The Southwestern Naturalist 53(4):480–487 December 2008

SHORT-TERM RESPONSE OF HERPETOFAUNA TO VARIOUS BURNING REGIMES IN THE SOUTH TEXAS PLAINS

Donald C. Ruthven, III,* Richard T. Kazmaier, and Michael W. Janis

Chaparral Wildlife Management Area, Texas Parks and Wildlife Department, P.O. Box 115, Artesia Wells, TX 78001 (DCR)
Department of Life, Earth, and Environmental Sciences, West Texas A&M University, Box 60808, Canyon, TX 79016 (RTK)
Matador Wildlife Management Area, Texas Parks and Wildlife Department, 3036 FM 3256, Paducah, TX 79248 (MWJ)
Present address of DCR: Matador Wildlife Management Area, Texas Parks and Wildlife Department, 3036 FM 3256, Paducah, TX 79248
**Correspondent: cruthven@caprock-spur.com*

Abstract—Data on effects of fire on herpetofauna generally are lacking. With increased use of prescribed fire to manage rangelands in South Texas for wildlife and livestock, a better understanding of effects of fire on the herpetofauna is needed. We investigated effects of combinations of winter and summer prescribed fire on rangeland sites on the Chaparral Wildlife Management Area in southern Texas. Dormant-season fires had little effect on diversity and abundance of the herpetofauna. Inclusion of growing-season fire into the burning regime tended to increase diversity and abundance of grassland species, such as the six-lined racerunner (*Cnemidophorus sexlineatus*). Although our experimental design limits interpretation of results to the study site, our data suggest that prescribed fire may be used to manage rangelands in South Texas without negative affects on the herpetofauna. A varied burning regime is recommended to increase herpetofaunal diversity.

Resumen—Información sobre el efecto del fuego en la herpetofauna generalmente es muy escueta. Con el aumento del uso de quemas prescritas para manejar pastizales del sur de Texas para la fauna silvestre y el ganado doméstico es necesario tener un mejor entendimiento del efecto del fuego en la herpetofauna. Investigamos el efecto de combinaciones de quemas prescritas de invierno y de verano en sitios del Chaparral Wildlife Management Area en el sur de Texas. Las quemas conducidas durante la estación latente tuvieron muy poco efecto en la diversidad y abundancia de los reptiles. La diversidad y abundancia de las especies de pastizal como la lagartija *Cnemidophorus sexlineatus* tendieron a aumentar con la adición de quemas durante la temporada de crecimiento. Aunque nuestro diseño experimental limita la interpretación de resultados al área de estudio, los datos sugieren que las quemas prescritas realizadas en terrenos del sur de Texas pueden ser implementadas sin efectos negativos en la herpetofauna. Se recomienda utilizar un régimen de quemas variado para aumentar la diversidad de la herpetofauna.

The Rio Grande plains of South Texas is the southern-most extension of the Great Plains grasslands. Fire, along with other climatic variables such as drought, presumably maintained the honey mesquite (*Prosopis glandulosa*) savannas and interspersed grasslands of pre-European settlement in South Texas (Scifres and Hamilton, 1993). Frequency of fire appeared to be highly variable and ranged from 5 to 30 years (Wright and Bailey, 1982). Following European settlement, suppression of fire combined with heavy grazing by livestock has lead to the current thorn woodlands common throughout southern Texas (Archer et al., 1988; Archer, 1994).

Beginning in the mid-20th century, landowners in South Texas began to convert thorn woodlands back to grasslands to enhance rangelands for livestock production. Mechanical treatments such as root plowing were commonly used methods for achieving this goal. Mechanical brush-manipulation practices can significantly reduce woody plant cover while increasing herbaceous vegetation (Scifres et al., 1976; Bozzo et al., 1992). However, upon recolonization by woody species, their diversity may be dramatically reduced (Fulbright and Beasom, 1987; Ruthven et al., 1993), which may negatively impact diversity of wildlife.

Land ownership and land-use practices in South Texas have changed in recent years. Size of individual landholdings has decreased and revenues derived from those properties have become increasingly dependent on wildlife rather than traditional livestock operations. Many wildlife-management programs are directed toward game species such as the white-tailed deer (*Odocoileus virginianus*) and northern bobwhite (*Colinus virginianus*). Prescribed burning in the Rio Grande plains of southern Texas can reduce brush cover while maintaining diversity of woody plants (Box and White, 1969; Ruthven et al., 2003), increase herbaceous vegetation for wildlife (Hansmire et al., 1988; Ruthven et al., 2000; Ruthven and Synatzske, 2002), increase bare ground, and decrease litter (Burrow, 2000; Ruthven et al., 2002*a*). As a result of these reported benefits, prescribed fire is recommended to enhance wildlife habitat on rangelands of South Texas (Guthery, 1986; Fulbright and Ortega-S., 2006).

Management and conservation of reptiles and amphibians generally has fallen behind other species (Scott and Seigel, 1992). Of particular concern, is the possible decline of amphibian populations (Blaustein and Wake, 1990; Pechmann and Wilbur, 1994), but recent observations suggest that reptile populations may be declining at a rate similar to amphibians (Gibbons et al., 2000). Although most herpetofauna appear to avoid direct impacts of fire (Means and Campbell, 1981; Floyd et al., 2002), there are concerns that hibernating reptiles in southern Texas, such as the Texas horned lizard (*Phrynosoma cornutum*), might suffer direct mortality from management activities, including prescribed fire (Fair and Henke, 1997). In xeric environments, reptiles that depend on open, early successional habitats can increase in abundance following fires (Mushinsky, 1985; Greenberg et al., 1994; Pianka, 1996).

Most investigations into effects of burning on herpetofauna are from Australia and forested environments of the eastern United States (Russell et al., 1999; Pilliod et al., 2003). In South Texas, dormant-season prescribed fire had a positive effect on the ecology of *P. cornutum* by increased rates of survival and greater abundance of prey (Burrow et al., 2002); yet, few data are available on effects of fire on other herpetofauna in the region. Objectives of this study were to investigate effects of various burning regimes on diversity and abundance of the herpetofauna, which would assist managment of wildlife resources on semiarid rangelands in the Tamaulipan Biotic Province.

MATERIALS AND METHODS—*Study Area*—The study area was on the Chaparral Wildlife Management Area (28°20′N, 99°25′W) in the western South Texas plains (Gould, 1975; Hatch et al., 1990) and northern portion of the Tamaulipan Biotic Province (Blair, 1950). Climate is characterized by hot summers and mild winters with an average daily minimum winter (January) temperature of 5°C, an average daily maximum summer (July) temperature of 37°C, and a growing season of 249–365 days (Stevens and Arriaga, 1985). Average annual precipitation is 54 cm with peaks occurring in late spring (May–June) and early autumn (September–October; Texas Parks and Wildlife Department, unpublished data).

Soils consist of Duval fine sandy loam, gently undulating, Duval loamy fine sand, 0–5% slopes, and Dilley fine sandy loam, gently undulating (Stevens and Arriaga, 1985; Gabriel et al., 1994). The Duval series are fine-loamy, mixed, hyperthermic Aridic Haplustalfs and the Dilley series are loamy, mixed, hyperthermic shallow Ustalfic Haplargids. Topography is nearly level to gently sloping and elevation is 168–180 m.

Plant communities are characteristic of the mesquite-granjeno (*Celtis pallida*) association (McLendon, 1991). Within this association are two primary communities, the mesquite-colima (*Zanthoxylum fagara*)-granjeno community, in which colima and bluewood brasil (*Condalia hookeri*) are the subdominants, and the mesquite-granjeno/hog-plum (*Colubrina texana*) community, in which hogplum is the subdominant. Woody plant canopy cover and dominant species composition was similar among study plots prior to application of burning treatments (Gabor, 1997). Prominent herbaceous species include Lehmann lovegrass (*Eragrostis lehmanniana*), an introduced perennial, hooded windmillgrass (*Chloris cucullata*), hairy grama (*Bouteloua hirsuta*), partridge pea (*Chamaecrista fasciculata*), and croton (*Croton*).

The study area had been grazed by domestic livestock since the 18th century (Lehmann, 1969). Cattle were the major species of livestock since about 1870, whereas sheep were grazed from about 1750 to 1870. Before 1969, grazing by cattle was continuous (G. Light, pers. comm.). From 1969 to 1984, cattle (cow-calf) were grazed yearlong using a four-pasture rotation system. In response to persistent drought conditions, grazing was discontinued on the entire study site in 1984. Grazing resumed in 1990 using stocker-class animals (two steers ≤ 227 kg = one animal unit) under a high-intensity, low-frequency, grazing system in which cattle, in two separate herds, rotated once through six pastures on each one-half of the area 1 October through 30 April. Stocking rates were considered low and averaged 15 animal-unit days (AUD) · ha^{-1} · year^{-1}. Beginning in autumn 1997, cattle were combined into one herd and rotated through the 12 pastures making up the core of the study area under light-to-moderate (15–25 AUD · ha^{-1} · year^{-1}) stocking rates.

Dormant-Season Burns—Three sites subjected to prescribed burns were paired with three untreated sites using a randomized-block design. Burned plots were located within larger areas (>40 ha) that had been burned. Rangeland fire in southern Texas typically produces a mosaic of burned and nonburned areas as a result of uneven fuel loads (Box and White, 1969). All burned plots received 100% coverage by burns. Study sites were burned during winter (December–February) 1997–1998 and again in winter 1999–2000. Study plots were ca. 2 ha in size. Burning conditions were similar among study plots and years (Ruthven et al., 2000, 2002*a*). Study plots and surrounding rangeland had no previous history of prescribed burning or wildfires, for ≥40 years.

We captured herpetofauna in drift fence-pitfall arrays as described by Ruthven et al. (2002*b*). Three arrays were installed on each study plot. Arrays were <100 m apart and from the edge of study plots. As spring and summer are peak activity periods for most herpetofauna on the study area (Ruthven et al., 2002*b*), each array was monitored for 13 days in spring (May–June) 1998, 7 days in summer (August) 1998, 14 days in spring 1999, and 21 days in spring 2000. Arrays were checked twice daily. Captured animals were identified to species, sex was determined when possible, and snout–vent and total lengths recorded. Lizards and amphibians were marked by toe clipping. Because of low rates of encounters, snakes were identified as recaptures by comparing snout–vent length. Species diversity was estimated with Shannon's index (Pielou, 1975). Scientific nomenclature and common names of reptiles and amphibians follow Dixon (2000).

Growing-Season Burns—Five sites subjected to prescribed burns were paired with five nontreated sites using a randomized-block design. Study plots were ca. 2 ha in size. Burned plots were located within larger areas (>40 ha) that had been burned. All study sites received 100% coverage by burns. Fire was applied to study plots and surrounding rangeland in August 1999 and burning conditions were similar among plots (Ruthven and Synatzske, 2002). Study plots and surrounding rangeland had been subjected to prescribed burning during winter (January–March 1997) under conditions similar to dormant-season, burned plots.

One drift fence-pitfall array was established in the center of each study plot and monitored for 14 days each during Spring 2000 and 2001 and Summer (July–September) 2000 and 2001. Data-collection methods followed those in the dormant-season plots.

Data Analyses—We analyzed burn data for summer using a two-way analysis of variance (ANOVA) with repeated measures (PROC GLM; SAS Institute, Inc., 1999). Treatment (burned or nonburned) was a between-subjects factor and year was a within-subjects factor. We also tested for a treatment-by-year interaction effect to indicate a possible differential response to time since burning. Response variables tested were the number of captures by species and taxonomic group, and computed diversity indices for each plot. We analyzed burn data for winter similarly, except we used average captures/day as response variables because sampling effort was not equal among all study plots. Standard errors and *P*-values are reported to facilitate interpretation of practical significance (Gould and Steiner, 2002). All statistical comparisons were considered significant at $P \leq 0.05$ with trends towards significance at $P \leq 0.1$.

We realize the implications of pseudoreplication (Hurlbert, 1984); however, Wester (1992) suggested that pseudoreplication is a matter of scale and that statistical analyses of single-treatment studies in which samples are taken within a relatively small area can be useful in assessing impacts of treatments. Although conclusions of these analyses were limited to the study site and may not be extrapolated to other populations, they may be helpful in explaining potential effects of temporal factors on results of this study.

RESULTS—*Dormant-Season Burns*—We captured 1,861 individuals representing 23 species during trapping sessions in 1998, 1999, and 2000 (Table 1). Great Plains narrowmouth toad (*Gastrophryne olivacea*) and Texas spotted whiptail (*Cnemidophorus gularis*) were the dominant species encountered making up 61 and 10% of total captures, respectively. Diversity did not exhibit ($P > 0.3$) a year or treatment-by-year interaction and was similar ($P = 0.824$) among burned (1.18 ± 0.08; mean ± *SE*) and nonburned (1.26 ± 0.09) plots. *Cnemidophorus gularis* ($P = 0.092$) and total number of lizards ($P = 0.084$) tended to be greater on nonburned plots (Table 1). Total captures of amphibians ($P = 0.022$) and lizards ($P = 0.005$), as well as abundance of Texas toads (*Bufo speciosus*; $P = 0.001$) was greatest in 1999 (Table 1). Total captures also tended ($P = 0.083$) to be greatest in 1999. The Great Plains skink (*Eumeces obsoletus*) was most abundant ($P < 0.001$) in 1998, whereas total captures of snakes ($P = 0.027$) was greatest in 2000. The six-lined racerunner (*Cnemidophorus sexlineatus*) exhibited a slight ($P = 0.094$) treatment-by-year interaction with greatest abundance on burned plots in 1998 (Table 1).

Growing-Season Burns—We encountered a total of 495 individuals representing 18 species during trapping sessions in 2000 and 2001 (Table 2). *Cnemidophorus gularis* and *G. olivacea* were the dominant species encountered making up 42 and 21% of total captures, respectively. Diversity did not show ($P > 0.5$) a year or treatment-by-year interaction, but generally was greater,

TABLE 1—Mean (± *SE*) captures per array day of herpetofauna on dormant-season burned ($n = 3$) and unburned sites ($n = 3$) on the Chaparral Wildlife Management Area, Dimmit and LaSalle counties, Texas, 1998–2000. Different letters within rows indicate differences ($P < 0.05$) among years.

	1998		1999		2000		*P*-values		
Herpetofauna	Burned	Unburned	Burned	Unburned	Burned	Unburned	Treatment	Year	Interaction
Amphibians									
Bufo debilis	0	0.02 (0.02)	0.33 (0.33)	0	0	0	0.395	0.426	0.394
Bufo speciosus	0.29[a1] (0.13)	0.32[a] (0.11)	2.31[b] (0.98)	2.48[b] (0.23)	0.29[a] (0.02)	0.14[a] (0.07)	0.973	<0.001	0.914
Bufo valliceps	0	0	0.02 (0.02)	0	0	0	0.374	0.410	0.410
Gastrophryne olivacea	5.11 (2.62)	2.95 (1.06)	3.26 (1.65)	3.98 (1.19)	3.28 (1.74)	2.30 (1.16)	0.733	0.233	0.163
Rana belandieri	0.02 (0.02)	0	0	0	0	0	0.374	0.410	0.410
Scaphiopus couchii	0.05 (0.05)	0	0	0	0.05 (0.05)	0	0.116	0.683	0.683
Total	5.46[a] (2.45)	3.29[a] (0.93)	5.93[b] (1.22)	6.45[b] (0.99)	3.62[a] (1.74)	2.43[a] (1.09)	0.638	0.022	0.355
Lizards									
Cnemidophorus gularis	0.60[a] (0.08)	0.56[a] (0.08)	0.17[b] (0.05)	0.43[b] (0.11)	0.52[a] (0.12)	0.79[a] (0.1)	0.092	0.013	0.233
Cnemidophorus sexlineatus	0.06 (0.04)	0	0.02(0.02)	0	0.03 (0.03)	0.02 (0.02)	0.350	0.214	0.094
Coleonyx brevis	0	0	0.02(0.02)	0	0	0	0.374	0.410	0.410
Eumeces obsoletus	0.17[a] (0.02)	0.17[a] (0.04)	0.02[b] (0.02)	0.07[b] (0.04)	0.05[b] (0.03)	0.09[b] (0.03)	0.472	<0.001	0.290
Phrynosoma cornutum	0.16 (0.06)	0.25 (0.07)	0.12 (0.02)	0.14 (0.14)	0.06 (0.04)	0.12 (0.04)	0.350	0.373	0.899
Sceloporus olivaceus	0.02 (0.02)	0.02 (0.02)	0	0.02 (0.02)	0.05 (0.03)	0.02 (0.02)	0.909	0.496	0.305
Sceloporus undulatus	0.08[ab] (0.02)	0.16[ab] (0.11)	0.02[a] (0.02)	0.10[a] (0.02)	0.20[b] (0.03)	0.36[b] (0.10)	0.102	0.029	0.784
Total	1.10[a] (0.10)	1.16[a] (0.21)	0.38[b] (0.06)	0.76[b] (0.02)	0.91[a] (0.18)	1.39[a] (0.19)	0.084	0.005	0.331
Snakes									
Arizona elegans	0.06 (0.03)	0	0	0	0	0	0.116	0.063	0.063
Heterodon nasicus	0.02 (0.02)	0.02 (0.02)	0	0	0	0	1.000	0.198	1.000
Hypsiglena torquata	0	0.02 (0.02)	0.02 (0.02)	0.05 (0.02)	0.03 (0.02)	0.02 (0.02)	0.562	0.361	0.567
Leptotyphlops dulcis	0.02 (0.02)	0.06 (0.06)	0	0.02 (0.02)	0.14 (0.07)	0.14 (0.09)	0.706	0.081	0.877
Masticophis flagellum	0.02 (0.02)	0	0	0	0	0	0.374	0.410	0.410
Rhinocheilus lecontei	0.03 (0.02)	0.03 (0.02)	0.05 (0.02)	0	0	0.02 (0.02)	0.411	0.331	0.156
Sonora semiannulata	0.03 (0.02)	0	0	0.02 (0.02)	0.08 (0.05)	0.05 (0.03)	0.593	0.215	0.568
Tantilla gracilis	0.02 (0.02)	0	0	0.02 (0.02)	0	0.02 (0.02)	0.417	0.952	0.394
Tantilla nigriceps	0	0	0	0.02 (0.02)	0.03 (0.02)	0	0.829	0.423	0.122
Thamnophis marcianus	0.02 (0.02)	0	0	0	0	0	0.374	0.410	0.410
Total	0.21[a] (0.02)	0.13[a] (0.08)	0.07[ab] (0.04)	0.14[ab] (0.04)	0.28[c] (0.05)	0.23[c] (0.05)	0.746	0.027	0.242
Total herpetofauna	6.76 (2.46)	4.57 (0.79)	6.38 (1.12)	7.36 (0.97)	4.81 (1.78)	4.05 (1.28)	0.740	0.083	0.288

TABLE 2—Mean (± *SE*) captures per array day of herpetofauna on growing-season burned ($n = 5$) and unburned sites ($n = 5$) on the Chaparral Wildlife Management Area, Dimmit and LaSalle counties, Texas, 2000–2001.

	2000		2001		*P*-values		
Herpetofauna	Burned	Unburned	Burned	Unburned	Treatment	Year	Interaction
Amphibians							
Bufo speciosus	1.8 (0.97)	0.6 (0.40)	0	0.2 (0.20)	0.364	0.080	0.237
Gastrophryne olivacea	5.2 (0.92)	8.4 (1.36)	2.8 (0.73)	4.2 (1.83)	0.131	0.025	0.473
Total	7.0 (1.61)	9.0 (1.58)	2.8 (0.73)	4.4 (1.73)	0.267	0.016	0.893
Lizards							
Cnemidophorus gularis	10.6 (1.54)	10.8 (2.35)	9.6 (2.06)	10.4 (1.25)	0.833	0.591	0.817
Cnemidophorus sexlineatus	4.8 (2.96)	0.4 (0.25)	4.6 (2.50)	0.2 (0.20)	0.123	0.850	1.000
Eumeces obsoletus	0.2 (0.20)	1.0 (0.45)	1.0 (0.32)	0.4 (0.25)	0.785	0.725	0.034
Eumeces tetragrammus	0	0.2 (0.20)	0	0	0.347	0.347	0.347
Phrynosoma cornutum	0.6 (0.40)	0	0.4 (0.25)	0.4 (0.25)	0.273	0.725	0.305
Sceloporus olivaceus	0	0.4 (0.40)	0.2 (0.20)	0.4 (0.40)	0.290	0.771	0.771
Sceloporus undulatus	3.6 (0.40)	2.0 (0.77)	2.4 (0.93)	1.8 (0.49)	0.124	0.360	0.508
Total	19.8 (1.62)	14.8 (2.71)	18.2 (1.32)	13.6 (1.81)	0.058	0.425	0.907
Snakes							
Heterodon nasicus	0	0	0.6 (0.40)	0	0.172	0.172	0.172
Hypsiglena torquata	0	0	0.2 (0.20)	0	0.347	0.347	0.347
Leptotyphlops dulcis	0.2 (0.20)	0.6 (0.25)	0.8 (0.37)	0.8 (0.58)	0.636	0.291	0.587
Rhinocheilus lecontei	0.2 (0.20)	0	0.2 (0.20)	0.2 (0.20)	0.545	0.608	0.608
Salvadora grahamiae	0.4 (0.25)	0	0	0	0.141	0.141	0.141
Sonora semiannulata	1.4 (0.68)	0.4 (0.25)	1.0 (0.32)	0.6 (0.25)	0.211	0.725	0.305
Tantilla gracilis	0.2 (0.20)	0	0.8 (0.37)	0.2 (0.20)	0.065	0.182	0.486
Tantilla nigriceps	0	0	0	0.2 (0.20)	0.347	0.347	0.347
Total	2.4 (0.87)	1.0 (0.45)	4.0 (0.63)	2.2 (0.97)	0.148	0.007	0.620
Total herpetofauna	29.2 (0.97)	24.8 (1.66)	24.8 (1.53)	20.2 (3.29)	0.081	0.040	0.958

although non-significant ($P = 0.115$), on burned (1.55 ± 0.06; mean ± *SE*) than nonburned (1.28 ± 0.01) plots. Abundance of lizards ($P = 0.058$), total captures of herpetofauna ($P = 0.081$) and flathead snakes (*Tantilla gracilis*; $P = 0.065$) tended to be greatest on burned plots (Table 2). Abundance of *C. sexlineatus* was greater, though non-significant ($P = 0.123$), on burned plots compared to unburned plots. Total captures ($P = 0.040$), total encounters of amphibians ($P = 0.016$), and abundance of *G. olivacea* was greatest in 2000 (Table 2). Snakes were encountered most commonly in 2001($P = 0.007$).

DISCUSSION—Prescribed-burning regimes incorporating both dormant-season and growing-season fire appeared to have little short-term effect on diversity of the herpetofauna and were consistent with other investigations (Keyser et al., 2004; Wilgers and Horne, 2006). Overall, abundance of lizards, snakes, and amphibians appeared unaffected by dormant-season fires. *Cnemidophorus gularis* showed slight decreases in abundance in response to winter burns, whereas *C. sexlineatus* demonstrated a positive response during the first year post burn in 1998. In contrast, inclusion of summer fires had little effect on *C. gularis*; yet encounters of *C. sexlineatus* were 10-times greater on burned sites compared to unburned areas. The positive response of *C. sexlineatus* to fire is similar to previous studies (Mushinsky, 1985; Greenberg et al., 1994). *Cnemidophorus sexlineatus* typically inhabits open, xeric habitats (Carpenter, 1959; Greenberg et al., 1994) and increases following fire are likely the result of increases in bare ground and reductions of woody plant cover, which occur following fire (Ruthven et al., 2002*a*, 2003). Little is known of the habitat preferences of *C. gularis*; however, it is a common denizen of South Texas shrublands. Prior to initiation of prescribed burning, *C. sexlineatus* rarely was encountered on the study area (Texas Parks and Wildlife Department, unpublished data). Fire suppression has been a driving factor in the conversion of grasslands and savannas in South Texas to thorn woodlands (Archer et al., 1988; Archer, 1994) and historically *C. sexlineatus* may have been the dominant teiid in this ecosystem.

In the tallgrass prairie of Kansas, prescribed fire can increase abundance of *P. cornutum* and *E. obsoletus* through changes in vegetational structure and increases in bare ground, which facilitate thermoregulatory activities (Wilgers and Horne, 2006). On our study area, previous studies have demonstrated that *P. cornutum* positively responds to prescribed fire by reductions in size of home range (Burrow et al., 2002). The lack of a treatment effect by *P. cornutum*, and possibly other species, in the present study may be a result of sampling methods. Reductions in size of home range may decrease vulnerability of certain species to be captured in drift fence-pitfall arrays.

Sampling methods limited most captures of snakes to diminutive species. However, rates of capture were relatively low making inferences about treatment effects difficult. Even so, four species (*Arizona elegans*, *Masticophis flagellum*, *Thamnophis marcianus*, *Salvadora grahamiae*) were encountered only on burned sites, whereas no species of snake was encountered solely on unburned plots.

Effects of prescribed fire on amphibians are highly variable (Pilliod et al., 2003). The lack of a treatment effect in this study was similar to that reported in semi-arid rangelands in Australia, where the fossorial nature of most amphibians appears to provide a degree of resilience to fire (Friend, 1993). *Gastrophryne olivacea* and *B. speciosus* are active burrowers and readily use burrows of other vertebrates and invertebrates as refugia. Friend (1993) also suggested that abundance of amphibians was more closely related to moisture than fire regimes. This may explain yearly variation in abundance that we observed that was associated with greater precipitation prior to and during sampling sessions in 1999 and 2000. Effects of fire on sedimentation of breeding ponds is also of concern (Pilliod et al., 2003); however, it is unclear how this process might affect the ephemeral ponds on which *G. olivacea* and *B. speciosus* depend for their reproductive cycle.

Most ecological investigations into the effects of habitat-altering practices are short-term, and as with this study, may not be of sufficient duration to accurately assess the full impacts of range-management practices such as prescribed fire. Long-term investigations into the response of lizards in Australia suggest most species exhibit an ebb and flow pattern following wildfire, which produces a mosaic of large burned landscapes with islands of unburned vegetation (Pianka, 1996). Species that predominate in early successional seres tend to increase following fire, whereas species that depend on later seral stages or climax vegetation decrease following fire. However, species that rely on later seral stages or climax vegetation persist on burned landscapes through retention of unburned areas and may later increase as succession progresses on burned areas. Prescribed fires on rangelands in South Texas typically produce a mosaic affect on the landscape (Box and White, 1969). Although study plots received 100% coverage by prescribed burns, adjacent burned areas produced a typical mosaic of burned and nonburned areas, which may have impacted our results. Braithwaite (1987) found that intensity of fire influenced post-fire selection of habitats by lizards and that a varied fire regime may increase overall diversity of lizards. The landscape of South Texas lends itself to varying degrees of fire intensity within a single burn. The herbaceous-dominated interspace between clusters of shrubs can produce low-intensity fires, while stands of volatile shrubs such as whitebrush (*Aloysia gratissima*) can produce high-intensity burns.

In the short-term, burning rangelands in South Texas during winter appears to have little affect on the herpetofauna, whereas fire in summer provided slight increases in diversity and an increase in abundance of grassland species. Our data suggested that land managers can use fire as a management tool without deleterious effects on herpetofaunal communities. We concur with the findings of Braithwaite (1987), that a mosaic of burning regimes may promote overall faunal diversity. Research investigating affects of land-use practices, such as prescribed fire, on herpetofauna lag behind other vertebrates (Friend, 1993; Russell et al., 1999; Pilliod et al., 2003). To fully understand impacts of prescribed fire on the herpetofauna of rangelands in South Texas, long-term research and monitoring of a wide variety of burning regimes with broader sampling methods to increase sample sizes and species encountered is warranted.

We thank J. Franco for the translation of the Spanish resumen.

Literature Cited

Archer, S. 1994. Woody plant encroachment into southwestern grasslands and savannas: rates, patterns and proximate causes. Pages 13–68 in Ecological implications of livestock herbivory in the West (M. Vavra, W. A. Laycock, and R. D. Pieper, editors). Society for Range Management, Denver, Colorado.

Archer, S., C. Scifres, C. R. Bassham, and R. Maggio. 1988. Autogenic succession in a subtropical savanna: conversion of grassland to thorn woodland. Ecological Monographs 58:111–127.

Blair, W. F. 1950. The biotic provinces of Texas. Texas Journal of Science 2:93–117.

Blaustein, A. R., and D. B. Wake. 1990. Declining amphibian populations: a global phenomenon. Trends in Ecology and Evolution 5:203–204.

Box, T. W., and R. S. White. 1969. Fall and winter burning of South Texas brush ranges. Journal of Range Management 22:373–376.

Bozzo, J. A., S. L. Beasom, and T. E. Fulbright. 1992. Vegetation responses to brush management practices in South Texas. Journal of Range Management 45:170–175.

Braithwaite, R. W. 1987. Effects of fire regimes on lizards in the wet-dry tropics of Australia. Journal of Tropical Ecology 3:265–275.

Burrow, A. L. 2000. The effect of prescribed burning and grazing on the threatened Texas horned lizard (*Phrynosoma cornutum*) in the western Rio Grande Plains. M.S. thesis, Oklahoma State University, Stillwater.

Burrow, A. L., R. T. Kazmaier, E. C. Hellgren, and D. C. Ruthven, III. 2002. The effects of burning and grazing on survival, home range, and prey dynamics of the Texas horned lizard in a thornscrub ecosystem. Pages 43–51 in Proceedings: the role of fire for nongame wildlife management and community restoration: traditional uses and new directions (W. M. Ford, K. R. Russell, and C. E. Moorman, editors). United States Department of Agriculture, Forest Service, Northeastern Research Station, General Technical Report NE-288:1–145.

Carpenter, C. C. 1959. A population of the six-lined racerunner (*Cnemidophorus sexlineatus*). Herpetologica 15:81–86.

Dixon, J. R. 2000. Amphibians and reptiles of Texas. Texas A&M University Press, College Station.

Fair, W. S., and S. E. Henke. 1997. Effects of habitat manipulations on Texas horned lizards and their prey. Journal of Wildlife Management 61:1366–1370.

Floyd, T. M., K. R. Russell, C. E. Moorman, D. H. Van Lear, D. C. Guynn, Jr., and J. D. Lanham. 2002. Effects of prescribed fire on herpetofauna within hardwood forests of the upper piedmont of South Carolina: a preliminary analysis. Pages 123–127 in Proceedings of the eleventh biennial southern silvicultural research conference (K. W. Outcalt, editor). United States Department of Agriculture, Forest Service, Southern Research Station, General Technical Report SRS-48:1–622.

Friend, G. R. 1993. Impact of fire on small vertebrates in mallee woodlands and heathlands of temperate Australia: a review. Biological Conservation 65: 99–114.

Fulbright, T. E., and S. L. Beasom. 1987. Long-term effects of mechanical treatments on white-tailed deer browse. Wildlife Society Bulletin 15:560–564.

Fulbright, T. E., and J. A. Ortega-S. 2006. White-tailed deer habitat: ecology and management on rangelands. Texas A&M University Press, College Station.

Gabor, T. 1997. Ecology and interactions of sympatric collard peccaries and feral pigs. Ph.D. dissertation, Oklahoma State University, Stillwater.

Gabriel, W. J., D. Arriaga, and J. W. Stevens. 1994. Soil survey of LaSalle County, Texas. United States Department of Agriculture, Washington, D.C.

Gibbons, J. W., D. E. Scott, T. J. Ryan, K. A. Buhlmann, T. D. Tuberville, B. S. Metts, J. L. Greene, T. Mills, Y. Leiden, S. Poppy, and C. T. Winne. 2000. The global decline of reptiles, déjà vu amphibians. BioScience 50:653–666.

Gould, F. W. 1975. The grasses of Texas. Texas A&M University Press, College Station.

Gould, W. R., and R. L. Steiner. 2002. Viewpoint: improving range science through the appropriate use of statistics. Journal of Range Management 55: 526–529.

Greenberg, C. H., D. G. Neary, and L. D. Harris. 1994. Effect of high-intensity wildfire and silvicultural treatments on reptile communities in sand-pine scrub. Conservation Biology 8:1047–1057.

Guthery, F. S. 1986. Beef, brush and bobwhites: quail management in cattle country. Caesar Kleberg Wildlife Research Institute Press, Kingsville, Texas.

Hansmire, J. A., D. L. Drawe, D. B. Wester, and C. M. Britton. 1988. Effects of winter burns on forbs and grasses of the Texas coastal prairie. Southwestern Naturalist 33:333–338.

Hatch, S. L., K. N. Gandhi, and L. E. Brown. 1990. Checklist of the vascular plants of Texas. Texas Agricultural Experiment Station MP-1655:1–158.

Hurlbert, S. H. 1984. Pseudoreplication and design of ecological field experiments. Ecological Monographs 54:187–211.

Kyser, P. D., D. J. Sausville, W. M. Ford, D. J. Schwab, and P. H. Brosew. 2004. Prescribed fire impacts to amphibians and reptiles in shelterwood-harvest oak-dominated forests. Virginia Journal of Science 55: 159–168.

Lehmann, V. W. 1969. Forgotten legions: sheep in the Rio Grande plain of Texas. Texas Western Press, El Paso.

McLendon, T. 1991. Preliminary description of the vegetation of South Texas exclusive of coastal saline zones. Texas Journal of Science 43:13–32.

Means, D. B., and H. W. Campbell. 1981. Effects of prescribed fire on amphibians and reptiles. Pages 89–96 in Prescribed fire and wildlife in southern forests (G. W. Wood, editor). Belle Baruch Forest Science Institute, Clemson University, Georgetown, South Carolina.

Mushinsky, H. R. 1985. Fire and the Florida sandhill herpetofaunal community: with special attention to response of *Cnemidophorus sexlineatus*. Herpetologica 41:333–342.

Pechmann, J. H. K., and H. M. Wilbur. 1994. Putting declining amphibian populations in perspective: natural fluctuations and human impacts. Herpetologica 50:65–84.

Pianka, E. R. 1996. Long-term changes in lizard assemblages in the Great Victorian Desert: dynamic habitat mosaics in response to wildfire. Pages 191–215 in Long-term studies of vertebrate communities (M. L. Cody and J. L. Smallwood, editors). Academic Press, San Diego, California.

Pielou, E. C. 1975. Ecological diversity. John Wiley and Sons, New York.

Pilliod, D. S., R. B. Bury, E. J. Hyde, C. A. Pearl, and P. S. Corn. 2003. Fire and amphibians in North America. Forest Ecology and Management 178: 163–181.

Russell, K. R., D. H. Van Lear, and D. C. Guynn, Jr. 1999. Prescribed fire effects on herpetofauna: review and management implications. Wildlife Society Bulletin 27:374–384.

Ruthven, D. C., III, and D. R. Synatzske. 2002. Response of herbaceous vegetation to summer fire in the western South Texas plains. Texas Journal of Science 54:195–210.

Ruthven, D. C., III, J. F. Gallagher, and D. R. Synatzske. 2000. Effect of fire and grazing on forbs in the western South Texas plains. Southwestern Naturalist 45:89–94.

Ruthven, D. C., III, J. F. Gallagher, and D. R. Synatzske. 2002*a*. Response of herbaceous vegetation to winter burns in the western South Texas plains: an observation. Texas Journal of Agriculture and Natural Resources 15:60–70.

Ruthven, D. C., III, T. E. Fulbright, S. L. Beasom, and E. C. Hellgren. 1993. Long term effects of root plowing on vegetation in the eastern South Texas plains. Journal of Range Management 46:351–354.

Ruthven, D. C., III, R. T. Kazmaier, J. F. Gallagher, and D. R. Synatzske. 2002*b*. Seasonal variation in herpetofauna abundance and diversity in the South Texas plains. Southwestern Naturalist 47:102–109.

Ruthven, D. C., III, A. W. Braden, H. J. Knutson, J. F. Gallagher, and D. R. Synatzske. 2003. Woody vegetation response to various burning regimes in South Texas. Journal of Range Management 56: 159–166.

SAS Institute, Inc. 1999. SAS/STAT user's guide. Version 8. Volume 2. SAS Institute, Inc., Cary, North Carolina.

Scifres, C. J., and W. T. Hamilton. 1993. Prescribed burning for brushland management: the South Texas example. Texas A&M University Press, College Station.

Scifres, C. J., J. L. Mutz, and G. P. Durham. 1976. Range improvement following chaining of South Texas mixed brush. Journal of Range Management 29: 418–421.

Scott, N. J., Jr., and R. A. Seigel. 1992. The management of amphibian and reptile populations: species priorities and methodological and theoretical constraints. Pages 343–368 in Wildlife 2001: populations (D. R. McCullough and R. H. Barrett, editors). Elsevier Applied Science, London, United Kingdom.

Stevens, J. W., and D. Arriaga. 1985. Soil survey of Dimmit and Zavala counties, Texas. United States Department of Agriculture, Washington, D.C.

Wester, D. B. 1992. Viewpoint: replication, randomization, and statistics in range research. Journal of Range Management 45:285–290.

Wilgers, D. J., and E. A. Horne. 2006. Effects of different burn regimes on tallgrass prairie herpetofaunal species diversity and community composition in the Flint Hills, Kansas. Journal of Herpetology 40:73–84.

Wright, H. A., and A. W. Bailey. 1982. Fire ecology. John Wiley and Sons, New York.

Submitted 20 August 2007. Accepted 1 May 2008.
Associate Editor was William I. Lutterschmidt.