The Connecticut Agricultural Experiment Station

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Putting Science to Work for Society
Protecting Agriculture, Public Health, and the Environment

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Subject: Redding, CT Aerial Infrared (IR) Deer Survey Results

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On 15 January 2015, to satisfy the terms of its Volunteer Authorization (#1315006b) with the Connecticut Department of Energy and Environmental Protection, The Connecticut Agricultural Experiment Station's subcontractor Davis Aviation conducted an intensive IR survey over the four 1-square mile research areas that are a part of the Centers for Disease Control-funded Integrated Tick Management study in Redding, CT. Numbers reported here are raw numbers with no correction factor; it can be assumed that these numbers represent a minimum density and that anecdotal evidence suggests that an IR survey of this nature has a 90%+ detection rate.

- White Birch research area: 50 confirmed, 3 possible. Area surveyed = 2.12 square miles. Minimum density = 24 - 25 deer/square mile.

- Pheasant Ridge research area: 76 confirmed, 4 possible. Area surveyed = 2.46 square miles. Minimum density = 31 - 33 deer/square mile.

- Drummer Lane research area: 35 confirmed, 2 possible. Area surveyed = 1.0 square miles. Minimum density = 35 - 37 deer/square mile.

- Blueberry Hill research area: 29 confirmed, 1 possible. Area surveyed = 1.0 square miles. Minimum density = 29 - 30 deer/square mile.

- Total = 190 confirmed, 10 possible. Total area surveyed = 6.58 square miles. Minimum density = 29 - 30 deer/square mile.

Because of scheduling for another aspect of the project, whole corn piles had been placed within and around the White Birch and Pheasant Ridge research areas at the time of the flight, which had the potential to draw deer in from outside research boundaries. As a result, we searched an additional 1500 feet either side at Pheasant Ridge (total search area of 8,280' x 8,280') and an additional 1200 feet at White Birch (7,680' x 7,680') which more than doubled our search areas and should have negated the impact of baiting. Additional area outside research boundaries were searched at Drummer and Blueberry Hill as well, but were not included in density calculations as deer were not manipulated with bait as a part of this study on these sites. This survey technique is similar to and might be easily confused with forward-looking infrared (FLIR), but the camera in this survey technique was in the belly of the aircraft oriented straight down resulting in excellent detection of deer on the ground in forested landscapes.

Aerial Infrared Deer Count Report

Connecticut Agricultural Experiment Station

New Haven, CT

Redding, CT Area Deer Counts

30 January 2015

Four one-square-mile plots were the subjects of an aerial infrared (IR) deer count flight on the night of 15 January 2015. The IR imaging conditions were good during the flight. Additional details can be found in the analysis notes below.

This report package includes this written report, DVD+R discs containing video of the raw infrared imagery of the count areas, map printouts of the deer count and dispersion within and near the count area and a copy of the maps in *.jpeg* format on CD-ROM. Deer and possible deer are noted on the map by dots of different colors. Deer are red and possible deer are gray. A possible deer is defined as an animal that is thought to be a deer but whose infrared signature is somewhat weak or otherwise difficult to plainly distinguish it as a deer. The dots representing animals cover an area approximately 60 feet in diameter on the maps so they can be seen and printed easily.

Results:

LOCATION	Acres	DEER Inside/Possible // Outside/Possible
Pheasant	640	47 / 4 // 29 / 0
Whitebirch	640	44 / 1 // 6 / 2
Drummer	640	35 / 2 // 19 / 4
Blueberry	640	29 / 1 // 5 / 0

Analysis Notes

Redding, CT deer count areas Pheasant, Whitebirch, Drummer & Blueberry 1/15/2015
The aerial infrared imaging flight for these 1 mile squared areas was conducted between 2020 and 315, 15 January 2015. Imaging conditions were good and I estimate the accuracy of the count to be 90% or better. Small animals were visible in the imagery on the ground and in trees in the count area. Surface winds were initially light (four knots) from the south-southwest, later becoming calm. At the imaging altitude of 1500 above ground level, the winds were from the northwest at five to ten knots with generally smooth flight conditions, with occasional light turbulence. The ground was free of snow and the temperature was minus six to minus nine Celsius. The sky was clear.

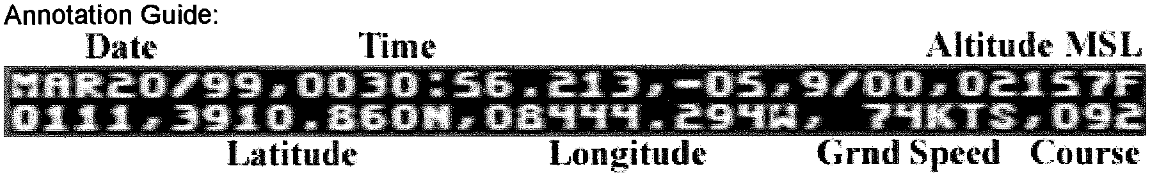
Mapping:
If the deer count number and dispersion information is destined for a Geographic Information System (GIS) and AutoCAD files have not been provided, my recommended method of transferring the data into the GIS is to import the map image file and overlay/register it on an existing map of the park. Use an input device (mouse, pen, etc.) to rapidly note the location of each dear count 'dot' as a new data point. Once these data are entered as a new layer, the imported map can be discarded from GIS, leaving the new 'deer count' layer to be incorporated with other GIS data and maps. If AutoCAD .dwg or .dxf files have been provided, one of these formats should be directly transferable into the GIS system so the 'deer points' can be placed into any desired map type produced by the GIS operator.

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 alpha-numeric 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 and laying out the flight lines is DeLorme's GPS Link II and MapExpert version 2.0.

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:



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 375 feet wide on the ground surface. Flight lines are spaced an average of 325 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 evergreen 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 for very good and excellent conditions, 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 original digital video tape of this deer count for at least one year.

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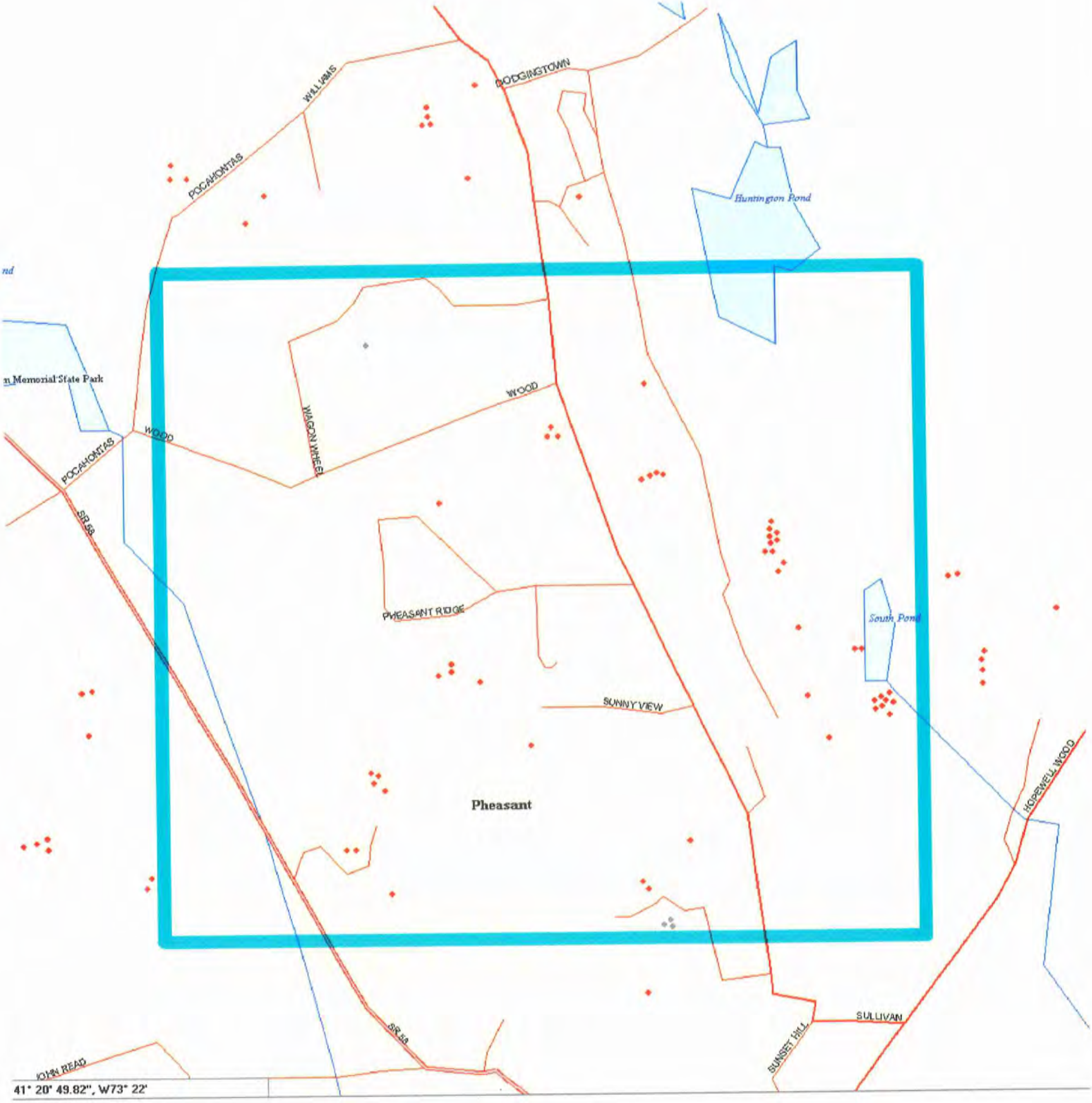

DODGINGTOWN
WILLIAMS
POCAHONTAS
Huntington Pond
nd
Memorial State Park
WOOD
WAGON WHEEL
WOOD
POCAHONTAS
SR 58
PHEASANT RIDGE
South Pond
SUNNY VIEW
Pheasant
HOPEWELL WOOD
SULLIVAN
SUNSET HILL
SR 58
JOHN READ
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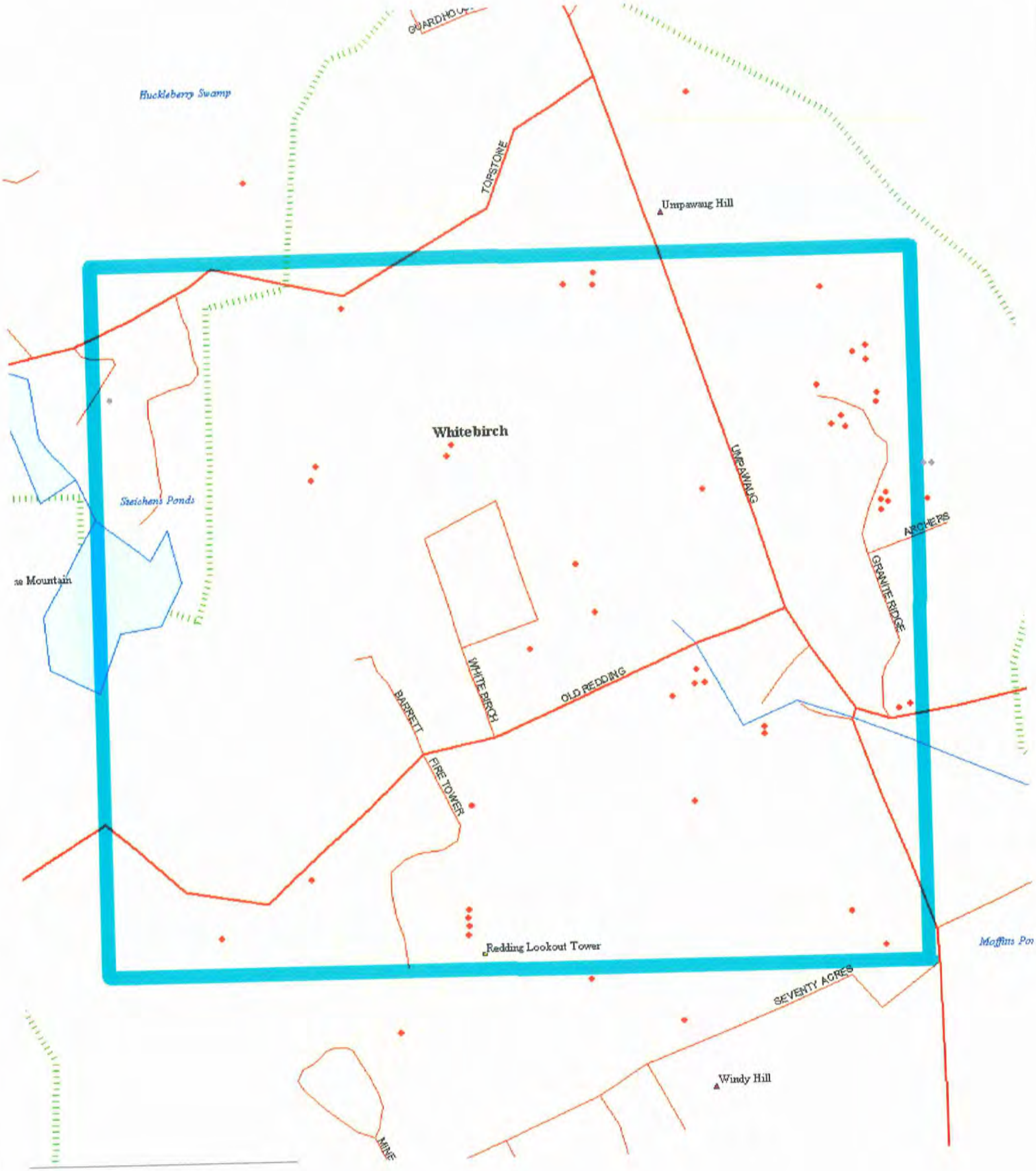
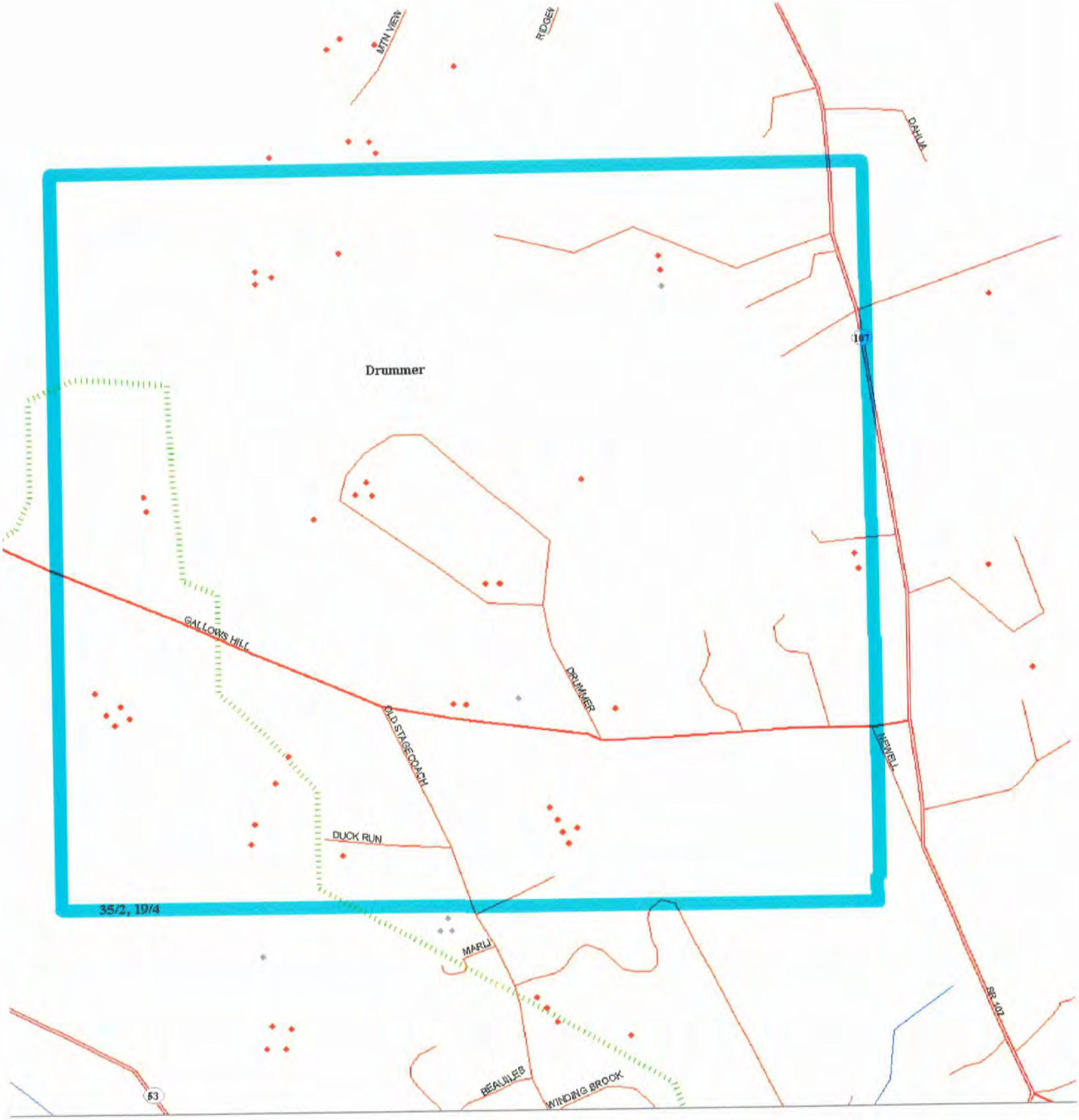
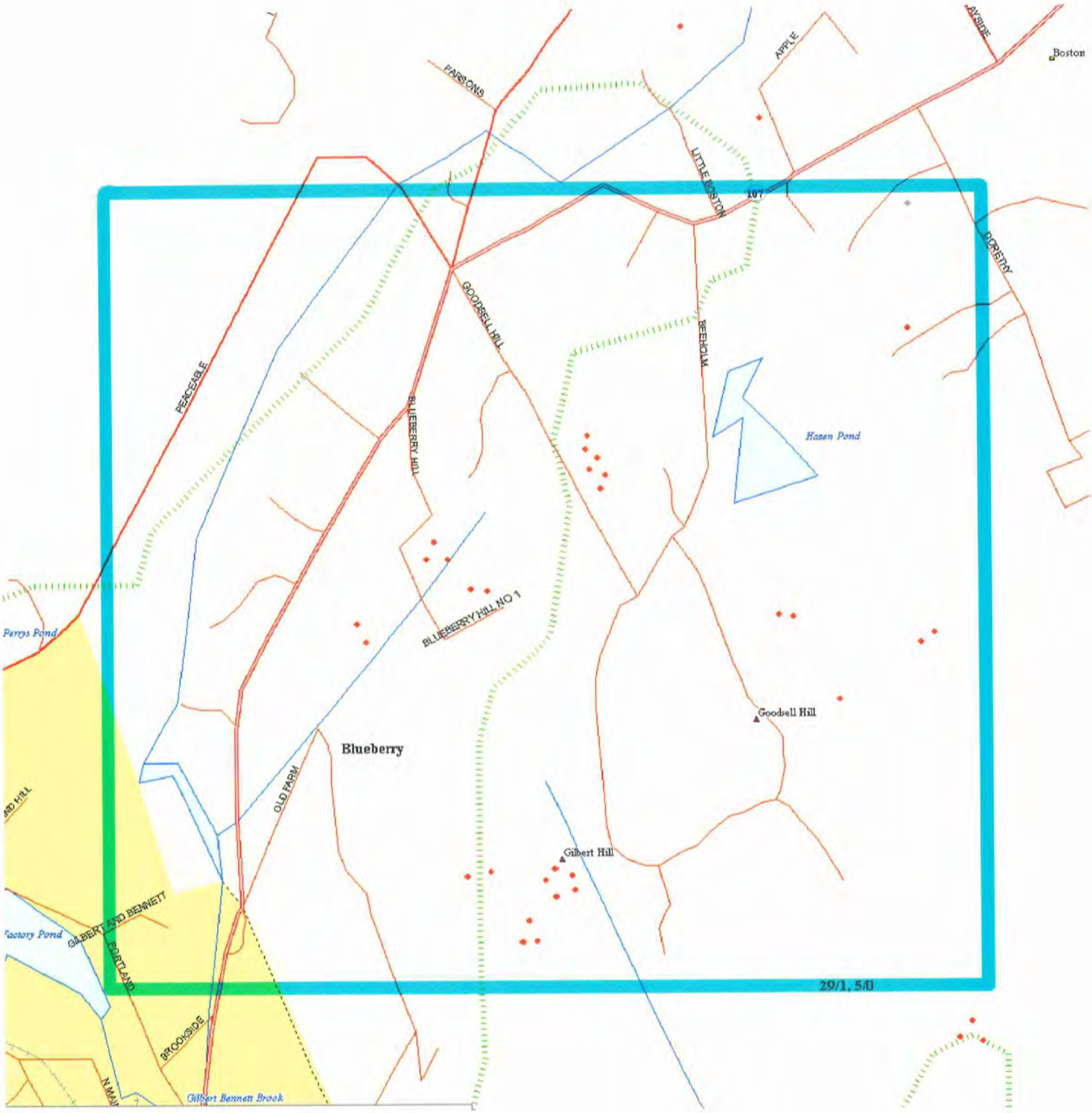

Huckleberry Swamp
TOPSTONE
Umpawaug Hill
Whitebirch
UMPAWAUG
Steichens Ponds
ARCHERS
GRANITE RIDGE
OLD REDDING
WHITE BIRCH
BARRETT
FIRE TOWER
Redding Lookout Tower
SEVENTY ACRES
Windy Hill
MINE


MTN VIEW
RIDGEV
DAHLIA
107
Drummer
GALLOWS HILL
DRUMMER
OLD STAGECOACH
NEWELL
DUCK RUN
35/2, 19/4
MARLI
SR 107
BEAULIEB
WINDING BROOK
53


PARSONS
APPLE
Boston
LITTLE BOSTON
107
DORETHY
PEACEABLE
GOODSELL HILL
BEEHOLM
BLUEBERRY HILL
Hazen Pond
BLUEBERRY HILL NO 1
Perrys Pond
Goodsell Hill
Blueberry
OLD FARM
Gilbert Hill
GILBERT AND BENNETT
PORTLAND
BROOKSIDE
Gilbert Bennett Brook
29/1, 5/0