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STREAMSIDE ZONE WIDTH AND AMPHIBIAN AND REPTILE ABUNDANCE

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Many natural pine-hardwood stands in the southeastern United States are being converted to pine plantations with short rotations. This forest conversion alters vertebrate communities, particularly amphibians and reptiles (Bennett et al., 1980; Rakowitz, 1983). One practice in stand conversion to accommodate vertebrate species is the retention of strips of unharvested, mature trees along permanent and intermittent streams. These strips are termed riparian zones, streamside zones, streamers, or stringers.

Several studies indicate that streamside zones influence the abundance of various taxa. Squirrels (*Sciurus* sp.) were more abundant in riparian zones than in adjacent pine-hardwood stands (Warren and Hurst, 1980) or pine plantations (McElfresh et al., 1980; Dickson and Huntley, 1986). In a concurrent study using the same sites as the present study, terrestrial small mammals were more abundant in the narrower streamside zones with well developed herbaceous vegetation compared to wider zones with sparse herbaceous vegetation (Dickson and Williamson, 1988). Conversely, squirrels were more abundant in the wider zones with numerous large trees and mast production (Dickson and Huntley, 1986).

Several studies have examined amphibian and reptilian communities in riparian habitats, primarily in relatively arid ecosystems (e.g., Brode and Bury, 1984; Jakle and Gatz, 1985; Jones and Glinski, 1985; Lowe, 1985). In the more mesic environments of the southeastern United States, streamside zone habitats are generally less distinct from adjacent forested habitat, and published information on amphibian and reptilian communities is lacking. In this study, we test the hypothesis that streamside zone width affects amphibian and reptilian communities, and we examine the effects of zone width on the relative abundance of amphibians and reptiles.

Six young pine plantations (2 to 4 years old) traversed by streamside zones were selected as study sites in eastern Texas. Three of these sites were near Broaddus in San Augustine Co., and three near Douglass in Nacogdoches Co. Sites with similar soil type, topography, and size of intermittent streams were selected to minimize geophysical and geochemical differences. Each site in each area represented one of three treatments in relation to width of the streamside zone: narrow (0 to 25 m), medium (30 to 40 m), and wide (50 to 95 m). These treatments were a result of commercial timber harvest of the adjacent pine-hardwood forest, site preparation, and planting of loblolly pine (*Pinus taeda*). Vegetation of each residual streamside zone consisted of mature mixed pine-hardwood stands dominated by oaks (*Quercus* sp.), sweetgum (*Liquidambar styraciflua*), loblolly pine, and American beech (*Fagus grandifolia*). Stands on adjacent slopes were dominated by loblolly pine saplings, hardwood sprouts, other woody plants, and forbs. Vegetation heights were generally <2 m.

Four 200-m transects were established on each study site, two within the streamside zones and two in the adjacent pine plantations. The transects within the streamside zones ran along the middle of the zones, those in the adjacent plantation were oriented laterally from the streamside zones. A path approximately 1-m wide was maintained along each transect to allow easy access.

Amphibians and reptiles were surveyed on each of the study sites by a variety of techniques. Four sampling points were established at 50-m intervals along each transect. Drift fences with funnel traps were established at each sample point on two of the transects at each study site, one in the streamside zone and one in the plantation. Drift fences were constructed of 6-mil black plastic sheeting supported by a wire held in place by wooden stakes. The bottom of each fence was buried approximately 4 cm in the soil. Each drift fence was approximately 25 cm in height and 16 m in length. During 1984, a funnel trap was positioned at the midpoint of each drift fence, and, during 1985, funnel traps were positioned at each end of the drift fences. The traps were constructed of 6.4-mm hardware cloth fashioned into open ended cylinders (44 cm in length, 12 cm in diameter) with a hardware cloth funnel approximately 23 cm in length placed in one (1984) or both (1985) ends. Funnel openings were approximately 3 cm in diameter. A sheet of black plastic covered with available litter was placed over each trap to reduce stress on captured specimens. Captured specimens were removed from traps and released. Specimens were not marked.

Two artificial shelters, one tin and one plywood, were placed at each of the four sampling points on the remaining two transects in each study site to attract amphibians and reptiles and provide an easily checked microhabitat. The shelters consisted of corrugated roofing tin (approximately 150 by 150 cm) or 6.4-mm plywood (approximately 60 by 150 cm) placed on the soil surface, in shaded locations where possible.

Three surveys per month during 2 months each year were conducted at approximately weekly intervals. Surveys were conducted during May and June (1984) and April and June (1985). A survey consisted of checking all traps and artificial shelters. In addition, time-constant, visual searches (Bury and Raphael 1983) were conducted along the transect lines in the streamside zones (1 h) and the adjacent plantations (1 h) during each survey. Visual searches, rather than habitat destructive searches under logs, bark, or other items, were chosen to avoid habitat degradation. Surveys were conducted between 0800 and 1030 h. All individuals observed were recorded.

Various groupings and subsets of the data were analyzed for effects of the three riparian zone width treatments on relative abundances of amphibians and reptiles. The Kolmogorov-Smirnov goodness of fit test indicated that the data did not meet the assumption of normality. Therefore, the nonparametric Kruskal-Wallis test was used to test for differences between treatments.

During the study, 1,628 individual amphibians and reptiles of 31 species were recorded (Table 1). Eighty-two percent of total detections were from visual surveys, 12% from artificial shelters, and 6% from traps. The low percentage of records from traps reflects the recurrent disruption of drift fences by armadillos (*Dasypus novemcinctus*).

The relatively low number of individuals of each species and the high variances among data precluded statistical analysis of treatment effects by individual species, so species were grouped in various ways for statistical analysis. The first set of groups was based on higher taxonomic categories: amphibians, reptiles, lizards, and snakes. Turtles (n = 8) and salamanders (n = 1) were omitted from lower taxonomic categories due to small sample sizes. Total amphibians essentially equalled anurans because there was only one salamander recorded.

Ecological groupings were also established and examined (Table 2). An aquatic group was established which contained species closely associated with aquatic habitats, and the nonaquatic group contained all remaining species. The total data set (amphibians plus reptiles) was also used as a group. Data also were analyzed by streamside zone and pine plantation.

It is clear from the streamside zone section of Table 2 that all groupings plus the totals for all species exhibited a significant effect due to treatment. A more detailed examination of the data reveals that the primary dichotomy in the data is between low abundances in the narrow streamside zone treatment and higher abundances in the medium and wide treatments.

Examination of Table 1 provides specific information for the differences between treatments, with the skinks *Eumeces fasciatus* and *Scincella lateralis* as major contributors. Populations of both species benefit from aspects of the habitat provided by the forest overstory. *Eumeces fasciatus*

TABLE 1—Number of individuals of 31 species of amphibians and reptiles recorded on sites with different streamside zone widths.

	Treatment								
	Streamside zone			Pine plantation			Total		
Taxon	Narrow	Medium	Wide	Narrow	Medium	Wide	Narrow	Medium	Wide
Turtles									
Chelydra serpentina	0	1	0	0	0	0	0	1	0
Terrapene carolina	0	2	2	0	0	3	0	2	5
Lizards									
Anolis carolinensis	33	31	43	15	19	18	48	50	61
Sceloporus undulatus	19	46	9	33	50	47	52	96	56
Cnemidophorus sexlineatus	0	0	0	7	22	34	7	22	34
Eumeces fasciatus	3	21	19	1	5	0	4	26	19
Eumeces laticeps	0	1	2	0	0	0	0	1	2
Scincella lateralis	19	149	193	3	14	12	22	163	205
Ophisaurus attenuatus	0	0	0	1	0	0	1	0	0
Snakes									
Nerodia erythrogaster	1	12	11	1	0	0	2	12	11
Nerodia fasciata	1	3	6	0	0	0	1	3	6
Thamnophis proximus	0	0	1	0	0	0	0	0	1
Storeria dekayi	2	3	3	0	2	1	2	5	4
Heterodon platyrhinos	1	0	1	0	0	0	1	0	1
Diadophis punctatus	0	1	0	0	0	0	0	1	0
Coluber constrictor	6	2	0	3	2	1	9	4	1
Masticophis flagellum	0	0	0	1	1	0	1	1	0
Opheodrys aestivus	0	0	3	0	1	1	0	1	4
Elaphe obsoleta	2	3	4	1	2	1	3	5	5
Lampropeltis calligaster	0	0	1	0	0	0	0	0	1
Micrurus fulvius	1	1	0	0	0	0	1	1	0
Agkistrodon contortrix	0	2	3	0	0	0	0	2	3
Agkistrodon piscivorus	0	4	1	1	0	0	1	4	1
Salamander									
Eurycea quadridigitata	0	1	0	0	0	0	0	1	0
Anurans									
Bufo woodhousei	5	1	4	0	0	0	5	1	4
Acris crepitans	33	40	93	6	0	5	39	40	99
Hyla versicolor/chrysoscelis	7	10	12	0	0	0	7	10	12
Hyla cinerea	0	1	1	0	0	0	0	1	1
Gastrophryne carolinensis	0	2	1	0	0	1	0	2	2
Rana sphenocephala	32	97	26	5	31	7	37	128	34
Rana clamitans	0	26	101	0	1	0	0	27	101
Rana sp.	3	50	51	0	0	0	3	50	51
Total	167	510	591	78	150	131	245	660	722

benefits primarily from fallen limbs and loose bark (Fitch, 1954), and *S. lateralis* from well developed leaf litter accumulations (Lewis, 1951; Brooks, 1967). These habitat characteristics are only marginally present in the narrow treatments but are well developed in both wider treatments.

Several species associated with aquatic habitats (*Nerodia* sp., *Acris crepitans, Rana clamitans*) also were more abundant in the wider treatments. These species possibly benefitted from some combination of more extensive shading of aquatic habitats and more open understory vegetation.

TABLE 2—Number of amphibians and reptiles in streamside zones and adjacent pine plantations.

			Streamside zone			Pine plantation			Total individuals		
Group	Year	*n*	Narrow	Medium	Wide	Narrow	Medium	Wide	Narrow	Medium	Wide
Lizards	1984	485	48	124	130**	37	70	76**	85	194	206**
	1985	383	25	123	135**	23	40	37	48	163	172**
	Both	868	73	247	265**	60	110	113*	133	357	378**
Snakes	1984	57	5	19	18**	6	8	1	11	27	19
	1985	42	4	13	17*	5	1	2	9	14	19
	Both	99	9	32	35**	11	9	3	20	41	38
Amphibians	1984	297	37	96	110*	18	32	4	55	128	114
	1985	358	33	107	183**	4	24	7	37	131	90
	Both	655	70	203	293**	22	56	11	92	259	304
Reptiles	1984	546	53	145	50**	43	78	77*	96	223	227**
	1985	427	29	137	152**	28	42	39*	57	179	191**
	Both	973	82	282	302**	71	120	116*	153	402	418**
Aquatic species	1984	241	31	98	70	1	31	10	32	129	80
	1985	351	27	106	186**	4	23	5	31	129	191*
	Both	592	58	204	256**	5	54	15	63	258	271**
Nonaquatic species	1984	602	59	143	190**	60	79	71	119	222	261**
	1985	434	35	138	149**	28	45	39	63	183	188**
	Both	1,036	94	281	339**	88	124	110	182	405	449**
Total species	1984	843	90	241	260**	61	110	81	151	351	341**
	1985	785	62	244	335**	32	66	46	94	310	381**
	Both	1,628	152	485	595**	93	176	127	245	661	722**

* $P < 0.05$.
** $P < 0.01$.

The data for the young pine plantation portions of the study sites (Table 2) reveal few significant differences due to treatment. The exception was lizard and reptile data for 1984 that showed higher numbers in young pine plantations adjacent to wider streamside zones. Table 1 indicates that this is due primarily to *Cnemidophorus sexlineatus*. This is a highly cursorial species restricted to open habitats (Hardy, 1962). *Cnemidophorus sexlineatus* was found exclusively in the plantation portions of the study sites. The occurrence of populations at the various study sites probably reflects availability of adjacent open habitats. Additionally, the 1985 data indicated marked declines in some populations of *C. sexlineatus* presumably because the plantations were becoming more dense.

Streamside zone width significantly influenced the abundance of amphibians and reptiles within the streamside zones. There were fewer amphibians and reptiles in narrow (0 to 25 m) streamside zones than in wider zones (30 to 95 m). The wider zones were characterized by an intact overstory and midstory, sparse shrub and herbaceous vegetation, and abundant leaf litter. In contrast, the narrow treatments lacked these characteristics and had dense shrub and herbaceous vegetation, similar to that of the adjacent pine plantations. Habitat structure is known to influence amphibian and reptilian community structure (Pianka, 1966; Jones, 1981). In this study it appears that the higher abundance of amphibians and reptiles in streamside zones was associated with a closed canopy and leaf litter ground cover. No effect of management zone width on abundances of amphibians and reptiles in the adjacent young pine plantations was detected. We recommend retaining streamside zones of mature trees at least 30 m wide and preferably wider when forest stands are harvested. Zones this wide will benefit amphibians, reptiles, and other vertebrates.

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