HERPETOLOGICAL HABITAT RELATIONS IN THE OUACHITA MOUNTAINS, ARKANSAS

Doyle L. Crosswhite, Stanley F. Fox, and Ronald E. Thill[1]

Abstract—We studied habitat relationships of the herpetofauna inhabiting managed pine-oak woodlands of the Ouachita Mountains, Arkansas. We used drift fence arrays with pitfall and double-ended funnel traps to sample two replications each of three treatments: young clearcuts, selectively harvested stands, and late-rotation untreated controls. Our objectives were to compare herpetofaunal communities among these treatments and to quantify habitat relationships. Ninety-one days of trapping over two field seasons yielded 633 captures representing 35 species. Canonical correspondence analysis indicated that species composition differed significantly among treatments. The most distinct separation of species groups was between reptiles and amphibians; reptiles were far more abundant in the young, xeric clearcuts, while amphibians were most abundant in the other two treatments. Four habitat parameters (canopy coverage, litter depth, woody plant cover, and large, woody debris) explained much of the variation in species composition among sample sites. Several species showed clear preferences for particular habitats.

INTRODUCTION

Several geographical and geological factors have contributed to the unique fauna and flora of the Interior Highlands of Arkansas, Oklahoma, and Missouri. Unlike the Southwestern United States, the Interior Highlands were not covered by shallow inland seas during the Cretaceous period (Dowling 1956); consequently, these highlands served as an island refuge. The region also may have served as a refuge for plants and animals during the Pleistocene epoch when glaciers covered adjacent northern regions and the formation of the Arkansas River divided the region into the Ozark Mountains to the north and the Ouachitas to the south (Dowling 1956). During the late Cenozoic era, sediments that had been deposited by inland seas were eroded, further defining boundaries and isolating the uplift.

The Ouachita uplift has unique habitats that supports a rich flora and fauna, including more than a dozen endemic plant species (Mohlenbrock 1993). The herpetofauna is also rich, with high species densities of both reptiles and amphibians (Kiester 1971). Reptile faunal assemblages are more or less representative of adjacent regions and no endemic species are found within the uplift. Frogs and toads, which are relatively mobile, also are not represented by endemic forms. Salamanders, however, are represented by five endemic species, and several endemic subspecies (Connant and Collins 1998).

Many of the species of reptiles and amphibians in the Ouachitas are relatively uncommon and some are considered threatened due to limited distributions or low population densities. Ashton (1976), Black (1977), and Reagan (1974) list the following as rare or threatened: *Amphiuma tridactylum*, three-toed amphiuma, *Ambystoma annulatum*, ringed salamander, *Ambystoma talpoideum*, mole salamander, *Plethodon ouachitae*, Rich Mountain salamander, *Plethodon caddoensis*, Caddo Mountain salamander, *Hyla avivoca*, bird-voiced tree frog, *Cemophora coccinea*, scarlet snake, and *Terrapene ornata*, ornate box turtle.

Two silvicultural systems are employed in the region: even-aged management (e.g., clearcutting) and selective harvesting. With clearcutting, all or most of the trees are harvested from an area such that the "forest influence" is removed from most of the area (Kimmins 1992). A new population of seedlings is then established through natural regeneration or planting such that one dominant age-class of trees is represented. With selective harvesting, individual trees or groups of trees are removed periodically so that the resulting forest eventually contains trees of several distinct age/size classes (Kimmins 1992). Even-aged silviculture employing clearcutting, site preparation, and planting of pines has been the primary method of pine regeneration on southern forests for >30 years. Although young pine plantations provide excellent habitat for many wildlife species adapted to early successional stages (such as deer, rabbits, and quail), clearcutting is generally detrimental to species that require an abundance of snags and cavity trees, hardwoods, hard mast, woody debris, and other forest habitat features (Kimmins 1992, Thill 1990). It has been shown that some reptiles and amphibians require similar mature habitat features; e.g., oak-hickory habitats supported greater numbers of amphibians than nearby managed-pine habitats in South Carolina (Bennett and others 1980). Similarly, Enge and Marion (1986) found that clearcutting and site preparation in Florida had a negative impact on reptile and amphibian numbers and reptile species richness. The decrease in amphibian numbers in heavily disturbed areas was primarily due to reduced reproductive success in certain species, such as *Scaphiopus* spp., *Rana utricularia*, and *Gastrophryne carolinensis*. Low numbers of young-of-the-year were noted in clearcut areas, possibly due to disappearance of standing water before young frogs and toads could metamorphose. In another study, presence and numbers of amphibians in managed stands were strongly affected by the occurrence and longevity of intermittent ponds and streams during winter (Whiting and others 1987).

[1] Assistant Professor, St. Gregory's University, Division of Science, Shawnee, OK; Professor, Oklahoma State University, Department of Zoology, Stillwater, OK; and Supervisory Research Wildlife Biologist, USDA Forest Service, Southern Research Station, Nacogdoches, TX, respectively.

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By altering soil structure, hydrology, and horizontal and vertical vegetation structure, clearcutting can affect microclimatic conditions (Geiger 1971), which influences amphibian and reptile distribution and abundance (Ash 1988, Matlack 1994, Pechman and others 1991, Pough and others 1987). These changes result from canopy removal, reduction in moisture-retaining litter, and soil compaction (Bratton 1994, Bury 1983, Raymond and Hardy 1991).

Many terrestrial salamanders require moisture-containing deciduous leaf litter for site colonization (Jaeger 1971). Thus, pure stands of conifers are generally unsuitable for salamanders in the Eastern and Central United States (Bennett and others 1980, Pough and others 1987, Williams and Mullin 1987). In loblolly-shortleaf pine (*Pinus taeda* and *P. echinata*) stands of east Texas, Whiting and others (1987) found that understory development and degree of deciduous litter accumulation strongly influenced herpetofaunal communities.

Petranka and others (1993) compared 5-year-old clearcuts with mature stands over 80 years old and found that terrestrial salamanders were reduced by 75 to 100 percent following clearcutting. Furthermore, Petranka and others (1994) estimated that it would require a century or more for salamander populations to return to predisturbance levels. There is concern that this reduction could produce population bottlenecks and decreased genetic diversity. In some cases, local populations of sedentary species may be prone to extinction (Petranka and others 1993).

On a regional scale, survival of a reduced population depends upon recolonization through immigration from undisturbed areas (Fahrig and Merriam 1994). However, several factors limit salamander immigration: (1) salamanders generally only migrate under a narrow set of environmental conditions, (2) migrating individuals may encounter interspecific competition with other herps, and (3) adult salamanders are often highly philopatric (Petranka 1994, Petranka and others 1993). Consequently, recolonization of heavily disturbed areas by salamanders is slow.

Like amphibians, reptile species richness and community composition are affected by silvicultural treatments (Enge and Marion 1986, Whiting and others 1987). Populations of some reptiles increase in response to clearcutting due to increased prey abundance, creation of favorable microhabitats or refugia, and other factors (Enge and Marrion 1986). *Cnemidophorus sexlineatus*, a cursorial lizard that prefers open sandy areas, increased in abundance following clearcutting (Enge and Marion 1986). Several grassland species were also common in young plantations, including *Thamnophis proximus*, *Masticophis flagellum*, *Lampropeltis calligaster*, and *L. getula* (Whiting and others 1987). Clearcutting typically results in increased small mammal densities and species diversity (Atkinson and Johnson 1979; Kirkland 1977, 1990), providing more prey for snakes that feed primarily on small rodents.

Reptile community composition is related to understory and overstory development as well as presence of woody debris, rocky outcroppings, and prey abundance. Many habitat characteristics affecting herpetofaunal community composition are ultimately dependent upon age of the forest and degree of disturbance.

Because amphibians are often habitat specialists with restricted distributions, they may be valuable indicators of ecosystem health and stability. Despite new evidence that reptiles and amphibians are important components in many ecosystems, they continue to be neglected by land managers (Pough and others 1987). Some management plans may even promote midsuccessional stages to maximize alpha diversity of other taxa at the expense of sensitive reptile and amphibian species (Faaborg 1980, Samson and Knopf 1982).

Our objectives were to (1) determine if herpetofaunal community structure differs among silvicultural treatments in the Ouachitas, (2) quantify microhabitat differences among treatments, and (3) relate herpetological community composition to microhabitat conditions.

MATERIALS AND METHODS

We sampled six stands (two replicates of three treatments) located within Perry County, AR, about 70 km north of Hot Springs. The treatments were young (3 and 5 years old at study initiation) clearcut plantations, late-rotation (80+ years old) naturally regenerated stands (hereafter controls), and selectively harvested stands (table 1). Stands of the first two treatments were managed by the USDA Forest Service; selectively harvested stands were managed by forest industry.

All stands had a predominately south, southeast, or southwest aspect and slopes of 5 to 20 percent. We chose stands with southerly aspect because these best represent sites that the USDA Forest Service manages for *P. echinata* in the Ouachitas.

Table 1—Treatment histories for six study areas in the Ouachita Mountains

Treatment	Year of harvest	Year of burn[a]	Year of herbicide treatment
Selectively harvested	1972,92	1985,88	1973 (2,4,5-T)
Selectively harvested	1976,91	1988	1973 (2,4,5-T)
Control	1912	—	—
Control	1912	—	—
Clearcut	1990	—	1990 (Garlon 3A)
Clearcut	1988	—	1988 (Garlon 3A)

[a] Prescribed burning of understory was conducted to reduce woody debris and young hardwoods.

We established three drift fence arrays with associated pitfall and funnel traps on each site (fig. 1a). The array design was modified from Campbell and Christman (1982), Vogt and Hine (1982), and Jones (1986). Within each stand, arrays were positioned at 100-m intervals along a central transect situated approximately 100 m from roads, streams, or stand borders to minimize treatment confoundments. Each array consisted of three 15.2-m by 30.5-cm wings (galvanized flashing) originating from the center and radiating outward at approximately 120° angles. Drift fences were buried 5 cm in the ground to help prevent burrowing under the fence. An 18.9-l pitfall trap (plastic bucket) was buried at the center of the array and at the end of each of the three wings (fig. 1a). Pitfalls were buried flush with the ground, allowing the drift fence to overhang the lip of the pitfall (fig. 1b). Drain holes were punched in the bottom of each pitfall. Two double-ended funnel traps, one of hardware cloth (0.64 cm mesh) (Fitch 1951) and one of aluminum window screen (Jones 1986), were placed on both sides of each wing for a total of 12 funnel traps per array. Funnel traps were molded and positioned as close to the fence as possible to prevent animals from moving between the funnel traps and the drift fence.

Arrays were installed during March 1993, about 2 months prior to initial trapping. Arrays were checked on alternate days for a total of 91 days during six periods: three in 1993 (May 22 to June 6, June 15 to 30, and July 15 to 25) and three in 1994 (March 6 to 21, May 14 to 29, and June 15 to 29). When pitfalls were not in use, they were closed with

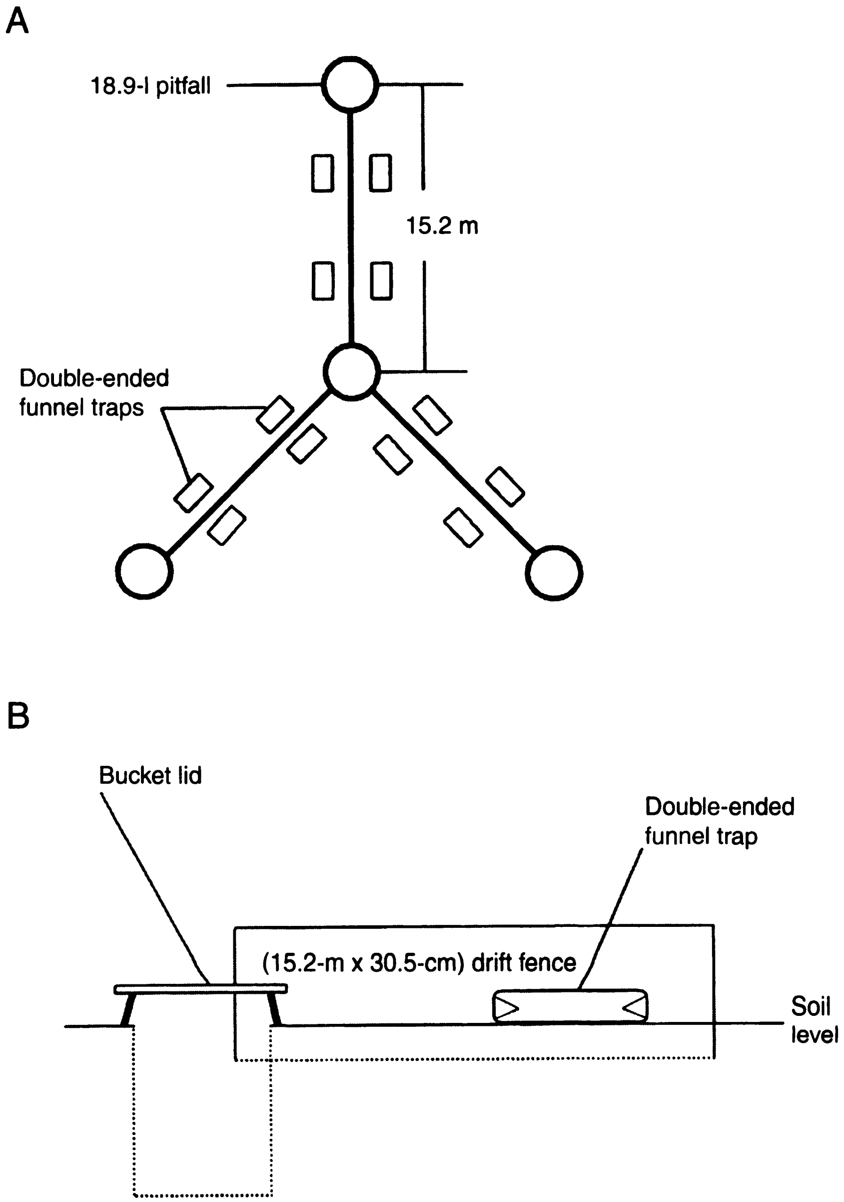

Figure 1—(A) Array design showing configuration of drift fences, pitfall traps, and double-ended funnel traps; (B) side view of an array segment showing the intersection of a pitfall trap with the drift fence.

tight-fitting snap lids; funnel traps were closed by lodging a plug of aluminum foil in their entrances. To minimize mortality from overheating and desiccation, a piece of asphalt shingle was draped over each funnel trap for shade. Pitfalls were shaded using small sticks to prop lids 10 to 15 cm above the container (fig. 1b).

Twelve habitat measurements were collected at each of the 18 arrays during July 15-30, 1993. Habitat changes from 1993 to 1994 were negligible, so the measurements made in 1993 characterize the total study period. Leaf litter, exposed rock, woody plant cover, herbaceous cover, and woody debris were quantified by visually estimating, with an ocular tube, the percent of the ground surface covered by each. Percent coverage by woody debris was recorded in two size classes (Maser and others 1979): total woody debris and large debris with a mean diameter >20 cm. Forest canopy cover was estimated using a spherical densiometer (Lemmon 1957). Pine and hardwood basal area was estimated with a 10-factor English prism. Litter depth was measured with a metric ruler and horizontal cover was estimated using a 1-m by 1-m density board at two heights: resting on the ground and centered at 1 m aboveground (MacArthur and MacArthur 1961). For each array, these data were collected at right angles to the drift fence, 2 m to either side of each of the peripheral pitfall traps, for a total of six points per array. Horizontal cover, litter depth, and all percent coverage estimates were recorded at these points. Basal area was estimated from the center of each pitfall trap. The data for each parameter were then averaged to characterize each array.

DATA ANALYSIS

We employed canonical correspondence analysis (CCA) to test for differences in herpetofaunal communities among silvicultural treatments and to identify associations of habitat variables with the treatments and with particular reptiles and amphibians. CCA is a gradient analysis that utilizes aspects of multivariate regression and correspondence analysis to relate species composition of the samples with measured habitat variables. Ordination axes are constrained such that they are linear combinations of the habitat variables and each subsequent axis explains variation in the data set not already explained by previous axes (i.e., axes are orthogonal). Ordination diagrams show the relationships among species abundances, sites, and habitat variables (Taylor and others 1993, Ter Braak and Smilauer 1998).

In CCA ordination diagrams, sites and species are represented by symbols (points) while habitat variables are represented by vectors. The length of a vector symbolizes the importance of the environmental variable while the direction of vectors indicates the degree of correlation among habitat variables and sites, and/or habitat variables and species. Only the positive end of environmental vectors are shown in the CCA diagrams; therefore, one must remain aware of the equally important negative portion of each vector. For each environmental variable shown in the ordination, one can imagine a vector of equal length extending from the center of the figure and in the opposite direction. The closer environmental vectors are to one another the more they are correlated, and the closer these vectors align with an axis the more the nature of that axis is identified. The location of sites relative to environmental vectors indicates the habitat characteristics of the sites, while the position of species points relative to vectors shows the environmental associations of individual species.

Analyses were performed using the program CANOCO with downweighting of rare species (Ter Braak and Smilauer 1998). Each drift fence array was considered a sample site. Species abundances were $\log_{10}$ transformed and environmental data expressed as proportions were transformed to the arcsine of the square root of the value. For purposes of ordination, it was valid to incorporate the total set of variables, but for purposes of hypothesis testing, the number of habitat variables (12) was large relative to the number of samples (18) (Ter Braak and Smilauer 1998). Therefore, before applying the CCA for hypothesis testing, we reduced the number of habitat variables using Principal Components Analysis (PCA) to identify those variables that were redundant or superfluous. From this analysis, we identified four habitat variables (canopy cover, litter depth, woody plant cover, and large, woody debris) that most influenced the herp community structure. Although canopy cover and litter depth are strongly correlated, both were included in the model because of the known importance of a well-developed litter layer to amphibians (Bury 1983, Diller and Wallace 1994).

Monte Carlo permutation tests (Manly 1992) were used to test the overall effects of (1) treatment and (2) the selected habitat variables on species composition. Monte Carlo permutation tests were also used to test the effect of the first CCA axis (CCA1) for each of the analyses.

RESULTS

We captured 633 individuals representing 35 species of reptiles and amphibians (table 2). Of these, 62 percent (395) were lizards (Phrynosomatidae, Teidae, Scincidae), 26 percent (162) were frogs and toads (Microhylidae, Bufonidae, Ranidae), and 10 percent (66) were snakes (Colubridae, Viperidae). Salamanders and turtles (Ambystomatidae, Plethodontidae and Testudinidae) combined represented < 2 percent of all captures and therefore will only be briefly discussed.

Based on CCA using treatment as the only environmental variable, the pattern of species abundances (overall ordination) was nonrandom along CCA1 (Monte Carlo test, $p < 0.01$). In other words, the herpetofaunal communities differed significantly among the three treatments. Using this same analysis with four preselected variables (canopy cover, litter depth, woody plant cover, and large, woody debris), patterns of species abundances among treatments also differed ($P < 0.01$).

In the ordination using all habitat variables (fig. 2), CCA1 was positively correlated with leaf litter, pine basal area, canopy cover, litter depth, and hardwood basal area; CCA 1 was negatively correlated with horizontal cover at 1 m. Over the first three canonical axes, the three silvicultural treatments were well separated (fig. 3), with CCA1 providing the greatest separation. Overlaying the habitat variables (fig. 2), clearcut stands were characterized by dense ground cover including woody and herbaceous vegetation as well as an

Table 2—Amphibians and reptiles captured using drift fence arrays in the Ouchita Mountains of Arkansas, 1993–94[a]

Species	Acronym	Clearcut	Selectively harvested	Control	Total	(%)
Frogs and Toads						
Bufo americanus	BUFAME	5	65	39	109	(17.2)
Gastrophryne carolinensis	GASCAR	2	37	5	44	(7.0)
Rana clamitans	RANCLA	4	0	2	6	(0.9)
Rana catesbeiana	RANCAT	0	0	2	2	(0.3)
Rana utricularia	RANUTR	1	0	0	1	(0.1)
Salamanders						
Eurycea multiplicata	EURMUL	0	2	3	5	(0.7)
Ambystoma opacum	AMBOPA	0	1	0	1	(0.1)
Ambystoma talpoideum	AMBTAL	0	1	0	1	(0.1)
Turtles						
Terrapene carolina	TERCAR	1	0	1	2	(0.3)
Terrapene ornata	TERORN	0	1	0	1	(0.1)
Lizards						
Sceloporus undulatus	SCEUND	80	54	45	179	(28.3)
Scincella lateralis	SCILAT	16	28	34	78	(12.3)
Cnemidophorus sexlineatus	CNESEX	48	5	2	55	(8.7)
Eumeces fasciatus	EUMFAS	8	20	6	34	(5.4)
Eumeces anthracinus	EUMANT	9	8	6	23	(3.6)
Eumeces laticeps	EUMLAT	10	3	4	17	(2.7)
Anolis carolinensis	ANOCAR	5	4	0	9	(1.4)
Snakes						
Agkistrodon contortrix	AGKCON	4	4	4	12	(1.9)
Coluber constrictor	COLCON	6	3	2	11	(1.7)
Thamnophis proximus	THAPRO	2	1	2	5	(0.8)
Storeria dekayi	STODEK	4	0	1	5	(0.7)
Elaphe guttata	ELAGUT	3	1	0	4	(0.6)
Thamnophis sirtalis	THASIS	0	1	2	3	(0.4)
Storeria occipitomaculata	STOOCC	1	0	2	3	(0.4)
Carphophis amoenus	CARVER	2	1	0	3	(0.4)
Masticophis flagellum	MASFLA	1	0	2	3	(0.4)
Lampropeltis triangulum	LAMTRI	2	0	1	3	(0.4)
Virginia valeriae	VIRVAL	1	0	1	2	(0.3)
Cemphora coccinea	CEMCOC	2	0	0	2	(0.2)
Heterodon platyrhinos	HETPLA	1	0	1	2	(0.3)
Diadophis punctatus	DIAPUN	1	0	1	2	(0.3)
Opheodrys aestivus	OPHAES	1	1	0	2	(0.3)
Tantilla gracilis	TANGRA	1	1	0	2	(0.3)
Elaphe obsoleta	ELAOBS	1	0	0	1	(0.1)
Sistrurus miliarius	SISMIL	1	0	0	1	(0.1)
Total					633	(100.0)

[a] Herpetological nomenclature follows Connant and Collins 1998.

abundance of woody debris. Clearcuts had scanty leaf litter, reduced canopy cover, and low pine and hardwood basal areas. Control and selectively harvested stands were closely grouped along CCA1 to the right and shared several habitat characteristics including greater litter depth, greater canopy cover, and greater pine and hardwood basal areas. In turn, selectively harvested and control stands differed along CCA3 (fig. 3b) due to greater herbaceous cover and more large, woody debris in selectively harvested stands; conversely, control stands had a higher proportion of woody plant cover. These habitat differences are apparent from the variable means (table 3).

The most distinct separation of species groups (fig. 4) was between reptiles and amphibians, with reptiles predominating in clearcuts and amphibians being most abundant in

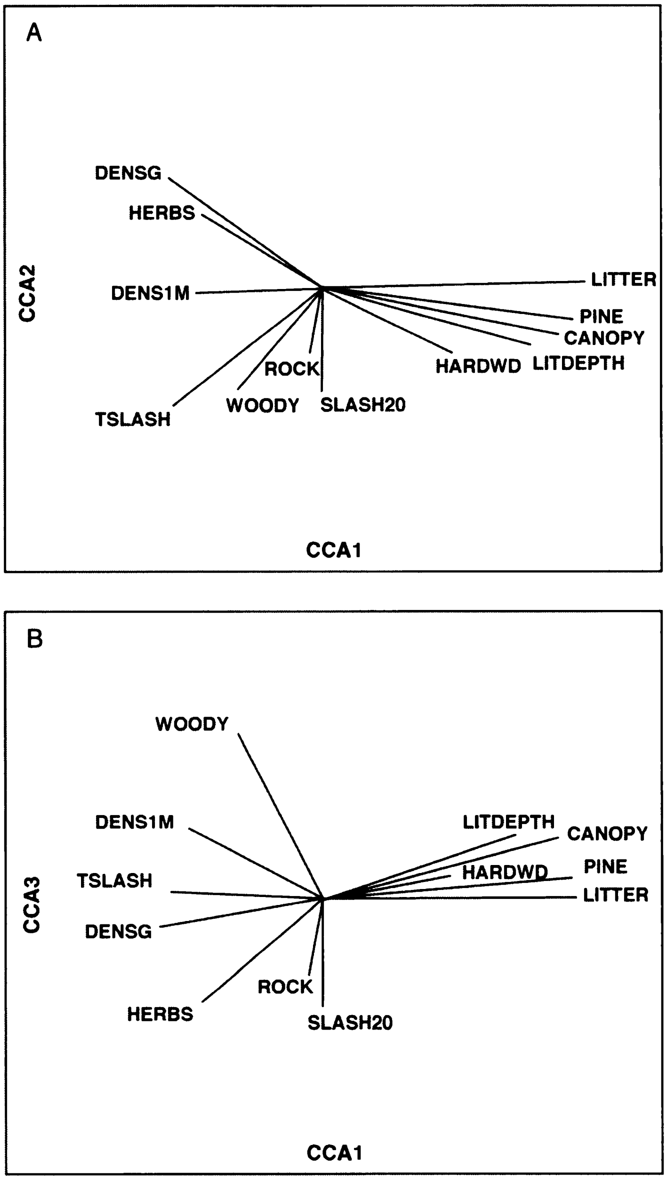

Figure 2—Canonical correspondence analysis (CCA) ordination of habitat variables: CANOPY = canopy cover, DENSG = horizontal cover at ground level, DENS1M = horizontal cover at 1 m above the ground, HARDWD = hardwood basal area, HERBS = herbaceous cover, LITDEPTH = litter depth, LITTER = leaf litter cover, PINE = pine basal area, ROCK = exposed rock, SLASH20 = woody debris with a diameter >20 cm, TSLASH = total woody debris, and WOODY = woody plant cover.

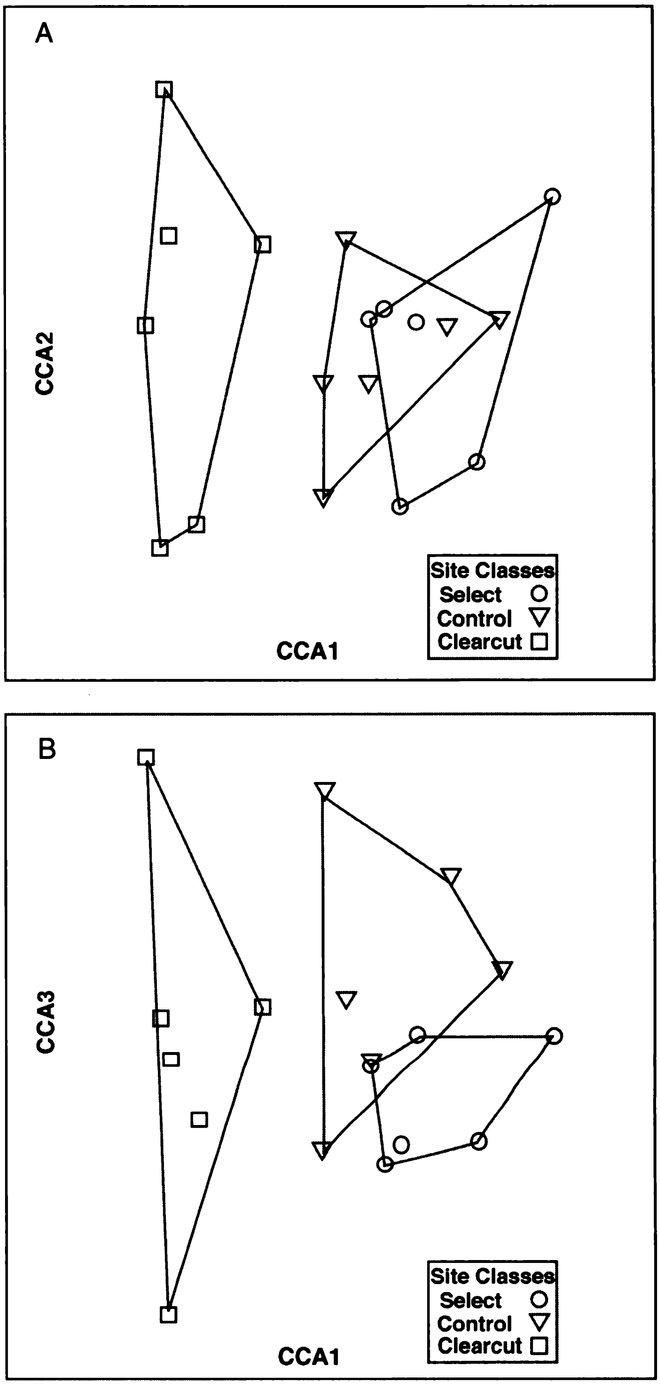

Figure 3—Canonical correspondence analysis (CCA) ordination of sample sites against (A) axes 1 and 2, and (B) axes 1 and 3.

forested stands. Frequencies of captures by species groups showed the same pattern (table 2).

Although not abundant in control or selectively harvested stands, salamanders were never observed in either clearcut. *Eurycea multiplicata*, the most abundant of the three salamander species (table 2), was not strongly associated with any habitat variable (fig. 5). All salamanders and most frogs and toads were collected in forested areas. *Gastrophryne carolinensis* and *Bufo americanus* were the most abundant frogs and toads (table 2) and were strongly associated with the higher canopy cover and litter depth of the two forested treatments (fig. 5). Both species were most common in selectively harvested stands (table 2).

The most commonly encountered snakes were *Agkistrodon contortrix* and *Coluber constrictor* (table 2). *Agkistrodon contortrix* was found equally in all treatments, whereas we caught more *C. constrictor* in clearcuts. These species occurred in a broad range of habitats within both forested

Table 3—Means and standard deviations (in parentheses) of habitat variables by treatment[a]

Habitat variable	Clearcut		Selective harvest		Control	
Slope (percent)	15.0	(1.8)	12.0	(4.5)	12.0	(2.5)
Pine basal area (m^2/ha)	0.0	(0.0)	16.1	(3.8)	19.0	(3.8)
Hardwood basal area (m^2/ha)	0.2	(0.4)	2.3	(1.6)	7.3	(3.6)
Canopy cover (percent)	7.0	(12.1)	83.0	(7.2)	97.0	(2.0)
Litter depth (cm)	1.0	(0.9)	3.0	(0.5)	3.0	(1.5)
Litter coverage (percent)	25.0	(8.9)	97.0	(2.3)	99.0	(3.2)
Herbaceous cover (percent)	42.0	(14.2)	32.0	(12.6)	7.0	(6.6)
Woody plant cover (percent)	27.0	(24.8)	16.0	(6.2)	17.0	(8.0)
Total woody debris (percent)	20.0	(9.5)	10.0	(3.9)	4.0	(2.1)
Large woody debris (percent)	6.0	(5.8)	4.0	(4.6)	3.0	(2.5)
Exposed rock cover (percent)	3.0	(3.3)	3.0	(2.6)	2.0	(3.4)
Horizontal cover at ground level (percent)	87.0	(8.0)	69.0	(26.1)	31.0	(12.8)
Horizontal cover at 1 m (percent)	63.0	(27.4)	42.0	(22.6)	19.0	(14.6)

[a] Each value is based on a sample size of 36 measurements.

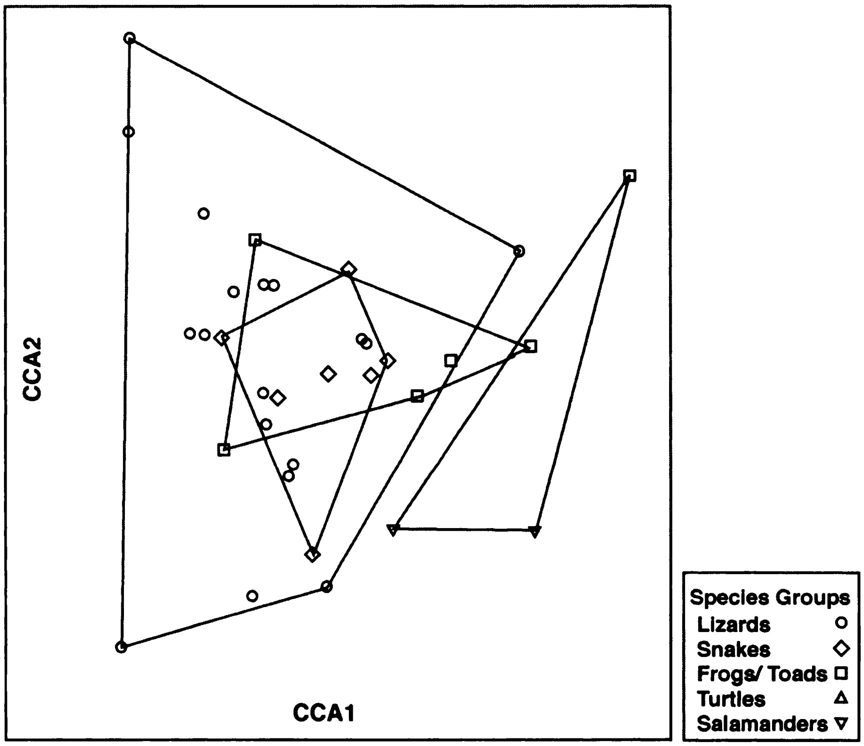

Figure 4— Canonical correspondence analysis (CCA) ordination of species groups, which can be superimposed on figures 2A and 3A in order to interpret patterns of community composition along silvicultural treatments and environmental gradients.

and open, grassy areas. Both species were associated with large, woody debris, woody vegetation, and exposed rock (fig. 5).

Thamnophis spp. were encountered mostly within controls and were generally observed near water, while both *Elaphe guttata* and *Storeria dekayi* were commonly observed within the clearcut stands (table 2). *E. guttata* was strongly associated with dense, herbaceous ground cover (fig. 5).

Lizards were the most abundant taxon (table 2), occupying most habitats (fig. 5). The most abundant species, *Sceloporus undulatus* (n = 179), was found in a wide variety of habitats and is therefore found near the center of the ordination (fig. 5). It was most common in clearcuts, but was also found in good numbers in the other treatments (table 2). *Scincella lateralis* and *Eumeces fasciatus* were most commonly encountered in forested areas (table 2) in association with abundant litter (fig. 5). *Cnemidophorus sexlineatus*

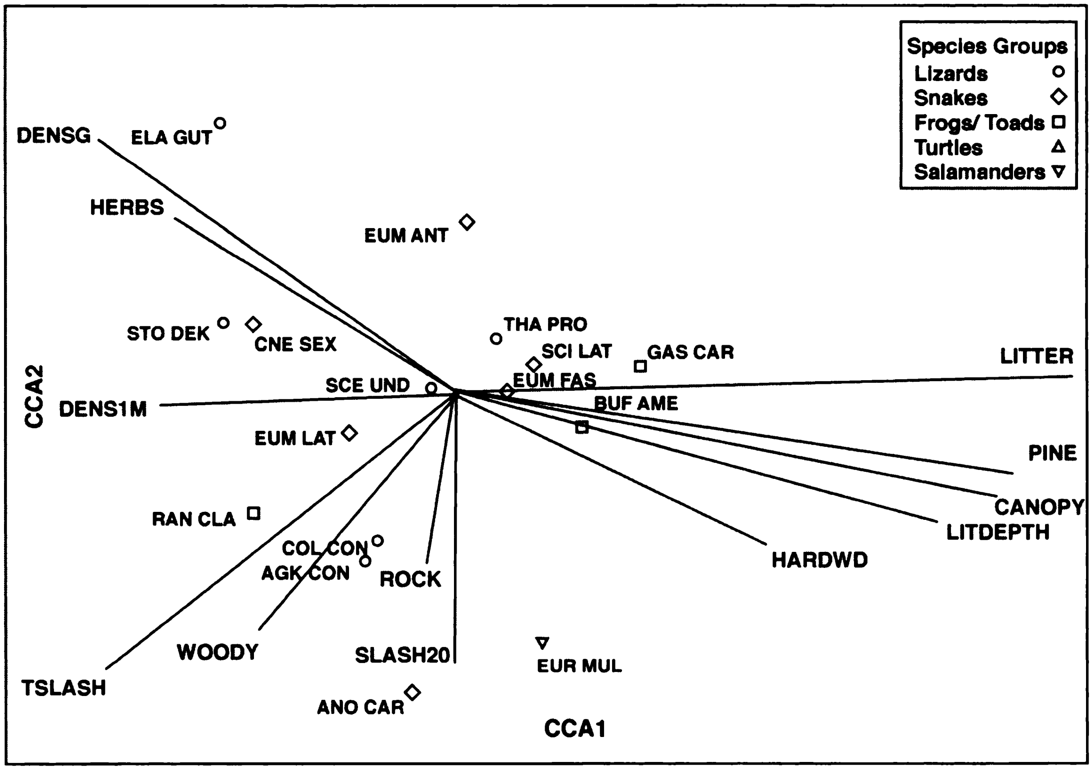

Figure 5— Canonical correspondence analysis (CCA) ordination of species and habitat variables. See table 2 for a key to species' acronyms.

and *Eumeces laticeps* were more prevalent in clearcuts (figs. 3 and 5), while *Eumeces anthracinus* was not clearly associated with any of the treatments (table 2). *Anolis carolinensis* was common in clearcut and selectively harvested stands, but was never found in control stands (table 2). *Anolis carolinensis* was associated positively and *Eumeces anthracinus* negatively to an abundance of large, woody debris.

DISCUSSION

Herpetofaunal communities differed significantly among treatments. Generally, microhabitat preferences of species explain these differences, with reptiles and amphibians responding predictably to gross changes in habitat structure among treatments. Because of increased insolation, higher ground temperatures, and higher evaporative water loss, fewer amphibians would be expected in young clearcuts (Bennett and others 1980; Geiger 1971; Petranka and others 1993, 1994). Although there was considerable overlap of taxa among habitats, our results suggested that amphibians generally favored forested areas over clearcuts. In particular, the two most common amphibians, *Gastrophryne carolinensis* and *Bufo americanus*, were strongly correlated with litter depths.

Unlike amphibians, reptiles preferred the open sunny habitats of the young clearcuts. Of the variables examined, horizontal cover and presence of woody debris (positively), and canopy cover and litter (negatively) seemed to be the most important factors determining reptile species composition within clearcuts. In loblolly-shortleaf pine (*Pinus taeda* and *P. echinata*) stands of east Texas, Whiting and others (1987) also found that vegetative cover and the degree of deciduous litter accumulation strongly influenced herpetofaunal communities. We found that *E. guttata* and *Cnemidophorus sexlineatus*, two grassland species, were both positively associated with dense, herbaceous ground cover and negatively with canopy cover. Surprisingly, *Eumeces laticeps*, an arboreal lizard, was strongly associated with woody plant cover and was more abundant in clearcuts than in either of the forested treatments. Enge and Marion (1986) found populations of *E. laticeps* to be reduced within clearcuts.

Some reptiles (especially lizards) may be attracted to recent clearcuts because the dense, low-growing vegetation provides an abundance of perching sites. For example, *Anolis carolinensis* was positively associated with woody plant cover and large, woody debris, habitat features largely absent from control stands. *Cnemidophorus sexlineatus*, a cursorial lizard, often inhabits early-succession habitats, shrubby hillsides, and open, grassy areas (Collins 1993, Webb 1970). Like us, Enge and Marion (1986) found this lizard favored the most intensively disturbed clearcuts.

A greater abundance and diversity of prey (invertebrates, birds, and small mammals) may contribute to higher abundances of reptiles (especially snakes) within clearcuts. A sharp increase in small mammal densities could attract large snakes such as *E. obsoleta* and *E. guttata*, which were found primarily in clearcuts. The Fulvous Harvest Mouse, *Reithrodontomys fulvescens*, Southern Short-tailed Shrew, *Blarina carolinensis*, Golden Mouse, *Ochrotomys nuttalli*, and mice, *Peromyscus* spp. were commonly captured in our pitfall traps in the clearcuts, while only *Peromyscus* spp. were captured in the other two treatments.

Perhaps the most significant limitation of this study is pseudoreplication (Hurlbert 1984). The three arrays within each treatment replicate were not spatially independent sites. Given adequate resources, it would be best to have multiple, spatially independent replications of each treatment. We attempted to limit this problem by separating sample sites by 100 m, but readers should use caution in interpreting the results.

Some species (e.g., *Thamnophis proximus*, *Storeria dekayi*, and *Eurycea multiplicata*) were not associated with any of the habitat variables we measured. Potentially important variables for future studies include invertebrate and small-mammal prey densities, microclimate, and proximity of sample sites to water. The latter two should aid in predicting occurrence of most amphibians (especially semiaquatic salamanders such as *E. multiplicata* and *Desmognathus brimleyorum*) (Crosswhite and others 1998), as well as reptiles (e.g., *T. proximus* and *T. sirtalis*) known to inhabit riparian areas or sloughs (Collins 1993, Webb 1970).

This and other studies (Crosswhite and others, in press; Dodd 1991; Gibbons and Bennett 1974; Gibbons and Semlitsch 1982; Jones 1986) suggest that some species (e.g. turtles and tree frogs) are not effectively sampled using pitfall and funnel traps. These species might be more effectively sampled using alternate techniques such as quadrat sampling, aural surveys for frogs and toads, or artificial habitat, (i.e., cover boards, frog houses, and artificial pools) (Heyer and others 1994).

Reptiles are generally favored by more open canopies and denser understory, as well as the presence of woody debris or rocky outcroppings. Most habitat characteristics determining herpetofaunal community composition are ultimately dependent upon stand age and the degree of site disturbance.

Reptiles and amphibians play significant roles in many ecosystems. They can be important components of the food web and may contribute substantially to community biomass (Burton and Likens 1975, Pough and others 1987). Furthermore, because amphibians are often habitat specialists with restricted distributions, they may be valuable indicators of ecosystem health and stability. We hope our findings will aid land managers in protecting reptile and amphibian habitat.

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