2016 Report to the New York State Department of Environmental Conservation

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White-tailed Deer Contraception and Impact Study
Village of Hastings-on-Hudson, New York

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INTRODUCTION

After an extended community discussion of how to manage its conflicts with deer, the Village of Hastings on Hudson (HoH) joined with The Humane Society of the United States (HSUS) and Cummings School of Veterinary Medicine at Tufts University to undertake a comprehensive approach to deer population management and impact measurement. This collaboration features an experimental effort to apply and evaluate the PZP (porcine zona pellucida) immunocontraceptive vaccine to stabilize and reduce deer numbers in HOH.

The scientific objectives of the HOH immunocontraception project are to:

- confirm that a single, hand-delivered, timed-release PZP preparation first tested on Fripp Island, South Carolina, is effective for more than one year;
- evaluate whether the same timed-release PZP vaccine can be effective and long-lasting when delivered by dart as a booster, when compared to an emulsion-only PZP booster;
- test whether contraception can be used to manage a deer population in a suburban/urban environment in which deer movements are not tightly restricted by geographic boundaries (as distinct from islands and other isolated areas).

During the first field season, beginning February 2014, eight deer were initially captured and treated with PZP- 22. The second field season was held from February to mid-April of 2015, where 22 more animals were captured, and 20 of those captures treated with PZP-22. One animal captured was a young buck who was tagged (#13) and released, whereas the other additional animal was a re-capture who was fitted with a new eartag (#30) and released without retreatment.

Scientific objectives aside, a cornerstone of the HoH deer project is community engagement in assisting the research team with locating deer, and measuring impacts of the deer

population in terms of deer-vehicle collisions, damage to backyard vegetation, and ecological impact on open space.

METHODS

Deer Capture and Treatment

***Bait Stations*.** Four fixed feeders were placed during the week of January 20, 2016. These feeders were set to release whole corn in 5-7 second durations twice daily. One bait station was removed during the beginning phase of the capture season due to complaints of accumulation of excessive animal droppings in a well-traveled area. This feeder was replaced on another property in early March. The remaining stations remained in place until their removal on March 31, 2016.

Each bait station was monitored with one or two trail cameras to provide the research team with information about when deer were visiting feeders.

In addition to automatic feeders, 4 other homeowners provided access to their properties allowing for manual baiting. On these properties whole corn and apples were placed daily to establish routine feeding times.

Capture. This years' darting season ran from February 23rd through March 31st, a total of six weeks (vs. eight weeks in 2015). All animals were chemically immobilized via 2 cc self-injecting PneuDart® transmitter dart with a 1" needle tip with double wire barbs, using a Dan-Inject Model JM Standard CO2 rifle. Darts were filled with 2.0 mL of BAM (Butorphanol/Azaperone/Medetomidine), pre-mixed formulation from Wildlife Pharmaceuticals, Inc. (Windsor, CO; http://wildpharm.com/bam-kit/item/2-wildlife/61-bamiikit.html), dosed approximately at 55 mg Butorphanol, 18 mg Azaperone, and 22 mg Medetomidine per dart. Supplemental injections of 1 to 2 mL were administered on an as-needed basis if animals were not fully sedated at time of approach for work-up.

Animals were captured both over bait at fixed feeder stations and in yards of cooperating homeowners. All darts and sharps were recovered following each work-up.

Use of chemical immobilizing drugs was carried out under the supervision and authority of Dr. Richard Joseph, DVM, VCA Animal Medical Center, Yonkers, NY.

Work-up Process. Upon tracking the anesthetized animal via radio-telemetry, each doe was quietly approached and stabilized via placing in sternal or lateral recumbent (right side up) body position, covering eyes to reduce stimulation, and opening the airway and administering supplemental oxygen via nasal cannula or muzzle-encompassing mask at a rate of 2 to 4 liters per minute. Animals that were not at an acceptable level of sedation for safe handling were administered a supplemental injection of BAM in 1 to 2 mL doses. Ophthalmic lubricant was instilled in eyes to reduce corneal desiccation. Rectal temperature, cardiac & respiratory auscultation, pulse oximetry and mucous membrane color assessments were performed and recorded approximately every 5 minutes

throughout the workup. Yellow, numbered ear tags were placed in both ears, with the larger of the two tags in the right ear pinna, and the smaller button tag in the left ear pinna. Darts were carefully removed and wounds were cleansed/flushed with dilute betadine and packed with topical antibiotic ointment. Emulsified PZP vaccine and timed- release pellets were injected intramuscularly in the quadriceps muscles of the left or right hind limb in each animal. Eight to ten mL of blood was collected for pregnancy testing. Each animal received approximately 600mg of Liquamycin (Oxytetracycline), an antibiotic injection administered subcutaneously. Body condition scores and measurements including weight, body length, girth, and distal hind limb were obtained and recorded when possible. Age estimates were made upon evaluation of body size and characteristics and dental assessment. Due to field team difficulty with heavy lifting, location safety, level of anesthetic depth, or missing equipment, some animals were not weighed. Reversal agents Atipamezole and Naltrexone were administered intramuscularly upon completion of animal handling procedures and recipients were monitored closely for any complications. In most cases the animals were alert and fully ambulatory within 5 to 15 minutes of antagonist administration.

Following protocols established in 2014, blood samples were spun down and serum was sent, frozen, to BioTracking, Inc. (Moscow, ID), for pregnancy testing using an assay for Pregnancy-Specific Protein B.

Deer Impact Studies

Population Surveys. A grid of 15 motion-sensitive cameras was placed at pre-determined locations throughout HoH on August 27 and September 3, 2015. Cameras were removed on October 20, 2015, so that cameras were in place either 47 or 54 days. Four sites used in 2014 were not used this year because the sites were not available or had not shown any deer use in 2014.

Data from the 2014 survey were analyzed by Christopher Johnson, an MS student at Pace University, under the supervision of Dr. Mark Weckel of the American Museum of Natural History, New York. For the analysis, Mr. Johnson used a modification of the antler-identification methods described by Jacobson (Weckel et al. 2011). Camera captures of the identified bucks were also used to estimate their average range of movement, and infer an estimate of the effective study site area based on that buffer.

Photographs from the fall 2015 surveys have been compiled in an Excel spreadsheet; analysis will be conducted in summer 2016. We expect to use both the modified Jacobson's method and a mark-resight approach using ear-tagged females to allow corroboration of density estimates.

Host-a-Hosta. Hostas were placed with 41 households in 2015, of whom 40 provided data on plant survival and timing of deer consumption.

RESULTS

Community Outreach:

At the beginning of the field season, the research team supplied updated and current materials to the HoH, which the Village posted on its website (http://www.hastingsgov.org/deer-issues). Multiple properties were again flagged (totals pending), indicating signed permission to access the property for darting and handling deer. Unfortunately, many properties were not flagged until later in the darting season, which proved an obstacle to the darting team in the initial weeks of the season.

The Village and the research team also cooperated to set up a "Deer Hotline," by which local residents could call the research team and leave messages about current and recent deer sightings. Although not intended as a "Deer 911" line, on at least three occasions residents provided information that led directly to the capture and treatment of new deer. Like the flagging effort, however, the Deer Hotline was not put in place until half-way through the field season.

Captures:

Twenty does were captured and treated, increasing the project three-year totals to 50 captures and 48 treated does (Table 1). No males or other non-target animals were captured, and all animals that were darted were processed and recovered well. No capture- or treatment-related mortalities were observed this year or in any deer thus far in the project.

Average time under anesthesia using the new BAM protocol was 75.2 $\pm$36.0 minutes ($\pm$sd) (Table 2). Omitting three does that were not immediately located, average time under anesthesia was 62.9$\pm$18.5 minutes. Time from administration of reversal to release was 9.7$\pm$6.3 minutes. By comparison, time under anesthesia during 2015 captures using the Telazol/xylanzine combination averaged 144.4 ($\pm$42.7) minutes and time from reversal to release averaged 71.1 ($\pm$38.5) minutes.

Table 1. Description of deer captured in the Village of Hastings-on-Hudson, New York, February-March 2016. All deer captured were females.

Tag #	Date Captured	Estimated Age	Weight (Kg)	Physical Condition	Hind-Foot Length (cm)	Girth (cm)	Body Length (cm)
31	2/25/16	2	58	2	46.5 (L)	88.2	153
32	2/29/16	2	not obtained	1	43.9	88.9	139.7
33	3/1/16	Adult	not obtained	1	44.7	93.5	152.4
34	3/4/16	3-4 y	not obtained	2	not obtained	not obtained	not obtained
35	3/6/16	Adult	not obtained	1	47.6	104.6	146.05
36	2/26/16	Adult	not obtained	2	43 (R)	96.4	139.5
37	2/27/16	2-3 yr	not obtained	2	45 (R)	93.9	139
38	3/1/16	3 y	62	2	48 (R)	91.8	146.2
39	3/1/16	3 y	64	2	48.2 (R)	94.2	149.8
40	3/8/16	Adult>3	not obtained	2 to 3	not obtained	not obtained	not obtained
41	3/12/16	2-3 yr	52	1	43 (R)	93.2	137.4
42	3/13/16	3-4 yr	not obtained	2	45.5 (R)	94.5	148
43	3/15/16	4-5 yr	not obtained	1	46 (R)	102	144
44	3/15/16	Adult	63	1	44.4 (R)	98.04	154.94
45	3/20/16	3 yr	64	1	45.5	56 (?)	161
46	3/22/16	1.5-2.5yr	44	2	43 (R)	92	131
47	3/29/16	1.5-2.5yr	40	2	41.5 (R)	84.5	129.5
49	3/20/16	3-4 yr	62	1	48 (L)	101	141
50	3/22/16	3-4 yr	72	1	46.2 (R)	104	154
51	3/22/16	3 yr	60	2	43 (L)	96	138.2

Table 2. Darting, reversal, and recovery times of deer captured using the BAM immobilization protocol in Hastings-on-Hudson, NY, in February-March 2016.

Tag #	Time at Darting	Time at Reversal	Time at Release	Time, Reversal to Release (min.)	Total Time, Darting to Release (min.)
31	8:11	09:02	9:09	7	58
32	8:11	09:11	9:39	28	88
33	17:54	19:06	19:27	21	93
34	17:14	19:43	20:02	19	168
35	17:41	18:36	18:43	7	62
36	7:13	07:55	07:59	4	46
37	08:18, 09:12	10:42	10:49	7	97
38	6:53	07:36	07:44	8	51
39	18:07	18:49	18:55	6	48
40	18:54	19:38	19:45	7	51
41	6:45	07:30	7:34	4	49
42	7:07	08:46	08:55	9	108
43	18:54	19:35	19:46	11	52
44	10:08	11:17	11:31	14	83
45	6:39	07:30	7:34	4	55
46	11:58	14:34	14:40	6	158
47	19:23	20:07	20:17	10	54
49	17:45	19:06	19:11	5	86
50	11:41	12:26	12:37	11	56
51	18:48	19:22	19:28	6	40

Population Dynamics:

Reproduction. Pregnancy diagnoses based on assays for Pregnancy-Specific Protein B (BioTracking, Inc., Moscow, ID) were obtained from blood samples taken at the time of capture in 2016 in 16 of the 20 captured females. Fifteen of the 16 females (93.8%) were diagnosed as pregnant; the sole exception was accompanied by a relatively small fawn at the time of capture.

Of the eight adult does hand-injected in winter 2014 with PZP emulsion + pellets, five were observed during summer and autumn 2015. None was observed with fawns. When combined with the winter 2015 negative pregnancy test on the recaptured doe that had lost its tag (presumed to be #7, now #30), we infer that none of the 2014-treatment does for which we have data (N=6) fawned in 2015.

Mortality and Disappearances. Of the 28 females captured and ear-tagged in 2014 and 2015, one (#1) was reported killed by a hunter in 2014, and three (3, 17, and 20) were not observed in winter 2016 (although #17 was observed in summer 2015). Thus at least 86% of females tagged in 2014 and 2015 (plus the one male tagged in 2015) were still alive and present in HoH in winter 2016. More rigorous calculations will be performed in future years, but our results to date suggest that annual adult female survival and persistence in HoH is about 90%.

Village of Hastings-on-Hudson police reported five (5) deer-vehicle collisions in 2015. None of the deer involved was reported as tagged.

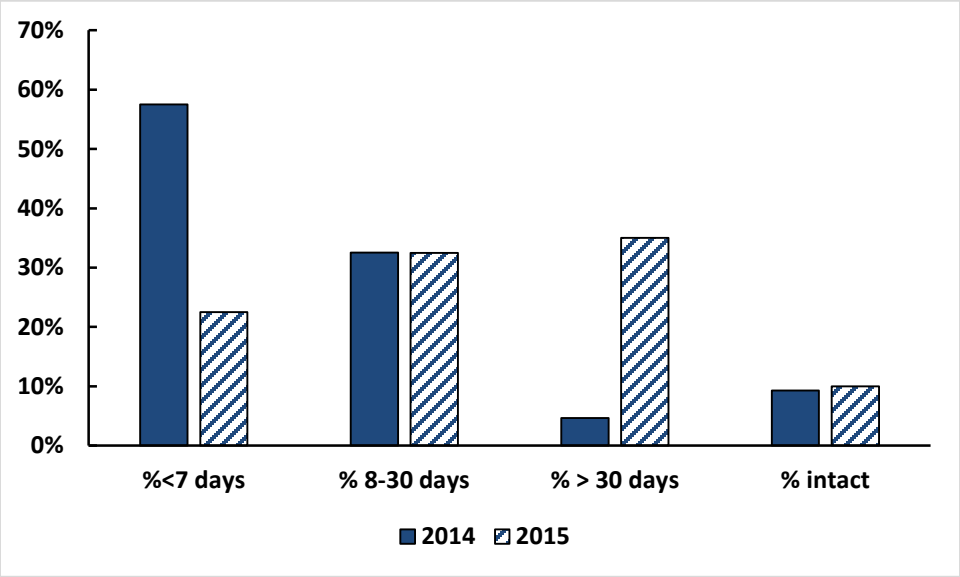
Deer Density and Herd Composition. Chris Johnson and Mark Weckel used the modified Jacobson's method to yield an estimate of 207 deer total in the Village in autumn 2014 (upper CI=260; lower CI 161). Approximate breakdown by age-sex class was 28 bucks, 37 spikes, 61 fawns, and 79 does. This breaks down to spike:buck ratio = 1.3; female:male ratio = 1.18; and fawn:female ratio = 0.78. Ratio of does to adult+spike bucks = 1.22.

For identified bucks, they calculated an average Mean Max Distance Moved (MMDM) and 1/2 MMDM of 1425.39 m and 712.69 m respectively; based on the literature, they used the 1/2 MMDM to estimate the buffer. The effective total area of the study site is 12.4 square kilometers. Density of individuals was estimated to be 16.7 deer per square km (43.3 per square mile), with a range of 13.0 to 21.0 individuals per square km (33.7-54.4 per square mile).

Vegetation Impacts:

Host-a-Hosta. Proportion of hostas placed in the backyard Host-a-Hosta program consumed by deer was unchanged from 2014-2015 (Fig. 1). It did, however, take deer longer to find and consume the backyard hostas in 2015, with the median time-to-consumption shifting from $\leq$ 7 days to 8-30 days.

Figure 1. Reported survival of backyard hostas placed during the Host-a-Hosta program, Village of Hastings-on-Hudson 2014-2015.



DISCUSSION

Capture and Treatment:

Although the sample size is small (N=6), the apparent effectiveness of the first year of PZP treatments in Year One after treatment is extremely encouraging, so far replicating the effectiveness of one-shot PZP treatments administered at Fripp Island, SC (Rutberg et al. 2013).

Several factors presented challenges to our ability to capture and treat additional animals this season.

First, the lack of significant winter weather, consecutive freezes, and snowfall allowed animals to move more freely with less restriction to specific known paths than was possible in the heavy snow cover experienced in previous darting seasons. Natural and planted vegetation remained available and the bait feeders were less attractive due to easy access to these other food sources. Acorns were also abundant, offering deer another high-quality food source that competed with the bait stations.

Second, limited darting area permissions restricted the field team's access to deer. Many deer were observed in areas that were "off limits" to the project, and thus reduced the number of potential treatments. Press and other anecdotal accounts have asserted that as many as 70 deer have been seen in one day inside one of the restricted areas, the Andrus School campus that straddles the Hastings-Yonkers border. Unless the team can access this land, most animals regularly residing in that campus will continue to remain untreated. In addition, a previously successful bait station with a fixed feeder was removed from our workable area due to complaints. The darting teams also did not receive permission to

work at night, when deer are more active and human activity is at its lowest, further reducing access to mobile animals making their way through the community at night.

Population Dynamics:

Timing of the 2015 camera placement was more standardized and more compressed than that of the 2014 camera grid. In 2014, placement began on August 28, 2014 and continued through September 27, 2014; two were removed in mid-September, and the rest were removed on November 1.

Population estimates yielded by the application of Jacobson's method to camera-trapping results in autumn 2014 were more or less in line with expectations developed by informal observations. The estimated deer density of ~17/km^2 is not extreme, but is in line with that reported by other suburban communities that are experiencing conflicts with deer. Because only eight female deer (at least one deceased) were treated with PZP in 2014, and therefore had only a minimal effect on population fawning rates in 2015, the data currently being compiled and analyzed from the fall 2015 camera trapping survey will largely supplement the baseline data reported for 2014, as well as hinting at whether the Village deer population was stable or continuing to increase prior to the onset of PZP treatments.

Pregnancy rates in untreated females at time of first capture approach 95% over the three years of the study. The high pregnancy rates combined with the low fawn:doe ratio observed in the camera trapping studies suggest that either low litter size or relatively high early fawn mortality or both are limiting recruitment. Low recruitment rates will facilitate population control via contraception, since even untreated females will contribute to recruitment at relatively low levels.

On the other hand, adult female survival and retention within the community appears to be high, on the order of 90% annually. Although we do not seem to be seeing significant adult female migration into the community, high survival of resident females will slow prospective population declines associated with reduced recruitment.

If the estimated number of resident females (~80) is accurate and has been relatively stable since 2014, we have tagged and treated nearly 60% of the adult female deer resident in Hastings-on-Hudson as of winter 2016. Rutberg and Naugle (2008a) estimated that a fawn:doe ratio of 0.4 would result in the stabilization of the population at the National Institute of Standards and Technology (NIST), MD, with a survival rate of ear-tagged adult females similar to that so far observed in HoH. If PZP treatments work as expected, fertility rates among HoH fawns should decline to about that level in 2017, and population-level effects of PZP treatments should be measurable at that time.

The number of deer-vehicle collisions (5) reported to police in 2015 was lower than that reported in 2013 (12) and 2014 (≥7). From a community viewpoint, this is a good development. However, because the number of DVC's is small, and subject to random fluctuation as well as causal variables unrelated to this project, DVC's may not turn out to be an effective metric of success for the project. But while the observed 2015 decline in DVC's is unlikely to be related to the project, it does provide additional evidence against the

hypothesis that PZP administration increases deer-vehicle collision risk by changing deer behavior (Rutberg and Naugle 2008b).

Work Planned for the Remainder of 2016 and Beyond

During summer 2016, the team will return to HoH for approximately 3 days to observe and locate previously tagged animals and confirm fawn production.

In autumn 2016, we will attempt to locate and re-treat all surviving females captured and treated in 2014 (year one). Following the experimental protocol, emulsified PZP and emulsified PZP plus timed-release pellets will alternately be administered remotely via a barbless, self-injecting dart. Each dart will then be recovered following inoculation. Chemical immobilization will not be necessary as these animals are already identified with numbered yellow ear tags. Deer location information will be sought from HoH residents via the DeerLog website and the Deer Hotline.

Because we are not yet confident that we have tagged and treated enough animals to create the population impact sufficient to satisfy community needs, we will propose to add one additional season of captures in winter 2017. In addition to capturing and treating younger females (born 2014-2016), to increase our pool of catchable deer we will seek access to previously excluded areas including the Andrus School, the Graham School, and the Burke Estate. We will also seek permission to work overnight in limited areas of HoH, and seek cooperation from homeowners who might be affected by night-time darting.

Because we feel that community outreach lagged in winter 2016, in the future we will be more proactive in seeking out new channels for communicating with HoH residents about the process and progress of the project. Outreach may include:

- seeking permissions from homeowners for access to properties well before darting begins;
- extending the use of the Deer Hotline we implemented in 2016 to be active throughout the field season. The hotline proved helpful, but was implemented after the field season started, and not many community members were aware of its function and existence;
- Seeking platforms in addition to the Village website for posting up-to-date information about project process and progress;
- making presentations in HoH to update the community on progress and plans.

Finally, we will continue to strive to improve handling and care of captured deer by inclusion of supplemental pain management, such as a nonsteroidal anti-inflammatory (e.g., Banamine (Flunixin)), with which animal handlers can better address physical discomfort that deer are exposed to from dart wounds and ear tagging.

References

Rutberg, A.T., and Naugle, R.E. 2008a. Population-level effects of immunocontraception in white-tailed deer (*Odocoileus virginianus*). *Wildlife Research* 35:494-501.

Rutberg, A.T., and Naugle, R.E. 2008b. Deer-vehicle collision trends at a suburban immunocontraception site. *Human-Wildlife Conflicts* 2:60-67.

Rutberg, A.T., R.E. Naugle, J.W. Turner, Jr., M.A. Fraker, and D.R. Flanagan. 2013. Field testing of single-admiistration porcine zona pellucida contraceptive vaccines in white-tailed deer (*Odocoileus virginianus*). *Wildlife Research* 40:281-288.

Weckel, M., R.F. Rockwell, and F. Secret. 2011. A modification of Jacobson et al.'s (1997) individual branch-antlered male method for censusing white-tailed deer. *Wildlife Society Bulletin* 35:445-451.