

2021 Report to the New York State Department of Environmental Conservation

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Developing techniques to reduce animal-handling in deer immunocontraception programs

Village of Head of the Harbor, New York

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INTRODUCTION

After an extended community discussion of how to manage its conflicts with deer, the Village of Head of the Harbor (HotH), NY, joined with Avalon Nature Preserve (formerly Avalon Park and Preserve), The Humane Society of the United States (HSUS), and Cummings School of Veterinary Medicine at Tufts University to undertake a comprehensive approach to addressing deer population growth. This collaboration features an experimental effort to test technologies that will improve cost-effectiveness and practicality of PZP contraceptives for management of suburban deer. Specifically, we propose to:

1. Test remote delivery of priming doses of controlled-release PZP vaccines ("PZP-22"). Although there is evidence for effectiveness of remotely delivered PZP-22 primers in wild horses, for deer PZP-22 primers have only been administered by hand.
2. Test individual identification systems, including implantable microchips and Artificial Intelligence (AI) systems, that could ultimately reduce the need to capture all deer prior to treatment. Capturing deer for ear-tagging is more time-consuming, costlier, and riskier to animals and field personnel than direct administration of vaccine by dart. Capture also requires higher levels of personnel training, expertise, permitting, and personal commitment. In addition, capturing deer with immobilizing drugs poses higher risks to secondary consumers (including predators, scavengers, and hunters) than direct PZP administration.

3. Test and cross-check a variety of population estimation techniques, including drone surveillance, distance sampling, mark-resight, and AI-based identification of deer in camera trap grids.
4. Contingent on successful outcomes in accomplishing goals 1 and 2, develop and test tools to deliver PZP-22 and PIT tags remotely in a single package.

2021 METHODS

Deer Capture and Treatment

Bait Stations. Five fixed feeders were placed during February 2021. These feeders were set to release whole corn in 5-7 second bursts two to four times daily. In addition, 2 darting locations were baited manually with whole corn and apples twice daily for the duration of capture efforts. Each bait station was located at a distance greater than 300 feet from a road and monitored with one or two trail cameras to provide the research team with information about when deer were visiting feeders. Feeders were taken down at the end of April 2021.

Capture. Three teams of two or three were available to conduct captures. This year's darting season ran from March 1 – March 10, for a total of twelve field days (where poor weather prevented the team from darting during 1 of those days). All animals were chemically immobilized via 2 cc self-injecting Pneu Dart® 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 BAM were administered on an as-needed basis if animals were not fully sedated at time of approach for work-up.

Animals were captured over bait at fixed feeder stations, or opportunistically at the roadside from a marked vehicle without the use of bait. All darts and sharps were recovered following each work-up and discarded into medical sharps containers. Use of chemical immobilizing drugs was carried out under the supervision and authority of Dr. Christopher Miller, DVM, Miller & Associates, Hampton Bays, NY.

Work-up Process. Our radiotelemetry darting and animal handling procedures remained the same as previously described in the study proposal and annual report from 2019 and 2020, with the exception of ear tag color and type. In addition, deer captured in 2021 did not receive a PIT tag during the work-up as they will be delivered by dart at a later date, contingent on existing tag performance data still being collected from previously PIT-tagged animals. In effort to increase efficiency for field personnel in identifying individual animals with their treatment group during observations throughout the course of the study, we utilized orange and blue ear tag colors for animal captured in 2021, along with a GPS ear tag to assist with observations and gain an understanding of how deer are utilizing the landscape (mOOvement, Utrecht, Netherlands, <https://www.moovement.com.au/gps-ear-tags>).

Blood samples were taken from the jugular vein at the time of capture and sent to BioTracking, Inc., (Moscow, ID) for pregnancy diagnoses based on assays for Pregnancy-Specific Protein B.

Remote Primer Delivery. Remote delivery of priming doses of PZP-22 via dart was attempted during capture efforts in March and April, and in mid-September 2021. All does receiving priming doses of PZP-22 were darted at a range of 10-22 yards. Remote delivery of PZP-22 was accomplished with a 1 cc self-injecting prototype implant dart with a 14g x 1" needle (Pneudart®, Williamsport, PA). Darts were delivered with a Dan-Inject® Model CO2 PI pistol, or Model JM Standard CO2 rifle or equivalent.

Remote Booster Delivery. Remote delivery of booster doses of native PZP (ZonaStat-H) via dart was carried out in mid-September 2021. Does previously treated in 2019 received booster doses of PZP from a range of 10-22 yards. Remote delivery was accomplished with a 1 cc self-injecting dart with a 14g x 1" needle (Pneudart®, Williamsport, PA). Darts were delivered with a Dan-Inject® Model CO2 PI pistol, or Model JM Standard CO2 rifle or equivalent.

Deer Population and Identification Studies

Population Camera Trap Surveys. A grid of 11 un-baited motion-sensitive IR trail camera stations was placed by Avalon Park and Preserve Staff at pre-determined locations throughout the village for six-week periods from March 2021 to May 2021, and again from October 2021 through November 2021. Analysis of images captured on this grid in 2019, 2020, and 2021 is underway.

2021 Drone Surveillance. The team resumed mapping and testing potential flight patterns throughout the village to set the stage for counting deer via drone surveillance throughout the study. This year, we were able to successfully fly the Inspire 1 v2.0 drone with a standard Zenmuse x3 camera and a zoom Zenmuse z3 camera both manually and autonomously. Currently, the team is shortening the flight grids to work through some issues regarding frequency interference and weak image transmission. For autonomous flights, the application Litchi was used to plot grid patterns for each specific property. Flights were conducted at an altitude above ground level (AGL) of 150 ft. at a cruising speed of 13.0 mph to ensure a proper speed relative to the ground for spotting deer.

Individual identification with Artificial Intelligence. Photographs and videos of deer from both Head of the Harbor and Hastings-on-Hudson are being incorporated into machine learning models to initially recognize deer out of photographs, and then to use spatial measurements and body dimensions to try to distinguish individuals. Image data collection is ongoing.

Individual Identification with PIT Tags. To read PIT tags previously injected into deer during chemical capture efforts, we built preliminary schematic models of multi-antenna array and single antenna array units. We continue to refine them to obtain positive ID capture and maintain battery life at each reader station.

Community Outreach

At the beginning of the field season, the research team supplied updated and current materials to village residents in the form of a mailed letter, as well as posting project information and updates throughout the year on the Avalon Nature Preserve's website (<https://avalonnaturepreserve.org/conservation/>). In addition, residents are encouraged to reach out with observations and questions via email throughout the year, or by telephone during active darting sessions.

2021 RESULTS

Capture and Darting Success and Vaccine Effectiveness:

Capture and Treatment. A total of twenty (20) adult female white-tailed deer (*Odocoileus virginianus*) were captured in the Village of Head of the Harbor in an abbreviated field session during March 2021 (Table 1; Appendix 1).

All darted deer were recovered, and all darts were retrieved and discarded into medical sharps. One doe was darted twice, approximately 20 hours apart, as she remained ambulatory after the first dart but retreated into a thick woodlot and did not sedate. Following the initial darting, field staff attempted to re-dart her but could not do so safely, and after monitoring her location via radiotelemetry, decided to attempt to locate and dart her over bait the following morning to reduce risks of capture-related cardio myopic event. She returned to bait the following morning, where she was calmly sedated and both darts were retrieved.

During capture efforts, ten (10) does tagged with BLUE ear tags were also given PZP-22 via hand injection. Following the experimental protocol, ten (10) does tagged with ORANGE ear tags were not vaccinated at capture and were reserved for later remote darting with priming doses of PZP-22. All deer captured were also tagged with a GPS ear tag (mOOvement, Utrecht, Netherlands, <https://www.moovement.com.au/gps-ear-tags>).

Remote Vaccination. Nine (9) does that were previously captured and tagged in 2020 and 2021 were remotely vaccinated with PZP-22 (Table 2). During remote delivery efforts in April, 7 of 10 orange-tagged does were administered PZP-22 remotely via dart. One of the two remaining white-tagged does and one of the 3 remaining orange-tagged does were administered PZP-22 remotely via dart in September. In addition, of the twelve (12) remaining does initially treated in 2019, five (5) were remotely treated with a booster dose in September, per project design. All does were vaccinated at or near the locations at which they were initially captured and tagged (Table 2, Appendix 2; Table 3, Appendix 3).

Of the 76 animals captured and tagged thus far, only four have not been vaccinated. All vaccine darts were recovered and discarded into medical sharps.

During capture and treatment efforts in March, field staff observed a white-tagged deer with antler buds present (white tag #83), confirming this animal was a male that was previously

misidentified as a female in 2020. This finding was corroborated by a later report from a resident confirming the presence of antlers.

Individual Identification and Population Dynamics:

Individual Identification using PIT Tags. We did not administer PIT tags to animals captured in 2021. A PIT tag will be delivered remotely to these animals in the future contingent on the performance of PIT tags previously hand-injected in captured animals. A total of 52 animals received a PIT tag via hand injection at time of capture in 2019 and 2020. PIT tag readability will be further evaluated in 2022 and beyond via free standing reader stations.

Although COVID-19 delayed the refinement and deployment of these structures, we erected one fully functional model in 2021 and monitored it with motion-triggered IR trail cameras to cross-check reader function on tagged deer. Data download confirmed the capture for 1 PIT tag. With the use of bait and a second reader configuration in early 2022, we hope to detect additional tags.

Individual Identification using Artificial Intelligence. To automate the non-invasive monitoring and tracking deer of populations, an artificial intelligence (AI) based pipeline is being applied. Continued efforts are underway to detect and re-identify deer in camera trap images to build algorithms for detection and identification. So far, an AI model has been developed that predicts body landmarks on deer to help isolate parts of the body for carrying out measurements to further confirm identification. Drawing on other established mammalian data sets that estimate distance of animals from camera traps, the team is developing similar algorithms using the deer image collection we have obtained through camera trapping. Adding a new PhD student to the project in 2021 should speed the development of these algorithms.

Reproduction. Blood samples for PSP-B pregnancy diagnoses were obtained at the time of capture in Winter 2021 for 17 of the 20 captured females. All but two of the samples submitted yielded a positive pregnancy status (Table 4).

Of the 20 does captured in March 2021, we resighted 15 during summer and fall. Except for the two does diagnosed as non-pregnant by blood sampling and an additional doe of which observation could not confirm udder size, all others were accompanied by fawns or observed to have an udder present, consistent with the pre-treatment pregnancy rates from blood sampling.

Of the 42 does captured and treated in 2020, we resighted 25 during summer and fall. Five (5) of these animals appear to have been contracepted (no fawn, no udder). Eleven (11) does were accompanied by fawns, seven (7) were observed to have an udder present. We could not confirm udder presence on 3 animals. Given the treatment success observed in previous observations and in previous studies, these observed pregnancies were not expected. Because all animals captured and treated in 2020 were given liquid vaccine from the same PZP lot, we suspect that the vaccine failure may be related to that particular batch of PZP-22.

Of the remaining 12 does captured and treated in 2019, seven (7) were resighted during 2021. One of these animals were observed with a single fawn, two were observed to have an

engorged udder present, and four were observed without fawns and without the presence of an udder.

Mortality and Disappearances. Eight (8) of the remaining 12 does captured during 2019, twenty-six (26) of the remaining 31 does captured during 2020, and 18 of the 20 does captured during 2021 were sighted in the village or along village boundaries throughout the year, in close proximity to capture locations.

As of December 2021, we are aware of twelve tagged deer mortalities, overall. Two deer captured in 2019 were reported as deceased later that year. Of the 42 females captured and ear-tagged in February-March 2020, we are aware of nine deaths, 8 of which were previously reported that year, and one, white tag #80, was found deceased this summer after reports of neurologic symptoms from homeowners; her remains were collected and necropsied by NYSDEC. Of the 20 does captured in 2021, we are aware of one death (orange tag #47) due to impalement on a metal spike fence in December. Her remains were collected for incineration by project staff.

Deer-Vehicle Collision Reports. The Village police department responded to 5 deer-related calls within the village in 2021. Two were deceased deer at the roadside reported by motorists, and 3 reports were for injured deer that were euthanized on site by PD or NYSDEC officers.

Deer Density and Herd Composition. Analysis of deer densities and herd composition for camera trap data collected from 2019 through 2021 is pending.

Community Outreach and COVID-19 Impacts:

Residents provided feedback, observations and consent for property access by project staff throughout the year. The “deer hotline” was utilized by residents to report deer observations but the messages were not recovered, and an additional 3 calls were placed directly with the Avalon Nature Preserve office. Residents reported sightings, and provided consent for property access through email, yielding 1 deer sighting report, and 26 property consent forms.

In efforts to be compliant with state emergency regulations and maintain safety of study animals, field personnel, and residents, field sessions were carefully planned throughout the year to adhere to travel and quarantine restrictions and foster very limited in-person interactions with individuals outside of the project’s primary field staff. We were diligent in tailoring our efforts to the primary priorities for field work in 2021, which included capture and tagging, treatments, and observations of study animals. Secondary and tertiary priorities of the study, including population estimate efforts and RFID tag reader build-outs, were delayed and will be pursued in 2022 and beyond.

WORK PLANNED FOR 2022

Official workplans that provide further detail of any animal treatment and observation efforts will be provided prior to each of those periods of fieldwork. While the COVID-19 pandemic continues, all field work will be subject to modification and adaptation to assure the health and safety of the study animals, field team, and the community.

To confirm that poor vaccine performance was linked to a specific batch, the team plans to return to Head of the Harbor to re-treat deer remotely with a new supply of PZP-22 vaccine via barbless self-injecting dart during winter 2022. In addition, bait stations will be utilized during March-April 2022 to refine and test PIT tag reader arrays. Camera traps will be installed for approximately 6 weeks in winter to assist with population modelling and individual AI algorithm work.

We will continue exploring vegetation impacts and developing and implementing planting strategies for inclusion and exclusion of deer and other wildlife in designated areas of Avalon Nature Preserve. Through this work, we hope to develop template strategies for homeowners to reduce conflicts with wildlife on their own properties. While we are in the preliminary phases of collecting baseline inventory of existing plants, this work will be ongoing through the duration of the study and further defined in later reports as an additional tool for community education, participation, and outreach.

In summer and autumn 2022, we will also observe and locate previously tagged animals, match tagged and untagged females with fawns, and estimate the proportion of females in the population that is tagged. Camera traps will be installed for approximately 6 weeks in autumn to assist with population modelling and individual AI algorithm development. We will also return in autumn for remote vaccine delivery on animals due for booster doses per project design.

Stationary PIT Tag reading and village-wide drone surveillance efforts will continue to be tested, refined, and modified throughout the duration of the study. During times of ideal field conditions, the drone pilot will continue to perform test flights with the Inspire 1 equipped with a Zenmuse XT FLIR camera and continue flight mapping to widen transects to improve visibility and flight time efficiency. To assist with these efforts, we will be outsourcing a trained pilot and wildlife research expert to cover a greater distance, allow for longer flight times and review video footage at higher resolution. Overall, this would improve reliability and accuracy for data analysis.

The engineering team will continue to develop an algorithm that can be trained and fine-tuned for the deer dataset, advancing deer recognition and modeling. Based on these trials, we anticipate recommendations for camera placement or laser integration in the cameras placed onsite to further refine the AI pipeline.