White-tailed deer (*Odocoileus virginianus*) population censusing through pellet counts and spotlighting surveys

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Abstract

Working on the 7500 acre University of Notre Dame Environmental Research Center (UNDERC) property, we attempted to estimate the population of White-tailed deer (*Odocoileus virginianus*) and determine if deer density differs between sugar maple, quaking aspen and conifer forests. We used pellet counts and spotlight surveys to estimate the population, along with a vegetation analysis to differentiate deer density between forest types. There was a statistical different between deer abundance in the different forest types, with the conifer forests having the most deer per km^2, less in sugar maple forests and the smallest density in the aspen forests. While there was no significant difference between the three methods, the pellet count method gave us a population estimate of 170 deer and the spotlight method gave us an estimate of 153 deer. By adjusting the pellet count results to account for forest type abundance on the property, we estimated 220 deer. Improvements for future research include using random plots instead of choosing sites and using different plot sizes and shapes for the pellet counts. The main improvement for the spotlight survey would be to use an attention-eliciting device to help reduce the number of deer missed during the survey.

Keywords: White-tailed deer, pellet count, spotlight, population, census.

Introduction

Reliable estimates of deer populations are important for a variety of reasons including hunting and herd management. Changes in population can indicate changes in predators, as well as changes in the environment such as vegetation composition. There is a variety of methods for estimating deer populations including mark and recapture, radio collaring, drive-netting and day-time visual counts. Two of the most commonly used methods are pellet counts and night spotlighting. These two methods were used to estimate the population of white-tailed deer (*Odocoileus virginianus)* on the property of the University of Notre Dame Environmental Research Center (UNDERC). This property consists of 7500 acres on the border of Wisconsin (Vilas Co.) and the Upper Peninsula of Michigan (Gogebic Co). It contains 1350 acres of open water habitats, as well as northern hardwood and boreal forests. Since the property is closed to the public, the deer population is not effected by hunting or motor-vehicle collisions.

Bennet, English and McCain introduced the pellet count method in 1940 and its reliability for population estimation has been well investigated (Etten et al. 1956). One benefit of using this method is that it depends on deer presence in an area over an extended period of time and does not depend on highly varying factors such as deer activity (Eberhardt 1956). However, studies have also shown that factors such as observer error, pellet deterioration and incorrect pellet identification can give unsatisfactory census results. The method of spotlight surveys depends on the reflection of light from the tapetum in deer eyes. Spotlighting has many disadvantages as a method for conducting censuses. It can be affected by deer activity, which varies greatly depending on time, weather and season. Night spotlighting can also prevent certain habitats from being surveyed due to route location, as well as lack of light penetration. While this method has certain disadvantages, it can be useful in revealing changes in deer activity and their presence based on a variety of abiotic factors (McCullough 1982).

Our goal was to estimate the population of deer on the UNDERC property using both the pellet count and spotlighting methods and to then compare the two methods. Through vegetation surveys of the pellet count plots, we also examined the relationship between forest types and deer abundance. We hypothesized that due to the numerous sources of error in both methods, our population estimates would be significantly different. We based our reasoning on the fact that in spotlight surveys, deer are least likely to be spotted during the months of June and July, which is when we did our surveys (McCullough 1982). Furthermore, error could arise due to the exclusion of bog and swamp habitats in our pellet surveys, which based on personal observation, had a considerable number of deer pellets present. We also hypothesized that we would find significantly different deer densities in the different forest types due to the fact that deer defecate in areas where they rest (areas with increased canopy) rather than where they feed (Rothley 2001). Based on this information, we should find the fewest groups of deer pellets in areas of high understory density and the most groups in clear understory with dense canopy cover.

Materials and Methods

To conduct the pellet surveys of deer, we chose nine sites for transect groups. They were selected based on visual determination of their vegetation, with three sites of primarily sugar maple (*Acer saccharum*), three sites of quaking aspen (*Populus tremuloides*), and three sites of conifer (Pinaceae) [Figure 1]. Each site contained three parallel transects, 40 meters apart, with three plots spaced 40m apart on each transect, for a total of nine plots site. The layout of the plots was changed in some of the sites to account for obstacles such as water, but they were always maintained at least 40m apart. Each plot had a 10m radius, which we cleared of all deer pellets at the beginning of the census. Approximately 5 weeks later we returned to the plots and counted the total number of deer pellets groups. When we found a group, it was marked with a flag and both researchers agreed to its identification before it was counted in our study.

In order to perform the vegetation analysis of our sites, we randomly chose four of the nine plots that were used for the deer pellet surveys. Within a five-meter radius from the center of the plot, vegetation greater than one meter tall were counted as trees; at the two-meter radius, vegetation measuring a half a meter to one meter tall were counted as saplings; at the one-meter radius mark, vegetation less than half a meter tall were counted as seedlings. Trees were recorded by species and samples were taken for any unknown species and identified at a later point in time.

For the spotlighting surveys, we used a 16.9 km route that was driven at approximately 16 km/hour [Figure 2]. We began our route shortly after dark (9:30 pm CST) and usually continued until approximately 11pm or until our route was finished. Our vehicle was a Ford Bronco with the top removed. One person drove while the two researchers spotlighted from the back, with one person on each side of the vehicle. When a deer was spotted, we marked the area with flagging and returned during daylight the next day to take notes on the vegetation of the area. The deer were counted on the same sampling route on eight different nights. In order to determine the total area that was surveyed, as well as the average depth of visibility, we drove our route stopping every .42 km to test visibility, for a total of 40 stops. At each stop, one person on each side of the vehicle walked into the forest carrying a measuring tape that was connected to the Bronco. Each person also had a red bike reflector on their upper back to imitate tapetum reflection. They started from the back tire of the Bronco and walked in a straight line, going through any vegetation that they encountered. Two people spotlighted from the Bronco and measured how far away the walkers were when they lost site of them. Using the average distance visibility depth and the length of our route, we calculated the total area surveyed on the spotlighting surveys.

To determine the deer population, we first used the average defecation rate of deer to determine the population size present. Deer defecate at a rate of 13 groups per day per deer (Van Etten and Bennett 1965). To determine the number of deer on property, we first determined the number of pellet groups deposited in each site per day. We then divided that value by 13 groups to find the number of deer per forest site. We converted our plot area from meters to kilometers to then calculate the number of deer per km^2. We took the average number of deer per km^2 and multiplied it by the total dry land area of the UNDERC property. To correct for the composition of tree species on UNDERC property, we utilized data from the BIOS 569 property sampling project to provide a more accurate number of deer per forest type.

To determine if there was a relationship between the forest types and the number of pellet groups, an ANOVA was performed to find any significant relationships. We used a Chi-Square Test to determine if there is a relationship between the different forest types and abundance of sugar maple, quaking aspen, and conifer trees. A Chi-Square Test was also used to determine if there was a relationship between the forest type and the abundance of seedlings, saplings and trees.

In order to determine the deer population using the spotlighting method, we calculated the total area in square kilometers that was surveyed each time we drove our route. Using the average number of deer spotted per night divided by the area we surveyed, we found deer per square kilometer. By multiplying by the square kilometers of dry land on the UNDERC property, we estimated the deer population. We then compared the population estimates from the pellet count method and the corrected pellet count method via a two-tailed t-test, as well as between the correct pellet count and the spotlighting method using a two-tailed t-test.

Results

According to our pellet count survey, there are an average of 6.4 deer/km^2 on the UNDERC property, for a total of 170 ±188 deer. According to the spotlighting survey there are 5.74 deer/km^2 for a total of 153 ±124 deer. We noticed that the majority of the deer were spotted in two areas of the property [Figure 3]. Using a t-test to compare the two censusing methods, we found no significant difference between the two methods (t-stat =-.214, df=15, P=.417) [Figure 3].

In the vegetation analysis, we grouped the nine sites that were chosen by forest type and then compared them. We determined through a Chi-Square Test that there was a significant difference between forest types and the composition of seedlings, saplings and trees (χ^2=37.70, df=4, P= <.001). It was also determined through a Chi-Square Test that there was a significant difference between the forest type classifications and the composition of sugar maple, aspen, conifer and other species ($\chi2$ = 704.38, df=6, P= <.001).

We found that the deer per kilometer in the different forest types were 5.5 ± 6 deer/km^2 in sugar maple forest, 12.4 ±8.1 deer/km^2 in conifer forest, and 1.2 ± 1.5 deer/km^2 in aspen forest. We used an ANOVA to determine if there is a relationship between forest type and number of pellet groups and found that there is a significant difference (F=5.769, df=2, P=.005), with the Tukey Post Hoc test illustrating the difference between aspen and conifer only (P=.003) [Figure 5]. We also used an ANOVA to determine if there is a relationship between the number of pellets and number of seedlings in a plot, as well as number of pellets and number of saplings. We found that neither abundance of seedlings (F=1.294, df=19, P=.304) nor abundance of saplings (F=.991, df=7, P=.458) have a significant effect on the number of pellets found.

In order to get a more accurate census of the deer population on the UNDERC property in different forest types, we used the data from a forest sampling project done by the 2003 BIOS 569 class. We classified the UNDERC property as approximately fifty percent conifer, nineteen percent sugar maple, nineteen percent aspen, and twelve and half percent as other. We used an MANOVA (Wilks' Post Hoc: F ratio= 11.889; df = 12, 24; P=.0001) to demonstrate that the sites that we classified were different from each other. We found a significant different in the abundance of sugar maple (P=.001), quaking aspen (P=.0001) and other species (P=.011) in our different forest types. The abundance of conifer (P=.153) was not significantly different between the forest types. Using the values we obtained of deer/km^2 for the three forest types and the percent abundance of each forest type on the property, we calculated a new value for the deer population of UNDERC. The average deer/km^2 in each forest type was multiplied by the total square kilometers of the specific forest type on the UNDERC property. Since we did not have a value for deer/km^2 in the forest that we classified as "other," we used the average of the deer/km^2 in the other three forest types. Our calculations gave us a value of approximately 220 ± 164 deer on property. We used a two-tailed t-test to compare this value to our population estimates using the original pellet count, as well as to our spotlighting estimate. We found that this estimate is not statistically different from our original pellet count estimation (t-stat=-.599, df=16, .5<P<.9) or our spotlighting estimate (t-stat=.9332, df=15, .4<P<.8) [Figure 4].

Discussion

It is very difficult to decide which of our population estimates is most reliable for the UNDERC property. Because the estimates from the spotlight count, the original pellet count and the corrected pellet count are not statistically different, we have reason to believe that these values could accurately reflect the deer population property. However, there were noticeable flaws in both methods. Our initial calculation from pellet counts made inaccurate assumptions about the forest make-up of the property. Furthermore, it did not include any bog or marsh areas, which make up a considerable portion of the property and are also used by deer.

Another possible source of error is the miscounting of pellets due to observer error. A considerable obstacle in our counts, particularly in our aspen plots, was ground cover that obstructed our view. It is likely that some pellet groups were missed because we could not see them. The census could be improved by having it take place in early spring when vegetation is less dense. Using smaller or rectangular shaped plots that are easier to survey could also reduce observer error (Smith 1968). We also believe that in order to get a more accurate population estimation, plot locations on the property should be chosen at random and the plots cleared and counted several times throughout the year. The goals and time constraints of our survey did not allow for this, but we feel these improvement would give a more reliable estimation.

There is reason to believe that the population estimate from spotlighting could be lower than the actual value because studies have shown that deer are generally less active during the months of June and July and therefore less likely to be seen while spotlighting. McCullough (1982) found that in an area of known deer population only 12-13% of deer were seen while spotlighting in June and July, while in the months from December through April an average of 30-45% were seen. Furthermore, in the months of July and August, deer have a smaller home range and are less likely to be active because they are fawning (Progulske et al. 1964). Another source of error in our spotlight counts is deer missed because they were not facing the vehicle and therefore not seen. Other spotlight surveys have used whistles and predator calls to attract the deer's attention (Cypher 1991). This could be especially important in our area where deer are accustomed to passing vehicles. Our census could also be improved if it were done during the months of October or November because studies have shown that these months have the lowest variance in deer sightings (McCullough 1982). It would also be interesting to record temperature, humidity, wind conditions and other abiotic conditions to see if there is a relationship between them and the number of deer spotted.

Our statistical comparisons of our plots gave us confidence that the sites that we chose visually are different from each other in actual vegetation composition. Statistical analysis showed that there is a significant difference in deer density in our three forest types. Our results support our original hypothesis by showing that deer are most abundant in conifer forests, less abundant in sugar maple forests and least abundant in aspen forests. We expected these results due to the fact that deer on the UNDERC property have been shown to feed primarily in aspen forest where there is dense undergrowth and a more open canopy (Long and Wright 2002 unpb report). Deer are more likely to defecate in areas where they bed, which we would expect to be in conifer and maple forests given that they have denser canopies and less under story vegetation (Rothley 2001).

We believe that the population estimate that we obtained using the percent abundance of different forest types on property is the most accurate method. The values of 50 percent conifer, 19 percent sugar maple and 19 percent quaking aspen are not near the values of 33 percent that we assumed for our original pellet count calculation. We feel that correcting for vegetation abundance was important for having a more realistic estimate of the deer population. While we feel that the correct pellet count method may be the best option for deer population censusing, in order to determine statistically and more accurately which one is best would require more surveys over an extended period of time.

Conclusions

Since the actual number of deer present on the UNDERC property is not known, it is not possible to say which method gave the best estimate. However, the difference between the values from the original pellet count and the corrected pellet count suggest that neither method, as used in our survey, can be used as the sole method of census in an area. We feel that the correction based on the percent composition of forest types on property could possibly provide a better estimate of the deer population. Our results of the deer pellet density differing between forest types reflects the feeding and bedding preferences of deer.

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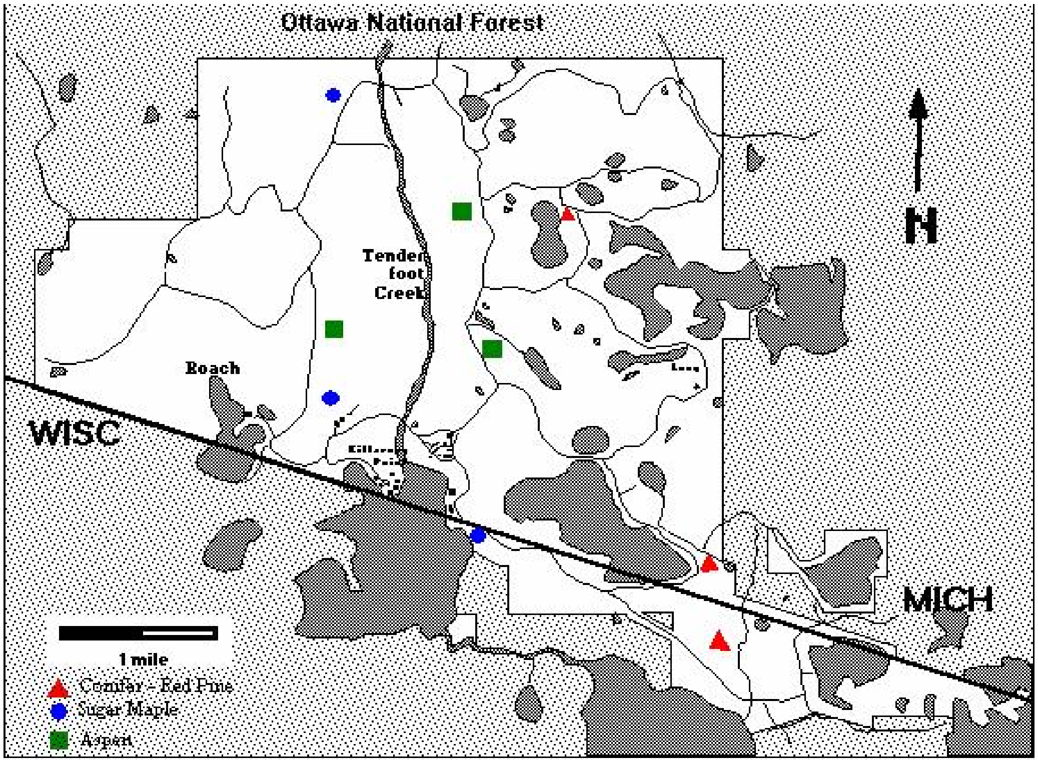

Figure 1: Map of UNDERC property with the three type of forest sites market for the pellet count surveys.

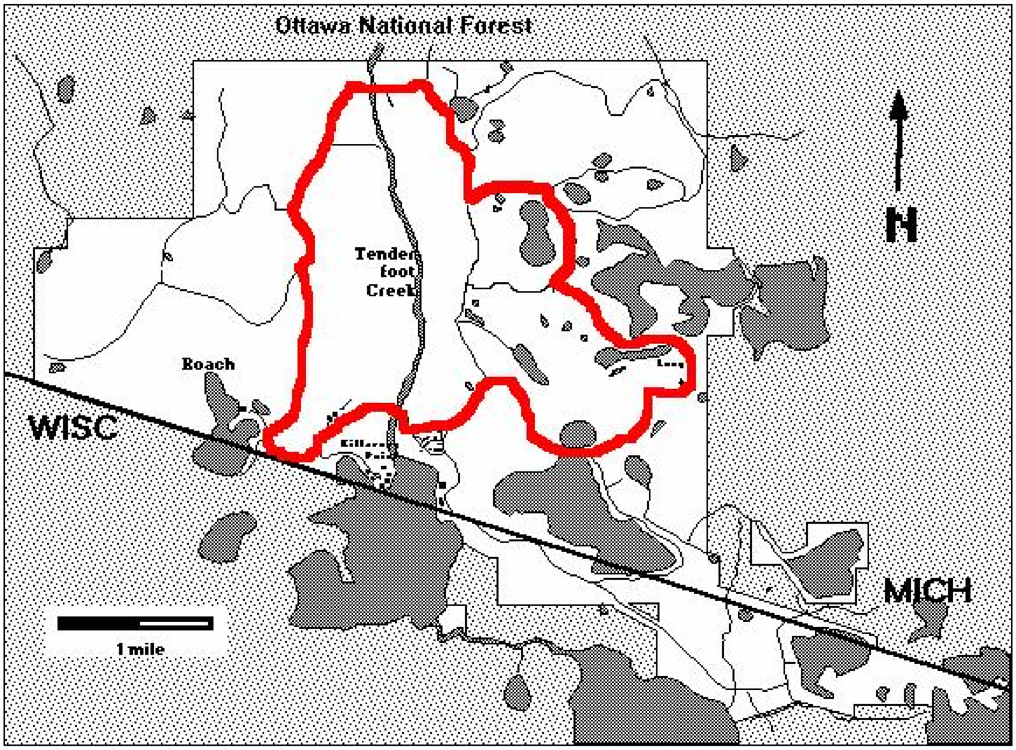

Figure 2: Map of UNDERC property with the 16.9 km spotlight surveying route highlighted.

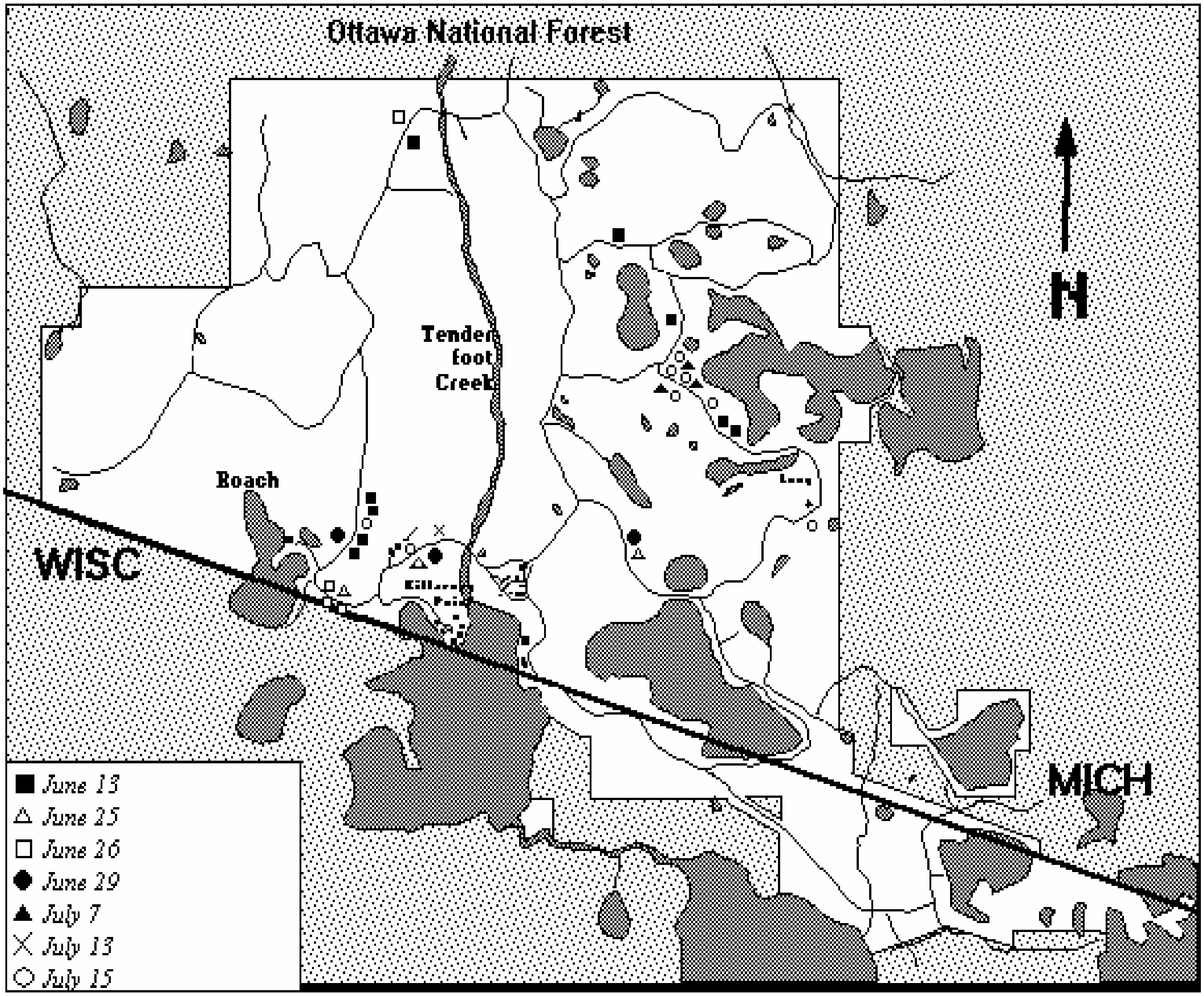

Figure 3: Map of the UNDERC property marked with the locations of the deer spotlighted by date.

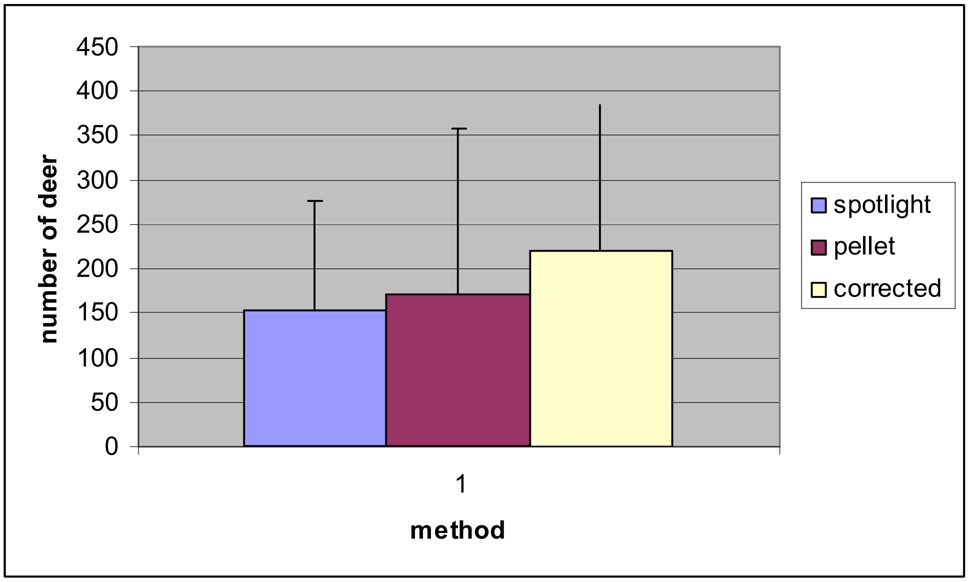

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Figure 4: Comparison of the total deer population on the UNDERC property by the pellet count method, the corrected pellet count method based on vegetation composition and the spotlight method.

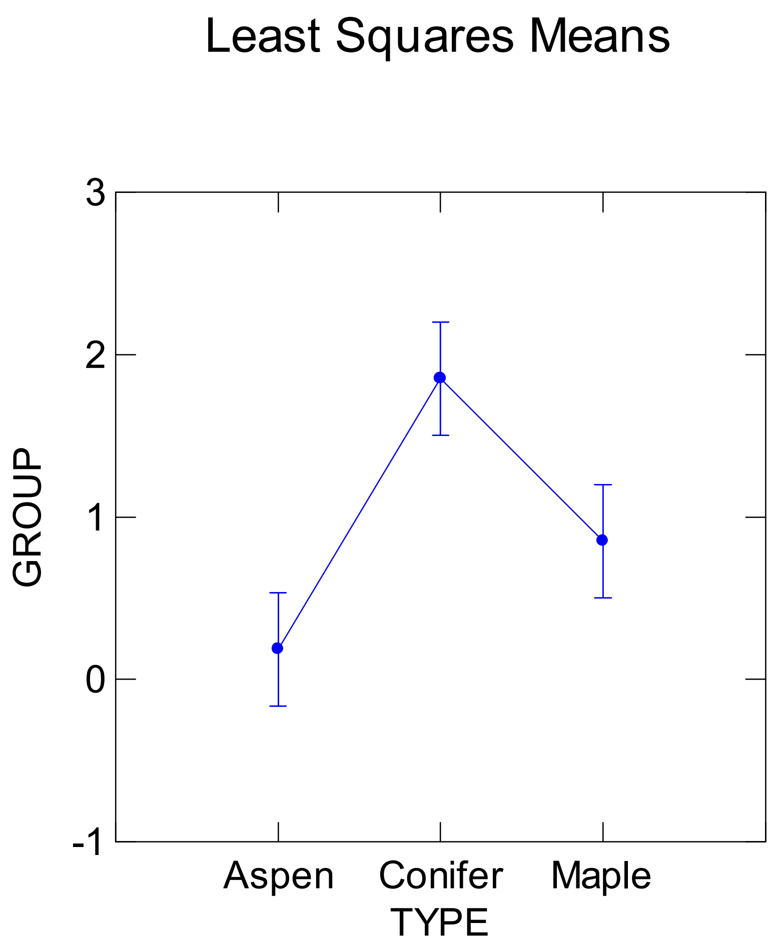

Figure 5: ANOVA relationship between the number of pellet groups per plot and forest type.