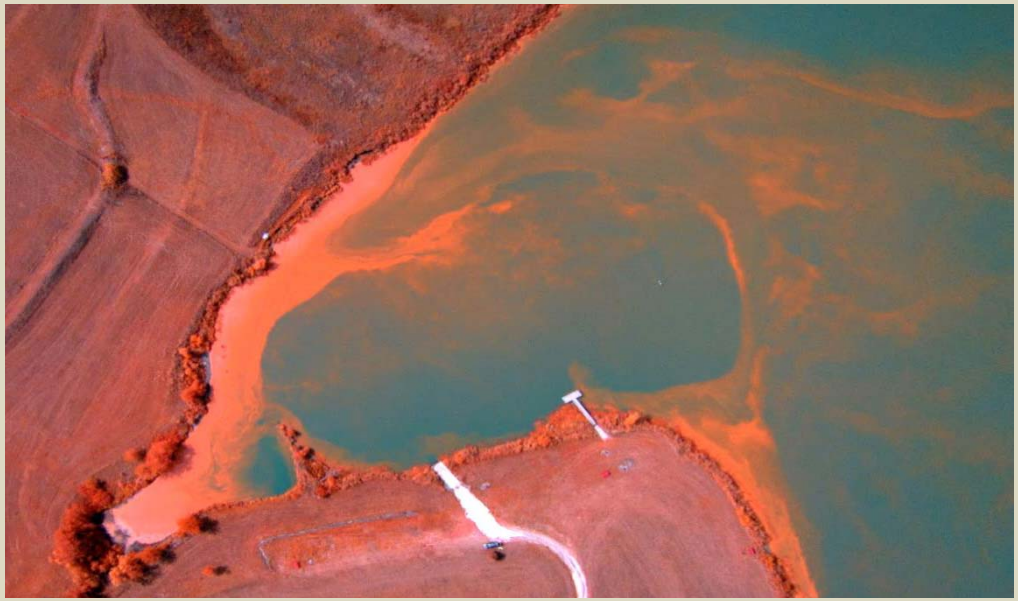
Using sUAS for high resolution characterization of harmful algal



Deon van der Merwe (Diagn Med/Pathobiol)

Kevin P. Price (Agronomy)

Kansas State University

What are cyanobacteria?

- Carbon-fixing, oxygenic photosynthesizing bacteria
- Among the oldest organisms (oldest fossils *c*. 3.5 billion years old)
- Not always a bad thing
  - Important primary producers in aquatic ecosystems
  - Food: eg. spirulina
  - Biofuels

Fossilized cyanobacteria

Green algae and cyanobacteria

Biology

- Photosynthetic
  - Need light and nutrients
- Certain types can fix nitrogen
  - Symbiotic relationships with plants
- Not always a bad thing
  - Important primary producers in many aquatic ecosystems
  - Human food: eg. spirulina
  - Biofuels

Harmful algal blooms (HABs)

- HABs refer to unchecked, exponential growth
  - Toxin production
  - Oxygen depletion
- HAB risk conditions
  - Sunlight
  - High temperature
  - Nutrients
  - Slow-moving or stagnant water
  - Low competition/predation

Impacts

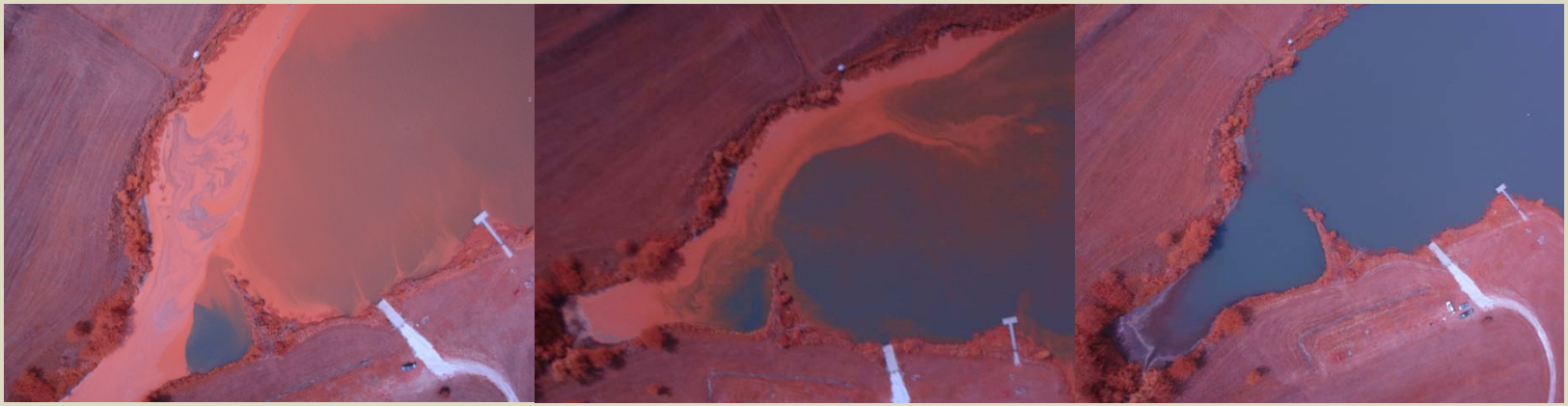
- Health effects
  - Animals and people
  - Need to provide alternative water
- Recreational access to affected waters may have to be restricted
- Expensive water treatment

Risk assessment

How to sample?
Where to sample?
How many samples?
Sampling frequency?

Traditional methods are inefficient

HABs are highly variable and rapidly changing in space and time



Aug 31 Sept 14 Sept 24

A potentially lethal risk not detected by traditional sampling

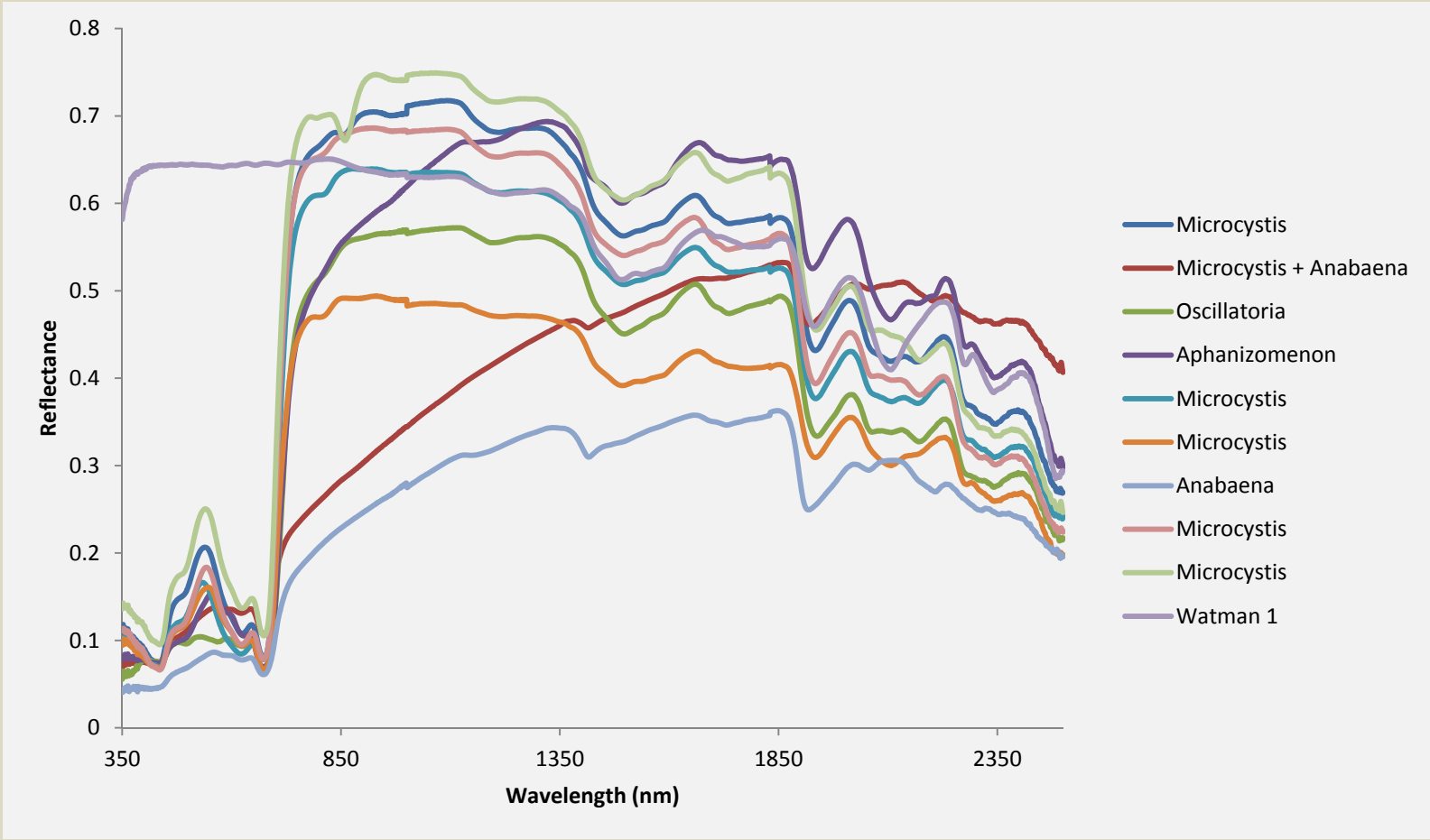
We need efficient, high resolution sampling!

Monitoring by air massively increases efficiency and resolution

500 acres/20 minutes
at 6 cm resolution

Smaller areas at mm resolution

Visible and NIR reflectance

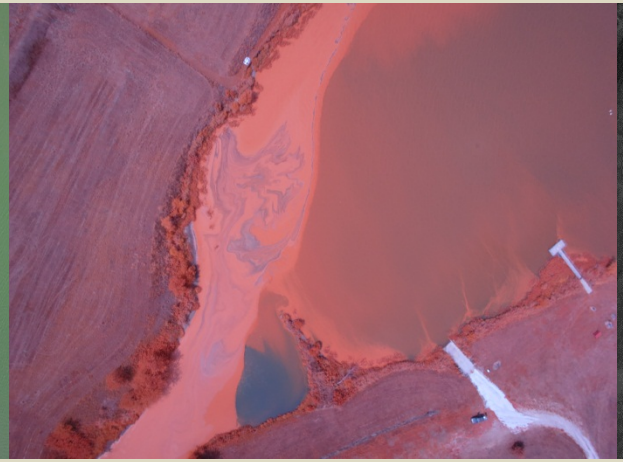


$$\mathrm{NDVI} = \frac{(\mathrm{NIR} - \mathrm{VIS})}{(\mathrm{NIR} + \mathrm{VIS})}$$

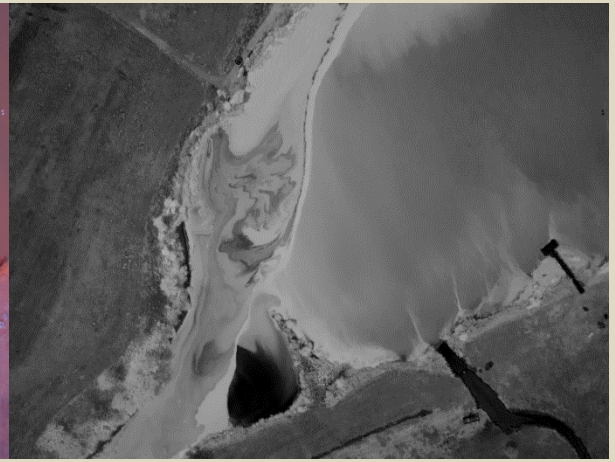
Sensor options

Visible

Color-infrared

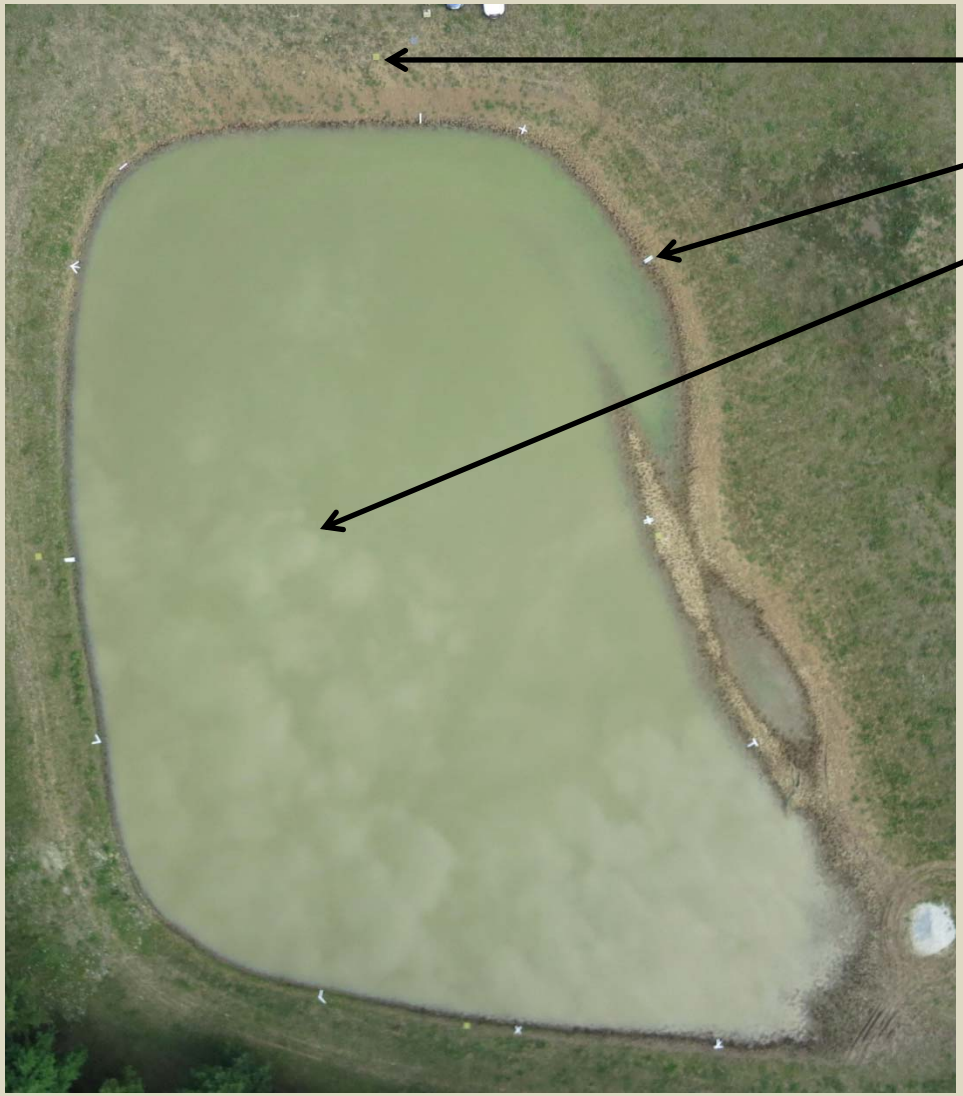


Blue NDVI



Livestock pond example

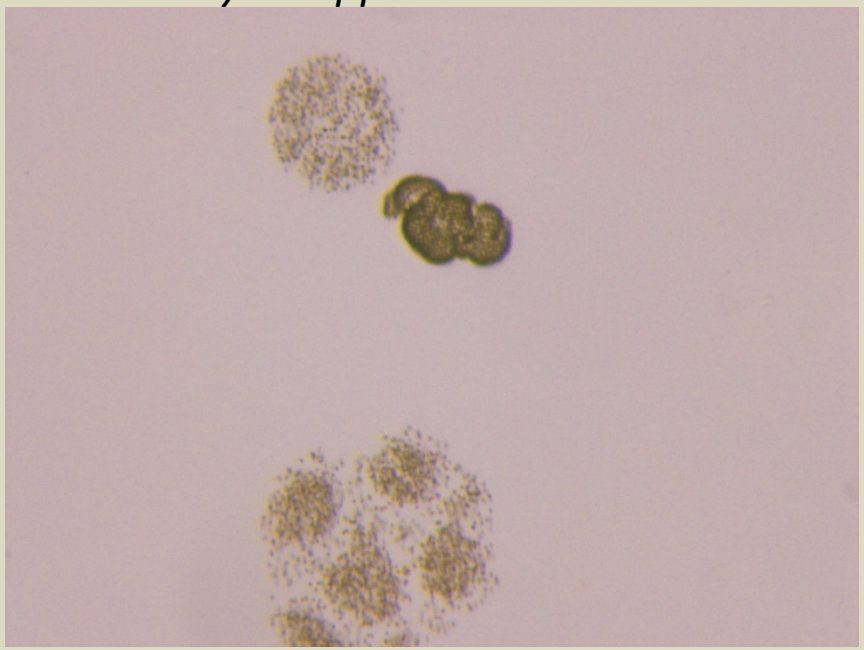
Normal image (red/green/blue)



Note: No obvious algae gradient
Bright cloud reflections

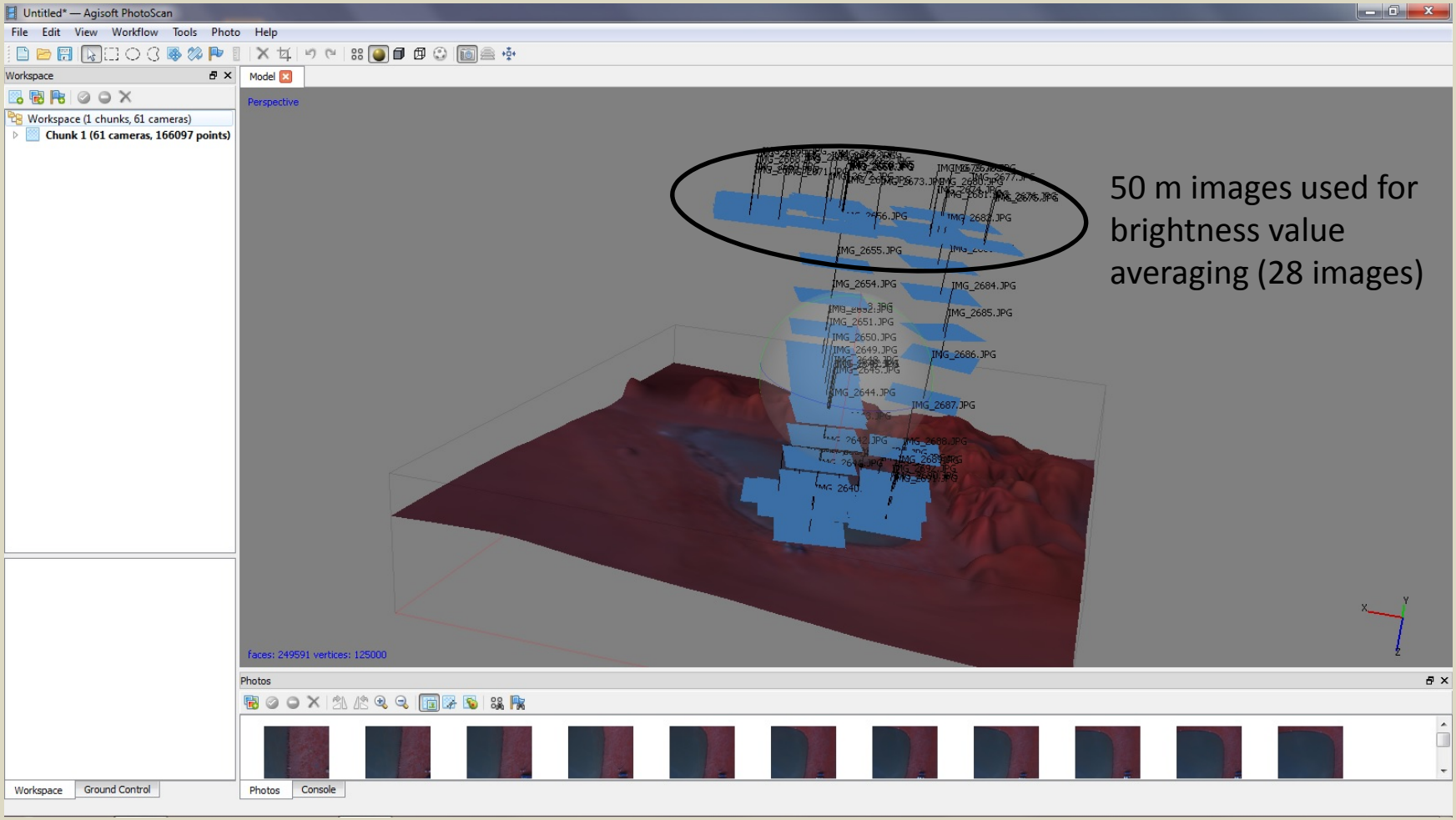
Microscopy

Microcystis spp.

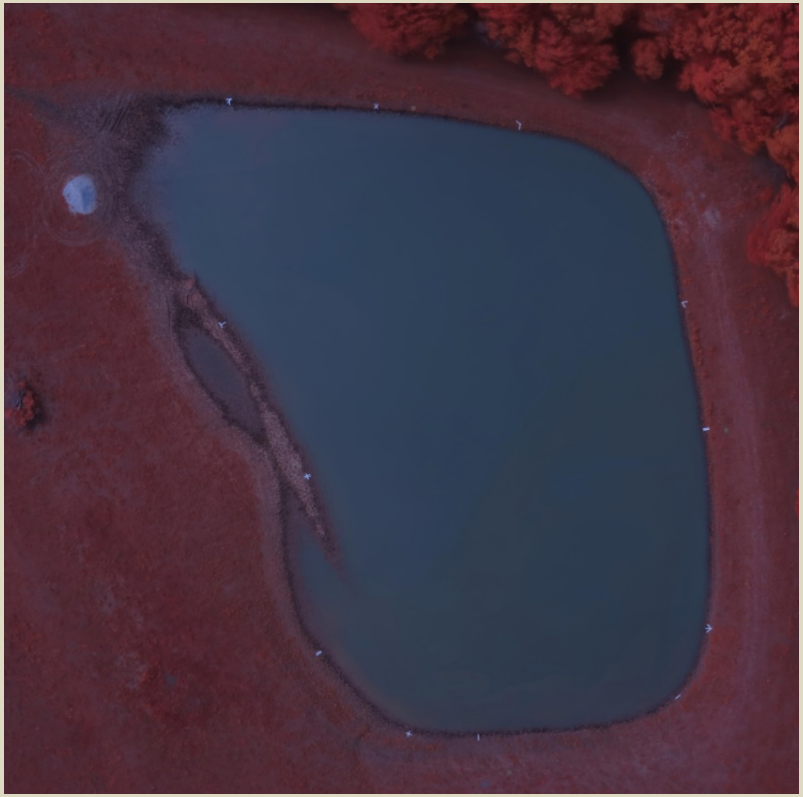


Aphanizomenon flos-aquae

Agisoft surface model

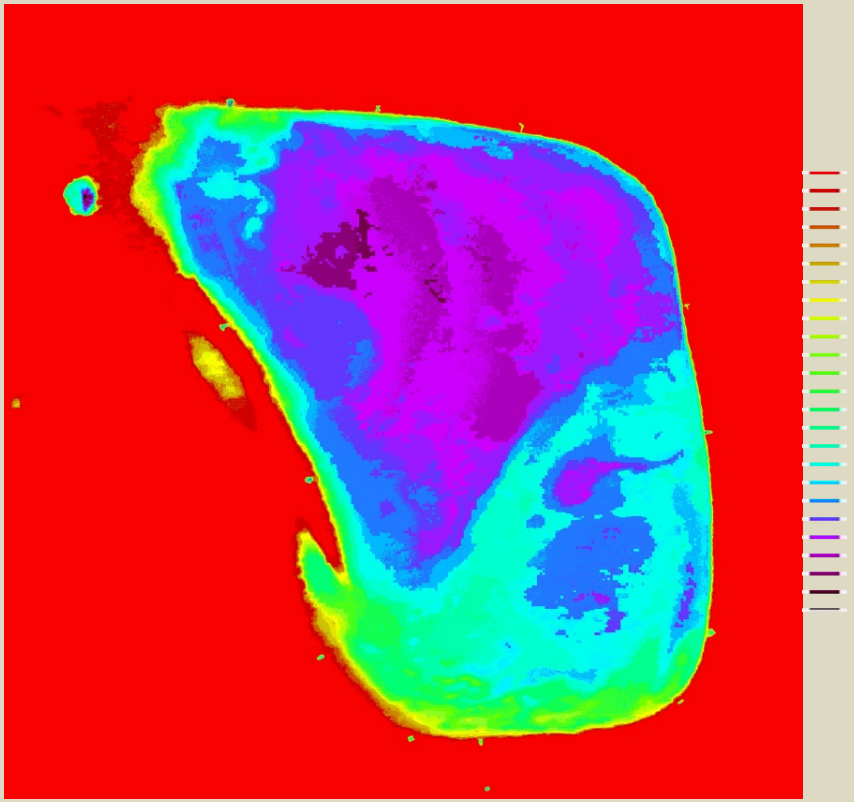


Averaged color-infrared image
(NIR/green/blue)



Note: Visible algae gradient
No cloud reflections

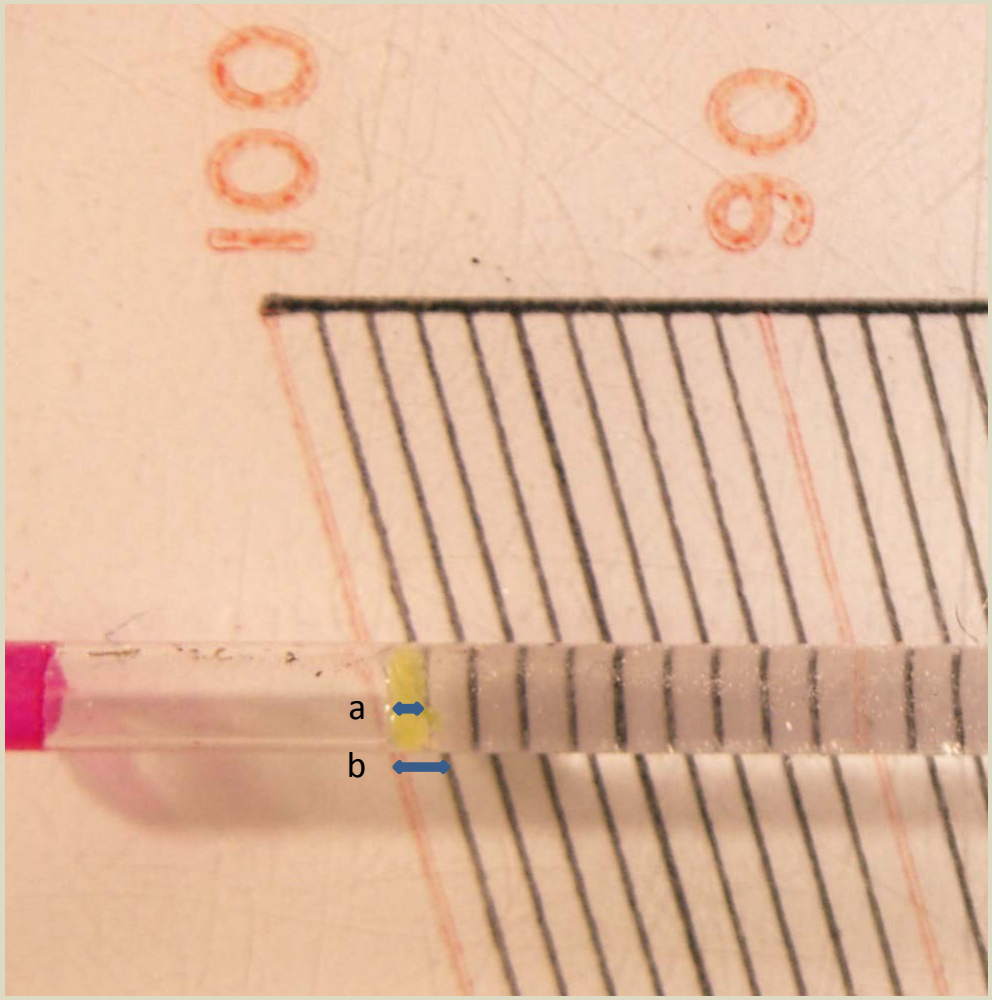
Blue NDVI image
(NIR-blue)/(NIR+blue)



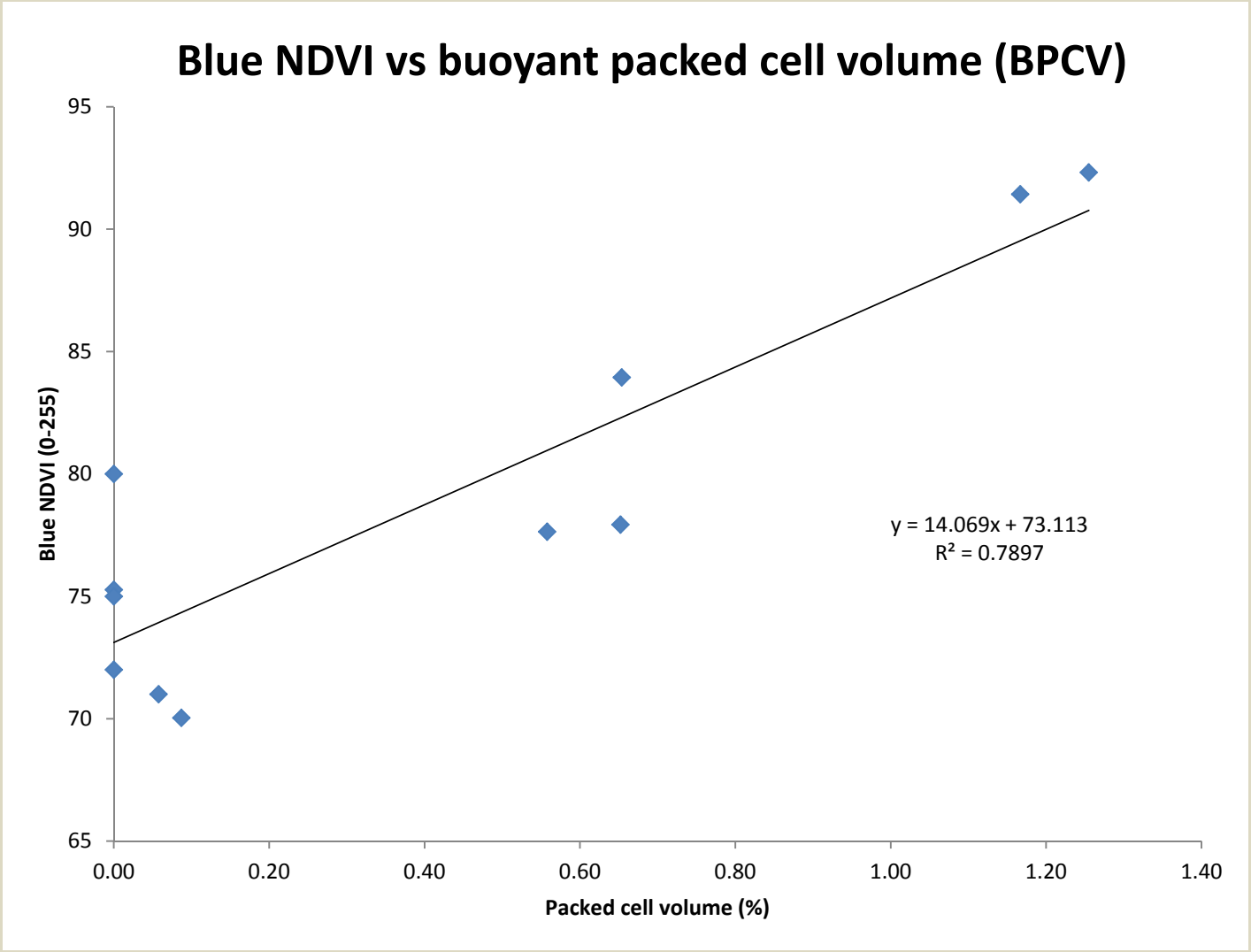
NDVI image generated in AgPixel

Buoyant packed cell volume (BPCV)

expressed as a percentage of total water volume



BPCV = a/b



Blue NDVI = (NIR-blue)(NIR+blue)

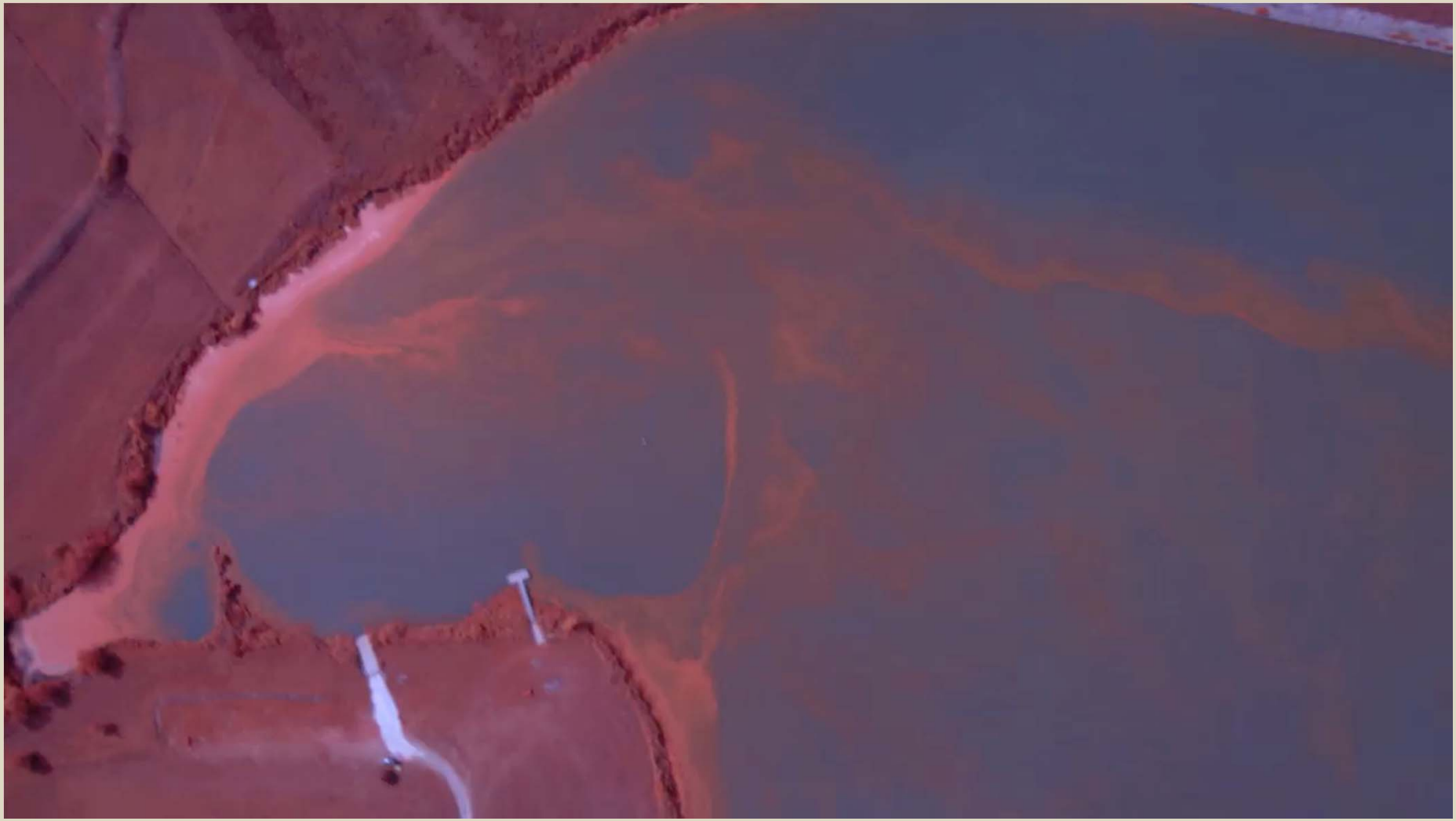
Note: Blue NDVI values were transformed to a 0-255 scale

Conclusion

- Traditional sampling:
  - High cost; long delay
  - Uncertain local risk assessment

- sUAS remote sensing:
  - Virtually complete surface sampling; efficient
  - High spatial and temporal resolution

Ideally suited for rapid, local risk assessment



Questions?