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 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, Curtis et al. 2009). 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 between December 2012 and March 2016 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 January 2018, 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 years of the project. 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 starting January 22, 2018. The cameras were active through mid-day January 29, 2018. 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 January 29, 2018, the photo survey was completed, and cameras were removed. A sufficient number of pictures were taken in 7 days (n = 1,375 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 with similar antler branching are difficult to tell apart. 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 survey pictures included 24 females (Table 1). The possible total number of marked deer in the Village of Cayuga Heights used for analysis was 27 (Table 1), as there were 3 tagged deer seen in December 2016 that were

not observed in January 2018 (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 2016 (Tables 1 and 2), whether the deer were observed or not in the January 2018 camera survey. The lower population bound included only the tagged deer observed on camera and known to be alive during the January 2018 survey.

There was only one reported mortality for a marked deer between April 1, 2016 and January 2018. A young buck (Y6/6) was killed on State Route 13 outside of the Village. Since the start of the sterilization surgeries in 2012, 99 tagged deer (both females and males) have been confirmed dead as of March 1, 2018. Twenty of those 99 deer (21.2%) died as a result of deer vehicle collisions. Seventeen of the 98 deer (17.2%) were legally killed by shooters on Cornell University lands. Seven deer (7.1%) died from other causes. One deer (1.0%) 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 (6.1%) because their carcasses were too decomposed when found. During 2015, 2016, and 2017, 47 tagged deer (47.5%) were removed from the Village via the NYSDEC Deer Damage Permit (Table 3).

Deer population estimates generated by program NOREMARK were conducted two times. The first population estimate (n = 87) and associated 95% confidence interval (67-115) included all deer known to be alive (via photo confirmation) in the area during the time of the camera survey in January 2018. The second population estimate (n = 98) and 95% confidence interval (73-131), includes an additional 3 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. It is unknown for sure if these deer are still alive and in the community but it is very unlikely. Therefore the 87 deer, or 48.3 deer per square mile is the best estimate of the deer population for January 2018.

As the resident population of tagged decreases from removals, the potential for immigration of unmarked, fertile deer increases. Over the last few years, we have seen an increase in the percentage of unmarked deer in the total number of deer pictures. The percentage of untagged deer in photos during January 2018 was 64% (1,291 of 2,026 deer in photos), which

is substantially higher than the 44% observed in December 2016. Eventually as the percentage of known tagged deer alive decreases, the precision of the mark-recapture population estimate will be reduced. Generally, as long as about 20% or more of the deer in photos are tagged, the population estimate should be reliable.

Discussion

Our current estimate of deer numbers remaining in the Village (n = 87 in January 2018), is higher than for March 2017 (approximately 57 deer based on the camera survey, Fig. 1). Some deer movement in and out of the Village continues, especially at the northeastern and southern edges. The sites with the highest numbers of deer in the photographs in January 2018 included Site 1, Palmer Woods (n =264); and Site 12, Warwick Place (n = 230). There has never been a shooting site near Warwick Place in the northeast corner, and no deer have been removed from Palmer Woods by Cornell University staff for at least 3 years. Deer immigration is problematic in these locations, and contributes to the increasing deer numbers seen in the photo survey. The bottom line is that the deer management program in Cayuga Heights has been highly effective to date, and the challenge will be sustaining the program success over time by removing immigrating female deer.

In the southwestern corner of the Village at Site 3, Strawberry Lane, there were no pictures of marked deer in the 125 photos containing deer. At Site 3 in January 2016, there 73 tagged deer (legible or not) in 276 out of 370 photos with deer. In December 2016, there were 53 tagged deer in 134 out of 160 deer pictures. While most of the marked does previously observed at Site 3 have been culled or died, not all have been removed. Does C114 and C76, previously observed at Site 3, were in pictures at 305 The Parkway, 876 Highland Road, 210 N. Sunset Drive, and on Forest Drive in 2018. Consequently, some deer may have shifted their core areas or home ranges to locations further into the Village now that densities in those areas have been reduced. This opens up space along the Village edges for new immigrating deer.

In addition, as the total number of marked deer drops as tagged deer are removed, there may be some bias for tagged deer to avoid frequent use of baited sites, which could possibly increase the population estimate from the camera survey. Lower samples sizes of tagged deer will also increase the 95% confidence interval for population estimates (Figure 1). Maintaining a marked component of deer in the community will be import for reliable photo surveys (Table 4).

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 do not use the current bait sites for removal.

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 limited number sites available for deer control efforts, and the repeated use of these same sites for the past three years, it will be increasingly difficult to make further progress toward the targeted deer density without enlisting new sites, or exploring other control options. Also, the new DEC policy to eliminate deer baiting within 300 feet of a public highway will reduce available shooting sites, and will negatively impact both the culling program and future camera surveys. 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 would also be helpful to have a standardized measure of deer impact reduction over time, especially if camera surveys cannot be used in the future. It is really the impacts that are important to community members, not the number of deer. It appeared the number of reported deer-vehicle collisions in the Village was zero in 2016-18. This is an important result from the project. It would also be good to know if reports of plant damage have also been reduced. We would strongly encourage developing one or more of these additional metrics to document success of the program, and show that the time and funding expended were reasonable.

Recommendations

Based on the current deer 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 2018. 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 22 January through 29 January, 2018.

Marked female deer observed in the camera survey	24
Marked deer not observed in the Village (with no mortality report)[a,]	3
Potential total marked deer in the Village	**27**

[a] There were 3 deer observed in the December 2016 photo survey that were not seen in January 2018 (see Table 2). It is very likely that these 3 tagged deer were not in the Village at the time of the camera survey.

Table 2. Deer that were not observed in the January 2018 photo survey, but were observed in December 2016 (n = 3). 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 Dec 2016	Photo survey Jan 2018
128		Yes	No
C120		Yes	No
C126		Yes	No

Table 3. Causes of mortality for tagged deer in Cayuga Heights during December 2012, through March 1, 2018.

Cause of Death	Total	Percent*
Deer vehicle mortality (DVC)	**21**	21.2%
Hunter harvested (HH)	**17**	17.2%
Other mortality causes (O)	**7**	7.1%
Capture-related mortality (CM)	**1**	1.0%
Not determinable mortality (ND)	**6**	6.1%
Deer damage permit (DDP)	**47**	47.5%
Total known deer mortality (male and female)	**99**	

*Percent of total known mortality of tagged deer, including the 47 deer (46 F, 1 M) taken over 2 years of the deer removal effort via the NYSDEC Deer Damage Permit.

Table 4. Tag numbers for deer potentially alive during the photo survey in January 2018.

Tag #	Total photos		Tag #	Total photos
128	**0**		**C41**	**18**
C120	**0**		**C61**	**23**
C126	**0**		**C76**	**4**
241	**3**		**C85**	**11**
242	**5**		**C106**	**30**
244	**5**		**C114**	**8**
245	**9**		**C127**	**12**
312	**62**		**C131**	**19**
C17	**5**		**C137**	**4**
C24	**14**		**C139**	**20**
C31	**21**		**C143**	**10**
C38	**20**		**C145**	**11**
C39	**24**		**C146**	**23**
C40	**16**			

*Grey highlighted numbers were tagged deer observed in 12/2016 but not in 1/2018.

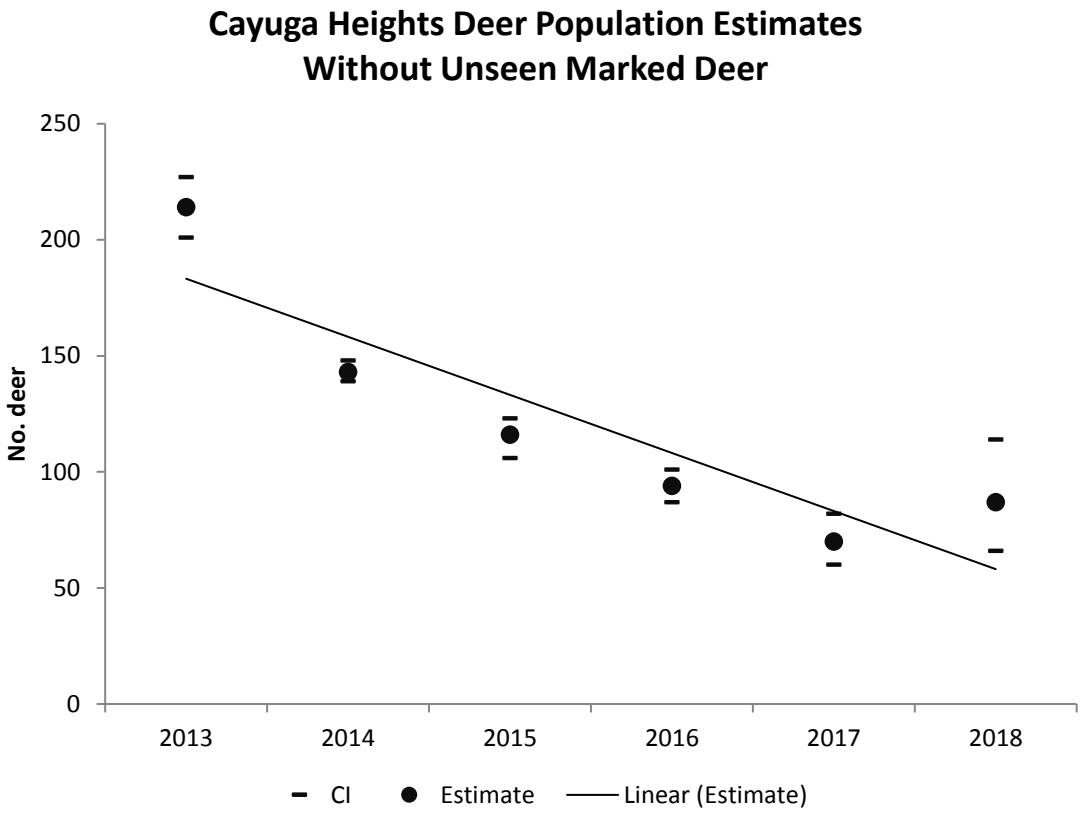

Figure 1. Trend in deer abundance for Cayuga Heights based on camera surveys of tagged deer and population estimation using Program NOREMARK, 2013 to 2018.