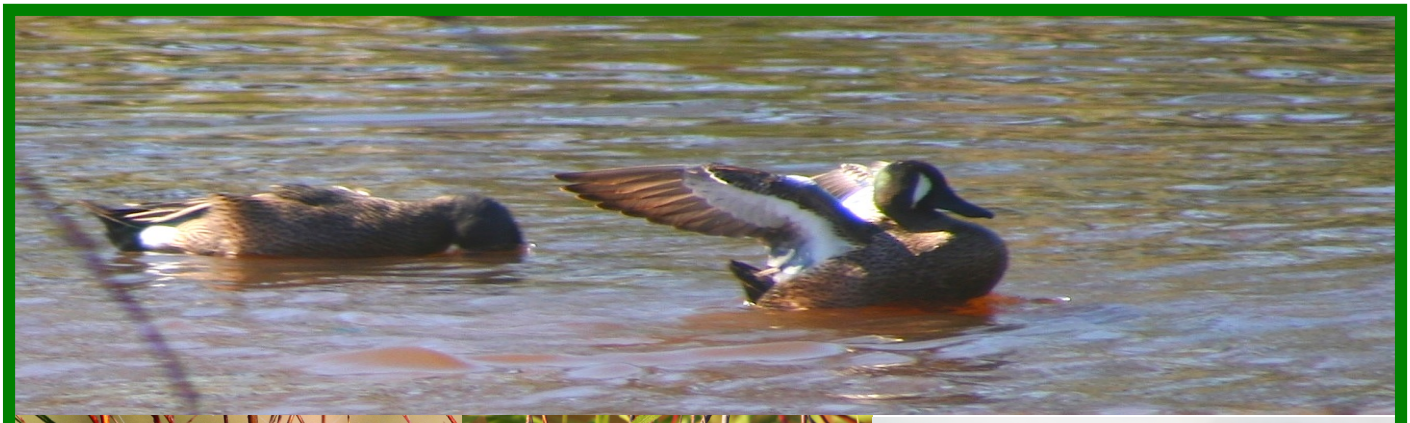

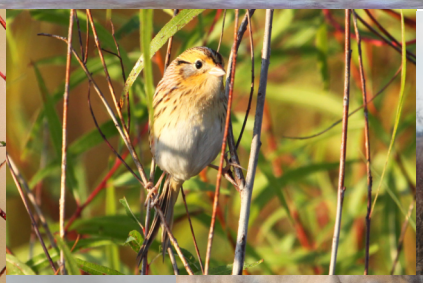







City Of Fayetteville, Arkansas
Wastewater Systems Improvements Project
Compensatory Wetland Mitigation Monitoring Report No. 5

Fayetteville
ARKANSAS

404 Permit File No. 14207
December 28, 2011

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

City Of Fayetteville, Arkansas
Wastewater Systems Improvements Project
Compensatory Wetland Mitigation Monitoring
Report No. 5

404 Permit File No. 14207
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Field Work and Report Preparation Conducted by Bruce Shackleford and Theo Witsell
Environmental Consulting Operations, Inc., Benton Arkansas

"Special Thanks" to OMI and OERI for assistance in site management,

MWY for design work, surveys, and hydrobudget model,

Joe Neal and Mike Mlodinow for bird records,

Frou Gallagher, Government Channel Videography and Program Editing

and

"Much Gratitude" to David *"Keep Smiling"* Jurgens and the City of Fayetteville for believing in "The Team" and allowing us to do what we do!

Cover Photograph Credits:
Joe Neal: Northern Shrike, Cassin's Sparrow
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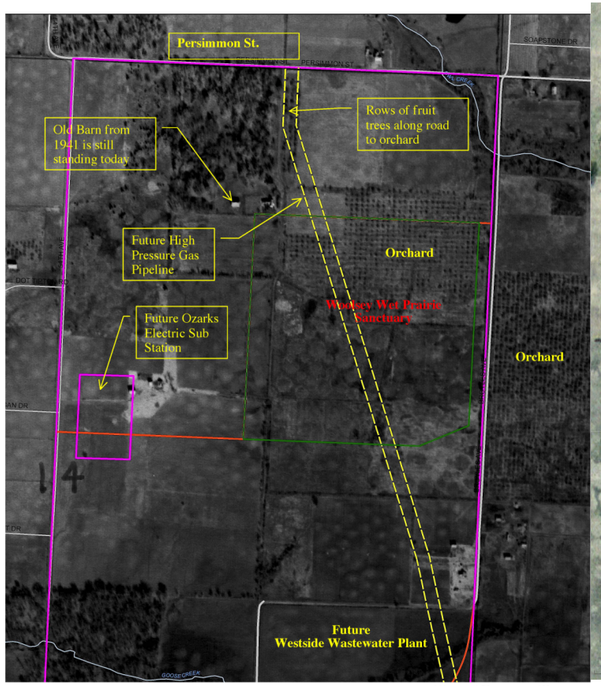
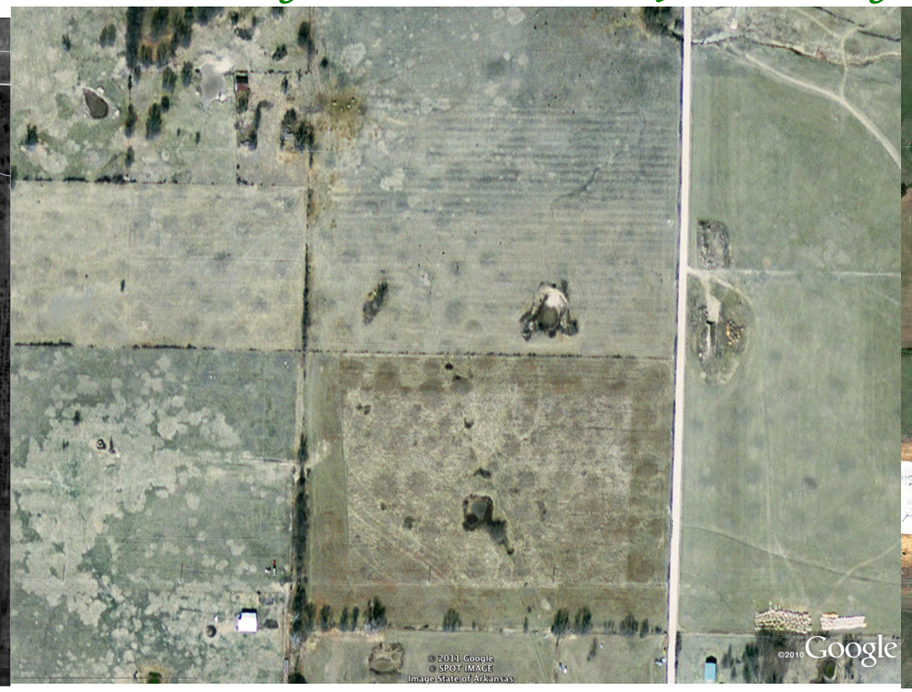
Environmental Consulting Operations
ECO, INC.
"Integrating ECOnomy and ECOlogy"

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

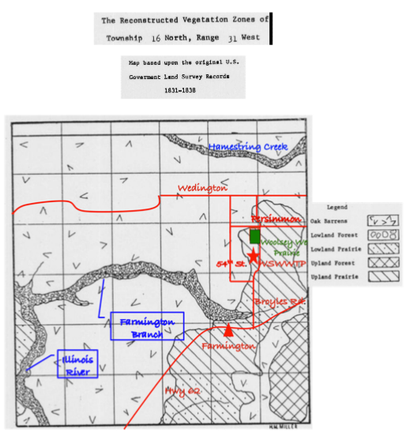




Woolsey Wet Prairie – 1941

Woolsey Wet Prairie – 2006

Woolsey Wet Prairie - 2010



Woolsey Wet Prairie – 1830's

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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 were completed near the end of the year 2011. The WSIP involved discharges of fill into "waters of the U.S." within the Illinois River Watershed (within the Arkansas River Basin) and the Beaver Reservoir Watershed (within the White River Basin) 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.

1.1 - Individual Section 404 Permit No. 14207

On March 10, 2005, the City of Fayetteville received Individual Section 404 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 9.56 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 monitoring activities and results at Woolsey Wet Prairie for the 2011 Monitoring Year No. 5.

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 the 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.

1.2 - Section 404 Nationwide Permit No. 19371

On March 29, 2006, the City of Fayetteville received Section 404 Nationwide Permit No. 19371 from the 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 palustrine-forested wetlands. The compensatory mitigation was to be achieved at the City's wetland mitigation site.

1.3 - Section 404 Nationwide Permit No. 14207-1

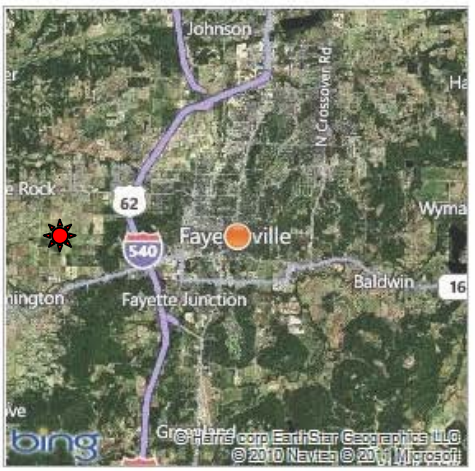
Nationwide Section 404 Permit No.14207-1 was issued to the City of Fayetteville WSIP on October 30, 2007 due to unavoidable impacts to Goose Creek (within the Illinois Watershed) as a result of construction of an outfall structure for the Westside WWTP. This permit required the creation of approximately 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 was 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.

1.4 – Mitigation Site Concept and Team

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. OMI subcontracts herbicide applications to Ozark Ecological Restoration, Inc. (OERI). Prescribed burns are contracted by the City of Fayetteville through an informal bidding process. Environmental Consulting Operations, Inc. oversees environmental regulatory compliance and conducts annual monitoring and site adaptive management strategy development at Woolsey Wet Prairie.

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 - Woolsey Wet Prairie Site Location Map



2.0 - 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 and expressed that monitoring reports must be concise and effectively provide the information needed to determine the status of compensatory mitigation efforts. It 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**
- **June 2011**
- **November 2011**

Table 1 shows 47 permanent monitoring stations (plots) that were established on the basis of the original percent acreage of each plant community zone within each wetland cell.

Table 1 - 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

2.1 - Plant Species Inventory/Species Richness

Overall plant species richness at Woolsey Prairie has increased from 2006 to 2011 (Figure 2). A total of 385 plant species have been documented from the site, although 9 have not been observed since wetland cells were created and were likely lost to subsequent hydrologic changes. However, many more species have colonized the site as a result of the wetland creation/restoration, and others have appeared on the site, presumably from the seed bank, following reduction of tall fescue (*Schedonorus arundinaceus*) cover. Eighty-one species on the site (21.0% of the total) are considered not native to northwestern Arkansas. Seven species (1.8% of the total) are identified as species of conservation concern (rare species) by the Arkansas Natural Heritage Commission.

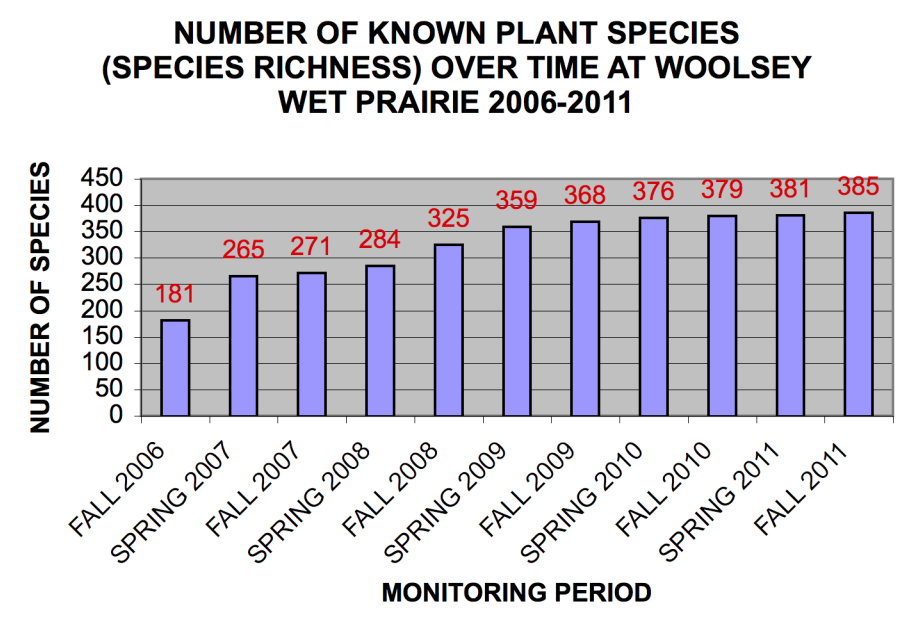


Figure 2. Total number of plant species documented from Woolsey Wet Prairie by monitoring period from 2006 to 2011.

Plot data taken from Fall 2006 to Fall 2011 show that species richness within plots has fluctuated both seasonally and yearly (Figures 3 and 4). 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 linked to wetland mitigation activities. This was followed by a general decrease in species richness in 2008 as 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.

Decreases in species richness due to loss of less water-tolerant species were especially evident in wetland plots between Spring 2007 and Spring 2008 (Figure 3). During 2008, the appearance of emergent aquatic vegetation was noted in the marsh areas, as prolonged inundation prevailed within all wetland cells. With the exception of plots on top of the

prairie mounds, 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.

Drier upland plots and some wetland plots also experienced a general decrease in species richness during 2007 as tall fescue, released from grazing pressure, out-competed most other species (Figure 3). Increases in species richness from 2008 to 2010 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. 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 warm season weedy forbs and grasses from competition. These forbs and grasses became dominant in many upland plots, which may have temporarily reduced species richness. Declines in species richness in all plot types between 2010 and 2011 is likely the result of an extended period of hot, dry weather during 2011, during which many wetland cells dried out for an extended period. However, with a wetter year in 2011, and the discontinuation of drawdowns, a greater level of inundation reduced the density of pale smartweed, as discussed in Section 3.0.

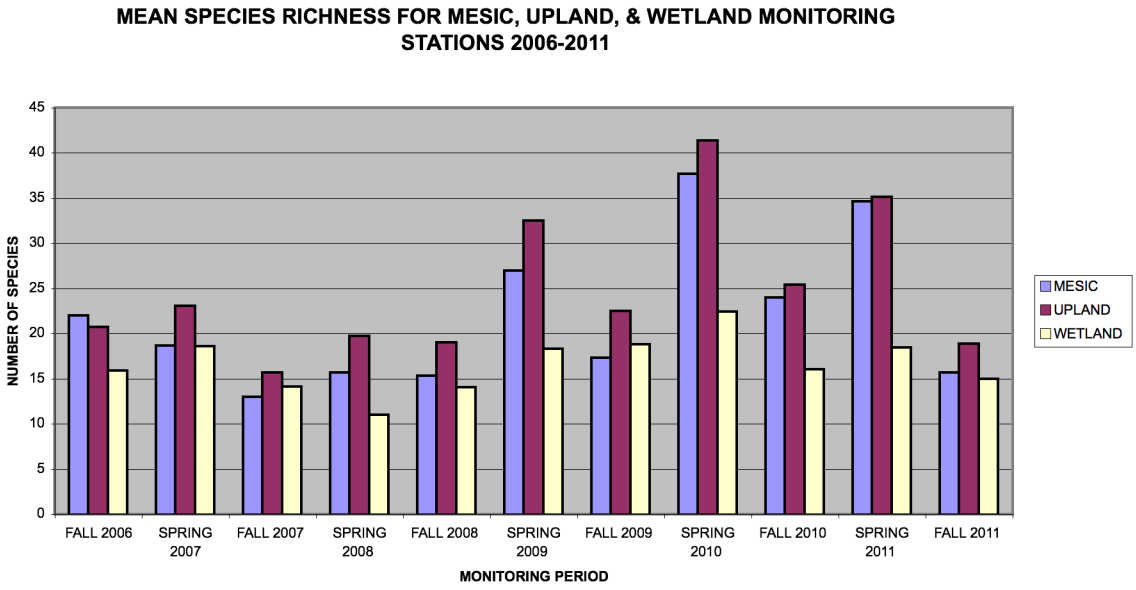


Figure 3. Fall and Spring mean species richness per plot by habitat type and monitoring period at Woolsey Wet Prairie from 2006 to 2011. These data include all species found within 5 m radius plots. Note seasonal fluctuation with more species detected during spring monitoring periods.

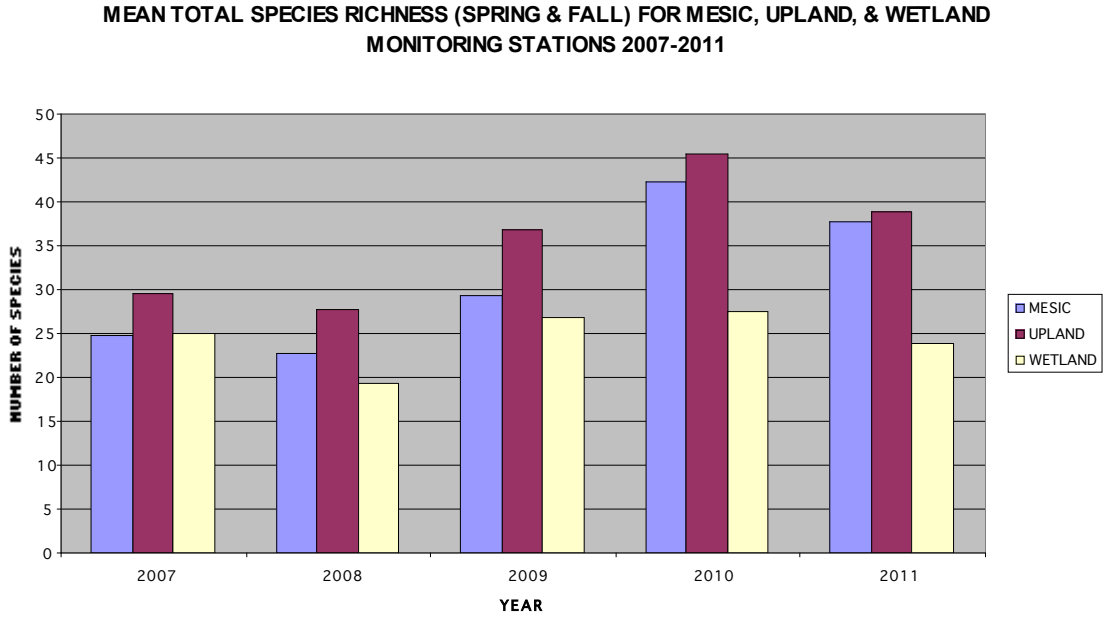
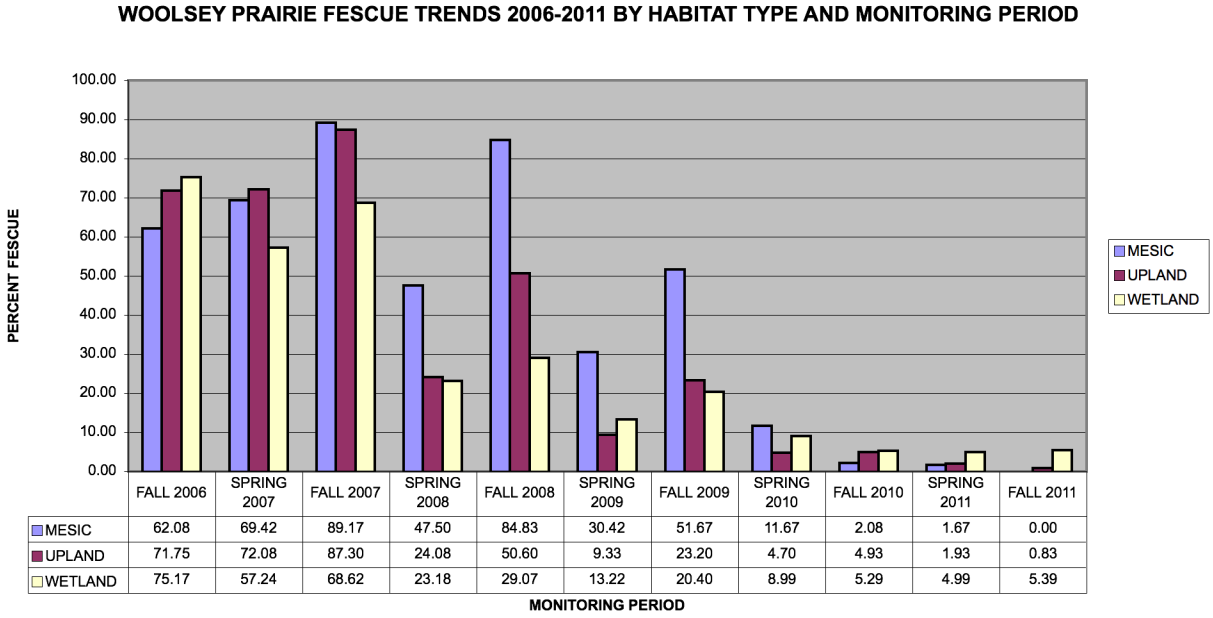


Figure 4. Total species richness per plot by year at Woolsey Wet Prairie from 2006 to 2011. Total number of species per plot are combined across seasons of a given year to control for seasonal variation. Note that 2006 is not included since it was only sampled in the Fall. These data include all species found within 5 m radius plots.

2.2 – 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 5, tall fescue percent cover ranged from 60% 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 5% tall fescue cover.



	FALL 2006	SPRING 2007	FALL 2007	SPRING 2008	FALL 2008	SPRING 2009	FALL 2009	SPRING 2010	FALL 2010	SPRING 2011	FALL 2011
MESIC	62.08	69.42	89.17	47.50	84.83	30.42	51.67	11.67	2.08	1.67	0.00
UPLAND	71.75	72.08	87.30	24.08	50.60	9.33	23.20	4.70	4.93	1.93	0.83
WETLAND	75.17	57.24	68.62	23.18	29.07	13.22	20.40	8.99	5.29	4.99	5.39

Figure 5. Tall fescue % density by plot type and monitoring period at Woolsey Wet Prairie from 2006 to 2011.

Since 2008, it has been observed 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, and the ability to effectively inundate the cell to drown out the fescue cannot be achieved since no stop logs are available to set for retention of water. Although the trend shows a reduction from more than 80% density to less than 20% density, the reduction in fescue density within Wetland Cell W-2 has not been to the proportion of the other wetland cells, as shown in Figure 6.

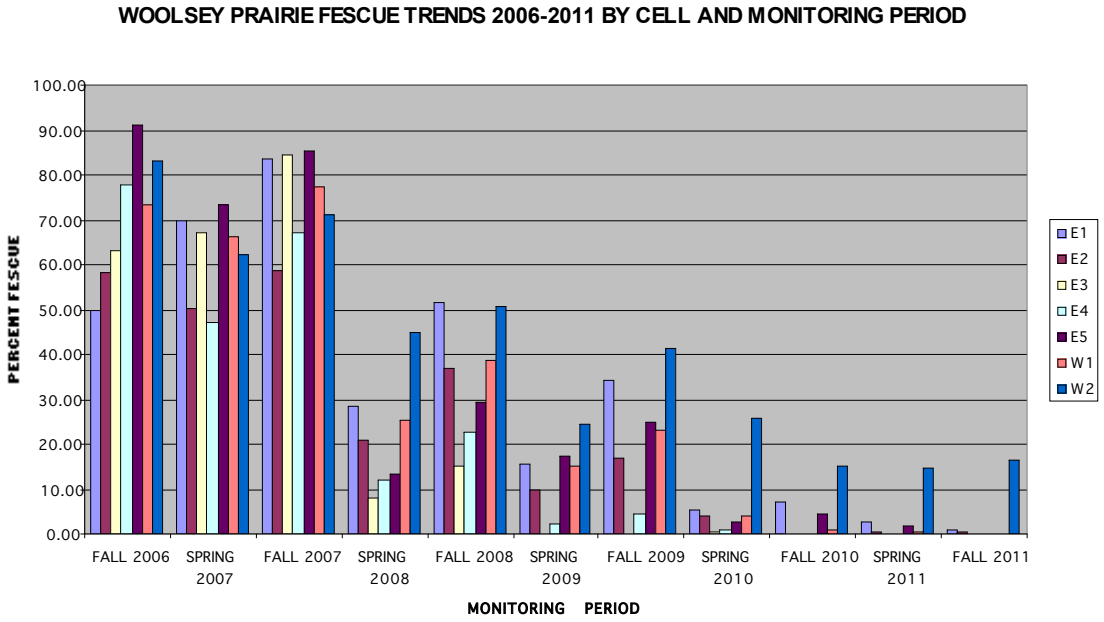


Figure 6. Tall fescue % density trend by wetland cell and monitoring period at Woolsey Wet Prairie from 2006 to 2011.

2.3 – Woody Vegetation Stem Density And Mitigation Of Lost Forested Wetlands

On March 27, 2008, 201 green ash, Shumard oak, pecan, northern red oak, and black walnut saplings were planted at designated forested wetland zones as a part of meeting the Section 404 permit requirement of mitigating for the loss of forested wetlands. During the fall of 2008, a field survey conducted to evaluate survival rate indicated an overall survival rate of 87 percent. Many volunteers of persimmon, black willow, green ash, and winged elm were also observed. Monitoring efforts during 2009 indicated that the majority of the planted tree saplings had not survived.

As the site hydrology and vegetation community evolved, it became essential for the management strategy to evolve. Although the planted tree saplings did not prove to have a good survival rate, it became apparent that efforts would be needed to control the density of volunteer tree and shrub growth in order to maintain the wet prairie marsh-like character of the mitigation site. Consequently, mitigation for lost forested wetlands from the WSIP has been refocused on maintaining designated areas of volunteer tree species in lieu of designated forested planting zones. 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 are approximately 3.0 acres set aside where volunteer trees are allowed to grow.

Volunteer tree and shrub species observed at Woolsey Wet Prairie are shown in Table 2.

Table 2 – Volunteer Tree and Shrub Species Observed 2006-2011

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

Black willow is the predominate species and provides habitat for declining bird species, such as willow flycatchers, Bell's vireos and dickcissels. Another volunteer tree community dominant is green ash.

Woody vegetation was present as scattered stump sprouts in 2006 but had been suppressed by annual haying prior to construction of the wetland cells. Shrubs increased

modestly from 2006 through 2008 as existing plants grew to 1 meter in height (and were thus counted in the shrub tally). However many of these shrubs were top-killed by prescribed burns, while others were killed by prolonged flooding of the wetland cells. By 2009 wetland cells were well established and wetland shrubs and trees (mostly black willow, but also some buttonbush and green ash) were increasing in sites where prescribed fire did not burn intensely (due to wet soil conditions). Figure 7 shows the trend of woody vegetation over a five-year period in terms of stem counts, and Figure 8 shows Figure 7 shows the trend of woody vegetation over a five-year period in terms of stem counts, and Figure 8 shows the progression of the increase in woody vegetation in terms of habitat type.

Note: *For the purposes of the monitoring at Woolsey Prairie, shrubs are defined as woody plants at least three feet in height and no more than 1 inch in diameter at breast height. Trees are defined as woody plants 1 inch or greater in diameter at breast height. For species with multiple trunks, such as black willow and buttonbush, each stem arising from the base of a plant was counted in the shrub tally. Stems branching from another stem above ground level were not counted. All stems were tallied in each of the 47 5 m radius plots. Only live stems were counted.*

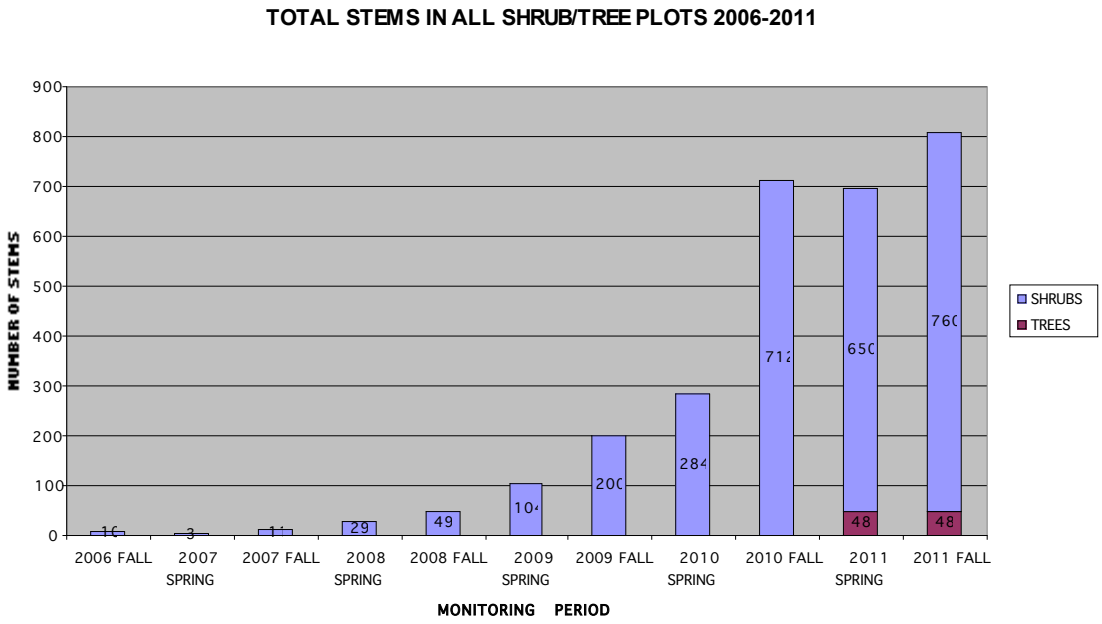


Figure 7. Total stems (all species) in all 5 m radius shrub plots observed in each sampling period from Fall 2006 to Fall 2011. Note that no stems were recorded in the tree class until Spring 2011 (red bar).

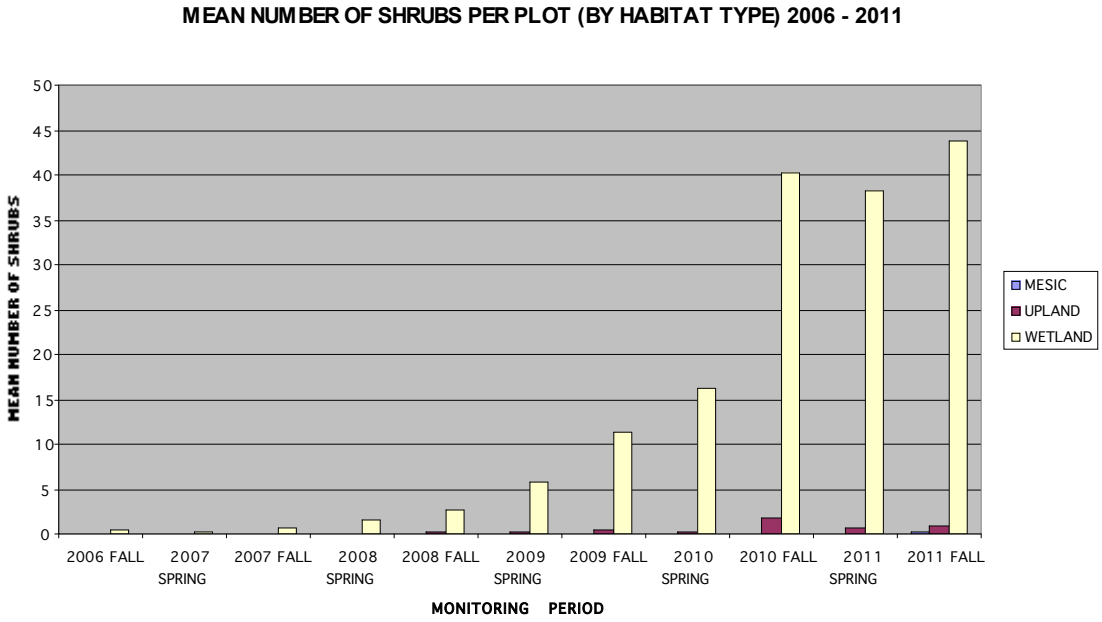


Figure 8. Mean number of shrubs per plot in each of the three habitat types (mesic, upland, and wetland) from Fall 2006 to Fall 2011.

No trees (as defined above) were encountered in the 5 m radius monitoring plots until the spring of 2011 when a number of black willow trees, mostly in cell W-1, reached ≥ 1-inch in diameter. As shown in Figure 9, shrub cover within all wetland cells is predominately black willow.

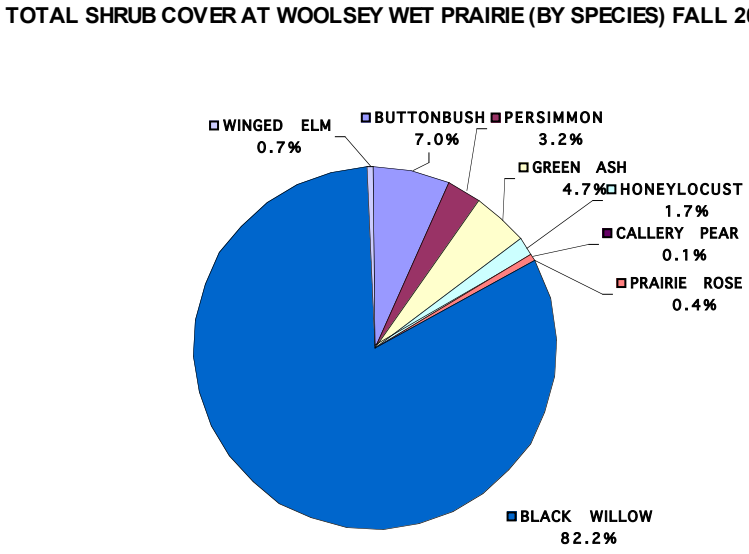


Figure 9. Shrub abundance by species during the most recent monitoring period (Fall 2011). Values expressed as percentage of total shrub stems (n = 760).

2.4 – 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 3 for Monitoring Years 2006-2011. Monitoring Year 2006 represents baseline conditions prior to implementation of adaptive management. The addition of non-native species relative to native species has remained relatively flat since 2008.

Table 3 – Non-Native Plant Species Trend

Monitoring Year	2006	2007	2008	2009	2010	2011
# Non-native species of total species	38/166	69/278	73/325	79/367	79/379	81/385
% Non-native species	22.9	24.8	22.5	21.5	20.8	21

Table 4 shows nine species that were observed on Woolsey Wet Prairie prior to commencement of water retention in 2006 and/or 2007, but were not observed during 2008 to 2011. Of these species, 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 4 – 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)

Table 5 shows 35 species observed in 2009, but not previously observed. It is likely that these appeared 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 5 – New Plant Species and Wetland Indicator Status Observed In 2009 (* non-native)

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

Table 6 – 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**

Table 7 shows 6 species observed in 2011, but not in prior monitoring years. All are native plant species

Table 7 – New Plant Species and Wetland Indicator Status Observed In 2011 (* non-native)

Carex glaucodea (blue sedge) **Not Found**
Carex shortiana (Short's sedge) **FACW**
Rhynchospora recognita (a beakrush) **FACW**
Setaria italica * (Italian foxtail) **FACU**
Sorghum bicolor * (sorghum) **FACU**
Typha latifolia (broadleaf cattail) **OBL**

Thirty (57.7%) of the 52 new species observed in 2009-2011 are FAC, FACW, or OBL; seven (13.5%) are FACU; and 15 (28.8%) are not indicated on the 1996 National List Of Vascular Plant Species That Occur In Wetlands.

2.5 - 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 unplowed tallgrass 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 2007-2011.

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 and 2011growing seasons after excessive droughts followed by excessive rain events restored naturally occurring water level fluctuations.

***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.

2.6 – 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 8 were planted at the designated riparian zone. 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 and native grass and forb volunteers had 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. Consequently, the riparian area was replanted with 2-3-inch caliper trees during early April of 2011. Five

trees each of the following species were planted and much of the dense undergrowth of honeysuckle, sericea lespedeza, and green briar was removed:

Eastern Redbud *(Cercis canadensis)*
River birch *(Betula nigra)*
Sycamore (*Platanus occidentalis*)
Cottonwood *(Populus deltoides)*
Swamp white oak (*Quercus bicolor)*

Field observations made in December of 2011 revealed that 12 of the 15 trees had survived. Furthermore, 27 of the 96 seedlings planted in 2008 exhibited flexible stems and leaf remnants. It was apparent that the 2010 survey had erroneously documented most of the seedlings to be dead. Perhaps this was due to the dense ground cover that made it difficult to adequately evaluate the condition of the seedlings and the fact that the survey was done during the dormant season.

Table 8 – Tree Seedlings Planted at Outfall Structure Riparian Zone

Common Name	Botanical Name	Indicator Status	# Surviving in 2008	# Surviving in 2010	# Surviving in 2011
Black walnut	*Juglans nigra*	FACU	22	1	7
Pecan	*Carya illinoensis*	FAC	7	0	5
N. Red Oak	*Quercus rubra*	FACU	24	2	9
Shumard oak	*Quercus shumardii*	FACW	22	1	6

2.7 - 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 and 2011 growing seasons, the majority of these areas reverted back to Wet Meadow habitat, but still exhibited positive wetland characteristics, although the vegetation community composition changed significantly at some locations. Overall, the cumulative effects of hydrological modifications continue to sustain created and restored wetlands, even though 2010 and 2011 were dry years.

2.8 - Wetland Functional Assessment

The Charleston Method was utilized to determine that a total of 79.2 mitigation credits were needed to offset the permanent alteration of 9.56 acres of wetlands by the WSIP, as

follows:

Table 9 – Permanently Altered Wetland Acreage and Credits Needed for Mitigation

Location	Debits From Permanent Alterations
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"

Due to optimized hydrological controls in 2008, an increase in wetland acreage was observed that was well beyond what designers anticipated. 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 10). 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.

During the 2009 survey, it was determined that the 43.8-acre site (and partial wetland restoration along collection system sites) had generated a total of 175.18 mitigation credits, 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 and 2011 that some of the former upland stations are beginning to exhibit wetland characteristics, no significant change in the number of credits from 2009 to 2011 is indicated. Table 10 shows the wetland acreage and credits from the 2009 through 2011 assessments.

Table 10 – Woolsey Wet Prairie Acreage And Wetland Mitigation Credits Generated

Mitigation Type	2009-2011 Mitigation Credits
Existing Mitigation Site PEM Wetlands Restored/Enhanced	7.29 acres/37.9 credits
Existing PEM Wetlands Outside Cells Restored/Enhanced	1.49 acres/7.75 credits
Eastside Collection System PFO Wetlands partially restored	0
Westside Collection System PFO Wetlands partially restored	1.42 acres/7.1 credits
Total Non-Buffer Wetlands Restored/Enhanced	10.2 acres/52.75 credits
Upland Buffer (berms/mounds) in Cells Restored/Enhanced	5.59 acres/27.39 credits
Upland Prairie Outside Cells Restored/Enhanced	11.98 acres/58.7 credits
Total Upland Buffer Restored/Enhanced	17.57 acres/86.09 credits
PEM Wetlands Created in Cells	10.72 acres/22.51 credits
PEM Wetlands Created Outside Cells	3.71 acres/7.79 credits
PFO Wetlands Created in Cells	3.02 acres/6.04
Total Wetlands Created	17.45 acres/36.34 credits
Total Mitigation Acreage/Credits Generated	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

Figure 10 – Woolsey Wet Prairie A-s Built Drawing

= 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
© 2009 Fayetteville, Arkansas

STRUCTURE NO. -

SHEET NO. 1/1

3.0 - 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 11 below:

Table 11 - 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 Triclopyr
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
March 18, 2011	Prescribed burn
April 15, 2011	Spray tall fescue in Cell W-2 with Clethodim
May 17, 2011	Spray sericea lespedeza on berms with 2-4-D
May 19, 2011	Spray fire line with Glyphosate
May-June 2011	Spray sericea lespedeza on berms with Triclopyr on 3-4 week rotation
June 15-18, 2011	Mow tall fescue and Queen Anne's Lace around perimeter of mitigation site prior to formation of seed heads
June 16-17, 2011	Hand pull Queen Anne's Lace and curly dock on entire mitigation site
June-September 2011	Monthly spot spraying of selected woody vegetation with Triclopyr
June-November 2011	Hand cut selected black willow, honey locust, persimmon and green ash
December 2011	Spot spray tall fescue with Clethodim

3.1 - 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; December 16, 2009; and March 18, 2011.

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 3.2 - 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. The March 18, 2011 prescribed burn was done as a measure to control woody vegetation, as further discussed in Section 5.2. 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.

Prescribed burns aide in preventing woody encroachment and maintain the wet prairie habitat, depending upon the time of year of the burn, and the site hydrology at the time of

the burn. The volunteer tree growth has primarily occurred in the wetter areas where inundation protects trees from fire. During 2010-2011, many of the black willow trees have reached a diameter of five to six inches and are growing along the edges of the earthen berms. Continued growth of these trees will eventually cause damage to the berms. Furthermore, allowing woody vegetation to grow uncontrolled would be detrimental to the survival of the rare sedge species observed at the site that grow in full sunlight.

3.2 - 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, February 19, 2009, and March 18, 2011 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 2.0 - Mitigation Site Monitoring Results, tall fescue has steadily declined. In a continued effort to eradicate it from the site, Clethodim, a post-emergent graminicide, was applied via boom spray 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. Continued spot spraying with Clethodim has been done throughout 2010 and 2011 on the isolated areas of tall fescue that remain. Clethodim applications have been done during the cool season while desirable native warm season grasses are dormant. This herbicide only controls true grasses and does not control sedges, rushes or any broadleaf weeds that may be actively growing during the cool season. Therefore, an increase in the density of sedges and rushed has been observed since Clethodim has been used at the site.

3.3 – Mowing And Hand Cutting

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.

Management activities targeted woody vegetation in some areas with both mechanical and chemical control, which contributed to the decline in several species, particularly between 2010 and 2011. One non-native invasive woody species, callery pear (*Pyrus calleryana*) was encountered frequently but has largely been controlled on the site. It will need to be monitored and controlled into the future.

In late 2011, selected black willows were hand cut and the stumps were treated with Triclopyr. The cut trees were stacked into brush piles that will provide winter habitat for migrating sing birds. The brush piles will likely burn during the planned prescribed burn in March-April of 2012.

3.4 - Hydrological Controls

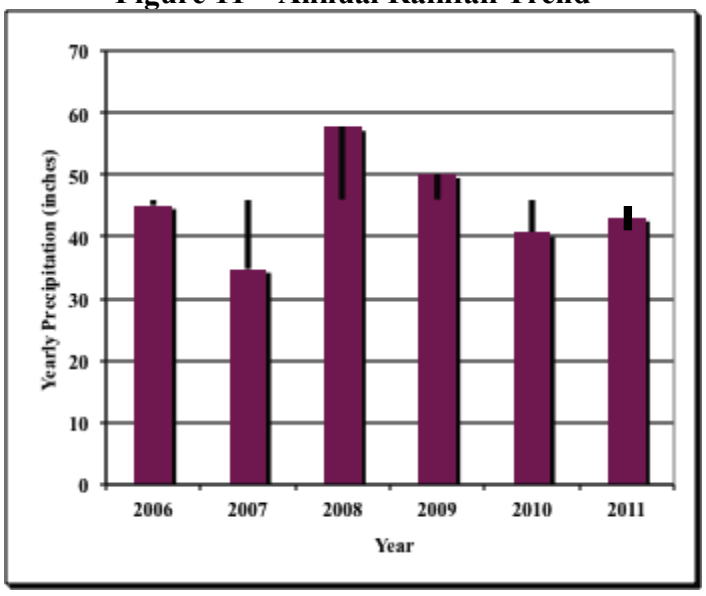
The annual average precipitation at Fayetteville is 46.02 inches. Table 12 shows the annual rainfall trend for 2006 through 2011, with percent ± average rainfall amount for each year.

Table 12 – Annual Rainfall Trend

Year	Annual Rainfall (inches)	% Departure From Average
2006	45.1	-2.0
2007	34.8	-24.4
2008	57.7	+25.4
2009	50.9	+10.6
2010	40.6	-11.8
2011	43.1	-6.4

Figure 11 graphically shows the annual rainfall trend for 2006 through 2011, with inches of departure from average rainfall amount for each year.

Figure 11 – Annual Rainfall Trend



The deviation (±) from mean annual rainfall is displayed as black bars (Long-term average annual precipitation = 46.02 inches).

Field observations have indicated that the hydrological design developed by McGoodwin, Williams, and Yates Consulting Engineers, Inc. and Environmental Consulting Operations, Inc. 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 approximately 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 prolonged heavy rainfall. At that time, stop logs of water level control structures were adjusted to a level to maximize retention of water and prevent water from overflowing the berms.

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, which received well over the average rainfall amount. During the 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 was observed in wetland cells, although soils remained saturated and wetland vegetation was present in areas previously delineated as wetlands. During 2011, a summer drought and below average annual rainfall was again observed. However, wetland cells had areas of inundation, but not to the degree of the 2008-2009 period.

Two drawdown events have taken place since the 2008-2009 period when all wetland cells were inundated during the majority of the year. The first such event occurred during November 19-24, 2009 in preparation for a prescribed burn. The second drawdown occurred on March 23, 2010 in preparation for herbicide boom spraying.

The drawdowns, coupled with a very dry 2010 is believed to have been the cause for the emergence of dense stands of pale smartweed (*Persicaria lapathifolia*) during the 2010 growing season. 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.

Although pale smartweed is a native species that provides value to wildlife, both as food and as cover, it did appear to reduce the diversity of sedges, rushes, and emergent aquatic plants in certain areas. The 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 became necessary to avoid a monoculture situation.

The application of herbicides to reduce the density of pale smartweed was not a feasible management alternative because it actively grows during the warm season when many desirable plant species are thriving. It also covered significant wet meadow areas that had previously been inundated during 2008-2009. It would require a broadleaf-specific herbicide such as 2,4-D to control it. The need for repeated applications was anticipated, due to the density of growth, thereby making it difficult to achieve good herbicide coverage on all plants within a given stand. Consequently, there was a risk of damage to nearby desirable species.

Management of hydrology was selected as the primary tool to control the smartweed since it 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. Therefore, restoring water retention to previous levels of inundation and soil saturation was anticipated to reduce the density of smartweed and allow other species to grow. This is to be achieved via discontinuation of drawdowns.

4.0 - PLANNED ADAPTIVE MANAGEMENT ACTIVITIES FOR 2011

4.1 - Hydrology Management

Currently, all stop logs at water level control structures are set for maximum water retention in the wetland cells. They will be maintained at these settings in order to restore and maintain optimal inundation. This will allow for standing water in areas of dense smartweed growth as an effort to continue the reduction in smartweed density observed in 2011. 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, since the tall fescue is largely under control and herbicide applications with the large boom sprayer should not be necessary. Similarly, it has been observed that a prescribed burn can be achieved without a drawdown.. 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. The strategy for management of hydrology has not only included considerations for the volume of water retained, but also the time of the year water is retained. It is vital to retain water during the growing season in order to maintain areas of soil saturation and/or inundation to support wetland vegetation.

It was observed in 2008-2009 that the wetland cells can fill rather quickly to the maximum level of inundation after summer dry periods, when followed by above average rainfall during the fall. However, during excessive summer droughts, followed by below average autumn rainfall, the wetland cells have exhibited low levels of inundation, and/or dry conditions for extended periods of time.

Management of hydrology is an important tool in vegetation community diversity optimization because 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.

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 through management of hydrology.

Hydrology is measured by nine monitoring wells and five staff gauges that were installed within the wetland cells to evaluate groundwater and surface water conditions. With five years of available data, an effort to develop a predictive model for hydrology management will be considered in 2012.

4.2 - Prescribed Burning

The season of the year at which a prescribed burn is conducted has a great influence over the vegetation community (Table 13). 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 2012 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 adequate fuel from the vegetation killed by winter cold weather. A burn during this time should:

- **Reduce the density of smartweed and woody seedlings**
- **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 13 - 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,

giving the NWSG an earlier emergence thereby providing a competitive edge against cool season invasives. 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. Although total forb yields may usually be reduced more by Dormancy Break 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.

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 non-target plant species by reducing the frequency and quantities of herbicides at Woolsey Wet Prairie.

4.3 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 2012 prescribed burn, Clethodim will be applied to the remaining tall fescue 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.

The City is also considering the construction of an earthen berm and installation of a water level control structure on Wetland Cell W-2 at the immediate location of where drainage from the cell enters the old farm pond. This will allow for better hydrological control, which in turn will improve vegetation management and provide a long-term savings in management costs.

4.4 - 2012 Adaptive Management Activities

A general schedule for 2012 is shown in Table 14. Site conditions will be observed and changes will be made to scheduling, as necessary.

Table 14 - 2012 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	**Spray tall fescue before native plants come out of dormancy**
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 and hand cutting of selected trees (OERI)**

5.0 - CONCLUSIONS

The success of Woolsey Wet Prairie Sanctuary has been well noted in local media coverage via newspapers, periodicals, and television programs. 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.

Woolsey Wet Prairie has won awards and special recognitions for the City of Fayetteville, including:

April 2009 - Arkansas Environmental Stewardship Award (ENVY Award) Finalist presented by Arkansas Department of Environmental Quality

August 2009 - Governor's Conservation Awards - Corporate Conservationist of the Year presented by Arkansas Wildlife Federation in (the first and only time this award has been presented to a city since the inception of the AWF in 1936)

November 2009 - Golden Paddle Award presented by Illinois River Watershed Partnership

February 2011 - designation as a Certified Wildlife Habitat by the National Wildlife Federation

October 2011 – Special recognition in the America in Bloom National Turf and Groundcover Award

Woolsey Wet Prairie 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 through 2011, pairs of Canada geese raised their goslings at the site.

To date, over 150 species of birds have been observed at Woolsey Wet Prairie between 2006 and 2011, and the site has proven to be a habitat well know for the sitings of rarely seen birds in the State of Arkansas, as follows:

Two hen blue-winged teal were observed together with heir broods and photographed by Bruce Shackleford in June 2008; the eighth breeding record for Arkansas, and the first with more than one set of young.

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.

In March 2011, a northern shrike was discovered at Woolsey Wet Prairie by Mike Mlodinow and photographed by Joe Neal. This is the second state record for this species.

During April 2011, Mike Mlodinow observed a purple gallinule, the only known record north of Cleburne County in Arkansas for this bird.

October 2011proved to be a very productive month for birders. Mike Mlodinow found a Cassin's Sparrow at Woolsey that was photographed by Joe Neal. This is the second state record for this species. The rare Henslow's sparrow was observed and photographed by Jacque Brown, as was a Spotted Towhee. On the average, only one or two spotted towhees are seen in Northwest Arkansas each year, and are missed in some years.

In early December 2011, Mike Mlodinow found a Brewer's sparrow that was photographed by Jacque Brown, David Oakley, and Mitchell Pruitt. This is the first or second record for Arkansas.

Preparations are being made to nominate Woolsey Wet Prairie for designation as an Important Bird Area (IBA) by Audubon Arkansas. There are currently 29 IBAs in Arkansas.

Due to the fact that Woolsey Wet Prairie has more than met mitigation performance standards, the City of Fayetteville will be making a request to the Little Rock District to reduce the formal annual monitoring requirements from 7 years to 5 years. An abbreviated 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 and Environmental Action Committees. The timing of this expansion will be largely driven by economic conditions and the need for wetland credits in the area.

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

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