

Harmful algal blooms: links to nitrogen overloading



Christopher J. Gobler

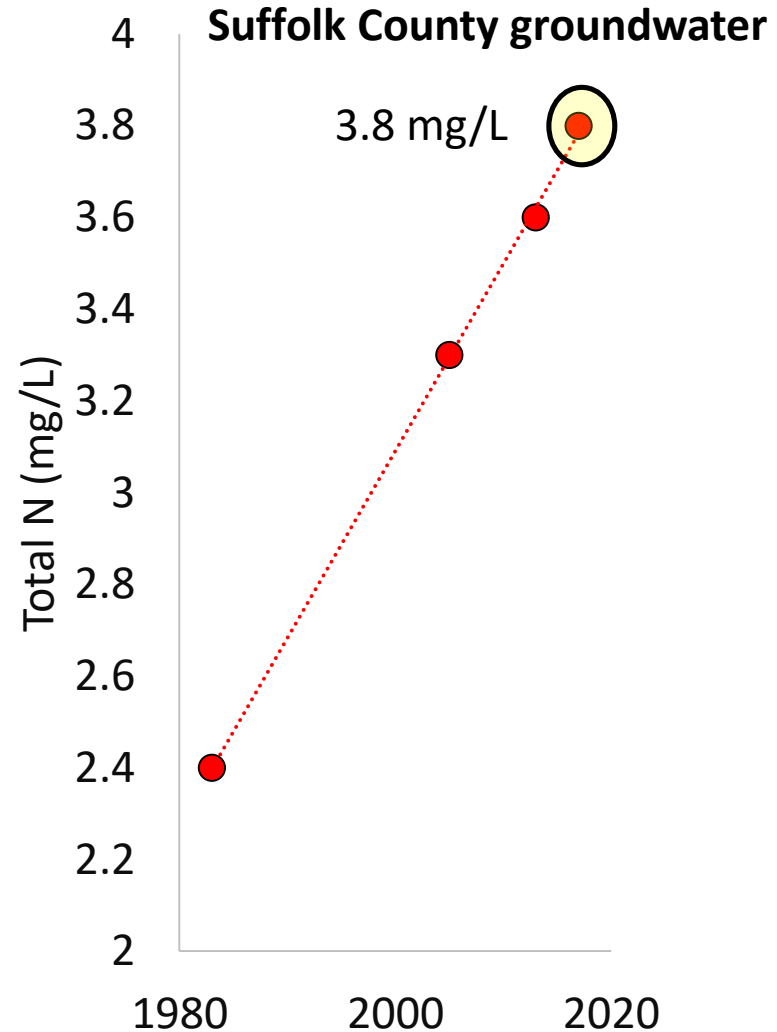
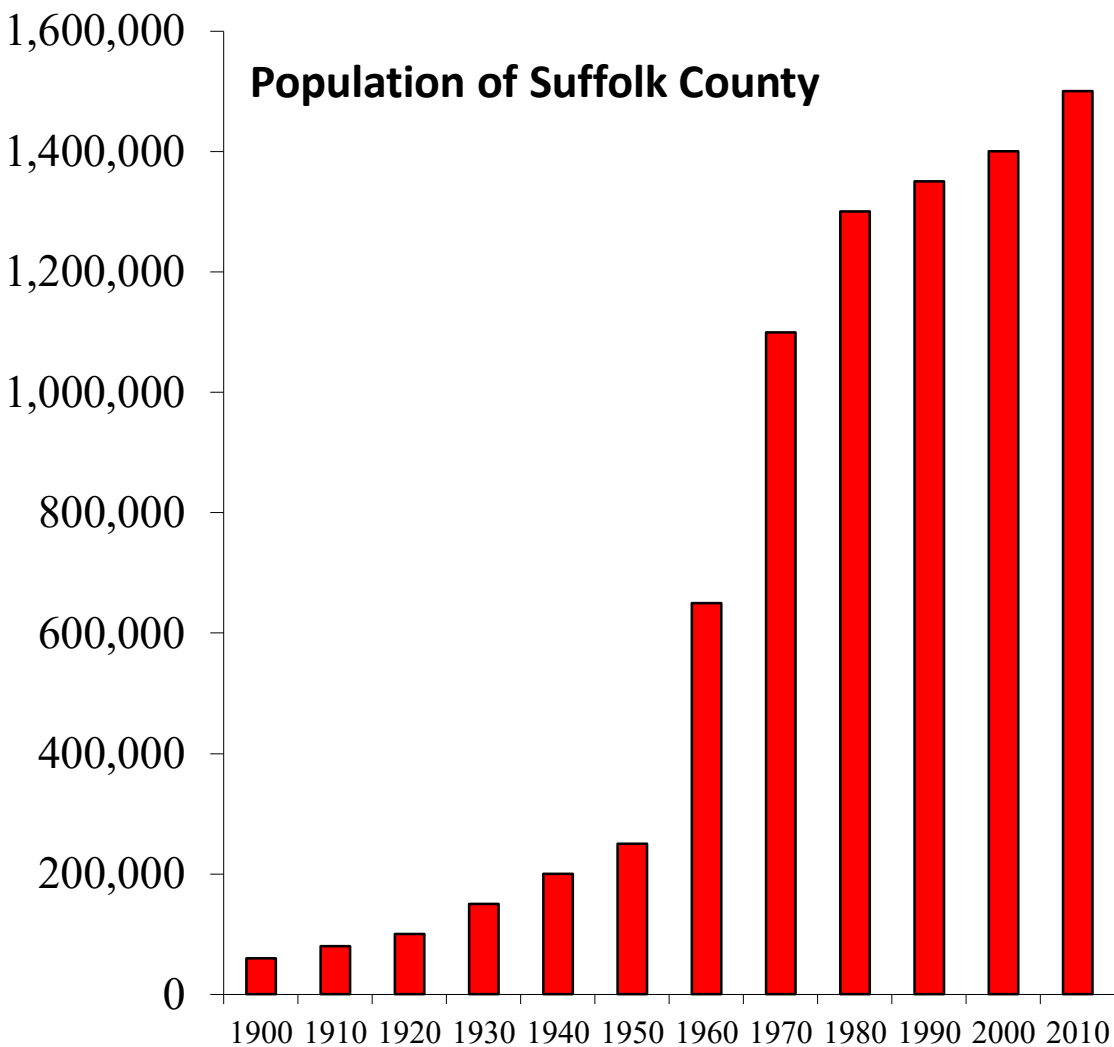


All of Long Island is a watershed -

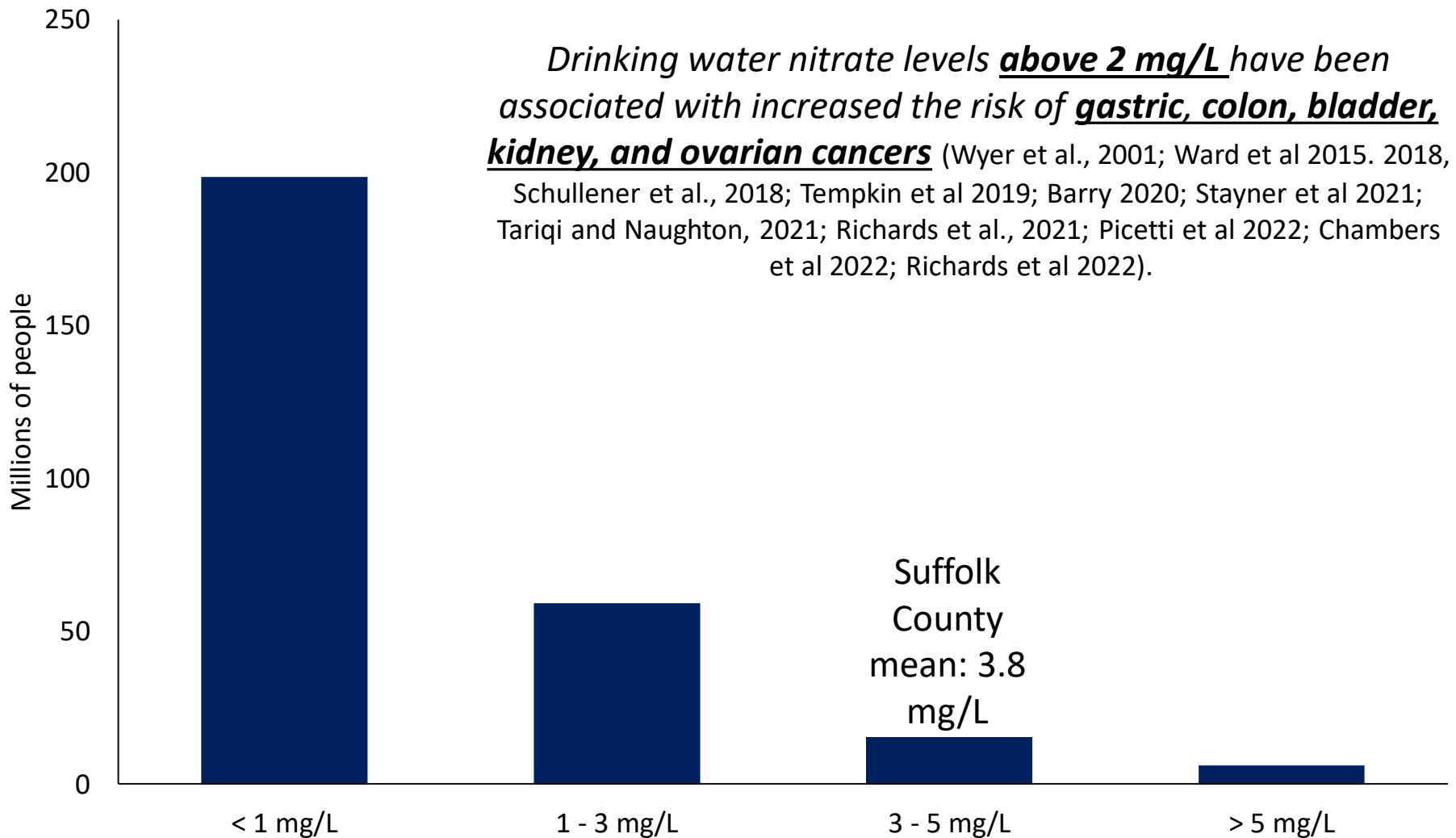
Materials from land are washed into our sole source aquifer and surface waters.



Expanding population, nitrogen levels



Suffolk County public water is in the top 5% of nitrate levels in the US



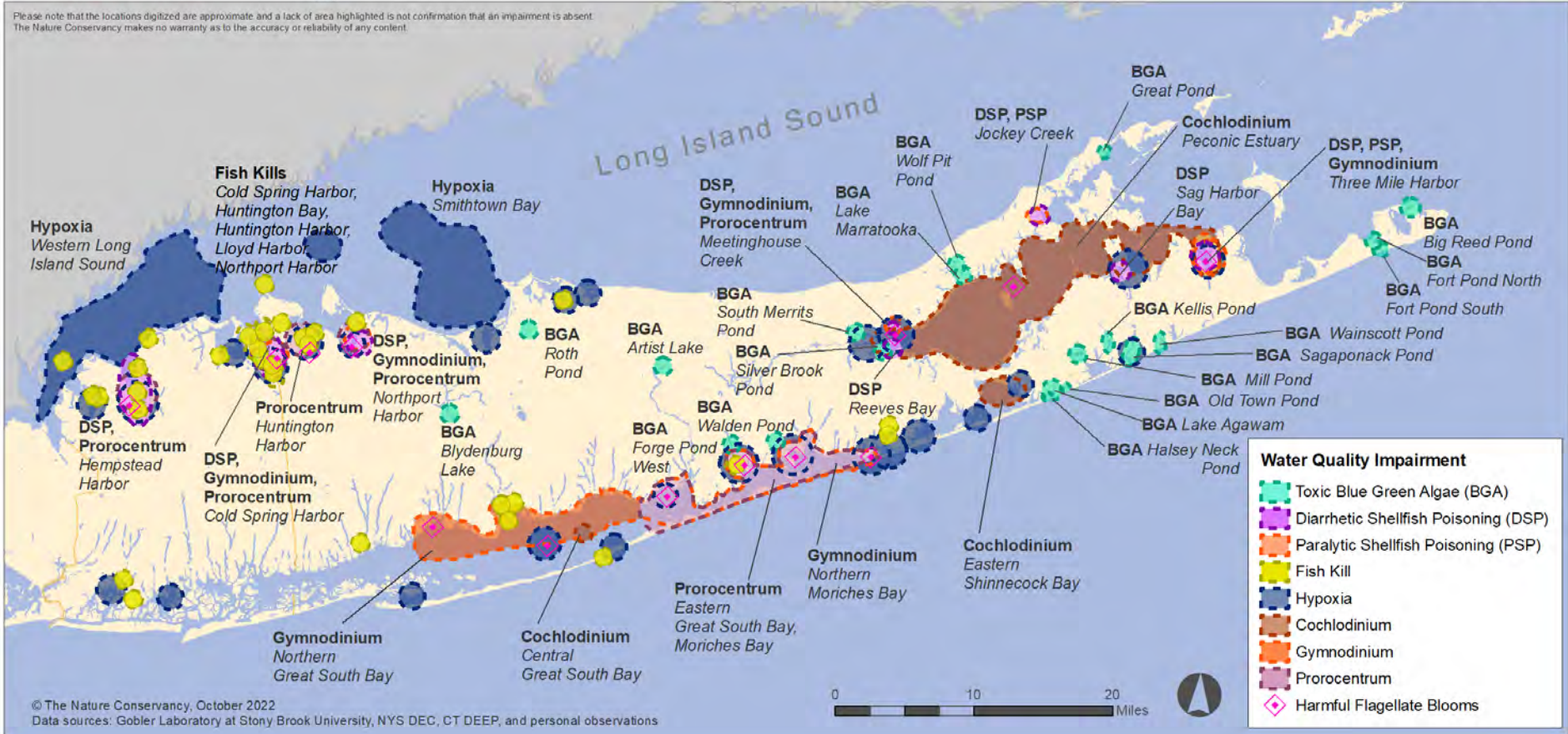
Most nitrogen loading from wastewater

((Kinney and Valiela, 2011; Lloyd 2014, 2016; Gobler and Stinette, 2016; SCSWP, 2020; NCSWP, 2020, 2022))

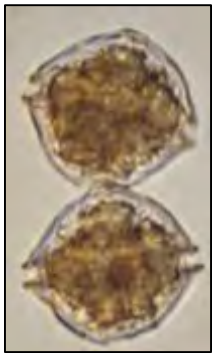


Long Island Water Quality Impairments Summer 2022

Please note that the locations digitized are approximate, and a lack of area highlighted is not confirmation that an impairment is absent. The Nature Conservancy makes no warranty as to the accuracy or reliability of any content.



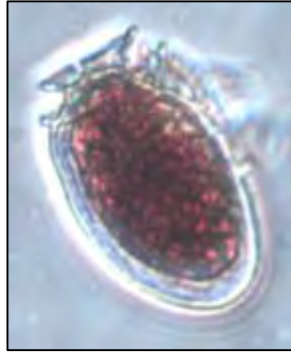
Harmful algal blooms across Long Island



PSP



Toxic blue green algae



DSP



Brown tide



Seaweeds



Rust Tide



Blue-green algal blooms



Exceptional landscape-wide cyanobacteria bloom in Okavango Delta, Botswana in 2020 coincided with a mass elephant die-off event

Jan Veerman ^a, Abhishek Kumar ^{a, b}, Deepak R Mishra ^a  



Article

Canine Cyanotoxin Poisonings in the United States (1920s–2012): Review of Suspected and Confirmed Cases from Three Data Sources




Lorraine C. Backer ^{1,*}, Jan H. Landsberg ², Melissa Miller ^{3,4}, Kevin Keel ⁴ and Tegwin K. Taylor ³

¹ National Center for Environmental Health, [Centers for Disease Control and Prevention](#),
4770 Buford Highway NE, MS F-60, Chamblee, GA 30341, USA

~400 confirmed cases: “The canine cyanotoxin poisoning events reviewed here likely represent a **small fraction** of cases that occur throughout the U.S. each year.” - CDC

NYSDEC blue green algae page

Blooms across NYS tracked weekly May - Nov



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Home » Chemical and Pollution Control » Water » Water Quality Information » Blue-Green Harmful Algal Blooms

Blue-Green Harmful Algal Blooms

No harmful algae blooms that have been identified in the waters of western Lake Erie have affected New York State drinking water and bathing beaches. Monitoring and surveillance of the New York portions of Lake Erie, as well as the Niagara River and Lake Ontario, have revealed no such blooms. More information about HABs can be found on this page; an [overview of HABs and drinking water concerns, including concerns about Lake Erie \(PDF, 170 KB\)](#) is available.

What is a Harmful Algal Bloom (HAB)?

Most algae are harmless and are an important part of the food web. Algae are naturally present in slow moving streams, lakes, marine waters and ponds in low numbers. Certain types can become abundant and form blooms under the right conditions. Some algae can produce toxins that can be harmful to people and animals. These are collectively called harmful algal blooms (HABs).

Avoid Algae Blooms

Algae blooms most frequently occur in nutrient-rich waters, particularly during hot, calm weather.

Because it is hard to tell a harmful algae bloom from other algae blooms, we recommend avoiding contact with any floating rafts, scums, and discolored water. Find out what waterbodies have a [blue-green algal bloom notice](#).

Freshwater Blue-green Algal Blooms

Blue-green algae, technically known as **cyanobacteria**, are naturally present in lakes and streams in low numbers. Blue-green algae can form **HABs** that discolor the water or produce floating rafts or scums on the surface of the water. These can cause health risks to people and animals when they are exposed to them.


Blue-green algae blooms can occur in freshwater lakes and ponds and can reduce the recreational value of a waterbody, due to unpleasant appearances and odors, and can cause a variety of ecological problems, such as reduced oxygen levels. They also have the potential to form harmful (toxic) blue-green algal blooms, although the factors that cause blue-green algae to produce toxins are not well understood.

Harmful blue-green algae blooms can cause health effects when people and animals come in contact with them. Symptoms can include nausea, vomiting, diarrhea, skin or throat irritation, allergic reactions or breathing difficulties. Blue-green algae can also produce toxins that affect the liver and nervous systems when water is consumed in sufficient quantities.

[More information about blue-green algae and blue-green harmful algal blooms effect on lakes.](#)

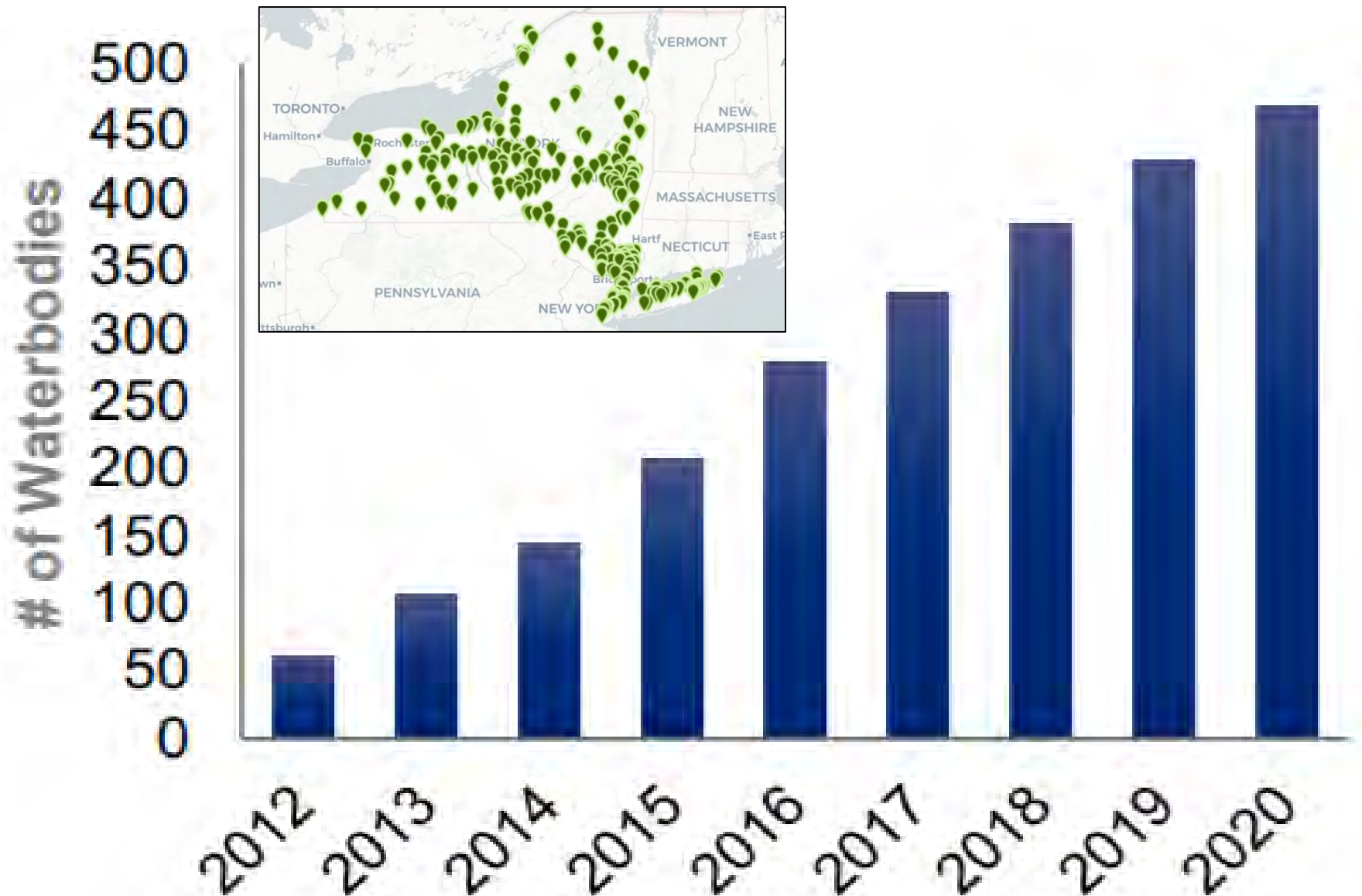
Marine Algal Blooms

- Outdoor Activities
- Animals, Plants, Aquatic Life
- Chemical and Pollution Control
 - Water
 - Water Quality Information
 - Blue-Green Harmful Algal Blooms
 - What is a Blue-green Harmful Algal Bloom?
 - Photo Gallery of Green and Blue-green Algae
 - Blue-Green Algal Bloom Notices
 - Information about Blue-green Algae HABs for Individuals and Communities
 - Archived Blue-green Algal Bloom Notices
 - FAQs About Blue-green Algae
- Energy and Climate
- Lands and Waters
- Education
- Permit, License, Registration
- Public Involvement and News
- Regulations and Enforcement
- Publications, Forms, Maps
- About DEC



Blue-green algae blooms may have the appearance of spilled green paint.

Blue-green algae blooms, NYS

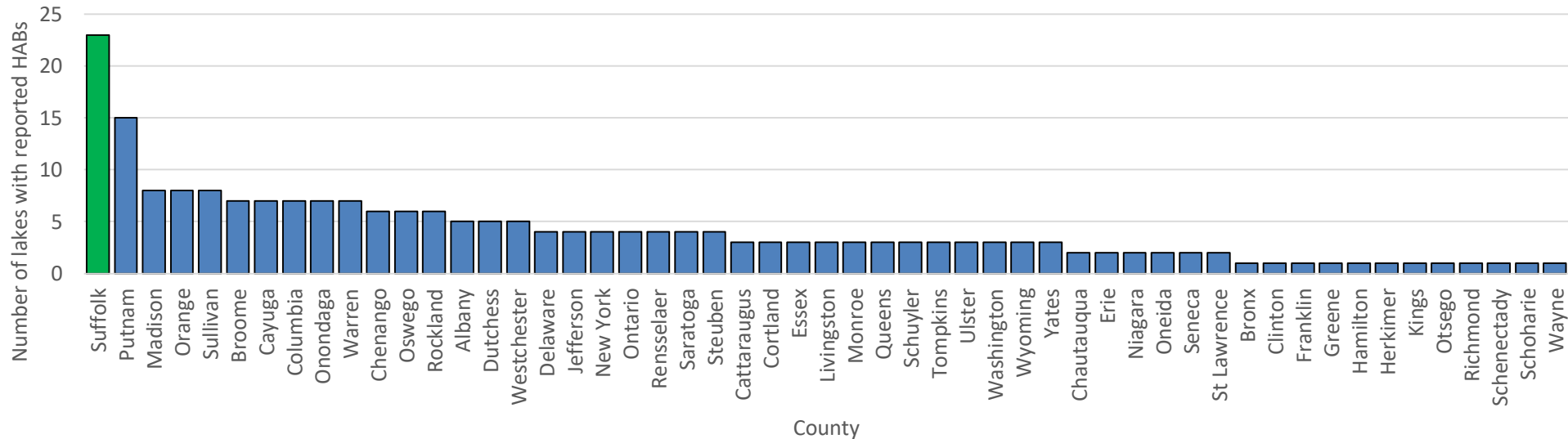


Number of waterbodies with blue-green algal blooms per county, 2021

53 of 62 counties with blooms (Nassau = none!)

~50% more waterbodies in Suffolk County with blue-green algae blooms compare to next highest NYS county.

HABs per county 2021





Contents lists available at ScienceDirect

Harmful Algae

journal homepage: www.elsevier.com/locate/hal



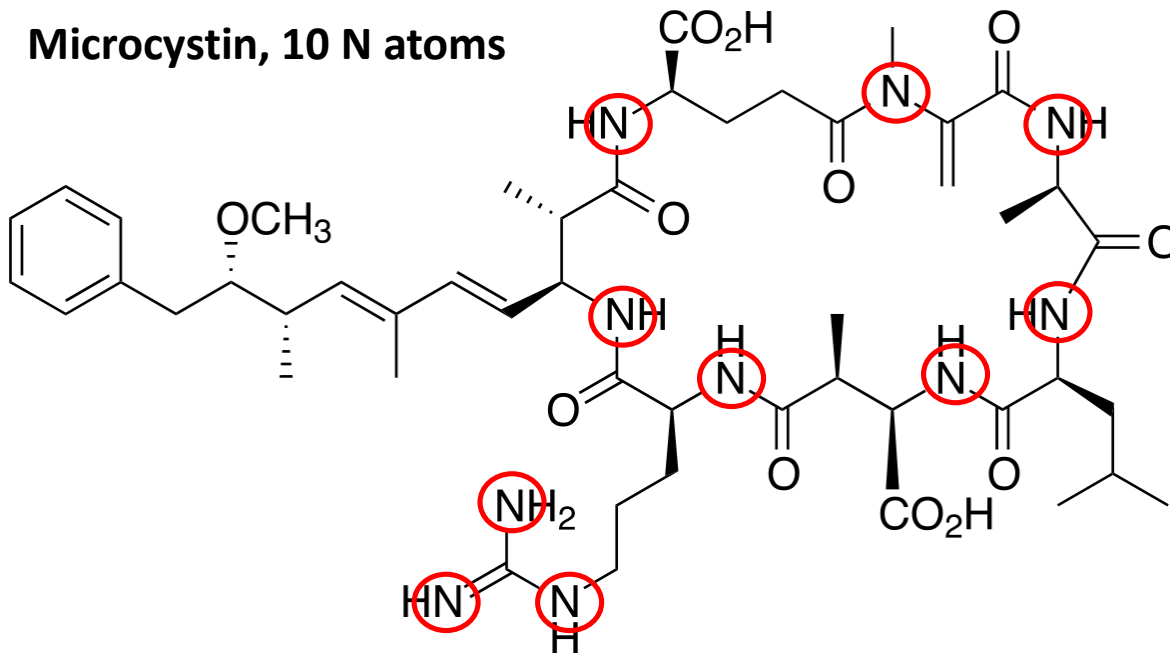
Review

The dual role of nitrogen supply in controlling the growth and toxicity of cyanobacterial blooms

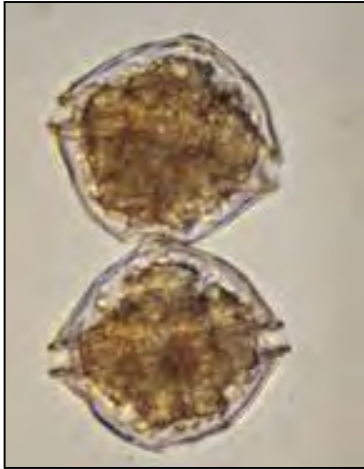


Christopher J. Gobler^{a,*}, JoAnn M. Burkholder^{b,1}, Timothy W. Davis^{c,1},
Matthew J. Harke^{a,1}, Tom Johengen^{d,1}, Craig A. Stow^{c,1}, Dedmer B. Van de Waal^{e,1}

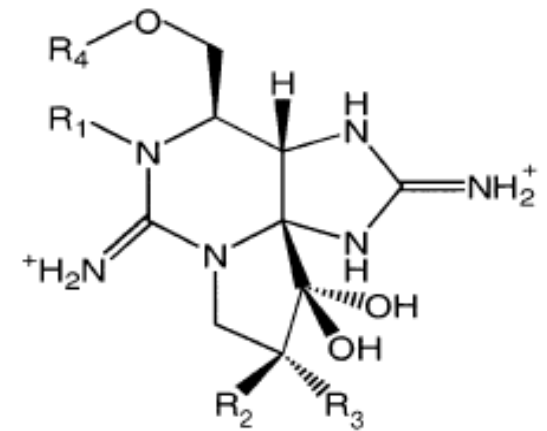
Microcystin, 10 N atoms



Alexandrium HABs and paralytic shellfish poisoning (PSP)



Alexandrium



Saxitoxin





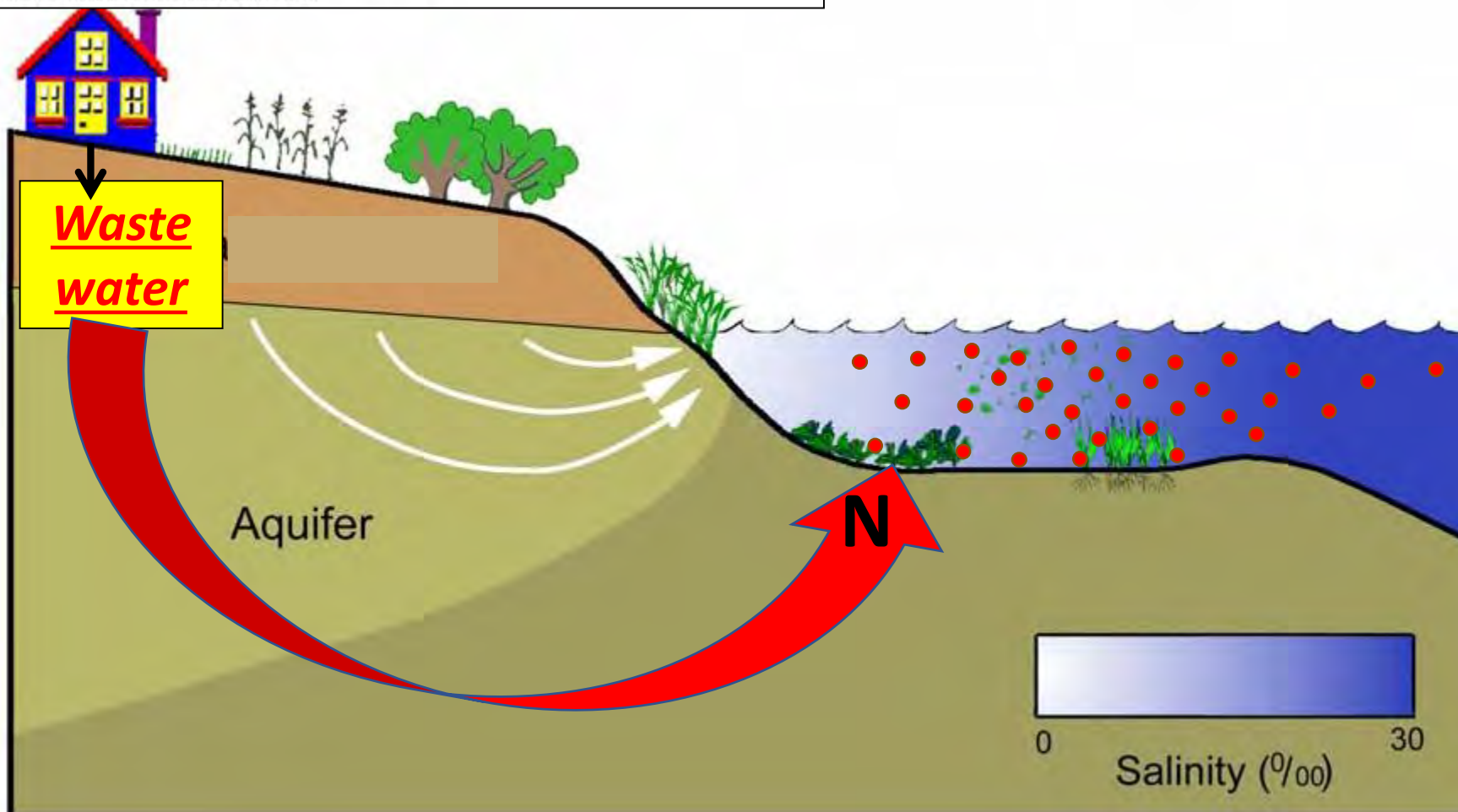
The influence of anthropogenic nitrogen loading and meteorological conditions on the dynamics and toxicity of *Alexandrium fundyense* blooms in a New York (USA) estuary

Theresa K. Hattenrath^a, Donald M. Anderson^b, Christopher J. Gobler^{a,*}

^aStony Brook University, School of Marine and Atmospheric Sciences, Southampton, NY 11968, USA

^bWoods Hole Oceanographic Institution, Woods Hole, MA 02543, USA

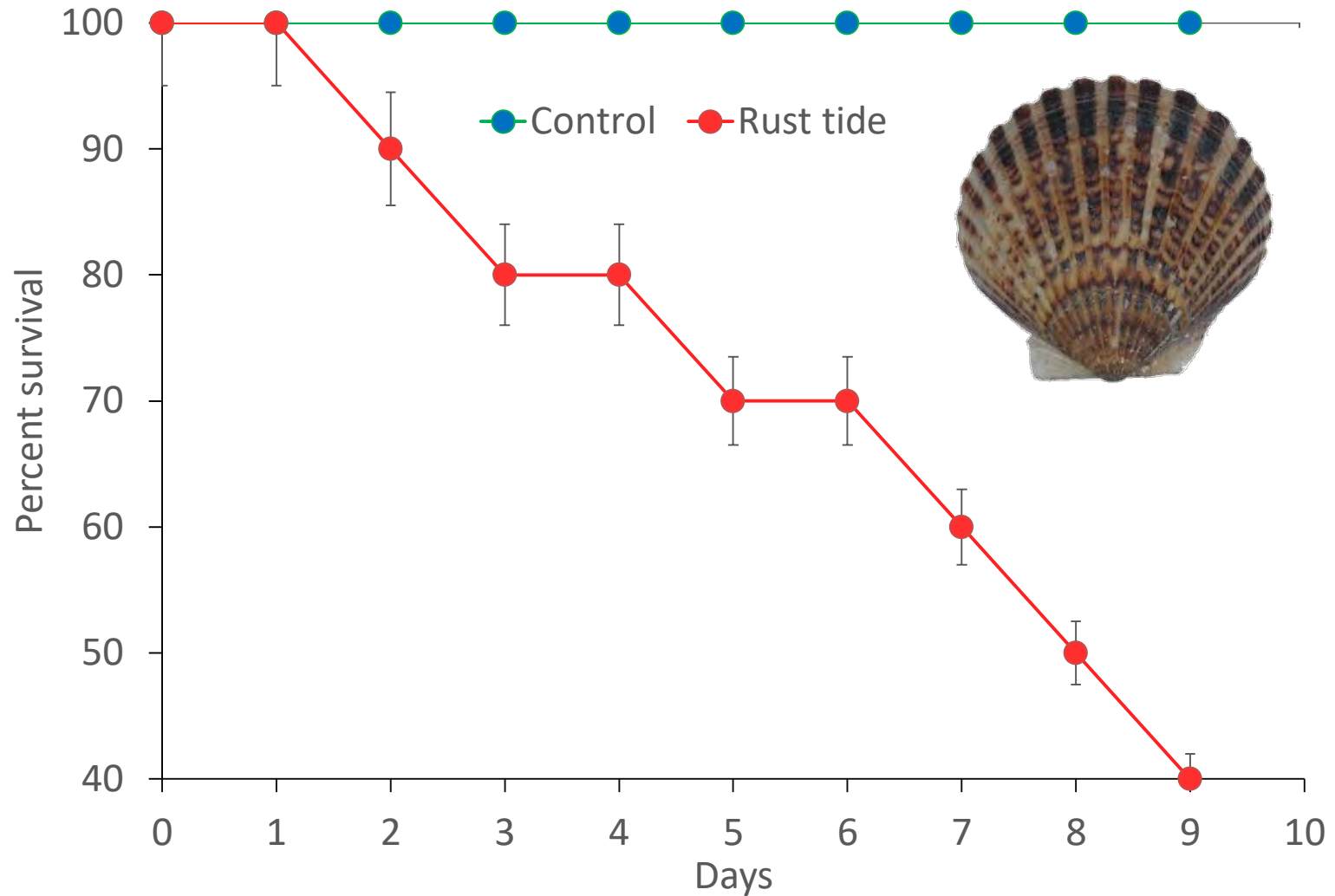
“Wastewater-derived nitrogen (N) loading can promote intense and toxic *A. fundyense* blooms.”
– Hattenrath et al 2010



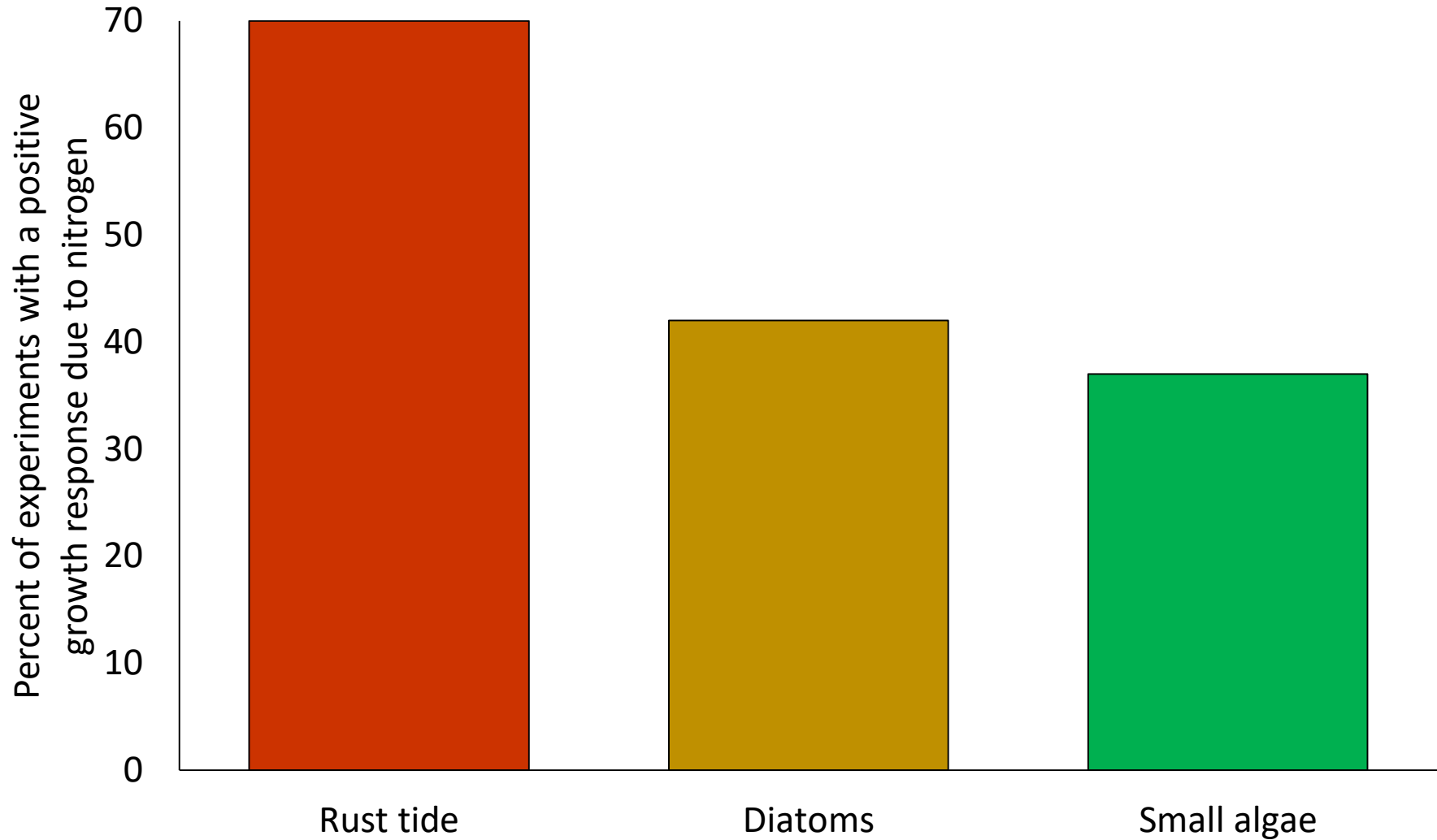
Cochlodinium rust tides, 2004-2022



Bay scallops exposed to rust tide bloom



Rust tide and nitrogen



An aerial photograph showing a vast expanse of water with a prominent, dense, reddish-brown algal bloom. The bloom extends from the foreground, where it appears as a thick, textured carpet of red and brown, into the open water, where it forms a large, irregular shape. The water in the background is a deep blue, contrasting with the reddish-brown of the bloom. The sky is clear and light blue. The text "Long Island's new HAB" is overlaid on the image in a white, serif font with a drop shadow.

Long Island's new HAB

Dasy: Long Island's new HAB

Dasysiphonia japonica

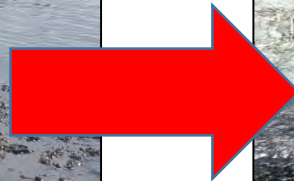


Great South Bay, summer 2019

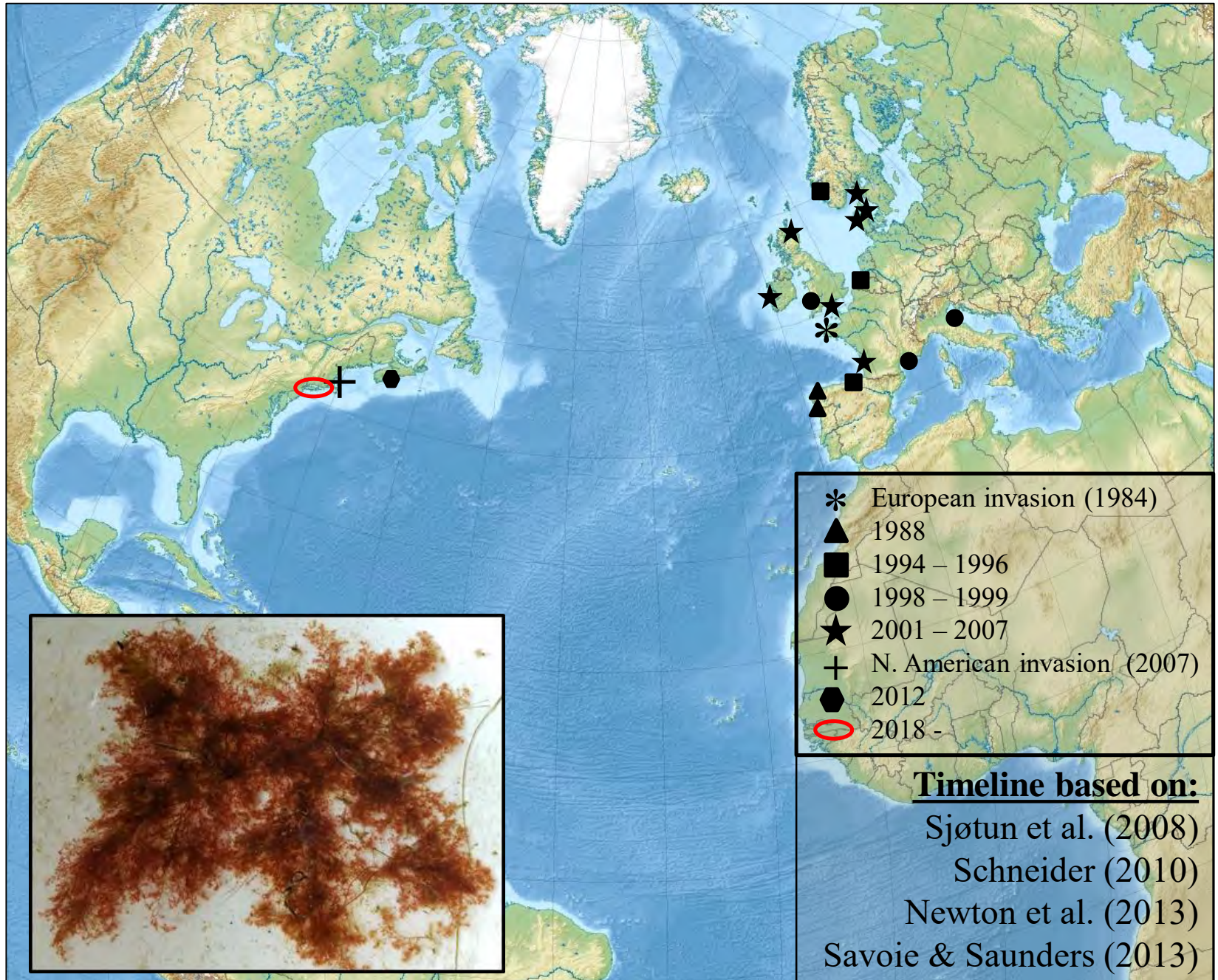
Overgrowth of seaweeds: public health threat

- High concentrations of hydrogen sulfide cause **potentially fatal hypoxic pulmonary, neurological, and cardiovascular lesions** (Resiere et al 2018; The Lancet).
- Subchronic and chronic exposures can cause **airway irritation, headaches, vestibular syndrome, memory loss, and modification of learning abilities** (Resiere et al 2018; The Lancet).

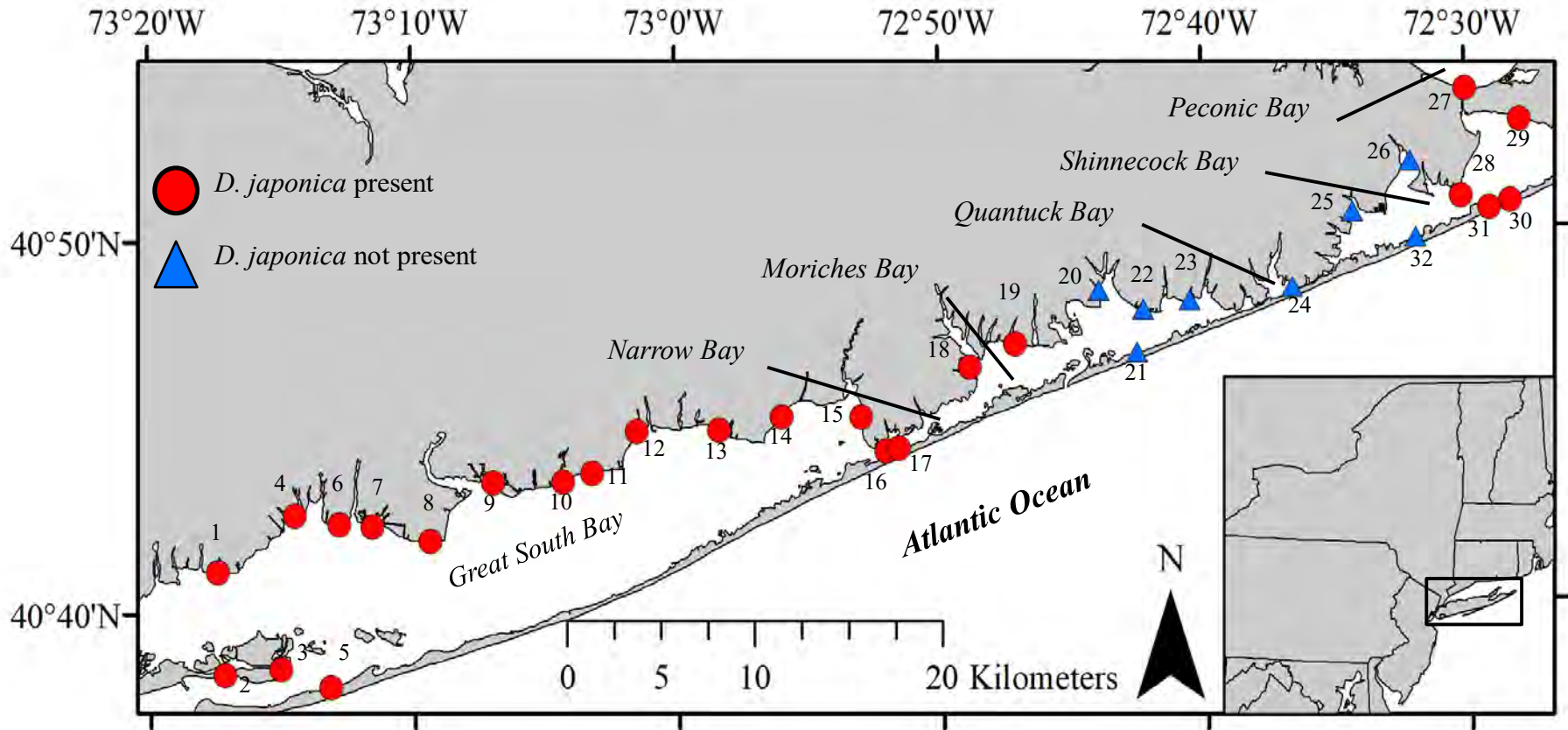
Great South Bay, July 2018

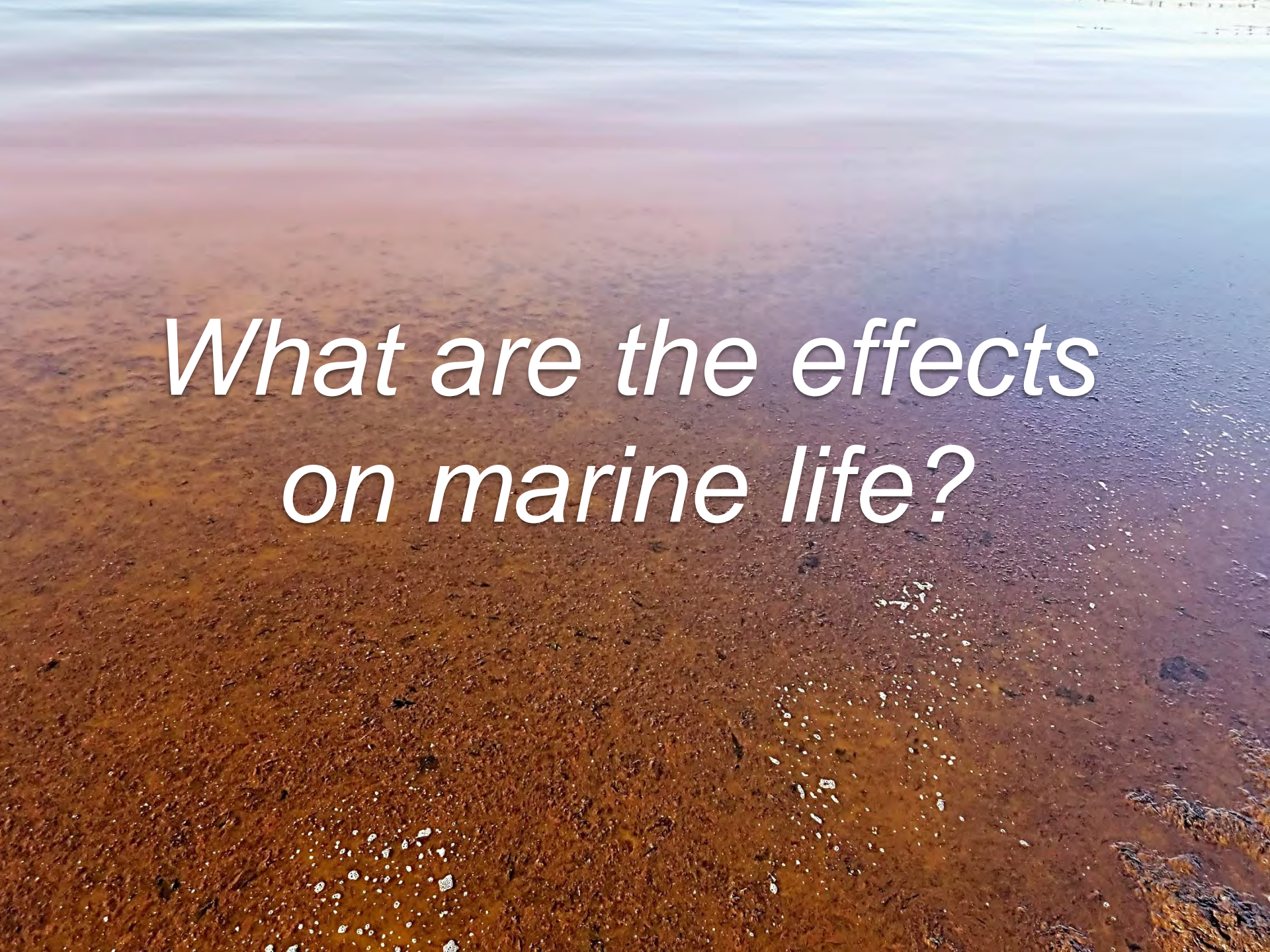


Invasion by *Dasysiphonia japonica*



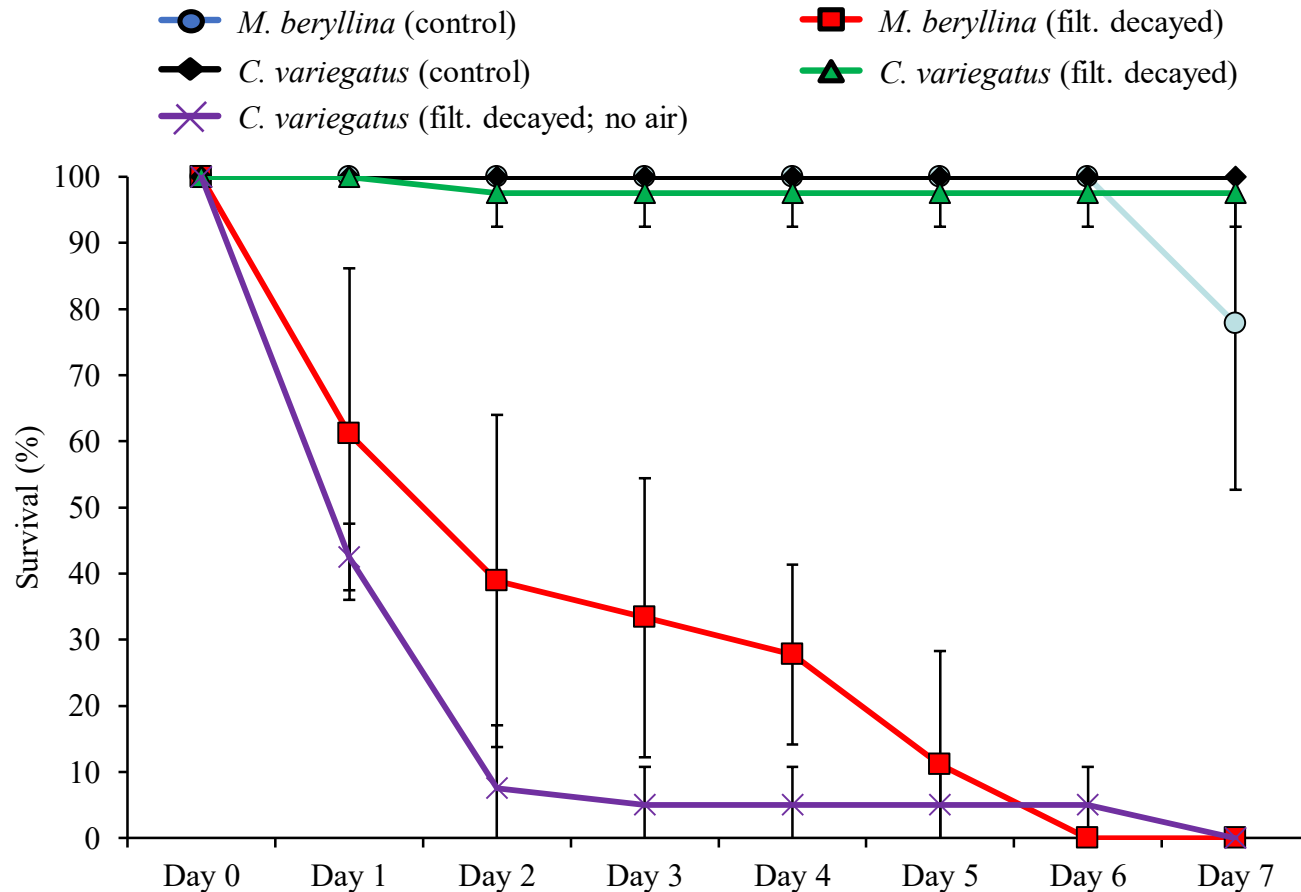
Spread of *Dasysiphonia* across south shore



An aerial photograph of a coastal area. The foreground is dominated by a wide, reddish-brown beach, likely composed of iron-rich sand or silt. The beach is textured with small rocks and pebbles. In the middle ground, the ocean is visible, showing a gradient of colors from light blue near the shore to a deeper blue further out. The horizon line is visible in the upper part of the image. The overall scene is serene and natural.

*What are the effects
on marine life?*

Larval fish exposed to decayed *Dasysiphonia*

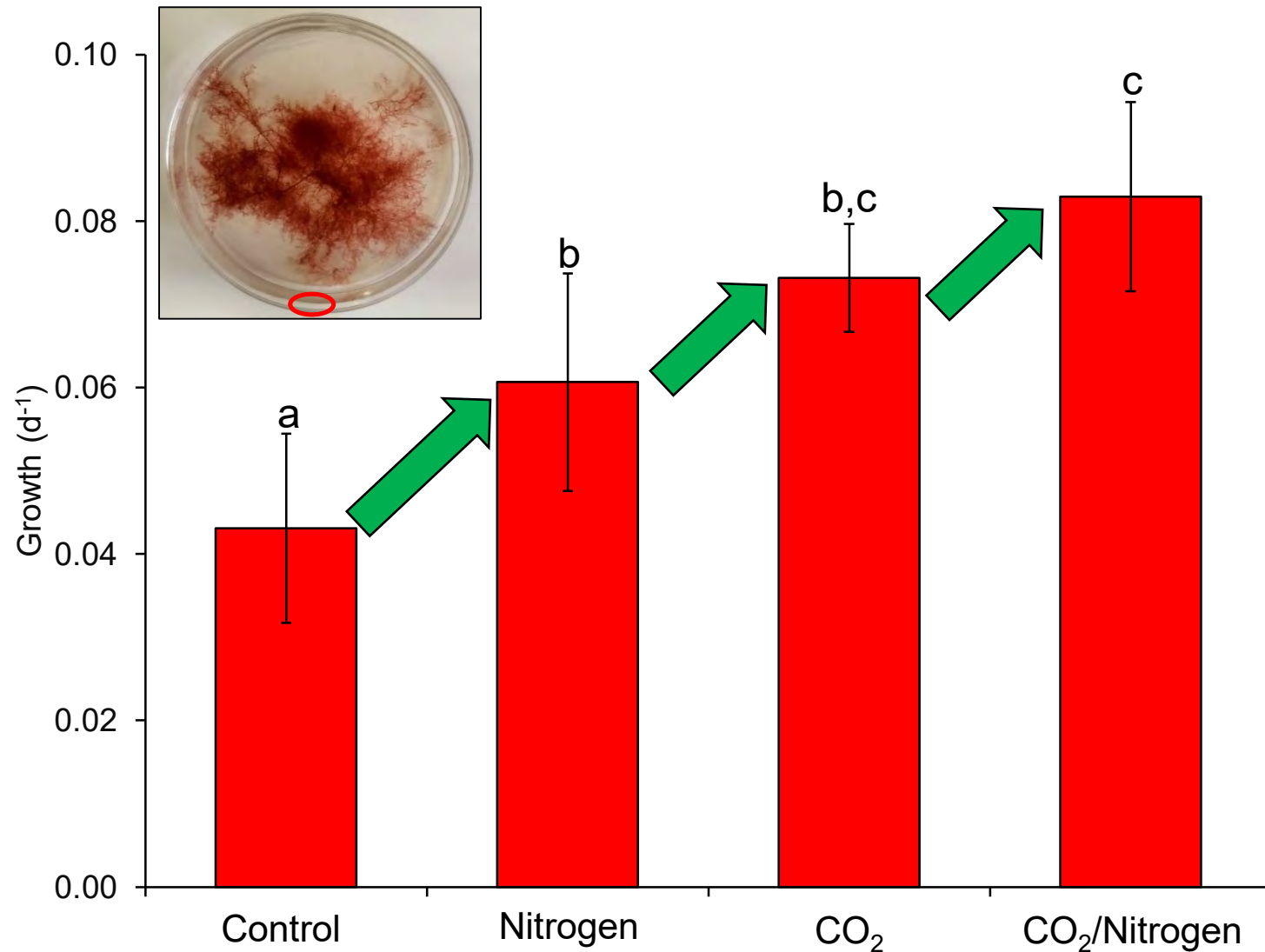




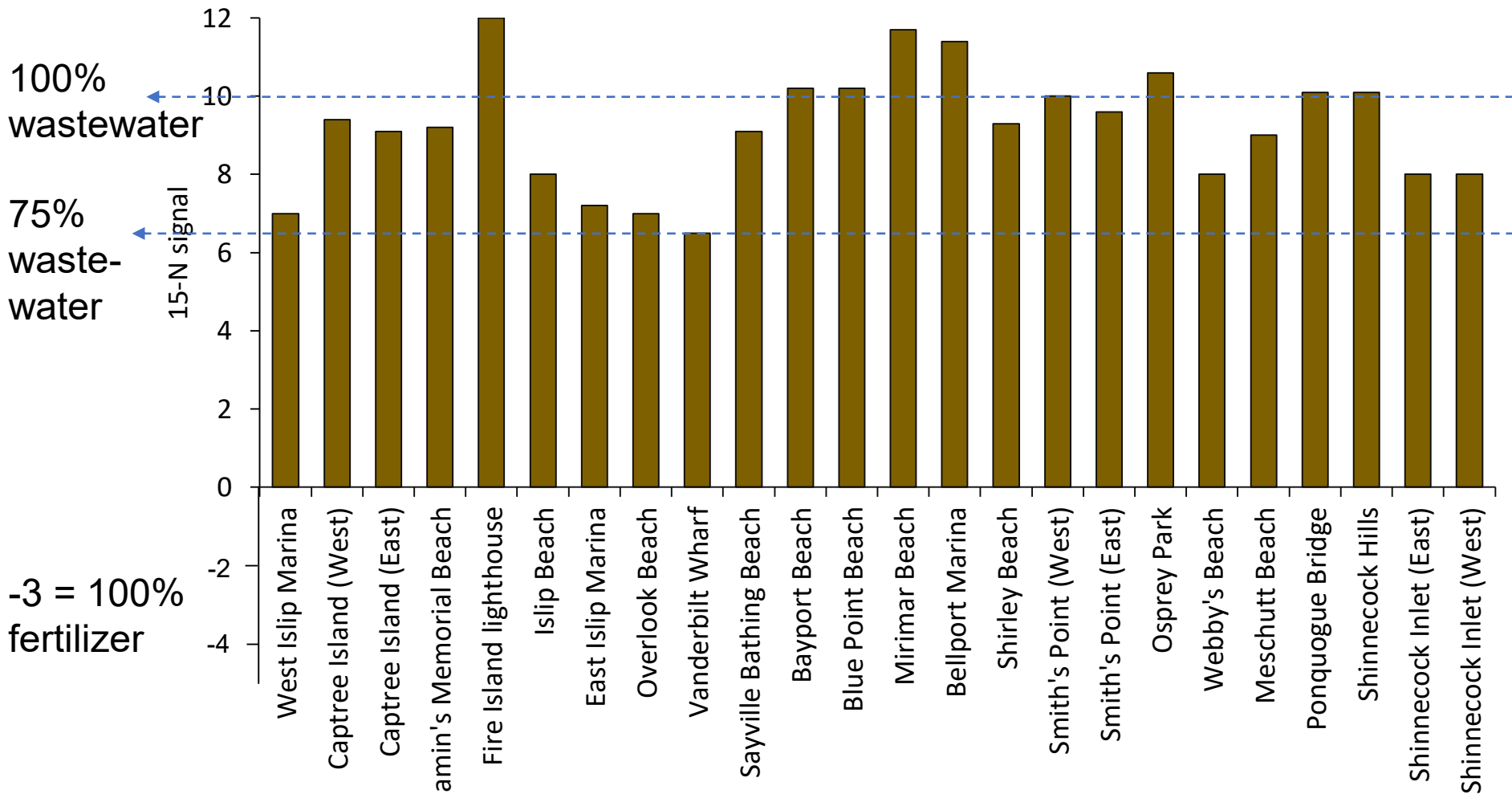
Why did Dasy take up residence on Long Island?



Growth of *Dasysiphonia* exposed to elevated CO₂ concentrations with and without nitrogen additions



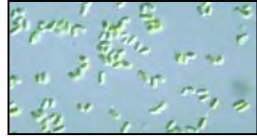
Tissue content indicates the invasive algae is *fueled by wastewater-derived nitrogen*



History of Long Island, 1950 - 2022

1950 1960 1970 1980 1990 2000 2010 2020

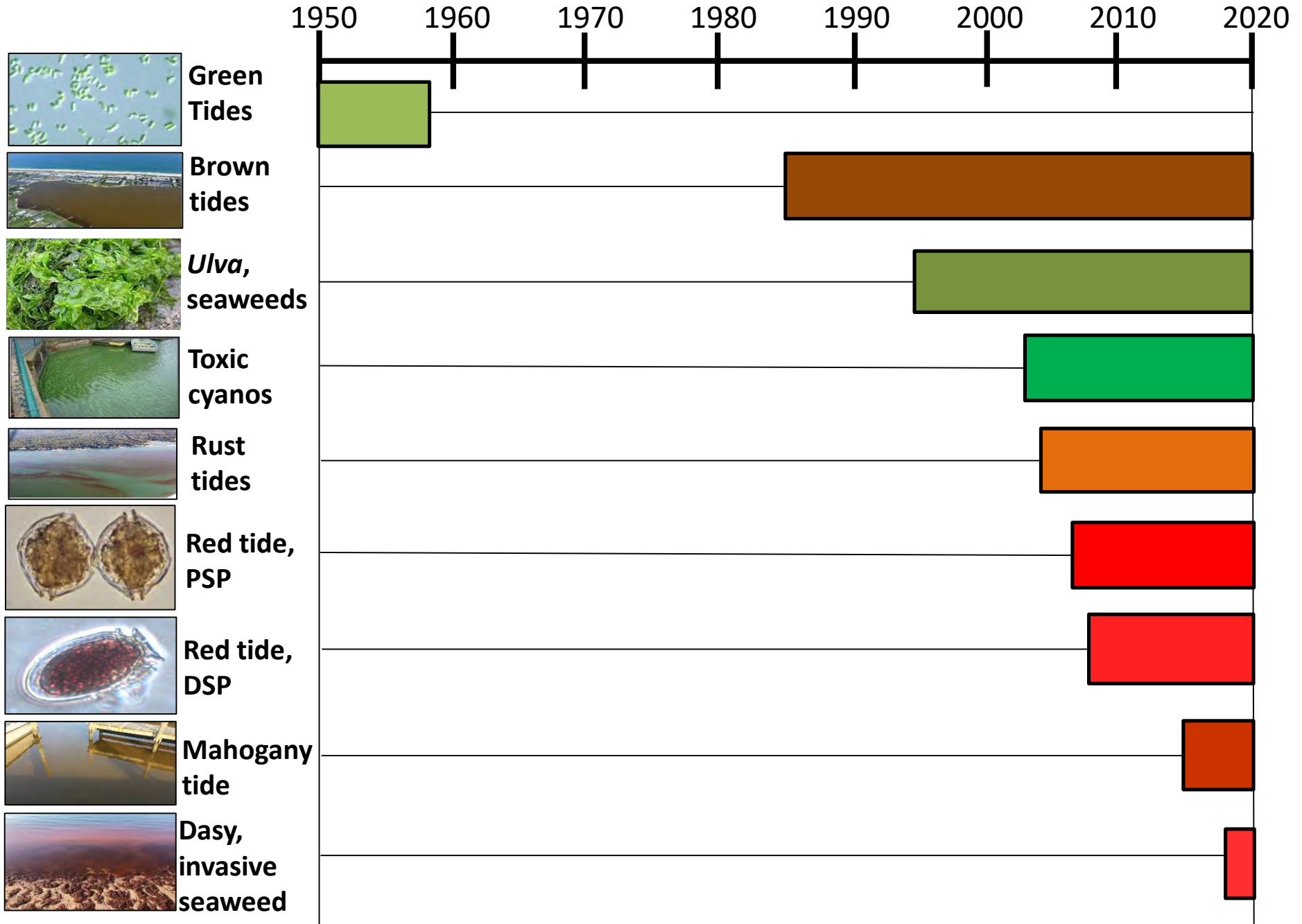
Green
Tides



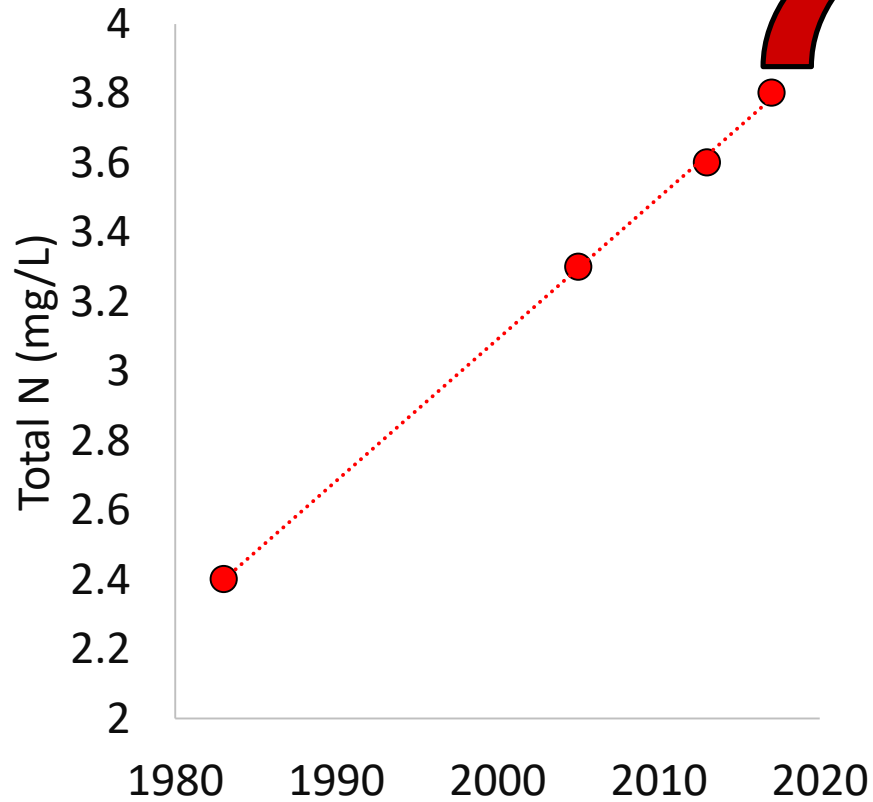
1960 – 1985
Record setting
hard clam and
bay scallop
landings



History of Long Island, 1950 - 2022



More nitrogen makes harmful algae on Long Island grow faster and/or more toxic



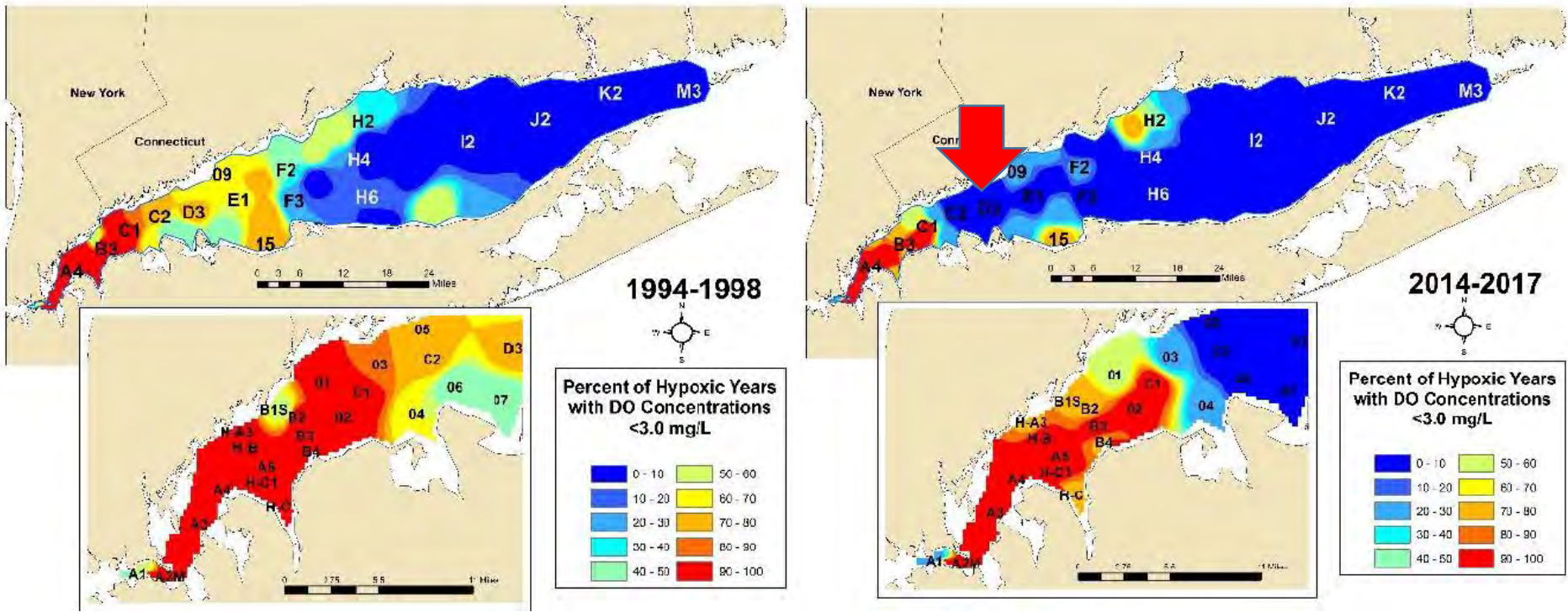
Studies: Hattenrath et al 2010; Gobler et al 2011, 2012; Gobler and Sunda 2012; Harke and Gobler 2013, 2015; Hattenrath-Lehmann et al 2015A&B; Gobler et al 2016; Harke et al 2016.

Hope

Mitigating N loading works...

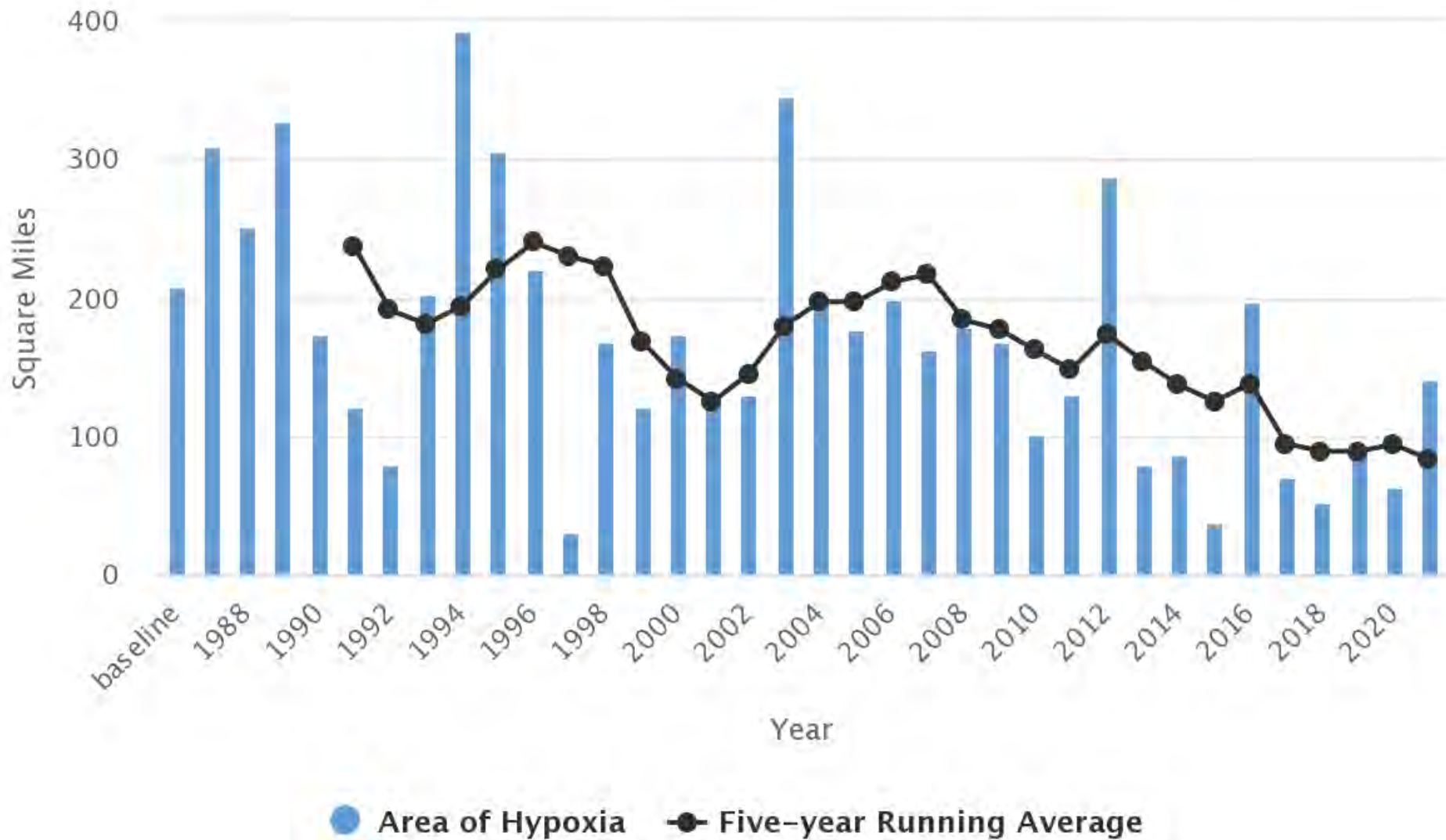


Long Island Sound oxygen improvements

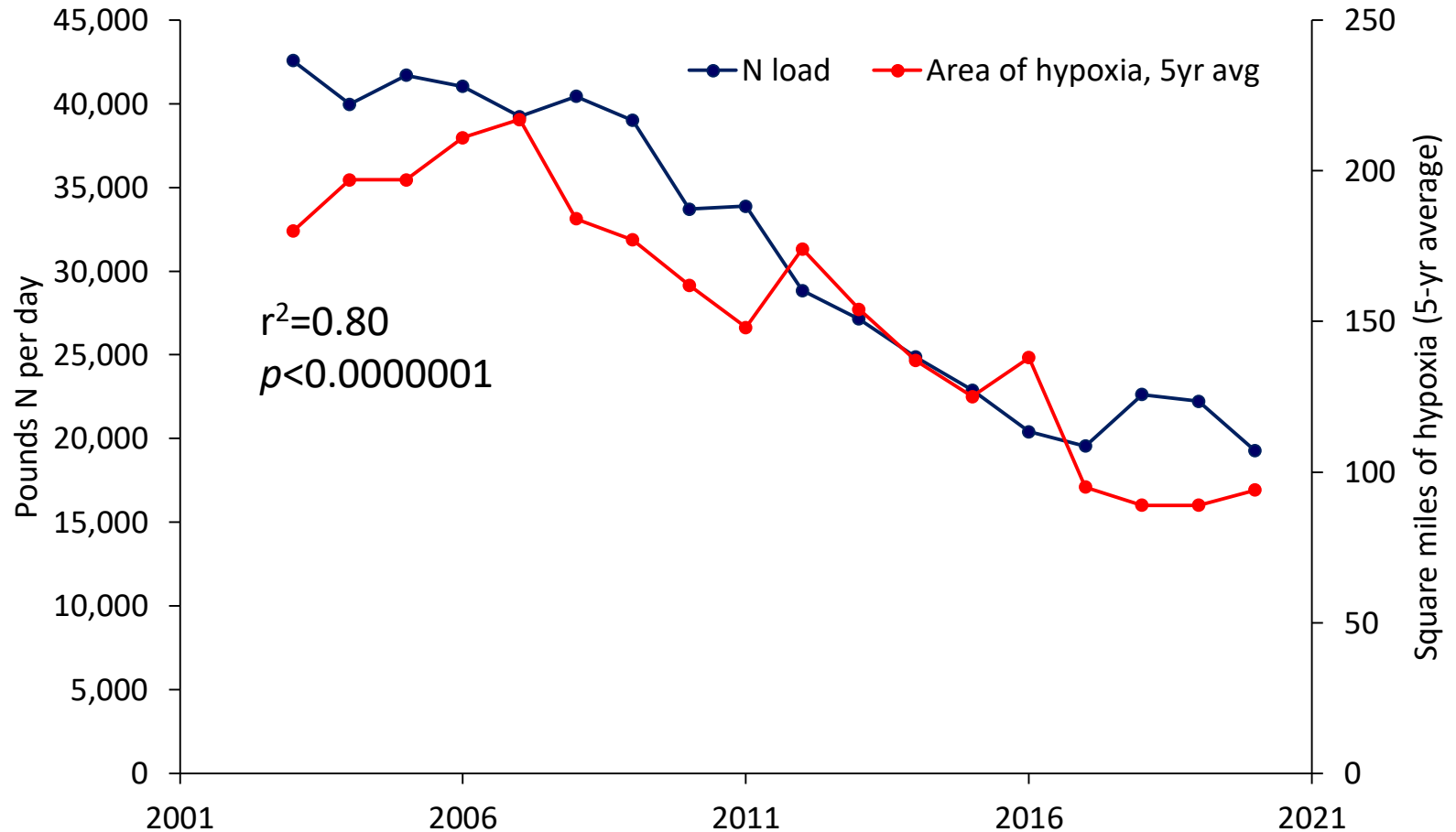


60% reduction in nitrogen loading since 2000.

Hypoxia (Dissolved Oxygen ≤ 3 mg/L) in Long Island Sound



Long Island Sound hypoxia and N load



Hope

Policies and practices to reduce nitrogen loading are underway...






SUFFOLK COUNTY SUBWATERSHEDS WASTEWATER PLAN

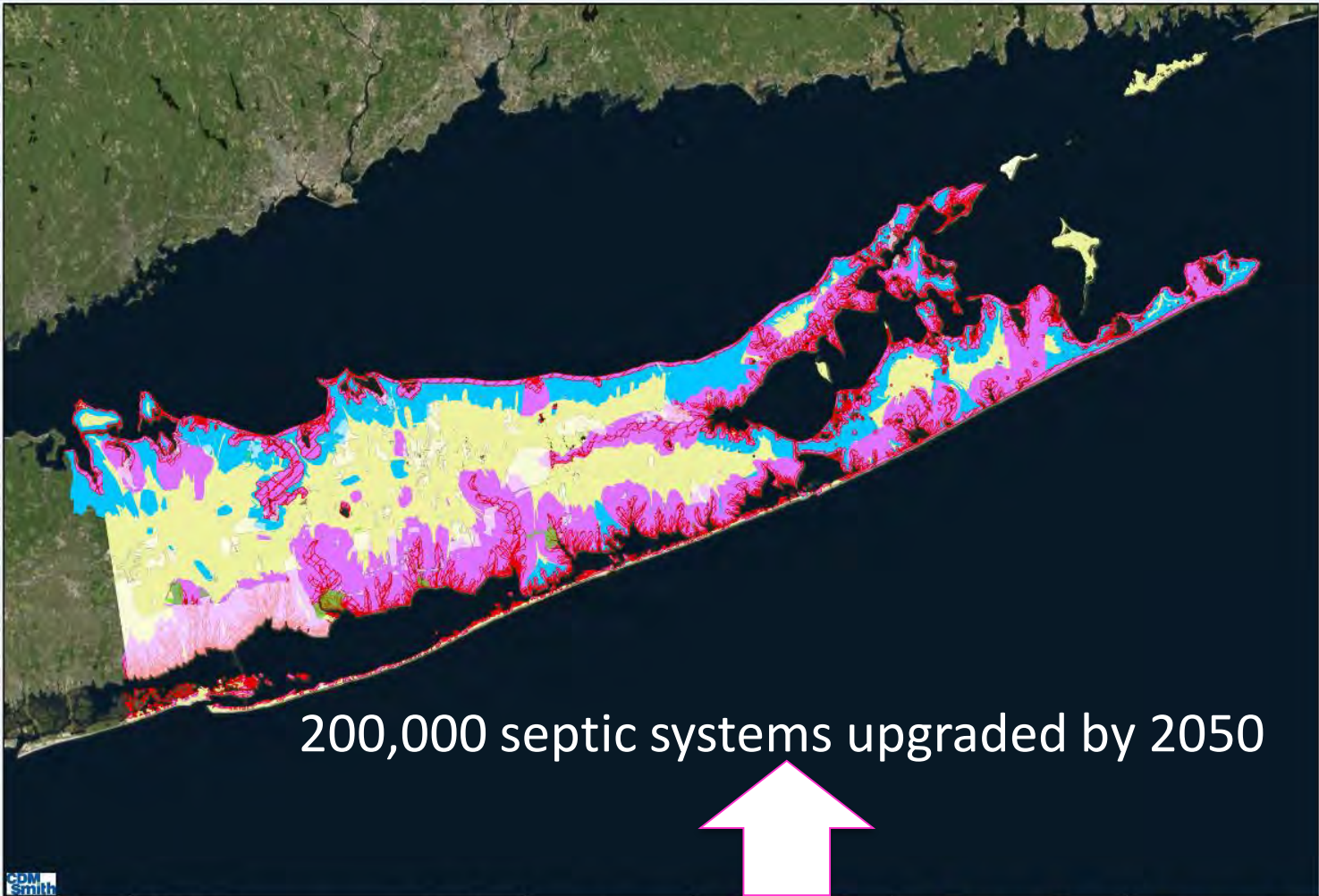
JUNE 2020

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

Subwatershed Plan Implementation Phases



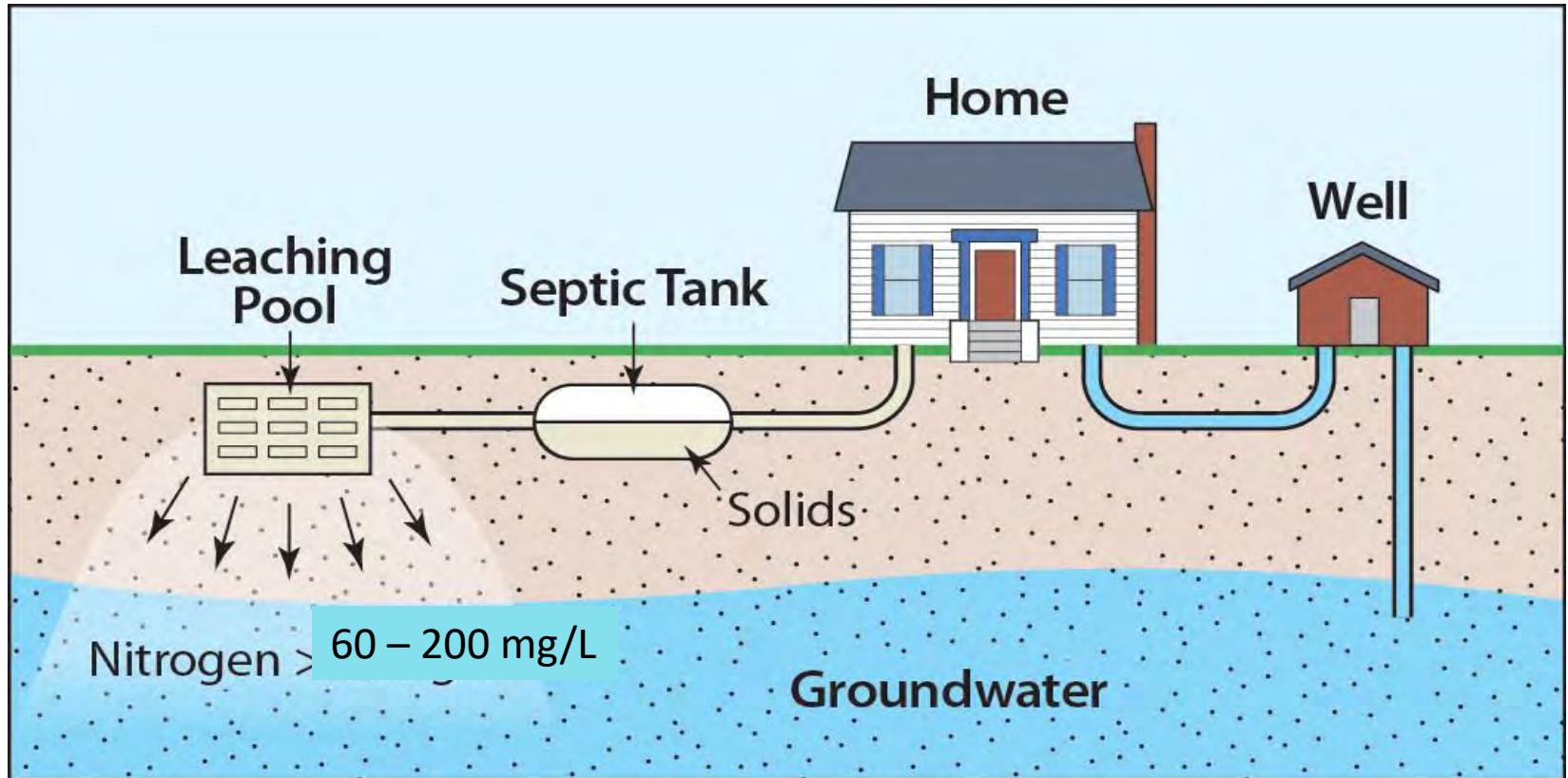
200,000 septic systems upgraded by 2050



 	Sewering Existing  Proposed 	Travel Time (Years)  2	 0 24,000 48,000 Ft	Phase II SW Priority Area 1 GW Priority Area 1 0-2 Year Contributing Area	Phase III SW Priority Area 2-4 GW Priority Area 2 2-25/50 Year Contributing Area	Phase IV Remaining Surface Water and Groundwater Protection Parcels
	Implementation Phase Phase II  Phase III  Phase IV 					

400,000 septic tank question

How will Long Island deal with 400,000 unsewered homes?



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



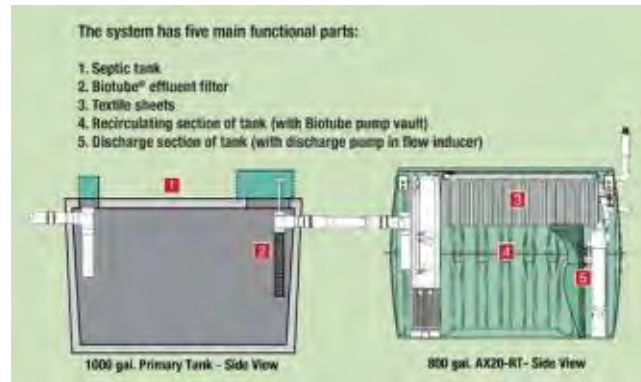
Hydro-Action



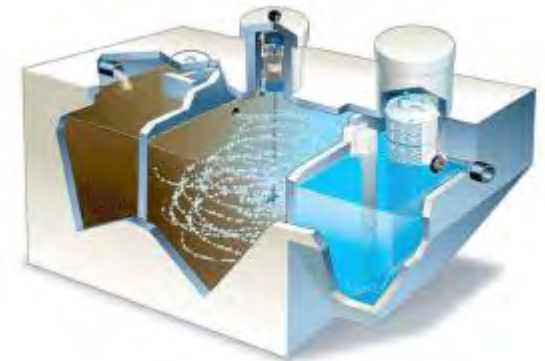
Fuji Clean System



Norweco Hydrokinetic



Orenco Advantex AX-RT

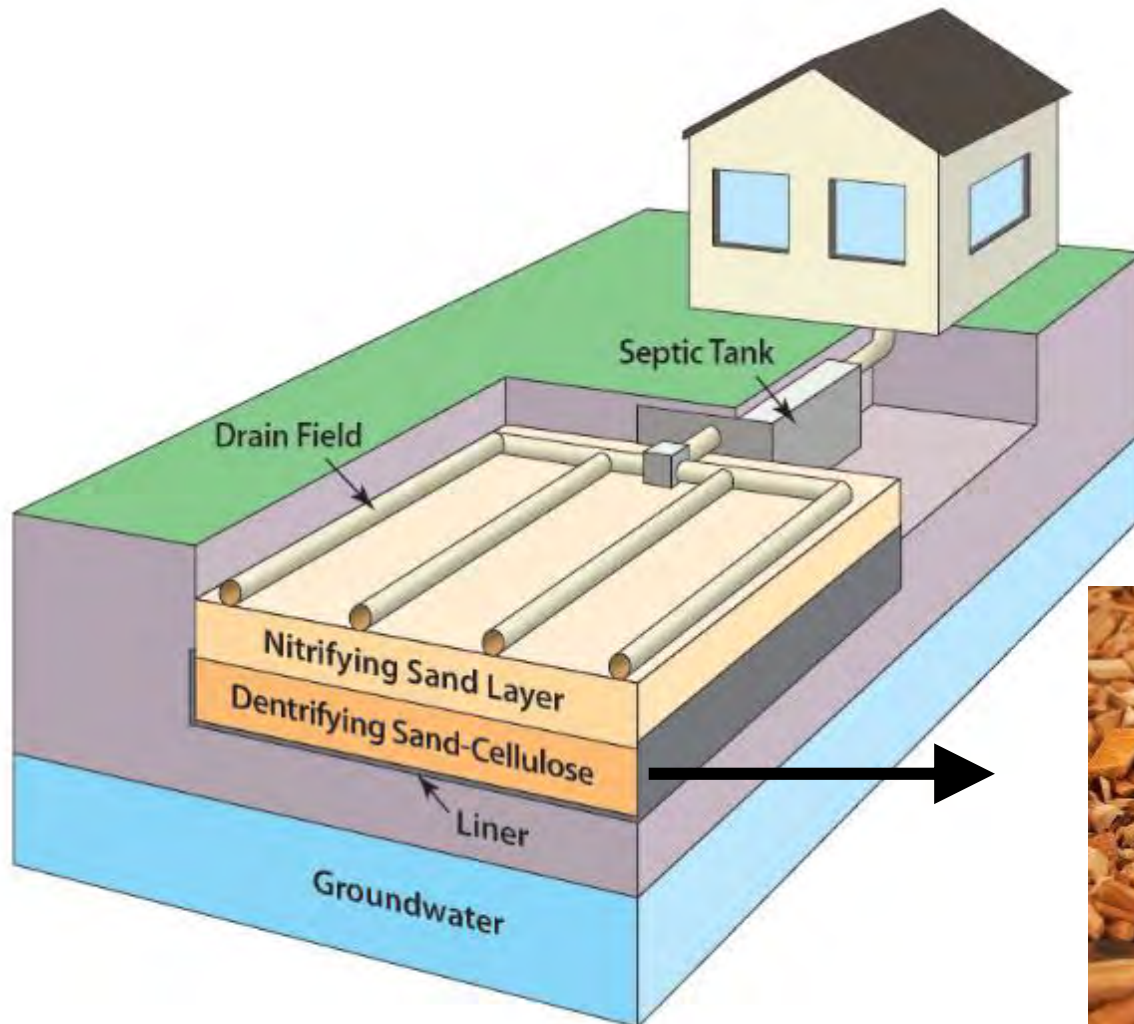


Norweco Singlair TNT

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)

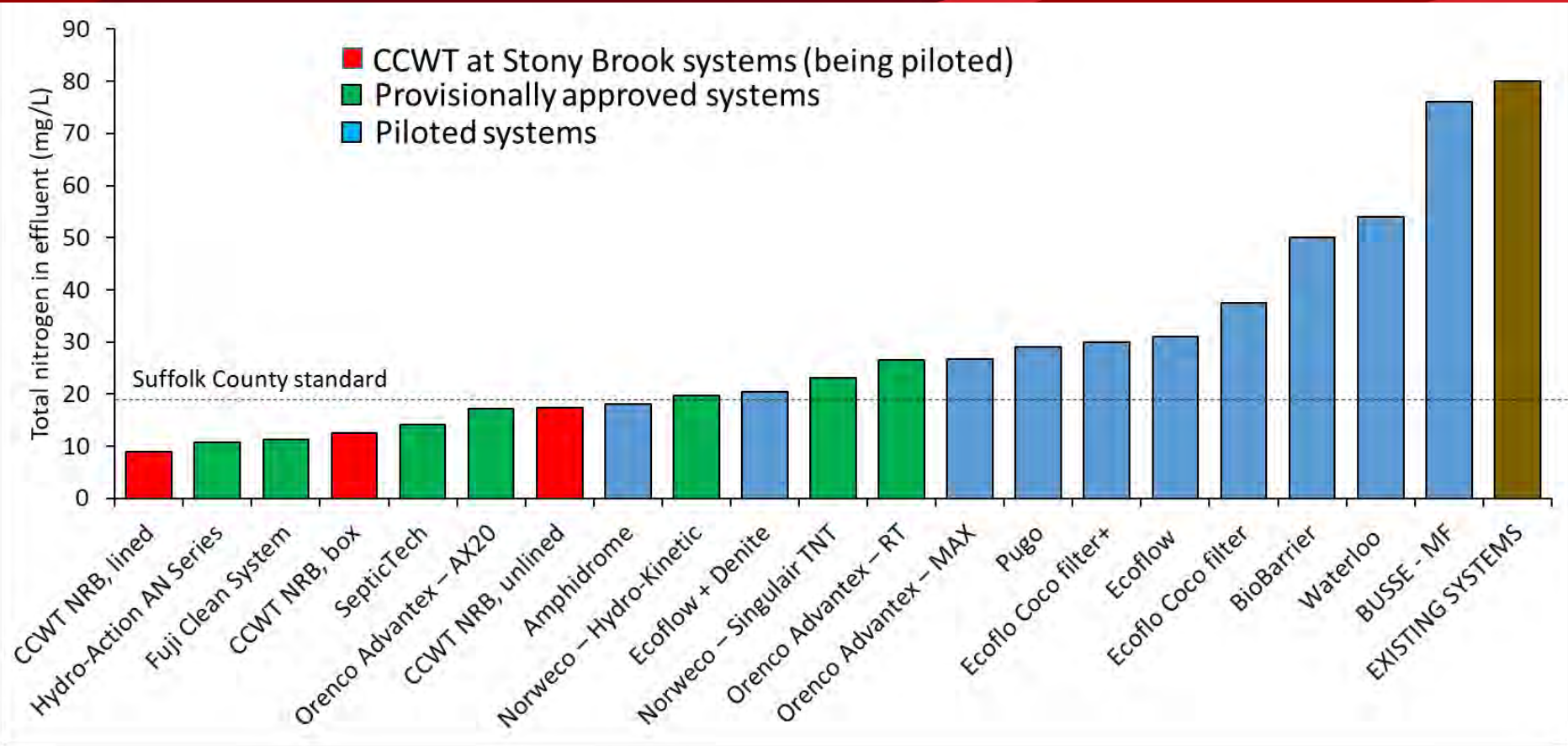


Lignocellulose = wood, chips

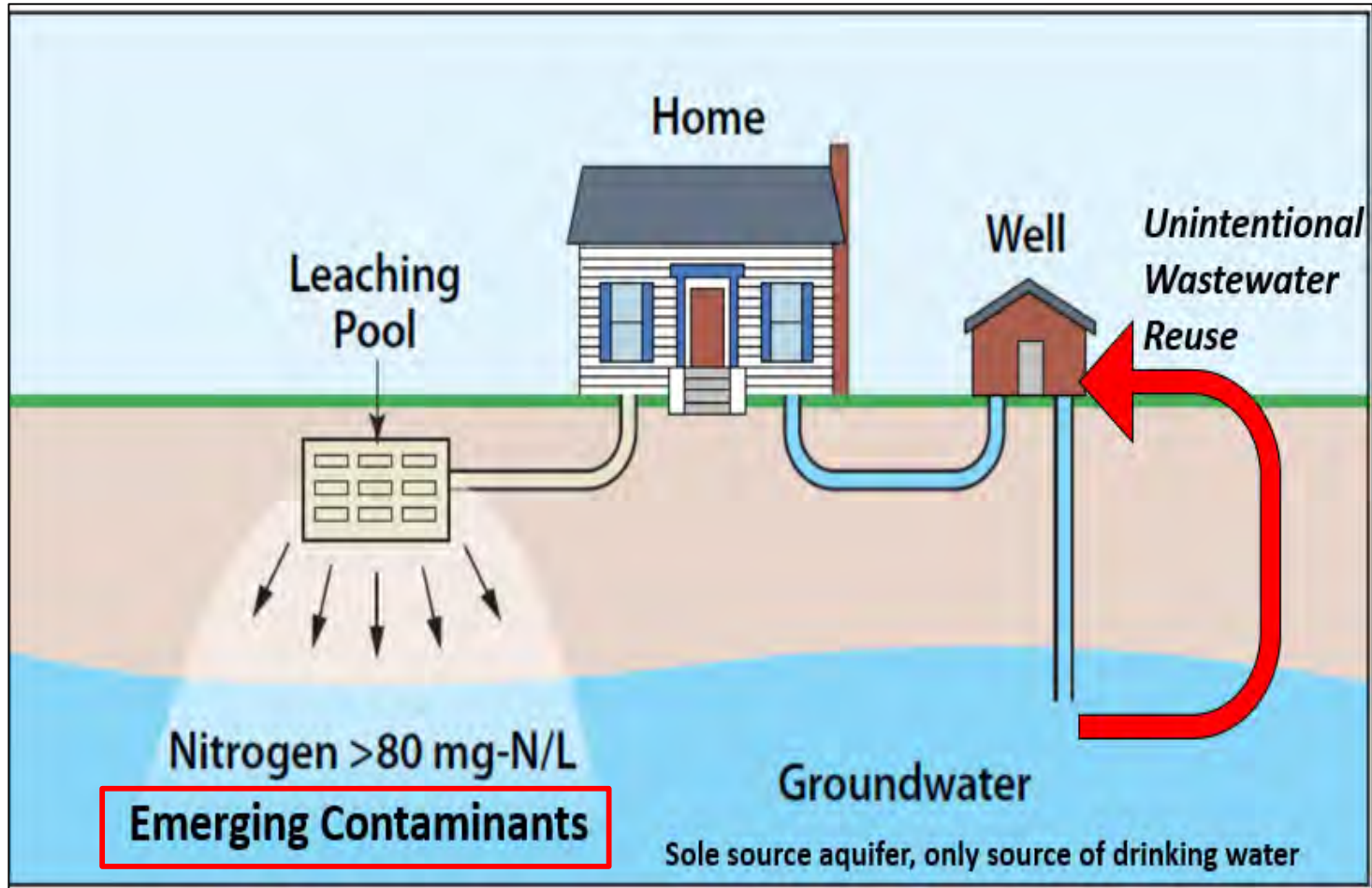


Carbon source to promote denitrification

Comparison of I/A performance in Suffolk County



Wastewater contains more than nitrogen



50 – 100% removal of two dozen drugs, pharmaceuticals, personal care products by NRBs in Suffolk County

Compound	Use	Removal (%)
Acetaminophen	NSAID	94 – 100
Caffeine	stimulant	99 – 100
Paraxanthine	human metabolite of caffeine	98 – 99
DEET	mosquito repellent	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

Data courtesy
of Dr. Tricia
Clyde



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journal homepage: www.elsevier.com/locate/scitotenv

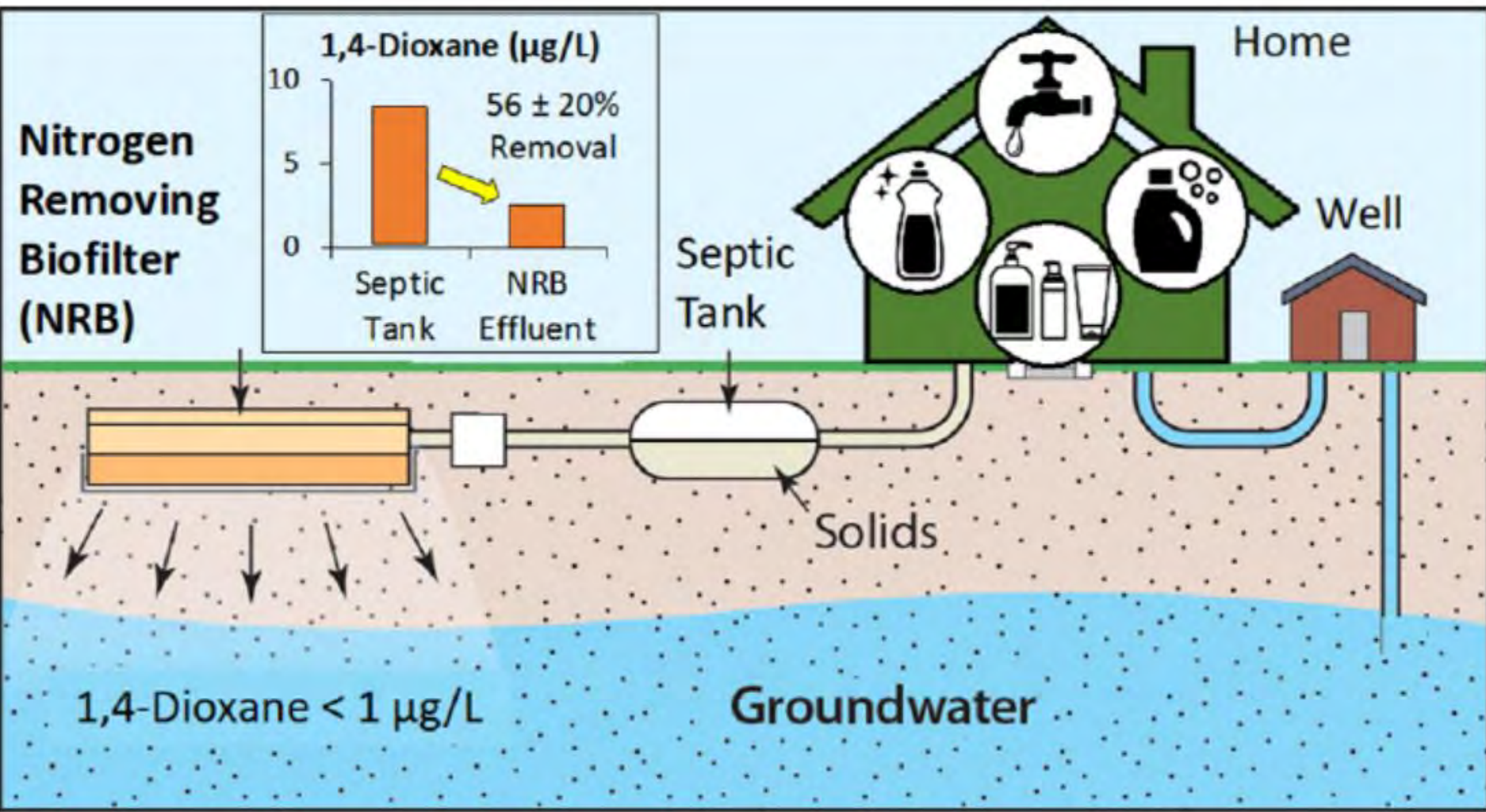


Removal of 1,4-dioxane during on-site wastewater treatment using nitrogen removing biofilters

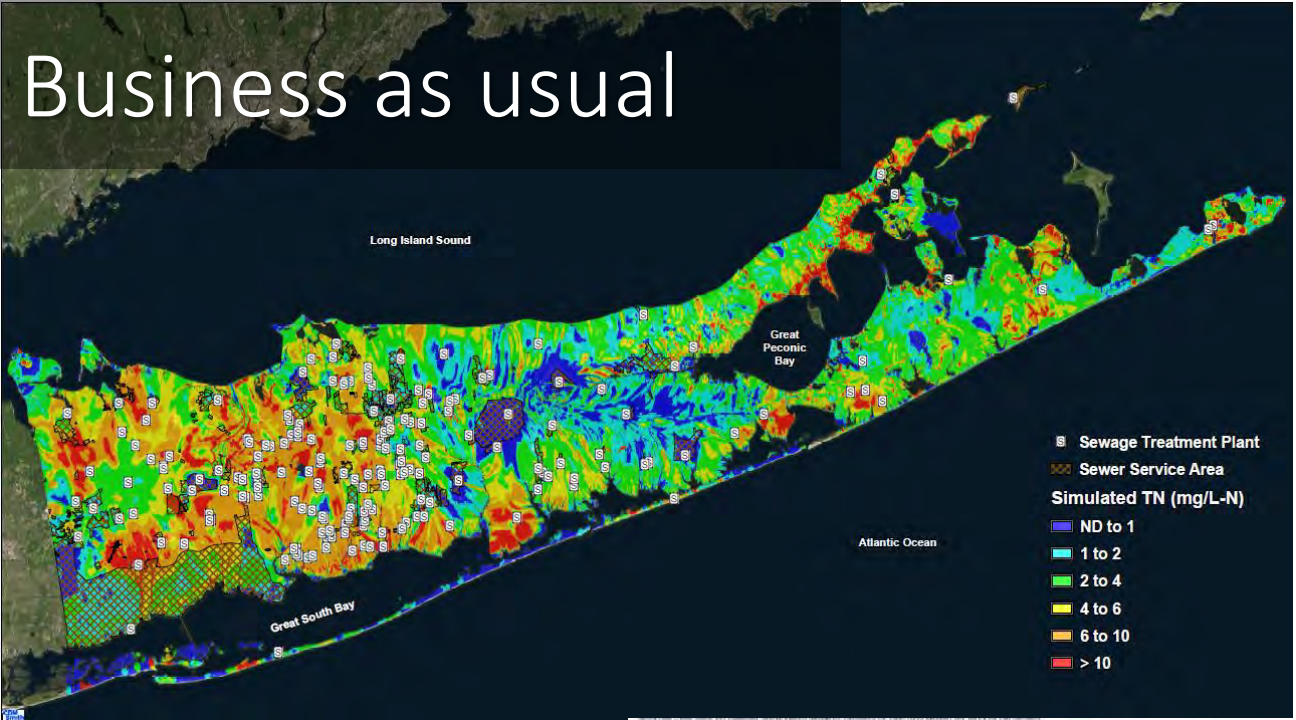


Cheng-Shiuan Lee^a, Caitlin Asato^a, Mian Wang^{a,c}, Xinwei Mao^{a,c},
Christopher J. Gobler^{a,b}, Arjun K. Venkatesan^{a,b,c,*}

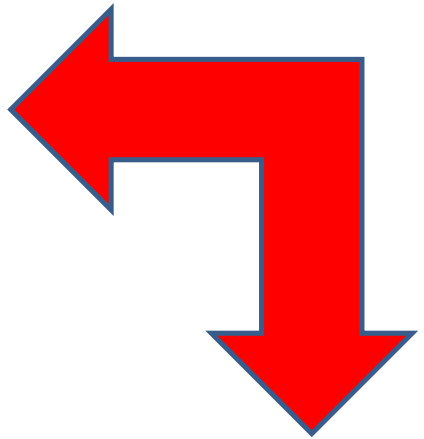
1,4-dioxane is listed as probable carcinogen by US EPA



Business as usual

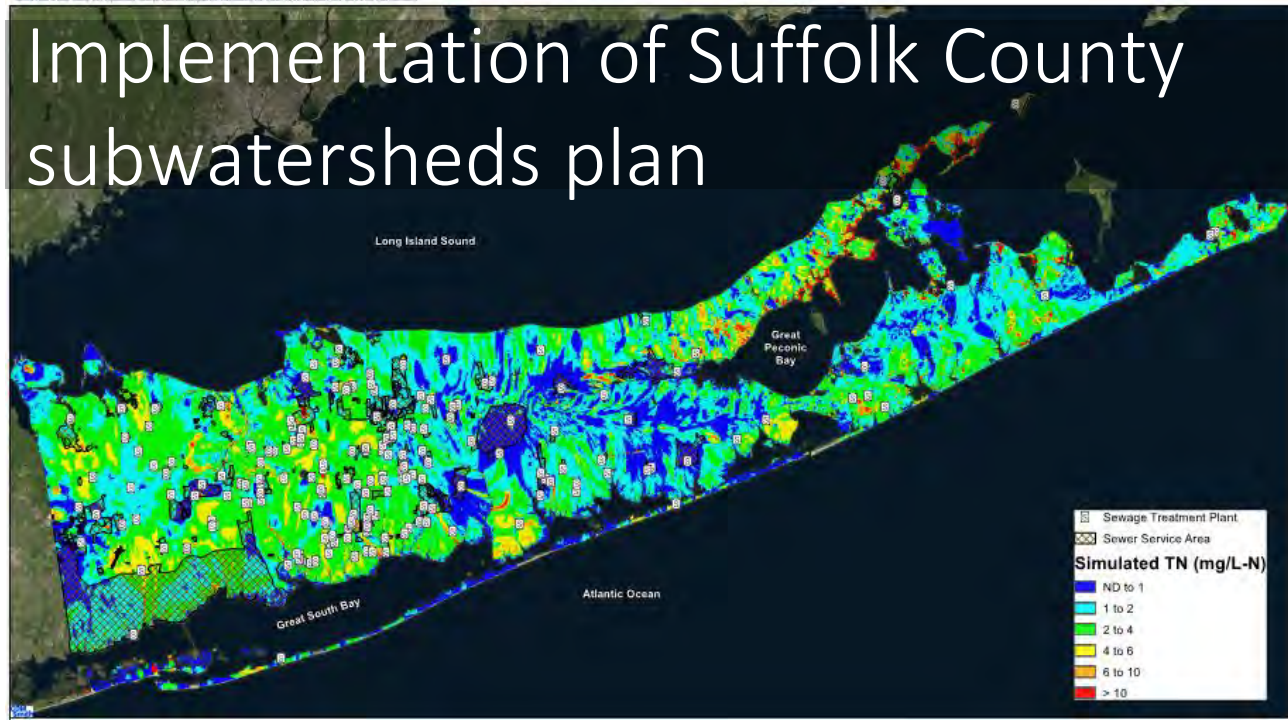


A World of Difference



Red,
orange,
yellow =
> 4mg/L

Implementation of Suffolk County subwatersheds plan



Thank you for your attention

