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A One-year Study of the Species Diversity and Relative Abundance of Snakes and Lizards in the Jack Mountain Region of Hot Spring County, Arkansas

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Introduction

Reptiles make up a large component of the vertebrate ecosystem (Scaro et al., 1988), and some groups (i.e., lizards) have played an instrumental role in the development of community ecology (for review see Losos, 1994). However, in general, reptiles often have been overlooked as being important structural elements of biotic communities (Vitt, 1987; Scaro et al., 1988). For example, biomass production by lizards (Turner et al., 1976) and turtles (Iverson, 1982) may be equal or greater than that of birds or mammals in the same areas. In addition some snake species have been found to comprise over half of the food biomass delivered to nestling hawks (Grothe, 1992), and yet snakes as predators may consume a significant percentage of rodent populations (Diller and Johnson, 1988).

Characterizing the role of reptiles in ecological communities is critical for better understanding the biodiversity of ecosystems. Of the many different aspects of community ecology, the structural composition of organisms is a central theme (Andrewartha and Birch, 1954; James, 1994). On a cosmopolitan scale geographic location is one of the most important factors dictating species richness and diversity among reptiles (Pianka, 1985; Vitt, 1987). Although latitude may still have significant effects at the regional level (Brown and Parker, 1982; Vitt, 1987), as sampling areas get smaller many other factors (e.g., habitat, predation pressure, prey availability, and morphology) become increasingly significant (Pianka, 1986). Even though this tends to complicate one's ability to describe how species diversity is being influenced, describing local communities of organisms is important for developing more regional themes (Scott, 1982).

Although the general distribution ranges of reptiles in Arkansas have been documented (Hurter and Strecker, 1909; Dowling, 1956, 1957), detailed data regarding reptile abundance and diversity for specific small regions within Arkansas are lacking (notable exception, Schuier et al., 1972). Ecological studies of reptile communities have been carried out in nearby states such as Kansas (Fitch, 1967, 1982), Oklahoma (Force, 1930), and Texas (Ford et al., 1991), but the variable physiography of Arkansas make most of these data inapplicable. Therefore, ecological data documenting reptile composition and density of specific areas of Arkansas are needed to develop an accurate picture of regional species diversity (Stan Trauth, pers. comm.). The purpose of this study was to assess the composition, species diversity, and relative abundance of reptiles in a forested region along the southeastern most aspect of the Ouachita Mountain range (i.e., Jack Mountain region).

Materials and Methods

This project was conducted in the Jack Mountain range on approximately 27,000 acres owned by The Ross Foundation within Hot Spring County, Arkansas. The Jack Mountain range has north and south facing slopes with steep ridges and is located at the northern-most extent of southwest Arkansas's Gulf Coastal Plain.

Three specific sites approximately five km north of Bismarck, Hot Spring County, Arkansas were chosen to serve as sampling locations from March through October of 1995. The three sites were all fairly representative of typical oak-hickory-pine forest. However, considerable variation occurred between these three sites regarding elevation, topography, soil type, water drainage, and undercover vegetation. The three sampling sites are referred to as Needle's Eye, Turkey Trail, and Curl Creek.

Needle's Eye, the western most sampling site, is a high elevation ridge with an east/west orientation west of U.S. Highway 7. Two drift fences were placed near the top of the south-facing ridge at an elevation of approximately 350 m. One drift fence was erected parallel to the mountain's orientation in a flattened area at the top of the ridge. The other fence was placed so that it coursed down the south slope of the ridge. Numerous rocky outcroppings were present along the ridge's slopes. No significant standing water was within 2 km of the drift fences and the closest streams were ephemeral. In many regions near the top of the mountain the habitat was low, scrubby, and dry.

Turkey Trail is located east of U.S. Highway 7, approximately 4.5 km east of the Needle's Eye site. The

drift fences are located at an elevation of approximately 275 m between and near the bottom of the two east/west oriented ridges. The northern most of the two ridges is smaller and one drift fence was erected perpendicular to the ridge and on the south facing slope. The second drift fence was located near the bottom of the ridges and parallel with their orientation and an old dirt road. An ephemeral stream separated the two drift fences and drained into a permanent stream (Curl Creek) 1.3 km eastward. Here the soil was more mesic than near the ridge tops, and several salamander species were present (i.e., *Ambystoma annulatum, A. maculatum, Eurycea multiplicata, Hemidactylium scutatum* and *Plethodon albagula*).

The Curl Creek site is located next to its namesake along Land Camp Road (dirt road), approximately 6.5 km southeast of the Turkey Trail site. The elevation here is 145 m. This is a flat woodland containing a permanent stream that has a saltatory water flow with some areas being slow moving and others shallow and fast moving. The soil appeared to be a mixture of loamy sand and decaying vegetation, and several amphibian species were present. The canopy was low but thick; thus, the ground was completely shaded most of the day. One drift fence was placed parallel to and south of the creek. The second fence was located within 50 m of a plantation of 10-20 year old *Pinus taeda*.

Animals were live trapped using drift fences or by hand-capture techniques. Each drift fence consisted of a 33 m length of aluminum flashing 50 cm high. The flashing was buried up to 10 cm to form a metal fence that prevented reptiles from going under it. Funnel traps one m in length and 18 cm in diameter were constructed from 3.175 mm hardware cloth and contained a funnel leading into one or both ends (Fitch, 1951). Two traps were placed equidistance apart (11 m) along each side of the drift fence and one trap was placed at each end of the drift fence. Two drift fences were erected at each sampling site. Drift fences were situated perpendicular to each other and were approximately 60 m apart.

For each capture the trap location was recorded, the animal's snout-vent length and total length were measured to the nearest millimeter (for large snakes the nearest centimeter); animals were massed to the nearest gram (for small snakes and lizards the nearest tenth gram) using Pensola spring scales, identified to sex visually or by everting hemipenes, and given a unique mark for recapture identification purposes. Snakes had the ventral scales clipped and lizards were toe clipped, both following a numerical pattern. Immediately after processing, animals were released in the vicinity of their capture location.

Total numbers of species (not including recaptures) from each site were recorded and used to calculate Shannon's indices of species diversity and evenness (Krebs, 1989). Recaptures were not sufficient to determine densities. For the most common snake species and all the lizard species, relative abundances of each site and all sites combined were calculated. Seasonal variation in abundance was calculated for all lizard species and the five most numerous snake species. For the latter calculation, numbers of species were totaled for each month, and recaptured individuals were counted a maximum of once per month to prevent any sampling bias.

Results

A total of 465 individuals from 29 snake and lizard species were captured, processed, and released from the three sampling sites. At each site there were more snakes species than lizard species. However, the number of individuals, regardless of species number, was greatest for the lizards at each site (Tables 1 and 2).

The abundance, species diversity, and evenness of snakes and lizards at all three sampling sites are given in Tables 1 and 2, respectively. For snakes Curl Creek had the highest diversity and evenness values of the three sites but the lowest number of individuals. Turkey Trail had the same number of species as Curl Creek but had a lower diversity and evenness. Needle's Eye contained the greatest number of species but diversity and evenness was low because of the disproportionate dominance by one or two species.

Needle's Eye and Turkey Trail each had seven lizard species while Curl Creek had six (Table 2). The greatest number of individuals was found at Needle's Eye which had a comparably low diversity and the lowest evenness. Turkey Trail had the highest diversity and evenness values and was intermediate in number of individuals. As with the snakes, Curl Creek had the least number of individual lizards but a high diversity and evenness.

Analyses of species composition and relative abundance revealed that *Agkistrodon contortrix* made up 30% of the snake community at Turkey Trail. *Diadophis punctatus* and *Thamnosphis sirtalis* were the dominant snake species at Needle's Eye and the second and fourth most abundant species, respectively, at Turkey Trail (Table 1). Although *Coluber constrictor* was an abundant snake at Turkey Trail and Curl Creek, only one was found at Needle's Eye. *Masticophis flagellum* was abundant at Needle's Eye but absent from the other sites. Other common species at Curl Creek were *A. piscivorus* and *Storeria dekayi*. The ubiquitous distribution of *A. contortrix, D. punctatus, T. sirtalis, C. constrictor,* and *S. dekayi* helps make them the five most common snake species in the Jack Mountain region. Four of these five species were most often captured during the late spring and early summer (Fig. 1) with only *D. punctatus* showing a small peak of activity in the fall.

Table 1. Abundance and species diversity of snakes at three sites on Ross Foundation property in Hot Spring County, Arkansas. Recaptured snakes are not included.

Species	Common Name	Needle's Eye	Turkey Trail	Curl Creek	Total
Agkistrodon contortrix	Copperhead	6	19	6	31
Agkistrodon piscivorus	Cottonmouth		2	5	7
Carphophis vermis	Western Worm Snake	5	3		8
Cemophora coccinea	Scarlet Snake	1		1	2
Coluber constrictor	Southern Black Racer	1	7	6	14
Diadophis punctatus	Ringneck Snake	26	8	2	36
Elaphe guttata	Corn Snake	2			2
Elaphe obsoleta	Black Rat Snake			2	2
Heterodon platirhinos	Eastern Hognose Snake	4		2	6
Lampropeltis calligaster	Prairie Kingsnake			2	2
Lampropeltis getula	Speckled Kingsnake	2	3	1	6
Lampropeltis triangulum	Louisiana Milk Snake	3	1	1	4
Masticophis flagellum	Coachwhip	7			7
Nerodia erythrogaster	Yellowbelly Watersnake		1	3	4
Nerodia sipedon	Midland Watersnake		1		1
Opheodrys aestivus	Rough Green Snake	1	3	2	6
Sistrurus miliarius	Western Pygmy Rattlesnake	3			3
Storeria dekayi	Brown Snake	4	3	4	11
Storeria occipitomaculata	Redbelly Snake	1	3	3	7
Tantilla gracilis	Flathead Snake	3			3
Thamnophis sirtalis	Eastern Garter Snake	14	7	3	24
Virginia valeriae	Smooth Earth Snake	6	1		7
Number of Individuals		89	62	42	193
Number of Species		17	14	14	22
Shannon Diversity Index (H')		2.39	2.23	2.50	2.66
Eveness (J')		0.84	0.85	0.95	0.86

Captures of *C. constrictor* were relatively high from March throughout June but dropped off in the late summer and fall. *Storeria dekayi* never showed any major peak of abundance but seemed relatively common at a low level throughout the sampling period.

The most obvious feature of lizard abundance was that at both Needle's Eye and Turkey Trail *Sceloporus undulatus* and *Scincella lateralis* were the dominant species (Table 2), and comprised 55% of the total lizards for all sites combined. At Turkey Trail the remaining four species appeared in approximately equal numbers, while at Needle's Eye *Eumeces laticeps* was the third most common lizard and *Cnemidophorus sexlineatus* was the least abundant. At Curl Creek, *S. undulatus* and *S. lateralis* again were common, and equally abundant were *E. laticeps* and *C. sexlineatus*. Also, *E. anthracinus* was not found at Curl Creek but was the third and fourth most common species at Turkey Trail and Needle's Eye, respectively. Although *Anolis carolinensis* and *E. fasciatus* were ubiquitous in this region, they occurred in the lowest number at each site.

Monthly variation in lizard abundance (Fig. 2) shows distinct differences in periods of activity. *Eumeces anthracinus*, and *E. fasciatus* exhibit peaks of abundance in the early spring and taper off through the summer and fall. The latest to be captured were *C. sexlineatus* which showed a short peak in May and June. *Eumeces laticeps* exhibit a long period of activity that lasts throughout the summer. Two lizards exhibiting bimodal periods of abundance were *S. undulatus* and *S. lateralis* with a long active period in the spring and early summer and smaller peak in September. *Anolis carolinensis* peaks slightly in April and remained stable at low levels throughout the summer.

Discussion

The species richness of snakes and lizards from all

Table 2. Abundance and species diversity of lizards at three sites on Ross Foundation property in Hot Spring County, Arkansas. Recaptured lizards are not included.

Species	Common Name	Needle's Eye	Turkey Trail	Curl Creek	Total
Anolis carolinensis	Green Anole	10	10	2	22
Cnemidophorus sexlineatus	Six-lined Racerunner	2	9	4	15
Eumeces anthracinus	Coal Skink	15	14		29
Eumeces fasciatus	Five-lined Skink	9	8	1	18
Eumeces laticeps	Broadhead Skink	25	10	4	39
Sceloporus undulatus	Fence Lizard	45	26	7	78
Scincella lateralis	Ground Skink	40	28	3	71
Number of Individuals		146	105	21	272
Number of Species		7	7	6	7
Shannon Diversity Index (H')		1.67	1.82	1.65	1.77
Eveness (J')		0.86	0.94	0.92	0.91

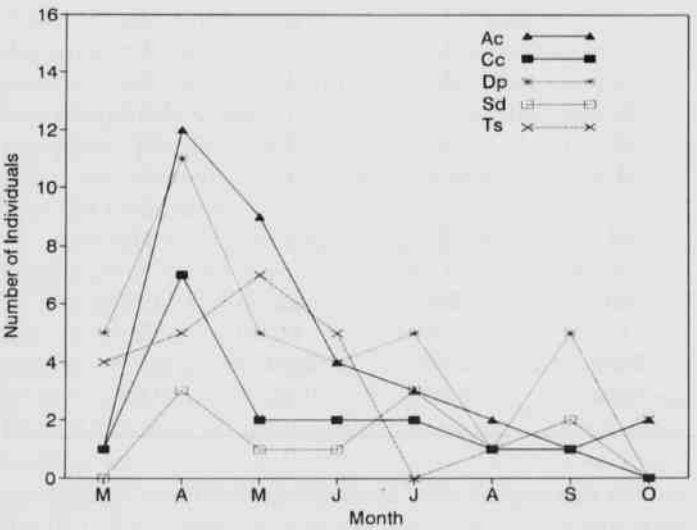

Fig. 1. Monthly variation in the five most abundant snakes (N = 122) captured in drift fences and by hand from the three sampling sites in Hot Spring County, Arkansas. Recaptured individuals were counted a maximum of once per month. Letters in legend abbreviate species names.

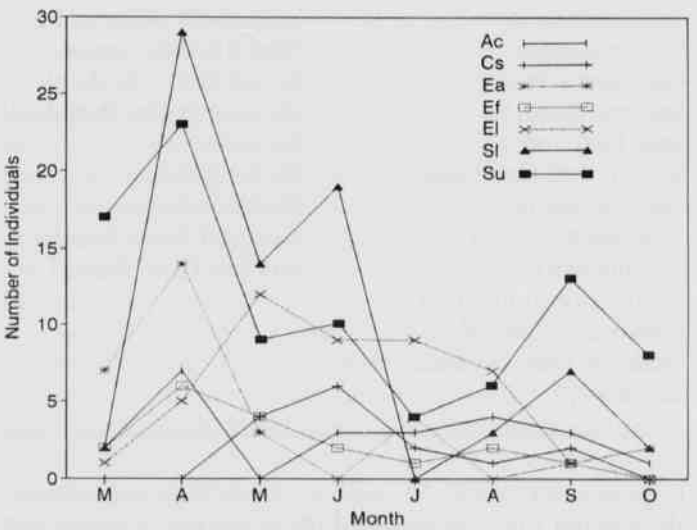

Fig. 2. Monthly variation in the number of lizards (N = 297) captured in drift fences and by hand from the three sampling sites in Hot Spring County, Arkansas. Recaptured individuals were counted a maximum of once per month. Letters in legend abbreviate species names.

three sampling sites falls within expected ranges for this latitude and region (Pianka, 1986; Vitt, 1987; Conant and Collins, 1991). The number of snake species (22) is above the mean predicted value for this latitude (18; Vitt, 1987). The total number of lizard species listed as occurring in this general area of Arkansas is eight (Conant and Collins, 1991). Seven lizard species were found to occur at Needle's Eye and Turkey Trail and six species were found at Curl Creek (Table 2). Snake species diversity at each site was high compared to 10 North American studies (H' = 1.32; Brown and Parker, 1982). Species diversity for this study (H' = 2.2 - 2.5) also was considerably higher than comparable data from both temperate and tropical snake communities at latitudes similar to Arkansas' (H' = 1.2; Vitt, 1987). Lizard diversity of this region (H' = 1.6 - 1.8) falls within previously observed values for lizard studies, but compared to 12 lizard studies in western North America (H' = 3.2) summarized in Pianka (1986) they are relatively low. Unfortunately, comparable data sets from nearby deciduous woodland regions are uncommon (notable exceptions, Force, 1930; Fitch, 1967; Schuier et

al., 1972). However, these exceptions are mostly lists of species and did not have standardized sampling methods; thus, species diversity calculations could not be completed. Force's (1930) study encompassed an entire county in eastern Oklahoma and resulted in 12 lizard species, and Fitch's (1967) study on a 239 ha preserve in southeast Kansas documented seven lizard species. The one Arkansas study, Schuier et al. (1972), sampled 170,000 acres in the north central region and found six lizard species and 19 snakes species similar to this study. Consistency in snake relative abundance for many of the same species is seen in a twelve year study from Kansas (Fitch, 1992) which reported the four most commonly captured snakes to be *Diadophis punctatus, Coluber constrictor, Thamnophis sirtalis,* and *Agkistrodon contortrix,* matching this study's four most captured species.

A few species known to occur in this general region of Arkansas (Conant and Collins, 1991) were not captured in this survey. *Crotalus horridus* is well documented to occur in this region but was not trapped or seen during this study. Other snakes expected but not captured were *Virginia striatula* and *Thamnophis proximus*. Although a total of 193 snakes were captured, biases may have existed from trapping terrestrially active species, and arboreal, aquatic, and semi-fossorial species may be underrepresented. Conversely, arboreal species (*Elaphe obsoleta* and *Opheodrys aestivus*), aquatic snakes (*Nerodia* sps.), and semi-fossorial species (*Tantilla gracilis, Carphophis vermis,* and *Cemophora coccinea*) were captured in funnel traps, albeit in low numbers. A variety of sampling methods is useful in preventing the bias of one sampling method (Fitch, 1992). However, by using a small mesh hardware cloth for funnel traps and making sure the drift fence was buried a few cm, we were successful at capturing individuals of all sizes.

The only lizard expected but not captured was *Ophisaurus attenuatus*. This species is more typically found in open grassy areas (Fitch, 1967). Grassy habitats were not present in this study region but are abundant a few km to the south, such as at DeGray Lake State Park (Glenda Pryor, pers. comm.) which is 16 km south of this study region. All lizard species except *Eumeces anthracinus* which was not captured at Curl Creek occurred at all three sites. It is possible that *E. anthracinus* occurs in the Curl Creek region in low numbers, as only 21 lizards were captured at this site.

Several of the snake species did not exhibit a clear general distribution throughout this region because they were found at only one of the three sites. For example, Curl Creek was the only site at which *Elaphe obsoleta* and *Lampropeltis calligaster* were found. *Elaphe obsoleta* is a well known habitat generalist but is highly arboreal; this trapping bias may have influenced its capture. *Lampropeltis calligaster* is not arboreal; however, it does not tend to prefer more open areas which are prevalent beyond 2 km south of Curl Creek. Snakes only found at Needle's Eye were *T. gracilis, M. flagellum, S. miliarius* and *E. guttata*. The restricted distribution of *T. gracilis* and *M. flagellum* is most likely related to habitat and/or prey base. Both of these snakes prefer environments that are relatively open and attain warm daytime temperatures. Steep rocky hillsides with loose dry to slightly moist soil is typical for *T. gracilis* while the dry, open scrub habitat along the ridge top is typical for *M. flagellum* (Tennant, 1985). Also, *M. flagellum* is primary prey, lizards (Jones and Whitford, 1989), were numerous at Needle's Eye. The absence of the regionally abundant *C. constrictor* with similar body morphology and physiology (Ruben, 1976, 1977) and similar hunting style suggests that their non-overlapping distributions may, in part, be to avoid competition. However, one of the authors (VAC) has observed both species within the same locality of the Ouachita National Forest. *Sistrurus miliarius* and *E. guttata*, although only captured at Needle's Eye, are known to occur in regions near Turkey Trail and Curl Creek, respectively. In addition one road-killed *E. guttata* was found on Land Camp Road, which is adjacent to the Curl Creek site and approximately four km west of the actual trapping site; it was not included in the calculations.

The greatest number of individuals was found at Needle's Eye while Curl Creek had the least numbers. Lizards at Needle's Eye were seven times more abundant than at Curl Creek, and the number of snakes at Needle's Eye was twice that of Curl Creek. Turkey Trail was intermediate in numbers of individuals for both snakes and lizards. Because our trapping intensity was comparable for the three sites, these differences were surprising. A study of the snake community at a small reserve in East Texas found a lowland floodplain to have significantly more individuals than either an upland deciduous or coniferous habitat (Ford et al., 1991). Possibly there were some indigenous characteristics of the habitats that facilitated these differences. Extrinsic factors such as the level of human activity also may play an important role. Needles's Eye and Turkey Trail regions received considerably less human activity than did Curl Creek which was near a regularly traveled dirt road.

Most species were captured in the spring and early summer. The total number of species captured was greatest in May and steadily declined until late summer after which the number remained at a relatively low level through October, similar to levels in March when species were first emerging from hibernation. Several species followed this trend, but some exhibited a variety of patterns such as bimodal seasonality in *Scincella lateralis* to plateaus of seasonal activity as in *Eumeces laticeps* and *Storeria dekayi*. A variety of abiotic factors (e.g., rainfall, moisture levels, and temperature) are known to influence

reptile activity; however, spring activity in temperate reptiles also may be associated with biotic factors such a mating. Biotic factors were not measured during this study; but, courtship behaviors were observed for some species. In mid April *S. lateralis* was observed mating at Needle's Eye. Indirect evidence of mating behavior in mid May was a two week surge of male *E. laticeps* being captured in traps and sometimes multiple males in a trap with a single female. The general decline in captures was most likely due to the heat and drought of summer conditions. Comparisons of seasonal activity showed strong agreement for *Coluber constrictor* and *Diadophis punctatus* in South Carolina (Gibbons and Semlitsch, 1987) and for *Agkistrodon contortrix* in Texas (Ford et al., 1991). Activity of *S. dekayi* from South Carolina indicated greater activity in the fall which was not seen in this study. Because of low capture numbers for many species in this study, comparisons could be misleading.

Overall, these data suggest that species richness and diversity in this region of Arkansas is relatively high, and that small geographic localities can possess a large number and diverse group of reptile species. This study also emphasizes the need for more thorough studies to be conducted in Arkansas in order to develop generalities regarding reptile diversity and abundance with regard to habitat types and other geographic features (Owen and Dixon, 1989). Even intensive one-year samplings may reveal general patterns within reptile communities. Although land management implications are not mentioned here, the general importance of understanding the significant role of reptiles in the biotic community is critical to enable land managers to make more informed and more environmentally sensitive decisions.

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A Mail Survey to Determine the Status of the Black-tailed Jackrabbit, Ringtail Cat, Long-tailed Weasel, Badger and Eastern Spotted Skunk in Arkansas

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Surveys have long been used as a tool in wildlife management studies (e.g., Filion, 1980). In Arkansas, Bailey and Heidt (1978) used mail surveys to determine the status and distribution of the nutria *(Myocastor coypus)*. More recently, Blumberg (1993) used surveys to examine present mammal distributions in South Dakota.

Heidt et al. (1996) discussed a number of mammals in Arkansas for which little information is known. To supplement these data we employed a mail survey to document five of the more well known of those conspicuous species: the black-tailed jackrabbit *(Lepus californicus)*, ringtail *(Bassariscus astutus)*, long-tailed weasel *(Mustela frenata)*, badger *(Taxidea taxus)*, and eastern spotted skunk *(Spilogale putorius)*.

The basic questionnaire format used in this survey included a brief introduction and statement of purpose. A table format was used for responses; counties within the state were listed individually, as were species of interest to the survey. A list of possible responses was provided; A- abundant, C-common, E-extirpated, H-suitable habitat present, N-not historically present and P-present. A separate section for responses dealing with wildlife management areas was provided as was a section for comments. The survey sent to trappers differed slightly in that we asked if they would be willing to save specimens that they trapped during the year. Because of subjective opinions, we feel that in the future, respondents should not be asked to supply data on the abundance or history of a species. If possible, it might also be useful to include descriptions or pictures of the species in question.

A total of 274 surveys with self addressed stamped envelopes were mailed statewide in the spring and summer 1995 to selected state biologists (Arkansas Game and Fish, U.S. Forest Service, and timber company biologists) and members of the Arkansas Trapper's Association. Of these, 116 were returned for a total return rate of 42.3% (142 and 61 for biologists, and 132 and 55 for trappers). Response rates for mail surveys are largely determined by the group surveyed, length of survey and whether or not a stamped return envelope is provided (Linsky, 1975). The individual response rate of 42.9% for biologists was somewhat lower than those reported by Blumberg (1993); however, the 41.6% response rate by the Arkansas trappers was higher. The combined response rate for this survey was higher than that of Blumberg's survey and higher than most surveys of this type audience conducted without follow-up (Kanuck and Berenson, 1975).

The range of the black-tailed jackrabbit *(Lepus californicus)* is restricted to 8 northwest counties in Arkansas with specimens only recorded from Benton and Washington counties (Sealander and Heidt, 1990). Most responses were within the expected range (Table 1). Some respondents indicated that they had seen the black-tailed jackrabbit in the past, but not in recent years. We are skeptical of responses for 2 counties, Calhoun and Pike because of their distance from the known range of jackrabbits and the possibility that swamp rabbits *(Sylvilagus aquaticus)* may have been mistaken for jackrabbits. Multiple responses were consistent with reported specimen counties.

Table 1. Survey response for black-tailed jackrabbit *(Lepus californicus)*

County	Trappers Association	State Biologists	Reported Specimens
BENTON	R,P	R	X
CALHOUN		C	
CRAWFORD	R	R	
FRANKLIN	P,R		
HOWARD	P		
JOHNSON	P		
LOGAN	P		
MADISON	R	R	
MARION	P		
MONTGOMERY		C	
PIKE	P		
SEBASTIAN	R		
WASHINGTON	R,P		X

A=Abundant C=Common R=Rare
P=Present, species status unknown
x=Actual Specimens

The ringtail *(Bassariscus astutus)* appears to be a rare and elusive mammal in Arkansas. However, based on one record and other sightings Sealander and Heidt (1990) proposed the range to include the eastern two-thirds of the Gulf Coastal Plain. The survey response for Polk and Howard counties was provided by a trapper who gave detailed accounts of his sightings as well as a description of a ringtail having been killed by a hunting dog. Other numerous sightings were reported in and around Sebastian County (Table 2). Suitable habitat exists in the