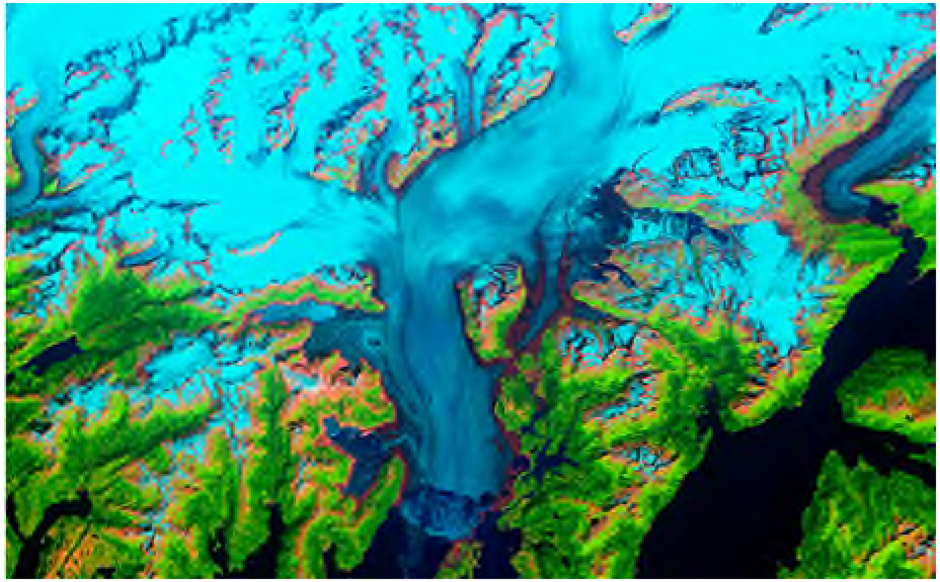
Predicting Water Quality In Kentucky Lakes Using Landsat Satellite Imagery



http://nasaesw.strategies.org/mapping-world-landsat

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NWQMC 2014

Limitations of Current Lakes Sampling

Over 600 lakes in Kentucky – One assigned staff

High Cost – Travel – Equipment – Lab Analysis

Sample Size Not Representative – One sample taken near the dam does not describe the whole water-body

Harmful Algal Bloom Identification (HAB) - No time to explore the lake searching for bloom conditions

Objective:

Develop a program to effectively monitor Lake water quality – trophic state

Identify locations with the high probability of HAB's for further investigation

Produce graphics to communicate water quality conditions to the public

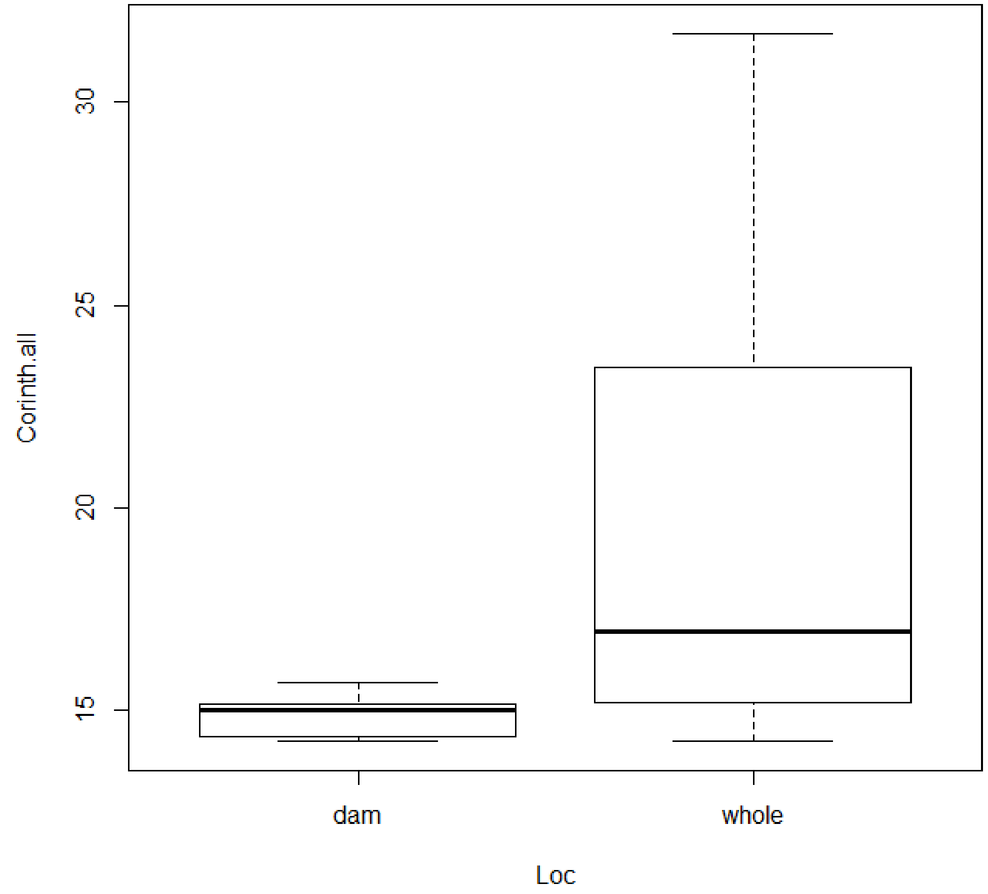
Use remote sensing and Landsat satellite data to model these conditions

Sample size not representative of entire waterbody

Corinth lake
96 acres ~ 4000 pixels

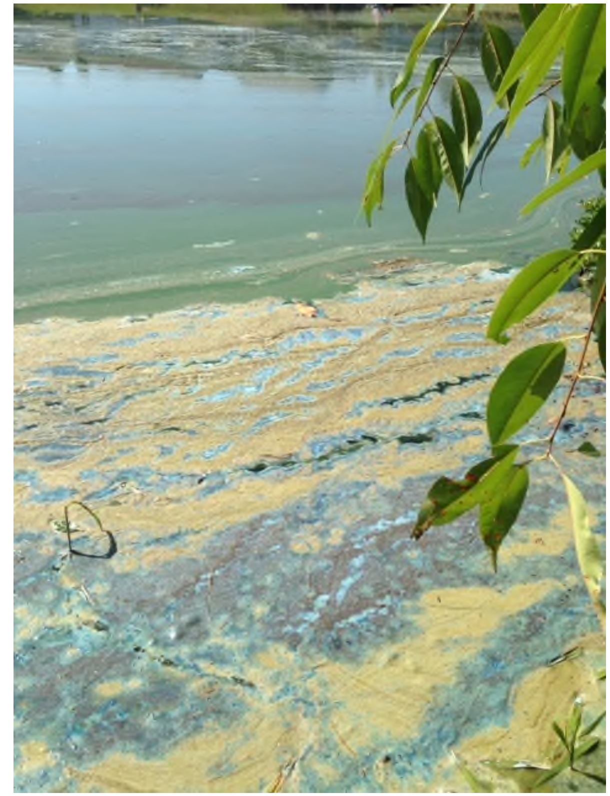
Dam N=9 - 15 ug/L Chl a

Whole N=39 - 17 ug/L Chl a



Kruskal-Wallis chi-squared = 10.1376, df = 1, p-value = 0.001453

Identify harmful algal blooms



These are obvious

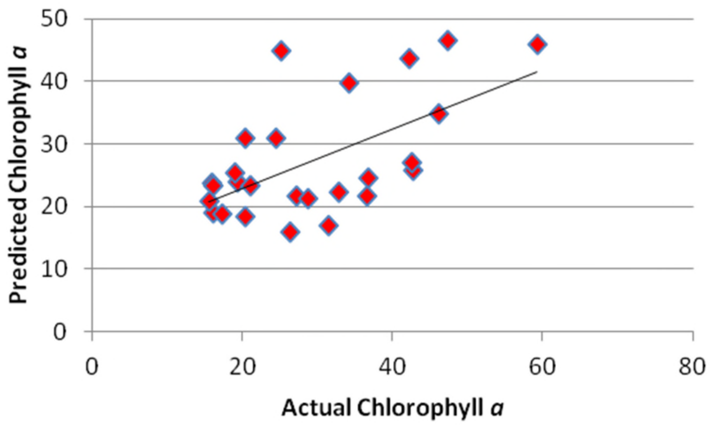
A Bloom might look like this

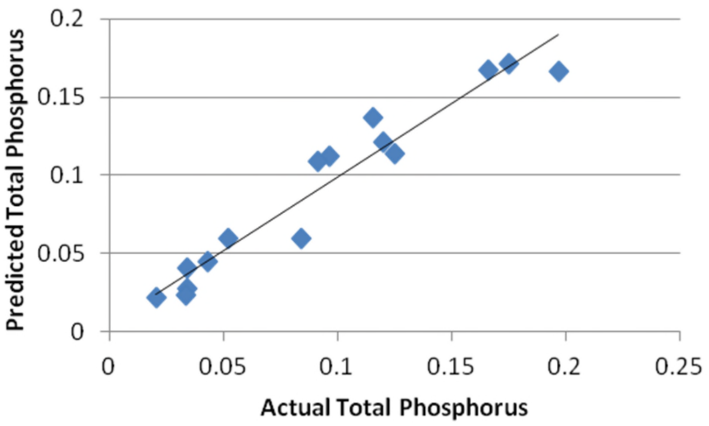
Field Methods

- Lakes were sampled from georeferenced locations.
- *In situ* **Secchi depth**, **chlorophyll *a*** and **total P** samples were collected on the same day as the satellite fly over
- 2014 – Sampling design test to optimize ground-truthing methods.
- 2014 – Phycocyanin samples to model cyanobacteria density

MLR Models

- **Employed Stepwise Multiple Linear Regression**
  - Water quality variables as the dependent variable (chl *a* and total P)
  - Bands 1-8 as the independent variables.
- **Used stepwise comparison of single bands and ratio of bands to find model with the best fit**
  - Chl *a* = 46.399 - (0.068*B3) + (0.108*B4) – (0.042*B6)
    - **(<u>Adj R^2 = 0.60</u> $p < 0.001$ n = 27)**
  - Total P = 5.859 – (2.876*B2:B4) – (0.0002507*B3)
    - **(<u>Adj R^2 = 0.92</u> $p < 0.001$ n = 15)**

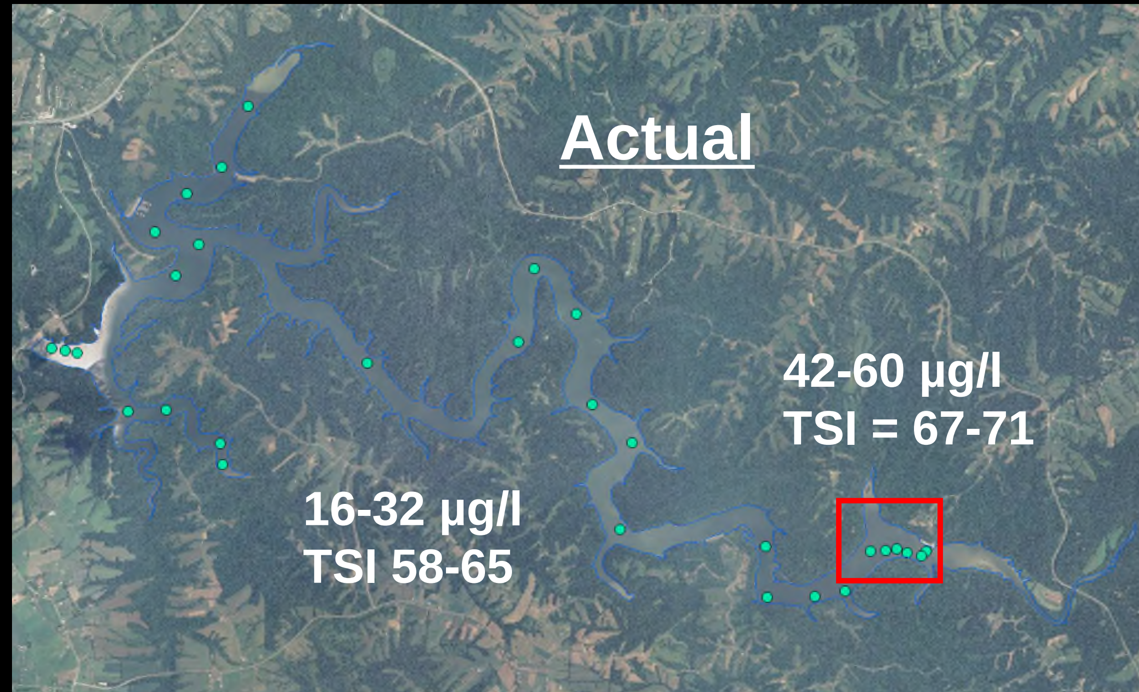


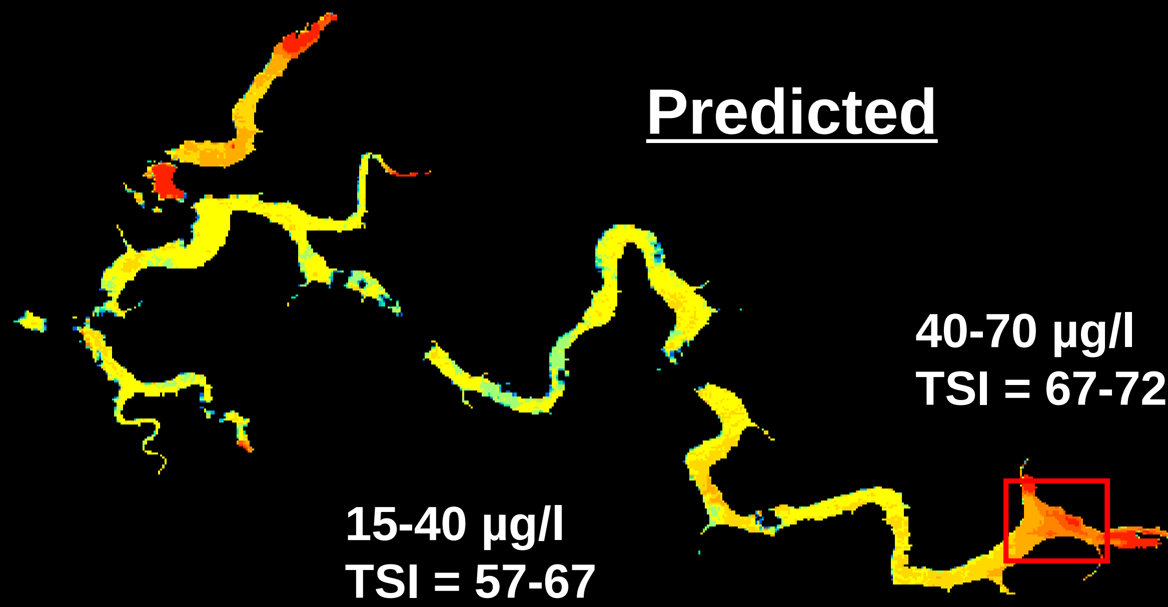


Taylorsville Lake

Chlorophyll a (µg/l)

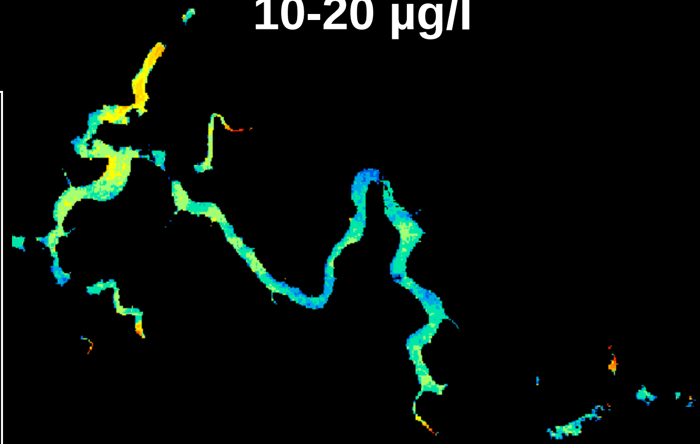
- 0 - 5
- 5-10
- 10-15
- 15-20
- 20-25
- 25-30
- 30-40
- 40-50
- 50-60
- > 70



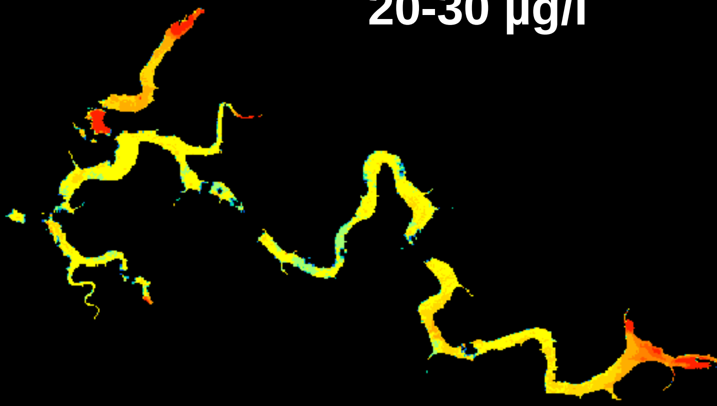


Taylorsville Lake

10-20 µg/l



20-30 µg/l

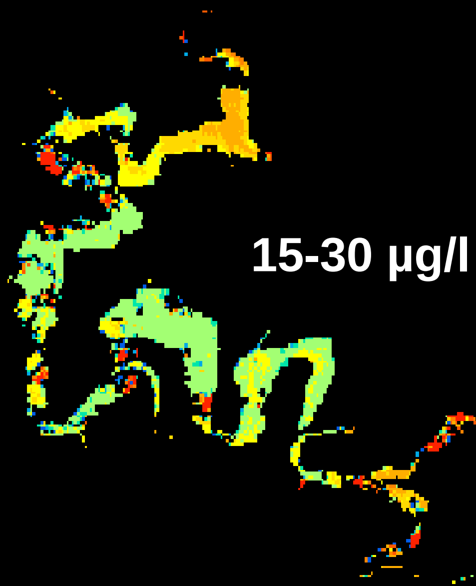


July 29, 2013

Aug 30, 2013

Green River Lake

5-10 µg/l



15-30 µg/l

Chlorophyll a (µg/l)
0 - 5
5-10
10-15
15-20
20-25
25-30
30-40
40-50
50-60
> 70

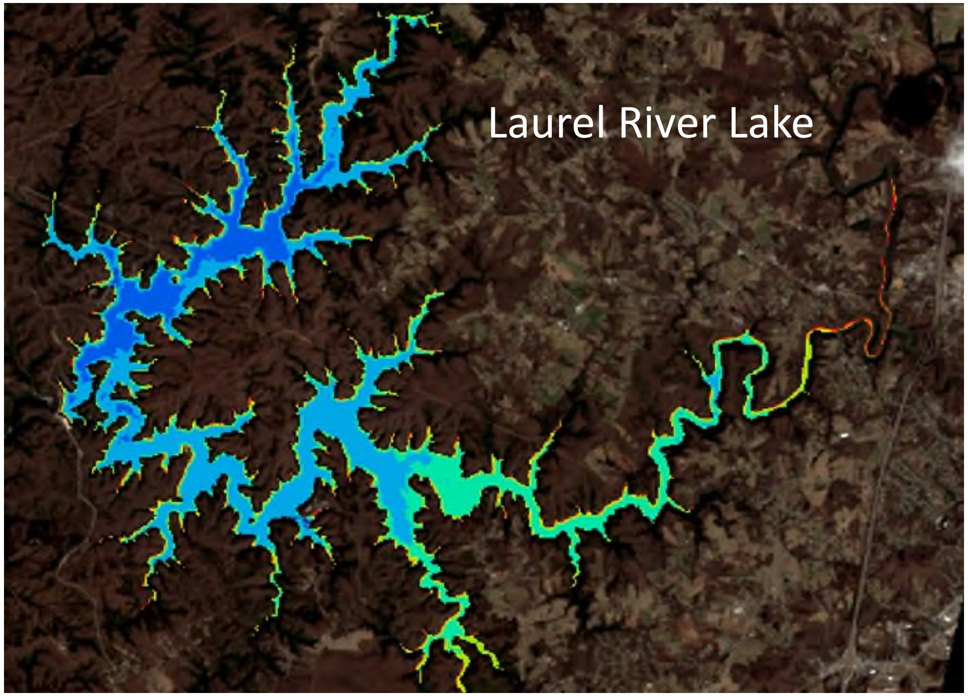
Secchi Depth Model

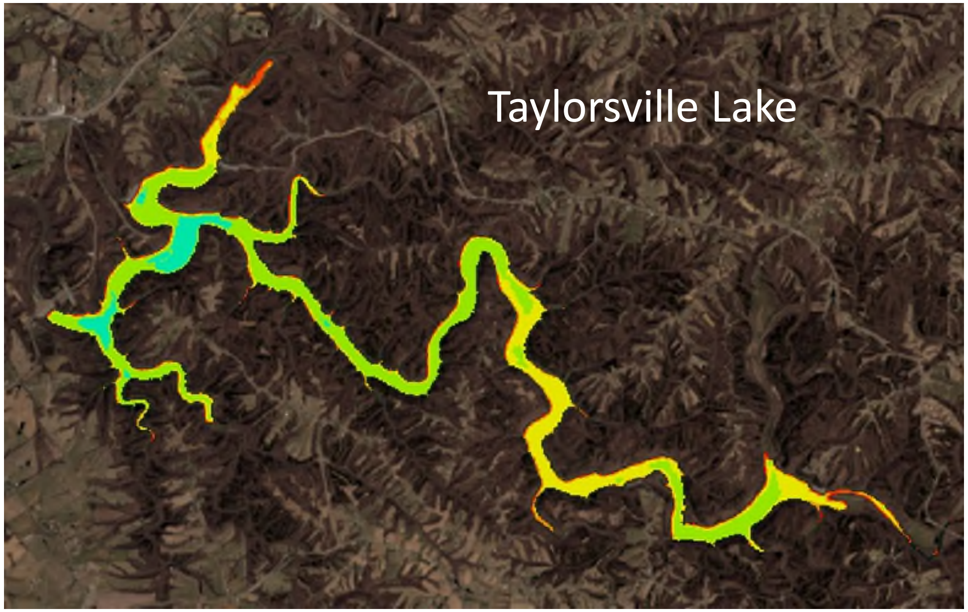
$SD = -3.4815 + (0.0021*B2) - (0.0015*B3) - (0.0004*B7)$

Adj R square = 0.66

Secchi Depth (meters)

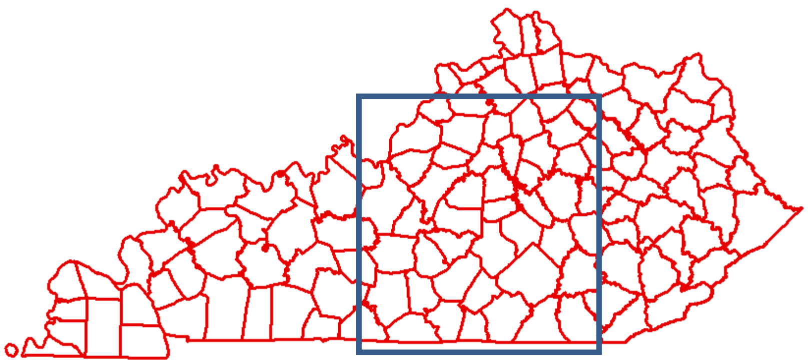
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- 1.0- 1.2
- 1.2- 1.4
- 1.4 - 1.6
- 1.6 - 1.8

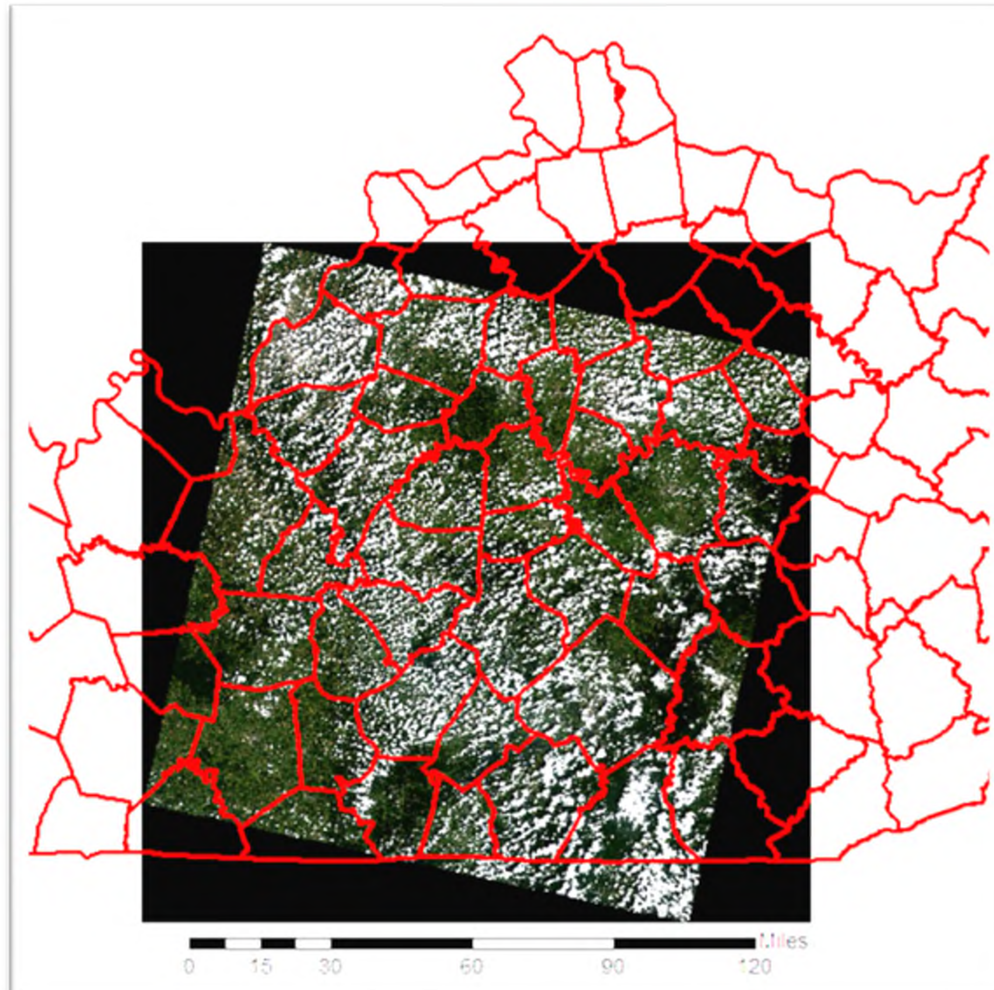




Model is Applied to the Scene

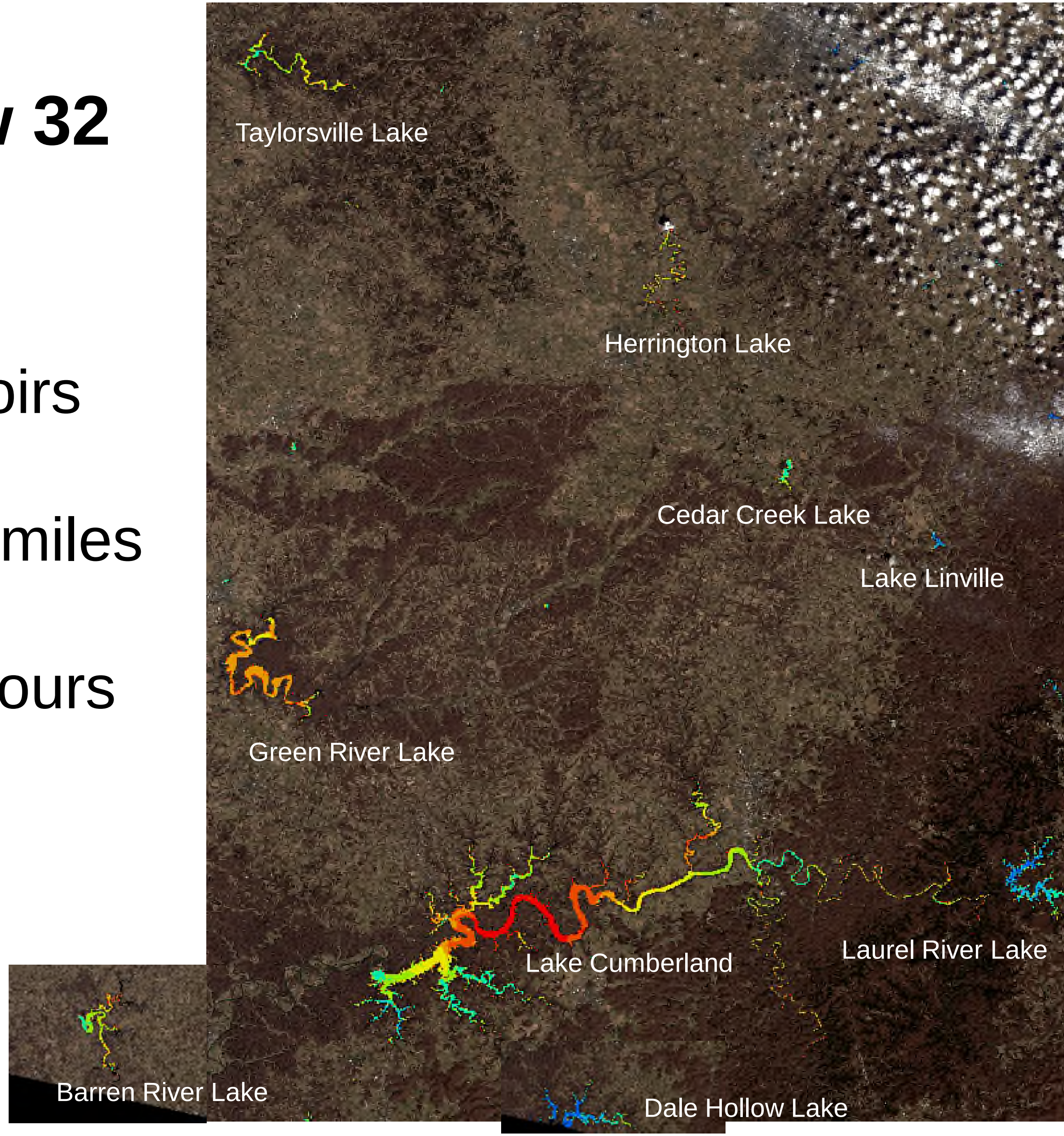
One Landsat 8 image covers ~12,000 mi^2 (115 mi x 105 mi).





Path 20, Row 32

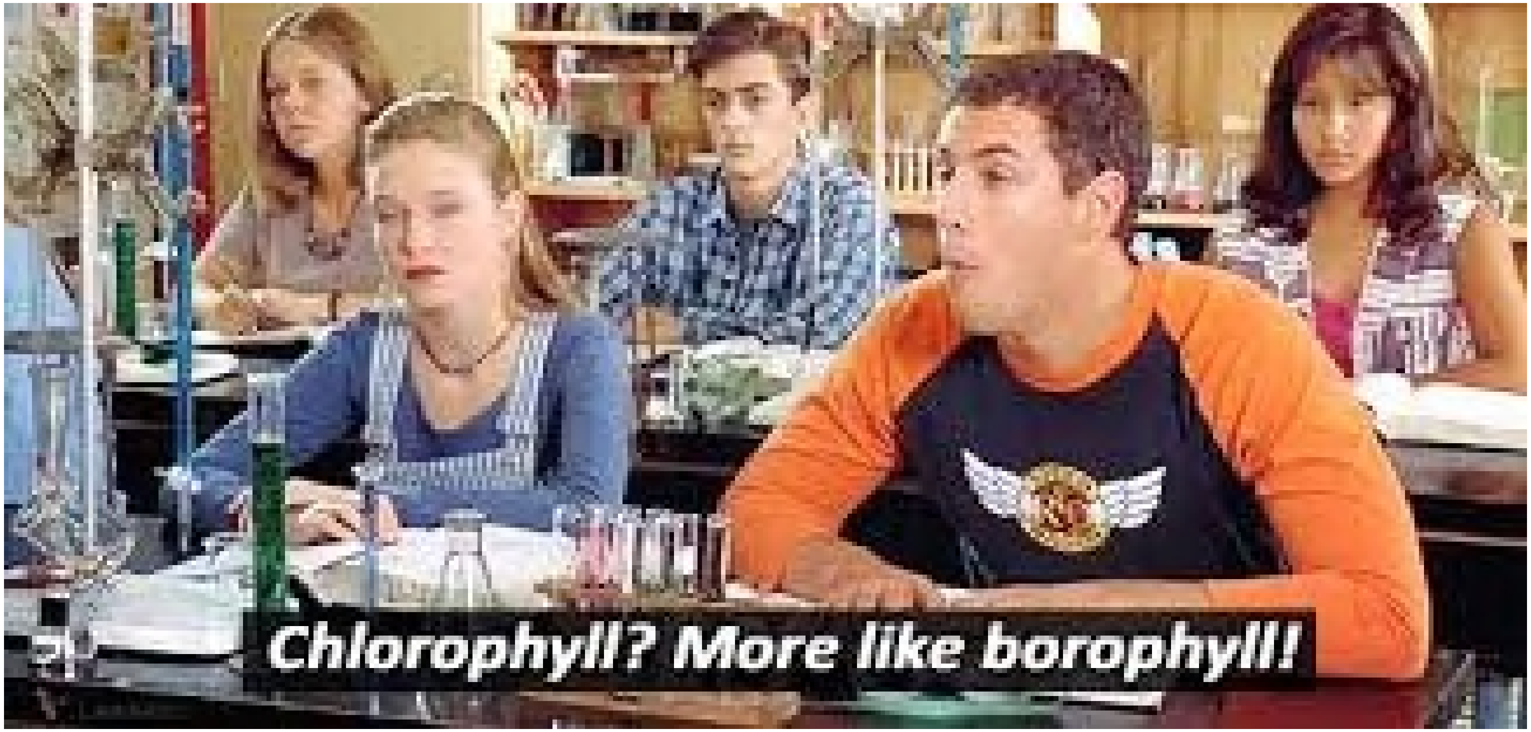
- 9 major reservoirs
- 12,000 square miles
- 24 personnel hours



Conclusion

- **Able to monitor many environmental variables.**
- **Time and cost efficient.**
- **A useful tool to identify geographic and temporal water quality trends in lakes and some rivers.**

Thank You.



Questions?