City Of Fayetteville, Arkansas
Wastewater Systems Improvements Project
Compensatory Wetland Mitigation Monitoring Report No. 4

404 Permit File No. 14207
December 30, 2010

Environmental Consulting Operations ECO, INC.
"Integrating ECOnomy and ECOlogy"

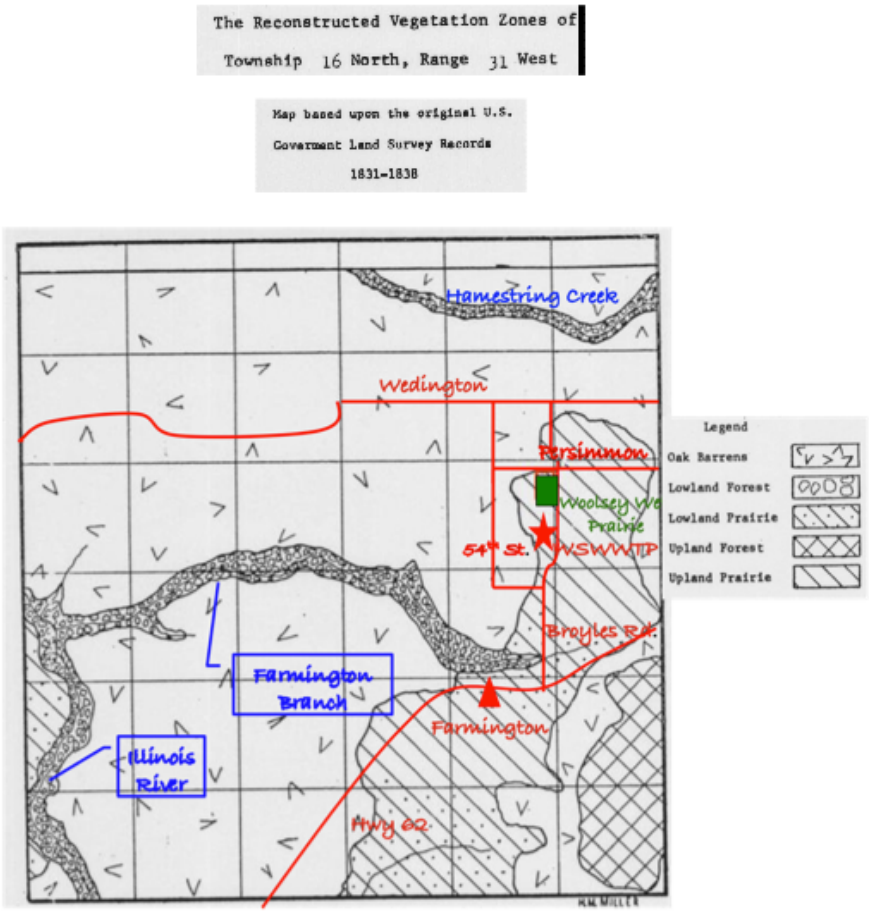
City Of Fayetteville, Arkansas
Wastewater Systems Improvements Project
Compensatory Wetland Mitigation Monitoring
Report No. 4

404 Permit File No. 14207
December 30, 2010

Cover Photocredits:
Andrew Scaboo
Theo Witsell
Bruce Shackleford

Field Work and Report Preparation Conducted by Bruce Shackleford and Theo Witsell, and of Environmental Consulting Operations, Inc., Benton Arkansas

"Special Thanks" to OMI, OERI, and Wildand, Inc. for assistance in site management.
and
"Much Gratitude" to David *"Keep Smiling"* Jurgens and the City of Fayetteville for believing in us and allowing us to do what we do!



Woolsey Wet Prairie Sanctuary
"Banking on the future, by restoring the past"

TABLE OF CONTENTS

List of Figures

List of Tables

1.0 - INTRODUCTION AND PROJECT OVERVIEW

The City of Fayetteville, Arkansas' Wastewater System Improvement Project (WSIP) was designed to improve the City's sewer collection system, upgrade the Paul Noland Wastewater Treatment Plant (WWTP), and construct a new (Westside) WWTP. The project's primary purpose was to implement corrective actions to eliminate/reduce odor and overflow problems associated with the Noland Plant and collection system, and to provide wastewater treatment to areas currently outside the treatment area while reducing the total hydraulic loading to the system. The linear portions of the project involved installation and replacement of approximately 38.02 miles of gravity flow sewer lines and force mains, and resulted in approximately 459.38 acres of surface disturbance. Construction activities commenced during the mid part of 2005 and are to be completed near the end of the year 2010.

Roughly half of the Fayetteville sewer service is located within the Illinois River Watershed (within the Arkansas River Basin) and the other half is within the Beaver Reservoir Watershed (within the White River Basin). The WSIP involved discharges of fill into "waters of the U.S." therefore permitting under Section 404 of the Clean Water Act was required. This was done under one individual and two Nationwide Section 404 permit actions, as described below.

On March 10, 2005, the City of Fayetteville received Section 404 Individual Permit No. 14207 from the U.S. Army Corps of Engineers, Little Rock District (Corps) for the portion of the WSIP in the Illinois River Watershed (west side) that involved 36 stream crossings and 15 wetland crossings during construction of the new Westside WWTP, sewer lines, and road improvements. The permit required wetland compensatory mitigation due to the permanent alteration of 9.88 acres of wetlands. As part of the terms and conditions included in the Section 404 permit, five annual reports on the status of the mitigation site must be submitted to the Corps. The first annual wetland monitoring report was due December 31st after the first growing year, and each year thereafter, for a total of five years. The first Monitoring Year was 2007. The information contained within this report constitutes the findings and results of adaptive site management at Woolsey Wet Prairie for Monitoring Year No. 4.

Individual Permit No. 14207 specified, that prohibited activities within the mitigation areas include, but are not limited to: clearing, logging, bushhogging, mowing, grazing, spraying with herbicides, filling, leveling, ditching, draining, dumping, construction of any structure, or any other activity that would adversely impact the natural state of the area without obtaining a revision of this Department of the Army permit. Recognizing the need to control non-native invasive species (tall fescue in particular) ECO, Inc. made a request for a permit modification on November 26, 2007. The Section 404 Individual Permit No. 14207 was modified on December 19, 2007 as Permit No. 14207-3 to allow the use of vegetation management tools including herbicide application, mowing, and

prescribed burning. The permit modification required two additional years of monitoring, and the submittal of monitoring reports for seven years instead of five years.

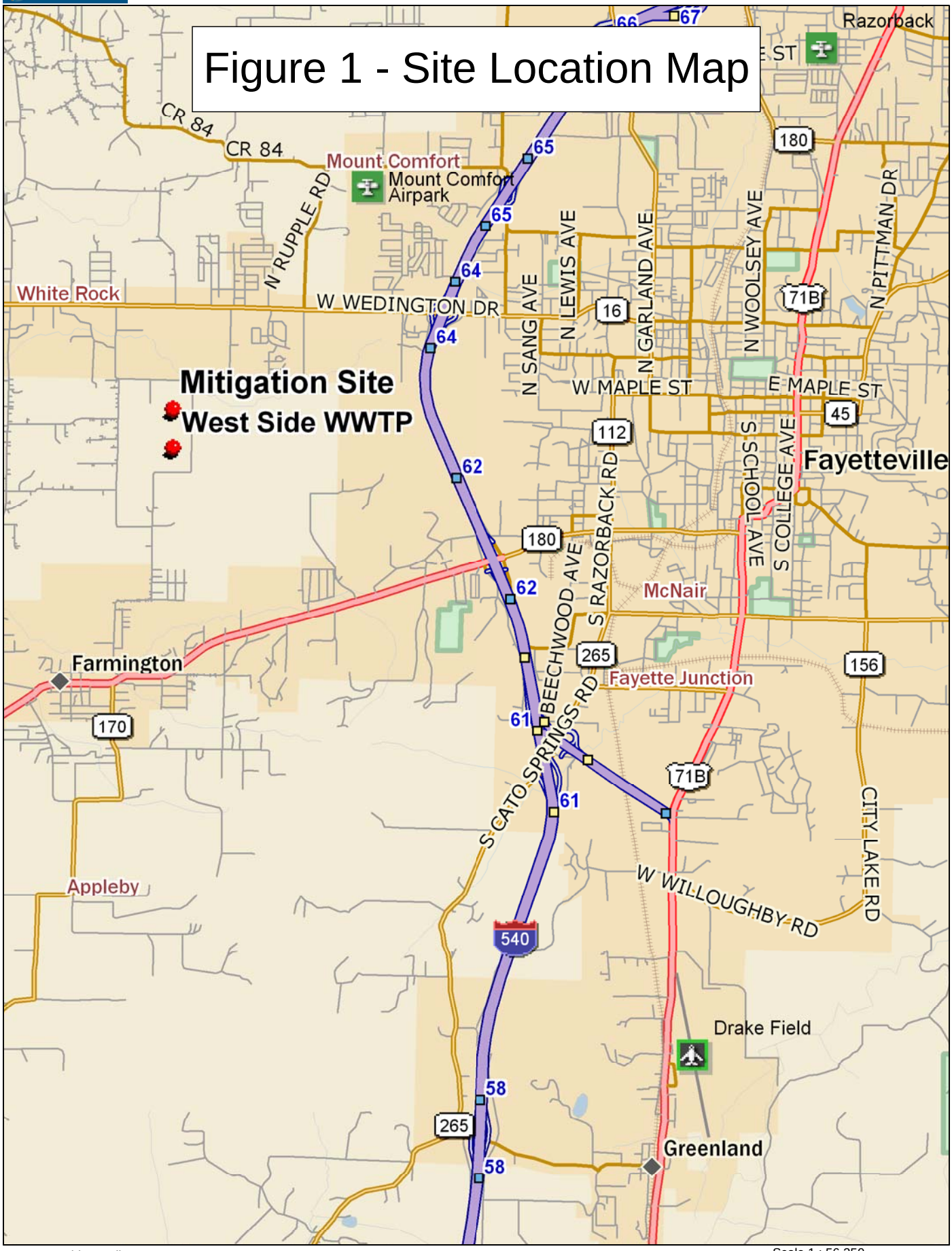
On March 29, 2006, the City of Fayetteville received Section 404 Nationwide Permit No. 19371 from the U.S. Army Corps of Engineers, Little Rock District (Corps) for the portion of the WSIP in the White River Watershed (east side) that involved 27 stream crossings and 4 wetland crossings during construction of sewer lines. The permit required wetland compensatory mitigation due to the permanent alteration of 0.16 acres of wetlands. The compensatory mitigation has been achieved at the City's wetland mitigation site.

Within the Illinois Watershed, another Nationwide Section 404 permit (No.14207-1) was issued to the City of Fayetteville WSIP on October 30, 2007 due to unavoidable impacts to Goose Creek as a result of construction of an outfall structure. This permit required the creation of approximately 0.084 acres of riparian buffer zone along the channel of Goose Creek, as mitigation. Planting of trees was required within the riparian buffer zone and monitoring is required for a period of three years. Two annual monitoring reports are required for years 1 and 3, and the reports are to be submitted to the Little Rock District within the monitoring reports required for Permit No. 14207.

The 43.65-acre wetland mitigation site is located immediately to the north of the Westside WWTP that became operational on June 1, 2008. A site location map is shown in Figure 1. McGoodwin, Williams, and Yates Consulting Engineers, Inc. of Fayetteville designed hydrological features and Environmental Consulting Operations, Inc. of Benton has done ecological feature design, site management, and monitoring. Brasfield and Gorrie General Contractors completed construction of earthen berms and water level control structures. Operation of hydrological controls, mowing, and herbicide applications are managed through Operations Management International, Inc. (OMI) a subsidiary of the CH2M Hill Companies, Ltd that also manages and maintains the City's wastewater utility system.

Modifications to the existing hydrology at the mitigation site were achieved via the construction of low elevation perimeter earthen berms designed to provide a mechanism for water retention. Water level control structures with stop logs were constructed within the berms in order to provide the ability to both hold and release water, as needed. Construction of the earthen berms resulted in two cells (W-1 and W-2) within the West Mitigation Site, and five cells (E-1 through E-5) within the East Mitigation Site. The mitigation site has been named "Woolsey Wet Prairie Sanctuary" in honor of Samuel Gilbert Woolsey, whose family settled the property in 1830.

Figure 1 - Site Location Map



TN
MN (2.5°E)

Scale 1 : 56,250
1" = 4,687.5 ft
Data Zoom 11-0

2.0 - SITE ADAPTIVE MANAGEMENT ACTIVITIES

The "adaptive management" approach has been utilized to manage site vegetation and hydrology. Adaptive management is a structured, iterative process of optimal decision-making in the face of uncertainty, with the objective to reduce uncertainty over time via system monitoring. Consequently, decision making simultaneously maximizes one or more resource objectives and, either passively or actively, generates information needed to improve future management. Adaptive management is often characterized as "learning by doing" in a decision-making process whereby any given selection of a vegetation management tools is done after observing the results of the previous vegetation management tool.

Among the adaptive management tools used for vegetation management at Woolsey Wet Prairie are:

- **Mowing to prevent undesirable plant species from forming seed heads**
- **Hand pulling of undesirable plant species**
- **Herbicide applications**
- **Prescribed burning**
- **Water level control**

Use of mowing, prescribed burning, and herbicide applications for control of non-native and invasive plant species have become commonly accepted practices among ecological restoration professionals. Implementation of "adaptive management" techniques that were previously prohibited at wetland mitigation sites are now not only condoned, but actually encouraged, by both the Corps and EPA.

With regard to ecological restoration projects, each site has its own unique characteristics such as soil chemistry, hydrology, and dormant seeds within the relict seed bank. This creates a scenario whereby the observed results from the implementation of site management tools can be somewhat unpredictable. The timing of implementation of each management tool can also be a very critical factor in the results that are produced. For the Woolsey Wet Prairie Sanctuary, the use of each site management tool was based upon the observed results from the previously used management tool, and was done in the following sequence, shown in Table 1 below:

Table 1 - Woolsey Wet Prairie Adaptive Management Activities

Date	Activity
May 2006	Discontinuation of decades of cattle grazing and haying operations
May - July 2006	Construction on of earthen berms for hydrological modification
October 2006	Spot spray Bermuda, Johnson grass, honey locust, sericea lespedeza, elm with Trichlopyr
March 2007	Installation of water level control structures
April 27, 2007	Mow to height of 10-12 " to prevent tall fescue seed head development
February 29, 2008	Prescribed burn
March 27, 2008	Plant tree saplings in forested wetland cells and at outfall structure
March 27 - April 5, 2008	Boom spray fescue with Sulfosulfuron
June 13, 2008	Plant approximately 10 Rattlesnake Master (*Eryngium yuccifolium) plants*
June 25, 2008	Plant approximately 50 tallhorned beaksedge (*Rhynchospora macrostachya)*
November 14, 2008	Boom spray tall fescue with Sulfosulfuron
February 19, 2009	Prescribed burn
March 25, 2009	Boom spray fescue with Glyphosate
March 29, 2009	Spot spray Johnsongrass with Sethoxydim
June – October 2009	Weekly spot spraying of invasive woody vegetation with Triclopyr
November 19-24, 2009	Wetland cell drawdown in preparation for prescribed burn
December 16, 2009	Prescribed burn
December 17, 2009	Reset stop logs in water level control structures to restore water levels in wetland cells
March 23 2010	Wetland cell drawdown in preparation for herbicide application
April 9-12, 2010	Boom spray with Clethodim.
June 2, 2010	Mow berms
June 10-15. 2010	Adjacent (west and north) fescue fields hayed before tall fescue goes to seed
June 18-22, 2010	Mow berm sides and site perimeter to primarily keep Queen Anne's Lace from going to seed
May – October 2010	Weekly spot spraying of invasive woody vegetation with Triclopyr

2.1 - Prescribed Burning

Prescribed burning is a widely accepted vegetation management tool for ecological restoration projects and is routinely conducted in Arkansas by the Arkansas Forestry Commission, the Nature Conservancy, and the Arkansas Natural Heritage Commission at natural areas. To date, prescribed burns have been conducted at Woolsey Wet Prairie on February 29, 2008, February 19, 2009, and December 16, 2009.

A multitude of studies have shown that the anthropogenic suppression of fire has been responsible for the eradication of many native plant communities nationwide.

Historically, Native Americans intentionally set fires for various reasons, one of which was for habitat enhancement for attraction of large migrating mammals such as bison and elk. In contrast, European settlers created fires for land clearing for agricultural purposes. Consequently, fire was used for two totally different ways of living. Native Americans' use of fire was one of promoting diversity (create food plots for game), whereas, the white settlers used fire to promote uniformity (wheat fields, corn fields, or pastures for livestock).

For ecological restoration, fire has become recognized as a valuable vegetation management tool that can be used to enhance community diversity. It has also been documented that prescribed burning should be done at a variety of seasons throughout the year instead of the same time each year. Fire removes much of the surface layer of decaying vegetation "thatch" that covers the ground. Many native plant species require sunlight to germinate, while others actually require fire to germinate. Prescribed burning is commonly used to increase native plant species richness. It has been obvious that many native plant species (some of them rare) are within the seedbed at the mitigation site, and have been either dormant or suppressed until conditions became favorable for them to complete their life cycle. The full extent of what species lie dormant within the existing seed bank is currently unknown, as new species continue to be added during each monitoring event.

At Woolsey Wet Prairie, the February 29, 2008 and February 19, 2009 prescribed burns were conducted in order to improve the density of native warm season grasses (NWSGs). Burns were also done at these periods to remove thatch in preparation for herbicide applications on tall fescue, as discussed in 2.2 - Herbicide Applications.

In an effort to further add to species diversity, a burn was conducted on December 16, 2009. No burns were conducted during 2010. Other considerations for burn scheduling include nesting season. Therefore burning at Woolsey Wet Prairie has been avoided during May through August when the majority of songbirds are nesting, and/or waterfowl are rearing their young.

2.2 - Herbicide Applications

Herbicides have been applied for control of tall fescue and other non-native invasive species. ECO, Inc. has conferred with Dr. Tom Barnes of the University of Kentucky Agricultural Extension Service, a nationally renowned expert in native grassland restoration, and control of non-native invasive species. He has conducted several studies showing the effectiveness of several herbicides for NWSG restoration.

The herbicide sulfosulfuron was selected as the herbicide to be used at Woolsey Wet Prairie Sanctuary in 2008 soon after the February 29, 2008 prescribed burn for control of tall fescue *(Schedonorus arundinaceus)*. Sulfosulfuron is a grass-specific herbicide that

causes minimal harm to many native plant species, has a very short half-life, and has been proven to be very effective for control of tall fescue.

Glyphosate was applied in 2009, soon after the February 19, 2009 prescribed burn. It is a broad-spectrum herbicides used for control of both grasses and forbs. However, its use at Woolsey Wet Prairie was done to control tall fescue at a time when native plants were dormant and not affected.

Tall fescue was originally introduced from Europe to the United States during the late 1800s. The University of Kentucky began developing tall fescue varieties in the early 1900s and released the KY 31 variety for distribution in 1943. Tall fescue is extremely competitive and capable of forming monocultures in former native grasslands. It is estimated that approximately 4 million of the 5.4 million acres of pasturelands in Arkansas are dominated by tall fescue. It contains a toxic alkaloid that is detrimental to bobwhite quail, white-tailed deer, songbirds, wild turkey, and other wildlife. Tall fescue has a wetland indicator status of FAC- and is capable of dominating wet meadow areas, significantly reducing native plant species richness.

Tall fescue is a cool season grass and actively begins photosynthesis very early in the growing season. It goes dormant during hot dry weather and actively grows in the fall even after several killing frosts. This provides an advantage in vegetation management since the fescue can be sprayed at a time when native plant species are still dormant. As observed soon after the February 29, 2008 and February 19, 2009 prescribed burns, tall fescue was the first plant species to become active after completion of the prescribed burn. It was apparent that three to four weeks after these burns would be a critical time to apply herbicides on the fescue.

Although small stands of cool season sedges and rushes that exist in marsh areas were flagged in the field, and designated as “no spray” areas, a slight reduction in sedge and rush species density was observed in 2009. This sedge/rush reduction is believed to have been caused by dense stands of large macrophytes (i.e. *Ludwigia spp., Persicaria spp., Typha spp*.) that were released due to reduction in tall fescue density and due to hydrological changes at the site. Residual sulfosulfuron and/or glyphosate may have also contributed somewhat to the observed reduction of sedges and rushes.

As shown in **3.0 - Mitigation Site Monitoring Results**, tall fescue has steadily declined. In a continued effort to eradicate tall fescue from the site, Clethodim, a post-emergent graminicide, was applied in April 2010. Clethodim is of low persistence in most soils with a reported half-life of approximately 3 days. Breakdown is mainly by aerobic processes, although photolysis may make some contribution. While it may be somewhat mobile in the soil environment, it is very short-lived. A dramatic reduction in tall fescue density was observed after use of Clethodim. Its effectiveness on control of tall fescue appeared to better than Sulfosulfuron or Glyphosate.

2.3 - Mowing

The mowing is aimed toward invasive species such as tall fescue, Johnson grass, ragweed, and sericea lespedeza. When necessary, stands of these species are mowed to a height of 10-12 inches as they begin to mature, but before they form seed heads. This is intended to prevent the dispersal of additional seeds from invasive species. Currently, most areas at the mitigation site remain too wet to mow. However, periodic mowing will be continued in a 50-foot perimeter around the mitigation site and on the earthen berms, as necessary.

2.4 - Hydrological Controls

Field observations have indicated that the hydrological model was extremely accurate in delineating wetland habitat type hydrology size and location. The model used 100 years of rainfall data, soil properties, evaporation, and detailed drawings with 6-inch contour lines.

Although the earthen berms were completed in July 2006, stormwater was only retained for 8 months. In March 2007, narrow excavations were made through the berms in order to install the water level control structures. The majority of the retained water was discharged at that time. Due to this water loss, and the fact that 2007 was a dry year, the full benefit of hydrological modifications to allow for a full year of uninterrupted rainfall storage was not experienced until March 2007 through March 2008. Year 2008 was an extremely wet year that had significant impacts upon the site hydrology, completely filling the wetland cells during periods of heavy rainfall.

The annual average precipitation at Fayetteville is 46.02 Inches. Rainfall distribution is fairly even throughout the year. The wettest month of the year is typically June with an average rainfall of 5.26 inches. As shown in Figure 2, rainfall amounts were 45.1 inches in 2006 (2.0% below average), 34.8 inches in 2007 (24.4% below average), 57.7 inches in 2008 (25.4% above average), 50.9 inches in 2009 (10.6 % above average), and 40.64 in 2010 (11.7% below average). Given that the site was allowed to collect a full year of rainfall in 2008 (a very wet year) an increase in monitoring stations exhibiting wetland vegetation, soils, and hydrology was observed. This trend continued during the 2009 monitoring year, which received well over the average rainfall amount. During this 2008-2009 period, all wetland cells were inundated during the majority of the year, with the prairie mounds as the only areas of dry land. The 2010 monitoring year was dry, and little inundation in wetland cells was observed. During the 2010 summer drought, little standing water was observed within the cells, although saturated soils remained.

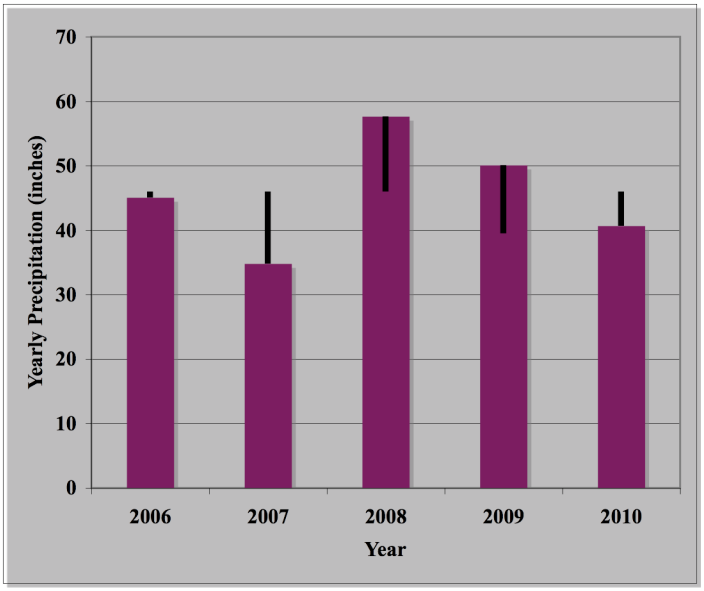


Figure 2. Annual Rainfall for Fayetteville, Arkansas. The deviation (±) from mean annual rainfall is displayed as black bars (Long-term average annual precipitation = 46.02 inches).

2.5 – Mitigation in Forested Wetland Planting Zones

The majority of the seven rare plant species have been observed at wet meadow areas within the West Mitigation Site that were originally targeted for planting of wetland trees and shrubs. Planting of trees and shrubs within these areas would be detrimental to the survival of the rare sedge species that grow in full sunlight. Consequently, forested planting zones were relocated to be predominately on the north end of the mitigation site where rare sedges have not been observed. On March 27, 2008, 201 green ash, Shumard oak, pecan, northern red oak, and black walnut saplings of each of the following tree species were planted at designated forested wetland zones.

During the fall of 2008, a field survey was conducted to evaluate survival rate. Survey results indicated an overall survival rate of 87 percent. Many volunteers of persimmon, black willow, green ash, and winged elm were also observed. Native prairie grass and forb volunteers have provided good ground cover. More efforts will likely be required to control the density of tree and shrub growth in order to maintain the wet prairie marsh-like character of the mitigation site.

Monitoring efforts during 2009 indicated that the majority of the planted tree saplings had not survived. However, numerous volunteer trees and shrubs have been observed of the following species shown in Table 2

Table 2 – Volunteer Tree and Shrub Species Observed 2006-2010

Volunteer Tree Species and Wetland Indicator Status		
winged elm	***Ulmus alata***	**FACU+**
American elm	***Ulmus americana***	**FACW**
chittum wood	***Sideroxylon lanuginosum***	**FACU**
persimmon	***Diospyros virginiana***	**FAC**
sassafras	***Sassafras albidum***	**FACU**
black cherry	***Prunus serotina***	**FACU**
eastern cottonwood	***Populus deltoides***	**FAC+**
eastern redcedar	***Juniperus virginiana***	**FACU-**
green ash	***Fraxinus pennsylvanica***	**FACW**
hackberry	***Celtis occidentalis***	**FACU**
honey locust	***Gleditsia triacanthos***	**FAC-**
silver maple	***Acer saccharinum***	**FACW**
American sycamore	***Platanus occidentalis***	**FACW-**
callery pear	***Pyrus calleryana ****	**No Data**
oak	***Quercus sp.***	**-**
bois d'arc	***Maclura pomifera ****	**FACU**
box elder	***Acer negundo***	**FACW**
tree-of-heaven	***Ailanthus altissima ****	**NI**
catalpa	***Catalpa bignonioides***	**FAC-**
black willow	***Salix nigra***	**OBL**
Volunteer Shrub Species and Wetland Indicator Status		
rough-leafed dogwood	***Cornus drummondii***	**FAC**
coral berry	***Symphoricarpos orbiculatus***	**FAC-**
button bush	***Cephalanthus occidentalis***	**OBL**
cockspur hawthorn	***Crataegus crus-galli***	**FAC-**
winged sumac	***Rhus copallinum***	**NI**
smooth sumac	***Rhus glabra***	**no data**
multiflora rose	***Rosa multiflora ****	**UPL**
Carolina rose	***Rosa carolina***	**FACU**
prairie rose	***Rosa setigera***	**FACU**
Himalayan blackberry	***Rubus pascuus ****	**UPL**
highbush blackberry	***Rubus argutus***	**FACU+**
creeping St. Andrew's cross	***Hypericum hypericoides var. multicaule***	**FAC**

* = nonnative species

Due to the observed success with volunteer species, management of woody species has been revised to include management of volunteers in lieu of management of planted species. The volunteer species provide more natural and diverse microhabitats, are composed of individuals of native species that are local genotypes, exist at desired density and ground cover, and are more sustainable than planted species. Due to the nature of Woolsey Wet Prairie management activities, planting trees in specific areas has not proven to be an effective way to achieve mitigation of forested wetlands. Planted

trees actually interfere with completion of activities such as herbicide applications and prescribed burning. Volunteer trees are grouped naturally, and better adapted to site hydrology than planted trees. Currently, there is approximately 2.95 acres set aside where volunteer trees are allowed to grow. Black willow is the predominate species and provides habitat for declining bird species, such as willow flycatchers, Bell's vireos and dickcissels. Prescribed burns prevent woody encroachment and maintain the wet prairie habitat. The volunteer tree growth has occurred in the wetter areas where inundation protects trees from fire.

3.0 - MITIGATION SITE MONITORING RESULTS

As specified within the City's 404 permit, ***"monitoring reports shall include inventories of all plant species, along with their relative frequency and percent cover, and photographs showing all representative areas of the mitigation site".*** Since the issuance of the City's 404 permit, the Director of Civil Works, Headquarters, U.S. Army Corps of Engineers issued Regulatory Guidance Letter (RGL) No. 06-03 on August 3, 2006, to provide guidance for minimum monitoring requirements for compensatory mitigation projects. Specifically, the RGL expressed that monitoring reports must be concise and effectively provide the information needed to determine the status of compensatory mitigation efforts. It also outlined the use of the three parameters defined in the 1987 Corps Wetland Delineation Manual (soils, hydrology, vegetation) and the use of functional assessment methods as performance standards for wetland mitigation monitoring. Consequently, the following performance standards were evaluated to determine success in achieving mitigation goals and objectives:

- **Inventories of all plant species**
- **Estimated relative frequency and species dominance**
- **1987 Corps Delineation Manual parameters –soils, hydrology, vegetation**
- **Functional Assessment – "Pre" & "Post" Charleston Method**

Monitoring activities completed to date include:

- **2002-2005 Pre-Mitigation Baseline Site Characterization**
- **October 2006**
- **May 2007**
- **November 2007**
- **June 2008**
- **October 2008**
- **July 2009**
- **November 2009**
- **July 2010**
- **October/November 2010**

Forty-seven permanent monitoring stations (plots) were established, based upon the original percent acreage of each plant community zone within each wetland cell, as shown in Table 3 below:

TABLE 3 - Plant Community Zone Acreage and # Plots Per Zone/Cell

Zone	Cell W1	Cell W2	Cell E1	Cell E2	Cell E3	Cell E4	Cell E5	TOTALS
Wet Meadow	0	4.45 ac. 7 plots	0	0.78 ac. 1 plot	0	1.80 ac. 3 plots	1.25 ac. 2 plots	8.28 ac. 13 plots
Forested	2.34 ac. 4 plots	0	0.46 ac. 1 plot	0	0.35 ac. 1 plot	0	0	3.15 ac. 6 plots
Marsh	0.12 ac. 1 plot	0.67 ac. 1 plot	0.36 ac. 1 plot	0.77 ac. 1 plot	0.19 ac. 1 plot	0.43 ac. 1 plot	0	2.54 ac. 6 plots
Open Water	0	0.05 ac. 1 plot	0.03 ac. 1 plot	0.04 ac. 1 plot	0.0	0.31 ac. 1 plot	0	0.43 ac. 4 plots
Upland Buffer	2.8 ac. 4 plots	1.61 ac. 2 plots	1.15 ac. 2 plots	1.41 ac. 2 plots	0.91 ac. 1 plot	2.67 ac. 4 plots	1.67 ac. 3 plots	12.22 ac. 18 plots
Acreage Totals	5.26 ac.	6.78 ac.	2.0 ac.	3.0 ac.	1.45 ac.	5.21 ac.	2.92 ac.	26.62 ac.
Total # Plots	9 plots	11 plots	5 plots	5 plots	3 plots	9 plots	5 plots	47 plots

3.1 - Plant Species Inventory/ Species Richness

Overall plant species richness at Woolsey Prairie has increased steadily from 2006 to 2010 (Figure 3). A total of 379 plant taxa have been documented from the site, though 9 have not been observed since wetland cells were created and were likely lost to subsequent hydrologic changes. However, many more wetland species have colonized the site as a result of the wetland creation, and others have appeared on the site, presumably from the seed bank, following reduction of tall fescue (*Schedonorus arundinaceus*) cover. Seventy nine species on the site (20.8% of the total) are considered to be not native to northwest Arkansas. Seven species (1.8% of the total) are identified as species of conservation concern (rare species) by the Arkansas Natural Heritage Commission.

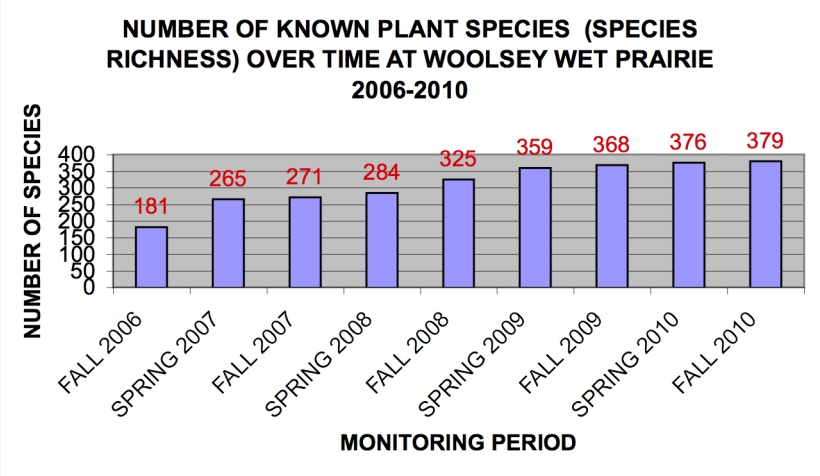


Figure 3. Total number of plant species documented from Woolsey Wet Prairie by monitoring period from 2006 to 2010.

Plot data taken from Fall and Spring 2006 to Fall and Spring 2010 show that species richness within plots has fluctuated both seasonally and yearly (Figures 4 and 5). Initial increases in species richness in 2006 and 2007 were likely the result of cessation of grazing on the site, though the addition of a few weed and wetland species were associated with wetland restoration/creation activities. This was followed by a general

decrease in species richness in 2008. This decrease is the result of two main factors: 1) drowning of non-wetland species as wetland cells filled with water, and 2) competitive exclusion by tall fescue in drier areas. However, replacement of these species with obligate wetlands plants was observed in wetter areas. During 2008, the appearance of emergent aquatic vegetation was noted, as prolonged inundation prevailed within all wetland cells. The density of many aquatic emergents was reduced during the drought of 2010, leaving areas with a much drier hydrology and pale smartweed (*Persicaria lapathifolia*) replaced the emergent aquatics as the dominant species in most of the marsh areas.

With the exception of upland plots, all plot types became wetter with time, especially in 2008 and 2009, which were very wet years. This led to shifts in species composition and dominance across the site, even in areas that already supported wetland flora. Specifically, shallower water may support higher species richness than deeper water, in which fewer species are adapted to live.

Increases in species richness from 2008 - 2010 in wet meadow and upland plots are likely the result of two factors: 1) maturation of the created/restored wetlands in 2006 and 2007 (and associated arrival of new species via waterfowl using these new wetlands), and 2) decrease in tall fescue cover following prescribed fire and herbicide application in March and April 2008, respectively. This fescue reduction released warm season forbs and grasses formerly suppressed by fescue competition.

Decreases in species richness between 2009 and 2010 in forested and marsh areas can be attributed to two events; 1) A dense stand of pale smartweed (*Persicaria lapathifolia*) became established in many of the wetland cells during a drawdown of water in March of 2010, followed by the summer drought of 2010. This species rapidly became dominant and excluded all other species in some plots; and 2) Clethodim was applied in early April 2010 to help control non-native cool-season grasses (such as tall fescue). This herbicide application was effective in reducing fescue, but also is possibly responsible for releasing some aggressive weedy forbs and grasses from competition.

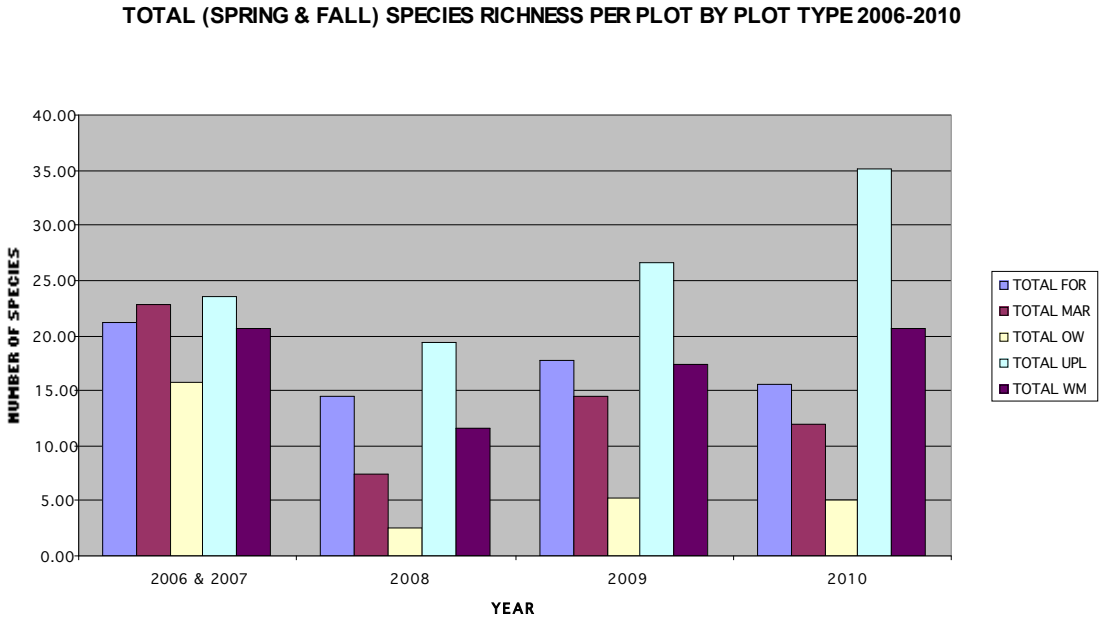


Figure 4. Total species richness per plot by year at Woolsey Wet Prairie from 2006 to 2010. Total number of species per plot are combined across seasons of a given year to control for seasonal variation. Note that Fall 2006 is totaled with 2007. FOR = forested plots, MAR = marsh plots, OW = open water plots, UPL = upland prairie plots, and WM = wet meadow plots. These data include only species found in the four 1 m by 1 m herbaceous subplots and not species found outside the subplots but within the larger 5 m radius plots.

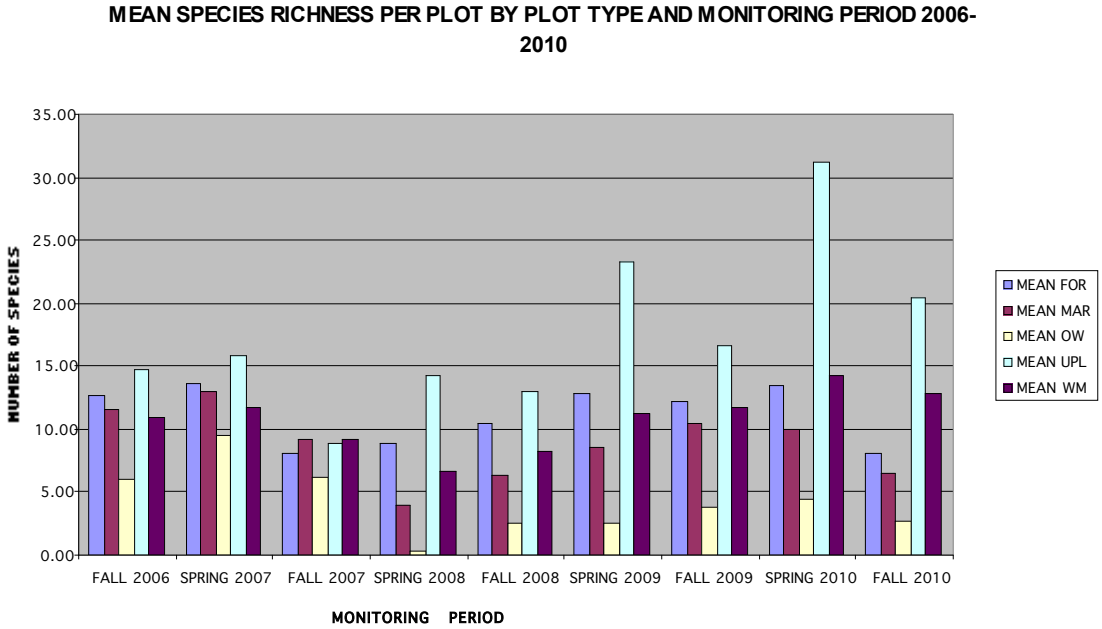
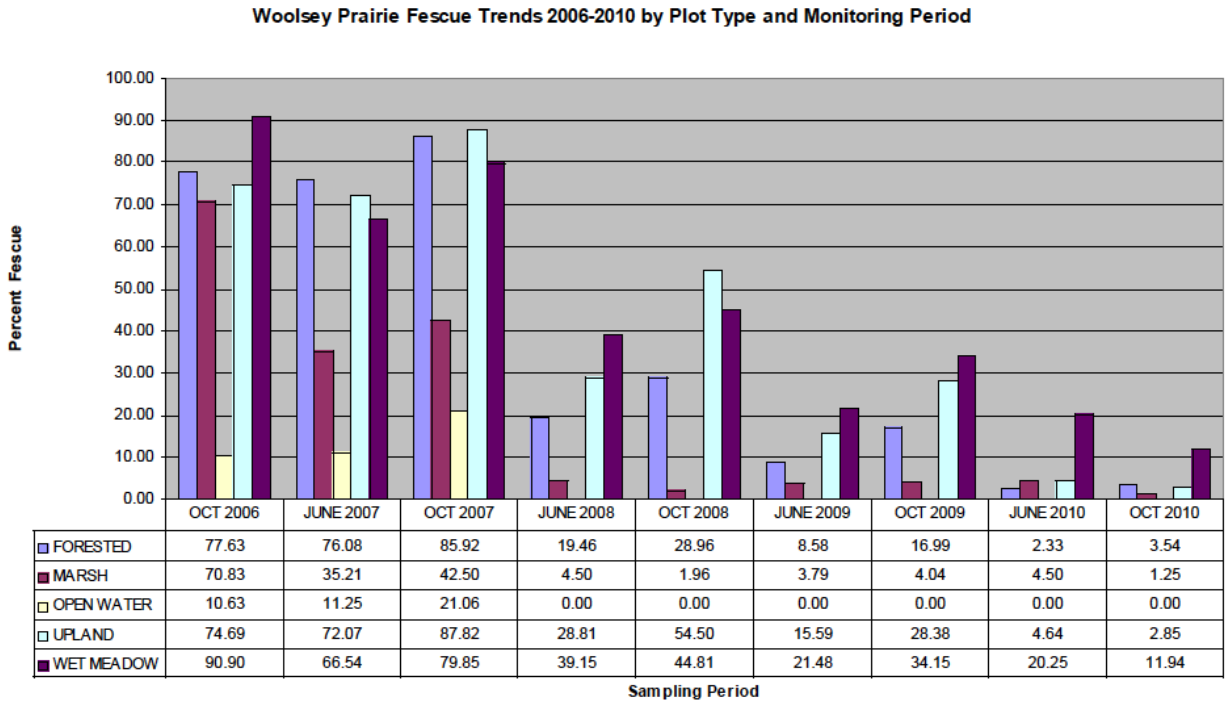


Figure 5. Mean species richness per plot by plot type and monitoring period at Woolsey Wet Prairie from 2006 to 2010. FOR = forested plots, MAR = marsh plots, OW = open water plots, UPL = upland prairie plots, and WM = wet meadow plots. These data include only species found in the four 1 m by 1 m herbaceous subplots and not species found outside the subplots but within the larger 5 m radius plots.

3.2 – Tall Fescue Density Reduction

Tall fescue has been the primary non-native invasive species responsible for inhibition of native forbs and grasses at Woolsey Wet Prairie in virtually all habitat types. Once it was observed that there is an apparent correlation between fescue reduction and native species richness and density, the primary adaptive management strategy was focused upon reduction of tall fescue density as a means to "release" native plant species. As shown in Figure 6, tall fescue percent cover ranged from 70% to 90% prior to implementation of adaptive management. Slight increases were observed at some habitat types upon discontinuation of haying/grazing at the site. A significant reduction in tall fescue was first observed upon use of herbicide applications that began in 2008. Since that time, a progressive reduction in tall fescue density has occurred, with most areas currently having less than 10% tall fescue cover. It was observed during 2010 that Wetland Cell W-2, on the southwestern portion of the mitigation site, is the only cell having any significant tall fescue densities. This is due to the fact that Wetland Cell W-2 drains to an old farm pond and does not have a water level control structure. Therefore, access with a boom spray rig in Wetland Cell W-2 has been limited.



	OCT 2006	JUNE 2007	OCT 2007	JUNE 2008	OCT 2008	JUNE 2009	OCT 2009	JUNE 2010	OCT 2010
FORESTED	77.63	76.08	85.92	19.46	28.96	8.58	16.99	2.33	3.54
MARSH	70.83	35.21	42.50	4.50	1.96	3.79	4.04	4.50	1.25
OPEN WATER	10.63	11.25	21.06	0.00	0.00	0.00	0.00	0.00	0.00
UPLAND	74.69	72.07	87.82	28.81	54.50	15.59	28.38	4.64	2.85
WET MEADOW	90.90	66.54	79.85	39.15	44.81	21.48	34.15	20.25	11.94

Figure 6. Tall fescue % density by plot type and monitoring period at Woolsey Wet Prairie from 2006 to 2010.

3.3 – Plant Species Recruitment and Loss

Adaptive management techniques aimed at reducing a dominant non-native species in order to release native flora also have the potential to release other non-native species. This can include the vegetation community response to herbicide applications, mowing, prescribed burning, and hydrological modifications. The non-native to native species relative abundance is shown in Table 4 for Monitoring Years 2006-2010. Monitoring

Year 2006 represents baseline conditions prior to implementation of adaptive management. The addition of non-native species relative to native species has been negligible and has remained relatively flat since 2007.

Table 4 – Non-native Plant Species Trend

Monitoring Year	2006	2007	2008	2009	2010
# Non-native species of total species	38/166	69/278	73/325	79/367	79/379
% Non-native species	22.9	24.8	22.5	21.5	20.8

The following nine species were observed on Woolsey Prairie prior to commencement of water retention in 2006 and/or 2007, but were not observed during 2008 to 2010.

Table 5 – Plant Species Observed in 2006-2007, But Not Observed in 2008-2010

Asclepias amplexicaulis (curly milkweed)
Baptisia bracteata var. *leucophaea* (cream false indigo)
Corydalis crystallina (mealy fumewort)
Festuca rubra (red fescue)
Helianthus grosseserratus (sawtooth sunflower)
Helianthus mollis (ashy sunflower)
Hieracium gronovii (hawkweed)
Penstemon tubaeflorus (whitewand beard-tongue)
Schizachyrium scoparium (little bluestem)

Only *Hieracium gronovii* (**UPL**), and *Helianthus grosseserratus* (**FAC+**), are listed in the 1996 National List of Vascular Plant Species that Occur in Wetlands. Therefore, this is indicative that these species likely did not recur on the site due to changes in hydrology associated with mitigation activities, and their lack of adaptation to hydric soils.

Table 6 shows 35 species that were observed in 2009 but not observed previously (species preceded by an * are non-native). With the exception of rattlesnake master and oak seedlings, which were introduced, it is likely that these appeared either from recruitment from the seed bank following the reduction in tall fescue and/or arrived at the site via waterfowl which began actively using the site once the wetland cells began to hold water, and colonized newly created wetland habitat.

Table 6 – New Plant Species and Wetland Indicator Status Observed In 2009

* *Ailanthus altissima* (tree-of-heaven) **FACU**	*Physalis longifolia* (longleaf groundcherry) **NL**
Ampelopsis cordata (heartleaf ampelopsis) **FAC+**	*Polygala sanguinea* (purple milkwort) **FAC-**
Andropogon glomeratus (bushy bluestem) **FACW+**	*Polygonum erectum* (erect knotweed) **FACU**
Campsis radicans (trumpet creeper) **FAC**	*Populus deltoides* (eastern cottonwood) **FAC+**
Ceratophyllum demersum (coontail) **OBL**	*Potamogeton pusillus* (narrowleaf pondweed) **OBL**
Cyperus erythrorhizos (redroot flatsedge) **OBL**	*Quercus, sp*. seedlings (introduced) **NL**
Dichanthelium commutatum (variable rosettegrass) **FAC**	*Rhexia mariana* (meadow beauty) **FACW+**
Eryngium yuccifolium (rattlesnake master) (introduced) **FAC**	*Rhus copallinum* (winged sumac) **FACU**
Hypericum gymnanthum (clasping St. John's wort) **FACW**	*Rhus glabra* (smooth sumac) **NL**
Ipomoea lacunosa (whitestar morning glory) **FAC+**	* *Salsola tragus* (Russian thistle) **NI**
Juncus diffusissimus (spreading rush) **FACW**	* *Sonchus asper* (spiny sowthistle) **FAC+**
Lindernia anagallidea (false pimpernel) **NL**	*Spiranthes vernalis* (spring ladies'-tresses) **FACW-**
Luzula echinata (wood rush) **FAC**	*Teucrium canadense* (germander) **FACW-**
Melothria pendula (dwarf cucumber vine) **FACW-**	*Tridens × oklahomensis* (Oklahoma purpletop) **NI**
Mollugo verticillata (green carpetweed) **FAC**	* *Verbascum thapsus* (woolly mullein) **NI**
* *Paspalum notatum* (Bahia grass) **FACU+**	*Vernonia arkansana* (Arkansas ironweed) **FAC**
Paspalum pubiflorum (hairyseed crowngrass) **FACW**	*Wolffia brasiliensis* (wolffia) **OBL**
Physalis heterophylla (clammy groundcherry) **NL**	

Table 7 shows 11 species observed in 2010, but not in prior monitoring years. All are native plant species

Table 7 – New Plant Species and Wetland Indicator Status Observed In 2010

Achillea millefolium (yarrow) **FACU**
Bidens frondosa (tickseed) **FACW**
Crotalaria sagittalis (rattlebox) **NL**
Cuscuta campestris (field dodder) **NL**
Desmodium canescens/illinoense (tick-trefoil) – sterile plant = ID is uncertain at present **NL**
Platanus occidentalis (American sycamore) **NL**
Pycnanthemum pilosum x P. tenuifolium (hybrid mountain mint) **NL**
Pyrrhopappus carolinianus (false dandelion) **NL**
Rorippa palustris ssp. fernaldiana (Fernald's yellowcress) **OBL**
Scleria ciliata (fringed nutrush) **FAC**
Solidago rugosa (wrinkleleaf goldenrod) **FAC**

Twenty seven (58.7%) of the 46 new species observed in 2009-2010 are FAC, FACW, or OBL; five (10.9%) are FACU; and 14 (30.4%) are not indicated on the 1996 National List of Vascular Plant Species that Occur in Wetlands.

3.4 - Rare plant species at Woolsey Wet Prairie Sanctuary

Seven plant species tracked as elements of conservation concern (rare species) by the Arkansas Natural Heritage Commission, were found to naturally occur at the mitigation site. All are sedges (family Cyperaceae) and are characteristic of wet prairie remnants. These include:

Carex arkansana **(Arkansas sedge) – G4S1 –** This uncommon sedge is known in Arkansas from wet prairie remnants, hydric oak flatwoods, and similar open wetland

habitats (ANHC, 2007). While it has no wetland indicator status code in the USDA Plants Database, it is listed by Yatskievych (1999) as occurring primarily in bottomland prairies and moist depressions of upland prairies. At Woolsey Wet Prairie it is scattered in wetter areas of the prairie.

***Carex opaca* (opaque prairie sedge) – G4S2S3 –** This rare sedge is primarily associated with unplowed, wet tallgrass prairie remnants in Arkansas (ANHC, 2007). While it has no wetland indicator status code in the USDA Plants Database, it is listed by Yatskievych (1999) as primarily occurring in "bottomland prairies, moist depressions of upland prairies, and margins of fens." At Woolsey Wet Prairie it is scattered in wetter areas of the prairie.

***Carex fissa* var. *fissa* (a sedge) – G3G4S1 –** Prior to its discovery at Woolsey Wet Prairie, this rare sedge was known in Arkansas from only two sites in Saline and Lonoke Counties where is occurs in disturbed prairie-associated wetlands and wet hardwood flatwoods (ANHC, 2007). At Woolsey Wet Prairie, it occurs in small numbers in two naturally occurring prairie swales in cells W-1 and W-2.

***Carex pellita* (a sedge) – G5S1 –** Prior to its collection at Woolsey Wet Prairie, this species was known to be extant at a single Arkansas locality, in a fen in Marion County. At Woolsey Wet Prairie it is uncommon in one open water plot and locally common in one marsh plot. It is apparently increasing at the site based on observations in 2007.

***Eleocharis wolfii* (Wolf's spikerush) – G3G4S2 –** This wetland sedge occurs in Arkansas primarily in wet areas in unplowed tallgrass prairie remnants but can persist in wet, open areas in landscapes that were formerly dominated by prairie vegetation (ANHC, 2007). At Woolsey Wet Prairie it is locally common in several naturally occurring swales and is now expanding around at least two of the marsh plots.

***Rhynchospora macrostachya* (tall horned beaksedge) – G4S1 -** Prior to its collection at Woolsey Wet Prairie, this species was known from Arkansas only from historical collections. At Woolsey Wet Prairie it was known from two natural prairie swales prior to construction of the berms, but is now increasing in marsh areas at the site. In the fall of 2006, ECO, Inc. gathered seeds and successfully propagated over 50 specimens during the 2007 growing season that were transplanted into marsh areas at the mitigation site during 2008. A 90 percent survival rate was observed, and transplanted specimens produced large seed heads by the end of the 2008 growing season. During the 2009 growing season, it was observed that much of the beaksedge failed to return. The suspected cause for this is believed to be related to hydrology and the appearance of dense stands of large macrophytes (i.e. *Ludwigia spp., Persicaria spp., Typha spp.*) that were released due to reduction in tall fescue density and due to hydrological changes at the site. This species typically grows in wet areas of shallow inundation where water levels fluctuate. Tall horned beaksedge requires conservation of habitat and protection of

the hydrology, including maintenance of cyclical drawdown regime and water table. No drawdowns were performed during the 2009 growing season and an abundance of standing water prevailed at the site. This lack of fluctuating water levels is likely responsible for reduced densities. It was observed that the high densities returned during the 2010 growing season after drawdowns were performed in late November 2009 in preparation for a prescribed burn, and again I late March 2010 in preparation for a herbicide application.

Scleria pauciflora **(fewflower nutrush) – G5S3 –** This sedge is known in Arkansas from unplowed tallgrass prairies, saline barrens, and open pine flatwoods (ANHC, 2007). At Woolsey Wet Prairie it occurs in areas that support other characteristic prairie vegetation.

SOURCES:
ANHC (Arkansas Natural Heritage Commission). 2007. Database of Elements of Conservation Concern. Arkansas Natural Heritage Commission. Little Rock, AR.

Yatskievych, G. 1999. Steyermark's Flora of Missouri. Vol. 1. Revised Edition. Missouri Dept. of Conservation & Missouri Botanical Garden Press. St. Louis, MO. 991 pp.

3.5 - 1987 Corps Delineation Manual Parameters

Wetland parameters that included soils, hydrology, and vegetation (based on wetland plant community dominance) were sampled within each plot type (upland, forested and wet meadow, marsh, and open water). The size and location of each of these zones was based upon a hydrological model that predicted areas of soil saturation and/or inundation. The use of habitat type (i.e. wet meadow, upland, etc.) at the 47 monitoring stations has been continued for purposes of developing a trend analysis, although most of the habitat types have changed significantly since monitoring activities began in 2006.

Many of the former upland plots now exhibit wetland characteristics in the soil, hydrology, and vegetation, with the exception of plots located on top of prairie mounds. Most of the Forested and Wet Meadow Plots evolved into Marsh and Open Water areas during the higher levels of inundation throughout the very wet 2008-2009 period. During the dry 2010 growing season, the majority of these areas reverted back to Wet Meadow habitat, but still exhibited positive wetland characteristics, although the vegetation community composition changed significantly.

A trend of successful establishment of wetland vegetation was analyzed by calculating the type of dominant vegetative species present during nine biennial monitoring events. Plots in which more than 50% of the dominant species are OBL, FACW, or FAC are considered to exhibit wetland vegetation. Figure 7 shows the wetland vegetation trend. When comparing Fall 2009 to Fall 2010, the predominance of wetland vegetation at Forested Wetland Plots remained unchanged at 83%; Marsh plots increased from 83% to 100 %; Open Water Plots remained unchanged at 100%; Wet Meadow plots increased from 54% to 85% and Upland plots showed an increase from 11% to 33%. Similarly, a comparison of Spring 2009 to Spring 2010 indicated steady conditions at Forested plots

at 83%; an increase from 83% to 100% at Marsh plots; an increase from 75% to 100% at Open Water plots; an increase from 39% to 62% at Wet Meadow plots; and an increase from 28% to 50% at Upland plots.

Overall, the cumulative effects of hydrological modifications continue to not only sustain created and restored wetlands, but also indicate additional upland areas are becoming wetlands, even though 2010 was a drier year than 2009.

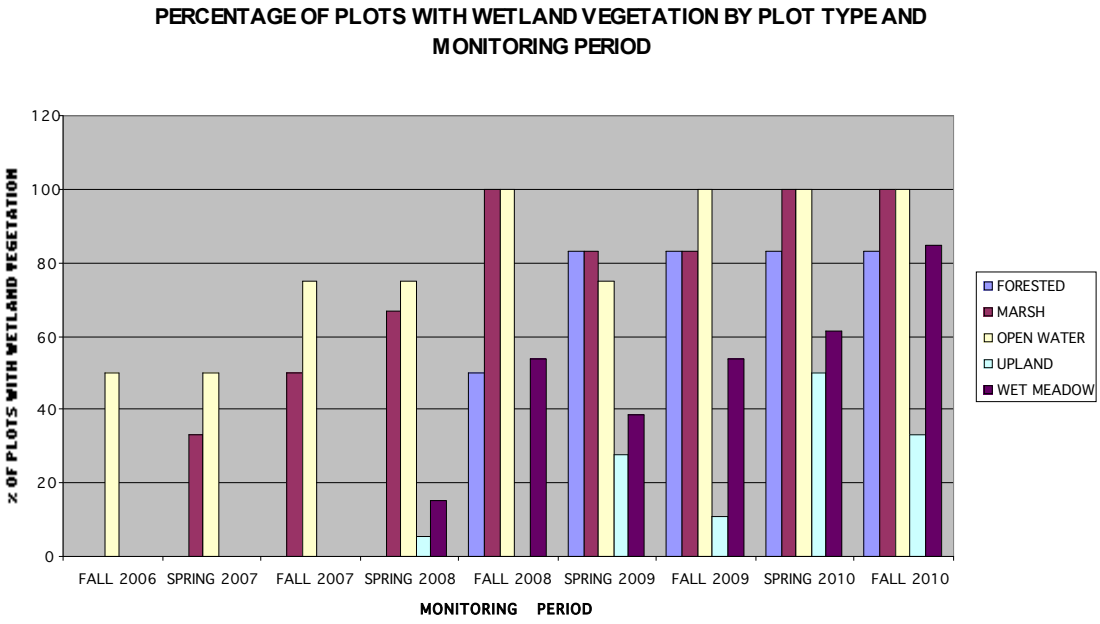


Figure 7. Percentage of plots dominated by wetland vegetation (OBL, FACW, or FAC), based on the 50/20 rule for calculating dominance, for Fall 2006, Spring 2007, Fall 2007, Spring 2008, Fall 2008, Spring 2009, Fall 2009, Spring 2010, and Fall 2010 monitoring periods.

3.6 - Wetland Functional Assessment

The Charleston Method was initially utilized to determine that a total of 80.8 mitigation credits were needed to offset the permanent alteration of 9.88 acres of wetlands by the WSIP, as follows:

Table 8 – Permanently Altered Wetland Acreage and Credits Needed for Mitigation	
North Broyles Road PEM Wetlands Permanently Altered	1.27 acres/9.13 debits
Westside WWTP PEM Wetlands Permanently Altered	5.64 acres/40.6 debits
Broyles Road/Goose Creek PFO Wetlands Permanently Altered	1.39 acres/16.0 debits
Westside Collection System PFO Wetlands Permanently Altered	1.42 acres/13.5 debits
Total Permanently Altered Wetlands	9.56 acres/79.2 debits

*PFO – palustrine forested wetlands "seasonally inundated forest"
*PEM – palustrine emergent wetlands "wet meadow"

During construction of the eastside collection system, a sewerline realignment was designed that resulted in a diversion around the 0.16 acres of PFO wetlands on the eastside collection system. Therefore, 1.52 of the needed credits can be deducted,

leaving a need for 79.2 mitigation credits were needed to offset the permanent alteration of 9.56 acres of wetlands by the WSIP.

The City of Fayetteville WSIP Wetland Compensatory Mitigation Plan, developed and submitted to the Little Rock District in January 2005, and the City's Section 404 permit outlined the creation of 4.05 acres of wet meadow wetlands and 3.06 acres of forested wetlands (total creation acreage = 7.11 acres), restoration and enhancement of 7.29 acres of existing emergent wetlands, and enhancement of 12.22 acres of existing upland prairie as buffering. This resulted in a total of 110 credits to be generated on 28.2 acres to offset wetland losses. This produced an excess of 30.8 credits over the 79.2 credits needed, as shown below.

Table 9 - Project Acreage and Credits Originally Generated in 2007	
Existing Mitigation Site PEM Wetlands Restored/enhanced	**7.29 acres/37.9 credits**
Upland Prairie Buffer Restored/enhanced	**12.22 acres/55.0 credits**
Eastside Collection System PFO Wetlands partially restored	**0.16 acres 0.2 credits**
Westside Collection System PFO Wetlands partially restored	**1.42 acres 2.3 credits**
Total Wetlands Restored/Enhanced	**21.09 acres/95.4 credits**
PEM Wetlands Created	**4.05 acres/8.5 credits**
PFO Wetlands Created	**3.06 acres/6.1 credits**
Total Wetlands Created	**7.11 acres/14.6 credits**
Total Mitigation Acreage/Credits Generated	**28.2 acres/110 credits**

***PFO – palustrine forested wetlands "seasonally inundated forest"**
***PEM – palustrine emergent wetlands "wet meadow"**

The 110 credits were based upon field surveys and quantifications of wetland/upland acreage during the calendar year 2007. As previously stated, water losses were experienced from installation of water level control structures and excessively low rainfall amounts in 2007. Therefore, a full year of uninterrupted rainfall storage was not experienced until March 2007 through March 2008. Regardless, the site demonstrated a high capability of water storage. Stop logs at water level control structures were set to optimize water storage and prevent berm overflows that may cause erosional damage to the berms.

Due to optimized hydrological controls in 2008, an increase in wetland acreage was observed that was well beyond what designers anticipated. The increase in created wetland acreage resulted in a corresponding reduction in upland buffer enhancement acreage. A portion of the increase in wetland acreage and credits was generated from improved hydrology and site management, and a portion was generated from including acreages of wetland creation, wetland enhancement, and upland buffer enhancement in areas outside of the wetland cells, but within the deed-restricted area. Observations of these areas have shown improved habitat function and value as compared the preconstruction conditions. Additionally, the earthen berms themselves serve as upland buffers and were included in the 2008 revised values. These areas outside of the cells qualify for the generation of wetland mitigation credits since they meet the following criteria:

1) They are located within the 43.8-acre parcel that was deed restricted in perpetuity as a mitigation site;

2) They contain native species not observed within the wetland cells;

3) They contribute to wetland habitat at Woolsey Wet Prairie;

4) They are managed in the same manner as Woolsey Wet Prairie. Management activities including removal of cattle, discontinuation of haying, application of herbicides, and mowing to provide a protective buffer around the perimeter of the cells that preclude the introduction of non-native invasive species.

5) Construction of the berms has also resulted in wetland enhancement and creation outside of the wetland cells in these areas.

The 2008 monitoring activities indicated that a total of 160.13 credits had been generated from mitigation activities. This equates to an excess of 80.93 credits over the 79.2 credits needed. In 2009, ecologists from Environmental Consulting Operations, Inc. and surveyors from McGoodwin, Williams, and Yates Consulting Engineers, Inc. conducted field work to get an accurate updated quantification of wetland acreage, and develop an "as-built" drawing of the mitigation site (Figure 8). Wetland delineations were conducted, and wetland/nonwetland interfaces were marked in the field. Subsequently, the "as-built" drawing was completed, and wetland acreage was quantified. Table 10 shows the revised 2009 wetland acreage and credits, as compared to the 2007 and 2008 assessments.

With a more accurate quantification and delineation of wetland areas, an increase in wetland credits was observed. For 2009, the total mitigation credits were 175.18, or an overage of 95.98 credits (121%) of the 79.2 credits required for compensatory mitigation. This is attributed to vegetation management activities and improved control of site hydrology. Due to observations in 2010 that some of the former upland stations are beginning to exhibit wetland characteristics, no significant change in the number of credits from 2009 to 2010 is indicated.

Table 10 – Revised Project Acreage and Credit Comparison for 2007-2009			
Mitigation Type	**2007**	**2008**	**2009**
Existing Mitigation Site PEM Wetlands Restored/Enhanced	7.29 acres/37.9 credits	7.29 acres/37.9 credits	7.29 acres/37.9 credits
Existing PEM Wetlands Outside Cells Restored/Enhanced	0	1.49 acres/7.75 credits	1.49 acres/7.75 credits
Eastside Collection System PFO Wetlands partially restored	0.16 acres/0.2 credits	0	0
Westside Collection System PFO Wetlands partially restored	1.42 acres/2.3 credits	1.42 acres/7.1 credits	1.42 acres/7.1 credits
Total Non-Buffer Wetlands Restored/Enhanced	8.87 acres/40.4 credits	10.2 acres/52.75 credits	10.2 acres/52.75 credits
Upland Buffer (berms/mounds) in Cells Restored/Enhanced	12.22 acres/55.0 credits	10.91 acres/53.46 credits	5.59 acres/27.39 credits
Upland Prairie Outside Cells Restored/Enhanced	0	5.14 acres/25.19 credits	11.98 acres/58.7 credits
Total Upland Buffer Restored/Enhanced	12.22 acres/55.0 credits	16.05 acres/78.65 credits	17.57 acres/86.09 credits
PEM Wetlands Created in Cells	4.05 acres/8.5 credits	9.95 acres/20.89 credits	10.72 acres/22.51 credits
PEM Wetlands Created Outside Cells	0	1.01 acres/2.12 credits	3.71 acres/7.79 credits
PFO Wetlands Created in Cells	3.06 acres/6.1 credits	2.86 acres/5.72	3.02 acres/6.04
Total Wetlands Created	7.11 acres/14.6 credits	13.82 acres/28.73 credits	17.45 acres/36.34 credits
Total Mitigation Acreage/Credits Generated	28.2 acres/110 credits	40.07 acres/160.13 credits	45.22 acres/175.18 credits

175.18 mitigation credits generated by mitigation activities
- 79.2 mitigation credits to offset the permanent alteration of 9.56 acres of wetlands by the WSIP
95.98 surplus credits

= MITIGATION BOUNDARY

= BERMS AND NON WETLAND AREAS

=	WETLAND AREA OUTSIDE BERMS	226,345 SQ. FT. 5.20 AC.

= WETLAND AREA INSIDE BERMS

WETLAND AREA INSIDE BERMS		
	SQUARE FEET	ACRES
CELL W-1	176,720	4.057
CELL W-2	227,356	5.224
CELL E-1	67,072	1.540
CELL E-2	111,213	2.553
CELL E-3	39,979	0.918
CELL E-4	185,770	4.265
CELL E-5	107.861	2.475
TOTAL	915,971	21.028

WETLAND AREA OUTSIDE BERMS	226,345 SQ. FT. 5.20 AC.

TOTAL WETLAND AREA OUTSIDE AND INSIDE BERMS WITHIN MITIGATION BOUNDATY
1,142,316 SQUARE FEET 26.224 ACRES

OZARKS ELECTRIC SUB-STATION SITE

DATE: 2-24-09
EXISTING WELL BY NE CORNER OF OZARK'S ELECTRIC SITE
TOP WELL ELEV.: 1234.42'
TOP TO BOTTOM WELL: 18.40'
TOP TO WATER LEVEL: 3.03'

REV	DATE	BY	DESCRIPTION

DESIGNED JF | DRAWN JF | CHECKED GD

PLANS NO. FY-316

McGoodwin Williams & Yates
Engineering Confidence

STRUCTURE NO. -

SHEET NO. 1/1

4.0 – RIPARIAN MITIGATION AT OUTFALL STRUCTURE

As required by NWP No. 19371, riparian mitigation must be completed to offset unavoidable impacts to 0.02 acres of waters of the US caused by redirection of Goose Creek during the construction of the wastewater plant outfall structure. The permit requires riparian restoration activities on 0.084 acres of riparian buffer zone near the outfall structure. The 404 permit requires monitoring of the site for three years, with annual reports to be submitted to the Little Rock District on the first and third years. The 2008 mitigation monitoring report developed in 2008 the first year of monitoring, and the report contained herein is the third year of monitoring.

On March 27, 2008, 24 seedlings of each of the tree species shown in Table 11 were planted at the designated riparian zone.

Table 11 – Trees Planted at Outfall Structure Riparian Zone

Common Name	Botanical Name	Indicator Status	# Surviving in 2008	# Surviving in 2010
Black walnut	***Juglans nigra***	**FACU**	**22**	**1**
Pecan	***Carya illinoensis***	**FAC**	**7**	**0**
N. Red Oak	***Quercus rubra***	**FACU**	**24**	**2**
Shumard oak	***Quercus shumardii***	**FACW**	**22**	**1**

During the fall of 2008, a field survey was conducted to evaluate percent survival. Survey results indicate an overall survival rate of 78 percent. Volunteers of honeysuckle and greenbrier were also observed. Native grass and forb volunteers have provided good ground cover.

Observations made in the fall of 2010 revealed only a 4% survival rate. It was apparent that the 2010 drought and competition from thick growth of green briar, sericea lespedeza, and honeysuckle had contributed to the low survival rate. Currently, the City of Fayetteville is planning to replant the area with 2-3-inch caliper trees during the winter of 2010-2011 in lieu of tree seedlings. The trees will be watered regularly during the summer of 2011. Planting larger trees and watering is anticipated to result in an improved survival rate.

5.0 - PLANNED ADAPTIVE MANAGEMENT ACTIVITIES FOR 2011

5.1 - Hydrology Management

The dominance of dense stands of pale smartweed (*Persicaria lapathifolia*) is not necessarily a bad thing, although it did appear to reduce the biodiversity of sedges, rushes, and emergent aquatic plants in certain areas. The dramatic change in hydrology during the 2010 growing season is likely the primary cause. The seeds of pale smartweed (achenes) are a popular source of food for 20 species of ducks, 4 species of rails, snipe, bobwhite quail,, mourning doves, and 30 species of songbirds. Therefore, its value to

wildlife is quite high. The flowers attract Halictid bees, wasps, flies, and occasionally small butterflies, and the foliage is eaten by various species of beetles and the caterpillars of the butterflies and moths. However, due to the foliage being bitter and peppery, it is not often eaten by mammalian herbivores.

Although pale smartweed provides value to wildlife, management of Woolsey Wet Prairie is aimed at promoting biodiversity, and avoidance of near monoculture conditions, even with native species. Such a situation has the potential to adversely affect species richness. Species richness can be affected directly by local environmental conditions that determine the pool of species physiologically capable of living at any given site; and indirectly through biomass, which can affect competitive exclusion. Thus, there is a correlation between productivity (above ground biomass) and species richness. In essence, there is a mechanism whereby favorable environmental conditions that lead to increased accumulation in biomass of any given species can lead to competitive exclusion of other species. Therefore, declines in biodiversity can often be observed when vegetation surpasses normal productivity. It is apparent that this mechanism was in place to a degree during the 2010 growing season with the dense stands of pale smartweed. This did not adversely affect the wetland mitigation success, or wetland credits generated, however, preventative measures are being planned to avoid a monoculture situation. This will best be managed via management of site hydrology.

Plant zonation occurs along water depth and soil saturation gradients. Consequently, variations in water depth and degree of soil saturation lead to variations in species composition. The timing and frequency of flooding and drawdowns are also among the most important filters in species assemblages. Inundation causes physical disturbances, removal of litter, transport of sediments and nutrient availability and an increased dispersal of seeds.

Variations in plant zonation were reduced during the 2010 growing season, due to drought conditions. This may have been affected to a degree by the March 23, 2010 wetland cell drawdown in preparation for the herbicide application. However, Wetland Cell W-2, which cannot be drained since it has no water level control structure, became very dry like the other cells. Therefore, it is speculated that the lack of previously observed variations in water depth and degree of soil saturation would have occurred anyway due to drought conditions. This is believed to have been the underlying cause of excessive pale smartweed growth.

Pale smartweed prefers moist soil in poorly drained areas with abundant organic matter. It is somewhat weedy, and can be aggressive when favorable conditions exist. It tolerates occasional flooding, but typically grows at the edge of flooded areas. It does not grow as well in standing water with depths of one foot or more. Restoring water retention to previous levels of inundation and soil saturation should reduce the density of smartweed and allow other species to grow. The presence of smartweed is not necessarily a bad

thing; however, it has grown so dense in some locations that a reduction in mud flat habitat that is attractive to the many species of shorebirds has been observed. It is one of the management goals to restore a portion of the mudflat habitat via control of smartweed.

Currently, all stop logs at water level control structures are set for water retention in the wetland cells. They will be maintained at these settings in order to restore inundation. This will allow for standing water in areas of dense smartweed growth. During the 2011 growing season, the smartweed growth should not be as dense as observed during 2010. Therefore, a return of some of the mudflats as well as denser growth of sedges and rushes should be observed.

Drawdowns are not planned in the near future, with the exception of Wetland Cell W-2. Since the tall fescue is largely under control, herbicide applications with the large boom sprayer should not be necessary. Consequently, wetland cell draining will no longer be necessary for large equipment access. In summary, for management of hydrology, the major emphasis will be to recreate natural hydrological regimes in a manner to limit productivity of any single species from becoming excessively high, while at the same time, enriching biodiversity.

5.2 - Prescribed Burning

The season of the year at which a prescribed burn is conducted has a great influence over the vegetation community (Table 12). This knowledge can be used as a management tool to achieve desired effects. The February 29, 2008 and February 19, 2009 prescribed burns can be considered to be "Late Dormant" burns, and the December 16, 2009 burn was a "Mid Dormant" burn. The results of all burns were an increase in species diversity, although the December 16, 2009 burn appeared to encourage the preponderance of forbs over grasses.

With the objective of increasing encouraging native warm season grasses (NWSG) and suppressing hardwood sprouts, a prescribed burn will be conducted during the Mid-March to Mid-April 2011 time frame. Ideally, this will occur during the transition from the Late Dormant to Dormancy Break periods. At that time, most of the warm season species will still be dormant and there will be plenty of fuel from the vegetation killed by winter cold weather. A burn during this time should:

- **Reduce the density of smartweed**
- **Set back cool season invasives such as tall fescue**
- **Favor NWSGs**
- **Be outside the bird breeding season**

An important consideration for prescribed burning of uplands versus wetlands as restoration tools lies in the fact that some wetland sedges and native wetland grasses are C3 cool-season plants, that can be disadvantaged as much as their exotic competitors by a

mid- to late-spring burn. Given that a drawdown will not be done in preparation for the burn, as was done previously, areas supporting C3 cool season plants should be wet enough to prevent encroachment of fire. Woolsey Wet Prairie is a mesic (saturated soils and shallow inundation) prairie that has a tendency to be dominated by forbs. The species composition can be shifted toward grasses that historically dominated prairies in northwest Arkansas via yearly spring burns.

Table 12 - Effects Of Season Of Prescribed Burn

Season of Burn	Effect	Timing Indicators
Early Dormant (Late Fall: Oct-Nov)	Encourages forbs. Suppresses NWSG *Note: Never burn newly established Native Warm Season Grasses (NWSG) at this time*	After the first frost. Native grasses have ceased growing for the year. Above-ground stems have turned any variation of brown, gold, red, or yellow only within the last few weeks or month. Broken stems may be slightly green inside. Hardwoods are losing their leaves.
Mid-Dormant (Winter: Dec-Jan)	Encourages NWSG and forbs. Minimal impact on hardwood sprouts	Above-ground stems are dry and, when broken, are dry within their core. Hardwoods are dormant and have lost their leaves.
Late Dormant (Late Winter/Early Spring: Feb –Mar)	Encourages NWSG	Above-ground stems are dry hardwood buds have not yet swollen or may have just begun to swell.
Dormancy Break (Spring: April-May)	Encourages most NWSG species while suppressing cool-season grasses and hardwood sprouts; favors dominant tall grasses over forbs and woody species.	Hardwood buds are swollen, and a few have leafed out. Check the base of grass crowns for emerging shoots of new growth up to 1 inch in height. Many times these can be found just below the soil's surface.
Growing Season (Summer: June - July)	Suppresses NWSG and encourages forbs	NWSG seed stems are elongated, plant is blooming and/or seed heads have formed.
Late Growing Season (Late Summer/Early Fall: Aug-Sept)	Stresses NWSG and encourages forbs. Provides the best hardwood sprout control.	Late summer, early fall. Seed has set. Stems are just beginning to change color or have turned but are still green inside when broken. Hardwood leaves are changing color.

Prairie burning reduces mulch cover, increases the number of reproductive grass shoots, and results in a more rapid phenological development of young plants and an increase in flower production. Removal of the litter allows soil temperatures to warm more rapidly

Although total forb yields may usually be reduced more by spring burns than fall burns, forb composition will very likely be increased by burning when plants are dormant. Otherwise, young, actively growing forbs will be severely harmed by fire.

The cumulative effects of fire seem to be important in controlling invasion by nonnative species due to the increased productivity of dominant native C4 grasses under a regime of frequent fire rather than to direct negative impacts of fire on nonnative species/

One study of long-term annual spring burning resulted in 80 percent to 100 percent reductions in number and abundance of nonnative plant species compared with infrequently burned plots. Nonnative species were absent from sites that had been burned 26 of 27 years, and nonnative species richness steadily increased as the number of times a site was burned decreased. The highest nonnative species richness occurred on sites burned fewer than 6 times over the 27-year period. Thus it appears that repeated spring burning offers a substantial opportunity for shifting the competitive balance toward native species. Once achieved, this will provide a savings and protect the ecosystem by reducing the frequency and quantities of herbicides at Woolsey Wet Prairie.

5.3 Herbicide Applications

It is anticipated that future herbicide applications can be accomplished with backpack sprayers and/or ATV mounted spray equipment. Most of the fescue has been significantly reduced, with the exception of Wetland Cell W-2 (southwestern-most cell). Access with the boom sprayer has been limited due to the fact a drawdown of Cell W-2 cannot be achieved because it has no water level control structure. Consequently, Cell W-2 has a few areas where dense stands of fescue persist.

Soon after the 2011 prescribed burn, Cell W-2 will be drained with a motorized pump. Clethodim will be applied via backpack sprayers and/or ATV mounted spray equipment. Excellent results on eradication of fescue with very minimal harm to non-target plant species, including sedges and rushes, have been observed when applied while native warm season species are dormant.

5.4 - 2011 Adaptive Management Activities

A general schedule for 2011 is shown in Table 13. Site conditions will be observed and changes will be made to scheduling, as necessary.

Table 13 - 2011 Woolsey Wet Prairie Adaptive Management Tentative Schedule

General Timeframe	Activity
January	**Prescribed burn informal bid process; establishment of fire line**
Mid-March to Mid-April	**Prescribed burn**
Mid-April	**Pump water from Wetland Cell W-2**
Mid April	**Spray tall fescue in Wetland Cell W-2**
Early June	**Mow berms (OMI)**
Mid June	**Adjacent (west and north) fescue fields to be hayed before tall fescue goes to seed**
Mid to Late June	**Mow berm sides and site perimeter to primarily keep Queen Anne's Lace from going to seed (OMI)**
May – October	**Weekly spot spraying of invasive woody vegetation (OERI)**

6.0 - CONCLUSIONS

The success of Woolsey Wet Prairie Sanctuary has been well noted in local media coverage via newspapers, periodicals, and television. In addition to achieving above and beyond the required wetland compensatory mitigation requirements, it has provided passive recreation and educational value for the public and academia, and has won three awards for the City of Fayetteville, including the Arkansas Environmental Stewardship Award (ENVY Award) Finalist presented by Arkansas Department of Environmental Quality in April 2009; the Governor's Conservation Awards - Corporate Conservationist of the Year presented by Arkansas Wildlife Federation in August 2009; and the Golden Paddle Award presented by Illinois River Watershed Partnership in November 2009.

The site is listed on "ebird.org" (a website co-sponsored by Audubon and Cornell University) as one of the countries birding hotspots in the U.S. To date, 21 species of shorebirds have been observed at the site, and migratory waterfowl seasonally make their visits, some of them staying to raise their young. During 2008, 2009, and 2010, pairs of Canada geese raised their goslings at the site. Two hen blue-winged teal raised their broods to maturity at Woolsey in 2008; the eighth breeding record for Arkansas, and the first with more than one set of young. Amphibian and reptiles have thrived at this newly created habitat, and many visitors go to the site at dusk simply to hear the frogs singing. To date, 150 species of birds have been observed at Woolsey Wet Prairie between 2006 and 2010. Of special note is the siting of a grasshopper sparrow during the 2010 50th Annual Fayetteville Christmas Bird Count by local birders Andrew Scaboo and Brandon Schmidt. Since the conception of the Christmas Bird Count by Dr. Doug James in 1961, no one had previously reported a siting of a grasshopper sparrow. This is a first for this 50-year event.

Systematic monitoring and assessment of wetland condition will be continued to generate additional data that will be used in the "adaptive management" strategy to maintain the site. This information will also be used to establish cause and effect relationships when developing the management strategy for a future expansion of Woolsey Wet Prairie.

Originally a tall grass wet prairie, Woolsey Wet Prairie still has intact upland prairie mounds that appear to have never been plowed and depressional areas between mounds where water seasonally ponds forming wetlands. Such prairie mounds and wet prairie depressions were common in the area prior to the western expansion by settlers in the early to mid 1800's. Plant ecologists universally agree that today, prairie is the rarest and most fragmented of North American ecosystems, and the one most in danger of being lost completely. Tall grass prairies once extended from Manitoba to the Texas Coast and eastward into Indiana. Today, only 2,000 acres (only one percent) of the original two million acres of tall grass prairie in this region of the country are as yet unplowed. Decades of crop farming, cattle grazing, mowing for hay, fire suppression, introduction of non-native plant species, and drainage ditches have contributed to the pre-restoration degraded condition of the Woolsey Wet Prairie Sanctuary.

The Woolsey Wet Prairie Sanctuary is part of the original prairie of Prairie Township, Fayetteville, Arkansas that extended all the way to the Prairie Grove and Lincoln areas in Washington County. Conversion of an estimated 100,000 acres of prairie habitat to production of wheat in northwest Arkansas in the late 1800's and early 1900's was the beginning of the decimation of prairie habitat.

With more than twice the credits needed for compensatory mitigation, the Little Rock District Corps of Engineers has given verbal approval to sell surplus credits to infrastructure improvement projects needing wetland credits. Expansion of Woolsey Wet Prairie to include an additional 70 acres as a Mitigation Bank is also being planned, and the topic has been discussed by the City of Fayetteville Water and Sewer Committee and Environmental Action Committee.

Federal Guidance on the Use of the Transportation Equity Act (TEA-21) established a "Preference for Mitigation Banking to fulfill Mitigation Requirements under Section 404 of the Clean Water Act – July 11, 2003." Furthermore, as published in the Federal Register on April 10, 2008, the 40 CFR 230 Compensatory Mitigation For Losses of Aquatic Resources: Final Rule established a preference for mitigation bank credits over permittee-sponsored mitigation due to findings that banks involves less risk of failure because they must

undergo a multi-resource agency review process. They also provide lower costs for the consumer of wetland permits and are more stable, support more diversity, and contribute more to larger ecosystem relationships than small onsite mitigation projects.

Additional information and periodic updates will be posted at the Woolsey Wet Prairie Sanctuary Website at:

http://ecoarkansas.com/WoolseyMain.html

For questions or comments, contact:

Bruce Shackleford, President
Environmental Consulting Operations, Inc.
17724 I-30, Suite 5A
Benton, AR 72019
501-315-9009
bruceshackleford@aristotle.net