

UAS's, Current Legislation and Remote Sensing

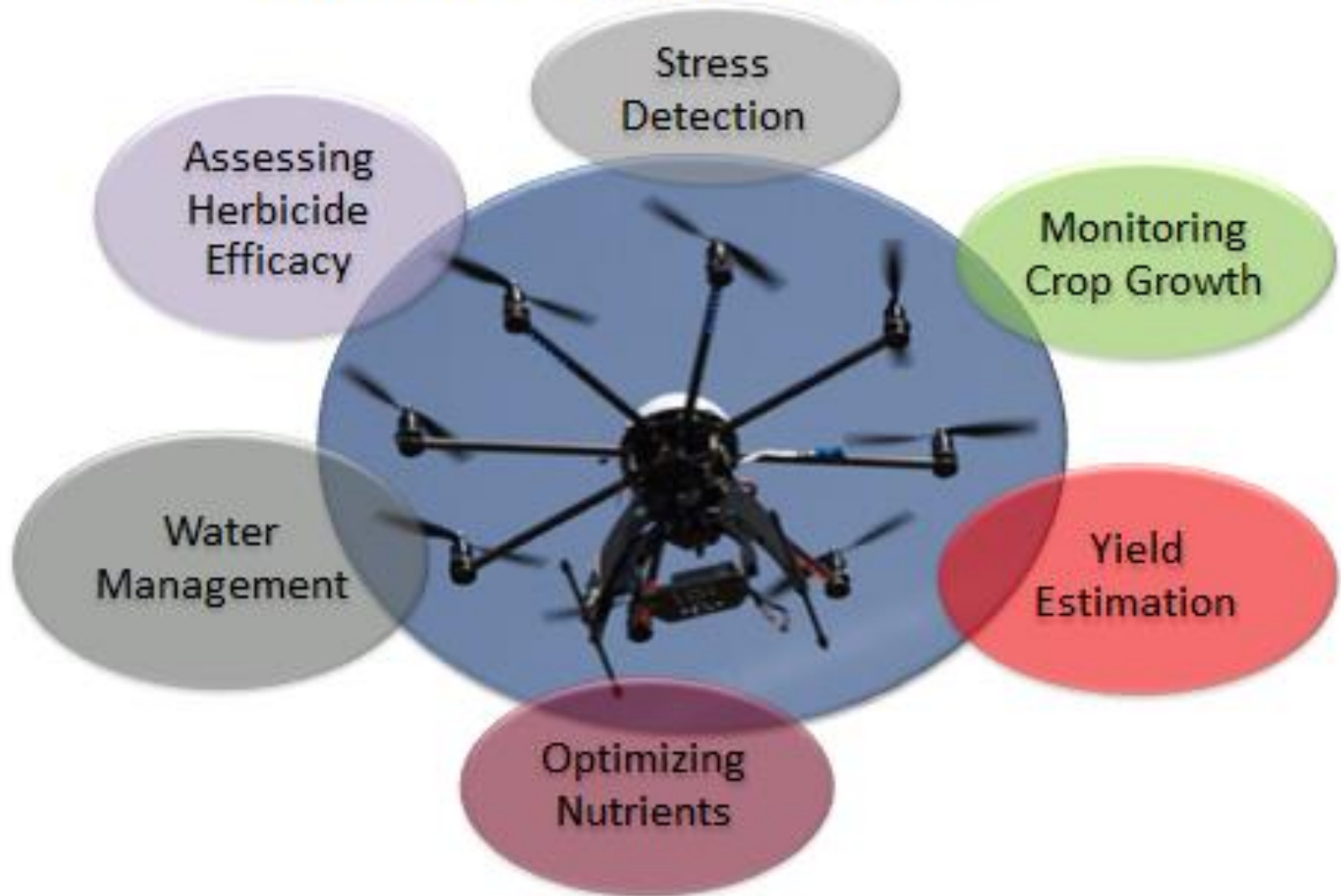
Glen C Rains

Professor

Department of Entomology



UAVs in Agriculture





DJI Spraying UAV



Yamaha helicopter spraying crops in Japan

Major Concerns

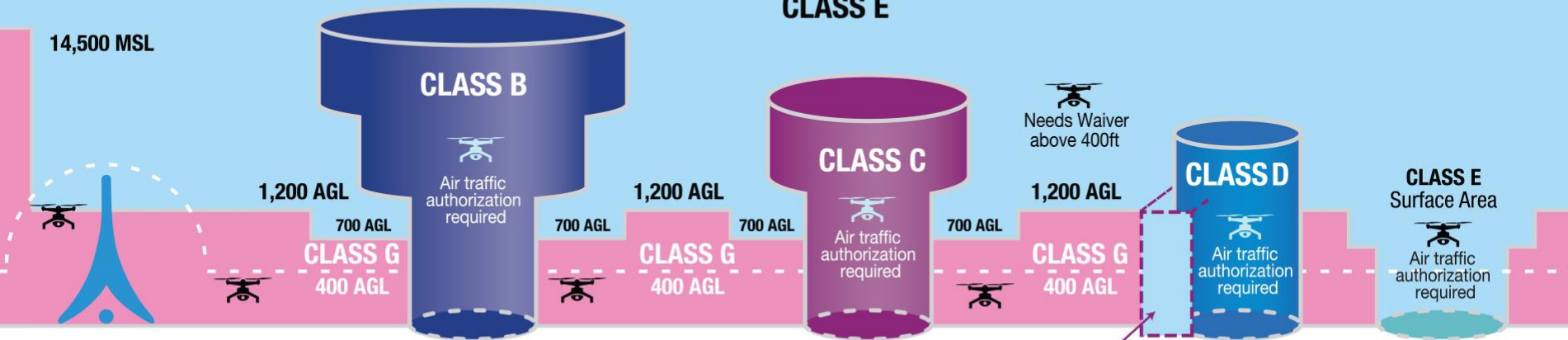
- Safety (FAA)
 - Aircraft out of control
 - Shared Airspace
 - Too near take-off and landing (airport)
 - Crop Dusters
 - Large Urban Populations
- Privacy (State)
- Law Enforcement (State)



FL 600
18,000 MSL

CLASS A

CLASS E



AGL Above Ground Level
FL Flight Level
MSL Mean Sea Level

Class E Surface Extension

Airspace Guidance for Small UAS Operators



Federal Aviation Administration

- FAA ensures the safety of airspace
 - Less than 400 ft
 - Controlled Airspace
 - Line of sight
 - Nighttime
 - Operations over people
- sUAS rules
 - Small UAS (sUAS) are UAS that are less than 55 lbs and over 0.55 lbs
 - Applicable to agricultural operations

FAA CFR Rules

The drone community flies under Parts 49, 89, 91, 107, 137

- Part 89
 - Remote ID (Now in effect)
- Part 107 (remote UAS pilots license)
 - Registered drone
 - drone pilots license – take a knowledge test
 - Operated according to restrictions in part 107
 - Waivers BVLOS, nighttime, above 400', 55 lb limit
- Part 137 (dropping pesticides, fertilizer etc.. From drone, Poisons)
 - Agricultural Aircraft Operations for dispensing
 - Must have a part 137 and part 107 license for flying and dispensing and certified in an appropriate category
 - Must file exemption via FAA Part 47 process (time-consuming and tricky)
 - State commercial applicators license
 - Complete 10 hours of training every 5 years (GA requirement) category 21,34
- Section 44809 Exception for limited recreational operations of unmanned aircraft:
 - (a) Educational and Research Purposes.-For the purposes of section 44809 of title 49, United States Code, as added by this Act, a 'recreational purpose' as distinguished in subsection (a)(1) of such section shall include an unmanned aircraft system operated by an institution of higher education for educational or research purposes

Eligible for 44809 Exception

- (2) The aircraft is operated in accordance with or within the programming of a community-based organization's set of safety guide-lines that are developed in coordination with the Federal Aviation Administration.
- (3) The aircraft is flown within the visual line of sight of the person operating the aircraft or a visual observer co-located and in direct communication with the operator.
- (4) The aircraft is operated in a manner that does not interfere with and gives way to any manned aircraft.
- (5) In Class B, Class C, or Class D airspace or within the lateral boundaries of the surface area of Class E airspace designated for an airport, the operator obtains prior authorization from the Administrator or designee before operating and complies with all airspace restrictions and prohibitions. (LAANC)
- (6) In Class G airspace, the aircraft is flown from the surface to not more than 400 feet above ground level and complies with all airspace restrictions and prohibitions.
- (7) The operator has passed an aeronautical knowledge and safety test described in subsection (g) and maintains proof of test passage (TRUST) to be made available to the Administrator or law enforcement upon request.
- (8) The aircraft is registered and marked in accordance with chapter 441 of this title and proof of registration is made available to the Administrator or a designee of the Administrator or law enforcement upon request.

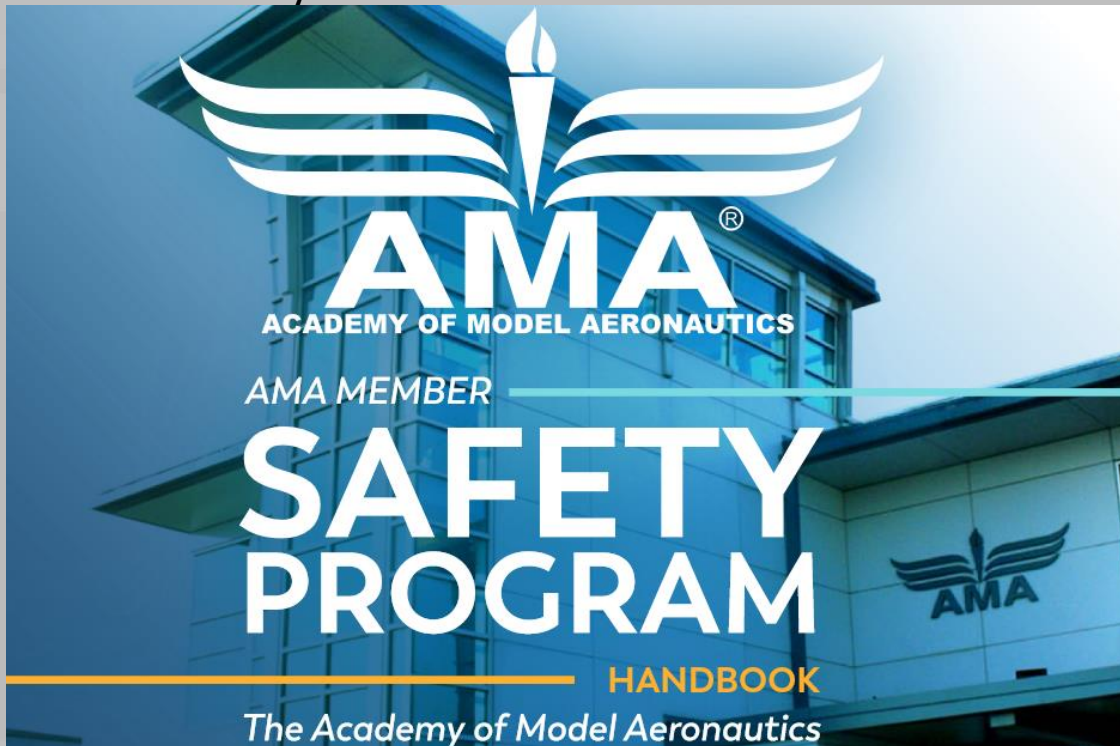


Community-Based Organization

- <https://www.faa.gov/uas/recreationalfliers/faa-recognized-community-based-organizations>

- Academy of Model Aeronautics

<https://www.modelaircraft.org/sites/default/files/documents/100.pdf> Academy of Model Aeronautics Safety Handbook



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Visual line of Sight

- PIC – pilot in charge can be “spotter”
- Must have second “spotter” if using FPV goggles

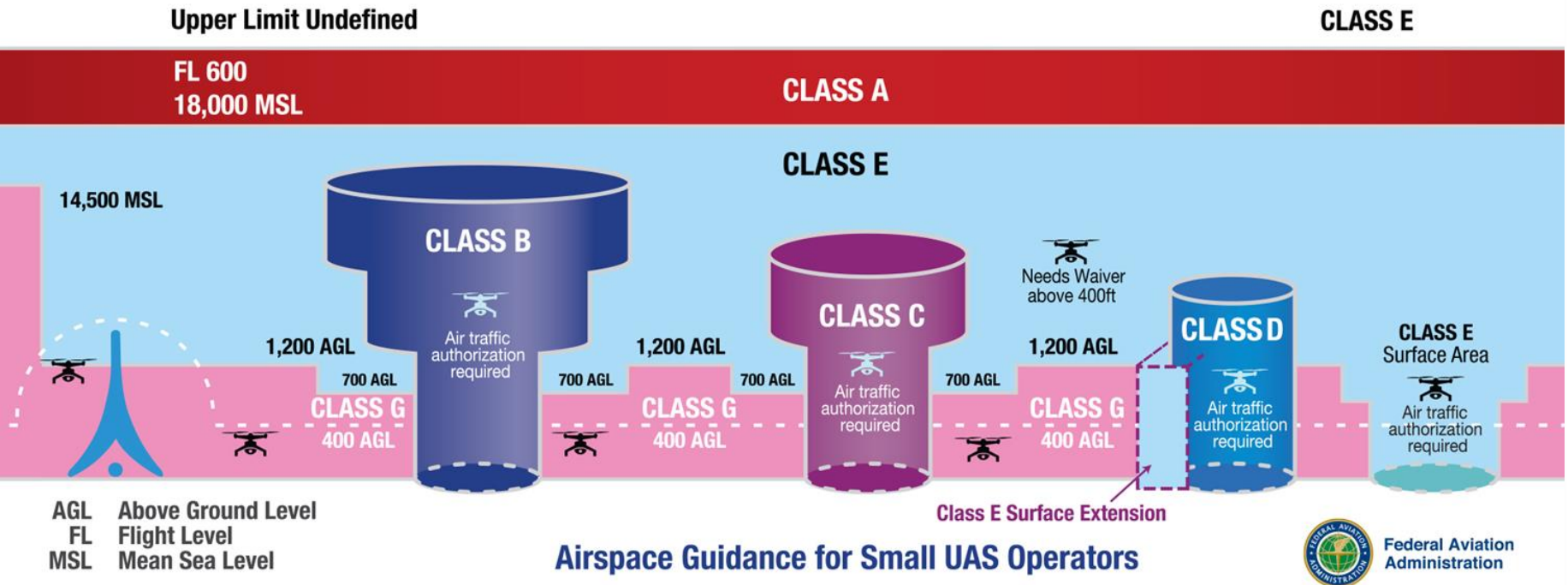


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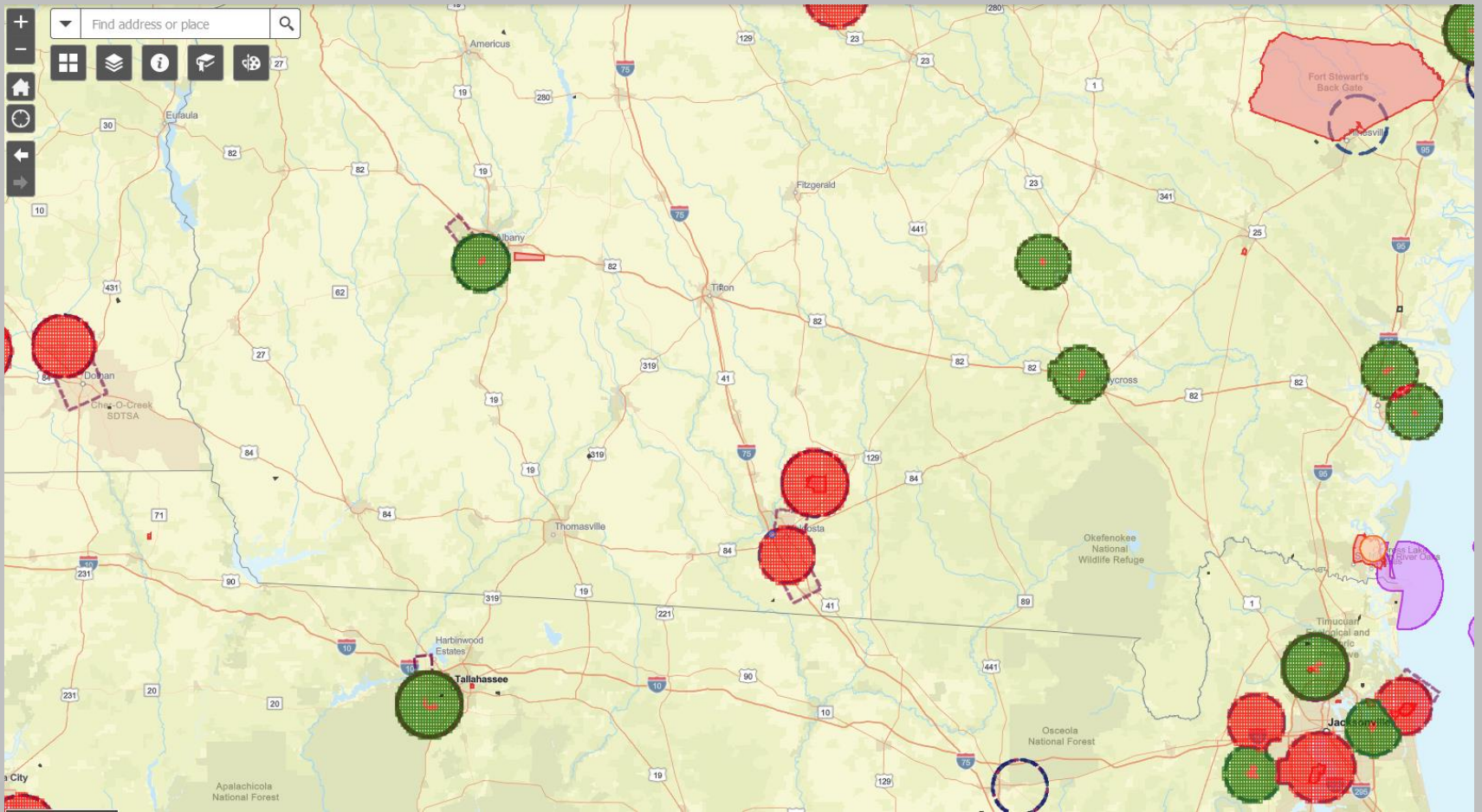
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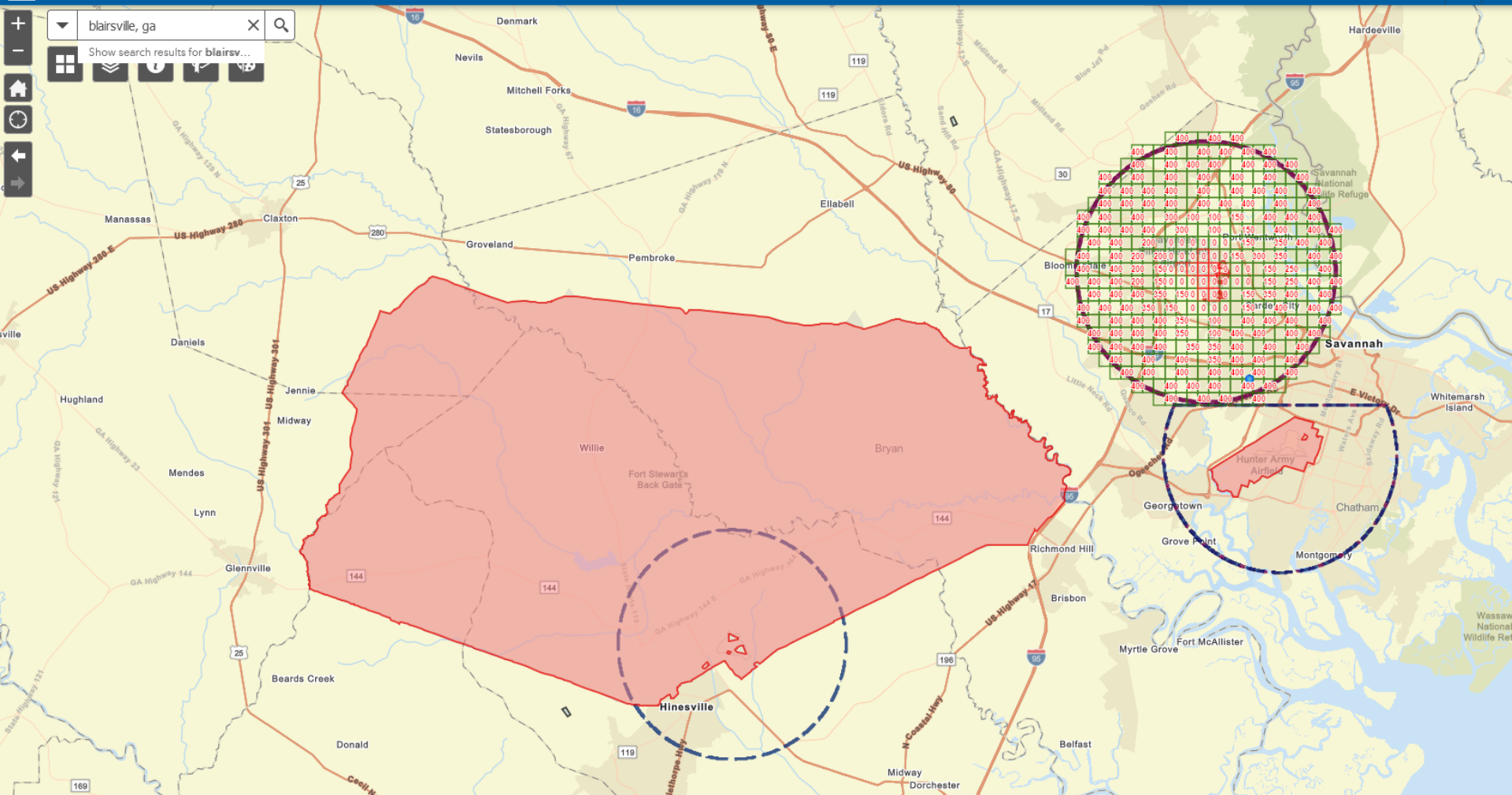


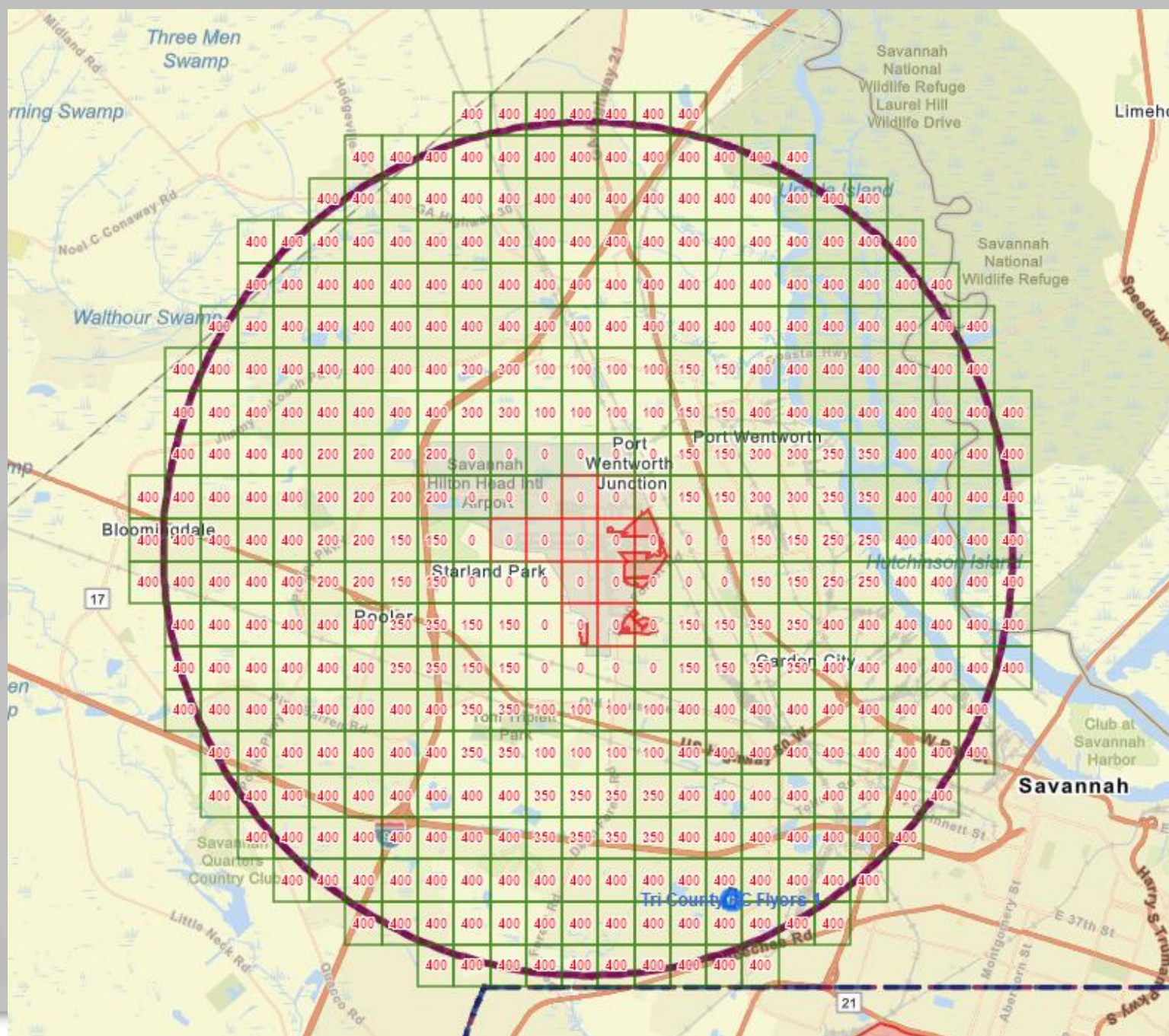
Class Airspace



UAS Data Delivery System - UAS Facility Maps







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Steps for recreational operation??

- Register Drone
 - Must broadcast remote ID (as of Sept 2023)
 - Must make registration mark on outside of drone
 - Keep registration with Drone
- https://www.faa.gov/uas/recreational_flyers
- Take the Recreational UAS Safety Test (TRUST)
 - Free
 - Online – Drone Trust
- Download a B4UFLY App
 - I use the AutoPilot App
 - Use B4UFLY App to determine if you need to fly in controlled airspace (Class B, C, D or E)
 - Get authorization



B4UFLY App

- Information about controlled airspace, special use airspace, critical infrastructure, airports, national parks and military training routes
- Information about Temporary Flight Restrictions for special events.
- A clear status indicator that informs the operator whether it is safe to fly or not.
 - For example, an indicator shows that flying in the Special Flight Rules Area around Washington, D.C. is prohibited.
- Informative, interactive maps with filtering options.
- The ability to check whether it is safe to fly in different locations by searching for a location or moving the location pin.
- Links to other FAA drone resources.
- LAANC service
 - Low Altitude Authorization and Notification Capability
 - Airport has to be part of the program
 - If not, DJI Fly App can get authorization to fly
 - IF not, need to apply for waiver on FAADroneZone

Software

- Photos
- Videos
- Missions (automated take-off, flight path and landing)
- Taking data and making information
 - NDVI (Normalized Difference Vegetative Index)
 - Stitching images together
- Software
 - Pix4D
 - Agisoft
 - DroneDeploy
 - DJI FlightHub2
 - Proprietary software developed in-house
 - DIY – QGIS



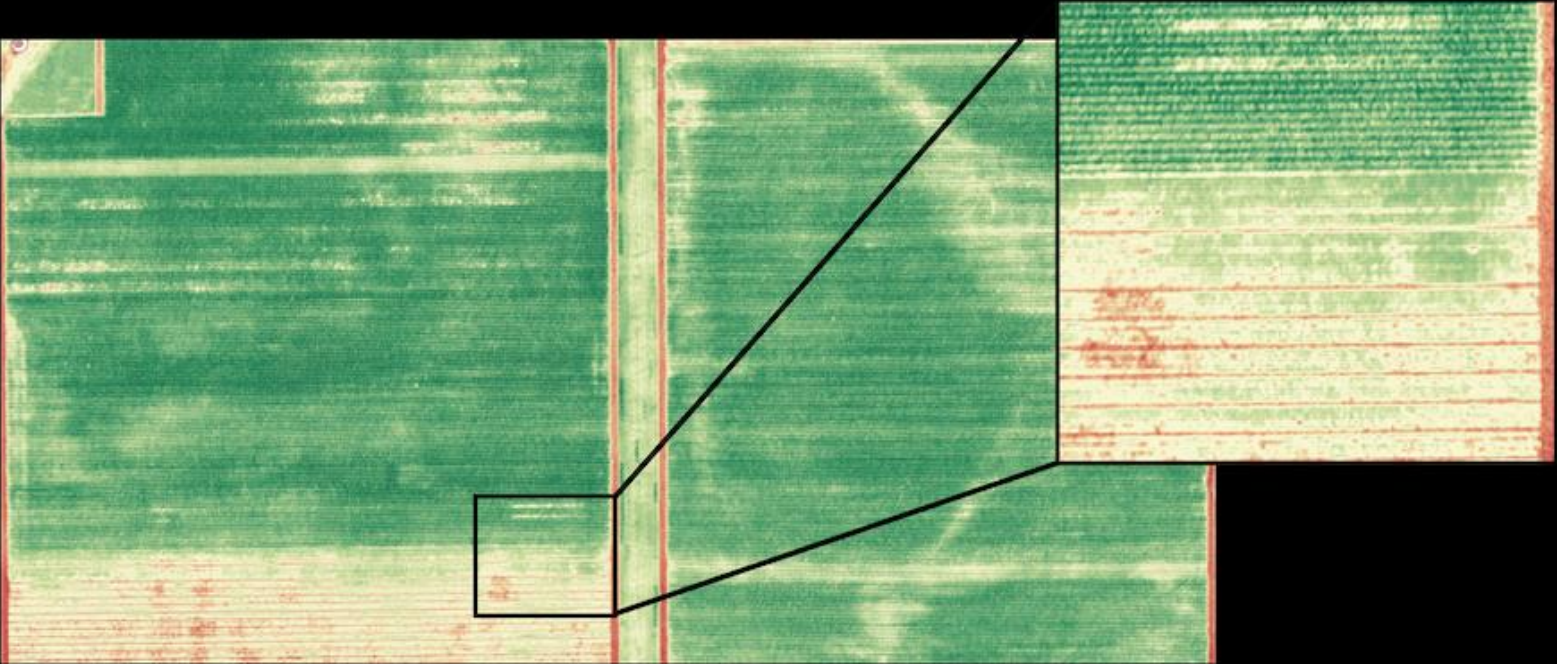
$$\text{NDVI} = \frac{[\text{NIR}-\text{Red}]}{[\text{NIR}+\text{Red}]}$$



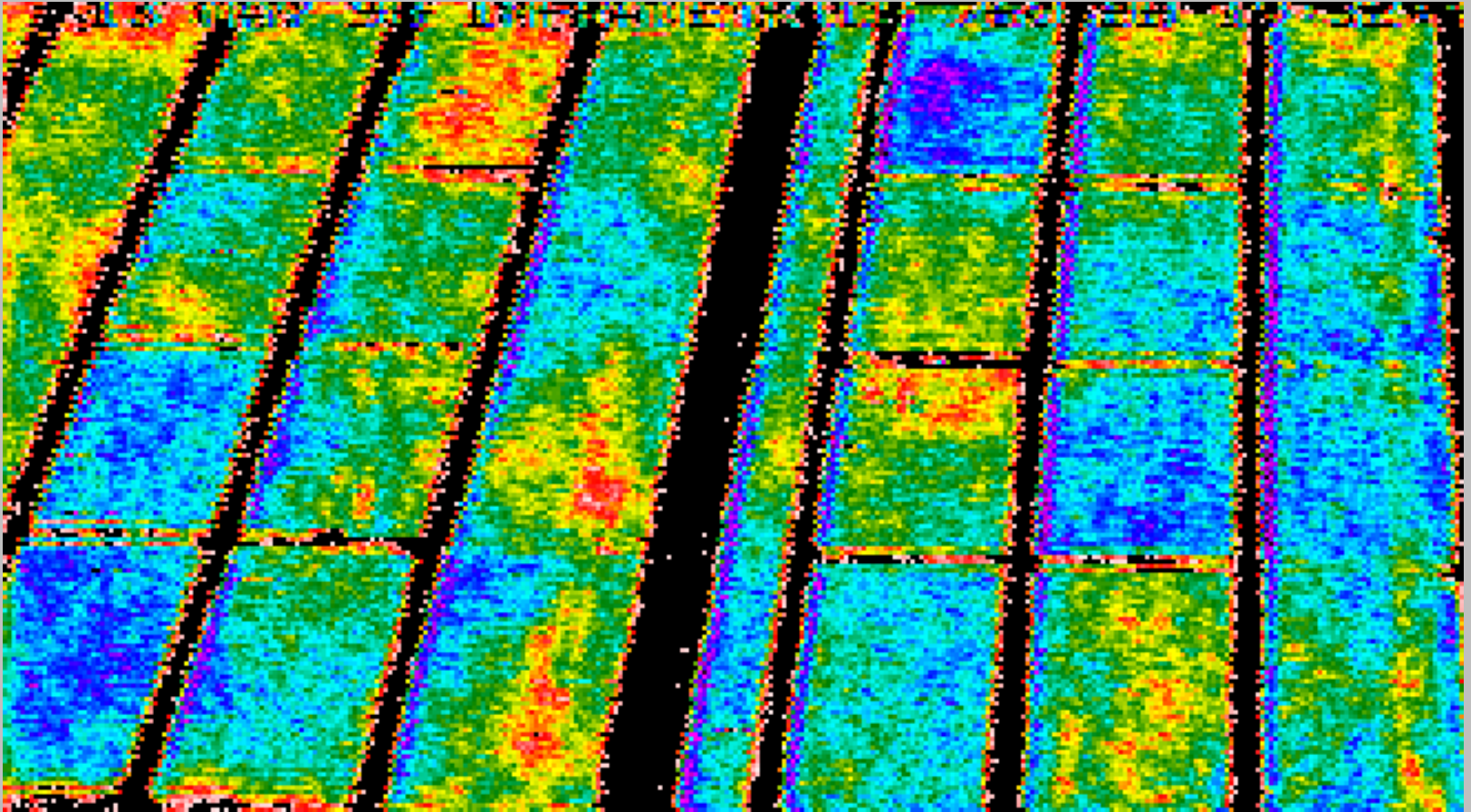
RedEdge on Draganflyer X4 Pro-Ag

GNDVI

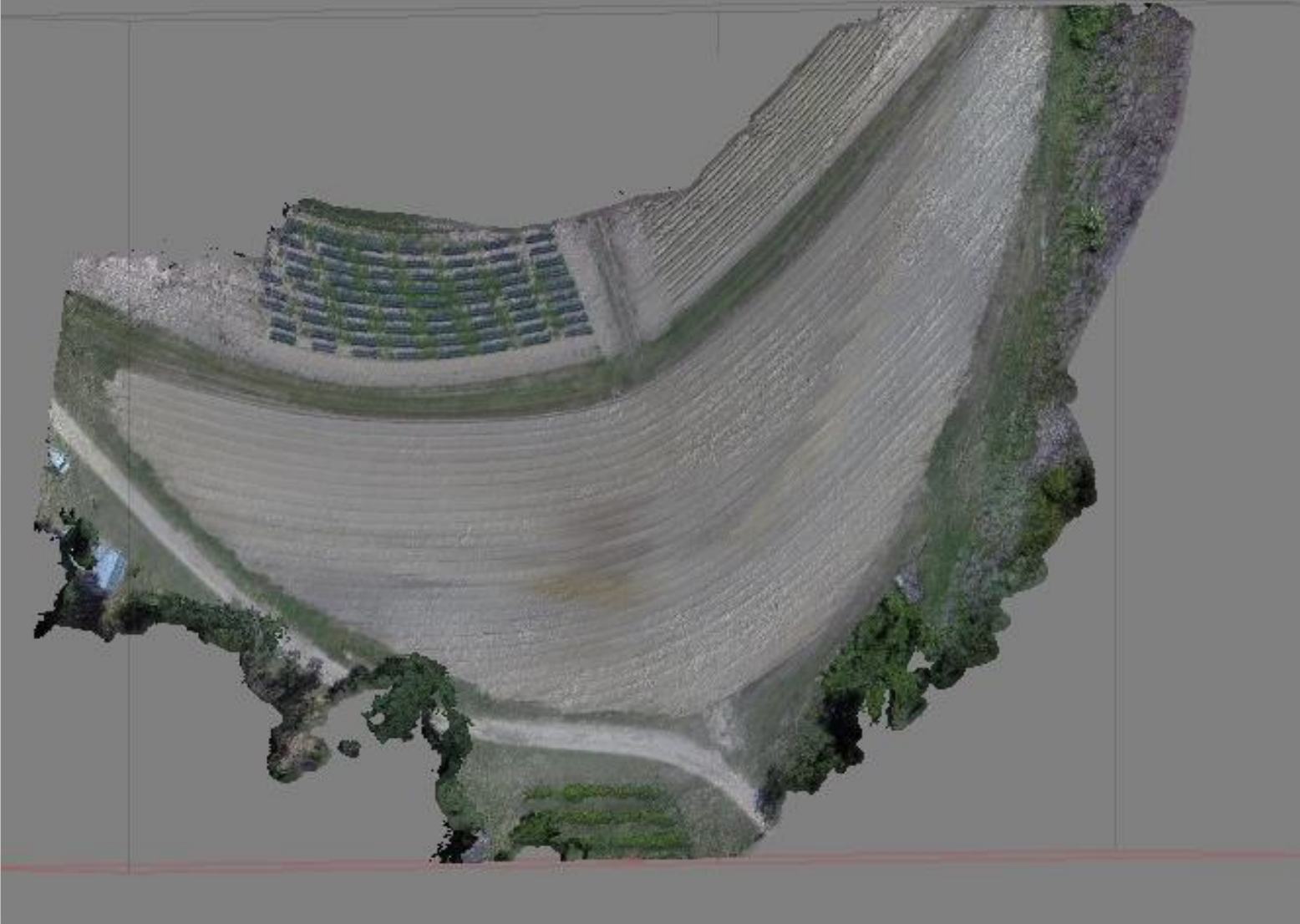
- 0.40
- 0.44
- 0.48
- 0.52
- 0.56
- 0.60
- 0.64
- 0.68
- 0.72
- 0.76
- 0.80
- 0.85



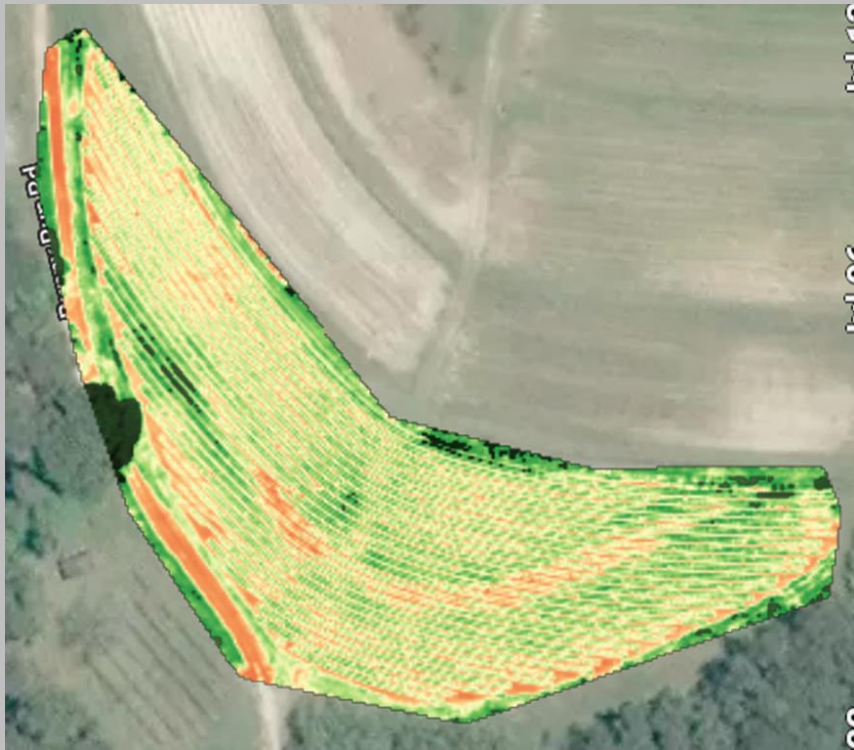
Thermal Imagery



Bare-soil Image

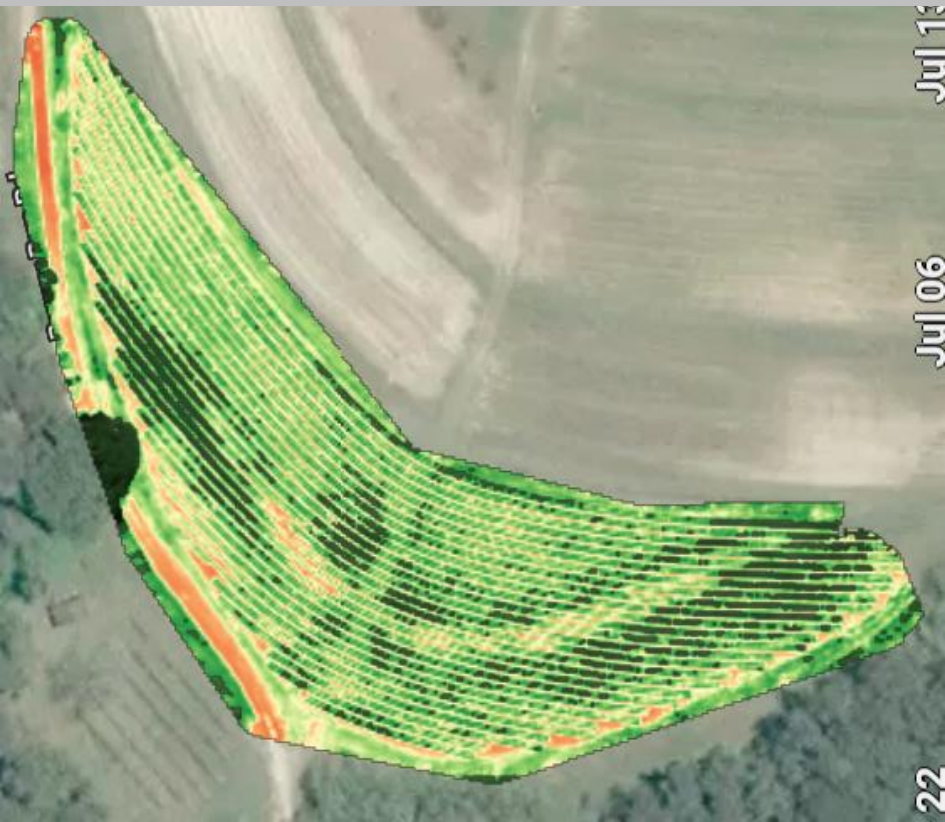


Peanut Field – 1.6 acres



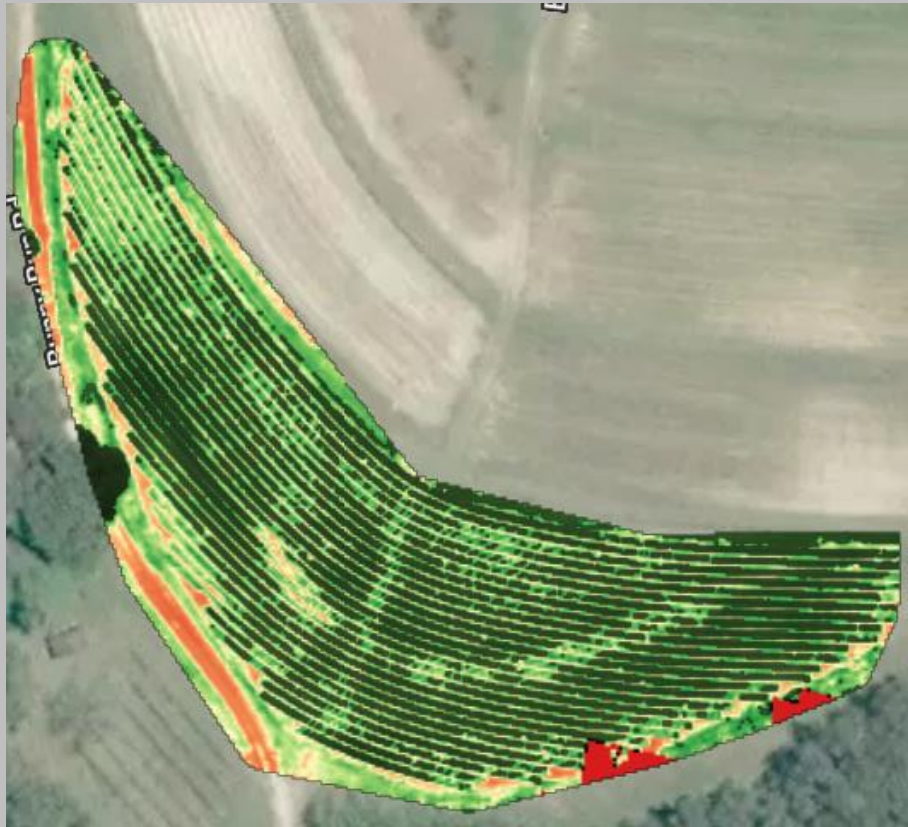
July 6





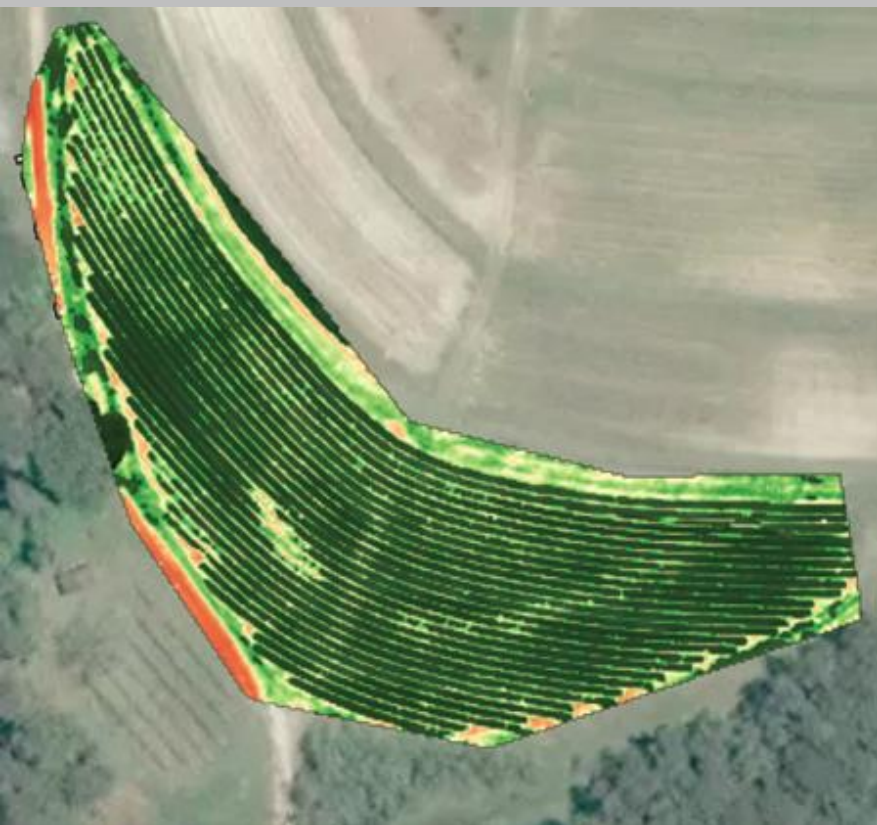
July 13





July 21

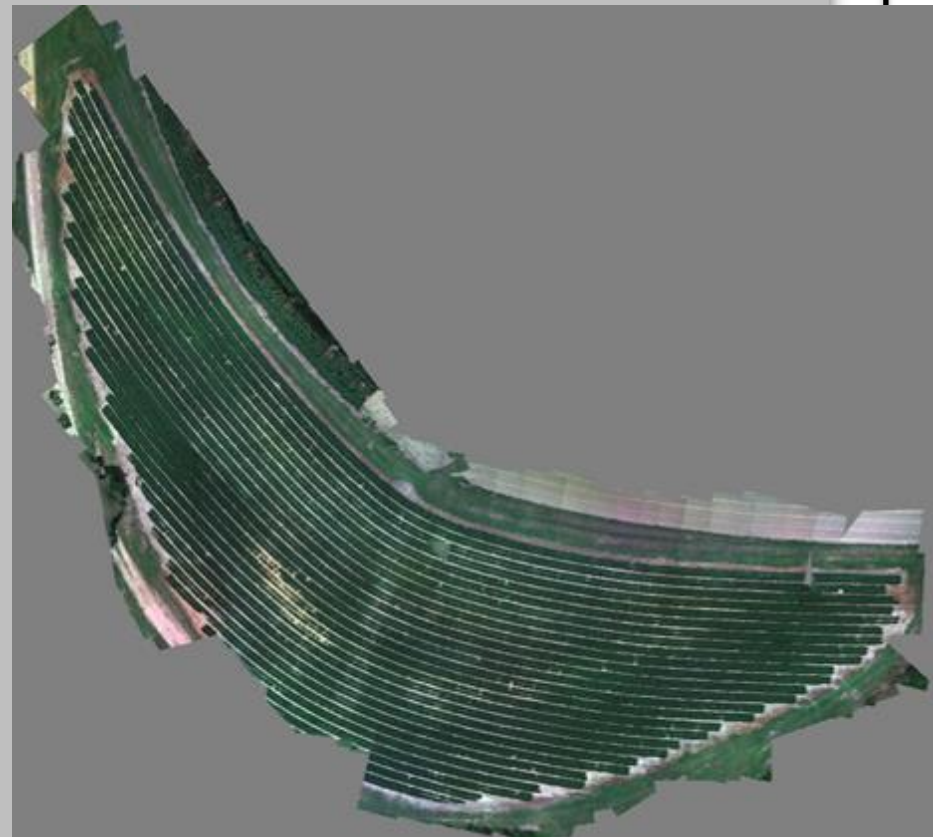


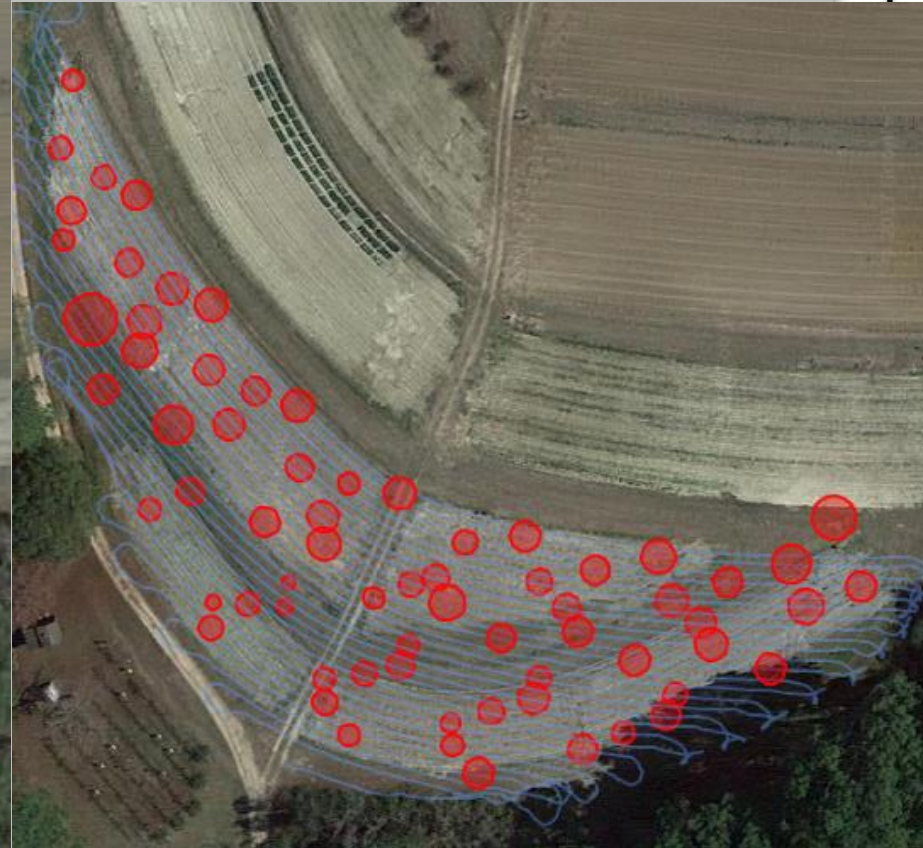


July 30

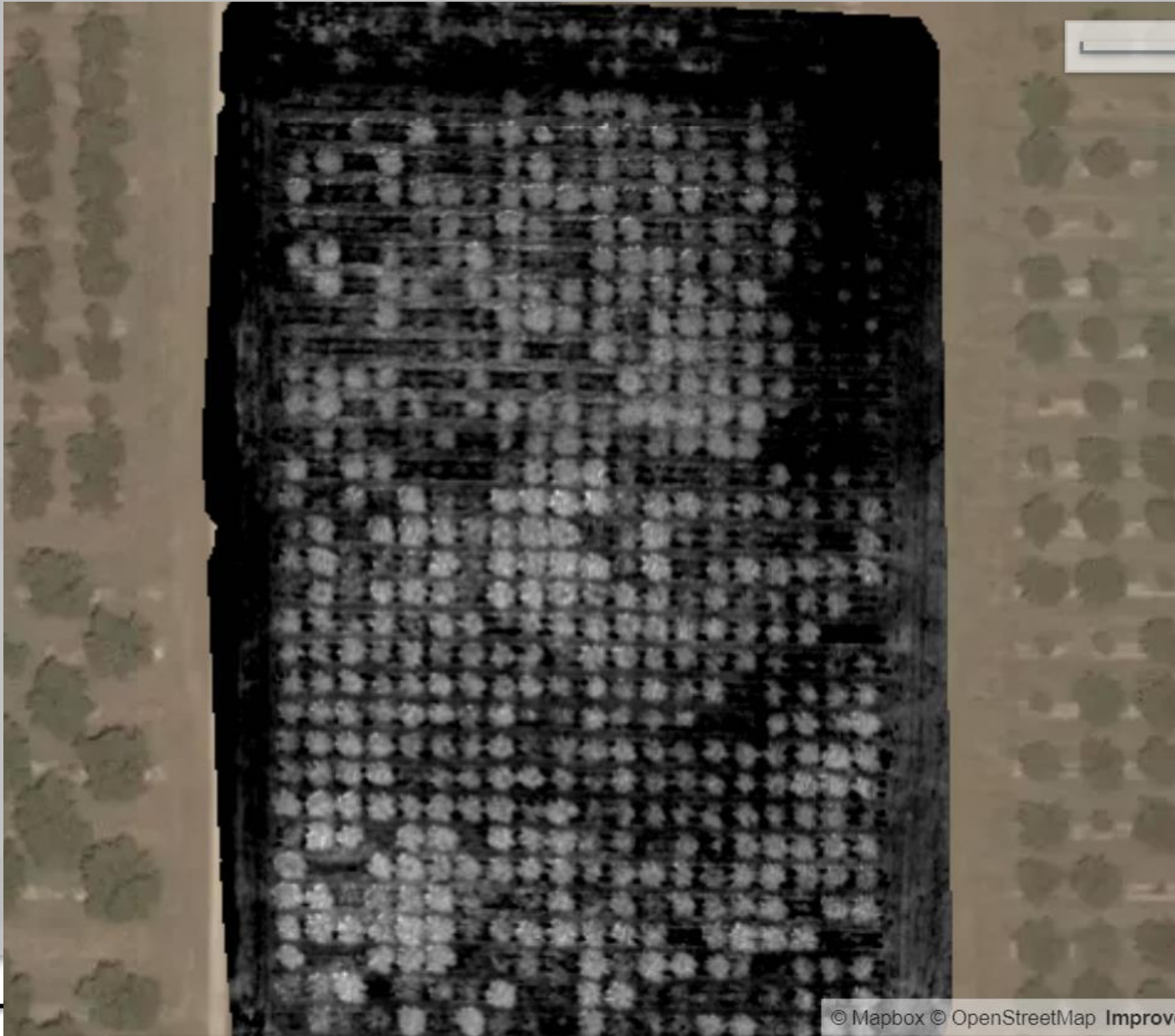


August 16





Peaches





dense_cloud



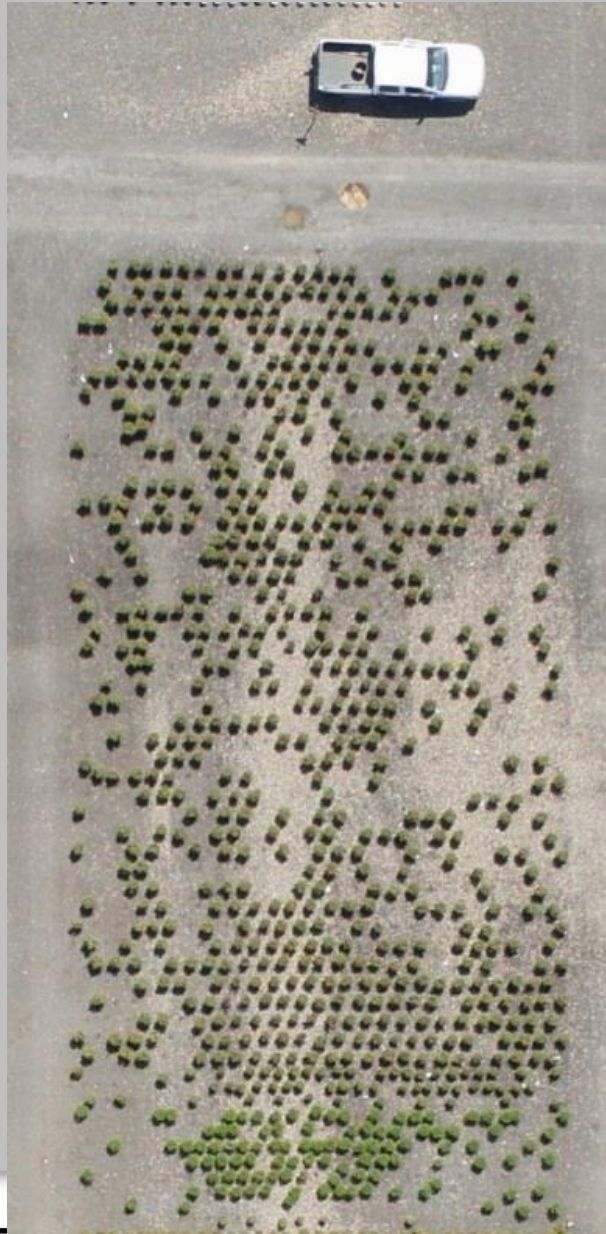
Perspective 30°



faces: 28,430,041 vertices: 24,230,683



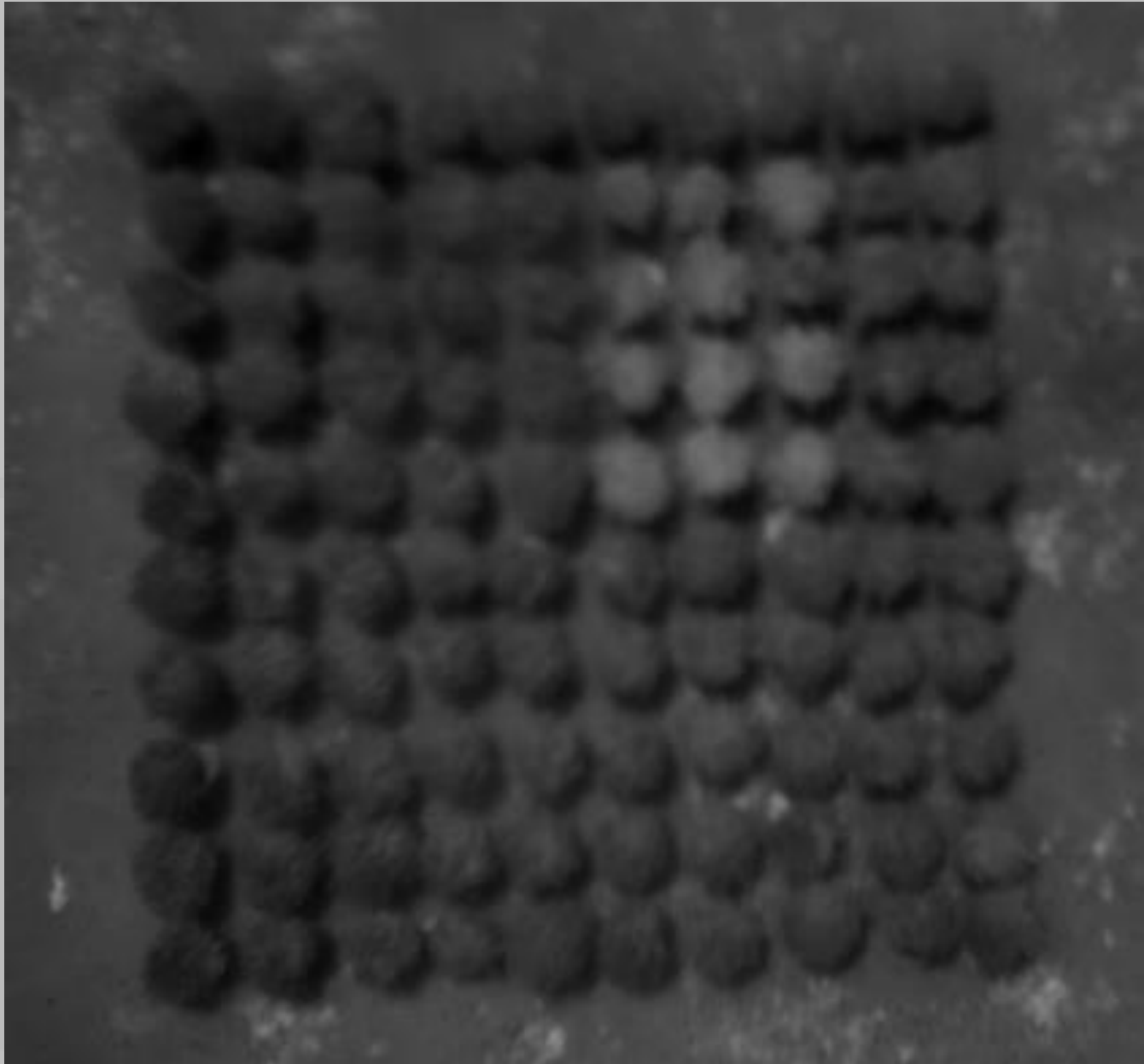
Inventory



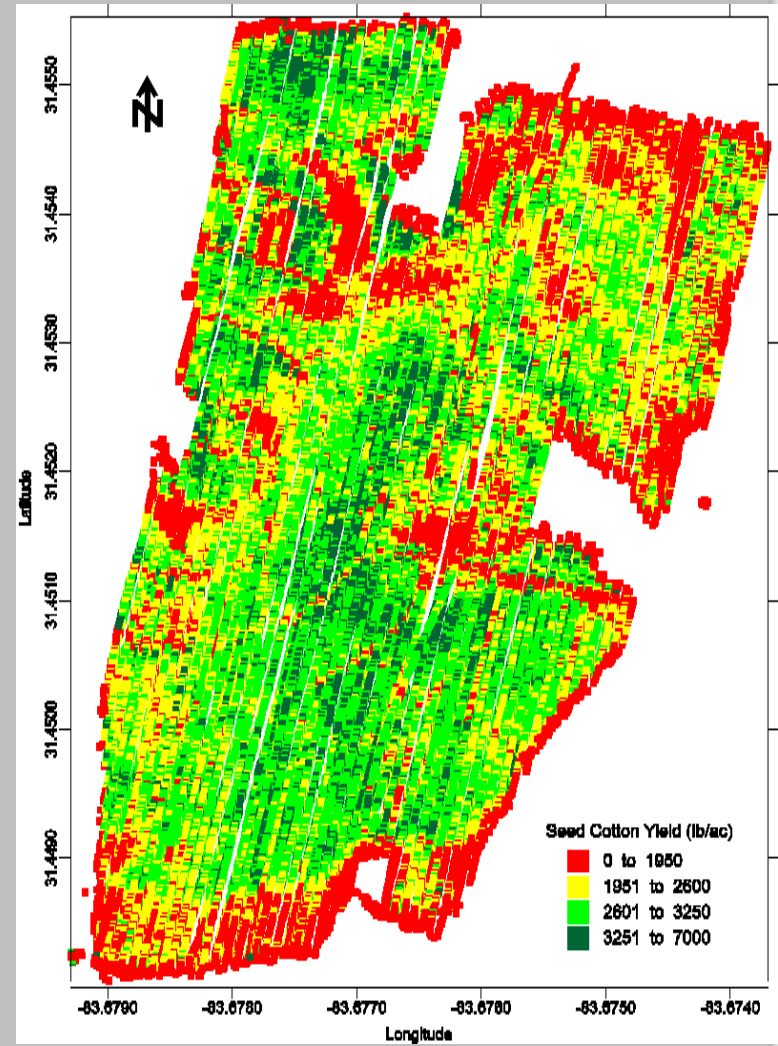
Counting overlapping plants in containers



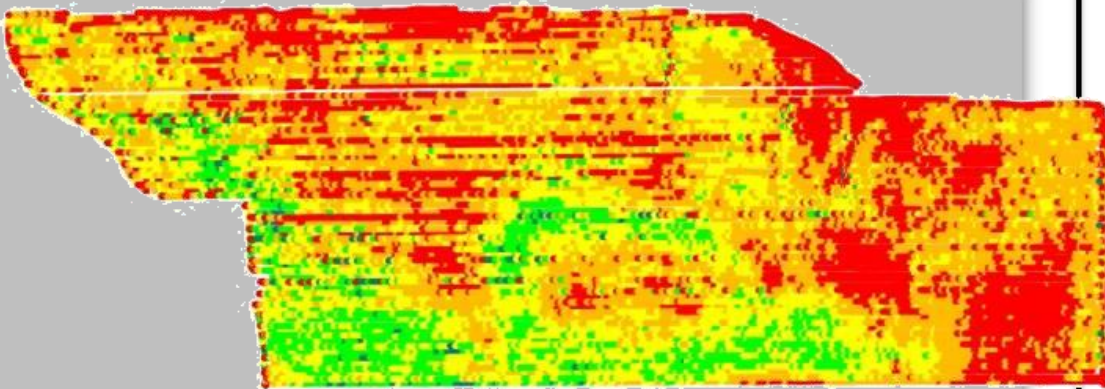




Yield Monitoring Cotton



Yield Map using Agleader



Aerial Photo of Same Field during The Season



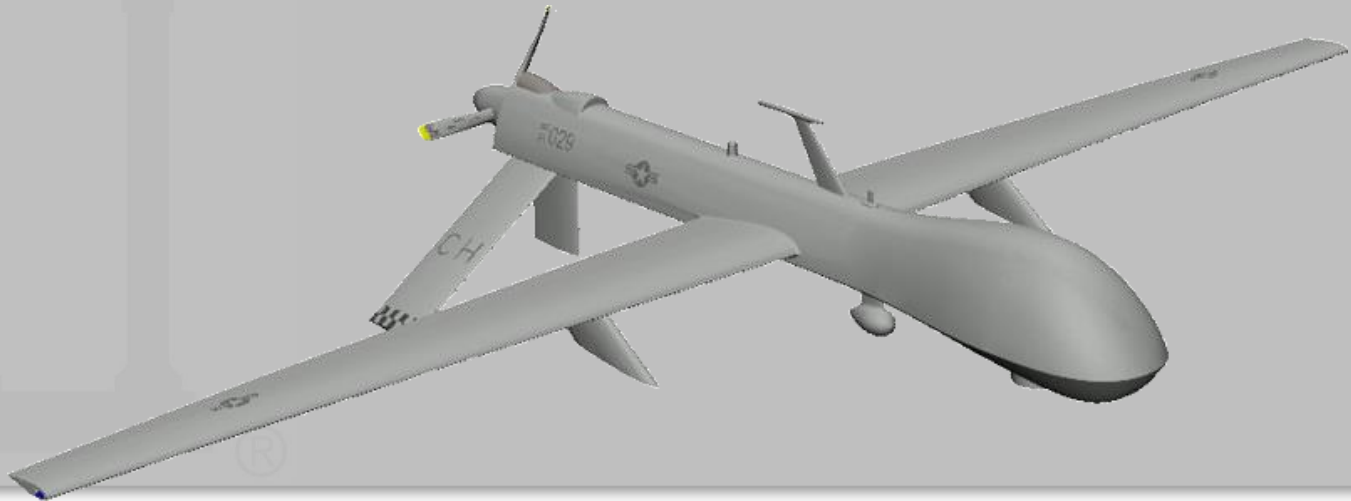
7/5/01



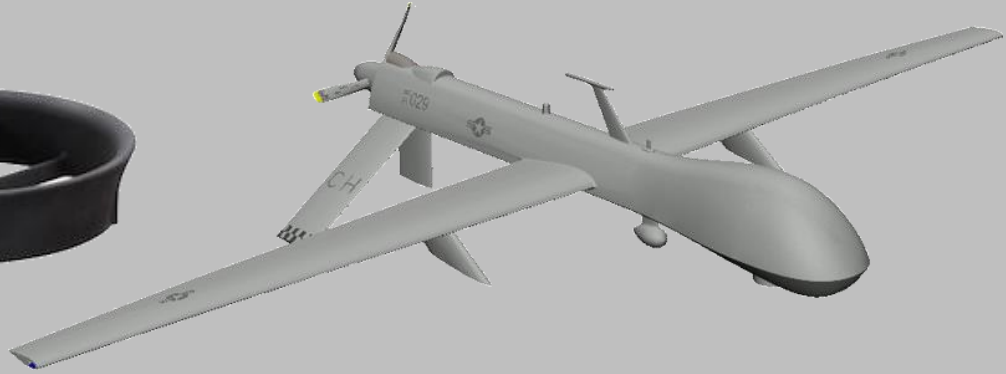
7/22/01

UAS Platform Selection Criteria

- What is it that I want to do?
- Where do I want to do it?
- How long do I want to do it?
- What tools do I need to do it? (ie, cameras, sensors)



Platforms



ROTARY WING	FIXED WING
<ul style="list-style-type: none">• Single rotor (Complex, expensive, high payload capacity, reasonable duration, reasonable speed, vtol)	<ul style="list-style-type: none">• reasonable payload, extended duration, high speed, cover large areas, Intermediate cost and complexity, takeoff requires runway or method of launch, recovery requires runway or parachute
<ul style="list-style-type: none">• Multi rotor (Affordable, simple, safe, limited payload, limited duration, limited speed, vtol)	



Key Considerations

- What is my budget?
- What on board sensors do I need?
- Does the platform match my capabilities?
- Does the platform match the area of operation?



Getting Started with a UAS Plan

- Purchase and operate internally
 - Complexity of platform needed
 - Personnel to operate it
 - FAA requirements for operation
 - Data Analysis Headache
- Hire UAS service provider
 - Ask around (check references on companies)





Crop Protection

Efficient & Autonomous Operation

AGRAS T20P

AGRAS T40

AGRAS T30

AGRAS T10



Mission Planning

Detect Every Detail

Mavic 3M

DJI Terra



DJI Delivery

DJI Flycart 30

DJI DeliveryHub

DJI DOCK

For Roads Less Traveled

[Watch Video](#)



Compact and portable

Foldable for easy storage

Multispectral Camera

4 x 5MP
G/R/RE/NIR

RGB camera

20 MP
4/3 CMOS, mechanical shutter

DJI FlightHub 2 Software
Matrice 30 Drone
Camera configurable

DJI Air 2S
DJI Air 3