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Vegetation Classification and Mapping at Chickasaw National Recreation Area

Natural Resource Technical Report NPS/SOPN/NRTR—2010/286

ON THE COVER
Panther Falls within the Platt Historic District of Chickasaw National Recreation Area.
NPS Photograph

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Natural Resource Technical Report NPS/SOPN/NRTR—2010/286

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Contents

Page

Figures vi

Tables viii

List of Contacts and Contributors ix

Executive Summary xi

Acknowledgments xiii

List of Abbreviations and Acronyms xiv

Introduction 1

Background 1

USGS-NPS Park Vegetation Mapping Program 1

Chickasaw National Recreation Area Vegetation Mapping Project 2

Scope of Work 2

The National Vegetation Classification (NVC) and Standard (NVCS) 2

Introduction to Natural Heritage Program Methodology and Element Ranking 5

The Natural Heritage Ranking System 5

Element Occurrences and their Ranking 6

Project Area 8

Location and Regional Setting 8

Climate and Weather 9

Physiography and Topography 10

Geology 10

Soils 12

Wildlife 12

Vegetation 12

Methods 23
Planning and Scoping 23
Responsibilities and Deliverables 23
Preliminary Data Collection and Review of Existing Information 23
Field Survey 23
Aerial Photography 26
Photo Interpretation 27
Map Units and Polygon Attribution *27*
Field Photographs *27*
Digital Transfer 29
Plot Data Management and Classification Analysis 29
Plot Data Management *29*
Vegetation Classification 29
Map Verification 29
Sample Design 31
Sample Method 31
Sample Site Selection 31
Results 35
Field Data Collection 35
Vegetation Classification 35
Vegetation Alliances and Associations 40
Herbaceous Vegetation *40*
Shrublands *71*
Forest *84*
Photo-interpretation and map units 111

Vegetation Map 111

Fuzzy Accuracy Assessment *111*

Discussion 121

NVC Classification 121

Global Rarity *121*

Non-native species *121*

Photo-interpretation and Map Units 121

Map Accuracy 122

General Considerations *122*

Individual Map Unit Metrics *123*

The Accuracy Standard for the NBS/NPS Vegetation Mapping Program *125*

Literature Cited 127

Appendix A – Species List 131

Figures

Page

Figure 1. Location map for project area 8

Figure 2. Average annual precipitation (inches) for south central Oklahoma 9

Figure 3. Topography for project area 10

Figure 4. Geology of the project area and vicinity 11

Figure 5. Soils map for project area 13

Figure 6. Regional view of Omernik's (1987) ecoregions 17

Figure 7. Regional view of Bailey's (1983) ecoregions 17

Figure 8. Taylor and Taylor phytogeographic regions of Oklahoma. 18

Figure 9. Game types of Oklahoma map (Duck and Fletcher 1943) 19

Figure 10. Oklahoma GAP vegetation map (2005) 19

Figure 11. National land cover map (1992) 20

Figure 12. 1997 Chickasaw National Recreation Area Vegetation and Environs 21

Figure 13. CHIC flight line map. 26

Figure 14. Location of vegetation plots collected in 2006 30

Figure 15. Location of accuracy assessment points collected in 2008. 32

Figure 16. Carex emoryi Herbaceous Vegetation 40

Figure 17. Typha (angustifolia, domingensis, latifolia) - Schoenoplectus americanus Herbaceous Vegetation 42

Figure 18. *Typha latifolia* Southern Herbaceous Vegetation 45

Figure 19. Muhlenbergia reverchonii - Bouteloua curtipendula - Desmanthus velutinus Herbaceous Vegetation 48

Figure 20. Schizachyrium scoparium - Bouteloua curtipendula - Bouteloua gracilis Central Plains Herbaceous Vegetation 51

Figure 21. *Bouteloua hirsuta* - *Bouteloua curtipendula* Herbaceous Vegetation 54

Figure 22. Schizachyrium scoparium - Sorghastrum nutans - Bouteloua curtipendula Herbaceous Vegetation 56

Figure 23. Sorghum halepense Semi-natural Herbaceous Alliance..... 59

Figure 24. Buchloe dactyloides Modified Herbaceous Vegetation 61

Figure 25. Polygonum spp. (section Persicaria) Seasonally Flooded Herbaceous Alliance 63

Figure 26. Justicia americana Herbaceous Vegetation 66

Figure 27. Aristida-Digitaria Grassland..... 69

Figure 28. Old Field..... 70

Figure 29. Cornus drummondii – (Rhus glabra, Prunus spp.) Shrubland..... 71

Figure 30. Prunus angustifolia Shrubland Alliance 73

Figure 31. Quercus sinuata var. breviloba Shrubland..... 75

Figure 32. Juniperus ashei / Bouteloua (curtipendula, hirsuta) Woodland..... 78

Figure 33. Quercus stellata - Quercus marilandica / Schizachyrium scoparium Woodland 80

Figure 34. Disturbed Woodland..... 83

Figure 35. Quercus buckleyi - Fraxinus texensis - Quercus muehlenbergii Forest..... 84

Figure 36. Quercus muehlenbergii - Quercus shumardii Forest 87

Figure 37. Carya illinoinensis - Celtis laevigata Forest..... 90

Figure 38. Ulmus americana - Celtis (laevigata, occidentalis) - Fraxinus pennsylvanica Forest..... 93

Figure 39. Platanus occidentalis - (Populus deltoides) - Acer negundo Forest 96

Figure 40. Quercus macrocarpa - Quercus shumardii - Carya cordiformis / Chasmanthium latifolium Forest..... 98

Figure 41. Juniperus virginiana var. virginiana / Schizachyrium scoparium Forest 101

Figure 42. Quercus stellata - Quercus marilandica - (Carya texana) Forest..... 103

Figure 43. Quercus stellata - Ulmus alata Forest..... 106

Figure 44. Salix nigra Forest..... 108

Tables

Page

Table 1. Summary of the National Vegetation Classification System Hierarchal Approach. 3

Table 2. Definition of Natural Heritage Imperilment Ranks. 6

Table 3. Element Occurrence Ranks and their Definitions..... 7

Table 4. Map units and area for GAP land cover within the mapping boundary. 16

Table 5. Map units and area for NLCD within the mapping boundary 16

Table 6. Ecoregions of CHIC..... 18

Table 7. Frequency and abundance of map units from the 1997 vegetation map. 22

Table 8. Summary of Plots and Vegetation types sampled May 22–July 13, 2006. 25

Table 9. Observation Point Waypoints collected at CHIC May-July, 2006. 25

Table 10. Structural categories for vegetation photointerpretation. 28

Table 11. Polygon attribute items and descriptions used in the CHIC spatial database. 28

Table 12. Recommended map accuracy sample number per class by frequency and area. 33

Table 13. Vegetation alliances and associations from field plots. 37

Table 14. Map units and member associations. 113

Table 15. Map units, frequency and area statistics for CHIC. 114

Table 16. Fuzzy set accuracy ranks (Gopal and Woodcock, 1994). 115

Table 17. Overall map accuracies for each fuzzy class. 115

Table 18. Contingency table for fuzzy accuracy assessment level 5. 116

Table 19. Contingency table for fuzzy accuracy assessment level 4. 117

Table 20. Contingency table for fuzzy accuracy assessment level 3. 118

Table 21. Map unit accuracies for omission and commission errors for all errors at all fuzzy levels. 119

Table 22. Comparative fuzzy accuracies for seven national parks. 125

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Executive Summary

Chickasaw National Recreation Area encompasses approximately 4,072 ha (10,062 acres) in south central Oklahoma. The mapped area includes a ¼ mi. buffer around the Park boundary. The total mapped area is 6,570 ha (16,235 acres). Lake of the Arbuckles was created by the building of Arbuckle Dam by the Bureau of Reclamation in 1966. The Lake and nearby pools and ponds cover 1,011 ha (2,497 acres). The Park is surrounded by private lands. Chickasaw National Recreation Area was originally known as "Peaceful Valley of rippling Waters" by the Plains Indians. In 1904 Congress set aside the springs area and designated them the Platt National Park. The Park was redesignated in 1976 to its current name.

Floristically the area is quite unique. The Park represents the eastern most extent of the eastern deciduous forests and mixes with the western prairie ecosytems. The vegetation is a complex mix of oaks and other deciduous trees occurring along the drainages and some upland areas. An active invasion of Juniper trees is occurring in many of the upland areas and has been addressed by an active fire control program. So diverse is the area that it has been estimated that with in the Park itself there are over 60 species of trees alone.

A three-year program was initiated to complete the task of mapping and classifying the vegetation at CHIC. 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 Geographic Information Group produced a digital vegetation map. To classify the vegetation, 89 representative plots located throughout the approximately 6,570 ha (16,235 acres) project area (park + environs) were sampled during the summer of 2006. Analysis of the plot data by NatureServe in the winter of 2006-2007 produced 29 distinct plant associations and alliances. Descriptions for three new alliances described in the National Vegetation Classification (NVC) are included. Descriptions for all 29 unique plant assemblages for CHIC are included in this report.

To produce the digital map, a combination of 1:12,000-scale aerial color infrared photographs acquired in October 2005, GPS referenced ground data and two reconnaissance field trips were used to interpret the complex patterns of vegetation and land-use. Ultimately, 19 map units were defined to describe all the land cover within the project boundary. This includes 13 that describe the vegetation. 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. During the summer of 2008 275 accuracy assessment (AA) data points were collected and used to determine the map's accuracy. After final revisions, the accuracy assessment revealed an overall thematic accuracy of 75%.

The CHIC vegetation inventory was conducted in accordance with the following USGS-NPS Vegetation Mapping Program specified protocols and standards:

Nationally defined standards:

- National Vegetation Classification Standard
- Spatial Data Transfer Standard
- Metadata Standard
- Positional Accuracy
- Taxonomy

Additional Program Defined Standards

- Classification Accuracy
- Minimum Mapping Unit

Products developed for Chickasaw National Recreation Area are described and presented in this report, and are stored on the accompanying CD-ROM. These include:

- A *Final Report* that details the production steps, results and discussion:
- A *Spatial GIS Database* containing vegetation, plots, & flight line index layers in geodatabase format;
- *Digital Photos* from each observation point along with representative ground photos for each map class and miscellaneous park views;
- *Printable Graphics* of all spatial database layers;
- *Metadata* for spatial database layers which is Federal Geographic Data Committee (FGDC)-compliant
- *Vegetation Descriptions* of the vegetation communities.
- In addition, CHIC and the NPS Inventory and Monitoring Program both received copies of:
- 9x9-in. Prints of the 1:12,000-scale Aerial Photography;
- Uncompressed Digital Orthophoto;
- Digital data files and hard copy data sheets of the observation points
- Hardcopy vegetation maps.

The DVD attached to this report contains text and metadata files, keys, lists, field data, spatial data, the vegetation map, graphics, and ground photos. The USGS will post this project on its website: http://biology.usgs.gov/npsveg/index.html

For more information on the NVC standards, please go to the FGDC (Federal Geographic Data Committee), National Vegetation Classification Standard website: http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation . For more information on NVC associations in the U.S., please go to NatureServe's website: http://www.natureserve.org..

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We would also like to thank Mike Story and Karl Brown, National Vegetation Mapping Program, and the many scientists of the National Park Service who produced the original study protocols, including those used in the fi eld to ensure consistency and scientifi c integrity. Their eff orts helped to ensure that this report would be compatible with other studies conducted in National Park Service units throughout the country.

List of Abbreviations and Acronyms

AA	Accuracy Assessment
BOR	Bureau of Reclamation (also USBR)
BRD	Biological Resource Division (of the USGS)
CBI	Center for Biological Informatics (of the USGS/BRD)
CHIC	Chickasaw National Recreation Area
DEM	Digital Elevation Model
DLG	Digital Line Graph
DRG	Digital Raster Graphic
DOQQ	Digital Orthophoto Quarter Quadrangle
FGDC	Federal Geographic Data Committee
GIS	Geographic Information System(s)
GPS	Global Positioning System
MMU	Minimum Mapping Unit
NPS	U.S. National Park Service
NAD	North American Datum
NBII	National Biological Information Infrastructure
NLCD	National Land Cover Data
NRCS	Natural Resources Conservation Service (formerly the Soil Conservation Service - SCS)
NVC	National Vegetation Classification
NVCS	National Vegetation Classification System
PARK	CHIC
RSGIG	Remote Sensing and Geographic Information Group
TNC	The Nature Conservancy
USBR	United States Bureau Of Reclamation (also BOR)
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VMP	Vegetation Mapping Program

Introduction

Background

USGS-NPS Park Vegetation Mapping Program

In 1994, the U.S. Geological Survey (USGS) and National Park Service (NPS) formed a partnership to map National Parks in the United States using the National Vegetation Classification (NVC). The goals of the USGS-NPS Vegetation Mapping Program is to provide baseline ecological data for park resource managers, create data in a regional and national context, and provide opportunities for future inventory, monitoring, and research activities (FGDC 1997; Grossman et al. 1998, http://biology.usgs.gov/npsveg/index.html).

Central to fulfilling the goals of this national program is the use of the NVC as the standard vegetation classification. This classification:

- is based upon current vegetation;
- uses a systematic approach to classify vegetation communities across environmental continuums;
- 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 standard National Vegetation Classification and mapping protocols (TNC and ESRI 1994b) 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, and provide a structure for framing and answering critical scientific questions about vegetation communities and their relationship to environmental processes across the landscape.

The NVC has primarily been developed and implemented by The Nature Conservancy (TNC) and the network of Natural Heritage Programs over the past twenty years (Grossman et al. 1998). Currently the NVC is maintained and updated by NatureServe. Additional support has come from federal agencies, the Federal Geographic Data Committee (FGDC), and the Ecological Society of America. Refinements to the classification occur in the application process, leading to ongoing proposed revisions that are reviewed both locally and nationally. NatureServe has made available a 2-volume publication presenting the standardized classification. This document provides 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). This publication can be found on the Internet at: http://www.natureserve.org/publications/library.jsp.

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

Chickasaw National Recreation Area Vegetation Mapping Project

The decision to map the vegetation at CHIC as part of the U.S. Vegetation Mapping Program was made in response to the NPS Natural Resources Inventory and Monitoring Guidelines issued in 1992. The vegetation mapping portion of the inventory and monitoring program lies in its need for the Parks to spatially analyze the vegetation at a fine enough scale to accurately predict various management issues.

In 2005, the Southern Plains Inventory and Monitoring Network initiated this project by asking the U.S. Bureau of Reclamation's Remote Sensing and Geographic Information Group (RSGIG) to undertake the mapping of this Park as part of a larger agreement for the mapping of Washita Battlefield National Historic Site, San Antonio Missions National Historical Park, and Lyndon B. Johnson National Historic Park.

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

Spatial Data

- Aerial photography
- Map classification
- Map classification description
- Spatial database of vegetation communities
- Hardcopy maps of vegetation communities
- Metadata for spatial databases

Vegetation Information

- Vegetation classification
- Formal description for each vegetation class
- Ground photos of vegetation classes
- Field data in database format

Scope of Work

Vegetation at CHIC was to be mapped and classified through a combination of new field data and photo interpretation. The protocols and standards used are described in the USGS/NPS program documents (TNC and ESRI (1994a) for medium sized parks (section 5.1). In 2005, the SOPN contracted the BOR to map approximately 6,570 ha (16,235 acres) of CHIC and a ¼ mile environs buffer. Because areas outside of the Park boundary are all privately held, field reconnaissance and plot collection were conducted exclusively within the Park boundary. Vegetation mapping for CHIC encompassed both the executive boundary of CHIC, and a 1/4 mile environ buffer.

The National Vegetation Classification (NVC) and Standard (NVCS)

In 1994, the U.S. Geological Survey - National Park Service (USGS - NPS) Vegetation Mapping Program (VMP) adopted the U.S. National Vegetation Classification (USNVC) (The Nature Conservancy and Environmental Systems Research Institute 1994, Grossman et al. 1998) as a basis for the a priori definition of vegetation units to be inventoried. The Federal Geographic Data Committee (FGDC) adopted a modified version of the upper (physiognomic) levels as a federal standard (FGDC-STD-005)(FGDC 1997). This standard is hereafter termed the National

Vegetation Classification Standard (NVCS)[1.] 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. Table 1 identifies the 7 levels of the NVC and depicts their placement in the hierarchical relationship (Maybury 1999). 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 VMP whenever feasible. For purposes of this document, the federal standard (FGDC 1997) is denoted as the National Vegetation Classification Standard (NVCS); the U.S. National Vegetation Classification (USNVC) will refer exclusively to NatureServe's treatment for vegetation floristic units treatment (alliances and associations only).

Table 1. Summary of the National Vegetation Classification System Hierarchal Approach (Maybury 1999).

LEVEL	PRIMARY BASIS FOR CLASSIFICATION	EXAMPLE
Class	Structure of vegetation	Woodland
Subclass	Leaf phenology	Evergreen Woodland
Group	Leaf types, corresponding to climate	Temperate or Subpolar Needle-Leaved Evergreen Woodland
Subgroup	Relative human impact (natural/semi-natural, or cultural)	Natural/Semi-natural
Formation	Additional physiognomic and environmental factors, including hydrology	Saturated Temperate or Subpolar Needle-Leaved Evergreen Woodland
Alliance	Dominant/diagnostic species of the uppermost or dominant stratum	Longleaf Pine -- (Slash Pine, Pond Pine) Saturated Woodland Alliance
Association	Additional dominant/diagnostic species from any strata	Longleaf Pine / Little Gallberry / Carolina Wiregrass Woodland

Alliances and associations are based on both the dominant (greatest canopy cover) species in the upper strata of a stand as well as on diagnostic species (those consistently found in some types but not others). Associations are the most specific classification and are hierarchically subsumed in the alliance. Each association is included in only one Alliance, while each alliance typically includes many associations. Alliance names are generally based on the dominant/diagnostic species in the uppermost stratum of the vegetation, though up to four species may be used if necessary to define the type. Associations define a distinct plant composition which repeats across the landscape and are generally named using both the dominant species in the uppermost

[1] The VMP program standards refer to the National Vegetation Classification System (also NVCS). Because of nomenclatural and acronym confusion with the federal (FGDC) National Vegetation Classification Standard, this term is no longer used by the VMP.

stratum of the vegetation and one or more dominant species in lower strata, or a diagnostic species in any stratum. A table listing the documented species is included in Appendix A. The species nomenclature for all alliances and associations follows that of Kartesz (1999). Documentation from NatureServe (2005) describes the naming and syntax for all NVC names:

- A hyphen ("-") separates names of species occurring in the same stratum.
- A slash ("/") separates names of species occurring in different strata.
- Species that occur in the uppermost stratum are listed first, followed successively by those in lower strata.
- Order of species names generally reflects decreasing levels of dominance, constancy, or indicator value.
- Parentheses around a species name indicates the species is less consistently found either in all associations of an alliance, or in all occurrences of an association.
- Association names include the dominant species of the significant strata, followed by the class in which they are classified (e.g., "Forest," "Woodland," or "Herbaceous Vegetation").
- Alliance names also include the class in which they are classified (e.g., "Forest," "Woodland," "Herbaceous"), but are followed by the word "Alliance" to distinguish them from Associations.

Examples of alliance names from CHIC:

- *Bouteloua hirsuta* Herbaceous Alliance
- *Juniperus virginiana* Semi-natural Forest Alliance

Examples of association names from CHIC:

- *Bouteloua hirsuta - Bouteloua curtipendula* Herbaceous Vegetation
- *Schizachyrium scoparium - Sorghastrum nutans - Bouteloua curtipendula* Herbaceous Vegetation
- *Juniperus virginiana var. virginiana / Schizachyrium scoparium* Forest

For more information on the NVC, see the USGS-NPS Vegetation Mapping Program standards (http://biology.usgs.gov/npsveg/standards.html) or Grossman et al. (1998).

In addition to the NVC, NatureServe has created standardized Ecological Systems Classification for describing sites based on both the vegetation and the ecological processes that drive them. Ecological systems are mid-scale biological communities that occur in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding. They are not conceptually a unit within the NVC and do not occupy a place in the NVC hierarchy. However, within each Ecological System resides a specific list of NVC associations that are likely to occur. Because the structure of the NVC is hierarchical, each association occurs in only one alliance. An association may occur in any number of Ecological Systems, limited only by the range of ecological settings in which that Association occurs. Ecological Systems are much like the map units used for the map legend; they are a broader scale concept that embodies the concepts of several highly specific associations that might be found in a particular setting. Since this project has been completed, the NVC has undergone revision. A new version (FGDC-

STD-005-2008 (Version 2)) has been produced. The primary revisions include a mid-level hierarchy between Formation and Alliance. This level better represents vegetation mapping realities.

Introduction to Natural Heritage Program Methodology and Element Ranking

The Oklahoma Natural Heritage Program (NHNM) is a member of the NatureServe Network of Natural Heritage Programs and Conservation Data Centers. The Natural Heritage Programs (and conservation data centers) are located in all the States and Canadian Provinces. Each Program serves as that state's biological diversity data center, gathering information and field observations to help develop national and statewide conservation priorities.

The multi-disciplinary team of scientists, planners, and information managers at the Heritage Programs use a standardized methodology to gather information on the rare, threatened, and endangered species and significant plant communities that occur in each state. The species and plant communities each Program maintains data for are referred to as “elements of natural diversity” or simply “elements”. Life history, status, and locational data are regularly updated in a comprehensive shared data system. Sources of element data include published and unpublished literature, museum and herbaria labels, and field surveys conducted by knowledgeable naturalists, experts, agency personnel, and our own staff of botanists, ecologists, and zoologists.

The Natural Heritage Ranking System

The cornerstone of Natural Heritage methodology is the use of a standardized element imperilment ranking system. Ranking species and ecological communities according to their imperilment status provides guidance for where Natural Heritage Programs should focus their information-gathering activities and provides data users with a concise and meaningful tool for decision-making.

To determine the status of an element within Oklahoma, ONHI gathers information on plants, animals, and plant communities. Each of these elements of natural diversity is assigned a rank that indicates its relative degree of imperilment on a five-point scale (1 = critically imperiled, 5 = demonstrably secure). The criteria used to define the element imperilment rank are number of occurrences, size of population, and quality of population. The primary criterion is the number of occurrences (in other words, the number of known distinct localities or populations). This factor is weighted more heavily than other factors because an element found in one place is more imperiled than something found in twenty-one places. Also of importance are the size of the geographic range, the number of individuals, the trends in both population and distribution, identifiable threats, and the number of protected occurrences.

Element imperilment ranks are assigned both in terms of the element's degree of imperilment within Oklahoma (its State-rank or S-rank) and the element's imperilment over its entire range (its Global-rank or G-rank). Taken together, these two ranks indicate the degree of imperilment of an element. For example, the bluntface shiner (*Cyprinella camura*), which is thought to be secure in northern North America but is rare in Oklahoma, is ranked G5 S1 (globally-secure, but critically imperiled in this state). Thread-leaved bladderpod (*Lesquerella angustifolia*) is ranked a G3 S3 -vulnerable both in the state and globally. Further, the maple-leaved oak (Quercus acerifolia) is ranked G1 S? (critically imperiled globally but unknown in Oklahoma). ONHI actively collects, maps, and electronically processes specific occurrence information for animal

and plant species considered extremely imperiled to vulnerable in the state (S1 - S3). Certain elements are “watchlisted,” meaning that specific occurrence data are periodically analyzed to determine whether more active tracking is warranted. A complete description of each of the Natural Heritage ranks is provided in Table 2.

This single rank system works readily for all elements except migratory animal species. Those animals that migrate may spend only a portion of their life cycles within the state. In these cases, it is necessary to distinguish between breeding, non-breeding, and resident species. As noted in Table 2, ranks followed by a "B,” for example S1B, indicate that the rank applies only to the status of breeding occurrences. Similarly, ranks followed by an "N” refer to non-breeding status, typically during migration and winter. Elements without this notation are believed to be year-round residents within the state.

Element Occurrences and their Ranking

Actual locations of elements, whether they are single organisms, populations, or plant communities, are referred to as element occurrences. The element occurrence is considered the most fundamental unit of conservation interest and is at the heart of the Natural Heritage Methodology. To prioritize element occurrences for a given species, an element occurrence rank (EO-Rank) is assigned according to the size, ecological quality and landscape context of the occurrences whenever sufficient information is available. This ranking system is designed to indicate which occurrences are the healthiest and ecologically the most viable, thus focusing conservation efforts where they will be most successful. The EO-Rank is based on three factors:

Table 2. Definition of Natural Heritage Imperilment Ranks. (Note: Where two numbers appear in a state or global rank (for example, S2S3), the actual rank of the element is uncertain, but falls within the stated range.

G/S1	Critically Imperiled globally/state because of rarity (5 or fewer occurrences in the world/state; or 1,000 or fewer individuals), or because some factor of its biology makes it especially vulnerable to extinction.
G/S2	Imperiled globally/state because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range.
G/S3	Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals).
G/S4	Apparently Secure globally/state, though it may be quite rare in parts of its range, especially at the periphery. Usually more than 100 occurrences and 10,000 individuals.
G/S5	Demonstrably Secure globally/state, though it may be quite rare in parts of its range, especially at the periphery.
G/SX	Presumed Extinct globally, or extirpated within the state.
G#?	Indicates uncertainty about an assigned global rank.
G/SU	Unable to assign rank due to lack of available information.
GQ	Indicates uncertainty about taxonomic status.
G/SH	Historically known, but usually not verified for an extended period of time.
G#T#	Trinomial rank (T) is used for subspecies or varieties. These taxa are ranked on the same criteria as G1-G5.
S#B	Refers to the breeding season imperilment of elements that are not residents.
S#N	Refers to the non-breeding season imperilment of elements that are not permanent residents. Where no consistent location can be discerned for migrants or non-breeding populations, a rank of SZN is used.
SZ	Migrant whose occurrences are too irregular, transitory, and/or dispersed to be reliably identified, mapped, and protected.
SA	Accidental in the state.
SR	Reported to occur in the state but unverified.
S?	Unranked. Some evidence that species may be imperiled, but awaiting formal rarity ranking.

Size – a measure of the area or abundance of the element's occurrence. Takes into account factors such as area of occupancy, population abundance, population density, population fluctuation, and minimum dynamic area (which is the area needed to ensure survival or re-establishment of an element after natural disturbance). This factor for an occurrence is evaluated relative to other known, and/or presumed viable, examples.

Condition/Quality – an integrated measure of the composition, structure, and biotic interactions that characterize the occurrence. This includes measures such as reproduction, age structure, biological composition (such as the presence of exotic versus native species), structure (for example, canopy, understory, and ground cover in a forest community), and biotic interactions (such as levels of competition, predation, and disease).

Landscape Context – an integrated measure of two factors: the dominant environmental regimes and processes that establish and maintain the element, and connectivity. Dominant environmental regimes and processes include herbivory, hydrologic and water chemistry regimes (surface and groundwater), geomorphic processes, climatic regimes (temperature and precipitation), fire regimes, and many kinds of natural disturbances. Connectivity includes such factors as a species having access to habitats and resources needed for life cycle completion, fragmentation of ecological communities and systems, and the ability of the species to respond to environmental change through dispersal, migration, or re-colonization.

Each of these factors is rated on a scale of A through D, with A representing an excellent rank and D representing a poor rank. These ranks for each factor are then averaged to determine an appropriate EO-Rank for the occurrence. If not enough information is available to rank an element occurrence, an EO-Rank of E is assigned. EO-Ranks and their definitions are summarized in Table 3

Table 3. Element Occurrence Ranks and their Definitions

A	Excellent viability.
B	Good viability
C	Fair viability.
D	Poor viability.
H	Historic: known from historical record, but not verified for an extended period of time.
X	Extirpated (extinct within the state).
E	Extant: the occurrence does exist but not enough information is available to rank.
F	Failed to find: the occurrence could not be relocated.

Project Area

Location and Regional Setting

CHIC lies in south central Oklahoma within Murray County and roughly 100 miles north of the Texas border. (Figure 1). Park headquarters are in the City of Sulphur which lies immediately to the north of the eastern most extension of the Park. The Park is roughly two hours driving time north of the Dallas / Fort Worth area and 1½ hours south of Oklahoma City.

Figure 1. Location map for project area (scale 1:1,000,000)(Inset scale 1:20,000,000).

Climate and Weather

"Summers are hot and humid with daytime temperatures near 100 degrees common from July to September. Humidity frequently exceeds 50 percent. Thunderstorms are common April through July. Winters are mild with temperatures rarely dropping below 32 degrees for more than two or three consecutive days" (http://www.nps.gov/chic/planyourvisit/weather.htm). Figure 2 shows the general precipitation trend of lower rainfall from east to west . The Oklahoma Climatological Survey reports the following for Murray County: (http://climate.mesonet.org/county_climate/Products/QuickFacts/murray.pdf).

Temperature
Average Annual: 63 degrees
Average Maximum: 74 degrees
Average Minimum: 51 degrees
Highest: 114 degrees
(Sulphur, August 11, 1936)
Lowest: -15 degrees
(Sulphur, January 18, 1930)
Days of 90 Degrees or Higher: 83
Days of 20 Degrees or Lower: 13

Precipitation
Average Annual: 39.65 inches
Days With Precipitation: 73
Wettest Year: 65.21 inches in 1990
Driest Year: 19.56 inches in 1963
Greatest Daily Rainfall: 11.61 inches
(Sulphur, October 8, 1970)

Winter Weather
Average Annual Snowfall: 4.5 inches
Days with snow on ground: 2
Greatest Seasonal Snowfall: 26.3 inches (1977-1978)
Greatest Daily Snowfall: 13.5 inches
(Sulphur, March 1, 1942)
Last Freeze in Spring: March 29
First Freeze in Autumn: November 5
Growing Season: 221 Days

Other Facts
Average Wind Speed: 9 mph
Sunshine: 55- 75%
Average Humidity: 70%
Thunderstorm Days: 47
Hail Events: 2 per year
Tornadoes (1950-2003): 30

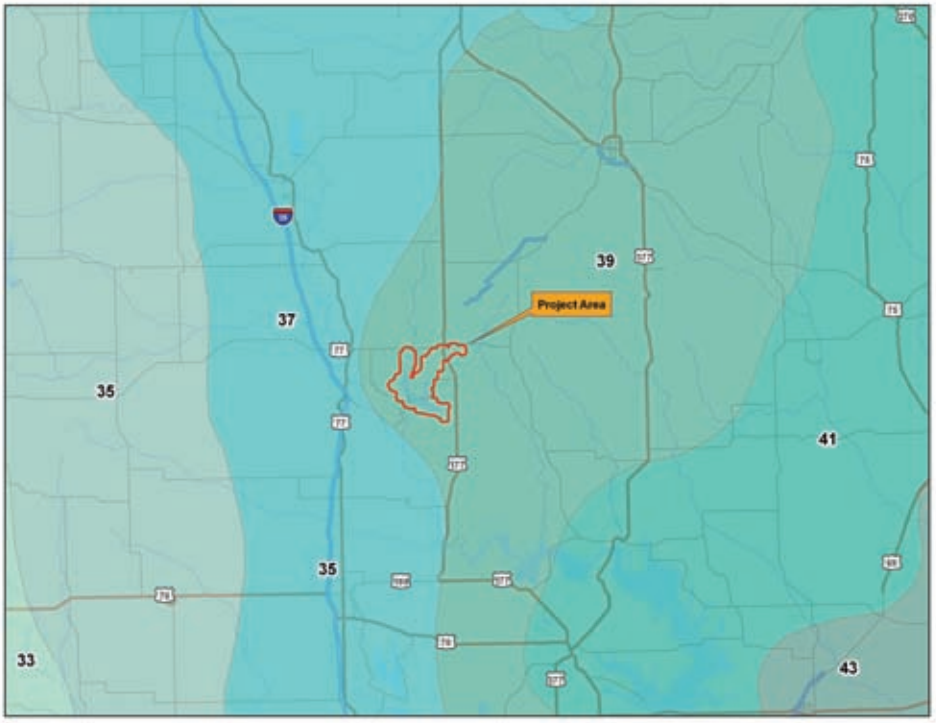


Figure 2. Average annual precipitation (inches) for south central Oklahoma (scale 1:500,000).

Physiography and Topography

CHIC lies within the Interior Plains Division, Central Lowland Province, and Osage Plains Section of Fennemans and Johnsons 1946 Physiographic Regions. The Osage Plains section is an area of varied relief, with flat or gently rolling plains broken by a series of low, linear ridges that trend north-south (http://encarta.msn.com/encnet/features/dictionary/dictionaryhome.aspx). Figure 3shows the topographic relief in the vicinity of the project area. Dominating the area is the topographic low that allowed for the damming and creation of "Lake of the Arbuckles". Most of the Park lies within this area. The uplands outside the Park are generally low and rolling and extend in all compass directions for many miles. Roughly 50 miles to the east is the Oauchita Mountain Range. By and large the topography is not marked by any extreme ranges in elevation.

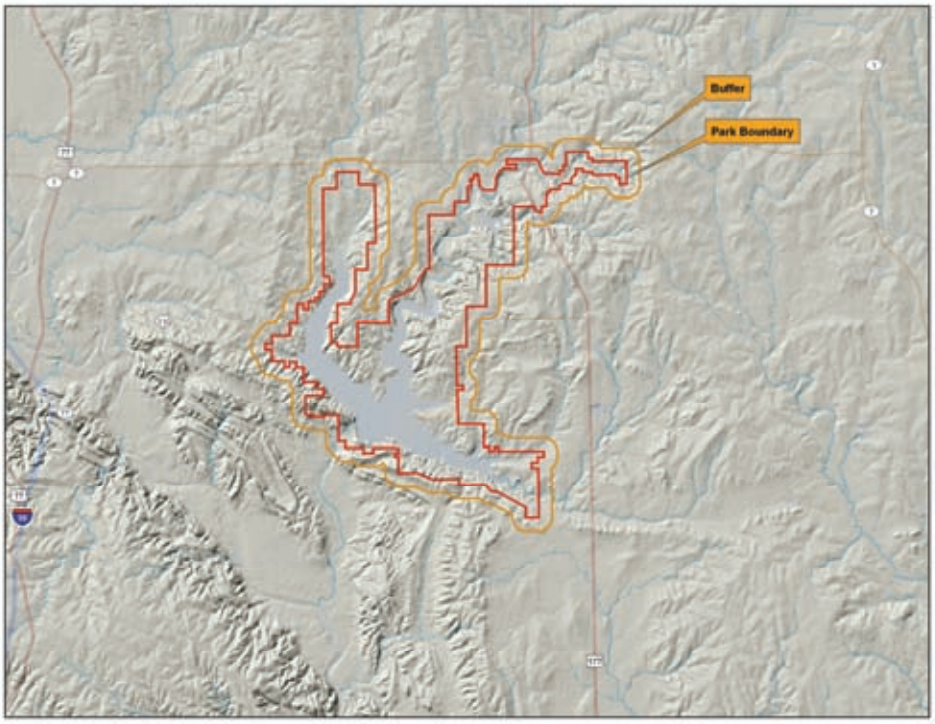


Figure 3. Topography for project area (scale 1:100,000).

Geology

In general the project area is made up of three broad geological groups. These include the Quaternary deposits that follow the principle drainages of Guy and Rock Creeks. To the north, east and west Lake of the Arbuckles is the Pennsylvanian System that includes the Vanoss Group and Ada Formation. To the south of the lake are the Middle Ordovician through Mississippian Systems that are made up of various limestones and shale deposits. These formations are all part of the regional Arbuckle uplift. Figure 4 shows the distribution of the formations throughout the project area and environs.

Geomorphology: This Section is in the Central Lowlands geomorphic province. The predominant landform on about 70 percent of the Section consists of irregular plains that originated from uplift of level bedded continental sediments, that had been deposited into a shallow inland sea, followed by a long period of erosion. Other landforms include plains with

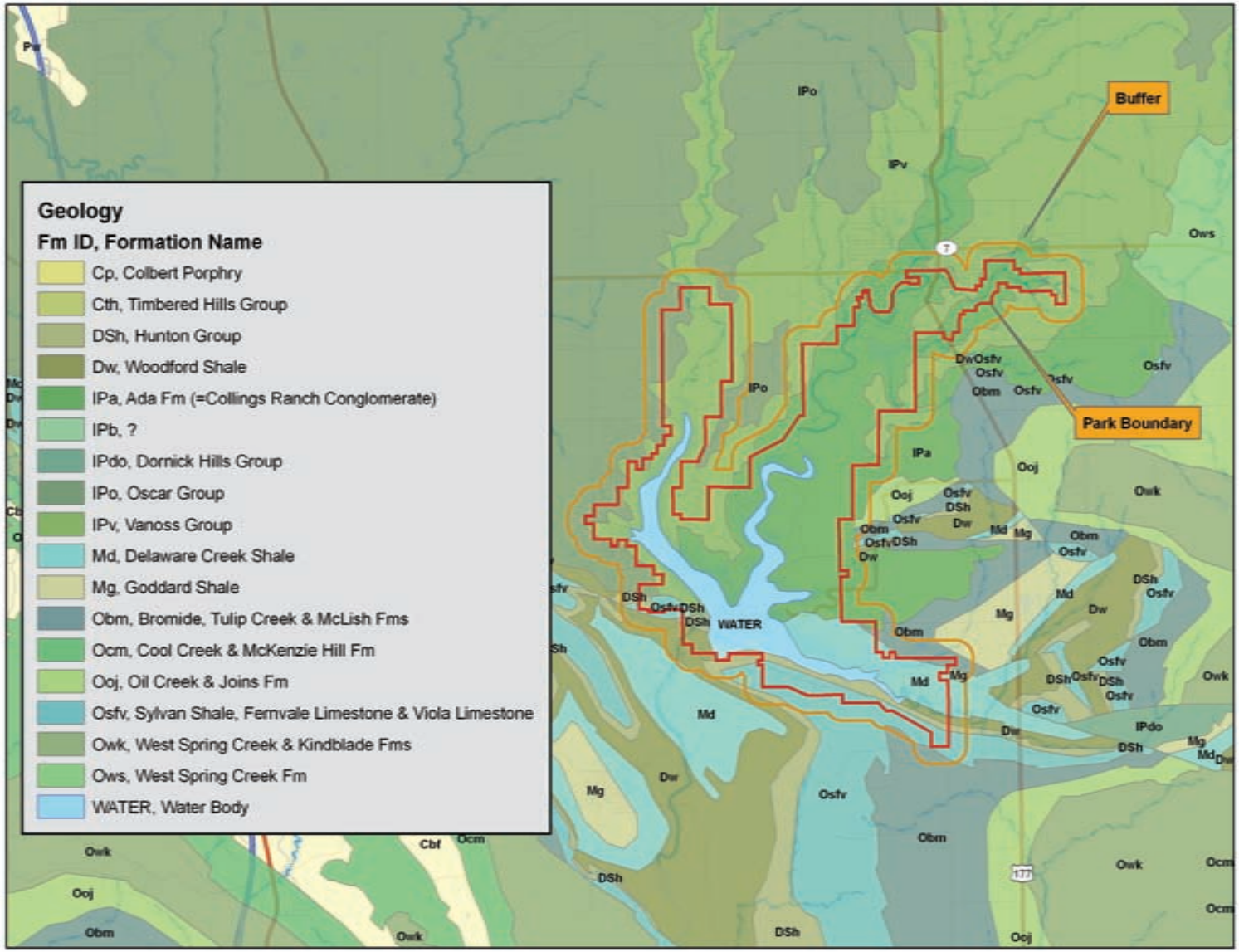


Figure 4. Geology of the project area and vicinity (scale 1:100,000).

hills and open high hills. Elevation ranges from 330 to 1,300 ft (100 to 400 m). Local relief ranges from 100 to 300 ft (30 to 90 m). (From http://www.fs.fed.us/land/pubs/ecoregions/ch29.html)

Soils

Soils for the project area can be generalized by two broad categories . These are the lowland soils and upland soils . The lowland soils are characterized by their location along waterways and are derived from transported alluvial material (Barker and Jameson, 1975) . Consequently, these soils are mostly clay loams with some flood-deposited sand in the upper layer . These soils are characteristically deep (7-10 feet). The upland soils are derived from in situ breakdown of the parent rock material (Barker and Jameson, 1975) . Much of the upland areas are Vanoss conglomerate and resistant to weathering . These tend to form steep slopes (summarized from Wikle et al. 1998). Lowland soils are typically Garvin and Bandco soils, Durant loams or Elandco silt loams. Upland soils generally fall into the Rayford cobbly loams or Kiti-Rock outcrop complex in the most southern portion of the project area (Figure 5).

Wildlife

Among the fauna in this Section are white-tailed deer, black bear, bobcat, gray fox, raccoon, cottontail rabbit, gray squirrel, fox squirrel, eastern chipmunk, white-footed mouse, pine vole, short-tailed shrew, and cotton mouse. The turkey, bobwhite, and mourning dove are game birds in various parts of this Section. Songbirds include the red-eyed vireo, cardinal, tufted titmouse, wood thrush, summer tanager, blue-gray gnatcatcher, hooded warbler, and Carolina wren. The herpetofauna include the box turtle, common garter snake and timber rattlesnake. (From http://www.fs.fed.us/land/pubs/ecoregions/ch29.html)

Vegetation

Prior vegetation within Oklahoma and, more specifically, south central Oklahoma include both the non-spatial and spatial. This is particulary salient to this project as we are both describing the vegetation in addition to mapping it.

Milby (1977) summarizes the literature on the vegetation of Oklahoma and shows that the south central portion of the state is the most heavily investigated. Hoagland and Johnson (2000) also summarized earlier vegetation studies.

The spatial (mapped) history is summarized first from a broad ecoregional view followed by more detailed descriptions at the state level.

CHIC lies within the “Cross Timbers” ecoregion as described by Omernik (1987) (Figure 6) and “Cross Timbers and Prairie ecoregions as described by Bailey (1995) (Figure 7). The Park falls entirely within Omernik’s Central Oklahoma/Texas Plains ecoregion (Ecoregion 29) and Baileys Prairie Parkland (Subtropical) Province (

Table **6**). Adjacent Omernik ecoregions include the Central Great Plains to the north and west while to the east are the Arkansas Valley, Ouachita Mountains, South Central Plains, East Central Texas Plains and the Texas Blackland Prairies. Adjacent Bailey’s ecoregions include the Redbed Plains section to the west and the Ouachita Mountains, Oak woods and Prairies, and the Blackland Prairies Sections to the east and southeast. Other work by Taylor and Talor show the Park within the “Prairie Great Plains Region” (Figure 8).

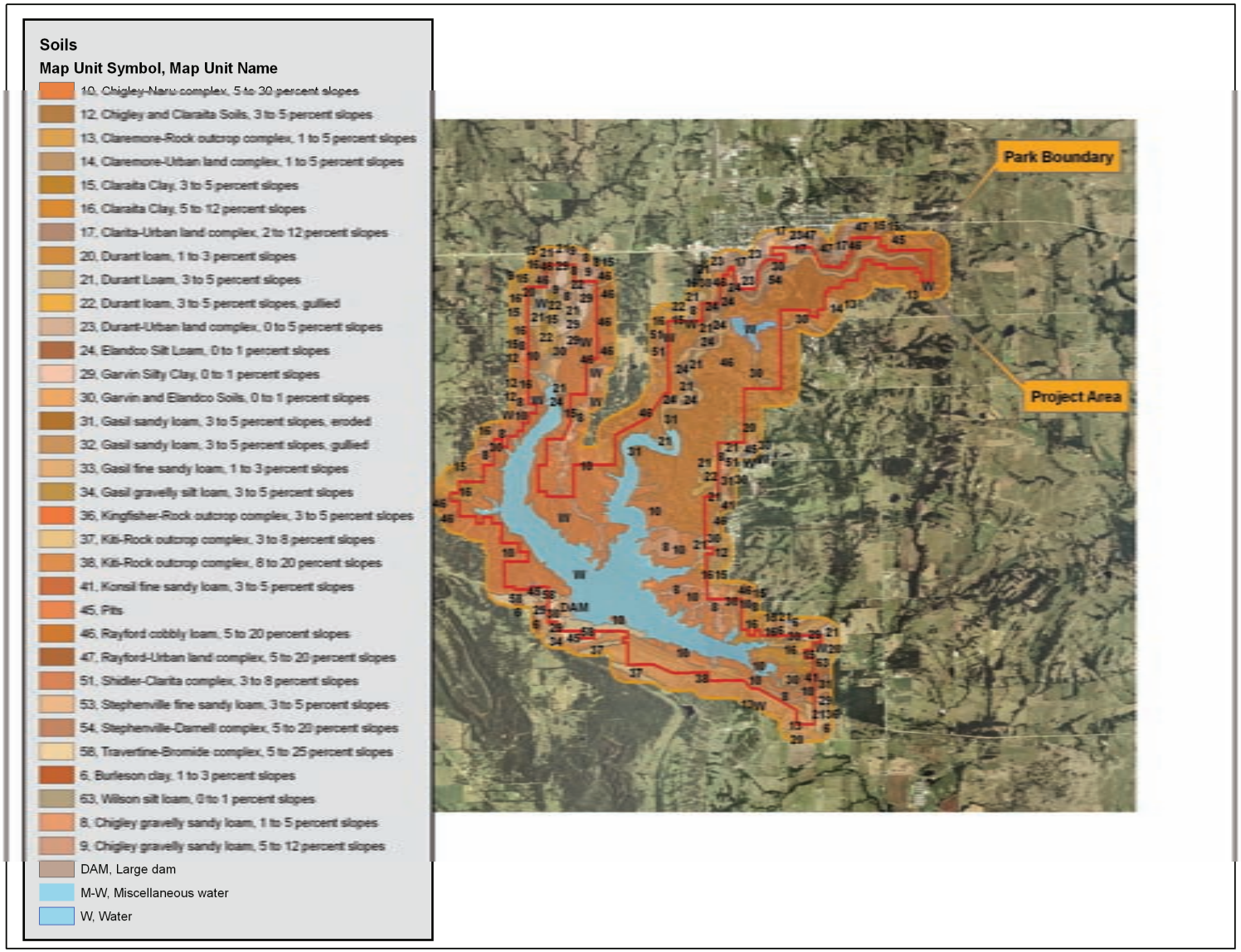


Figure 5. Soils map for project area (scale 1:100,000)

More detailed information at the state level was developed by Duck and Fletcher (1943) when they created a game map of the state. Their map shows the lowland areas within the mapping area as Postoak – Blackjack Oak Forest while the more upland areas are described as Tall Grass Prairies (Figure 9). The following definitions are taken from the web edition of the Duck and Fletcher report (Hoagland – Oklahoma Biological Survey)

Post Oak – Blackjack Game Type: The Post Oak - Blackjack Game Type represents the forest-grassland ecotone and contains dominants from both the deciduous formation and the grassland formation. The overstory is largely composed of post oak *(Quercus stellata)*, blackjack oak *(Q. marilandica)*, and black hickory *(Carya texana)* with the percent of blackjack oak increasing in the composition as one moves west through the Post Oak - Blackjack Game Type. The understory is made up of little bluestem *(Schizachyrium scoparium)*, big bluestem *(Andropogon gerardii)*, and other species depending upon the site. Its best correlation with other works is with the Oak Savannah of the Soil Conservation Service. There are approximately 17,600 square miles of this condition which includes generally the east central portion of the state with fingers reaching as far west as Cleo Springs in Major County, Curtis in Woodward County, Webb in Dewey County, and western Comanche County. The northeastern portion lying on the north side of the South Canadian, North Canadian, and Cimarron rivers differs importantly from the rest of the Post Oak - Blackjack Game Type. This section is supported by deep sandy Quaternary soils.

Tallgrass Prairie Game Type: The Tallgrass Prairie Game Type occupies most of the best of the agricultural soils of Oklahoma and, with the exception of the Arbuckle Mountains and Osage areas is characterized by clean cultivation and low game potentiality. On the basis of original vegetation this type includes the big bluestem subtype, the little bluestem subtype and probably a portion of the eastern edge of the mixed grass ecotone type of Osborn and Whittaker (1936, 1937a, b).

For the most part the natural vegetation consists of a mixture of such species as big bluestem *(Andropogon gerardii)*, little bluestem *(Schizachyrium scoparium)*, Indian grass *(Sorghastrum nutans)*, switch grass *(Panicum virgatum)*, and silver beard grass *(Bothriochloa saccharoides)*, in the eastern portions of the type, with a gradual increase of such species as buffalo grass *(Buchloë dactyloides)*, blue grama *(Bouteloua gracilis)* and side oats grama *(Bouteloua curtipendula)*. Continued grazing has removed the tall grass species from the composition of the western portion of the type leaving only the short grasses. This is the largest Game Type in the state, comprising around 20,500 square miles occupying generally a belt from north to south just east of the Post Oak - Blackjack Game Type. The Cherokee prairie, a sizeable area, is located in northeastern Oklahoma.

Two much more detailed maps for the state include the Oklahoma GAP Vegetation Map (2005) (Figure 10) and the National Land cover Maps (NLCD)(1992) (Figure 11) produced by the U.S. Department of Agriculture[2].

[2] A 2005 edition of the NLCD map is in production but has not been made available to the public.

These maps were designed to be used in modern GIS and remote sensing platforms and thus the images are very busy and difficult to interpret at first glance. The GAP map shows 16 landcover types within the mapping boundary of this project. A summary table of the land cover and area is shown in **Table 4**.

The NLCD map is similar to the design of the GAP map although the map units vary somewhat. Table 5 is a summary table that shows map units and area within the mapping boundary.[3]

More specific larger scale information with particular reference to the Park or surrounding areas is well covererd by Hoagland and Johnson (2000). Briefly, they acquired and digitized 1871 and 1897 Plat maps from the Oklahoma State Depatment of Libraires. The classification system for these plat maps is coarse yet do provide a glimpse of the development pace of the area. Aerial photography was interpreted for 1956 and 1997 and digital maps were produced. These maps are particularly useful in showing the extent of redcedar expansion in addition to the increase of urban areas.

Graphics for the above mentioned land cover maps are in the Hoagland and Johnson 2000 report and, with the exception of the 1997 vegetation map, are not repeated here. However, the digital versions of these maps are included as part of the geodatabase. The 1997 Hoagland map is shown in Figure 12. The mapped area shows a woodland dominated by Juniperus virginiana, Quercus stellata and Q. texana (also known as Q. buckleyi). Grasses are dominated by Andropogon gerardii and A. virginicus. Quercus sinuata and Rhus glabra make up the bulk of the shrublands. Table 7 shows the frequency and abundance within the mapped area of each of the map units.

“Kuchler classified vegetation as cross timbers (Quercus-Andropogon}), oak-hickory forest, and oak-hickory-pine forest. The predominant vegetation form is cold-deciduous broad-leaved forest and extensive areas of tall grassland with a tree layer. Forest cover consists of post, live, and blackjack oaks, and pignut and mockernut hickories. Grasses consist of big and little bluestems, indiangrass, and sunflower.” (From http://www.fs.fed.us/land/pubs/ecoregions/ch29.html)

[3] The total area for the map units for both GAP and NLCD will vary due to the clipping arc intersecting the 30 meter pixels differently. The pixels of the GAP and NLCD maps do not intersect due to different origins.

Table 4. Map units and area for GAP land cover within the mapping boundary.

NAME	Acres	Hectares
Riverine	1.4	0.6
Eastern Red Cedar Woodland	188.2	76.2
Crop - Warm Season	253.4	102.5
Pond	425.9	172.4
Tallgrass Cedar Savanna	469.2	189.9
Tallgrass Oak Savanna	817.2	330.7
Central Bottomland Forests	1015.2	410.9
Residential/Industrial	1673.5	677.3
Oak Woodland	1854.0	750.3
Central Crosstimbers	1944.5	786.9
Lake/Reservoir	2279.0	922.3
Midgrass Prairie	2376.0	961.5
Midgrass Oak Savanna	2587.3	1047.0
Eastern Red Cedar - Oak Woodland	3498.3	1415.7
Tall Grass Prairie	3587.6	1451.8
Oak - Cedar Forests	4013.3	1624.1
Total	26984.0	10920.1

Table 5. Map units and area for NLCD within the mapping boundary

NAME	**Acres**	**Hectares**
Bare Rock	0.8	0.3
Emergent / Herbaceous Wetlands	1.0	0.4
Urban / Recreational Grasses	4.8	2.0
Mixed Forest	26.7	10.8
Woody Wetlands	91.7	37.1
Commercial / Industrial / Transportation	142.0	57.5
Row Crops	202.5	81.9
Hi Intensity Residential	219.1	88.7
Shrubland	921.2	372.8
Low Intensity Residential	991.9	401.4
Small Grains	1492.4	603.9
Pasture / Hay	1709.8	691.9
Evergreen Forest	2181.2	882.7
Water	3022.2	1223.0
Grasslands / Herbaceous	9266.5	3750.0
Deciduous Forest	11415.3	4619.6
Total	**31689.0**	**12824.1**

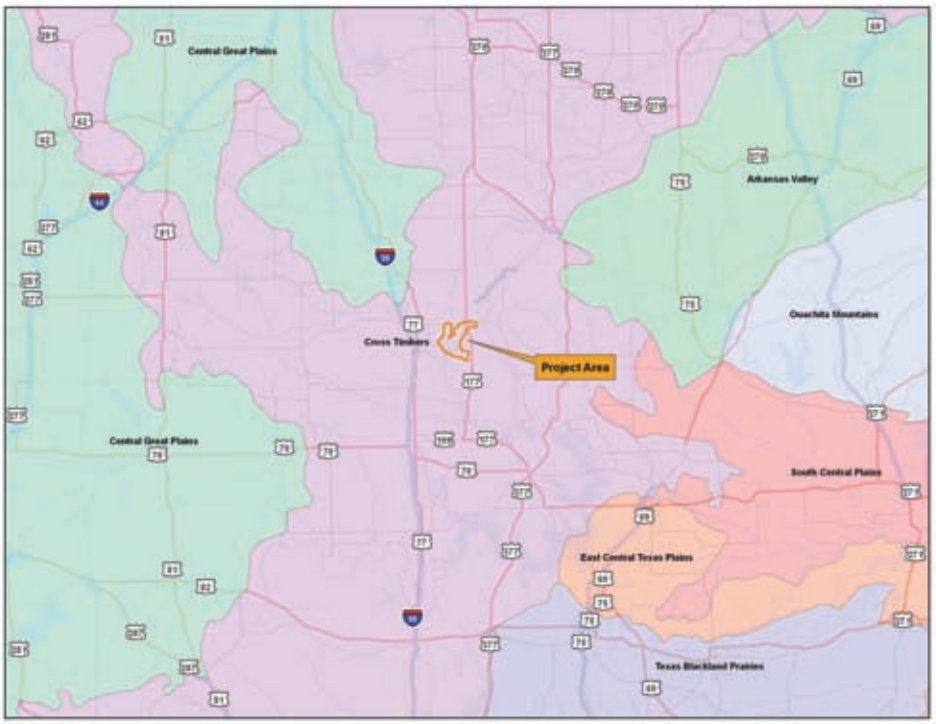


Figure 6. Regional view of Omernik's (1987) ecoregions (1:1,000,000 scale

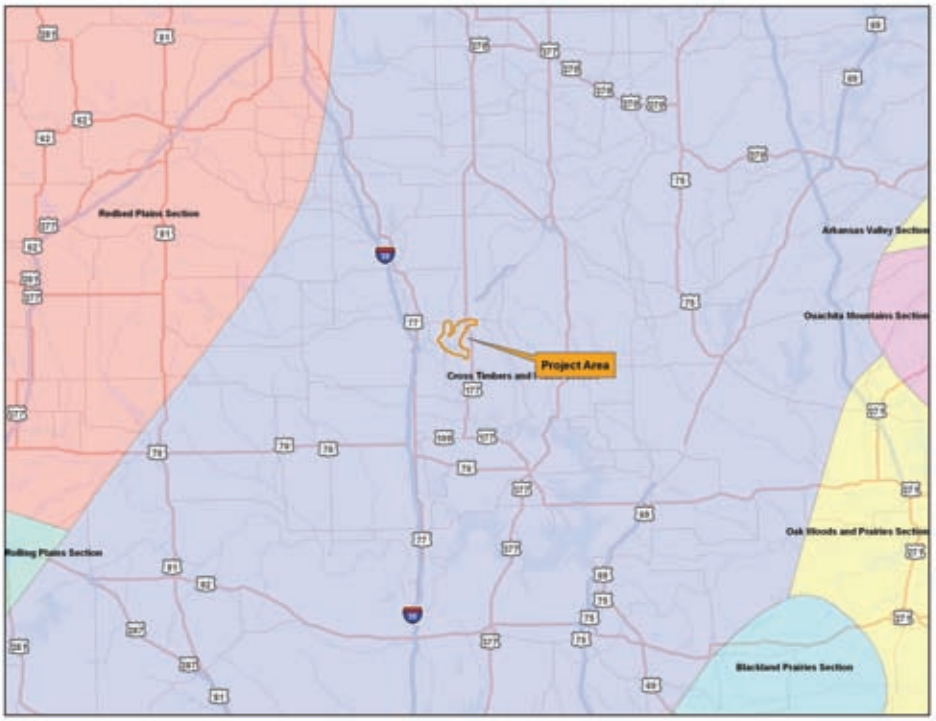
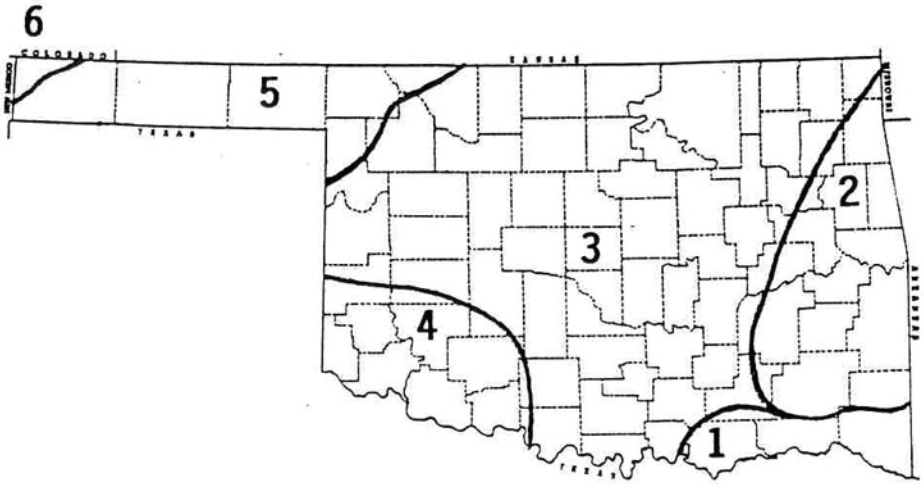


Figure 7. Regional view of Bailey's (1983) ecoregions (1:1,000,000 scale).

Table 6. Ecoregions of CHIC.

Ecoregions - Omernik
Ecoregion Code: 29
Name: Cross Timbers
Description: The Central Oklahoma/Texas Plains ecoregion is a transition area between the once prairie, now winter wheat growing regions to the west, and the forested low mountains of eastern Oklahoma. The region does not possess the arability and suitability for crops such as corn and soybeans that are common in the Central Irregular Plains to the northeast. Transitional "cross-timbers" (little bluestem grassland with scattered blackjack oak and post oak trees) is the native vegetation, and presently rangeland and pastureland comprise the predominant land cover. Oil extraction has been a major activity in this region for over eighty years.
Ecoregions - Bailey
Domain: Humid Temperate Domain
Division: Prairie Division
Province: Prairie Parkland (Subtropical) Province
Section: Cross Timbers and Prairie Section



1. Gulf Coastal Plain Region
2. Ozarkian Region
3. Prairie Great Plains Region
4. Southwestern Region
5. High Plains Region
6. Rocky Mountain Region

Figure 8. Taylor and Taylor phytogeographic regions of Oklahoma. CHIC lies within region 3.

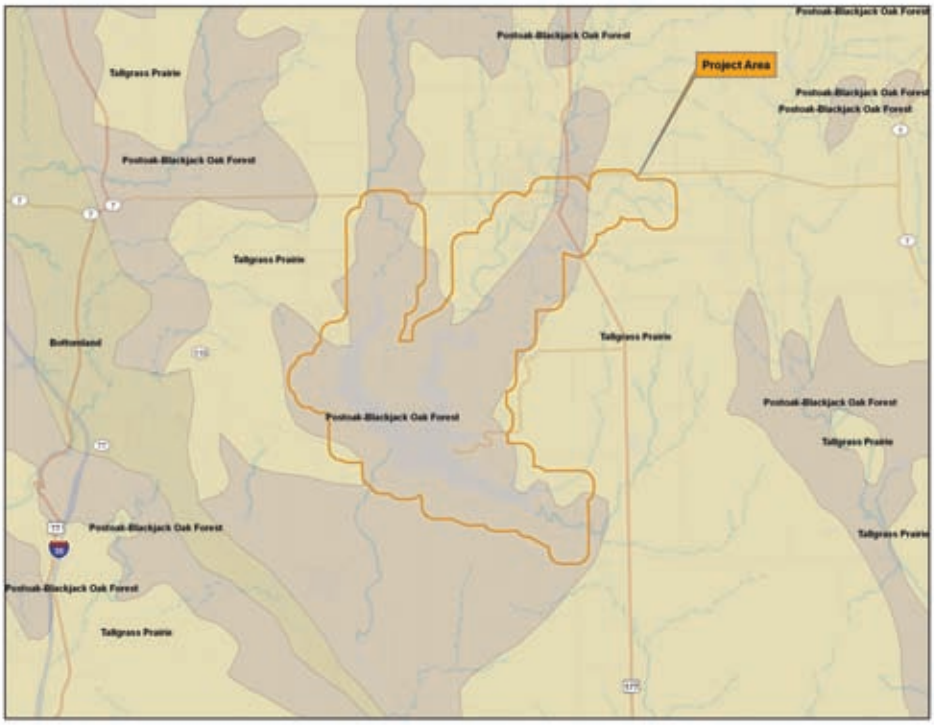


Figure 9. Game types of Oklahoma map (Duck and Fletcher 1943) (Scale 1:100,000).

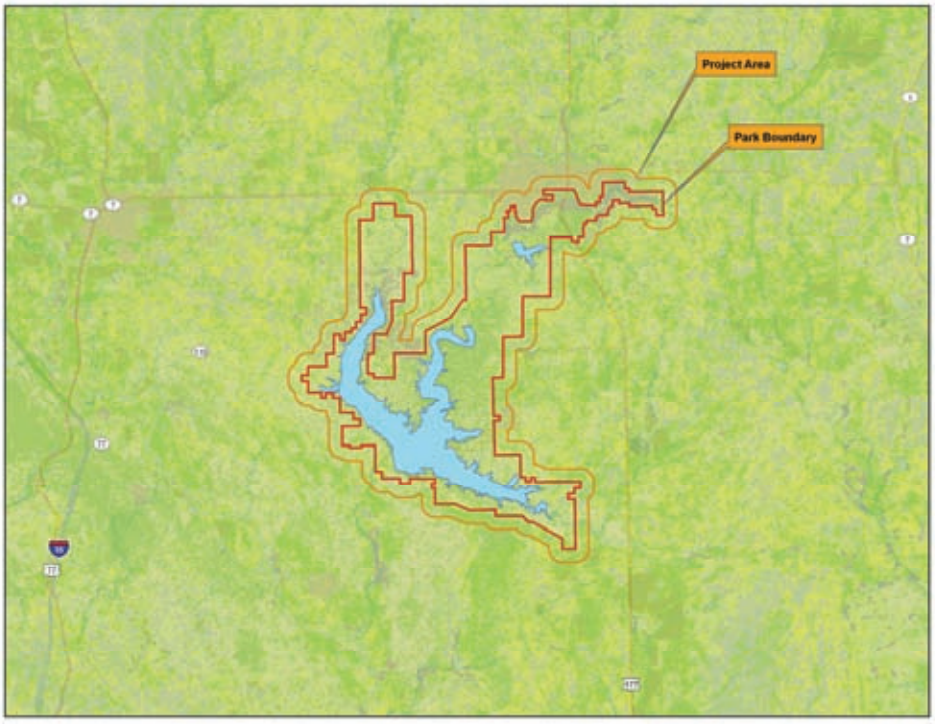


Figure 10. Oklahoma GAP vegetation map (2005)(Scale 1:100,000)

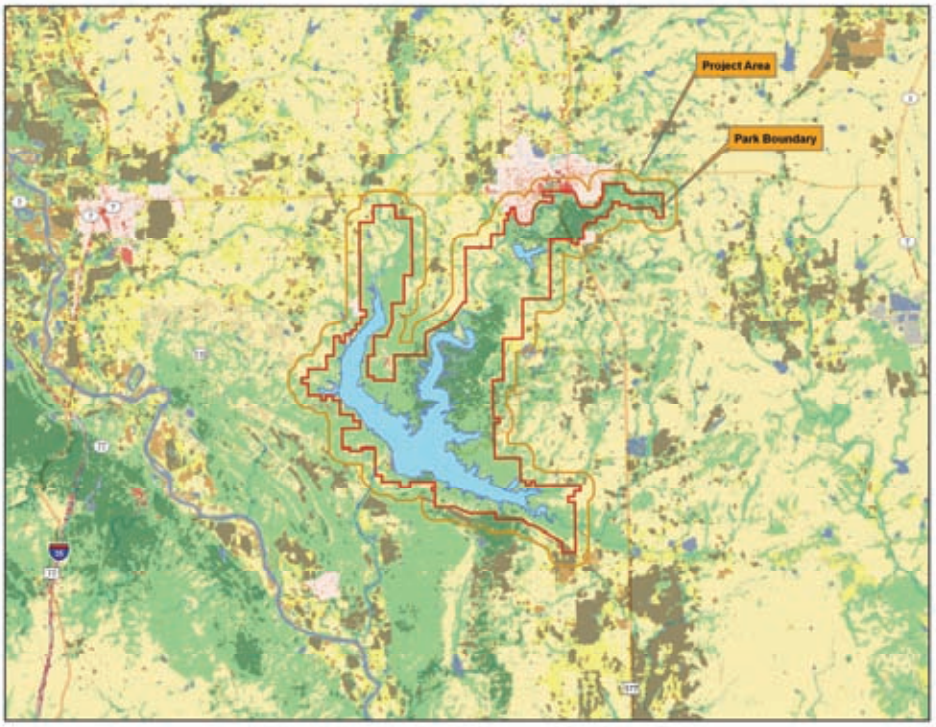


Figure 11. National land cover map (1992) (Scale 1:100,000).

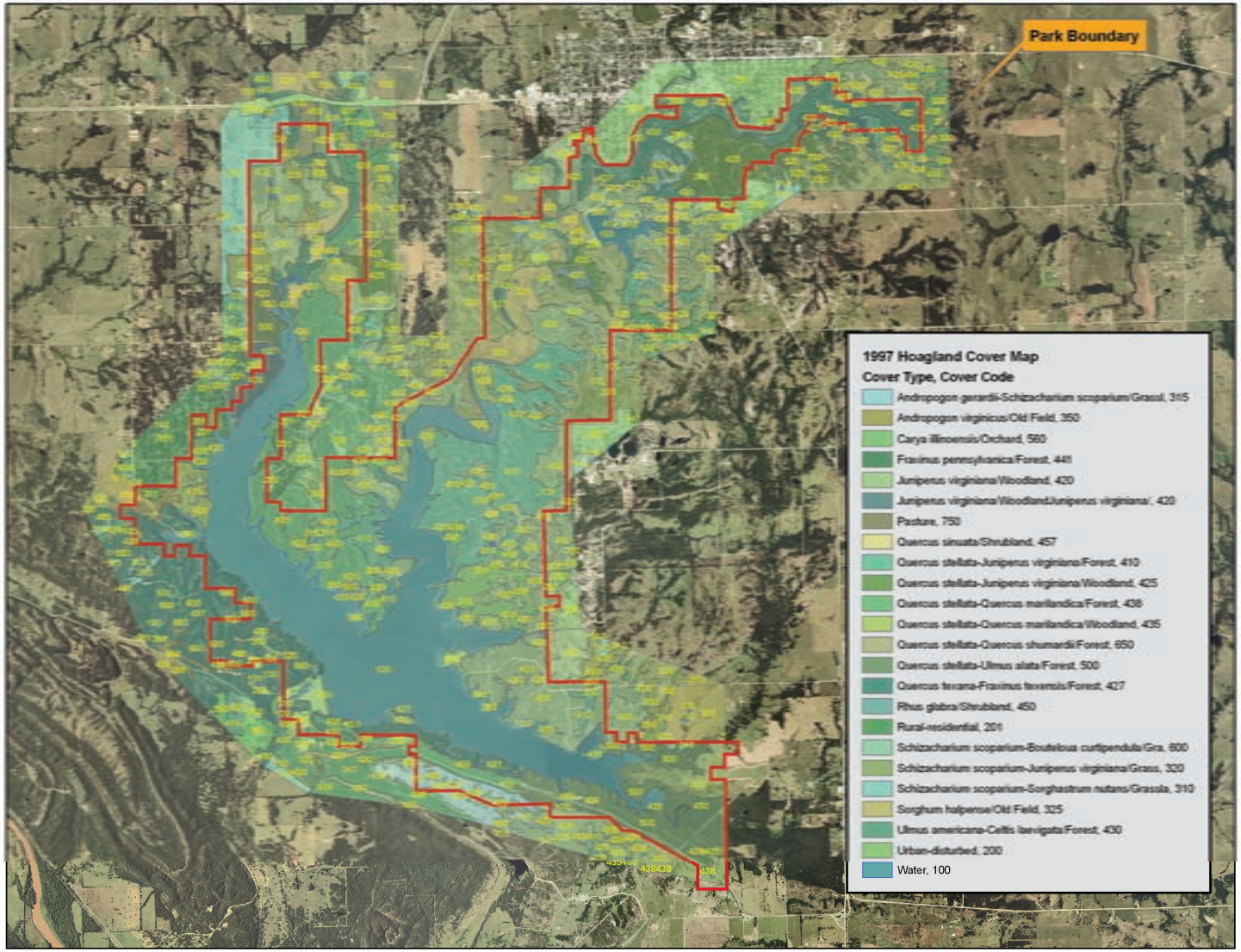


Figure 12. 1997 Chickasaw National Recreation Area Vegetation and Environs (Hoagland et. al 1997)(Scale 1:60,000).

Table 7. Frequency and abundance of map units from the 1997 vegetation map.

Cover Type	Frequency	Acres
Quercus sinuata / Shrubland	1	2
Fraxinus pensylvanica / Forest	1	2
Quercus stellata-Quercus shumardii / Forest	1	6
Unlabeled	8	6
Schizacharium scoparium-Bouteloua curtipendula / Grassland	12	17
Rhus glabra / Shrubland	3	56
Carya illinoensis / Orchard	2	76
Juniperus virginiana / WoodlandJuniperus virginiana /	3	107
Andropogon gerardii-Schizacharium scoparium / Grassland	7	174
Pasture	7	268
Andropogon virginicus / Old Field	11	288
Sorghum halpense / Old Field	13	350
Schizacharium scoparium-Sorghastrum nutans / Grassland	30	442
Rural-residential	18	447
Quercus stellata-Ulmus alata / Forest	7	518
Quercus stellata-Juniperus virginiana / Woodland	11	571
Quercus stellata-Quercus marilandica / Woodland	38	649
Ulmus americana-Celtis laevigata / Forest	14	677
Quercus texana-Fraxinus texensis / Forest	9	1,069
Quercus stellata-Juniperus virginiana / Forest	23	1,083
Urban-disturbed	53	1,290
Schizacharium scoparium-Juniperus virginiana / Grassland	43	1,831
Quercus stellata-Quercus marilandica / Forest	47	1,839
Water	57	2,514
Juniperus virginiana / Woodland	154	2,873
Total	573	17,156

Methods

The methods to produce a vegetation map of a restricted size such as CHIC are quite different from those of larger Parks. CHIC falls into the "medium park" category, which is defined as falling between 1 and 100 km2. For the larger "medium parks" the sampling area is the entire Park with data points collected using a stratified approach. Because CHIC is on the small end of the "medium park" we collected observation points throughout the Park. This is described in more detail below.

Planning and Scoping

A general planning and scoping meeting was held in April 2006 at Chickasaw National Recreation Area to discuss the mapping needs. Several topics were discussed. These include:

- Project Background – National Program Standards
- Unit Overviews
- Task Overviews
    - Compilation and Preparation of Existing Data
    - Preliminary Classification and Data Review
    - Data Collection
    - Map Classification
    - Available Photographs
    - Database for Information
    - Local Descriptions
    - Metadata
    - Map Production
- Field Season

Responsibilities and Deliverables

BOR assumed the primary responsibility for all the tasks for this project. Products will include a full report, metadata, and distribution of the data and information to the appropriate NPS offices and websites. The data will ultimately be made available through the USGS website (http://biology.usgs.gov/npsveg/).

Preliminary Data Collection and Review of Existing Information

No preliminary data were collected in association with the CHIC vegetation mapping project. This project was the first to examine, report, and/ or map vegetation at CHIC. Milby (1977) summarizes the literature on the vegetation of Oklahoma and shows that the south central portion of the state is the most heavily investigated. Hoagland and Johnson (2000) also summarized earlier vegetation studies. Each of the existing reports mentioned above was reviewed to gain further insight into the ecology of CHIC and aid in the mapping of vegetation on a landscape scale.

Field Survey

For each provisional vegetation type that represents actual or potential National Vegetation Classification (NVC) associations in the Natural and Seminatural Subgroups (Grossman et al. 1998; NatureServe 2006), classification plot data was collected in accordance with VMP training

and protocols (The Nature Conservancy and Environmental Systems Research Institute 1994) at CHIC.

Plot dimensions were made in accord with the following sizes. Minimum plot sizes were those specified by The Nature Conservancy and Environmental Systems Research Institute (1994b) and modified as recommended by NatureServe for LYJO and SAAN (2005).

- Forests and Woodlands: 400 square meters
- Shrublands: 100 square meters
- Herbaceous Vegetation: 100 square meters
- Sparse Vegetation: 100 square meters
- Numbers of plots (total for park and per type):

The total number of 100 plots was projected for the park based on its size. Due to the extensive area covered by the lake, especially previous mesic bottomland sites, the actual area of vegetation was less, as was the diversity of habitats. Therefore, field observation clarified the need for somewhat fewer plots as the project progressed during the field season. See Table 8 below.

Based on the vegetation classes accepted by NatureServe (2006) as potentially occurring in CHIC, a provisional classification of vegetation types was developed following a two-day reconnaissance. An attempt was made to collect 5 plots of each vegetation type, and at least 2 plots were collected with one exception discussed in Table 8.

The primary sampling strategy for vegetation plots was to adequately represent vegetation types with a secondary focus to distribute them geographically within the park. Thus, plots were spaced so as to be in separate presumed polygons (polygons not actually delineated on field aerials available). An exception to this rule was made, especially for grasslands and wetlands. In several cases, plots of the different grassland and aquatic associations were selected to be in close proximity to one other to show the patchiness of the environments and to help the mappers determine if these associations have distinct enough signatures to be identified in the aerial images.

Five additional waypoints were taken as observation points for areas that were too small to be mapped or were not suited to plot techniques, such as submerged aquatic vegetation. These observation points were collected to aid the mappers in developing signatures for these distinct but localized vegetation types (Table 9).

Agricultural/urban sites that fall within the Anderson classification scheme were not sampled nor given observation points.

Samples were collected only of plants encountered at CHIC that could not be identified with certainty in the field. Of these, no vouchers were archived.

Table 8. Summary of Plots and Vegetation types sampled May 22–July 13, 2006.

Type No.	Approx. IECS no.	Cover type	Provisional Vegetation class	Plots sampled
1	IA8NcA137	Forest/Woodl.	Juniperus virginiana-Schizachyrium scoparium upland	5
2	IB2NaA1912	Forest	Quercus shumardii-Carya cordiformis bottomland	5
3	IB2NaA1912	Forest	Q. buckleyi-Q. muhlenbergii-Fraxinus texensis upland	6
4	IB2NaA253	Forest	Q. stellata-C. cordi.-Frax. texensis upland	6
5	IB2NaA253	Forest	Q. stellata-Ulmus alata upland	2
6	IB2NdA279 or A236	Forest	Mixed deciduous (or also Juniper) bottomland forest	7
7	IB2NdA290	Forest/Woodl.	Platanus occidentalis creek bottom	2
8	IC3NaA383	Forest	Q. stellata-Junip. virg. Upland	3
9	IIB2NaA625	Woodland	Quercus spp.-Schiz. scop. upland	7
10	IIB2Na??	Woodland	Mixed decid. succession. upland	4
11	IIB2NbA636	Woodland	Salix nigra shoreline	1
12	IIIB2NaA1884	Shrubland	Prunus ang.-Rhus glab. (incl. mixed decidous-Juniper) oldfield	5
13	IIIB2NaA???	Shrubland	Junip. vir.-Schiz. scop. Upland	3
14	IIIB2NaA907	Shrubland	Quercus. sinuata forest-inclusion upland	2
15	VA5NaA1194	Grassland (Semiaquatic)	Panicum virgatum shoreline strips	2
16	VA5NcA1225	Grassland	Schiz. scop.-Sorghas. nutans upland	5
17	VA5NeA1282	Grassland	Bouteloua hirsuta-Thin soil grass/herb.	7
18	VA5NeA1282	Grassland	Muhlenbergia reverch. seep area	5
19	VA5NeA1279	Grassland	Oldfields (upland & bottomland)	4
20	VA5NlA1432	Aquat. Herb.	Carex emoryi shoreline	2
21	VA5NlA1436	Aquat. Herb.	Typha spp. Shoreline	2
22	VB2NhA1881	Aquat. Herb.	Polgonum spp. Shoreline	2
23	VA5Nj?	Grass/Aquat.	Creek depositional bars	2
	Total			89

Table 9. Observation Point Waypoints collected at CHIC May-July, 2006.

Waypt. No.	Approx. IECS no.	Cover type	Provisional Veg. class	UTM 14S coordinates
168	VA5NeA1279	Grassland	Sorghum halapense	0683890 3817235
165	VA5NaA1194	Grassland	Tripsacum dactyloides	0683857 3817224
202	VA5Nj???	Herbaceous	Oldfield swale	0680940 3819529
175	VC2NaA1754	Aquatic Herb	Ceratophyllum near shore	0680673 3817239
198	VC2NaA1754	Aquatic Herb	Ceratophyllum near shore	0680589 3817617

We conducted field work during the following periods:

- May 22-26 (first two days, reconnaissance only)
- June 12–16 (accompanied by Tomye Folts-Zettner, SOPN)
- June 19–23 (accompanied by Tomye Folts-Zettner, SOPN)
- June 26–30 (accompanied by Heidi Sosinksi, SOPN)
- July 10–13 (accompanied by Destry Richardson, CHIC)

Table 8 summarizes 23 potential vegetation classes at CHIC that were discernable. Most of these classes were sampled by 4-5 plots. The aquatic classes were sampled with only two plots each because the areas were small in area and restricted in distribution, mostly to the backwater areas where the creeks emptied into the Lake of the Arbuckles. Other vegetation types that were not sampled with more than two or three plots were also of limited distribution or were not developed as a distinct vegetation type from the surrounding vegetation (such as, Veg. Type 14 not distinct from Veg type 3). Therefore, we collected 89 plots (48 forest/woodland plots and 41 grassland/shrubland plots).

Aerial Photography

Color infrared photography was acquired August 26, 2005. Aerial Photograph centers are shown in Figure 13.

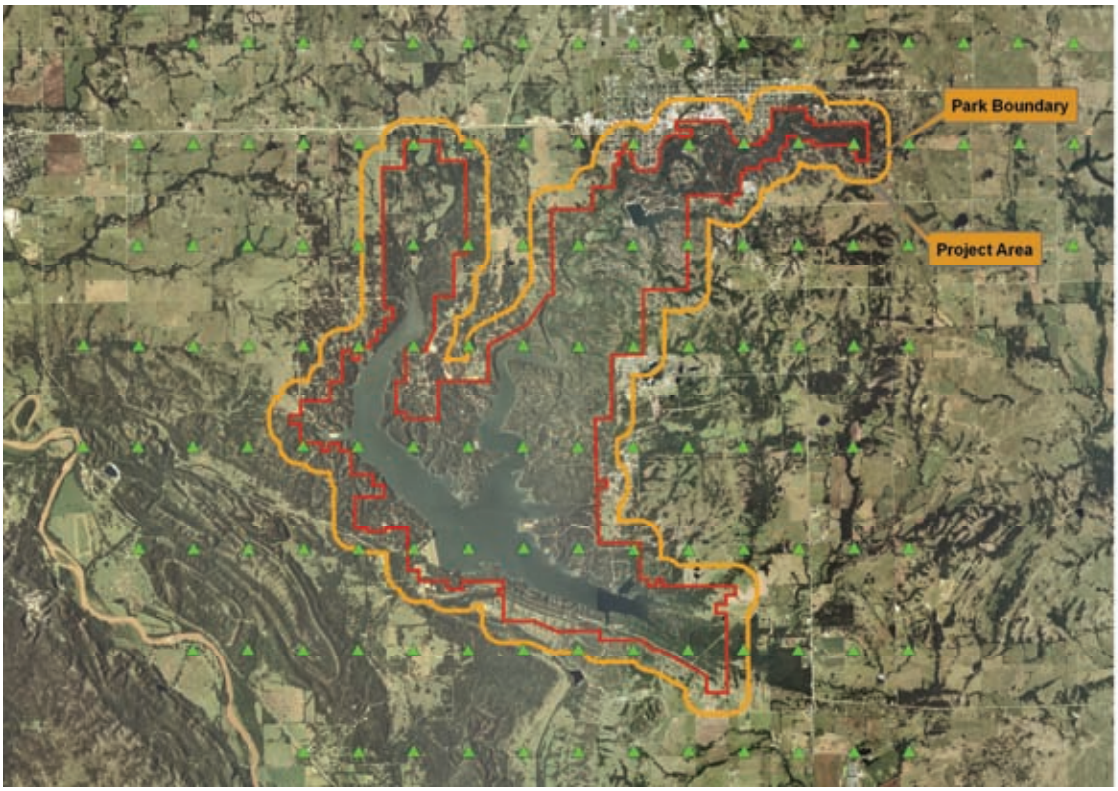


Figure 13. CHIC flight line map.

Photo Interpretation

Photo interpretation was done using the 9 x 9, 1:12,000 2005 scale color photographs. Mylar overlays placed on each aerial photo allowed us to make notes and delineate polygons. At this stage of interpretation a stereoscope was used to help recognize complex photo signatures and three-dimensional features on the 9 x 9 aerial photos. No attempt was made at the initial photo interpretation stage to label polygons. Polygons were delineated using homogenous ground features as a mapable unit. These drawn polygons were later revisited after collection of field data to then assign a map unit and other polygon attributes.

Map Units and Polygon Attribution

The map units delineated on the orthophotos were derived from the NVC. A preliminary list of potential vegetation types was developed by NatureServe. The photo interpretation included vegetation context and structure. Four attributes are included. These are map unit, height, density and coverage pattern. The structural categories and codes are listed in Table 10.

Each polygon has a number of attributes that are stored in the associated table within the GIS database. Many of these attributes are derived from the photo interpretation and others are calculated or crosswalked from other classifications. **Table 11** shows all the attributes and their sources.

Anderson Level 1 and 2 codes are also included (Anderson et al. 1976). These codes should allow for a more regional perspective on the vegetation types. A lookup table for the names associated with the codes is included within the geodatabase.

Slope (degrees), aspect and elevation are calculated for each polygon label point using a DEM and an ArcView script developed by Jenness enterprises and downloadable from www.jennessent.com. The slope figure will vary if one uses a TIN versus a GRID for the calculation (Jenness 2005). A grid was used for the slope figure in this dataset.

Acres and hectares are calculated using XTools Pro for ArcGis Desktop (www.xtoolspro.com).

Additional information is included in a vegetation look-up table within the geodatabase. This look-up table contains all the NVC formation information as well as alliance names and Unique ID’s. In addition, we also include the ecological system codes (El_Code) for the associations. These El_Codes are often a one-to-many relationship. That is, one association may be related to more than one ecological system.The NatureServe conservation status is included as a separate item.

Field Photographs

Instrumental to the photo interpretive effort was the use of the GPS located vegetation plots collected by the field crew. These plots provided an idea of what the signatures of the individual map units should look like. In addition to the tablular data associated with each vegetation plot were five photographs collected at each plot. These photographs helped not only in identifying the immediate area but also provided us with a “look” at the areas surrounding the vegetation plot which might be a different map unit. These photographs may be “hyperlinked” within ArcMap to the salient vegetation observation point for a better concept of on the ground conditions.

Table 10. Structural categories for vegetation photointerpretation.

Code	HEIGHT
1	< 1 Meter
2	1 - 5 Meters
3	5 - 15 Meters
4	15 - 30 Meters
5	> 30 Meters
	COVERAGE DENSITY
1	Closed Canopy / Continuous 75 – 100 %
2	Discontinuous 50 – 75 %
3	Dispersed 25 – 50 %
4	Sparse < 25 %
	COVERAGE PATTERNS
1	Evenly Dispersed
2	Clumped / Bunched
3	Gradational / Transitional
4	Alternating

Table 11. Polygon attribute items and descriptions used in the CHIC spatial database (GIS coverage).

Attribute	Description	
AREA*	Surface area of the polygon in meters squared	
PERIMETER*	Perimeter of the polygon in meters	
CHIC_VEG#*	Unique internal polygon coding	
CHIC_VEG-ID*	Unique internal polygon coding	
POLYGON_ID	Unique Polygon identifier	
VEG_NAME	Vegetation (Land Cover) Name associated to each Polygon	
MAP_UNIT	Final Map Unit Codes - BOR derived, project specific	
HEIGHT	Height range of the dominant vegetation layer.	
		(Height classes: < 1, 1-5, 5-15, 15-30, >30 meters)
DENSITY	Density of the tallest strata.	
		(Density classes:<25%, 25-50%, 50-75%, >75%)
PATTERN	Vegetation pattern within the polygon.	
		(Vegetation pattern classes: Evenly dispersed, Clumped/bunched, Gradational, Alternating)
SLOPE	Slope of label point within polygon (degrees).	
ASPECT	Aspect of label point within polygon.	
ANDERSON_1	Land Use and Land Cover Classification System (USGS, Anderson et al. 1976) Level 1.	
ANDERSON_2	Land Use and Land Cover Classification System (USGS, Anderson et al. 1976) Level 2.	
HECTARES	Area in Hectares	
ACRES	Area in Acres	
ELEV_M	Elevation in meters for label point	
ELEV_FT	Elevation in feet for label point	
(*ArcInfo© default items)		

Digital Transfer

All interpreted mylar layers were scanned at 300 dpi. Each scanned mylar was then rectified to the NAIP base layer using recognizable ground features as registration points. The resulting scan produced a raster image that was subsequently vectorized. Each vectorized output was then extensively edited to produce clean digital vector lines. From the digitized vectors we created polygons by building topology in the GIS program. Finally, we created labels for each polygon and used these to add the attribute information. Attribution for all the polygons at CHIC included information pertaining to map units, NVC associations, Anderson land-use classes, and other relevant data. Attribute data were taken directly from the interpreted photos or were added later using the orthophotos as a guide.

Plot Data Management and Classification Analysis

Plot Data Management

Following the field season and prior to data entry, all plot forms were checked to ensure quality control (QC). Particular attention was paid to making sure that the recorded plot location was correct and that all relevant fields were filled in.

Following the QC of the datasheets, the data were entered into the PLOTS database, and all plots were subjected to a second QC to eliminate any data entry errors. During this second QC, the database was examined, sorted, and queried to find missing data, misspellings, duplicate entries, and typos. The species lists were carefully examined to make sure that only USDA PLANTS (USDA, NRCS 2005) names and acronyms were used, and that species names and assignments to strata were consistent and logical. Plant lists were compared to the assigned association name to assure correlation. The location of the vegetation plots is shown in Figure 14.

Vegetation Classification

The classification process involved a combination of iterative runs of ordination and clustering analyses, removing groups of plots that were identified as most different from the rest in each run, and qualitative interpretation and comparison of plots with existing NVC vegetation associations. PC-Ord 4 (McCune and Mefford 1999) was used to do two ordination techniques, Non-metric multidimensional analysis (NMS) and Detrended Correspondence Analysis (DCA), and one clustering method, flexible beta. The results of this allowed a vegetation name to be assigned to each plot and, by proxy, to each polygon that intersected the plot. Polygons that did not receive a field visit were assigned to a map unit based upon field notes and photointerpretation. All polygons outside the park boundary that were not contiguous with polygons within the park were assigned a map unit based upon photointerpretation.

Map Verification

As we completed portions of the draft 1:12,000-scale, hard copy vegetation maps were printed for review. In all cases, we checked these draft maps against the interpreted photographs to ensure that the polygons were labeled properly and to locate any extra or missing lines. We also compared the map labels to the plot data if they fell in the same location. Copies of the revised draft map accompanied the photo-interpreter into the field for ground-truthing. During the ground-truthing process, we verified aerial photograph signatures using landmarks and GPS waypoints. The map and map units were then modified to correct any mistakes.

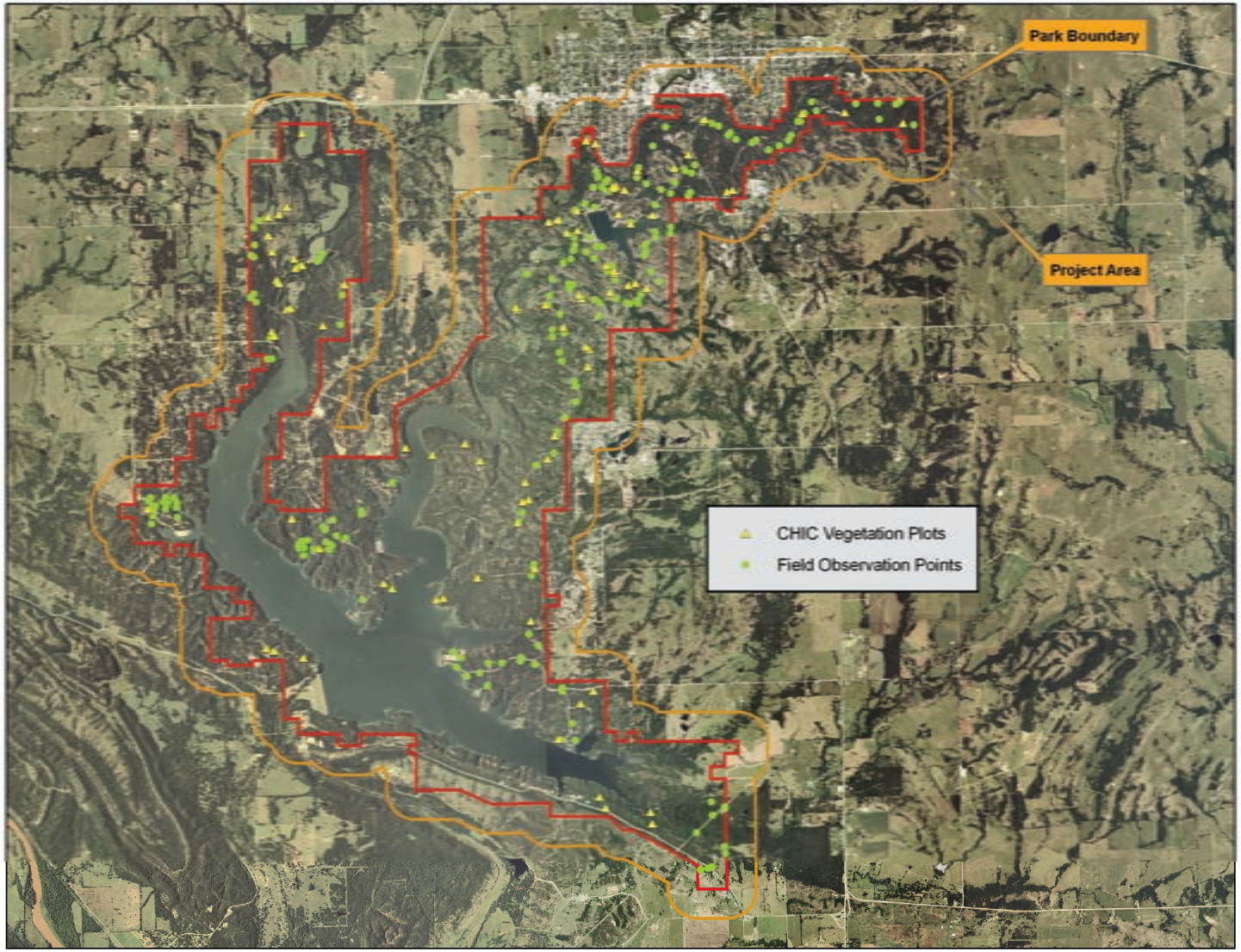


Figure 14. Location of vegetation plots collected in 2006.

Sample Design

Selection of AA sample points followed that described by the NBS/NPS Vegetation Mapping Program, Accuracy Assessment Procedures manual. The design attempts to adhere to scientific principles that govern sampling and statistical analysis and also be practical. The consideration of map accuracy typically can have two components: thematic map accuracy and positional accuracy. The accuracy assessment that follows reflects only thematic map accuracy. Positional accuracy is not considered. Given that polygon boundaries are only occasionally “hard” and subject to interpretation it makes little sense to spend the effort to quantify a subjective boundary.

Sample Method

The accuracy assessment protocol takes into consideration maximum and minimum sample sizes. Considerations include statistical as well as cost constraints and mapped class abundance and frequency. The sample selection is a stratified random sample, stratified by map units. Five scenarios are based on class abundance and frequency and are defined in Table 12.

Sample Site Selection

These parameters were coded into in-house software programs that allows for repeat sample selection using a variety of sample choices such as cost weighting and distance from polygon boundary. Cost weighting is used to eliminate sample points that had extremely arduous access (distance/difficulty = cost) or were in dangerous locations. This option was not used at CHIC due to the small size and relative ease (distance) and access to points. Being able to choose minimum distance to polygon boundaries helped to eliminate ecotonal boundaries which lead to confusion and loss of effort. A minimum distance of 10 meters was chosen for this effort. The distribution of sample points is shown in Figure 15.

AA sample points were selected only for areas within the Park boundary and not the entire mapping area. Lands outside the boundary are private lands spread out over hundreds of owners therefore, access and permsion would have been prohibitively difficult.

Field crews were provided with two sets of samples. The primary set included the preferred target for the sample selection. If a target was inaccessible for any reason, the crews were free to substitute from a secondary set of points. The effect of this arbitrary reselection reduces somewhat the stratified random selection of points. The positive effect of this is to take advantage of the cost of sending a crew to a particular location.

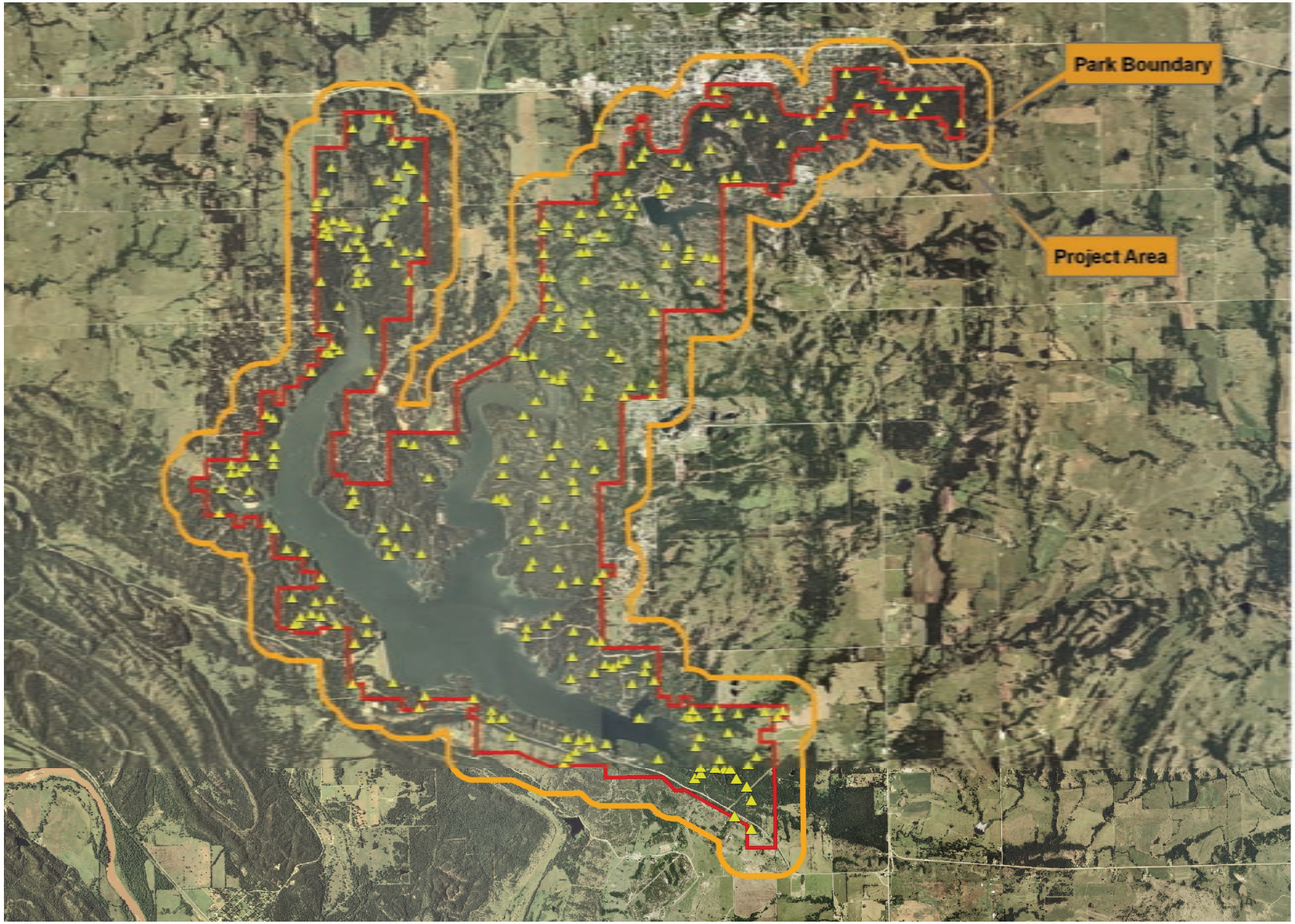


Figure 15. Location of accuracy assessment points collected in 2008.

Table 12. Recommended map accuracy sample number per class by frequency 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

Results

Field Data Collection

For each provisional vegetation type that represents actual or potential National Vegetation Classification (NVC) associations in the Natural and Seminatural Subgroups (Grossman et al. 1998; NatureServe 2005), classification plot data were collected in accordance with VMP training and protocols (The Nature Conservancy and Environmental Systems Research Institute 1994) at CHIC.

Minimum plot sizes were those specified by The Nature Conservancy and Environmental Systems Research Institute (1994). Forests and Woodlands were sampled with 400 square meter plots. Shrublands, Herbaceous Vegetation, and SparseVegetation were sampled with 100 square meter plots.

We projected that 100 plots would be needed to sample park based on its size. Due to the extensive area covered by the lake, especially previous mesic bottomland sites, the actual area of vegetation was less, as was the diversity of habitats. Therefore, field observation clarified the need for somewhat fewer plots as the project progressed during the field season. Based on the vegetation classes accepted by NatureServe (2006b) as potentially occurring in CHIC, a provisional classification of vegetation types was developed following a two-day reconnaissance. An attempt was made to collect 5 plots or each vegetation type. The aquatic classes were sampled with only two plots each because the areas were small in area and restricted in distribution, mostly to the backwater areas where the creeks emptied into the Lake of the Arbuckles. Other vegetation types that were not sampled with more than two or three plots were also of limited distribution or were not developed as a distinct vegetation type from the surrounding vegetation (such as, Veg. Type 14 not distinct from Veg type 3). Therefore, the total number of plots collected were 89 (48 forest/woodland plots and 41 grassland/shrubland plots). Twenty-nine provisional vegetation types were discernable by the PI.

The primary sampling strategy for vegetation plots was to adequately represent vegetation types with a secondary focus to distribute them geographically within the park. Thus, plots were spaced so as to be in separate presumed polygons (polygons not actually delineated on field aerials available). An exception to this rule was made, especially for grasslands and wetlands. In several cases, plots of the different grassland and aquatic associations were selected to be in close proximity to one another to show the patchiness of the environments and to help the mappers determine if these associations have distinct enough signatures to be identified in the aerial images.

Five additional observation points were taken for areas that were too small to be mapped or were not suited to plot techniques, such as submerged aquatic vegetation. These observation points were collected to aid the mappers in developing signatures for these distinct but localized vegetation types. Agricultural/urban sites that fall within the Anderson classification scheme were not sampled nor given observation points.

Vegetation Classification

To gain information on the potential NVC classifycations that might occur in the CHIC project boundary, the project team used a report prepared by NatureServe that listed the potential types

that might exist in the area. These were types that existed in the NVC at the time and which local experts were reasonably certain would occur in the park. The analysis of the field plots collected for this effort identified some of those types as well as others not on the preliminary list compiled from NatureServe.

Using the methods described above, the vegetation-plot data collected in 2006 were classified into 29 distinct vegetation types based on species composition, structure, and environmental characteristics (Table 13). Of the 29 vegetation classifications, 26 are recognized NVC types, while three additional classifications are not official NVC types. Of the five unofficial classifications, these may be considered a local type specific to the park. Some of the field data collected was only sufficient to classify types to the alliance level.

Table 13. Vegetation alliances and associations from field plots.

Alliance Name	Association Name	Translated Name	NVC ELCODE	Number of Plots	Plot List
Juniperus virginiana Semi-natural Forest Alliance	Juniperus virginiana var. virginiana / Schizachyrium scoparium Forest	Eastern Red-cedar / Little Bluestem Forest	CEGL003628	7	CHIC.35, CHIC.36, CHIC.49, CHIC.59, CHIC.70, CHIC.75, CHIC.79
Quercus buckleyi Forest Alliance	Quercus buckleyi - Fraxinus texensis - Quercus muehlenbergii Forest	Buckley Oak - Texas Ash - Chinquapin Oak Forest	CEGL004912	7	CHIC.41, CHIC.64, CHIC.65, CHIC.68, CHIC.69, CHIC.72, CHIC.77
Quercus muehlenbergii - (Acer saccharum) Forest Alliance	Quercus muehlenbergii-Quercus shumardii Forest	Chinquapin Oak - Shumard Oak Forest	CEGL004602	5	CHIC.27, CHIC.39, CHIC.43, CHIC.46, CHIC.61
Quercus stellata - Quercus marilandica Forest Alliance	Quercus stellata - Quercus marilandica - (Carya texana) Forest	Post Oak - Blackjack Oak - (Black Hickory) Forest	CEGL002074	8	CHIC.20, CHIC.21, CHIC.42, CHIC.45, CHIC.52, CHIC.56, CHIC.62, CHIC.76
Quercus stellata - Quercus marilandica Forest Alliance	Quercus stellata - Ulmus alata Forest	Post Oak - Winged Elm Forest	CEGL004546	3	CHIC.3, CHIC.26, CHIC.74
Carya illinoinensis - (Celtis laevigata) Temporarily Flooded Forest Alliance	Carya illinoinensis - Celtis laevigata Forest	Pecan - Sugarberry Forest	CEGL002087	2	CHIC.54, CHIC.89
Fraxinus pennsylvanica - Ulmus americana - Celtis (occidentalis, laevigata) Temporarily Flooded Forest Alliance	Ulmus americana - Celtis (laevigata, occidentalis) - Fraxinus pennsylvanica Forest	American Elm - (Sugarberry, Northern Hackberry) - Green Ash Forest	CEGL002090	3	CHIC.29, CHIC.51, CHIC.71
Populus deltoides Temporarily Flooded Forest Alliance	Platanus occidentalis - (Populus deltoides) - Acer negundo Forest	Sycamore - (Eastern Cottonwood) - Box-elder Forest	CEGL002092	2	CHIC.38, CHIC.44
Quercus macrocarpa - Quercus bicolor - (Carya laciniosa) Temporarily Flooded Forest Alliance	Quercus macrocarpa - Quercus shumardii - Carya cordiformis / Chasmanthium latifolium Forest	Bur Oak - Shumard Oak - Bitternut Hickory / River-oats Forest	CEGL004544	2	CHIC.47, CHIC.73
Salix nigra Temporarily Flooded Forest Alliance	Salix nigra Forest	Black Willow Forest	CEGL002103	1	CHIC.55

Alliance Name	Association Name	Translated Name	NVC ELCODE	Number of Plots	Plot List
Juniperus ashei Woodland Alliance	Juniperus ashei / Bouteloua (curtipendula, hirsuta) Woodland	Ashe's Juniper / (Sideoats Grama, Hairy Grama) Woodland	CEGL002125	1	CHIC.50
NEW	Woodland, Disturbed		NEW	3	CHIC.60, CHIC.81, CHIC.83
Quercus stellata - Quercus marilandica Woodland Alliance	Quercus stellata - Quercus marilandica / Schizachyrium scoparium Woodland	Post Oak - Blackjack Oak / Little Bluestem Woodland	CEGL002147	4	CHIC.48, CHIC.63, CHIC.85, CHIC.88
Cornus drummondii Shrubland Alliance	Cornus drummondii – (Rhus glabra, Prunus spp.) Shrubland	Roughleaf Dogwood - (Smooth Sumac, Cherry species) Shrubland	CEGL005219	1	CHIC.8
Prunus angustifolia Shrubland Alliance	Prunus angustifolia Shrubland Alliance	Chickasaw Plum Shrubland Alliance	A.1884	3	CHIC.25, CHIC.67, CHIC.78
Quercus sinuata var. breviloba Shrubland Alliance	Quercus sinuata var. breviloba Shrubland	White Shin Oak Shrubland	CEGL004453	2	CHIC.28, CHIC.40
Schizachyrium scoparium - Sorghastrum nutans Herbaceous Alliance	Schizachyrium scoparium - Sorghastrum nutans - Bouteloua curtipendula Herbaceous Vegetation	Little Bluestem - Yellow Indiangrass - Sideoats Grama Herbaceous Vegetation	CEGL002214	7	CHIC.2, CHIC.7, CHIC.9, CHIC.13, CHIC.17, CHIC.19, CHIC.57
NEW	Aristida-Digitaria Grassland		NEW	2	CHIC.18, CHIC.23
Muhlenbergia reverchonii Herbaceous Alliance	Muhlenbergia reverchonii - Bouteloua curtipendula - Desmanthus velutinus Herbaceous Vegetation	Seep Muhly - Sideoats Grama - Velvet Bundleflower Herbaceous Vegetation	CEGL004219 NEW for OK	3	CHIC.1, CHIC.14, CHIC.22
NEW	Old Field		NEW	3	CHIC.24, CHIC.37, CHIC.86
Schizachyrium scoparium - Bouteloua curtipendula Herbaceous Alliance	Schizachyrium scoparium - Bouteloua curtipendula - Bouteloua gracilis Herbaceous Vegetation	Little Bluestem - Sideoats Grama - Blue Grama Central Plains Herbaceous Vegetation	CEGL002246	2	CHIC.58, CHIC.80
Sorghum halepense Semi-Natural Herbaceous Alliance	Sorghum halepense Semi-Natural Herbaceous Alliance	Johnson Grass Semi-Natural Herbaceous Vegetation	A.2020	1	CHIC.53
Bouteloua hirsuta Herbaceous Alliance	Bouteloua hirsuta - Bouteloua curtipendula Herbaceous Vegetation	Hairy Grama - Sideoats Grama Herbaceous Vegetation	CEGL001764	6	CHIC.6, CHIC.12, CHIC.15, CHIC.66, CHIC.82, CHIC.87

Alliance Name	Association Name	Translated Name	NVC ELCODE	Number of Plots	Plot List
Buchloe dactyloides Herbaceous Alliance	Buchloe dactyloides Modified Herbaceous Vegetation	Buffalo Grass Modified Herbaceous Vegetation	CEGL004948	1	CHIC.84
Carex emoryi Herbaceous Alliance	Carex emoryi Herbaceous Vegetation	Emory's Sedge Herbaceous Vegetation	CEGL005559	3	CHIC.4, CHIC.30, CHIC.32
Typha (angustifolia, latifolia) - (Schoenoplectus spp.) Semipermanently Flooded Herbaceous Alliance	Typha (angustifolia, domingensis, latifolia) - Schoenoplectus americanus Herbaceous Vegetation		CEGL002032	1	CHIC.33
Typha (angustifolia, latifolia) - (Schoenoplectus spp.) Semipermanently Flooded Herbaceous Alliance	Typha latifolia Southern Herbaceous Vegetation	Broadleaf Cattail Southern Herbaceous Vegetation	CEGL004150	1	CHIC.10
Justicia americana Temporarily Flooded Herbaceous Alliance	Justicia americana Herbaceous Vegetation	American Water-willow Herbaceous Vegetation	CEGL004286	1	CHIC.5
Polygonum spp. (section Persicaria) Seasonally Flooded Herbaceous Alliance	Polygonum spp. (section Persicaria) Seasonally Flooded Herbaceous Alliance	Smartweed species Seasonally Flooded Herbaceous Alliance	A.1881	1	CHIC.31

Vegetation Alliances and Associations

In the descriptions that follow, the only information specific to Chickasaw National Recreation Area appears under “Local description” and “Plots.” All other information is part of a general, “global” description of a given alliance or association. This global information was provided by NatureServe. All photos are courtesy of the Southern Plains Inventory and Monitoring Network, National Park Service.

Herbaceous Vegetation

Carex emoryi Herbaceous Vegetation

Translated Name: Emory’s Sedge Herbaceous Vegetation
Unique Identifier: CEGL005559
Classification Approach: International Vegetation Classification (IVC)

Figure 16. *Carex emoryi* Herbaceous Vegetation

Summary: This wetland community has been identified in the south-central Great Plains. It occurs on mucky to sandy soils along streams on sites that receive periodic flooding. Stands are nearly always small and may have significant shading by trees in adjacent communities. Herbaceous cover is typically high. Carex emoryi is the dominant species. Sorghum halepense may be common on the drier edges of stands. Other taxa are typical of streamside habitats.

Classification Confidence: 2 - Moderate
Classification Comments: This association was defined based on plot data from Chickasaw NRA in south-central Oklahoma. Further data are needed to determine its full geographic and compositional range.

Vegetation Hierarchy

Formation Class	V	Herbaceous Vegetation
Formation Subclass	V.A	Perennial graminoid vegetation
Formation Group	V.A.5	Temperate or subpolar grassland
Formation Subgroup	V.A.5.N	Natural/Semi-natural temperate or subpolar grassland
Formation Name	V.A.5.N.k	Seasonally flooded temperate of subpolar grassland
Alliance Name		Carex emoryi Herbaceous Alliance

Global Status: GNA
Rounded Global Status:
Reasons: This community has only been identified at Chickasaw NRA and its rank is not known.

U.S. Distribution: OK
Global Distribution: United States
Global Range: This community has been identified in south-central Oklahoma but is likely found in nearby areas of northern Texas and other parts of the southern Great Plains.
Vegetation Summary:

Wetland Indicator: Y

Environmental Summary: This type occurred in light shade at the edges of the bottomland forest and willow woodland and as pockets in Panicum virgatum (switchgrass) strips.

Local Vegetation Summary:
This community is described by three field plots (CHIC.4, CHIC.30, CHIC.32) in seasonally flooded, poorly drained muck of wetland meadows and a depositional bar. This type occurred in light shade at the edges of the bottomland forest and willow woodland and as pockets in *Panicum virgatum* (switchgrass) strips. Ground cover consisted primarily of litter (50-60%) and bare ground (35-50%), except for the sand (90%) and small rock (5%) of the depositional bar. The dominant herbaceous stratum accounted for 70-80% of the cover, with >55% cover of Emory's sedge (*Carex emoryi*). Frequently associated species include smallspike false nettle (*Boehmeria cylindrical*), green ash (*Fraxinus pennsylvanica*), rice cutgrass (*Leersia oryzoides*) and perennial ryegrass (*Lolium perenne*). A wide variety of annual and perennial forbs, grasses and aquatic species augmented the herbaceous layer depending on the quantity of moisture associated with each plot. A canopy stratum (<20%) was present in one plot, consisting of common persimmon (*Diospyros virginiana*), American sycamore *(Platanus occidentalis*), slippery elm *(Ulmus rubra)* and black willow *(Salix nigra).* When present, the shrub stratum provided <10% cover. The most commonly found shrubs included boxelder *(Acer negundo)* and green ash *(Fraxinus pennsylvanica)* saplings, desert false indigo *(Amorpha fruiticosa),* and buttonbush *(Cephalanthus occidentalis)*. This association is mapped as Map Unit 22 – Emory's Sedge Herbaceous Vegetation.

Typha (angustifolia, domingensis, latifolia) - Schoenoplectus americanus Herbaceous Vegetation

Translated Name: (Narrowleaf Cattail, Southern Cattail, Broadleaf Cattail) - Chairmaker's Bulrush Herbaceous Vegetation
Unique Identifier: CEGL002032
Classification Approach: International Vegetation Classification (IVC)

Figure 17. T*ypha (angustifolia, domingensis, latifolia) - Schoenoplectus americanus* Herbaceous Vegetation

Summary: This community type is found in the southeastern Great Plains region of the United States. Stands occur in oxbows and low areas along creeks and streams. Soils are poorly drained clays and silty loams. The vegetation is dominated by tall emergents 1-2 m tall. Dominant species include various combinations of *Typha angustifolia*, *Typha domingensis*, *Typha latifolia*, and *Schoenoplectus americanus (= Scirpus americanus*). Other species include *Carex hyalinolepis*, *Eleocharis* spp., *Lemna minor*, and *Sagittaria latifolia*. In Kansas *Schoenoplectus americanus* is very uncommon in this type

Classification Confidence: 2 - Moderate
Classification Comments: This association includes vegetation dominated by various combinations of *Typha* spp. with *Schoenoplectus americanus* in regions to the west of the Ozarks, Ouachitas, and Upper West Gulf Coastal Plain. It should be compared to related

vegetation to the east, e.g., *Typha latifolia* Southern Herbaceous Vegetation (CEGL004150), which is also attributed to Oklahoma and Texas. The relative distribution, composition, and relationship of these two associations in these states need to be properly defined.

Vegetation Hierarchy

Formation Class	V	Herbaceous Vegetation
Formation Subclass	V.A	Perennial graminoid vegetation
Formation Group	V.A.5	Temperate or subpolar grassland
Formation Subgroup	V.A.5.N	Natural/Semi-natural temperate or subpolar grassland
Formation Name	V.A.5.N.l	Semipermanently flooded temperate or subpolar grassland
Alliance Name		Typha (angustifolia, latifolia) - (Schoenoplectus spp.) Semipermanently Flooded Herbaceous Alliance

Global Status: G3G4 (24Oct2002)
Rounded Global Status: G3 - Vulnerable
Reasons: Although primarily defined for Oklahoma and occurring only in small patches, this type is likely common in the southeastern areas of the Great Plains west of the Ozarks, Ouachitas, and Upper Gulf Coastal Plain. It is not as widespread as similar communities east of its range (e.g., *Typha latifolia* Southern Herbaceous Vegetation (CEGL004150)). Invasion by tamarix, heavy trampling by cattle, and wetland conversion have degraded examples of this type and may decrease the number of occurrences (K. Kindscher pers. comm. 2002). More information on the status of this type is needed.

Vegetation Summary: The vegetation is dominated by tall emergents 1-2 m tall. Dominant species include various combinations of *Typha angustifolia, Typha domingensis, Typha latifolia*, and *Schoenoplectus americanus (= Scirpus americanus*). Other species include *Carex hyalinolepis, Eleocharis* spp., *Lemna minor*, and *Sagittaria latifolia*. In Kansas *Schoenoplectus americanus* is very uncommon in this type (Lauver et al. 1999).

Wetland Indicator: Y

Environmental Summary: Stands occur in oxbows and low areas along creeks and streams. Soils are poorly drained clays and silty loams (Lauver et al. 1999).

Local Vegetation Summary:
This association was described from one field plot (CHIC.33) along Veteran's Lake, at an elevation of 1000 ft., in poorly drained muck. The ground cover was 50% water, 20% litter and 30% bare soil. Lacustrine cattail marshes typically have a muck-bottom zone bordering the shoreline, where cattails are rooted in the bottom substrate. These marshes have hydric soils and are flooded with water levels ranging from several centimeters to more than 1 m for a significant part of the growing season. Soils are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part. Vegetative diversity and density is highly variable in response to water depth, water chemistry, and natural forces. Dominant aquatic species include southern cattail (*Typha domingensis)* and softstem bulrush (*Schoenoplectus tabernaemontani)*. Other species include sedge species (*Carex* spp.), spikerush species *(Eleocharis* spp.), and American water-willow (*Justicia americana).* A componant of

shrubs ranged along the shore side of this community include buttonbush (*Cephalanthus occidentalis),* leadplant (*Amorpha canescens)* and American sycamore (*Platanus occidentalis).* This association was mapped as Map Uit 24 – Cattail Wetlands, a grouping that includes *Typha latifolia* Southern Herbaceous Vegetation. Remote differentiation was difficult for these two associations.

***Typha latifolia* Southern Herbaceous Vegetation**

Translated Name: Broadleaf Cattail Southern Herbaceous Vegetation
Unique Identifier: CEGL004150
Classification Approach: International Vegetation Classification (IVC)

Figure 18. *Typha latifolia* Southern Herbaceous Vegetation

Summary: This association is a semi-natural type, consisting of *Typha latifolia* as an essentially monospecific stand, especially in artificial wetlands, such as borrow pits or ponds. The water table is at or above the soil surface for at least part of the growing season. The dominant species, *Typha latifolia*, often forms dense, almost monotypic stands. *Carex* spp. and *Schoenoplectus* spp. (= *Scirpus* spp.) are often found in this community, especially on the margins. Other co-occurring species of this association are not fully understood. It is a widespread type. In the Interior Low Plateau of Tennessee, *Typha latifolia* is commonly found with *Scirpus cyperinus* in roadside ditches and on the margins of ponds and reservoirs.

Classification Confidence: 2 - Moderate
Classification Comments: This community is a common element found in many Southeastern wetland systems, but little work has been done to determine its diagnostic features and component species. The variability of this association across its range and its relation to adjacent types in this and related alliances are not fully understood. At Arnold Air Force Base, Coffee and Franklin counties, Tennessee, this vegetation is found scattered along the border of Woods

Reservoir. It appears to be a component of a mosaic of communities which form bands from the edge of the reservoir to the surrounding forest. The band found at the reservoir's edge is dominated by *Typha latifolia* and *Scirpus cyperinus. Juncus* spp., grasses, and an occasional *Alnus serrulata* are also present. The *Typha latifolia* grows patchily, being concentrated in dense clumps throughout the outer band.

Vegetation Hierarchy

Formation Class	V	Herbaceous Vegetation
Formation Subclass	V.A	Perennial graminoid vegetation
Formation Group	V.A.5	Temperate or subpolar grassland
Formation Subgroup	V.A.5.N	Natural/Semi-natural temperate or subpolar grassland
Formation Name	V.A.5.N.l	Semipermanently flooded temperate or subpolar grassland
Alliance Name		Typha (angustifolia, latifolia) - (Schoenoplectus spp.) Semipermanently Flooded Herbaceous Alliance

Global Status: G5 (14Jun2001)
Rounded Global Status: G5 - Secure
Reasons: This is a wide-ranging type that includes naturally occurring and artificial wetlands.

U.S. Distribution: AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA, WV
Global Distribution: United States
Global Range: This vegetation is possible throughout the southeastern United States.

Vegetation Summary: Stands of this association consist of *Typha latifolia* as an essentially monospecific stand. *Carex* spp. and *Schoenoplectus* spp. (= *Scirpus* spp.) are often found in this community, especially on the margins. Other co-occurring species of this association are not fully understood. In the Interior Low Plateau of Tennessee, *Typha latifolia* is commonly found with *Scirpus cyperinus*. In addition, *Juncus effusus* and an occasional *Alnus serrulata* are also present.

Wetland Indicator: Y

Environmental Summary: This type is found especially in artificial wetlands, such as borrow pits or ponds. The water table is at or above the soil surface for at least part of the growing season.

Local Vegetation Summary:
This association was described by one field plot (CHIC.10) at Guy Sandy West in the semi-permanently flooded muck where Guy Sandy Creek empties into Lake of the Arbuckles. The water table is at or above the soil surface for at least part of the growing season. Soils of muck are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in their upper part. Water and floating litter (80%) provided the ground cover. This community is dominated by a mix of broadleaf cattail (*Typha latifolia)* and southern cattail (*Typha domingensis),* in addition to a large presence of Emory's sedge (*Carex emoryi).* The shrub common buttonbush (*Cephalanthus occidentalis)* is found along the margin of the community. This community is mapped as Map Uit 24 – Cattail Wetlands, as it is difficult to

remotely distinguish from *Typha (angustifolia, domingensis, latifolia)* - *Schoenoplectus americanus* Herbaceous Vegetation.

***Muhlenbergia reverchonii - Bouteloua curtipendula - Desmanthus velutinus* Herbaceous Vegetation**

Translated Name: Seep Muhly - Sideoats Grama - Velvet Bundleflower Herbaceous Vegetation
Unique Identifier: CEGL004219 (NEW for Chickasaw NRA)
Classification Approach: International Vegetation Classification (IVC)

Figure 19. *Muhlenbergia reverchonii - Bouteloua curtipendula - Desmanthus velutinus* Herbaceous Vegetation

Summary: This association is found in mesic areas, often along ephemeral streams or adjacent to more permanent streams on the Edwards Plateau and Lampasas Cutplain of central Texas. The vegetation is dominated by Muhlenbergia reverchonii. Other graminoid species include *Eleocharis spp., Cyperus spp., Schizachyrium scoparium, Bouteloua curtipendula, Aristida purpurea, Sorghastrum nutans, Tridens albescens, and Bothriochloa laguroides*. Forbs include *Symphyotrichum ericoides (= Aster ericoides), Lythrum californicum, Desmanthus illinoensis, Bifora americana, Scutellaria drummondii, Monarda citriodora, Ambrosia psilostachya, Helianthus maximiliani, Desmanthus velutinus, Hedyotis nigricans, Hedeoma acinoides, Liatris mucronata, Spiranthes cernua,* and *Krameria lanceolata.*

Classification Confidence: 2 - Moderate
Classification Comments: These areas are small inclusions in broader grassland and woodland areas. Often they are near streams but terrain is level to rolling. They occur on clay loam range

site and Pleistocene alluvium. Apparently they occupy slight microtopographic depressions in clay loam soils that stay slightly moister.

Vegetation Hierarchy

Formation Class	V	Herbaceous Vegetation
Formation Subclass	V.A	Perennial graminoid vegetation
Formation Group	V.A.5	Temperate or subpolar grassland
Formation Subgroup	V.A.5.N	Natural/Semi-natural temperate or subpolar grassland
Formation Name	V.A.5.N.c	Medium-tall sod temperate or subpolar grassland
Alliance Name		Muhlenbergia reverchonii Herbaceous Alliance

Global Status: GNR (21May2007)
Rounded Global Status: GNR - Not Yet Ranked

U.S. Distribution: TX
Global Distribution: United States
Global Range: This community occurs on the Edwards Plateau and Lampasas Cutplain of central Texas.

Vegetation Summary: At Fort Hood, this vegetation is dominated by *Muhlenbergia reverchonii* or codominated by *Schizachyrium scoparium* and *Muhlenbergia reverchonii*. The exotic grass *Bothriochloa ischaemum* is present in some occurrences. Three plots near the stream are characterized by *Muhlenbergia reverchonii, Schizachyrium scoparium, Bouteloua curtipendula, Aristida purpurea, Sorghastrum nutans,* and *Bothriochloa laguroides*. Forbs include *Symphyotrichum ericoides (= Aster ericoides), Helianthus maximiliani, Desmanthus velutinus, Hedyotis nigricans, Liatris mucronata,* and *Krameria lanceolata*. More information is need on the composition and range of this association.

Wetland Indicator: N

Environmental Summary: This association occurs as small inclusions in swales or low spots in broader grasslands or woodlands on level terrain. Often they are near streams (clay loam range site) and Pleistocene geology (alluvium). Apparently they occupy slight microtopographic depressions in clay loam soils that stay slightly moister. Adjacent vegetation may include grasslands dominated by little bluestem and Indiangrass or woodlands dominated by Juniperus ashei.

Local Vegetation Summary:
This association was described by three field plots (CHIC.1, CHIC.14, CHIC.22) at elevations of 1000-1050 ft. occuring as small inclusions in seeps, swales or low spots on level to sloping ($\leq$10%) terrain with western exposures. They occupy slight microtopographic features in cobbly clay loam to sandy loam soils that stay slightly moister. The ratio of bare soil to plant litter is highly variable and may be a result of prescribed burning. Small rock is found at $\leq$5%.

The herbaceous layer is the dominant stratum with a coverage $\geq$ 60%. This vegetation is dominated by seep muhly (*Muhlenbergii reverchonii).* Other gramanoid species include little bluestem (*Schizachyrium scoparium* at $\leq$ 10% cover) and traces of Indiangrass (*Sorghastrum*

nutans), slim tridens (*Tridens muticus)* and sideoats grama (*Bouteloua curtipendula)*. Forbs in the herbaceous layer include Berlandier's sundrops (*Calylophus berlandieri),* prairie fleabane (*Erigeron strigosus),* blue wild indigo (*Baptisia australis*), longleaf buckwheat (*Eriogonum longifolium*), trailing krameria (*Krameria lanceolata*), narrowleaf Indian breadroot (*Pediomelum linearifolium*) and firewheel (*Gaillardia pulchella).* If a shrub layer exists it is due to the woody encroachment into the grassland of elbowbush (*Forestiera pubescens),* Texas ash (*Fraxinus texensis)* and twistspine pricklypear (*Opuntia microrhiza).* At Chickasaw NRA, this association is found as a limited community on Bromide Hill and in the uplands south of Veterans Lake and east of Lake of the Arbuckles. Increased moisture levels are important for maintaining this community. This association was mapped as Map Unit 28 - Upland Forbs/Grasslands. This map unit contains several associations that cannot be differentiated through remote sensing.

***Schizachyrium scoparium - Bouteloua curtipendula - Bouteloua gracilis* Central Plains Herbaceous Vegetation**

Translated Name: Little Bluestem - Sideoats Grama - Blue Grama Central Plains Herbaceous Vegetation
Unique Identifier: CEGL002246
Classification Approach: International Vegetation Classification (IVC)

Figure 20. *Schizachyrium scoparium - Bouteloua curtipendula - Bouteloua gracilis* Central Plains Herbaceous Vegetation

Summary: This little bluestem - sideoats grama grassland community is found in the south-central Great Plains of the United States. Stands occur on level to moderately sloping uplands, but are more likely to be on steep ravine slopes. The loam, clay loam, silty loam, or silty soils are usually formed over limestone. They are shallow to moderately deep, well-drained, and usually contain a substantial amount of rock fragments. The vegetation often forms two layers, a shorter layer of grasses and a taller layer of mixed grasses and forbs. Cover is moderately dense to dense in most stands. The vegetation is characteristically dominated by three species, *Schizachyrium scoparium, Bouteloua curtipendula,* and *Bouteloua gracilis*. The first two are mid grasses and the latter is a short grass. *Schizachyrium scoparium* is often the tallest dominant grass, reaching 0.5-0.8 m in Oklahoma. *Andropogon gerardii, Sporobolus cryptandrus,* and *Sorghastrum nutans* are present, especially on lower slopes. The short grasses *Buchloe dactyloides* and *Bouteloua hirsuta* grow on upper slopes and level ground. Forbs include *Ambrosia psilostachya, Dalea enneandra, Echinacea angustifolia, Liatris punctata, Calylophus serrulatus,* and *Psoralidium tenuiflorum*.

Classification Confidence: 3 - Weak
Classification Comments: Characteristics of this type that distinguish it from other mixedgrass prairie types need to be further studied. This type may be synonymous with *Schizachyrium scoparium - Bouteloua curtipendula* Western Great Plains Herbaceous Vegetation (CEGL001594).

Vegetation Hierarchy

Formation Class	V	Herbaceous Vegetation
Formation Subclass	V.A	Perennial graminoid vegetation
Formation Group	V.A.5	Temperate or subpolar grassland
Formation Subgroup	V.A.5.N	Natural/Semi-natural temperate or subpolar grassland
Formation Name	V.A.5.N.c	Medium-tall sod temperate or subpolar grassland
Alliance Name		Schizachyrium scoparium - Bouteloua curtipendula Herbaceous Alliance

Global Status: G2G4 (22Jun1998)
Rounded Global Status: G3 - Vulnerable
Reasons: The total number of occurrences is unknown. Seven have been documented in Kansas, where the community is ranked S2(?). Although no other occurrences have been documented, the community is also reported in Oklahoma (S?), where it may be more common.

U.S. Distribution: KS, OK
Global Distribution: United States
Global Range: This little bluestem - sideoats grama grassland community is found in the south-central Great Plains of the United States, particularly in Kansas and Oklahoma.

Vegetation Summary: The vegetation in this community often forms two layers, a shorter layer of grasses and a taller layer of mixed grasses and forbs (Kuchler 1974). Cover is moderately dense to dense in most stands (Weaver and Albertson 1956). The vegetation is characteristically dominated by three species, *Schizachyrium scoparium*, *Bouteloua curtipendula*, and *Bouteloua gracilis*. The first two are mid grasses and the latter is a short grass. *Schizachyrium scoparium* is often the tallest dominant grass, reaching 0.5-0.8 m in Oklahoma (Bruner 1931). *Andropogon gerardii*, *Sporobolus cryptandrus*, and *Sorghastrum nutans* are present, especially on lower slopes. The short grasses *Buchloe dactyloides* and *Bouteloua hirsuta* grow on upper slopes and level ground. Forbs include *Ambrosia psilostachya*, *Dalea enneandra*, *Echinacea angustifolia*, *Liatris punctata*, *Calylophus serrulatus (= Oenothera serrulata)*, and *Psoralidium tenuiflorum (= Psoralea tenuiflora).*

Wetland Indicator: N

Environmental Summary: This community is primarily found on level to moderately sloping uplands, but is more likely to be on steep ravine slopes in western Kansas (Kuchler 1974). The loam, clay loam, silty loam, or silty soils usually formed over limestone. They are shallow to moderately deep, well-drained, and usually contain a substantial amount of rock fragments (Heitschmidt et al. 1970, Johnston 1987).

Local Vegetation Summary:
This association was described from two field plots (CHIC.58, CHIC.80) at elevations over 1000 ft on slopes ≤6% with varying aspects. The tall grasses are more prevalent on moderate or gentle lower slopes. The short grasses tend to be more common on flat uplands or steep slopes with heavier soils. The soils of these plots were loam and sandy loam. The ground cover ranged from predominately bare soil (>90%) to a mix of litter (<60%) and bare soil (30%), often with a large rock component (≤10%). The vegetation

cover can be moderately sparse to dense. The dominant species are the nominal species, little bluestem (*Schizachyrium scoparium* at ≥ 40% cover) and hairy grama (*Bouteloua hirsuta* at ≥ 20%). Indiangrass (*Sorghastrum nutans),* seep muhly (*Muhlenbergia reverchonii*), composite dropseed (*Sporobolus compositus*) and sideoats grama (*Bouteloua curtipendula)* are common associates with ≤ 10% cover each. Forbs found in this community include blue wild indigo (*Baptisia australis),* narrowleaf Indian breadroot (*Pediomelum linearifolium)* and trailing Krameria (*Krameria lanceolata).* When a shrub stratum exists, it is usually dominated by eastern red cedar (*Juniperus virginiana) and* includes other species such as eastern redbud (*Cercis canadensis),* skunkbush sumac (*Rhus trilobata),* persimmon (*Diospyros virginiana*) and Texas ash (*Fraxinus texensis).* This association is found at Chickasaw NRA on the uplands found south of Veterans Lake and east of Lake of the Arbuckles. Fire frequency directly affects the amount of woody invasion and bare soil that occurs in this association. This association was mapped as Map Unit 28 - Upland Forbs/Grasslands. This map unit contains several associations that cannot be differentiated through remote sensing.

***Bouteloua hirsuta* - *Bouteloua curtipendula* Herbaceous Vegetation**

Translated Name: Hairy Grama - Sideoats Grama Herbaceous Vegetation
Unique Identifier: CEGL001764
Classification Approach: International Vegetation Classification (IVC)

Figure 21. *Bouteloua hirsuta - Bouteloua curtipendula* Herbaceous Vegetation

Summary: In Oklahoma, this association occurs on shallow or coarse soils, in central and western Oklahoma. Other characteristic species include *Aristida purpurascens, Bouteloua rigidiseta, Croton willdenowii (= Crotonopsis elliptica), Chaetopappa asteroides, Echinocereus reichenbachii (= Echinocereus caespitosa), Lithophragma tenellum, Opuntia macrorhiza, Schizachyrium scoparium, Rhus glabra, Sida abutifolia (= Sida procumbens),* and *Thelesperma filifolium.*

Classification Confidence: 2 - Moderate

Vegetation Hierarchy

Formation Class	V	Herbaceous Vegetation
Formation Subclass	V.A	Perennial graminoid vegetation
Formation Group	V.A.5	Temperate or subpolar grassland
Formation Subgroup	V.A.5.N	Natural/Semi-natural temperate or subpolar grassland
Formation Name	V.A.5.N.e	Short sod temperate or subpolar grassland
Alliance Name		Bouteloua hirsuta Herbaceous Alliance

Global Status: G4 (23Feb1994)
Rounded Global Status: G4 - Apparently Secure

U.S. Distribution: NM, OK, TX
Global Distribution: United States

Wetland Indicator: N

Local Vegetation Summary:
This association was described from six field plots (CHIC.6, CHIC.12, CHIC.15, CHIC.66, CHIC.82, CHIC.87) at elevations of 950 – 1100 ft with aspects of 55 - 260°. This association occurs on shallow or coarse soils of well-drained cobbly loam or sandy loam on upland ridges and gentle to steep slopes with thin soils and calcareous bedrock outcrops and cobbles. The ground layer exhibits stone fragments, generally ≤ 30%, and varying amounts of bare ground (<65%) and litter (<40%)depending on frequency of fire. The herbaceous layer exhibits a moderate density of ≤ 60% cover. Between the outcrops and cobbles, the soil is well enough developed to support the graminoid dominates, including hairy grama (*Bouteloua hirsuta* at ≤ 30% cover), sideoats grama (*Bouteloua curtipendula* at ≤ 30% cover), and little bluestem (*Shizachyrium scoparium* at ≤ 20%). Indiangrass (*Sorghastrum nutans*) and other species of graminoids are found at ≤ 5% cover. The forbs found in the herbaceous layer are quite varied and for the most part perennial, with blue wild indigo (*Baptisia australis)* being common throughout the communities. The shrub layer, when present, is a result of woody invasion and is composed primarily of eastern red cedar (*Juniperus virginiana)* and pricklypear species (*Opuntia* spp.) This community is found on the highest ridges and slopes at Chickasaw NRA, primarily in the uplands south of Veterans Lake and east of Lake of the Arbuckles. This association occurs as small inclusions in the medium tall sod grassland and openings in the woodlands. The amount of woody invasion and litter buildup taking place in these grasslands is a direct result of past fire suppression. The park is currently reinstating a prescribed burn policy. This association was mapped as Map Unit 28 - Upland Forbs/Grasslands. This map unit contains several associations that cannot be differentiated through remote sensing.

***Schizachyrium scoparium - Sorghastrum nutans - Bouteloua curtipendula* Herbaceous Vegetation**

Translated Name: Little Bluestem - Yellow Indiangrass - Sideoats Grama Herbaceous Vegetation
Unique Identifier: CEGL002214
Classification Approach: International Vegetation Classification (IVC)

Figure 22. *Schizachyrium scoparium - Sorghastrum nutans - Bouteloua curtipendula* Herbaceous Vegetation

Summary: This dry-mesic prairie community type is found in the central midwestern United States. Stands occur on upper slopes and hillcrests with moderate to steep slopes. Rarely, it can be found on level plains, especially in the southern parts of its range. The aspect is most often southern or western, but others are possible. Soils are shallow (40-100 cm), well-drained to excessively well-drained, and clay loam, sandy loam, or loamy sand. The sites typically occur over loess, glacial outwash, or glacial till. The dominant vegetation of this community is mid and tall grasses, 1-2 m tall. Total plant cover is moderate to dense. The most abundant species are *Schizachyrium scoparium*, *Sorghastrum nutans*, and *Hesperostipa spartea (= Stipa spartea*). Other common herbaceous species include *Andropogon gerardii*, *Bouteloua curtipendula*, *Echinacea pallida*, *Potentilla arguta*, and *Sporobolus heterolepis*. *Amorpha canescens* is a common subshrub species. Woody species occur but are not common in high-quality examples of this community.

Classification Confidence: 2 - Moderate
Classification Comments: This type is currently reported from subsections 251Bd and 251Be (and subsections east), but these two subsections could also go with *Schizachyrium scoparium - Bouteloua*

curtipendula - Hesperostipa spartea - (Pascopyrum smithii) Herbaceous Vegetation (CEGL002377), which occurs primarily in 251A. In Ohio, this type is probably extirpated, except perhaps Buffalo Beats (on clay dome). However, those stands are far east of much of the range of this type, and they should be compared to other eastern prairie openings. Type may closely resemble *Schizachyrium scoparium - Bouteloua curtipendula* Gravel Herbaceous Vegetation (CEGL002215).

Vegetation Hierarchy

Formation Class	V	Herbaceous Vegetation
Formation Subclass	V.A	Perennial graminoid vegetation
Formation Group	V.A.5	Temperate or subpolar grassland
Formation Subgroup	V.A.5.N	Natural/Semi-natural temperate or subpolar grassland
Formation Name	V.A.5.N.a	Tall sod temperate grassland
Alliance Name		Schizachyrium scoparium - Sorghastrum nutans Herbaceous Alliance

Global Status: G2G3 (06Feb2007)
Rounded Global Status: G2 - Imperiled
Reasons: This community has a fairly broad and matrix-scale distribution in the Midwest, but current high-quality sites tend to be small patches restricted to upper slopes and hillcrests. This community has probably been substantially reduced by conversion to agriculture, or degraded by grazing and fire suppression.

U.S. Distribution: AR, IA, IL, IN, MI, MN, MO, OH, OK, WI
Global Distribution: United States
Global Range: This dry-mesic prairie community type is found in the central midwestern United States, ranging from outliers in Ohio west to east-central Minnesota, south to Missouri and possibly Oklahoma, and east to Indiana.

Vegetation Summary: The dominant vegetation of this community is mid and tall grasses, 1-2 m tall. Total plant cover is moderate to dense. The most abundant species are *Schizachyrium scoparium, Sorghastrum nutans,* and *Hesperostipa spartea (= Stipa spartea).* Other common herbaceous species include *Andropogon gerardii, Bouteloua curtipendula, Echinacea pallida, Potentilla arguta,* and *Sporobolus heterolepis. Amorpha canescens* is a common subshrubby species. Woody species occur but are not common in high-quality examples of this community (Curtis 1959, Nelson 1985, MNNHP 1993).

Wetland Indicator: N

Environmental Summary: This community is found on upper slopes and hillcrests with moderate to steep slopes. Rarely, it can be found on level plains, especially in the southern parts of its range (Nelson 1985). The aspect is most often southern or western, but others are possible (Curtis 1959, Chapman 1984). Soils are 40-100 cm deep (Nelson 1985), well-drained to excessively well-drained, and clay loam, sandy loam, or loamy sand (MNNHP 1993). The sites typically occur over loess, glacial outwash, or glacial till.

Dynamics: This community is invaded by woody species in the prolonged absence of fires (Curtis 1959).

Local Vegetation Summary:
This association is the most extensive of the grassland areas and has been described from seven field plots (CHIC.2, CHIC.7, CHIC.9, CHIC.13, CHIC.17, CHIC.19, CHIC.57) throughout the park at elevations of

900-1050 ft., on level ridgetops and slopes of ≤10%. Soils are shallow (40-100 cm), well-drained to excessively well-drained, and clay loam, sandy loam, or loamy sand. Bare soil accounts for ≥ 40% of the ground coverage with litter making up the remainder, except for occasional rocks.

The vegetation is characterized by moderate to dense (≤ 70%) cover of medium and tall grasses (1-2 m tall) and a diverse mixture of forbs. Woody species that are found in stands of this association are those that can adapt to the dry to dry-mesic conditions, such as eastern red cedar (*Juniperus virginiana),* smooth sumac (*Rhus glabra)* and skunkbush sumac (*Rhus trilobata).* Winged elm (*Ulmus alata)* occasionally appears in this community. The amount of woody shrubs appear to be directly dependent on the frequency of past fires. The most dominent specie in the herbaceous layer is little bluestem (*Schizachyrium scoparium),* with an average of 60% coverage, although this may drop to 30% in areas that have been heavily invaded by woody species. Indiangrass (*Sorghastrum nutans)* is present in all plots at a lower coverage of ≤ 20%. Sideoats grama (*Bouteloua curtipendula),* if present at all, is found at ≤ 5% coverage. Other graminoid species common in parts of this association are various species of blustem (*Andropogon* spp.*),* purple threeawn (*Aristida purpurea),* and species of dropseed (*Sporobolus* spp.). A mix of annual and perennial forbs are present, including wild indigos (*Baptisia* spp.), narrow;eaf Indian breadroot *(Pediomelum linearifolium*) and annual ragweed (*Ambrosia artemisifolia).* Identified by the presence of Indiangrass (*Sorghastrum nutans).* At Chickasaw NRA, this association is found on uplands of the east side of Lake of the Arbuckles and among grasslands surrounding upper Guy Sandy creek. Fire presumably played an important ecological role in maintaining natural stands of this vegetation in the presettlement landscape, but has more recently been suppressed, resulting in woody invasion. The park is currently reintroducing fire in their management plans. This association was mapped as Map Unit 28 - Upland Forbs/Grasslands. This map unit contains several associations that cannot be differentiated through remote sensing.

***Sorghum halepense* Semi-natural Herbaceous Alliance**

Translated Name: Johnson Grass Semi-natural Herbaceous Alliance
Unique Identifier: A.2020
Classification Approach: International Vegetation Classification (IVC)

Figure 23. *Sorghum halepense* Semi-natural Herbaceous Alliance

Summary: This alliance includes the edges of fields, roadsides, and disturbed or formerly cultivated areas dominated by *Sorghum halepense*. It is common as small patches in agricultural landscapes in the southern United States and has invaded adjacent riparian areas in the desert Southwest.

Vegetation Hierarchy

Formation Class	V	Herbaceous Vegetation
Formation Subclass	V.A	Perennial graminoid vegetation
Formation Group	V.A.5	Temperate or subpolar grassland
Formation Subgroup	V.A.5.N	Natural/Semi-natural temperate or subpolar grassland
Formation Name	V.A.5.N.c	Medium-tall sod temperate or subpolar grassland

U.S. Distribution: AZ, NM, TX
Global Distribution: United States
Global Range: This alliance is presumably widespread in agricultural regions of the southeastern U.S. and has invaded adjacent riparian areas in the desert Southwest.

Vegetation Summary: This alliance includes herbaceous vegetation heavily dominated by *Sorghum halepense* which is a tall-growing, robust and weedy non-native grass. Other non-native grasses, such as *Phleum pratense, Lolium arundinaceum, Setaria parviflora*, and *Digitaria ischaemum* may be present at lower cover values. *Andropogon* spp., *Cyperus* spp., and *Carex cherokeensis*, are other (native) graminoids which may be present. Forbs include *Melothria pendula, Commelina communis, Cocculus carolinus, Erechtites hieraciifolia, Lactuca floridana, Rumex* sp., *Diodia virginiana, Trifolium pratense, Solanum carolinense*, and *Chamaesyce maculata (= Euphorbia maculata*). In southern Arizona, the native annual forb *Amaranthus palmeri* often codominates. Associated species are sometimes many and include scattered *Prosopis velutina* shrubs and grasses and forbs such as *Chenopodium berlandieri, Chloris virgata, Eragrostis cilianensis, Eragrostis pectinacea, Eriochloa acuminata, Ipomoea* spp., *Kallstroemia grandiflora, Leptochloa panicea* ssp. *brachiata (= Leptochloa filiformis), Salsola kali*, and *Solanum elaeagnifolium*.

Wetland Indicator: N

Dynamics: This alliance occurs in old fields and along the edges of roads and fields. *Sorghum halepense* is kept out of agricultural fields with herbicides but can colonize after cultivation ceases. Sorghum *halepense* is considered to be one of the ten worst invasive weeds in the world (Holm et al. 1977).

Local Vegetation Summary:
This alliance is described by one field plot (CHIC.53), although its presence at Chickasaw NRA is widespread in abandoned fields, roadsides and other disturbed areas. This plot was at an elevation just over 800 ft, in an abandoned floodplain field of clay loam. The ground cover was 95% litter. The herbaceous layer covered 70% of the plot, with Johnsongrass (*Sorghum halepense*) providing 50% cover. Other codominants include cheatgrass (*Bromus tectorum*) and Canadian horseweed (*Conyza canadensis*). Other species found in this plot include broomsedge bluestem (*Andropogon virginicus*), white heath aster (*Symphyotrichum ericoides* var. *ericoides*), southern sedge (*Carex austrina*), needleleaf rosette grass (*Dichanthelium aciculare*), tumble lovegrass (*Eragrostis sessilispica*), prairie fleabane (*Erigeron strigosus*), southwestern bedstraw (*Galium virgatum*), blackeyed Susan (*Rudbeckia hirta*), curly dock (*Rumex crispus*), and field clover (*Trifolium campestre*). This alliance was mapped as Map Unit 19 - Disturbed Forbs/Grasslands. This map unit contains several associations that cannot be differentiated through remote sensing.

***Buchloe dactyloides* Modified Herbaceous Vegetation**

Translated Name: Buffalo Grass Modified Herbaceous Vegetation
Unique Identifier: CEGL004948
Classification Approach: International Vegetation Classification (IVC)

Figure 24. *Buchloe dactyloides* Modified Herbaceous Vegetation

Summary: This alliance includes modified vegetation dominated by *Buchloe dactyloides*, in pastured and other disturbed areas, especially over clay or compacted soils. Other characteristic species include *Aristida oligantha*, *Ambrosia psilostachya*, *Bouteloua gracilis*, and *Sporobolus compositus*.

Vegetation Hierarchy

Formation Class	V	Herbaceous Vegetation
Formation Subclass	V.A	Perennial graminoid vegetation
Formation Group	V.A.5	Temperate or subpolar grassland
Formation Subgroup	V.A.5.N	Natural/Semi-natural temperate or subpolar grassland
Formation Name	V.A.5.N.e	Short sod temperate or subpolar grassland
Alliance Name		Buchloe dactyloides Herbaceous Alliance

Global Status: GNA
Global Reasons: This community results from anthropogenic disturbances and thus does not get standard GRanks.

Global Distribution: United States
Global Range: This association has been identified in Oklahoma and Texas and is likely more widespread in the southern Great Plains.

Vegetation Summary:
This association includes modified vegetation dominated by *Buchloe dactyloides*. Other characteristic species include *Aristida oligantha, Ambrosia psilostachya, Bouteloua gracilis*, and *Sporobolus compositus*.

Wetland Indicator: N

Environmental Summary:
This association is typically found on clay or compacted soils.

Local Vegetation Summary:
This limited community was described by one field plot (CHIC.84) located in the bison pasture, which is the only incident of this association. This relatively level pasture was at an elevation of 1050 ft, with a 3% slope on well-drained silt loam soil. The ground cover was predominately litter (65%) and bare soil (30%) with a few small rocks. The herbaceous layer covered 60% of the area, dominated by buffalo grass (*Buchloe dactyloides*) and seep muhly (*Muhlenbergia reverchonii*), with associated grass species of Texas tussockgrass (*Nassella leucotricha*) and Texas grama (*Bouteloua rigidiseta*). Minor associates include annual ragweed (*Ambrosia artemisiifolia*), blue wild indigo (*Baptisia australis*), purple threeawn (*Aristida purpurea*), and silver beargrass (*Bothriochloa laguroides*). Shrubs were few in this area and limited to smooth sumac (*Rhus glabra*) and coralberry (*Symphoricarpos orbiculatus*). This association is present and maintained by grazing of bison, occurring nowhere else within the park. This association was mapped as Map Unit 19 - Disturbed Forbs/Grasslands. This map unit contains several associations/alliances that cannot be differentiated through remote sensing.

***Polygonum spp.* (section Persicaria) Seasonally Flooded Herbaceous Alliance**

Translated Name: Smartweed species Seasonally Flooded Herbaceous Alliance
Unique Identifier: A.1881
Classification Approach: International Vegetation Classification (IVC)

Figure 25. *Polygonum* spp. (section Persicaria) Seasonally Flooded Herbaceous Alliance

Summary: This alliance covers various wet depressions, lakes, and ponds dominated by various *Polygonum* species (section Persicaria), singly or in combination, or with other obligate wetland plant species. Associations have been described that are dominated by, or contain, *Polygonum amphibium, Polygonum densiflorum, Polygonum hydropiperoides, Polygonum lapathifolium, Polygonum pensylvanicum, Polygonum punctatum,* and/or related *Polygonum* spp. The many associated species vary with geography and habitat. In western Kentucky, this alliance occurs in marshes associated with the Ohio River in backflood areas around oxbows, beaver-flooded areas, levees, and depressional drainages. Associated species include *Nelumbo lutea, Cephalanthus occidentalis, Sagittaria brevirostra, Peltandra virginica,* and *Juncus effusus*. Associates in Oklahoma include *Ammannia coccinea, Helianthus annuus, Lemna minor, Stuckenia pectinata (= Potamogeton pectinatus), Spirodela polyrrhiza, Utricularia gibba (= Utricularia biflora),* and *Xanthium strumarium*. In Mississippi, one example of this vegetation is dominated by the perennial *Polygonum densiflorum*; associated species include *Lemna minor, Saccharum giganteum, Hydrocotyle umbellata, Saururus cernuus, Carex lupulina, Triadenum walteri, Cephalanthus occidentalis, Leersia sp., Ludwigia peploides, Boehmeria cylindrica, Juncus effusus, Rhynchospora corniculata, Ludwigia decurrens, Habenaria repens, Mikania scandens, Scirpus cyperinus,* and others. It occurs as a band ringing the

shores of ponds in the East Gulf Coastal Plain and along the banks of ditches and sloughs in the Mississippi River Alluvial Plain. This alliance also occurs in a wide variety of human- and beaver-created wetlands. Composition is highly variable and re-evaluation may be required as additional data become available. In the western United States and adjacent Canada, this alliance is found primarily over a wide elevational range from near sea level to over 2700 m. Stands are found in permanently flooded depressions such as margins of lake shores and oxbow lakes in river floodplains. The vegetation is characterized by the dominance or codominance of *Polygonum amphibium*. Associates may include species of *Potamogeton* and other aquatic plants.

Vegetation Hierarchy

Formation Class	V	Herbaceous Vegetation
Formation Subclass	V.B	Perennial forb vegetation
Formation Group	V.B.2	Temperate or subpolar perennial forb vegetation
Formation Subgroup	V.B.2.N	Natural/Semi-natural temperate or subpolar perennial forb vegetation
Formation Name	V.B.2.N.h	Seasonally flooded temperate perennial forb vegetation

U.S. Distribution: AL, AR, FL, GA, IA, IL, IN, KY, LA, MO, MS, NC, NJ, OK, PA, SC, TN, TX, WI
Global Distribution: Canada, United States
Global Range: This alliance is widespread but scattered throughout the eastern and midwestern United States. In the western United States, this alliance is found in California (?), Oregon, Washington, Montana, and Colorado. It also occurs in British Columbia, Canada.

Vegetation Summary: Stands of this alliance are dominated by various *Polygonum* species (section Persicaria), singly or in combination, or with other obligate wetland plant species. Associations have been described that are dominated by, or contain, *Polygonum amphibium, Polygonum densiflorum, Polygonum hydropiperoides, Polygonum lapathifolium, Polygonum pensylvanicum, Polygonum punctatum*, and/or related *Polygonum* spp. The many associated species vary with geography and habitat. In western Kentucky, associated species include *Nelumbo lutea, Cephalanthus occidentalis, Sagittaria brevirostra, Peltandra virginica*, and *Juncus effusus*. Associates in Oklahoma *include Ammannia coccinea, Helianthus annuus, Lemna minor, Stuckenia pectinata (= Potamogeton pectinatus), Spirodela polyrrhiza, Utricularia gibba (= Utricularia biflora)*, and *Xanthium strumarium*. In Mississippi, one example of this vegetation is dominated by the perennial *Polygonum densiflorum*; associated species include *Lemna minor, Saccharum giganteum, Hydrocotyle umbellata, Saururus cernuus, Carex lupulina, Triadenum walteri, Cephalanthus occidentalis, Leersia sp., Ludwigia peploides, Boehmeria cylindrica, Juncus effusus, Rhynchospora corniculata, Ludwigia decurrens, Habenaria repens, Mikania scandens, Scirpus cyperinus*, and others. In the western United States and adjacent Canada, stands are characterized by the dominance or codominance of *Polygonum amphibium*. Associates may include species of *Potamogeton* and other aquatic plants. Floating-leaved aquatic forbs cover at least 30% of the water's surface (Kunze 1994). In the western United States, *Polygonum amphibium* often forms dense, nearly monotypic stands. *Lemna minor, Potamogeton natans, Spirodela polyrrhiza*, and *Wolffia* spp. are occasionally present. In addition, *Typha latifolia and Schoenoplectus acutus (= Scirpus acutus)* may grow adjacent to the vegetation in this alliance in deeper water, and *Carex aquatilis* grows in shallower water along the shore.

Wetland Indicator: Y

Environmental Summary: In the southeastern United States, this alliance occurs in a wide variety of human- and beaver-created wetlands (wet depressions, lakes, and ponds), including a band ringing the shores of ponds in the East Gulf Coastal Plain and in ditches and sloughs in the Mississippi River Alluvial Plain. In the western United States, Great Plains, and one province in Canada, it occurs over a wide elevational range from near sea level to over 2700 m. Stands are found in permanently flooded depressions such as margins of lake shores and oxbow lakes in river floodplains. It also occurs in shallow water along the edges of ponds and lakes in the western United States. Stands are found in oxbow lakes and backwater areas of the Columbia River floodplain, in glacial ponds, or prairie potholes, in northern Montana, and in shallow lakes in the mountains of Colorado. Stands are located in standing water that is permanent or present at least during the growing season. These ponds have low concentrations of ions and salts and bottoms composed of finer sediments, organic muck, clay, or silt. The elevation of the vegetation in the alliance varies depending on geographical location. Stands on the Columbia River are located just above sea level, in Montana between 640-1080 m, and in Colorado from 2050-2700 m. *Typha latifolia* and *Schoenoplectus acutus* may grow adjacent to the vegetation in this alliance in deeper water, and *Carex aquatilis* grows in shallower water along the shore.

Local Vegetation Summary:
This alliance was described from one field plot (CHIC.31) at an elevation of 882 ft in poorly-drained muck. Vegetation covers $\geq$ 70% of the open water. In water up to a half meter deep, dense stands of willow smartweed (Polygonum lapathifolium) and water smartweed (*Polygonum punctatum*) occur. Associates may include species of common duckmeat (*Spirodella polyrrhiza)* and sedge species (*Carex* spp.). This alliance was sampled on Guy Sandy Creek near where the impounded Lake of the Arbuckles meets the creek. The species composition of each stand may be dependent on chance flooding events to introduce various species. This alliance was too small to map.

***Justicia americana* Herbaceous Vegetation**

Translated Name: American Water-willow Herbaceous Vegetation
Unique Identifier: CEGL004286
Classification Approach: International Vegetation Classification (IVC)

Figure 26. *Justicia americana* Herbaceous Vegetation

Summary: This association is found primarily in the Piedmont, Central Appalachians, Cumberland Plateau, Interior Low Plateau, Ozarks, Ouachita Mountains, and adjacent provinces. Stands occur on the shoals or bars of rocky streams and riverbeds, where they are subject to frequent high-energy floods. It provides habitat in some portions of its range for globally rare dragonflies and herbs. *Justicia americana* is the characteristic dominant. *Saururus cernuus* is often present and may be codominant. Other herbaceous species that may be present include *Leersia oryzoides, Leersia virginica, Lemna minor, Orontium aquaticum, Podostemum ceratophyllum, Scirpus* sp., *Schoenoplectus pungens, Schoenoplectus tabernaemontani, Cyperus* spp., *Eleocharis* spp., *Diodia teres, Gratiola brevifolia, Bidens* spp., *Polygonum caespitosum* var. *longisetum*, and *Xyris difformis* var. *difformis*. Exotics include *Lythrum salicaria* and *Lysimachia vulgaris*. A sparse canopy layer, which can include *Carpinus caroliniana* ssp. *caroliniana, Salix interior, Acer saccharinum, Platanus occidentalis, Betula nigra, Fagus grandifolia*, and *Fraxinus pennsylvanica*, among other species, may be present. Scattered shrub seedlings of *Salix nigra, Betula nigra, Acer saccharinum*, or *Platanus occidentalis* may also be present.

Classification Confidence: 2 - Moderate
Classification Comments: This type, in Ohio, often forms pure patches, but consistent identification may require a simple cutoff rule, such as at least 50% cover of Justicia (Anderson 1982). However, Anderson (1996) no longer recognizes this type.

Vegetation Hierarchy

Formation Class	V	Herbaceous Vegetation
Formation Subclass	V.B	Perennial forb vegetation
Formation Group	V.B.2	Temperate or subpolar perennial forb vegetation
Formation Subgroup	V.B.2.N	Natural/Semi-natural temperate or subpolar perennial forb vegetation
Formation Name	V.B.2.N.d	Temporarily flooded temperate perennial forb vegetation
Alliance Name		Justicia americana Temporarily Flooded Herbaceous Alliance

Global Status: G4G5 (12Sep1997)
Rounded Global Status: G4 - Apparently Secure

U.S. Distribution: AL, AR, GA, KY, MD, NC, NJ, NY, OH, OK, PA, SC, TN, VA, WV
Global Distribution: United States
Global Range: This type is found primarily in the Piedmont, Interior Low Plateau, Cumberland Plateau, Ozarks, Ouachita Mountains, and adjacent provinces. It ranges from Alabama, Georgia and the Carolinas west to Arkansas and Oklahoma and north to Ohio, Pennsylvania, and Delaware.

Vegetation Summary: *Justicia americana* is the dominant (and sometimes the only) species, forming lawnlike stands in shallow reaches of rivers. Cover by *Justicia americana* ranges from 40 to 85%. *Saururus cernuus* is often present and may be codominant. Other herbaceous species may be present but rarely achieve more than 1% cover; they include *Leersia oryzoides, Leersia virginica, Lemna minor, Orontium aquaticum, Podostemum ceratophyllum, Scirpus* sp., *Schoenoplectus pungens, Schoenoplectus tabernaemontani, Cyperus* spp., *Elodea* sp., *Eleocharis* spp., *Equisetum arvense, Bidens* spp., *Polygonum caespitosum* var. *longisetum, Diodia teres, Gratiola brevifolia*, and *Xyris difformis* var. *difformis*. Exotics include *Lythrum salicaria* and *Lysimachia vulgaris*. In some areas, *Justicia* usually grows in nearly pure patches, so that few other species are associated with it. *Bidens* spp., *Cuscuta gronovii, Mimulus ringens, Polygonum* spp., *Rumex* spp., and *Salix interior* can occur (Anderson 1982). Some stands have low cover by scattered flood-suppressed trees or an overhanging canopy. Trees in plots include *Acer saccharinum, Betula nigra, Fraxinus pennsylvanica*, and *Platanus occidentalis*. A sparse canopy layer may be present, which can include *Carpinus caroliniana, Fagus grandifolia*, and *Fraxinus pennsylvanica*, among others. Scattered shrub seedlings of *Salix nigra, Betula nigra, Acer saccharinum*, or *Platanus occidentalis* may also be present. In the Cumberland Plateau of Alabama, *Justicia americana* is present in dense patches with some interspersion of other species, including *Pilea pumila, Boehmeria cylindrica, Eclipta prostrata (= Eclipta alba), Juncus coriaceus, Mikania scandens, Ludwigia palustris, Leersia* sp., and *Bidens* sp. Schmalzer and DeSelm (1982) discuss *Orontium aquaticum* growing along streambanks or in shallow riffles "along or with" *Justicia americana* in the Obed River in the Cumberland Plateau of Tennessee. In 29 plots sampled in the Potomac River watershed (Piedmont, Blue Ridge and Ridge and Valley provinces), *Justicia* was overwhelmingly dominant (50-75% mean cover), and no associated species occurred in more than 48% of the plots. Vascular plant species richness in sampled plots is low (typically 6-14 taxa). The exotic invasive *Lythrum salicaria* was found in one West Virginia plot but has not been observed in abundance in this community, possibly due to intolerance of high-energy flooding.

Wetland Indicator: Y

Environmental Summary: This association occurs on the shoals or bars of rocky streams and riverbeds, on bedrock, boulders, cobble, gravel, and sands. They are subject to frequent high energy floods, and are entirely submerged by most flood events. During extreme low water periods, the soil below the beds can be exposed, showing a varied mixture of sand, gravel and cobbles, often with deposits of silt and muck. Stands commonly occur on the edge of the river and at the heads and tails of islands and may sometimes occur on deposition bars in the middle of the river. Substrate pH was circumneutral (6.0 - 6.5) in two samples. Slopes range from level to moderate but are typically gentle. Elevations of West Virginia stands range from 73 to at least 654 m; the type occurs at lower elevations in the Piedmont and Coastal Plain.

Dynamics: Stands in some situations may be obliterated by ongoing river channeling. Anderson (1982) describes some of the life-history characteristics of *Justicia americana* that allow it to persist in river channels.

Local Vegetation Summary:
This community was described from one field plot (CHIC.5) at an elevation of 990 ft in poorly drained muck at the mouth of streams as they meet the lake. This association occurs on the shoals or bars of rocky streams and riverbeds in 0.5 meters of water. American water-willow (*Justicia americana)* is the characteristic dominant. Other species present include smartweed species (*Polygonum* spp.), littleleaf buttercup (*Ranunculus arbortivus)* and marsh seedbox (*Ludwigia palustris)*. Overall, the vegetation covers approximately 70% of the open water. American water-willow (*Justicia americana)* is the principal component of aquatic vegetation. Only one community was sampled at Chickasaw NRA, making it difficult to generalize. Found on Guy Sandy Creek near where the impounded Lake of the Arbuckles meets the creek. The species composition of each stand may be dependent on chance flooding events to introduce various species. This association was too small to map.

Aristida-Digitaria Grassland

Figure 27. Aristida-Digitaria Grassland

This is a NEW association for Chickasaw NRA. It is described from two field plots (CHIC.18, CHIC.23). These plots were located at an elevation just below 1000 ft on gentle to moderately steep (<16%) upland slopes with aspects of 120-185°. Soils were rapidly drained loam to sandy loam. Ground cover was 30% large rocks, <30% small rocks, <5% litter, <30% bare soil, and up to 40% moss or lichen. The herbaceous layer covered 50-60% with the dominants of Carolina crabgrass (*Digitaria cognata),* slim tridens (*Tridens muticus)* and purple threeaen (*Aristida purpurea)*. Codominants included sideoats grama (*Bouteloua curtipendula),* hairy grama (*Bouteloua hirsuta),* hairy woolygrass (*Erioneuron pilosum),* seep muhly *(Muhlenbergia reverchonii),* and twistspine pricklypear (*Opuntia macrorhiza).* Associated species included spider milkweed *(Asclepias asperula),* longleaf buckwheat *(Eriogonum longifolium),* Texas bindweed *(Convolvulus equitans),* spineystar *(Escobaria vivipara),* and trailing krameria *(Krameria lanceolata)*. This association was mapped as Map Unit 19 - Disturbed Forb/Grasslands.

OLDFIELD

Figure 28. Old Field

This is a NEW association not described by NatureServe due to the anthropogenic aspects of this community. This association was described from three field plots (CHIC.24, CHIC.37, CHIC.86) occurring mostly in the cleared bottomlands along the creeks that presumably were in cultivation in the past. At least three similar areas are currently under cultivation as wheat fields (and were cut for straw/hay in June, 2006). These plots were located at elevations of just below 900 – 950 ft in moserately well-drain silt and clay loams. The ground cover was predominately litter ($\geq$65%) with areas of bare soil (< 30%). These old field usually are heavily invaded by weedy forbs and the grasses are exotic or weedy natives. In particular, Johnsongrass (*Sorghum halapense*), Texas wintergrass (*Nassela leucotricha*), composite dropseed (*Sporobolus compositus var. drummondii*), and needleleaf rosette grass (*Dichanthelium aciculare*) are common elements along with common rageweed (*Ambrosia artemisiifolia*), slender lespedeza (*Lespedeza virginica*), and sericea lespedeza (*Lespedeza cuneata*). Additional species include Japanese brome (*Bromus japonicus)*, Mead's sedge (*Carex meadii)*, and Canada goldenrod (*Solidago canadensis)*. This association was mapped as Map Unit 19 - Disturbed Forbs/Grasslands. This map unit contains several associations/alliances that cannot be differentiated through remote sensing.

Shrublands

Cornus drummondii – (Rhus glabra, Prunus spp.) Shrubland

Translated Name: Roughleaf Dogwood – (Smooth sumac, Cherry species) Shrubland
Unique Identifier: CEGL005219
Classification Approach: International Vegetation Classification (IVC)

Figure 29. *Cornus drummondii – (Rhus glabra, Prunus* spp.) Shrubland

Summary: This sumac - dogwood shrubland community is found in the central Great Plains and western tallgrass regions of the United States. Stands occur on level to moderate, well-drained slopes of uplands, usually along the borders of upland woods, but also in grassland ravines. Soils are silty loams formed in loess or glacial till. The vegetation consists of bands or patches of shrubs 2-3 m tall. *Rhus glabra* and *Cornus drummondii* are usually the dominant species, though in places *Corylus americana*, *Prunus americana*, *Prunus angustifolia*, *Symphoricarpos orbiculatus*, or *Rhus aromatica* may dominate. Where shrub cover is dense, vines such as *Celastrus scandens* and *Parthenocissus vitacea* may be present. Under the dense canopy, the herbaceous layer may be sparse, consisting of exotic species, such as *Poa pratensis* and *Nepeta cataria*. In open stands, the herbaceous layer is more dense and consists of species of tallgrass and mixedgrass prairie.

Classification Comments: This type is probably both a natural and a semi-natural type. Because most stands have originated through human disturbance, the type is probably best treated as a semi-natural type. Rosburg and Glenn-Lewin (1996) describe both a shrub edge type, dominated by *Cornus*

drummondii and *Symphoricarpos* spp., and a dogwood/elm woodland type, with *Ulmus rubra* and other woody tree species present. Those types are treated together here.

Vegetation Hierarchy

Formation Class	III	Shrubland
Formation Subclass	III.B	Deciduous shrubland
Formation Group	III.B.2	Cold-deciduous shrubland
Formation Subgroup	III.B.2.N	Natural/Semi-natural cold-deciduous shrubland
Formation Name	III.B.2.N.a	Temperate cold-deciduous shrubland
Alliance		Cornus drummondii Shrubland Alliance

Global Distribution: United States
Global Range: This alliance is found in Alabama, Iowa, Kansas, Nebraska, Oklahoma, Tennessee, New York, Massachusetts, and possibly Arkansas and Mississippi.

Vegetation Summary: The vegetation consists of bands or patches of shrubs 2-3 m tall. In the shrubland/oak woodland transition, woody tree species may also be present. *Rhus glabra* and *Cornus drummondii* are usually the dominant species, though in places *Corylus americana, Prunus americana, Prunus angustifolia, Symphoricarpos orbiculatus* or *Rhus aromatica* may dominate. Where shrub cover is dense, vines such as *Celastrus scandens* and *Parthenocissus vitacea* may be present. Under the dense canopy, the herbaceous layer may be sparse, consisting of exotic species, such as *Poa pratensis* and *Nepeta cataria*. In open stands, the herbaceous layer is more dense and consists of species of tallgrass and mixedgrass prairie (Hoagland 1998a, Rosburg and Glenn-Lewin 1996, Steinauer and Rolfsmeier 2000).

Wetland Indicator: N

Environmental Summary: This community is found in the central Great Plains on level to moderate, well-drained slopes of uplands, usually along the borders of upland woods, but also in grassland ravines. Soils are silty loams formed in loess or glacial till.

Local Vegetation Summary:
This association was described from one field plot (CHIC.8) at an elevation of 960 ft. on a 5% slope and an aspect of 85°. The soil was well-drained. The ground layer was comprised of 55% bare soil and 45% litter. Shrubs covered 50% of the plot. Roughleaf dogwood (*Cornus drummondii)* and smooth sumac (*Rhus glabra)* were the dominant shrubs at 20-30%, with common persimmon *(Diospyros virginiana)* and coralberry *(Symphoricarpos orbiculatus*) present at <5%. The herbaceous layer provided 60% cover in the plot. The dominant graminoid was little bluestem (*Schizachyrium scoparium*) at 30%. Yellow wild indigo (*Baptisia sphaerocarpa*) and false boneset (*Brickellia eupatorioides* var. *eupatorioides*) were the dominant forbs at <5%. Indiangrass (*Sorghastrum nutans*), Nuttall's prairie parsley (*Polytaenia nuttallii*) and a species of goldenrod (*Solidago* spp.) were also present. This association was found at Chickasaw NRA in the Guy Sandy unit and in other similar areas undergoing management with prescribed fire throughout the park in stands too small to map.

***Prunus angustifolia* Shrubland Alliance**

Translated Name: Chickasaw Plum Shrubland Alliance
Unique Identifier: A.1884
Classification Approach: International Vegetation Classification (IVC)

Figure 30. *Prunus angustifolia* Shrubland Alliance

Summary: This alliance is largely anthropogenic, occurring on sand dunes, old fields, disturbed areas, and pastures. *Prunus angustifolia* dominates in clonal thickets. Other characteristic species include *Andropogon hallii, Bouteloua curtipendula, Gaillardia pulchella, Prunus gracilis*, and *Rhus aromatica*. In Oklahoma, it is often the result of physical or chemical removal of *Artemisia filifolia*. In the sandhills of the Georgia Coastal Plain, formerly dominated by *Pinus palustris*, vegetation of this alliance is generated from degraded or disturbed examples of other communities.

Vegetation Hierarchy

Formation Class	III	Shrubland
Formation Subclass	III.B	Deciduous shrubland
Formation Group	III.B.2	Cold-deciduous shrubland
Formation Subgroup	III.B.2.N	Natural/Semi-natural cold-deciduous shrubland
Formation Name	III.B.2.N.a	Temperate cold-deciduous shrubland

Global Distribution: United States

Global Range: This alliance is found in central and western Oklahoma, the sandhills of the Georgia Coastal Plain, and possibly elsewhere.

Vegetation Summary: *Prunus angustifolia* dominates in clonal thickets. In Oklahoma, other characteristic species include *Andropogon hallii, Bouteloua curtipendula, Gaillardia pulchella, Prunus gracilis*, and *Rhus aromatica*.

Wetland Indicator: N

Environmental Summary: This alliance is largely anthropogenic, occurring on sand dunes, old fields, disturbed areas, and pastures.

Dynamics: In Oklahoma, vegetation of this alliance is often the result of physical or chemical removal of *Artemisia filifolia* (Hoagland 1997). In the sandhills of the Georgia Coastal Plain, formerly dominated by *Pinus palustris*, vegetation of this alliance is generated from degraded or disturbed examples of other communities.

Local Vegetation Summary:
This association is described at Chickasaw NRA by three field plots (CHIC.25, CHIC.67, CHIC.78) in the southern half of the park. The elevation of these plots ranged from just under 900 ft. -1100 ft., on ridges, slopes and flood plains of various aspects, and on well-drained loam, sandy loam and clay loam. On two plots, litter was the predominant ground cover (≥ 85%), while the third plot was primarily bare ground (90%). This difference in the ground layer was due to a recent prescribed burn. Shrubs 2-5 m tall covered ≤20% of the plots, while shorter shrubs accounted for ≤60% cover. The dominant tall shrub was the invasive eastern red cedar (*Juniperus virginiana)*, followed by small varying quantities of mixed deciduous saplings of sugarberry (*Celtis laevigata*), eastern redbud (*Cercis canadensis*), common persimmon (*Diospyros virginiana*) and winged elm (*Ulmus alata*). Chickasaw plum (*Prunus angustifolia*) was the dominant short shrub (≤40%) with skunkbush sumac (*Rhus trilobata*) and stretchberry (*Forestiera pubescens*) as associated species. Herbaceous cover was ≥60% with the dominant little bluestem (*Schizachyrium scoparium*) present in all plots, and big blustem (*Andropogon gerardii*), giant golden rod (*Solidago gigantean*), and the invasive Bermuda grass (*Cynodon dactylon*) dominating at least one plot. Other associated herbaceous species include Carruth's sagewort (*Artemisia carruthii*), sideoats grama (*Bouteloua curtipendula*), twistspine pricklypear (*Opuntia macrorhiza*), composite dropseed (*Sporobolus compositus*), spreading hedgeparsley (*Torilis arvensis*), and purpletop tridens (*Tridens flavus*). This association was found at CHIC in disturbed areas at the north end of Trail #1, the south end of Trail #3 and the dam overlook, in stands too small to map.

***Quercus sinuata* var. *breviloba* Shrubland**

Translated Name: White Shin Oak Shrubland
Unique Identifier: CEGL004453
Classification Approach: International Vegetation Classification (IVC)

Figure 31. *Quercus sinuata var. breviloba* Shrubland

Summary: This association is found in the Arbuckle Mountains of Oklahoma (Garvin, Johnston, and Murray counties) and the Lampasas Cutplain and Edwards Plateau of central Texas, where it occurs on shallow soils over limestone mesatops, upper slopes and escarpments. *Quercus sinuata* var. *breviloba* is dominant. Other characteristic species may include, within their respective ranges, *Bouteloua curtipendula, Bouteloua hirsuta, Bouteloua rigidiseta, Hedeoma drummondii, Hilaria belangeri, Cercis canadensis* var. *texensis, Engelmannia peristenia (= Engelmannia pinnatifida), Forestiera pubescens, Fraxinus texensis, Sideroxylon lanuginosum, Ilex decidua, Celtis laevigata* var. *reticulata, Ulmus crassifolia, Sophora secundiflora, Quercus buckleyi, Polygala lindheimeri, Ptelea trifoliata, Rhus lanceolata, Rhus virens* var. *virens, Rhus trilobata* var. *trilobata (= Rhus aromatica* var. *flabelliformis), Schizachyrium scoparium*, and, in more mesic areas, *Toxicodendron radicans* ssp. *eximium, Ungnadia speciosa, Sporobolus vaginiflorus* var. *ozarkanus (= Sporobolus ozarkanus), Carex planostachys, Lespedeza texana*, and *Opuntia engelmannii*. Herbaceous cover is usually low beneath shrubs and high between clumps of shrubs. This community is favored by fire, other disturbances, and harsh environmental conditions. It is considered good habitat for the endangered black-capped vireo (*Vireo atricapilla*) which prefers an open, primarily deciduous shrubland with dense foliage extending to ground level.

Classification Confidence: 2 - Moderate

Vegetation Hierarchy

Formation Class	III	Shrubland
Formation Subclass	III.B	Deciduous shrubland
Formation Group	III.B.2	Cold-deciduous shrubland
Formation Subgroup	III.B.2.N	Natural/Semi-natural cold-deciduous shrubland
Formation Name	III.B.2.N.a	Temperate cold-deciduous shrubland
Alliance Name		Quercus sinuata var. breviloba Shrubland Alliance

Global Status: G2G3 (17Jan2001)
Rounded Global Status: G2 - Imperiled
Reasons: This association is restricted to limestone outcrops in southern Oklahoma and central Texas. High-quality occurrences have been reduced by fire suppression, overgrazing and overbrowsing; all of these factors continue to threaten the persistence of this community.

U.S. Distribution: OK, TX
Global Distribution: United States
Global Range: This association is restricted to limestone outcrops in southern Oklahoma and central Texas.

Vegetation Summary: The shrub canopy is dominated by *Quercus sinuata* var. *breviloba*. Other woody components may include *Forestiera pubescens, Eysenhardtia texana, Cercis canadensis* var. *texensis, Fraxinus texensis, Ptelea trifoliata, Quercus buckleyi, Rhus lanceolata, Rhus virens* var. *virens, Rhus trilobata* var. *trilobata, and Mahonia trifoliolata (= Berberis trifoliata*). Grassy or rocky openings may include *Bouteloua curtipendula, Bouteloua hirsuta, Bouteloua rigidiseta, Hilaria belangeri, Schizachyrium scoparium, Hedeoma drummondii, Polygala lindheimeri, and Engelmannia peristenia (= Engelmannia pinnatifida).*

Wetland Indicator: N

Environmental Summary: This community occupies mesa tops, upper slopes and escarpment edges with thin soils over limestone outcrops where it forms dense shrubby thickets usually occurring in a patchy mosaic with open, grassy or rocky areas and occasionally scattered small trees.

Dynamics: This community is maintained by xeric conditions and thin soils over rocky limestone substrates and as a disclimax community by periodic fires. It may have persisted on the landscape in a shifting mosaic with earlier and later seral stages. Vegetation similar to this natural type may result from the encroachment of woody plants into grassland areas.

Local Vegetation Summary:
This association was described from two field plots (CHIC.28, CHIC.40) at elevations of (950-1100 ft) on ≤4% slopes with aspects of 246-322° The well-drained soils range from loam to sandy loam. Underlying geology may be a factor in the distribution of this community. Plant litter covers the ground at ≥ 60% coverage, with exposed bedrock and large rock ≤30% and minimal bare soil ≤5%. The sparse tree canopy covers ≤ 30% and is composed of Texas ash (*Fraxinus texensis),* shin oak *(Quercus sinuata* var. *breviloba)* and a *Quercus sinuata x stellata* hybrid. Eastern red cedar (*Juniperus virginana)* can be a minor invader. The shrub layer comprises ≥ 60% coverage and is dominated by shin oak (*Quercus sinuata var. breviloba)*. Other woody components may include elbowbush (*Forestiera pubescens),* winged elm *(Ulmus alata),* smooth sumac *(Rhus glabra),* skunkbush sumac *(Rhus trilobata),*and

coralberry *(Symphoricarpos orbiculatus*). The herbaceous layer is sparse (≤ 30%) due to the heavy plant litter. Grassy or rocky openings may include little bluestem (*Schizachyrium scoparium),* Virginia creeper (*Parthenocissus quinquefolia),* saw greenbriar (*Smilax bona-nox),* sedges (*Carex* spp). and hairy sunflower (*Helianthus hirsute).* It is suspected that the underlying geology may affect the distribution of this community. These shrublands occur on limestone outcrops in the Arbuckle Mountains of southern Oklahoma. At Chickasaw NRA they appear to be limited to Bromide Hill and a small area east of the Goddard Youth Camp. This community responds to occasional fire. It is considered good habitat for the endangered Black-capped Vireo which prefers an open, primarily deciduous shrubland with dense foliage extending to the ground level. Occurances of this community were too small to map.

Woodland

***Juniperus ashei / Bouteloua (curtipendula, hirsuta)* Woodland**

Translated Name: Ashe Juniper / (Sideoats Grama, Hairy Grama) Woodland
Unique Identifier: CEGL002125
Classification Approach: International Vegetation Classification (IVC)

Figure 32. *Juniperus ashei / Bouteloua (curtipendula, hirsuta)* Woodland

Summary: *Juniperus ashei* woodlands are found in the Arbuckle Mountains of Oklahoma (Johnston, Marshall, Murray, and Pontotoc counties). Other characteristic species include *Bouteloua curtipendula*, *Bouteloua hirsuta*, *Bouteloua rigidiseta*, *Engelmannia peristenia (= Engelmannia pinnatifida)*, *Forestiera pubescens*, and *Fraxinus texensis*.

Classification Confidence: 1 - Strong
Classification Comments: This type is only in the Arbuckle Mountains of Oklahoma. All the pure *Juniperus ashei* Ozark stands are moved to *Juniperus ashei* Ozark Clifftop Woodland (CEGL004672).

Vegetation Hierarchy

Formation Class	II	Woodland
Formation Subclass	II.A	Evergreen woodland
Formation Group	II.A.4	Temperate or subpolar needle-leaved evergreen woodland
Formation Subgroup	II.A.4.N	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland
Formation Name	II.A.4.N.a	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland
Alliance Name		Juniperus ashei Woodland Alliance

Global Status: G2G3 (03Oct1996)
Rounded Global Status: G2 - Imperiled

U.S. Distribution: OK
Global Distribution: United States
Global Range: This community occurs in the Arbuckle Mountains of Oklahoma (Johnston, Marshall, Murray, and Pontotoc counties).

Wetland Indicator: N

Local Vegetation Summary:
This type is found only in the Arbuckle Mountains of Oklahoma and is described by one field plot (CHIC.50). The occasional woodlands in this association generally occur on calcareous clay substrates, with shallow, rocky soils over limestone, on upland slopes of invaded grassland. Ground cover consists of bare soil (>40%), litter (>40%) and exposed rock (15%). The canopy of this community covers only 20 – 30% of the area, representing relatively recent encroachment of juniper into existing grassland, and is comprised solely of young Ashe juniper (*Juniperus ashei)* 2 – 5 meters tall. The herbaceous layer is dominated by 20% hairy grama (*Bouteloua hirsuta)* and up to 50% little bluestem (*Schizachyrium scoparium)* grassland interspersed with a variety of perennial forbs in trace amounts. The most common forbs include diamondflowers *(Hedyotis nigricans)*, trailing krameria *(Krameria lanceolata)* and narrowleaf Indian breadroot *(Pediomelum linearifolium).* At Chickasaw NRA, this community is found along the western grasslands/woodlands of Guy Sandy creek. Ashe juniper (*Juniperus ashei)* encroachment has been limited in these areas by both prescribed and wildland fire. This association is mapped as Map Unit 13 – Juniper Woodlands, which also includes *Juniperus virginiana* var. *virginiana / Schizachyrium scoparium* Forest due to the difficulty of remotely distinguishing between the two associations.

***Quercus stellata - Quercus marilandica / Schizachyrium scoparium* Woodland**

Translated Name: Post Oak - Blackjack Oak / Little Bluestem Woodland
Unique Identifier: CEGL002147
Classification Approach: International Vegetation Classification (IVC)

Figure 33. *Quercus stellata - Quercus marilandica / Schizachyrium scoparium* Woodland

Summary: This post oak - blackjack oak woodland type is found in the southeastern Great Plains and tallgrass prairie areas, sometimes called the Cross Timbers region, of the United States. Stands are found on ridgetops and gently to steeply sloping hillsides. Soils are shallow to moderately deep, sandy to loamy, and somewhat poorly drained to well-drained. The parent material is typically sandstone. The vegetation structure is an open canopy of trees. Dominant species include *Quercus stellata* and *Quercus marilandica,* with occasional *Quercus prinoides* and *Celtis tenuifolia*. The shrub layer is often absent. The ground layer consists of *Schizachyrium scoparium, Andropogon gerardii,* and *Sorghastrum nutans*.

Classification Confidence: 2 - Moderate
Classification Comments: Type has been described in the Cross Timbers region of Kansas and Oklahoma by Kuchler (1974). Distinctions between the forest type, *Quercus stellata - Quercus marilandica - (Carya texana)* Forest (CEGL002074), and this woodland type need review. *Quercus stellata - Quercus marilandica - Quercus velutina - Carya texana / Schizachyrium scoparium* Woodland (CEGL002149) occurs further east in the Ozarks.

Vegetation Hierarchy

Formation Class	II	Woodland
Formation Subclass	II.B	Deciduous woodland
Formation Group	II.B.2	Cold-deciduous woodland
Formation Subgroup	II.B.2.N	Natural/Semi-natural cold-deciduous woodland
Formation Name	II.B.2.N.a	Cold-deciduous woodland
Alliance Name		Quercus stellata - Quercus marilandica Woodland Alliance

Global Status: G4 (03Oct1996)
Rounded Global Status: G4 - Apparently Secure

U.S. Distribution: KS, OK, TX
Global Distribution: United States
Global Range: This post oak - blackjack oak woodland type is found in the southeastern Plains and tallgrass prairie areas of the United States, occupying the Cross Timbers region of central Kansas, western and central Oklahoma, and Texas.

Vegetation Summary: The vegetation structure is an open canopy of trees. Dominant species include *Quercus stellata* and *Quercus marilandica*, with occasional *Quercus prinoides* and *Celtis tenuifolia*. The shrub layer is often absent. The ground layer consists of *Schizachyrium scoparium, Andropogon gerardii*, and *Sorghastrum nutans* (Lauver et al. 1999).

Wetland Indicator: N

Environmental Summary: Stands are found on ridgetops and gently to steeply sloping hillsides. Soils are shallow to moderately deep, sandy to loamy, and somewhat poorly drained to well-drained. The parent material is typically sandstone (Lauver et al.1999).

Local Vegetation Summary:
Found throughout the park, this association was described by four field plots (CHIC.48, CHIC.63, CHIC.85, CHIC.88). Stands are found on ridgetops and gently to steeply sloping hillsides (≤ 10%) at elevations of (900 – 1050 ft) on all but north-facing slopes. Soils are shallow to moderately deep, sandy to loamy, and somewhat poorly drained to well-drained. The ratio of plant litter to bare ground is quite variable, with small rock and/or downed wood, when present at all, contributing < 25% to the ground cover.The vegetation structure is an open canopy of trees with a coverage of 20 – 40%. The dominant species of the canopy is post oak (*Quercus stellata*) at≤ 30% cover. Blackjack oak (*Quercus marilandica*) is found most often in the shrub layer at ≤ 20% coverage. Other saplings include those of eastern red cedar (*Juniperus virginiana*) and winged elm (*Ulmus alata).* The shrub layer presents a general coverage of 20 - 40% and is composed primarily of canopy saplings, Chickasaw plum *(Prunus angustifolia),* and flameleaf sumac (*Rhus copallinum).* The ground layer is moderately dense with 30 – 70% coverage and consists of little bluestem (*Schizachyrium scoparium*) at 30 – 50% cover, composite dropseed *(Sporobolus compositus*) at ≤ 20% cover, and traces of Indiangrass (*Sorghastrum nutans).* Forbs in the herbaceous layer tend to be perennials, with slender lespedeza (*Lespedeza virginica)* a consistent component. Similar to the *Quercus stellata – Quercus marilandica - (Carya texana)* Forest association, this plant community is differentiated by its strong representation of little bluestem (*Schizycharium scoparium),* an open canopy and shorter canopy height. These woodlands often have substantial encroachment of eastern red cedar (*Juniperus virginiana var. virginiana),* especially as a

result of fire suppression. This association was mapped as Map Unit 2 – Upland Post Oak Communities, which contains other post oak associations too difficult to distinguish through remote sensing.

Disturbed Woodland

Figure 34. Disturbed Woodland

This is a NEW association for Chickasaw NRA. It is described from three field plots (CHIC.60, CHIC.81, CHIC.83). These are areas that have received frequent disturbances of various types over a long period of time. These areas show very mixed succession to deciduous woodlands, resulting in no clear community association. Elevations of these plots were 1000-1050 ft. on ridges and slope <7% and aspects of 150-300°. The soils were well-drained loam to sandy loam. Ground cover varied, with one plot containing 20% bedrock, while the others had little to no exposed rock component. Litter in two plots ranged from 45-60%, while another contained over 90% bare soil. Canopy in all plots was 5-10m tall, with a cover of <40%. Canopy dominants include Texas ash (*Fraxinus texensis)* and sugarberry (*Celtis laevigata*), with associated species of Osage orange (*Maclura pomifera)* and gum bully (*Sideroxylon lanuginosum*). The shrub layer provided <30% cover. Shrub dominants in all plots included common persimmon (*Diospyros virginiana)*, skunkbush sumac *(Rhus trilobata)* and coralberry (*Symphoricarpos orbiculatus*). Stretchberry (*Forestiera pubescens)* was a codominant in two plots. Other associated shrub species were saw greenbriar (*Smilax bona-nox)* and canopy saplings. Cover in the herbaceous layer ranged from 30-60%. Annual ragweed (*Ambrosia artemisifolia)* and twistspine pricklypear *(Opuntia macrorhiza)* were present at <10% in all plots. Other common associates include Texas tussockgrass (*Nasella leucotricha)*, purpletop tridens (*Tridens flavus)*, big bluestem *(Andropogon gerardii)*, Bermuda grass (*Cynodon dactyloides)*, Texas grama (*Bouteloua rigidiseta*), little bluestem *(Schizachyrium scoparium)* and composite dropseed *(Sporobolus compositus)*, along with a variety of weedy annual forbs. This association is mapped as Map Unit 1 – Disturbed Woodlands.

Forest

***Quercus buckleyi - Fraxinus texensis - Quercus muehlenbergii* Forest**

Translated Name: Buckley Oak - Texas Ash - Chinkapin Oak Forest
Unique Identifier: CEGL004912
Classification Approach: International Vegetation Classification (IVC)

Figure 35. *Quercus buckleyi - Fraxinus texensis - Quercus muehlenbergii* Forest

Summary: This forest occurs on xeric to mesic rocky slopes over conglomerate or limestone in the Arbuckle Mountains (Carter and Murray counties, Oklahoma). Stands are dominated by *Quercus buckleyi, Fraxinus texensis,* and *Quercus muehlenbergii*. The canopy and subcanopy may also contain *Quercus stellata*. Other typical associates include *Bouteloua curtipendula, Bouteloua hirsuta, Bouteloua rigidiseta, Engelmannia peristenia (= Engelmannia pinnatifida*), and *Forestiera pubescens*.

Classification Confidence: 1 - Strong
Classification Comments: The taxon properly called *Quercus buckleyi* has been called *Quercus texana, Quercus shumardii* var. *texana,* and *Quercus shumardii* var. *microcarpa,* but Nixon & Dorr (1985. Taxon 34: 225) concluded that these names were misapplied and named the species in honor of Samuel Botsford Buckley (1809-1884, State Geologist of Texas).

Vegetation Hierarchy

Formation Class	I	Forest
Formation Subclass	I.B	Deciduous forest
Formation Group	I.B.2	Cold-deciduous forest
Formation Subgroup	I.B.2.N	Natural/Semi-natural cold-deciduous forest
Formation Name	I.B.2.N.a	Lowland or submontane cold-deciduous forest
Alliance Name		Quercus buckleyi Forest Alliance

Global Status: G2G3 (12Oct1997)
Rounded Global Status: G2 - Imperiled

U.S. Distribution: OK
Global Distribution: United States
Global Range: This type is restricted to the Arbuckle Mountains of Carter and Murray counties, Oklahoma.

Vegetation Summary: Stands of this association are dominated by *Quercus buckleyi, Fraxinus texensis*, and *Quercus muehlenbergii*. The canopy and subcanopy may also contain *Quercus stellata*. Other typical associates include *Bouteloua curtipendula, Bouteloua hirsuta, Bouteloua rigidiseta, Engelmannia peristenia (= Engelmannia pinnatifida*), and *Forestiera pubescens* (Hoagland 2000).

Wetland Indicator: N

Environmental Summary: This forest occurs on xeric to mesic rocky slopes over conglomerate or limestone in the Arbuckle Mountains of Carter and Murray counties, Oklahoma (Hoagland 2000).

Local Vegetation Summary:
This association was described from seven field plots (CHIC.41, CHIC.64, CHIC.65, CHIC.68, CHIC.69, CHIC.72, CHIC.77) located throughout the park area on the highest upland ridges (elevations of 900-1100 ft) and steeper slopes ($\geq$ 10°) with varying aspects. Soils are varied, well-drained loam and sandy loam. A heavy plant litter covers the forest floor with a component of exposed large and/or small rocks. Bare soil is normally non-existant but can be present in amounts $\leq$ 30%. The canopy/subcanopy is the dominant strata, reaching a height of 10-15 meters and a coverage of 40 – 70%. Buckley oak (*Quercus buckleyi* at $\geq$ 40%) is the clear dominent in the canopy, but there is also a noticeable presence of post oak (*Quercus stellata* at $\geq$ 10%). Other species present in the canopy include chinkapin oak (*Quercus muhlenbergia* at $\leq$ 30%), Texas ash (*Fraxinus texensis* at $\leq$ 10%), and on occasion, eastern red cedar (*Juniperus virginiana)* and winged elm (*Ulmus alata).* The shrub layer ranges from 30 – 50% coverage and is never dominated by any particular species. Rusty blackhaw viburnum (*Viburnum rufidulum)* is noticeably present in this plant community at $\leq$ 5% coverage, while eastern redbud (*Cercis canadensis)* and coralberry (*Symphoricarpos orbiculatus)* may be present. The herbaceous layer is very sparse, with a coverage of $\leq$ 10%. Various species of sedges (*Carex* spp.), Virginia creeper (*Parthenocissus quinquefolia)* and saw greenbriar (*Smilax bona-nox)* are usually present, with seedlings of the canopy trees generally providing the majority of the cover. Grasses are seldom present.

This association intergrades with the Shumard red oak-bitternut hickory forests at the bottom of the slopes. In the transition area, it is difficult to distinguish Buckley red oak (*Quercus buckleyi)* from Shumard red oak *(Quercus shumardii)*, as both species are intermediate in stature with similar acorn characteristics. Probably these intermediate trees are hybrids between the two closely related species. On certain limestones where very steep slopes and/or bluffs occur, shin oak (*Quercus sinuata*) is part of the

understory or forms small shrubby inclusions. However, shin oak (*Quercus sinuata*) was subdominant to a higher canopy of Buckley red oak (*Quercus buckleyi)* and/or Texas ash (*Fraxinus texensis*), never forming shrubland extensive enough to map. Invasive junipers were sometimes subdominant in this association. This association is mapped as Map Unit 3 – Upland Buckley Oak Communities.

***Quercus muehlenbergii - Quercus shumardii* Forest**

Translated Name: Chinkapin Oak - Shumard Oak Forest
Unique Identifier: CEGL004602
Classification Approach: International Vegetation Classification (IVC)

Figure 36. *Quercus muehlenbergii - Quercus shumardii* Forest

Summary: This association occurs in lowlands and on mesic slopes over basic soils. Boulders or fragments of limestone or other basic rock may be present at the surface. It is abundant in the eastern half of Oklahoma, with localized occurrences in western Oklahoma; it ranges east to the Arkansas Ozarks and Ouachitas. In Oklahoma other characteristic species include *Aesculus glabra, Carya cordiformis, Carya illinoinensis, Desmodium glutinosum, Frangula caroliniana, Fraxinus americana, Myosotis verna,* and *Quercus macrocarpa*. Arkansas examples also may contain *Acer saccharum, Carya ovata, Quercus rubra,* and *Juglans nigra* in the canopy; *Carya ovalis, Celtis occidentalis, Cercis canadensis* var. *canadensis, Cladrastis kentukea, Cornus florida, Fraxinus quadrangulata, Magnolia acuminata,* and *Ulmus rubra* in the subcanopy; *Asimina triloba, Cornus drummondii, Philadelphus pubescens, Ptelea trifoliata* var. *mollis,* and *Staphylea trifolia* as tall shrubs; and *Arundinaria gigantea, Dirca palustris, Hydrangea arborescens, Juniperus virginiana* var. *virginiana, Lindera benzoin* var. *pubescens, Sideroxylon lanuginosum, Symphoricarpos orbiculatus, Toxicodendron radicans* ssp. *negundo,* and *Viburnum rufidulum* as low shrubs. Herbs include *Aquilegia canadensis, Arabis laevigata* var. *laevigata, Asarum canadense, Asplenium platyneuron, Asplenium resiliens, Chasmanthium latifolium, Cystopteris protrusa, Dicentra cucullaria, Dioscorea quaternata, Dryopteris marginalis, Galium circaezans, Geum canadense,*

Hybanthus concolor, Hydrophyllum appendiculatum?, Lilium superbum, Maianthemum racemosum, Oxalis stricta, Polymnia canadensis, Polystichum acrostichoides, Silene ovata, Solidago caesia, and *Woodsia obtusa*. Additional information is needed regarding landscape position and floristics of this association across its range.

Classification Confidence: 2 - Moderate
Classification Comments: The relationship of dry to moist phases to the overall geographic distribution of this association and a related eastern type, *Quercus muehlenbergii - Quercus shumardii - Carya (carolinae-septentrionalis, ovata)* Forest (CEGL007808), is under investigation. Forest versus woodland placement of the type is uncertain.

Vegetation Hierarchy

Formation Class	I	Forest
Formation Subclass	I.B	Deciduous forest
Formation Group	I.B.2	Cold-deciduous forest
Formation Subgroup	I.B.2.N	Natural/Semi-natural cold-deciduous forest
Formation Name	I.B.2.N.a	Lowland or submontane cold-deciduous forest
Alliance Name		Quercus muehlenbergii - (Acer saccharum) Forest Alliance

Global Status: G2G4 (15Aug1997)
Rounded Global Status: G3 - Vulnerable

U.S. Distribution: AR, OK
Global Distribution: United States
Global Range: This association is abundant in the eastern half of Oklahoma, with localized occurrences in western Oklahoma; it ranges east to the Arkansas Ozarks and Ouachitas.

Vegetation Summary: In Oklahoma other characteristic species include *Aesculus glabra, Carya cordiformis, Carya illinoinensis, Desmodium glutinosum, Frangula caroliniana, Fraxinus americana, Myosotis verna*, and *Quercus macrocarpa*. Arkansas examples also may contain *Acer saccharum, Carya ovata, Quercus rubra*, and *Juglans nigra* in the canopy; *Carya ovalis, Celtis occidentalis, Cercis canadensis, Cladrastis kentukea, Cornus florida, Fraxinus quadrangulata, Magnolia acuminata*, and *Ulmus rubra* in the subcanopy; *Asimina triloba, Cornus drummondii, Philadelphus pubescens, Ptelea trifoliata* var. *mollis*, and *Staphylea trifolia* as tall shrubs; and *Arundinaria gigantea, Dirca palustris, Hydrangea arborescens, Juniperus virginiana, Lindera benzoin* var. *pubescens, Sideroxylon lanuginosum, Symphoricarpos orbiculatus, Toxicodendron radicans* ssp. *negundo*, and *Viburnum rufidulum* as low shrubs. Herbs include *Aquilegia canadensis, Arabis laevigata, Asarum canadense, Asplenium platyneuron, Asplenium resiliens, Chasmanthium latifolium, Cystopteris protrusa, Dicentra cucullaria, Dioscorea quaternata, Dryopteris marginalis, Galium circaezans, Geum canadense, Hybanthus concolor, Hydrophyllum appendiculatum?, Lilium superbum, Maianthemum racemosum, Oxalis stricta, Polymnia canadensis, Polystichum acrostichoides, Silene ovata, Solidago caesia*, and *Woodsia obtusa*.

Wetland Indicator: N

Environmental Summary: This association occurs in lowlands and on mesic slopes over basic soils. Boulders or fragments of limestone or other basic rock may be present at the surface.

Local Vegetation Summary:
Five field plots (CHIC.27, CHIC.39, CHIC.43, CHIC.46, CHIC.61) of this type were examined throughout the park in bottomland riparian areas of intermittent and perennial streams. These plots reflected elevations from (900-1200 ft) on relatively flat to sloped (<8%) moderately well-drained, loamy flood plains. The forest floor contains a heavy cover of plant litter (70-100%) with ≤ 10% bare soil and <20% downed wood. The canopy of this community is some of the tallest found at Chickasaw NRA, reaching 20 – 35 meters and covering ≥ 50%. Chinkapin Oak *(Quercus muhlenbergii)* is present in variable quantities from a trace to ≥ 30% of the canopy/subcanopy mix, while Shumard oak (*Quercus shumardii)* provides cover from 10 – 60%. A third component of the canopy, bur oak (*Quercus macrocarpa)* is normally present only at ≤ 20% cover. Other species found in the canopy/subcanopy include various species of elm (*Ulmus* spp.*)*, pecan (*Carya illinoisnensis)* and bitternut hickory (*Carya cordiformis).* A dense shrub layer exists with a cover of 50-80%. Carolina buckthorn (*Frangula caroliniana),* Virginia creeper (*Parthenocissus quinquefolia)* and coralberry (*Symphorocarpus orbiculatus)* are consistent dominent components of this layer and white ash (*Fraxinus americana),* winged elm (*Ulmus alata)* and slippery elm *(Ulmus rubra)* saplings are also consistently present. A wide variety of other saplings and vines were found among the plots. The density of the herbaceous layer (averaging 50%) is reversely proportional to the density of the shrub layer and is limited overall by a heavy cover of plant litter. Sanicle (*Sanicula sp.*) is present in at least trace amounts and graminoids, when present, consist of sedges (*Carex sp.)* and Virginia wildrye (*Elymus virginicus).* Virginia creeper *(Parthenocissus quinquefolia),* pointedleaf ticktrefoil (*Desmodium glutinosum*) and saw greenbrier *(Smilax bona-nox)* are common components, as are various hardwood seedlings. This forest contains many of the principal tree species of the similar *Quercus macrocarpa – Quercus shumardii* association, with the key differentiation in the percentages of the mix of species and the absence of inland sea oats (*Chasmanthium latifolium)* in the understory. This association is mapped as Map Uit 4 – Chinquapin Oak – Shumard Oak Ozark Forest.

***Carya illinoinensis - Celtis laevigata* Forest**

Translated Name: Pecan - Sugarberry Forest
Unique Identifier: CEGL002087
Classification Approach: International Vegetation Classification (IVC)

Figure 37. *Carya illinoinensis - Celtis laevigata* Forest

Summary: This forest is found on nearly level floodplains and terraces along major streams and rivers in the central and south-central United States, ranging from Kansas and Arkansas, south to Texas and Louisiana. Soils are deep, poorly drained to well-drained, and formed in silty, loamy and clayey recent alluvium. The vegetation is dominated by a closed-canopy forest. Characteristic dominants include *Carya illinoinensis* and *Celtis laevigata*. In Oklahoma, other characteristic species include *Fraxinus pennsylvanica, Ilex decidua, Quercus shumardii, Sapindus saponaria* var. *drummondii*, in Kansas they include *Acer negundo, Fraxinus pennsylvanica, Juglans nigra, Platanus occidentalis*, and *Ulmus americana*, and in Texas they include *Fraxinus pennsylvanica, Ulmus americana, Platanus occidentalis, Sapindus saponaria* var. *drummondii, Cornus drummondii, Ilex decidua*, and *Acer negundo*. Ground layer species may include *Carex grayi, Parthenocissus quinquefolia, Verbesina virginica*, and *Toxicodendron radicans*.
Classification Confidence: 2 - Moderate
Classification Comments: Understory species need to be added. There are likely several associations that should be recognized, or the type itself may be a part of other associations, e.g., in Kansas, see *Fraxinus pennsylvanica - Ulmus* spp. - *Celtis occidentalis* Forest (CEGL002014). In Kansas, the type is found at Fort Leavenworth (H. Loring pers. comm. 1999). This community may be found in the northern

periphery of the Gulf Coast Prairies and Marshes of Texas where it grades into the Crosstimbers and Southern Tallgrass Prairies. It is similar to *Ulmus crassifolia - Carya illinoinensis - Celtis laevigata / Chasmanthium sessiliflorum - Carex cherokeensis* Forest (CEGL002388) described from the Columbia Bottomlands region of coastal Texas. The relationship of these two communities needs clarification. They share many species, but the latter has a strong dominance of *Ulmus crassifolia* and may represent a part of this broadly described type.

Vegetation Hierarchy

Formation Class	I	Forest
Formation Subclass	I.B	Deciduous forest
Formation Group	I.B.2	Cold-deciduous forest
Formation Subgroup	I.B.2.N	Natural/Semi-natural cold-deciduous forest
Formation Name	I.B.2.N.d	Temporarily flooded cold-deciduous forest
Alliance Name		Carya illinoinensis - (Celtis laevigata) Temporarily Flooded Forest Alliance

Global Status: G4? (01Jan2001)
Rounded Global Status: G4 - Apparently Secure
Reasons: This is a wide-ranging and broadly described association. The degree of uncertainty in the rank reflects the need for further inventory and description of this community. The relationship of this community to similar communities needs clarification.

U.S. Distribution: AR, KS, LA, OK, TX
Global Distribution: United States
Global Range: This pecan - sugarberry forest is found in the central and south-central United States, ranging from Kansas and Arkansas, south to Texas and Louisiana.

Vegetation Summary: The vegetation is dominated by a closed-canopy forest. Characteristic dominants include *Carya illinoinensis* and *Celtis laevigata*. In Oklahoma, other characteristic species include *Fraxinus pennsylvanica, Ilex decidua, Quercus shumardii*, and *Sapindus saponaria* var. *drummondii* (Hoagland 1997), in Kansas they include *Acer negundo, Fraxinus pennsylvanica, Juglans nigra, Platanus occidentalis*, and *Ulmus americana*, and in Texas they include *Fraxinus pennsylvanica, Ulmus americana, Platanus occidentalis, Sapindus saponaria* var. *drummondii, Cornus drummondii, Ilex decidua*, and *Acer negundo*. Ground layer species include *Carex grayi, Parthenocissus quinquefolia, Verbesina virginica* and *Toxicodendron radicans* (Lauver et al. 1999).

Wetland Indicator: Y

Environmental Summary: Stands occur on nearly level floodplains and terraces along major streams and rivers. Soils are deep, poorly drained to well-drained, and formed in silty, loamy and clayey recent alluvium.

Local Vegetation Summary:
This association was described from two field plots (CHIC.54, CHIC.89) nearly level floodplains and terraces along creeks and streams in the bottomland riparian areas of the old Platte District and occasionally where the current mouth of streams meet the lake. Elevations ranged from 900-1050 ft. and aspects of 80°. Soils are deep, poorly drained to well-drained, and formed in silty, loamy and clayey recent alluvium. Ground cover was predominately litter (>85%) with minimal bare soil and woody debris. The canopy of this plant community reaches 10 – 15 meters tall with a cover of 40 – 70%. Pecan (*Carya*

illinoisnensis) is generally the dominent component at ≥ 10% coverage, with slippery elm (*Ulmus rubra)*, Shumard oak *(Quercus shumardii)* and wingleaf soapberry (*Sapindus saponaria* var. *drummondii*) as other characteristic species. Eastern red cedar *(Juniperus virginiana)* can be and invasive component in this strata. The sparse shrub layer contains a mix of hardwood saplings and shrubs, including roughleaf dogwood (*Cornus drummondii)*, coralberry (*Symphiocarpus orbiculatus)* and eastern poison ivy (*Toxicodendron radicans)*, none exhibiting dominence over another. Inland seaoats (*Chasmanthium latifolium)* is the characteristic graminoid for this community but does not always dominate the herbaceous layer, which is often composed of numerous vining/trailing species such as Carolina coralbead (*Cocculus carolinus)* and Virginia creeper *(Parthenocissus quinquefolia).* This association is mapped as Map Unit 7 – Pecan – Sugarberry Forest.

***Ulmus americana - Celtis (laevigata, occidentalis) - Fraxinus pennsylvanica* Forest**

Translated Name: American Elm - (Sugarberry, Northern Hackberry) - Green Ash Forest
Unique Identifier: CEGL002090
Classification Approach: International Vegetation Classification (IVC)

Figure 38. *Ulmus americana - Celtis (laevigata, occidentalis) - Fraxinus pennsylvanica* Forest

Summary: In Oklahoma, this association occurs in moist to wet soils in riparian corridors, throughout Oklahoma except the panhandle. The canopy of this forest is characteristically dominated by some combination of *Ulmus americana, Celtis laevigata, Celtis occidentalis*, and *Fraxinus pennsylvanica*. Other characteristic species include *Carya cordiformis, Carya illinoinensis, Juglans nigra, Quercus macrocarpa*, and *Quercus shumardii* in the canopy and subcanopy, as well as *Arisaema dracontium, Chasmanthium latifolium, Cocculus carolinus, Elephantopus carolinianus, Elymus virginicus, Sambucus canadensis*, and *Sapindus saponaria* var. *drummondii* as herbs and shrubs. In addition, *Juglans microcarpa* is a common associate in Caddo, Kiowa, and Greer counties, Oklahoma.

Classification Confidence: 3 - Weak
Classification Comments: Hoagland (2000) places this in an *Ulmus (americana/rubra)* Forest Alliance, and states that the habitat of that alliance is "wet to mesic soil in riparian corridors", and that this association "corresponds to SAF 93," which implies that its global placement in *Fraxinus pennsylvanica - Ulmus americana - Celtis (occidentalis, laevigata)* Temporarily Flooded Forest Alliance (A.286) is plausible. More information is needed.

Vegetation Hierarchy

Formation Class	I	Forest
Formation Subclass	I.B	Deciduous forest
Formation Group	I.B.2	Cold-deciduous forest
Formation Subgroup	I.B.2.N	Natural/Semi-natural cold-deciduous forest
Formation Name	I.B.2.N.d	Temporarily flooded cold-deciduous forest
Alliance Name		Fraxinus pennsylvanica - Ulmus americana - Celtis (occidentalis, laevigata) Temporarily Flooded Forest Alliance

Global Status: G3? (04Jan2001)
Rounded Global Status: G3 - Vulnerable
Reasons: This community, and other types of floodplain forests, are threatened by alteration of the hydroperiod by artificial impoundments or river diversion projects, or the disruption of the floodplain communities by forestry or agriculture.

Vegetation Summary: The canopy of this forest is characteristically dominated by some combination of *Ulmus americana, Celtis laevigata, Celtis occidentalis*, and *Fraxinus pennsylvanica*. Other characteristic species include *Carya cordiformis, Carya illinoinensis, Juglans nigra, Quercus macrocarpa*, and *Quercus shumardii* in the canopy and subcanopy, as well as *Arisaema dracontium, Chasmanthium latifolium, Cocculus carolinus, Elephantopus carolinianus, Elymus virginicus, Sambucus canadensis*, and *Sapindus saponaria* var. *drummondii* as herbs and shrubs. In addition, "*Juglans microcarpa* is a common associate in Caddo, Kiowa, and Greer counties," Oklahoma (Hoagland 1997).

Wetland Indicator: Y

Environmental Summary: In Oklahoma, this association occurs in moist to wet soils in riparian corridors, throughout Oklahoma except the panhandle.

Local Vegetation Summary:
This community is described by three field plots (CHIC.29, CHIC.51, CHIC.71). Forests of this association occur on alluvial sites in floodplains of large and small, generally alluvial or brownwater streams, on low ridges, flats, and sloughs of first bottoms; and terrace flats and sloughs at elevations of (850-1000 ft). Species composition differs somewhat with topographic position and likely reflect chance species introduction due to flooding events. Ground cover primarily consists of litter (> 60%) with varying amounts of downed wood (< 20%) and bare soil (< 10%). The canopy of this forest, reaching 15 to 20 meters tall, is characteristically dominated by some combination of elm (*Ulmus* spp.*)*, sugarberry (*Celtis laevigata)* and green ash (*Fraxinus pennsylvanica)* with 40 – 80% coverage. However, while some elm species (*Ulmus* spp.*)* will be present at ≥ 30%, hackberry (*Celtis)* and ash (*Fraxinus)* will not always be present in each plot. Pecan (*Carya illinoinensis)* is usually present at ≤ 10%. Other characteristic species include black walnut (*Juglans nigra)*, boxelder (*Acer negundo)*, and Shumard oak (*Quercus shumardii)* in the canopy and subcanopy. Occasionally, small occurrences of this community may be composed of almost pure green ash (*Fraxinus pennsylvanica)* particularly on moist flats or in shallow sloughs. The sparse shrub layer is comprised of saplings of the canopy/subcanopy species and occasionally red mulberry (*Morus rubra).* The herbaceous layer is fairly dense (50 – 70% cover) considering the thick cover of plant litter found in this forest community. Indian woodoats (*Chasmanthium latifolium)*, Virginia wildrye (*Elymus virginicus)* and sedge species (*Carex* spp.*)*

make up the dominant graminoids in the herbaceous layer, which also includes saw greenbriar (*Smilax bona-nox),* Virginia creeper (*Parthenocissus quinquefolia),* coralberry (*Symphoricarpos orbiculatus*) and various hardwood seedlings.. This association is mapped as Map Unit 8 – American Elm – (Sugarberry, Northern Hackberry) – Green Ash Forest.

***Platanus occidentalis - (Populus deltoides) - Acer negundo* Forest**

Translated Name: American Sycamore - (Eastern Cottonwood) - Box-elder Forest
Unique Identifier: CEGL002092
Classification Approach: International Vegetation Classification (IVC)

Figure 39. *Platanus occidentalis - (Populus deltoides) - Acer negundo* Forest

Summary: This type, defined for forests of Oklahoma and Texas, is dominated by *Platanus occidentalis* (and *Populus deltoides*) occurring with *Acer negundo*.

Classification Confidence: 2 - Moderate
Classification Comments: This type, defined for forests of Oklahoma and Texas, is dominated by *Platanus occidentalis* (and *Populus deltoides*) occurring with *Acer negundo*. It was placed in this alliance, *Populus deltoides* Temporarily Flooded Forest Alliance (A.290), based on the assumption that this Great Plains association is more similar to types in Kansas [see *Populus deltoides - Platanus occidentalis* Forest (CEGL002095) in this alliance] rather than types with these dominants in Kentucky and Tennessee [see *Acer negundo - (Platanus occidentalis, Populus deltoides)* Forest (CEGL004690) in *Acer negundo* Temporarily Flooded Forest Alliance (A.278)]. More information on species composition and environmental variables is needed to better distinguish these forests from one another.

Vegetation Hierarchy

Formation Class	I	Forest
Formation Subclass	I.B	Deciduous forest
Formation Group	I.B.2	Cold-deciduous forest
Formation Subgroup	I.B.2.N	Natural/Semi-natural cold-deciduous forest
Formation Name	I.B.2.N.d	Temporarily flooded cold-deciduous forest
Alliance Name		Populus deltoides Temporarily Flooded Forest Alliance

Global Status: GNR (15Dec1994)
Rounded Global Status: GNR - Not Yet Ranked

U.S. Distribution: OK, TX
Global Distribution: United States
Global Range: This type is defined for forests of Oklahoma and Texas.

Wetland Indicator: Y

Local Vegetation Summary:
This association was described from two field plots (CHIC.38, CHIC.44). This plant community is found in intermittently flooded streambeds/drainages, at elevations of (850-950 ft), in deep, medium-textured alluvium with adequate moisture available during the growing season. Ground cover varies depending on the nature of the site, with >90% litter on alluvial sites, and 30% litter on sites with large (35%) and small (20%) rocks. The canopy is normally comprised solely of American sycamore (*Platanus occidentalis)* rising 15 – 35 meters tall and providing 50 – 60% coverage. The subcanopy can contain a mix of hardwoods, including Osage orange (*Maclura pomifera),* slippery elm *(Ulmus rubra)* and sugarberry (*Celtis laevigata).*The shrub layer is often sparse yet diverse, usually dominated at ≤ 30% by coralberry (*Symphiocarpus orbiculatus)*. Additional species found in the shrub layer in amounts of ≤ 3% include roughleaf dogwood (*Cornus drummondii),* eastern red cedar *(Juniperus virginiana),* eastern redbud (*Cercis canadensis)* and eastern poison ivy (*Toxicodendron radicans).* Herbaceous growth can be thick and lush but is often patchy and sparse due to frequent inundation. Virginia creeper (*Parthenocissus quinquefolia)* and Indian woodoats (*Chasmanthium latifolium)* are found in these habitats at < 20% coverage, but most forbs and saplings are found in trace amounts. The presence of invasive plant species such as Bermuda grass (*Cynodon dactylon)* and Johnsongrass (*Sorghum halepense)* is to be expected in riparian areas. This community is found at Chickasaw NRA in intermittently flooded dry streambeds/drainages of the perennial streams. Tree diversity is limited due to the dynamics of flooding and deposition/scouring of sediments. This association is mapped as Map Unit 9 – Eastern Cottonwood Temporarily Flooded Forest Alliance.

***Quercus macrocarpa - Quercus shumardii - Carya cordiformis / Chasmanthium latifolium* Forest**

Translated Name: Bur Oak - Shumard Oak - Bitternut Hickory / River-oats Forest
Unique Identifier: CEGL004544
Classification Approach: International Vegetation Classification (IVC)

Figure 40. *Quercus macrocarpa - Quercus shumardii - Carya cordiformis / Chasmanthium latifolium* Forest

Summary: This association is found in the United States in the southeastern Great Plains and adjacent Ozark-Ouachita region, ranging from the Arbuckle Mountains of Oklahoma to northeastern Oklahoma and southeastern Kansas and adjacent Missouri and Arkansas. Stands occur on floodplains, where they are temporarily flooded for short periods as a result of river flooding, and more rarely on other mesic habitats. Soils are deep, medium-textured and formed in alluvium. The vegetation is dominated by a closed-canopy layer of trees, with *Quercus macrocarpa, Quercus shumardii*, and *Carya cordiformis* the major dominants. Other characteristic species include *Carya illinoinensis, Frangula caroliniana, Populus deltoides*, and *Ulmus americana* in Oklahoma and *Acer negundo, Acer saccharinum, Fraxinus pennsylvanica*, and *Platanus occidentalis* in Kansas. Ground layer species include *Carex* spp. and *Leersia oryzoides*.
Classification Confidence: 3 - Weak

Vegetation Hierarchy

Formation Class	I	Forest
Formation Subclass	I.B	Deciduous forest
Formation Group	I.B.2	Cold-deciduous forest
Formation Subgroup	I.B.2.N	Natural/Semi-natural cold-deciduous forest
Formation Name	I.B.2.N.d	Temporarily flooded cold-deciduous forest
Alliance Name		Quercus macrocarpa - Quercus bicolor - (Carya laciniosa) Temporarily Flooded Forest Alliance

Global Status: G3? (31Oct1997)
Rounded Global Status: G3 - Vulnerable
Reasons: This type is ranked S1S2 in Kansas, S? in Oklahoma, and it may occur in Missouri. The type has a very restricted distribution and few high-quality occurrences have been reported.

U.S. Distribution: AR, KS, MO, OK
Global Distribution: United States
Global Range: This association is found in the United States in the southeastern Great Plains and possibly adjacent Ozark-Ouachita region, ranging from northeastern Oklahoma and the Arbuckle Mountains of Oklahoma to southeastern Kansas and adjacent Missouri.

Vegetation Summary: The vegetation is dominated by a closed-canopy layer of trees, with *Quercus macrocarpa, Quercus shumardii*, and *Carya cordiformis* the major dominants. Other characteristic species include *Carya illinoinensis, Frangula caroliniana, Populus deltoides*, and *Ulmus americana* in Oklahoma (Hoagland 1997) and *Acer negundo, Acer saccharinum, Fraxinus pennsylvanica*, and *Platanus occidentalis* in Kansas (Lauver et al. 1999). Ground layer species include *Carex* spp. and *Leersia oryzoides*.

Wetland Indicator: Y

Environmental Summary: Stands occur on floodplains, where they are temporarily flooded for short periods as a result of river flooding, and more rarely on other mesic habitats (Hoagland 1997). Soils are deep, medium-textured and formed in alluvium (Lauver et al. 1999).

Local Vegetation Summary:
This association was described from two field plots (CHIC.47, CHIC.73) at elevations of 850-950 ft in floodplain loams. Ground cover was primarily litter (>80%) with small amounts of bare soil (<10%) and downed wood (<10%). The canopy reaches 15-20m tall and provides ≤70% cover. Bur oak (Quercus macrocarpa) and black walnut (*Juglans nigra)* are the dominates with Shumard oak (*Quercus shumardii)* and slippery elm *(Ulmus rubra)* common subdominants. Associated canopy species include white ash *(Fraxinus americana)*, American sycamore *(Platanus occidentalis)*, chinkapin oak *(Quercus muehlenbergii)* and bitternut hickory *(Carya cordiformis)*. Eastern red cedar *(Juniperus virginiana)* can be found in the subcanopy and understory. The shrub strata varied from sparse (5%) to moderate (≤40%) cover. In addition to saplings of canopy species, coralberry *(Symphoricarpos orbiculatus)*, and eastern redbud *(Cercis canadensis)* are commonly found. Associated shrub species include saplings of boxelder *(Acer negundo)* and sugarberry *(Celtis laevigata)*, as well as roughleaf dogwood *(Cornus drumondii)* and eastern poison ivey *(Toxicodendron radicans).* Herbaceous cover is dependant on canopy density, ranging from 30 – 70%. Dominant species in this stratum include Indian woodoats *(Chasmanthium latifolium)*, Virginia creeper *(Parthenocissus quinquefolia)*, Canadian

black snakeroot *(Sanicula canadensis)*, and saw greenbriar *(Smilax bona-nox).* Associated species include Virginia wildrye *(Elymus virginicus)*, whitegrass *(Leersia virginica)*, and purple meadow rue (*Thalictrum dasycarpum*). This association was found at Chickasaw NRA along Upper Guy Sandt Creek and in the bottomlands of Cedar Blue. This association is mapped as Map Unit 10 – Burr Oak – Shumard Oak Mixed Bottomland Forest.

***Juniperus virginiana var. virginiana / Schizachyrium scoparium* Forest**

Translated Name: Eastern Red-cedar / Little Bluestem Forest
Unique Identifier: CEGL003628
Classification Approach: International Vegetation Classification (IVC)

Figure 41. *Juniperus virginiana var. virginiana / Schizachyrium scoparium* Forest

Summary: This type results from fire suppression in glades and grasslands. This community is found throughout Oklahoma, ranging into the West Gulf Coastal Plain of Texas and into the Interior Highlands of Arkansas and Missouri.

Classification Confidence:
Classification Comments: This association is currently very generally defined.

Vegetation Hierarchy

Formation Class	I	Forest
Formation Subclass	I.A	Evergreen forest
Formation Group	I.A.8	Temperate or subpolar needle-leaved evergreen forest
Formation Subgroup	1.A.8.N	Natural/Semi-natural temperate or subpolar needle-leaved evergreen forest
Formation Name	I.A.8.N.c.	Conical-crowned temperate or subpolar needle-leaved evergreen forest
Alliance Name		Juniperus virginiana Semi-natural Forest Alliance

Global Status: GNA
Rounded Global Status:
Global Reasons: This forest represents early successional, modified, or silviculturally managed vegetation and is thus not of conservation concern and does not receive a conservation status rank. This vegetation may be easily restorable by either management, time, or restoration of ecological processes.

U.S. Distribution: AR, MO, OK, TX
Global Distribution: United States
Global Range: This community is found throughout Oklahoma, ranging into the West Gulf Coastal Plain of Texas and into the Interior Highlands of Arkansas and Missouri.

Wetland Indicator: N

Environmental Setting: Forests in this alliance occur on usually high pH, fire-suppressed sites or old fields. The habitat for this alliance is most commonly old fields and pastures, successional cleared land, and other various locally disturbed areas, especially on calcareous rocks.

Local Vegetation Summary:
This association is described by seven plots (CHIC.35, CHIC.36, CHIC.49, CHIC.59, CHIC.70, CHIC.75, CHIC.79), ranging in elevation from (900 – 1100 ft), with slopes of 2 – 14% and varying aspects of 100 – 300°. This plant community occurs primarily on ridges and xeric upland slopes, on well-drained loam to sandy-loam soil. The ground cover is variable, consisting primarily of bare ground (1-55%), litter (10-95%) and rock (up to 20%). Occurances of the community are wide-spread throughout the park, a result of fire suppression and subsequent invasion of existing grasslands. The canopy of this association is 5 – 10 meters tall, with a variable cover of 20 – 70%. In addition to the dominant eastern red cedar (*Juniperus virginiana*), the canopy can contain Texas ash (*Fraxinus texensis),* winged elm (*Ulmus alata)* and occasionally Buckley oak (*Quercus buckleyi)*. The shrub layer generally provides 40% cover or less and is composed of saplings of the more common canopy species, as well as occasional eastern redbud (*Cercis canadensis),* roughleaf dogwood (*Cornus drummundii)* and skunkbush sumac (*Rhus trilobata)*. The herbaceous layer is dominated by little bluestem (*Schizachyrium scoparium)* at 20 – 60% cover, followed by hairy grama (*Bouteloua hirsute)* at 10-30% cover. While generally present, cedar sedge (*Carex planostachya)* never covers more than 5%. The remainder of the herbaceous layer is comprised of any number of perennial forbs/grasses and only a few weedy annuals, all present in trace amounts. Most well-developed communities are restricted to the dry highlands south of Veteran's Lake and east of Rock Creek, as well as limited locations within the original Platt District, where juniper was first introduced in the 1930s. Active removal of encroaching juniper is being carried out in the park, primarily in bottomland communities. This association is mapped as Map Unit 13 – Juniper Woodlands, which also includes *Juniperus ashei / Bouteloua (curtipendula, hirsuta)* Woodland due to the difficulty of remotely distinguishing.

***Quercus stellata - Quercus marilandica - (Carya texana*) Forest**

Translated Name: Post Oak - Blackjack Oak - (Black Hickory) Forest
Unique Identifier: CEGL002074
Classification Approach: International Vegetation Classification (IVC)

Figure 42. *Quercus stellata - Quercus marilandica - (Carya texana)* Forest

Summary: This post oak - black jack oak type is found in the Crosstimbers region of the southeastern Great Plains. Stands occur on ridgetops and nearly level to steep hillsides. Soils are shallow to moderately deep, sandy and loamy in texture, derived from sandstone bedrock. The vegetation is dominated by relatively closed-canopy forest. Typical dominants include *Quercus stellata* and *Quercus marilandica. Carya texana* is often present. Other associates include *Carya cordiformis, Quercus prinoides* and *Quercus velutina*. Common shrubs include *Rhus copallinum* and *Rhus glabra*. Ground layer species may include *Schizachyrium scoparium*.

Classification Confidence: 2 - Moderate
Classification Comments: The absence of *Vaccinium arboreum* is part of what distinguishes this type from the related CEGL002075 of the Ozarks and Interior Low Plateau to the east (B. Hoagland pers. comm.). This association was created for the Western Crosstimbers forests. It needs further research. This association has been well described at a broad level in the Crosstimbers region of Kansas and Oklahoma (see especially Kuchler 1974). It may, however, extend eastward towards and into western Missouri.

Vegetation Hierarchy

Formation Class	I	Forest
Formation Subclass	I.B	Deciduous forest
Formation Group	I.B.2	Cold-deciduous forest
Formation Subgroup	I.B.2.N	Natural/Semi-natural cold-deciduous forest
Formation Name	I.B.2.N.a	Lowland or submontane cold-deciduous forest
Alliance Name		Quercus stellata - Quercus marilandica Forest Alliance

Global Status: G4 (03Oct1996)
Rounded Global Status: G4 - Apparently Secure

U.S. Distribution: AR, KS, OK, TX
Global Distribution: United States
Global Range: This post oak - black jack oak type is found in the cross timbers region of the southeastern Great Plains, from Kansas to Texas.

Vegetation Summary: The vegetation is dominated by relatively closed-canopy forest. Stands are dominated by *Quercus stellata* and *Quercus marilandica*. *Carya texana* is often present. Other associates include *Carya cordiformis, Quercus prinoides* and *Quercus velutina*. Common shrubs include *Rhus copallinum* and *Rhus glabra*. Ground layer species may include *Schizachyrium scoparium* (Lauver et al. 1999).

Wetland Indicator: N

Environmental Summary: Stands occur on ridgetops and nearly level to steep hillsides. Soils are shallow to moderately deep, sandy and loamy in texture, derived from sandstone bedrock (Lauver et al. 1999).

Local Vegetation Summary:
This association was sampled by eight field plots (CHIC.20, CHIC.21, CHIC.42, CHIC.45, CHIC.52, CHIC.56, CHIC.62, CHIC.76). These plots were located on ridges, slopes and level uplands at elevations between (850-1100 ft) with well developed loam or sandy loam soil. Soils have a common characteristic of an impermeable substratum and are shallow to moderately deep, derived from sandstone bedrock. Ground cover is predominately litter (>85%), with very little bare ground (<5%) and downed wood (<5%). This plant association is limited to openings and forest edges. While the post oaks *(Quercus stellata)* form the canopy, the blackjack oaks *(Quercus marilandica)* are usually present as immature, large shrub-sized saplings. Only occasional mature blackjacks *(Quercus marilandica)* are present where the area has remained woodland for many years. Accompanying grasses are usually tall or mixed grasses. It is unknown how past management or lack of fire has influenced this community.

The vegetation is dominated by relatively closed-canopy forest ranging from 40 – 70% coverage, but averaging at least 60%. This canopy reaches10 – 15 m tall. Post oak (*Quercus stellata*) dominates the canopy at ≥ 40% coverage. Blackjack oak (*Quercus marilandica*) is rarely present, found only in the subcanopy along roadside openings. The most commonly associated tree species of the canopy/subcanopy are bitternut hickory (*Carya cordiformis*), Texas ash (*Fraxinus texensis*), eastern red cedar (*Juniperus virginiana,* which often dominates the subcanopy), Buckley oak (*Quercus buckleyi* at ≤ 15% cover), Chinkapin oak (*Quercus muhlenbergii* at ≤ 15% cover), and winged elm (*Ulmus alata* ≤ 10% cover). Understory layers can be somewhat sparse and scrubby, attaining ≤ 30% coverage. The shrub layer primarily includes saplings of the canopy trees, in addition to occasional red mulberry (*Morus rubra)* and coralberry (*Symphiocarpus orbiculatus*). The herbaceous layer is very sparse at ≤ 10% coverage and

rarely contains any graminoids. Species found in the herbaceous layer may include Virginia creeper (*Parthenocissus quinquefolia),* saw greenbriar (*Smilax bona-nox),* seedlings of gum bully (*Sideroxylon lanuginose),* common persimmon (*Diospyros virginiana)* and a varied mix of other hardwood seedlings, annual and perennial forbs. This association was mapped as Map Unit 2 – Upland Post Oak Communities, which contains other post oak associations too difficult to distinguish through remote sensing.

***Quercus stellata - Ulmus alata* Forest**

Translated Name: Post Oak - Winged Elm Forest
Unique Identifier: CEGL004546
Classification Approach: International Vegetation Classification (IVC)

Figure 43. *Quercus stellata - Ulmus alata* Forest

Summary: This association comprises upland forests of the Crosstimbers region of eastern and central Oklahoma, possibly extending into adjacent areas of Arkansas and Texas. This association is variable in canopy closure and encompasses forest, woodland, and savanna; a woodland equivalent may be needed, or its placement should be reviewed. The canopy is dominated by *Quercus stellata* and *Ulmus alata*. Other characteristic species include *Andropogon gerardii, Carya texana, Cercis canadensis* var. *canadensis, Helianthus hirsutus, Prunus mexicana, Viburnum rufidulum*, and *Schizachyrium scoparium*.

Classification Confidence: 3 - Weak
Classification Comments: This association is variable in canopy closure and encompasses forest, woodland, and savanna; a woodland equivalent may be needed (Hoagland 1997). Should its placement be reviewed? *Quercus stellata - Quercus marilandica / Schizachyrium scoparium* Woodland (CEGL002147) is a possible woodland equivalent (MP 10-00).

Vegetation Hierarchy

Formation Class	I	Forest
Formation Subclass	I.B	Deciduous forest
Formation Group	I.B.2	Cold-deciduous forest
Formation Subgroup	I.B.2.N	Natural/Semi-natural cold-deciduous forest
Formation Name	I.B.2.N.a	Lowland or submontane cold-deciduous forest
Alliance Name		Quercus stellata - Quercus marilandica Forest Alliance

Global Status: GNR (15Oct1996)
Rounded Global Status: GNR - Not Yet Ranked
Reasons: This type cannot be ranked until its concept and range are better defined and clarified.

U.S. Distribution: AR, OK, TX
Global Distribution: United States
Global Range: This association is found in the Crosstimbers region of eastern and central Oklahoma, possibly extending into adjacent areas of Arkansas and Texas.

Vegetation Summary: The canopy is dominated by *Quercus stellata* and *Ulmus alata*. Other characteristic species include *Andropogon gerardii, Carya texana, Cercis canadensis* var. *canadensis, Helianthus hirsutus, Prunus mexicana, Viburnum rufidulum*, and *Schizachyrium scoparium*.

Wetland Indicator: N

Local Vegetation Summary:
This association is described from three field plots (CHIC.3, CHIC.26, CHIC.74) throughout the park. Elevations ranged from (900-1000 ft) on unpland ridges and slopes of <7% and varied aspects, with sandy loan to loam soils. Plant litter comprises 50-100% of the forest floor, while bare soil comprises the rest of the ground cover. The canopy is dominated by post oak (*Quercus stellata* at ≥ 50%) with an overall coverage of ≥ 50% and a height of 10 – 15 meters. Winged elm (*Ulmus alata*), while present, is limited to the subcanopy and shrub layer at a coverage of ≤ 20%. Texas ash (*Fraxinus texensis*) can also be found in the subcanopy and shrub layer. Both the shrub and herbaceous layer provide < 40% cover, and more generally ≤ 20%. Other characteristic species include coralberry (*Sympohiocarpus orbiculatus*), Mexican plum (*Prunus mexicana)*, sedges (*Carex* spp.), saw greenbriar (*Smilax bona-nox)*, and seedlings and saplings of various hardwoods. This association was mapped as Map Unit 2 – Upland Post Oak Communities, which contains other post oak associations too difficult to distinguish through remote sensing.

***Salix nigra* Forest**

Translated Name: Black Willow Forest
Unique Identifier: CEGL002103
Classification Approach: International Vegetation Classification (IVC)

Figure 44. *Salix nigra* Forest

Summary: The black willow forest type is found widely but sporadically across the eastern United States. Stands occur on the banks of small to large rivers where they are a component of point bar succession. It may also be present in the inflows of manmade lakes where similar sand bars may develop over time and where the seasonal draining patterns of the lake may mimic similar natural processes. Surface water is present for brief periods during the growing season, but the water table usually lies well below soil surface. The vegetation is a closed-canopy forest dominated by *Salix nigra*. Associates may include *Populus deltoides, Planera aquatica, Betula nigra, Platanus occidentalis, Celtis laevigata, Fraxinus pennsylvanica, Carya illinoinensis, Diospyros virginiana, Quercus nigra, Cornus drummondii, Ulmus americana, Acer rubrum, Acer negundo*, and *Acer saccharinum*. Shrubs and herbaceous plants are absent to fairly dense. They include *Ampelopsis arborea, Mikania scandens, Toxicodendron radicans, Polygonum* spp., *Erechtites hieraciifolia, Boehmeria cylindrica, Commelina virginica, Phytolacca americana*, and *Asplenium platyneuron*. In Kentucky, stands may contain *Dichanthelium commutatum*.

Classification Confidence: 3 - Weak

Classification Comments: This type needs a thorough rangewide assessment to standardize its concept. In Missouri, stands of this nature are included in the *Populus deltoides - Salix nigra* Forest (CEGL002018).

Vegetation Hierarchy

Formation Class	I	Forest
Formation Subclass	I.B	Deciduous forest
Formation Group	I.B.2	Cold-deciduous forest
Formation Subgroup	I.B.2.N	Natural/Semi-natural cold-deciduous forest
Formation Name	I.B.2.N.d	Temporarily flooded cold-deciduous forest
Alliance Name		Salix nigra Temporarily Flooded Forest Alliance

Global Status: G4 (15Oct2002)
Rounded Global Status: G4 - Apparently Secure
Reasons: This association is currently broadly described to cover a large geographic range. It occurs sporadically on the banks of small to large rivers. There is a need for further inventory and description of this community to determine its relationship to similar communities, but it is assumed to be under no severe threats and its wide distribution means that it is not a rare community type.

U.S. Distribution: AL, AR, DE, FL, GA, IA, IL, IN, KY, LA, MS, NC, OH, OK, SC, TN, TX, VA, WV
Canadian Province Distribution: ON
Global Distribution: Canada, United States
Global Range: The black willow forest type is found widely, but sporadically across the eastern United States, ranging from Ohio west to Iowa, south to Arkansas, Louisiana and Texas, east to Florida and North Carolina.

Vegetation Summary: The vegetation is a closed-canopy forest dominated by *Salix nigra*. Associates include *Populus deltoides, Planera aquatica, Betula nigra, Platanus occidentalis, Celtis laevigata, Fraxinus pennsylvanica, Carya illinoinensis, Diospyros virginiana, Quercus nigra, Cornus drummondii, Ulmus americana, Acer rubrum, Acer negundo*, and *Acer saccharinum*. Shrubs and herbaceous plants are absent to fairly dense. They include *Ampelopsis arborea, Mikania scandens, Toxicodendron radicans, Polygonum* spp., *Erechtites hieraciifolia, Boehmeria cylindrica, Commelina virginica, Phytolacca americana*, and *Asplenium platyneuron* (Central Appalachian Ecoregional Team pers. comm. 1998).

Wetland Indicator: Y

Environmental Summary: Stands occur on the banks of small to large rivers where they are a component of point bar succession. Surface water is present for brief periods during the growing season, but the water table usually lies well below soil surface (Central Appalachian Ecoregional Team pers. comm. 1998).

Dynamics: Flooding is typically brief during the growing season.

Local Vegetation Summary:
Only one plot (CHIC.55) was sampled, at an elevation of (850 ft) in poorly drained muck, as the areas are restricted and there is little variation among the few sites in the park. Ground cover for this plot consisted of 55% litter, 20% downed wood and 20% bare soil. Black willow (*Salix nigra)* is the sole canopy component, reaching a height of 15 meters and a coverage of $\geq$ 40%. Associates in the sparse subcanopy may include slippery elm *(Ulmus rubra)* and boxelder (*Acer negundo)*. The limited shrub layer contains saplings of tree species as well as buttonbush (*Cephalanthus occidentalis)*, lead plant (*Amorpha canescens)* and persimmon (*Diospyros virginiana)*. The herbaceous layer can be dominated by Emory's

sedge (*Carex emoryi)* and include smartweeds (*Polygonum* spp.) and smallspike false nettle (*Boehmeria cylindrical)* in trace amounts. Only one community was sampled so shrub and herbaceous associates are questionable. Stands develop over time on the banks of manmade Lake of the Arbuckles as a successional component, where the seasonal drainage patterns of the lake may mimic the natural process of point bars. Along the still backwater margins of the lake where the original floodplain is just barely flooded by the lake, lines of black willow (usually only a single row wide) occur along the margins of the lake. These are usually separated from the adjacent bottomland forest to be distinct. This association was so limited in distribution and patch size that it could not be mapped.

Photo-interpretation and map units

We initially recognized and delineated 31 map units on the true color aerial photographs for CHIC. These map units were modified as the photointerpretation process proceded and we realized that discerning the various oak vegetation types was going to be more of a challenge than we originally thought. We eventually settled on 19 map units, 14 of which are vegetated and received an accuracy assessment. All map units were developed from a combination of an initial NVC vegetation classification provided by NatureServe with input from Park and Network biologists, BRIT and BOR ecologists, fieldwork, and preliminary photo-interpretation.

Table 14 details each of the map units and salient associations. Table 15 shows the frequency and area statistics summed for the entire mapping area and also lands within the Park boundary.

A few map units have a one to one relationship with the vegetation associations, but most have several associations as part of each map unit. This is largely due to the fact that many associations are defined by the understory vegetation which is often not visible from overhead.

Vegetation Map

A total of 16,235 acres (6,570 ha) comprising CHIC and its environs was mapped. The area mapped within the Park boundary was 10,064 acres (4,073 ha). Nineteen map units were used to describe the landscape. Of these, five were un-vegetated or special use map units. Of all the map units, the most frequently occurring within the entire mapping area was Map Unit 2 Upland Post Oak communites with 289 polygons ranging in size from 0.1 acres (0.05 ha) to 554 acres (224 ha). The most abundant map unit in terms of area was also Map Unit 2, Upland Post Oak communites, covering 5,175 acres or about 32% of the project area.

The map units and statistics presented here may have significant differences from the conditions present in 2005 when we acquired the photography. CHIC has aggressive weed control and prescribed burn programs and differences between the amount of Juniper and grasslands may be significantly different at the time of this publication.

Fuzzy Accuracy Assessment4

The use of “fuzzy” techniques to describe the accuracy of thematic maps is a useful if somewhat ambiguous tool. Now one is forced to interpret the thematic accuracy of a product from multiple perspectives and a number of caveats. There is no “one” figure to use as an estimate for either overall or individual map unit accuracies. It is now standard to couch the results in statistical parlance of confidence intervals and sample sizes. Its use in many thematic products today originates from the recognition that the binary approach of either “right” or “wrong” belies the true nature of most map units and even the view from the person or persons providing the “reference” data.

The great utility of a fuzzy approach is the acknowledgement of degrees of correctness. Only occasionally do map units have discrete boundaries; more often grading into one another over

[4] Modified from Salas et al 2004

distances ranging from a few to hundreds of meters. The necessity of drawing discrete lines representing non-discrete entities requires other than a binary approach.

We performed a fuzzy accuracy assessment on the digital thematic map for CHIC. Only vegetated map units were sampled. Table 16 describes the 5 fuzzy classes used during this analysis. This concept and class descriptions was first described by Gopal and Woodcock (1994) using fuzzy set theory described by Zadeh (1965). A fuzzy class was only analyzed using a contingency table for the top three fuzzy classes that are considered "correct. The overall map accuracies for each of the fuzzy classes are outlined in and include a 90% confidence interval and Kappa statistic. Fuzzy accuracy summary results are listed in

Table **17**. The contingency table detailed results are shown in tables 18, 19 and 20 for fuzzy classes 5, 4 and 3 respectively. Each map unit is analyzed in terms of its individual accuracy for omission and commission (producer's error and user's error respectively) for three levels of fuzzy accuracy and includes a 90% confidence interval. Mean errors of omission and commission for each fuzzy level are shown in the last row in Table 21. Individual map unit metrics are discussed in later sections.

Table 14. Map units and member associations.

Map Unit	Map Unit Name	Associations (Land Cover) included
1	Disturbed Woodlands	
2	Upland Post Oak Communites	*Quercus stellata - Quercus marilandica / Schizachyrium scoparium* Woodland
		Quercus stellata - Quercus marilandica - (Carya texana) Forest
		Quercus stellata - Ulmus alata Forest
3	Upland Buckley Oak Communities	*Quercus buckleyi - Fraxinus texensis - Quercus muehlenbergii* Forest
4	Chinquapin Oak - Shumard Oak Ozark Forest	*Quercus muehlenbergii - Quercus shumardii* Forest
7	Pecan - Sugarberry Forest	*Carya illinoinensis - Celtis laevigata* Forest
8	American Elm - (Sugarberry, Northern Hackberry) - Green Ash Forest	*Ulmus americana - Celtis (laevigata, occidentalis) - Fraxinus pennsylvanica* Forest
9	Eastern Cottonwood Temporarily Flooded Forest Alliance	*Platanus occidentalis - (Populus deltoides) - Acer negundo* Forest
10	Bur Oak - Shumard Oak Mixed Bottomland Forest	*Quercus macrocarpa - Quercus shumardii - Carya cordiformis / Chasmanthium latifolium* Forest
13	Juniper Woodlands	*Juniperus ashei / Bouteloua (curtipendula, hirsuta*) Woodland
		Juniperus virginiana var. *virginiana / Schizachyrium scoparium* Forest
19	Disturbed Forb/Grasslands	*Aristida-Digitaria* Grassland
		Old Field
		Sorghum halepense Grassland
		Buchloe dactyloides Modified Herbaceous Vegetation
22	Emory's Sedge Herbaceous Vegetation	*Carex emoryi* Herbaceous Vegetation
24	Cattail Wetlands	*Typha (angustifolia, domingensis, latifolia*) - *Schoenoplectus americanus* Herbaceous Vegetation
		Typha latifolia Southern Herbaceous Vegetation
28	Upland Forb/Grasslands	*Muhlenbergia reverchonii - Bouteloua curtipendula - Desmanthus velutinus* Herbaceous Vegetation
		Schizachyrium scoparium - Bouteloua curtipendula - Bouteloua gracilis Central Plains Herbaceous Vegetation
		Bouteloua hirsuta - Bouteloua curtipendula Herbaceous Vegetation
		Schizachyrium scoparium - Sorghastrum nutans - Bouteloua curtipendula Herbaceous Vegetation
34	Agriculture / Pasture	All agricultural and ranching lands
31	Roads	Roads
32	Water	Lakes, ponds, and streams
33	Urban	All populated areas
36	Picnic / Campground Areas	Picnic / Campground Areas
37	Other	Dams, parking lots, borrow pits etc

Table 15. Map units, frequency and area statistics for CHIC.

Map Unit No.	Map Unit Name	Total Polygons	Sum Acres	Sum Hectares	Total Polygons	Sum Acres	Sum Hectares
		Map Area			Park Area		
1	Disturbed Woodlands	128.5	52.0	128.5	13	96.3	39.0
2	Upland Post Oak Communites	5174.9	2094.2	5174.9	173	4409.1	1784.3
3	Upland Buckley Oak Communities	594.2	240.5	594.2	34	550.7	222.9
4	Chinquapin Oak - Shumard Oak Ozark Forest	468.9	189.7	468.9	24	432.1	174.9
7	Pecan - Sugarberry Forest	68.8	27.8	68.8	9	68.6	27.7
8	American Elm - (Sugarberry, Northern Hackberry) - Green Ash Forest	754.8	305.4	754.8	69	687.2	278.1
9	Eastern Cottonwood Temporarily Flooded Forest Alliance	59.3	24.0	59.3	12	56.1	22.7
10	Bur Oak - Shumard Oak Mixed Bottomland Forest	62.0	25.1	62.0	5	62.0	25.1
13	Juniper Woodlands	2157.8	873.2	2157.8	224	1835.5	742.8
19	Disturbed Forb/Grasslands	396.0	160.3	396.0	24	340.8	137.9
22	Emory's Sedge Herbaceous Vegetation	1.1	0.4	1.1	1	1.1	0.4
24	Cattail Wetlands	6.4	2.6	6.4	3	6.4	2.6
28	Upland Forb/Grasslands	1463.5	592.2	1463.5	143	1228.9	497.3
31	Agriculture / Pasture	244.2	98.8	244.2	8	207.1	83.8
32	Roads	2597.9	1051.3	2597.9	49	2512.9	1016.9
33	Water	1064.8	430.9	1064.8	14	743.1	300.7
34	Urban	857.2	346.9	857.2	17	433.5	175.4
36	Picnic / Campground Areas	87.1	35.2	87.1	14	87.1	35.2
37	Other	48.2	19.5	48.2	12	46.7	18.9
	Total	**1343**	**16235.3**	**6570.2**	**848**	**13805.0**	**5586.7**

Table 16. Fuzzy set accuracy ranks (Gopal and Woodcock, 1994).

Fuzzy Class	Description
1	Absolutely Wrong: This answer is absolutely unacceptable. Very Wrong
2	Understandable but Wrong: Not a good answer. There is something about the site that makes the answer understandable but there is clearly a better answer. This answer would pose a problem for the users of the map
3	Reasonable or Acceptable Answer: Maybe not the best possible answer but it is acceptable; this answer does not pose a problem to the user if it is seen on the map. Correct
4	Good Answer: Would be happy to find this answer given on the map. Very Right
5	Absolutely Right: No doubt about the match. Perfect

Table 17. Overall map accuracies for each fuzzy class.

Fuzzy Class	Overall Map Accuracy	Standard Deviation (90% - two tailed)	Overall Map Accuracy (Kappa)
5	58.8	5.1	51.7
4	78.8	4.2	74.9
3	79.2	4.2	75.4

Table 18. Contingency table for fuzzy accuracy assessment level 5.

															Sum	Commission Error %Correct	+/ - (90% Conf. Interval)
	Reference (Accuracy Assessment Field Data)																
Sample Data (Polygon Map Data)		1	2	3	4	7	8	9	10	13	19	22	24	28			
	1	2	0	0	0	0	0	1	0	1	1	0	0	0	5	40.0%	46.0%
	2	3	43	15	5	0	2	0	3	6	1	0	0	1	79	54.4%	9.9%
	3	0	7	20	0	1	1	0	0	0	0	0	0	0	29	69.0%	15.9%
	4	0	4	1	9	0	3	1	1	1	0	0	0	0	20	45.0%	20.8%
	7	0	1	1	2	0	0	1	0	0	0	0	0	0	5	0.0%	10.0%
	8	1	3	1	4	1	13	3	1	1	1	0	0	0	29	44.8%	16.9%
	9	0	0	0	0	0	2	3	0	0	0	0	0	0	5	60.0%	46.0%
	10	0	1	2	0	0	1	0	0	0	0	0	0	0	4	0.0%	12.5%
	13	1	1	2	0	0	2	0	0	23	0	0	0	1	30	76.7%	14.4%
	19	0	0	0	0	0	0	0	0	0	7	0	0	4	11	63.6%	28.4%
	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.0%
	24	1	0	0	0	0	0	1	0	0	0	1	0	0	3	0.0%	16.7%
	28	0	0	0	0	0	0	0	0	0	13	0	0	41	54	75.9%	10.5%
Sum		8	60	42	20	2	24	10	5	32	23	1	0	47	Total Correct = 161 Total Samples = 274		
% Accurate		25.0%	71.7%	47.6%	45.0%	0.0%	54.2%	30.0%	0.0%	71.9%	30.4%	0.0%	0.0%	87.2%			
+/ - (90% Conf. Interval)		31.4%	10.4%	13.9%	20.8%	25.0%	18.8%	28.8%	10.0%	14.6%	18.0%	50.0%	0.0%	9.1%			
	OVERALL TOTAL ACCURACY = 58.8% OVERALL KAPPA INDEX = 51.7% OVERALL 90% UPPER AND LOWER CONFIDENCE INTERVAL: 63.9% and 53.7%																
Producers Accuracy (Omission Error)																	
Confidence Interval is 90% two-sided limit																	

Users Accuracy (Commission Error)

Table 19. Contingency table for fuzzy accuracy assessment level 4.

															Sum	Commission Error %Correct	+/ - (90% Conf. Interval)
	Reference (Accuracy Assessment Field Data)																
Sample Data (Polygon Map Data)		1	2	3	4	7	8	9	10	13	19	22	24	28			
	1	4	0	0	0	0	0	0	0	0	0	0	0	1	5	80.0%	39.4%
	2	1	67	4	2	0	1	0	2	0	1	0	0	0	78	85.9%	7.1%
	3	0	1	26	0	0	1	0	0	0	1	0	0	0	29	89.7%	11.0%
	4	0	1	2	14	1	2	0	0	0	0	0	0	0	20	70.0%	19.4%
	7	0	0	1	0	3	0	0	0	1	0	0	0	0	5	60.0%	46.0%
	8	0	1	1	0	2	21	1	0	3	0	0	0	0	29	72.4%	15.4%
	9	0	0	0	1	0	0	4	0	0	0	0	0	0	5	80.0%	39.4%
	10	0	1	0	0	0	0	0	3	0	0	0	0	0	4	75.0%	48.1%
	13	3	1	2	0	0	1	0	0	23	0	0	0	0	30	76.7%	14.4%
	19	0	0	0	0	0	0	0	0	0	7	0	0	4	11	63.6%	28.4%
	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.0%
	24	0	0	0	0	0	0	0	0	0	1	2	0	0	3	0.0%	16.7%
	28	0	0	0	0	0	0	0	0	0	10	0	0	44	54	81.5%	9.6%
Sum		8	72	36	17	6	26	5	5	27	21	2	0	49	Total Correct = 216 Total Samples = 274		
% Accurate		50.0%	93.1%	72.2%	82.4%	50.0%	80.8%	80.0%	60.0%	85.2%	35.0%	0.0%	0.0%	89.8%			
+/ - (90% Conf. Interval)		35.3%	5.6%	13.7%	18.2%	41.9%	14.6%	39.4%	46.0%	13.1%	20.0%	25.0%	0.0%	8.1%			
	OVERALL TOTAL ACCURACY = 78.8% OVERALL KAPPA INDEX = 75.4% OVERALL 90% UPPER AND LOWER CONFIDENCE INTERVAL: 83.4% and 75.0%																
Producers Accuracy (Omission Error)																	
Confidence Interval is 90% two-sided limit																	

Users Accuracy (Commission Error)

Table 20. Contingency table for fuzzy accuracy assessment level 3.

															Sum	Commission Error %Correct	+/ - (90% Conf. Interval)
		Reference (Accuracy Assessment Field Data)															
Sample Data (Polygon Map Data)		1	2	3	4	7	8	9	10	13	19	22	24	28			
	1	4	0	0	0	0	0	0	0	0	0	0	0	1	5	80.0%	39.4%
	2	1	68	3	2	0	1	0	2	0	2	0	0	0	79	86.1%	7.0%
	3	0	1	26	0	0	1	0	0	0	1	0	0	0	29	89.7%	11.0%
	4	0	1	2	14	1	2	0	0	0	0	0	0	0	20	70.0%	19.4%
	7	0	0	1	0	3	0	0	0	1	0	0	0	0	5	60.0%	46.0%
	8	0	1	1	0	2	21	1	0	3	0	0	0	0	29	72.4%	15.4%
	9	0	0	0	1	0	0	4	0	0	0	0	0	0	5	80.0%	39.4%
	10	0	1	0	0	0	0	0	3	0	0	0	0	0	4	75.0%	48.1%
	13	3	1	2	0	0	1	0	0	23	0	0	0	0	30	76.7%	14.4%
	19	0	0	0	0	0	0	0	0	0	7	0	0	4	11	63.6%	28.4%
	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.0%
	24	0	0	0	0	0	0	0	0	0	1	2	0	0	3	0.0%	16.7%
	28	0	0	0	0	0	0	0	0	0	10	0	0	44	54	81.5%	9.6%
Sum		8	73	35	17	6	26	5	5	27	21	2	0	49	Total Correct = 217 Total Samples = 274		
% Accurate		50.0%	93.2%	74.3%	82.4%	50.0%	80.8%	80.0%	60.0%	85.2%	33.3%	0.0%	0.0%	89.8%			
+/ - (90% Conf. Interval)		35.3%	5.5%	13.6%	18.2%	41.9%	14.6%	39.4%	46.0%	13.1%	19.3%	25.0%	0.0%	8.1%			
	OVERALL TOTAL ACCURACY = 79.2% OVERALL KAPPA INDEX = 75.4% OVERALL 90% UPPER AND LOWER CONFIDENCE INTERVAL: 83.4% and 75.0%																
Producers Accuracy (Omission Error)																	
Confidence Interval is 90% two-sided limit																	

Users Accuracy (Commission Error)

Table 21. Map unit accuracies for omission and commission errors for all errors at all fuzzy levels (only vegetated polygons).

Map Unit No.	Map Unit Name	Fuzzy 5		Fuzzy 4		Fuzzy 3	
		Producers' accuracy	Users' accuracy	Producers' accuracy	Users' accuracy	Producers' accuracy	Users' accuracy
1	Disturbed Woodlands	25.0	40.0	50.0	80.0	50.0	80.0
2	Upland Post Oak Communites	71.7	54.4	93.1	84.8	93.1	84.8
3	Upland Buckley Oak Communities	47.6	69.0	72.2	89.7	72.2	89.7
4	Chinquapin Oak - Shumard Oak Ozark Forest	45.0	45.0	82.4	70.0	82.4	70.0
7	Pecan - Sugarberry Forest	0.0	0.0	50.0	60.0	50.0	60.0
8	American Elm - (Sugarberry, Northern Hackberry) - Green Ash	54.2	44.8	80.8	72.4	80.8	72.4
9	Eastern Cottonwood Temporarily Flooded Forest Alliance	30.0	60.0	80.0	80.0	80.0	80.0
10	Bur Oak - Shumard Oak Mixed Bottomland Forest	0.0	0.0	60.0	75.0	60.0	75.0
13	Juniper Woodlands	71.9	76.7	85.2	76.7	85.2	76.7
19	Disturbed Forb/Grasslands	30.4	63.6	33.3	63.6	33.3	63.6
22	Emory's Sedge Herbaceous Vegetation	0.0	0.0	0.0	0.0	0.0	0.0
24	Cattail Wetlands	0.0	0.0	0.0	0.0	0.0	0.0
28	Upland Forb/Grasslands	87.2	75.9	89.8	81.5	89.8	81.5
	Mean	**35.6**	**40.7**	**59.8**	**64.1**	**59.8**	**64.1**

Discussion

NVC Classification

Global Rarity

Only associations were matched to their global rarity. A total of seven associations described for CHIC have yet to receive a ranking. Five associations were ranked at the G3 (Vulnerable) level: Chinquapin Oak – Shumard Oak Forest; American Elm – (Sugarberry, Northern Hackberry) – Green Ash Forest; Burr Oak – Shumard Oak – Bitternut Hickory / River-oats Forest; (Narrowleaf Cattail, Southern Cattail, Broadleaf Cattail) - Chairmaker's Bulrush Herbaceous Vegetation; and Little Bluestem – Sideoats Grama – Blue Grama Central Plains Herbaceous Vegetation. Four associations were ranked at the G2 (Imperiled) level in CHIC. These associations were Buckley Oak – Texas Ash – Chinquapin Oak Forest; Ashe's Juniper / (Sideoats Grama, Hairy Grama) Woodland; Little Bluestem – Yellow Indiangrass – Sideoats Grama Herbaceous Vegetation; and White Shin Oak Shrubland.

Non-native species

Occurrences of non-native species within plots were documented on the field plot forms and in the database for future management consideration.

Photo-interpretation and Map Units

Inherent to vegetation mapping projects is the need to produce both a consistent vegetation classification and a set of map units. Experience has shown us that mapping Associations is extrememly difficult and that even mapping Alliances can be a questionable exercise in some areas. This is due to the remote sensing nature of photographic interpretation and its ability to only 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 photos. Canopy closure, shadows, and timing of the photography can also distort or obscure photo signatures. In addition to the normal challenges of photointerpretation CHIC has an abundant number of oak species that are discernable at a close distance however from an aerial photograph they tend to look the same. It became apparent that early attempts to discern oak Alliances were going to be difficult. Accuracy assessment data proved this to be correct. Initially several Alliances or Associations were mapped separately such as *Quercus stellata - Quercus marilandica Woodland* Alliance *and Quercus stellata - Quercus marilandica* Forest Alliance *(*component associations - *Quercus stellata - Ulmus alata* Forest and *Quercus stellata - Quercus marilandica* - (*Carya texana*) Forest). However, the similarity of these types on the ground and from a remote sensing perspective necessitated a change in map units to a less floristically specific level. The NVCS is currently under revision to include MacroGroup and Group classification levels between Alliance and Formation that better reflects these mapping realities. Likewise, all upland grass and forb associations were combined into one upland forbs and grasses map unit as most of these types share similar species in varying amounts. These associations include *Schizachyrium scoparium - Bouteloua curtipendula - Bouteloua gracilis Central Plains* Herbaceous Vegetation, *Schizachyrium scoparium - Sorghastrum nutans - Bouteloua curtipendula* Herbaceous Vegetation, *Bouteloua hirsuta - Bouteloua curtipendula* Herbaceous Vegetation, *Buchloe dactyloides* Modified Herbaceous Vegetation, and *Muhlenbergia reverchonii - Bouteloua curtipendula - Desmanthus velutinus* Herbaceous Vegetation.

Map Accuracy

General Considerations

Judging the accuracy of a thematic map has become as important as the actual creation of that map yet the methods for collecting and interpreting accuracy assessment data remains problematic. The concept of accuracy assessment is straightforward however; the practicality (measurement and expression) can be tricky (Foody 2001). Foody (2001, 2002) and even the Park mapping protocols (Accuracy Assessment Procedures – 1994) discuss the many sources of thematic error which may lead to misinterpretations of accuracy assessments. The improper use or reporting of accuracy data may lead to over or under estimation of map or map unit accuracy. Problems may arise from inaccurate reference data, data set miss-registration, poor or inappropriate sampling design, spatial variation of accuracy, error magnitude and procedural errors during the creation of the digital products. This project has attempted to address these many pitfalls and these problem areas are discussed below.

The term ground truth can be misleading as even classification of a location on the ground is subject to interpretation (Foody 2001, Bird et al. 2002). The determination of vegetation association using keys usually has some room for interpretation of vegetative characteristics and even presence of species. The original vegetation classification may have been developed from samples collected during significantly different climatic periods (e.g. wet year vs. dry year) or even seasonal variation (e.g., spring sampling vs. fall sampling). A temporal change in the landscape between photo acquisition / interpretation and field sampling for accuracy assessment is also common (Fire, landslides, avalanches, vegetation management programs, etc.). Vegetation association descriptions also depend heavily on estimations of cover that, in spite of extensive training prior to sampling, may be different enough to produce erroneous site classifications.

Exacerbating all of these potential problems is the underlying but false assumption that the vegetation classes are discrete rather than continuous. We know that rarely are vegetation types distinguished by sharp boundaries but rather grade into one another (Gleason 1917, 1926, Whittaker 1956, 1962, Curtis 1959). The degree of gradation often will relate to the steepness of the environmental gradient. “Steep environmental gradients tend to produce distinct vegetation boundaries where gradual environmental gradients tend to produce wider transition zones between vegetation types.” (Standardized National Vegetation Classification System, 1994). Environmental gradients within CHIC vary from gradual to steep. Thus, the membership of a location or sample to a single discrete vegetation type or description is suspect. The field key also assumes that any accuracy samples described in a plot have already been described when in reality a new association may be confounding the classification in the field. Implicit is that the vegetation classification is complete and correct. Because the emphasis for this project is the vegetation map rather than the vegetation classification, no testing of the classification has been conducted. In a statistically perfect world, another round of samples would have been collected to test the vegetation classification prior to any mapping. The prohibitive costs for this test preclude it ever happening.

Given that source data may be rife with problems, Foody (2001) suggests that the “…the typical accuracy assessment is rather a measurement of the degree of agreement or correspondence

between the two data sets, rather than an evaluation of the closeness of the thematic map to reality." This is probably the case with many vegetation mapping projects.

Given the detail of the map and the variability of the vegetation, we believe the accuracy assessment for CHIC was successful due to several factors. First we made sure that the overall sampling design followed closely the protocols described for by the National Park Mapping Program. We did make some allowances for practicality and statistical necessities. Boundaries between polygons were minimally avoided but not so much so that only large homogenous areas were sampled. The distribution of the sample points was excellent and most map units received an adequate number of points per type to draw general conclusions at each fuzzy level. In addition the spatial distribution of the AA sample points across the Park was very good and the field crews made every effort to reach many difficult sites.

The overall magnitude of error for this project can be discerned by an examination of the contingency tables. Typically, one will find errors between similar map units.

Comparison of mean overall and omission/commission accuracies between fuzzy levels: Predictably, overall map accuracy increases as one relaxes requirements for individual map unit membership. Table 17 shows the increasing overall accuracy from fuzzy level 5 to fuzzy level 3. There is little difference between fuzzy levels 4 and 3 (Tables 17 and 18) due to the lack of ambiguity in most AA plots. We also include a Kappa statistic as a metric of the overall accuracy. This statistic assumes that a certain number of correct classifications will occur by chance. Therefore, the Kappa statistic penalizes the overall map accuracy. The mean error for omission and commission also increase as one relaxes map unit membership requirements.

Individual Map Unit Metrics

Map Unit 1 - Disturbed Woodlands: Disturbed Woodlands are most often confused with Juniper woodlands. Accuracies improve from 40.0% and 25% for errors of commission and omission at fuzzy level 5 to 80.0% and 50.0% at fuzzy level 4.

Map Unit 2 - Upland Post Oak Communities: As expected we see confusion between the two upland Oak map units (map units 2 and 3). Commission and omission errors for the Upland Post Oak map unit include the Upland Buckley Oak, Chinquapin Oak – Shumard Oak Ozark Forest and the Juniper Woodlands. The Chinquapin Oak – Shumard Oak Ozark Forest often grades into the more lowland types and we see this in the fewer but still notable errors for the upland Oak map units. The confusion with the Juniper type (Map Unit 13) is expected as there is considerable Juniper mixing in most wooded Map Units throughout the study area. Accuracies in this type improve dramatically at fuzzy level 4 giving us 84.8% and 93.1% for commission and omission errors respectively.

Map Unit 3 - Upland Buckley Oak Communities: The Upland Buckley Oak community is primarily confused with the Upland Post Oak community and to a lesser degree the Chinquapin Oak – Shumard Oak Ozark Forest. A small proportion of the omission error is also found with both the Bur Oak – Shumard Oak Mixed Bottomland Forest and the Juniper Woodlands. Accuracies in this type improve at fuzzy level 4 to 89.7% and 72.2% for commission and omission errors respectively.

Map Unit 4 - Chinquapin Oak – Shumard Oak Ozark Forest: Misclassification errors for this type was primarily with Upland Buckley Oak Communities and secondarily with Pecan – Sugarberry Forest and American Elm – (Sugarberry, Northern Hackberry) – Green Ash Forests. Errors were similar for both commission and omission. At fuzzy level 4, accuracy improves to 82.4% and 70.0% for commission and omission respectively.

Map Unit 7 - Pecan – Sugarberry Forest: This map unit occurs rarely within the mapping area occupying less than 1% of the total mapped area. The few polygons mapped as Pecan – Sugarberry Forest occur primarily along Rock Creek and to the south of Veterans Lake. Because of the low frequency of this type only 5 AA points were assigned to this type. At fuzzy level 5 we see 0% accuracies for commission and omission increasing to 60.0% and 50.0% respectively. Confusion for this class was widespread and included the both upland oak communities, Chinquapin Oak – Shumard Oak Ozark Forest, and Eastern Cottonwood Temporily Flooded Forest Alliance for commission erros at fuzzy level 5.

Map Unit 8 - American Elm – (Sugarberry, Northern Hackberry) – Green Ash Forest: This map unit also is rare within the mapping area and represents less than 5% of the total mapped polygons. Fuzzy level 5 accuracies are 44.8% and 54.2% for errors of commission and omission respectively. Errors are spread over most forested types for both errors of commission and omission.

Map Unit 9 - Eastern Cottonwood Temporily Flooded Forest Alliance: This map unit was primarily confused with American Elm – (Sugarberry, Northern Hackberry) – Green Ash Forest for both errors of commission and omission. At fuzzy level 5 we have 60.0% and 30.0% for errors of commission and omission respectively. These accuracies improve to 80.0% for both categories.

Map Unit 10 - Bur Oak – Shumard Oak Mixed Bottomland Forest: This map unit represents about 0.3% of the mapping area and has 0% accuracy at fuzzy level 5 for both errors of commission and omission. However, at fuzzy level 4 the accuracies rise to 75.0% and 60.0% for commission and omission errors respectively.

Map Unit 13 - Juniper Woodlands: These woodlands make up about 13% of the mapped polygons for the project area. At fuzzy level 5, mapped accuracies where high at 76.7% and 71.9% for commission and omission errors respectively. At fuzzy level 4 the accuracy for commission error remains 76.7% but the omission error increases to 85.2%.

Map Unit 19 - Disturbed Forb/Grasslands: This map unit comprises about 2.5% of the mapped area and is mostly commonly confused with the Upland Forb/Grasslands map unit. There is very little change from fuzzy level 5 to 4 or 3.

Map Unit 22 - Emory's Sedge Herbaceous Vegetation: The accuracy of this type is difficult to determine given the exteremely low frequency with which it occurs within the mapping area. There is only one 1 acre polygon mapped as this type.

Map Unit 24 - Cattail Wetlands: As with the Emory's Sedge Herbaceous vegetation above, the frequency of this type is extrememly low throughout the mapping area.

Upland Forb/Grasslands: At fuzzy level 5 accuracy levels are low for almost all map units with the exception of map unit 28 (Upland Forb/Grasslands). This map unit maintains high accuracy for both errors of commission and omission.

The Accuracy Standard for the NBS/NPS Vegetation Mapping Program

The program standards for accuracy are 80% for both overall accuracy and individual class accuracy. The program recognizes that these levels of accuracy may be difficult to achieve. Indeed, the Program Accuracy Assessment Procedures states that ***"Given that vegetation mapping is necessarily interpretive, it is recommended that relaxed requirements be used in terms of acceptable levels of error as well as confidence levels in the estimate. Otherwise, regardless how carefully the mapping process is carried out, it is unlikely that accuracy requirements will be met".*** With the advent of fuzzy accuracy procedures we now have the capability to express the accuracy of a thematic map in several ways - very stringent to relaxed. The choice of which standard to use would depend on the subject being mapped. In the case of vegetation mapping, the preferred rigor would be relaxed vs. stringent.

When the vegetation mapping program began, the use of fuzzy accuracy was recognized but considered experimental with little use or publication. At this point, fifteen years after the publication of the Accuracy Assessment Procedures several vegetation mapping projects have been completed that have used fuzzy accuracy assessment. The overall fuzzy accuracies of these parks are presented in Table 22 for comparative purposes. The trends across this small set are similar. Given the suggestions from the program standards and the results of four fuzzy accuracy assessments within the vegetation mapping program we recommend that the standard for stated and recognized accuracy be fuzzy level 3. The definition for fuzzy level 3 as proposed by Gopal and Woodcock (1994) is "Reasonable or Acceptable Answer: Maybe not the best possible answer but it is acceptable; this answer does not pose a problem to the user if it is seen on the map. Correct" therefore it would seem reasonable to accept this level as a program standard.

Table 22. Comparative fuzzy accuracies for seven national parks.

National Park Unit	Fuzzy 5	Fuzzy 4	Fuzzy 3
Rocky Mountain National Park [1]	50.3%	74.7%	86.7%
Walnut Canyon National Monument [2]	50.0%	69.2%	96.9%
Sunset Crater Volcano National Monument [3]	53.9%	70.3%	86.8%
Wupatki National Monument [4]	59.1%	69.7%	92.2%
Lake Meredith National Recreation Area [5]	60.4%	67.7 %	80.9 %
Grand Teton National Park [6]	65.5%	72.8%	82.4%
Chaco Culture National Historic Park [7]	57.9%	75.7%	79.9%
Bent's Old Fort National Historic Site[8]	47.1%	87.0%	93.0%
Chickasaw National Recreation Area[9]	58.8%	78.8%	79.2%
Mean	**55.89%**	**73.99%**	**86.44%**

[1] Salas et al. 2005
[2] Hansen et al. 2004a
[3] Hansen et al. 2004b
[4] Hansen et al. 2004c
[5] Fenton et al. 2007
[6] Cogan et al. 2005
[7] Salas et al. 2009
[8] Stevens et al. 2007
[9] This report

Literature Cited

Anderson, D. M. 1982. Plant communities of Ohio: A preliminary classification and description. Division of Natural Areas and Preserves, Ohio Department of Natural Resources, Columbus, OH. 182 pp.

Anderson, D. M. 1996. The vegetation of Ohio: Two centuries of change. Draft. Ohio Biological Survey.

Bailey, R. G. 1995. Description of the Ecoregions of the United States, 2nd edition. Washington, D. C: U. S. Department of Agriculture, Forest Service.

Barker, B.M., and C. Jameson. 1975. *Platt National Park: Environment and Ecology*. 1st ed. University of Oklahoma Press. Norman, OK.

Bruner, W. E. 1931. The vegetation of Oklahoma. Ecological Monographs 1:99-188.

CAP [Central Appalachian Forest Working Group]. 1998. Central Appalachian Working group discussions. The Nature Conservancy, Boston, MA.

Chapman, K. A. 1984. An ecological investigation of native grassland in southern Lower Michigan. Unpublished Master's thesis, Western Michigan University, Kalamazoo. 235 pp.

Cogan, D., Varga, K., Kittel G., McCloskey K., Abendroth D., Gremer, J., Bolen, C. 2005. Grand Teton National Park 2002 – 2005 Vegetation Mapping Project – Final Report. Technical Memorandum 8260-06-02, U.S. Dept of the Interior, Bureau of Reclamation, Technical Service Center, Denver CO.

Curtis, J. T. 1959. The vegetation of Wisconsin: An ordination of plant communities. University of Wisconsin Press, Madison. 657 pp. [reprinted in 1987]

Fenneman, N.M. and Johnson, D.W. 1946. Physiographic Divisions of the United States. U.S. Geological Survey. Scale 1:7,000,000, 1 sheet.

Federal Geographic Data Committee Vegetation Subcomittee. 1997. Vegetation Classification Standard. June 1997. FGDC-STD-005. (http://www.fs.fed.us/research/fgdc/fgdcindex2.htm).

Federal Geographic Data Committee. 1998a. FGDC Spatial Data Transfer Standard. Reston, VA. (http://www.fgdc.gov/standards/projects/FGDC-standards-projects/SDTS/sdts_point).

Federal Geographic Data Committee. 1998b. FGDC Content Standard for Digital Geospatial Metadata. Reston, VA. (http://www.fgdc.gov/metadata/csdgm).

Fenton, K., J.R. Bell, D. Wegner, J. Drake. 2007. USGS-NPS Vegetation Mapping Program: Lake Meredith National Recreation Area Alibates Flint Quarries National Monument. Tech. Memorandum 8260-07-01, Remote Sensining and GIS Group, Bureau of Reclamation, Denver, CO.

Galloway, L. A. 1964. The vegetation of an actively eroding canyon in Canadian County, Oklahoma. Proceedings of the Oklahoma Academy of Science 45:20-23.

Grossman, D.H., D. Faber-Langendoen, A.S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International classification of ecological communities: Terrestrial vegetation of the United States. Volume I. The National Vegetation Classification System: development, status and applications. The Nature Conservancy, Arlington VA. (http://www.natureserve.org/publications/library.jsp#nspubs.)

Hansen, M., J. Coles, K.A. Thomas, D.Cogan, M. Reid, J.V. Loh, K. Schulz. 2004a. USGS NPS Vegetation Mapping Program: Walnut Canyon National Monument, Arizona, Vegetation Classification and Distribution.

Hansen, M., J. Coles, K.A. Thomas, D.Cogan, M. Reid, J.V. Loh, K. Schulz. 2004b. USGS-NPS National Vegetation Mapping Program: Sunset Crater Volcano National Monument, Arizona, Vegetation Classification and Distribution.

Hansen, M., J. Coles, K.A. Thomas, D.Cogan, M. Reid, J.V. Loh, K. Schulz. 2004c. USGS-NPS National Vegetation Mapping Program: Wupatki National Monument, Arizona, Vegetation Classification and Distribution.

Heitschmidt, R. K., G. K. Hulett, and G. W. Tomanek. 1970. Vegetational map and community structure of a west central Kansas prairie. Southwestern Naturalist 14(3):337-350.

Hoagland, B. W. 1997. Preliminary plant community classification for Oklahoma. Unpublished draft document, version 35629. University of Oklahoma, Oklahoma Natural Heritage Inventory. Norman, OK. 47 pp.

Hoagland, B. W., F. L. Johnson, and S. Gray. 1998. Vegetation study of Chickasaw National Recreation Area, Oklahoma. Final report submitted to the National Park Service.

Hoagland, B. 2000. The vegetation of Oklahoma: A classification for landscape mapping and conservation planning. The Southwestern Naturalist 45(4):385-420.

Hoagland, Bruce W. Personal communication. Ecologist, Oklahoma Natural Heritage Inventory, University of Oklahoma. Norman, OK.

Johnston, B. C. 1987. Plant associations of Region Two: Potential plant communities of Wyoming, South Dakota, Nebraska, Colorado, and Kansas. R2-ECOL-87-2. USDA Forest Service, Rocky Mountain Region. Lakewood, CO. 429 pp.

Kindscher, Kelly. Personal communication. Ecologist/Associate Scientist. Kansas Biological Survey, Lawrence, KS.

Kuchler, A. W. 1974. A new vegetation map of Kansas. Ecology 55:586-604 (with map supplement).

Kunze, L. M. 1994. Preliminary classification of native, low elevation, freshwater wetland vegetation in western Washington. Washington State Department of Natural Resources, Natural Heritage Program. 120 pp.

Milby, T.H. 1977. Literature on the vegetation of Oklahoma, 1964 – 1975.

Proc. Okla. Acad. Sci. 57: 176-184 (1977).

Lauver, C. L., K. Kindscher, D. Faber-Langendoen, and R. Schneider. 1999. A classification of the natural vegetation of Kansas. The Southwestern Naturalist 44:421-443.

McCune, B. and M. J. Mefford. 1999. PC-ORD. Multivariate analysis of ecological data. Version 4. MjM Software. Gleneden Beach, OR.

MNNHP [Minnesota Natural Heritage Program]. 1993. Minnesota's native vegetation: A key to natural communities. Version 1.5. Minnesota Department of Natural Resources, Natural Heritage Program, St. Paul, MN. 110 pp.

NatureServe. 2005. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.2. NatureServe, Arlington, Virginia. Available: http://www.natureserve.org/explorer.

NatureServe. 2006a. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available: http://www.natureserve.org/explorer.

NatureServe. 2006b. International Ecological Classification Standard: Terrestrial Ecological Classifications. (Subset publication: Associations and Alliances of Chickasaw NRA, 8 February 2006). NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of 8 February 2006.

Nelson, P. W. 1985. The terrestrial natural communities of Missouri. Missouri Natural Areas Committee, Jefferson City. 197 pp. Revised edition, 1987.

Omernik, J.M. 1987. Ecoregions of the conterminous United States. Map (scale 1:7,500,000). Annals of the Association of American Geographers 77(1):118-125.

Rosburg, T. R., and D. C. Glenn-Lewin. 1996. Species composition and environmental characteristics of grassland and ecotonal plant communities in the Loess Hills of western Iowa (USA). Natural Areas Journal 16:318-334.

Salas, D., J. Stevens, K. Schulz. 2005. USGS-NPS National Vegetation Mapping Program: Rocky Mountain National Park. Final Report. U.S. Bureau of Reclamation Remote Sensing and GIS Group Technical Memorandum 8260-05-02. Denver, Colorado.

Salas, D, L. Floyd-Hanna, D. Hanna. 2009. Vegetation Classification and Mapping Project Report: Chaco Culture National Historical Park. Natural Resource Technical Report (in preparation).

Schmalzer, P. A., and H. R. DeSelm. 1982. Vegetation, endangered and threatened plants, critical plant habitats and vascular flora of the Obed Wild and Scenic River. Unpublished report. USDI National Park Service, Obed Wild and Scenic River. 2 volumes. 369 pp.

Steinauer, G., and S. Rolfsmeier. 2000. Terrestrial natural communities of Nebraska (January 2000 version). Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 143 pp.

Stevens, J.E., K. Forrest, S. Neid, and M. Fink. 2007. Bent's Old Fort National Historic Site: Vegetation Classification and Mapping. Natural Resource Technical Report NPS/SOPN/NRTR—2007/049. National Park Service, Fort Collins, Colorado.

The Nature Conservancy and Environmental Systems Research Institute. 1994. NBS/NPS Vegetation Mapping Program: Standardized National Vegetation Classification System. Prepared for the U.S. Department of the Interior, National Biological Survey and National Park Service. Washington, D. C. Available: http://biology.usgs.gov/npsveg/standards.html.

USGS. U.S. Geological Survey. 1999. U.S. National Map Accuracy Standards. Reston, VA 20192 (http://egsc.usgs.gov/isb/pubs/factsheets/fs17199.html).

Weaver, J. E., and F. W. Albertson. 1956. Grasslands of the Great Plains: Their nature and use. Johnsen Publishing Co., Lincoln, NE. 395 pp.

Wikle, T., M. Nicholl, T. Brown, J. Nord, R. Parker, and D. Weeks. 1998. Water Resources Management Plan Chickasaw National Recreation Area. U.S. Department of the Interior, National Park Service. 121 pp.

Appendix A – Species List

Abundance Codes:

U – Ubiquitous
C – Common
R – Rare

Family	ScientificName	Common Names	Abundance
Acanthaceae	*Dicliptera brachiata* (Pursh) Spreng	branched foldwing	**U**
Acanthaceae	*Justicia americana* (L.) Vahl	American water-willow; common water-willow; spike justicia	**C**
Acanthaceae	*Ruellia humilis* Nutt.	fringeleaf wild petunia; low ruellia; wild petunia	**U**
Acanthaceae	*Ruellia strepens* L.	limestone wild petunia	**U**
Aceraceae	*Acer negundo var. texanum* Pax	ashleaf maple; boxelder	**C**
Aceraceae	*Acer saccharinum* L.	silver maple	**U**
Agavaceae	*Yucca arkansana* Trel.	Arkansas yucca	**R**
Agavaceae	*Yucca glauca* var. *mollis* Engelmann ex Branner & Coville *(Not listed in ITIS; Hoagland list; may be syn of Y. glauca)*		**C**
Alismataceae	*Echinodorus berteroi* (Spreng.) Fassett	upright burrhead	**U**
Alismataceae	*Sagittaria latifolia* Willd.	broadleaf arrowhead; common arrowhead; duck-potato; wapato	**U**
Amaranthaceae	*Amaranthus albus* L.	tumble pigweed; tumbleweed; white pigweed; pigweed amaranth; prostrate pigweed	**U**
Amaranthaceae	*Amaranthus palmeri* S. Wats.	Palmer's amaranth; careless weed	**U**
Amaranthaceae	*Amaranthus retroflexus* L.	redroot pigweed; rough pigweed; red-root amaranth; careless weed	**C**
Amaranthaceae	*Amaranthus rudis* Sauer	common waterhemp; tall amaranth	**C**
Amaranthaceae	*Amaranthus spinosus* L.	spiny amaranth	**U**
Amaranthaceae	*Froelichia floridana* (Nutt.) Moq.	plains snakecotton; field snakecotton; prairie froelichia; cottonweed; Florida snakecotten	**U**
Anacardiaceae	*Rhus copallinum* L.	flameleaf sumac	**C**
Anacardiaceae	*Rhus glabra* L.	smooth sumac	**C**
Anacardiaceae	*Rhus trilobata* var. *trilobata* Nutt.	ill-scented sumac; skunkbush; skunkbush sumac	**C**
Anacardiaceae	*Toxicodendron radicans* (L.) Kuntze	poison ivy; eastern poison ivy	**C**
Apiaceae	*Ammoselinum popei* Torr. & Gray	plains sandparsley	**C**
Apiaceae	*Chaerophyllum tainturieri* Hook.	chervil; hairy-fruited chervil	**U**

Family	ScientificName	Common Names	Abundance
Apiaceae	*Cicuta maculata* L.	spotted water hemlock; common water hemlock; water hemlock; spotted cowbane; poison parsnip; spotted parsley;	**U**
Apiaceae	*Daucus pusillus* Michx.	American wild carrot; rattlesnake cotton; rattlesnake weed; southwest wild carrot	**U**
Apiaceae	*Eryngium leavenworthii* Torr. & Gray	Leavenworth's eryngo	**C**
Apiaceae	*Eryngium yuccifolium* Michx.	button eryngo; buttonsnakeroot; yuccaleaf eryngo	**C**
Apiaceae	*Hydrocotyle verticillata* Thunb.	whorled marsh pennywort; whorled pennyroyal	**U**
Apiaceae	*Lomatium foeniculaceum* ssp. *daucifolium* (Torr. & Gray) Theobald	carrot-leaf desert-parsley; desert biscuitroot	**U**
Apiaceae	*Osmorhiza longistylis* (Torr.) DC.	aniseroot; longstyle sweetroot	**U**
Apiaceae	*Polytaenia nuttallii* DC.	Nuttall's prairie parsley; prairie parsley	**C**
Apiaceae	*Ptilimnium capillaceum* (Michx.) Raf.	herbwilliam; threadleaf mockbishopweed	**C**
Apiaceae	*Sanicula canadensis* L.	Canada sanicle; Canadian blacksnakeroot	**U**
Apiaceae	*Sanicula odorata* (Raf.) K.M. Pryer & L.R. Phillippe	cluster sanicle; clustered blacksnakeroot	**C**
Apiaceae	*Spermolepis divaricata* (Walt.) Raf. Ex Ser.	forked scaleseed; roughfruit scaleseed	**U**
Apiaceae	*Spermolepis inermis* (Nutt. Ex DC.) Mathias & Constance	Red River scaleseed	**U**
Apiaceae	*Thaspium barbinode* (Michx.) Nutt.	hairyjoint meadowparsnip; hairyspine thaspium	**U**
Apiaceae	*Torilis arvensis* (Huds.) Link	Canada hedgeparsley; spreading hedgeparsley	**C**
Apiaceae	*Zizia aurea* (L.) W.D.J. Koch	golden alexanders; golden zizia	**C**
Apocynaceae	*Amsonia ciliata* var. *texana* (Gray) Coult.	Texas bluestar	**U**
Apocynaceae	*Amsonia tabernaemontana* var. *salicifolia* (Pursh) Woods.	eastern bluestar	**U**
Apocynaceae	*Apocynum cannabinum* L.	hemp dogbane; Indian hemp; common dogbane; prairie dogbane	**C**
Apocynaceae	*Vinca minor* L.	common periwinkle; lesser periwinkle; myrtle	**U**
Araceae	*Arisaema dracontium* (L.) Schott	green dragon	**U**
Aristolochiaceae	*Aristolochia tomentosa* Sims	common dutchmanspipe; wooly dutchman's pipe	**U**
Asclepiadaceae	*Asclepias asperula* (Dcne.) Woods.	antelope horns; antelopehorn milkweed; spider antelope-horns; spider milkweed	**C**
Asclepiadaceae	*Asclepias engelmanniana* Woods.	Engelmann's milkweed	**U**
Asclepiadaceae	*Asclepias hirtella* (Pennell) Woods.	green milkweed	**U**
Asclepiadaceae	*Asclepias stenophylla* Gray	narrowleaved milkweed; slimleaf milkweed	**U**

Family	ScientificName	Common Names	Abundance
Asclepiadaceae	*Asclepias tuberosa* ssp. *interior* Woods.	butterfly milkweed	**U**
Asclepiadaceae	*Asclepias verticillata* L.	whorled milkweed; eastern whorled milkweed	**U**
Asclepiadaceae	*Asclepias viridiflora* Raf.	green antelope milkweed; green comet milkweed; green milkweed	**C**
Asclepiadaceae	*Asclepias viridis* Walt.	green antelopehorn	**U**
Asclepiadaceae	*Cynanchum laeve* (Michx.) Pers.	honeyvine milkweed; sandvine; climbing milkweed; honeyvine	**U**
Asclepiadaceae	*Matelea biflora* (Raf.) Woods.	star milkvine; two-flowered matelea; twoflower milkvine	**U**
Asclepiadaceae	*Matelea gonocarpos* (Walt.) Shinners	angularfruit milkvine	**U**
Aspleniaceae	*Asplenium platyneuron* (L.) B.S.P.	ebony spleenwort	**U**
Aspleniaceae	*Asplenium resiliens* Kunze	blackstem spleenwort	**U**
Asteraceae	*Achillea millefolium* L.	common yarrow; western yarrow; woolly yarrow; milfoil; wild tansy; bloodwort; carpenter's weed;	**C**
Asteraceae	*Ageratina altissima* var. *altissima* (L.) King & H.E. Robins.	white snakeroot; richweed; snakeroot	**C**
Asteraceae	*Ambrosia artemisiifolia* L.	common ragweed; short ragweed; annual ragweed; small ragweed; Roman wormwood; low ragweed; ragweed	**C**
Asteraceae	*Ambrosia psilostachya* DC.	western ragweed; perennial ragweed; Cuman ragweed	**A**
Asteraceae	*Ambrosia trifida* L.	giant ragweed; horseweed; great ragweed; blood ragweed; great perennial ragweed; tall ragweed	**C**
Asteraceae	*Amphiachyris dracunculoides* (DC.) Nutt.	common broomweed; prairie broomweed	**C**
Asteraceae	*Antennaria parlinii* Fern.	Parlin's pussytoes	**U**
Asteraceae	*Arnoglossum plantagineum* Raf.	arnoglossum; groovestem Indian plantain	**C**
Asteraceae	*Artemisia carruthii* Wood ex Carruth.	Carruth's sagewort; Carruth's sagebrush	**C**
Asteraceae	*Artemisia ludoviciana* Nutt.	Louisiana wormwood;cudweed sagewort; gray sagewort; mugwort wormwood; prairie sage; white sagebrush; Louisiana sagewort	**U**
Asteraceae	*Aster praealtus* var. *praealtus* Poir.	willowleaf aster	**C**
Asteraceae	*Astranthium integrifolium* (Michx.) Nutt.	entireleaf western daisy	**U**
Asteraceae	*Brickellia eupatorioides* (L.) Shinners	false boneset	**C**
Asteraceae	*Centaurea americana* Nutt.	American basketflower; American star-thistle	**C**
Asteraceae	*Chaetopappa asteroides* Nutt. ex DC.	Arkansas leastdaisy; least daisy	**C**
Asteraceae	*Chrysopsis pilosa* Nutt.	soft goldaster; soft goldenaster	**U**
Asteraceae	*Cirsium altissimum* (L.) Hill	tall thistle; roadside thistle	**C**
Asteraceae	*Cirsium undulatum* (Nutt.) Spreng.	wavy-leaf thistle; gray thistle	**U**

Family	ScientificName	Common Names	Abundance
Asteraceae	*Conoclinium coelestinum* (L.) DC.	blue mistflower	**C**
Asteraceae	*Conyza canadensis* (L.) Cronq.	horseweed; mares tail; horseweed fleabane; Canada horseweed;	**C**
Asteraceae	*Coreopsis grandiflora* Hogg ex Sweet	bigflower coreopsis; largeflower tickseed	**C**
Asteraceae	*Coreopsis tinctoria* Nutt.	plains coreopsis; golden tickseed; common tickseed; plains tickseed	**C**
Asteraceae	*Dracopis amplexicaulis* (Vahl) Cass.	clasping coneflower	**C**
Asteraceae	*Echinacea angustifolia* DC.	blacksamson echinacea	**C**
Asteraceae	*Echinacea atrorubens* Nutt.	Topeka purple coneflower; yellowsamson	**U**
Asteraceae	*Echinacea paradoxa* var. *neglecta* R.L. McGregor	Bush's purple coneflower	**U**
Asteraceae	*Eclipta prostrata* (L.) L.	eclipta; false daisy; yerba de tago; yerba de tajo	**U**
Asteraceae	*Elephantopus carolinianus* Raeusch.	Caroliina elephantsfoot; leafy elephantsfoot	**U**
Asteraceae	*Engelmannia peristenia* (Raf.) Goodman & Lawson	Engelmann's daisy	**C**
Asteraceae	*Erechtites hieraciifolia* (L.) Raf. ex DC.	American burnweed	**U**
Asteraceae	*Erigeron annuus* (L.) Pers.	annual fleabane; eastern daisy fleabane	**C**
Asteraceae	*Erigeron philadelphicus* L.	Philadelphia fleabane; Philadelphia daisy	**U**
Asteraceae	*Erigeron strigosus* Muhl. ex Willd.	rough fleabane; daisy fleabane; prairie fleabane	**U**
Asteraceae	*Eupatorium altissimum* L.	tall joepyeweed; tall thoroughwort	**C**
Asteraceae	*Eupatorium serotinum* Michx.	late eupatorium; lateflowering thoroughwort	**U**
Asteraceae	*Euthamia graminifolia* (L.) Nutt.	flat-top goldentop; flattop goldentop	**U**
Asteraceae	*Evax prolifera* Nutt. ex DC.	bighead pygmycudweed; rabbit tobacco	**U**
Asteraceae	*Gaillardia pulchella* Fouq.	firewheel; Indian blanket; rosering gaillardia; Indianblanket	**C**
Asteraceae	*Gaillardia suavis* (Gray & Engelm.) Britt. & Rusby	perfumeballs; sweey gaillardia	**U**
Asteraceae	*Grindelia lanceolata* Nutt.	Gulf fumweed; narrowleaf gumweed; spiny toothed gumweed	**U**
Asteraceae	*Grindelia papposa* Nesom & Suh	Spanish gold; wax goldenweed	**C**
Asteraceae	*Helianthus annuus* L.	common sunflower; annual sunflower; wild sunflower	**U**
Asteraceae	*Helianthus hirsutus* Raf.	hairy sunflower	**C**
Asteraceae	*Helianthus maximiliani* Schrad.	Maximillian sunflower	**C**
Asteraceae	*Helianthus tuberosus* L.	Jerusalem artichoke; Jerusalem sunflower; girasole	**C**
Asteraceae	*Heliopsis helianthoides* var. *scabra* (Dunal) Fern.	oxeye; heliopsis sunflower; smooth oxeye; heliopsis	**U**
Asteraceae	*Heterotheca subaxillaris* (Lam.) Britt. & Rusby	camphorweed; golden aster	**C**

Family	ScientificName	Common Names	Abundance
Asteraceae	*Hieracium longipilum* Torr.	hairy hawkweed; longbeard hawkweed	**U**
Asteraceae	*Hymenopappus scabiosaeus* var. *corymbosus* (Torr. & Gray) B.L. Turner	Carolina woolywhite	**C**
Asteraceae	*Iva annua* L.	annual marshelder; seacoast sumpweed	**U**
Asteraceae	*Krigia caespitosa* (Raf.) Chambers	weedy dwarf dandelion	**U**
Asteraceae	*Lactuca canadensis* L.	Canada lettuce; Florida blue lettuce; wild lettuce	**U**
Asteraceae	*Lactuca floridana* (L.) Gaertn.	Florida lettuce; woodland lettuce	**C**
Asteraceae	*Lactuca serriola* L.	prickly lettuce; wild lettuce; China lettuce	**U**
Asteraceae	*Liatris mucronata* DC.	cusp blazing star; narrowleaf gayfeather	**A**
Asteraceae	*Liatris pycnostachya* Michx.	cat-tail gayfeather; Kansas gayfeather; prairie blazing star	**C**
Asteraceae	*Liatris squarrosa* var. *glabrata* (Rydb.) Gaiser	scaly blazing star; scaly gayfeather	**U**
Asteraceae	*Lindheimera texana* Gray & Engelm.	Texas star; Texas yellowstar	**U**
Asteraceae	*Lygodesmia texana* (Torr. & Gray) Greene	Texas skeletonplant	**U**
Asteraceae	*Oligoneuron rigidum* var. *rigidum* (L.) Small	stiff goldenrod	**C**
Asteraceae	*Packera obovata* (Muhl. ex Willd.) W.A. Weber & A. Löve	round-leaf ragwort; roundleaf ragwort	**C**
Asteraceae	*Packera plattensis* (Nutt.) W.A. Weber & A. Love	prairie groundsel; prairie ragwort	**C**
Asteraceae	*Parthenium hysterophorus* L.	ragweed parthenium; Santa Maria feverfew; whitetop weed	**U**
Asteraceae	*Pluchea odorata* (L.) Cass.	marsh fleabane; sweetscent	**C**
Asteraceae	*Pseudognaphalium obtusifolium* ssp. *obtusifolium* (L.) Hilliard & Burtt	rabbit tobacco	**C**
Asteraceae	*Pyrrhopappus carolinianus* (Walt.) DC.	Carolins desert chicory; Carolina false dandelion	**C**
Asteraceae	*Ratibida columnifera* (Nutt.) Woot. & Standl.	prairie coneflower; redspike Mexican hat; upright prairie coneflower	**C**
Asteraceae	*Rudbeckia hirta* L.	blackeyed Susan	**C**
Asteraceae	*Silphium integrifolium* var. *integrifolium* Michx.	wholeleaf rosinweed	**U**
Asteraceae	*Silphium laciniatum* L.	compassplant; compass plant	**U**
Asteraceae	*Smallanthus uvedalius* (L.) Mackenzie ex Small	hairy leafcup	**U**
Asteraceae	*Solidago canadensis* var. *hargeri* Fern.	Canadian goldenrod; Harger's goldenrod	**C**
Asteraceae	*Solidago canadensis* var. *scabra* Torr. & Gray	Canada goldenrod; Canadian goldenrod	**C**
Asteraceae	*Solidago gigantea* Ait.	giant goldenrod	**C**
Asteraceae	*Solidago missouriensis* Nutt.	Missouri goldenrod; prairie goldenrod	**C**
Asteraceae	*Solidago nemoralis* Ait.	dyersweed goldenrod; gray goldenrod	**C**
Asteraceae	*Solidago petiolaris* Ait.	downy goldenrod; downy ragged goldenrod	**C**

Family	ScientificName	Common Names	Abundance
Asteraceae	*Solidago speciosa* var. *rigidiuscula* Torr. & Gray	showy goldenrod	**U**
Asteraceae	*Solidago ulmifolia* Muhl. ex Willd.	elmleaf goldenrod	**C**
Asteraceae	*Sonchus asper* (L.) Hill	spiny sowthistle; prickly sowthistle; perennial sowthistle; spiny-leaf sowthistle	**U**
Asteraceae	*Symphyotrichum divaricatum* (Nutt.) Nesom	slender aster; saltmarsh aster; panicled aster; annual saltmarsh aster; southern annual saltmarsh aster	**C**
Asteraceae	*Symphyotrichum drummondii* var. *drummondii* (Lindl.) Nesom	Drummond's aster	**C**
Asteraceae	*Symphyotrichum ericoides* var. *ericoides* (L.) Nesom	heath aster; white aster; white heath aster;	**C**
Asteraceae	*Symphyotrichum patens* var. *patentissimum* (Lindl. ex DC.) Nesom	late purple aster;	**C**
Asteraceae	*Symphyotrichum praealtum* var. *praealtum* (Poir.) Nesom	willowleaf aster;	**U**
Asteraceae	*Taraxacum officinale* G.H. Weber ex Wiggers	dandelion; common dandelion; faceclock; blowball	**C**
Asteraceae	*Tetraneuris linearifolia* (Hook.) Greene	fineleaf fournerved daisy; fien-eleaf four-nerved daisy; slimleaf actinea	**U**
Asteraceae	*Thelesperma filifolium* var. *filifolium* (Hook.) Gray	stiff greenthread	**C**
Asteraceae	*Tragopogon dubius* Scop.	western salsify; yellow goat's beard; yellow salsify; wild oysterplant; common salsify; goatsbeard; goat's beard; meadow goat's-beard; salsify; western goat's beard; oysterplant	**C**
Asteraceae	*Verbesina alternifolia* (L.) Britt. ex Kearney	wingstem	**C**
Asteraceae	*Verbesina helianthoides* Michx.	gravelweed; gravelweed crownbeard	**U**
Asteraceae	*Verbesina virginica* L.	iceweed; Virginia crownbeard; white crownbeard	**U**
Asteraceae	*Vernonia baldwinii* Torr.	western ironweed; Baldwin's ironweed; ironweed	**U**
Asteraceae	*Xanthium strumarium* L.	common cocklebur; cocklebur; rough cocklebur	**C**
Bignoniaceae	*Campsis radicans* (L.) Seem. ex Bureau	common trumpetcreeper; cow-itch; trumpet creeper	**U**
Bignoniaceae	*Catalpa bignonioides* Walt.	southern catalpa	**U**
Bignoniaceae	*Catalpa speciosa* (Warder) Warder ex Engelm.	northern catalpa	**U**
Boraginaceae	*Buglossoides arvensis* (L.) I.M.Johnston	corn gromwell; puccoon; field gromwell	**C**
Boraginaceae	*Heliotropium tenellum* (Nutt.) Torr.	pasture heliotrope	**C**
Boraginaceae	*Lithospermum incisum* Lehm.	fringed gromwell; fringed puccoon; narrowleaf gromwell; narrowleaf pucoon; narrowleaf stoneseed; trumpet stoneseed	**C**

Family	ScientificName	Common Names	Abundance
Boraginaceae	*Myosotis macrosperma* Engelm.	largeseed forget-me-not; southern forget-me-not	**C**
Boraginaceae	*Myosotis verna* Nutt.	spring forget-me-not	**U**
Brassicaceae	*Arabis canadensis* L.	sicklepod' sicklepod rockcress	**U**
Brassicaceae	*Capsella bursa-pastoris* (L.) Medik.	shepard's purse; shepardspurse	**U**
Brassicaceae	*Cardamine parviflora* var. *arenicola* (Britt.) O.E. Schulz	sand bittercress	**C**
Brassicaceae	*Descurainia pinnata* (Walt.) Britt.	tansymustard; green tansymustard; western tansymustard; pinate tansy mustard; pinnate tansymustard	**U**
Brassicaceae	*Draba brachycarpa* Nutt. ex Torr. & Gray	shortpod Whitlowgrass; short-fruited draba; shortpod draba	**U**
Brassicaceae	*Draba cuneifolia* Nutt. ex Torr. & Gray	wedgeleaf draba; wedgeleaf whitlowgrass	**U**
Brassicaceae	*Erysimum capitatum* var. *capitatum* (Dougl. ex Hook.) Greene	plains wallflower; prairie rocket; sanddune wallflower; western wallflower	**U**
Brassicaceae	*Erysimum repandum* L.	bushy wallflower; spreading wallflower; spreading wormseed; repand wallflower	**U**
Brassicaceae	*Lepidium densiflorum* Schrad.	greenflower pepperweed; common pepperweed; peppergrass; miner's pepperwort; miner's pepperweed; pepperweed; prairie pepperweed	**C**
Brassicaceae	*Lesquerella ovalifolia* ssp. *alba* (Goodman) Rollins & Shaw	roundleaf bladderpod; round leaf bladderpod	**C**
Brassicaceae	*Rorippa nasturtium-aquaticum* (L.) Hayek	watercress	**C**
Brassicaceae	*Rorippa sessiliflora* (Nutt.) A.S. Hitchc.	stalkless yellowcress	**C**
Brassicaceae	*Sinapis arvensis* L.	wild mustard; charlock; charlock mustard; corn mustard	**C**
Brassicaceae	*Sisymbrium altissimum* L.	tumble mustard; tumbling mustard; tall mustard; Jim Hill mustard; tall tumblemustard; tall hedge-mustard; tall hedgemustard; tumbleweed mustard	**U**
Cactaceae	*Echinocereus reichenbachii* var. *reichenbachii* (Terscheck ex Walp.) Haage f.	lace hedgehog cactus; Reichenbach's hedgehog cactus	**U**
Cactaceae	*Escobaria vivipara* (Nutt.) Buxbaum	spinystar	**U**
Cactaceae	*Opuntia engelmannii* var. *lindheimeri* (Engelm.) Parfitt & Pinkava	Texas prickly pear	**C**
Cactaceae	*Opuntia humifusa* (Raf.) Raf.	devil's-tongue; devil's tongue; pricklypear	**C**
Cactaceae	*Opuntia macrorhiza* Engelm.	bigroot pricklypear; twistspine pricklypear; grassland pricklypear; plains twistspine pricklypear	**U**
Campanulaceae	*Lobelia cardinalis* L.	cardinal flower	**U**

Family	ScientificName	Common Names	Abundance
Campanulaceae	*Lobelia siphilitica* L.	great blue lobelia	**U**
Campanulaceae	*Triodanis leptocarpa* (Nutt.) Nieuwl.	slimpod Venus' looking-glass	**C**
Campanulaceae	*Triodanis perfoliat*a (L.) Nieuwl.	Venus' looking-glass; clasping bellwort; roundleaved triodanis; clasping Venus' looking-glass; clasping-leaf Venus' looking-glass	**U**
Capparaceae	*Polanisia dodecandra* ssp. *trachysperma* (Torr. & Gray) Iltis	western clammyweed; clammyweed; red-whisker clammyweed; red whisker clammyweed; sandyseed clammyweed	**U**
Caprifoliaceae	*Lonicera albiflora* Torr. & Gray	western white honeysuckle; white honeysuckle	**U**
Caprifoliaceae	*Lonicera flava* Sims	yellow honeysuckle	**U**
Caprifoliaceae	*Lonicera japonica* Thunb.	Chinese honeysuckle; Japanese honeysuckle	**C**
Caprifoliaceae	*Lonicera maackii* (Rupr.) Herder	Amur honeysuckle bush; Maack honeysuckle	**U**
Caprifoliaceae	*Lonicera reticulata* Raf.	grape honeysuckle	**U**
Caprifoliaceae	*Lonicera sempervirens* L.	trumpet honeysuckle	**C**
Caprifoliaceae	*Sambucus nigra* ssp. *canadensis* (L.) R. Bolli	blue elder; common elderberry; elder; elderberry; Mexican elderberry	**U**
Caprifoliaceae	*Symphoricarpos orbiculatus* Moench	buckbrush; coralberry; buck brush; Indian currant coralberry	**A**
Caprifoliaceae	*Viburnum rufidulum* Raf.	rusty blackhaw viburnum	**C**
Caryophyllaceae	*Arenaria serpyllifolia* L.	thymeleaf sandwort	**C**
Caryophyllaceae	*Cerastium brachypodum* (Engelm. ex Gray) B.L. Robins.	bractpod chickweed; mouse-ear chickweed; shortstalk mouse-ear chickweed; shortstalk chickweed	**U**
Caryophyllaceae	*Cerastium glomeratum* Thuill.	sticky chickweed	**C**
Caryophyllaceae	*Holosteum umbellatum* L.	jagged chickweed	**U**
Caryophyllaceae	*Minuartia michauxii* var. *texana* (B.L. Robins.) Mattf.	Texas stitchwort	**C**
Caryophyllaceae	*Paronychia canadensis* (L.) Wood	smooth forked nailwort	**U**
Caryophyllaceae	*Paronychia jamesii* Torr. & Gray	James' nailwort; nailwort	**C**
Caryophyllaceae	*Paronychia virginica* Spreng.	Virginia nailwort; yellow nailwort	**U**
Caryophyllaceae	*Saponaria officinalis* L.	bouncingbet; soapwort; sweet Betty; bouncing-bet; bouncingbet soapweed;	**C**
Caryophyllaceae	*Silene antirrhina* L.	sleepy catchfly; catchfly; sleepy campion; sleepy silene	**U**
Caryophyllaceae	*Silene stellata* (L.) Ait. f.	whorled catchfly; widowsfrill	**U**
Caryophyllaceae	*Stellaria media* (L.) Vill.	common chickweed; chickweed; nodding chickweed	**C**
Celastraceae	*Celastrus scandens* L.	American bittersweet; staffvine; waxwork	**U**
Celastraceae	*Euonymus atropurpurea* Jacq.	eastern wahoo; wahoo	**U**

Family	ScientificName	Common Names	Abundance
Ceratophyllaceae	*Ceratophyllum demersum* L.	common hornwort; coon's tail; coontail; hornwort	**C**
Chenopodiaceae	*Chenopodium album* L.	common lambsquarters; lambsquarters goosefoot; white goosefoot	**U**
Chenopodiaceae	*Chenopodium ambrosioides* L.	Mexican tea	**U**
Chenopodiaceae	*Chenopodium berlandieri* Moq.	pitseed goosefoot; netseed lambsquarters; pigseed goosefoot	**U**
Chenopodiaceae	*Chenopodium simplex* (Torr.) Raf.	mapleleaf goosefoot; giant-seed goosefoot; giantseed goosefoot; maple-leaf goosefoot	**C**
Cistaceae	*Lechea mucronata* Raf.	hairy pinweed	**C**
Cistaceae	*Lechea tenuifolia* Michx.	narrowleaf pinweed	**U**
Clusiaceae	*Hypericum cistifolium* Lam.	roundpod St. Johnswort	**U**
Clusiaceae	*Hypericum drummondii* (Grev. & Hook.) Torr. & Gray	Drummond St. Johnswort; nits and lice	**U**
Clusiaceae	*Hypericum hypericoides* ssp. *multicaule* (Michx. ex Willd.) Robson	St. Andrew's cross	**U**
Clusiaceae	*Hypericum punctatum* Lam.	spotted St. Johnswort	**U**
Commelinaceae	*Commelina erecta* var. *erecta* L.	whitemouth dayflower	**U**
Commelinaceae	*Commelina virginica* L.	Virginia dayflower	**C**
Commelinaceae	*Tradescantia ohiensis* Raf.	bluejacket; Ohio spiderwort	**C**
Commelinaceae	*Tradescantia tharpii* E.S. Anderson & Woods.	Tharp's spiderwort	**C**
Convolvulaceae	*Convolvulus arvensis* L.	field bindweed; creeping jenny; small-flower bindweed; small bindweed; European bindweed; greenvine; morningglory; perennial morning glory; smallflowered morning glory	**U**
Convolvulaceae	*Convolvulus equitans* Benth.	gray bindweed; Texas bindweed	**U**
Convolvulaceae	*Evolvulus nuttallianus* J.A. Schultes	prostrate evolvulus; shaggy dwarf morning-glory; silver wild morningglory	**C**
Convolvulaceae	*Ipomoea cordatotriloba* var. *cordatotriloba* Dennst.	cotton morning glory; sharppod morningglory; tievine	**U**
Convolvulaceae	*Ipomoea lacunosa* L.	pitted morningglory; white morning glory; whitestar	**U**
Convolvulaceae	*Ipomoea pandurata* (L.) G.F.W. Mey	bigroot morningglory; big root morning glory; man of the earth; man-of-the-earth	**U**
Cornaceae	*Cornus drummondii* C.A. Mey.	roughleaf dogwood	**C**
Cornaceae	*Cornus florida* L.	flowering dogwood	**U**
Crassulaceae	*Penthorum sedoides* L.	ditch stonecrop; Virginia penthorum	**U**
Crassulaceae	*Sedum nuttallianum* Raf.	yellow stonecrop	**U**
Crassulaceae	*Sedum pulchellum* Michx.	widowscross	**U**
Cucurbitaceae	*Cucurbita foetidissima* Kunth	buffalo gourd; wild pumpkin; Missouri gourd; wild gourd; calabazilla; buffalogourd pumpkin;	**U**

Family	ScientificName	Common Names	Abundance
Cucurbitaceae	*Melothria pendula* L.	drooping melonnettle; Guadalupe cucumber	**U**
Cupressaceae	*Juniperus ashei* Buchh.	Ashe juniper	**C**
Cupressaceae	*Juniperus virginiana* L.	eastern red cedar; red cedar; juniper	**A**
Cuscutaceae	*Cuscuta cuspidata* Engelm.	cusp dodder	**U**
Cuscutaceae	*Cuscuta indecora* Choisy	bigseed alfalfa dodder; large-seed dodder; pretty dodder	**U**
Cuscutaceae	*Cuscuta pentagona* var. *pentagona* Engelm.	field dodder; dodder; lespedeza dodder; five-angle dodder; bush-clover dodder; fiveangle dodder	**U**
Cuscutaceae	*Cuscuta polygonorum* Engelm.	smartweed dodder	**U**
Cyperaceae	*Carex albolutescens* Schwein.	greenwhite sage	**U**
Cyperaceae	*Carex amphibola* Steud.	eastern narrowleaf sedge; amphibolus sedge	**U**
Cyperaceae	*Carex blanda* Dewey	bland sedge; eastern woodland sedge; woodland sedge	**U**
Cyperaceae	*Carex cephalophora* Muhl. ex Willd.	oval-leaf sedge; ovalleaf sedge	**U**
Cyperaceae	*Carex emoryi* Dewey	Emory's sedge	**U**
Cyperaceae	*Carex frankii* Kunth	Frank's sedge	**U**
Cyperaceae	*Carex granularis* var. *haleana* (Olney) Porter	limestone meadow sedge	**U**
Cyperaceae	*Carex hyalina* Boott	tissue sedge	**U**
Cyperaceae	*Carex meadii* Dewey	Mead's sedge; Mead sedge	**U**
Cyperaceae	*Carex microdonta* Torr. & Hook.	littletooth sedge	**U**
Cyperaceae	*Carex muehlenbergii* var. *enervis* Boott	Muhlenberg's sedge	**U**
Cyperaceae	*Carex normalis* Mackenzie	greater straw sedge	**U**
Cyperaceae	*Carex oligocarpa* Schkuhr ex Willd.	eastern few-fruit sedge; richwoods sedge	**U**
Cyperaceae	*Carex retroflexa* Muhl. ex Willd.	reflexed sedge	**C**
Cyperaceae	*Cyperus acuminatus* Torr. & Hook. ex Torr.	tapertip flatsedge; taper-tip flat sedge	**U**
Cyperaceae	*Cyperus echinatus* (L.) Wood	globe flatsedge; globe flat sedge	**U**
Cyperaceae	*Cyperus esculentus* L.	yellow nutsedge; yellow nutgrass; chufa flatsedge; chufa; chufa flat sedge	**U**
Cyperaceae	*Cyperus lupulinus* (Spreng.) Marcks	Great Plains flatsedge	**U**
Cyperaceae	*Cyperus pseudovegetus* Steud.	marsh flatsedge; marsh flat sedge	**U**
Cyperaceae	*Cyperus setigerus* Torr. & Hook.	lean flatsedge; lean flat sedge	**C**
Cyperaceae	*Cyperus squarrosus* L.	awned flat sedge; bearded flatsedge; bearded nutgrass	**C**
Cyperaceae	*Cyperus strigosus* L.	strawcolored flatsedge; straw-color flat sedge; strawcolored nutgrass; straw-color nutgrass	**U**
Cyperaceae	*Eleocharis acutisquamata* Buckl.	sharpscale spikerush	**U**
Cyperaceae	*Eleocharis compressa* Sullivant	flat-stem spike-rush; flatstem spikerush; flatstemmed spikesedge	**C**

Family	ScientificName	Common Names	Abundance
Cyperaceae	*Eleocharis montevidensis* Kunth	sand spikerush; sand spike-rush	**C**
Cyperaceae	*Eleocharis quadrangulata* (Michx.) Roemer & J.A. Schultes	squarestem spikerush; squarestem spikesedge	**U**
Cyperaceae	*Fuirena simplex* Vahl	western umbrella-sedge; western umbrellasedge	**U**
Cyperaceae	*Rhynchospora globularis* (Chapman) Small	globe beakrush; globe beaksedge	**U**
Cyperaceae	*Schoenoplectus tabernaemontani* (K.C. Gmel.) Palla	great bulrush; soft-stem bulrush; softstem bulrush	**U**
Cyperaceae	*Scirpus pendulus* Muhl.	hanging bulrush; pendulous bulrush; rufous bulrush	**U**
Cyperaceae	*Scleria ciliata* var. *ciliata* Michx.	fringed nutrush	**U**
Dryopteridaceae	*Cystopteris fragilis* (L.) Bernh.	brittle bladder fern; fragile fern; brittle bladderfern	**U**
Dryopteridaceae	*Woodsia obtusa* (Spreng.) Torr.	blunt-lobe woodsia; bluntlobe cliff fern	**U**
Ebenaceae	*Diospyros virginiana* L.	persimmon; common persimmon; eastern persimmon	**U**
Equisetaceae	*Equisetum hyemale* L.	common scouring rush; horsetail; scouring horsetail; scouring rush; scouring rush horsetail; tall scouring rush; western scouring rush	**U**
Euphorbiaceae	*Acalypha gracilens* Gray	slender copperleaf; slender threeseed mercury	**C**
Euphorbiaceae	*Acalypha ostryifolia* Riddell	hophornbeam copperleaf; pineland threeseed mercury	**C**
Euphorbiaceae	*Acalypha virginica* L.	Virginia copperleaf; Virginia threeseed mercury; mercuryweed; threeseeded mercury; wax balls	**U**
Euphorbiaceae	*Argythamnia mercurialina* (Nutt.) Muell.-Arg.	tall silverbush; tall wildmercury	**U**
Euphorbiaceae	*Chamaesyce geyeri* (Engelm.) Small	Geyer's sandmat; geyer spurge	**U**
Euphorbiaceae	*Chamaesyce maculata* (L.) Small	spotted spurge; milk purslane; spotted sandmat; large spurge	**U**
Euphorbiaceae	*Chamaesyce missurica* (Raf.) Shinners	Missouri spurge; prairie sandmat	**C**
Euphorbiaceae	*Chamaesyce nutans* (Lag.) Small	nodding spurge; eyebane; spotted sandmat; spotted spurge	**U**
Euphorbiaceae	*Chamaesyce prostrata* (Ait.) Small	ground spurge; prostrate sandmat; prostrate spurge	**U**
Euphorbiaceae	*Cnidoscolus texanus* (Muell.-Arg.) Small	Texas bullnettle; bullnettle	**U**
Euphorbiaceae	*Croton capitatus* Michx.	doveweed; hogweed; hogwort; woolly croton; wooly croton	**U**
Euphorbiaceae	*Croton glandulosus* var. *septentrionalis* Muell.-Arg.	vente conmigo	**U**
Euphorbiaceae	*Croton monanthogynus* Michx.	oneseeded croton; prairie tea	**C**
Euphorbiaceae	*Croton texensis* (Klotzsch) Muell.-Arg.	Texas croton; doveweed; skunkweed; croton; goatweed	**C**

Family	ScientificName	Common Names	Abundance
Euphorbiaceae	*Euphorbia bicolor* Engelm. & Gray	snow on the prairie; snow-on-the-prairie	**U**
Euphorbiaceae	*Euphorbia corollata* L.	flowering spurge; floweringspurge euphorbia	**U**
Euphorbiaceae	*Euphorbia dentata* Michx.	toothed spurge; toothedleaf poinsettia; toothed euphorbia;	**C**
Euphorbiaceae	*Euphorbia heterophylla* L.	Mexican fireplant;painted euphorbia	**U**
Euphorbiaceae	*Euphorbia hexagona* Nutt. ex Spreng.	sixangle spurge	**C**
Euphorbiaceae	*Euphorbia spathulata* Lam.	roughpod spurge; warty spurge	**C**
Euphorbiaceae	*Phyllanthus polygonoides* Nutt. ex Spreng.	knotted leaflower; smartweed leaf-flower	**C**
Euphorbiaceae	*Tragia ramosa* Torr.	branched noseburn; branched tragia; catnip noseburn; noseburn	**U**
Fabaceae	*Acacia angustissima* (P. Mill.) Kuntze	prairie acacia; whiteball acacia	**C**
Fabaceae	*Albizia julibrissin* Durazz.	mimosa; powderpuff tree; silk tree	**U**
Fabaceae	*Amorpha canescens* Pursh	leadplant amorpha	**C**
Fabaceae	*Amorpha fruticosa* L.	desert false indigo; desert indigobush; dullleaf indigo; false indigo; false indigo-bush; indigobush; leadplant	**C**
Fabaceae	*Amphicarpaea bracteata* (L.) Fern.	American hogpeanut; hogpeanut	**C**
Fabaceae	*Apios americana* Medik.	groundnut; potato bean	**U**
Fabaceae	*Astragalus canadensis* L.	Canada milkvetch; Canadian milkvetch	**U**
Fabaceae	*Astragalus crassicarpus* Nutt.	ground-plum; groundplum milkvetch	**U**
Fabaceae	*Astragalus distortus* Torr. & Gray	bentpod milkvetch; Ozark milkvetch	**U**
Fabaceae	*Astragalus nuttallianus* var. *nuttallianus* DC.	smallflowered milkvetch	**C**
Fabaceae	*Astragalus plattensis* Nutt.	Platte milkvetch; Platte River milk-vetch	**U**
Fabaceae	*Baptisia australis* var. *minor* (Lehm.) Fern.	blue wild indigo	**U**
Fabaceae	*Baptisia sphaerocarpa* Nutt.	green wildindigo; round wild indigo; yellow wild indigo	**U**
Fabaceae	*Cercis canadensis* L.	eastern redbud; redbud	**A**
Fabaceae	*Chamaecrista fasciculata* var. *fasciculata* (Michx.) Greene	partridge pea; showy partridgepea; sleeping plant	**C**
Fabaceae	*Chamaecrista nictitans* (L.) Moench	partridge pea	**C**
Fabaceae	*Clitoria mariana* L.	Atlantic pigeonwings; pigeon wings	**C**
Fabaceae	*Coronilla varia* L.	crownvetch; purple crownvetch; varia crownvetch	**U**
Fabaceae	*Dalea aurea* Nutt. ex Pursch	golden dalea; golden prairie clover; silktop dalea	**U**
Fabaceae	*Dalea enneandra* Nutt.	9-anther dalea; bigtop dalea; nine-anther prairie clover	**U**
Fabaceae	*Dalea frutescens* Gray	black dalea; black prairie	**U**

Family	ScientificName	Common Names	Abundance
		clover	
Fabaceae	*Dalea multiflora* (Nutt.) Shinners	roundhead prairie clover	**U**
Fabaceae	*Dalea purpurea* var. *purpurea* Vent.	purple prairie clover; violet dalea; violet prairie clover	**U**
Fabaceae	*Desmanthus illinoensis* (Michx.) MacM. ex B.L. Robins. & Fern.	Illinois bundleflower; prairie bundleflower	**C**
Fabaceae	*Desmodium canescens* (L.) DC.	hoary tickclover; hoary ticktrefoil	**C**
Fabaceae	*Desmodium glutinosum* (Muhl. ex Willd.) Wood	largeflower tickclover; pointedleaf ticktrefoil; trefoil tickclover	**C**
Fabaceae	*Desmodium illinoense* Gray	Illinois tickclover; Illinois ticktrefoil	**U**
Fabaceae	*Desmodium laevigatum* (Nutt.) DC.	smooth tickclover; smooth ticktrefoil	**U**
Fabaceae	*Desmodium obtusum* (Muhl. ex Willd.) DC.	stiff tickclover; stiff ticktrefoil	**C**
Fabaceae	*Desmodium paniculatum* (L.) DC.	narrowleaf ticktrefoil; panicled tickclover; panicled ticktrefoil	**U**
Fabaceae	*Desmodium perplexum* Schub.	perplexed ticktrefoil	**U**
Fabaceae	*Desmodium sessilifolium* (Torr.) Torr. & Gray	sessile tickclover; sessileleaf tickclover; sessileleaf ticktrefoil	**U**
Fabaceae	*Galactia regularis* (L.) B.S.P.	eastern milkpea	**U**
Fabaceae	*Gleditsia triacanthos* L.	honeylocust; common honeylocust; honey locust	**U**
Fabaceae	*Indigofera miniata* var. *leptosepala* (Nutt. ex Torr. & Gray) B.L. Turner	western indigo	**U**
Fabaceae	*Kummerowia stipulacea* (Maxim.) Makino	Korean clover; Korean lespedeza	**C**
Fabaceae	*Lathyrus hirsutus* L.	Caley pea; singletary pea	**U**
Fabaceae	*Lespedeza capitata* Michx.	roundhead lespedeza	**U**
Fabaceae	*Lespedeza cuneata* (Dum.-Cours.) G.Don	sericea lespedeza; Chinese lespedeza; Chinese bushclover	**A**
Fabaceae	*Lespedeza procumbens* Michx.	trailing lespedeza	**U**
Fabaceae	*Lespedeza violacea* (L.) Pers.	violet lespedeza	**C**
Fabaceae	*Lespedeza virginica* (L.) Britt.	slender lespedeza	**U**
Fabaceae	*Lotus unifoliolatus* (Hook.) Benth.	American bird's-foot trefoil	**U**
Fabaceae	*Medicago lupulina* L.	black medic clover; black medik; hop medic; yellow trefoil; hop clover; nonesuch	**U**
Fabaceae	*Medicago minima* (L.) L.	burr medick; little burclover	**U**
Fabaceae	*Medicago sativa* L.	alfalfa	**U**
Fabaceae	*Melilotus officinalis* (L.) Lam.	yellow sweet-clover; yellow sweetclover	**A**
Fabaceae	*Mimosa nuttallii* (DC.) B.L. Turner	catclaw sensitivebriar; Nuttall's sensitive-briar	**U**
Fabaceae	*Neptunia lutea* (Leavenworth) Benth.	yellow neptunia; yellow puff	**C**
Fabaceae	*Oxytropis lambertii* var. *articulata* (Greene) Baarneby	purple locoweed	**U**
Fabaceae	*Pediomelum cuspidatum* (Pursh) Rydb.	largebract Indian breadroot; tallbread scurfpea	**U**
Fabaceae	*Pediomelum digitatum* (Nutt. ex Torr. & Gray) Isely	palmleaf Indian breadroot	**U**

Family	ScientificName	Common Names	Abundance
Fabaceae	*Pediomelum linearifolium* (Torr. & Gray) J. Grimes	narrowleaf Indian breadroot; slimleaf scurfpea	**C**
Fabaceae	*Pediomelum reverchonii* (S. Wats.) Rydb.	rock Indian breadroot; rock scurfpea	**U**
Fabaceae	*Psoralidium tenuiflorum* (Pursch) Rydb.	scurfpea; slimflower scurfpea	**U**
Fabaceae	*Robinia pseudoacacia* L.	black locust; false acacia; yellow locust	**U**
Fabaceae	*Senna marilandica* (L.) Link	Maryland senna; wild senna	**U**
Fabaceae	*Sesbania herbacea* (P. Mill.) McVaugh	bigpod sesbania; hemp sesbania; peatree	**C**
Fabaceae	*Sophora affinis* Torr. & Gray	Eve's necklace; Texas sophora	**U**
Fabaceae	*Strophostyles helvula* (L.) Ell.	trailing fuzzybean; trailing wildbean	**U**
Fabaceae	*Strophostyles leiosperma* (Torr. & Gray) Piper	slick-seed fuzzy-bean; slickseed fuzzybean; smoothseed wildbean	**U**
Fabaceae	*Strophostyles umbellata* (Muhl. ex Willd.) Britt.	perennial wildbean; pink fuzzybean	**C**
Fabaceae	*Stylosanthes biflora* (L.) B.S.P.	endbeak pencilflower; sidebeak pencilflower	**U**
Fabaceae	*Tephrosia virginiana* (L.) Pers.	Virginia tephrosia	**C**
Fabaceae	*Trifolium campestre* Schreb.	big-hop field clover; field clover; large hop clover; lesser hop clover; low hop clover	**U**
Fabaceae	*Trifolium dubium* Sibthorp	hop clover; small hop clover; suckling clover	**C**
Fabaceae	*Vicia ludoviciana* Nutt.	deerpea vetch; Louisiana vetch; slim vetch	**C**
Fabaceae	*Vicia sativa* L.	common vetch; garden vetch; narrowleaf vetch; sweetpea	**U**
Fagaceae	*Quercus macrocarpa* Michx.	bur oak	**C**
Fagaceae	*Quercus marilandica* Muenchh.	blackjack oak	**C**
Fagaceae	*Quercus muhlenbergii* Engelm.	chinkapin oak; chinquapin oak	**C**
Fagaceae	*Quercus shumardii* Buckl.	Shumard oak; Shumard's oak	**C**
Fagaceae	*Quercus sinuata* var. *breviloba* (Torr.) C.H. Muller	bastard oak; white shin oak	**C**
Fagaceae	*Quercus stellata* Wangenh.	post oak	**A**
Fagaceae	*Quercus texana* Buckl.	nuttall oak; Texas red oak	**C**
Fumariaceae	*Corydalis micrantha* ssp. *micrantha* (Engelm. ex Gray) Gray	smallflower fumewort	**U**
Gentianaceae	*Centaurium beyrichii* (Torr. & Gray ex Torr.) B.L. Robins.	mountain pink; quinineweed; rock centaury	**U**
Gentianaceae	*Centaurium texense* (Griseb.) Fern.	Lady Bird's centaury; Texas centaury	**U**
Gentianaceae	*Eustoma exaltatum* ssp. *russellianum* (Hook) Kartesz, comb. nov. ined.	showy prairie gentian	**U**
Gentianaceae	*Sabatia campestris* Nutt.	meadow pink; Prairie rose gentian; Texas star	**U**

Family	ScientificName	Common Names	Abundance
Geraniaceae	*Erodium cicutarium* (L.) L'Hér. ex Ait.	alfilaree; alfilaria; California filaree; cutleaf filaree; filaree; red-stem stork's-bill; redstem; redstem filaree; redstem stork's bill; stork's bill; storksbill	**C**
Geraniaceae	*Geranium carolinianum* L.	Carolina crane's-bill; Carolina geranium	**U**
Haloragaceae	*Myriophyllum heterophyllum* Michx.	broadleaf water-milfoil; changeleaf parrotfeather; two-leaf water-milfoil; twoleaf watermilfoil	**U**
Hippocastanaceae	*Aesculus glabra* var. *arguta* (Buckl.) B.L. Robins.	Ohio buckeye; Texas buckeye	**U**
Hydrangeaceae	*Philadelphus laxus* Schrad. ex DC. *(NO ITIS listing; per GRIN)*		**U**
Hydrophyllaceae	*Phacelia hirsuta* Nutt.	fuzzy phacelia; hairy phacelia	**U**
Iridaceae	*Hypoxis hirsuta* (L.) Coville	common goldstar; eastern yellow star-grass	**U**
Iridaceae	*Iris germanica* L.	German iris; orris	**U**
Iridaceae	*Iris sanguinea* Hornem. ex Donn	Japanese iris	**U**
Iridaceae	*Nemastylis geminiflora* Nutt.	prairie pleatleaf	**U**
Iridaceae	*Sisyrinchium campestre* Bickn.	prairie blue-eyed grass; prairie blueuyed grass	**U**
Iridaceae	*Sisyrinchium langloisii* Greene	roadside blue-eyed grass; roadside blueeyed grass	**C**
Juglandaceae	*Carya cordiformis* (Wangenh.) K. Koch	bitternut hickory	**C**
Juglandaceae	*Carya illinoinensis* (Wangenh.) K. Koch	pecan	**C**
Juglandaceae	*Carya texana* Buckl.	black hickory	**C**
Juglandaceae	*Juglans nigra* L.	black walnut	**U**
Juncaceae	*Juncus interior* Wieg.	inland rush	**U**
Juncaceae	*Juncus marginatus* Rostk.	grassleaf rush	**U**
Juncaceae	*Juncus tenuis* Willd.	field rush; path rush; poverty rush; slender rush; slender yard rush; wiregrass	**U**
Juncaceae	*Juncus torreyi* Coville	torrey rush; Torrey's rush	**U**
Krameriaceae	*Krameria lanceolata* Torr.	spreading ratany; trailing krameria; trailing ratany	**C**
Lamiaceae	*Clinopodium arkansanum* (Nutt.) House	limestone calamint	**U**
Lamiaceae	*Hedeoma drummondii* Benth.	drummond falsepennyroyal; Drummond's false pennyroyal; Drummond's pennyroyal	**U**
Lamiaceae	*Hedeoma hispida* Pursh	rough false pennyroyal; rough pennyroyal; false pennyroyal	**U**
Lamiaceae	*Isanthus brachiatus* (L.) B.S.P.	false pennyroyal; fluxweed	**U**
Lamiaceae	*Lamium amplexicaule* L.	henbit; henbit deadnettle; common henbit; giraffehead	**C**
Lamiaceae	*Lycopus americanus* Muhl. ex W. Bart.	American bugleweed; water horehound; American water horehound; cutleaf water horehound	**U**

Family	ScientificName	Common Names	Abundance
Lamiaceae	*Lycopus virginicus* L.	Virginia bugleweed; Virginia water horehound	**U**
Lamiaceae	*Marrubium vulgare* L.	horehound; white horehound	**U**
Lamiaceae	*Mentha spicata* L.	bush mint; spearmint	**U**
Lamiaceae	*Monarda citriodora* Cerv. ex Lag.	lemon beebalm; lemon mint	**C**
Lamiaceae	*Monarda clinopodioides* Gray	basil beebalm	**U**
Lamiaceae	*Monarda fistulosa* L.	wild bergamont; mintleaf beebalm; Oswego-tea; wild bergamont horsemint	**C**
Lamiaceae	*Nepeta cataria* L.	catnip; catmint; catwort; field balm	**U**
Lamiaceae	*Prunella vulgaris* L.	healall; selfheal; common selfheal; heal all	**U**
Lamiaceae	*Pycnanthemum tenuifolium* Schrad.	narrowleaf mountainmint	**C**
Lamiaceae	*Salvia azurea* var. *grandiflora* Benth.	blue sage; pitcher sage; Pitchers sage	**C**
Lamiaceae	*Salvia lyrata* L.	lyreleaf sage	**C**
Lamiaceae	*Scutellaria drummondii* Benth.	Drummond's skullcap	**C**
Lamiaceae	*Scutellaria ovata* Hill	eggleaf skullcap; heartleaf skullcap	**C**
Lamiaceae	*Scutellaria parvula* var. *australis* Fassett	small skullcap	**U**
Lamiaceae	*Scutellaria wrightii* Gray	resin-dot skullcap; resinous skullcap; skullcap; Wright's skullcap	**U**
Lamiaceae	*Teucrium canadense* var. *occidentale* (Gray) McClintock & Epling	American germander; western germander	**C**
Lemnaceae	*Lemna minor* L.	common duckweed; least duckweed; lesser duckweed	**U**
Liliaceae	*Allium canadense* var. *canadense* L.	Canada garlic; meadow garlic	**C**
Liliaceae	*Allium canadense* var. *mobilense* (Regel) Ownbey	meadow garlic	**U**
Liliaceae	*Allium cernuum* Roth	nodding onion	**U**
Liliaceae	*Androstephium caeruleum* (Scheele) Greene	blue funnel lily	**U**
Liliaceae	*Asparagus officinalis* L.	garden asparagus	**U**
Liliaceae	*Camassia scilloides* (Raf.) Cory	Atlantic camas	**U**
Liliaceae	*Cooperia drummondii* Herbert	evening rainlily; Texas rainlily	**R**
Liliaceae	*Erythronium mesochoreum* Knerr	modland fawnlily; white fawnlily	**U**
Liliaceae	*Nothoscordum bivalve* (L.) Britt.	crowpoison	**U**
Liliaceae	*Ornithogalum umbellatum* L.	Pyrenees Star of Bethlehem; sleepydick; Star-of-Bethlehem	**U**
Liliaceae	*Polygonatum biflorum* (Walt.) Ell.	Solomon's seal; smooth Solomon's seal; King Solomon's seal	**U**
Liliaceae	*Zigadenus nuttallii* (Gray) S. Wats.	nuttall deathcamas; Nuttall's deathcamas	**R**
Linaceae	*Linum lewisii* Pursh	blue flax; Lewis blue flax; Lewis' flax	**U**
Linaceae	*Linum medium* (Planch.) Britt.	stiff yellow flax	**C**
Linaceae	*Linum pratense* (J.B.S. Norton) Small	blue flax; meadow flax	**C**
Linaceae	*Linum rigidum* Pursh	orange flax; stiff flax; stiffstem flax	**U**

Family	ScientificName	Common Names	Abundance
Linaceae	*Linum sulcatum* Riddell	grooved flax; grooved yellow flax	**U**
Lythraceae	*Ammannia robusta* Heer & Regel	grand redstem; longleaf ammannia	**C**
Lythraceae	*Lythrum alatum* var. *lanceolatum* (Ell.) Torr. & Gray ex Rothrock	winged loosestrife; winged lythrum	**U**
Malvaceae	*Abutilon theophrasti* Medik.	velvetleaf; Indian mallow; butterprint; buttonweed; velvetleaf Indian mallow	**U**
Malvaceae	*Callirhoe alcaeoides* (Michx.) Gray	plains poppymallow; pink poppymallow; light poppymalow	**U**
Malvaceae	*Callirhoe bushii* Fern.	bush poppymallow; Bush's poppymallow	**U**
Malvaceae	*Callirhoe digitata* Nutt.	fringe poppymallow; winecup	**U**
Malvaceae	*Callirhoe involucrata* (Torr. & Gray) Gray	purple poppymallow; low poppymallow; purple poppy mallow; winecup	**U**
Malvaceae	*Hibiscus moscheutos* ssp. *lasiocarpos* (Cav.) O.J. Blanchard	crimsoneyed rosemallow; marshmallow	**U**
Malvaceae	*Malvastrum hispidum* (Pursh) Hochr.	hispid false mallow	**U**
Malvaceae	*Sida abutifolia* P. Mill.	procumbent sida; prostrate sida; spreading fanpetals	**C**
Malvaceae	*Sida spinosa* L.	prickly fanpetals; prickly sida	**C**
Meliaceae	*Melia azedarach* L.	chinaberry; Chinaberry tree; Indian lilac; lelah; paraiso; pride of India; white cedar	**U**
Menispermaceae	*Cocculus carolinus* (L.) DC.	Carolina coralbead; Carolina snailseed; redberry moonseed	**U**
Molluginaceae	*Mollugo verticillata* L.	carpetweed; green carpetweed; Indian chickweed; whorled chickweed; devil's grip	**U**
Moraceae	*Broussonetia papyrifera* (L.) L'Hér. ex Vent.	paper mulberry; wauke	**U**
Moraceae	*Maclura pomifera* (Raf.) Schneid.	bois d'arc; osage orage;	**C**
Moraceae	*Morus rubra* L.	red mulberry	**C**
Najadaceae	*Najas guadalupensis* (Spreng.) Magnus	common waternymph; Guadalupe waternymph; southern naiad; southern waternymph	**U**
Nyctaginaceae	*Mirabilis albida* (Walt.) Heimerl	mountain four o'clock; white four-o'clock	**U**
Nyctaginaceae	*Mirabilis hirsuta* (Pursh) MacM.	hairy four o'clock; hairy four-o'clock	**U**
Nyctaginaceae	*Mirabilis nyctaginea* (Michx.) MacM.	wild four-o'clock; heartleaf four-o'clock; heart-leaved four o'clock; prairie four o'clock;	**U**
Nymphaeaceae	*Nymphaea odorata* Ait.	American waterlily; American white waterlily; white waterlily	**U**
Oleaceae	*Forestiera pubescens* Nutt.	desert olive; downy forestiera; elbowbush; stretchberry	**C**
Oleaceae	*Fraxinus americana* L.	white ash	**U**

Family	ScientificName	Common Names	Abundance
Oleaceae	*Fraxinus pennsylvanica* Marsh	green ash	**C**
Oleaceae	*Fraxinus texensis* (Gray) Sarg.	Texas ash	**C**
Oleaceae	*Jasminum nudiflorum* Lindl.	winter jasmine	**U**
Oleaceae	*Ligustrum vulgare* L.	European privet; wild privet	**U**
Onagraceae	*Calylophus berlandieri* ssp. *pinifolius* (Engelm. ex Gray) Towner	Berlandier's sundrops	**U**
Onagraceae	*Calylophus serrulatus* (Nutt.) Raven	halfshrub calylophus; halfshrub sundrop; serrateleaf eveningprimrose; yellow sundrops	**U**
Onagraceae	*Gaura biennis* L.	biennial beeblossom	**C**
Onagraceae	*Gaura coccinea* Nutt. ex Pursh	scarlet gaura; scarlet beeblossom	**U**
Onagraceae	*Gaura mollis* James	velvety gaura; velvetweed	**C**
Onagraceae	*Gaura sinuata* Nutt. ex Ser.	wavyleaf beeblossom; wavyleaf gaura	**U**
Onagraceae	*Gaura suffulta* ssp. *suffulta* Engelm. ex Gray	kisses	**U**
Onagraceae	*Ludwigia palustris* (L.) Ell.	marsh primrose-willow; marsh seedbox	**U**
Onagraceae	*Oenothera biennis* L.	common evening primrose; hoary evening primrose; common evening-primrose; evening primrose; king's-cureall	**U**
Onagraceae	*Oenothera laciniata* Hill	cut-leaved evening primrose; cut-leaf evening-primrose; cutleaf evening primrose	**U**
Onagraceae	*Oenothera macrocarpa* ssp. *oklahomensis* (J.B.S. Norton) Wagner	Oklahoma evening-primrose; Oklahoma evening primrose	**C**
Onagraceae	*Oenothera speciosa* Nutt.	pinkladies; showy evening-primrose; showy evening primrose	**U**
Onagraceae	*Oenothera triloba* Nutt.	stemless evening-primrose; stemless evening primrose	**U**
Onagraceae	*Oenothera villosa* Thunb.	hairy evening-primrose; hairy evening primrose	**C**
Onagraceae	*Stenosiphon liniflorus* (Nuttal Ex James) Heynh.		**C**
Ophioglossaceae	*Botrychium virginianum* (L.) Sw.	rattlesnake fern	**C**
Ophioglossaceae	*Ophioglossum engelmannii* Prantl	adderstongue; limestone adderstongue	**U**
Orchidaceae	*Spiranthes cernua* (L.) L.C. Rich.	nodding ladies'-tresses; nodding ladiestresses; white nodding ladies'-tresses	**U**
Oxalidaceae	*Oxalis stricta* L.	gray-green woodsorrel; sourgrass; toad sorrel; yellow woodsorrel; sheep sorrel; common yellow oxalis; erect woodsorrel; upright yellow wood-sorrel; upright yellow woodsorrel; yellow woodsorrel	**U**
Oxalidaceae	*Oxalis violacea* L.	purple woodsorrel; violet woodsorrel; violet wood-sorrel	**U**

Family	ScientificName	Common Names	Abundance
Papaveraceae	*Argemone polyanthemos* (Fedde) G.B. Ownbey	annual pricklypoppy; bluestem pricklypoppy; thistle poppy; crested pricklypoppy; bluestem prickly poppy; pricklypoppy; white prickly poppy; white pricklypoppy	**U**
Passifloraceae	*Passiflora incarnata* L.	purple passionflower	**U**
Passifloraceae	*Passiflora lutea* L.	passionflower; yellow passionflower	**U**
Phytolaccaceae	*Phytolacca americana* L.	common pokeweed; pokeberry; inkberry; pigeonberry; American pokeweed; poke; pokeweed	**U**
Plantaginaceae	*Plantago lanceolata* L.	buckhorn plaintain; English plantain; ribwort; ribgrass; narrowleaf plantain; lanceleaf Indianwheat; lanceleaf plantain	**C**
Plantaginaceae	*Plantago patagonica* Jacq.	woolly plaintain; wooly Indianwheat; wooly Indianwheat; wooly plantain	**U**
Plantaginaceae	*Plantago rhodosperma* Dcne.	redseed Indianwheat; redseed plantain	**C**
Plantaginaceae	*Plantago rugelii* Dcne.	blackseed plantain; Rugel's plantain	**U**
Plantaginaceae	*Plantago virginica* L.	paleseed plantain; paleseed Indianwheat; Virginia plantain	**C**
Platanaceae	*Platanus occidentalis* L.	American sycamore; sycamore	**C**
Poaceae	*Aegilops cylindrica* Host	jointed goat grass; jointgrass; jointed goatgrass	**U**
Poaceae	*Agrostis elliottiana* J.A. Schultes	Elliot bentgrass; Elliott's bentgrass	**U**
Poaceae	*Agrostis gigantea* Roth	redtop bent; creeping bentgrass; seaside bentgrass; redtop; black bent; water bentgrass	**•**
Poaceae	*Andropogon gerardii* Vitman	big bluestem; bluejoint; turkeyfoot	**A**
Poaceae	*Andropogon glomeratus* (Walt.) B.S.P.	bushy bluestem	**C**
Poaceae	*Andropogon ternarius* Michx.	splitbeard bluestem	**U**
Poaceae	*Andropogon virginicus* L.	broomsedge; broomsedge bluestem; yellow bluestem	**C**
Poaceae	*Aristida oligantha* Michx.	prairie threeawn; oldfield threeawn; old field threeawn;	**C**
Poaceae	*Aristida purpurascens* Poir.	arrowfeather threeawn	**C**
Poaceae	*Aristida purpurea* var. *nealleyi* (Vasey) Allred	blue threeawn	**A**
Poaceae	*Aristida purpurea* var. *purpurea* Nutt.	purple threeawn; purple three-awn; red threeawn	**U**
Poaceae	*Bothriochloa ischaemum* var. *songarica* (Rupr. ex Fisch. & C.A. Mey.) Celarier & Harlan	king ranch bluestem; yellow bluestem	**U**
Poaceae	*Bothriochloa laguroides* ssp. *torreyana* (Steud.) Allred & Gould	silver beardgrass; silver bluestem	**U**
Poaceae	*Bouteloua curtipendula* (Michx.) Torr.	sideoats grama	**A**

Family	ScientificName	Common Names	Abundance
Poaceae	*Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths	blue grama	**U**
Poaceae	*Bouteloua hirsuta* Lag.	hairy grama	**C**
Poaceae	*Bouteloua rigidiseta* (Steud.) A.S. Hitchc.	Texas grama	**U**
Poaceae	*Bromus catharticus* Vahl	rescue brome; rescue grass; rescuegrass	**C**
Poaceae	*Bromus japonicus* Thunb. ex Murr.	Japanese brome; Japanese chess; Japanese bromegrass	**U**
Poaceae	*Bromus pubescens* Muhl. ex Willd.	pubescent brome; hairy wood brome grass; hairy woodland brome	**C**
Poaceae	*Bromus tectorum* L.	downy brome; cheatgrass; wild oats ; military grass; early chess; thatch bromegrass; cheat grass	**A**
Poaceae	*Buchloe dactyloides* (Nutt.) Engelm.	buffalograss	**U**
Poaceae	*Cenchrus spinifex* Cav.	coastal sandbur	**U**
Poaceae	*Chasmanthium latifolium* (Michx.) Yates	broadleaf uniola; Indian wood-oats; Indian woodoats	**C**
Poaceae	*Chloris verticillata* Nutt.	windmillgrass; tumble windmillgrass; tumble windmill grass	**U**
Poaceae	*Coelorachis cylindrica* (Michx.) Nash	Carolina jointtail; cylinder jointtail grass	**U**
Poaceae	*Cynodon dactylon* (L.) Pers.	Bermudagrass; common bermudagrass; devilgrass	**C**
Poaceae	*Danthonia spicata* (L.) Beauv. ex Roemer & J.A. Schultes	poverty danthonia; poverty oatgrass; poverty wild oat grass	**U**
Poaceae	*Dichanthelium acuminatum* var. *fasciculatum* (Torr.) Freckmann	Huachuca panic; tapered rosette grass; western panicgrass	**U**
Poaceae	*Dichanthelium boscii* (Poir.) Gould & C.A. Clark	Bosc's panicgrass	**U**
Poaceae	*Dichanthelium clandestinum* (L.) Gould	deertongue	**C**
Poaceae	*Dichanthelium laxiflorum* (Lam.) Gould	openflower rosette grass	**C**
Poaceae	*Dichanthelium linearifolium* (Scribn. ex Nash) Gould	slim-leaf rosette grass; slimleaf panicgrass; slimleaf panicum	**U**
Poaceae	*Dichanthelium malacophyllum* (Nash) Gould	softleaf rosette grass	**U**
Poaceae	*Dichanthelium ravenelii* (Scribn. & Merr.) Gould	Ravenel's rosette grass	**C**
Poaceae	*Dichanthelium villosissimum* var. *praecocius* (A.S. Hitchc. & Chase) Freckmann	white-hair rosette grass; whitehair rosette grass	**U**
Poaceae	*Digitaria sanguinalis* (L.) Scop.	large crabgrass; crabgrass; hairy crab grass; hairy crabgrass; purple crabgrass; redhair crabgrass	**U**
Poaceae	*Echinochloa colona* (L.) Link	Jungle ricegrass; jungle rice; junglerice; watergrass	**U**
Poaceae	*Echinochloa crus-galli* (L.) Beauv.	barnyardgrass; cockspur; watergrass; Japanese millet; barnyard grass; large barnyard grass	**C**
Poaceae	*Elymus canadensis* L.	Canada wildrye	**C**

Family	ScientificName	Common Names	Abundance
Poaceae	*Elymus villosus* Muhl. ex Willd.	hairy wild rye; hairy wildrye; slender wild-rye	**C**
Poaceae	*Elymus virginicus* L.	Virginia wild-rye; Virginia wildrye	**U**
Poaceae	*Eragrostis capillaris* (L.) Nees	lace grass; lacegrass	**C**
Poaceae	*Eragrostis cilianensis* (All.) Vign. ex Janchen	stinkgrass; candy grass; lovegrass; stink grass; strongscented lovegrass	**U**
Poaceae	*Eragrostis intermedia* A.S. Hitchc.	plains lovegrass	**U**
Poaceae	*Eragrostis pectinacea* (Michx.) Nees ex Steud.	tufted lovegrass; Carolina lovegrass; purple love grass; purple lovegrass; spreading lovegrass	**U**
Poaceae	*Eragrostis pilosa* var. *pilosa* (L.) Beauv.	Indian lovegrass	**U**
Poaceae	*Eragrostis spectabilis* (Pursh) Steud.	purple lovegrass; petticoat-climber	**U**
Poaceae	*Erioneuron pilosum* (Buckl.) Nash	hairy tridens; hairy woollygrass	**C**
Poaceae	*Glyceria striata* (Lam.) A.S. Hitchc.	fowl manna grass; fowl mannagrass	**U**
Poaceae	*Hordeum pusillum* Nutt.	little barley; little wildbarley	**C**
Poaceae	*Leersia oryzoides* (L.) Sw.	rice cutgrass; rice cut grass	**A**
Poaceae	*Leersia virginica* Willd.	white grass; whitegrass	**U**
Poaceae	*Leptochloa panicea* ssp. *brachiata* (Steudl.) N. Snow	mucronate sprangeltop	**U**
Poaceae	*Lolium perenne* ssp. *perenne* L.	perennial ryegrass; perennial rye grass	**C**
Poaceae	*Lolium pratense* (Huds.) S.J. Darbyshire	meadow fescue; meadow ryegrass	**U**
Poaceae	*Muhlenbergia reverchonii* Vasey & Scribn.	seep muhly	**C**
Poaceae	*Muhlenbergia sobolifera* (Muhl. ex Willd.) Trin.	rock muhly	**U**
Poaceae	*Muhlenbergia sylvatica* Torr. ex Gray	forest muhly; woodland muhly	**U**
Poaceae	*Nassella leucotricha* (Trin. & Rupr.) Pohl	Texas tussockgrass; Texas wintergrass	**U**
Poaceae	*Panicum capillare* L.	witchgrass; annual withcgrass; common panic grass; panicgrass; common witchgrass; panicgrass; ticklegrass; tumble panic; tumbleweed grass; witches hair	**U**
Poaceae	*Panicum obtusum* Kunth	vine mesquite; vine-mesquite	**U**
Poaceae	*Panicum rigidulum* Bosc ex Nees	redtop panicgrass; redtop panicum	**U**
Poaceae	*Panicum virgatum* L.	old switch panic grass; switchgrass	**C**
Poaceae	*Paspalum dilatatum* Poir.	dallas grass; dallis grass; dallisgrass; water grass	**C**
Poaceae	*Paspalum floridanum* Michx.	Florida paspalum	**C**
Poaceae	*Paspalum laeve* var. *laeve* Michx.	field paspalum	**U**
Poaceae	*Paspalum setaceum* Michx.	fringeleaf paspalum; sand paspalum; slender crown grass; thin paspalum	**C**

Family	ScientificName	Common Names	Abundance
Poaceae	*Pennisetum glaucum* (L.) R. Br.	yellow foxtail; yellow bristlegrass; pigeongrass; wild millet; golden foxtail; pearl millet; pearl-millet;	**U**
Poaceae	*Poa annua* L.	annual bluegrass; walkgrass; annual blue grass	**U**
Poaceae	*Poa arachnifera* Torr.	Texas bluegrass	**C**
Poaceae	*Poa pratensis* L.	Kentucky bluegrass	**C**
Poaceae	*Schizachyrium scoparium* (Michx.) Nash	little bluestem	**A**
Poaceae	*Setaria parviflora* (Poir.) Kerguélen	knotroot bristlegrass; marsh bristle grass; marsh bristlegrass; yellow bristlegrass	**C**
Poaceae	*Sorghastrum nutans* (L.) Nash	Indiangrass; yellow indian-grass	**A**
Poaceae	*Sorghum halepense* (L.) Pers.	Johnsongrass; aleppo milletgrass; Johnson grass	**A**
Poaceae	*Sphenopholis obtusata* (Michx.) Scribn.	prairie wedgegrass; prairie wedgescale	**U**
Poaceae	*Sporobolus compositus* var. *compositus* (Poir.) Merr.	composite dropseed; dropseed; tall dropseed	**C**
Poaceae	*Sporobolus cryptandrus* (Torr.) Gray	sand dropseed	**C**
Poaceae	*Sporobolus vaginiflorus* var. *ozarkanus* (Fern.) Shinners	Ozark dropseed	**U**
Poaceae	*Tridens albescens* (Vasey) Woot. & Standl.	white tridens	**U**
Poaceae	*Tridens flavus* (L.) A.S. Hitchc.	purpletop; purpletop tridens	**C**
Poaceae	*Tridens muticus* (Torr.) Nash	slim tridens	**C**
Poaceae	*Triticum aestivum* L.	common wheat; wheat	**U**
Poaceae	*Vulpia octoflora* (Walt.) Rydb.	sixweeks fescue; sixweeks grass; pullout grass; eight-flower six-weeks grass	**U**
Poaceae	*Vulpia sciurea* (Nutt.) Henr.	squireltail fescue	**U**
Poaceae	*Zizaniopsis miliacea* (Michx.) Doell & Aschers.	giant cutgrass	**C**
Polemoniaceae	*Ipomopsis rubra* (L.) Wherry	standing-cypress; Texas plume	**U**
Polemoniaceae	*Phlox pilosa* L.	downy phlox	**U**
Polygonaceae	*Eriogonum longifolium* var. *longifolium* Nutt.	longleaf buckwheat	**C**
Polygonaceae	*Polygonum convolvulus* L.	wild buckwheat; climbing buckwheat; dullseed cornbind; black bindweed; cornbind; black-bindweed; climbing knotweed; pink smartweed	**U**
Polygonaceae	*Polygonum hydropiper* L.	annual smartweed; marshpepper knotweed; mild water-pepper	**U**
Polygonaceae	*Polygonum lapathifolium* L.	pale smartweed; curltop ladysthumb; curlytop knotweed; curlytop smartweed; dock-leaf smartweed; nodding smartweed; smartweed	**U**

Family	ScientificName	Common Names	Abundance
Polygonaceae	*Polygonum persicaria* L.	lady's-thumb; ladysthumb; ladysthumb smartweed; smartweed; spotted knotweed; spotted ladysthumb; spotted smartweed	**C**
Polygonaceae	*Polygonum punctatum* Ell.	dotted smartweed	**C**
Polygonaceae	*Polygonum ramosissimum* Michx.	bushy knotweed; tall knotweed; yellow knotweed; yellow-flowered knotweed	**U**
Polygonaceae	*Polygonum virginianum* L.	jumpseed; Virginia smartweed	**U**
Polygonaceae	*Rumex altissimus* Wood	pale dock; smooth dock	**C**
Polygonaceae	*Rumex crispus* L.	curley dock; sour dock; yellow dock; narrowleaf dock; curly dock	**U**
Polygonaceae	*Rumex hastatulus* Baldw.	heartwing dock; heartwing sorrel	**U**
Polygonaceae	*Rumex pulcher* L.	fiddle dock	**U**
Portulacaceae	*Claytonia virginica* L.	narrow-leaved spring beauty; Spring beauty; Virginia springbeauty	**U**
Portulacaceae	*Portulaca halimoides* L.	silk-cotton purslane; silkcotton purslane; sinkerleaf purslane	**U**
Portulacaceae	*Portulaca pilosa* L.	chisme; kiss me quick; kiss-me-quick	**U**
Portulacaceae	*Talinum calycinum* Engelm.	largeflower flameflower; rockpink	**U**
Potamogetonaceae	*Potamogeton nodosus* Poir.	long-leaf pondweed; longleaf pondweed	**U**
Potamogetonaceae	*Potamogeton pusillus* L.	baby pondweed; small pondweed	**U**
Potamogetonaceae	*Stuckenia pectinatus* (L.) Boerner	sago pondweed	**U**
Primulaceae	*Dodecatheon meadia* L.	common shooting star; pride of Ohio	**U**
Primulaceae	*Samolus valerandi* L.	seaside brookweed	**U**
Pteridaceae	*Pellaea atropurpurea* (L.) Link	purple cliffbrake; purple-stem cliff-brake; purple-stem cliffbrake	**U**
Ranunculaceae	*Anemone berlandieri* Pritz.	tenpetal thimbleweed	**U**
Ranunculaceae	*Anemone caroliniana* Walt.	Carolina anemone	**U**
Ranunculaceae	*Clematis pitcheri* Torr. & Gray	bluebill; pitcher clematis; pitchers virginsbower	**U**
Ranunculaceae	*Clematis terniflora* DC.	leatherleaf clematis; sweet autumn virginsbower; yarn-leaves clematis	**U**
Ranunculaceae	*Delphinium carolinianum* ssp. *virescens* (Nutt.) Brooks	paririe larkspur; plains larkspur; Carolina larkspur; white larkspur	**U**
Ranunculaceae	*Ranunculus abortivus* L.	smallflower buttercup; smallflower crowfoot; early woodbuttercup; littleleaf buttercup; kidney-leaf buttercup	**U**
Ranunculaceae	*Thalictrum dasycarpum* Fisch. & Avé-Lall.	purple meadow-rue; purple meadowrue	**U**

Family	ScientificName	Common Names	Abundance
Rhamnaceae	*Berchemia scandens* (Hill) K. Koch	Alabama supplejack	**U**
Rhamnaceae	*Ceanothus herbaceus* Raf.	inland ceanothus; Jersey tea; prairie redroot	**U**
Rhamnaceae	*Frangula caroliniana* (Walt.) Gray	Carolina buckthorn	**C**
Rosaceae	*Agrimonia rostellata* Wallr.	beaked agrimony; woodland groovebur	**U**
Rosaceae	*Crataegus crus-galli* L.	bush hawthorne; cockspur hawthorne	**U**
Rosaceae	*Crataegus viridis* Linnaeus		**U**
Rosaceae	*Geum canadense* Jacq.	white avens	**U**
Rosaceae	*Potentilla recta* L.	sulphur cinquefoil; roughfruit cinquefoil; erect cinquefoil; sulfur cinquefoil	**U**
Rosaceae	*Prunus angustifolia* Marsh.	Chickasaw plum	**C**
Rosaceae	*Prunus mahaleb* L.	Mahaleb cherry	**U**
Rosaceae	*Prunus mexicana* S. Wats.		**C**
Rosaceae	*Prunus serotina* Ehrh.	black cherry; black chokecherry	**U**
Rosaceae	*Rosa carolina* L.	Carolina rose	**C**
Rosaceae	*Rosa foliolosa* Nutt. ex Torr. & Gray	white prairie rose	**U**
Rosaceae	*Rubus flagellaris* Willd.	northern dewberry; whiplash dewberry	**U**
Rosaceae	*Rubus trivialis* Michx.	southern dewberry	**U**
Rubiaceae	*Cephalanthus occidentalis* L.	buttonbush; common buttonbush	**C**
Rubiaceae	*Diodia teres* Walt.	poor joe; poorjoe; rough buttonweed	**U**
Rubiaceae	*Galium aparine* L.	catchweed bedstraw; cleavers; bedstraw; cleaverwort; white hedge; scarthgrass; stickywilly; goose grass; sticky-willy	**U**
Rubiaceae	*Galium circaezans* Michx.	licorice bedstraw; wild licorice; woods bedstraw	**C**
Rubiaceae	*Galium pilosum* Ait.	hairy bedstraw	**C**
Rubiaceae	*Galium virgatum* Nutt.	southwest bedstraw; southwestern bedstraw	**C**
Rubiaceae	*Hedyotis nigricans* (Lam.) Fosberg	diamondflowers	**C**
Rubiaceae	*Houstonia pusilla* Schoepf	tiny bluet	**U**
Rutaceae	*Ptelea trifoliata* ssp. *trifoliata* L.	common hoptree	**U**
Rutaceae	*Zanthoxylum americanum* P. Mill.	common pricklyash; common pricky-ash; toothache tree	**U**
Salicaceae	*Populus deltoides* ssp. *monilifera* (Ait.) Eckenwalder	eastern cottonwood; plains cottonwood	**U**
Salicaceae	*Salix exigua* Nutt.	coyote willow; desert wiollow; narrowleaf willow; sandbar willow	**U**
Salicaceae	*Salix nigra* Marsh	black willow	**C**
Santalaceae	*Comandra umbellata* ssp. *pallida* (A. DC.) Piehl	bastard toadflax; bastard-toadflax; common toadflax; pale bastard toadflax; pine bastard toadflax	**U**
Sapindaceae	*Cardiospermum halicacabum* L.	balloonvine; love in a puff	**U**

Family	ScientificName	Common Names	Abundance
Sapindaceae	*Sapindus saponaria* var. *drummondii* (Hook. & Arn.) L. Benson	western soapberry	**C**
Sapotaceae	*Sideroxylon lanuginosum* ssp. *oblongifolium* (Nutt.) T.D. Pennington	gum bully	**C**
Scrophulariaceae	*Agalinis densiflora* (Benth.) Blake	Osage false foxglove	**U**
Scrophulariaceae	*Agalinis heterophylla* (Nutt.) Small ex Britt.	prairie false foxglove; prairie false-foxglove	**U**
Scrophulariaceae	*Aureolaria grandiflora* var. *serrata* (Torr. ex Benth.) Pennell	largeflower yellow false foxglove	**U**
Scrophulariaceae	*Castilleja coccinea* (L.) Spreng.	Indian paintbrush; scarlet Indian paintbrush	**A**
Scrophulariaceae	*Castilleja indivisa* Engelm.	entireleaf Indian paintbrush; Texas paintbrush	**U**
Scrophulariaceae	*Dasistoma macrophylla* (Nutt.) Raf.	mullein foxglove; mullien seyemeria	**U**
Scrophulariaceae	*Leucospora multifida* (Michx.) Nutt.	narrowleaf paleseed	**U**
Scrophulariaceae	*Nuttallanthus texanus* (Scheele) D.A. Sutton	Texas toadflax; Texas-toadflax	**U**
Scrophulariaceae	*Penstemon cobaea* Nutt.	cobaea beardtongue; Cobaea penstemon	**C**
Scrophulariaceae	*Penstemon oklahomensis* Pennell	Oklahoma beardtongue; Oklahoma penstemon	**U**
Scrophulariaceae	*Verbascum thapsus* L.	common mullein; flannel leaf; feltwort; Jacob's staff; woolly mullein; velvet plant; velvet dock; flannel plant; big taper; flannel mullein; great mullein; mullein;	**C**
Scrophulariaceae	*Veronica agrestis* L.	field speedwell; green field speedwell	**U**
Scrophulariaceae	*Veronica peregrina* ssp. *xalapensis* (Kunth) Pennell	hairy purslane speedwell; neckweed	**U**
Smilacaceae	*Smilax bona-nox* L.	saw greenbrier	**U**
Smilacaceae	*Smilax herbacea* L.	herbaceous greenbriar; smooth carrionflower	**C**
Smilacaceae	*Smilax rotundifolia* L.	bullbriar; common catbrier; greenbrier; horsebrier; roundleaf greenbrier; roundleaf greenbriar	**C**
Smilacaceae	*Smilax tamnoides* L.	bristly greenbrier	**C**
Solanaceae	*Datura inoxia* Miller	angel's trumpet; desert thornapple; sacred datura	**U**
Solanaceae	*Datura stramonium* L.	jimsonweed; thorn apple; moonflower; mad apple; stinkwort; Jamestown weed	**U**
Solanaceae	*Lycium barbarum* L.	matrimony vine; common matrimonyvine; matrimony-vine; matrimonyvine	**U**
Solanaceae	*Physalis cinerascens* (Dunal) A.S. Hitchc.	smallflower groundcherry	**U**
Solanaceae	*Physalis heterophylla* Nees	clammy groundcherry; clammy ground-cherry	**U**
Solanaceae	*Physalis longifolia* Nutt.	longleaf groundcherry; common groundcherry; long-leaf ground-cherry	**U**

Family	ScientificName	Common Names	Abundance
Solanaceae	*Solanum carolinense* L.	horsenettle; Carolina horsenettle; devil's tomato; sand briar; apple of Sodom; bull nettle	**U**
Solanaceae	*Solanum dimidiatum* Raf.	torrey nightshade; Torrey's nightshade; western horsenettle	**U**
Solanaceae	*Solanum elaeagnifolium* Cav.	silverleaf nightshade; tomato weed; trompillo; white horsenettle; white nightshade	**U**
Solanaceae	*Solanum ptychanthum* Dunal	eastern black nightshade; black nightshade; West Indian nightshade; nightshade	**U**
Solanaceae	*Solanum rostratum* Dunal	buffalobur; Kansas thistle; Texas thistle; Mexican thistle; Colorado bur; buffalobur nightshade; horned nightshade	**U**
Tamaricaceae	*Tamarix chinensis* Lour.	China tamarisk; Chinese saltcedar; Chinese tamarisk; five-stamen tamarisk; fivestamen tamarisk; saltcedar; tamarisk; tamarix	**U**
Typhaceae	*Typha angustifolia* L.	narrowleaf cattail; narrow-leaf cat-tail	**C**
Ulmaceae	*Celtis laevigata* var. *laevigata* Willd.	sugarberry	**C**
Ulmaceae	*Celtis laevigata* var. *reticulata* (Torr.) L. Benson	netleaf hackberry	**U**
Ulmaceae	*Celtis tenuifolia* Nutt.	dwarf hackberry; georgia hackberry	**C**
Ulmaceae	*Ulmus alata* Michx.	winged elm	**U**
Ulmaceae	*Ulmus americana* L.	American elm	**C**
Ulmaceae	*Ulmus crassifolia* Nutt.	cedar elm	**U**
Ulmaceae	*Ulmus rubra* Muhl.	slippery elm	**C**
Urticaceae	*Boehmeria cylindrica* (L.) Sw.	small-spike false nettle; smallspike false nettle; smallspike falsenettle	**U**
Urticaceae	*Parietaria pensylvanica* Muhl. ex Willd.	Pennsylvania pellitory	**U**
Urticaceae	*Pilea pumila* (L.) Gray	Canada clearweed; Canadian clearweed	**U**
Valerianaceae	*Valerianella amarella* (Lindheimer ex Engelm.) Krok	hairy cornsalad; hairyseed cornsalad	**C**
Valerianaceae	*Valerianella radiata* (L.) Dufr.	beaked cornsalad	**U**
Verbenaceae	*Glandularia bipinnatifida* (Nutt.) Nutt.	Dakota mock vervain	**U**
Verbenaceae	*Glandularia canadensis* (L.) Nutt.	rose mock vervain; rose verbena	**C**
Verbenaceae	*Glandularia pumila* (Rydb.) Umber	pink mock vervain; pink verbena	**C**
Verbenaceae	*Phryma leptostachya* L.	American lopseed; lopseed	**C**
Verbenaceae	*Phyla lanceolata* (Michx.) Greene	frog fruit; lanceleaf frogfruit; lanceleaf frog fruit; northern frogfruit	**C**
Verbenaceae	*Phyla nodiflora* (L.) Greene	frog fruit; sawtooth frogfruit; turkey tangle; turkey tangle frogfruit	**U**

Family	ScientificName	Common Names	Abundance
Verbenaceae	*Verbena bracteata* Lag. & Rodr.	prostrate vervain; bracted vervain; bigbract verbena; carpet vervain; prostrate verbena;	**C**
Verbenaceae	*Verbena stricta* Vent.	hoary vervain; woolly verbena; tall vervain; hoary verbena; wooly verbena	**U**
Verbenaceae	*Verbena urticifolia* L.	white vervain; nettleleaved vervain; white verbena	**U**
Violaceae	*Hybanthus verticillatus* (Ortega) Baill.	baby slippers; babyslippers; whorled nodding violet	**U**
Violaceae	*Viola affinis* Le Conte	Arizona bog violet; lecontes violet; sand violet	**U**
Violaceae	*Viola bicolor* Pursh	field pansy	**C**
Violaceae	*Viola sororia* Willd.	common blue violet; hooded blue violet;	**C**
Viscaceae	*Phoradendron leucarpum* (Raf.) Reveal & M.C. Johnston	oak mistletoe	**U**
Vitaceae	*Ampelopsis arborea* (L.) Koehne	peppervine	**U**
Vitaceae	*Ampelopsis cordata* Michx.	heartleaf ampelopsis; heartleaf peppervine	**U**
Vitaceae	*Cissus trifoliata* (L.) L.	sorrelvine	**U**
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	American ivy; fiveleaved ivy; Virginia creeper; wodbine	**A**
Vitaceae	*Vitis cinerea* (Engelm.) Millard	graybark grape; sweet grape	**U**
Vitaceae	*Vitis riparia* Michx.	river-bank grape; riverbank grape	**U**
Vitaceae	*Vitis vulpina* L.	fox grape; frost grape; wild grape	**C**
Zannichelliaceae	*Zannichellia palustris* L.	horned pondweed; horned poolmat; horned-pondweed	**U**
Zygophyllaceae	*Kallstroemia parviflora* J.B.S. Norton	warty caltrop	**U**
Zygophyllaceae	*Tribulus terrestris* L.	puncturevine; goathead; Mexican sandbur; Texas sandbur; bullhead; caltrop; puncture vine	**U**

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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