White – tailed Deer Population Survey
Delaware Division of Fish and Wildlife

Deer foraging around a home capture in infrared from 1,000 ft above ground level.

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August 17, 2009

The goal of the project was to conduct a population census within each of 17 zones to better manage white-tailed deer in Delaware. The purpose of the aerial infrared survey was to locate and map the group locations and enumerate deer found within each group within each of the 17 survey blocks established. Vision Air Research, Inc. was contracted to conduct the surveys by the DNREC Division of Fish and Wildlife. Survey flights were conducted February 23 – March 10, 2009.

Study Area

Data was collected in each of the 17 management zones (Figure 1). Study plots were defined as 8 mile by 2 mile plots which were efficient block configuration for aerial surveys. A single plot was placed within each of the 17 Deer and Turkey Management Zones by Department personnel (Figure 2). Plot placement was based on the range of habitat or vegetation cover types found within each management unit. The plot was placed to afford the plot with the same proportion of the range of cover types found within that zone.

Methods

Parallel transects were placed to run the long way within each rectangular plot. Transects were spaced 500 ft apart to provide complete coverage. The plot size and configuration allows for a plot to be completed within a single survey session to avoid the potential for over or under counting deer through movement.

Flight altitude was 1,000 ft. above ground level of the highest point along transect flown and the adjacent transect for flight safety. The sensor look angle was approximately 45 ^{o} elevation or down look angle. We have the ability to switch fields of view to zoom in and confirm objects as needed.

The portion of the flight within the study area was recorded on video. 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 start of transect. 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.

Duplicates or repeat groups were identified. Groups were mapped at their observed position not the position of the airplane. I performed an additional check of the data through sampling the videotape for detection verification, and checking for duplicate groups. The base layer for mapping was orthophoto quadrangles which provide vegetation cover type to assist in mapping group locations.

Figure 1. Delaware Deer and Turkey Management Zones. Source: DNREC Division of Fish and Wildlife.

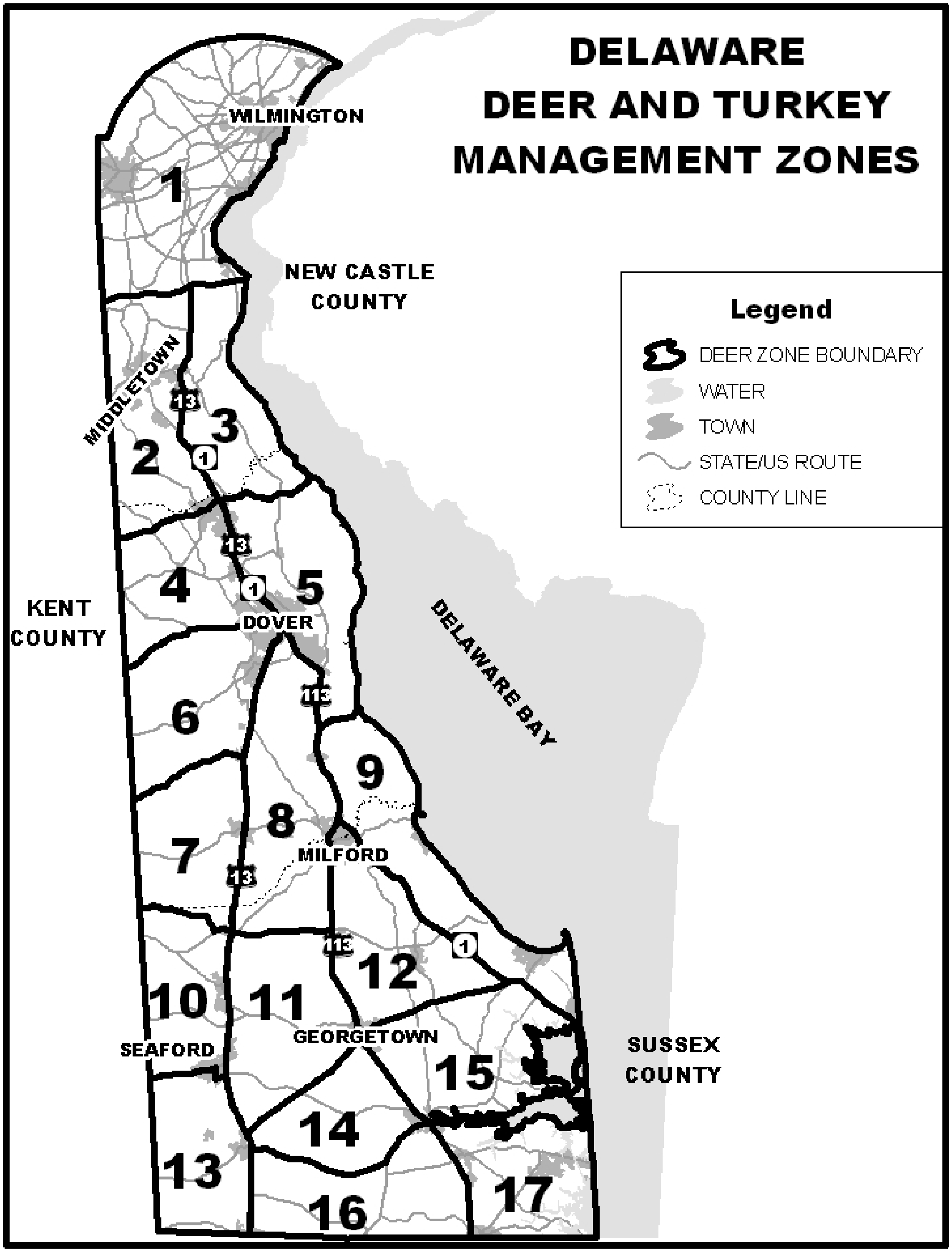
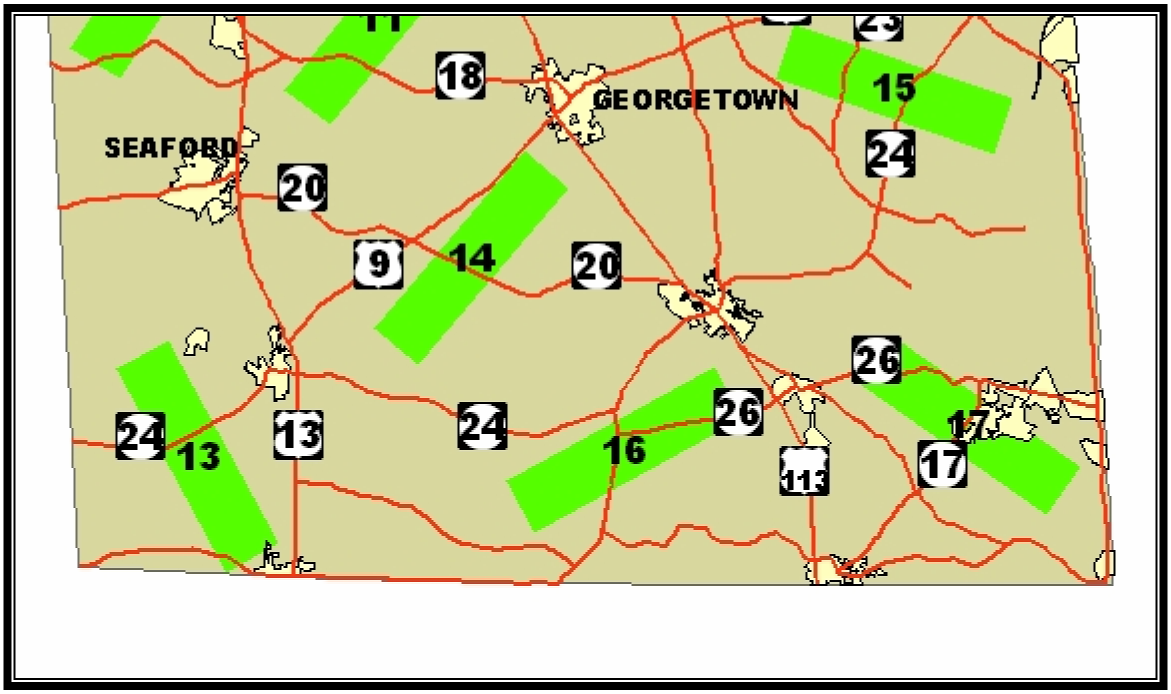


Figure 2. Example deer survey plot placement within deer management zones in southern Delaware. Placement depicted was used for the 2005 deer surveys. Source: DNREC Division of Fish and Wildlife.



Equipment

We used a PolyTech Kelvin 350 II (Sweden) mounted on the left wing of a Cessna 206 "Stationair" (Figure 3). The sensor gimbal allows 330 ^{o} of azimuth and 90 ^{o} 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 ^{o} C, which means it can detect objects with less than 1 ^{o} C different than the background. There are 2 fields of view (FOV): wide (20 ^{o}) and narrow (5 ^{o}). 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. Cessna 206 with Polytech Kelvin 350 II gimbal with infrared sensor mounted on the left wing is used for aerial infrared wildlife surveys.

Results

A total of 3,652 deer were detected in 1,208 groups (Table 1) for all 17 zone plots. Only deer within the blocks were counted. The number of groups found within each plot ranged from 40 groups in zone 15 to 142 in zone 14. Total numbers ranged from 61 deer in zone 5 to 608 deer in zone 14.

Discussion

The weather changed dramatically throughout the survey period. The survey commenced in with high temperatures in the 40s and lows in the 30s (Table 2). Temperatures dropped after two days when a nor'easter came through with high winds, snow and cold temperatures. Two weeks later temperatures were in 70s. As such, some blocks were surveyed in winter conditions with snow covering the ground, very cold night time temperatures, and conditions of spring green up in the agricultural lands. Block 6 was first surveyed on March 5th when night time temperatures were well below freezing and then again on March 9th when temperatures were in the 70s.

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 because more of the deer could be obscured by the tree branches. 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.

Table 1. Total groups and deer observed during the FLIR Deer Survey in February – March 2009 within each deer management zone. Survey date for the block is noted for block 6 since this block was surveyed twice.

Deer Management Zone	**Total Groups**	**Total Deer**
1	54	153
2	88	299
3	51	133
4	62	100
5	36	61
6 March 5	53	121
6 March 9	52	168
7	137	322
8	64	215
9	43	141
10	93	406
11	58	98
12	44	67
13	78	250
14	142	608
15	40	120
16	101	323
17	64	236

Table 2. Archived temperature (^{o} F) data for the survey periods per the National Oceanic and Atmospheric Administration (http://www.hpc.ncep.noaa.gov/dailywxmap/) for Dover, DE.

Date	High	Low
22-Feb	43	30
23-Feb	40	27
24-Feb	38	19
25-Feb	38	11
26-Feb	49	19
27-Feb	59	47
28-Feb	67	42
1-Mar	57	34
2-Mar	37	29
3-Mar	32	11
4-Mar	23	1
5-Mar	33	12
6-Mar	49	42
7-Mar	65	47
8-Mar	74	60
9-Mar	78	69
10-Mar	73	32
11-Mar	46	32

The meteorological conditions were good for flight safety and infrared surveys. On days when conditions were not conductive to good data collection such as rain or snow we did not fly. Each survey block was conducted under different weather and environmental conditions however all were within the range of allowing animal detection.

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 in variables which influence detection. The primary variable which influenced detection was vegetation cover type. Infrared can not 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

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, rocks, puddles). Solar gain or sunlight can effectively bounce off objects confounding good survey results.