Estimating Deer and Moose Densities on DWSP Lands using Pellet-Group Counts

2015 Pilot Project Results

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INTRODUCTION

Estimating free-ranging deer and moose populations in a forested landscape can be a challenging task. Since the Quabbin white-tailed deer hunts began in 1991, DWSP has relied almost exclusively on annual deer harvest data to track changes in population, age structure, etc. DWSP has investigated (and in some cases used) other methods to independently assess the Quabbin deer herd, including aerial infra-red surveys, distance sampling, mark-recapture techniques, and trail cameras. In 2007, DWSP hired a contractor to survey deer and moose populations on Quabbin Reservation using aerial infra-red technology. Unfortunately, the results of the study were inconclusive; the contractor didn't observe enough deer or moose to calculate an estimate. In 2010, DWSP made another attempt to use aerial infra-red technology and collaborated with a researcher from Mt. Holyoke College. This attempt also provided no useable information. DWSP has successfully used distance sampling to estimate deer densities in Quabbin Park, but this technique becomes impractical at deer densities less than 20/mi^2 and could not be used over most of the Reservation. Trail cameras have been used in small landscapes with success, but they are cost prohibitive (Curtis et al. 2009). Based on camera densities in a published study, DWSP would need at least 150 cameras to sample an area the size of Prescott Peninsula (Curtis et al. 2009). Finally, mark-recapture studies can provide an unbiased estimate of deer densities but would require DWSP to capture and mark a number of deer prior to the Quabbin hunts.

While infra-red surveys proved unsuccessful in estimating moose populations, DWSP has successfully used Quabbin hunter sighting data to estimate moose numbers on the Reservation. This technique provides a reasonable estimate of moose but is dependent on hunter accuracy and interpretation of the data.

Counting deer or moose droppings instead of individuals has several distinct advantages. First, droppings are easy to see, don't move, and can be counted over a longer period of time. In addition, counting droppings is relatively straight forward and can be done with a minimal amount of equipment or personnel. Further, a recently published paper has provided a solid framework for conducting this type of survey over large forested areas (DeCalesta 2013).

METHODS

Sampling protocol

DWSP properties were divided into 7 study sites based on current hunting zones or other delineations: Pelham, Prescott, New Salem, Petersham, Hardwick, Quabbin Park, and Ware River. For the pilot study, 3 of these areas were chosen to be sampled: Pelham, Quabbin Park, and Ware River. At each site, a grid of points 1,610 m (1 mile) apart was laid out in a north-south and east-west direction. Depending on the size of each study area, 3-9 points were randomly selected. At each selected point, a second grid was constructed comprised of 5 transects 1,610 m (1 mile) long and spaced 300 m (1000 feet) apart. Each originally selected point formed the mid-point of the middle transect. All points and lines were generated in ArcGIS and transferred to hand-held GPS units that were used for navigation. In some cases, the total 1,610 m line could not be created because the line left DWSP property, entered the reservoir, etc. All transects were laid out in true north/south orientation (Figure 1).

Most transects were walked by at least 2 observers. The lead observer used a GPS and compass to identify the start and end of each transect and walk a straight line. The lead observer paced out 30.5 m (100 feet) intervals and established a plot by placing a wire flag at their feet. The second observer followed the lead person and counted pellet groups (both deer and moose) within 1.2 m (4 feet) radius plots centered on the wire flag. Pellet groups were tallied if there were ≥10 pellets in a group and at least half of the pellets in a group were within the plot boundary. All second observers carried a 1.2 m (4 foot) pole to identify the edges of a plot. Approximately 52 plots/transect were surveyed. However, observers kept an accurate record of how many plots per transect were actually sampled.

Calculating density from pellet-group counts

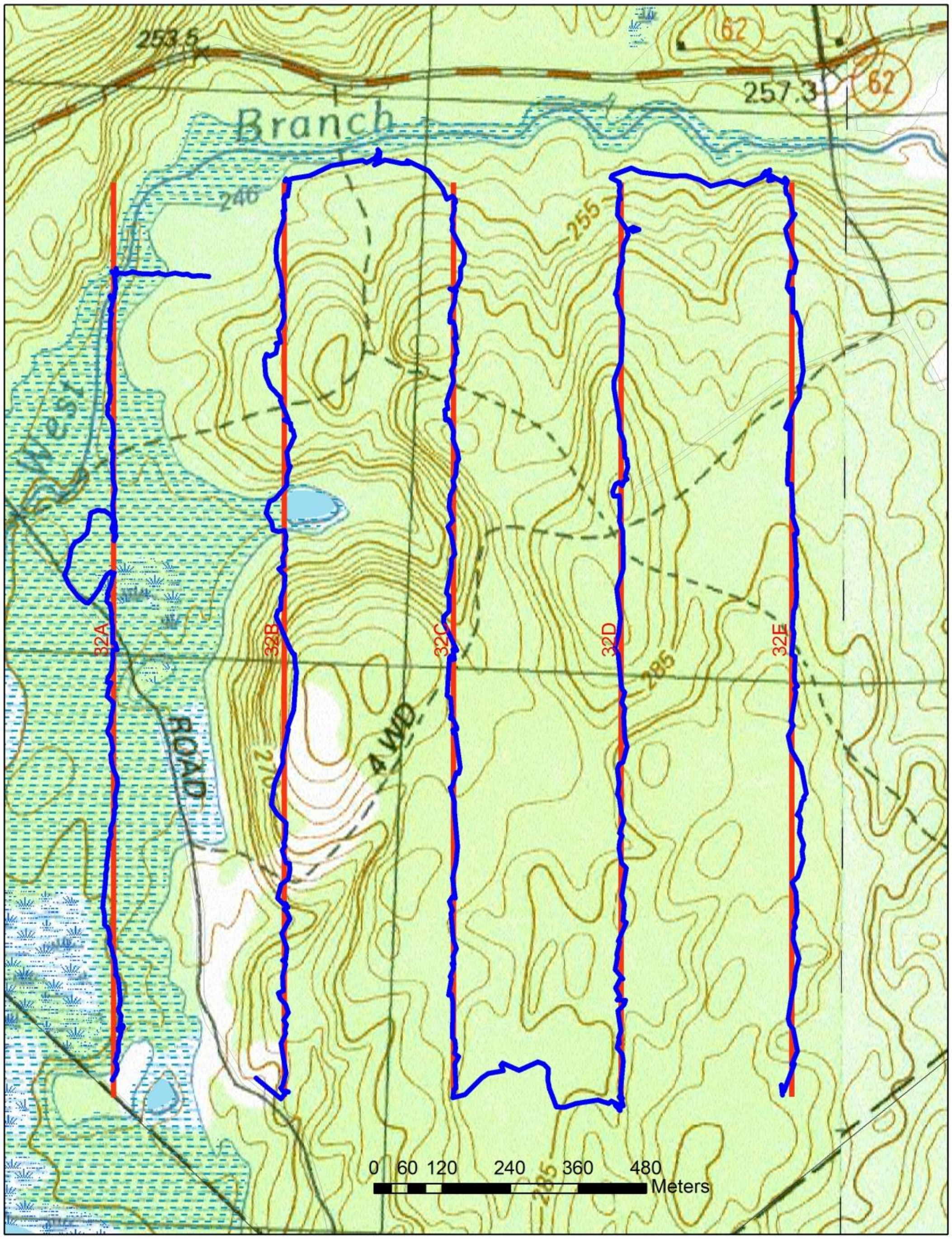
Unadjusted deer and moose densities (#/km^2) were calculated using the following formula:

Deer or Moose/km^2 = $\sum$number of pellet groups counted/(pellet-group deposit rate x deposition period x $\sum$ plot area in m^2/1,000,000 m^2)

To convert this estimate into deer or moose/mi^2, the estimate was divided by 0.386.

Based on data collected by Harvard Forest, a leaf-off date of 12 November, 2014 was used. The deposition period was determined by calculating the number of days between leaf-off and the survey date. The sum of the plot area was the area of an individual plot (4.52 m^2) multiplied by the number of plots. The pellet-group deposit rate can be the most challenging variable to determine and can influence the final density estimate. Based on published deer and moose deposit rates, a low, medium, and high deposit rate of 13, 25, and 33 pellet-groups/day for deer and 7, 14, and 25 pellet-groups/day for moose (Persson et al. 2000, DeCalesta 2013) was used to generate unadjusted estimates in one calculation.

Figure 1. A sampling grid in the Ware River showing the 5 north-south transects (in red) and the survey route walked (in blue).



However, the unadjusted density estimate doesn't account for deer or moose that were killed or died during the period after leaf-off but before the transects were completed. The unadjusted estimates represent average overwinter densities. To calculate spring densities, the number of pellet groups produced by deer and moose that died before the spring survey was subtracted from an estimate of all pellet groups (across the study area, not just the ones counted) deposited by deer and moose that died and deer and moose that survived until spring. For this estimate, average deposit rates for deer and moose of 25 and 14 per animal per day, respectively were used. Coefficients of variation (CVs) and 95% confidence intervals were calculated for the Pelham and Ware River study sites. Five replicate samples were drawn from each study site by assigning each transect within each grid a number from 1 to 5. Replicate one consisted of all the transects assigned number one and so on. Mean deer and moose density estimates, standard deviations, confidence intervals and coefficient of variation were calculated from the 5 replicates. No estimates of precision were calculated for the Quabbin Park study site.

RESULTS

Transects were walked between 15 April and 11 May, 2015. Eleven individuals participated in the study and collectively walked over 120 km (Table 1). Deer pellets were counted in each study area, while moose pellets were only seen in Pelham and Ware River and not in Quabbin Park. Very few dead deer (n=6) and moose (n=2) were encountered on transects.

Table 1. Survey effort and number of pellet-groups seen in each study area, 2015.

Study Site	# Transects	# km walked	# Plots sampled	# Deer Pellet Groups	# Moose Pellet Groups
Pelham	34	63.9	1659	112	50
Quabbin Park	15	19.6	572	95	0
Ware River	44	86.9	2239	174	64

Using the published estimates of deer deposit rates, unadjusted deer densities for the Pelham study area ranged from 6.8-17.7 deer/mi^2 (Table 2). For Quabbin Park, deer densities ranged from 18-47 deer/mi^2, and for the Ware River estimates were 7.5-19.4 deer/mi^2. Unadjusted estimates for moose were also quite variable, depending on the deposit rate. Moose densities ranged from 3.8/mi^2 up to 14.9/mi^2 (Table 2).

Table 2. Unadjusted deer and moose densities (km^2) using three levels (low, medium, & high) of pellet-group deposition rates.

Study Site	Deer Pellet Daily Deposition Rate (mi^2)			Moose Pellet Daily Deposition Rate (mi^2)		
	Low (13)	Med (25)	High (33)	Low (7)	Med (14)	High (25)
Pelham	6.8 (17.7)	3.5 (9.0)	2.6 (6.8)	5.7 (14.9)	2.9 (7.5)	1.6 (4.1)
Quabbin Park	18.0 (46.8)	9.3 (24.1)	7.0 (18.1)	-	-	
Ware River	7.5 (19.4)	3.8 (9.9)	2.9 (7.5)	5.2 (13.5)	2.6 (6.7)	1.5 (3.8)

Deer and moose densities adjusted for overwinter or harvest mortality were similar to unadjusted densities (Table 3). Very few dead moose and deer were discovered during the transects and motor vehicle mortality of moose was minimal. A modest number of deer were harvested in Pelham and the Ware River during the 2014 deer hunting season.

Table 3. Mean unadjusted and adjusted deer densities (km^2), 95% confidence intervals (CI), and coefficients of variation (CV) for Pelham and Ware River study areas, 2015. An average pellet-group deposition rate of 25 was used.

	Unadjusted Deer Density			Adjusted Deer Density		
Study Site	Avg.	95% CI	CV	Avg.	95%CI	CV
Pelham	3.8	±1.05	32.5%	3.7	±1.05	33.1%
Ware River	3.96	±0.51	14.7%	3.90	±0.51	14.9%

Table 4. Mean unadjusted and adjusted moose densities (km^2), 95% confidence intervals (CI), and coefficient of variation (CV) for Pelham and Ware River study areas, 2015. An average pellet-group deposition rate of 14 was used.

	Unadjusted Moose Density			Adjusted Moose Density		
Study Site	Avg.	95% CI	CV	Avg.	95%CI	CV
Pelham	3.1	±1.14	40.5%	3.1	±1.14	40.5%
Ware River	2.6	±0.55	23.9%	2.6	±0.55	24.0%

DISCUSSION

Collecting deer and moose pellet-group data was relatively straightforward and simple. Because the actual sample plots (4.52 m^2) were small, and only pellets on top of the leaves were counted, it is unlikely that any pellet-groups were missed. Most transects were easy to locate and walk. However, there were a few transects that bisected large areas of wetlands. In 2 cases, the whole transect (1,610 m) was relocated several hundred feet from its original location in order to avoid wetlands or open water. In other cases, short detours were necessary when observers were walking the lines in order to avoid open water or deep wetlands.

Estimates of precision for the Ware River study site were reasonable, while those for the Pelham site were unacceptably large. It is likely that deer and moose distribution within Pelham is highly variable. Adding additional transects for this site would be helpful.

The biggest potential influence on deer and moose estimates was the pellet-group deposit rate. While published literature offered helpful guidelines on what rate to include in the formula, these studies were published outside Massachusetts. As a result, deposit rates for moose and deer in Massachusetts may be different or may vary throughout the winter. While deer density estimates were comparable to estimates obtained from deer harvest data, moose density estimates were much higher than reported elsewhere. Reported moose densities in Maine ranged from 0.8-3.4 moose/mi^2 and densities in New Hampshire were estimated at 3 moose/mi^2 (Morris 1999). In Alaska, densities estimated from aerial surveys ranged from 0.19-0.31 moose/mi^2 (Lawler et al. 2006). Our estimates were 1.1 to 4.4 times higher, depending on the pellet-group deposition rate. Using the highest deposition rate yielded densities that were similar to densities in New Hampshire and parts of Maine, but were more than 13 times higher than those reported for Alaska.

While finding the appropriate pellet-group deposition rate for moose and deer will be a challenge, this survey can provide an index of relative abundance. In addition, continuing the survey in the other hunting blocks will provide a clearer picture of deer and moose densities across Quabbin Reservation.

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