Population Analysis for White-tailed Deer
in the Village of Cayuga Heights, New York

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Introduction

Many communities face overabundant populations of white-tailed deer (*Odocoileus virginianus*) in suburban areas and a concomitant increase in humanï wildlife conflicts (DeNicola and Williams 2008, DeNicola et al. 2000, DeNicola et al. 2008). Knowing the abundance and distribution of white-tailed deer is important for making population management decisions, and estimates of population size before and after a management action is how the success of a management program is often judged (Lancia et al. 1994).

Camera-trapping has been used to estimate population size for big cats (Karanth and Nichols 1998) and free-ranging deer (Jacobsen et al. 1997, Koerth et al. 1997). This method has the advantage that physical ñrecaptureò of animals is not needed to get reliable data to use with capture-recapture models. Curtis et al. (2009) documented that using infra-red triggered cameras and the program NOREMARK (White 1996) was a reliable method for estimating abundance of suburban white-tailed deer herds. Data gathered during earlier deer studies conducted in Cayuga Heights were used to validate this technique and models.

The capture and tagging of deer during December 2012 and 2013 in the Village of Cayuga Heights provided a known, marked population of deer necessary for an abundance estimate using mark-recapture analyses. By conducting a photo survey with infrared-triggered cameras after the deer tagging and sterilization was completed, we were able to estimate herd size in the community with good confidence in the results.

Methods

During 2015, the Village of Cayuga Heights (1.8 square miles) was again divided into 12 equally-sized sections by overlaying a grid of approximately 100-acre blocks over a map of the community. We made an effort to use the same properties and camera sites in all three years. Twelve infrared-triggered, digital cameras (Cuddeback, Non Typical, Inc. Green Bay, WI) were deployed over bait piles on properties with a high probability of deer activity within each block. It was intended that each camera would ñcaptureò a large sample of the deer population for that 100-acre block. In accordance with our NYSDEC permit, technicians were granted permission by each landowner before setting up the cameras and putting out bait for deer.

Camera sites were pre-baited daily with approximately 14 pounds of dry, shelled corn for several days prior to the camera deployment on 6 January 2015. Once the cameras were operating, the bait was increased to as much as 30 pound per day at sites with higher deer activity, and less than 14 pounds if there was bait left from the previous day. The cameras were set to run continuously for 24 hours per day, with a preset delay of 5 minutes between pictures. Every other day during the field survey, the memory cards in the cameras were changed so that technicians could confirm the cameras were functioning properly. On 13 January 2015, the photo survey was completed, and cameras were removed. A sufficient number of pictures were taken in 7 days (n = 2,162 photos) with all 12 cameras functioning to run the statistical analysis for population estimation.

After the cameras were removed from the field, all the pictures containing deer were sorted by site and numbered. Each picture was then closely studied, and any legible ear tag number was recorded. We also recorded the total number of deer, the number of unmarked deer, and the number of unidentifiable marked deer for each photo. The number of bucks was recorded in each picture, but these data were not completely reliable, as some bucks had shed their antlers by early January. From these photographic data, the total number of times each identifiable, marked deer was observed was entered into the program NOREMARK (White 1996), along with the total number of unmarked deer, and the total number of marked deer known to be alive in the population during the survey.

Results

The total number of marked deer that were identifiable in the pictures was 86 (Table 1). The potential total number of marked deer in the Village of Cayuga Heights used for analysis was 120 (Table 1). For deer that were not collared, and not moving with a radio-collared deer, it was impossible to know for certain if they were still in the community and alive (Table 2). Because of this uncertainty, we decided to run the analysis three times. The upper population bound included all the possible live deer within the analysis, whether the deer were observed or not in the camera survey. The lower population bound included only the tagged deer observed on camera and known to be alive during the survey. There were two tagged female deer (C70, C141), and one male deer (H04) observed while supporting the White Buffalo, Inc., operations in February and March 2015 that did not appear during the January 2015 camera survey.

Since deer capture and tagging were completed in December 2012, there have been 43 recorded deaths for marked deer through 1 April, 2015 (Tables 3, 4, and 5). This total does not include the 48 deer removed by White Buffalo, Inc., via the NYSDEC Deer Damage Permit (see below, Table 6). Sixteen of those 43 deer (37.2%) died as a result of deer vehicle collisions. Fifteen of the 43 deer (34.9%) were legally killed by hunters on Cornell University lands. Seven deer (16.3%) died from other causes. One deer (2.3%) died shortly after release in 2012, and this animal was presumed to have succumbed from complications associated with either capture or surgery. It was not possible to determine the cause of death for four deer (9.3%) because their carcasses were too decomposed when found.

Deer population estimates generated by program NOREMARK were conducted in three ways. The first population estimate (n = 116) and associated 95% confidence interval (109-123) included all deer known to be alive (via photo confirmation) in the area during the time of the camera survey in January 2015. The second population estimate (n = 161) and 95% confidence interval (148-176), includes an additional 34 deer that may potentially be alive in the community (Table 1), but that did not appear on photographs during the camera survey. We ran the analysis a third time using tagged deer observed during the 2013 and 2014 photo surveys, but that were missed in 2015. This third population estimate (n = 137) and 95% confidence interval (127-148) provides the most reasonable estimate of deer abundance in Cayuga Heights. It is also very close to the midpoint (138 deer) between the upper and lower possible bounds for population estimation. So deer density in January 2015 was approximately 76 deer per square mile based on the most likely population estimate of 137 deer. This is much lower than the 125 deer per square mile (based on a total of 225 deer) calculated in January 2013. Sterilization surgery with 98% of female deer treated, and observed mortality rates, resulted in about a 39% population decline over two years.

The Village contracted with White Buffalo, Inc., staff to remove deer from the area under a NYSDEC Deer Damage Permit (DDP) during late winter 2015. The Village police approved use of crossbows for deer removal at selected sites. Landowner permission was obtained by the Village for each site as required by the NYSDEC permit. A total of 48 deer were removed, including 26 tagged deer, and 22 untagged deer (Table 7). Twenty-five of the 26 tagged deer removed were females (Tables 8 and 9), which is not surprising given the low number of bucks initially tagged in the Village.

Discussion

Based on our photo survey and discussions with A. DeNicola concerning the untagged female deer removed, we believe that there may have been 11 untagged, transient deer removed from the community by White Buffalo, Inc., staff during the deer removal effort in March 2015. It is impossible to know for certain if these 11 deer in the Village were transient, but it is very likely. Untagged deer in these groups did not show up on our camera survey in January, nor did they appear at the bait sites during more than a month of pre-baiting prior to the deer removal efforts. These deer arrived in the Village during early March after more than six weeks of deep persistent snow, and several were in wooded areas on the west side. We saw similar movements of deer into the Village during a severe winter about a decade ago while we were radio-tracking animals during the initial deer fertility-control study.

Consequently, White Buffalo, Inc., staff likely removed 37 (26 tagged and 11 untagged) deer that may have been present in the Village during the time of the camera survey in January 2015 (plus the 11 additional untagged transient deer). Subtracting these probable 37 resident deer from the population estimate of 137 deer in January, leaves a residual population of about 100 deer in the Village (56 deer per square mile) by late March 2015. This is a 55.6% reduction in deer numbers since the original camera survey was conducted in January 2013. Combining lethal removal with sterilization surgery rapidly reduced the deer population because much of the deer mortality was additive. Removal alone would have been less effective without prior sterilization because the remaining female deer would likely have produced enough fawns to offset the removals if those deer were still breeding.

Current deer densities are still more than double the proposed Village goal of 20 deer per square mile. Additional deer removal will be needed to achieve this goal in future years. It will be very important to target immigrating, untagged female deer that would likely provide a new cohort of fawns. Given the sites available for deer removal this year, there were pockets of the Village with very few deer removed. It will be necessary to expand the number of sites available for deer removal in future years and conduct these efforts over a longer time period.

In the White Buffalo, Inc., 2015 report there was a concern raised about the quality of the corn bait used. We have used the same locally-grown corn from Cornell University Farm Services for our deer camera surveys on campus for many years with no apparent problems or issues. Also, the same bait source has been used for deer camera surveys in the Village for the past three years, and for baiting during deer capture efforts for sterilization surgery in 2012 and 2013. However, if corn quality is an issue, it is important to know this to improve the success of future deer program efforts in the Village and on the Cornell University campus. With the severe winter weather in February 2015, NYSDEC extended our Cornell Deer Damage Permit for an additional two

weeks (until April 15th). This provided an opportunity for us to conduct a preliminary field trial to compare corn quality and deer preference between Cornell-grown corn, and corn purchased at Ithaca Agway (locally-grown in Lansing, NY).

The moisture content of the corn from Agway and CU Farm Services was checked on the afternoon of 7 April, 2015. Two bins of corn from CU Farm Services were tested separately with moisture readings of 13.3% and 13.1%. One bag of corn purchased from Agway was tested at 12.8% moisture. Equal measures of each corn were weighed for comparison, and the corn purchased from Agway tended to be slightly lighter, which was most likely accounted for by the difference in percent moisture.

We selected six deer-removal sites on the Cornell campus and provided two piles of corn bait at each location (one from CU Farm Services and the other from Agway) about a yard apart during April 7 to14 (Table 10). Initial bait position (left or right side) was selected randomly, and corn location was switched back and forth each time both piles were completely consumed. Sites were baited late afternoon each day during the trial, and usually 7 pounds of each corn type was placed at the site. For sites with very high deer use (Hawthorn Thicket and Arboretum initially), 14 pounds of each corn type was used. Sites were checked the next day during late afternoon, and the proportion of corn consumed from each pile was estimated to the nearest 5%. It was impossible to gather and weigh remaining corn because it was sometimes trampled into the soil and would have collected moisture. The total weight of corn consumed was calculated based on the weight put out and proportion remaining.

We saw no predictable or significant differences in deer consumption of corn bait from Agway versus CU Farm Services (Table 10). On a few days deer did take slightly more Agway corn, but during most days and at most sites, the consumption of the two corn types was not different. At the end of the trial, deer consumed 185.1 of the 203 pounds (91.2%) of the Agway corn provided, and 175.2 of the 203 pounds (86.3%) of the CU Farm Services corn provided. This difference was not great enough for us to switch corn sources for deer research on campus. Also, using the bulk corn from CU Farm Services reduced camera survey and pre-baiting costs in the Village by nearly $500 versus purchasing bagged corn from the local farm supply store. So we believe that other deer behavior factors were likely responsible for lower early success with deer removal by White Buffalo, Inc., staff.

Continued monitoring of the deer herd via a survey with infra-red triggered cameras will be critical to document the impacts of the program. It may not be necessary to do a camera survey and population estimate every year. However, camera surveys should be conducted at least every other year to document that the deer population trajectory continues toward goal density. Maintaining a marked component of deer in the community will be import for reliable photo surveys, unless we shift to another method using branch antlered bucks as the ñmarkedò population. Within a few years, it may be possible to achieve the goal density and shift to a maintenance program targeting primarily immigrating female deer. Much will depend on obtaining additional removal locations on private lands in the Village to access deer that did not use the current bait sites.

It would also be helpful to have a standardized measure of deer impact reduction over time. It is really the impacts that are important to community members, not the number of deer. Do numbers deer-vehicle collisions in the Village decrease over time? Are reports of plant damage reduced? Is there a way to track the number of cases of tick-borne diseases in the Village? We would strongly encourage developing one or more of these metrics to document success of the program, and show that the time and funding expended were reasonable.

Recommendations

Based on the current population analysis and knowledge of deer behavior, we make the following recommendations:

1. During summer, the DPW crew and others in the community should watch for spotted fawns, and note their locations. That should help focus follow-up removal efforts in areas where immigrant, reproducing female deer have established home ranges.
2. Continue to record locations of dead, tagged deer. The Village Police and DPW staff have been very helpful in providing us with the location and tag numbers for known deer mortalities. This will continue to help us with future population estimation.
3. Determine if follow-up sterilization surgeries are warranted. Given that current deer removal sites only cover a portion of the Village, immigrating pregnant deer may establish home ranges in areas that are currently not accessible for deer removal. If additional removal sites are not found, it may be necessary to tag, capture, and sterilize these immigrating deer to prevent population growth that would offset removal efforts.
4. Plan for follow-up deer removal in winter 2016. Removal efforts should focus on immigrant, untagged does, and female fawns. Discussions should occur with A. DeNicola, P. Curtis, and DEC staff (C. LaMere, DEC Region 7, Cortland, NY) to plan for follow-up deer removal efforts and LCP renewal.
5. Develop ways to document reductions in deer-related impacts. The Village Board should discuss and determine ways to assess the success of the ongoing deer management program. Impact indicators could include reports of deer-vehicle collisions, reported cases of Lyme disease, and damage to natural plants or ornamentals. Such measures will be important for maintaining community support for the deer program.

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Table 1. Potential total number of marked deer alive in the Village of Cayuga Heights at the time of the photo survey conducted during 6 January through 13 January, 2015.

Marked female deer observed in the camera survey	85
Marked male deer observed in the camera survey	1
Marked deer not observed in the village (with no mortality report)	31
Marked deer observed in the village but not during the camera survey	3
Potential total marked deer in the Village	**120**

Table 2. Deer that were not observed in the 2015 photo survey, not seen during the 2015 DDP effort by White Buffalo, Inc., and have no recorded mortality information (n = 31). Without functioning radio-collars, it is difficult to determine if these deer are alive, or still residing in the Village.

Tag #	Photo Survey 2013	Observed December 2013	Photo Survey 2014	Photo Survey 2015
C06	Yes	No	No	No
C07	Yes	Yes	Yes	No
C08	Yes	No	No	No
C18	No	No	No	No
C33	No	No	No	No
C35	Yes	No	No	No
C37	Yes	No	No	No
C45	Yes	Yes	Yes	No
C53	Yes	No	No	No
C54	Yes	No	No	No
C64	Yes	No	No	No
C65	Yes	Yes	Yes	No
C71	Yes	No	No	No
C78	Yes	No	No	No
C79	Yes	No	No	No
C86	Yes	Yes	No	No
C88	No	Yes	No	No
C96	No	No	No	No
C97	No	No	No	No
C98	Yes	No	No	No
C99	Yes	No	No	No
C100	Yes	No	No	No
C113	Yes	No	No	No
C117	No	No	No	No
C118	Yes	No	No	No
C122	No	Yes	No	No
C129	Yes	Yes	Yes	No
C130	Yes	Yes	Yes	No
C136	Yes	No	No	No
C144	N/A	Yes	Yes	No
C145	N/A	Yes	Yes	No

Table 3. Known mortality of tagged deer (n = 15) in Cayuga Heights during December, 2012 through May 1, 2013.

Tag#	Age at capture	Recovery Codes*	Recovery Date
C13	F	HH	1/30/2013
C21	10+	DVC	4/25/2013
C58	5.5	DVC	2/4/2013
C82	3.5	DVC	2/26/2013
C94	1.5	ND	4/16/2013
C95	1.5	ND	3/24/2013
C116	5.5	CM	12/18/2012
C119	1.5	HH	3/20/2013
C124	2.5	DVC	3/26/2013
35	>3.5	OC	1/22/2013
59	>4.5	OC	2/27/2013
73	>3.5	DVC	4/12/2013
H01	F	DVC	12/21/2012
H08	2.5	DVC	2/17/2013
H14	F	ND	4/2/2013

*HH= hunter harvest; DVC= deer-vehicle collision; ND= not possible to determine; CM= capture-related mortality; OC= other causes.

Table 4. Known mortality of tagged deer (n = 18) in Cayuga Heights during May 1, 2013 through April 1, 2014.

Tag#	Age at capture	Recovery Codes*	Recovery Date
131	8+	OC	1/2/2014
C04	A	DVC	1/13/2014
C23	A	DVC	7/29/2013
C56	4.5	HH	3/7/2014
C62	8.5	DVC	7/26/2013
C92	1.5	HH	1/14/2014
C93	1.5	HH	10/19/2013
C105	1.5	HH	2/4/2014
C108	2.5	HH	2/4/2014
C109	3.5	DVC	11/21/2013
C115	3.5	DVC	8/19/2013
C125	3.5	HH	3/7/2014
C132	2.5	HH	1/5/2014
C134	4.5	HH	3/17/2014
C135	4.5	HH	3/17/2014
H05	F	HH	11/5/2013
H16	F	HH	11/18/2013
H28	F	HH	12/13/2013

Table 5. Known mortality of tagged deer (n = 10) in Cayuga Heights during April 1, 2014 through April 1, 2015, not including deer removed with the NYSDEC Deer Damage Permit.

Tag#	Age at capture	Recovery Codes*	Recovery Date
H03	F	ND	5/7/2014
C10	F	DVC	6/6/2014
C12	F	DVC	6/6/2014
C50	2.5	DVC	6/6/2014
C01	A	O	6/19/2014
C66	6.5	O	9/30/2014
C84	2.5	O	10/2/2014
C15	A	HH	10/7/2014
C14	5.5	O	1/26/2015
C28	3.5	DVC	3/17/2015

*HH= hunter harvest; DVC= deer-vehicle collision; ND= not possible to determine; CM= capture-related mortality; OC= other causes.

Table 6. Causes for total tagged deer mortality in Cayuga Heights during December 2012, through April 1, 2015.

Cause of Death	Total	Percent*

Deer vehicle mortality (DVC)	**16**	23.2%
Hunter harvested (HH)	**15**	21.7%
Other mortality causes (O)	**7**	10.1%
Capture-related mortality (CM)	**1**	1.4%
Not determinable mortality (ND)	**4**	5.8%
Deer damage permit (DDP)	**26**	37.7%
Total known deer mortality (male and female)	**69**	

*Percent of total known mortality for tagged deer, including the 48 deer taken as part of the deer removal effort via the NYSDEC Deer Damage Permit.

Table 7. Deer removed by White Buffalo, Inc., staff with a deer NYSDEC deer damage permit (DDP) in the Village of Cayuga Heights, New York, during late winter of 2015.

Marked female deer removed	25
Marked male deer removed	1
Total marked deer	26
Unmarked female deer removed	14
Unmarked male deer removed	8
Total unmarked deer	22
Total deer removed during late winter of 2015	**48**

Table 8. Marked female deer removed via the NYSDEC Deer Damage Permit (DDP) in Cayuga Heights, New York, during late winter 2015.

Tag#	Recovery Date	
C05	3/11/2015	
C09	3/11/2015	
C11	3/11/2015	
C16	3/6/2015	
C19	3/6/2015	
C27	3/8/2015	
C34	3/13/2015	
C43	3/8/2015	
C44	3/14/2015	
C48	3/6/2015	
C55	3/12/2015	
C57	3/8/2015	
C60	3/13/2015	
C63	3/13/2015	
C67	3/11/2015	
C80	3/12/2015	
C81	3/8/2015	
C83	3/6/2015	
C107	3/14/2015	
C121	3/9/2015	
C128	3/11/2015	
C133	3/7/2015	
C140	3/11/2015	
C141	3/13/2015	
C147	3/14/2015	
Total	**26**	**Marked females harvested**

Table 9. Marked male deer recovered with NYSDEC deer damage permit (DDP) in Cayuga Heights, New York, during late winter 2015.

Tag#	Recovery Date	
H02	3/07/2015	
Total	**1**	**Marked males harvested**

Table 10. Comparison of the percent of corn consumed during a 24-hour period for bulk corn procured from Cornell Universityôs Farm Services, and bagged corn purchased from Ithaca Agway, during April 2015.

		Agway			Cornell		
	Date	***Corn provided**	**% consumed**	**Pounds consumed**	***Corn provided**	**% consumed**	**Pounds consumed**
	4/7/2015	14	100%	14	14	100%	14
	4/7/2015	7	100%	7	7	98%	6.9
	4/7/2015	7	100%	7	7	100%	7
	4/7/2015	7	100%	7	7	100%	7
	4/7/2015	14	100%	14	14	100%	14
	4/7/2015	7	100%	7	7	98%	6.9
	4/8/2015	7	95%	6.7	7	40%	2.8
	4/8/2015	7	100%	7	7	100%	7
	4/8/2015	7	25%	1.8	7	25%	1.8
	4/8/2015	7	95%	6.7	7	50%	3.5
	4/8/2015	14	70%	9.8	14	70%	9.8
	4/8/2015	7	100%	7	7	100%	7
	4/10/2015	7	100%	7	7	100%	7
	4/10/2015	7	85%	6	7	85%	6
	4/10/2015	7	95%	6.7	7	95%	6.7
	4/10/2015	7	100%	7	7	99%	6.9
	4/10/2015	14	100%	14	14	100%	14
	4/10/2015	7	80%	5.6	7	80%	5.6
	4/14/2015	7	100%	7	7	100%	7
	4/14/2015	7	100%	7	7	60%	4.2
	4/14/2015	7	30%	2.1	7	40%	2.8
	4/14/2015	7	98%	6.7	7	90%	6.3
	4/14/2015	14	100%	14	14	100%	14
	4/14/2015	7	100%	7	7	100%	7
Totals		203		185.1	203		175.2

*Corn provided the previous late afternoon and available overnight. Pounds consumed are calculated from the estimated percentages.