FINAL PERFORMANCE REPORT

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Survey and Inventory of Amphibians and Reptiles of the Wildlife Management Areas of Oklahoma

OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION

June 1, 2006 through May 31, 2011

FINAL REPORT

State: Oklahoma **Grant Number:** T-35-P-1

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A. ABSTRACT

We conducted intensive surveys and inventories for amphibians and reptiles on three Wildlife Management Areas (Packsaddle, Atoka, and Cookson) and supplemental surveys on two other WMAs (Sandy Sanders and Pushmataha) where the Oklahoma Department of Wildlife Conservation had previously collected data. We confirmed the presence of herpetofaunas at each site that should be expected based on known distributions of amphibians and reptiles in the United States. We found several range extensions for reptiles on the Packsaddle and Atoka WMAs. We collected and archived voucher specimens and tissue samples that can be used for future systematic studies using gene sequence data. Species accumulation curves for the first three sites indicate that sampling by drift-fence arrays picked up most trappable species. Additional species were recorded based on daytime and nighttime searches and the use of other trapping systems. Species considered rare (e.g. Texas Horned Lizard, Southern Crawfish Frog) were common in appropriate habitats on the wildlife management areas. Analysis of the relationship of amphibian and reptile species to habitat characteristics revealed significant associations only for the Atoka site, which contains a mixture of forested and open habitats and a mixture of amphibian and reptile species associated with those habitats. We were not able to detect obvious declines in amphibians or reptiles at this time.

B. INTRODUCTION

Biodiversity is often considered to indicate the health of a given ecosystem (Soule, 1986; Wilson, 2002). In general terms, biodiversity refers to all of the species, their evolutionary relationships, and their interactions with both the environment as a whole and other species in the immediate area. Surveys and inventories are usually conducted over relatively short time periods to provide a snapshot of a dynamic process in which relative abundances, activity patterns, local distributions, and even species composition may fluctuate naturally over time. Sorting out natural variation in abundance from variation caused by human-induced environmental change requires a starting point (baseline surveys and inventories) and long-term monitoring (either continuous or at designated intervals). With continued expansion of the human population, both in Oklahoma and globally, natural habitats for our native fauna will continue to be impacted, resulting in changes in biodiversity (McKee, 2004; Soule, 1986).

Public awareness is a necessary driver of public policy. Public awareness of the connection between biodiversity and the long-term maintenance of quality of life for humans has increased rapidly during the last two decades (e.g., see Kareiva, 2008; Miller, 2005; Pergrams and Zaradic, 2008). For example, observations on amphibians have contributed greatly to this awareness partly because losses of amphibian populations, and in many cases, extinctions, have occurred even in areas where habitats have not been directly altered (Wake and Vredenburg, 2008; McCallum, 2007; but see Pechmann et al, 1991). Amphibian declines appear to have been caused by interactions of several different factors, either directly or indirectly (e.g., Daszak et al., 2004; Kinney et al., 2011; Lehtinen and Skinner, 2006; Lips et al., 2008; Skerratt et al., 2007, 2011). Recently, the losses of lizard populations at multiple sites throughout the world have been correlated to local temperature changes, a portion of which can be attributed to the activities of man (Sinervo et al., 2010; Deutsch et al., 2008; Huey et al., 2010). Consequently, amphibians and reptiles are becoming model vertebrates for detecting the effects of both habitat and climate change on biodiversity (e.g., Whitfield et al., 2007). Nevertheless, the proportion of our population that understands the connection between biodiversity and long-term maintenance of quality of life for humans is offset by the proportion of people who appear to be losing contact with nature.

This disconnect appears evident when examining participation in nature-related activities. Overall visitation of national parks in the United States has been declining for the last 16 years (starting in 1987) (Pergams and Zaradic, 2006) and the same appears to be true for other activities in nature, including camping, fishing, and visits to national parks in other countries (Pergams and Zaradic, 2008). The world's greatest environmental threat may be the disconnect between humans and nature (Kareiva 2008). Integrating what we have learned into policy remains a major challenge because of this disconnect, even though great strides have been made in the study of conservation biology (Meffe et al., 2006, Miller, 2005).

The eighty-one Wildlife Management Areas in the state of Oklahoma (WMAs: see http://www.wildlifedepartment.com/wmastate.htm) offer the residents of Oklahoma the opportunity for direct contact with the natural environments that maintain the diversity of animal and plant species native to the state and region. Although used primarily for hunting and fishing, Oklahoma's WMAs offer diverse opportunities to observe other wildlife. As such, they can contribute to the development of a genuine interest in the natural biological systems that provide the basis for life on Earth and help to create a value awareness of the organisms living in the WMAs. Scientific institutions, museums, nature organizations, and the public already use the WMAs as a resource for learning and teaching about animals and plants of Oklahoma. We believe that the full potential of Oklahoma's WMAs is only beginning to be realized, and that use for public education can significantly add to recreational uses that currently exist. Moreover, these uses do not conflict with other priorities (e.g., hunting and fishing) because the ODWC can and does regulate access during various hunting seasons.

Management of native fauna and flora serve all residents of the State of Oklahoma and guarantee that these resources will be maintained for future generations. Management of the naturally occurring fauna and flora is not in conflict with management policies aimed at maintaining recreational uses such as hunting and fishing. Rather, an integrated management system that includes the native fauna and flora contributes to better management and sustainability of game species. Integrated and long-term management plans depend on accurate surveys of native species. Engaging the public that might be interested in using WMAs for non-game wildlife purposes (e.g., nature education) will depend upon making information available via the Internet and other kinds of media so that they are aware of the resources offered by WMAs. We again emphasize that non-game uses of WMAs are not at all inconsistent with recreational (hunting and fishing) use.

During the past four years, we have been conducting baseline surveys and inventories of amphibians and reptiles on some of Oklahoma's Wildlife Management Areas (hereafter, WMAs). Our goals included the determination of the species composition and relative abundance on each area and the production of Internet Web Pages to provide reliable information on amphibians and reptiles of the WMAs for the public. The first three years involved intensive surveys of three WMAs (Packsaddle, Atoka, and Cookson WMAs) using drift-fence arrays (see previous annual reports). During the last two years of the grant, we conducted supplemental surveys on two additional WMAs, Sandy Sanders and Pushmataha, where there were existing data collected prior to 2005.

Our surveys confirmed the existence of amphibian and reptile species that were expected to occur at each WMA. Additionally, we found several species that had not been reported from some of the sites, including some substantial range extensions. Because the WMAs contain large tracts of habitat that have been relatively undisturbed for a considerable period of time, many amphibian and reptile populations appear to be thriving, and in the most general terms, management of these WMAs for other wildlife (deer, elk, turkey, quail, doves, etc.) appears to have had an overall positive effect on amphibians and reptiles. In this report, we make several recommendations that might further enhance management of these valuable resources.

C. OBJECTIVE

The primary objective of this project is to provide reliable, accurate, and verifiable species lists, estimates of relative abundance, and microhabitat associations for amphibians and reptiles on State controlled lands (WMAs) in accordance with the Oklahoma Comprehensive Wildlife Conservation Plan. Resultant data will be provided in Performance Reports and web sites.

D. APPROACH

Packsaddle, Atoka, and Cookson Hills WMAs

During the first three years of our project, we conducted intensive surveys of Packsaddle WMA, Atoka WMA, and Cookson Hills WMA, respectively. Brief descriptions of each WMA appear in Table 1. On each WMA, we selected two primary study areas that allowed us to run linear series of drift-fence arrays across most identified habitats. Each array consisted of three linear fences made of plastic, a central, five-gallon bucket and two minnow traps at the end of each drift fence (six per array)(Figure 1). Arrays were installed at 50m intervals with 20 arrays at each selected site. A set of 20 arrays covers approximately 1km and crosses most available microhabitats. At Packsaddle WMA, we conducted 56 continuous days of trapping using 40 arrays, providing 15,680 trap days. At Atoka WMA, we conducted 69 continuous days of trapping using 40 arrays, yielding a total of 19,320 trap days. At the Cookson WMA, we conducted 63 continuous days of trapping using 40 arrays, yielding a total of 17,640 continuous trap days.

Drift-fence arrays alone are not sufficient to survey entire herpetofaunas because some species do not enter the traps at all, some are too large for traps, and some are so small that they pass through minnow traps. In addition, the structure of drift-fence arrays can affect sampling (e.g., Friend et al., 1969; Hobbs et al., 1994; Jorgensen et al., 1998; Todd et al., 2007). In addition to drift fences, we conducted daytime and nighttime searches for amphibians and reptiles. Daytime searches included observations of active animals in their natural habitats, rock and log turning to find species with cryptic behavior, and netting for amphibian larvae in ponds. Nighttime searches involved driving roads to obtain individuals crossing roads, searching ponds and streams with lights, conducting call surveys for frogs, and making tape recordings of calls. We used hoop-net traps baited with sardines to capture most aquatic turtles.

Data collection was identical on all three wildlife management areas. Each animal that was trapped was identified, sexed, measured for snout-vent length, palpated (if female adult) to determine reproductive condition, and either released or euthanized and preserved as a voucher specimen. Voucher specimens and their tissues (to be used in systematic studies using DNA sequences) were deposited in the Oklahoma Genomic Resources Collection at the Sam Noble Oklahoma Museum of Natural History.

To examine success rate in terms of species sampling, we assembled matrices that contained species of amphibians and reptiles as rows and day of collection as columns for each WMA. Entries in the matrix were the number of individuals of each species collected per given day. We then calculated species accumulation curves using the program EstimateS Version 7.5.0 (Colwell and Coddington, 1994; Colwell, 2005). EstimateS generates smooth species accumulation curves by randomizing sample order. The shapes of species accumulation curves, based strictly on empirical data, are determined by the order in which samples are added, integrating numbers of individuals per species per unit time. To generate estimators of diversity, 1000 randomizations without replacement were performed. The resulting values are numbers of species expected based on empirical data (Colwell et al. 2004). The program Abundance-based Coverage Estimator (ACE) was used to estimate the completeness of sampling (Chazdon et al., 1998; Chao et al., 2000). We then used likelihood ratios between three curve fitting models, Clench, logarithmic, and exponential, to determine the best fit using the methods and software described by Díaz-Francés and Soberón (2005). The model providing the best fit can then be used to estimate the asymptote of the species accumulation curves. Species accumulation curves most accurately predict species richness when the number of rare species is low, species richness is relatively low so that the probability of picking up additional rare species over time is low, and most importantly, when the species accumulation curve reaches a plateau (Thompson and Withers, 2003; Thompson et al., 2003).

We also collected data on vegetative and physical structure of the habitat at each array and entered these data into a database. We measured the following vegetative and structural habitat variables in each array; leaf litter mass, percent open ground, percent of surface open to the sky, number of plant stem contacts, number of burrows in ground, number of ant nests within 6 meters, distance to nearest tree, trunk diameter as a measure of tree size, total number of fallen logs, and distance to closest rock. To do this, we constructed a 1-m square frame from wooden dowels and placed strings across each side at 10-centimeter intervals to form 100 equal-size squares. In each area (triangular) delineated by drift fences within each array, the square was thrown over the researcher's shoulder and its landing point was used as our random sample site. We counted squares represented by more than 50% open ground, squares not under canopy (open to sky), and picked up all leaf litter under it and weighed it. At the center of the spot where the square landed, we placed a vertical stake with a 1-m horizontal dowel 20 cm above ground and rotated the stick 360°. We counted the number of plant stem contacts with the horizontal stick and then measured the distance to the nearest tree from the center of square. This procedure gave three independent measurements for each variable in each array. We used the means from each array for our analyses. From 1 m beyond the end of each array wings (6 m from center of array), we counted all burrows, all ant nests, and the total number of fallen logs within the array.

To examine the relationship between amphibian and reptile species and microhabitat characteristics, we performed separate Canonical Correspondence Analyses (CCA; Ter Braak, 1986) for each WMA. A CCA is a multivariate ordination procedure that directly associates variation in one matrix (herpetofauna assemblage as the dependent variable) to variation in another matrix (habitat characteristics as the independent variable). The independent variables consisted of a matrix with mean values for each habitat variable as columns and array identity as rows. The dependent variables consisted of a matrix with the number of individuals of each amphibian or reptile species as columns and the array identity as rows. Thus, in this analysis, we asked whether an association exists between specific habitat characteristics and abundance of particular herp species. The CCA was performed with the program CANOCO 4.5 (Ter Braak and Smilauer, 1998), with the following options: focus scaling set on symmetric, biplot scaling type, downweighting of rare species, Monte Carlo test with 9,999 permutations of the reduced model, and unrestricted permutations. If no significant association exists between the independent and dependent variables, then no further analysis is warranted. However, if a significant association exists, then the analysis was re-run with manual removal of significant variables from the model until no further significant portions of the variation are explained.

Sandy Sanders and Pushmataha WMAs

During the fourth and fifth years of our project, we made several site visits to the Sandy Sanders and Pushmataha WMAs. We conducted both daytime and nighttime searches for amphibians and reptiles. Nighttime searches involved driving roads to obtain individuals crossing roads, searching ponds and streams with lights, conducting call surveys for frogs, and making digital recordings of calls. Voucher specimens and their tissues (to be used for systematic studies) were deposited in the Herpetology Collection and the Oklahoma Genomic Resources Collection at the Sam Noble Oklahoma Museum of Natural History.

We also continued to summarize field and museum collection data. We surveyed literature and our own field notes to compile information for our Web Pages. Throughout the project, we worked on a website based on our fieldwork and relevant literature. The website was constructed using DreamWeaver software for the Macintosh and is hosted on the Sam Noble Oklahoma Museum of Natural History's website.

Most fieldwork was conducted by Donald Shepard, Buddy Brown, and Tim Colston, but the following people also participated in fieldwork: Laurie Vitt, Janalee Caldwell, Chris Wolfe, and Gabriel Costa. The website was produced by Laurie Vitt and Janalee Caldwell as well as most data analyses. All reports were prepared by Laurie Vitt and Janalee Caldwell.

E. RESULTS

Packsaddle, Atoka, and Cookson Hills WMAs

Species Lists

Table 2 is a combined species list for all three of these WMAs, with the presence of species indicated under each WMA label. Although a core set of species occurs on all three WMAs, some clear differences exist as well. Packsaddle WMA includes a number of species associated with western deserts, including the Texas Long-nosed Snake, the Kansas Glossy Snake, the Bullsnake, the Spotted Nightsnake, The Spotted Whiptail Lizard, and the Plains Spadefoot. The Cookson WMA contains a number of species associated with the eastern deciduous forest and the Ozark Mountains, including the Cave Salamander, the Dark-sided Salamander, the Ozark Zig-zag Salamander, the Ringed Salamander, and the Spotted Salamander. Atoka WMA contains a herpetofauna typical of southeastern Oklahoma.

Based on a combination of our trapping data and all records obtained by day and night searches, we recorded 1784 captures of 44 species of amphibians and reptiles on the Packsaddle WMA (Table 1). One additional species was added (Western Diamond-backed Rattlesnake) based on an observation by Packsaddle WMA personnel, bringing the total number of species to 45. These records included six turtle species in four families, eight lizard species in five families, 22 snake species in three families, eight frog species in five families, and one salamander species.

Most turtle species were never picked up in drift fence arrays, but were common in the Canadian River or in ponds on Packsaddle WMA. During low water periods, aquatic turtles could be easily observed by examining pools in the river at night. Likewise, watersnakes (both *Nerodia erythrogaster* and *N. rhombifer*) were common in the river and ponds but not picked up in drift fences and although we observed several Graham's Watersnakes (*Regina grahami*) in the river, we were unable to capture a specimen. Our examination of records from the Herpetology Collection of the Sam Noble Oklahoma Museum of Natural History did not add other species.

Based on existing general distribution maps (e.g., Conant and Collins, 1998; Sievert and Sievert, 2011), the possibility exists that five additional species could occur on the Packsaddle WMA. These are: the Red-spotted Toad (*Anaxyrus punctatus*), the Eastern Hog-nosed Snake (*Heterodon platirhinos*), the Plains Hog-nosed Snake (*Heterodon nasicus*), Marcy's Checkered Gartersnake (*Thamnophis marcianus*), and the Ground Snake (*Sonora semiannnulata*). Although we spent considerable effort searching specifically for these species, we found none. Nevertheless, isolated populations may occur at Packsaddle WMA and could be found in the future.

Based on a combination of our trapping data and all records obtained by day and night searches, we recorded 11,855 captures or direct observations of 56 species of amphibians and reptiles on the Atoka WMA (Table 1). Four additional species were added (Alligator Snapping Turtle, Woodhouse's Toad, Glossy Crawfish Snake, and the Prairie Kingsnake) based on observations close to the Packsaddle WMA either by Atoka WMA personnel or us. Overall, we recorded thirteen frog species in four families, three salamanders in two families, ten turtle species in four families, eight lizard species in five families, and twenty-five snake species in two families. The remote possibility exists that the Texas Nightsnake (*Hypsiglena torquata*) and the Northern Scarlet Snake (*Cemophora coccinea*) occur on the Atoka WMA because both species occur at McGee Creek State Park, which is located a few miles to the southeast of the Atoka WMA. However, we have not included them in our list of species. Other species that could be found on the Atoka WMA in the future include Hurter's Spadefoot (*Scaphiopus hurteri*), Pickerel Frog (*Lithobates palustris*), Collared Lizard (*Crotaphytus collaris*), Prairie Skink (*Plestiodon septentrionalis*), and Western Pygmy Rattlesnake (*Sistrurus miliarius*).

Similar to the Packsaddle WMA, our drift fence arrays failed to pick up some common species, primarily the aquatic turtles and watersnakes. We were able to document these by using turtle traps, driving roads at night, and searching in streams and ponds at night. All watersnakes and all aquatic turtles (with the exception of the Alligator Snapping Turtle) were common on the Atoka WMA. Our examination of records from the Herpetology collection of the Sam Noble Oklahoma Museum of Natural History did not add additional species.

We recorded 1,103 captures of 35 species of amphibians and reptiles in our drift-fence arrays on the Cookson WMA (Table 1). Five frog species, the American Toad (*Anaxyrus americanus*), the Green Frog (*Lithobates clamitans*), the Southern Leopard Frog (*Lithobates sphenocephalus*), the Eastern Narrow-mouth Toad (*Gastrophryne carolinensis*), and the Pickerel Frog (*Lithobates palustris*) dominated the amphibians collected in traps. One salamander, the Slimy Salamander (*Plethodon albagula*) was also common. Among lizards, the Broad-headed Skink (*Plestiodon laticeps*), the Southern Plains Fence Lizard (*Sceloporus undulatus*) and the Five-lined Skink (*Plestiodon fasciatus*) dominated. Among snakes, only the Osage Copperhead (*Agkistrodon contortrix*) was most common.

Because many amphibian and reptile species are extremely common in the Cookson WMA, we did not record each individual observed outside of the drift-fence arrays as we had at the other two WMAs. Nevertheless, our general searches of habitats, coupled with nighttime surveys produced additional species of amphibians and reptiles, several of which were common. In addition, we examined records from the Herpetology collection of the Sam Noble Oklahoma

Museum of Natural History. Taken together, we are able to confirm 22 amphibian and 37 reptile species in the Cookson WMA. Only one additional species, the Northern Scarlet Snake (*Cemophora coccinea*) was expected and is likely to be found on the area in the future.

Three lizard species were common in the Cookson WMA, but were not picked up in our trap arrays. The Prairie Whiptail (*Aspidoscelis sexlineatus*) was common in open areas and the Little Brown Skink (*Scincella lateralis*) was common in areas with leaf litter (we did collect one of these in our traps). Eastern Collared Lizards (*Crotaphytus collaris*) were common, but in a very restricted habitat type, and they were seen only in open habitats with large rocks exposed to sun. Several common snakes that were either not collected or infrequently collected in our drift-fence arrays were the Western Wormsnake (*Carphophis vermis*), the Rough Greensnake (*Opheodrys aestivus*), the Eastern Racer (*Coluber constrictor*), the Prairie Kingsnake (*Lampropeltis calligaster*), and the Western Cottonmouth (*Agkistrodon piscivorous*).

We found only a single Three-toed Box Turtle (*Terrapene carolina*) in our trap arrays at the Cookson WMA. Nevertheless, Three-toed Box Turtles were common there. Similarly, we either observed or trapped with hoop nets Red-eared Sliders (*Trachemys scripta*), Western Snapping Turtles (*Chelydra serpentina*), and Stinkpots (*Sternotherus odoratus*); the first two of these are common throughout the Cookson WMA inhabiting ponds and streams. Stinkpots may also be common, but they are not easily trapped. We found one large female Cooter (*Pseudemys concinna*) crossing the southern boundary road of the Cookson WMA. These may occur in the larger ponds on the WMA, but they typically do not occur in small streams or ponds. They are most common in rivers, large streams, and lakes.

Among amphibians, several species are common on the Cookson WMA but either rarely or never picked up in our drift-fence arrays. They include Bullfrogs (*Lithobates catesbeianus*), Cajun Chorus Frog (*Pseudacris fouquettei*), Woodhouse's Toad (*Anaxyrus woodhousii*), the Many-ribbed Salamander (*Eurycea multiplicata*), and the Ozark Zig-zag Salamander (*Plethodon angusticlavius*). Two addition species of mole salamanders, the Small-mouthed Salamander (*Ambystoma texanum*) and the Ringed Salamander (*Ambystoma annulatum*) breed in some temporary ponds in the Cookson Hills where they are locally abundant.

Estimate S results

For all three WMAs, the number of species collected or observed began decline rapidly after 40–50 days of continuous sampling (Figure 2). Continued sampling after 50 days would produce few additional species per unit time. It is instructive to point out that the *EstimateS* results are based on trap data and do not include those species that were observed, trapped with other methods, or captured by hand. Consequently, they reflect only the "trappable" species.

Mathematical models can be applied to simulated species accumulation curves and used to estimate the total number of species, given the assumption that the trapping system works for all species. Of course, this assumption is violated as noted above. Nevertheless, among the trappable species, the Clench model best fits trap data for the Packsaddle WMA whereas a logarithmic model best fits data for Atoka and Cookson WMAs. The most important conclusion from the combined tapping data and other methods of recording species on the WMAs is that even with a combination of methods, recording all species in a defined area requires a considerable effort. Short-term or spot surveys and inventories are likely to produce incomplete species lists and inaccurate data on relative abundances of species.

Relative abundance

Relative abundance of all amphibians and reptiles captured or observed on the Packsaddle WMA appears in Figure 4. A relatively few species were easily observed or captured whereas many species were rarely observed or captured. Prairie Racerunners, Southern Plains Fence Lizards, and Great Plains Narrow-mouth Toads were most common in trap arrays whereas Bullfrogs, Red-eared Sliders and Diamond-backed Watersnakes were most often observed but not captured while searching various habitats on the WMA. Observation records for some species were very easy to make because the habitat at Packsaddle WMA is open.

The relative abundance of all amphibians and reptiles captured or observed in drift-fence arrays on the Atoka WMA appears in Figure 5. The following six species were most frequently captured in traps: the American Toad, the Great Plains Narrow-mouth Toad, the Southern Leopard Frog, The Southern Plains Fence Lizard, the Southern Crawfish Frog, and the Southern Copperhead. Observation records were difficult at the Atoka WMA because most of the habitat was forested and, because it was structurally complex due to numerous large rocky outcrops. A number of small snake species (e.g., the Rough Earth Snake, the Prairie Ring-necked Snake, the Western Worm Snake, and the Texas Brownsnake) were common under rocks during late Spring and early Summer, but only collected infrequently in drift fence arrays. Little Brown Skinks also were very common in leaf litter throughout the area but only occasionally picked up in drift-fence arrays.

The relative abundance of all amphibians and reptiles captured or observed in drift-fence arrays on the Cookson WMA appears in Figure 6. The most commonly captured species in drift-fence arrays were the American Toad, the Broad-headed Skink, the Osage Copperhead, the Green Frog, the Southern Plains Fence Lizard, and the Five-lined Skink. Similar to the Atoka WMA, several reptile species were very common but not collected in representative frequencies in drift-fence arrays. These include the Little Brown Skink, the Western Wormsnake, the Rough Earth Snake, Prairie Ring-necked Snake, the Flat-headed Snake, the Rough Earth Snake, and the Texas Brownsnake. Likewise, some frog species that breed in early Spring and are temporally common (e.g., Spring Peeper, Cajun Chorus Frog) were under-represented in drift-fence arrays. Many salamanders in the Ozark region (e.g., the Dark-sided Salamander, the Cave Salamander, the Gray-bellied Salamander, the Ozark Zig-zag Salamander) are common and can easily be found in large numbers during early Spring or at night following rainstorms but are under-represented in drift-fence arrays.

Sandy Sanders and Pushmataha WMAs

During the fourth and fifth years of our project, we conducted surveys at Sandy Sanders and Pushmataha Wildlife Management Areas (see Table 1). Because of limited funds for travel and per diem, we did not establish time-intensive drift-fence arrays. We made several visits to both WMAs, during the Spring, Summer, and Fall seasons of both years. Some of these trips were aimed at species listed as *Species of Greatest Conservation Need* by the Oklahoma Comprehensive Wildlife Conservation Strategy or species that we thought should occur at the sites, but had not been observed. We also examined our collection records for both areas in the Sam Noble Museum and received species lists from ODWC personnel who conducted surveys on the area prior to our study. During our site visits, we made some collections of specimens and their tissues. Voucher specimens and their tissues (to be used for future DNA studies) were deposited in the Herpetology Collection and the Oklahoma Genomic Resources Collection at the Sam Noble Oklahoma Museum of Natural History. We conducted both daytime and nighttime searches for amphibians and reptiles. Nighttime searches involved driving roads to obtain individuals crossing roads, searching ponds and streams with lights, conducting call surveys for frogs, and making digital tape recordings of calls. In addition, the Curators (Laurie Vitt and Janalee Caldwell) and their graduate students have made many collecting trips to the Sandy Sanders WMA during the past 20 years, and as a result, good records exist for that WMA.

The Sam Noble Museum contains 745 specimens of 47 species of amphibians from Beckham and Greer Counties, many of which were collected over the years on the Sandy Sanders WMA. These include six turtle species in four families, seven lizard species in five families, 22 snake species in three families, 11 frog species in five families, and one salamander species (Table 3). Based on habitats available at the Sandy Sanders WMA, the possibility exists that an additional 7 species could occur in the area; however, our supplemental field surveys did not reveal these additional species. Species that were expected to be common (Texas Horned Lizard, Southern Plains Fence Lizard, Eastern collared lizard, Texas Nightsnake, Sonoran Ground Snake, Western Coachwhip, Plains Black-headed snake, the three rattlesnake species, Bullfrogs, Southern Leopard Frogs, Red-spotted Toads, Western Green Toads, Plains Narrow-mouthed Toads, and Barred Tiger salamanders) indeed were common in their respective microhabitats. Many of the species have cryptic habits, limited activity periods, or occur at very low density and thus are not easily observed. Nevertheless, our collections and observations indicate that all of these occur at densities expected based on field collections.

The Sam Noble Museum contains 258 specimens of 53 species of amphibians and reptiles from Pushmataha County, many of which were collected over the years on the Pushmataha WMA. We have additional specimens that were collected during the last two years. The collected specimens include eight turtle species in four families, six lizard species in three families, 23 snake species in two families, 13 frog species in four families, and 3 salamander species in two families (Table 4). Based on habitats available at the Pushmataha WMA, the possibility exists that an additional 13 species could occur in the area. Common species that were located in our surveys included Pickerel Frogs, Southern Leopard Frogs, Cricket Frogs, Eastern Newts, Western Slimy Salamanders, Southern Plains Fence Lizards, Five-lined Skinks, Red-eared Sliders, Gulf Cooters, Brown Snakes, Flat-headed Snakes, and Rough Earth Snakes. Species that were expected to be difficult to encounter (e.g., Milksnakes, Eastern Hog-nosed Snakes) were found occasionally. Our impression is that relative abundance of most of these species is comparable to those in surrounding areas.

Relationship of species with habitat characteristics

Canonical Correspondence Analysis of species occurrence versus habitat characteristics revealed no significant association in Packsaddle or Cookson WMAs (Table 5). However, a significant association was found for amphibians and reptiles in the Atoka WMA (Table 5). Canopy, nearest tree, and number of logs were the habitat variables that explained significant portions of the variation among species in distribution among trap arrays (Table 6).

Web Pages

Based on our surveys and information from museum collections and the published literature, we have been able to assemble websites for each of the five WMAs that we visited. The index page for these websites can be accessed at:

http://www.snomnh.ou.edu/personnel/herpetology/vitt/WMA/index.shtml

Websites for each WMA can be accessed from the index page above or directly at the following urls:

Packsaddle	http://www.snomnh.ou.edu/personnel/herpetology/vitt/WMA/Packsaddle.shtml
Atoka	http://www.snomnh.ou.edu/personnel/herpetology/vitt/WMA/Atoka.shtml
Cookson	http://www.snomnh.ou.edu/personnel/herpetology/vitt/WMA/Cookson.shtml
Sandy Sanders	http://www.snomnh.ou.edu/personnel/herpetology/vitt/WMA/SandySanders.shtml
Pushmataha	http://www.snomnh.ou.edu/personnel/herpetology/vitt/WMA/Pushmataha.shtml

In addition to containing photographs of each species, clicking on the photographs links to individual species web pages for all of the species on each of the five WMAs as well as species that are likely to be found with additional survey effort on these areas. These web pages include information on identification, size, natural history, how to observe each species, and its conservation status. Range maps and additional photographs are included as well. For turtles and lizards, photographic keys to heads are provided making it very easy to identify turtles and lizards if they are in hand. Additional links within the web pages aid in identification as well.

F. DISCUSSION

Our intensive drift-fence array surveys at Packsaddle, Atoka, and Cookson WMAs reveal that each of these WMAs contains nearly complete herpetofaunas based on comparisons with general distribution maps (e.g., Conant and Collins, 1998). The trap results speak for themselves in this regard (Table 1, Figure 1). Our species accumulation curves indicate that intensive drift-fence sampling does a very good job of sampling trappable species. Species that are not easily picked up in drift-fence arrays were specifically sought and captured with either alternative trapping techniques (e.g. turtles) or hand collected (e.g. aquatic snakes and large snakes).

Given that the landscapes surrounding all three of these WMAs consist of patches of varying levels of disturbance, reductions in some of the more obvious species might be expected. However, we found no indications that this was the case. For example, the Packsaddle WMA contains relatively undisturbed habitat for Texas Horned Lizards, and they remain relatively common. These lizards have been impacted throughout their geographic range by loss of natural habitat, use of pesticides affecting ant populations, and other stressors (Castellano and Valone, 2006; Hellgren et al., 2007, 2010; McIntyre, 2003; Newbold and MacMahan, 2008). Nevertheless, even with some grazing on the Packsaddle WMA, these lizards remain common. Salamanders on the Cookson WMA provide another example. The Cookson WMA contains large populations of salamanders that typify the Ozark Mountains, including Cave Salamanders, Dark-sided Salamanders, Gray-bellied Salamanders, and Ozark Zig-zag Salamanders. In addition, a large number of small snake species (e.g., Smooth Earth Snake, Rough Earth Snake, Texas Brownsnake, Redbelly Snake, Flat-headed Snake, Western Worm Snake, Prairie Ring-necked Snake, and Milksnake), that inhabit leaf litter or live within the limestone rock matrix lying under much of the area remain common. Likewise, salamanders and frogs that use fishless temporary ponds to breed (e.g., Pickerel Frog, Southern Leopard Frog, Spring Peeper, Cajun Chorus Frog, Woodhouse's Toad, American Toad, Ringed Salamander, Spotted Salamander, and Small-mouthed Salamander) appear to be doing well (but see recommendations below). Similar comments can be made about the herpetofauna of Atoka WMA.

Our habitat analyses revealed a significant association between habitat characteristics and species occurrence in trap arrays only for the Atoka WMA. Atoka WMA not only contains a mixture of forested habitats, but also has some open prairie segments. As a result, it contains species associated with western prairies in these open habitats (e.g., Western Narrow-mouth Toads and Ornate Box Turtles) and sister species associated with eastern deciduous forests (e.g., Eastern Narrow-mouth Toads and Three-toed Box Turtles). Nevertheless, most species on the Atoka WMA are associated with eastern deciduous forests.

The Packsaddle WMA is relatively open, with narrow bands of forest in canyons leading to the Canadian River. Nearly all species of amphibians and reptiles on the Packsaddle WMA are typical of open habitats to the west and as a result do not sort out by the habitat variables that we measured. The Cookson WMA consists of relatively continuous forested habitats interrupted by fields managed for deer and elk. Amphibians and reptiles of the Cookson WMA are typical of eastern deciduous forest herpetofaunas. Consequently, our analysis did not reveal obvious correlations of species with habitat characteristics.

In addition to our drift-fence survey at Cookson WMA, we have made many visits to the Cookson WMA since 1991, sometimes with a Herpetology class (University of Oklahoma) and sometimes with graduate students. An important point that comes out when comparing our drift-fence trapping with general collecting is that on each visit to the Cookson WMA, we observed only a portion of species that we were able to detect with drift-fence arrays. In other words, many species would remain undiscovered based on one or several site visits. Short-term (several days or visits) surveys would under-estimate the number of species and could lead to unreliable conclusions about species richness and relative abundances.

Our surveys on Sandy Sanders and Pushmataha WMA during the course of this study were short-term and if considered alone would underestimate species richness. Moreover, comments regarding relative abundances are less reliable. To offset this bias, we used a combination of museum records and lists of species observed by other investigators (some university people, and some ODWC wildlife biologists). In addition, similar to the Cookson WMA, curators at the Sam Noble Museum have been making visits to the Sandy Sanders WMA over the past 20 years and thus had put together a considerable amount of information on its herpetofauna. Taken together, we consider our species lists to be reliable, but we have indicated species that we may have missed during our surveys.

None of the five WMAs that we surveyed contain threatened or endangered species. Two of the WMAs (Packsaddle and Sandy Sanders) contain populations of Texas Horned Lizards, which are considered rare. However, they appear to be common in these areas, likely because extensive tracts of horned lizard habitat exist. Alligator Snapping Turtles, also considered rare, have been seen near the Atoka WMA and likely occur there. A large breeding population of Southern Crawfish Frogs was found on the Atoka WMA. Informal surveys that we have done in several southeastern counties indicate that these winter-breeding frogs are common in the southeastern part of the state, but are often missed because of their restricted breeding season. Although we have observed no obvious declines of either amphibians or reptiles in the five WMAs that we surveyed, our results should be useful as a baseline for detecting declines should they occur in the future.

Recommendations

Considering that all of the WMAs that we sampled contain large tracts of relatively undisturbed habitat for amphibians and reptiles, it *appears* that land-management practices aimed at game species have had little if any impact on amphibians and reptiles. However, we do not have historic records against which we can compare our results. We don't really know whether populations were larger or smaller in the past; we only know that populations appear to be sustained at present. As such, our surveys can serve as a dated baseline for future comparisons.

We offer four primary recommendations:

1. Because many amphibians breed in temporary ponds that do not contain fish, we recommend that WMA managers consider this when altering waterways. We provide two examples: 1) when small ponds are constructed to hold water for deer and other terrestrial game species, do not introduce fish, which feed on eggs and larvae of amphibians, and 2) when constructing large impoundments (lake-size) for fishing, construct a series of smaller depressions upstream from the impoundment reservoir that can serve as temporary ponds for breeding amphibians.
2. Expand development of educational materials and/or programs for hunters and fisherman who use the WMAs. These can make use of existing materials (e.g., the web pages that we have developed or the ODWC-sponsored Field Guide to Amphibians and Reptiles by Sievert and Sievert 2011). In doing so, emphasize the value of all species for maintaining the WMA's as resources to be used into the foreseeable future.
3. Consider additional promotion of the WMAs for use by amateur and professional naturalists outside of the game seasons. This provides an added value component aimed at an audience that might otherwise consider the WMA program to be using public funds to support special interests (hunters and fisherman) when in fact, no conflict exists between making use of WMAs for educational purposes and hunting and fishing.
4. Consider a long-term program of surveys and inventories of amphibians, reptiles, and small mammals on Oklahoma's WMAs. Considering that amphibians and lizards appear to be in serious decline globally, and much of Oklahoma's landscape is broken into pieces of various sizes and uses, the WMAs offer unique opportunities to monitor the health of our ecosystems. The reason that we add small mammals is that during

independent drift-fence surveys in Oklahoma, we have discovered that drift-fence arrays are excellent for sampling small mammals (Braun et al., 2011).

G. DEVIATIONS

The only substantive deviation is that we were able to constrain our expenditures during the first three years and as a result had sufficient funds to extend the study two additional years to conduct supplemental surveys on the Sandy Sanders WMA and the Pushmataha WMA.

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Table 1. Brief descriptions of five Wildlife Management Areas that were surveyed for amphibians and reptiles.

WMA	County	Year	Size (acres)	Habitat Description
Packsaddle	Ellis	2006	19,659	Sandy rolling hills, wooded canyons and river bottomlands. Upland sites contain mixed grass prairie plant communities, canyons contain riparian vegetation including mixed oak and cottonwood stands, and river-bottom areas are dominated by cottonwoods, elms, and hackberries
Atoka	Atoka	2007	19,642	Oak-hickory associations with scattered natural and managed open areas of grasslands. Hillsides contain granitic rock outcrops, some of which are extensive. Open patches on some hills contain prairie vegetation. Aquatic habitats include temporary and permanent streams and ponds, lakes, and seeps (springs).
Cookson	Cherokee and Adair	2008	15,469	Oak-hickory forest with some short leaf pine on rolling, rocky, and relatively steep hills. Limestone cliff areas occur on tops of hills. Permanent and semi-permanent streams, springs, ponds, and lakes occur throughout the area.
Sandy Sanders	Beckham and Greer	2009	19,100	The western portion of the WMA contains rugged terrain, with mesquite and redberry juniper. The eastern portion transitions into mixed grass prairie. Several semi-permanent streams and a number of natural and managed ponds exist.
Pushmataha	Pushmataha	2010	19,250	Oak and pine forest dominates the area and overall plant diversity is high (more than 450 species identified). Steep slopes, rock outcrops, streams, and ponds (both permanent and temporary) exist.

Table 2. Species of amphibians and reptiles occurring at Packsaddle (PS), Atoka (AT), and Cookson (CH) WMAs. An X indicates presence of the species for each respective WMA. Common names may vary among tables because of regionally described subspecies (which we do not recognize).

Common Name	Scientific Name	PS	AT	CH
Turtles				
Family Emydidae				
Three-toed Box Turtle	*Terrapene carolina*		X	X
Ornate Box Turtle	*Terrapene ornata*	X	X	
Red-eared Slider	*Trachemys scripta*	X	X	X
Ouachita Map Turtle	*Graptemys ouachitensis*		X	
Gulf Cooter	*Pseudemys concinna*		X	X
Family Chelydridae				
Eastern Snapping Turtle	*Chelydra serpentina*	X	X	X
Family Trionychidae				
Smooth Softshell	*Apalone mutica*	X		
Spiny Softshell	*Apalone spinifera*	X	X	
Family Kinosternidae				
Yellow Mud Turtle	*Kinosternon flavescens*	X		
Eastern Mud Turtle	*Kinosternon subrubrum*		X	
Stinkpot	*Sternotherus odoratus*		X	X
Lizards				
Family Phrynosomatidae				
Texas Horned Lizard	*Phrynosoma cornutum*	X		
Southern Plains Fence Lizard	*Sceloporus undulatus*	X	X	X
Family Crotaphytidae				
Eastern Collared Lizard	*Crotaphytus collaris*	X		X
Family Scincidae				
Southern Coal Skink	*Plestiodon anthracinus*		X	
Five-lined Skink	*Plestiodon fasciatus*		X	X
Broad-headed Skink	*Plestiodon laticeps*		X	X
Southern Prairie Skink	*Plestiodon septentrionalis*	X		
Great Plains Skink	*Plestiodon obsoletus*	X		
Little Brown Skink	*Scincella lateralis*	X	X	X
Family Anguidae				
Western Slender Glass Lizard	*Ophisaurus attenuatus*	X	X	
Family Teiidae				
Prairie Racerunner	*Aspidoscelis sexlineatus*	X	X	X
Snakes				
Family Leptotyphlopidae				
Plains Threadsnake	*Leptotyphlops dulcis*	X		
Family Colubridae				
Kansas Glossy Snake	*Arizona elegans*	X		
Western Worm Snake	*Carphophis vermis*		X	X
Eastern Yellow-bellied Racer	*Coluber constrictor*	X	X	X

Prairie Ring-necked Snake	*Diadophis punctatus*	X	X	X
Great Plains Ratsnake	*Pantherophis emoryi*	X	X	X
Texas Ratsnake	*Pantherophis obsoleta*	X	X	X
Eastern Hog-nosed Snake	*Heterodon platirhinos*		X	X
Texas Nightsnake	*Hypsiglena torquata*	X		
Prairie Kingsnake	*Lampropeltis calligaster*	X	X	X
Speckled Kingsnake	*Lampropeltis getula*	X	X	X
Milksnake	*Lampropeltis triangulum*		X	X
Coachwhip	*Masticophis flagellum*	X	X	X
Blotched Watersnake	*Nerodia erythrogaster*	X	X	X
Banded Watersnake	*Nerodia fasciata*		X	
Northern Diamond-backed Watersnake	*Nerodia rhombifer*	X	X	
Midland Watersnake	*Nerodia sipedon*			X
Rough Greensnake	*Opheodrys aestivus*		X	X
Bullsnake	*Pituophis catenifer*	X		
Graham's Crayfish Snake	*Regina grahamii*	X		
Texas Long-nosed Snake	*Rhinocheilus lecontei*	X		
Texas Brownsnake	*Storeria dekayi*	X	X	X
Redbelly Snake	*Storeria occipitomaculata*			X
Flat-headed Snake	*Tantilla gracilis*		X	X
Plains Black-headed Snake	*Tantilla nigriceps*	X		
Texas Gartersnake	*Thamnophis sirtalis*	X	X	X
Western Ribbonsnake	*Thamnophis proximus*	X	X	X
Smooth Earth Snake	*Virginia valeriae*		X	X
Rough Earth Snake	*Virginia striatula*		X	X
Family Viperidae				
Copperhead	*Agkistrodon contortrix*		X	X
Western Cottonmouth	*Agkistrodon piscivorus*		X	X
Prairie Rattlesnake	*Crotalus viridis*	X		
Western Massasauga	*Sistrurus catenatus*	X		
Western Pigmy Rattlesnake	*Sistrurus miliarius*			X
Timber Rattlesnake	*Crotalus horridus*		X	X
Western Diamond-backed Rattlesnake	*Crotalus atrox*	X	X	X
Frogs				
Family Ranidae				
Southern Crawfish Frog	*Lithobates [Rana] areolatus*		X	
Bullfrog	*Lithobates [Rana] catesbeianus*	X	X	X
Green Frog	*Lithobates [Rana] clamitans*		X	X
Plains Leopard Frog	*Lithobates [Rana] blairi*	X		
Pickerel Frog	*Lithobates [Rana] palustris*			X
Southern Leopard Frog	*Lithobates [Rana] sphenocephalus*		X	X
Family Hylidae				
Spotted Chorus Frog	*Pseudacris clarkii*	X		
Spring Peeper	*Pseudacris crucifer*		X	X
Cajun Chorus Frog	*Pseudacris fouquettei*		X	X
Strecker's Chorus Frog	*Pseudacris streckeri*		X	
Green Treefrog	*Hyla cinerea*		X	

Grey Treefrog	*Hyla versicolor/chrysoscelis*		X	X
Blanchard's Cricket Frog	*Acris crepitans*	X	X	X
Family Scaphiopodidae				
Plains Spadefoot	*Spea bombifrons*	X		
Hurter's Spadefoot	*Scaphiopus hurteri*			X
Family Bufonidae				
Woodhouse's Toad	*Anaxyrus [Bufo] woodhousii*	X	X	X
American Toad	*Anaxyrus [Bufo] americanus*		X	X
Great Plains Toad	*Anaxyrus [Bufo] cognatus*	X		
Family Microhylidae				
Great Plains Narrow-mouthed Toad	*Gastrophryne olivacea*	X	X	X
Eastern Narrow-mouthed Toad	*Gastrophryne carolinensis*		X	X
Salamanders				
Family Ambystomatidae				
Barred Tiger Salamander	*Ambystoma tigrinum*	X		
Ringed Salamander	*Ambystoma annulatum*			X
Spotted Salamander	*Ambystoma maculata*			X
Small-mouthed Salamander	*Ambystoma texanum*			X
Family Salamandridae				
Eastern Newt	*Notophthalmus viridescens*		X	X
Family Plethodontidae				
Cave Salamander	*Eurycea lucifuga*			X
Dark-sided Salamander	*Eurycea longicauda*			X
Gray-bellied Salamander	*Eurycea "multiplicata"*			X
Ozark Zig-zag Salamander	*Eurycea angusticlavius*			X
Many-ribbed Salamander	*Eurycea multiplicata*		X	
Western Slimy Salamander	*Plethodon albagula*		X	X

Table 3. Species of amphibians and reptiles occurring either on the Sandy Sanders WMA or in similar nearby habitats. Common names may vary among tables because of regionally described subspecies (which we do not recognize).

Common Name	Scientific Name
Turtles	
Family Emydidae	
Ornate Box Turtle	*Terrapene ornata*
Red-eared Slider	*Trachemys scripta*
Family Chelydridae	
Common Snapping Turtle	*Chelydra serpentina*
Family Trionychidae	
Smooth Softshell	*Apalone mutica*
Spiny Softshell	*Apalone spinifera*
Family Kinosternidae	
Yellow Mud Turtle	*Kinosternon flavescens*
Lizards	
Family Phrynosomatidae	
Texas Horned Lizard	*Phrynosoma cornutum*
Southern Plains Fence Lizard	*Sceloporus consobrinus*
Family Crotaphytidae	
Eastern Collared Lizard	*Crotaphytus collaris*
Family Scincidae	
Great Plains Skink	*Plestiodon obsoletus*
Little Brown Skink	*Scincella lateralis*
Family Anguidae	
Western Slender Glass Lizard	*Ophisaurus attenuatus*
Family Teiidae	
Spotted Whiptail	*Aspidoscelis gularis*
Snakes	
Family Leptotyphlopidae	
Plains Threadsnake	*Leptotyphlops dulcis*
Family Colubridae	
Kansas Glossy Snake	*Arizona elegans*
Eastern Yellow-bellied Racer	*Coluber constrictor*
Prairie Ring-necked Snake	*Diadophis punctatus*
Plains Ratsnake	*Pantherophis emoryi*
Texas Nightsnake	*Hypsiglena torquata*
Prairie Kingsnake	*Lampropeltis calligaster*
Speckled Kingsnake	*Lampropeltis getula*
Western Coachwhip	*Masticophis flagellum*
Blotched Watersnake	*Nerodia erythrogaster*
Northern Diamond-backed Watersnake	*Nerodia rhombifer*

Bullsnake	*Pituophis catenifer*
Sonoran Ground Snake	*Sonora semiannulata*
Plains Black-headed Snake	*Tantilla nigriceps*
Eastern Hognose Snake	*Heterodon platirhinos*
Plains Hognose Snake	*Heterodon nasicus*
Texas Gartersnake	*Thamnophis sirtalis*
Marcy's checkered Gartersnake	*Thamnophis marcianus*
Orange-striped Ribbonsnake	*Thamnophis proximus*
Family Viperidae	
Prairie Rattlesnake	*Crotalus viridis*
Western Diamondback	*Crotalus atrox*
Western Massasauga	*Sistrurus catenatus*
Frogs	
Family Ranidae	
BullFrog	*Lithobates [Rana] catesbeianus*
Plains Leopard Frog	*Lithobates [Rana] blairi*
Family Hylidae	
Clark's Chorus Frog	*Pseudacris clarkii*
Blanchard's Cricket Frog	*Acris blanchardi*
Family Scaphiopodidae	
Couch's Spadefoot	*Scaphiopus couchi*
Plains Spadefoot	*Spea bombifrons*
Family Bufonidae	
Woodhouse's Toad	*Anaxyrus [Bufo] woodhousii*
Texas Toad	*Anaxyrus [Bufo] speciosus*
Great Plains Toad	*Anaxyrus [Bufo] cognatus*
Western Green Toad	*Anaxyrus [Bufo] debilis*
Red-spotted Toad	*Anaxyrus [Bufo] punctatus*
Family Microhylidae	
Plains Narrow-mouthed Toad	*Gastrophryne olivacea*
Salamanders	
Family Ambystomatidae	
Barred Tiger Salamander	*Ambystoma tigrinum*
Likely species (not yet observed)	
Lesser Earless Lizard	*Holbrookia maculata*
Prairie Racerunner	*Aspidoscelis sexlineatus*
Graham's Crayfish Snake	*Regina grahamii*
Texas Brownsnake	*Storeria dekayi*
Texas Ratsnake	*Pantherophis obsoletus*
Central Plains milksnake	*Lampropeltis triangulum*
Texas Long-nosed Snake	*Rhinocheilus lecontei*

Table 4. Species of amphibians and reptiles occurring either on the Pushmataha WMA or in similar nearby habitats. Common names may vary among tables because of regionally described subspecies (which we do not recognize).

Common Name	Scientific Name
Turtles	
Family Trionychidae	
Spiny Softshell	*Apalone spinifera*
Family Chelydridae	
Common Snapping Turtle	*Chelydra serpentina*
Family Kinosternidae	
Eastern Mud Turtle	*Kinosternon subrubrum*
Stinkpot	*Sternotherus odoratus*
Family Emydidae	
Mississippi Map Turtle	*Graptemys kohnii*
Gulf Cooter	*Pseudemys concinna*
Eastern Box Turtle	*Terrapene carolina*
Red-eared Slider	*Trachemys scripta*
Lizards	
Family Phrynosomatidae	
Southern Plains Fence Lizard	*Sceloporus consobrinus*
Family Scincidae	
Little Brown Skink	*Scincella lateralis*
Southern Coal Skink	*Plestiodon anthracinus*
Five-lined Skink	*Plestiodon fasciatus*
Broad-headed Skink	*Plestiodon laticeps*
Family Teiidae	
Prairie Racerunner	*Aspidoscelis sexlineatus*
Snakes	
Family Colubridae	
Western Wormsnake	*Carphophis vermis*
Eastern Yellow-bellied Racer	*Coluber constrictor*
Prairie Ring-necked Snake	*Diadophis punctatus*
Eastern Hognose Snake	*Heterodon platirhinos*
Prairie Kingsnake	*Lampropeltis calligaster*
Speckled Kingsnake	*Lampropeltis getula*
Louisiana Milksnake	*Lampropeltis triangulum*
Eastern Coachwhip	*Masticophis flagellum*
Plain-bellied Watersnake	*Nerodia erythrogaster*
Northern Diamondback Watersnake	*Nerodia rhombifer*
Rough Greensnake	*Opheodrys aestivus*
Great Plains Ratsnake	*Pantherophis emoryi*

Texas Ratsnake	*Pantherophis obsoletus*
Brown Snake	*Storeria dekayi*
Northern Redbelly Snake	*Storeria occipitomaculata*
Flat-headed Snake	*Tantilla gracilis*
Texas Garter Snake	*Thamnophis sirtalis*
Rough Earth Snake	*Virginia striatula*
Family Viperidae	
Southern Copperhead	*Agkistrodon contortrix*
Western Cottonmouth	*Agkistrodon piscivorus*
Western Diamondback Rattlesnake	*Crotalus atrox*
Timber Rattlesnake	*Crotalus horridus*
Western Pygmy Rattlesnake	*Sistrurus miliarius*

Frogs

Family Ranidae	
Pickerel Frog	*Lithobates [Rana] palustris*
BullFrog	*Lithobates [Rana] catesbeianus*
Green Frog	*Lithobates [Rana] clamitans*
Southern Leopard Frog	*Lithobates [Rana] sphenocephalus*
Family Hylidae	
Blanchard's Cricket Frog	*Acris blanchardi*
Green Treefrog	*Hyla cinerea*
Gray Treefrog	*Hyla versicolor/chrysoscelis*
Spring Peeper	*Pseudacris crucifer*
Strecker's Chorus Frog	*Pseudacris streckeri*
Cajun Chorus Frog	*Pseudacris fouquettei*
Family Bufonidae	
American Toad	*Anaxyrus [Bufo] americanus*
Woodhouse's Toad	*Anaxyrus [Bufo] woodhousii*
Family Microhylidae	
Eastern Narrow-mouthed Toad	*Gastrophryne carolinensis*

Salamanders

Family Plethodontidae	
Many-ribbed Salamander	*Eurycea multiplicata*
Western Slimy Salamander	*Plethodon albagula*
Family Salamandridae	
Eastern Newt	*Notophthalmus viridescens*

Likely species (observed near the Pushmataha WMA)

Small-mouthed Salamander	*Ambystoma texanum*
Ouachita Dusky Salamander	*Desmognathus brimleyorum*
Southern Crawfish Frog	*Lithobates [Rana] areolatus*
Hurter's Spadefoot	*Scaphiopus hurteri*
Alligator Snapping Turtle	*Macrochelys temminckii*
Razor-backed Musk Turtle	*Sternotherus carinatus*
Eastern Collared Lizard	*Crotaphytus collaris*

Western Slender Glass Lizard	*Ophisaurus attenuatus*
Western Ribbon Snake	*Thamnophis proximus*
Banded Watersnake	*Nerodia fasciata*
Smooth Earth Snake	*Virginia valeriae*
Northern Scarlet Snake	*Cemophora coccinea*
Glossy Crawfish Snake	*Regina rigida*

Table 5. Full model results of Canonical Correspondence Analysis from species occurrence in drift-fence arrays versus habitat characteristics. Only the Atoka WMA showed significant effects of habitat on species occurrence.

First canonical axis	**eigenvalue**	**F ratio**	**P value**
Packsaddle WMA	0.264	2.912	0.1748
Atoka WMA	0.545	10.791	0.0001
Cookson WMA	0.220	0.000	1.0000

All canonical axes	**trace**	**F ratio**	**P value**
Packsaddle WMA	0.813	1.135	0.2154
Atoka WMA	0.849	1.799	0.0001
Cookson WMA	1.247	0.000	1.0000

Table 6. Contribution of habitat variables to distribution of amphibians and reptiles in drift-fence arrays on the Atoka WMA. P values < 0.05 are considered statistically significant. Total variation explained by the model was 84.9%.

Variable	Variation explained	% variation	F	P
Canopy	0.387/0.849	45.6	9.662	0.0001
Nearest tree	0.096/0.849	11.3	2.487	0.0010
Logs	0.092/0.849	10.8	2.485	0.0003
% litter	0.052/0.849	6.1	1.410	0.0829
Stems	0.043/0.849	5.1	1.185	0.2504
Tree diameter	0.034/0.849	4.0	0.942	0.5462
Burrows	0.036/0.849	4.2	0.981	0.4625
Rock distance	0.030/0.849	3.5	0.812	0.7135
Percent open	0.029/0.849	3.4	0.794	0.6626
Percent rock	0.020/0.849	2.4	0.524	0.9163
Ant mound	0.019/0.849	2.2	0.488	0.7965
Percent grass	0.011/0.849	1.3	0.270	0.9961
Percent logs	Doesn't improve fit			

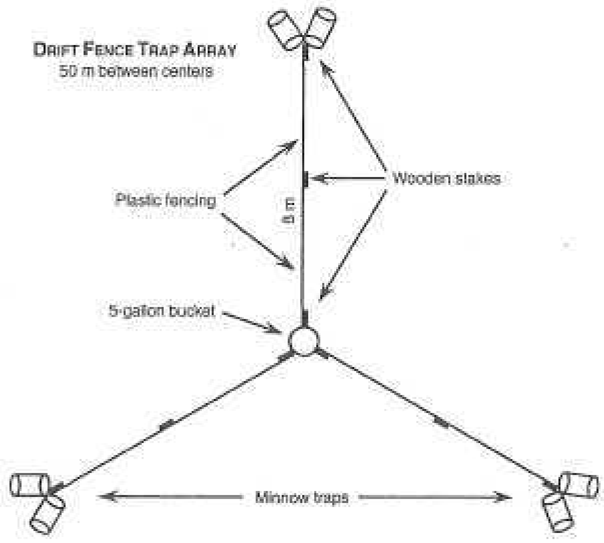


Figure 1. Typical drift fence array with central 5-gallon bucket sunk flush with ground, three wings constructed of plastic or vinyl fencing, and six minnow traps installed as pairs at the end of each fence.

Figure 2. Photograph of typical drift-fence array taken at the Packsaddle Wildlife Management Area.

Figure 3. (A) Species accumulation curve (blue triangles) for amphibians and reptiles collected or observed at Packsaddle WMA. Estimates of species numbers are based on actual data collected. Three different curves, Clench, exponential, and logarithmic are shown for comparison. In this case, The Clench model best fits the data.

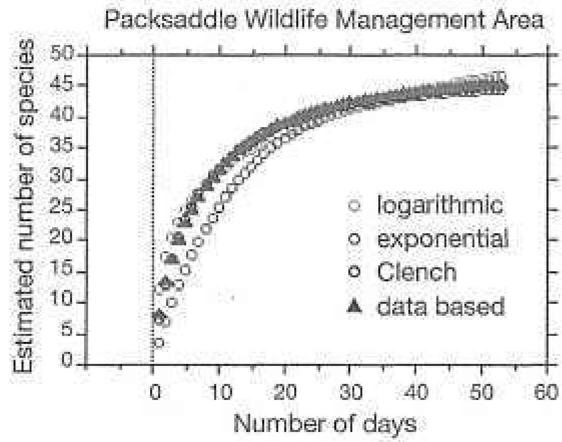


Figure 3. (B) Species accumulation curve (blue triangles) for amphibians and reptiles collected or observed at Atoka WMA. Estimates of species numbers are based on actual data collected. Three different curves, Clench, exponential, and logarithmic are shown for comparison. In this case, The logarithmic model best fits the data.

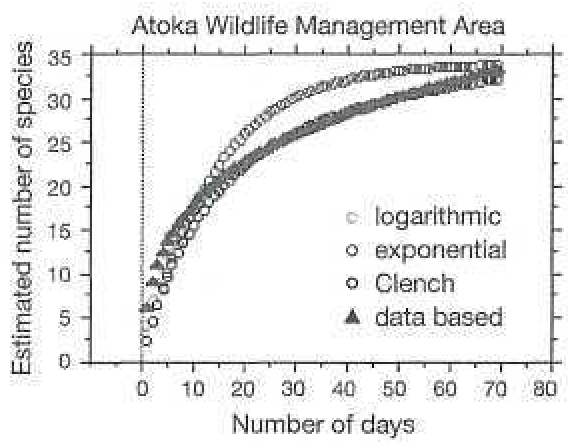
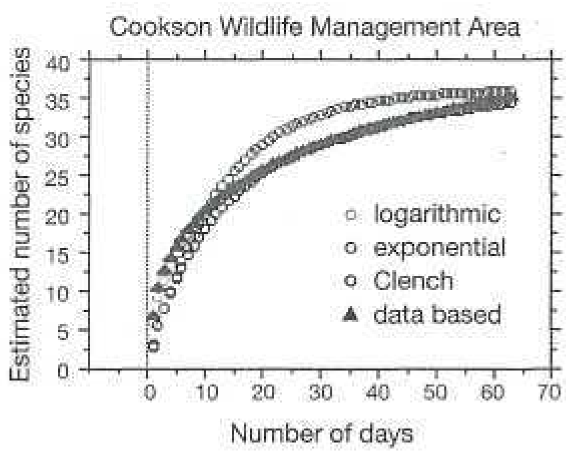


Figure 3. (C) Species accumulation curve (blue triangles) for amphibians and reptiles collected or observed at Cookson WMA. Estimates of species numbers are based on actual data collected. Three different curves, Clench, exponential, and logarithmic are shown for comparison. In this case, The logarithmic model best fits the data.



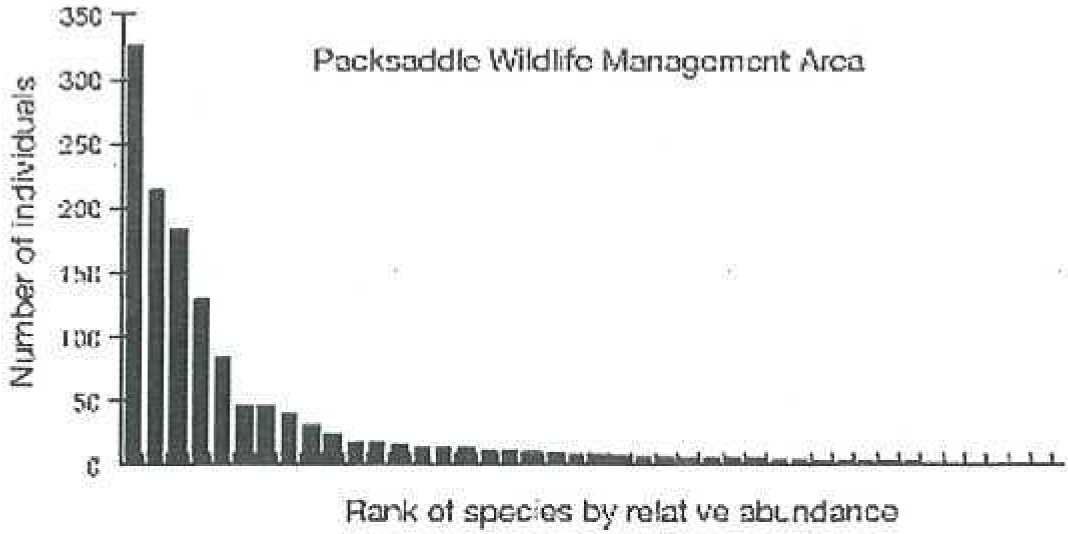


Figure 4. Relative abundance of amphibians and reptiles on the Packdsaddle WMA based on all combined trapping and collecting methods. Species are ranked from left to right as follow: *Aspidoscelis sexlineatus, Lithobates catesbeianus, Trachemys scripta, Sceloporus undulatus, Gastrophryne olivacea, Nerodia rhombifer, Phrynosoma cornutum, Coluber constrictor, Acris crepitans, Nerodia erythrogaster, Thamnophis proximus, Plestiodon obsoletus, Sistrurus catenatus, Anaxyrus woodhousii, Scincella lateralis, Masticophis flagellum, Leptotyphlops dulcis, Lithobates blairi, Thamnophis sirtalis, Spea bombifrons, Apalone spinifera, Kinosternon flavescens, Crotaphytus collaris, Lampropeltis calligaster, Tantilla nigriceps, Ambystoma tigrinum, Plestiodon septentrionalis, Rhinocheilus lecontei, Terrapene ornata, Arizona elegans, Diadophis punctatus, Hypsiglena torquata, Lampropeltis getula, Pituophis catenifer, Storeria dekayi, Chelydra serpentina, Ophisaurus attenuatus, Apalone mutica, Pantherophis obsoleta,* and *Regina grahami.*

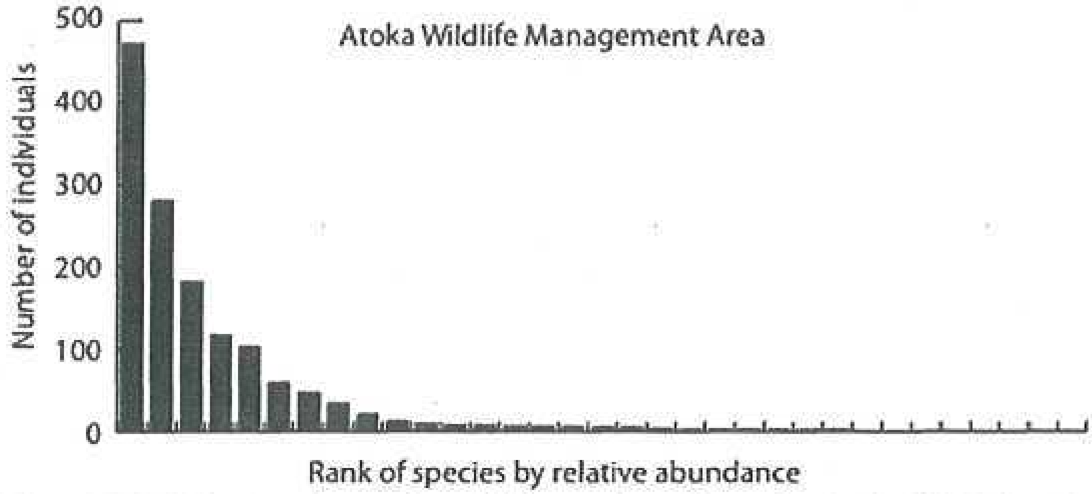


Figure 5. Relative abundance of amphibians and reptiles on the Atoka WMA based on drift-fence array data. Species are ranked from left to right as follow: *Anaxyrus americanus, Gastrophryne olivacea, Lithobates sphenocephalus, Sceloporus undulatus, Lithobates areolatus, Agkistrodon contortrix, Scincella lateralis, Aspidoscelis sexlineatus, Terrapene carolina, Plestiodon laticeps, Plestiodon fasciatus, Acris crepitans, Coluber constrictor, Lithobates clamitans, Notophthalmus viridescens, Lampropeltis getula, Lampropeltis triangulum, Storeria dekayi, Masticophis flagellum, Pantherophis obsoleta, Pseudacris triseriata, Heterodon platirhinos, Nerodia erythrogaster, Opheodrys aestivus, Virginia striatula, Gastrophryne carolinensis, Pseudacris streckeri, Terrapene ornata, Plestiodon anthracinus, Crotalus atrox, Pantherophis emoryi, Thamnophis proximus,* and *Virginia valeriae*.

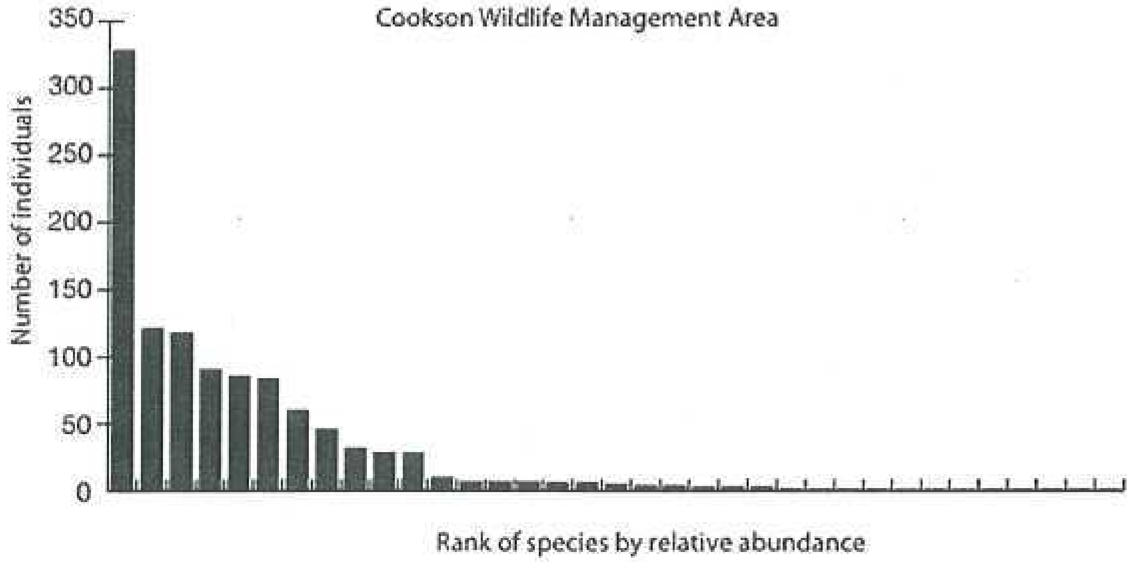


Figure 6. Relative abundance of amphibians and reptiles on the Cookson WMA based on drift-fence array data. Species are ranked from left to right as follow: *Anaxyrus americanus, Plestiodon laticeps, Agkistrodon contortrix, Lithobates clamitans, Sceloporus undulatus, Plestiodon fasciatus, Lithobates sphenocephalus, Gastrophryne carolinensis, Plethodon albagula, Lithobates palustris, Scincella lateralis, Pantherophis obsoleta, Ambystoma maculatum, Eurycea longicauda, Lampropeltis getula, Notophthalmus viridescens, Thamnophis sirtalis, Lampropeltis triangulum, Masticophis flagellum, Storeria occipitomaculata, Gastrophryne olivacea, Scaphiopus hurterii, Storeria dekayi, Crotalus horridus, Eurycea lucifuga, Nerodia erythrogaster, Crotalus atrox, Diadophis punctatus, Heterodon platyrhinos, Hyla versicolor, Pantherophis emoryi, Pseudacris crucifer, Tantilla gracilis, Terrapene carolina*, and *Virginia valeriae*.