

The Use of Sentinel-2 to Monitor Yellow Floating Heart (*Nymphoides peltata*)



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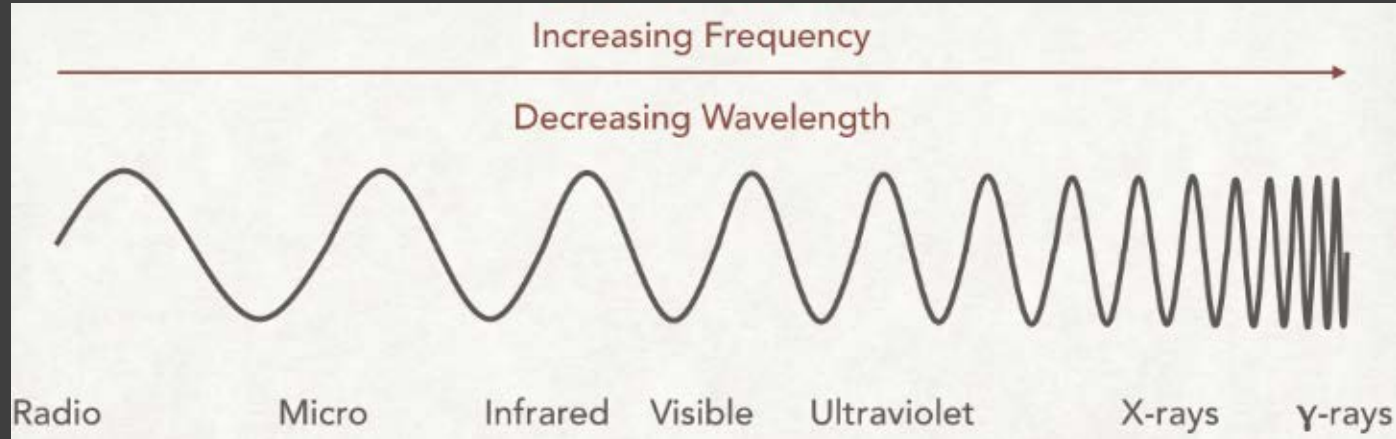
Lake Carl Blackwell

Table of Contents

- Purpose
- Remote Sensing
- Case Study
- Sentinel-2
- Methods
- Validation
- Future goals
- Citations
- Questions

Purpose

- Design cost effective monitoring method
- Establish presence
- Monitor spatial extent of Yellow Floating Heart (YFH)
- Monitor plant health
- Determine plant density



What is remote sensing?

“the art and science of acquiring information about an object, without coming into direct physical contact with the object”

- John R. Jensen

Remote Sensing in natural resource management

- Forestry
- Agriculture
- Watershed Management
- Invasive Species

Remote sensing of aquatic plants

- Classification of species and functional groups
- Emergent plant signatures often overlap with terrestrial vegetation, water, or soil
- Improves understanding of seasonal changes of macrophyte growth
- Satellites provide repetitive coverage

Conditions for Remote Sensing to be an effective tool

1. Distinctive vegetation
 - a) Distinguishable morphology
 - i. Color
 - ii. Growth patterns
 - iii. Biochemistry
2. Significant spatial extent
3. Appropriate spectral and spatial resolution



Lake Carl Blackwell Case Study

1. Distinctive vegetation
 - Only two floating leaved macrophytes
 - Yellow Floating Heart
 - American Lotus
2. YFH peak coverage: 51 acres 2018
3. Data source: Sentinel-2





Sentinel-2, European Space Agency

- Dual, sun-synchronous satellites
 - Sentinel-2 A (June 23, 2015)
 - Sentinel-2 B (March 7, 2017)
 - 56° S to 84° N
- Temporal resolution: 5 days
- Multispectral Instrument
- Land variability monitoring
- Open source data
 - Orthorectified
 - Geocorrected

Sentinel-2 MSI

Table 1: Wavelengths and bandwidths of MSI instrument spatial resolutions.

Spatial Resolution (m)	Band Number	Central Wavelength (nm)	Bandwidth (nm)
10	2	490	65
	3	560	35
	4	665	30
	8	842	115
20	5	705	15
	6	740	15
	7	783	20
	8a	865	20
	11	1 610	90
	12	2 190	180
60	1	443	20
	9	945	20
	10	1 380	30

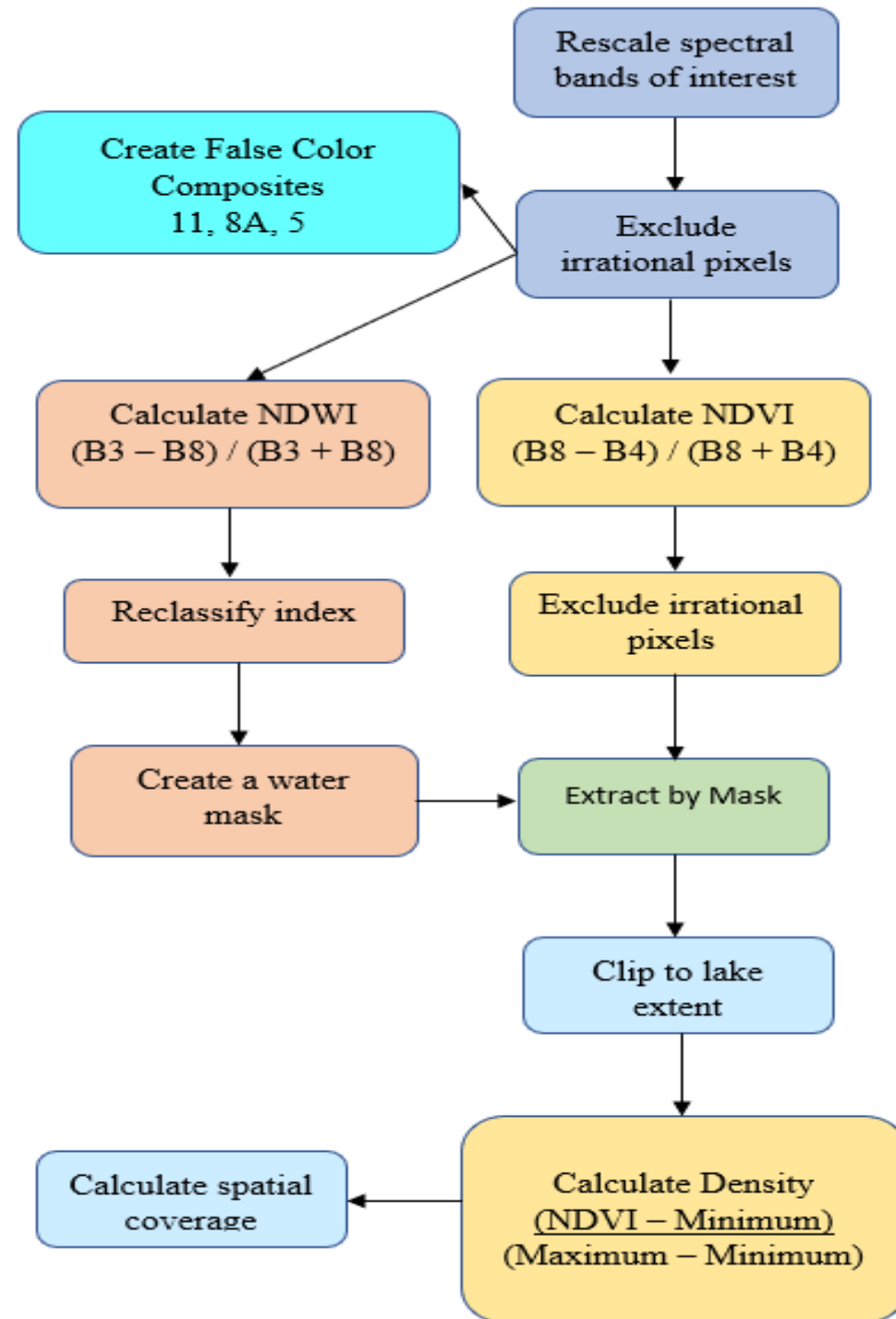
Methods

- Collect imagery
- Spectral confirmation of the presence of YFH
- Delineate water pixels, enhance vegetation
- Isolate pixels of aquatic vegetation within Lake Carl Blackwell
- Calculate physiological and phenological parameters
- Validate

Sentinel-2 imagery over Lake Carl Blackwell

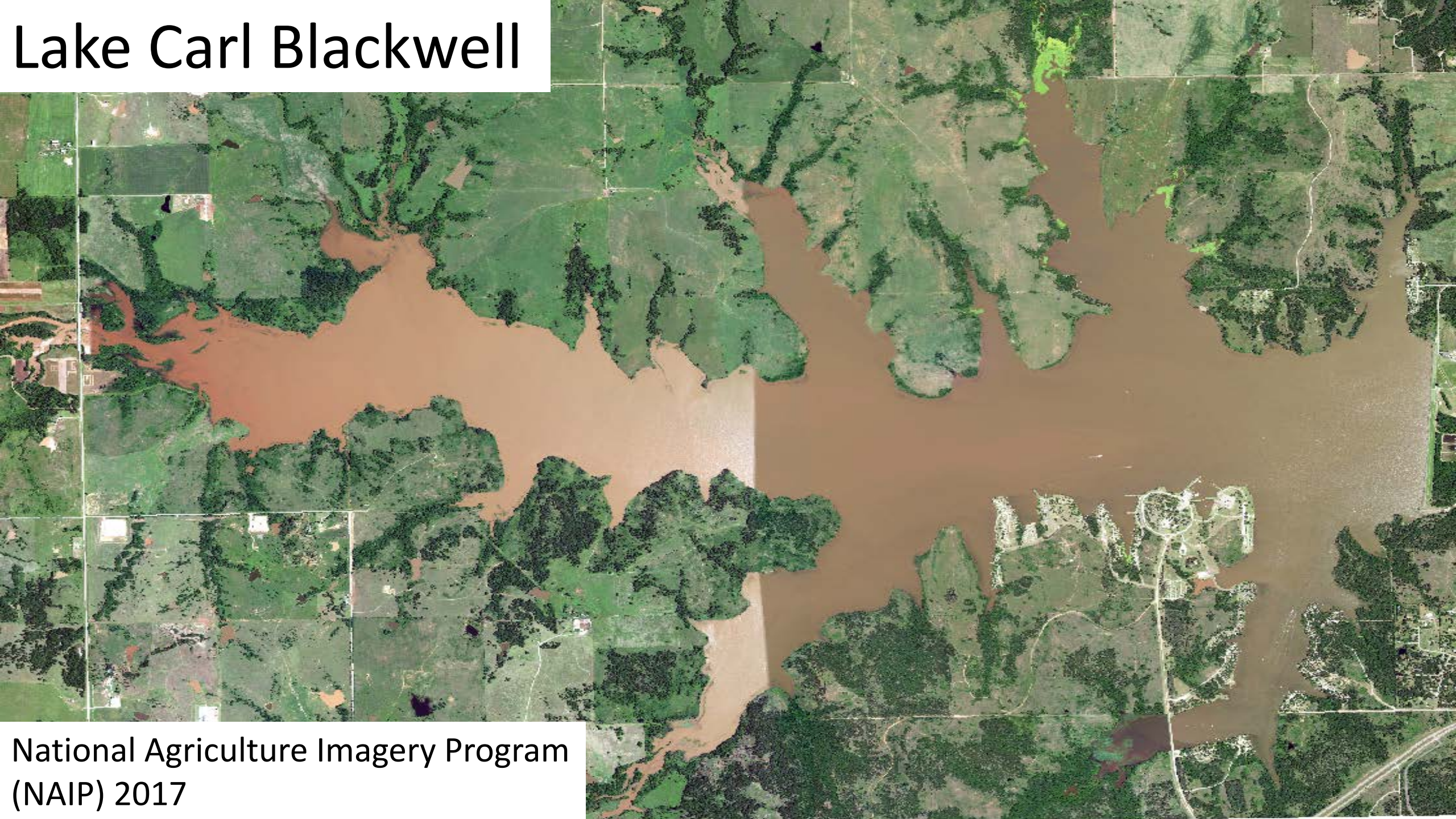
	Total images	Usable	Average revisit time (days)	Longest period between visits (days)
2018	45	46.67%	5	10
2017	11	72.73%	20	40
2016	8	62.50%	25.7	40

Processing Chain

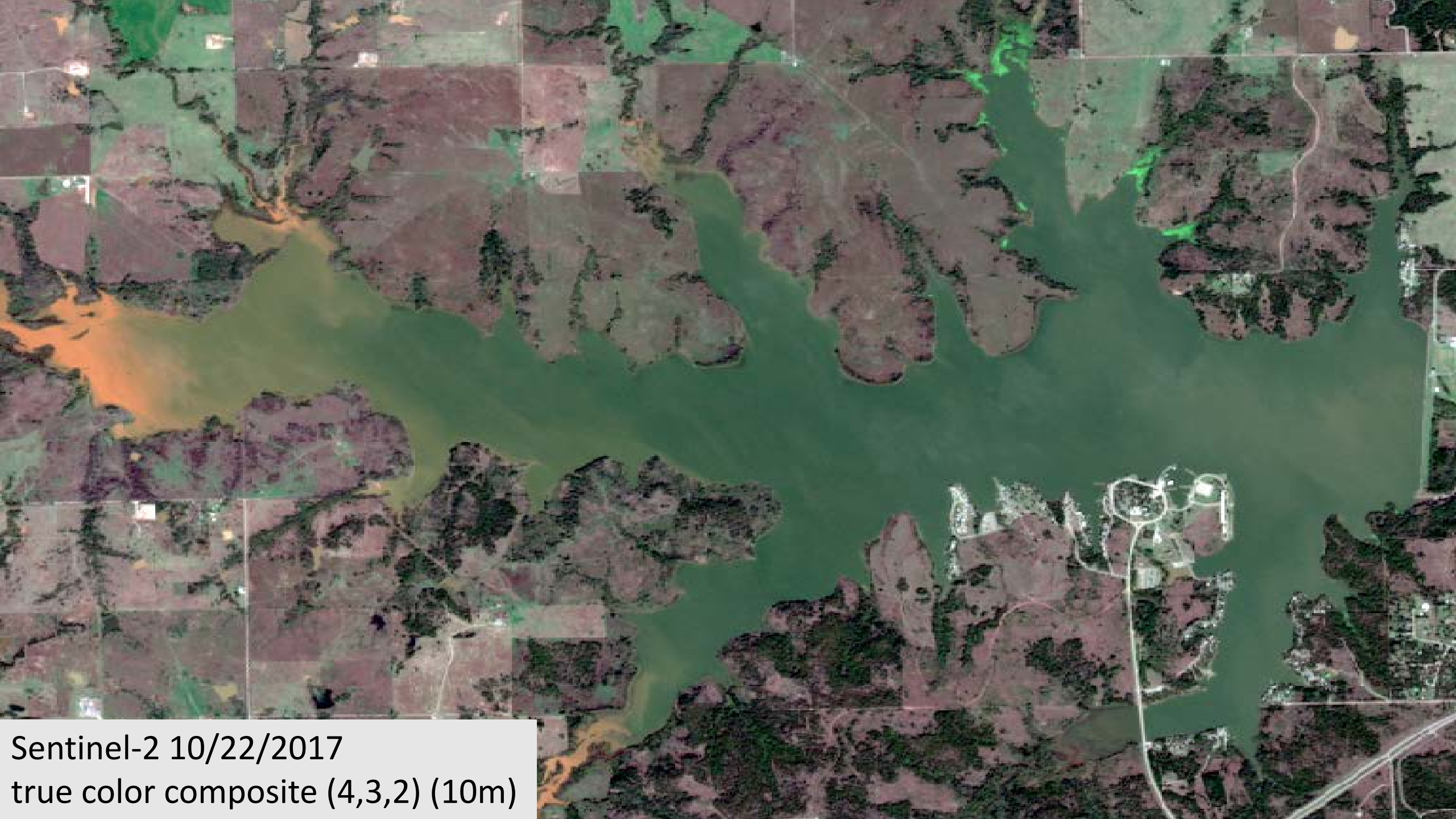


Establishing Presence

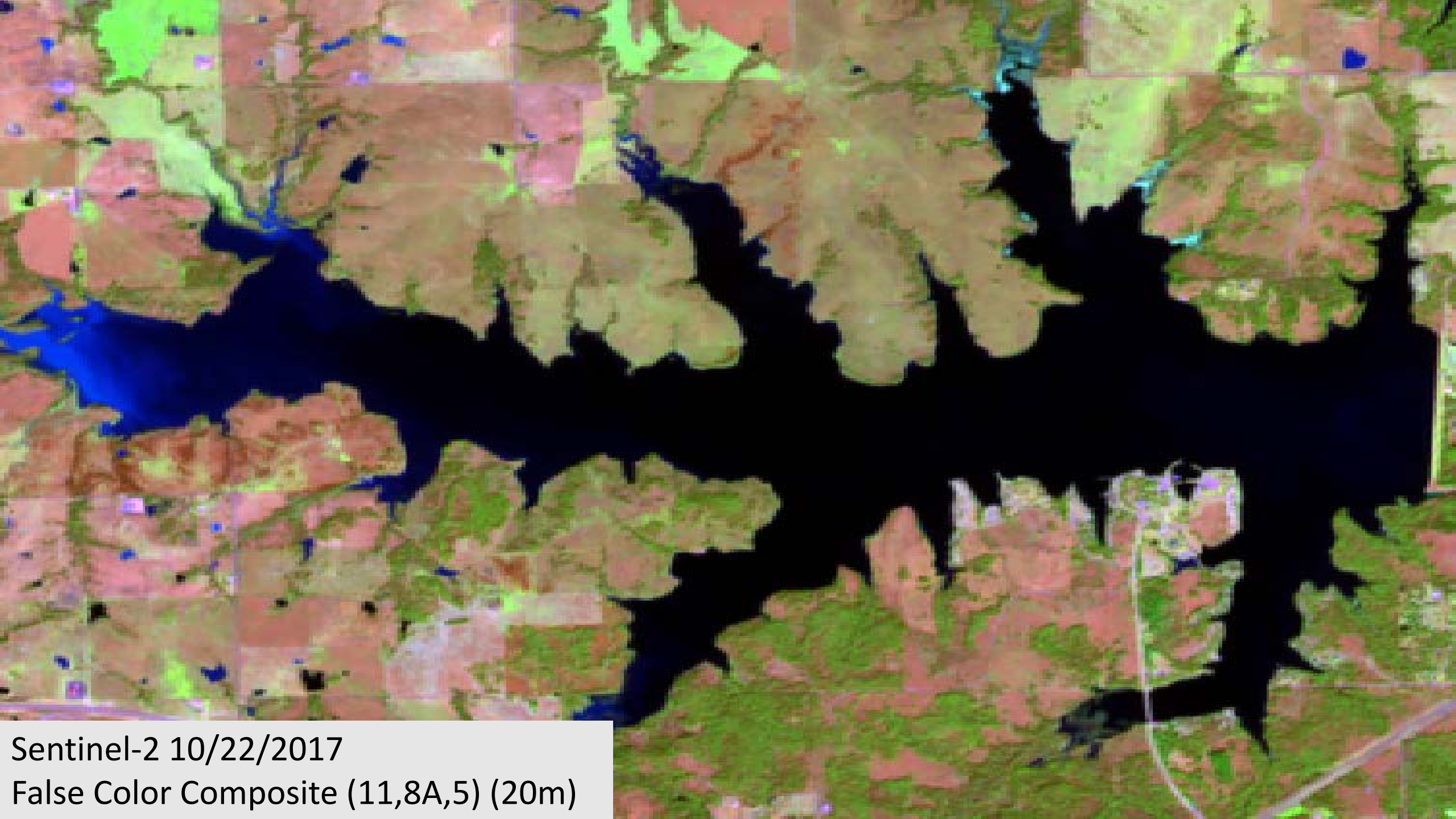
Lake Carl Blackwell



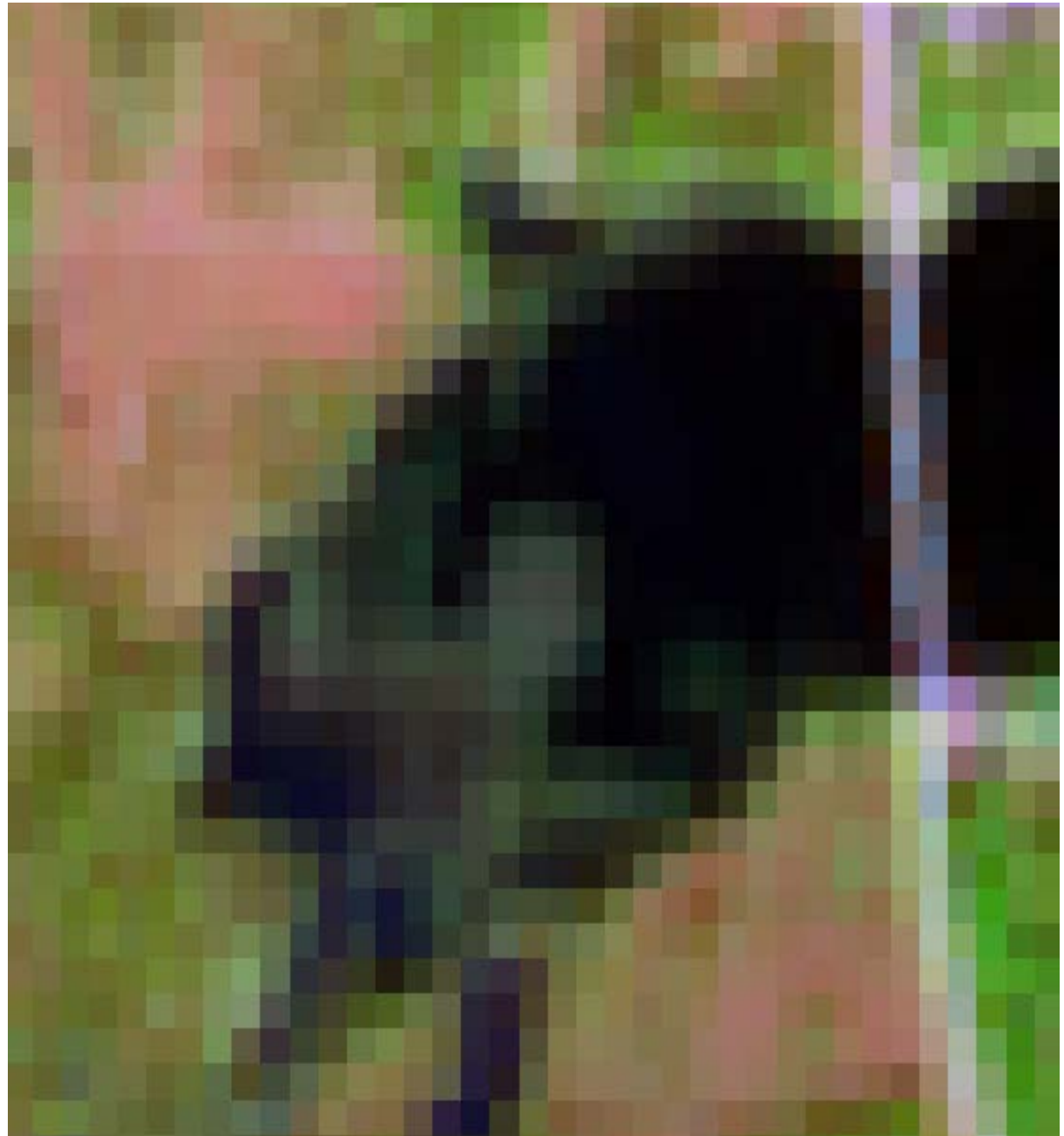
National Agriculture Imagery Program
(NAIP) 2017



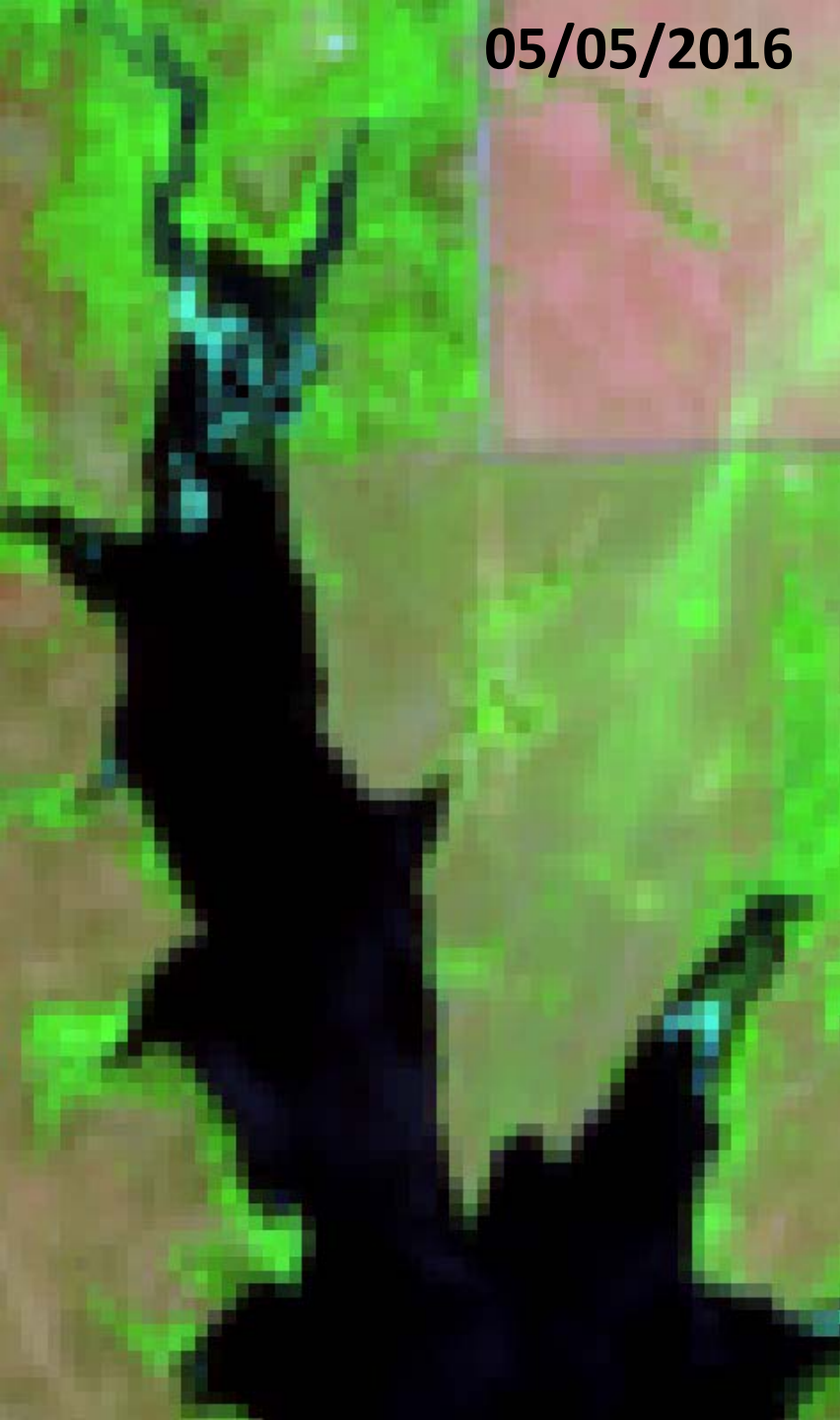
Sentinel-2 10/22/2017
true color composite (4,3,2) (10m)



Sentinel-2 10/22/2017
False Color Composite (11,8A,5) (20m)



05/05/2016



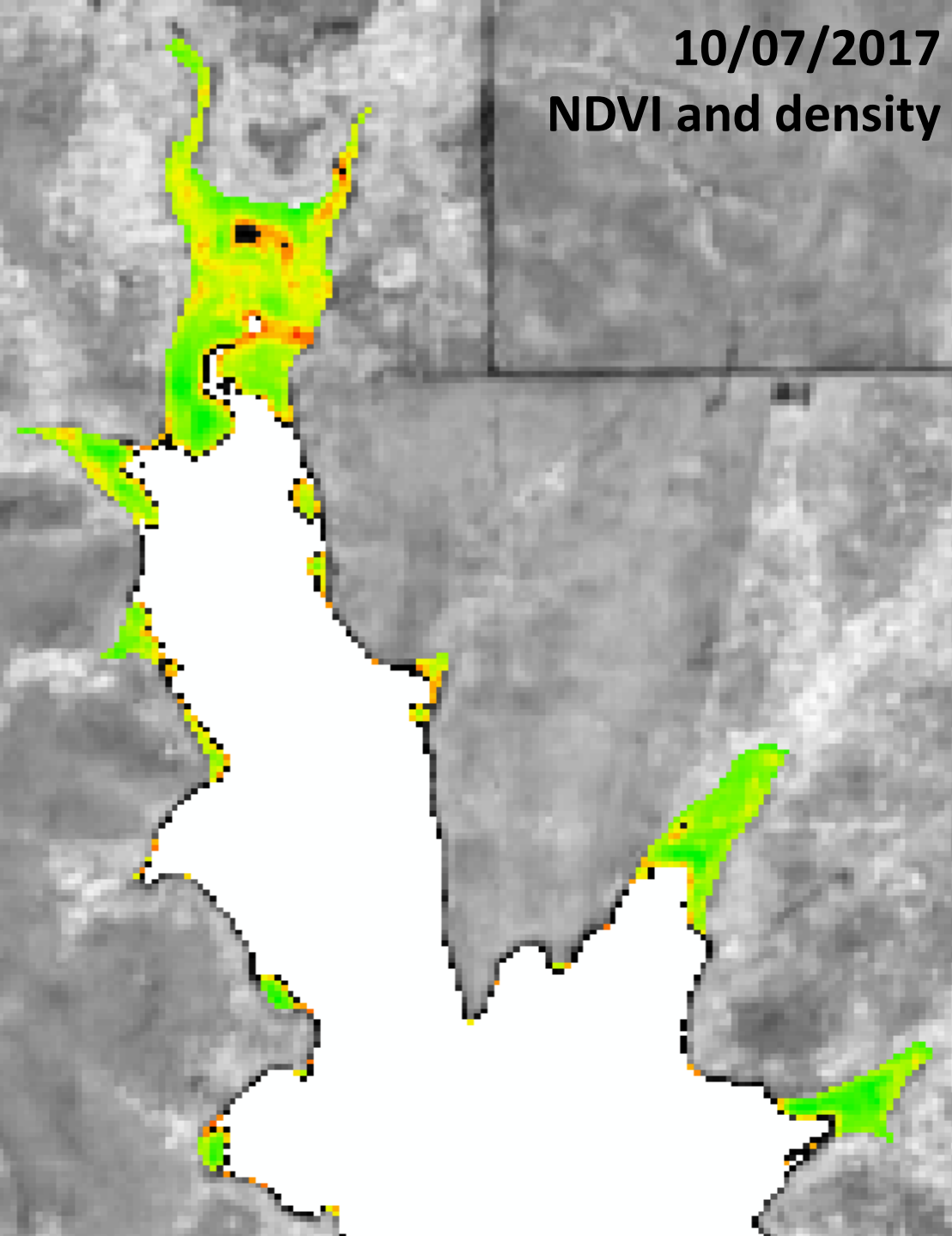
10/22/2017



09/27/2018



10/07/2017
NDVI and density



Isolating Aquatic Vegetation

- Normalized Difference Water Index

$$NDWI = \frac{Green - NIR}{Green + NIR}$$

- Normalized Difference Vegetation Index

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

Calculating YFH Density

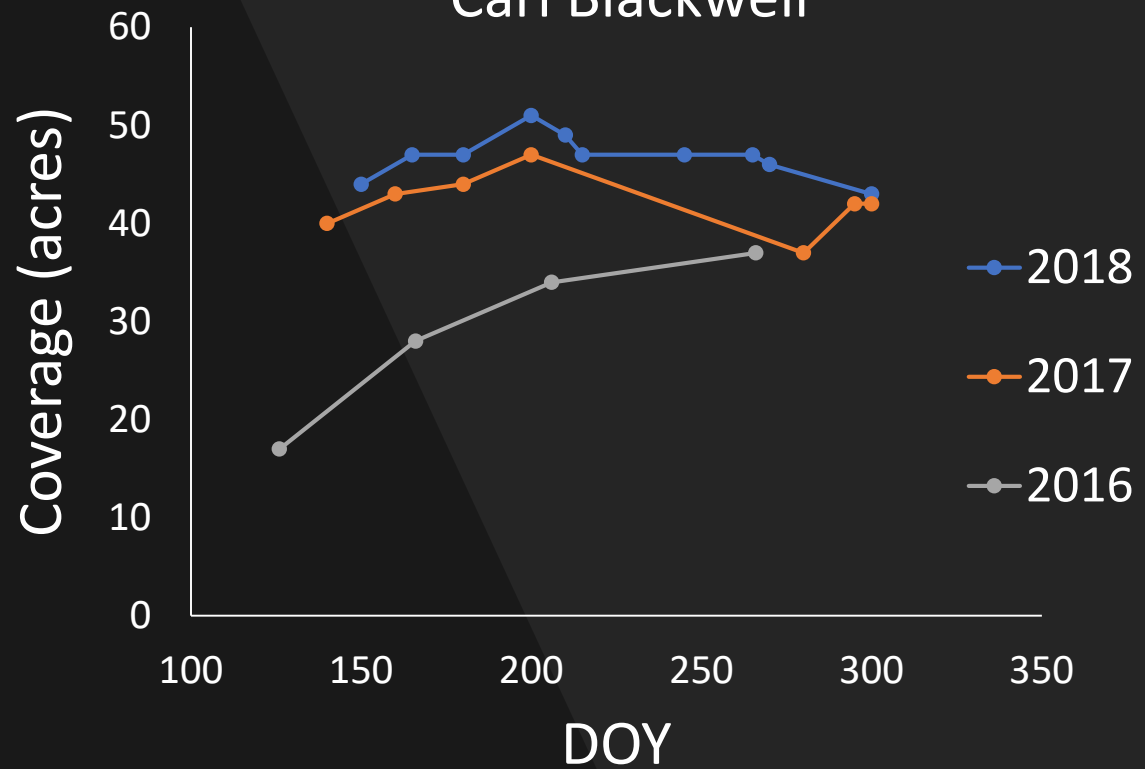
- Derived from NDVI
- Factor of Fractional Vegetation Cover (FVC)

$$FVC = \left[\frac{(NDVI - NDVI_{Minimum})}{(NDVI_{Maximum} - NDVI_{Minimum})} \right] * 100$$

- Design treatment options
- Monitor treatment efficacy over time

Results

Seasonal coverage of YFH in Lake Carl Blackwell

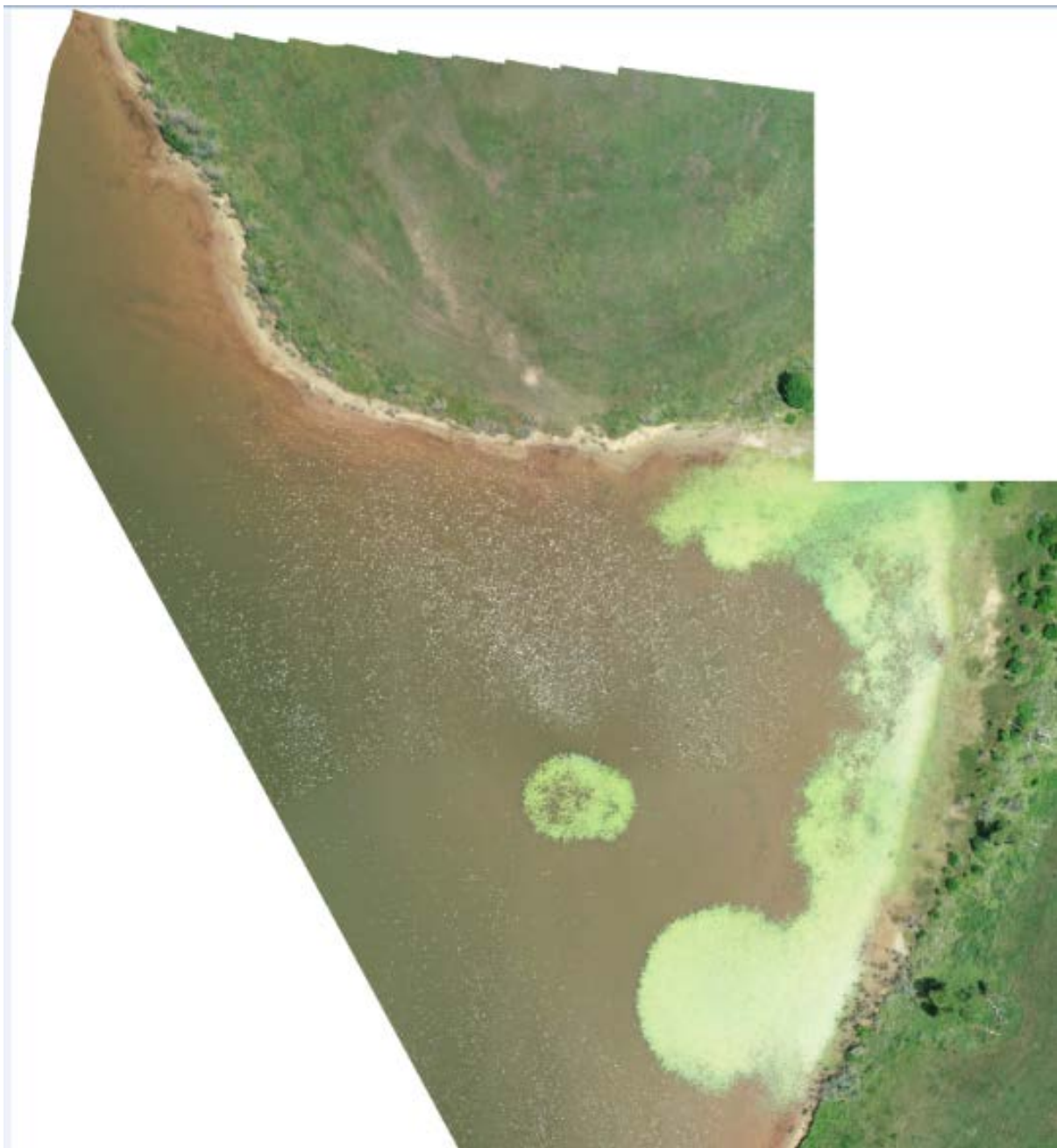


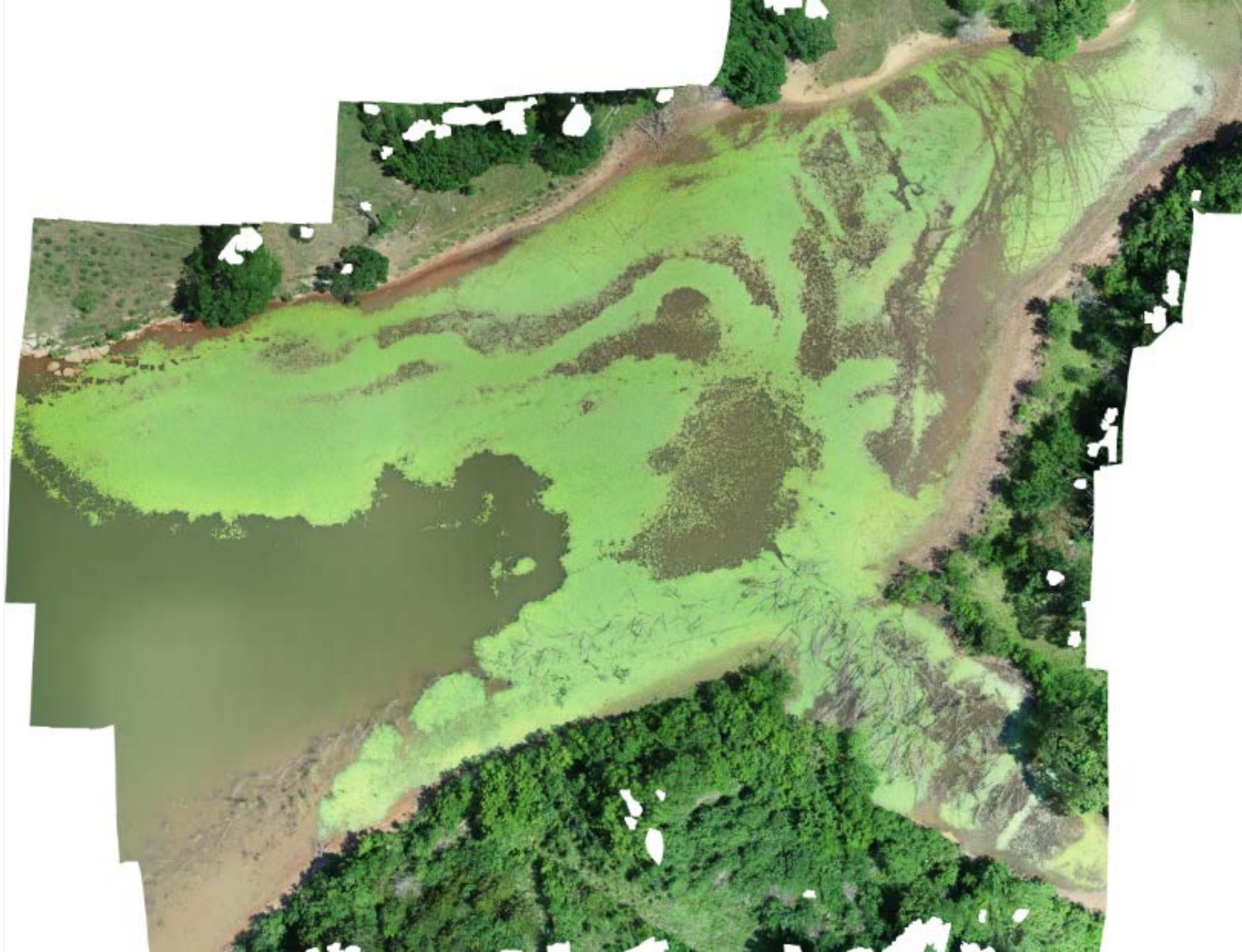
UAV Validation

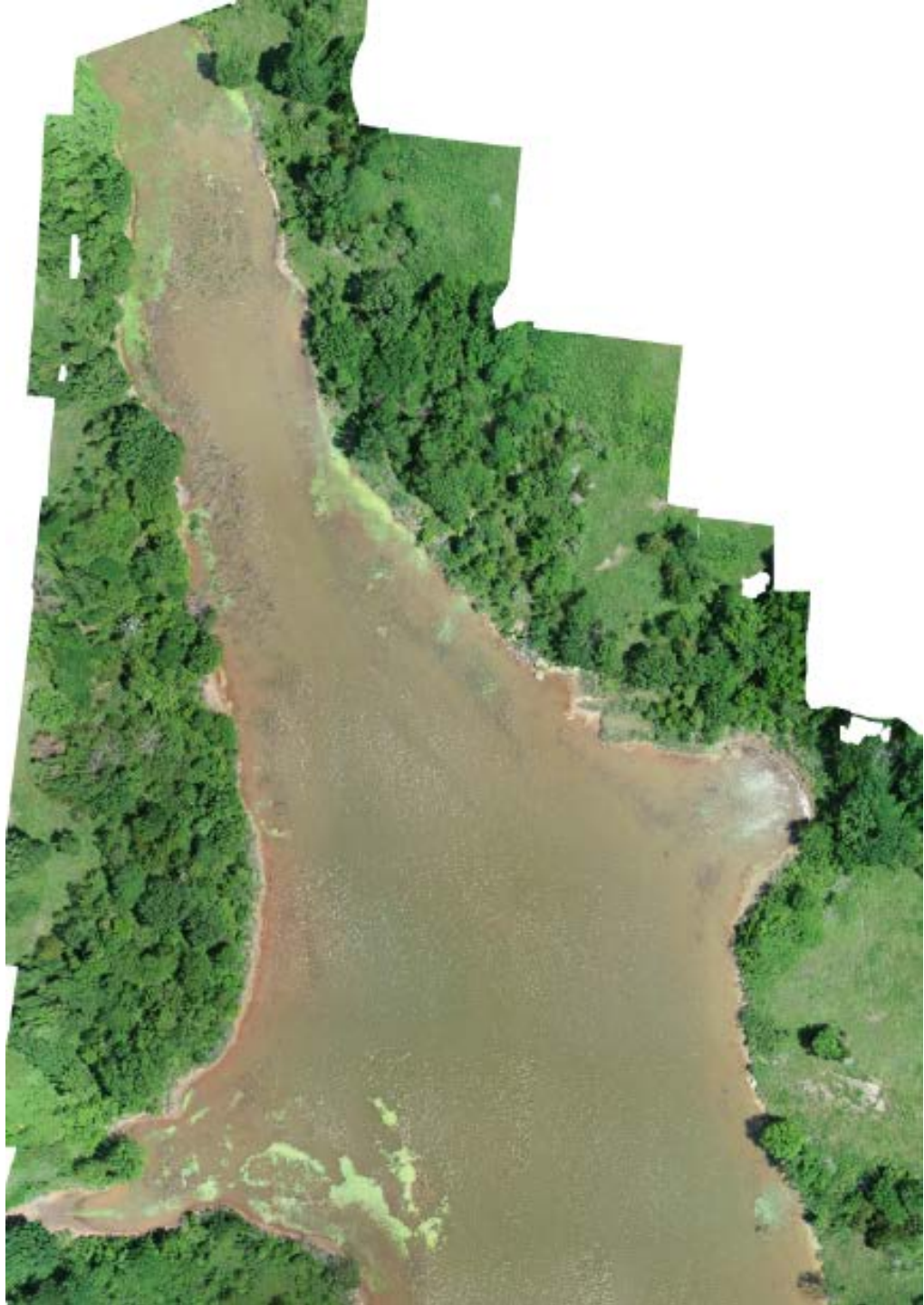
June 6, 2018

(Angle and Natalie, 2018)









Future goals

- Determine spectral signature of Yellow Floating Heart
- Automate a code to actively scan for new imagery
- Fully automate spectral analysis process

Conclusions

- UAV imagery and *in situ* observations validate procedural results
- Open-source data confirms the presence of an invasive species
 - Sentinel-2
 - high temporal and spatial resolution
- Determined the annual and interannual spatial extent of Yellow Floating Heart
 - 2016 – 2018

Citations

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Questions?
