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Topographical Variables Influencing Dermacentor andersoni Distribution in Montana

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ABSTRACT

The Rocky Mountain wood tick, *Dermacentor andersoni*, is a known arthropod vector for Rocky Mountain spotted fever, Colorado Tick Fever, and Tularemia. This tick is prevalent in the western part of the United States. The adult ticks ingest blood meals from large mammals and can easily spread disease to humans. Using an infectious disease ecology approach, we developed a drag sampling protocol to capture ticks in order to quantify and survey their population distribution. We sampled 77 tick sites on the upper Missouri drainage in west-central and southwestern Montana. The variables of interest were slope aspect and elevation. We found no correlation between the distribution of ticks and elevation, but there was statistical difference in tick distribution due to slope aspect. Ticks were found more frequently and in greater number on south and east facing slopes rather than north and west facing slopes.

INTRODUCTION

It is of the utmost importance for the scientific community to study the vectors of pathogens. Without more knowledge, the diseases these pathogens cause could spread in unknown ways, perhaps with a higher death rate. A well-known vector in the west, associated with multiple pathogens is the Rocky Mountain wood tick, *Dermacentor andersoni*. James et al., (2006) have compiled records of established populations of Rocky Mountain wood ticks in 14 states encompassing the area from Washington to New Mexico, and North Dakota to Southern California. The data generated were only analyzed by county; therefore they only showed a very broad and nonspecific distribution of *D. andersoni*, (James et al., 2006). Ticks were said to be “reported” in a county if only one tick was found, and a *D. andersoni* population was “established” in a county if there were at least six ticks found during one collection period (James et al., 2006). Montana had ticks in 44 out of 56 counties; 78.6% of the states counties (James et al., 2006). [This paper has a small error. The paper shows Montana has 57 counties; however in reality Montana has 56. The percentage of counties was also corrected, because 57 counties was used to divide 44 (44/57=77.2%) The correct function is 44/56=78.6%. I have contacted the editor in chief of the journal and he instructed me to correct it this way (Montana Association of Counties, and James et al., 2006)]. Montana also had the most established tick populations at 20% of the counties (James et al., 2006). Correspondingly, an in depth analysis of the distribution of ticks in the areas of established tick populations is crucial to understanding the transmission of pathogens to the tick’s hosts (Dergousoff et al., 2013).

Rocky Mountain wood ticks have a three-year life span, consisting of a different developmental stage and host each year (James et al., 2006). The first stage is larval; and these ticks parasitize at maximum abundance during June (James et al., 2006). This parasitizing and host seeking behavior is also known as questing (Dergousoff et al., 2013). Small mammals such as ground squirrels, pikas, rabbits, and chipmunks are typical hosts for the larval and nymph stages (James et al., 2006). *D. andersoni* nymphs and adults are at peak abundance during April and May, though adults can be found questing as early as March and as late as July (James et al., 2006, and Eisen, 2007). Adults can be found parasitizing large mammals, for example horses, cattle, mule deer, whitetail deer, elk, and even humans (James et al., 2006).

With such a large questing period for adult ticks and the increase of humans in the Rocky Mountain region, the contact between humans and *D. andersoni* ticks is expected to be on the rise (Eisen, 2007). Though the county based distribution data and tick life-cycle data are beneficial, data that are specific to human risks and human contact with ticks might be more valuable. Eisen et al (2008) explain how this vector and the human risks have been ignored for dozens of years. The pathogens associated with *D. andersoni* are the bacteria *Rickettsia rickettsii*, and *Francisella tularensis*, and the Colorado Tick Fever Virus which manifest in humans as Rocky Mountain spotted fever, tularemia, and Colorado Tick Fever, respectively. All previously listed pathogens exist in the Rocky Mountain region (Eisen et al., 2007). Because these pathogens can cause death in humans, data that reveal risk of exposure and high tick density indicators could be very beneficial for minimizing human exposure.

Monello and Gompper (2007) have linked *Dermacentor* ticks to the following environmental variables: temperature (maximum, minimum, and mean), relative humidity, soil type, vegetation density, and vapor pressure. James et al (2006) found ticks in semiarid and mountainous habitat. Eisen et al (2008) found that ticks are associated with big sagebrush and grassy south-facing micro-habitats. The objective of this study was to determine if ticks have a higher abundance at different slope aspects and elevations in west-central and southwestern Montana. This knowledge will further the crucial investigation in understanding the transmission of pathogens to the tick's host (Dergousoff et al., 2013). In the present study I hypothesize that ticks will have a higher density on south facing slopes and elevation of 1300 to 1800 meters. South facing slopes will on average have more sunlight, therefore be warmer and have less snow.

MATERIALS AND METHODS

Tick sampling sites were both predetermined and chosen randomly. The random sites were done along roads using a random number table. The predetermined sites were chosen based on appearance. Brushy and shrubby draws were considered ideal as draws would funnel wildlife and thus have an abundance of questing ticks on the shrubbery. The sites were solely contained in one ecosystem. For example if a riparian ecosystem bordered a coniferous ecosystem near a tick site, we would make two sites out of the area; one in the riparian and one in the coniferous. The sampling site was searched for the duration of a "person-hour." Search time was multiplied by the number of surveyors present so the search time was equivalent to one person searching for 60 minutes. The trapping material consisted of one square meter of white flannel. The soft flannel was ideal for ticks to attach too. It was also easy to see the dark ticks against the white material. The flannel was mounted to the crossbar of a PVC pipe T-apparatus so it could be easily dragged or swept over the ground and vegetation. Questing ticks found on the flannel were immediately stored in 200 proof ethanol until identified in the lab. To avoid confusion, a site was deemed absent of ticks if it was swept for a person hour and no ticks were caught. It could mean that ticks were indeed completely absent, or there were so few ticks present none were detected. One must also consider the possibility of many ticks present that aren't questing, but ticks are opportune hunters, thus making it very unlikely they would refrain from questing. Tick presence was defined as catching a tick.

The coordinates of the sample site were obtained on site with a Garmin eTrex 20 GPS using the North American Datum 1983 (NAD83). The waypoint-averaging program on the GPS was used to obtain the most precise coordinates and also provided a small uncertainty value for the coordinates. Topographical variables that were recorded on site were elevation, aspect, and slope. The elevation was included in the GPS coordinate. The slope aspect was obtained on site by approximating the fall-line direction and then aligning a compass heading on the direction. The slope was measured on site by aligning a slope meter with the ground. Slopes were merely classified into three bins: zero to 20 degrees, 20 to 40 degrees, and above 40 degrees.

RESULTS

Research in the summer of 2013 primarily focused on building the methodology and protocols for trapping ticks and gathering data. After creating and refining the techniques, we were able to sample 77 tick sites. Frequency analysis revealed a statistical difference in tick presence between slope aspects (**Figure 1)**. Ticks were more frequently found on east and south slopes than on north and west slopes. Recall that ticks sites were searched for a person hour. Some initial sites were only searched until a tick was found. This could have happened at 20 minutes for example. It is a safe assumption this example site would have yielded three ticks if it had been searched for a person hour. This hypothesis was tested by analyzing the number of ticks per person hour and **Figure 2** shows the number of Ticks per Person Hour was statistically different across slope aspects.

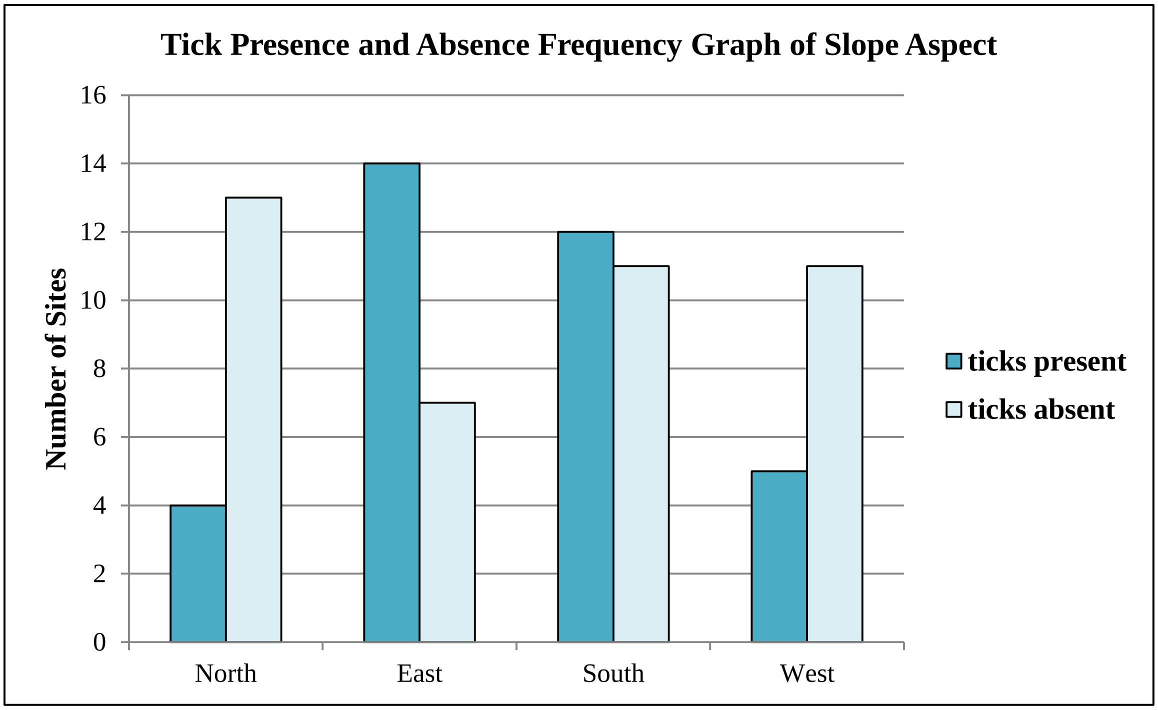

Figure 1. Frequency graph shows that ticks were caught more often than not on East and South facing slopes. The opposite is true for the North and West facing slopes. P-Value=0.032

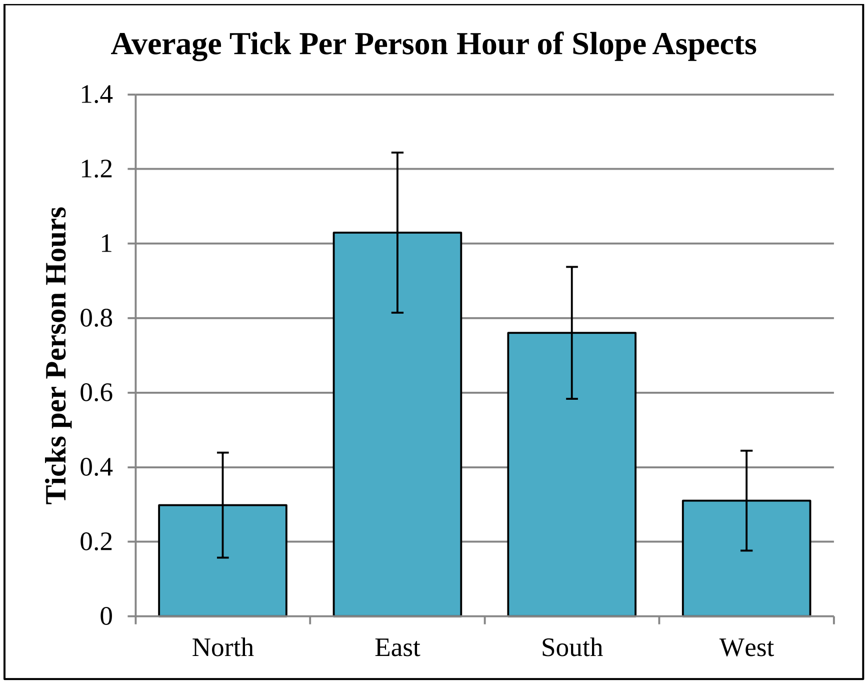

Figure 2. The average ticks per person hour for each slope aspect and the associated uncertainty. East and South have more Ticks per Person Hour than West and North. East and South cannot be distinguished which can be gleaned from the error bars overlapping. The same can be said of West and North. This means that East and South can be grouped as can West and North. In conclusion, East and South facing slopes have statistically higher Ticks per Person Hour than North and West facing slopes. This was inferred using a Single Factor Analysis of Variance (ANOVA) Test. P-Value=0.012

Another objective of this research was to test for differences in tick distribution due to elevation. From the elevation data we gathered we could not statistically differentiate elevations in tick presence and absence frequency or ticks per person hour (**Figure 3** and **Figure 4)**.

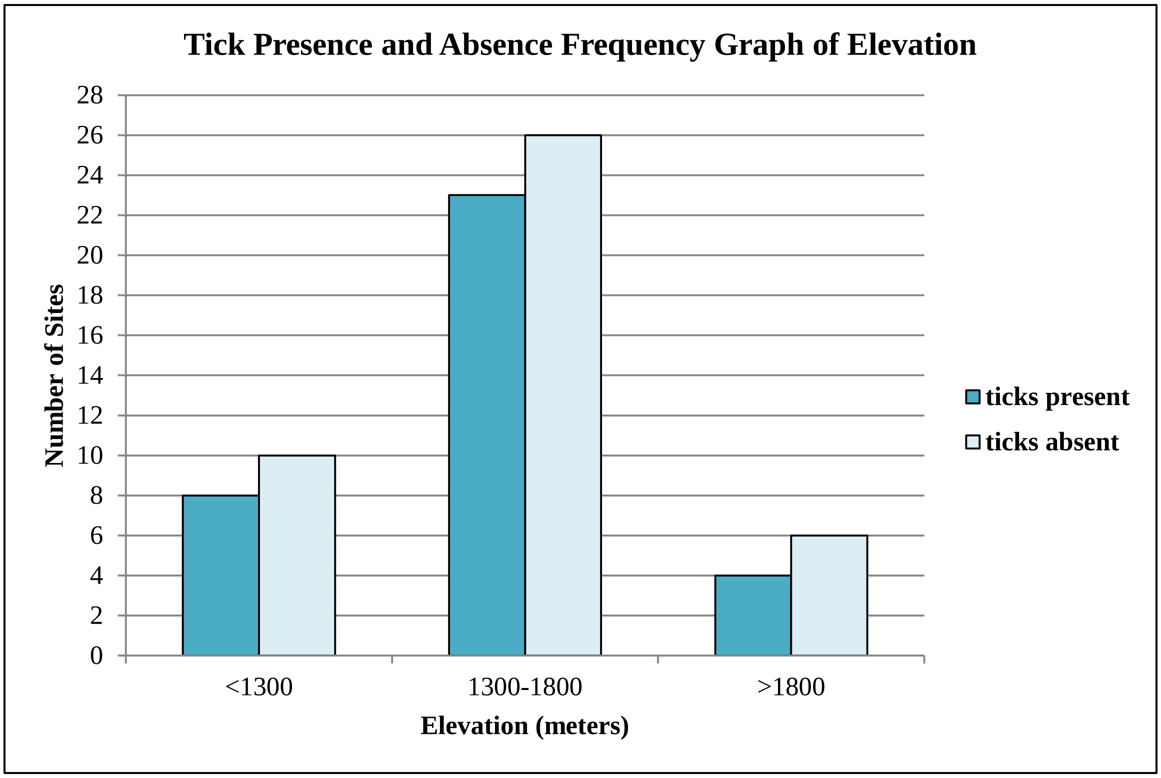

Figure 3. Tick Presence based on Elevation. With the current data no effect of elevation can be distinguished. The data are divided into three bins; high, mid, and low elevation sites. All elevation intervals have more tick absence then presence. The P-Value is 0.918 which means ticks are not dependent on elevation at least at the measured sites.

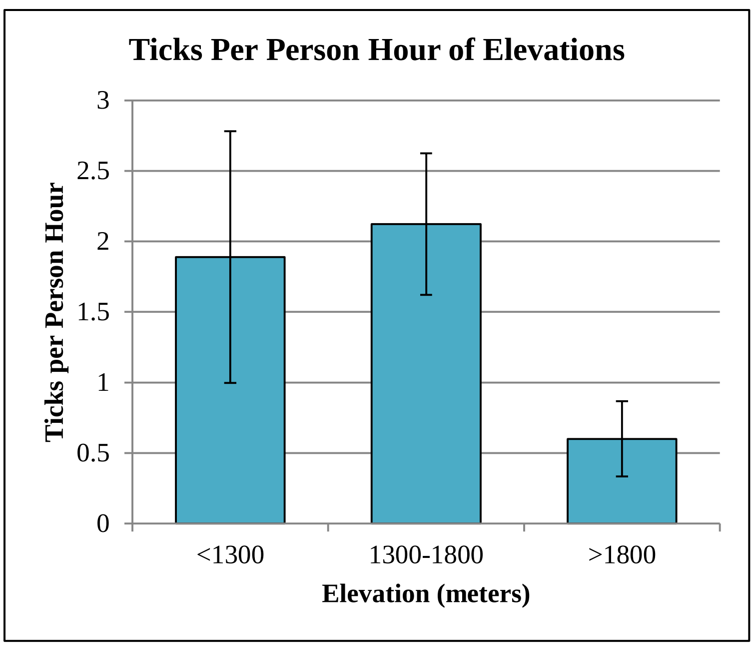

Figure 4. Tick per Person hour (with standard error bars) at different elevations. The P-Value for the Single Factor ANOVA test is 0.433 which indicates the means are not significantly different. Thus, there is no difference between ticks per person hour at the measured elevations.

DISCUSSION

Having only 77 sites and merely 35 of those yielding ticks was insufficient for certain analyses, and unequal distribution of the topographical factors in the 77 sites was a great hindrance to the application of statistics. Nevertheless, significant value was gleaned from the data.

North and west facing slope aspects had significantly more tick absence than tick presence. Additionally south and east facing slope aspects had significantly more tick presence than tick absence. This means ticks were found more often questing on south and east facing slopes than west and north facing slopes. This differs from Eisen's et al. study (2008) in which the sampling purposefully only took place on west and south facing slope aspects. We found that there were more ticks per person hour present on south and east facing slopes than on north and west facing slopes. We speculate the ticks are found on the east and south facing slopes because these are the slopes that receive the first and most sunlight during the spring. Ticks begin questing as soon as the weather becomes hospitable because once the end of June or beginning of July hits the temperature rises to unfavorable limits for the ticks (Eisen, 2007). In a study in Colorado, Eisen (2007) found that tick density reached 50% of the peak density when the daily maximum temperature reached 11^{o}C consistently and then will fall below 50% of the peak when the daily maximum reached 21^{o}C consistently.

The sites in Colorado were all above 2000 meters and all yielded many ticks (Eisen, 2008). Of course, Montana has a much lower number of mountain ranges in the 2000 meter level when compared to Colorado. We had ten sites above 1800 meters and only three of those were over 2000. There are two possible explanations for the elevation data. One possibility is that the elevation has no effect on the tick abundance. In other words, tick distribution and abundance could be independent of the elevation. The other possibility is that uneven sampling of lower elevation sites skewed the data. This unevenness in sampling can be visualized in **Figure 3** where the 1300-1800 bin has 49 data points and the other two bins have 28 data points combined. Future studies should sample more sites so that all the bins have nearly the same number of data points.

These data provide the beginning of a model that can predict tick distribution to avoid pathogen exposure from a tick bite. During the questing season, south and east facing slopes have yielded more questing ticks and, therefore should be considered higher risk areas than west and north facing slopes which yielded fewer ticks. Other easily recognizable topographical markers, such as steepness of slope, would be beneficial to humans who spend time in tick habitat. Therefore continuation of topographical data collection and analysis of aspect and elevation data is a necessity. Future studies should include variables such as weather, vegetation, and other simple indicators to have a more concrete model and idea of where questing ticks can be found or avoided.

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