

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

1 April 2016

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Introduction

Many communities face overabundant populations of white-tailed deer (*Odocoileus virginianus*) in suburban areas and a concomitant increase in human–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 “recapture” 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 2016, 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 four 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 “capture” 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 18 January 2016. Once the cameras were operating, the bait was increased to as much as 20 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 25 January 2016, the photo survey was completed, and cameras were removed. A sufficient number of pictures were taken in 7 days ($n = 1,946$ photos with deer) 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 53 (Table 1). The possible total number of marked deer in the Village of Cayuga Heights used for analysis was 59 (Table 1), as there were 6 tagged deer seen in 2015 that were not observed in 2016 (Table 2). 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. Because of this uncertainty, we decided to run the analysis twice. The upper population bound included all the possible tagged deer seen within the community during 2015 and 2016 (Tables 1 and 2), whether the deer were observed or not in the 2016 camera survey. The lower population bound included only the tagged deer observed on camera and known to be alive during the 2016 survey. All tagged deer observed during the White Buffalo, Inc., operations in March 2016 were seen during the January 2016 camera survey.

During 1 April 2015 through 1 April 2016, there were 6 recorded deaths for marked deer (Table 3). This total does not include the 13 tagged deer removed by White Buffalo, Inc., via the NYSDEC Deer Damage Permit (see below, Table 6). Overall, 90 tagged deer (both females and males) were confirmed dead between December 2012 and April 1, 2016. Twenty of those 90 deer (22.2%) died as a result of deer vehicle collisions. Sixteen of the 90 deer (18.9%) were legally killed by hunters on Cornell University lands. Seven deer (7.8%) died from other causes. One deer (1.1%) 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 6 deer (6.7%) because their carcasses were too decomposed when found. During 2015 and 2016, 39 tagged deer (43.3%) were removed from the Village via the NYSDEC Deer Damage Permit.

Deer population estimates generated by program NOREMARK were conducted two times. The first population estimate ($n = 94$) and associated 95% confidence interval (87-101) included all deer known to be alive (via photo confirmation) in the area during the time of the camera survey in January 2016. The second population estimate ($n = 104$) and 95% confidence interval (95-115), includes an additional 6 tagged deer that may potentially be alive in the community (Tables 1 and 2), but that did not appear on photographs during the camera survey. These 6 deer were observed in 2015, but not 2016, by either Cornell University or White Buffalo, Inc., staff. It is unlikely that any of these 6 deer are still alive and in the community. So the deer population in January 2016 was 94 deer, or 52 deer per square mile based on the population estimate (a 58% reduction during 3 years). This is much lower than the total of 225 deer (125 deer per square mile) calculated in January 2013.

The Village contracted with White Buffalo, Inc., staff to remove deer from the area under a NYSDEC Deer Damage Permit (DDP) during late winter 2016. 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 24 deer were removed, including 13 tagged deer, and 11 untagged deer (Tables 5 and 6). All of the 13 tagged deer removed were females (Table 6), which is not surprising given the low number of bucks initially tagged in the Village. Also, two tagged deer died (C51, C142) after the camera survey was completed. Consequently post-removal, the estimated number of deer remaining in the Village on April 1, 2016, is 68 (38.3 deer per square mile), and 37 of those were tagged, sterilized deer.

During March 2016, White Buffalo staff also captured and sterilized 5 new female deer (Table 7). So 42 of the estimated 68 deer (61.8%) remaining in the Village should now be tagged and sterilized females. We reviewed the January 2016 photos to get an estimate of the number of untagged bucks in the community. It is difficult to differentiate between spike-antlered bucks, and a few of the branch-antlered adult males. Based on the January camera survey, there were likely at least 8 different spike bucks, and 7 branch-antlered males. Some adult male deer may have shed antlers by mid-January, so it is possible that some bucks were missed. The estimate of 15 yearling and adult bucks in the Village is conservative. Checking the November 2015 photos, there were at least 3 more different branch-antlered males observed at that time. Some male deer move in and out of the community, so any estimate provides a snapshot at a given point in time. We also observed untagged female deer with button bucks (fawn males) at several sites. It appeared there were at least 8 different button bucks based on group size, tagged deer associated with the group, and different locations frequented.

Discussion

White Buffalo, Inc., staff removed 24 (13 tagged and 11 untagged) deer that were present in the Village during the time of the camera survey in January 2016. Subtracting these 24 resident deer from the population estimate of 94 deer in January, plus the two tagged deer (C51, C142) that died since the camera survey was completed, leaves a residual population of 68 deer in the Village (37.8 deer per square mile) by April 1, 2016. This is a 69.8% 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 higher than the proposed goal of 20 deer per square mile in the Village ($n = 36$ total deer). 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 control efforts this year, most untagged female deer in the Village were removed during March 2016. White Buffalo staff were only able to capture, tag, and sterilize 5 new female deer in the community that avoided shooting sites.

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 important for reliable photo surveys. Within the next year or two, it may be possible to achieve the goal density of 20 deer per square mile, 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 2017. 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.

Literature Cited

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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 18 January through 25 January, 2016.

Marked female deer observed in the camera survey	53
Marked male deer observed in the camera survey	0
Marked deer not observed in the village (with no mortality report) ^a	6
Marked deer observed in the village but not during the camera survey	0
Potential total marked deer in the Village	59

^a Only deer observed sometime during 2015 and 2016 are included in this table. There were 6 deer observed in winter 2015 that were not seen in winter 2016 by either Cornell University or White Buffalo staff (see Table 2). It is very likely that these 6 tagged deer were not in the Village at the time of the camera survey. Also, tagged deer that have not been seen since 2014 or before are unlikely to be in the Village.

Table 2. Deer that were not observed in the 2016 photo survey, not seen during the 2016 DDP effort by White Buffalo, Inc., but were observed in 2015 ($n = 6$). Without functioning radio-collars, it is difficult to determine if these deer are alive, or still residing in the Village.

Tag #	Capture location	Photo survey 2013	Photo survey 2014	Photo survey 2015	Photo survey 2016
C30	Parkway/Comstock	Yes	Yes	Yes	No
C46	327 The Parkway	Yes	Yes	Yes	No
C73	109 Cayuga Heights	Yes	Yes	Yes	No
C75	Comstock	Yes	Yes	Yes	No
C123	Lexington	No	Yes	Yes	No
C138	Triphammer	N/A	Yes	Yes	No

Table 3, Known mortality of tagged deer ($n = 7$) in Cayuga Heights during April 1, 2015 through April 1, 2016, not including deer removed with the NYSDEC Deer Damage Permit.

Tag#	Age at capture	Capture Location	Alive?	Recovery Codes*	Recovery Date	Recovery Site
C111	F	109 Cayuga Heights	N	DVC	6/24/2015	Corner of Lake St. and E. Lincoln St.
118	2.5	103 Comstock	N	DVC	10/25/2015	409 Hanshaw Rd.
C03	3.5	Spruce Ln.	N	HH	10/31/2015	Next to Ithaca Swim Club on Uptown Rd.
C74	4.5	109 Cayuga Heights	N	DVC	11/6/2015	The intersection of Triphammer and Country Club Rds.
C90	A	506 Highland	N	DVC	1/2/2016	911 E. Shore Drive
C51	1.5	Highland	N	ND	2/1/2016	507 Hanshaw Rd
C142	3.5	North Sunset	N	ND	3/26/2016	South Sunset Drive

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

Table 4. Causes of mortality for tagged deer in Cayuga Heights during December 2012, through April 1, 2016.

Cause of Death	Total	Percent*
Deer vehicle mortality (DVC)	20	22.2%
Hunter harvested (HH)	17	18.9%
Other mortality causes (O)	7	7.8%
Capture-related mortality (CM)	1	1.1%
Not determinable mortality (ND)	6	6.7%
Deer damage permit (DDP)	39	43.3%
Total known deer mortality (male and female)	90	

*Percent of total known mortality of tagged deer, including the 39 deer (38 F, 1 M) taken over 2 years of the deer removal effort via the NYSDEC Deer Damage Permit.

Table 5. 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 2016.

Marked female deer removed	13
Marked male deer removed	0
Total marked deer	<hr/> 13
Unmarked adult female deer removed	5
Unmarked fawns removed (1 M, 3 F)	4
Unmarked adult male deer removed (2 yearlings)	2
Total unmarked deer	<hr/> 11
Total deer removed March of 2016	<hr/> 24

Table 6. Tagged female deer removed via the NYSDEC Deer Damage Permit (DDP) in Cayuga Heights, New York, during March 2016.

Tag#	Recovery Date	Recovery Site
C20	3/8/2016	Hanshaw Rd.
C22	3/18/2016	Highgate Rd.
C26	3/6/2016	Highland Rd.
C52	3/6/2016	Highland Rd.
C59	3/4/2016	Upland Estates
C68	3/7/2016	Highgate Rd.
C69	3/19/2016	Highland Rd.
C70	3/6/2016	Highland Rd.
C87	3/6/2016	Highland Rd.
C89	3/5/2016	Cayuga Hts. Rd.
C91	3/25/2016	Highland Rd.
C112	3/5/2016	Cayuga Hts. Rd.
127 (Yellow)	3/20/2016	Hanshaw Rd.
Total	13	Tagged females harvested

Table 7. Newly tagged female deer sterilized in Cayuga Heights, New York, during 3/26 and 3/27 March, 2016.

Tag Number	Age @ Capture	Treatment	Capture Date	Capture Method	Capture Location	Comments
241	2.5	OV	3/26/2016	Dart	Sunset/Wycoff	w/2bb, C143
242	6.5	OV	3/26/2016	Dart	Texas	w/C243, 2bb
243	8+	OV	3/26/2016	Dart	Texas	w/C242, 2bb
244	2	OV	3/27/2016	Dart	Sunset/Wycoff	Solo
245	2	OV	3/27/2016	Dart	Hanshaw	w/fawn