Thermal Infrared Imaging White-tailed Deer Survey
City of Morgantown, West Virginia

Submitted to:

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Via email: jmikorski@morgantownwv.gov

Submitted by:

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Vision Air Research was retrained to conduct an aerial survey for deer survey in the City of Morgantown, WV. The project goal was to provide information on distribution and abundance. The aerial infrared also commonly called forward-looking infrared (FLIR) survey provided deer group locations, and provides a tally of deer observed within each group. The study area encompassed the City of Morgantown which included suburban areas with lawns and ornamental shrubs and trees, golf course and larger areas of eastern deciduous forests with mixed deciduous and conifer forests as well as commercial and municipal buildings and roads and highways.

Methods

The survey was conducted February 18, 2016 between 1900 – 2300 hours. Winds were calm and the relative humidity was favorable for an infrared survey. The survey commenced on the northeast corner and proceeded west to completion. Transects were spaced 800 ft apart and flown at 1,000 ft above ground level. The north / south transects were oriented to minimize airport conflicts. We coordinated with Morgantown airport tower to maximize flight safety.

The sensor look angle was approximately 45° elevation. The sensor was moved to aim and focus as needed. The wide field of view (WFOV) was used to search for the deer while the narrow field of view (NFOV) was used to verify the object, as needed. Portion of the flight along transects were recorded to on onboard computer. The time "stamped" on the video is based on standard aviation time (GMT), not local time. The position is the airplane's GPS position not the location of the subject animals because we are looking in front of the airplane.

We used a forward – looking infrared (FLIR) by PolyTech Kelvin 350 II (Sweden) mounted on the left wing of a Cessna 206 "Stationair". The sensor gimbal allows 330° of azimuth and 90° of elevation allowing us to look in all directions except directly behind the airplane. The infrared sensor installed in the gimbal is the high resolution Agema Thermovision 1000, which is a long wave system (8-12 micron). It has 800 by 400 pixels providing good resolution with the ability to determine animals by their morphology or body shape. The thermal delta is less than 1° C, which means it can detect objects with less than 1° C different than the background. There are 2 fields of view (FOV): wide (20 °) and narrow (5°). At 1,000 ft. above ground level looking straight down using the wide FOV the footprint or area covered by the sensor is 360 ft. x 234 ft. while the narrow FOV provides a footprint 90 ft. x 59 ft. This information on the field of view footprint is for reference only since we use an oblique look angle allowing coverage of the entire transect. The sensor operator / wildlife biologist sat in the rear seat and watched a high resolution 15 in. monitor to aim and focus sensor.

The video was reviewed by playing the video backward and forward and in slow motion and frame by frame as needed to identify deer group and count within the group, and map group location. Deer were located by observing their level of emitted infrared energy versus

background levels. Video editing and image extraction was not conducted. The video was collected for use by a skilled thermographer not for entertainment or educational purposes.

Figure 1. Examples of wide and narrow fields of view (FOV). These images were extracted from video taken during the aerial infrared survey of the City of Morgantown, WV, on February 18, 2016 by Vision Air Research. Date and time recorded on the screen are GMT not local time. Figure 1a. Wide FOV was used to scan along transect for detect deer. The time "stamped" on the video is based on standard aviation time (Greenwich Mean Time - GMT), not local time.

Duplicates or repeat groups were identified. Groups were mapped at their approximate location not airplane position since the sensor looking position is in front of the airplane. I performed an additional check of the data through sampling the videotape for detection verification, and checking for duplicate groups. Orthophoto quadrangles were used as the base layer, which provided vegetation cover type to assist in mapping group locations.

Figure 1b. Narrow FOV was used to verify objects. No deer are found within this image but power lines are evident to show detection scale.

Results

The meteorological conditions were good for flight safety and infrared surveys. Image clarity was good. Locations of deer groups were plotted and the total number in each group was tallied. A total of 264 deer were found in 98 groups (Figure 2). This is a decrease the number of groups, total deer counted and group sizes were smaller. In 2011, a total of 689 deer located in 296 groups. As with found in 2011, most deer were found in forest settings. Deer group size ranged from 1 – 8 individuals. Higher group densities were found in the eastern half of Morgantown.

Detection Potential

Cover type influences the availability of the deer to be detected by the sensor. A dense canopy will make it more difficult to detect the deer since infrared, like human vision doesn't see through vegetation. It will detect through holes in the canopy. Research I've conducted to determine detection rates have been based on known target subjects. One or more individuals in a group had radio collars. The location of the target subject was monitored by a second aircrew in another airplane or via ground based crews to avoid any detection bias.

Figure 2. Deer group distributions of the City of Morgantown, WV found during the forward – looking infrared (FLIR) deer survey conducted by Vision Air Research. The aerial survey was conducted February 18, 2016 between 1900 – 2300 hours.

These controls allowed me to determine if the individual or groups were detected, were available to be detected and subsequently missed, or unavailable to be detected because they were no longer in the search area. In areas where no collared animals were available, previously detected animals were used as targets in subsequent replicates. This is similar to a mark – recapture method for determining detection. These efforts have revealed a consistency as to which variables influence detection. The vegetation cover type is the primary variable to confound detection rates. Infrared cannot detect or "see" through a canopy cover. As such, evergreen trees can thwart detection. But unlike with human vision,

IR is detecting a warmer object that will show up as "white hot" against the colder background as opposed to a brown animal against a brown or green background. Branches and tree boles can also influence detection based on the size of the animal. Cloud cover can enhance detection. Ambient temperatures do not influence detection unless it changes the subject animals habitat use or behavior. The multiple look angles provided by an oblique angle and the ability to aim and focus increases detection. Video capture instead of still images provides a dynamic view of the landscape.

Detection rates for open areas such as parks and meadow can be 100% (Figure 4), deciduous forests were roughly 86%, and conifer can range from 50 – 80% or less depending on the canopy closure. What was not obvious was the effect of bud break on detection. Although the deer, for example, could be seen visually through tree branches during bud break, the deer can be masked by the energy given off by the bud break. Buds effectively "glow" masking deer behind the canopy. Bud break may have diminished detection under some tree species and shrubs but it did not appear to be widespread during this survey.

All wildlife surveys are a snapshot in time whether they conducted from the air or ground. This survey can provide a good index or baseline for density and distribution of deer within the community.

Figure 4. Meadow or lawns provide easier detection than in the shrubs or trees.

Morgantown WV
Morgantown

Thermal Infrared Imaging White - tailed Deer Count
City of Morgantown, West Virginia

Deer group found long a road during the aerial infrared survey for deer within the City of Morgantown, WV, March 2011

Submitted to:

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Via email: jmikorski@cityofmorgantown.org

Submitted by:

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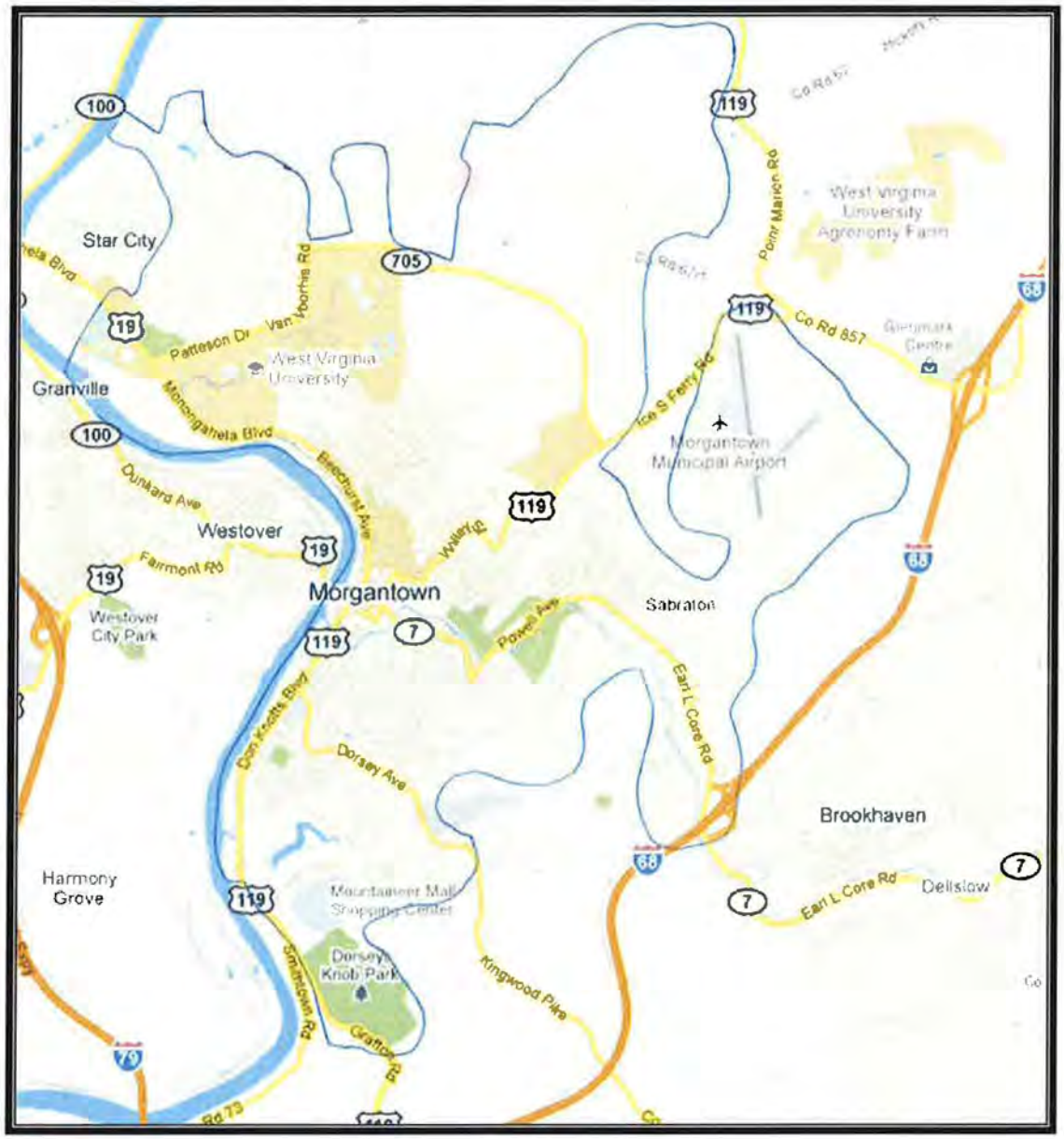
May 18 2011

The City of Morgantown, West Virginia retained Vision Air Research to conduct a deer count. The project goal was to conduct an aerial infrared survey for white – tailed deer within the City of Morgantown, WV; map deer group locations, and provide a count of deer observed. A map of the study area was provided by the City of Morgantown (Figure 1).

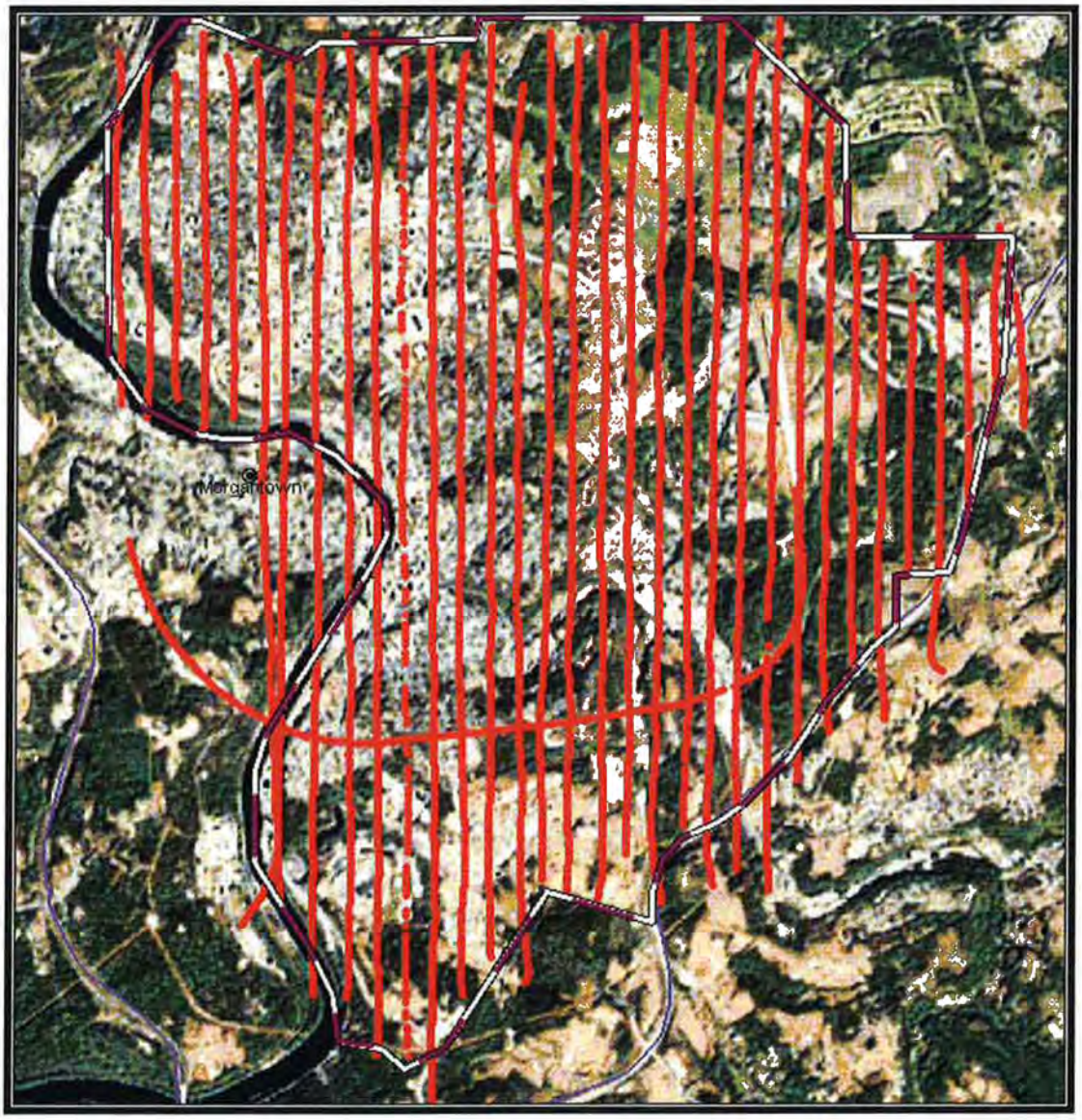
Figure 1. A solid blue line delineates City of Morgantown, WV.
Source: City of Morgantown, WV.



Methods

The City of Morgantown, WV, boundary is irregular in shape. The survey area was squared to allow a cost effective survey. North – south transects were established to conduct the survey (Figure 2). Transects were spaced 800 ft apart and flown at 1,000 ft above ground level. The pilot used a Garmin 496 which provided the transect locations and tracked transects flown. The sensor look angle was approximately 45° elevation or look angle. The sensor was aimed to gain more oblique or vertical look angle as needed for species identification. Wide field of view was used to search for the deer while the narrow field of view was used to verify the object as needed.

Figure 2. City of Morgantown, WV survey transects for deer conducted in March 2011.



The survey was conducted March 13, 2011 between 1800 and 2200 hours. Portion of the flight along transects were recorded on mini digital videotape. The pilot and sensor operator communicated to verify the location of the boundaries to turn the tape off and on. The sensor operator turned the tape off at the transect end and commenced recording at the transect start. Deer were located by observing their level of emitted infrared energy versus background levels.

The tapes were reviewed by playing the tape backward and forward and in slow motion and frame by frame as needed to identify deer group and count within the group, and map group location. Deer were located by observing their level of emitted infrared energy versus background levels. I performed an additional check of the data through sampling the videotape for detection verification, and checking for duplicate groups. Groups were mapped at their observed position not the position of the airplane. Group location is approximate. Orthophoto quadrangles (year 2000) were used as the base layer, which provided vegetation cover type to assist in mapping group locations.

Equipment

We used a PolyTech Kelvin 350 II (Sweden) mounted on the wing of a Cessna 206 (Figure 3). The sensor gimbal allows 330 ° of azimuth and 90 ° of elevation allowing us to look in all directions except directly behind the airplane. The infrared sensor installed in the gimbal is the high resolution Agema Thermovision 1000, which is a long wave system (8-12 micron). It has 800 by 400 pixels providing good resolution with the ability to determine animals by their morphology or body shape. The thermal delta is less than 1 ° C, which means it can detect objects with less than 1 ° C different than the background. There are 2 fields of view (FOV): wide (20 °) and narrow (5 °). At 1,000 ft. above ground level looking straight down using the wide FOV the footprint or area covered by the sensor is 360 ft. x 234 ft. while the narrow FOV provides a footprint 90 ft. x 59 ft. The sensor operator / wildlife biologist sat in the rear seat and watched a high resolution 15 in. monitor to aim and focus sensor.

Figure 3. Forward-looking infrared attached to the left wing of the Cessna 206.

Results

The meteorological conditions were good for flight safety and infrared surveys. Locations of deer groups were plotted and the total number in each group was recorded. A total of 156 deer groups were identified with a total of 654 deer (Figure 4). Example deer groups are presented in Appendix A. A shapefile was sent for import into a GIS.

Figure 4. Deer group locations within the City of Morgantown, WV, found during the March 13, 2011 FLIR survey by Vision Air Research.

Detection Potential

Cover type influences the availability of the deer to be detected by the sensor. A dense canopy will make it more difficult to detect the deer since infrared doesn't see through the vegetation canopy. Detection rates for open areas such as agricultural fields and meadow were 100%, deciduous forests were roughly 86 %, and conifer can range from 50 – 80 % depending on the canopy closure.

There were no "controls" or known deer to allow developing a search image of deer in this study area. Other research I've conducted to determine detection rates have been based on known target subjects. For example, one or more individuals in a group had radio collars. The location of the target subject was monitored by a second aircrew in another airplane or via ground based crews to avoid any detection bias. These controls allowed me to determine if the individual or groups were detected, were available to be detected and subsequently missed, or unavailable to be detected because they were no longer in the search area. In areas where no collared animals were available, previously detected animals were used as targets in subsequent replicates. This is similar to a mark – recapture method for determining detection. These efforts have revealed a consistency as to which variables influence detection. The vegetation cover type is the primary variable to confound detection rates. Infrared cannot detect or "see" through leaf cover. As such, evergreen species can thwart detection. Branches and tree boles can also influence detection based on the size of the animal. Some animals may be able to effectively hide behind tree boles or masked by dense branches. This variable is fairly easy to comprehend – if the animal is hidden it is not available to be detected. If the animal can't be seen by visual methods (e.g., a deer is bedded behind a tree bole) it can't be see or was considered "unavailable". What was not obvious was the effect of bud break on detection. Although the deer, for example, could be seen visually during bud break, the deer can be masked by the energy given off by the bud break. Buds effectively "glow" masking deer behind the canopy. Bud break was not an issue during the survey.

The other variable which had a strong influence on detect was "sky" or the effect the cloud deck had on how quickly infrared energy was emitted. A cloud layer allows the animals to glow hot compared to the radiant energy emitted by rocks, soil, and vegetation. A cloud layer enhances detection. The solar gain during daylight hours can reduce detection depending on the vegetation cover types and background conditions (i.e., snow, sand).

Appendix A – in a separate file.

City of Morgantown's Urban Archery Deer Hunt:

Five-Year Summary

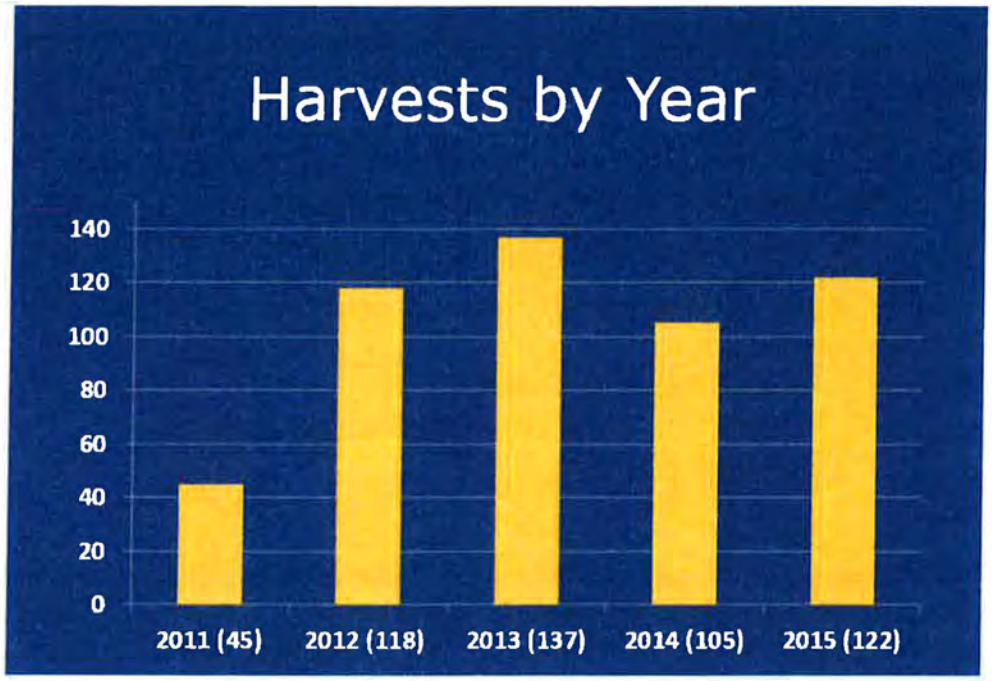
Submitted to the City Manager & City Council, February 2016

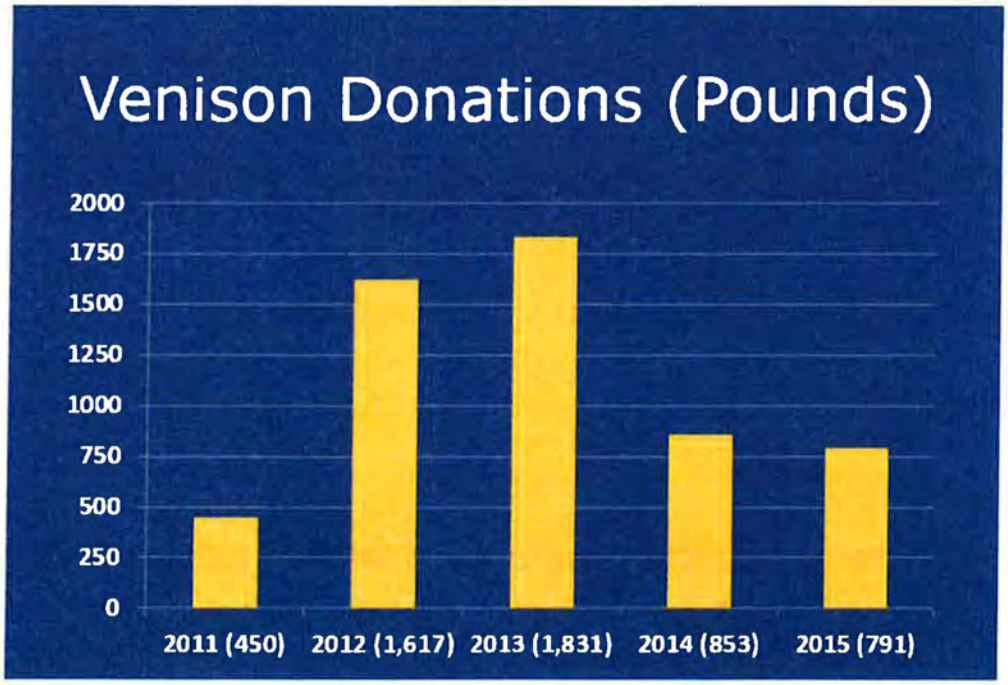
Rick Bebout, Volunteer Coordinator

Summary of Hunter Accomplishments

- Harvested 527 deer.
- Worked with the City Manager to start a venison donation program to deliver processed deer to city food kitchens and organizations to help those in need.
    - A completely hunter-driven program. Hunters scheduled, loaded and delivered the meet to local organizations.
    - Donated 5,542 pounds of ground venison.
- Established a solid network of landowners/land managers that have allowed hunter access to their properties.
- Organized and taught five mandatory bowhunter education courses for new hunters prior to their first year of hunting in the city.
- Educated the general Morgantown public on the need for the urban hunt and how the outcomes benefit the city and its residents.
- Worked with the Morgantown Police Department and WVU Police on numerous non-hunting incidents:
    - Stolen property
    - Illegal hunting within the City
    - Trespassers
    - Illegal tent camps on public and private property
- Worked with the WVU Extension Service on a project, led by Dr. Sheldon Owen, to conduct an on-ground thermal deer survey on properties across the city in the spring of 2014.
- There have been no safety accidents or issues.

New hunters participating in the mandatory bowhunter education course taught by Kent Garvin and Justin Hettick, certified instructors and urban hunt participants.


Harvests by Year
140
120
100
80
60
40
20
0
2011 (45)
2012 (118)
2013 (137)
2014 (105)
2015 (122)


Venison Donations (Pounds)
2000
1750
1500
1250
1000
750
500
250
0
2011 (450)
2012 (1,617)
2013 (1,831)
2014 (853)
2015 (791)

2016 Landowner/Land Manager Survey Results

- A total of 12 out of 15 landowners/landowners responded to the survey.
- 9 of 12 responders noted they have observed fewer deer since the urban hunt began in 2011. 3 responders reported seeing the same number of deer.
- Given multiple options:
    - 9 responders noted a concern for damage to landscaping/garden/crops.
    - 6 responders noted a concern for deer-automobile accidents.
    - 5 responders noted a concern for fear of deer ticks and the spread of Lyme disease.
    - 2 responders selected that they did not have a main concern, but feel it is good for the neighborhood.
    - 2 responders entered responses under "Other":
        - Heavy deer browsing of native plants facilitates invasive plants.
        - Benefit to local food organizations.
- 9 of 12 responders noted they have observed less deer-related damage. 3 responders reported seeing the same amount of damage.
- All 12 responders described their interactions with hunters as "Positive, the hunters were polite and respectful while hunting my property."
- All 12 responders felt "the urban bowhunt is a positive project to manage the City's deer herd."
- Additional comments made by landowners/land managers:
    - Small reduction in herd size has resulted in 1. somewhat less browsing of native plants, enabling them to compete against unbrowsed invasive plants, and 2. larger and apparently healthier deer.
    - The hunters using our land have been outstanding. We've only had our property for two years and this was our first urban hunt, so we look forward to seeing how the hunt affects the local deer population over time.
    - ALL of the hunters have been absolutely wonderful.
    - It's great for the community in so many ways. It reduces the number of deer whom create damage and spread disease while also providing meat for local organizations. The hunters are very respectful of the property and provide information of the wildlife within city limits. The average citizen wouldn't even know some of these animals exist in their neighborhood.
    - My neighbors are grateful, too, for less damage to their shrubs and gardens and also less injured deer passing through our properties. We are very grateful for the program.
    - Great group hunting. Need to continue still need thin herd out
    - The urban deer hunt station was 30 yards from my back door I never knew they were there. They picked a well-used deer trail into town and our neighborhood. Deer droppings abound. I thank them for their volunteer efforts They add to the health and beauty of Morgantown. Please keep up the efforts!

Morgantown Urban Archery Deer Hunt Landowner Survey

Since 2011, the City of Morgantown's urban archery deer hunt has worked to address the deer-related issues across the City. In the first five years, our hunters have harvested 527 deer and donated 5,542 pounds of ground venison to organizations within the City to help those in need. Most importantly, we've not had a single accident or safety issue.

As a participating landowner/land manager, I would appreciate you completing this short, anonymous survey. Results will be included in a report submitted to City Council later this spring.

* Required

Location of the property you own/manage? *

1. **I participate in the City's urban hunt because I have the following concerns (check all that apply): ***
   - o damage to landscaping/garden/crops
   - o fear of deer ticks and the spread of Lyme disease
   - o deer-automobile accidents
   - o I do not have a main concern, but feel it is good for the neighborhood
   - o Other:
2. **Based on your observations on your property since the City's hunt began in 2011, how many deer are you seeing? ***
   - o fewer deer
   - o about the same number of deer
   - o more deer
3. **Based on your observations on your property since the City's hunt began in 2011, what amount of property damage are you witnessing? ***
   - o less damage
   - o about the same amount of damage
   - o more damage
4. **How would you describe your interactions with the bowhunter(s) assigned to your property? ***
   - o Positive, the hunters were polite and respectful while hunting my property
   - o No opinion, my interactions were very limited
   - o Negative, the hunters were rude and careless while hunting my property
5. **Overall, I feel ***
   - o the urban bowhunt is a positive project to manage the City's deer herd
   - o no opinion
   - o the urban bowhunt is a negative project to manage the City's deer herd
6. **Additional comments regarding the City of Morgantown's urban archery deer hunt?**