Conservation Effects Assessment Project

Missouri Pilot

Using NatureServe Information to Assess Farm Bill Practice Effects on At-risk Species and Habitats

Final Report
February 11, 2007

NatureServe is a non-profit organization dedicated to providing the scientific knowledge that forms the basis for effective conservation action.

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Front cover:

Waterfowl over a re-flooded crop field enhancement practice in Scott County, Missouri.
Photo by: Bill Holmes

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Executive Summary

The Conservation Effects Assessment Project (CEAP) is an effort to document the environmental benefits of farm bill conservation program practices. The program is intended to enable USDA and stakeholders to understand fish and wildlife benefits achieved from various practices and to tailor conservation programs and practices that increase their effectiveness in addressing fish and wildlife conservation needs on agricultural landscapes.

NatureServe, in cooperation with USDA-NRCS, University of Missouri Resource Assessment Partnership (MoRAP) and Missouri Department of Conservation, completed a pilot research project to develop and evaluate methods for assessing benefits of conservation practices on at-risk wildlife species and habitats in Missouri. Our key objective was to utilize NatureServe data and other data sources to demonstrate processes that could both evaluate the impacts of currently implemented conservation practices as well as help prioritize future Farm Bill program allocations.

To meet these objectives, we developed methodologies to 1) assess the impacts (positive negative or neutral) of conservation practices on at at-risk wildlife species and habitats and 2) demonstrate the spatial concurrence of conservation practices with the at-risk species and habitats. We used the State of Missouri as a pilot area to evaluate our ability to measure conservation impacts of various practices given different types of expert knowledge and spatial data.

Because one-by-one evaluation of the response of each species to each conservation practice in Missouri is not practical, we selected a subset of species and practices and developed a methodology to group practices that are likely to have similar impacts on wildlife and to group species that are expected to have similar responses to practices. We then used expert knowledge to develop a matrix that identified whether each practice grouping would likely have a positive, negative or neutral impact on the species grouping. We ranked each practice according to its relative impact on the species groupings – from strongly negative to strongly positive. For terrestrial species groups, most (54%) of the conservation practices had a neutral impact on species. Only 11% of the conservation practices had a negative impact and 21% had a positive impact on species. The remaining 14% represent variable responses. For aquatic species 39% had a positive impact, 21% had a negative impact and 40% had a neutral impact

Using overlays of multiple data layers (e.g., NatureServe species occurrence data and digitized MO NRCS common land units), we conducted an analysis in the Spring River watershed in southwest Missouri to explore spatial correlations of the locations of known conservation practice applications with the locations at-risk wildlife species and habitats. To examine the impact of different representations of species occurrence, we selected four datasets for terrestrial species: Missouri Natural Heritage Programs' occurrence data (most precise), MO NRCS Modified Heritage occurrences, USDI Gap Analysis Program (GAP) species distribution models, and MO NRCS Modified Heritage occurrence data intersected with Gap species distribution models.

The appropriateness of the spatial data set used depends on the relative abundance of a given at-risk wildlife species or. For at-risk species and habitats only known from a few locations statewide (e.g., <20 locations), direct use of Natural Heritage occurrence data seems most appropriate. For at-risk terrestrial species and habitats that are at least known from a 10s to hundreds of locations in a given state, MO NRCS Modified Heritage occurrence data intersected with Gap species distribution models is most appropriate. For relatively common terrestrial wildlife that are of conservation concern for reasons other rarity, and especially for those known to utilize agricultural lands, use of unaltered GAP predictive distributions may be appropriate. For freshwater aquatic species, the only practical way to represent species distributions is through predictive distribution maps that depict all stream segments and lake features where the species has some likelihood of occurrence.

We also documented the relative currency and completeness of relevant information on conservation practices, species and habitat occurrence, and conservation status of species nationally and evaluated the lessons learned from the Missouri pilot to make recommendations for completing similar analyses at regional and national scales. Results from the Missouri pilot indicate that conservation effects assessment could be implemented at several consistent spatial scales, including watershed, state, regional, national scales. Standard methods can be developed (albeit within certain data limitations) to evaluate impacts of past and current applications of conservation practices. This methodology would also allow NRCS state offices the ability to direct conservation practices to achieve wildlife conservation objectives in each state.

Introduction

The Conservation Effects Assessment Project (CEAP) is an effort to document the environmental benefits of farm bill conservation program practices. The Wildlife component of CEAP was established to define methods to assess the benefits to fish and wildlife gained from USDA conservation programs and practices on landscapes influenced by agriculture. The program is intended to enable USDA and stakeholders to understand fish and wildlife benefits achieved from various practices and to tailor conservation programs and practices that increase their effectiveness in addressing fish and wildlife conservation needs on agricultural landscapes.

NatureServe, in cooperation with USDA-NRCS, University of Missouri Resource Assessment Partnership (MoRAP) and Missouri Department of Conservation, completed a pilot research project to develop and evaluate methods for assessing benefits of conservation practices on at-risk wildlife species and habitats in Missouri. In this project, we leveraged and integrated data compilations already initiated with MO NRCS and funded by the Environmental Defense Center for Conservation Incentives. Our key objective was to utilize NatureServe data to demonstrate processes that could both evaluate the impacts of currently implemented conservation practices as well as help prioritize future Farm Bill program allocations.

To meet these objectives, we required 1) information that identifies the impacts (positive negative or neutral) of conservation practices on at at-risk wildlife species and habitats and 2) a method to demonstrate the spatial concurrence of conservation practices with the at-risk species and habitats.

Available information for evaluating the likely effects of practices on wildlife habitat requirements is often limited, and spatial and tabular data sets used in this type of analysis vary across different jurisdictions; limiting the types of analyses that can be conducted nationally. We used the state of Missouri as a pilot area to evaluate our ability to measure conservation impacts of various practices given different types of expert knowledge and spatial data. We developed a methodology to assess the impacts of conservation practices on at-risk wildlife species and habitats using expert knowledge. We used overlays of multiple data layers (e.g., NatureServe species occurrence data and digitized MO NRCS common land units) to explore spatial correlations of known conservation practices with at-risk wildlife species and habitat occurrences. We evaluated levels of uncertainty associated with available knowledge and the spatial precision of component data sets. We also documented the relative currency and completeness of relevant information on conservation practices, species and habitat occurrence, and conservation status of species nationally and evaluated the lessons learned from the Missouri pilot to make recommendations for completing similar analyses at regional and national scales.

Background

NatureServe, and its member natural heritage programs residing in every state, the District of Columbia, and the Navajo Nation, are a leading source for reliable conservation-relevant biodiversity data and knowledge across the United States. NatureServe and its member programs work together to help inform land use planning by collaborating with a diverse user community including public agencies, tribes, landowners, universities, natural history museums, private industry, other non-profit organizations, and the general public. For over twenty-five years NatureServe has implemented a ranking system for identifying at-risk elements of biodiversity, including documented species and ecological communities (see Stein et al. 2000; Appendix 1). Standard ranking procedures are used to categorize elements in terms of their global status, from "critically imperiled – G1" to "secure – G5." Standard conservation status ranks (G1, G2, G3, G4, and G5) have been applied to most plant and animal species in the United States. Similar rankings exist for species and communities within each state (S1-S5 ranks). Field-based "element occurrence" data are gathered and maintained through field surveys for most at-risk species and communities, and are housed with NatureServe member programs. These 'occurrences' reflect standard protocols for consistent mapping of each biodiversity feature. These combined data represent over 500,000 field-verified occurrences of at-risk species and communities relevant to CEAP. NatureServe coordinated this study and led the development of the methodologies and analytical procedures.

The Missouri Natural Heritage Program (MONHP), housed within the Missouri Department of Conservation, is one of NatureServe's U.S. member programs. MONHP identifies species and natural communities of conservation concern in each Missouri county. MONHP receives biological data from the Missouri Natural Features Inventory, field biologists, universities, scientific literature, herbaria and other individuals and organizations. This information provides an understanding of the abundance, distribution, condition, and conservation needs of these sensitive features. The MONHP database contains accurate and current information for conservation planning, environmental review, scientific research, land acquisition and planning for economic development. There are currently over 18,000 element occurrence records of more than 1,000 species and natural community types of conservation concern in Missouri. MONHP provided the precise species location data used in this study and input on the development of the analysis of species responses to practices.

The Missouri Resource Assessment Partnership (MoRAP) is an interagency partnership at the University of Missouri that provides expertise in geographic information systems (GIS), remote sensing, and natural resource management. MoRAP develops, analyzes, and delivers high quality, low cost geospatial data for natural and cultural resource management. For this study, MoRAP provided expertise in freshwater and terrestrial biodiversity, and conducted the spatial analyses provided in this report.

The Missouri Office of Natural Resource Conservation Service contributed staff expertise in conservation practices, wildlife effects, GIS and databases, and state-based knowledge of NRCS procedures for administering conservation incentive programs. They also contributed an initial documentation of expected wildlife effects from conservation practices implemented in the state, along with the "buffered heritage" data set (see below) used in state program administration.

Evaluating At-Risk Wildlife and Habitat Responses to NRCS Conservation Practices

Our first step was to develop a methodology to identify the impacts conservation practices on wildlife species and habitats. A one-by-one evaluation of the response of each species to each conservation practice in Missouri is not practical. For example, there are over 5,400 plant and animal species in the state and over 160 different practices, yielding about 864,000 possible combinations of practices and species. If we just select the 1,000+ at-risk species in Missouri, that still leads to 160,000 possible combinations. To overcome this obstacle, we selected a subset of species and practices and developed a methodology to group practices that are likely to have similar impacts on wildlife and to group species that are expected to have similar responses to practices. We then used expert knowledge to develop a matrix that identified whether each practice grouping has a positive, negative or neutral impact on the species grouping.

At-Risk Species and Habitats

NatureServe member programs, such as the Missouri Natural Heritage Program, maintain information on species of conservation concern under their geographic jurisdiction. In many cases, programs also track natural community types, described through one or more classification system. Each program maintains descriptive, distribution, and status information for the species that they feel are of conservation concern in their jurisdiction. A given state may track over 1,000 species and natural community types of conservation concern. States with fewer rare species may track data on all of the species in the state, while states with many rare species may track only those that are ranked S1-S3 in their state. The relative currency and completeness of data on tracked elements varies across states, depending on institutional setting, program resources, and historical considerations.

For our analysis, we aimed to select a subset of at-risk species that characterize a range of common environments and life histories. In this case, we defined ‘at-risk’ as those species of conservation concern tracked by MONHP (generally those ranked S1-S3 in the state). This subset included species primarily found in terrestrial environments, such as grassland birds and mammals, upland forest and shrubland-dwelling birds and mammals, water birds, wetland birds, reptiles, etc.. Freshwater aquatic species included fish, crayfish, mussels, and amphibians. We also used information on several natural community types of interest in Missouri, and tracked by the Natural Heritage Program.

Conservation Practices

Conservation practices supported through Farm Bill programs have been established over recent decades to meet the variety of needs across the country. Today, over 280 practices vary from those that are quite popular, widespread, and effecting extensive acreage, while others are less commonly applied and/or effect very small land/water area (see http://ias.sc.egov.usda.gov/prsreport2006/report.aspx?report_id=222 for a summary of the area of application of conservation practices nationwide in 2006). Of this national total, over 160 practices are currently implemented in locations throughout Missouri. These include, for example, Brush Management (code #311), providing Conservation Cover (#327), Pasture and Hayland Planting (#512), Restoration and Management of Declining Habitats (#643), and others.

Wildlife/Practice Matrix

Identifying the likely effects of conservation practices on at-risk wildlife is a complex problem with many ambiguities. For example, the actual expression of most practices may vary considerably in the actual type of habitat alteration/improvement, species mixes included in plantings, and acreage effected. Undoubtedly there are many circumstances where the implemented form a given practice takes could have either positive, neutral, or negative effects on a given at-risk species. However, in most cases, the most probable relationships can be identified.

In an effort completed in 2005, wildlife biologists in Missouri NRCS developed a matrix that expresses - - the expected effects of practices - *in terms of positive, neutral, and negative* - on a selected set of species that had been grouped from a taxonomic perspective. Each of the conservation practices applied in Missouri were scored against six groupings of at-risk wildlife (in this case, ESA-listed T/E species), including 1) mammals, 2) birds, 3) bats, 4) reptile/amphibians/insects, 5) fish/crustaceans/mollusks, and 6) plants (Appendix 2). In cases where a species group's or individual species' response to a given practice might vary according to variation in the practice itself, variation in the ecological setting in which the practice is applied, or variation in life history traits of a given species, additional details as to the circumstances where a given effect would most likely apply were provided as footnotes.

This previous effort suggested some potential for further advancement. Our team reviewed this matrix and concluded that, for at least some taxa, the taxonomic groupings used in the 2005 effort were too coarse to ensure that all included species would respond similarly to a given practice. For example, grassland birds would respond differently to grassland habitat management than forest/shrubland inhabiting birds. We analyzed the footnotes recorded in the Missouri matrix to identify likely areas where original species groupings could be appropriately subdivided or recombined in terms of functional traits and habitat requirements. We also conducted – for well documented species in each grouping - a general review of the literature pertaining to the principal habitat requirements, ecology, and the full range of human disturbances and/or limiting factors that are considered to negatively affect each.

So we then took what was learned from that initial pilot effort to draft national lists of both wildlife groupings and grouped practices. We hoped to identify a set of both species groupings and practice groupings that could be used to predict a consistent effect (positive, neutral, negative) for each unique combination as implemented nationwide.

To provide a starting point for the analysis, we grouped 163 conservation practices that are implemented in Missouri into 23 initial groupings based on similar implementation techniques, habitat similarities, or expected ecological outcomes. For example we grouped all practices related to well management into one practice group, all practices related to wetland habitat management into another, and all practices associated with fire control or management into another. Our groupings, as they related to wildlife responses, considered only long-term effects on wildlife habitat requirements. We did not consider any potential short-term disturbances that may be associated with a given practice (e.g., construction activities).

We then reviewed each conservation practice in relation to each species habitat requirements, ecology/guild, and human disturbances. If, in our expert opinion, the conservation practice benefited any element of the habitat or alleviated any of the documented disturbances we assigned a positive effect. If the conservation practice was determined to negatively affect any of the habitat elements we assigned a negative effect. Otherwise we assigned a neutral effect.

For terrestrial species we assessed the expected response (negative, neutral, positive, or variable) of species in the 13 terrestrial species groups to EACH of the individual 163 conservation practices – yielding 2119 individual assessments (Appendix 3a.). Using the responses to inform the creation of groups, we further subdivided the initial 23 groupings so that the new groups reflected similar patterns of species responses. We grouped practices if no more than three of the responses differed among species groups. For groups where the species responses differed (i.e. the same species group responded positively to one practice, but neutrally to another, we noted that the response of the species group was variable (i.e. positive/neutral). We did not combine any practices where the response of a given species group was positive for one and negative for another. This process yielded 71 practice groupings. Forty seven of these "groups" only contained a single practice because the response of the species groups was sufficiently different from practices in the initial grouping. Terrestrial species group responses to the conservation practice groupings are summarized in Table 2.

For aquatic species we did not individually assess species group responses to each of the 163 practices. Instead we started with the initial 23 groupings, assessed species group responses to the conservation practice groups and split the practice groups as needed when the species response was expected to be different from that of others in the initial group. This process yielded 49 practice groupings that were somewhat different than the practice groupings for terrestrial species (Appendix 3b). This difference is based on the fact that aquatic species groups can have a very different response to a given conservation practice than terrestrial species groups. Aquatic species group responses to the conservation practice groupings are summarized in Table 3.

Table 1. Species groups used for analysis of practice effects on at-risk wildlife.

Species Groups
Terrestrial Species Groups (n=13)
Terrestrial plethodontid salamanders
Terrestrial amphibians with aquatic larvae
Completely aquatic riverine or spring-dwelling amphibians
Wetland birds (marsh, swamp, riparian)
Water birds (ponds, lakes, rivers)
Upland forest/shrubland birds
Upland grassland birds
Upland reptiles
Aquatic/wetland reptiles
Bats
Aquatic/wetland mammals (e.g., otter, raccoon, muskrat)
Upland forest/shrubland mammals
Upland grassland mammals (e.g., voles, ground squirrels)
Aquatic Species Groups (n=22)
Mussel/gravel
Mussel/mud
Cray/burrower
Cray/semiburrower/lotic
Cray/semiburrower/lentic
Cray/nonburrowing/lotic
Cray/nonburrowing/lentic
Cray/Troglogbitic
Fish/grazer
Fish/benthic insect
Fish/piscivore
Fish/omnivore/pelagic
Fish/omnivore/surface
Fish/lithophil/nocare
Fish/lithophil/care
Fish/pelagophil
Fish/phytophil
Fish/speleophil
Fish/floodplain
Fish_Cray/headwater
Fish_Cray/Midsize
Fish_Cray/Large

Table 2. Terrestrial Species Group (n=13) Responses to Conservation Practice Groups (n=71)

Practice Group Name (n=number of practices in group if >1)	**Number of Terrestrial Species Groups (n=13) with a Given Response to Each Practice Group**						
	Negative	**Variable/ Negative**	**Neutral**	**Positive**	**Variable/ Positive**	**Variable/ 3-way**	**?**
Strongly Negative							
Recreation Area Improvement	13						
Access Road	12		1				
Land Clearing	10		1	2			
Negative to Neutral							
Recreation Land Grading and Shaping	8		5				
Fence	7		6				
Soil Management -Physical II (n=2)	6	1	6				
Precision Land Forming	2	5	6				
Forest Slash Treatment	5		8				
Irrigation Canal or Lateral	5		8				
Forest Trails and Landings	4		8			1	
Aquaculture (n=3)	1	3	9				
Atmospheric Resource Quality Management	1	3	9				
Pasture and Hay Planting		3	10				
Water Control III (n=2)	3		10				
Strongly Positive							
Mined Land Reconstruction (n=2)				12	1		
Land Use Restriction (n=2)				12	1		

Practice Group Name (n=number of practices in group if >1)	**Number of Terrestrial Species Groups (n=13) with a Given Response to Each Practice Group**						
	Negative	**Variable/ Negative**	**Neutral**	**Positive**	**Variable/ Positive**	**Variable/ 3-way**	**?**
Salinity and Sodic Soil Management			1	12			
Trails and Walkways (n=2)		1		12			
Soil Management Vegetation II (n-4)			1	11		1	
Positive to Neutral							
Riparian Herbaceous Cover			4	9			
Riparian Forest Buffer			3	8		2	
Range Planting			5	8			
Land Reclamation, Toxic Discharge Control			6	7			
Soil Management - Vegetation I (n=5)			4	7	2		
Nutrient Management			7	6			
Feed Management			7	6			
Stream Crossing			7	6			
Soil Management Physical I (n-6)			6	6	1		
Waste Management I (n=10)		1	6	6			
Spoil Spreading			8	5			
Streambank and Shoreline Protection			9	4			
Wetland Habitat Management (n=4)			6	4	1	2	
Row Arrangement			9	4			
Hedgerow Planting	1		8	4			
Irrigation Storage Reservoir	1		7	4		1	
Neutral							

Practice Group Name (n=number of practices in group if >1)	**Number of Terrestrial Species Groups (n=13) with a Given Response to Each Practice Group**						
	Negative	**Variable/ Negative**	**Neutral**	**Positive**	**Variable/ Positive**	**Variable/ 3-way**	**?**
Pond Sealing (n=4)			13				
Fire Management (n=3)			13				
Mulching			13				
Dry Hydrant			13				
Soil Management- Physical III (n=3)			13				
Restoration and Management of Declining Habitats			13				
Soil Management Vegetation III (n=6)			13				
Water Control II (n=7)			13				
Waste Management II (n=4)			13				
Water Provision I (n=2)			13				
Well Management (n=3)			13				
Irrigation Systems (n=18)			13				
Obstruction Removal	1		12				
Mine Shaft and Adit Closing	1		12				
Tree/Shrub Pruning	2		11				
Irrigation Regulating Reservoir	2		10	1			
Forage Harvest Management			10			3	
Variable							
Forest Stand Improvement	2		7			4	
Water Control V	4		6			3	
Prescribed Grazing	3		4			6	

Practice Group Name (n=number of practices in group if >1)	**Number of Terrestrial Species Groups (n=13) with a Given Response to Each Practice Group**						
	Negative	**Variable/ Negative**	**Neutral**	**Positive**	**Variable/ Positive**	**Variable/ 3-way**	**?**
Windbreak/Shelterbelt Establishment		2	8	2	1		
Brush Management	2		7	2		2	
Early Successional Habitat Development/Management	2		3	3	2	3	
Pest Management						13	
Water Control IV (n=6)			2			6	
Silvopasture Establishment	1		6	1		5	
Tree/Shrub Establishment	2		1	6		4	
Aquatic Habitat Improvement (n=2)		1	6	4		2	
Water Control I (n=11)		2	6	5			
Water Provision II (n=3)		2	7	4			
Water Harvesting Catchment			8	2		3	
Upland Wildlife Habitat Management			5	2		6	
Stream Habitat Improvement and Management			6	2		5	
Forest Site Preparation	3		4	6			
Spring Development		1	6			6	
Anionic Polyacrylamide (PAM) Erosion Control			5		2		6
	Negative	**Variable/ Negative**	**Neutral**	**Positive**	**Variable/ Positive**	**Variable/ 3-way**	**?**

Practice Group Name (n=number of practices in group if >1)	**Number of Terrestrial Species Groups (n=13) with a Given Response to Each Practice Group**						
	Negative	**Variable/ Negative**	**Neutral**	**Positive**	**Variable/ Positive**	**Variable/ 3-way**	**?**
Total Number of Species x Group Assessments (n=923)	105	25	496	195	18	78	6
Percent	11.4%	2.7%	53.7%	21.1%	2.0%	8.5%	0.7%

Table 3. Aquatic Species Group (n=22) Responses to Conservation Practice Groups (n=49)

Practice Group Name (n= number of practices in group if >1)	**Number of Aquatic Species Groups (n=22) with a Given Response to Each Practice Group**					
	Negative	**Negative/ Neutral**	**Neutral**	**Positive**	**Neutral/ Positive**	**Variable/ 3-Way**
Strongly Negative						
Trails and Roads I (n=3)	22					
Dam Diversion	22					
Diversion	22					
Dike	21		1			
Spring Development	20		2			
Clearing and Snagging	19		3			
Deep Tillage	18		4			
Negative to Neutral						
Water Control I (n=18)	17		5			
Land Clearing	14		8			
Irrigation Systems I (n=14)	9		13			
Irrigation Land Leveling	5		17			
Recreation Land Grading and Shaping	5		17			
Land Smoothing	5		17			
Aquaculture (n=3)	4		15	3		
Drainage Conduits (n=2)	4		18			
Pond Sealing (n=4)	4		18			
Pest Management		3	19			
Strongly Positive						

Practice Group Name (n= number of practices in group if >1)	**Number of Aquatic Species Groups (n=22) with a Given Response to Each Practice Group**					
	Negative	**Negative/ Neutral**	**Neutral**	**Positive**	**Neutral/ Positive**	**Variable/ 3-Way**
Habitat Management I (n=11)				22		
Riparian Habitat Management (n=3)				22		
Mined Land Reconstruction (n=2)				22		
Land Use Restriction (n=3)				22		
Pasture and Hay Planting				21	1	
Feed Management				22		
Salinity and Sodic Soil Management				22		
Trails and Roads II (n=2)				22		
Waste Management I (n=10)				22		
Waste Management II (n=5)				22		
Streambank Protection and Channel Stabilization (n=3)				22		
Land Reclamation, Toxic Discharge Control				22		
Wetland Habitat Management (n=5)			1	21		
Fish Passage			3	19		
Soil Management - Physical (n=11)			3	19		
Soil Management - Vegetation (n=15)			3	19		
Forestry (n=4)			4	18		
Channel Bank Vegetation			4	18		
Positive to Neutral						
Soil Management - Chemical (n=3)			11	11		
Irrigation Systems II (n=5)			14	8		

Practice Group Name (n= number of practices in group if >1)	**Number of Aquatic Species Groups (n=22) with a Given Response to Each Practice Group**					
	Negative	**Negative/ Neutral**	**Neutral**	**Positive**	**Neutral/ Positive**	**Variable/ 3-Way**
Shallow Water Management for Wildlife			16	6		
Neutral						
Atmospheric Resource Quality Management			22			
Fire Control (n=4)			22			
Mine Shaft Adit Closing			22			
Recreation Area Improvement			22			
Water Provision II (n=2)			22			
Watering Facilities (n=2)			22			
Well Management (n=3)			22			
Windbreak/Shelterbelt Establishment			19	3		
Water Provision I (n=2)			19	3		
Variable						
Irrigation Reservoirs (n=2)	9		9	4		
Dam	7		6	9		
Aquaculture (n=3)	4		15	3		
	Negative	**Variable/ Negative**	**Neutral**	**Positive**	**Variable/ Positive**	**Variable/ 3-way**
Total Number of Species x Group Assessments (n=1078)	227	3	423	425	1	0
Percent	21.1	0.3%	39.9%	39.4%	0	0

Summary Results of Practice Impacts on Species Groups

Practice groups in tables 2 and 3 are ordered as to the degree to which they have negative, positive, or neutral impacts on the species groups overall. For terrestrial species groups, the majority (54%) of the species groups had a neutral response to the practices. Only 11% of the species groups had a negative response to the practices and 21% had a positive response. The remaining 14% represent variable responses. For aquatic species there was a higher percentage of both positive (39%) and negative (21%) responses to practices and a lower percentage of neutral responses (40%). Table 4 provides the number, linear feet, or acres of selected practice groupings with the most strongly positive and strongly negative practices that were applied in 2006 based on NRCS Practice Data (http://ias.sc.egov.usda.gov/prsreport2006/report.aspx?report_id=222.

Table 4. Numbers, Acreage, or Linear Feet Affected by Conservation Practices that have Strongly Negative and Strongly Positive Impacts on Species.

Practice	**Practices Applied Nationwide In 2006** **(acres, number, or linear feet; or other unit specified)**
Strongly Negative on Terrestrial Species	
Recreation Area Improvement (acres)	68
Access Road (linear feet)	1,494,961
Land Clearing (acres)	975
Strongly Negative on Aquatic Species	
Trails and Roads I (n=3) (linear feet)	1,543,764
Dam Diversion (number)	31
Diversion (linear feet)	999,986
Dike (linear feet)	1,460,919
Spring Development (number)	1244
Clearing and Snagging (linear feet)	883,101
Deep Tillage (acres)	40,011
Strongly Positive on Terrestrial Species	
Mined Land Reconstruction (n=2) (acres)	0
Land Use Restriction (n=2) (acres)	1,372,580
Salinity and Sodic Soil Management (acres)	32,676
Trails and Walkways (n=2) (linear feet)	286,791
Soil Management Vegetation II (n-4) (acres and linear feet)	23,034,893
Strongly Positive on Aquatic Species omitting overlap with those positive on terrestrial species (n=number of practices in group)	
Habitat Management I (n=11) (acres and linear feet)	26,923,369

Riparian Habitat Management (n=3) (acres)	79,427
Land Use Restriction (n=3) (acres and linear feet)	48,026,068
Pasture and Hay Planting (acres)	497,583
Feed Management (animal units)	36,108
Trails and Roads II (n=2) (linear feet)	247,173
Waste Management I (n=10) (numbers, acres, animal units)	408,500
Waste Management II (n=5) (number)	8330
Streambank Protection and Channel Stabilization (n=3) (linear feet)	1,239,867
Land Reclamation, Toxic Discharge Control (number)	1
Wetland Habitat Management (n=5) (acres)	717,575
Fish Passage (number)	36
Soil Management - Physical (n=11) (acres and linear feet)	5,942,744
Soil Management - Vegetation (n=15) (acres and linear feet)	30,753,443
Forestry (n=4) (acres)	258736
Channel Bank Vegetation (acres)	283

Currently, there are currently some 16,000 "at-risk" species or subspecies (those listed as G1-critically imperiled, G2-imperiled, or G3 –vulnerable) in the United States. An individual species-by-practice approach to assessing responses to conservation practices would require over 4.5 million individual assessments. The approach of grouping species into 35 species groups and practices into practice groups (71 for terrestrial species and 49 for aquatic species – with some overlap) required just over 2000 assessments to be made for Missouri practices. Additional work will be needed to develop practice groups for all of the 288 practices nationwide. Many practices will fit within the practice groups defined based on the 163 practices in Missouri, but it is likely that others will need to be defined. While many site-specific issues will continue to require additional interpretation, this matrix approach should greatly facilitate an initial assessment of the impacts of conservation practices on at-risk wildlife. Further studies at regional and local levels can then be completed as the need is identified.

Spatial Data Analysis and Reporting

Identifying and representing the spatial concurrence of at-risk wildlife and habitats and the implementation of conservation practices on the ground is also complex. At-risk wildlife and habitats are, by definition, rare and often difficult to locate. In some cases, documentation of their occurrence is incomplete and their exact distributions are not certain. Many conservation practices are conducted in limited areas, so the ability so sample sizes for analyses are also small. As stated previously, the method of implementation of given conservation practices vary and this variation is often not documented – limiting our ability to draw general conclusions about impacts. Simultaneous to our analysis of practice and species groupings, we conducted an analysis using the Spring River watershed in southwest Missouri to better understand and document these issues (Figure 1).

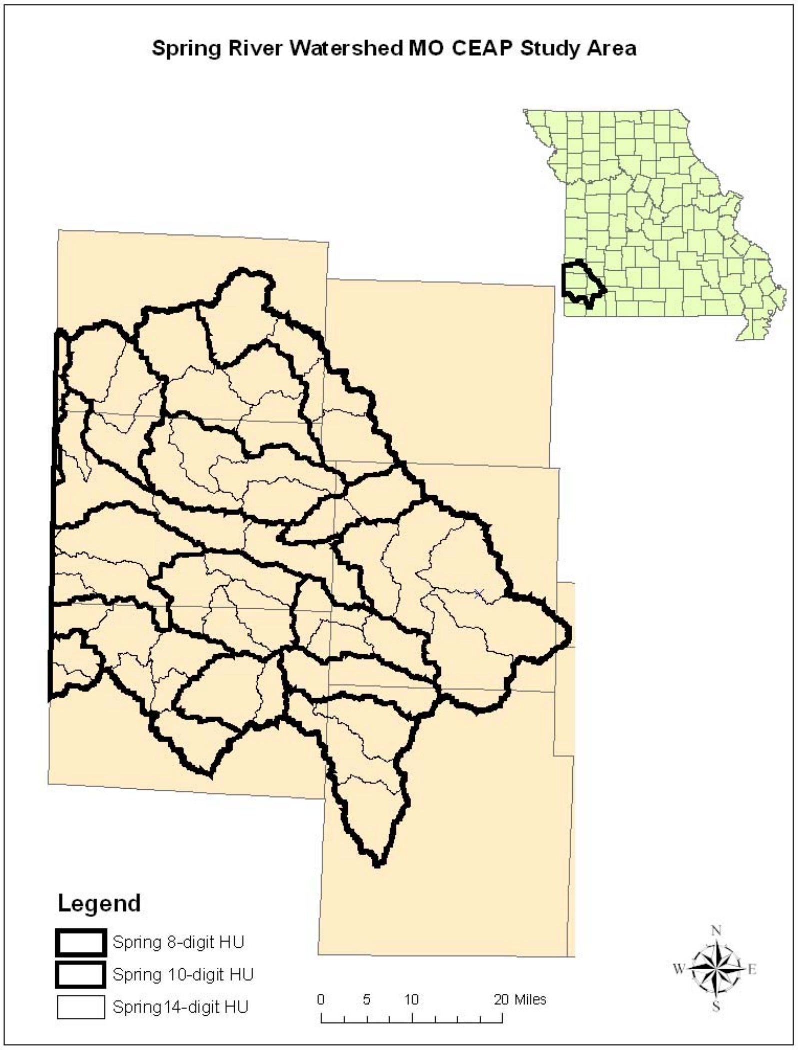


Figure 1. Study Area Locator Map

We chose the Spring River watershed for evaluation because it provided a reasonably representative example for the state and south-central Midwest region and included numerous funded practices. We selected several levels of hydrologic units for purposes of analysis and reporting. These included 8, 10, and 14-digit catalog units (Figure 1). We defined our study area spatially using the polygon for the 8-digit hydrologic unit (HU) boundary outlining the Spring River watershed, obtained from the NRCS in Columbia, Missouri. The Spring River watershed in southwest Missouri covers 1,307,469 acres (2,042 miles^2) and includes parts of Barry, Barton, Christian, Dade, Jasper, Lawrence, Newton and Stone counties.

Since this watershed analysis was being conducted concurrently with the above mentioned national species/practice matrix, the previously established list of Missouri's 107 conservation practices and their positive, negative, and neutral affects on six groups of wildlife taxa (mammals other than bats; bats; birds; reptiles, amphibians, and insects; fish, crustaceans, and mollusks; plants) was used here.

Of all funded practices in the Spring River watershed, NRCS staff initially selected a short list of 10-15 practices for spatial analysis. Local biologists assembled to evaluate these practices that are commonly found in the watershed and selected up to 10 at-risk terrestrial species for further evaluation (Table 5).

Table 5: Evaluated species from the Spring River watershed

Bat	**Mammal other than Bat**	**Bird**
Gray Bat (*Myotis crisescens*)	Black-tailed Jackrabbit (*Lepus californicus*)	Bobwhite Quail (*Colinus virginianus*)
		Northern Harrier (*Circus cyaneus*)
Amphibian	**Insect**	**Plant**
Northern Crayfish Frog *(Rana ariolata)*	Prairie Mole Cricket (*Gryllotalpa major*)	Mead's Milkweed (*Asclepias meadii*)
		Barbara's Buttons (*Marshallia caespitosa*)
Fish	**Mussel**	**Crayfish**
Bigeye shiner (*Notropis boops*)	Fatmucket (*Lampsilis siliquoidea*)	Prairie Crayfish (*Procambarus gracilis*)
Blackstripe topminnow (*Fundulus notatus*)	Paper pondshell (*Utterbackia imbecillis*)	Virile Crayfish (*Orconectes virilis*)
Brindled madtom (*Notorus minurus*)	Slippershell (*Alasmidonta virdis*)	
Ozark Cavefish (*Amblyopsis rosae*)	Neosha Mucket (*Lampsilis rafinesqueana*)	

We created a matrix for these species containing the chosen conservation practices and affects of those practices (Table 6). Species experts from various land managing agencies examined the conservation practice standards and came to a professional consensus confirming whether the practice would have a negative, positive, or neutral effect on a species. They documented many exceptions and assumptions and included them as footnotes to the matrix.

Table 6: Terrestrial species /practice matrix for the Spring River watershed

SPRING RIVER	528a	528b	512a	512b	645	590	378	345
Gray Bat	Neut	Neut	Neut	Neut	Neut	Pos	Pos	Neut
Black-tailed Jackrabbit	Pos	Pos	Neg	Pos	Pos	Neut	Neut	Neut
Barbara's Buttons	NA	Pos	Neg	Neut	Pos	Neut	NA	NA
Mead's Milkweed	NA	Pos	Neg	Neut	Pos	Neut	NA	NA
Bobwhite Quail	Pos	Pos	Neg	Pos	Pos	Neut	Neut	Pos
Northern Harrier	Neut	Neut	Neg	Pos	Pos	Neut	Neut	Neut
Northern Crayfish Frog	Neut	Neut	Neg	Pos	Pos	Pos	Neg	NA
Prairie Mole Cricket	NA	Pos	Neg	Pos	Pos	Neut	NA	NA
528a is being applied to a continuous grazed fescue/clover pasture								
528b is being applied to a continuous grazed remnant prairie								
512a is dominated by bermuda grass or fescue and adjacent to a listed plant site								
512b is a mixture of native grasses and forbs								
645 is woody cover control on a grassland								
590 is waste spreading on grassland								
378 is suitable for fish stocking and will not destroy a natural plant community								

We also selected and reviewed ten at-risk freshwater aquatic (fish, mussel, and crayfish) species for this spatial analysis. Habitat requirements for selected aquatic species are presented in Table 7. These attributes form the basis for assessment of effects of selected practices and/or practice groupings (Table 8).

The Spring River watershed is well-documented to be impacted by point source discharges, acid mine drainage, excessive sediments associated with cropland and riparian disturbance, excessive nutrients associated with CAFO’s, herbicides and pesticides associated with cropland (Davis and Schumacher. 1992; Missouri Department of Natural Resources. 1996; Kiner, Vitello, and Hash. 2005).

Table 7. Habitat Requirements, Relevant Life History Characteristics, and Human Disturbances Effecting Selected Freshwater Aquatic Species of the Spring River Watershed.

Species	Habitat Requirements, Relevant Life History Characteristics, and Human Disturbances Effecting Species
Fish	
Bigeye shiner (*Notropis boops*)	• Requires slackwater habitats with sufficient cover during baseflow conditions. • Requires instream an floodplain flow refugia in order to escape elevated current velocities during high-flow events • Requires a channel complexity and instream retention devices (large complexes of woody debris) to retain detrital material suited to the establishment of diverse and productive invertebrate communities. • Requires riparian vegetation suited to the establishment of diverse and abundant terrestrial invertebrate community. • Requires relatively silt-free gravel or larger substrates with sufficient flow to

Species	Habitat Requirements, Relevant Life History Characteristics, and Human Disturbances Effecting Species
	maintain these silt-free conditions and prevent the establishment of dense algal communities during the period in which eggs and fry are developing. • Decline of this species is mainly tied to siltation and increased turbidity of streams
Blackstripe topminnow (Fundulus notatus)	• Requires slackwater habitats with sufficient cover during baseflow conditions. • Requires instream an floodplain flow refugia in order to escape elevated current velocities during high-flow events • Requires a channel complexity and instream retention devices (large complexes of woody debris) to retain detrital material suited to the establishment of diverse and productive invertebrate communities. • Needs abundant riparian vegetation to produce a sufficient supply of terrestrial invertebrates, which is the principal food of this species • Needs aquatic macrophytes within slackwater habitats to provide suitable spawning habitat • Vulnerable to channelization, destruction of riparian vegetation, and water withdrawls
Brindled madtom (*Notorus minurus*)	• Require stable substrates and flow refugia in form of coarse substrates, woody debris or vegetation • Require stable, relatively silt-free, gravel or larger substrates and woody debris suitable for the attachment of primary producers and the establishment of diverse and productive invertebrate communities • Needs slackwater habitats with coarse substrates, large woody debris, or significant amounts of detrital material in order to provide daytime hiding places. • Require slackwater habitats suited to excavating and guarding a nest and are also relatively protected from increases in flow. • Cavity nester: Also requires cobble or larger substrates, large woody debris, or undercut banks in order to excavate cavities suited to egg fanning and guarding their eggs and fry. • Typically found in pools below riffles in stream reaches containing emergent aquatic vegetation. • Species is intolerant of channelization, flow alteration, and siltation
Mussels	
All species treated the same	• The vast majority of mussel species inhabit a wide range of substrates (e.g., silt to cobble). • All mussels require substrates that are relatively stable, Consequently, some of the greatest threats to the persistence of mussels are; decreased stability of substrates, increased stream competence, capacity, or shear stress, which can result from increased channel gradients, reduction in channel complexity and flow obstructions, and/or a constriction of the bankfull channel. • No matter how much you reduce sediment, nutrient, or contaminant inputs, if substrates are unstable then mussel populations will not be able to persist. • Other significant threats to mussels include contaminants, sediments, and loss or alteration of habitat due to impoundments
Crayfish	
Prairie Crayfish (*Procambarus gracilis*)	• This species occurs in grasslands or areas that were formerly native grasses. • However, in Illinois this species has also been readily found in forested bottomland wetlands • Its burrows, which are up to six feet in depth, are often found long distances from permanent water. • Juveniles and occasional adults of this species occur in temporary wetlands,

Species	Habitat Requirements, Relevant Life History Characteristics, and Human Disturbances Effecting Species
	ditches and streams channels during seasons when the water table is high • Primary threats include destruction of shallow permanent or seasonal wetlands, compaction of soil, lowering of water table, and contaminants.
Virile Crayfish (*Orconectes virilis*)	• This species occurs primarily in streams and is most abundant in water that is fertile, warm, and moderately turbid without strong base flows and with abundant cover in the form of slab rock, logs, and organic debris. • It is often collected in the open or around rocks, logs, or deposits of organic debris. • It is also abundant in some artificial ponds with relatively stable water levels and lacking populations of predatory fish. • In prairie creeks and sloughs having intermittent flow, deep mud bottoms and wide seasonal fluctuations in area and depth, the virile crayfish is often replaced by the papershell crayfish. • Primary threats include channelization, removal of instream cover, unstable substrates and siltation, and introduction of predatory fish.

As the study progressed, we decided to focus this aspect of analysis on the most frequent management practice, Pasture and Hayland Planting (#512), because other practices amounted to a relatively small total area of the watershed.

Table 8. Summary of results from overlays of #512 practices on freshwater aquatic species in the Spring River watershed, MO.

SPRING RIVER	**Stream Length Affected (km) (Total 2)**	**% of Species Distribution Affected by Practice 512 (Total 4/Total3)**	**Relative Influence of Practice 512 within each HU (Total 4/ Total 2)**	**512a**	**512b**
Bigeye shiner (*Notropis boops*)	22.7	31	17	Pos	Pos
Blackstripe topminnow (*Fundulus notatus*)	36.5	31	28	Pos	Pos
Brindled madtom (*Notorus minurus*)	4.9	8	4	Pos	Pos
Fatmucket (*Lampsilis siliquoidea*)	123.7	31	98	Pos	Pos
Paper pondshell (*Utterbackia imbecillis*)	55.3	35	43	Pos	Pos
Slippershell (*Alasmidonta viridis*)	24.3	30	15	Pos	Pos
Virile Crayfish (*Orconectes virilis*)	110.5	31	90	Pos	Pos
	Acres Affected	**% of Dist Affected**	**%Influence**		
Prairie Crayfish (*Procambarus gracilis*)	25,000	24	24	Neg*	Pos
NOTES:					
512a is dominated by bermuda grass or fescue and adjacent to a listed plant site					
512b is a mixture of native grasses and forbs					
*Assumes practices were applied on abandoned cropland, if applied on a forested or grassland site most responses would be negative					

GIS Data Acquisition

Conservation Practices

To assess potential effects of conservation practices across the watershed, the location, amount and type of applied practices needed to be spatially located. These locations may take two forms, including georeferenced points and digitized polygon. The implementation of NRCS' National Conservation Planning Database (NCPDB) allows these data to be generated. The NCPDB is an ArcSDE/Microsoft SQL Server-managed geodatabase storing information about conservation practices, among other data, entered by conservation planners in NRCS field offices. The NCPDB data is comprehensive for practices applied since 2004, while documentation of older practices varies by workload and directives of individual offices.

Customer Service Toolkit is NRCS' client software for interacting with the NCPDB. Toolkit is an integration of Microsoft Office and ESRI ArcGIS software. Toolkit allows a user to check out, edit and check back in the customer data from the NCPDB. Customer data are identified spatially by the planned land units they manage. For watershed-level information, all customers of the counties comprising the watershed were checked out. The check-out process results in a locally-stored personal geodatabase. An Access query was written that extracted a table of applied practice codes, application measurements, the spatial centroid of the practice and the tract number where applied. The table was used to create a point shapefile of applied practices. The shapefile was subset to only the practice codes being used for this pilot study, and clipped by the Spring River watershed boundary.

Common Land Unit (CLU) polygons depict individual fields where practices have been applied. These data were obtained from the USDA Farm Service Agency (FSA) Aerial Photography Field Office by way of NRCS. The dataset was digitized by the FSA using 1:7920 scale rectified photomaps and published 06/03/2005. Using the Spring River watershed boundary, we intersected and clipped the CLUs for each county, then appended them into a single shapefile to produce a Spring River CLU layer. Again, we decided to focus this aspect of analysis on the most frequent management practice, Pasture and Hayland Planting (#512), because other practices amounted to a relatively small total area of the watershed. We extracted the point shapefile with practice 512 points and spatially intersected it with the CLU layer, resulting in a created layer called 512 CLUs.

At-risk Species Locations

To examine the impact of different representations of species occurrence, we selected four datasets for terrestrial species: Missouri Natural Heritage Programs' occurrence data (most precise), MO NRCS Modified Heritage occurrences, USDI Gap Analysis Program (GAP) species distribution models, and MO NRCS Modified Heritage occurrence data intersected with Gap species distribution models. We attempted various methods of intersection, clipping and querying, but the process steps outlined in the following pages proved to be the most efficient means of achieving desired results.

Missouri Natural Heritage Data

The Missouri Natural Heritage data was obtained from the MDC and was published in May 2006. The Heritage ARC/INFO coverage was created using 1:24,000 USGS quadrangles and heritage records interpreted by the Natural Heritage staff. The data used in this analysis was last updated in May, 2006.

We clipped the data for each of the selected species (Gray Bat, Black-tailed Jackrabbit, Barbara's Buttons, Mead's Milkweed, Northern Harrier, Neosho Mucket, Northern Crayfish Frog, Prairie Mole Cricket, and Ozark Cavefish) to the Spring River boundary and exported them as a new layer. In this particular analysis, we also included location information on three natural community types described in the Missouri NHP state community classification (Limestone Glade, Limestone Prairie, and Prairie Swale). We then spatially joined this new layer to the 14-digit HU layer, and recalculated the area. If a HU Code (HUC) was not assigned because a species polygon was in more than one HU then we manually assigned the polygon to the HUC that contained the majority of the polygon.

NRCS Modified Heritage Data ("Buffered Heritage")

Missouri NRCS personnel use a modified version of the Missouri Heritage database for their planning processes. The modifications made to the Heritage polygon database are for two purposes – 1) to eliminate historic records for which relocation efforts of the past 30 years have failed (i.e., there is very low confidence that the species remains present at the location), and 2) to spatially generalize the records to larger surrounding areas. This spatial generalization serves two functions. First, it serves to include additional area where the at-risk species may in fact be present, but was not observed during field surveys. Second, this 'buffer' area may be combined with practice locations to evaluate if a given conservation practice might effect that species. The spatial generalization varies by species groups depending on their mobility and other behaviors. The Heritage occurrence polygons of amphibians, reptiles, insects, and mammals except endangered bats are buffered 1 mile. Plant records are buffered 0.25 mile. Bird records are buffered 1-7 miles, depending on the species. Bat records are buffered 1, 4, or 12.4 miles depending on species and type of Heritage record (known as a 'source feature' - hibernacula, maternity roost, or other).

We clipped each buffered species' occurrence record to the Spring River boundary and exported each as a new layer. We then spatially joined this new layer to the 14-digit HU layer, and recalculated the area and acres. If a HU Code (HUC) was not assigned because a species polygon was in more than one HU then we manually assigned the polygon to the HUC that contained the majority of the polygon. Figure 2 depicts the buffered occurrence records for black-tailed jackrabbit in the Spring River watershed.

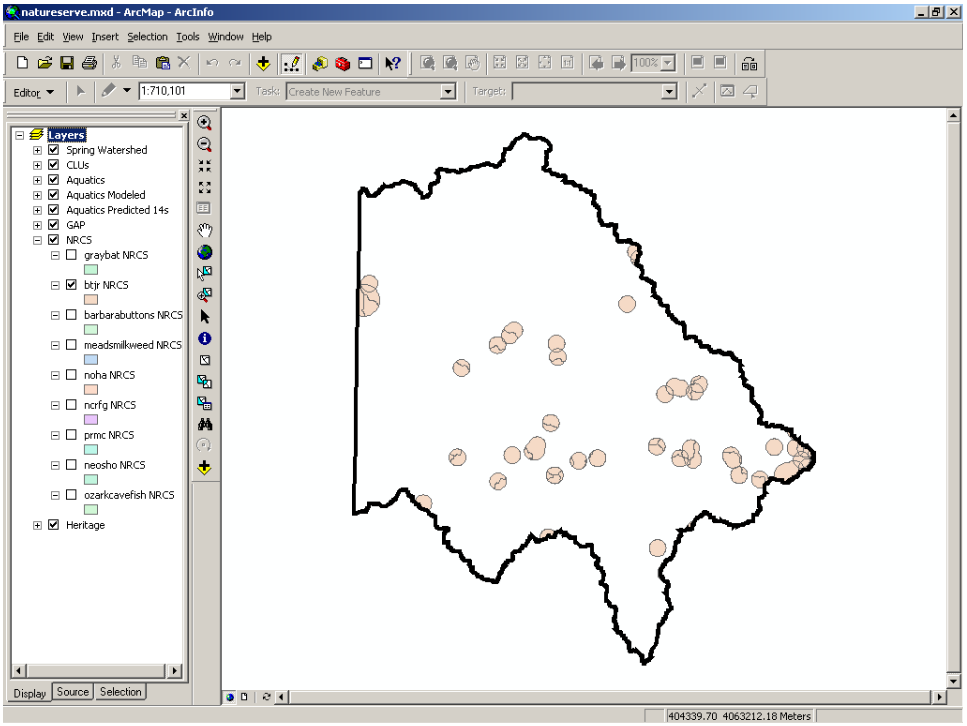


Figure 2. Buffered Heritage Occurrences of the Black-tailed Jackrabbit in the Spring River watershed.

GAP Species Distribution Models

The GAP species distribution data used for this project was created by the Geographic Resources Center, University of Missouri, as part of the Missouri GAP Analysis Project that was published in December 1999. Most GAP species distribution data sets, either developed for individual states, or for regional GAP projects address all major vertebrate species for the jurisdiction. A limitation of this MO dataset is the lack of information concerning one vertebrate group: reptiles, as well as insects and plants. For Missouri's GAP distributions, maps are summarized to square mile sections throughout the state.

We clipped data for each selected species [Gray Bat, Black-tailed Jackrabbit, Northern Harrier, Neosho Mucket (although this species is aquatic, it was handled the same as the terrestrial species in this analysis), Northern Crayfish Frog] to the Spring River boundary and exported each as a new layer. We then spatially joined this new layer to the 14-digit HU layer, and recalculated area and acres. If a HU Code (HUC) was not assigned because a species polygon was in more than one HU then we manually assigned the polygon to the HUC that contained the majority of the polygon. Figure 3 depicts the GAP distribution for black-tailed jackrabbit in the Spring River watershed.

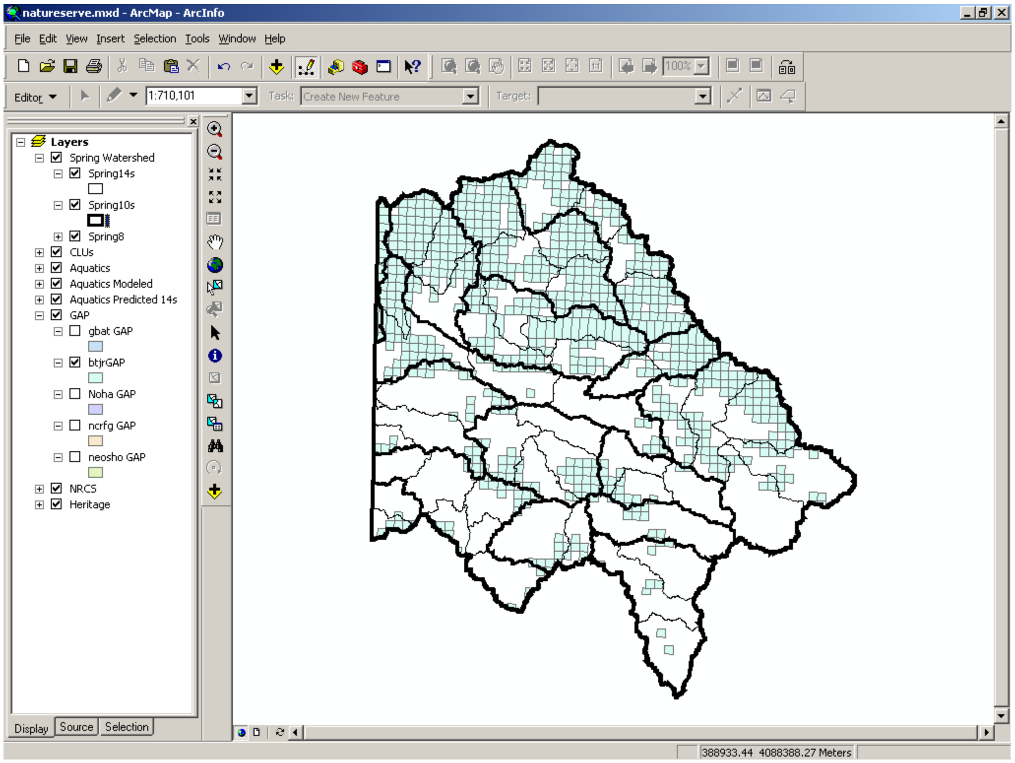


Figure 3. GAP distribution of the Black-tailed Jackrabbit in the Spring River watershed.

Buffered Heritage Occurrences Intersected with Gap Species Models

While the Heritage occurrences, buffered Heritage occurrences, and GAP distribution models present three forms of at-risk species distributions – and represent a range of confidence in actual species location (high, moderate, low, respectively) - one additional form may be developed by combining these layers. We created a new dataset using the NRCS modified Heritage shapefile ("buffered Heritage") to clip the GAP data. This process eliminated areas identified as unsuitable habitat in the GAP data from the NRCS Heritage buffers.

As with other approaches, we clipped data for each chosen species (Gray Bat, Black-tailed Jackrabbit, Northern Harrier, Neosho Mucket, and Northern Crayfish Frog) to the Spring River boundary and exported them as a new layer. We then spatially joined this new layer to the 14-digit HU layer, and recalculated area and acres. If a HU Code (HUC) was not assigned because a species polygon was in more than one HU then we manually assigned the polygon to the HUC that contained the majority of the polygon. Figure 4 depicts the GAP-modified buffered occurrence records for black-tailed jackrabbit in the Spring River watershed.

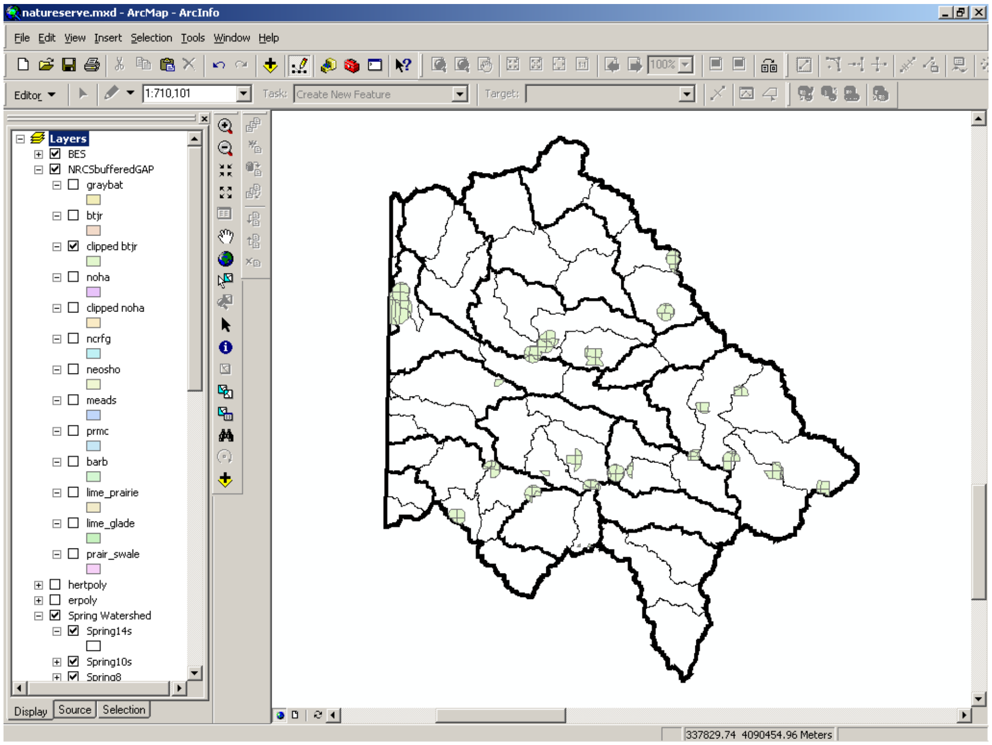


Figure 4. GAP-Modified Buffered Heritage Occurrences of the Black-tailed Jackrabbit in the Spring River watershed.

Freshwater Aquatic Species Distributions

At-risk freshwater aquatic species present additional challenges for depicting their distributions for conservation effects assessment. Most practices apply directly to lands surrounding aquatic features, but may impact those features through runoff. Aquatic species are often observed in specific locations, but in many cases migrate and utilize miles of interconnected streams and lakes. Missouri Natural Heritage Program records (fish, mussels, and crustaceans) are commonly supplemented with additional sample observation data, depicting points of stream and lake margins where species have been observed.

For the ten aquatic species that were selected for the Spring River watershed, we spatially joined Heritage records to stream-segment watersheds for spatial generalization. Stream-segment watershed (or “segmentsheds”) are derived from digital elevation models to depict the surrounding uplands that immediately drain into a given stream segment. However, limitations in these observation-based data became immediately apparent. Both incomplete sampling and spatial bias in samples greatly decrease confidence in the use of these data. As a result, we decided that, for freshwater aquatic species, the only practical way to represent species distributions is through predictive distribution maps. All of our subsequent analyses involving freshwater aquatic species were therefore based on the predicted distribution of each species produced through the Missouri Aquatic Gap Analysis project (Sowa et al. 2005). These models depict all stream segments and lake features where the species has some likelihood of occurrence.

Combining Wildlife Distributions with Mapped Conservation Practices

Conservation Land Units Including Practice #512

We assigned the shapefile with CLUs including practice #512 a 14 & 11-digit HU Code by spatially joining it to the Spring River watershed boundary and created copies of this shapefile for each of the wildlife distribution data sets. We modified the attribute table for each shapefile by adding a field for each selected species and community type. We intersected each wildlife file with the 512 CLUs and calculated a 1/0 value in the field to indicate presence/absence of the practice intersecting directly with polygons depicting the wildlife distribution. For terrestrial species and communities, again, these came in several forms, including Heritage polygons, NRCS buffered polygons, GAP distributions, and GAP-modified NRCS buffered polygons. We then copied the resultant 512 CLUs attribute tables and renamed, then imported into Microsoft Access.

In spatial analyses for the aquatic species, we calculated a set of seven statistics for each of the selected species. All statistics were calculated at two spatial resolutions, the 14 and 11-digit HU level in order to also assess the influence of the spatial resolution on the utility of the resulting information for assessment and planning. First we calculated the total length of stream (m), based on the MoRAP 1:100,000 scale valley segment coverage, within each 11 and 14-digit HU in the Spring River watershed (Total 1). Next we calculated the total length of stream affected by practice 512 (Total 2). To calculate this value we intersected the 512 CLU polygons in the Spring River drainage basin with the segmentshed polygon coverage. Again, this segmentshed polygon coverage contains polygons that represent the immediate drainage of every individual stream segment (Figure 5 Map A). Then, assuming that the 512 practice only influenced the individual stream segment within the segmentshed that the practice occurred, we summed the length of all the affected stream segments for each HU (Figure 5 Map B). We then calculated the total length of stream in which each species was predicted to occur within each HU, based on the models developed by Sowa et al. (2005) (Total 3) (Figure 6).

The predicted distribution of each species was then intersected with the 512 affected stream segments coverage to calculate the total length of each species distribution that was affected by practice 512 (Total 4) (Figure 6). These methods were used for all but the prairie crayfish, which is a burrowing species that does not occur in riverine environments. For this crayfish, we calculated the number of acres in which this species is predicted to occur in each HUs and the total number of acres that are affected by practice 512, by using the actual number of acres of the 512 practice.

We divided **Total 2 by Total 1** to calculate the percentage of stream in each HU that is affected by practice 512 (Table 8). We then divided **Total 4 by Total 3** to calculate the percentage of each species distribution that is affected by practice 512. Finally, we divided **Total 4 by Total 2** to calculate the relative influence of practice 512 within each HU. A high value for this last calculation indicates that the practice is primarily being applied where the species occurs within the HU, while a low value indicates that the practice is mainly being applied outside of where a species occurs.

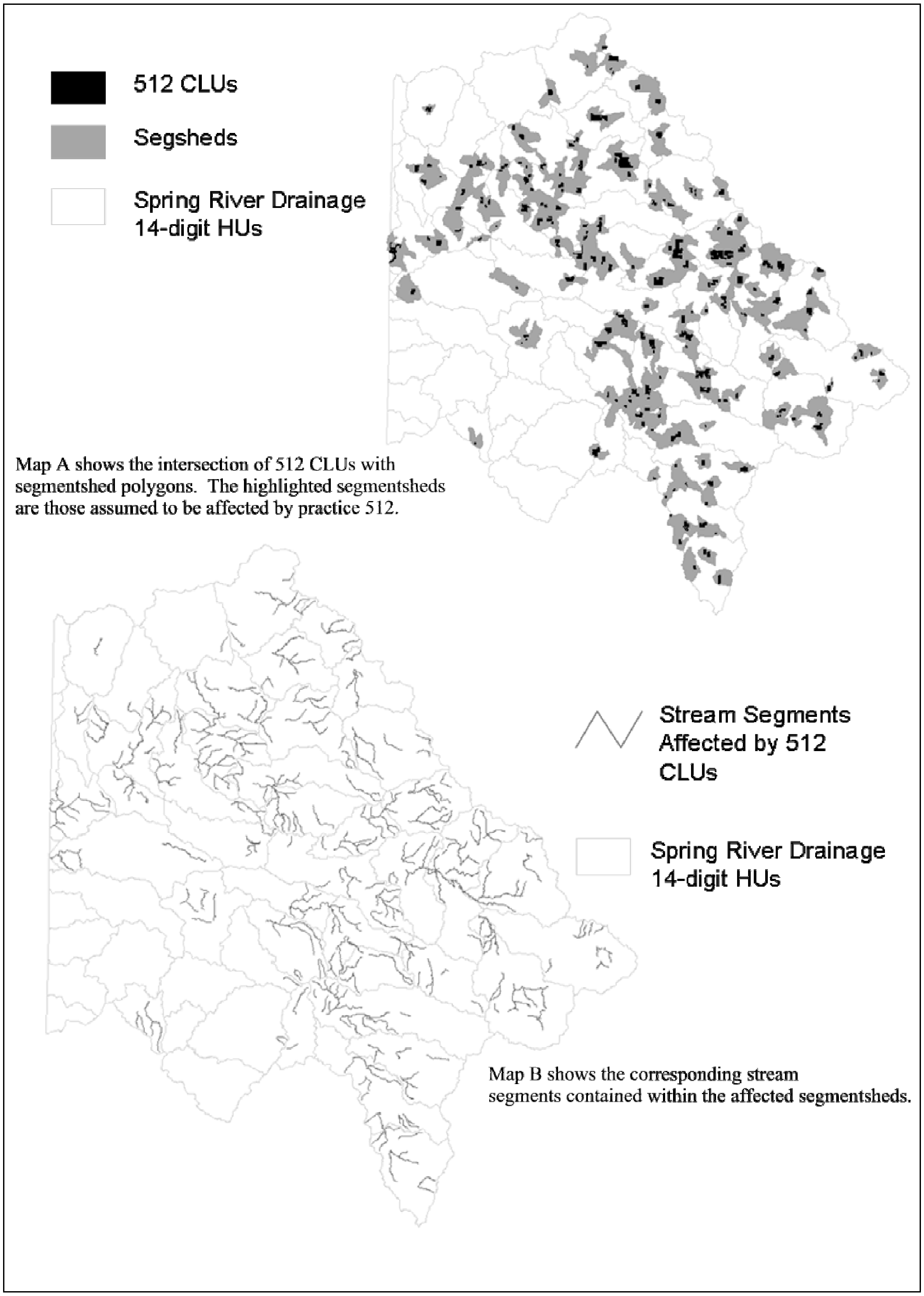


Figure 5. Segmentsheds and steam segments resulting from intersecting 512 CLUs with segmentsheds in the Spring River watershed, MO.

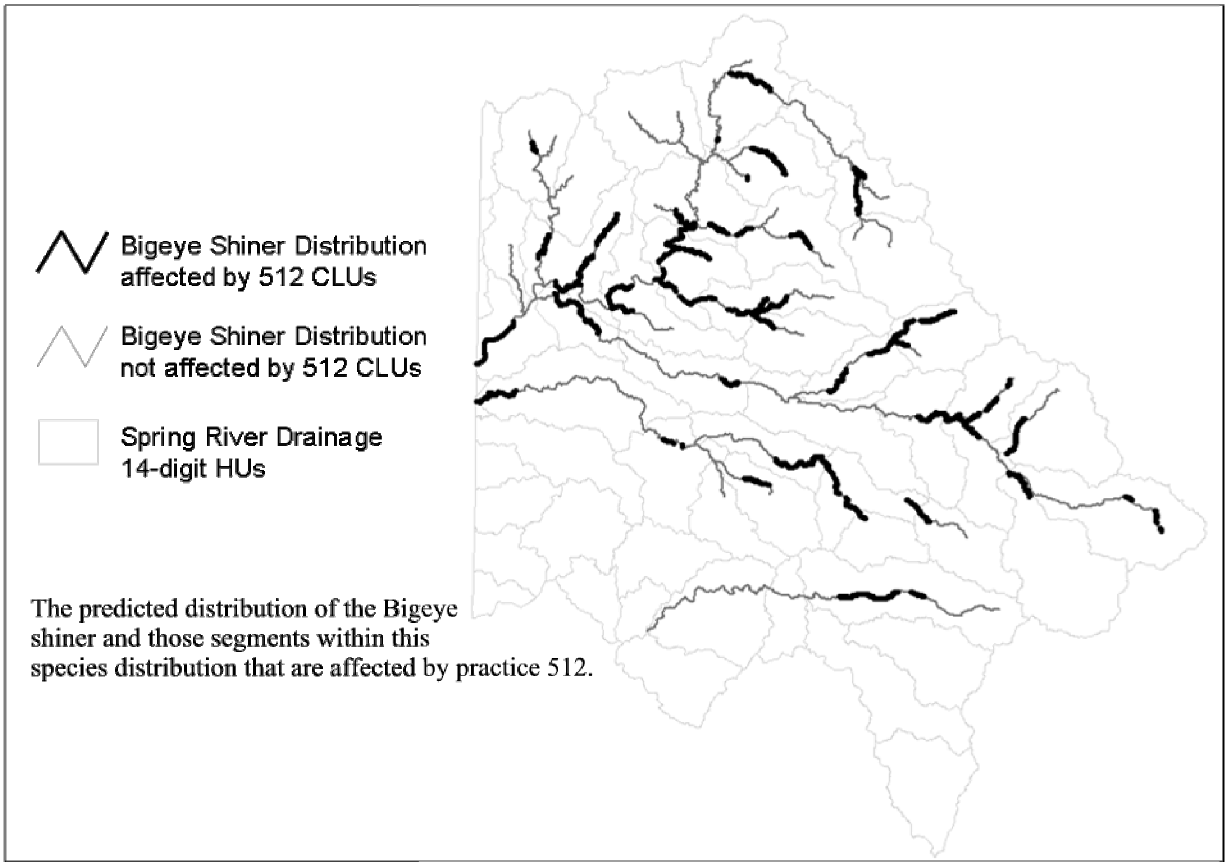


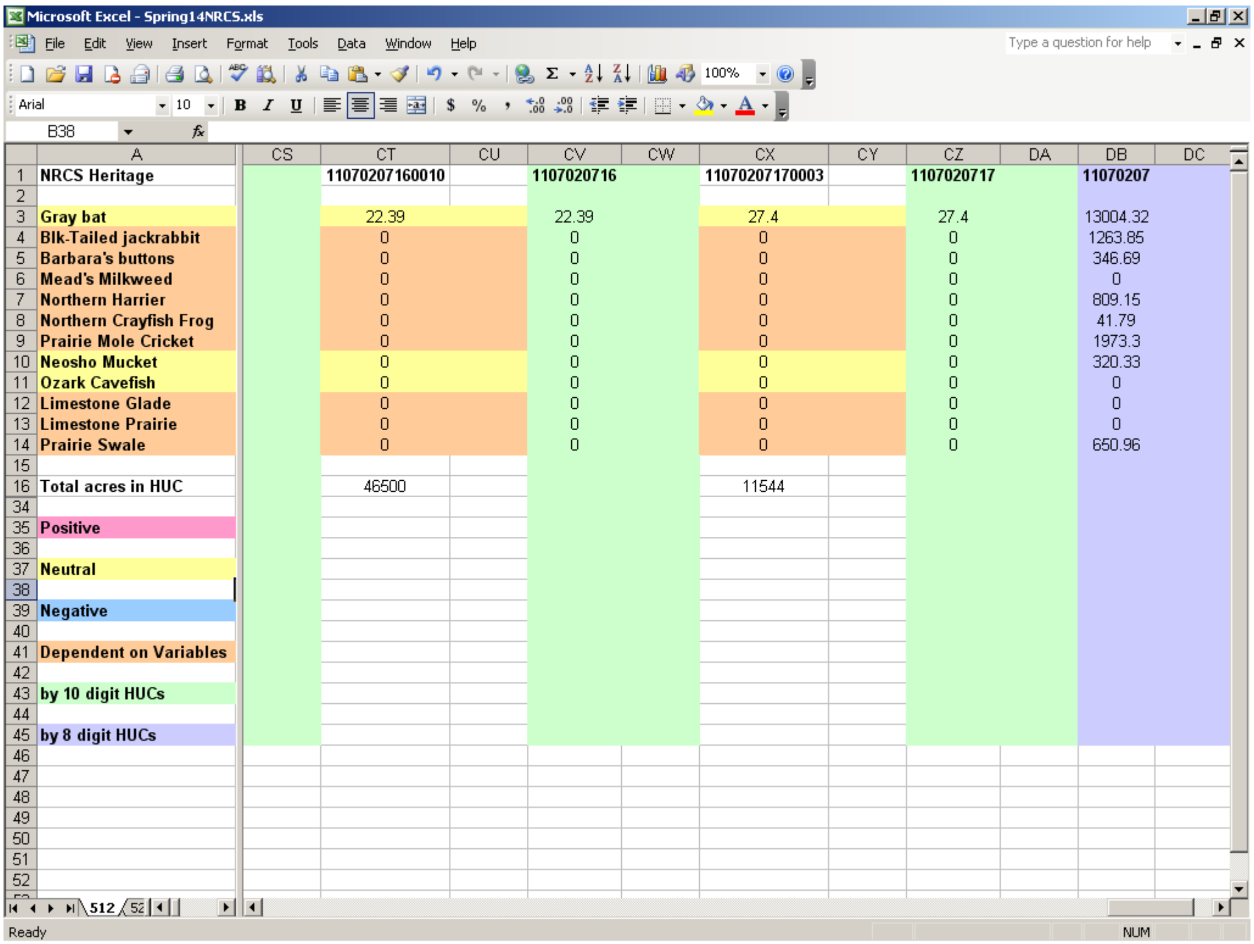
Figure 6. Bigeye Shiner Distribution and Practice #512 affected segments within the Spring River Watershed, MO.

Tabular Reporting

With the many options for spatial data overlay mentioned above, a large number of calculations can be completed, and measurable results may take the form of maps, text, and tables. We explored options for tabular reporting to capture these typical results from our spatial overlays.

In the Access database, we build a make-table query to sort by the 14-digit HU code and sum area (in acres) for each species. We exported the resulting table, which gave the total amount of acres of each species that was affected by 512 CLUs, and opened it in Excel. We transferred the data to a spreadsheet that has species occurrence broken down by 14-digit HU code and color coded them to reflect positive/neutral/negative effects of 512 on species (Figure 7).

In Figure 7, we list practice #512 affected acreage for each species (as represented by unmodified Heritage occurrence polygons) within two 14-digit (columns CT and CX) watersheds, two 10-digit (columns CV and CZ) watersheds, and finally, the one 8-digit HU code for the entire Spring River watershed. In this case, only Gray bat had any overlapping acreage with practice #512, and that effect, over 22.39 and 27.4 acres, respectively, is assumed to be neutral. Total affected acreage for the Spring River watershed for each species is indicated in purple on the right side of the table. Also note in this example where color coded cells indicate neutral effects of practices on species, or in the majority of cases, where additional factors – primarily the actual form of practice #512 implementation, would determine positive, neutral, or possibly negative effects.



	A	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC
1	NRCS Heritage		11070207160010		1107020716		11070207170003		1107020717		11070207	
2												
3	Gray bat		22.39		22.39		27.4		27.4		13004.32	
4	Blk-Tailed jackrabbit		0		0		0		0		1263.85	
5	Barbara's buttons		0		0		0		0		346.69	
6	Mead's Milkweed		0		0		0		0		0	
7	Northern Harrier		0		0		0		0		809.15	
8	Northern Crayfish Frog		0		0		0		0		41.79	
9	Prairie Mole Cricket		0		0		0		0		1973.3	
10	Neosho Mucket		0		0		0		0		320.33	
11	Ozark Cavefish		0		0		0		0		0	
12	Limestone Glade		0		0		0		0		0	
13	Limestone Prairie		0		0		0		0		0	
14	Prairie Swale		0		0		0		0		650.96	
15												
16	Total acres in HUC		46500				11544					
34												
35	Positive											
36												
37	Neutral											
38												
39	Negative											
40												
41	Dependent on Variables											
42												
43	by 10 digit HUCs											
44												
45	by 8 digit HUCs											

Figure 7. Spreadsheet showing acreage of species affected by practice #512 per 14-digit HU

Exploring Uncertainty with Overlain Spatial Data

In order to investigate and document levels of uncertainty associated with the spatial precision of component data sets for this type of analysis, we compared output from the various overlay options including 1) various ways of depicting location and area of conservation practices, 2) the various ways of depicting wildlife distributions, and 3) the various spatial units for summarizing results (e.g., different levels of watershed HU codes).

Differences in Representation of Practices

Initially, we analyzed datasets that represented area of practices at various spatial resolutions including CLUs, 1-mile^2 Sections from the Township/Range/Section grid, and an intermediate level (e.g., ¼ sections, or 160 acre squares). Representation of acreage by these other spatial forms would be most relevant to NRCS practice records that are typically older, and less precisely located, than current CLU data provide. An initial comparison of most detailed CLU data with 1-mile^2 Section results is provided in Figure 8. In all cases, there is a significant over-estimate of the amount of affected acreage for each species resulting from the use of 1-mile^2 Sections to represent the locations of practices. In other words, the coarser grid (in this case, over 60 times larger than the average CLU size) is much more likely to cause a spatial overlap of presumed practices with wildlife species distributions.

Because management practices are recorded by CLU and the average size of CLU in Missouri is 10 acres, using any spatial resolution larger than CLUs would likely significantly distort the assumed area affected by applied practices. The degree to which this is true in other states and regions needs further investigation; i.e., if average CLU sizes are much larger than, for example 40 acres elsewhere, use of regular 40 acre (¼ ¼ Section) grids may be better suited for this purpose. In any case, with these initial results, we did not pursue further representation of practices at different spatial resolutions.

Microsoft Excel - Terrestrial all watersheds NRCS Heritage 8 HUC 4_06.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	**Spring River**		**528a**	%	**528b**	%	**512a**	%	**512b**	%	**645**	%	**590**	%	**Total acres**
2	CLUs	in acres													**in watershed**
3	**Gray bat**		6805.12	1.04%	6805.12	1.04%	2403.78	0.37%	2403.78	0.37%	1654.7	0.25%	2140.7	0.33%	653413.27
4	**Blk-Tailed jackrabbit**		704.62	0.46%	704.62	0.46%	299.55	0.19%	299.55	0.19%	46.4	0.03%	213.3	0.14%	154168.78
5	**Barbara's buttons**		0	0.00%	0	0.00%	193.86	0.94%	193.86	0.94%	83.5	0.41%	69.4	0.34%	20529.04
6	**Mead's Milkweed**		0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1167.21
7	**Northern Harrier**		84.12	0.07%	84.12	0.07%	193.02	0.16%	193.02	0.16%	163.6	0.13%	368.4	0.30%	121501.41
8	**Northern Crayfish Frog**		41.79	0.16%	41.79	0.16%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	26544.93
9	**Prairie Mole Cricket**		904.09	1.83%	904.09	1.83%	31.55	0.06%	31.55	0.06%	1037.7	2.10%	148.3	0.30%	49481.63
10	**Neosho Mucket**		52.1	0.34%	52.1	0.34%	0	0.00%	0	0.00%	268.2	1.75%	0	0.00%	15368.53
11	**Ozark Cavefish**		0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	994.25
12	**Total acres**	**in watershed**	11105		11105		4275.6		4275.6		4836.37		3985.62		
13															
14	Positive		756.72		1660.81		0		524.12		1331.2		2140.7		
16	Neutral		6931.03		6931.03		2403.78		2597.64		1922.9		21585.78		
18	Negative		0		0		717.98		0		0		0		
20	Number of CLUs by practice		452				153				197		171		
21	Number of CLUs with multiple practices = 291														
23															
24	**Spring River**		**528a**	%	**528b**	%	**512a**	%	**512b**	%	**645**	%	**590**	%	**Total acres**
25	T/R (1 mile)	in acres													**in watershed**
26	**Gray bat**		51424.93	7.55%	51424.93	7.55%	29646.05	4.36%	29646.05	4.36%	25551.21	3.75%	18429.32	2.71%	680690.63
27	**Blk-Tailed jackrabbit**		12882.09	6.67%	12882.09	6.67%	8404.81	4.35%	8404.81	4.35%	5151.92	2.67%	4469.22	2.31%	193225.07
28	**Barbara's buttons**		0	0.00%	0	0.00%	1286.52	3.27%	1286.52	3.27%	1945.85	4.95%	643.36	1.64%	39288.94
29	**Mead's Milkweed**		0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	3218.08
30	**Northern Harrier**		1923.23	1.33%	1923.23	1.33%	2556.78	1.77%	2556.78	1.77%	1988.67	1.38%	1296.76	0.90%	144173.34
31	**Northern Crayfish Frog**		4047.6	8.95%	4047.6	8.95%	4047.6	8.95%	4047.6	8.95%	0	0.00%	0	0.00%	45229.73
32	**Prairie Mole Cricket**		6183.99	7.66%	6183.99	7.66%	2324.41	2.88%	2324.41	2.88%	4540.27	5.62%	1304.63	1.62%	80774.93
33	**Neosho Mucket**		1315.29	3.75%	1315.29	3.75%	3130.53	8.93%	3130.53	8.93%	1915.73	5.46%	645.95	1.84%	35074.95
34	**Ozark Cavefish**		0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	3912.83
35	**Total acres**	**in watershed**	77024.46		77024.46		47482.68		47482.68		50230.29		33498.65		
43	CLUs area % of T/R		14.42%		14.42%		9.00%		9.00%		9.63%		11.90%		
44															
45															
46															

Spring / Chariton / St Francois

Figure 8. Total area (acres) of selected species affected by practices by CLUs (top half of sheet) & by 1 mile stream lengths (bottom half of sheet).

Differences in Representation of Wildlife Distributions

We used four different datasets to represent predominantly terrestrial wildlife distributions to learn more about the impact of relative precision in their spatial representation on measured effects of practice application. In the Spring River watershed, there are 24,202.59 acres of #512 practices measured within CLUs. Table 9, contains the total acreage for the selected species for each of the four datasets that is affected by the 512 practice throughout the watershed. This table demonstrates the varying results derived from varying precision of wildlife distributions, from Heritage polygons (most specific; based on recorded field observation and delineation), to (most generalized) GAP predicted distributions. These results are depicted graphically for the black-tailed jackrabbit in Figures 9a, 9b, and 9c. In each of these figures, red polygons indicate overlap of practice #512 with each mapped distribution of the same species.

Table 9: Total acres of selected species from each dataset affected by 512 CLUs

Target	Heritage	NRCS Buffered Heritage	NRCS Modified GAP	GAP
Gray Bat	0	13004.32	13004.21	23385.48
Black-tailed Jackrabbit	0	1263.85	599.1	12962.02
Northern Harrier	0	809.15	809.15	23285.15
Northern Crayfish Frog	0	41.79	41.79	22433.47
Neosho Mucket	349.11	320.33	4087.24	6462.47
Ozark Cavefish	0	0	0	3189.35

While Heritage occurrence data likely provide the highest confidence in reflecting where at-risk wildlife and habitats are likely to be found, they say nothing of the potential distribution of at-risk wildlife in un-surveyed areas (i.e., the absence of an occurrence does not mean the species is not there). Therefore, for some at-risk species, our overlay process would be expected to result in a significant underestimate of conservation effects. On the other extreme, use of predicted distributions from the GAP effort would likely greatly overestimate conservation effects on many types of wildlife, in that a large proportion of these generalized mapped distributions would be somewhat unlikely to support those individual at-risk wildlife species and habitats.

From our initial results, it would appear that one could use current knowledge of the relative abundance of a given at-risk wildlife species or habitat to guide selection of appropriate spatial data to represent their distribution. For certain at-risk species and habitats only known from a few locations statewide (e.g., <20 locations), direct use of Natural Heritage occurrence data would seem appropriate. Depending upon survey effort – information one can obtain from Natural Heritage Program biologists - these very rare biodiversity features are unlikely to be found in many new locations outside of those already documented. For many at-risk terrestrial species and habitats that, while uncommon, are at least known from a 10s to hundreds of locations in a given state, using combinations of these common data sets, such as the GAP modified, NRCS buffered Heritage polygons, would be an appropriate choice. For relatively common terrestrial wildlife that are of conservation concern for reasons other rarity, and especially for those known to utilize agricultural lands, use of unaltered GAP predictive distributions may be appropriate.

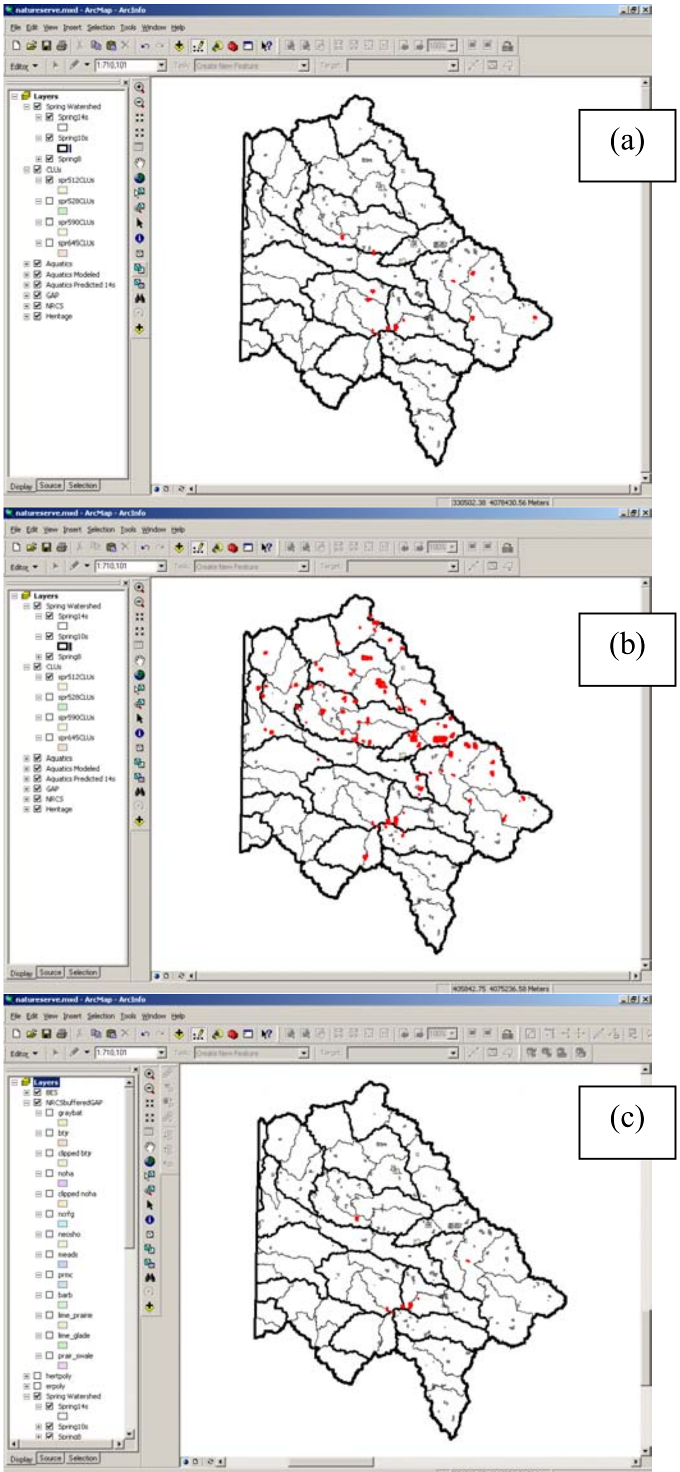


Figure 9 (a, b, c). Practice #512 overlapping (in red) with distributions of black-tailed jackrabbit (a) NRCS buffered Heritage polygons, (b) GAP distribution, and (c) GAP-modified NRCS buffered Heritage polygons

Recommendations for Analysis and Reporting

This Missouri pilot provides a number of practical insights for analysis and reporting for likely effects of NRCS-funded conservation practices on at-risk wildlife species and habitats. Below we organize our discussion around key analytical steps covered in Missouri, and consider implications for analysis and reporting at national, regional, statewide, and more local watershed scales. These recommendations, in some instances, point to the need for additional investigation to clarify the current status of certain data sets and estimated costs for filling critical information gaps. Table 10, located at the end of this section provides a summary of recommendations, current status, priority actions, and cost estimates for recommended actions.

Criteria for Wildlife Selection

Species Selection

As noted previously 'at-risk' wildlife were not rigorously defined for purposes of this Missouri pilot. We simply selected a subset of species of "conservation concern" identified by **MONHP to use as the basis for exploring the full range of analytical issues associated assessing** impacts of conservation practices on species. However, for national application of these analyses, we recommend that a standard set of criteria be established to help guide state NRCS offices in conducting similar assessments. Similar types of selection criteria have been developed for other related purposes such as the development of comprehensive state wildlife strategies (http://www.teaming.com/state_wildlife_strategies.htm), and selection of 'species of concern' or 'species of interest' for national forest planning (http://www.fs.fed.us/emc/nfma/includes/rule%20.pdf). The Nature Conservancy has also recently developed a full list of 'conservation targets' (i.e., species, communities, and ecosystem types) using published data and expert knowledge to comprehensively represent biodiversity in each ecoregion of the United States (http://www.nature.org/aboutus/howwework/cbd/). Finally, each Natural Heritage Program throughout the country applies criteria to determine a list of species and habitats of conservation concern to be tracked in their jurisdiction factoring in representativeness, rarity, and threat.

NatureServe global ranks (G1-G5) as well as sub national ranks (S1-S5) are fundamental criteria for selecting species of conservation concern. We recommend that NRCS state offices develop the list of species of conservation concern in their state by selecting all species and habitats ranked by NatureServe as G1-G3, and by their state Natural Heritage Program as S1-S3. Using this method will ensure that they select the plant and animal taxa and habitats in need of specific conservation attention. A list of these species for a given state may be acquired at any time at no cost from the NatureServe Explorer website (http://www.natureserve.org/explorer/). This listing may be augmented by additional species of conservation interest, such as game species, or other well-recognized species on public interest, not already captured by the NatureServe selection criteria.

The lists of species and habitats of conservation concern will change over time, so periodic expert review (e.g., on 5 year intervals) should be programmed into NRCS activities to ensure that collaborations with other federal and state wildlife agencies, as well as non-government conservation interests maintain the currency of species lists. While this type of activity will vary in cost, an initial estimate of $25,000 per 3-5 year time interval is realistic.

Habitat Selection

While much of the previous discussion emphasized species of conservation concern, selection of habitats is an equally important avenue for consideration. Habitats may be defined in a variety of ways. Most generically, 'habitat' is defined from the perspective of individual taxa, such as an individual species, or taxonomic groups, and environmental features are described and mapped under those constraints. However ecological classifications are often developed to characterize recurrent, recognizable pattern in biotic assemblages (e.g., vegetation), land features, and/or aquatic assemblages and environments. These classification units are not defined from an individual species perspective, but instead apply rules to characterize the terrestrial or aquatic classification unit, then map those units accordingly. They may then be applied to assess conservation effects on all forms of wildlife that might use these types of ecological features.

Selection of ecological classifications for use in conservation effects assessment is inevitably influenced by the availability of mapped data. Since ecological classifications describe the majority of the land and waterscape, in order to be useful, they need a relatively comprehensive mapped expression. Both terrestrial and aquatic community classifications have been completed in Missouri, and these serve as state-based examples of ecological classifications (Sowa et al. 2005, Nelson, P.W., et al. 2005). There is currently no nationally standardized classification of freshwater ecological units that has been mapped, although substantial progress in this area has been accomplished by the Gap Analysis Program and The Nature Conservancy (http://www.nature.org/initiatives/freshwater). In terrestrial environments (i.e., uplands and wetlands), there are several options. Wetlands have been classified and mapped nationally through the National Wetlands Inventory. The current location of wetlands are depicted in these maps, electronic versions are available for much of the country, and the classification concepts described through NWI would be amenable to conservation effects assessment (http://www.fws.gov/nwi).

In addition to NWI, terrestrial ecological systems – encompassing both uplands and wetlands – have been described for the United States by NatureServe (Comer et al. 2003, NatureServe 2007, current descriptions at http://www.natureserve.org/explorer/), and form the thematic basis for national mapping efforts underway or already completed. For example, the Gap Analysis Program now utilizes the NatureServe ecological systems concepts for regional land cover mapping, and regional GAP efforts in the southwest, southeast, and Pacific northwest have produced, or are producing, moderate-high resolution land cover maps depicting these classification units over those 18 states. GAP map products may be accessed via the national website: http://gapanalysis.nbii.gov/portal/server.pt.

The NatureServe ecological systems concepts also form the thematic basis for national mapping by the inter-federal-agency Landfire effort. These maps depict existing vegetation and predicted biophysical setting for most ecological system types. In addition, vegetation structure and fire regime are treated in mapped form by this national effort. Map products from Landfire are made available at http://gisdata.usgs.net/website/landfire/ as they are finalized. The first complete national data set is due in 2009.

Wildlife Distributions

The Missouri pilot analysis clarified a number of issues regarding the mapped form of wildlife species distributions for application to conservation effects assessment. Our recommendations are organized into five categories determined by life history characteristics (e.g., terrestrial vs. aquatic species; plants vs. animals, etc.) and relative rarity or abundance within a given state.

At-Risk Freshwater Aquatic Species

Incomplete point observations and likely biases in sampling effort severely limit the utility of point observations for most aquatic wildlife. Freshwater aquatic species are best represented using predictive distribution models that indicate the lakes and streams where a given species is likely to occur. These types of predictive distribution models have been completed for a relatively small number of species nationwide, so investments in development of these models for at-risk aquatic species is a high priority national investment. [Cost estimate: $1,800,000 – approximately $2,000 for each of the G1-G3 fish (507), mussels (197), crayfish (195)].

Very Rare Terrestrial Species with Small Home Ranges

For terrestrial species, including most plants, small mammals, small reptiles and amphibians, and terrestrial invertebrates that are NatureServe ranked G1 or G2, un-buffered heritage occurrence data should be appropriate for conservation effects assessment. Species ranked G1 or G2 are very rare, typically with fewer than 10 occurrences per state, and their habitat requirements are often highly specific and geographically localized. Use of buffering techniques for this group of species would likely exaggerate their extent, as well as the measured effect of conservation practices. A national occurrence data set may be accessed directly from NatureServe through licensing agreement via NatureServe's national multi-jurisdictional database (cost estimate $750,000/yr. for ongoing access vs. single project analysis done by NatureServe; $400,000). Appendix 4 provides a breakdown of species occurrence records by state and a discussion of the currency and completeness of occurrence nationwide. This assessment of the status of species occurrence data will assist in planning of future state, regional or nationwide projects.

Other At-Risk Terrestrial Species with Small Home Ranges

For more common and/or abundant (G3G5; S1S3) plants and terrestrial invertebrates, the Missouri NRCS buffers provide a useful case study for further investigation –addressing variation that may exist across the country. As noted previously, in Missouri, Heritage occurrence polygons of insects were buffered 1 mile. Plant records were buffered 0.25 mile. These buffers appear to be appropriate for use nationwide, but focused research using NatureServe's multi-jurisdictional database would enable rigorous evaluation of these standard buffers for common plants and invertebrates. (Cost estimate for research: $40,000)

Other At-Risk Terrestrial Species with Larger Home Ranges

For other at-risk terrestrial species (G3; S1S3), including birds, larger mammals, reptiles and amphibians, as well as more common small mammals, small amphibians and small reptiles we recommend the approach that intersected NRCS buffered heritage data with Gap distribution models. The intersection of predictive distribution models with buffer polygons allows for appropriate elimination of non-habitat portions of the buffer polygon and should provide the most accurate depiction of effected habitat for conservation effects assessment. Again, the standard buffers applied by Missouri should be explored in more detail using selected Heritage occurrence records from a representative sample of states; aiming to confirm the Missouri standards or recommend modifications suitable to taxonomic groups in a given regional setting (cost estimate: $20,000).

More Common Terrestrial Species with Larger Home Ranges

Heritage occurrence data are not often available for more common terrestrial vertebrate species (e.g., G4G5) including birds, mammals, reptiles and amphibians that are locally rare or of conservation interest for reasons other than rarity. We recommend use of predictive distribution models for these groups of species. These models will vary in their precision, based mainly on the knowledge of habitat requirements, available observation data and other spatial data inputs, and modeling technique. However, for this subset of wildlife species, predicted distributions should be the most practical for conservation effects assessment. One primary objective of the USDI Gap Analysis Program is to produce predicted distributions of this type for all vertebrates across the United States. Currently, some 2,000 such models exist for terrestrial vertebrates throughout the United States where state or regional Gap Analysis projects have been completed over the past decade (Jill Maxwell, pers. comm.). Although many of these models could be improved with additional investment, the current situation leaves relatively minor ‘gaps’ in data availability for this group of wildlife species (estimated cost: $200,000).

See Table 10 for a summary of recommendations on wildlife distributions, current status, priority actions, and estimated costs for recommended actions.

Conservation Practices

As noted above, conservation practices supported through Farm Bill programs have been established over a number of years to meet the variety of needs across the country. Today, over 280 practices vary from those that are quite popular, widespread, and effect extensive acreage, while others are less commonly applied and/or effect very small land/water area. As summarized in Tables 2 and 3, this pilot project identified the potential to organize all current practices into practice groups. Within each of these groups, all practices would likely have a similar effect on selected wildlife for assessing conservation effects.

To fully understand the utility of these groupings for conservation effects assessment nationwide, additional analysis is needed to; 1) extend the practice groups developed in this project to all practices nationwide; 2) better characterize the actual forms that practices are implemented; 3) clarify circumstances where standard practices are applied vs. custom applications are determined by local site conditions and customer desires, and; 4) ensure the practice groups are specific enough to have consistent positive, neutral, or negative effects on wildlife groups. For example, practice 512 may be implemented by planting either native or non-native species. While the planting of native species may be beneficial for some wildlife, the planting non-natives may be either neutral or negative. Critical factors such as these must be documented and entered into the NRCS Toolkit to ensure that the effects of these practices on wildlife are properly assigned.

Proper documentation of relevant variations in practices might require changes to the names and codes of funded practices within the Toolkit. These changes would enable more robust reporting of conservation effects into the future. Because changes to practice names and codes to existing data in Toolkit would be costly, we do not recommend implementing any new code changes retroactively on historical practice information. The benefits of this would likely not exceed the costs. (Cost estimate: $200,000)

Conservation Effects Matrices

This pilot provided useful insights for development of conservation effects matrices that document expected effects of practices on wildlife. Our exploratory research indicated not only that practices might be feasibly grouped into practice groups , but also, wildlife species could likely be organized into some 35 groups - based on ecologically functional traits - for purposes of effects assessment. We recommend pursuing this approach on a national scale (modifying the matrix regionally as needed - see below). This builds on work already completed in states such as Missouri, and if successful, should enable robust assessment in a greatly streamlined fashion.

It is important to acknowledge the weaknesses of any attempt to assign consistent effects of any given practice towards wildlife. First and foremost are the many and varied local circumstances that may interact with the actual implementation of a practice and could reverse, or simply negate, the presumed conservation effect relative to wildlife. Implementing what appears to be a clearly positive or negative practice may have no net effect if in fact that aspect of wildlife habitat is not limiting in the local landscape. We also not expect that every species in a group to have the exact same response to a given practice. We cannot realistically factor in all possible extenuating local circumstances or all individual species responses. The creation of a single national matrix of species groups and practice groups, establishing all positive, neutral, and negative relationships may not produce ecologically meaningful results for some species or species groups.

It may be necessary to develop a series of regionally-defined matrices, based roughly on these practice groups, and species groups, that also incorporate major land/water conditions, threats - and especially, limiting factors - that most directly impact wildlife. Those regions might be defined through ecoregion-based concepts, such as EPA Level I ecoregions (15 nationwide) or level II ecoregions (26 nationwide) (http://www.epa.gov/wed/pages/ecoregions/) or through other means.

To construct a regionalized matrix, one would conduct general review of the literature pertaining to the principal habitat requirements, ecology, and the full range of human disturbances that potentially negatively affect well-known species within each species group within the given region. Then one would hierarchically rank these habitat requirements and human disturbances for each species group in order to identify the principle negative factor(s).

Using this collection of information, one could then assign a positive effect only if the conservation practice addressed the most critical limiting factor(s). A negative effect would be assigned if the practice would negatively affect any habitat element. Otherwise a neutral effect would be assigned. It is likely that this sort of regionalized process would result in some modifications to practice groupings and wildlife species groupings, so this should be anticipated from the perspective of national data management and maintenance.

Since the current matrix information has been developed for both aquatic and terrestrial species and practice groupings, these products could be evaluated in the context of several representative, albeit different regions of the United States. A peer-review effort might rapidly identify whether the existing draft matrices are best applied nationally, or of indeed there would be need for regionalization. A more limited peer-review effort could cost approximately $100,000 to implement, including workshops and covering costs for expert reviewers. If in fact a set of regionalized matrices must be developed, we estimate that costs for their development could reach $500,000.

Spatial Analysis Units

There are several spatial units needed to analyze conservation effects, and the Missouri pilot indicated some particularly robust options. The NRCS Common Land Unit provides a fine-grain analysis unit to depict the location of funded conservation practices. The average size of CLUs units in Missouri is 10 acres. In most circumstances, this level of spatial resolution is adequate for conservation effects assessment in Missouri.

However, there are additional issues that must be resolved before deciding to use CLU's as spatial units for national analyses. First, both availability and the size of CLUs will vary throughout the country. CLUs that are large relative to actual area of the practice polygons will introduce error into the assessment if practices are mapped only in terms of the entire CLU (rather than a subsection of the CLU). NRCS planners have the tools to digitize the actual practice boundaries within CLUs, but this practice is currently done in an ad hoc manner. If NRCS planners begin to consistently digitize the location of each intended practice, conservation effects assessment will be able to utilize these polygons directly and maintain the highest spatial resolution possible with limited additional effort. Second, where NRCS planners are digitizing actual practice polygons, the CLUs then serve primarily as a unit to for summary statistics and reporting. Again, it was outside of the scope of the Missouri pilot to clarify all issues regarding CLUs nationwide, so it remains unclear just how much CLUs vary in size in other regions of the country. If average CLU size extends much beyond 40-100 acres in others states, their utility as analysis units decreases (in favor of directly digitized practice polygons) and their utility as reporting units also decreases (in favor of small watershed units).

Ideally, CLUs would be in place nationwide, of appropriate size, and attributed with not only current practices, but all past practices. This would enable robust cumulative effects assessment of conservation practices. However, attribution of CLU polygons in Missouri with practices from most recent years (2002-2005) required approximately 45 FTEs (Liz Cook, pers. comm.) to complete, so we do not recommend that CLUs be attributed with past practices across the nation. Retrospective analysis might be more feasibly addressed with coarser spatial resolutions, such as Sections (1 $mile^2$), quarter Townships (9 $mile^2$), and/or 14-digit watershed units.

Another spatial analysis unit that will be critical to aquatic assessment is the segmentshed, or land area draining immediately into a given stream segment. These watershed subunits serve as the primary spatial unit to locate aquatic features and serve as the principle unit for overlay with practice polygons. Segmentsheds are available in digital form nationally in NHD Plus, but additional research is needed to clarify the status and quality of these data nationwide.

Summary Units for Reporting

Summarizing the area of funded practices and their positive, neutral, or negative effects on wildlife appears to be best completed using relatively fine-grained analysis units to minimize distortions introduced by larger watershed units. National watershed data sets, part of the National Hydrologic Database (NHD) have been upgraded. Nearly all of the country now has 12, 10, and 8 digit HUs that should more provide more accurate summary units than the previous 14, 10, and 8 digit units. We recommend that NRCS adopt these three levels for summary reporting of conservation effects.

Table 10. Summary of assessment components, current status, needs, cost estimate.

Analysis Component	Current Status	Priority Actions	Estimated Costs
Selecting Wildlife for Assessment	Related criteria and lists available; in need of nationally consistent criteria	Review existing criteria, organize expert review to gather input and finalize criteria	$25,000/3-5 yr. interval
Accessing ecological classifications to map habitat	Terrestrial maps being produced through GAP and Landfire; Aquatic classifications and maps being produced through TNC and GAP	Compile existing data; update where needed, partner with others to fill holes.	Requires further analysis and clarification of contributions from partner agencies.
Wildlife Distributions – Freshwater Species predictive Distributions	Limited availability through Aquatic GAP	Develop models for about 900 at-risk aquatic species nationwide	$1,800,000
Wildlife Distributions – G1G2 plants, small mammals, small herps – NatureServe MJD		Provide MJD license to NRCS; or NRCS subcontract with NatureServe for one time use of location data and analysis at 12 digit HUC scale	$750,000/yr license fee for ongoing NRCS access to precise location data or: $400,000 for one time use of data provided at the 12 digit HUC scale.
Wildlife Distributions – Buffered G3G5; S1S3 plants and terrestrial invertebrates – NatureServe (augmented MJD)	Need to complete research on selected Eos and MO standard buffers to finalize national standard	Compile G3G5; S1S3 occurrence data from HPs, apply standard buffer	$40,000
Wildlife Distributions – G3; S1S3 birds, mammals, herps	Need to finalize buffer sizes across all related types; assess status of data	Compile HP occurrences from NatureServe databases,	$20,000

	availability for predictive distributions from GAP and elsewhere	apply standard buffers, clip based on predictive distributions	
Wildlife Distributions – G4G5 birds, mammals, herps with large home ranges	Predictive distributions exist for most from GAP and other efforts	Compile and evaluate existing models, prioritize and develop ~100 new models	$200,000
Conservation Practices	Practices defined over time, many inconsistencies or unclear definition relative to actual implementation	Need better descriptions of practices; regional/local variation; possibly adjust codes and names of practices in Toolkit	$200,000
Conservation Effects Matrices	Draft national matrices complete for aquatic and terrestrial groupings	Need to attribute all likely at-risk species to group in Biotics. Need to develop practical regionalization to refine matrices – resulting in 15-25 regional matrices that appropriately factor in regional threat and limiting factors for regional wildlife	$100,000-$500,000
Spatial Analysis Units	Unclear availability of CLUs and segmentsheds, size of CLUs, and technical accessibility of CLUs nationwide; practice polygons digitized in ad hoc manner	Clarify CLU and segmentshed -related questions and, if needed establish additional spatial analysis units; formalize digitizing of practice polygons	Requires further analysis
HUC 12, 10, &8 units for reporting	Nearly complete	Make available to NRCS offices	$5,000

Recommendations for Conservation Effects Assessment at Regional and National Scales

Assessing Impacts of Past and Current Practices

Results from the Missouri pilot indicate that conservation effects assessment could be implemented at several consistent spatial scales, including watershed, state, regional, national scales. Standard methods can be developed (albeit within certain data limitations) to evaluate impacts of past and current applications of conservation practices.

The essential ingredients for conservation effects assessment are summarized in Table 10 above. “At-risk” wildlife species need to be defined and selected in a consistent manner for analysis. The methodology proposed above provides practical options for establishing nationally consistent selection criteria that maintain flexibility to meet the local interests in each state. Mapped distributions of selected wildlife can take a variety of forms, and there are relatively few locations in the country where all forms are sufficiently available for all species. It is likely however, that appropriate data are available nationally for a subset of wildlife that would allow national assessments to be completed. Conservation practices vary in their actual application across the country, but there are undoubtedly many areas where the most commonly applied practices are consistently applied, and our existing conservation effects matrix could be applied with minimal need for caveats and footnoted exceptions. The spatial representation of practices introduces a number of challenges, but it appears that in states where Farm Bill-funded conservation practices are most abundant, Common Land Units are in place and populated with current years projects.

Current obstacles to conducting conservation effects analysis at national scale include 1) unclear status of conservation practice information within Common Land Units across the nation, 2) insufficient data on at-risk wildlife distributions, primarily for freshwater aquatic species, which are best represented as predictive distribution maps, and 3) uncertainties of the applicability of our draft conservation effects matrices across diverse regions of the United States. The primary obstacle to including past practices in the analyses is the lack of spatial precision in the location of funded practices.

We recommend designing a two-phased regional analysis to address a number of outstanding questions/obstacles identified during the Missouri pilot to clarify the feasibility of completing conservation effects assessment at multiple scales for past and current practices. The first phase would be to complete a regional assessment by applying the methodology developed in the Missouri Pilot to surrounding states. The assessment could use aggregated state information from the central Midwest, expanding beyond Missouri, and encompassing adjacent states that overlap EPA level I and Level II ecoregions of the eastern and central United States (e.g., MO, IA, IL, IN). The first phase analysis would concentrate on terrestrial wildlife and focus on:

1) evaluating and refining buffer rules and GAP-derived modifications to buffered polygons across all terrestrial wildlife groups
2) evaluating and refining practice descriptions and variation in their application on the ground
3) evaluating and refining the draft national conservation effects matrix by identifying the benefits of regionalization across EPA Level 1 and Level II ecoregions (or other regionalizations)
4) Prototype use of CLUs and/or digitized practice polygons for assessment of current-years practices
5) evaluating the feasibility of documenting the type and extent of practices over the past 20 years using spatial analysis units such as such as Sections (1 $mile^2$), quarter Townships (9 $mile^2$), and/or 12-digit watershed units (within Missouri).

The second phase analysis would follow from previous work with freshwater ecological wildlife distributions and would document additional implications of using segmentsheds for overlays with practice information. This second phase would also focus on reporting formats (mapped, tabular, and text) and options for documenting uncertainty among input data for assessment at local watershed, state, and regional, and national scales.

Assessing Potential Impacts of Proposed Conservation Practices

Stakeholders can use the same techniques deployed for effects assessment of current practices to evaluate the potential impacts of proposed conservation practices. Successful refinement and implementation of analytical methods explored in Missouri should set the stage for reporting at watershed, state, regional, and national scales, indicating the types of wildlife currently *least* affected by practices that could provide significant benefit. This information could be integrated with results of comprehensive state wildlife plans, and wildlife distribution maps to provide a geographic focus for extension to land owners, encouraging their enrollment in appropriate conservation programs. This methodology would also allow NRCS state offices the ability to direct conservation practices to achieve wildlife conservation objectives in each state.

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Appendix 1. NatureServe Conservation Status Assessment Methodology

Biodiversity Data Methodology

NatureServe is a non-profit organization dedicated to developing and providing information about the world's plants, animals, and ecological communities. NatureServe works in partnership with over 70 independent natural heritage programs and conservation data centers that gather scientific information on rare species and ecosystems in the United States, Latin America, and Canada (the NatureServe network). NatureServe is a leading source for biodiversity information that is essential for effective conservation action.

One of the most important reasons the information NatureServe supplies is so valuable is because it has been developed centrally at NatureServe or within the programs in the network with a common methodology. This document will discuss the main components of the natural heritage methodology that are significant contributions to conservation and directly applicable to this analysis.

Elements of Biological Diversity

The natural heritage programs function to inventory each state or subnation (e.g. Navajo Nation or Tennessee Valley Authority) for biological features in need of conservation attention. Because these features may include more than just the locations of individual species, the inclusive phrase 'Elements of natural diversity' was put into use with the creation of the first heritage program in 1974. The concept and term 'Element' still remains in use today and will be used in this document.

An Element is defined as a unit of natural biological diversity, representing species (or infraspecies taxa), ecological communities, or other non-taxonomic biological entities, such as migratory species aggregation areas.

For the purposes of this analysis, these Elements of diversity refer to the state-level summary of species and communities only.

Assigning Conservation Status Ranks

An Element is assigned one global conservation status rank (Grank), which applies across its entire range; a national conservation status rank (Nrank) for each nation in its range; and a subnational conservation status rank (Srank) for each state, province, or other subnational jurisdiction in its range. In general, NatureServe scientists assign global ranks and U.S. and Canadian national ranks. These scientists receive guidance from subnational data centers, especially for endemic Elements, and from experts on particular taxonomic groups. Local data centers assign subnational ranks for Elements in their respective jurisdictions and contribute information for national and global ranks. New information provided by field surveys, monitoring activities, consultation, and literature review improves accuracy and keeps ranks current. NatureServe’s centrally aggregated data are stored in the natural heritage Central Databases. These databases are updated continually with revisions, corrections, and information on ranked Elements. Species' conservation status ranks are updated annually in the data exchange process between the natural heritage programs and NatureServe’s central office.

A detailed table summarizing the global and state ranks by taxonomic groups for each state is provided in Appendix 6 (electronic only). This table also provides information on the currency of the ranks

What the Ranks Mean

The conservation rank of an Element known or assumed to exist within a jurisdiction is designated by a whole number from 1 to 5, preceded by a G (Global), N (National), or S (Subnational) as appropriate. The numbers have the following meaning:

1 = critically imperiled
2 = imperiled
3 = vulnerable to extirpation or extinction
4 = apparently secure
5 = demonstrably widespread, abundant, and secure.

G1, for example, indicates critical imperilment on a range-wide basis—that is, a great risk of extinction. S1 indicates critical imperilment within a particular state, province, or other subnational jurisdiction—i.e., a great risk of extirpation of the Element from that subnation, regardless of its status elsewhere.

Species known in an area only from historical records are ranked as either H (possibly extirpated/possibly extinct) or X (presumed extirpated/presumed extinct). Certain other codes, rank variants, and qualifiers are also allowed in order to add information about the Element or indicate uncertainty. Additional detail on conservation ranks is provided in Appendix 1.

Elements that are imperiled or vulnerable everywhere they occur will have a global rank of G1, G2, or G3 and equally high or higher national and subnational ranks. (The lower the number, the "higher" the rank, and therefore the conservation priority.) On the other hand, it is possible for an Element to be rarer or more vulnerable in a given nation or subnation than it is range-wide. In that case, it might be ranked N1, N2, or N3, or S1, S2, or S3 even though its global rank is G4 or G5. The three levels of the ranking system give a more complete picture of the conservation status of a species or community than either a range-wide or local rank by itself. They also make it easier to set appropriate conservation priorities in different places and at different geographic levels.

In an effort to balance global and local conservation concerns, global as well as national and subnational (provincial or state) ranks are used to select the Elements that should receive priority for research and conservation in a jurisdiction. Highest priority should be given to Elements that are most vulnerable to extinction—that is, those ranked G1, G2, or G3. And, according to the rules of ranking, these must have equally high or higher national and subnational ranks. Elements vulnerable to national or subnational extirpation (ranks N1, N2, N3, or S1, S2, S3) with global ranks of G4 or G5 should be considered next.

Ranking Factors

Use of standard ranking criteria and definitions makes natural heritage ranks comparable across Element groups—thus G1 has the same basic meaning whether applied to a salamander, a moss, or a forest community. Standardization also makes ranks comparable across jurisdictions, which in turn allows NatureServe scientists to use the national and subnational ranks assigned by local data centers to determine and refine or reaffirm global ranks.

Ranking is a qualitative process: it takes into account several factors, which function as guidelines rather than arithmetic rules. The ranker's overall knowledge of the Element allows him or her to weigh each factor in relation to the others and to consider all pertinent information for a particular Element. The factors considered in ranking species and communities are similar, but the relative weight given to the factors differs.

For species Elements, the following factors are considered in assigning a rank:

- **total number and condition of Element Occurrences**
- **population size**
- **range extent and area of occupancy**
- **short- and long-term trends in the foregoing factors**
- **threats**
- **environmental specificity**
- **fragility**

Relationship of Ranks to Other Status Designations

Conservation status ranks and their documentation are a valuable complement to national and subnational statuses assigned by government agencies (e.g. the United States Fish and Wildlife Service governs threatened and endangered statuses). The detailed and extensive information gathered by natural heritage programs can provide support for official designations. However, since natural heritage lists of vulnerable species and official lists of endangered or threatened species have different criteria, evidence requirements, purposes, and/or taxonomic depth and breadth, they normally do not coincide completely. For example, a species listed by a subnational jurisdiction as "endangered" may not be ranked S1, and vice versa. Multilevel ranking (using global, national, and subnational ranks), and the use of range ranks (e.g., S2S4 which represents an Element meeting criteria for S2, S3, or S4 ranks) to indicate the degree of uncertainty also sets natural heritage ranks apart from official status designations.

Rounded Global Conservation Status Ranks

In general, rounded ranks represent the "basic ranks" displayed in the Grank, Nrank, and Srank field values. Rounded ranks simplify complex conservation status rank values. They may be useful when performing tallies or analyses, or when summarizing complex Element status information. Rounded ranks serve as an approximate substitute only; they are not intended as a replacement for the detailed Element status information contained in the global, national, and subnational conservation status rank. Details regarding Rounded ranks are found in Appendix 1.

Global Conservation Status Ranks

Listed below are definitions for interpreting the global (i.e., range-wide) conservation status

ranks. Global ranks are assigned by NatureServe scientists.

Global Conservation Status Rank Definitions

Rank	Definition
GX	Presumed Extinct (species)—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.
GH	Possibly Extinct (species)—Known from only historical occurrences, but may nevertheless still be extant; further searching needed.
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 (<2,000) or linear miles (<10).
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.

Variant Global Ranks

Rank	Definition
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).
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.
GNA	Unranked—Global rank not yet assessed.
HYB	Hybrid—(species Elements only) Element not ranked because it represents an interspecific hybrid and not a species. (Note, however, that hybrid-derived species are ranked as species, not as hybrids.)

Rank Qualifiers

Rank	Definition
?	Inexact Numeric Rank—Denotes inexact numeric rank
Q	Questionable taxonomy that may reduce conservation priority. Distinctiveness of this entity as a taxon at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority (numerically higher) conservation status rank.
C	Captive or Cultivated Only—Taxon at present is extant only in captivity or cultivation, or as a reintroduced population not yet established.

Infraspecific Taxon Ranks

Rank	Definition
T_	Infraspecific Taxon (trinomial)—The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank. Rules for assigning T ranks follow the same principles outlined above. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A T subrank cannot imply the subspecies or variety is more abundant than the species (e.g., a G1T2 subrank should not occur). A vertebrate animal population (e.g., listed under the U.S. Endangered Species Act or assigned candidate status) may be tracked as an infraspecific taxon and given a T rank; in such cases a Q is used after the T rank to denote the taxon's informal taxonomic status.

Rounded Global Conservation Status Ranks

Rounded GRANK are generated by a calculated field, ROUNDED.GRANK. In general, the rounding algorithm eliminates range ranks, strips the qualifiers "?", "C", and "Q" off the GRANK, and focuses on the "T" subrank for infraspecific taxa.

Appendix 2 Missouri T&E Species Planning Matrix (2005)

NOTE: This is a guide only and cannot address all situations. If application of practice/system/activity points towards negative effects consult area office staff for further guidance. Refer to current MDC Heritage database adapted for NRCS use to determine if practice will be in an area where T&E species occur. Any negative impact on one species may supercede a positive impact on a different species. The short term impacts of one practice can be lessened by the application of the complete conservation system. The system effects must be analyzed for complete impacts on the species in question.

Numbers in the columns refer to "footnotes" at the end of this appendix.

Title	Mammals			Fish, Crustaceans & Mollusks			Bats			Plants			R/A/I			Bird		
	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-
Access Road (560)			1, 2	17		16, 22 25, 28			11			2, 16			2, 16			1, 2, 10
Alley Cropping (311)	3		2	17			12			17		2	17		2	3, 8		2, 6
Anaerobic Digester(365)		X			X				13			2		X			X	
Anaerobic Digester(366)		X			X				13			2		X			X	
Animal Mortality Facility(316)		X			X				13			2		X			X	
Brush Management (AC) (314)	3		2			16		X		5		2, 16	5		2, 16	3, 5		9, 10
Clearing and Snagging (326)		X				26			11			2, 16	17		1, 2, 16, 22			1, 2
Closure of Waste		X		17				X			X			X			X	

Title	Mammals			Fish, Crustaceans & Mollusks			Bats			Plants			R/A/I			Bird		
	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-
Impoundments																		
Composting Facility (No.) (317)		X		17				X				2			2, 16			2
Conservation Cover (327)	3			17			12			3, 5, 17		1, 2	3, 17		2, 16	3		2
Conservation Crop Rotation (328)		X		17				X		17			3, 17				X	
Contour Buffer Strips (332)	3			17				X		17		2	3, 17		2	3		2
Contour Farming (330)		X		17				X		17			17				X	
Contour Stripcropping (585)		X		17				X		17			3, 17				X	
Cover Crop (340)	3			17				X		17		2	3, 17				X	
Critical Area Planting (342)	3			17			12			3, 5, 17		1, 2	3, 17		2	3		2
Cross Wind Ridges (589A)		X			X			X			X		17		20		X	
Cross Wind Stripcropping (589B)		X		17				X		3, 5, 17,		2	3, 17				X	
Cross Wind Trap Strip (589C)		X		17				X		3, 5, 17,		2	3, 17					2
Dam (NO. and AC-FT)(402)			2	17, 18		2, 16			11	17		2, 16	17, 18		2	3		1, 2, 10
Dam, Diversion (348)			2	17		2, 16			11	17		2, 16	17		2, 16	3		1, 2, 10

Title	Mammals			Fish, Crustaceans & Mollusks			Bats			Plants			R/A/I			Bird		
	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-
Dike (356)			2	17		16			11	17		2, 16	17, 18		2, 16	3		1, 2, 10
Diversion (FT)(362)			2	17		2, 16			11	17		2, 16			2, 16	3		1, 2, 10
Drainage Water Management (554)		X		17		16		X		5, 17		2, 16	17		2, 16			2
Dry Hydrant (432)		X				16		X				2, 16			2, 16			2
Early Successional Habitat Development Management (647)	3		2			16		X		5		2, 16	3, 5, 17		2, 16	3		2
Fence (382)		X			X			X				2, 16			2, 16			1, 2
Field Border (386)	3			17				X		3, 17		2	3, 17		2	3		2
Filter Strip (393)	3			17				X		3, 17		2	3, 17		2	3		2
Forage Harvest Management (AC) (511)	3		9		X			X		5		2	5, 18		2	4		9
Forest Harvest Trails and Landings (655)			1, 2	17		16, 22, 25, 28		X		17		1, 2, 16	17		2			1, 2
Forest Site Preparation (490)			2			16	12		11			1, 2, 16	17		2			2, 10
Forest Stand Improvement (666)	3				X	16	13		11	5		1, 2, 16	18		2	5		1, 2
Geotextile (753)		X		17				X			X				30		X	

Title	Mammals +	Mammals 0	Mammals -	Fish, Crustaceans & Mollusks +	Fish, Crustaceans & Mollusks 0	Fish, Crustaceans & Mollusks -	Bats +	Bats 0	Bats -	Plants +	Plants 0	Plants -	R/A/I +	R/A/I 0	R/A/I -	Bird +	Bird 0	Bird -
Grade Stabilization Structure (410)			2	17		16	14		11	17		2, 16	17, 18		2	3		1, 2, 10
Grassed Waterway (412)	3		2	17		16			11	17		2, 16	3, 17		2	3		2, 10
Heavy Use Area Protection (561)		X		17		22	14			5, 17		2	3, 5, 17		2	3, 5		2
Hedgerow Planting (422)	3		2		X		12					1, 2	18, 20		2	8		2, 6
Herbaceous Wind Barrier (603)		X			X			X		3		2	18, 20				X	
Incinerator (769) Specification		X			X			X			X			X			X	
Incinerator (769) Standard		X			X			X			X			X			X	
Irrigation Land Leveling (464)		X				2, 16		X				2			2			2
Irrigation Regulating Reservoir (No.) (552)			2			16			11			2	18		2			2
Irrigation Storage Reservoir (NO. and AC-FT) (436)			2			2, 16			11			2	18		2			2
Irrigation System, Sprinkler (442)		X			X			X				2		X			X	

Title	Mammals +	0	-	Fish, Crustaceans & Mollusks +	0	-	Bats +	0	-	Plants +	0	-	R/A/I +	0	-	Bird +	0	-
Irrigation System, Surface and Subsurface (443)		X				16		X				2			2			2
Irrigation System, Tailwater Recovery (447)			2	17		16			11	17		2	18		2			2
Irrigation Systems, Drip (441)		X			X			X				2		X			X	
Irrigation Water Conveyance (430DD)		X				16		X			X			X			X	
Irrigation Water Conveyance (Aluminum Tubing Pipeline) 430-AA		X				16		X			X			X			X	
Irrigation Water Conveyance - Low-pressure, Underground, Plastic Pipeline (430-EE)		X				16, 22		X			X	2		X			X	
Irrigation Water Management (449)		X		17				X		17				X			X	
Lined Waterway or			2	17		16			11	17		2, 16	17		2			2

Title	Mammals			Fish, Crustaceans & Mollusks			Bats			Plants			R/A/I			Bird		
	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-
Outlet (FT) (468)																		
Manure Transfer (NO)(634)		X			X			X			X			X			X	
Mulching (484)		X		17				X		17		2			30		X	
Nutrient Management (590)		X		17		16	14			17		2	17				X	
Pasture and Hayland Planting (512)	3		2	17				X		17		1, 2	3, 17		2	3		2
Pest Management (AC) (595)		X		17		16	14			5, 17		2	17		2	5		2
Pipeline (516)		X				16, 22		X				2, 16		X			X	
Pond (NO.) (378)			2	17, 18		2, 16	14		11	17		2	17, 18		2	3		1, 2, 10
Pond Sealing or Lining (Bentonite Sealant) (521C)		X			X			X			X			X			X	
Pond Sealing or Lining (Flexible Membrane Lining) (521-A)		X			X			X			X			X			X	
Pond Sealing or Lining (Soil Dispersant) (521B)		X			X			X			X			X			X	
Prescribed Burning	3		2, 9			16	13			3, 5		2	5, 19		2	3, 5		2, 9,

Title	Mammals +	0	-	Fish, Crustaceans & Mollusks +	0	-	Bats +	0	-	Plants +	0	-	R/A/I +	0	-	Bird +	0	-
(338)									29									10
Prescribed Grazing (528A)	3			17		16		X		3, 5, 17		2	5,18		2	3, 4, 5		10
Pumping Plant (NO.) (533)			2			2, 16			11			2, 16			2, 16			2
Recreation Area Improvement (562)			2	17		16	12, 13		11	17		1, 2, 16	3		2, 16	3		2, 10
Recreation Trail and Walkway (568)			2	17		16		X		17		1, 2, 16			2, 16			1,2, 10
Residue Management, Mulch Till (329B)		X		17				X		17			17, 20				X	
Residue Management, No Till / Strip Till (329A)		X		17				X		17			17, 20				X	
Residue Management, Ridge Till		X		17				X		17				X			X	
Residue Management, Seasonal (344)		X		17				X		17			17, 20				X	
Restoration and Management of Declining Habitats (643)	3			17			12, 13			3, 5, 17, 18		2	5, 17, 18		2	3, 5, 8		10

Title	Mammals +	0	-	Fish, Crustaceans & Mollusks +	0	-	Bats +	0	-	Plants +	0	-	R/A/I +	0	-	Bird +	0	-
Riparian Forest Buffer (391)	3			17			12			3, 5, 17, 18		2	3, 17, 18		2	3, 5, 8		2, 6
Runoff Management System (570)		X		17				X		17			17				X	
Sediment Basin (350)			2	17		16			11	17		2, 16	17		2	3		1, 2, 10
Shallow Water Management for Wildlife (646)	5, 18			17		2	14			5, 17, 18		2	5, 17, 18		2	3, 5		
Silvopasture (381)			1, 2			16	12		11	3		2			2			1, 2
Spring Development (574)			2			26		X				2, 16, 26			2, 26			2
Streambank and Shoreline Protection (580)	3		2	17		16, 22	12		11	3, 5, 17		2, 16	17, 18		2	3		2, 10
Structure for Water Control (587)		X		17		22		X		17		2, 16		X			X	
Subsurface Drain (606)			2			16			11			2, 16			2, 16, 20			2
Surface Drainage (FT), Main or Lateral (608)			2			16			11	17		2, 16			2, 16, 20			2
Surface Drainage, Field			2			16			11	17		2, 16			2, 16,			2

Title	Mammals +	0	-	Fish, Crustaceans & Mollusks +	0	-	Bats +	0	-	Plants +	0	-	R/A/I +	0	-	Bird +	0	-
Ditch (607)															20			
Surface Roughening (AC) 609		X			X			X			X			X			X	
Terrace (600)		X		17		16			11	17		2, 16	17		2, 16			2
Tree Shrub Establishment (612)	3		2	17			12			3, 17		1, 2	3, 17		2	3, 5, 8		1, 2, 6
Tree Shrub Pruning (660)		X			X			X				2		X			X	
Trough or Tank (Watering Facility)(614)		X			X			X				2, 16		X			X	
Underground Outlet (620)		X		17		16			11			2, 16			2			2
Upland Wildlife Habitat Management (AC) (645)	3		2	17			5, 12, 13		1	3, 5, 17, 18		2	3, 5, 17, 18		2	3, 5, 8		1, 2, 6, 9, 10
Use Exclusion (AC) 472	3			17, 23			13			5, 17		2, 16	5, 17, 18			3, 5		
Vegetative Barrier (FT) 601		X		17				X		3, 17		2	17				X	
Vertical Drain (630)		X		17		16, 27		X				2, 16			2			2
Waste Facility Cover		X			X			X			X			X			X	

Title	Mammals			Fish, Crustaceans & Mollusks			Bats			Plants			R/A/I			Bird		
	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-
(367)																		
Waste Storage Facility (313)			2	17		16			11	17		2, 16			2			2
Waste Treatment Lagoon (359)			2	17		16	14		11	17		2, 16			2			2
Waste Utilization (633)		X		17				X		17		2, 16	17				X	
Water and Sediment Control Basin (638)			2	17		16			11	17		2, 16	17		2	3		1, 2, 10
Water Well (642)		X			X			X				2, 16		X			X	
Well Decommissioning (351)		X		23				X			X		23				X	
Wetland Creation (658)	3, 18		2	17, 18		16	12, 13, 14			5, 17, 18		2, 16	3, 5, 17, 18		2	3, 5		1, 2, 10
Wetland Enhancement (659)	3, 5, 18		2	17, 18		16	12, 13, 14			5, 17, 18		2, 16	3, 5, 17, 18		2	3, 5		2, 10
Wetland Restoration (657)	3, 5, 18		2	17, 18		16	12, 13, 14			5, 17, 18		2, 16	3, 5, 17, 18		2	3, 5		2, 10
Wetland Wildlife Habitat Management (644)	3, 5, 18		2	17, 18		16	12, 13, 14			5, 17, 18		2	3, 5, 17, 18		2	3, 5		2, 10
Wildlife Watering Facility (648)		X			X		14			5, 17,		2	5, 18		2	3		1, 2, 10

Title	Mammals +	Mammals 0	Mammals -	Fish, Crustaceans & Mollusks +	Fish, Crustaceans & Mollusks 0	Fish, Crustaceans & Mollusks -	Bats +	Bats 0	Bats -	Plants +	Plants 0	Plants -	R/A/I +	R/A/I 0	R/A/I -	Bird +	Bird 0	Bird -
										18								
Windbreak-Shelterbelt Establishment (380)	3		2		X		12					2	3, 17		2	3, 8		1, 2, 6

Missouri Statewide T&E Planning Matrix Footnotes

1. If the practice causes significant fragmentation (i.e. greater than 40' in width) regardless of community type – forest, grassland, wetland, etc... Consult Area Office for guidance when these situations occur.

2. If practice results in the destruction or significant degradation of native (aquatic or terrestrial) or wildlife-friendly habitat/plant community, or plants of conservation concern. This could include managing for a monoculture, or planting a species that is rated poor on Table 2, 327 Conservation Cover or Table 2, 342 Critical Area Planting adjacent to a native community or a T&E plant site (e.g. reed canary grass next to wetland). Consult Area Office for guidance when these situations occur.

3. Establishing/maintaining wildlife-friendly herbaceous species (rated fair/good/excellent on Table 2, 327 Conservation Cover or Table 2, 342 Critical Area Planting), or native tree/shrub species, or native annual/perennial forbs. Refer to species fact sheets for specifics (e.g. positive for Regal Fritillary only if practice restores the prairie violet that they rely upon—a WSG/forb seeding would not be positive for this species if it didn't include prairie violets in the mix).

4. If area is a lek site for prairie chickens and harvested or grazed after July 15.

5. If practice restores/maintains an **existing native plant community** or habitat that the species relies upon (refer to the attribute table of the Natural Heritage Database for habitats). Refer to species fact sheets for specifics (e.g. Positive for Regal Fritillary only if practice restores the prairie violet that they rely upon. Positive if removing woody cover between Blanding's mud turtle grassland nesting sites and wetland habitat).

6. If planting on a ridge top or established in a way to block vista for grassland birds.

7. (Reserved)

8. If woody planting consists of native shrubs for Bell's vireo, loggerhead shrike or painted bunting.

9. If practice occurs on greater than 75% of grassland acres during the primary nesting season May 1-July 15. (Example: prairie chicken, northern harrier, short-eared owl, Henslow's sparrow, Swainson's hawk, upland sandpiper, Bachman's sparrow, black-tailed jackrabbit, plains pocket mouse)

10. For Bell's vireo, loggerhead shrike, Bachman's sparrow and painted bunting if removing shrubs.

11. Effects on Indiana Bat, or Gray Bat. See MO-eFOTG-Section II - F.4 for Conservation Priorities and impact analysis. (for example: road adjacent to cave entrance, significant trees removed from riparian buffer) Increase or improved access to cave entrances may result in increased human activity and disturbance to cave.

12. If it is an establishment that is predominately trees and it occurs in the buffer zone of a listed bat occurrence site. See MO-eFOTG-Section II - F.4 for Conservation Priorities and impact analysis.

13. If managing/maintaining a woodland site for Indiana Bat. Follow Indiana bat guidelines to avoid negative impacts.

14. If occurs in the buffer zone around a listed bat occurrence site.

15. (Reserved)

16. If erosion, animal waste, or pesticide application affects sinkhole, cave entrance, springs, or other aquatic habitat. Earthmoving practices may temporarily create a negative impact, follow BMPs (refer to species fact sheets and/or standard and specifications) that will prevent negative impacts.

17. If practice improves ground or surface water quality for aquatic species (including amphibians and aquatic reptiles, plants and insects).

18. If practice creates suitable habitat for a species (refer to the attribute table of the Natural Heritage Database for habitats). Refer to species fact sheets for specifics or contact Area Office (e.g. positive for Northern Crayfish Frog if practice creates new fishless pond sites). **This is for non-planted practices.**

19. If done before February 15th or after November 1st. Refer to species fact sheets for specifics or consult Area Office for guidance when these situations occur.

20. For eastern spadefoot toad and Illinois chorus frog. Refer to species fact sheets for specific habitat needs, or consult Area Office for guidance when these situations occur.

21. (Reserved)

22. If practice will have a direct physical impact on a mussel bed.

23. If occurs in an identified karst recharge zone. Identified in Heritage Database.

24. (Reserved)

25. If stream crossing presents a potential restriction to fish passage (structure built above streambed elevation).

26. Adverse effects on aquatic species and/or communities. Consult with Area Office.

27. If vertical drain is installed without a filter strip.

28. In cave/sinkhole/karst areas potential adverse effects on aquatic or cave species and/or communities. Increase or improved access to cave entrances may result in increased human activity and disturbance to cave and bats.

29. If atmospheric conditions hold smoke at ground level and smoke settles into cave or sinkhole openings.

30. If geotextile (for example: monofilament mesh presents an entrapment or entanglement hazard.

Appendix 3 Status of At-Risk Species Occurrence Data by State

This document supports the Element Occurrence and species summary by state (Table A4.1) This dataset includes all species for which Element Occurrence (EO) data is being tracked by the NatureServe network and/or all taxonomic standard or provisional species that occur in the 50 United States.

This analysis was conducted using both global level (range-wide) tracking data developed centrally at NatureServe as well as state level tracking data provided by natural heritage programs across the United States. The following contains an explanation of NatureServe and natural heritage program methods and details of the data to aid NRCS in proper interpretation and representation of the information provided. For additional information, please contact the NatureServe Products and Services team at 703-908-1824 or ProductsandServices@natureserve.org.

Element Occurrence Data

The Element Occurrence (EO) is the mapping unit developed by natural heritage programs for documenting the distribution of species populations. Formally defined as "an area of land and/or water in which a species or natural community is, or was, present," an Element Occurrence ideally reflects species population units; either a distinct population, part of a population (subpopulation), or a group of populations (metapopulation).

Data Completeness

The completeness of these data varies between species. The Network is particularly strong and very complete in tracking the terrestrial and freshwater vertebrate species, vascular plants and entities with federal status under the Endangered Species Act (ESA). Many invertebrate groups are completely tracked, but the data on these Elements continue to expand. The non-vascular plant data (lichens, mosses, liverworts & hornworts, fungi) is being actively developed and Element Occurrences of these groups will expand over time. Marine species, even in coastal areas are not completely tracked and documented with Element Occurrences, however this varies across the network. NatureServe has included in the NRCS analysis all available data that meet the criteria.

NatureServe performs a data exchange with each Heritage Program in the U.S. on an annual basis, but NatureServe cannot guarantee the currency or completeness of any data provided. *Because data is constantly being revised and new data is constantly being developed, for ongoing analyses NatureServe recommends this dataset be refreshed on an annual basis.*

NatureServe's centrally aggregated EO data, including the data used in this analysis, is generally considered "complete" for all species with a global rank of G1/T1 – G2/T2 or having federal USESA status. By "complete" this means that all natural heritage programs actively track locations of these species within their states. For species that are more common - that is, having a Global Rank of G3-G5 with no federal USESA status - the location data is "spotty" and whether it exists often depends on how rare a species is within a particular subnation. This is extremely important to remember when doing analyses that will compare biodiversity of one geographic area of the country to another based on the EO data. In those cases it is often more appropriate to do a comparison using only the core dataset of G1/T1 – G2/T2 or federal USESA status species, which allows for a consistent dataset across subnations.

As an example, if there is a fish that is a G5 with no federal USESA status, and it is an S5 in Pennsylvania, then the Pennsylvania natural heritage program is not likely to be tracking any location data for that species beyond having it on their state species list and tracking state-level data for it (i.e. Srank), because it is so common. However, if that same species is an S1 in North Carolina because it is at the edge of its range there, then the North Carolina natural heritage program may have complete location data for that species because it is so rare within their state.

Furthermore, regardless of whether a species falls into the category of having "complete" location data, the absence of data for a particular species in a particular area does not necessarily mean the species does not occur there – it could also mean the area has not yet been inventoried, or a particular subnation may not yet have developed data for a particular species group (especially invertebrates and non-vascular plants). Any question as to the presence or absence of a particular species in a particular location should be addressed to the appropriate natural heritage program. A directory of contact information for all of the natural heritage programs in the US and Canada can be found at the following location on NatureServe's homepage: http://www.natureserve.org/visitLocal/index.jsp.

Data Gaps

For the species level analysis included in this deliverable, the taxonomic completeness of all species groups that are tracked by NatureServe for the United States are summarized at the following link: http://www.natureserve.org/explorer/summary.htm.

For the EO level analysis, the following data is known to be missing in the NatureServe Central Databases. Generally speaking, data is not available for Native American Tribal lands in most states (with the exception of Navajo Nation which has its own natural heritage program and has a subnation code of "NN" in this dataset), for many marine species, and for certain groups of invertebrates as well as non-vascular plants.

- Alaska – no data is currently available for animals.

- Arizona – no data for tribal lands (see Tribal Lands note below), with the exception of Navajo Nation.

- District of Columbia – No EO data is currently available for Washington D.C.

- Florida - Of 114 plant species listed threatened by the state of Florida (FDACS), 54 are formally tracked, 56 are watch-listed, while 4 species are considered (by FNAI) to be sufficiently common such that tracking is not warranted. Of the 431 plant species listed endangered, we track 378 species and maintain 39 species on a watch-list. All state listed (FFWCC) animal species are tracked, excluding the sei, fin, humpback, and sperm whales. Due to historical priorities and FNAI program resources, the invertebrate and fish (particularly marine and estuarine) components of biodiversity are less well represented than are the other Element categories. Geographically, some areas which have not been as thoroughly surveyed or researched due to access restrictions include some corporate timberlands, primarily across north Florida, and several large (over 10,000 acres) private ranches, mostly in central Florida. Aquatic areas in general, and in particular marine and estuarine habitats, have not been as extensively surveyed due in part to the historical mission of FNAI and a lack of funding support for work in these areas.

- Idaho - The IDCDC tracks site-specific information on all federally listed Threatened, Endangered, Proposed, and Candidate species EXCEPT grizzly bear, woodland caribou, chinook salmon, steelhead, and bull trout. Grizzly bear and caribou are currently treated in the IDCDC database as polygonal recovery areas. Chinook salmon and steelhead are currently treated in the IDCDC database as NOAA-defined Ecologically Significant Units. Bull trout are currently treated in the IDCDC database as USFWS-defined Core Areas. The IDCDC tracks site-specific information on all State of Idaho Threatened and Endangered species EXCEPT fishes. In general, there are no geographic gaps except for a core area of wilderness in eastern Idaho County and extreme northern Lemhi County which is inconveniently accessed and poorly surveyed for most species that might occur there.

- Illinois - This data set includes all information regarding Endangered and Threatened plants and animals in Illinois. However, in the case of animals, data submitted to the database shall only be included in the database if it can be reasonably shown that the animal is breeding, or attempting to breed in Illinois. Exceptions to this rule include, but are not limited to, instances such as large concentrations of Wintering Bald Eagles. The only criteria for being tracked in IL is that the species is listed as Threatened or Endangered by the Illinois Endangered Species Protection Board.

- Indiana - No location data for non-vascular plants.

- Massachusetts – NatureServe does not currently have location data available for this program beyond the state level (lists and ranks).

- Minnesota - The only federal or state listed species Minnesota does not maintain Element Occurrences for is Gray Wolf.

- Montana - Data gaps for most tribal lands; only have data on private lands where they have landowner permission.

- New Hampshire – NatureServe does not currently have location data available for this program beyond the state level (lists and ranks).

- New Mexico – no data available for tribal lands (see Tribal Lands note below) with the exception of Navajo Nation; data not available for White Sands Missile Range and Fort Bliss Military Reservation.

- Rhode Island - The Rhode Island NHP currently does not track the following federal status species: Caretta caretta (Atlantic Loggerhead), Chelonia mydas mydas (Atlantic Green Turtle), and Lepidochelys kempii (Atlantic Ridley).

- Texas – no data for non-vascular plants; Texas has extensive areas of privately owned land that have not been surveyed.

- Tribal Lands – data is not available for Native American Tribal lands in most western states (with the exception of Navajo Nation which has its own natural heritage program and has a subnation code of "NN" in this dataset).

- Utah – no data available for tribal lands (see Tribal Lands note above).

- Washington - with the exception of some select invertebrate species, animal location data in Washington is tracked by an agency outside the Washington natural heritage program and the methodology of that animal location data is not currently compatible with natural heritage Element Occurrence (EO) methodology. Animal data in Washington is available from the Washington Dep't. of Fish and Wildlife at the following website: http://www.wdfw.wa.gov/hab/release.htm.

- Wisconsin - Gray Wolf data are maintained in a separate database, and are not included in this analysis. Not currently tracking / mapping data for nonvascular plants. Private Land and Tribal Land inventories are incomplete.

- Wyoming – The only geographical data gap in WY is for the Wind River Indian Reservation, owned by the Shoshone/ Arapahoe tribes, located roughly between T33N-T44N and R94W-R106W, covering approx. 98 townships, and is generally impossible to access for political reasons. Because of legal and security constraints, WY NHP can not provide to NatureServe the precise locations of restricted data records. Restricted data records may include: (1) Certain private land information.; (2) Data that has been shared with WYHP but has specific security constraints imposed by the individual or agency that provided the data.; (3) Data for certain species or communities or for certain locations of species or communities that have been determined as sensitive for the continuing existence of the species or community.

Data Exchange Cycle and Data Upload

NatureServe is linked to the natural heritage programs through a process of regular annual data exchanges. Each month a series of natural heritage programs send their data to NatureServe for upload of the past year's updates to status ranking and inventory work. The exchange process includes both taxonomic and status reconciliation. New or updated Element Occurrence data is uploaded to NatureServe, and in return, centrally developed scientific information is distributed to the state and provincial natural heritage programs.

Table A3.1 provides a state by state listing of the number of each species in broad taxonomic groups and an indication of how many in that group are at risk at the global and state levels. The table also provides a listing of the number of occurrences documented in the state and how recently they have been observed. The taxonomic groups in the table do not match the species groups developed for this report because the data in our Biotics 4 database are not yet coded according to the new, finer species groupings. This table will provide planners of future projects assistance in gauging data currency and completeness on a state by state basis. A detailed status assessment of occurrence data by individual species (rather than taxonomic group) by state is provided in Appendix 7 (electronic only).

Table A3.1 Status of At-Risk Species Occurrence by State
(Metadata including field definitions provided at the end of this table)

Sub-nation	Species Group	Total Species	GXTX-G3T3 Species	GXTX-G3T3 Rank Updated in Last 10 Years	SX-S3 Species	EO Count	EOs Observed Within Last 20 Years	Percent EOs Observed Within Last 20 Years
AK	Amphibians	6	0	0	6			
AK	Birds	443	49	25	151			
AK	Fishes	63	7	1	10			
AK	Invertebrates	463	51	49	8			
AK	Mammals	151	57	23	62			
AK	Plants	2566	278	231	420	1659	652	39%
AK	Reptiles	3	2	1	0			
AL	Amphibians	73	13	13	26	336	186	55%
AL	Birds	425	16	9	113	273	247	90%
AL	Fishes	334	67	44	165	914	244	27%
AL	Invertebrates	1755	679	655	713	3003	2389	80%
AL	Mammals	73	13	8	28	101	76	75%
AL	Plants	4246	426	340	580	3431	2694	79%
AL	Reptiles	107	20	10	46	363	267	74%
AR	Amphibians	70	7	6	31	239	48	20%
AR	Birds	366	13	7	93	468	366	78%
AR	Fishes	218	30	20	86	581	262	45%
AR	Invertebrates	1715	232	208	248	3131	2237	71%
AR	Mammals	77	9	7	31	184	111	60%
AR	Plants	3713	179	140	457	3420	2111	62%
AR	Reptiles	112	1	0	28	95	13	14%
AZ	Amphibians	36	8	7	17	1209	841	70%

Sub-nation	Species Group	Total Species	GXTX-G3T3 Species	GXTX-G3T3 Rank Updated in Last 10 Years	SX-S3 Species	EO Count	EOs Observed Within Last 20 Years	Percent EOs Observed Within Last 20 Years
AZ	Birds	543	29	14	224	2977	2487	84%
AZ	Fishes	95	38	18	41	1945	1704	88%
AZ	Invertebrates	1037	351	338	123	473	393	83%
AZ	Mammals	208	35	23	83	2374	1665	70%
AZ	Plants	5625	969	773	726	5214	2406	46%
AZ	Reptiles	215	28	22	88	1951	1036	53%
CA	Amphibians	73	40	38	49	3974	3222	81%
CA	Birds	510	58	32	147	8794	6019	68%
CA	Fishes	163	92	48	99	737	541	73%
CA	Invertebrates	1967	1145	1049	501	3148	1988	63%
CA	Mammals	299	122	64	164	4324	2347	54%
CA	Plants	9323	3066	2540	2055	24638	13150	53%
CA	Reptiles	114	32	26	50	3117	1975	63%
CO	Amphibians	26	1	1	14	402	229	57%
CO	Birds	454	17	9	99	1750	1498	86%
CO	Fishes	96	17	10	29	607	358	59%
CO	Invertebrates	1083	141	138	210	404	184	46%
CO	Mammals	219	29	23	84	740	455	61%
CO	Plants	5498	600	491	707	4747	3149	66%
CO	Reptiles	78	2	2	32	356	234	66%
CT	Amphibians	24	0	0	6	85	40	47%
CT	Birds	323	7	4	75	985	499	51%
CT	Fishes	71	5	5	22	57	49	86%
CT	Invertebrates	858	60	59	248	645	314	49%
CT	Mammals	60	4	4	17	82	18	22%
CT	Plants	2732	75	50	334	3826	1497	39%
CT	Reptiles	29	5	2	10	279	197	71%
DC	Amphibians	29	0	0	13			
DC	Birds	292	5	2	203			
DC	Fishes	108	3	3	35			
DC	Invertebrates	324	19	19	52			
DC	Mammals	54	3	3	23			
DC	Plants	1784	36	30	297			
DC	Reptiles	45	1	1	18			
DE	Amphibians	27	0	0	11	57	47	82%
DE	Birds	390	6	2	103	369	307	83%
DE	Fishes	90	4	4	18	118	49	42%
DE	Invertebrates	624	38	38	213	196	132	67%

Sub-nation	Species Group	Total Species	GXTX-G3T3 Species	GXTX-G3T3 Rank Updated in Last 10 Years	SX-S3 Species	EO Count	EOs Observed Within Last 20 Years	Percent EOs Observed Within Last 20 Years
DE	Mammals	61	9	4	12	3	3	100%
DE	Plants	2724	77	59	957	2121	2080	98%
DE	Reptiles	43	7	3	16	92	62	67%
FL	Amphibians	77	12	11	15	557	300	54%
FL	Birds	454	36	13	74	6065	4679	77%
FL	Fishes	221	29	21	45	360	101	28%
FL	Invertebrates	1344	451	424	372	582	299	51%
FL	Mammals	126	52	17	49	701	408	58%
FL	Plants	4322	626	486	668	10121	7978	79%
FL	Reptiles	170	40	27	42	3003	1662	55%
GA	Amphibians	85	19	19	28	402	184	46%
GA	Birds	384	17	9	79	927	851	92%
GA	Fishes	318	57	40	159	2531	1813	72%
GA	Invertebrates	1274	348	330	263	911	516	57%
GA	Mammals	107	23	12	38	243	155	64%
GA	Plants	4770	538	429	1087	5194	3359	65%
GA	Reptiles	92	16	9	34	699	384	55%
HI	Amphibians	3	0	0	0			
HI	Birds	159	89	52	90	3305	1158	35%
HI	Fishes	8	5	3	6	66	20	30%
HI	Invertebrates	1173	456	250	427	1283	354	28%
HI	Mammals	15	9	4	3	476	281	59%
HI	Plants	1864	1267	982	1197	6735	3147	47%
HI	Reptiles	8	5	1	4	53	17	32%
IA	Amphibians	22	0	0	8	83	3	4%
IA	Birds	309	8	3	145	587	119	20%
IA	Fishes	143	10	9	68	550	30	5%
IA	Invertebrates	722	76	75	177	2003	932	47%
IA	Mammals	70	2	1	27	305	53	17%
IA	Plants	2513	52	42	627	3448	660	19%
IA	Reptiles	52	4	3	27	426	22	5%
ID	Amphibians	17	2	2	8	343	180	52%
ID	Birds	360	5	1	91	2432	1969	81%
ID	Fishes	94	22	11	31	38	38	100%
ID	Invertebrates	876	219	216	22	150	103	69%
ID	Mammals	118	5	3	44	1530	972	64%
ID	Plants	4247	427	336	505	5171	4256	82%
ID	Reptiles	26	1	1	7	56	27	48%

Sub-nation	Species Group	Total Species	GXTX-G3T3 Species	GXTX-G3T3 Rank Updated in Last 10 Years	SX-S3 Species	EO Count	EOs Observed Within Last 20 Years	Percent EOs Observed Within Last 20 Years
IL	Amphibians	49	2	1	15	119	105	88%
IL	Birds	423	15	6	97	1141	1026	90%
IL	Fishes	202	20	17	124	494	338	68%
IL	Invertebrates	1434	188	177	232	564	485	86%
IL	Mammals	72	7	6	29	175	156	89%
IL	Plants	3418	92	75	970	2261	1975	87%
IL	Reptiles	81	5	4	25	274	235	86%
IN	Amphibians	51	3	3	14	245	153	62%
IN	Birds	385	14	6	106	2037	1396	69%
IN	Fishes	201	20	14	64	709	514	72%
IN	Invertebrates	1874	243	230	579	3025	2494	82%
IN	Mammals	69	7	7	32	1101	720	65%
IN	Plants	3454	99	80	560	4794	2058	43%
IN	Reptiles	81	5	4	23	662	319	48%
KS	Amphibians	31	1	1	13	177	60	34%
KS	Birds	427	13	5	166	672	585	87%
KS	Fishes	135	11	10	65	843	483	57%
KS	Invertebrates	784	72	68	139	745	635	85%
KS	Mammals	88	5	4	44	160	91	57%
KS	Plants	2923	77	63	791	2086	580	28%
KS	Reptiles	68	3	2	23	276	111	40%
KY	Amphibians	72	3	3	17	396	260	66%
KY	Birds	351	12	5	86	929	615	66%
KY	Fishes	260	35	23	77	1301	672	52%
KY	Invertebrates	1529	336	324	505	3200	1372	43%
KY	Mammals	83	11	8	29	833	669	80%
KY	Plants	3453	163	134	703	3785	2404	64%
KY	Reptiles	100	3	2	43	411	225	55%
LA	Amphibians	53	2	2	14	73	32	44%
LA	Birds	444	14	8	81	1779	1556	87%
LA	Fishes	274	20	15	47	228	63	28%
LA	Invertebrates	797	117	100	80	351	257	73%
LA	Mammals	79	12	7	21	115	17	15%
LA	Plants	3868	223	186	456	2606	1441	55%
LA	Reptiles	90	14	6	26	298	129	43%
MA	Amphibians	23	0	0	8			
MA	Birds	340	8	4	95			

Sub-nation	Species Group	Total Species	GXTX-G3T3 Species	GXTX-G3T3 Rank Updated in Last 10 Years	SX-S3 Species	EO Count	EOs Observed Within Last 20 Years	Percent EOs Observed Within Last 20 Years
MA	Fishes	69	4	4	14			
MA	Invertebrates	994	97	91	213			
MA	Mammals	80	14	6	25			
MA	Plants	3040	95	71	329			
MA	Reptiles	33	8	4	17			
MD	Amphibians	44	2	2	11	128	35	27%
MD	Birds	414	18	9	139	1357	1027	76%
MD	Fishes	129	5	5	34	102	32	31%
MD	Invertebrates	875	86	83	246	585	324	55%
MD	Mammals	102	17	9	28	192	84	44%
MD	Plants	3289	131	102	711	5139	2387	46%
MD	Reptiles	52	7	3	13	197	114	58%
ME	Amphibians	19	0	0	3	20	7	35%
ME	Birds	393	10	6	122	399	289	72%
ME	Fishes	70	6	5	11	24	17	71%
ME	Invertebrates	918	88	88	123	657	576	88%
ME	Mammals	79	12	8	16	74	62	84%
ME	Plants	2683	91	76	432	4072	2556	63%
ME	Reptiles	24	4	1	10	545	424	78%
MI	Amphibians	29	0	0	7	150	73	49%
MI	Birds	392	13	5	69	3049	2636	86%
MI	Fishes	150	13	10	46	775	357	46%
MI	Invertebrates	1358	119	110	143	1994	1385	69%
MI	Mammals	68	3	2	17	96	22	23%
MI	Plants	3916	131	108	440	6192	2740	44%
MI	Reptiles	34	5	5	12	1220	893	73%
MN	Amphibians	25	0	0	2	194	158	81%
MN	Birds	336	6	3	38	6892	5560	81%
MN	Fishes	139	9	6	24	1664	1187	71%
MN	Invertebrates	958	95	91	100	2828	2317	82%
MN	Mammals	87	2	1	26	466	222	48%
MN	Plants	2985	93	79	279	10309	7631	74%
MN	Reptiles	32	2	2	13	2100	1746	83%
MO	Amphibians	51	5	4	13	1216	948	78%
MO	Birds	327	12	7	55	2095	1898	91%
MO	Fishes	218	25	20	66	3604	2251	62%
MO	Invertebrates	1201	190	178	262	2175	1452	67%
MO	Mammals	76	8	7	24	1098	850	77%

Sub-nation	Species Group	Total Species	GXTX-G3T3 Species	GXTX-G3T3 Rank Updated in Last 10 Years	SX-S3 Species	EO Count	EOs Observed Within Last 20 Years	Percent EOs Observed Within Last 20 Years
MO	Plants	3529	129	101	573	7436	4351	59%
MO	Reptiles	83	6	4	19	261	137	52%
MS	Amphibians	65	8	8	18	174	46	26%
MS	Birds	393	13	7	60	838	379	45%
MS	Fishes	254	25	17	73	709	31	4%
MS	Invertebrates	977	165	143	137	727	249	34%
MS	Mammals	61	9	6	15	187	61	33%
MS	Plants	3435	205	171	448	5075	2526	50%
MS	Reptiles	105	18	8	35	957	348	36%
MT	Amphibians	19	1	1	5	51	40	78%
MT	Birds	421	10	4	81	6269	516	8%
MT	Fishes	93	13	11	19	105	25	24%
MT	Invertebrates	974	148	145	116	175	49	28%
MT	Mammals	117	2	2	38	2464	66	3%
MT	Plants	4438	298	244	688	3085	2295	74%
MT	Reptiles	22	0	0	9	36	14	39%
NC	Amphibians	91	22	22	48	693	281	41%
NC	Birds	456	16	9	129	1784	1275	71%
NC	Fishes	258	40	29	127	644	300	47%
NC	Invertebrates	1834	457	428	701	2311	1581	68%
NC	Mammals	133	25	13	58	454	274	60%
NC	Plants	4730	521	438	2036	10285	7058	69%
NC	Reptiles	84	10	4	40	1089	454	42%
ND	Amphibians	11	0	0	0	2	1	50%
ND	Birds	324	7	3	34	1310	547	42%
ND	Fishes	95	6	6	16	271	52	19%
ND	Invertebrates	503	21	20	23	200	90	45%
ND	Mammals	90	3	3	18	88	10	11%
ND	Plants	1891	22	21	202	1425	442	31%
ND	Reptiles	15	0	0	1	16	1	6%
NE	Amphibians	14	0	0	3	29	19	66%
NE	Birds	402	11	5	86	2599	1907	73%
NE	Fishes	110	7	7	33	812	422	52%
NE	Invertebrates	692	43	42	138	261	231	89%
NE	Mammals	90	5	3	37	201	126	63%
NE	Plants	2483	44	36	454	3890	1928	50%
NE	Reptiles	49	1	1	20	325	188	58%

Sub-nation	Species Group	Total Species	GXTX-G3T3 Species	GXTX-G3T3 Rank Updated in Last 10 Years	SX-S3 Species	EO Count	EOs Observed Within Last 20 Years	Percent EOs Observed Within Last 20 Years
NH	Amphibians	24	0	0	7			
NH	Birds	326	6	3	69			
NH	Fishes	69	5	3	15			
NH	Invertebrates	956	74	73	134			
NH	Mammals	67	4	4	14			
NH	Plants	2496	72	61	408			
NH	Reptiles	23	4	1	8			
NJ	Amphibians	46	0	0	14	724	436	60%
NJ	Birds	355	10	4	84	2417	1494	62%
NJ	Fishes	102	4	4	14	2	2	100%
NJ	Invertebrates	960	101	101	240	1146	551	48%
NJ	Mammals	90	13	7	13	107	85	79%
NJ	Plants	3261	116	94	936	5221	1382	26%
NJ	Reptiles	68	7	3	9	1535	989	64%
NM	Amphibians	30	6	6	15	179	100	56%
NM	Birds	540	23	12	157	1640	1199	73%
NM	Fishes	115	40	18	59	2998	349	12%
NM	Invertebrates	1118	295	291	93	440	281	64%
NM	Mammals	183	30	25	84	646	267	41%
NM	Plants	5281	625	467	438	3181	1679	53%
NM	Reptiles	109	8	7	37	144	111	77%
NN	Amphibians	16	0	0	2	105	79	75%
NN	Birds	386	8	5	140	646	556	86%
NN	Fishes	36	7	2	7	34	18	53%
NN	Invertebrates	44	14	12	5	24	22	92%
NN	Mammals	133	11	10	41	163	54	33%
NN	Plants	220	99	84	93	836	563	67%
NN	Reptiles	69	2	1	14	11	5	45%
NV	Amphibians	24	6	6	11	170	124	73%
NV	Birds	448	20	11	130	215	124	58%
NV	Fishes	154	81	31	83	528	369	70%
NV	Invertebrates	766	299	283	199	810	515	64%
NV	Mammals	156	20	11	76	805	473	59%
NV	Plants	4931	897	728	450	4579	2624	57%
NV	Reptiles	77	3	3	19	539	499	93%
NY	Amphibians	34	1	1	9	215	152	71%
NY	Birds	415	12	5	85	1858	1459	79%
NY	Fishes	238	15	11	100	392	186	47%

Sub-nation	Species Group	Total Species	GXTX-G3T3 Species	GXTX-G3T3 Rank Updated in Last 10 Years	SX-S3 Species	EO Count	EOs Observed Within Last 20 Years	Percent EOs Observed Within Last 20 Years
NY	Invertebrates	1367	145	144	293	870	693	80%
NY	Mammals	96	13	7	22	121	49	40%
NY	Plants	3881	155	117	1084	5204	2450	47%
NY	Reptiles	41	9	5	24	484	321	66%
OH	Amphibians	41	2	2	9	208	85	41%
OH	Birds	314	9	4	81	927	414	45%
OH	Fishes	158	16	9	57	815	360	44%
OH	Invertebrates	1102	132	127	152	1087	485	45%
OH	Mammals	69	5	5	25	165	128	78%
OH	Plants	3189	97	81	655	11504	7346	64%
OH	Reptiles	47	5	5	17	368	166	45%
OK	Amphibians	55	2	2	25	155	99	64%
OK	Birds	389	16	9	166	782	617	79%
OK	Fishes	181	18	12	75	655	199	30%
OK	Invertebrates	1000	167	156	67	674	532	79%
OK	Mammals	110	11	10	64	203	136	67%
OK	Plants	3517	125	95	439	1952	937	48%
OK	Reptiles	93	4	3	32	208	145	70%
OR	Amphibians	36	13	12	26	1188	906	76%
OR	Birds	461	34	23	100	6732	5482	81%
OR	Fishes	178	80	51	87	3252	3008	92%
OR	Invertebrates	1237	462	423	274	865	598	69%
OR	Mammals	180	33	18	49	1315	613	47%
OR	Plants	5580	825	689	781	12181	8432	69%
OR	Reptiles	35	6	3	8	766	555	72%
PA	Amphibians	38	2	2	15	29	6	21%
PA	Birds	374	11	5	81	953	555	58%
PA	Fishes	185	16	12	88	474	152	32%
PA	Invertebrates	1511	159	156	380	2265	1269	56%
PA	Mammals	81	7	4	25	702	474	68%
PA	Plants	3801	117	97	625	10900	4726	43%
PA	Reptiles	40	5	5	24	635	368	58%
RI	Amphibians	19	0	0	6	45	0	0%
RI	Birds	319	5	2	118	308	0	0%
RI	Fishes	49	4	4	16	1	0	0%
RI	Invertebrates	432	27	27	90	337	0	0%
RI	Mammals	56	8	4	16	15	0	0%
RI	Plants	2272	52	39	361	1461	0	0%

Sub-nation	Species Group	Total Species	GXTX-G3T3 Species	GXTX-G3T3 Rank Updated in Last 10 Years	SX-S3 Species	EO Count	EOs Observed Within Last 20 Years	Percent EOs Observed Within Last 20 Years
RI	Reptiles	26	4	1	9	42	0	0%
SC	Amphibians	72	11	11	12	229	107	47%
SC	Birds	334	16	9	34	1110	864	78%
SC	Fishes	135	14	9	19	107	51	48%
SC	Invertebrates	1058	231	220	58	318	316	99%
SC	Mammals	109	18	11	30	459	342	75%
SC	Plants	3667	345	281	206	5050	2976	59%
SC	Reptiles	81	14	9	13	179	80	45%
SD	Amphibians	15	0	0	6	53	11	21%
SD	Birds	353	8	3	102	1487	813	55%
SD	Fishes	100	6	6	33	514	313	61%
SD	Invertebrates	591	29	29	57	573	458	80%
SD	Mammals	100	6	3	29	508	228	45%
SD	Plants	2323	33	30	132	1505	547	36%
SD	Reptiles	34	0	0	20	422	139	33%
TN	Amphibians	78	20	20	31	669	152	23%
TN	Birds	307	12	6	132	840	394	47%
TN	Fishes	312	74	50	129	1801	879	49%
TN	Invertebrates	1762	610	593	613	2633	1049	40%
TN	Mammals	87	13	8	28	1153	471	41%
TN	Plants	4068	316	270	983	7110	4860	68%
TN	Reptiles	63	3	2	12	274	60	22%
TV	Amphibians	54	22	22	0	265	107	40%
TV	Birds	100	7	3	0	702	503	72%
TV	Fishes	273	104	70	0	1486	704	47%
TV	Invertebrates	1013	717	649	0	3148	1406	45%
TV	Mammals	55	14	7	0	435	298	69%
TV	Plants	1215	313	265	0	2952	1706	58%
TV	Reptiles	65	11	5	0	185	44	24%
TX	Amphibians	81	19	17	34	290	58	20%
TX	Birds	599	36	21	219	1305	791	61%
TX	Fishes	224	47	18	98	184	39	21%
TX	Invertebrates	1665	555	531	159	198	171	86%
TX	Mammals	195	44	25	93	482	368	76%
TX	Plants	6649	711	584	1061	4685	1788	38%
TX	Reptiles	177	23	14	61	366	95	26%
UT	Amphibians	19	4	4	10	377	184	49%

Sub-nation	Species Group	Total Species	GXTX-G3T3 Species	GXTX-G3T3 Rank Updated in Last 10 Years	SX-S3 Species	EO Count	EOs Observed Within Last 20 Years	Percent EOs Observed Within Last 20 Years
UT	Birds	420	13	7	152	1345	852	63%
UT	Fishes	78	24	16	28	537	441	82%
UT	Invertebrates	992	157	151	275	882	244	28%
UT	Mammals	135	7	5	76	942	431	46%
UT	Plants	6088	1148	869	1567	4642	2010	43%
UT	Reptiles	55	0	0	32	422	154	36%
VA	Amphibians	78	11	11	31	152	62	41%
VA	Birds	419	14	8	99	963	883	92%
VA	Fishes	222	38	26	111	545	153	28%
VA	Invertebrates	2027	548	444	1005	2196	1042	47%
VA	Mammals	130	27	12	40	136	105	77%
VA	Plants	4379	296	242	1030	4006	2537	63%
VA	Reptiles	79	7	3	23	185	114	62%
VT	Amphibians	23	0	0	6	78	65	83%
VT	Birds	294	2	1	96	571	412	72%
VT	Fishes	91	5	3	32	179	141	79%
VT	Invertebrates	753	37	36	160	102	77	75%
VT	Mammals	62	3	3	21	61	42	69%
VT	Plants	3100	81	64	887	4467	2604	58%
VT	Reptiles	19	0	0	11	73	59	81%
WA	Amphibians	27	8	8	12	495	475	96%
WA	Birds	463	32	21	129			
WA	Fishes	123	35	24	27			
WA	Invertebrates	858	211	204	168	103	43	42%
WA	Mammals	155	30	18	58	16	12	75%
WA	Plants	4595	478	398	532	4006	2711	68%
WA	Reptiles	29	6	3	11			
WI	Amphibians	24	0	0	6	237	126	53%
WI	Birds	397	10	4	117	3284	2841	87%
WI	Fishes	162	10	7	41	1463	201	14%
WI	Invertebrates	1752	121	115	398	2768	2401	87%
WI	Mammals	72	2	1	25	243	96	40%
WI	Plants	3372	92	75	530	7593	4420	58%
WI	Reptiles	48	3	3	21	965	621	64%
WV	Amphibians	54	6	5	22	571	268	47%
WV	Birds	316	7	3	98	192	155	81%
WV	Fishes	173	15	10	79	473	296	63%
WV	Invertebrates	1240	199	179	375	1122	634	57%

Sub-nation	Species Group	Total Species	GXTX-G3T3 Species	GXTX-G3T3 Rank Updated in Last 10 Years	SX-S3 Species	EO Count	EOs Observed Within Last 20 Years	Percent EOs Observed Within Last 20 Years
WV	Mammals	77	10	6	38	569	412	72%
WV	Plants	2897	120	97	1062	3161	1431	45%
WV	Reptiles	54	1	1	29	148	54	36%
WY	Amphibians	18	5	5	13	64	34	53%
WY	Birds	413	9	5	102	453	264	58%
WY	Fishes	90	18	10	34	326	227	70%
WY	Invertebrates	728	78	78	11	2	1	50%
WY	Mammals	139	11	7	71	413	139	34%
WY	Plants	4221	330	266	2035	4553	2777	61%
WY	Reptiles	44	0	0	18	1	1	100%

NRCS Analysis and Data Summary Description

The following description summarizes the dataset used for the NRCS analysis and the resulting summary table.

File Descriptions

EO_summary_by_state_by_group_012907.xls - worksheets with complete lists of species by subnation in the United States, including tallies of total EOs, and numbers of EOs by Last Observed Date. If the "EO Count" field is blank, that means the species is known or thought to occur in the subnation, but no location data is currently being tracked by the natural heritage program. (NOTE: There are cases where a program may track their EO data under what NatureServe considers to be a non-standard taxonomy. In these cases, a field is provided to indicate which taxonomic standard record(s) the non-standard relates to, and the taxonomic standard record is also included, though the EO tally fields will be blank. In addition, all standard taxonomic elements that occur in the subnation but which do not have EO data are included. The result is that a complete species list for each state is provided, but there will be some duplication in cases where a program is tracking EOs under nonstandard taxonomic records.)

RGR_ RSR_by_state_by_group_012907.xls - worksheets with tallies of total number of species by subnation by taxonomic group by Global rank and Subnational rank. The Global rank table also includes tallies of how recently ranks have been reviewed for certain Global rank categories.

Additional_State_Summaries_012907.xls – worksheets with summaries of total species by groups, total EOs by groups, and total species within each subnation.

NatureServe Records Included

The NRCS analysis is based on global-level (rangewide) tracking data developed by NatureServe's science staff and state-level species tracking data (including EO data) provided by natural heritage programs across the United States, and includes the following.

- EO analysis: All species for which each natural heritage program is tracking location data, as well as all NatureServe taxonomic standard species which are known to occur in each subnation but for which no location data is currently being tracked by the natural heritage program within the subnation. For the species for which no location data is being tracked, only NatureServe taxonomic standard or provisional records that are native and regularly occurring in the subnation are included.

NOTE: In some instances, a natural heritage program may choose to track a species and its associated EO data under a taxonomic concept that is different from NatureServe's standard reference. The "Taxonomic Status" field was included to indicate this, as well as the "Related Taxonomic Standards (if Nonstandard)" field, which indicates which NatureServe taxonomic standard(s) the species relates to if the natural heritage program is tracking the species under what NatureServe considers to be a nonstandard taxonomy. There are also cases where a natural heritage program may choose to track EOs of a sub- species at the full-species level, whereas other programs may not. These points should be taken into consideration when comparing numbers of EOs and/or species between states based on the data provided in this analysis.

- Species analysis: All NatureServe taxonomic standard or provisional records that are native and regularly occurring in the subnation are included in the tallies by rank.

Field Definitions

Included below are definitions for fields provided in the species dataset.

EO Count - The number of Element Occurrence records (populations) for a species that are being tracked by the subnation.

Element Global ID - Unique global record identifier for the species that is assigned by the NatureServe central database staff.

EOs Observed Within Last 20 Years - The number of EOs that the subnation is tracking for the Element that were last observed within 20 years.

Common Name - The standard global (i.e., rangewide) common name of species adopted for use in the NatureServe Central Databases (e.g. the common name for Haliaeetus leucocephalus is bald eagle).

G Rank - The conservation status of a species from a global (i.e., rangewide) perspective, characterizing the relative rarity or imperilment of the species. Individual rank categories are defined in Appendix 1.

G Rank Tallies – A series of fields in the species analysis table (G1, G2, G3, etc. etc.) that indicate the number of Elements that are being tracked by NatureServe for each global rank category. G Ranks and T Ranks are tallied separately in these fields.

G Rank Review Date Tallies – Two groups of 5 fields in the species analysis table (GXTX-G3T3 and Other Granks) that indicate the number of Elements that are being tracked by NatureServe based on how recently the G Rank was reviewed. Unlike the G Rank Tallies, the T Ranks are grouped in with their equivalent G Ranks in these fields. There are 5 categories:

less than 3 yrs – the G Rank was last reviewed 3 years ago or less.
3 to 5 yrs – the G Rank was last reviewed more than 3 years ago but no more than 5 years ago.
5 to 10 yrs – the G Rank was last reviewed more than 5 years ago but no more than 10 years ago.
over 10 yrs – the Grank was last reviewed over 10 years ago.
unknown yrs – the Global Rank Review date field is null in the database and it cannot be determined how recently the G Rank was reviewed.

Last Obs 10 yrs or less – The number of EOs that the subnation is tracking for the Element that were last observed within 10 years.

Last Obs 11 to 20 yrs – The number of EOs that the subnation is tracking for the Element that were last observed over 10 years years ago, but more recently than 20 years ago.

Last Obs 21 yrs or more – The number of EOs that the subnation is tracking for the Element that were last observed over 20 years years ago.

Last Obs Unknown – the number of EOs that the subnation is tracking for the Element that either do not have a Last Observed Date, or the Last Observed Date is populated in a non-standard format and was excluded from this analysis.

Percent EOs Observed Within Last 20 Years - The percent of EOs that the subnation is tracking for the Element that were last observed within 20 years.

Related Taxonomic Standards (if Nonstandard) – The NatureServe taxonomic standard(s) that the Element relates to in cases where a subnation is tracking an Element under a nonstandard taxonomic classification.

Scientific Name - The standard global (i.e., rangewide) scientific name (genus and species) adopted for use by the NatureServe Central Databases based on selected standard taxonomic references.

Species Group - The informal taxonomic group of the species.

S Rank Tallies – A series of fields in the species analysis table (G1, G2, G3, etc. etc.) that indicate the number of Elements that are being tracked by NatureServe for each Subnational rank category. (NOTE: Instead of single ranks, birds are assigned breeding, non-breeding, and/or migratory ranks when appropriate. For the purposes of this analysis, Sranks were summarized into the following categories: SX, SH, S1, S2, S3, S4, S5, SNA, SNR, and SU. For birds, if only a single breeding, non-breeding, or migratory rank was assigned, then that rank was used. If more than one were assigned, then breeding ranks were taken over the others. If a non-breeding and migratory rank was assigned, then the non-breeding rank was used.)

Taxonomic Status - Indicates the status of the Element in relation to NatureServe's standard classification.

Domain values for Classification Status are:

Standard - the Element has been formally recognized, described, and accepted by the standard classification.

Nonstandard - the Element has been addressed but not accepted by the standard classification.

Provisional - The Element has not yet been formally addressed and accommodated (by acceptance or rejection) in the standard classification. For botanical species: the Element is not addressed in a standard classification for the pertinent type of Element and geographic area. For zoological species: the Element is not yet formally described and accepted.

Rounded G Rank - The Global Conservation Status rank rounded to a single character. This value is calculated using a rounding algorithm to systematically produce conservation status values that are easier to interpret and summarize.

Rounded S Rank - The Subnational Conservation Status Rank assigned by the state or province for the Element rounded to a single character. This value is calculated using a rounding algorithm to systematically produce conservation status values that are easier to interpret and summarize.

S Rank - The conservation status of a species from the subnational jurisdiction perspective, characterizing the relative rarity or imperilment of the species. Together these values provide national distribution data. The basic subnational conservation ranks are:

- *SX* - Presumed Extirpated,
- *SH* - Possibly Extirpated (Historical),
- *S1* – Critically Imperiled,
- *S2* – Imperiled,
- *S3* – Vulnerable,
- *S4* - Apparently Secure,
- *S5* – Secure,
- *SNR* – Rank not yet assessed,
- *SU* – Unrankable,
- *SHB* – State Hybrid,
- *SNA* – State Not Applicable.

For more detailed definitions and additional information, please see: http://www.natureserve.org/explorer/nsranks.htm.

Subnation – Abbreviation of the subnation (state) where the species occurs.

USESA Status - Official federal status assigned under the U.S. Endangered Species Act of 1973. Basic USESA status values include: LE – Listed endangered, LT - Listed threatened, PE - Proposed endangered, PT – Proposed threatened, C – Candidate, PDL - Proposed for delisting, LE(S/A) – Listed endangered because of similarity of appearance, LT(S/A) - Listed threatened because of similarity of appearance, XE - Essential experimental population, XN - Nonessential experimental population. NOTE: This field contains EITHER the current status of the taxon designated under the U.S. Endangered Species Act (USESA), which is also recorded in the associated U.S. Endangered Species Act Status field, OR the current status as interpreted by NatureServe Central Sciences. Interpreted status is derived from the taxonomic relationship of the Element to a taxon having USESA status, or to geopolitical or administratively defined members of a taxon having USESA status. For additional information about how NatureServe manages US ESA status information, please see: http://www.natureserve.org/explorer/statusus.htm.

Conservation Status Definitions –

See Appendix I.

United States Federal Status Listing Process and Definitions

The U.S. Fish and Wildlife Service (USFWS) and the U.S. National Marine Fisheries Service designate and/or propose federal status in accordance with the U.S. Endangered Species Act of 1973, as amended (U.S. ESA). Plant and animal species, subspecies (including plant varieties), and vertebrate populations are considered for Endangered or Threatened status according to the criteria established under the U.S. ESA.

Proposals and determinations to add taxa or populations to the Lists of Endangered and Threatened Wildlife and Plants are published in the Federal Register. Additionally, USFWS periodically publishes a Notice of Review in the Federal Register that presents an updated list of plant and animal taxa that are regarded as candidates or proposed for possible addition to the Lists of Endangered and Threatened Wildlife and Plants.

How NatureServe manages U.S. Federal Status Data

The U.S. Federal Status Date represents the date of publication in the Federal Register of notification of an official status for a taxon or population. Dates appear only for taxa and populations which are specifically named in a Federal Register Notice of Review Table or in the section of a Federal Register Proposed or Final Rule that proposes or declares an amendment to 50 CFR Part 17 Section 11 or 12 (i.e., changes to the Lists of Endangered and Threatened Wildlife and Plants).

Dates represent:

For listed endangered and threatened taxa and populations: the date recorded in the USESA Date field is the date of publication of the Federal Register "Final Rule" for the taxon or population. For proposed taxa and populations: the date of publication of the most recent Federal Register "Proposed Rule" for the taxon or population. For candidate taxa and populations: the date of publication of the most recent "Notice of Reclassification" or "Notice of Review" in which the candidate appears.

Staff update the natural heritage Central Databases with changes in status due to proposals and determinations to add taxa to the Lists of Endangered and Threatened Wildlife and Plants within two weeks of publication in the Federal Register. Addition and removal of candidates in Notices of Review are entered within four weeks of their publication.

Status Due to Taxonomic Relationship (Values in* INTERPRETED USESA Status *but not in* U.S. Endangered Species Act Status*)

The taxonomic relationships between species and their infraspecific taxa may determine whether a taxon has federal protection. Section 17.11(g) of the U. S. ESA states, "the listing of a particular taxon includes all lower taxonomic units." Also, if an infraspecific taxon or population has federal status, then by default, some part of the species has federal protection. Some taxa show values indicating U.S. Federal Status even though the Element may not be specifically named in the Federal Register. Where status is implied due to a taxonomic relationship alone, the status abbreviation appears only in the INTERPRETED USESA Status field but not U.S. Endangered Species Act Status and no date of listing is given.

Nomenclature for Taxa and Populations with U.S. Federal Status

For most species that have U.S. Federal Status, any available distribution, conservation, and management information is maintained in records under the same scientific name as the one used by USFWS (and printed in the Federal Register). For animal subspecies and populations that have U.S. Federal Status, most of this information is maintained in the species record associated with the subspecies or population. Where the names used by USFWS and NatureServe differ, data may be found using either name.

Basic U.S. Federal Status Designations and Definitions

Abbreviation	U.S. Federal Status
LE	Listed endangered
LT	Listed threatened
PE	Proposed endangered
PT	Proposed threatened
C	Candidate
PDL	Proposed for delisting
E(S/A) or T(S/A)	Listed endangered or threatened because of similarity of appearance
XE	Essential experimental population
XN	Experimental nonessential population
Combination values	The taxon has one status currently, but a more recent proposal has been made to change that status with no final action yet published. For example, LE-PDL indicates that the species is currently listed as endangered, but has been proposed for delisting.
Values in INTERPRETED USESA Status *but not in* U.S. Endangered Species Act Status	The taxon itself is not named in the Federal Register as having federal status; however, it does have federal status as a result of its taxonomic relationship to a named entity. For example, if a species is federally listed with endangered status, then by default, all of its recognized subspecies also have endangered status. The subspecies in this example would have the value "LE" under INT_USESA. Likewise, if all of a species' infraspecific taxa (worldwide) have the same federal status, then that status appears in the record for the "full" species as well. In this case, if the taxon at the species level is not mentioned in the Federal Register, the status appears in INT_USESA in that record.
PS	Indicates "partial status" - status in only a portion of the species' range and only appears in INT_USESA. Typically indicated in a "full" species record where an infraspecific taxon or population has federal status, but the entire species does not.
Null value	Usually indicates that the taxon does not have any federal status. However, because of potential lag time between publication in the Federal Register and entry in the NHCD, some taxa may have a status that does not yet appear.