Infrared Aerial Deer Survey 2005
Final Report

Purpose:

The mission of the Bureau of Forestry is to ensure the long-term health, viability, and productivity of the Commonwealth's forests and to conserve native wild plants. Deer overbrowsing has been documented as threatening the Bureau's ability to meet this mission. In addition to other management tools, to accomplish this mission the Bureau uses the Deer Management Assistance program focusing hunter pressure on specific areas where deer overbrowsing is occurring. DMAP provides feedback to the landowner in the form of mandatory hunter reporting of harvest success, which is helpful in decision-making in land management and in administration of the program. Harvest reporting does not provide information, however, on the number of deer remaining following hunting, or on the impact of that local herd on the habitat of the forest.

DCNR decided to use Forward Looking InfraRed Surveys (FLIR) to provide an additional feedback mechanism on the effectiveness of the DMAP program on a trial basis. The decision to harvest additional deer in a particular location must be based on the impact of those deer on the habitat, but the decision on how many permits to allocate is more directly related to the number of deer available. FLIR, upon initial examination, promised to be a relatively cost effective method of providing reasonably accurate deer counts for landscape-scale areas. Other methods examined for localized deer population census included deer pellet group surveys, mark-resighting surveys, visual observations (aerial or land-based), and baited remotely-triggered camera surveys. All these other methods were either overly labor-intensive or inaccurate for our purposes on this scale. FLIR also promised to produce the most defensible deer number estimates (video images of all deer reported); this was an important consideration following a hunting season where hunter discontent and mistrust of resource management agency decisions was high.

Another goal of the surveys was to verify reports by hunters, agency staff, and others of local deer herd conditions. Many hunters reported seeing few or no deer during the hunting season, and agency staff, in some areas, was reporting positive progress in reduction of deer browsing.

The final goal of the project was to assess the technique's potential for future broader use in Pennsylvania, either for complete census or sampling of larger areas. By conducting complete census (100% coverage) of the survey areas, it is possible to assess the precision of the technique using a sampling scheme where transects would be flown at a lower frequency to increase cost- and time-effectiveness, enabling larger areas to be surveyed. This would make it possible to potentially survey all of the State Forests or entire Game Commission Wildlife Management Units.

The results of this survey were intended to be analyzed along with other deer and habitat information, including DMAP harvests, regular antlerless license deer harvests, deer browsing survey results, and other habitat measures.

Scope:

The 2005 deer survey was in many ways a pilot project, to test the effectiveness and applicability of FLIR technology, to develop the mechanism for subsequent use of this technology, and to calibrate other field techniques for assessing deer populations. It was decided that the Department would commit $150,000 to this initial effort. At a rate of approximately $ .50 per acre, this equated to about 300,000 acres.

Methods:

Contractor and Specifications:

The Department contacted other agencies and landowners that used FLIR in the past to seek recommendations on which contractor to use. Criteria included quality, expertise, years of experience, cost-effectiveness, and ability to survey on this scale. Vision Air Research of Idaho was selected for this pilot project, based on the above criteria. They have the most expertise and experience on aerial infrared surveys for wildlife, and use techniques that produce the highest quality results. It was determined that fixed-wing aircraft produce better results than helicopters (less disturbance to wildlife, less vibration produces higher quality imagery, and more cost-effective). The sensor is a gamble-type unit which is mounted to the underside of the aircraft with gyro stabilizers and the ability to pan (Figure 1). The best time to conduct the surveys is after midnight through early daylight hours, when the thermal emissions from the vegetation and substrate are at their lowest, producing the greatest contrast between the subjects (deer) and the background.

Results are considered minimum estimates, since some deer are not detectable when obscured by overhead vegetation. The detection rates have been reported as approaching 100% in open habitats, 70-90% in hardwood forests, and 30-50% under an evergreen canopy.

Selection of Survey Areas:

Areas were selected for survey that met one or more of three criteria:

1) They were included in the DMAP program;
2) They were study areas for the Game Commission's Doe Mortality Study;
3) They were areas where hunters reported seeing few deer.

Generally, these areas were large enough to represent a local population of deer (several thousand acres on up), where the majority of the deer surveyed were likely to spend the majority of their seasonal movements within the survey area. Most often these areas represented the most severely overbrowsed habitats within the State Forests, or areas where we expected deer densities would be at their lowest within the system - a worst-case scenario for seeing deer, but a possible most-likely scenario to detect initial forest recovery responses in subsequent habitat monitoring efforts.

Eleven areas were selected initially, with one expanded and another added later, bringing the total survey contract to12 areas encompassing 311,134 acres (Figure 2, Table 1).

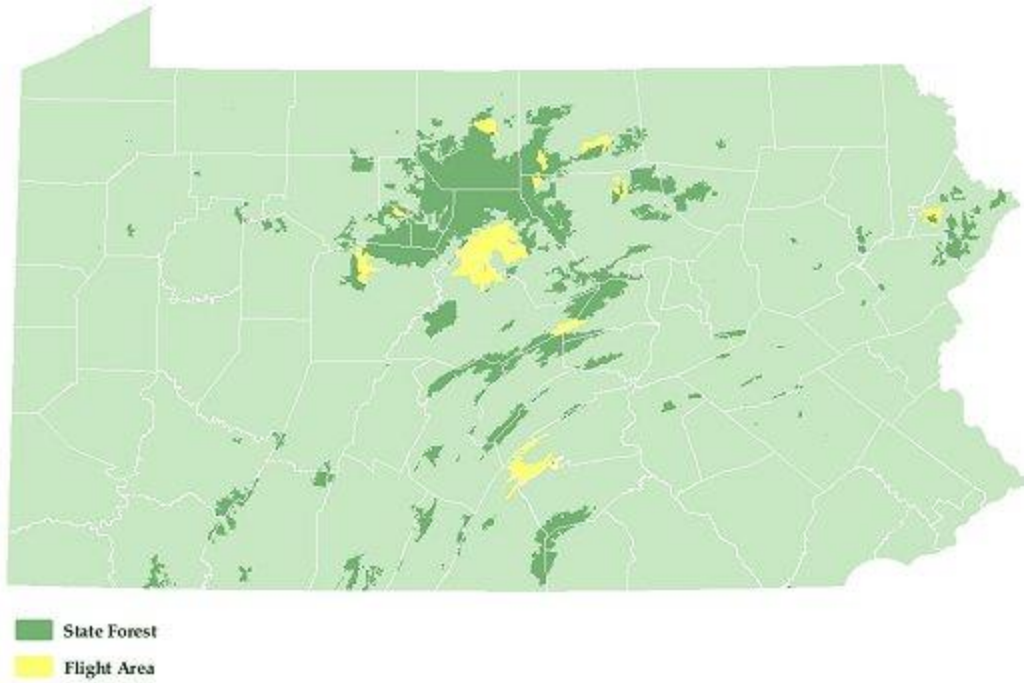

Figure 2 - 2005 FLIR Survey Areas on Pennsylvania State Forests

District	Acreage	Description	WMU	County		
10	140,542	Southern Sproul FRA	2G	Clinton	Centre	
3	54,747	Tuscarora South Block FRA	4B	Perry	Franklin	Cumberland
15	13,987	Denton Hill	2G	Potter		
7	13,969	Bald Eagle	4D	Union	Centre	
19	15,005	Promised Land	3D	Pike		
16	14,710	Arnot	2G	Tioga		
16	6,908	Cedar Run	2G	Tioga		
13	4,028	Hicks Run	2G	Elk		
9	18,605	Moshannon	2G	Clearfield		
12	4,991	Algerine Wild Area	2G	Lycoming		
12	12,614	McIntyre Wild Area to Devils Elbow	3B	Lycoming		
5	11,028	Trough Creek	4A	Huntingdon		
total	311,134					

Table 1 - 2005 FLIR Survey Areas on Pennsylvania State Forests

Data Collection and Analysis:

Shapefiles of the survey areas were sent to the contractor, who planned out flight transects depending on the shape of the tract, the local topography, and wind speed and direction. The air crew consisted of the pilot who flew the aircraft and navigated using GPS and Visual Flight Rules (VFR), and the researcher, who controlled the detector and operated the recording hardware and software. The aircraft was flown at 1000 feet above ground level. The detector at 1000 feet has approximately a 400 foot field of view. Imagery from the sensor was recorded on miniDV (Digital Video) tapes that were brought back for analysis. Raw data was analyzed by a trained observer watching reviewing the video footage (sample imagery in Figure 3), locating

groups of deer, determining group number, recording the GPS location of the image, and mapping the data into a GIS (Geographic Information System) shapefile. The locations were further analyzed to detect possible double counts of individual groups of deer where flight transects overlapped. A final, clean shapefile was sent to the Bureau of Forestry for density analysis and overlay onto other GIS coverages.

Figure 3. Sample image of deer recorded on miniDV using FLIR technology

The flights were initiated February 13, 2005, and completed by April 11, 2005. The onset of spring brought leafout conditions that prevented further surveys beyond April 11, 2005. The leaves block detection of the thermal energy, reducing the detection rates and reducing the accuracy and precision of the technique. Throughout the survey period, flights were delayed when weather conditions either created unsafe flight conditions or reduced the detection rates of wildlife. Such conditions included strong wind or precipitation (rain, sleet, snow), or heavy fog. One of the contracted areas was not flown entirely, the Sproul State Forest area, and two areas were not surveyed at all, the Moshannon State Forest and Tuscarora State Forest survey areas. Following survey flights, Vision Air Research interpreted the raw video footage and mapped the data, which was sent to the Bureau of Forestry in final form on June 15, 2005. These data were then added to the Bureau of Forestry's Geographic Information System and analyzed to calculate deer densities and perform other spatial analyses.

Results & Discussion:

This deer survey was designed to assess deer populations on individual areas, so the results will be discussed by area. It is important to note that deer were not distributed uniformly among or within areas, and the results between areas varied greatly, even when the areas represented similar habitats (forest interior) within the same Wildlife Management Unit. The results will be discussed in this report in order the surveys were completed.

Browsing surveys were conducted on the FLIR survey areas to measure the overwinter impacts of the deer seen on the areas, and to quantify the long-term impacts of browsing on the areas, as well. Those data will allow DCNR to determine whether or not the deer density observed is low enough to allow regeneration or if it remains excessive. The browsing surveys were conducted on six-foot radius plots at an intensity of one plot per square mile (640 acres). The woody species diversity recorded on the plots will provide quantitative information about the browsing history of the site (long-term impact), and the species preferences compared to the level of browsing observed will provide a current-year browsing indicator. These two indices, in light of the observed local deer densities, are being used in deer management decision-making by DCNR.

Research is underway to measure seasonal movements and distribution of deer, which will provide answers to questions like how representative these overwinter surveys are of deer movements throughout other seasons, especially hunting season. The Game Commission's Doe Study is using intensive radio-tracking to measure seasonal movements and causes of mortality of female deer. Site-specific deer management techniques will be tested for effectiveness, including different hunting regimes.

Other research is being planned to intensively measure the browsing impacts of deer on forested habitats, in conjunction with the Doe Study. This Forest Restoration research will seek to identify thresholds in the local deer population that allow regeneration to occur, what plant species are good indicators of regeneration, how long the population must remain low to allow sustainable recovery, what order of browsing preference deer exhibit by plant species, and answer other questions. The ultimate focus of Forest Restoration research is to provide the basis of knowledge necessary for managers to balance local deer numbers with the habitat conditions to allow a sustainable forest.

Summary:

Observations of deer using FLIR imagery appear to be a useful technique in determining a minimum count of deer on a site-specific basis in Pennsylvania's forests. The numbers indicate that FLIR surveys provide a lower count than the estimates generated by pellet group surveys, but have not been compared to other measures of localized deer populations.

FLIR surveys provide useful information for deer and forest management decision making, but are not as useful without the contextual information of habitat condition and hunter harvest pressure.

It is possible this technique will be useful in providing estimates of deer populations across larger areas through sampling rather than complete census, and become a more cost-effective tool in this way. Further analysis of these results is necessary to evaluate this, and develop an optimal sampling scheme.

Finally, deer densities have been demonstrated through these surveys to vary greatly on a local, regional, and statewide basis (Table 2), and local monitoring of the deer, the hunter success rates, and the habitat are important to most effectively use management tools like the DMAP program.

District	Description	PGC WMU	County		Date completed	Acres Flown	Deer/Sq Mile
10	Southern Sproul FRA	2G	Clinton	Centre	4/11/2005	105,345	8.63
15	Denton Hill	2G	Potter		2/23/2005	13,987	20.29
7	Paddy Mountain	4D	Union	Centre	3/22/2005	13,398	14.89
19	Promised Land	3D	Pike		2/13/2005	15,005	23.69
16	Arnot	2G	Tioga		2/25/2005	19,652	10.91
16	Cedar Run	2G	Tioga		2/26/2005	6,908	9.64
13	Hicks Run	2G	Elk		4/14/2005	4,028	12.2
12	Algerine Wild Area	2G	Lycoming		2/26/2005	4,991	13.97
12	McIntyre Wild Area to Devils Elbow	3B	Lycoming		2/27/2005	12,614	18.21
5	Trough Creek	4A	Huntingdon		4/9/2005	11,028	11.20
total						207,527	

Table 2. 2005 FLIR Survey Results on Pennsylvania State Forests.