Working Towards a Sustainable Remediation of Georgica Pond

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School *of* Marine and Atmospheric Sciences

GOBLER LABORATORY

Why remediate Georgica Pond?

- Blooms of macroalgae
- Blooms of toxic blue green algae
- Low oxygen
- Kills of fish, eels, birds, dogs
- Pathogenic bacteria

Overview

- Observations from 2022-2023
- Actions to improve conditions

Real-time monitoring buoy

An investigation led by the Gobler Lab of Stony Brook University

Georgica Pond

Chart View | Table View | Site Information

GP_south
Site Id

40.934192
Latitude

-72.22572
Longitude

Georgica Pond Buoy - The Gobler Lab of Stony Brook University
Description

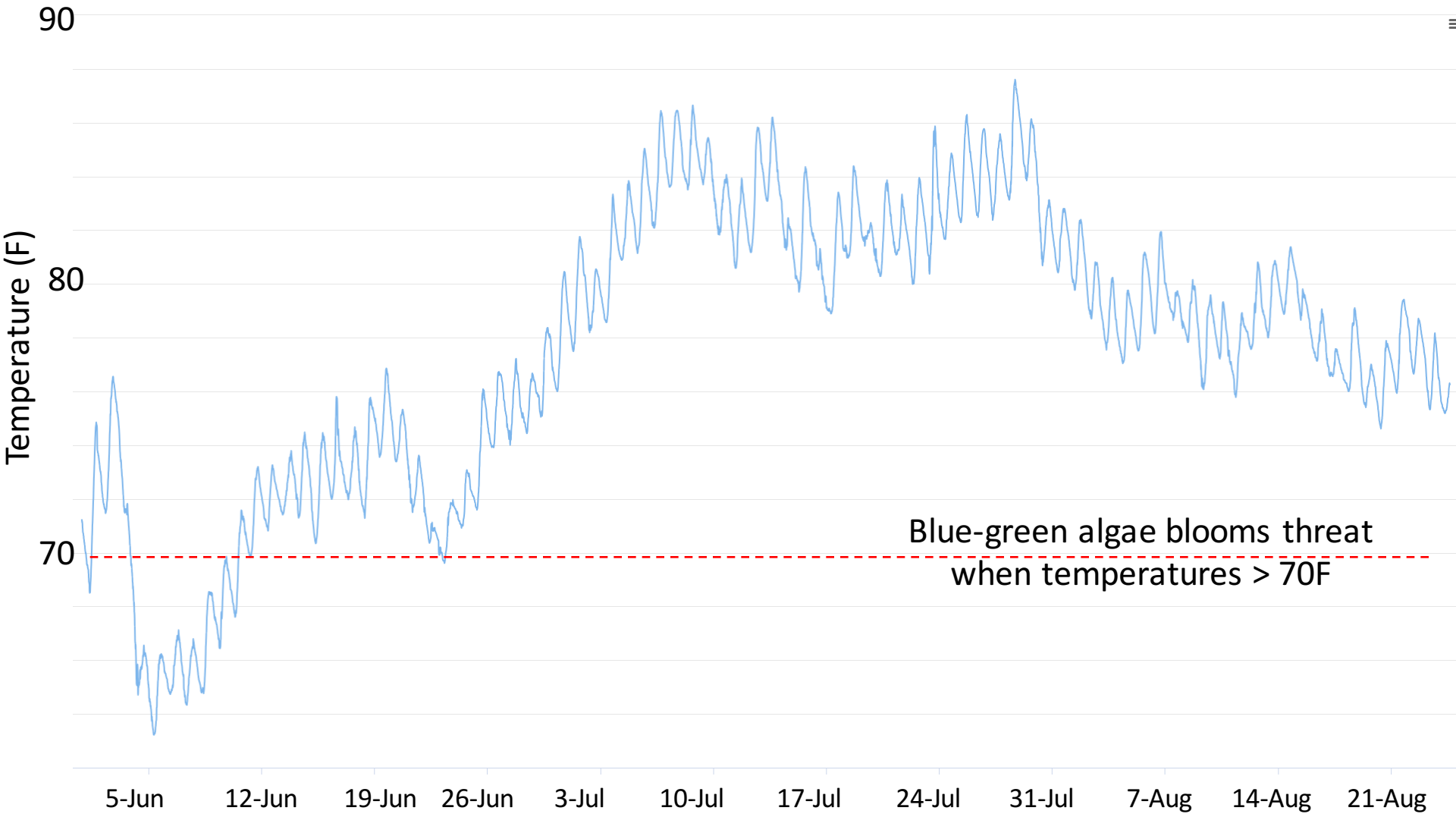
As part of The Georgica Pond Project, the Gobler laboratory has installed a water quality monitoring buoy in Georgica Pond. This device is making continuous, real-time measurements of key water quality indicators that are instantly telemetered to this web site.


An investigation led by the Gobler Lab of Stony Brook University
Georgica Pond
Chart View
Table View
Site Information
Parameters
Studies
Last Month
Last Day
Last Week
Last Month
Last Year
Custom range
Y-axis scaling
Min
Max
Clear
Blue-Green Algae (ug/L)
5
4
3
2
1
0

Cut opened in spring, closed since March 31st

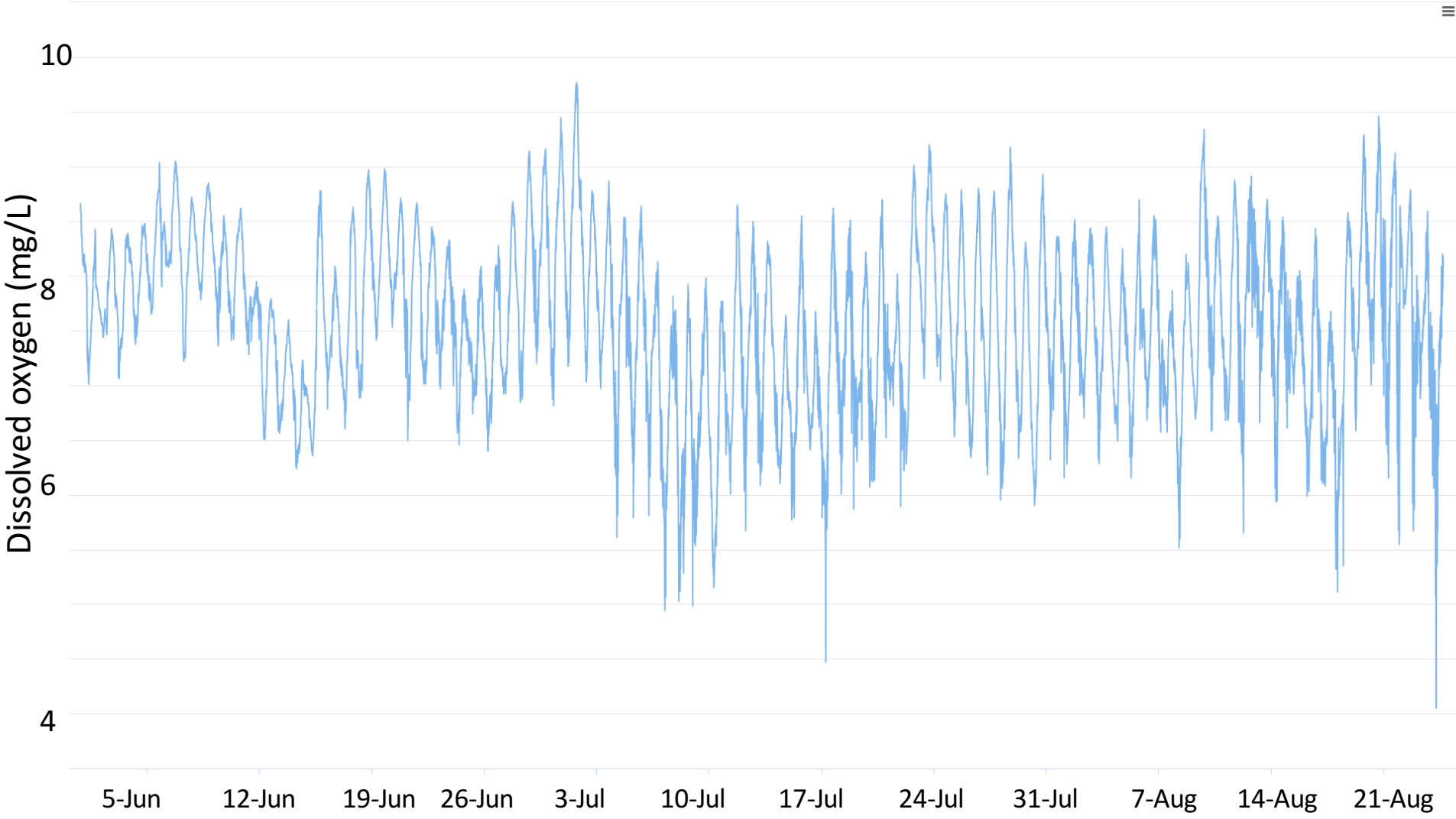
Salinity, 2023

Temperature, 2023



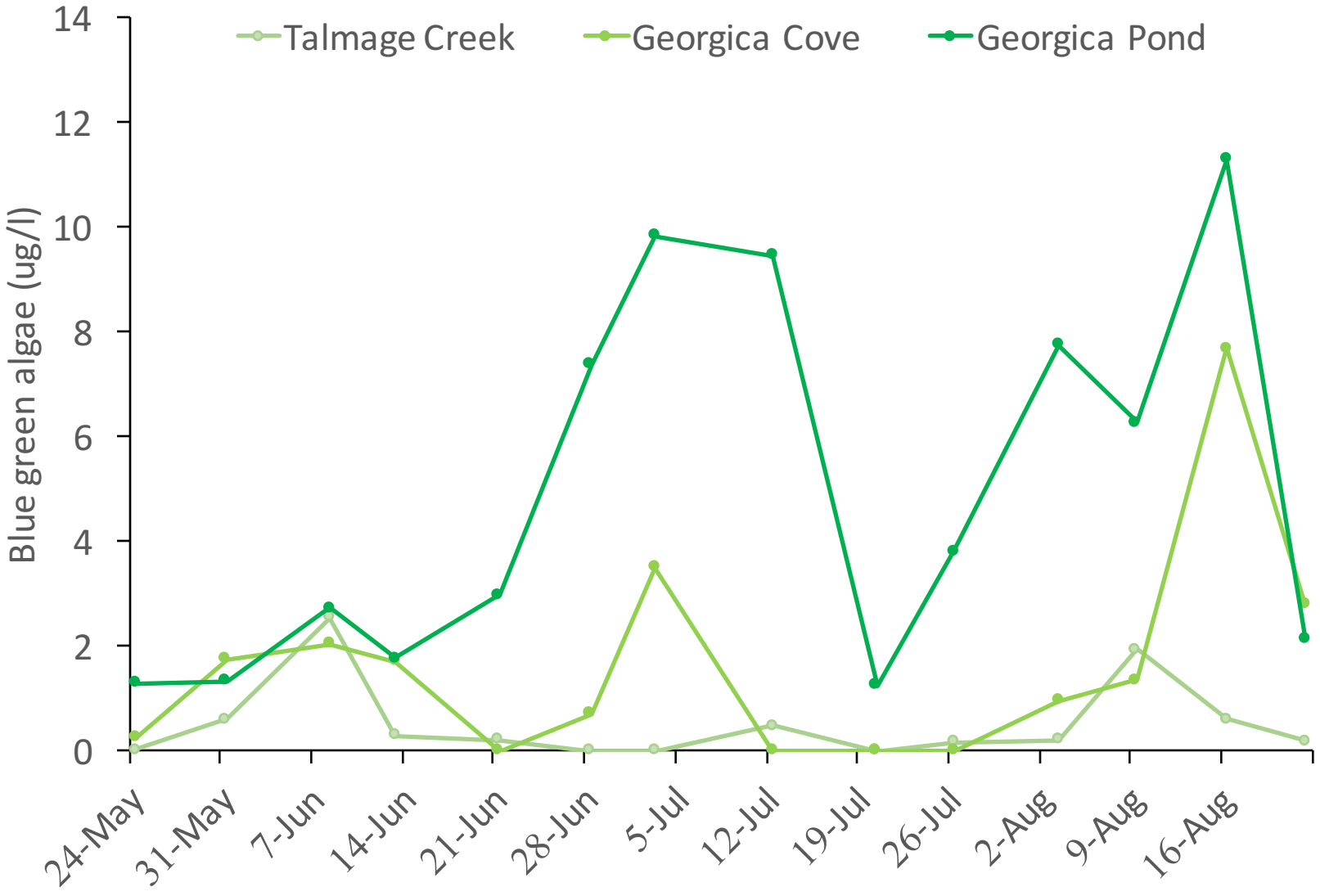
Dissolved oxygen, 2023

NYSDEC minimum standard = 3mg/L

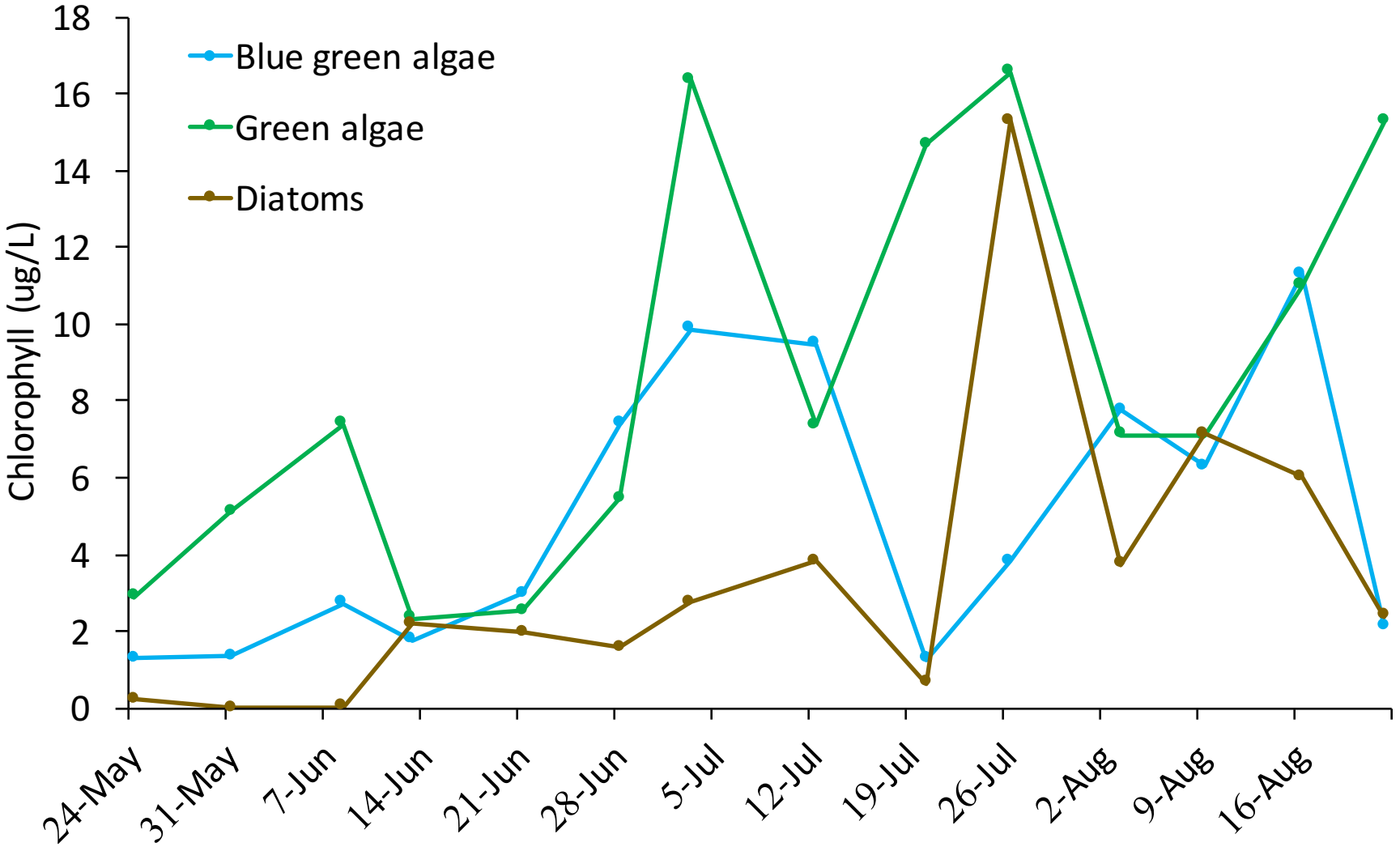


Blue-green algae, 2023

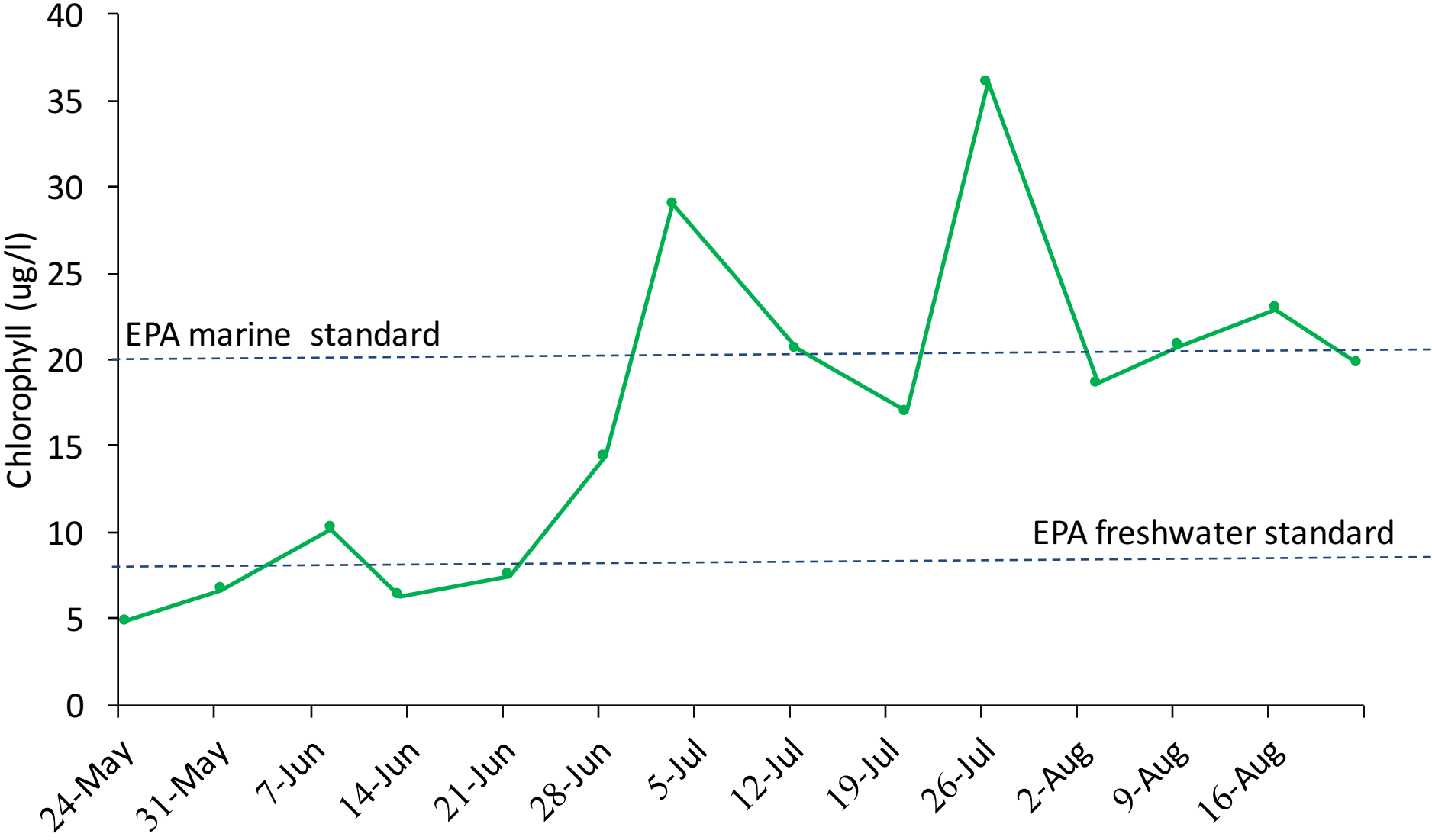
(NYSDEC standard = 25)



Algae communities, 2023

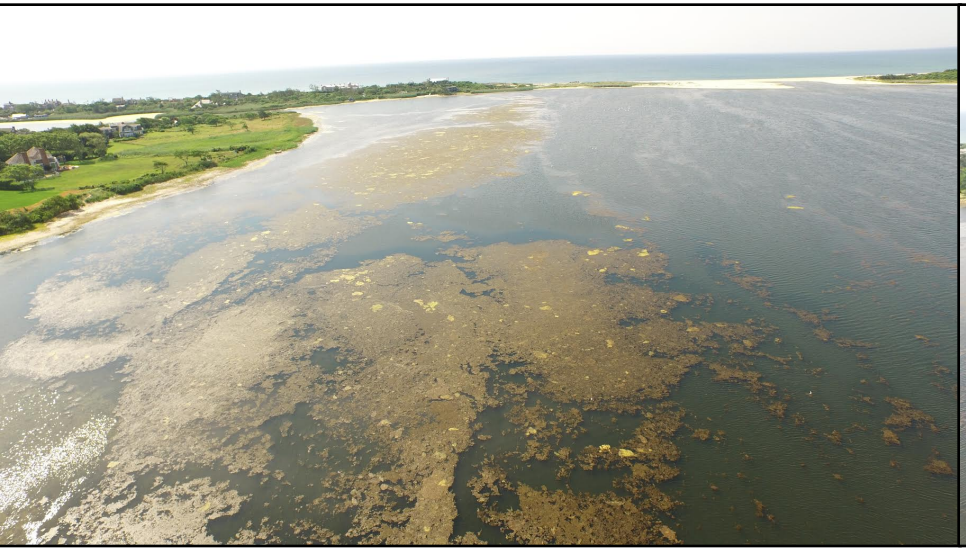


Chlorophyll *a*, 2023



Pond weed in Georgica Pond

Macroalgae bloom, 2015



The macroalgae – blue green algae hypothesis

June → July → August

Hunting the eagle killer: A cyanobacterial neurotoxin causes vacuolar myelinopathy

Breinlinger *et al.*, *Science* **371**, eaax9050 (2021) 26 March 2021

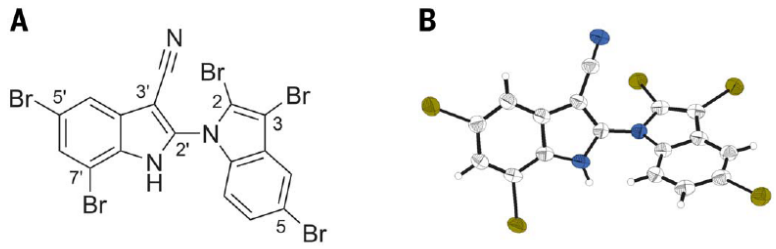
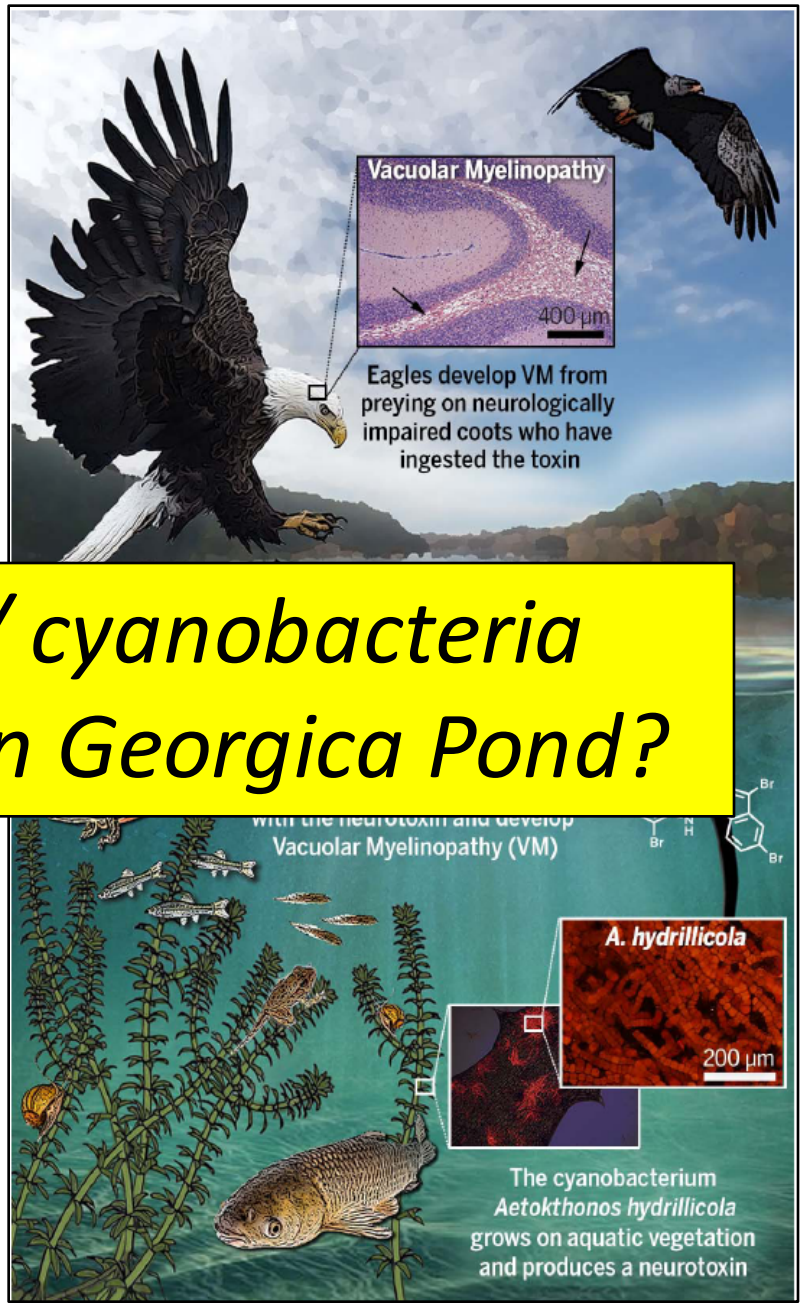


Fig. 3. AETX is a pentabrominated biindole alkaloid. (**A** and **B**) Structure (A) and x-ray crystallography structure (B) of AETX.



Are blue-green algae / cyanobacteria growing on pond weed in Georgica Pond?

- Neurotoxin from cyanobacteria enters aquatic food web as birds and fish consume the pond weed.
- Bald eagles consuming prey with neurotoxins expire from vacuolar myelinopathy.

Blue Green Algae on Sago Pond Weed in Georgica Pond

- *400X greater than in the water*
- *Cyanotoxins also present*

Georgica Pond macrophytes

Excessive nutrient loading in Pond

Macroalgae bloom

Collapsing macroalgae releases nutrients, toxic blue-green algae

Blue-green algae use released nutrients; hypoxia

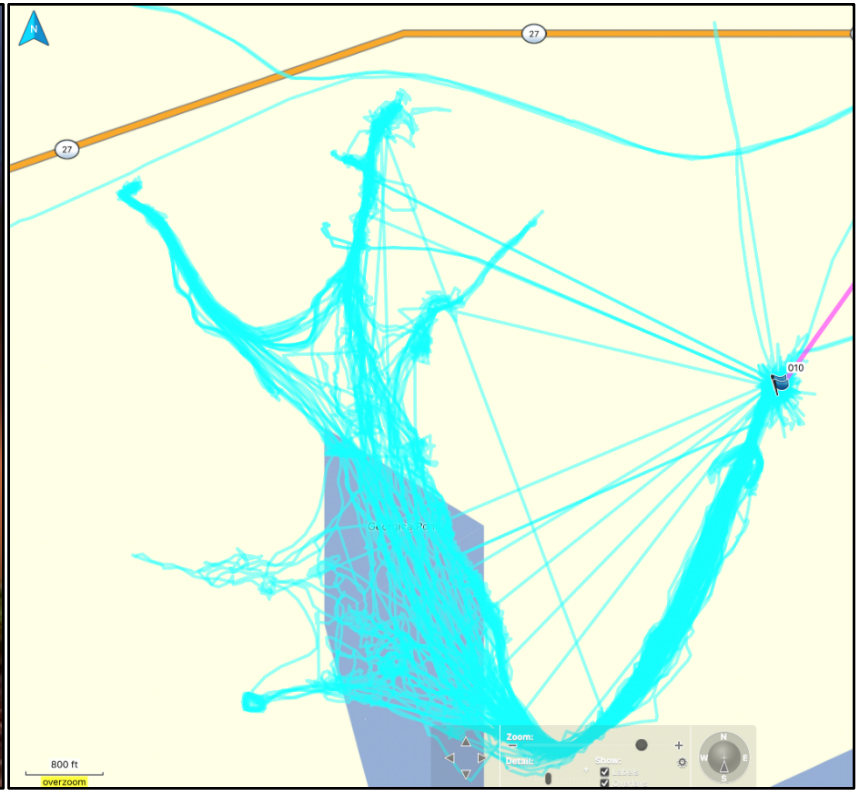
Aquatic weed harvester:

Began in 2016; Current NYSDEC permit 2021 - 2026

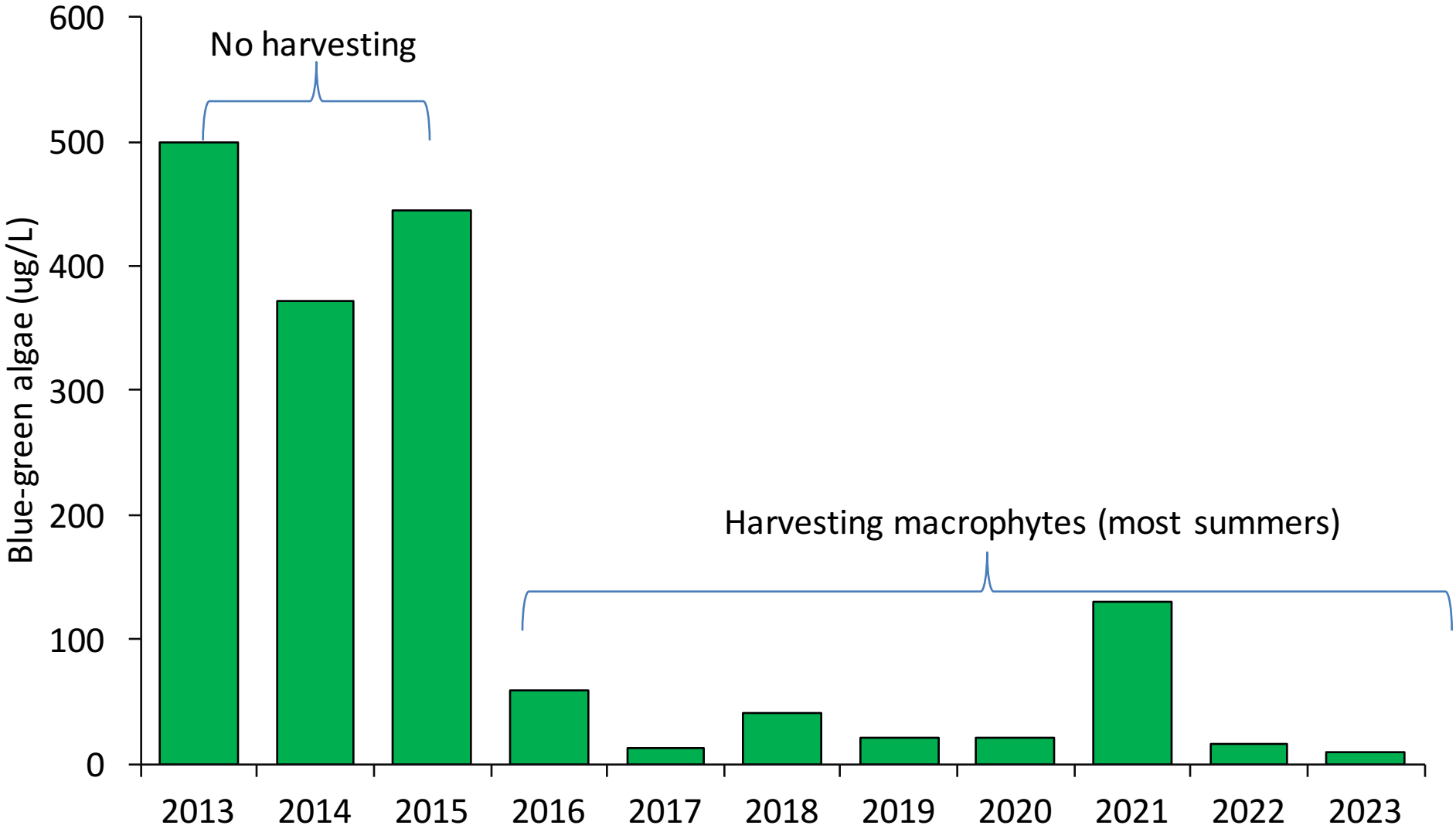
Bioextraction: macroalgal harvest, summer 2022

72,060 lbs removed

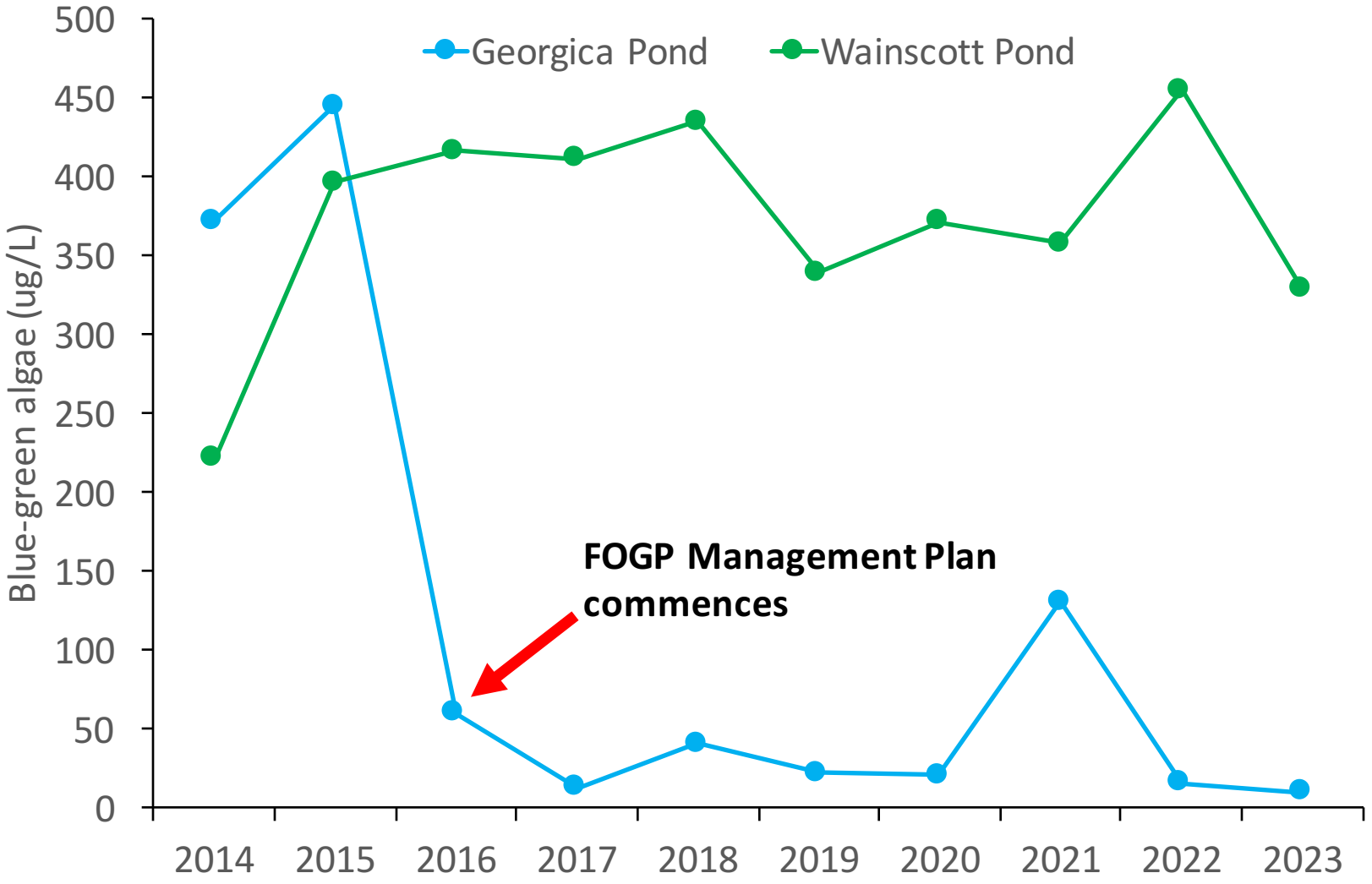
10% and 20% of summer N and P load



History of blue-green algae and harvesting

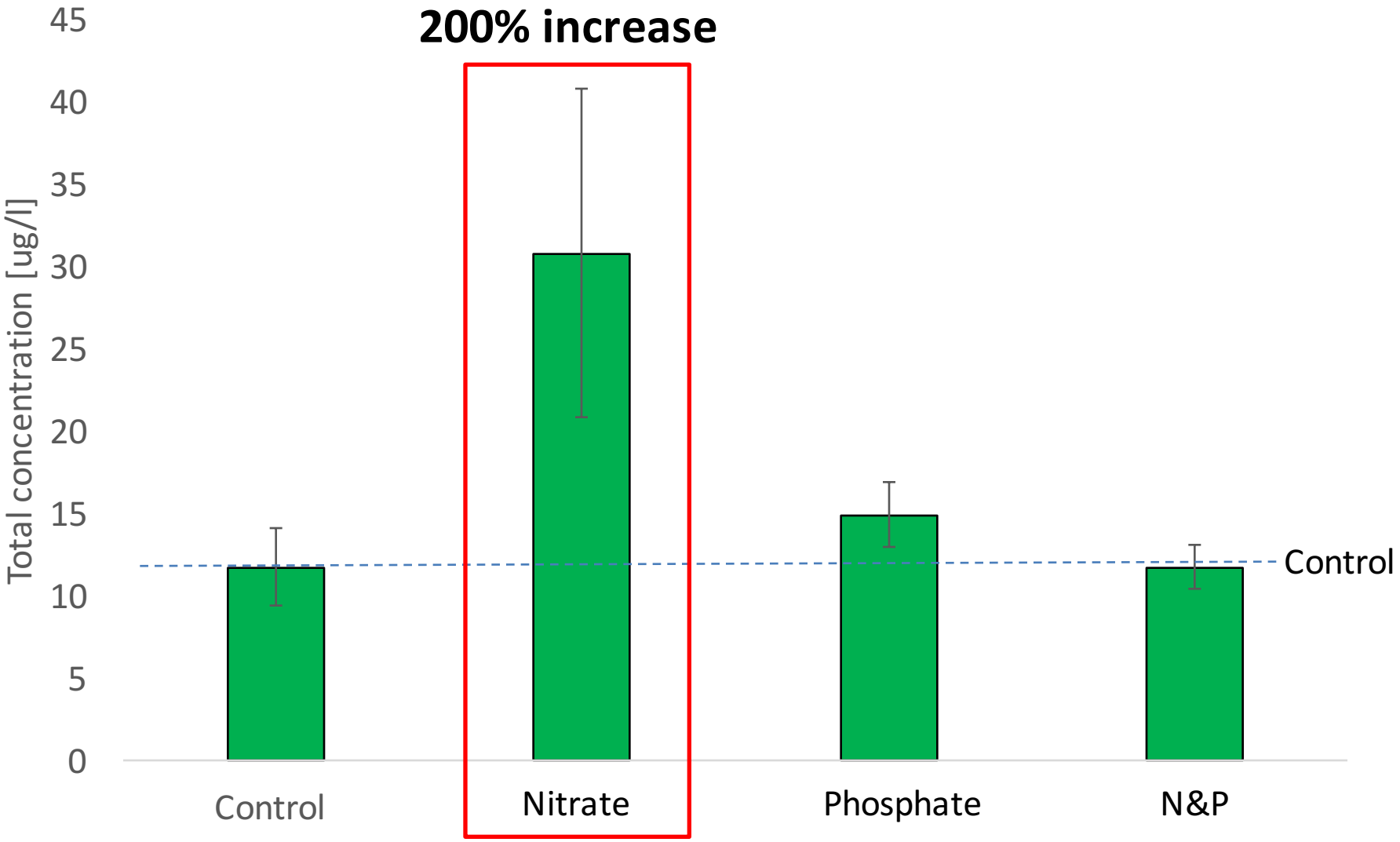


FOGP management plan is working!

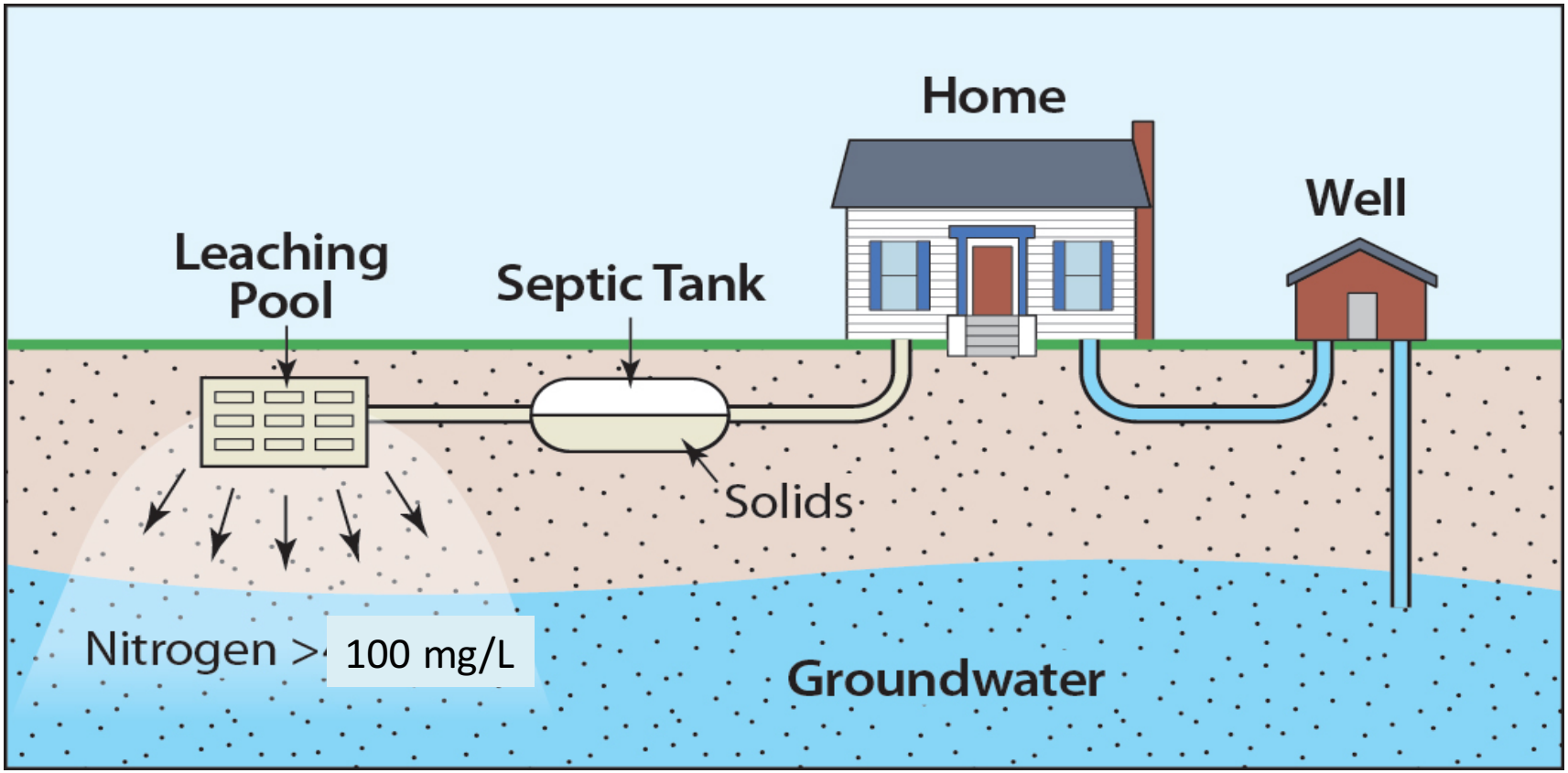


What is promoting algal blooms in Georgica Pond?

Nutrients controlling blue-green algae



Suffolk County wastewater systems



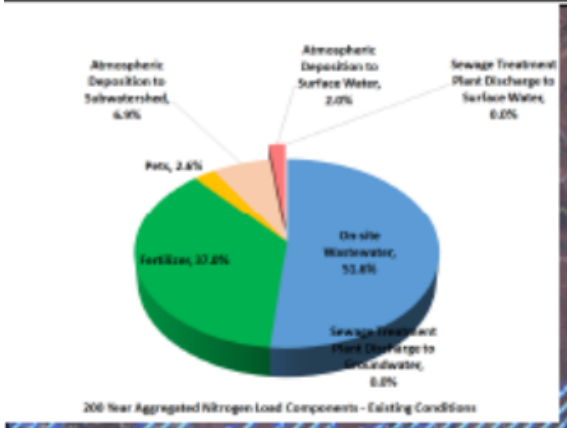
SUFFOLK COUNTY SUBWATERSHEDS WASTEWATER PLAN

JUNE 2020

FROM WORST TO FIRST!

Reclaim Our Water

This presentation was prepared with funding provided by the New York State Department of Environmental Conservation as part of the Long Island Nitrogen Action Plan and by New York State Department of State under the Environmental Protection Fund



Ecological Sensitivity Rank

1

Travel Time Interval (Years)	Contributing Area (%)	Cumulative Contributing Area (%)
0 to 2	30.2%	30.2%
2 to 10	34.3%	64.5%
10 to 25	16.3%	80.8%
25 to 50	15.8%	96.6%
50 to 100	2.9%	99.5%
100 to 200	0.5%	100%

Georgica Pond

Management Area/Nitrogen Reduction Goal

13 63%

Travel Time (Years)

0 to 2
2 to 10
10 to 25
25 to 50

Subwatershed is Poorly Characterized

Waterbody
Sewered Area
Well Contribut

N

0 1,250 2,500

Ft

Firefox

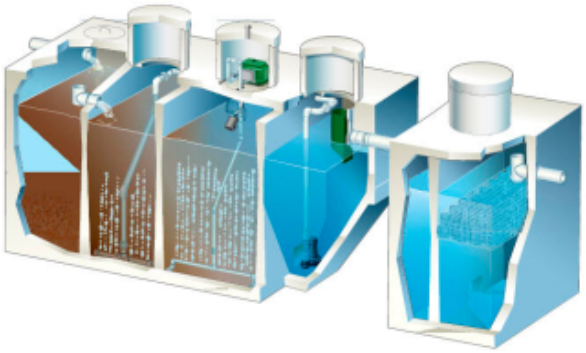
Wastewater Management and Water Quality Characterization
25 Year Contributing Area
1701-0145
Georgica Pond

Provisionally approved low N septic systems (<19 mg N/L)

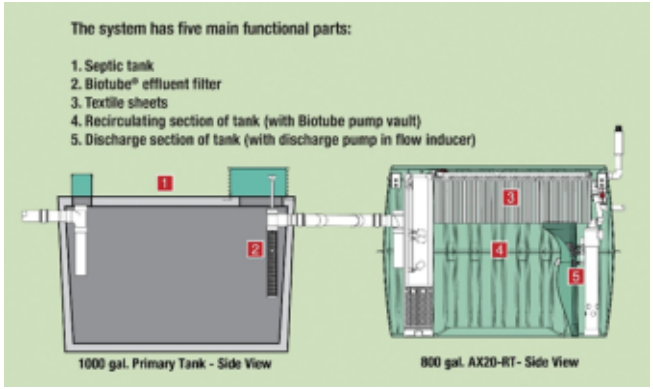
Hydro-Action

SUFFOLK COUNTY SEAL
FREEDOM AND INDEPENDENCE
NEW YORK

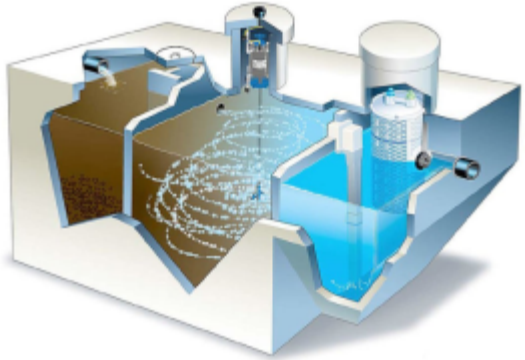
Fuji Clean System



Norweco Hydrokinetic



Orenco Advantex AX-RT



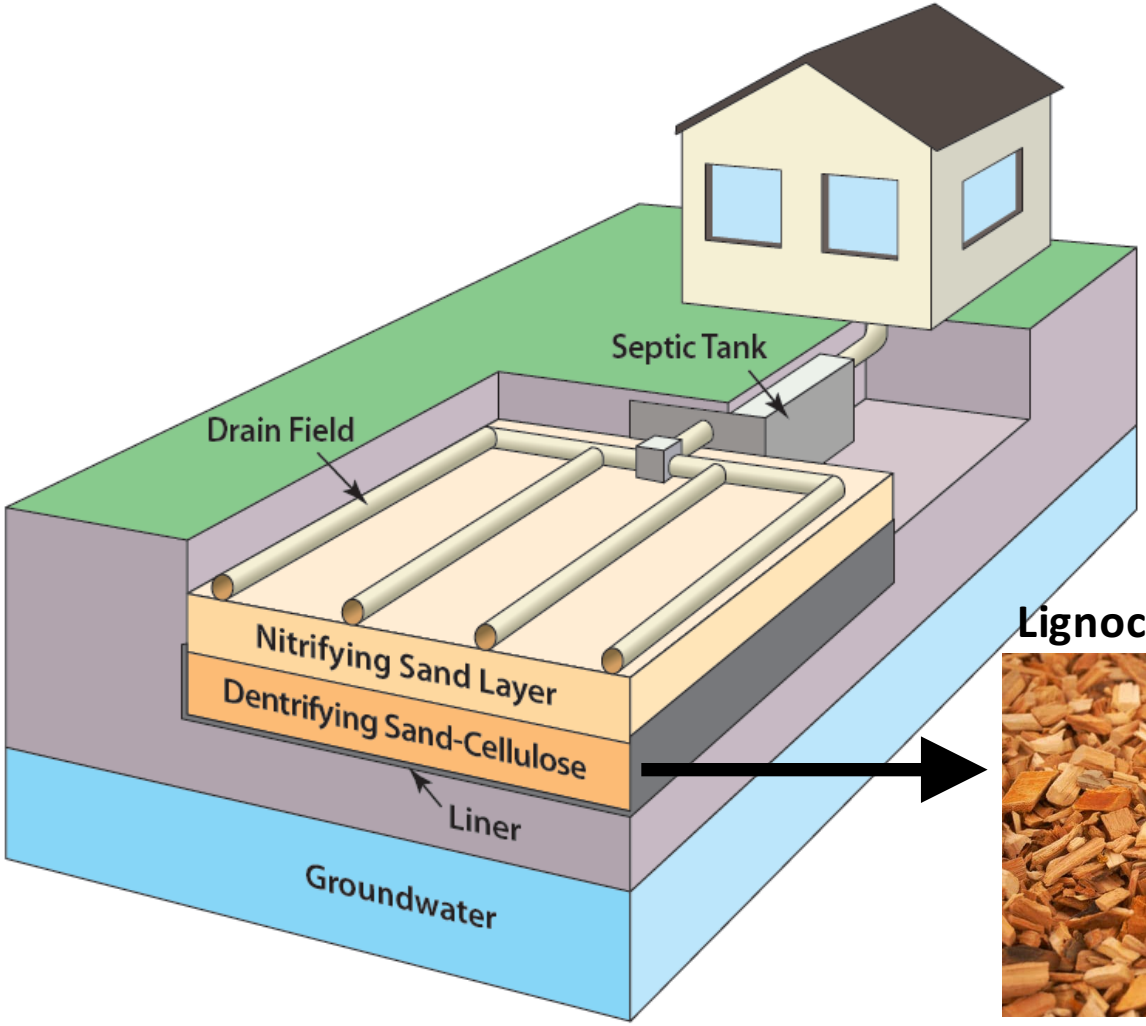
Norweco Singlair TNT

Stony Brook University

The New York State Center for Clean Water Technology:

Harnessing science to engineer clean water for the protection of public health and the environment in New York and beyond.

Nitrogen Removing Biofilters (NRB)



Materials list:

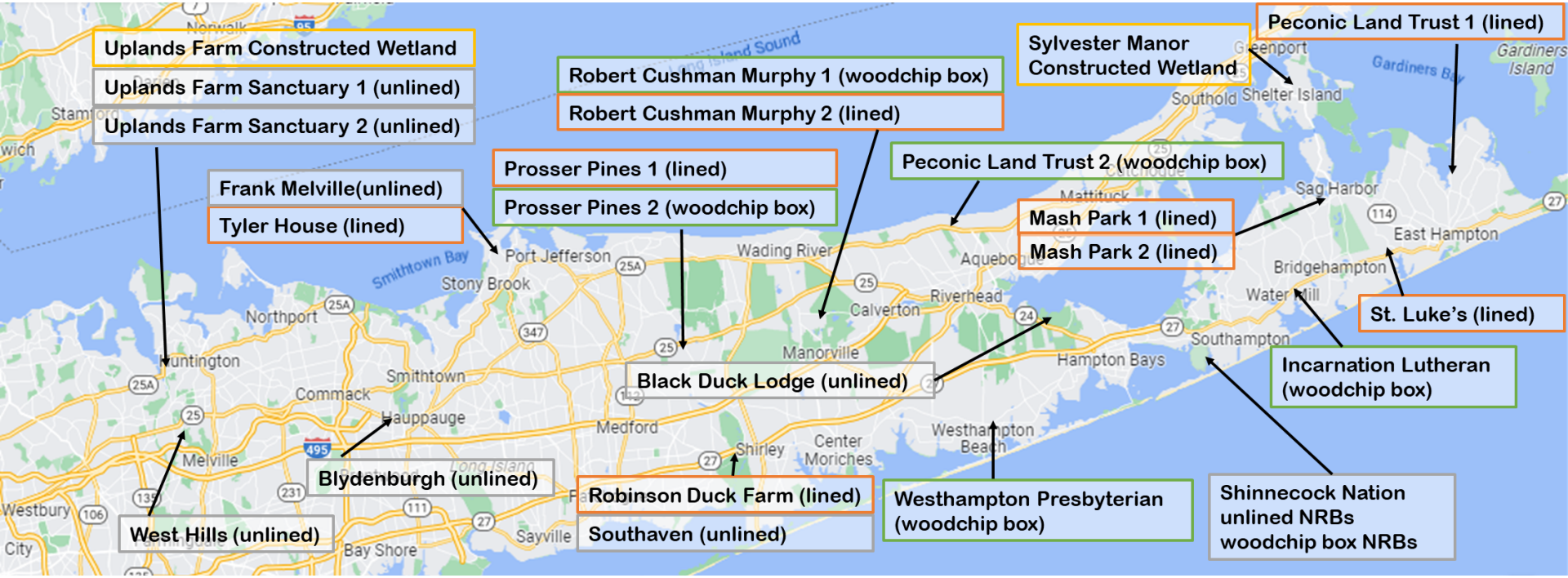
- Sand
- Wood chips
- PVC pipe
- Home Depot pump

Lignocellulose = wood, chips

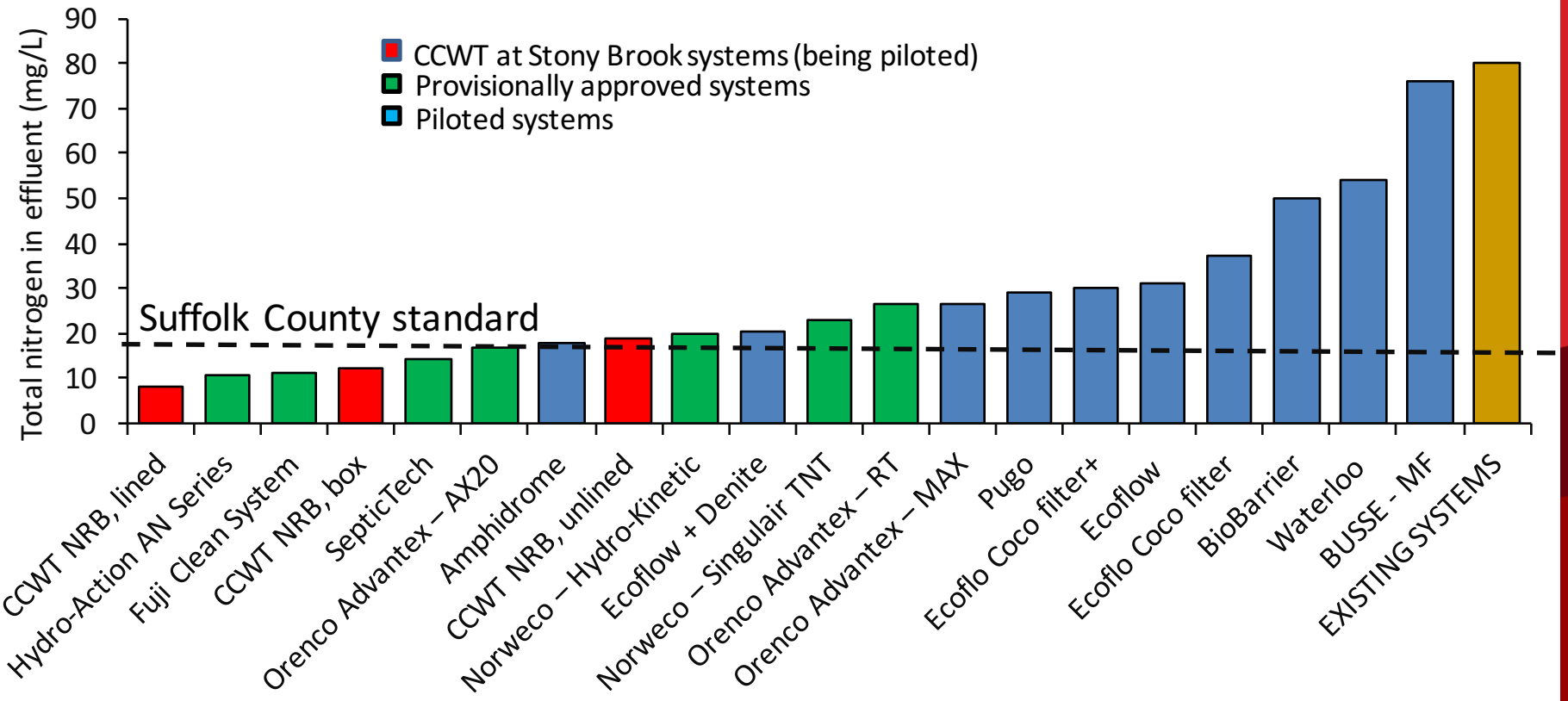
Carbon source to promote denitrification

More than 30 NRBs installed since 2018

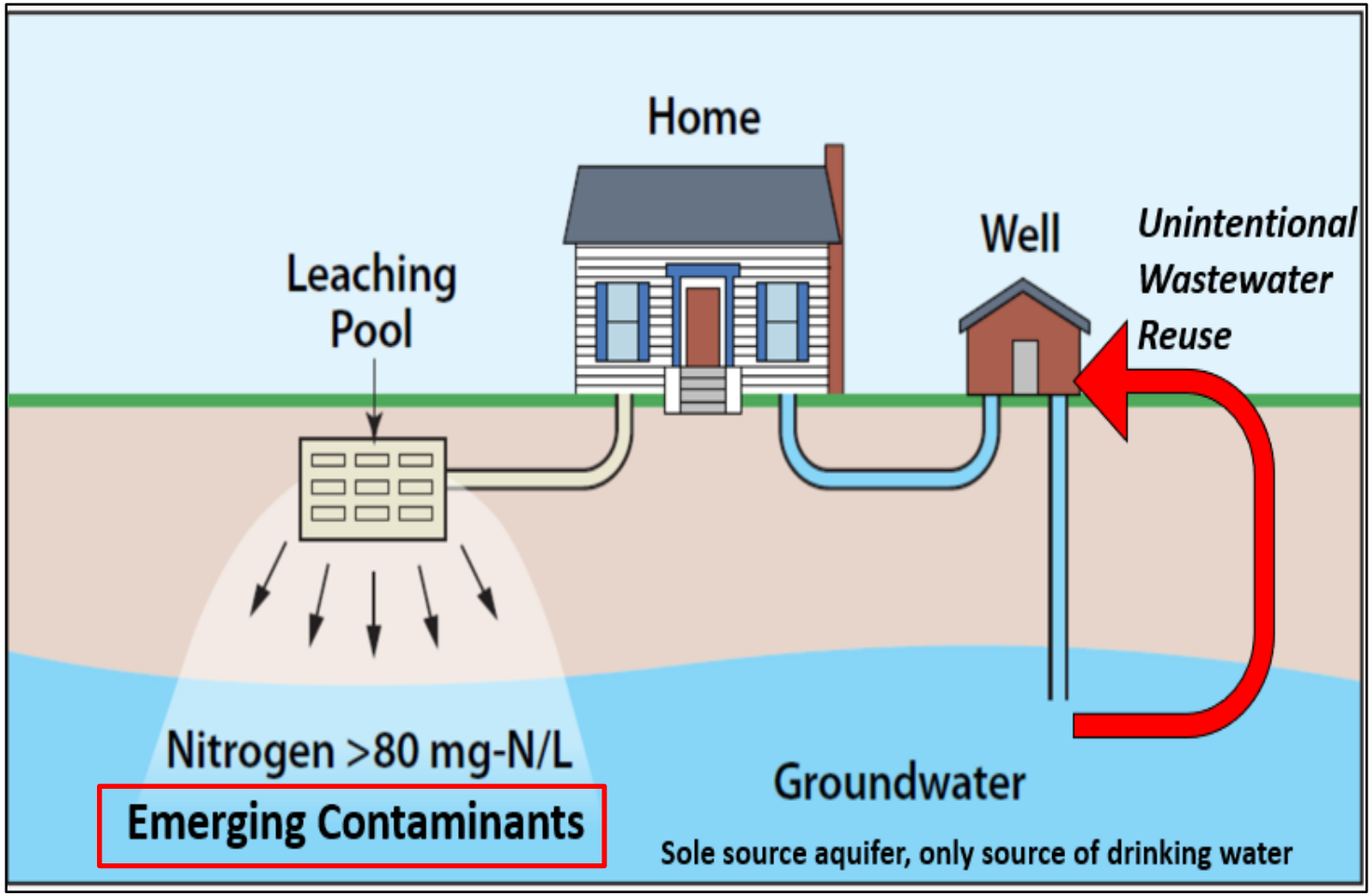
Funded by more than $1M in **external grants** obtained by CCWT



Comparison of I/A performance in Suffolk County



Wastewater contains more than nitrogen



NRBs remove 60 – 100% of 25 emerging contaminants

- All removal percentages exceed this of sewage treatment plants.
- Removal occurs via bacterial degradation within the oxic sand filter layer of the NRB; no other approved I/A system has that layer.
- No other I/A system has been assessed for the removal of these compounds.

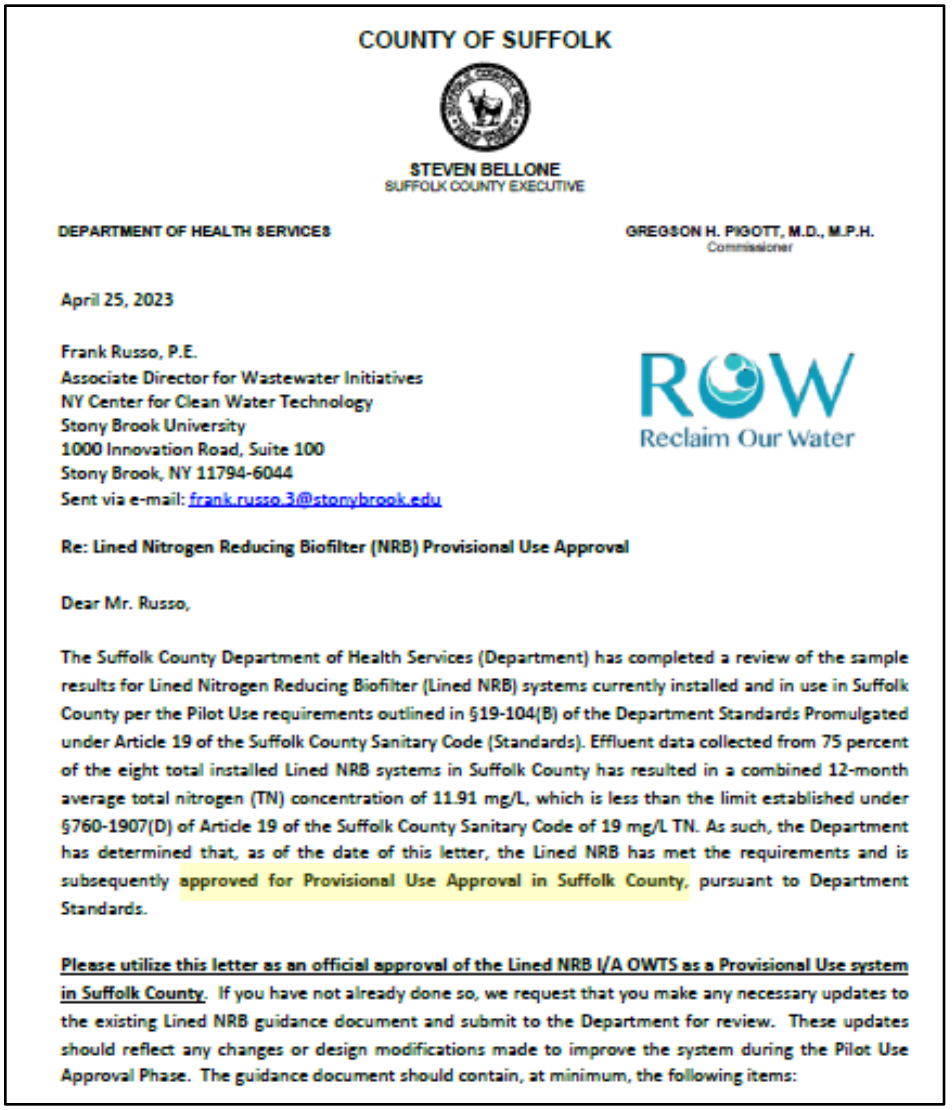
Compound	Use	Removal (%)
1,4-dioxane	solvent	60%
Acetaminophen	NSAID	94 – 100
Caffeine	stimulant	99 – 100
Paraxanthine	human metabolite of caffeine	98 – 99
DEET	mosquito repellant	82 – 96
Nicotine	stimulant	92 – 97
Cotinine	human metabolite of nicotine	86 – 98
Sulfamethoxazole	antibiotic	85 – 97
Diphenhydramine	antihistamine	97 – 95
Trimethoprim	antibiotic	87 – 90
Ciprofloxacin	antibiotic	64 – 78
Atenolol	beta blocker	88 – 97
Metoprolol	beta blocker	85 – 90
Diltiazem	calcium channel blocker	76 – 90
Carbamazepine	anticonvulsant	51 -60
Ketoprofen	NSAID	68 – 74
TCEP	flame retardant	60 – 70
Salbutamol	bronchiodialator	50 – 78
Ranitidine	anti-acid	82 – 100
Diclofenac	NSAID	76
Propranolol	beta blocker	98 – 100
Venlafaxine	antibiotic	98
Fluoxetine	antidepressant (SSRI)	64 – 66
Lamotrigine	anticonvulsant	82
Primidone	anticonvulsant	58

Venkatesan et al., 2021; Sci. Total Environ.
Clyde et al 2021, Water Research

Nitrogen Removing Biofilters have been approved for provisional use in Suffolk County

Installations offered by

- A&A Sewer and Drain,
- Excav Services,
- Spadefoot Design.



COUNTY OF SUFFOLK

STEVEN BELLONE
SUFFOLK COUNTY EXECUTIVE

DEPARTMENT OF HEALTH SERVICES

GREGSON H. PIGOTT, M.D., M.P.H.
Commissioner

April 25, 2023

Frank Russo, P.E.
Associate Director for Wastewater Initiatives
NY Center for Clean Water Technology
Stony Brook University
1000 Innovation Road, Suite 100
Stony Brook, NY 11794-6044
Sent via e-mail: frank.russo.3@stonybrook.edu

ROW
Reclaim Our Water

Re: Lined Nitrogen Reducing Biofilter (NRB) Provisional Use Approval

Dear Mr. Russo,

The Suffolk County Department of Health Services (Department) has completed a review of the sample results for Lined Nitrogen Reducing Biofilter (Lined NRB) systems currently installed and in use in Suffolk County per the Pilot Use requirements outlined in §19-104(B) of the Department Standards Promulgated under Article 19 of the Suffolk County Sanitary Code (Standards). Effluent data collected from 75 percent of the eight total installed Lined NRB systems in Suffolk County has resulted in a combined 12-month average total nitrogen (TN) concentration of 11.91 mg/L, which is less than the limit established under §760-1907(D) of Article 19 of the Suffolk County Sanitary Code of 19 mg/L TN. As such, the Department has determined that, as of the date of this letter, the Lined NRB has met the requirements and is subsequently approved for Provisional Use Approval in Suffolk County, pursuant to Department Standards.

Please utilize this letter as an official approval of the Lined NRB I/A OWTS as a Provisional Use system in Suffolk County. If you have not already done so, we request that you make any necessary updates to the existing Lined NRB guidance document and submit to the Department for review. These updates should reflect any changes or design modifications made to improve the system during the Pilot Use Approval Phase. The guidance document should contain, at minimum, the following items:

Georgica Pond Watershed Manager – Tom Varley

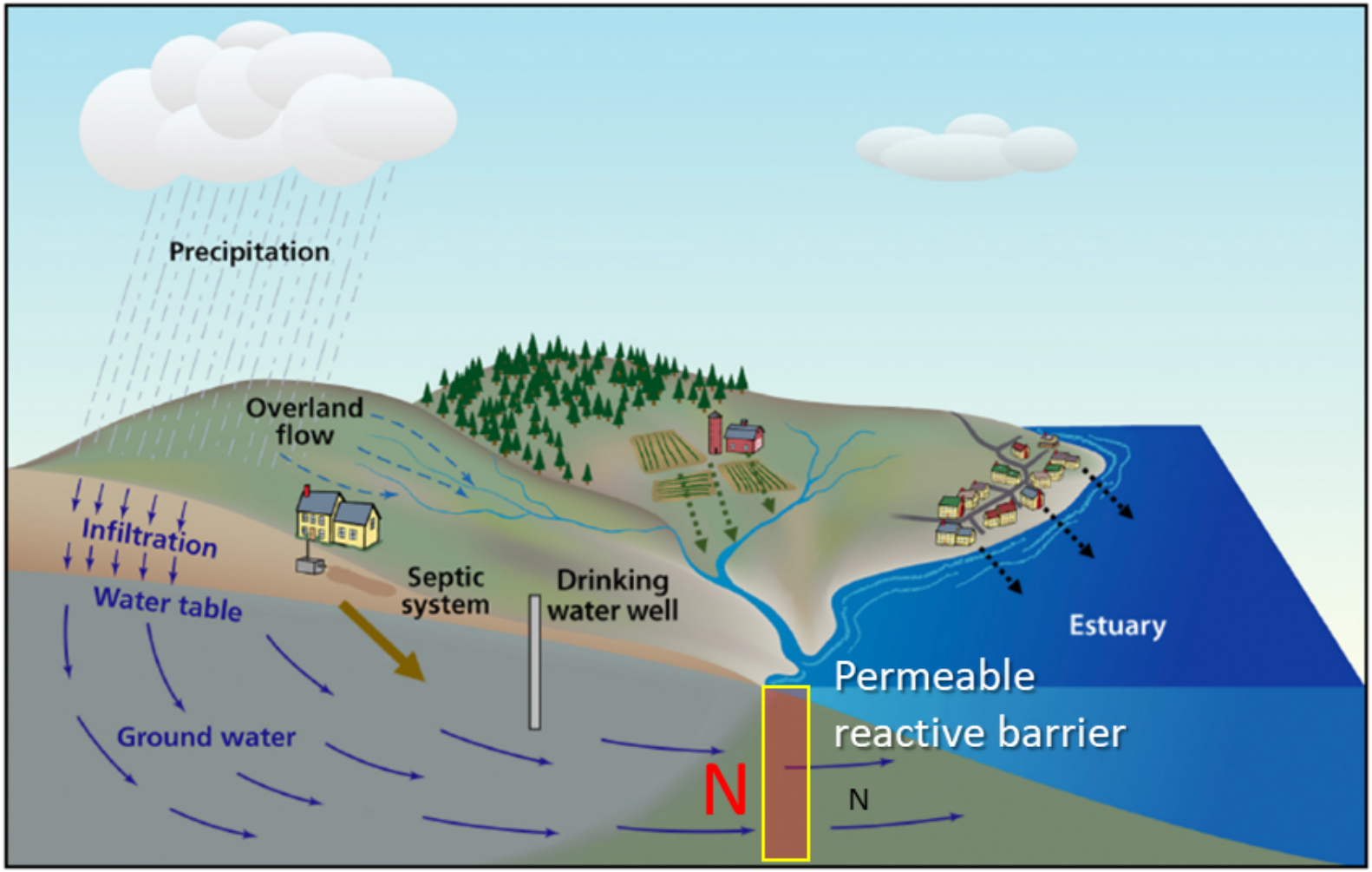
- 40 years experience in wastewater treatment specializing in operation & maintenance
- Certified Grade 4 Wastewater Operator in NY, NJ & CT
- Experience in groundwater remediation
- Working with Georgica Pond and Sagaponack Pond homeowners on septic upgrade.
- **Tom is here to help you seamlessly upgrade your septic systems**: System selection, system design, obtaining grants, installation, operation and maintenance.

Stony Brook University

NYS Center for Clean water Technology

PECONIC LAND TRUST

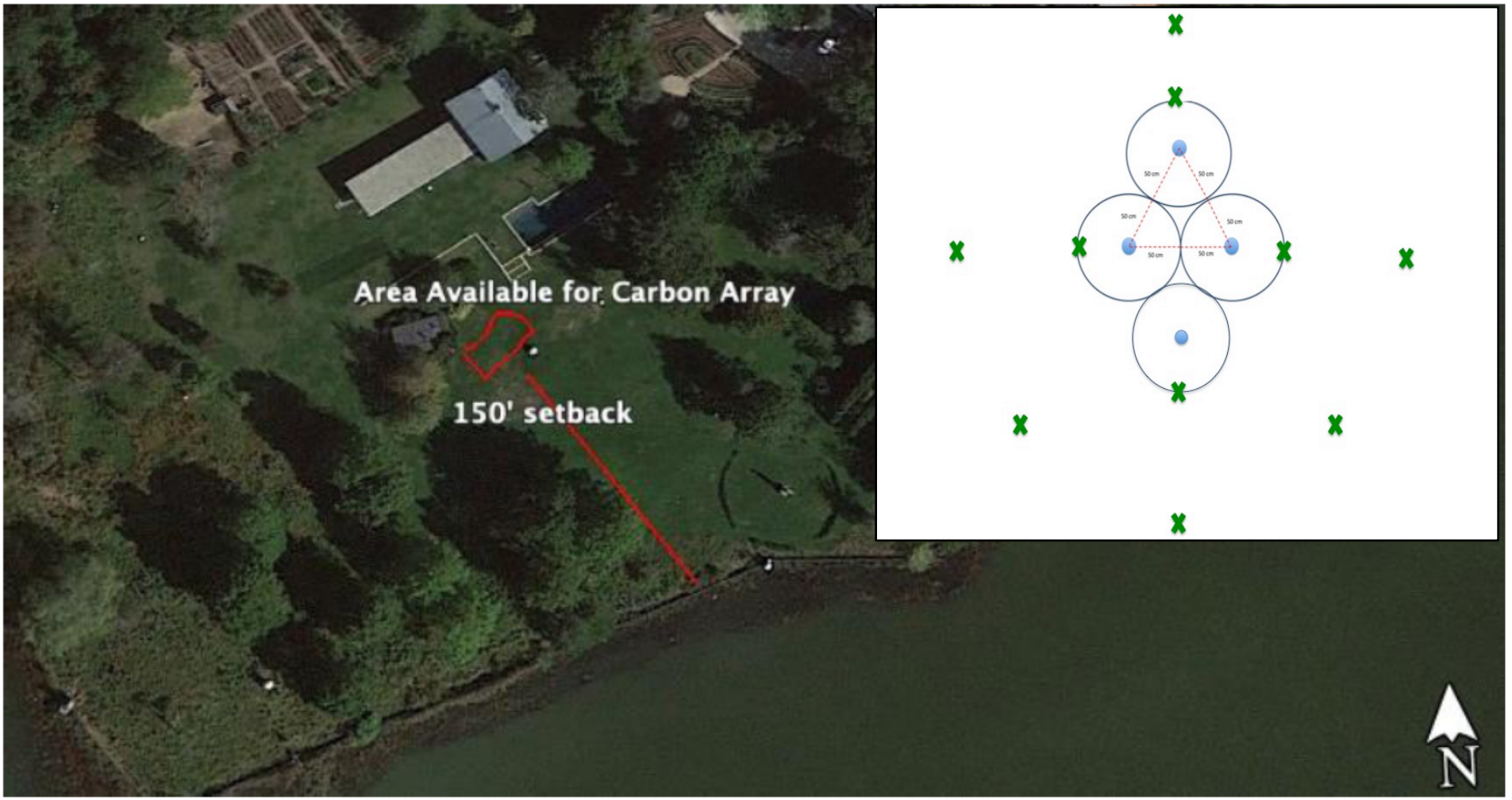
Permeable reactive barriers



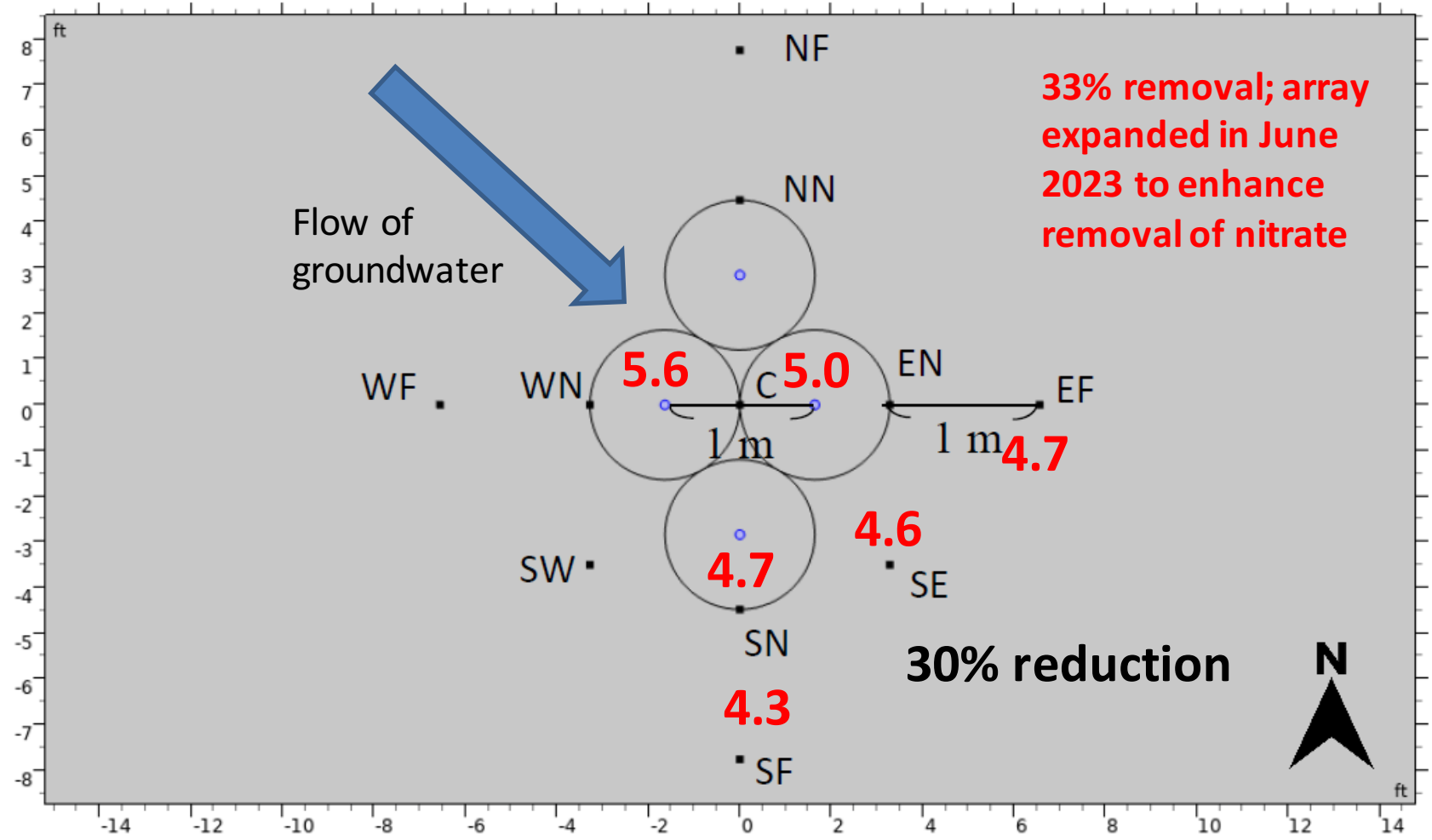
- It will take decades to upgrade hundreds of thousands septic systems on Long Island and for legacy contamination to flush out of the aquifer.
- PRBs allow for the removal of legacy N before entering ecosystems or well heads.

Carbon array installation barrier at the Creeks

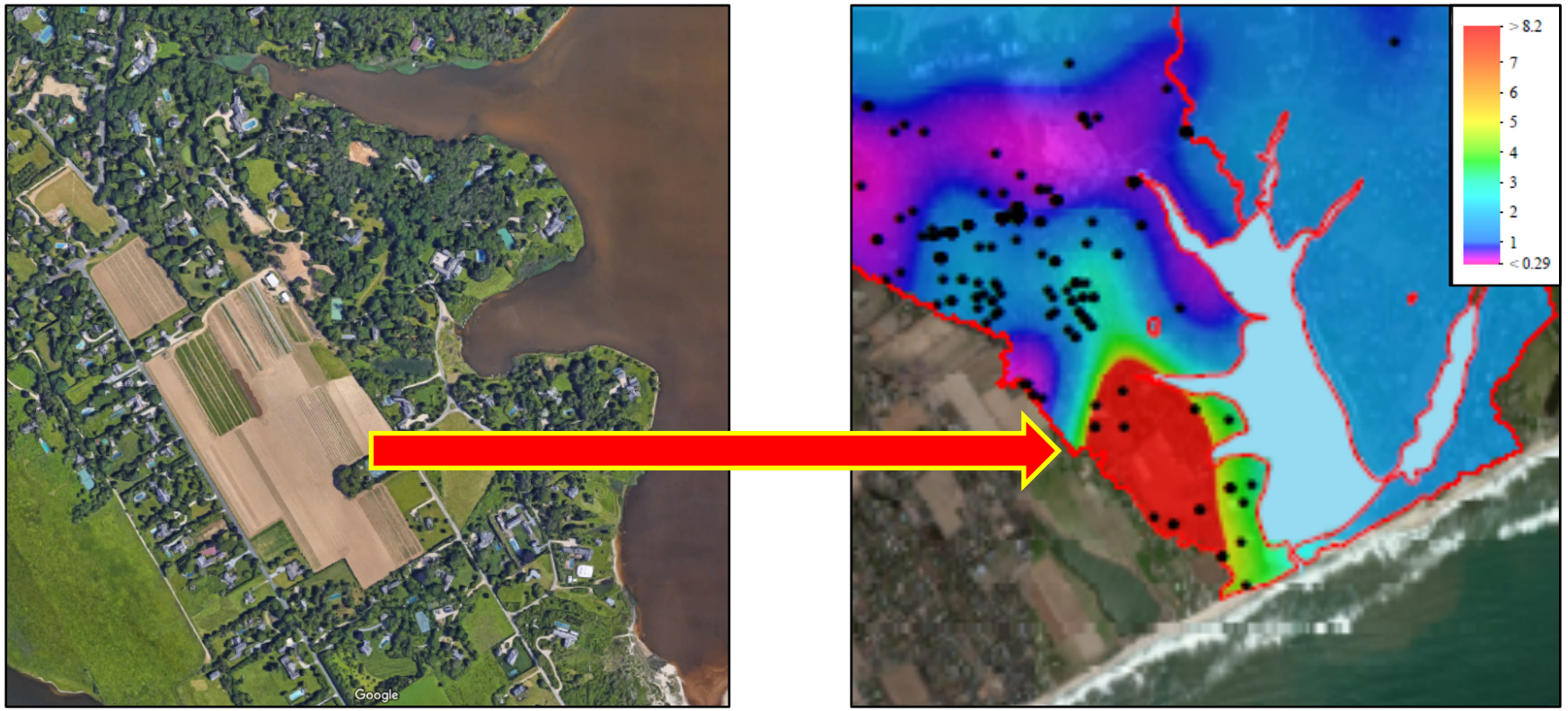
Carbon array installation at The Creeks



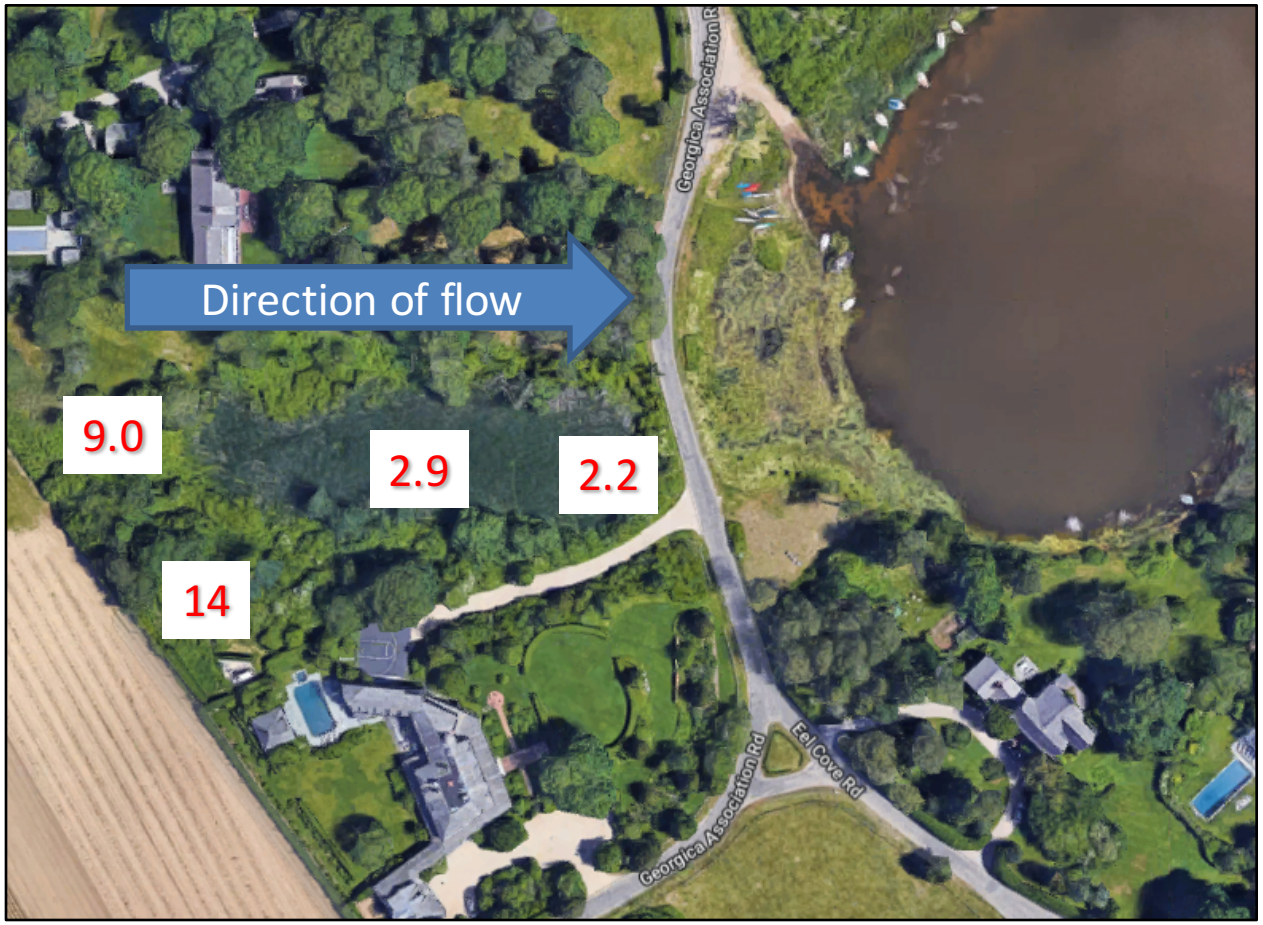
Nitrate concentrations (mg/L)



High nitrate plume entering Eel Cove



Eel Cove groundwater investigation
- *nitrate values in mg/L*



Kagan and Yass families are assisting in detailed groundwater study to site a PRB

OYSTERS in Georgica Pond

Oysters are 'Ecosystem Engineers'

Oysters are filter feeders, and when abundant can:

- Control phytoplankton abundance
- Reduce harmful algal blooms
- Improve water clarity

Georgica Pond may provide an ideal habitat for oyster restoration

- Oysters thrive in brackish waters
  - Low salinities provide a disease refuge

Georgica Pond may provide an ideal habitat for oyster restoration

- Oysters thrive in brackish waters
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- Restricted circulation with ocean may result in high retention of larvae

Georgica Pond may provide an ideal habitat for oyster restoration

- Oysters thrive in brackish waters
  - Low salinities provide a disease refuge
- Restricted circulation with ocean may result in high retention of larvae
- Nearby and very similar Mecox Bay has most robust oyster population on Long Island's South Shore

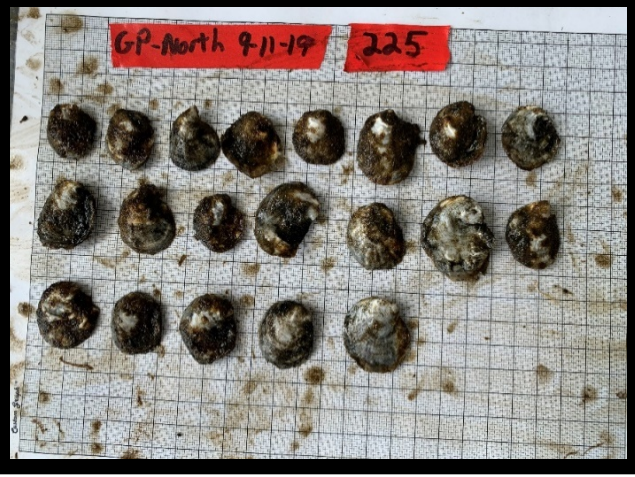

Can oysters survive, grow, and reproduce in Georgica Pond?

Phase 1 – Oyster Seed

- Deployed three size/age classes of hatchery-produced oyster seed in cages
  - 2018 & 2019 year-classes deployed in summer 2019
  - 2020 year-class deployed in summer 2020 (smallest initial size)

2018 year-class "one-year olds"

2019 year-class "zero-year olds"



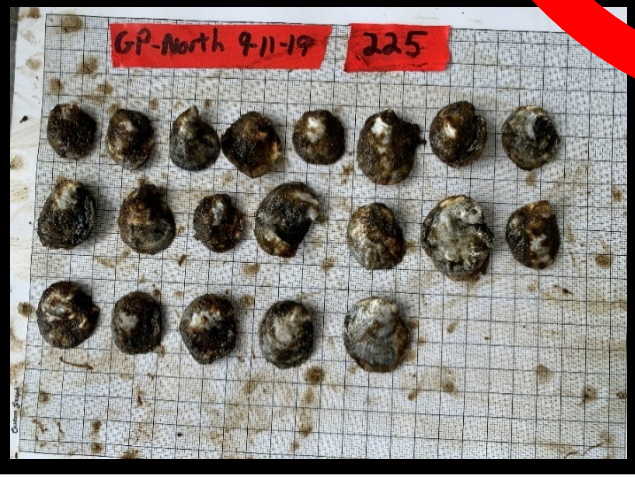
2020 year-class "zero-year olds"

Phase 1 – Oyster Seed

- Deployed three size/age classes of hatchery-produced oyster seed in cages
  - 2018 & 2019 year-classes deployed in summer 2019
  - 2020 year-class deployed in summer 2020 (smallest initial size)
  - Predators excluded

2018 year-class "one-year olds"

2019 year-class "zero-year olds"

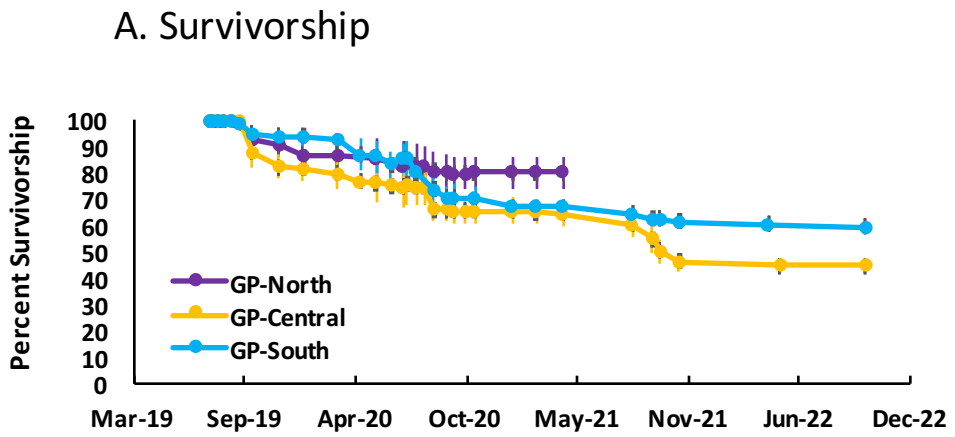


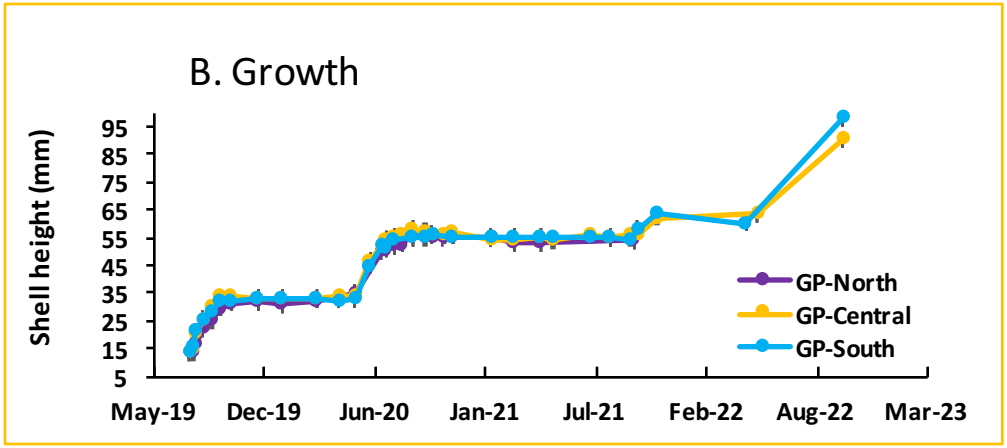
Phase 1 – Oyster Seed

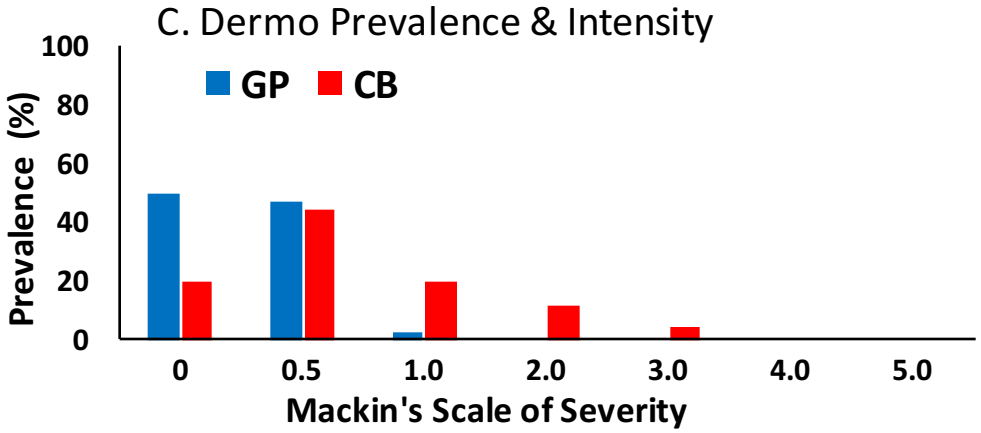
- Three near-shore study locations
  - North-South transect across the Pond

Phase 1 – Oyster Seed

- In general, **high survivorship and growth** of oysters in cages over **four year period**
  - North site terminated in 2021 due to mud
- **Low** prevalence and intensity of **disease** (Dermo) in Georgica Pond compared to more saline Long Island embayments







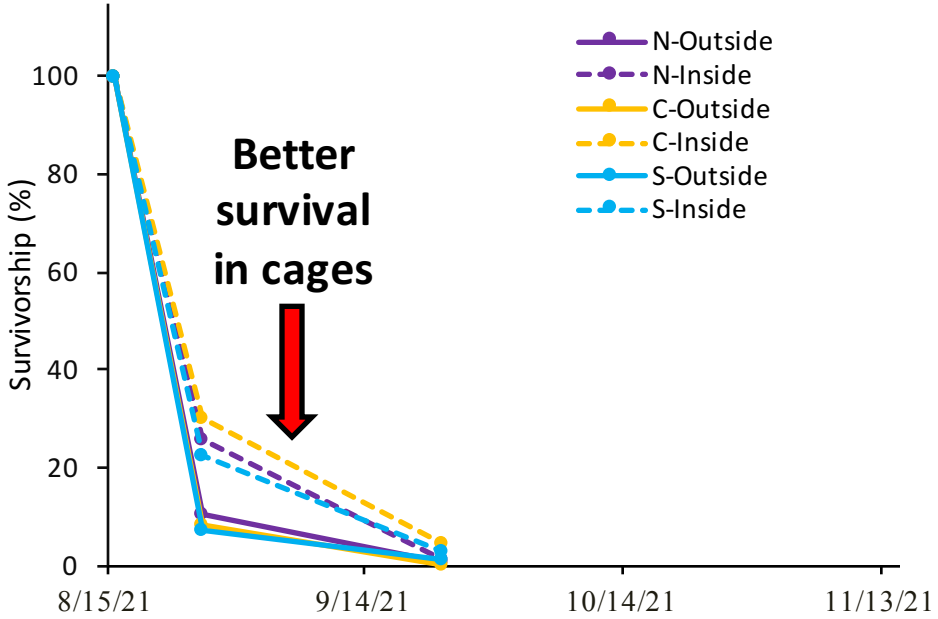
Phase 2 – Spat-on-shell

- Spat-on-shell produced at the Southampton Marine Station by setting larvae onto oyster and surf clam shell
- Spat-on-shell deployed in **two trials in 2021** when salinities in the Pond were low before the cut was opened
  - ***Trial 1:*** Deployed spat-on-shell **inside and outside of cages to evaluate impacts of predation**
  - ***Trial 2:*** **Acclimated spat to low salinity** and deployed acclimated and unacclimated spat into Georgica Pond

Phase 2 – Oyster Seed

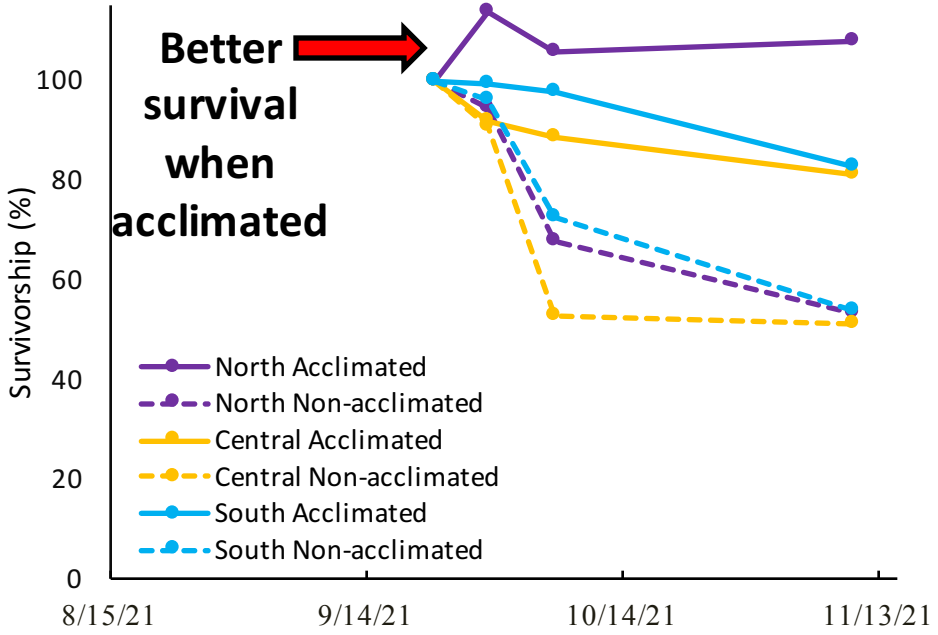
Trial 1 Results

- **More rapid mortality of spat-on-shell outside cage than inside cage** at all sites suggests predation is contributing to mortality, but is not the primary cause as mortality was high in both treatments



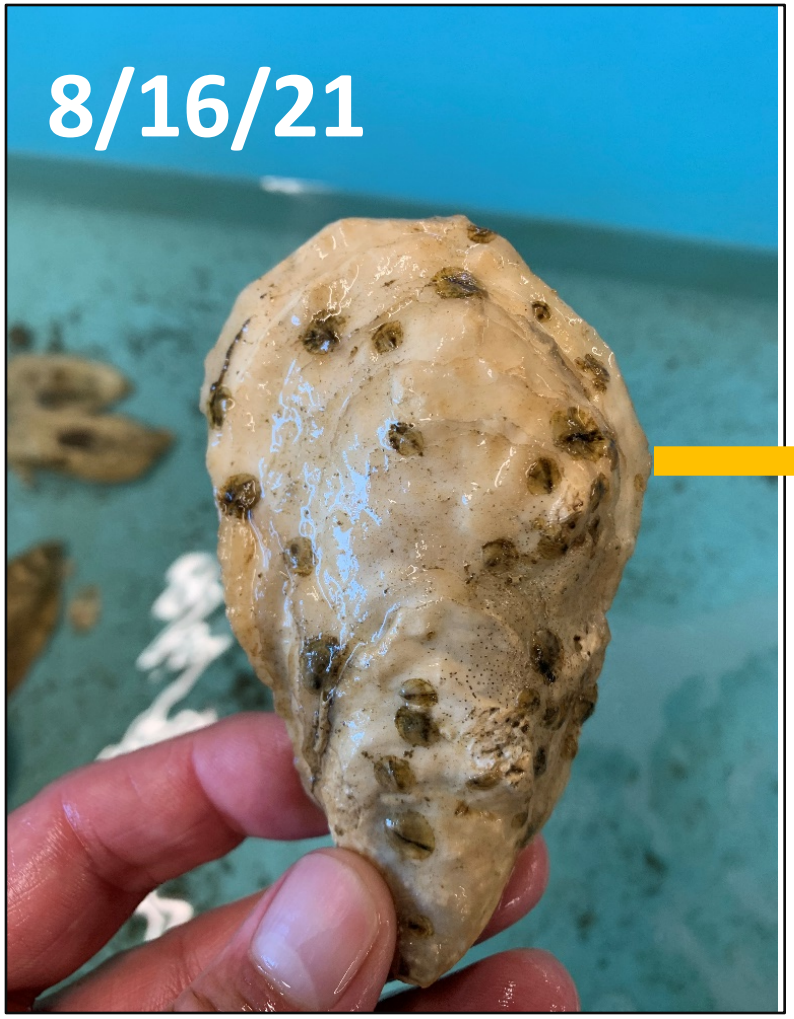
Trial 2 Results

- Higher survival of spat-on-shell that was acclimated to low salinity before deployment
- Rapid salinity change during stressful summer temperature may be reason for high mortality in Trial 1

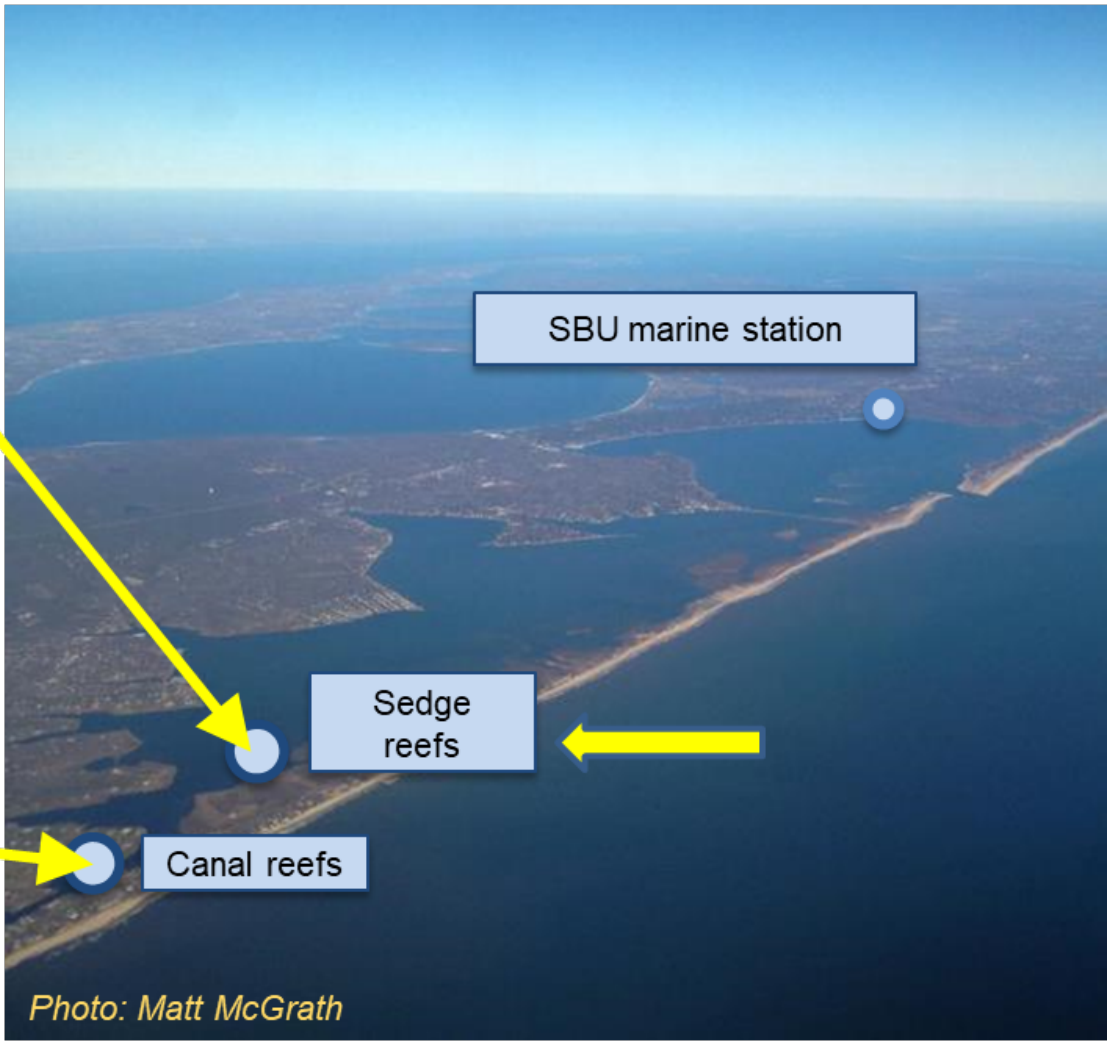


Phase 2 – Oyster Seed; *Trial 2 Results*

- High survivorship and growth of spat-on-shell; ***two inch oysters in ~one year!***



First eight NYSDEC permitted oyster reefs in NYS constructed across western Shinnecock Bay, 2017 - 2023



Oyster reef, Shinnecock Bay

Phase 3 – Small Oyster Reef, 2022 - 2023

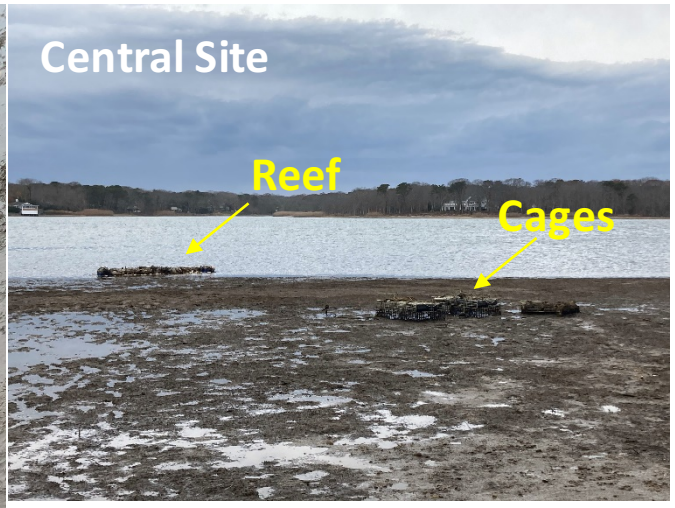
- Installed small test oyster reefs at two sites (central and south)
- Preliminary surveys of potential areas identified these two sites as having most firm bottom

Phase 3 – Small Oyster Reef

- At each site, placed twelve ‘shell bags’ in two adjacent, parallel lines on top of a base of loose shell
- Each shell bag was filled with five gallons of clean shell on which oyster spat was set

Phase 3 – Small Oyster Reef

- Reefs were constructed on 11/22/22 when water level was low after the first cut opening in November 2022
- Re-opening of the cut several days lowered water level further and exposed the reefs, requiring the reefs to be moved further from shore



Phase 3 – Small Oyster Reef

- As of August 2023, growth and survival has been lower compared to the spat on shell deployed in cages in 2021.
- The extra disturbances or predation may be responsible for the low growth and survivorship
- Reefs will be supplemented and expanded in the fall, after the cut is opened, potentially with predator exclusion.

Conclusions:

- Georgica Pond suffers from algal blooms, blue-green algae, low oxygen, and fish kills.
- Harvesting macroalgae has been coincident with improved conditions.
- Algal blooms are promoted by excessive nitrogen.
- Suffolk County's 2020 Subwatersheds Study's findings closely match the 2015 and 2022 study of Georgica Pond by Stony Brook University
- Most of the nitrogen entering Georgica Pond comes from wastewater.
- Accelerating the removal of nitrogen from wastewater is the central long-term solution.
- Long-term, significantly improved water quality can occur in < 10 years if rapid action is taken now.
- Oysters can be part of long-term remediation

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Thank you for your attention.

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