Application of satellite imagery to detect, quantify, and inform management of cyanoHABs in Oregon

April 28, 2021

Protecting Drinking Water Sources from Cyano-HAB Impacts in the Willamette Basin

Dan Sobota, Yuan Grund, Erin Costello, and Brian Fulfrost*
Oregon DEQ - Watershed Management Section

*currently with BFA Consultants

DEQ
State of Oregon
Department of Environmental Quality

Why satellite imagery?

- Field sampling and instrumentation costly and time consuming
  - CyanoHABs sampling in Oregon has relied on reports to OHA and DEQ from stakeholders, municipalities, or the public
  - OAR 333-061-0510 to 333-061-0580 in place since 2019 require “susceptible” drinking water systems to test for cyanotoxins regularly

- Satellite imagery allows fast, low-cost screening for cyanoHABs
  - Could help improve efficiency and efficacy of field sampling
  - Improve the understanding of factors contributing to cyanoHABs

DEQ
State of Oregon
Department of
Environmental
Quality

DEQ satellite-cyanoHABs objectives

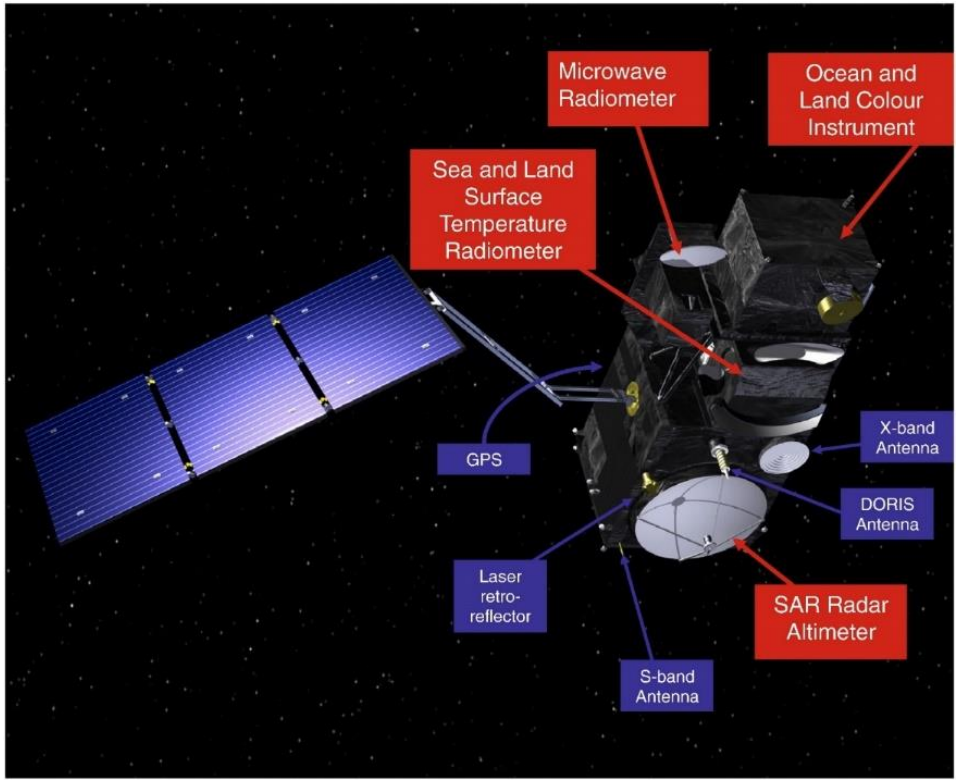
- Identify and monitor cyanoHABs in Oregon using satellite imagery
- Develop early warning system(s) for cyanoHABs using a combination of satellite and in situ continuous data
- Use satellite imagery to help identify factors contributing to cyanoHABs

DEQ
State of Oregon
Department of
Environmental
Quality

CyAN imagery from US EPA

Sentinel-3 OLCI

- 300 m pixels
- optimal spectral bands
- from 2016 (June)
- 1-2 day return time
- Uses both Sentinel 3a and 3b



44+ 'resolvable' lakes within Oregon

Data:

- **Cyanobacteria Abundance (CI) in cells/ml**
- Spectral Shape Algorithm focusing on phycocyanin
  - (Wynne *et al. 2008; 2010*)
- Includes error detection (for exploratory purposes)
  - mixed land water, dry lakes, snow/ice, stray light
- ~85% correlation of blooms (> 100,000 cells/ml) with advisories throughout US

DEQ
State of Oregon
Department of Environmental Quality

Using satellite imagery for cyanoHABs

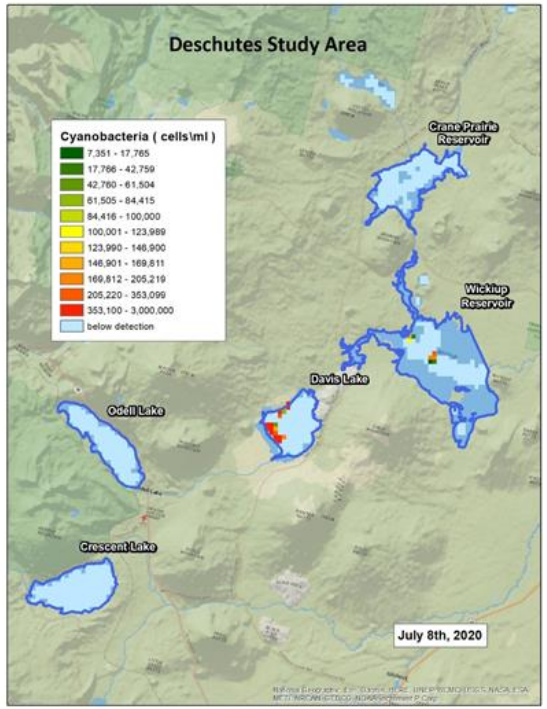
- Need to verify that satellite imagery reflects on-the-ground observations

- Need to update imagery on a regular basis and compile in an easy-to-use format

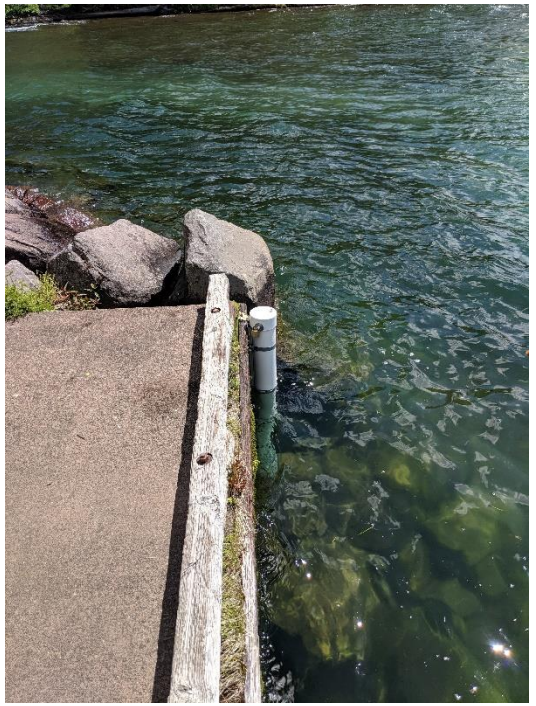
DEQ
State of Oregon
Department of
Environmental
Quality

Comparing satellite data with field measurements

- Builds confidence that satellite imagery can be used
- Tests the sensitivity of satellite detection of cyanoHABs

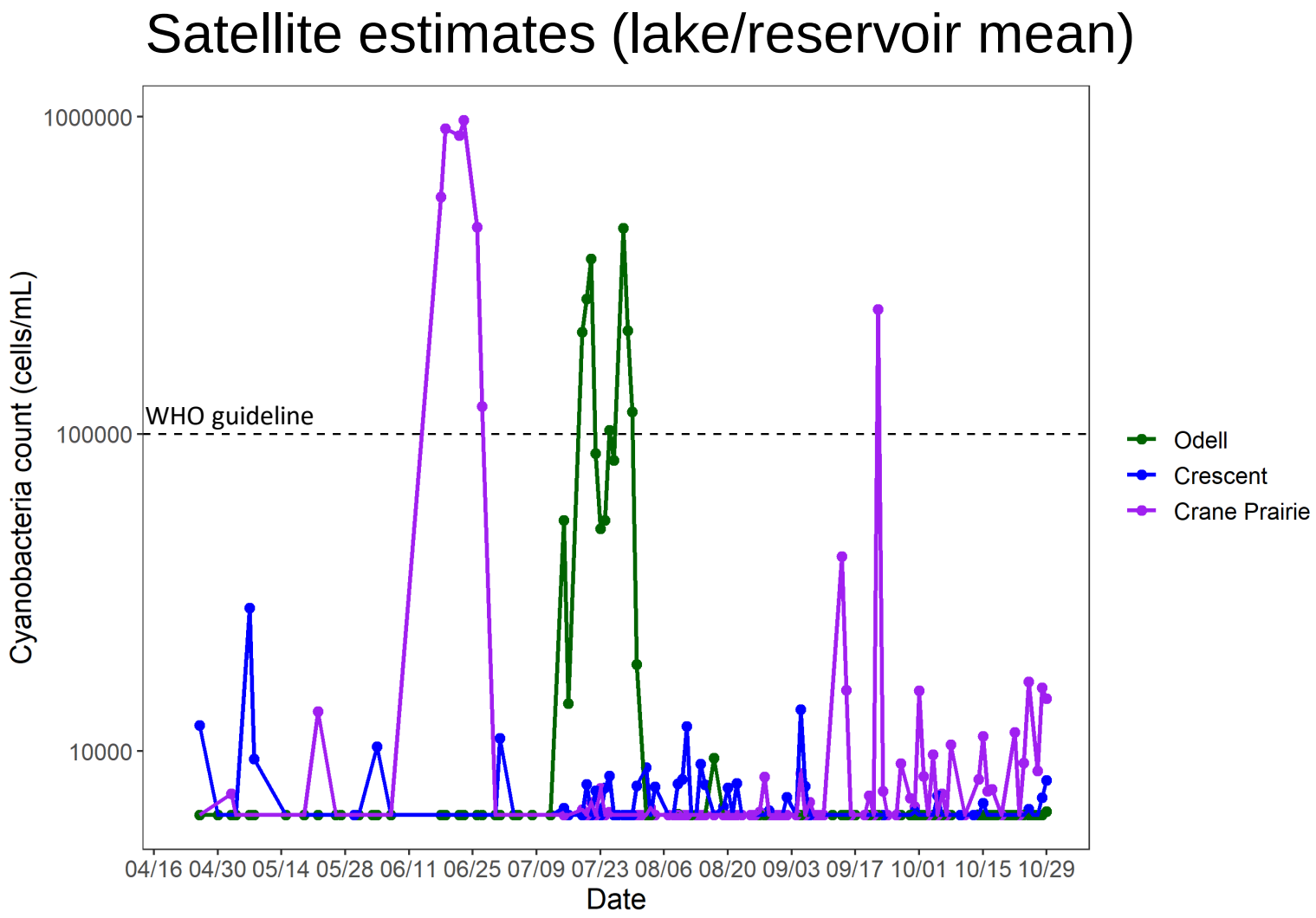


Vs.



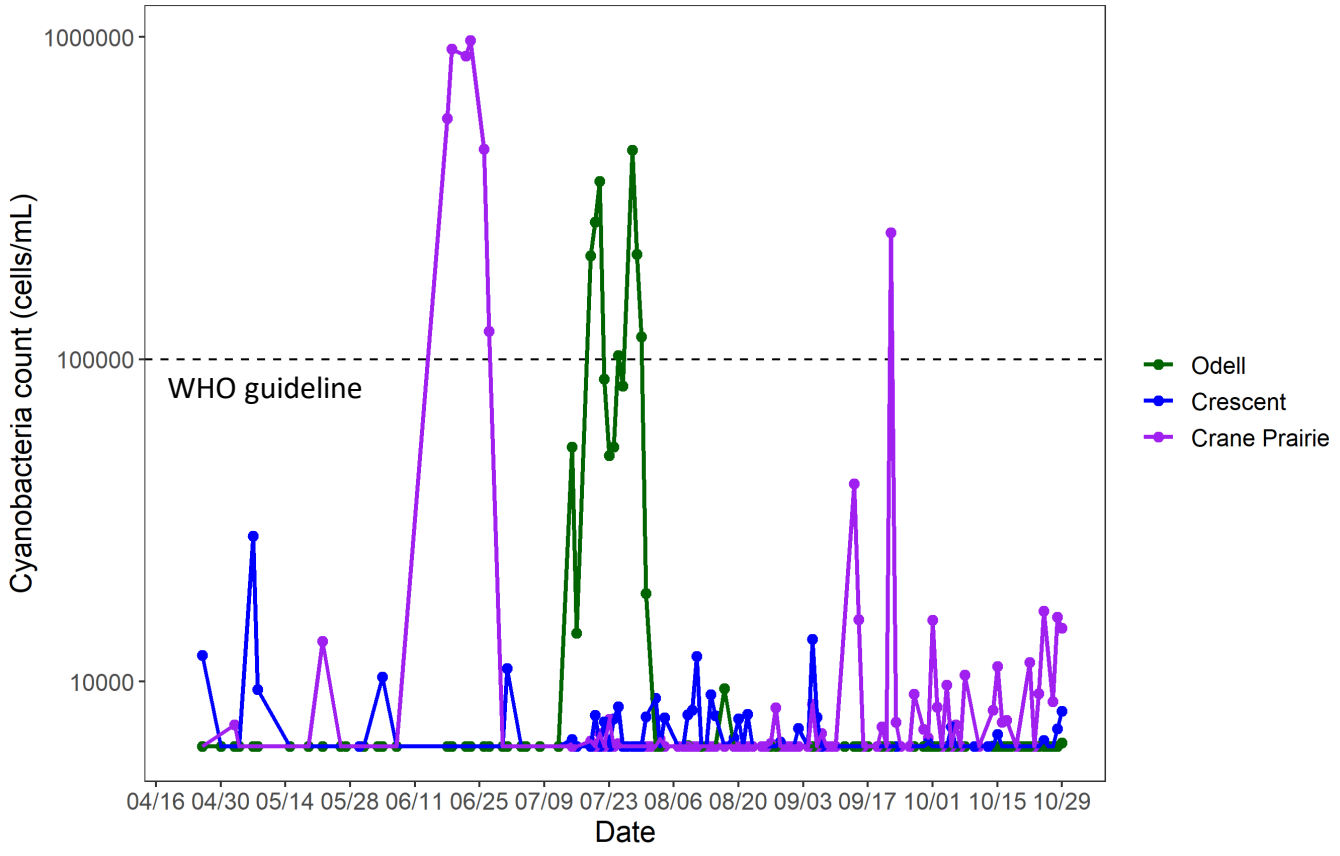
DEQ
State of Oregon
Department of Environmental Quality

Cyanobacteria monitoring – 2020 season

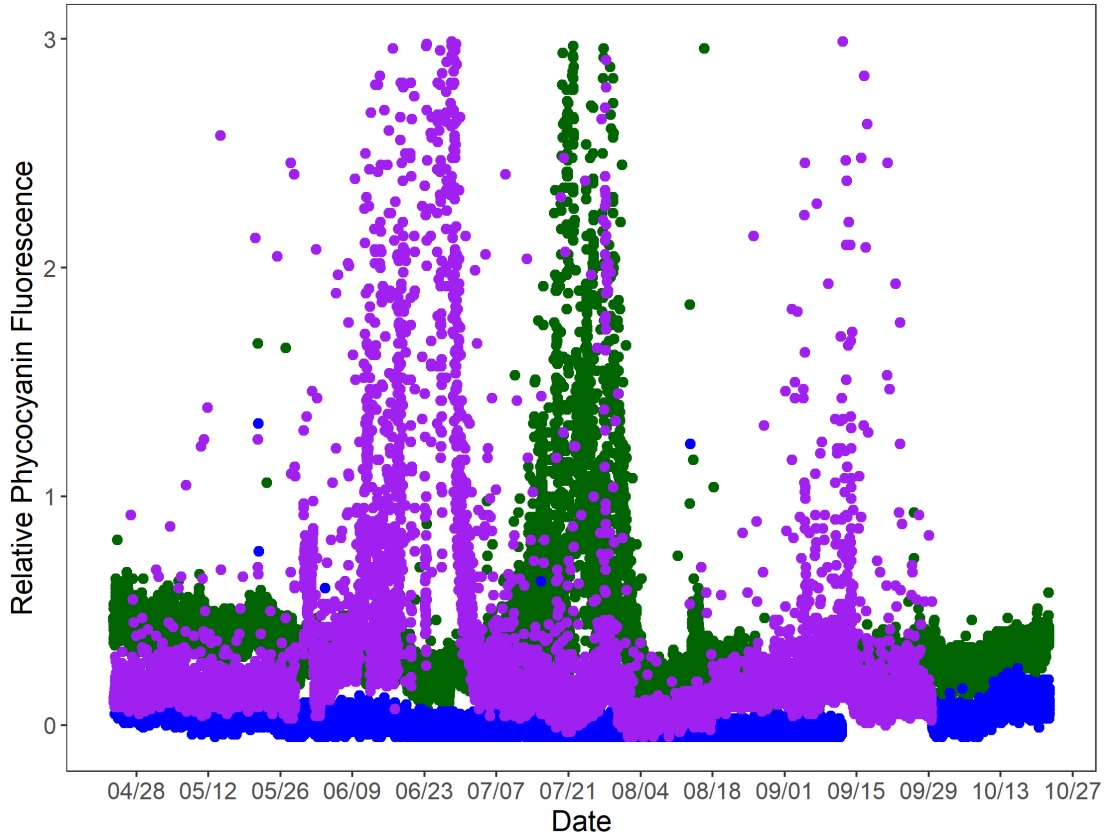


Cyanobacteria monitoring – 2020 season

Satellite estimates (lake/reservoir mean)

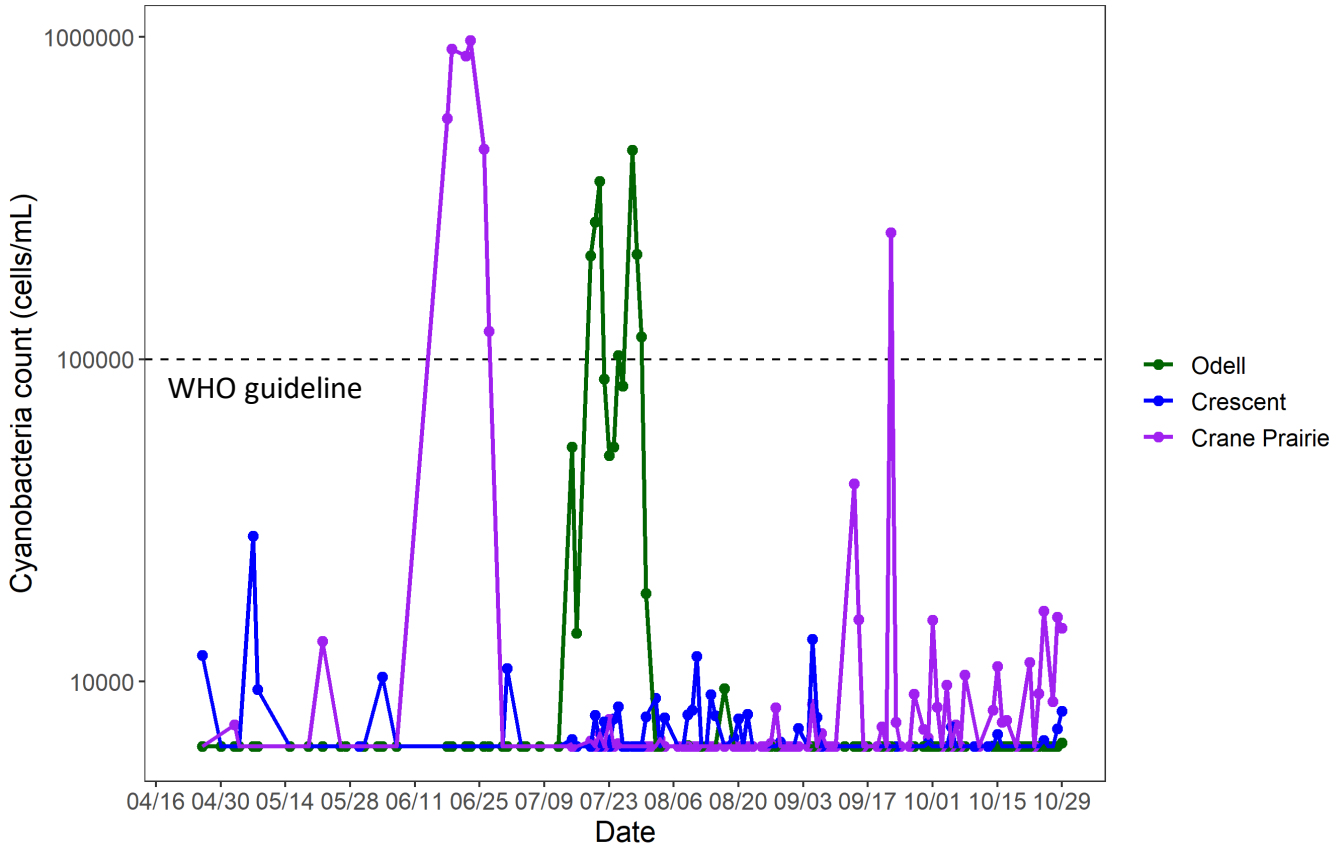


in situ measurements (15-minute intervals)

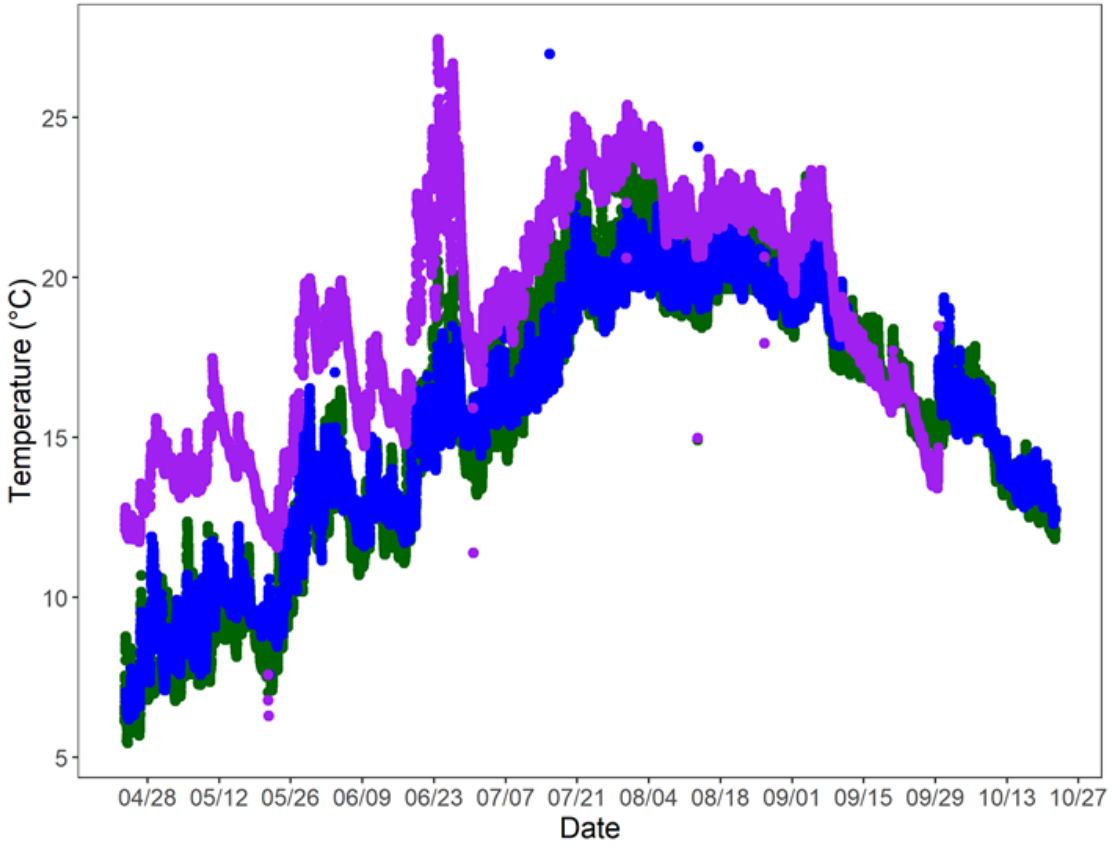


Cyanobacteria and water quality – 2020 season

Satellite estimates (lake/reservoir mean)



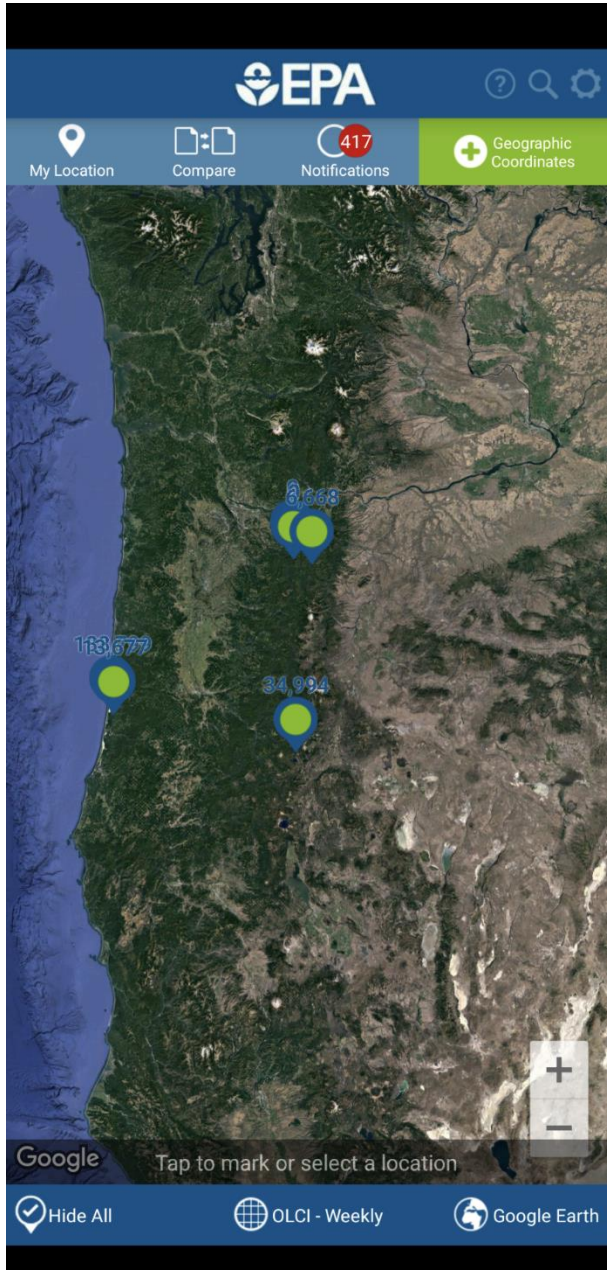
in situ measurements (15-minute intervals)

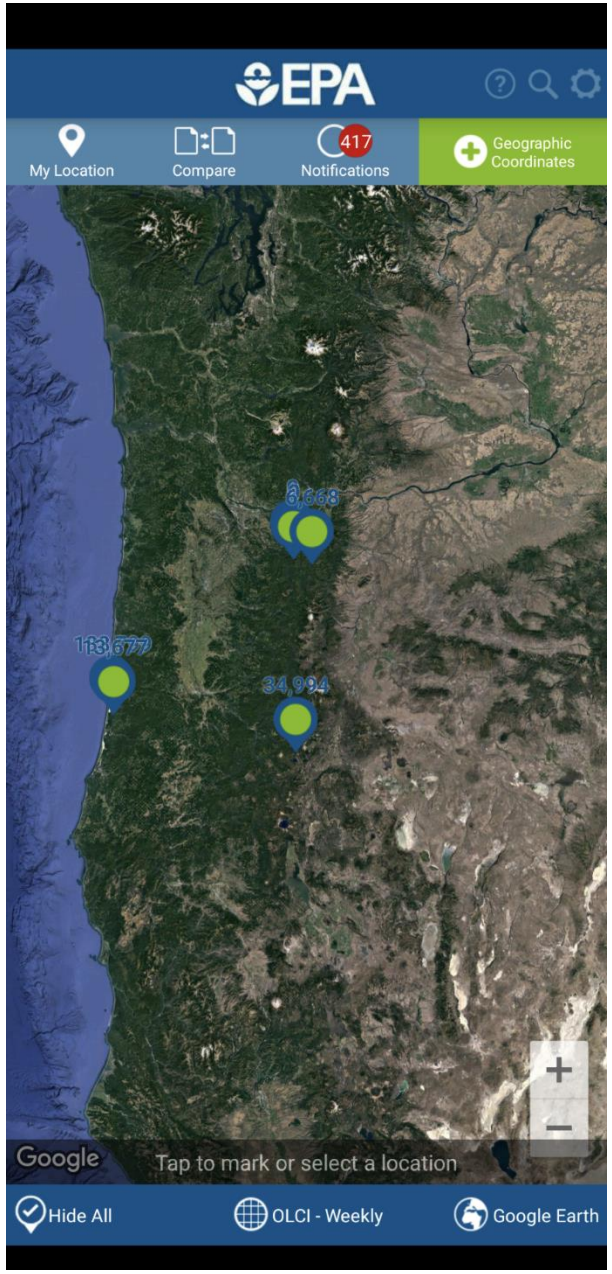


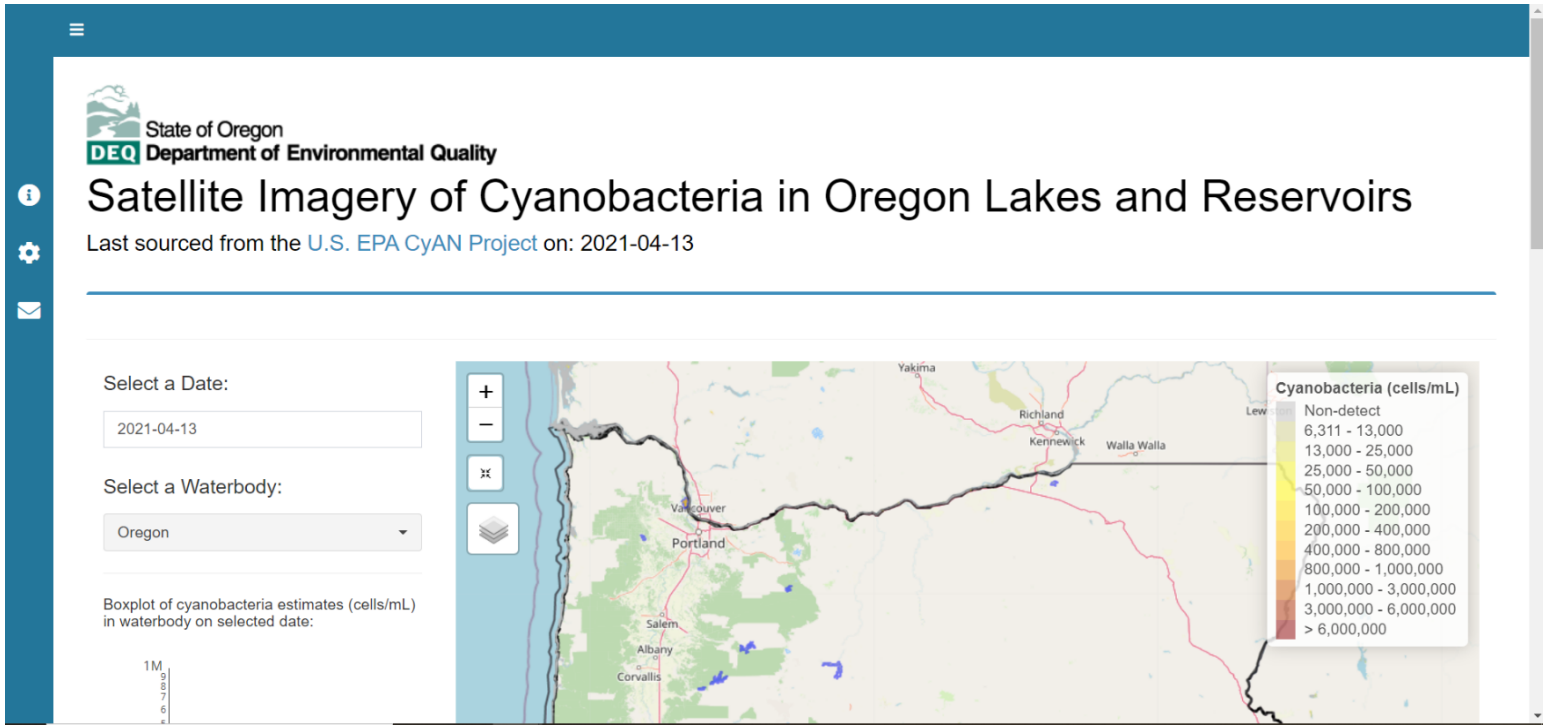
Updating and disseminating data

- Need access to near real-time satellite imagery
- Need processing steps to convert raw imagery to cyanobacteria counts
- Need a platform to disseminate data

DEQ
State of Oregon
Department of
Environmental
Quality


EPA
My Location
Compare
417
Notifications
Geographic Coordinates
8,668
133,577
34,994
Google
Tap to mark or select a location
Hide All
OLCI - Weekly
Google Earth


EPA
My Location
Compare
417
Notifications
Geographic Coordinates
8,668
133,577
34,994
Google
Tap to mark or select a location
Hide All
OLCI - Weekly
Google Earth


State of Oregon
DEQ Department of Environmental Quality
Satellite Imagery of Cyanobacteria in Oregon Lakes and Reservoirs
Last sourced from the U.S. EPA CyAN Project on: 2021-04-13
Select a Date:
2021-04-13
Select a Waterbody:
Oregon
Boxplot of cyanobacteria estimates (cells/mL) in waterbody on selected date:
Yakima
Richland
Kennewick
Walla Walla
Portland
Salem
Albany
Corvallis
Cyanobacteria (cells/mL)
Non-detect
6,311 - 13,000
13,000 - 25,000
25,000 - 50,000
50,000 - 100,000
100,000 - 200,000
200,000 - 400,000
400,000 - 800,000
800,000 - 1,000,000
1,000,000 - 3,000,000
3,000,000 - 6,000,000
> 6,000,000

Oregon DEQ R Shiny application

- Access to processed Sentinel 3 satellite data
- Processed identically to EPA CyAN (but without some of the filters)
- Regularly updated to get a running record for 'resolvable' waterbodies

DEQ
State of Oregon
Department of
Environmental
Quality

Select a Date:

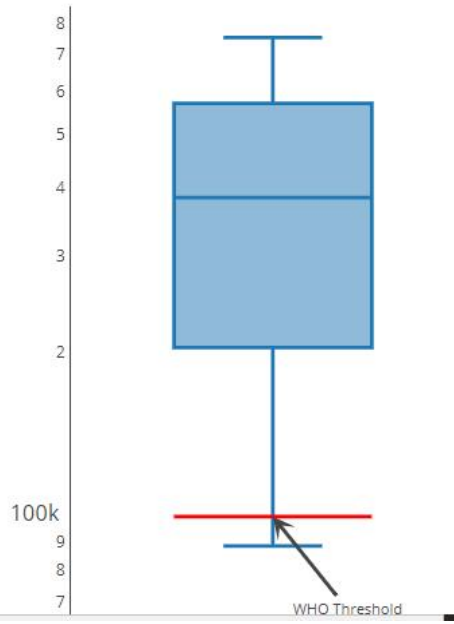
2020-05-27

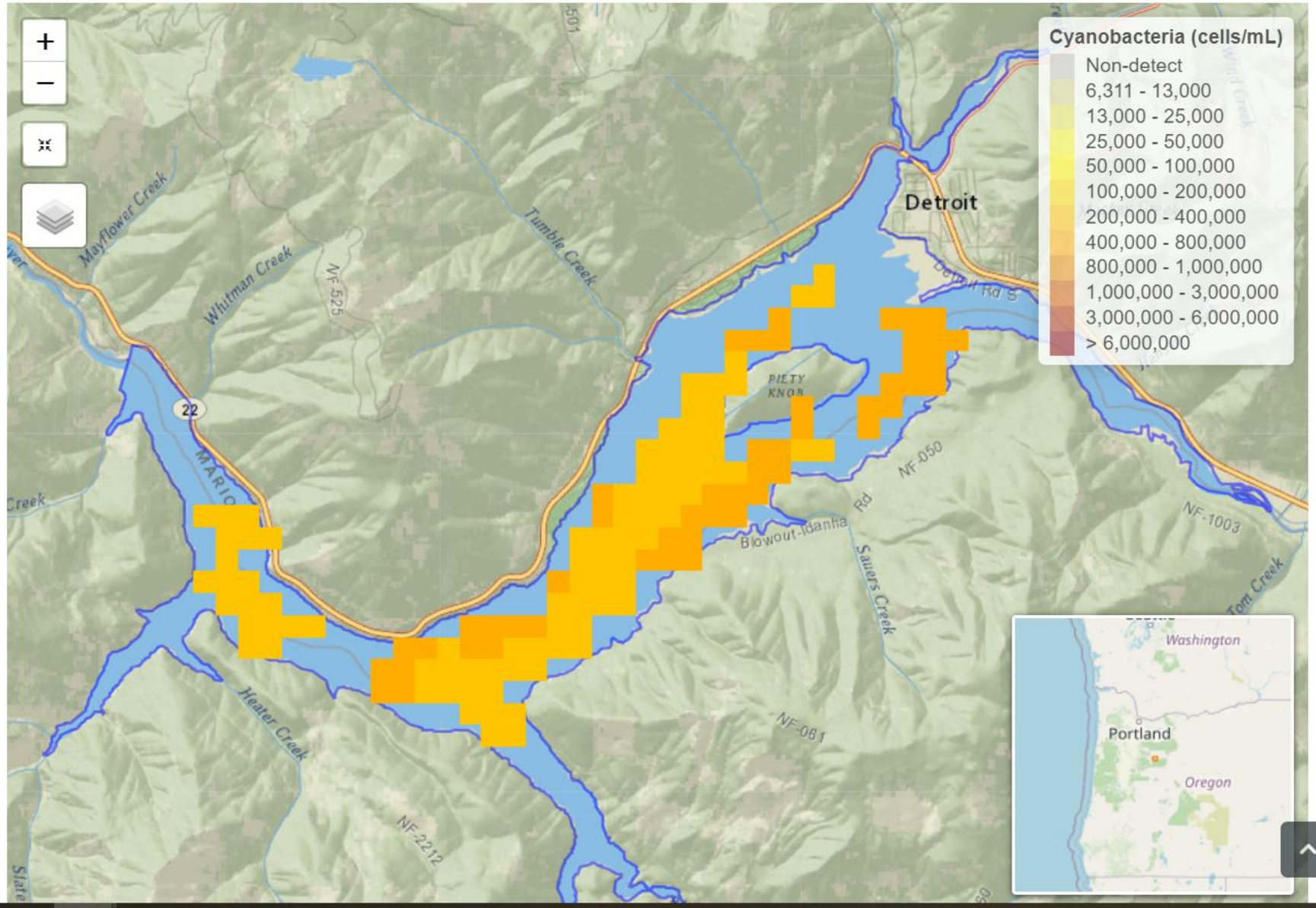
Select a Waterbody:

Detroit Lake_01639301

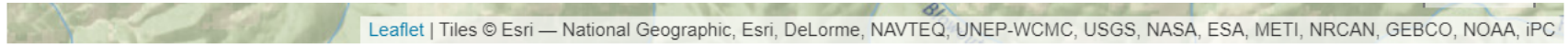
Public Drinking Water Source

Boxplot of cyanobacteria estimates (cells/mL) in waterbody on selected date:





DEQ
State of Oregon
Department of Environmental Quality



Date Range:

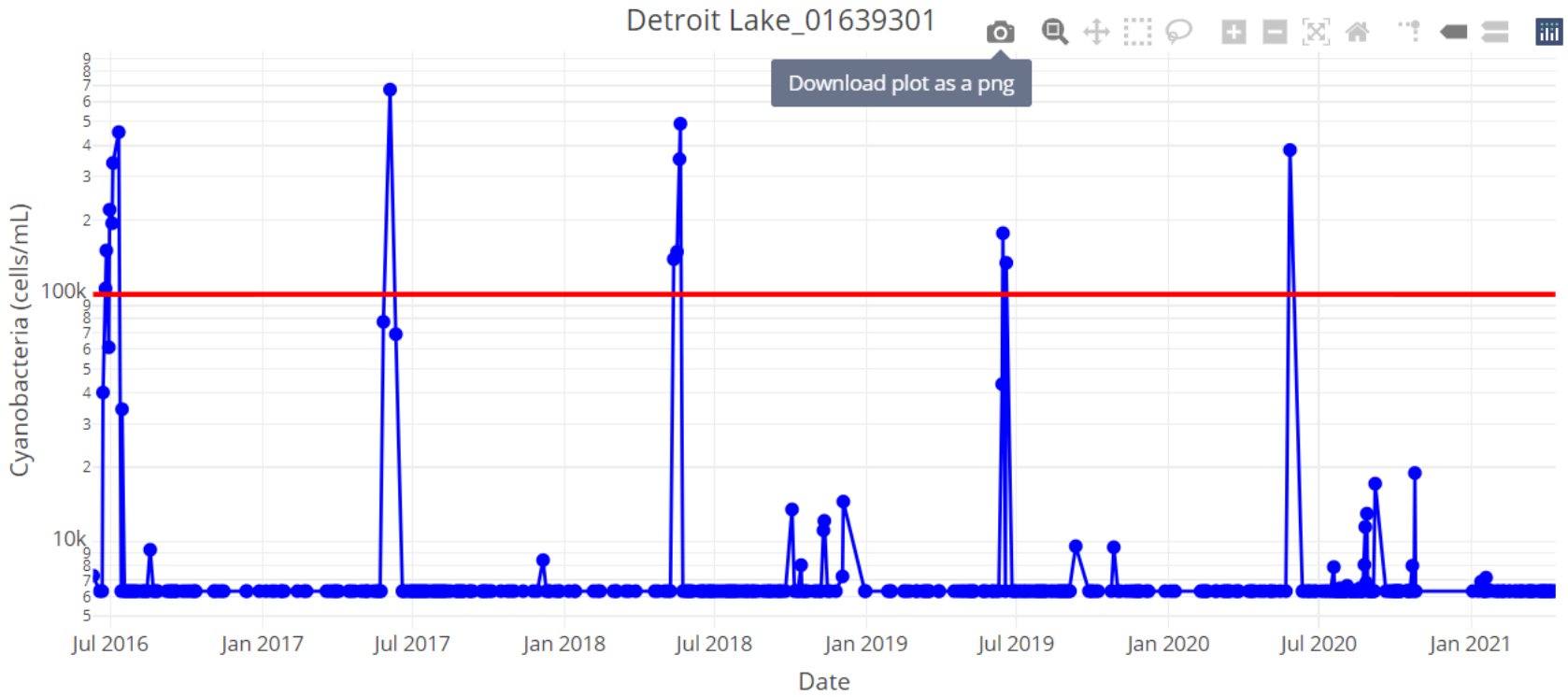
2016-06-07 to 2021-04-13

Summary Statistics:

- [ ] Maximum
- [x] Mean
- [ ] Minimum

y-axis:

- [x] Log Scale



DEQ
State of Oregon
Department of
Environmental
Quality

Next steps

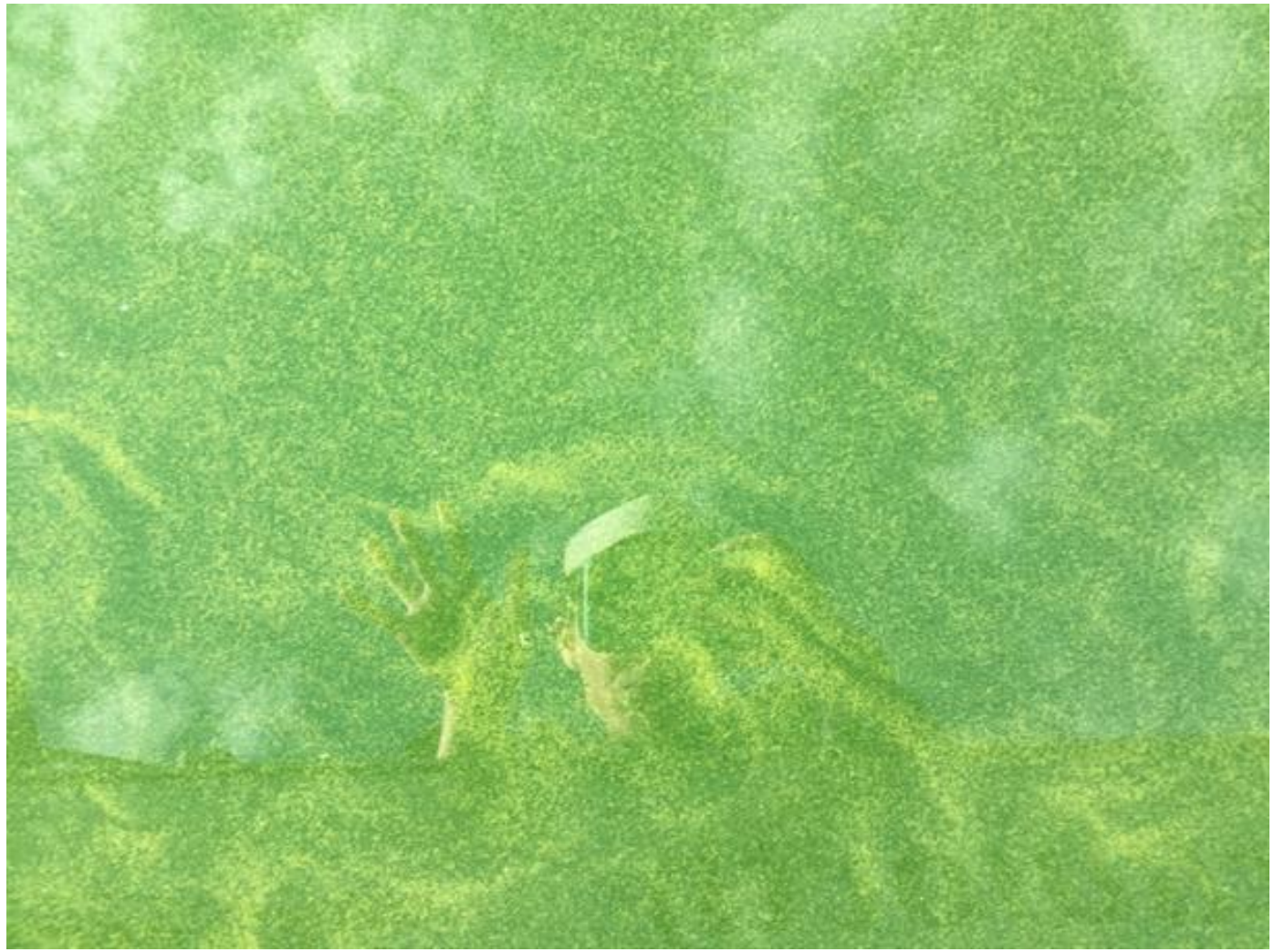
- Continue satellite – *in situ* comparison studies in the Deschutes (and elsewhere... such as in the Willamette)
- Make the DEQ R Shiny app available to a wider audience
- Compare satellite data with cyanotoxin and other relevant field measurements

DEQ
State of Oregon
Department of
Environmental
Quality

Questions?

Thanks to:

- Julie Harvey (DEQ)
- Gene Foster (DEQ)
- Josh Seeds (DEQ)
- Jacquie Fern (DEQ)
- Rebecca Hillwig (OHA)



Contact:

Dan Sobota
Oregon DEQ
Daniel.sobota@state.or.us

DEQ
State of Oregon
Department of
Environmental
Quality