Impacts of Prescribed Burning on Three Eastern Box Turtles (Terrapene carolina carolina) in Southwestern Virginia

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Introduction

The Eastern Box Turtle (*Terrapene carolina carolina*) is a common species throughout most of Virginia, but is listed as a Tier III species in the Virginia Wildlife Action Plan, indicating a high conservation need and action needed to stabilize or increase populations of the species.

Eastern box turtles typically overwinter in forests (Dodd, 2001). Overwintering behavior in southern Virginia varies with winter weather conditions, but in a normal winter, overwintering depths of turtles is typically not deep, with the top of the carapace often at or just below the duff layer (Ellington et al., 2007). Box turtles may even emerge during the winter for brief periods (Ellington et al., 2007; Dodd, 2001).

Because of their overwintering behavior, another potential conservation threat to the Eastern Box Turtle may be the increasing use of prescribed fire. Prescribed fire is carried out for a number of different management objectives, including controlling the composition of tree regeneration, fuel reduction, wildlife habitat improvement, and control of invasive species. In southern Virginia, prescribed burns are typically carried out in the late winter and early spring (Waldrop and Goodrick, 2012).

Studies on the effect of prescribed burning on box turtles are relatively scarce. Dodd (2001) noted that there is anecdotal information of turtles scarred by fires losing scutes which, although not fatal, may make turtles more susceptible to cold, heat and drought. Platt et al. (2010) reported that season of burning had a significant effect on box turtle mortality in Florida. Box turtle mortality was higher during the wet season (when box turtles were more active) than during the dry season. Greenberg and Waldrop (2008) also note that box turtles may be indirectly affected by fire because of habitat alteration. Box turtles use leaf litter for thermal cover and removal of leaf litter by fire may therefore reduce habitat quality. It is also conceivable that leaf litter removal by fire may reduce habitat quality for overwintering, but no studies have investigated this hypothesis. In a review of the effects of prescribed fires on reptiles, Russell et al. (1999) conclude that there are probably few long-term effects of controlled burning on reptiles in general, but box turtles may be more susceptible because of their limited ability to escape fire and their dependence on forest leaf litter.

The objective of this study was to determine the impact of prescribed fires on Eastern Box Turtles by carrying out simulated prescribed burning in areas where turtles are overwintering and recording their subsequent behavior during and after overwintering.

Materials and Methods

The study was conducted at two locations on the campus of Ferrum College in Franklin County (Chapman Pond and Moonshine Creek), Virginia and another site on private property approximately one mile from the College (Rambling Rose). All study sites contained mature (> 70-year-old) mixed pine-hardwood forests with the canopy dominated by Oaks (*Quercus* spp.), Red Maple (*Acer rubrum*), Tuliptree (*Liriodendron tulipifera*), and White Pine (*Pinus strobus*). The forests had been subjected to light selective logging approximately 30 years ago. The Chapman Pond study area is situated on a low ridge with relatively flat topography. The Moonshine Creek area is on a moderate (2-10%) slope with an East-facing aspect. The Rambling Rose area has variable aspects and slopes (0-10%).

We searched the three study areas and located ten turtles during the summer and fall of 2014. We located three turtles at Chapman Pond, five at Moonshine Creek, and two at the Rambling Rose site. Radio-transmitters (Wildlife Materials Inc., Murphysboro, KY) were affixed to the carapace of each of the ten turtles using gel epoxy. Turtles were tracked approximately every ten days using radio-telemetry using a TRX 2000 telemetry receiver and antenna (Wildlife Materials, Murphysboro, KY) until they settled into their overwintering sites.

We randomly selected 1-2 turtles at each of the study areas (a total of five turtles) for a simulated prescribed burn surrounding their overwintering site at some point between early December and late March when prescribed burns are normally carried out in Virginia. The remaining five turtles were used as a control population to compare hibernation behavior with the turtles at the prescribed burn sites.

The simulated prescribed burn consisted of burning the leaf litter over an area approximately 2 x 2 m surrounding the overwintering site. Leaf litter was raked away around the burn area to prevent the spread of fire and the litter was ignited using a drip torch on the downwind side of the area in order to conduct a back fire (a fire backing into the wind) (Figure 1). Back fires are normally used in prescribed burning because they burn more slowly, are easier to control, and provide for a more complete combustion of fuels (Waldrop and Goodrick, 2012).

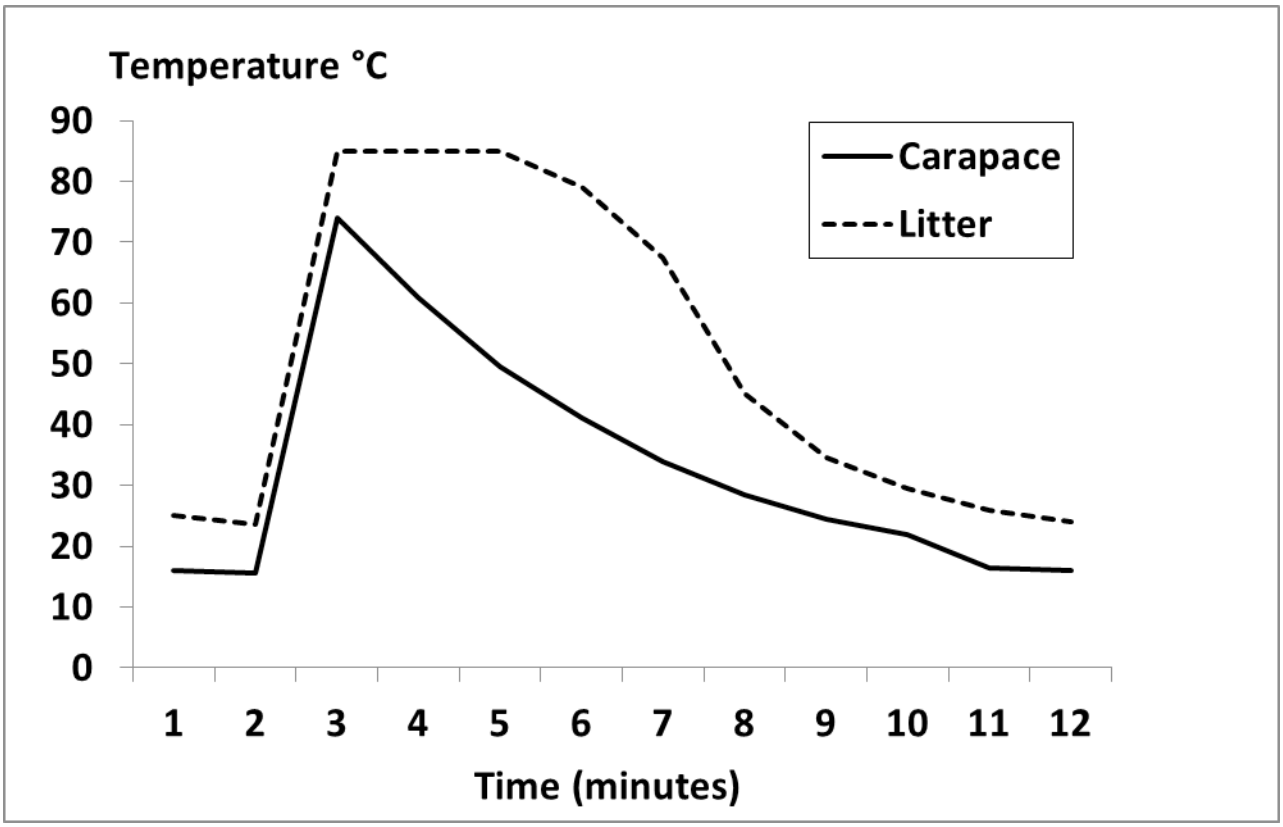
Because of logistic issues and weather conditions, we were only able to conduct burns over three turtles at two sites on March 17-18. Burning can only be carried out safely under appropriate weather conditions and when adequate personnel support is available. Burning is also restricted until after 1600 hours from February 15-May 1 by Virginia state law. Burns on these days were carried out between 1700-1830 hours. Ambient weather conditions during this were favorable for prescribed burns: air temperature ranged from 18-20 °C, relative humidity ranged from 25-35%, and wind velocity was < 15 km/hr. Leaf litter at each site was dry enough to support a burn. The temperature at the surface of the litter and on the top of the turtle carapace was measured immediately before, during and after the burns using i-button sensors (Thermochron Corporation, Dallas TX) that were set to record temperatures at one-minute intervals. We

observed the behavior of the turtles before, during, and after the burn. We also visited the burn sites 30 minutes and 1 day after the burns to determine if the turtles moved after the burn. In addition, we tracked each of the ten turtles weekly after the burns to determine the approximate date of emergence from the overwintering sites for the three turtles on the burn sites compared to the other seven turtles where burning was not conducted.

Results

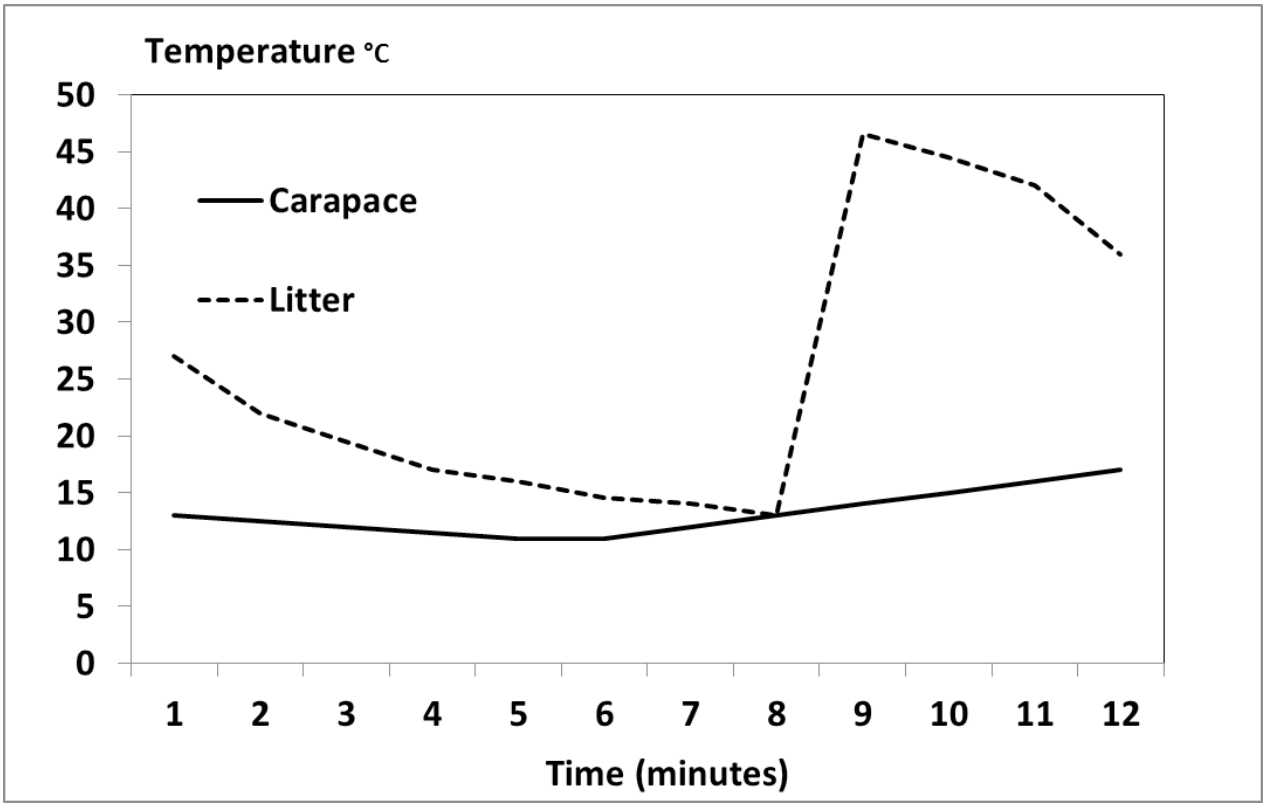
Only one of the three turtles was immediately impacted by the experimental burn (Turtle 1). The depth of this overwintering site was relatively shallow with the turtle buried mostly in the duff layer and with approximately 30% of the carapace exposed at the base of the loose leaf litter layer. Leaf litter temperatures reached 85°C during the burn and the sensor on the carapace temperature reached 72°C (Figure 2). There was some visible movement of the turtle immediately after the burn and the affected turtle emerged from the overwintering site approximately one hour following the burn and was observed slowly moving away from the burn site. It did not appear to be injured by the fire although the wire on the transmitter was slightly melted. The transmitter was still functional. One day later, the turtle was buried into the duff layer approximately 3 m from the burn site. It was active on the surface in mid-April with no apparent injury.

Figure 2. Temperature of sensors on surface of leaf litter and turtle carapace during the fire event for turtle 1.



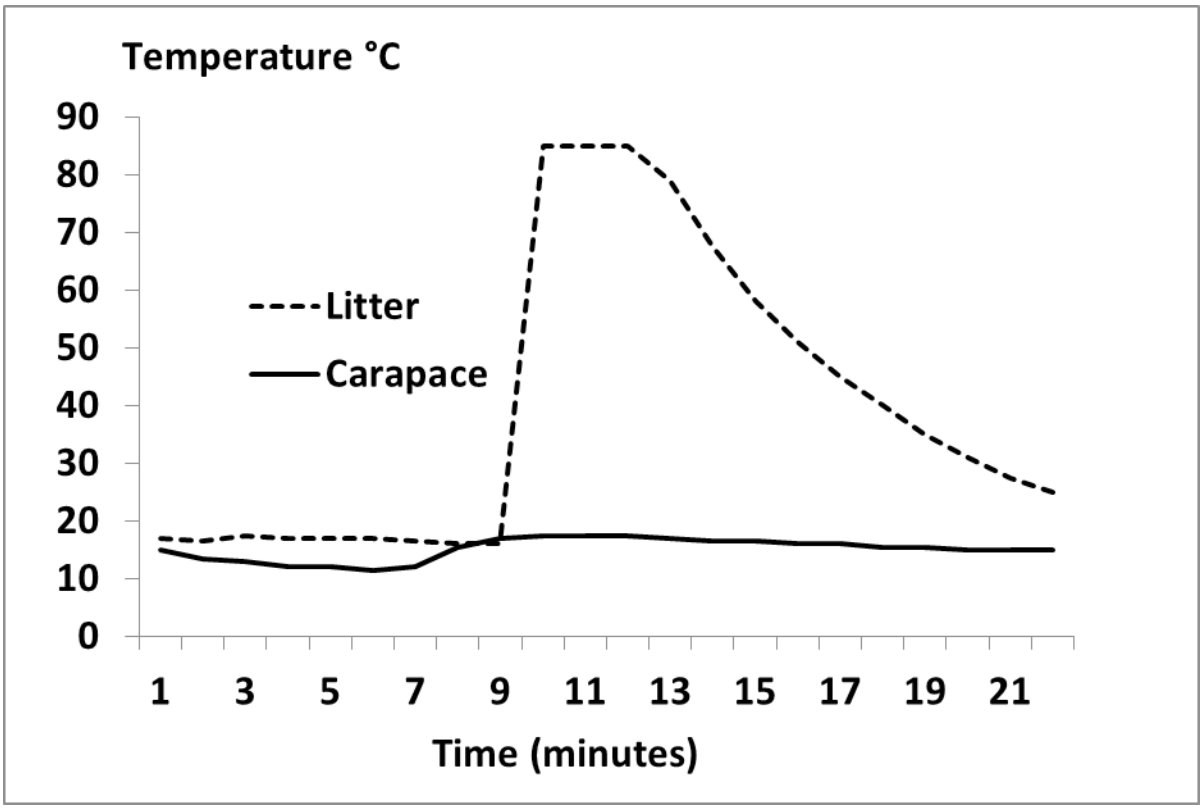
Turtle 2 was buried more deeply than turtle 1, with only 5% of the carapace exposed at the base of the loose leaf litter layer. The duff layer at this site also appeared to be moister compared to the site of turtle 1. The leaf litter temperature during the burn at this site reached a maximum of 45°C and carapace temperature rose only slightly during the burn (Figure 3). The turtle did not move during or after the burn and had not moved by the following day. It emerged from overwintering in mid-April with no apparent effects from the fire.

Figure 3. Temperature of sensors on surface of leaf litter and turtle carapace during fire event for turtle 2.



Turtle 3 was buried in the duff layer with approximately 10% of its carapace exposed. We noticed some movement of this turtle while preparing the site for the burn. The temperature during the burn reached 87ºF, but the carapace temperature rose only slightly (Figure 4), perhaps because the duff layer appeared more moist compared to the sites for turtles 1 and 2. Immediately following the burn, the turtle's head emerged from its shell and it seemed to have been aroused more by the smoke than the fire itself. Its head was still exposed from the shell after 1 hour. On the following day, it was still in its overwintering site with its head in its shell. It emerged from overwintering in mid-April.

Figure 4. Temperature of sensors on surface of leaf litter and turtle carapace during fire event for turtle 3.



The other seven turtles showed no activity during the winter monitoring period and emerged from their overwintering sites during mid-April, except for one turtle which moved from its overwintering site in early April.

Discussion

The results of this study are somewhat anecdotal because prescribed burns were carried out over the overwintering sites of only three box turtles during one time of the year. The data, however, indicate variability in the behavior of box turtles following the occurrence of burning over their overwintering sites, mostly due to the depth of the turtle below the leaf litter and microsite conditions such as soil and duff layer moisture levels. The one turtle that moved out of the overwintering site after the fire, experienced high carapace temperatures, most likely due to a larger percentage of the carapace protruding out of the duff and exposed to the fire burning through the leaf litter. The other two turtles did not move from their overwintering sites after the fire, presumably because of lower carapace temperatures due to reduced carapace exposure and observed moister duff layer conditions.

Box turtles in Virginia are likely to be more susceptible to prescribed fire compared to turtles in northeastern states because their overwintering sites are relatively shallow (Ellington et al. 2007), but they are likely to be overwintering throughout the period when prescribed burning

is carried out (December – March). Prescribed burning is normally not carried out during the growing season because higher humidity makes it difficult to sustain a prescribed burn (Waldrop and Goodrick, 2012). However, Howey and Roosenberg (2013) documented a prescribed burn carried out in September at a site in Kentucky and reported injuries to turtles that were not yet overwintering. In contrast to mid-Atlantic states, the states in the lower southeastern U.S. have a shorter overwintering season for box turtles and are exposed to more frequent prescribed burning, particularly in pine forests, likely making turtles more vulnerable to fire. Platt et al. (2010) recommended burning during seasons when turtles are dormant. It was also recommended that burns be carried out using slower-moving backfires and that burning be conducted on smaller areas. Interestingly, they also noted that more frequent light burning may reduce fuel loads and potentially reduce mortality from more severe fires on areas with higher fuel loads. In Virginia, more research on box turtle responses to prescribed fire would be particularly useful in the southeastern portion of the state where burning is more common in pine forest ecosystems.

Although burning did impact the behavior of two of the three turtles in this study, it did not appear to injure the turtles or impact their longer-term overwintering behavior. All three turtles in this study emerged from overwintering in mid-April and the removal of leaf litter over the overwintering site did not result in emergence compared to overwintering turtles not exposed to the burning treatment. More intense fires resulting from larger fuel loads or hotter fires that occur under dryer conditions are likely to burn more deeply into the duff layer and may cause injury to turtles and/or alter their overwinter behavior. In addition, the burns carried out in this study occurred during relatively warm weather. If turtles are disturbed by burns carried out under colder weather conditions, they may not be able to successfully acclimate in time to resume overwintering. More testing is necessary to increase the sample size (for statistical significance) and to obtain data under a wider range of conditions, e.g. testing under colder conditions with larger fuel loads. This will provide more reliable data needed for prudent management decisions regarding prescribed burns in a variety of box turtle habitats. However, our results indicate that prescribed burning (given similar weather conditions and fuel loads) poses no discernable threat to hibernating box turtles.

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Figure 1. Prescribed burn on an overwintering site of an Eastern Box Turtle.