# FORESTRY MANAGEMENT AND HERPETOFAUNAL DIVERSITY IN A LONGLEAF PINE FOREST ECOSYSTEM

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**ABSTRACT**

Amphibians and reptiles were sampled in eight different sites and four different habitats in the sandhills of South Carolina to examine the effect of different forestry management practices on herpetofaunal diversity. The treatments at the four sites on the Sand Hills State Forest were fragmentation, clear cutting, selective cutting, and stump removal. The four sites on the adjacent Carolina Sandhills National Wildlife Refuge represent control sites. Paired comparisons between comparable habitats were made between the state forest and the refuge. Species richness, species diversity, community evenness, and capture rate were measured at each site. Species richness was comparable in two of four habitats sampled. Species diversity was significantly greater for two sites on the state forest and one site on the refuge. Capture rates were significantly greater for three refuge sites. Capture rates were also significantly greater on the refuge for data from all four sites combined. A comparison of pre-treatment and post-treatment data at a clearcut site showed that species richness, species diversity and community evenness were lower after the clearcut. Species richness and number of captures of salamanders were lower on the state forest.

## INTRODUCTION

In recent decades there has been increased interest in forestry management practices and their effects upon amphibian and reptile communities in North America. Thus far, efforts have focused upon eastern deciduous forests (Pough et al., 1987; Petranka et al., 1993, 1994; Mitchell et al., 1996), pine plantations and clear cuts (Bennett et al., 1980; Ash, 1988; Grant et al., 1994; deMaynadier, Hunter, 1998; Leiden et al., 1999; Hanlin et al., 2000), riparian forests (Phelps, Lancia, 1995; Clawson et al., 1997), and conifer forests of the Pacific Northwest (Murphy, Hall, 1981; Raphael, 1988; Corn, Bury, 1989). In particular some forestry management practices have been shown to negatively impact salamanders (Ash, 1988; Petranka et al., 1993, 1994; Mitchell et al., 1996). See reviews for amphibians by Bury and Corn (1988) and deMaynadier and Hunter (1995).

Longleaf pine forests were once the most abundant upland terrestrial habitat of the southeastern coastal plain. However, they have been reduced to about three percent of their former distribution (Ware et al., 1993). In addition to their destruction, longleaf pine forests have very high levels of habitat diversity, extraordinary plant species diversity (Means, 1986) and exhibit among the highest amphibian and reptile diversity of any temperate zone ecosystem (Guyer, Bailey, 1993).

Few studies have focused on the effects of forestry management in longleaf pine (*Pinus palustris*) forests and their amphibian and reptile inhabitants. Species diversity and community evenness of herpetofaunas were reduced in clearcuts in Florida sandhills (Campbell, 1980), however, species richness was not affected. Labisky and Hovis (1987) found greater capture rate, biomass, species richness, and species diversity in natural longleaf pine forest than in slash pine (*Pinus elliottii*) plantations in Florida. Williams and Mullin (1987) found lower abundance of amphibians and reptiles and Pearson et al. (1987) found lower herpetofaunal species richness in clearcut longleaf-slash pine forests when compared to more mature forest stands in central Louisiana and southern Mississippi, respectively. The objective of this study was to determine the effect that different forestry management practices have upon communities of amphibians and reptiles in four different sandhills habitats in South Carolina.

## MATERIALS AND METHODS

This study was conducted in the Sand Hills State Forest (SHSF) and adjacent Carolina Sandhills National Wildlife Refuge (CSNWR) in Chesterfield Co., South Carolina. Both encompass 18,600 ha, each with significant tracts of restored longleaf pine/turkey oak (*Quercus laevis*) forest, riparian forest, wetlands and permanent artificial ponds and lakes. The SHSF receives no state funding and must generate revenue for the state via timber harvest, stump removal, and sale of pine cones and fallen pine needles (Jones, 1995 pers. comm.). However, the SHSF contains populations of the federally endangered red-cockaded woodpecker, *Picoides borealis* (RCW), so stands of longleaf pine are managed for this species. The CSNWR is managed primarily for longleaf pine forest habitat and is much less fragmented than the SHSF.

I sampled four different habitats in the SHSF that were managed differently and four comparable habitats in the CSNWR. The habitats sampled included upland longleaf pine/turkey oak sandhills, riparian forest, artificial permanent ponds

and temporary wetlands (Table 1). Because no temporary ponds could be located on the SHSF, a shrub bog (pocosin) with numerous small temporary pools was sampled. The CSNWR sites served as reference sites. The longleaf pine/turkey oak forest, riparian forest, and permanent ponds at the SHSF were sampled from 1995 to 1998 and the CSNWR sites were sampled during

Table 1. Habitat, site descriptions, and treatments for eight sites sampled in the Sand Hills State Forest and the Carolina Sandhills National Wildlife Refuge. The CSNWR sites served as reference sites.

| Habitat | Sand Hills State Forest | Carolina Sandhills NWR |
|---|---|---|
| Longleaf Pine / Turkey Oak Forest | 51 ha fragment among clear cut and pine plantation | 782 ha tract bordered by 3 tracts of similar size |
| Riparian Forest | Black Creek Floodplain selective cut – spring 1994 | Black Creek Floodplain 18.9 km upstream from SHSF site |
| Permanent Pond | Flory Pond – 17.4 ha Slash Pine clear cut - winter 1997 | McLeod Pond - surrounded by longleaf pine/turkey oak forest |
| Wetlands | Pocosin with numerous small pools - stump removal spring 1996 | Vernal pool in longleaf pine/turkey oak forest |

1996 and 1997 (Table 2). The pocosin on the SHSF was sampled during 1997 and 1998.

Each site contained at least one 16 m aluminum drift fence with eight 19L pitfall traps and two funnel traps. However, two 16 m aluminum drift fences with eight 19L pitfall traps and two funnel traps per drift fence were used to sample the temporary pond at the CSNWR. Each sampling site also contained from 1-8 wood and 4-9 metal coverboards, and linear transects of 10 2-cm-inside-diameter 1-m-

long pvc pipe treefrog retreats. Wood coverboards were plywood that measured 1.24 m per side and metal coverboards were 2m by 1m. More wood boards were

Table 2. Sampling effort and months of sampling for eight sites in the Sand Hills State Forest and the Carolina Sandhills National Wildlife Refuge. One trap day (TD) is one drift fence open for one day.

| Habitat | Year | Sand Hills State Forest | Effort (TD) | Carolina Sandhills NWR | Effort (TD) |
|---|---|---|---|---|---|
| Longleaf Pine / | 1995 | M,Jn,Ju,S,O* | 69 | | |
| Turkey Oak | 1996 | Ap,M,Jn,Ag | 31 | Ap,M,Jn,Ag | 40 |
| Forest | 1997 | Mr,Jn,Ju,Ag | 37 | F,Mr,Ap | 60 |
| | 1998 | F,Mr,Ap,M,Jn,Ju | 155 | | |
| Total | | | 292 TD | | 100 TD |
| Riparian Forest | 1995 | M,Jn,Ju,S,O | 69 | | |
| | 1996 | F,Mr,Ap,M,Jn,A | 81 | F,Mr,Ap,M,Jn,A | 81 |
| | 1997 | g | 38 | g | 60 |
| | 1998 | Mr,Jn,Ju,Ag | 155 | F,Mr,Ap | |
| | | F,Mr,Ap,M,Jn,Ju | | | |
| Total | | | 343 TD | | 141 TD |
| Permanent | 1995 | M,Jn,Ju,S,O | 69 | | |
| Pond | 1996 | F,Mr,Ap,M,Jn,A | 81 | F,Mr,Ap,M,Jn,A | 81 |
| | 1997 | g | 38 | g | 60 |
| | 1998 | Mr,Jn,Ju,Ag | 155 | F,Mr,Ap | |
| | | F,Mr,Ap,M,Jn,Ju | | | |
| Total | | | 343 TD | | 141 TD |
| Wetlands | 1996 | | | F,Mr,Ap,M,Jn,A | 162** |
| | 1997 | Ju,Ag | 14 | g | 120 |
| | 1998 | F,Mr,Ap,M | 92 | F,Mr,Ap | |
| Total | | | 106 TD | | 282 TD |
| Grand Total | | | 1084 TD | | 664 TD |

*F=February, Mr=March, Ap=April, M=May, Jn=June, Ju=July, Ag=August, S=September, O=October

**Two drift fences were used at this site.

placed at mesic sites and more metal boards at drier sites because amphibians prefer wood and reptiles metal coverboards, respectively (Grant et al., 1992). At the longleaf pine and wetland sites the pvc pipe transects were perpendicular to the drift fences.

At the riparian forest and pond sites these transects paralleled shorelines. Coverboards and treefrog retreats were only checked when drift fences were in use. Hoop net turtle traps and funnel traps were used to sample the permanent ponds. Turtle trapping effort consisted of ten traps for one night at Flory Pond (SHSF) and nine traps for one night at McLeod Pond (CSNWR). Pools at the wetland sites were sampled by dip netting and with funnel traps. Unless otherwise stated, frog calls were recorded as the presence of the species and one capture of one individual for all analyses. All animals collected were marked by toe-clipping amphibians and lizards, PIT tagging snakes and notching the marginal scutes of turtles prior to release at capture site. Data were combined from all sampling methods for each sampling site. One voucher specimen of each species from both the CSNWR and SHSF was deposited in the Charleston Museum, Charleston, SC.

Because of unequal trapping effort data was standardized as number of captures / 100 trap days for statistical analysis (deMaynadier, Hunter, 1998). One trap day (TD) is defined as one drift fence open for one day. The Mann-Whitney *U* Test was used to compare the mean number of captures / 100 TD between analogous habitats. With samples where $n_1$ and $n_2$ were too large for the Mann-Whitney *U* Test, the z test was used instead (Zar, 1984). The Z test was used to test data pooled from all four sites within the SHSF and CSNWR, respectively, and to test the wetland sites. Species richness, species diversity and community evenness were calculated for each sampling site. Species diversity was compared between analogous SHSF and CSNWR habitats by rarefaction starting with a random number seed of 10 and performing 1000 iterations using Ecosim software (Gotelli, Entsminger, 2001). EcoSim compares the observed species richness value from the smaller sample with the predicted mean and 95% confidence interval (CI) based upon random samples taken from the larger sample. Communities were considered to be significantly different if the expected species richness value does not fall within the bounds of the 95% CI for that observed in the larger sample. Community evenness was calculated as $J' = H' / \ln S$ where S is species richness and H' is the Shannon-Weiner index (Ludwig, Reynolds, 1988). The community evenness index ranges from 0 for communities dominated by a single species to 1 for communities consisting of species occurring in equal proportions. A *p* value of 0.05 or less is considered significant in all hypothesis testing.

## RESULTS

Logistical concerns precluded equal sampling effort at the SHSF and the CSNWR. Data from a total of 664 TD at the CSNWR and 1084 TD at the SHSF were used in this study (Table 2). A total of 363 captures of 37 species with 30 recaptures were found at the CSNWR and 322 captures of 40 species with 32 recaptures were found at the SHSF. A capture rate of 1.05 captures / 100 TD at the CSNWR was significantly greater than 0.36 captures / 100 TD at the SHSF ($Z=2.43$, $P<0.05$). Two species, the southern toad (*Bufo terrestris*) and the ground skink (*Scincella lateralis*) were captured at all eight sampling sites (Table 3).

Table 3. Numbers of captures (recaptures included) and observations of amphibians and reptiles from four habitats at eight sites sampled at the Sand Hills State Forest (SF) and the Carolina Sandhills National Refuge (NWR), Chesterfield Co., South Carolina.

| Species | Longleaf Pine | | Riparian Forest | | Ponds | | Wetlands | |
|---|---|---|---|---|---|---|---|---|
| | SF | NWR | SF | NWR | SF | NWR | SF | NWR |
| Amphibia: Caudata | | | | | | | | |
| *Eurycea cirrigera* | | | | 4 | | 1 | | |
| *Notophthalmus viridescens* | | | | | | | | 111 |
| *Plethodon chlorobryonis* | | | 2 | 7 | | | 7 | |
| *Pseudotriton ruber* | | 5 | | | | 6 | 1 | 2 |
| *Siren intermedia* | | | | | | 1 | | |
| *Siren lacertina* | | | | | 1 | | | |
| Anura: | | | | | | | | |
| *Acris gryllus* | | | | | 39 | 1 | 2 | 4 |
| *Bufo fowleri* | | | | | | 1 | | 3 |
| *Bufo terrestris* | 7 | 9 | 24 | 36 | 1 | 4 | 14 | 6 |
| *Gastrophryne carolinensis* | | | 4 | | 1 | | 1 | 2 |
| *Hyla andersonii* | | | | | 1 | | 1 | 3 |
| *Hyla cinerea* | | | 1 | | 1 | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Hyla femoralis* | | | 1 | | | | 1 | 3 |
| *Hyla chrysocelis* | 1 | | 1 | 1 | | | 1 | 1 |
| *Pseudacris crucifer* | | | | 3 | | | 1 | 15 |
| *Rana capito* | | | | | | | 2* | |
| *R. catesbeiana* | 4 | | | 1 | | | | |
| *Rana clamitans* | 1 | | 2 | 7 | 12 | 1 | 24 | 1 |
| *Rana sphenocephala* | | | 2 | | | 1 | 1 | 1 |
| *Rana virgatipes* | | | 1 | | 10 | 1 | | 1 |
| *Scaphiopus holbrookii* | | | | | | | | 4 |
| Reptilia: Testudines | | | | | | | | |
| *Kinosternon subrubrum* | | | | 1 | 4 | | | |
| *Sternotherus odoratus* | | | | | | 2 | | |
| *Pseudemys concinna* | | | | | 3 | | | |
| *Terrapene carolina* | | | | | | | 1 | |
| *Trachemys scripta* | | | 1 | | 10 | 20 | | |
| Squamata: Sauria | | | | | | | | |
| *Anolis carolinensis* | 1 | | 4 | 4 | 1 | 2 | 2 | 4 |
| *Cnemidophorus sexlineatus* | 1 | | 8 | | 8 | 4 | 5 | |
| *Eumeces fasciatus* | 6 | 1 | 6 | 1 | | | | |
| *Eumeces laticeps* | 1 | | 3 | | 1 | | 1 | |
| *E. inexpectatus* | 5 | 6 | 1 | | | | 1 | |
| *Scincella lateralis* | 9 | 5 | 8 | 4 | 1 | 5 | 6 | 19 |
| *Ophisaurus ventralis* | | | | | | | 1 | |
| *Sceloporus undulatus* | 7 | 7 | | 2 | 3 | 1 | 6 | 10 |
| Serpentes: | | | | | | | | |
| *Agkistrodon piscivorous* | | | 2 | | 2 | 1 | 2 | |
| *Carphophis amoenus* | 2 | | | | | | | |
| *Coluber constrictor* | | | 1 | | 1 | | | 1 |
| *Crotalus horridus* | | | 1 | | | | | |
| *Diadophis punctatus* | | | 1 | 1 | | 2 | | 1 |
| *Elaphe obsoleta* | | | 2 | 1 | | | | |
| *Lampropeltis getula* | | | 1 | | | | | |
| *L. triangulum* | 1 | | 1 | | | | 2 | |
| *Nerodia fasciata* | | | | | 4 | 2 | | |
| *Nerodia taxispilota* | | | 1 | | | | | |
| *Storeria dekayi* | | | | 3 | | | | |
| *Tantilla coronata* | 2 | 1 | 4 | | 1 | | | 1 |
| *Thamnophis sirtalis* | | | | 1 | | | | |
| *Virginia striatula* | | | 2 | 1 | | | 1 | |

*Two males were heard calling on 11 May 1996. Despite considerable effort neither specimens nor a breeding population has been verified.

Thirteen of 21 species of amphibians and 17 of 28 species of reptiles documented were found on both the SHSF and CSNWR. When species richness is compared between habitats (SHSF and CSNWR sites combined) amphibian species richness was highest (15 species) in the temporary wetlands and lowest in longleaf pine forest (6 species).

The longleaf pine/turkey oak forest site in the SHSF is a 51 ha RCW colony surrounded by clear cut and young pine stands (Table 1). This site was sampled for 292 TD whereas the reference site at CSNWR was sampled for only 100 TD (Table 2). Fourteen species were documented at the SHSF site and seven at CSNWR. Community evenness was higher for the CSNWR site but species diversity was greater for the SHSF site (Table 4). However, the CSNWR site had a significantly higher capture rate (Table 4; Mann-Whitney *U*=86, df=7, 14,

Table 4. Summary statistics for amphibian and reptile samples from eight sites sampled at the Sand Hills State Forest (SF) and the Carolina Sandhills National Refuge (NWR), Chesterfield Co., South Carolina. Refuge sites served as reference sites. Capture rate is number of captures / 100 TD where one trap day (TD) is one drift fence open for one day. CI is confidence interval.

| Measure | Longleaf Pine | | Riparian Forest | | Ponds | | Wetlands | |
|---|---|---|---|---|---|---|---|---|
| | SF | NWR | SF | NWR | SF | NWR | SF | NWR |
| Species Richness | 14 | 7 | 25 | 17 | 21 | 18 | 23 | 22 |
| Species Diversity X (95% CI) | 14* (9.8-13.6) | 11.6 | 25 | 25 | 14.8 (11.5-18.0) | 21* | 15.3 (12.1-18.4) | 23* |
| Community Evenness | 0.853 | 0.899 | 0.777 | 0.573 | 0.742 | 0.803 | 0.794 | 0.720 |
| Capture Rate | 1.17 | 4.86** | 0.98 | 3.25** | 1.50 | 2.20** | 3.45 | 3.14 |

*Significantly greater species diversity based on rarefaction analysis.
**Significant at P<0.05, Mann-Whitney *U* test.

p<0.05). The red salamander (*Pseudotriton ruber*) was the only species present at CSNWR but not at the SHSF site (Table 3).

Both riparian forest sites sampled were along Black Creek, a coastal plain black water creek that flows southeast into the Great Pee Dee River (Table 1). The SHSF site had the mature pond pine (*Pinus serotina*) removed in spring 1994 (Jones, 1995 pers. comm.). Large numbers of captures of *B. terrestris* characterized the CSNWR sample. Although no significant differences in species diversity were found, species richness and community evenness were greater for the SHSF site (Table 4). Ten species were found at both sites (Table 3). Even though trapping effort was greater at the SHSF site than at the CSNWR site, capture rate was significantly higher at CSNWR (Table 4; Mann-Whitney *U*=278; df=17, 25; p<0.05).

The temporary wetlands sampled included a pocosin at the SHSF and a temporary pond in upland longleaf pine/turkey oak forest in the CSNWR. The pocosin had been selectively cut in 1993 and had stumps removed in spring 1996 (Jones, 1995 pers. comm.). Species richness and community evenness were slightly greater at the SHSF site, but species diversity was significantly higher at the CSNWR site (Table 4). Capture rate was higher, but not significant, at the CSNWR site (Table 4; Z=0.012, p>0.05). Large numbers of eastern newts (*Notophthalmus viridescens*) were collected at the CSNWR pond whereas no single species dominated captures at the SHSF site (Table 3).

The permanent ponds sampled included Flory Pond on the SHSF and McLeod Pond on the CSNWR. Both are artificial impoundments caused by the damming of small streams. Community evenness and capture rate were higher at the CSNWR site (Table 4) whereas species richness, species diversity, and trapping effort were greater for the SHSF site (Tables 2, 4). Differences in capture rate were significantly higher for McLeod Pond on the CSNWR (Table 4; Mann-Whitney *U*=333; df=18, 21; p<0.05). Eleven species were found at both sites (Table 3). Flory Pond had a 17.4 ha clear cut on its north side during the winter of 1996. Because the clear cut occurred during the study and adjacent to the sampling site, I compared data from Flory Pond before and after the clear cut (Table 5). Despite the fact that trapping effort was about 25% greater after the clear cut, species diversity, species richness, and community evenness were greater prior to the clear cut.

Table 5. Data from the Sand Hills State Forest, Chesterfield Co., South Carolina before and after clear cutting along the north side of Flory Pond. One trap day (TD) is one drift fence open for one day. CI is confidence interval.

| Parameter | Before Clear cut | After Clear cut |
|---|---|---|
| Trapping effort | 143 TD | 193 TD |
| Number of captures | 49 | 46 |
| Species richness | 18 | 10 |
| Species diversity X (95% CI) | 18* | 16.3 (14.9-17.7) |

| | | |
|---|---|---|
| Community evenness | 0.827 | 0.664 |

*Significantly greater species diversity based on rarefaction analysis

Significantly fewer captures of salamanders were recorded on the SHSF (Table 6). Only 11 captures of three species were recorded from the SHSF whereas 108 captures of five species were recorded on the CSNWR. Whereas terrestrial salamanders were captured at all sites on CSNWR, they were found only at the wetland and riparian forest sites on SHSF (Table 3).

## DISCUSSION

That species richness was similar between CSNWR and SHSF, despite greater trapping effort at the latter, was not unexpected. However, capture rates were significantly greater at three CSNWR sites possibly indicating greater abundance at those sites (Table 4). Approximately 72 species of amphibians and reptiles have been documented at CSNWR (Garton, Sill, 1976) whereas only 55 species have been documented on SHSF (Camper, 1999). Garton and Sill (1976) found 63 species using time constrained searching, road collecting, and three different types of aquatic sampling. The difference in species richness probably reflects differences in sampling methods. Their sampling methods allowed them to search more localities and more habitats. Even though they found more species, I found two species (*Pseudotriton ruber* and *Diadophis punctatus*) that they did not find. Garton and Sill (1976) found more large snakes while road collecting. This study probably underestimated snakes because drift fences with pitfall traps do not sample snakes well because larger specimens escape from pitfall traps (Enge, 2001).

Table 6. Numbers of salamander captures during sampling at the Sand Hills State Forest and Carolina Sandhills National Wildlife Refuge, Chesterfield Co., South Carolina. Recaptures are excluded.

| Species | Sand Hills State Forest | Carolina Sandhills NWR |
|---|---|---|
| *Eurycea cirrigera* | 0 | 5 |
| *Plethodon chlorobryonis* | 9 | 7 |
| *Pseudotriton ruber* | 1 | 13 |
| *Notophthalmus viridescens* | 0 | 89 |
| *Siren intermedia* | 0 | 1 |
| *Siren lacertina* | 1 | 0 |
| Total | 11 | 108 |

$\chi^2 = 77.45$, df = 1, $P<0.05$

Neither study found any salamanders of the genus *Ambystoma* which occur in this region (Conant, Collins, 1991). Since the termination of my study, tiger salamanders (*Ambystoma tigrinum*) and marbled salamanders (*Ambystoma opacum*) have been documented on the CSNWR (Blihovde, 1998; Irwin, 1999 pers. comm.). The latter species was found along the Lynches River where I did not sample. For two *Ambystoma* species to go undetected despite a considerable amount of effort to inventory CSNWR shows that long term sampling using many techniques is needed to thoroughly inventory public lands (Gibbons et al., 1997).

The reason for the significantly greater species diversity and higher species richness for the SHSF longleaf pine/turkey oak forest site is unclear but may be an artifact of greater sampling effort at the SHSF site. However, mean capture rate was significantly higher at CSNWR and more than double that at the SHSF site (Table 4). Although similar, the soils at the SHSF site are characterized by more loam and shallower subsoil with a dense sandy clay loam layer (Morton, 1995). Perhaps the soils at the SHSF site retain more moisture and therefore are better habitat for amphibians and reptiles. The 14 species I found at the longleaf pine forest on CSNWR were comparable to what was found in Florida sandhills. Campbell (1980) found 12 species and Campbell and Christman (1982) found 13 species. However, most other studies of southeastern coastal plain pine forest habitats have reported much higher species richness (Mushinsky, 1984; Enge, Marion, 1986; Labisky, Hovis, 1987; Pearson et al., 1987; Williams, Mullin, 1987; Stout et al., 1988; Greenberg et al., 1994). More mesic sites were more productive in studies at other longleaf pine sites in Florida (Campbell, 1980) and Louisiana (Williams, Mullin, 1987). Perhaps lower species richness was due to sampling in only two upland localities in this study that were not near water.

The riparian forest sites sampled in this study (Table 4) had greater species richness than reported by Clawson et al. (1997) for a site in Alabama. A comparable value of 23 species was reported for a riparian forest in South Carolina (Phelps, Lancia, 1995). The lack of significant differences between these sites in species diversity suggests that selective logging may not be detrimental to herpetofauna. The SHSF site had the highest species richness of all eight sites sampled (Table 4) and was one of only two sites on the SHSF where terrestrial salamanders were captured. The structure of the forest at this site appeared relatively intact despite the removal of mature pond pine in 1994. Selective logging did not negatively impact salamanders in central New York (Pough et al., 1987) and may be beneficial to amphibians by increasing the amount of coarse woody debris (deMaynadier, Hunter, 1995). However, too little data exists to draw definitive conclusions regarding the effects of selective

cutting on herpetofauna (deMaynadier, Hunter, 1995) and at least one study (Mitchell et al., 1996) found that *Plethodon hubrichti* was less abundant in selectively cut stands in Virginia.

Temporary ponds in the southeastern coastal plain are known to have high herpetofaunal species richness (Dodd, Charest, 1988; Dodd, 1992; Russell et al., 2002a). Large numbers of *N. viridescens* captured at the wetland CSNWR site may have depressed community evenness values and increased capture rates (Table 4). However, species diversity was significantly greater for the temporary pond at CSNWR than the SHSF site which was a pocosin with many small pools. My intent was to compare temporary ponds but none could be located on SHSF. The drift fence at the SHSF site was up hill from most of the pools so amphibian captures at this site may be an underestimate of abundance and species richness. Comparisons between these habitats are precluded because so little information is available concerning herpetofaunal species diversity in pocosins (Wilbur, 1981; Sharitz, Gibbons, 1982; Richardson, Gibbons, 1993). Species richness for one coastal plain temporary pond in Florida sandhills (Dodd, 1992) and five in the lower coastal plain of South Carolina (Russell et al., 2002a) was greater than found in this study. However, the ponds studied by Dodd (1992) and Russell et al. (2002a) were completely surrounded by drift fences.

The results from Flory Pond before and after the clear cut are not unexpected. It has been shown that clear cutting may negatively impact amphibian and reptile abundance and species richness (Blymyer, McGinnes, 1977; Enge, Marion, 1986; Pough et al., 1987; Williams, Mullin, 1987; Raymond, Hardy, 1991; Petranka et al., 1993, 1994; Grant et al., 1994; Dupuis et al., 1995; McLeod, Gates, 1998). However, the relationship between clear cutting and species diversity may not be straightforward because (Campbell, 1980) showed that clearcuts reduced abundance but not species richness and Russell et al. (2002b) found no changes in species richness or abundance six months and 1.5 years after clear cutting.

The differences in salamander captures were unexpected given the levels of species richness and diversity at SHSF. However, even in areas of relatively intact habitat on SHSF salamander captures were rare. The SHSF sells the leaf litter as pine straw for garden mulching and it is also illegally poached from intact forest stands (Jones, 1995 pers. comm.). Perhaps the removal of leaf litter in a xeric habitat such as sandhills longleaf pine/turkey oak forest may cause a decline in salamander populations even in relatively intact forest stands. Leaf litter depth and type have been shown to affect salamander activity and abundance (Heatwole, 1962; DeGraaf, Rudis, 1990; Petranka et al., 1993, 1994). Results from this study must be interpreted with caution because of small sample sizes and a lack of replication.

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