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The Effects of Roadways on the Spatial and Temporal Movement Patterns of Timber Rattlesnakes (Crotalus horridus)

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Background

- Roadways = one of the most widespread, prominent, and disruptive human land use features that influence animal behavior and movement[1,2,3,4]
- Negative impacts: vehicle-induced mortality, habitat destruction and fragmentation, and creating barriers to movement[1,4,5]
- Radio telemetry derived spatial data historically used to measure movement
- Integrating hand-held radio telemetry with accelerometry (RT-ACT)[6] → more comprehensive evaluation of animal response to roadways

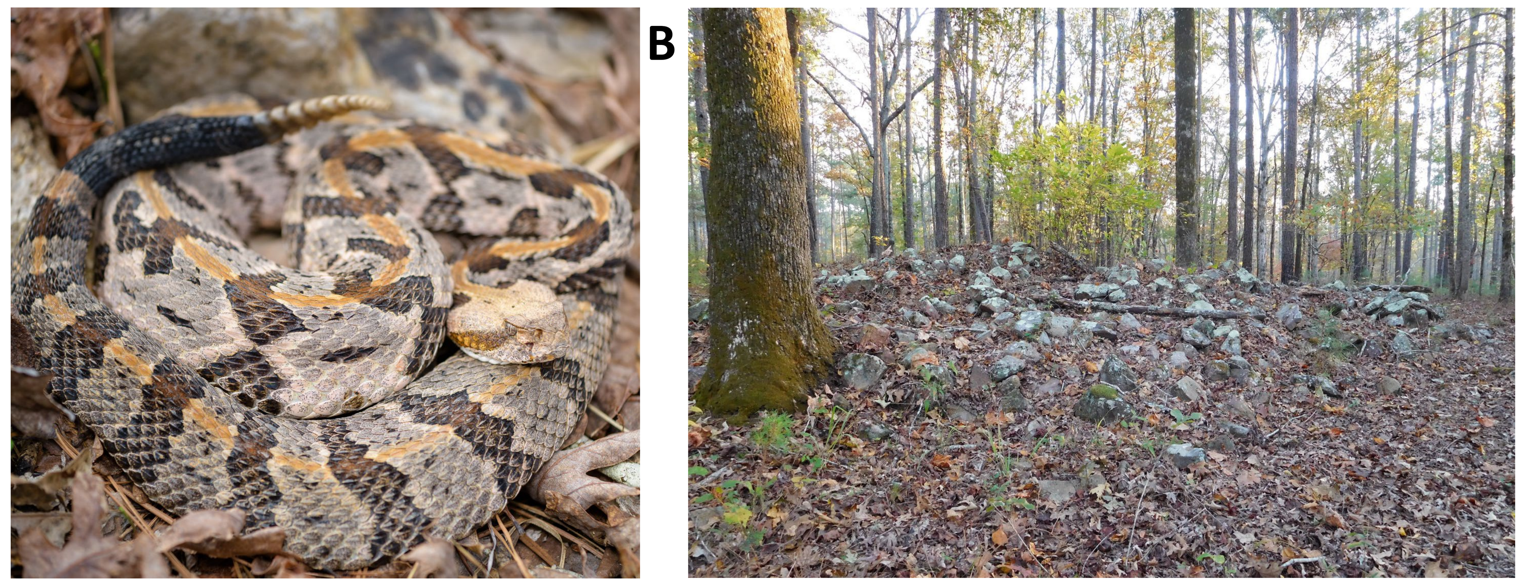

Fig. 1. Male *C. horridus* obtained for study (A) Study site, Cedar Creek Wildlife Management Area, Putnam County, GA

Study System

Study species: Timber Rattlesnake (*Crotalus horridus*)

- Cryptic large-bodied pit viper, prominent ambush predator in woodlands across eastern US
- Documented negative effects of roadways on snake movement: road mortality and road avoidance[2]→ decrease gene flow and increase risk of local extirpation

Study site: Cedar Creek Wildlife Management Area, Putnam County, Georgia

- Abundance of paved and un-paved roadways

Objectives

- Quantify movement behavior of *C. horridus* using the RT-ACT technique
- Evaluate the spatial and temporal movement response to roadways using Radio Telemetry derived spatial data and Accelerometry derived temporal data

Hypotheses

1. Rattlesnake movement and space use (RT) will exhibit a positive correlation with distance to roadway
2. Rattlesnake activity (ACT) will also exhibit a positive correlation with distance to roadway

Methods

Radio telemetry: *N*= 16 (9 females, 7 males)

- Relocate every 3-4 days → obtain spatial coordinates
- Response Variables: Meters Per Day (MPD), Distance Per Movement (DPM), Movement Frequency (MF), Dynamic Brownian Bridge Motion Model Occurrence Distributions (50, 95, 99% OD)

Accelerometry: *N*= 6 (3 females, 3 males)

- Continuous recording (1 Hz) of activity for 4-7 months Random forest algorithm: 99% accuracy in activity classification (moving vs. immobile) → continuous activity budgets → mean time spent moving/24hrs (MOV)

Statistical analysis: Linear regressions relating Mean Distance to Roadway (DTR) to Spatial Response Variables and MOV.

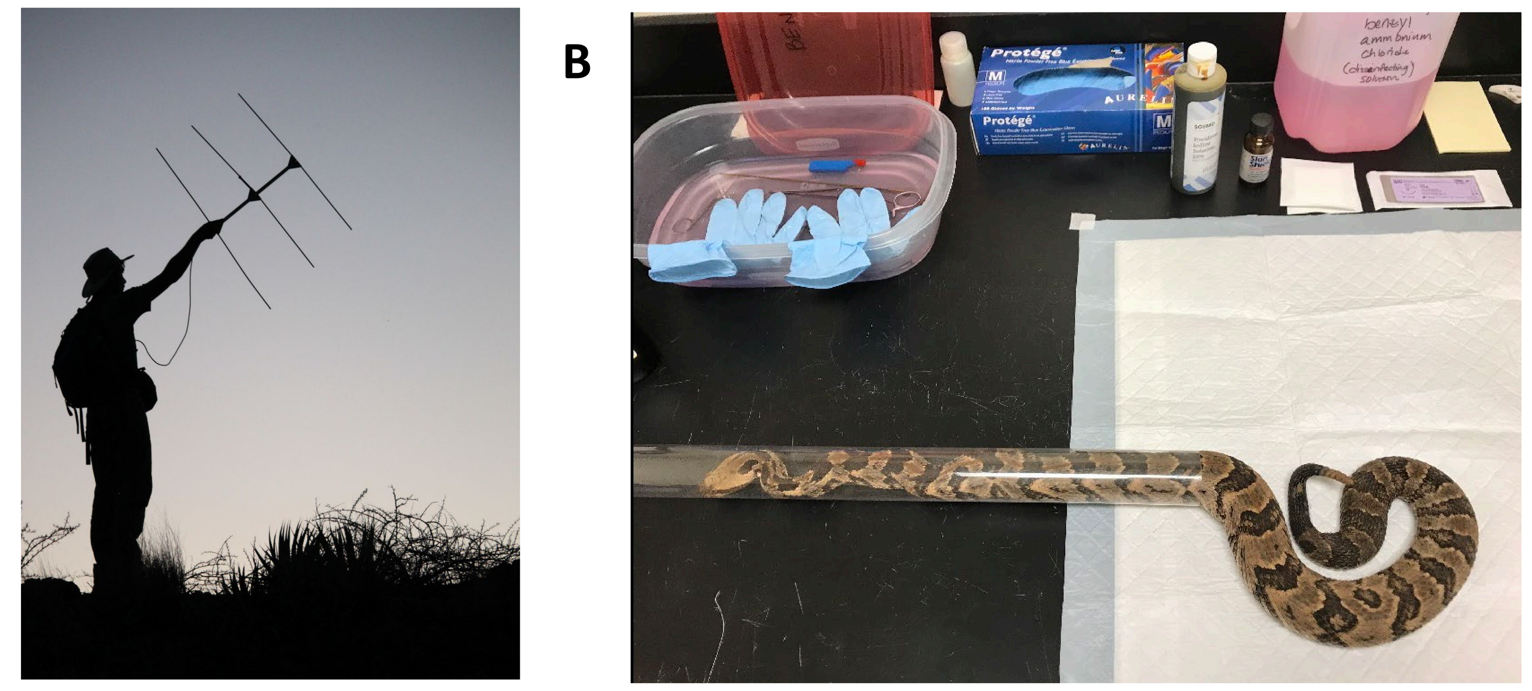

Fig. 2. Hand-held radio telemetry (A), RT-ACT implantation procedure (B)

Results

- Full sample: no significant relationships
- Males*:* significant positive linear relationship between DTR and DPM (adjusted R^2 = 0.81, p < 0.01; Fig. 3) and between DTR and 50, 95, and 99% UDs (adjusted R^2 = 0.58, 0.68, 0.69, p = 0.049, 0.026, 0.025; Fig. 3)
- Males: significant negative linear relationship between DTR and MOV (adjusted R^2 = 0.26, p = 0.038; Fig. 3)

Results

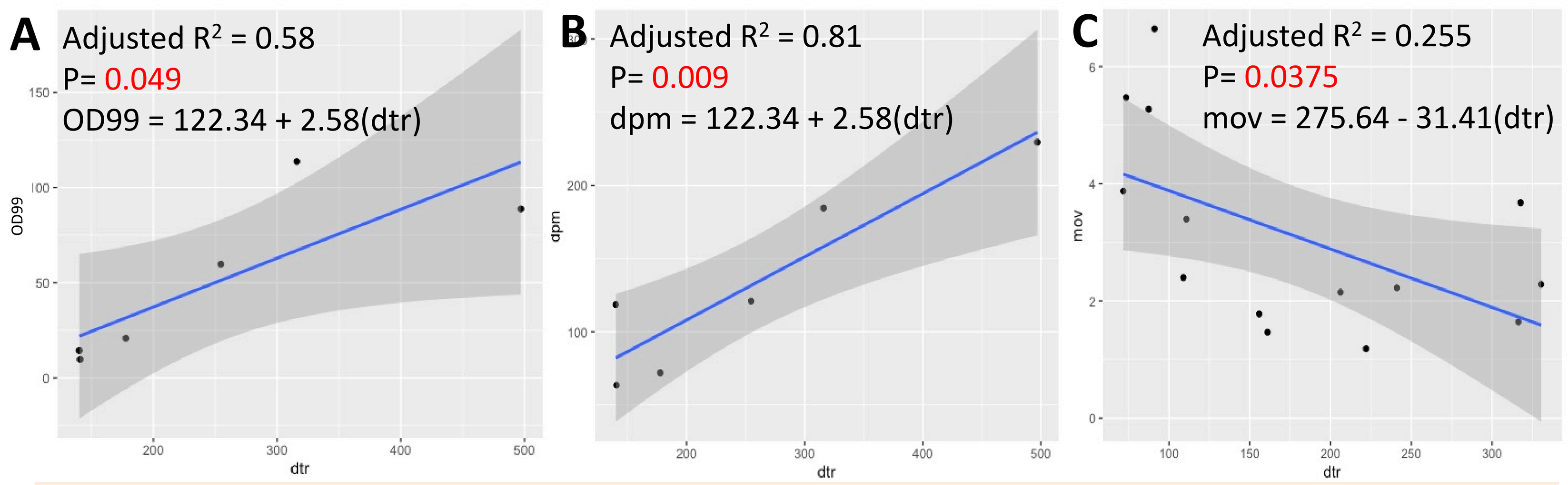

Fig. 3. Significant linear relationships in males between DTR and spatial metrics (99% OD (A) and DPM (B)) and temporal metric MOV (C)

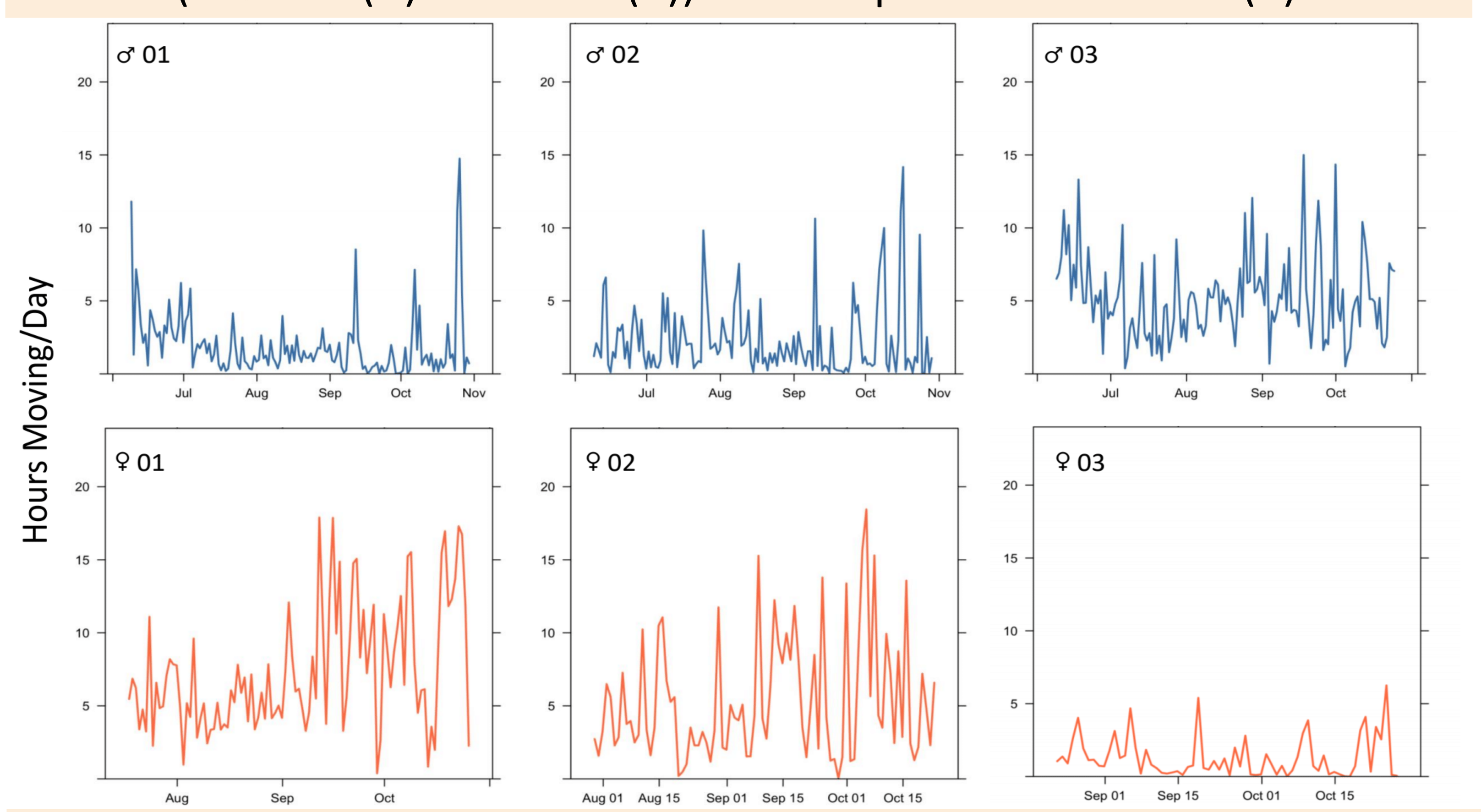

Fig. 5. MOV time series plots over entire recording period for individual rattlesnakes subjected to ACT monitoring (top row: males, bottom row: females). Note the high within and between-individual variance in MOV profiles.

Discussion

- Decreasing distance to roads → males use less space and move shorter distances per movement: roads may pose as a passive barrier for males in our population
- Unexpectedly, with decreasing distance to roads → males spend more time moving/24hrs (MOV)
- No significant relationships in females between DTR and spatial and temporal metrics
- Males closer to roads might be compensating for smaller home range sizes by increasing MOV during the mating season (August-October) to elevate encounter frequencies with reproductive females
- Increase sample size and duration of monitoring→ refine preliminary findings; Generalized Linear Mixed Effects Models will be used with full sample to account for repeated measures and snake ID

References

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