropped, and rotated if necessary, to produce a graphic file which had boundaries corresponding as closely as possible to the township boundaries. These were resampled to a density of 72 to 96 dpi (dots per inch) and converted to a compressed .jpg graphics format. The resulting graphics for each township were approximately 1700-1800 × 1700-1800 pixels in size. This resolution and size for each township graphic had previously been determined to be sufficiently detailed so as to not lose any resolution of the original plat map lines and notes.

Each graphics file was georeferenced for display in ArcView. In order to georeference the files, the map coordinate of the upper left corner of each township graphic was matched to the equivalent township corner in the statewide public land survey coverage produced by the State of Florida (plss100.sha), and the width and height of each pixel in meters was determined. This coverage is in a custom projection used by the State of Florida for all GIS products, and is in State Plane coordinates in the Albers equal-area projection, with false easting of 400,000 meters. It was necessary to utilize this projection and coordinate system for this project in order to provide compatibility with existing data layers, particularly digital orthophoto quadrangles (DOQ) aerial photographic base coverage to be utilized in subsequent tasks in this study.

The georeferencing of each township graphic was readjusted, if necessary, by displaying the image in ArcView, overlaid with the grid of township and section boundaries. Exact matching was not possible, primarily because the original plat map is not a rectified, geospatially accurate product. Instead, it is a hand-drawn sketch map, with the inherent inaccuracies of the method. These slight inaccuracies should be kept in mind when examining the exact position of presettlement vegetation type boundaries relevant to other coverage layers.

After georeferencing and displaying township plat map images in ArcView, the lines representing vegetation boundaries, particularly those separating prairie from other vegetation types, were traced and converted to a line coverage shapefile. The georeferencing of the township plat map images was adjusted approximately every two miles in order to more precisely match the section lines in each area of each plat map to the section lines coverage. This resulted in a more precise transfer of the vegetation boundaries to a line coverage than if the images were kept in one fixed position. Nevertheless, it is possible that some line segments in the resulting coverage are as much as 50 meters different from their position on the plat maps. In most cases it would have been difficult for surveyors to determine a prairie/pineland boundary with more accuracy than this, so the amount of error is within tolerance limits.

The presettlement extent of Florida dry prairie in the region was determined and plotted with other coverages as an ArcView line coverage of vegetation type boundaries. In some cases near the distant borders of the region, it is difficult to determine whether there was much "upland" prairie present within areas mapped as prairie, or whether prairie openings were restricted to wetland areas (wet prairies and shallow marshes). The boundary of the true upland dry prairie region was more precisely defined after analysis of topography, soil types, and hydrology of areas mapped as prairie. The resulting coverage gives a good idea of the presettlement extent of prairie vegetation in the region, and provides the base coverage for further analysis.

Color-infrared DOQs were acquired for all the area covered by the 77 townships previously referenced. Each

of these is an image covering an area 3.75' by 3.75' of longitude and latitude, or one quarter of a standard USGS 7.5' topographic quadrangle. These provide a base aerial photographic coverage of the region for use in determining current vegetation pattern.

All published county soil surveys for the region (McCollum and Pendleton 1971, Readle 1979, Carter et al. 1989, Ford et al. 1990) were obtained, although they are not available in digital format. They were used to determine the soil mapping units of selected areas near the pineland/prairie border to determine any soil correlations with the border.

Topographic coverage of the region was obtained, both as print maps at the 1:24,000 (7.5' quadrangle) and 1:100,000 scale. Historical information on vegetation types was obtained from published manuscripts by John Kunkel Small (see Bridges 2006), Roland Harper (1921, 1927), and Harshberger (1914). Although these do not have much geographically specific detail, they provide general descriptions of the vegetation pattern before the widespread logging of the pinelands of the region. Therefore, where these authors refer to prairies, we can safely assume they are not referring to cutover pinelands.

Data collection on current vegetation in the region is an ongoing process, and includes data sets from both sides of the pineland/prairie border in Three Lakes Wildlife Management Area (TLWMA), and data from prairies and hardwood hammocks in Kissimmee Prairie Preserve State Park (KP - including prairies on the former Ordway-Whittell Kissimmee Prairie Sanctuary). I also made field observations of current pineland/prairie boundaries in the region of Kenansville and Yeehaw Junction in southeastern Osceola County, from Lorida and Cornwell south to Brighton in Highlands County, and from Okeechobee and north to Fort Drum in Okeechobee County. Field data on the current boundaries between pinelands and prairies, presence of other landscape features such as transverse glades, scrubby islands, and hardwood hammocks, and GPS locations of specific reference points for determining edaphic conditions of historical and current vegetation were compiled in parts of Highlands, Osceola, and Okeechobee counties during reconnaissance field trips through the region.

The lines representing vegetation boundaries in the unadjusted vegetation boundaries line coverage were overlaid with aerial photography and other resource information from the State of Florida GIS system in order to determine where the rough boundaries crossed major soil and landtype boundaries, which would not have changed from the time of the presettlement surveys. Since it was very difficult for a surveyor to estimate the exact configuration of a vegetation boundary from a vantage point as much as 0.5 miles away, it is not surprising that the shapes of some clear landscape features (particularly depression marshes) were not precisely depicted on the presettlement plat maps. These boundaries were adjusted where appropriate so that the major vegetation boundaries conformed more to natural soils/landtype/hydrologic boundaries.

In addition, an attempt was made to "edge-match" the vegetation boundaries from surveys of adjacent townships. This was usually done by determining what hydrologic or edaphic landtype boundary was being followed by each surveyor, and to smooth out any differences or discrepancy near the township boundary. This was done with caution so as to minimize bias based on present-day vegetation, by only considering edaphic conditions which were not likely to have significantly changed since the presettlement surveys. Some major vegetation boundaries, such as the prairie/pineland boundary, were also slightly adjusted using the same methods.

Adjusting the presettlement plat map boundaries resulted in a revised line coverage of vegetation boundaries for the region. This was then converted to a polygon coverage to create maps of the presettlement dry prairie landscape extent. It should be emphasized that this coverage includes only features indicated by the surveyors on the presettlement survey plat maps for each township. In general, depression marshes (= ponds) would have been indicated only where they were crossed by section lines. There are obviously very many other depression marshes within the region which are not indicated on the presettlement surveys. Areas of hardwood forests (as indicated by an outline of small tree symbols on the plat maps) would have been noted only if they were crossed by or in close proximity to a section line. It is quite likely that there were many more small areas of hardwood forests (hammocks, seepage swamps, and depression swamps) than were indicated on the presettlement surveys.

RESULTS AND DISCUSSION

General Landscape Ecology of Central Florida Pineland and Dry Prairie Regions

Ecologists typically suggest that little difference exists between pine flatwoods and dry prairie (summarized by Abrahamson and Hartnett 1990), to the point that I once doubted their distinctiveness as natural community types. Some areas referred to as dry prairie may be cutover or extremely sparse pine savannas. The extensive presettlement occurrence of large expanses of dry prairie in the Kissimmee River dry prairie region, before alteration of the landscape by Europeans, supports the hypothesis that dry prairies in this region are a natural occurrence, and probably have some long-term stability of location and boundaries. There have been few hypotheses, however, on the landscape factors that maintain large areas as dry prairie rather than pineland communities.

In considering just the dry prairies of the Kissimmee River region, it is possible to take a closer look at landscape factors that may be correlated with the occurrence of dry prairie rather than pinelands. Any such consideration must be tempered by the realization that many interrelated factors influence the vegetation at any particular point, and to compound matters, at any particular time. Correlations based on single factors explain only a very small percentage of the occurrence of pineland and prairie at given locations. Even an approach based on a combination of factors fails to explain the occurrence of the majority of the area of dry prairie. Although there is a tendency for "upland" soils that are alfisols or alfic subgroups to be somewhat more correlated with prairie than pineland, there are still many pinelands on alfisols and many prairies on spodosols. The

same can be said for correlations of prairie with areas having poorer soil drainage, fewer barriers to the spread of landscape fires, and any other edaphic factors investigated. Most of the variation cannot be explained by measurable environmental factors, and can only be attributed to historical events related to the frequency and intensity of fires, perhaps extending back several hundred or thousand years. Once pines have been eliminated from an area by intense recurring fires, a long period may be required for pines to be reestablished in a grassland matrix, now capable of supporting even more frequent fires because grass-dominated communities have a more continuous and dense fine fuel load than the ground cover under dense pinelands.

Another possibility is that the pineland/prairie border we see in the presettlement data and on the current landscape is the advancing front of pineland into areas that had been in prairie vegetation since the mid-Holocene interval, from about 11,000 years before present (BP) to 5,000 years BP, during which south-central Florida was more severely xeric. Much of the evidence for the climate and vegetation of Florida during this period is based on pollen records from deep lake sediment cores. Watts (1980) found that at Lake Annie (in Archbold Biological Station, in Highlands County on the Lake Wales Ridge not far from the dry prairie region), at 10,410 BP, oak pollen was at a peak and pine pollen was less frequent than at any time in the past 13,000 years, at <20% of its current levels. At the same time, wax myrtle (*Myrica cerifera*) pollen was also low, and pollen of grasses and composites (plants of the Aster family) was much higher than at present. This indicates that the regional vegetation was a mixture of oak scrub and prairie, with relatively little pine, at that time. Pine pollen did not supply more than 50% of the pollen rain (noting that pine produces abundant pollen, and therefore is much more likely to be detected in these samples than other species) until about 4,715 BP, perhaps being near the date of the establishment of the modern flora with its larger amounts of slash and longleaf pines. Also notable in this pollen core is that *Taxodium* pollen is not frequent until about 2,630 BP, indicating that it was moving southward at this time into south-central Florida as the climate became wetter.

This hypothesis is strongly supported by the pollen core taken at Lake Tulane (in the town of Avon Park, on the Lake Wales Ridge) (Watts and Hansen 1988, 1994). Lake Tulane has an exceptionally detailed and long pollen record in its sediment core, extending back to over 50,000 BP, the longest complete pollen core record in eastern North America to date. At Lake Tulane, pine pollen comprised less than 20% of the total pollen at 4,650 BP, when it began to increase and assume dominance over oak pollen, coinciding with a decrease in grass pollen. Based on their decades of study of historical environments based on pollen profiles, Watts and Hansen (1994) conclude that "the Holocene (in central Florida) had abundant oak and prairie plants with only a small representation of mesic trees or conifers (including pine) until about 5000 BP." They infer that the vegetation of central Florida between 12,000-5,000 BP was "oak forest or scrub with prairie," and that there seemed to be higher solar radiation (hotter climate) and less precipitation than at present in the region. All of Watts' studies of pollen cores throughout Florida and southern Georgia tend to support the increase of pine and decrease of oaks and grasses at about 5,000 BP.

Based on this evidence it is possible that much of south-central Florida was covered in scrub and grasslands until about 5,000 years before present, and that pines have been slowly advancing, subject to the vagaries of frequent fires, soil conditions, and hydrology, since that period. The most favorable sites, perhaps associated with the more dissected landscapes of the Lake Wales Ridge and the adjacent sideslopes and flats, and the more hydrologically dissected landscape north and east of the dry prairie region were colonized by pines first. When the advancing pine front met the extensive relatively flat Osceola Plain, the rate of advance may have slowed, due to alternating flooding and drought in the poorly drained soils and frequent extensive landscape fires. Perhaps this advance may have been less than one mile or so per century. If so, what we see in the presettlement data may be a snapshot in time of a very slowly advancing pine front into a prairie region, which would explain the lack of strong edaphic correlations at the pineland/prairie boundary, such as one would expect if the two communities were in temporal equilibrium. Unfortunately, the disruption of this process by the alterations of land use and fire regime throughout much of the region in the past century makes it essentially impossible to determine if this border would have advanced if the climatic and edaphic factors which controlled fire frequency and pine establishment had not been altered by man.

Based on the adjusted boundaries of the dry prairie landscape of the presettlement land surveys, as described in the methods section previously, the total extent of dry prairie landscape in the Kissimmee River dry prairie region was determined to be approximately 786.6 mi^2 (503,428 ac; 2037 km^2). It should be emphasized that this figure includes not only the dry prairie natural community type, but also includes other communities closely associated with dry prairie in the landscape, such as wet prairies, depression and basin marshes, herbaceous sloughs and swales, and small hardwood hammocks. It does not include extensive areas of floodplain marshes, such as the Kissimmee River floodplain marsh and the marshes adjacent to Lake Istokpoga, Lake Kissimmee, and other smaller lakes. The area mapped as the dry prairie landscape also excludes areas of pine islands or lobes of pineland mapped adjacent to dry prairie regions. The largest single area of dry prairie is in southern Osceola and western Okeechobee counties, and comprises about 540 mi^2 (345,626 ac). All other mapped areas of the dry prairie landscape are much smaller in extent. The area mapped as presettlement Florida dry prairie landscape is indicated in Fig. 2. Landscape-level general vegetation trends, which differ between the Florida dry prairie landscape and the nearby pineland landscapes, are summarized in Table 2.

Descriptions of Presettlement Vegetation Types

Many descriptive names for vegetation types within the Florida dry prairie landscape were used in the presettlement land survey notes, but very few of these were mapped as distinct boundaries on the accompanying maps. Most of the variation in description concerned

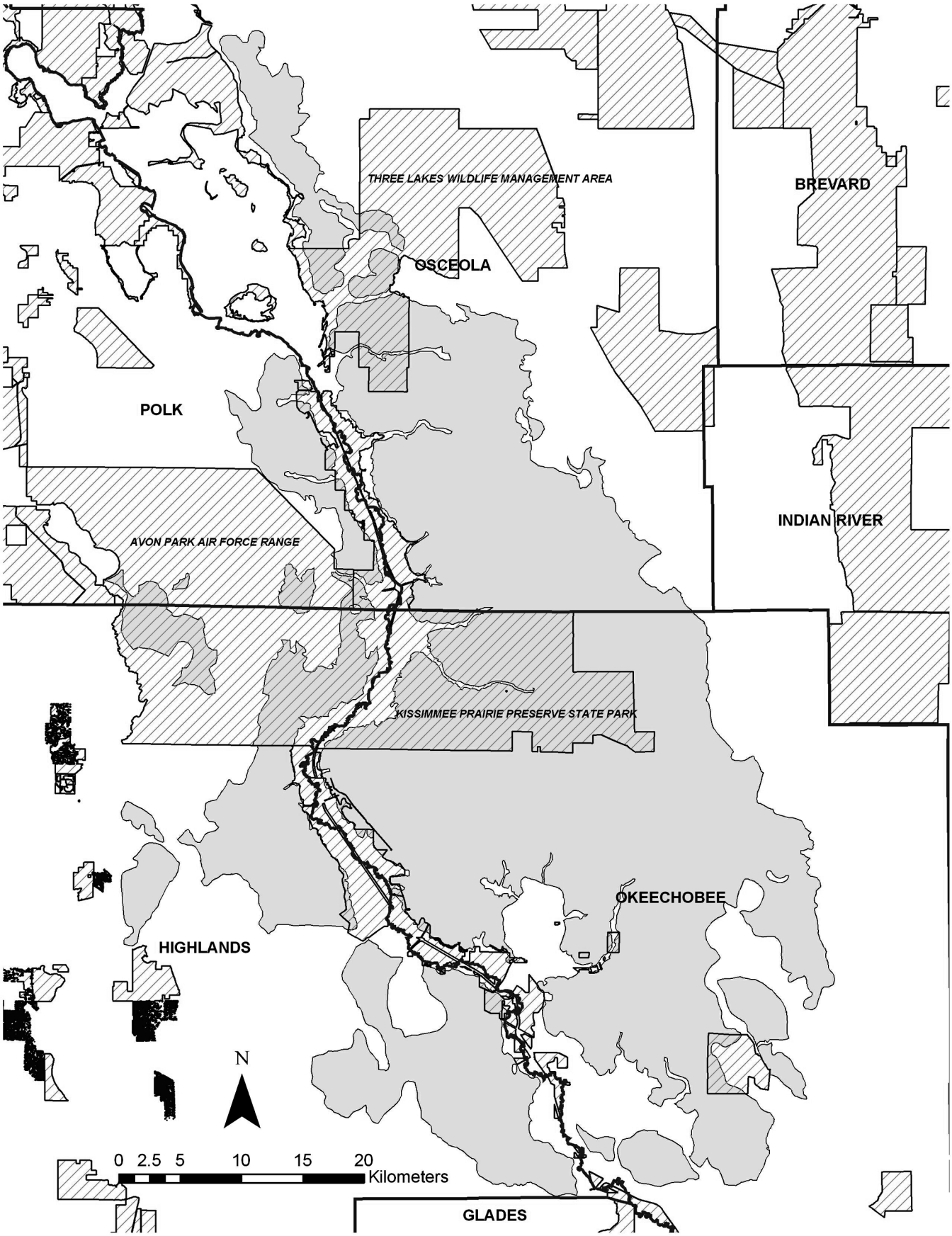

Figure 2. Presettlement extent of the Kissimmee River region dry prairie landscape (light gray), with county boundaries (thick lines). Current and proposed conservation (or mixed resource utilization/conservation) areas crosshatched.

Table 2. General landscape characteristics of pineland and dry prairie regions.

Landscape feature	Dry prairie region	Pineland region
Dominant tree species	*Sabal palmetto* - *Quercus virginiana* (with some *Pinus elliottii*)	*Pinus palustris* (with *Taxodium ascendens*, *Magnolia virginiana, Gordonia lasianthus*)
Most common pine	*Pinus elliottii* var. *densa*	*Pinus palustris*
Scrubby flatwoods and Scrub patches	Very rare	Occasional
Forested wetlands	Rare	Common
Streams/sloughs	Mostly herbaceous dominated (originally sawgrass)	Many with forested wetlands (hydric hammock, floodplain swamp)
Depressional wetlands	Very rarely forested	Occasionally forested (*Taxodium ascendens*, *Magnolia virginiana*)
Topographic dissection (local relief)	Mostly <10 ft. difference between elevations within a section	Often 10 to 25 feet difference between elevations in a section
Isolated hammocks (not associated with streams)	Occasional to common (*Sabal palmetto* dominated)	Rare to absent (*Quercus virginiana* dominated)
Circumneutral (calcareous) depressions	Common, in parts (*Iris hexagona* - *Spartina bakeri* often present)	Very rare
Calcareous wet prairies	Occasional (*Muhlenbergia sericea* characteristic)	Very rare to absent, present only near prairie border

variation in characteristics within a type. Most of these were descriptive of the conditions along a particular mile of section line, not of a defined area of land. For example, pinelands were often described as "third rate pine," which I interpret as meaning an open or "poorly stocked" stand of relatively small diameter pines, at least in comparison with the pinelands of northern Florida and adjacent states. Other names used within pinelands included "third rate wet pine and saw palmetto," "low, flat pine and saw palmetto," and in at least one instance "low, wet short-straw pine land" (referring to a wet *Pinus elliottii* pineland, in contrast to longleaf pine areas). Many other descriptive names were used for pineland types, but not in a manner consistent enough to define subtypes of pinelands from the presettlement data.

Definitions of "Prairie" Types of the Presettlement Surveys

The use of the term "prairie" in the presettlement land surveys for central Florida must be understood in order to describe its relationship to present day concepts of natural vegetative communities. Prairies were described quite often in the vegetation descriptions, usually with no differentiation as to whether the area was dry prairie or wet prairie. Sometimes the description "low prairie" or "wet prairie" was used, but it is obvious that in other cases wet prairies within a dry prairie matrix were not differentiated. Rarely, an area was identified specifically as "dry prairie" (as in T35S, R31E) or "high prairie" (as in T36S, R35E) which makes the correlation with our present concept of dry prairie very evident (Fig. 3). In some cases shallow marshes were included within the area described as prairie. This is consistent with the use of the term "prairie" in north-central Florida (i.e., Paynes Prairie near Gainesville, and many "prairies" in the Ocala National Forest area), as well as to a lesser extent in south-central Florida (i.e., the "Indian Prairie" of southern Highlands and Glades counties). Since many of the surveys may have been conducted during dry seasons (it seems that few, if any, of the surveys were conducted in the months of July through September), and the natural hydrologic seasonal fluctuations were likely greater in the presettlement landscape than at present, many of the outer zones of marshes (particularly Arbuckle Marsh and other lakeshore and floodplain marshes), may have been quite dry at the time of survey, and seemed to the surveyors only as a prairie dominated by a different type of grass and lacking saw palmetto. Therefore, these would not have been differentiated from the prairies upslope.

Based on the above reasoning, descriptions found in Harper (1921, 1927), comparison of presettlement plat maps to modern soil surveys, known examples of relatively undisturbed vegetation types, and interpretations of survey methods and results, the following types of "prairie" seem to be distinguishable within the areas in and near the Kissimmee River dry prairie region.

1. Dry Prairie—Defined as those areas of the presettlement extent of "prairie" which are relatively contiguous to the main body of Florida dry prairie above the Kissimmee River marshes on one or both sides of the river, and occurring on poorly drained but rarely flooded soils: mostly spodosols such as the Immokalee, Myakka, Smyrna, Ona, EauGallie, and Oldsmar soil series, but sometimes on alfisols such as Malabar. These areas are topographically above the floodplain zone of the Kissimmee River and tributaries, the Kissimmee Chain of Lakes, and large basin marshes. They are the areas we still refer to as true "dry prairie," and have a ground cover similar to that of open mesic to wet pine flatwoods.

2. Wet Prairie—Defined as those areas with sufficient ponding to lack a well-distributed layer of low shrubs interspersed with grasses and sedges, and with shallow inundation for several months during a normal wet season. These can comprise a fairly large percentage of some areas of "prairie" within the region. Soils are mostly of series such as Basinger, Placid, Valkaria, and Smyrna. These are mostly found interspersed throughout the dry prairie matrix and not expected to be mapped as separate units in the presettlement surveys. However, some areas slightly outlying the main area of the dry prairie region that are mapped as "prairie" are comprised solely of wet prairies.

3. Shallow River Floodplain Marshes—Along the Kissimmee River, the outer zones of the floodplain marsh would have been subject to only infrequent flooding and had a grass-dominated aspect. These seem to have been lumped with the adjacent dry prairie when encountered in the presettlement surveys, and the term "marsh" in these surveys restricted to deeper broadleaf

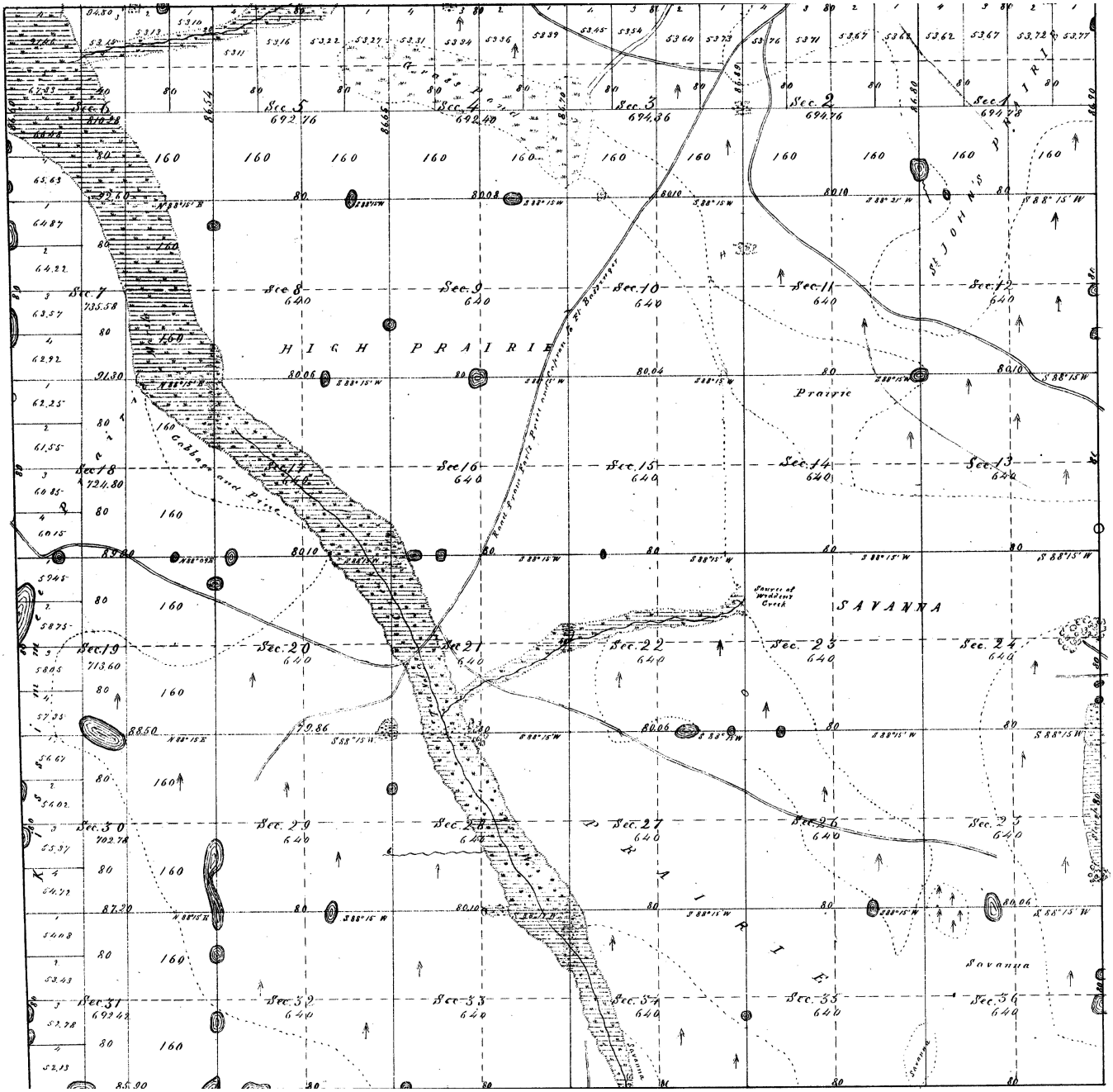

Figure 3. Presettlement land survey plat map for Township 36S, Range 35E, Okeechobee County, by Charles Hopkins (1881). Note the use of the terms "high prairie," "prairie," "savanna," and "St. Johns prairie" to indicate what this surveyor perceived as different vegetation types.

marsh or sawgrass marsh zones with longer hydroperiods. These can be recognized by being below the 100-year flood elevation of the unchannelized Kissimmee River, and by not having a contiguous matrix of interspersed low shrubs, grasses, and sedges characteristic of dry prairie, but rather a more patchy vegetation with more tall shrub invasion.

Also, just a few miles east of the eastern boundary of the dry prairie region at some places, one encounters the marshes associated with the upper reaches of the St. Johns River. All of the areas mapped as prairie within the floodplain of the St. Johns River are herein referred to the Shallow River Floodplain Marshes category.

4. Shallow Lakeshore Floodplain Marshes—Mostly found in the northern part of the region, extending for up to a mile from the permanent water zone of Lake Kissimmee, Lake Tohopekaliga, and to a lesser extent from Lake Marian, Lake Jackson, Tiger Lake, Lake Rosalie, Lake Hatchineha, and Cypress Lake. Some surveyors mapped these areas as just "prairie," not distinguishing the lakeshore marshes as a separate vegetation type unless they were dominated by "Sawgrass." If surveyed during a dry period, it would be easy to see how these seasonally flooded and seasonally dry grass and sedge dominated communities would not have been distinguished from prairies. The distinction of these areas can often be made by soil type, with the Lokosee soils series in Osceola County being highly correlated with their occurrence.

5. Shallow Basin Marshes—Although many depression marshes are mapped as "ponds" or "grass ponds" when encountered along survey lines, other areas do not seem to be distinguished as such. Other areas, just outside the main dry prairie region, which are

mapped as "prairie" seem to represent these shallow basin marshes, such as in T29S, R34E and in T31S, R34E. There would be no reason to distinguish a shallow basin marsh from a prairie in the presettlement notes as long as it was not dominated by sawgrass or contained a large amount of open water (as in depression marshes, often referred to as "ponds"). For example, the outer zones of Arbuckle Marsh not dominated by sawgrass are lumped in with the surrounding prairie by the surveyors (Fig. 4).

6. Community Mosaic complexes—These include "Prairie, Savanna, and Sawgrass" (T28S, R30E), here believed to be a mosaic of shallower and deeper lakeshore floodplain marshes with interspersed "islands" of cabbage palm or other trees on the small areas of higher ground within a mostly marshland matrix. Also included here are other mosaic types, such as "Prairie, Sawgrass, and Cypress." These do not seem to represent areas of true dry prairie landscape.

7. "Savanna"—This is both one of the most accurate and most problematic uses of a term for presettlement vegetation in the region. "Savanna" was very rarely used as a vegetation type description in the presettlement surveys of the region, and was usually used within a township also having areas defined as "prairie" and others as "pine." We can safely assume that in this context the term "savanna" was used for areas that had significantly lower pine density than the nearby pinelands over a fairly broad area. Most surveyors probably encountered such areas, and some referred to similar sites as "prairie with scattering pines" or other such terms.

Definitions and Types of "Marshes" in the Presettlement Surveys

The use of the term "marsh" in the presettlement survey was likely restricted to areas with almost year-round inundation, with at least several inches or more of water at the date of survey. These were often specifically described as "saw grass marsh," and at a certain point were considered "impracticable," as surveyors could not penetrate these areas to establish section lines. The inability of the surveyors to establish lines through these marshes could be due to one or both of two factors—the thickness of the vegetation or the depth of the water above the surface. Since most of the surveys were conducted in the dry season, in most cases it was probably the impenetrability of the dense sawgrass of the marshes that was the limiting factor in establishment of section lines. Depression marshes, and even larger basin marshes not dominated by sawgrass, did not seem to limit the ability of the surveyors. These would likely have had water as deep or deeper than the floodplain marshes, hence water level does not seem to be the limiting factor. Even the deep water seepage swamp of the interior of Bill's Bay (within APAFR) was traversed in all directions by section lines. Consequently, I interpret "impracticable" marshes, even those not specifically designated as "sawgrass," as consisting of a dense, thick stand of sawgrass, which would have been maintained by dry season fires that burned through the sawgrass marshes and reduced competition. This seems to have been the presettlement vegetation of most of Arbuckle Marsh and the Kissimmee River Marsh, as well as the upper St. Johns River Marsh and many smaller marshes or "glades" within the dry prairie region. This is quite significant since much of the Kissimmee River Marsh sawgrass has been lost to decades of fire suppression and water level manipulation, and only small patches of sawgrass can still be found in the sections of the Kissimmee River Marsh in and near APAFR. Additionally, although cypress was present along sections of Arbuckle Creek, it was not mentioned in surveys of most of Arbuckle Marsh (Fig. 4). Therefore, the cypress stands in most of Arbuckle Marsh are of recent origin, again due to the combination of fire suppression and water-level manipulation.

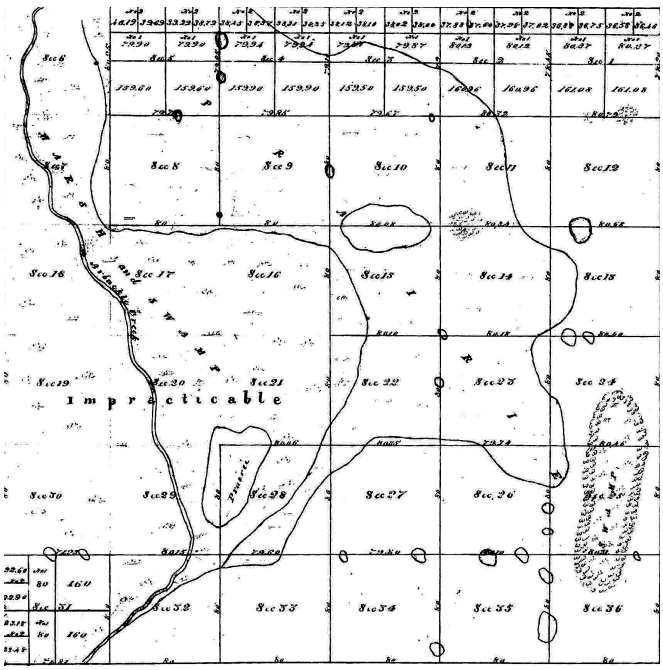

Figure 4. Presettlement land survey plat map for Township 33S, R30E, Highlands County, by William Mickler (1859). The area mapped as "impracticable" is an extensive sawgrass marsh along Arbuckle Creek (Arbuckle Marsh), the "swamp" is a cypress strand, and the area of tree canopy along the line between Sections 11 and 14 is a diverse hardwood hammock. The area mapped as "prairie" includes both dry prairie and the seasonally shallow inundated outer zones of Arbuckle Marsh dominated by grasses, sedges, and/or broadleaf marsh plants (anything other than sawgrass).

Many marshes are specifically identified as "sawgrass" in the presettlement surveys, and others are designated only as "glade." In the context of these surveys, it seems that the term "glade" is used for a linear slough or swale of sawgrass dominance, functioning as a slowly flowing stream as opposed to the usually depressional basins of most "sawgrass" communities. Other areas are designated as "marsh" or "marsh and glade;" in these cases it is likely that the word "marsh" refers to broadleaf marshes or mixtures of broadleaf and grass marsh dominance, with species such as *Pontederia cordata* (pickerelweed), *Sagittaria lancifolia* (arrowhead), and *Panicum hemitomon* (maidencane), among others. If it were possible to put survey lines through an area, then probably it was not sawgrass dominated unless indicated specifically as such on the presettlement plat maps. If it were not possible to put survey lines through an area (absence of section lines and/or the word "impracticable" used to describe the area) then it probably was sawgrass dominated unless indicated specifically not.

Definition and Types of Forested Areas in the Presettlement Surveys

Areas of denser trees are usually indicated as such on the presettlement plat maps, but without differentiation

as to which type of forest they represented. However, it is often possible to discern which natural community each of the areas designated as forested represents by a correlation with topographic position, soil types, and current forest composition. As such, it is often possible to distinguish forest types delineated on the presettlement plat maps.

Swamps

Some swamps were distinguished by the word "swamp" within the area noted as forested (i.e. Long Cypress Slash, the swamp in the southeast part of Fig. 4), or by use of marsh symbols inside an area delineated as forested (i.e., Bill's Bay, Blue Jordan Swamp). Some areas at the north end of the dry prairie region are specifically indicated as "cypress," "cypress drain," or "cypress swamp," being the more extensive linear cypress strands of the northern part of the Osceola Plain.

Most of the larger areas of swamps include witness tree points indicating their general canopy composition. Areas of particular note include an area of "bay and pine swamp" between Willingham Branch and the Bombing Range Ridge, now known as "The Deadens," and still consisting of a slash pine swamp with a bay subcanopy. Possibly similar areas occurred north of Avon Park AFR in T29S, R29E ("Bay Swamp"), T30S, R29E ("Boggy Pine Slough"), T31S, R30E (a large area mapped as swamp), and T33S, R29E ("bay and pine flat," at the site of a current large dairy farm north of County Road 64). Other clearly recognizable features in this category include the bay-dominated "Bill's Bay," and the cypress-dominated "Long Cypress Slash," each of which had witness trees confirming their current composition. Composition of many other examples can be differentiated by reference to the accompanying survey notes as to the description of types encountered along survey lines or the witness trees within each area.

Floodplain swamp is very rare within the presettlement land surveys of the Florida dry prairie region. Parts of Chandler Slough and Cypress Slough in Okeechobee County were likely forested at the time of the presettlement surveys. Most of the drainageways within the dry prairie region were indicated with marsh symbols, referred to as "marsh", "glade", or "grass slough", or otherwise indicated as being non-forested. There seems to have been a dramatic increase in woody dominance along these drainages in the past century, probably due to suppression of intense landscape-level fires, which would have been sufficient to burn through these drainages. The decline of sawgrass dominance in the remaining sloughs and marshes is also a result of fire suppression. Floodplain swamp is also very limited in natural extent within KP, occurring only in the lower reaches of Sevenmile Slough, in part of Duck Slough, in the lower part of Threemile (Gum) Slough, and a small stand along Fivemile Slough. In these examples at KP, floodplain swamp has a canopy of *Quercus laurifolia*, *Acer rubrum*, *Ilex cassine*, *Nyssa sylvatica* var. *biflora*, and *Fraxinus caroliniana*. The canopy is often rather open and composed of deciduous trees, resulting in a rather marshy ground cover. Common ground cover species include *Blechnum serrulatum, Thelypteris interrupta*, *Saururus cernuus*, *Polygonum punctatum*, and *Boehmeria cylindrica*. Several species seem to be restricted to floodplain swamp at KP, perhaps occurring in no other natural community in this landscape. These include *Apios americana*, *Carex lupuliformis*, *Dichanthelium scabrisculum*, and *Smilax walteri*. The floodplain swamps of KP have flowing water during high water periods, which distinguishes them from all other forested communities in the Florida dry prairie landscape.

Floodplain swamp becomes the prevalent natural community type of small drainageways almost exactly in correlation with the boundaries of the dry prairie region. At the northeast border of the dry prairie region, most of the floodplain swamps, as well as basin, depression, and strand swamps, are dominated by cypress (*Taxodium ascendens*). To the east of the dry prairie region dominance of floodplain swamps can be more mixed, including *Acer rubrum*, *Quercus laurifolia*, *Taxodium ascendens*, as well as other species. These small drainageways are very common in eastern Okeechobee County just east of the dry prairie boundary, extending north into southeastern Osceola County. The western edge of dry prairie is often near the eastern extent of bay swamps (= seepage swamps) at the base of the Bombing Range Ridge and the Lake Wales Ridge. However, few of these are found within the dry prairie region.

Scrub

Only a very few areas are mapped or described as "scrub" within the boundaries of the Kissimmee River dry prairie region. More areas are mapped as scrub just outside the border of the dry prairie region, from 1-4 mi from the prairie border with the continuous pinelands. Areas of scrub are mapped within a few miles west of the western border of the dry prairie region, associated with the Bombing Range Ridge and the Lake Wales Ridge. Other than these ridge-associated scrub areas, very few areas are mapped as scrub on any of the presettlement plat maps examined.

Only four small areas are mapped as "scrub" within the boundaries of the Kissimmee River dry prairie region. One of these (in T32S, R32E, and Sect. 31 and 32, near the southern border of Osceola County) is clearly not a scrub, based on the soil survey, nor even an area of "treeless scrubby flatwoods" also known as the "xeric community type of dry prairie" (Bridges 1998, Orzell and Bridges 1999). It has mostly Myakka and Smyrna soils mapped, with only a small area of Immokalee soils and no areas of drier soil types. This may have been mapped as scrub on the presettlement surveys because it may have had taller and denser shrub cover than was typical for prairie, perhaps because it fell within a fire shadow for the decade before the survey. Regardless of the reason it was mapped as such, it should not be considered an inclusion of scrub within dry prairie.

The other three small areas mapped as "scrub" within the region have several features in common. They are located in T33S, R32E, Sect. 19 and 30 (the Fort Kissimmee site), T36S, R33E, Sect. 6 (between Cornwell and Fort Basinger), and in T36S, R33E, Sect. 34 (south of S65-D). All of these occur on the backside of dry sandy hardwood hammocks bordering short, steep bluffs above the channel of the Kissimmee River. Soil series of these areas are

Duette (Grossarenic Entic Haplohumods) and Pomello (Arenic Haplohumods), which both are commonly associated with scrubby flatwoods in this region (Bridges 1998, Bridges 2000). In vegetation mapping of KP, other areas of Pomello soils were found, associated with short, steep bluffs above the channel of the Kissimmee River, and with sand ridges along major tributaries to the Kissimmee River. The vegetation of these areas, which is likely typical of less-disturbed examples of these scrubby patches in the dry prairie landscape, is described as follows (from Bridges 1998), updated with the nomenclature used in Orzell and Bridges (1999).

The dry (sub-xeric) type of dry prairie occurs in scattered roughly circular to elliptic patches in the western half of KP, mostly associated with the escarpments of the floodplains of Duck Slough, Fivemile Slough, Sevenmile Slough and the Kissimmee River. These areas are often referred to as "scrub" in previous surveys of the property. They do not precisely fit the definition of either scrub or scrubby flatwoods, but have more characteristics in common with scrubby flatwoods than scrub. They differ from typical scrubby flatwoods only in the absence of a pine canopy, and can be thought of as a treeless variant of this community. The dominant species of the dry (sub-xeric) community type of dry prairie on the property include *Quercus geminata*, *Q. myrtifolia*, *Q. chapmanii*, *Lyonia fruticosa*, *L. lucida*, *Serenoa repens*, *Befaria racemosa*, *Aristida beyrichiana*, and *Vaccinium myrsinites*. Characteristic species of this community are often restricted to herbaceous openings, and include *Balduina angustifolia*, *Piloblephis rigida*, *Rhynchospora intermedia*, and *Polygonella polygama*. These herbaceous openings also support large populations of such wetland species as *Drosera brevifolia*, *Syngonanthus flavidulus*, *Eleocharis baldwinii*, *Utricularia subulata*, and *Xyris brevifolia*. The presence of these herbaceous species indicative of seasonally saturated soils serves to easily distinguishes the dry (sub-xeric) prairie from scrub, which has open patches of excessively drained white sandy soil and does not support wetland herbs. Also, this community lacks narrow scrub endemic plant or vertebrate species, including such widespread and characteristic species as *Garberia heterophylla*, *Persea borbonia* var. *humilis*, and *Sceloporus woodi* (Florida scrub lizard). Also, in contrast to scrub, there are few to no white sandy openings within the community except along cleared roadsides. Openings tend to be vegetated by wiregrass and other grasses.

The dry (sub-xeric) community type of dry prairie occurs on very slight rises within the dry prairie matrix, often only a few feet above the surroundings. The patches tend to be concentrated near the drainage escarpments of the major sloughs and at high points along the Kissimmee River escarpment. The best examples are found on Pomello fine sand (Typic Haplohumods), although some are also mapped as Immokalee fine sand (Arenic Haplaquods). Presumably, the proximity of a major drainage feature serves to more quickly lower the water table after rain events and therefore reduces the duration of soil saturation, even though a spodic layer (hardpan) is present in these soils at depths from 35-42 in.

Examples of this community are almost all subject to occasional fire. The fire frequency is naturally less than in dry prairie, but some portions may burn as often as every five years, while other parts of the same patch may escape fire for 10 to 15 years. Prescribed fire in these patches should be accomplished as much as possible without the use of firebreaks between the dry (sub-xeric) patches and the surrounding dry prairie. The goal should be that only part of a particular patch burns in most fires, leaving some of the oaks unburned, while rejuvenating the growth of those that burned. Over a 15-year period, the majority of all patches should be subject to some burning, which should be sufficient to retard succession to a poor-quality xeric hammock, while allowing enough oak growth to maintain their distinctiveness from dry prairie and to support oak-dependent wildlife (i.e., Florida Scrub-Jay).

These communities do not seem to be significantly different from scrubby flatwoods patches throughout the Osceola Plain except for the absence of canopy pines. Examples mapped on the presettlement maps may have had some pine trees, since most are mapped adjacent to or nearby pine islands on the presettlement maps.

More examples of scrubby communities, here fitting the description mostly of scrubby flatwoods, are found within 1-4 mi east of the pineland/prairie border in northeastern Okeechobee and southeastern Osceola counties. Examples, which are delineated as "scrub" on the presettlement plat maps, are found in T30S, R33E, Sect. 9 and 10; T31S, R34E, Sect. 24; T35S, R36E, Sect. 7 and 8; and T35S, R36E, Sect. 28, 29, 32, and 33. Many other examples of equally xeric scrubby flatwoods are not distinguished from the surrounding pinelands on the presettlement plat maps, particularly those west of Yeehaw Junction in T32S, R34E and near Fort Drum in T34S, R35E, which are also only a few miles eastward of the pineland/prairie border. The landscape dissection and drainage, which results in these scrubby communities also seems to be correlated with better condition for pinelands than for prairie.

Hardwood Hammocks

Many small areas mapped as forested on the presettlement surveys within the dry prairie region are essentially hardwood hammocks. These are defined as areas of hardwood trees without marsh or swamp symbols included, and which do not included bays, cypress, or other wetland trees. Most presettlement plat maps indicate hardwood hammocks as small (generally less than 40 ac), roughly circular to elliptic clusters of small rounded tree symbols, often adjacent to an open pond or marsh, or between two ponds or marshes. These stand in contrast to the more linear arrays of tree symbols used for floodplain swamps or larger aggregations of tree symbols, which often indicate basin swamps. There are relatively few of these areas on the presettlement plat maps, and most still exist in roughly the same configuration. It should be emphasized that these features would likely only be indicated where they were crossed by section or township lines, and would not be mapped if they occurred in the interior of a section. Therefore, there were likely many other areas of hardwood hammocks that were not crossed by section lines and therefore not indicated on the maps.

The occurrence and composition of hardwood hammocks in the dry prairie region has been studied at KP in

Okeechobee County (Bridges 1998, Bridges and Orzell, unpublished data), and to a lesser extent at adjacent properties (Bridges 2000a). Naturally forested areas on KP are extremely rare and localized, representing no more than a few percent of the total area. However, these areas are extremely important to local biodiversity, and function as islands of forest in a vast sea of grassland. In combination with presettlement plat maps, the naturally occurring forested areas on KP were distinguished from areas more recently invaded by trees by aerial photographs from 1943. Only those areas that were forested in 1943, when fire and hydrology on the Preserve were much less altered than at present, are mapped as being forested communities. These are divided between four natural community types, each of which occurs in different topographic and hydrologic situations: prairie hammock, hydric hammock, baygall, and floodplain swamp.

Prairie hammock is often used to refer to any clump of live oak and/or cabbage palms surrounded by prairie or marsh communities. These hammocks vary greatly in size, soil type, degree of protection from fire, and hydrology. In the vegetation mapping for KP, prairie hammock is reserved for those hammocks with a substantial elevation rise from the surrounding marshes or prairies, sufficient to support some upland vegetation in the center of the hammock. Although the borders of even these hammocks are saturated or inundated such as to resemble hydric hammocks, these wetter zones are lumped with the prairie hammock for mapping. This distinction between prairie hammocks and hydric hammocks is rather arbitrary, but may be useful in relating biodiversity of these areas to the different hammock types.

Even with this distinction between prairie hammocks and hydric hammocks, three distinct subtypes of prairie hammocks were found on KP. All of these prairie hammocks have a canopy dominated by live oak and cabbage palm, but differ in associated tree species and understory components. The most unusual of these subtypes can be described as prairie hammock with a subtropical understory. Seven examples of this hammock type were surveyed, five of which were located by a predictive model for the location of this hammock type, applying that model to determine the location of potential examples of this hammock type on the 1943 aerial photos (Fig. 5). A few others are potentially this type. The canopy of these areas is mature *Quercus virginiana*, *Sabal palmetto*, *Celtis laevigata*, *Ulmus americana*, and *Quercus laurifolia*. What most distinguishes this hammock type is the tall subcanopy layer of *Myrcianthes fragrans* and the presence of other subtropical shrubs and vines such as *Ardisia escallonioides*, *Myrsine floridana*, *Psychotria nervosa*, *Sageretia minutiflora*, *Forestiera segregata*, *Zanthoxylum fagara*, and *Cynanchum scoparium*. This suite of species indicates a marly soil with likely a higher pH than the surrounding landscape. The understory density of these hammocks may have been reduced somewhat by past grazing, and many are in the process of recovery. Hammocks with subtropical understory components are very unusual in the interior of central Florida, although they are more common along the coasts. These areas are very important local biodiversity components and are extremely sensitive to alterations by overuse by animals (cattle, feral hogs) or intensive human use (camping, horseback riding). The presence of several of this suite of restricted subtropical shrubs and vines is an excellent indicator of the long-term forested nature of this hammock type.

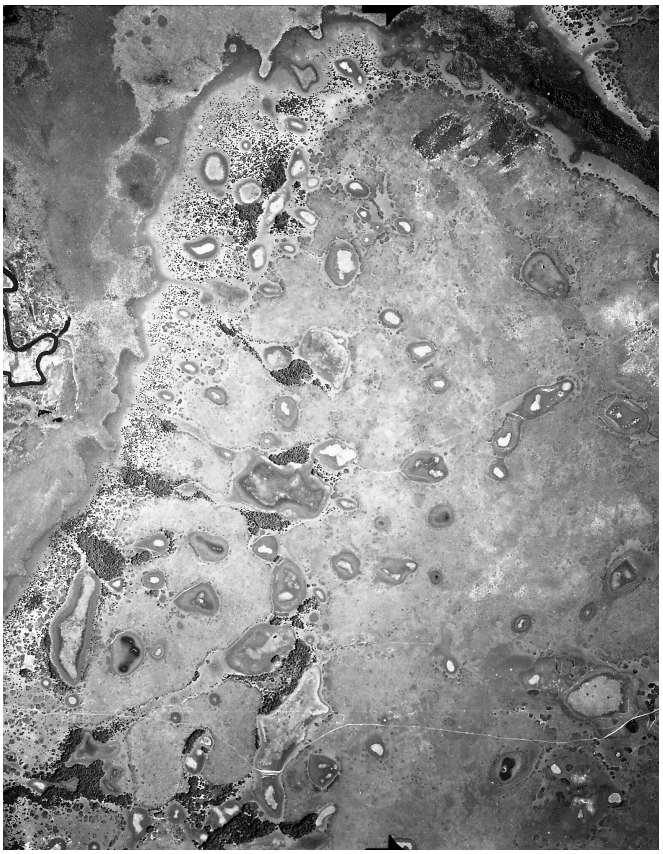

Figure 5. Aerial photography from May 1, 1943, on the east side of the Kissimmee River in Okeechobee County, from Sevenmile Slough southward, now part of Kissimmee Prairie Preserve State Park. Dry prairie landscape is the relatively even light-gray textured area, with the outer zones of the Kissimmee River floodplain having a lighter tone with dark patches (clumps of saw palmetto and other shrubs). Hardwood hammocks shown as areas of dense tree canopy on this photo are mostly rich, diverse hammocks with natural protection from landscape level fires.

A second prairie hammock subtype was only seen at one site at KP, the high sandy prairie hammock. This type was found on a high ridge along the edge of the floodplain of the Kissimmee River (just northeast of the old Prescott Homestead, Section 1, T34S, R31E), and is the site of a known Indian mound. Canopy trees here include *Quercus virginiana*, *Sabal palmetto*, and *Carya glabra*, and the understory includes such sandy soil indicators as *Diospyros virginiana*, *Osmanthus americanus*, *Persea borbonia*, *Prunus caroliniana*, *Erythrina herbacea*, and *Ilex ambigua*. This hammock is extremely protected from fire by its unusual position between a large area of scrubby flatwoods and the Kissimmee River floodplain. The zone where this hammock meets the adjacent scrubby flatwoods resembles a xeric hammock, but is only a narrow zone and is not mapped separately. This seems to be the only high sandy "bluff" along the river floodplain on the Preserve that is so well-drained and protected from fire as to support this type of hammock. This type also occurs at Avon Park AFR, the Fort Kissimmee and Orange Hammock hardwood hammocks being referable to this type, both in

species composition and landscape position. Other examples would have occurred at locations where a high sandy bluff occurred in proximity to the river floodplain, mostly in close proximity to the river channel, and some other remnant examples may still occur at other downstream locations.

The remainder of the prairie hammocks surveyed could be classified as low-diversity low prairie hammocks. These have a canopy of *Quercus virginiana* and *Sabal palmetto* and patches of *Serenoa repens* in ground cover of the higher parts of the hammock. *Serenoa repens* sometimes reaches 15-20 ft tall in the understory of these hammocks. Groundcover diversity is low, and consists mainly of scattered clumps of the grasses *Panicum anceps*, *Paspalum setaceum*, *P. conjugatum*, *Oplismenus setarius*, *Dichanthelium commutatum*, and *D. laxiflorum*. Some of these hammocks, as well as the outer, wetter zones of the subtropical understory hammocks, support large populations of the restricted grass species *Muhlenbergia schreberi*. Within south-central Florida this grass is known to occur only in these hammocks in Okeechobee County. Areas of past disturbance by cattle and feral hogs often have high cover of the weedy *Sida acuta*. These hammocks have fairly high diversity in the epiphyte layer, as do all the hammock types. Typically, there are 5 to 6 species of *Tillandsia* in most hammocks (*T. balbisiana*, *T. fasciculata* var. *densispica*, *T. recurvata*, *T. setacea*, *T. usneoides*, and *T. utriculata*), three species of epiphytic ferns (*Phlebodium aureum*, *Polypodium polypodioides*, and *Vittaria lineata*), and some prairie hammocks also have clumps of the epiphytic butterfly orchid (*Encyclia tampensis*).

The prairie hammocks of the Kissimmee River dry prairie region are very unusual and sensitive habitats. The low biodiversity of the majority of prairie hammocks could be the result of past damage to the groundcover by cattle and feral hogs, both of which preferentially utilize these sites. Alternatively, some hammocks may have lower diversity by being subject to occasional fire, where during dry periods fires from the surrounding prairies and marshes burn through the groundcover of the hammocks.

Hydric hammock referes to those hammocks that periodically inundate or saturate to the soil surface to the extent that there is little or no upland area within the hammock. These tend to have a mostly *Sabal palmetto* canopy, with little or no *Quercus virginiana*, and occasional *Acer rubrum* and *Quercus laurifolia*. A characteristic shrub that distinguishes these from prairie hammocks is *Viburnum obovatum*. The ground cover is disturbed in most examples visited, comprised of mostly the same grasses as in the low diversity prairie hammocks. The outer or wetter zones of these hammocks may naturally have a sparse groundcover due to the combined effects of periodic flooding and dense shade, which limits the plant species able to grow in this situation. Most of the hydric hammocks in the region have similar damage from cattle and feral hogs.

At the level of detail on the presettlement plat maps, it may be difficult to distinguish small seepage swamps (baygalls) from hardwood hammocks. Seepage swamps are restricted in extent in the Kissimmee River dry prairie region. On KP they perhaps occur in only four locations, each of only a few acres. The seepage swamps are found in small, somewhat U-shaped small drainageways near the escarpments between the dry prairie landscape and major drainageways (Sevenmile Slough and the Kissimmee River). These differ from other natural communities in the region in having a primary water source of diffuse lateral groundwater seepage. The seepage swamps of the dry prairie region are poorly developed in comparison to examples associated with higher sandy ridges or in the continuous pinelands to the east of the dry prairie region near Fort Drum. The canopy dominant is *Magnolia virginiana*, with a few *Nyssa sylvatica* var. *biflora*, and occasional *Acer rubrum*, *Persea palustris*, and *Gordonia lasianthus*. The shrub layer is often composed of *Myrica cerifera*, *Vaccinium corymbosum*, *Lyonia lucida*, and *Itea virginica*, tied together by dense tangles of *Smilax laurifolia*. Groundcover species restricted to or more common in seepage swamps than in other communities include *Osmunda cinnamomea*, *Woodwardia areolata*, *Peltandra virginica*, *Triadenum virginicum*, and *Orontium aquaticum*. Most of the seepage swamps of the dry prairie region have been penetrated by fire at various times, which kills the dominant *Magnolia virginiana* trees, resulting in an open, scraggly canopy appearance. It is possible that some of these seepage swamp edges, should fire penetrate them often enough, may potentially support some open herbaceous seepage slope species. Only tiny fragments indicating the potential of occurrence of this community type were found under the dense shrubs of some seepage swamp edges. There are no examples of herbaceous seepage slopes known from the dry prairie region, and consequently, the restricted seepage-dependent herbaceous species of these communities are absent from the region.

Factors Influencing the Location of Presettlement Pineland/Prairie Boundaries

No single factor or single set of factors in combination can explain the location of all pineland/prairie boundaries within the Kissimmee River dry prairie region. In some cases there is no obvious change in environmental factors at or near the pineland/prairie boundary. In many instances the location of the pineland/prairie border is roughly correlated with a combination of other environmental factors.

The Prairie/Shallow Marsh Boundary in Osceola County

As previously discussed, the use of the term "prairie" in the presettlement surveys often included large areas of shallow marshes, particularly along the floodplains of lakes and rivers. Sinuous areas of "prairie" are mapped on the presettlement surveys on the east side of the Kissimmee River and around the Kissimmee Chain of Lakes at least as far as the east side of Lake Tohopekaliga, just south of St. Cloud. However, a more detailed examination of other historical sources, soil surveys, topographic contours, and aerial photography indicates that many of these northern extensions of "prairie" are actually the shallow outer zones of lakeshore floodplain marshes along Lake Tohopekaliga, Cypress Lake, Lake Hatchineha, and Lake Kissimmee. After careful consideration, the northern extent of true "dry prairie" within the region has been determined to fall just south of Canoe Creek, in T28S, R30E, Section 12, and T28S, R31E, Sections 5, 6, 7, and 8 (Fig. 6). Areas within these sections seem to have

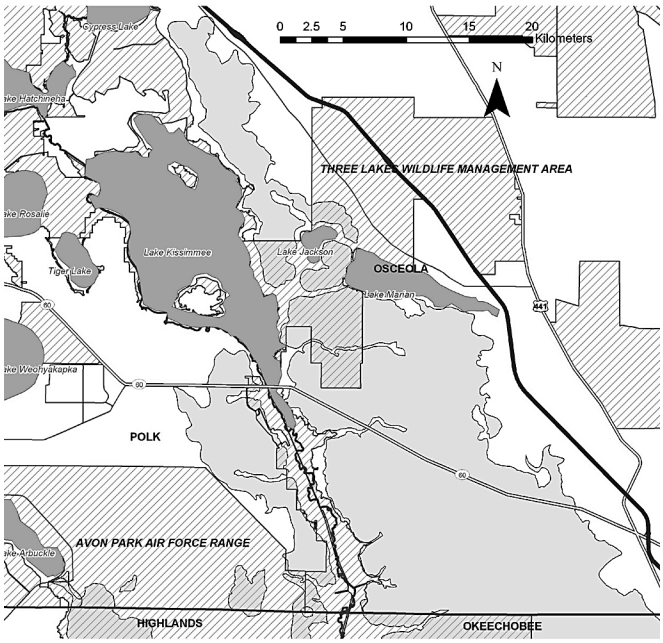

Figure 6. Presettlement extent of the Florida dry prairie landscape in Polk and Osceola counties (light gray). Current and proposed conservation (or mixed resource utilization/conservation) areas cross-hatched.

all the characteristics of true dry prairie and are bordered to the north and west by areas more likely to have been shallow marshes, particularly before the drainage canals cut through this region in the 1880s. This border can be followed southward through T29S, R31E and T30S, R31E by following the boundary between the Myakka, EauGallie, and Immokalee (all Spodosols) soil series of the dry prairies and the Lokosee (Grossarenic Ochra-qualfs), Riviera (Arenic Glossaqualfs), Malabar (Grossarenic Ochraqualfs), and Pompano (Typic Psammaquents) soil series of the shallow marshes. This border extends south along Lake Kissimmee to its southern edge, and then follows the escarpment of the Kissimmee River floodplain from there to the southern border of the county. In some cases the drained outer floodplain marsh zones of the Kissimmee River are mapped on Oldsmar and EauGallie soils, while in other cases Basinger or wetter soil series are mapped as the outer floodplain zones. As further south in Okeechobee County, the border between drained floodplain and dry prairie can be recognized by the absence of the continuous low-stature shrub/grass matrix more typical of dry prairie than the outer drained zones of floodplain marshes.

The Prairie/Pineland Boundary in Osceola County

The northern extent of the dry prairie region is a relatively narrow band between the shallow lakeshore floodplain marshes and the beginning of quite continuous pinelands in T28S, R31E (Fig. 6). In general, this border also seems to be correlated with the presence of many roughly linear to elliptic cypress depression and strand swamps in the area mapped as pineland. Near its northern limit, this boundary is roughly near the present route of FL 523 (Canoe Creek Road). The width of the dry prairie region remains rather narrow (1-3 mi wide) southward to Lake Jackson, where it broadens to encircle Lake Jackson and extend eastward to the west shore of Lake Marian. At this point the pineland/prairie boundary enters TLWMA, where the composition on both sides of the border has been investigated in the field by the author. In this region (centered on T29S, R32E, Sect. 32 and 33), the prairie/pineland border is still visible in essentially the same location as it is mapped on the presettlement plat maps. Remarkably, the change from streams with broad, shallow channels and cypress dominance to streams with incised channels and an oak-palm hammock fringe occurs at almost the same point as the change from pineland to prairie.

At this point pinelands extend south to the north shore of Lake Marian, whereas all of the area to the south of Lake Marian is dry prairie. In this instance the lake itself may be the major barrier to the spread of landscape-level fires, which apparently protect the pinelands to the north, which are more dissected by numerous cypress-dominated drainageways that serve as minor barriers to the spread of fire. In contrast, there are few to no large drainageways that would serve as barriers to fire south of Lake Marian for many miles in any direction. At this point the dry prairie region on the east side of the Kissimmee River widens considerably, becoming eight to ten miles wide, with essentially no pine islands noted on the presettlement surveys. The eastern border of dry prairie at this point becomes rather complex, starting in the southern half of T30S, R33E and extending into T31S, R33E and T31S, and R34E. In this region there are interdigitating and alternating bands of pineland, prairie, sawgrass, and marsh, without very obvious soil or landscape differences between the locations of pinelands and prairies. The westernmost pinelands in this area are roughly near the current route of Peavine Trail between the Florida Turnpike and Florida Highway 60. At some places along this route the pineland/prairie border can still be seen in about the same position as on the presettlement maps. In this area there seems to be a greater extent of Smyrna (Aeric Haplaquods, with a shallow spodic layer) soils in the pinelands, and a greater extent of Oldsmar (Alfic Arenic Haplaquods), and EauGallie (Alfic Haplaquods) soils in the prairie region, both of which have a spodic layer and an argillic (clay) layer in the subsoil. As suggested in an earlier report on dry prairie (Bridges 1997), it is possible that these clay layers serve to create a more extreme degree of shallow groundwater fluctuation from shallow inundation to extreme droughty soils, and therefore are perhaps more stressful to young pine seedlings than are Spodosols, with only a single hardpan layer.

It is possible that some of the areas mapped as prairie that occur eastward of the first pineland/prairie boundary (heading east) are not areas of true dry prairie, but rather are areas which had a large extent of wet prairie at the time of the presettlement survey. This is apparent on the soil survey for some areas (such as T31S, R34E, Sect. 4, 9, and 10) mapped as prairie, which have a large extent of Pompano (Typic Psammaquents), Smyrna, and Vero soils, which may more likely have seasonal inundation and are associated more with wet prairie than with dry prairie.

The pineland/prairie border curves around a large (now drained) marsh in T31S, R33E, Sect. 22, 23, 26, and

27, where there is a dramatic difference in vegetation between the two sides of the marsh, with open prairie on the west side of the marsh and rather dense pinelands on the east side. It appears that this marsh may have been of sufficient size to serve as a barrier to landscape fire. From this point the border heads further south and east and the dry prairie region becomes even wider, extending from 12 to 14 miles east of the Kissimmee River. The pineland/prairie border along Florida Highway 60 (in T32S, R34E, near the west edge of Sect. 5, about three miles west of Yeehaw Junction) can be seen at the present day in almost exactly the same location as on the presettlement surveys. From this point eastward the landscape becomes more dissected, with wetland strands and scrubby flatwoods ridges alternating with pinelands. In this region it seems that the increased landscape dissection provides the barrier to landscape-level fires to favor pinelands over prairie. The pineland/prairie border follows near the western edge of this more dissected landscape south from this point to the Okeechobee County line, at a point only one mile west of the Indian River County line. Based on the interpretations of this study, the true dry prairie region does not extend into Indian River County.

The Prairie/Pineland Boundary in Okeechobee County

The western extent of relatively continuous pinelands at the eastern extent of the dry prairie region in Okeechobee County seems to be correlated with increased density of streams with forested wetlands and increased landscape topographic dissection. This boundary lies near US 441 extending north from Okeechobee through Fort Drum towards Yeehaw Junction (Fig. 7). The southern edge of this boundary is in T37S, R35E, very near where Taylor Creek flows into the presettlement extent of lakeshore marsh on the north edge of Lake Okeechobee. At this point there are a few small areas of pineland on the west side of Taylor Creek (now mostly occupied by the town of Okeechobee, which was built on this pine ridge), and there are continuous pinelands, with no prairie openings mapped for several miles on the east side of Taylor Creek. This seems to be correlated with an increased density of streams, most of which have at least some cypress swamps indicated in the presettlement surveys, from Taylor Creek eastward. This was the possible barrier to landscape-level frequent fire, which resulted in increased pine dominance.

Through central Okeechobee County the prairie/pineland boundary becomes very complex and interdigitating, with alternating areas of pineland and prairie from east to west. It is difficult to determine which of these areas of prairie represent true dry prairie, and which are areas of wet prairie or open wetland pine savanna. The surveyor of T36S, R35E mapped "prairie," "high prairie," "St. Johns prairie," "savanna," and "pineland" all in the same township, in what is perhaps the most detailed and artistic of the survey plat maps for the entire region (Fig. 3). Field reconnaissance of this area indicates that many of these boundaries are still extant. Although there has been an expansion of woody vegetation into the presettlement "high prairie" on the east side of Taylor Creek, this woody expansion has not been of pine trees, but rather of oaks and cabbage palms, forming an extensive hydric hammock in an area mapped as presettlement prairie. This is perhaps due to long-term fire suppression in this area, allowing the hammock formerly restricted to areas near the stream to extend up to a half-mile further from Taylor Creek. In general, there seems to have been an expansion of low-diversity oak-palm hammocks along streams, sloughs, and swales throughout the dry prairie region, but this may be the largest expansion of this community in the region.

Further north, in T35S, R35E, the pineland/prairie boundary becomes less complex, and continuous pinelands begin about one to two miles east of US 441, with US 441 being mostly in the dry prairie region, now occupied by extensive dairy farms with little remnant natural vegetation. Near this pineland/prairie border, one also begins to see cypress domes and strands, which are nearly absent from the center of the dry prairie region. Extending eastward from this boundary, in T35S, R36E, forested wetland strands become much more common, and the upland areas are mapped as pineland with a few small patches of "scrub." Areas mapped as prairie in the eastern half of T35S, R36E have a large percentage of the Felda soil series, and are not dry prairie, but rather more of a wet prairie/shallow marsh matrix (Fig. 8). These areas lie immediately eastward of the northwest to southeast trending escarpment [10 ft elevation difference, from about 45 ft at the top of the escarpment (the Penholloway terrace) to 35 ft at the base (the Talbot terrace)]. This may be true of many of the areas of prairie mapped eastward of the border of the dry prairie region.

Pinelands are very evident in T34S, R36E, along Hilolo Road from FL 68 north to Fort Drum. These are almost all dominated by longleaf pine, in contrast to the slash pine dominance of most of the pine islands within the dry prairie region. Near Fort Drum, there are many areas of scrub and many forested wetland drainages within the pinelands, which contrasts greatly with the landscape of the dry prairie region only a few miles to the west. Interestingly, most of these forested wetland drainageways are tributaries of the St. Johns River. Although the sources of these streams are within the dry prairie region, as they flow eastward and develop forested wetland strands, they enter the pineland region. There is a very strong correlation in the Fort Drum area between the development of forested wetlands along streams, presence of scrub or scrubby flatwoods patches, increased landscape dissection, and the pineland/prairie border. Pinelands can be seen extending westward along Old Eagle Island Road to near their presettlement limit. The prairie/pineland boundary stays a few miles west of US 441 from south of Fort Drum to the Osceola County line and beyond, with a similar pattern of forested wetlands and scrubby patches in the pinelands throughout this stretch.

The Prairie/Floodplain Marsh Boundary in Okeechobee County

At the Osceola /Okeechobee County line, the Kissimmee River floodplain marsh is about a half-mile wide on the eastern side of the river, and soon expands to over 1.5-mi wide where Sevenmile Slough enters the floodplain (Fig. 7). In this township (T33S, R32E), the phrase "river bog" is used on the presettlement plat map to de-

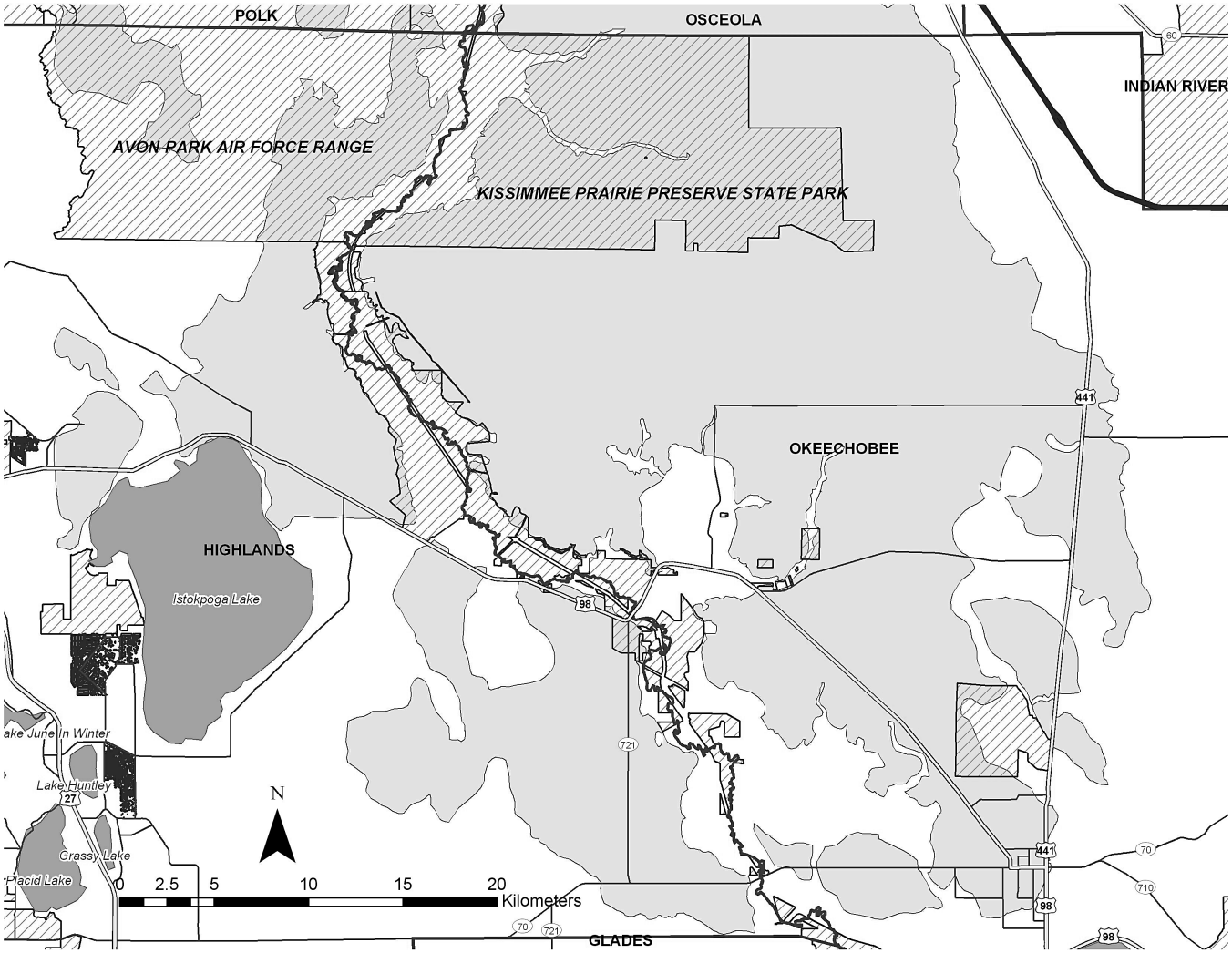

Figure 7. Presettlement extent of the Florida dry prairie landscape in Okeechobee and eastern Highlands counties (light gray). Current and proposed conservation (or mixed resource utilization/conservation) areas crosshatched.

scribe the Kissimmee River floodplain, and the phrase "boggy grass slough" to describe Sevenmile Slough. The surveyor of this township often refers to the "boggy" conditions of the river and slough floodplains, and all section lines were run without any being considered as "Impracticable," as is the case in many other townships. This may indicate that this stretch of the Kissimmee River marsh had a greater amount of broadleaf marsh than sawgrass. The prairie/floodplain marsh border south of the junction of Sevenmile Slough has been previously studied (Bridges 1998), and the pre-channelization boundary between dry prairie and the shallow outer zones of floodplain marsh (now drained) was mapped as part of this project. Based on the results of this mapping, the area shown as "prairie" on the presettlement plat map of T33S, R32E includes all of these outer floodplain marsh zones. The actual boundary between true dry prairie and the floodplain marsh is actually from 0.2 to 0.5 miles further east than the boundary shown for prairie on the presettlement surveys. This is understandable because the infrequently flooded grassy outer zones of floodplain marsh would have been more similar physiognomically to prairie than to "river bog."

This stretch of the prairie/marsh boundary is also notable for having a large concentration of hardwood hammocks just waterward of the prairie/marsh border, often protected from fires by deep depression marshes, which sometimes almost completely encircle the hammocks. This may be the largest concentration of old-growth, presettlement, subtropical understory hammocks anywhere in the Kissimmee River dry prairie region.

At the southwestern corner of T33S, R32E, the floodplain on the east side of the river becomes narrow, and there is a dry, sandy hardwood hammock (Long Hammock) on a short bluff above the river floodplain, with an area of dry, scrubby habitat lying landward (south) of the hammock. This is very similar to the hammock/scrubby area combination referred to earlier at Fort Kissimmee and other locations on the east side of the river.

Perhaps the opposite situation was found by the surveyor of T34S, R31E as that of T33S, R32E, although the situation was likely somewhere between that found by the two surveyors. Whereas the surveyor of T33S, R32E surveyed every section line, and referred to the Kissimmee River deep marsh as "river bog," the surveyor of T34S, R31E, immediately downstream, surveyed no section

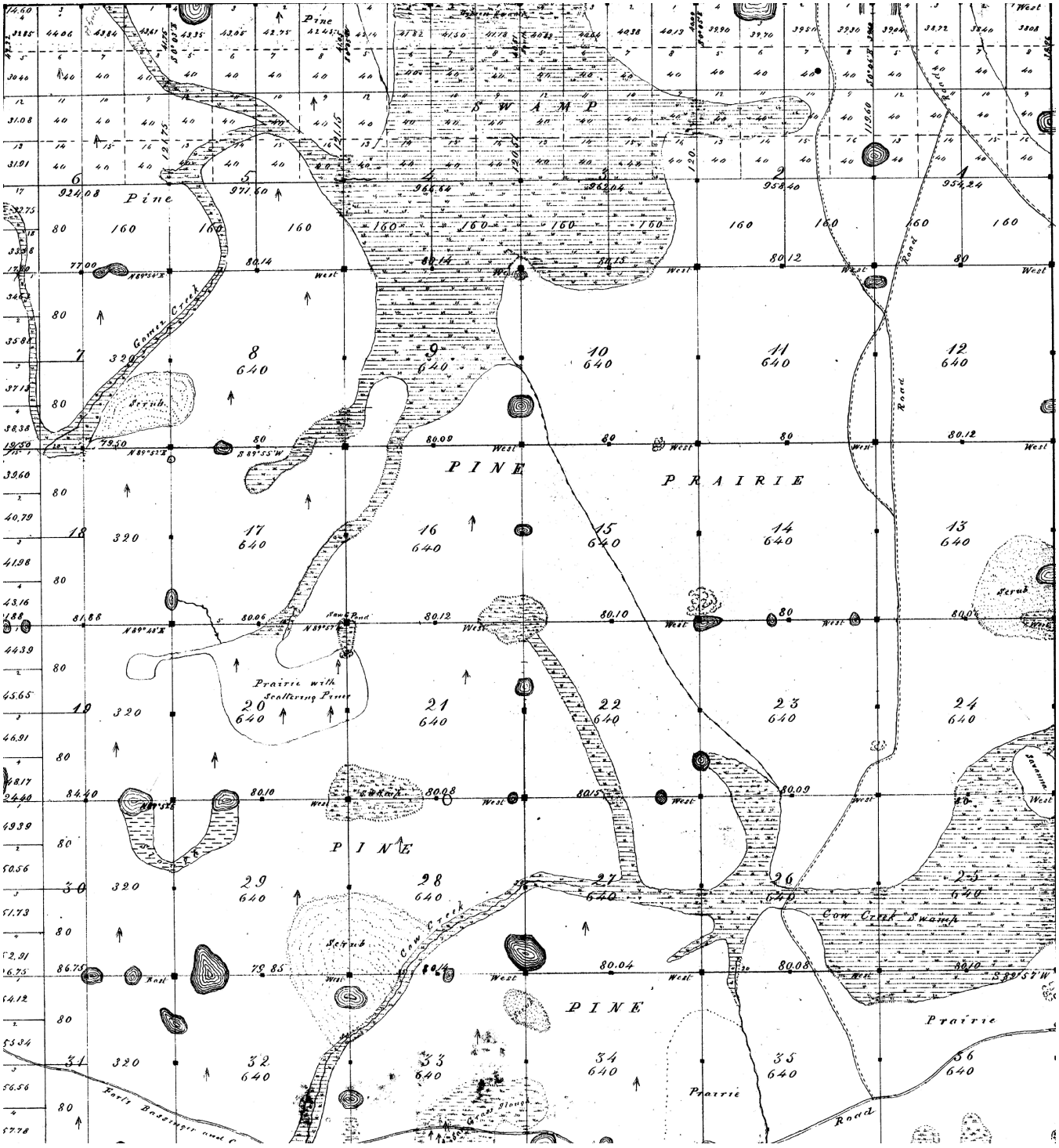

Figure 8. Presettlement land survey plat map for Township 35S, Range 36E, Okeechobee County, by Charles Hopkins (1881). Note the interdigitation of the pineland and prairie boundaries, the presence of a "Prairie with Scattering Pines" (probably a wet flatwoods/wet prairie), and "Scrub."

lines at all for a 0.5-2.0-mi distance on the east side of the river, and referred to the entire area as "impracticable sawgrass and river bottom." It is unlikely that the floodplain vegetation changed this dramatically in a distance of a few miles, although the surveyors to the south of this township were also unable to run section lines through the floodplain. This suggests that the surveyor of T33S, R32E was extremely persistent in traversing difficult terrain. Nevertheless, this indicates significant amount of sawgrass in the river floodplain by this point.

It is difficult to determine from the presettlement survey plat maps the precise boundary between marsh and prairie south of Long Hammock. From examination of soil surveys it seems that the Okeechobee County side of the floodplain becomes narrower, between 0.5-1.0-mile wide, through most of T34S, R31E. In T35S, R32E,

the deeper part of the floodplain is shown as unsurveyed, without notes as to its composition. However, the point where the floodplain narrows at Micco Bluff (T35S, R32E, Sect. 16) is shown by the drawing of a small section of the river channel just west of the prairie/marsh boundary.

The floodplain returns to a width of 0.5-1.0-mile south of Micco Bluff, widens at the junction of a sizeable unnamed tributary shown on the presettlement plat map in T35S, R33E, Sect. 30 and 31, and becomes even wider where the large marsh of Chandler Slough enters the floodplain at Basinger. At this point (in the east half of T35S, R33E, Sect. 33) we have the first location where pinelands border the Kissimmee River marsh on the east side of the river south of where the dry prairie region began at Canoe Creek (T28S, R31E, Sect. 5), about 50 miles to the north.

From this point south there are several pine islands in the prairie region on the east side of the river floodplain, as well as some areas were prairie meets marsh (as in T36S, R33E, Sect. 3), but the pine islands meet the floodplain for a longer distance than does the prairie. In a few places where the presettlement plat map seems to indicate prairie adjoining the floodplain marsh (as in T36S, R33E, Sect. 22), examination of soils maps indicates this "prairie" is better considered as a broad zone of shallow outer floodplain marsh. Just south of this area is the "bluff" at the midpoint of the line between Sect. 35 and 36, T36S, R33E where pineland (on Immokalee soils) is found adjacent to the river channel.

Just a few miles south of this point the pineland border heads eastward, and there is again a zone of prairie bordering the floodplain marsh, however, it now borders both the lower reaches of the Kissimmee River marsh and the northern limit of the historical floodplain marsh of Lake Okeechobee. This border is generally still recognizable as being near the southern limit of Immokalee soils along the border with the historical marsh. There has been quite a bit of woody invasion near this border (as in T37S, R34E, Sect. 25, 26, and 27).

It should also be noted that the floodplain marsh of the north shore of Lake Okeechobee was much more extensive on the presettlement plat maps than at the present day. For example, the downtown area of the city of Okeechobee is built on a pine ridge just north of the edge of the presettlement extent of lakeshore marsh. The current location of the edge of the lake is now about three miles south of this point. Most of the route of US 98 east of Okeechobee is in the former floodplain marsh of Lake Okeechobee, and in places this marsh extends over a mile inland to near FL 710. West of Okeechobee, the marsh zone along the lake is much broader, extending to within a mile of FL 70 at some points and nowhere more than 1.8 miles south of FL 70. Just west of Okeechobee, the boundary between prairie and marsh is generally near the 20 foot elevation contour, rising to between the 20- and 25-ft contour from this point westward to the lower reaches of the Kissimmee River floodplain marsh. In southwestern Okeechobee County there were many winding linear "glades" of sawgrass marshes through the prairies, and perhaps other areas of sawgrass interspersed within the dry prairie landscape, before giving way to the continuous floodplain marsh.

The Prairie/Pineland/Shallow Marsh Boundary in Polk County

Very little Florida dry prairie landscape occurs in Polk County. There are some areas mapped as grassland symbols on the southwest border of Lake Kissimmee in T30S, R29E and T30S, R30E, but these seem from landform and soils to represent broad areas of shallow lakeshore floodplain marshes and basin marshes connecting to the lakeshore marsh. Thus, these areas are excluded from the dry prairie region.

The northernmost extent of true dry prairie in Polk County seems to be in T30S, R31E, Sect. 32 and 33, about two miles north of Florida Highway 60, just west of its crossing of the outlet of Lake Kissimmee. Here, there are substantial areas of prairie mapped on Myakka soils, the same soil type as the pinelands immediately to the west. This area broadens considerably just south of Hwy 60, but with little soil differences between the prairies and pinelands, except for perhaps a greater extent of EauGallie (Alfic Haplaquods) and Malabar (Grossarenic Ochraqualfs) soils in the prairies. There are several short herbaceous dominated sloughs traversing the prairie area, most of which have their origin near the pineland/prairie border.

The prairie region begins within a half-mile east of APAFR at its northeast border and roughly follows the northeastern border of the base southward to around Tick Island Slough at which point it occurs in a narrow band on the eastern part of APAFR. A hardwood hammock is shown on the presettlement plat map on the section line between Sect. 24 and 25. A rather sizable pine island is shown in T32S, R32E, at the corner of Sect. 29, 30, 31, and 32. Another pine island is not mapped on the plat map, but is indicated in the notes made at the time the outer borders of the townships were surveyed; it occurs at the outer border of four townships, at the corner of T32S, R31E; T32S, R32E; T33S,R31E; and T33S, R32E, at the Highlands County line. This pine island remains as a longleaf pine island with mature trees to the present day. There are no apparent soil differences between this pine island and the surrounding prairies, and no hydrologic difference except for perhaps being slightly more elevated than the immediate surroundings. The prairie region in this vicinity is quite narrow, only one to two miles wide, and contains many wet prairie strands and depressions.

There is an outlying area of prairie shown in T32S, R31E, Sect. 27, 28, 33, and 34, which was locally known in the early 1900s as "Crane Prairie." This area encompasses quite a bit of wet prairie and shallow depression marsh habitats, as well as some areas with the hydrology of dry prairie. The borders of the pinelands around this prairie "island" can still be seen in several locations, near their presettlement extent.

Most of the length of the Kissimmee River floodplain marsh in Polk County is rather narrow and fairly well-defined by differences in soil type. No description is given for the floodplain marsh in T31S, R31E, although several of the section lines through the marsh were not surveyed, indicating its impassability. In T32S, R32E, the river floodplain is indicated as "overflowed sawgrass marsh," as well as parts of the area being indicated as "impractica-

ble." At two locations there are hardwood hammocks immediately above the river floodplain, in T31S, R31E, Sect. 24 and 25. There are also significant hammocks along the edges of major tributaries to the river, such as Tick Island Slough. A hammock on the east edge of T32S, R31E contains the only locations in southern Polk County for several of the rare subtropical hammock species which were found in the Okeechobee County hammocks.

The Prairie/Pineland Boundary in Highlands County

The prairie/pineland boundary in northern Highlands County has been subject to more intense scrutiny than any other area of the pineland/prairie border, because this border falls entirely within APAFR, south to the southern border of the range. In addition, the dry prairie areas of APAFR support several of the largest concentrations of the Federally Endangered Florida Grasshopper Sparrow, which is an obligate dry prairie species.

One large pine island occurs within the main body of dry prairie at APAFR, a slash pine island along Orange Hammock road with many mature trees. This island is shown clearly on the presettlement surveys. Most of this pine island is on Smyrna and Myakka soils, which are not different from the soils of the nearby prairies. There are several large, interconnected depressional wetland sloughs immediately to the west of this pine island, which may have served to partially protect it from landscape fires.

More of the original pineland/prairie boundary is preserved in roughly its presettlement location on APAFR than anywhere else within the dry prairie region. This is due to several factors. One is the very small extent of improved pasture conversion from pinelands and prairies, which can obscure the original boundary. Secondly, the uninterrupted sequence of prescribed burning since settlement has retarded the invasion of dry prairie by pines. Thirdly, there has not been extensive timbering of natural longleaf and slash pine stands since the original wave of logging of the region in the 1920s, allowing 70 years or more for the development of mature second-growth stands, with some remnant old-growth trees.

The presettlement prairie/pine boundary at APAFR crosses Kissimmee Road (at this point following the route of the original road from Ft. Kissimmee to Ft. Meade from the 1840s) at exactly the location of the present-day boundary. The boundary curves southward for about a mile, then westerly and northwesterly, back north almost to Kissimmee Road again, before turning south at the east edge of Bill's Bay, a large seepage swamp forest associated with the base of the Bombing Range Ridge. For the next five miles southward the boundary follows a short distance east of the base of the Bombing Range Ridge. In this section, the areas mapped as prairie also include some areas of open cutthroat grass communities, including both drier and wetter types. Cutthroat grass communities were only very rarely distinguished on the any of the presettlement surveys, and then only by noting that the areas were particularly "boggy." Most of this 2-5 mi wide section of dry prairie on APAFR is within the active impact areas of Charlie (which also has a significant area of pinelands in the northern half) and Echo Ranges. These areas are subject to prescribed burning at least every three years, and sometimes more often due to military-mission or lightning-ignited fires. The result is perhaps the most frequently burned area remaining anywhere in the Kissimmee River dry prairie region.

There are not many significant differences in soil types between the dry prairie in this area and the adjacent pinelands. Although there are some small areas in this region mapped as EauGallie, Malabar, and Valkaria soils, which are perhaps more associated with prairie than pinelands, most of the area is on the standard Spodosol toposequence of Immokalee, Myakka, Smyrna, and Basinger soils.

A large and significant area of dry prairie disjunct from the main body of the dry prairie landscape, and entirely falling within Avon Park AFR, occurs north and east of Arbuckle Marsh, mostly in T33S, R30E, extending into Polk County in T32S, R30E. The presettlement map in this area maps some areas of shallow floodplain marsh as "prairie," but there is still a 1-3 mi wide band of true dry prairie in the area. Parts of the presettlement pineland/prairie boundary in this area are still extant at the present day. Unfortunately, part of this original pineland/prairie boundary was cut in 1998, in an effort to increase the amount of available habitat for the Florida Grasshopper Sparrow adjacent to the current population area. This occurred only a few months before the first study of presettlement vegetation boundaries (Bridges 2000a) in the area began, thus the significance of the location of pine stands in this area was not yet known. Part of the original boundary still remains to the north and west of the cut area. This area of dry prairie has a fairly significant percentage of Malabar and Oldsmar soils, which are believe to be more prairie than pineland associated, in addition to areas of Myakka and Immokalee soils.

South of APAFR, the main pineland/prairie boundary turns further westward, extending into the southeastern part of T34S, R30E. It curves around the south end of the Bombing Range Ridge, then south and west towards Arbuckle Creek. No soil differences are apparent between pineland and prairie in this section. Of interest is a large area mostly in Section 25, which was described by the surveyor as a "cane grass pond." This would undoubtedly be a large depression marsh dominated by *Panicum hemitomon* (maidencane), which is now ditched and drained. This pond is erroneously shown as a "pine" island on sketch maps produced in the early 1900s from the presettlement plat maps and current roads, railroads, and settlements by the Consolidated Tomoka Land Company.

The dry prairie/pineland boundary resumes on the west side of Arbuckle Creek and extends to near the edge of the seepage swamps at the base of the Lake Wales Ridge. This area (T35S, R30E, Sect. 5, 7, 8, 18, and19) is the only place where the Kissimmee River dry prairie region adjoins the Lake Wales Ridge (Fig. 7). In this area the Sebring International Speedway and Airport and the town of Spring Lake are built on presettlement prairie. This western lobe of dry prairie reaches its southern terminus north of the confluence of Josephine Creek and Lake Istokpoga. In this same township, T35S, R30E, an error on the presettlement survey should be noted. All of Section 15 is shown as being within the open water area of Lake Istokpoga. Although there has been some lowering of the lake level in the last 150 years, it would not have been to such an extent that all of this section would have

been submerged. What the surveyor missed was a pine island hidden behind the outer zone of "boggy swamp and sawgrass" in this section, several hundred acres in extent. This pine island is traversed by the current route of US 98, just west of the swamp and marsh along Arbuckle Creek.

The Prairie/Marsh Boundary in Highlands and Northern Glades counties

The dry prairie region curves around the north and east sides of Lake Istokpoga, and has no further boundaries with continuous pinelands. The prairie/marsh border along Lake Istokpoga is fairly near its current location on the north side of the lake, but apparently has changed significantly along the eastern shore. In this area almost no dry prairie is shown south of the southern edge of T35S, R31E, Sections 21, 22, 23, and 24. What was shown on the presettlement maps as "impracticable swamp and sawgrass" and even with a few thousand acres of open water, is now almost all drained. This area includes almost all of T35S, R31E, Sections 25 through 29 and 33 through 36, as well as almost all of the current land area of T36S, R31E. If the presettlement data is to be interpreted literally, as the preponderance of the evidence supports, the marshes and swamps, as well as the area of open water, of Lake Istokpoga has retreated several miles on its east and southeast shores in the past 150 years. Such are the overwhelming drainage effects of the Istokpoga Canal, the C-41A canal, and the lowering of the general water levels of the region's tributaries by the channelization of the Kissimmee River.

The dry prairie region here is separated by the historic floodplain of Istokpoga Creek, which becomes rather narrow as it approaches the floodplain of the Kissimmee River. South of Istokpoga Creek, dry prairie extends from the marsh border along Lake Istokpoga to the marsh border along the Kissimmee River, with the exception of a large pine island and several smaller pine islands. The larger pine island extends from the southeast quarter of Sect. 33 and the southwest quarter of Sect. 34, T35S, R32E, southward to parts of sections 20 to 23, T36S, R32E. This slash pine island appears to have mostly been converted to citrus production in recent years, as has part of the adjacent dry prairie. There does not seem to be much of a soil difference between this pine island and the adjacent prairies.

Dry prairie, broken by a few large sawgrass-dominated basin marshes and sloughs, extended southwest to the northeastern part of T37S, R31E (Sect. 1, 2, 11, 12), and part of the northern half of T37S, R32E. At this point it is bordered to the west and south by "sawgrass marsh" with scattered clumps of palm trees indicated within the marsh area on the presettlement surveys. This is the beginning of the "Indian Prairie" region of Harper (1927), a region quite distinct from the dry prairie region. Because of extensive drainage the boundary between the two regions has become rather obscure, but generally corresponds to an increase in the area of wetter soil series, such as Basinger, Felda, and Hicoria at the northern edge of the Indian Prairie region, being replaced by larger areas of muck soil series such as Kaliga as one ventures further into the historic marsh region. The town of Brighton is on one of the larger presettlement pine-oak islands within the Indian Prairie region ("Marvin's Island" on the presettlement plat map). Florida Highway 70 crosses the presettlement prairie/marsh boundary at roughly the location of its bridge over C-41A (marsh to the south and west, prairie to the north and east). From this point east to the Kissimmee River floodplain, the presettlement prairie/marsh boundary roughly follows the route of C-41A.

One substantial island of dry prairie was missed totally by the presettlement land surveyors—Buck Island in southern Highlands County, now mostly occupied by MacArthur Agro-Ecology Research Center (MAERC). I have included this island within the Desoto-Glades dry prairie region, since it is closer to the larger prairie areas of this region than to those prairies along the Kissimmee River. It is not hard to see why this prairie was overlooked. When the surveyors encountered the extensive sawgrass marshes south of Lake Istokpoga, approaching from both the east and west sides of the marsh, they would have seen an expanse of sawgrass with no pines on the horizon. The only trees would likely have been scattered cabbage palms, based on current vegetation of the region. The surveyors would not suspect that there was an island of almost 8000 acres of dry prairie landscape occupying much of the center of T38S, R31E, since no indications would have been visible above the sawgrass. This does clearly indicate, however, that Buck Island was prairie, not pineland, since the surveyors would have made extra effort to reach and survey the boundaries of all pine islands (Bridges and Orzell 2005).

There were probably some areas of dry prairie in the northeastern corner of Glades County, just south of the sawgrass marsh through which the C-41A canal was cut. Some areas in T38S, R33E, particularly in sections 3, 10, 11, 13, and 14, are mapped on the presettlement plat maps as "prairie" (with "sawgrass" mapped to the north, west, and south of this area) and as having Immokalee soils on the Glades County soil survey. These islands of prairie in the predominant sawgrass matrix are also indicated on the vegetation map by Harshberger (1914). All of this area is in private ownership, with no public roads traversing the prairie islands, so I have been unable to determine if the ground-cover vegetation of these areas is similar to that of true dry prairie, or perhaps represents another vegetation type unique to the Indian Prairie region.

Pine "Islands" in the Prairie Landscape

Small to rather large "islands" of pinelands are scattered throughout much of the presettlement Florida dry prairie landscape. Some townships apparently had no pine islands in the presettlement landscape, particularly T32S, R33E; T33S, R33E; T34S, R32E; T34S, R33E; T34S,R34E; and T35S, R34E. However, most other townships in this region have either a border with contiguous pinelands or at least some pine islands noted on the presettlement surveys. Some of these are rather small areas of pine, covering <50 ac or so, while others are large areas where pinelands occur for several hundred to a few thousand acres, unbroken except by wetland drainages. In general, the occurrence of pine islands seems to be mostly correlated with one or both of two factors: better drained soils, or dissection and fire protection by deep streams and marshes.

Many of the smaller pine islands seem to be associated with small areas of better drained sandy soils, particularly near the edges of escarpments to major drainages, such as the Kissimmee River and major tributaries. These soil differences are not always apparent on soil survey maps, but are evident upon close field examination of soil and landscape position. The proximity to a drainage escarpment results in better drainage of these sites in comparison to the very flat prairie landscape away from the escarpment. Some of these areas in Highlands County are mapped as occurring on Pomello soils (Arenic Haplohumods), a better drained soil series than most of the dry prairie landscape, whereas others are mapped on Immokalee soils, as are many areas of dry prairie. There is probably a slightly higher percentage of area mapped as Immokalee soils in pine islands than the percentage of this soil series mapped in prairie, although there are many areas of prairie on Immokalee soils. In addition, the areas of Pomello soils and the best drained areas of Immokalee soils just above the drainage escarpments of the Kissimmee River, Sevenmile Slough, and Duck Slough in KP in Okeechobee County almost totally lack pines. These areas have a similar composition to the ground cover of Scrubby Flatwoods, but without the canopy pine trees. In addition, no pine islands are mapped in KP on the original land surveys. Therefore, the presence of better drained soils near drainage escarpments is not necessarily indicative of the presence of presettlement pine islands.

The largest pine islands seem to be associated with areas dissected by marshy drainageways in more than one compass direction. It seems that a single deep marsh does not serve as a sufficient barrier to landscape level fire to allow pine establishment in most areas of the dry prairie region. However, several such drainages or deep marshes in close proximity might provide sufficient fire protection.

The largest of these areas of pineland within the dry prairie region is found in southwestern Okeechobee County, in the area overlapping T36S, R33E and 34E and T37S, R33E and 34E, south of US 98 and north of FL 70 between the Kissimmee River and Okeechobee. This area was investigated by driving county roads north from FL 70 via County Road 599 as far as T36S, R33E, Section 26. This pine island of at least 6000 ac is comprised of slash pine, with no longleaf pine seen. In places this pineland island is dissected by narrow transverse "glades," which would originally have been dominated by sawgrass. Most of these have been cleared, but a sawgrass-dominated remnant was documented in T37S, R34E, Sect. 7. No frequently burned pinelands were seen within the extent of this island traversed, and many of the pinelands had a dense shrub layer of saw palmetto and other shrubs. For most of its northern boundary this pine island is bordered by an extensive deep marsh, Yates Marsh. It is possible that this marsh acted as a barrier to the spread of landscape-level fires, creating an area with less frequent fires between Yates Marsh and the Kissimmee River, allowing pines to become established. At one point within this pine island, there is the remarkable occurrence of slash pines extending to the banks of the Kissimmee River (midpoint of the line between Sect. 35 and 36, T36S, R33E), exactly at the point where the presettlement plat maps indicate pineland bordering the Kissimmee River floodplain. Most of the area of this large pine island is mapped as Immokalee soils, with a lesser extent of Myakka and Pomello soils. However, much of the dry prairie in Okeechobee County is also mapped as occurring on Immokalee soils, with perhaps a higher percentage of Myakka soils.

The large pine island south of Cornwell in Highlands County (in T36S, R32E) also seems not to be distinguished by soil type from the surrounding prairies, being mapped mostly on Myakka soils. It is composed of slash pine, at least from the area visible from US 98. The same is true of pine islands in Avon Park AFR (along Orange Hammock Road in T33S, R32E), and of pine islands north of Okeechobee near US 441.

Only one large pine island within the Kissimmee River dry prairie region is so far known to be dominated by longleaf pine, the predominant pine species of the continuous pinelands at the northern, western, and eastern limits of the dry prairie region. This is the pine island at and north of the town of Basinger in Okeechobee County, within T35S, R33E (Fig. 9). Based on observations from US 98, County Road 700A, and several small side roads which traverse this pine island, longleaf pine predominates throughout the area. Most of this pine island is mapped as occurring on Myakka soils, the same as in the dry prairie found to the west, east, and north. Only a relatively small area along US 98 is mapped as occurring on Immokalee and Pomello soils. To the south this island is bordered by the extensive marshes of Chandler Slough, and the upper reaches of Chandler Slough, as well as Ash Slough and Gore Slough, dissect this pine island into four segments. It is possible that in combination these rather deep wetland strands, now mostly occupied by floodplain swamps, but only indicated as being forested in small areas on the presettlement plat maps, served as sufficient fire breaks to allow the establishment of pines, but not so completely as to favor slash pine over longleaf pine. The only other pine island within the prairie region that is dominated by longleaf pine is the small pine island in T32S, R32E, at the corner of Sect. 29, 30, 31, and 32, discussed in a previous section on the pineland/prairie boundary in Polk County.

CONCLUSION

Limitations of use of Presettlement Data

Mapping of vegetation types from presettlement land survey data alone must be approached with extreme caution. Since vegetation mapping was not the primary purpose of the surveys, many of the boundaries between currently recognized types may have been of little concern to the surveyors, and therefore were not indicated in the maps and notes. There is definite inconsistency between surveyors in the detail to which different major vegetation types were recorded, and to the number of types distinguished. As such, edge-matching adjacent surveys can be problematic, since the boundaries of a type may be dropped entirely from the survey of the adjacent township.

There is a very low coverage of an area with traversing of section lines at one-mi intervals and recording of witness trees only at section corners and midpoints. This would be considered an insufficient sample size for vege-

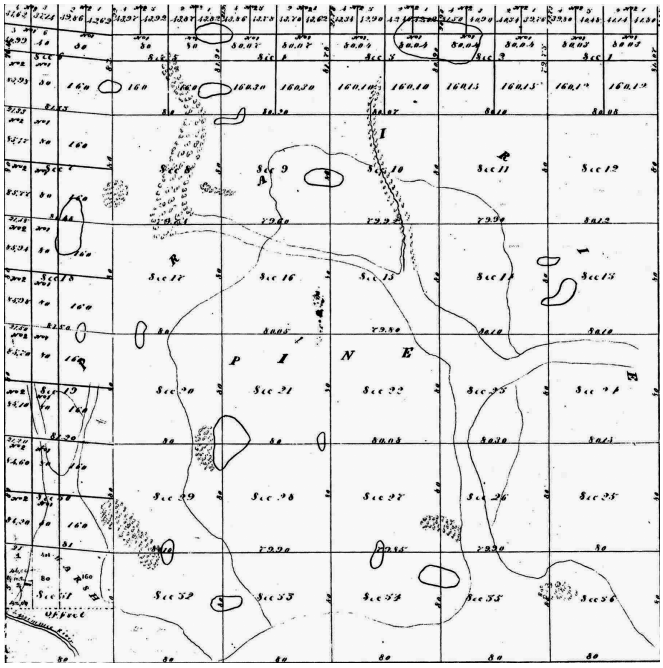

Figure 9. Presettlement land survey plat map for Township 35S, Range 33E, in Okeechobee County in the vicinity of Basinger, by S. J. Perry (1858). There is a large presettlement pine island dissected by perennial creek swamps in this area.

tation characterization by almost any authority today; therefore, any results from public land surveys should be considered only a rough approximation of actual conditions at the time of the survey. Boundaries of vegetation types on plat maps represent estimates based on observation from vantage points as much as a half mile away from the area being drawn. It is impossible to draw an accurate boundary from that distance, and it should be expected that these boundaries are only approximations. Nevertheless, when these boundaries can be correlated with edaphic conditions and with boundaries at essentially the same location 150 years later, as can be done at many locations throughout the region, the presettlement surveys provide almost incontestable proof of the locations of some vegetation types and boundaries.

Management Considerations Based on Presettlement Data

In general, the results of analysis of the public land survey data support the preposition that most of the major vegetation types of the Kissimmee River dry prairie region exist in roughly the same general configuration and composition at present as they did almost 150 years ago. In particular, the prairie/pineland boundary seems to have changed little in the intervening period, despite a full round of timber removal and regeneration since 1920. Although further study is needed, there may be intrinsic landscape factors that limit the natural regeneration and establishment of pine trees in the areas of presettlement prairies. Despite the presence of nearby pine seed sources, there seems to have been little movement of pines into historical prairies.

Given the stability of the pineland/prairie boundary at most of the locations where it has been preserved, caution is advised when a conversion from one type to another is considered. No obvious reason exists in an ecosystem management context, to convert presettlement pinelands into prairies, or vice versa. It may be impossible for a land manager to recreate or facilitate natural processes that shape this boundary, since the landscape-level events that were likely most significant in producing the boundary are long since gone, with the dissection of the landscape by roads, canals, and other firebreaks, as well as the extensive drainage.

Perhaps some of the most significant vegetation change at Avon Park AFR and in the surrounding region has been in the composition of marshes. Presettlement plat maps and descriptions indicate that sawgrass was a major dominant of Arbuckle Marsh and the Kissimmee River Marsh. Although there still is extensive sawgrass within Arbuckle Marsh, there has also been a change to cypress dominance in many areas of the marsh. More significantly, sawgrass has been essentially eliminated from the Kissimmee River Marsh, and from many other marshes in the region. The presettlement composition of the Kissimmee River Marsh likely consisted of a mosaic of broadleaf marsh, shrub swamp, and sawgrass marsh, but with sawgrass predominating. Restoration efforts for the Kissimmee River channel should promote the restoration of sawgrass dominance of the marshes. This will require the continued and perhaps more frequent use of prescribed burning in the Kissimmee River Marsh.

Areas for Further Study

Presettlement land survey data in conjunction with additional historical data sources may be used to obtain more definitive results about the long-term conditions of the major vegetation types of the Kissimmee River dry prairie region. In particular, it could be very informative to add data from additional sources to help determine the long-term stability of the pineland/prairie border. One data set with relevance to this study is the 1918-1921 Forest Inventory data from Consolidated Naval Stores Company, which included plat maps of the pineland/prairie boundary for each section and estimates of timber volume for each 40-ac block (quarter-quarter section) within the current area of APAFR. This inventory was conducted between 59 and 67 years after the presettlement land survey, with no major timber harvesting in the intervening period. A project is currently underway to convert this forest inventory information into database and GIS coverage formats, after which it could be utilized for future analysis.

Another data set that has not been fully exploited is the historical aerial photography for APAFR, with the first complete set available being from the period 1941-1943, and additional dates available for periods varying between 3-10 years until the present. These historical aerial photographs begin about 20-25 years after the forest inventory, which was closely followed by turpentining and then almost total clearcutting of the pinelands of the installation, and represent the mostly deforested landscape that existed at the time of the establishment of APAFR. Subsequent years of aerial photography document the regrowth of pinelands in these formerly clearcut areas, and perhaps also changes in vegetation boundaries as a result

of management. Careful examination of these photos in conjunction with the aforementioned historical data sources may reveal the mechanisms of vegetation change. These historical aerial photos have been digitized and georeferenced and are available on CD-ROM to be imported into ArcView projects for analysis.

Unfortunately, equally detailed data sets are probably not available for most of the remainder of the Kissimmee River dry prairie region. Aerial photography dating back to the 1940s is probably available for most of the region, and has been examined by the author for KP. Landscape-level studies of the position and stability of forested areas of the region, and their correlation with climatic and fire behavior patterns, are underway by Ms. Jean Huffman, a graduate student at Louisiana State University under Dr. William Platt.

Utilizing these several data sources, it may be easier to interpret how much of the variation in vegetation and structural characteristics of pinelands is due to actual vegetation change since settlement, versus differing estimates from the various methodologies in each historical data source and their interpretation. All of this brings us closer to determining the presettlement natural condition of the area, and to define the desired conditions for each particular area of land. This information is valuable in defining ecosystem management goals and techniques, and perhaps essential in making the right ecosystem management decisions.

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Special acknowledgment is given to the many surveyors and their assistants who had to walk mile after mile in straight lines through the central Florida landscape, in hot and wet conditions, through ponds, thickets, swamps, and many other hazards, in order to produce the notes and maps used as the primary data source for this study. Careful examination has found the majority of their data to be of much higher quality and detail than would be expected under such difficult field conditions.

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