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Southern Plains Inventory and Monitoring Network
Johnson City, Texas

Vegetation Classification and Mapping Project Report, Lyndon B. Johnson National Historical Park

Natural Resource Technical Report NPS/SOPN/NRTR—2007/073

ON THE COVER
The Lyndon B. Johnson Ranch House, the "Texas White House", partially hidden by live oak trees.
Photograph by: Dan Cogan

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Natural Resource Technical Report NPS/SOPN/NRTR—2007/073

A Report for the Southern Plains Inventory and Monitoring Network

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Southern Plains Inventory and Monitoring Network
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Jim Drake with NatureServe in the Minneapolis office was once again a pleasure to work with. His professionalism, dedication, and ecological and botanical knowledge was integral to the data collection, analysis, report writing/reviewing, and implementation of the National Vegetation Classification System for LYJO and the other parks in the Southern Plains Network. Without him this project would not have been possible.

I would like to acknowledge the assistance that my former colleagues provided at the BOR. A special thank you goes to David Salas who backed me up throughout the whole project by fielding questions and reviewing materials. I would also like to thank Mike Pucherelli for his continued support on these projects and for his companionship on one of the first trips to LYJO.

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I would like to give a real big thank you to Roger Sanders for providing an extremely rich data-set of invaluable plot, accuracy assessment and photo verification data.

Finally, let me conclude by apologizing to anyone I may have inadvertently left off this list. Please know that I had a great experience working and meeting with everyone associated with this endeavor and I really appreciate all the effort that went into this project. - Dan.

List of Abbreviation and Acronyms

AA	Accuracy Assessment
AML	Arc Macro Language
BOR	Bureau of Reclamation (also USBR)
BRD	Biological Resource Division (of the USGS)
BRIT	Botanical Research Institute of Texas
CBI	Center for Biological Informatics (of the USGS/BRD)
CIR	Color Infrared Imagery
CTI	Cogan Technology Inc.
FGDC	Federal Geographic Data Committee
FSA	Farm Service Agency
GIS	Geographic Information System(s)
GPS	Global Positioning System
LBJ	Lyndon Baines Johnson
LYJO	Lyndon B. Johnson National Historical Park
MMU	Minimum Mapping Unit
NAD	North American Datum
NAIP	National Agriculture Imagery Program
NBII	National Biological Information Infrastructure
NPS	U.S. National Park Service
NRCS	Natural Resources Conservation Service
NVC	National Vegetation Classification
NVCS	National Vegetation Classification System
RSGIG	Remote Sensing and Geographic Information Group
SOPN	Southern Plains Inventory and Monitoring Network
TNC	The Nature Conservancy
USBR	United States Bureau of Reclamation (also BOR)
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UTM	Universal Transverse Mercator

Links

http://www.nature.nps.gov/im/units/sopn/index.cfm	Southern Plains Inventory and Monitoring Network
http://biology.usgs.gov/npsveg/index.html	USGS-NPS Vegetation Mapping Program
http://www.nps.gov	The National Park Service
http://usgs.gov	United States Geologic Survey
http://biology.usgs.gov/cbi	USGS Center for Biological Informatics
http://biology.usgs.gov/cbi/nbii	National Biological Information Infrastructure
http://www.nps.gov/lyjo	Lyndon B. Johnson National Historical Park
http://www.usbr.gov	United States Bureau of Reclamation
http://www.natureserve.org	NatureServe
http://www.natureserve.org/explorer	NatureServe Explorer® online database server
http://plants.usda.gov	NRCS PLANTS Database

Executive Summary

Lyndon B. Johnson National Historical Park (LYJO) encompasses approximately 674 acres in the Texas Hill Country, approximately 60 miles north of San Antonio and 50 miles west of Austin. This unique terrain supports over 450 species of vascular plants and includes many examples of native plant communities indigenous to this area. The park consists of two districts, the LBJ Ranch District near Stonewall, TX and the Johnson City District in the heart of Johnson City. Both units are managed to preserve and maintain the heritage of Lyndon B. Johnson, the 36th President of the Unites States. To better understand the distribution of the plant assemblages located on these sites, the National Park Service (NPS) Southern Plains Inventory and Monitoring Network (SOPN) started a vegetation mapping and classification effort at LYJO in 2005.

A three-year program was initiated to complete the task of mapping and classifying the vegetation at LYJO. Phase one, directed by the Botanical Research Institute of Texas (BRIT) in conjunction with NatureServe developed a vegetation classification using the National Vegetation Classification System (NVCS). Phase two, directed by the U.S. Bureau of Reclamation's (BOR) Remote Sensing and GIS group in conjunction with Cogan Technology, Inc (CTI) produced a digital vegetation map. To classify the vegetation, 36 representative plots located throughout the approximately 4,600 acre project area (parks + environs) were sampled during the summer of 2005. Analysis of the plot data by NatureServe in the winter of 2005-2006 produced 11 distinct plant associations and alliances, 3 of which were newly described in the National Vegetation Classification (NVC). In addition, CTI described 2 more alliances and 1 distinctive stand of vegetation (i.e. Park Special) that primarily occurred outside of the park boundary in the environs. Descriptions and a field key for all 14 unique plant assemblages for LYJO are included in this report.

To produce the digital map, a combination of 1:12,000-scale color infrared digital ortho-imagery acquired in 2003, 1:12,000-scale true color ortho-rectified imagery acquired in 2005, and all of the GPS referenced ground data were used to interpret the complex patterns of vegetation and land-use. All imagery was acquired from the U.S. Department of Agriculture - Farm Service Agency's Aerial Photography Field Office and the National Agriculture Imagery Program. In the end, 27 map units (14 vegetated and 13 land-use) were developed and directly cross-walked or matched to corresponding plant associations and land-use classes. All of the interpreted and remotely sensed data were converted to Geographic Information System (GIS) databases using ArcGIS© software. Draft maps were printed, field tested, reviewed, and revised. One hundred and thirty three accuracy assessment (AA) data points were collected in 2006 and used to determine the map's accuracy. After final revisions, the accuracy assessment revealed an overall thematic accuracy of 92%.

Products developed for LYJO are described and presented in this report, and are stored on the accompanying DVD. These include:

- A *Final Report* that includes keys to the vegetation and imagery signatures, AA information, and all of the methods and results of the project;
- A *Spatial GIS Database* containing spatial data for the vegetation, plots, and AA points;
- *Digital Photos* from sample plots and miscellaneous park views;
- *Metadata* for all spatial data [Federal Geographic Data Committee (FGDC)-compliant];
- *Vegetation Descriptions and Photo Signature Key* to the map classes and associations/alliances.

In addition, LYJO and the SOPN both received copies of:
- Digital data files and hard copy data sheets of the observation points, vegetation field plots, and accuracy assessment points;
- Hardcopy vegetation maps.

Additional data not included in this report can be found on the attached DVD. This includes text and metadata files, keys, lists, field data, spatial data, the vegetation map, and ground photos. Please access the following USGS website for posting of this information: http://biology.usgs.gov/npsveg/index.html

For more information on the NVCS and NVC alliances/associations in the United States please visit NatureServe's website: http://www.natureserve.org.

Pictures of the Ranch Dam (left) and the Junction School attended by LBJ (right).
Photographs by: NPS Archives

Project Statistics

Field Work Summers of 2005 and 2006:

Plot Sampling = 36 Plots:
36 Plots sampled between June and October by Roger Sanders from the Botanical Research Institute of Texas and Tomye Folts Zettner from Southern Plains Inventory and Monitoring Network.

Accuracy Assessment Points = 133
133 Points collected in 2006 by Roger Sanders from the Botanical Research Institute of Texas.

Classification:

14 NVC Plant Associations and Alliances

GIS Database 2002-2005:

Project Size = 4,600 acres
Lyndon B. Johnson National Historical Park = 674 acres
Lyndon B. Johnson State Park and Historic Site = 418 acres

Base Imagery acquired from the USDA FSA Aerial Photography Field Office acquired through the National Agriculture Imagery Program:
2005 - 1:12,000-scale true color ortho-rectified imagery, compressed county mosaic,2 meter pixel resolution
2003 - 1:12,000-scale color infrared digital ortho-imagery, compressed county mosaic,1 meter pixel resolution

27 Map Classes
14 Vegetated
13 Non-vegetated

Minimum Mapping Unit = ½ hectare is the program standard but this was modified at LYJO to ¼ acre.

Total Size = 1,080 Polygons

Average Polygon Size = 4.3 acres

Overall Thematic Accuracy = 92%

Project Completion Date: 05/31/07

Introduction

Background

In 1994, the U.S. Geological Survey (USGS) and NPS formed the USGS-NPS Vegetation Mapping Program to cooperatively inventory and map the vegetation in the United States National Parks. The goals of this program are to provide baseline ecological data for park resource managers, obtain data that can be examined in a regional and national context, and provide opportunities for future inventory, monitoring, and research activities (FGDC 1997, Grossman et al. 1998).

In the same year, the USGS-NPS Vegetation Mapping Program also adopted the U.S. National Vegetation Classification (USNVC) (The Nature Conservancy and Environmental Systems Research Institute 1994a, Grossman et al. 1998) as a basis for the *a priori* definition of vegetation units to be inventoried. The Federal Geographic Data Committee adopted a modified version of the upper (physiognomic) levels as a federal standard (FGDC-STD-005)(FGDC 1997). This standard was hereafter termed the National Vegetation Classification Standard (NVCS). The NVCS established a federal standard for a complete taxonomic treatment of vegetation in the United States at physiognomic levels. It also established conceptual taxonomic levels for the floristic units of alliance and association, largely following the USNVC, but did not offer a taxonomic treatment for the floristic levels because of the immense scope of establishing robust floristic units for the entire United States. The FGDC standard requires that federally funded vegetation classification efforts collect data in a manner that enables crosswalking the data to the NVCS (i.e., the physiognomic levels) and sharing between agencies, but does not require use of that standard by agencies for internal mission needs. NatureServe maintains a treatment of floristic units (alliances and associations), which, though not a federal standard, are used as classification and mapping units by the vegetation mapping program whenever feasible. For purposes of this document, the federal standard (FGDC 1997) is denoted as the NVCS; the USNVC will refer exclusively to NatureServe's treatment for vegetation floristic units (alliances and associations only).

Use of the NVCS as the standard vegetation classification system is central to fulfilling the goals of this national program. This system:

- is vegetation based;
- uses a systematic approach to classify a continuum;
- emphasizes natural and existing vegetation;
- uses a combined physiognomic-floristic hierarchy;
- identifies vegetation units based on both qualitative and quantitative data;
- is appropriate for mapping at multiple scales.

The use of the NVC and the USGS-NPS vegetation mapping protocols facilitate effective resource stewardship by ensuring compatibility and widespread use of the information throughout the NPS as well as by other federal and state agencies. These vegetation maps and associated information support a wide variety of resource assessment, park management, and planning needs. In addition they can be used to provide a structure for framing and answering

critical scientific questions about vegetation communities and their relationship to environmental conditions and ecological processes across the landscape.

The NVC has primarily been developed and implemented by The Nature Conservancy (TNC) and the network of State Natural Heritage Programs over the past twenty years (TNC 1994a; Grossman et al. 1998). The NCV is currently supported and endorsed by multiple federal agencies, the FGDC, NatureServe, State Heritage Programs, and the Ecological Society of America. Refinements to the classification occur in the process of application, leading to ongoing proposed revisions that are reviewed both locally and nationally. TNC and NatureServe have made available a 2-volume publication presenting the standardized classification, providing a thorough introduction to the classification, its structure, and the list of vegetation types found across the United States as of April 1997 (Grossman et al. 1998). *Volume I: The National Vegetation Classification Standard* can be found on the Internet at: http://www.natureserve.org/publications/library.jsp.

NatureServe has since superseded Volume II of the publication (the classification listing), providing regular updates to ecological communities in the United States and Canada. This online database server, NatureServe Explorer®, can also be found on the Internet at: http://www.natureserve.org/explorer.

Lyndon B. Johnson National Historical Park

Located in the Hill Country of Texas, LYJO encompasses two important sites unique to Lyndon B. Johnson, the 36th President of the United States. The two separate districts of the park are the Johnson City District in Blanco County and the Ranch District in Gillespie County. The Johnson City District is located in the center of Johnson City and contains the National Historical Park Visitor Center, Johnson's boyhood home, and the Johnson Settlement where the President's grandparents first settled in the 1860's. The Ranch District is located about 14 miles west of Johnson City near Stonewall, Texas. This site contains another visitor center operated by Lyndon B. Johnson State Park and Historic Site, LBJ's home ("The Texas White House"), birthplace, and his 1960's-era working cattle ranch. The park was authorized on December 2, 1969 and was re-designated from a historic site to a national historical park on December 28, 1980. Present holdings are approximately 1,570 acres, 674 of which are federal. The main mission of the Park is to preserve and maintain the cultural history of Lyndon B. Johnson, including his working ranch, family cemetery, schoolhouse, and other important sites of the former president's family. By maintaining this environment it is hoped that the public will better understand the background and values of LBJ and how these values helped to eventually create the programs and policies of his administration.

Natural Setting

Both districts of the park are located in the Pedenales River Valley that meanders through the geologic region of Texas known as the Llano Uplift. This is a unique region of Texas that is bounded on the south and west by the Edwards Plateau and on the east by the Central Texas Hill Country. This area is mostly within a basin area, defined by rough upland terrain and relatively flat lowlands. The Llano Uplift is basically a dome of igneous and metamorphic rocks capped by limestone. The resulting characteristic knobs and stair-stepped/benched appearance of the uplands are a direct result of the weathering of the different rock layers.

LYJO ranges in elevation from 1,190 to 1,565 feet above sea level and both districts lie primarily within the flat 100-year and 500-year floodplain of the Pedenales River. This location places many important LYJO structures at risk from flooding, which is not uncommon to this area. The spring and fall usually produce frequent thunderstorms and other intense rainfall events. Coupled with the thin soils and poor percolation, these events commonly result in flash floods. Flood conditions may be frequent, but are usually offset by the dry conditions in the summer that create low flows. Other major streams at LYJO include Town, Wittington and Roundhead Creeks.

In addition to the rivers and streams the hot, dry Texas summers create a need for other water sources for irrigation and cattle operations. These typically include surface water impoundments and small ponds. LYJO contains many ponds and larger dams. These include the Johnson Settlement Pond (which is spring-fed), and a small spring-fed seep in the Johnson Settlement area of the Johnson City District. At the LBJ Ranch District numerous earthen ponds have been constructed in addition to the Jordan and Johnson Dams on the Pedenales River.

Soils for the two districts are distinct. The Johnson City District contains loamy, clayey, stony soils of the Brackett-Purves-Doss Association. These soils are characterized as having

moderately slow permeability, limited depth to rock, and a high shrink and swell potential. The LBJ Ranch District contains more fertile soils of the Luckenbach-Pedenales-Heatly Association. These consist of sand, silt and clay in the lower areas, with interblended limestone, dolomite, and marl in higher elevations. These soils are characterized as moderately well drained, having a moderately slow permeability, and moderate runoff.

Vegetation

The vegetation at LYJO contains a mix of common Texas Hill Country native plants and agriculture-influenced non-native species. The native elements mainly include trees and shrubs, whereas the grasslands for this site have been altered through seeding and irrigation. Natural plant communities in the area are not well-described but appear to be separated into broad groups of evergreen savannas, upland deciduous woodlands, and riparian forests. The uplands are typically drier and are loosely associated with west and south-facing slopes supporting Ashe juniper, live oak and honey mesquite. The cooler and wetter east and north-facing slopes, especially in canyons and draws, contain a mix of deciduous trees such as post oak, blackjack oak, and walnut trees. Riparian corridors are usually lush with multi-strata of deciduous vines, shrubs, and trees. Common species include pecan, hackberry, sugar hackberry, and cedar elm trees. Shrubs include dense thickets of buckthorn, and black willow.

Relatively recent human disturbance to the natural landscape has introduced many non-native species to the area, which are replacing the native prairie grasses and riparian trees. This includes a pronounced planting of Bermuda grass for pasture and hay. Other non-natives observed in and around LYJO include Chinaberry, Japanese honeysuckle, and Johnsongrass. Currently the park is actively restoring some of the native tall-grass prairie at an approximate 12-acre site at the settlement area.

LYJO Vegetation Mapping Project

The specific decision to classify and map the vegetation at LYJO was made in response to guidelines set forth by the NPS Natural Resources Inventory and Monitoring Program and implemented by the SOPN. The SOPN consists of 11 National Park units spread across 5 states in the south central portion of the United States (Figure 1). This network of parks was formed to create and centralize much-needed information about the nature and status of selected biological resources occurring within park boundaries so as to be used for making management decisions, for scientific research, and for educating the public. One of the goals of this network is to provide baseline inventory information for resource management and to help monitor the health of park ecosystems. Stemming from this goal, developing a vegetation classification to the plant community level and associated GIS map and database for each park was viewed as a high priority.

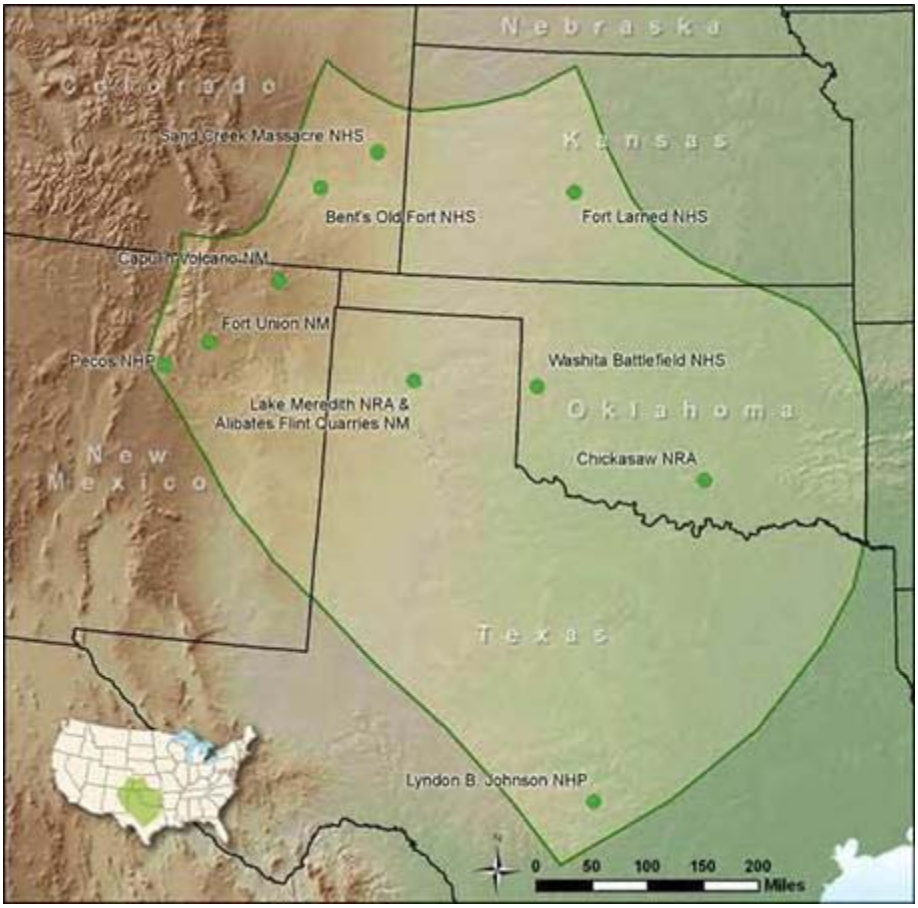

Figure 1. Map of SOPN showing the location of the park units in the network.

In 2005 Dusty Perkins, the network coordinator for SOPN at that time contacted the Bureau of Reclamation's Remote Sensing and Geographic Information Group (RSGIG) requesting a proposal for creating vegetation spatial databases for three park units in the SOPN. These parks included Fort Larned National Historic Site, Washita Battlefield National Historic Site, and Lyndon B. Johnson National Historical Park. In addition San Antonio Missions National Historical Park in the Gulf Coast Network (GULN) was added due to its proximity to LYJO. All four units totaled approximately 11,800 acres and included a 0.25-mile buffer into the surrounding environs. Upon acceptance of the RSGIG proposal, work was started by acquiring existing imagery and visiting the respective sites. In conjunction with the mapping portion, ecologists were contracted by SOPN to collect vegetation sample plots and observation points. These data were used by NatureServe to classify the vegetation to the association and alliance levels of the National Vegetation Classification System (NVCS). For LYJO the ecological sampling was conducted by Roger Sanders, formerly with the Botanical Research Institute of

Texas. After the project was started, Dan Cogan the principal investigator left the BOR to start his own company, Cogan Technology Inc (CTI). All of the subsequent mapping and GIS work was sub-contracted to CTI through existing contracts with Science Applications International Corp.

Together CTI, BRIT, NatureServe, BOR, SOPN and LYJO formed a team, each responsible for a specific portion of the project as outlined in the program standards and flowchart provided by the Center for Biological Informatics (USGS/BRD) (Appendix A). BRIT and SOPN took the lead in collecting the standardized field samples and writing the field key and descriptions for the natural and semi-natural vegetation types. They also helped cross-walk the associations/alliances to map classes. NatureServe's Midwest Regional Office was tasked with training the BRIT field personnel in the standardized field collection techniques, classifying the field data, using the NVC, and reviewing the vegetation descriptions, field key, and vegetation database. CTI and BOR were responsible for the imagery interpretation and creating a digital vegetation map and spatial database. SOPN and LYJO staff reviewed and evaluated the draft classification, entered field data into a database and wrote and field-tested the key to the vegetation classification. LYJO staff also provided logistical and technical support, and helped coordinate activities.

The objectives of this team were to produce final products consistent with the national program's mandates. These included:

- A Vegetation Classification based on the National Vegetation Classification System;
- A Map Unit Classification based on LYJO-specific requirements;
- A spatial database of LYJO's vegetation, using remote sensing and GIS techniques;
- Digital and hard copy vegetation maps with a minimum 80% accuracy per map class.

Scope of Work

Vegetation mapping for LYJO occurred within an approximate 4,600 acre project boundary, encompassing the authorized boundary of LYJO (both the Ranch and Johnson City Districts), the adjoining Lyndon B. Johnson State Park and Historic Site, a general 0.25-mile environ radius, an extension to the east of the Ranch District, and an extension to the north of the Johnson City District. The final project area determination was based on management needs, financial constraints, and time limitations (Figure 2).

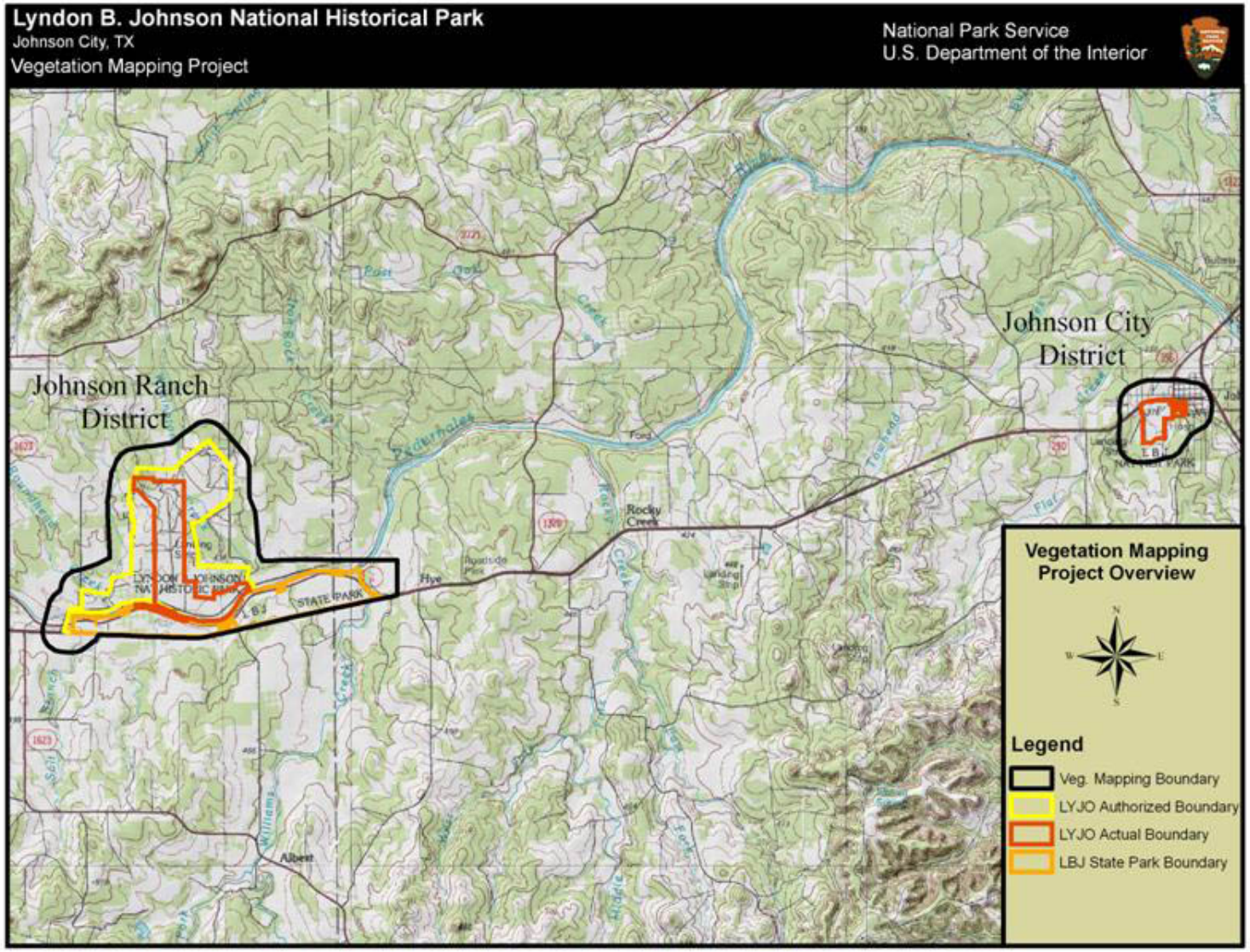

Figure 2. Map of the vegetation project boundary and park boundaries.

Methods

The vegetation mapping project at LYJO was considered to be in the "medium park" category based on the overall size of the project area (TNC 1994b). As such, the standard methodology for sampling and mapping is to visit the entire park and select representative sites. These sites are used to characterize the vegetation types and explain their distribution across the park without having to survey each stand of vegetation. Based on this approach the assignment of responsibilities was divided into five major steps following the flowchart of major steps produced for the national program by the USGS (Appendix A). These responsibilities included the following:

1. Plan, gather data, and coordinate tasks;
2. Survey LYJO to understand and sample the vegetation;
3. Classify the vegetation using the field data to NVC standard associations and alliances and crosswalk these to recognizable map units;
4. Acquire current digital imagery and interpret the vegetation from these using the classification scheme and a map unit crosswalk;
5. Assess the accuracy of the final map product.

All protocols for this project as outlined in the following sections can be found in documents produced by The Nature Conservancy (1994a, 1994b, and 1994c) for the USGS-NPS Vegetation Mapping Program and are found at this website: http://biology.usgs.gov/npsveg.

Planning, Data Gathering and Coordination

A series of planning conference calls were held throughout 2005 attended by representative USGS, NPS, NatureServe, BOR, and SOPN staff. The goals of these calls were to (1) inform the SOPN/LYJO staff about the National Vegetation Mapping Program, (2) learn about the park's management issues and concerns, (3) review existing data, (4) develop a schedule and assign tasks, (5) get a commitment from SOPN/LYJO, (6) define possible cooperation with others, and (7) start defining a project boundary.

These calls in addition to follow-up meetings, conference calls, and e-mails helped determine the project boundary and base imagery. As stated above, the final project boundary included both districts of LYJO, Lyndon B. Johnson State Park and Historic Site, a modest ¼ mile environs, and several small extensions in order to match the final project boundary with road and river corridors (Figure 2). Once the boundary was finalized all of the latest NAIP imagery for this area was ordered from the USDA Geospatial Gateway website (http://datagateway.nrcs.usda.gov). These included both the county mosaics acquired in 2003, 2004, and 2005 and the corresponding individual quarter quadrangles. Upon review by BOR and CTI, the 2004 imagery was not used for this project since it had a coarse 2-meter pixel resolution. The 2003 had 1-meter resolution and the 2005 had 2-meter resolution and since they occurred in different formats (i.e. true color vs. infrared) they were both deemed useful for this project.

The remaining work responsibilities were assigned to the following participants:

LYJO-SOPN-NPS Responsibilities

- Provide oversight and project funding;
- Supply digital boundary files and ancillary data files;
- Assist with fieldwork and logistical considerations;
- Work with NatureServe to develop the vegetation classification;
- Compile, review, and update drafts of the vegetation map, classification and report;
- Accept the final products and close the project.

BRIT Responsibilities

- Coordinate the field work with LYJO;
- Collect representative plot data;
- Collect less detailed observations about the draft vegetation map;
- Write descriptions of the vegetation types found at LYJO;
- Write a field key to the vegetation types of LYJO;
- Collect accuracy assessment data;
- Write a summary report.

NatureServe Responsibilities

- Work with NPS to develop a vegetation classification for the study area based on the NVC using quantitative analysis and ecological interpretation of the field data;
- Provide guidance regarding the crosswalk of vegetation types to map units;
- Train BRIT staff on the field data collection methods for the project;
- Review the local vegetation descriptions and field key;
- Review the final database containing the field data.

CTI-BOR Responsibilities

- Help with overall project facilitation and coordination;
- Verify vegetation and land use/land cover signatures on the imagery;
- Develop map units linked to the NVC;
- Provide field maps and GIS support to the field crews;
- Interpret and delineate the final vegetation and land-use types;
- Transfer and automate interpreted data to a digital spatial database;
- Produce spatial layers of plot and accuracy assessment site locations;
- Assist with the accuracy assessment by picking the stratified random target points, creating field maps and providing GIS support;
- Provide a final report describing all aspects of the project;
- Provide a visual guide to the photo signatures of each map unit;
- Document FGDC-compliant metadata for all vegetation data;
- Create a DVD with reports, metadata, guides, vegetation classification, plot data, spatial data, the vegetation database (map), graphics, and ground photos.

Field Survey

Overall, the field methods used for developing the classification and conducting the accuracy assessment at LYJO followed the methodology outlined by the USGS-BRD/NPS Vegetation Mapping Program (TNC 1994b) for medium sized parks. First, NatureServe provided a preliminary list of vegetation associations and alliances from the NVC based on previous studies and local knowledge. The resulting list was initially used to set targets for data collection with each association marked for 3-5 plots. This list was then taken in the field during the summer of 2005 by BRIT botanists who surveyed the entire site for representative stands of vegetation either fitting this list or for new types.

Once a stand of vegetation was located that appeared to be representative of the plant communities in the area a Relevé macroplot was laid out to capture its characteristics. In this manner transitional areas such as ecotones were avoided. Once a plot was laid out all data were recorded on a modified plot form (Appendix B). Environmental information included: elevation, slope, aspect, landform, topographic position, soil texture and drainage, hydrologic (flooding) regime, and evidence of disturbance or wildlife use. The unvegetated surface was recorded as percent cover of each of the following: bedrock, litter and duff, wood, bare soil, large rocks (>10 cm), small rocks (0.2-10 cm), sand (0.1-2 mm), lichens, mosses, and fungi. Vegetation structure and species composition were sampled using plots that varied in size depending on the dominant physiognomy of the vegetation. Forest and woodland plots were 400 m^2, while shrubland, dwarf-shrubland, and herbaceous vegetation plots were 100 m^2. Plot dimensions were recorded on the forms and the plot shape usually was square, but was modified to best represent the vegetation (e.g. narrow, linear rectangles for riparian vegetation).

Within each plot, BRIT visually divided the vegetation into strata, with the height and canopy cover of vegetation estimated for each stratum. Physiognomic class, leaf phenology, and type of dominant stratum were recorded. The species of each stratum were then listed and percent canopy cover estimated using a twelve-point cover scale (e.g. <1%, 1-5%, >5-15% …) (Daubenmire 1959). Additional species within the vegetation unit that occurred outside of sampled plots were listed separately. No attempt was made to identify individual non-vascular plant species. Species that were not identifiable in the field were collected for later identification. Species were recorded by scientific epithet familiar to researchers. For plots with trees, the diameter at breast height (DBH) was measured and recorded for trees with DBH greater than 10 cm. Trees with stems 5-10 cm DBH were tallied. Finally, a provisional vegetation type was assigned to the plot.

After all the physiognomic and environmental information was collected researchers used a Garmin GPS receiver to record the plot center. Universal Transverse Mercator (UTM) NAD83 X-Y coordinates and elevation were recorded both manually on the plot forms and stored as waypoints in the GPS unit. Finally four or five representative photos were taken in the four cardinal directions (N, E, S, and W) of the plot for monitoring purposes.

During the summer of 2006 a total of 36 plots were sampled across both districts of the park (Figure 3).

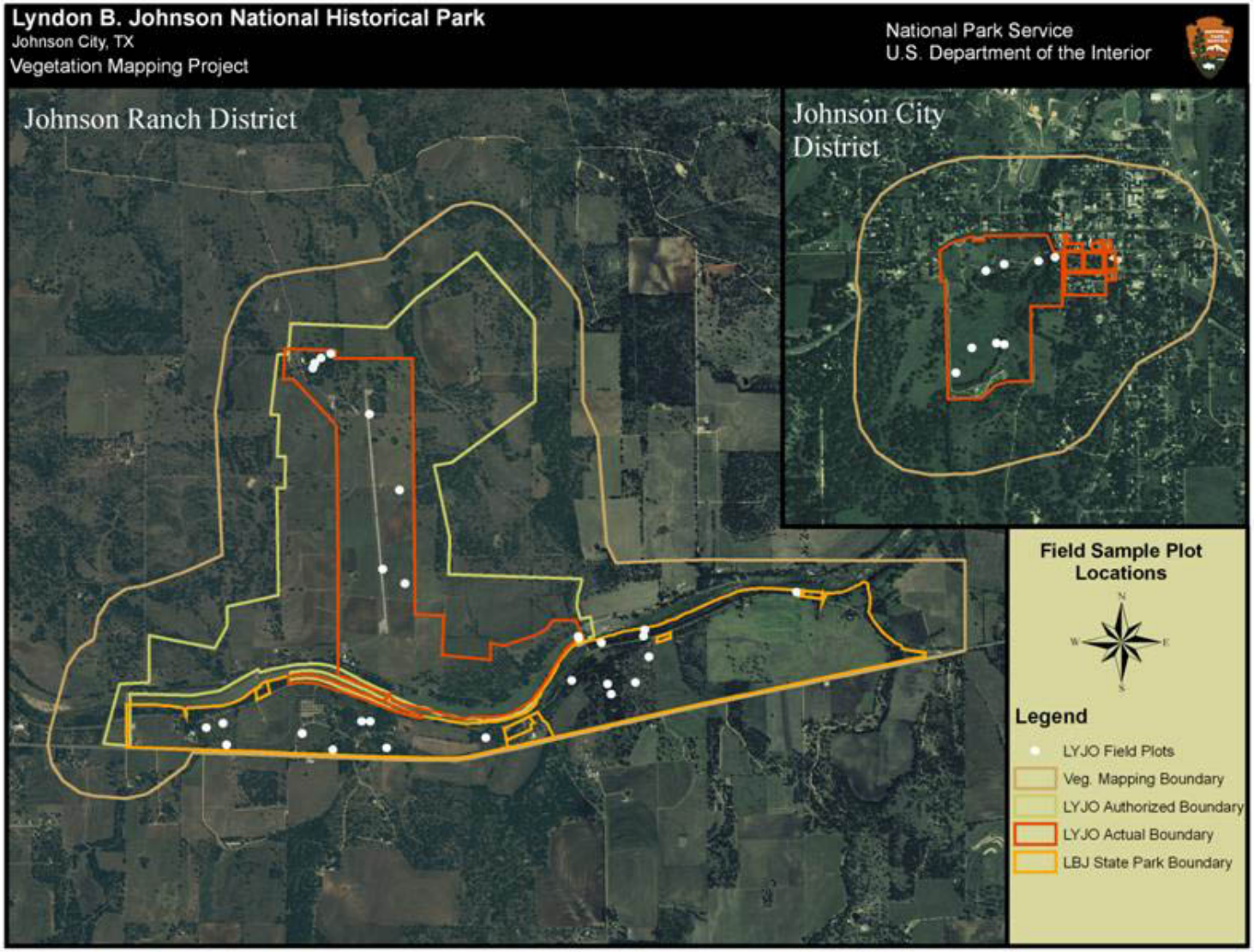

Figure 3. Location of all vegetation plots collected at LYJO in 2005.

Vegetation Classification

Upon completion of field surveys, all recorded data were entered into the NPS PLOTS2 database (NatureServe 2005), a MS Access-derived program. The PLOTS2 database was developed specifically for the NPS vegetation and mapping program so that the electronic data entry fields mirror the standard field form. Data entry was facilitated by assigning each plant taxon a unique, standardized code and name based on the PLANTS database developed by National Resources Conservation Service in cooperation with the Biota of North America Program (see website at http://plants.usda.gov). After data entry, checking was performed to minimize errors associated with duplicate entries or erroneously selected plant names. Problems regarding unknown species, especially those with high cover, were resolved, as were other taxonomic issues such as grouping subspecies and varieties judged to be ecologically similar.

Prior to quantitative analysis the database was prepared for use in the analytical programs. Data preparation followed these steps:

1). Standardize strata for certain taxa. Some taxa are listed in different strata in different plots even though they should all be the same, especially if there are multiple field crews. For example cacti may sometimes be listed as shrubs and sometimes listed as herbaceous;

2). Create "pseudospecies" for each taxon by appending the stratum in which it was found in each plot to a code for the taxon. For example, *Celtis laevigata* (CELA) found in the subcanopy (T3 stratum) would be converted to the code CELAT3 for analyses. Seedlings (H stratum) of the same species would be converted to the code CELAH for analyses. These two codes would be treated as separate entities during the quantitative analyses;

3). Simplify the strata for woody species. The strata for trees and shrubs were collapsed from three for each to just one for each. This reduces complexity in the data that does not add to the quality of the classification (though these distinctions do add to the ability to describe the plots and vegetation communities). The field crew might see *Carya illinoinensis* in the canopy (T2) and subcanopy (T3) in a plot. These two are combined into one "T" stratum observation so that plots are not separated based on fine differences like this;

4). Remove plots with grossly incomplete or missing data.

Due to the small size of the park many of the preliminary calls by the field teams to the association were simply matched to existing NVC associations. The remaining types were analyzed in a series of runs in PC-ORD Multivariate Analysis software package (McCune and Mefford 1997) using Indicator Species Analysis (Dufrêne and Legendre 1997, as cited in McCune and Grace 2002). Further analysis using Agglomerative Clustering with Sørensen distance and Flexible beta linkage functions (McCune and Grace 2002) was used to explore each of the indicator groups, and define plant associations. Preliminary plant associations were then compared with the NVC (NatureServe 2006). Throughout, care was taken not to over-emphasize local variations found at LYJO compared to more extensive information compiled at the regional level. Nevertheless, several types in the NVC were revised based on these analyses and new associations were identified from LYJO's data.

NPS and BRIT staff worked with NatureServe to refine and finalize the classification for LYJO. Plant association descriptions and literature references contained within the NVC were compared to LYJO results. Quantitative tables of cover and constancy by LYJO associations were generated by the PLOTS database, and compared to published tables. Based on qualitative comparisons, some associations were changed, and some plots were moved from one association to another and in some cases new associations were created.

LYJO plot data were then used to update and improve the world-wide (i.e. global) descriptions for the associations. LYJO specific (i.e. local) descriptions were then written based on LYJO plot and AA data. Once the associations were finalized, a dichotomous key was developed for use during the Accuracy Assessment (Appendix C).The final LYJO classification contains 14 plant associations and alliances. The full NVC hierarchical classification and local descriptions are available in Appendix D. In addition, the final associations were linked to map classes for use in the photo-interpretation and mapping portions of the project.

Digital Imagery and Interpretation

Since LYJO represented a fairly small and accessible site no new imagery or aerial photography was deemed necessary for this project. Instead existing sources of imagery were evaluated and two NAIP products were selected to be used as base maps. These included the 2003 and 2005 NAIP products (Figure 4). Both have 1-meter resolution and were acquired at 1:12,000-scale, which is adequate for vegetation mapping purposes. The 2003 was acquired in color infrared format that helps highlight subtle differences in vegetation reflectance. This type of imagery is useful in separating difficult signatures that occur between different associations in the physiognomic class (i.e. different grasslands or herbaceous vegetation types). The 2005 imagery was more recent than the 2003 and although it lacked the color infrared component and had a coarser resolution it did highlight all of the recent changes to the landscape such as recent fires, new roads, tree removals, etc.

After obtaining both sets the 2003 imagery was color balanced in Imagine Software to removed some of the edge-matching issues and sharpen the image. The 2005 imagery was also color balanced but edge-matching was not necessary. The resulting images from both sets were mosaiced and clipped to just beyond the project boundary extent.

Interpretation of the vegetation at LYJO involved a three step process: (1) image segmentation, (2) cleaning and smoothing, and (3) ground-truthing of the data. First the 2003 imagery was re-sampled to a 3-meter pixel resolution to reduce noise and to generalize the vegetation signatures. Next this imagery was segmented using eCognition software to delineate obvious landforms (e.g. open water and fields) and physiognomic features (e.g. grasslands versus woodlands). The initial segments were created using a series of trial-and-error multi-resolution segmentation routines in the software. The settings for scale and shape were manipulated until a desired network of image objects resulted. The objective of the segmentation was to create a system of lines with as coarse a scale as possible without omitting most of the small, important and obvious land-cover patches. By iteratively increasing segmentation size within the program small image objects (i.e. preliminary polygons) were continuously merged into larger ones.

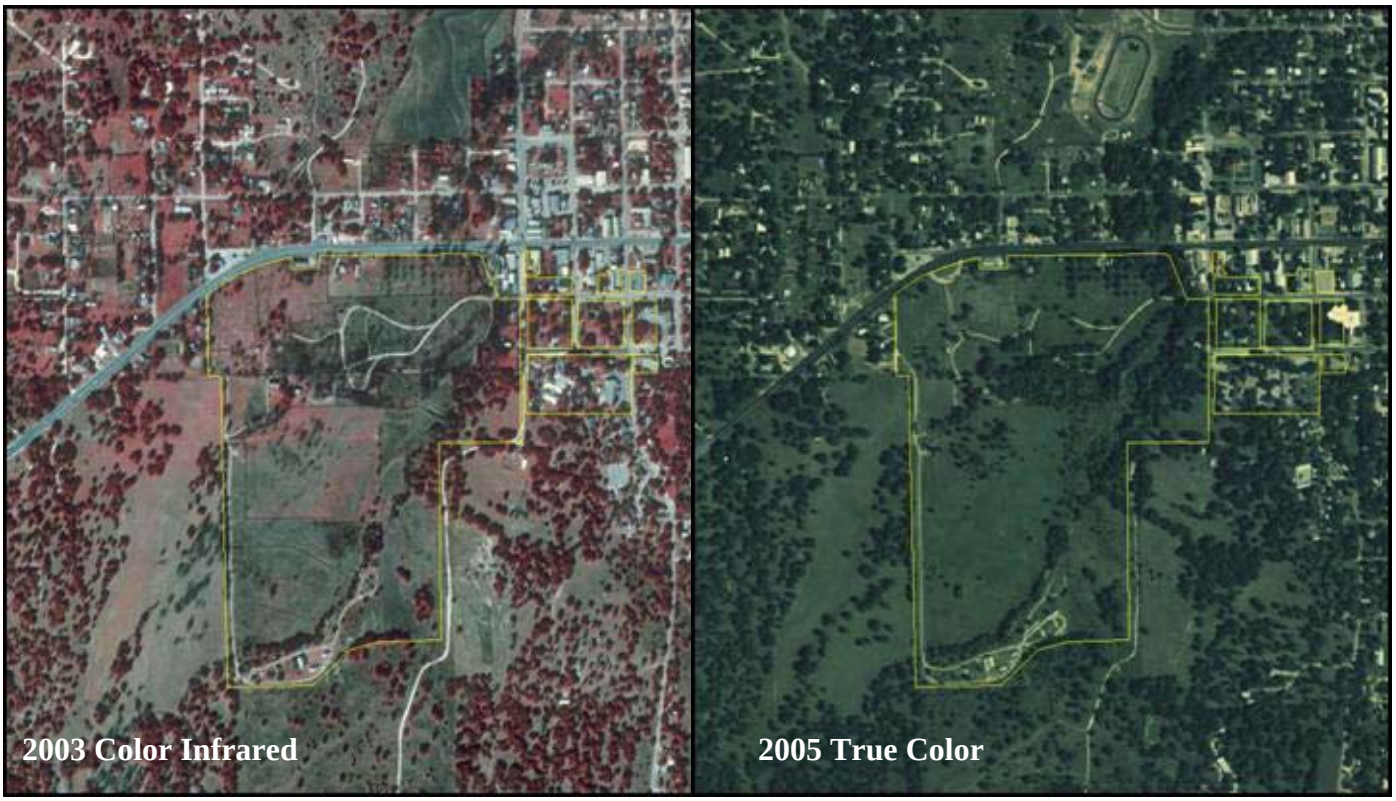

Figure 4. Examples of the NAIP 2003 and 2005 imagery for the Johnson City District.

Completion of the segmentation was based on visual judgment of the analyst when obvious, distinct features were lost. At this point in the process the previous segmentation was adopted as the final treatment.

Following segmentation, the lines were exported as ArcInfo shapefiles and converted to ArcInfo coverages. The resulting coverages were run through a series of smoothing routines provided in the ArcGIS software. Smoothing was conducted to reduce the stair-stepping pattern of the lines resulting from the large pixels. Smoothing ended when no obvious artificial and relict breaks in the lines were visible. Following smoothing, the linework was manually cleaned to remove extraneous lines, small polygons, and polygons that obviously split a homogenous stand of vegetation. The cleaning stage was considered complete when all resulting polygons matched homogenous stands of vegetation apparent on the 2003 imagery

The lines resulting from the 2003 imagery segmentation were visually inspected in ArcInfo comparing them to the more recent 2005 imagery. Any obvious changes in the landscape between the two years were added or edited. Review of the merged polygon layer revealed that the roads and the facilities were not adequately separated from the surrounding vegetation. To resolve this, all large buildings, roads, streams and other linear and rectangular features were

manually digitized directly off the 2005 imagery and incorporated into the final segmentation. After merging the digitized lines with the segmented linework the resulting preliminary GIS layer was considered complete and ready to be ground-truthed in the field.

Once the preliminary vegetation layer for LYJO was completed, 1:6,000-scale hard copy maps were printed for review. These contained both the 2003 and 2005 basemaps and the linework as an overlay. During three days in 2006, researchers from CTI and BOR visited almost every polygon at both districts of LYJO. Ground-truthing consisted of verifying the maps against the actual vegetation on the ground to ensure that the polygons were labeled properly and to locate any extra or missing vegetation polygons. More general observations were also taken during this trip to help write descriptions for this report and create map units. All the information from this trip was subsequently added to the final GIS layer to correct any errors.

Upon return from the field, CTI researchers used the final NVC classification supplied by NatureServe to create map units. In most cases the map units were derived on a 1 association or alliance to 1 map unit basis. Due to the limitations of the imagery some of the associations could not be recognized consistently. This issue was addressed by scaling up the NVC to the alliance level. All of the resulting map units were then correlated or "crosswalked" by noting when plant associations were lumped into a single map unit or when associations were split into multiple map units. To round-out the mapping scheme, map units were created for land-use types based on a mapping system developed by Anderson et al. (1976). This included unvegetated lands not in the NVC, such as roads, facilities, and agricultural fields. A separate class of map modifiers or "Park Specials" was defined especially for LYJO to cover types that occurred outside of the park boundary, and thus were not sampled. This included Chinaberry, hackberry, black willow and, Ashe juniper stands. In some cases NVC alliances were matched to the park specials. All of the resulting map unit names, map unit codes, NVC information, and other relevant attributes were added to each polygon in the GIS layer (Table 1).

Pictures of the Lyndon B. Johnson Boyhood Home (left) and bluebonnet field at the Johnson City District (right). Photographs by: NPS Archives

Table 1. Polygon attribute items and descriptions used in the LYJO GIS coverage.

ATTRIBUTE	DESCRIPTION
AREA*	Surface area of the polygon in meters squared
PERIMETER*	Perimeter of the polygon in meters
LYJO_VEG#*	Unique code for each polygon
LYJO_VEG-ID*	Unique identification code for each polygon
MAP_CLASS	Final Map Unit Codes – Project specific
MAP_DESC	Map Unit Common Description Name – Project specific
DENS_MOD	Modifier - Percent cover of the upper stratum layer in the polygon Percent cover classes: Sparse **10 - 25%,** Open **25 - 60%,** Discontinuous - Closed > **60%**
PTRN_MOD	Modifier - Vegetation pattern within the polygon Vegetation pattern classes: Evenly Dispersed **= Homogeneous, Alternating,** Grouped Stands of Vegetation = **Bunched / Clumped,** String of Vegetation **= Linear**
HT_MOD	Modifier - Height range of the dominant vegetation layer Height classes: **0-0.5, 0.5-1, 1-5, 5-15, 15-30 meters**
CES_CODE	Ecological Systems Code – NVC derived (NatureServe)
CES_NAME	Ecological Systems Name – NVC derived (NatureServe)
IDENTIFIER	Corresponding Association or Alliance Name Code – NVC derived (NatureServe) Association **=** Community Element Global Code – Elcode link to the NVC Alliance = Alliance Global Code – Alliance Link to the NVC
ASSN_NAME	Project Community Name - NVC Association(s)
ASSN_CNAME	Project Common Community Name - synonym name of Association(s)
NVCS_CODE	NVC Code - to NVC Formation level
ALL_NAME	Project Alliance Name = NVC Alliance(s)
ALL_CNAME	Project Common Alliance Name = NVC Alliance(s)
FORMATION	NVC Formation = Formation name NVC Code – Formation name
SUBGROUP	NVC Formation Subgroup = NVC Code – Subgroup name
GROUP	NVC Formation Group = NVC Code – Group name
SUBCLASS	NVC Formation Subclass = NVC Code – Subclass name
CLASS	Formation Class = NVC Code – Class name
LUC_II_GEN	General Land Use and Land Cover Classification System Name – Project specific based on Level II of Anderson et al. (1976)
LUC_II	Specific Land Use and Land Cover Classification System Name – Project specific Level II of Anderson et al. (1976)
ACRES	Surface area of the polygon in acres

(*****ArcInfo© default items)

Accuracy Assessment

Once the vegetation layer was completed and finalized the accuracy assessment (AA) was conducted. Typically in mapping exercises both thematic or attribute map accuracy as well as the positional or polygon line accuracy are considered. In the case of the USGS-NPS National Vegetation Mapping Program however, the positional accuracy is usually omitted since rarely does vegetation split on discrete edges that can be positively located in the field. The subjectivity involved in this effort plus the high resolution and accuracy of the NAIP basemaps usually allows for the assumption that all products derived from them are well within National Map Accuracy Standards for 1:12,000-scale maps (±30 feet). Further since no additional funding was budgeted or available the positional accuracy was not assessed.

The thematic accuracy of the vegetation map was assessed using the methodology following the standards provided by the USGS-NPS National Vegetation Mapping Program's Accuracy Assessment Procedures manual (TNC 1994c). This included a four step process consisting of a sample design, sample site selection, data collection, and data analysis. The design of the AA process followed the five possible scenarios provided in the field manual with stratified random targets placed in each map class based on their respective frequency and abundance (Table 2).

Table 2. Target number of AA samples per map class based on number of polygons and area.

Scenario	Description	Polygons in class	Area occupied by class	Recommended number of samples in class
Scenario A:	The class is abundant. It covers more than 50 hectares of the total area and consists of at least 30 polygons. In this case, the recommended sample size is 30.	> 30	> 50 ha	30
Scenario B:	The class is relatively abundant. It covers more than 50 hectares of the total area but consists of fewer than 30 polygons. In this case, the recommended sample size is 20. The rationale for reducing the sample size for this type of class is that sample sites are more difficult to find because of the lower frequency of the class.	< 30	> 50 ha	20
Scenario C:	The class is relatively rare. It covers less than 50 hectares of the total area but consists of more than 30 polygons. In this case, the recommended sample size is 20. The rationale for reducing the sample size is that the class occupies a small area. At the same time, however, the class consists of a considerable number of distinct polygons that are possibly widely distributed. The number of samples therefore remains relatively high because of the high frequency of the class.	> 30	< 50 ha	20
Scenario D:	The class is rare. It has more than 5 but fewer than 30 polygons and covers less than 50 hectares of the area. In this case, the recommended number of samples is 5. The rationale for reducing the sample size is that the class consists of small polygons and the frequency of the polygons is low. Specifying more than 5 sample sites will therefore probably result in multiple sample sites within the same (small) polygon. Collecting 5 sample sites will allow an accuracy estimate to be computed, although it will not be very precise.	5-30	<50 ha	5
Scenario E:	The class is very rare. It has fewer than 5 polygons and occupies less than 50 hectares of the total area. In this case, it is recommended that the existence of the class be confirmed by a visit to each sample site. The rationale for the recommendation is that with fewer than 5 sample sites (assuming 1 site per polygon) no estimate of level of confidence can be established for the sample (the existence of the class can only be confirmed through field checking).	< 5	< 50 ha	Visit all and confirm

These parameters were loaded into a custom GIS program along with the vegetation layer. This program picked the random target locations and also buffered them 10 meters away from any polygon boundary and 50 meters away from any other point. Being able to choose minimum distance to polygon boundaries helped to minimize confusion and accounted for the horizontal error typically encountered in common GPS receivers (±5 m). The resulting target locations were restricted to only within the boundaries of LYJO due to private land access constraints.

Once the target locations were selected, BRIT botanists were provided with draft field maps, overview maps, map unit definitions, the key to the associations (Appendix C), and digital GPS files containing the location of the target AA sites. During the summer of 2006 the botanists traveled to the AA target sites and determined the vegetation association using the field key. At each target they recorded the primary and secondary associations that occurred within a roughly 50-meter radius. They also recorded height and cover of vegetative strata, environmental data, and percent canopy cover of the major species (see AA point form in Appendix B). Other nearby vegetation types outside the 50-meter radius and any recent disturbance were also recorded. To better assist the analysis a minimum of 4 photographs were taken at each AA point, in the sequence of cardinal directions, N-E-S-W. If the point was too close to dense, especially shrubby vegetation, one or more optional photographs were taken at a distance to show the character of the vegetation. In such cases, the site of the optional photograph was given a GPS waypoint which was recorded along with the aspect of the photograph at that point.

During 2006 a total of 133 points were sampled (Figure 5). The data recorded on the field forms were subsequently entered into the PLOTS2 database and reviewed for data entry errors by NPS and NatureServe staff. Incomplete data on the field sheets were corrected if possible. The results were imported from the database into a GIS layer where they were visually compared in two stages to the vegetation map coverage. The first step was to compare the AA points to the original target locations to check for erroneous points and remove these from further analysis. General errors in the data were recorded at this time, including documenting points that had GPS and location errors. The most common GPS receiver error included transposing two UTM coordinate numbers. Location errors involved having the final AA point occur in the wrong target polygon either due to bad GPS satellite positioning or the point occurred to close to a polygon boundary. Through this process UTM coordinates for four points were corrected and three points were removed due to poor GPS receiver accuracy or were located in the wrong target polygon.

The second review step involved deciding between the primary and secondary call for the plant association as recorded by the field crew. In larger vegetation mapping projects such as Rocky Mountain National Park (Salas et al. 2004), AA analysis has involved fuzzy logic which assigns different levels of accuracy based on the primary, secondary and sometimes even the tertiary calls. However due to the small size of this project and the confusion that fuzzy logic can cause for the end user, a simple binary assessment was conducted. To accomplish this, CTI had to assign a final map unit for every point by choosing between the primary and secondary calls. This was done by first adding a new attribute to the point layer labeled “Final_Code and then by comparing the assigned field names of the point with its corresponding location on the digital imagery. In most cases the primary vegetation map unit name assigned by the field crew was used. However some points were assigned their secondary field call based on one of the

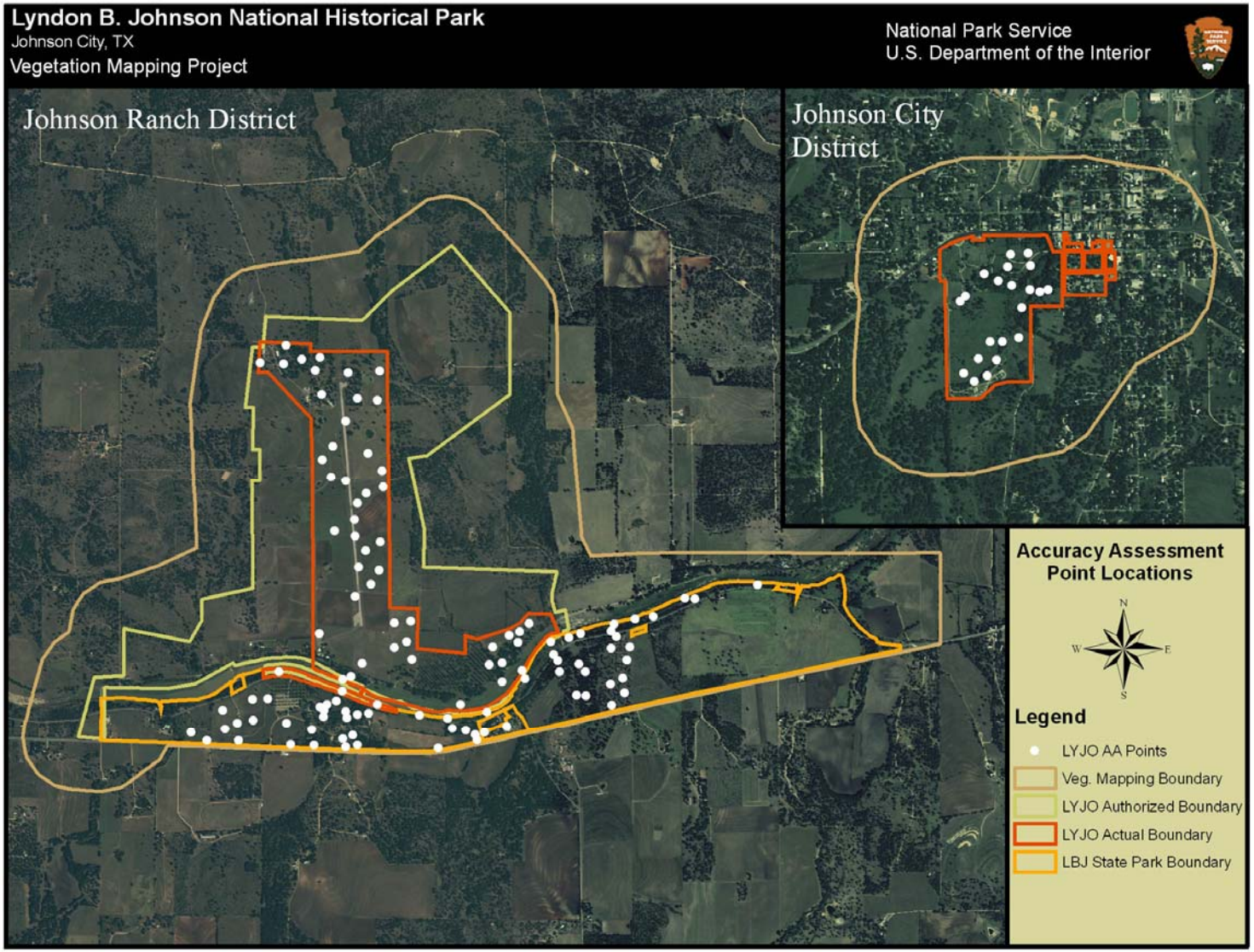

Figure 5. Location of all accuracy assessment points collected at LYJO in 2006.

following reasons: (1) it appeared that the second call was the better choice due to the overhead perspective (e.g. a stand judged to be sparse woodland on the imagery vs. called herbaceous vegetation in the field), 2) the data were actually recorded in a stand that was too small (i.e. inclusion), or 3) the second call better matched the ecological context (e.g. riparian woodland located next to a stream vs. upland woodland located next to a stream). Overall, roughly 20-30 points were reassigned to their secondary field call instead of their primary identification.

Once the data were reviewed the accuracy analysis was conducted. In the case of LYJO, the process was streamlined using methods developed from previous studies at Rocky Mountain National Park (Salas et al. 2004) and Wupatki National Monument (Hansen et al. 2004). Specifically many of the in-house GIS programs developed for these projects were used to compare the AA data, generate confidence intervals, Kappa statistics, and error matrices (contingency tables). Through this automated process, the final map units in the AA layer were compared to the map unit designations for their corresponding polygons. All of the statistics and calculations used to analyze these data are described at length in the program manuals (TNC 1994c) and are summarized in Table 3. Final assessments for each point were recorded using an error matrix.

Table 3. Summary of the AA Statistics used at LYJO.

Statistic	Formula	Description
User's - accuracy:	$\frac{n_{ii}}{n_{i+}}$	Where i is the land cover type, n_{ii} is the number of matches between map and reference data and n_{i+} is the total number of samples of i in the map. This formula is the number of "correct" observations divided by the sum of the row.
Producer's accuracy	$\frac{n_{ii}}{n_{+i}}$	Where n_{+i} = total number of sample of i in the reference data. This formula is the number of "correct" observations divided by the sum of the column.
Confidence Interval	$\hat{p} \pm \left\{ z_{\alpha} \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} + \frac{1}{(2n)} \right\}$	Where z_{α} = 1.645 (this comes from a table of the z-distribution at the significance level for a two-sided limit with a 90% confidence interval). The term 1/ (2n) is the correction for continuity. The correction should be applied to account for the fact the binomial distribution describes discrete populations $\hat{p}$ = the sample accuracy (0 -1.0), n = the number of sites sampled.
Kappa Index	$k = \frac{N\sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r}(x_{i+} \times x_{+i})}{N^2 - \sum(x_{i+} \times x_{+i})}$	Where N is the total number of sites in the matrix, r is the number of rows in the matrix, x_{ii} is the number in row i and column i, x_{+i} is the total for row i, and x_{i+} is the total for column I.

Results

Vegetation Classification

The final classification for LYJO resulted in 8 associations and 3 alliances, 3 of which were newly described in the NVC. In addition, during ground-truthing efforts, CTI described 2 more alliances and 1 distinctive stand of vegetation (i.e. Park Special) that primarily occurred outside of the park boundary in the environs. The classification results reflect both the moderate amount of diversity of vegetation in the park and a respectable high number of native species. It is also notable that two of the three new vegetation classes, *Cynodon dactylon* Herbaceous Vegetation and *Bothriochloa laguroides – Sorghum halepense* Herbaceous Vegetation, represent disturbed vegetation. The NVC is best developed for natural/semi-natural vegetation and new exotic species dominated communities are often found during applications such as this. Table 4 contains the complete list of LYJO plant associations that were described in this study, and Appendix D provides complete descriptions for each. During the sampling efforts a total of 251 species were recorded (Appendix E).

Digital Imagery and Interpretation

For LYJO, 27 map units were developed and directly cross-walked or matched to corresponding plant associations and land-use classes (Table 5). These included mostly a direct 1 map unit to 1 NVC association/alliance relationship. In the case of the post oak communities it was determined by SOPN staff that the two original associations and alliances should be combined into a single alliance to increase the map unit's accuracy. Since the park special map units were not classified to the NVC these do not have a corresponding NVC association or alliance. Please reference Appendix F for detailed descriptions and representative photos for all vegetation map units.

Relationship between Map Units and Plant Associations/Alliances

The LYJO map units represent a compromise between the detail of the NVC, the needs of the park and the limitations of the imagery. As a result, the mapping scheme does not exactly match the NVC. Rather, the vegetation map units were linked (i.e. "crosswalked") to the NVC plant associations or alliances when possible. When the NVC link was not feasible other map units were created.

The following were the possible map scenarios that were encountered at LYJO: (1) when a plant association or alliance had a unique photo signature and could be readily delineated on the photos, the map unit adopted the plant association/alliance name. This was considered a one-to-one relationship. (2) When plant associations occurred in stands too small to map or when related plant associations shared the same signature and could not be distinguished on the photos, several plant associations were collapsed into a single alliance. This was considered a one-to-many relationship. (3) When unique stands of vegetation did not have a corresponding NVC association or alliance these were considered "park specials". (4) Finally, non-vegetated areas and vegetation types not recognized by the NVC received Anderson et al. (1976) Land Use – Land Cover map unit designations.

Table 4. List of NVC Plant Associations and Alliances found at LYJO.

Scientific Name	**Common Name**	**Elcode**[1]
Forest and Woodlands		
Carya illinoinensis – Celtis laevigata Forest	Pecan – Sugar Hackberry Forest	CEGL002087
Quercus fusiformis – Celtis reticulata var. *reticulata* Woodland	Plateau Live Oak - Netleaf Hackberry Woodland	CEGL002153
Quercus fusiformis / Schizachyrium scoparium Woodland	Plateau Live Oak / Little Bluestem Woodland	CEGL002115
Quercus stellata – Quercus marilandica Woodland Alliance	Post Oak - Blackjack Oak Woodland Alliance	A.625
Quercus stellata - (Quercus fusiformis - Quercus marilandica) - Juniperus ashei / Schizachyrium scoparium Woodland	Post Oak - (Plateau Live Oak - Blackjack Oak) - Ashe Juniper / Little Bluestem Woodland	New Type
**Juniperus ashei* Woodland Alliance	Ashe Juniper Woodland Alliance	A.501
**Prosopis glandulosa* Woodland Alliance	Honey Mesquite Woodland Alliance	A.611
Shrublands		
Salix nigra Temporarily Flooded Shrubland Alliance	Black Willow Temporarily Flooded Shrubland Alliance	A.948
Herbaceous Vegetation		
Cynodon dactylon Herbaceous Vegetation	Bermuda Grass Herbaceous Alliance	New Type
Bothriochloa laguroides – Sorghum halepense Herbaceous Vegetation	Silver Beardgrass - Johnsongrass Herbaceous Vegetation	New Type
(No Scientific Name)	Restored Grassland Prairie	New Type
Panicum virgatum – Tripsacum dactyloides Herbaceous Alliance	Switchgrass – Eastern Gammagrass Herbaceous Alliance	A.1194
Bouteloua hirsuta – Bouteloua curtipendula Herbaceous Vegetation	Hairy Grama - Sideoats Grama Herbaceous Vegetation	CEGL001755

*Represents discrete stands of vegetation that were not sampled either due to their small size or they occurred outside of the park boundary.
[1] **ELCODE** represents NatureServe's internal database tracking code for each recognized plant association or alliance.

Table 5. Map units identified in LYJO.
The units are organized into ecological groups. "Level" refers to whether the map unit represents a NVC plant association/alliance (NVC unless otherwise noted) or a local plant community/plant population (Park Special), or a land use class. Anderson Land Use Classes are identified by Roman numerals.

Map Code	Map Unit Name	Map Unit Common Name	Level
Forest and Woodlands			
F -PECN	*Carya illinoinensis – Celtis laevigata* Forest	Pecan – Sugar Hackberry Forest	Association
W-LONH	*Quercus fusiformis – Celtis reticulata* var. *reticulata* Woodland	Plateau Live Oak - Netleaf Hackberry Woodland	Association
W-LOLB	*Quercus fusiformis / Schizachyrium scoparium* Woodland	Plateau Live Oak / Little Bluestem Woodland	Association
W-POBO	*Quercus stellata – Quercus marilandica* Woodland Alliance	Post Oak - Blackjack Oak Woodland Alliance	Alliance
W-CHIN	**Melia azedarach* Woodland Stand	Chinaberry Woodland Stand	Park Special
W-AJUN	**Juniperus ashei* Woodland Alliance	Ashe Juniper Woodland Alliance	Alliance
W-MESQ	*Prosopis glandulosa* Woodland Alliance	Honey Mesquite Woodland Alliance	Alliance
Shrublands			
S-BLWL	**Salix nigra Temporarily* Flooded Shrubland Alliance	Black Willow Temporarily Flooded Shrubland Alliance Stand	Alliance
S-HACK	**Celtis laevigata* Shrubland Stand	Sugar Hackberry Shrubland Stand	Park Special
Herbaceous Vegetation			
H-BERM	*Cynodon dactylon* Herbaceous Vegetation	Bermuda Grass Herbaceous Alliance	Alliance
H-SVJN	*Bothriochloa laguroides – Sorghum halepense* Herbaceous Vegetation	Silver Beardgrass - Johnsongrass Herbaceous Vegetation	Association
H-REPR	(No Scientific Name)	Restored Grassland Prairie	Association
H-SWGR	*Panicum virgatum – Tripsacum dactyloides* Herbaceous Alliance	Switchgrass – Eastern Gammagrass Herbaceous Alliance	Alliance
H-HGSG	*Bouteloua hirsuta – Bouteloua curtipendula* Herbaceous Vegetation	Hairy Grama - Sideoats Grama Herbaceous Vegetation	Association

*Park Special: Represents discrete stands of vegetation that were too small and/or occurred too infrequently to classify.

Land Use – Land Cover			
L-STRM	(No Scientific Name)	Stream / River	Level III
L-CANL	(No Scientific Name)	Canal / Ditch	Level III
L-POND	(No Scientific Name)	Lake / Pond	Level III
L-RESD	(No Scientific Name)	Residential	Level II
L-AGRI	(No Scientific Name)	Agricultural Business	Level III
L-ROAD	(No Scientific Name)	Transportation	Level III
L-RNWY	(No Scientific Name)	Airport	Level IV
L-URBN	(No Scientific Name)	Mixed Urban	Level II
L-TRAN	(No Scientific Name)	Transitional	Level II
L-FLAT	(No Scientific Name)	Flats	Level II
L-ORCH	(No Scientific Name)	Orchards / Vineyards / Groves	Level III
L-FILD	(No Scientific Name)	Planted / Cultivated	Level III
L-FACL	(No Scientific Name)	Park Facilities	N/A

Below is a comprehensive breakdown of the crosswalking of the NVC associations to the map units for LYJO:

-Map Units Representing Single NVC Units (either existing or new)
(One Alliance/Association-to-One Map Class)

The following map units were created from the NVC and represent established or provisional plant alliances that could be discerned and delineated on the imagery.

Map Code	Map Unit *NVC Plant Alliance / Association(s)*
F -PECN	*Carya illinoinensis – Celtis laevigata* Forest *Carya illinoinensis – Celtis laevigata* Forest
W-LONH	*Quercus fusiformis – Celtis reticulata* var. *reticulata* Woodland *Quercus fusiformis – Celtis reticulata* var. *reticulata* Woodland
W-LOLB	*Quercus fusiformis / Schizachyrium scoparium* Woodland *Quercus fusiformis / Schizachyrium scoparium* Woodland
W-AJUN	*Juniperus ashei* Woodland Alliance *Juniperus ashei* Woodland Alliance
W-MESQ	*Prosopis glandulosa* Woodland Alliance *Prosopis glandulosa* Woodland Alliance
S-BLWL	*Salix nigra Temporarily* Flooded Shrubland Alliance *Salix nigra Temporarily* Flooded Shrubland Alliance
H-BERM	*Cynodon dactylon* Herbaceous Vegetation *Cynodon dactylon* Herbaceous Vegetation
H-SVJN	*Bothriochloa laguroides – Sorghum halepense* Herbaceous Vegetation *Bothriochloa laguroides – Sorghum halepense* Herbaceous Vegetation
H-REPR	Restored Grassland Prairie Restored Grassland Prairie
H-SWGR	*Panicum virgatum – Tripsacum dactyloides* Herbaceous Alliance *Panicum virgatum – Tripsacum dactyloides* Herbaceous Alliance
H-HGSG	*Bouteloua hirsuta – Bouteloua curtipendula* Herbaceous Vegetation *Bouteloua hirsuta – Bouteloua curtipendula* Herbaceous Vegetation

-Map Units Representing Aggregations of Plant Associations/Alliances

(Many Alliances /Associations-to-One Map Class)

In cases where closely related plant associations could not be distinguished on the photos, they were combined into a single map unit. Often these occurred from the inability to recognize the understory species or to distinguish between very similar species.

Map Code	Map Unit *NVC Plant Alliance / Association(s)*
W-POBO	*Quercus stellata – Quercus marilandica* Woodland Alliance *Quercus stellata – Quercus marilandica* Woodland Alliance *Quercus stellata - (Quercus fusiformis - Quercus marilandica) – Juniperus ashei / Schizachyrium scoparium* Woodland

-Map Units Representing No Association

These map units were created for LYJO to describe vegetation that had no corresponding NVC association for the following reason:

Local Stands - Represents infrequent or rare types that were observed primarily in the environs during the photo interpretation and could not be classified to an association since no plots or points were collected;

Map Code	Map Unit
W-CHIN	*Melia azedarach* Woodland Stand (Local Stands)
S-HACK	*Celtis laevigata* Shrubland Stand (Local Stands)

Vegetation Map

Just over 4,600 acres including 708 acres in the current (i.e. actual) boundary of LYJO and an additional 3,893 acres in the environs (including the authorized boundary of LYJO) were mapped using 27 map classes (Appendix G). This included 13 land cover classes and 14 vegetation classes. Of all the map units, the most frequent was Plateau Live Oak / Little Bluestem Woodland with 254 polygons. The most abundant map unit in terms of area was also Plateau Live Oak / Little Bluestem Woodland covering 971 acres (388 hectares) or about 21% of the project area. All of the frequencies for each map unit (i.e., number of polygons) along with their acreages are listed in Table 6.

Table 6. Total acreage and frequency of map units for LYJO.

Map Code	Map Unit Description	Ranch District (Actual Park Boundary)			City District (Actual Park Boundary)			Total Project Area		
		Freq.	Acres	HA	Freq.	Acres	HA	Freq.	Acres	HA
F-PECN	Pecan – Sugar Hackberry Forest	2	6	2	19	12	5	37	92	37
W-LONH	Plateau Live Oak - Netleaf Hackberry Woodland	0	0	0	2	4	2	17	75	30
W-LOLB	Plateau Live Oak / Little Bluestem Woodland	52	52	21	21	8	3	254	971	393
W-POBO	Post Oak - Blackjack Oak Woodland Alliance	11	21	8	3	1	1	110	234	95
W-CHIN	Chinaberry Woodland Stand	0	0	0	0	0	0	1	2	1
W-AJUN	Ashe Juniper Woodland Alliance	11	4	2	7	9	3	59	133	54
W-MESQ	Honey Mesquite Woodland Alliance	7	3	1	8	8	3	47	204	82
S-BLWL	Black Willow Temporarily Flooded Shrubland Alliance Stand	0	0	0	0	0	0	7	27	11
S-HACK	Sugar Hackberry Shrubland Stand	4	2	1	1	0.3	0	14	13	5
H-BERM	Bermuda Grass Herbaceous Alliance	20	146	60	19	23	9	99	767	311
H-SVJN	Silver Beardgrass - Johnsongrass Herbaceous Vegetation	17	45	18	6	16	7	95	292	118
H-REPR	Restored Grassland Prairie	0	0	0	5	9	4	6	18	7
H-SWGR	Switchgrass – Eastern Gammagrass Herbaceous Alliance	6	8	3	2	2	1	19	41	16
H-HGSG	Hairy Grama - Sideoats Grama Herbaceous Vegetation	11	39	16	0	0	0	67	210	85
L-STRM	Stream / River	17	2	1	0	0	0	7	74	30
L-CANL	Canal / Ditch	0	0	0	0	0	0	1	2	1
L-POND	Lake / Pond	9	5	2	1	0.1	0	30	22	9
L-RESD	Residential	6	7	3	2	0.3	0	48	94	38
L-AGRI	Agricultural Business	13	9	4	0	0	0	30	27	11
L-ROAD	Transportation	5	25	10	18	8	3	8	173	70
L-RNWY	Airport	1	11	4	0	0	0	1	11	4
L-URBN	Mixed Urban	0	0	0	4	2	1	38	100	40
L-TRAN	Transitional	0	0	0	0	0	0	4	9	4
L-FLAT	Flats	0	0	0	0	0	0	1	2	1
L-ORCH	Orchards / Vineyards / Groves	3	53	21	1	2	1	9	71	29
L-FILD	Planted / Cultivated	8	157	64	0	0	0	37	901	365
L-FACL	Park Facilities	0	0.4	0	20	11	4	34	40	16
Total Land-Use / Land Cover		62	269	109	46	23	9	248	1,526	618
Total Natural Vegetation		141	326	132	93	92	38	832	3,079	1,245
Totals		**203**	**595**	**241**	**139**	**115**	**47**	**1,080**	**4,601**	**1,863**

Normally the standard minimum mapping unit for NPS vegetation mapping projects is defined as 0.5 hectare. However this is a nominal unit and due to the small size of LYJO and the resolution of the imagery it was reduced to ¼ acre. This size allowed for more detail in the mapping and allowed for better delineation of important stands of vegetation such wetlands, weedy patches and riparian vegetation. This ability to recognize small patches of vegetation is reflected in the high number of polygons created (1,080) and the average size of the polygons for this project, ~4 acres (2 hectares).

Accuracy Assessment

The 2006 accuracy assessment effort yielded 133 points that were distributed throughout LYJO and Lyndon B. Johnson State Park and Historic Site with none sampled in the environs due to access constraints. Due to GPS and location issues, three points were removed from the final analysis. In addition to their use in the AA analysis many of the points were also used to update the classification and to revise the local descriptions. These data helped strengthen the classification for LYJO and added to the global perspective of the individual types.

Actual analysis of the AA points involved a point-by-point review in two stages. During stage one, an AA GIS point file was created from the AA point coordinates recorded in the field. These were then overlaid on the vegetation map and a comparison of the final AA field call versus the vegetation polygon label was conducted by CTI staff. This resulted in a preliminary error matrix that was sent to SOPN for review. The first binary assessment revealed an overall accuracy of 87%. Concentrations of error were found between mapping of the Post Oak - Blackjack Oak Woodland Alliance and the Post Oak - (Plateau Live Oak - Blackjack Oak) - Ashe Juniper / Little Bluestem Woodland Association. It was decided by SOPN that these two types should be combined yielding a final overall accuracy of 92%. Based on their recommendations the vegetation GIS layer was modified and a second analysis was conducted resulting in the final error matrix for the vegetation layer (Table 7).

Examination of the final error matrix (Table 7) shows that areas of confusion were found between similar herbaceous types. For example the Silver Beardgrass - Johnsongrass Herbaceous Vegetation type was confused with the Bermuda Grass Herbaceous Alliance one time and the Hairy Grama - Sideoats Grama Herbaceous Vegetation was confused with both the Restored Grassland Prairie and the Beardgrass - Johnsongrass Herbaceous Vegetation types. This difficulty is likely compounded by the fact that these types are also being used as pastures or mown for hay. This creates uncertainty of whether the stand of vegetation should be classified as an agricultural field (land-use) or a (semi)natural association.

Another general trend of the accuracy reveals the difficulty in accurately delineating between deciduous woodland/forest types. Again this is partially due to similar types containing the same species but it also points out the difficulty in distinguishing different deciduous trees on overhead imagery. Finally some errors in the map can be explained by the difficulty in resolving the difference in scale and perspective between viewing the vegetation on the imagery and assessing it on the ground. For example, sampling could have occurred in inclusions or openings in woodland canopies and documented smaller units than were mapped.

Table 7. Contingency table (error matrix) for vegetation mapping at LYJO.

Sample Data (Polygon Map Data)	Reference Data (Accuracy Assessment Field Data)															User's Error		
Map Units	F-PECN	W-LONH	W-LOLB	W-POBO	W-AJUN	W-MESQ	S-BLWL	H-BERM	H-SVJN	H-REPR	H-SWGR	H-HGSG	L-ORCH	L-FILD	*Other	Totals	Commission Accuracy	90% Conf. Interval
																		- / +
F-PECN	**18**	3	0	0	0	0	0	0	0	0	0	0	0	0	0	**21**	86%	72% / 100%
W-LONH	0	**14**	0	0	0	0	0	0	0	0	0	0	0	0	0	**14**	100%	96% / 100%
W-LOLB	0	0	**7**	0	0	0	0	0	0	0	0	0	0	0	0	**7**	100%	93% / 100%
W-POBO	0	0	0	**12**	0	0	0	0	0	0	0	0	0	0	0	**12**	100%	94% / 100%
W-AJUN	0	0	0	1	**9**	0	0	0	0	0	0	0	0	0	0	**10**	90%	69% / 100%
W-MESQ	0	0	1	0	0	**7**	0	0	0	0	0	0	0	0	0	**8**	88%	62% / 100%
S-BLWL	0	0	0	0	0	0	**3**	0	0	0	0	0	0	0	0	**3**	100%	83% / 100%
H-BERM	0	0	0	0	0	0	0	**20**	0	0	0	0	0	0	0	**20**	100%	98% / 100%
H-SVJN	0	0	0	0	0	0	0	1	**8**	0	0	0	1	0	2	**12**	67%	40% / 93%
H-REPR	0	0	0	0	0	0	0	0	0	**5**	0	0	0	0	0	**5**	100%	90% / 100%
H-SWGR	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	**1**	100%	50% / 100%
H-HGSG	0	0	0	0	0	0	0	0	1	1	0	**8**	0	0	0	**10**	80%	54% / 100%
L-ORCH	0	0	0	0	0	0	0	0	0	0	0	0	**2**	0	0	**2**	100%	75% / 100%
L-FILD	0	0	0	0	0	0	0	0	0	0	0	0	0	**5**	0	**5**	100%	90% / 100%
*Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	-	- / -
Totals	**18**	**17**	**8**	**13**	**9**	**7**	**3**	**21**	**9**	**6**	**1**	**8**	**3**	**5**	**2**			
Omission Accuracy	100%	82%	88%	92%	100%	100%	100%	95%	89%	83%	100%	100%	50%	100%	-	**119 Total Correct Points**		
90% Conf. -	97%	64%	62%	76%	94%	93%	83%	85%	66%	50%	50%	94%	0%	90%	-	**130 Total Points**		
Level +	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	-			
Overall Total Accuracy = 92% **Overall Kappa Index = 87%** **Overall 90% Upper and Lower Confidence Interval = 88% and 97%**																		

Producer' Error

*Represents Points that were recorded on land-use types not in the accuracy analysis
Please Note: three correct points were removed from the analysis since they occurred on Park Facilities likely due to bad coordinates

Instructions on Using the Accuracy Assessment Contingency Table:

The contingency table or error matrix found above presents an array of numbers set out in rows and columns corresponding to a particular vegetation map unit relative to the actual vegetation type as verified on the ground. The column headings represent the vegetation classification as determined in the field and the row headings represent the vegetation classification taken from the vegetation map. The highlighted diagonal indicates the number of points assessed in the field that agree with the map label. Conversely, the inaccuracies of each map unit are described as both errors of inclusion (user's or commission errors) and errors of exclusion (producer's or omission errors). By reading across this table (i.e., rows) one can calculate the percent error of commission, or how many polygons for each map unit were incorrectly labeled when compared to the field data. By reading down the table (i.e., columns) one can calculate the percent error of omission, or how many polygons for that type were left off the map. Numbers "on the diagonal" tell the user how well the map unit was interpreted and how confident they can be in using it. Numbers "off the diagonal" yield important information about the deficiencies of the map including which types were: 1) over- mapped - commission errors on the right or 2) under-mapped - omission errors on the bottom

Discussion

Lyndon B. Johnson National Historical Park is truly a special place combining an unique mix of historically important agricultural lands intermingled with remnants of native plant communities. Across this fragmented landscape a wide array of native and exotic plants thrive in habitats typical of the Central Texas Hill Country including the Pedenales River Valley and the Edwards Plateau. The multiple land uses on this landscape made it very challenging to both classify and map the vegetation into meaningful context for all levels of interest (local, regional, and national). However, due to the small size of the park and the accessibility afforded to the sampling and verifying efforts a highly accurate classification and map was completed. Even though the accuracy is high there are still some areas were improvements can be made, which are summarized below.

Field Survey

The vegetation data presented in this project should be used as a "baseline" to build upon. New survey work on a timely manner would greatly improve both the classification and mapping efforts. Using the accuracy assessment as a guide, map classes with lower accuracy could be further surveyed in the field to create more accurate delineations. While it may appear that there are a large number of associations and alliances described for this small study area, some of the associations/alliances were either only minimally sampled or not sampled at all due to access constraints. It is recommended that these types should receive additional survey work to further define their classification. For example some of the herbaceous types should be examined throughout the growing year to document both the cool and warm season species in order to refine their composition. Also, accessing neighboring private lands would allow new plot samples to be obtained increasing the confidence in these types, thereby strengthening the classification.

NVC Classification

Along with access onto private lands the other main classification challenge at LYJO is keeping up with the rapid changes to plant life caused by agricultural manipulation and anthropogenic disturbance. Changes include tree removal, planting new pasture grasses, plowing, wild fires, and flooding. At all times, but especially after these events, new data should be collected to reflect these changes. For example, as the park continues to restore its tallgrass prairie, this type may later need to be classified using a more natural association such as a Big Bluestem – Indiangrass community type. Overall more specialized and targeted data collection in these areas would help to document any changes and would greatly increase our understanding of these types in general.

Digital Imagery and Interpretation

The decision to use existing NAIP imagery as the basemap for this project was based on cost savings. Although the imagery proved adequate, it was not acquired by the USDA for this purpose. In the future it may be beneficial to purchase new orthophotos or aerial photos exclusively for mapping the vegetation at LYJO. This would allow the timing to better match the phenology of the vegetation and due to the small size of the park a finer scale (such as 1:6,000) could be acquired allowing for more precise delineations.

Inherent to all vegetation mapping projects is the need to produce both a consistent vegetation classification and a comprehensive set of map units. Typically the systems are very similar, but when using a national classification such as the NVC there is usually not a strict one-to-one correspondence. Nonconformity is due to the remote sensing nature of the interpretation and its ability to delineate map units based on complex photo signatures. Subtle vegetation characteristics that can be seen on the ground are not necessarily the same as those apparent on the imagery. Canopy closure, shadows, and the timing of the imagery acquisition can all impact the vegetation signatures. At LYJO these issues can be offset not only by acquiring new imagery but also by conducting more map verification or ground-truthing. Increasing the amount of time and money budgeted for verification of the map would greatly improve the accuracy and level of detail. Similarly, this work should only be viewed as an initial mapping effort that needs to be refined and periodically updated. To perform field checking, the existing map could be examined in the field by qualified park or contract staff, changes could be made to the map and these could be incorporated into new versions that would keep the product current over the years.

Accuracy Assessment

An important and necessary aspect of this project is the accuracy assessment. Collecting independent ground data determines the usefulness of the vegetation map. As such, users of this product should remember that the GIS mapping and classification portions of the project were conducted separately from both the plot and AA field data collection. These three divisions in work created some challenges related to communication among all the teams, including: (1) adequately conveying changes to the classification based on revising the preliminary associations as recorded in the field into the NVC by NatureServe, (2) mapping some types less than the one-quarter acre minimum mapping unit, (3) mapping new associations/alliances found in the environs but not found in the park, and (4) generally providing enough instruction and interaction to the field crews to explain how these changes would effect the AA.

Specifically at LYJO, new associations and alliances occurring in the environs should have been marked as such in the field key. Field key notes would have indicated to the crews that they would probably not encounter some types in the AA and if they did, these associations would be new and should be sampled with a full plot and not an AA point. Also it should have been explained or documented which preliminary associations corresponded to the newly classified NVC associations. For example, the original Upland Disturbed Herbaceous Vegetation dominated by *Nassella leucotricha* (Texas Wintergrass) or *Sporobolus compositus* (Meadow dropseed) was subsequently classified as the Silver bluestem-Johnsongrass Herbaceous Vegetation in the NVC. This classification caused some confusion when the field team accessed sites that only contained wintergrass or dropseed.

Finally insufficient interaction between the field and GIS teams created some scale-related issues. As mentioned previously, looking at vegetation from an overhead perspective varies greatly from seeing it on the ground. Because of the extensive field exposure to the vegetation at LYJO, the field team was very knowledgeable about the parks' habitats. Onsite knowledge included a thorough understanding of when one association changed to another either due to succession or due to an ecotone. Since the mapping team was tasked to provide a map of the existing vegetation the delineation on the map did not always match what the field team viewed as the break between plant associations. Similarly small stands of vegetation that were accurately

mapped on the aerial photography were seen by the field crews as actually being inclusions in larger units and vice versa. This discrepancy could also be defined as stemming from the fundamental difference between deriving vegetation from imagery signatures versus ecological or field experience. In the future it would be helpful if more communication could occur between all teams involved. This communication would at a minimum include multiple field visits by all teams at the same time and possibly reducing the number of researchers by finding participants that could conduct multiple tasks.

Future Recommendations

In summary, this project represents the best efforts put forth by a multi-disciplined team over a relatively short period in time. In order to create the best possible "long-term" vegetation classification for LYJO and the most accurate and detailed GIS layer, this project should be viewed as a place to start rather than an end product. In other words, present and future NPS staff should be encouraged to scrutinize this project, building from its strengths and bolstering its weaknesses. By keeping in mind that this project was only a snapshot in time, future efforts can help complete our understanding of the vegetation in and around LYJO and how it changes. It is the hope of the producers that the products presented here will help focus and direct future efforts. The following recommendations are summarized below.

1. The diversity of plant species and dynamic nature of the park with respect to the agricultural aspect warrants periodic **field surveys** by experienced ecologists. Further the inaccessibility of the private lands in the environs should be addressed by seeking permission to sample and verify the vegetation. In this way new plant associations could be discovered and existing types could be updated.

2. Remote sensing does not replace on-the-ground knowledge provided by GPS-linked plots, observations and ground verification. Time and funding limitations curtailed the amount of map **ground-truthing** performed. As opportunities arise, maps should be examined in the field by experienced crews. Also GPS receiver data and other GIS layers should be used to improve and update the spatial data. This map product should not be viewed as static but should be updated with more current and accurate information.

3. To better understand the limitations of the map, the **accuracy assessment** data presented in Table 7 should be thoroughly reviewed by the park staff. Map classes with low accuracy should be examined to see if they could be improved with future studies using ground-truthing or other remote-sensing formats (i.e. fine-scale imagery, hyperspectral, etc). Also, landscape modeling may help to tease out the location of specific types based on specific habitat information. Finally for some applications it may make sense to combine map classes into higher units, such as alliances or ecological systems to improve their accuracy**.**

4. For monitoring purposes, **change over time** could be addressed by similar remote sensing projects. New aerial photos or NAIP imagery acquired every year could be used in regular intervals to capture change. Specifically this new imagery could be used to create up-to-date vegetation layers that could be used to compare changes in both individual vegetation stands and across the entire park.

5. In the future, resource management personnel could link the habitat for **species of concern** to specific associations and map units. These map units could then be used to help locate potential sites of endangered or threatened species in the field or identify areas for non-native plant removal or treatment.

Research Opportunities

Having an accurate and current vegetation classification and map presents many new and exciting research opportunities. Research could include expanding or linking the GIS layer to derive other information such as fire models, habitat monitoring locations, guides for rare plant surveys, and inventorying areas that likely contain exotic or invasive species. The map could also be enhanced by overlaying other existing GIS layers such as geology, hydrology, elevation, and soils. In this manner complex interactions between these layers could be examined and yield important information about growth rates, regeneration after disturbance, biomass distribution, and stream morphology. Finally, through innovative analyses the vegetation layer could possibly be used as a springboard for other ecological studies such as examining how the vegetation interacts with soil chemistry, pollution, archeological sites, weather patterns, etc.

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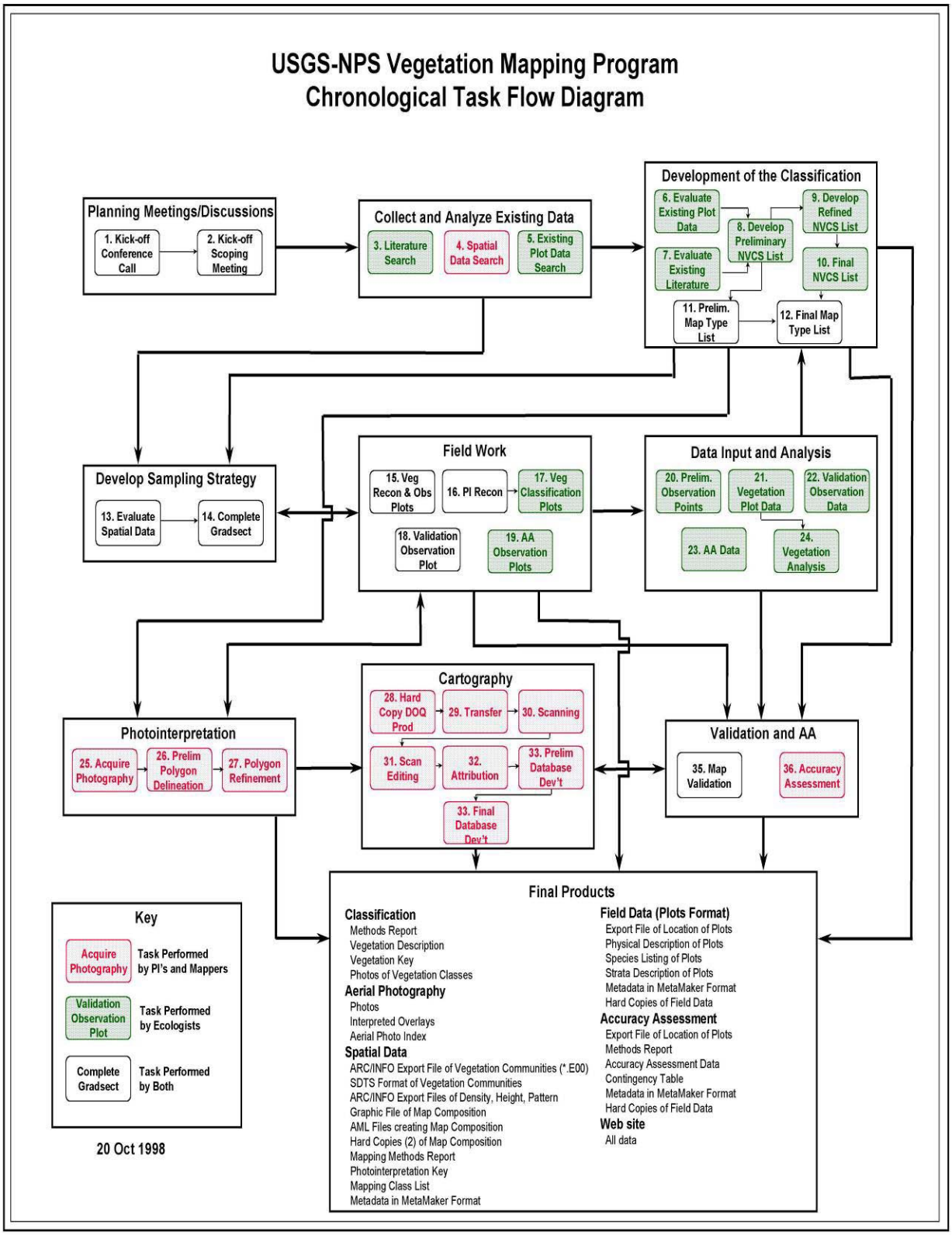
APPENDIX A: Components and Flow Diagram of the Vegetation Classification and Mapping Program

(Developed by Tom Owens USGS – BRD)



APPENDIX B: Field Data Forms and Instructions

General instructions for filling out fields in the PLOT SURVEY FORM (adapted from Salas et al. 2004)

IDENTIFIERS/LOCATORS

Plot Code
Code indicating the specific plot within the vegetation polygon.

Surveyors
Names of surveyors, with principal surveyor listed first.

Date
Date the survey was taken; year, month, day.

BPU Code
The biophysical unit identified.

Provisional Community Name
Using the provisional classification of the Park that was provided, assign the name of the vegetation type which most closely resembles this type. Enter the finest level of the classification possible. If it's a new type, name it based on the two or three most dominant species in the plot.

Quad Name
Appropriate name/scale from survey map used; use 7.5-minute quadrangle if possible.

Park Site Name
Provisional name assigned by field worker that describes where the data were collected. It should represent an identifiable feature on a topographic map.

GPS Rover File
Record the number of the file from the GPS unit.

Field UTM X
Use GPS; do not estimate. If you can't get a GPS reading, estimate coordinates from a topo map and note on the form that this method was used.

Field UTM Y
Use GPS; do not estimate. If you can't get a GPS reading, estimate coordinates from a topo map and note on the form that this method was used.

Error
Record this off the GPS unit.

Plot Length and Plot Width
Enter width and length dimensions for square or rectangular plots. Choose the appropriate plot size based on the following:

Vegetation Class	Standard Plot Dimensions	PLOT AREA
Forest	20 m x 20 m	400 m^2
Woodland	20 m x 20 m	400 m^2
Shrubland	20 m x 20 m	400 m^2
Dwarf-shrubland (heath)	10 m x 10 m	100 m^2
Herbaceous	10 m x 10 m	100 m^2
Nonvascular	5 m x 5 m	25 m^2

Photo numbers
If photos of the plot have been taken at the time of sampling, indicate their numbers from the ones the camera assigns.

Plot Permanent
Note if the plot has been permanently marked.

Plot Representativeness
Does this plot represent the full variability of the polygon? If not, were additional plots taken? Note: we distinguish in this section the plot's ability to represent the stand or polygon you are sampling as one component, and the ability of this sample to represent the range of variability of the association in the entire mapping area. The former comment may be ascertained by reconnaissance of the stand. The latter comment comes only after some familiarity with the vegetation type throughout the mapping area and may be left blank if you have no opinion at this time.

ENVIRONMENTAL DESCRIPTION

Elevation
Elevation of the plot obtained from the GPS

Slope
Measure the slope in percent using a clinometer.

Aspect
Measure the aspect using a compass (be sure compass is set to correct for the magnetic declination).

Topographic Position
Choose one:

INTERFLUVE (crest, summit, ridge). Linear top of ridge, hill, or mountain; the elevated area between two fluves (drainageways) that sheds water to the drainageways.

SHOULDER (shoulder slope, upper slope, convex creep slope). Geomorphic component that forms the uppermost inclined surface at the top of a slope. Includes the transition zone from backslope to summit. Surface is dominantly convex in profile and erosional in origin.

BACKSLOPE. Subset of midslopes that are steep, linear, and may include cliff segments (fall faces).

FOOTSLOPE (lower slope, foot slope, colluvial footslope). Inner gently inclined surface at the base of a slope. Surface profile is generally concave and a transition between backslope, and toeslope.

TOESLOPE (alluvial toeslope). Outermost gently inclined surface at base of a slope. In profile, commonly gentle and linear and characterized by alluvial deposition.

TERRACE Valley floor or shoreline representing the former position of an alluvial plain, lake, or shore.

CHANNEL (narrow valley bottom, gully arroyo). Bed of single or braided watercourse commonly barren of vegetation and formed of modern alluvium.

BASIN FLOOR (depression). Nearly level to gently sloping, bottom surface of a basin.

Describe Topographic Position (Optional)
Give more details here, if needed.

Cowardin System
Indicate "upland" if the system is not a wetland. If the system is a wetland, check off the name of the USFWS system which best describes its hydrology and landform.

- Riverine: Below the high water mark on a moving water system (a creek bed). A community of *Eleocharis* on a sand bar would be in this category.
- Palustrine: In the riparian zone. Plants regularly have wet roots through much of the summer. A community of willows and sedges would be in this category.
- Lacustrine: Below the high water mark of a lake. The marshy stuff on the edge of a lake would be in this category.

Assess the hydrologic regime of the plot using the descriptions below (adapted from Cowardin et al. 1979).

PERMANENTLY FLOODED - Water covers the land surface at all times of the year in all years. Equivalent to Cowardin's "permanently flooded."

SEMIPERMANENTLY FLOODED - Surface water persists throughout growing season in most years except during periods of drought. Land surface is normally saturated when water level drops below soil surface. Includes Cowardin's Intermittently Exposed and Semipermanently Flooded modifiers.

SEASONALLY FLOODED - Surface water is present for extended periods during the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is very variable, extending from saturated to a water table well below the ground surface. Includes Cowardin's Seasonal, Seasonal-Saturated, and Seasonal-Well Drained modifiers.

SATURATED - Surface water is seldom present, but substrate is saturated to surface for extended periods during the growing season. Equivalent to Cowardin's Saturated modifier.

TEMPORARILY FLOODED - Surface water present for brief periods during growing season, but water table usually lies well below soil surface. Often characterizes flood-plain wetlands. Equivalent to Cowardin's Temporary modifier.

INTERMITTENTLY FLOODED - Substrate is usually exposed, but surface water can be present for variable periods without detectable seasonal periodicity. Inundation is not predictable to a given season and is dependent upon highly localized rain storms. This modifier was developed for use in the arid West for water regimes of Playa lakes, intermittent streams, and dry washes but can be used in other parts of the U.S. where

appropriate. This modifier can be applied to both wetland and non-wetland situations. Equivalent to Cowardin's Intermittently Flooded modifier.

UNKNOWN - The water regime of the area is not known. The unit is simply described as a non-tidal wetland.

Unvegetated Surface
Estimate the approximate percentage of the *total* surface area covered by each category.

Soil Texture
Using the key below, assess average soil texture.

<u>Simplified Key to Soil Texture</u>
Soil does not remain in a ball when squeezed.....sand
Soil remains in a ball when squeezed.....2

Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you can push up over your finger.
2. Soil makes no ribbon.....……..……loamy sand
2. Soil makes a ribbon (may be very short).....3

3. Ribbon extends less than 1 inch before breaking.....4
Add excess water to small amount of soil:

4. Soil feels smooth.....silt loam
4. Soil feels at least slightly gritty……...…….…5
Squeeze a moistened ball:
5. Cast is formed which can be handled CAREFULLY without breaking…..……. sandy loam
5. Cast is formed which can be handled FREELY without breaking…… ……loam

3. Ribbon extends 1 inch or more before breaking.....6

5. Soil makes a ribbon that breaks when 1 to 2 inches long; cracks if bent into a ring.....7

Add excess water to small amount of soil:
7. Soil feels at least slightly gritty…….....clay loam
7. Soil feels smooth.....silt

6. Soil makes a ribbon 2+ inches long; does NOT crack when bent into a ring…… 8
Add excess water to a small amount of soil:

8. Soil feels at least slightly gritty.....……..clay
8. Soil feels smooth.....silty clay

HANDBOOK ON SOILS

In the field, soil texture is determined by the feel of a moist soil when it is rubbed between the thumb and fingers. Since sand particles feel gritty, silt particles have a smooth velvety feel and clay is both sticky and plastic, an estimate of the relative proportions of the separates may be made. This procedure, of course, will not give the exact percentage of sand, silt, and clay, but, with a little practice on samples of known composition, the relative proportions of the individual separates can be closely estimated. Practice with known samples is the only way to acquire this knowledge.

The outstanding physical characteristics of the main textural grades as determined by the feel of the soil are described below.

1. Sandy Soil. A sandy soil is loose and single grained. The individual grains can be seen readily or felt. Squeezed in the hand when dry, it will fall apart when pressure is released. Squeezed when moist, it will form a cast, but will crumble when touched.

2. Sandy Loam Soil. A sandy loam soil contains much sand, but has enough silt and clay to make it somewhat coherent. Individual sand grains can be easily seen and felt. Squeezed when dry, it will form a cast which will readily fall apart; but if squeezed when moist a cast can be formed which will bear careful handling without breaking.

3. Loam Soil. A loam soil is about an equal mixture of the sand and silt with the clay content being between 7 and 27 percent. A loam is mellow with a somewhat sandy feel, yet fairly smooth and slightly plastic. Squeezed when moist, it will form a cast which can be handled freely without breaking.

4. Silt Loam Soil. A silt loam soil, when dry, may appear cloddy, but lumps are readily broken, and when pulverized, it feels soft and floury. When wet, the soil readily runs together. Either dry or moist, it will form casts which can be handled freely without breaking, but when moistened and extruded between the thumb and fingers, it will not form a ribbon, but will give a broken appearance.

5. Clay Loam Soil. A clay loam soil is fine-textured and usually breaks into clods or lumps that are hard when dry. When moist and extruded between the thumb and fingers, it will form a thin "ribbon" which will break readily, barely sustaining its own weight. The moist soil is plastic and will form a cast that will bear much handling. When kneaded in the hand, it does not crumble readily, but tends to work into a heavy, compact mass.

6. Clay Soil. A clay soil is fine-textured and usually forms very hard lumps or clods when dry and is plastic and sticky when wet. When the moist soil is ribboned out between the thumb and fingers, it will form a long flexible strip. A clay soil leaves a "slick' surface on the thumb and fingers when rubbed together and tends to hold the thumb and fingers together due to the stickiness of the clay.

The characteristics described above are suggestive only, and will only apply to a group of similar soils. The characteristics of clay vary with the kind of clay mineral. For this reason, textural

grades may exhibit different properties from region to region. For instance, clays of the montmorillonite group are very sticky and plastic; those of the oxide group are plastic and waxy with relatively little stickiness.

The preceding discussion has been directed to those soil particles whose diameters are less than 2 millimeters--the sands, silts, and clays. Soils may also contain larger sized particles that may be collectively called coarse fragments. These large particles may on occasion exceed the smaller soil particles in volume.

Soil Drainage

The soil drainage classes are defined in terms of (1) actual moisture content (in excess of field moisture capacity) and (2) the extent of the period during which excess water is present in the plant-root zone. It is recognized that permeability, level of groundwater, and seepage are factors affecting moisture status. However, because these are not easily observed or measured in the field, they cannot generally be used as criteria of moisture status. It is further recognized that soil profile morphology, for example mottling, normally, but not always, reflects soil moisture status. Although soil morphology may be a valuable field indication of moisture status, it should not be the overriding criterion. Soil drainage classes cannot be based solely on the presence or absence of mottling. Topographic position and vegetation as well as soil morphology are useful field criteria for assessing soil moisture status.

> WELL DRAINED - The soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant part of the year.
>
> MODERATELY WELL DRAINED - The soil moisture content is in excess of field capacity for a small but significant period of the year.
>
> POORLY DRAINED - The soil moisture content is in excess of field capacity in all horizons for a large part of the year.

VEGETATION DESCRIPTION

Leaf Phenology
Select the value which best describes the leaf phenology of the dominant stratum. The dominant stratum is the uppermost stratum that contains at least 10% cover.

> EVERGREEN - Greater than 75% of the total woody cover is never without green foliage.
>
> COLD DECIDUOUS - Greater than 75% of the total woody cover sheds its foliage in connection with an unfavorable season mainly characterized by winter frost.

MIXED: EVERGREEN & COLD DECIDUOUS - Evergreen and deciduous species generally contribute 25-75% of the total woody cover. Evergreen and cold-deciduous species are mixed.

PERENNIAL - Herbaceous vegetation composed of more than 50% perennial species.

ANNUAL - Herbaceous vegetation composed of more than 50% annual species.

Leaf Type
Select the value which best describes the leaf form of the dominant stratum. The dominant stratum is the uppermost stratum that contains at least 10% cover.

BROAD-LEAVED - Woody vegetation primarily broad-leaved (generally contributes greater than 50 percent of the total woody cover).

NEEDLE-LEAVED - Woody vegetation primarily needle-leaved (generally contributes greater than 50 percent cover).

GRAMINOID - Herbaceous vegetation composed of more than 50 percent graminoid/stipe leaf species.

FORB (BROAD-LEAF-HERBACEOUS) - Herbaceous vegetation composed of more than 50% broad-leaf forb species.

PTERIDOPHYTE - Herbaceous vegetation composed of more than 50 percent species with frond or frond-like leaves. (Ferns)

Physiognomic Class
Choose one:
Forest: Trees with their crowns overlapping (generally forming 60-100% cover).

Woodland: Open stands of trees with crowns not usually touching (generally forming 25-60% cover). Canopy tree cover may be less than 25% in cases where it exceeds shrub, dwarf-shrub, herb, and nonvascular cover.

Shrubland: Shrubs generally greater than 2.5 feet tall with individuals or clumps overlapping to not touching (generally forming more than 25% cover, trees generally less than 25% cover). Shrub cover may be less than 25% where it exceeds tree, dwarf-shrub, herb, and nonvascular cover.

Dwarf-Shrubland: Low-growing shrubs usually under 2.5 feet tall. Individuals or clumps overlapping to not touching (generally forming more than 25% cover, trees and tall shrubs generally less than 25% cover). Dwarf-shrub cover may be less than 25% where it exceeds tree, shrub, herb, and nonvascular cover.

Herbaceous: Herbs (graminoids, forbs, and ferns) dominant (generally forming at least 25% cover; trees, shrubs, and dwarf-shrubs generally with less than 25% cover). Herb cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and nonvascular cover.

Nonvascular: Nonvascular cover (bryophytes, non-crustose lichens, and algae) dominant (generally forming at least 25% cover). Nonvascular cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and herb cover.

Sparse Vegetation: Abiotic substrate features dominant. Vegetation is scattered to nearly absent and generally restricted to areas of concentrated resources (total vegetation cover is typically less than 25% and greater than 0%).

Strata, Height Class, Cover Class, Diagnostic Species
Visually divide the community into vegetation layers (strata). Indicate the average height class of the stratum in the first column, using the Height Scale on the form. Enter the average percent cover class of the whole stratum in the second column, using the Cover Scale on the form. Height and Cover classes are also listed below.

Trees are defined as single-stemmed woody plants, generally 15 feet in height or greater at maturity and under optimal growing conditions. Shrubs are defined as multiple-stemmed woody plants generally less than 15 feet in height at maturity and under optimal growing conditions.

List the dominant species in each stratum.

Animal Use Evidence
Comment on any evidence of wildlife (i.e., tracks, scat, gopher or prairie dog mounds, etc.). Notes on domestic animals should be made in the field below.

Natural and Anthropogenic Disturbance
Comment on any evidence of natural or anthropogenic disturbance and specify the source.

Environmental Comments
Enter any additional noteworthy comments on the environmental setting. This field can be used to describe site history such as fire events (date since last fire or evidence of severity) as well as other disturbance or reproduction factors

Other Comments
Any miscellaneous comments.

Species/Strata/Percent Cover Table

The main use of the strata information is to categorize the plots by life form, in order to subset the data into forest, woodland, shrublands, and herbaceous plots for analysis. It is imperative that things be called the same throughout the data set.

Starting with the uppermost stratum, list all the species present and their cover class using the scale provided below. If a species is in the tree layer (single-stemmed woody plants, generally 15 feet in height or greater at maturity), list whether it is T1 (emergent tree), T2 (tree canopy), or T3 (tree sub-canopy). If a species is in the shrub layer, note if S1 (tall shrub), or S2 (short shrub), or S3 (dwarf shrub). If in the ground layer, note if H (herbaceous), N (nonvascular). Some species will be in more than one layer. For example, Cottonwoods might have one or two especially tall specimens, which would be in the T1 (emergent tree) layer. Then the majority of the mature trees would be in T2 (tree canopy). The saplings that are coming up in the understory would be in the T3.

Seedlings are defined as trees less than "breast height" or less than 4.5 feet tall. Seedlings between knee height and breast height should be labeled as being in the short shrub layer (S2), and those below knee height should be labeled as being in the dwarf shrub layer (S3).

Cover Scale for Species Percent Cover

Use the cover scales provided on the forms.

NATIONAL PARK VEGETATION MAPPING PROGRAM: PLOT SURVEY FORM

IDENTIFIERS/LOCATORS

Plot Code_____ Polygon Code_____

Provisional Community Name_____

State ___ Park Name_____ Park Site Name_____

Quad Name_____ Quad Code_____

GPS file name_____ Field UTM X___ ___ ___ ___ ___ ___ m E Field UTM Y___ ___ ___ ___ ___ ___ ___ m N

Error +/-_____ m

please do not complete the following information when in the field

Corrected UTM X___ ___ ___ ___ ___ ___ m E Corrected UTM Y___ ___ ___ ___ ___ ___ ___ m N UTM Zone_____

Survey Date_____ Surveyors_____

Directions to Plot

Plot length_____ Plot width_____ Plot Photos (y/n) ___ Roll Number _____ Frame Number _____ Plot Permanent (y/n) ___

Plot representativeness

ENVIRONMENTAL DESCRIPTION

Elevation _____ Slope _____ Aspect_____

Topographic Position

Landform

Surficial Geology

Cowardian System ___Upland ___Riverine ___Palustrine ___Lacustrine	Non-Tidal ___Permanently Flooded ___Semipermanetly Flooded ___Seasonally/Temporarily Flooded	___Saturated ___Seasonally Flooded/Saturated ___Intermittently Flooded	

Environmental Comments:	Soil Taxon/Description
	Unvegetated Surface: *(please use the cover scale on next page)* ___ Bedrock ___ Litter, duff ___ Wood (> 1 cm) ___ Large rocks (cobbles, boulders > 10 cm) ___ Small rocks (gravel, 0.2-10 cm) ___ Sand (0.1-2 mm) ___ Bare soil ___ Other:_____
Soil Texture ___ sand ___ loamy sand ___ sandy loam ___ loam ___ silt loam ___ silt ___ clay loam ___ silty clay ___ clay ___ peat ___ muck	Soil Drainage ___ Rapidly drained ___ Well drained ___ Moderately well drained ___ Somewhat poorly drained ___ Poorly drained ___ Very poorly drained

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	Cover Scale for Strata & Unvegetated Surface		Height Scale for Strata	
Trees and Shrubs		___Forest				
___Evergreen	___Broad-leaved	___Woodland	01	5%	01	<0.5 m
___Cold-deciduous	___Needle-leaved	___Shrubland	02	10%	02	0.5-1m
___Drought-deciduous	___Microphyllous	___Dwarf Shrubland	03	20%	03	1-2 m
___Mixed evergreen - cold-deciduous	___Graminoid	___Herbaceous	04	30%	04	2-5 m
___Mixed evergreen - drought-deciduous	___Forb	___Nonvascular	05	40%	05	5-10 m
	___Pteridophyte	___Sparsely Vegetated	06	50%	06	10-15 m
Herbs			07	60%	07	15-20 m
___Annual			08	70%	08	20-35 m
___Perennial			09	80%	09	35 - 50 m
			10	90%	10	>50 m
			11	100%		

Strata	Height Class	Cover Class	Diagnostic species (if known)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short Shrub			
H Herbaceous			
N Non-vascular			
V Vine/liana			
E Epiphyte			

please see above table for height and cover scales

Animal Use Evidence

Natural and Anthropogenic Disturbance Comments

Other Comments

Plot Code_____

Species/percent cover: Starting with the uppermost stratum, list all species with % cover for each species in the stratum. For each tree species estimate seedling, sapling, mature and total cover indicating stratum. Also for forests and woodlands, on a separate page or line below each tree species, list the DBH of all trees above 5 cm diameter. Separate measurements with a comma (note if measurements are from multi-stemmed tree). Put an asterisk next to any species that are known diagnostics for a particular community in the classification. **Also list species outside the plot at the end of the table or designate with a 0 in Cover Class column.**

Stratum	Species Name	Cover Class	Stratum	Species Name	Cover Class	Stratum	Species Name	Cover Class

Cover Class Scale

T = >0-1%	5 = >45-55%
P = >1-5%	6 = >55-65%
1 = >5-15%	7 = >65-75%
2 = >15-25%	8 = >75-85%
3 = >25-35%	9 = >85-95%
4 = >35-45%	10 = >95%

Tree D.B.H Form

Plot Code:______________________________Units in cm or inches (circle one)

Record tree diameter over 5 cm at 4.5 feet (1.37 m) height for species that contribute to tree canopy.

Separate measurements of multi-stemmed trees with commas. Can estimate by 5 cm dia. classes

Species	D.B.H.(s) for multi-stems trees	Species	D.B.H.(s) for multi-stems trees

NATIONAL PARK VEGETATION MAPPING PROGRAM: OBSERVATION POINT FORM (1997)

IDENTIFIERS/LOCATORS

Plot Code_____ Polygon Code_____

Provisional Community Name_____

State ___ Park Name _____ Park Site Name _____

Quad Name_____ Quad Code_____

GPS file name_____ Field UTM X___ ___ ___ ___ ___ ___ m E Field UTM Y___ ___ ___ ___ ___ ___ ___ m N

please do not complete the following information when in the field
Corrected UTM X___ ___ ___ ___ ___ ___ m E Corrected UTM Y___ ___ ___ ___ ___ ___ ___ m N UTM Zone_____

Survey Date_____ Surveyors_____

ENVIRONMENTAL DESCRIPTION

Elevation _____ Slope _____ Aspect_____

Topographic Position

Landform

Cowardian System	Hydrologic Regime		Salinity Modifiers
___Upland	Non-Tidal		___Saltwater
___Riverine	___Permanently Flooded	___Saturated	___Brackish
___Palustrine	___Semipermanetly Flooded	___Temporarily Flooded/Saturated	___Freshwater
___Lacustrine	___Seasonally Flooded	___Intermittently Flooded	

Environmental Comments:	Unvegetated Surface: (please use the cover scale below)
	___ Bedrock ___ Litter, duff ___ Wood (> 1 cm)
	___ Large rocks (cobbles, boulders > 10 cm)
	___ Small rocks (gravel, 0.2-10 cm)
	___ Sand (0.1-2 mm) ___ Bare soil
	___ Other:_____

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	Cover Scale for Strata & Unvegetated Surface		Height Scale for Strata	
Trees and Shrubs		___Forest				
___Evergreen	___Broad-leaved	___Woodland	01	5%	01	<0.5 m
___Cold-deciduous	___Needle-leaved	___Shrubland	02	10%	02	0.5-1m
___Drought-deciduous	___Mixed broad-leaved/Needle leaved	___Dwarf Shrubland	03	20%	03	1-2 m
___Mixed evergreen - cold-deciduous	___Microphyllous	___Herbaceous	04	30%	04	2-5 m
___Mixed evergreen - drought-deciduous	___Graminoid	___Nonvascular	05	40%	05	5-10 m
	___Forb	___Sparsely Vegetated	06	50%	06	10-15 m
Herbs	___Pteridophyte		07	60%	07	15-20 m
___Annual			08	70%	08	20-35 m
___Perennial			09	80%	09	35 - 50 m
			10	90%	10	>50 m
			11	100%		

Strata	Height	Cover Class	Dominant species (mark any known diagnostic species with a *)	Cover Class
T1 Emergent	____	____		
T2 Canopy	____	____		
T3 Sub-canopy	____	____		
S1 Tall shrub	____	____		
S2 Short Shrub	____	____		
S3 Dwarf-shrub H Herbaceous	____	____		
N Non-vascular	____	____		
V Vine/liana	____	____		
E Epiphyte	____	____		

please see the table on the previous page for height and cover scales for strata

Other Comments

Cover Scale for Species
01 <1%
02 1-5%
03 5-25%
04 25-50%
05 50-75%
06 75-100%

ACCURACY ASSESSMENT POINT FORM

IDENTIFIERS/LOCATORS

Field Point Code _____ Database Point Code _____

State __ Park Name _____ Park Site Name _____

Quad Name_____ QuadCode_____

Primary Name Veg Assoc: _____

Secondary Name Veg Assoc:_____

Other Veg Assoc within 50 m _____

Classification Comments:

GPS file name_____ Field UTM X___ ___ ___ ___ ___ ___ m E Field UTM Y___ ___ ___ ___ ___ ___ ___ m N

GPS Error _____ m

please do not complete the following information when in the field

Corrected UTM X___ ___ ___ ___ ___ ___ m E Corrected UTM Y___ ___ ___ ___ ___ ___ ___ m N UTM Zone____

Survey Date_____
Surveyors_____

ENVIRONMENTAL DESCRIPTION

Elevation _____ Slope _____Aspect_____

Topographic Position

Landform

Environmental Comments (including hydrology):	Unvegetated Surface: *(please use the cover scale below)* ___ Bedrock ___ Litter, duff ___ Wood (> 1 cm) ___ Large rocks (cobbles, boulders > 10 cm) ___ Small rocks (gravel, 0.2-10 cm) ___ Sand (0.1-2 mm) ___ Bare soil ___ Other:_____

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	HEIGHT (M)	COVER SCALE
Trees and Shrubs	___Broad-leaved	___Forest	01 -<0.5	T - <1%
___Evergreen	___Needle-leaved	___Woodland	02 - 0.5-1	01 - 1-5%
___Cold-deciduous	___Mixed broad-lvd/Needle-lvd	___Shrubland	03 - 1-2	02 - 6-15%
___Drought-deciduous	___Microphyllous	___Dwarf-shrubland	04 - 2-5	03 - 16-25%
___Mixed evergreen - cold-deciduous	___Graminoid	___Herbaceous	05 - 5-10	04 - 26-35%
___Mixed everg. - drought-deciduous	___Forb	___Nonvascular	06 - 10-15	05 - 36-45%
Herbs	___Pteridophyte	___Sparsely Vegetated	07 - 15-20	06 - 46-55%
___Annual			08 - 20-35	07 - 56-65%
___Perennial			09 - 35-50	08 - 65-75%
			10 ->50	09 - 76-85%
				10 - 86-95%
				11- 96-100%

Strata	Height Class	Cover Class	Dominant species (mark any known diagnostic species with a *)	Cover Class
T1 Emergent	____	____		
T2 Canopy	____	____		
T3 Sub-canopy	____	____		
S1 Tall shrub	____	____		
S2 Short Shrub	____	____		
S3 Dwarf-shrub	____	____		
H Herbaceous	____	____		
N Non-vascular	____	____		
V Vine/liana	____	____		
E Epiphyte	____	____		

APPENDIX C: Dichotomous Key to LYJO Plant Associations

Key to Vegetation types at LYJO (Developed By Roger Sanders, Botanical Research Institute of Texas, May 2006)

1. Trees forming ≥ 10% canopy, subcanopy may or may not be developed: forests and woodlands **2**

1. Tree canopy ≤ 10%, subcanopy not developed: non-forested vegetation **8**

2. Canopy and subcanopy both developed, together usually constituting ≥ (40-)50% cover..... **3**

2. Subcanopy not developed, the single-layered canopy constituting about 10-40% cover..... **6**

3. Forest and woodlands on alluvial terraces, old stream channels, or footslope drainageways **4**

3. Forest and woodlands on rocky upland slopes or well drained footslopes..... **5**

4. Forest and woodlands dominated by *Carya illinoinensis* accompanied by significant numbers of *Celtis laevigata* and *Ulmus americana* or *Fraxinus pennsylvanica.*

   ***Carya illinoinensis – Celtis laevigata* Forest**

4. Forest and woodlands dominated by *Quercus fusiformis* or *Ulmus crassifolia*, although *Carya illinoinensis* may be present.

   ***Quercus fusiformis – Celtis reticulata var. reticulata* Woodland**

5. Forest and woodlands dominated by *Quercus stellata* with an understory of *Juniperus ashei* and often accompanied by *Sophora affinis* and *Quercus marilandica.*

   ***Quercus stellata – (Quercus fusiformis - Quercus marilandica) –Juniperus ashei/ Schizachyrium scoparium Woodland* (Provisional)**

5. Forest and woodlands dominated by a mixture of *Quercus fusiformis* and *Quercus buckleyi* or *Quercus stellata*, often with an understory of *Juniperus ashei*.

   ***Quercus fusiformis / Schizachyrium scoparium* Woodland**

6. Savanna dominated by scattered trees of *Carya illinoinensis*, ground layer dominated by tallgrass prairie species over 1 m tall.

   Restored Tallgrass Prairie

6. Savanna and woodland not dominated by *Carya illinoinensis*, ground layer composed of mixed or midgrass prairie and exotic species about 0.5 m tall **7**

7. Savanna dominated by scattered trees of *Quercus stellata*

***Quercus stellata – Quercus marilandica* Woodland Alliance**

7. Savanna and woodland dominated by *Prosopis glandulosa*

***Prosopis glandulosa* Woodland Alliance**

8. Shrubs dominant

***Panicum virgatum – Tripsacum dactyloides* Herbaceous Alliance**

8. Herbs dominant.....**9**.

9. Vegetation in intermittently flooded stream banks, old stream channels, or seepy swales; canopy 1-2 m tall.

***Panicum virgatum – Tripsacum dactyloides* Herbaceous Alliance**

9. Vegetation on well-drained alluvial terraces or uplands; canopy usually ≤1 m tall.....**10**

10. Vegetation on thin limestone soils; *Bouteloua curtipendula* dominant or co-dominant with *Nassella leucotricha* and/or *Sporobolus compositus* var. *drummondii*; other *Bouteloua* species usually present.

Bouteloua hirsuta – Bouteloua curtipendula Herbaceous Vegetation

10. Vegetation on thick soils, *Bouteloua curtipendula* sometimes a subdominant or associate species, but other *Bouteloua* species lacking.....**11**

11. Canopy usually less than 0.5 m tall, dominated by *Cynodon dactylon*.

***Cynodon dactylon* Herbaceous Vegetation**

11. Canopy usually 0.5-1 m tall, dominated by other grasses. **12**

12. Vegetation consisting of a mixture of tallgrass and midgrass grasses; if dominated by *Sporobolus compositus* var. *drummondii*, *Bothriochloa ischaemum*, or *Bothriochloa laguroides,* then containing significant amounts of a mixture of *Elymus canadensis, Panicum virgatum*, *Schizachyrium scoparium,* and *Sorghastrum nutans* without significant amounts of *Bromus japonicus* or *Sorghum halepense*.

Restored Tallgrass Prairie

12. Vegetation consisting of a mixture of primarily midgrass grasses, dominated in the spring by *Bromus japonicus* and *Nassella leucotricha* and later by *Sporobolus compositus* var. *drummondii*, *Bothriochloa ischaemum*, or *Bothriochloa laguroides*, often with large patches of *Sorghum halepense*, but without significant amounts of a mixture of *Elymus canadensis, Panicum virgatum*, *Schizachyrium scoparium,* and *Sorghastrum nutans.*

***Bothriochloa laguroides – Sorghum halepense* Herbaceous Vegetation**

APPENDIX D: Vegetation Association Descriptions for LYJO

NatureServe. 2006. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of December 2006.

U.S. NATIONAL VEGETATION CLASSIFICATION

Lyndon B. Johnson National Historical Park

December 31, 2006

By
NatureServe
1101 West River Parkway Suite 200
Minneapolis, Minnesota 55415

And
NPS - Southern Plains Network Coordinator
P.O. Box 329, 100 Ladybird Lane
Johnson City, TX 78636

This subset of the U.S. National Classification covers vegetation associations and alliances attributed to Lyndon B. Johnson National Historical Park**.** This classification has been developed in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. Comments and suggestions regarding the contents of this subset should be directed to Jim Drake, Regional Vegetation Ecologist, 612-331-0729, jim_drake@natureserve.org or Heidi Sosinski, Data Manager, 830-868-7128 ext. 282, heidi_sosinski@nps.gov.

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NatureServe
1101 Wilson Blvd, 15th floor
Arlington, VA 22209

These data are extracted from:
NatureServe. 2006. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of December 2006.

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NatureServe1 and LYJO. 2006. U.S. National Vegetation Classification: Lyndon B. Johnson National Historical Park: Global and Local Descriptions. NatureServe Central Databases. Arlington, VA, NatureServe Midwest Office, Minneapolis, MN and Lyndon B. Johnson National Historical Park, Johnson City, TX. Data current as of December 2006.

1 NatureServe is an international organization including NatureServe regional offices, a NatureServe central office, U.S. State Natural Heritage Programs, and Conservation Data Centres (CDC) in Canada and Latin America and the Caribbean. Ecologists from the following organizations have contributed the development of the ecological systems classification:

CEGL002087 *Carya illinoinensis – Celtis laevigata* Forest

Translated Name: Pecan – Sugar Hackberry Forest
Common Name: Pecan – Sugar Hackberry Forest

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and chance historical events. This community occurs on the primary terraces, natural levees and filled-in old stream channels bordering the Pedenales River. Topography and water availability appear to be a more important factor than are soils, as the community occurs on a range of alluvium-derived soils, including silt, clay loam, sandy loam, and loamy sand. Composition of tree species at any given site is probably largely dependent on chance establishment, especially following damaging floods. Flooding of major proportions does not occur as it once did due to impoundments along the river.

VEGETATION DESCRIPTION

The canopy varies from 12 to 20 m high, producing 80 to 50 percent cover or less. The lower, more open canopies occur along the main channel bank where flooding is most disruptive to soil stability and plant establishment. Along with the dominant *Carya illinoinensis*, characteristic trees are *Celtis laevigata*, *Ulmus americana*, and *Fraxinus pennsylvanica.* In the more disturbed sites and on the bank of the main channel, the open communities are dominated by a mix of *Ulmus americana*, *Fraxinus pennsylvanica*, *Platanus occidentalis,* and invasive *Melia azedarach.* The understory is generally open, consisting of scattered tree saplings. However, some sites develop a dense shrub layer of up to 90% cover, consisting primarily of *Cornus drummondii*. Typically the ground layer covers only about 30% of the surface and consists of seedlings, low shrubs and vines (especially *Rubus trivialis*), and shade-tolerant forbs (*Geum canadense, Verbesina virginica*) and grasses (*Elymus virginicus*). In the openings, the herbaceous layer is denser (up to 70% cover) and is more diverse, dominated primarily by *Bromus japonicus* and *Cynodon dactylon*, which are mixed with *Elymus virginicus*, *Panicum virgatum*, *Sorghum halepense*, *Tripsacum dactyloides*, *Tridens flavus*, and *Verbesina encelioides*.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Carya illinoinensis	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Celtis laevigata	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Ulmus americana	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Fraxinus pennsylvanica	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Platanus occidentalis	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Cornus drummondii	Shrub/sapling (tall & short)	Broad-leaved deciduous shrub
Rubus trivialis	Short shrub/sapling	Other shrub
Geum canadense	Herb (field)	Forb
Verbesina virginica	Herb (field)	Forb
Elymus virginicus	Herb (field)	Graminoid

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Melia azedarach			Invasive alien
Bromus japonicus			Subinvasive alien
Cynodon dactylon			Subinvasive alien
Ligustrum japonicum			Invasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments: Disturbance to the riparian habitats of this area has degraded these communities, making classification of the more modified sites tentative.

Other Comments:

ELEMENT DISTRIBUTION

This community occurs in the Johnson City Unit along Town Creek where it passes by the headquarters building. It has largely been displaced from the Ranch Unit where the terraces of the Pedenales River have been converted to shaded pasture (select pecans and American elms retained over planted exotic pasture grasses. It is best developed in the State Park along the south bank of the Pedenales River east of the Park Road 49 bridge. It also occurs along the creek where it flows north into the Pedenales River below the Sauer-Beckman Farm.

ELEMENT SOURCES

Inventory Notes:
LYJO Plots: LYJO.13, LYJO.17, LYJO.23, LYJO.25, LYJO.27
Description Author(s): R. Sanders

CEGL002153 *Quercus fusiformis – Celtis reticulata var. reticulata* Woodland

Translated Name: Plateau Live Oak – Netleaf Hackberry Woodland
Common Name: Plateau Live Oak – Netleaf Hackberry Woodland

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and chance historical events. This community occurs on the secondary and tertiary terraces, natural levees and filled-in old stream channels paralleling the Pedenales River. Water appears to be somewhat less available than in the adjacent and slightly lower Pecan-Sugar Hackberry Forest. Soils are alluvium-derived consisting mostly of loam, sandy loam, and loamy sand. Composition of tree species at any given site is probably largely dependent on chance establishment, especially following damaging floods. Flooding of major proportions does not occur as it once did due to impoundments along the river.

VEGETATION DESCRIPTION

The canopy is low at about 10-15 meters and provides between 20 and 70 percent cover. The subcanopy is well developed often contributing equally or more cover than does the main canopy. Composition varies from strongly dominated by *Quercus fusiformis* to strongly dominated by *Ulmus crassifolia*. Associated trees often include *Carya illinoinensis*, *Celtis laevigata,* and *Juniperus ashei*. The shrub layer is sparse to moderate consisting mostly of tree saplings, *Juniperus ashei,* and *Ilex decidua.* The density of the ground layer is about 30%, which consists of shade-tolerant forbs such as *Calyptocarpus vialis* and *Verbesina virginica*, spring ephemeral grasses, such as *Bromus japonicus*, or herbs under small openings in the canopy, such as the disturbance-tolerant grass *Nassella leucotricha*.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Quercus fusiformis	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Ulmus crassifolia	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Carya illinoinensis	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Celtis laevigata	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Juniperus ashei	Tree (canopy & subcanopy)	Needle-leaved tree
Juniperus ashei	Shrub/sapling (tall & short)	Needle-leaved tree
Ilex decidua	Shrub/sapling (tall & short)	Broad-leaved deciduous shrub
Calyptocarpus vialis	Herb (field)	Forb
Verbesina virginica	Herb (field)	Forb
Bromus japonicus	Herb (field)	Graminoid
Nassella leucotricha	Herb (field)	Graminoid

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Bromus japonicus			Subinvasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments:

Other Comments:

ELEMENT DISTRIBUTION

This community occurs in the Johnson City Unit along Town Creek where it passes through the southern portion of the unit. It has largely been displaced from the Ranch Unit where the terraces of the Pedenales River have been converted to shaded pasture (select plateau live oaks over planted exotic pasture grasses). It is best developed in the State Park along both sides of Ranch Road 1 paralleling the south bank of the Pedenales River, especially east of the Park Road 49 bridge. It also occurs on the slopes along the creek below the Sauer-Beckman Farm.

ELEMENT SOURCES

Inventory Notes:
LYJO Plots: LYJO.14, LYJO.24, LYJO.26, LYJO.27
Description Author(s): R. Sanders

CEGL002115 *Quercus fusiformis / Schizachyrium scoparium* Woodland

Translated Name: Plateau Live Oak / Little Bluestem Woodland
Common Name: Plateau Live Oak / Little Bluestem Woodland

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and disturbance. This community occurs on the loamy soils overlying calcareous bedrock of uplands, including low rocky mounds projecting above foot-slopes and upper alluvial terraces near the Pedenales River. Composition of tree species at any given site is probably largely dependent on exact soil and substrate composition, elevation in relation to drainage, history of fire disturbance, and past management.

VEGETATION DESCRIPTION

The canopy is low at about 10-15 meters and provides between 20 and 70 percent cover. The subcanopy is sparse and not well differentiated from the main canopy, except where junipers have invaded heavily. *Quercus fusiformis* usually dominates over other species. However, on the driest upper slopes with thin rocky soils, *Quercus buckleyi* can dominate locally, and on sandier loams of foot-slopes, *Quercus stellata* can become co-dominant. *Celtis laevigata* can be a minor associate. The subcanopy and shrub layers, when present, consist almost entirely of tree saplings and *Juniperus ashei.* The density of the ground layer varies from 5 to 50%, depending on the density of the canopy, amount of invasion of junipers, and availability of water to the grasses in the upper slope openings. In the savanna openings, herbaceous composition is similar to that of the Upland Disturbed Herbaceous communities, except that the native *Schizachyrium scoparium* and *Nassella leucotricha* often dominate. Under the tree canopy, the ground layer consists of shade-tolerant forbs (*Verbesina virginica*) and graminoids (*Carex planostachys*).

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Quercus fusiformis	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Quercus buckleyi	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Quercus stellata	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Celtis laevigata	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Juniperus ashei	Tree (canopy & subcanopy)	Needle-leaved tree
Juniperus ashei	Shrub/sapling (tall & short)	Needle-leaved tree
Smilax bona-nox	Shrub/sapling (tall & short)	Vine/Liana
Croton monanthogynus	Herb (field)	Forb
Verbesina virginica	Herb (field)	Forb
Schizachyrium scoparium	Herb (field)	Graminoid
Nassella leucotricha	Herb (field)	Graminoid
Carex planostachys	Herb (field)	Graminoid

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)

CLASSIFICATION & OTHER COMMENTS

Classification Comments: This class is heterogeneous varying from nearly open herbaceous vegetation to forest, in which the dominants vary from site to site.

Other Comments:

ELEMENT DISTRIBUTION

This class occurs only at the Ranch unit in the northwest corner upland and in the State Park on rocky mounds south of the Sauer-Beckman Farm and on footslopes east of the Lutheran Church/Rest Area.

ELEMENT SOURCES

Inventory Notes:
LYJO Plots: LYJO.9, LYJO.20, LYJO.30, LYJO.35, LYJO.36
Description Author(s): R. Sanders

NEW *Quercus stellata – (Quercus fusiformis - Quercus marilandica) –Juniperus ashei/ Schizachyrium scoparium* Woodland (Provisional)
Translated Name: Post Oak – (Plateau Live Oak – Blackjack Oak) – Ashe Juniper/Little Bluestem Woodland
Common Name: Lampassas Cutplain Limestone Post Oak Woodland

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and lack of fire disturbance. This community occurs on the loamy soils overlying calcareous bedrock of uplands or old alluvial terraces of foot-slopes near the Pedenales River.

VEGETATION DESCRIPTION

The canopy is about 15 meters high and provides between 50-60 percent cover. The subcanopy is well developed, providing half to equal amounts of cover as the canopy. The dominant species is *Quercus stellata* and documented associates are *Celtis laevigata* and *Sophora affinis*. Although undocumented in the samples, *Quercus marilandica* is expected to be associated. The subcanopy and shrub layers are dominated by *Juniperus ashei*, but *Ilex decidua* and saplings of the other trees, as well as *Ulmus crassifolia* are present. The density of the ground layer is sparse due to the invasion of junipers. The ground layer consists of shade-tolerant forbs (e.g., *Vernonia baldwinii*) and scattered grasses that are persisting despite juniper invasion (*Schizachyrium scoparium*, *Nassella leucotricha*).

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Quercus stellata	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Sophora affinis	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Juniperus ashei	Tree (canopy & subcanopy)	Needle-leaved tree
Juniperus ashei	Shrub/sapling (tall & short)	Needle-leaved tree
Celtis laevigata	Shrub/sapling (tall & short)	Broad-leaved deciduous tree
Ilex decidua	Shrub/sapling (tall & short)	Broad-leaved deciduous shrub
Smilax bona-nox	Herb (field)	Vine/Liana
Vernonia baldwinii	Herb (field)	Forb
Schizachyrium scoparium	Herb (field)	Graminoid
Nassella leucotricha	Herb (field)	Graminoid

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)

CLASSIFICATION & OTHER COMMENTS

Classification Comments:

Other Comments:

ELEMENT DISTRIBUTION

This community is found only at the Ranch unit in the northwest upland on convex slopes and at the State Park on footslopes southeast of the park headquarters.

ELEMENT SOURCES

Inventory Notes:
LYJO Plots: LYJO.8, LYJO.28
Description Author(s): R. Sanders

A.625 *Quercus stellata – Quercus marilandica* Woodland Alliance

Translated Name: Post Oak – Blackjack Oak Woodland Alliance
Common Name:

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, past management. This community occurs on loamy soils overlying calcareous bedrock or old alluvial terraces of foot-slopes near the Pedenales River. The community appears to have been maintained as a native pasture in which the characteristic trees were kept for shade, but invasive species were removed by mowing or by hand. It is not known to what degree fire disturbance or the lack of it has shaped the current vegetation.

VEGETATION DESCRIPTION

The canopy is low, not exceeding 10 meters high, is sparse, averaging about 10-25% cover, and consists almost entirely of *Quercus stellata*. Although undocumented in the samples, *Quercus marilandica* and *Sophora affinis* are expected to be associated and may have been overlooked. A small area (observed but not sampled) consisted of the latter two species without *Quercus stellata*. A subcanopy is lacking. Scattered shrubs include *Juniperus ashei*, *Prosopis glandulosa, Diospyros texana*, and *Mahonia trifoliolata*. The ground layer provides a cover of about 70% and is dominated by *Sporobolus compositus* var. *drummondii* and *Nassella leucotricha* except where *Cynodon dactylon* has invaded from adjoining cultivated pastures. *Opuntia* spp. are usually present, at least, at low frequency. Various forbs are present, including some wildflower species (especially *Ratibida columnifera*).

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Quercus stellata	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Sophora affinis	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Quercus marilandica	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Juniperus ashei	Shrub/sapling (tall & short)	Needle-leaved tree
Prosopis glandulosa	Short shrub/sapling	Thorn tree
Diospyros texana	Short shrub/sapling	Broad-leaved deciduous shrub
Cynodon dactylon	Herb (field)	Graminoid
Nassella leucotricha	Herb (field)	Graminoid
Sporobolus compositus var. *drummondii*	Herb (field)	Graminoid

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Cynodon dactylon			Subinvasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments: This class could be combined with the Post Oak – (Plateau Live Oak – Blackjack Oak) – Ashe Juniper/Little Bluestem Woodland.

Other Comments:

ELEMENT DISTRIBUTION

This community has not been found at the Ranch unit, but a small area occurs at the Johnson City unit along the extreme southern boundary (consisting of two trees of *Quercus marilandica*, two trees of *Sophora affinis*, and none of *Quercus stellata*). It is best developed in the State Park east of the Lutheran Church/Rest Area.

ELEMENT SOURCES

Inventory Notes:
LYJO Plots: LYJO.18, LYJO19
Description Author(s): R. Sanders

A.501 *Juniperus ashei* Woodland Alliance

Translated Name: Ashe's Juniper Woodland Alliance
Common Name:

ENVIRONMENTAL DESCRIPTION

Woodlands in this alliance generally occur on calcareous substrates, with shallow, rocky soils, often with much exposed bedrock and lichen coverage. These woodlands occur on dolomite, rimrock bluffs (Ozarks), and on slopes with shallow soils over limestone (Edwards Plateau, Arbuckle Mountains). Fire and drought are thought to play important roles in maintaining these woodlands.

VEGETATION DESCRIPTION

This alliance includes evergreen woodlands dominated by *Juniperus ashei* occurring in the Ozarks and southwest to central Texas. In Texas associated species include evergreen oaks *Quercus fusiformis, Quercus vaseyana (= Quercus pungens var. vaseyana)* and deciduous oaks *Quercus sinuata var. breviloba* and *Quercus buckleyi*, as well as *Mahonia trifoliolata (= Berberis trifoliolata), Bouteloua curtipendula, Carex planostachys, Celtis laevigata var. reticulata (= Celtis reticulata), Diospyros texana, Fraxinus texensis, Lespedeza texana, Nolina texana, Toxicodendron pubescens (= Rhus toxicodendron), Rhus virens, Schizachyrium scoparium*, and *Yucca rupicola*. In the Ozarks, the canopy is dominated by *Juniperus ashei*, although *Juniperus virginiana* may be present and *Quercus muehlenbergii* and *Fraxinus quadrangulata* may form a minor component. Woodlands in the Arbuckle Mountains of Oklahoma have a grassy understory dominated by *Schizachyrium scoparium*.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)

CLASSIFICATION & OTHER COMMENTS

Classification Comments: This type was not sampled at LYJO but instead represents stands that were observed in areas surrounding the park.

Other Comments:

ELEMENT DISTRIBUTION

This alliance includes evergreen woodlands dominated by *Juniperus ashei*, occurring in the Ozarks of Arkansas and southern Missouri, the Arbuckle Mountains of Oklahoma, and in the Edwards Plateau of Texas.

ELEMENT SOURCES

Inventory Notes:
LYJO Plots:
Description Author(s):

A.611 *Prosopis glandulosa* Woodland Alliance

Translated Name: Honey Mesquite Woodland Alliance
Common Name: Honey Mesquite Woodland Alliance

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and past management. This community occurs on the loamy soils overlying calcareous bedrock or old alluvial terraces of foot-slopes near the Pedenales River. The community appears to have developed in abandoned cultivated pasture in which the invasive species were allowed to succeed. Fire suppression has probably contributed to the current vegetation.

VEGETATION DESCRIPTION

The canopy is dominated by *Prosopis glandulosa* and is about 10 meters high and open, averaging about 30% cover, except where succession has permitted taller riparian trees to invade or encroach. Thus, associated trees may include *Celtis laevigata, Juniperus ashei, Quercus fusiformis,* or *Sapindus saponaria*. Except for saplings, the subcanopy and shrub layers are lacking. The ground layer provides a cover of about 80% and is dominated by *Bromus japonicus* and *Cynodon dactylon*. Various weedy forbs (*Croton monanthogynus, Marrubium vulgare, Ruellia nudiflora, Solanum elaeagnifolium, Tragia brevispica, Verbesina virginica*) and grasses (*Cenchrus spinifex, Setaria scheelei, Sorghum halepense*) are present, especially in shady patches

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Prosopis glandulosa	Tree (canopy & subcanopy)	Thorn tree
Celtis laevigata	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Juniperus ashei	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Quercus fusiformis	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Croton monanthogynus	Herb (field)	Forb
Solanum elaeagnifolium	Herb (field)	Forb
Tragia brevispica	Herb (field)	Forb
Verbesina virginica	Herb (field)	Forb
Bromus japonicus	Herb (field)	Graminoid
Cynodon dactylon	Herb (field)	Graminoid
Setaria scheelei	Herb (field)	Graminoid

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Bromus japonicus			Subinvasive alien
Cynodon dactylon			Subinvasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments:

Other Comments: This community is largely successional and dependent on the time since management was relaxed. Therefore, it is somewhat heterogeneous and not well developed in the parks.

ELEMENT DISTRIBUTION

The class is mappable only in scattered patches between Ranch Road 1 and Highway 290 near the Danz Farm and near the bison pastures.

ELEMENT SOURCES

Inventory Notes:
LYJO Plots: LYJO.22, LYJO.32
Description Author(s): R. Sanders

A.948 *Salix nigra* Temporarily Flooded Shrubland Alliance

Translated Name: Black Willow Temporarily Flooded Shrubland Alliance

ENVIRONMENTAL DESCRIPTION

These thickets of *Salix nigra* are found along rivers or the shores of artificial lakes.

VEGETATION DESCRIPTION

These young, or frequently disturbed, thickets of *Salix nigra* often have few to no other species present.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)

CLASSIFICATION & OTHER COMMENTS

Classification Comments: Currently (2000-05-17) includes the former *Salix nigra* Woodland (CEGL003731). Later successional and/or more communities with *Salix nigra* as a dominant will be found in *Salix nigra* Temporarily Flooded Forest Alliance (A.297).

Other Comments: This type was not sampled at LYJO but represents stands that were observed in areas surrounding the park.

ELEMENT DISTRIBUTION

This alliance is present in the following regions: Piedmont, Cumberland Plateau, Coastal Plain, Ozark Highlands, Boston Mountains, Ouachita Mountains, Arkansas Valley, Mississippi River Alluvial Plain, and Florida Peninsula. It is found throughout the eastern United States from Maine to Florida, west to Oklahoma and Texas. It may also occur in Ontario, Canada.

ELEMENT SOURCES

Inventory Notes:
LYJO Plots:
Description Author(s):

NEW *Cynodon dactylon* Herbaceous Vegetation

Translated Name: Bermuda Grass Herbaceous Vegetation
Common Name:

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, and past management. In the parks, this community occurs on loamy sands and sandy loams (although other soils would support it, as well) overlying lower to upper alluvial terraces of the Pedenales River. The community appears to have developed in abandoned cultivated pasture often in association with seeding to native wildflower species. These areas are regularly mowed/shredded, and fire suppression has probably contributed to the current vegetation.

VEGETATION DESCRIPTION

The canopy is usually about 0.5 m high and provides 60-70% cover. *Cynodon dactylon* strongly dominates with only about 10% of the cover consisting of persisting native (*Aristida purpurea, Bouteloua curtipendula, Bothriochloa laguroides, Dichanthelium oligosanthes, Eragrostis intermedia, Paspalum setaceum*, and *Schizachyrium scoparium*) and alien (*Bromus japonicus*) grasses and low frequency forbs, especially commonly planted prairie wildflower species. Of these latter, *Ratibida columnifera* was observed in all plots sampled.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Cynodon dactylon	Herb (field)	Graminoid
Aristida purpurea	Herb (field)	Graminoid
Bouteloua curtipendula	Herb (field)	Graminoid
Bothriochloa laguroides	Herb (field)	Graminoid
Bromus japonicus	Herb (field)	Graminoid
Eragrostis intermedia	Herb (field)	Graminoid
Paspalum setaceum	Herb (field)	Graminoid
Schizachyrium scoparium	Herb (field)	Graminoid
Ratibida columnifera	Herb (field)	Forb

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Bromus japonicus			Subinvasive alien
Cynodon dactylon			Subinvasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments: This class is differentiated from cultivated land primarily by the greater mix of low frequency native grasses and forbs.

Other Comments:

ELEMENT DISTRIBUTION

This class occurs in the Ranch unit only along the Pedenales River opposite the Junction School, on the flood plain to the outside of the cattle guards. All such sites inside the cattle guards are maintained as cultivated pastures. In the State Park, it occurs in several mowed "prairie" areas near the headquarters building and other public display areas where wildflowers have been seeded.

ELEMENT SOURCES

Inventory Notes:
Plots: LYJO.15, LYJO.16, LYJO.34
Description Author(s): R. Sanders

NEW *Bothriochloa laguroides – Sorghum halepense* Herbaceous Vegetation

Translated Name: Silver Beardgrass – Johnsongrass Herbaceous Vegetation
Common Name:

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, and past management. In the parks, this community occurs on a variety of soils from clay to sandy loams overlying upper alluvial terraces and level to sloping foot slopes to mid-slopes along the Pedenales River. The community appears to have developed in abandoned or lightly grazed native pasture. Management does not include restoration except for the possible seeding to native wildflower species. These areas are intermittently mowed/shredded and occasionally grazed. Prescribed burning may have been practiced in recent years.

VEGETATION DESCRIPTION

The canopy is usually about 1 m high and provides 70-80% cover. Dominance varies from site to site and among patches within sites. The most consistent dominants include *Bouteloua curtipendula, Bothriochloa laguroides, Nassella leucotricha, Schizachyrium scoparium,* and *Sporobolus compositus* var. *drummondii*. The invasive alien grasses *Sorghum halepense* and *Bothriochloa ischaemum* often from extensive late-season stands; whereas *Bromus japonicus* can dominate sites in spring. A few weedy forbs (*Ambrosia psilostachya, Croton monanthogynus, Iva angustifolia, Phyla nodiflora*) are usually common. A variety of low frequency grasses and forbs, especially common prairie wildflower species are associated with this vegetation. Of these latter, *Ratibida columnifera* is almost always present.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Bouteloua curtipendula	Herb (field)	Graminoid
Bothriochloa ischaemum	Herb (field)	Graminoid
Bothriochloa laguroides	Herb (field)	Graminoid
Bromus japonicus	Herb (field)	Graminoid
Nassella leucotricha	Herb (field)	Graminoid
Schizachyrium scoparium	Herb (field)	Graminoid
Sorghum halepense	Herb (field)	Graminoid
Sporobolus compositus var. *drummondii*	Herb (field)	Graminoid
Ambrosia psilostachya	Herb (field)	Forb
Croton monanthogynus	Herb (field)	Forb
Iva angustifolia	Herb (field)	Forb
Phyla nodiflora	Herb (field)	Forb
Ratibida columnifera	Herb (field)	Forb

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Bothriochloa ischaemum			Subinvasive alien
Bromus japonicus			Subinvasive alien
Sorghum halepense			Subinvasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments: This association could be a degraded version of *Schizachyrium scoparium – Bouteloua curtipendula – Nassella leucotricha* Herbaceous Vegetation (CEGL004070).

Other Comments:

ELEMENT DISTRIBUTION

This class occurs in the Ranch unit in the fields paralleling the airstrip. These areas have not been plowed in several years and are not maintained as fertilized coastal Bermuda-grass pastures. In the State Park, it occurs in several infrequently mowed grassland areas between Ranch Road 1 and Highway 290.

ELEMENT SOURCES

Inventory Notes:
LYJO Plots: LYJO.3, LYJO.4, LYJO.6, LYJO.7, LYJO.21
Description Author(s): R. Sanders

Local Vegetation Unit Restored Tallgrass Prairie

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and past management. In the parks, this community occurs on clayey soils overlying calcareous strata on level to sloping mid-slopes along the Pedenales River. The community composition is dependant on restoration management in an abandoned pecan grove that probably served as native pasture. Recent management includes seeding to native tallgrass grasses and wildflower species, intermittently mowing/shredding, and prescribed burning.

VEGETATION DESCRIPTION

Besides the overstory of scattered pecan trees (*Carya illinoinensis*) at about 15 m high (0–40% cover), the canopy is usually about 1 m high and provides 60-80% cover. Dominance varies from site to site and among patches within sites. The most consistent dominants include *Bouteloua curtipendula, Bothriochloa laguroides, Elymus canadensis, Nassella leucotricha, Panicum virgatum*, *Schizachyrium scoparium, Sorghastrum nutans,* and *Sporobolus compositus* var. *drummondii*. Due to shading by the pecans and proximity to swales and drainageways, a number of species are frequent but are atypical to the park (*Carex planostachys, Rubus aboriginum, Vitis mustangensi*). A variety of low frequency grasses and forbs, especially common prairie wildflower species are associated with this vegetation. Of these, *Gaillardia pulchella* and *Ratibida columnifera* is almost always present.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Carya illinoinensis	Tree canopy	Broad-leaved deciduous tree
Bouteloua curtipendula	Herb (field)	Graminoid
Bothriochloa ischaemum	Herb (field)	Graminoid
Bothriochloa laguroides	Herb (field)	Graminoid
Elymus canadensis	Herb (field)	Graminoid
Nassella leucotricha	Herb (field)	Graminoid
Panicum virgatum	Herb (field)	Graminoid
Schizachyrium scoparium	Herb (field)	Graminoid
Sorghumastrum nutans	Herb (field)	Graminoid
Sporobolus compositus var. *drummondii*	Herb (field)	Graminoid
Gaillardia pulchella	Herb (field)	Forb
Ratibida columnifera	Herb (field)	Forb

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Bothriochloa ischaemum			Subinvasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments: Apparently, plans for restoration management include removal of pecan trees over the next several years and the planting of a few plateau live oaks (*Quercus fusiformis*).

Other Comments:

ELEMENT DISTRIBUTION

This vegetation occurs only at the Johnson City unit between Town Creek and the west end of the Johnson Settlement.

ELEMENT SOURCES

Inventory Notes:
LYJO Plots: LYJO.1, LYJO.2, LYJO.5
Description Author(s): R. Sanders

A.1194 *Panicum virgatum – Tripsacum dactyloides* Herbaceous Alliance

Translated Name: Switchgrass – Eastern Gammagrass Herbaceous Alliance
Common Name:

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, and water availability and drainage. In the parks, this community occurs in alluvial situations such as river channel banks and seepy prairie swales. The community appears to have developed in abandoned or lightly grazed native pasture where the water table is high or intermittent flooding occurs. Most of these areas are intermittently mowed/shredded and occasionally grazed, and prescribed burning may have been practiced in recent years. One site with moderate shrub cover may have resulted from a lack of grazing and fire.

VEGETATION DESCRIPTION

The canopy is 1 to 2 meters high, and cover is close to 100%. The community is composed of flood tolerant native grasses and sedges. The dominant species usually is *Panicum virgatum*, but can be replaced in patches by *Andropogon glomeratus, Carex emoryi*, *Sorghastrum nutans*, or *Tripsacum dactyloides.* In depressions of old channels, open patches often form between patches of the taller grasses where mats of *Muhlenbergia utilis* carpet the damp soil. Other associates include *Eleocharis montevidensis* and a mix of low frequency, water tolerant graminoids and forbs (especially the showy *Agalinis heterophylla* and *Sesbania drummondii*) while *Cynodon dactylon* and *Bothriochloa ischaemum* may be common on the edges of this community where it is near current or former pastures. One site has abundant *Baccharis neglecta* but is included in this community due to similarity in the herbaceous stratum and environmental setting.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Panicum virgatum	Herb (field)	Graminoid
Andropogon glomeratus	Herb (field)	Graminoid
Carex emoryi	Herb (field)	Graminoid
Sorghastrum nutans	Herb (field)	Graminoid
Tripsacum dactyloides	Herb (field)	Graminoid
Muhlenbergia utilis	Herb (field)	Graminoid
Eleocharis montevidensis	Herb (field)	Graminoid
Agalinis heterophylla	Herb (field)	Forb

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Cynodon dactylon			Subinvasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments: The areas may by too small to map.

Other Comments:

ELEMENT DISTRIBUTION

At the Ranch unit, this vegetation occurs along the banks of the channel of the Pedenales River and in swales of the primary terrace of the river. At the Johnson City unit, it occurs in old channels or sluggish drainageways in the grassland areas paralleling Town Creek.

ELEMENT SOURCES

Inventory Notes:
Plots: LYJO.10, LYJO.31, LYJO.33
Description Author(s): R. Sanders

CEGL001764 *Bouteloua hirsuta – Bouteloua curtipendula* Herbaceous Vegetation

Translated Name: Hairy Grama – Sideoats Grama Herbaceous Vegetation
Common Name: Hairy Grama – Sideoats Grama Shortgrass Prairie

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and past management. In the parks, this community occurs on thin stony, loamy soils overlying calcareous substrate on sloping mid-slopes and low ridges along the air landing strip. These sites are well drained with lower water availability than nearby sites with thicker soils. Especially at the very edge of the landing strip, the soil has been modified to contain caliche gravel. Otherwise, the community appears has developed in abandoned native pasture.

VEGETATION DESCRIPTION

The canopy is usually about 0.5 m high and provides 60-70% cover. Dominance varies from site to site and among patches within sites. The most consistent dominants include *Bouteloua curtipendula, Bothriochloa ischaemum,* and *Sporobolus compositus* var. *drummondii*. Associated grasses occurring at lower densities include *Aristida purpurea, Bouteloua hirsuta*, and *Bouteloua rigidiseta*. A diversity of native prairie forbs are also associated, the most common being *Aphanostephus riddellii, Desmanthus virgatus* var. *acuminatus, Hedyotis nigricans*, and *Liatris mucronata*.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Bouteloua curtipendula	Herb (field)	Graminoid
Bothriochloa ischaemum	Herb (field)	Graminoid
Sporobolus compositus var. *drummondii*	Herb (field)	Graminoid
Aristida purpurea	Herb (field)	Graminoid
Bouteloua hirsuta	Herb (field)	Graminoid
Bouteloua rigidiseta	Herb (field)	Graminoid
Aphanostephus riddellii	Herb (field)	Forb
Desmanthus virgatus var. *acuminatus*	Herb (field)	Forb
Hedyotis nigricans	Herb (field)	Forb
Liatris mucronata	Herb (field)	Forb

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Bothriochloa ischaemum			Subinvasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments: This class has limited occurrence as linear strips along the air landing strip where the soil and vegetation have remained more or less undisturbed (following initial construction of the airstrip) for 40 to 50 years. Therefore, it is not clear whether this will be mappable. Management does not include restoration except for the possible seeding to native wildflower species. These areas probably are intermittently mowed/shredded.

Other Comments: Mrs. Lyndon B. Johnson made it a point in the 1960s and 1970s to collect seed of species from nearby rocky prairies for planting along the airstrip.

ELEMENT DISTRIBUTION

This class occurs only on the Ranch unit as narrow strips along both sides of the air landing strip.

ELEMENT SOURCES

Inventory Notes:
Plots: LYJO.11, LYJO.12
Description Author(s): R. Sanders

APPENDIX E: LYJO Species List

This is not a complete list for LYJO. This list only contains the species recorded for the 2005 sample plots and the 2006 accuracy assessment points. Genus-only records indicate an unknown species.

Family	Scientific Name	Common Name
Acanthaceae	*Dicliptera brachiata*	branched foldwing
	Ruellia nudiflora	violet wild petunia
Agavaceae	*Yucca*	yucca
Anacardiaceae	*Toxicodendron radicans*	eastern poison ivy
Apiaceae	*Conium maculatum*	poison hemlock
	Hydrocotyle verticillata	whorled marshpennywort
	Spermolepis inermis	Red River scaleseed
Aquifoliaceae	*Ilex decidua*	possumhaw
Asclepiadaceae	*Asclepias asperula*	spider milkweed
Asclepiadaceae	*Asclepias oenotheroides*	zizotes milkweed
	Cynanchum	swallow-wort
	Matelea biflora	star milkvine
Asteraceae	*Ambrosia psilostachya*	Cuman ragweed
	Ambrosia trifida	great ragweed
	Aphanostephus	dozedaisy
	Aphanostephus riddellii	Riddell's dozedaisy
	Artemisia louisianica	
	Baccharis neglecta	Rooseveltweed
	Berlandiera ×betonicifolia	
	Calyptocarpus vialis	straggler daisy
	Chaptalia texana	silverpuff
	Cirsium texanum	Texas thistle
	Cirsium undulatum	wavyleaf thistle
	Conyza canadensis	Canadian horseweed
	Coreopsis tinctoria	golden tickseed
	Engelmannia peristenia	Engelmann's daisy
	Erigeron	fleabane
	Erigeron modestus	plains fleabane
	Erigeron strigosus	prairie fleabane
	Eupatorium serotinum	lateflowering thoroughwort
	Gaillardia pulchella	firewheel
	Gamochaeta pensylvanica	Pennsylvania everlasting
	Gutierrezia texana	Texas snakeweed
	Helianthus annuus	common sunflower
	Heterotheca canescens	hoary false goldenaster
	Heterotheca subaxillaris	camphorweed
	Hymenopappus scabiosaeus	Carolina woollywhite
	Iva angustifolia	narrowleaf marshelder
	Liatris mucronata	cusp blazing star
	Lygodesmia texana	Texas skeletonplant

	Melampodium leucanthum	plains blackfoot
	Parthenium hysterophorus	Santa Maria feverfew
	Ratibida columnifera	upright prairie coneflower
	Solidago canadensis	Canada goldenrod
	Solidago gigantea	giant goldenrod
	Symphyotrichum ericoides var. ericoides	white heath aster
	Symphyotrichum subulatum	eastern annual saltmarsh aster
	Verbesina encelioides	golden crownbeard
	Verbesina virginica	white crownbeard
	Vernonia baldwinii	Baldwin's ironweed
	Wedelia texana	hairy wedelia
	Xanthium strumarium	rough cockleburr
Berberidaceae	*Mahonia trifoliolata*	algerita
	Nandina domestica	sacred bamboo
Boraginaceae	*Buglossoides arvensis*	corn gromwell
Brassicaceae	*Lepidium austrinum*	southern pepperwort
Bromeliaceae	*Tillandsia recurvata*	small ballmoss
Cactaceae	*Opuntia*	pricklypear
	Opuntia engelmannii	cactus apple
	Opuntia leptocaulis	Christmas cactus
	Opuntia macrorhiza	twistspine pricklypear
Capparaceae	*Polanisia dodecandra*	redwhisker clammyweed
Caprifoliaceae	*Sambucus nigra*	European black elderberry
Caryophyllaceae	*Arenaria benthamii*	hilly sandwort
Commelinaceae	*Commelina erecta var. angustifolia*	whitemouth dayflower
Convolvulaceae	*Dichondra carolinensis*	Carolina ponysfoot
	Evolvulus sericeus	silver dwarf morning-glory
	Ipomoea cordatotriloba	tievine
Cornaceae	*Cornus drummondii*	roughleaf dogwood
Cupressaceae	*Juniperus ashei*	Ashe's juniper
Cyperaceae	*Carex*	sedge
	Carex emoryi	Emory's sedge
	Carex microdonta	littletooth sedge
	Carex planostachys	cedar sedge
	Cyperus	flatsedge
	Cyperus odoratus	fragrant flatsedge
	Cyperus retroflexus	oneflower flatsedge
	Cyperus retrorsus	pine barren flatsedge
	Cyperus strigosus	strawcolored flatsedge
	Eleocharis	spikerush
	Eleocharis montevidensis	sand spikerush
	Fuirena simplex	western umbrella-sedge
	Rhynchospora colorata	starrush whitetop
	Schoenoplectus pungens	common threesquare
Ebenaceae	*Diospyros texana*	Texas persimmon
Euphorbiaceae	*Acalypha ostryifolia*	pineland threeseed mercury
	Argythamnia humilis	low silverbush
	Cnidoscolus texanus	Texas bullnettle

	Croton glandulosus	vente conmigo
	Croton monanthogynus	prairie tea
	Croton texensis	Texas croton
	Euphorbia davidii	David's spurge
	Euphorbia marginata	snow on the mountain
	Phyllanthus polygonoides	smartweed leaf-flower
	Stillingia texana	Texas toothleaf
	Tragia brevispica	shortspike noseburn
	Tragia ramosa	branched noseburn
Fabaceae	*Amorpha fruticosa*	desert false indigo
	Desmanthus	bundleflower
	Desmanthus illinoensis	prairie bundleflower
	Desmanthus virgatus var. acuminatus	wild tantan
	Desmodium paniculatum	panicledleaf ticktrefoil
	Gleditsia triacanthos	honeylocust
	Hoffmannseggia tenella	slender rushpea
	Indigofera miniata	coastal indigo
	Lupinus texensis	Texas lupine
	Mimosa borealis	fragrant mimosa
	Mimosa roemeriana	Roemer's mimosa
	Prosopis glandulosa	honey mesquite
	Rhynchosia senna	Texas snoutbean
	Rhynchosia senna var. texana	Texas snoutbean
	Sesbania	riverhemp
	Sesbania drummondii	poisonbean
	Sophora affinis	Eve's necklacepod
Fagaceae	*Quercus buckleyi*	Buckley oak
	Quercus fusiformis	plateau oak
	Quercus marilandica	blackjack oak
	Quercus stellata	post oak
Gentianaceae	*Eustoma exaltatum ssp. russellianum*	showy prairie gentian
Juglandaceae	*Carya illinoinensis*	pecan
Juncaceae	*Juncus texanus*	Texas rush
Krameriaceae	*Krameria lanceolata*	trailing krameria
Lamiaceae	*Hedeoma acinoides*	slender false pennyroyal
	Hedeoma reverchonii	Reverchon's false pennyroyal
	Marrubium vulgare	horehound
	Monarda citriodora	lemon beebalm
	Salvia coccinea	blood sage
	Salvia texana	Texas sage
	Teucrium canadense	Canada germander
Linaceae	*Linum rigidum*	stiffstem flax
	Linum rupestre	rock flax
Malvaceae	*Callirhoe involucrata*	purple poppymallow
	Rhynchosida physocalyx	buffpetal
	Sida abutifolia	spreading fanpetals
Meliaceae	*Melia azedarach*	Chinaberrytree
Menispermaceae	*Cocculus carolinus*	Carolina coralbead

Moraceae	*Maclura pomifera*	osage orange
	Morus alba	white mulberry
	Morus rubra	red mulberry
Nyctaginaceae	*Boerhavia diffusa*	red spiderling
	Mirabilis jalapa	marvel of Peru
Oleaceae	*Forestiera pubescens*	stretchberry
	Fraxinus caroliniana	Carolina ash
	Fraxinus pennsylvanica	green ash
	Ligustrum japonicum	Japanese privet
	Ligustrum sinense	Chinese privet
Onagraceae	*Gaura*	beeblossom
	Gaura mollis	velvetweed
Ophioglossaceae	*Ophioglossum engelmannii*	limestone adderstongue
Oxalidaceae	*Oxalis drummondii*	Drummond's woodsorrel
	Oxalis stricta	common yellow oxalis
Papaveraceae	*Argemone aurantiaca*	Texas pricklypoppy
Plantaginaceae	*Plantago rhodosperma*	redseed plantain
	Plantago wrightiana	Wright's plantain
Platanaceae	*Platanus occidentalis*	American sycamore
Poaceae	*Andropogon glomeratus*	bushy bluestem
	Aristida purpurea	purple threeawn
	Aristida purpurea var. purpurea	purple threeawn
	Bothriochloa ischaemum	yellow bluestem
	Bothriochloa laguroides	silver beardgrass
	Bothriochloa pertusa	pitted beardgrass
	Bouteloua	grama
	Bouteloua curtipendula	sideoats grama
	Bouteloua hirsuta	hairy grama
	Bouteloua rigidiseta	Texas grama
	Bromus japonicus	Japanese brome
	Cenchrus spinifex	coastal sandbur
	Chasmanthium latifolium	Indian woodoats
	Chloris	windmill grass
	Chloris cucullata	hooded windmill grass
	Chloris verticillata	tumble windmill grass
	Cynodon dactylon	Bermudagrass
	Dichanthelium	rosette grass
	Dichanthelium acuminatum	tapered rosette grass
	Dichanthelium oligosanthes	Heller's rosette grass
	Digitaria cognata	Carolina crabgrass
	Elymus canadensis	Canada wildrye
	Elymus virginicus	Virginia wildrye
	Eragrostis intermedia	plains lovegrass
	Eragrostis sessilispica	tumble lovegrass
	Erioneuron pilosum	hairy woollygrass
	Lolium arundinaceum	tall fescue
	Muhlenbergia bushii	nodding muhly
	Muhlenbergia lindheimeri	Lindheimer's muhly

	Muhlenbergia sobolifera	rock muhly
	Muhlenbergia utilis	aparejograss
	Nassella leucotricha	Texas tussockgrass
	Panicum	panicgrass
	Panicum capillare	witchgrass
	Panicum coloratum	klinegrass
	Panicum virgatum	switchgrass
	Paspalum dilatatum	dallisgrass
	Paspalum pubiflorum	hairyseed paspalum
	Paspalum setaceum	thin paspalum
	Paspalum urvillei	Vasey's grass
	Schizachyrium scoparium	little bluestem
	Setaria parviflora	marsh bristlegrass
	Setaria scheelei	southwestern bristlegrass
	Sorghastrum nutans	Indiangrass
	Sorghum halepense	Johnsongrass
	Sporobolus compositus	composite dropseed
	Sporobolus compositus var. drummondii	Drummond's dropseed
	Stenotaphrum secundatum	St. Augustine grass
	Tridens albescens	white tridens
	Tridens flavus	purpletop tridens
	Tridens muticus	slim tridens
	Tripsacum dactyloides	eastern gamagrass
Polygalaceae	*Polygala alba*	white milkwort
	Rumex	dock
	Rumex pulcher	fiddle dock
Primulaceae	*Samolus valerandi ssp. parviflorus*	seaside brookweed
Ranunculaceae	*Clematis*	leather flower
Rosaceae	*Geum canadense*	white avens
	Rubus aboriginum	garden dewberry
	Rubus trivialis	southern dewberry
	Cephalanthus occidentalis	common buttonbush
	Diodia virginiana	Virginia buttonweed
	Hedyotis nigricans	diamondflowers
	Richardia tricocca	prairie Mexican clover
	Ptelea trifoliata	common hoptree
	Zanthoxylum hirsutum	Texas Hercules' club
Salicaceae	*Salix nigra*	black willow
Sapindaceae	*Sapindus saponaria*	wingleaf soapberry
	Ungnadia speciosa	Mexican buckeye
Sapotaceae	*Sideroxylon lanuginosum*	gum bully
Scrophulariaceae	*Agalinis heterophylla*	prairie false foxglove
	Bacopa monnieri	herb of grace
	Castilleja indivisa	entireleaf Indian paintbrush
Smilacaceae	*Smilax bona-nox*	saw greenbrier
Solanaceae	*Datura inoxia*	pricklyburr
	Physalis cinerascens	smallflower groundcherry
	Solanum dimidiatum	western horsenettle

	Solanum elaeagnifolium	silverleaf nightshade
Taxodiaceae	*Taxodium distichum*	bald cypress
Ulmaceae	*Celtis laevigata*	Sugar hackberry
	Ulmus alata	winged elm
	Ulmus americana	American elm
	Ulmus crassifolia	cedar elm
Verbenaceae	*Glandularia bipinnatifida*	Dakota mock vervain
	Lantana camara	lantana
	Phyla nodiflora	turkey tangle fogfruit
	Verbena brasiliensis	Brazilian vervain
	Verbena canescens	gray vervain
	Verbena halei	Texas vervain
Vitaceae	*Ampelopsis arborea*	peppervine
	Cissus trifoliata	sorrelvine
	Parthenocissus	creeper
	Parthenocissus quinquefolia	Virginia creeper
	Vitis aestivalis	summer grape
	Vitis mustangensis	mustang grape

APPENDIX F: Photo Interpretation Mapping Conventions and Visual Key

Lyndon B. Johnson National Historical Park - Map Units

This section describes the map units for the Lyndon B. Johnson National Historical Park Vegetation Mapping Project. Its purpose is to:

- Describe the vegetation of each map unit;
- Provide a ground photo image for each map unit;
- Describe the link between each map unit and the U.S. National Vegetation Classification;
- Provide visual examples of each map unit with aerial photographs and delineated overlays.

The map units for LYJO were based on a combination of NVC plant associations/alliances, local requests (i.e. Park Specials), the limitations of the digital imagery, and land-use / land-cover classes. The vegetation described in this section reflects the classification designed specifically for this project. Lookup tables that include the names of each code are included on the DVD. Non-vegetated map units are not described in this key.

Each map unit is described by a variety of characteristics and features. These include vegetation descriptions, a ground photograph and typical digital imagery signatures taken from the 2005 true color NAIP digital orthophoto and the 2003 color infrared NAIP digital orthophoto used as basemaps for this project. Many of the map unit descriptions rely heavily on the vegetation descriptions for the corresponding associations/alliances provided by NatureServe. Each map unit is typically made up of one vegetation association or alliance as listed. The sample ground photographs are from a variety of sources including ground photos of the sample plots and photos taken during signature verification trips or provided by Roger Sanders.

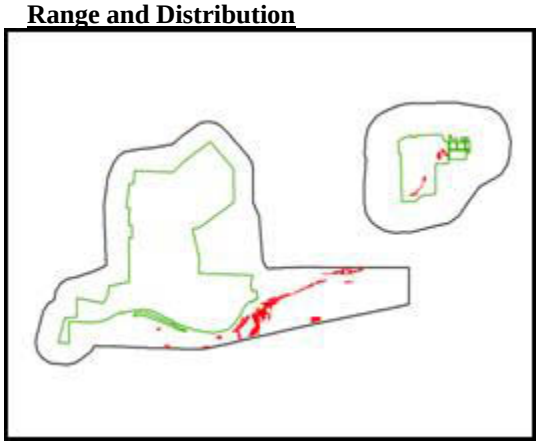
Forests and Woodlands

F –PECN *Carya illinoinensis – Celtis laevigata* Forest
Pecan – Sugar Hackberry Forest

Associations and Alliances
Carya illinoinensis – Celtis laevigata Forest

Common Species
Carya illinoinensis
Celtis laevigata
Ulmus americana
Fraxinus pennsylvanica
Platanus occidentalis
Cornus drummondii
Rubus trivialis
Geum canadense
Verbesina virginica

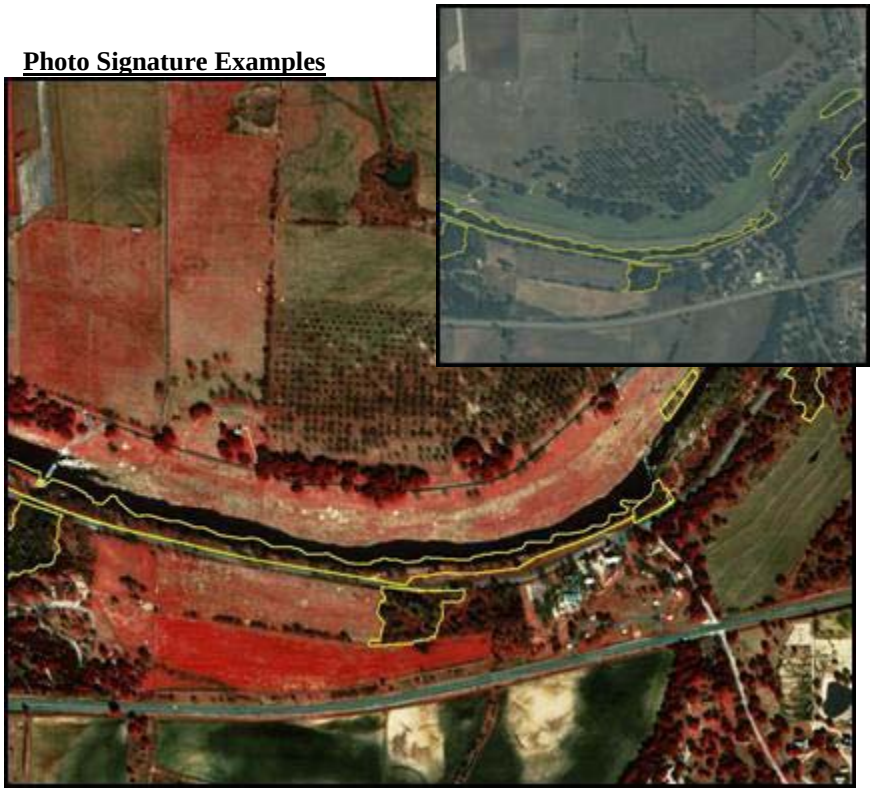
Range and Distribution



Description
This community occurs in the Johnson City Unit along Town Creek where it passes by the headquarters building. It has largely been displaced from the Ranch Unit but it is best developed in the State Park along the south bank of the Pedenales River. It also occurs along the creek that flows below the Sauer-Beckman Farm. Pecan trees are found both in the native setting and are also cultivated for nuts in the area. The pecan stands that were obviously planted in rows were mapped as Orchards/Vineyards/Groves. The native stands of this type appeared as mature trees with a gray-brown signature on the color infrared imagery. Open stands were found away from the rivers and had an herbaceous understory. Stands found in the riparian corridors were lusher with closed deciduous canopies.

Representative Ground Photos

Photo Signature Examples

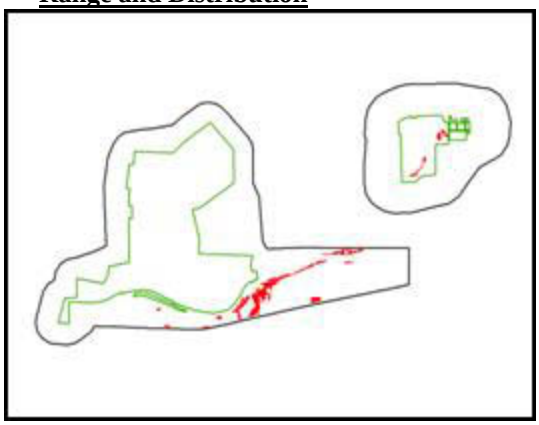


W-LONH *Quercus fusiformis – Celtis reticulata* var. *reticulata* Woodland
Plateau Live Oak - Netleaf Hackberry Woodland

Associations and Alliances
Quercus fusiformis – Celtis reticulata var. *reticulata* Woodland

Common Species
Quercus fusiformis
Ulmus crassifolia
Carya illinoinensis
Celtis laevigata
Juniperus ashei
Ilex decidua
Calyptocarpus vialis
Verbesina virginica
Bromus japonicus
Nassella leucotricha

Range and Distribution



Description
This community occurs in the Johnson City Unit along Town Creek where it passes through the southern portion of the unit. It has largely been displaced from the Ranch Unit but is best developed in the State Park along both sides of Ranch Road. This type also occurs on the slopes along the creek below the Sauer-Beckman Farm. This type is differentiated from the other live oak type by the presence of deciduous trees in the understory. On the color infrared imagery the live oaks were conspicuous with large, bright red crowns and the hackberry was apparent in the canopy openings as brown-gray trees.

Representative Ground Photos

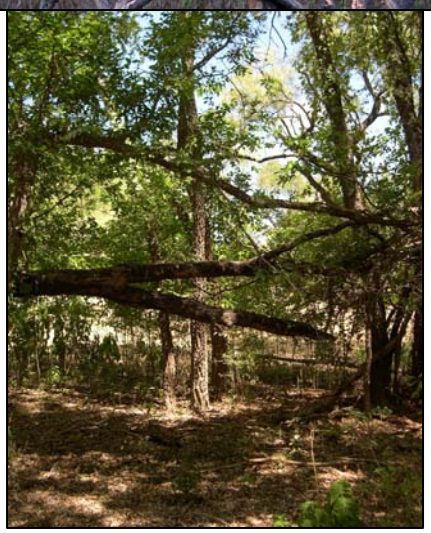
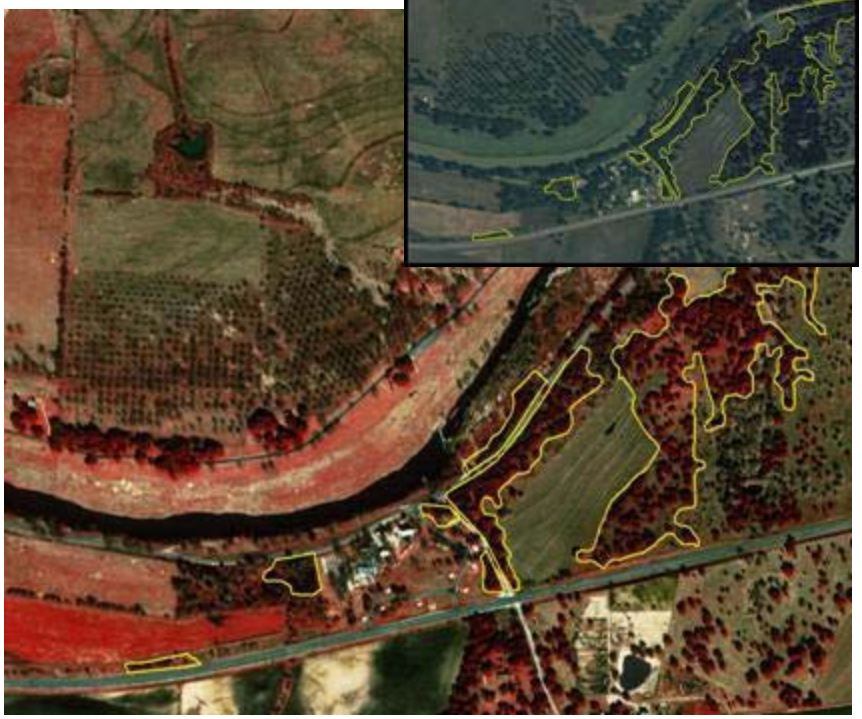


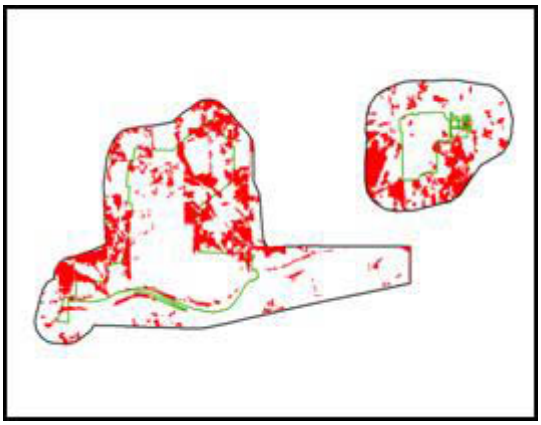
Photo Signature Examples



W-LOLB *Quercus fusiformis / Schizachyrium scoparium* Woodland
Plateau Live Oak / Little Bluestem Woodland

Associations and Alliances
Quercus fusiformis / Schizachyrium scoparium Woodland

Range and Distribution



Common Species
Quercus fusiformis
Quercus buckleyi
Quercus stellata
Celtis laevigata
Juniperus ashei
Smilax bona-nox
Croton monanthogynus
Verbesina virginica
Schizachyrium scoparium
Nassella leucotricha
Carex planostachys

Description
This map unit is scattered around the study area and is concentrated on the Ranch Unit in the northern uplands, in the State Park on rocky mounds south of the Sauer-Beckman Farm, and on footslopes east of the Lutheran Church/Rest Area. This map unit was also used to map extensive stands that contained live oaks with an herbaceous understory in the environs. These situations off the park may represent planted and cultivated types that contain exotic grasses. More sampling focused in these areas would help refine the classification and possibly warrant a new map class. On the color infrared imagery this type was mapped using the obvious bright red signature for the live oaks and the prominence of an herbaceous signature in the understory.

Representative Ground Photos

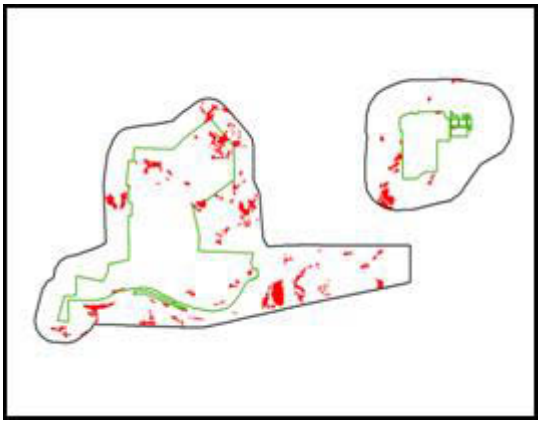
Photo Signature Examples

W-POBO *Quercus stellata – Quercus marilandica* Woodland Alliance
Post Oak - Blackjack Oak Woodland Alliance

Associations and Alliances
Quercus stellata – Quercus marilandica Woodland Alliance
Quercus stellata - (Quercus fusiformis - Quercus marilandica) – Juniperus ashei / Schizachyrium scoparium Woodland

Common Species
Quercus stellata
Sophora affinis
Juniperus ashei
Celtis laevigata
Ilex decidua
Smilax bona-nox
Vernonia baldwinii
Schizachyrium scoparium
Nassella leucotricha

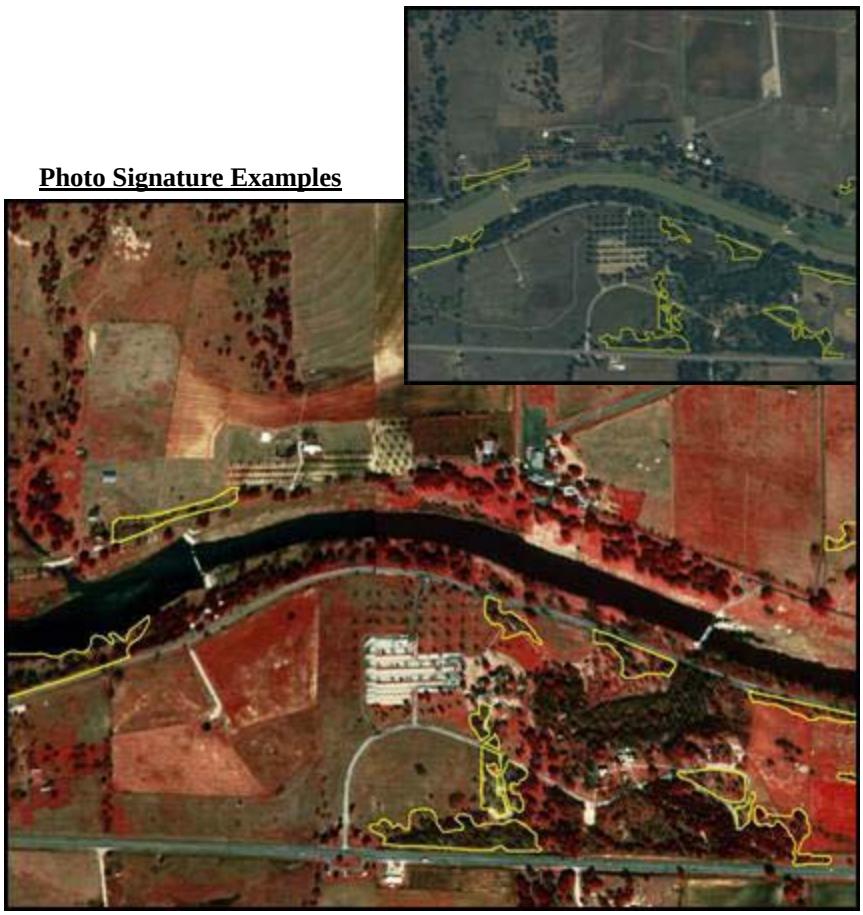
Range and Distribution



Description
This map unit is found throughout the project areas and is concentrated on the park in the northern portions of the Ranch Unit on convex slopes and at the State Park on footslopes southeast of the park headquarters. In the environs this type was found in stands that may have been planted. This type was mapped using the color infrared imagery where it appeared as large trees with a brown-gray signature. This color contrasted with the red of the live oaks and the reddish-brown of the mesquite and juniper. This type did appear similar to the pecan map unit although post oak tended to occur in more dry and open conditions.

Representative Ground Photos

Photo Signature Examples

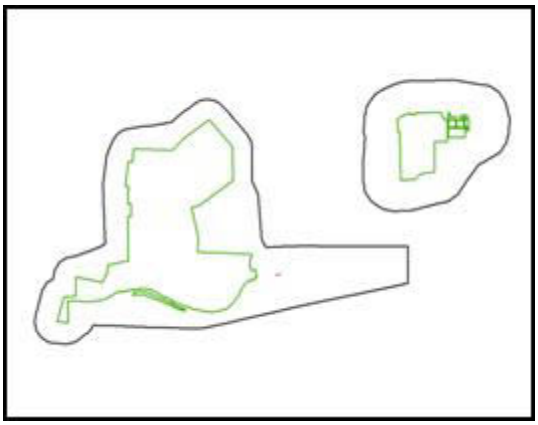


W-CHIN *Melia azedarach* Woodland Stand
Chinaberry Woodland Stand

Associations and Alliances
Local Stand (no NVC Alliance at this time)

Common Species
Melia azedarch
Quercus stellata
Juniperus ashei
Celtis laevigata
Schizachyrium scoparium
Nassella leucotricha

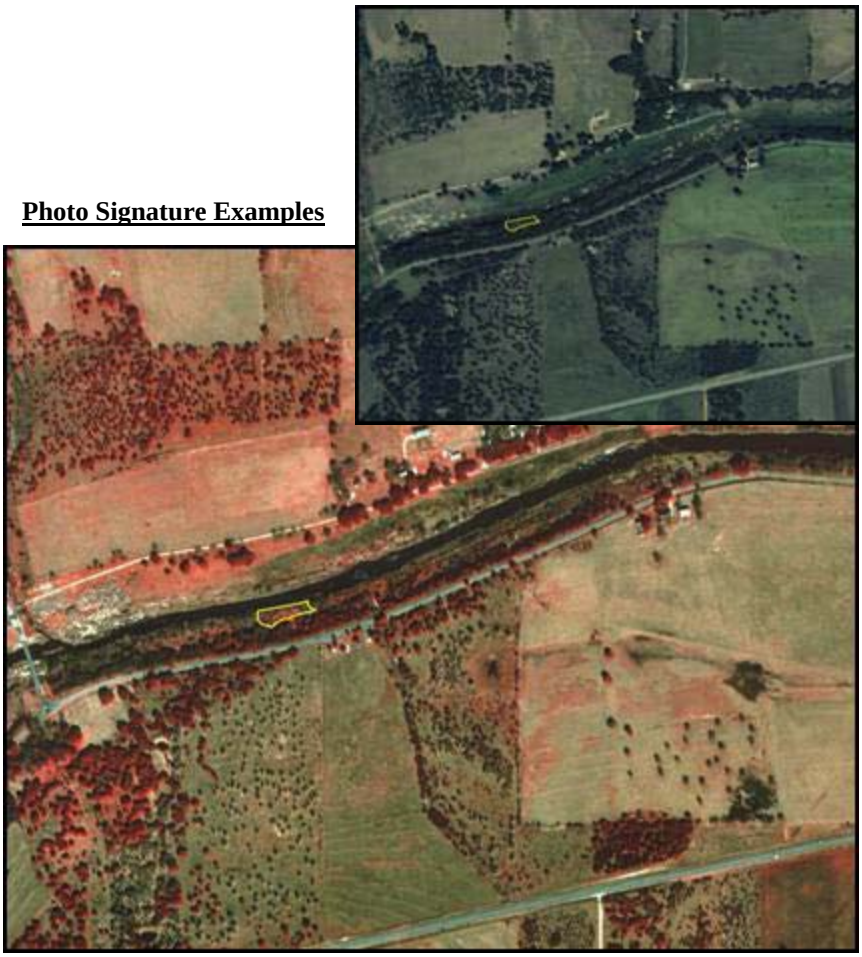
Range and Distribution



Description
Chinaberry trees were found throughout the river and creek bottoms in and surrounding both units of LYJO. Only one mapable stand was observed in the Ranch District although others may exist. Since this is an exotic species, removal efforts may dramatically effect its distribution over time. On the color infrared imagery this type appeared as bright pink trees intermixed with other deciduous trees.

Representative Ground Photos

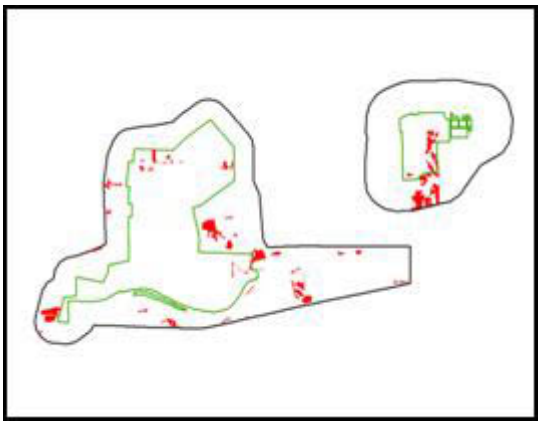
Photo Signature Examples



W-AJUN *Juniperus ashei* Woodland Alliance
Ashe Juniper Woodland Alliance

Associations and Alliances
Juniperus ashei Woodland Alliance

Range and Distribution

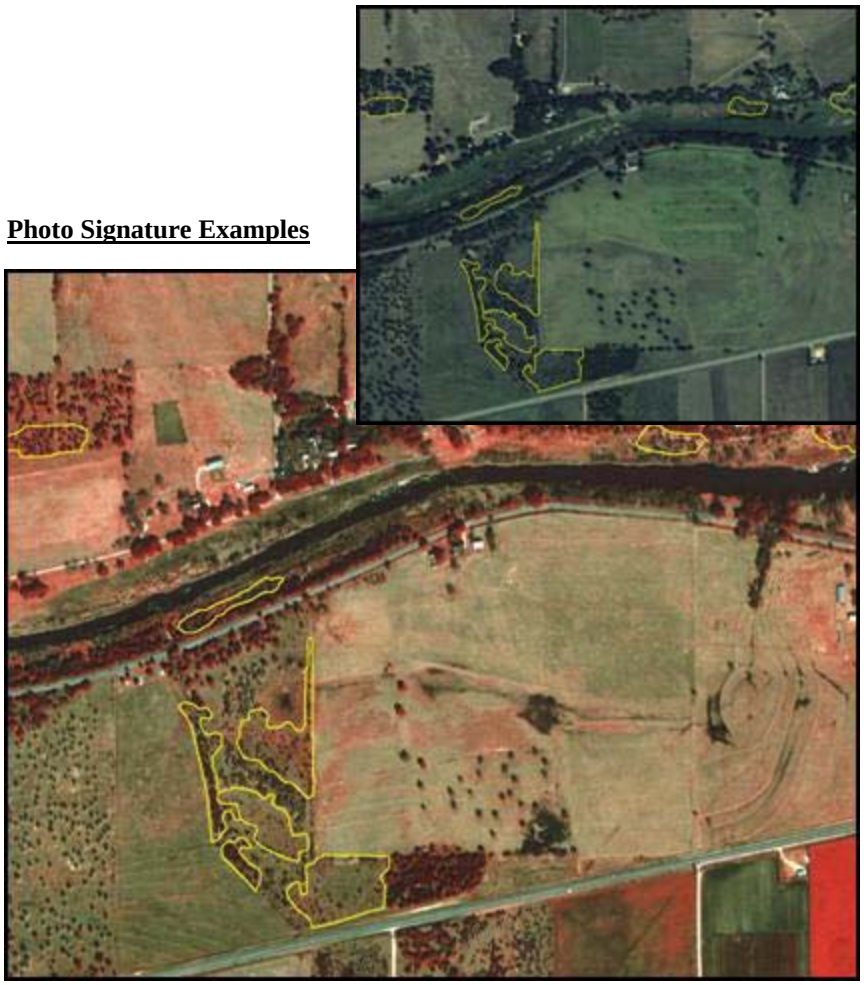


Common Species
Juniperus ashei
Quercus fusiformis
Quercus buckleyi
Quercus stellata
Quercus marilandica
Mahonia trifoliolata
Bouteloua curtipendula
Carex planostachys,
Celtis laevigata var. reticulata

Description
Ashe juniper stands were found throughout the project area but were primarily associated with other plant communities in LYJO. In the environs, juniper tended to be more conspicuous and likely represent true associations or alliances. Active thinning of this type was witnessed in the area especially to the north of the Ranch District. On the color infrared imagery this type appeared as brown trees that contrasted with the red and pink deciduous tree signature. Mesquite and small live oaks had similar signatures that may have led to some confusion in the environs where ground-truthing did not occur.

Representative Ground Photos

Photo Signature Examples



W-MESQ *Prosopis glandulosa* Woodland Alliance
Honey Mesquite Woodland Alliance

Associations and Alliances
Prosopis glandulosa Woodland Alliance

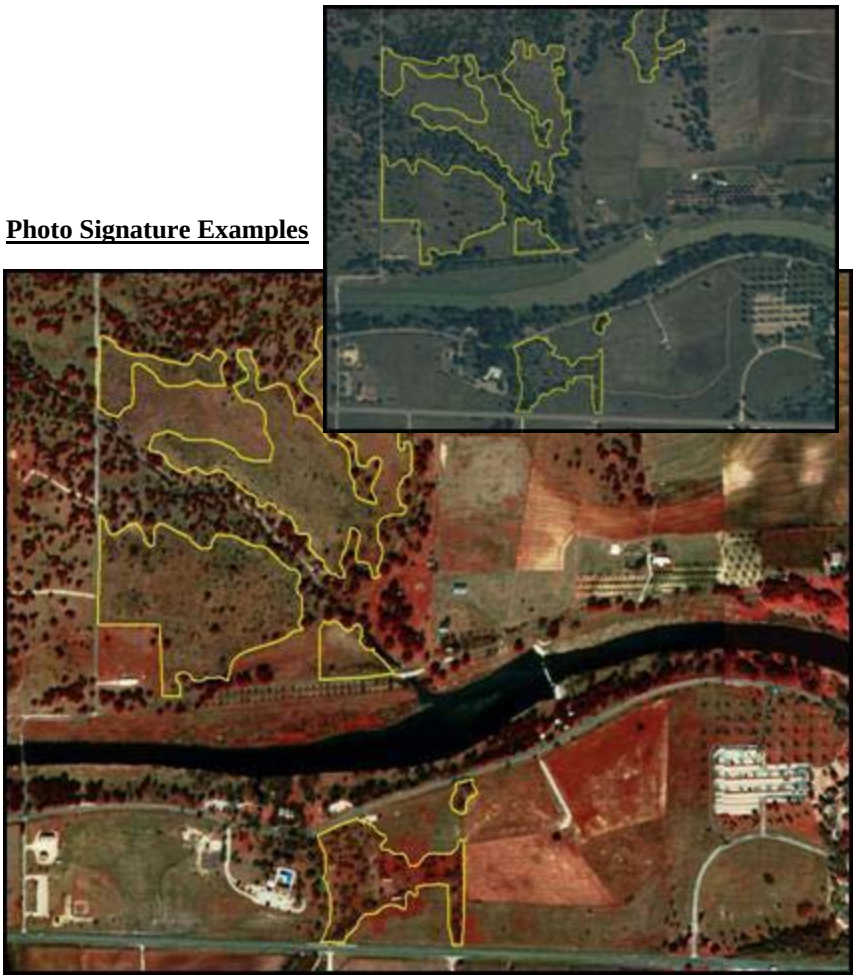
Common Species
Prosopis glandulosa
Celtis laevigata
Juniperus ashei
Quercus fusiformis
Verbesina virginica
Bromus japonicus
Cynodon dactylon

Range and Distribution

Description
This map unit was used to map mesquite ranging from small shrubs to medium trees. This type was largely successional and heterogeneous occurring in old fallow fields. The class was mapped in scattered patches between Ranch Road 1 and Highway 290 near the Danz Farm, near the bison pastures, and scattered throughout the environs. The signature of mesquite was a dark brownish-red that was similar to the juniper map unit. The size of the mesquite ranged on the imagery from small almost unnoticeable specks (shrubs) to larger spots for the trees.

Representative Ground Photos

Photo Signature Examples



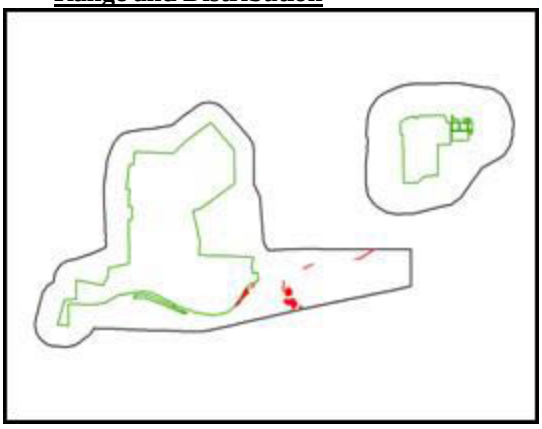
Shrublands

S-BLWL *Salix nigra* Temporarily Flooded Shrubland Alliance
Black Willow Temporarily Flooded Shrubland Alliance Stand

Associations and Alliances
Salix nigra Temporarily Flooded Shrubland Alliance

Common Species
Salix nigra
Quercus fusiformis
Carya illinoinensis
Celtis laevigata
Juniperus ashei
Ilex decidua
Bromus japonicus
Nassella leucotricha

Range and Distribution



Description
Thickets of black willow were rare on the Ranch Unit occurring in small stands along the rivers and streams and occurring as small wet depressions in fallow fields. This type was not sampled but was mapped based on observations in the field. Most of the stands appeared to be young or frequently disturbed thickets often having few to no other species present. The presence of this vegetation is related to disturbance frequency, both natural and anthropogenic. On the color infrared imagery this type appeared as small brown spots contrasted with either a smooth herbaceous understory (fallow fields) or a mottled signature in riparian stands.

Representative Ground Photos

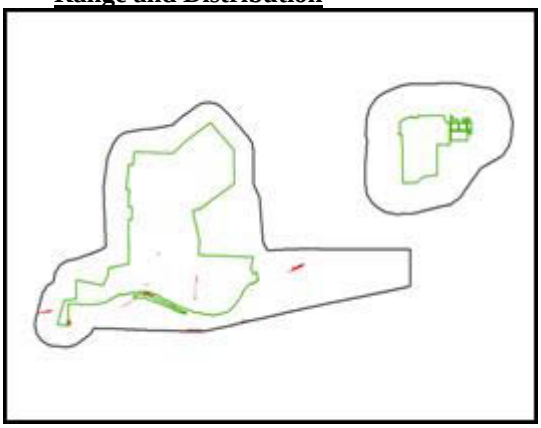
Photo Signature Examples

S-HACK *Celtis laevigata* Shrubland Stand
Sugar Hackberry Shrubland Stand

Associations and Alliances
Local Stand (no NVC Alliance at this time)

Common Species
Celtis laevigata
Salix nigra
Quercus fusiformis
Carya illinoinensis
Ilex decidua
Bromus japonicus
Nassella leucotricha

Range and Distribution



Description
Small stands of sugar hackberry were observed in riparian and mesic sites in the Ranch Unit of the project. Most of the mapable stands occurred in the environs and no sampling was conducted in this type due to their small size and lack of access. This type is characterized by having small to medium-sized sugar hackberry with few associated trees. Stands of this type may also have occurred as associates in the Pecan – Sugar Hackberry Forest type. On the color infrared imagery this type appeared as brown and gray trees, small in stature with an herbaceous understory. With more sampling this type might represent a sugar hackberry association or be joined with the pecan forest type.

Representative Ground Photos

Photo Signature Examples

Herbaceous Vegetation

H-BERM *Cynodon dactylon* Herbaceous Vegetation
Bermuda Grass Herbaceous Alliance

Associations and Alliances
NEW *Cynodon dactylon* Herbaceous Vegetation

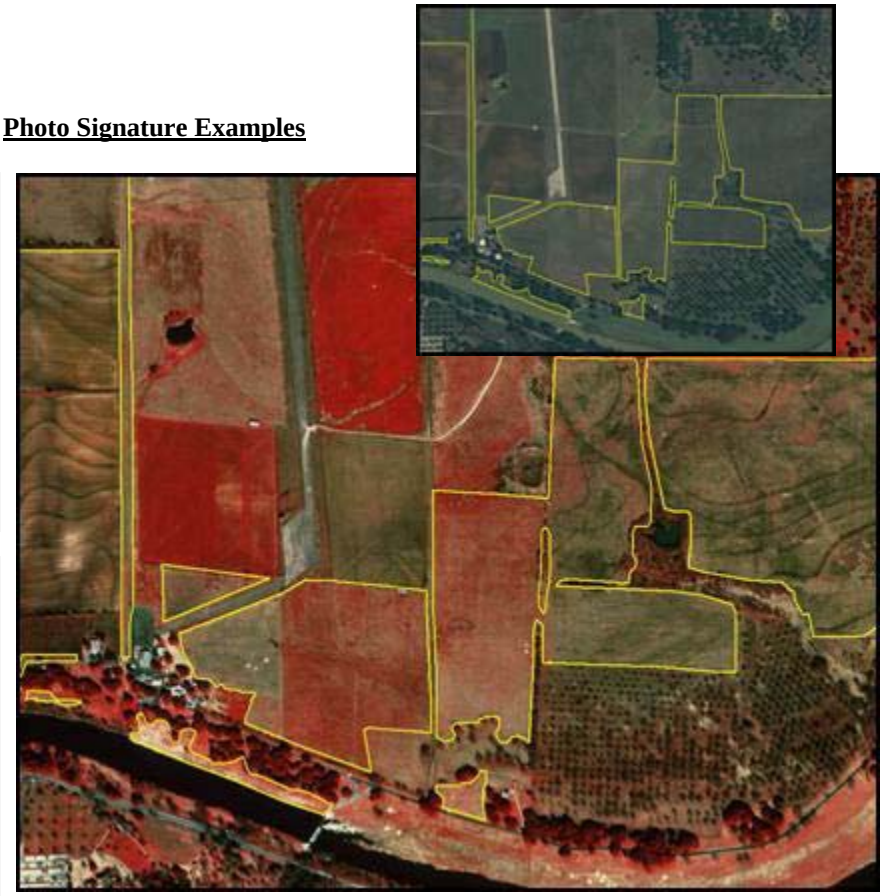
Range and Distribution

Common Species
Cynodon dactylon
Aristida purpurea
Bouteloua curtipendula
Bothriochloa laguroides
Bromus japonicus
Eragrostis intermedia
Paspalum setaceum
Schizachyrium scoparium
Ratibida columnifera

Description
This type was used to map primarily pasture and cultivated land and was differentiated from agricultural fields by its greater mix native grasses and forbs. This map class was observed in both units where it may have been planted. In the State Park, this type also occurred as several mowed "prairie" areas near the headquarters building and other public display areas where wildflowers have also been seeded. On the color infrared imagery this type usually has a smooth, pale green/blue signature except in areas that contained more forbs where it appeared pink or red.

Representative Ground Photos

Photo Signature Examples

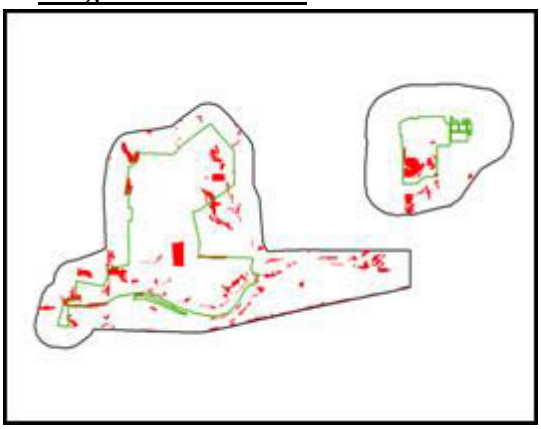


H-SVJN *Bothriochloa laguroides – Sorghum halepense* Herbaceous Vegetation
Silver Beardgrass - Johnsongrass Herbaceous Vegetation

Associations and Alliances
NEW *Bothriochloa laguroides – Sorghum halepense* Herbaceous Vegetation

Common Species
Bouteloua curtipendula
Bothriochloa ischaemum
Bothriochloa laguroides
Bromus japonicus
Nassella leucotricha
Schizachyrium scoparium
Sorghum halepense
Sporobolus compositus var. *drummondii*
Ambrosia psilostachya
Croton monanthogynus
Iva angustifolia
Phyla nodiflora
Ratibida columnifera

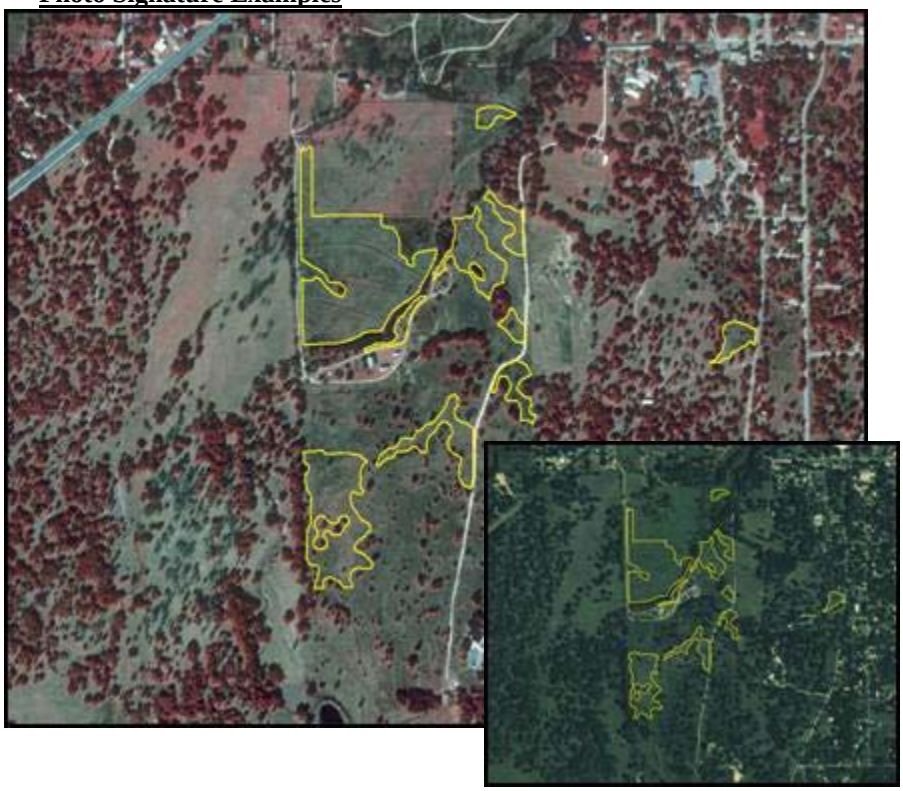
Range and Distribution



Description
This type represents degraded fields and old pastures that may have been seeded. This type is probably successional and has replaced native grasslands such as the little bluestem-sideoats grama type. This class occurs in both units of LYJO where it occurs as old fields and pastures. In these settings it appeared that the ground had not been plowed in several years and are not maintained as fertilized coastal Bermuda-grass pastures. In the State Park, it occurs in several infrequently mowed grassland areas between Ranch Road 1 and Highway 290. On the color infrared imagery this type appeared as a smooth, dark blue/green color.

Representative Ground Photos

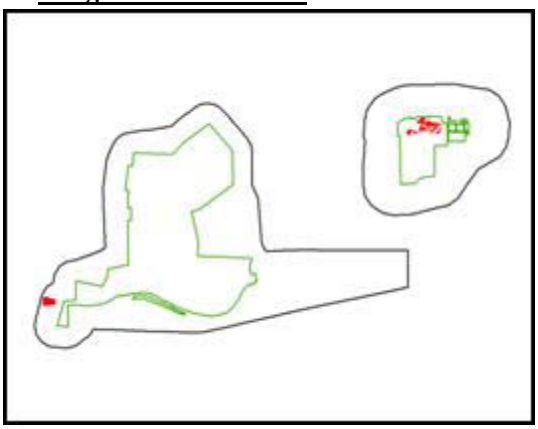
Photo Signature Examples



H-REPR Restored Grassland Prairie

Associations and Alliances
Local Stand (no NVC Alliance at this time)

Range and Distribution

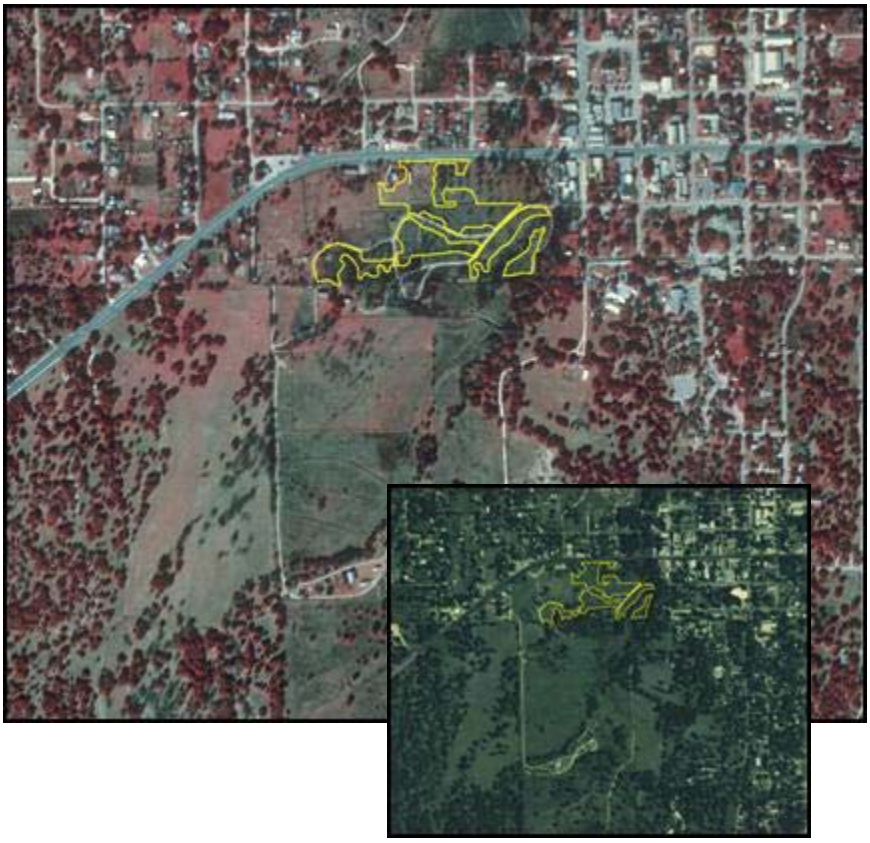


Common Species
Bouteloua curtipendula
Bothriochloa ischaemum
Bothriochloa laguroides
Elymus canadensis
Nassella leucotricha
Panicum virgatum
Schizachyrium scoparium
Sorghastrum nutans
Sporobolus compositus var. *drummondii*
Gaillardia pulchella
Ratibida columnifera

Description
This type was used to map stands of vegetation that represent restored prairie. Included were stands in the Johnson City Unit along with one field observed in the environs. This type is characterized by the presence of native tall- and mid-grass prairie species. In the park this class includes sites that are undergoing restoration by removing pecan trees and replacing them with plateau live oak trees. On the color infrared imagery restored prairie appeared as black smudges in the park due to recent burns at the time the imagery was acquired.

Representative Ground Photos

Photo Signature Examples

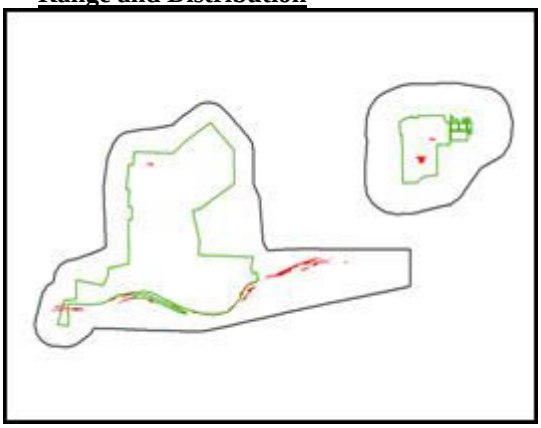


H-SWGR *Panicum virgatum – Tripsacum dactyloides* Herbaceous Alliance
Switchgrass – Eastern Gammagrass Herbaceous Alliance

Associations and Alliances
Panicum virgatum – Tripsacum dactyloides
Herbaceous Alliance

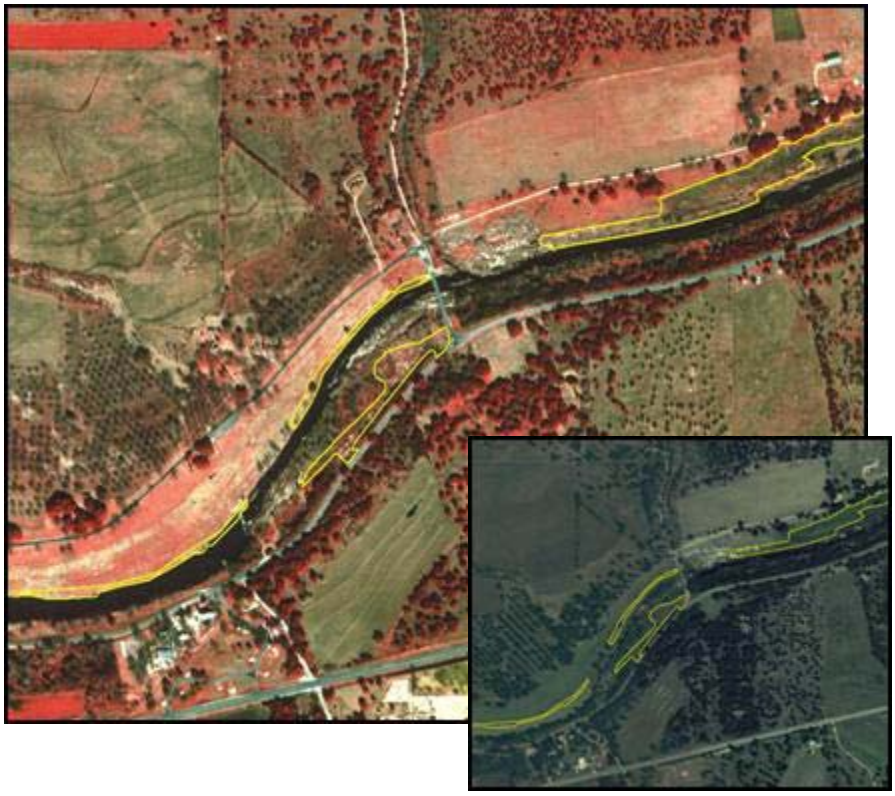
Common Species
Panicum virgatum
Andropogon glomeratus
Carex emoryi
Sorghastrum nutans
Tripsacum dactyloides
Muhlenbergia utilis
Eleocharis montevidensis
Agalinis heterophylla

Range and Distribution



Description
This native grassland type occurred in both units of the park. At the Ranch Unit, this type occurred primarily along the banks of the channel of the Pedenales River and in swales of the primary terrace of the river. In the Johnson City unit switchgrass was restricted to the old channels or sluggish drainageways paralleling Town Creek. On the color infrared imagery this type appeared mottled, ranging in color from pink to blue/green, likely due to the presence of non-native and native forbs.

Photo Signature Examples



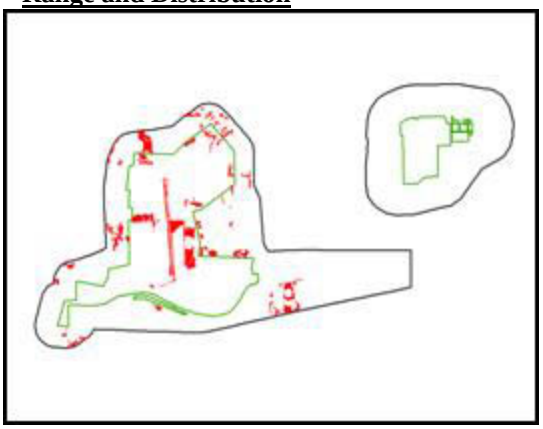
Representative Ground Photos

H-HGSG *Bouteloua hirsuta – Bouteloua curtipendula* Herbaceous Vegetation
Hairy Grama - Sideoats Grama Herbaceous Vegetation

Associations and Alliances
Bouteloua hirsuta – Bouteloua curtipendula
Herbaceous Vegetation

Common Species
Bouteloua curtipendula
Bothriochloa ischaemum
Sporobolus compositus var. *drummondii*
Aristida purpurea
Bouteloua hirsuta
Bouteloua rigidiseta
Aphanostephus riddellii
Desmanthus virgatus var. *acuminatus*
Hedyotis nigricans
Liatris mucronata

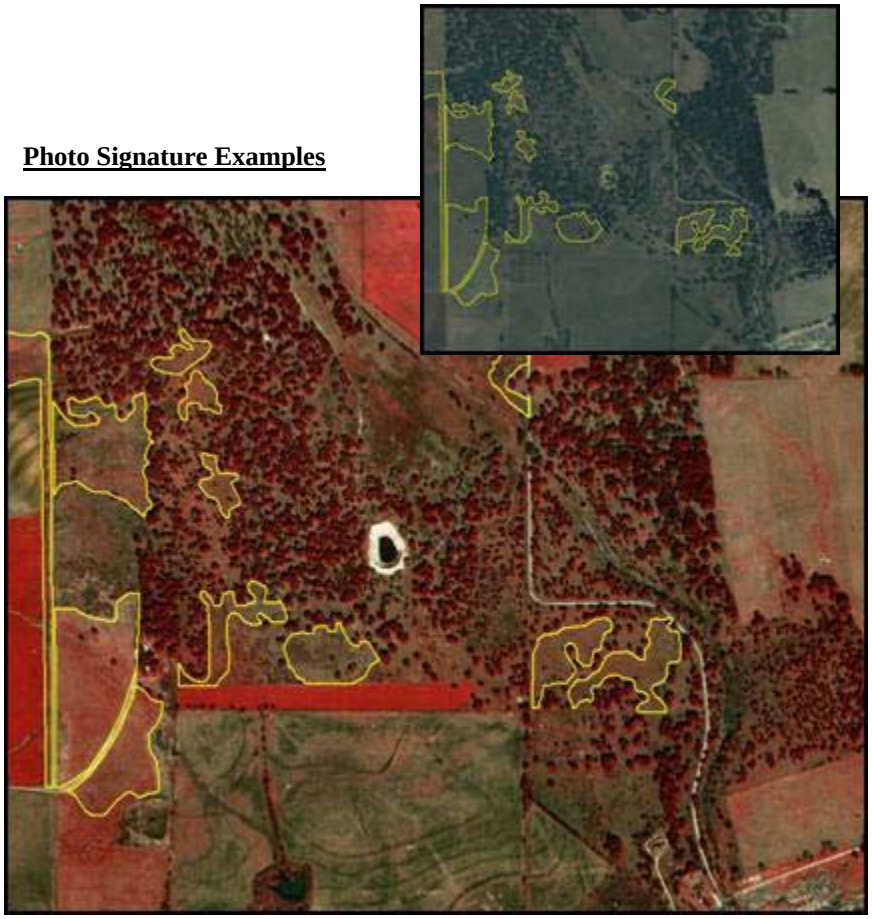
Range and Distribution



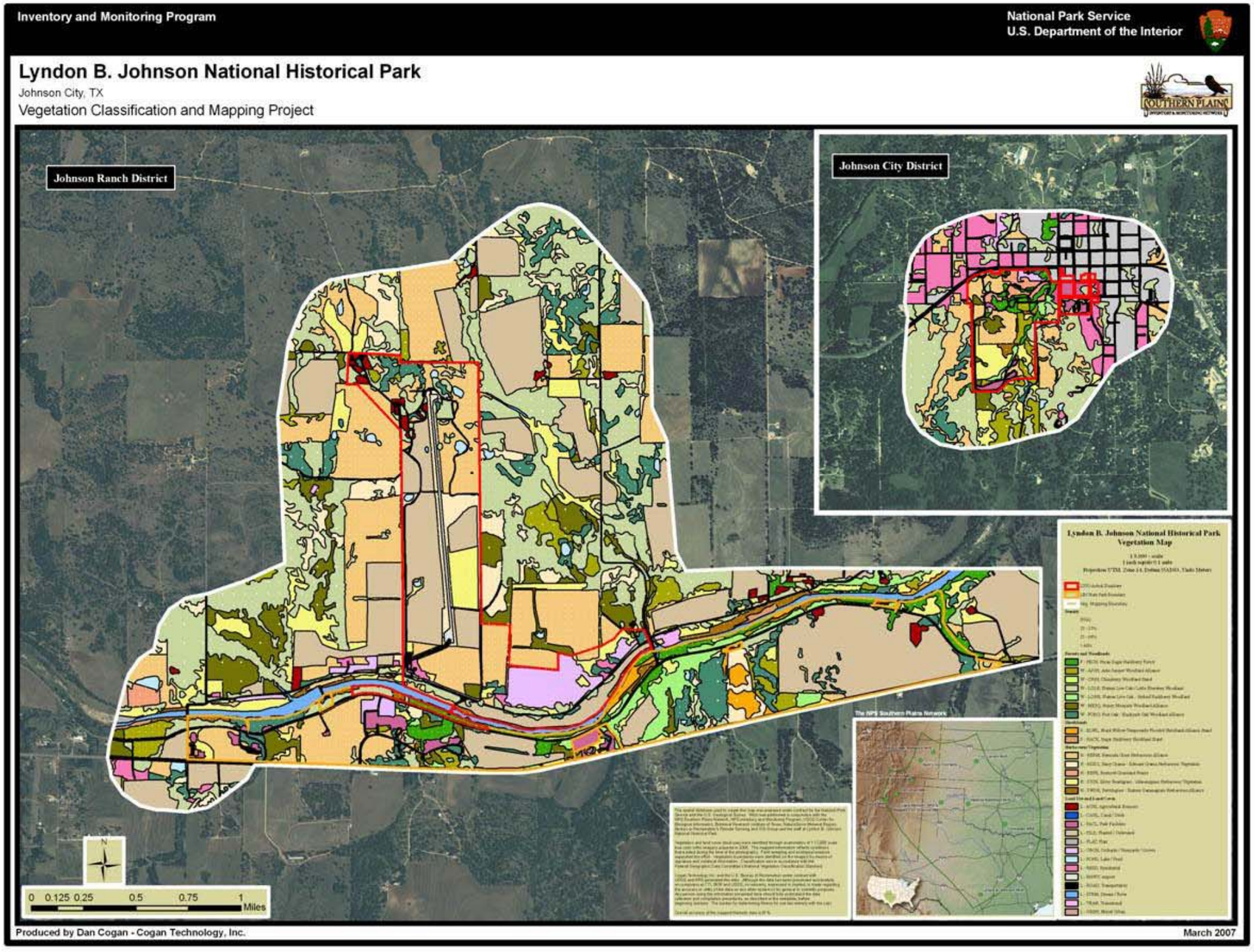
Description
This map unit was limited primarily to linear strips of small fields in the Johnson Ranch Unit. This type represents the most native of the grasslands and has undergone little disturbance except for some mowing. Some seeding of wildflower species may also have occurred in these areas in addition to some initial planting of the native seed collected from nearby rocky prairies by the Johnson family in the 1960's and 1970's. This type had a light pink signature on the color infrared imagery and contained few trees.

Representative Ground Photos

Photo Signature Examples



APPENDIX G: Final LYJO Vegetation Map


Inventory and Monitoring Program
National Park Service
U.S. Department of the Interior
Lyndon B. Johnson National Historical Park
Johnson City, TX
Vegetation Classification and Mapping Project
Johnson Ranch District
Johnson City District
Lyndon B. Johnson National Historical Park
Vegetation Map
The NPS Southern Plains Network
0 0.125 0.25 0.5 0.75 1
Miles
Produced by Dan Cogan - Cogan Technology, Inc.
March 2007

The U.S. Department of the Interior (DOI) is the nation's principal conservation agency, charged with the mission "*to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities."* More specifically, Interior protects America's treasures for future generations, provides access to our nation's natural and cultural heritage, offers recreation opportunities, honors its trust responsibilities to American Indians and Alaska Natives and its responsibilities to island communities, conducts scientific research, provides wise stewardship of energy and mineral resources, fosters sound use of land and water resources, and conserves and protects fish and wildlife. The work that we do affects the lives of millions of people; from the family taking a vacation in one of our national parks to the children studying in one of our Indian schools.

NPS D-77, May 2007

National Park Service
U.S. Department of the Interior

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