Observations on the response of four eastern box turtles (*Terrapene carolina carolina*) to clearcut logging and chipping in southern Virginia

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Introduction

The eastern box turtle (*Terrapene carolina carolina* L.) is a common terrestrial turtle (Testudines: Emydidae) found throughout the eastern United States. The species occurs in a wide variety of habitats, but its range closely coincides with that of the eastern deciduous forest (Dodd, 2001). Although considered to be a common species, box turtles are threatened by a suite of factors including habitat destruction and alteration, mortality on roads, pet collection, and environmental contaminants (Dodd, 2001; Budischak et al., 2006). Box turtles are long-lived, but have a very low reproductive potential compared to other reptiles (Klemens, 2000). In one study in Virginia, Wilson and Ernst (2005) found that less than half of adult females were gravid during the breeding season and the mean clutch size per female was 3.15. Young turtles are particularly vulnerable to predation by increasing numbers mesopredators in fragmented landscapes, such as raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), and striped skunk (*Mephitis mephitis*) (Dodd, 2001).

Since 2005, we have studied the eastern box turtle on the campus of Ferrum College and surrounding sites. We have used radiotelemetry to study its home range and hibernation behavior (Fredericksen et al., 2007; Ellington et al., 2007). We have also compared the occurrence of box turtles on recently logged stands with that of mature forest stands (Fredericksen et al., 2006). Box turtles have relatively small home ranges (1.2-4.7 ha) (Mitchell 1994) and low vagility, making

them vulnerable to disturbances such as logging.

A survey of box turtle abundance in a sample of forest stands in Franklin and Henry Counties in Virginia found, however, that box turtles were equally common on logged and unlogged stands (Fredericksen et al. 2006). Yet, it is uncertain how much mortality occurs to box turtles by logging equipment or tree felling. It is also unclear whether logging disturbance causes turtles to leave their home range or whether sites are recolonized by box turtles following logging.

In 2008, we studied the behavior and fate of four box turtles using radiotelemetry on a tract in Franklin County that was clearcut logged and chipped. Logging began in June and we were able to follow the four turtles through the four-week logging event, as well as for two months following logging.

Methods

The study site was approximately 8 ha in size and located on relatively flat terrain. The site contained commercially mature forest tree species and was dominated by tuliptree (*Liriodendron tulipera*), red maple (*Acer rubrum*), white pine (*Pinus strobus*) and a mixture of oak (*Quercus*) species. Between 29 May and 4 June, we searched the stand and located four mature box turtles. The carapace length of the turtles ranged between 125-140 mm and weight ranged between 340-455 g. We affixed a small radiotransmitter (Model SOPR-2190-MVS, Wildlife Materials, Murphysboro, KY) to the rear right marginal scutes using gel epoxy. We then located each of the turtles every 2-3 days with a TRX 2000 telemetry receiver and antenna (Wildlife Materials, Murphysboro, KY). Turtle locations were recorded using a Garmin GP3 Mapper global positioning system (Garmin Ltd., Ogathe, KS). Logging began on 11 June and finished on 10 July. We continued to monitor the movements of turtles during and after logging until late September. We estimated the home range size of turtles using the minimum convex area method.

Results

The movements of the box turtles were only monitored a short time before logging and only a few months following logging. The home range estimates of the turtles in this study are thus only approximate. Behavior of the four turtles during the period of logging varied considerably.

Turtle #1 spent nearly the entire period of the study near the riparian area north of the logged area (Figure 1), but was frequently near the boundary of the logging area. This turtle moved frequently, but only for short distances. It moved for a few days into a pasture north of the logged area, but then returned to the riparian area for the remainder of the course of the study. The area of its movement from the beginning of the logging to the end of the monitoring period was approximately 0.5 ha in size.

Turtle #2 was initially within the logged area and was found close to skid trails (Figure 1). Approximately two weeks after the beginning of logging (June 27), turtle #2, the only female of the monitored turtles, moved off of the logged area (presumably to nest) and remained within a hayfield for the next three weeks. This turtle returned to the logged site approximately one week after logging and was found under some remnant slash. It remained under slash for approximately six weeks during a period of very hot and dry weather. In September, the turtle was found active on the surface within the riparian buffer on the north side of the logged area.

Turtle #3 also spent most of its time within the logged area, although its movements were considerably larger, covering approximately 2.5 ha. This turtle was found several times hiding beneath log or brush piles that were about to be moved. This turtle was last found alive on 30 June within a strip yet to be logged. On 3 July, the remains of the turtle were found in the forest adjacent to the logged area. Its carapace was crushed and it appeared to have been run over by logging machinery. The location of the carcass outside of the study area may

have been due to a scavenger, since it was partially eaten.

Turtle #4 moved off of the site and was found on an edge of the forested tract near hay bales. Turtle #4 eventually moved across a field into another forested tract approximately 0.5 km from the logged site. This turtle continued to move further away from the logged area and we removed the transmitter from this turtle approximately one month after logging ceased.

Discussion

As observed with other behavioral patterns in box turtles, such as hibernation and home range size (Ellington et al. 2007, Fredericksen et al., 2007), the response of box turtles in this study varied markedly among individuals. Two of the turtles moved out of the logging area soon after logging began, while two remained on or near the logging site throughout most or all of the period of logging. It is unclear whether the movements of the two turtles which left the logging site were triggered by the logging event. For example, turtle #2 was a female and the timing of her movement coincided with the period of egg laying for this species. It is common for female turtles to seek open areas, such as fields, for egg deposition because these openings provide a more favorable incubation environment (Hall et al., 1999; Dodd, 2001; Wilson and Ernst, 2008). It also appears that sudden unexplained movements are not atypical of box turtles on undisturbed sites. At the same time as this study, we monitored the movements of eight other box turtles on two other mature forest sites within Franklin County. Four of these turtles moved more than 200 m in a short period of time (2-3 days) away from an area where they had been consistently found.

Although turtle #2 left the site during the period of logging, it exhibited a high degree of philopatry by returning to and staying within its home range, which was then largely devoid of vegetation and cover. Unexpectedly, this turtle remained buried under some remnant slash for more than one month under very hot, dry conditions. Box

turtles typically avoid open areas under these environmental conditions (Dodd, 2001; Rossell et al., 2006). This turtle only moved twice within this period, and did not leave the clearcut area. Turtles #1 and #3 never moved far from the logged area, despite high levels of noise and habitat disturbance. Cook (2004) found that box turtles imprint on their home range and do not tend to abandon it and, if moved away from a site, they will attempt to return to it.

The tendency to remain on a site that is being logged obviously can have negative consequences for box turtles, as was the case for turtle #3, which was apparently run over by a logging skidder. The likelihood of mortality or negative effects of reduced habitat quality is high on sites such as the one in this study, which was clearcut followed by chipping of most of the logging slash. There are few places on such sites where turtles can seek shelter from logging machinery and falling trees. Turtles are slow-moving and do not burrow into the soil very far during the growing season. Even during hibernation, turtles may not burrow deep enough during mild winters (Ellington et al. 2007) and may possibly sustain injury on sites logged during the winter. The landscape context of a site is also important. Isolated patches of forest which are clearcut would provide no potential for box turtles to adopt a new home range with forest.

In summary, we observed that one out of our four turtles remained in the area during logging operations and was subsequently killed while another one returned to the logged site possibly after laying eggs in an adjacent field. Conclusions could not be drawn about the effects of logging on the movement patterns of the other two turtles.

Acknowledgements:

We thank the Appalachian College Association and Ferrum College Professional Development Fund for financial support of this study. Jim Ebbert and Scott Schallenberger provided us with site data and logistical support. Finally, we thank William and Martha Sue Gibson for the use of their land for this study.

Figure 1. The home range of four box turtles on the study site. The area that was clearcut logged and chipped is approximated by the black polygon. Turtle #1 stayed in or near the riparian buffer indicated by the upper elipse during the entire study. Turtle #2 left the site during logging, but returned following logging and remained under logging debris for approximately one month in the middle of a period of hot and dry weather. Turtle #3 remained on the site during logging and was killed (presumably by being run over by a skidder) in early July. Turtle #4 left the site during logging (black line) and did not return to the site. Because they travelled long distances from the study area, the home ranges shown for turtles #2 and #4 are larger than the shaded areas in the figure.

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