An Evaluation of Direct Effects of Heavy Equipment Use on Gopher Tortoise Burrows

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Introduction

Gopher tortoises (*Gopherus polyphemus*) occur in open canopy habitats on well-drained sandy soils, where they construct extensive burrows that offer protection from thermal extremes, fire, and predators. Tortoise burrows vary in length and depth depending on soil characteristics and depth to the water table, but burrows generally have only one entrance at the soil surface and the width of the burrow is correlated with the size of the tortoise. The angle of declination of burrows is approximately 30˚ and burrows average 4.6 m in length and 1.8 m in depth (Cox et al. 1987). However, in excessively well-drained soils, burrows as long as 14.5 m have been reported (Cox et al. 1987).

Forestry management practices such as thinning and hardwood removal benefit gopher tortoises by creating a more open canopy and encouraging growth of herbaceous food plants. However, harvesting, site preparation, and use of heavy equipment associated with these activities, can directly impact burrows. In particular, operation of heavy equipment in proximity to burrows can cause burrows to collapse. Numerous studies have documented the ability of gopher tortoises to self-excavate from collapsed burrows (Diemer and Moler 1982, Diemer 1992, Epperson 1997, Landers and Buckner 1981, Mendonça et al. 2007). However, there is concern about loss of shelter and potential stress or injury to gopher tortoises from burrow collapse. The distance from a burrow entrance at which heavy equipment is likely to cause collapse has not been investigated.

Objective

Test the distance at which three commonly used types of heavy equipment cause unoccupied gopher tortoise burrows to collapse.

Methods

- Study was conducted in southwest Georgia, USA (31° 13.188'N, 84° 28.708'W).
- Unoccupied burrows of adult tortoises (burrow opening >22 cm in width) were selected (Photo).
- Soils were sandy clay loam (Troup series; Grossarenic Kandiudult) and undifferentiated deep sand (Lakeland and Bigbee series; Typic Quartzipsament).
- 3 types of equipment used: feller buncher, rubber tire front-end loader, and agricultural tractor with tree mower (Table 1 and Photos).
- Burrows were scoped with a burrow camera immediately preceding collapse trials to ensure they were unoccupied (Photo).
- Burrow length was measured to the nearest 0.25 m using the camera scope and flagged at the approximate end (Table 2).
- Vehicle were driven across 5 different burrows in each of the two soil types (2 soil types x 3 vehicles x 5 burrows = 30 total burrows).
- Vehicles were driven across and perpendicular to burrows at incrementally decreasing distances from burrow end to entrance.
- Each pass across a burrow consisted of the front and rear tires of the vehicle crossing the burrow 4 times.
- On the first pass, the inside wheels of the vehicle crossed the approximate end of the burrow.
- On the second pass, the inside wheel was placed one vehicle width closer to the burrow entrance, with the outside tires placed in the track of the previous pass, and the process was repeated until wheels approached 1.0-1.5 m of the burrow entrance.
- The number of passes differed among burrows due to the variation in the length of burrows.
- After each pass the burrow was re-scoped for collapse.
- If collapsed, the length of the burrow to the point of collapse was recorded to the nearest 0.25 m using the burrow camera cable and the distance from the inside tire of the vehicle to the burrow entrance was recorded (Table 2).

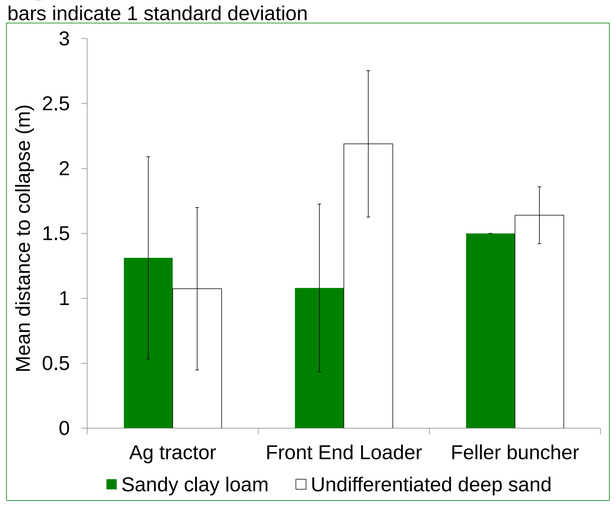
Table 1. Approximate specifications for heavy equipment.

Vehicle	Width (m)	Weight (kg)
Ag tractor w/tree mower	1.8	5,000
Rubber tire front-end loader	2.1	10,000
Feller buncher	2.4	15,000

Results

- Burrows varied considerably in length from 2.5-6.0 m (Table 2).
- The three types of heavy equipment tested caused collapse of most burrows (87%) when driven across the burrow within 3 m of the entrance.
- There was a significant interaction between equipment and soil type ($F_{1,2}$=3.588, P=0.043).
- In sandy clay loam, the maximum distance to collapse was 2.25 m (ag tractor), in undifferentiated deep sand, the maximum distance to collapse was 3.0 m (front-end loader) (Table 2).
- In sandy clay loam mean distance to collapse was greatest for the feller-buncher (1.50 ± 0.00), in undifferentiated deep sand mean distance to collapse was greatest for the front-end loader (2.19 ± 0.56) (Figure 1).
- In almost all cases, if a burrow collapsed, soil from the collapse could be detected within 1.0-2.0 m of the burrow entrance (Table 2).

Figure 1. A comparison of mean distance to collapse. Error bars indicate 1 standard deviation

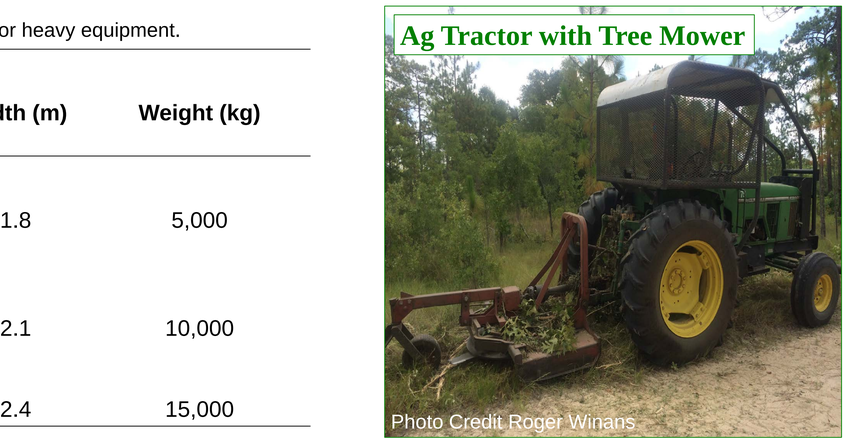


Conclusion

We suspect that differences in wheel base and tire width/surface area, rather than total weight, among the vehicle types may explain differences in distance to collapse. Given the variation in distance to collapse, we recommend a buffer that extends 4 m in radius from the entrance of the gopher tortoise burrow to minimize the risk from heavy equipment and that burrows be adequately marked prior to heavy equipment use.

Table 2. Results of burrow collapse study. Lengths reported in meters. SD = standard deviation

Soil Type	Heavy Equipment	# of burrows	Burrow lengths	Max distance for collapse	Mean distance for collapse (SD)	Burrow length to collapse	# of burrows collapsed
sandy clay loam	Ag tractor w/ mower	5	3.25 - 5.0	2.25	1.31 (0.78)	0.5 - 1.0	4 of 5
	Front-end loader	5	3.0 - 6.0	2.0	1.08 (0.65)	1.0 - 2.25	4 of 5
	Feller buncher	5	3.0 - 4.0	1.5	1.50 (0.00)	1.0 - 1.25	5 of 5
undifferentiated deep sand	Ag tractor w/ mower	5	3.5 - 5.5	1.75	1.07 (0.62)	0.5 - 2.0	5 of 5
	Front-end loader	5	3.5 - 5.25	3.0	2.19 (0.56)	1.0 - 3.0	5 of 5
	Feller buncher	5	2.5 - 4.0	2.0	1.36 (0.73)	0.75 - 1.0	4 of 5



Publication

This study was recently accepted for publication as, **Smith, L.L., M. Hinderliter, R.S. Taylor, and J.M. Howze.** 2015. A New Recommended Gopher Tortoise Burrow Buffer to Avoid Collapse from Heavy Equipment. Journal of Fish and Wildlife Management. Online Early Access. http://fwspubs.org/toc/fwma/0/0

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