Working Towards a Sustainable Remediation of Georgica Pond

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Stony Brook University
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

- Findings from 2024-2024
- 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

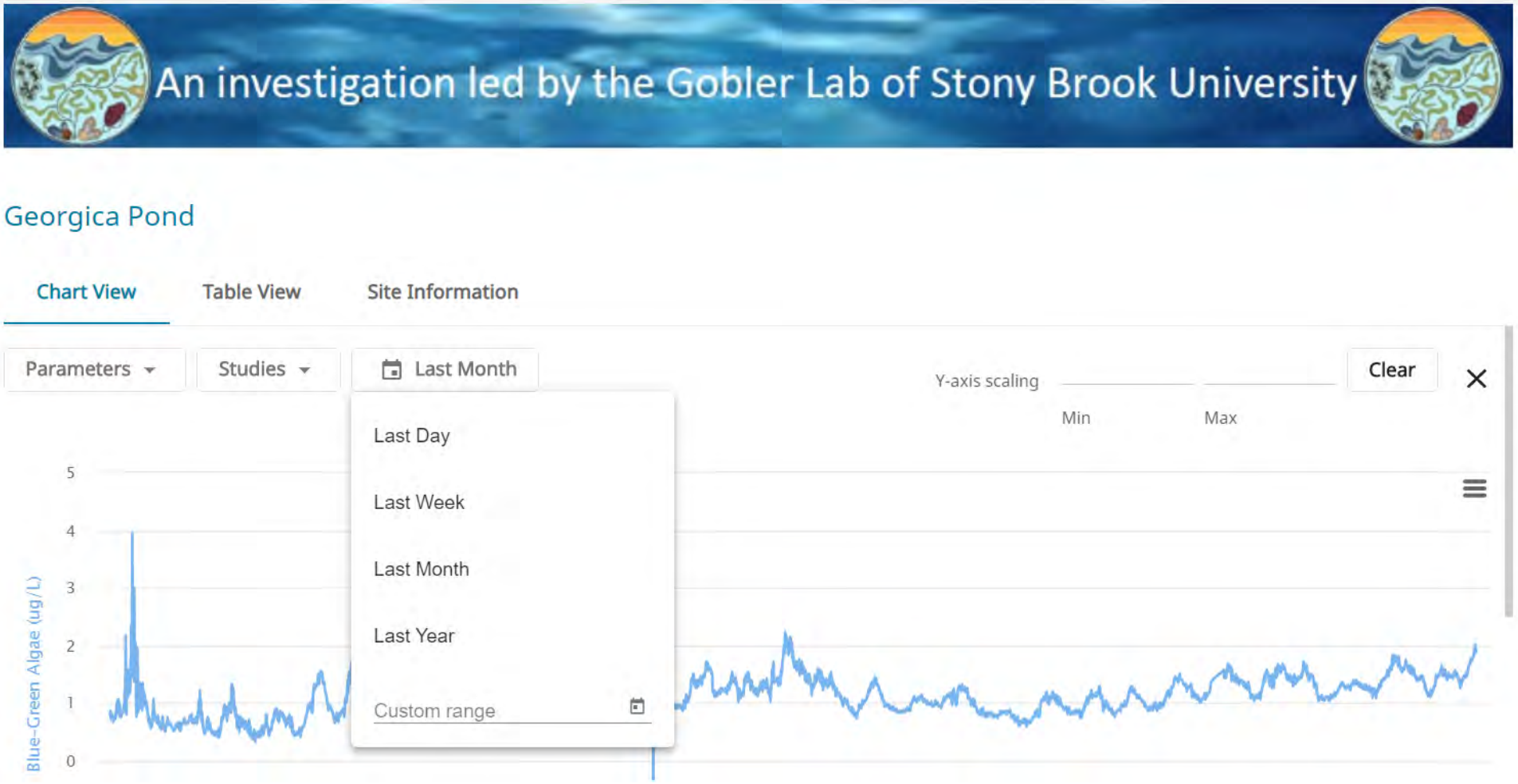
40.934192
Latitude

-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.

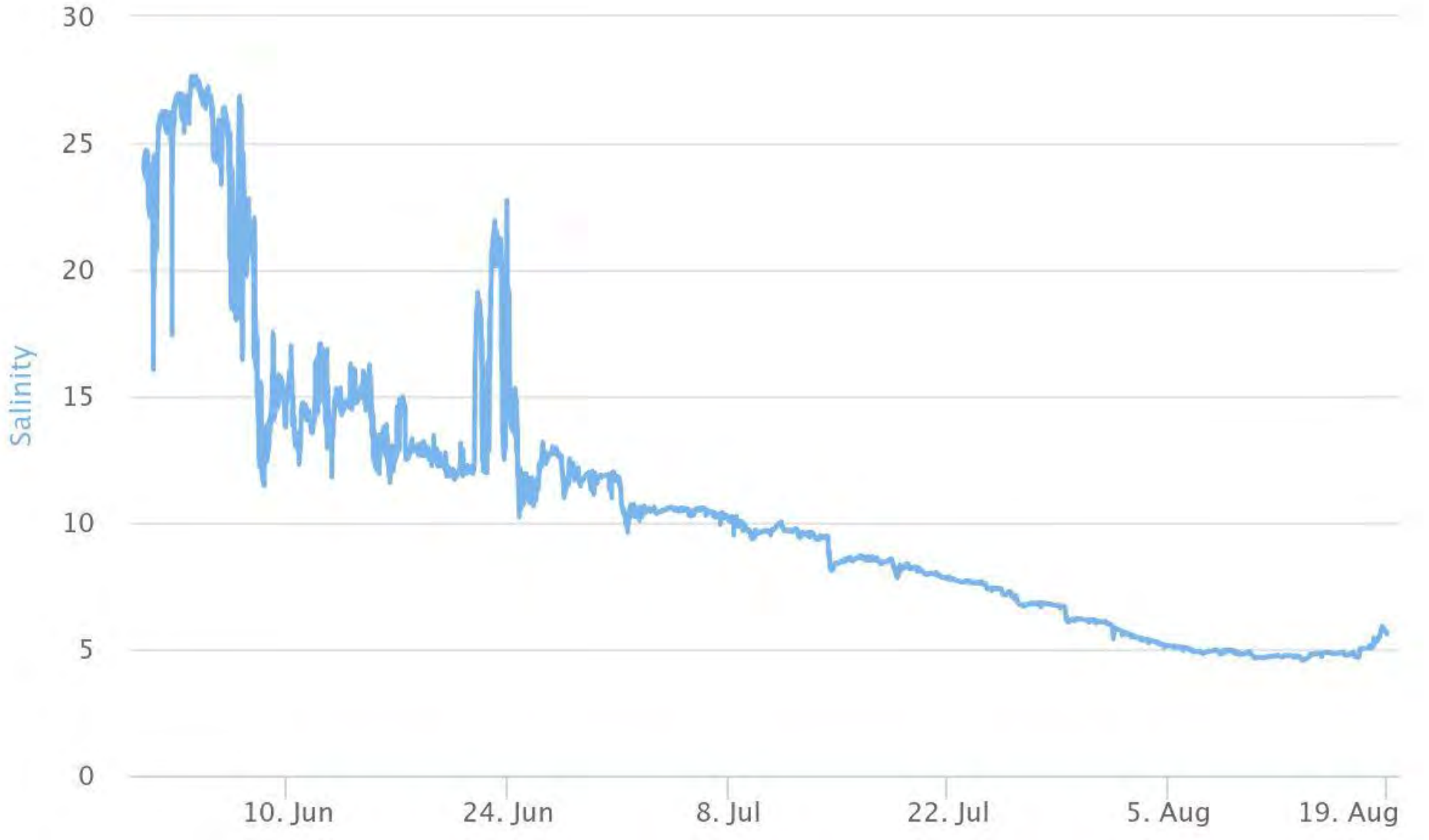
Real-time monitoring buoy



Cut opened in spring, fully closed since June 24th

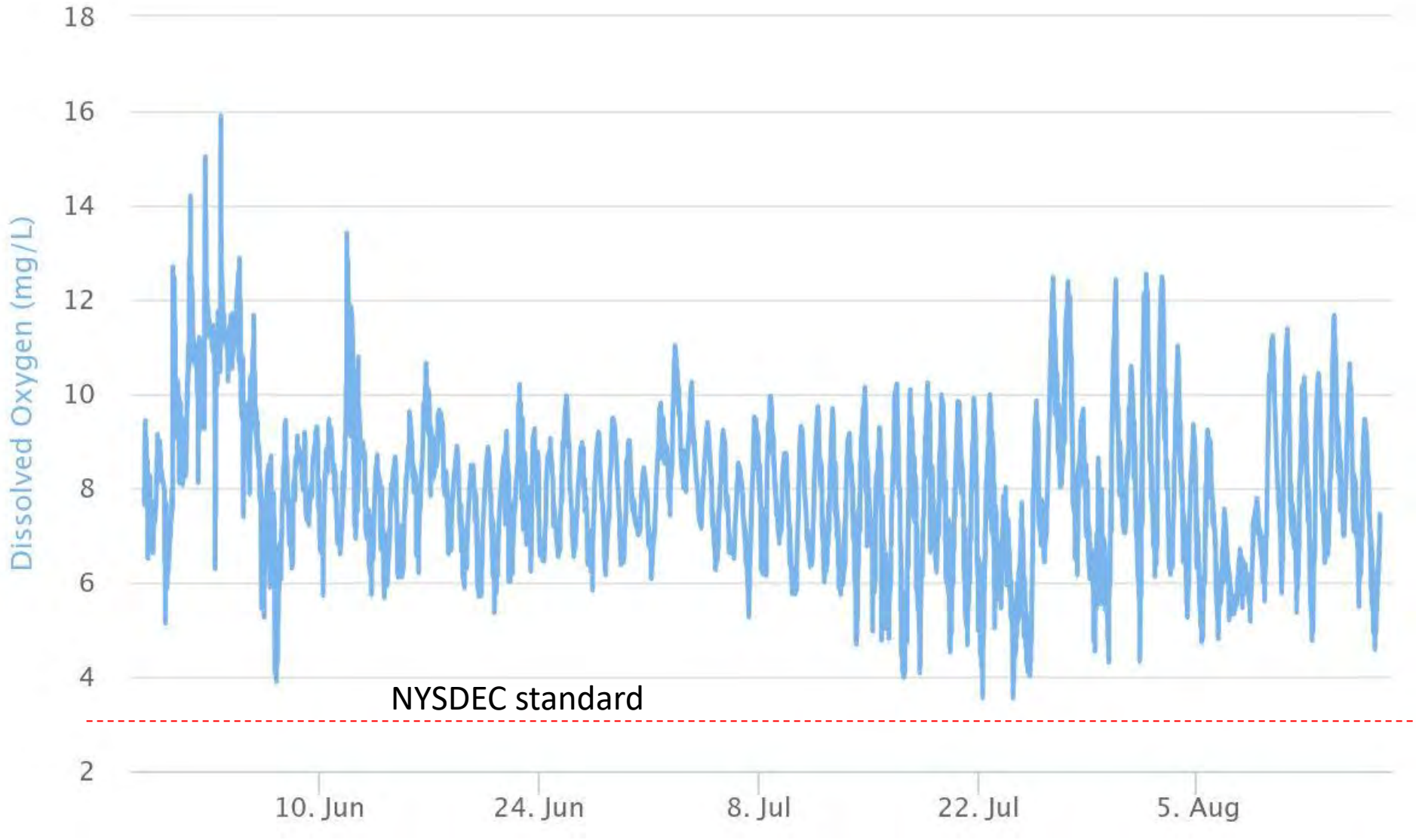
Salinity, 2024

Blue-green algae blooms threat when salinity < 15



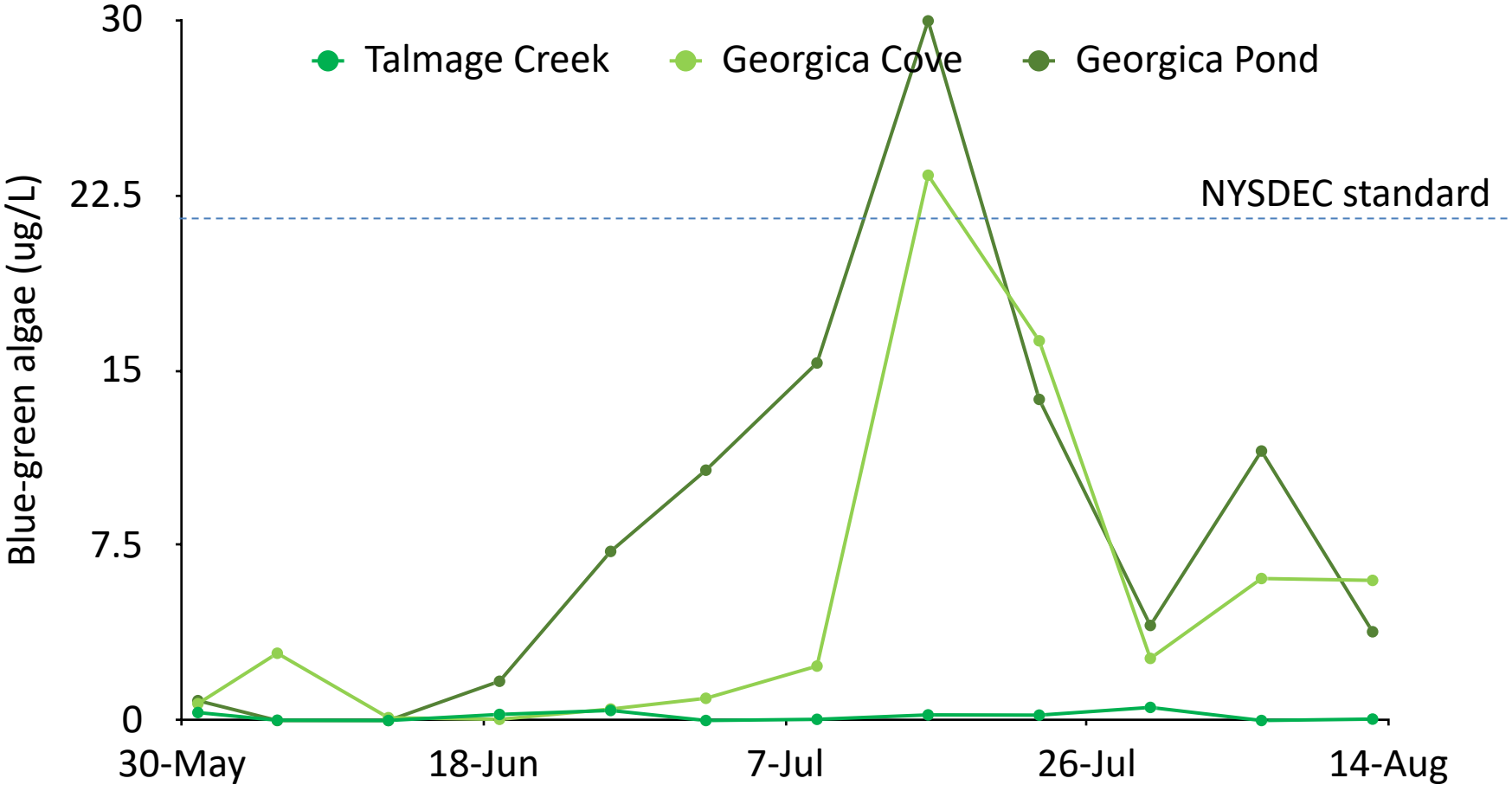
Dissolved oxygen, 2024

NYSDEC minimum standard = 3mg/L

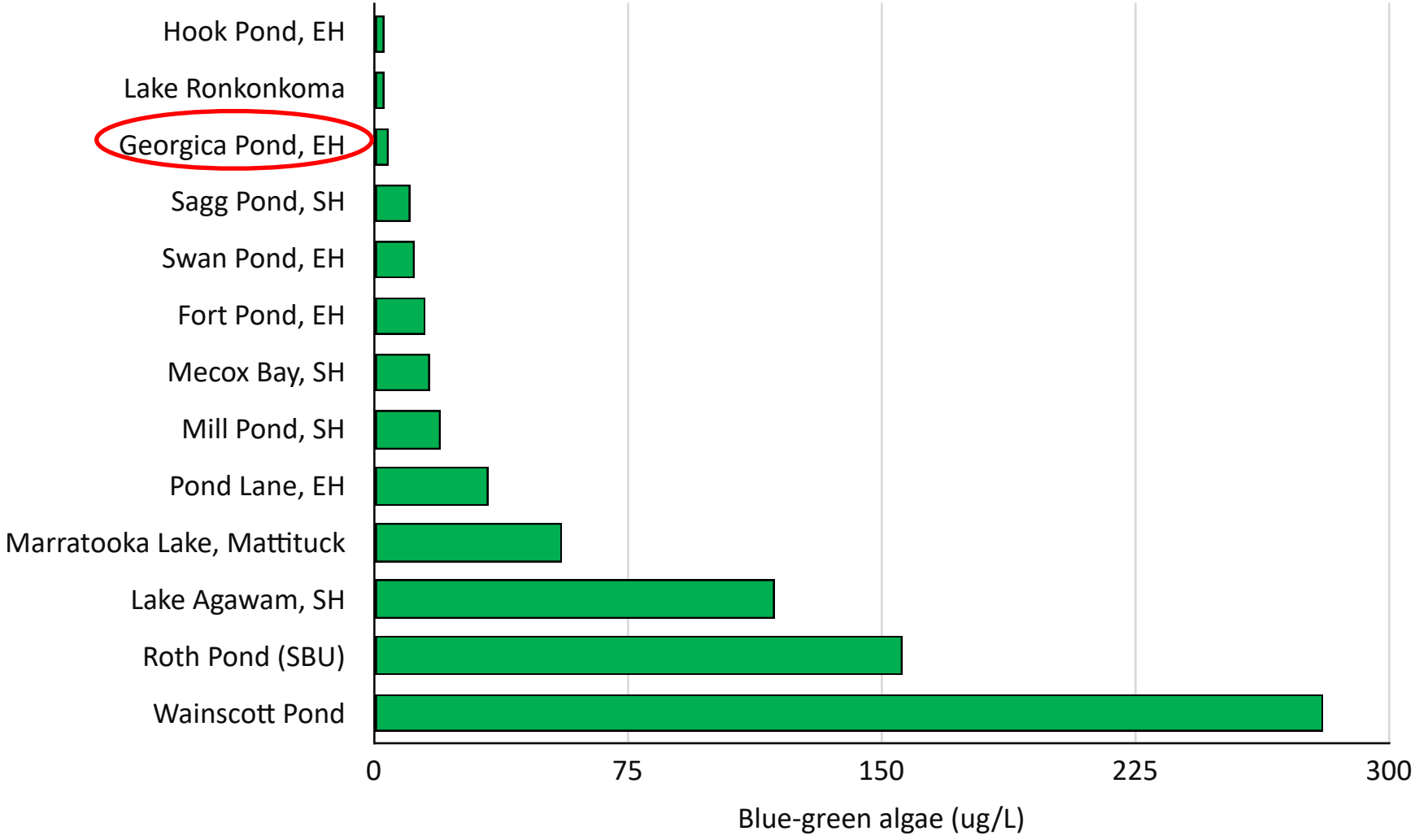


Blue-green algae, 2024

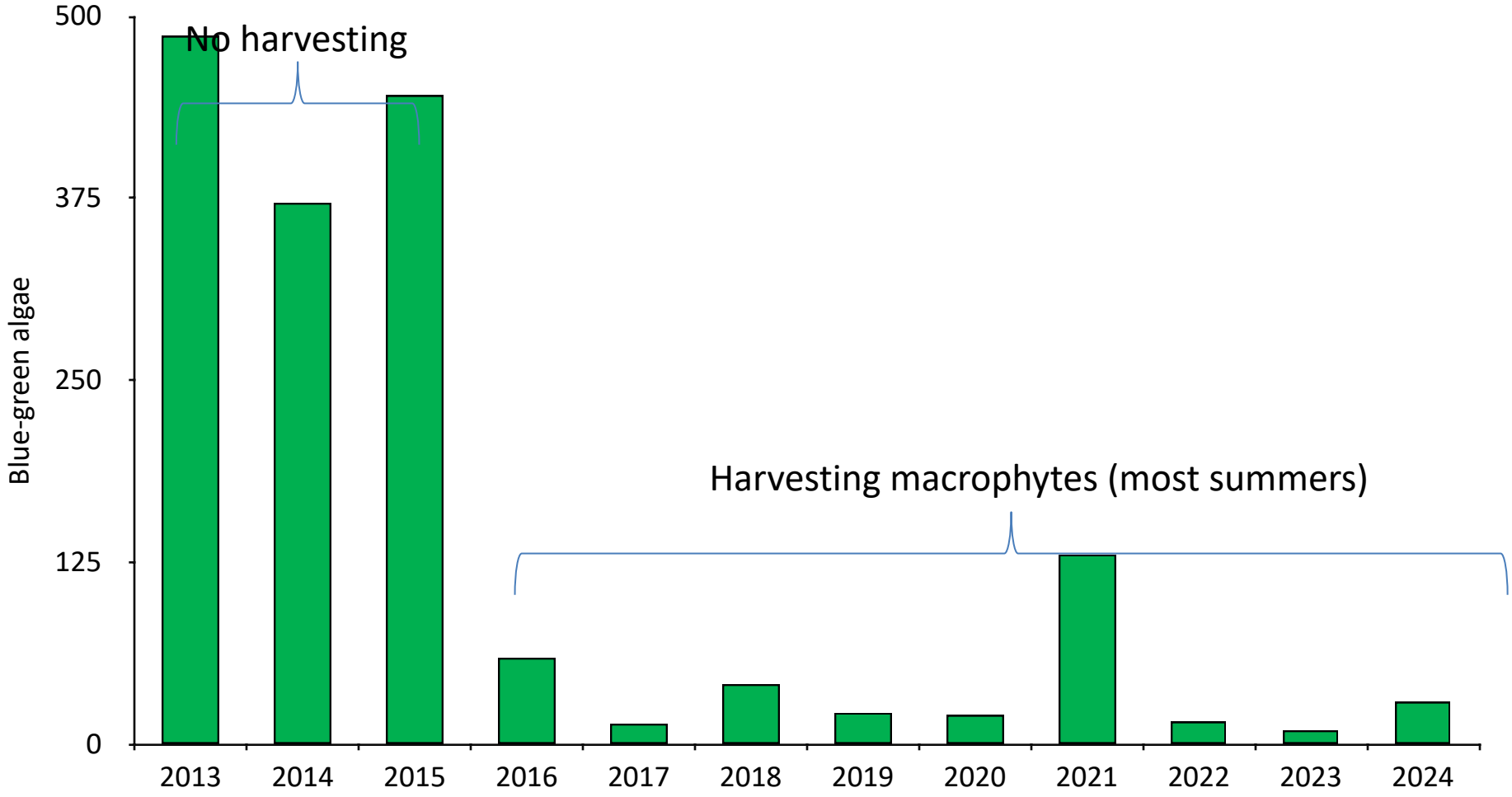
(NYSDEC standard = 25)



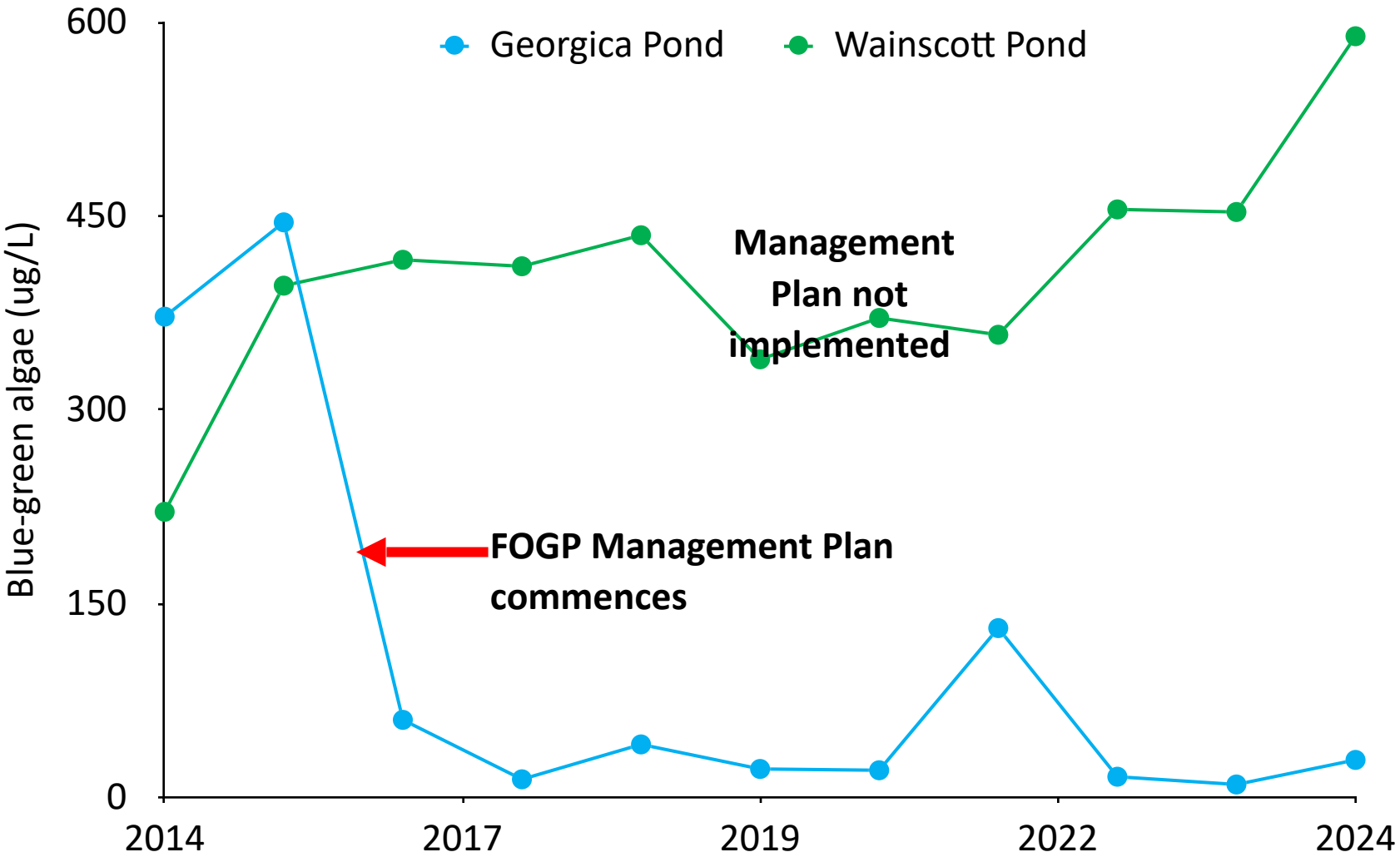
Comparison among local ponds, average blue-green algae, 2024



Decadal trend in blue-green algae

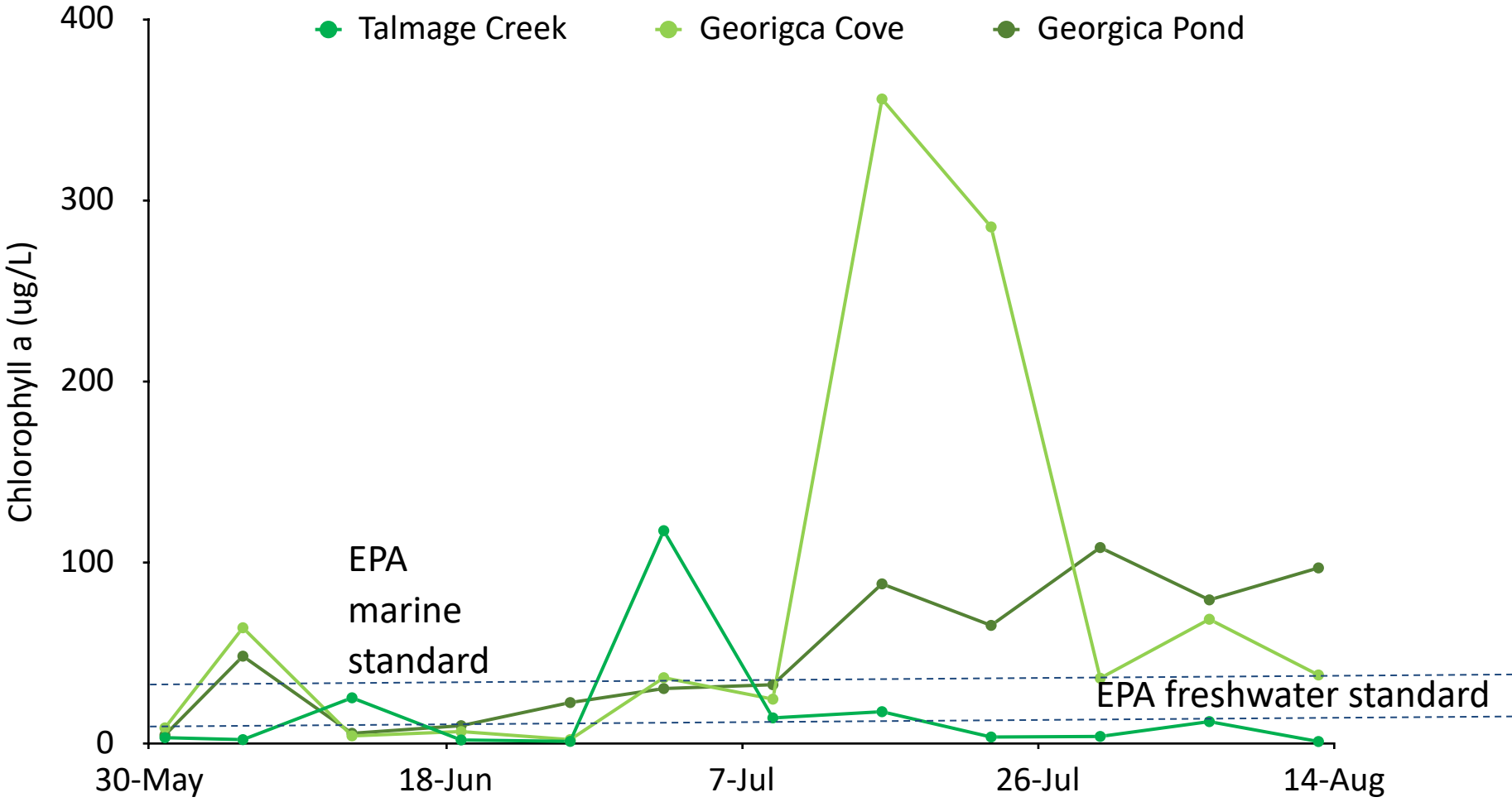


FOGP management plan is working!



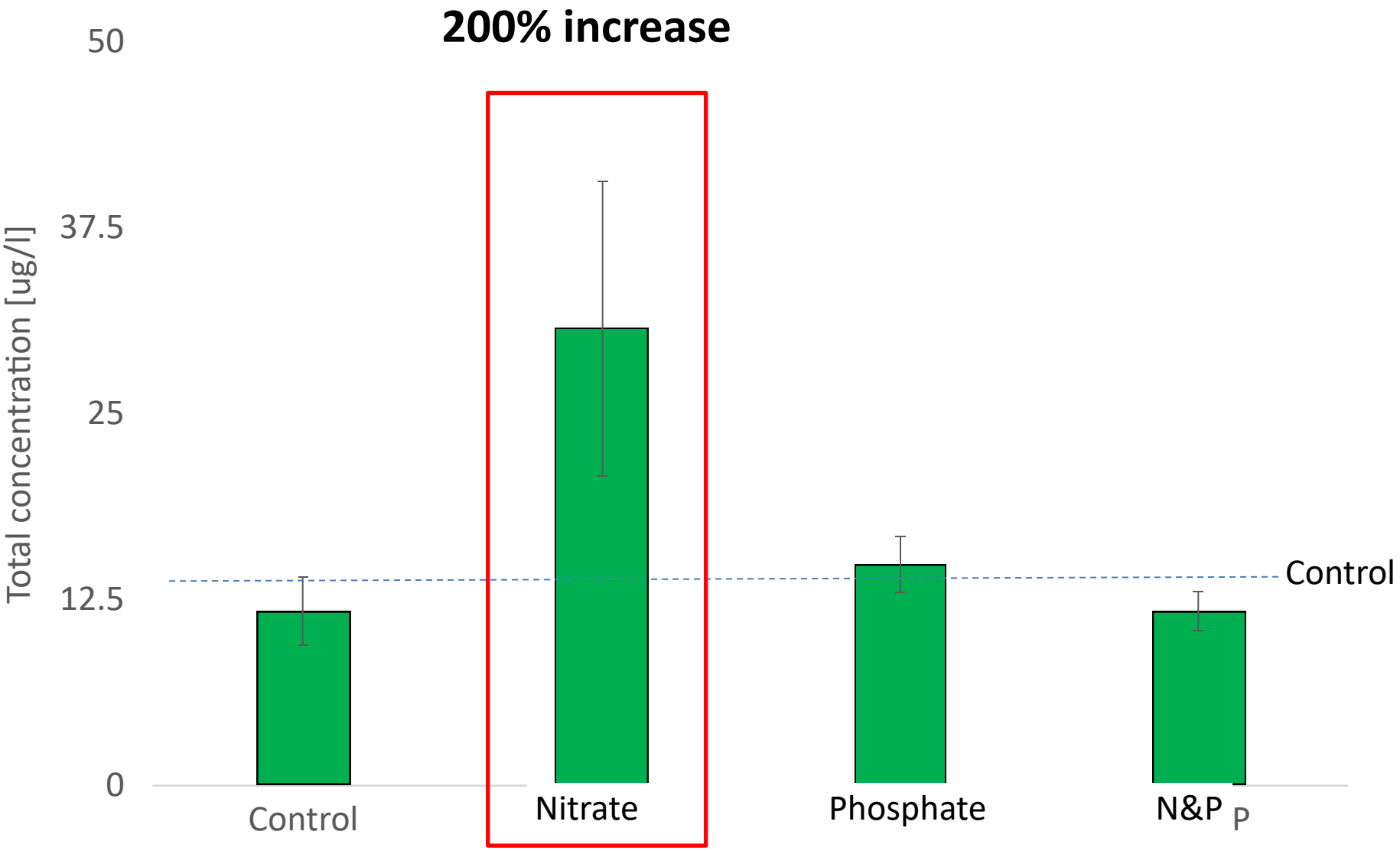
Total algae, 2024

Still work to be done!



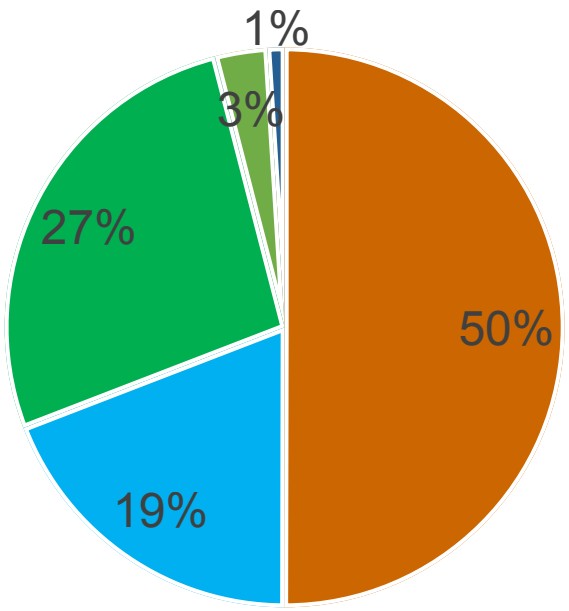
What promotes algal blooms in Georgica Pond?

Nutrients controlling blue-green algae



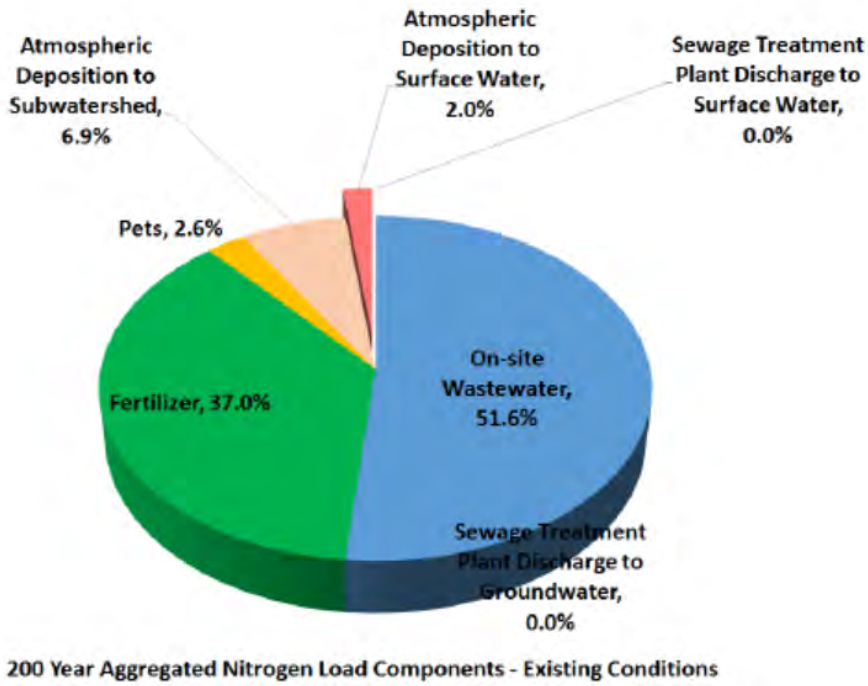
Sources of N to Georgica Pond

Gobler study

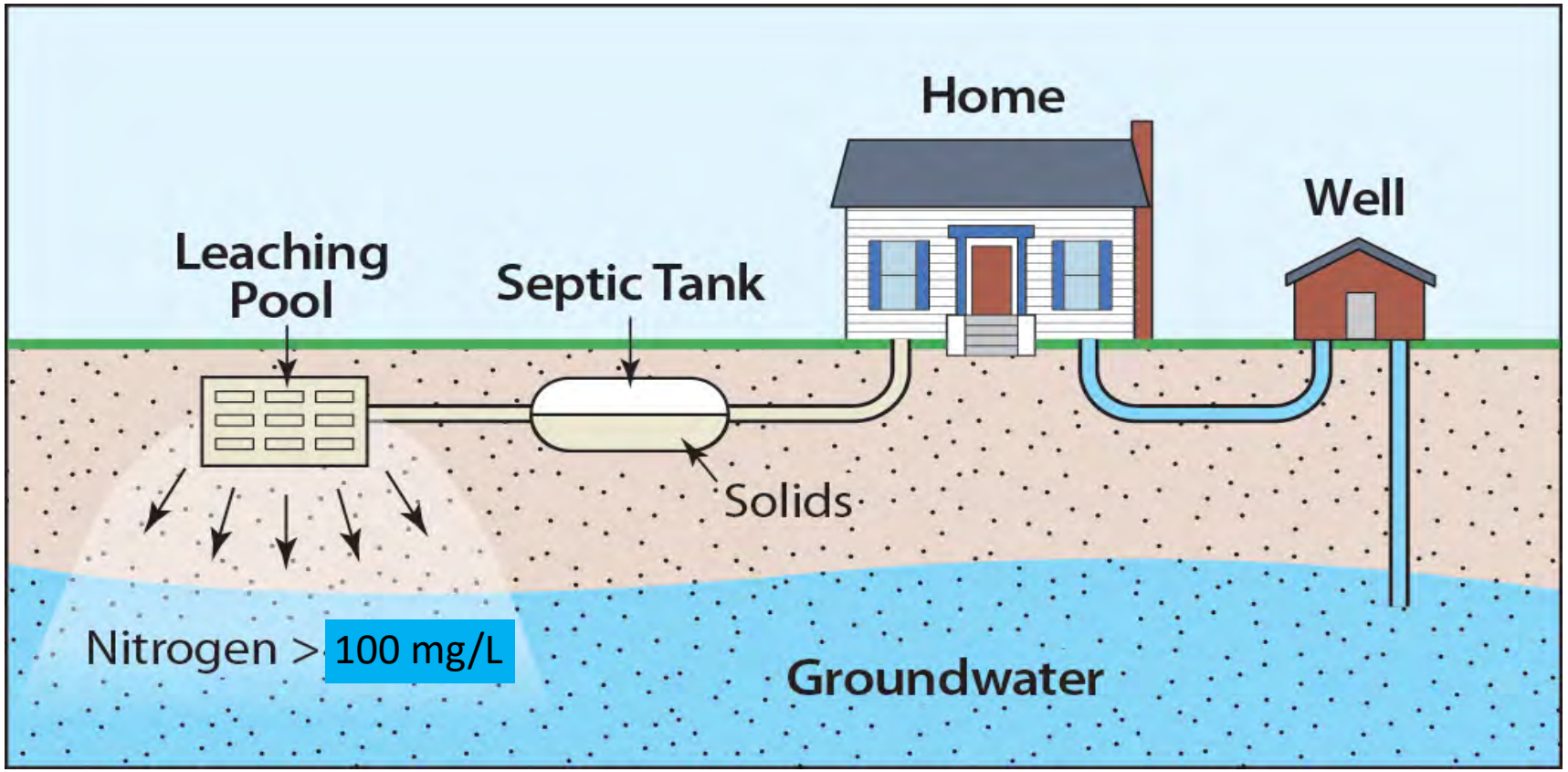


- Cesspool/Septic
- STP
- Atmospheric
- Residential Lawns
- Parks and Golf Lawns
- Agriculture

Suffolk County study



Suffolk County septic systems



SUFFOLK COUNTY
SUBWATERSHEDS WASTEWATER PLAN

JUNE 2020

FROM WORST TO FIRST!

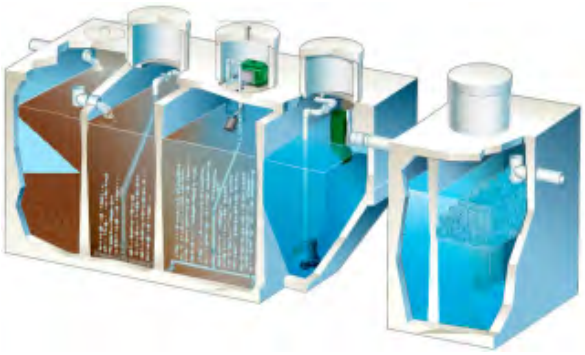
Reclaim Our Water

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

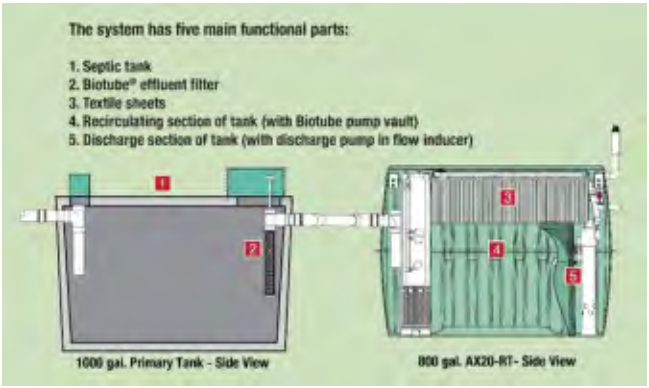
County approved low N septic systems (<19 mg N/L)

Hydro-Action

Fuji Clean System



Norweco Hydrokinetic

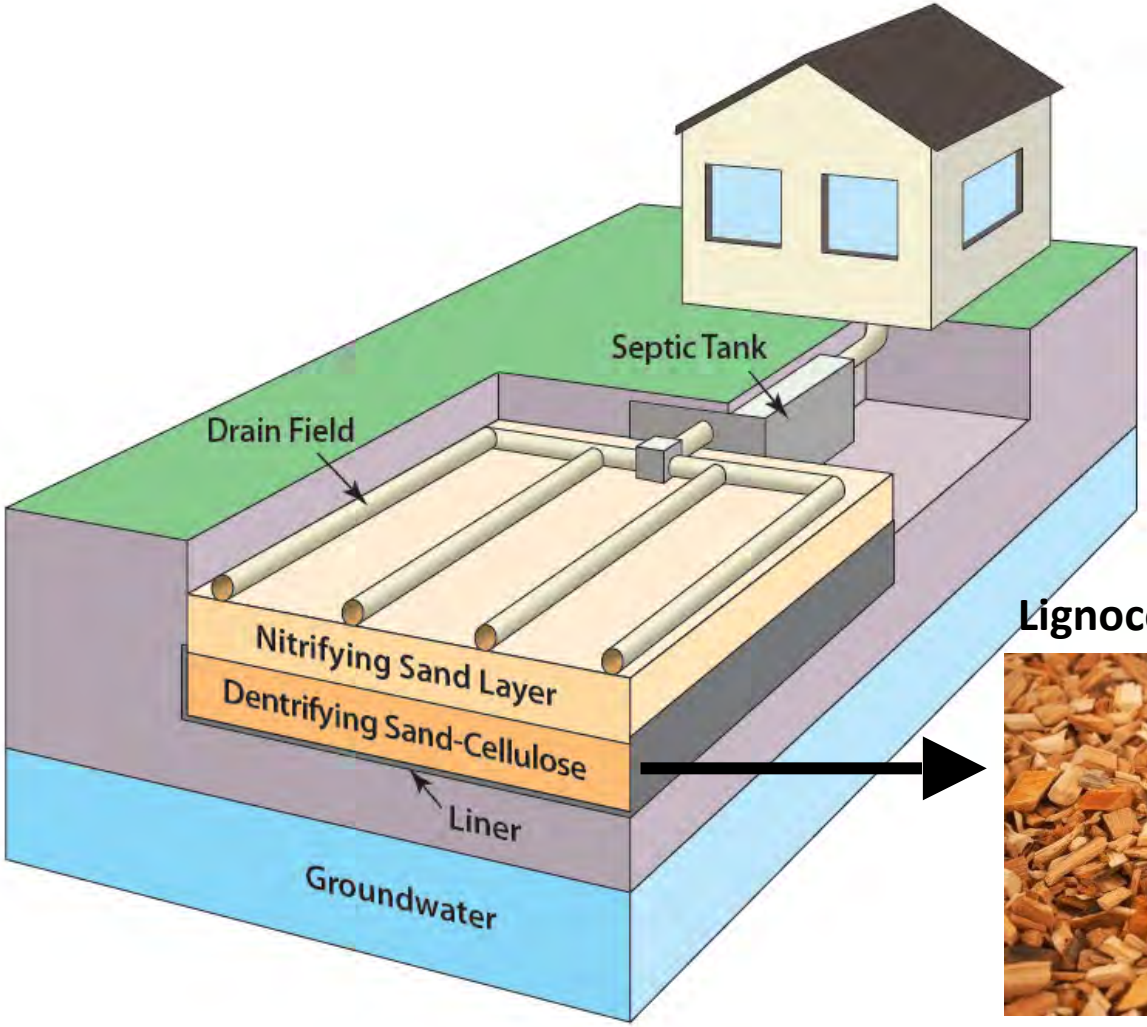


Orenco Advantex AX-RT

Norweco Singlair TNT

Nitrogen Removing Biofilters (NRB)

NYS CENTER FOR CLEAN WATER TECHNOLOGY



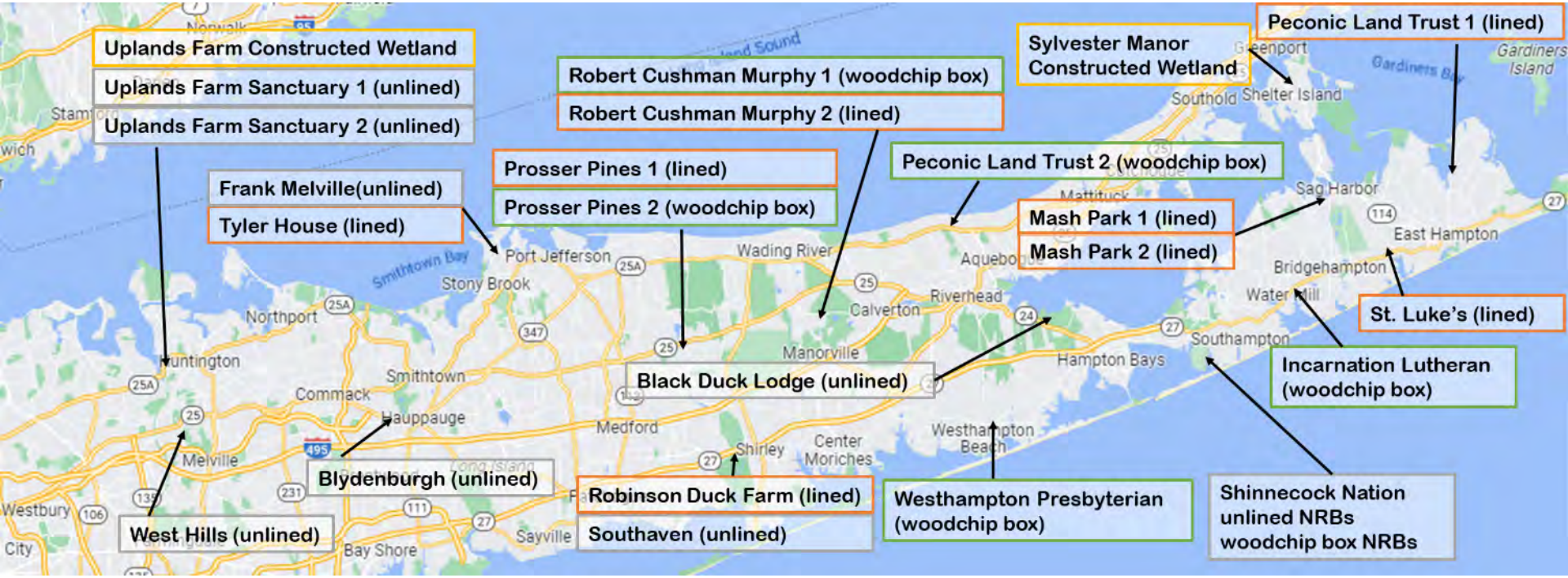
<u>Materials list</u>:

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

Lignocellulose = wood, chips

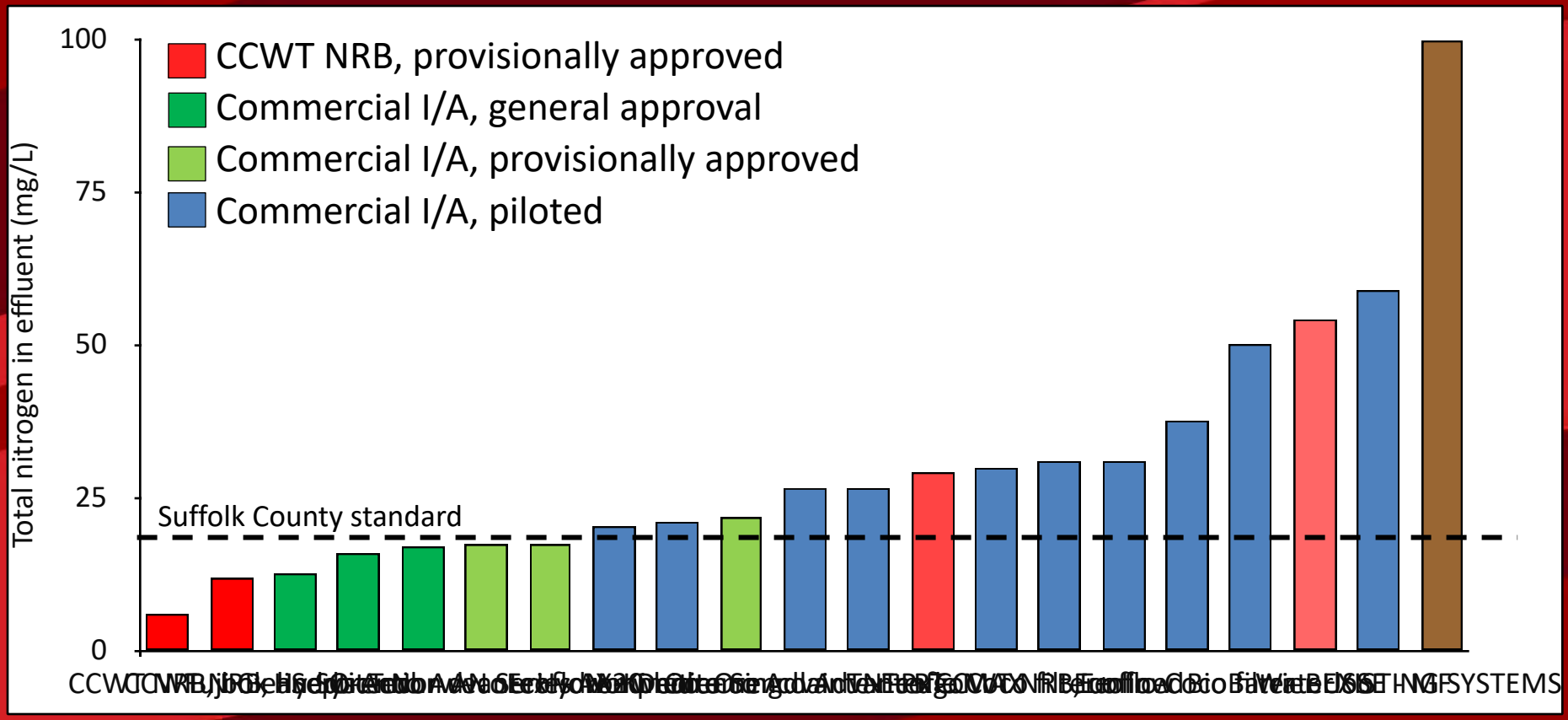
Carbon source to promote denitrification

More than 30 NRBs installed since 2018



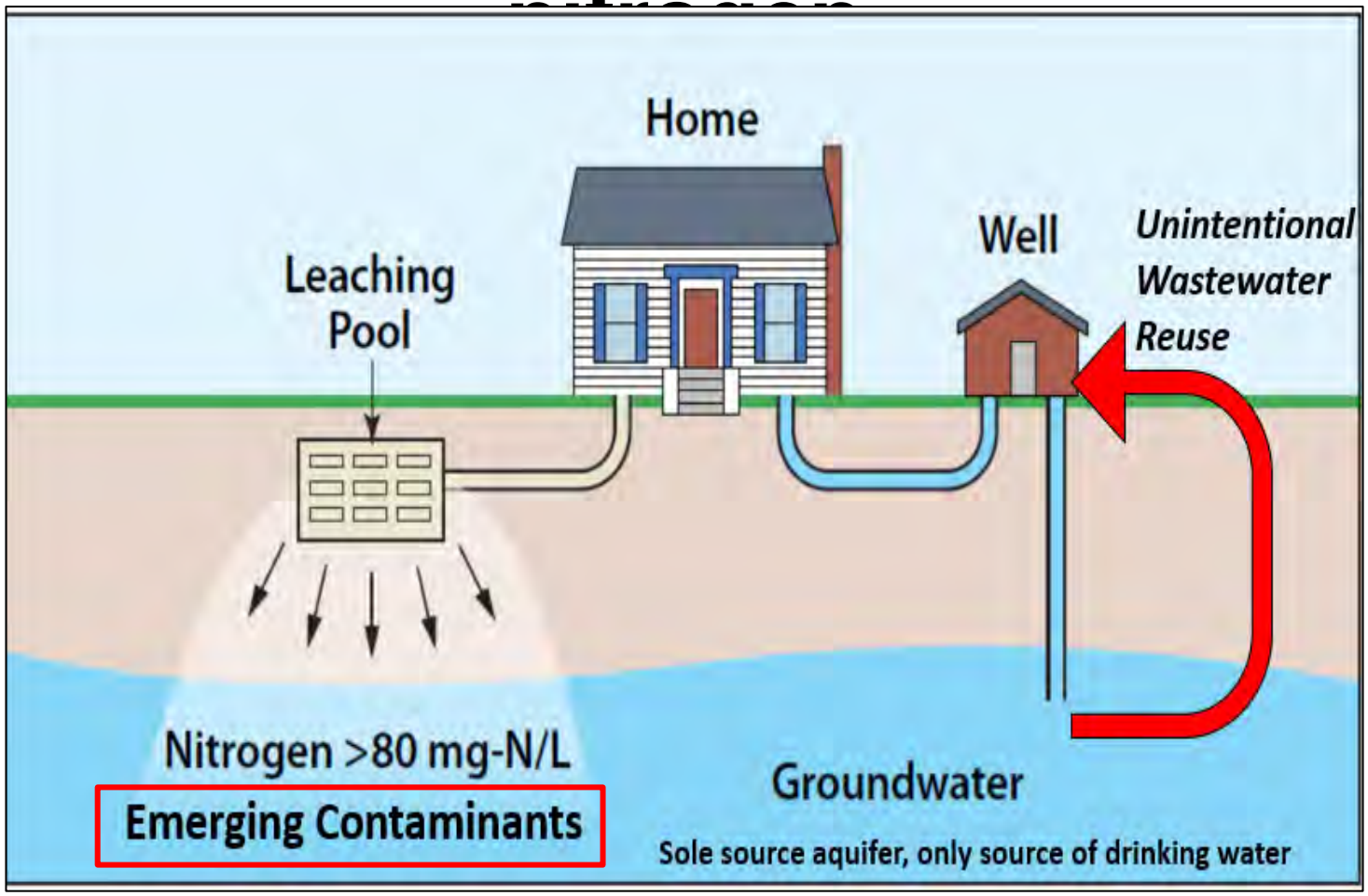
Stony Brook University

Comparison of I/A performance in Suffolk County



FAR BEYOND

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.

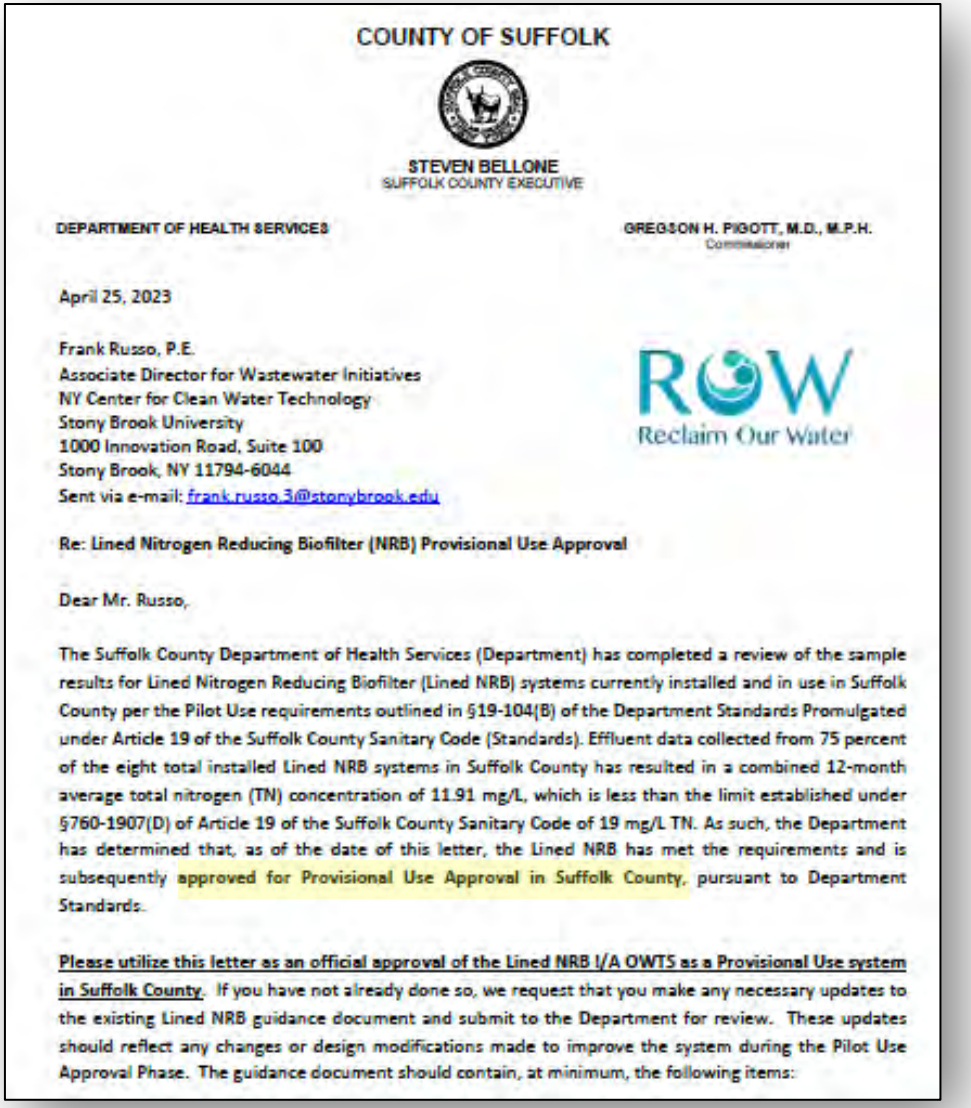
Compound	Use	Removal (%)
1,4-dioxane	solvent	60%
Acetaminophen	NSAID	94 – 100
Caffeine	stimulant	99 – 100
Paraxanthine	human metabolite of caffeine	98 – 99
DEET	mosquito repellant	82 – 96
Nicotine	stimulant	92 – 97
Cotinine	human metabolite of nicotine	86 – 98
Sulfamethoxazole	antibiotic	85 – 97
Diphenhydramine	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

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

- Excav Services,
- A&A Sewer and Drain



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

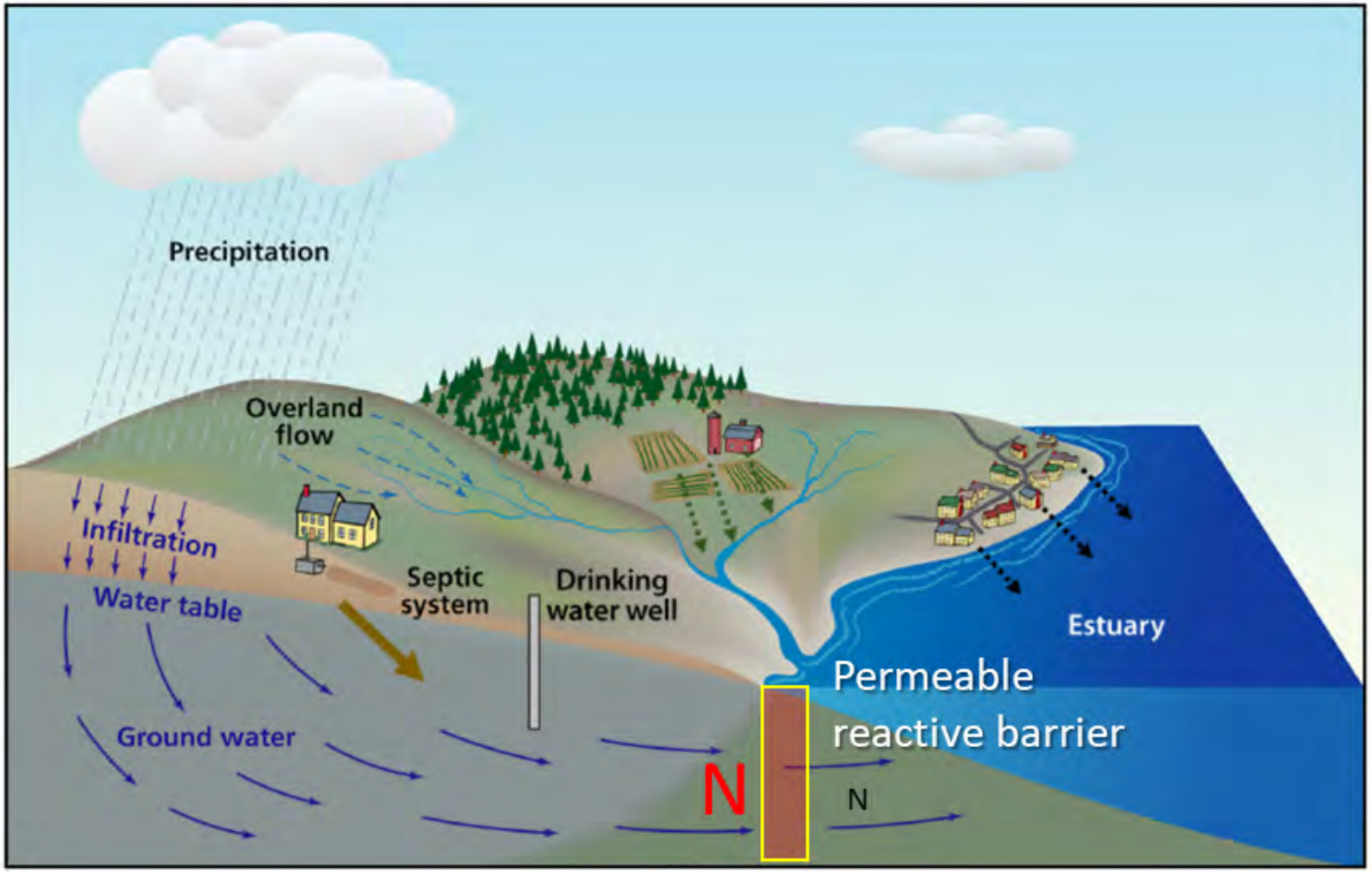
- 40 years experience in wastewater treatment specializing in operation & maintenance
- Certified Grade 4 Wastewater Operator in NY, NJ & CT
- Experience in groundwater remediation
- Working with Georgica Pond and Sagaponack Pond homeowners on septic upgrade.
- **Tom is here to help you seamlessly upgrade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

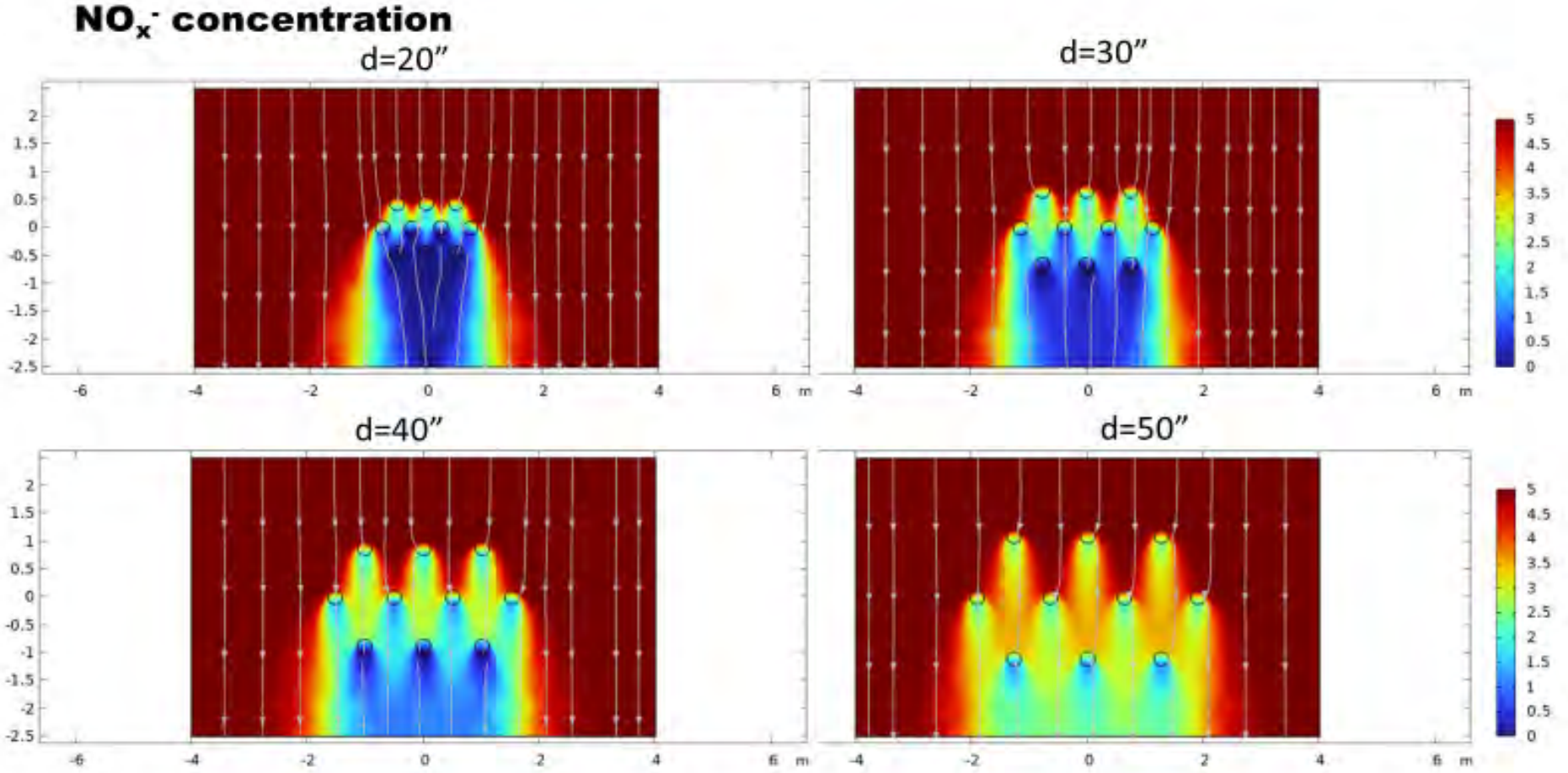


- It will take decades to upgrade hundreds of thousands septic systems on Long Island and for legacy contamination to flush out of the aquifer.
- PRBs allow for the removal of legacy N before entering ecosystems or well heads.

Carbon array installation at Georgica Pond, June 2023

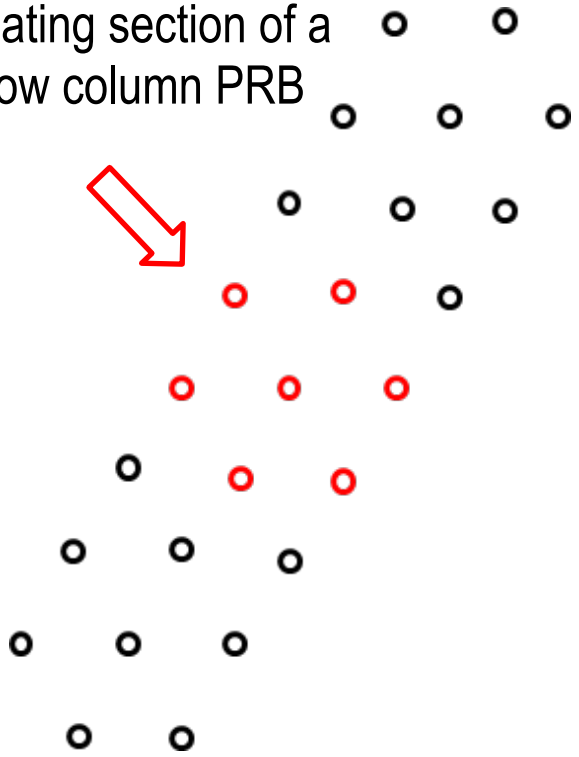
Installation informed by model simulations:

10” woodchip columns spaced 36” apart



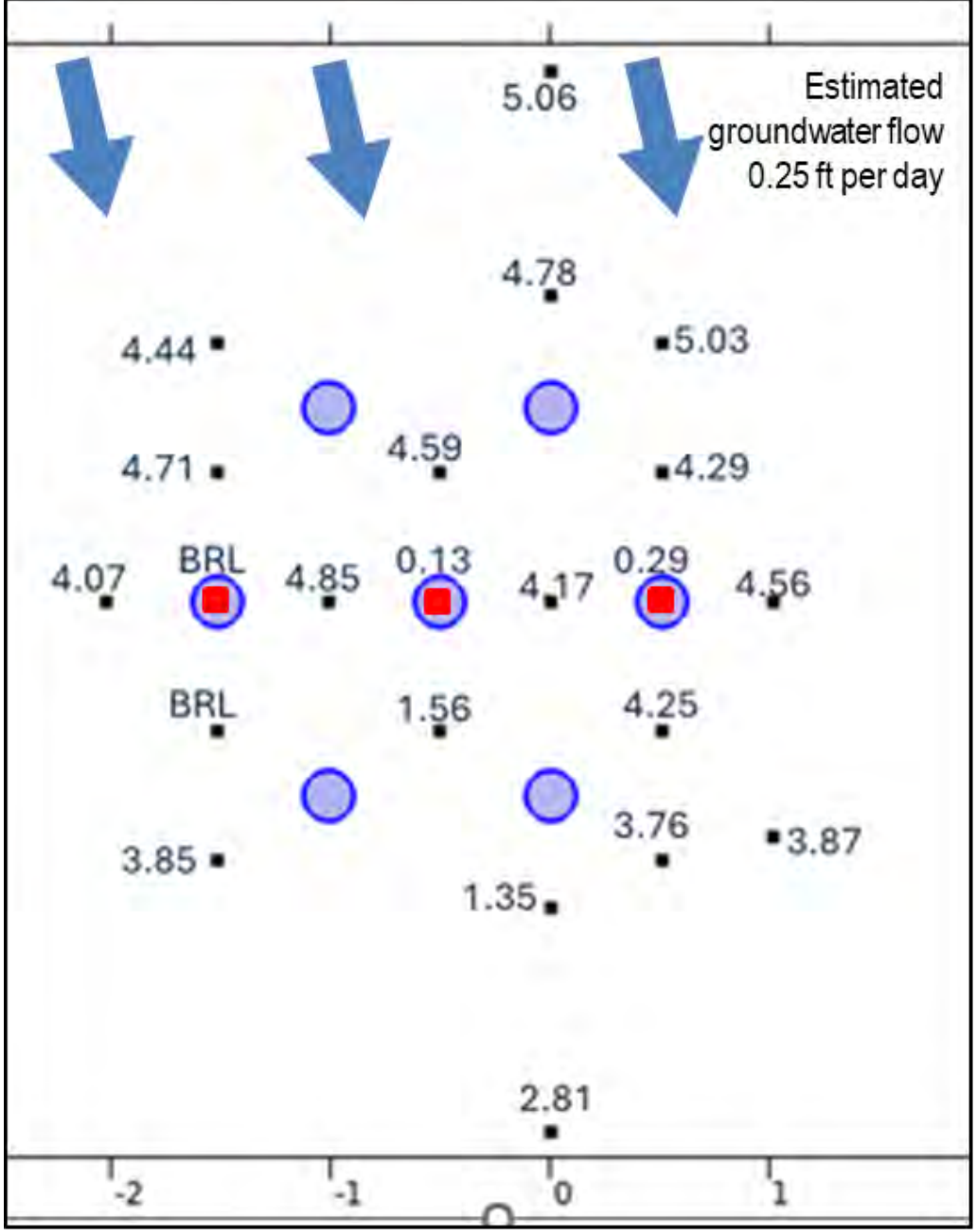
Carbon Array

"Flower" represents a repeating section of a 3-row column PRB



Carbon Array

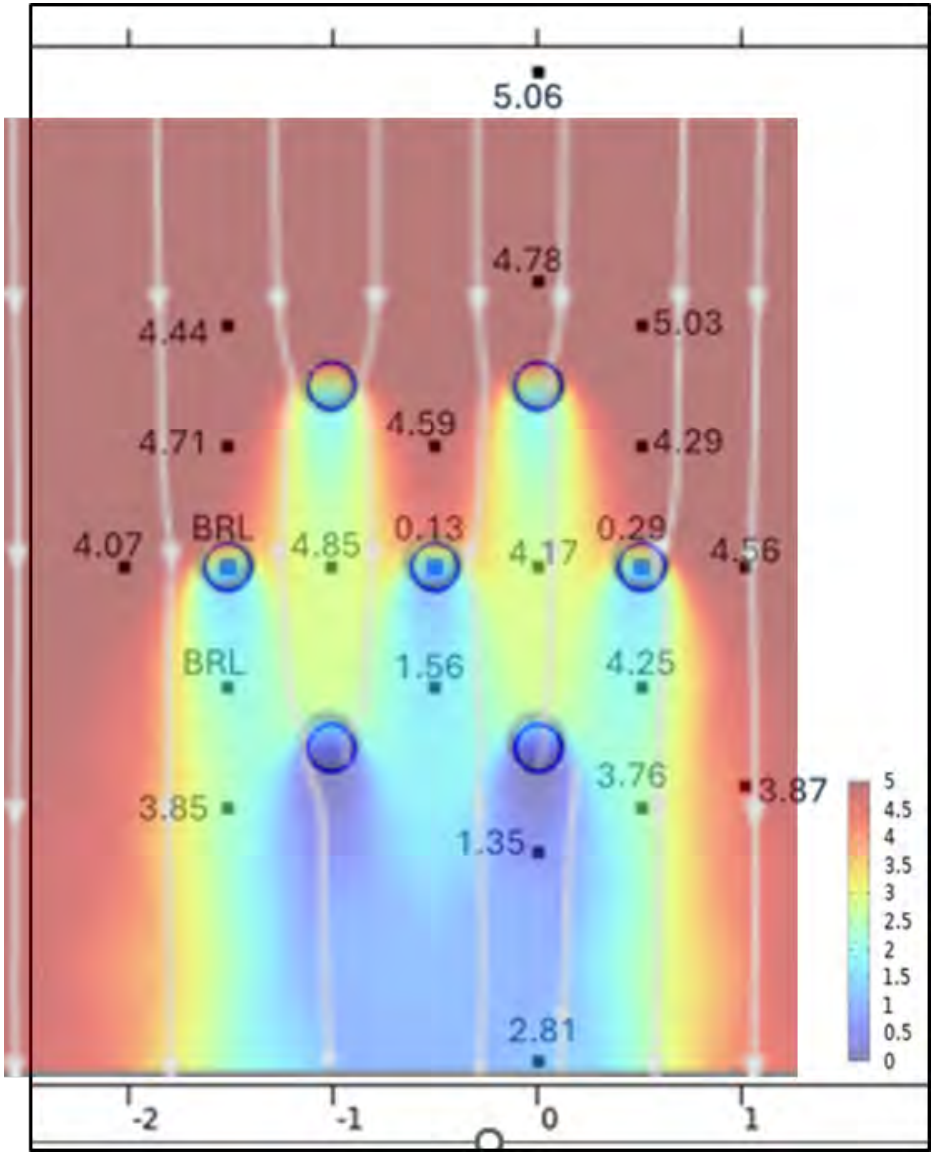
- Nitrate depleted in the center of woodchip columns
- Lower nitrate concentrations downstream



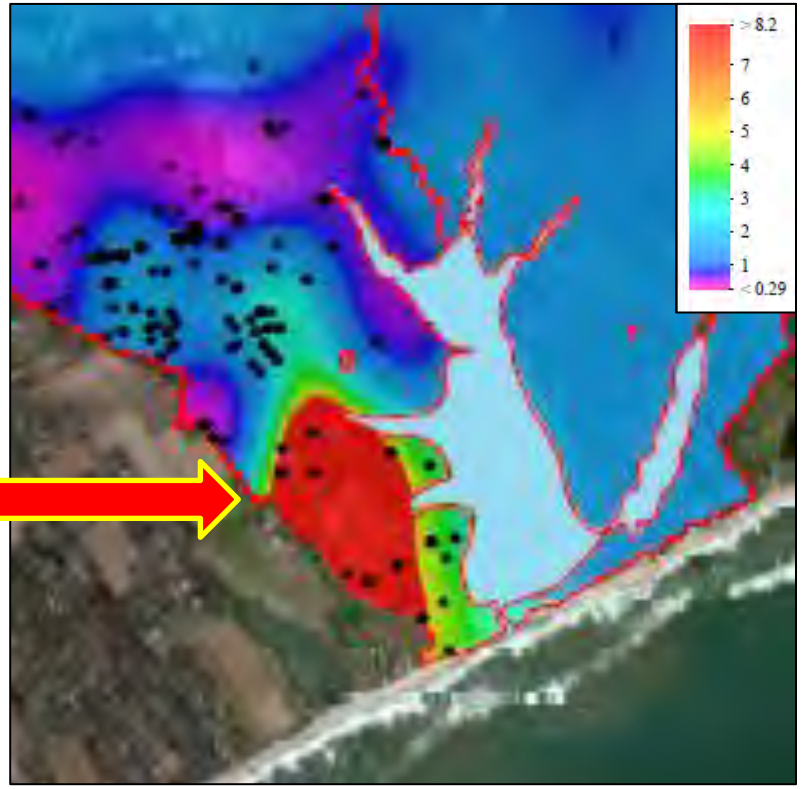
Groundwater Nitrate sampled over the 5ft-10ft depth interval on 10/23/23

Carbon Array

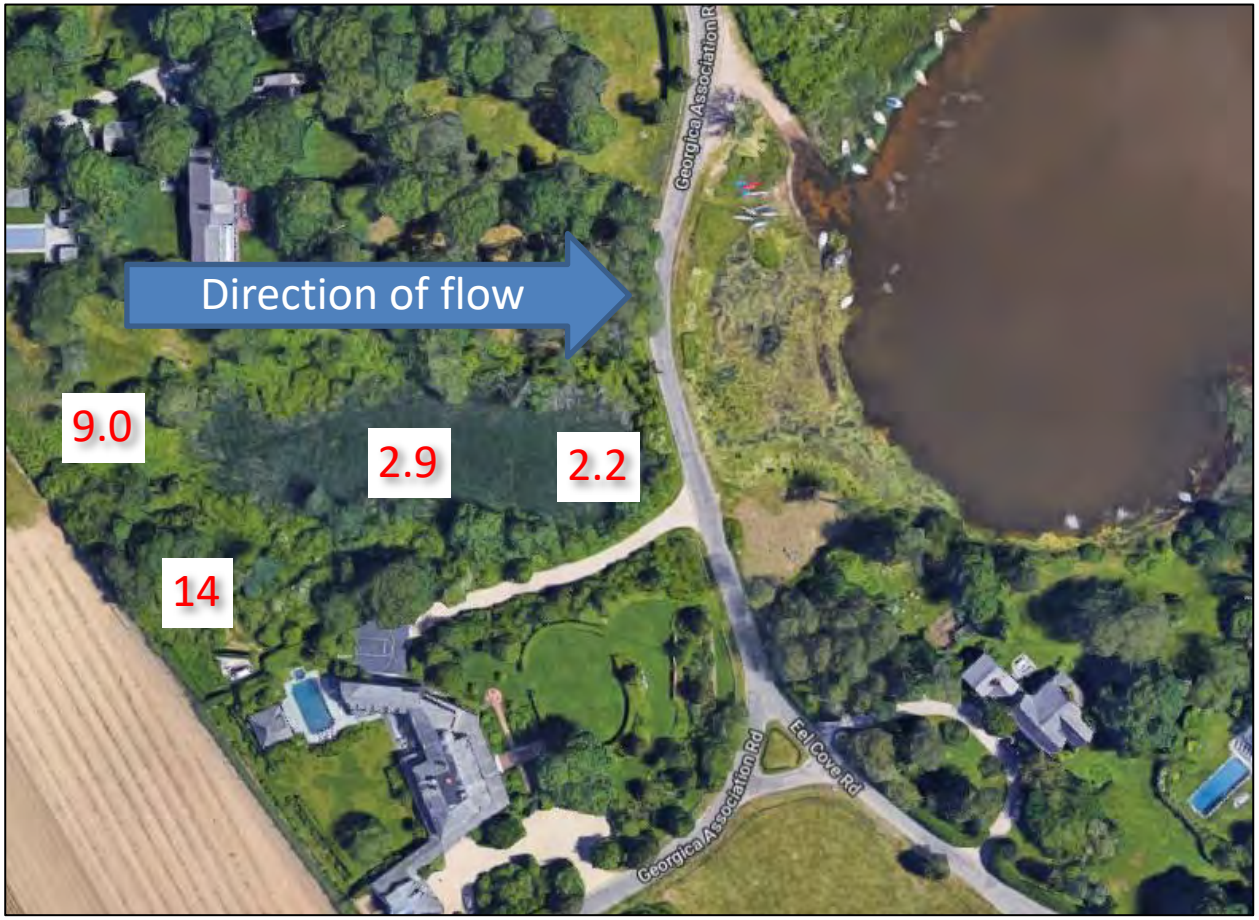
- Nitrate depleted in the center of woodchip columns
- Lower nitrate concentrations downstream
- Matches model simulation



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

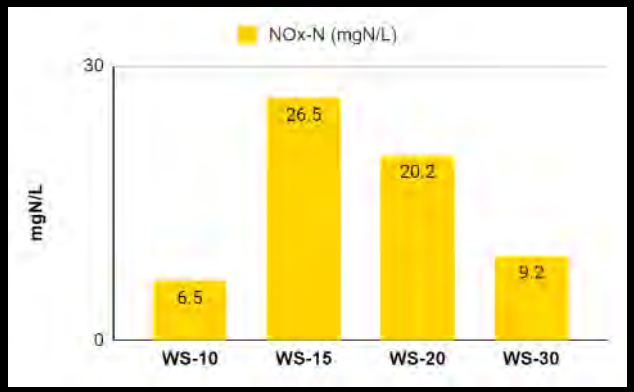
Sampling Strategy

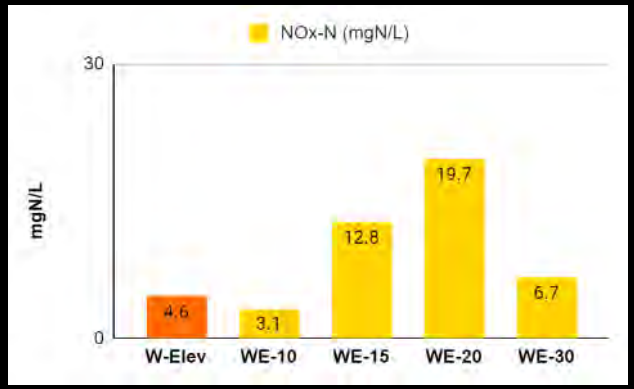
- Cluster Wells Depths:
  - 5 – 10’
  - 10 – 15’
  - 15 – 20’
  - 20 – 30’

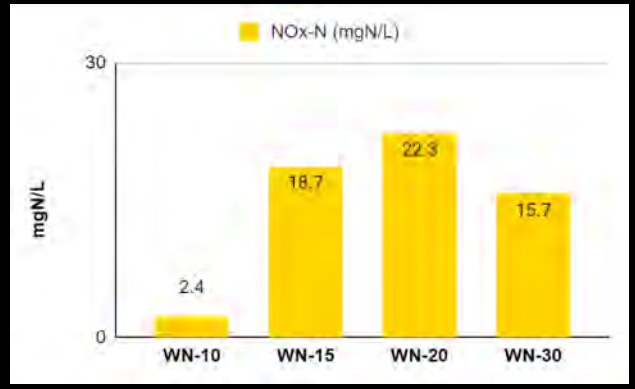
NO_x - depth profiles

West Cluster Wells

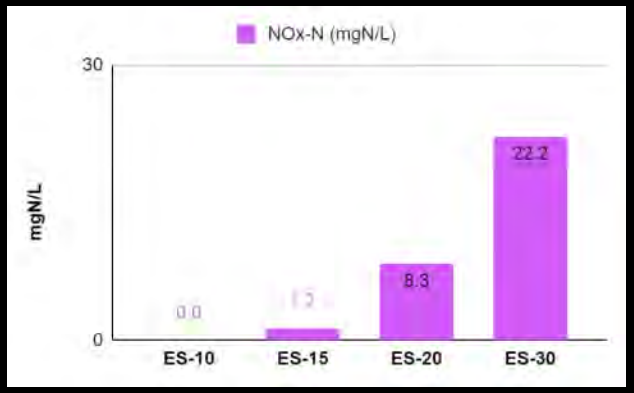
>26 mg nitrate per liter

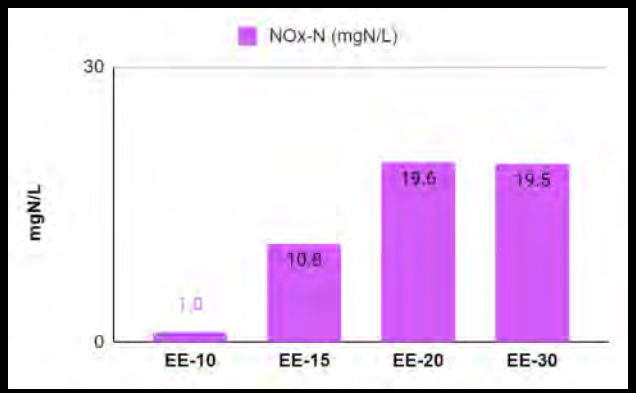


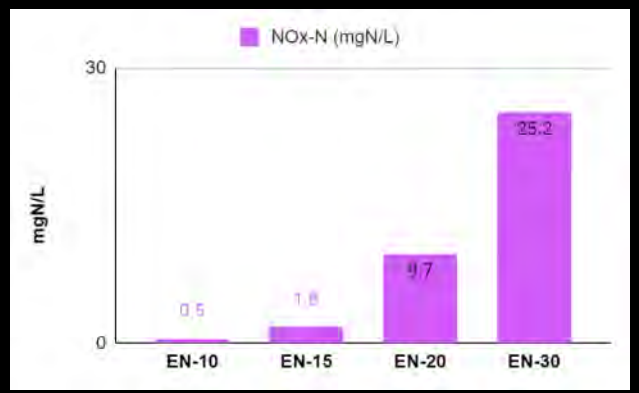




NO_x - depth profiles
East Cluster Wells
>25 mg nitrate per liter







Eel Cove groundwater remediation

- These are the highest groundwater N levels ever measured in in East Hampton Town.
- CCWT is continuing to investigate the nitrate plume around Eel Cove this fall and will submit a grant application to the Town of East Hampton CPF fund in February for a PRB.

Transport and Bioaccumulation Per- and Polyfluoroalkyl Substance (PFAS) in an Aqueous Film Forming Foam (AFFF)-Impacted Estuary

Kevin W. Shaffer

Master's Seminar

July 29, 2024

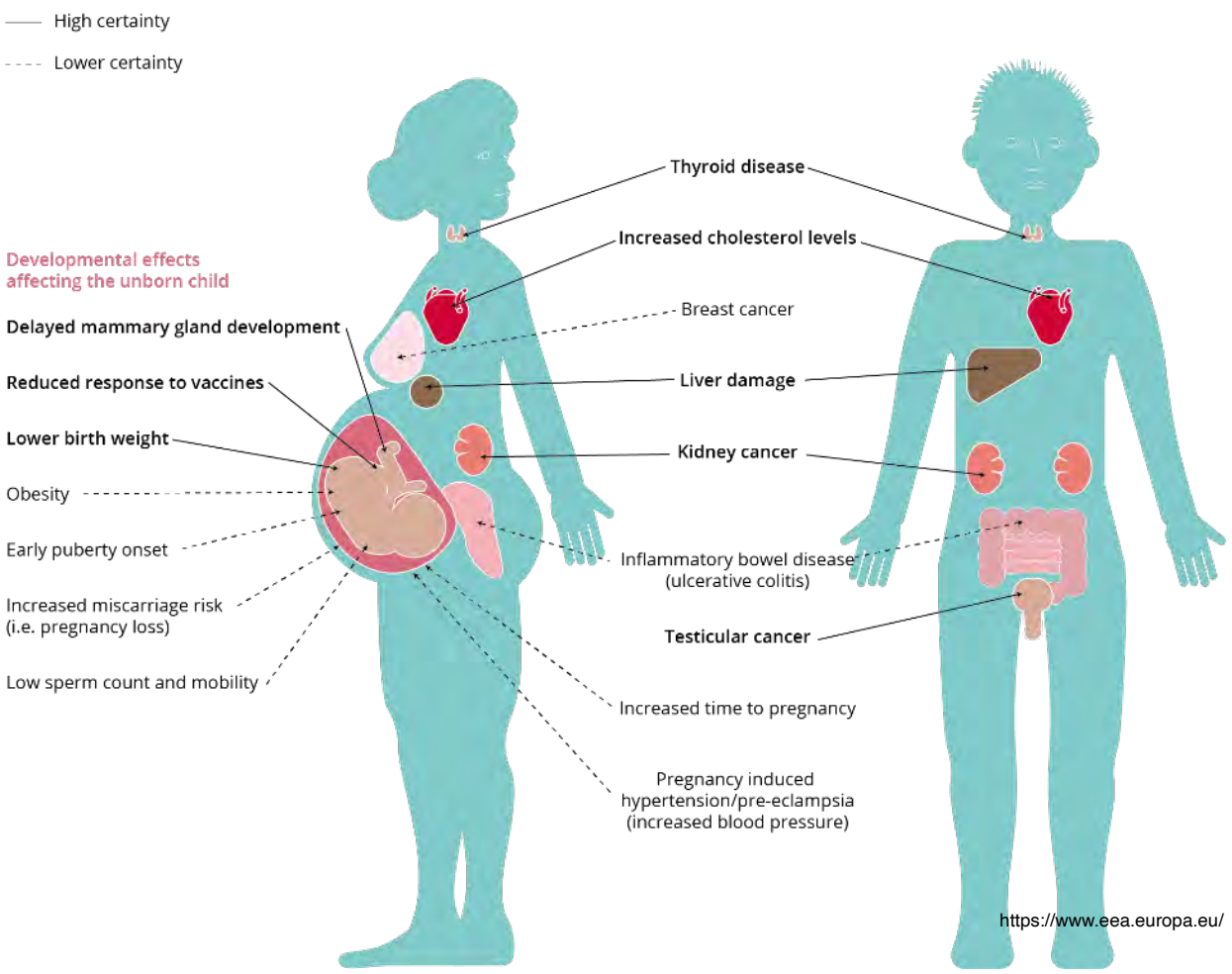
Photo: Doug Kuntz

Per- and Polyfluoroalkyl Substances (PFAS)

- Commercial and industrial uses
- Oil, water, and heat resistant
- Environmental release during production, disposal, AFFF
- Mobile in water and air
- Resistant to degradation

PFAS Health Risks

- Toxic: adverse health effects
  (Sunderland et al., 2019; Wang et al., 2017)
- Perfluorooctanoic acid (PFOA): classified as a **possible human carcinogen** by International Agency for Research on Cancer (IARC)



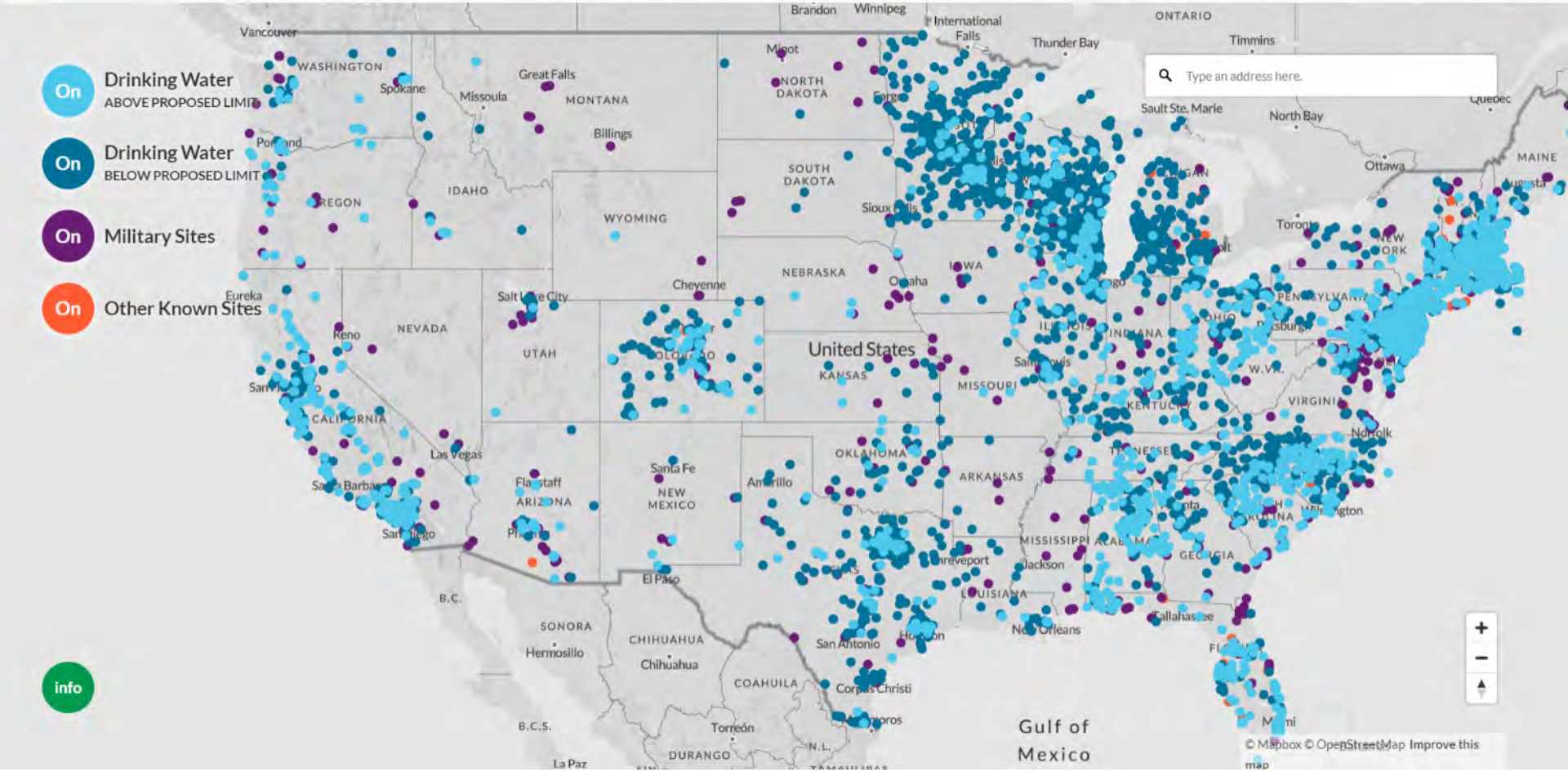
New EPA PFAS Regulations

- Thousands of PFAS in existence
- 2024, EPA announced the final National Primary Drinking Water Regulation establishing MCLs for six PFAS (4 -10 ng/L or parts per trillion)

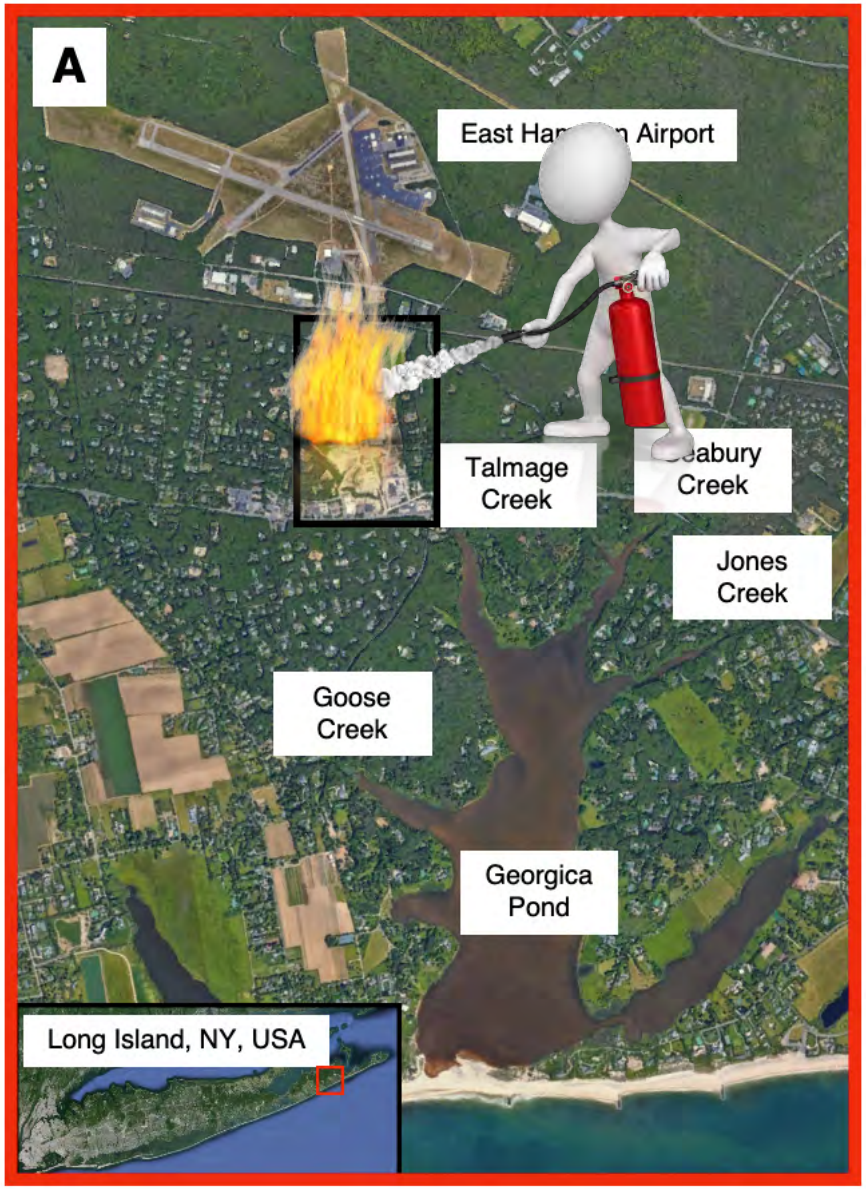
EPA National Primary Drinking Water Standards			
PFAS		Maximum Contaminant Level Goal	Maximum Contaminant Level
PFOA		0	4.0 ppt
PFOS		0	4.0 ppt
PFNA		10 ppt	10 ppt
PFHxS		10 ppt	10 ppt
GenX		10 ppt	10 ppt
Mixture of 2 or more	PFNA	1 (unitless) Hazard Index	1 (unitless) Hazard Index
	PFHxS		
	GenX		
	PFBS		

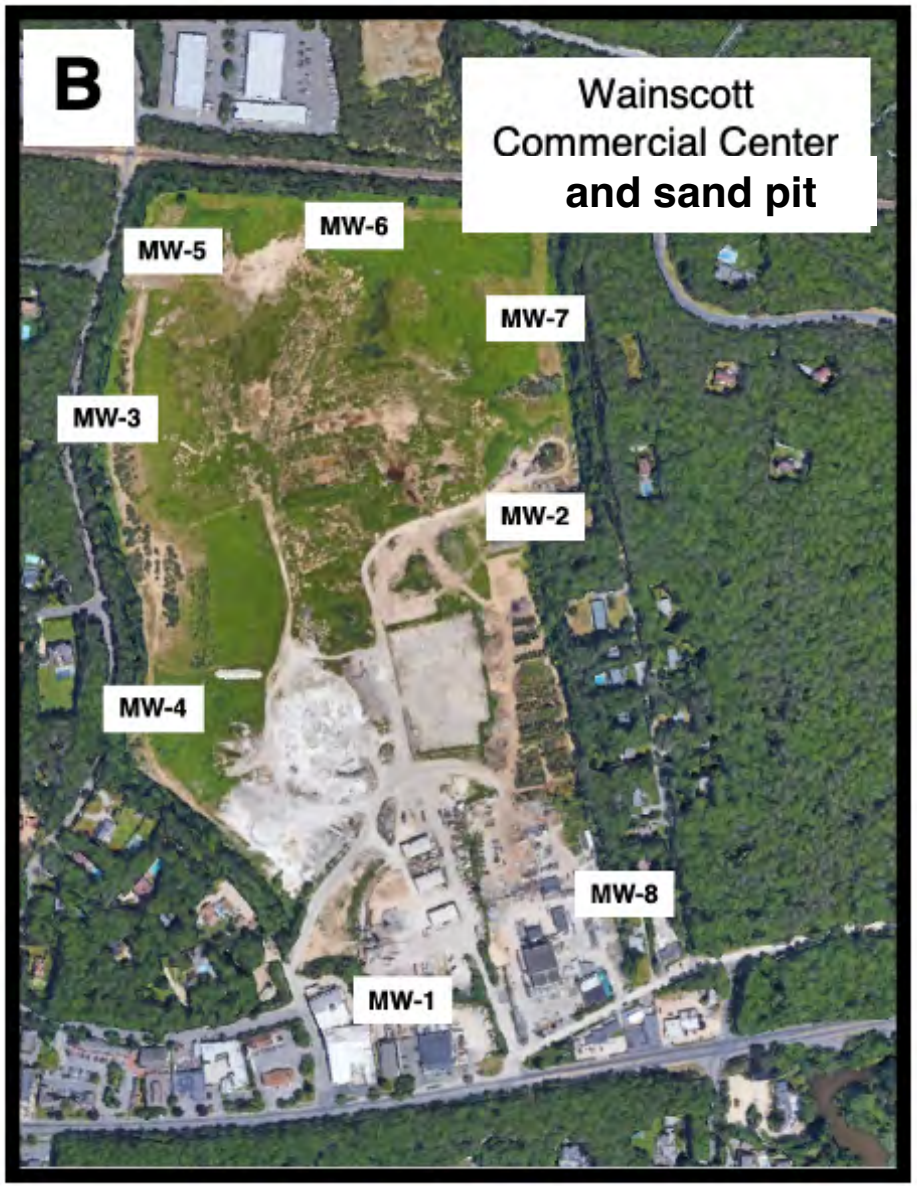
https://www.mass.gov/info-details/epa-maximum-contaminant-levels-mcls-for-pfas

PFAS Contamination in the U.S. (May 21,2024)

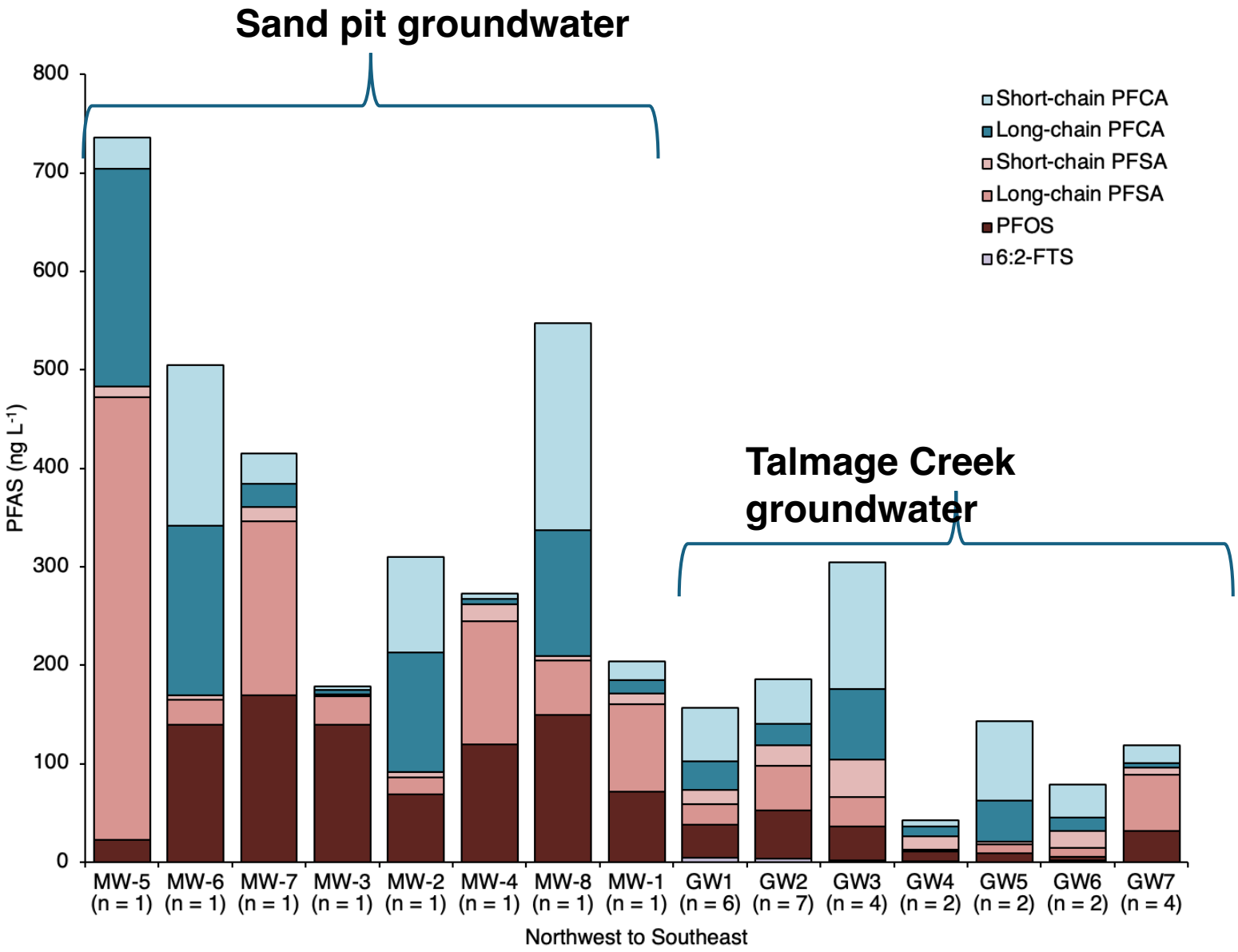


Study Site: Georgica Pond Watershed

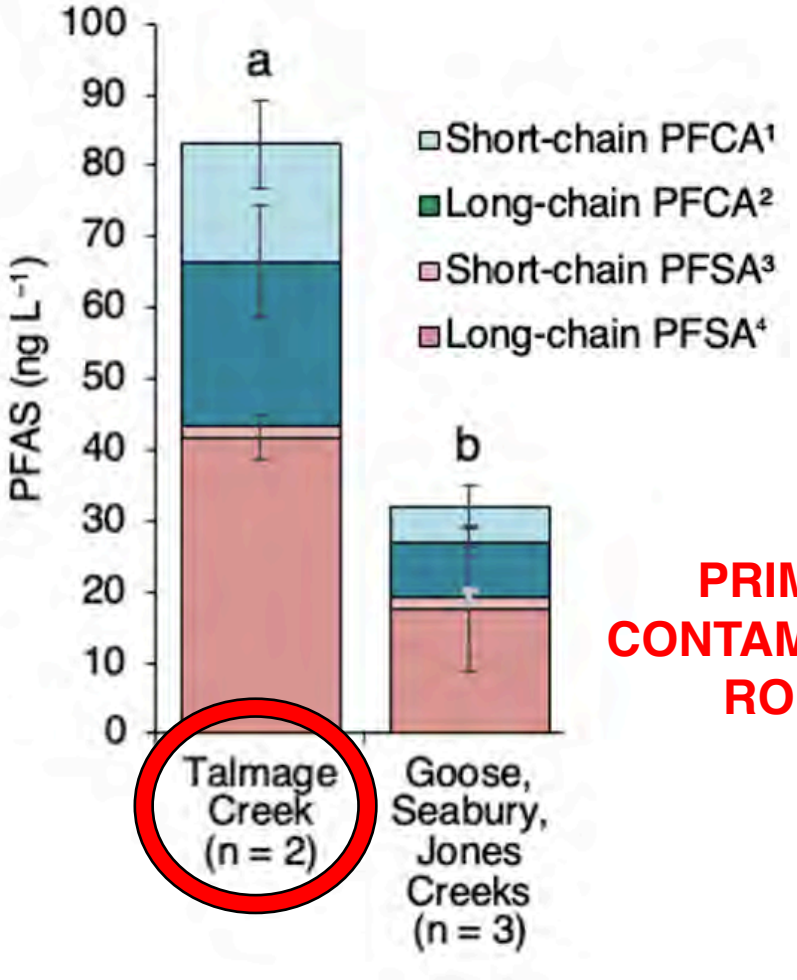




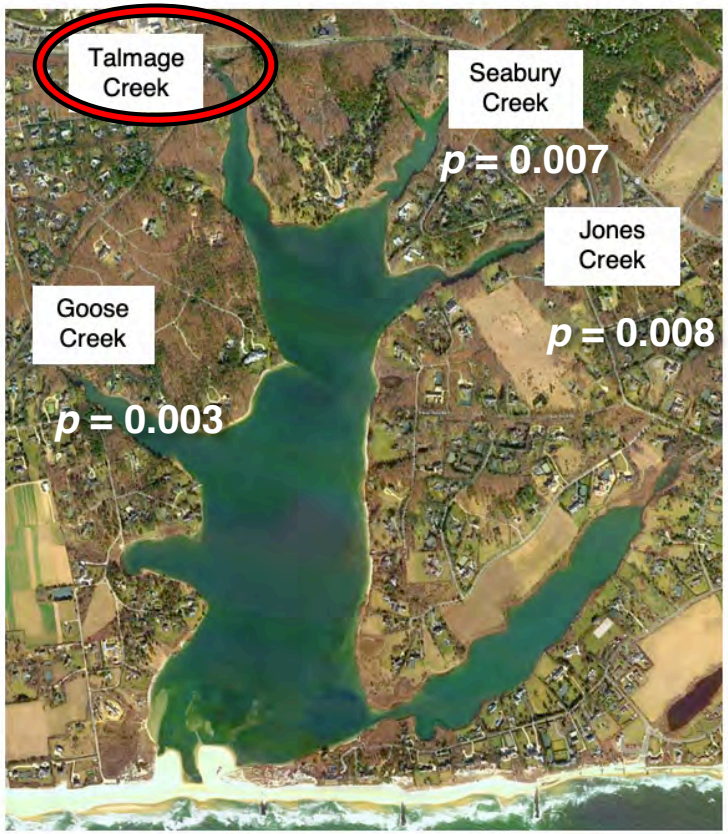
PFAS Transport to Georgica Pond



Route of PFAS to Georgica Pond: Tributary Comparison



PRIMARY CONTAMINATION ROUTE

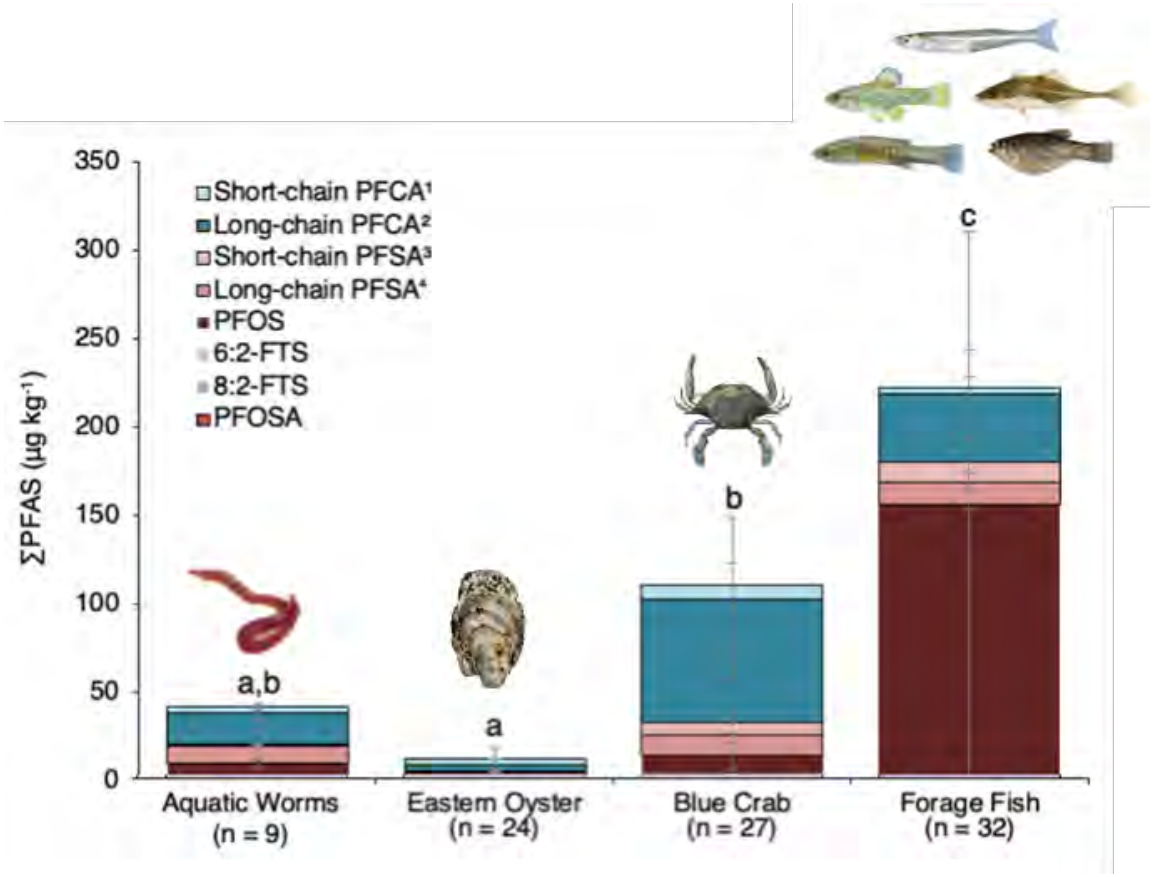


Biota Comparison of Total Concentration

- Total PFAS in fish greater than all other biota

- Eastern Oysters $p < 0.001$
- Aquatic Worms $p = 0.003$
- Blue Crab $p = 0.032$

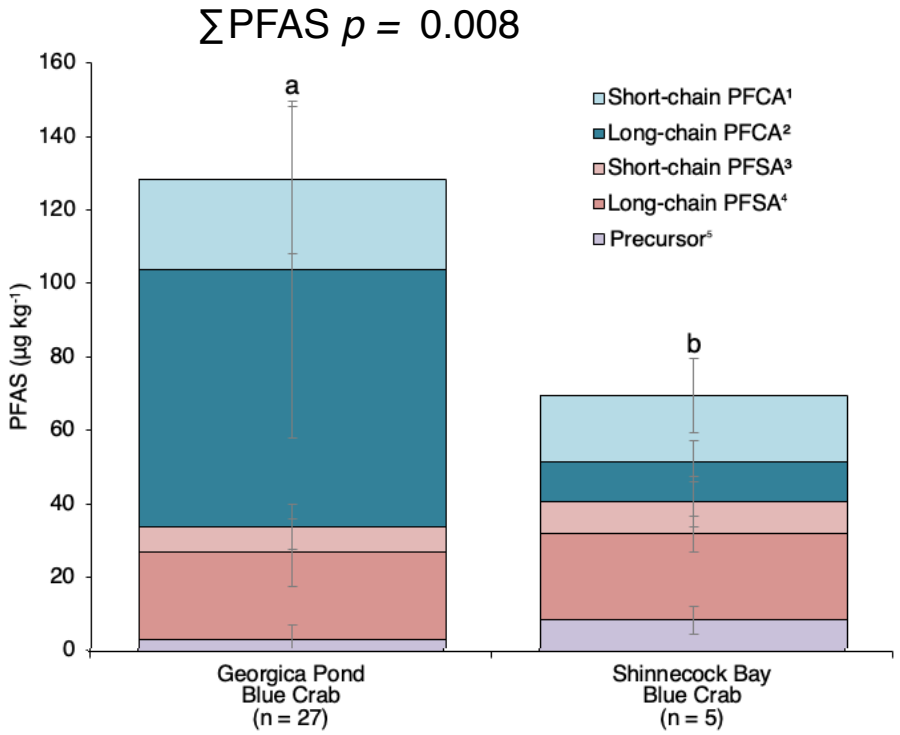
- Total PFAS in blue crab greater than Eastern oysters $p = 0.021$



Blue Crab Comparison

Georgica Blue Crab

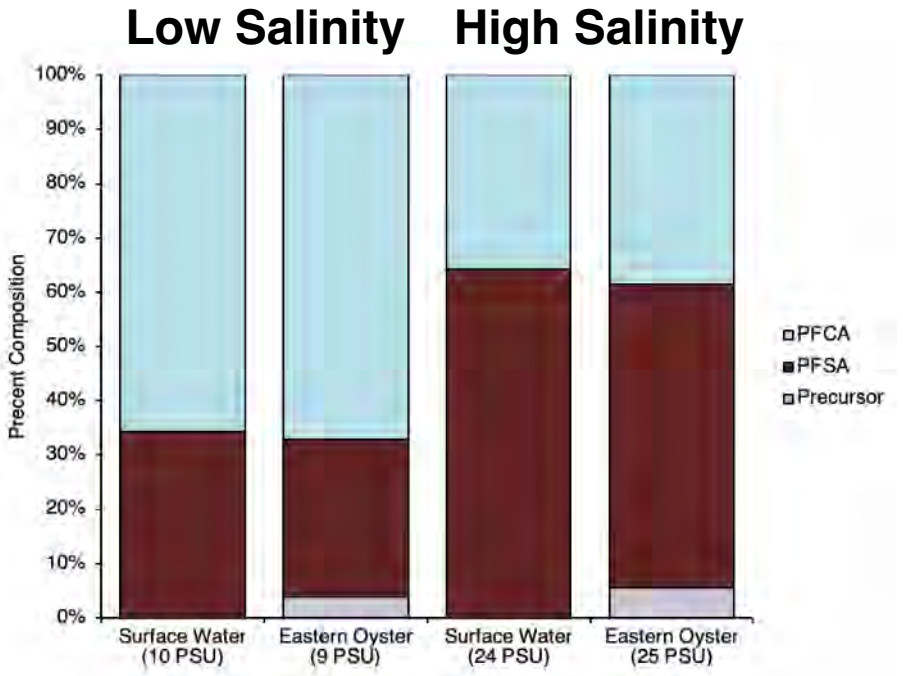
- Long-chain PFCA dominated (PFOA)
- Concentrations twice that of Shinnecock Bay
- Reflects AFFF contamination



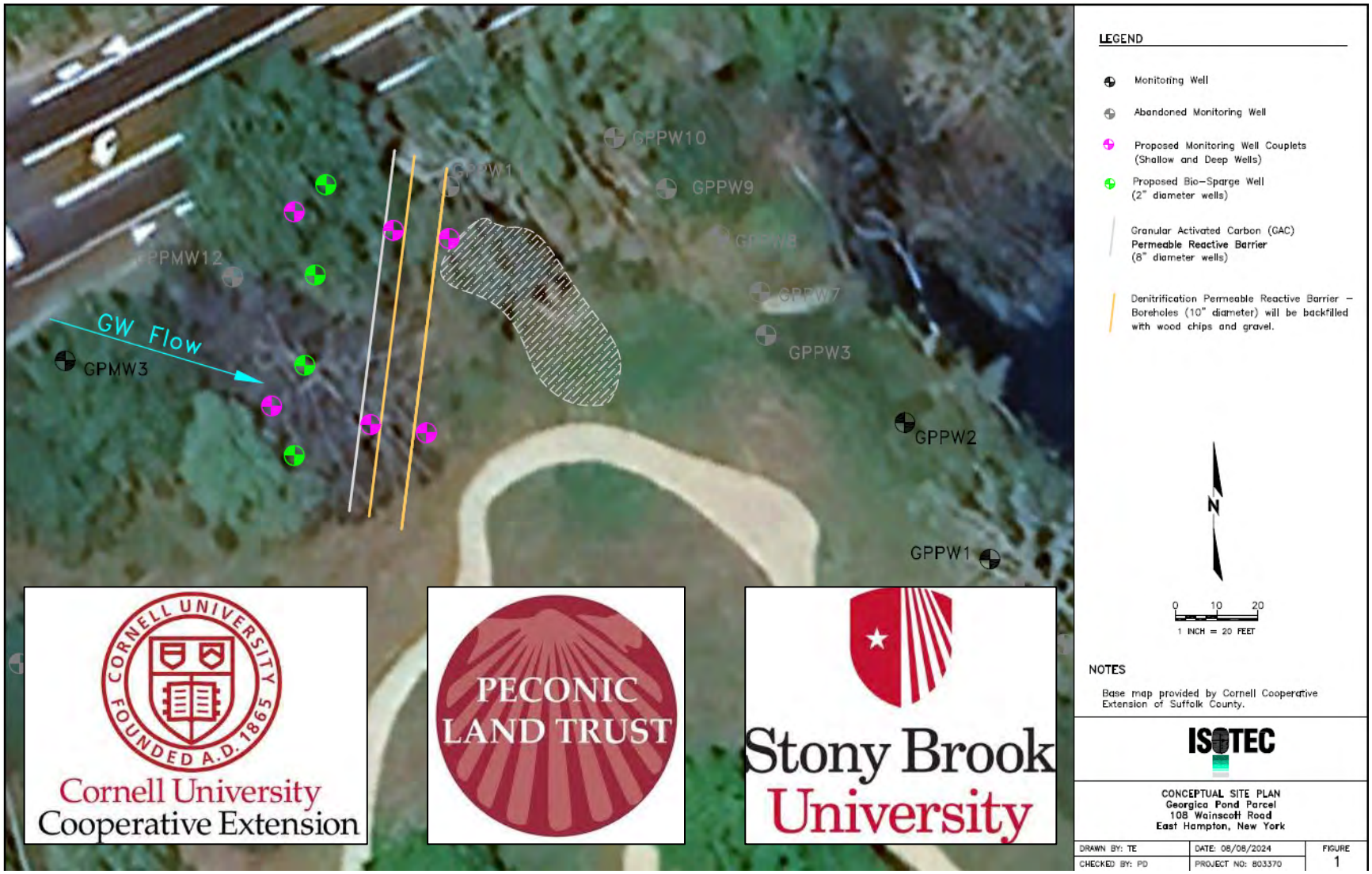
Eastern Oysters as a PFAS Biomonitoring Species

Eastern Oysters

- 17 different PFAS
- Eastern oysters closely mirrored water PFAS profile
- Potential as biomonitoring species for PFAS in estuaries



Talmage Creek permeable reactive barrier to remove PFAS and nitrogen grant application to East Hampton CPF Aug 2024



OYSTERS in Georgica Pond 2019 - 2024

Cage Experiments

- Initial experiments conducted to map oyster survivorship, growth, and disease across Georgica Pond
- Oysters placed in cages at 3 study sites (North, Central, South)
  - Single-seed oyster seed deployed in 2019
  - Spat-on-shell deployed in 2021

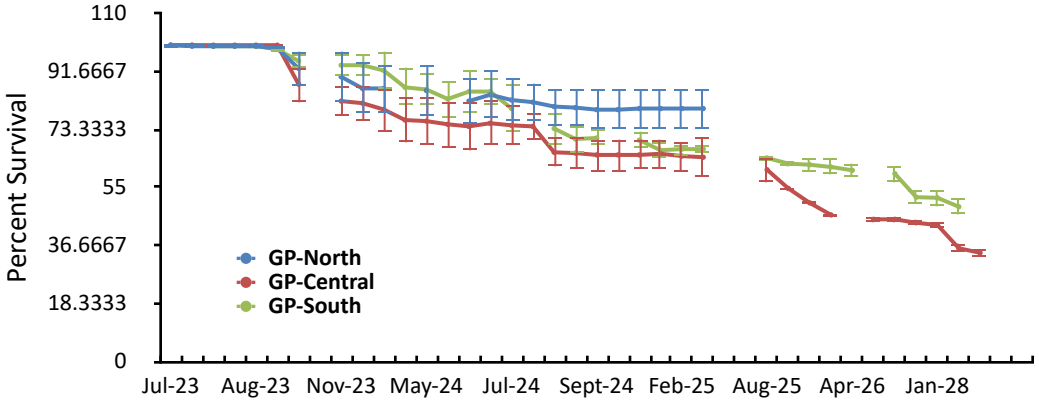
Single-set seed

Spat-on-shell

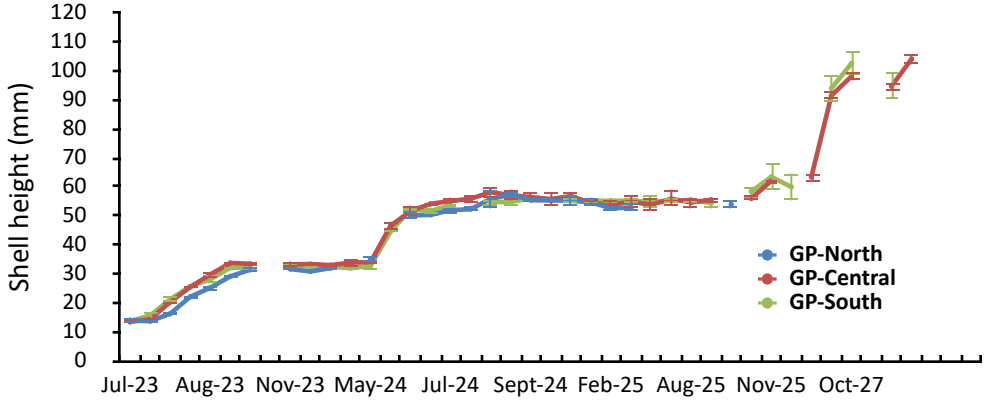
Cage experiments - Oyster seed

- In general, high survivorship and growth of single-set oysters in cages over ***5+ years***!
  - 40-50% survival of oysters after 5 years at central and south sites!
  - 5-year old oysters currently about 4-inches long!
  - North site terminated in 2021 due to mud

Survivorship



Growth

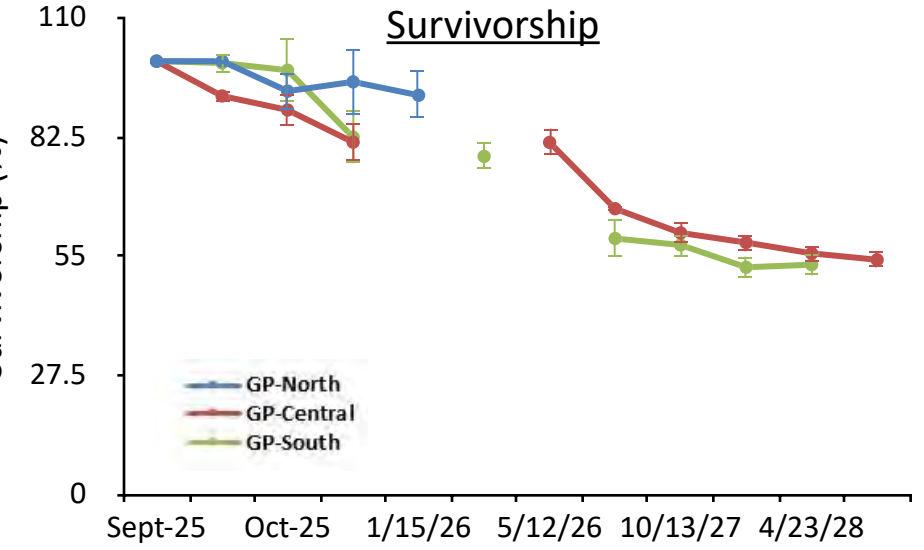


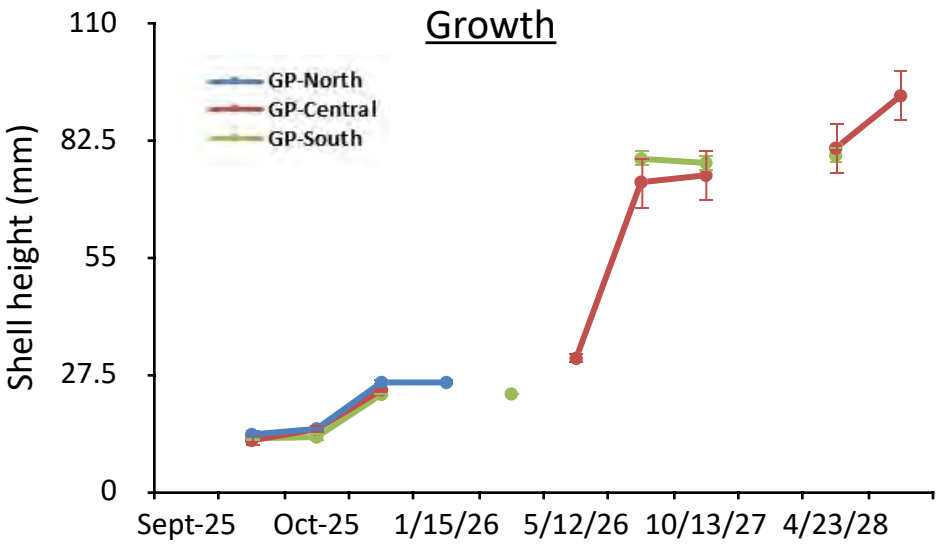
July 18, 2019

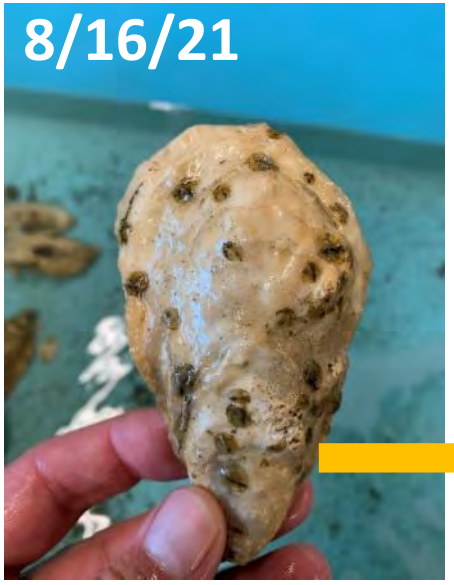
April 22, 2024

Cage experiments – Spat-on-shell

High survivorship and growth of spat-on-shell in cages over ***3 years***!

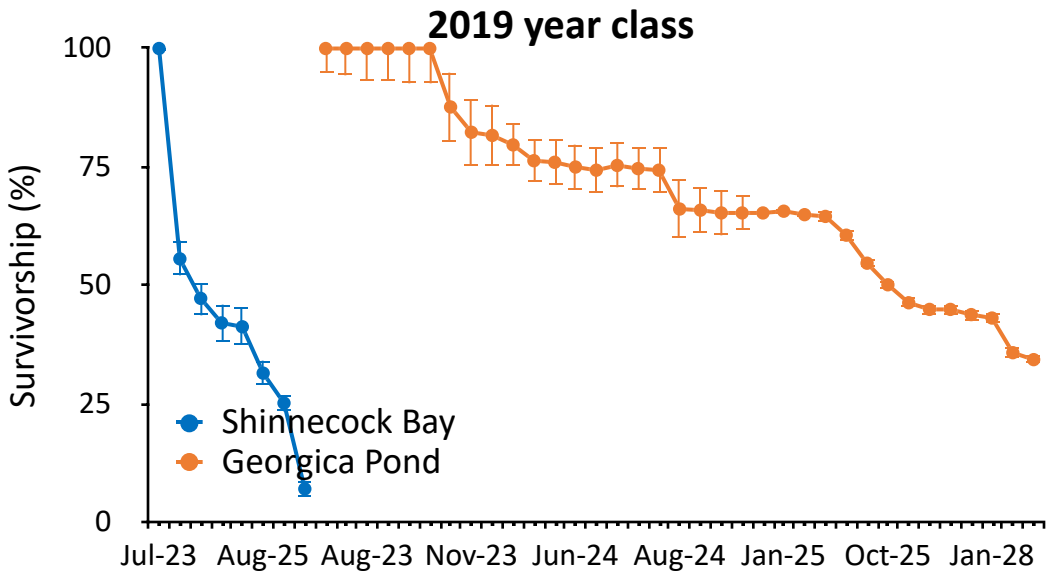


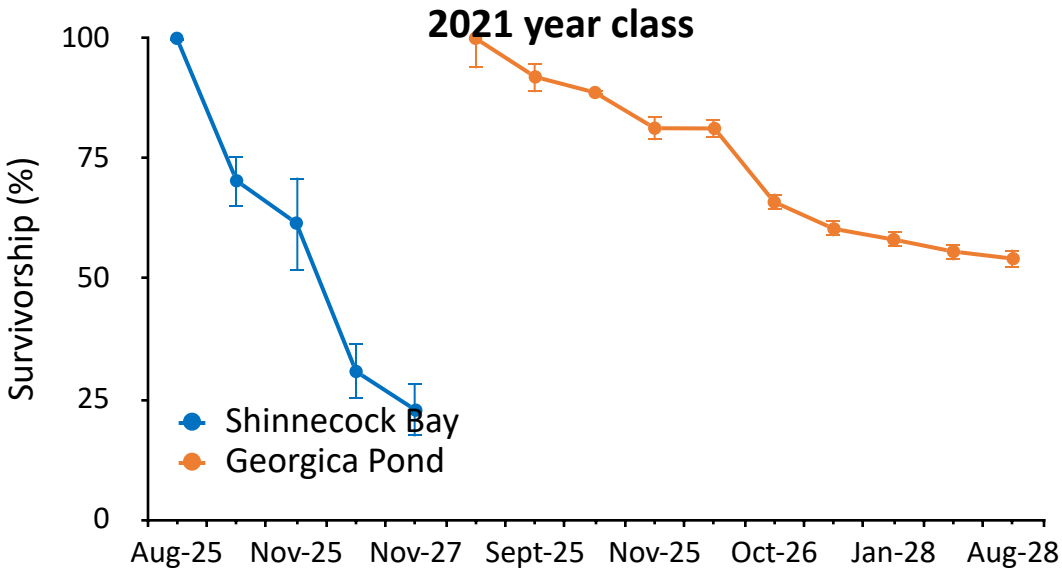




High long-term survival of oysters in Georgica Pond

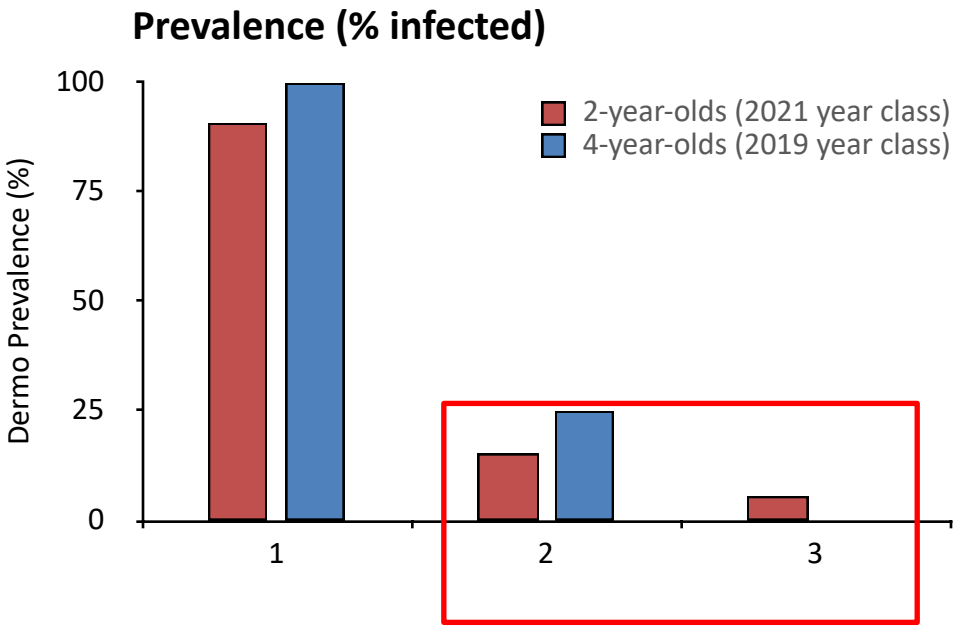
- **Highest long-term survival in Long Island coastal waters.**
- Predation is one factor leading to lower survival in Shinnecock Bay
  - Oysters in Georgica Pond in cages (predator exclusion)
  - Oysters in Shinnecock Bay on restored reef (exposed to predators)

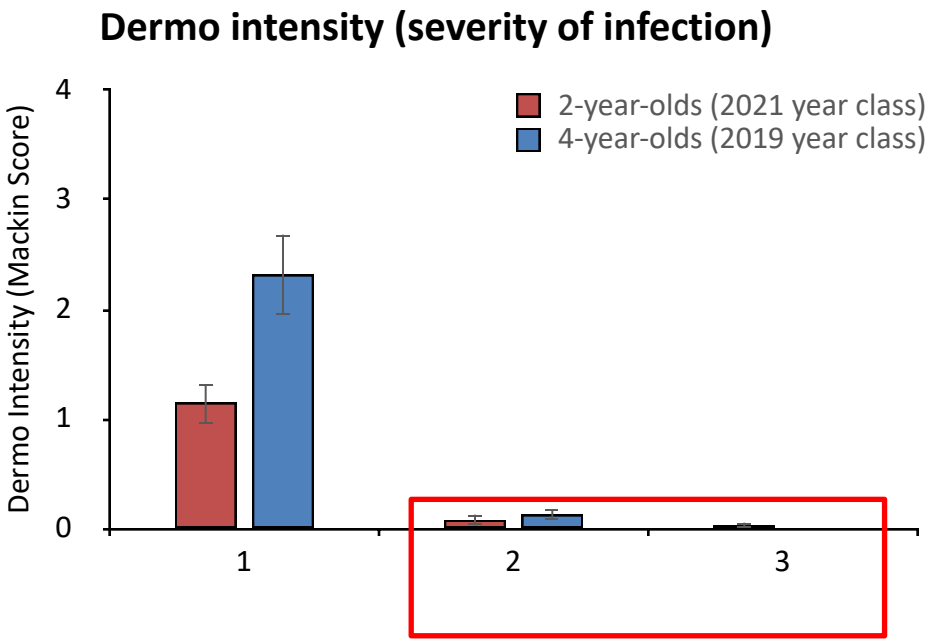




Low prevalence of the oyster disease Dermo in Georgica Pond

- Dermo testing conducted in early fall 2023
  - 2019 year class were 4 years old
  - 2021 year class were 2 years old
- **Lower prevalence and intensity of Dermo in Georgica Pond than Shinnecock Bay for both year classes**
- Low salinity is Georgica Pond creates a refuge from Dermo
- Dermo is a leading cause of mortality in older oysters in Shinnecock Bay and other coastal waters around Long Island





Pilot Oyster Reefs

- Encouraging results from cage experiments
- Installed small test oyster reefs at two sites (central and south) in fall 2022
- Reefs constructed using shell bags containing oyster spat-on-shell

Pilot Oyster Reefs

- Shell bags initially deployed to the two sites on November 2022
- At each site, placed twelve ‘shell bags’ in two adjacent, parallel lines on top of a base of loose shell
- Sometime during spring/summer 2023, **all shell bags at the south site went missing**. The cause is unknown (storms, dredging, theft?)
- New spat-on-shell bags added to each site in fall 2023
- Unlike the oyster spat deployed in cages in previous years, the spat on the shell bags are exposed to predators, like blue crabs

Pilot oyster reefs – results to data

- As of August 2024, there are living oysters on shell bags at each reef site, including **2-year-old oysters from the spat-on-shell initially deployed in 2022 at the central site**
- Oysters are not readily apparent on the shell bags without careful inspection
- Many **oysters found within the shell matrix of the bags**. Predation 'scar' observed on surface of bags.
- We believe **blue crabs predated on oyster spat on the outer surface of the bags**, while oyster spat within the shell matrix were protected from predation

Oyster wrap-up and recommendations

- Results are encouraging for pursuing large scale oyster restoration in Georgica Pond
  - High long-term survival and growth of oysters across the Pond
  - Low prevalence and intensity of Dermo
- Blue crab predation will be an obstacle to oyster restoration in Georgica Pond; shell bags to build oyster reefs will protect small spat from predators, providing a refuge from predation within the shell matrix.
- The siting of future oyster reefs is important to ensure survival and growth of oysters, and to avoid user conflicts.
  - Our surveys have found suitable bottom for reef restoration in areas of central and south Georgica Pond
  - Recurring dredging in the southern part of Georgica Pond may limit oyster restoration opportunities in that area
  - The Friends of Georgica Pond, the East Hampton Trustees, and Gobler Lab researchers should work together to identify the most promising locations.

Final conclusions:

- Georgica Pond has experienced algal blooms, toxic blue-green algae, low oxygen, and fish kills.
- Algal blooms are promoted by excessive nitrogen.
- Most of the nitrogen entering Georgica Pond comes from wastewater.
- Accelerating the removal of nitrogen from wastewater is the central long-term solution.
- PFOS chemicals have entered the pond from past industrial activities to the north with remediation plans underway.
- Legacy agricultural nitrogen is being investigated and will be remediated.
- Oysters are thriving in Georgica Pond and can be part of long-term remediation.

Acknowledgements:

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GOBLER LABORATORY