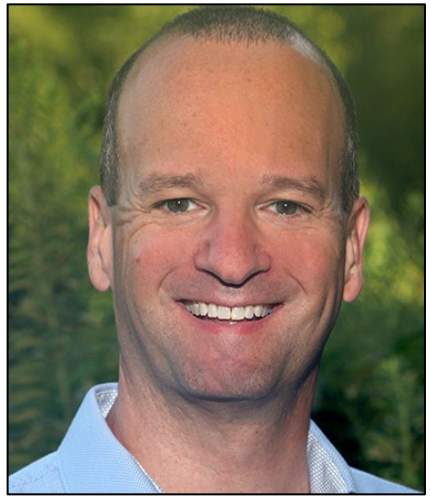
CyAN potential satellite monitoring of drinking water sources



Blake Schaeffer

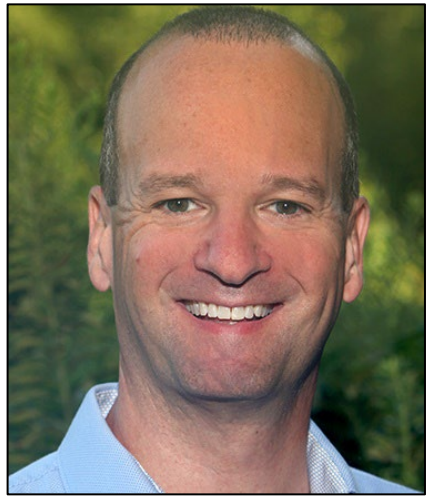
Bridget Seegers

Megan Coffer

Julie Harvey

Daniel Sobota

CyAN potential satellite monitoring of drinking water sources



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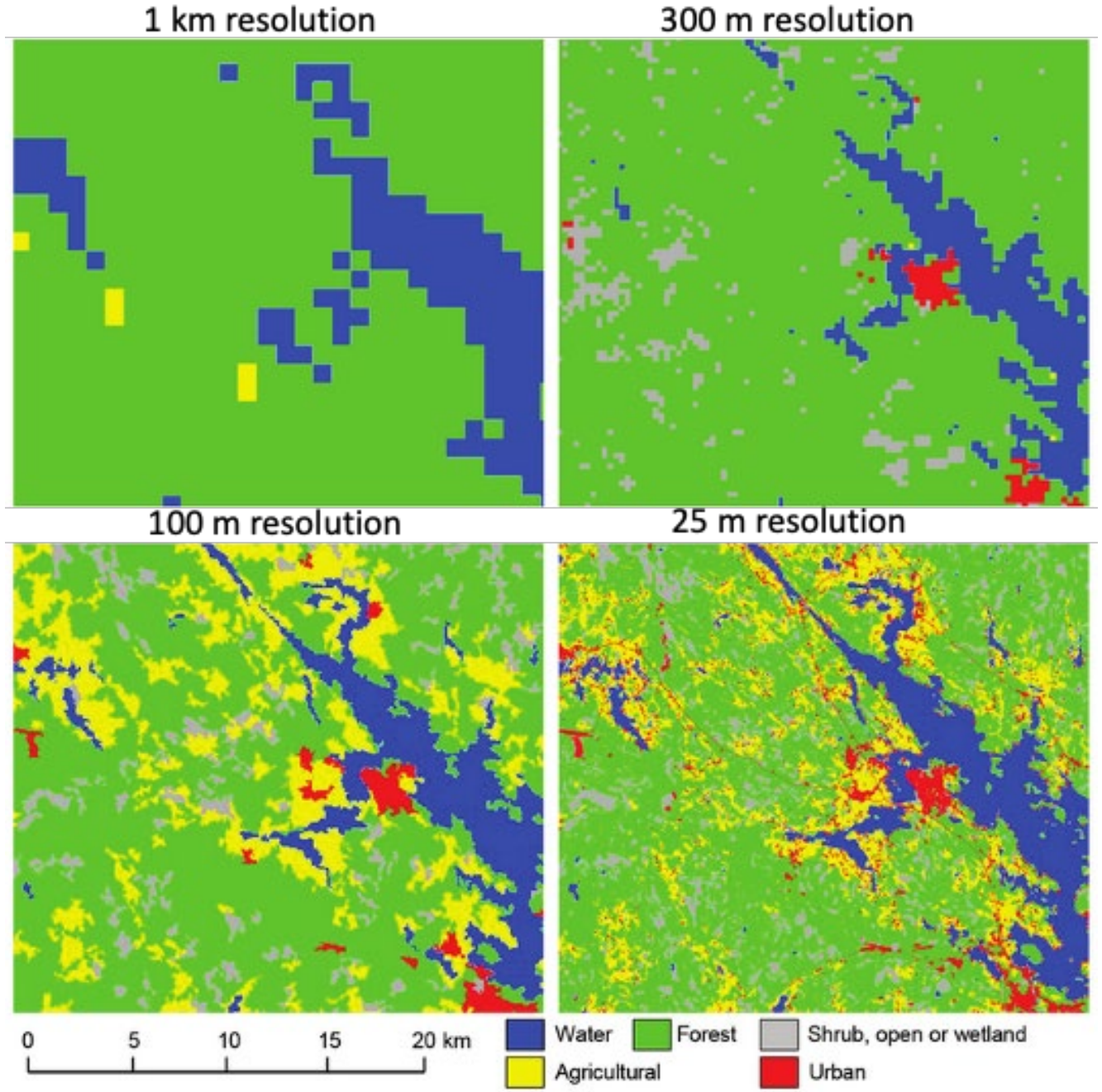
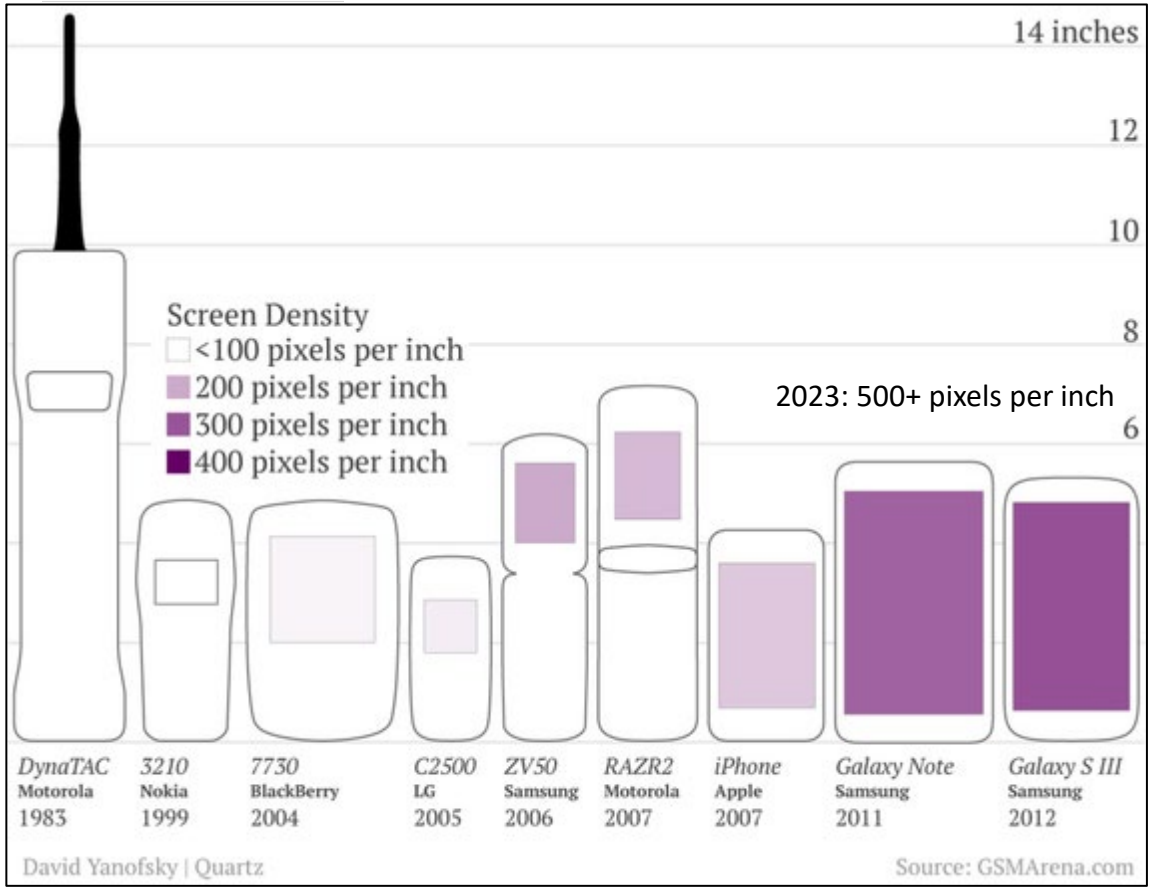


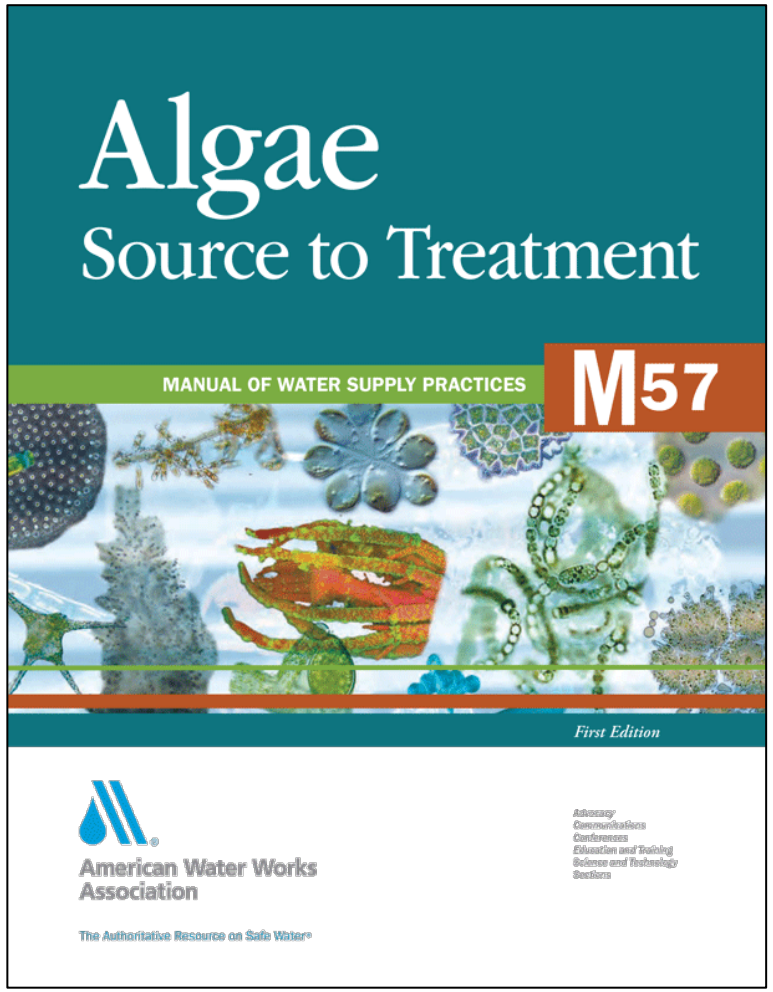
Adopted from Törmä et al., 2015

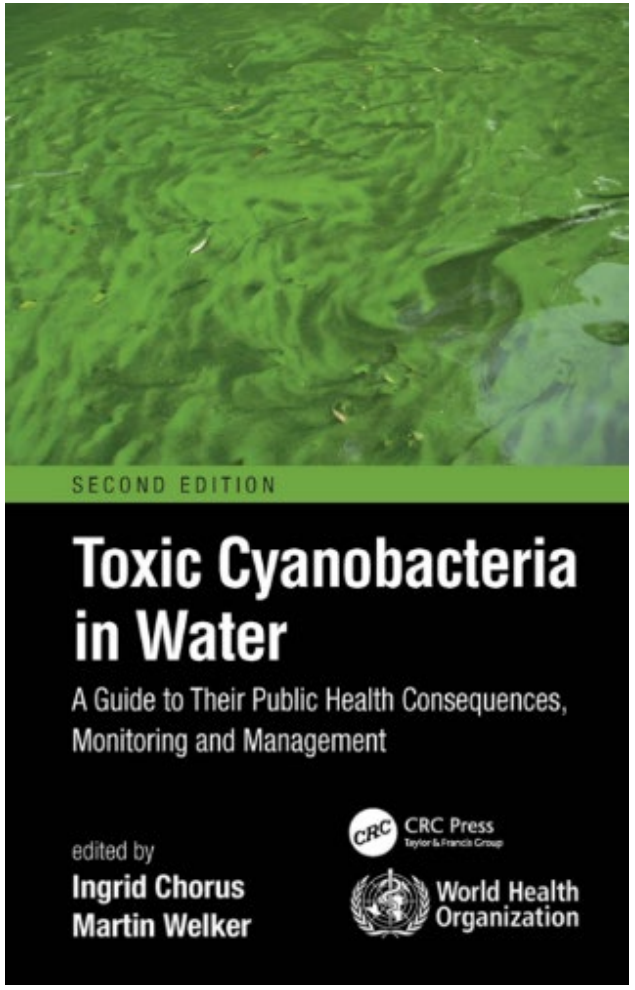
1973 first prototype mobile phone
Source: The Atlantic



Limitations

Photo credits: EPA, NIH, NOAA NCEI, NPS, San Bernardino Co.





INTERSTATE COUNCIL ITRC TECHNOLOGY REGULATORY

Strategies for Preventing and Managing Harmful Cyanobacterial Blooms (HCBs)

AVAILABLE NOW!

HCB Strategies

Field sampling

Long term sondes

Satellite

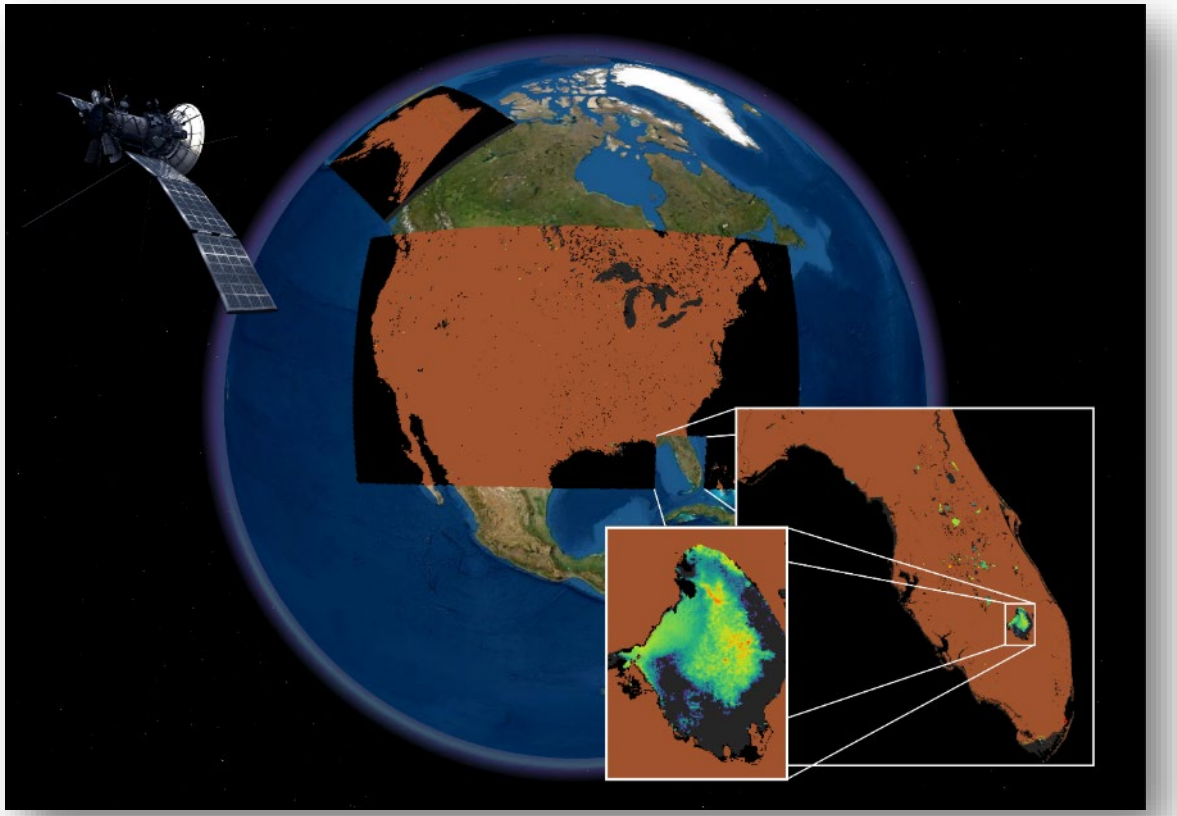
Drones

Citizen Science

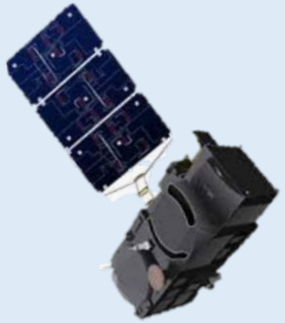
Toolbox

Photo credits: EPA, NACEPT

EPA CyAN website



NASA CyAN website



V/UV
B
G
Y
O
R
NIR

AIR

WATER

Two possible things happen to a photon in water

ABSORPTION (a)

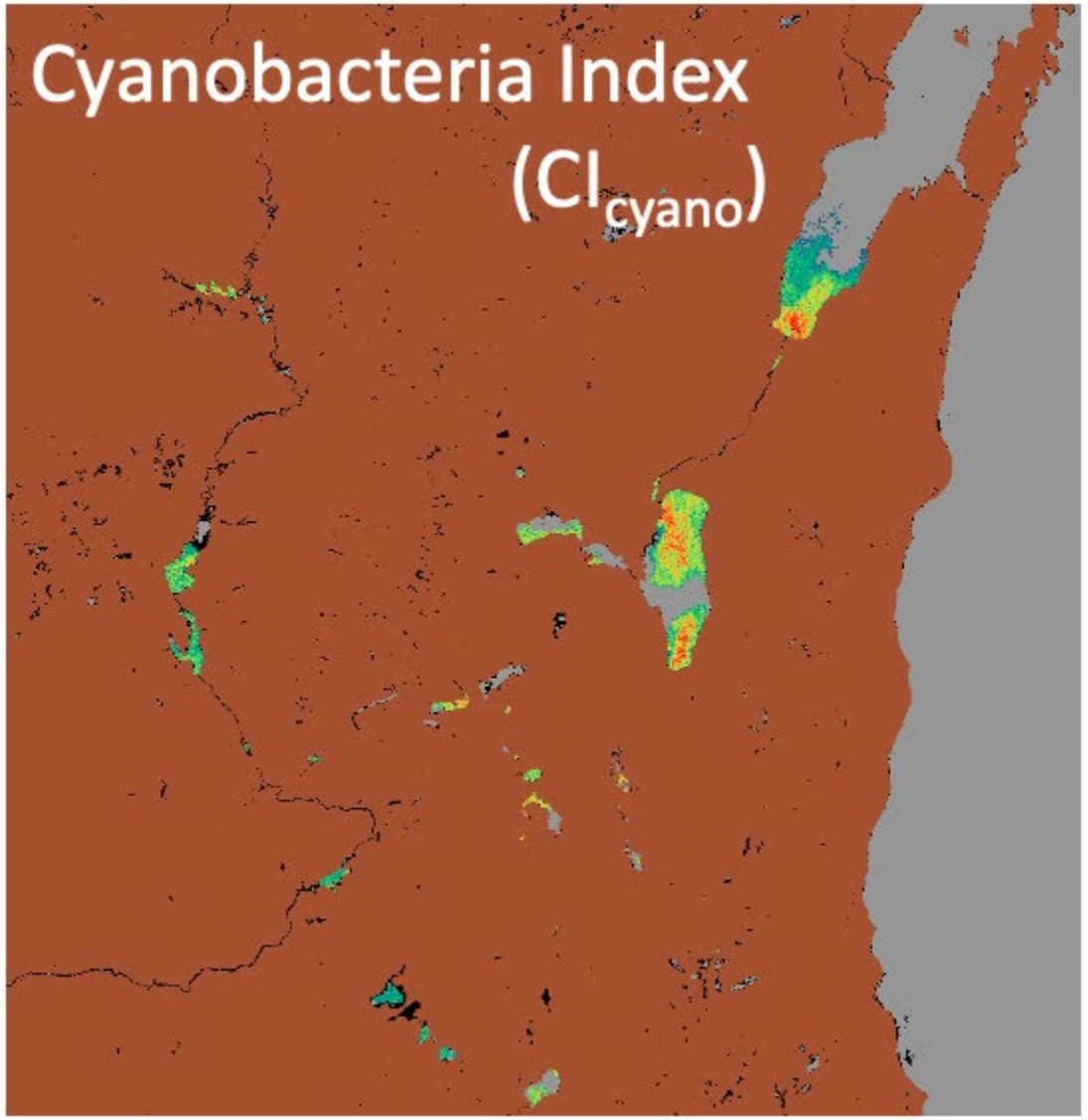
SCATTERING (b_b)

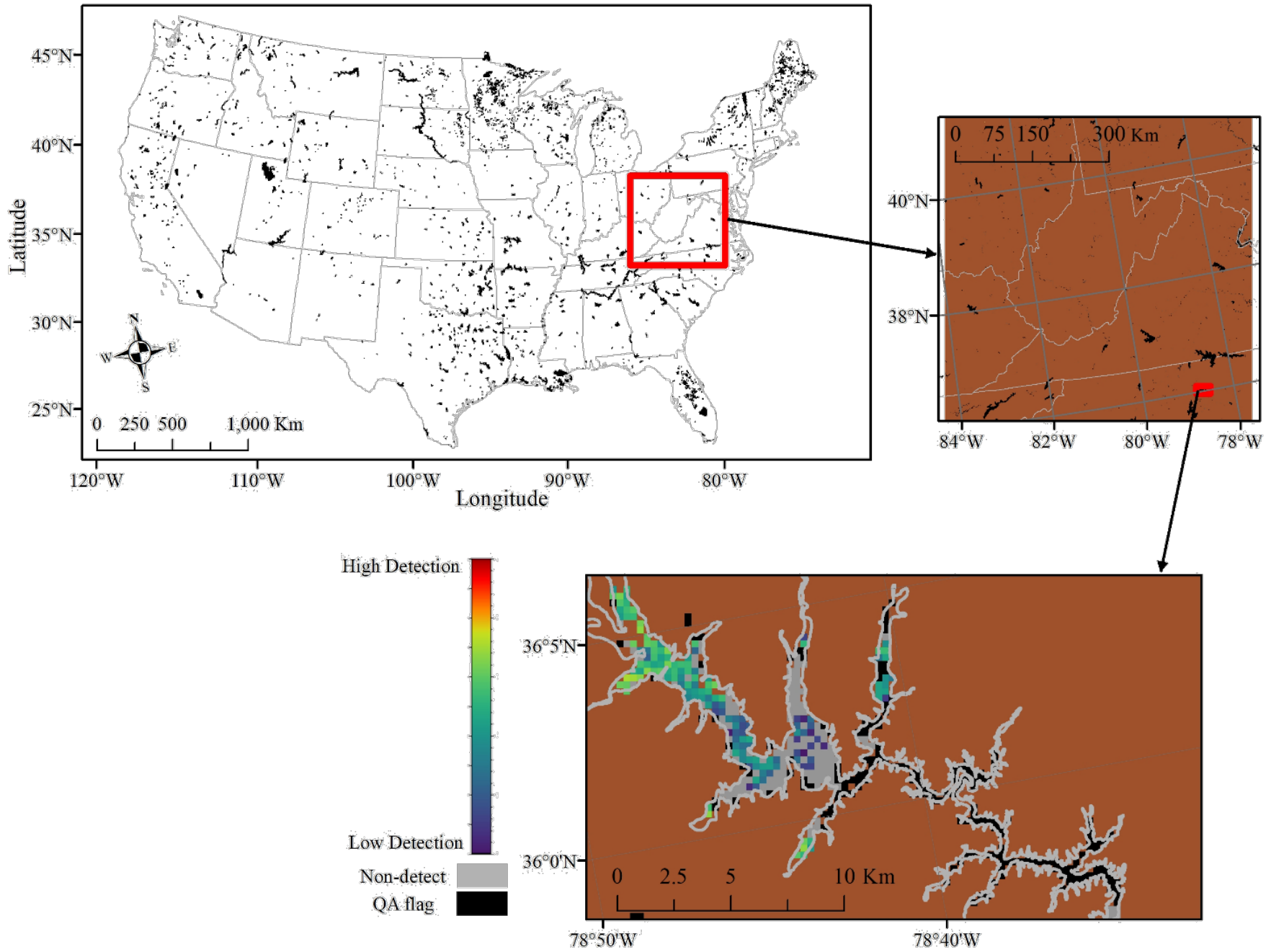
cyanobacteria

Phytoplankton
Organic Matter
Detritus

Adapted from Ryan Vandermeulen


True Color


Cyanobacteria Index
(CI_{cyano})

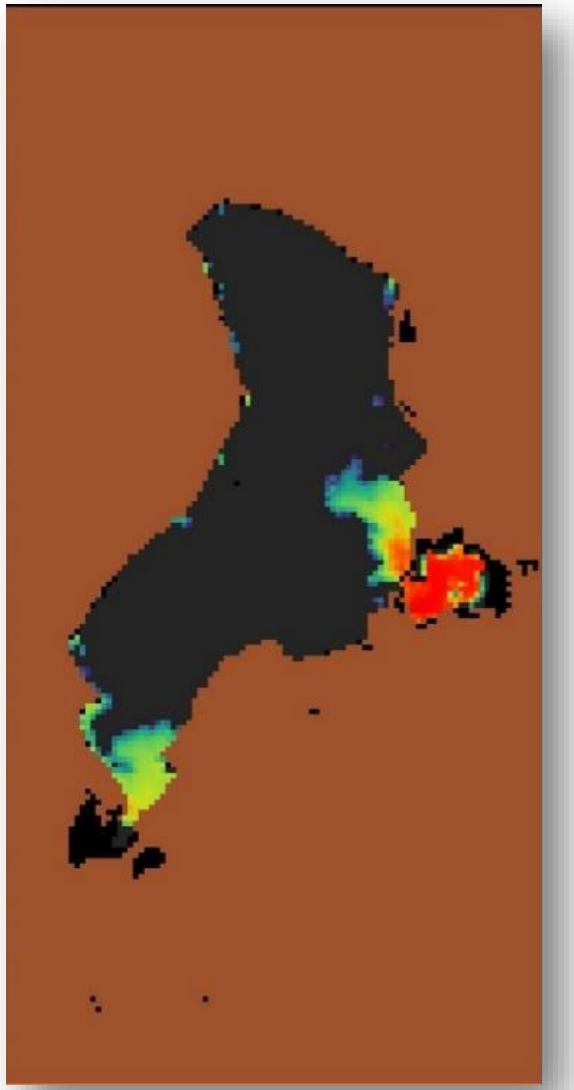

45°N
40°N
35°N
30°N
25°N
Latitude
120°W
110°W
100°W
90°W
80°W
Longitude
N
W
E
S
0 250 500 1,000 Km
0 75 150 300 Km
40°N
38°N
84°W
82°W
80°W
78°W
High Detection
Low Detection
Non-detect
QA flag
36°5'N
36°0'N
0 2.5 5 10 Km
78°50'W
78°40'W

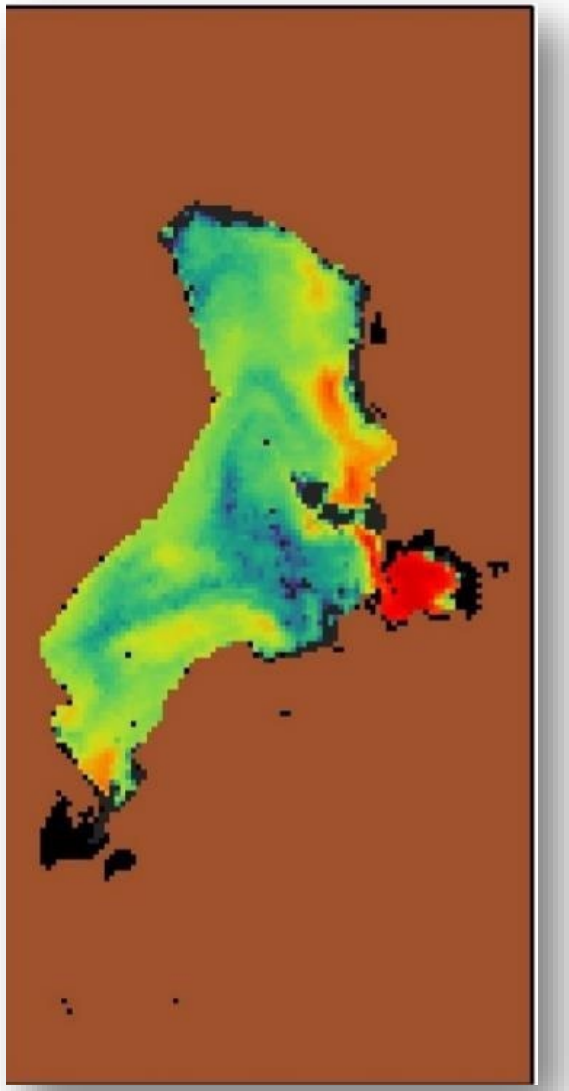
Utah Lake

(Rick Egan/The Salt Lake Tribune)

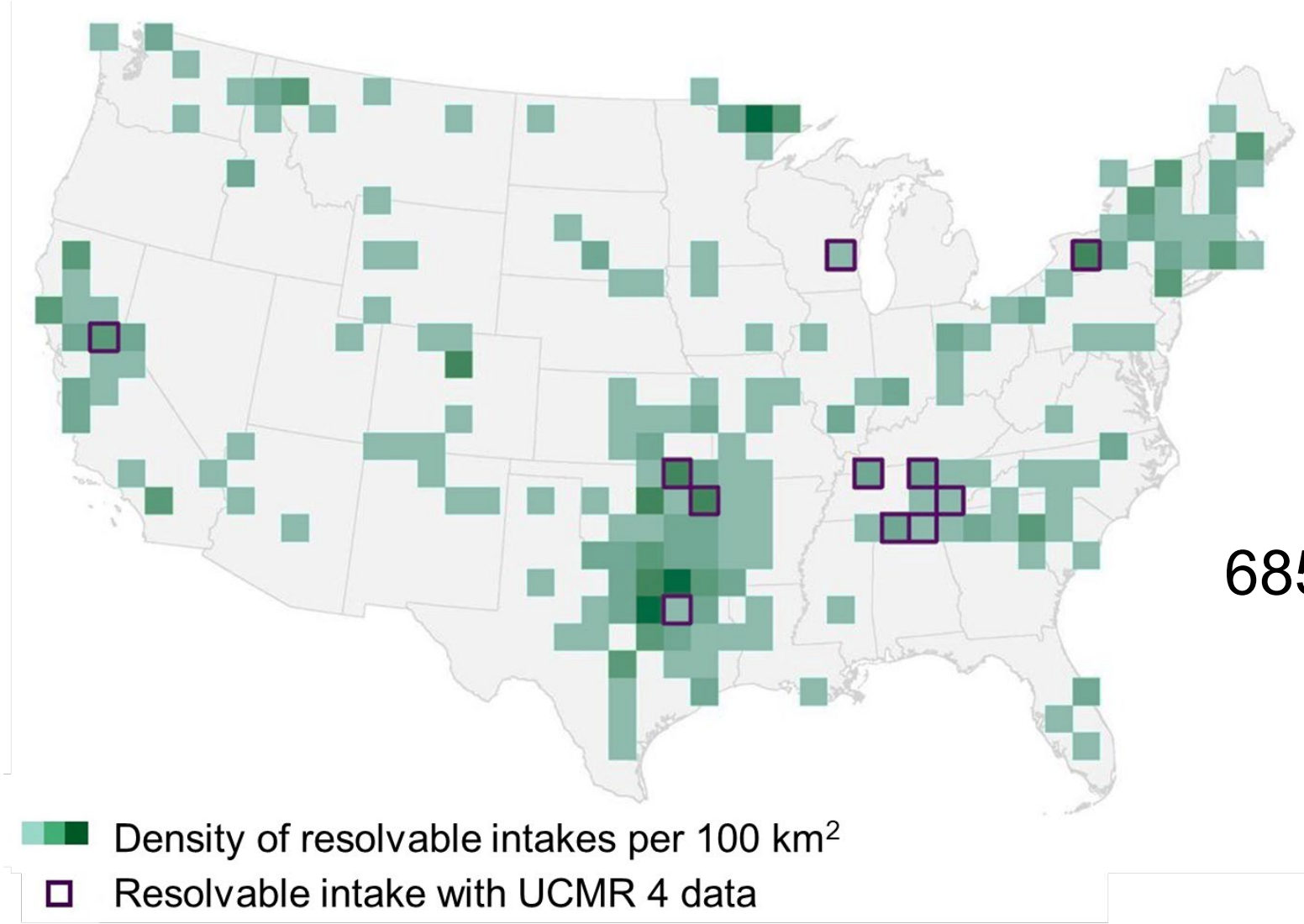
RESOURCES for the FUTURE

Utah Lake





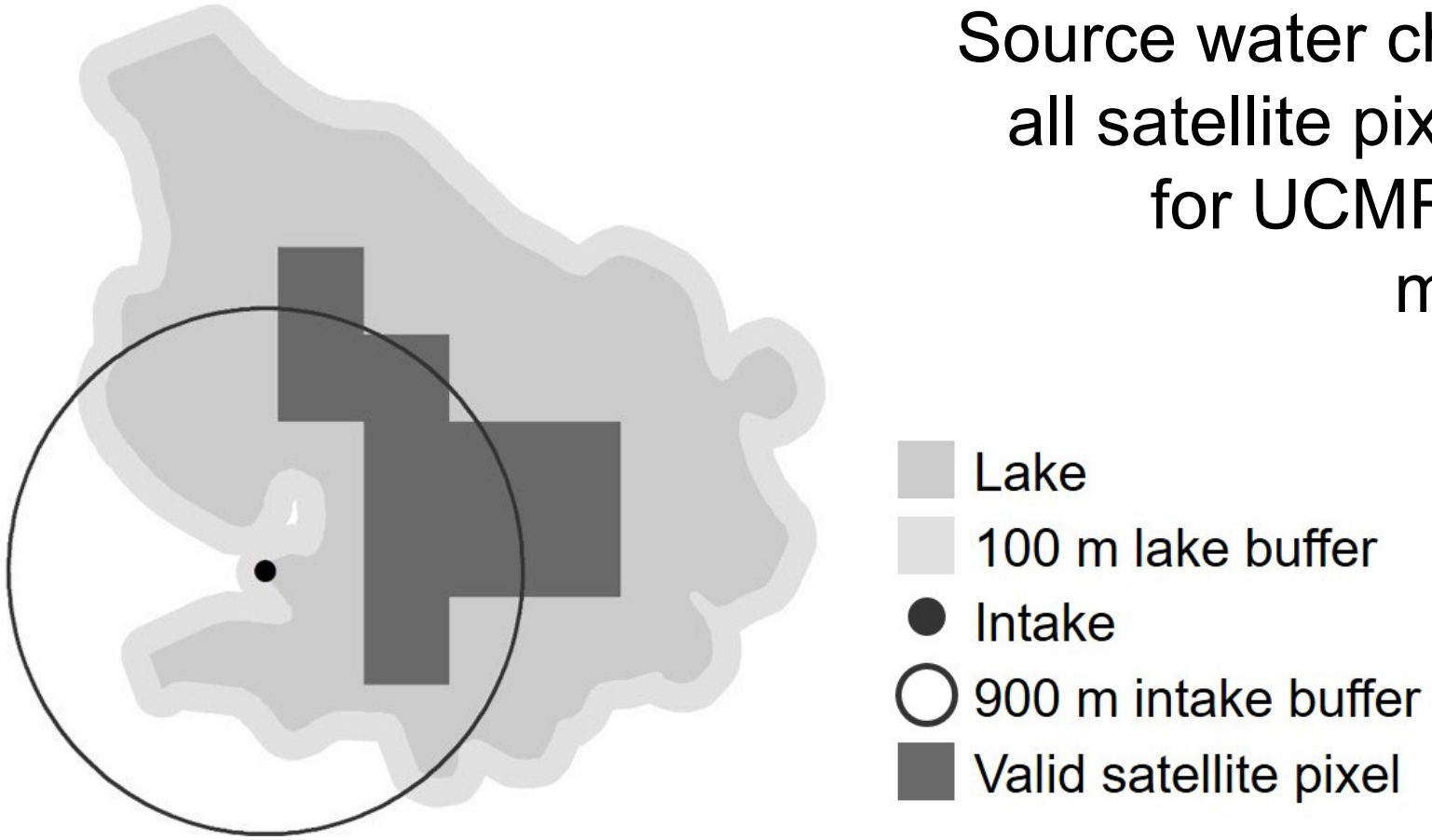
UCMR 4: Preceding the finished water sample collection, did you observe an algal bloom in your source waters near the intake?



685 resolvable source waters

Coffer et al., 2021. *Water Res.*

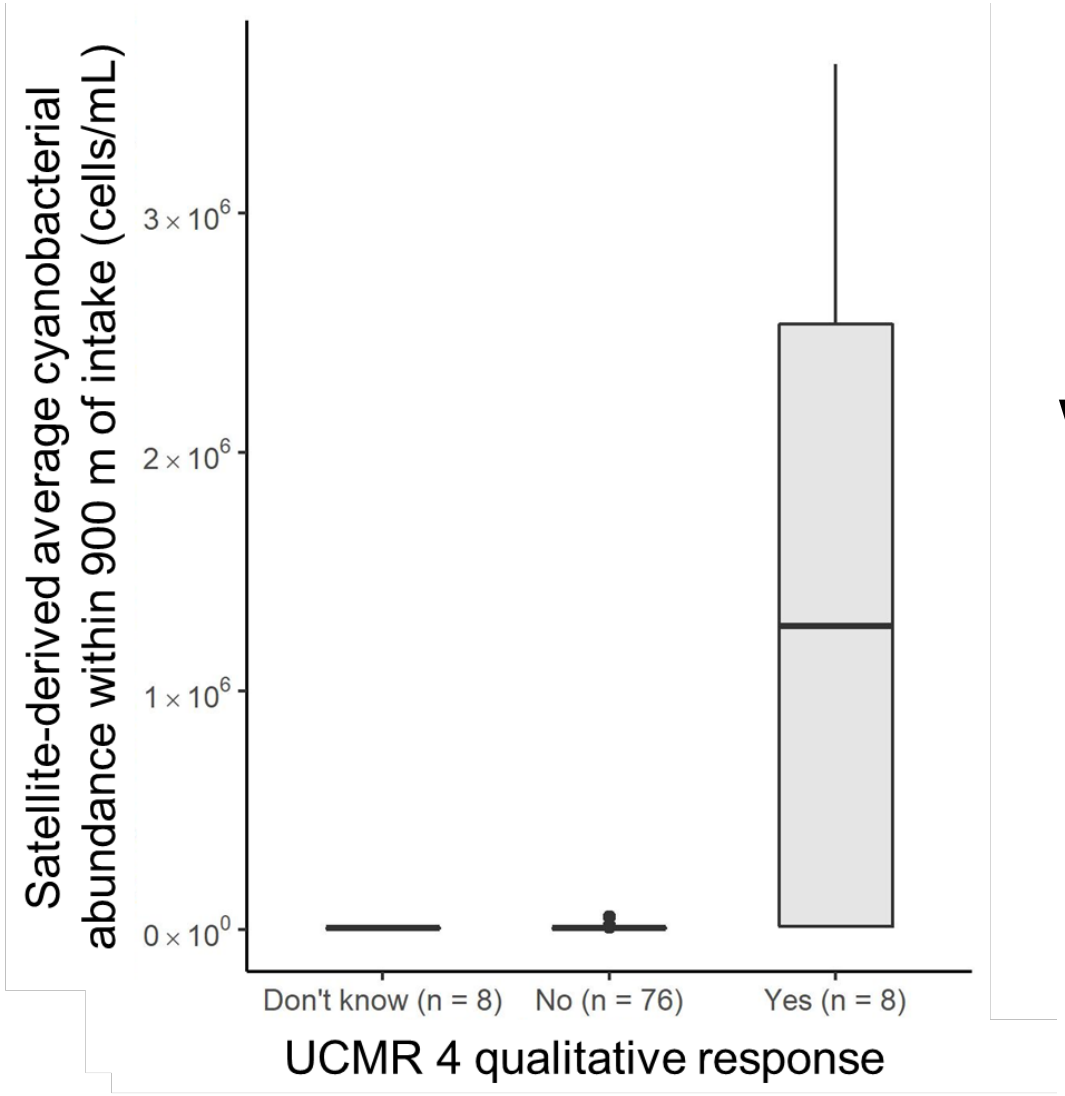
UCMR 4: Preceding the finished water sample collection, did you observe an algal bloom in your source waters near the intake?



Source water characterized by averaging all satellite pixels within 900 m of intake for UCMR 4 data collected within 1 month of satellite overpass

Coffer et al., 2021. *Water Res.*

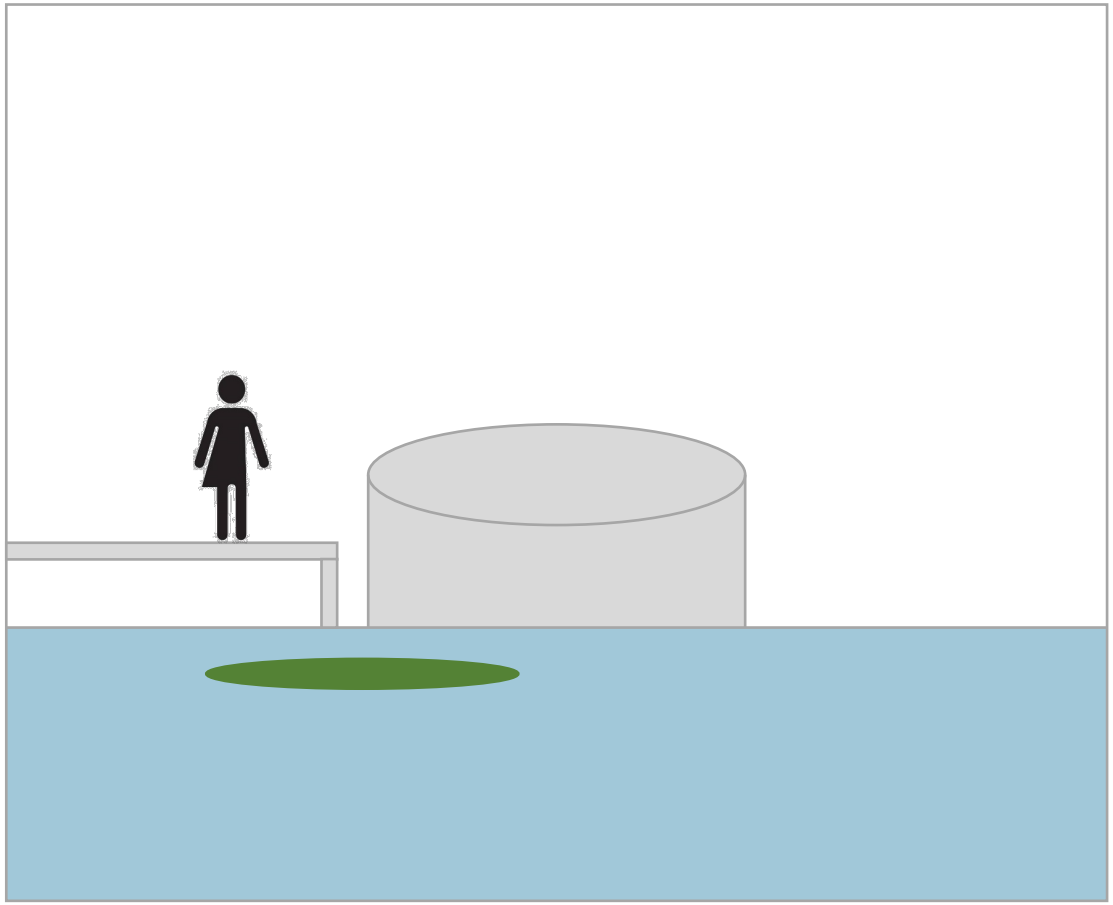
UCMR 4: Preceding the finished water sample collection, did you observe an algal bloom in your source waters near the intake?



Satellite-derived results and UCMR 4 qualitative responses of “Yes” and “No” were compared using the Mann-Whitney U test and had 94% agreement

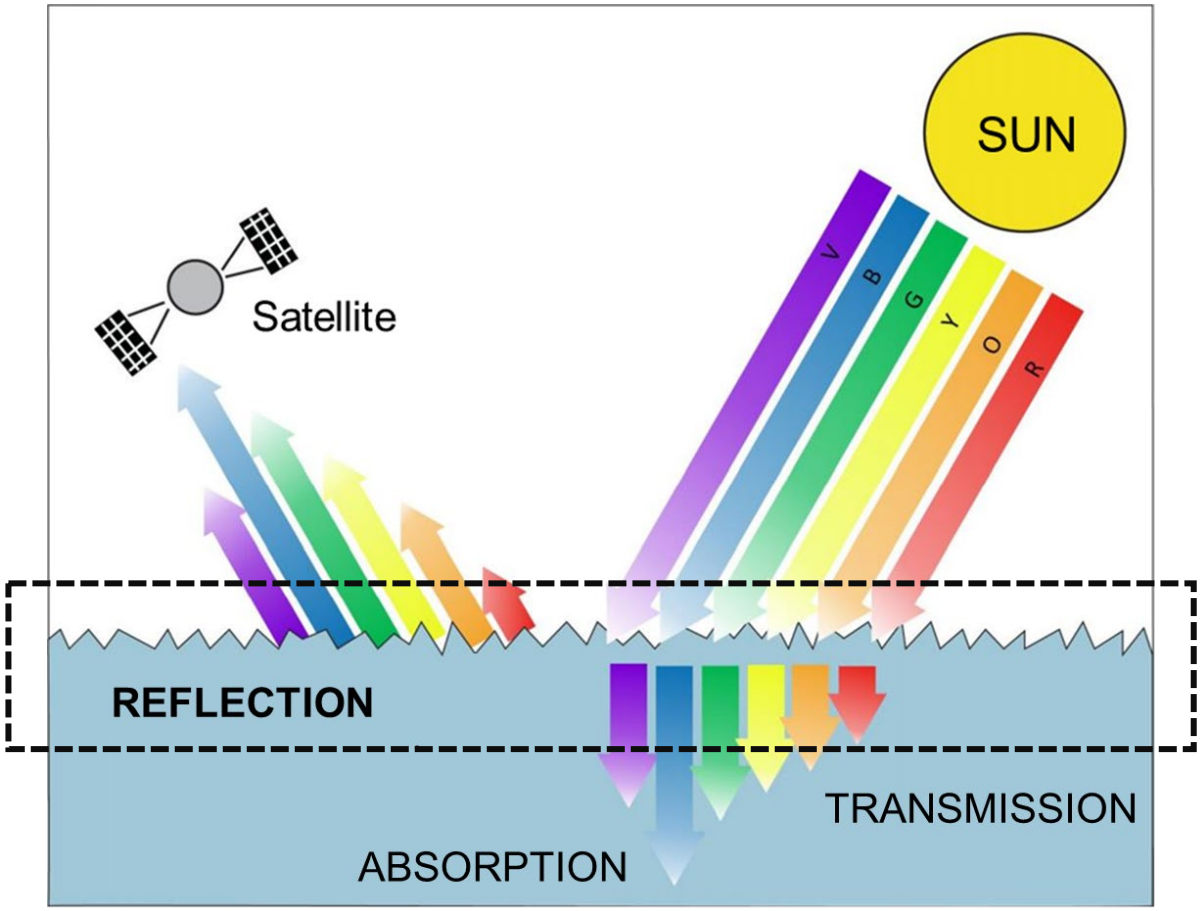
Coffer et al., 2021. *Water Res.*

UCMR 4 observations



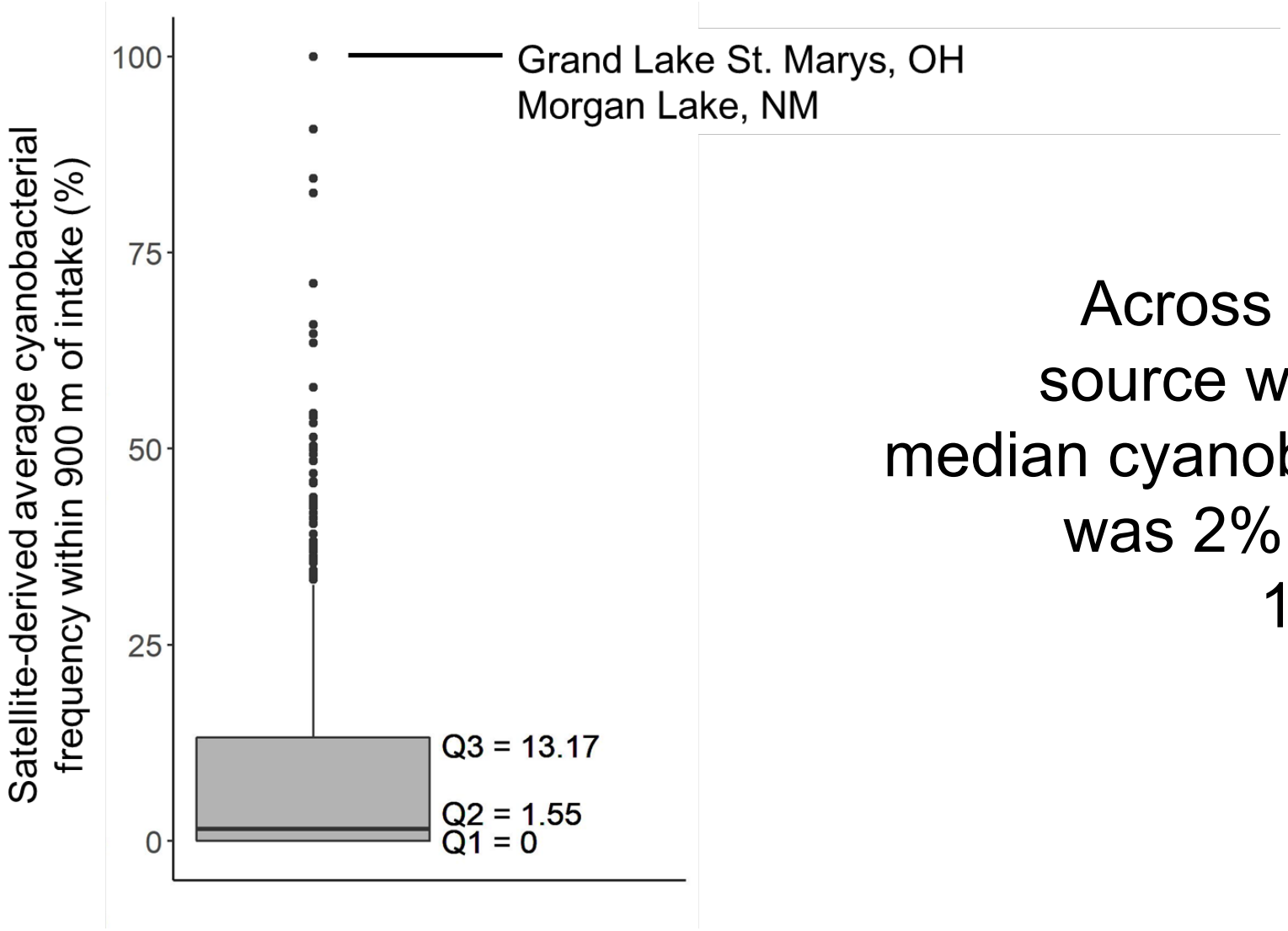
Asked PWS observers if a surface bloom was observed near the intake

Satellite imagery



Primarily characterizes the upper portion of the water column

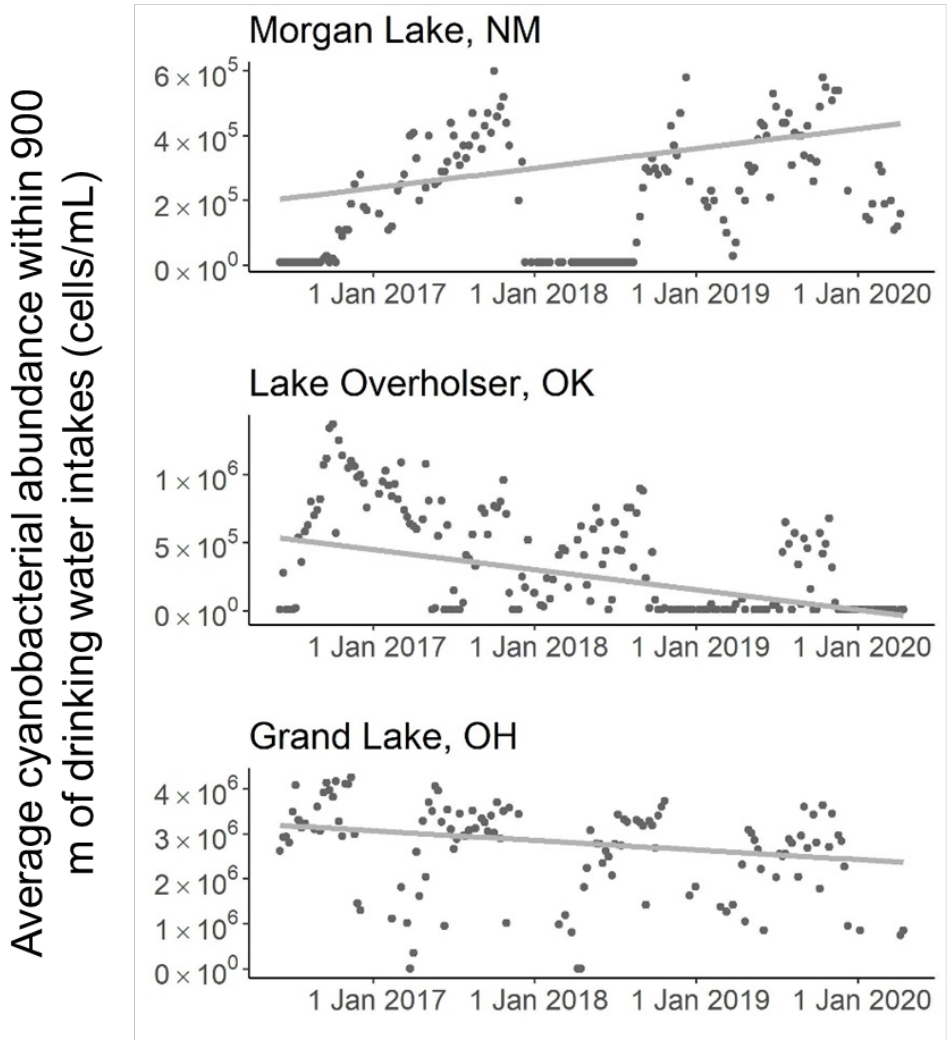
After confirming satellite imagery can be used to monitor source water cyanobacteria, we can assess large-scale patterns

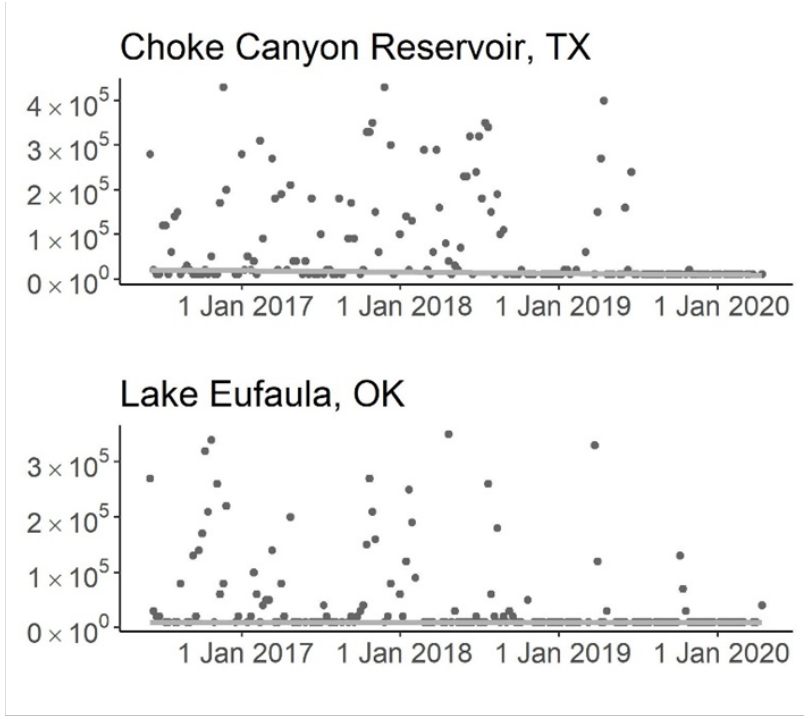


Across all 685 satellite-resolvable source waters in the United States, median cyanobacterial bloom frequency was 2%; Maximum frequency was 100% at two source waters

Coffer et al., 2021. *Water Res.*

After confirming satellite imagery can be used to monitor source water cyanobacteria, we can assess large-scale patterns

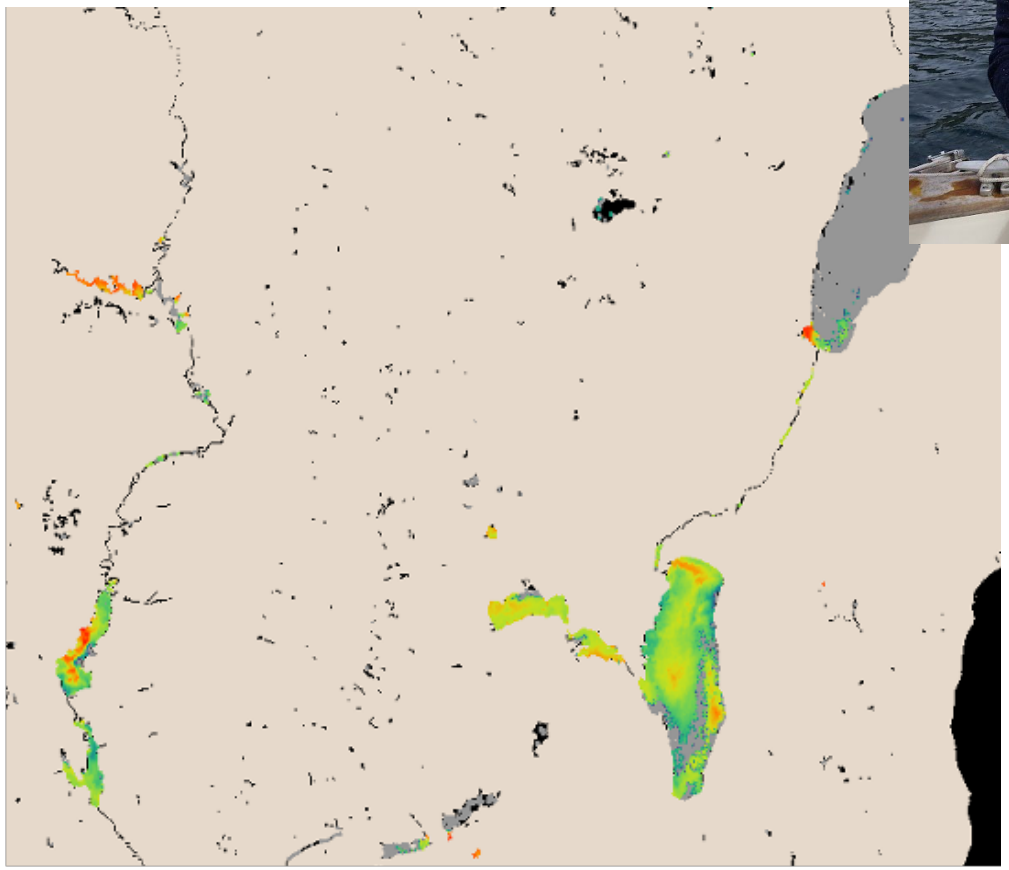


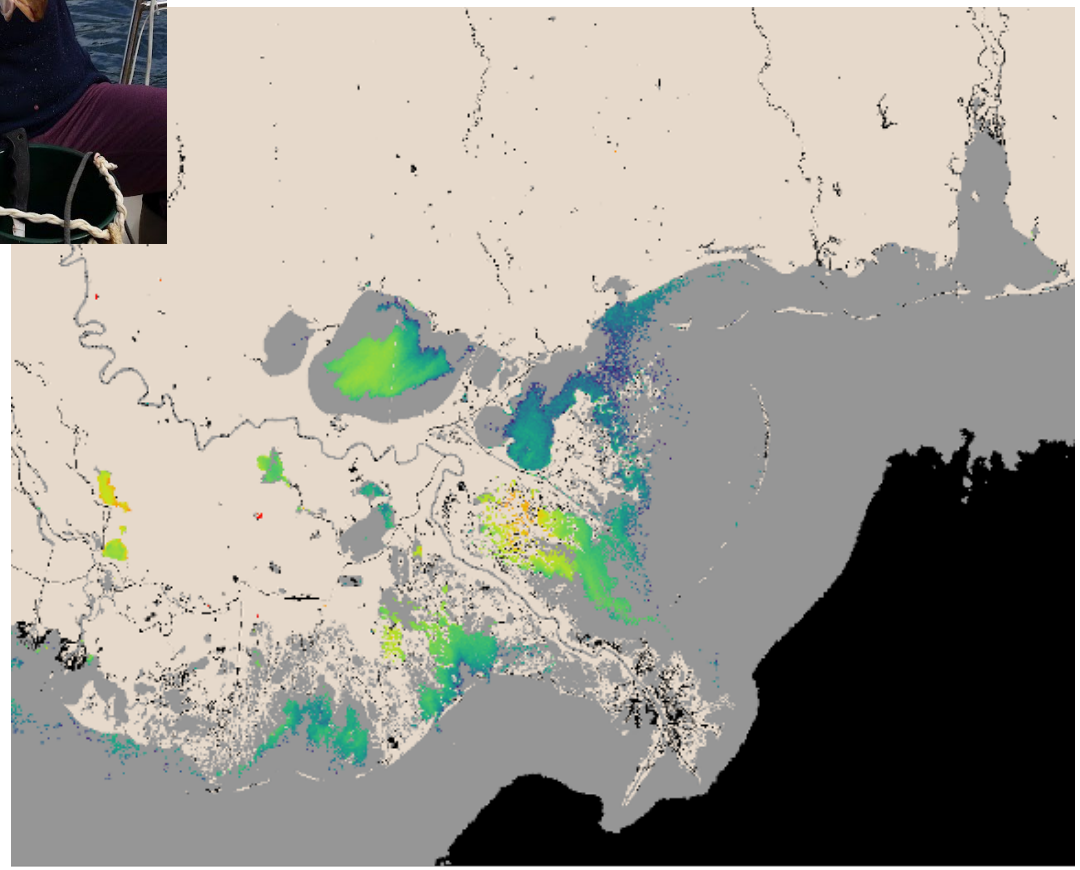


Trend assessment indicates source waters at one intake increased in cyanobacteria abundance from 2016-2020 while 4 source waters decreased

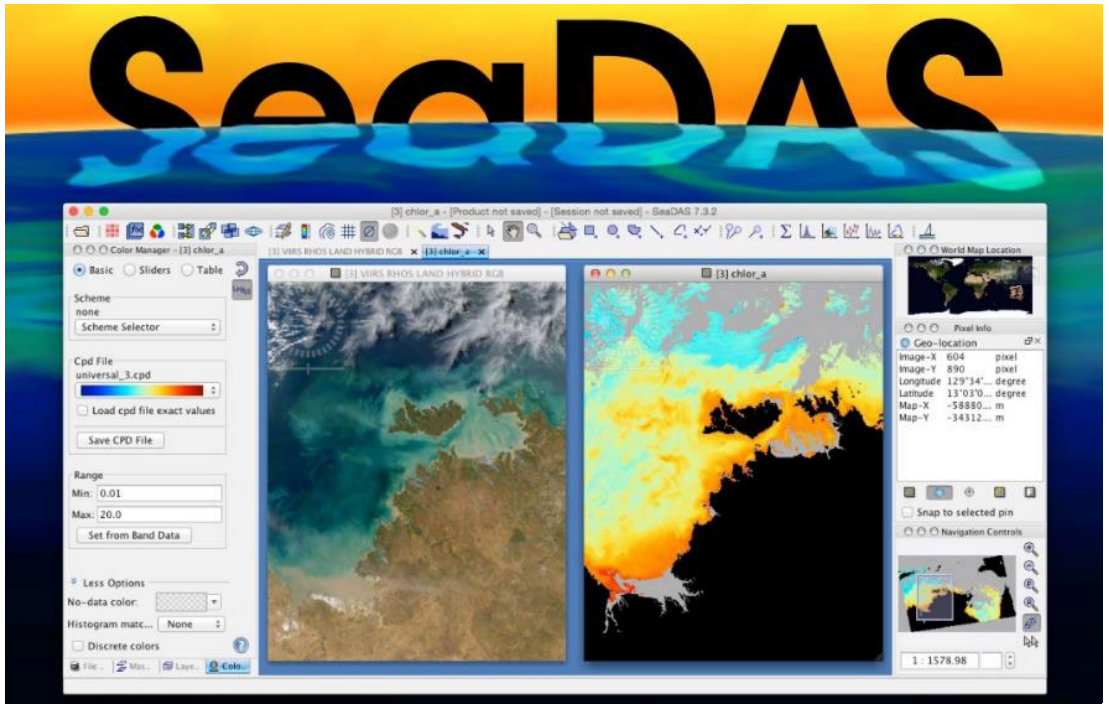
Coffer et al., 2021. *Water Res.*

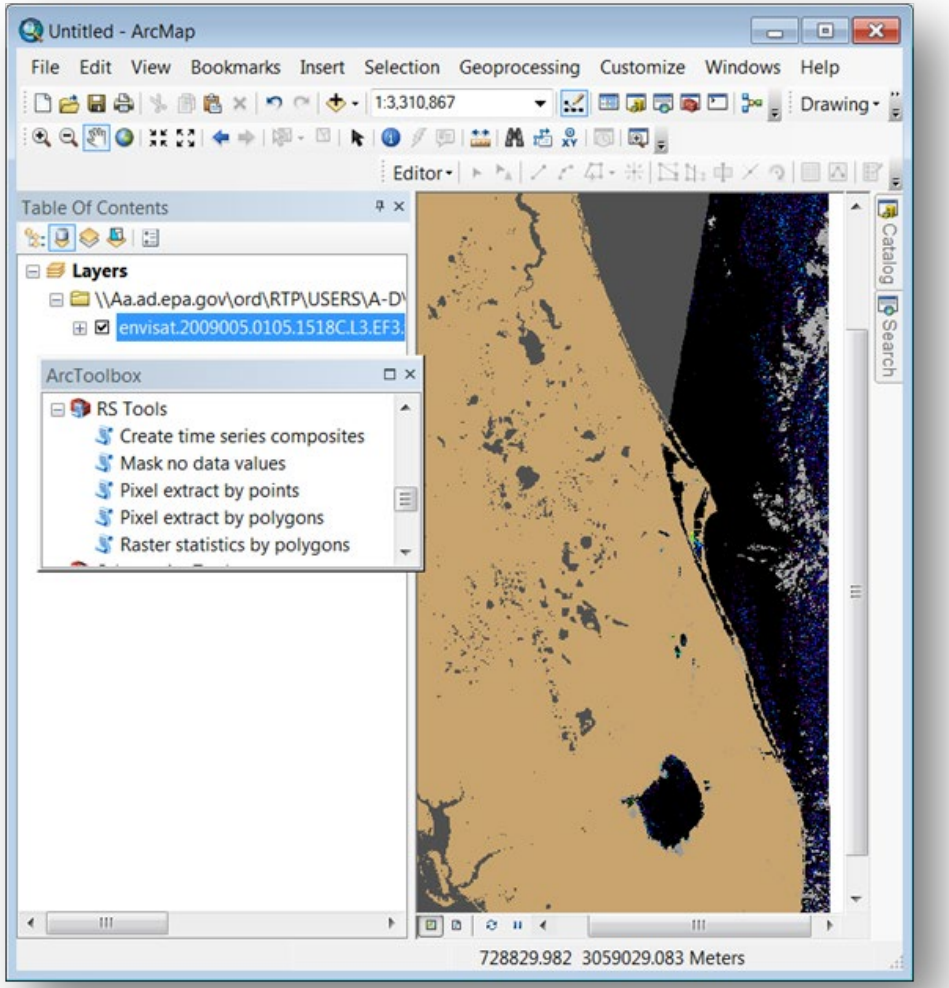
GeoTIFFs





NASA CyAN website





NASA CyAN website

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

CyAN

Version 5 of CyAN data were released on May 22, 2023. Click here for details.

Introduction

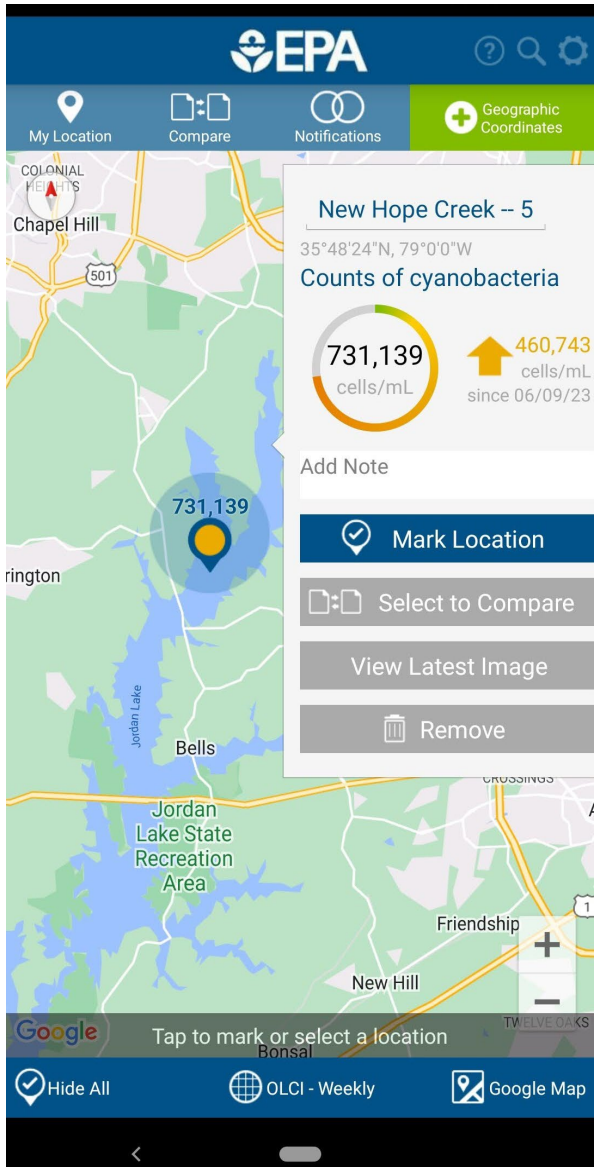
Cyanobacteria Assessment Network (CyAN) is a multi-agency project among EPA, the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the United States Geological Survey (USGS) to support the environmental management and public use of U.S. lakes and estuaries by providing a capability of

CyAN app demo

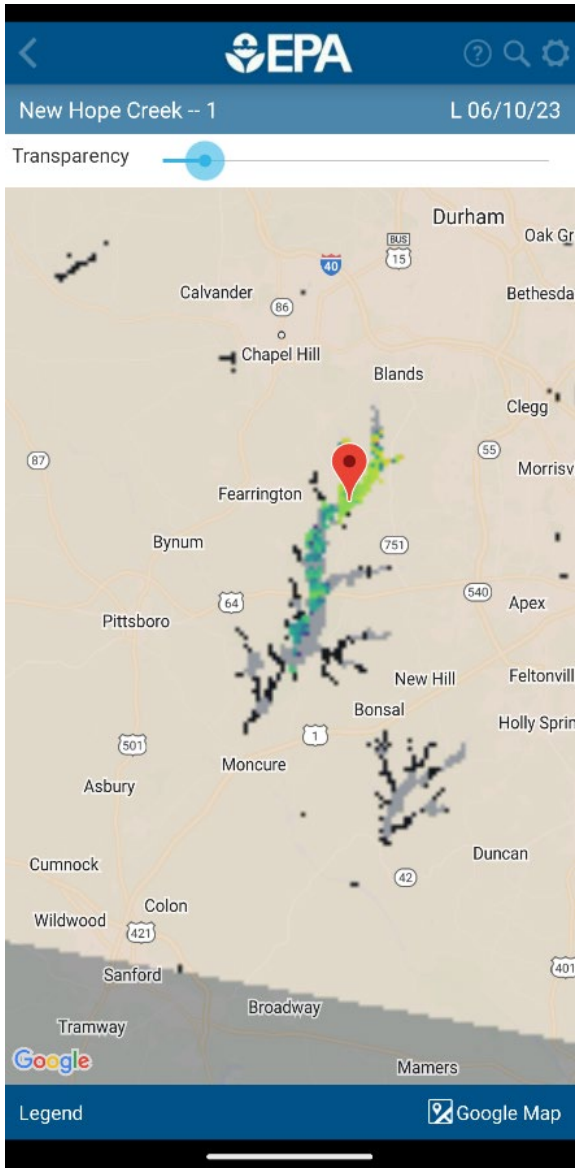
www.epa.gov/water-research/cyanobacteria-assessment-network-application-cyan-app

1

2



3



ASDWA HABS Webinar: CyAN and Potential Satellite Monitoring of Drinking Water Sources

Oregon DEQ

Julie Harvey, Drinking Water Protection Program

Dan Sobota, Senior Water Quality Analyst and Harmful Algal Blooms Coordination Team Lead

September 19, 2023

Willamette River at the Hawthorne Bridge 8/15/2023

Photo credit: Multnomah County Health Department

Oregon's Web application using CyAN data

State of Oregon
DEQ Department of Environmental Quality

Satellite Estimates of Cyanobacteria in Oregon Lakes and Reservoirs

Reporting Period: Aug. 21, 2023 - Aug. 27, 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

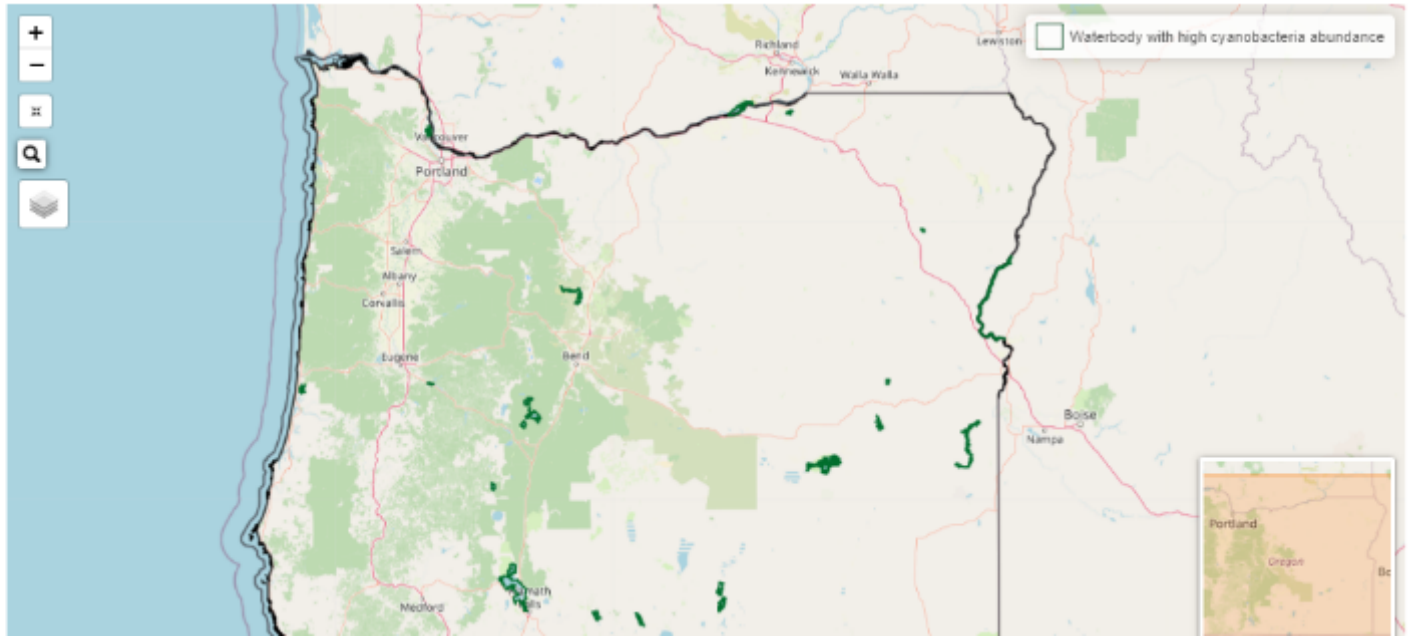
Waterbodies with high cyanobacteria abundance (>100,000 cells/mL) based on the average of daily maximum estimates during the 7-day reporting period (7DADM).

Reporting Period: Aug. 21, 2023 - Aug. 27, 2023

Search:

Waterbody_GNISID*	Basin	7DADM (cells/mL)	Days of Data
Gerber Reservoir_01121105	Klamath	5,293,102	4
Upper Klamath Lake_01151685	Klamath	4,194,077	4
Drews Reservoir_01141243	Upper Sacramento	3,712,077	5
Malheur Lake_01123710	Oregon Closed Basins	3,524,062	6
Brownlee Reservoir_00378278	Middle Snake-Powder	3,428,273	6
Sturgeon Lake_01127681	Lower Willamette	2,812,943	5
Hart Lake_01121637	Oregon Closed Basins	2,466,300	5
Davis Lake_01140686	Deschutes	2,367,769	5
Renner Lake_00267175	Upper Sacramento	2,112,984	5
Lake Billy Chinook_01138120	Deschutes	1,873,700	4
All	All	All	

Showing 1 to 10 of 22 entries



Data Visualization

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

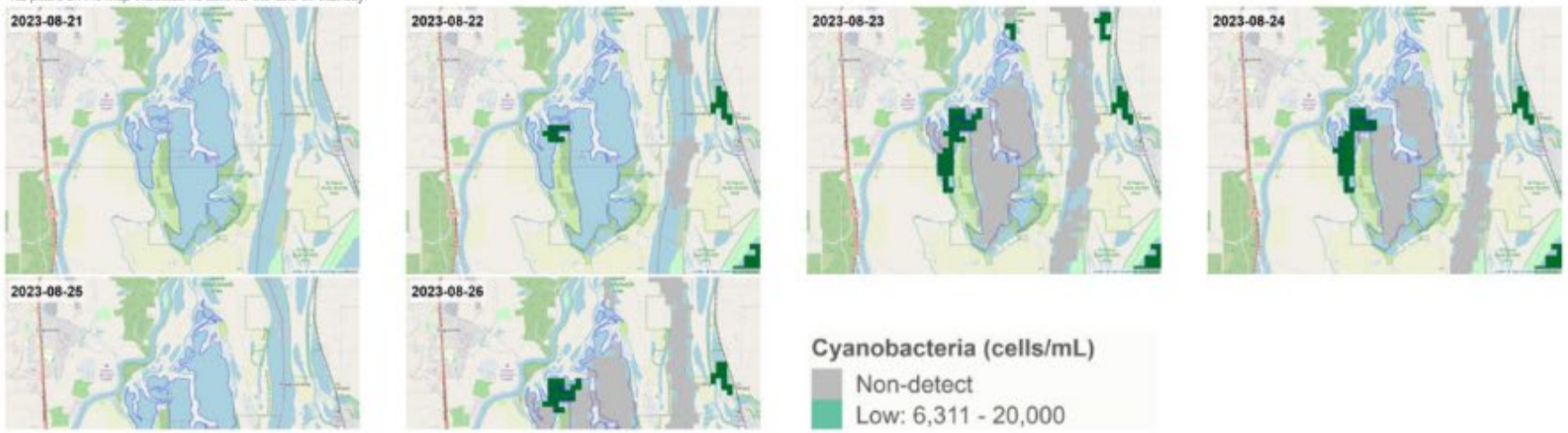
Select a Waterbody:

Sturgeon Lake_01127681

Public Drinking Water Source

Satellite estimates of cyanobacteria abundance from Aug. 21, 2023 to Aug. 27, 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 2023-08-27

Data for Sturgeon Lake_01127681 is available since June 14, 2016.

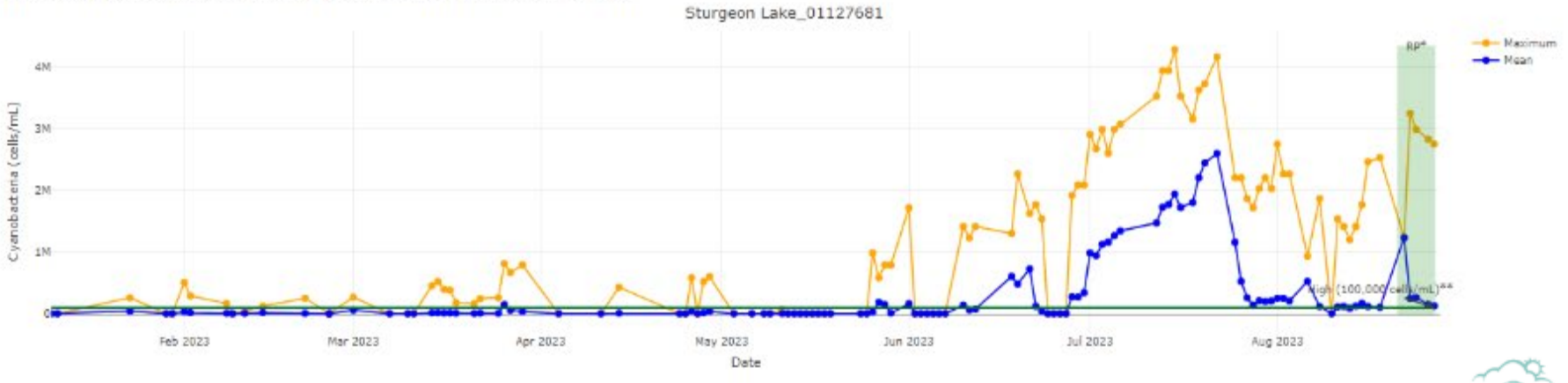
Summary Statistics:

- Maximum
- Mean
- Minimum

y-axis:

- Log Scale

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



*RP: Reporting period from Aug. 21, 2023 to Aug. 27, 2023.

**High (100,000 cells/mL): World Health Organization (WHO) Recreational Use Value (RUV) Guideline for moderate probability of adverse health effects.

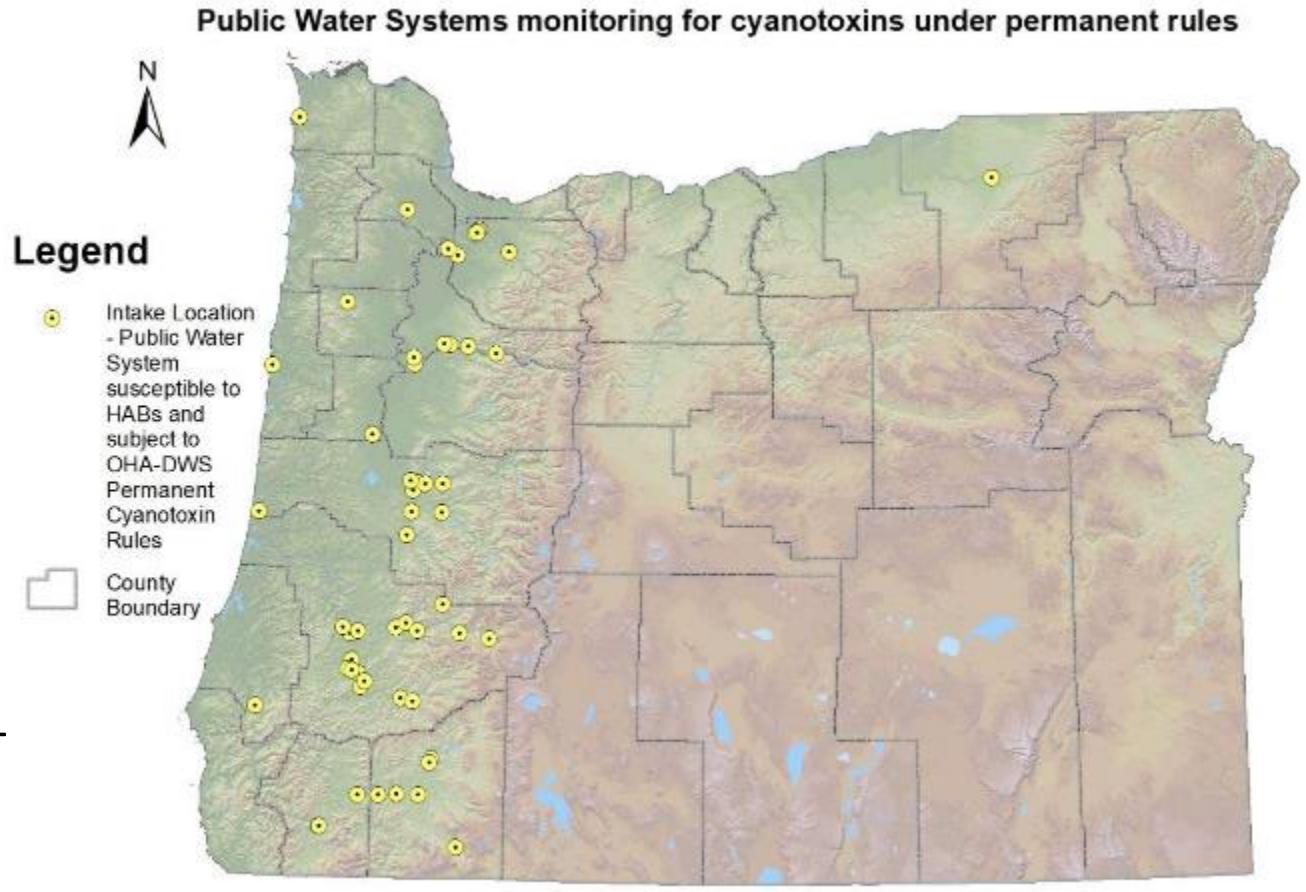
Satellite Estimates of Cyanobacteria in Oregon Lakes and Reservoirs - https://www.oregon.gov/deq/wq/pages/harmful-algal-blooms.aspx

DEQ
State of Oregon
Department of
Environmental
Quality

EPA NASA USGS NOAA

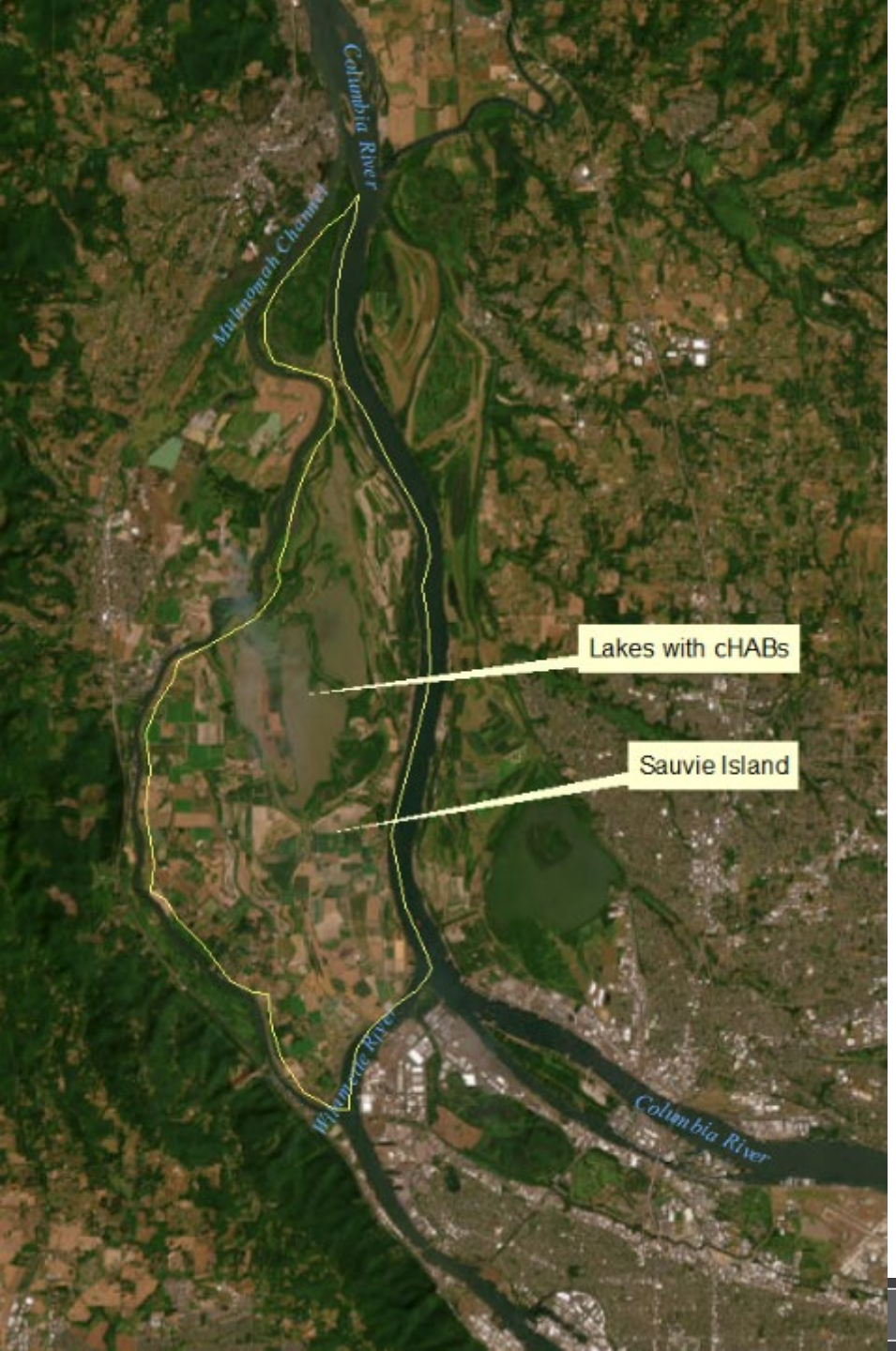
Susceptible Water Systems – OHA Rules (2019)

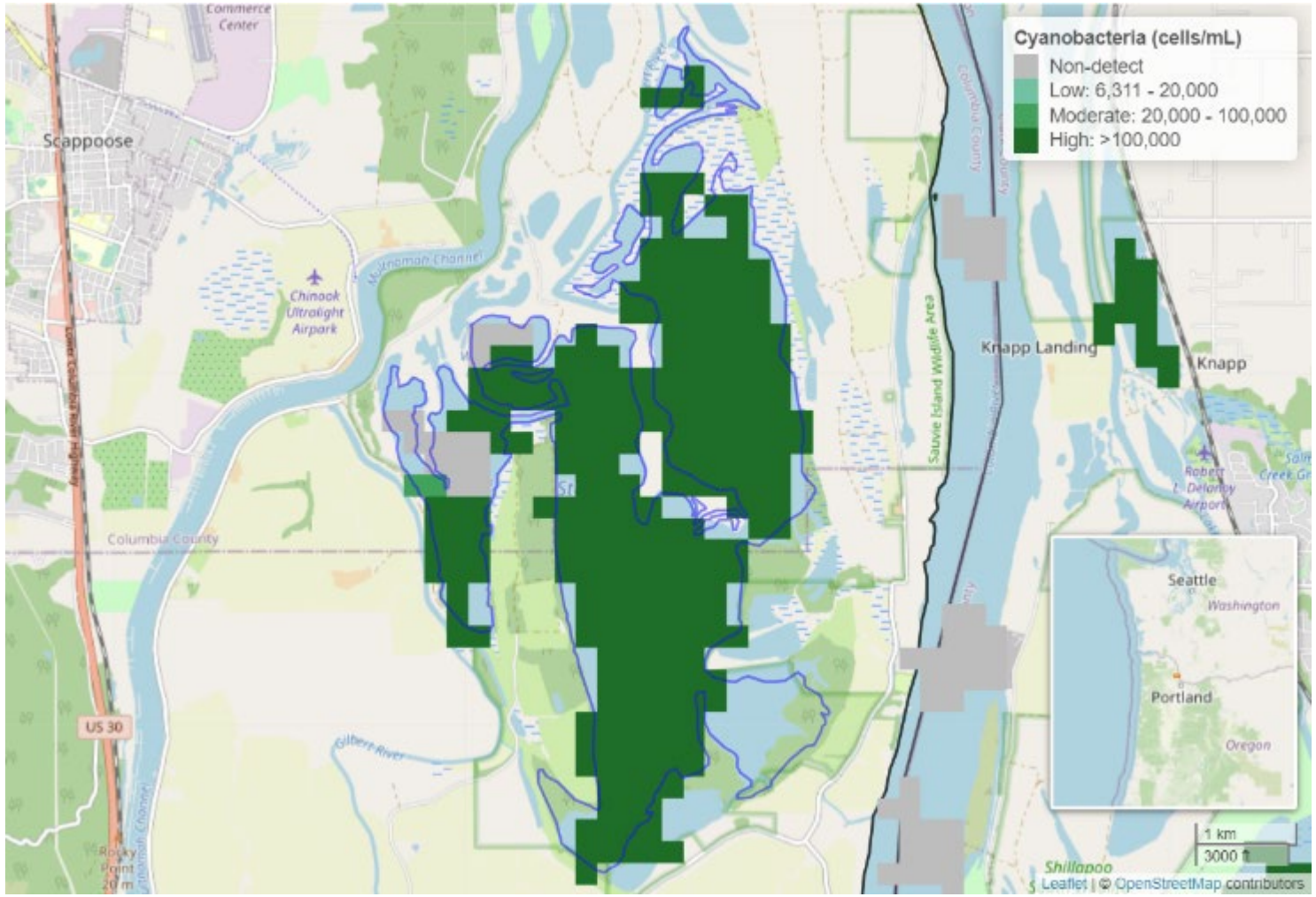
1. Documented HABs with cyanotoxin detected;
2. Source or upstream waterbody on DEQ 303(d) list for not meeting WQ standards for algae and aquatic weeds;
3. Downstream of source susceptible to HABs or cyanotoxins
4. OHA determination based on characteristics of the source, including, but not limited to, slow moving or stagnant water, temperature, available sources of nutrients, water quality data, satellite imagery, presence of microcystin- or cylindrospermopsin-producing genes, or other relevant information.



Sturgeon Lake – Sauvie Island, Multnomah County, Oregon 7/21/2023

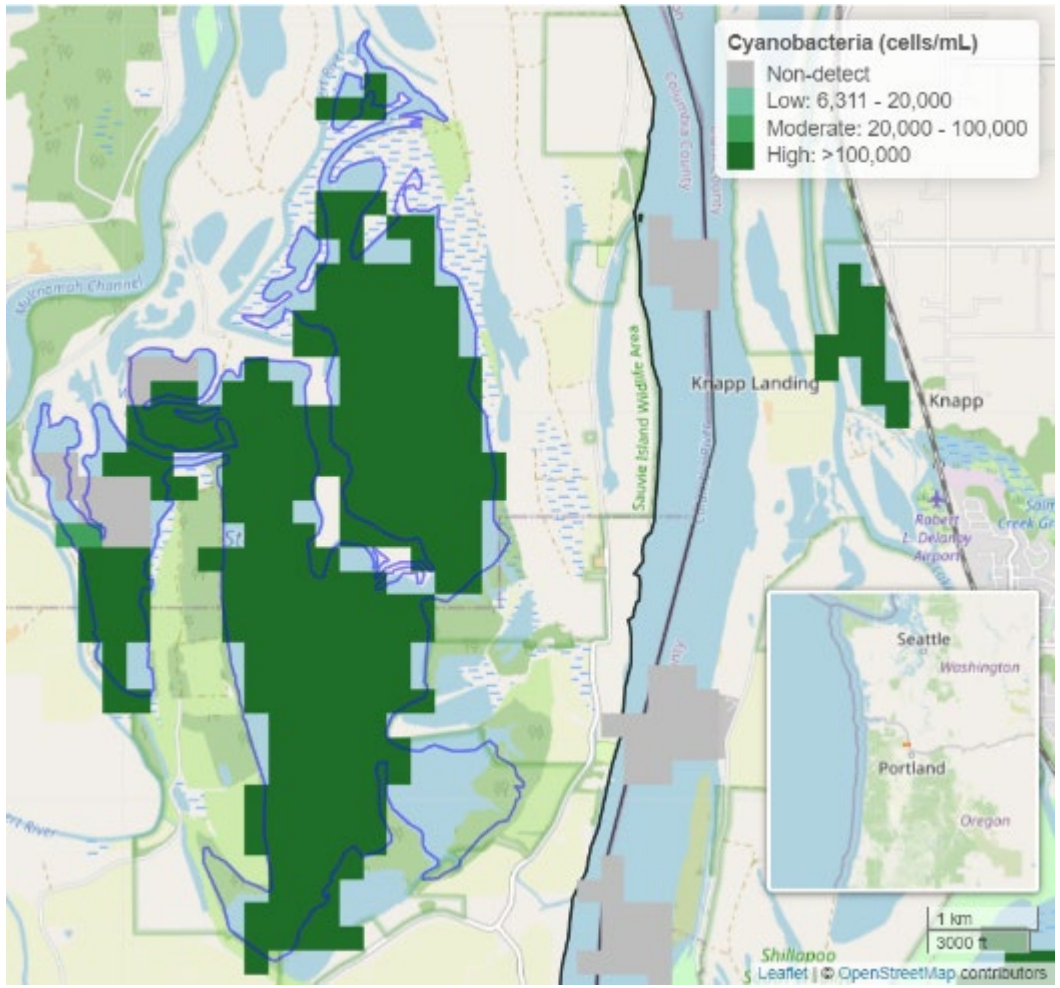
Photo credit: Oregon DEQ



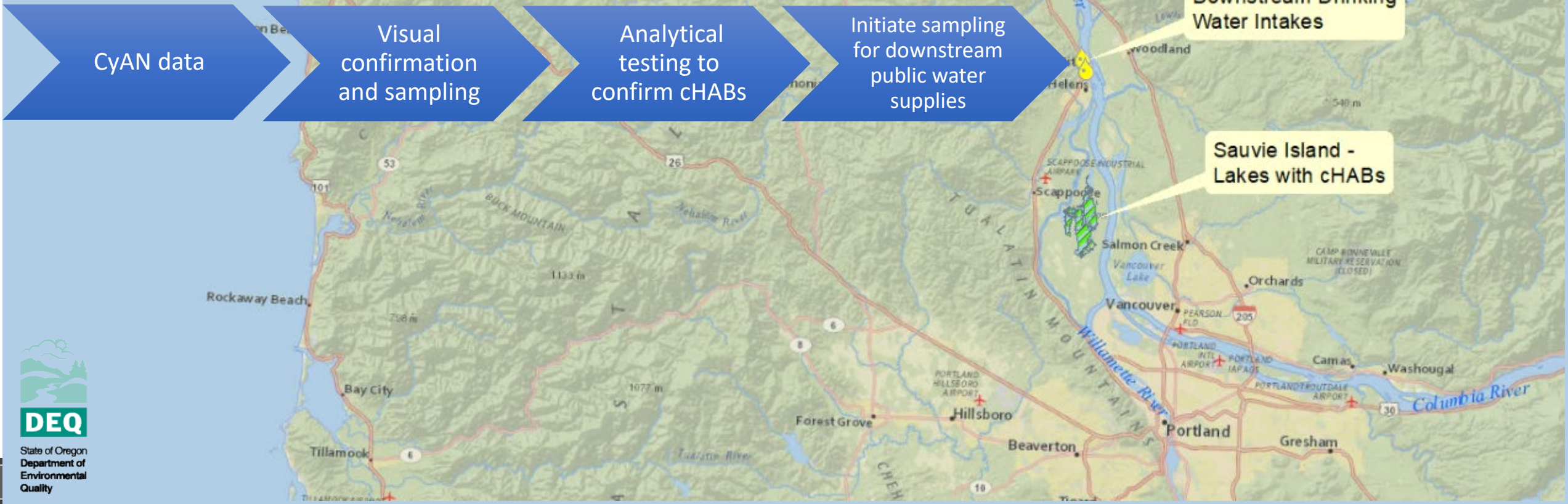


Sturgeon Lake – Sauvie Island, Multnomah County, Oregon 7/21/2023

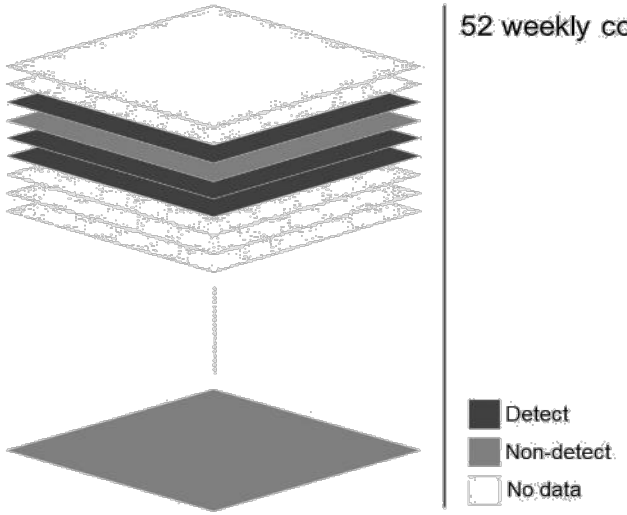
Photo credit: Oregon DEQ



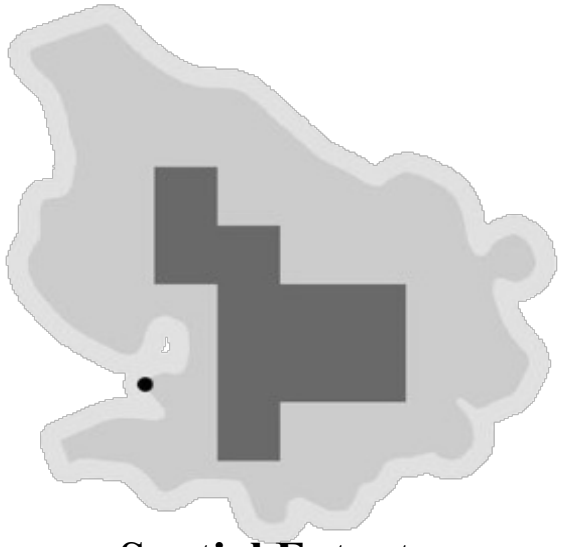
CyAN Satellite Data allows us to screen more places, more frequently to we can prioritize resources for sampling and make decisions that protect public health and the environment



DEQ
State of Oregon
Department of
Environmental
Quality



Temporal Frequency



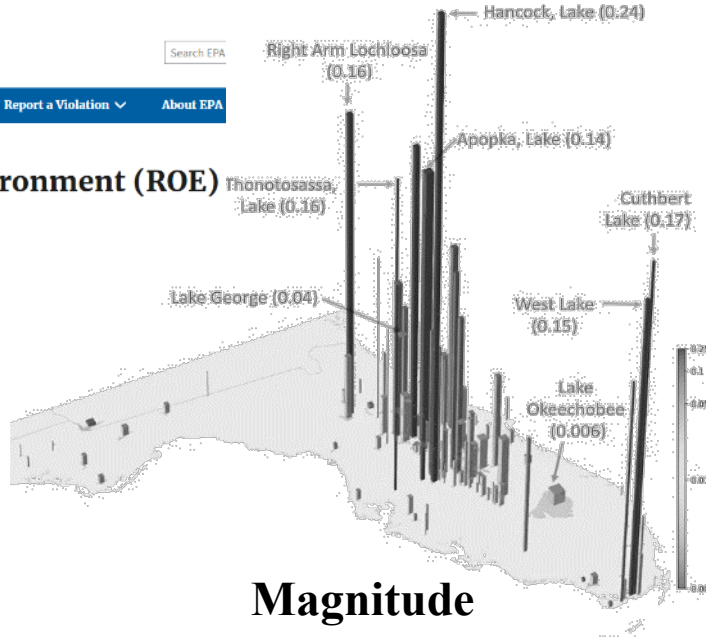
Spatial Extent

EPA United States Environmental Protection Agency

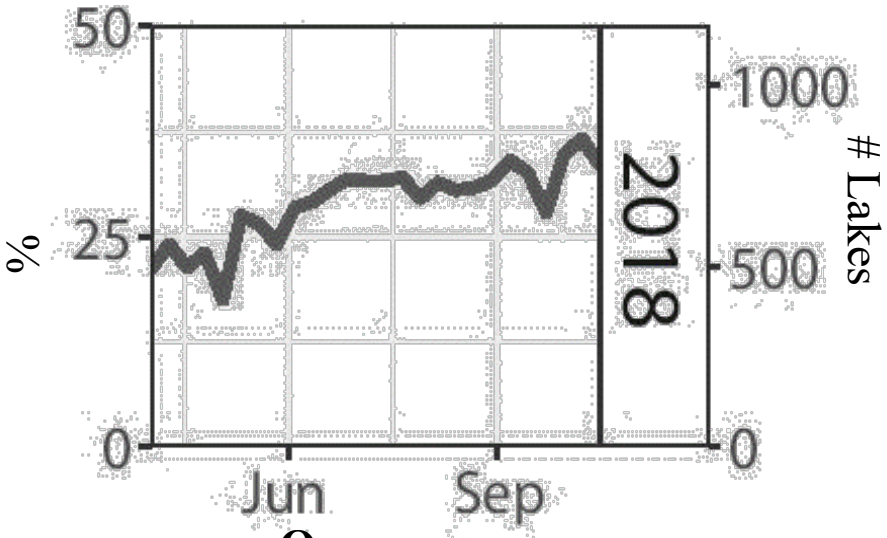
Search EPA

Environmental Topics | Laws & Regulations | Report a Violation | About EPA

EPA's Report on the Environment (ROE)



Magnitude



Occurrence

US Army Corps of Engineers®

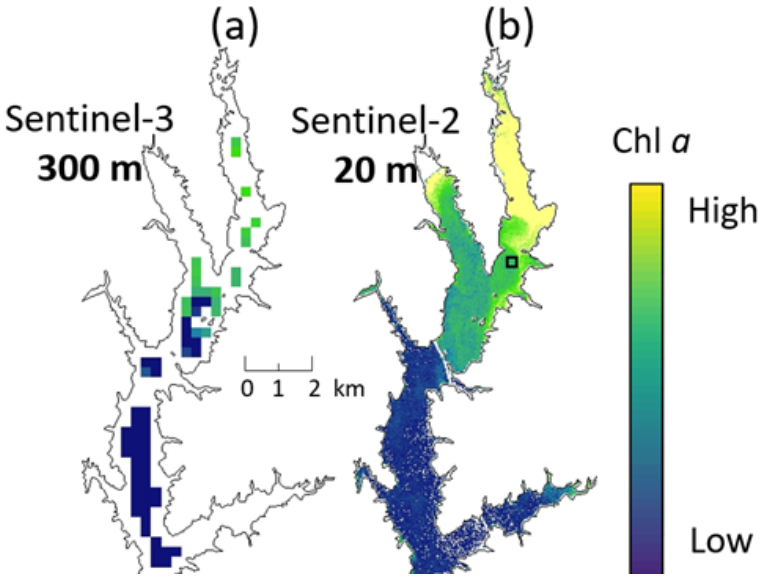
NOAA

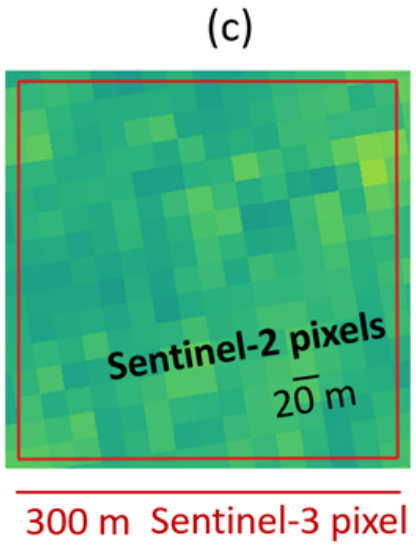
NASA

USGS science for a changing world

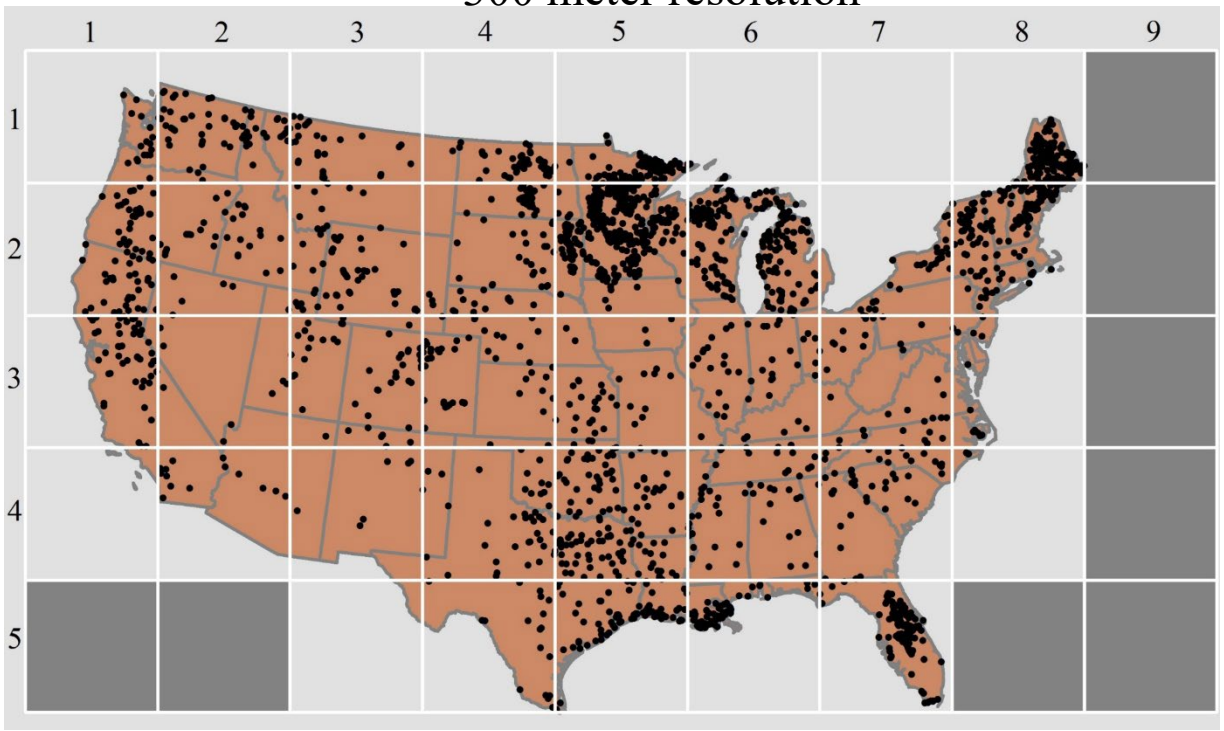
National Environmental Satellite Data and Information Service
DEPARTMENT OF COMMERCE

United States Environmental Protection Agency

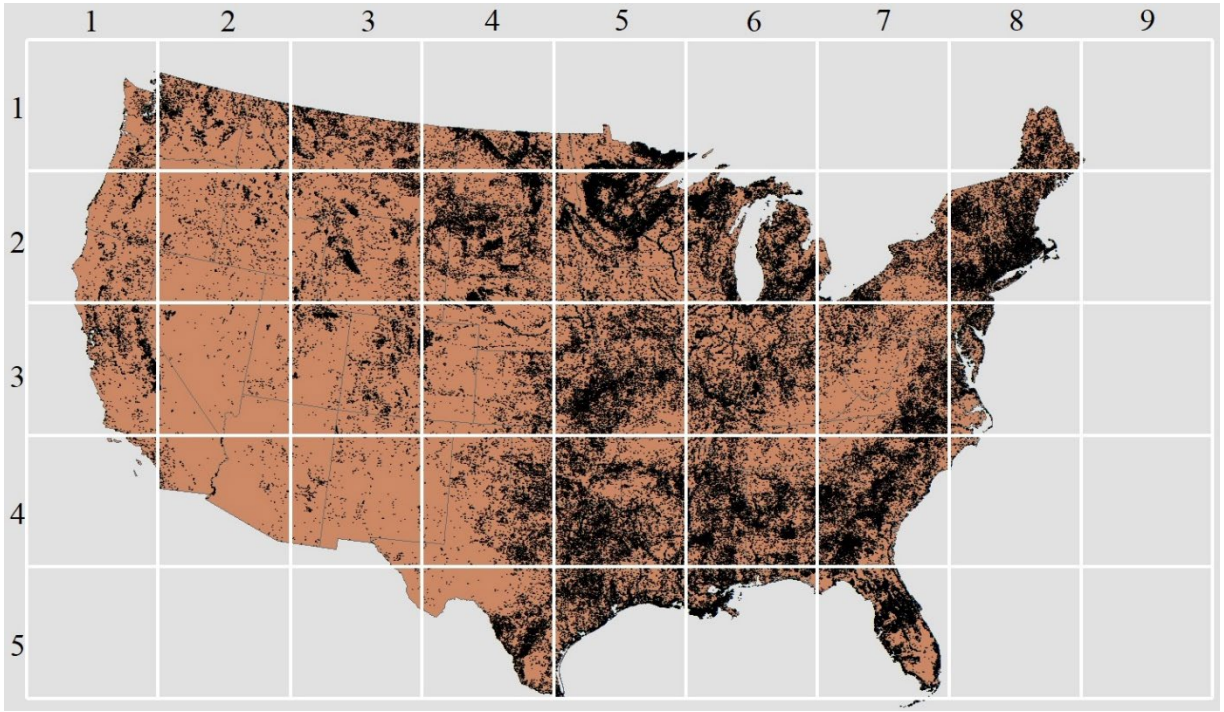




Original CyAN data
300 meter resolution



CyAN S2.0
10-60 meter resolution



>270,000 (98%) lakes
312 (83%) estuaries & 85 (100%) sub estuaries

Annual potential avoided costs
~$42 million/year

Sources: Clark et al. 2017. Ecological Indicators;
Papenfus et al. 2020. Environmental Monitoring and Assessment

Summary

- CIcyano satellite images available daily and weekly
  - Annual potential avoided costs ~$5.7 million/year
- Training, software (open source, GIS, Andorid, web-based)
  - NASA website
  - SeaDAS
  - ArcMAP and ArcPRO RS Tools
  - Android mobile and web-applications
- Demonstrations
  - Utah Lake
  - Surface source waters
  - Oregon DEQ

EPA CyAN website

NASA CyAN website

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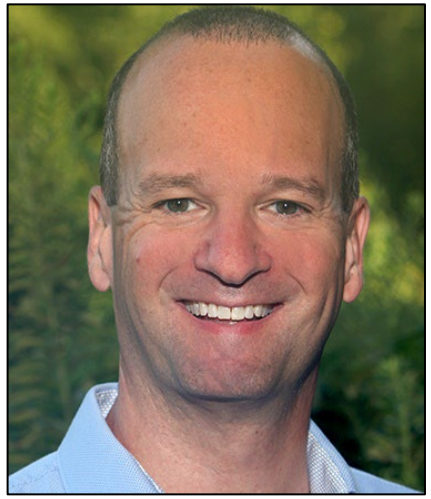
  - Sounds
    - BBC Sound effects
  - Any mention of trade names, manufacturers or products does not imply an endorsement by the United States Government or the U.S. EPA. The views expressed are those of the authors and do not necessarily reflect the views of policies of the U.S. EPA.

CyAN potential satellite monitoring of drinking water sources



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