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INVASIVE PLANT DETECTION UING AERIAL IMAGERY

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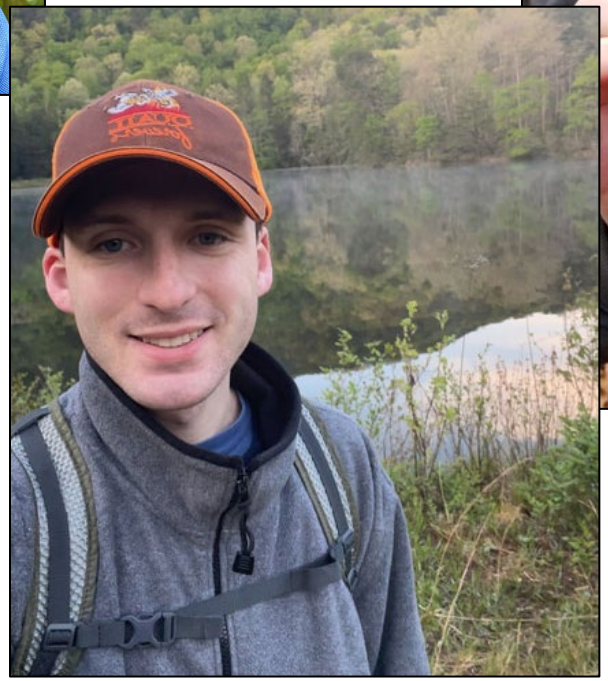
Dave Coyle

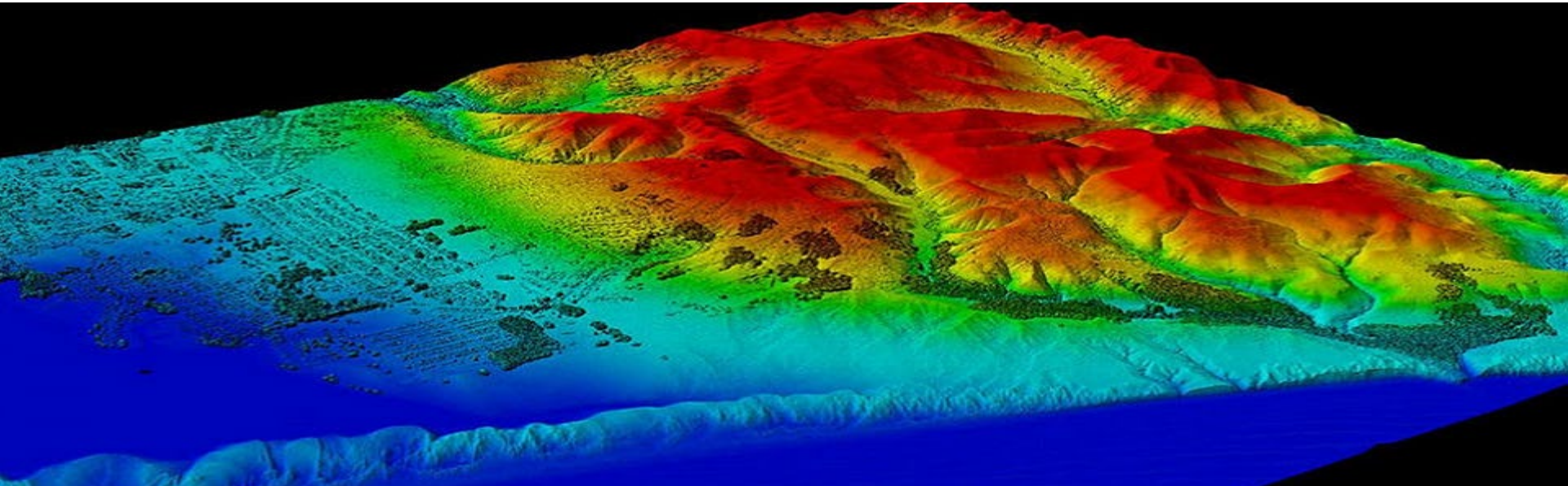


David Lenser

Forest Palmer

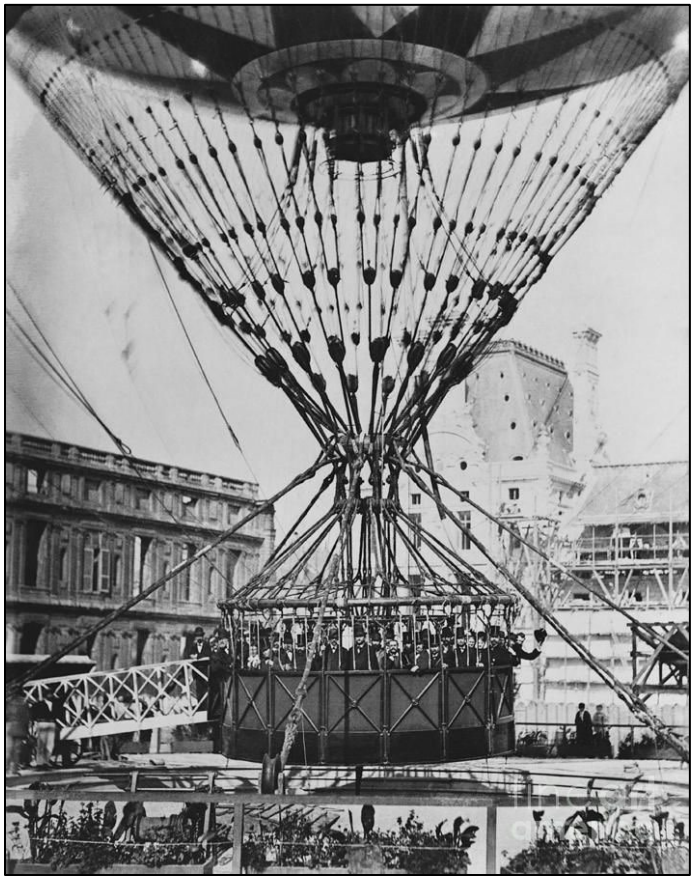
Remote Sensing

- "The acquisition of information about the state and condition of an object through sensors that do not touch it." (Chuvieco 2020)



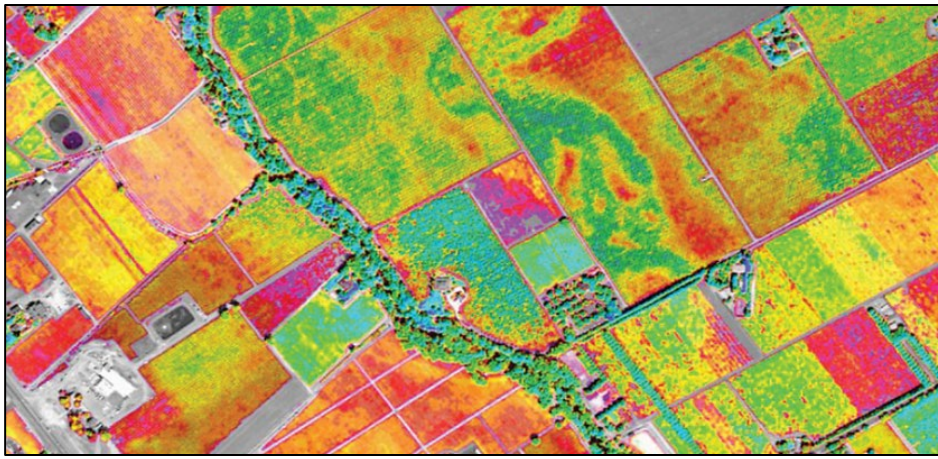
History of RS

- France – mid-1800s
- WWII advancements
  - Color infrared films
  - Thermal scanners
  - Imaging radar systems
- Mid to late 1900s
  - Satellites for Earth observations



RS Applications

- Precision agriculture
- Marine pipeline leaks
- Urban planning
- Climate change data
- Forest health monitoring



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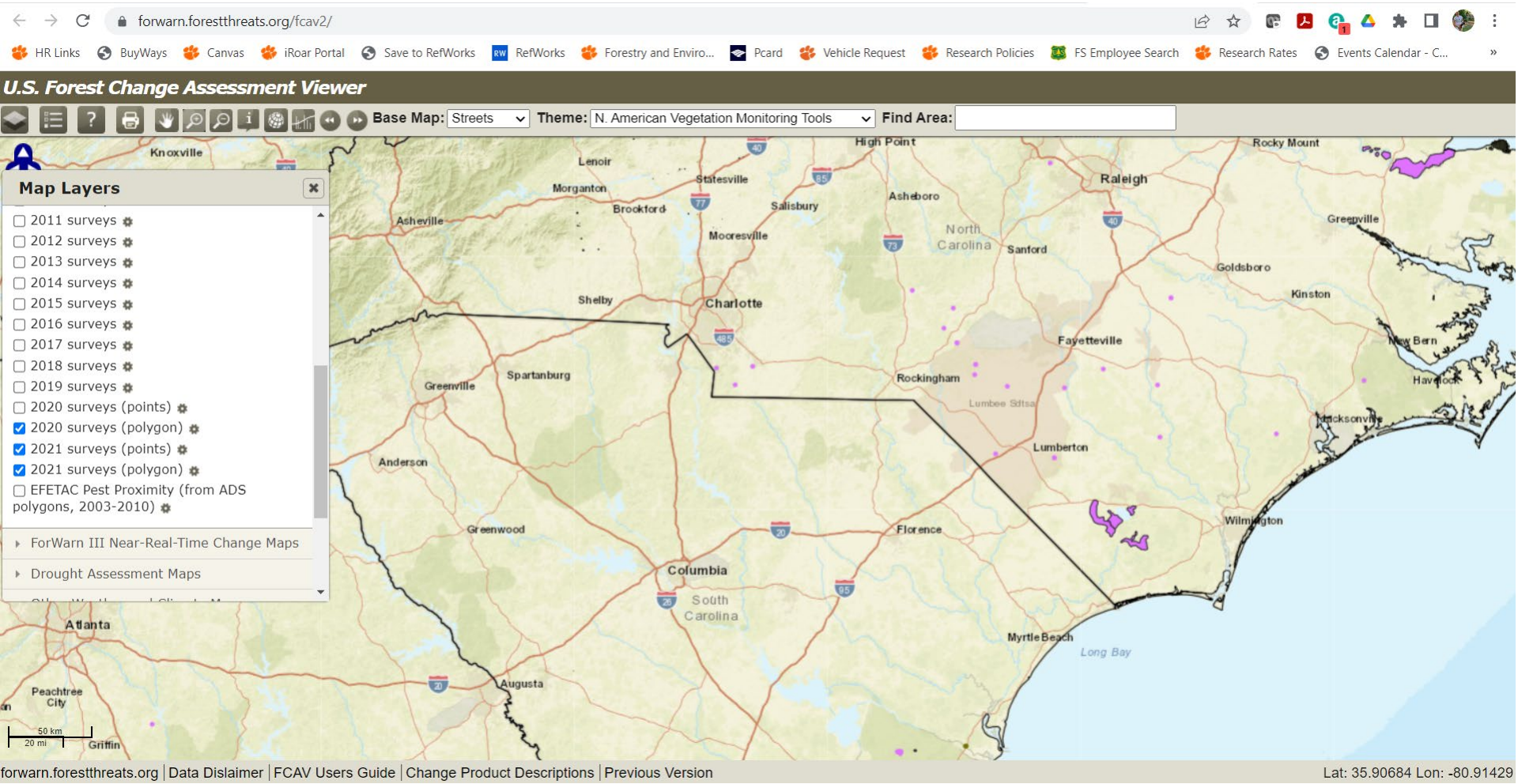

RS Uses for Invasive Plants

- Map distributions
- Prioritize management
- Quantify impacts
- Early detection

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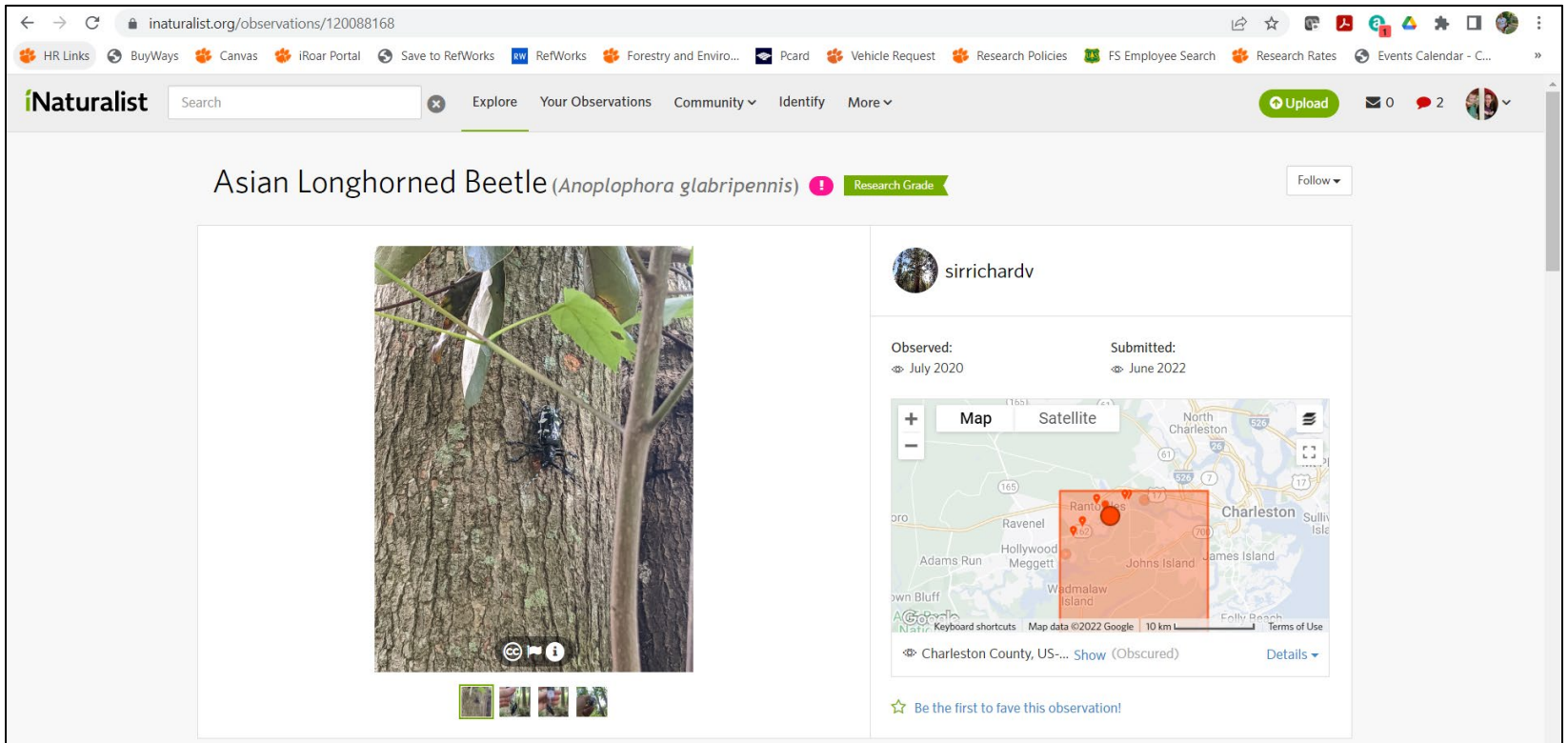
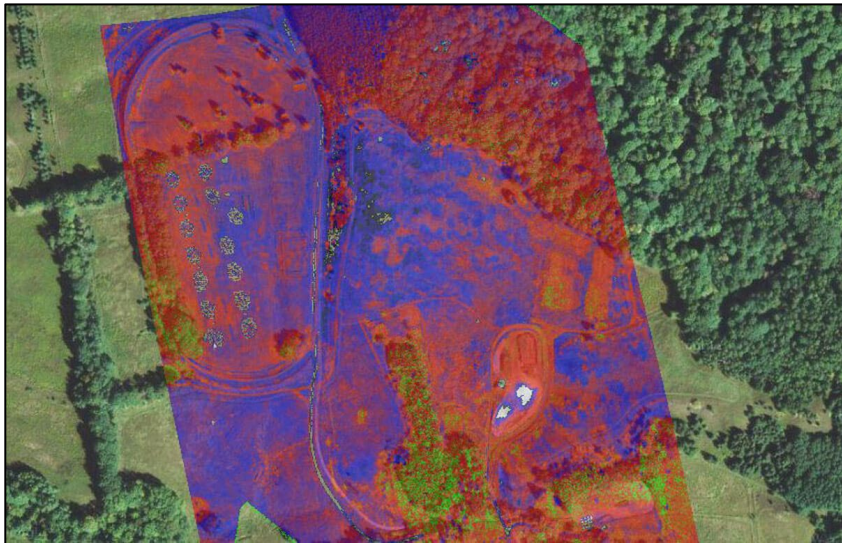
Invasive Species Detection

- Citizen reports
- Systematic trapping
- eDNA
- State, federal surveys



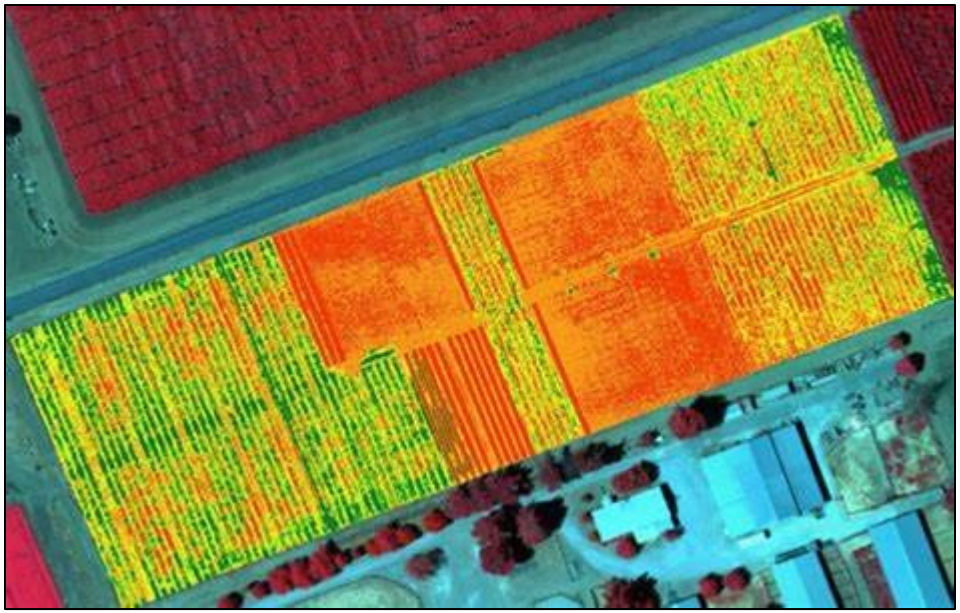
Invasive Species Detection with RS

- Must have unique signal
- Relative to surrounding vegetation
- Physical characteristics
  - Color
  - Shape
- Physiological characteristics
  - Phenology
  - Senescence



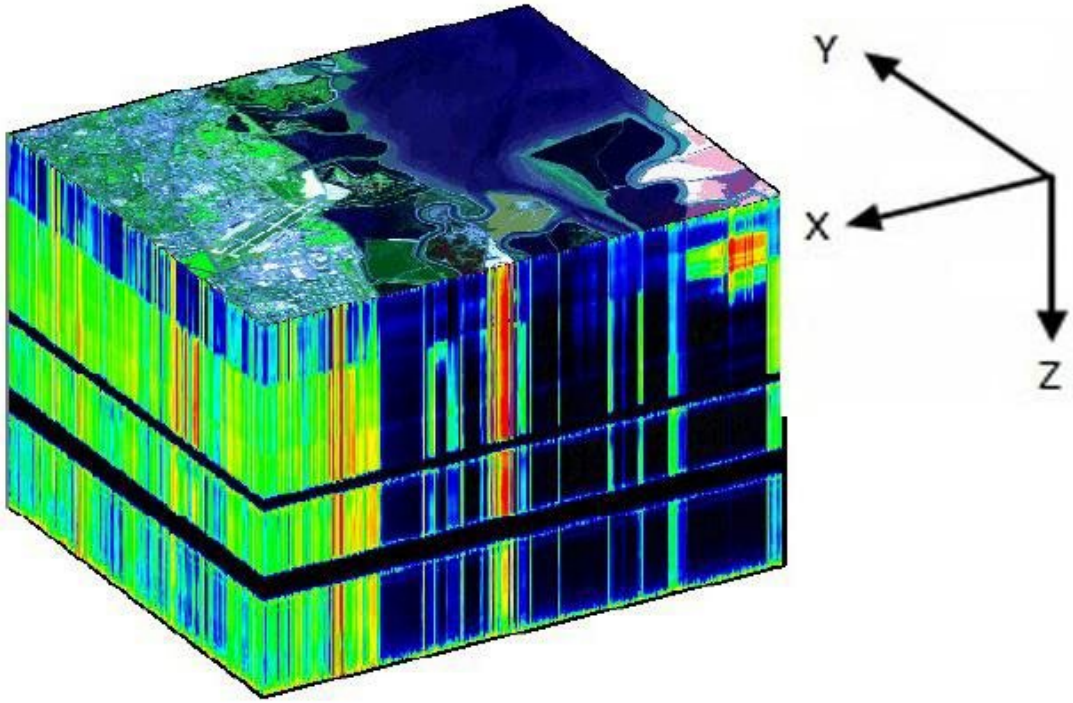
Multi-spectral

- 3 to 10 bands
  - Red
  - Green
  - Blue
  - Near-infrared
  - Short-wave infrared
  - Etc…
- Landsat-8 (USGS)



Hyperspectral

- May have hundreds or thousands of bands
- Narrower bands (10-20 nm)
- Hyperion (NASA)
  - 242 bands
  - 30 m resolution



Aerial Photos

- Planes
- Drones

Remote Sensing Methods

Method	Pros	Cons
Multi-spectral	- Can target specific wavelengths/bands - Cost efficient	- Requires a priori knowledge - Less detailed than HSI
Hyperspectral	- Higher resolution - Allows for more elaborate/detailed models - No need for prior knowledge	- Adds layers of complexity - Cost prohibitive - Significant storage capacity required
Aerial photos	- Can be specific about timing - Cost-efficient	- Requires training and possibly licensing - Scale may not be uniform

Successful Stories

- Bracken fern in South Africa
- Water hyacinth in South Africa
- Mesquite in Australia
- Goldenrod in Japan

Pyrus calleryana (Callery pear)

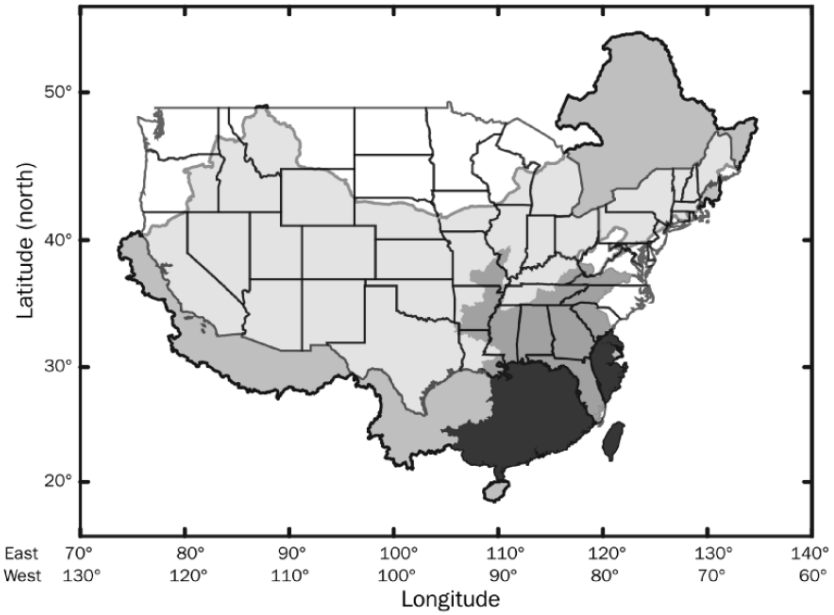


Figure 2. The United States and China are located at similar latitudes. Provinces in China where Pyrus calleryana *are found (shown in black) are at the same latitude as areas in the southeastern United States where the species is already invasive. Source: Adapted from Qian and Ricklefs (1999).*

Pyrus calleryana (Callery pear)

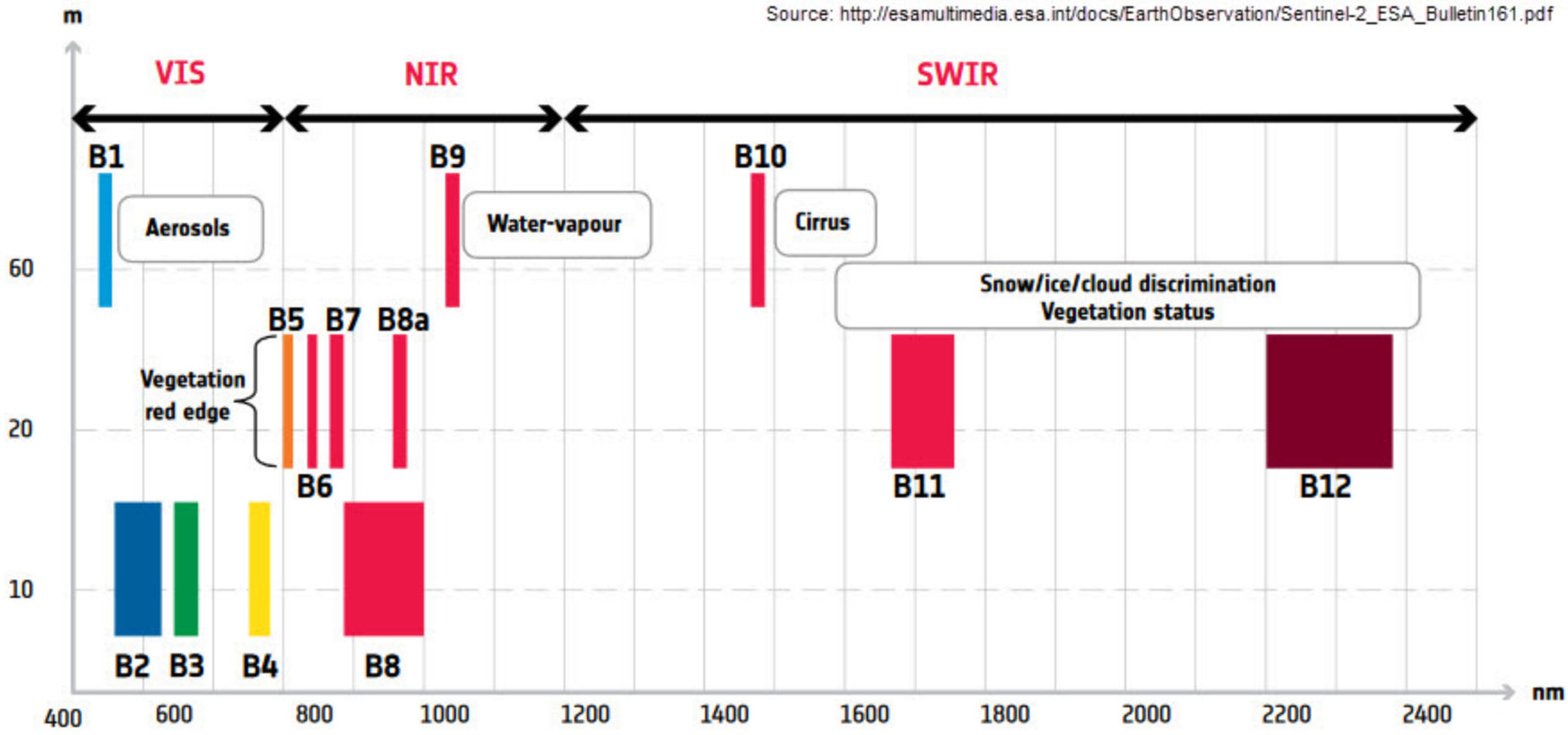
- 'Bradford' x *Pyrus*
- Wide range of environments
- Managed, natural forests
- Rights-of-way
- Other disturbed areas
- Thorns!

Callery pear Proof of Concept

- Sentinel-2
- Color Infrared (CIR)
- 41 initial training sites
- 23 final sites
- Maximum likelihood
- Minimum distance
  - Flowers?
  - Lack of herbivory?
  - Late senescence?

Sentinel-2

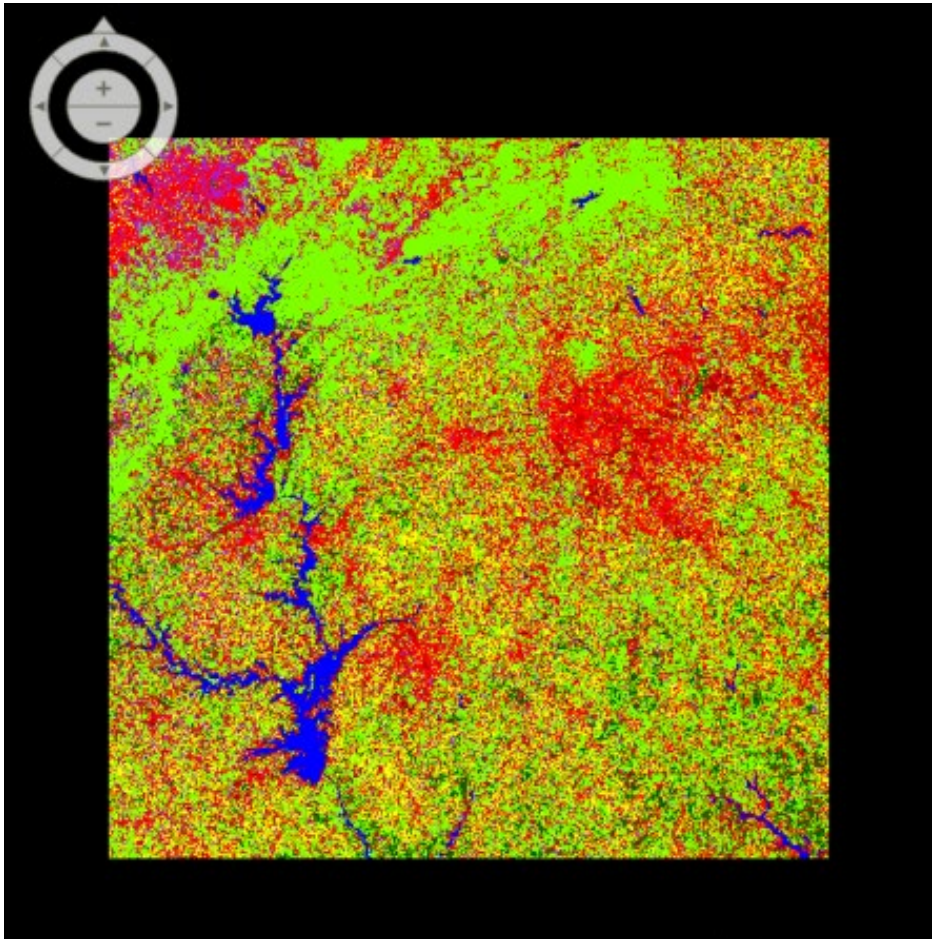
- European Space Agency
- 10-60 m resolution
- 13 bands (visible, NIR, SWIR)
- Two satellites (A and B)
- Free and open data policy



↑ Spatial resolution versus wavelength: Sentinel-2's span of 13 spectral bands, from the visible and the near-infrared to the shortwave infrared at different spatial resolutions ranging from 10 to 60 m on the ground, takes land monitoring to an unprecedented level

Analyses

- ERDAS Imagine
- Classifications
  - Urban (High)
  - Urban (Light)
  - Cultivated crop
  - Water
  - Evergreen forest
  - Deciduous forest
  - Grassland/pasture
  - Callery pear



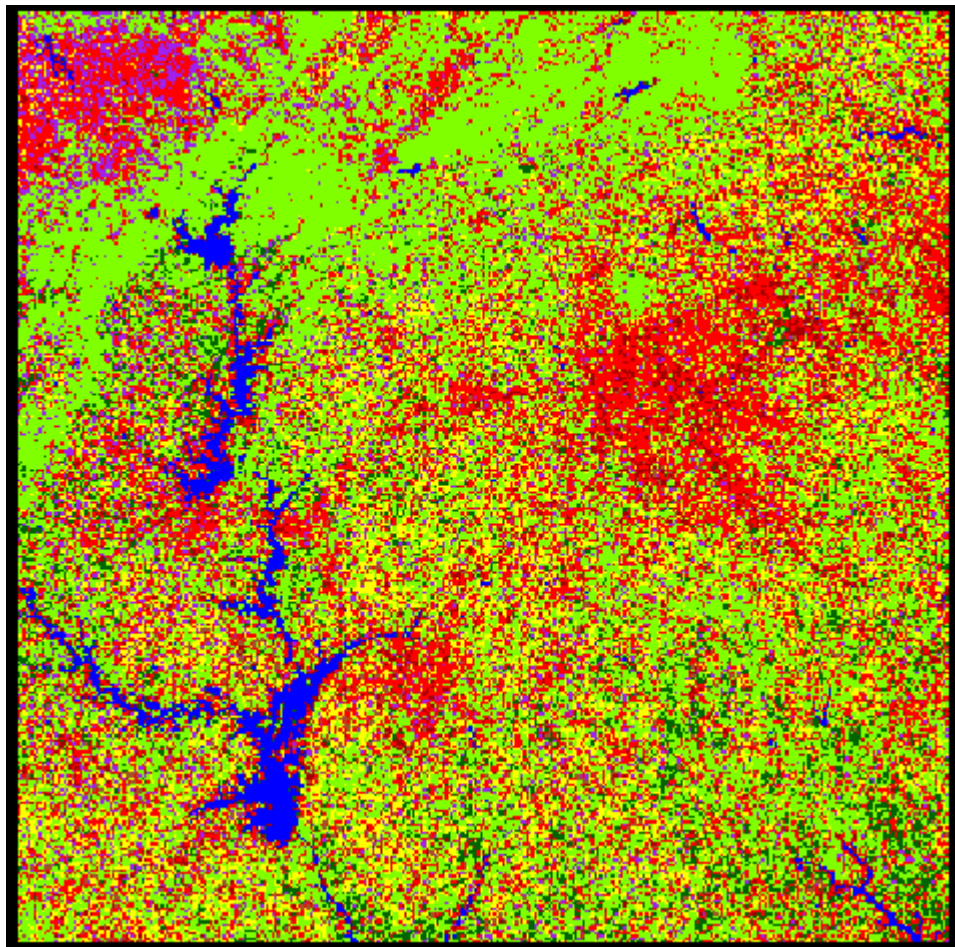
Results

- Overall classification = 81%

Classification	# References	# Classified	# Correct	% Accurate
Urban (High)	32	50	32	64
Urban (Light)	43	50	37	74
Cultiv. crop	44	50	40	80
Water	61	50	50	100
Evergreen	53	50	47	94
Deciduous	82	50	48	96
Grassland	29	50	41	82
Callery pear	56	50	29	58

Limitations

- Resolution
  - Size of new infestations?
  - Processing power/time
- Site accessibility
- False positives
- False negatives*



Summary

- RS potential for invasive plant detection
- Pros and cons to different methods
- Will vary by species and goals

Future Research

- Can we apply this to other invasive plants?
- How do we increase the sensitivity?
- How do we make this technology more accessible?

Other Species

- Japanese stiltgrass
- Bush honeysuckles
- *Elaeagnus*
- Chinese privet
- *Wisteria*
- Cogongrass
- *Miscanthus*
- Chinese tallow
- Mimosa
- Buckthorn(s)
- Brazillian peppertree
- *Phragmites*
- Chinaberry
- Tree-of-heaven

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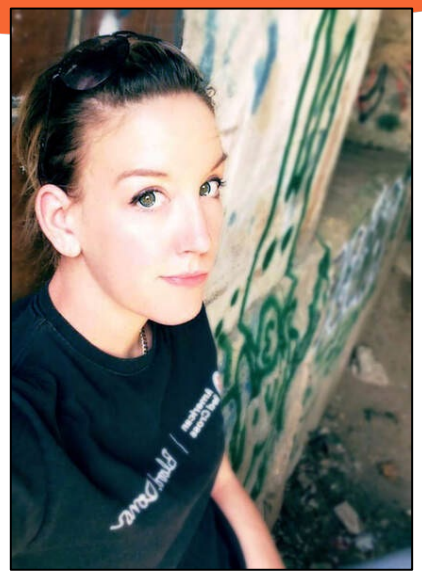

Alexandra Tsalickis (PhD student)
- Diptera ecology in longleaf forests

Crystal Strickland (MS student)
- Recreationists spread of invasive plants

Sara Lalk (PhD student)
- Invasive species policy

Prabina Sharma (MS student)
- Callery pear biomass and pollinator community
- TA for Forest Protection

QUESTIONS?