Relationships among Hosts, Habitats, and Ticks throughout Alabama

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Importance

Ticks are tiny arthropods that feed by sucking blood from animals, including mammals, birds, reptiles, and amphibians[1]. In Alabama, lone star, blacklegged, American dog, and Gulf coast ticks may carry pathogens associated with Lyme disease, spotted fever rickettsiosis, ehrlichiosis, and many others. Ticks opportunistically attach to wildlife, pets, and humans, and, if infected, can transfer pathogens to the host during feeding. An infected host can act as a reservoir for pathogens (e.g., white-tailed deer and ehrlichiosis[2]) and transport ticks to new areas, facilitating tick dispersal and disease transmission.

In Alabama, the number of tick-borne illness(TBI)-related cases continue to increase every year[3]. As climate changes and habitats are altered by human activities (i.e., urbanization, agriculture, etc.), tick and host distributions and disease transmission rates are expected to shift and grow[4,5]. Additionally, despite the high occurrence of ticks throughout Alabama, little is known about their current distribution, relationship to wildlife and climatic variables, or degree of TBI transmission.

Objectives ------------- Approach

1. Use Alabama DCNR's Wildlife Management Areas (WMAs), AU-owned properties, other state/public areas, and private land to collect ticks and monitor wildlife

- Samples from white-tailed deer harvested during summer reproductive studies and winter hunting seasons (Fig. 1)
- Monthly sampling of 105 plots using dry ice, a CO_2 attractant, in residential, agricultural, and forested sites (Figs. 1,2)
- Opportunistic collections from raccoons and feral hogs

Sex, age, weight, body condition, and location recorded for each deer

Wildlife movement, vegetation, soil, and climatic data recorded at each plot

2. Identify land use, climatic, and wildlife effects on tick and TBI distribution and risk at broad- and fine-scales in Alabama

- Analyze tick, TBI, wildlife, vegetation, and climate data using a negative binomial regression with zero-inflated model

Ticks stored in ETOH, identified, and screened for *Ehrlichia, Rickettsia,* and *Borrelia* TBI species using PCR

3. Develop a predictive model that projects wildlife and TBI risk as a function of geographic region, short-term climate, vegetation, and other factors

- Use field collected data to validate model(s)
- Run regression analysis and predictive modeling under various future climate, land use, and demographic scenarios

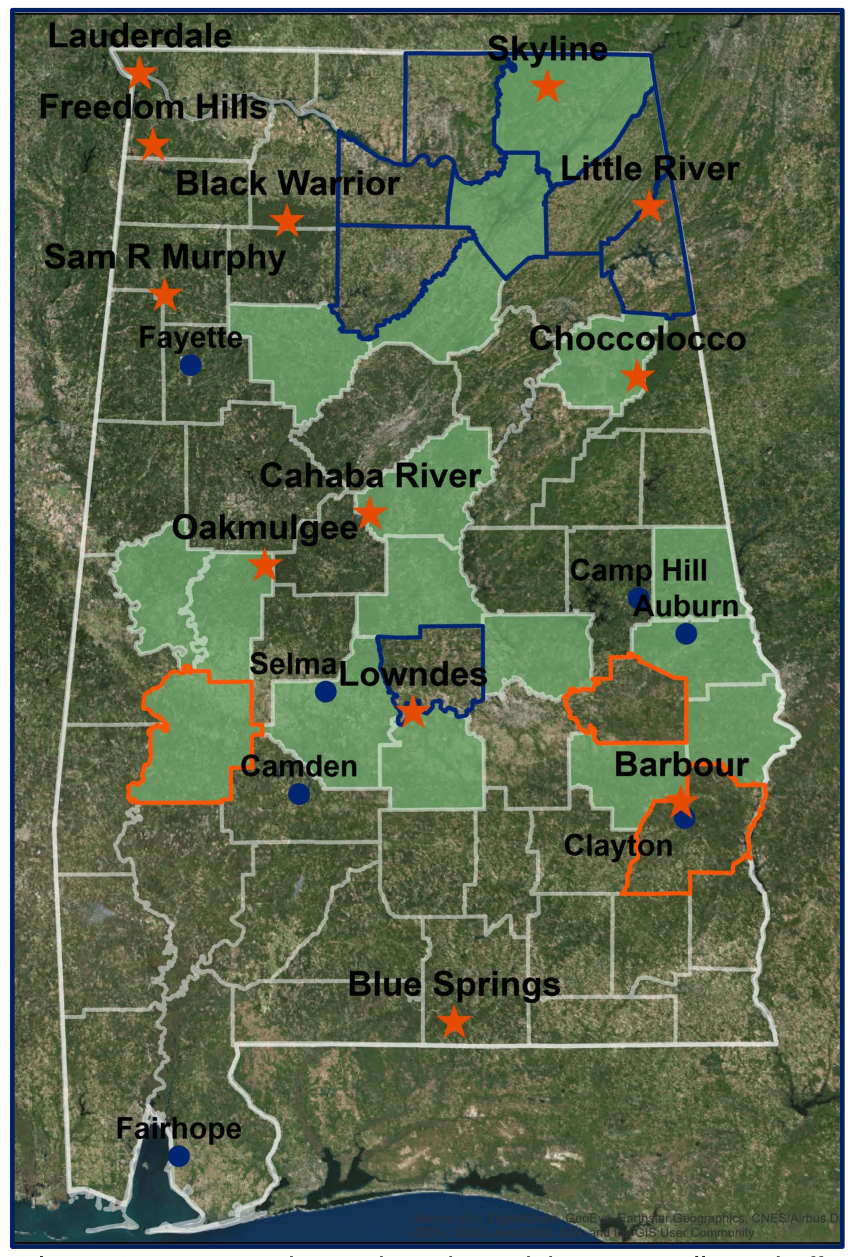

Figure 1. WMAs and counties where ticks were collected off deer during the hunting season (**stars**) or reproductive study (shaded), off hogs during summer 2016 (outline) and raccoons during winters 2016 and 2017 (outline), and cities were ticks were sampled with CO_2 (**dots**), 2015-2017

Figure 2. (A) CO_2 trap catching ticks, and (B) an adult female lone star tick and nymphs stuck on tape after 24 hours of sampling

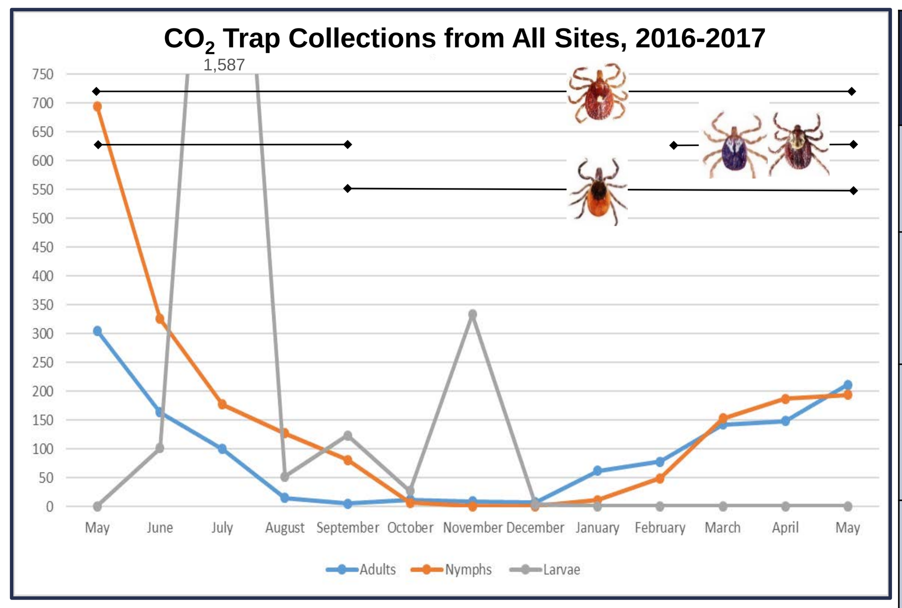

Figure 3. Adult, nymphal, and larval ticks collected from 7 Alabama cities (Fig. 1, blue dots) using CO_2 traps, and range of active months (black lines) by species (ticks pictured, top to bottom: lone star, Gulf coast, American dog, blacklegged), 2016-2017

Table 1. Minimum infection rates (# positive individuals or pools ÷ total tested), all sites		
Tick-borne Illness	**Lone star**	**Gulf coast**
Ehrlichia chaffeensis	0.61% (0–2.56%)	
E. ewingii	0.36% (0–1.71%)	
Rickettsia parkeri		18.07% (0–35.71%)
R. amblyommii	26.06% (16.53–48.72%)	7.72% (0–33.33%)

Discussion Points

- Illness transmitting ticks are active year-round in Alabama and can be found in areas where people recreate, work, and relax, such as backyards, parks, and hunting areas
- Dragging, a traditional tick sampling method used throughout the US, is inefficient for southeastern ticks. Future sampling efforts should consider using dry ice or collections from wildlife, depending on ticks desired
- Wildlife play a critical role in tick survival and movement, especially in regard to deer and blacklegged ticks in the cooler months, and feral hogs and American dog ticks in warmer months
- Preliminary analyses suggest that adequate temperature, moisture availability, and substrate structure at the forest floor level greatly effect tick abundance, agreeing with past research from other parts of the US

References

[1]Center for Disease Control and Prevention: http://www.cdc.gov/ticks/index.html

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Preliminary Results

Field Sampling

From May 2016 to May 2017, 5,489 ticks were collected from CO_2 traps; 23% were adult ticks and 37% were nymphal ticks. A majority were lone star ticks (93%), however, 81 adult and 6 nymphal blacklegged ticks were collected (2%). Tick activity occurred year-round but months active varied for each species (Fig. 3). Ticks were most commonly captured in deciduous areas, but also found in coniferous, residential, or shrubby areas depending on species (Fig. 4).

As of December 2016, 75% of adult and nymphal samples were tested for two *Ehrlichia spp.* and two *Rickettsia spp.* No American dog or blacklegged ticks tested positive, but minimum infection rates of *Ehrlichia spp.* ranged from 0% to 2.56% in lone star ticks across all sites (Table 1). Additionally, across all sites minimum infection rates of *Rickettsia spp.* ranged from 16.53% to 48.72% in lone star ticks and 0% to 35.71% in Gulf coast ticks. No blacklegged ticks tested positive for *Borrelia spp.* Tests on remaining samples are in progress.

A preliminary analysis was conducted on tick (larvae excluded), forest floor, soil, and monthly temperature and humidity data using a negative binomial regression with a zero-inflated model (Fig.5). Across all locations and land uses, minimum and range of temperature and humidity are the primary drivers of tick abundance. Additionally, forest floor depth and weight and sandy soils have significant effects. Further exploration into the role of these variables and others is in progress.

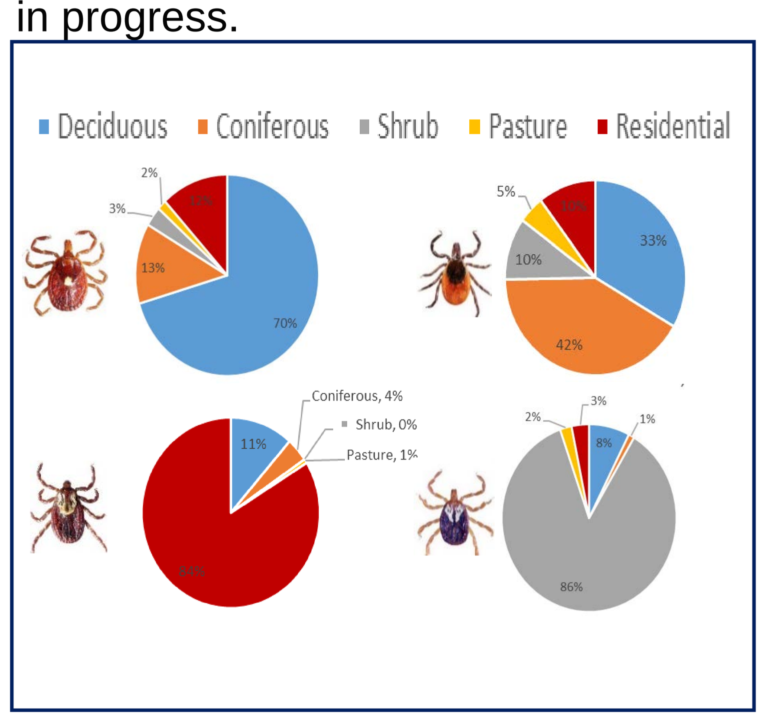

Figure 4. Land use types where ticks were most commonly found by species (ticks pictured, left to right: lone star, blacklegged, American dog, Gulf coast), 2016-2017

Variables Considered
Average temperature, month
Minimum temperature, month
Maximum temperature, month
Range temperature, month
Average humidity, month
Minimum humidity, month
Maximum humidity, month
Median humidity, month
Range humidity, month
Forest floor depth
Forest floor weight
Forest floor moisture
Soil-sand
Soil-clay
Soil-pH
Soil-base saturation

Adult Females
Minimum temp.
Range temp.
Range humidity
Soil-sand
Soil-clay

Adult Males & Nymphs
Min. temp.
Range temp.
Min. humidity
Range humidity
FF depth
FF weight
Soil-sand

Figure 5. Variables considered for the negative binomial regression analysis, and the output of significant variables by life stage

Wildlife Sampling

In the summers of 2015 to 2017, 765 ticks were collected from 125 deer; 93% were lone star, 5% were Gulf coast, and 1% were blacklegged ticks. In the winters of 2015/2016 and 2016/2017, 3,303 ticks were collected from 626 deer; 88% were blacklegged ticks, followed by 7% lone star, 4% winter, and 0.27% Gulf coast ticks. Additionally, in the summer of 2016, 111 ticks were collected from 19 hogs, comprising of 44% lone star, 33% American dog, and 23% Gulf coast ticks. In the winter of 2016, 150 ticks were collected from 51 raccoons, comprising of 52% *Ixodes cookei,* 22% American dog, 19% *I. texanus* , *and* 4% lone star ticks. In the winter of 2017, 244 ticks were collected from 112 raccoons, comprising of 63% *I. cookei and 32% I. texanus* ticks. Testing for pathogens is in progress.