Analysis of Missouri Wetlands Reserve Program Easement Monitoring Data

Before photo of WRP site

After photo of WRP site

Scott Frazier
Department of Fisheries &
Wildlife Sciences
302 ABNR Building
University of Missouri, Columbia
MO 65211-7240

and

David L. Galat
U.S. Geological Survey, Missouri Cooperative Fish & Wildlife Research Unit
302 ABNR Building, University of Missouri, Columbia, MO 65211-7240

Prepared for: Natural Resources Conservation Service, Resource Inventory & Assessment Division, Conservation Effects Assessment Project, Beltsville, MD 20705-5410.

May 2009

Final Report

Analysis of Missouri Wetlands Reserve Program Easement Monitoring Data

Scott Frazier
Department of Fisheries & Wildlife Sciences
302 ABNR Building
University of Missouri
Columbia, MO 65211-7240

and

[1]David L. Galat
U.S. Geological Survey
Missouri Cooperative Fish & Wildlife Research Unit
302 ABNR Building
University of Missouri
Columbia, MO 65211-7240
Email: galatd@missouri.edu

May 2009

Prepared for: Natural Resources Conservation Service, Resource Inventory & Assessment Division, Conservation Effects Assessment Project, Beltsville, MD 20705-5410.

[1]Author to whom correspondence should be addressed

Suggested citation: Frazier, S. and D.L. Galat. 2009. Analysis of Missouri Wetlands Reserve Program easement monitoring data. Final Report to Natural Resources Conservation Service, Resource Inventory & Assessment Division, Conservation Effects Assessment Project. University of Missouri, Columbia, MO.

Cover Photos: Aerial photographs of a before (left, 18 October 1998) and after (right, 23 October 2006) 250 acre WRP easement Massasauga Flats in southwest Linn County, Missouri. Source: Dale Humburg, Missouri Department of Conservation.

Final Report
Analysis of Missouri Wetlands Reserve Program Easement Monitoring Data

Executive Summary

Against a historical backdrop of massive wetland loss, Missouri was one of nine states to first enroll in the USDA's Wetlands Reserve Program. The WRP is one of a host of voluntary conservation programs for landowners that are supported and administered by the Department's Natural Resources Conservation Service (NRCS). The goal of the WRP is to maximize wetland functions and values, and optimize wildlife habitat "on every acre enrolled…" Whereas the Program is national in scope, Missouri is one of the leading states in both number and area of easements enrolled.

Missouri is also in the unique position of having gone further than any other state in terms of ecological monitoring of WRP sites. Whereas WRP policy mandates monitoring easements at least once every 3 years, typical WRP monitoring is primarily concerned with Program compliance. However since sites were being visited anyway for this purpose, the Missouri NRCS office and the Missouri Department of Conservation (MDC) joined together in an ecological monitoring program to quantify the habitat value of Missouri wetlands restored through the WRP.

Compliance and ecological monitoring data in Missouri were collected by contracted "technical service providers". The initial monitoring dataset covered a period of approximately three *fiscal* years (2004-2006) and involved single-visits to 594 easement sites. Ecological data were collected in the field using GIS software on handheld computers, a global positioning system (GPS), and custom electronic data forms. Previously digitized easement boundaries, planned wetland habitat type boundaries (polygons), and information on installed practices were used with the mobile GIS and GPS in the field to locate and verify features. Post-restoration wetland habitat type was recorded using a modified Cowardin habitat classification system (Cowardin et al. 1979). Habitat data variables were also collected during monitoring for input into habitat suitability index (HSI) models for several representative bird species.

In October 2006, the "Missouri WRP Analysis Project" commenced to analyze this ecological monitoring dataset. It was executed by the University of Missouri and USGS for the existing program. Analyses employed GIS and conventional database methods. Data analysis focused on easements for which pre-restoration Cowardin wetland classes had been mapped and digitized for an earlier project. The resulting overlapping "parent" dataset for analyses covered approximately 66,700 acres in 594 conservation easements. The restoration age of easements included in the analysis ranged from 2.7 to 12.2 years.

"Habitat succession" was indicated by change in land cover conditions observed before and after restoration. This analysis demonstrated a clear change from primarily agricultural cropland cover to herbaceous or forested wetland vegetation. HSI indices derived from three models for species associated with non-forested habitats, and three for species associated with forested habitats, were analyzed to quantify wildlife habitat values. Post-restoration HSI scores were markedly higher than the assigned pre-restoration baseline for all non-forest species models and for two of the three forest species models on the restored cropland. The increase in habitat quality (HSI) was greatest for species associated with emergent herbaceous habitats, which develop faster than forest habitats, but are often a precursor of forested wetlands. These results suggest that WRP is contributing substantially to Missouri wetland wildlife conservation.

Whereas direct observation during single site visits did not directly indicate WRP site importance to rare, threatened or endangered species, GIS analysis of species ranges revealed that a slight majority of WRP sites do provide habitat that potentially supports rare, threatened or endangered species. The contrast between WRP sites in Missouri's four Ecological Sections was also looked at in the study, as well as the utility of site photography employed in the Missouri WRP monitoring program. Recommendations based on analyses in the project study are suggested to further improve ecological monitoring of WRP easements in Missouri and elsewhere.

Final Report
Analysis of Missouri Wetlands Reserve Program Easement Monitoring Data

Table of Contents

Final Report

Analysis of Missouri Wetlands Reserve Program Easement Monitoring Data

List of Tables and Boxes

Final Report

Analysis of Missouri Wetlands Reserve Program Easement Monitoring Data

List of Figures

Final Report
Analysis of Missouri Wetlands Reserve Program Easement Monitoring Data

Chapter 1: Project Overview

Introduction

This is the Final Report for the project initially entitled "Assessing the Effectiveness of the Wetlands Reserve Program in Missouri through Analysis of Existing Easement Data and Linkage to Previous Floodplain Investigations." The project is referred to as the "[Missouri] WRP Analysis Project" or simply "the project" in this report.

The Missouri WRP Analysis project was a cooperative undertaking of the Natural Resources Conservation Service (NRCS), the Missouri Department of Conservation (MDC), and the University of Missouri (School of Natural Resources, Department of Fisheries & Wildlife Sciences) through the Missouri Cooperative Fish and Wildlife Research Unit along with the United States Geological Survey (USGS). Funding was provided by the Conservation Effects Assessment Project (CEAP – wildlife component) of NRCS (under Contract No. 68-3H75-3-122 Mod 13) to the University of Missouri (Account No. C00013696, DA130).

The goal of this project was to conduct geospatial and database analyses of a dataset covering 594 Missouri Wetlands Reserve Program easements monitored over a three-year period (Fiscal Years 2004-2006) by the NRCS and MDC, cooperating.

The project proposal (Annex 1) envisioned six products:

1) A complete summary of wetland area and distribution, restored wetland types, and hydrologic condition.

2) A complete listing of plant and animal taxa with emphases on rare and endangered species.

3) An evaluation of restoration status including influence on plant and animal response.

4) Photographic documentation of wetland benefits and values resulting from WRP restorations.

5) Analysis of other data in Missouri (e.g., Missouri River Post-flood Evaluation, Avian Use of Missouri River Floodplain Wetlands Evaluation, fall migratory bird surveys, etc.) to determine the usefulness in documenting wildlife response to WRP restored wetlands.
6) Recommendations for improved WRP monitoring.

The project commenced on 2 October 2006 with the installation of Scott Frazier as project officer. Dr. David L. Galat of the Missouri Cooperative Research Unit (USGS and University of Missouri) served as project supervisor. Elizabeth Cook was the GIS specialist adviser from NRCS. The project was conducted with the guidance of a *de facto* steering committee composed of representatives of cooperating agencies and other experts (see the annex of this chapter - Annex 1 - for the list of members).

The following products, in addition to this Final Report, were also produced:

- Oral PowerPoint Presentation entitled "Ecological Monitoring Insights: the Wetlands Reserve Program in Missouri" (by S. Frazier and D. Galat) delivered at the Soil and Water Conservation Society Annual Conference, July 21–26, Tampa, Florida.

- CEAP Conservation Insight. Ecological Monitoring Insights: the Wetlands Reserve Program in Missouri (2008). See References.

Missouri WRP Analysis Project findings were also featured in the NRCS in-house publication "CEAP Highlights" August 2007 edition.

Background

The United States Department of Agriculture sponsors a host of voluntary conservation programs for landowners that are supported and administered by its Natural Resources Conservation Service (NRCS). Collectively, these programs help people to improve the functioning of ecosystem services and natural values on their lands, and to ameliorate damage from natural processes and disasters. Society also benefits both economically and environmentally from these programs (NRCS 2007d). One such conservation program is aimed at wetlands.

The Wetlands Reserve Program (WRP) provides landowners "the opportunity to protect, restore, and enhance wetlands on their property… in an environmentally beneficial and cost effective manner." NRCS provides technical and financial support to assist with wetland restoration. The goal of the program is to "achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled…" Through the WRP, landowners have an opportunity to establish long-term conservation including practices which enhance and protect wildlife (NRCS. 2007b, 2007c). Three conservation options are available to landowners through WRP: Permanent easements, 30-year easements, and restoration cost-share agreements.

The Wetlands Reserve Program was authorized in the 1990 "Farm Bill." It was reauthorized in the Farm Security and Rural Investment Act of 2002 (i.e. Farm Bill), to a total nationwide cap of 2,275,000 acres. At April 2007, there were 9,951 projects on 1,899,979 acres enrolled in the program across the country (NRCS 2007c).

The Wetlands Reserve Program started in Missouri as a pilot project in 1992 along with eight other states. As of September 2006, 787 WRP applications had been funded statewide encompassing 115,583 acres (NRCS 2007a).

Nationwide, Wetlands Reserve Program monitoring has typically focused solely on administrative compliance and implementation of restoration practices. The Missouri WRP is unique among states in that it includes field ecological monitoring in addition to administrative compliance monitoring for all WRP easements (Charles Rewa, NRCS, pers. comm.).

Ecological and compliance monitoring data were collected on almost 600 WRP easements throughout Missouri during 2003−2005, through a partnership between NRCS and the Missouri Department of Conservation (NRCS 2006). The data accrued under this work were analyzed under the WRP Analysis Project.

CEAP (the project funder) is an interagency effort that began in 2003. It is aimed at quantifying the environmental benefits of conservation practices used by private landowners participating in selected USDA conservation programs like WRP (NRCS 2007e). The Wildlife Component of the CEAP "National Assessment" seeks quantitative information on the effects of the USDA's conservation practices and programs on fish and wildlife and their habitats in agriculture influenced landscapes in the United States. Within CEAP, wildlife component and wetlands component works are linked (NRCS 2006).

Report Structure

This Final Report is structured by analyses. The project proposal (see Annex 1) served as guideline for initial selection of analyses. Final selection of analyses was based on availability and characteristics of data, and the discussion and advice of steering group members. The proposed Product 5, *An Analysis of other data in restoration data in Missouri*, was deemed asymmetrical in scope to the other products after the project commenced, and has not been included in this report. However issues pertinent to restoration studies and monitoring in general are covered in the final chapter, Conclusions and Recommendations.

Chapters are paired with an annex (as necessary), numbered accordingly, where more detailed supplementary materials are found. The voluminous body of other supplementary or complementary work compiled or created in support of this project, including databases, programs (applications), graphical outputs, methods documents and other materials, has been systematically archived on compact disc with Elizabeth Cook, USDA-NRCS 601 Business Loop 70 W, Parkade Center Suite 250, Columbia, MO 65203; email: elizabeth.cook@mo.usda.gov.

References

Frazier S and Galat D. 2008. Ecological Monitoring Insights from the Wetlands Reserve Program in Missouri. CEAP Conservation Insight (February 2008). United States Department of Agriculture. Natural Resources Conservation Service. Accessed 31 December 2008 at ftp://ftp-fc.sc.egov.usda.gov/NHQ/nri/ceap/MO_WRP_021108.pdf

Natural Resources Conservation Service (NRCS). 2006. Work Plan for the Wildlife Component Conservation Effects Assessment Project (CEAP) National Assessment. August 15, 2006. USDA, Natural Resources Conservation Service Resource. Inventory and Assessment Division. Beltsville, Maryland. Working Draft. Also available at http://www.nrcs.usda.gov/technical/nri/ceap/wildlifeworkplan/

Natural Resources Conservation Service (NRCS). 2007a. NRCS in Missouri. October 1, 2005 - September 30, 2006. United States Department of Agriculture. Natural Resources Conservation Service.

Natural Resources Conservation Service (NRCS). 2007b. Wetlands Reserve Program. Accessed 5 November 2007 at www.nrcs.usda.gov/PROGRAMS/wrp/.

Natural Resources Conservation Service (NRCS). 2007c. Key Points – Wetlands Reserve Program. April 2007. Accessed 5 November 2007 at http://www.nrcs.usda.gov/PROGRAMS/wrp/2007WRPKeyPoints.pdf.

Natural Resources Conservation Service (NRCS). 2007d. NRCS Conservation Programs. Updated 08/23/2007. Accessed 5 November 2007 at www.nrcs.usda.gov/PROGRAMS/.

Natural Resources Conservation Service (NRCS). 2007e. Conservation Effects Assessment Project (CEAP). Updated 10/15/2007. Accessed 5 November 2007 at www.nrcs.usda.gov/Technical/nri/ceap/.

Chapter 2: Summary Findings

Background

At the beginning of major European settlement (ca 1780s), the territory of present day Missouri is estimated to have held slightly more than 4.8 million acres of wetlands, or an area equivalent to nearly 11% of the state today. The vast majority of these wetlands were associated with the state's great rivers, the Mississippi and Missouri, and their major tributaries. Large-scale wetland losses began in Missouri after the federal Swamp Act (1850) was enacted. This legislation, while targeting flood control and reclamation for agriculture, resulted in the transfer federal lands to the state and ultimately into private hands, and led to massive drainage. Channelization and damming of rivers also contributed to the loss and degradation of the state's wetlands. By the early 1980s, losses due to agricultural conversion, urban development, and flood-control measures resulted in a decrease of approximately 87 percent of Missouri's wetlands to about 643,000 acres, or approximately 1.4 percent of the state's area (Demas and Demcheck, 1996, citing others including Dahl, 1990, Epperson, 1992 and Shaw and Fredine, 1971).

Wetlands, typically components in a larger hydrologic system, provide a composite of significant and influential ecological and socio-economic benefits and services. Wetlands may contribute to the amelioration of flooding, groundwater replenishment, sediment and nutrient retention and export, and water purification. Wetlands also afford opportunities for recreation and tourism as well as education and research, and support economic activities like food, fisheries and timber production. Wetlands are often reservoirs of biodiversity, providing habitats for birds, fish and other animals and plants, including threatened and endangered species. See De Groot et al (2006), Stuip et al (2002), Ramsar Convention Bureau (2000) and Barbier et al (1997) for information on wetland values, benefits and functions, and wetland valuation.

Introduction

Compliance and ecological monitoring data in Missouri were collected on WRP easements by contracted specialists ("technical service providers" or TSPs). This initial monitoring dataset covered a period of approximately three *fiscal* years (2004-2006) and involved single-visits to 594 easement sites. Monitoring data enable assessment of restoration progress, namely allowing evaluation of whether site-specific species targets are being met. Monitoring provides the feedback necessary to adjust WRP restoration to continually deliver positive responses from wetland fauna and flora.

The WRP Analysis Project commenced in October 2006 for the purpose of analyzing the data accrued during the previous, separate monitoring regime. This chapter provides a *summary* of WRP easement distribution and area, eco-geography and restored wetland types.

Methods

Primary Datasets

Compliance and ecological data were collected during previous WRP field monitoring regime, using mobile GIS software on handheld computers, GPS, and custom electronic data entry forms to populate GIS attribute tables.

GIS data were in ESRI® "shapefile" (digital vector) format. The associated attribute (descriptive) component of shapefile format data is stored in linked "DBF" format files. Attribute data are tabular, with conventional data "fields" and "records." Fields may be of several types, including character, numeric and logical. WRP monitoring data files also included many free-form text "comment" fields dedicated to various themes, where non-structured data were entered.

Monitoring data were collected at both the easement and sub-easement (polygon and sub-polygon) levels, and recorded spatially (with linked attribute information) in two primary corresponding datasets (comp_3yrall.shp and plan_3yrall.shp, respectively). Whole easement data included both administrative compliance/management and ecological data, whereas polygon data were primarily ecological. The "enrolled dataset" (wrp_a_mo.shp), an administrative running total of the state's enrolled WRP easements (to January 2007), was available for basic analysis. Current wetland habitat types were recorded in the Missouri monitored WRP dataset utilizing a habitat data standard based on a *modified* version of "Classification of wetland and deepwater habitats of the United States" (Cowardin *et al*, 1979; see ModifiedCowardin.xls & ModifiedCowardin-Families.xls in Annex 4) hereafter referred to as "modified Cowardin codes." A separate, partially complete spatial dataset (29_wrp_existing.shp) of digitized site boundaries with habitat condition (also modified Cowardin codes) *existing* at enrollment – the "existing dataset" – was available for comparative analysis.

Stratification Datasets

The Missouri Ecological Classification System (Nigh and Schroeder, 2002) was selected for (any) geographical stratification of the Missouri WRP dataset. Two (core-) equivalent GIS shapefiles representing this dataset were obtained from NRCS and MDC (ecslta.shp and lta2-03data.shp, respectively). The spatially hierarchical system integrates a wide variety of physical and biotic factors to delineate ecological units at all levels of the hierarchy (Nigh and Schroeder, 2002). It divides Missouri into four ecological *sections*: 1) Central Dissected Till Plains – CDTP (north); 2) Osage Plains – OP (west); 3) Ozark Highlands – OH (south) and 4) Mississippi Alluvial Basin – MAB (southeast). The latter region, also known as the "boot heel" because of its shape, coincides with the northernmost extent of the Lower Mississippi Alluvial Valley (LMAV). (See maps of these regions as figures in Results). The geomorphic stratification of the LMVA by Saucier (1994) was nominated for any *subsequent* detailed stratification of the *boot heel* region.

Analyses

GIS shapefile format files were analyzed with ESRI® ArcMap™ (ArcGIS™) 9.2 software. Microsoft® Office Excel® 2003 and Microsoft® FoxPro 2.6a (X) software were also used for supplementary and complementary analysis of (DBF) attribute data.

Summary Analysis

Summary statistics were obtained using the abovementioned GIS's "statistics" and "summarize" facilities, conventional database counting, summing and filtering techniques and/or Excel® PivotTable® functionality. Full methodology treatments are found in the specific chapter where *detailed* analyses are featured.

Stratification

Enrolled WRP easements and Missouri monitored WRP polygons were variously plotted on a Missouri base map (NAD_1983_UTM_Zone_15N / GCS_North_American_1983 "MOBORDER.shp" obtained from MDC). Each of the four Missouri ecological sections were "clipped" using ArcMap™ to obtain sectional subsets of whole and partial easements contained within the section. (See "Clip Method Example.doc", Annex 2, for the detailed GIS "clipping" technique used). Sectional "clips" were analyzed for shared easements using Excel®.

Habitat Analysis

Modified Cowardin habitat codes (records) were simplified to facilitate analysis via a method developed under this project (see *Derivation, definition and rationale for Cowardin four character codes* in "Cowardin four character codes.doc" in Annex 4). Several discrete standard elements were first identified in the parent codes. Individual alphanumeric characters were adjusted, and character position and order were standardized within each code record to enable cleaving of segments within multiple code strings. "Prefixes" denoting land restoration "status" and "land-type" prefixes were removed, as were "water regime" and "special modifier" "suffixes." These manipulations distilled the parent code to a core "four character code" that encompassed the "System, Class and Subclass" levels of the original coding system. Four-Character Codes were sorted and summed using PivotTable® functionality to provide the summary analysis. However, the primary focus of habitat analyses undertaken during the project was to document change or succession. This is covered in Chapter 4: *Restoration Status*.

Results

At January 2007, 825 WRP sites had been enrolled in Missouri (Figure 2.1). These easements extended over approximately 119,437 acres. The monitored subset (i.e. the WRP analysis dataset) consisted of 594 of these easements (Figure 2.2), and covered approximately 66,706 acres. The majority of monitored easements (94%) were composed of more than one land-unit ("polygon"). WRP easements fell into one of three conservation categories: Permanent easements (719 or 87% of enrolled Missouri easements), 30-year easements (86 or 10%), and restoration cost-share agreements (20 or 2%). See Figure 2.3.

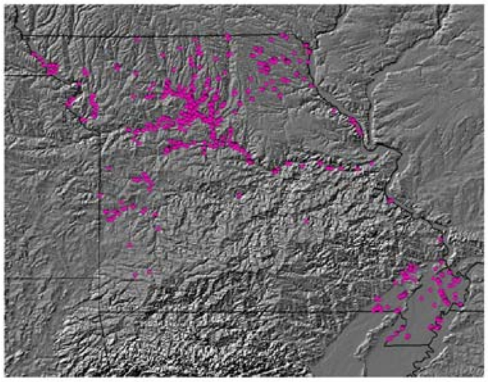


Figure 2.1. Map displaying general distribution of WRP easements in Missouri (January, 2007).

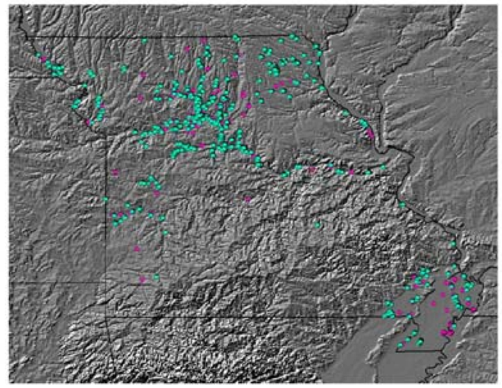


Figure 2.2. Map depicting the general distribution of 594 WRP easements monitored in Missouri during FY2004 – 2006 (in light blue).

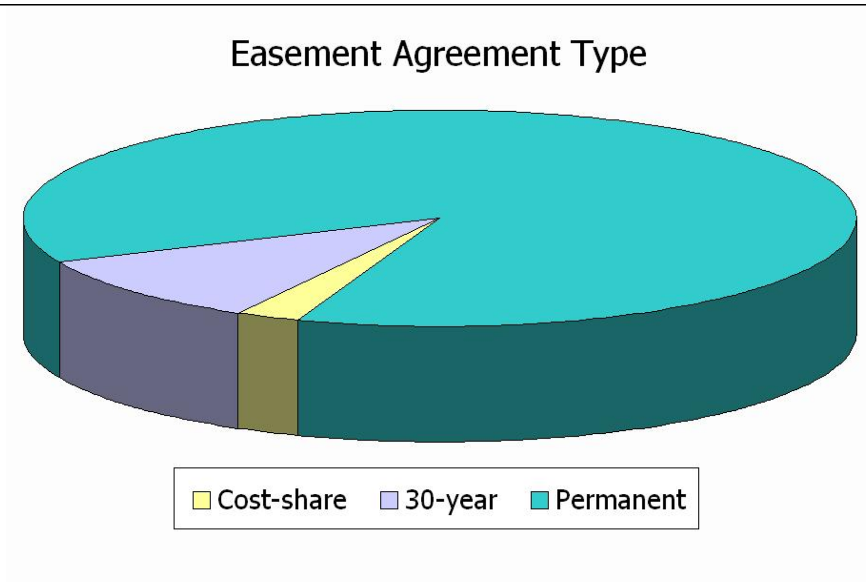


Figure 2.3. There are three conservation categories of WRP easements. Missouri's 825 easements are dominated by "permanent" easements which constitute 87% of all easements enrolled. 30-year easements make up 10% of the total and cost-share agreements account for 2% of Missouri WRP easements.

Ecological Stratification

Missouri covers approximately 44,600,000 acres. Division into Ecological Sections results in four partitions of the state of widely varying size. The Ozark Highlands section is largest at over 23,000,000 acres while the Mississippi Alluvial Basin is smallest measuring just over 2,500,000 acres. See Figure 2.4 for the geographic position of the "eco-sections" and Table 2.1 for the acreage of each region. Figure 2.5 illustrates the link between Missouri's MAB eco-section and the larger LMAV (mentioned above).

The Central Dissected Till Plains contained the most easements (including partial easements) of any eco-section from both the enrolled (542 of 825: 66%) and monitored (388 of 594: 65%) datasets. The CDTP also hosted the largest WRP acreage of any of the eco-sections (65,032 acres: 54% of enrolled acreage, and 37,268 acres: 56% of total acres). The MAB contained the next largest extent of acreage in the enrolled dataset (20,396 acres) whereas in the monitored dataset, the second-highest acreage was found in the OH (15,980 acres). The Osage Plains eco-section contained the least acreage of any eco-section in both datasets (16,768 and 6,154 acres, respectively). The largest Missouri WRP easement (6,997 acres) was located in the OP eco-section while the smallest (2 acres) was found in the Ozark Highlands.

Site breakdowns per each *clipped* eco-section for both the enrolled and monitored datasets are listed in Tables 2.2 and 2.3, and graphically depicted in Figures 2.6a & b and 2.7a & b, respectively.

Figure 2.4. Missouri's four ecological sections: Central Dissected Till Plains (purple), Osage Plains (green), Ozark Highlands (blue) and Mississippi Alluvial Basin (tan); from Nigh & Schroeder, 2002.

Table 2.1. Acreage of Missouri's Four Ecological Sections (from Nigh & Schroeder, 2002)

ECOLOGICAL SECTION	ACRES
Ozark Highlands	23,186,097
Central Dissected Till Plains	14,885,200
Osage Plains	3,987,320
Mississippi Alluvial Basin	2,537,195
MISSOURI TOTAL	44,595,812

Figure 2.5. Overlap of Mississippi Alluvial Basin (Nigh & Schroeder, 2002) and the Lower Mississippi Alluvial Valley (Saucier, 1994), in brown.

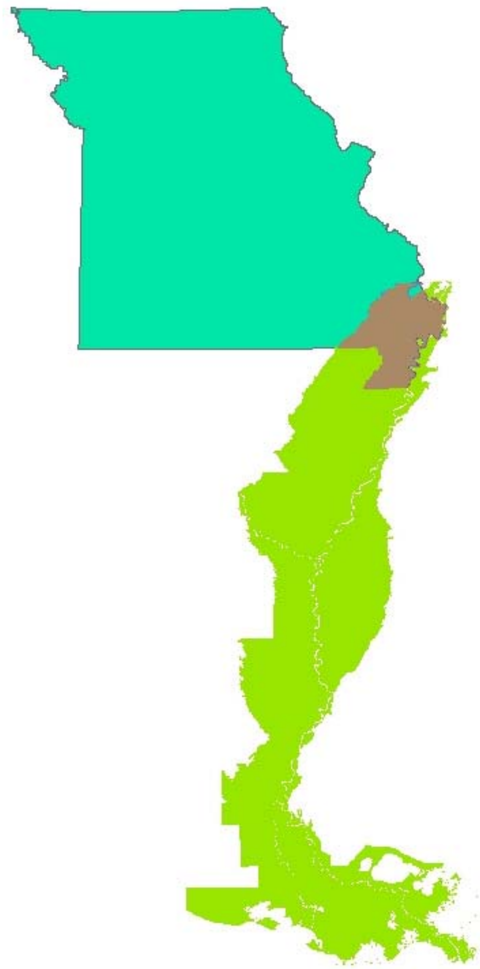


Table 2.2. Stratified Ecological Section breakdown of the full WRP easement enrollment dataset (at January 2007)

ECOLOGICAL SECTION	ALL SITES	ACRES (rounded)
Central Dissected Till Plains (14,885,200 acres)	542	65,032
Mississippi Alluvial Basin (2,537,195 acres)	104	20,396
Ozark Highlands (23,186,097 acres)	125	17,135
Osage Plains (3,987,320 acres)	70	16,768
Sum of raw clipped section datasets	841	119,331
Entire WRP dataset	825	119,437
WRP "transboundary" sites (difference as technical artifact of GIS processing)	16	107

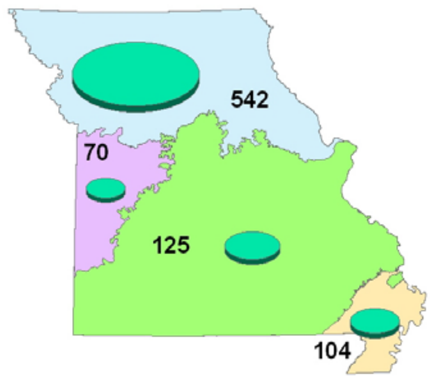


Figure 2.6a. All WRP easements enrolled per Missouri Ecological Section depicted using graduated symbols and value labels (at January 2007).

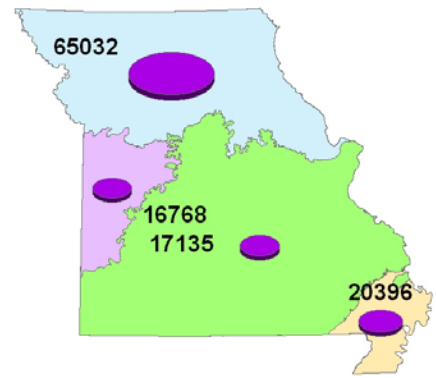


Figure 2.6b. Acreage of all WRP easements enrolled per Missouri Ecological Section depicted using graduated symbols and value labels (at January 2007).

Table 2.3. Stratified Ecological Section breakdown of the Monitored WRP easement dataset (FY2004-2006)

ECOLOGICAL SECTION	MONITORED SITES	ACRES (rounded)
Central Dissected Till Plains (14,885,200 acres)	388	37,267
Ozark Highlands (23,186,097 acres)	109	15,980
Mississippi Alluvial Basin (2,537,195 acres)	54	7,276
Osage Plains (3,987,320 acres)	55	6,154
Sum of raw clipped section datasets	606	66,678
Entire monitored WRP dataset	594	66,704
WRP "transboundary" sites (difference as technical artifact of GIS processing)	12	27

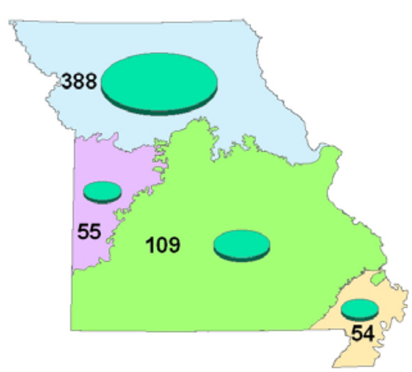


Figure 2.7a. Number of WRP easements monitored in each Missouri Ecological Section depicted using graduated symbols and value labels (FY2004-2006).

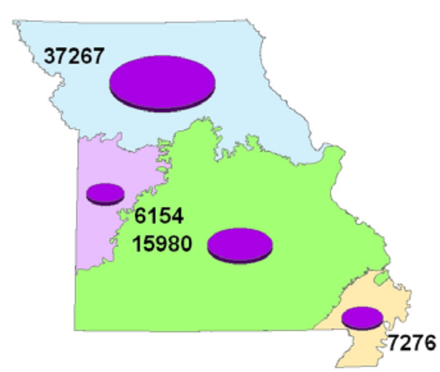


Figure 2.7b. Acreage of WRP easements monitored in each Missouri Ecological Section depicted using graduated symbols and value labels (FY2004-2006).

The distribution of Missouri's WRP sites in terms of general topography, one of the main elements underlying Missouri's ecological section concept, can be observed in Figure 2.8.

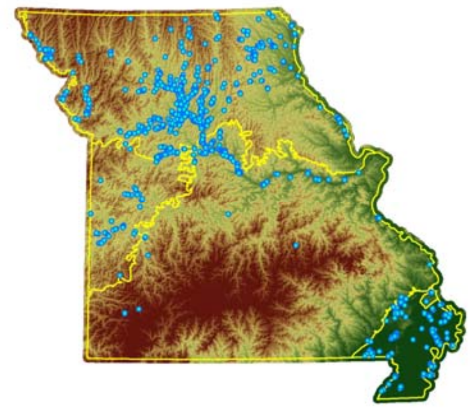


Figure 2.8. Missouri's WRP sites (blue) plotted on a general shaded relief topographic background, with eco-section boundaries (yellow).

Restored Wetland Habitats

There were 536 easements in *common* (overlapping in some way) between the existing (*de facto* baseline) and monitored datasets; 530 of these easement records included modified Cowardin habitat codes. This "common monitored dataset" totaled 58,415 acres. More precise GIS results indicated 488 "appreciable" (set at >0.40 acres) common easements (or part easements) measuring 52,208 acres.

There were a total of 422 unique modified Cowardin codes employed for recording habitat in the monitored easements of the appreciable common dataset. Simplification of the habitat codes resulted in 21 unique core, four-character codes (the unit developed for comparing habitats under this project). The most widespread restored class represented by four character codes was Palustrine Broad-leaved Deciduous Forest (26,304 acres, or 50% of the total). Results for all four-character code restored classes are tabulated in Table 2.4.

Table 2.4. Process **s**implification of the 422 unique variants of modified Cowardin habitat codes recorded within the 52,208 acre habitat restoration dataset resulted in a more manageable 21 "four-character codes," the core habitat class unit for comparative habitat analyses developed for this study. The summed area of each habitat class was also calculated, listed in descending order.

Four Character Code description	**Code**	**Acres**
Palustrine Forested Broad-leaved Deciduous	PFO1	26,304
Palustrine Emergent Persistent	PEM1	11,474
Palustrine Emergent Non-persistent	PEM2	9,650
Other Riparian Woody	ORP3	959
Palustrine Open Water	POWZ	855
Palustrine Floodplain Non-hydric soils, Woody	PFP3	659
Upland Herbaceous Introduced	UHE2	633
Upland Herbaceous Native	UHE1	515
Upland Wooded Deciduous	UWO1	470
Palustrine Scrub Shrub Broad-leaved Deciduous	PSS1	279
Palustrine Floodplain Non-hydric soils, Herbaceous	PFP2	156
Other Riparian Herbaceous	ORP2	73
Palustrine Forested Needle-leaved Deciduous	PFO2	72
Palustrine Substantially Altered Non-persistent	PSA2	47
Other Farmed Wetland or Farmed Wetland Pasture, Cropped	OFW1	19
Palustrine Forested (unspecified)	PFO	15

Table 2.4. (continued)

Other Substantially Altered, Herbaceous	OSA2	13
Palustrine Forested Dead	PFO5	6
Palustrine Substantially Altered Persistent	PSA1	3
Other Substantially Altered, Open Water	OSA3	2
Upland Wooded Deciduous	UWO	2
TOTAL Code Classes	21	52,208

Regional stratification of (derived, four-character code) restored habitat classes mirrored the broader results above. In the un-stratified dataset and three of the four eco-sections, the top three habitat classes (in terms of extent) were the same. These were (in descending order) Palustrine Broad-leaved Deciduous Forest (PFO1), Palustrine Emergent Persistent (PEM1) and Palustrine Emergent Non-Persistent (PEM2). Only in the Osage Plains eco-section were there differences, and these concerned the ranking *order* of the same three restored habitat classes (Table 2.5).

Table 2.5. Eco-regional stratification of the five most-extensive four-character code (F-C-C) habitat classes of WRP easements monitored during restoration.

CDTP section		OH section		OP section		MAB section	
F-C-C	**acres**	**F-C-C**	**acres**	**F-C-C**	**acres**	**F-C-C**	**acres**
PFO1	14,261	**PFO1**	9390	***PEM2***	2,054	**PFO1**	1,329
PEM1	7,805	**PEM1**	1419	***PFO1***	1,456	**PEM1**	1,199
PEM2	5,868	**PEM2**	1136	***PEM1***	1,059	**PEM2**	674
ORP3	626	PFP3	640	UHE1	134	PSS1	106
UHE2	572	POWZ	341	POWZ	55	PFO2	65

Discussion

The vast majority of Missouri's WRP easements are contracted on a permanent basis. Indeed, considered with the 30-year contracts, only a few of Missouri easements are *not* in it for the long haul. While site selection and contracting are administrative rather than ecological, putting these easements into wetland conservation for such a long time will have ecological impacts, hopefully restoring benefits and services of wetland habitats that have been previously lost.

Ecological region stratification of the WRP dataset was undertaken to see if any patterns emerged in the distribution of WRP wetlands and restored wetland types, ultimately with a view to assist in assessing the effectiveness of restoration of Missouri Wetlands Reserve Program sites. Nigh and Schroeder's (2002) Atlas of Missouri Ecoregions divides Missouri into four Ecological Sections. These are delineated from a host of interacting biotic and abiotic factors. One of the foremost and most obvious is the lay of the land, the topography.

We have found that in terms of sheer area, Missouri's largest eco-section (Ozark Highlands) holds nearly the least WRP acreage of any eco-section. Conversely, the smallest of four eco-sections (Mississippi Alluvial Basin), hosts the second-highest easement acreage (Figures 2.6a

& b). Notwithstanding the aforementioned administrative considerations in the determination of WRP sites (--or perhaps enabling it), why this near inverse relationship? The answer may be due to the topography of these eco-regions (Figure 2.8). Missouri is bordered and bisected by two great rivers, the Mississippi and the Missouri. The Mississippi Alluvial Basin as its name reveals is wholly formed and influenced by the great river. This is what makes it so fertile and what led to the need to now restore its drained-for-agriculture wetlands. It is not surprising to find so much WRP acreage here given what has been lost. Likewise, the CDTP's pre-imminent position as the eco-section with the most Missouri WRP acreage comes not only from its large area but from the large potential for, and realized concentration of easements bounding the branches of the Grand River, a major tributary of the Missouri. On the other hand, the largest but most "mountainous" eco-section, the Ozark Highlands is the also by area, clearly the most depauperate in (agricultural) wetlands. But here too, it is along the Missouri River where most of its (potential) WRP easements are found.

Despite the differences seen in restored acreages between the eco-sections, there is a strong similarity between these regions in the most dominant kinds of wetlands that have been or are undergoing restoration (See again Table 2.5). In each region it is the palustrine wetlands that have been restored most often. Usually these are forested followed by emergent types, and if not, the forested types constitute a very large share.

As this is a summary chapter, the subject of restoration has only received summary treatment here. Chapter four will provide a detailed treatment of selected restoration elements including detailed methods, results, discussion and recommendations.

References

Barbier, E.B., Acreman, M.C. and Knowler, D. 1997. Economic valuation of wetlands: A guide for policy makers and planners. Ramsar Convention Bureau, Gland, Switzerland.

Cowardin, L.M., Carter, V., Golet, F.C. and LaRoe, E.T. 1979. Classification of Wetland and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service Report FWS/OBS-79/31. Washington D.C. 131 p.

Dahl, T.E., 1990, Wetlands–losses in the United States, 1780's to 1980's: Washington, D.C., U.S. Fish and Wildlife Service Report to Congress. 13 p.

De Groot, R.S., Stuip, M.A.M., Finlayson, C.M. & Davidson, N. 2006. Valuing wetlands: guidance for valuing the benefits derived from wetland ecosystem services, Ramsar Technical Report No. 3/CBD Technical Series No. 27. Ramsar Convention Secretariat, Gland, Switzerland & Secretariat of the Convention on Biological Diversity, Montreal, Canada.

Demas, C.R., and Demcheck, D.K.. 1996. Missouri Wetland Resources *in* National Water Summary on Wetland Resources: U.S. Geological Survey Water-Supply Paper 2425. pp 249-253.

Epperson, J.E. 1992. Missouri Wetlands: A Vanishing Resource. Missouri Department of Natural Resources, Division of Geology and Land Survey. Water Resources Report No. 39.

Nigh, T.A. and Schroeder, W.A.. 2002. Atlas of Missouri Ecoregions. Missouri Department of Conservation. Jefferson City, Missouri. xii + 212 p and GIS data.

Ramsar Convention Bureau. 2000. Wetland Values and Functions. (Information Pack). Ramsar Convention Secretariat, Gland, Switzerland. On-line version available at: http://www.ramsar.org/info/values_intro_e.htm

Natural Resources Conservation Service (NRCS). 2006. NRCS in Missouri. October 1, 2005 - September 30, 2006. Available at: http://www.mo.nrcs.usda.gov/news/news/Annual%20Report%2006.pdf

Saucier, R. T. 1994. Geomorphology and quaternary geologic history of the Lower Mississippi Valley. U.S. Army Corps of Engineers. Waterways Experiment Station, Vicksburg, Mississippi, USA.

Shaw, S.P., and Fredine, C.G. 1956. Wetlands of the United States–their extent, and their value to waterfowl and other wildlife: U.S. Fish and Wildlife Service Circular 39. 67 p.

Stuip, M.A.M., Baker, C.J. and Oosterberg, W. 2002. The Socio-economics of Wetlands. Wetlands International and RIZA, The Netherlands.

Chapter 3: Species Analysis

Introduction

Recording observations of species that reside or visit restored wetlands is one component of Missouri's unique WRP ecological monitoring program. Such observations provide an indication about the ecological state of the sites and the progress of restoration. Enhancement of easement biota is a major goal of the WRP (NRCS [2007]).

The Wildlife Component of NRCS's Conservation Effects Assessment Project (CEAP) seeks to quantify the effects of USDA "conservation practices and programs on fish and wildlife and their habitats in landscapes influenced by agriculture in the United States" (NRCS 2006).

This chapter details the direct and implied importance of Missouri's WRP sites to species, including rare, threatened or endangered species, based on analyses of available data. Initial summaries of animal and plant species observations collected during ecological monitoring of Missouri WRP sites are presented. Species data are augmented with "heritage" range data of Missouri rare, threatened and endangered species. The objective here was to look for implied/potential easement contributions to the maintenance and protection of these species *by virtue of site proximity* to their ranges. This chapter's analyses also contribute to documenting wildlife effects under the CEAP Wildlife Component. Monitoring and analysis of wildlife *habitat* are discussed in Chapter 4.

Methods

Primary Datasets

Ecological data including species observation data were collected and stored as described in Chapter 2: Summary Findings. Likewise the same primary datasets corresponding to easement and sub-easement (polygon and sub-polygon) levels (comp_3yrall.shp and plan_3yrall.shp, respectively) were employed in the species analyses.

MONHP Dataset

The Missouri Natural Heritage Program (MONHP[1]) dataset, a suite of six GIS layers (shapefiles) of Missouri's *conservation status species* ("status species") and communities, was

[1] "The MONHP receives biological data from the Missouri Natural Features Inventory, field biologists, universities, scientific literature, herbaria and other individuals and organizations. This information

obtained under a MOU between the project officer and the Missouri Department of Conservation (MDC). One layer, Hertpoly.shp (comprised of lumped Heritage taxa and community element observations as extrapolated range polygons), was selected for use from the MDC MONHP dataset. NRCS also provided individual layers (shapefiles) comprised of a single higher taxon (or a group of related taxa) processed from the MONHP dataset, with the approval of MDC.

Subsidiary Plant Databases

The PLANTS (National) Database (NPDB) of NRCS was selected as the primary plant reference source for the project following extensive on-line testing. The on-line NPDB was selected because: 1) it was versatile, including capable of issuing outputs in formats compatible with project databases; 2) the NPDB was *actively* being developed and maintained by the same agency that administers the WRP (i.e. NRCS); 3) botanists at the National Plants Data Center (sponsor of the NPDB)[2] were responsive to queries and troubleshooting (pers. obs. S. Frazier); and 4) the NPDB is a major cooperative intra-agency effort within the USDA, but it also involves several other federal and academic partners[3], thereby becoming a national standard.

Comprehensive (MOPLNTZ3.DBF) and summary (DICVEG1.DBF) plant data dictionaries were developed using external information sources (Table 3.1). A data dictionary of Missouri rare, threatened or endangered plant species (ST&EPLNT.DBF) was also compiled from the MONHP heritage dataset to help identify status species in voluminous observation data. This dictionary contained Missouri plants with any one or more of the following statuses: federal status (Endangered, Threatened), state status (Endangered) and/or state rank (S1, S2 or S3 state-ranked elements, including those assigned a range of these *SRANK*s that includes at least one of these values). Any species with a Global Rank (GRANK) were for all practical purposes also SRANK species, and it was not necessary to filter these species out separately. (A detailed explanation of how MONHP "ranking" has been applied in this analysis is found in the document: "WRP Site Proximity to T&E Species Ranges 1.doc" in Annex 3).

A checklist of "species and communities of conservation concern" is also produced by MDC's MONHP annually (see Missouri Natural Heritage Program 2007). MDC also hosts a complementary on-line source of Missouri species information (including status species) called the Missouri Fish and Wildlife Information System (MOFWIS).[4] These sources were also consulted during the project.

---

provides an understanding of the abundance, distribution, condition, and conservation needs of these sensitive elements. There are currently over 18,000 element occurrence records of more than 800 sensitive species and natural community types in Missouri." from http://www.mdc.mo.gov/nathis/aboutmohhp.htm.

[2] http://npdc.usda.gov/

[3] See http://plants.usda.gov/partners.html

[4] http://mdc4.mdc.mo.gov/applications/mofwis/mofwis_search1.aspx

Table 3.1. The main plant taxonomic and distribution sources consulted during this project for checking plant observations (concerning questions of taxonomy and distribution) and building plant dictionaries.

Primary sources
USDA, NRCS. 2007. The PLANTS Database (http://plants.usda.gov, 19 November 2007). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.
Integrated Taxonomic Information System on-line database (http://www.itis.gov, 19 November 2007).
Supplementary sources
USDA, ARS, National Genetic Resources Program. *Germplasm Resources Information Network - (GRIN)* [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: http://www.ars-grin.gov/cgi-bin/npgs/html/taxgenform.pl (19 November 2007)
The International Plant Names Index (2004). Published on the Internet http://www.ipni.org [accessed 19 November 2007].

Analyses

The analyses examine animals, plants, and then rare, threatened and endangered species, separately. Select, detailed, step-by-step methods used in developing this analysis are found under "Methods" in Annex 3.

Animals

Incidental animal sightings were recorded in free-form comment fields at the easement level. These comments, and feature level monitoring files, were "mined" for faunal observations using a combination of simple database filtering techniques and visual scrolling.

Plants

Plant observations were recorded in dedicated data fields at the polygon level and sometimes in comment fields at the easement and feature (sub-polygon) level. The three most dominant plant species (based on "percent canopy cover") were generally recorded for each polygon. These species were referred to as Species1, Species2 and Species3 (in order of decreasing dominance). However the specific percentages of canopy closure (or acreages) of dominant plants were not recorded in the monitoring dataset.

Species1, Species2 and Species3 dominant plant observation records were normalized – removing non-species data, converting shorthand, correcting misspellings, standardizing usage and translating common names to scientific names when possible. Query lists of discrepancies were forwarded to the TSPs and any reply input received was used to effect further corrections. (Annex 3 "Methods" includes additional information on the methods employed in developing the plant dictionary).

Plant species observations were then subjected to simple frequency analyses using Microsoft® Office Excel® 2003 using PivotTable® feature to derive the most commonly recorded species. The total number of unique species recorded in the monitoring dataset was also calculated.

Seventy six GIS "line-feature" records and 127 "polygon-feature" records that included "abbreviated" and/or *common* plant-names were not analyzed owing to their ambiguous, non-standard format, and the *un*likelihood that they contained status species given the purposes of the files concerned.

Rare, Threatened or Endangered Species

Observations of faunal status-species (a subset of animal observations) were restricted to comment fields. (A logical [yes/no] data field indicating easements *ranked* for status species was not species specific). The low number of total faunal observations yielded by mining the free-form text enabled manual cross-checking of these sightings against the animal status-species listed in the aforementioned "species of conservation concern" checklist (see Missouri Natural Heritage Program 2007).

Plants, with three dedicated data fields in each monitored polygon record, required an additional, more conventional database approach to check for status species. Using a "database relation," processed plant monitoring observation data were checked against the records of rare, threatened or endangered species in the dictionary list of Missouri status species plants (ST&EPLNT.DBF).

The MONHP heritage dataset was also employed to provide a measure of implied potential importance of WRP sites to rare, threatened and endangered species (plants and animals) and natural communities. This was accomplished through GIS spatial proximity analyses, primarily using the ArcMap™ "Geoprocessing – Intersect" procedure. First, the collective status-species range polygons (of all included taxonomic groups) were spatially related to two WRP datasets: 1) *all* WRP sites (enrolled through January 2007), and 2) the *monitored set* of WRP sites (those 594 easements monitored during *fiscal* years 2004-2006). Then, the spatial relationship of each (higher) taxon level (e.g. "birds") to the set of (monitored) easements was examined.

Species and natural community data were lumped in the general (non-taxon-specific) MONHP base layer (Hertpoly.shp); however total community records were low. The constitution of taxonomic groupings in the analyses was determined by the source taxon-specific GIS shapefiles received from NRCS (Missouri). Whereas these analyses typically involved the basic spatial intersection of a WRP easement (site) dataset and the range of all or a specific taxonomic group(s) of status species, there were some variations. Detailed proximity analysis methods have been documented in Annex 3 ("Methods" WRP Site Proximity to T&E Species Ranges1 & WRP Site Proximity to T&E Species Ranges 2).

Stratification

Stratification analyses involving Rare, Threatened or Endangered Species and Missouri WRP easements involved the same ecological section datasets and methods described in Chapter 2: Summary Findings. See also "Clip Method Example.doc" in Annex 2 for the detailed GIS technique used.

Results

Animals

Eight bird species were recorded from incidental observations on 12 (2%) of 594 monitored WRP easements (Table 3.2). A few easement records also mentioned "ducks" or "rails." *Sign* of two mammal species were also noted on several easements, usually in the context of damage to the site or structures.

Table 3.2. Minimum number of individuals of faunal species and the number of easements they were observed on during monitoring of Missouri WRP sites, 2003-2005.

Observed species	Total minimum number of individuals	Number of easements
American bittern (*Botaurus lentiginosus*)	4	3
least bittern (*Ixobrychus exilis*)	9	3
great egret (*Ardea alba*)	45	1
bald eagle (*Haliaeetus leucocephalus*)	2	2
king rail (*Rallus elegans*)	1	1
purple gallinule (*Porphyrula martinica*)	1	1
greater yellowlegs (*Tringa melanoleuca*)	"several"	1*
lesser yellowlegs (*Tringa flavipes*)	"several"	1*
beaver (*Castor canadensis*)	?	4
muskrat (*Ondatra zibethicus*)	?	3

* greater and lesser yellowlegs observed together on the same easement

Plants

The total number of unique species recorded in 594 Missouri WRP easements as (co-) dominant plants was 238. (The complete list of these species is found in Annex 3, Table A3.1). This total represents a maximum number of species because some records only listed genus (i.e. there was no species epithet). If some of the genus-only entries prove to match already recorded species of that genus, then the number of unique species will decrease. Approximately 40 species names did not match entries in the project's Missouri plant dictionary. Some of these may have represented synonyms. (These names were forwarded to the TSPs and await resolution). These 238 unique species were divided among 45 plant families (Table 3.3). Just over 42% (or 94 of 222) of the plant species recorded could be roughly ascribed to "herbaceous" plant life forms. "Grass" forms were represented by 68 species (~31%) and "woody" forms by 60 plant species (27%).

Table 3.3. The 45 families of plants (listed in taxonomic order) and the maximum number of species recorded from each family during monitoring of Missouri WRP sites, 2003-2005.

Family	**No. of species**	**Family**	**No. of species**
Azollaceae -- Azolla family	1	Amaranthaceae -- Amaranth family	1
Cupressaceae -- Cypress family	2	Polygonaceae -- Buckwheat family	10
Alismataceae -- Water-plantain family	5	Ebenaceae -- Ebony family	1
Potamogetonaceae -- Pondweed family	1	Malvaceae -- Mallow family	3
Lemnaceae -- Duckweed family	2	Salicaceae -- Willow family	7
Cyperaceae -- Sedge family	17	Betulaceae -- Birch family	1
Poaceae -- Grass family	55	Fagaceae -- Beech family	12
Sparganiaceae -- Bur-reed family	1	Hamamelidaceae -- Witch-hazel family	1
Typhaceae -- Cat-tail family	3	Platanaceae -- Plane-tree family	1
Liliaceae -- Lily family	3	Juglandaceae -- Walnut family	5
Asteraceae -- Aster family	34	Moraceae -- Mulberry family	3
Hippuridaceae -- Mare's-tail family	1	Ulmaceae -- Elm family	6
Campanulaceae -- Bellflower family	1	Nelumbonaceae -- Lotus-lily family	1
Caprifoliaceae -- Honeysuckle family	1	Apiaceae -- Carrot family	1
Apocynaceae -- Dogbane family	2	Aquifoliaceae -- Holly family	1
Asclepiadaceae -- Milkweed family	1	Cornaceae -- Dogwood family	2
Lamiaceae -- Mint family	1	Fabaceae -- Pea family	21
Verbenaceae -- Verbena family	2	Lythraceae -- Loosestrife family	2
Plantaginaceae -- Plantain family	1	Onagraceae -- Evening Primrose family	5
Rubiaceae -- Madder family	1	Rosaceae -- Rose family	7
Bignoniaceae -- Trumpet-creeper family	1	Aceraceae -- Maple family	5
Oleaceae -- Olive family	1	Anacardiaceae -- Sumac family	4
Scrophulariaceae -- Figwort family	1	TOTAL Species	238

The most commonly recorded dominant plant species on an easement basis was *Populus deltoides*, the eastern cottonwood (35.7% of the 594 monitored sites). This was followed closely by *Acer saccharinum* (32.5% of easements) the silver maple. The third most commonly encountered dominant species on Missouri's monitored WRP sites was another tree *Salix nigra*, the black willow (21.7% of sites, Table 3.4). The three most commonly recorded species when records of dominant and co-dominant plants were lumped were the same three tree species, but in a different numerical order: *Salix nigra*, *Populus deltoides* and *Acer saccharinum* (derived from Table 3.5).

Table 3.4. The most commonly recorded dominant plants (by greatest proportion of "canopy cover") in Missouri's 594 monitored WRP easements.

Species	No. Sites	Species	No. Sites
Populus deltoides (tree)	212	*Quercus palustris* (tree)	79
Acer saccharinum (tree)	193	*Phalaris arundinacea* (grass)	70
Salix nigra (tree)	129	*Polygonum pensylvanicum* (forb/herb)	62
Echinochloa crus-galli (grass)	103	*Fraxinus pennsylvanica* (tree)	60
Aster pilosus (forb/herb)	84	*Solidago nemoralis* (forb/herb)	54

Table 3.5. The most commonly recorded plant species in three categories of (descending) dominance in 594 monitored Missouri WRP easements. "Species1" refers to the most dominant plant by highest percentage of canopy cover, "Species 2" the second most dominant, and "Species3," the third most dominant plant species.

SPECIES 1	No. Sites	SPECIES 2	No. Sites	SPECIES 3	No. Sites
Populus deltoides	212	*Salix nigra*	199	*Salix nigra*	167
Acer saccharinum	193	*Acer saccharinum*	155	*Fraxinus pennsylvanica*	143
Salix nigra	129	*Populus deltoides*	154	*Populus deltoides*	118
Echinochloa crus-galli	103	*Fraxinus pennsylvanica*	128	*Platanus occidentalis*	98
Aster pilosus	84	*Echinochloa crus-galli*	110	*Acer saccharinum*	97
Quercus palustris	79	*Solidago nemoralis*	94	*Echinochloa crus-galli*	81
Phalaris arundinacea	70	*Aster pilosus*	85	*Quercus palustris*	80
Polygonum pensylvanicum	62	*Polygonum pensylvanicum*	66	*Acer negundo*	79
Fraxinus pennsylvanica	60	*Quercus palustris*	64	*Aster pilosus*	77
Solidago nemoralis	54	*Acer negundo*	58	*Solidago nemoralis*	76

Rare, Threatened or Endangered Species

Within the WRP monitoring dataset, 481 (81%) of the 594 easements were *flagged* as being ranked important for status species (animals *or* plants). Five observed species were also of rare, threatened or endangered status (Table 3.6). *No* status-species plants were among those recorded in the three dedicated plant species data fields of the monitoring dataset. Other plant species data in GIS easement feature files were not analyzed for conservation status because they were not recorded in a standard format. Furthermore, it is unlikely these records contained any status species given the purpose of the files that held them.

Table 3.6. *Status species* fauna observed in Missouri's monitored WRP sites.

Observed species	Conservation status
American bittern (*Botaurus lentiginosus*)	MONHP-S1; State-Endangered
least bittern (*Ixobrychus exilis*)	MONHP-S3
great egret (*Ardea alba*)	MONHP-S3
bald eagle (*Haliaeetus leucocephalus*)	MONHP-S3; State-Endangered
king rail (*Rallus elegans*)	MONHP-S1; State-Endangered

Augmentation of the sparse status species *observation* results above was effected through intersection of Missouri WRP easement datasets with Missouri Natural Heritage Program

(MONHP) datasets. A slight majority of *enrolled* WRP sites (52% or 431 of 825 sites) do provide habitat that *potentially* supports (208) rare, threatened or endangered species, based on the proximity of the sites to known and extrapolated status species ranges. Collectively, 316 of 594 (or 53%) of *monitored* easements provide potential habitat to 186 status species. Potential support of WRP habitats to individual taxonomic groupings of status species varied from a high of 57% (enrolled sites) for status birds to 5% (enrolled or monitored sites) for status mammals not including bats. The results of all status species proximity analyses are summarized below in Table 3.7. Detailed results for Table 3.7 are found in Annex 3: Results (T&E Proximity Summary.doc).

Table 3.7. Summary Results: Proximity Analyses for WRP Sites and *Status Species*.

Analysis	Dataset 1	Dataset 2	Result of Spatial Intersection
1	825 Enrolled WRP sites	All T&E species range polygons	439 (**53%** of) easements intersected 217 MONHP T&E species/community ranges[1]
as above	*as above*	*as above*	396 (**48%** of) easements intersected 182 MONHP T&E species ranges[2]
2	Product of Analysis#1	594 Monitored WRP sites	320 (**54%** of) monitored easements intersected 193 MONHP T&E species/community ranges
as above	*as above*	*as above*	305 (**51%** of) monitored easements intersected 183 MONHP T&E species/community ranges[3]
3	594 Monitored WRP sites	All T&E species range polygons	316 (**53%** of) monitored easements intersected 186 MONHP T&E species ranges[4]
as above	*as above*	*as above*	307 (**52%**) monitored easements intersected 183 MONHP T&E species/community ranges[3]
4	825 Enrolled WRP sites	All T&E species range *points*	*Observations* of 43 T&E species occurred *within* 38 (**5%** of) WRP easements
5B	825 Enrolled WRP sites	Buffered T&E Bat range polygons	128 (**16%** of) easements intersected ranges of 2 SRANK123 **bat** species
5C	594 Monitored WRP sites	Buffered T&E Bat range polygons	104 (**18%** of) monitored easements intersected ranges of 2 SRANK123 **bat** species
as above	*as above*	*as above*	93 (**16%** of) monitored **wooded** easements intersected ranges of 2 SRANK123 **bat** species
6A	825 Enrolled WRP sites	Buffered T&E Bird range polygons	467 (**57%** of) easements intersected 24 T&E **bird** species ranges
6B	594 Monitored WRP sites	Buffered T&E Bird range polygons	322 (**54%** of) monitored easements intersected 24 T&E **bird** species ranges
7A	825 Enrolled WRP sites	Buffered T&E Mammal range polygons	43 (**5%** of) easements intersected 6 T&E **mammal** species ranges.
7B	594 Monitored WRP sites	Buffered T&E Mammal range polygons	29 (**5%** of) monitored easements intersected 4 T&E **mammal** species ranges
8A	825 Enrolled WRP sites	Buffered T&E reptile-amphibian-insect range polygons	108 (**13%** of) easements intersected 22 T&E **reptile** and/or **amphibian** and/or **insect** species ranges
8B	594 Monitored WRP sites	Buffered T&E reptile-amphibian-insect range polygons	75 (**13%**) monitored easements intersected 16 T&E **reptile** and/or **amphibian** and/or **insect** species ranges
9[5]	825 Enrolled WRP sites	Buffered T&E fish-crustacean-mollusc range polygons	90 (**11%** of) easements intersected 16 T&E **fish** and/or **crustacean** and/or **mollusc** species spatially generalized ranges
10A	825 Enrolled WRP sites	Buffered T&E plant distribution polygons	97 (**12%** of) easements intersected 62 T&E **plant** distributions
10B	594 Monitored WRP sites	Buffered T&E plant distribution polygons	71 (**12%** of) monitored easements intersected 44 T&E **plant** species distributions

Notes for Table 3.7

T&E = rare, threatened or endangered
1 = If status *community* records are *excluded*, the numbers are **431** (52% of) easements/**208** species ranges
2 = results when *fish* (and status *communities*) are *excluded*
3 = including only those fish range records that overlapped with "POWZ" *palustrine open water* habitat.
4 = Analysis 2 and Analysis 3 yielded, for all practical purposes, identical results. Analysis 2 was regarded as redundant.
5 = Analysis of this taxonomic grouping was undertaken for the all enrolled WRP dataset only.

Status species range and WRP site proximity analyses results were also analyzed by Missouri's Ecological Sections. By percentage of WRP sites, the smallest ecological section, the Mississippi Alluvial Basin or MAB (2,537,195 acres), provided the highest percentages of potential support of any eco-section to status species in every category analyzed except bats. A total of 97.1% of enrolled WRP sites intersected status species ranges for all taxa (lumped) in the MAB. Status bird ranges intersected 71.2% of MAB enrolled WRP sites. The MAB also had the highest percentage of areal coverage by status species ranges (92%). The eco-section with the highest percentage of sites offering potential support for bats (40.8% of sites) was the Ozark Highlands or OH, the largest eco-section (23,186,097 acres). The lowest percentages WRP sites intersecting status species ranges was observed in the Osage Plains or OP (3,987,320 acres), where 38.6% of sites provided potential support to status species (all taxa; lumped), and percentages for all categories analyzed were the lowest of any eco-section except for plants. The Central Dissected Till Plains or CDTP (14,885,200 acres) showed the lowest percentage of WRP sites providing potential support to status plants (5.7% of sites). See Table 3.8 for full results of the eco-sectional breakdown for Missouri's enrolled WRP sites.

Table 3.8. Summary Results: Proximity Analyses for WRP Sites and *Status Species* by Missouri's Ecological Sections.

ALL (825) WRP SITES		Sites Intersecting Species Ranges						
		all taxa	**bats**	**other mammals**	**birds**	**reptiles amphibians insects**	**fish crustaceans molluscs**	**plants**
State-wide	Sites in Range	433	128	43	467	108	90	97
	Total Sites	825	825	825	825	825	825	825
	Percent	52.5	15.5	5.2	56.6	13.1	10.9	11.8
Central Dissected Till Plains	Sites in Range	222	71	23	310	56	44	31
	Total Sites	542	542	542	542	542	542	542
	Percent	41.0	13.1	4.2	57.2	10.3	8.1	*5.7*
Osage Plains	Sites in Range	27	0	1	29	2	3	8
	Total Sites	70	70	70	70	70	70	70
	Percent	*38.6*	*0.0*	*1.4*	*41.4*	*2.9*	*4.3*	11.4
Ozark Highlands	Sites in Range	87	51	4	56	12	10	26
	Total Sites	125	125	125	125	125	125	125
	Percent	69.6	**40.8**	3.2	44.8	9.6	8.0	20.8
Mississippi Alluvial Basin	Sites in Range	101	6	18	74	38	33	35
	Total Sites	104	104	104	104	104	104	104
	Percent	**97.1**	5.8	**17.3**	**71.2**	**36.5**	**31.7**	**33.7**

Discussion

Robust lists of animals and plants that would: a) illustrate the biodiversity observed in easements under WRP restoration, and b) examine the extent to which WRP easements support and sustain rare, threatened and endangered species of flora and fauna did not result from this analysis. Just 10 animal species were noted on 594 easements during three years of monitoring (Table 3.2).

Site monitoring, at least in terms of this project's analysis dataset, was limited to a single site visit. Most animals are generally inconspicuous, shy and/or mobile, and there's a high likelihood that most species will *not* be observed during monitoring that is limited to a solitary site visit. This effect can be exacerbated further by the seasonality, weather, time of day of the visit and other factors. The corollary to single-site-visits is that there is no *monitoring emphasis* on field recording of animal presence and use of Missouri's WRP sites.

This is by design because comprehensive faunal listing is not cost effective.[5] This intent is evidenced by the absence of data recording procedures and structures for faunal observations. This does not discount the broader WRP emphasis on species, however. The form used for "ranking" suitability of proposed WRP sites uses, if not direct observations, then *association* to status species based on proximity to their ranges. The analysis of such proximities became the default primary species analysis for this product owing to the dearth of direct (faunal) observations.

Given the high likelihood that fiscal constraints preclude intensive animal surveying across the entire WRP site network, it is necessary to either discount the importance of this component of ecological monitoring, or to find alternatives. If it is unrealistic to adequately survey and document the importance of fauna in all WRP easements, site by site, perhaps on a programmatic level it may be useful to document them on a representative sample basis. For example, a more rigorous monitoring program could be conducted on 10% of all sites with each of the four ecological sections. Another possibility, either as a surrogate, or as an adjunct to representative surveying, is to make use of existing species observation data. There are a number of Missouri WRP easements that include public lands. Many of these areas likely have existing species lists. In addition, certain WRP sites are known bird watching sites, and bird lists from these areas could be obtained to supplement the WRP monitoring dataset. See Chapter 6 for general monitoring design recommendations to detect temporal trends.

In contrast, plant observation data were plentiful, and were a primary target of monitoring data collection, as exemplified by dedicated data fields and thousands of records entered. Thus, delivering a simple plant list (Table A3.1, Annex 3) and ranking plant species by number of easement records (Tables 3.4 & 3.5) was possible. There was however, no scientifically robust way to associate acreage to the "dominant species" within an easement unit (polygon), because the "percentages of canopy cover" which connoted the dominance, were *not* specified in the data. Even if they had been specified, the accuracy of such figures may have been suspect given methodology concerns. Some taxonomic issues emerged as they are always wont to do, but this and other issues were overshadowed by a predominating question about the applicability and efficacy of using plant canopy cover in the monitoring methodology. As with animal observations, seasonality and single-site-visits call into question the value of collecting plant data as it is currently being done. Since monitoring is a year round activity, a significant portion of plant observations take place outside of the growing season. For ephemeral herbaceous emergents, identifying the species and calculating the "percentage canopy cover" for the three most dominant cohorts on each land unit (polygon) comprising a WRP easement may present some real problems, especially in winter. A similar problem with persistence of identifiable vegetation was seen during a period of prolonged drought (S. Young, pers. comm.). The absolutely *fundamental* nature of this question of "appropriateness" of canopy cover was voiced during project meetings, when the issue of discrepancies in plant species names was being discussed (S. Frazier, pers. obs.). But dealing with the species names issue is a moot point in the short term until this larger methodology issue is resolved. Perhaps an integrated suite of data gathering methods including targeted and intensive survey scheduling and aerial/remote sensing options would provide a more useful approach for procuring plant species coverage data.

[5] Internal Project Meeting Minutes from 12 October 2006.

The effort to effectively *emphasize* rare, threatened and endangered species, from among those species *directly* observed was not possible. For animals this was simply due to the dearth of total sightings. This is slightly ironic since conservation status species are emphasized in the WRP site ranking/selection process. Some 81% of easements were ranked as being important for status species. Unfortunately the particular species used in ranking are *not* recorded in the monitoring dataset. The disconnect between recording these species in individual hardcopy files and not in the centralized monitoring dataset needs to be addressed. An NRCS WRP administrative database also includes specific status species occurrence information in its easement records. However only eight easements from the *monitoring dataset* are included among the status species records found in the *administrative database* and no further analysis of the latter dataset was undertaken.

Whereas plant observation records were plentiful in the monitoring dataset, *none* of them involved rare, threatened or endangered species (as defined in this analysis). This is not surprising since the emphasis placed on recording plants in the field has to do with *dominant* species and these species typically do not warrant a conservation status.

The link between the MONHP heritage dataset and the WRP ranking/site designation process has been alluded to previously. The latter process calls upon the former dataset. The MONHP dataset also provides a ready "surrogate" for indicating the potential importance of WRP sites to rare, threatened and endangered status species, in lieu of (a paucity of) direct observations. A cursory look at the results of the several proximity analyses involving WRP sites and MONHP range data summarized above (in Table 3.7) does suggest, that a slight majority of WRP sites do provide habitat that potentially supports rare, threatened or endangered species. For individual taxonomic groupings, the level of implied importance of these WRP easements varies, as would be expected. Anticipated differences in potential support to status species among the subsets of WRP sites in each ecological section were also demonstrated.

Another indirect but certainly more scientifically rigorous measure of the potential importance of WRP easements to wildlife is provided by the calculation of numeric Habitat Suitability Indices or HSI through the application of a Wildlife Habitat Appraisal Guide. An analysis of HSI values derived for Missouri's monitored WRP sites is part of Chapter 4, "Restoration Status."

Recommendations

This chapter was concerned with delivery of those most familiar and tangible of monitoring products: Site Species Lists. However, owing to logistical and fiscal constraints, the procedures and mechanisms currently in place for this kind of descriptive monitoring are insufficiently resourced to service a broad and ever growing network of sites. It seems certain that comprehensive and effective survey and recording of species observations on all polygons of all WRP sites is unrealistic, simply because it is not cost effective. However inventorying the biota of a representative sample of sites does seem within reach, and results from such an aligned approach can probably satisfy the need to evaluate in that traditional and tangible way, what "biodiversification" can be expected to attend WRP wetland restorations.

The following recommendations are specific to the issue of species inventories. However the emphasis and importance that compilation of species lists achieves within WRP monitoring should be informed by an integrated holistic WRP monitoring program (See Chapter 6, WRP Monitoring Recommendations). Other program-wide recommendations may have relevance to this issue.

Recommendation 3.1
To whatever extent species observation data are collected on/for WRP sites, they should be collected and recorded statewide according to an annually evaluated comprehensive data collection, recording and management protocol, which includes detailed relevant guidance for managing species information.

Recommendation 3.2
The protocol should specify the taxonomic authorities (sources) which will be followed for each higher taxon included. These sources should be peer recognized and dynamic (updated and maintained) standards, with a biogeograhical foundation that is compatible within the national mosaic. This project found the NRCS "PLANTS" National Database to meet these specifications for Missouri monitored WRP plant species.

Recommendation 3.3
All species inventory data that are amassed or used in the ranking/selection of WRP easements, and that may be collected and stored about WRP sites at the regional NRCS or MDC offices, should be obtained and integrated into the centralized WRP monitoring information system.

Recommendation 3.4
Representative sampling and use of alternative data sources should become constituent parts of the strategy and toolset for acquiring all necessary species inventory information.

- 3.4.1. Existing and planned species inventories from state and federal public lands that are also WRP easements should be integrated into the centralized WRP monitoring information system.
- 3.4.2. Species inventory information collected on Missouri WRP sites by others outside of the program and which might presumably be readily available (e.g., from amateur bird watching networks) should be obtained and integrated into the centralized WRP monitoring information system.

Recommendation 3.5
The extent to which aerial photography and remote sensing can deliver useful quality plant community information (instead of ground surveys) should be assessed.

References

Missouri Natural Heritage Program. 2007. Missouri species and communities of conservation concern checklist. Missouri Department of Conservation. Jefferson City, Missouri. 51pp. Also available at: mdc.mo.gov/documents/nathis/endangered/checklist.pdf

Natural Resources Conservation Service (NRCS). [2007]. Conservation Programs Manual Title 440, Wetland Reserve Program, Pt. 514.01(A). Accessed 29 November 2007 at www.info.usda.gov/scripts/lpsiis.dll/M/M_440_514_A.htm

Natural Resources Conservation Service (NRCS) 2006. Work Plan for the Wildlife Component Conservation Effects Assessment Project (CEAP) National Assessment. August 15, 2006. USDA, Natural Resources Conservation Service Resource. Inventory and Assessment Division. Beltsville, Maryland. Working Draft. Also available at: www.nrcs.usda.gov/technical/nri/ceap/wildlifeworkplan/

Chapter 4: Restoration Status

Introduction

Chapter 2 provided *summary* analyses undertaken in this study including those focusing on habitats. Chapter 3 looked at the direct and implied importance of Missouri's WRP sites to species. The current chapter uses these ecological components – habitats and species – as the primary *indicators* in analyses of wetland restoration success on Missouri WRP easements. The habitat analyses reported in this chapter document change or succession of wetlands undergoing restoration. This chapter includes an analysis of Habitat Suitability Indices (HSI) recorded during monitoring as a surrogate for restoration success, whereby HSI values increase as habitats succeed to become of (potentially) greater importance to Missouri wildlife.

Methods

<u>Primary Datasets</u>

The ecological monitoring data analyzed in this chapter were recorded in the manner and structures previously described (Chapters 2 and 3) on an easement (for HSI) and sub-easement/(sub-)polygon (for habitat) basis.

Habitat Succession

Two datasets – a "before restoration" dataset known as the "existing dataset"[6] (29_wrp_existing.shp) and an "after restoration" or "current dataset"[7] (plan_3yrall.shp) – provided the basis for analyzing habitat succession on WRP lands. Both existing and current spatial easement datasets recorded wetland habitat types with "modified Cowardin codes" (after Cowardin *et al*, 1979; see ModifiedCowardin.xls & ModifiedCowardin-Families.xls, Annex 4). The recorded codes were then simplified under this project into core, "four-character codes" (Chapter 2) to facilitate analysis (see Cowardin four character codes.doc, Annex 4).

Habitat Suitability Indices

In Missouri, where the many WRP sites being monitored could only be visited once (or occasionally twice), the Habitat Suitability Index (HSI) was selected as a surrogate measure

---

[6] Dataset in which pre-restoration land cover (using the modified Cowardin wetland classes) had been mapped and digitized in an earlier project; also can be considered the "starting dataset".
[7] Also known as the "monitored dataset" since modified Cowardin habitats were recorded during the monitoring visit at some time after the existing dataset had been digitized.

or indicator of effectiveness of habitat restoration for wildlife. These models are driven by habitat variables measured in the field that are associated with species' life-history requirements documented in the scientific literature. Habitat variable values measured in the field are combined through the use of algorithms that represent species-specific habitat associations to generate HSI scores for each site. HSI is a numerical index without units that represents the potential of a specific habitat to support a particular species. HSI scores run from a low of 0 (unsuitable for a species) to a theoretical high of 1 (optimum for a species), (USFWS 1981).

During monitoring, HSI data were recorded on an easement basis (in comp_3yrall.dbf) for six[8] representative species that had been selected for the Missouri WRP dataset (Figure 4.1), namely three species, *Anas platyrhynchos* (mallard), *Aix sponsa* (wood duck) and *Protonotaria citrea* (prothonotary warbler) for "forested" habitats and three species, mallard, *Ixobrychus exilis* (least bittern) and *Tringa flavipes* (lesser yellowlegs) for non-forested habitats.

All 157 of the HSI models originally published by the U.S. Fish and Wildlife Service are available in PDF format on the National Wetlands Research Center Library pages at http://www.nwrc.usgs.gov/wdb/pub/hsi/hsiintro.htm (accessed 31 December 2008). (See Schamberger *et al* 1982; USACE 1998; Rennie *et al* 2000; Burgman *et a*l 2001; and Barry *et al* 2006 for more information on Habitat Suitability Indices).

Figure 4.1. Missouri WRP HSI species. Counter clockwise from left: wood duck, prothonotary warbler, mallard, least bittern and lesser yellowlegs. (See Photograph Credits at chapter end).

Analyses

GIS shapefile format files were analyzed with ESRI® ArcMap™ (ArcGIS™) 9.2 software. Microsoft® Office Excel® 2003 and Microsoft® FoxPro 2.6a (X) software were also used for supplementary and complementary analysis of (DBF) attribute data.

8 There were actually just 5 species, but the mallard was used both as a forest and a non-forest indicator species.

Habitat Succession Analysis

Change in land-cover or "habitat succession" was examined by contrasting before and after restoration conditions and at discrete, four-year intervals.

Starting habitat *condition* was provided by the abovementioned "existing" digitized spatial dataset. The coverage of this "starting dataset" was that portion of the overall WRP spatial dataset where digitization of initial habitat condition had been completed previously. The *period* assessed for habitat change or succession (restoration age) was that amount of time between the starting time as documented in project files (and regarded as the date when the initial habitat condition was recorded) and the date of the site monitoring visit, where modified Cowardin habitat codes (as well as other data) were again recorded. Any polygons (land parcels) where Cowardin habitat data were unrecorded in either dataset, were discarded from the analyses of habitat succession.

A spatial (GIS) intersection was then established between the two datasets. This process may produce many small "slivers" (polygons) where small differences in digitization between the intersecting spatial datasets occur. The GIS intersection in the WRP analyses was refined by excluding "negligible" polygon slivers (somewhat arbitrarily defined in this study as polygons < 0.40 acres in extent).

The refined overlap resulting from this intersection yielded a parent dataset, the "common appreciable intersect" (Common_appreciable_intersect.shp) from which child datasets were derived for all subsequent analyses of habitat succession representing WRP restoration. (See Habitat polygon succession analysis procedure 1.doc in Annex 4 for the detailed methods employed. For a graphically illustrated example of WRP easement habitat succession, See: WRP easement illustrated restoration example.doc in Annex 4).

The successional fate of lands of agricultural origin was looked at in more detail using a relevant subset, "Common_appreciable_intersect_AG_origin.shp." The following steps summarize the method by which this was achieved:

1. Select easements that were agricultural at the start of restoration ("existing")
2. Find the common agreement numbers between this "existing" subset and the "monitored" dataset
3. Eliminate any polygons which do not contain Cowardin data
4. Establish an intersection of remaining Cowardin polygons between the "existing" (agricultural origin) and "monitored" datasets
5. Discard/alleviate the influence of "slivers" (negligible GIS artifacts)
6. Determine the restoration fate of the Agricultural-origin polygons into the following successors: Forest; Scrub Shrub; Non-Woody Vegetated; Agricultural; and Other/Open Water.

(See Habitat polygon succession analysis procedure 2.doc in Annex 4 for the detailed methods used).

To look at change in a more meaningful way, boundaries for the duration of time that easements were undergoing restoration were established. Dates recorded for "start" of restoration and the date of the monitoring site visit ("review" date) provided the period of longest duration. Easements where one or both of these dates were unknown, were excluded. Three time intervals of approximately 4 years duration were selected for a more detailed analysis of change. Acreage corresponding to each habitat group (or species for HSI) was then apportioned according to these age-class intervals, and converted to percentages of total acres in each of the age classes (see Results).

HSI Analysis

Records were selected from the parent HSI dataset where at least one of the six representative species had an HSI value greater than zero. This subset became an interim database in the development of a successor to the parent in the analyses. The vast majority of easements were represented by a single HSI data record (listing HSI values for the six species on one easement). The few multiple data-record easements in the interim HSI dataset were consolidated into single data-record easements (records) so that the number of data records equaled the number of easements. This dataset (HSI!ZER2.DBF/.XLS) became the final HSI dataset from which all other subsets were derived in subsequent analyses.

To relate indicator species to the representative habitat, first records for easements containing HSI values for forest species were intersected to WRP parcels containing forested/wooded land-cover types. However, these parcels were filtered to select only those that originated from agricultural land-cover. Likewise, HSI records for easements corresponding to non-forest representative species were related to intersecting WRP parcels containing emergent/herbaceous land-cover types that originated from agricultural land-cover. HSI values run from a low (poor for species) of 0.100 (assigned baseline) to a theoretical high (good for species) of 0.999. Values were arbitrarily clustered into four HSI range groups of *up to* 0.100, 0.101-0.399, 0.400-0.699 and 0.700-0.999. Since on-site HSI data do not exist for sites prior to restoration, pre-restoration HSI values for all species were assigned an arbitrary value of 0.1.

An analysis of HSI data by age categories followed the relevant methodology described above under Habitat Succession Analysis.

Results

The dataset of monitored sites covered approximately 66,700 acres in 594 conservation easements. The "existing" pre-restoration land-cover dataset consisted of 599 easements covering approximately 87,140 acres. The overlap between these two datasets yielded the parent database – the "common appreciable intersection" for the study, covering approximately 52,208 acres in 488 easements. That subset of the common easements (easements with parcels in common) that were of agricultural origin was approximately 39,731 acres in extent and was comprised in 469 easements.

The longest duration of time between "start of restoration" and "monitored date" was 12.2 years; the shortest was 2.7 years. Therefore, the abovementioned three (approximate) 4-year time intervals considered were: 0.1 to 4, 4.1 - 8 and 8.1 – 12.2 years. However, the net acreage for the 1st age class of 0.1 to 4 years proved nearly negligible in terms of illustrating trend (measuring only 669 acres). For this reason the habitat analyses disregarded the 0 - 4 year interval as an age class and considered a dataset of approximately 43,762 acres at intervals of "start time" (time 0) to "review date" (effective "end date") *or* at the two age-class intervals of 4.1 - 8 years after the "start of restoration" (or after restoration began) and 8.1 – 12.2 years after restoration began. These two time intervals encompassed 33,700 acres of lands with agricultural origins. For the HSI analyses, acreage corresponding to each species was apportioned according to the age-class intervals mentioned above. Analysis of HSI data by age categories showed no discernable patterns among age classes examined, and no further age class results involving HSI are reported.

All figures in Results are supported by detailed Excel® worksheets in the CD archive of this project.

Habitat Succession

Figure 4.2 presents an overall breakdown of five general land-cover classes for the period just before restoration commenced, and at the time the site was monitored. A successional shift from former cropland to natural and semi-natural land-covers is evident.

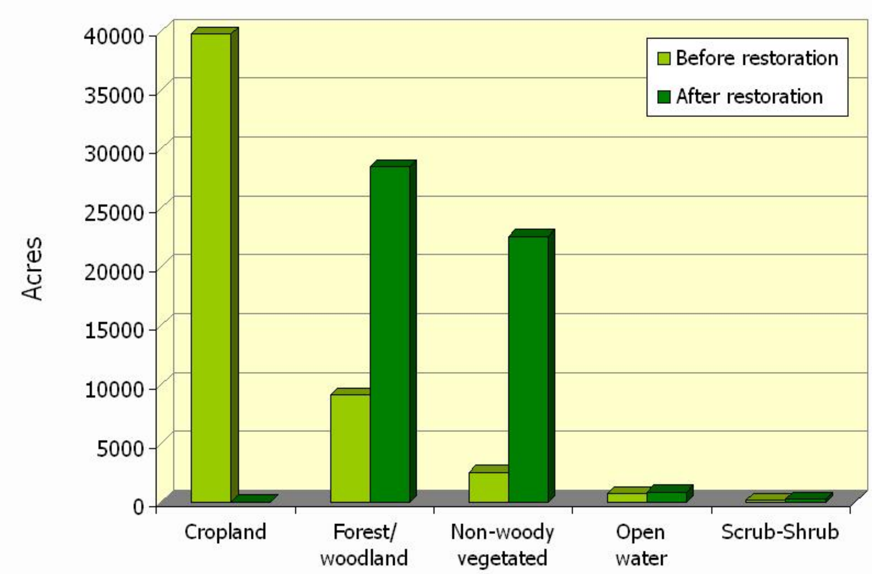


Figure 4.2. Land-cover status before (light green) and after (dark green) restoration of 52,208 acres of WRP easements in Missouri.

Figure 4.3 is a refinement of the successional analysis, charting restoration progress within two discrete (approximate) 4-year periods (4.1 – 8 years and 8.1 – 12.2 years since restoration began). By the fifth year of restoration, only scant remnants of cropland remain. As reported above, records falling into a 0.1 to 4-year age interval were not included. It is important to remember that the total acreage in each discrete age-interval will vary. Thus the *percentage* of the total acreage that each land-cover class constitutes in each age-interval was used to reflect habitat changes.

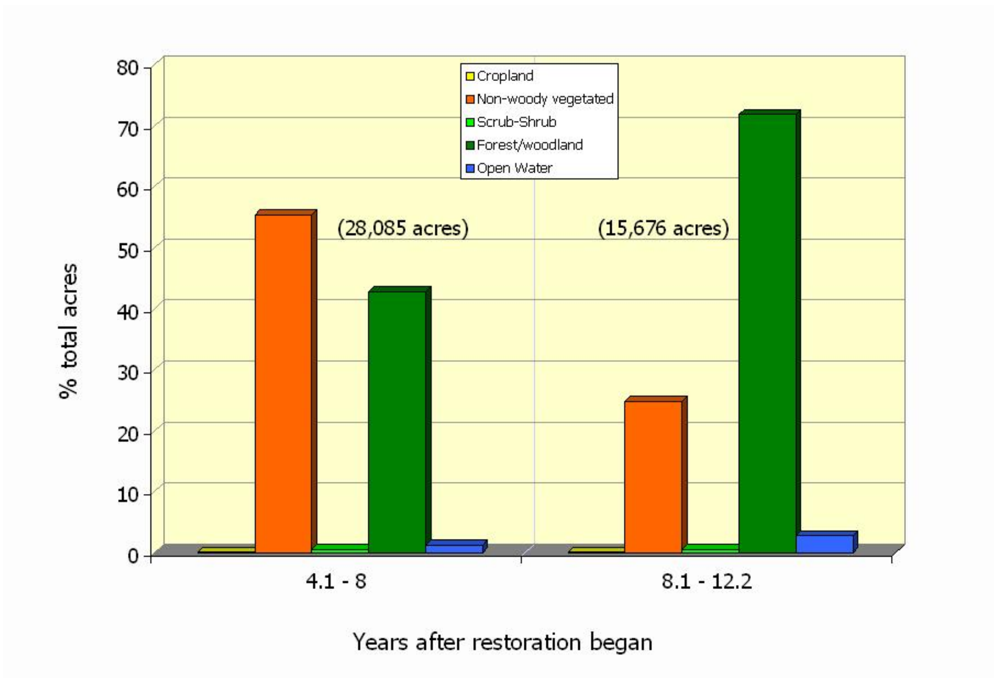


Figure 4.3. Relative land-cover composition observed in two post-restoration age classes covering nearly 43,800 acres of Missouri WRP easements.

Figure 4.4 represents the successional fate of the exclusive subset of WRP lands that were comprised of cropland types at the start of restoration. At easement monitoring, almost all of the lands had succeeded to emergent-herbaceous and forested-wooded land-cover types. The forest-woodland category is a mixture of natural regeneration and tree planting.

Habitat Suitability Indices

Ultimately, the HSI analysis for forest species suitability encompassed approximately 15,700 acres of forested/wooded land of agricultural origin. Similarly, the HSI analysis for non-forest species suitability encompassed approximately 16,900 acres of emergent/herbaceous cover on land of agricultural origin.

Figure 4.4. Land-cover before and after wetland restoration on 33,700 acres of former cropland enrolled in WRP in Missouri.

Post-restoration HSI scores appear markedly higher than the pre-restoration score (0.1) for all non-forest models (Figure 4.5) and two of the three forest models (Figure 4.6).

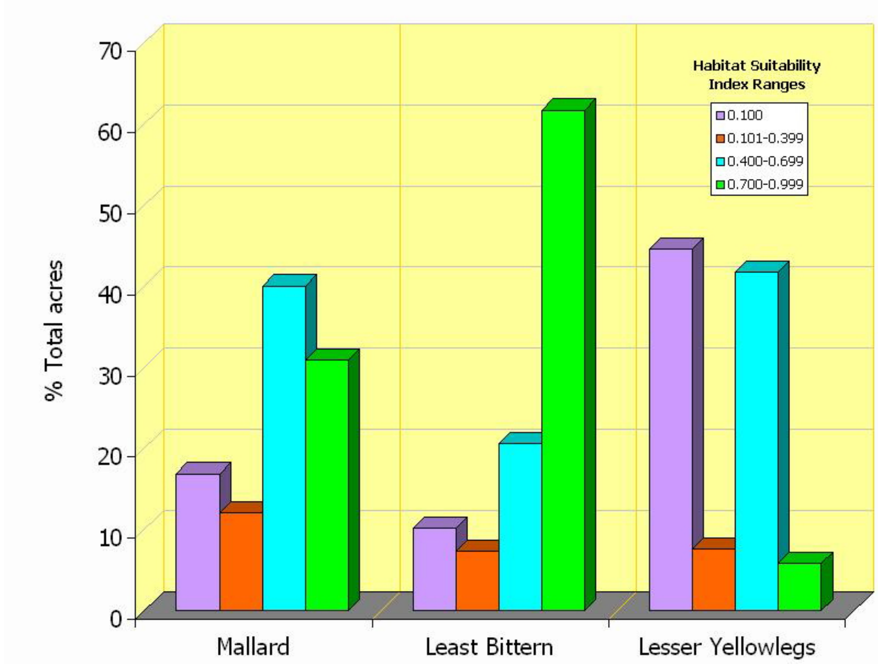


Figure 4.5. Habitat Suitability Index (HSI) value ranges recorded for species associated with non-forest habitats following wetland restoration on 17,200 acres of former cropland enrolled in the Wetlands Reserve Program in Missouri.

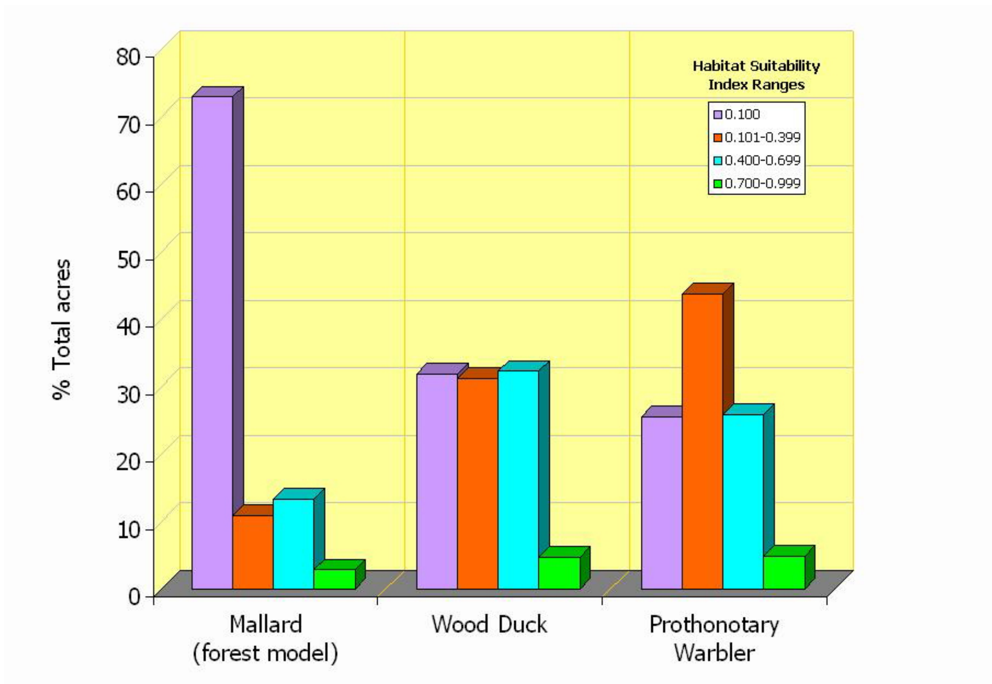


Figure 4.6. Habitat Suitability Index (HSI) value ranges recorded for species associated with forest habitats following wetland restoration on 15,900 acres of former cropland enrolled in the Wetlands Reserve Program in Missouri.

The magnitude of the increase in habitat quality was greatest for species associated with emergent-herbaceous (non-forest) habitats that develop faster than forest, and are often an early precursor of forested wetlands. However, 45% of acres restored showed no improvement of habitat quality for the lesser yellowlegs, an early successional wetland species that prefers the sparse vegetation characteristic of the earlier stages of restoration. In contrast, least bittern showed the greatest improvement in habitat quality due to its dependence on dense herbaceous vegetation, a condition which increased on most easements as succession proceeded following wetland restoration (Figure 4.5). The mallard, a species associated with both forested and non-forest categories of restored land, depending on the season, showed the least HSI improvement of species associated with forest (Figure 4.6). However the forest model for mallard relies on mature bottomland hardwood forest – a habitat that has not had time to develop fully in the majority of study sites. Habitat Suitability Indices on restored forested sites exceeded the baseline value to a greater extent in the wood duck and prothonotary warbler models.

Discussion

This chapter has detailed two different sets of analyses aimed at directly gauging the restoration success or effectiveness of the Wetland Reserve Program in Missouri. The first looked at the successional change in land-cover from the start of restoration to the point when data were recorded during a monitoring visit – considered the end of restoration (for the purpose of this study). The second set of analyses concerned change over time as well, in this instance change toward more optimum habitat for several "representative" bird species, through an examination of Habitat Suitability Indices or HSI.

Whereas succession of plant communities on individual sites was not closely tracked through time, observation of land-cover conditions among sites of varying post-restoration age can be used as an indicator of how wetland vegetation changes in the years following restoration. Ecological monitoring data from wetlands enrolled in WRP in Missouri *clearly* show land-cover changes associated with wetland restoration, with major shifts from open crop fields to forested wetlands through time. This includes both passive succession and active intervention. However it was not possible to globally analyze the relative influence of each of these restoration paths because such data were not uniformly systematized, quantified or accessible throughout the monitoring dataset.

Some easements contained significant areas of natural vegetation at enrollment. These areas were excluded from the HSI analysis because it was assumed that they already possessed some higher than baseline measure of wildlife habitat value. An HSI of 0.1 was assigned to the remaining areas assumed to have very limited wildlife value, since their pre-restoration condition consisted of cropland.

Habitat quality (as modeled and represented by HSI values) for select wetland wildlife species has improved due to WRP restoration in Missouri. For non-forest species (e.g., least bittern) habitat quality is better in the early (herbaceous) years following restoration than in older easements, where forest succeeds open habitat. For forest species, habitat quality is expected to continue to improve as trees mature. Whereas an analysis of HSI data by age categories showed no patterns among age classes examined, as wetlands succeed in the future, temporal changes in habitat quality for indicator species are expected to emerge. Therefore, *overall* values presented above provide the most useful HSI information at this time.

Habitat Suitability Index scores are based on hypotheses of species-habitat relationships and do not connote proven cause and effect. Whereas, some HSI models have been validated by species response data, most rely on published life-history requirements and species experts for their reliability. As a planning tool, HSI scores provide a useful measure of the *potential* of the habitat to support particular fish and wildlife species in a study area.

Ecological monitoring in Missouri provides clear *indications* of the regional ecological and wildlife benefits of WRP. Continued and enhanced ecological monitoring of WRP easements is needed to track the value of habitat and other wetland functions through time to maximize benefits derived from the program.

Recommendations

Chapter 3 (Missouri WRP Species Analysis) noted logistical and fiscal constraints to comprehensive and regular descriptive monitoring in the context of species observations.

These same concerns attend to other aspects of ecological monitoring with an ever growing network of sites. Nevertheless, monitoring change in land cover can to some extent be insulated from these constraints, since at a minimum, it only requires data recording at enrolment (restoration start time) and at an obligatory site monitoring visit (effective restoration study end). A comprehensive recording of species observations on all polygons of all WRP sites is unrealistic; however, it seems reasonable that Habitat Suitability Indices could be calculated to a much greater precision than simply at the whole easement level as has been done at present. After all, the vast majority of easements support more than just one habitat and these habitats have been recorded in the monitoring dataset.

Chapter 5 (Photographic Documentation) will provide recommendations as to how photography including aerial photography and remote sensing might assist monitoring of successional change.

<u>Recommendation 4.1</u>
Habitat Suitability Index calculations are currently applied at the easement level for each representative species, however habitat data upon which they depend are recorded on at the "management unit" (e.g., crop field) or polygon level. This imprecision should be rectified to the extent that is possible. Habitat Suitability Indices should be calculated for every polygon exceeding a designated threshold acreage.

<u>Recommendation 4.2</u>
Habitat Suitability Index scores indicate the *potential* of the habitat to support wildlife species. Although this is a useful and practical tool, it is theoretical and based on expert opinion, therby making comparisons between different species models difficult. Some authors (e.g., Burgman *et al* 2001; Barry *et al* 2006) have questioned the suitability, reliability of, and reliance on HSIs under certain situations or for certain purposes. Habitat Suitability Indices should be evaluated in the context of (Missouri) WRP to assess their suitability over other alternatives.

<u>Recommendation 4.3</u>
Missouri WRP sites are adding natural and semi-natural habitat to the state's natural areas resource. However in the WRP ecological monitoring program these sites are primarily looked at as isolates rather than as elements in a functional natural mosaic. There is a wealth of designated conservation and natural area types in Missouri, often in proximity to or encompassing WRP sites. An envisioned analysis of WRP sites as functional elements in the greater natural landscape of Missouri that did not eventuate under this study should be realized in subsequent analyses to demonstrate the full extent of WRP contribution to wildlife.

<u>Recommendation 4.4</u>
In common with Recommendation 3.5 (and 5.6), more detailed study and guidance on the feasibility and limitations of using aerial photography and remote sensing to bolster visual documentation of restoration progress (habitat succession) given the fiscal and logistical constraints to multiple site visits is needed. Specific guidelines for applying these technologies should be developed.

References

Barry D, Fischer RA, Hoffman KW, Barry T, Zimmerman EG and Dickson KL. 2006 Assessment of Habitat Values for Indicator Species and Avian Communities in a Riparian Forest. Southeastern Naturalist: Vol. 5, No. 2 pp. 295–310.

Burgman MA, Breininger DR, Duncan BR and Ferson S. 2001. Setting Reliability Bounds on Habitat Suitability Indices. Ecological Applications, Vol. 11, No. 1., pp. 70-78.

Rennie JC, Clark JD and Sweeney JM. 2000. Evaluation of habitat suitability index models for assessing biotic resources In: Hansen, Mark; Burk, Tom, eds. Integrated tools for natural resources inventories in the 21st century. Gen. Tech. Rep. NC-212. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station. 321-325.

Schamberger M, Farmer AH and Terrell JW. 1982. Habitat suitability index models: introduction. USDI. Fish and Wildlife Service. FWS/OBS-82/10. 2 pp.

USACE. 1998. Habitat Suitability Index Model Availability for Wetland Cover Types. WRP Technical Note, FW-RS-2.1. January 1998.United States Army Corps of Engineers; Engineer Research and Development Center; Wetlands Research Program. Accessed 31 December 2008 at http://el.erdc.usace.army.mil/wrtc/wrp/tnotes/fwrs2-1.pdf

U.S. Fish and Wildlife Service. 1981. Standards for the development of Habitat Suitability Index models. ESM 103, Division of Ecological Services, Washington, DC.

Photograph Credits

wood duck Dave Menke, U.S. Fish and Wildlife Service (public domain)	*Credits for Figure 4.1. Missouri WRP HSI species.*	**lesser yellowlegs** U.S. Fish and Wildlife Service (public domain)
prothonotary warbler Peter Kondrashov, used with permission.	**mallard** Gary M. Stolz, U.S. Fish and Wildlife Service (public domain)	**least bittern** Chris Valentine, used with permission.

Chapter 5: Photographic Documentation

Introduction

Wetland inventory activities can contribute to wetland monitoring[9]. Many wetland inventories have been ground-based, often with the support of maps, aerial photography and increasingly, satellite imagery (Finlayson 2001). While aerial photography has been the basis of many wetland inventories, ground photography has been used as well in historical analyses and long-term monitoring, including monitoring of change in landscape and (wooded and forest) vegetation (Curtin et al 2002; Clay et al 2001; Ducrotoy et al 2001). Ground photography is useful for documenting prior conditions (Palmer et al 2005) and conditions that are difficult to quantify on a field datasheet (Lund et al 1995) and it creates a permanent record for future monitoring (Ducrotoy et al 2001). It also can assist with interpretation and ground-truthing of aerial photos (USFWS 2006). Ground photography is currently used, or proposed for use, in various ways in (wetland) survey/monitoring protocols (see USFWS 2006, Bracciano 2005; Boyd et al 2006, Clay et al 2001 and Ducrotoy et al 2001).

Ground photographs were taken during monitoring of Missouri WRP easements and provided to the project for analysis, with a view to documenting the efficacy of WRP restoration. Here we summarize this photographic documentation, describe the analyses undertaken, and make recommendations to improve the protocol for site photography in Missouri WRP monitoring.

Methods

<u>Photographic datasets</u>

Missouri WRP digital photographs were provided to the analysis project on a data CD and filed in *supra*folders labeled by fiscal year. An affiliated e-mail message indicated that this photographic dataset was not complete, owing to a technical issue with some digital photographic files (not included on the CD) which could not be opened. All photographs were in "JPEG" image format.

Two sources of *information about* Missouri WRP site photographs were available for analysis: 1) attribute data associated with separate GIS photo points (information about the photograph entered into the WRP GIS, relative to the position of the photograph point; GIS file described below), and 2) information linked to, and about the photographs themselves (metadata). For the latter source, there were potentially two *kinds* of metadata

---

[9] For discussion on the relationship and distinctions between inventory, assessment and monitory, as part of wetland management, see Finlayson et al. 2001and Ramsar Convention Secretariat 2004, 2007.

that could be extracted from a WRP site photograph; information that was automatically acquired at the time of recording (i.e., by a digital camera) and information that was subsequently manually added to a digital photo.

The first kind of metadata is called Exchangeable Image file Format or "ExIF" metadata, and includes technical information about the photograph (e.g., shutter speed and lens aperture) but *not* about the subject of the photo. Exchangeable Image file Format information is generally not very useful for documenting the efficacy of restoration. However as GPS readings become part of routine, automatically acquired photographic data, ExIF metadata will become increasingly useful for site monitoring. The second type of metadata, optional "creator information," meta information that is added to the digital image by the photographer/custodian (e.g., photograph description and location details) using camera/imaging software, holds the most potential for analysis of site attributes.

The photographic filing system of folders (easements), and in some cases, filenames (of the photographs) also proved useful in the collective photographic dataset analysis.

GIS dataset

The GIS dataset employed in this analysis was a shapefile[10] (firstmon-all-field_pt-photos.shp) containing 2,595 photo points with associated attribute data (including photo number, bearings and other information stored as "comments").

Photo file preparation and analysis

Several methods for preparing and analyzing meta information on the digital photographs and photographic records of the monitored Missouri WRP easement dataset were developed under the project. These are detailed in Annex 5 - Photo Documentation Methods.doc.

Digital photographs

The photographic filing system was copied from the provided data CD to the project computer using the file manager, Microsoft® Windows® Explorer™. The structure and content of this dataset were examined, and folders and files were moved, removed and/or renamed as necessary to standardize filing and labeling. Digital photographs that could not be ascribed to specific easements in the monitored WRP dataset were removed from the analysis. Random samples in excess of 100 digital photo metadata records were accessed using Corel® Paint Shop Pro® X (10.03).

The reorganized folder structure and contents were captured and converted as surrogate records of the digital photographs, with a view to analysis using a detailed method sequence, including specialized software. (See Annex 5 – Methods: Method 3). These records were imported into a database ALLPHOTO.DBF created for this purpose and fields were

[10] A geographic "digital vector" format file (by ESRI®) used in GIS.

populated using Microsoft® FoxPro 2.6a (X), and the database was analyzed in Microsoft® Office Excel® 2003 using PivotTable® functionality in the spreadsheet PhotoCount.xls.

GIS photo points

The non-referenced, GIS photo points layer (firstmon-all-field_pt-photos.shp) including "bearing" information (orientation of camera to subject) and "comments" was associated with relevant easement records via a spatial intersection (photos_intersect_plan.shp) using the "Geoprocessing – Intersect" procedure with ESRI® ArcMap™ (ArcGIS™) 9.2. This associated the easement agreement number to the photo points, enabling further analysis. These combined records were parsed and prepared for database (FOTOINTS.DBF) analysis (See Annex 5 – Methods: Method 5).

Comparing datasets

Database relations were established between the processed outputs of the analyses of photographs and of photo points to identify intersections. Table 5.1 summarizes the photographic coverage of monitored WRP easements in Missouri per relevant dataset.

Table 5.1. Parent and select derived photography dataset components available for Missouri WRP easement monitoring analysis.

Base Theme	Description	Records	Easements
monitored easements	All monitored **WRP easements**	594	**594**
photo points	Parent GIS spatial file of easement **photo points**	2,595	*no key field*
Raw digital photographic dataset	**Gross contents** of photographic filing system (analysis dataset)	2,492	545
Screened digital photographs	Net **digital photographs** in filing system	**2,380**	530
monitored easements	**Easements with digital photo(s)** (No photo present)	532	**530** (64)
photo points in monitored easement units	GIS easement **photo points** *intersecting* monitored easement **units** (polygons)	**2,300**	**464**
photo points *and* easements with photos	GIS monitored easement **photo points** and **easements** with digital photos	**2,172**	**424**
photo points *and* digital photos	GIS monitored easement **photo points** and **digital photos** from monitored easements	**2,084**	**414**

Beginning with the parent dataset of 594 easements, database processing, spatial analysis and intersecting with GIS or database relations revealed various levels of photographic coverage.

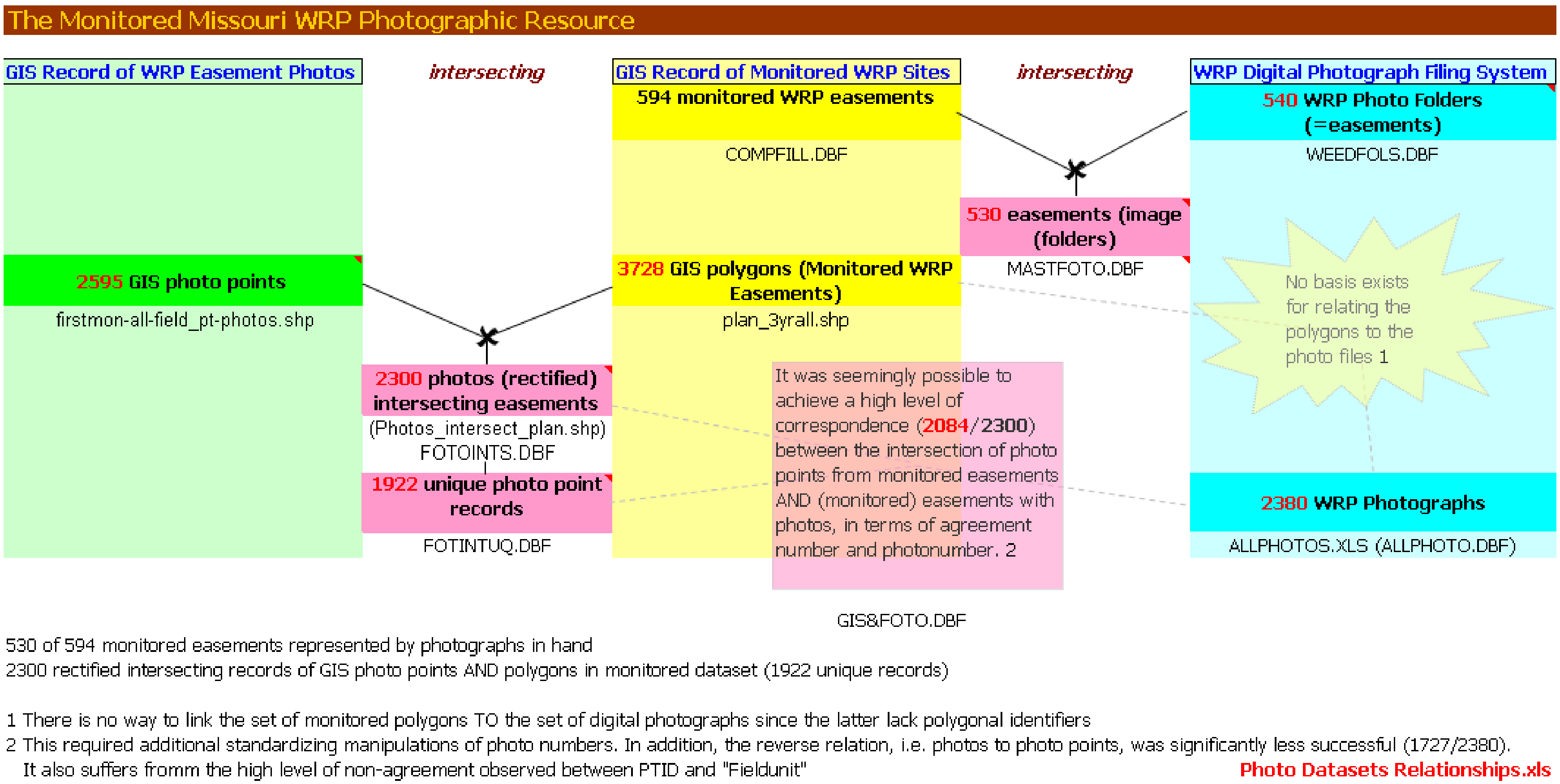
For digital photos, 530 out of 594 easements had them. GIS photo point records occurred for 464 easements. When these two datasets were "intersected" the overlapping coverage dropped to between 424 - 414 easements (depending on how the intersections were devised).

Figure 5.1 charts the same relationships between the parent datasets (easements, photographs and GIS photo points) and between the derived analyses results and comparisons, in a quasi-flowchart illustration.

Results

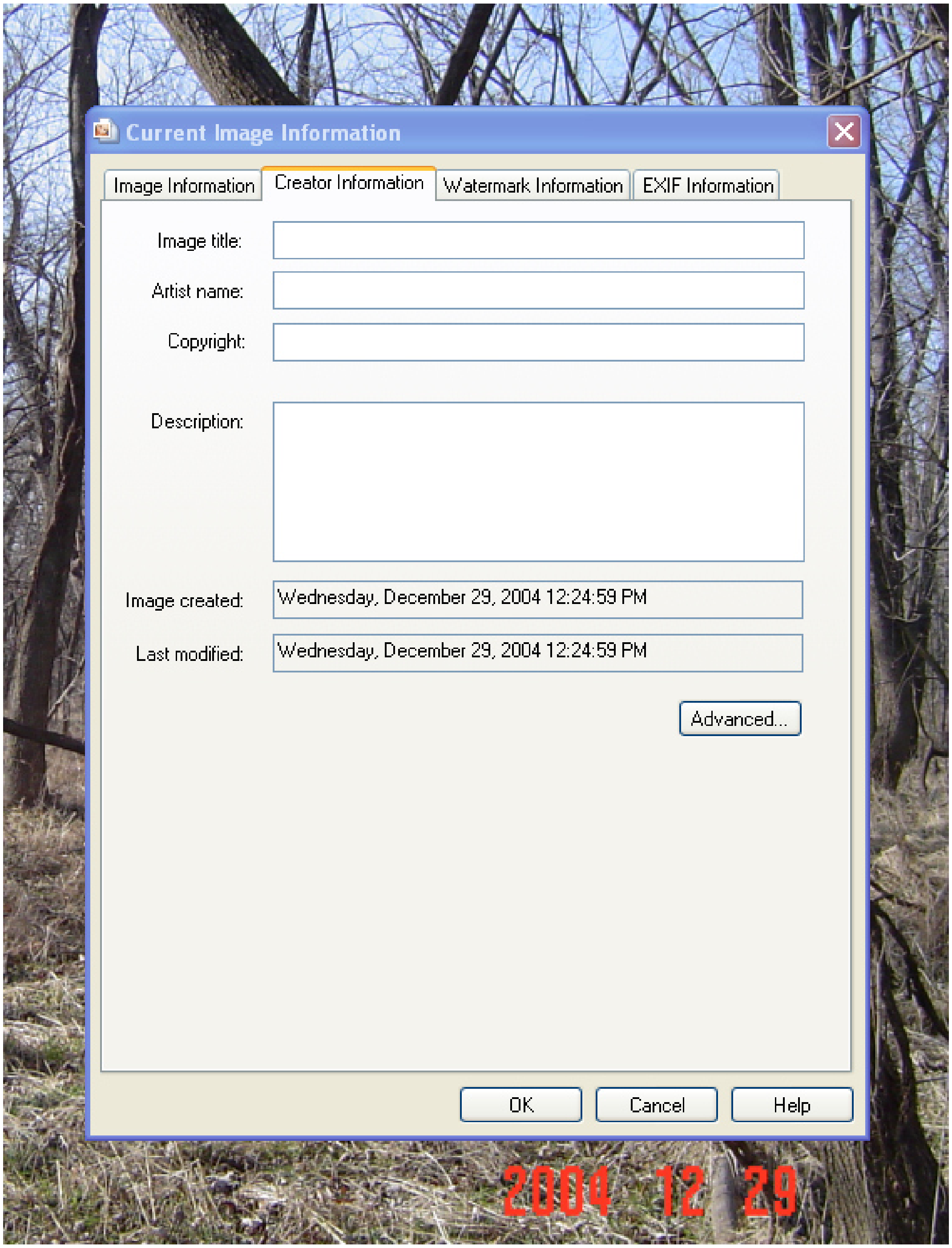
Eighty-nine percent of 594 monitored easements were covered by at least one photograph in the analysis dataset. However, recorded information about the *subjects* of those photographs was absent. *None* of the 2,380 photographs that were attributable to specific easements were tagged with "creator" meta information including a description of what the photo represented (based on a random sample of 100 site photographs). Figure 5.2 is an image captured from one of these randomly selected records. Some 110 digital photographs were not considered because they were not attributable to a specific easement, were misallocated to the monitored dataset altogether or were non-easement photos (i.e., general thematic photos).

Figure 5.1. Diagram illustrating natural and affected relationships between components in the Missouri WRP Monitoring "photographic dataset."



The complete original parent file Photo Datasets Relationships.xls, a workbook containing three worksheets, is found in the project CD archive.

Figure 5.2. Randomly selected WRP photograph and its metadata record. The advanced information record (button only depicted) was also blank.



This spatial intersection of the original 2,595 photo points and 3,728 monitored easement polygons was rectified into single photo-point records to yield **2,300** records of linked photo-point easements.

With these two (potential) sources of photographic metadata described above cleaned and organized, a database relation between the two was established. This yielded **2,084** records of GIS photo points from the monitored easement dataset linked to photographs in the photographic filing system. However only 246 (11.8%) of these records contained comments (with potential value for analysis). These comments covered a diverse range of subjects including easement violations, field (plot) numbers, directional orientation, water control structures, invasive species, field boundaries, habitat modification and other information. The combined low number of comments and the disparate subjects they covered did not allow any meaningful analysis of these annotations as regards the documentation of wetland restoration efficacy.

Discussion

Current image management software is "tailor made" for storing information that identifies a digital photograph, and in theory, it can hold information that can be categorized and analyzed. None of a large sample of the digital photographs was populated with any descriptive meta information. The GIS photo points file mirrored the function of a metadata record in that it held a "comments" data field. However, just over 10% of these records contained information and much of this was compliance or management oriented as opposed to ecological information. This is borne out by information from the field, where the routine practice is to record photo number (taken from the camera) and degree heading of photo (using a compass bearing). The main purpose of the photos is to establish a "permanent" photo station that *can be used over time* to visually document plant and wetland succession. Sometimes, but not often, other information might be recorded such as a violation or damage. Usually representative habitat types on the easement are photographed as well (S. Young, in litt.). However, again, these were not labeled. The absence of embedded information or descriptive commentary meant that other, less promising alternatives for obtaining meta information were explored.

It is a tenuous to draw ecological conclusions about a photograph based solely on its engineered database relational association to a particular GIS habitat polygon. The photograph must first actually depict the habitat in order to corroborate it in the database, or in a "proof" of restoration success. Seasonality is an issue for habitats normally identified with herbaceous/emergent vegetation, where a photograph taken in winter (or during a drought) might not actually depict recognizable intact vegetation. Given that photo descriptions were not originally included in standard metadata fields associated with digital photographs, the project officer "described" a sample of photographs by viewing them on computer and recording the observations in a database. This was strictly an effort to gauge the difficulty and time burden of "backfilling" these data, however the exercise raised the question of the efficacy of this after-the-fact approach. The authors can only conclude that *completing* such an effort on this large dataset does not coincide with what was envisaged for this analysis project. Of most concern was the likelihood that, having never visited those sites, any description crafted by the authors would be inaccurate and render any analysis based on them, invalid. Photo descriptions are inherently far more accurate when written by the photographer/observer of the scene and at the time of the photography, as opposed to being described at a location removed both in time and space, utilizing assembly-line style and pace of data entry.

Given the apparent disconnect with what was likely envisioned from the photographs in the project proposal and what was possible with the photographic dataset in hand, it seems pertinent to ask the question "what was the purpose of easement photographs?" A search of the official "WRP Program Manual" (NRCS 2007b) and various field-data instruments in use was undertaken to see what role photography plays in easement monitoring; e.g., when is it called for, how is it to be undertaken and what are its intended uses. Of four likely sources of such information, two yielded a number of allusions to easement photography. Relevant passages (with attribution) have been excerpted to "Summary of guidance on photographic documentation of WRP easements" in Annex 5.

The "MISSOURI 20[*07*] WRP RANKING FORM" (a.k.a. the "Missouri WRP Preliminary Planning Checklist') made no mention of photographic documentation for WRP sites. Similarly the form for landowners, "Missouri WRP Bid Pilot Self Assessment Guide" does not mention photographs or request photographic documentation as part of the submission of a nominated site, although a map is requested if available. [Photographs would seem eminently complementary to providing the evidence requested]. Discounting for the moment, clauses and advice concerning aerial photography, the two other sources did make some references to easement photography.

The form "WRPmonitoringagreementATTACHMENT A" is for both compliance and ecological monitoring of WRP easements. This form makes numerous allusions to photography. Several of these are related to recording easement compliance violations including listing examples of the kinds of violations that should be recorded. However photography in reference to ecological monitoring merely mentions that photographs should be taken as part of the process. For both compliance and ecological monitoring, the document instructs that photographs should be taken from "photo points." The document also states that "photos will be spatially associated with the easement boundary." The remaining information source, the "WRP Program Manual" (NRCS 2007b), refers to photography in several sections. Again however, the emphasis seems to be on compliance monitoring photography. However in reference to the Final Restoration Plan, the manual states that "[the]…plan shall consist of the following**:** photographs that document site conditions before, during, and after restoration." These site conditions should also include visual documentation that would "provide documentation of wetland benefits and values resulting from WRP restorations," the purpose of photographic documentation under this project product (i.e., analysis).

Ground photography is a part of a site monitoring "toolkit," especially for compliance monitoring. Compliance photographs typically capture restoration "practices" (e.g., a water control structure) or a violation of a *Compatible Use Authorization* or CUA, (e.g., building construction or a "food plot"). Effective compliance photographs can usually be taken as observed, i.e., at any time. Ground photography has and is being employed in ecological monitoring, especially to *qualitatively document vegetation and land-use change* (Clay and Marsh

2001). Vegetation attributes that can be interpreted from photographs may include species composition, structure, biomass and health or condition (Lund et al 1995). However in Missouri these attributes vary seasonally.

The absence of associated descriptive information (that could be mined, categorized and analyzed) requires an assumption that the easement photographs in the analysis dataset do connote visual information that documents "site conditions." This documentation would be from the time of photographic recording, some time "during restoration." Although photographs of the site before commencement are called for, these were not available for analysis, presumably because they are not part of a centralized dataset. Nor were they often available to the TSPs from the regionally housed individual easement files, although nominally required (S. Young, in litt.).

Another consideration in evaluating the potential of photography to document restoration success is the timing and frequency of monitoring visits. Thus far, Missouri WRP site monitoring has run on a schedule of one site visit every three years. In practice this means that only now are sites starting to receive a first follow-up visit. The analysis dataset only includes data – and photographs – from a single site visit. As Missouri experiences four distinct seasons, depending on when a particular site is visited, photographs of habitat and vegetation might depict starkly different images and convey vastly different levels of information, from similar sites (a lush summer versus a barren winter scene, for example). Ground photography to document vegetation succession (as an indication of restoration success) may be more effective during specific times of the year, especially for herbaceous vegetation.

Recommendations

Visual imagery is a powerful medium that can document restoration progress and success. Photographs provide a convincing message to stakeholders and funding sources of WRP program accomplishments. Currently the emphasis of easement photography is on documenting (non-)compliance. However ecological restoration also needs to be documented and this can be supported by easement photography. Time-series documentation is particularly useful. WRP monitoring guidance already suggests that a final restoration plan should contain *before*, *during*, and *after* restoration photographs to document site conditions. However this documentation is on a site-by-site basis and not yet part of a centralized data management system.

Recommendation 5.1

A large body of digital site photographs has been amassed during monitoring of WRP easements in Missouri. If descriptive information on these photos exists that was not part of the data package available to us (e.g., field notes or a separate dedicated photographic file), it should be affiliated with the photographs. Intermediate data by-products developed under the analysis would provide suitable vehicles for linking and storing any such data. Then if the level and content of new documentation indicated sufficient potential, a new analysis of the photographic resource should be undertaken.

Recommendation 5.2
All WRP easements should be photographed before, during, and after restoration. Pre-restoration photos document starting conditions, including the state of water and vegetation and serve as a baseline against which to compare restoration effectiveness. Photographs should be taken again immediately following restoration activities to provide a reference for subsequent ecological succession (as well as for compliance documentation). Photographs should be taken during each subsequent 3-year visit to record progress of ecological performance relative to restoration objectives.

Recommendation 5.3.
A careful, detailed description and other meta data should be associated with each digital photograph using standard imaging software by the photographer/observer at or near the time the photograph was taken. A simple set of keywords should be developed for and employed in descriptions to facilitate analysis of the ecological state of the easement as depicted in the photograph.

Recommendation 5.4
Every site monitoring visit should be documented with photography from designated photo points, covering ecological (as well as compliance themes). Vegetation type and seasonality should inform the scheduling of site visits to maximize the utility of the photographs for ecological monitoring.

Recommendation 5.5
All easement photographs should be part of a centralized data management system for Missouri WRP easements. The data management system should be capable of managing photographs just like any other data item and this should work seamlessly with the WRP GIS.

Recommendation 5.6
More detailed study and guidance on the feasibility and limitations of using aerial photography and remote sensing to bolster visual documentation of restoration progress given the fiscal and logistical constraints to multiple site visits is needed. Specific guidelines for applying these technologies should be developed.

Literature Cited

Boyd, C.S., Hopkins, K.T. and SVEJCAR, T.J. 2006. A Photo-Based Monitoring Technique for Willow Communities. Wildlife Society Bulletin **34**:1049-1054.

Bracciano, D. 2005. Wetland Assessment Procedure (WAP) Instruction Manual for Isolated Wetlands. Southwest Florida Water Management District and Tampa Bay Water, a Regional Water Supply Authority. URL: http://www.swfwmd.state.fl.us/waterres/ntb/wap/files/wap_manual2005.pdf [accessed on 29 November 2007]

Clay, G.R. and Marsh, S.E. 2001. Monitoring Forest Transitions Using Scanned Ground Photographs as a Primary Data Source. Photogrammetric Engineering & Remote Sensing **67**: 319-330.

Curtin, C.G., Sayre, N.F. and Lane, B.D. 2002. Transformations of the Chihuahuan Borderlands: grazing, fragmentation, and biodiversity conservation in desert grasslands, Environmental Science & Policy **5**:55-68.

Ducrotoy, JP.A. and Simpson, SD. 2001. Developments in the application of photography to ecological monitoring, with reference to algal beds. Aquatic Conservation: Marine and Freshwater Ecosystems **11**: 123-135.

Finlayson, C.M. 2001. Considerations for undertaking a wetland inventory. Pages 11-22 *In* C.M. Finlayson, N.C. Davidson, and N.J. Stevenson (editors). Wetland inventory, assessment and monitoring: practical techniques and identification of major issues. Supervising Scientist Report 161, Supervising Scientist, Darwin, Australia.

Finlayson, C.M., Davidson, N.C. & Stevenson, N.J. 2001. Wetland inventory, assessment and monitoring practical techniques and identification of major issues: Summary. *In* Wetland inventory, assessment and monitoring: practical techniques and identification of major issues C.M. Finlayson, N.C. Davidson, and N.J. Stevenson (editors). Supervising Scientist Report 161, Supervising Scientist, Darwin, Australia.

Lund, H.G., Evans, D.L. and Linden, D.S. 1995. Scanned, zapped, timed, and digitized: advanced technologies for measuring and monitoring vegetation diversity. Ch. 25 *In* Boyle, T.J.B. and Boontawee, B. (editors). Measuring and Monitoring Biodiversity in Tropical and Temperate Forests. Center for International Forestry Research, Bogor, Indonesia.

Natural Resources Conservation Service (NRCS). 2007a. Farm Bill 2002. Wetlands reserve Program. Key Points. April 2007. (Factsheet). URL: http://www.nrcs.usda.gov/PROGRAMS/wrp/2007WRPKeyPoints.pdf [accessed on 21 April 2008]

Natural Resources Conservation Service (NRCS). [2007b]. Conservation Programs Manual Title 440, Part 514. Wetland Reserve Program. URL: www.info.usda.gov/scripts/lpsiis.dll/M/M_440_514.htm. [accessed on 29 November 2007]

Palmer, M.A., E.S. Bernhardt, J.D. Allan, P.S. Lake, G. Alexander, S. Brooks, J. Carr, S. Clayton, C.N. Dahm, J. Follstad-Shah, D.L. Galat, S. Gloss, P. Goodwin, D.D. Hart, B. Hasset, R. Jenkinson, G.M. Kondolf, R. Lave, J.L. Meyer, T.K. O'Donnelll, L. Pagano, and E. Sudduth. 2005. Standards for ecologically successful river restoration. Journal of Applied Ecology **42**: 208-217.

Ramsar Convention Secretariat, 2004. Wetland inventory: A Ramsar framework for wetland inventory. Ramsar handbooks for the wise use of wetlands, 2nd edition, vol. 10. Ramsar Convention Secretariat, Gland, Switzerland.

Ramsar Convention Secretariat, 2007. Inventory, assessment, and monitoring: An Integrated Framework for wetland inventory, assessment, and monitoring. Ramsar handbooks for the wise use of wetlands, 3rd edition, vol. 11. Ramsar Convention Secretariat, Gland, Switzerland.

USFWS 2006. Platte River Recovery Implementation Program. December 07, 2005. Appendix D *in* Biological Opinion on the Platte River Recovery Implementation Program. June 16, 2006. URL: http://www.fws.gov/filedownloads/ftp_region6_upload/Platte%20River%20Final%20Biological%20Opinion/Appendix%20D.pdf [accessed on 29 November 2007].

Chapter 6: Conclusions and Recommendations

Introduction

The purpose of the Conservation Effects Assessment Project (CEAP) is to quantify environmental benefits of conservation practices used by private landowners participating in selected U.S. Department of Agriculture's conservation programs including the Wetland Reserve Program (WRP). This report contributes to the CEAP mission of helping "*farmers and ranchers make informed conservation choices"* by providing a summary and analysis Missouri's WRP program, including number, area, distribution and type of enrolled parcels; a listing of plant and animal taxa with emphases on rare and endangered species, and; an evaluation of restoration status including influence on plant and animal responses.

Restoring habitat for "*migratory birds and other wildlife*" is the ultimate goal of the national WRP; however, the young age of the program and vegetation succession, as well as the lack of monitoring, have limited evaluation of program success from this perspective (King et al. 2006). Similarly, our analysis of the Missouri WRP is preliminary as to date most easements have experienced only first-time monitoring and evaluation. This report is intended to provide baseline information that establishes initial gains in wetland value, compliance with easement restrictions, initial vegetation response, and the degree of agreement between predicted and actual wetland recovery. Project findings and results can be used to document progress on the environmental effects of WRP, guide WRP implementation, aid discussions on conservation policy development, and ultimately improve success of the WRP in Missouri and elsewhere.

Conclusions

Approximately 119,400 acres on 825 sites, or about 0.27% of the total area of Missouri was enrolled in the WRP program as of January 2007. Nearly 90% of these lands are in permanent easements and about 66% of all enrolled sites and 54% of total enrolled acreage are located in the Central Dissected Till Plains ecoregion of northern Missouri (0.44% of its total area). The subset monitored for this WRP analysis consisted of 72% (594 sites) of the total statewide easements and included approximately 56% (66,706 acres) of the total enrolled acreage.

The three dominate wetland habitat types of monitored WRP easement acreage, based on Cowardin et als. (1979) classification were: Palustrine Forested Broad-leaved Deciduous (50.4%), Palustrine Emergent Persistent (22.0%), and Palustrine Emergent Non-persistent (18.5%). Habitat succession, defined as changes in land cover, was examined by contrasting before and after restoration conditions and at discrete four-year intervals. Almost all of the lands that were comprised of cropland at the start of restoration had succeeded to emergent-herbaceous and forested-wooded land-cover types at the time of easement monitoring (range 2.7 to 12.2 years). The forest-woodland category is a mixture of natural regeneration and tree planting. Only scant remnants of cropland remained by the fifth year of restoration.

(range 2.7 to 12.2 years). The forest-woodland category is a mixture of natural regeneration and tree planting. Only scant remnants of cropland remained by the fifth year of restoration.

Habitat Suitability Index (HSI) data were recorded on an easement basis during monitoring for six representative species (models). Three species, *Anas platyrhynchos* (mallard), *Aix sponsa* (wood duck) and *Protonotaria citrea* (prothonotary warbler) were indicators for "forested" habitats and three species, mallard, *Ixobrychus exilis* (least bittern) and *Tringa flavipes* (lesser yellowlegs) were indicators for non-forested habitats. Post-restoration HSI scores were markedly higher than the pre-restoration score (set at 0.1) for all non-forest models and two of the three forest models. The magnitude of the increase in habitat quality was greatest for species associated with emergent-herbaceous (non-forest) habitats that develop faster than forest. Least bittern showed the greatest improvement in habitat quality due to its dependence on dense herbaceous vegetation, which increased on most easements following restoration as succession proceeded. The mallard, a species associated with both forested and non-forest categories of restored land depending on the season, showed the least HSI improvement of species associated with forest. However, mature bottomland hardwood forest on which the mallard model relies, has not had time to develop fully in the majority of study sites. Temporal changes in habitat quality for indicator species are expected to more clearly emerge as wetlands succeed in the future.

Ground photographs were taken during monitoring of Missouri WRP easements to document the efficacy of WRP restoration. Eighty-nine percent of monitored easements were covered by at least one photograph in the analysis dataset. However, recorded information about the subjects of those photographs was generally absent. Few of the digital photographs were populated with any descriptive meta-information, and of those that did contain information, much of it was compliance or management oriented as opposed to ecological information. Visual imagery is a powerful medium to demonstrate restoration success. Before, during, and after time series photographic documentation of easements as part of a centralized data management system would be particularly useful to document restoration progress.

Recommendations

Individual preceding Chapters provide specific operational recommendations to improve Missouri's WRP monitoring and evaluation program to better meet the CEAP purpose. Here we provide more strategic recommendations derived from a review of relevant technical literature in restoration ecology that addresses the challenges in achieving restoration success and designing cost-effective monitoring programs to evaluate program performance.

Hydrological conditions provide the basic control of wetland structure and functioning (National Research Council 1996). It is poorly known to what degree natural hydrological regimes must be mimicked to restore biodiversity and wetland functioning at the local scale (Zedler 2000). However, identifying essential attributes of the anticipated hydrological regime, including magnitude, timing, frequency, duration, and rate of change of flooding and drying events for the targeted wetland habitat type (e.g., Cowardin 1979) should be a core element of designing and implementing WRP projects.

We recommend adopting an adaptive management approach as outlined in Table 6.1 and detailed in Williams et al. (2007) to the Missouri WRP in general and also for individual

Table 6.1. Operational sequence for adaptive management. (Adapted from Williams et al. 2007)

Step	Purpose
Setup stage	
Stakeholder involvement:	Ensure agency and stakeholder commitment to adaptively manage the restoration for its duration.
Objectives:	Identify clear, measurable, and agreed-upon management objectives to guide decision making and evaluate restoration effectiveness over time.
Management actions:	Identify a set of potential restoration actions for decision making.
Models:	Identify models that characterize different ideas (hypotheses) about how the system works.
Monitoring plans:	Design and implement a monitoring plan to track resource status and other key resource attributes to inform decision making.
Iterative stage	
Decision making:	Select restoration actions based on management objectives, resource conditions, and enhanced understanding.
Follow-up monitoring:	Use monitoring to track system responses to restoration actions.
Assessment:	Improve understanding of resource dynamics by comparing predicted and observed change in resource status.
Iteration:	Cycle back to Steps 1 and 6.

easements. Wetland systems are inherently dynamic and variable and we often poorly understand how they will respond to management actions. Adaptive management recognizes these uncertainties in four ways that monitoring can help address (Williams 2001, Lyons et al 2008). First, environmental spatial and temporal variation often drives wetlands in ways that may or may not be consistent with management prescriptions. Second, considerable uncertainty exists about the underlying ecological mechanisms responsible for observed responses (e.g., rate of vegetation succession; see Box 6.1.). Third, many wetland variables of interest (e.g., population responses of targeted wildlife species) cannot be measured directly given available resources. Fourth, outcomes of restoration actions often deviate in degree and spatial extent from management prescriptions (e.g., dominance in plant species composition).

Box 6.1. (Source: Zedler 2000). **Succession theory is central to ecological restoration.** In nature, a disturbed habitat immediately begins to change and it continues to develop over centuries. Ecologists recognize broad patterns where sites of different ages occur within a region or when large-scale disturbances are followed over time. Although ecosystem recovery can be perceived as an orderly progression when viewed over long periods at a regional scale (e.g. 200 years for spruce forests that follow glacial melting in Alaska), shorter term, smaller scale patterns are hard to predict.

Restorationists seek to achieve a mature community in a short time by overcoming many constraints. Further complicating predictability, restorationists employ site-specific actions to accelerate the developmental process and each action has the potential to change the trajectory of ecosystem development in ways that are largely uncharted. One can argue that following larger restoration sites for longer periods would show that succession theory can predict outcomes. One can also argue that the outcomes of many restoration sites cannot be predicted, because succession theory does not accommodate smaller scale, shorter term, site-specific patterns. The fact remains that wetland restorationists are often charged with achieving specific outcomes on small sites in short periods, although the ability to predict specific outcomes is lacking for such settings, even for well studied communities.

Adaptive management addresses these uncertainties by integrating monitoring into decision-making, thereby allowing decision-makers to both achieve management objectives and generate new knowledge about how the system responds to restoration actions (Lyons et al 2008). A key element of adaptive management and any restoration effort is to articulate SMART (i.e., specific, measurable, achievable, relevant, time-dependent) objectives at the outset of the program and for each restoration project (Gregory & Failing 2002, Tear et al. 2005, Van Cleve et al. 2006).

The goal of the national WRP to, "*achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled…*" needs to be translated into measurable objectives for the state specific program in Missouri. Management objectives should be more than acres enrolled, or practices implemented as designed, but they should identify attributes of *ecological success* (see Table 6.2, Palmer et al. 2005). The primary purpose of a post-project monitoring program is to evaluate progress at realizing these management objectives.

Table 6.2. Five suggested criteria for ecological success to apply to Missouri's Wetland Reserve Program. (Adapted from Palmer et al. 2005).

Criteria	Description
A guiding image exists	A dynamic ecological endpoint is identified a priori and used to guide the restoration.
Ecosystems are improved	The ecological conditions of the site are measurably enhanced.
Resilience is increased	The site is more self-sustaining than prior to restoration.
No lasting harm is done	Implementing the restoration does not inflict irreparable harm during construction activity.
An ecological assessment is completed	Some level of both pre-and post- project assessment is conducted and information made available.

Unfortunately, assessment or monitoring was conducted on only about 10% of over 37,000 river restoration projects evaluated throughout U.S. (Bernhardt et al. 2005) and monitoring was reported on only between 0 and 50% of over 62,000 river-wetland restoration projects within the Upper Mississippi River Basin (O'Donnell and Galat 2007). The Missouri WRP program is an exception to this piecemeal approach to assessing program effectiveness in that over 70% of WRP easements to date have undergone post-project monitoring.

Missouri's present WRP monitoring program is largely directed towards compliance and implementation monitoring, along with limited status and trends monitoring (See Table 6.3. for categories of restoration monitoring).

Table 6.3. Restoration monitoring can be classified into six overlapping categories (Sources: Barko et al. 2006, Block et al. 2001).

Category	Purpose
Baseline monitoring	Characterize existing conditions, including natural variability; establish a database for planning or future comparisons; use as a reference of either existing or undisturbed conditions.
Status & trend monitoring	Evaluate state of system over time, with emphasis on "trends". Key issue is change of conditions over time. May or may not be related to specific project or question.
Implementation monitoring	Evaluate whether the restoration practices were carried out as planned. Includes monitoring of construction impacts, constructed features, and characterizing immediate post-project conditions.

Table 6.3 (continued)

Category	Purpose
Effectiveness monitoring	Evaluate whether the restoration practices met stated objectives. May be directed at an individual project or a coordinated suite of multiple projects. Typically requires information about baseline and reference conditions, or desired state of system.
Validation monitoring	Advance knowledge of underlying cause and effect relationships. Use demonstration projects to strengthen scientific basis for particular restoration approaches. Monitoring data used to validate models.
Compliance monitoring	Determine whether specific water quality or ecological integrity criteria are being met, as specified in some environmental standard, regulation, or law.

Effectiveness monitoring is particularly relevant to restoration and requires response variables to be clearly articulated so they can be measured accurately and precisely (Block et al. 2001). Plant species present (Chapter 3) are important indicators of system response to management actions. Identifying reference community composition based on representative species by ecological section (Nigh and Schroeder 2002) and Cowardin (1979) habitat types would further facilitate identifying performance metrics for effectiveness monitoring.

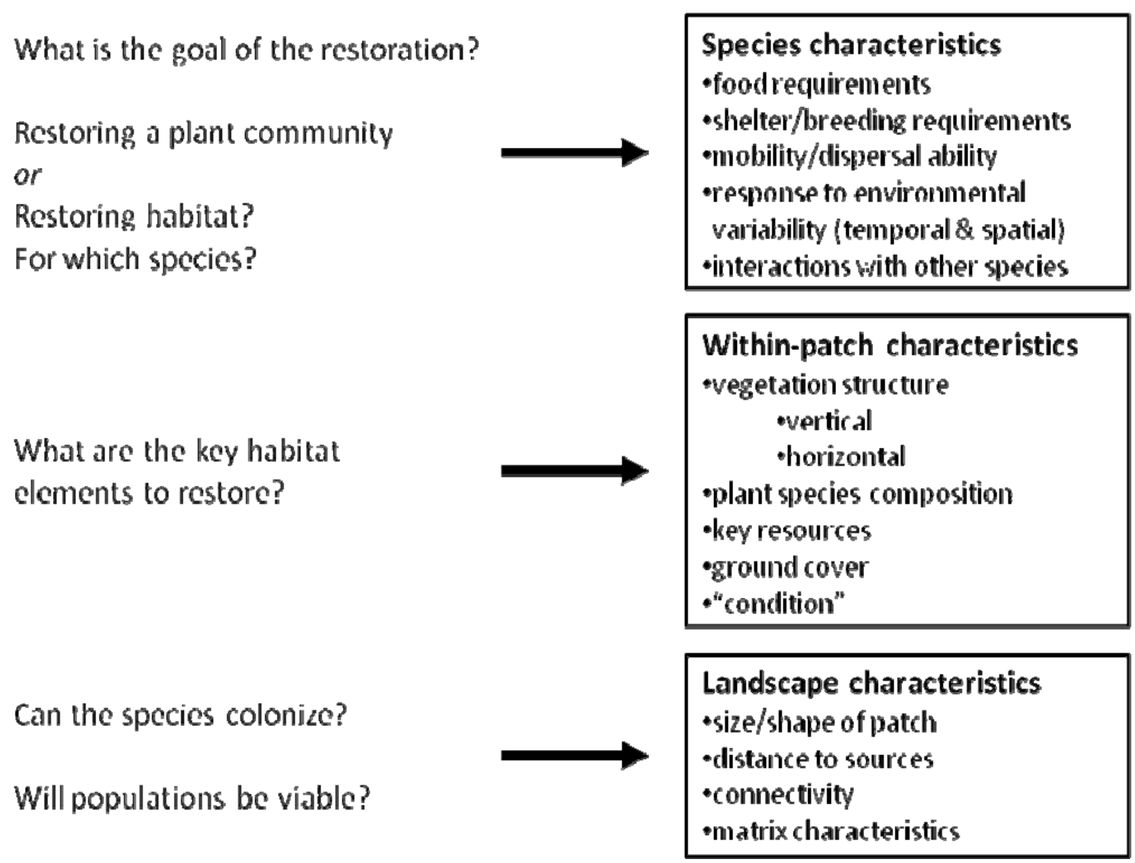
Indices are useful metrics to characterize biodiversity (Failing and Gregory 2003) and Habitat Suitability Index (HSI) models, such as used in the Missouri WRP monitoring program (Chapter 4), have been widely applied to assess habitat quality for a variety of wetland wildlife (National Wetlands Research Center : http://www.nwrc.usgs.gov/wdb/pub/hsi/ hsiintro.htm). An HSI is a numerical index that represents the capacity of a given habitat to support a selected species and most HSIs were developed by the U.S. Fish and Wildlife Service between 1980 and1987 to quantify effects of land management alternatives on wildlife habitat (U.S. Fish and Wildlife Service 1981). Use of HIS models is now often criticized because of unreliable model performance resulting from an inconsistent framework for model validation (Roloff and Kernohan 1999). Additionally, HSIs are single species habitat metrics and as such convey little information about overall ecosystem health. Two other approaches to characterize wetland condition have largely replaced HSIs and we recommend they be considered for evaluating WRP easements in Missouri.

Multimetric indices such as the Index of Biotic Integrity (IBI) have become popular as a summary tool to evaluate the health of wetlands and the IBI approach is now widely applied for wetland bioassessments (U.S. Environmental Protection Agency: http://www.epa.gov/owow/wetlands/bawwg/biobasic.html). See Mack (2007) for a review of wetland IBIs and the advantages of plant-based wetland IBIs.

The hydrogeomorphic (HGM) approach for assessing wetland functions is rapidly gaining favor among multiple federal agencies for identifying wetland restoration and management options (http://el.erdc.usace.army.mil/wetlands/hgmhp.html). The HGM approach requires classification of wetlands based on geomorphic setting, water source, and hydrodynamics. For each wetland type, or subclass, it also requires developing models for each classified wetland, collecting data from reference wetlands, and calibrating the models using that data. The calibrated models are then field tested, revised, and published as a regional guidebook (Smith et al. 1995). Heitmeyer (2008) has applied HGM to evaluate ecosystem restoration and management options for a Missouri Conservation Area and we recommend evaluating the HGM as a more holistic and functional approach for evaluating restoration options and defining potential outcomes for Missouri WRP easements.

A major challenge of any WRP program is to develop objective and scientifically defensible performance criteria when what constitutes "*optimum wildlife habitat*" is poorly known. Miller and Hobbs (2007) summarize a key set of considerations that should be addressed when undertaking habitat restoration projects. These include: (1) determining the target species of the restoration (see also Parrish et al. 2003), (2) deciding on the key habitat elements to be restored, and (3) assessing the project within a landscape-scale context (see Figure 6.1).

Figure 6.1. Key considerations when setting goals for habitat restoration programs (Source: Miller & Hobbs 2007).



Effectiveness monitoring to address these considerations need not be conducted on every easement, or every year. A project-by-project determination of the appropriate level and complexity of monitoring should be made based on the size/cost of the project, the scale of its likely impacts and its benefits and its potential for learning. Monitoring and evaluation of WRP easements shares may similarities with measuring trends in ecological resources in general and the May 1998 issue of *Ecological Applications* (Dixon et al. 1998) contains a collection of papers that can aid in improving effectiveness monitoring for WRP sites. The papers in this issue define what a 'trend' is and what separates long-term trends from other components of temporal variation. Other papers provide design-based survey sampling approaches to monitoring changes in ecological resources, how to generalize to larger regions from a few intensively monitored sentinel sites or many infrequently monitored sites, and others describe statistical techniques for analyzing trends in ecological communities. Additionally, The National Park Service has undertaken a program to inventory and monitor the condition of natural resources in our National Parks that is generally applicable to WRP sites and they provide detailed guidance for how to design an integrated monitoring program (http://science.nature.nps.gov/im/monitor/).

We would also like to draw attention to some of the pitfalls others have encountered in ecological restoration projects. Hilderbrand et al. (2005) articulated five central myths under which many restoration and management projects seem to have been conceived and implemented. (see Table 6.4). Identifying such myths can help us recognize our assumptions about complex wetland systems and understand why some restoration projects to not meet

Table 6.4. The myths of restoration and their features (Source: Hilderbrand et al. 2005)

Restoration Myth	Features
Carbon Copy	We can restore or create an ecosystem or site that is a copy of a previous or ideal state. Community assembly is predictable; a single endpoint exists.
Field of Dreams	Restore the physical structure for a particular ecosystem or site , and biotic composition and function will self-assemble.
Fast Forward	One can accelerate ecosystem or site development by controlling pathways such as dispersal, colonization and community assembly, to reduce the time required to
Cookbook	Over-use or continued use of a locally unsuccessful restoration prescription because it worked somewhere else, or is in the published literature.
Command and Control: Sisyphus Complex	Assumes We have the knowledge, abilities, and foresight to actively control ecosystem structure and function to manage for a particular ecosystem state indefinitely into the future.

expectations. Failing and Gregory (2003) identify 10 common mistakes in developing and using forest biodiversity indicators from the perspective of making better management choices (see Table 6.5). They are equally applicable to helping CEAP quantify environmental benefits of conservation practices as several of the mistakes stem in part from a focus on thinking about indicators as monitoring effects on forest (wetland) characteristics rather than as decision criteria.

Table 6.5. Ten mistakes in forest (wetland) biodiversity indicators. (Source: Failing & Gregory 2003).

Mistake
1. Failing to define endpoints
2. Mixing means and ends
3. Ignoring the management context
4. Making lists instead of indicators
5. Avoiding importance weights for individual indicators
6. Avoiding summary indicators or indices because they are considered overly simple
7. Failing to link indicators to decisions
8. Confusing value judgments with technical judgments
9. Substituting data collection for critical thinking
10. Oversimplifying: ignoring spatial and temporal tradeoffs

Lastly, cost of monitoring programs is always a challenge as most agencies elect to direct the majority of resources to on-the-ground restoration. However, we cannot overemphasize the necessity of designing and implementing effective ecological monitoring of WRP easements. Adaptive management is not possible without monitoring to assess performance of objectives and, equally important, to learning by doing. As noted above we recommend stratifying Missouri's WRP easements into similar types based on ecological section and dominant habitat types and this approach could redirect limited resources to improved effectiveness monitoring.

Successful ecological monitoring programs must be ecologically relevant, statistically credible and cost effective (Hinds 1984). For an ecological monitoring program to be successful the perceived information benefits must justify its cost. Caughlan and Oakley (2001) provide a general framework for building and operating a cost-effective, long-term ecological monitoring program and we urge the Missouri WRP to use the results and recommendations of this report to further cost-effective and realistic expectations of monitoring outcomes.

References

Barko, J., B. Johnson, and C. Theiling. 2006. Environmental Science Panel Report: Implementing adaptive management. U.S. Army Engineer Districts: Rock Island, Rock Island, IL; St. Louis, St. Louis, MO, and St. Paul, St Paul, MN.

Bernhardt, E. S., M.A. Palmer, J.D. Allan, G. Alexander, K. Barnas, S. Brooks, J. Carr, S. Clayton, C. Dahm, J. Follstad-Shah, D. Galat, S. Gloss, P. Goodwin, D. Hart, B. Hassett, R. Jenkinson, S. Katz, G. M. Kondolf, P. S. Lake, R. Lave, J.L. Meyer, T.K. O'Donnell, L. Pagano, B. Powell, and E. Sudduth. 2005. Synthesizing U. S. river restoration efforts. Science 308: 636-637.

Block, W.M., A.B. Franklin, J.P. Ward, Jr., J. L. Ganey, and G.C. White. 2001. Design and implementation of monitoring studies to evaluate the success of ecological restoration on wildlife. Restoration Ecology 9: 293-303.

Caughlan, L., and K. L. Oakley. 2001. Cost considerations for long-term ecological monitoring. Ecological Indicators 1:123-134.

Cowardin, L.M., Carter, V., Golet, F.C. and LaRoe, E.T. 1979. Classification of Wetland and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service Report FWS/OBS-79/31. Washington D.C. 131 p.

Dixon, P. M., A. R. Olsen, and B. M. Kahn. 1998 (and other papers in this issue). Measuring trends in ecological resources. Ecological Applications 8:225-227.

Failing, L., and R. Gregory. 2003. Ten common mistakes in designing biodiversity indicators for forest policy. Journal of Environmental Management 68:121-132.

Heitmeyer, M. E. 2008. An evaluation of ecosystem restoration and management options for the Ted Shanks Conservation Area. Greenbrier Wetland Services Report 08-03, Blue Heron Conservation Design and Printing LLC, Bloomfield, MO.

Hilderbrand, R. H., A. C. Watts, and A. M. Randle. 2005. The myths of restoration ecology. Ecology and Society 10(1):19: http:// \www.ecologyandsociety.org/vol10/iss11/art19/.

Hinds, W. T. 1984. Towards monitoring of long-term trends in terrestrial ecosystems. Environmental Conservation 11:11-18.

King, S. L., D. J. Twedt, and R. R. Wilson. 2006. The role of the Wetland Reserve Program in conservation efforts in the Mississippi River Alluvial Valley. Wildlife Society Bulletin 34:914-920.

Mack, J. J. 2007. Developing a wetland IBI with statewide application after multiple testing iterations. Ecological Indicators 7: 864–881.

Middleton, B. 1999. Wetland restoration, flood pulsing, and disturbance dynamics, John Wiley & Sons, New York.

Miller, J. R., and R. J. Hobbs. 2007. Habitat restoration - do we know what we're doing? Restoration Ecology 15:382-390.

National Research Council. 1996. Wetlands characteristics and boundaries. National Academy Press, Washington, DC.

Nigh, T.A. and Schroeder, W.A.. 2002. Atlas of Missouri Ecoregions. Missouri Department of Conservation. Jefferson City, Missouri. xii + 212 p and GIS data.

O'Donnell, T. K. and D. L. Galat. 2007. River enhancement in the upper Mississippi River basin: approaches based on river uses, alterations, and management agencies. Restoration Ecology. 15: 538-549.

Parrish, J. D., D. P. Braun, and R. S. Unnasch. 2003. Are we conserving what we say we are? Measuring ecological integrity within protected areas. BioScience 53:851-860.

Roloff, G.J. and B.J. Kernohan. 1999. Evaluating reliability of habitat suitability index models. Wildlife Society Bulletin 27: 973-985.

Smith, R. D., A. Ammann, C. Bartoldus, and M. M. Brinson. 1995. An approach for assessing wetland functions using hydrogeomorphic classification, reference wetlands, and functional indices. Wetlands Research Program Technical Report WRP-DE-9. U.S. Army Corps of Engineers, Washington, D.C. http://lawr.ucdavis.edu/classes/hyd143/HGM.pdf)

Tear, T. H., P. Kareiva, P. L. Angermeier, P. Comer, B. Czech, R. Kautz, L. Landon, D. Mehlman, K. Murphy, M. Ruckleshaus, J. M. Scott, and G. Wilhere. 2005. How much is enough? The recurrent problem of setting measurable objectives in conservation. BioScience 55:835-849.

U.S. Fish and Wildlife Service. 1981. Standards for the development of habitat suitability index models. U.S. Fish and Wildlife Service, Release No. 1-81, 103 ESM.

Van Cleve, F. B., T. Leschine, and T. Klinger. 2006. An evaluation of the influence of natural science in regional-scale restoration projects. Environmental Management 37:367-379.

Williams, B. K., R. C. Szaro, and C. D. Shapiro. 2007. Adaptive management: The U. S. Department of the Interior technical guide. U. S. Department of the Interior, Washington D.C.

Zedler, J. B. 2000. Progress in wetland restoration ecology. TREE 15: 402-407.

Acknowledgements

We would like to thank Elizabeth Cook for providing invaluable GIS technical support. Kevin Dacey (MDC), Harold Deckerd (NRCS), Chris Hamilton (NRCS), Doug Helmers (NRCS), Dale Humburg (MDC), and Mike Roell (MDC) collectively guided project design and feedback on process. We particularly appreciate input from Rob Leonard and Steve Young who shared their field notes and experiences collecting project data. Charles Rewa is thanked for providing financial and logistical support throughout this effort. Karen Decker contributed to layout and production of the final product. This is a contribution from the Missouri Cooperative Fish and Wildlife Research Unit (U.S. Geological Survey, Missouri Department of Conservation, University of Missouri, Wildlife Management Institute, and U.S. Fish and Wildlife Service cooperating). Funding was provided by the Conservation Effects Assessment Project (CEAP – wildlife component) of NRCS (under Contract No. 68-3H75-3-122 Modifications #13 and 20) via the Upper and Middle Mississippi Valley Cooperative Ecosystem Studies Unit (CESU) to the University of Missouri (Account No. C00013696, DA130).

ANNEX 1

SUPPLEMENTARY PROJECT DOCUMENTATION

Missouri WRP Analysis Project

Table of Contents

Note: The Progress Report of 17 January 2007, entitled "A Retrospective Analysis of Conservation Effects of WRP Sites in Missouri" is a PowerPoint presentation found in the project's CD archives.

PROJECT PROPOSAL

Assessing the Effectiveness of the Wetlands Reserve Program in Missouri through Analysis of Existing Easement Data and Linkage to Previous Floodplain Investigations

Principle Investigators:

Dr. David Galat, U.S. Geological Survey, Cooperative Fish and Wildlife Research Unit and University of Missouri
Dr. Mickey Heitmeyer, University of Missouri – Gaylord Memorial Laboratory

Collaborators:

Liz Cook, Natural Resources Conservation Service
Frank Nelson, Missouri Department of Conservation
Dr. Andy Raedeke, Missouri Department of Conservation
Dave Graber, Missouri Department of Conservation

Funding Requested:

Fiscal Year 2006: $49,500

Proposal:

Evaluate data from 600 Wetlands Reserve Program (WRP) easements collected during 2003-2005 in Missouri to assess initial effectiveness regarding wetland functions and values and to enhance future monitoring and evaluation protocols.

Products:

1) A complete summary of wetland area and distribution, restored wetland types, and hydrologic condition.
2) A complete listing of plant and animal taxa with emphases on rare and endangered species.
3) An evaluation of restoration status including influence on plant and animal response.
4) Photographic documentation of wetland benefits and values resulting from WRP restorations.
5) Analysis of other data in Missouri (e.g., Missouri River Post-flood Evaluation, Avian Use of Missouri River Floodplain Wetlands Evaluation, fall migratory bird surveys, etc.) to determine the usefulness in documenting wildlife response to WRP restored wetlands.
6) Recommendations for improved WRP monitoring.

Background:

The Wetlands Reserve Program, authorized in the 1990 Farm Bill, is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The Natural Resources Conservation Service (NRCS) of the United States Department of Agriculture provides technical and financial support to help landowners with their wetland restoration efforts. NRCS has a goal of maximizing wetland functions and values as well as wildlife habitat on every acre enrolled in the program. The objectives of the program include: 1) habitat for migratory birds and other wildlife, in particular at-risk species; 2) protection and improvement of water quality; 3) attenuation of water flows during flooding; 4) recharge of ground water; 5) protection and enhancement of open space and aesthetic quality; 6) protection of flora and fauna which contributes to the Nation's natural heritage; and 7) contribution to education and scientific scholarship.

NRCS is making a long term commitment that involves expenditure of federal taxpayer dollars to restore and maintain wetlands (through WRP easements) and associated biological functions and values. Documentation of restoration success, status of easement integrity, and biological response to restoration is needed to determine the effectiveness and appropriateness of restoration activities. Monitoring of WRP restoration is necessary to ensure that planned wetland functions and values are achieved and maintained. Updated information on WRP status also facilitates maintenance and opportunities for wetland enhancement.

Ongoing monitoring will provide the basis for continued program improvement. Changes in restoration strategies, management regimes, and the size, distribution, and configuration of WRP easements will be possible only if program elements and implementation are continuously evaluated. Targeted biological monitoring will document whether intended benefits for wetland fauna and flora are achieved and whether objectives for water quality and wetland protection are attained.

Missouri is well positioned to assess the effectiveness of WRP. During 2003-2005, 600 easements were monitored using several measures of physical and biological integrity. Information collected included:

1. Confirmation of boundary and easement identification maps, restoration designs, and wetland reserve plans of operation.
2. Digital photos from photo stations documenting representative conditions on each site.
3. GPS coordinates of water control structures, spillways, levees, and location of ingress/egress routes.
4. Habitat assessment and wetland classification (Cowardin et al. 1979) by GIS sub-polygon within each easement.
5. Condition of restoration practices, management activities, dominant wetland plants, invasive plant species, and wildlife use (to include levees, berms, and water control structures).
6. Site specific management plans including recommendations for water level management, vegetation control and management, remedial maintenance and

repair, documentation of the appropriateness and application of compatible use activities.

7. Initial contacts with landowners (as available) to review wetland management objectives, easement plans, and management intent.

Initial data have been compiled and verified for the first two years of sampling, which included 408 easements (49,313 acres). Of the 37,792 acres of prior converted cropland evaluated (the remainder was classified upland), 16,289 acres was classified as palustrine emergent, 19,135 acres as palustrine forest, 777 acres as palustrine shrub-scrub, 526 acres as palustrine open water, and 1,066 was classified as "other." Among plants, 230 different species were recorded as the top 3 dominant species among sites, an indication of plant diversity. Gains in wildlife values were evident in increases from assumed habitat suitability values of ≤ 1 for converted cropland for. Gains in wildlife values are assumed because habitat suitability index values for most wetland migratory birds are quite low for converted cropland (for example, HSI for forest mallards 0.216, forest wood ducks 0.403, forest prothonotary warblers 0.403, non-forest mallards 0.440, non-forest least bitterns 0.484, and non-forest lesser yellowlegs 0.246) but higher for those species in various wetland types after restoration.

Preliminary data from first-time monitoring and evaluation efforts are sufficient for establishing initial gains in wetland value, compliance with easement restrictions, initial vegetation response, and the degree of agreement between predicted and actual wetland recovery. The ultimate value from WRP monitoring efforts, however, will be in improved delivery of the program and the response of wetland fauna and flora to restoration. Thus, complete analysis of existing monitoring data should be a prerequisite for amendments to monitoring protocols and, more importantly, to assure efficient and effective WRP delivery.

Objectives:

1) Ensure accuracy and integrity of existing WRP monitoring data.
2) Conduct basic analyses of WRP monitoring data to establish the range of wetland conditions, vegetation response and diversity, wildlife use, and easement status.
3) Determine whether distinctions can be established among sites based on time since restoration, size, wetland type or other physical or ecological characteristics.
4) Develop a basis for more in-depth evaluation of WRP benefits (both ecological and social).
5) Recommend adaptations to WRP monitoring protocols that can be applied in Missouri and throughout the U.S.
6) Link WRP evaluation results to the results of previous floodplain investigations (for example, Missouri River Post-flood Evaluation, Avian Use of Missouri River Floodplain Wetlands Evaluation, fall migratory bird surveys, and so on)

Approach:

Initial effort will focus on data quality control and basic statistical analyses, such as univariate frequency distributions, measures of central tendency, variability, and so on. Next, vegetation and wildlife response to independent variables such as time since establishment and wetland classification modifiers can be explored with more elaborate statistical analyses. Recommendations for improved WRP monitoring will be developed from literature review and the expertise of experienced wetland managers and researchers.

Work will be accomplished by a Research Associate (M.S. or Ph.D. degree preferred) supervised by Dr. David Galat (University of Missouri). Interpretation of evaluation results will be a collaboration of the principle investigators, collaborators, research associate, and wetland managers.

Budget and Timeline:

Funding for this CEAP agreement will be supported by the CESU Network through the University of Missouri (Dr. Tony Prato as primary contact) and an existing cooperative agreement between the Missouri Department of Conservation and the University of Missouri.

The following budget and timeline is anticipated:

Budget Category	Budget	2006			2007								
		O	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**
Coordination/ supervision	$2,500												
Materials & Supplies	$2,600												
Consultation – Heitmeyer	$5,000												
Research Associate	$32,400												
Workshop	$2,500												
CESU Indirect costs (@10%)	$4,500												
Total	**$49,500**												

Literature Cited:

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetland and deepwater habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington D.C.

Occasional Members and Observers of the *de facto* WRP Analysis Project Steering Committee

Members
Elizabeth Cook (NRCS)
Kevin Dacey (MDC)
Harold Deckerd (NRCS)
Scott Frazier[11] (UMC)
David Galat (USGS/UMC)
David Graber (MDC)
Chris Hamilton (NRCS)
Mickey Heitmeyer (GML)
Doug Helmers (NRCS)
Dale Humburg (MDC)
Rob Leonard (TSP)
Andrew Raedeke (MDC)
Charles Rewa (NRCS)
Mike Roell (MDC)
Steve Young (TSP)

Observers
T. Kevin O'Donnell (UMC)
Michael Headrick (UMC)
Doreen Mengel (MDC/UMC)

GML = Gaylord Memorial Library (University of Missouri)
MDC = Missouri Department of Conservation
NRCS = Natural Resources Conservation Service (USDA)
TSP = Technical Service Provider (contractor)
UMC = University of Missouri/Columbia
USDA = United States Department of Agriculture
USGS = United States Geological Survey

[11] Project Officer

WRP ANALYSIS PROJECT TIMELINE (Main items)

Date	**Milestone/Event/Activity**
2 October 2006	Project Commenced
4 October	Project officer Scott Frazier and GIS Specialist Elizabeth Cook met at NRCS State Office for introductory look at WRP spatial dataset
12 October	WRP Analysis Project Inception Meeting at MDC Science Center
6 November	SF met Technical Service Providers Steve Young and Rob Leonard at Brookfield, Missouri
6 December	SF met EC at NRCS State Office
17 January 2007	Project Meeting at NRCS State Office
22 January	SF Met SY and RL at Brookfield, Missouri
8 February	WRP Analytical-Strategy Meeting at NRCS State Office
12 March	Project Meeting at NRCS State Office
23 March	SF met Dorothy Butler, Heritage Data Manager, at MDC HQ
4 May	Project conference call
21 May	SF met EC at NRCS State Office
25 May	Project Meeting and conference call at NRCS State Office
23-25 July	SF attended/presented preliminary findings at the Soil and Water Conservation Society Annual Conference, Tampa, Florida
16-November	Last funded day of project

WRP Project Two-Month Summary Report

Introduction

The Missouri WRP Assessment project commenced on 2 October 2006. The two month mark in the nine-month project has just been reached. The inception phase has been concerned with meeting administrative obligations, gearing up (researching background, obtaining software and data, bolstering skills and making contacts) and preliminary assessment of the dataset. To a lesser extent, some effort has been expended toward design analysis.

Installation of Project Officer

The project officer, Scott Frazier, was selected as research specialist for the position. He relocated from Warrensburg Missouri to Columbia during the inception phase. This transition from commuting to relocation now provides for increased (extended) input to the project.

Meetings

There have been three main meetings during this initial phase of the project as summarized below.

- Meeting at NRCS (Columbia) to view and obtain dataset (4 October)
- Project Inception meeting at Missouri Department of Conservation (Columbia), (12 October)
- Meeting at Brookfield, MO to meet the Technical Service Providers (TSP) who monitor Missouri's WRP sites (6 November)

A further meeting to at another WRP database at NRCS was requested during the period but did not eventuate. It is likely this meeting will take place during the 1st week of December.

In addition, one-on-one meetings were held with two graduate students working on WRP-related studies (Kevin O'Donnell, 6 October, and Doreen Mengel, 24 October) during this period.

Persons Met in Connection with the Project

Elizabeth Cook (NRCS)	Dale Humburg (MDC)
Kevin Dacey (MDC)	Rob Leonard (TSP)
Harold Deckerd (NRCS)	Doreen Mengel (UMC)
Chris Hamilton (NRCS)	Kevin O'Donnell (UMC)
Michael Headrick (UMC)	Mike Roell (MDC)
Mickey Heitmeyer (UMC-GML)	Steve Young (TSP)

Other Persons Contacted in Connection with the Project

Dennis Figg (MDC)
Doug Helmers (NRCS)
Timothy Nigh (MDC)
Charles Rewa (NRCS)
Larry Vangilder (MDC)

Field trip

A proposed field trip to a WRP site(s) in Moniteau County with TSP Steve Young was cancelled by the TSP. It will be rescheduled**.**

Provision of Computer and GIS Software

A laptop computer was received for the project on late 13 October. ArcGIS software became functional on 17 October.

Data Assessment

The major effort put forth in the project thus far has been toward assessing the dataset as a basis toward designing and implementing analyses. In order to assess a dataset one must first become familiar with it. The dataset is primarily a GIS system with supplementary attribute data recorded. The project officer has benefited from previous experience with GIS projects and software so that basic spatial concepts were already understood at the outset. Nevertheless as a first time user of ArcGIS (including precursors), time has been allocated to learning the software and this continues. The aforementioned attribute data contain a large number of coded and free-text fields (across several DBF databases) that constitute a potential wealth of information data to be mined under the project (Elizabeth Cook, pers. comm.). The project officer is well versed in this type of data manipulation.

The first step in assessment of a dataset is to study metadata or "information on the data", e.g. what kind of data were collected, what are the parameters of the data, how are data interrelated?, etc. Metadata can be highly structured with strict protocols for recording. But in a general sense, there is a need to know something of the origin, structure and content of data before it can be analyzed. In the case of the WRP dataset, most metadata are undocumented. Therefore in the course of looking at the individual databases that make up the dataset, quite some effort has been devoted to establishing rudimentary metadata while assessing those databases. This has not yet yielded formal metadata structures, but has been undertaken to facilitate a rapid assessment of the databases. This assessment is being undertaken in a systematic fashion, one database at a time.

On a few occasions datasets received have been problematic, either corrupted or incomplete and therefore not readable within the GIS system. This has been followed up during the period to resolve particular problems. Functional databases have revealed numerous anomalies (e.g. sporadic unconventional use of specific data fields) as well as unequivocal entry errors (e.g. species names). These are being resolved as is possible and systematically documented for, among other purposes, future resolution. The extent to which these possible problems may actually impact negatively on analyses has not been assessed. The results of these initial integrity analyses are being periodically shared with Elizabeth Cook (NRCS) and/or Steve Young/Rob Leonard (TSPs) with a view to understanding data (structures and content) and/or resolution of any real problems. This work continues apace, and is necessary to provide an environment for credible in-depth analyses.

Design of Analyses

At the inception meeting it was noted that it would be more meaningful to analyze the Missouri WRP data in a stratified way. Mickey Heitmeyer and others have been contacted toward designating a basic system to use for this purpose and M. Heitmeyer has suggested using the ecological classification "Nigh, T.A., Schroeder, W.A., 2002. Atlas of Missouri Ecoregions. Missouri Department of Conservation" as a basis for stratifying the WRP analysis. It took quite some time and effort to obtain both the hardcopy and (functional) digital versions of this classification. M. Heitmeyer is in the process providing a second overlaying layer comprised of a geomorphology GIS layer produced by Roger Saucier 1994. This combination should allow for correct sorting of SE Missouri sites. Information for similar stratification for the Missouri River and NW/NC Missouri sites should be sent shortly.

Another imperative analysis called for in the aforementioned meeting was the derivation of so-called *silver bullets* from the Missouri WRP dataset. These would constitute flagship indicators of the importance/success of the WRP program. As was recognized at the time, a period of intense data management (familiarization/mining/analysis) is needed in order to effect this. And derivation of these key selling points remains a top priority.

Constraints

It is two months into the project and certain constraints have become apparent during the inception period. There were a few logistical delays and delays brought on by administrative obligations. In any study with new people there is a period of familiarization required, and the existence of a learning curve is not an unexpected constraint. Data previously collected and entered, but later scrutinized for analysis will undoubtedly precipitate questions. This should be expected to a certain extent by all parties. The absence of most metadata has been somewhat of a constraint for a new analyst. And the apparent absence of a data-checking mechanism might lead to a recommendation already coming out of this project. Busy hectic schedules no doubt impact on turn around times for requested or agreed input. Recognition of the effect this might have on specific aspects of the suite of analyses envisioned in the project is important. However, at this early stage, delays of this nature have not been terribly detrimental because effort has necessarily been spent on shoring up the foundation of the analyses. The project is now poised to make increasing progress assuming potential problems identified in the initial screening are not significant and/or are easily resolvable.

Prepared by S. Frazier
4 December 2006

ANNEX 2

SUPPLEMENTARY PROJECT DOCUMENTATION

Missouri WRP Analysis Project

CLIP METHOD

To *clip* the Missouri WRP sites layer for one of the main divisions or "Sections" (in this example, the Central Dissected Till Plains).

[Create the Map to use]
Add the following layers:
wrp_a_mo.shp (all Missouri WRP sites January 2007; 825 unique sites)
or
plan_3yrall.shp (Missouri's 594 monitored WRP sites)
ecslta_Dissolve.shp (Missouri's ecological sections)

[Create the *Clip* feature]
choose Selection from the main menu
choose Set Selectable Layers
tick the **MO ecological sections** layer; *unselect* all other layers
click Close
select the **Central Dissected Till Plains** section polygon with the pointer tool
right-click on the **MO sections** layer in the table of contents
choose Selection from the context menu
choose Create Layer from Selected Features
(the layer is added to the top of the table of contents)
right-click on the new layer (just appearing at the top of the table of contents)
choose Properties from the context menu
choose the General tab from the layer properties window
rename the layer name, e.g. **CDTP section selection**
turn off the **MO sections** layer and drag it to the bottom of the table of contents

This **CDTP section selection** is the "input feature" when running the Geoprocessing | Clip procedure. The selection remains linked to the shapefile **ecslta_Dissolve.shp**.

[Use the *Clip* feature for monitored sites]
choose Tools from the main menu
choose Geoprocessing
choose Clip from the ArcToolbox window
choose Open Tool
choose **plan_3yrall.shp** from the Input Features ("features to be clipped") drop
down list in the Clip window

ANNEX 3

SUPPLEMENTARY PROJECT DOCUMENTATION

Missouri WRP Analysis Project

MISSOURI WRP SPECIES ANALYSES

Table of Contents

Missouri WRP Species Analysis
Annex 3: Methods & Meta Information

Steps used to develop the dictionary of Missouri plants

1. Use the PLANTS (national) database[12] to perform a Missouri state sort
2. Select a printer-friendly output
3. Right click, Select All and copy to clipboard
4. Paste clipboard into Excel ****NOTE: Excel converted the species codes FEBR4 & FEBR7 to 4-Feb and 7-Feb automatically!!!
5. Remove non-field header text
6. Save as *.CSV format ****NOTE: the symbol "x" (a specialized -- very small-- "x" denoting [?] "cross") translates as the character "?" in this operation/format.
7. Rename to *.TXT
8. Create a database in FoxPro: MOPLANTS.DBF (12,599 records)
9. Append from the *.TXT file ****NOTE: Using FoxPro replaced the "?" to a "α" (arbitrary character); then use FIXSPECI.PRG[13], the next steps:
10. Copy to a new database and used: MOPLNTS1.DBF (as a safety measure)
11. Insert pipes ("|") as markers for a new field after the root scientific name, to hold additional information such as naming authority and history.
12. Set a filter to select only species entries that have common names present
13. Copy to a new database: MOPLANTZ.DBF (4526 records)
14. Create a delimited text file MOPLNTZ1.TXT (to import later in this process).
15. Modify MOPLANTZ.DBF by adding a new field to hold all “extra information” currently in the field SCI_NAME.
16. Move “extra information” into the new field leaving the field SCI_NAME to hold the root scientific name only.
17. Import MOPLNTZ1.TXT into newly structured MOPLNTZ3.DBF, the base Dictionary of Plants for the WRP Analysis Project.

****NOTE: other international characters do not translate properly

[12]The PLANTS Database (http://plants.usda.gov/) includes information on the vascular and nonvascular plants of the United States and its territories. It includes checklists, species abstracts, distributional data, crop information, plants symbols, growth data, references and a variety of other plant information.

[13] This and other programs developed for this project are found in the CD archive.

Missouri WRP Species Analysis

Annex 3: Methods & Meta Information: Data Dictionaries

MISSOURI PLANT DATABASES DEVELOPED AS SPECIES DICTIONARIES FOR WRP MONITORING

NAME	RECORDS	COMMENTS
MOPLANTS.DBF	**12599**	This is a **parent database** created from a printer-friendly output of Missouri Plants from **http://plants.usda.gov/checklist.html**.
MOPLNTZ3.DBF	**4526**	This database was derived from MOPLANTS.DBF after going through several intermediate forms. It contains records for all Missouri plants but records without Common names have been removed as a proxy for removal of all synonyms. Furthermore all information about variant, subspecies, author, priority, year etc has been removed from the field SCI_NAME (and has been put into a new field EXTRAINFO) to facilitate comparison with WRP databases containing plant species records. This database serves as a **SPECIES dictionary**.
DICVEG1.DBF	**3657**	The unique names (SCI_NAME) from MOPLNTZ3.DBF copied to Species1, Species2 and Species3 fields in this new database to use in checking the species entries in the same fields in the Monitored Easement polygons data file COMBPLAN.DBF.
MOWETPLA.DBF	**1750**	This is a **parent database** created from an output of Missouri Wetland Status Indicator Plants from **http://plants.usda.gov/wetland.html**
MOWETPL4.DBF	**1509**	This database was ultimately derived from MOWETPLA.DBF after going through several intermediate forms. It contains records for all Missouri Wetland Status Indicator plants excluding synonyms (records without Common names have removed as a proxy for removal of all synonyms). Furthermore all variant and subspecies information has been removed from the field SCI_NAME (and has been put into the field EXTRAINFO) to facilitate comparison with WRP databases containing plant species records. This database serves as a **SPECIES dictionary**.
ST&EpInt.DBF/.xls	**113**	This contains Missouri plants with any one or more of the following of statuses: federal status (Endangered, Threatened), state status (Endangered) and/or state rank (S1, S2 or S3 state-ranked elements, including those assigned a range of these "SRANKs" that includes at least one of these values). Any species with a Global Rank (GRANK) were for all practical purposes also SRANK species, and were included by default (but not tagged as GRANK species). The source of status data is the MONHP "Heritage dataset" obtained under MOU with MDC by this project. This database serves as a **SPECIES dictionary**.

Missouri WRP Species Analysis
Annex 3: Methods & Meta Information

Heritage Database Codes

TERMS AND DEFINITIONS

FEDERAL STATUS

The federal status is derived from the provisions of the Endangered Species Act of 1973, as amended, which is administered by the U.S. Fish and Wildlife Service. Passage of the Endangered Species Act of 1973 gave the United States one of the most far-reaching laws ever enacted by any country to prevent the extinction of imperiled animals and plants. Protecting endangered and threatened species and restoring them to the point where their existence is no longer jeopardized is the primary objective of the Fish and Wildlife Service's Endangered Species Program.

E: Endangered:
: Any species which is in danger of extinction throughout all or a significant portion of its range.

T: Threatened:
: Any species which is likely to become endangered within the foreseeable future.

C: Candidate:
: Plants or animals which the Service is reviewing for possible addition to the list of endangered and threatened species.

PE: Proposed Endangered:
: Species officially proposed for listing as endangered; final ruling not yet made.

PT: Proposed Threatened:
: Species officially proposed for listing as threatened; final ruling not yet made.

STATE STATUS

Rule 3CSR10-4.111 of the Wildlife Code of Missouri and certain state statutes apply to state Code listed species.

E: "Endangered":
: Determined by the Department of Conservation under constitutional authority.

GLOBAL RANK

A numeric rank (G1 through G5) of relative endangerment based primarily on the number of occurrences of the Element (i.e., species, subspecies, or variety) globally. Other factors in addition to the number of occurrences are considered when assigning a rank, so the numbers of occurrences suggested for each numeric rank below are not absolute guidelines.

G1: Critically Imperiled:
    Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. Typically 5 or fewer occurrences or very few remaining individuals (<1,000) or acres (<2000) or linear miles.

G2: Imperiled:
    Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction or elimination. Typically 6 to 20 occurrences or few remaining individuals (1,000 to 3,000) or acres (2,000 to 10,000) or linear miles (10 to 50).

G3: Vulnerable:
    Vulnerable globally either because very rare and local throughout its range, found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extinction or elimination. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals.

G4: Apparently Secure:
    Uncommon but not rare (although it may be rare in parts of its range, particularly on the periphery), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long-term concern. Typically more than 100 occurrences and more than 10,000 individuals.

G5: Secure:
    Common; widespread and abundant (although it may be rare in parts of its range, particularly on the periphery). Not vulnerable in most of its range. Typically with considerably more than 100 occurrences and more than 10.000 individuals.

G#G#: Range Rank:
    A numeric range rank (e.g., G2G3) is used to indicate uncertainty about the exact status of a taxon. Ranges cannot skip more than one rank (e.g., GU should be used rather than G1G4).

GNR: Not Ranked:
    Status has not been assessed.

GU: Unrankable:
    Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. Note: Whenever possible, the most likely rank is assigned and the question mark qualifier is added (e.g., G2?) to express uncertainty, or a range rank (e.g., G2G3) is used to delineate the limits (range) of uncertainty.

GH: Possibly Extinct/Extirpated:
    Known from only historical occurrences, but may nevertheless still be extant; further searching needed.

GX: Presumed Extinct:
    Believed to be extinct throughout its range. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.

SUBRANK:

T: Taxonomic Subdivision:
Rank applies to a subspecies or variety.

QUALIFIERS:

?: Inexact Numeric Rank:
Denotes inexact numeric rank. (The ? is not used in combination with range ranks.)

Q: Questionable Taxonomy:
Distinctiveness of this entity as a taxon or community at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, inclusion of this taxon in another taxon, or inclusion of this community within another community, with the resulting Element having a lower-priority (numerically higher) conservation status rank.

STATE RANK

A numeric rank (S1 through S5) of relative endangerment based primarily on the number of occurrences of the Element (i.e., species, subspecies, or variety) within the state. Other factors considered when assigning a rank include: abundance, population trends, distribution, number of protected sites, degree of threat, suitable habitat trends, level of survey effort and life history. Thus, the number of occurrences suggested for each numeric rank below are not absolute guidelines. Missouri species of conservation concern typically do not fall within the range of S4-S5.

S1: Critically Imperiled:
Critically imperiled in the nation or state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state. Typically 5 or fewer occurrences or very few remaining individuals (<1,000).

S2: Imperiled:
Imperiled in the nation or state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the nation or state (1,000 to 3,000).

S3: Vulnerable:
Vulnerable in the nation or state either because rare and uncommon, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals.

S4: Apparently Secure:
Uncommon but not rare, and usually widespread in the nation or state. Possible cause of long-term concern. Usually more than 100 occurrences and more than 10,000 individuals.

S5: Secure:

Common, widespread, and abundant in the nation or state. Essentially ineradicable under present conditions. Typically with considerably more than 100 occurrences and more than 10,000 individuals.

S#S#: Range Rank:

A numeric range rank (e.g., S2S3) is used to indicate the range of uncertainty about the exact status of the Element. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4).

S?: Unranked:

Species is not yet ranked in the state.

SU: Unrankable:

Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

SE: Exotic:

An exotic established in the state; may be native in nearby regions (e.g., house finch or catalpa in eastern U.S.)

SA: Accidental/Nonregular:

Accidental or casual in the state (i.e., infrequent and outside usual range).

SP: Potential:

Potentially occurring in the state but no occurrences reported.

SR: Reported:

Element reported in the state but without persuasive documentation which would provide a basis for either accepting or rejecting (e.g., misidentified specimen) the report.

SRF: Reported Falsely:

Element erroneously reported in the state and the error has persisted in the literature.

SH: Historical:

Element occurred historically in the state (with expectation that it may be rediscovered). Perhaps having not been verified in the past 20 years, and suspected to be still extant.

SX: Extirpated:

Element is believed to be extirpated from the state.

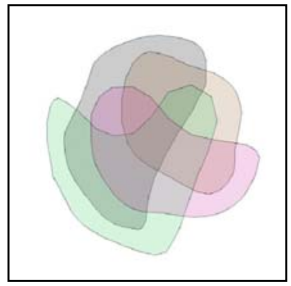
QUALIFIERS:

?: Inexact or Uncertain:

Denotes inexact or uncertain numeric rank. (The ? qualifies the character immediately preceding it in the SRANK. The ? is not used in combination with range ranks.)

Provided by: *Missouri Natural Heritage Program. Missouri Department of Conservation. Jefferson City, Missouri.*

WRP Site Proximity to T&E Species/(Community Ranges)



Research Topic: *To what extent do Missouri's* WRP *easements provide an implied POTENTIAL contribution to the maintenance and protection of threatened and endangered species/communities by virtue of their proximity to T&E species/community ranges?*

[Observation records compiled by the Missouri Department of Conservation - Missouri Natural Heritage Program – MONHP*]*

Main Questions:

In priority order

1). How may WRP sites *a*) *intersect* T&E species ranges [polygons] or *b*) *contain* T&E species observations [points]?

2). How many T&E species *a*) ranges intersect WRP sites or *b*) have been observed in WRP sites?

"The MDC point shapefiles do not represent the entire spatial extent of any Heritage record; they are intended to be used in small-scale (e.g., entire state) maps. A single point may represent one or more larger, irregularly shaped or disjunct polygons (e.g. aquatic communities can extend along the whole reach of a stream and across several counties but will be represented as a single point). The biology of a species is not reflected in a point-coverage (e.g., two fish occurrences may be mapped at collection sites one mile apart with suitable habitat between, or a gray bat may travel to and forage up and down a stretch of stream." (Missouri Natural Heritage Program GIS Shapefile Fact Sheet.doc)

Relevant Datasets:

1. WRP SITES: wrp_a_mo.shp
This is the NRCS master file of WRP sites as of 19 January 2007.
930 easement records; 119,437 acres. Unique records: 825 easements
THIS IS THE PRIMARY WRP DATASET IN THESE ANALYSES
2. HERITAGE "MONHP" POINTS: herallpt.shp
This is the MDC file of all Heritage EOs, one point per polygon – one EO may be represented by one-to-many points.
25,028 EO-point records

3. HERITAGE "MONHP" POLYGONS: hertpoly.shp
This is the MDC file of all Heritage POLYGON e*lement* o*bservations* (EOs).

"Only a polygonal spatial layer can reflect a species' true *sphere of influence*[14]"

20,768 EO-polygon records
FOR POLYGON EO RECORDS, Select all records that INTERSECT

4. NRCS RENDERING OF HERITAGE "MONHP" POINTS
These MDC Heritage data relate to the *Missouri Species and Communities of Conservation Concern Checklist*. The individual shapefiles correspond to the columns of the Missouri T&E Species Planning Matrix. They have been buffered to diameters which are based on the particular group represented. These NRCS datasets are coarse, using buffered polygons NOT points.

bats_a_mo.shp
birds_a_mo.shp
fishdb_a_mo.shp *(used to make this generalization mentioned below)*
fish-crustaceans-mollusks_a_mo.shp *(spatially generalized to the watershed of the immediate stream segment where they were collected)*
mammals_a_mo.shp
plants_a_mo.shp
reptiles-amphibians-insects_a_mo.shp
And
communities_a_mo.shp

---

[14] Missouri Natural Heritage Program GIS Shapefile Fact Sheet.doc

Ancillary Dataset:

5. HERITAGE "MONHP" EO POINTS: hertpt.shp
This is the MDC file of Heritage EOs @ one point per EO.
20,768 EO-point records
Presently excluded in lieu of the other point-dataset.

WRP Site Proximity to T&E Species/(Community Ranges)

ANALYSIS 1 - Intersection of MO WRP easements (polygons) and MO T&E species/community ranges (polygons)

Parent Map: **wrp&poly.mxd**

Datasets: \WorkCopy**wrp_a_mo.shp** (930 non-unique polygon records covering 825 easements)
And
\MDC_MONHP**hertpoly.shp** (20,768 EO polygon records)

Technique: Geoprocessing - Intersect
Step Sequence:
Open **wrp&poly.mxd**
Tools
Geoprocessing
Intersect
Open tool
Input features:
wrp_a_mo
hertpoly
Output feature class: **wrp_Intersect1_hertpoly.shp**
R/C on **wrp_Intersect1_hertpoly**
Open attribute table
8079 *gross intersections*

Preliminary Result:

8079 (2171 unique) intersections resulted from the intersection of (500 unique) easements (wrp_a_mo.shp) and (284 unique) ranked species/community EO-polygon range records (hertpoly.shp).

This result is preliminary because we are interested in Threatened and Endangered species *as defined in the following box*, not *all* ranked species. NOTE however that 77.5% of these records have an EORANK of “H” or “H?” = “historical.” [This is not to be confused with the state imperilment (SRANK) code “SH” = “historical”].

Within the MONHP dataset (acquired February 2007), species (and communities) have been assigned values of imperilment from the categories found below.

For the purposes of these WRP project analyses, "Threatened & Endangered" species (or communities) *are considered to be* those which are subject to the following qualifications.

Within the existing MONHP dataset, all and **only S1, S2 or S3 species** (including those assigned a range of SRANK values that includes one of these values) are included. SH species (see below) are NOT included. In terms of Global "GRANK" species, the following clarifications apply. (Currently) All G1 species (including those that may be assigned a range value that includes a G1 value) are also S1 species (n=50). All G2 species (including aforementioned "range values") which are not SH species (see below) equate to S1 or S2 species and are thus included (n=98 or n=19, respectively; ALL n=117). All G3 species (including aforementioned "range values") which are not SH species equate to S1 (n=331), S2 (n=153) or S3 (n=566) species (ALL n=1050).

CATEGORIES OF IMPERILMENT

S1: Critically Imperiled:

Critically imperiled in the nation or state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state

S2: Imperiled:

Imperiled in the nation or state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the nation or state.

S3: Vulnerable:

Vulnerable in the nation or state either because rare and uncommon, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation.

SH: Historical:

Element occurred historically in the state (with expectation that it may be rediscovered).

G1: Critically Imperiled:

Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction.

G2: Imperiled:

Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction or elimination.

G3: Vulnerable:

Vulnerable globally either because very rare and local throughout its range, found only in a restricted range (even if abundant at some

The intermediate product (dataset) **wrp_Intersect1_hertpoly.shp** can provide further (refined) answers.

A. To determine T&E species/communities as defined above
COPY **wrp_Intersect1_hertpoly.dbf** to **WRP&POLY.dbf**
USE **WRP&POLY.dbf**
SET FILTER TO 'S1'$SRANK OR 'S2'$SRANK OR 'S3'$SRANK
COPY TO **WRP&POL1.dbf**
6727 intersections

Alternatively

In ArcGIS, using an equivalent but much longer filter string of every combination present, i.e.

"SRANK" = 'S1' OR "SRANK" = 'S1?' OR "SRANK" = 'S1S2' OR
"SRANK" = 'S1S3' OR "SRANK" = 'S2' OR "SRANK" = 'S2?' OR
"SRANK" = 'S2S3' OR "SRANK" = 'S3' OR "SRANK" = 'S3?' OR
"SRANK" = 'S3S4'

the result is the same: 6727. This can be saved as a map layer:
R/C on **wrp_Intersect1_hertpoly**
Data
Export data
Selected features
[accept default coordinate system: "this layer's source data"]
Output shapefile or feature class
C:\WRPDB\WorkCopy**wrp_intersect2_hertpoly.shp**
OK
Do you want to add the exported data to the map as a layer?
Yes
R/C on **wrp_intersect2_hertpoly**
Open attribute table
6727 intersections

Preliminary Result:
Either way, this means that 6727 out of the original 8079 intersections of species/community EO-polygon records (hertpoly.shp) and easement polygon records (wrp_a_mo.shp) involve **S1**, **S2** or **S3** ranked T&E species/ communities. NOTE however that 76.3% of these records have an EORANK of "H" or "H?" = "historical" while 17.6 % of these records have

an EORANK of "E" = "extant." [Based on surrogate dataset WRP&POL1.DBF].

B. To determine unique easements with T&E species/communities

USE **WRP&POL1** (6727 *intersections)*
INDEX ON AGREE_NUM+LEFT(SNAME,45) TO XXX UNIQ
-OR-
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT

Preliminary Result:
1766 unique T&E species/community range-WRP polygon intersects

We still need to determine the unique number of easements, as opposed to polygon *records*, which intersect. We can obtain this by using the following command:

INDEX ON AGREE_NUM TO XXX UNIQ
COUNT

We can also determine the unique number of T&E species/communities involved by using this command:

INDEX ON ELCODE TO XXX UNIQ
COUNT

Results: **439** WRP easements intersected **217** MONHP T&E species/community ranges *OR* **431** easements/**208** *species ranges*

What this does not tell us: *Do the intersecting easements have* habitats *that would support the species in question?*

There are no habitat data in the WRP dataset used in above analysis (wrp_a_mo.shp does not include habitat information). Since fish obviously require water, and riverine and lacustrine habitats are in practice not recorded for most Missouri WRP easements (–there are just 3 freshwater open-water four-character Cowardin codes in use in the *monitoring* dataset), the analysis could me modified to **exclude** (filter out) **all fish records** so as to not inadvertently attribute them to a non-aquatic (non open water) habitat. In this case, the result would be:

Results: **417** WRP easements intersected **191** MONHP T&E species/ community ranges***** *OR* **396** easements/**182** *species ranges****

*excluding all fish records

WRP Site Proximity to T&E Species/(Community Ranges)

ANALYSIS 2 - Intersection of 6727 MO T&E* species/community records with WRP sites (polygons) **and** 3728 Monitored WRP Cowardin polygons

Since there are no habitat data in the WRP dataset used in the above analysis (wrp_a_mo.shp), an intersection with *monitoring* data was effected after the fact, as follows:

Parent Map: **wrp&poly&cowardin.mxd**

Datasets: \WorkCopy**wrp_Intersect2_hertpoly.shp** (6727 T&E* species/community records intersecting WRP sites)
And
\WorkCopy\20070413**plan_3yrall.shp** (3728 monitored WRP polygon records)

* = Filtered for S1 and/or S2 and/or S3 ranked species

Technique: Geoprocessing - Intersect
Step Sequence:
Open **wrp&poly&cowardin.mxd**
Tools
Geoprocessing
Intersect
Open tool
Input features:
wrp_Intersect2_hertpoly
plan_3yrall
Output feature class:
C:\WRPDB\WorkCopy**WRP_MONHP_COWARDIN.shp**
R/C on **WRP_MONHP_COWARDIN.shp**
Open attribute table
26,313 species/community records intersecting WRP easement records
Selection
Select by attributes
Layer: **WRP_MONHP_COWARDIN**

Method: Create a new selection
SELECT * FROM **WRP_MONHP_COWARDIN** WHERE:
"FOURCHACOD" <>' '
Verify
OK
Apply
Close
R/C on **WRP_MONHP_COWARDIN**
Open attribute table
Records (23,404 out of 26,313 Selected)
R/C on **WRP_MONHP_COWARDIN**
Data
Export data
Selected features
[Accept the default coordinate system: "this layer's source data"]
Output shapefile or feature class C:\WRPDB\WorkCopy**WRPOLHAB.shp**
OK
Do you want to add the exported data to the map as a layer?
Yes
R/C on **WRPOLHAB.shp**
Open attribute table
23,404 T&E species/(community) EO Polygon intersecting monitored WRP polygons

TO DETERMINE UNIQUE RECORDS:

USE **WRPOLHAB.DBF**
INDEX ON AGREE_NUM+ELCODE+FOURCHACOD TO XXX UNIQ
COUNT=**3,020** Unique easement-T&E species/community-habitat polygon combinations
COPY TO **WRPOLHB1.DBF**
USE **WRPOLHB1.DBF**
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**1312** unique T&E species/community –WRP monitored-polygon intersects
INDEX ON ELCODE+FOURCHACOD TO XXX UNIQ
COUNT=**828** Unique range-habitat combination "polygons" within the intersection
INDEX ON AGREE_NUM+FOURCHACOD TO XXX UNIQ

COUNT=**779** Unique easement-habitat combination "polygons" within the intersection
INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**320** Unique easements within the intersection
INDEX ON ELCODE TO XXX UNIQ
COUNT=**193** Unique T&E species/community ranges
CLOSE ALL
CLEAR ALL
USE **WRPOLHB1.DBF**
SET FILTER TO ELCODE#'AF' OR (ELCODE='AF' AND FOURCHACOD='POWZ')
COUNT=**2,710** Unique easement-habitat combinations within the intersection (*including only those FISH range records that overlap with "POWZ" palustrine open water habitat records*)
COPY TO **WRPOLHB2.DBF**

USE **WRPOLHB2.DBF**
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**1147** unique T&E species/community –WRP monitored-polygon intersects (*including only those FISH range records that overlap with "POWZ" palustrine open water habitat records*)
INDEX ON AGREE_NUM+FOURCHACOD TO XXX UNIQ
COUNT=**748** Unique easement-habitat combinations "polygons" within the intersection (*including only those FISH range records that overlap with "POWZ" palustrine open water habitat records*)
INDEX ON ELCODE+FOURCHACOD TO XXX UNIQ
COUNT=**740** Unique range-habitat combination "polygons" within the intersection (*including only those FISH range records that overlap with "POWZ" palustrine open water habitat records*)
INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**305** Unique easements within the intersection (*including only those FISH range records that overlap with "POWZ" palustrine open water habitat records*)
INDEX ON ELCODE TO XXX UNIQ
COUNT=**183** Unique T&E species/community ranges (*including only those FISH range records that overlap with "POWZ" palustrine open water habitat records*)

USE **WRPOLHAB.DBF**
SET FILTER TO ELCODE="AF" AND FOURCHACOD= "POWZ"

COPY TO **WRPTFISH.DBF** (288 RECORDS)
USE **WRPTFISH.DBF**
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**68** T&E Fish ranges in palustrine open water habitats ("POWZ") of easements within the intersection
INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**23** Unique easements with T&E Fish ranges in palustrine open water habitats ("POWZ") within the intersection
INDEX ON ELCODE TO XXX UNIQ
COUNT=**14** UNIQUE T&E Fish ranges in palustrine open water habitats ("POWZ") of easements within the intersection

Results: **320** WRP easement sites intersect **193** distinct MONHP T&E species/community ranges

305 easements and **183** T&E species/community ranges intersect (*including only those FISH range records that overlap with "POWZ" palustrine open water habitat records*)

EOs are rated by EORANK and within this dataset, 85.6% of these records have an EORANK of "H" or "H?" = "historical."

WRP Site Proximity to T&E Species/(Community Ranges)

ANALYSIS 3 - Intersection of 594 MO WRP easements (3728 polygons) and MO T&E species/community Ranges (polygons)

Parent Map: **MONHP&WRP_monitored.mxd**

Datasets:

\WorkCopy\20070413**plan_3yrall.shp** (3728 monitored WRP polygon records)

And

\MDC_MONHP**hertpoly.shp** (20,768 EO polygon records)

Technique: Geoprocessing - Intersect

Step Sequence:

Open **MONHP&WRP_monitored.mxd**
Tools
Geoprocessing
Intersect
Open tool
Input features:
plan_3yrall
hertpoly
Output feature class:
C:\WRPDB\WorkCopy**plan_intersect_hertpoly.shp**
R/C on **plan_intersect_hertpoly.shp**
Open attribute table
29,092 species/community EO-polygon range records
Selection
Select by attributes
Layer: **plan_intersect_hertpoly**
Method: Create a new selection
SELECT * FROM **plan_intersect_hertpoly** WHERE:
"SRANK" = 'S1' OR "SRANK" = 'S1?' OR "SRANK" = 'S1S2' OR
"SRANK" = 'S1S3' OR "SRANK" = 'S2' OR "SRANK" = 'S2?' OR
"SRANK" = 'S2S3' OR "SRANK" = 'S3' OR "SRANK" = 'S3?' OR
"SRANK" = 'S3S4'
Verify
OK
Apply
Close
R/C on **plan_intersect_hertpoly**
Open attribute table
Records (24,389 out of 29,092 Selected)
R/C on **plan_intersect_hertpoly**
Data
Export data
Selected features
[Accept the default coordinate system: "this layer's source data"]
Output shapefile or feature class
C:\WRPDB\WorkCopy**plan_intersect_hertpoly_S123.shp**
OK
Do you want to add the exported data to the map as a layer?
Yes
R/C on **plan_intersect_hertpoly_S123**

Open attribute table
24,389 MONHP T&E species/community range record intersections

COPY **plan_intersect_hertpoly_S123.dbf** to **planpoly.dbf**
USE **planpoly**
INDEX ON AGREE_NUM+LEFT(SNAME,45) TO XXX UNIQ
-OR-
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT
Preliminary Result:
1325 unique T&E species/community –WRP monitored-polygon intersects

We still need to determine the unique number of easements, as opposed to polygon *records*, which intersect. We can obtain this by using the following command:

INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**322** Unique easements within the intersection (including *all* FISH records)

We can also determine the unique number of T&E species/communities involved by using this command:

INDEX ON ELCODE TO XXX UNIQ
COUNT=**193** Unique T&E species/community ranges (including *all* FISH records)

TO DETERMINE UNIQUE RECORDS:

USE **PLANPOLY**
INDEX ON AGREE_NUM+ELCODE+FOURCHACOD TO XXX UNIQ
COUNT=**3,396** Unique easement-T&E species/Community-habitat polygon combinations
COPY TO **PLANPOL1**

USE **PLANPOL1** (**3,396** records)
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**1325** unique T&E species/community –WRP monitored-polygon intersects
INDEX ON ELCODE+FOURCHACOD TO XXX UNIQ

COUNT=**947** Unique range-habitat combination “polygons” within the intersection
INDEX ON AGREE_NUM+FOURCHACOD TO XXX UNIQ
COUNT=**862** Unique easement-habitat combination “polygons” within the intersection
INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**322** Unique easements within the intersection
INDEX ON ELCODE TO XXX UNIQ
COUNT=**193** Unique T&E species/community ranges

USE **PLANPOL1** (**3,396** records)
SET FILTER TO ELCODE#'AF' OR (ELCODE='AF' AND FOURCHACOD='POWZ')
COUNT=**3,042** Unique easement-habitat combinations within the intersection (*including only those FISH range records that overlap with “POWZ” palustrine open water habitat records*)
COPY TO **PLANPOL2**

USE **PLANPOL2**
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**1151** unique T&E species/community –WRP monitored-polygon intersects (*including only those FISH range records that overlap with “POWZ” palustrine open water habitat records*)
INDEX ON ELCODE+FOURCHACOD TO XXX UNIQ
COUNT=**844** Unique range-habitat combination “polygons” within the intersection (*including only those FISH range records that overlap with “POWZ” palustrine open water habitat records*)
INDEX ON AGREE_NUM+FOURCHACOD TO XXX UNIQ
COUNT=**826** Unique easement-habitat combinations “polygons” within the intersection (*including only those FISH range records that overlap with “POWZ” palustrine open water habitat records*)
INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**307** Unique easements within the intersection (*including only those FISH range records that overlap with “POWZ” palustrine open water habitat records*)
INDEX ON ELCODE TO XXX UNIQ
COUNT=**183** Unique T&E species/community ranges (*including only those FISH range records that overlap with “POWZ” palustrine open water habitat records*)

USE **PLANPOL1**
INDEX ON AGREE_NUM+ELCODE+FOURCHACOD TO XXX UNIQ
SET FILTER TO ELCODE="AF" AND FOURCHACOD= "POWZ"
COUNT=**68** T&E Fish ranges in palustrine open water habitats ("POWZ") of easements within the intersection
COPY TO WRPTFSH1.DBF
USE WRPTFSH1.DBF
INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**23** Unique Easements with T&E Fish ranges in palustrine open water habitats ("POWZ") within the intersection
INDEX ON ELCODE TO XXX UNIQ
COUNT=**14** UNIQUE T&E Fish ranges in palustrine open water habitats ("POWZ") of easements within the intersection

Results: **322** WRP easement sites intersect **193** distinct MONHP T&E species/community ranges *OR* **316** easements/**186** *species ranges*

307 WRP easement sites intersect **183** distinct MONHP T&E species/community ranges (*including only those FISH range records that overlap with "POWZ" palustrine open water habitat records*)

EOs are rated by EORANK and within this dataset, 86.3% of these records have an EORANK of "H" or "H?" = "historical."

WRP Site Proximity to T&E Species/(Community Ranges)

ANALYSIS 4 - T&E Species/community Element Observations (points) inside WRP easements (polygons)

Parent Map: **MONHP_points&WRP.mxd**

Datasets: \WorkCopy**wrp_a_mo.shp** (930 non-unique easement records)
And
\MDC_MONHP**herallpt.shp** (25,028 EO records)

Technique: Geoprocessing - Intersect
Step Sequence:
Open **MONHP_points&WRP.mxd**

Tools
Geoprocessing
Intersect
Open tool
Input features:
wrp_a_mo
herallpt
Output feature class:
C:\WRPDB\WorkCopy**WRP_intersect_EO_points.shp**
R/C on **WRP_intersect_EO_points**
Open attribute table
105 species/community EOs inside WRP easements

Preliminary Result:
This means that 105 species/community EO-point records from herallpt.shp have intersected some number of 930 easement polygon records from the WRP dataset wrp_a_mo.shp.

These results are preliminary for the following reasons.

1). We do not yet know the number of easement polygon records/sites which intersect (contain them), only the gross number of MONHP EO records which intersect (are contained by) them. 2). We are interested in Threatened and Endangered species (as defined in **Analysis 1**), not all species.

[For T&E species]
Selection
Select by attributes
Layer: **WRP_intersect_EO_points**
Method: Create a new selection
SELECT * FROM **WRP_intersect_EO_points** WHERE:
"SRANK" = 'S1' OR "SRANK" = 'S1?' OR "SRANK" = 'S1S2' OR
"SRANK" = 'S1S3' OR "SRANK" = 'S2' OR "SRANK" = 'S2?' OR
"SRANK" = 'S2S3' OR "SRANK" = 'S3' OR "SRANK" = 'S3?' OR
"SRANK" = 'S3S4'
Verify
OK
Apply
Close
R/C on **WRP_intersect_EO_points**

Open attribute table
Records (91 out of 105 Selected)
R/C on **WRP_intersect_EO_points**
Data
Export data
Selected features
[accept default coordinate system: "this layer's source data"]
Output shapefile or feature class C:\WRPDB\WorkCopy\
WRP_intersect_EO_points1.shp
OK
Do you want to add the exported data to the map as a layer?
Yes
R/C on **WRP_intersect_EO_points1**
Open attribute table
91 T&E Species/(Community) EO points

[For easements with T&E species/communities EOs]
COPY **WRP_intersect_EO_points1.dbf** to **WRPoint1.dbf**
USE **WRPoint1.dbf**
INDEX ON AGREE_NUM+LEFT(SNAME,45) TO XXX UNIQ
-OR-
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT
Preliminary Result:
73 unique T&E species/community EO -WRP polygons intersects

We still need to determine the unique number of easements, as opposed to polygon *records*, which intersect. We can obtain this by using the following command:

INDEX ON AGREE_NUM TO XXX UNIQ
COUNT = 41

We can also determine the unique number of T&E species/communities involved by using this command:

INDEX ON ELCODE TO XXX UNIQ
COUNT = 48

Results: **41** WRP easement sites intersect **48** distinct MONHP T&E species/community ranges; **73** unique easement-range intersections *OR* **38** easements/**43** *species ranges*

EOs are rated by EORANK and within this dataset, 51.6% of these records have an EORANK of "E" = "extant."

WRP Site Proximity to T&E Species/(Community Ranges)

NRCS RENDERING OF HERITAGE "MONHP" POINTS
These MDC Heritage data relate to the *Missouri Species and Communities of Conservation Concern Checklist*. The individual shapefiles correspond to the columns of the Missouri T&E Species Planning Matrix. They have been buffered to diameters which are based on the particular group represented. These NRCS datasets are coarse, using buffered polygons NOT points.

bats_a_mo.shp
birds_a_mo.shp
fishdb_a_mo.shp *(used to make this generalization mentioned below)*
fish-crustaceans-mollusks_a_mo.shp *(spatially generalized to the watershed of the immediate stream segment where they were collected)*
mammals_a_mo.shp
plants_a_mo.shp
reptiles-amphibians-insects_a_mo.shp
And
communities_a_mo.shp

Go to WRP Site Proximity to T&E Species Ranges2.doc f**or analyses using these datasets.**

WRP Site Proximity to T&E Species/(Community Ranges)
By Taxonomic Group

ANALYSIS 5A - Intersection of MO WRP easements (polygons) and buffered MO T&E **BAT** species ranges (polygons)

Parent Map: **MONHP_NRCS_BATS&WRP.mxd**

Datasets: \WorkCopy\20070413**plan_3yrall.shp** (3728 monitored WRP polygon records)
And
\NRCS-MONHP**bats_a_mo.shp** (294 EO buffered polygon records for two T&E species: *Myotis grisescens* and *Myotis sodalis*)

-OR-

Datasets: \WorkCopy**wrp_a_mo.shp** (930 non-unique polygon records covering 825 easements recorded through January 2007)
And
\NRCS-MONHP**bats_a_mo.shp** (294 EO buffered polygon records for two T&E species: *Myotis grisescens* and *Myotis sodalis*)

(Since all/both bat species in the dataset are SRANK123, filtering for SRANK was not necessary).

Technique: Select by location - Intersection

Step Sequence A:
Open : **MONHP_NRCS_BATS&WRP.mxd**
Selection
Select by location
Select features from **bats_a_mo**
That intersect **plan_3yrall**
OK
R/C **bats_a_mo**
Open attribute table
Records: 29 out of 294 selected

R/C **bats_a_mo**
Data
Export data
Export selected features
Use the same coordinate system as:
⦿ this layer's source data
Output shapefile or feature class:
C:\WRPDB\WorkCopy**bats_intersect_plan.shp**
(copy this to **BTINPLN.DBF** for future reference)
R/C on **bats_intersect_plan**
Open attribute table

Results: **29** buffered observation records of **2** bat species (as listed above) intersect with some number of monitored easements. A buffered observation record may include more than one easement. Given these qualifications, this method for analysis is not very useful.

Step Sequence B:
Open : **MONHP_NRCS_BATS&WRP.mxd**
Selection
Select by location
Select features from **bats_a_mo**
That intersect **wrp_a_mo**
OK
R/C **bats_a_mo**
Open attribute table
Records: 33 out of 294 selected
R/C **bats_a_mo**
Data
Export data
Export selected features
Use the same coordinate system as:
⦿ this layer's source data
Output shapefile or feature class:
C:\WRPDB\WorkCopy**bats_intersect_wrp.shp**
(copy this to **BTINTWRP.DBF** for future reference)
R/C on **bats_intersect_wrp**
Open attribute table

<u>Results</u>: 33 buffered observation records of **2** bat species (as listed above) intersect with some number of easements. A buffered observation record may include more than one easement. Given these qualifications, this method for analysis is not very useful.

Step Sequence C:
Open : **MONHP_NRCS_BATS&WRP.mxd**
Selection
Select by location
Select features from **wrp_a_mo**
That intersect **bats_a_mo**
OK
R/C **wrp_a_mo**
Open attribute table
Records: 149 out of 930 selected
R/C **wrp_a_mo**
Data
Export data
Export selected features
Use the same coordinate system as:
⦿ this layer's source data
Output shapefile or feature class:
C:\WRPDB\WorkCopy**wrp_intersect_bats.shp**
(copy this to **WRPINBAT.DBF**)
R/C on **wrp_intersect_bats**
Open attribute table
149 *gross intersections*
~~~~~
USE **WRPINBAT.DBF**
INDEX ON AGREE_NUM TO XXX UNIQ
COUNT

**<u>Results</u>: 128** unique easements intersect buffered ranges of at least **one** of **two** SRANK123 bat species.

*Step Sequence D:*
Open : **MONHP_NRCS_BATS&WRP.mxd**
Selection
Select by location
~~~~~

Select features from **plan_3yrall**
That intersect **bats_a_mo**
OK
R/C **plan_3yrall**
Open attribute table
Records: 667 out of 3728 selected
R/C **plan_3yrall**
Data
Export data
Export selected features
Use the same coordinate system as:
⦿ this layer's source data
Output shapefile or feature class:
C:\WRPDB\WorkCopy**plan_intersect_bats.shp**
(copy this to **PLINTBAT.DBF**)
R/C on **plan_intersect_bats**
Open attribute table
667 *gross intersections*
~~~~~
USE **PLINTBAT.DBF**
INDEX ON AGREE_NUM TO XXX UNIQ
COUNT

**Results: 104** unique monitored easements intersect buffered ranges of at least **one** of **two** SRANK123 bat species.

**ANALYSIS 5B** - Intersection of MO WRP easements (polygons) and buffered MO T&E **BAT** species ranges (polygons)

Datasets: \WorkCopy\**wrp_a_mo.shp** (930 non-unique polygon records covering 825 easements recorded through January 2007)
*And*
\NRCS-MONHP\**bats_a_mo.shp** (294 EO buffered polygon records for two T&E species: *Myotis grisescens* and *Myotis sodalis*)

**Technique:** Geoprocessing - Intersect
~~~~~

Step Sequence:
Open: **MONHP_NRCS_BATS&WRP.mxd**
Tools
Geoprocessing
Intersect
Open tool

Input features:
wrp_a_mo
bats_a_mo
Output feature class:
C:\WRPDB\WorkCopy**wrp_a_mo_Intersect_bats_a_mo.shp**
(copy this to **WRPIBATS.DBF**)
R/C on **wrp_a_mo_Intersect_bats_a_mo**
Open attribute table
436 *gross intersections*
~~~~~
USE **WRPIBATS.DBF**
INDEX ON AGREE_NUM TO XXX UNIQ
COUNT

**Results:** **128** unique easements intersect ranges of at least **one** of **two** SRANK123 bat species. [See also results of ANALYSIS 5A Step sequence C].

EOs are rated by EORANK and within the parent intersection dataset 12.4% of the records have an EORANK of "D" = "poor" while 49.3% of the records have an EORANK of "E" = "extant."

**ANALYSIS 5C** - Intersection of MO Monitored WRP easements (polygons) and buffered MO T&E **BAT** species ranges (polygons)

Datasets: \WorkCopy\20070413\**plan_3yrall.shp** (3728 monitored WRP polygon records)
*And*
~~~~~

\NRCS-MONHP**bats_a_mo.shp** (294 EO buffered polygon records for two T&E species: *Myotis grisescens* and *Myotis sodalis*)

Technique: Geoprocessing - Intersect

Step Sequence:
Open: **MONHP_NRCS_BATS&WRP.mxd**
Tools
Geoprocessing
Intersect
Open tool
Input features:
plan_3yrall
bats_a_mo
Output feature class:
C:\WRPDB\WorkCopy**plan_Intersect_bats_a_mo.shp**
(copy this to **PLNIBATS.DBF**)
R/C on **plan_Intersect_bats_a_mo**
Open attribute table
4048 *gross intersections*
~~~~~
USE **PLNIBATS.DBF**
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**113** unique WRP-T&E Bat species polygon intersects
INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**104** *unique easement-range intersects*
INDEX ON AGREE_NUM TO XXX
SET FILTER TO FOURCHACOD="ORP3" OR FOURCHACOD="PFO1" ;
OR FOURCHACOD="PFO2" OR FOURCHACOD="PFO3" ;
OR FOURCHACOD="PFO4" OR FOURCHACOD="PFO5" ;
OR FOURCHACOD="PFP3" OR FOURCHACOD="UWO1" ;
OR FOURCHACOD="UWO2"
COUNT=**2247** *gross wooded easement-range intersects*
~~~~~

Alternatively under ArcMap

R/C on **plan_Intersect_bats_a_mo**
Open attribute table
4048 *gross intersections*
Selection
Select by attributes
Layer: **plan_Intersect_bats_a_mo**
Method: Create a new selection
SELECT * FROM **plan_Intersect_bats_a_mo** WHERE:
"FOURCHACOD"='ORP3' OR "FOURCHACOD"='PFO1' OR
"FOURCHACOD"='PFO2' OR "FOURCHACOD"='PFO3' OR
"FOURCHACOD"='PFO4' OR "FOURCHACOD"='PFO5' OR
"FOURCHACOD"='PFP3' OR "FOURCHACOD"='UWO1' OR
"FOURCHACOD"='UWO2'
Verify
OK
Apply
Close
R/C on **plan_Intersect_bats_a_mo**
Open attribute table
Records (2247 out of 4048 Selected) *gross wooded easement-range intersects*

INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**93** *unique wooded easement-range intersects*

Results: **104** unique monitored easements intersect ranges of at least **one** of **two** SRANK123 bat species. [See also results of ANALYSIS 5A Step sequence D]. If only wooded habitats are considered, then **93** unique monitored wooded easements intersect ranges of at least **one** of **two** SRANK123 bat species.

EOs are rated by EORANK and within the parent intersection dataset 14.6% of the records have an EORANK of “D” = “poor” while 48.9% of the records have an EORANK of “E” = “extant.”

ANALYSIS 6A - Intersection of MO WRP easements (polygons) and buffered MO T&E **BIRD** species ranges (polygons)

Parent Map: **MONHP_NRCS_BIRDS&WRP.mxd**

Datasets: \WorkCopy**wrp_a_mo.shp** (930 non-unique polygon records covering 825 easements recorded through January 2007)
And
\NRCS-MONHP**birds_a_mo.shp** (813 EO buffered polygon records for 31 T&E bird species)

(Since all birds species in the dataset are SRANK123, filtering for SRANK was not necessary).

Technique: Geoprocessing - Intersect

Step Sequence:
Open: **MONHP_NRCS_BIRDS&WRP.mxd**
Tools
Geoprocessing
Intersect
Open tool
Input features:
wrp_a_mo
birds_a_mo
Output feature class:
C:\WRPDB\WorkCopy**wrp_a_mo_Intersect_birds_a_mo.shp**
(copy this to **WRPIBIRD.DBF**)
R/C on **wrp_a_mo_Intersect_birds_a_mo**
Open attribute table
3091 *gross intersections*
~~~~~
USE **WRPIBIRD.DBF**
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**935** unique WRP-T&E bird species polygon intersects

We still need to determine the unique number of easements, as opposed to polygon *records*, which intersect. We can obtain this by using the following command:
INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**467** unique easements

We can also determine the unique number of T&E species/communities involved by using this command:
~~~~~

INDEX ON ELCODE TO XXX UNIQ
COUNT=**24** unique BIRD species

Results: **467** unique WRP easements intersect **24** T&E bird species ranges.

EOs are rated by EORANK and within the parent intersection dataset 44.5% of the records have an EORANK of "E" = "extant."

ANALYSIS 6B - Intersection of MO Monitored WRP easements (polygons) and buffered MO T&E **BIRD** species ranges (polygons)

Parent Map: **MONHP_NRCS_BIRDS&WRP.mxd**

Datasets: \WorkCopy\20070413**plan_3yrall.shp** (~3728 monitored WRP polygon easement records)
And
\NRCS-MONHP**birds_a_mo.shp** (813 EO buffered polygon records for 31 T&E bird species)
(Since all birds species in the dataset are SRANK123, filtering for SRANK was not necessary).

Technique: Geoprocessing - Intersect

Step Sequence:
Open: **MONHP_NRCS_BIRDS&WRP.mxd**
Tools
Geoprocessing
Intersect
Open tool
Input features:
plan_3yrall
birds_a_mo
Output feature class:
C:\WRPDB\WorkCopy**plan_Intersect_birds_a_mo.shp**
(copy this to **PLNIBIRD.DBF**)

R/C on **plan_Intersect_birds_a_mo**
Open attribute table
10,098 *gross intersections*
~~~~~
USE **PLNIBIRD.DBF**
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**606** unique WRP-T&E bird species polygon intersects

We still need to determine the unique number of easements, as opposed to polygon *records*, which intersect. We can obtain this by using the following command:

INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**322** unique monitored easements

We can also determine the unique number of T&E species/communities involved by using this command:

INDEX ON ELCODE TO XXX UNIQ
COUNT=**24** unique T&E Bird species

**Results**: **322** unique monitored WRP easements intersect **24** T&E bird species ranges.
EOs are rated by EORANK and within the parent intersection dataset 38.4% of the records have an EORANK of "E" = "extant" while 10.9% of the records have an EORANK of "U" = "unranked."

*Related finding*:

**7** of 31 (NRCS-MONHP) Missouri T&E bird species **NOT** observed in Missouri WRP sites**:**

"Black Vulture"
"Black Rail"
"Greater Roadrunner"
"Chestnut-sided Warbler"
"Swainson's Warbler"
"Painted Bunting"
"Bachman's Sparrow"
~~~~~

ANALYSIS 7A - Intersection of MO WRP easements (polygons) and buffered MO T&E **MAMMAL** species ranges (polygons)

Parent Map: **MONHP_NRCS_MAMMALS&WRP.mxd**

Datasets: \WorkCopy**wrp_a_mo.shp** (930 non-unique polygon records covering 825 easements recorded through January 2007)
And
\NRCS-MONHP**mammals_a_mo.shp** (243 EO buffered polygon records for 8 T&E mammal species)

(Since all mammal species in the dataset are SRANK123, filtering for SRANK was not necessary).

Technique: Geoprocessing - Intersect

Step Sequence:
Open: **MONHP_NRCS_MAMMALS&WRP.mxd**
Tools
Geoprocessing
Intersect
Open tool

Input features:
wrp_a_mo
mammals_a_mo
Output feature class:
C:\WRPDB\WorkCopy**wrp_a_mo_Intersect_mammals_a_mo.shp**
(copy this to **WRPINMAM.DBF**)
R/C on **wrp_a_mo_ Intersect_mammals_a_mo**
Open attribute table
72 *gross intersections*
~~~~~
USE **WRPINMAM.DBF**
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**44** unique WRP-T&E mammal species polygon intersects
~~~~~

We still need to determine the unique number of easements, as opposed to polygon *records*, which intersect. We can obtain this by using the following command:

INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**43** unique easements

We can also determine the unique number of T&E species/communities involved by using this command:

INDEX ON ELCODE TO XXX UNIQ
COUNT=**6** unique Mammal species

Results: **43** unique WRP easements intersect **6** T&E mammal species ranges.

EOs are rated by EORANK and within the parent intersection dataset 50% of the records have an EORANK of "U" = "unranked" while 37.5% of the records have an EORANK of "E" = "extant"

ANALYSIS 7B - Intersection of MO Monitored WRP easements (polygons) and buffered MO T&E **MAMMAL** species ranges (polygons)

Parent Map: **MONHP_NRCS_MAMMALS&WRP.mxd**
Datasets: \WorkCopy\20070413**plan_3yrall.shp** (~3728 monitored WRP polygon easement records)
And
\NRCS-MONHP**mammals_a_mo.shp** (243 EO buffered polygon records for 8 T&E mammal species)

(Since all mammal species in the dataset are SRANK123, filtering for SRANK was not necessary).

Technique: Geoprocessing - Intersect

Step Sequence:

Open: **MONHP_NRCS_MAMMALS&WRP.mxd**
Tools
Geoprocessing
Intersect
Open tool
Input features:
plan_3yrall
mammals_a_mo
Output feature class:
C:\WRPDB\WorkCopy**plan_Intersect_mammals_a_mo.shp**
(copy this to **PLNINMAM.DBF**)
R/C on **plan_Intersect_mammals_a_mo**
Open attribute table
518 *gross intersections*
~~~~~
USE **PLNINMAM.DBF**
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**30** unique WRP-T&E mammal species polygon intersects

We still need to determine the unique number of easements, as opposed to polygon *records*, which intersect. We can obtain this by using the following command:

INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**29** unique monitored easements

We can also determine the unique number of T&E species/communities involved by using this command:

INDEX ON ELCODE TO XXX UNIQ
COUNT=**4** unique T&E Mammal species

**Results**: **29** unique monitored WRP easements intersect **4** unique T&E mammal species ranges.

EOs are rated by EORANK and within the parent intersection dataset 77% of the records have an EORANK of "U" = "unranked" while 23% of the records have an EORANK of "E" = "extant"

## *Related finding*:
~~~~~

2 of 8 (NRCS-MONHP) Missouri T&E mammal species **NOT** observed in Missouri WRP sites**:**

"Long-tailed Weasel"
"Plains Spotted Skunk"

ANALYSIS 8A - Intersection of MO WRP easements (polygons) and buffered MO T&E **HERP et al** species ranges (polygons)

Parent Map:
MONHP_NRCS_REPTILES_AMPHIBIANS_INSECTS&WRP.mxd

Datasets: \WorkCopy**wrp_a_mo.shp** (930 non-unique polygon records covering 825 easements recorded through January 2007)
And
\NRCS-MONHP**reptiles-amphibians-insects_a_mo.shp** (849 EO buffered polygon records for 68 T&E herp et al species)

(Since all reptile, amphibian & insect species in the dataset are SRANK123, filtering for SRANK was not necessary).

Technique: Geoprocessing - Intersect

Step Sequence:
Open:
MONHP_NRCS_REPTILES_AMPHIBIANS_INSECTS&WRP.mxd
Tools
Geoprocessing
Intersect
Open tool
Input features:
wrp_a_mo
reptiles-amphibians-insects_a_mo
Output feature class:
C:\WRPDB\WorkCopy**wrp_a_mo_Intersect_herps.shp**

(copy this to **WRPIHERP.DBF**)
R/C on **wrp_a_mo_ Intersect_herps**
Open attribute table
326 *gross intersections*
~~~~~
USE **WRPIHERP.DBF**
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**142** unique WRP-T&E herp et al species polygon intersects

We still need to determine the unique number of easements, as opposed to polygon *records*, which intersect. We can obtain this by using the following command:

INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**108** unique easements

We can also determine the unique number of T&E species/communities involved by using this command:

INDEX ON ELCODE TO XXX UNIQ
COUNT=**22** unique Herp et al species

**Results**: **108** unique WRP easements intersect **22** T&E Reptile and/or Amphibian and/or Insect species ranges.

EOs are rated by EORANK and within the parent intersection dataset 59.8% of the records have an EORANK of "E" = "extant" while 17.5% of the records have an EORANK of "U" = "unranked."

---

**ANALYSIS 8B** - Intersection of MO monitored WRP easements (polygons) and buffered MO T&E **HERP et al** species ranges (polygons)

Parent Map:
**MONHP_NRCS_REPTILES_AMPHIBIANS_INSECTS&WRP.mxd**

Datasets: \WorkCopy\20070413\**plan_3yrall.shp** (~3728 monitored WRP polygon easement records)
*And*
~~~~~

\NRCS-MONHP**reptiles-amphibians-insects_a_mo.shp** (849 EO buffered polygon records for 68 T&E herp et al species)

(Since all reptile, amphibian & insect species in the dataset are SRANK123, filtering for SRANK was not necessary).

Technique: Geoprocessing - Intersect

Step Sequence:
Open:
MONHP_NRCS_REPTILES_AMPHIBIANS_INSECTS&WRP.mxd
Tools
Geoprocessing
Intersect
Open tool
Input features:
    plan_3yrall
    reptiles-amphibians-insects_a_mo
Output feature class:
C:\WRPDB\WorkCopy**plan_Intersect_herps.shp**
(copy this to **PLNIHERP.DBF**)
R/C on **plan_ Intersect_herps**
Open attribute table
867 *gross intersections*
~~~~~
USE **PLNIHERP.DBF**
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**88** unique monitored WRP-T&E herp et al species polygon intersects

We still need to determine the unique number of easements, as opposed to polygon *records*, which intersect. We can obtain this by using the following command:
    INDEX ON AGREE_NUM TO XXX UNIQ
    COUNT=**75** unique monitored easements

We can also determine the unique number of T&E species/communities involved by using this command:
    INDEX ON ELCODE TO XXX UNIQ
    COUNT=**16** unique Herp et al species
~~~~~

Results: **75** unique monitored WRP easements intersect **16** T&E Reptile and/or Amphibian and/or Insect species ranges.

EOs are rated by EORANK and within the parent intersection dataset 60.8% of the records have an EORANK of "E" = "extant" while 24.2% of the records have an EORANK of "U" = "unranked."

"The fish, crustacean and mollusk data have been **spatially generalized** to the watershed of the immediate stream segment where they were collected. An additional file of data, called fishdb_a_mo.shp is used to make this generalization**…** It is important to remember that the fish-crustaceans-mollusks_a_mo.shp is the spatial extent of the fish, crustacean and mollusk records, while the fishdb_a_mo.shp contains the tabular information (heritage record or fish sampling data) about these locations." (Revisions to Heritage Data for Field Office Reviews.doc)

ANALYSIS 9 - Intersection of MO WRP easements (polygons) and spatially generalized MO T&E **FISH et al** species records (polygons)

Parent Map:
MONHP_NRCS_FISH_AQUATICS&WRP.mxd

Datasets: \WorkCopy**wrp_a_mo.shp** (930 non-unique polygon records covering 825 easements recorded through January 2007)

And/Or

\NRCS-MONHP**fishdb_a_mo.shp** (4473 EO polygon records of 68 T&E herp et al species)

And/Or

\NRCS-MONHP**fish-crustaceans-mollusks_a_mo.shp** (2312 EO buffered polygon records for 68 T&E herp et al species)

(Since all fish, crustacean & mollusk species in the dataset are SRANK123, filtering for SRANK was not necessary).

Technique: Geoprocessing - Intersect

Step Sequence:

Open: **MONHP_NRCS_FISH_AQUATICS&WRP.mxd**
Tools
Geoprocessing
Intersect
Open tool
Input features:
wrp_a_mo
fish-crustaceans-mollusks_a_mo
Output feature class:
C:\WRPDB\WorkCopy**wrp_a_mo_Intersect_fishetal.shp**
(copy this to **WRPIFISH.DBF**)
R/C on **wrp_a_mo_Intersect_fishetal**
Open attribute table
130 *gross intersections*
~~~~~
[BUILD **DATABASE RELATION** TO ACQUIRE SPECIES NAME ETC]
SELE 1
USE **WRPIFISH.DBF**
INDEX ON SEG_ID TO XXX
SELE 2
USE **FISHDBMO.DBF**
INDEX ON SEG_ID TO ZZZ
SELE 1
SET RELA TO SEG_ID INTO B
COPY FIELDS
AGREE_NUM,B.SEG_ID,B.ELCODE,B.SCINAME,B.SNAME,B.SCOM
NAME,B.S_RANK,B.G_RANK TO **ANYLFISH.DBF**
CLOSE ALL
~~~~~
USE **ANYFISH.DBF**
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**96** unique WRP-T&E fish et al species polygon intersects

We still need to determine the unique number of easements, as opposed to polygon *records*, which intersect. We can obtain this by using the following command:

INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**90** unique easements

We can also determine the unique number of T&E species/communities involved by using this command:

INDEX ON ELCODE TO XXX UNIQ
COUNT=**16** unique fish et al species

Results: 90 unique WRP easements intersect **16** T&E fish and/or crustacean and/or mollusk species spatially generalized ranges.

EORANK was not included in this dataset and so could not be analyzed.

There were distinct differences to the structures and contents of the datasets representing these aquatic organisms compared to the other taxa. This presumably relates to their specialized ecology. In light of these differences, the relevancy and efficacy of this analysis needs to be evaluated. Any further analysis is pending.

ANALYSIS 10A - Intersection of MO WRP easements (polygons) and buffered MO T&E **PLANT** species distributions (polygons)

Parent Map: **MONHP_NRCS_PLANTS&WRP.mxd**

Datasets: \WorkCopy**wrp_a_mo.shp** (930 non-unique polygon records covering 825 easements recorded through January 2007)
And
\NRCS-MONHP**plants_a_mo.shp** (3087 EO buffered polygon records for 406 T&E plant species)

(Since all plant species in the dataset are SRANK123, filtering for SRANK was not necessary).

Technique: Geoprocessing - Intersect

Step Sequence:
Open: **MONHP_NRCS_PLANTS&WRP.mxd**
Tools

Geoprocessing
Intersect
Open tool
Input features:
wrp_a_mo
plants_a_mo
Output feature class:
C:\WRPDB\WorkCopy**wrp_a_mo_Intersect_plants_a_mo.shp**
(copy this to **WRPIPLNT.DBF**)
R/C on **wrp_a_mo_Intersect_plants_a_mo**
Open attribute table
499 *gross intersections*
~~~~~
USE **WRPIPLNT.DBF**
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**174** unique WRP-T&E Plant species polygon intersects

We still need to determine the unique number of easements, as opposed to polygon *records*, which intersect. We can obtain this by using the following command:
INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**97** unique easements

We can also determine the unique number of T&E species/communities involved by using this command:
INDEX ON ELCODE TO XXX UNIQ
COUNT=**62** unique Plant species

**Results**: **97** unique WRP easements intersect **62** T&E plant distributions.

EOs are rated by EORANK and within the parent intersection dataset 38.5% of the records have an EORANK of “E” = “extant.”

---
~~~~~

ANALYSIS 10B - Intersection of MO monitored WRP easements (polygons) and buffered MO T&E **PLANT** species distributions (polygons)

Parent Map: **MONHP_NRCS_PLANTS&WRP.mxd**

Datasets: \WorkCopy\20070413**plan_3yrall.shp** (~3728 monitored WRP polygon easement records)
And
\NRCS-MONHP**plants_a_mo.shp** (3087 EO buffered polygon records for 406 T&E plant species)

(Since all plant species in the dataset are SRANK123, filtering for SRANK was not necessary).

Technique: Geoprocessing - Intersect

Step Sequence:
Open: **MONHP_NRCS_PLANTS&WRP.mxd**
Tools
Geoprocessing
Intersect
Open tool
Input features:
plan_3yrall
plants_a_mo
Output feature class:
C:\WRPDB\WorkCopy\plan_Intersect_plant_a_mo.shp
(copy this to **PLNIPLNT.DBF**)
R/C on plan_Intersect_plant_a_mo
Open attribute table
1106 *gross intersections*
~~~~~
USE **PLNIPLNT.DBF**
INDEX ON AGREE_NUM+ELCODE TO XXX UNIQ
COUNT=**119** unique monitored WRP-T&E plant species polygon intersects
~~~~~

We still need to determine the unique number of easements, as opposed to polygon *records*, which intersect. We can obtain this by using the following command:

INDEX ON AGREE_NUM TO XXX UNIQ
COUNT=**71** unique monitored easements

We can also determine the unique number of T&E species/communities involved by using this command:

INDEX ON ELCODE TO XXX UNIQ
COUNT=**44** unique Plant species

Results: **71** unique monitored WRP easements intersect **44** T&E Plant species distributions.

EOs are rated by EORANK and within the parent intersection dataset 38.3% of the records have an EORANK of “E” = “extant.”

Alphabetical list of plant 238 species recorded as (co-)dominant in 594 monitored Missouri WRP easements, 2003-2005. (The epithet "spp." has been added to genus-only entries).

Family	Species	Form
Malvaceae	*Abutilon theophrasti*	annual forb/herb
Aceraceae	*Acer* spp.	tree/shrub/vine
Aceraceae	*Acer negundo*	tree
Aceraceae	*Acer rubrum*	tree
Aceraceae	*Acer rubrum var drummondii*	tree
Aceraceae	*Acer saccharinum*	tree
Rosaceae	*Agrimonia* spp.	perennial forb/herb
Rosaceae	*Agrimonia parviflora*	perennial forb/herb
Poaceae	*Agrostis alba*	perennial grass
Poaceae	*Agrostis hyemalis*	perennial grass
Alismataceae	*Alisma* spp.	perennial forb/herb
Alismataceae	*Alisma subcordatum*	perennial forb/herb
Liliaceae	*Allium canadense*	perennial forb/herb
Liliaceae	*Allium stellatum*	perennial forb/herb
Liliaceae	*Allium vineale*	perennial forb/herb
Poaceae	*Alopecurus carolinianus*	annual grass
Amaranthaceae	*Amaranthus* spp.	annual forb/herb
Asteraceae	*Ambrosia artemisiifolia*	annual forb/herb
Asteraceae	*Ambrosia bidentata*	annual forb/herb
Asteraceae	*Ambrosia trifida*	annual forb/herb
Lythraceae	*Ammannia* spp.	annual forb/herb
Lythraceae	*Ammannia coccinea*	annual forb/herb
Fabaceae	*Amorpha* spp.	shrub
Fabaceae	*Amorpha croceolanata*	shrub
Apocynaceae	*Amsonia* spp.	perennial forb/herb
Poaceae	*Andropogon gerardii*	perennial grass
Poaceae	*Andropogon scoparius*	perennial grass
Poaceae	*Andropogon virginicus*	perennial grass
Apocynaceae	*Apocynum cannabinum*	perennial forb/herb
Asclepiadaceae	*Asclepias incarnata*	perennial forb/herb
Asteraceae	*Aster* spp.	perennial forb/herb
Asteraceae	*Aster lateriflorus*	perennial forb/herb
Asteraceae	*Aster nemoralis*	perennial forb/herb
Asteraceae	*Aster novae-angliae*	perennial forb/herb
Asteraceae	*Aster pilosus*	perennial forb/herb
Asteraceae	*Aster simplex*	perennial forb/herb
Asteraceae	*Aster vimineus*	perennial forb/herb
Azollaceae	*Azolla Mexicana*	annual/perennial forb/herb
Betulaceae	*Betula nigra*	tree
Asteraceae	*Bidens* spp.	annual forb/herb
Asteraceae	*Bidens aristosa*	annual forb/herb
Asteraceae	*Bidens frondosa*	annual forb/herb
Asteraceae	*Boltonia asteroides*	perennial forb/herb
Poaceae	*Bromus* spp.	perennial grass

Family	Species	Form
Poaceae	*Bromus inermis*	perennial grass
Poaceae	*Bromus tectorum*	perennial grass
Campanulaceae	*Campanula americana*	annual forb/herb
Bignoniaceae	*Campsis radicans*	perennial vine
Cyperaceae	*Carex* spp.	perennial grass
Cyperaceae	*Carex shortiana*	perennial grass
Cyperaceae	*Carex vulpinoidea*	perennial grass
Juglandaceae	*Carya cordiformis*	tree
Juglandaceae	*Carya illinoinensis*	tree
Juglandaceae	*Carya laciniosa*	tree
Juglandaceae	*Carya ovata*	tree
Fabaceae	*Cassia fasciculata*	annual forb/herb
Ulmaceae	*Celtis laevigata*	tree/shrub
Ulmaceae	*Celtis occidentalis*	tree/shrub
Poaceae	*Cenchrus* spp.	annual grass
Poaceae	*Cenchrus longispinus*	annual grass
Rubiaceae	*Cephalanthus occidentalis*	tree/shrub
Asteraceae	*Conyza canadensis*	annual/biennial forb/herb
Cornaceae	*Cornus* spp.	tree/shrub
Cyperaceae	*Cyperus* spp.	annual/perennial grass
Cyperaceae	*Cyperus erythrorhizos*	annual/perennial grass
Cyperaceae	*Cyperus esculentus*	perennial grass
Cyperaceae	*Cyperus strigosus*	perennial grass
Poaceae	*Dactylis glomerata*	perennial grass
Poaceae	*Danthonia spicata*	perennial grass
Apiaceae	*Daucus carota*	biennial forb/herb
Fabaceae	*Desmanthus illinoensis*	perennial subshrub/forb/herb
Fabaceae	*Desmodium* spp.	perennial forb/herb
Poaceae	*Digitaria* spp.	annual grass
Poaceae	*Digitaria ischaemum*	annual grass
Poaceae	*Digitaria sanguinalis*	annual grass
Ebenaceae	*Diospyros virginiana*	tree
Poaceae	*Echinochloa* spp.	annual grass
Poaceae	*Echinochloa crus-galli*	annual grass
Poaceae	*Echinochloa muricata*	annual grass
Poaceae	*Echinochloa walteri*	annual grass
Cyperaceae	*Eleocharis* spp.	perennial grass
Cyperaceae	*Eleocharis compressa*	perennial grass
Cyperaceae	*Eleocharis obtuse*	perennial grass
Cyperaceae	*Eleocharis palustris*	perennial grass
Cyperaceae	*Eleocharis quadrangulata*	perennial grass
Poaceae	*Elymus* spp.	perennial grass
Poaceae	*Elymus virginicus*	perennial grass
Poaceae	*Eragrostis hypnoides*	annual grass
Asteraceae	*Erigeron Canadensis*	annual/biennial forb/herb
Asteraceae	*Eupatoriadelphus fistulosus*	perennial forb/herb
Asteraceae	*Eupatorium altissimum*	perennial forb/herb

Family	Species	Form
Asteraceae	*Eupatorium fistulosum*	perennial forb/herb
Asteraceae	*Eupatorium perfoliatum*	perennial forb/herb
Poaceae	*Festuca* spp.	perennial grass
Poaceae	*Festuca arundinacea*	perennial grass
Poaceae	*Festuca rubra*	perennial grass
Oleaceae	*Fraxinus pennsylvanica*	tree
Fabaceae	*Gleditsia* spp.	tree/shrub
Fabaceae	*Gleditsia triacanthos*	tree/shrub
Poaceae	*Glyceria striata*	perennial grass
Fabaceae	*Glycine max*	annual forb/herb
Scrophulariaceae	*Gratiola neglecta*	annual forb/herb
Asteraceae	*Helianthus annuus*	annual forb/herb
Asteraceae	*Helianthus grosseserratus*	perennial forb/herb
Malvaceae	*Hibiscus* spp.	perennial forb/herb
Malvaceae	*Hibiscus militaris*	perennial forb/herb
Hippuridaceae	*Hippuris vulgaris*	perennial forb/herb
Aquifoliaceae	*Ilex decidua*	tree/shrub
Asteraceae	*Iva annua*	annual forb/herb
Asteraceae	*Iva ciliata*	annual forb/herb
Juglandaceae	*Juglans nigra*	tree
Cupressaceae	*Juniperus virginiana*	perennial subshrub
Onagraceae	*Jussiaea repens*	perennial forb/herb
Fabaceae	*Kummerowia stipulacea*	annual forb/herb
Poaceae	*Leersia oryzoides*	perennial grass
Lemnaceae	*Lemna* spp.	perennial forb/herb
Lemnaceae	*Lemna/Spirodela polyrrhiza*	perennial forb/herb
Poaceae	*Leptochloa* spp.	annual/perennial grass
Poaceae	*Leptochloa filiformis*	annual/perennial grass
Fabaceae	*Lespedeza cuneata*	perennial subshrub forb/herb
Fabaceae	*Lespedeza sericea*	perennial subshrub forb/herb
Hamamelidaceae	*Liquidambar styraciflua*	tree
Onagraceae	*Ludwigia* spp.	perennial forb/herb
Onagraceae	*Ludwigia palustris*	perennial forb/herb
Onagraceae	*Ludwigia peploides*	perennial forb/herb
Moraceae	*Maclura pomifera*	tree/shrub
Fabaceae	*Medicago sativa*	annual perennial forb/herb
Fabaceae	*Melilotus* spp.	
Fabaceae	*Melilotus officinalis*	annual biennial perennial forb/herb
Lamiaceae	*Monarda fistulosa*	perennial subshrub forb/herb
Moraceae	*Morus* spp.	
Moraceae	*Morus rubra*	tree
Nelumboaceae	*Nelumbo lutea*	perennial forb/herb
Cornaceae	*Nyssa aquatica*	tree
Onagraceae	*Oenothera biennis*	biennial forb/herb
Poaceae	*Panicum* spp.	
Poaceae	*Panicum dichotomiflorum*	annual grass
Poaceae	*Panicum rigidulum*	perennial grass

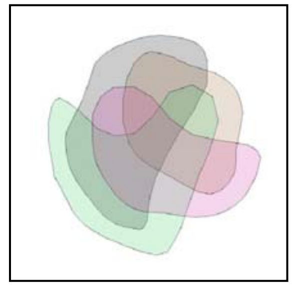
Family	Species	Form
Poaceae	*Panicum virgatum*	perennial grass
Poaceae	*Paspalum fluitans*	annual grass
Poaceae	*Pennisetum glaucum*	annual perennial grass
Poaceae	*Phalaris arundinacea*	perennial grass
Poaceae	*Phleum pratense*	perennial grass
Verbenaceae	*Phyla lanceolata*	perennial forb/herb
Plantaginaceae	*Plantago cordata*	perennial forb/herb
Plantanaceae	*Platanus occidentalis*	tree
Poaceae	*Poa pratensis*	perennial grass
Polygonaceae	*Polygonum* spp.	
Polygonaceae	*Polygonum amphibium*	perennial forb/herb
Polygonaceae	*Polygonum coccineum*	perennial forb/herb
Polygonaceae	*Polygonum hydropiperoides*	perennial forb/herb
Polygonaceae	*Polygonum lapathifolium*	annual forb/herb
Polygonaceae	*Polygonum pensylvanicum*	annual forb/herb
Polygonaceae	*Polygonum punctatum*	annual perennial forb/herb
Salicaceae	*Populus deltoides*	tree
Salicaceae	*Populus heterophylla*	tree
Potamogetonaceae	*Potamogeton* spp.	perennial forb/herb
Rosaceae	*Prunus serotina*	tree
Fagaceae	*Quercus* spp.	tree
Fagaceae	*Quercus alba*	tree
Fagaceae	*Quercus bicolor*	tree
Fagaceae	*Quercus falcata*	tree
Fagaceae	*Quercus imbricaria*	tree
Fagaceae	*Quercus lyrata*	tree
Fagaceae	*Quercus macrocarpa*	tree
Fagaceae	*Quercus palustris*	tree
Fagaceae	*Quercus phellos*	tree
Fagaceae	*Quercus rubra*	tree
Fagaceae	*Quercus stellata*	tree
Fagaceae	*Quercus velutina*	tree
Anacardiaceae	*Rhus* spp.	
Anacardiaceae	*Rhus glabra*	tree/shrub
Anacardiaceae	*Rhus trilobata*	shrub
Fabaceae	*Robinia pseudoacacia*	tree
Rosaceae	*Rosa multiflora*	perennial vine/subshrub
Rosaceae	*Rosa palustris*	perennial subshrub
Rosaceae	*Rubus* spp.	
Rosaceae	*Rubus flagellaris*	perennial subshrub
Asteraceae	*Rudbeckia subtomentosa*	perennial forb/herb
Polygonaceae	*Rumex* spp.	
Polygonaceae	*Rumex crispus*	perennial forb/herb
Polygonaceae	*Rumex verticillatus*	perennial forb/herb
Alismataceae	*Sagittaria* spp.	
Alismataceae	*Sagittaria engelmanniana*	perennial forb/herb
Alismataceae	*Sagittaria latifolia*	perennial forb/herb

Family	Species	Form
Salicaceae	*Salix amygdaloides*	tree/shrub
Salicaceae	*Salix discolor*	tree/shrub
Salicaceae	*Salix exigua*	tree/shrub
Salicaceae	*Salix interior*	tree/shrub
Salicaceae	*Salix nigra*	tree/shrub
Poaceae	*Schizachyrium scoparium*	perennial grass
Cyperaceae	*Scirpus* spp.	
Cyperaceae	*Scirpus americanus*	perennial grass
Cyperaceae	*Scirpus fluviatilis*	perennial grass
Cyperaceae	*Scirpus heterochaetus*	perennial grass
Cyperaceae	*Scirpus validus*	perennial grass
Poaceae	*Secale cereale*	annual grass
Fabaceae	*Sesbania* spp.	
Fabaceae	*Sesbania exalta*	annual perennial subshrub forb/herb
Poaceae	*Setaria* spp.	
Poaceae	*Setaria faberi*	annual grass
Poaceae	*Setaria glauca*	annual grass
Asteraceae	*Silphium integrifolium*	perennial forb/herb
Asteraceae	*Silphium perfoliatum*	perennial forb/herb
Asteraceae	*Solidago* spp.	
Asteraceae	*Solidago altissima*	perennial forb/herb
Asteraceae	*Solidago flexicaulis*	perennial forb/herb
Asteraceae	*Solidago nemoralis*	perennial forb/herb
Poaceae	*Sorghastrum nutans*	perennial grass
Poaceae	*Sorghum bicolor*	annual grass
Poaceae	*Sorghum halepense*	perennial grass
Sparganiaceae	*Sparganium eurycarpum*	perennial forb/herb
Poaceae	*Spartina pectinata*	perennial grass
Poaceae	*Sporobolus cryptandrus*	perennial grass
Caprifoliaceae	*Symphoricarpos orbiculatus*	shrub
Cupressaceae	*Taxodium distichum*	tree
Anacardiaceae	*Toxicodendron radicans*	perennial shrub forb/herb subshrub
Poaceae	*Tridens flavus*	perennial grass
Fabaceae	*Trifolium agrarium*	annual perennial forb/herb
Fabaceae	*Trifolium hybridum*	annual perennial forb/herb
Fabaceae	*Trifolium pratense*	biennial perennial forb/herb
Fabaceae	*Trifolium repens*	perennial forb/herb
Poaceae	*Triplasis purpurea*	annual grass
Poaceae	*Tripsacum dactyloides*	perennial grass
Poaceae	*Triticum* spp.	
Poaceae	*Triticum aestivum*	annual grass
Typhaceae	*Typha* spp.	
Typhaceae	*Typha angustifolia*	perennial forb/herb
Typhaceae	*Typha latifolia*	perennial forb/herb
Ulmaceae	*Ulmus* spp.	
Ulmaceae	*Ulmus alata*	tree
Ulmaceae	*Ulmus americana*	tree

Family	Species	Form
Ulmaceae	*Ulmus rubra*	tree
Verbenaceae	*Verbena hastata*	biennial perennial forb/herb
Asteraceae	*Vernonia missurica*	perennial forb/herb
Asteraceae	*Xanthium* spp.	
Asteraceae	*Xanthium strumarium*	annual forb/herb
Poaceae	*Zea mays*	annual grass

Summary of Proximity Analyses Results

Research Topic: *To what extent do Missouri's WRP easements provide an implied POTENTIAL contribution to the maintenance and protection of threatened and endangered species/communities by virtue of their proximity to T&E species/community ranges?*



NOTE: For the purposes of the WRP project analyses, **Threatened and Endangered** (T&E) "elements" are the **S1**, **S2** or **S3** State-ranked elements (including those assigned a range of SRANKs that includes at least one of these values). Element Observations (EO) have not been excluded on the basis of EORANK, however high percentages of "historical" and other perhaps suboptimal ranks are noted as a qualifier under the results.

Analysis 1

Spatial intersection of Missouri WRP easement polygons and Missouri Natural Heritage Program (MONHP) T&E species/community ranges (polygons).

Datasets:

wrp_a_mo.shp (825 easements in 930 polygons)
And
hertpoly.shp (20,768 MONHP *EO* polygons)

Technique: Geoprocessing - Intersect
(with additional database filtering and indexing)

Results: **439** easements intersected **217** T&E species/community ranges
OR **431** easements/**208** *species ranges*

<u>Additional qualifiers</u>:

- The initial spatial analysis above resulted in 6727 gross (non-unique) easement-range *intersections* (See ALSO Analysis 2, datasets).
- There are no habitat data in the WRP dataset used in this <u>or similar analyses</u> (wrp_a_mo.shp does not include habitat information).
- EOs are rated by EORANK and within the parent intersection dataset 76.3% of the records have an EORANK of "H" or "H?" = "historical" while 17.6 % of these records have an EORANK of "E" = "extant."

Furthermore, since fish obviously require water, and since riverine and lacustrine habitat categories have not been recorded in practice for monitored Missouri WRP easements (–there are just 3 freshwater open-water four-character Cowardin habitat codes that can be derived from the *monitoring* dataset), the above analysis could be modified to **exclude** (filter out) ***all*** **fish records** (26 species). This coarse action would avoid inadvertently attributing some fish records to a non-aquatic (non open water) habitat. In this case, the gross result would be:

<u>Results</u>: **417** easements intersected **191** T&E species/community ranges *OR* **396** easements/**182** *species ranges*

*However, Analysis 1 results could be intersected with the smaller monitoring (habitat) dataset…*See Analysis 2.

Analysis 2

Spatial *intersection* of the intersection between (MONHP) T&E species/community ranges and Missouri WRP sites (*the resulting polygon product of Analysis 1*), *and* monitored Missouri WRP polygons.

<u>Datasets</u>:

wrp_Intersect2_hertpoly.shp (6727 polygon records resulting from Analysis 1 above)

And

plan_3yrall.shp (~3730 monitored WRP habitat polygons)

Technique: Geoprocessing - Intersect
(with additional database filtering and indexing)

Results: **320** WRP easement sites intersect **193** distinct MONHP T&E species/community ranges.

305 WRP easements intersected **183** T&E species/community ranges (*including only those FISH range records that overlap with "POWZ" palustrine open water habitat records–68 unique FISH range-easement intersections which contain 14 species and 23 easements).* See Analysis 3.

Additional qualifier:
EOs are rated by EORANK and within the parent intersection dataset 85.6% of the records have an EORANK of "H" or "H?" = "historical."

Analysis 3

Intersection of monitored Missouri WRP polygons and (MONHP) T&E species/community polygon ranges.

Datasets:

plan_3yrall.shp (~3730 monitored habitat polygons from 594 easements)
And
hertpoly.shp (20,768 EO polygon records)

Technique: Geoprocessing - Intersect
(with additional database filtering and indexing)

Results: **322** WRP easement sites intersect **193** distinct MONHP T&E species/community ranges *OR* **316** easements/**186** *species ranges*

307 WRP easement sites intersect **183** distinct MONHP T&E species/ community ranges (*including only those FISH range records that overlap with "POWZ" palustrine open water habitat records–68 unique FISH range-easement intersections which contain 14 species and 23 easements*). See Analysis 2.

Additional qualifier:
EOs are rated by EORANK and within the parent intersection dataset 86.3% of the records have an EORANK of "H" or "H?" = "historical."

Analysis 2 and Analysis 3 yield, for all practical purposes, identical results. Therefore Analysis 2 is redundant.

Analysis 4

(MONHP) T&E species/community **E**lement **O**bservations (points) located inside Missouri WRP easements (polygons).

Datasets:

wrp_a_mo.shp (825 easements in 930 polygons)
And
herallpt.shp (MDC Heritage "MONHP" points)

Technique: Geoprocessing - Intersect
(with additional database filtering and indexing)

Results: **73** collective observations of **48** T&E species/communities occurred within **41** WRP easements *OR* **38** easements/**43** *species ranges*

Additional qualifier:
EOs are rated by EORANK and within this dataset, 51.6% of the parent intersection records have an EORANK of "E" = "extant."

[*5A disregarded*]

Analysis 5B

Intersection of Missouri WRP easements (polygons) and NRCS buffered MONHP T&E **BAT** species ranges (polygons).

Datasets:

wrp_a_mo.shp (930 non-unique polygon records covering 825 easements)

And

bats_a_mo.shp (294 EO buffered polygon records for two T&E species: *Myotis grisescens* and *Myotis sodalis*)

Technique: Geoprocessing - Intersect
(with additional database filtering and indexing)

Results: **128** unique easements intersect ranges of at least **1 of 2** SRANK123 **bat species**.

Additional qualifier:
EOs are rated by EORANK and within the parent intersection dataset 49.3% of the records have an EORANK of "E" = "extant" while 12.4% of these records have an EORANK of "D" = "poor."

Analysis 5C

Intersection of Missouri monitored WRP easements (polygons) and NRCS buffered MONHP T&E **BAT** species ranges (polygons).

Datasets:

plan_3yrall.shp (~3730 monitored WRP polygon records)

And

bats_a_mo.shp (294 EO buffered polygon records for two T&E species: *Myotis grisescens* and *Myotis sodalis*)

Technique: Geoprocessing - Intersect

(with additional database filtering and indexing)

Results: **104** unique monitored easements intersect ranges of at least **1 of 2** SRANK123 **bat species**.

If only wooded habitats are considered, then **93** unique monitored **wooded** easements intersect ranges of at least **1 of 2** SRANK123 **bat species**.

Additional qualifier:
EOs are rated by EORANK and within the parent intersection dataset 48.9% of the records have an EORANK of "E" = "extant" while 14.6 % of these records have an EORANK of "D" = "poor."

Analysis 6A

Intersection of Missouri WRP easements (polygons) and NRCS buffered MONHP T&E **BIRD** species ranges (polygons).

Datasets:

wrp_a_mo.shp (930 non-unique polygon records covering 825 easements recorded through January 2007)

And

birds_a_mo.shp (813 EO buffered polygon records for 31 T&E bird species)

Technique: Geoprocessing - Intersect
(with additional database filtering and indexing)

Results: **467** unique WRP easements intersect **24** T&E bird species ranges.

Additional qualifier:
EOs are rated by EORANK and within the parent intersection dataset 44.5% of the records have an EORANK of "E" = "extant."

Analysis 6B

Intersection of Missouri monitored WRP easements (polygons) and NRCS buffered MONHP T&E **BIRD** species ranges (polygons).

Datasets:

plan_3yrall.shp (~3730 monitored WRP polygon records)

And

birds_a_mo.shp (813 EO buffered polygon records for 31 T&E bird species)

Technique: Geoprocessing - Intersect
(with additional database filtering and indexing)

Results: **322** unique monitored WRP easements intersect **24** T&E bird species ranges.

Additional qualifier:
EOs are rated by EORANK and within the parent intersection dataset 38.4% of the records have an EORANK of “E” = “extant” while 10.9% of the records have an EORANK of “U” = “unranked”

Analysis 7A

Intersection of Missouri WRP easements (polygons) and NRCS buffered MONHP T&E **MAMMAL** species ranges (polygons).

Datasets:

wrp_a_mo.shp (930 non-unique polygon records covering 825 easements recorded through January 2007)

And

mammals_a_mo.shp (243 EO buffered polygon records for 8 T&E mammal species)

Technique: Geoprocessing - Intersect
(with additional database filtering and indexing)

Results: **43** unique WRP easements intersect **6** T&E mammal species ranges.

Additional qualifier:
EOs are rated by EORANK and within the parent intersection dataset 50% of the records have an EORANK of "U" = "unranked" while 37.5% of the records have an EORANK of "E" = "extant."

Analysis 7B

Intersection of MO Monitored WRP easements (polygons) and buffered MO T&E **MAMMAL** species ranges (polygons).

Datasets:

plan_3yrall.shp (~3730 monitored WRP polygon records)
And
mammals_a_mo.shp (243 EO buffered polygon records for 8 T&E mammal species)

Technique: Geoprocessing - Intersect
(with additional database filtering and indexing)

Results: **29** unique monitored WRP easements intersect **4** unique T&E mammal species ranges.

Additional qualifier:
EOs are rated by EORANK and within the parent intersection dataset 77% of the records have an EORANK of "U" = "unranked" while 23% of the records have an EORANK of "E" = "extant"

Analysis 8A

Intersection of Missouri WRP easements (polygons) and NRCS buffered MONHP T&E **REPTILE, AMPHIBIANS and INSECT** species ranges (polygons).

Datasets:

wrp_a_mo.shp (930 non-unique polygon records covering 825 easements recorded through January 2007)

And

reptiles-amphibians-insects_a_mo.shp (849 EO buffered polygon records for 68 T&E herp et al species)

Technique: Geoprocessing - Intersect
(with additional database filtering and indexing)

Results: **108** unique WRP easements intersect **22** T&E Reptile and/or Amphibian and/or Insect species ranges.

Additional qualifier:
EOs are rated by EORANK and within the parent intersection dataset 59.8% of the records have an EORANK of "E" = "extant" while 17.5% of the records have an EORANK of "U" = "unranked."

Analysis 8B

Intersection of Missouri monitored WRP easements (polygons) and NRCS buffered MONHP T&E **REPTILE, AMPHIBIANS and INSECT** species ranges (polygons).

Datasets:

plan_3yrall.shp (~3730 monitored WRP polygon records)

And

reptiles-amphibians-insects_a_mo.shp (849 EO buffered polygon records for 68 T&E herp et al species)

Technique: Geoprocessing - Intersect
(with additional database filtering and indexing)

Results: **75** unique monitored WRP easements intersect **16** T&E Reptile and/or Amphibian and/or Insect species ranges.

Additional qualifier:
EOs are rated by EORANK and within the parent intersection dataset 60.8% of the records have an EORANK of "E" = "extant" while 24.2% of the records have an EORANK of "U" = "unranked."

Analysis 9

Intersection of MO WRP easements (polygons) and spatially generalized MO T&E **FISH et al** species records (polygons).

Datasets:

wrp_a_mo.shp (930 non-unique polygon records covering 825 easements recorded through January 2007)

And/Or

fishdb_a_mo.shp (4473 EO polygon records of 68 T&E herp et al species)

And/Or

fish-crustaceans-mollusks_a_mo.shp (2312 EO buffered polygon records for 68 T&E herp et al species)

Technique: Geoprocessing - Intersect
Database Relation
(with additional database filtering and indexing)

Results: **90** unique WRP easements intersect **16** T&E fish and/or crustacean and/or mollusk species spatially generalized ranges.

Additional qualifier:
EORANK was not included in this dataset and so could not be analyzed.

There were distinct differences to the structures and contents of the datasets representing these aquatic organisms compared to the other taxa. This presumably relates to their specialized ecology. In light of these differences, the relevancy and efficacy of this analysis needs to be evaluated. Further analysis is pending.

Analysis 10A

Intersection of MO WRP easements (polygons) and buffered MO T&E **PLANT** species distributions (polygons).

Datasets:

wrp_a_mo.shp (930 non-unique polygon records covering 825 easements recorded through January 2007)

And

plants_a_mo.shp (3087 EO buffered polygon records for 406 T&E plant species)

Technique: Geoprocessing - Intersect
(with additional database filtering and indexing)

Results: **97** unique WRP easements intersect **62** T&E plant distributions.

Additional qualifier:
EOs are rated by EORANK and within the parent intersection dataset 38.5% of the records have an EORANK of “E” = “extant.”

Analysis 10B

Intersection of Missouri monitored WRP easements (polygons) and buffered MO T&E **PLANT** species distributions (polygons).

Datasets:

plan_3yrall.shp (~3730 monitored WRP polygon records)

And

plants_a_mo.shp (3087 EO buffered polygon records for 406 T&E plant species)

Technique: Geoprocessing - Intersect
(with additional database filtering and indexing)

Results: **71** unique monitored WRP easements intersect **44** T&E Plant species distributions.

Additional qualifier:

EOs are rated by EORANK and within the parent intersection dataset 38.3% of the records have an EORANK of "E" = "extant."

ANNEX 4

SUPPLEMENTARY PROJECT DOCUMENTATION

Missouri WRP Analysis Project

MISSOURI WRP RESTORATION STATUS

Table of Contents

MODIFIED COWARDIN CLASSIFICATION USED IN WRP

Original Source File: CowardianWETTeamREVMon072205.XLS (NRCS)

STATUS	LAND TYPE	Sys_code	System	Class_code	Class	Sbclas_cod	Subclass	Water Regime Modifiers	Special Modifiers (1)
EX	W	P	Palustrine	AB	Aquatic Bed	1	Algal	A Temporarily Flooded	b Beaver
EXISTING	**WETLAND**	P	Palustrine	AB	Aquatic Bed	2	Aquatic Moss	B Saturated	d Partially drained
		P	Palustrine	AB	Aquatic Bed	3	Rooted Vascular	C Seasonally Flooded	f Farmed
PR	RP	P	Palustrine	AB	Aquatic Bed	4	Floating Vascular	F Semi-permanently Exposed	h Dike/Impoundment
PROTECTED	**RIPARIAN**	P	Palustrine	AB	Aquatic Bed	5	Unknown Submergent	G Intermittently Exposed	k Sand/Rock
		P	Palustrine	AB	Aquatic Bed	6	Unknown Surface	H Permanently Flooded	n Natural regeneration
PL	UP	P	Palustrine	EM	Emergent	1	Persistent	J Intermittently Flooded	p Planted
PLANNED	**UPLAND**	P	Palustrine	EM	Emergent	2	Non-persistent	K Artificially Flooded	r Artificial substrate
		P	Palustrine	SA	*Substantially Altered*	1	Persistent	N Tidal	s Spoil
RE	FP	P	Palustrine	SA	*Substantially Altered*	2	Non-persistent	U Unknown	x Excavated
RESTORED	**FLOODPLAIN**	P	Palustrine	SS	Scrub Shrub	1	Broad-leaved deciduous	Z None	z None
		P	Palustrine	SS	Scrub Shrub	2	Needle-leaved deciduous		
	OT	P	Palustrine	SS	Scrub Shrub	3	Broad-leaved evergreen		
	OTHER	P	Palustrine	SS	Scrub Shrub	4	Needle-leaved evergreen		
		P	Palustrine	SS	Scrub Shrub	5	Dead		
		P	Palustrine	FO	Forested	1	Broad-leaved deciduous		
		P	Palustrine	FO	Forested	2	Needle-leaved deciduous		
		P	Palustrine	FO	Forested	3	Broad-leaved evergreen		
		P	Palustrine	FO	Forested	4	Needle-leaved evergreen		
		P	Palustrine	FO	Forested	5	Dead		
		P	Palustrine	FP	Floodplain - non hydric soils	1	Cropped		
		P	Palustrine	FP	Floodplain - non hydric soils	2	Herbaceous		
		P	Palustrine	FP	Floodplain - non hydric soils	3	Woody		
		P	Palustrine	OW	Open Water	Z	None		
		U	Upland	HE	Herbaceous	1	Native		
		U	Upland	HE	Herbaceous	2	Introduced		
		U	Upland	WO	Wooded	1	Deciduous		
		U	Upland	WO	Wooded	2	Evergreen		
		U	Upland	SH	Shrubs	1	Deciduous		
		U	Upland	SH	Shrubs	2	Evergreen		
		U	Upland	CR	Cropland	Z	None		
		O	Other	PC	Prior Converted Cropland	1	Cropped		
		O	Other	PC	Prior Converted Cropland	2	Herbaceous vegetation dominant		
		O	Other	RP	Riparian	1	Cropped		
		O	Other	RP	Riparian	2	Herbaceous		
		O	Other	RP	Riparian	3	Woody		
		O	Other	FW	Farmed Wetland and Farmed Wetland Pasture	1	Cropped		
		O	Other	FW		2	Native Grass		
		O	Other	FW		3	Introduced Grass		
		O	Other	SA	*Substantially Altered*	1	Cropped		
		O	Other	SA	*Substantially Altered*	2	Herbaceous		
		O	Other	SA	*Substantially Altered*	3	Open Water		
		O	Other	TD	Tidal	1	Cropped		
		O	Other	TD	Tidal	2	Herbaceous		
		O	Other	TD	Tidal	3	Open Water		
		O	Other	OC	Other Hydric Cropland	1	Cropped		
		O	Other	OC	Other Hydric Cropland	2	Herbaceous		
		O	Other	OC	Other Hydric Cropland	3	Open Water		

(1) Always use two Special Modifiers (i.e. PLWPFO1C**hp** *or* PLWPEM2C**hz** *or* PLWPOWZZ**zz**). The special modifier ***z*** should always be last.

STATUS	LAND TYPE	Sys_code	System	Class_code	Class	Sbclas_cod	Subclass	Water Regime Modifier	Special Modifier
		R	Riverine	RB	Rock Bottom	A	Temporaily Flooded		
		R	Riverine	RB	Rock Bottom	C	Seasonally Flooded	z NONE	z NONE
		R	Riverine	RB	Rock Bottom	E	Semi-permanently flooded		
		R	Riverine	RB	Rock Bottom	G	Intermittently Exposed		
		R	Riverine	RB	Rock Bottom	H	Permanently Flooded		
EX	IN	R	Riverine	UB	Unconsolidated Bottom	A	Temporaily Flooded		
EXISTING	**IN-STREAM**	R	Riverine	UB	Unconsolidated Bottom	C	Seasonally Flooded		
		R	Riverine	UB	Unconsolidated Bottom	E	Semi-permanently flooded		
PL		R	Riverine	UB	Unconsolidated Bottom	G	Intermittently Exposed		
PLANNED		R	Riverine	UB	Unconsolidated Bottom	H	Permanently Flooded		
		R	Riverine	AB	Aquatic Bed	A	Temporaily Flooded		
RE		R	Riverine	AB	Aquatic Bed	C	Seasonally Flooded		
RESTORED		R	Riverine	AB	Aquatic Bed	E	Semi-permanently flooded		
		R	Riverine	AB	Aquatic Bed	G	Intermittently Exposed		
		R	Riverine	AB	Aquatic Bed	H	Permanently Flooded		
		R	Riverine	SB	Stream Bed	A	Temporaily Flooded		
		R	Riverine	SB	Stream Bed	C	Seasonally Flooded		
		R	Riverine	SB	Stream Bed	E	Semi-permanently flooded		
		R	Riverine	SB	Stream Bed	G	Intermittently Exposed		
		R	Riverine	SB	Stream Bed	H	Permanently Flooded		
		R	Riverine	RS	Rocky Shore	A	Temporaily Flooded		
		R	Riverine	RS	Rocky Shore	C	Seasonally Flooded		
		R	Riverine	RS	Rocky Shore	E	Semi-permanently flooded		
		R	Riverine	RS	Rocky Shore	G	Intermittently Exposed		
		R	Riverine	RS	Rocky Shore	H	Permanently Flooded		
		R	Riverine	US	Unconsolidated Shore	A	Temporaily Flooded		
		R	Riverine	US	Unconsolidated Shore	C	Seasonally Flooded		
		R	Riverine	US	Unconsolidated Shore	E	Semi-permanently flooded		
		R	Riverine	US	Unconsolidated Shore	G	Intermittently Exposed		
		R	Riverine	US	Unconsolidated Shore	H	Permanently Flooded		
		R	Riverine	EM		A	Temporaily Flooded		
		R	Riverine	EM	Non-Persistent Emergent Wetland	C	Seasonally Flooded		
		R	Riverine	EM		E	Semi-permanently flooded		
		R	Riverine	EM		G	Intermittently Exposed		
		R	Riverine	EM		H	Permanently Flooded		

STATUS			Sys_code	System	Sbsys_code	Subsystem	Class_code	Class		Subclass	Modifiers
			L	Lacustrine	1	Limnetic	RB	Rock Bottom	1	Bed rock	
			L	Lacustrine	1	Limnetic	RB	Rock Bottom	2	Rubble	Z NONE
			L	Lacustrine	1	Limnetic	UB	Unconsolidated Bottom	1	Cobble Gravel	
			L	Lacustrine	1	Limnetic	UB	Unconsolidated Bottom	2	Sand	
			L	Lacustrine	1	Limnetic	UB	Unconsolidated Bottom	3	Mud	
EX			L	Lacustrine	1	Limnetic	UB	Unconsolidated Bottom	4	Organic	
EXISTING			L	Lacustrine	1	Limnetic	AB	Aquatic Bed	1	Algal	
			L	Lacustrine	1	Limnetic	AB	Aquatic Bed	2	Aquatic Moss	
PL			L	Lacustrine	1	Limnetic	AB	Aquatic Bed	3	Rooted Vascular	
PLANNED			L	Lacustrine	1	Limnetic	AB	Aquatic Bed	4	Floating Vascular	
			L	Lacustrine	1	Limnetic	AB	Aquatic Bed	5	Unknown Submergent	
RE			L	Lacustrine	1	Limnetic	AB	Aquatic Bed	6	Unkown Surface	
RESTORED			L	Lacustrine	1	Limnetic	OW	Open Water	Z	None	
			L	Lacustrine	2	Littoral	RB	Rock Bottom	1	Bedrock	
			L	Lacustrine	2	Littoral	RB	Rock Bottom	2	Rubble	
			L	Lacustrine	2	Littoral	UB	Unconsolidated Bottom	1	Cobble Gravel	
			L	Lacustrine	2	Littoral	UB	Unconsolidated Bottom	2	Sand	
			L	Lacustrine	2	Littoral	UB	Unconsolidated Bottom	3	Mud	
			L	Lacustrine	2	Littoral	UB	Unconsolidated Bottom	4	Organic	
			L	Lacustrine	2	Littoral	AB	Aquatic Bed	1	Algal	
			L	Lacustrine	2	Littoral	AB	Aquatic Bed	2	Aqautic Moss	
			L	Lacustrine	2	Littoral	AB	Aquatic Bed	3	Rooted Vascular	
			L	Lacustrine	2	Littoral	AB	Aquatic Bed	4	Floating Vascular	
			L	Lacustrine	2	Littoral	AB	Aquatic Bed	5	Unkown Submergent	
			L	Lacustrine	2	Littoral	AB	Aquatic Bed	6	Unkown Surface	
			L	Lacustrine	2	Littoral	RS	Rocky Shore	1	Bedrock	
			L	Lacustrine	2	Littoral	RS	Rocky Shore	2	Rubble	
			L	Lacustrine	2	Littoral	US	Unconsolidated Shore	1	Cobble Gravel	
			L	Lacustrine	2	Littoral	US	Unconsolidated Shore	2	Sand	
			L	Lacustrine	2	Littoral	US	Unconsolidated Shore	3	Mud	
			L	Lacustrine	2	Littoral	US	Unconsolidated Shore	4	Organic	
			L	Lacustrine	2	Littoral	US	Unconsolidated Shore	5	Vegetated	
			L	Lacustrine	2	Littoral	EM	Emergent	1	Persistent	
			L	Lacustrine	2	Littoral	EM	Emergent	2	Non-persistent	
			L	Lacustrine	2	Littoral	OW	Open Water	z	None	

Derivation, definition and rationale for Cowardin *"four character codes"*

The Missouri WRP monitoring dataset utilizes a habitat data standard based on a *modified* version of "Classification of wetland and deepwater habitats of the United States" (Cowardin *et al*, 1979). See the separate documents ModifiedCowardin.xls & ModifiedCowardin-Families.xls for the **modified** classification, in Annex 4.

The coarse dataset of monitored WRP easements undergoing analysis was comprised as follows: **3005** records with Cowardin data representing **530** easements. These records included **456** *unique* modified Cowardin habitat codes.

Thus for a meaningful and manageable "global" analysis of Missouri's restored WRP habitats it was necessary to significantly reduce this great variability. A system of "core" Cowardin codes was developed that encompassed the System, Class and Subclass levels of the original system in a **four character code**. This reduced the number of unique habitat categories for analysis from 456 to a manageable **22**. The sequential method for deriving this core four character code is illustrated below.

Sample Excerpt

→ *DERIVATION OF **FOUR CHARACTER CODES** FOR ANALYSIS* →

Original Code from database **[ORG_COWARD]**	Code characters corrected and position and order standardized **[CUR_COWARD]**	Status and Landtype prefixes removed **[CORECOWARD]**	Removed Water Regime and Special Modifier suffixes. **Code distilled to core 4 characters to facilitate analyses. [FOURCHACOD]**
PROTORP3Cz	PROTORP3Cz	ORP3Cz	ORP3
PLWPEM1Chn	PL WPEM1Chn	PEM1Chn	PEM1
PLWPEM1Fnz	PL WPEM1Fnz	PEM1Fnz	PEM1
PLWPEM1Fx	PL WPEM1Fx	PEM1Fx	PEM1
PLWPEM2Chn	PL WPEM2Chn	PEM2Chn	PEM2
PLWPEM2Ghn	PL WPEM2Ghn	PEM2Ghn	PEM2
WPEM2Ah	WPEM2Ah	PEM2Ah	PEM2
PFO1Anz	PFO1Anz	PFO1Anz	PFO1
PLWPFO1Anz	PL WPFO1Anz	PFO1Anz	PFO1
PRWPFO1Jz	PR WPFO1Jz	PFO1Jz	PFO1
WPFO1Cn	WPFO1Cn	PFO1Cn	PFO1
PLWPOWZZz	PL WPOWZZz	POWZZz	POWZ
WPOWZHz	WPOWZHz	POWZHz	POWZ
FPPSA1Jk	FPPSA1Jk	PSA1Jk	PSA1
FPPSA2Jk	FPPSA2Jk	PSA2Jk	PSA2
PLWPSS1Chn	PL WPSS1Chn	PSS1Chn	PSS1
PRUPUHE2Zz	PRUPUHE2Zz	UHE2Zz	UHE2

The original complete coding has been retained in the relevant databases so that more in-depth analysis of any core type is possible.

Four Character Codes of Modified Cowardin Classification arranged by Vegetative structure / function "Families"

FOREST TYPES

	Sys_code	System	Class_code	Class	Sbclas_cod	Subclass	4-CHAR CODE
1	P	Palustrine	FO	**Forested**	1	Broad-leaved deciduous	PFO1
2	P	Palustrine	FO	**Forested**	2	Needle-leaved deciduous	PFO2
3	P	Palustrine	FO	**Forested**	3	Broad-leaved evergreen	PFO3
4	P	Palustrine	FO	**Forested**	4	Needle-leaved evergreen	PFO4
5	P	Palustrine	FO	**Forested**	5	Dead	PFO5
6	P	Palustrine	FP	Floodplain - non hydric soils	3	**Woody**	PFP3
7	U	Upland	WO	**Wooded**	1	Deciduous	UWO1
8	U	Upland	WO	**Wooded**	2	Evergreen	UWO2
9	O	Other	RP	Riparian	3	**Woody**	ORP3

SCRUB SHRUB TYPES

	Sys_code	System	Class_code	Class	Sbclas_cod	Subclass	4-CHAR CODE
10	P	Palustrine	SS	Scrub Shrub	1	Broad-leaved deciduous	PSS1
11	P	Palustrine	SS	Scrub Shrub	2	Needle-leaved deciduous	PSS2
12	P	Palustrine	SS	Scrub Shrub	3	Broad-leaved evergreen	PSS3
13	P	Palustrine	SS	Scrub Shrub	4	Needle-leaved evergreen	PSS4
14	P	Palustrine	SS	Scrub Shrub	5	Dead	PSS5
15	U	Upland	SH	Shrubs	1	Deciduous	USH1
16	U	Upland	SH	Shrubs	2	Evergreen	USH2

NON-WOODY VEGETATED TYPES

	Sys_code	System	Class_code	Class	Sbclas_cod	Subclass	4-CHAR CODE
17	P	Palustrine	AB	Aquatic Bed	1	Algal	PAB1
18	P	Palustrine	AB	Aquatic Bed	2	Aquatic Moss	PAB2
19	P	Palustrine	AB	Aquatic Bed	3	Rooted Vascular	PAB3
20	P	Palustrine	AB	Aquatic Bed	4	Floating Vascular	PAB4
21	P	Palustrine	AB	Aquatic Bed	5	Unknown Submergent	PAB5
22	P	Palustrine	AB	Aquatic Bed	6	Unknown Surface	PAB6
23	P	Palustrine	EM	Emergent	1	Persistent	PEM1
24	P	Palustrine	EM	Emergent	2	Non-persistent	PEM2
25	P	Palustrine	SA	*Substantially Altered*	1	Persistent	PSA1
26	P	Palustrine	SA	*Substantially Altered*	2	Non-persistent	PSA2
27	P	Palustrine	FP	Floodplain - non hydric soils	2	Herbaceous	PFP2
28	U	Upland	HE	Herbaceous	1	Native	UHE1
29	U	Upland	HE	Herbaceous	2	Introduced	UHE2
30	O	Other	RP	Riparian	2	Herbaceous	ORP2
31	O	Other	SA	*Substantially Altered*	2	Herbaceous	OSA2
32	O	Other	TD	Tidal	2	Herbaceous	OTD2

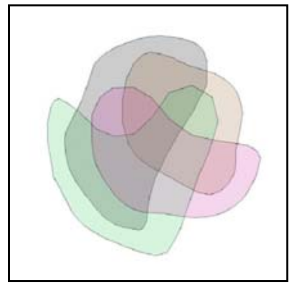
AGRICULTURAL TYPES

	Sys_code	System	Class_code	Class	Sbclas_cod	Subclass	4-CHAR CODE
33	P	Palustrine	FP	Floodplain - non hydric soils	1	Cropped	PFP1
34	U	Upland	CR	Cropland	Z	None	UCRZ
35	O	Other	PC	Prior Converted Cropland	1	Cropped	OPC1
36	O	Other	PC	Prior Converted Cropland	2	Herbaceous vegetation dominant	OPC2
37	O	Other	RP	Riparian	1	Cropped	ORP1
38	O	Other	FW	Farmed Wetland and Farmed Wetland Pasture	1	Cropped	OFW1
39	O	Other	FW		2	Native Grass	OFW2
40	O	Other	FW		3	Introduced Grass	OFW3
41	O	Other	SA	*Substantially Altered*	1	Cropped	OSA1
42	O	Other	TD	Tidal	1	Cropped	OTD1
43	O	Other	OC	Other Hydric Cropland	1	Cropped	OOC1
44	O	Other	OC	Other Hydric Cropland	2	Herbaceous	OOC2
45	O	Other	OC	Other Hydric Cropland	3	Open Water	OOC3

OTHER

	Sys_code	System	Class_code	Class	Sbclas_cod	Subclass	4-CHAR CODE
46	P	Palustrine	OW	Open Water	Z	None	POWZ
47	O	Other	SA	*Substantially Altered*	3	Open Water	OSA3
48	O	Other	TD	Tidal	3	Open Water	OTD3

WRP Procedure: Looking at (Cowardin) Habitat Succession over time



Datasets involved:

- **29_wrp_existing_Merger.shp** "Existing dataset" or initial state (**2376** records; **87,123 acres**)
- **plan_3yrall.shp** "Monitored dataset" or subsequent state (**3728** records; **66,704** acres)

Name of map file: **Cowardin_intersect.mxd**

STEP 1: Find the common easements between the temporal datasets

Using database methods, WRPEFILT.DBF was created to hold the common agreement numbers (easement records) shared between a dataset of initially recorded Cowardin habitats (original **29_wrp_existing.shp** was corrected to **29_wrp_existing_Merger.shp**[15]) and the Cowardin habitats which were recorded during a subsequent site visit (**plan_3yrall.shp**). It seems convenient to use this database to select those same records in the sister spatial datasets.

A. "Existing"
Right Click (hereafter R/C) on layer (29_wrp_existing_Merger)
Joins and Relates
Relate

1. AGREE_NUM
2. WRPEFILT
3. AGREE_NUM
4. Relate1
5. OK

R/C on layer (29_wrp_existing_Merger)
Open Attribute Table
Options (at bottom of "Attributes of 29_wrp_existing_Merger" table)
Related Tables
Relate1: WRPEFILT
Options (at bottom of "WRPEFILT" table)
Select All
Options (at bottom of "WRPEFILT" table)
Related Tables

[15] SEE **Corrections to Errors in GIS layers20070522.doc** in Project Archive

WRP Procedure: Looking at (Cowardin) Habitat Succession over time

Relate1: 29_wrp_existing_Merger
R/C on layer (29_wrp_existing_Merger)
Data
Export Data

Export: Selected features
⦿ this layer's source data
Output shapefile or feature class: Existing_in_common.shp
Add exported data to map as layer? Yes
2089 records; 62,057.acres

B. "Monitored"

Right Click on layer (plan_3yrall)
Joins and Relates
Relate

6. AGREE_NUM
7. WRPEFILT
8. AGREE_NUM
9. Relate2

OK
R/C on layer (plan_3yrall)
Open Attribute Table
Options (at bottom of "Attributes of plan_3yrall" table)
Related Tables
Relate2: WRPEFILT
Options (at bottom of "WRPEFILT" table)
Select All
Options (at bottom of "WRPEFILT" table)
Related Tables
Relate2: plan_3yrall
R/C on layer (plan_3yrall)
Data
Export Data
Export: Selected features
⦿ this layer's source data
Output shapefile or feature class: Monitored_in_common.shp
Add exported data to map as layer? Yes
3274 records

STEP 2: Eliminate the polygons which do not contain Cowardin data

A. "Existing"

R/C on layer (Existing_in_common)
Open Attribute Table

WRP Procedure: Looking at (Cowardin) Habitat Succession over time

Options (at bottom of "Attributes of Existing_in_common" table)
Select by Attributes
"COWARDIN" <> ‘ ’ [= !EMPTY(COWARDIN)]
Verify: OK
Apply
R/C on layer (Existing_in_common)
Data
Export data
Export: Selected features
⦿ this layer's source data
Output shapefile or feature class: Existing_in_common_with_habitat.shp
OK
Add exported data as layer to map? Yes
[Make sure the Existing_in_common_with_habitat.shp layer is active]
Tools
Calculate Acreage
Yes
2041 records

B. "Monitored"
R/C on layer (Monitored_in_common)
Open Attribute Table
Options (at bottom of "Attributes of Monitored_in_common" table)
Select by Attributes
"CUR_COWARD" <> ‘ ’ [= !EMPTY(COWARDIN)]
Verify: OK
Apply
R/C on layer (Monitored_in_common)
Data
Export data
Export: Selected features
⦿ this layer's source data
Output shapefile or feature class: Monitored_in_common_with_habitat.shp
Add exported data as layer to map? Yes
[Make sure the Monitored_in_common_with_habitat.shp layer is active]
Tools
Calculate Acreage
Yes
3012 Records

STEP 3: Establish the intersection of polygons with Cowardin data between the "Existing" and "Monitored" datasets

Tools
Geoprocessing

WRP Procedure: Looking at (Cowardin) Habitat Succession over time

Intersect
Open Tool
Input Features

Features:

- Existing_in_common_with_habitat.shp
- Monitored_in_common_with_habitat.shp

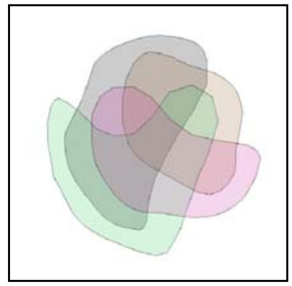
Output feature class:
C:\WRPDB\WorkCopy\Cowardin_Intersect**1**.shp
JoinAttributes (optional): All
[Make sure the Cowardin_Intersect**1**.shp layer is active]
Tools
Calculate Acreage
Yes
9818 records

NOTE: When executed with above input features listed in reverse order, the number of total records is the same (9815) but (after disregarding "slivers") the resulting breakdowns/ lumping of polygon records differ…thus order of listing layers in the Input Features window appears to lump/sum polygons for the last-listed feature. So listing order in this ArcGIS window seems analogous to the listing order in a database relation module…

STEP 4: Limit the influence of "slivers"

R/C on layer (Cowardin_Intersect**1**.shp)
Open Attribute Table
Options (at bottom of "Attributes of Cowardin_Intersect**1**" table)
Select by Attributes
"ACRES" >=0.4
Verify
OK
Apply
R/C on layer (Cowardin_Intersect**1**.shp)
Data
Export data
Export: Selected features
⦿ this layer's source data
Output shapefile or feature class: Common_appreciable_intersect.shp
Add exported data as layer to map? Yes
[Make sure the Common_appreciable_intersect.shp layer is active]
Tools
Calculate Acreage
Yes
488 easements; 4569 records; 52,208 acres

WRP Procedure: Looking at (Cowardin) Habitat Succession over time (on lands that were agricultural at commencement of restoration)



Datasets involved:

- **29_wrp_existing_Merger.shp** "Existing dataset" or initial state ***[replaces* 29_wrp_existing.shp]** (**2376** records; **87,123 acres**)
- **plan_3yrall.shp** "Monitored dataset" or subsequent state (**3728** records; **66,704** acres)

Name of map file: **Cowardin_intersect.mxd**

STEP 1: Modify the structure of the datasets to enable meaningful Cowardin habitat code analysis.

<u>Existing dataset</u>
Right Click ("R/C") on layer (29_wrp_existing_Merger)
Open Attribute Table
Options (at bottom of "Attributes of 29_wrp_existing_Merger" table)
Add field
Name: FOURCHACOD
Type: text
Length: 4
Deselect/Close the layer
Open database application

```
USE C:\WRPDB\WORKCOPY\29_WRP~1
REPLACE ALL FOURCHACOD WITH RIGHT(COWARDIN,6)
```

Close database application

<u>Monitored Dataset</u>
R/C on layer (plan_3yrall)
Open Attribute Table
Options (at bottom of "Attributes of plan_3yrall" table)
Add field
Name: FIXCOWARD
Type: text
Length: 11
Name: CORECOWARD
Type: text
Length: 8

WRP Procedure: Looking at (Cowardin) Habitat Succession over time
(on lands that were agricultural at commencement of restoration)

Name: FOURCHACOD
Type: text
Length: 4
Deselect/Close the layer

Note: "Existing" dataset Cowardin Codes were nearly uniform and did not need to be standardized en masse prior to deriving and entering the "Four character codes" that facilitate analysis (previous page). However, due to the varied state of data in the "Monitored" dataset, it was first necessary to standardize the Cowardin Codes prior to deriving and entering the "Four character codes". This was accomplished using a custom procedure CHGCWRD4.PRO. (This is abbreviated/excerpted below; only the main commands have been listed).

Open database application

```
USE C:\WRPDB\WORKCOPY\20070413\PLAN_3~1
INDEX ON CUR_COWARD TO XXX
SET FILTER TO FIXCOWARD="WP"
REPLACE FIXCOWARD WITH STRTRAN(FIXCOWARD,"WP","   WP")
SET FILTER TO FIXCOWARD="FPPFP"
REPLACE ALL FIXCOWARD WITH STRTRAN(FIXCOWARD,"FPPFP","  FPPFP")
SET FILTER TO FIXCOWARD="PE"
REPLACE FIXCOWARD WITH STRTRAN(FIXCOWARD,"PE","    PE")
SET FILTER TO FIXCOWARD="PF"
REPLACE FIXCOWARD WITH STRTRAN(FIXCOWARD,"PF","    PF")
SET FILTER TO FIXCOWARD="PLW"
REPLACE ALL FIXCOWARD WITH STRTRAN(FIXCOWARD,"PLW","PL W")
SET FILTER TO FIXCOWARD="PRW"
REPLACE ALL FIXCOWARD WITH STRTRAN(FIXCOWARD,"PRW","PR W")
SET FILTER TO FIXCOWARD="UP"
REPLACE ALL FIXCOWARD WITH STRTRAN(FIXCOWARD,"UP","  UP")
SET FILTER TO FIXCOWARD="OTO"
REPLACE ALL FIXCOWARD WITH STRTRAN(FIXCOWARD,"OTO","  OTO")
SET FILTER TO !ISDIGIT(RIGHT(FIXCOWARD,4)) AND (RIGHT(FIXCOWARD,4))#'Z' AND
!EMPTY(FIXCOWARD)
{perform manual editing for extraneous problematic codes}
SET FILTER TO ISLOWER(RIGHT(FIXCOWARD,3))
{perform manual editing for extraneous problematic codes}
SET FILTER TO !EMPTY(FIXCOWARD) AND ISLOWER(RIGHT(FIXCOWARD,1))
{perform manual editing for extraneous problematic codes}
SET FILTER TO !EMPTY(FIXCOWARD)
REPLACE ALL CORECOWARD WITH RIGHT(FIXCOWARD,7)
SET FILTER TO !EMPTY(FIXCOWARD) AND EMPTY(FOURCHACOD)
REPLACE FOURCHACOD with LEFT(CORECOWARD,4)
```

Close database application

WRP Procedure: Looking at (Cowardin) Habitat Succession over time
(on lands that were agricultural at commencement of restoration)

STEP 2: Select easements which were agricultural at the start of restoration.

<u>Existing dataset</u>
R/C on layer (29_wrp_existing_Merger)
Open Attribute Table
Options (at bottom of "Attributes of 29_wrp_existing_Merger" table)
Select by Attributes {some theoretically relevant codes my have been excluded if not present in dataset}
"FOURCHACOD" = 'OFW1' OR "FOURCHACOD" = 'OFW2' OR "FOURCHACOD" = 'OFW3' OR "FOURCHACOD" = 'OOC1' OR "FOURCHACOD" = 'OPC1' OR "FOURCHACOD" = 'OPC2' OR "FOURCHACOD" = 'ORP1' OR "FOURCHACOD" = 'OSA1' OR "FOURCHACOD" = 'PFP1' OR "FOURCHACOD" = 'UCRZ'

Verify: OK
Apply
R/C on layer (29_wrp_existing_Merger)
Data
Export data
Export: Selected features
⦿ this layer's source data
Output shapefile or feature class: Existing_with_AG_origin_habitat.shp
Add exported data to map as layer? Yes
{Make sure the Existing_with_AG_origin_habitat.shp layer is active}
Tools
Calculate Acreage
Yes
1161 records; 54,609 acres

STEP 3: Find the common easements between the temporal datasets

Using database methods, WRPEFILT.DBF was created to hold the common agreement numbers (easement records) shared between a dataset of initially recorded Cowardin habitats (**29_wrp_existing_Merger**) and the Cowardin habitats which were recorded during a subsequent site visit (**plan_3yrall**). It seems convenient to use this database to select those same records in the sister spatial datasets.

A. <u>Existing dataset</u>
R/C on layer (Existing_with_AG_origin_habitat.shp)
Joins and Relates
Relate

10. AGREE_NUM
11. WRPEFILT

WRP Procedure: Looking at (Cowardin) Habitat Succession over time
(on lands that were agricultural at commencement of restoration)

12. AGREE_NUM
13. Relate1
14. OK

R/C on layer (Existing_with_AG_origin_habitat.shp)
Open Attribute Table
Options (at bottom of "Attributes of Existing_with_AG_origin_habitat.shp" table)
Related Tables
Relate1: WRPEFILT
Options (at bottom of "WRPEFILT" table)
Select All
Options (at bottom of "WRPEFILT" table)
Related Tables
Relate1: Existing_with_AG_origin_habitat
R/C on layer (Existing_with_AG_origin_habitat.shp)
Data
Export Data
Export: Selected features
⦿ this layer's source data
Output shapefile or feature class: Existing_with_AG_origin_habitat_in_common.shp
Add exported data to map as layer? Yes
{Make sure the Existing_with_AG_origin_habitat_in_common.shp layer is active}
Tools
Calculate Acreage
Yes
1026 records; 42,495 acres

B. Monitored dataset

Right Click on layer (plan_3yrall)
Joins and Relates
Relate

15. AGREE_NUM
16. WRPEFILT
17. AGREE_NUM
18. Relate2

OK
R/C on layer (plan_3yrall)
Open Attribute Table
Options (at bottom of "Attributes of plan_3yrall" table)
Related Tables
Relate2: WRPEFILT
Options (at bottom of "WRPEFILT" table)
Select All
Options (at bottom of "WRPEFILT" table)
Related Tables

WRP Procedure: Looking at (Cowardin) Habitat Succession over time
(on lands that were agricultural at commencement of restoration)

Relate2: plan_3yrall
R/C on layer (plan_3yrall)
Data
Export Data
Export: Selected features
◉ this layer's source data
Output shapefile or feature class: Monitored_in_common.shp
Add exported data to map as layer? Yes
{Make sure the Monitored_in_common.shp layer is active}
Tools
Calculate Acreage
Yes
3728 records; **66,704**.acres

STEP 4: Eliminate the polygons which do not contain Cowardin data

A. Existing dataset

Elimination of polygons was accomplished as a byproduct of Step 2.

B. Monitored dataset

R/C on layer (Monitored_in_common)
Open Attribute Table
Options (at bottom of "Attributes of Monitored_in_common" table)
Select by Attributes
"CUR_COWARD" <> ' ' {equivalent to DB command " !EMPTY(CUR_COWARD)"}
Verify: OK
Apply
R/C on layer (Monitored_in_common)
Data
Export data
Export: Selected features
◉ this layer's source data
Output shapefile or feature class: Monitored_in_common_with_habitat.shp
Add exported data as layer to map? Yes
{Make sure the Monitored_in_common_with_habitat.shp layer is active}
Tools
Calculate Acreage
Yes
3408 Records; 62,739 acres

WRP Procedure: Looking at (Cowardin) Habitat Succession over time
(on lands that were agricultural at commencement of restoration)

STEP 5: Establish the intersection of polygons with Cowardin data between the "Existing" (i.e. the subset of existing with Agricultural origin) and "Monitored" datasets

Tools
Geoprocessing
Intersect
Open Tool
Input Features

Features:

- Existing_with_AG_origin_habitat_in_common.shp
- Monitored_in_common_with_habitat.shp

Output feature class:
C:\WRPDB\WorkCopy\Cowardin_AG_origin_Intersect.shp
JoinAttributes (optional): All
{Make sure the Cowardin_AG_origin_Intersect.shp layer is active}
Tools
Calculate Acreage
Yes
5800 records; 39,810.acres

> **Note:** From a previous test, the order of listing layers in the Input Features window appears to lump/sum polygons for the last-listed feature. So the effect of listing order in this ArcGIS window seems analogous to effect of listing order in a database relation module…

STEP 6: Discard/alleviate the influence of "slivers"

R/C on layer (Cowardin_AG_origin_Intersect.shp)
Open Attribute Table
Options (at bottom of "Attributes of Cowardin_AG_origin_Intersect" table)
Select by Attributes
"ACRES" >=0.4
Verify
OK
Apply
R/C on layer (Cowardin_AG_origin_Intersect.shp)
Data
Export data
Export: Selected features
⦿ this layer's source data

WRP Procedure: Looking at (Cowardin) Habitat Succession over time
(on lands that were agricultural at commencement of restoration)

Output shapefile or feature class: Common_appreciable_intersect_AG_origin.shp
Add exported data as layer to map? Yes
{Make sure the Common_appreciable_intersect_AG_origin.shp layer is active}
Tools
Calculate Acreage
Yes
2817 records; 39,731 acres NEW AS OF 6 JUNE 2007, TO THIS POINT

STEP 7: Determine the restoration fate of the Agricultural-origin polygons

FOREST SUCCESSORS
R/C on layer (Common_appreciable_intersect_AG_origin.shp)
Open Attribute Table
Options (at bottom of "Attributes of Cowardin_AG_origin_Intersect" table)
Select by Attributes {some theoretically relevant codes my have been excluded if not present in dataset}
"FOURCHAC_1" = 'ORP3' OR "FOURCHAC_1" = 'PFO1' OR "FOURCHAC_1" = 'PFO2' OR
"FOURCHAC_1" = 'PFO3' OR "FOURCHAC_1" = 'PFO4' OR "FOURCHAC_1" = 'PFO5' OR
"FOURCHAC_1" = 'PFP3' OR "FOURCHAC_1" = 'UWO1' OR "FOURCHAC_1" = 'UWO'
Verify: OK
Apply
R/C on layer (Common_appreciable_intersect_AG_origin.shp)
Data
Export data
Export: Selected features
⦿ this layer's source data
Output shapefile or feature class: AG_intersect_forest.shp
Add exported data to map as layer? Yes
{Make sure the AG_intersect_forest.shp layer is active}
Tools
Calculate Acreage
Yes
1317 records, 18,868 acres (11 June)

SCRUB SHRUB SUCCESSORS

R/C on layer (Common_appreciable_intersect_AG_origin.shp)
Open Attribute Table
Options (at bottom of "Attributes of Cowardin_AG_origin_Intersect" table)
Select by Attributes
"FOURCHAC_1" = 'PSS1' OR "FOURCHAC_1" = ' PSS2' OR "FOURCHAC_1" = ' PSS3' OR
"FOURCHAC_1" = ' PSS4' OR "FOURCHAC_1" = ' PSS5' OR "FOURCHAC_1" = ' USH1' OR
"FOURCHAC_1" = 'USH2'
Verify: OK

WRP Procedure: Looking at (Cowardin) Habitat Succession over time
(on lands that were agricultural at commencement of restoration)

Apply
R/C on layer (Common_appreciable_intersect_AG_origin.shp)
Data
Export data
Export: Selected features
⦿ this layer's source data
Output shapefile or feature class: AG_intersect_scrub&shrub.shp
Add exported data to map as layer? Yes
{Make sure the AG_intersect_scrub&shrub.shp layer is active}
Tools
Calculate Acreage
Yes
20 records

NON-WOODY VEGETATED SUCCESSORS

R/C on layer (Common_appreciable_intersect_AG_origin.shp)
Open Attribute Table
Options (at bottom of "Attributes of Cowardin_AG_origin_Intersect" table)
Select by Attributes {some theoretically relevant codes my have been excluded if not present in dataset}
"FOURCHAC_1" = 'ORP2' OR "FOURCHAC_1" = 'OSA2' OR "FOURCHAC_1" = 'PEM1' OR "FOURCHAC_1" = 'PEM2' OR "FOURCHAC_1" = 'PFP2' OR "FOURCHAC_1" = 'PSA1' OR "FOURCHAC_1" = 'PSA2' OR "FOURCHAC_1" = 'UHE1' OR "FOURCHAC_1" = 'UHE2'
Verify: OK
Apply
R/C on layer (Common_appreciable_intersect_AG_origin.shp)
Data
Export data
Export: Selected features
⦿ this layer's source data
Output shapefile or feature class: AG_intersect_nonwoody_veg.shp
Add exported data to map as layer? Yes
{Make sure the AG_intersect_nonwoody_veg.shp layer is active}
Tools
Calculate Acreage
Yes
1405 records, 20280 acres (11 June)

AGRICULTURAL SUCCESSORS

R/C on layer (Common_appreciable_intersect_AG_origin.shp)
Open Attribute Table

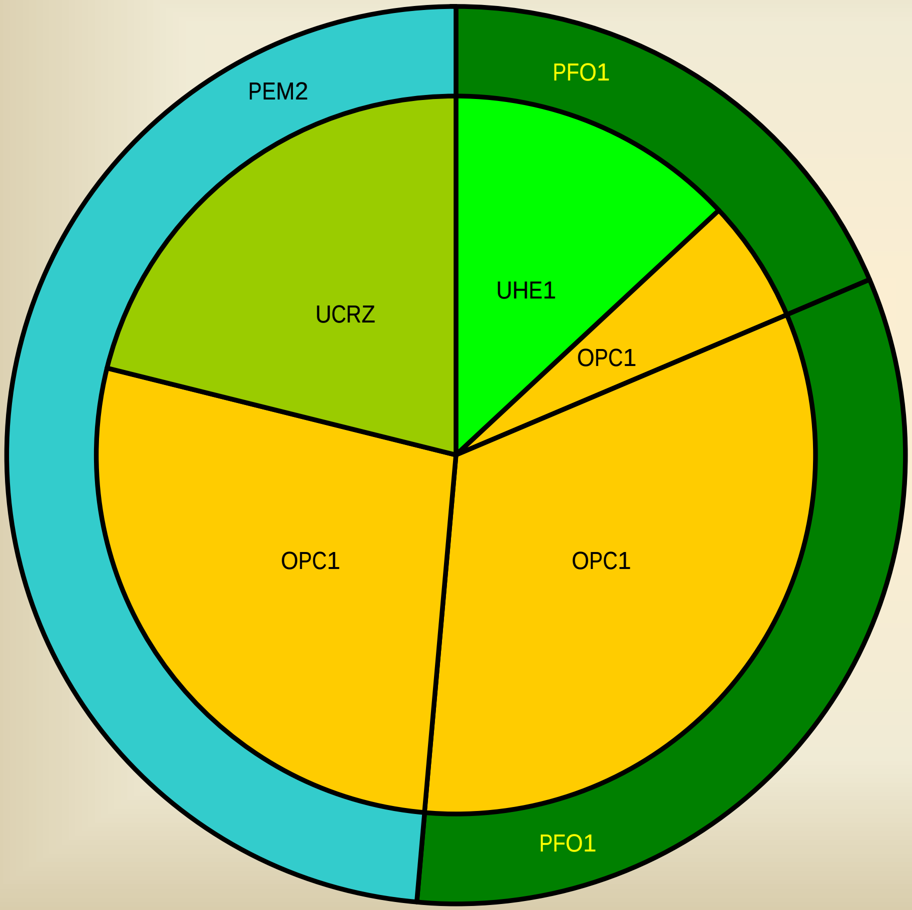
WRP Procedure: Looking at (Cowardin) Habitat Succession over time
(on lands that were agricultural at commencement of restoration)

Options (at bottom of "Attributes of Cowardin_AG_origin_Intersect" table)
Select by Attributes {some theoretically relevant codes my have been excluded if not present in dataset}
"FOURCHAC_1" = 'OFW1' OR "FOURCHAC_1" = 'OFW2' OR "FOURCHAC_1" = 'OFW3' OR "FOURCHAC_1" = 'OOC1' OR "FOURCHAC_1" = 'OOC2' OR "FOURCHAC_1" = 'OOC3' OR "FOURCHAC_1" = 'OPC1' OR "FOURCHAC_1" = 'OPC2' OR "FOURCHAC_1" = 'ORP1' OR "FOURCHAC_1" = 'OSA1' OR "FOURCHAC_1" = 'PFP1' OR "FOURCHAC_1" = 'UCRZ'
Verify: OK
Apply
R/C on layer (Common_appreciable_intersect_AG_origin.shp)
Data
Export data
Export: Selected features
⦿ this layer's source data
Output shapefile or feature class: AG_intersect_AG.shp
Add exported data to map as layer? Yes
{Make sure the AG_intersect_AG.shp layer is active}
Tools
Calculate Acreage
Yes
2 records

OTHER/OPEN WATER SUCCESSORS

R/C on layer (Common_appreciable_intersect_AG_origin.shp)
Open Attribute Table
Options (at bottom of "Attributes of Cowardin_AG_origin_Intersect" table)
Select by Attributes {some theoretically relevant codes my have been excluded if not present in dataset}
"FOURCHAC_1" = 'OSA3' OR "FOURCHAC_1" = 'POWZ'
Verify: OK
Apply
R/C on layer (Common_appreciable_intersect_AG_origin.shp)
Data
Export data
Export: Selected features
⦿ this layer's source data
Output shapefile or feature class: AG_intersect_otherwater.shp
Add exported data to map as layer? Yes
{Make sure the AG_intersect_otherwater.shp layer is active}
Tools
Calculate Acreage
Yes
73 records

Restoration of 16 acres of polygons in a WRP Easement

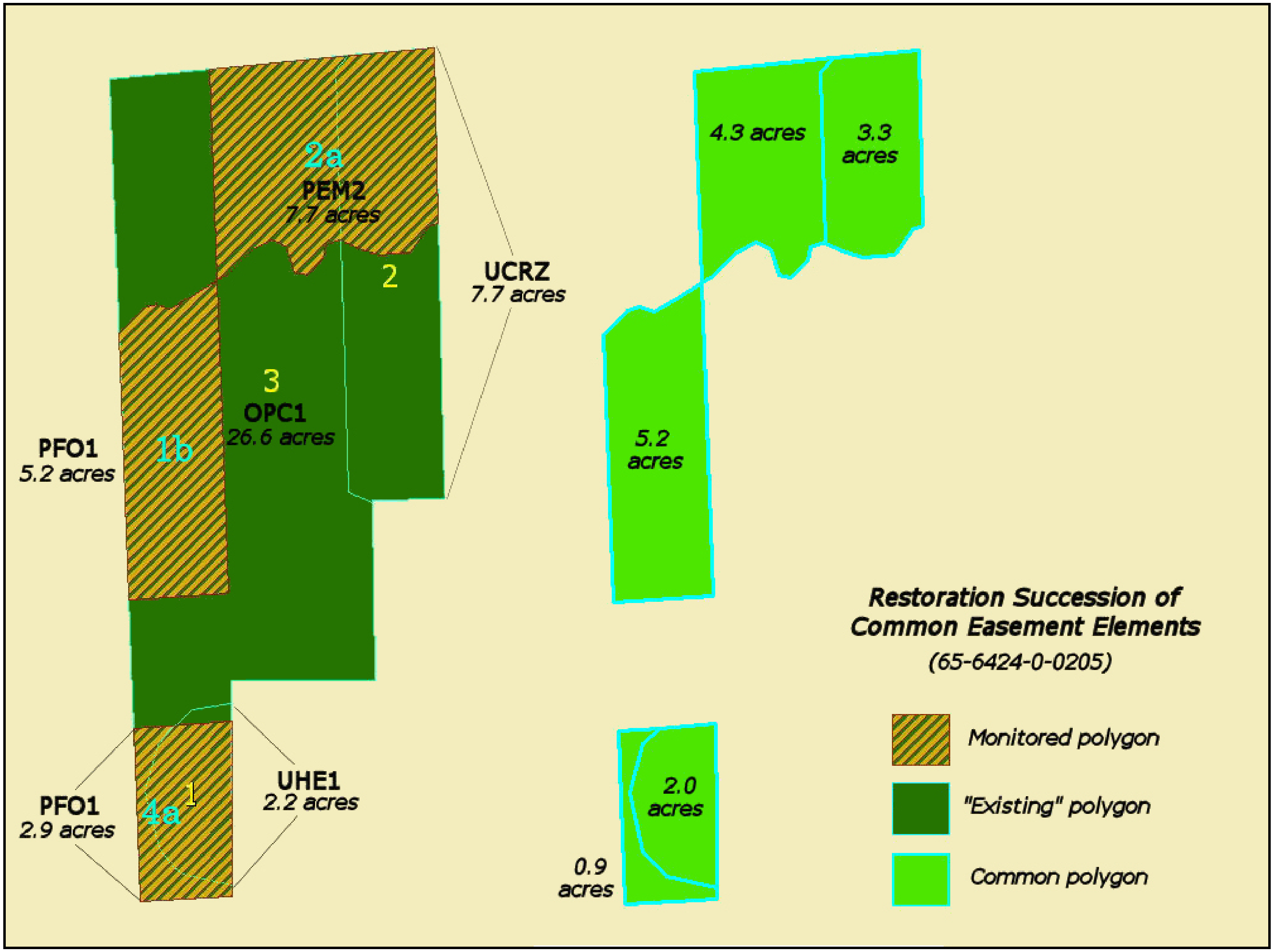


This graphic depicts the succession of polygons (spatial units) within an easement undergoing restoration. The habitat at the "start" of restoration (enrolled Jan 2001) is represented by the inner "pie" and the state it had reached at the first monitoring visit (Nov 2005) is represented by the outer circle. Each "slice" represents a polygon that can be compared between the two points in time. See the tables below for details. (Size of slices and rings not to scale for acreage).

Existing: Inner Circle			Monitored: Outer Circle		
field number	Cowardin	acres	field number	Cowardin	acres
1	UHE1	2.0	1a	PFO1	2.9
3	OPC1	0.9			
3	OPC1	5.2	1b	PFO1	5.2
3	OPC1	4.3	2a	PEM2	7.7
2	UCRZ	3.3			

Cowardin	Description
OPC1	Cropped, prior-converted cropland
UCRZ	Upland, cropland
UHE1	Upland, native herbaceous
PFO1	Palustrine, broad-leaf deciduous forest
PEM2	Palustrine, non-persistent emergent

Map illustrating successional change on 16 acres of WRP easement.



The alphanumeric labels for land parcels ("polygons") used above were those used in the relevant data records.

Excel® 2003 Acreage Calculations for above Graphic and Map Illustrations

Intersection between Monitored & Exisiting Datasets of Easement 65-6424-0-0205

MONITORED					EXISTING		
AGREE_NU_1	**FIELD**	**MANAGE_UN**	**FOURCHACOD**	**ACRES_1**	**AGREE_NUM**	**FOURCOWARD**	**Total**
65-6424-0-0205	1	b	**PFO1**	5.157	65-6424-0-0205	**OPC1**	5.157
					65-6424-0-0205 Total		5.157
				5.157 Total			5.157
			PFO1 Total				5.157
		b Total					5.157
	1 Total						5.157
	2	a	**PEM2**	7.671	65-6424-0-0205	**OPC1**	4.324
						UCRZ	3.346
					65-6424-0-0205 Total		7.67
				7.671 Total			7.67
			PEM2 Total				7.67
		a Total					7.67
	2 Total						7.67
	4	a	**PFO1**	2.937	65-6424-0-0205	**OPC1**	0.894
						UHE1	2.042
					65-6424-0-0205 Total		2.936
				2.937 Total			2.936
			PFO1 Total				2.936
		a Total					2.936
	4 Total						2.936

Existing: Inner Circle			**Monitored: Outer Circle**		
field number	**Cowardin**	**acres**	**field number**	**Cowardin**	**acres**
1	UHE1	2.0	1a	PFO1	2.9
3	OPC1	0.9			
3	OPC1	5.2	1b	PFO1	5.2
3	OPC1	4.3	2a	PEM2	7.7
2	UCRZ	3.3			
		15.8			**15.8**

Cowardin	**Description**
OPC1	Cropped, prior-converted cropland
UCRZ	Upland, cropland
UHE1	Upland, native herbaceous
PFO1	Palustrine, broad-leaf deciduous forest
PEM2	Palustrine, non-persistent emergent

ANNEX 5

SUPPLEMENTARY PROJECT DOCUMENTATION

Missouri WRP Analysis Project

PHOTOGRAPHIC DOCUMENTATION

Table of Contents

List of secondary outputs for the Photographic Documentation Product

<u>NOTE</u>: Due to format (and/or page dimension/length), these outputs have been provided on the project's systematically organized CD archive.

1. DIRLIST_All_Easement_Photos.txt

- Complete consecutive directory listings of all WRP photographs and ancillary files made available for project analysis.

2. ALLPHOTOS.xls

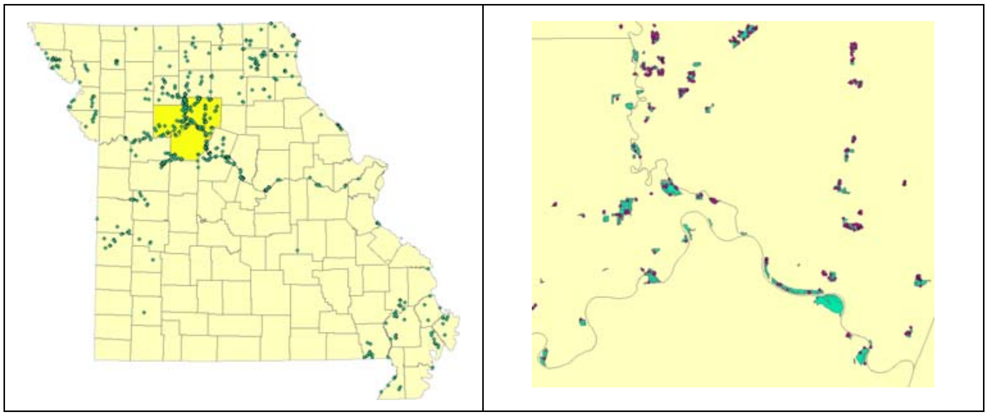
- COMBINED digital photo dataset records (from the four electronic file storage folders) generated with specific DIR listing software (Photographic documentation method 3). Cleaned and weeded. Sample of 37 photo descriptions added "after the fact" to assess input burden and effectiveness of this kind of effort.

3. PhotoCount.xls

- Summary Count of Digital Photographs per Storage Folder (easement)
- Pivot Table of the photo counts per folder (easement)
- Core excerpt of ALLPHOTOS.xls (next output) as basis for Pivot Table counts.
- List of 112 files (primarily photographs) excluded because they were not labeled with agreement numbers (not attributable to a specific easement), were misallocated to the monitored dataset, were non-easement photos (i.e. general thematic) or were not photos at all.

4. WRP photos.mxd & photos_intersect_plan.shp

- Map of Missouri plotted with monitored WRP sites and photo points.



- GIS spatial intersection of WRP photo points (2595 records[16]) and the WRP monitoring data file (3728 polygon records)

5. FOTOINTS.xls

- FOTOINTS.xls is a pared-down and cleaned-up spreadsheet version of FOTOINTS.DBF (from photos_intersect_plan.shp) the intersection of GIS WRP photo points and the GIS WRP monitoring data file. This dataset includes 2300 photo point records from 464 easements. (The archived file FOTINTUQ.DBF contains the 1922 unique photo point records that intersect the monitored dataset).

6. Photo Datasets Relationships.xls

- The complete version of this workbook with three worksheets provides tabular and diagrammatic representations of the attributes of, and the relationships between, the WRP easement photographs, GIS photo point and monitoring data records and derived databases of the Missouri WRP photographic dataset. An image of the relationships diagram is provided in Chapter 5.

[16] These records have no overt (attribute table field) connection to easement agreement number, thus a spatial intersection is called for to relate each photo point to a specific easement.

Summary of Guidance Provided on Photographic Documentation of WRP Easements

Introduction

There was some measure of disconnect between the implied aspiration of the project proposal for this product and what was achievable with the dataset. This begged the question: "What references, advice or instructions are there to/for photographing WRP sites in official documents or instruments?" The following allusions to this issue were uncovered in four documents/instruments.

Documentation / Instruments

A. The **MISSOURI 20[*07*] WRP RANKING FORM** (2006PrePlanRev101505_C.doc), labeled on-line as "Missouri WRP Preliminary Planning Checklist," is also available at: http://www.mo.nrcs.usda.gov/programs/wrp/out/2006PrePlanRev012706_A.pdf. The document appears to be an in-house form for use by NRCS staff in evaluating the suitability of a site for the WRP. It makes mo mention of photographic documentation for WRP sites.

B. The **Missouri WRP Bid Pilot Self Assessment Guide** is available at: http://www.mo.nrcs.usda.gov/programs/wrp/out/WRP%20Bid%20Pilot_MO_07182006.pdf. As its name implies, this is a form filled out by a landowner for nominating a site for the WRP. It does not mention photographs or request photographic documentation as part of the submission of a nominated site although a map is requested if available.

C. The document **WRPmonitoringagreementATTACHMENT A 2006-lizedits.doc** is comprised of three main sections. The first part, "ATTACHMENT A" entitled "Easement and Ecological Monitoring Functional Requirements [–] Missouri Wetlands Reserve Program," is a blend of instructions and operational elements (i.e., equipment and cost estimates). The second section entitled "MISSOURI WRP EASEMENT MONITORING[.] Revised 10/21/99[.] Version 2002[.] is a site compliance monitoring data form (including a "Practice and Cost Worksheet"). The last part of the document is entitled "Missouri WRP Ecological Monitoring Form." It includes WHAG (Wildlife Habitat Appraisal Guide) worksheets for Bottomland Hardwoods and Nonforest Wetland.

The following excerpts from this document include references, advice or instructions about monitoring photography:

<u>First section</u>
"…GPS will be used to locate digital **photo** documentation stations and violations. The monitoring form and **photos** will be spatially associated with the easement boundary and can be uploaded to the Web database or used in ArcView."
"a) Complete WRP Easement Monitoring Checklist, including **photo** records and identifying locations of violations. The monitoring form and **photos** will be spatially

associated with the easement boundary and can be uploaded to the Web database or used in ArcView"

"b) Complete WRP Ecological Monitoring Form for ecological monitoring, including delineation of current habitat conditions, **photo** records and identifying ecologically significant locations."

(Both of these points found under "Tasks, Equipment and Cost Estimate to Conduct Easement, Landowner Activity, and Ecological Monitoring")

"As a minimum, on-site monitoring will be completed every third year. In the years when there is no on-site monitoring the evaluation will be conducted using remote sensing such as satellite imagery and aerial **photography**."

2nd section (compliance form)

"Take **photograph** from designated **photo** points when doing on-site monitoring[.]
Location of **photo** points ____"

"Are easement conditions being met (e.g., no encroachment, dumping, cropping, etc.)?
Yes No *If no, describe and document with **photograph***)"

3rd section (ecological monitoring form)

"Take **photograph** from designated **photo** points when doing on-site monitoring[.]"

D. "The **WRP PROGRAM MANUAL**"

Natural Resources Conservation Service (NRCS). [2007]. Conservation Programs Manual Title 440, Part 514. Wetland Reserve Program. Accessed 29 November 2007 at www.info.usda.gov/scripts/lpsiis.dll/M/M_440_514.htm. Also available at http://policy.nrcs.usda.gov/ (using the "side menu").

Specific Excerpts: references to photography

514.19 WRP Restoration Plan
"c. Preliminary Restoration Plan Basic Elements
At a minimum, the Preliminary Restoration Plan will consist of:

- an aerial **photo** and/or map which identifies the offered land and the location of practices that will be established;"

"d. Final Plan Contents
The final restoration plan shall consist of the following:

- **photographs** that document site conditions before, during, and after restoration. Location points of **photography** will be recorded on a map of the easement or agreement area;"

FROM: M.440.514.D - Subpart D - Restoration http://policy.nrcs.usda.gov/viewDirective.aspx?id=1843

514.31 Boundary Description
“e. Legal Descriptions
The visual description of the easement (i.e., map or aerial **photograph**) that accompanies the description is extremely important to any future need to resolve differences of opinion. When reliance is entirely on a map and legend to provide a boundary description, it is critical that all the necessary information be illustrated. It is this visual, as well as the written, record that will be used in reconstructing the “intent” of the parties at that future date. Such information will also be extremely valuable to field personnel as easement administration, management, and monitoring efforts are carried out.”

514.34 Perfecting the Easement
“d. Follow-up Activity with FSA
Advise the local FSA office of the date that the easement was recorded and provide a graphic representation or aerial **photo** detailing the easement location and acreage. This information will be used by FSA to track the 25 percent county cropland acreage cap on WRP and Conservation Reserve Program lands and to reduce production flexibility contract acreage when applicable.”

514.36 Assembling WRP Files
“a. Recommended Folder Arrangement
Items to include:

- Reference **photography**”

FROM: M.440.514.E - Subpart E - Easement Acquisition
http://policy.nrcs.usda.gov/viewDirective.aspx?id=1845

514.46 Restoration Agreement Management
“c Items to be Reviewed
At a minimum, the review process should consider whether:

- **photographs** have been taken and maintained in the project file, and”

514.47 Easement Management and Monitoring
“f Inspecting the Site for Easement Violations
In the years when there is no onsite inspection, the evaluation will be by **slides**, satellite **imagery**, aerial **photography**, etc.”

514.48 Enforcement
“b Possible Violations
5 **Camera, video equipment,** or **digital camera** to record the condition of the site. **Photographs** should be taken as soon as possible when significant changes occur such as land use, new drainage facilities, or possible violations of the easement.”
“c About the Possible Violation Site Visit
During the site visit the following activities should occur.

4 Compile **photographic** documentation of all aspects of the possible violation including:

- **photographs, slides, videos,** or **digital photos** from various directions that capture the alleged violation, such as haying, mowing, grazing, cultivation, dumping, or encroachment, and the extent.
- the most serious aspects of the alleged violation.
- potentially controversial areas concerning compliance. Show the general nature of the surrounding easement area so that adequate compliance can be easier to achieve.

Mark on a map the points from which **photographic** coverage was taken, and label all pertinent data on the **photographic** coverage."
FROM: M.440.514.G - Subpart G - Quality Control
http://policy.nrcs.usda.gov/viewDirective.aspx?id=1847

PHOTOGRAPHIC DOCUMENTATION: *METHODS*

Missouri WRP Analysis Project

Methods for Inventorying and Assessing Photographic Coverage of Missouri WRP Easements (a.k.a. *Meta Data Management and Analysis of Missouri WRP Photos*)

Table of Contents

<u>CATEGORY</u>: Inventory of the physical stock of digital WRP photographs

<u>METHOD 1</u>: Effect a *gross* count of photographed easements and (associated) photographs using Windows® Explorer®.

<u>PURPOSE/USE</u>: Provides quick general assessment of easement coverage and volume of photographs available for management. Useful as a "Check sum" for other methods.

Technique to make gross counts of folders (to derive a surrogate number of easements) and files (mostly photographs).

<u>Steps</u>

1. In Windows Explorer, right click on the target folder name.
2. Access folder properties: Click on "Properties."
3. Consult the "General" tab.
4. Look at "Contains:"

Sample tabulated results below. (*Actual results are used in these examples*):

After some minor adjustments C:\WRPDB\easement_photos\	(mostly) photos [files]	easements [folders]
photos04	809	152
photos05	1323	205
photos06	637	87
photos3Y	273	103
Grand Total	3042	547

<u>NOTE</u>: Windows Explorer **counts one extra file per folder** for folders with image files. This is a protected operating system file named **Thumbs.db** which may not be visible in Windows Explorer depending on settings. Therefore it is necessary to adjust the gross count. (Step 5).

5. Subtract 1 x number of folders from the file count.

C:\WRPDB\easement_photos\	(mostly) photos [files]	easements [folders]
photos04	**657**	152
photos05	**1118**	205
photos06	**550**	87
photos3Y	**170**	103
Grand Total	**2495**	547

CATEGORY: Inventory of the physical stock of digital WRP photographs.

METHOD 2: List (photographic) folder contents to a text file.

PURPOSE/USE: Documentation of structure and content (for good practice); provides an auxiliary precursor (if needed) for a meta database on the photographic resource.

Technique to make a complete, combined listing of the directory contents of the four photographic folders. (See introduction).

Steps

1. Call up the command window and type the command [in bold]: **CD\ <Enter>** to reinstate the simple root directory prompt "C:\>"
2. Type the following command [in bold]:

C:\>**DIR > C:\WRPDB\easement_photos\ /s >** (type without a *manual* break here)
C:\WRPDB\easement_photos\META\DirPhotoList.txt <Enter>

CATEGORY: Inventory of the physical stock of digital WRP photographs

METHOD 3: [preferred, alternative method to] Create a meta database from the photographic folder filing system *using specialized software* to access additional/ancillary meta data about stored photographs.

PURPOSE/USE: Provides an *expanded* database of conventional and meta information directly from the photographic filing structure and photographs. Facilitates vetting of irrelevant records to enable a precise count of easement photographs. The resulting database can be imported into Excel to take advantage of its "Pivot Table" functionality (for ease of analysis).

BACKGROUND: Standard techniques and programs (Microsoft® Windows® and MS-DOS® directory-listing commands) were employed to generate a metadata inventory listing about the stored digital photographs of Missouri WRP easements. Two elements determine the utility of a directory listing. In the first instance, the *structure* of the raw metadata listing must support conversion to a database. The metadata *content* must also be considered. Contemporary digital photo technology enables storage of a number of ancillary photographic parameters ("image information" e.g. image title, creator/ photographer, date of photo, etc). Perhaps the most useful additional metadata available (in terms of this Missouri WRP easement analysis project) is the "date of photo." While a surrogate of "date of photo" in the form of "date of file creation" can be got through a rigid DOS DIR-listing command, it issues in a format that cannot be imported into a database. The output first requires excessive manual editing or a special parsing script must first be written and then run on the output. Owing to this surprising technical constraint of standard tools, alternative specialized software was sought. Due to budgetary constraints I downloaded and used a "shareware" program "Print Maestro™ 3." While this limited (i.e. free unregistered) version of the software accomplished the intended task – a workable raw directory listing of WRP digital photographs – it was just **one of a number of potentially suitable file manager programs available** for downloading from the internet.

Technique for using the program "Print Maestro™ 3" to create a CSV (comma separated values) from a directory structure for use in creating a database of photo-folders and photographs.

Steps (repeat for each of the four photo folders)
1. Start "Print Maestro" program
2. Select the folder of photographs to output a list
3. Select "Export" (menu)
4. Select "Other"
5. Skip down to and tick "include subfolders"
6. Under "Print attributes|more" select "Photo|Photo date"
7. Return to main window and select "Export" (button)
8. Under the "Export type|formats" tab selection, choose the "CSV file" radio button
9. Browse to and/or fill in a "Destination file"
10. Under the "fields" tab, select the following fields (in order):
    IsFolder
    Level
    FileName
    Photo date
11. Click "Start Export"
    This will open Excel automatically.
12. Save the Excel file as it is: a CSV file (i.e. choose to keep the format and exclude any incompatible features)
13. Exit Excel

Technique for preparing *.CSV lists to be appended, creating a database structure, populating the database, then cleaning up the data records.

Steps
1. Delimited each *.CSV file properly with a text editor to assist importation into a common database structure (*.DBF) as delineated below. This means manage spaces, and position commas in the appropriate places, so that the text will imported into the "target" fields, and not elsewhere!

2. Using FoxPro or other DBMS, create ALLPHOTO.DBF with the following structure:

Field	Field Name	Type	Width	
1	ISFOLDER	Logical	1	{To Be Deleted after checking below completed}
2	LEVEL	Numeric	1	{To Be Deleted after checking below completed}
3	DATASET	Character	10	
4	FOLDER	Character	16	
5	FILENAME	Character	26	
6	FOTODATE	Date	8	
7	TIME	Character	10	{To Be Deleted; not used}
** Total **			73	

3. Populate this database by **APPEND**ING from each *.CSV (delimited text) file; begin with the oldest photos (photos04.CSV).

4. *Weed* ALLPHOTO.DBF using filters (below) to get rid of irrelevant records. Begin with
"misfiled" records such as those labeled "NOT FOUND..." OR "NOT PART..." Copy these records elsewhere and delete them from ALLPHOTO.DBF.

SET FILTER TO "NOT"$FOLDER
SET FILTER TO ".TXT"$FILENAME OR ".DOC"$FILENAME

5. Identify photo folders which have not been labeled with a specific easement number (e.g.
labeled as "Bates Co." only), isolate them (copy them elsewhere), and then delete them from ALLPHOTO.DBF with these DB commands:

SET FILTER TO !"-"$FOLDER AND ISALPHA(FOLDER)=.T.
COPY TO GENFOT04.DBF
DELETE FOR !"-"$FOLDER AND ISALPHA(FOLDER)=.T
PACK

6. Then, use the following commands identify superfluous records. For example, the first two commands listed should yield the same total result, and the results of the third-listed command should be equal to the results from the fourth command; the sum of the results of the last two commands should equal the results of each of the first two commands:

COUNT FOR ISFOLDER=.T.
COUNT FOR LEVEL=0
COUNT FOR !("JPG"$FILENAME)
COUNT FOR EMPTY(FOTODATE)

Isolate them (copy them elsewhere), and then delete them from ALLPHOTO.DBF.

Technique to add agreement numbers to photo records extracted from the digital photo filing system.

Incorporate easement agreement numbers as part of the photo records in ALLPHOTO.DBF with these DB commands:

```
SELECTION 1
USE ALLPHOTO
INDEX ON NUMBER TO XXX
SELECTION 2
USE COMPFILL
INDEX ON NUMBER TO ZZZ
SELECTION 1
SET RELATION TO NUMBER INTO B
BROWSE FIELD B.AGREE_NUM,AGREE_NUM,B.NUMBER,NUMBER,
FOTODATE,B.REV_DATE
REPLACE ALL AGREE_NUM WITH B.AGREE_NUM FOR
EMPTY(AGREE_NUM)
BROWSE FIELD
B.AGREE_NUM,B.NUMBER,AGREE_NUM,NUMBER,FOTODATE,
B.REV_DATE
```

Technique to utilize intermediate product "ALLPHOTO.DBF" in Excel (to take advantage of its flexible counting facility).

Steps

1. Open ALLPHOTO.DBF in Excel and save as PhotoCount.xls[17].
2. In PhotoCount.xls, select the ALLPHOTO **tab**.
3. From the **Data** menu
4. Select **PivotTable and PivotChart Report**
5. Select **Microsoft Excel list or database | PivotTable**
6. Click **Next**
7. Where is the data that you want to use? Use the automatic selection: **database**
8. Click **Next**
9. Select **New worksheet**
10. Click **Finish**
11. Use this pivot table to tally the folders (easements) and files (photographs) in each main folder

[17] The refined PhotoCount.xls is a component output of product 4: Photographic Documentation.

CATEGORY: Assessment of the physical stock of digital WRP photographs.

METHOD 4: Check the correspondence between monitored easement agreement numbers (from a modified consolidated easement compliance file – COMPFILL.DBF) and easement photographic records (based on the photographic folder filing system), and produce related lists/databases.

PURPOSE/USE: To document photo coverage overlaps/matches AND omissions/non-matches with the WRP monitored easements dataset.

SYNOPSIS: This is a collection of procedures (originating from FOTO&DAT.PRO[18]) that operates on the photographic files storage system (directories of folders and files), using "element presence", i.e. "subfolder" to determine if easements have basic photographic coverage. (Sub)Folders here represent easements, and are labeled with the unique portion of easement numbers. (In many cases however, the name of the *photo* itself is NOT linked to the easement number).

The procedure first produces contents (– subfolders) lists in turn of each of four main directories (folders organized by fiscal year, see below) of photographs (organized by easement number); these lists are used to create databases. The four databases are *compared* to the monitoring dataset's easement agreement numbers (as listed in COMPFILL.DBF – 594 easements/records) through database *relations.* These comparisons (relations) are used to derive two lists for each of the four main directories/folders: one list of "subfolder" labels matching easement agreement numbers occurring in the monitoring dataset *and* one list of subfolder labels that do NOT match easement agreement numbers in the monitoring dataset. The four lists which contain agreement number matches (with subfolders) are combined to form a master photo list: MASTFOTO.DBF **–** 532 folders/530 easements. {The discrepancy seen here between folders and easements arises from the fact that "7-8536" is found in both photos04 & photos05, and "8-8484" is found in both photos04 & photos06}.

Technique to create a database of "easements that have photographs" from each of the main folders in the photographic filing system. See table list at right. Commands in bold text.

photos04
photos05
photos06
photos3Y

Steps (repeat for each of the four folders)

[18] A multi-part FoxPro procedure developed for analyzing the WRP photographic resource within the WRP analysis project.

3. Select one of the four parent folders of digital easement photographs. (These are differentiated by use of "FY**xx**," where "**xx**" is the fiscal year (e.g. 04) or similar descriptor (e.g. 3Y). (This follows the naming convention adopted for photo folders which is to use the unique, rightmost or last digits/characters of the easement agreement number).

4. Call up the command window and type the following command:
CD\ <Enter> to reinstate the simple root directory prompt "C:\>"

5. Type the following command:
C:\>**CD C:\WRPDB\easement_photos\photosxx\ <Enter>**

6. Type the following command :
C:\WRPDB\…\photos**xx**>**DIR > C:\WRPDB\WORKSHOP\FOLFOTxx.txt <Enter>**

7. With a text editor, delete header and footer text, and all columns EXCEPT the *folder name* (again, most photo folder names use last unique part of easement "agreement number"). Be sure to remove any preceding blanks. Save and Exit.

8. In FoxPro (or other DBMS) create a database "FOLFOT**xx**.DBF" with the following structure: **NUMBER Character 15**

9. **USE FOLFOTxx.DBF**

10. **APPEND from FOLFOTxx.TXT DELIMITED**

Technique to establish a common data field between easement folders (containing photographs) and monitored easement data records.

Key database commands are in bold; other text that is preceded by "&&" is commentary.

USE COMPFILL && This is the *consolidated* (i.e., 1 record – 1 easement) version of the compliance monitoring file (COMBCOMP.DBF)
MODIFY STRUCTURE && Add a field "NUMBER" and delete superfluous fields
REPLACE ALL NUMBER WITH AGREE_NUM
SET FILT TO "65-6424"$NUMBER
REPLACE ALL NUMBER WITH STRTRAN(NUMBER,"65-6424-","")
SET FILT TO "66-6424"$NUMBER
REPLACE ALL NUMBER WITH STRTRAN(NUMBER,"66-6424-","")

COMPFILL.DBF can now be used to provide complete agreement numbers for photographic folders through relational linkage (next page).

Technique to compare records of digital easement photographs (stored in one of the four folders mentioned above) against easement agreement numbers in the monitored easement dataset (COMPFILL.DBF) and document the results.

Key database commands are in bold. Repeat these steps for each of the four folders (denoted by **xx**).

SELECTION 1
USE FOLFOTxx
INDEX ON NUMBER TO XXX
SELECTION 2
USE COMPFILL
INDEX ON NUMBER TO ZZZ
SELECTION 1
SET RELATION TO NUMBER INTO B
BROWSE FIELD B.AGREE_NUM,B.NUMBER,NUMBER
SET FILTER TO EMPTY(B.NUMBER)
COPY FIELD NUMBER TO PICxxNIM.TXT DELIMIT
SET FILTER TO !EMPTY(B.NUMBER)
COPY FIELD AGREE_NUM,NUMBER TO PICxxINM.TXT DELIMIT

WHERE "PIC**xx**NIM" stands for **PIC**ture in FY**xx** folder is **N**ot found **I**n the **M**onitoring dataset or in other words, the agreement number label used on the folder of photographs does not match an agreement number in the monitored easement dataset. And WHERE "PIC**xx**INM stands for **PIC**ture in FY**xx** folder is found **IN** the **M**onitoring dataset or in other words, the agreement number label used on the folder of photographs matches an agreement number in the monitored easement dataset.

Technique to create a master list of digital photograph easement sets (=subfolders) with agreement numbers that match agreement numbers of easements in the monitored dataset.

Key database commands are in bold; other text that is preceded by "&&" is commentary.

CREATE MASTFOTO && Add fields AGREE_NUM, NUMBER, RECNO
USE MASTFOTO[19]
APPEND FROM PIC04INM.TXT DELIMIT
APPEND FROM PIC05INM.TXT DELIMIT
APPEND FROM PIC06INM.TXT DELIMIT
APPEND FROM PIC3YINM.TXT DELIMIT
REPLACE ALL RECNO WITH RECNO()
INDEX ON AGREE_NUM TO XXX UNIQ
COPY TO TEMP

[19] also saved in Excel as MasterPhotoList.xls

CLOSE ALL

Technique to find any duplicate folder names (easements) from among the four parent photo folders.

Key database commands are in bold.

SELECTION 1
USE MASTFOTO
INDEX ON RECNO TO XXX
SELECTION 2
USE TEMP
INDEX ON RECNO TO ZZZ
SELECTON 1
SET RELATION TO RECNO INTO B
BROWSE FIELD AGREE_NUM,RECNO,B.RECNO
SET FILTER TO EMPTY(B.AGREE_NUM)
COUNT
BROWSE FIELD AGREE_NUM,RECNO,B.RECNO
[**COPY TO** *[FILENAME]*]

CATEGORY: Assessment of the spatial records of WRP easement photographs.

METHOD 5: Assess the easement coverage symmetry between the photographic folder filing system inventory and the GIS photo points layer.

PURPOSE/USE: Promotes harmonization (of coverage and content) between easement photographs and spatial records of easement photographs.

Technique to effect a spatial intersection ("Geoprocessing – Intersect") of WRP easements (polygons) and WRP easement photo points thereby establishing a connection between agreement number and GIS photo points.

Application: ArcMap™ 9.2 (GIS)

Parent Map: WRP photos.mxd

Datasets: C:\WRPDB\WorkCopy\20070413\plan_3yrall.shp (3728 non-unique polygon records covering 594 easements)
And

C:\WRPDB_induk\20061107\firstmon-all-field_pt-photos.shp (2,595 point records)

Steps
open: **WRP photos.mxd**
menu: **Tools**
select: **Geoprocessing**
select: **Intersect**
click on: **open tool**
Input Features (select):
plan_3yrall
firstmon-all-field_pt-photos
Output Feature Class (type): **photos_intersect_plan.shp**
click on: **OK**
R/C on layer: **photos_intersect_plan**
select: **Open Attribute Table**

Results:
2282 *gross intersections*
464 unique easements[20]

NOTE: An alternative technique [listed here in abbreviated syntax]:

Selection | Select By Location | select features from | (the following layer(s):) firstmon-all-field_pt-photos.shp | (that:) are completely within | (the features in this layer:) plan_3yrall.shp | OK …

yields a selection dataset of 2276 records (similar to the above results of 2282 records) but does not merge data from the monitored easement dataset into the intersect selection. Furthermore, no linkage to easement agreement numbers is established in the latter technique.

Technique to compare digital photographs to GIS photo points of the monitored easements dataset.

Preparation:
Copy Photos_intersect_plan.dbf to FOTOINTS.DBF (464 easements/2282 records). Use the following database (FoxPro) commands [in bold]; other text that is preceded by "&&" is commentary.

USE FOTOINTS
MODIFY STRUCTURE && Add & rearrange fields to facilitate comparisons; Parse and

[20] from database command: INDEX ON AGREE_NUM TO [INDEXNAME] UNIQUE

```
                                && cleanup data. (Separated bearing information from
                                photo && numbers and photo && comments. Standardized
                                entries && based on input from original
                                photographers/surveyors).
SELECTION 1
USE FOTOINTS
INDEX ON AGREE_NUM TO XXX
SELECTION 2
USE MASTFOTO
INDEX ON AGREE_NUM TO ZZZ
SELECTION 1
SET RELATION TO AGREE_NUM INTO B
BROWSE FIELD AGREE_NUM,B.AGREE_NUM,COMMENTS
SET FILTER TO EMPTY(B.AGREE_NUM)
COUNT
COPY TO NOLINK    && Contains easements/agreement numbers in the intersection
of
                  && the GIS photo points and monitored datasets that are not
                  && found in MASTFOTO.DBF
```

CATEGORY: Inventory of the physical stock of digital WRP photographs

METHOD 6: [Auxiliary Conventional method to] Create a meta database from the photographic folder filing system, and use it for a precise inventory of easements and photographs on hand.

PURPOSE/USE: Provides a database of meta information directly from the photographic filing structure. Facilitates vetting of irrelevant records to enable a precise count of easement photographs. The database can be imported into Excel in order to take advantage of Pivot Table functionality (for ease of analysis).

> Note: Contemporary digital photo technology enables storage of a number of ancillary photographic parameters. The most useful additional meta data available (in terms of this Missouri WRP easement analysis project) is the "date of photo." Unfortunately, the directory-listing method below cannot output this particular ancillary data in an easily accessible format (see footnote). For this reason, the method herein must be considered an auxiliary method, if a more flexible method is available like that described in "Method 4: Alternative database creation…" This latter method, in addition to accomplishing everything above, can also make "date of photo" meta information easily accessible. [See "preferred Method #3]

Technique to make and modify a directory listing to use in creating a database of photo-folders and photographs.

Steps

1. Call up the C:\> prompt in the command window.
2. Type the following command[21] (in bold):
   C:\>**DIR /b /o /s C:\WRPDB\easement_photos\ |FIND "@" /v >** (type without a *manual* break here) **C:\WRPDB\easement_photos\META\fotcount.txt** **<Enter>**

3. Save "fotcount.txt" as "fotocont.txt" and modify it as follows. Use a text editor to remove the non-essential text, namely header and footer, any non-mage files (e.g. *.txt or *.doc), the entire set of entries from the META subdirectory, directory-only path statements, and the prefix directories of the path statements listing the individual photograph files. For example: remove "C:\WRPDB\easement_photos\" from "C:\WRPDB\easement_photos\photos04\6-142\6-142_0217.JPG" to derive "photos04\6-142\6-142_0217.JPG". Next, replace all "\" with "," (comma -- this will make a CSV or delimited file to use after the next step).

Technique to create, fill and weed a database from a photographic directory listing.

Steps

1. Use database software to create the database FOTOCNT.DBF with this structure:

```
Structure for database: C:\WRPDB\WORKSHOP\FOTOCNT.DBF
Number of data records:  2492
Date of last update    : 09/17/07
Code Page              : 437
Field  Field Name     Type       Width
   1  DATASET         Character    10
   2  FOLDER          Character    15
   3  FILENAME        Character    22
** Total **                        48
```

2. Populate FOTOCNT.DBF with data from fotocont.txt using the following database commands:

   USE FOTOCNT
   APPEND FROM FOTOCONT.TXT DELIMITED

3. Rid the meta database of records of all of the spurious/dubious, non-attributable, non-easement photos and non-photo files, which came to light by casual browsing

[21] A variation of this command can include "date of file creation", a surrogate (in most cases) for "date of photo" in the output list. However, this form of output is not easy to import into a database. The output first requires excessive manual editing or a special parsing script must first be written and then run on the output.

and running other procedures (e.g. FOTO&DAT.PRO[22]). Copy the records marked for deletion to a database DELEFOTO.DBF and then delete (PACK) them, saving the results to FOTOCNT1.DBF.

Technique to utilize intermediate product "FOTOCNT1.DBF" in Excel (to take advantage of its flexible counting facility).

Steps

1. Open FOTOCNT1.DBF in Excel and save as PhotoCount1.xls[23].
2. In PhotoCount1.xls, select the FOTOCNT1 **tab**.
3. From the **Data** menu
4. Select **PivotTable and PivotChart Report**
5. Select **Microsoft Excel list or database | PivotTable**
6. Click **Next**
7. Where is the data that you want to use? Use the automatic selection: **database**
8. Click **Next**
9. Select **New worksheet**
10. Click **Finish**
11. Use this pivot table to tally the folders (easements) and files (photographs) in each main folder

---

CATEGORY: Cross-checking disparate sources of digital WRP photographic records.

METHOD 7: Compare the GIS attribute table records of "photo numbers" with the set of digital photograph filenames that have been named with their "photo number."

PURPOSE/USE: Provides a data entry check and/or a basis of linkage between the two sources of information.

Technique to check, modify and compare the labeling of GIS photo records and the digital photos they represent.

Steps

1. Add a field [PHOTONUMBS] to ALLPHOTO.DBF using the same parameters for the field as found in FOTOINTS.DBF.
2. Replace all [PHOTONUMBS] with [FILENAME] in ALLPHOTO.DBF.

[22] A multi-part FoxPro procedure developed for analyzing the WRP photographic resource within the WRP analysis project.

[23] The refined PhotoCount.xls is a component output of product 4: Photographic Documentation.

3. Manually "tweak" the contents of [PHOTONUMBS] until they resemble [PHOTONUMBS] in FOTOINTS.DBF. This entails removing file extensions (e.g. ".JPG" and the filename prefix "DSC00" (where applicable), etc.
4. Make a relation between ALLPHOTO.DBF (the file of relevant digital photographs) and FOTOINTS.DBF (the intersection of GIS photo points and the monitored WRP dataset); See below.

Key database commands are in bold; other text that is preceded by "&&" is commentary.

SELECTION 1
USE ALLPHOTO
INDEX ON AGREE_NUM+PHOTONUMBS TO XXX
SELECTION 2
USE FOTOINTS
INDEX ON AGREE_NUM+PHOTONUMBS TO ZZZ
SELECTION 1
SET RELATION TO AGREE_NUM+PHOTONUMBS INTO B
BROWSE FIELD
AGREE_NUM,PHOTONUMBS,B.AGREE_NUM,B.PHOTONUMBS
SET FILTER TO !EMPTY(AGREE_NUM)
BROWSE FIELD
AGREE_NUM,PHOTONUMBS,B.AGREE_NUM,B.PHOTONUMBS
COUNT FOR EMPTY(B.AGREE_NUM) && 717 RECORDS
COUNT FOR !EMPTY(B.AGREE_NUM) && 1663 RECORDS
SET FILTER TO !EMPTY(AGREE_NUM) AND !EMPTY(B.AGREE_NUM)
COUNT
COPY TO GIS&FOTO && 1663 RECORDS
CLOSE ALL

<u>NOTE</u>: Substituting FOTINTUQ.DBF (the uniquely labeled records from FOTOINTS.DBF) for FOTOINTS.DBF above yields the same results.