30 years

NH Land Trust
Coalition Workshop

October 12, 2017

- Goals and principles for land monitoring
- Equipment and skills
- Procedures, systems and software
- The workflow: prior, during, & after
- The product: images and organization
- Regulations and etiquette

Goals & Principles for Aerial Monitoring

- create complete high-res photographic record
- targeting properties that are larger, ie 50 acres + up
- identifiable location for each photo
- photo collections accompanied by annotated maps
- easy for staff to work with the photo collections
- best results with most leaves off, not too much snow
- land trust staff manages landowner conversations
- flying only over land trust property, not neighbors
- create cost-effective systems and results
- this is NOT surveying and NOT mapping

The “Mission” is at the heart of each project

- The mission is the autonomous route that the drone takes over the land
- The mission automatically performs various tasks, in our case taking photographs at regular intervals
- The mission is manually planned in advance using apps on computer and tablet.
- Large properties (typically 150 acres+) require multiple mission plans, *aka* “zones
- Large zones are single missions, require multiple batteries

iTunes Preview

Overview Music Video Charts

The iOS app used to plot and fly the mission

DJI GS Pro

By DJI JAPAN

View More by This Developer

This app is only available on the App Store for iOS devices.

Free

Category: Productivity
Updated: Aug 11, 2017
Version: 1.6.0
Size: 81.4 MB
Languages: English, Japanese, Simplified Chinese
Seller: DJI JAPAN K.K.

Description

GS Pro (also known as Ground Station Pro) is an iPad app designed to control or plan automatic flights for DJI aircraft. Through its clear, concise interface, complex flight missions can be planned with a few taps. GS Pro will then automatically take pictures at pre-set waypoints, providing the accuracy required for precision mapping. A

DJI JAPAN Web Site ▸ DJI GS Pro Support ▸ ...More

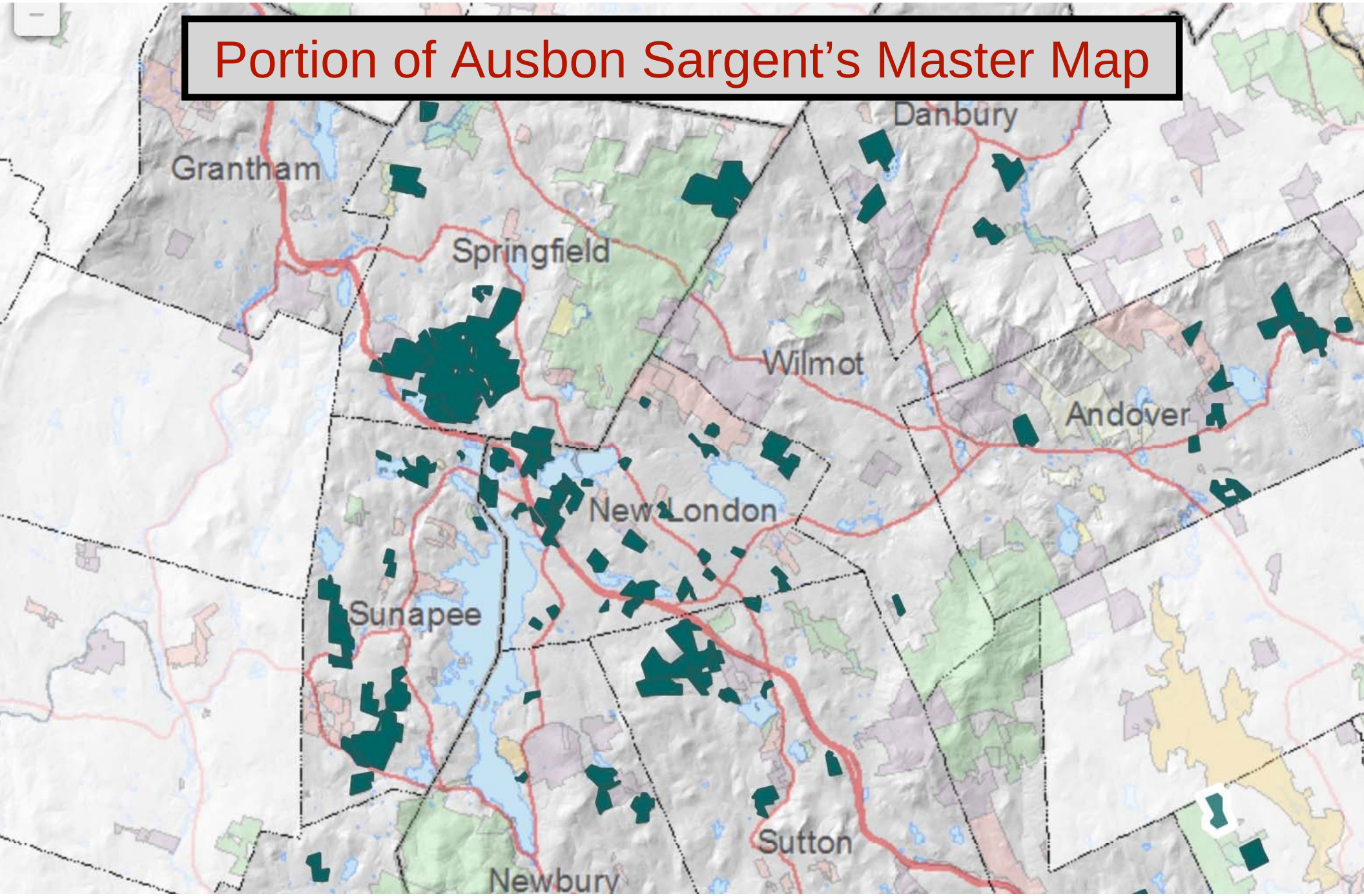
What's New in Version 1.6.0

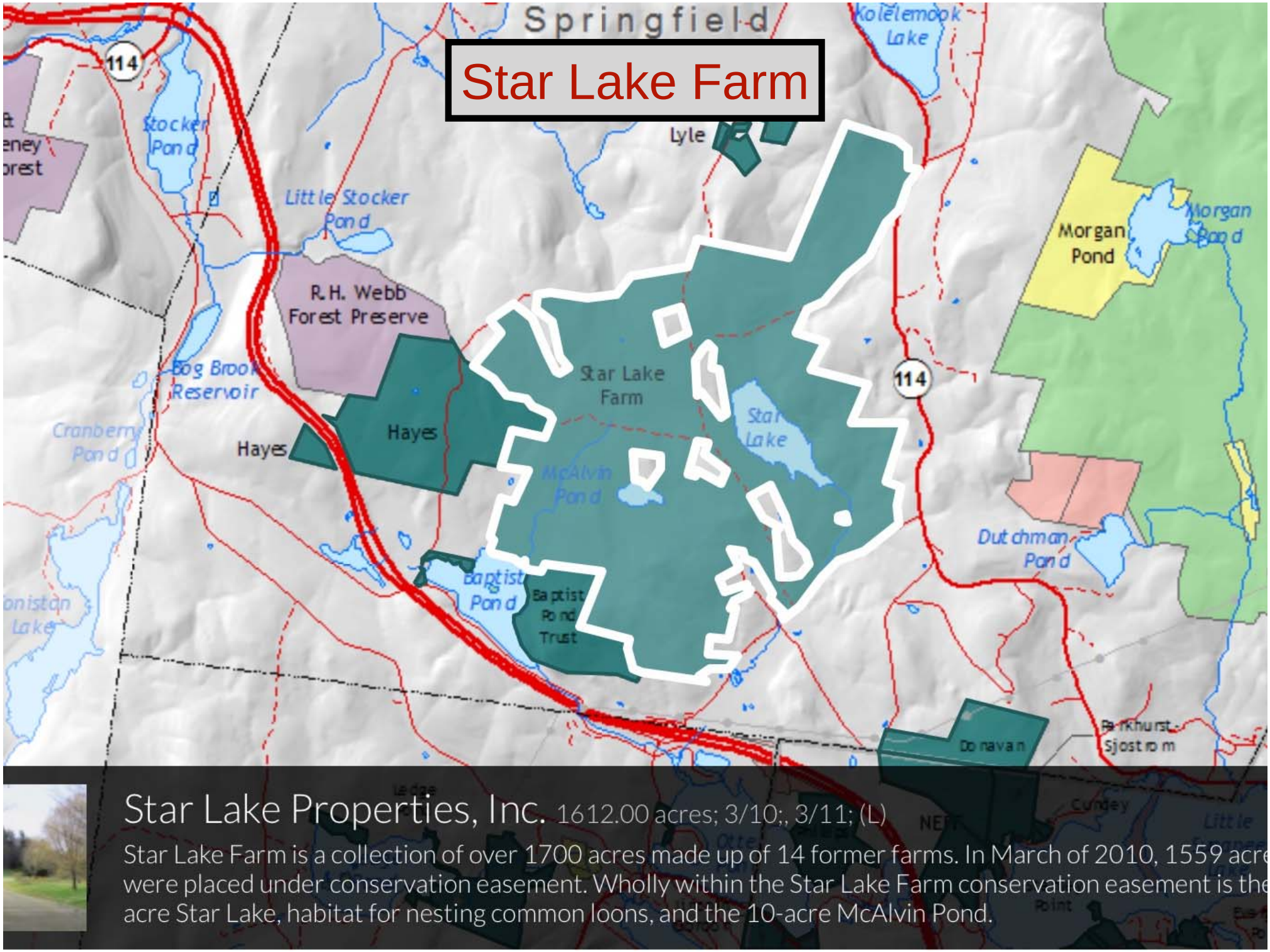
1. New: Support for M200/P4A
2. New: Support for KML/SHP/KMZ file import, view, and creating flight missions accordingly
3. New: Save the current mission's parameter as Default, so that newly created mission will follow the same

...More

iPad Screenshots

Portion of Ausbon Sargent's Master Map

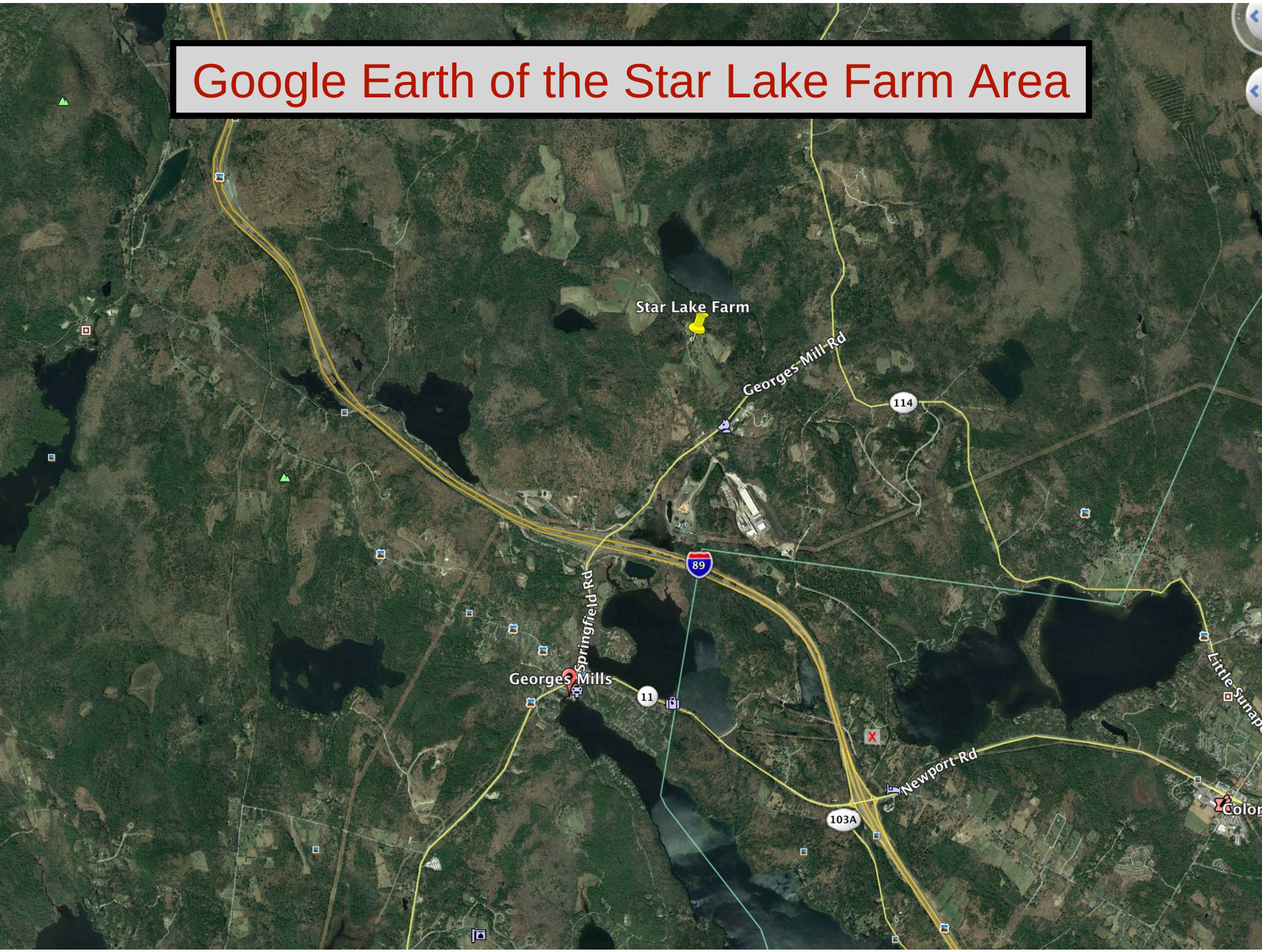


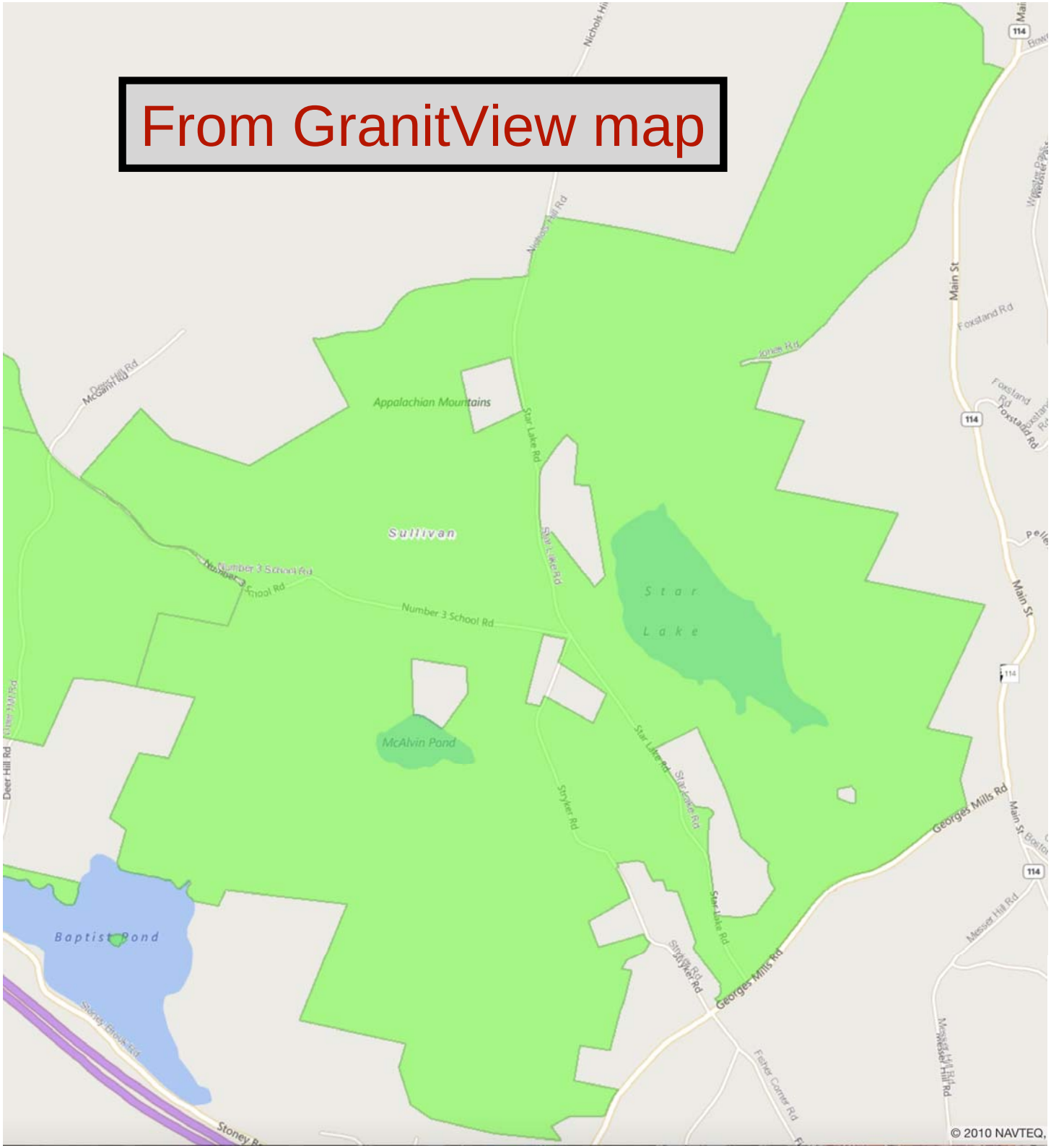


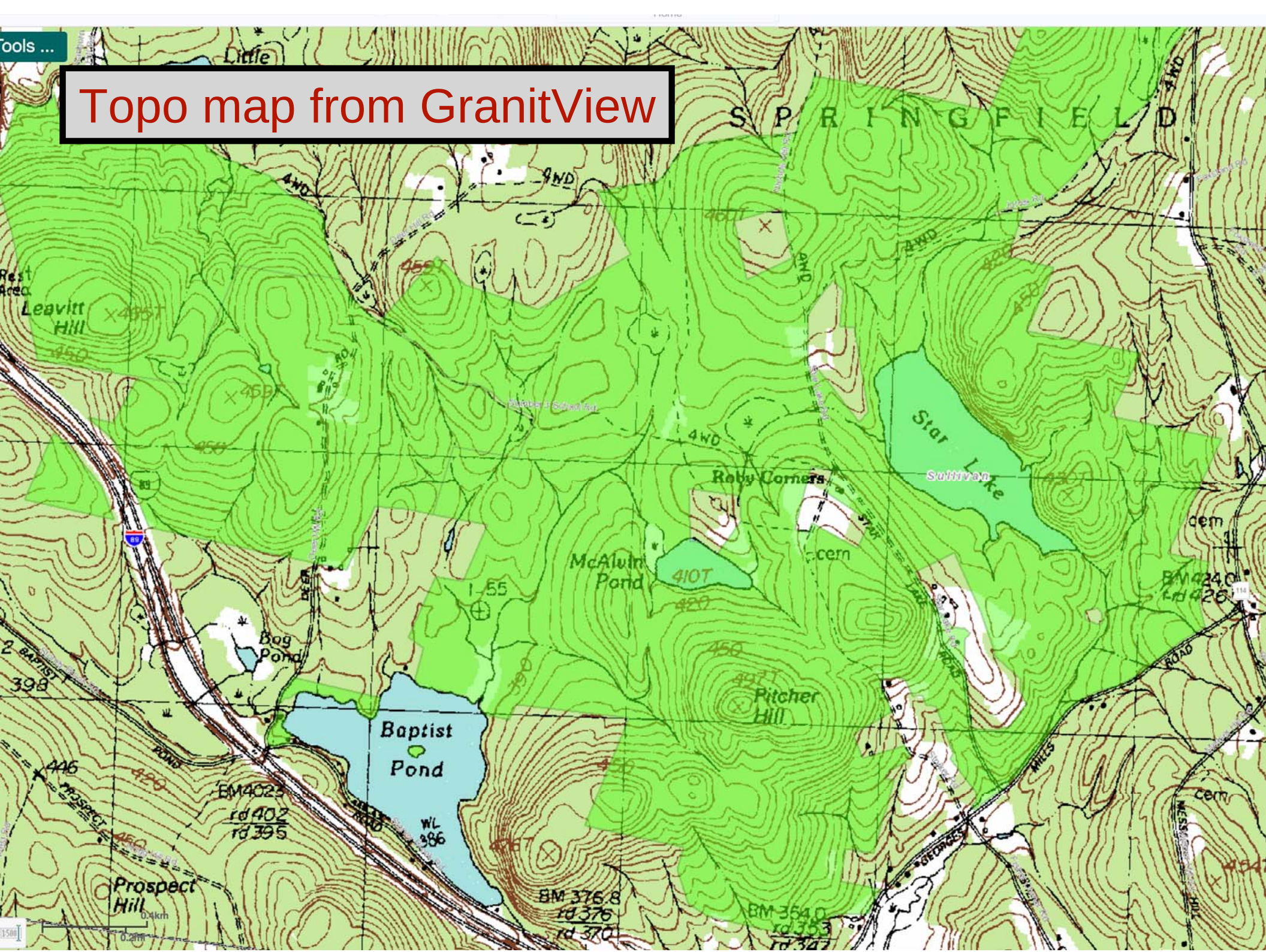
Star Lake Properties, Inc. 1612.00 acres; 3/10;, 3/11; (L)

Star Lake Farm is a collection of over 1700 acres made up of 14 former farms. In March of 2010, 1559 acre were placed under conservation easement. Wholly within the Star Lake Farm conservation easement is the acre Star Lake, habitat for nesting common loons, and the 10-acre McAlvin Pond.

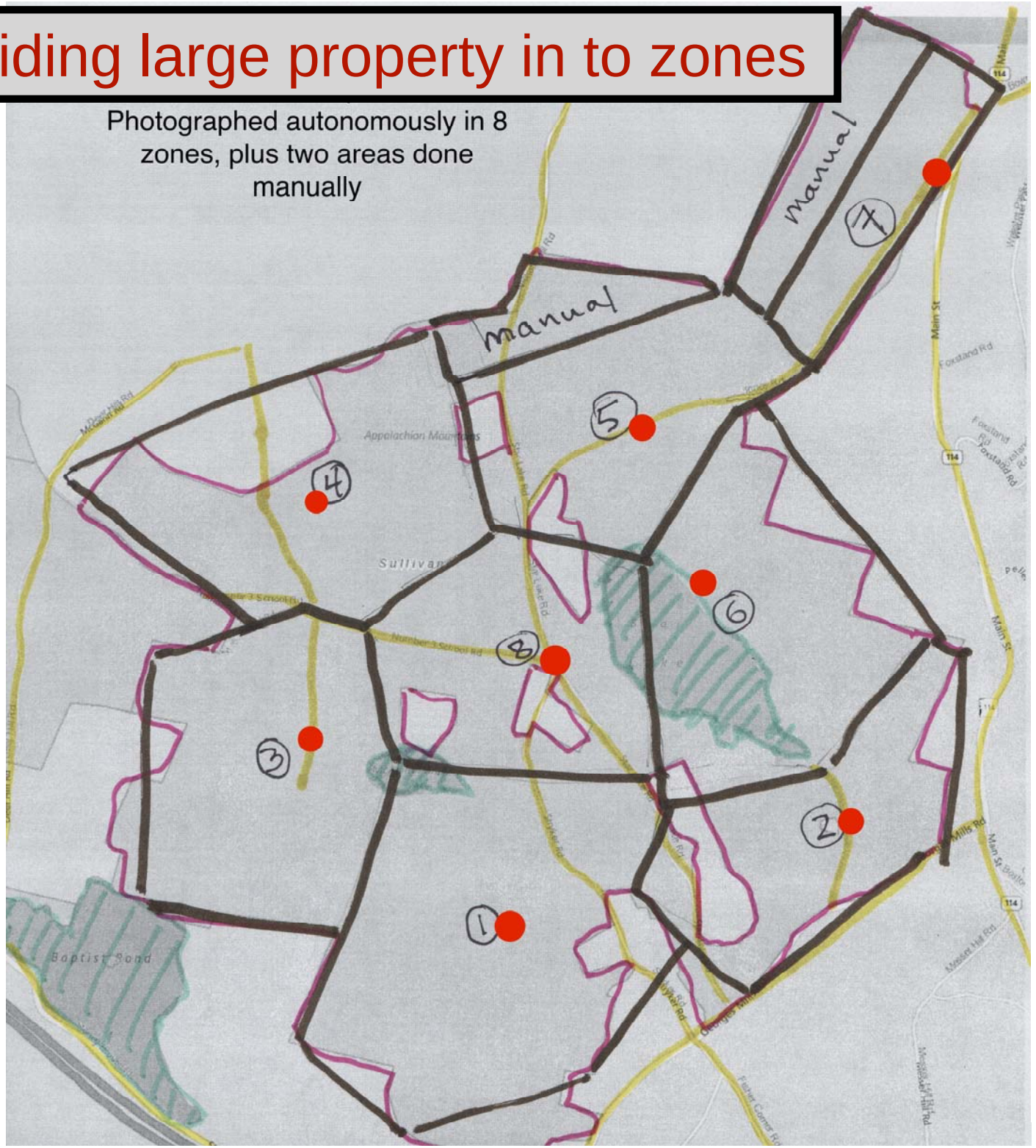
Google Earth of the Star Lake Farm Area




From GranitView map
Appalachian Mountains
Sullivan
Star Lake
McAlvin Pond
Baptist Pond
Number 3 School Rd
Star Lake Rd
Stryker Rd
Georges Mills Rd
Deer Hill Rd
Main St
Foxstand Rd
Jones Rd
Messer Hill Rd
Fisher Corner Rd
Stoney Brook Rd
114
© 2010 NAVTEQ,


Tools ...
Topo map from GranitView
Little
SPRINGFIELD
4WD
Rest Area
Leavitt Hill
Roby Corners
Star Lake
Sullivan
McAlvin Pond
410T
I-55
Bog Pond
Baptist Pond
Pitcher Hill
Prospect Hill
BM4023
rd402
rd395
WL 386
BM 376.8
rd376
rd370
BM 354.0
cem
0.4km
0.2mi

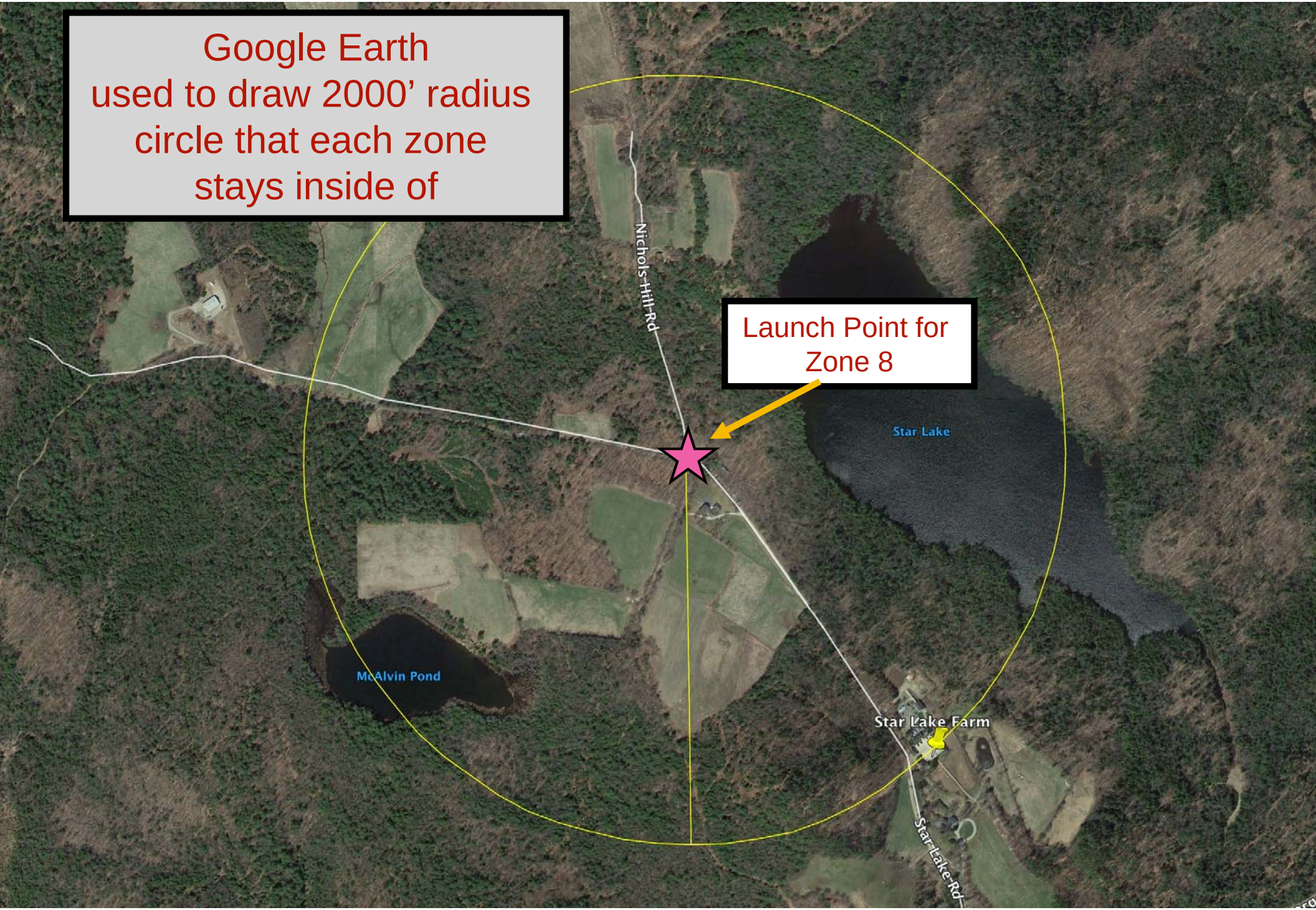
Dividing large property in to zones

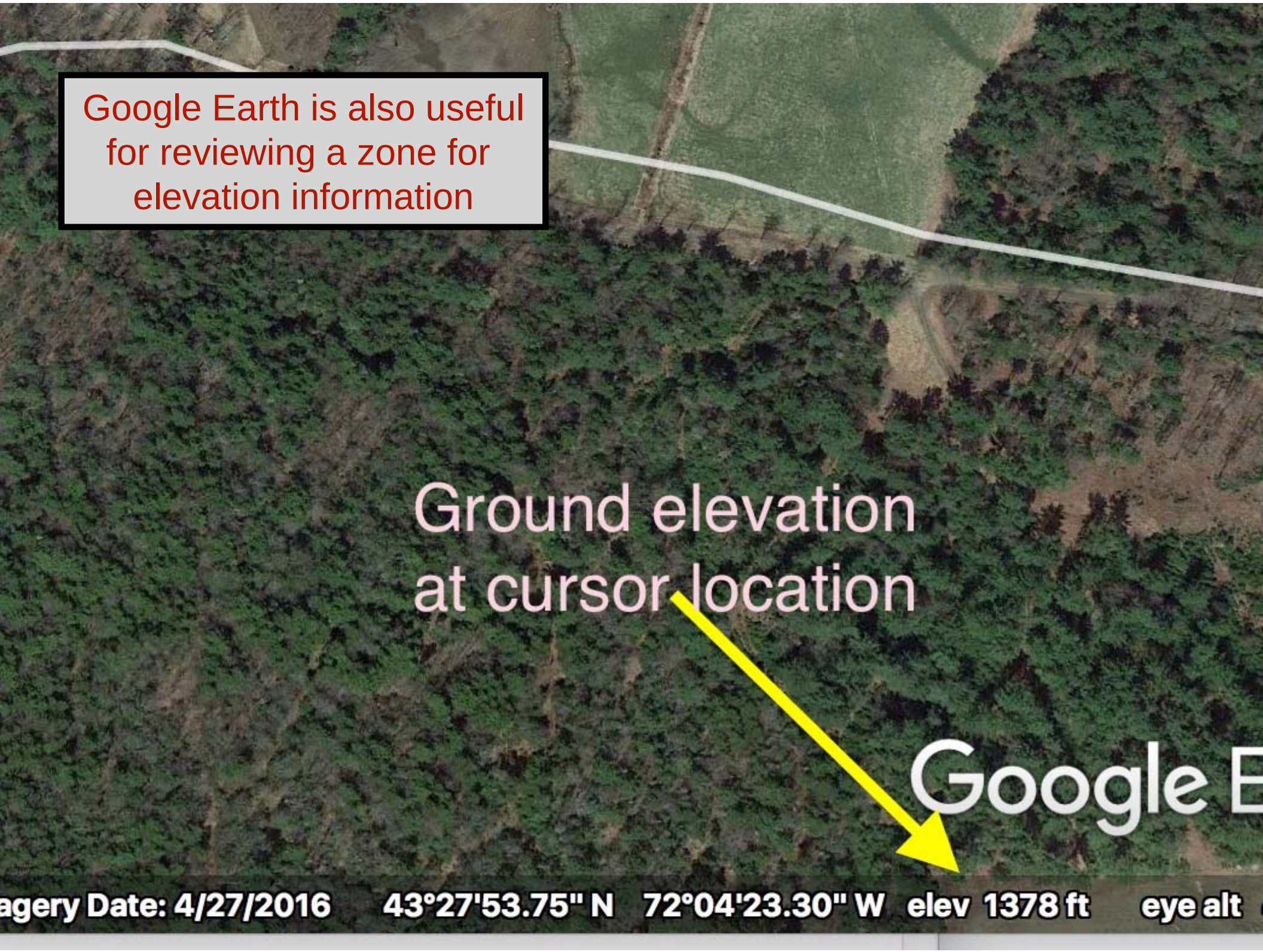


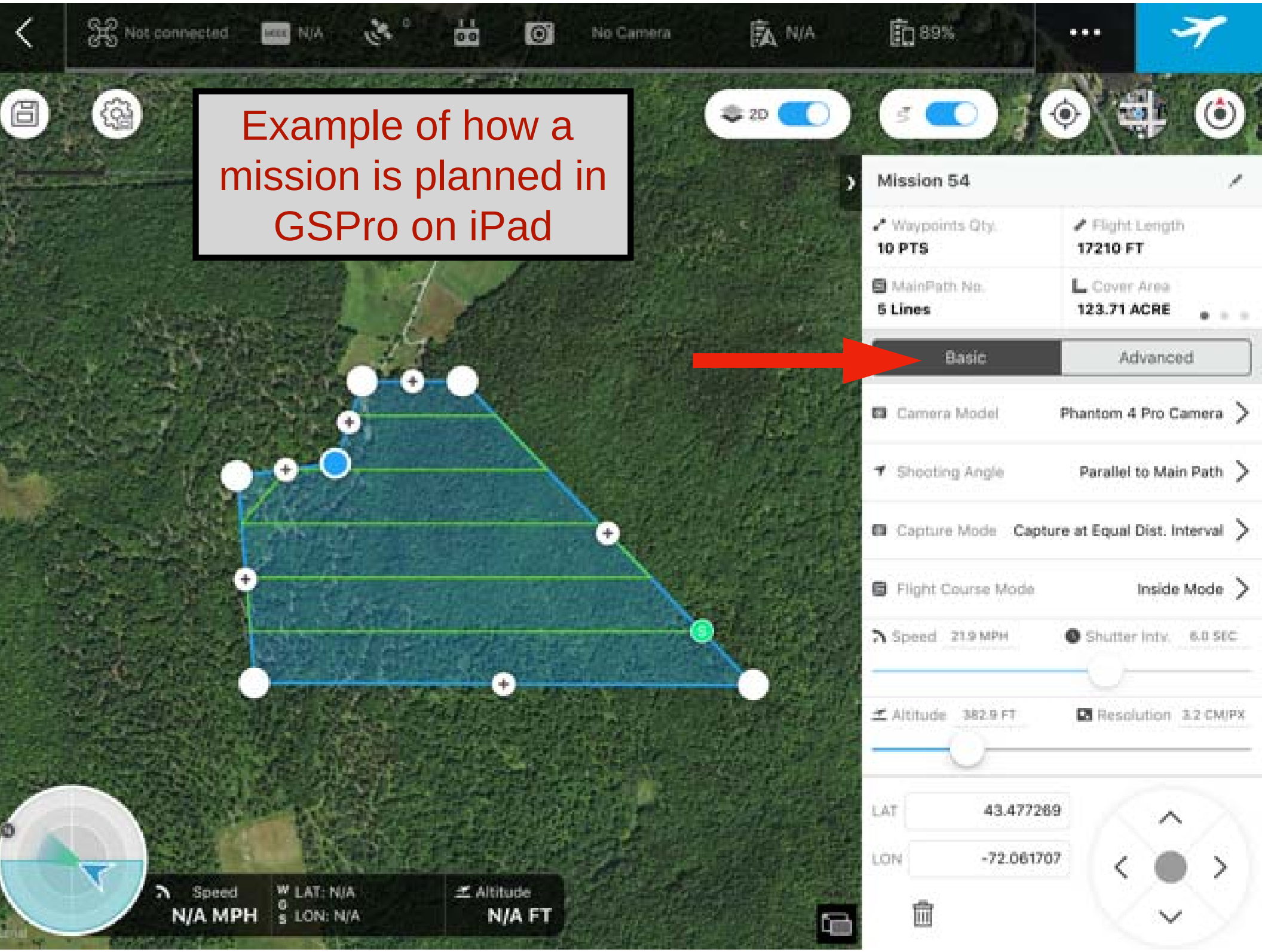
Defining the perimeter of a zone

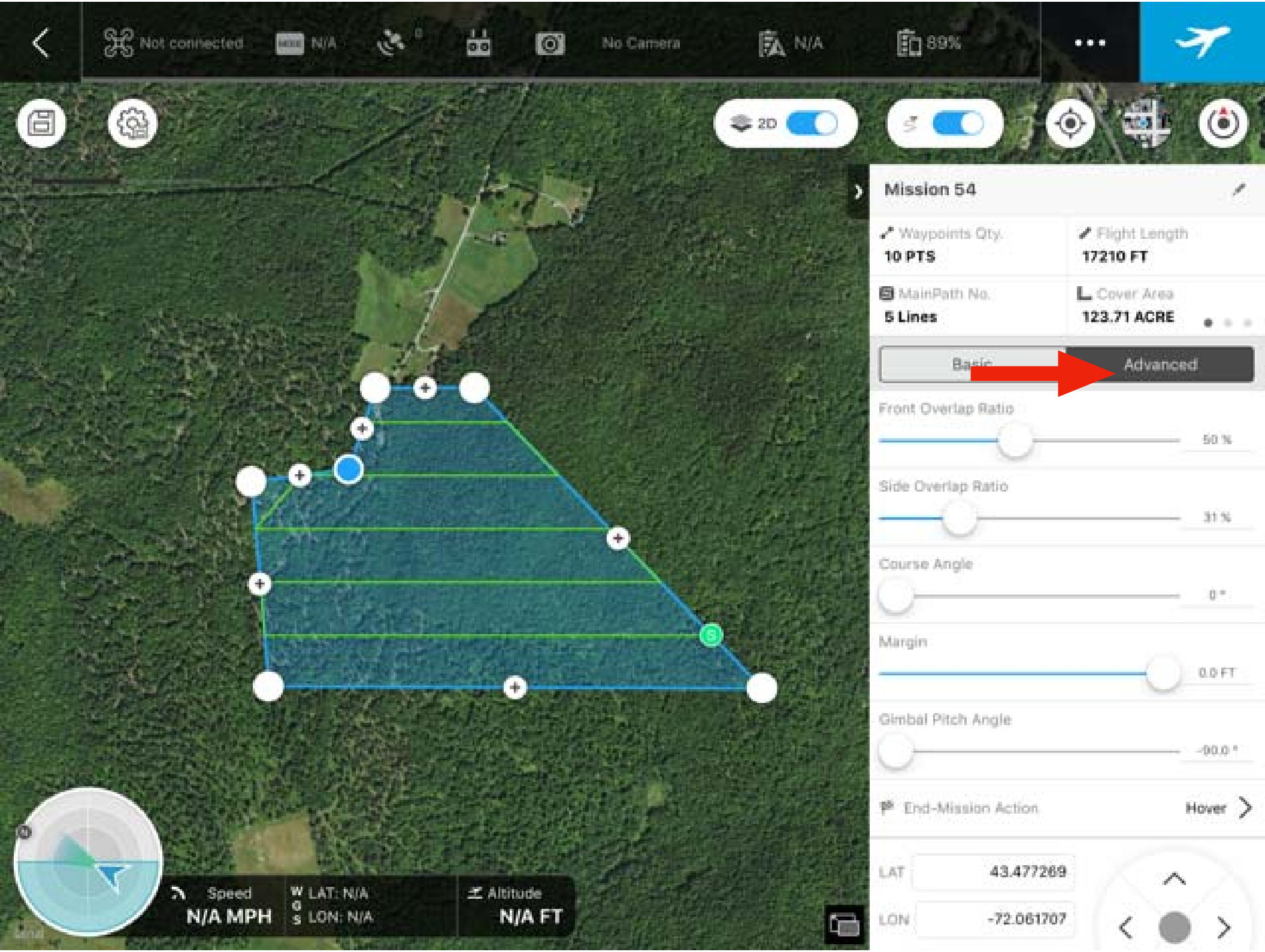
Draw a perimeter on the map that follows these guidelines:

- it approximately follows the exterior borders
- the launch point is on relatively high ground
- the launch point is more-or-less centered in the zone
- the launch point is accessible
- the entire zone is within 2000’ radius centered on launch point
- the perimeter of the zone overlaps slightly with adjoining zones


Google Earth
used to draw 2000’ radius
circle that each zone
stays inside of
Launch Point for
Zone 8
Nichols Hill Rd
Star Lake
McAlvin Pond
Star Lake Farm
Star Lake Rd


Google Earth is also useful for reviewing a zone for elevation information
Ground elevation at cursor location
Google E
agery Date: 4/27/2016 43°27'53.75" N 72°04'23.30" W elev 1378 ft eye alt


Not connected
N/A
No Camera
N/A
89%
2D
Example of how a mission is planned in GSPro on iPad
Mission 54
Waypoints Qty.
10 PTS
Flight Length
17210 FT
MainPath No.
5 Lines
Cover Area
123.71 ACRE
Basic
Advanced
Camera Model
Phantom 4 Pro Camera
Shooting Angle
Parallel to Main Path
Capture Mode
Capture at Equal Dist. Interval
Flight Course Mode
Inside Mode
Speed
21.9 MPH
Shutter Intv.
6.8 SEC
Altitude
382.9 FT
Resolution
3.2 CM/PX
LAT
43.477289
LON
-72.061707
Speed
N/A MPH
LAT: N/A
LON: N/A
Altitude
N/A FT

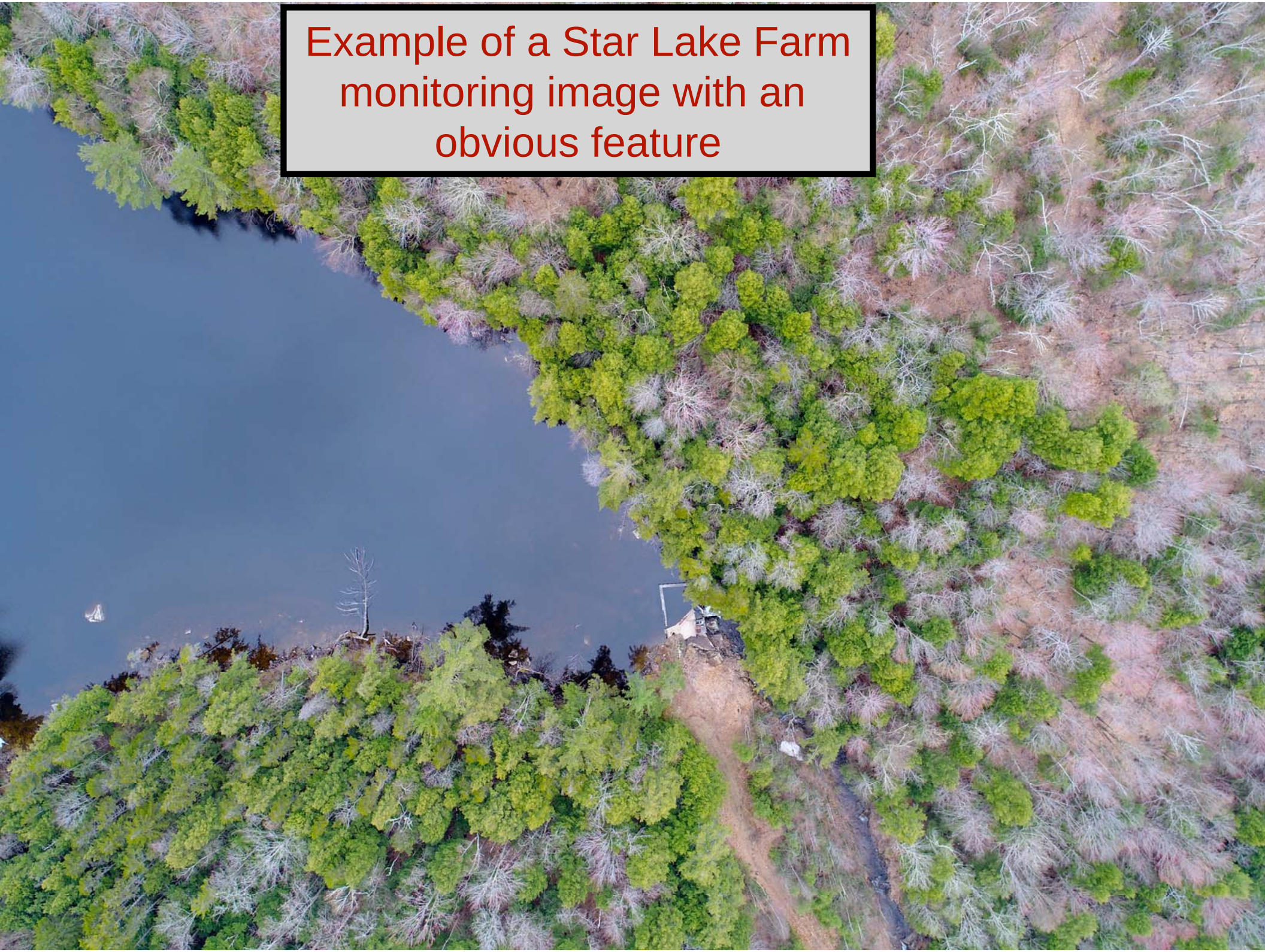

Not connected
N/A
No Camera
N/A
89%
2D
Mission 54
Waypoints Qty.
10 PTS
Flight Length
17210 FT
MainPath No.
5 Lines
Cover Area
123.71 ACRE
Basic
Advanced
Front Overlap Ratio
50 %
Side Overlap Ratio
31 %
Course Angle
0 °
Margin
0.0 FT
Gimbal Pitch Angle
-90.0 °
End-Mission Action
Hover
LAT
43.477269
LON
-72.061707
Speed
N/A MPH
WGS
LAT: N/A
LON: N/A
Altitude
N/A FT

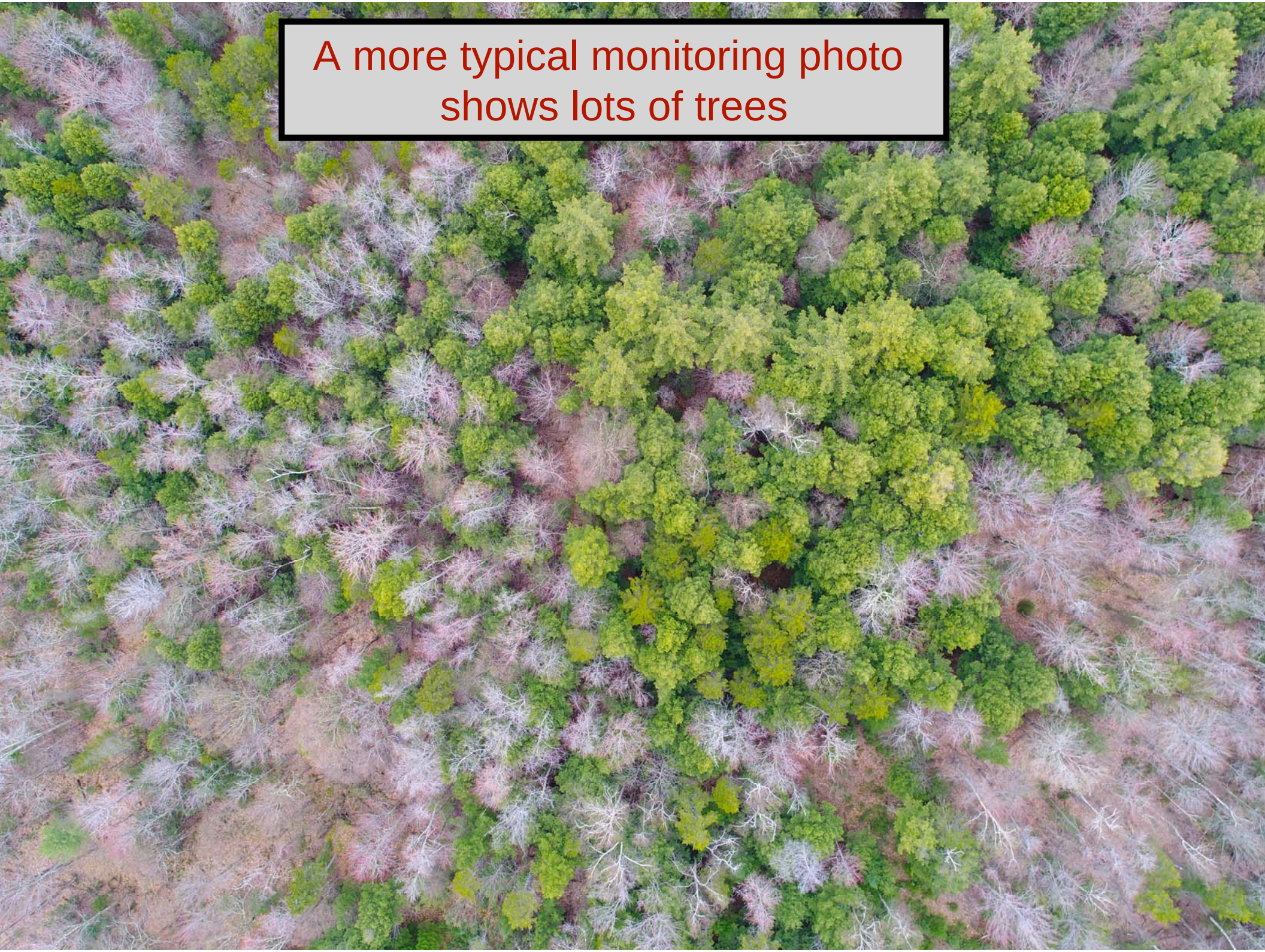
Flying the Missions

- Seasonal factors: preferably leaves down and minimal snow
- Weather factors: no precipitation, winds below 15mph, sunshine is not required, but does provide shadows that can help analyze images
- Launch points accessible by road, trail or bushwhacking
    - for obvious reasons, road access is preferred
- Adjusting mission parameters based on real-world situations
- Having enough batteries, have ways to recharge in the field
- Remember to take a few scenic pictures for the Trust and landowner

Launching at zone 8


Launch location for zone 3


Example of a Star Lake Farm monitoring image with an obvious feature

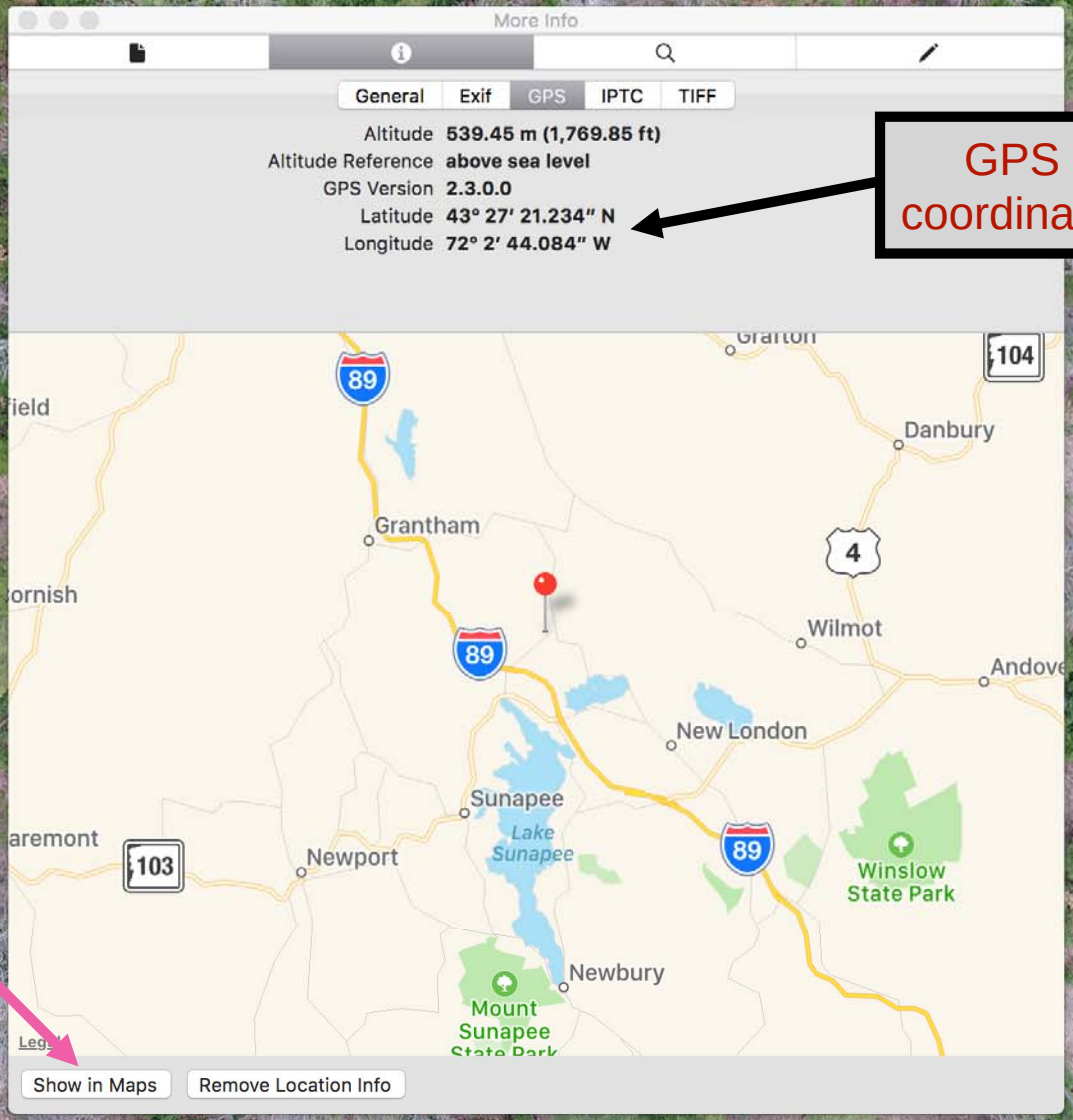

A more typical monitoring photo
shows lots of trees

How can we figure out exactly where each picture was taken?

How can we figure out exactly where each picture was taken?

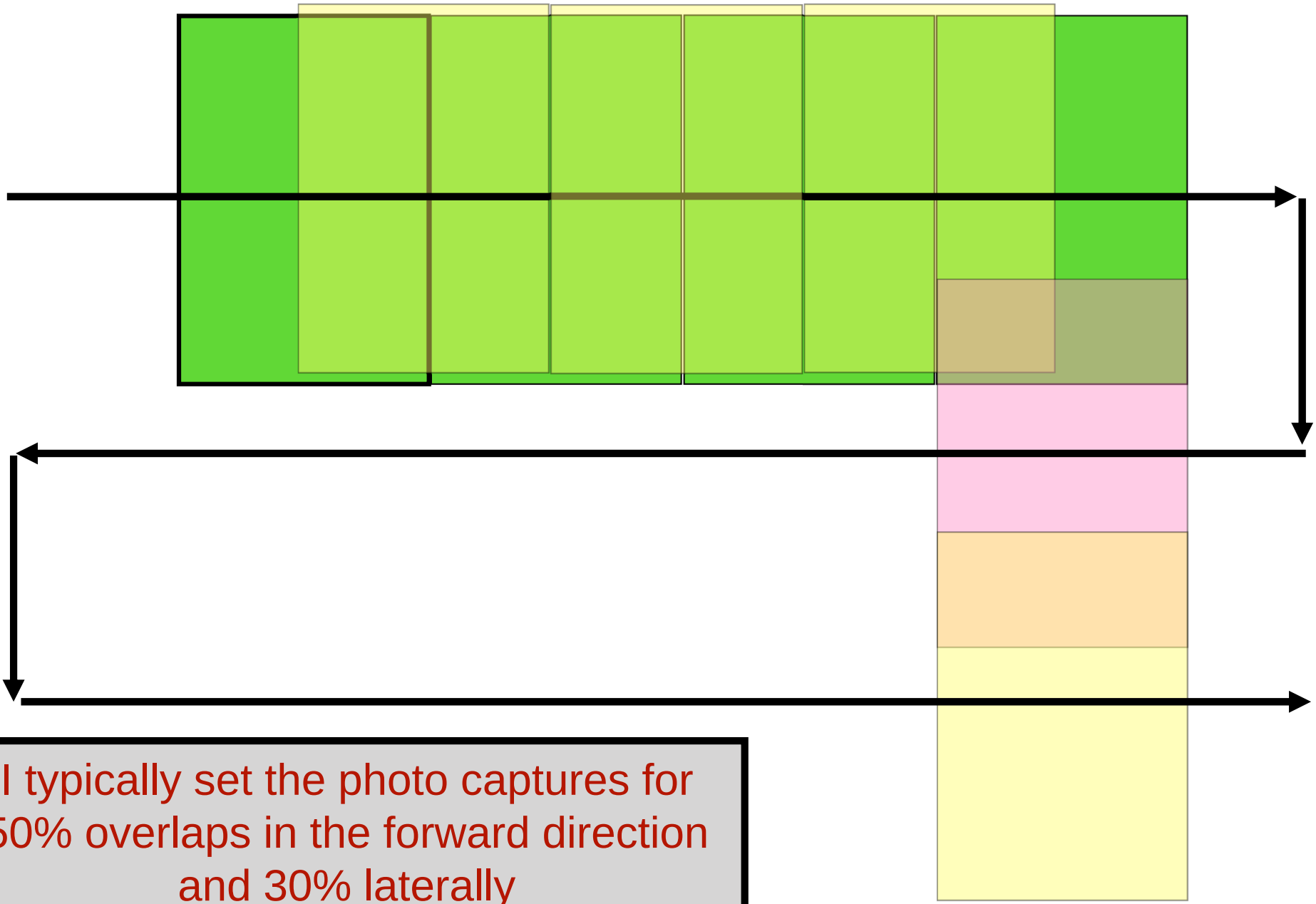
Geotagging, overlaps & dot maps

Every photo is automatically geotagged



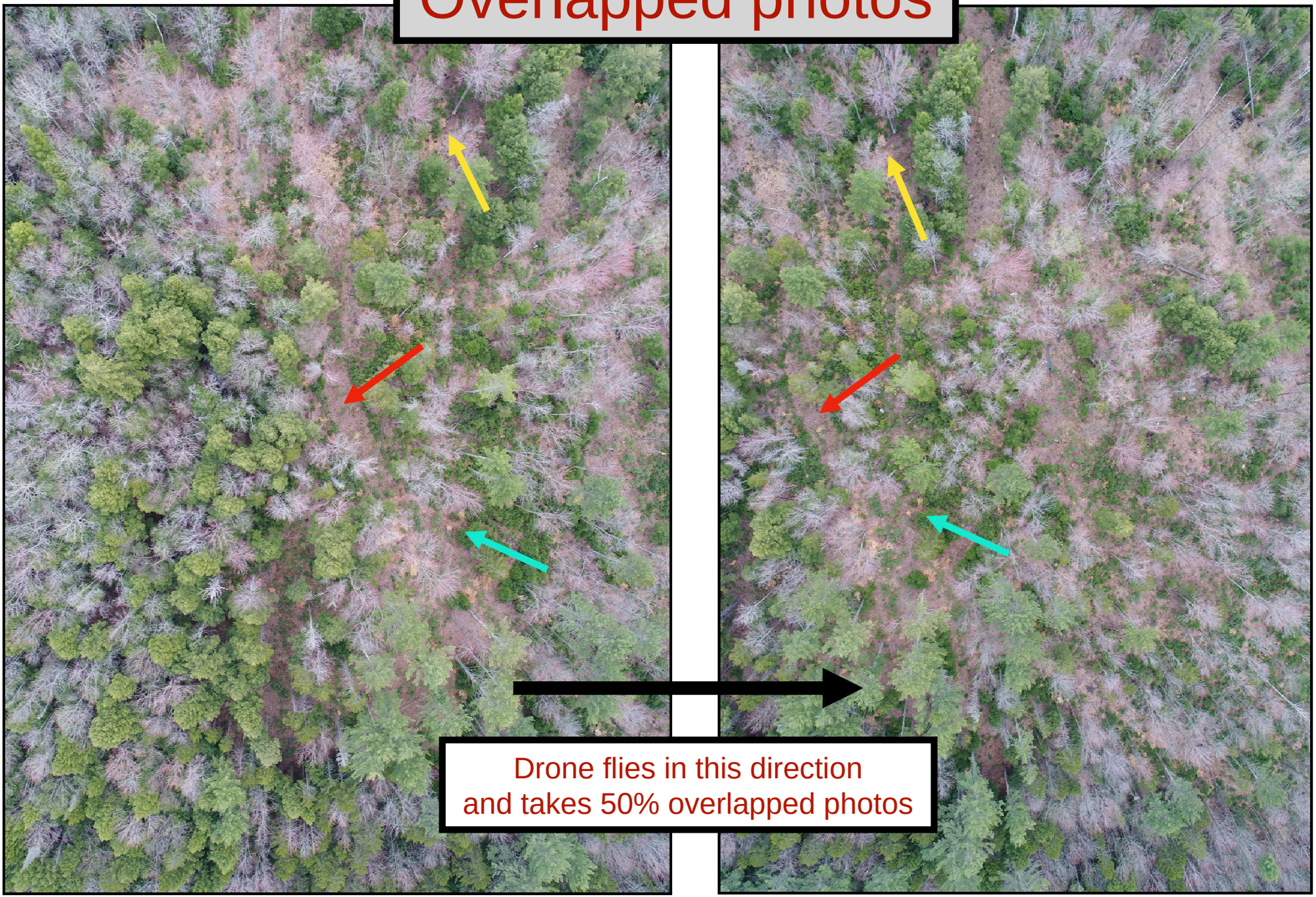
Going to Maps, then zooming in will provide very precise location info on a satellite map

Overlapping photos



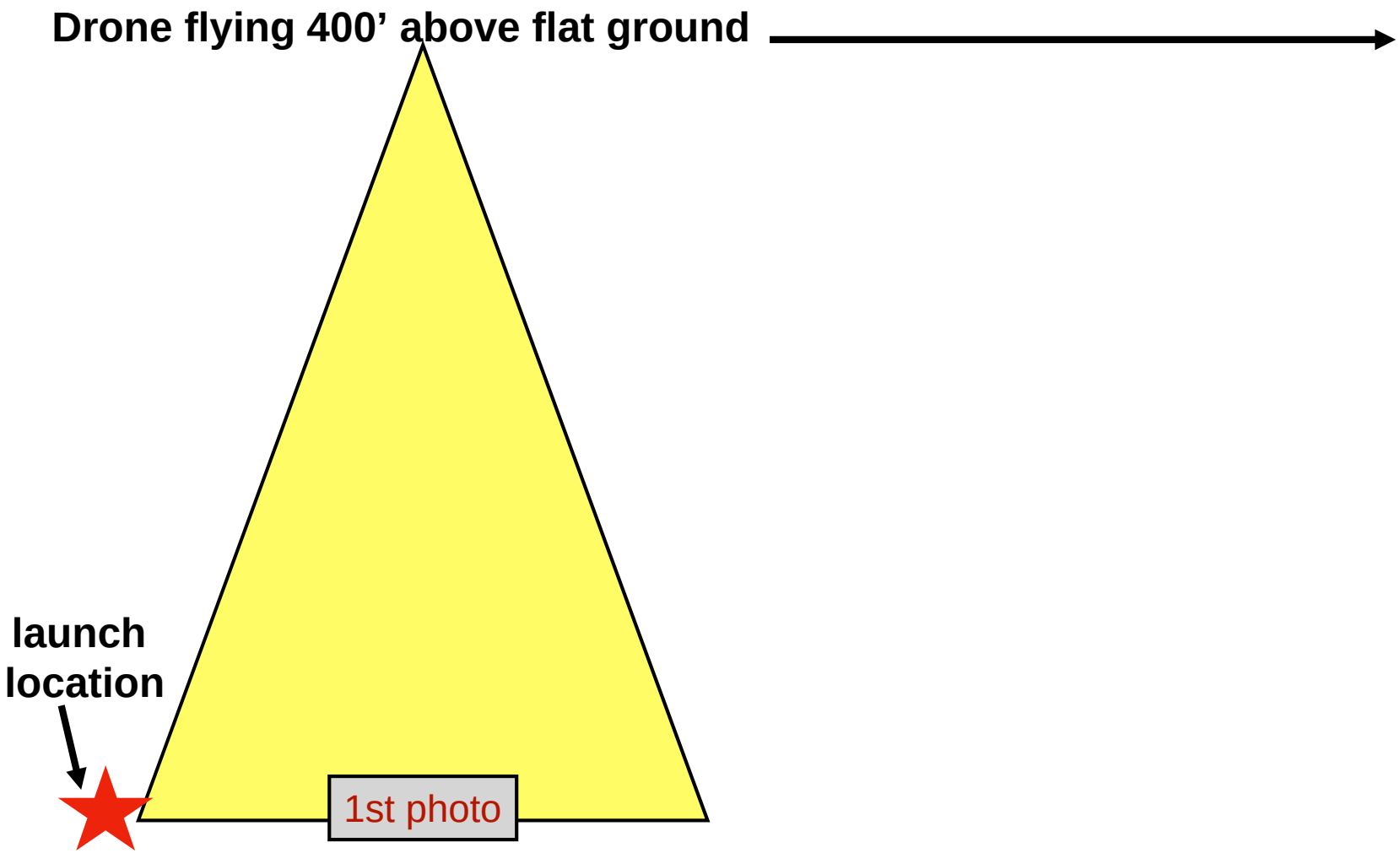
I typically set the photo captures for 50% overlaps in the forward direction and 30% laterally

Overlapped photos

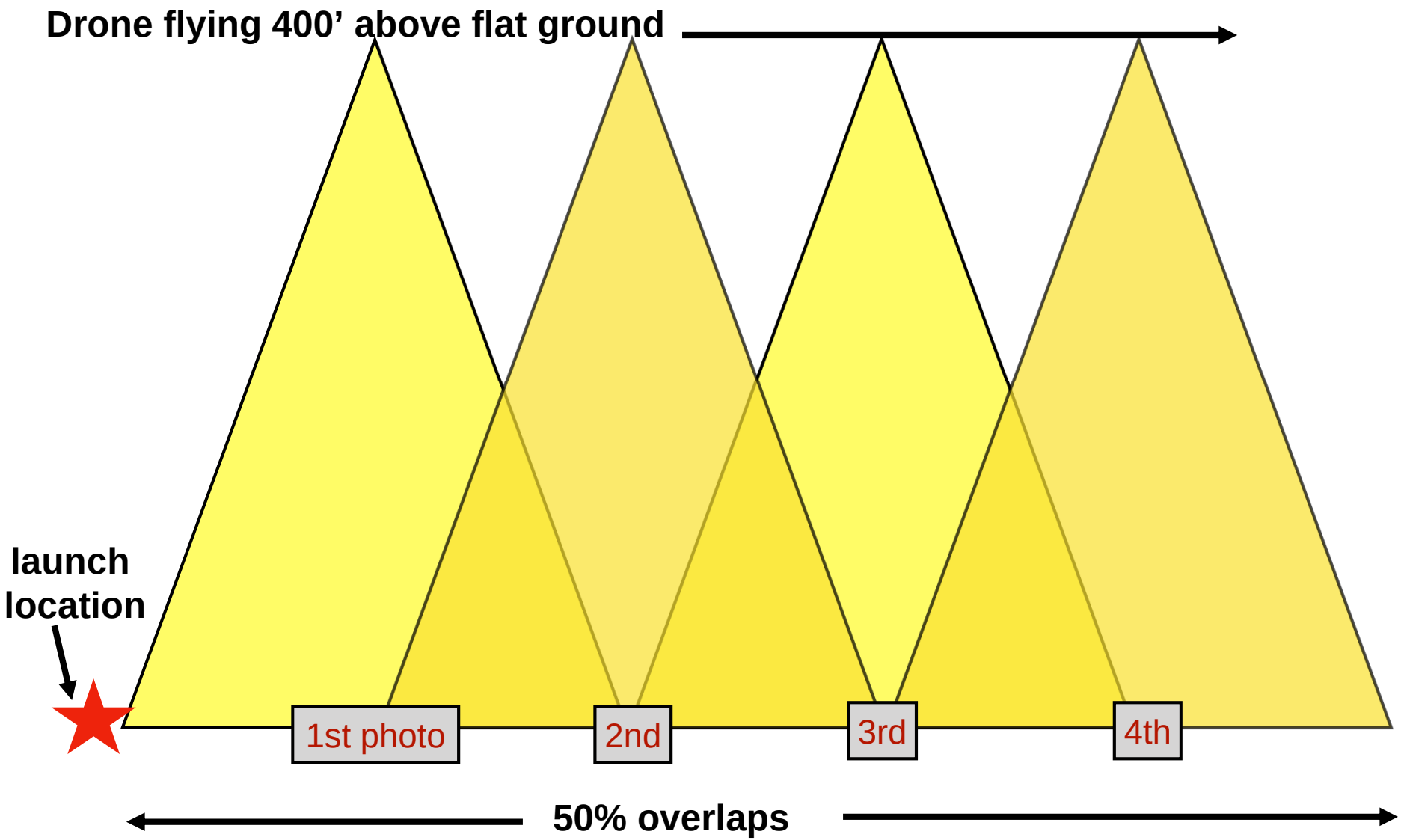


Drone flies in this direction
and takes 50% overlapped photos

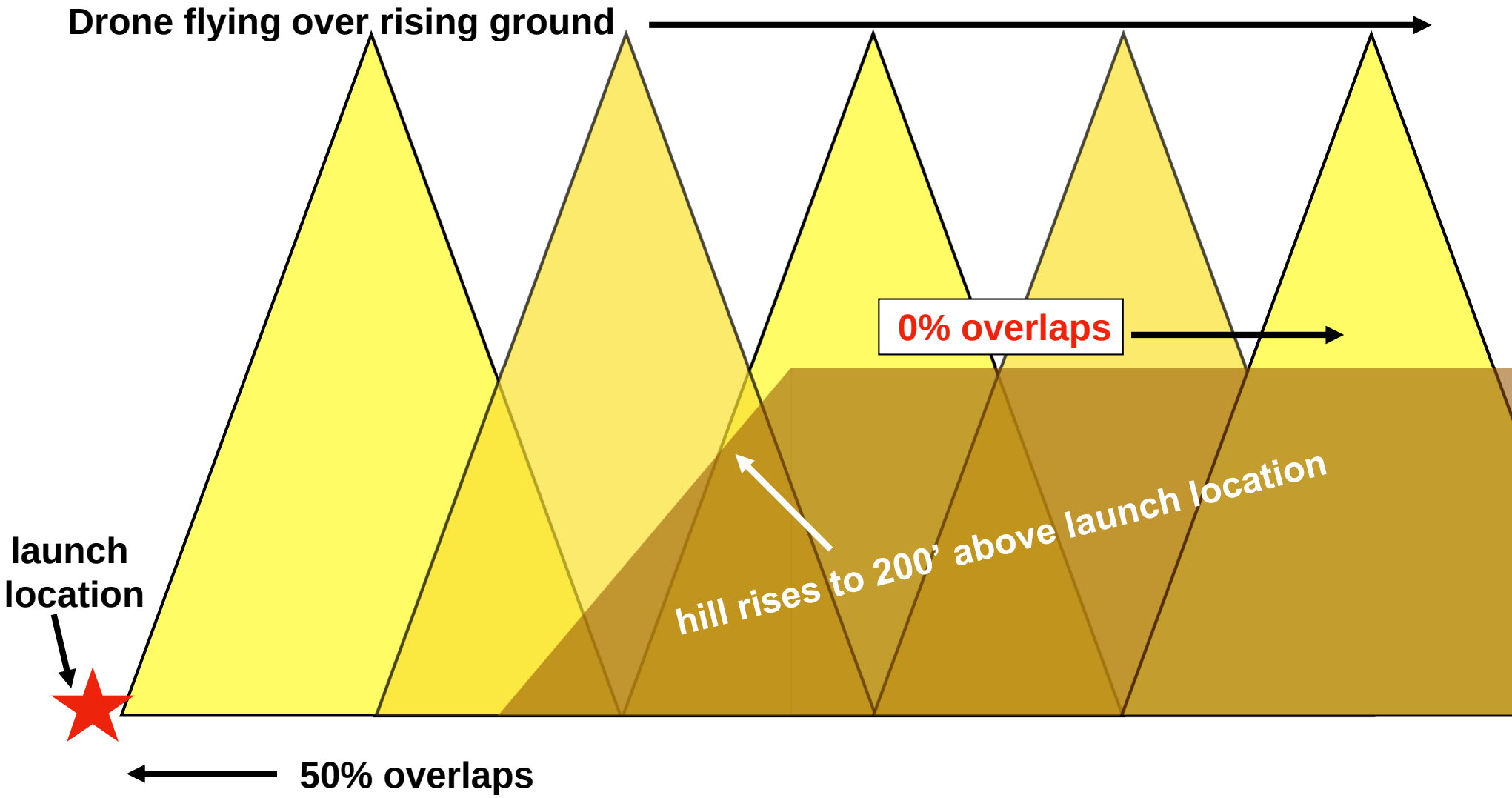
Flat terrain = consistent overlaps

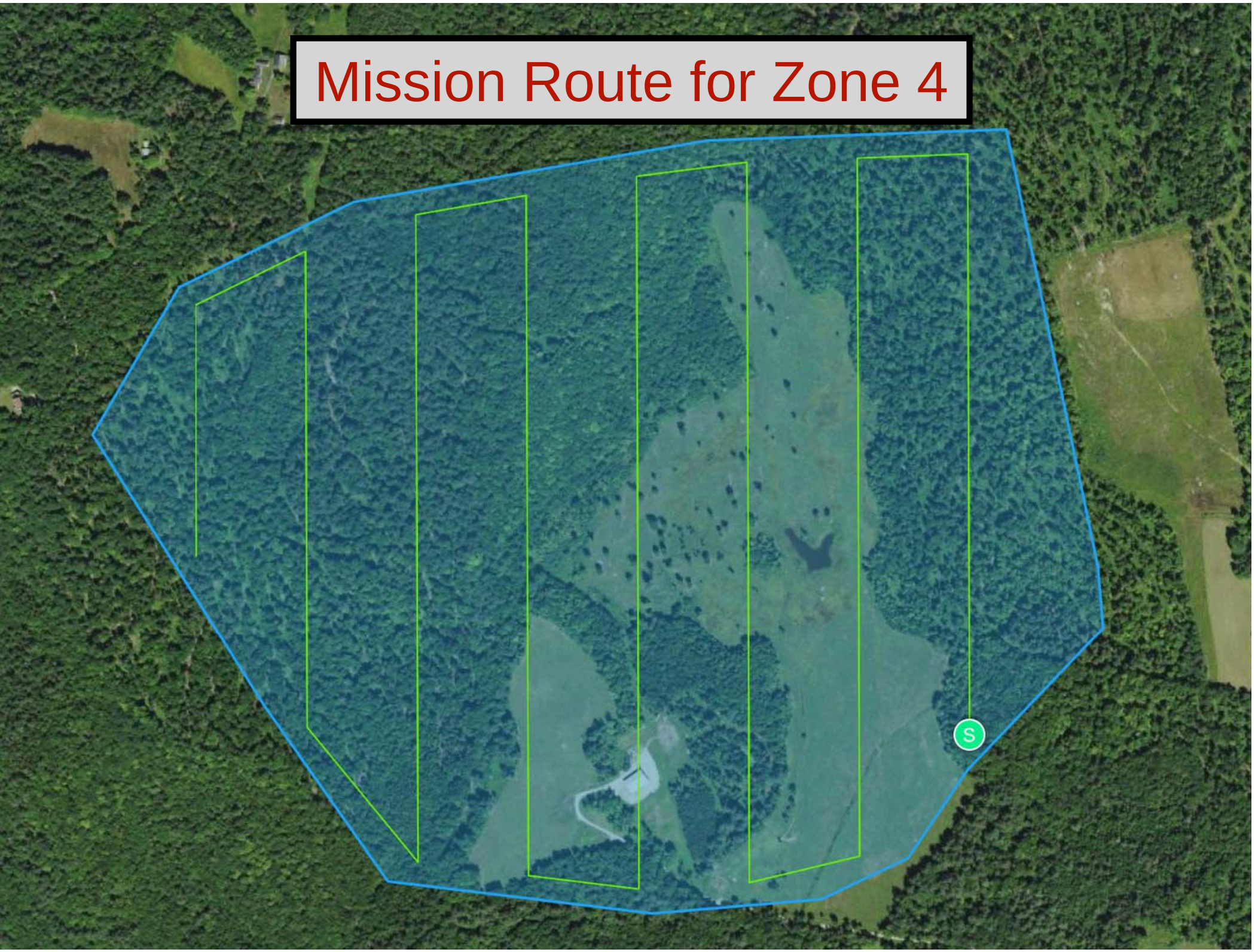


Flat terrain = consistent overlaps

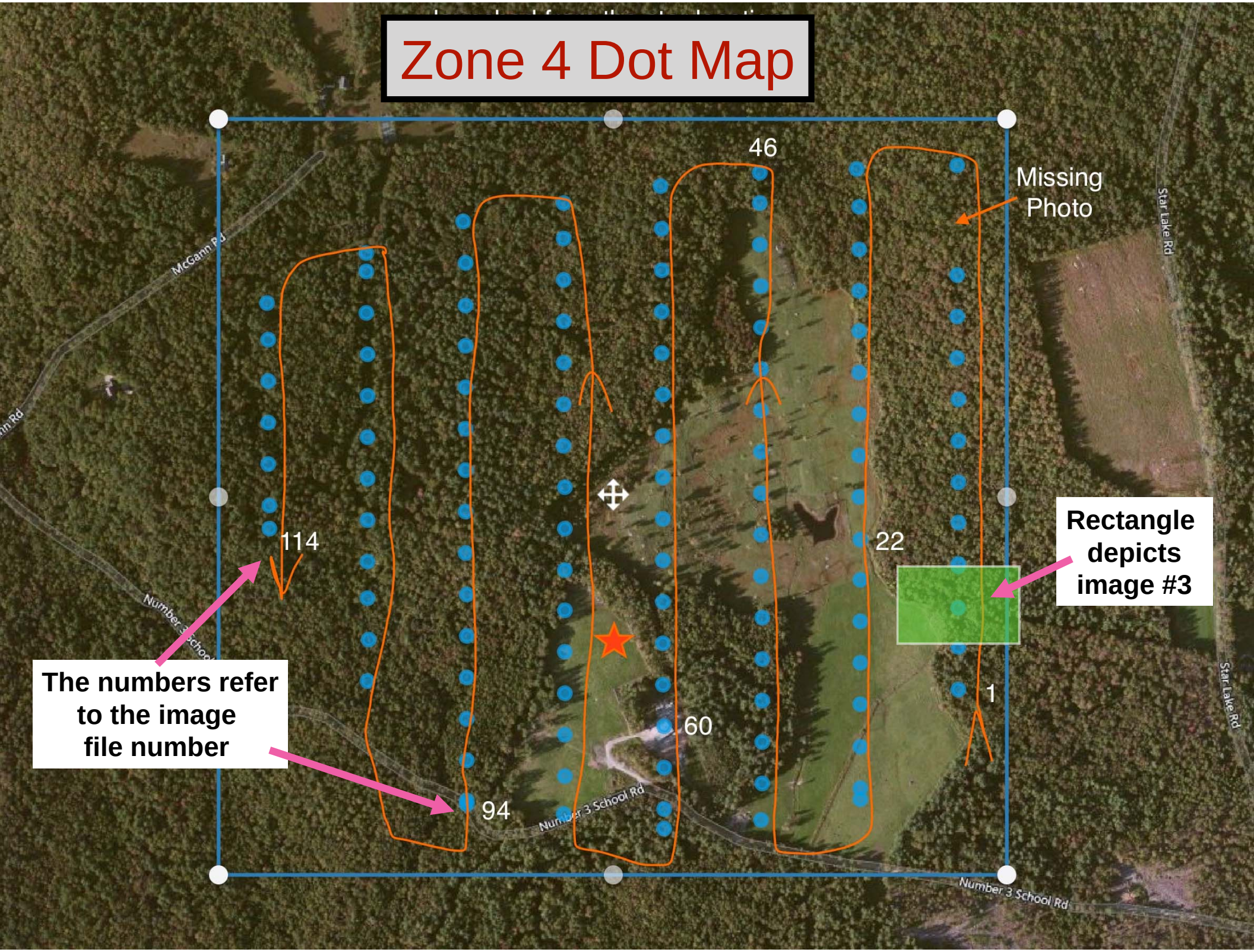


Uneven terrain = inconsistent overlaps



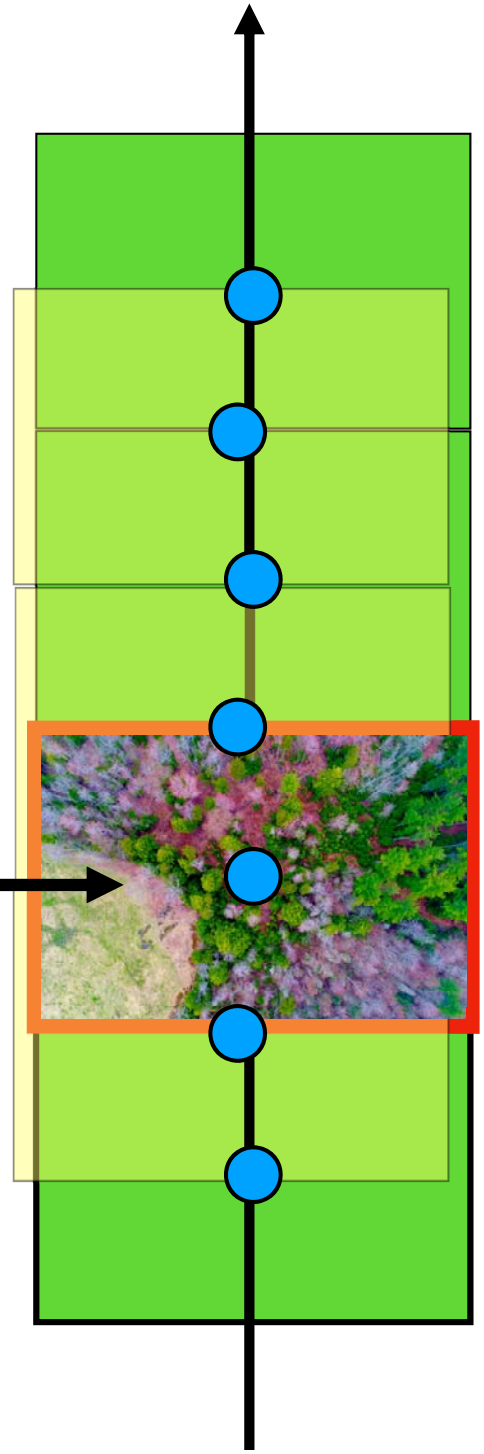

Mission Route for Zone 4
S

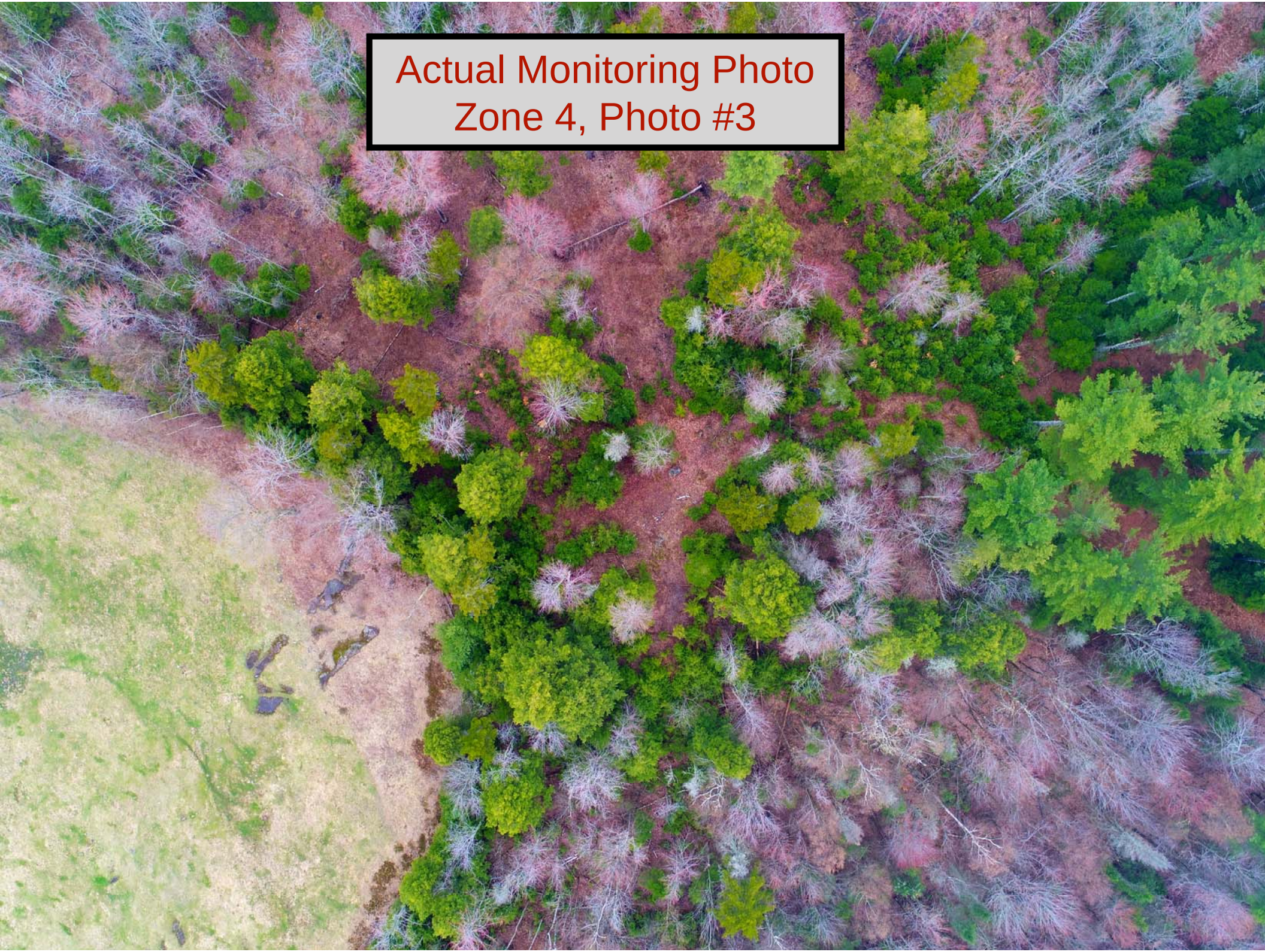
The Zone 4 mission produced 114 photos which are uploaded to DroneDeploy website, which reads the geotags on each photo and produces the “dot map”


Zone 4 Dot Map
46
Missing Photo
114
22
Rectangle depicts image #3
The numbers refer to the image file number
60
1
94
Number 3 School Rd
Number 3 School Rd
McGann Rd
Star Lake Rd
Star Lake Rd

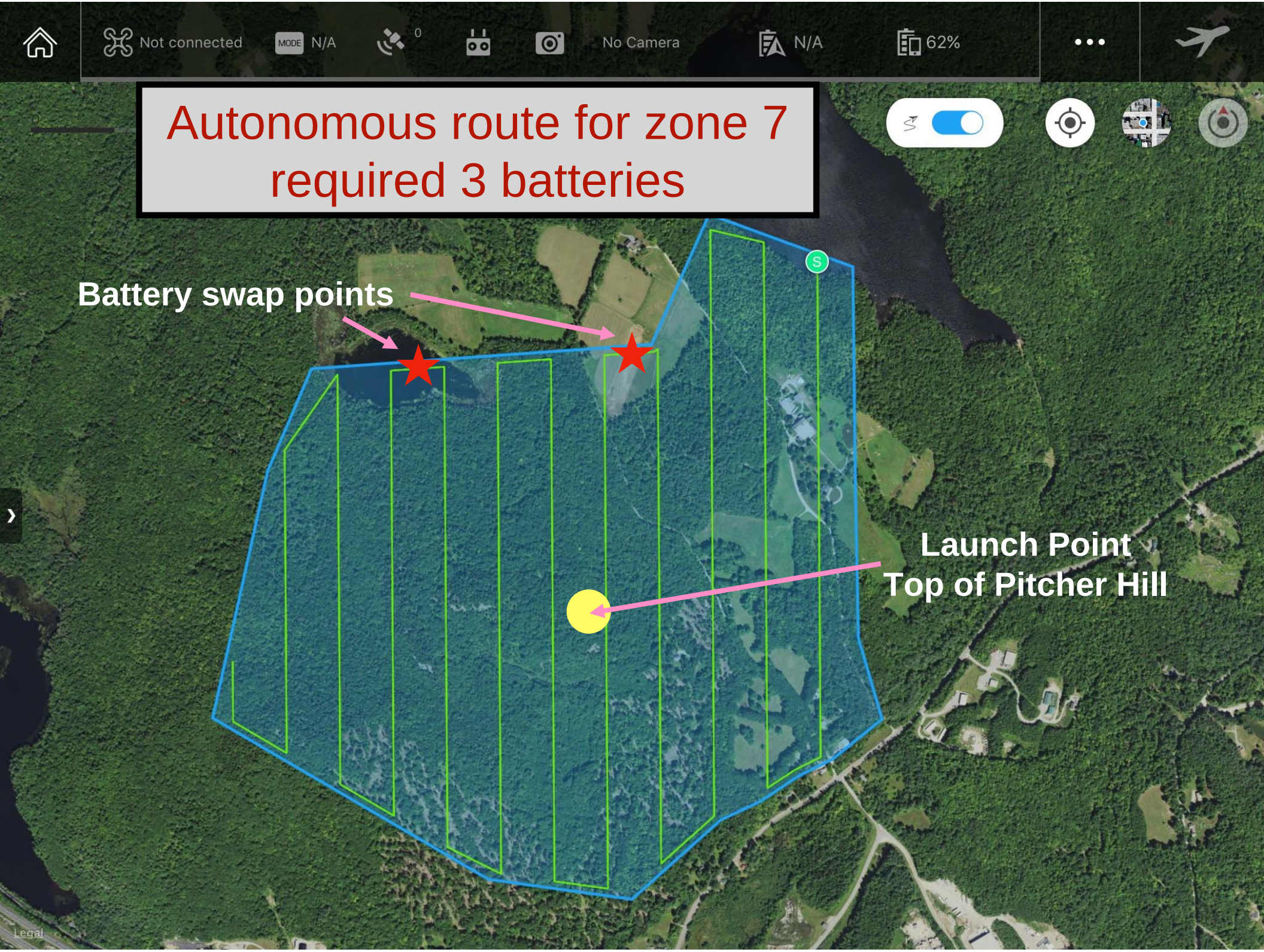
Each dot on the dot map is the center of a rectangular photo

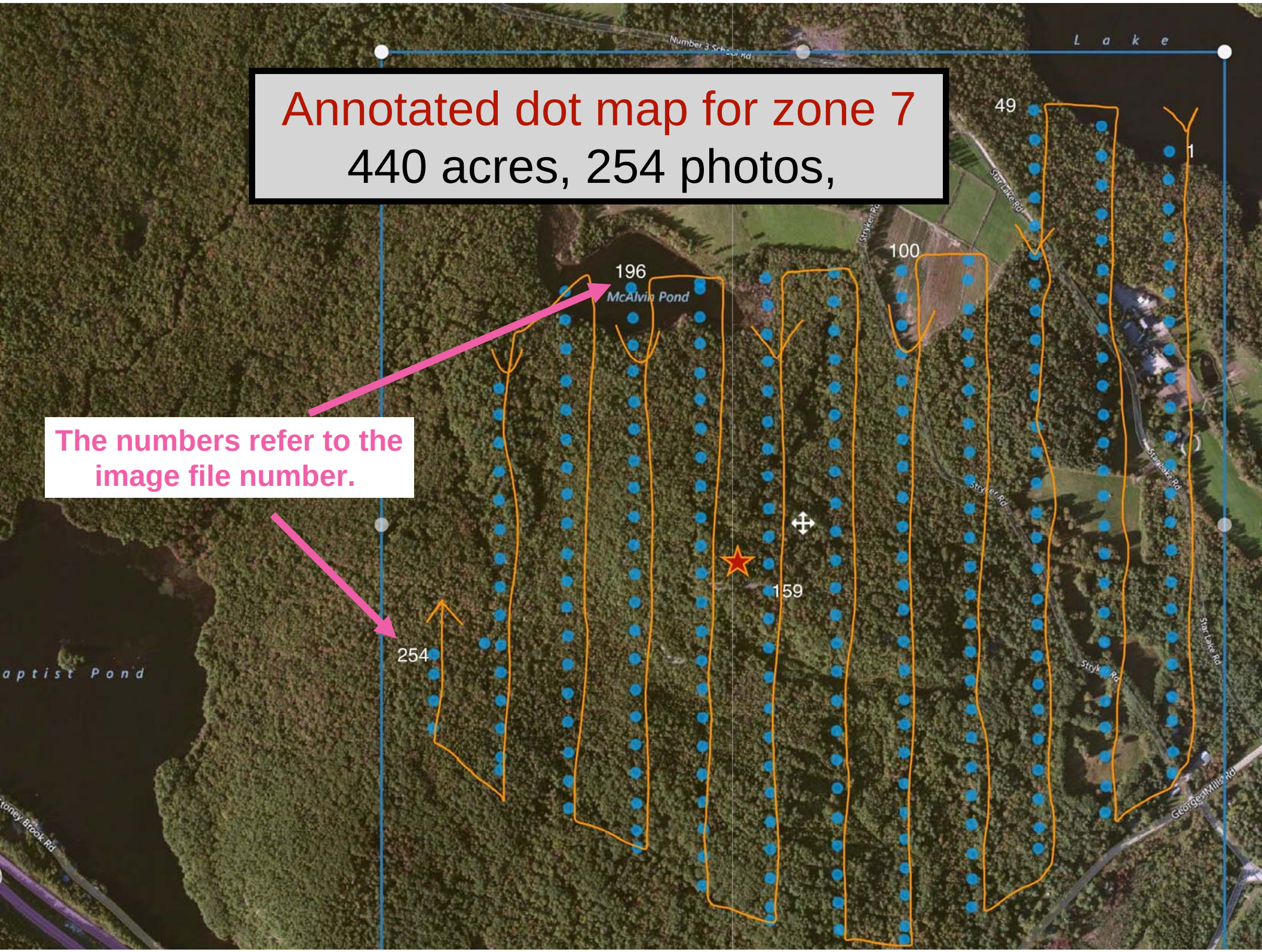
Image #3

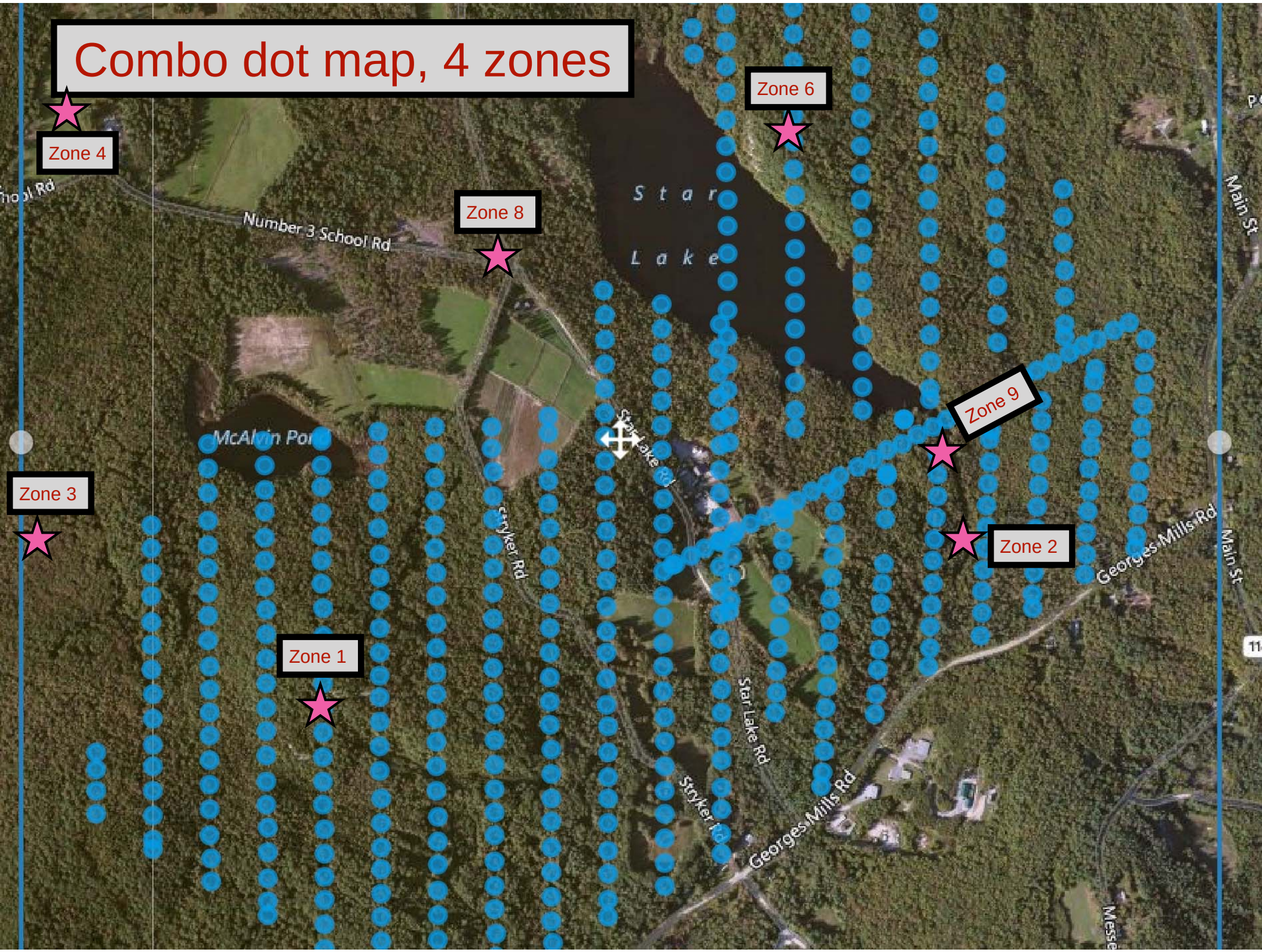



Actual Monitoring Photo
Zone 4, Photo #3


Same image
zoomed in


Not connected
MODE N/A
0
No Camera
N/A
62%
Autonomous route for zone 7
required 3 batteries
Battery swap points
Launch Point
Top of Pitcher Hill
S
Legal

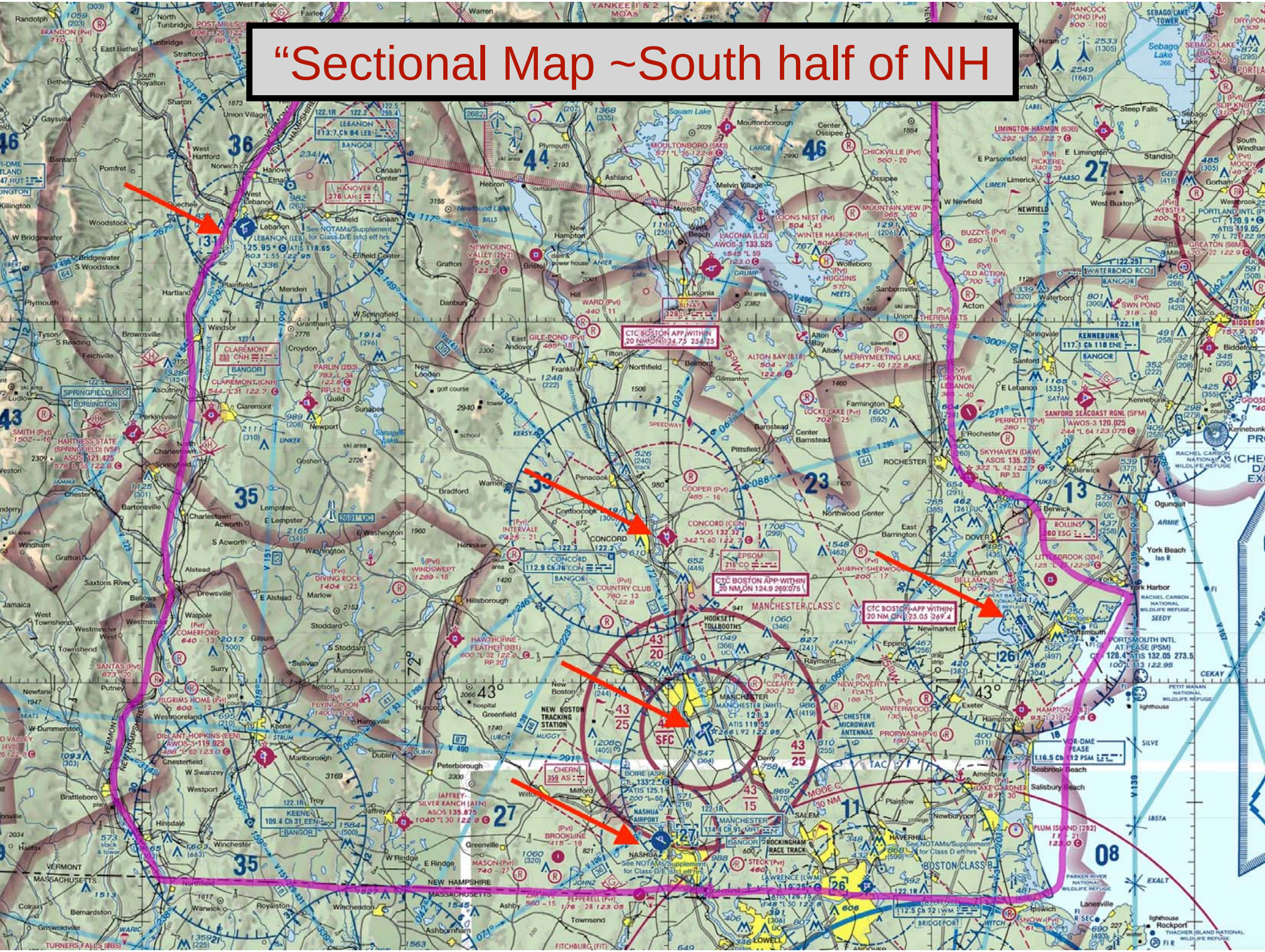

Annotated dot map for zone 7
440 acres, 254 photos,
The numbers refer to the image file number.
196
McAlvin Pond
100
49
1
159
254
Lake
Number 3 School Rd
Star Lake Rd
Stryker Rd
Georges Mills Rd
Stoney Brook Rd


Combo dot map, 4 zones
Zone 4
Zone 6
Zone 8
Zone 9
Zone 3
Zone 2
Zone 1
Number 3 School Rd
Star Lake
McAlvin Pond
Stryker Rd
Star Lake Rd
Georges Mills Rd
Main St

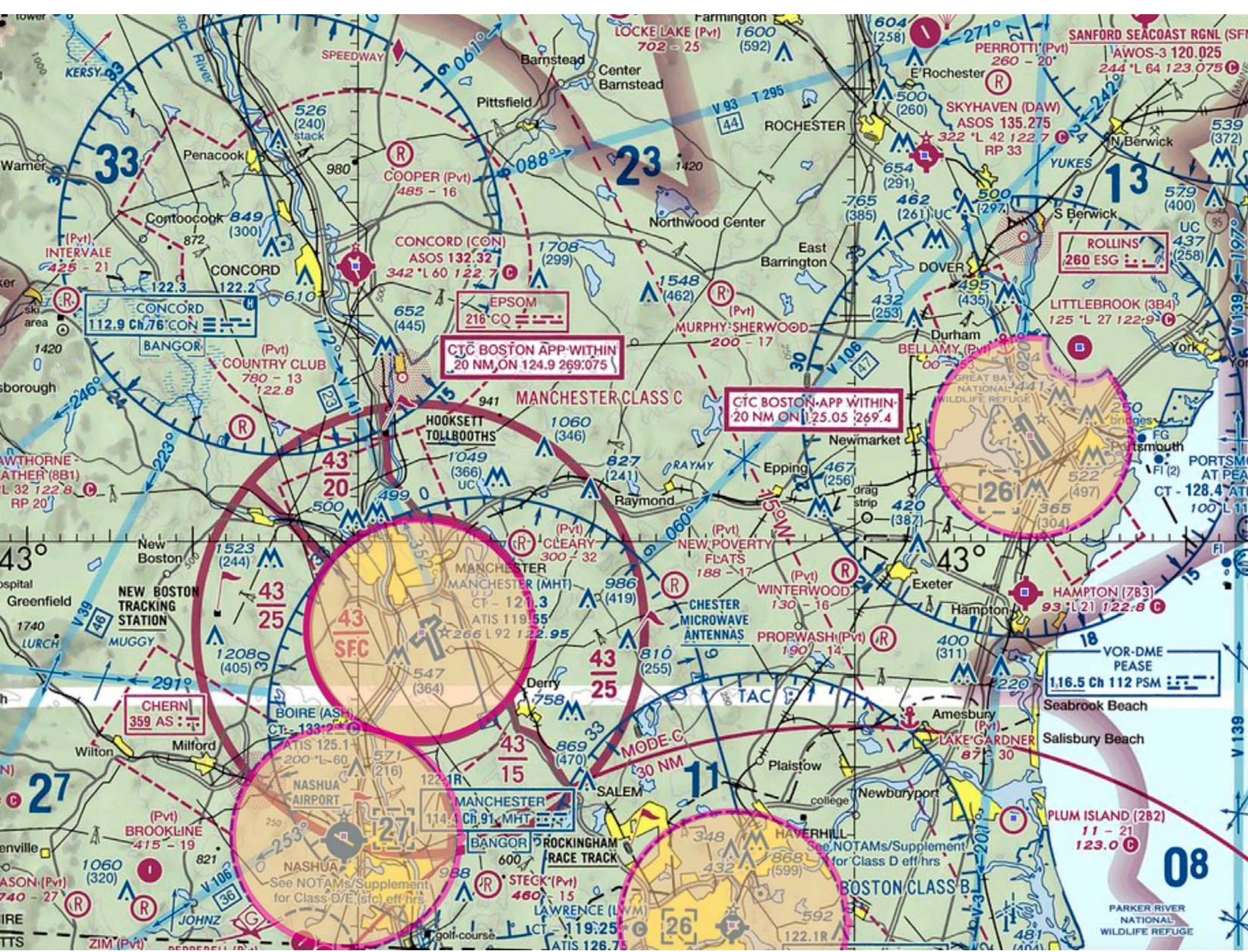

Example of “scenic pictures”
taken for promotional purposes

FAA Regulations

- FAA commercial UAS license required for anything done “in furtherance of a business” (known as Part 107)
- 400’ altitude above ground level
- not over people, not at night
- visual line of sight
- comply with sectional map restrictions, ie controlled airspace like airports


“Sectional Map ~South half of NH

LOCKE LAKE (Pvt)
702 – 25
Farmington
1600
(592)
604
(258)
SANFORD SEACOAST RGNL
AWOS-3 120.025
244 *L 64 123.075 C
PERROTTI (Pvt)
260 – 20
E Rochester
KERSY
SPEEDWAY
Barnstead
Center Barnstead
Pittsfield
V 93
T 295
44
ROCHESTER
500
(260)
SKYHAVEN (DAW)
ASOS 135.275
322 *L 42 122.7 C
RP 33
539
(372)
N Berwick
YUKES
33
23
13
526
(240)
stack
980
Penacook
COOPER (Pvt)
485 – 16
088°
061°
271°
242°
Warner
Contoocook
849
(300)
872
1420
Northwood Center
654
(291)
462
(261) UC
500
(297)
S Berwick
579
(400)
UC
437
(258)
(Pvt)
INTERVALE
425 – 21
CONCORD
CONCORD (CON)
ASOS 132.32
342 *L 60 122.7 C
1708
(299)
East Barrington
DOVER
ROLLINS
260 ESG
-765
(385)
CONCORD
112.9 Ch 76 CON
BANGOR
122.3
122.2
EPSOM
216 CO
1548
(462)
(Pvt)
MURPHY-SHERWOOD
200 – 17
495
(435)
432
(253)
LITTLEBROOK (3B4)
125 *L 27 122.9 C
652
(445)
ski area
1420
(Pvt)
COUNTRY CLUB
780 – 13
122.8
CTC BOSTON APP WITHIN
20 NM ON 124.9 269.075
Durham
BELLAMY (Pvt)
00 – 53
York
GREAT BAY NATIONAL WILDLIFE REFUGE
sborough
246°
223°
172°
V 141
23
941
MANCHESTER CLASS C
CTC BOSTON APP WITHIN
20 NM ON 125.05 269.4
V 106
47
HOOKSETT TOLLBOOTHS
1060
(346)
Newmarket
441
250
bridges
Portsmouth
AWTHORNE
ATHER (8B1)
L 32 122.8 C
RP 20
43
20
1049
(366)
UC
827
(241)
RAYMY
Epping
467
(256)
drag strip
522
(497)
PORTSM
AT PEA
CT - 128.4 ATI
100 L 11
126
365
(304)
499
500
Raymond
420
(387)
43°
New Boston
1523
(244)
ospital
43
25
(Pvt)
CLEARY
300 – 32
(Pvt)
NEW POVERTY FLATS
188 – 17
MANCHESTER
MANCHESTER (MHT)
CT – 121.3
ATIS 119.55
266 L 92 122.95
986
(419)
Exeter
43°
HAMPTON (7B3)
93 *L 21 122.8 C
Hampton
Greenfield
NEW BOSTON TRACKING STATION
(Pvt)
WINTERWOOD
130 – 16
CHESTER MICROWAVE ANTENNAS
V 39
46
1740
LURCH
MUGGY
1208
(405)
43
SFC
PROPWASH (Pvt)
190 – 14
400
(311)
810
(255)
VOR-DME
PEASE
116.5 Ch 112 PSM
291°
547
(364)
Derry
758
43
25
TAC
CHERN
359 AS
BOIRE (ASH)
CT - 133
ATIS 125.1
200 *L 60
Amesbury
Seabrook Beach
Salisbury Beach
LAKE GARDNER (Pvt)
87 – 30
Wilton
Milford
571
(216)
869
(470)
43
15
MODE C
30 NM
Plaistow
V 139
27
NASHUA AIRPORT
122.1R
MANCHESTER
114.4 Ch 91 MHT
BANGOR
SALEM
11
college
Newburyport
(Pvt)
BROOKLINE
415 – 19
253°
27
ROCKINGHAM RACE TRACK
600
348
HAVERHILL
See NOTAMs/Supplement for Class D eff hrs
868
(599)
PLUM ISLAND (2B2)
11 – 21
123.0 C
08
821
NASHUA
988
STECK (Pvt)
460 – 15
BOSTON CLASS B
1060
(320)
V 106
36
See NOTAMs/Supplement for Class D/E (sfc) eff hrs
LAWRENCE (LWM)
CT – 119.25 C
ATIS 126.75
26
592
122.1R
481
PARKER RIVER NATIONAL WILDLIFE REFUGE
ASON (Pvt)
740 – 27
JOHNZ
golf course
ZIM (Pvt)


MANCHESTER CLASS C
CTC BOSTON APP WITHIN 20 NM ON 124.9 269.075
CTC BOSTON APP WITHIN 20 NM ON 125.05 269.4
BOSTON CLASS B
CONCORD (CON) ASOS 132.32
MANCHESTER (MHT)
CT - 121.3
ATIS 119.55
MANCHESTER 114.1 Ch 91 MHT
CONCORD 112.9 Ch 76 CON
EPSOM 216 CO
ROLLINS 260 ESG
SKYHAVEN (DAW) ASOS 135.275
SANFORD SEACOAST RGNL (SFM)
AWOS-3 120.025
HAMPTON (7B3)
VOR-DME PEASE 116.5 Ch 112 PSM
CHERN 359 AS
BOIRE (ASH)
NASHUA AIRPORT
NASHUA See NOTAMs/Supplement for Class D/E (sfc) eff hrs
HAVERHILL See NOTAMs/Supplement for Class D eff hrs
LAWRENCE (LWM)
CT - 119.25
ATIS 126.75
BANGOR
ROCKINGHAM RACE TRACK
HOOKSETT TOLLBOOTHS
NEW BOSTON TRACKING STATION
CHESTER MICROWAVE ANTENNAS
MODE C 30 NM
TAC
PARKER RIVER NATIONAL WILDLIFE REFUGE
GREAT BAY NATIONAL WILDLIFE REFUGE
LOCKE LAKE (Pvt) 702 – 25
PERROTTI (Pvt) 260 – 20
COOPER (Pvt) 485 – 16
INTERVALE (Pvt) 425 – 21
COUNTRY CLUB (Pvt) 780 – 13 122.8
MURPHY SHERWOOD (Pvt) 200 – 17
CLEARY (Pvt) 300 – 32
NEW POVERTY FLATS (Pvt) 188 – 17
WINTERWOOD (Pvt) 130 – 16
PROPWASH (Pvt) 190 – 14
LAKE GARDNER (Pvt) 87 – 30
BROOKLINE (Pvt) 415 – 19
STECK (Pvt) 460 – 15
PLUM ISLAND (2B2) 11 – 21 123.0
LITTLEBROOK (3B4) 125 L 27 122.9
KERSY
MUGGY
LURCH
JOHNZ
RAYMY

Other Regulations
as best as I can determine

- No NH state laws at this point, other than a minor one about not harassing hunters. Other laws about privacy and recklessness would apply
- Not aware of any local community regulations in NH, and it is possible that such regulations would be struck down in court
- National Forest is case by case, but White Mountains seem to be open for drone flying
- National parks & NH state parks do not have drone prohibitions
- Regulating the airspace is a huge area of legal controversy, things will evolve quickly and be in the courts.

Etiquette & Courtesies

- Communicate with air ambulance operators + small airports
- Drone pilots need to work hard to NOT irritate citizens. The main issues are privacy and noise
- Fears also relate to concerns about bystander injuries. I am not aware of any serious injury caused by a drone.
- Do not intrude on people. Be communicative, offer photos to bystanders
- Don’t be distracted by bystanders
- **FLY SAFELY!**

How much does it cost to do this work

- Each property poses unique challenges, so this work is done on an hourly basis. Here are two examples:
  - Star Lake Farm was c. 1600 acres, divided in to 9 zones. That entailed 2.5 hours of prep work, 9.5 hrs of on-site flying, 2 hrs of post-production = 14 hours @ $100 per hr
  - 5 Bradford properties in one day, ranging from 136-318 acres: 11.5 hours total
- If we can drive to launch location = easy + fewer hours
- Bushwhacking up steep slopes = harder and more cost
- Travel time can add to the cost of a project

Resources

- iOS app for automatically flying and taking pictures: **GSPro** (only iOS)
- Web-based service for creating dot maps: **DroneDeploy.com**
- Map system for locating conservation boundaries and topo information: **granitview.unh.edu**
- FAA Sectional Maps: **vfrmap.com**
- Basic rules for commercial drone pilots: **faa.gov/uas/getting_started/fly_for_work_business/**
- Example of promotional movie for Ausbon Sargent: find easily on **ausbonsargent.org**
- Peter Bloch's contact info: **peterbloch@woodshades.com** **www.earthaerialproductions.com**