

Status of Owasco Lake / Watershed 2022 Research

Owasco Lake Watershed Management Council
1-17-2023 Mtg

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Environmental Studies Program
Department of Geoscience
Finger Lakes Institute
Hobart & William Smith Colleges

Owasco Lake looking South



2022

Weekly Lake Surveys
Buoy Deployment
Dockside Sensors



- **Lake Monitoring**

- Lake Monitoring – Lake Water Quality
 - Increased to Weekly Surveys, May – Oct, Two Sites
- Cayuga County Support

- **Stream Monitoring by OLWA Volunteers**

- Stream Monitoring (2x Month, Grab Sample & Discharge)
 - Dutch Hollow, Long Pt, Sucker, Veness, & 3 Sites Owasco Inlet
- Analyses at Certified Lab, Upstate Freshwater Institute

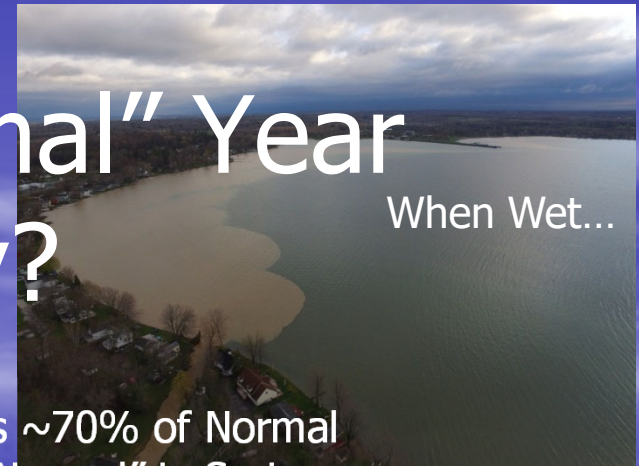


- **Buoy & Dockside Sensor Arrays**

- Deployment WQ & Air Monitoring Buoy, April - Nov
- Weather, Water Temperature & Photos at 4 Dock Sites, Aug-Oct
- Mesocosms, Macrophytes, Sediment Nutrient, Mussel Surveys
- Fred L. Emerson Foundation Support (3rd of 3 year award)
- Spectral Information of Cyanobacteria (County Support)

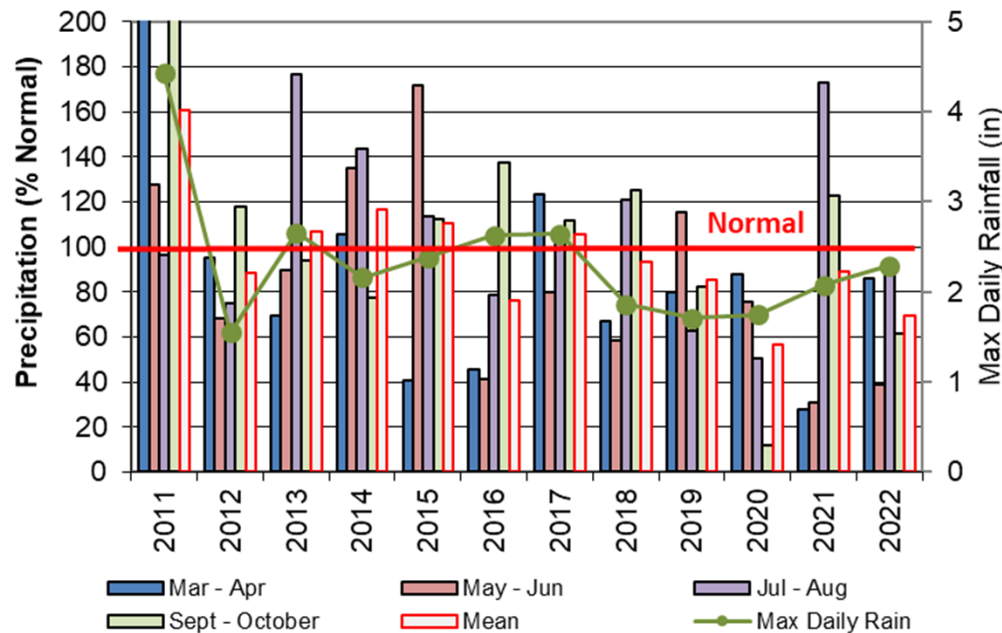


2022 Rain: A near "Normal" Year Impact on Water Quality?



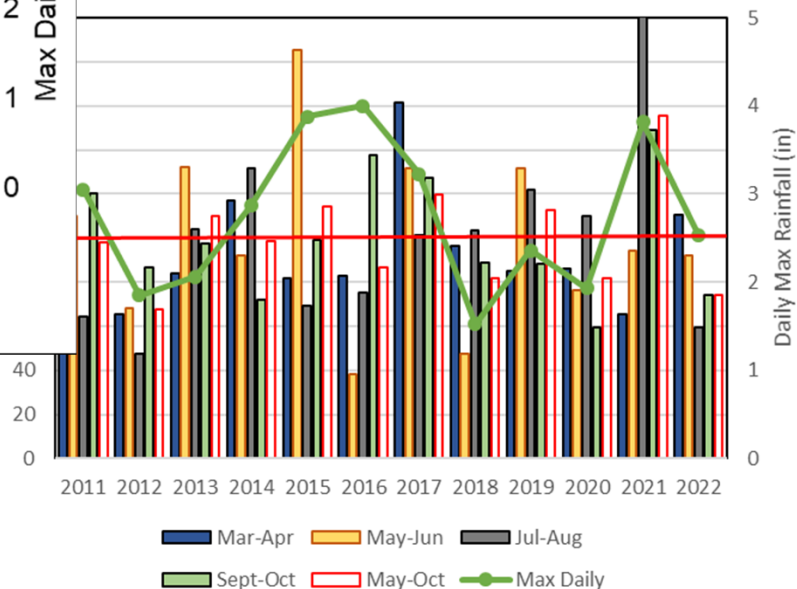
When Wet...

Seasonal Precipitation @ Ithaca Airport
2011-2022



Significant Regional Variability!
Especially largest events
→ Due to Global Warming

Seasonal Rainfall @ NY-CY-8



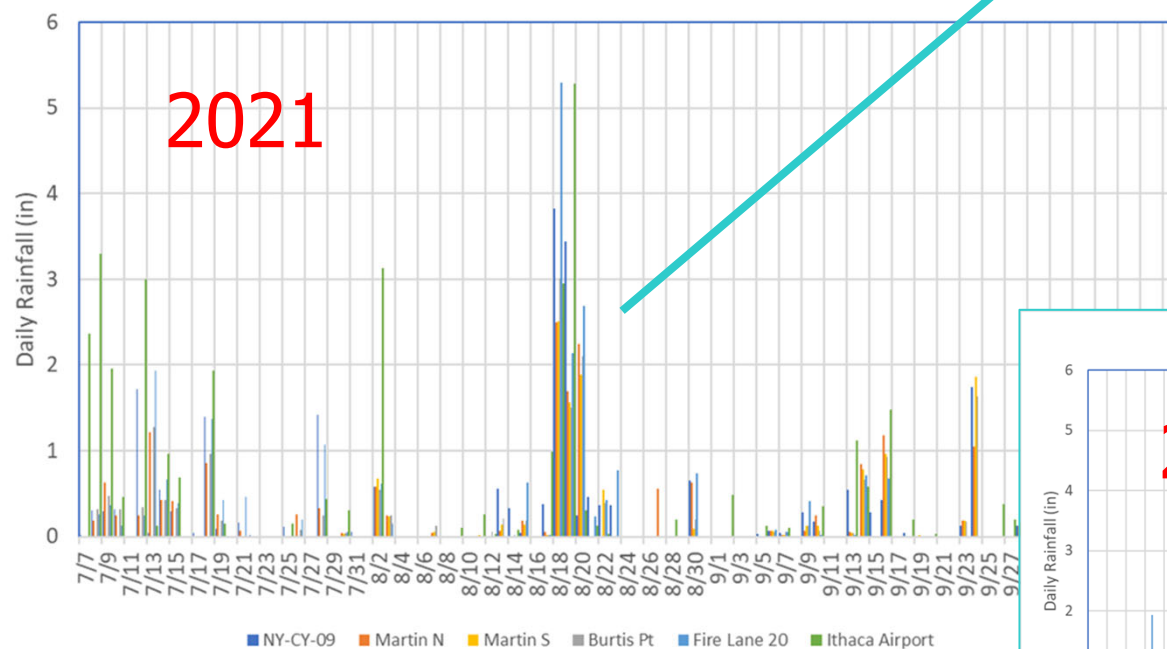
Events?

Nothing like 2021 Event

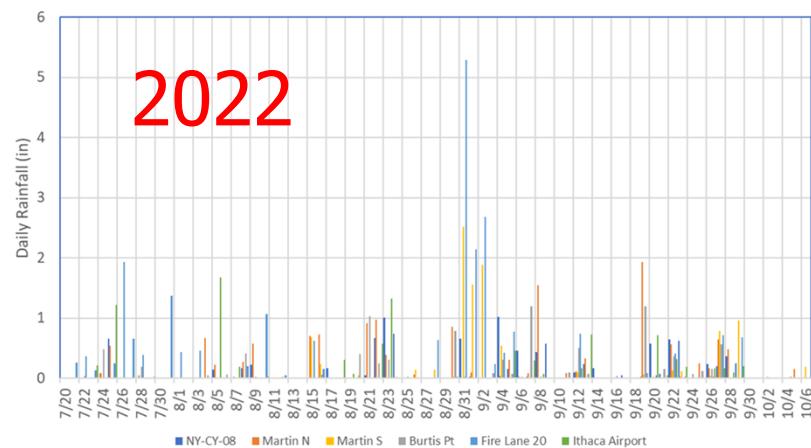
8/18/21 - 8/20/21



Daily Rainfall

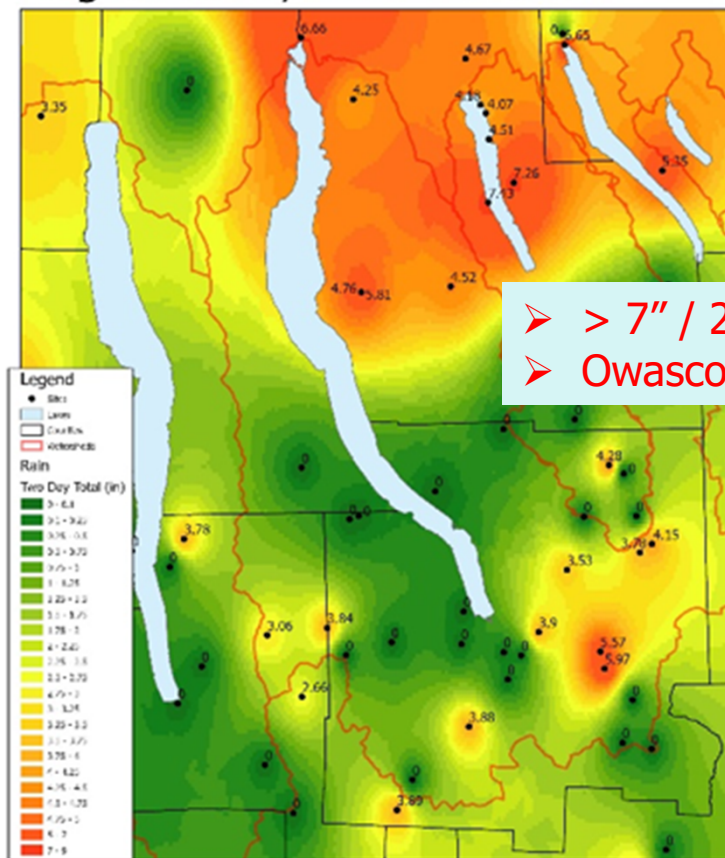


Daily Rainfall 2022 HABs Season



Rainfall Distribution – Variable, Localized & Intense

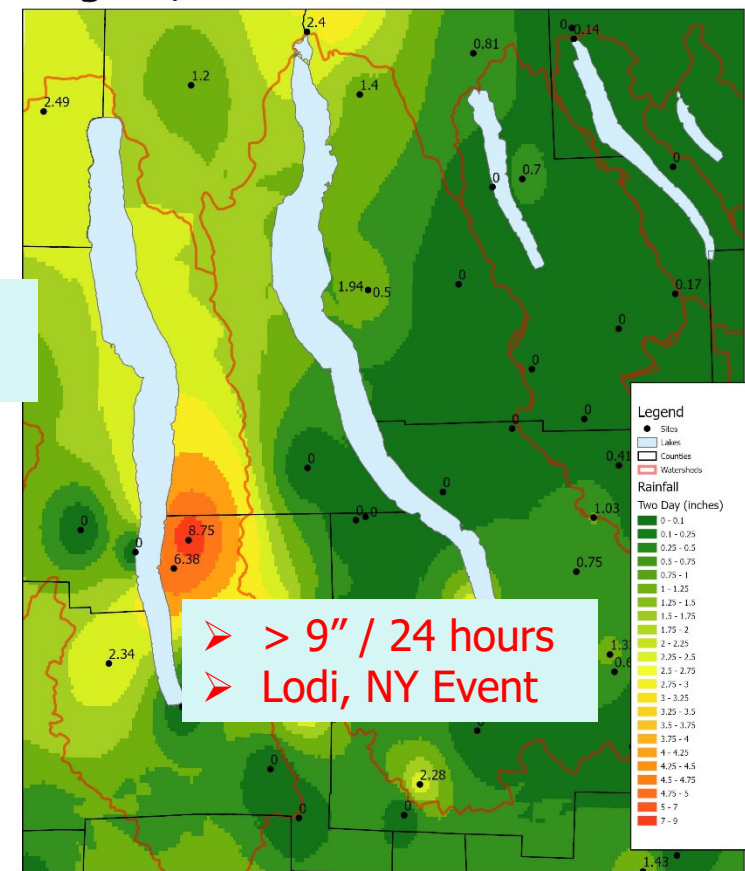
Aug 18 & 19, 2021 Rainfall



- > 7" / 24 hours
- Owasco Event

Aug 14, 2018

Lodi, NY Event



- > 9" / 24 hours
- Lodi, NY Event

Atmospheric Rivers Provide Extra Moisture Source – Climate Change

Colors show

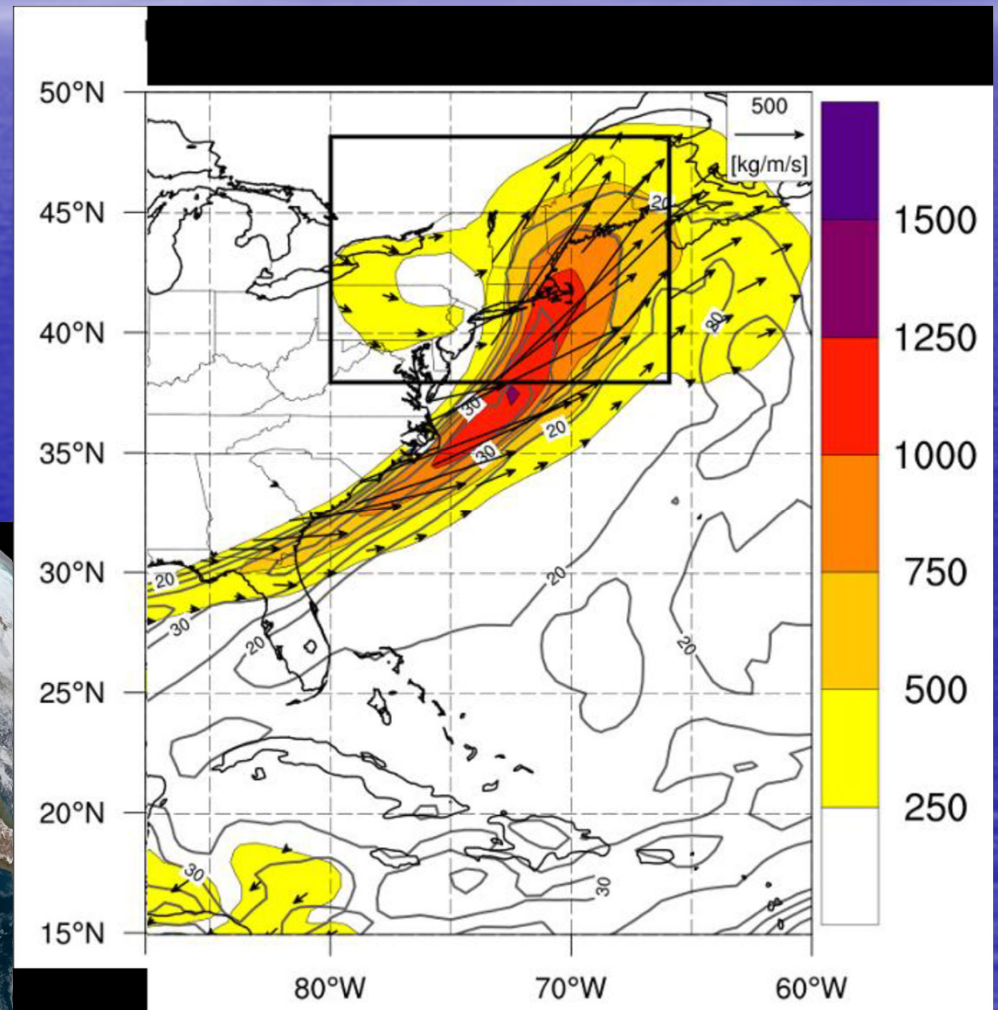
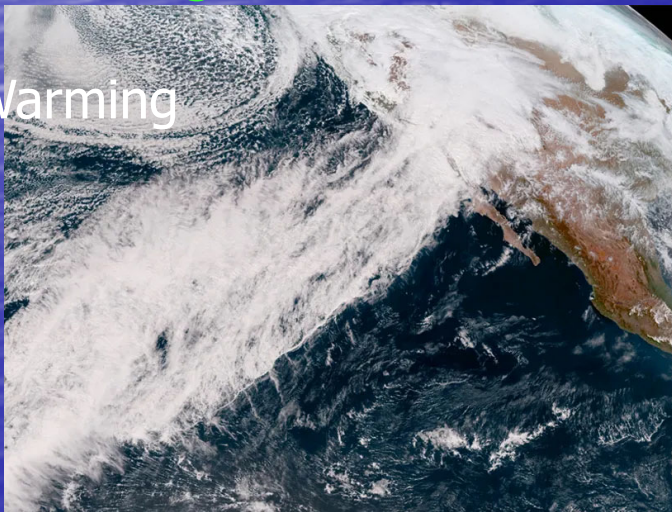
Integrative Vapor Transport (IVT)

AKA Atmospheric River

Moisture From Gulf & Atlantic to Northeast

2023 Rains Along West Coast

Global Warming

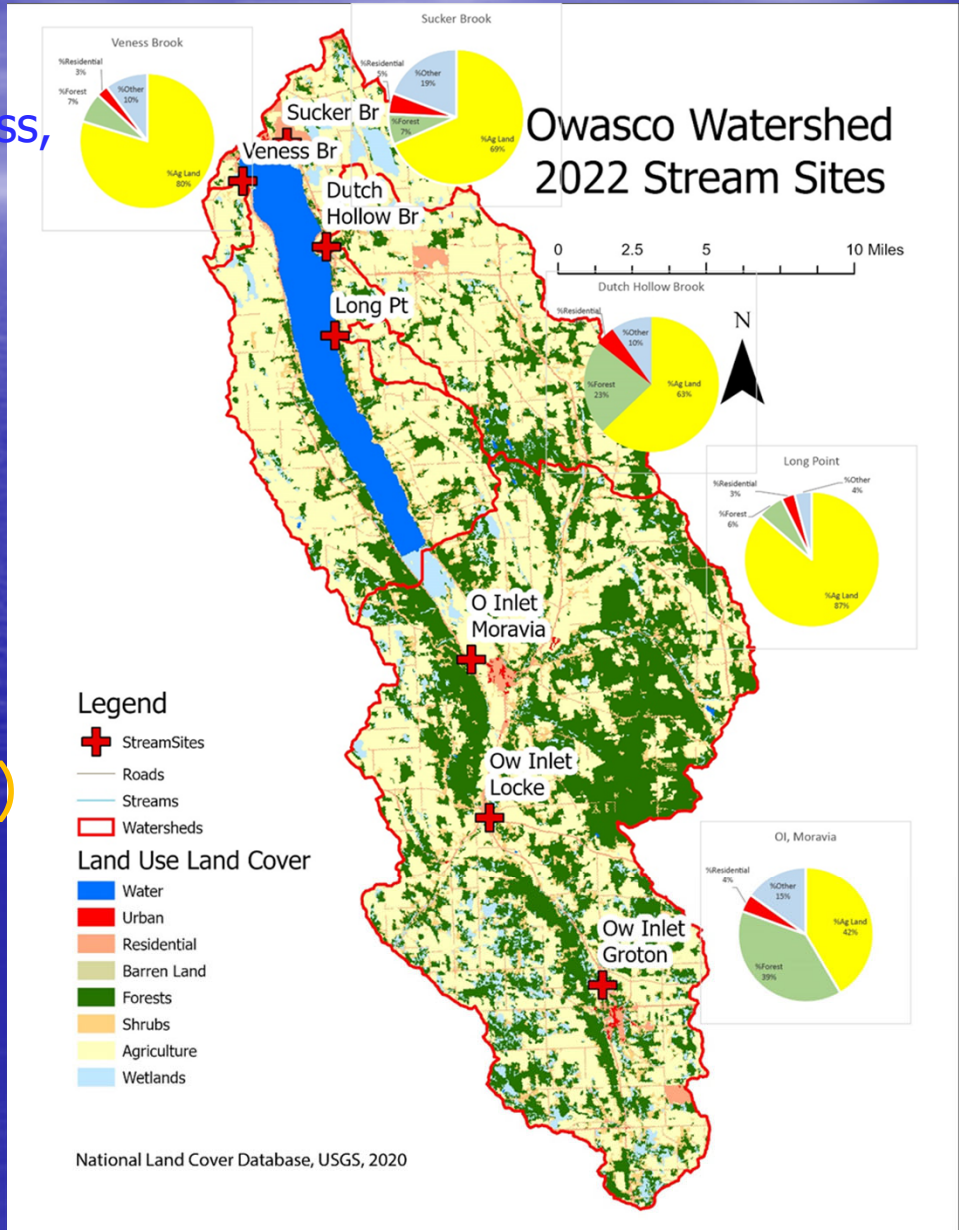


Nutrient Sources - Streams

OWLA Volunteers

Sites: Dutch Hollow, Long Pt, Sucker, Veness,
3 Sites along Owasco Inlet

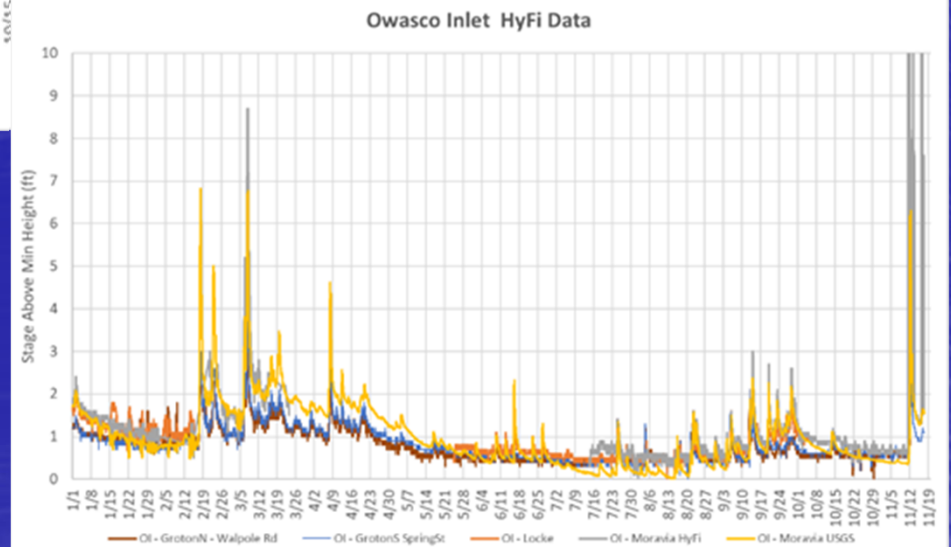
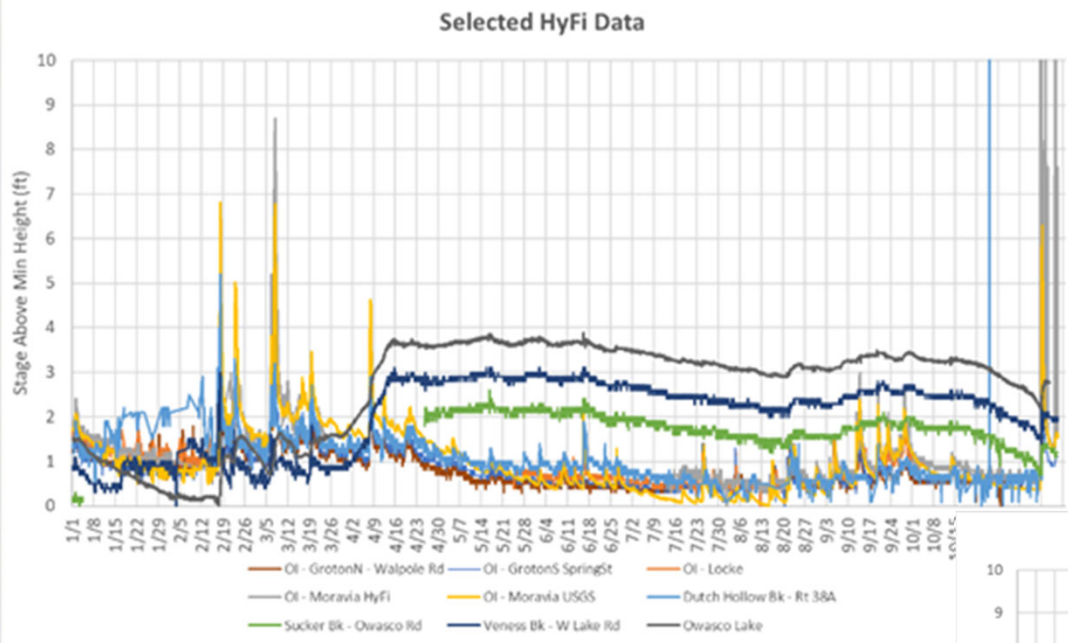
- Stream Monitoring
 - Grab Samples
 - Site Selection - Diversity
 - Watershed Size
 - Watershed LULC
 - Sampled 2x Month
 - May - October
- Certified Lab Analyses (UFI)
 - Phosphorus
 - TP, TDP, SRP
 - Nitrogen
 - TN, NO_x, NH₄
 - Total Suspended Solids



HyFi Sensors – Stream Stage

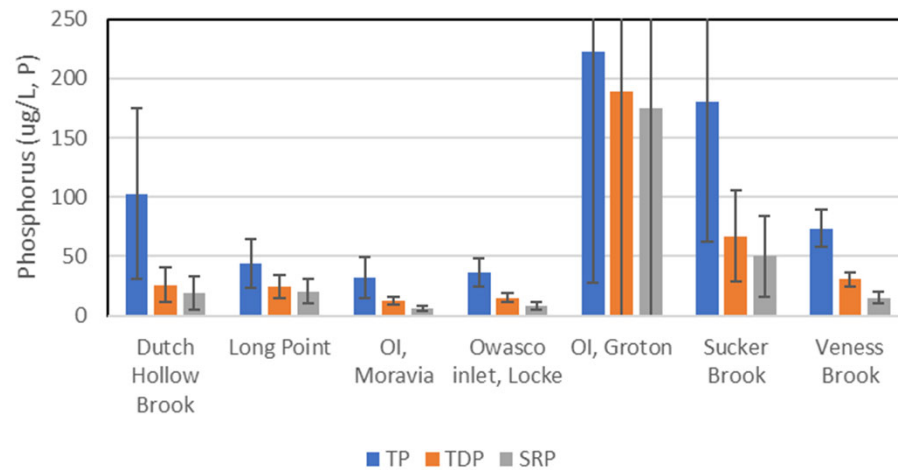
Issues:

- Veness Cr & Sucker Cr Measured Lake Levels
- Otherwise HyFi records looked sound
- Single Velocity Measurement Tentative for Discharge



Nutrient Concentrations

Phosphorus - Annual Averages

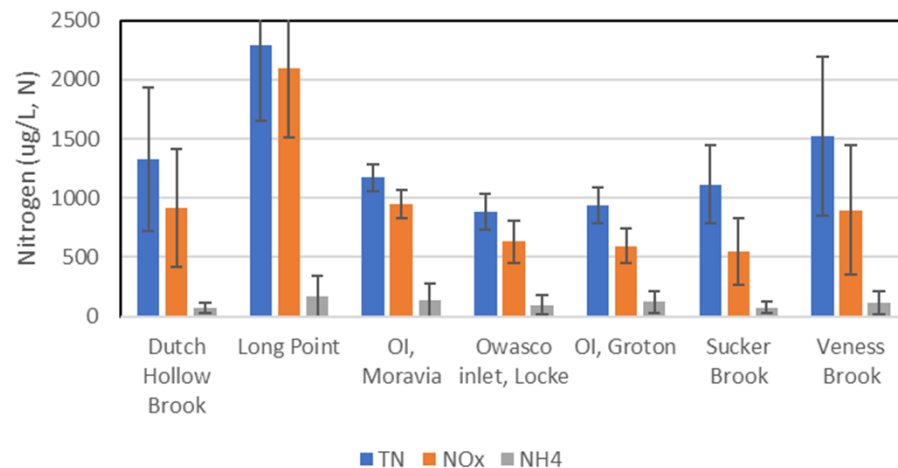


Similar Conc. to Past Data

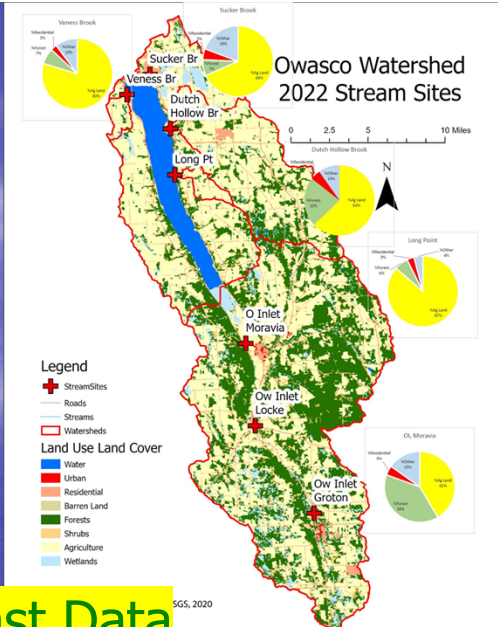
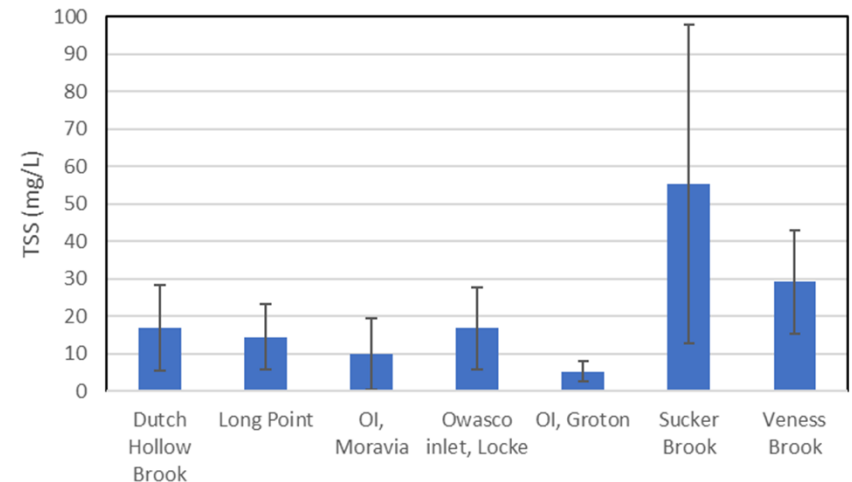
P highest Groton, MWWTF Source
Diluted Down Stream

N Highest Long Pt, Agricultural Runoff

Nitrogen - Annual Averages

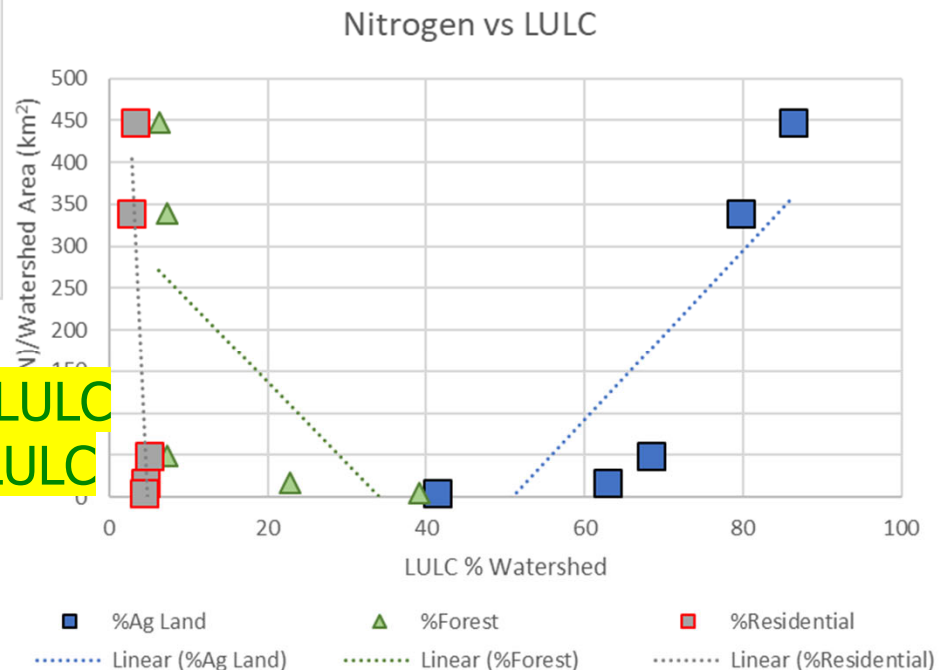
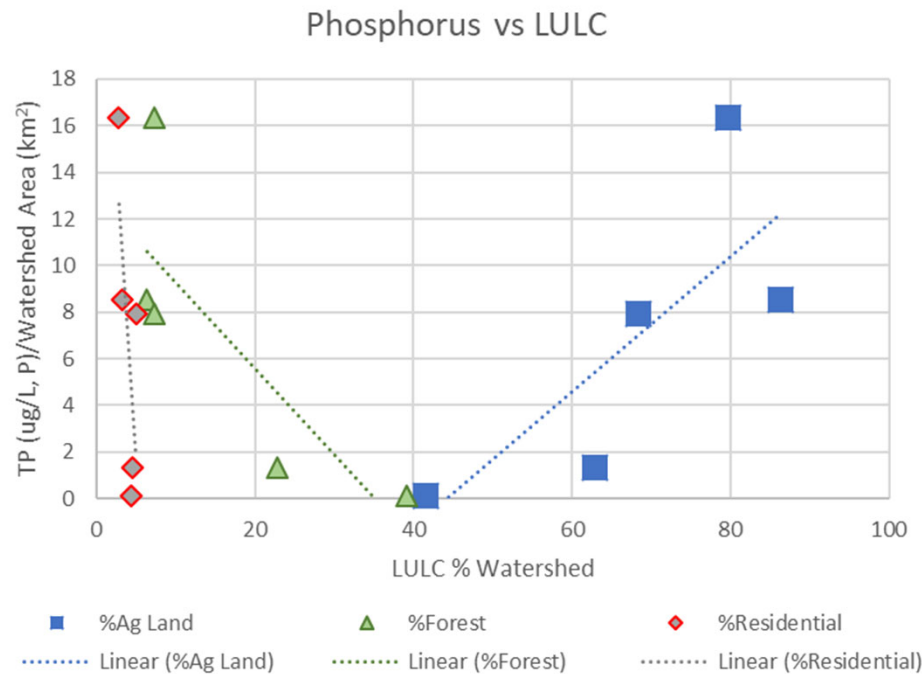
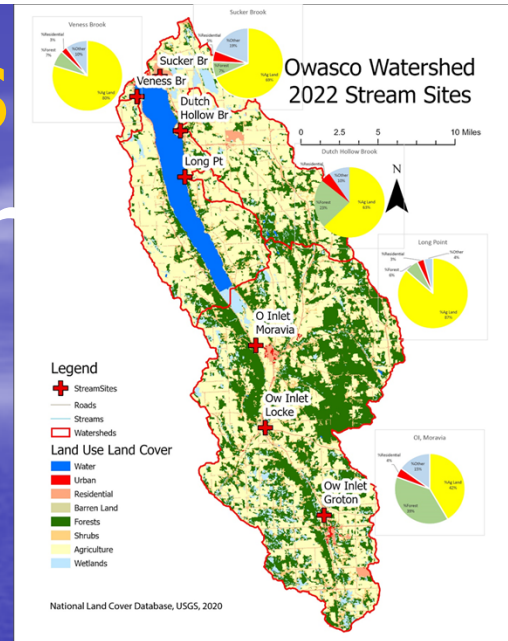


Total Suspended Sediments - Annual Averages



Nutrient LULC Connections

Mean Conc / Watershed Area



Nutrient & TSS Delivery ~ Agricultural LULC

Nutrient & TSS Delivery ~ 1/Forested LULC

Unclear Urban & Residential...

Parallels 9E Plan Results

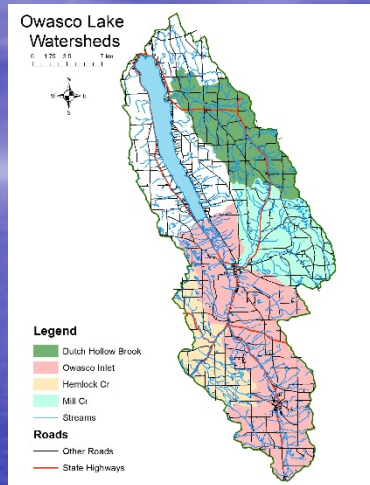
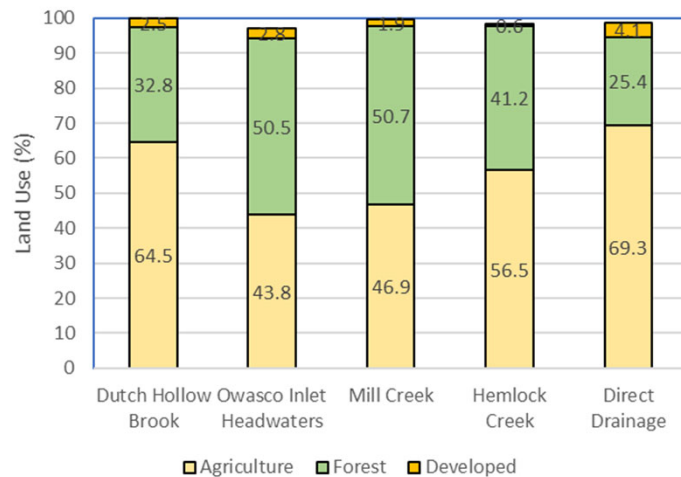
Implications for Remediation

Paralleled 9E Plan SWAT Model Results

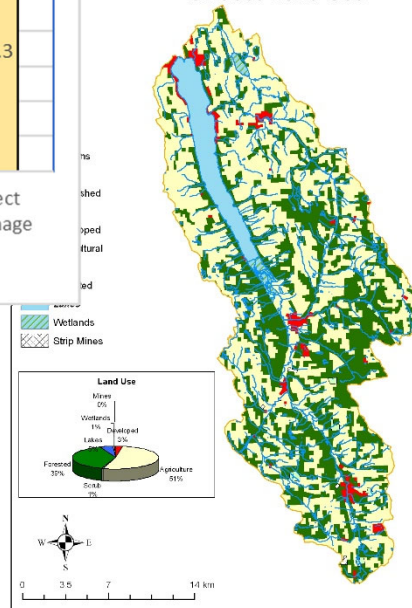
Landscape:
50-50 Agricultural &
Forested Land!

~90% TP Loads From:
Agricultural Land!

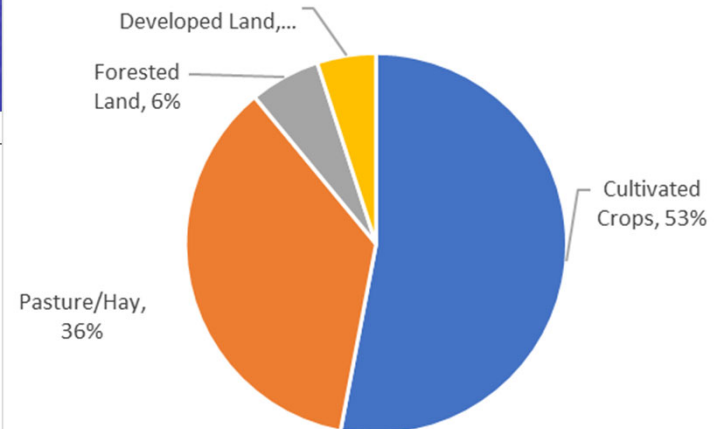
Land Use in Selected Basins



Owasco Land Use



Total Phosphorus Loads



TP Loads On Per Acre Basis:
Agricultural Land >> Forests

Phosphorus Budget

Past Decade

No 2022 Data

Before 2016

Inputs >> Outputs

2016 - 2020

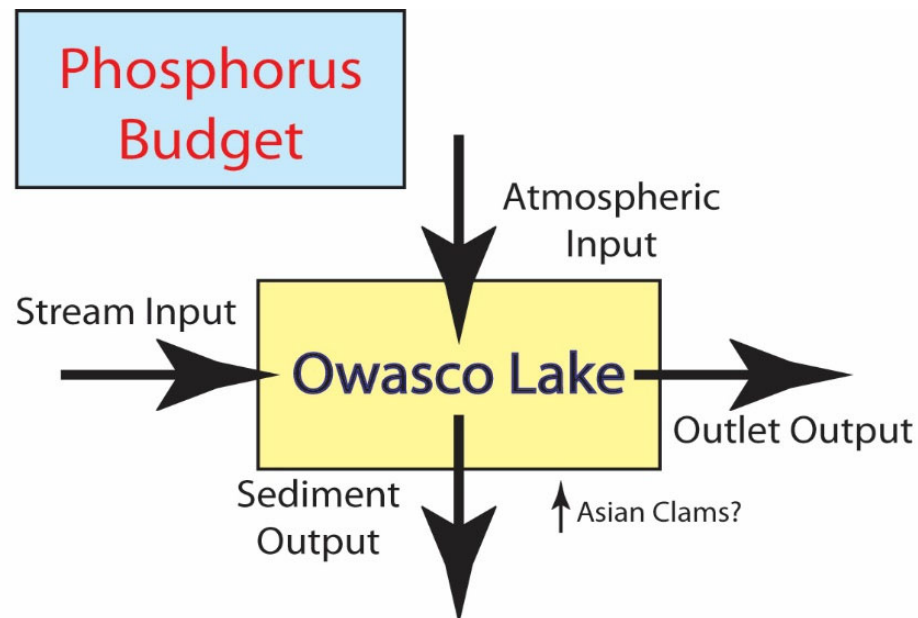
Inputs ~ Outputs

Were Remediation Efforts
Working?

HOWEVER, Disappointed
Lake Water Quality
LACKED Improvement!

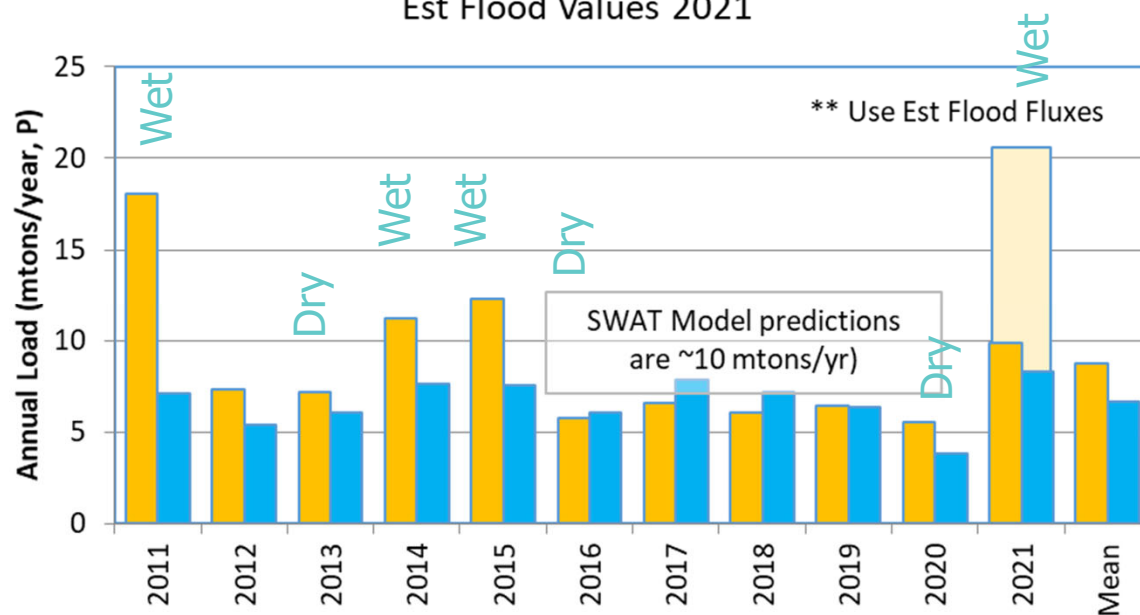
2021

Inputs >> Outputs
8/18 Event > 50% Load!
Future Climate?



Phosphorus Estimated Inputs & Outputs

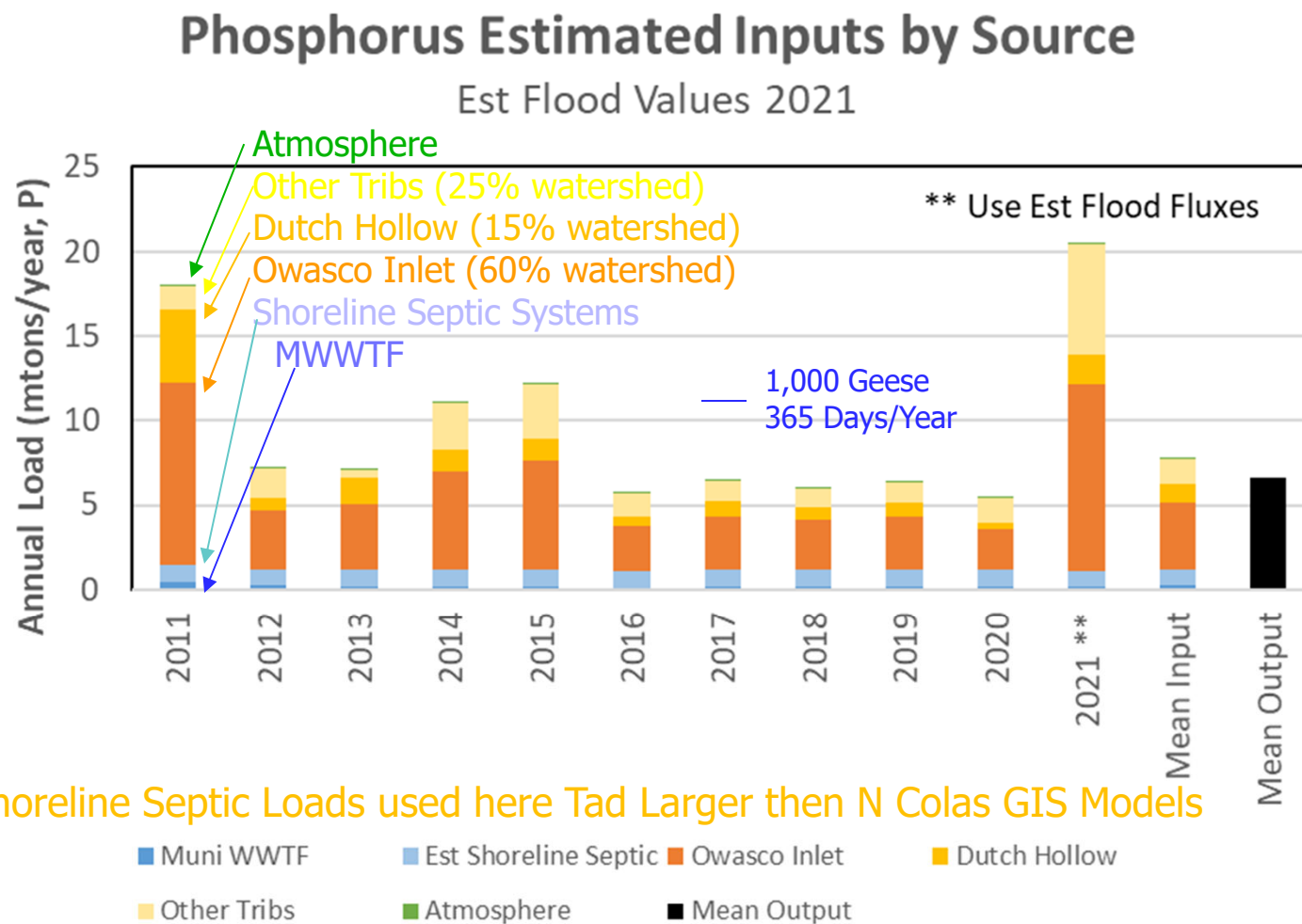
Est Flood Values 2021



Loads by Source

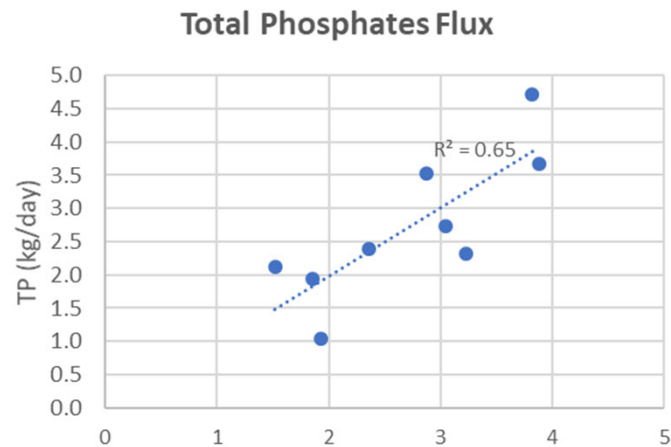
Majority From Rain Events

Rainfall Varied from Year to Year

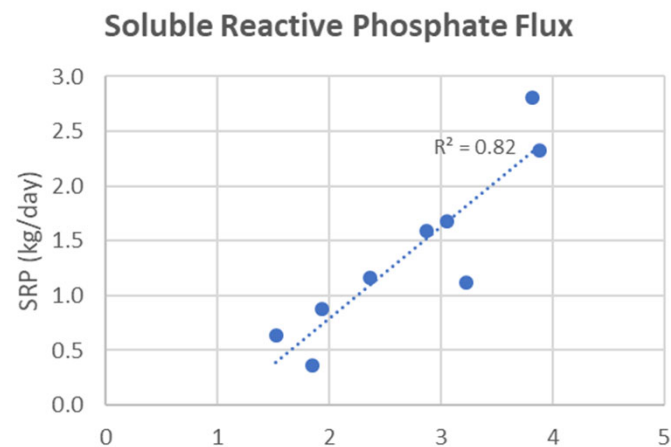


Rain's Impact on Streams

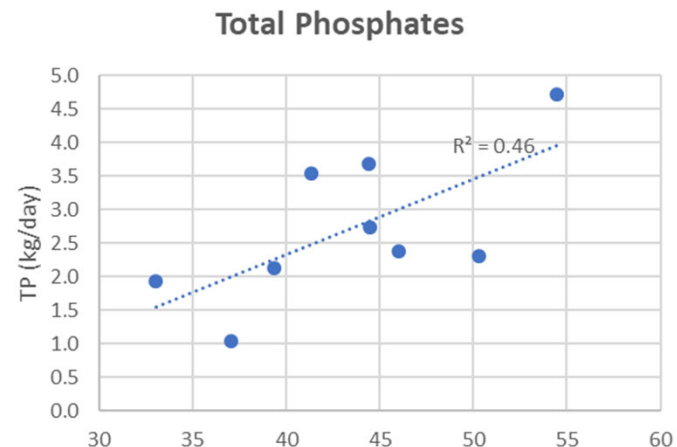
Mean Annual DH Fluxes vs. Total - Max Daily Rainfall



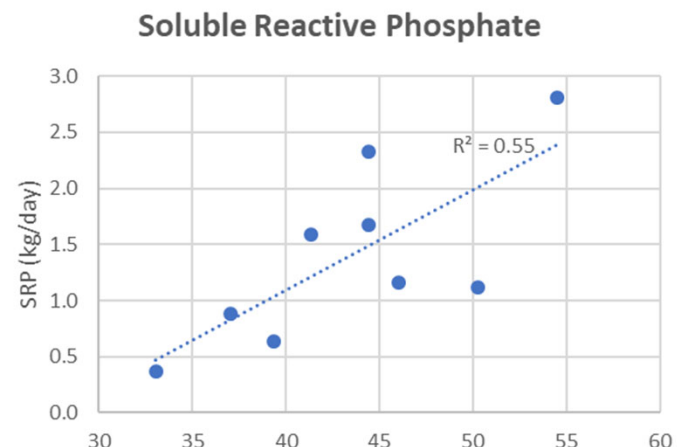
Maximum Daily Rainfall



Maximum Daily Rainfall



Total Rainfall

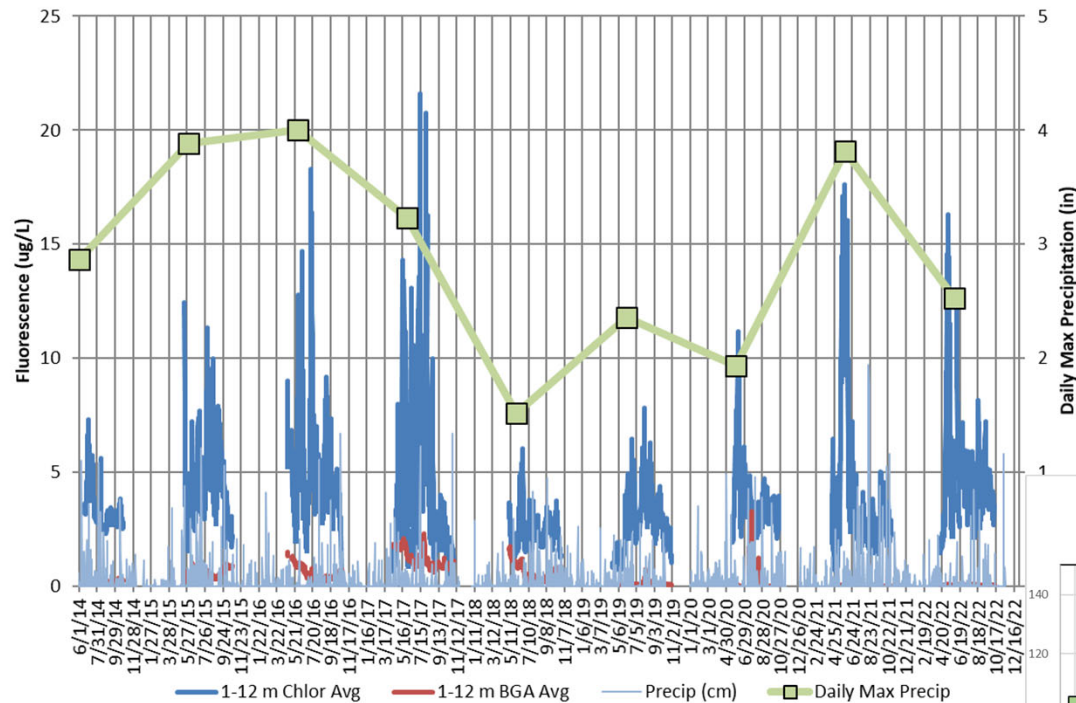


Total Rainfall

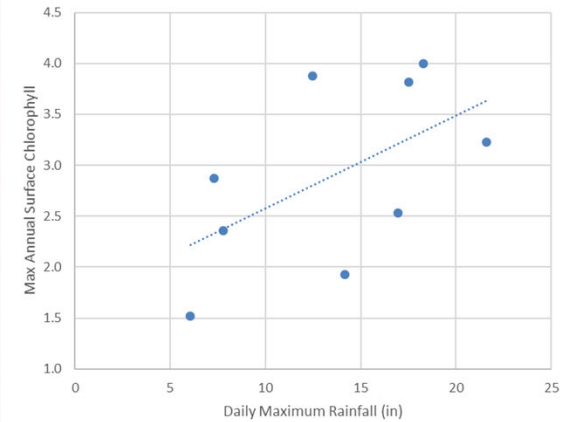
Rain's Impact on Lake

Algae & Dissolved Oxygen vs. Max Daily Rainfall

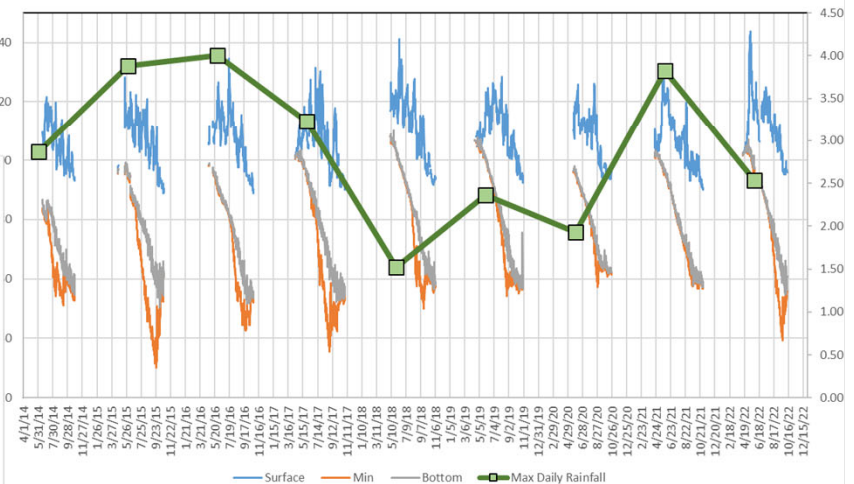
Owasco 1-12 m Average Fluorescence, 2014-22



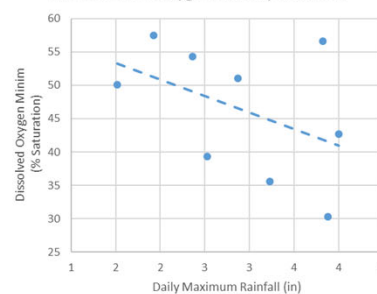
Annual Max Chloro vs Max Daily Rain



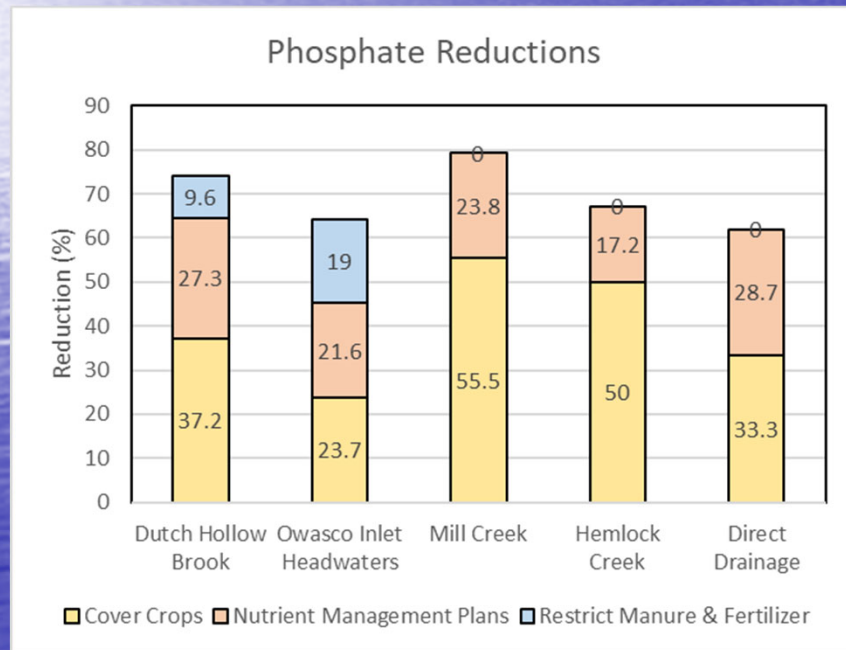
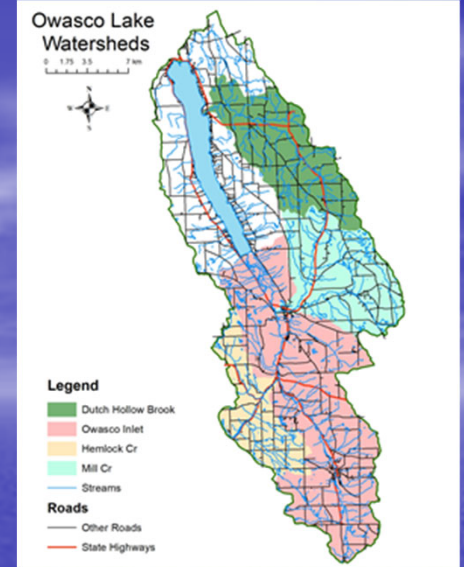
Dissolved Oxygen %Saturation
2014 - 2022



Min Dissolved Oxygen vs Daily Max Rain



9E Plan SWAT Model Threefold TP Reduction Strategies



Three Critical Remediation Strategies:

- Winter Cover Crops
- Nutrient Management Plans
- Restrict Manure & Fertilizer Use

~60-70% P Reductions

Critical Future Work

- Implement **Revised** Rules & Regulations!
- Implement **Recommendations** in 9E Plan
- Investigate **Loads** from Roadside Ditches & Drainage Tiles
 - Roadside Ditches & Drainage Tiles
 - Unquantified Importance in Owasco Watershed
 - Literature Suggests Important Source
 - Some studies suggest otherwise
 - Time to Reduce Debate
 - Roadside Ditches & Drainage Tile Example Remediation
 - Phosphorus Binding at Drain Tile Outlets
 - Hydro-seed & Catch Basins along Roadside Ditches
 - Bioreactors
 - Removes & Recovers P



Owasco Inlet Turbidity Plume

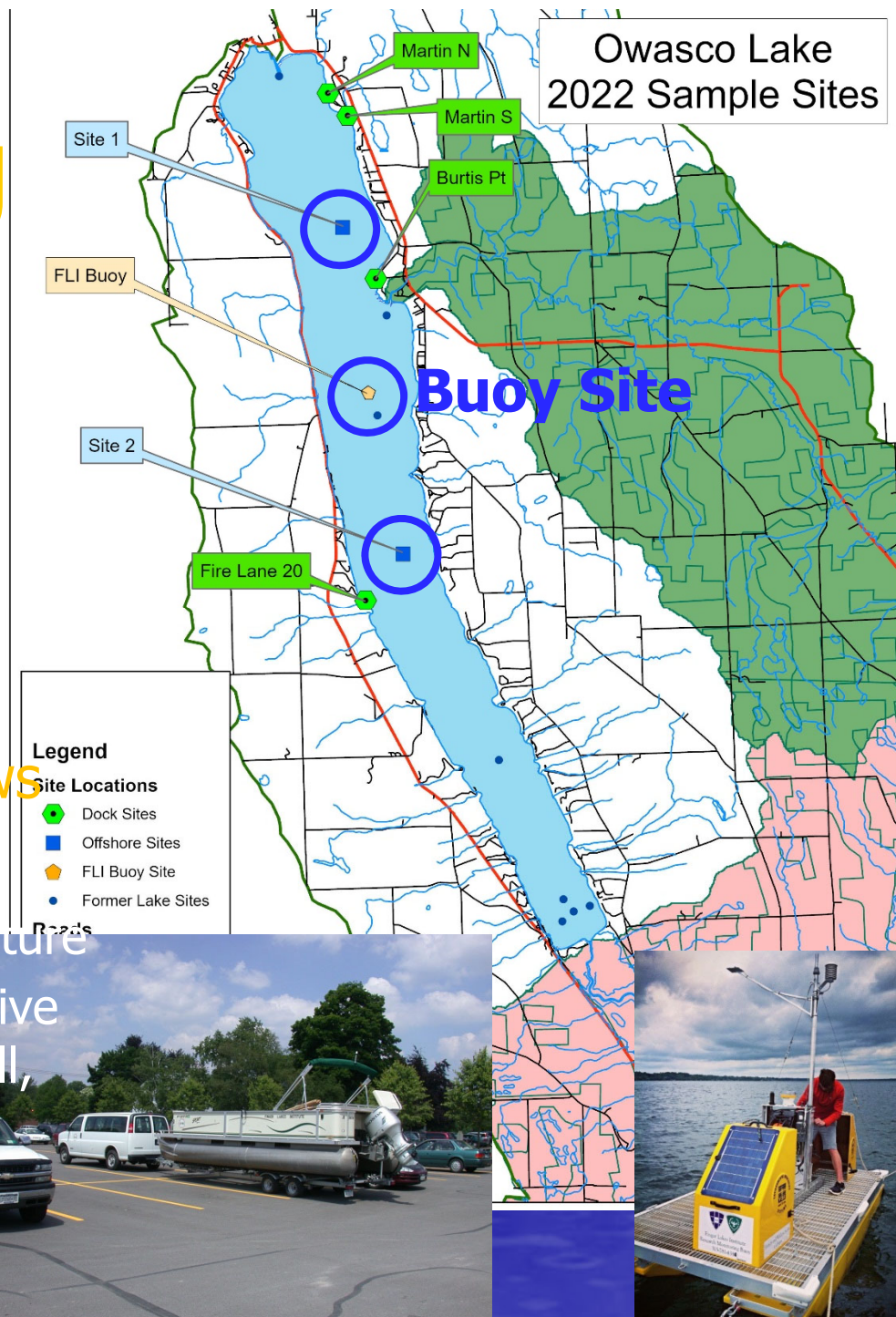
Veness Bk Turbidity



Joe Leonardi, by permission

Lake Monitoring

- Sites 1 & 2
 - Representative of Open Lake
- CTD Casts
 - Temperature & Conductivity
 - DO & pH
 - PAR, Fluorescence & Turbidity
- Secchi Depth & Plankton Tows
- Surface & Bottom Water
 - DO, pH, Conductivity, Temperature
 - Total Phosphate, Soluble Reactive Phosphate, Nitrates, Chlorophyll, Total Suspended Solids
- Spectral Signature of Water



Early Season Issues Required Repairs to Buoy Floats



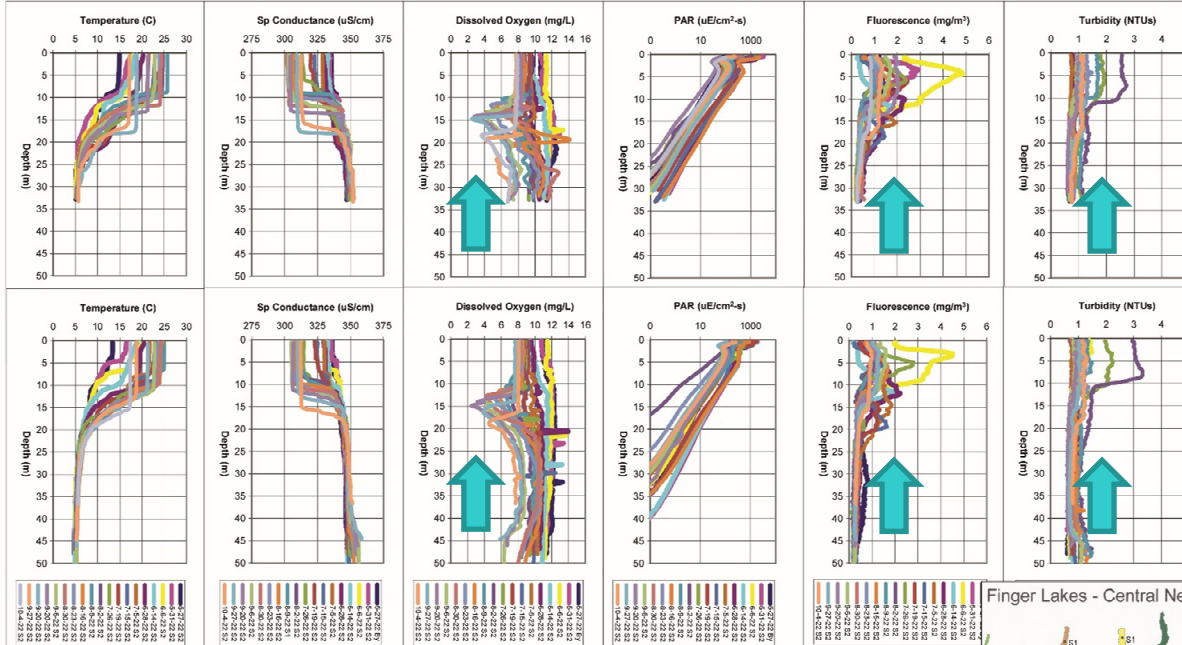
Patched Round Holes Found in Float Top
If noticed in future – let FLI know. Hate to lose \$150,000

2022 CTD Profiles

Near Normal Year
Spring Rains

Owasco Lake 2022 Data

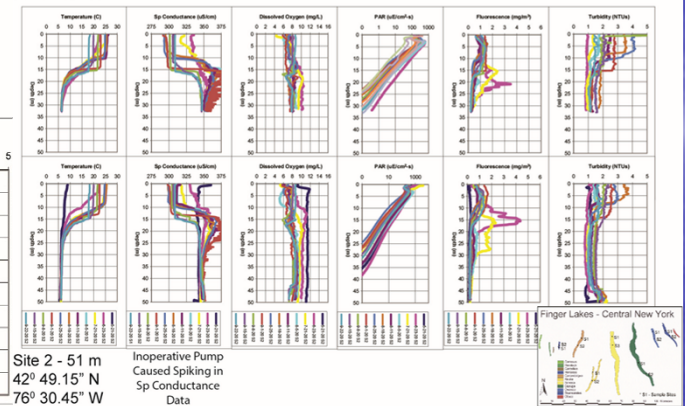
Site 1 - 34 m
42° 52.4" N
76° 31.35" W



Site 1 - 34 m
42° 52.4" N
76° 31.35" W

Owasco Lake 2020 Data

Dry

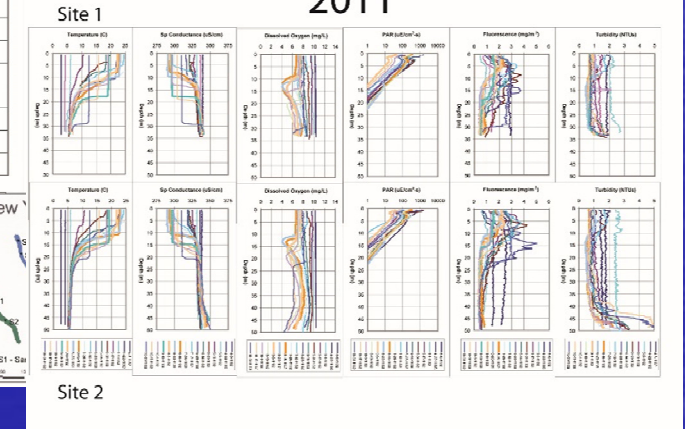


Site 2 - 51 m
42° 49.15" N
76° 30.45" W

Inoperative Pump
Caused Spiking in
Sp Conductance
Data

Owasco Lake 2011

Wet

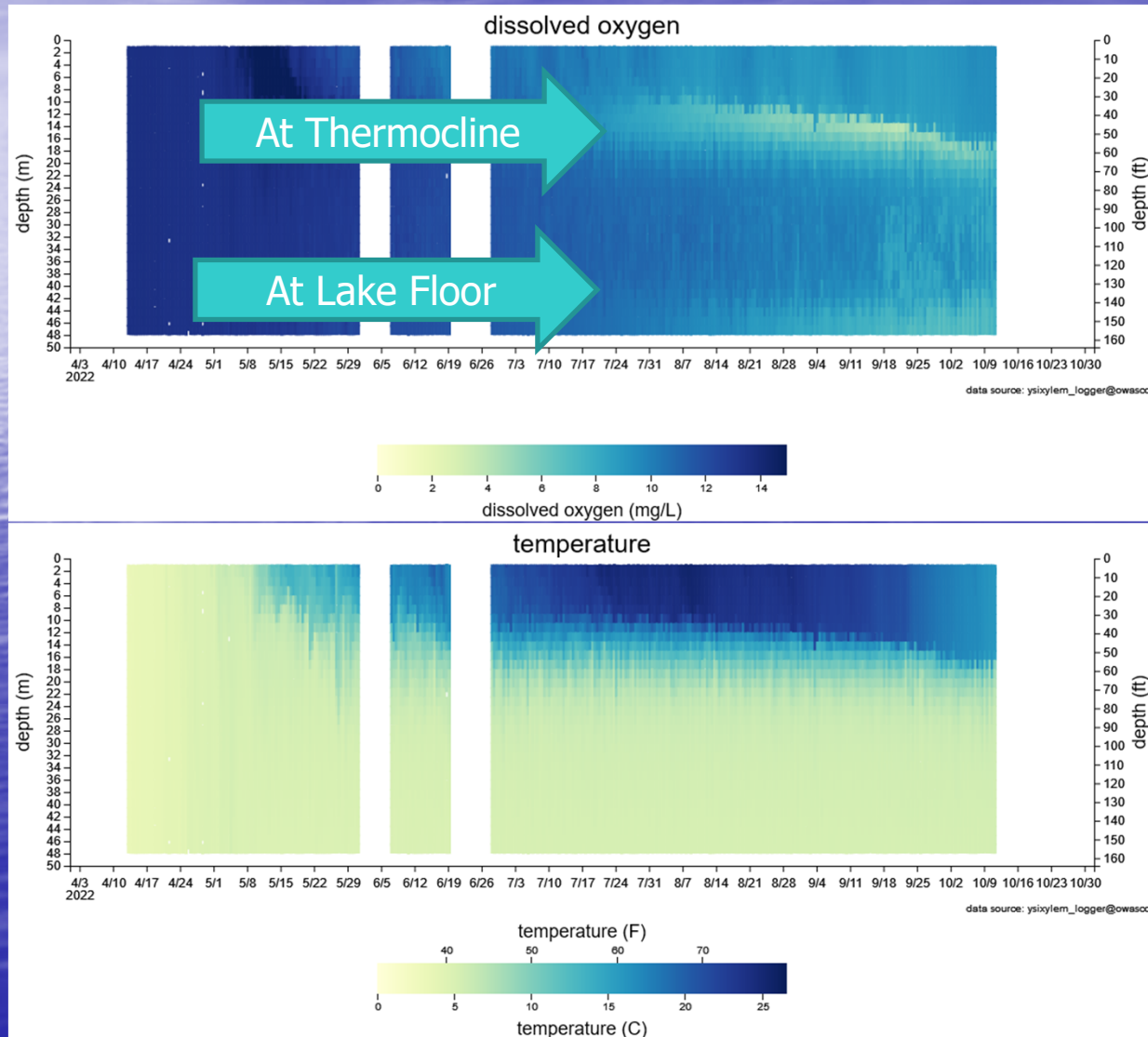


Site 2



Warm Temps (Global Warming)
Similar Sp Conductance, PAR
Depletion of Dissolved Oxygen – **More Algae in Epilimnion**
Epilimnetic Fluorescence – **More Algae in Epilimnion**

Dissolved Oxygen Depletion



Dissolved Oxygen depletion from bacterial decomposition of algal matter and other organics

Uses Dissolved Oxygen Releases Nutrients

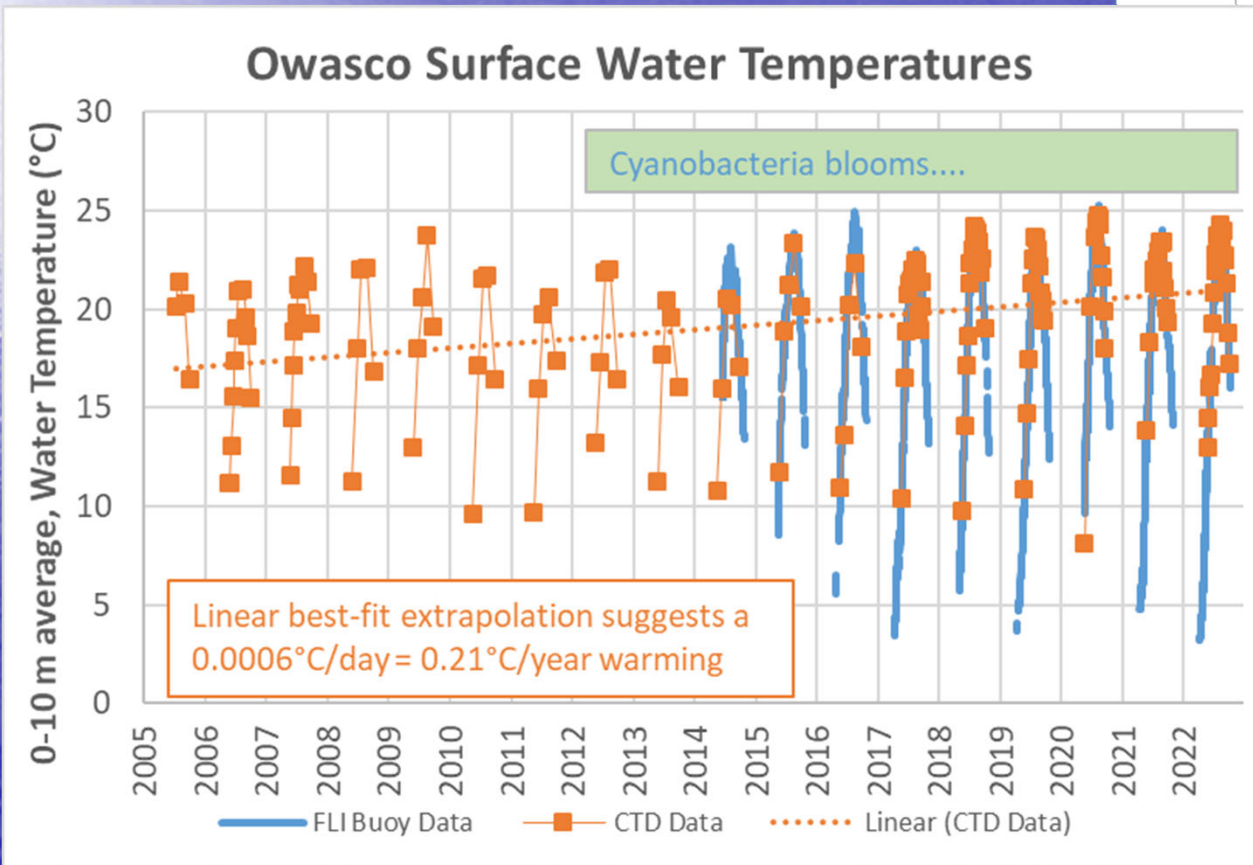
Typically trapped in Hypolimnion

Surface Water Temperatures

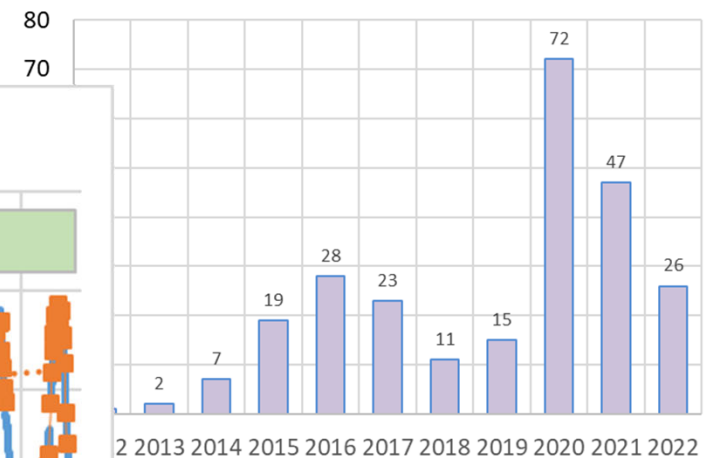
Warmer Water → More HABs?

Not Perfect Match

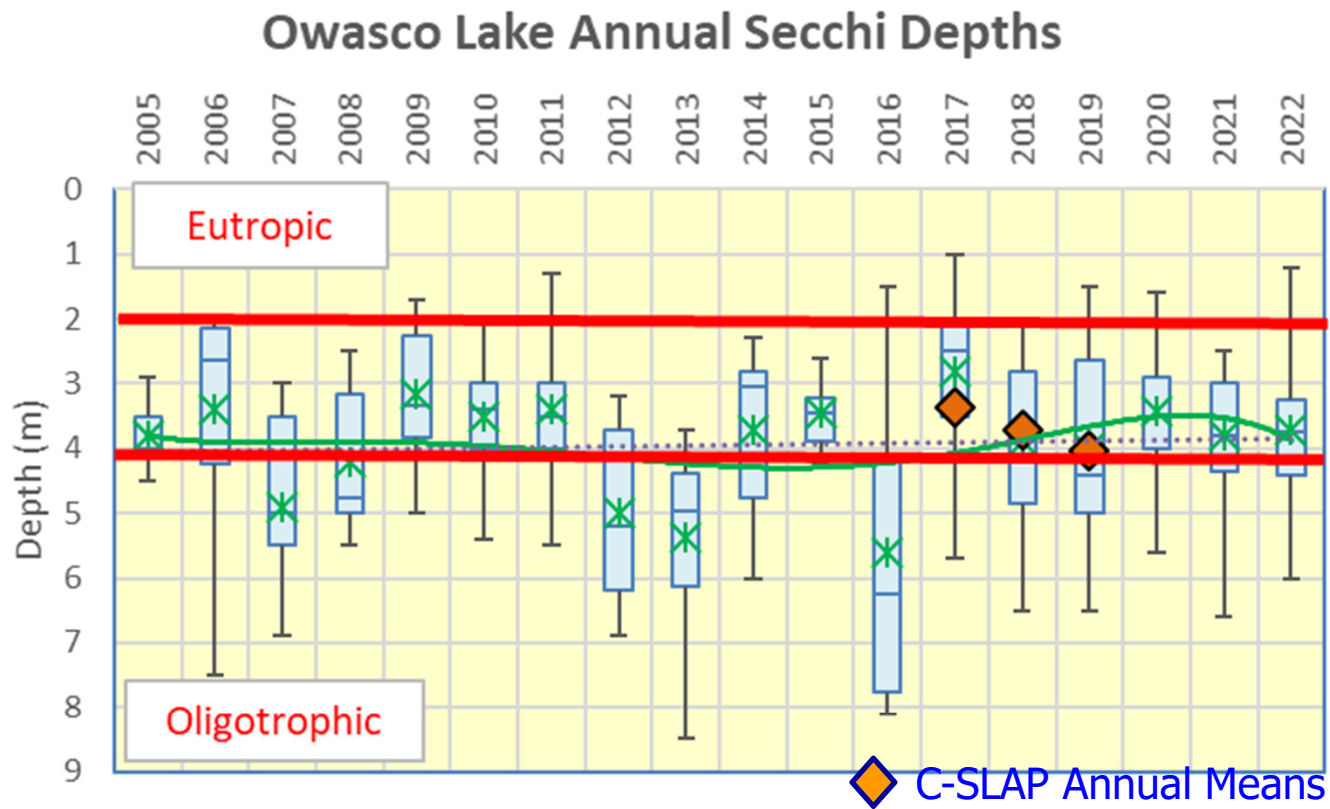
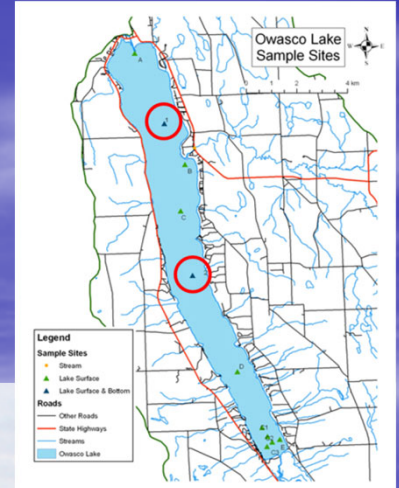
Pushed Lake over Threshold...



Cyanobacteria Blooms - Owasco Lake



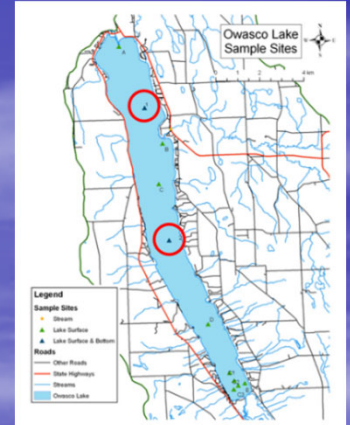
Secchi Depths



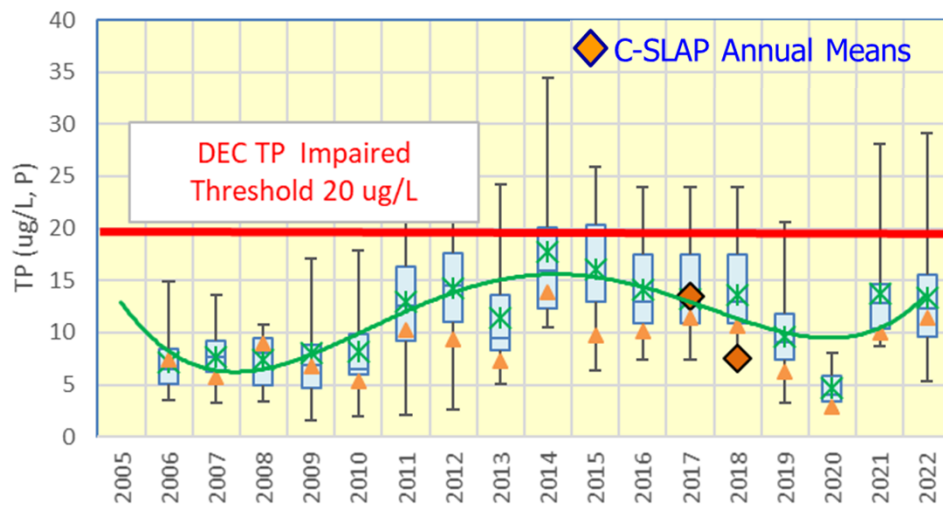
Water Quality Improvement?



Phosphate & Chlorophyll Concentrations



Owasco Annual Surface Total Phosphate



High TP:-

Phosphate \rightarrow 13.3 $\mu\text{g/L}$

Similar:-

P:N Ratio \rightarrow 1:1,000 (mass)

P: Limiting Nutrient

Near Normal Year

Trophic Status (Mesotrophic)

Secchi Depths – 3.7 m Mesotrophic

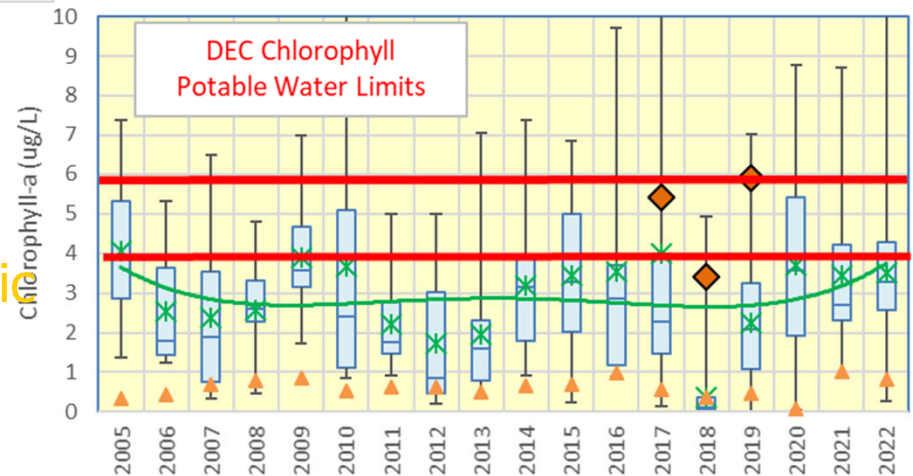
Nitrate – 0.7 mg/L Oligotrophic

Total Phosphate – 13.3 $\mu\text{g/L}$ Mesotrophic

Chlorophyll a – 3.8 $\mu\text{g/L}$ Oligotrophic

Oxygen – 20% Saturation Mesotrophic

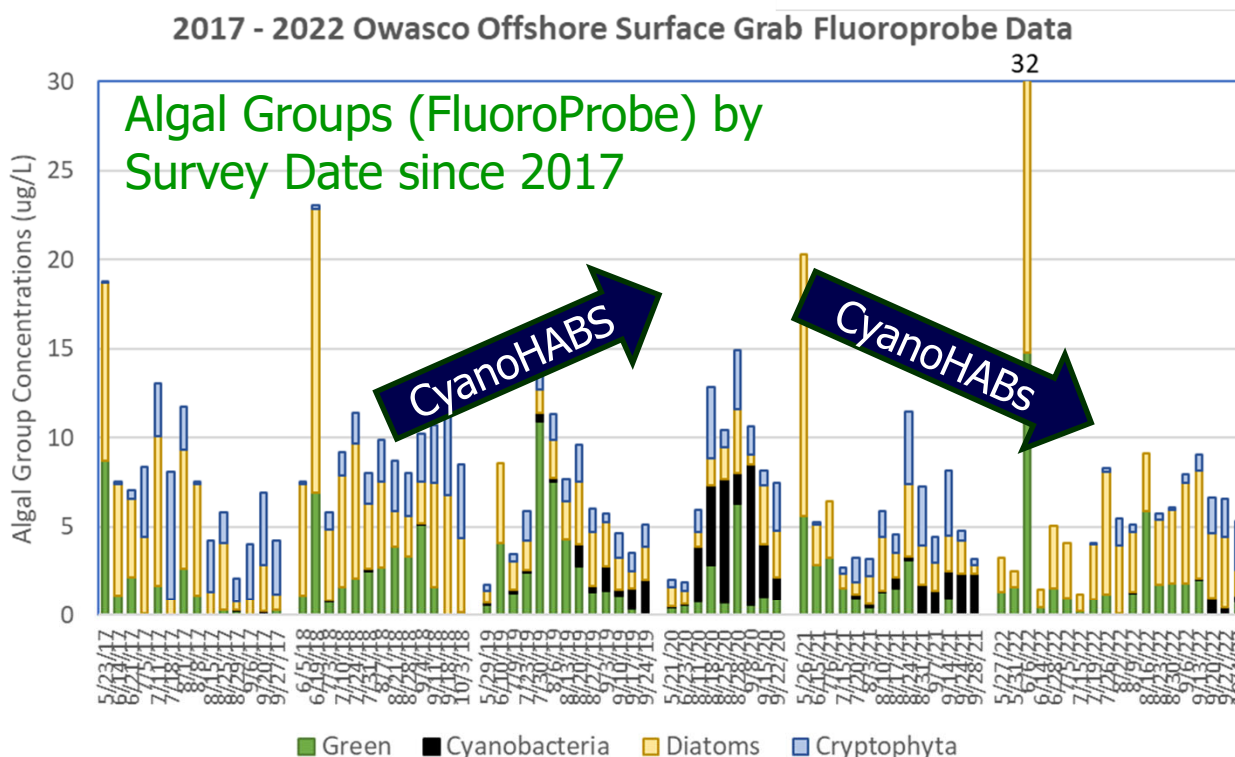
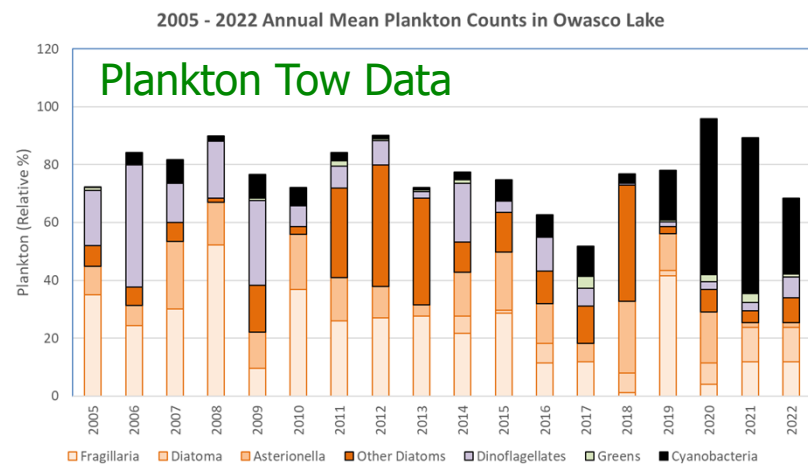
Owasco Annual Surface Chlorophyll-a



Plankton

Fluoroprobe & Plankton Tows

Annual Average
Plankton



FluoroProbe Measures

Brown
Diatoms
Green
Green Algae
Blue-Green
Cyanobacteria
Red
Cryptophytes
Yellow Subs.

HABs less
Dominant
August -
November

Decrease in
BGA compared
to previous
years

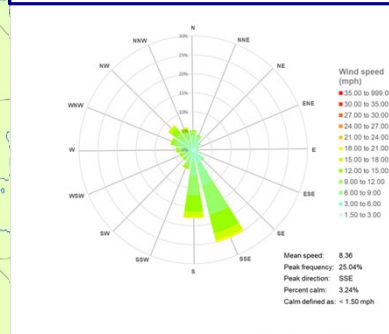
Decrease in Surface Water HABs in Open Lake is **interesting ...**
Winds/Waves moved Nearshore HABs in 2020?

Cyanobacteria

No 2022 BGA/HABs Conc. Data

Owasco Lake
2022 HABs Locations

Buoy Wind Direction



Legend
HABS Events
Dates Deected

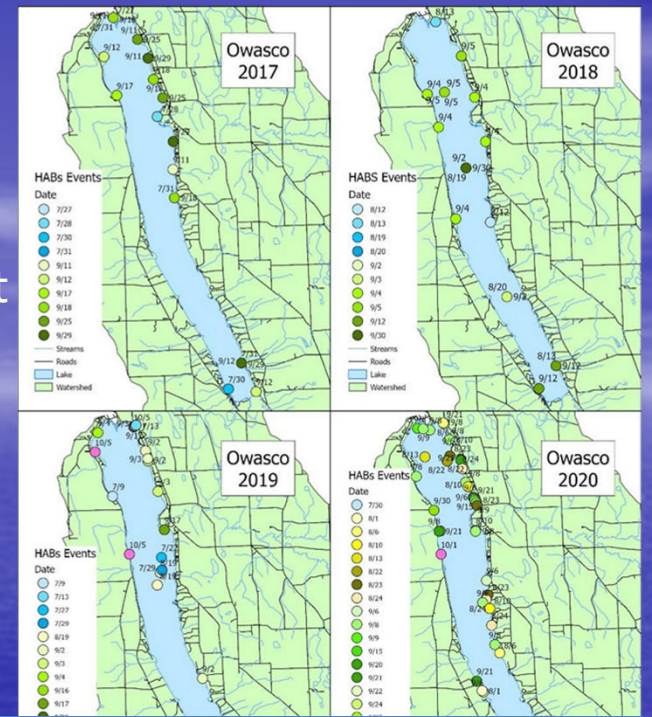
- 8/9
- 8/17
- 8/25
- 9/9
- 9/14
- 9/17
- 9/18
- 9/20
- 9/24
- 9/30
- 10/3
- 10/11
- 10/12
- 10/24
- 10/28

Streams
Roads
Lake
Watershed

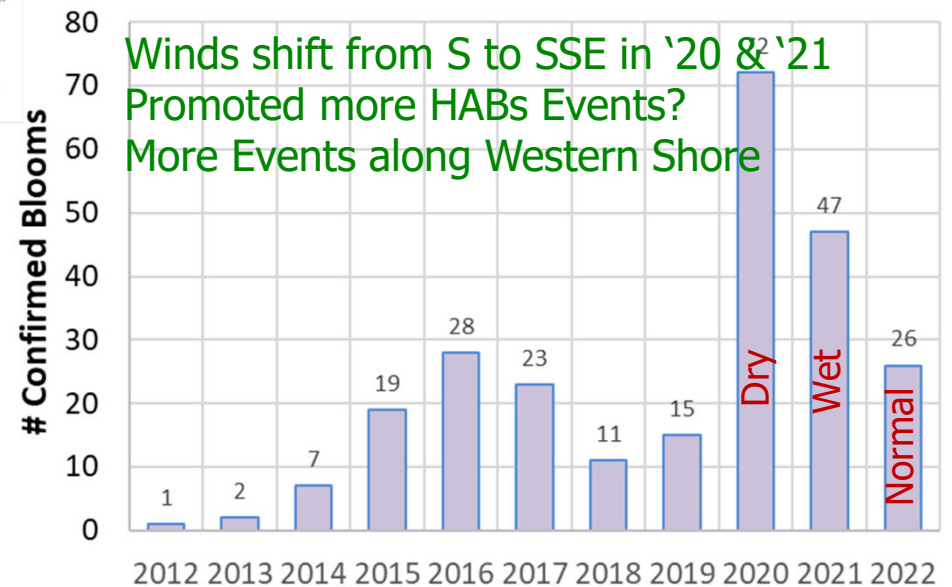


0 1.25 2.5 5 Miles
Data: DEC HABs Map Portal
NYS DEC HABs Viewer Map

Volunteers
Detected 4th Most
HABs Events



Cyanobacteria Blooms - Owasco Lake



Winds shift from S to SSE in '20 & '21
Promoted more HABs Events?
More Events along Western Shore

Dock Monitoring Effort

- Weather Station
 - Wind Speed & Direction
 - Sunlight
- Automatic Camera
 - Confirm HABs Events
 - Clear/Turbid
- Water Temperatures
- WQ Sonde
 - Total Algae
 - Cyanobacteria
 - Dissolved Oxygen
- Mesocosm Analyses
- Macrophyte Surveys
- Drone Surveys



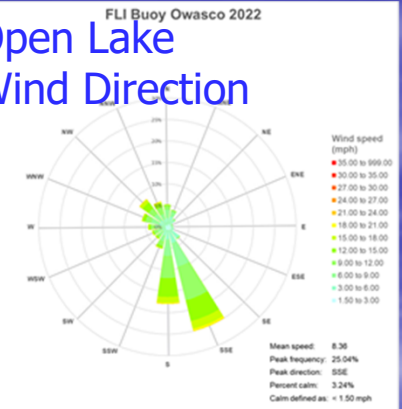
Nearshore Winds

Dock Wind Directions
Different!

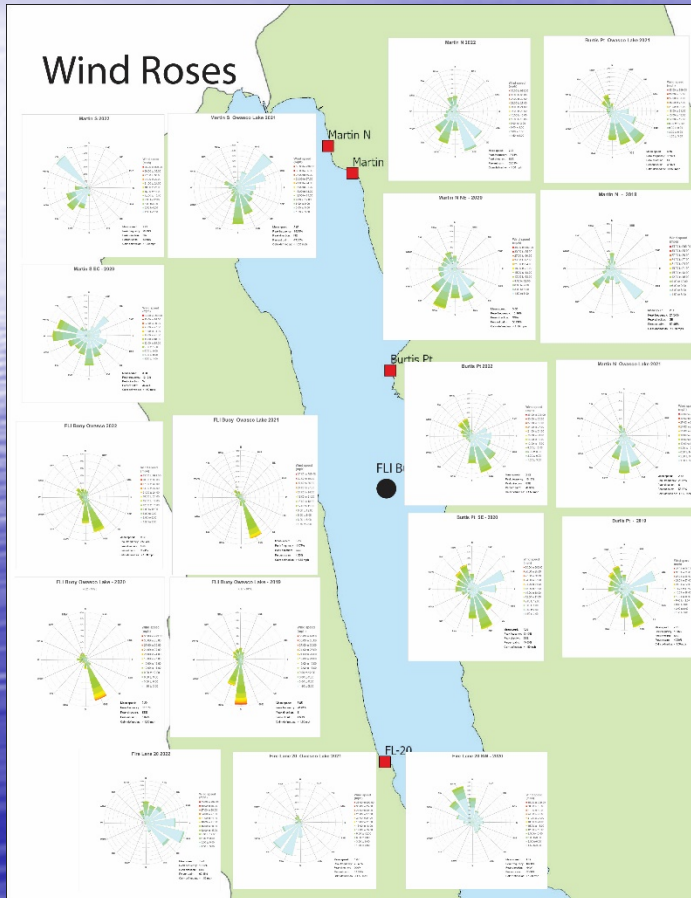
Wind Speeds Slower!



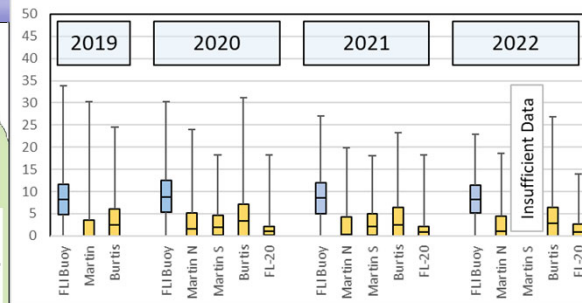
Open Lake Wind Direction



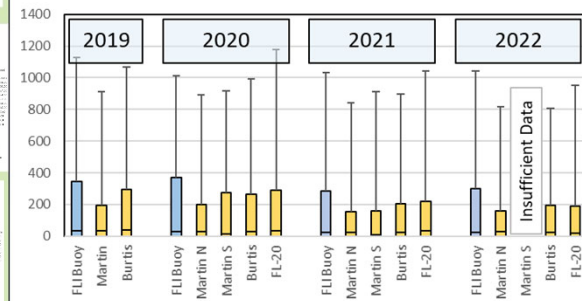
Wind Roses



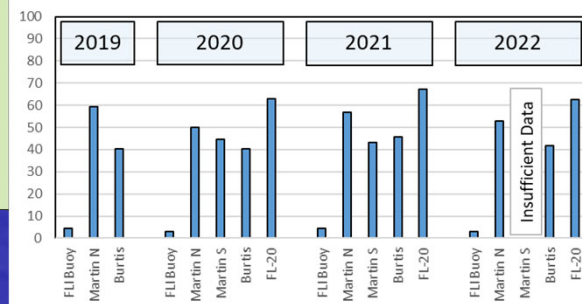
Owasco Wind Speed (mph)



Owasco Solar Intensity (watts/m²)



Owasco % Calm Conditions (<1.5 mph)

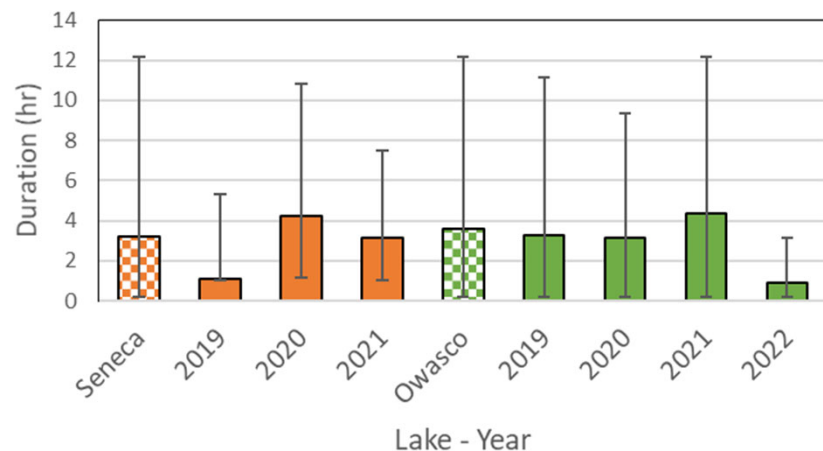


Nearshore Winds***
Decrease in Speed
Altered Directions
***Reason for
Bloom in One Area
BUT Not Others?

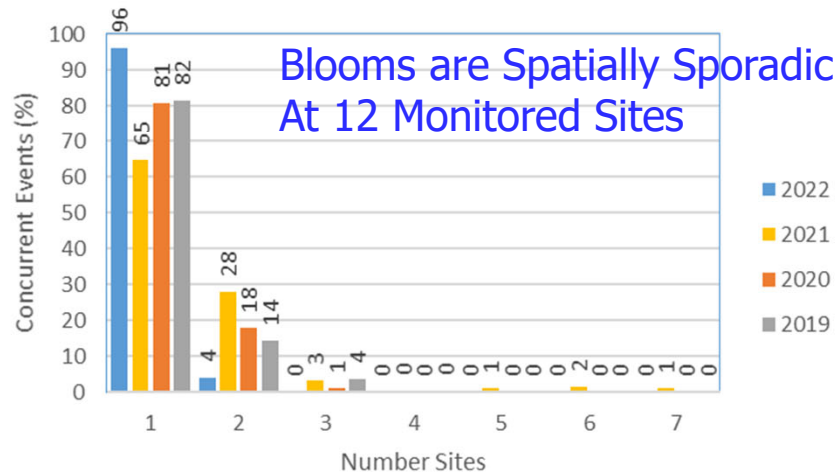
Automatic Cameras

Photo Every 10-minutes

Bloom Duration 2-4 Hours

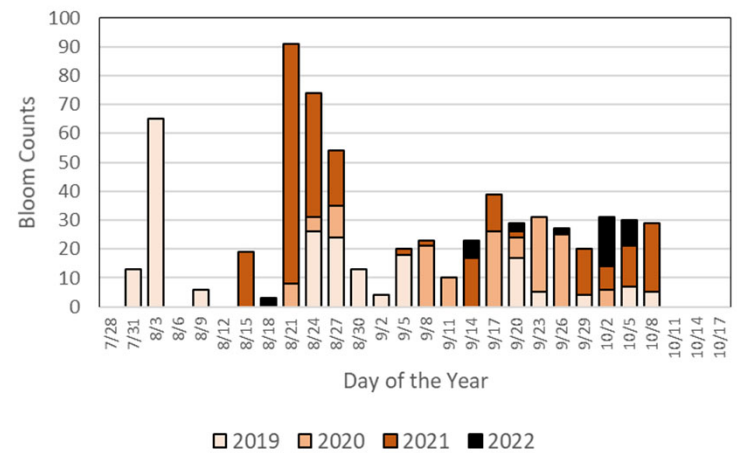


Concurrent Bloom Events both Lakes

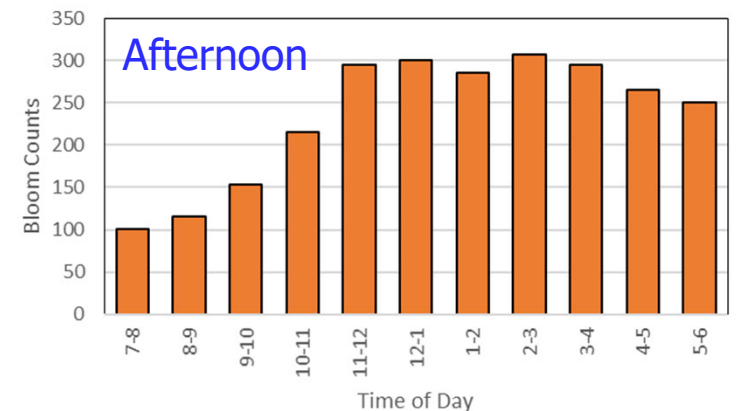


Blooms are Spatially Sporadic
At 12 Monitored Sites

Bloom Date - Owasco Aug-Oct



Time of Day - Owasco Summary



Automatic Cameras

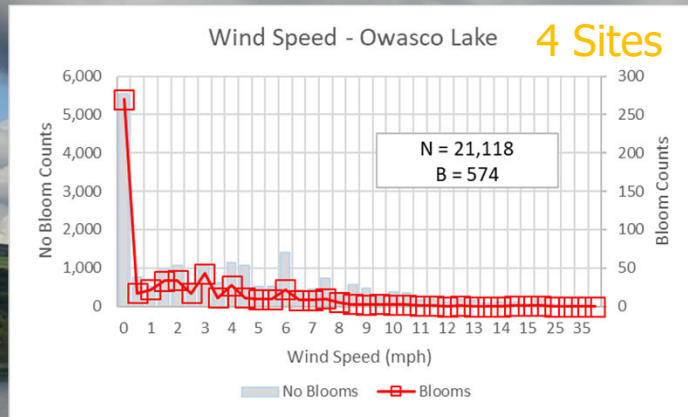
Faithfully Recorded 2x3 m area of Lake
Detected BGA Blooms,
Clear & Turbid Water, Ducks ...
Detected more blooms than Volunteers

Photo of HABs Event at Jim's Dock

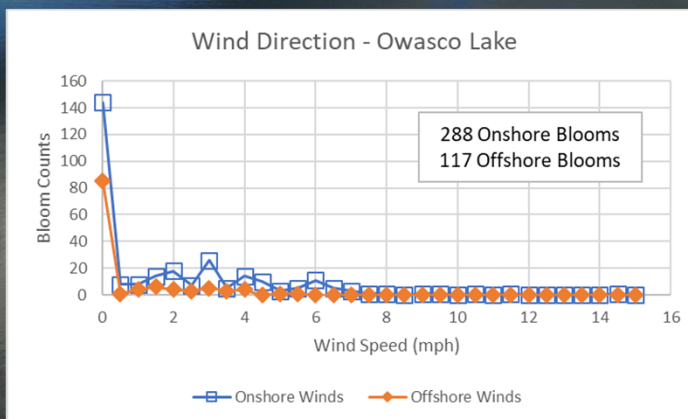
Calm Days

3+ years Daylight, 30-Min, Weather Data

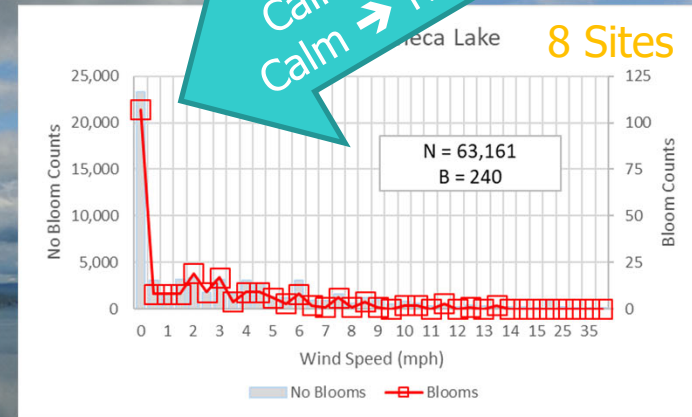
Wind Speed Histograms During Blooms



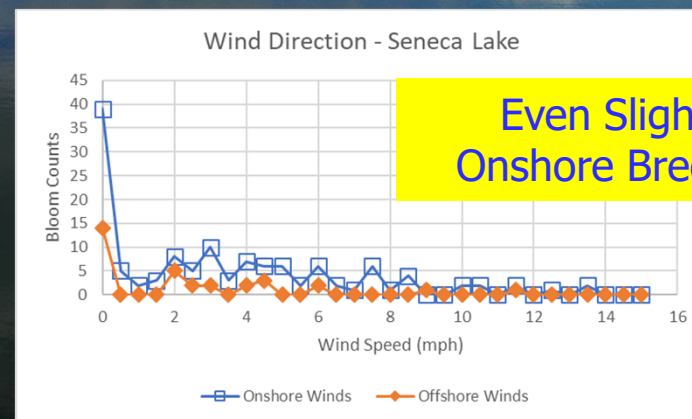
Blooms on Calm Days



Onshore Winds had Blooms
Liberate Nutrients & HABs form Rotting Macrophytes

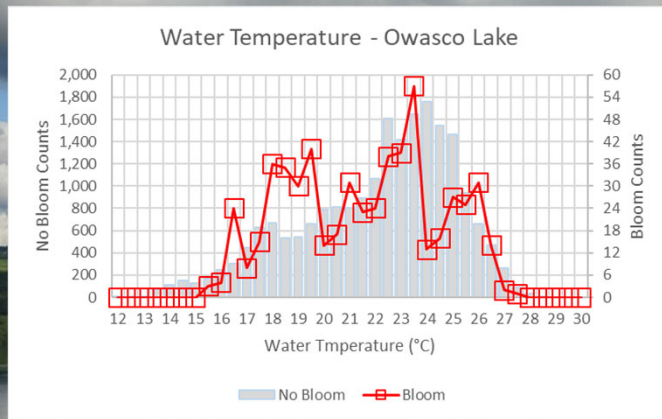


Most Calm Days without Blooms

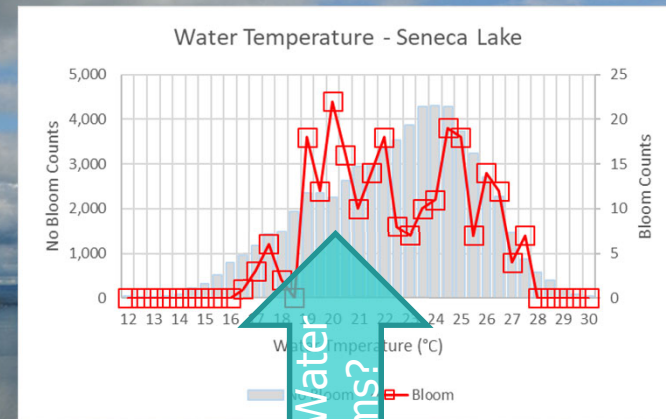


Warm Water & Air Days

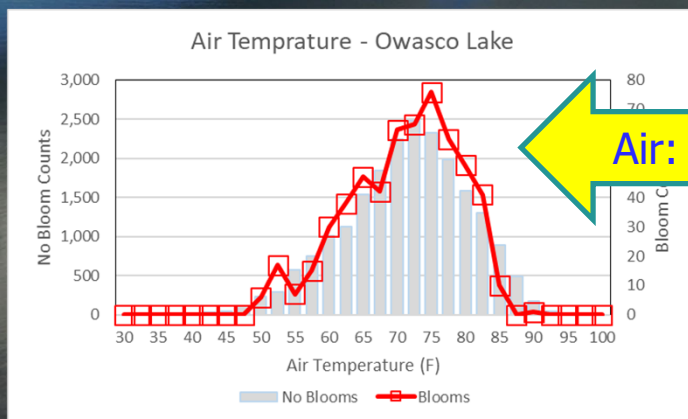
Water & Air Temp Histograms During Blooms, No Blooms



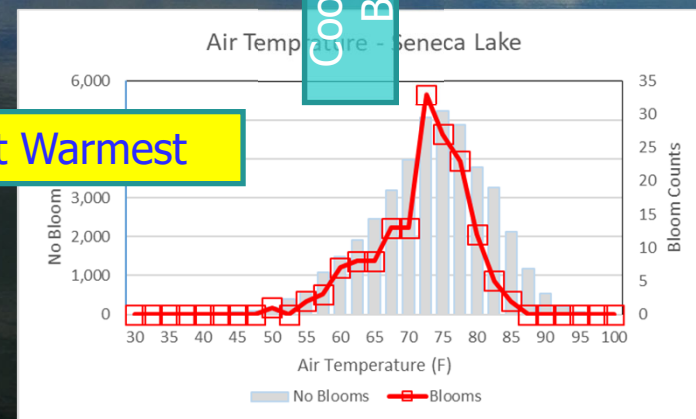
Dip in Water Temperature



Most Warm Water Days without Blooms



Warm Air



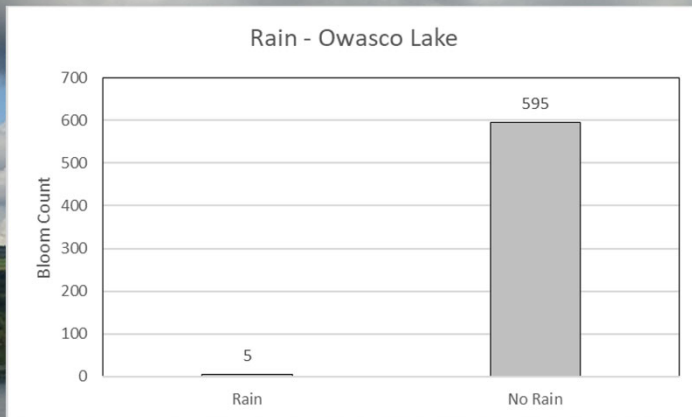
Most Warm Air Days without Blooms

Air: Warm not Warmest

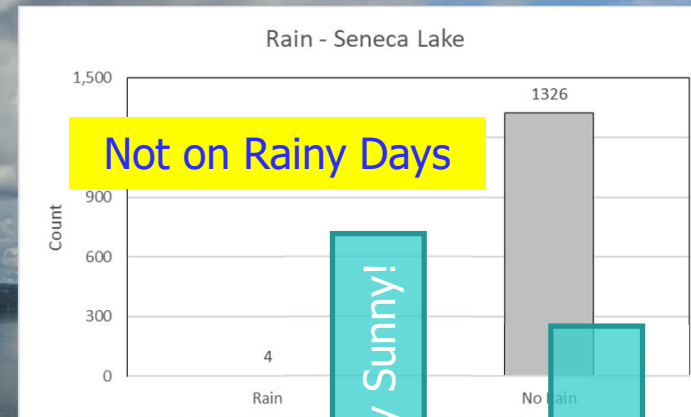
Cooler Water Blooms?

Rainy or Sunny Days

Rain & Sunlight Histograms During Blooms, No Blooms



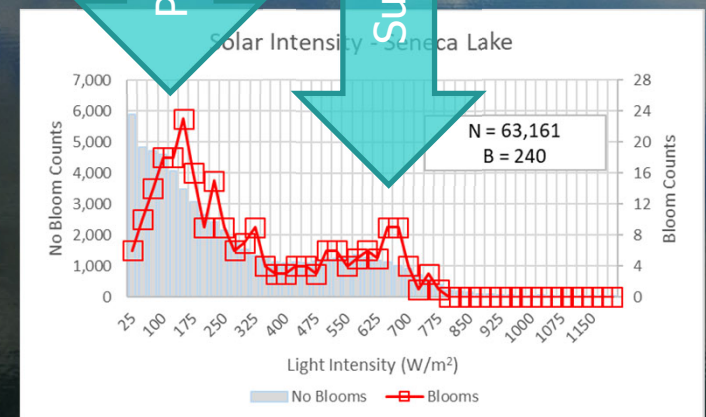
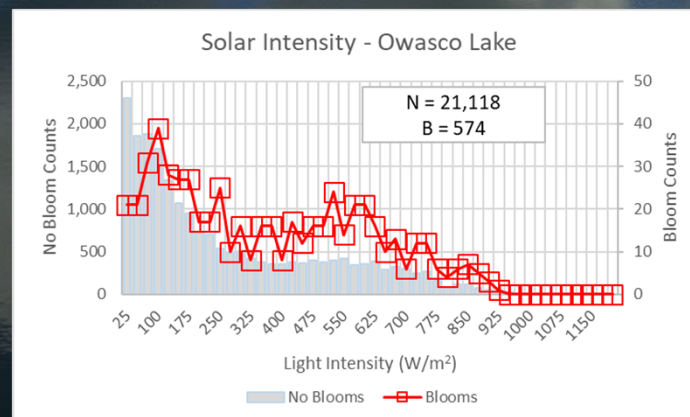
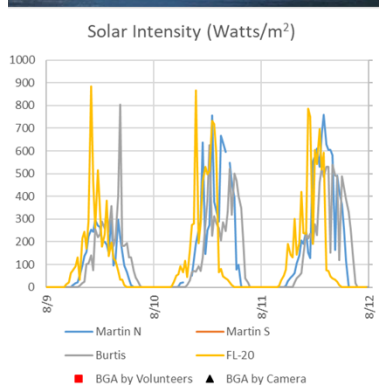
No Rain during Blooms



Not on Rainy Days

Partly Sunny!

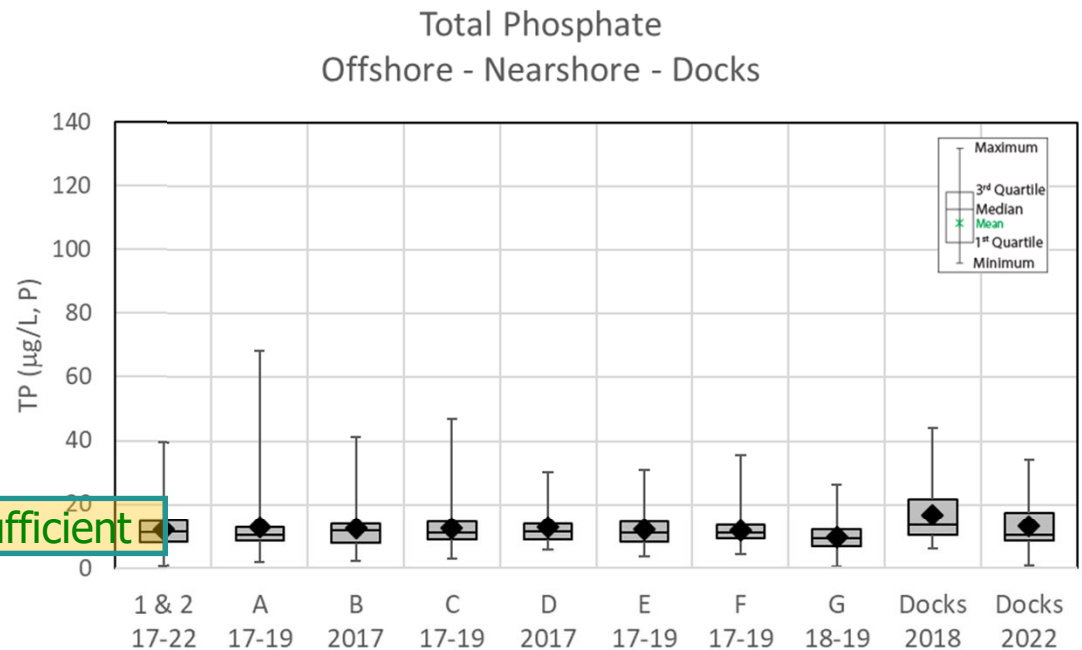
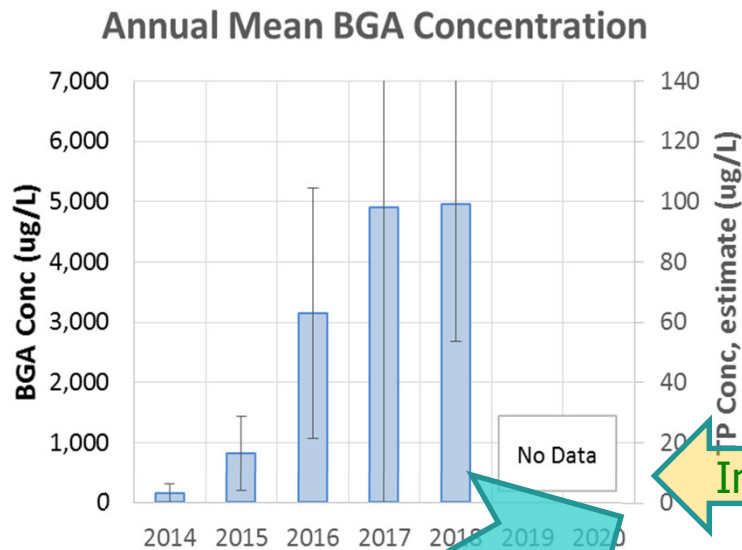
Sunny



3 Days Solar Intensity

Cloudy Skies (or Shade of Trees/Homes) Most Sunny Days without Blooms

Why No Blooms on Every Calm, Sunny Day after Every Rain?



TP in HABs
Redfield C:N:P Ratios

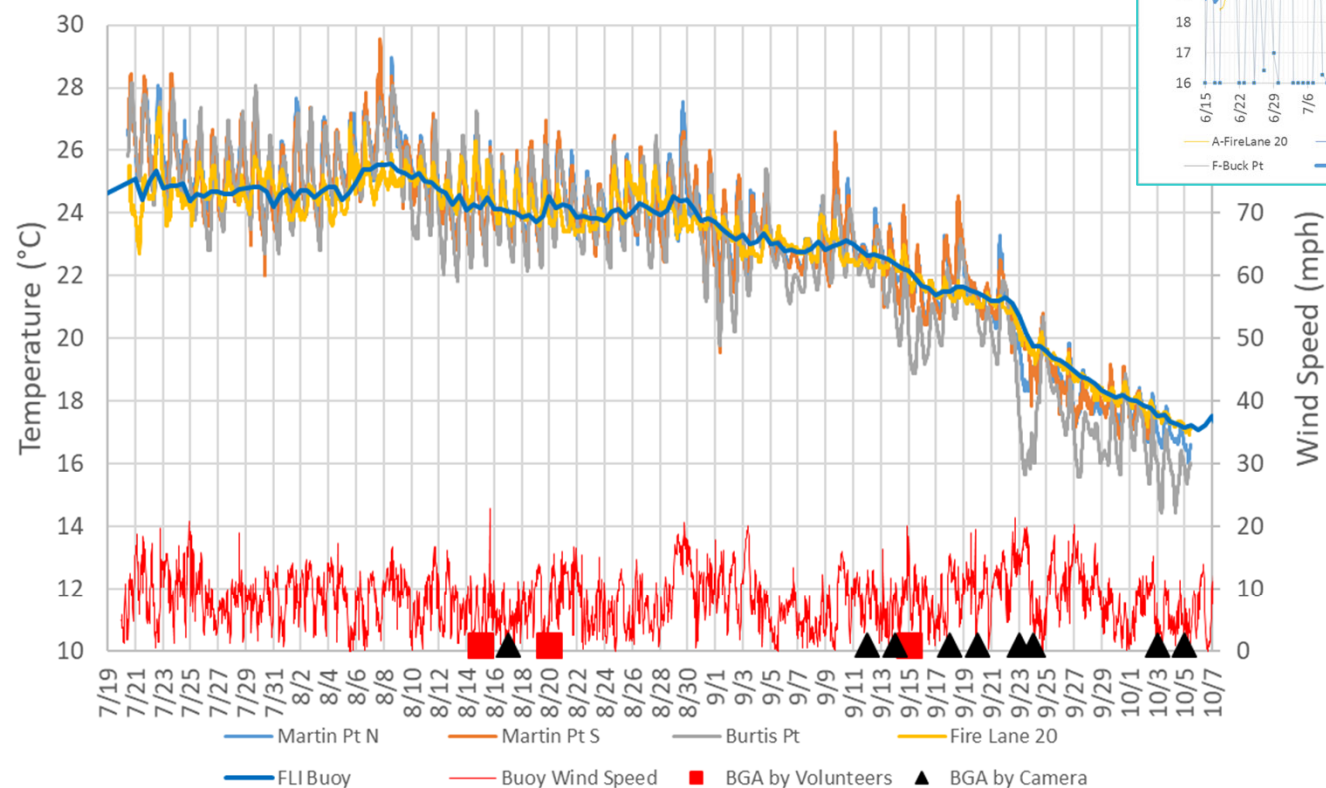
Insufficient

Insufficient Nutrients

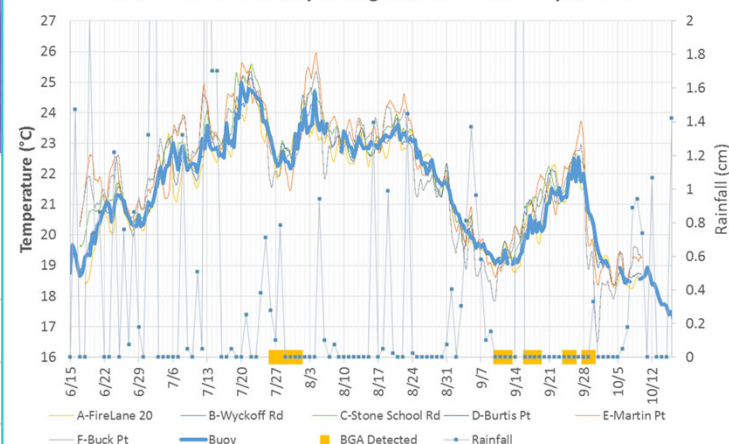
Bloom Triggers – Nearshore/Shoreline

Water Temperature Dips

Owasco Docks & FLI Buoy (1 m) Temperatures (°C)
Buoy Wind Speed



2017 Owasco Lake Daily Average Surface Water Temperatures



No Major Temp Dips
Fewer Blooms?

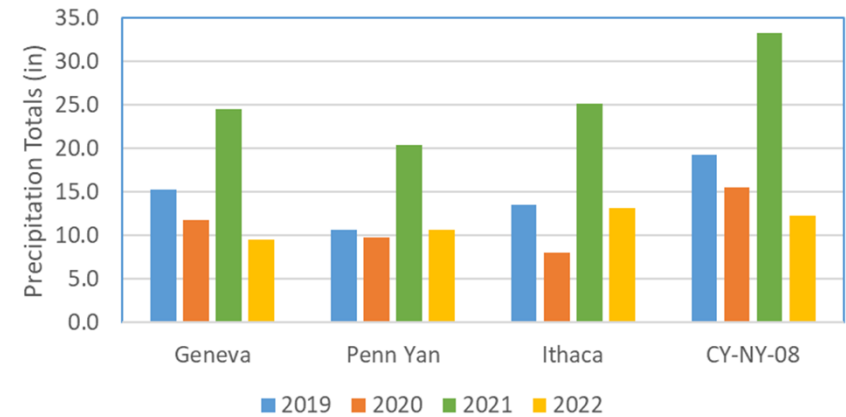
HABs After Temperature Dips? → Nutrient Source?

Nutrient Sources

Rainfall

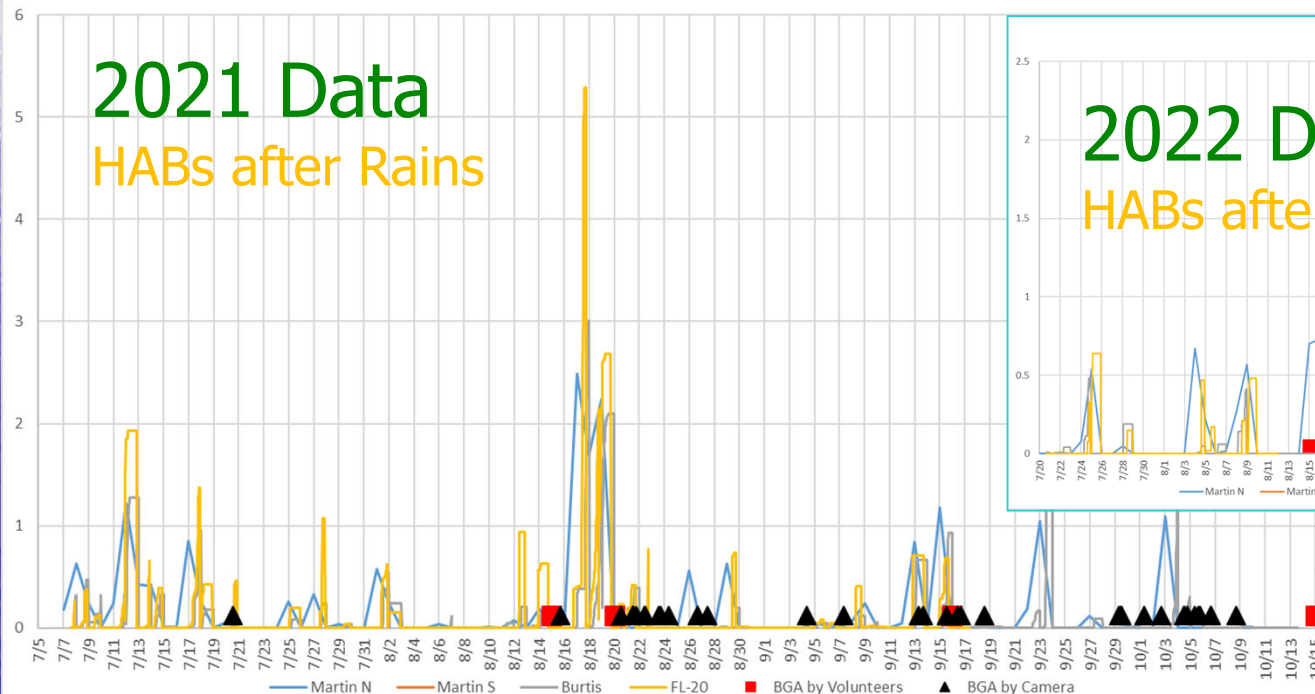
Esp. Huge Events

HABs Season Precipitation
July 1 through October 30



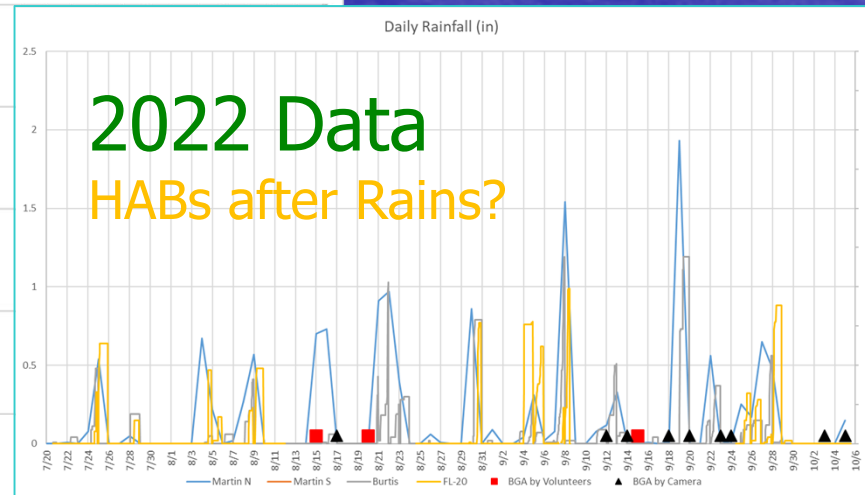
Daily Rainfall (in)

2021 Data
HABs after Rains



Daily Rainfall (in)

2022 Data
HABs after Rains?



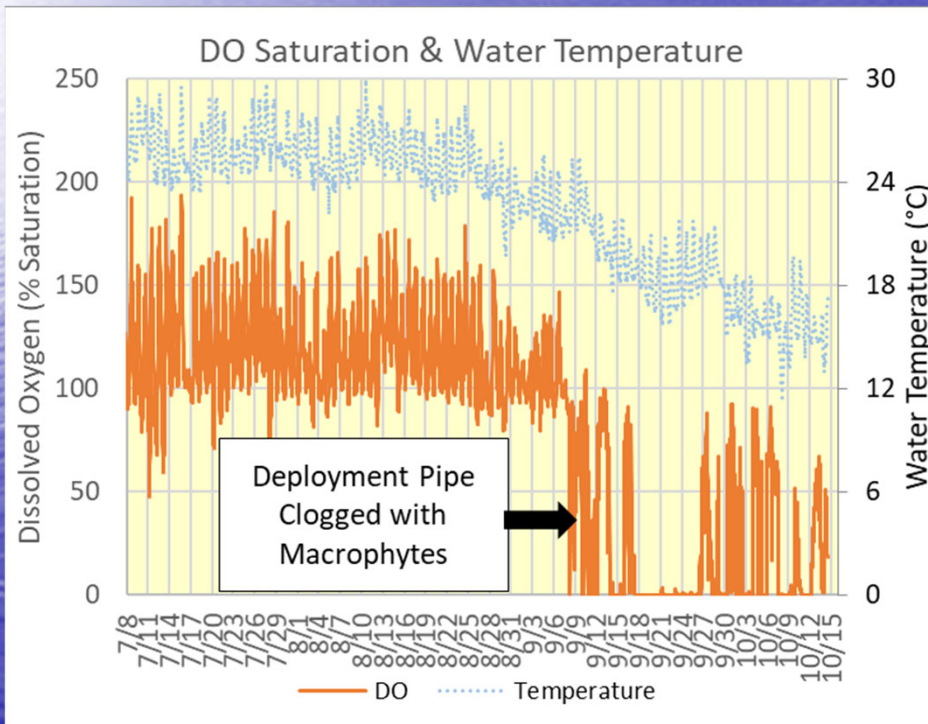
Nutrient Sources

Dock WQ Sondes

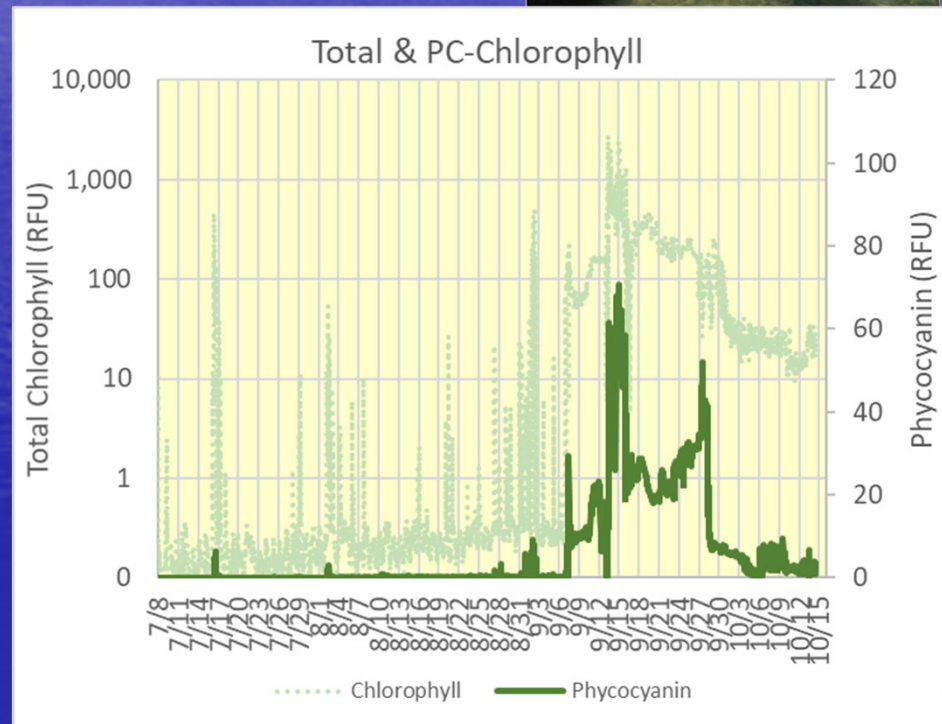
Decomposed Macrophytes



In-Situ Aqua Troll 600



Macrophyte Decomposition - Anoxia At
Martin Pt inside Pipe → → →



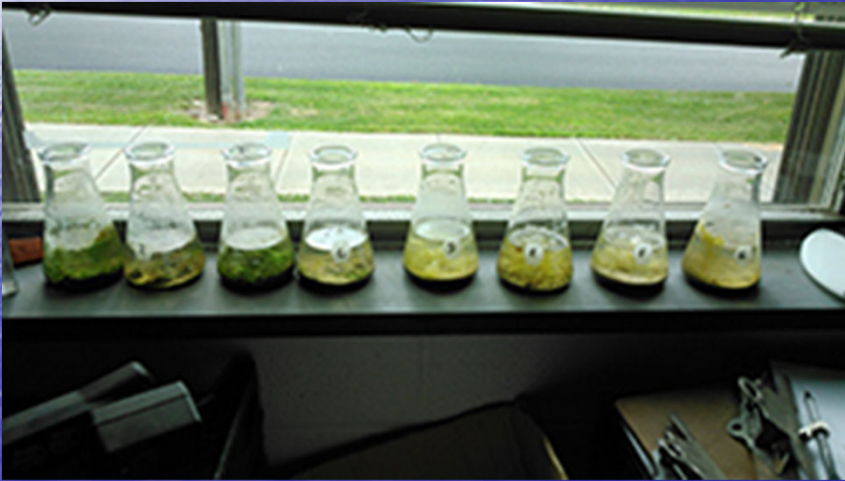
Induced Cyanobacteria Bloom inside Pipe

Nutrient Sources

Organic Matter Decay?

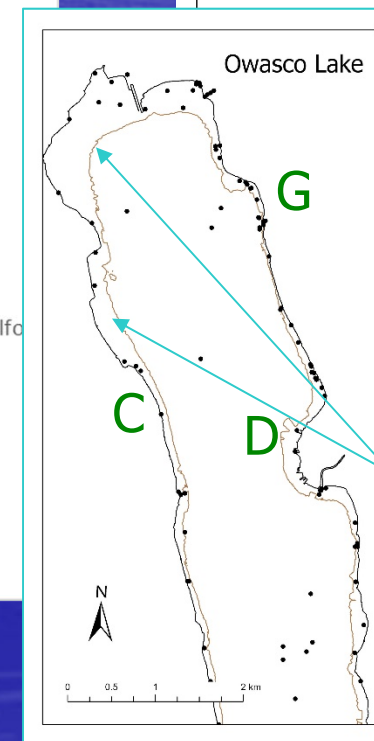
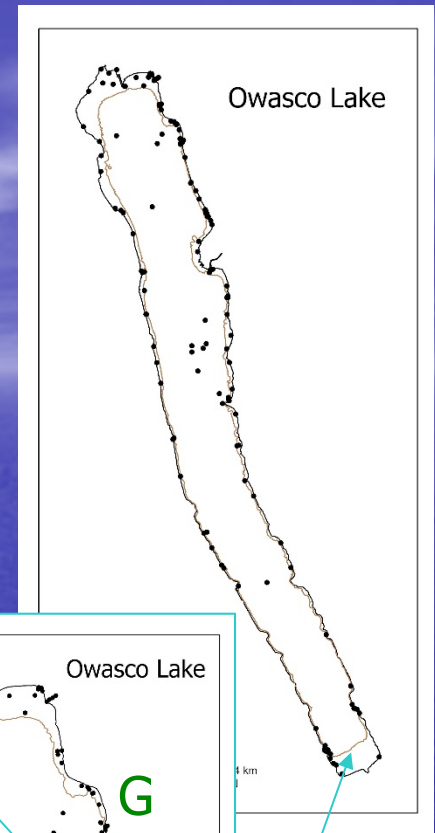
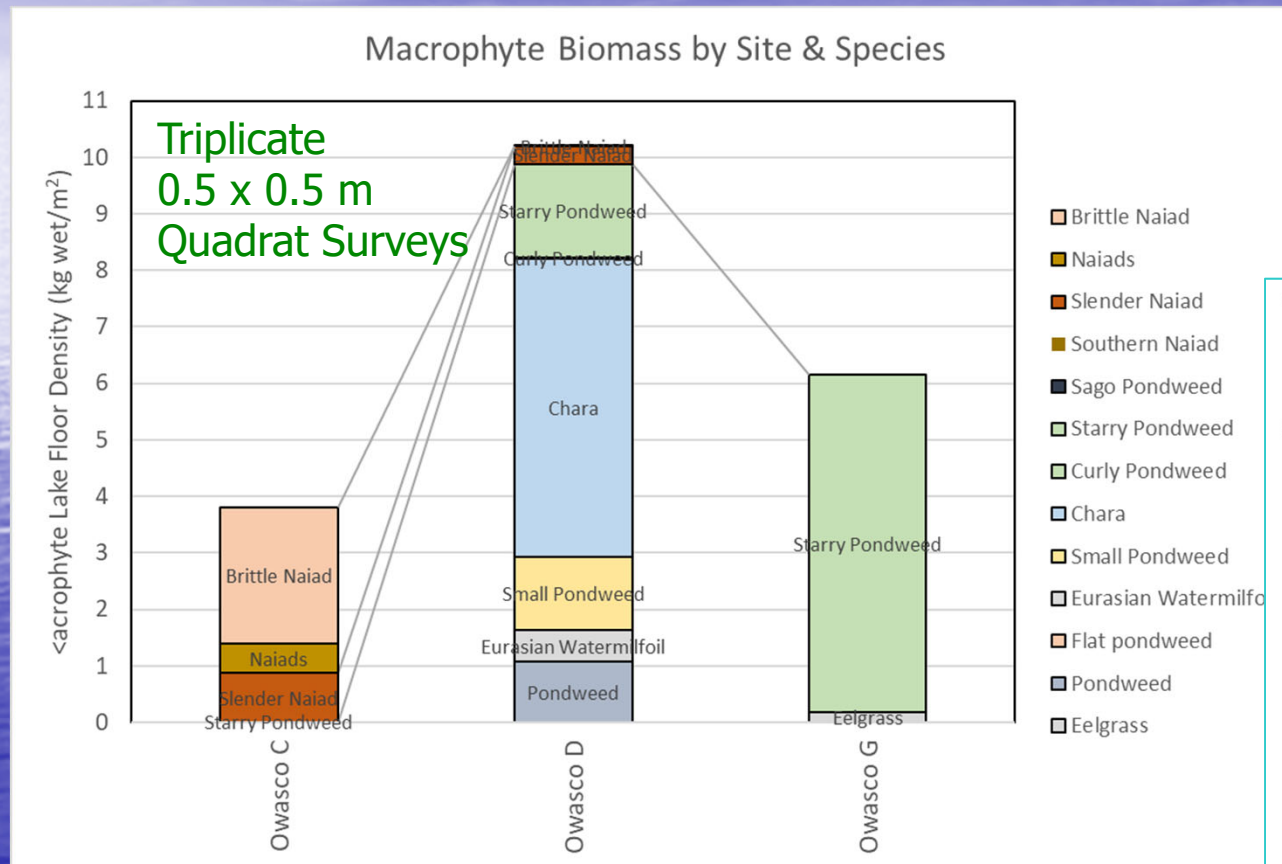
Sediments & Macrophytes

Blooms from Mud Samples



Blooms from Decaying Macrophytes

Nearshore Macrophyte Biomass – 2021 Data



4 m
Contour

More
shallow
water in
North &
Burtis Pt

Sufficient Biomass to Supply HABs Along Shoreline
More Shallow Water along Northern Shorelines
Dominant Winds blow Rotting Macrophytes towards North & East Shores

HABs Remediation

- Nearshore Bubblers, Ultrasonic Sound, Mats?
 - Ineffective when Tested in Owasco Lake
- NEVER use Herbicides
 - Owasco is Water Supply for over 45,000 People
- Remove/Harvest Nearshore Organic Matter
 - Macrophytes
 - BGA Blooms
 - If NOT Harvested, When Die
 - Bacterial Decomposition
 - Releases Nutrients to Nearshore Area
 - Zebra/Quagga Mussels & Asian Clams
- Reduce Nutrient Loading to Lake!

Last Monitoring Effort

- It Has Been Fun!
 - I hope my data has Informed the Watershed
- Reasons
 - I'm Close to Retirement (Spring 2024)!
 - Time to do other Things
- I Hope Monitoring & Remediation Efforts Continue!
 - Observe Improvements in WQ
 - In Consort with Increased Remediation Efforts
- Halfman Aerial Photos, LLC...



**HALFMAN
AERIAL
PHOTOS, LLC**

John Halfman, HWS
<http://people.hws.edu/halfman/>
 email: halfman@hws.edu

Questions

The collage features several images: a woman in a green tank top working on a boat, a close-up of hands holding a small vial, a sunset over a lake, a person on a boat with a solar panel, a close-up of a blue and silver probe, a person using a laptop on a boat, a person working with a large white container, and a dock with a boat.

Questions

