

Aerial Infrared Deer Count Report

US Military Academy USAG West Point, NY

12 April 2018

Eight one-half-square-mile tracts within the confines of the West Point Garrison were the subjects of aerial infrared (IR) deer count flights on the nights of 29 January and 13 March 2018. The IR imaging conditions were good to very good during the flights. Additional details can be found in the analysis notes below.

This report package includes this written report as well as mapping data of the deer count and dispersion within and near the count areas, and a digital copy of the raw IR imagery used in the analysis. Deer are noted on the map by red-colored dots. The dots representing deer on the maps cover an area much larger than the actual deer so they can be seen and printed easily. Raw infrared imagery of the count will be maintained at Davis Aviation for at least one year from the date of this report.

Analysis Notes

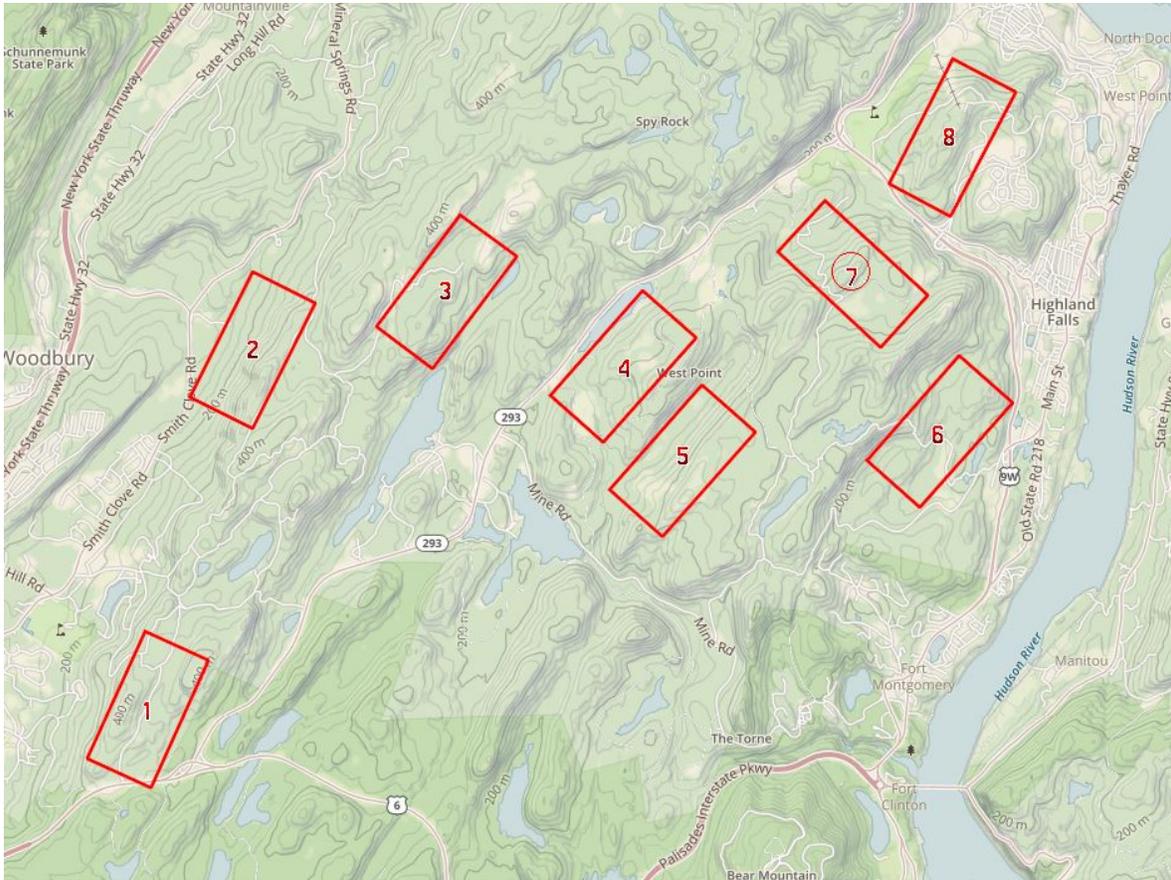
29 January and 13 March 2018

The aerial infrared imaging flights at West Point occurred on the nights of 29 January between 0153 and 0329, 30 January and 13 March 2018 between 2039 and 2139. The ground conditions were very good on 29-30 January and good on 13 March. The survey areas contain numerous rock formations and many natural ground water sources, surface streams and seeps, all of which provide a high contrast with the background terrain. Deer appear in the infrared as a similar temperature to the ground water sources and that can cause some confusion during analysis. In the interest of not over-counting, deer that may have been in areas of concentrated ground water, ground seeps and rocky areas not covered by snow may not have been counted due to the difficulty in determining the difference between the deer and the thermal distractions. Surface winds were light from the north-northeast at 6 knots during the first count flight and from the northwest at 15 gusting to 20 knots on 13 March. Conditions in the air were adequate during both flights. Winds at the imaging altitude of 1500-1600 feet above ground level were light to moderately turbulent during both flights. Low clouds and heavy snow caused the early termination of the 29 January flight. The ground was essentially clear of snow prior to the arrival of the snow storm. During the second flight on 13 March, the ground was mostly snow covered, except for rock outcroppings, and the sky had a broken layer of clouds at 7000 feet. Infrared screen capture images of all deer seen inside the study areas are included in the digital data files.

Tract Number (see guide below)	TOTAL DEER	IN	OUT	ACRES
1	47	18	29	320
2	24	10	14	320
3	16	12	4	320
4	44	30	14	320
5	37	21	16	320
6	36	23	13	320
7	27	24	3	320
8	40	23	17	320
Totals	271	161	110	2560

Mapping:

If the deer count number and dispersion information provided is destined for a Geographic Information System (GIS), I recommend importing the data from the accompanying Google Earth KMZ file. Otherwise the data can be displayed by opening the KMZ file in Google Earth. Screen captured images from Google Earth are also provided in .jpeg format on the accompanying disc.



Equipment:

This count was accomplished with a single-engine Cessna 182 airplane and using a high-resolution Mitsubishi M-600 thermal imager oriented 'looking' straight down through a camera hole in the belly of the airplane. The thermal imager NTSC video output is routed through a video encoder-decoder (VED) that labels the video with a continuous stream of GPS-derived position, time, date, speed and altitude information. A guide to the alphanumeric annotation seen on the accompanying videotape may be found at the end of the specification block below. A bar code of the same GPS alphanumeric information is recorded on the far left side of the imagery although it may not be within the visible portion of a conventional TV screen. The bar-coded information is used by the VED during video playback and analysis. The annotated video imagery is recorded with a Sony MiniDV digital video cassette recorder using digital videotape capable of storing 500 horizontal lines of video information (over 50% more than the 330 lines found on conventional VHS videotape.) The mapping program used for marking the count area borders, laying out the flight lines and doing analysis work is ExpertGPS by TopoGrafix.

Mitsubishi M-600 thermal imager specifications:

Detector	Platinum Silicide Schottky-Barrier IRCSD
Number of Elements	512 X 512 pixels
Detectable Wavelength Band	3 to 5 microns

Lens	Infrared, polarized f50 mm, F 1.2
NETD (Noise Equivalent Temperature Differential)	0.08 degrees C blackbody at 80.6 deg. F. (27 deg C) using f50 mm, F 1.2 lens
Field of View (using f50mm lens)	14 degrees horizontal X 11 degrees vertical
Field Time	1/60 second
Cooling Method	Stirling Cycle cooler
Image Display	Monochromatic, 256 gray levels
Video Output	RS170 video output (1 BNC port, 75 ohms)

Annotation Guide:

Date	Time	Altitude MSL
MAR20/99	0030:56.213	-05,9/00,02157F
0111,3910	.860N,08444.294W	74KTS,092
Latitude	Longitude	Grnd Speed Course

Flight Methodology:

The counts are flown at an average altitude of 1500 feet above ground level. The camera view directly below the airplane from that altitude is 400 feet wide on the ground surface. Flight lines are spaced an average of 350 feet apart to allow for image overlap and 100 percent coverage of the study area. A 'bread crumb' feature of the mobile mapping software used for the flight allows me to track my flight path and helps guide me along predetermined flight lines to assure complete coverage. The recording device is normally paused during the turns outside the study area; hence the tape appears to jump from the end of one run to the beginning of the next.

Analysis Methodology:

After the flight, I analyze the videotape using a TV monitor and a computer monitor. As the videotape plays, the VED decodes the bar-coded GPS signal that was received from the GPS during the flight. The VED recreates the original GPS signal and sends it to the computer so the mobile mapping software 'thinks' it is receiving a live signal. The mapping software shows the moving position of the airplane superimposed on a street map on the computer screen while the recorded infrared imagery of the area below the airplane is visible on the TV monitor. The GPS updates the airplane position once per second throughout the flight and at the same rate during the post-flight analysis.

To count the deer, I watch the entire tape, pausing and playing it backward and forward at regular speed and in slow motion, as necessary. Generally, for each hour of tape, three or more hours of analysis and reporting are required to complete the count. As I view the tape and note the deer, I mark each one as a dot on a computer version of the maps accompanying this report. When I have viewed the entire tape, I count the dots on the map to find the number of deer in the count area. If I note large domestic animals on the computer map, I mark them with a different color dot. In these counts, red dots denote deer, gray or yellow dots (if any) denote possible deer or other unknown animal similar in size to a deer but apparently not a deer and blue dots (if any) represent domestic animals such as cattle, sheep or horses. These animals are always much warmer and in the case of horses and cattle, substantially larger than any deer.

Deer usually appear as a fairly bright white dot or narrow line (similar to a grain of rice) in the infrared imagery. In this imagery, white and lighter shades of gray represents warmer objects while black and darker shades of gray are cooler. Other white (warmest in the scene) objects that are common are roads and pavement that retain latent heat from sunshine during the day, man hole covers, street lights, house lights, fires, furnace stacks on houses, car engines that are running or have run recently, groundwater seepages, puddles, ponds, streams, rivers and large rocks and

boulders in the woods. Other animals in the picture are often white or bright. Domestic animals are commonly very bright—hotter than deer, which have highly insulating coats.

In order to count deer with a high degree of confidence and accuracy, several factors have to be taken into account. Among them are deer infrared signatures, background infrared signatures, deer behavior and location. Questions I am commonly asked, and the answers I give, include the following:

Q. How do you know you are not counting the same deer twice?

Given:

- deer are not disturbed by a light plane flying more than a quarter of a mile above them,
 - deer often congregate in groups of two or more—up to 20 or more in extreme cases,
 - deer generally move very slowly as they graze, congregate or rest,
 - deer live and act according to generally well known behaviors,
 - I fly along a well-documented flight path with an ‘infrared view’ of a known area below the aircraft that is recorded on videotape.
- A.** With the help of the moving map program, I can place dots representing deer on a map in their respective positions and orientation to one another quite accurately, particularly when referring to the nearby streets, intersections, rivers and streams that may be in view or recently in view on the videotape. As I analyze the tape, becoming quite familiar with the ‘neighborhood’ of the count area (houses, roads, hills, streams, rivers, golf courses, trails, etc.) and place the dots on the map, I recognize specific deer and groups of deer as I pass them a second and sometimes third time. For example, I may see and place a group of three deer/dots in an equilateral triangle near a trail a few seconds after passing a particular road. In the case where I first saw them they may have been on the right side of my screen. When I fly the next adjacent run, thanks to overlapping imagery, they may appear on the extreme left side of the screen. Very often, they will be in the same spot or not far from it, in the same or similar ‘formation’ five, ten, fifteen or even thirty minutes later. If I fly along and see a lone deer in the forest, it will still be there in the same general area when I make adjacent passes. On occasion, I will fly over a group of deer in an area, and on subsequent passes, I will see an additional deer that I did not see earlier because it may have been out of the picture, too close to another deer (appearing larger than normal—but not counted as two) or it may have been obscured by a tree or foliage on the first pass. In those cases, I add the dot to the map. In uncommon cases where deer are moving quickly, I will look for them elsewhere in the direction they were originally seen moving. If I later see deer in the vicinity and cannot recognize them as the same group, I have to make a judgment whether to count them or not.

Q. How do you know what you are seeing and counting are deer and not some other animal?

Given:

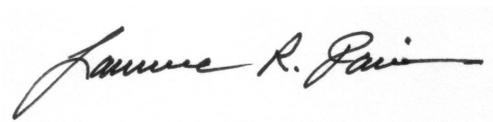
- there is usually a sizable quantity of deer in the area in which I am flying the deer count,
 - there are other wild and domestic animals in the same area, usually in smaller numbers,
 - deer don’t climb trees,
 - deer are somewhat ‘brazen’ in their occupation of human communities,
 - domesticated animals are often corralled, fenced in, densely grouped or tethered,
 - deer are notably larger than foxes, raccoons, skunks and many dogs and smaller than cows and horses,
 - deer have a variety of apparent temperature ranges/thermal signatures but are nearly always cooler than common domestic animals (dogs, horses, cattle, sheep),
 - skunks, raccoons, and foxes appear to have warmer apparent body temperatures than deer and often look like a bright pinpoint of light in the woods, whereas a deer is larger, usually cooler and with less distinguishable edge contrast with their surroundings (i.e., they look slightly ‘fuzzy’ around the edges).
 - deer congregate more and move less, and generally less rapidly, than smaller nocturnally active wild animals such as skunks, raccoons, coyotes and foxes.
- A.** Experience, practice and experiments with the Michigan Department of Natural Resources and others in counting and identifying a variety of captive animal types have given me high confidence in identifying deer in their normal forest, rural and suburban habitats. The deer that I

have difficulty identifying and counting are those that are partially hidden from view in ever-green vegetation or exhibit such a low apparent temperature (thermal signature) that I cannot see them or distinguish them sufficiently enough to identify them as deer, or even as animals. I do not count 'white dots or blobs' that I do not have a strong feeling are deer. This includes deer bedding areas in light snow cover that contain melted through areas to the ground that approximate deer thermal signatures. Close examination of most infrared deer count videotapes will reveal to the viewer quite a few animals in trees or on the ground that do not appear on the deer count map. These animals are most likely to be something other than deer. My deer counts are generally considered a minimum definite number, as opposed to a maximum. Some deer will go undetected in nearly every environment.

Q. How accurate is the count?

A. I don't know. I believe an average of 90% is in the ballpark, perhaps better, sometime worse. Conventional methods (deer-car collisions, spotlighting, pellet counts) are considered to be accurate within 30 to 40 percent—not a high number. In this method, we are looking at 100% of the area in question and under good conditions all active deer not hidden from view should be seen and counted with infrared.

Note: I will retain the digital videotape original of this deer count for at least one year.

A handwritten signature in black ink that reads "Larry R. Davis". The signature is written in a cursive style with a long, sweeping underline.

Larry Davis
Kent, Ohio