ASSESSMENT OF A LINE TRANSECT FIELD METHOD TO DETERMINE WINTER TICK ABUNDANCE ON MOOSE

Meghan Sine[1], Karen Morris[2], and David Knupp[3]

[1]P.O. Box 773 Unity, Maine 04988; [2]5510 Bennoch Road, Lagrange, Maine 04453; [3]Unity College, 90 Quaker Hill Road, Unity, Maine 04988

ABSTRACT: High infestations of winter ticks (*Dermacentor albipictus*) can exact high physiological costs on moose and are associated with high rates of juvenile mortality. Quantifying tick abundance on moose may help managers calculate overall mortality rates for moose and make harvest recommendations. We compared winter tick counts along hair transects on samples of moose hides to tick counts obtained from chemical digestion of those same samples. Winter tick counts from the two methods were strongly correlated (P <0.001, r^2 = 0.88, n = 31). We field-tested the hair transect count method to determine its practicality at moose check stations. Tick counts on 4 body areas per moose (n = 60) generally took ≤10 minutes and were rapid, non-destructive, inexpensive, and easily employed. This method has potential to serve as an effective method to index winter tick loads on moose.

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Winter ticks (*Dermacentor albipictus*) are ectoparasites that grow from larval stage into engorged adults while feeding on a single ungulate host (Addison and McLaughlin 1988). They were recognized as an important ectoparasite of moose as early as 1909 (Seton 1909), and Samuel (2004) has provided a summary of North American moose mortality related to winter ticks. Moose are particularly suitable as hosts for winter ticks because of their ineffective grooming behavior and long hair (Welch et al. 1991). Winter tick loads on 183 moose in Alberta averaged 30,683 ticks per moose, ranging from 2,774-149,916 (Samuel et al. 2000). Musante et al. (2007) estimated that blood loss during the 8-week engorgement period ranged from 64-112% of the normal blood volume of calf moose, and that this blood loss represented 50-100% of their daily protein requirement. Calf survival and recruitment rates may be reduced through the combined effects of protein loss, thermal energy loss associated with alopecia, and energy loss associated with increased grooming (Mooring and Samuel 1999).

Given the potential negative impact that winter ticks may have on moose survival and recruitment, biologists have attempted to monitor winter tick infestations. However most field survey methods, such as late winter aerial surveys to assess hair loss, are both time consuming and costly. Welch and Samuel (1989) developed a laboratory technique to estimate winter tick numbers by digesting moose hide in potassium hydroxide and counting the undigested ticks; however, this method is restricted to the laboratory and is also time consuming and costly. Our objective was to develop an efficient method to estimate winter tick abundance on moose by using easily accessed hunter-harvested moose.

METHODS

Hides from hunter-killed moose were collected from an on-site meat processor at a hunter check station in Greenville, Maine, 2-3 October 2005. We collected hides from moose harvested within 1-23 h. Pieces of hide measuring about 40 x 20 cm were cut from either the right shoulder or right rump;

we selected rump and shoulder areas based on a diagram of tick abundance presented by Samuel (2004). After the moose was skinned, hide samples were placed in sealed plastic bags in <30 min, put on ice, and frozen (-17 C°) within 6 h. Subsequently, we cut 10 cm x 10 cm samples from each 40 cm x 20 cm piece of hide in January 2006, and refroze the 10 cm x 10 cm samples for up to 2 weeks before counting ticks.

Each sample was systematically divided into 9 hair transects, 1 cm apart. Four of the 9 were sampled randomly; the hair was parted and ticks that were visible along the lines were counted using an illuminated 10X magnifier. The average width in which ticks were visible along a single transect was about 0.5 cm. Tick life-stages were not recorded.

After counting ticks in the hair transects, each sample was immediately placed into a 1,000 mL beaker and digested following the procedures of Welch and Samuel (1989). Ticks found loose in a sample bag were included in the digestion process; no sample had more than 4 loose ticks. The remaining solution was filtered through a 180 µm sieve and placed under an illuminated lens (10X magnification) to count the undigested tick exoskeletons. Linear regression analysis was used to determine whether the numbers of ticks counted in the hair transects were correlated with the total number of tick exoskeletons counted after digestion. Tick numbers on calves vs. adults were compared, and we analyzed tick numbers relative to median time since death. The generalizability theory, a method of partitioning measurement error, was borrowed from the field of educational measurement (Brennan 2001) to determine the appropriate number of transects to count on a given square of hide.

RESULTS

Hide samples were collected from 27 adult males, 2 adult females, and 2 calves (4-5 months). Because of the small number of females and calves, we did not test for statistical difference in tick counts for age or sex of moose. The number of ticks estimated from the hair transect method and the number of ticks enumerated from our total counts of digested samples were positively correlated (P <0.001; r^2 = 0.88) (Fig. 1). The proportion of ticks counted in the 4 transects averaged 42% of the total ticks per digested sample. In addition to determining whether the hair transect method could be used to predict the number of ticks determined by total count, we wanted to verify that 4 transects were sufficient in predicting tick numbers. Using 4 lines yielded a dependability index of 0.95 (scale from 0-1), indicating that adding more lines would not greatly improve the reliability of the process.

The difference in transect counts vs. total counts from the rump and shoulder area were compared to see if location may influence results. Initially, the ticks and a dummy variable indicating body region were included in the regression equation. When including both predictors, the body region coefficient was not different from zero (t = 1.023, p = 0.317). Therefore, the most statistically parsimonious and practical predictive equation included only the counted ticks as a predictor of the total number of ticks on the 10 cm² piece of hide.

Calves averaged twice as many ticks per 100 cm² than adults (261 vs. 113). The average tick count from moose dead <6.3 h (i.e.,

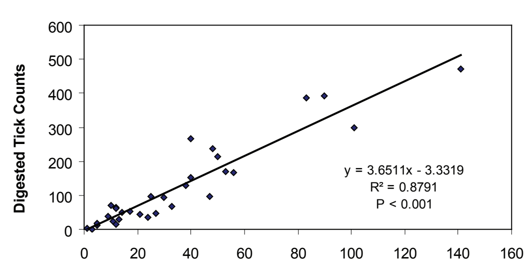

Fig. 1. The relationship between the number of winter ticks counted on 4 transects within a 10 x 10 cm piece of moose hide to the number of exoskeletons of winter ticks counted in the related 100 cm² of digested moose hide.

median time of death) was higher than that from moose dead >6.3 h (~ 50%; t = 2.25, 22 df, P = 0.017). Time spent counting ticks on each set of 4, 10 cm transect lines varied, but did not exceed 5 min. Time required for chemical digestion and counting ticks was approximately 5 h per run of 4 samples.

DISCUSSION

The strong relationship between transect counts and total counts of winter ticks on a 10 cm^2 plot indicated that the transect method may be useful for estimating winter tick numbers, and indexing trends in winter tick abundance on moose. Tick counts on the rump and shoulder areas of moose were not different, and the best predictor of tick density on moose was the total number of ticks counted on all transects.

Counting ticks on hair transects is well suited to field applications because it requires little equipment and training, and does not require the moose to be skinned. During Maine's 2006 moose hunting season we field-tested the practicality of our method on >60 hunter-harvested moose. We found that thin pointed objects such as knitting needles, pencils, and rat-tailed combs were excellent tools for parting moose hair; when marked with a 10 cm designation, the hair transect could be created and measured simultaneously. Counting ticks on 4 transects on each of the rumps, posterior ribs, shoulder, and neck areas required about 5 min with a counter and a recorder; time was doubled if the same person did both tasks. We also found that ticks were plainly visible under bright light without magnification for people with good vision.

Welch and Samuel (1989) found that approximately 15% of the hide had to be counted to estimate the total number of winter ticks on a moose. Measuring transects at this level of intensity would be impractical in most field situations. However, fewer transects would be necessary to describe broad infestation categories (e.g., benign vs. pathogenic, or low, medium, and high) for monitoring or indexing annual winter tick abundance.

Calves are of primary concern when monitoring winter ticks because they are most susceptible to tick-induced mortality (Addison et al. 1994). Welch and Samuel (1989) found that calves (<12 months) had higher tick densities than adults, and our limited sample (2 calves) supports this for Maine moose as well. However, obtaining an adequate, annual sample size of calves could be problematic in Maine because most hunters prefer to shoot larger moose. Unless calves became more available at check stations, we suggest that adult moose are more practical for developing a tick index.

Tick emigration from dead moose was anticipated when collecting samples, and our data indicate that this was a legitimate concern. Tick counts were reduced >50%, on average, after the median time since death (6.3 h). We recommend measuring only moose dead <6-8 h, or at least compensating for time of death. We believe that this transect method has good potential for objectively and rapidly assessing tick numbers on moose in the field, and will be most useful when used as an index. Standardizing time after death and transect location and length will be required for meaningful comparisons between years and areas.

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