Martha's Vineyard Deer Survey

Executive Summary

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Martha's Vineyard Deer Survey Summary Statistics

Total FLIR images recorded:	32676
Total color images recorded	8572
Total area of Island habitat (excluding Chappiquiddick)	82.6 $miles^2$
Total area of survey blocks:	17.2 $miles^2$
Total Island habitat surveyed	20.2%
Total deer identified in survey	333
Total unidentified emissions thought to be deer	41
Total farm animals and horses	60
Estimate of deer Island-wide (minimum)	1665
Estimate of deer Island-wide (minimum, conifer-corrected)	1953
Estimate of deer Island-wide (maximum)	1870
Estimate of deer Island-wide (maximum, conifer-corrected)	2157
Estimate of deer Island-wide (maximum, conifer-corrected at 2x the background rate)	2446
Estimate of deer Island-wide (maximum, conifer-corrected at 2.5 x the background rate)	2590
Estimate of deer Island-wide (maximum, conifer-corrected at 3x the background rate)	2734

Total canopy corrected deer density for all survey blocks (maximum):

33.0 per $mile^2$

Total canopy corrected deer density for all survey blocks (minimum):

23.6 per $mile^2$

* Total omission/commission error estimate +/- 11.0%

Survey Methodology

The main Island of Martha's Vineyard was flown on January 31, 2014 with the AIMS-Thermal aerial imaging system (Millette et al, 2011) for the purposes of estimating local deer *(Odocoileus virginianus*) population.

Survey Flights

The study area was sampled using a total of 56 flight line survey units (SU) distributed relatively evenly across the census area (Fig. 1). Each SU was laid out systematically in ArcMap to cover approximately 20% of the Island excluding Chappaquiddick and include all land cover types except for water surfaces. Total linear distance of the SUs was 206 miles.

Survey units were flown from a nominal altitude of 1000 ft. agl, with a nominal horizontal image swath of 306 ft. and a nominal vertical image swath of 282 ft., or 4.0 acres per image. Nominal instantaneous field of view (IFOV) of thermal images at 1000ft agl is 7.9 inches , while nominal IFOV for natural color images is 0 .68 inches. Airspeed of the aircraft was nominally 90 miles/hr and frame rates of the thermal and color cameras were set to 500% and 30% overlap along the flight line respectively. The 500% overlap on the thermal imagery was done to preserve the opportunity to conduct double counts on moose and deer observations should they be deemed necessary, and to provide a detailed imagery database from which to analyze false-positive heat signatures in future research.

The AIMS-T system was deployed January 31, 2014 and the entire study area was covered in a single flight flown between 0716 and 1509h. This flight resulted in a total of 32,676 thermal images and 8572 high-resolution color images recorded with 80% snow cover, and a variety of sky illumination conditions ranging from moderate overcast to broken sunshine. Mean temperature was 36^0 Fahrenheit and winds were 10mph from the west-south-west.

Imagery Analysis

Image analysis was done with visual interpretation by the report author. The analysis process involved scrolling through thermal images along each flight line looking for heat signatures. When candidate signatures were detected, the color photo center shapefile in the GIS was used to open the corresponding high resolution color photo which was then used to identify the actual source of heat. The distribution of deer observations across the Island illustrated in Fig. 2 indicate that they are spatially well-dispersed across the Island and show clear evidence of spatial clustering in some areas. Examples of a portion of a thermal and corresponding color photo for a typical heat signature are in *Fig. 3.* Note that the radiometric resolution of the thermal image suggests two hot targets, but that the spatial resolution is not adequate to identify the particular feature emitting the heat. Looking at the corresponding color image, it becomes obvious that the heat sources are three deer.

Images verified to contain deer had the thermal imagery attribute table in the GIS database updated to reflect the number of individuals at each observation location. In locations where heat signatures were conspicuous, but the color image was obscured due to vegetation, the observation was attributed as "unidentified" in the GIS attribute table. Although attributed as unidentified, in most cases it is reasonable to assume that these obscured signatures are in fact likely to be deer given the strength of their emittance and the lack of any plausible explanation for the thermal return. Having the census animal locations included in the GIS database offers the potential for ecological assessments of deer population and habitat characteristics such as forest cover, vegetation community and land use.

Density Calculations

Density calculations for the Martha's Vineyard deer population were done by a three step process that included identifying deer in the aerial imagery, estimating the potential number of deer that were hidden by conifer canopy, and by estimating errors of omission and commission in the imagery analysis.

Imagery analysis for the 20.2% sample of the Island covered by the flight identified a total of 333 deer with an additional 41 heat signatures being attributed as unidentified due to vegetation obstruction or image quality in the color photos. Since there is a significant amount of closed conifer canopy on the main Island and because deer were not identified in these stands in adequate numbers by the thermal camera, we were unable to use the locally developed conifer correction factor developed by Kilpatrick et al. (2001). This correction factor doubles the number of deer seen in conifers from an aerial survey based on experiments done with radio collared deer in an enclosed conifer stand in Connecticut.

To estimate the number of deer that was likely hidden in conifers and thick shrub we used a combination of Mass GIS data layers of vegetation communities, Mass GIS Orthophography, and AIMS-imagery from the survey flights to estimate the total amount of canopy (15.4% of the Island) that could potentially obscure deer from the thermal/color imaging systems. Subsequently we calculated Island wide density using three hypothetical conifer density rates and adding them to the density in the non-conifer areas of the study area. The three rates were conifer density at 2.0 times the background rate, 2.5 times the background rate, and at 3.0 times the background rate. The rationale for these rates are they provide a useful range of estimates which are based on a combination of the spatial pattern of deer observations seen in the imagery, a general understanding of winter behavior of New England deer.

The background deer density calculated from imagery for non-conifer areas was 21.7 per sq. mile. Estimating that deer occupied conifer stands (which represent 15.4% of the study area) at double the background rate results in overall density climbing to 30.3. Raising the conifer rate to 2.5 times the background rate results in an overall density of 32.0 deer per sq. mile. Tripling the conifer occupancy rate results in an overall density of 33.1 deer per sq. mile.

It was not possible to do a traditional estimate of errors of omission (deer missed by the imagery analyst) and commission (heat signatures identified as deer, but in fact were something other than deer) since there is no independent data source to verify our analysis. In an attempt to put some error range on our estimates we did the following: To estimate the error of omission we opened 654 (2% of all images and approximately 10% of the area imaged) random thermal images throughout the study area to see if any heat signatures that resulted in a deer identification had been missed and we found none. To create a substitute for a proper error of commission we used the observations attributed as unidentified to estimate the worst-case scenario that all unidentified observations were in fact not deer. In this case the 41 unidentified observations of the total pool of 374 leads to a commission error estimate of 11.0%.

The minimum density calculation for Martha's Vineyard was calculated as follows:

Density = (D+U+C)/(A) where D = deer observations, U = unidentified observations thought to be deer, C= canopy correction value, A=area sampled or (1665+0+288)/(82.6) = 23.6 deer per square mile.

The maximum density calculation for Martha's Vineyard was calculated as follows:

Density = (D+U+C)/A where D = deer observations, U = unidentified observations thought to be deer, C= canopy correction value at three times the non-conifer rate and A=area sampled or (1665+205+864)/82.6 = 33.1 deer per square mile.

Comparison to 2013 Survey

Overall the results of the 2014 survey were comparable to those of the 2013 survey to a remarkable degree. The 2013 survey covered 24% of the Island while the 2014 survey covered 20.1% of the island excluding Chappaquiddick. The total number of deer identified in 2013 was 315 while the total number of unidentified heat signatures thought to be deer was 63, making the total number of heat signatures 378 (Millette, 2013). These numbers for the 2014 survey were 333 and 41 respectively totaling 374 heat signatures, indicating that the increased number of deer identified in 2014 had a commensurate drop in the number of unidentified heat signatures. We believe these totals shifting categories is due to a new color camera that was integrated in to the AIMS-Thermal instrument that increased the spatial resolution of the color imagery by 58%.

It should be noted that despite the strikingly similar number of targets identified in both surveys, the density estimates are much lower for the 2014 survey (minimum density of 23.3 deer per mile^2 and maximum density of 33 deer per mile^2) compared to 2013 (minimum density of 39.7 deer per mile^2 and maximum density of 54.3 deer per mile^2). After checking the density calculations for the 2014 data several times and finding no discrepancies, we rechecked the calculations for the 2013 survey and found an error in one of the values used to scale data from the 24% survey to the total Island estimates which inflated the density numbers considerably. After eliminating the error in the model and recalculating the data from 2013 the deer density estimates for 2013 are as follows: Minimum density estimate for canopy-corrected at the background rate was 20.6 deer per mile^2, while the maximum density estimate for canopy-corrected at three times the background rate is 29.6 deer per mile^2.

Qualifications

We caution that the density estimates should be seen as a useful range rather than absolute numbers. These estimates may be vulnerable to errors in estimating the number of deer contained in conifer stands and the ad hoc methodology for estimating errors of commission.

Deer Observations Martha's Vineyard
February, 2014

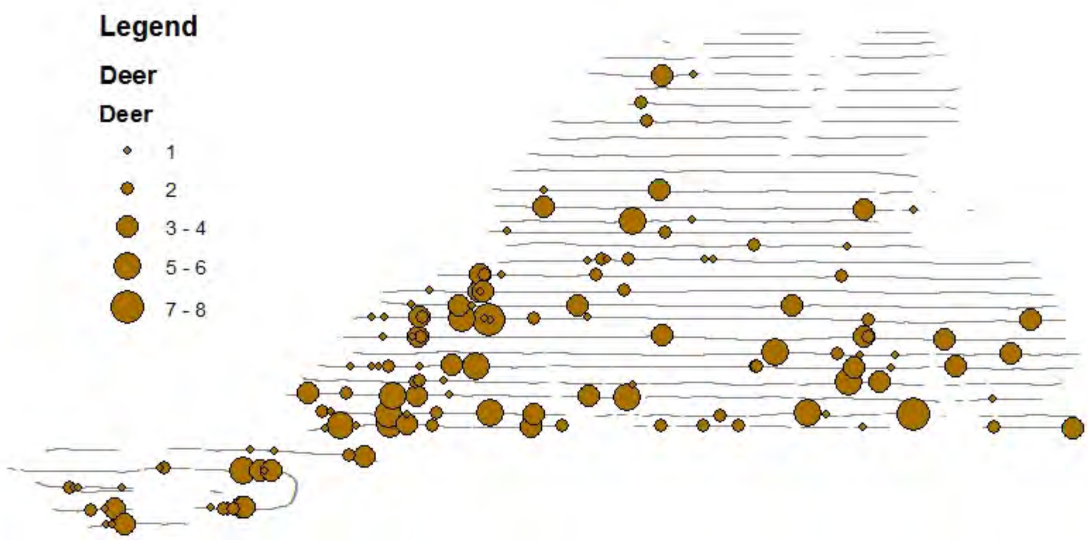

Fig. 1 Distribution of deer by flight line survey unit

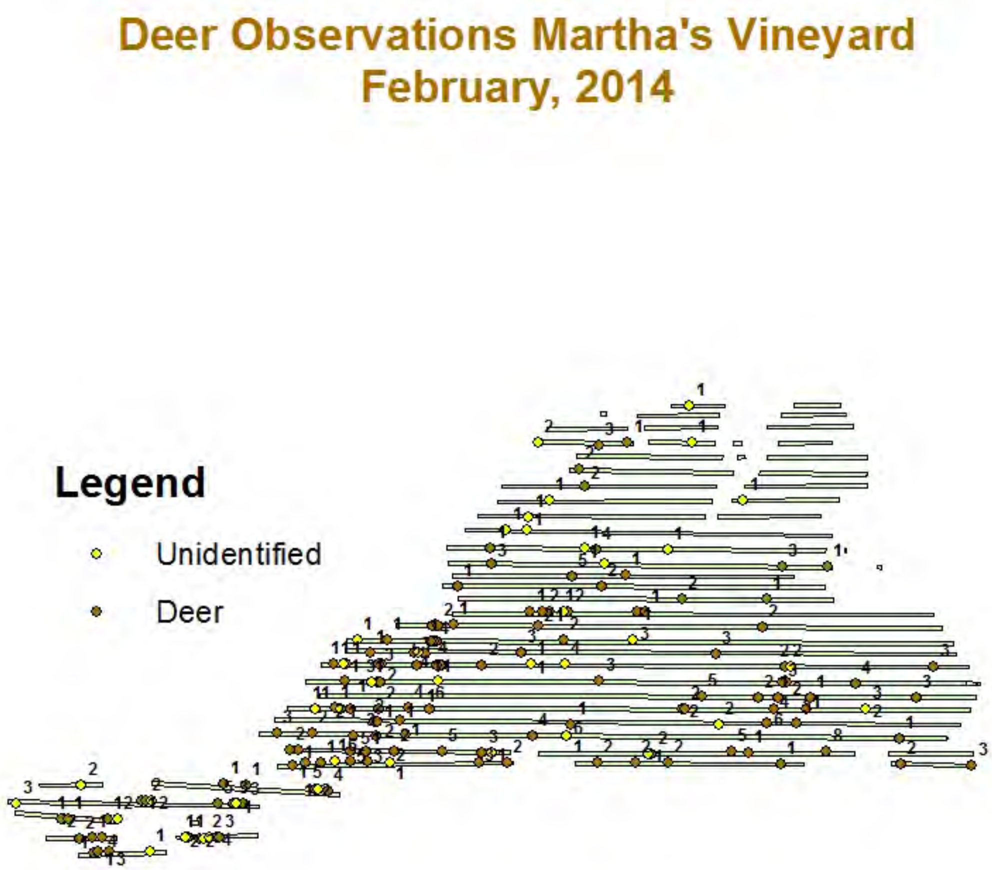

Fig. 2 - Deer counts by flight line survey unit

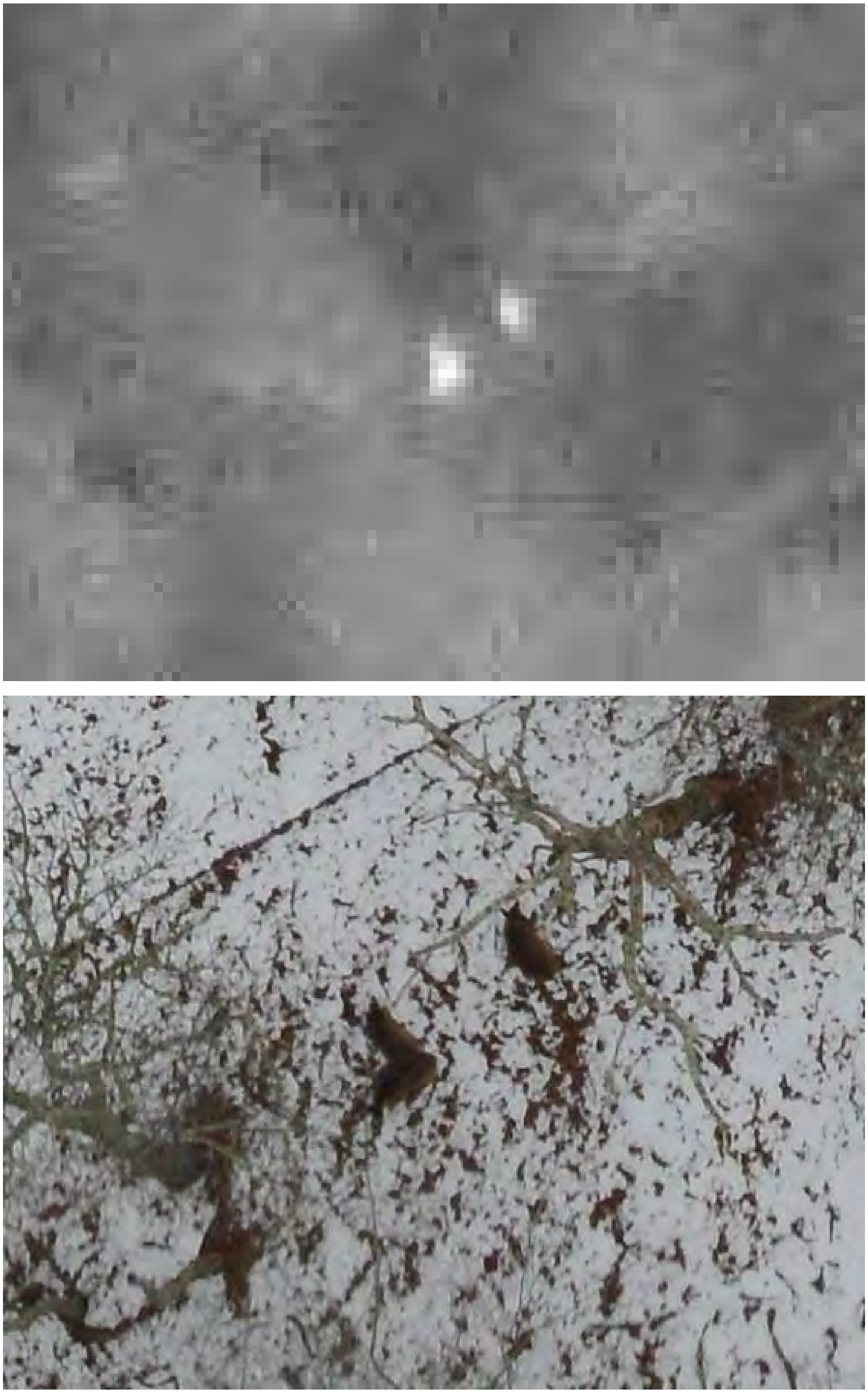

Fig. 3 Typical example of FLIR and matching color image from 2014 survey. Note three deer in lower color image

Martha’s Vineyard Survey Imagery Metadata

Contents of data drive:

1. Root folder of the data drive contains the project folder **2014-01-31** which contains 2 folders with raw imagery (**2014-01-31_Natural-Color** for color images and **2014-01-31_Flir** for thermal images).

2. Two shapefiles that contain the photo and deer locations for all images (**2014_color** for color and **2014_Flir** for thermal images).

3. One ArcMap MXD document (**MVY_2014_survey**) with hyperlinks that will allow you to explore the imagery and deer locations.

4. One image viewing utility (**i_view32**) that will display images from the hyperlink tool in ArcGIS.

Bibliography

Kilpatrick, H., S. Spohr, and K. Lima. 2001.Effects of population reduction on home ranges of female white-tailed deer at high densities. *Can. J. Zool.* 79:949-954.

Millette, T.L., D. Slaymaker, E. Marcano, C. Alexander and L. Richardson. 2011. Aims-Thermal a thermal and high-resolution color camera system integrated with GIS for aerial moose and deer census in northeastern Vermont. *Alces*. 47:27-37.

Millette, T.L. Martha's Vineyard Deer Survey; Executive Summary 2013. unpublished report to the Martha's Vineyard Tick-Borne Illness Initiative, Edgartown, MA.