

## Observations on Amphibians and Reptiles in Burned and Unburned Forests on the Upper Coastal Plain of Virginia

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### ABSTRACT

I evaluate the results of a short-term study on the effects of prescribed burning on terrestrial amphibians and reptiles on Fort A.P. Hill, Caroline County, Virginia. Six species of amphibians and reptiles were observed in unburned sites and eight species were observed in burned sites. More individual amphibians (46) were observed in unburned stands than in burned stands (15). Adults of two species (*Bufo americanus*, *Plethodon cinereus*) were found dead under logs in the still smoldering prescribed burn. The results of this study suggest that prescribed burning may have some negative effects on amphibians and reptiles. Because the literature on this subject from eastern North America is contradictory, it is premature to make broad scale geographic generalizations. More studies with replications are needed to provide evidence that prescribed burning is harmful to terrestrial amphibians and reptiles in the mid-Atlantic region.

### INTRODUCTION

Prescribed burning of temperate zone forests for timber and wildlife management has been used for decades (Pyne, 1982; Williams, 1989). The use of fire to achieve ecosystem management goals has been increasing substantially, especially in areas where the dominant plant communities evolved with fire (e.g., Stoddard, 1962; Robbins and Myers, 1992; Russell et al., 1999). Most of the research conducted on the effects of prescribed fire on amphibians and reptiles has been conducted in southeastern North America (e.g., Means and Campbell, 1981; Mushinsky, 1985, 1986), in prairie ecosystems (Bigham et al., 1964; Erwin and Stasiak, 1979), and in chaparral habitats in the far West (Lillywhite, 1977). These studies compare compositions of herpetofaunal assemblages in forest tracts maintained by fire management to assemblages in unburned forest tracts or report observations on mortality of individuals following fires. The literature review by Russell et al. (1999) included papers in fire-maintained ecosystems and only three papers from non-xeric habitats (Kirkland et al., 1996; McLeod and Gates, 1998; Ford et al., 1999). These studies examined the effects of prescribed fire on temperate zone hardwood forest herpetofaunas and small mammals. Fire is used as a forest management tool on Fort A.P. Hill (JCM, personal observations). However, the effects of prescribed burning in this area on amphibians and reptiles have not been evaluated.

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In 1997 I had the opportunity to obtain information on the terrestrial herpetofauna in an area on Fort A.P. Hill that was being burned for forest management. My hypothesis was that the numbers of species and individuals observed in burned forests would not be significantly different from numbers in adjacent unburned forests. Here I evaluate comparative information from these two areas and review the literature on this subject to gain insights into the effects of prescribed burning on terrestrial amphibians and reptiles in the upper Coastal Plain of Virginia.

#### MATERIALS AND METHODS

My field crews and I conducted time-constrained, haphazard transect surveys in mixed hardwood forests in Fort A.P. Hill Training areas 5C, 6B, 6C, and 7A during 2-7 April 1997 (see Mitchell and Roble, 1998 for locations of training areas). Fort A.P. Hill (US Army), Caroline County, Virginia, is a training facility for infantry and support operations, and is comprised of 30,329 ha of reclaimed farmland that is now in various stages of ecological succession. Descriptions of the base are in Mitchell and Roble (1998) and Bellows et al. (1999). Training area 5C, an area covered largely by mixed hardwood and pine forest, was burned with a low-intensity fire on 2 April 1997. I surveyed four different areas separated from each other by several hundred meters. The fire was still burning inside logs and along the forest floor during the afternoon of these surveys. I selected four nearby sites in the other training areas noted for comparative sampling. The other training areas supported stands of mixed oak (*Quercus* spp.) and Virginia pine (*Pinus virginiana*). These were surveyed on the same day, as well on three subsequent days. I assumed that recent rainfall history and pre-burn soil conditions were similar between burned and unburned sites and that these micrographic variations would have no measurable effects on the activity of amphibians and reptiles. All observations were recorded by 2-3 people during one-hour daytime surveys. All individuals were recorded and observations were made on dead and dying animals, as well as pertinent microhabitat features.

#### RESULTS

Six species of amphibians and reptiles (4 salamanders, 1 frog, 1 lizard) were observed in unburned sites and 8 species (3 salamanders, 1 frog, 2 lizards, 2 snakes) were observed in burned sites (Table 1). Forty-five individual amphibians were observed in unburned sites, most of which (43) were *Plethodon cinereus*. Comparatively, 14 amphibians (8 *P. cinereus*) were found in the burned sites. One lizard was observed in one unburned site and two lizards and two snakes were observed in the burned sites. No amphibians or reptiles were found in Training Area 6B despite the fact that 340 logs of various sizes were overturned. *Ambystoma maculatum* egg masses and strings *Bufo americanus* eggs were found in a vernal pool in 6B.

In Training Area 5C, one *Notophthalmus viridescens* eft was found alive and healthy under a 7.6 cm diameter log that had burned all the way around except directly underneath. One adult gravid female *P. cinereus* (43 mm SVL, 55 mm total length, 1.4 g) was found limp and apparently dead under a 25 cm diameter log. The adult *Bufo americanus* was found dead and partially concealed under a small log. The *Ambystoma maculatum* was a 48 mm SVL, 3.2 g juvenile that was found under a 7.6 cm diameter log at the top of its burrow entrance. In addition to these observations, one 35 mm adult

TABLE 1. Number of amphibians and reptiles observed in four unburned hardwood forest tracts and in four sampling sites in one large burned hardwood forest on Fort A.P. Hill, Virginia. Number and letter designations represent Training Areas. All the burned sites were located in Training Area 5C.

Species	Unburned				Burned			
	6C	6B	7A	5C	1	2	3	4
<b>Amphibians</b>								
<i>Ambystoma maculatum</i>	0	0	0	0	0	0	1	0
<i>Plethodon cinereus</i>	29	0	11	3	3	5	0	0
<i>Plethodon cylindraceus</i>	0	0	0	0	0	2	0	0
<i>Pseudotriton ruber</i>	1	0	0	0	0	0	0	0
<i>Notophthalmus viridescens</i>	0	0	1	0	1	1	1	0
<i>Bufo americanus</i>	0	0	0	0	0	0	0	1
<i>Rana clamitans</i>	0	0	1	0	0	0	0	0
Total Amphibians	30	0	13	3	4	8	2	1
<b>Reptiles</b>								
<i>Eumeces fasciatus</i>	0	0	1	0	0	0	1	0
<i>Sceloporus undulatus</i>	0	0	0	0	0	0	0	1
<i>Diadophis punctatus</i>	0	0	0	0	0	0	1	0
<i>Elaphe obsoleta</i>	0	0	0	0	0	0	0	1
Total Reptiles	0	0	1	0	0	0	2	2
No. Person Hours	2	2	2	2	3	2	2	2

four-toed salamander (*Hemidactylium scutatum*) was found in a small seepage area that was 2 m from burned substrate.

#### DISCUSSION AND CONCLUSIONS

Equal numbers of species of amphibians and four times the number of reptiles were found in burned forest sites than in unburned forest sites. In contrast, larger numbers of individual amphibians (mostly salamanders in the genus *Plethodon*) were found in unburned forests than in the burned forest. The few reptiles observed in these sites preclude any realistic conclusions. These observations suggest that there was no difference in species richness between burned and unburned forests. The larger number of salamanders in unburned sites may be due to the higher moisture content of unburned litter and cooler soil compared to the burned area that affected their occurrence on the surface.

Kirkland et al. (1996) used drift fences and pitfall traps to study small mammals and amphibians in burned and unburned oak-dominated forest plots following a prescribed fire in Pennsylvania. They captured a total of 6 species and 35 individual amphibians in the burned plot and 5 species and 15 individuals in the unburned plot. Most species were represented by 1-5 individuals. The American toad (*Bufo americanus*) was significantly more abundant in the burned plot than the unburned plot.

However, it is difficult to evaluate this result because the populations were not studied before the prescribed burn occurred, 4.5 months earlier. Ford et al. (1999) evaluated the effects of a high intensity burn on amphibians and small mammals in pitch pine habitats in a mountainous area in southwestern North Carolina. They sampled burned and unburned areas before and after the fire using time-constrained searches and drift fences with small pitfall traps. Four species of plethodontid salamanders were found but there were no significant differences between burned and unburned plots. Only one study has been conducted on herpetofaunal communities in burned forest habitats and other forest types in the mid-Atlantic region. McLeod and Gates (1998) conducted a two-year study using drift fences and pitfall traps in forest stands on the Eastern Shore of Maryland. The sites were comprised of hardwoods, cutover hardwoods, mixed pine-hardwoods, and prescribed burned pines. They found significantly fewer individual amphibians and reptiles in the burn site than in other sites. Nine species of amphibians and 8 species of reptiles were recorded for the burn site compared to hardwood stands (14 amphibians, 11 reptiles), cutover hardwoods (12/13), and pine (11/12) sites. Species richness between pine and burned stands was not significantly different. They concluded that the deeper leaf litter and more dense overstory in the pine stand kept the forest cooler and more moist than in the burned stand. These factors may have made the pine stand more hospitable to these ectotherms than the drier burned site. The conflicting results of these three studies suggests that there may be regional, habitat, and sampling design differences that affect inferences about prescribed burns on amphibians and reptiles.

The results of my short-term study on Fort A.P. Hill, combined with those in McLeod and Gates (1998), suggest that prescribed burning may have negative effects on amphibians and reptiles at lower elevations in the mid-Atlantic region. Although numbers of species may be similar between treatments, the number of individuals that burned stands can support may be less than numbers in unburned stands. Limited observations on Fort A.P. Hill on mortality in burned areas also indicate that some individuals may be at risk of death from heat in some circumstances. These observations are too few, however, to produce broad scale geographic generalizations. This is because a number of factors directly influence the effects of fire, including fire intensity, seasonal activity of amphibians and reptiles, seasonal timing of prescribed fires, microgeographic variation in moist areas, effects from recent rains, slope angle, aspect, and forest type. I agree with deMaynadier and Hunter (1995) and Russell et al. (1999) that more precise experimentally designed studies with replications are needed to evaluate the extent to which prescribed burning may be harmful to terrestrial amphibians and reptiles in the mid-Atlantic region.

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## LITERATURE CITED

- Bellows, S.A., J.F. Pagels, and J.C. Mitchell. 1999. Small Mammal Assemblages on Fort A.P. Hill, Virginia: Habitat Associations and Patterns of Capture Success. *Banisteria* 14:3-15.
- Bigham, S.R., J.L. Hepworth, and R.P. Martin. 1964. A Casualty Count of Wildlife Following Fire. *Proc. Oklahoma Acad. Sci.* 44:47-50.
- deMaynadier, P.G., and M.L. Hunter, Jr. 1995. The Relationship between Forest Management and Amphibian Ecology: a Review of the North American Literature. *Environ. Rev.* 3:230-261.
- Erwin, W.J., and R.H. Stasiak. 1979. Vertebrate Mortality during the Burning of a Reestablished Prairie in Nebraska. *Am. Midl. Nat.* 101:247-249.
- Ford, W.M., M.A. Menzel, D.E. McGill, J. Learn, and T.S. McCay. 1999. Effects of Community Restoration Fire on Small Mammals and Herpetofauna in the Southern Appalachians. *Forest Ecol. Manage.* 114:233-243.
- Kirkland, G.L., Jr., H.W. Snoddy, and T.L. Amsler. 1996. Impact of Fire on Small Mammals and Amphibians in a Central Appalachian Deciduous Forest. *Am. Midl. Nat.* 135:253-260.
- Lillywhite, H.B. 1977. Effects of Chaparral Conversion on small Vertebrates in Southern California. *Biol. Conser.* 11:171-184.
- McLeod, R.F., and J.E. Gates. 1998. Response of Herpetofaunal Communities to Forest Cutting and Burning at Chesapeake Farms, Maryland. *Am. Midl. Nat.* 139:164-177.
- Means, D.B., and H.W. Campbell. 1981. Effects of Prescribed Burning on Amphibians and Reptiles. Pp. 89-96 *In* G.W. Wood (ed.), *Proceedings of a Symposium: Prescribed fire and Wildlife in Southern Forests*. Belle W. Baruch Forest Science Institute, Clemson University, Georgetown, SC.
- Mitchell, J. C., and S. M. Roble. 1998. Annotated Checklist of the Amphibians and Reptiles of Fort A. P. Hill, Virginia, and Vicinity. *Banisteria* 11:19-31.
- Mushinsky, H.R. 1985. Fire and the Florida Sandhill Herpetofaunal Community: with Special Attention to Responses to *Cnemidophorus sexlineatus*. *Herpetologica* 41:333-342.
- Mushinsky, H.R. 1986. Fire, Vegetation Structure and Herpetofaunal Communities. Pp. 383-388 *In* A. Rocek (ed.), *Studies in Herpetology, Proceedings of the 3<sup>rd</sup> European Herpetological Meeting*. Prague, Czechoslovakia.
- Pyne, S.J. 1982. *Fire in America: a Cultural History of Wildland and Rural Fire*. Princeton University Press, Princeton, NJ. 653 pp.
- Robbins, L.E., and R.L. Myers. 1992. Seasonal Effects of Prescribed Burning in Florida: a Review. *Tall Timber Research Inc., Misc. Publ.* 8:1-96.
- Russell, K.R., D.H. Van Lear, and D.C. Guynn, Jr. 1999. Prescribed Fire Effects on Herpetofauna: Review and Management Implications. *Wildl. Soc. Bull.* 27:374-384.
- Stoddard, H.L. 1962. Use of Fire in Pine Forests and Game Lands of the Deep Southeast. *Proceedings of the Tall Timbers Fire Ecology Conference*. Tall Timbers Research Station, Tallahassee, FL, 1:31-42.
- Williams, M. 1989. *Americans & Their Forests, A Historical Geography*. Cambridge University Press, New York, NY. 599 pp.