Results of White-Tailed Deer (*Odocoileus virginianus*) Surveys in Readington Township in 2019

May 17, 2019

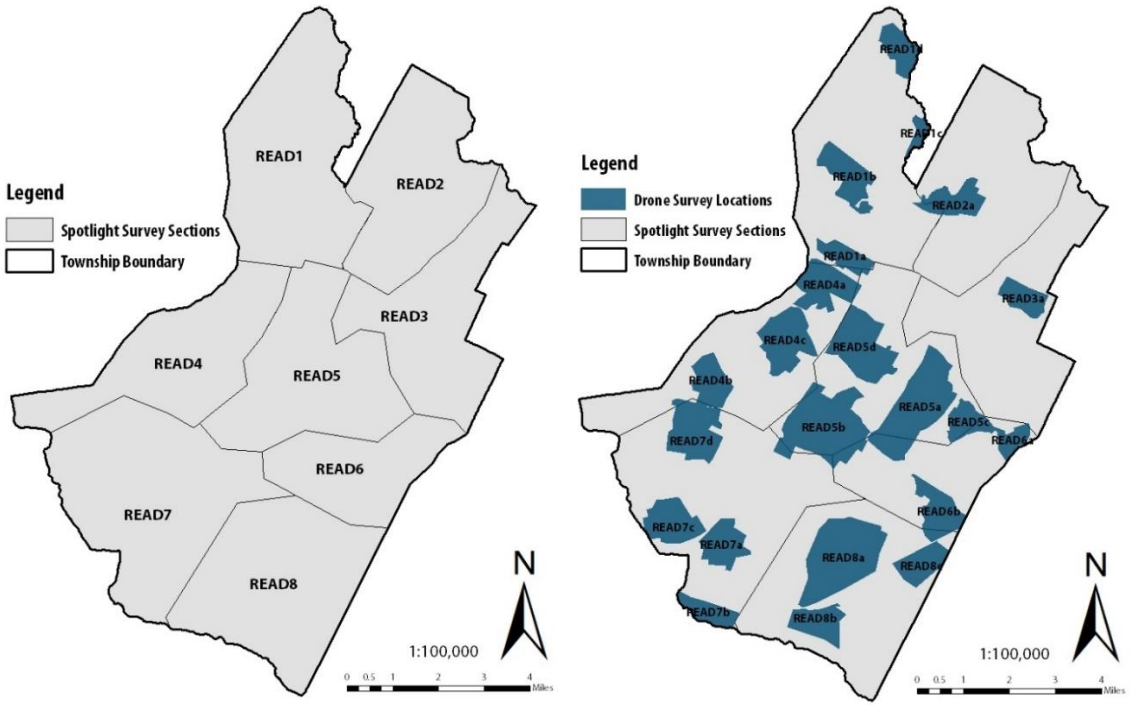
Jay F. Kelly, Ph.D., and Jessica Ray
Center for Environmental Studies
Raritan Valley Community College
118 Lamington Rd.
North Branch, NJ 08876

Objective: We documented densities of white-tailed deer (*Odocoileus virginianus*) in Readington Township in early spring of 2019 using road-based spotlight survey and aerial infrared drone techniques.

For the spotlight surveys, the Township was divided into eight sections (Figure 1), with one to two sections surveyed simultaneously each night by two different teams of Raritan Valley Community College wildlife research interns, and two replicate samples collected a minimum of 10 days apart. All eight sections were surveyed first between 3/24/2019 - 3/30/2019 and then resurveyed between 4/11/2019 – 4/18/2019. Surveys were conducted only on clear nights with no/low winds, from 9:30 PM to 2:00 AM, counting the number of deer for each 0.2 mile segment of road using high-powered flashlights (600 yard max. range), and measuring search area using laser rangefinders. All observations of deer and search limits were mapped in real time using ArcCollector software. Interns were given intensive training on safety and survey protocols prior to conducting formal surveys, and each group was led by an intern with prior experience from 2017 and/or 2018. Surveys were limited to roads with less than 40 mph speed limits. Deer density was calculated by dividing the total number of deer observed by the total search area, and was determined for both the first and second round of surveys for each individual section and for the Township as a whole. The average density was then calculated for each in order to estimate town-wide densities. The total deer population in the town was calculated by extrapolating the average number of deer observed per survey across the area of the town.

Because survey results may be biased by landscape and other factors, densities were also obtained from 22 infrared drone surveys (sUAS – small unmanned aerial systems) that covered a total of 13.9 mi^2 of the township, including the majority of Township-owned open space and some adjacent areas. Drone surveys were performed daily from 4/16/2019 to 4/21/2019 with a Zenmuse XT thermal imaging camera mounted on a DJI Inspire drone. Surveys were conducted at night to allow for adequate thermal contrast between the landscape and deer. All flights were flown below 400 feet above ground level in class G airspace, with an FAA-certified pilot aided by a visual observer, and under a night waiver as required by FAA regulations. All observations of deer and search areas were mapped in real time using ArcCollector software. Densities from the drone surveys were calculated by total deer found divided by the search area covered by the drone.

Figure 1. Road-based spotlight survey sections (left) and Infrared drone survey locations (right) in Readington Township.



Spotlight Survey Results:

A total search area of 10.0 mi^2 was covered across the entire township by the road-based spotlight surveys, or 20.9% of the 47.8 mi^2 of the Township as a whole. A total of 1697 deer were observed during the first census, resulting in a total density of 170 deer/mi^2, and 933 deer (93 deer/mi^2) observed during the second survey, resulting in an average Town-wide density of 132 deer/mi^2. Numbers of deer and associated densities were highly variable between individual survey sections and repeat surveys, from 79-257 deer per section, and densities of 54 to 255 deer/mi^2. Variation in maximum observed numbers and densities are displayed in Table 1 and Figure 3.

Table 1. Results of spotlight surveys for each section of Readington Township including search area (mi^2), number of deer observed, and density (deer/mi^2).

		1st Survey		2nd Survey		
Survey Section	Search Area	# Deer	Density	# Deer	Density	
READ1	1.47	245	167	79	54	
READ2	1.21	193	160	101	84	
READ3	1.32	192	145	136	103	
READ4	1.27	256	202	139	110	
READ5	1.01	257	255	132	131	
READ6	1.15	188	164	135	117	
READ7	1.33	176	132	100	75	Average
READ8	1.24	190	153	111	90	Density
TOTAL	9.99	1697	170	933	93	**132**

Infrared Drone Survey Results:

Drone surveys were conducted between 4/16/2019 - 4/21/2019. The cumulative area covered by the drone surveys was 12.2 mi^2, or ~25% of the Township area. Surveys were focused on covering the township owned open space as well as surrounding area. Densities from the drone surveys ranged from 64 deer/mi^2 to 280 deer/mi^2 (Figures 2-3). A total of 1652 deer were counted during the drone surveys for a cumulative density of 136 deer/mi^2.

Figure 2. Results of individual drone surveys for Readington Township including the number of deer observed, the drone search area (mi^2), and density (deer/mi^2) (left). Densities (deer/mi^2) by location shown on map (right).

Drone Survey Section	# Deer	Search Area	Density
READ1a	77	0.29	262
READ1b	39	0.53	73
READ1c	18	0.12	149
READ1d	65	0.35	187
READ2a	57	0.43	134
READ3a	39	0.31	127
READ4a	101	0.57	176
READ4b	46	0.41	111
READ4c	95	0.68	140
READ5a	157	1.23	128
READ5b	208	1.33	156
READ5c	50	0.31	160
READ5d	118	0.85	139
READ6a	54	0.19	280
READ6b	79	0.48	164
READ7a	53	0.44	119
READ7b	22	0.28	78
READ7c	39	0.54	72
READ7d	45	0.70	64
READ8a	188	1.33	142
READ8b	28	0.40	70
READ8c	74	0.37	201
TOTAL	1652	12.15	136

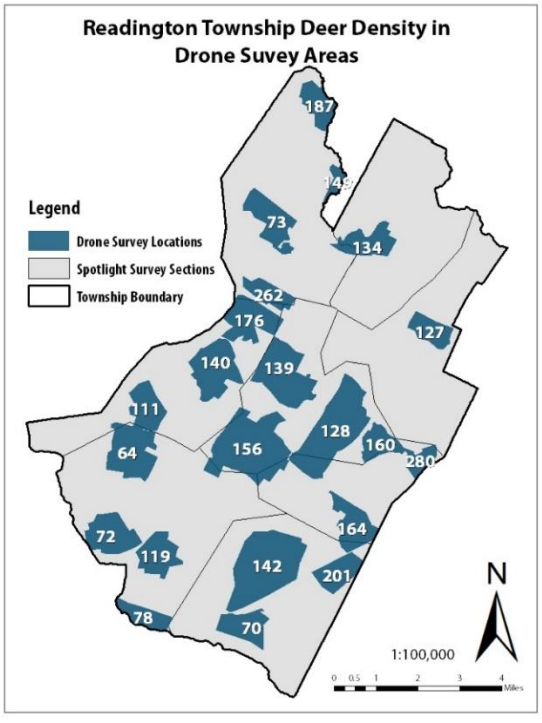
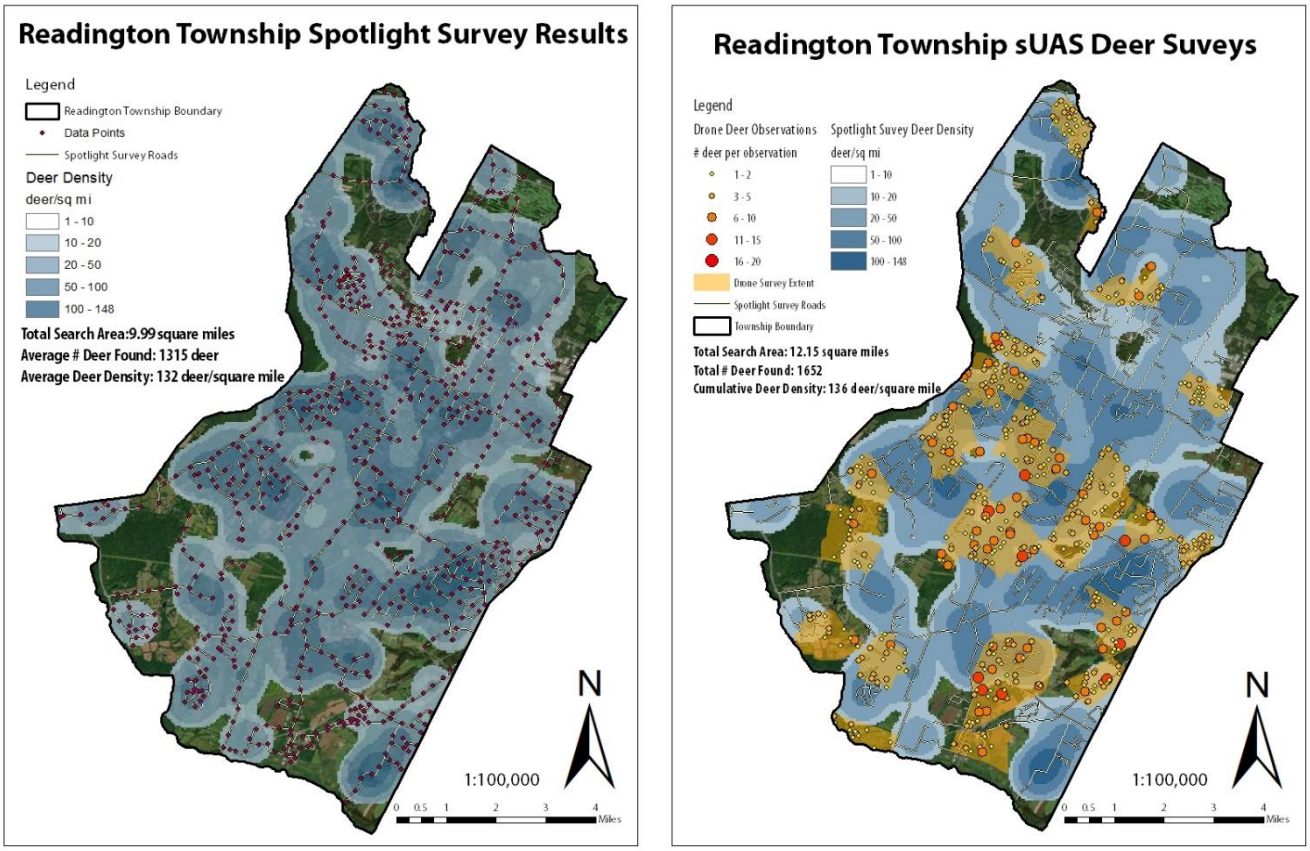


Figure 3. Number and density of deer observed during spotlight (left) and drone surveys (right). Note that the deer density displayed in shades of blue on all maps does not indicate actual deer density but density of maximum *observed* deer from spotlight surveys in order to illustrate general patterns of spatial variation in deer distribution. Drone observations are superimposed on these maps (right) for comparison.



The results from Readington Township in 2019 show deer densities (132-136 deer/mile^2) to be far higher than historical levels, statewide averages, and those needed to maintain ecosystem health. The most recent regional estimates of deer densities available from the New Jersey Department of Environmental Protection indicated minimum average densities to be as high as 78/mi^2 (NJ Division of Fish and Wildlife 1999). However, these estimates are based off of harvest statistics from hunting and may not be accurate in areas where hunting access is limited, such as the suburban or urban environments that characterize much of central and northeastern NJ (NJ Division of Fish and Wildlife 1999). Other survey methods such as road-based spotlight surveys or infrared aerial surveys are therefore needed in these circumstances to obtain more accurate population estimates. Indeed, local surveys using these direct measurement techniques have found local deer densities to be in excess of 150-200 deer/mi^2 in some areas of Hunterdon and Somerset Counties, New Jersey (NJDFW 1999, McWilliams et al. 2013). It is also important to note that the number and densities of deer observed in this study were recorded at the most conservative time of year; i.e., after the period of peak mortality from hunting and cold temperatures in the fall/winter months and before the birth of fawns in late spring. With females in this area regularly giving birth to 2-3 fawns per year, it is likely that the actual deer population size for the majority of the year is much higher than the survey results indicate.

Historical studies suggest that precolonial deer densities were likely to be approximately 5-11 deer/mi^2 (McCabe and McCabe 1997), and biological impacts to preferred browse species have been observed at densities above 10 deer/mi^2 (Horsley et al., 2003; deCalesta and Stout, 1997; Alverson et al., 1988; Frelich and Lorimer, 1985; Behrend et al., 1970). Impacts to forest regeneration, bird communities, invertebrates, and a host of other ecosystem variables tend to occur above deer densities of 15-20/mi^2 (McWilliams et al. 2018, Russell et al. 2017, Nuttle et al. 2011, Horsley et al. 2003, Drake et al. 2002, de Calesta 1994). The effects of overabundant deer are not limited to natural areas, moreover, but to human populations as well, costing millions of dollars a year from deer-vehicle collisions, damage to agricultural crops and landscaping, and impacts of Lyme's disease and other tick-borne diseases (Patton et al. 2018, Sherman 2018, Conover 2011). Deer management practices that successfully reduce deer populations may result in significant

reductions of these damages; e.g., with 60% reductions of deer populations in Princeton resulting in proportionate decreases in deer-vehicle collisions in the same year (Williams et al. 2013). To best maintain the greatest benefits for ecosystem health and integrity and minimization of economic and social costs, it is therefore advisable that targets for deer management be set at approximately 10 deer/mi^2 (Kelly 2019).

Literature Cited:

Alverson WS, Waller DM, Solheim SL. 1988. Forests to deer: edge effects in northern Wisconsin. Conservation Biology 2: 348-358.

Behrend DF, Mattfeld GF, Tierson WC, Wiley III JE. 1970. Deer density control for comprehensive forest management. Journal of Forestry 68: 695–700.

Bowman JL. 2011. Managing White-tailed Deer: Exurban, Suburban and Urban Environments, Pgs 599-616 In Hewitt DG (Ed.) Biology and Management of White Tailed Deer. Taylor & Francis Group, CRC Press, Boca Raton, FL.

deCalesta DS. 1994. Impact of white-tailed deer on songbirds within managed forests in Pennsylvania. Journal of Wildlife Management 58:711-718.

Conover MR. 2011. Impacts of deer on society, In Hewitt DG (ed.) Biology and management of white-tailed deer. CRC Press, Boca Raton, FL.

Drake D, Lock M and Kelly J. 2002. Managing New Jersey's Deer Population. Rutgers Agricultural Experiment Station, Rutgers University Press.

Frelich LE, Lorimer CG. 1985. Current and predicted long-term effects of deer browsing in hemlock forests in Michigan, USA. Biological Conservation 34: 99–120.

Horsley SB, Stout SL, deCalesta DS. 2003. White-tailed deer impact on the vegetation dynamics of a northern hardwood forest. Ecological Applications 13: 98-118.

Kelly JF. 2019. Regional changes to forest understories since the mid-Twentieth Century: Effects of overabundant deer and other factors in northern New Jersey. Forest Ecology and Management 444:151-162.

McCabe, R.E., McCabe, T.R., 1997. Recounting whitetails past. In: McShea, W.J., Underwood, H.B., Rappole, J.H. (Eds.), The Science of Overabundance: Deer Ecology and Population Management. Smithsonian Books, Washington, pp. 11–26.

McWilliams WH, Westfall JA, Brose PH, Dey DC, D'Amato AW, Dickinson YL, Fajvan MA, Kenefic LS, Kern CC, Laustsen KM, Lehman SL, Morin RS, Ristau TE, Royo AA, Stoltman AM, Stout SL. 2018. Subcontinental-scale patterns of large-ungulate herbivory and synoptic review of restoration management implications for midwestern and northeastern forests. Gen. Tech. Rep. NRS-182. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 24 p.

New Jersey Division of Fish and Wildlife. 1999. Governor's report on deer management in New Jersey. New Jersey Department of Environmental Protection, Trenton, NJ, USA.

Nuttle T, Yerger EH, Stoleson SH, Ristau TE. 2011. Legacy of topdown herbivore pressure ricochets back up multiple trophic levels in forest canopies over 30 years. Ecosphere 2:1–11.

Patton SR, Russell MB, Windmuller-Campione MA, Frelich LE. 2018. Quantifying impacts of white-tailed deer (Odocoileus virginianus Zimmerman) browse using forest inventory and socio-environmental datasets. PLoSONE 13(8): e0201334. https://doi.org/10.1371/journal.pone.0201334

Russell MB, Woodall CW, Potter KM, Walters BF, Domke GM, Oswalt CM. 2017. Interactions between white-tailed deer density and the composition of forest understories in the northern United States. Forest Ecology and Management 384: 26–33.

Sherman, T. "Where in N.J. are you most likely to hit a deer? The top 20 towns Bambi should avoid." July 12, 2018, NJ Advance Media for NJ.com, https://www.nj.com/news/2018/07/where_are_the_deadliest_places_in_nj_for_bambi_it.html

Williams, S.C., deNicola, A.J., Almendinger, T., Maddock, J. 2013. Evaluation of organized hunting as a management technique for overabundant white-tailed deer in suburban landscapes. Wildlife Society Bulletin 37: 137–145.