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:

1. Confirm that a single, hand-delivered, timed-release PZP preparation first tested on Fripp Island, South Carolina, is effective for more than one year;

2. 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;

3. 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).

   - To help us achieve objective 3, we are providing camera-trapping data for research exploring sight-resight techniques of population estimation developed by Dr. Mark Weckel at the American Museum of Natural History and explored by Christopher Johnson, MS, Pace University.

Through the first four field seasons, winters 2014-2017, 69 individual females were captured and treated with PZP-22. In addition, three males were captured incidentally,
and three previously tagged females who had lost their tag were recaptured and retagged. Blood sampling for pregnancy testing was conducted on captured females, and tagged females were observed for fawn associations through direct visual contact and camera trap records.

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. Residents of HoH have contributed substantially to the study through flagging of properties to indicate permission for access by the research team, online and telephone reports of deer observations, participation in the Host-a-Hosta impact measurement effort, and other means.

2019 METHODS

Deer Observations and Remote Booster Treatment

**Late Winter Observations.** In part to determine whether some eartagged females were only using the study area seasonally, we made observations 17-19 March 2019. During this period, observations were made from a labeled field vehicle, as well as on foot, during sessions with approximate hours of 5:00 – 11:00am and 4:30 – 10:00 pm. Spotlights were utilized in times of low light or reduced visibility. All deer observed were recorded, regardless of tag, sex, or age.

**Summer Fawning Session.** Observations were made during 25-28 August 2019. During this period, observations were made from a labeled field vehicle, as well as on foot, during sessions with approximate hours of 5:00 – 11:00am and 4:30 – 10:00 pm. Spotlights were utilized in times of low light or reduced visibility. All deer observed were recorded, regardless of tag, sex, or age.

**Fall Darter Session.** Booster darting was carried out from 25-29 September 2019, between the hours of 5:30 am and 10:00 pm. PZP emulsion and pellet sets were administered via 1cc self-injecting dart from a DanInject® JM Standard projector at a distance of 10-24 yards. Field team members carried out all tasks in a labeled vehicle. Spotlights were utilized in times of low light or reduced visibility. Additional observations of tagged deer and fawns were made at that time.

**Community Participation.** For the fourth year, the Village set up a “deer hotline” by which residents could report deer sightings in real time, either by speaking directly to the field team leader or leaving a recorded message. The purpose of the hotline was to provide the research team with immediate darting opportunities as well as information about deer movements. This year, the hotline was active throughout the fall darting session.
Deer Impact Studies

Population Surveys. Eleven motion-sensitive infrared trail cameras were placed mostly on the same grid used in previous years. One of the cameras was moved from its Hillside Woods location further down Circle Drive because an illegal treestand was found at the original location; another camera in Hillside Woods near Edgewood Drive was placed but appeared to have been tampered with during the survey period. Cameras were in place from October 16 – November 26, 2019 for a period of approximately 40 days.

Demographic descriptions of photographs from the 2015 and 2016 surveys have been entered in Excel spreadsheets by Maria Gavrutenko, a graduate student in biology at City University of New York, working under the supervision of Dr. Mark Weckel. Currently a graduate student at the Tufts Center for Animals and Public Policy is performing the analysis for population estimation for 2015-2016. We expect to use both the modified Jacobson’s method (Weckel et al. 2011) and a mark-resight approach using ear-tagged females to allow corroboration of density estimates.

RESULTS

Community Outreach

The deer hotline received 4 calls from residents reporting tagged doe sightings to assist the field team in locating targets for 2019 darting efforts. In addition, residents flagged down the field team to provide in person reports of their deer observations on 3 occasions in the summer and 5 occasions in the fall field sessions.

Remote Booster Treatments

A total of 6 deer from the 2017 capture cohort and 2 deer from the 2015 capture cohort were identified and re-treated with PZP via remote darting in 5 field days. Four of these does were treated with PZP emulsion + pellets, and four were treated with PZP emulsion per project design. All darts fired were recovered and discarded into a sharps container per project protocol.

Vaccine Effectiveness

Five (5) of the 26 ear-tagged does observed during August and September 2019 were accompanied by single fawns. These included

- 2/8 unboosted does from the 2017 capture cohort (Year Two after initial treatment)
- 2/3 unboosted does from the 2015 capture cohort (Year Four after initial treatment)
- 1/15 previously boosted does (0/6 in Year One, 1/4 in Year Two, and 0/5 in Year Three after boosting)
Over the course of the study, fawning rates among females receiving a single hand-injection of PZP emulsion plus controlled release pellets have averaged approximately 15% over the first two years (with limited data after two years; Table 1). Fawning rates among females receiving boosters 2.5 years after initial treatment have averaged approximately 7% over three years, although sample sizes for the third year are small (Table 2). So far, there appears to be no difference at all in fawning rates between females boosted with PZP emulsion only and PZP emulsion plus controlled-release pellets.

**Table 1. 2014-2019 fawning among untreated (Year 0) and treated does receiving a single hand-injection of PZP emulsion + controlled release pellets, all cohorts.**

<table>
<thead>
<tr>
<th>Years After Initial Vaccination</th>
<th># Females Fawning/Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 0 (based on pregnancy testing, 2014-17)</td>
<td>46/51 (90.2%)</td>
</tr>
<tr>
<td>Year 1 (2014-2017 cohorts)</td>
<td>5/38 (13.2%)</td>
</tr>
<tr>
<td>Year 2 (2014-2017 cohorts)</td>
<td>5/30 (16.7%)</td>
</tr>
<tr>
<td>Year 3 (2018 fawning for unboosted 2015 cohort)</td>
<td>0/2 (0%)</td>
</tr>
<tr>
<td>Year 4 (2019 fawning for unboosted 2015 cohort)</td>
<td>2/3 (67%)</td>
</tr>
<tr>
<td>Total Treated</td>
<td>12/73 (16.4%)</td>
</tr>
</tbody>
</table>

**Table 2. 2017-2019 fawning among does treated with a hand injection of PZP emulsion + controlled release pellets followed 2.5 years later by dart-delivered boosters, 2014-2016 cohorts.**

<table>
<thead>
<tr>
<th>Years After Booster</th>
<th>Native PZP Booster</th>
<th>Native PZP + Pellet booster</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>1/9 (11.1%)</td>
<td>0/7 (0%)</td>
<td>1/16 (6.3%)</td>
</tr>
<tr>
<td>Year 2</td>
<td>0/5 (0%)</td>
<td>1/3 (33%)</td>
<td>1/8 (12.5%)</td>
</tr>
<tr>
<td>Year 3</td>
<td>0/3 (0%)</td>
<td>0/2 (0%)</td>
<td>0/5 (0%)</td>
</tr>
<tr>
<td>Total</td>
<td>1/17 (5.9%)</td>
<td>1/12 (8.3%)</td>
<td>2/29 (6.9%)</td>
</tr>
</tbody>
</table>
Population Dynamics

Reproduction, Mortality and Disappearances. No more than 11 fawns were observed on a given day within HoH during late August observations. Most accompanied untagged females, and as in previous years were most likely to be sighted at the northern and southern boundaries of HoH, where females regularly accessed Dobbs Ferry and the Andrus School, respectively, where we had no access for darting.

Of the 69 females captured and ear-tagged since 2014, we are aware of 10 documented mortalities (one death, #73, was reported to us just prior to the 2019 September booster session; the body was reportedly found adjacent to the train track, a substantial distance away from her home range, where her fawn was still present; Appendix B).

During March, August, and September observations, we again located 30 of the 69 does captured during 2014-17. This is the same number observed in 2018 (mostly the same does, with a few exceptions) and while it should represent a minimum number of tagged does still in the community, the consistency of observations suggest that few other tagged females still inhabit the community. Of the females that were still alive at the end of 2018, we sighted all 5 females tagged in 2014; 8 of the 9 surviving females tagged in 2015 (one reappeared after having been missing for several years); 5 of 9 females tagged in 2016; and 11 of 18 females tagged in 2017 (several 2017 females reappeared; Appendix B).

Deer Density and Herd Composition. Formal analysis of deer densities and herd composition for 2015-2019 using the camera trap grid is in still progress. However, we continue to make rough estimates of population density and composition an informal mark-resight analysis based on observations of tagged and untagged females observed during August observations (Appendix A).

During observations carried out 17-19 March, 25-28 August, and 25-29 September 2019, we re-sighted 30 individual ear-tagged does. Initial inspection of photographs from the camera traps in place from mid-October to late November failed to identify with confidence any tagged females not observed directly in 2019. Summing raw observations of tagged and untagged females in August (Appendix A) yields 42 observations of tagged females and 23 observations of untagged females, or 65% tagged females (similar to the 2019 estimate of 59% tagged females). In August, we observed 0.38 fawns/doe (slightly up from last year) and a doe:buck ratio of 3.6 (slightly lower than last year). If we assume that we have seen all tagged does present onsite (30) and that 65% of the females are tagged, we can infer that there are approximately 46 does (also similar to last year), 18 fawns (up from 12 last year), and 13 bucks (also similar to last year), for a total of 77 deer onsite in August.

Although we had no basis to estimate deer densities in surrounding communities, we note that we observed a fawn:doe ratio of 1.07 in Yonkers and Dobbs Ferry just beyond the HoH boundaries. This is approximately 2.8 times higher than the number we observed within the study site.
DISCUSSION

This was the last year of PZP darting under the study’s experimental design. Although it is easier to dart with PZP than to dart for chemical immobilization, it is still very challenging within a community like Hastings-on-Hudson. Robust late summer vegetation makes it difficult to see deer compared to the late fall and winter months. The Village continues to set limits on times of day when the field team can work which, though understandable, reduce nighttime opportunities for sighting and darting animals. Rough terrain, fencing, sheds, and houses on private property also reduce observation and access to animals. Darting opportunities are sometimes interrupted by dog walkers and others passing by with questions and comments. Access to larger fenced lots where many deer are observed (e.g., the Andrus School and the Graham School) remained restricted.

Vaccine Effectiveness

Fawning continued at very low rates among treated females, with two of the five fawns seen belonging to unboosted does first treated in 2015, i.e., the fourth year after the last PZP treatment. We commonly saw fawns associated with untagged females, especially at the northern and southern edges of the village where does often crossed into areas to which we did not have access for darting. As observed above, fawn:doe ratios were nearly 3X higher in Yonkers and Dobbs Ferry just outside the HoH borders. Again, we have no reason to think there was any broader environmental factor affecting fawning rates in ear-tagged females.

Our first scientific objective for the HoH study has been achieved. Fawning data collected in 2019 affirm that hand injections of PZP emulsion plus controlled release pellets delivered in March are effective for at least two years, approximately replicating the efficacy and longevity results from the study conducted on Fripp Island, SC (Rutberg et al. 2013). Combining the fawning results for the 2014-2017 cohorts yields fawning rates of 13% in Year One and 17% in Year Two. By design, sample sizes in Year Three and beyond are too small to draw any inferences beyond Year Two.

Evidence is also beginning to accumulate with respect to our second scientific objective, testing efficacy and longevity of two different kinds of dart-delivered PZP boosters. Although sample sizes are still modest (N=29 fawning opportunities), the native PZP emulsion and the PZP-22 booster (which adds controlled-release components to the emulsion) appear equally effective over two to three years, with only two fawns having been born so far to booster-treated does (6.9% of all fawning opportunities).

Population Dynamics

A total of 69 adult females were tagged and treated since the beginning of the study in 2014. Observations suggest that tagged females continue to comprise significantly more than half of the adult females present onsite. This is especially true for more central areas of the Village as opposed to groups whose home ranges spill over into Dobbs Ferry, the east side of Saw Mill River Parkway, and the Andrus School in Yonkers.
Of the 20 females captured and tagged in 2017, our 2019 observations (including camera traps) recorded that four reappeared in 2019 that were not observed in summer or fall 2018; one 2017 doe died and one disappeared, so that 11 are known to be still alive.

Our observations indicate that the home ranges of some deer overlap the boundaries with Dobbs Ferry and Yonkers and cross the Saw Mill River Parkway, which complicates both population control efforts and population estimates. Our numerical estimates of the deer population may be best understood as a snapshot in time reflecting the dynamic nature of deer occupancy of the Village edges.

Although we await corroboration from camera-trapping-based estimates, the consistency of the 2018 and 2019 mark-resight estimates provides some reassurance about population trends, even if both estimates might be biased somewhat low. The informal mark-resight estimate of ~77 deer in HoH is very consistent with the 2018 estimate, with the number of does and bucks estimated virtually identical over the two years. The estimated number of fawns present (~18) is slightly higher than the 2018 estimates, but remains notably depressed compared to the 2014 fawn estimate (~61).

Both the rough numerical estimates and the increasing challenges of locating deer encourage us to believe that the current deer population of HoH is notably lower than was present when the study began in 2014, when camera trapping yielded estimates of 79 does and 207 deer total. The number of deer present on the site seems to be stable since last year.

**Vegetation Impacts**

Due in part to a leadership transition in the Village and to new and unexpected job commitments among our key volunteer collaborators, the Host-a-Hosta program was not carried out in 2019. We will work with the Village to conduct the program at least one more time, in 2020.

**Community Involvement**

In preparing this report, we noticed that the Village deer website has not been updated since last year. We will make a point of providing this report and the 2018 annual report to the Village and request they be posted.

The Deer Hotline remains a productive tool for the research team and helped keep open the lines of communication between the community and the research team and facilitated booster-darting and observations in late summer and early fall. Doing a better job alerting residents that the field team is working might improve the hotline’s usefulness.

**Work Planned for the Remainder of 2019 and Beyond**

Photographs from the camera traps in place in October and November have been secured on a hard drive. Photographs will be entered in the Excel database for 2019-20, and the methodology used to estimate populations that was developed in 2014 will be applied to 2015, 2016, 2018 and 2019 data, supplemented by mark-resight methodology associated with the presence of eartags. This process will be repeated the following year, during
October-November 2020.

During March and late August 2020, the team will return to HoH for approximately 4 days on each trip to observe and locate previously tagged animals, match tagged and untagged females with fawns, and estimate the proportion of females in the population that are tagged. The 2020 data should provide us with a firmer base for estimating the efficacy and longevity of the two types of PZP boosters.

References


### APPENDIX A. TABLE AND TRANSCRIPTION OF AUGUST OBSERVATIONS

<table>
<thead>
<tr>
<th></th>
<th># Tagged Doe sightings</th>
<th># HOH Untagged Does sightings</th>
<th># HOH Fawn sightings</th>
<th># HOH Bucks sightings</th>
<th>Total Deer Sightings</th>
<th>Tag Numbers</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DAY 1</strong> 8/25/19</td>
<td>18</td>
<td>9</td>
<td>11</td>
<td>3</td>
<td>41</td>
<td>4, 5, 6, 7/30, 8, 18, 20, 21/75, 24, 26, 29, 35, 37, 52, 59, 64, 68, 73</td>
<td>Missing tag doe with 4, 5 (possibly 36 or 44); 21/75 missing both tags (ID'd from behavior)</td>
</tr>
<tr>
<td><strong>DAY 2</strong> 8/26/19</td>
<td>14</td>
<td>9</td>
<td>6</td>
<td>3</td>
<td>32</td>
<td>4, 5, 8, 11, 15, 24, 26, 29, 31, 37, 59, 63, 64, 68</td>
<td>Missing tag doe with 4, 5 (possibly 36 or 44); 29 missing both tags (ID'd from behavior)</td>
</tr>
<tr>
<td><strong>DAY 3</strong> 8/27/19</td>
<td>6</td>
<td>4</td>
<td>5</td>
<td>8</td>
<td>23</td>
<td>26, 37, 39, 52, 63, 64</td>
<td>Bucks include Male #13</td>
</tr>
<tr>
<td><strong>DAY 4</strong> 8/28/19 AM only</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>12</td>
<td>29, 55, 68, 73</td>
<td>Bucks include Male #13</td>
</tr>
<tr>
<td><strong>Total HoH</strong></td>
<td><strong>42</strong></td>
<td><strong>23</strong></td>
<td><strong>25</strong></td>
<td><strong>18</strong></td>
<td><strong>108</strong></td>
<td><strong>24 individual tagged deer</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total outside HoH (Yonkers &amp; Dobbs)</strong></td>
<td>-</td>
<td>15</td>
<td>16</td>
<td>4</td>
<td><strong>35</strong></td>
<td></td>
<td>Incidental observations adjacent to HoH</td>
</tr>
</tbody>
</table>