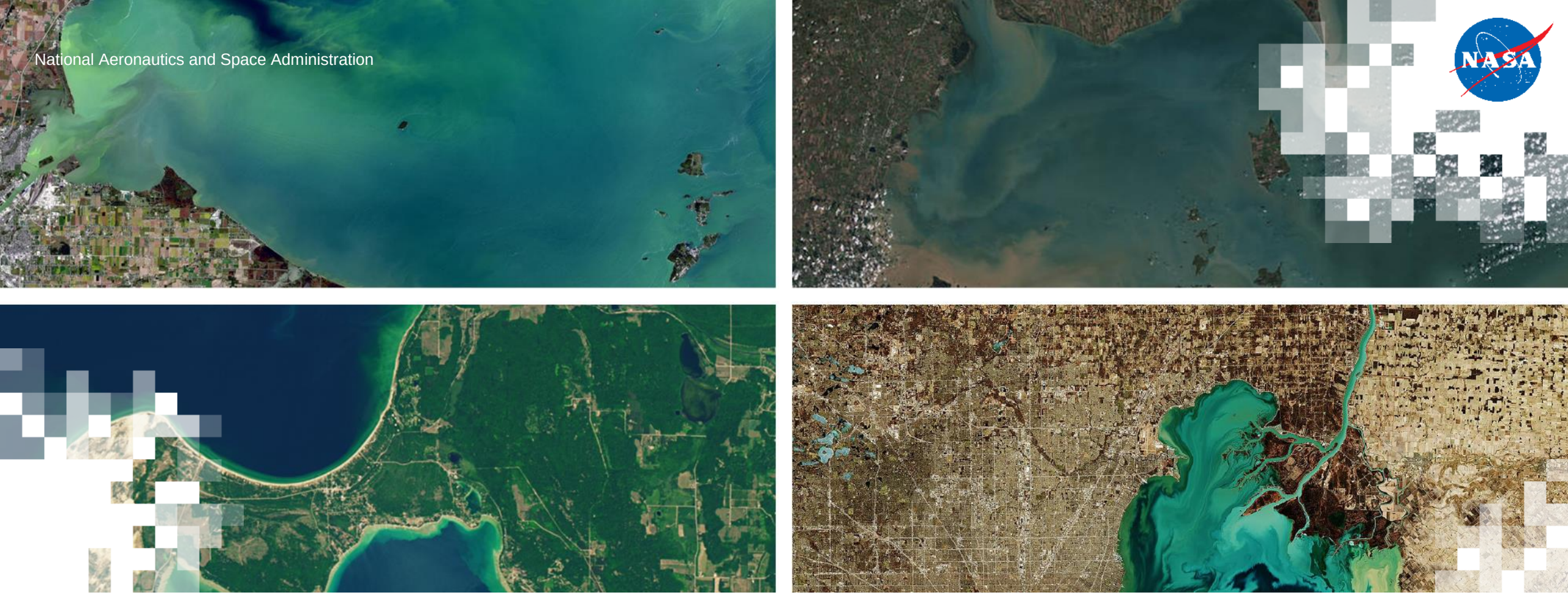


Monitoring Water Quality of Inland Lakes using Remote Sensing

Part 2: Cyanobacteria Assessment Network (CyAN)

Blake Schaeffer (U.S. EPA) and Bridget Seegers (NASA), with Special Guest Daniel Sobota (OR DEQ)

July 20, 2023

Review of Part 1

- Described state-of-the-art, high spatial and spectral resolution observations from Landsat 8, Sentinel-2, and Sentinel-3 for water quality remote sensing.
- Described selected, open source, *in situ* measurements of water quality parameters including from USGS Water Dashboard and Lake Water Quality Portal, National Harmonized Chlorophyll Data, UNEP GEMStat, and GLORIA.
- Reviewed algorithm development requirements for remote sensing of water quality parameters.
- Explored and downloaded GLORIA *in situ* measurements of chlorophyll-a concentration, TSS, and Secchi Depth for Lake Erie.
- Searched and identified optical surface reflectance data from Landsat 8 and Sentinel-2 collocated with in situ measurements for Lake Erie using GEE.

Training Outline

Part 1

Overview of Remote Sensing Observations to Assess Water Quality

July 18, 2023

Part 3

Assess Water Quality using Satellite and In Situ Observations

July 25, 2023

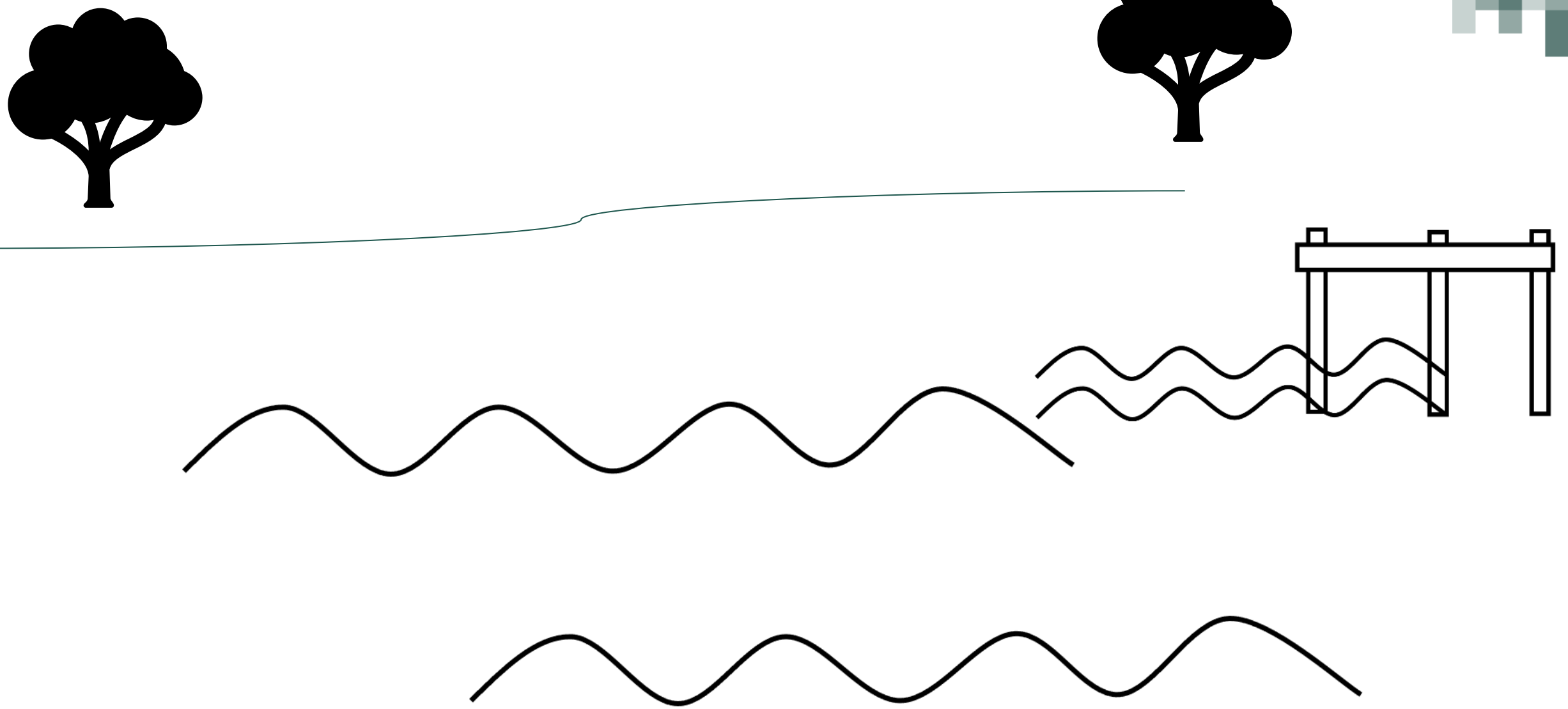
Homework

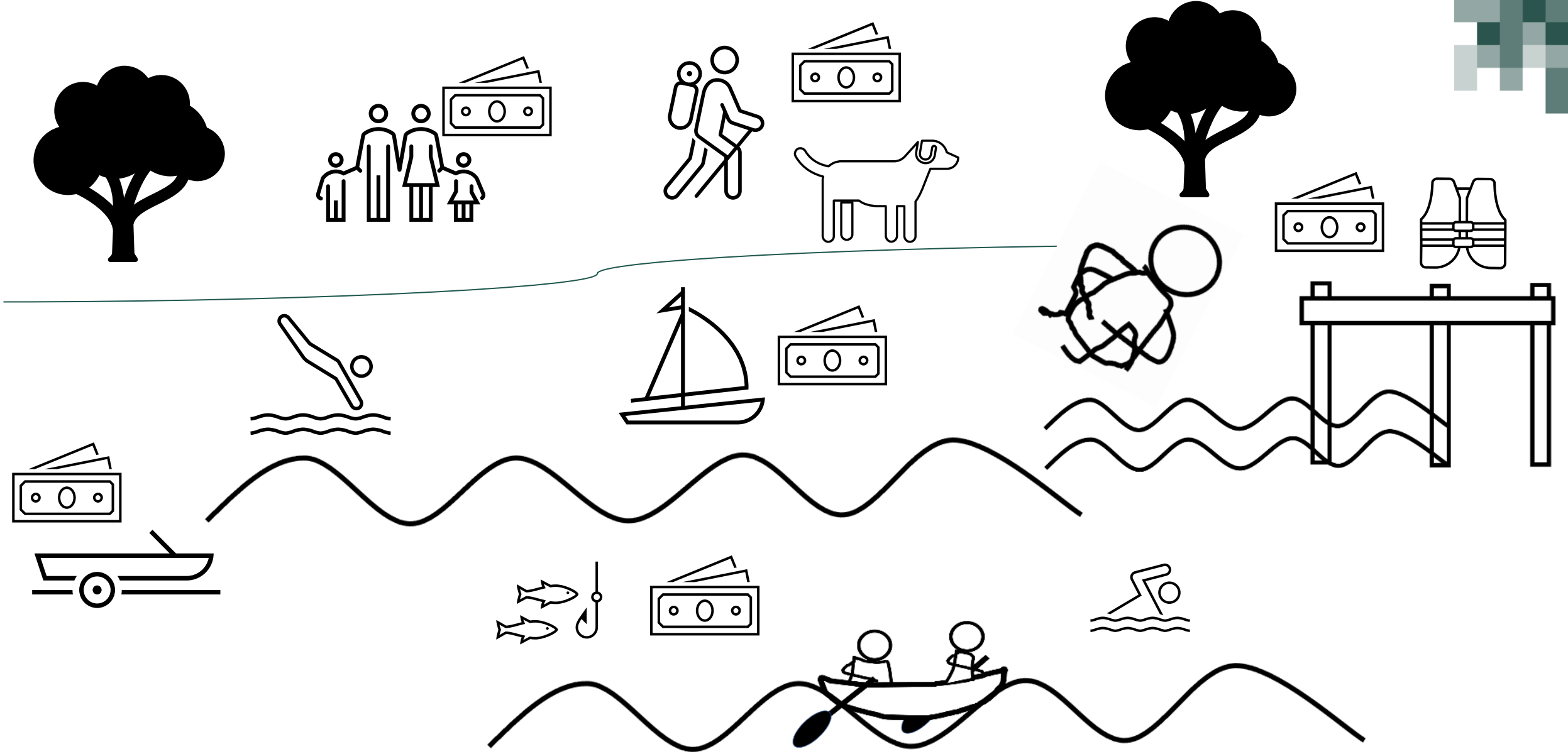
Opens July 25 – Due August 8 – Posted on Training Webpage

A **certificate of completion** will be awarded to those who attend all live sessions and complete the homework assignment(s) before the given due date.

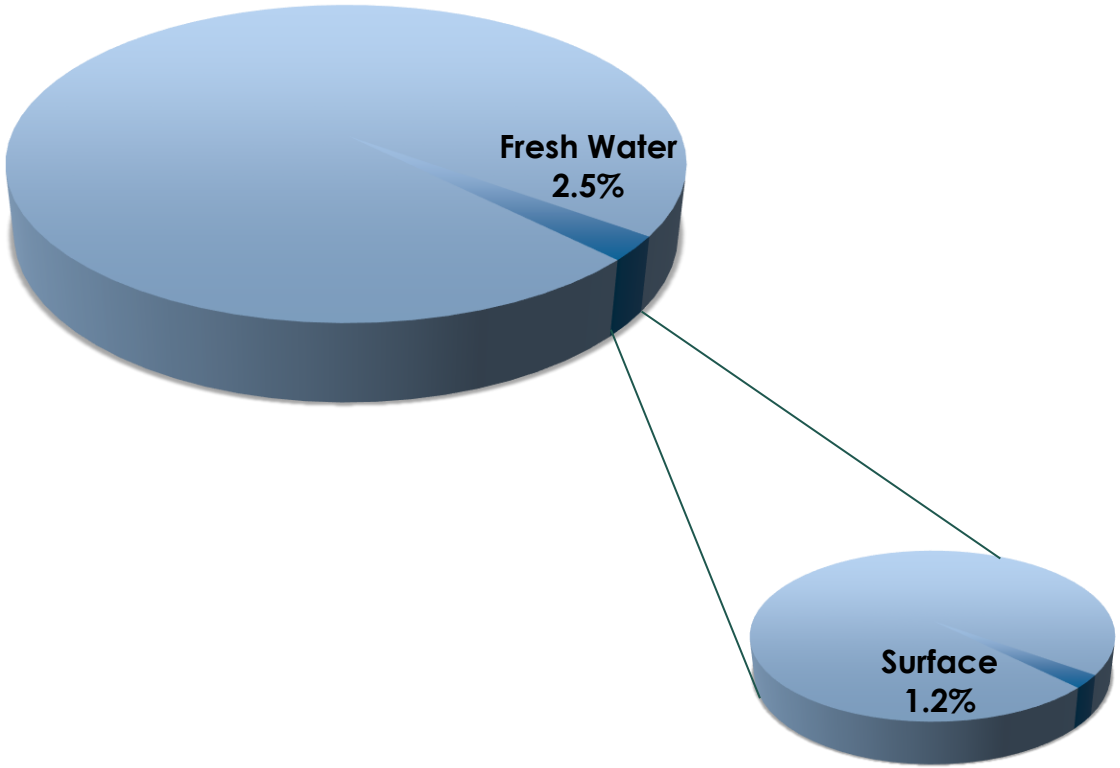
How to Ask Questions

- Please put your questions in the Questions box and we will address them at the end of the webinar.
- Feel free to enter your questions as we go. We will try to get to all of the questions during the Q&A session after the webinar.
- The remainder of the questions will be answered in the Q&A document, which will be posted to the training website about a week after the training.

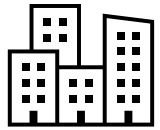




Earth's Water



~8,000,000,000



Houston, TX

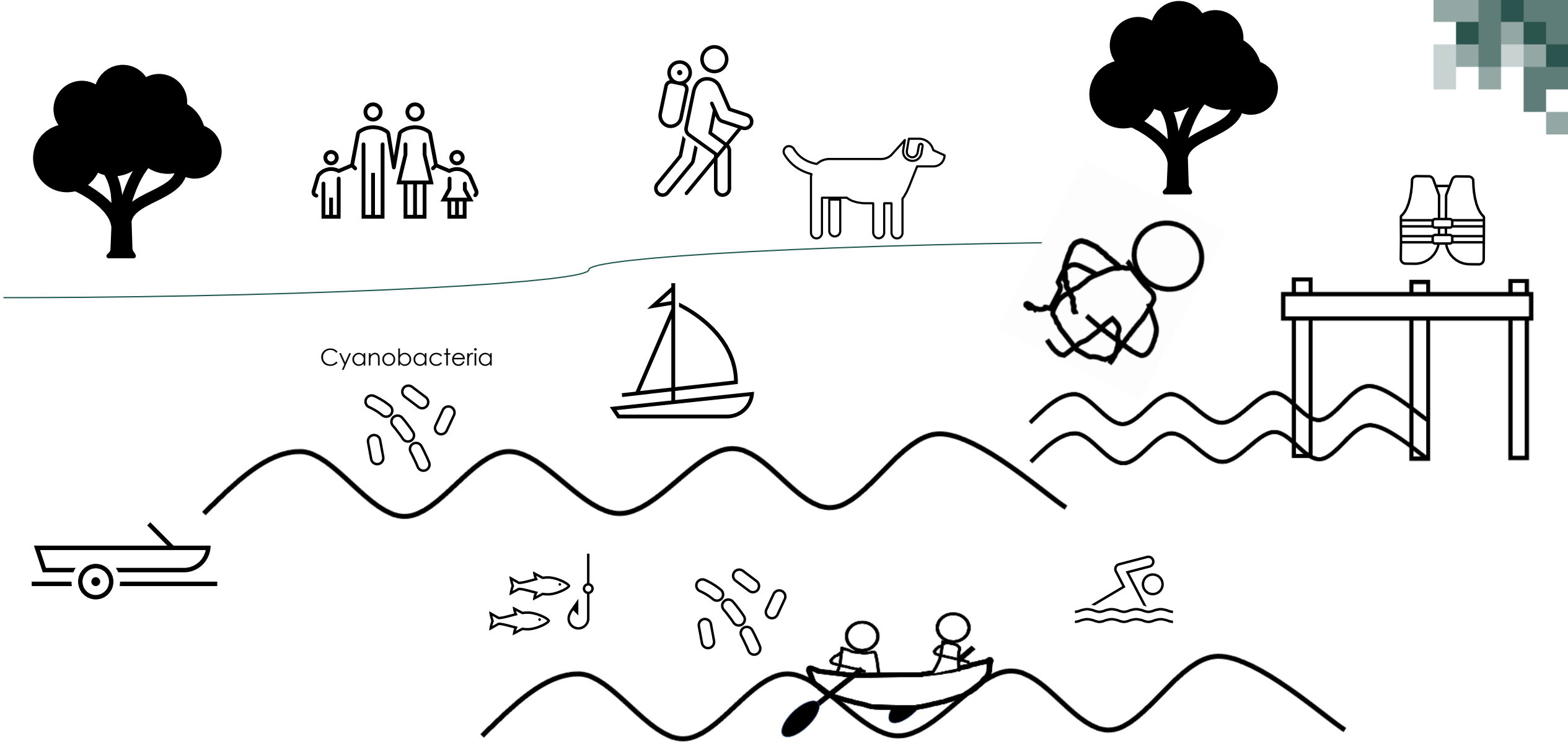
~2,400,000

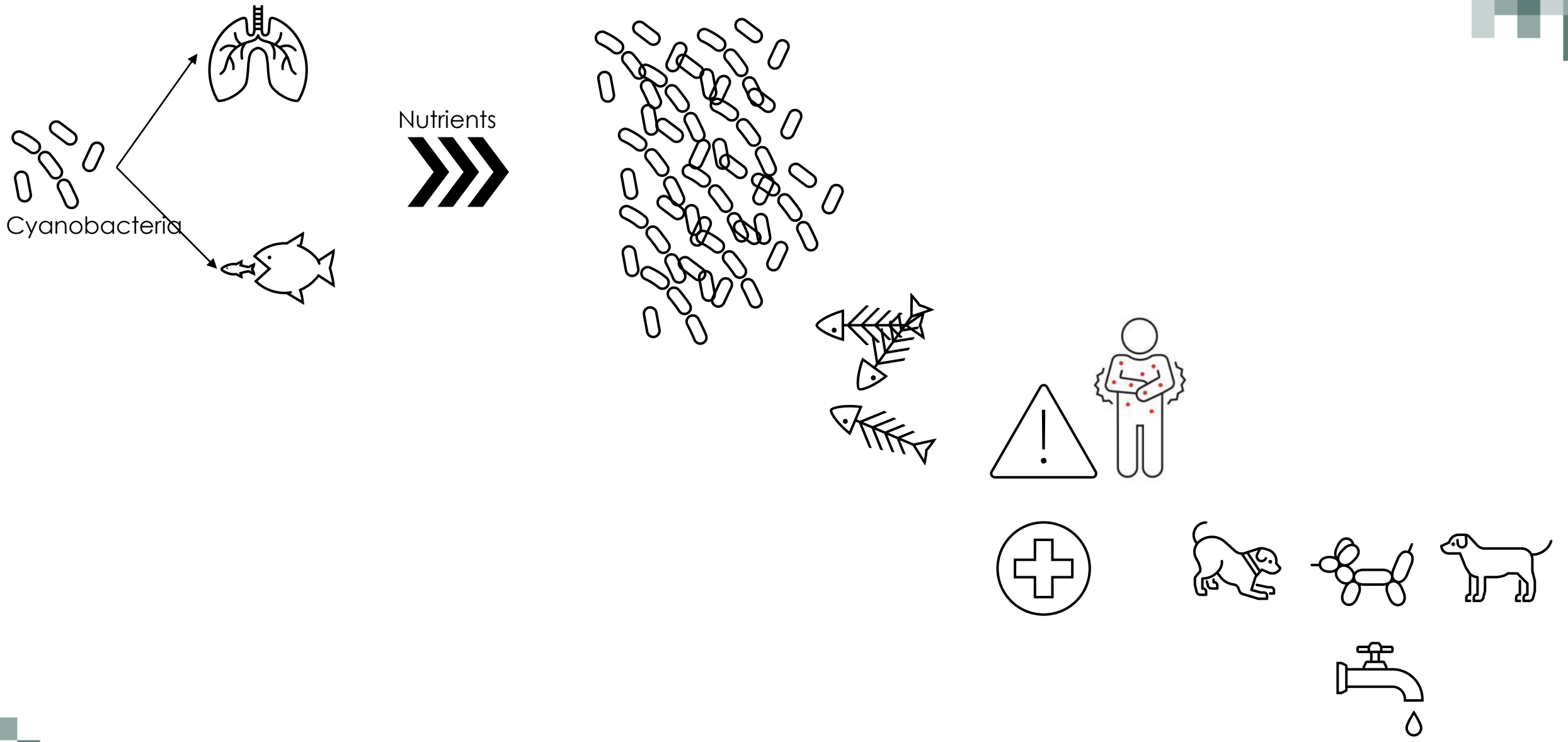
Part 2 – Trainers

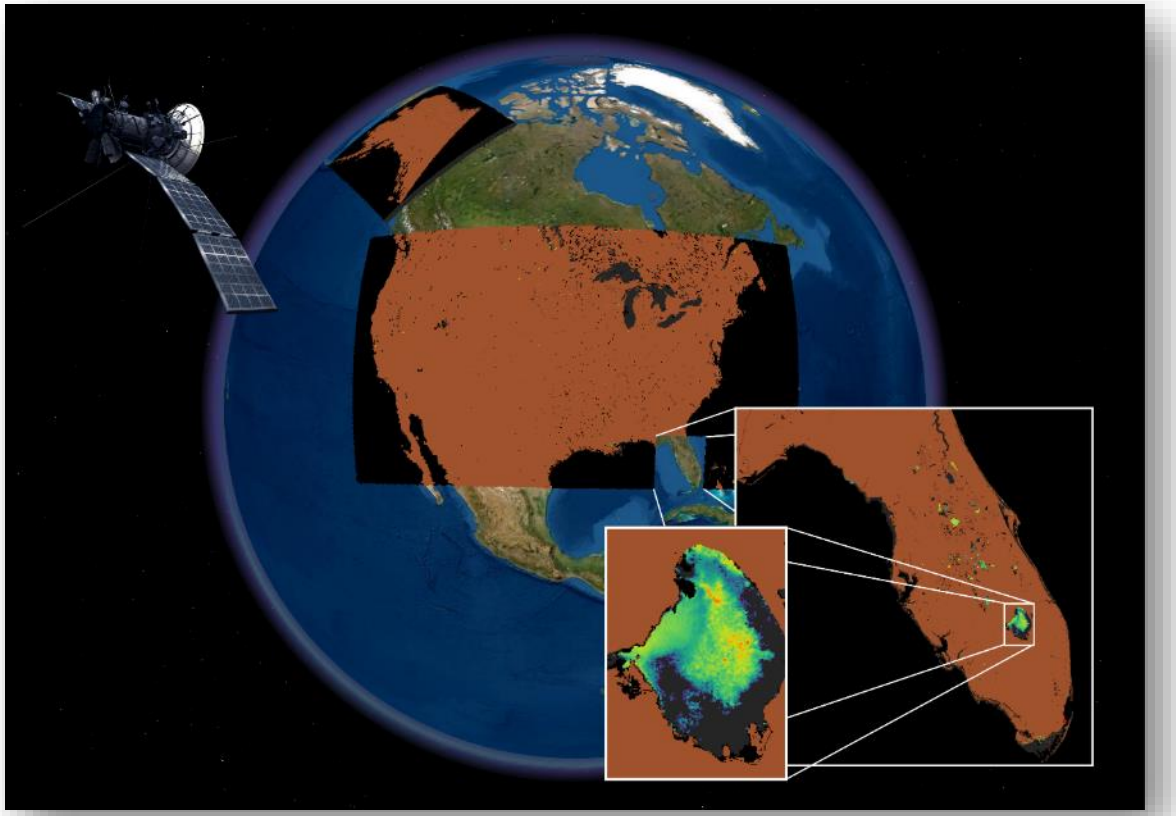
Blake Schaeffer
Research Scientist
US EPA

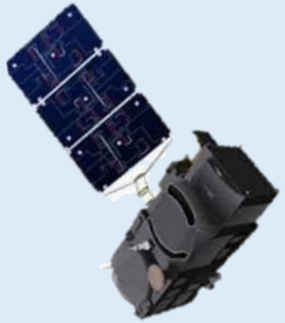
Bridget Seegers
Research Scientist
NASA

Daniel Sobota
Senior Water Quality Specialist
OR DEQ


Cyanobacteria


Nutrients
Cyanobacteria





V/UV
B
G
Y
O
R
NIR

AIR

WATER

Two possible things happen to a photon in water.

ABSORPTION (a)

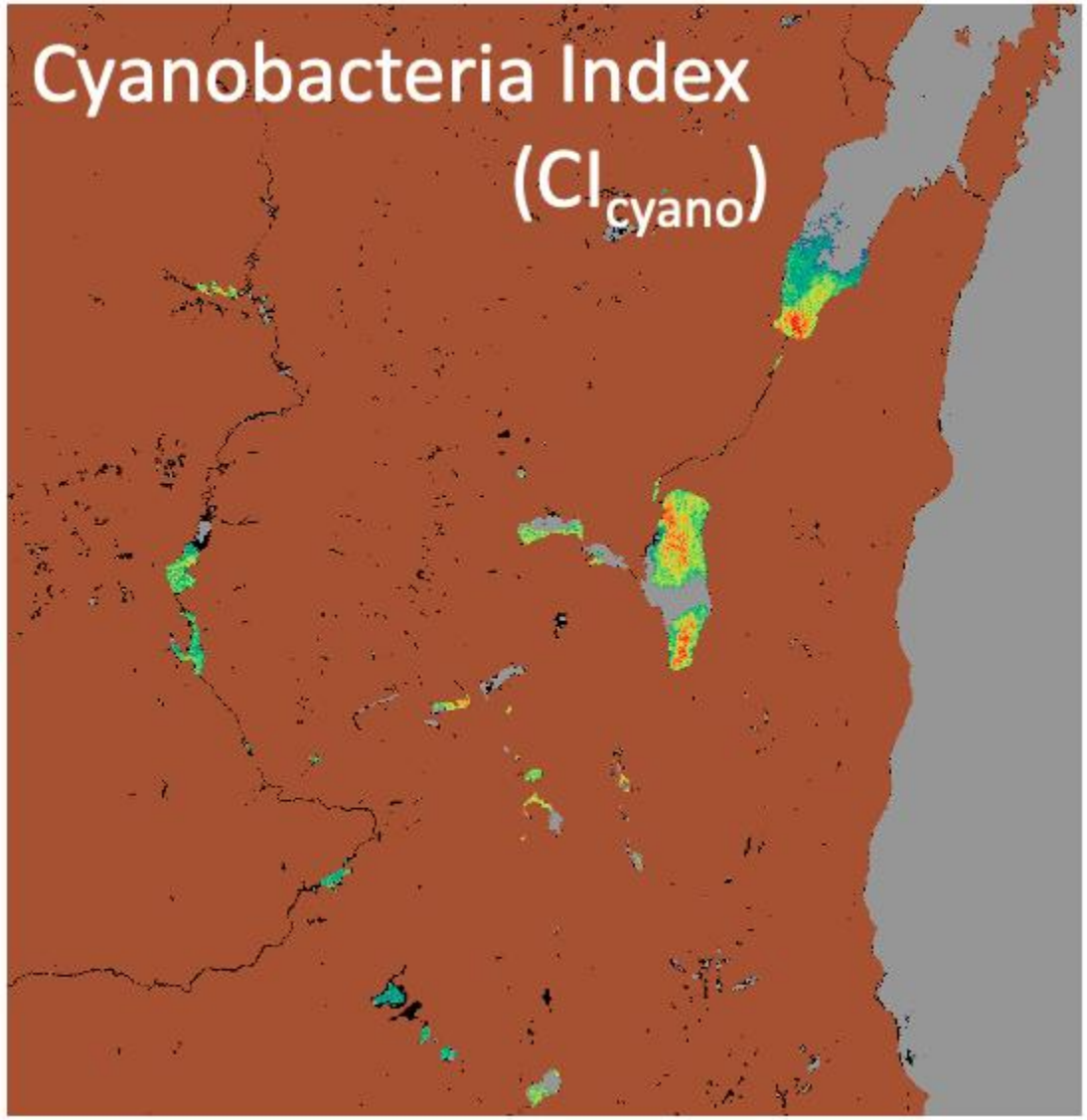
SCATTERING (b_b)

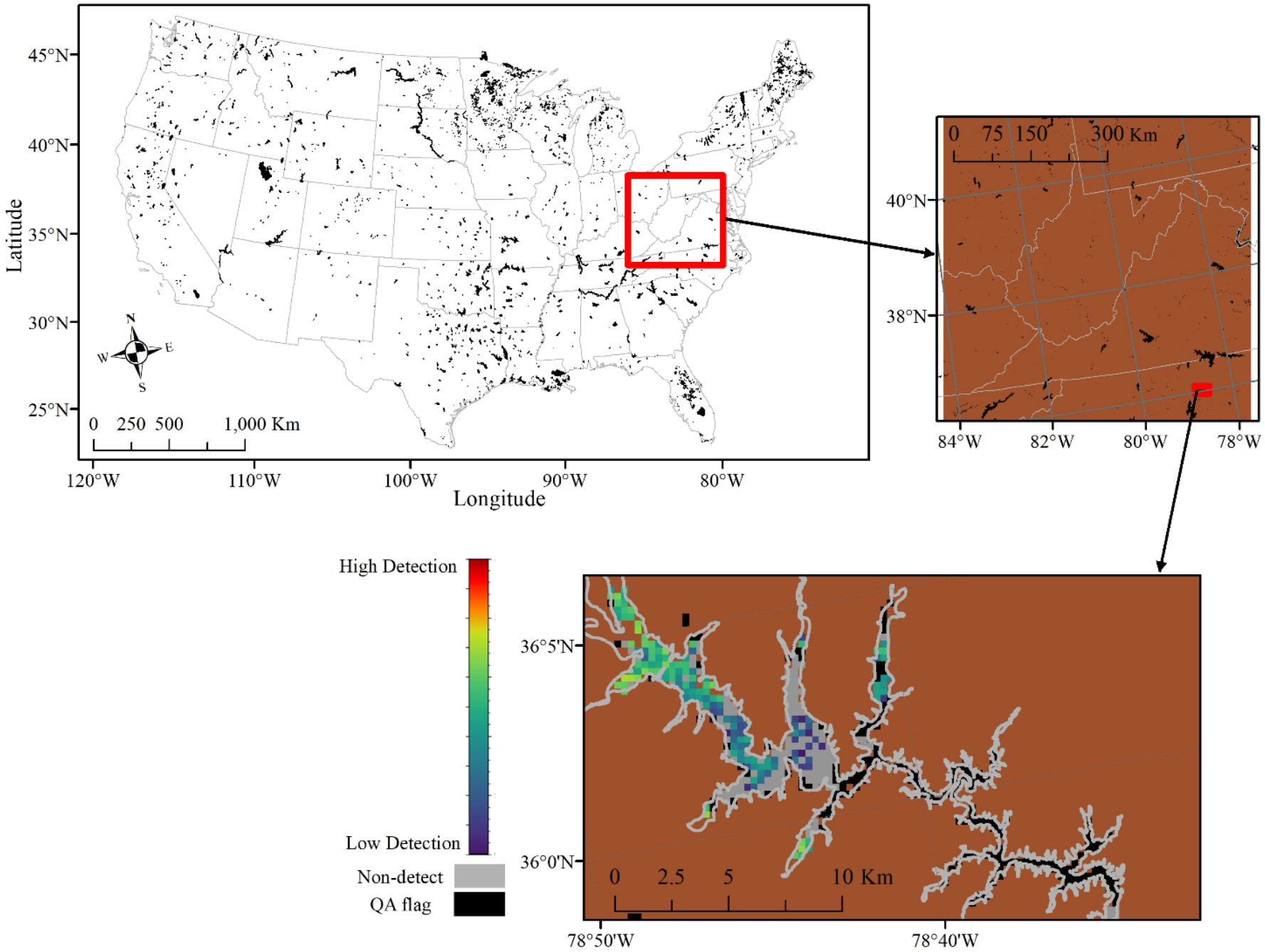
Cyanobacteria

Phytoplankton
Organic Matter
Detritus

Adapted from Ryan Vandermeulen


True Color


Cyanobacteria Index
(CI cyano)

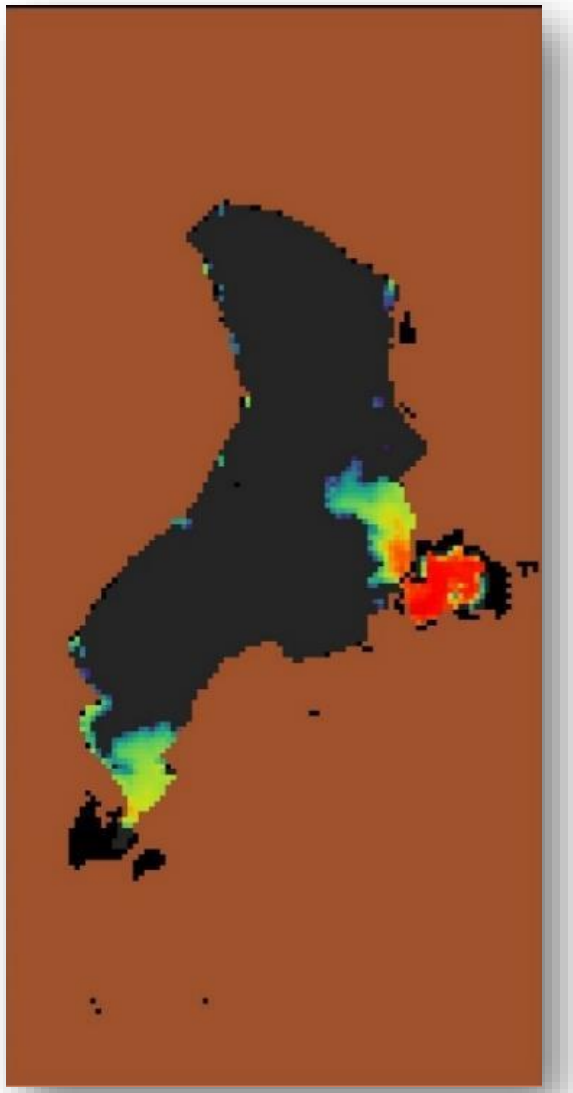

45°N
40°N
35°N
30°N
25°N
Latitude
120°W
110°W
100°W
90°W
80°W
Longitude
N
W
E
S
0 250 500 1,000 Km
0 75 150 300 Km
40°N
38°N
84°W
82°W
80°W
78°W
High Detection
Low Detection
Non-detect
QA flag
36°5'N
36°0'N
0 2.5 5 10 Km
78°50'W
78°40'W

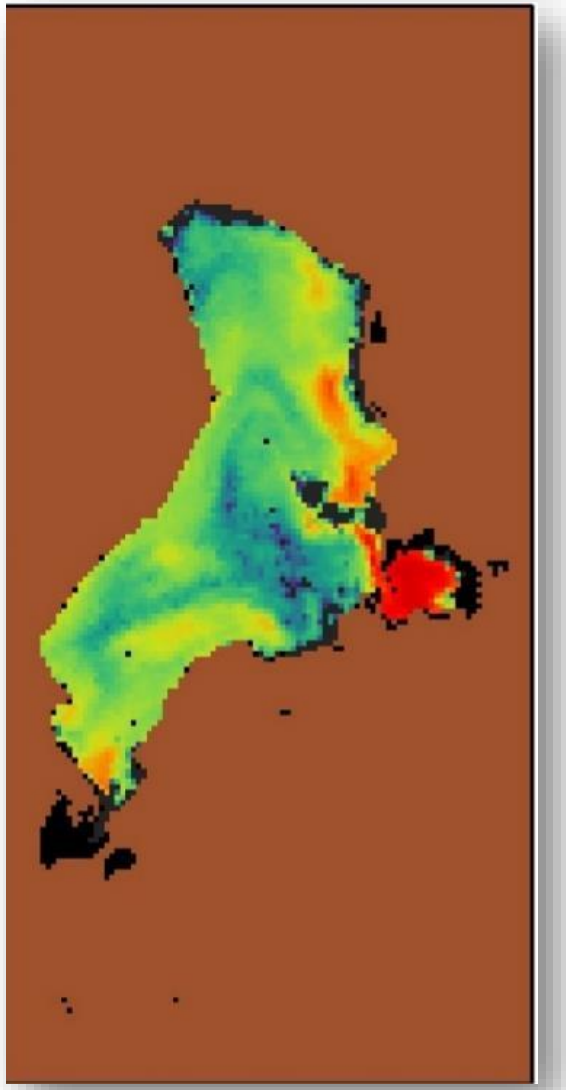
Utah Lake

(Rick Egan/The Salt Lake Tribune)

RESOURCES for the FUTURE

Utah Lake





State of Oregon
DEQ Department of Environmental Quality

Satellite Estimates of Cyanobacteria in Oregon Lakes and Reservoirs

Reporting Period: June 5, 2023 - June 11, 2023

Introduction

This report provides an update to estimates of cyanobacteria abundance derived from satellite imagery for 49 large Oregon waterbodies. Updates are scheduled to occur weekly from March to October each year. Estimates derive from the Cyanobacteria Assessment Network (CyAN) project. Three levels illustrate cyanobacteria abundance (cells/mL): Low: <20,000, Moderate: 20,000-100,000, and High: >100,000. The levels correspond to the World Health Organization (WHO) exposure guideline values (WHO, 2003). For more information on Harmful Algal Blooms in Oregon, please visit websites from the Oregon DEQ and the Oregon Health Authority.

All data presented in this report are provisional and subject to change. Estimates of cyanobacteria from satellite imagery do not imply the presence of cyanotoxins or other water quality impairments and do not have regulatory implications. **Visit the Oregon Health Authority to learn about recreational use and drinking water advisories related to cyanobacteria blooms.** Additional assessments with imagery from the Sentinel 2 Satellites, local visual assessment, and/or water quality sampling are needed to provide additional information on potential human health and environmental effects of cyanobacteria. Please note that estimates of cyanobacteria abundance presented in this report may be skewed by cloud cover, ice cover, sun glint, water surface roughness, dry lake beds, algal mats, and shoreline effects.

Highlighted Waterbodies

Waterbodies with high cyanobacteria abundance (>100,000 cells/mL) based on the average of daily maximum estimates during the 7-day reporting period (7DADM).

Reporting Period: June 5, 2023 - June 11, 2023

Search:

Waterbody_GNISID*	Basin	7DADM (cells/mL)	Days of Data
Upper Klamath Lake_01151685	Klamath	2,460,380	7
Lake Owyhee_01125099	Middle Snake-Boise	913,554	6
Davis Lake_01140666	Deschutes	906,507	5
Sturgeon Lake_01127681	Lower Willamette	534,787	5
Malheur Lake_01123710	Oregon Closed Basins	401,121	5
Wickiup Reservoir_01161711	Deschutes	257,260	5

Maps and time series plot of cyanobacteria estimates for each of the 49 resolvable waterbodies according to the methods outlined in the CyAN Project.

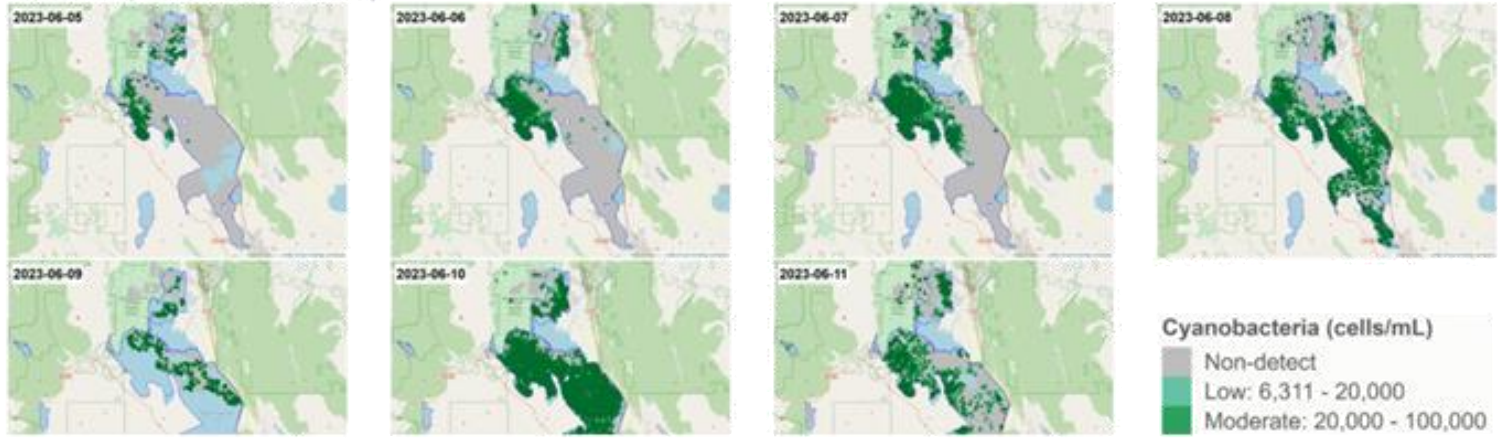
Select a Waterbody:

Upper Klamath Lake_01151685

Recreational Waterbody

Satellite estimates of cyanobacteria abundance from June 5, 2023 to June 11, 2023.

No pixels on the map indicates no data for the lake on that day.



Time Series Plot and Data:

Date Range:

Current Year: 2023

Select a Date Range

2016-06-07 to 2023-06-11

Data for Upper Klamath Lake_01151685 is available since June 7, 2016.

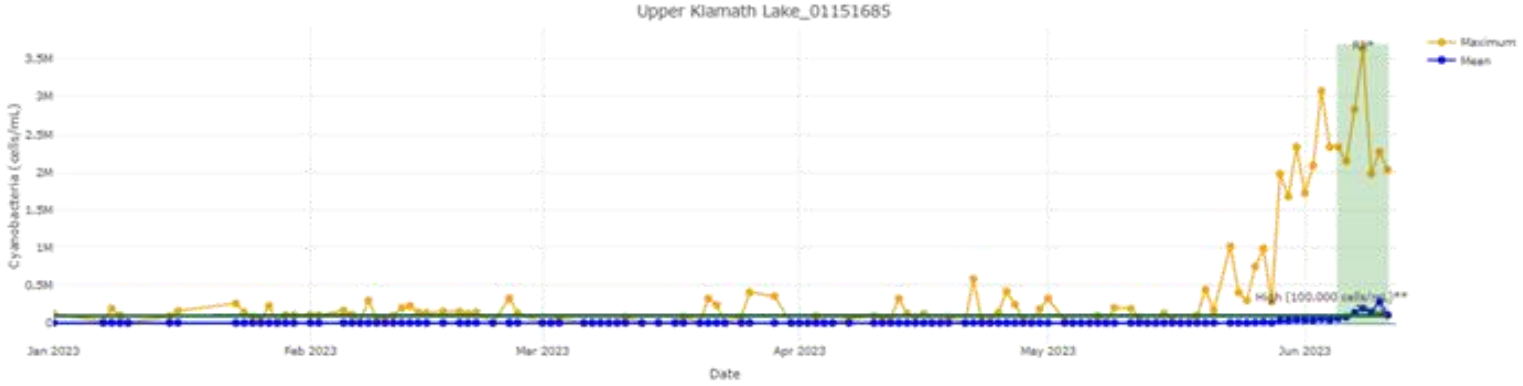
Summary Statistics:

Maximum

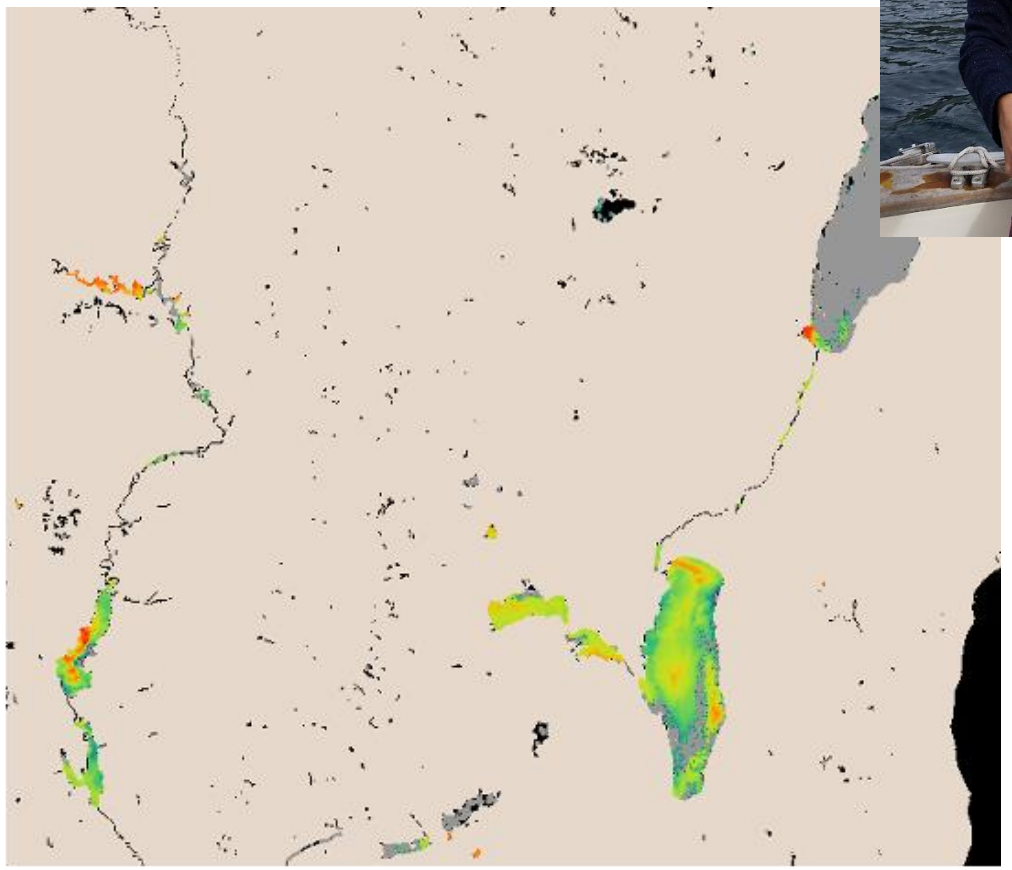
Mean

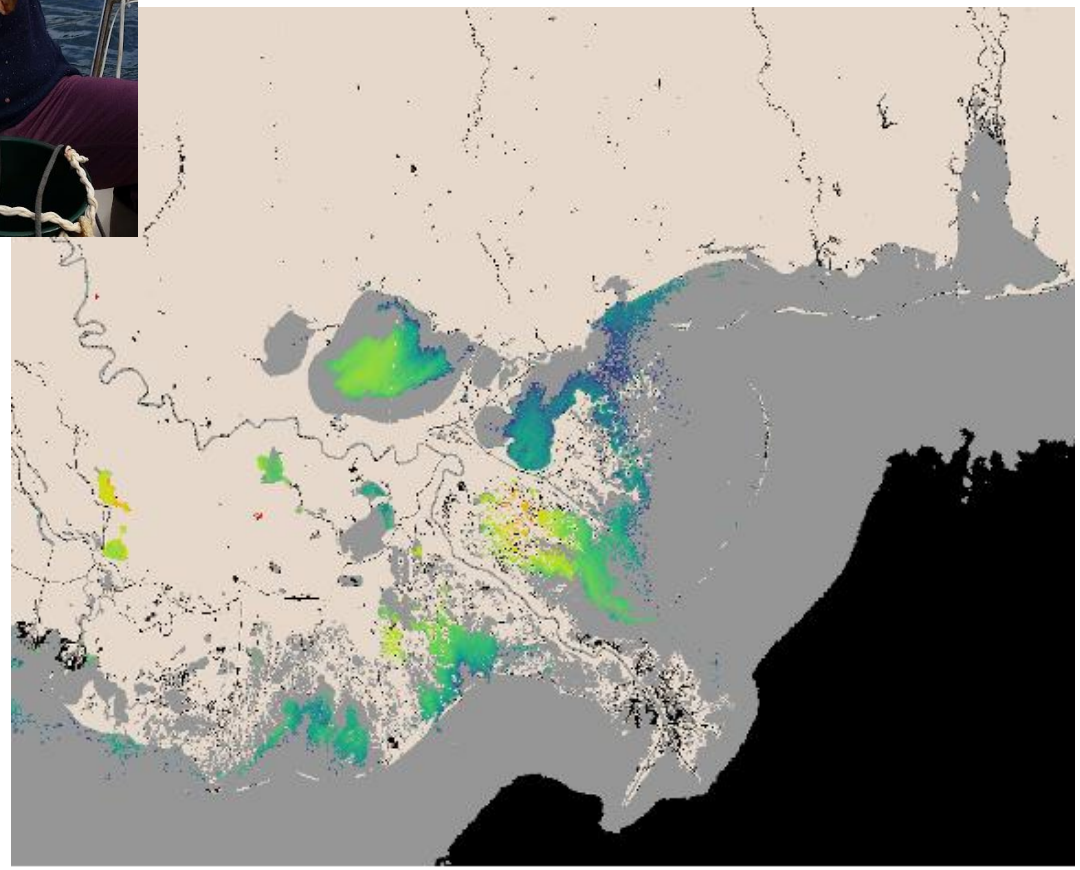
Minimum

Time series plot of cyanobacteria abundance (cells/mL) of the selected waterbody.

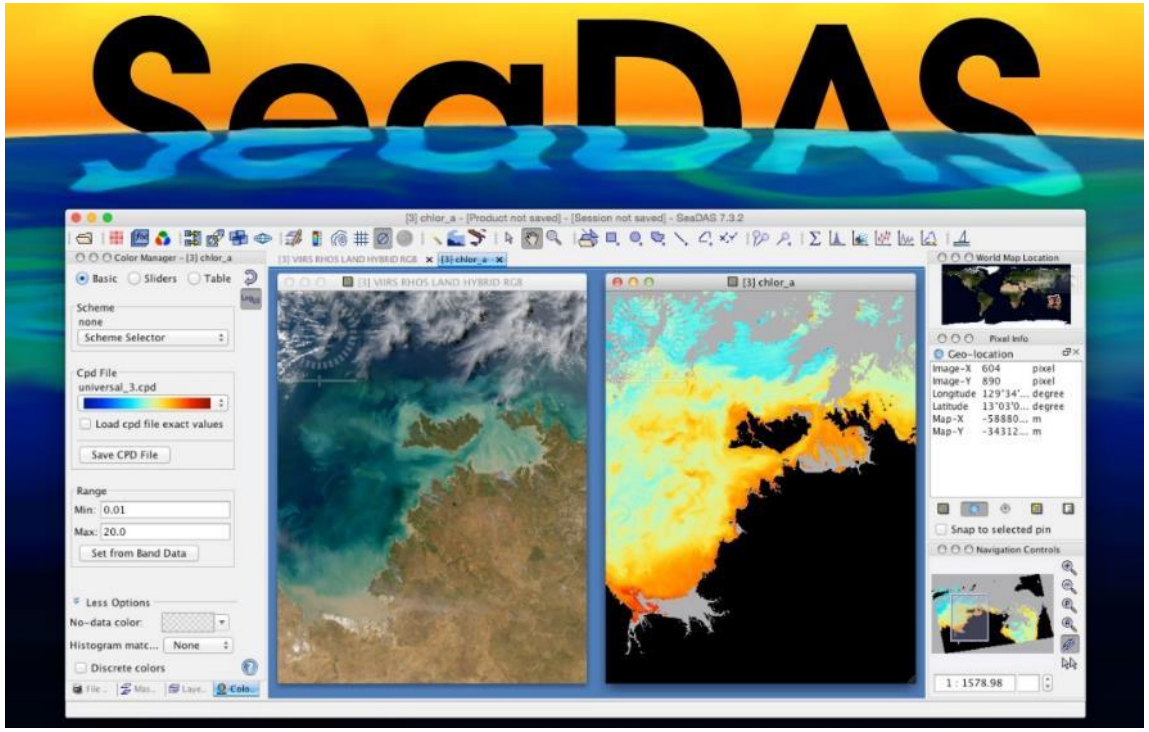


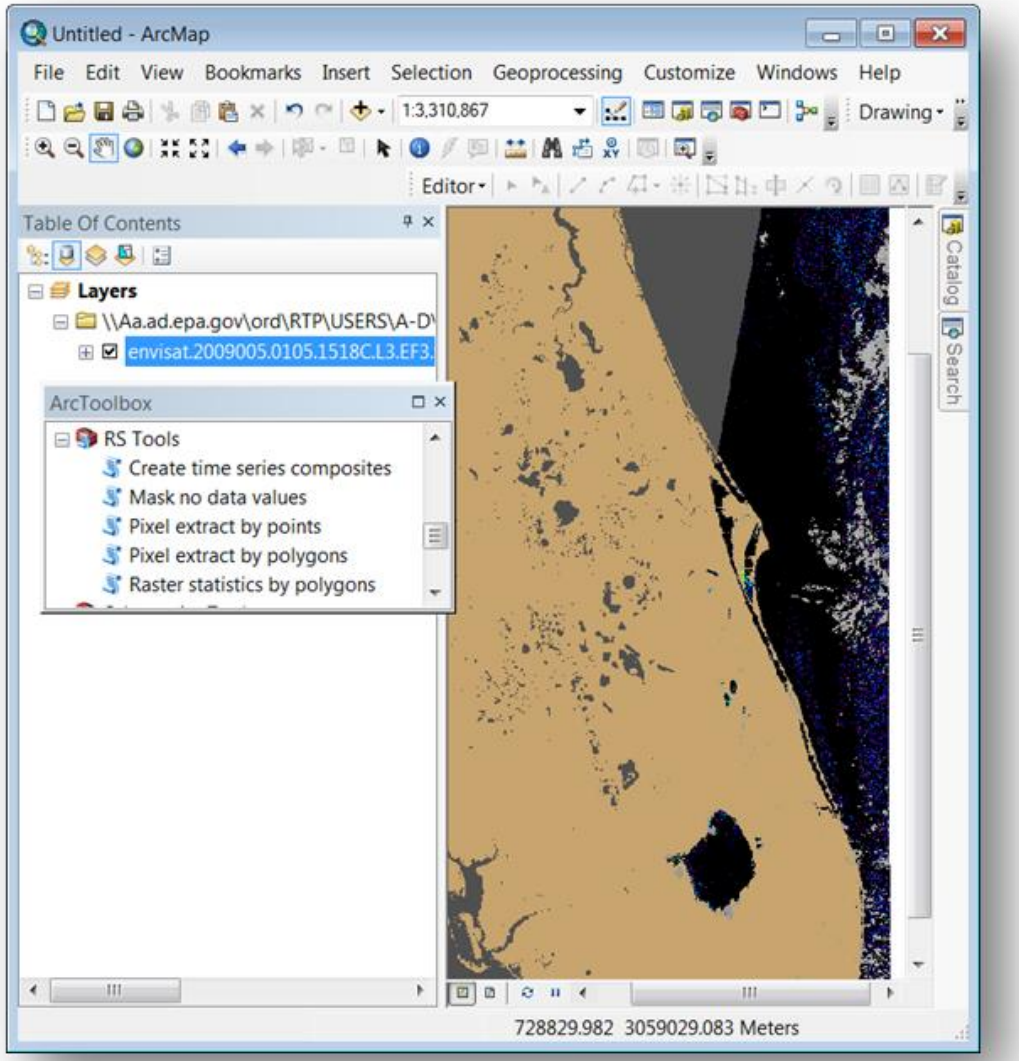
GeoTIFFs

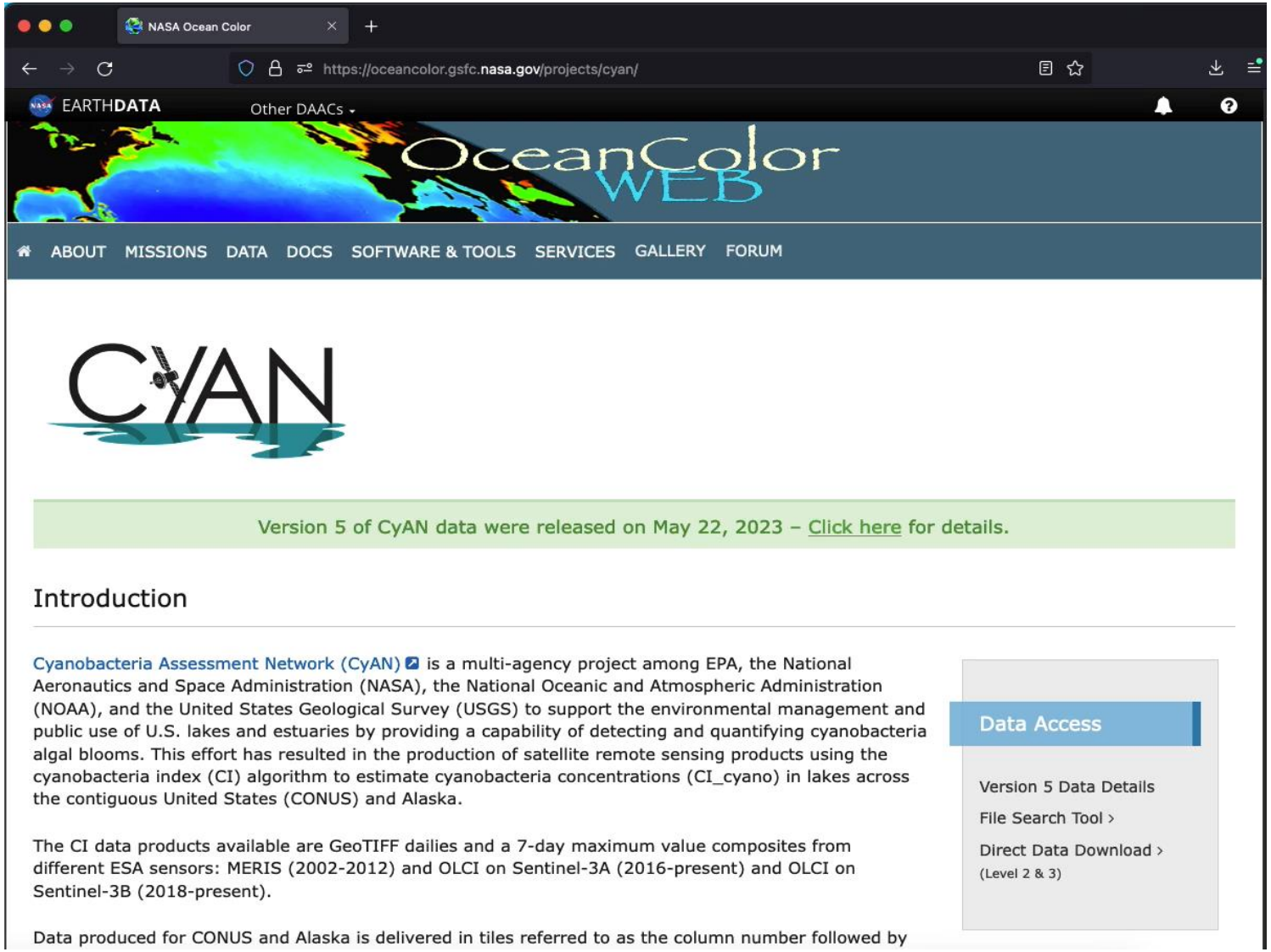




NASA Cyanobacteria Assessment Network





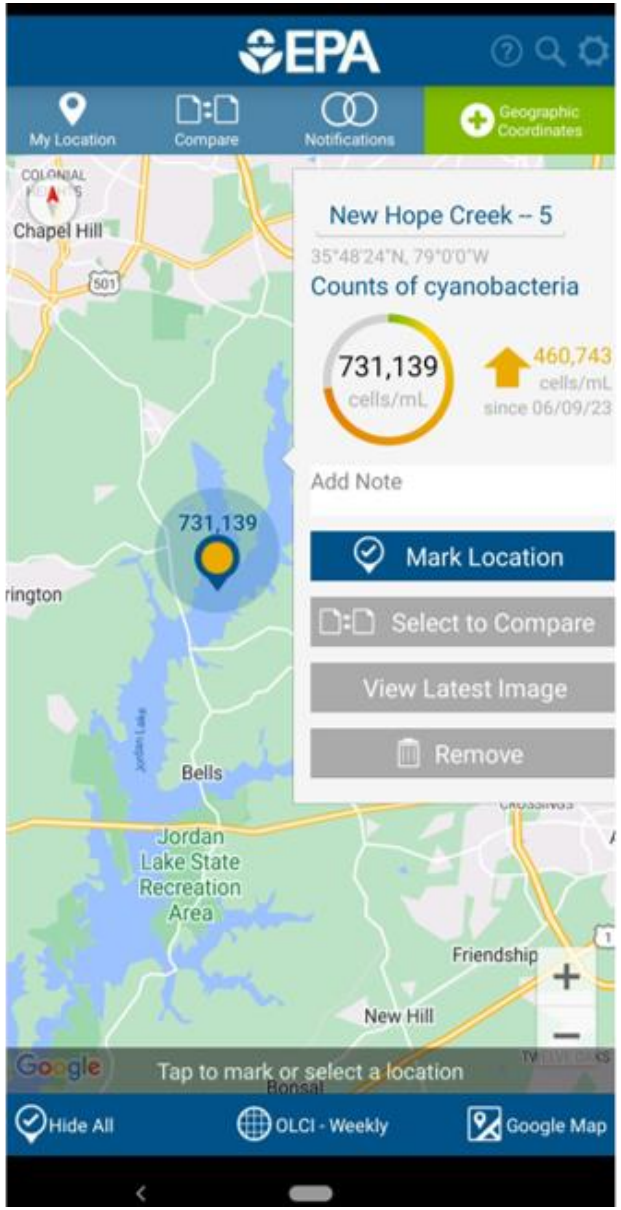


https://oceancolor.gsfc.nasa.gov/about/projects/cyan/

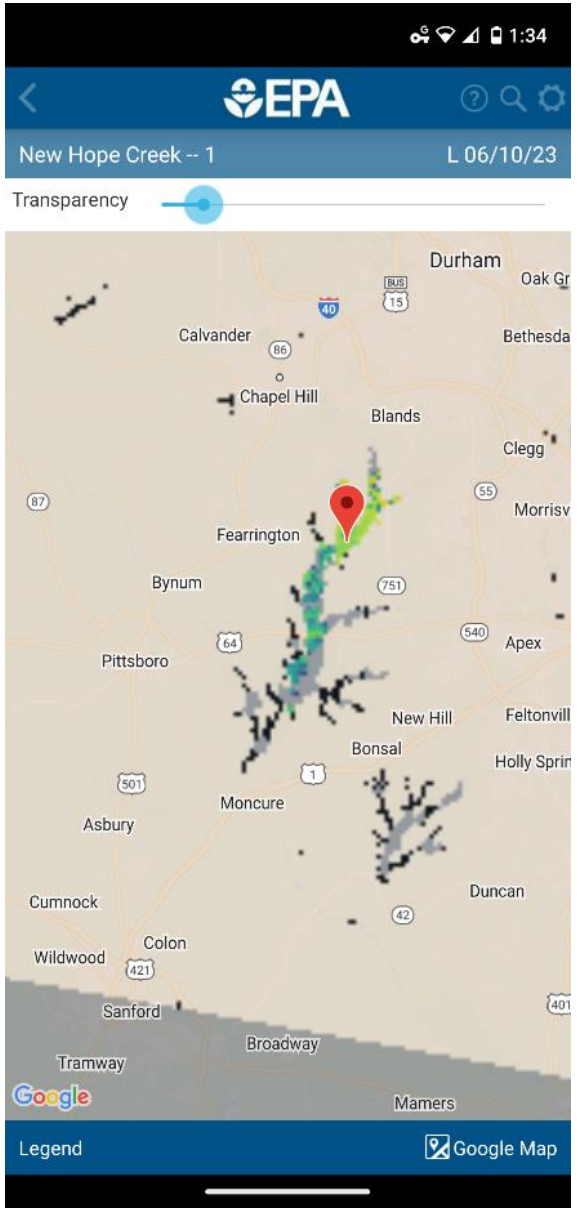
CyAN App Demo

1

2

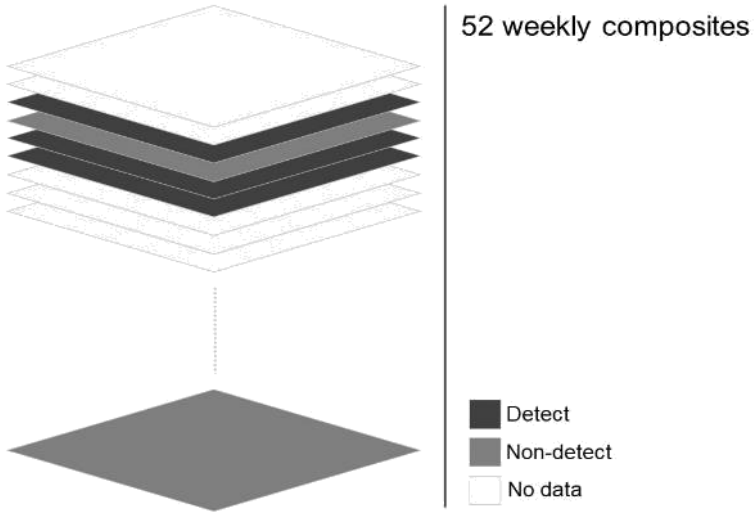


3

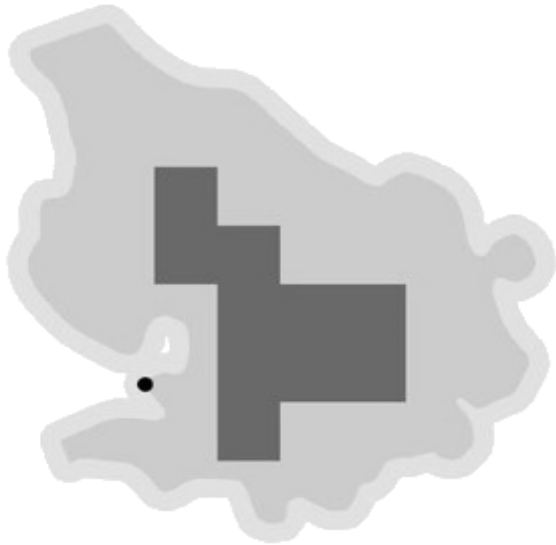


CyAN Web-App Demo

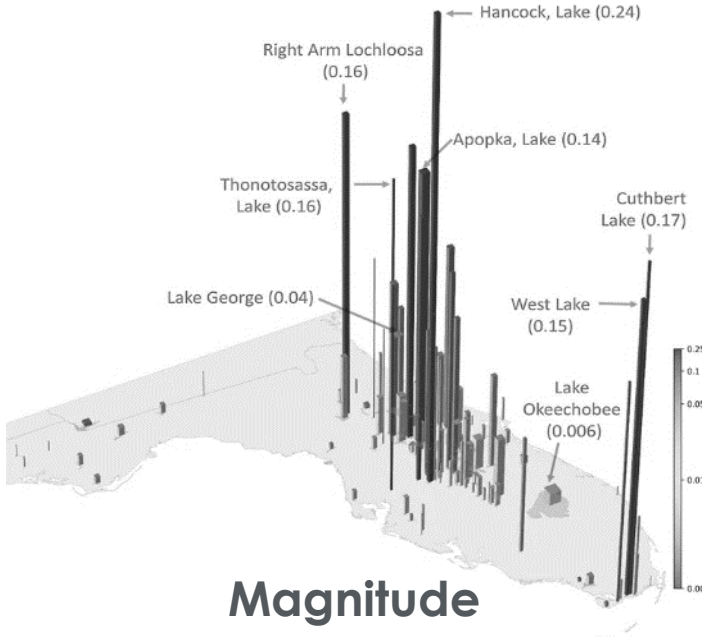
EPA's Report on the Environment (ROE)



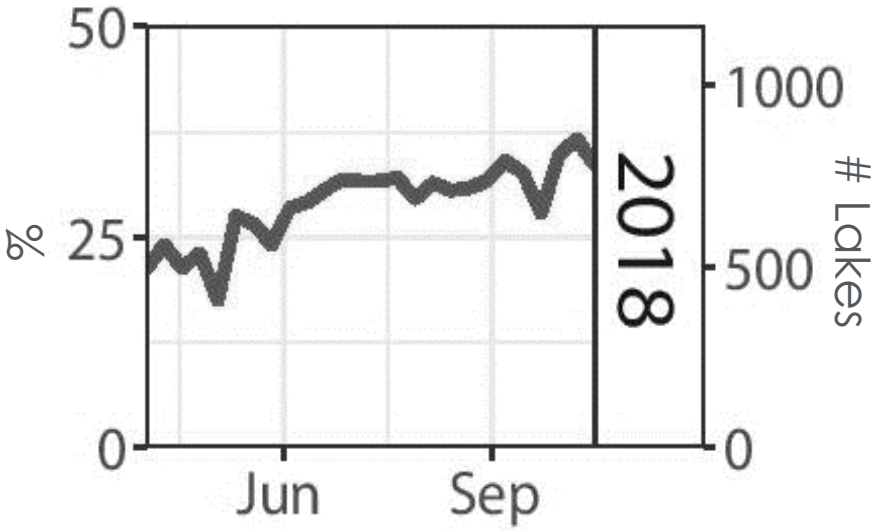
Temporal Frequency



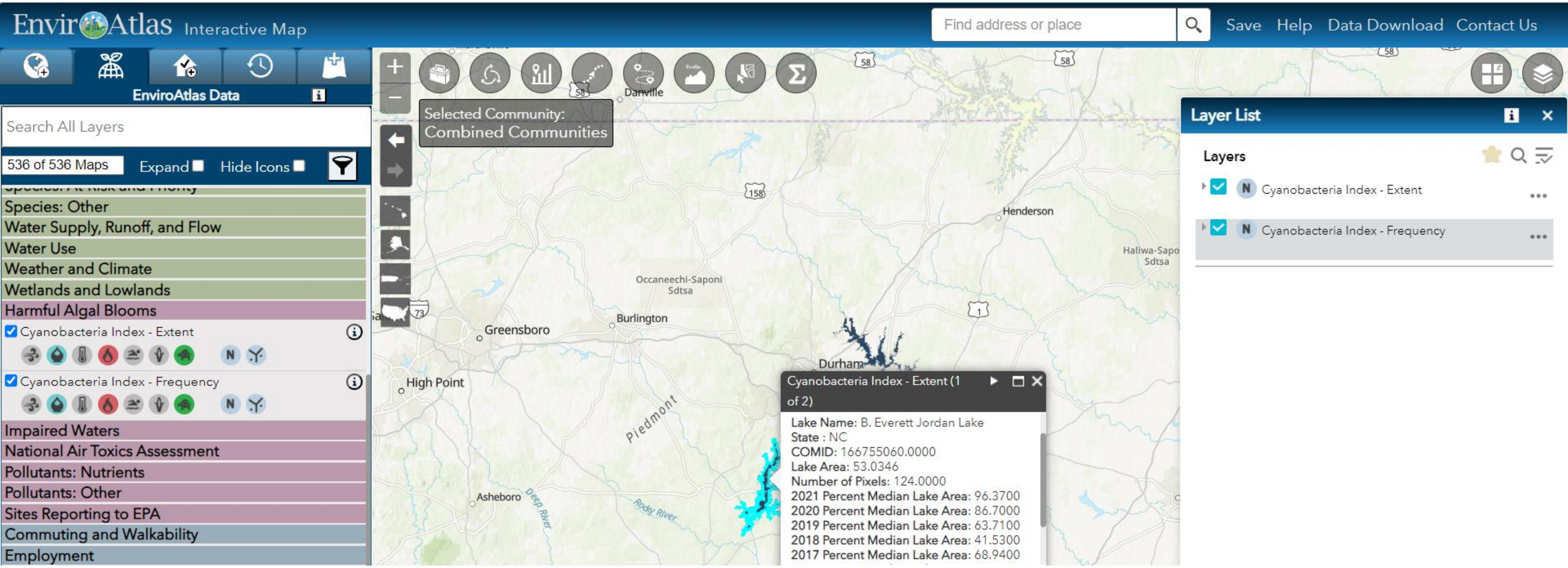
Spatial Extent



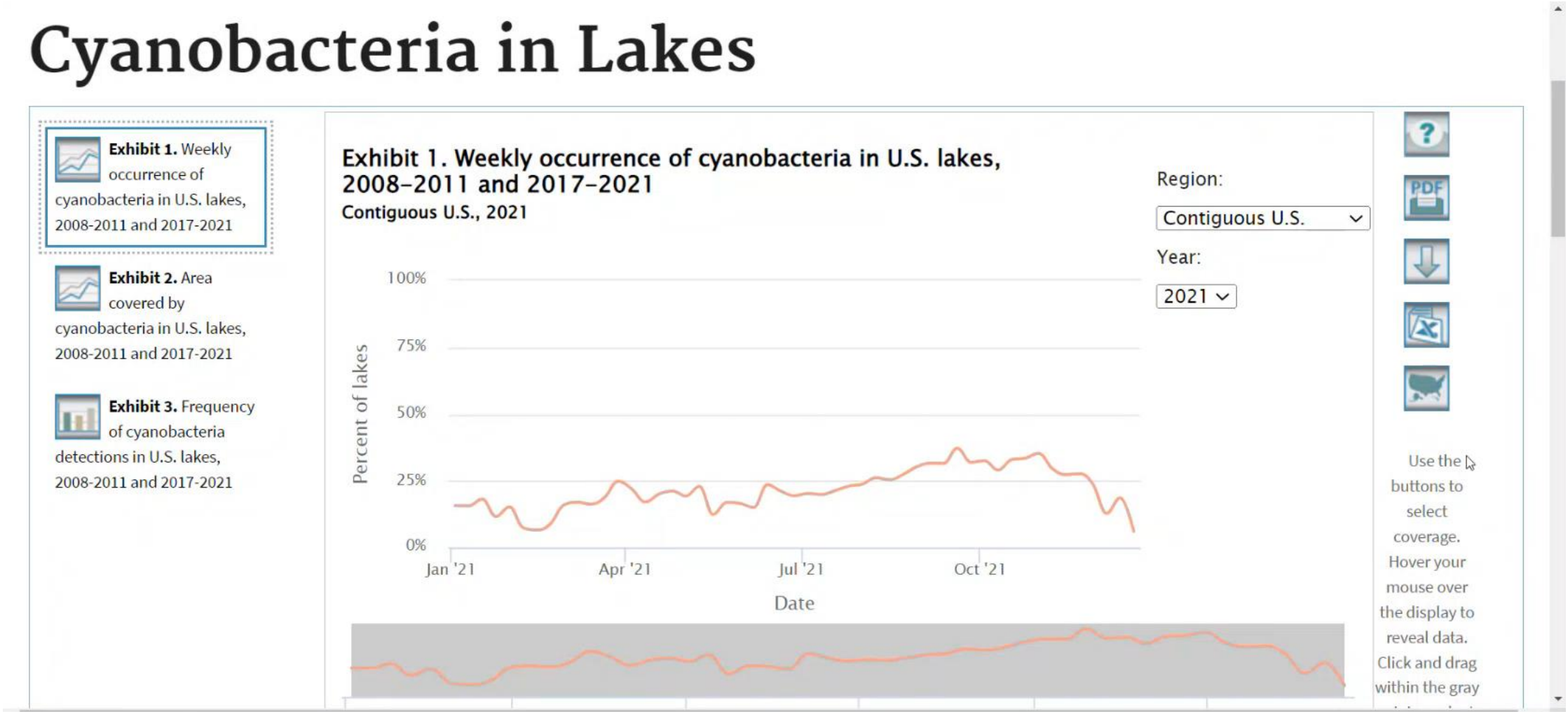
Magnitude



Occurrence


EnviroAtlas Interactive Map
Find address or place
Save
Help
Data Download
Contact Us
EnviroAtlas Data
Search All Layers
536 of 536 Maps
Expand
Hide Icons
Species: Other
Water Supply, Runoff, and Flow
Water Use
Weather and Climate
Wetlands and Lowlands
Harmful Algal Blooms
Cyanobacteria Index - Extent
Cyanobacteria Index - Frequency
Impaired Waters
National Air Toxics Assessment
Pollutants: Nutrients
Pollutants: Other
Sites Reporting to EPA
Commuting and Walkability
Employment
Selected Community:
Combined Communities
Danville
Henderson
Haliwa-Sapo Sdtsa
Occaneechi-Saponi Sdtsa
Burlington
Greensboro
High Point
Durham
Piedmont
Asheboro
Deep River
Rocky River
Layer List
Layers
Cyanobacteria Index - Extent
Cyanobacteria Index - Frequency
Cyanobacteria Index - Extent (1 of 2)
Lake Name: B. Everett Jordan Lake
State : NC
COMID: 166755060.0000
Lake Area: 53.0346
Number of Pixels: 124.0000
2021 Percent Median Lake Area: 96.3700
2020 Percent Median Lake Area: 86.7000
2019 Percent Median Lake Area: 63.7100
2018 Percent Median Lake Area: 41.5300
2017 Percent Median Lake Area: 68.9400

Report on Environment Demo

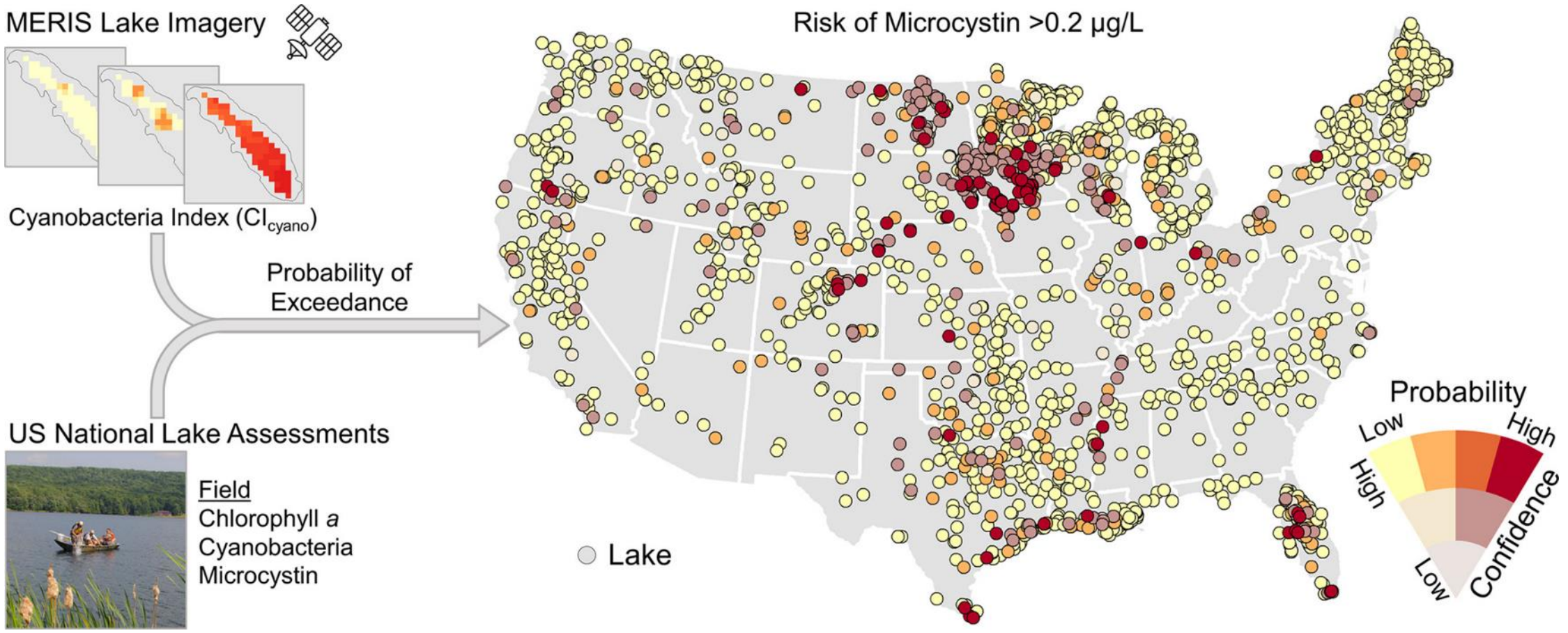


Per-House Annual Benefits

Scenario	Northeast Regional Annual Benefit
1 Week/Year Reduction in Cyanobacteria	$14,606,248

Zhang et al. 2022. Ecological Economics

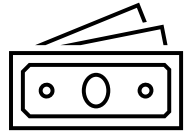
Lakes at Risk of Toxic Cyanobacteria

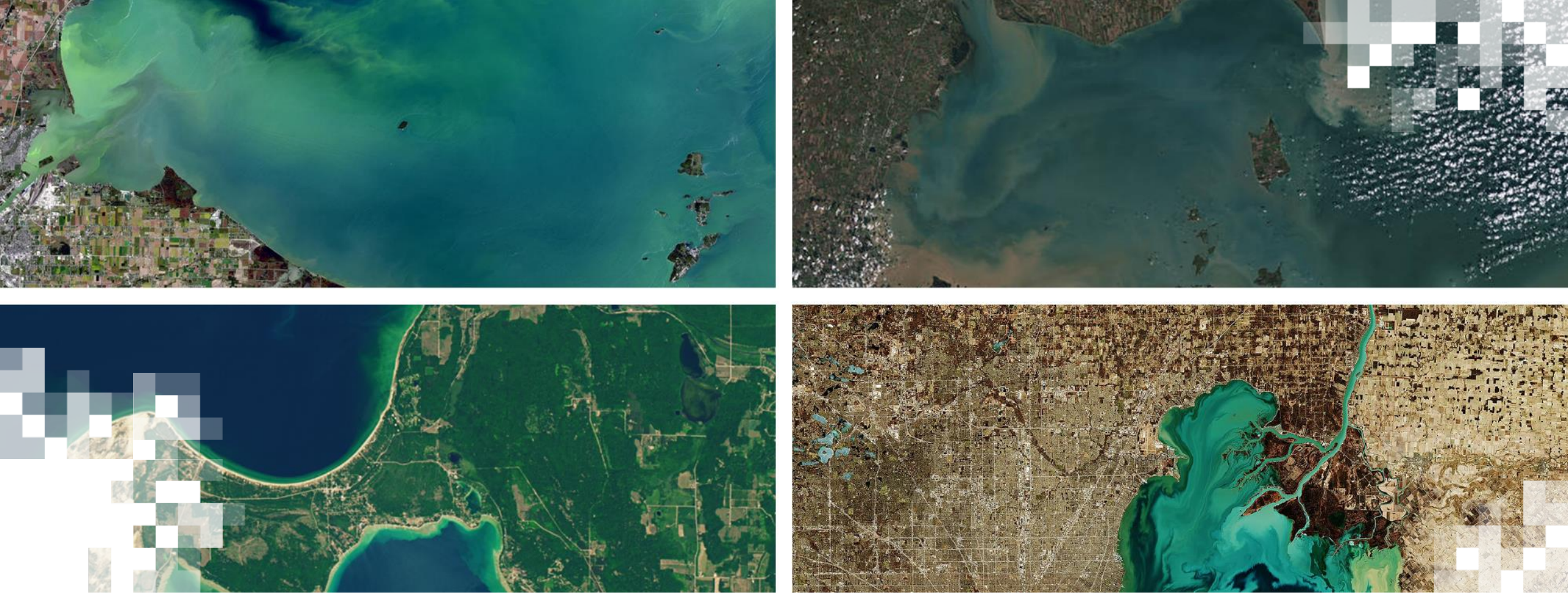


Handler et al. 2023. Science of the Total Environment

Summary

- Clcyano satellite images available daily and weekly
  - Annual potential avoided costs ~$5.7 million/year
- Training, Software (open-source, GIS, Android, web-based)
  - NASA Website
  - SeaDAS
  - ArcMAP and ArcPRO RS Tools
  - Android Mobile and Web Applications
- Metrics
  - Frequency, Extent, Magnitude, Occurrence
  - Report on the Environment and EnviroAtlas





Part 2: Cyanobacteria Assessment Network (CyAN)

Summary

Resources

- US EPA Cyanobacteria Assessment Network
- NASA Cyanobacteria Assessment Network

Acknowledgements

- Funding
  - This material is based upon work supported by the NASA Ocean Biology and Biogeochemistry Program/Applied Sciences Program (proposals 14-SMDUNSOL14-0001 and SMDSS20-0006) and by the US EPA, NOAA, U.S. Geological Survey Toxic Substances Hydrology Program
- Sounds
  - BBC Sound Effects
- Any mention of trade names, manufacturers or products does not imply an endorsement by the United States Government or the U.S. Environmental Protection Agency. The views expressed are those of the authors and do not necessarily reflect the views or policies of the US EPA.

Contact Information

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- Daniel Sobota
  - Daniel.sobota@deq.oregon.gov

- ARSET Website
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Visit our Sister Programs:

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Looking Ahead to Part 3

Part 3 will focus on:

- Developing statistical algorithms in GEE to obtain chlorophyll-a concentration, total suspended sediments, and water clarity from the Sentinel-2 and *in situ* data identified for Lake Erie in Part 1.
- Explore variability of the water quality parameters.

Homework and Certificates

- **Homework:**
  - One homework assignment
  - Opens on July 25, 2023
  - Access from the training webpage
  - Answers must be submitted via Google Forms
  - **Due by August 8, 2023**
  - There will be hands-on exercises in all sessions. **You will be instructed to submit results of these exercises to a Google Drive folder.**

- **Certificate of Completion:**
  - Attend all three live webinars (attendance is recorded automatically)
  - Complete the homework assignment by the deadline
  - You will receive a certificate via email approximately two months after completion of the course.

Questions and Answers

- Please put your questions in the Questions box
- We will try to get to all of the questions during the Q&A session
- Any remaining questions will be answered in the Q&A document, which will be posted to the training website about a week after the training.


APPLIED REMOTE SENSING TRAINING PROGRAM
TRAIN - EMPOWER - ADVANCE

Thank You!