ASSESSMENT OF WATER QUALITY IN MARINE WATERS SURROUNDING SAG HARBOR VILLAGE

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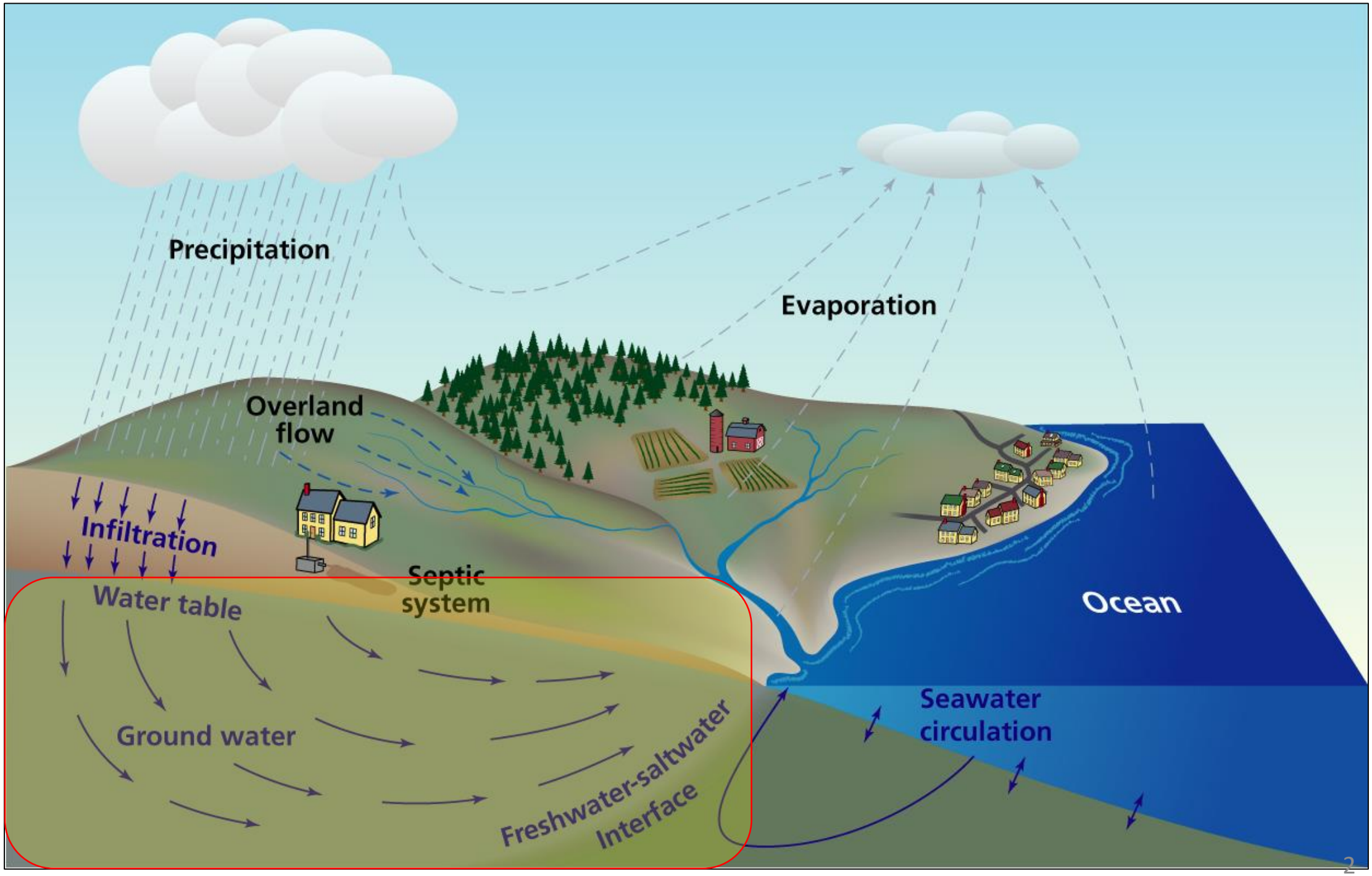
March 2020

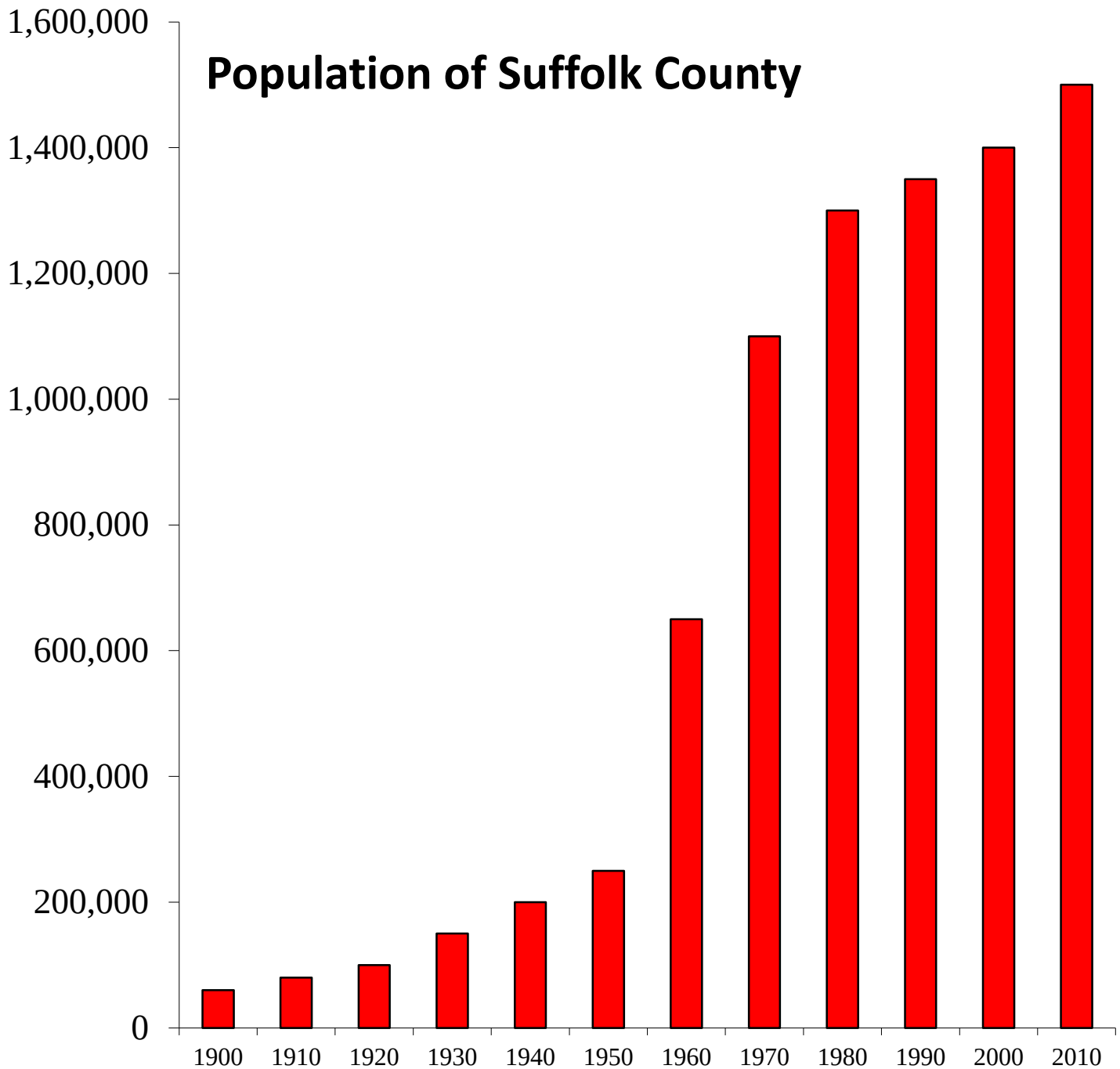
Stony Brook University
School of Marine and Atmospheric Sciences

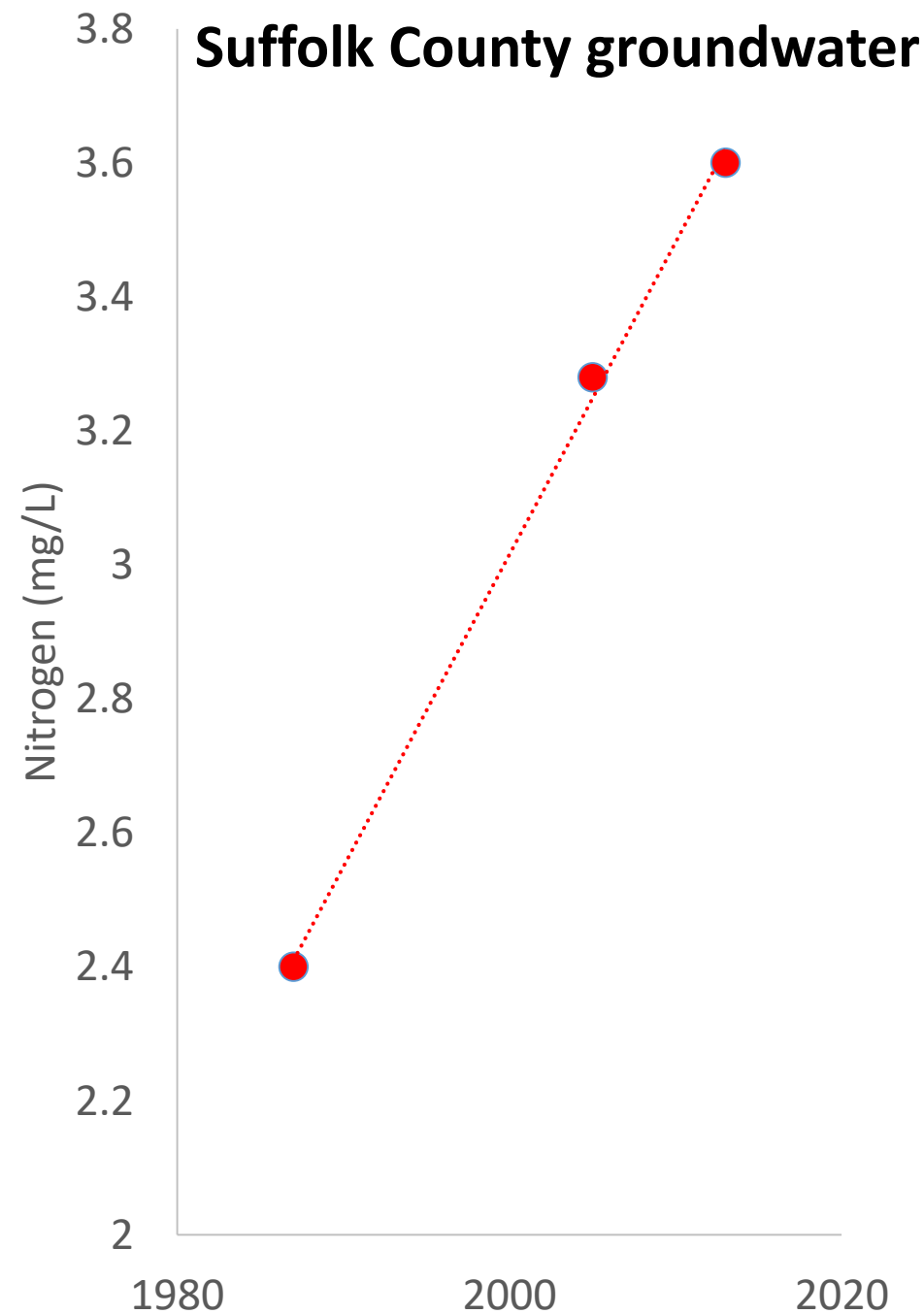
All of Long Island is a watershed -

Materials on land eventually enter our groundwater and surface water.



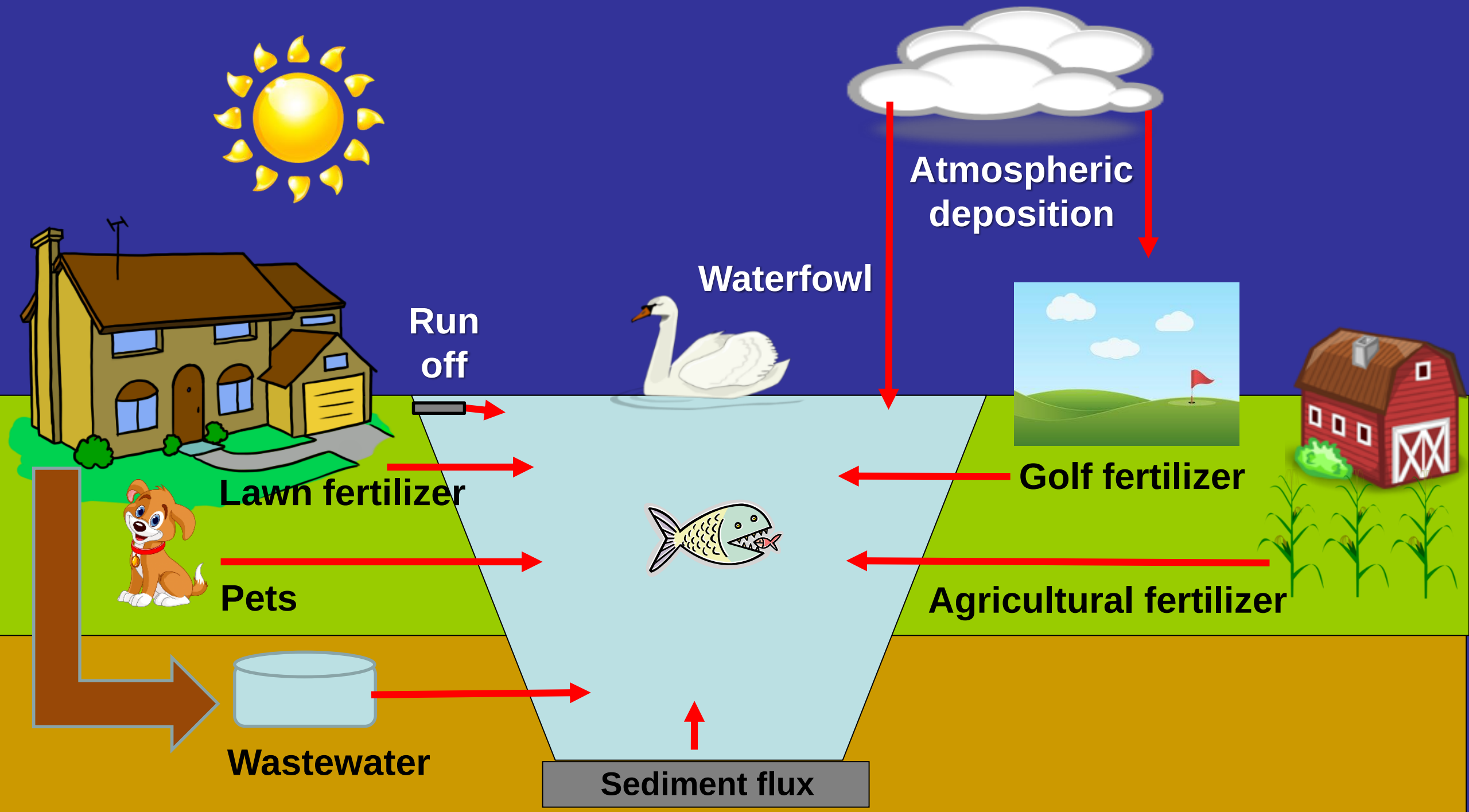
Expanding population, nitrogen levels





Nutrient loading models

Describes movement of nutrients ***from land to sea***

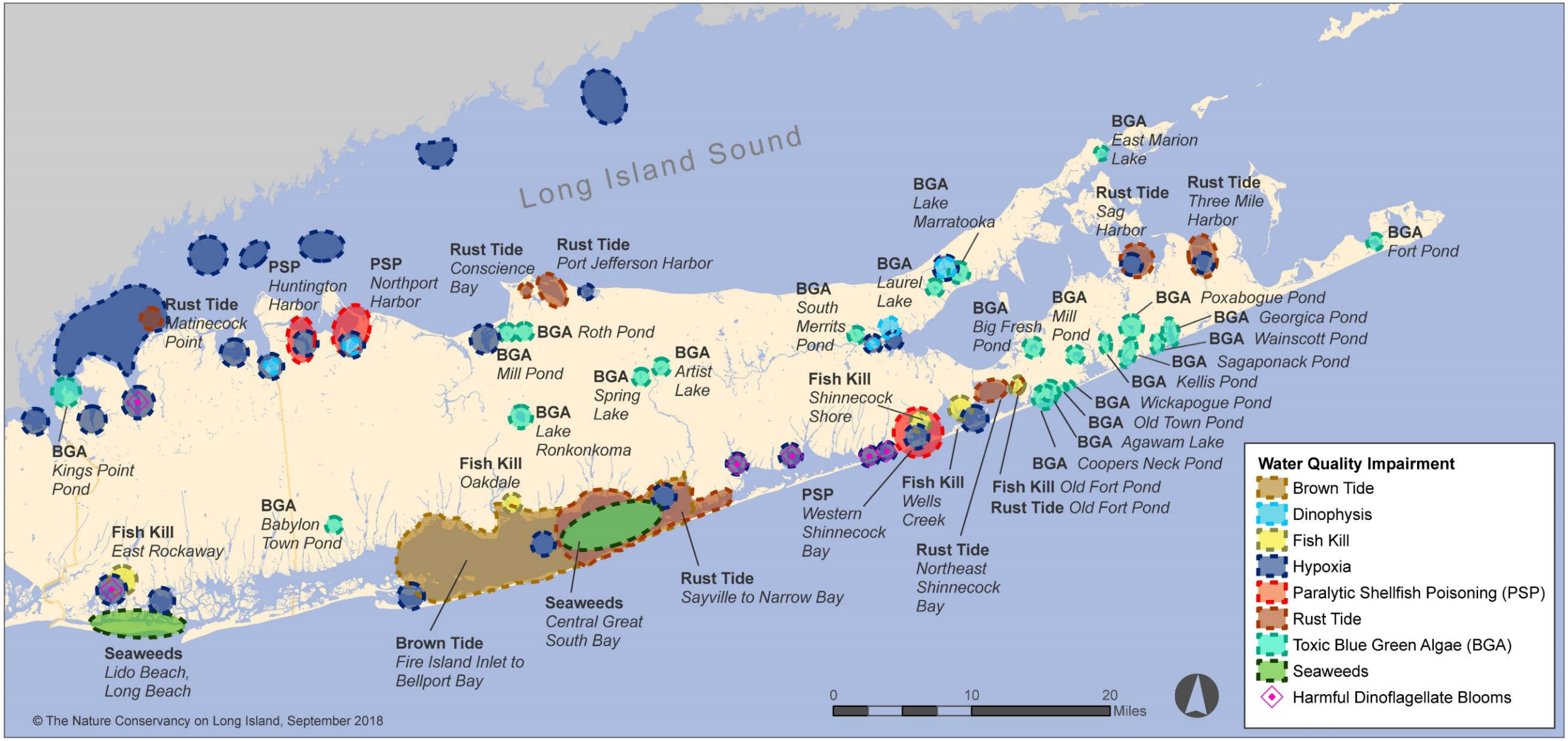


Stony Brook University School of Marine and Atmospheric Sciences

LICCRA

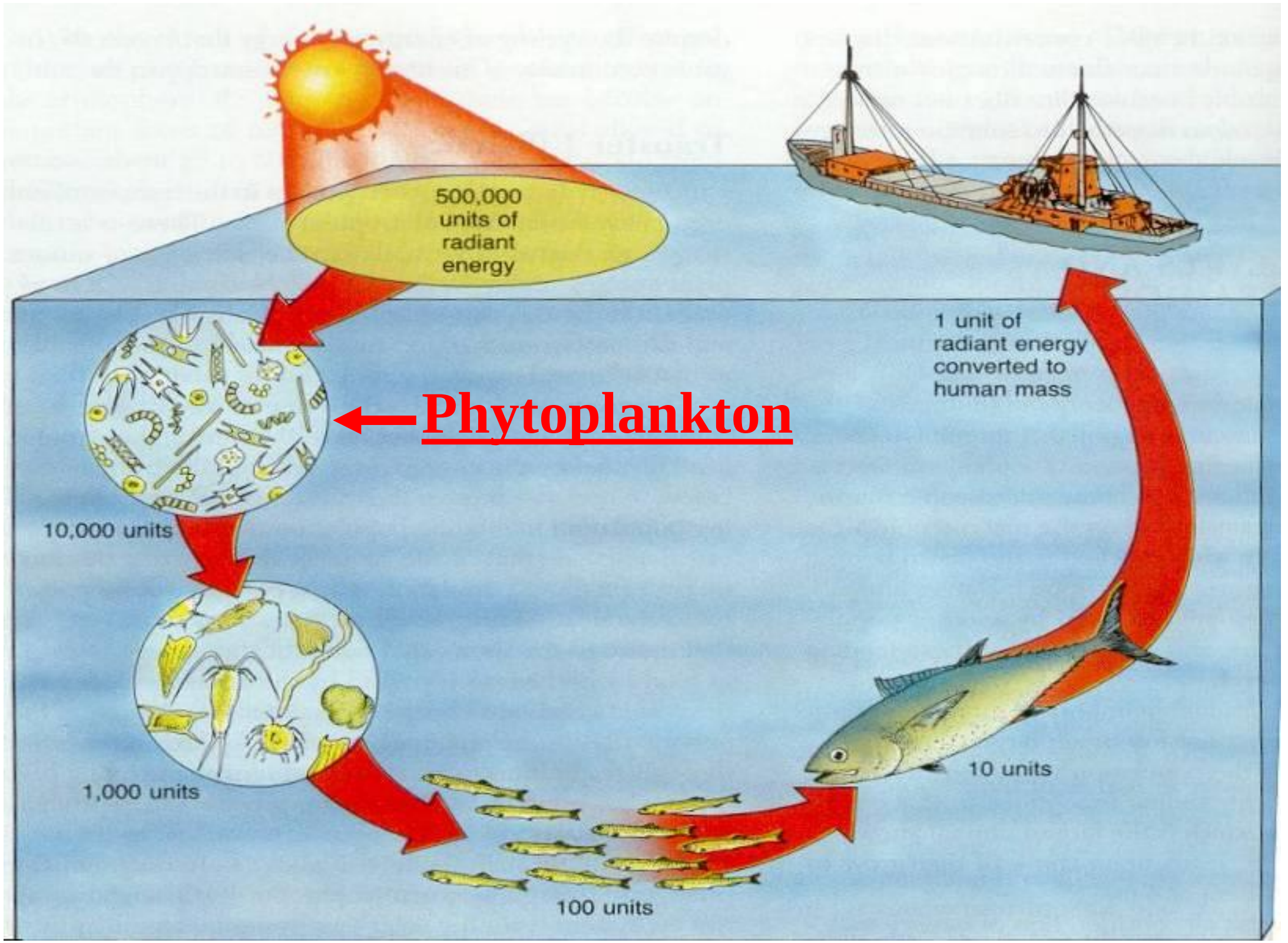
Long Island Water Quality Impairments
Summer 2018

The Nature Conservancy



© The Nature Conservancy on Long Island, September 2018

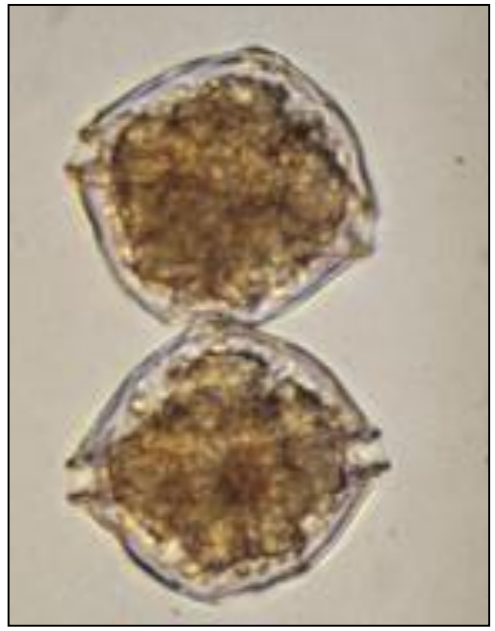
Phytoplankton serve as the foundation of marine food webs.



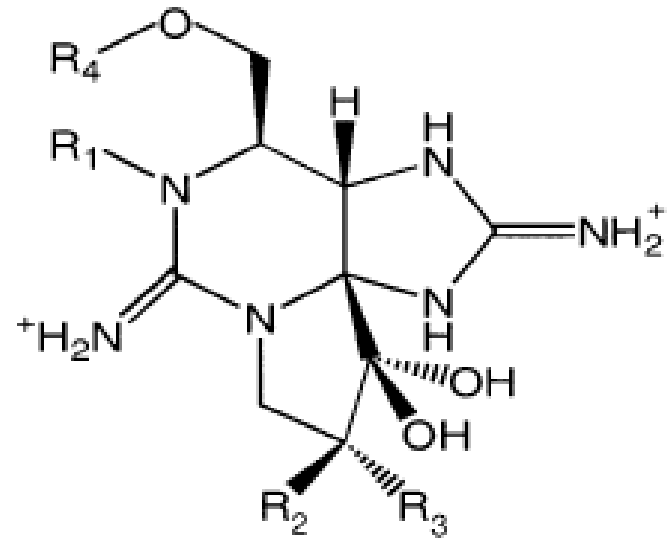
Harmful Algal Blooms (HABs)

Growth of an algal species to densities which negatively impact human health or an ecosystem.

Alexandrium red tides and paralytic shellfish

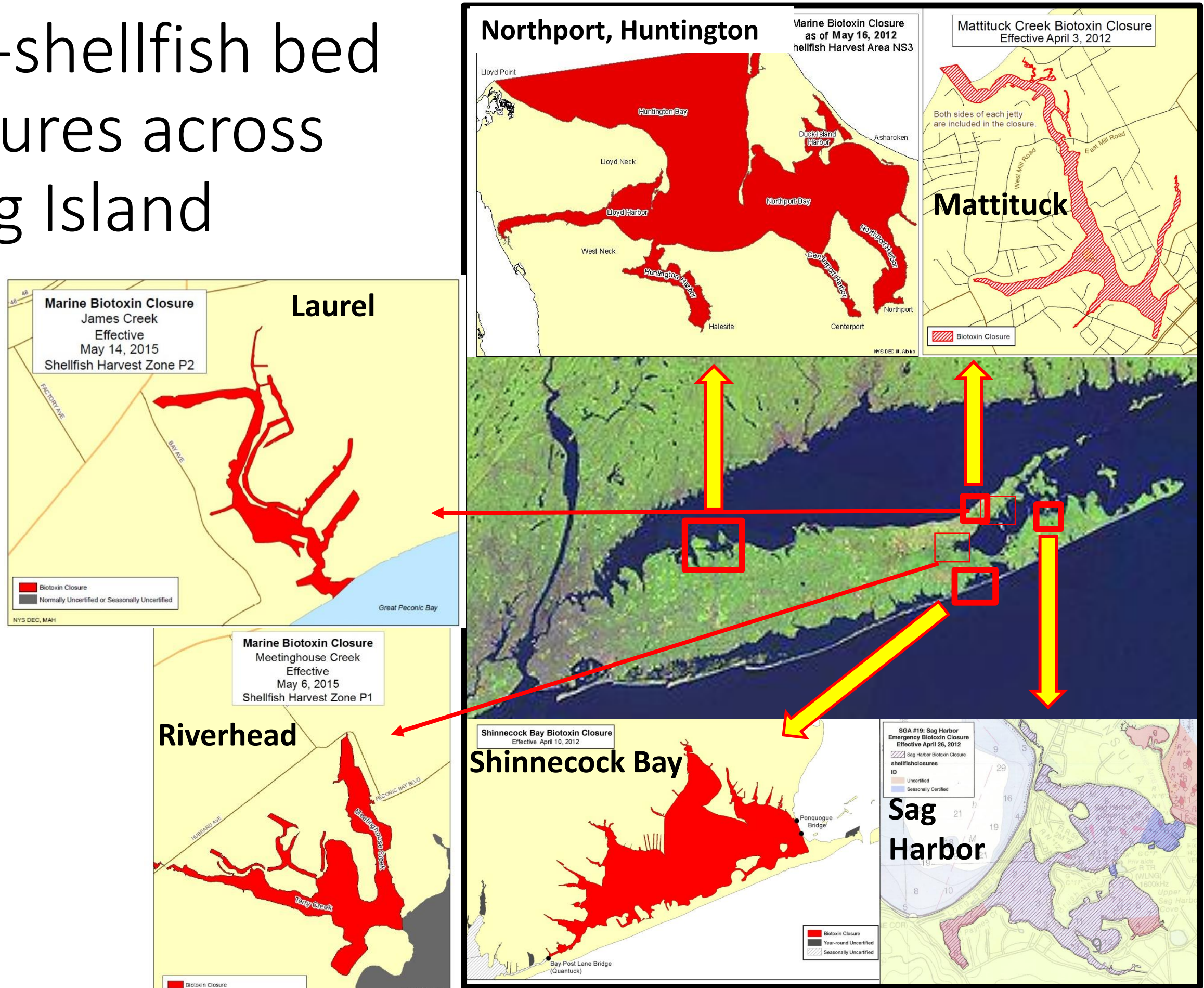


Alexandrium

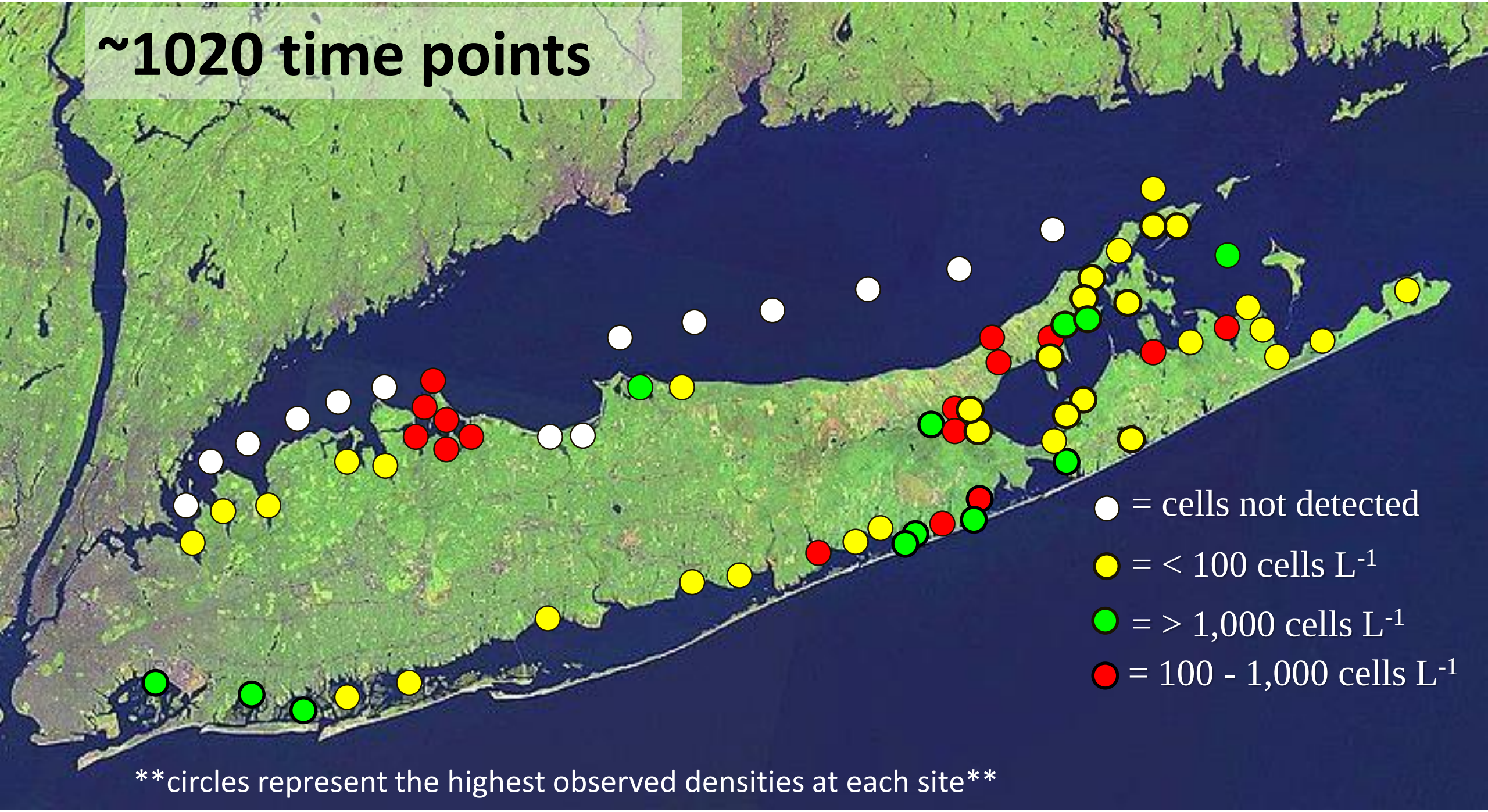


Saxitoxin

PSP-shellfish bed closures across Long Island



Presence of PSP-producing *Alexandrium* in LI: 2007-2019



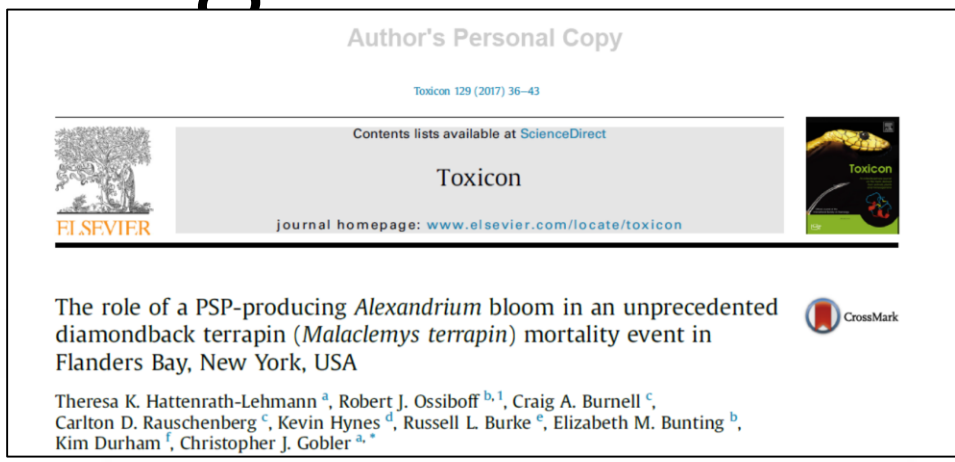
- *Alexandrium* found at 62 of 76 sites sampled (82%)

RiverheadLOCAL

riverheadlocal.com
https://www.riverheadlocal.com/2015/05/13/massive-die-off-of-turtles-dozens-of-dead-diamondback-terrapins-wash-up-along-flanders-bay-beaches/

‘Massive’ die-off of turtles: ~~Dozens~~ Hundreds of dead diamondback terrapins wash up along Flanders Bay beaches

Linking land-derived nitrogen to turtle deaths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Toxicon 129 (2017) 36–43

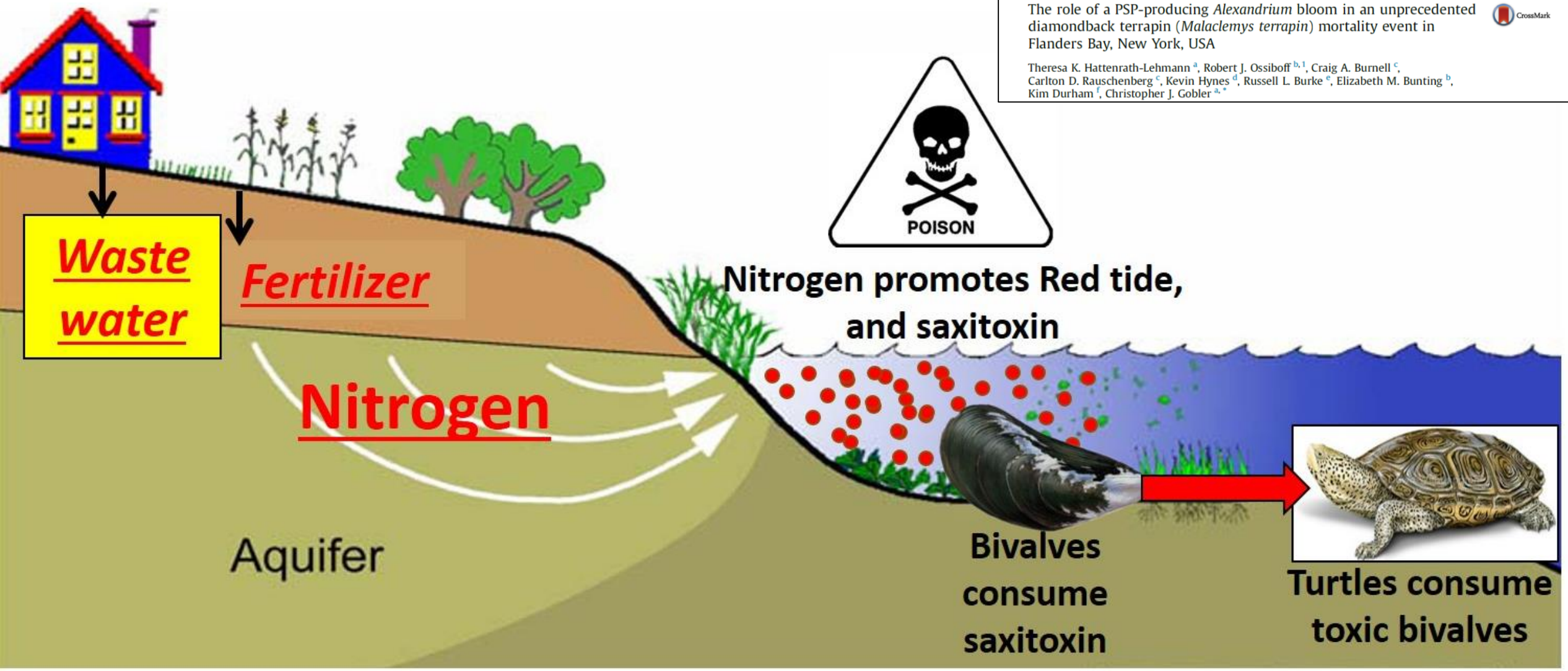
Contents lists available at ScienceDirect

Toxicon

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

The role of a PSP-producing *Alexandrium* bloom in an unprecedented diamondback terrapin (*Malaclemys terrapin*) mortality event in Flanders Bay, New York, USA

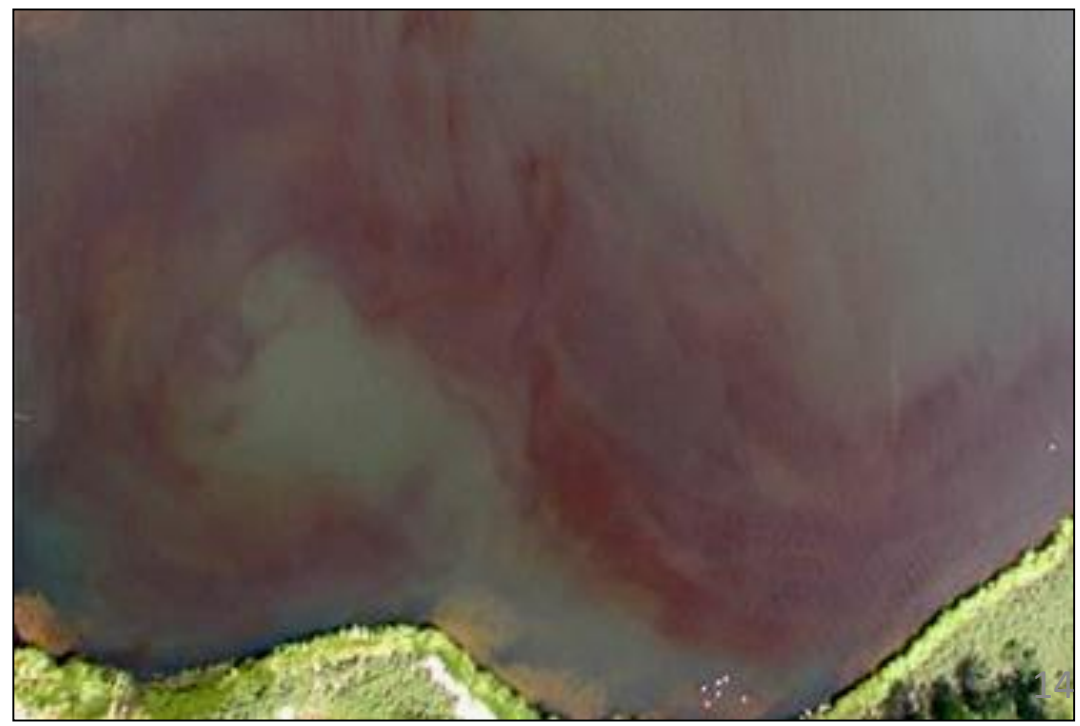
Theresa K. Hattenrath-Lehmann [a], Robert J. Ossiboff [b, 1], Craig A. Burnell [c], Carlton D. Rauschenberg [c], Kevin Hynes [d], Russell L. Burke [e], Elizabeth M. Bunting [b], Kim Durham [f], Christopher J. Gobler [a, *]



Conclusion: PST in shellfish was likely high enough to cause or contribute to the mortality in these small (<2.0 kg) animals.

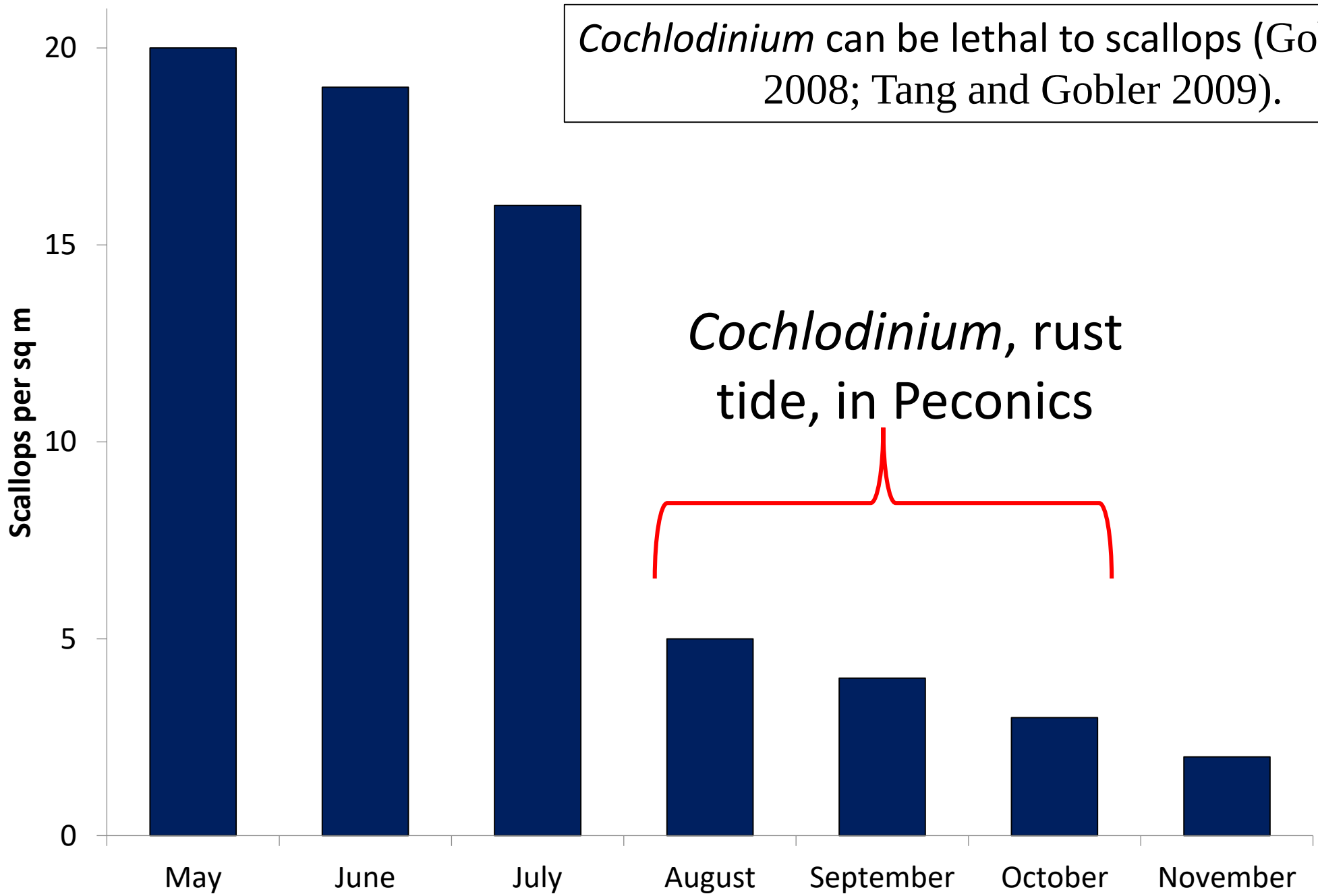
Cochlodinium rust tides

Cochlodinium polykrikoides blooms in NY, 2004 – 2016: Ichthyotoxic (Gobler et al 2008; Tang and Gobler 2009)



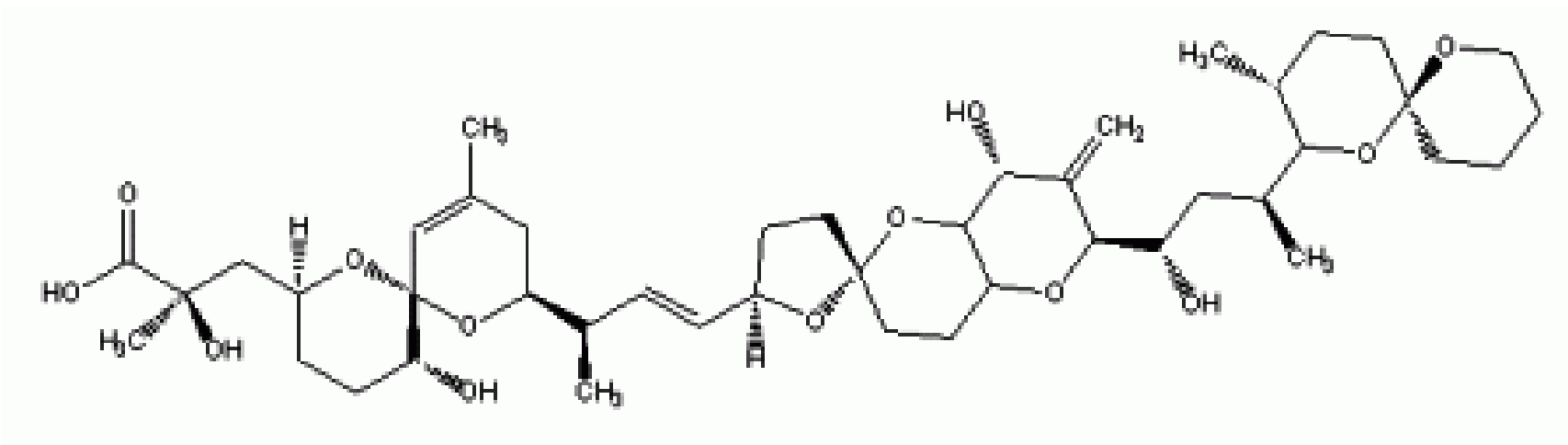
Scallop densities, Three Mile Harbor, 2012

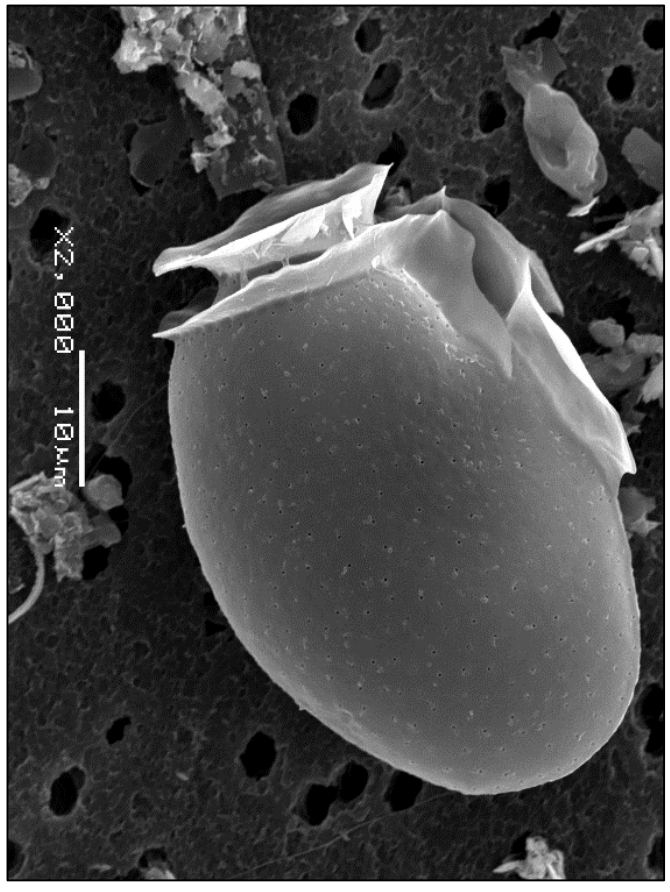
Cochlodinium can be lethal to scallops (Gobler et al 2008; Tang and Gobler 2009).



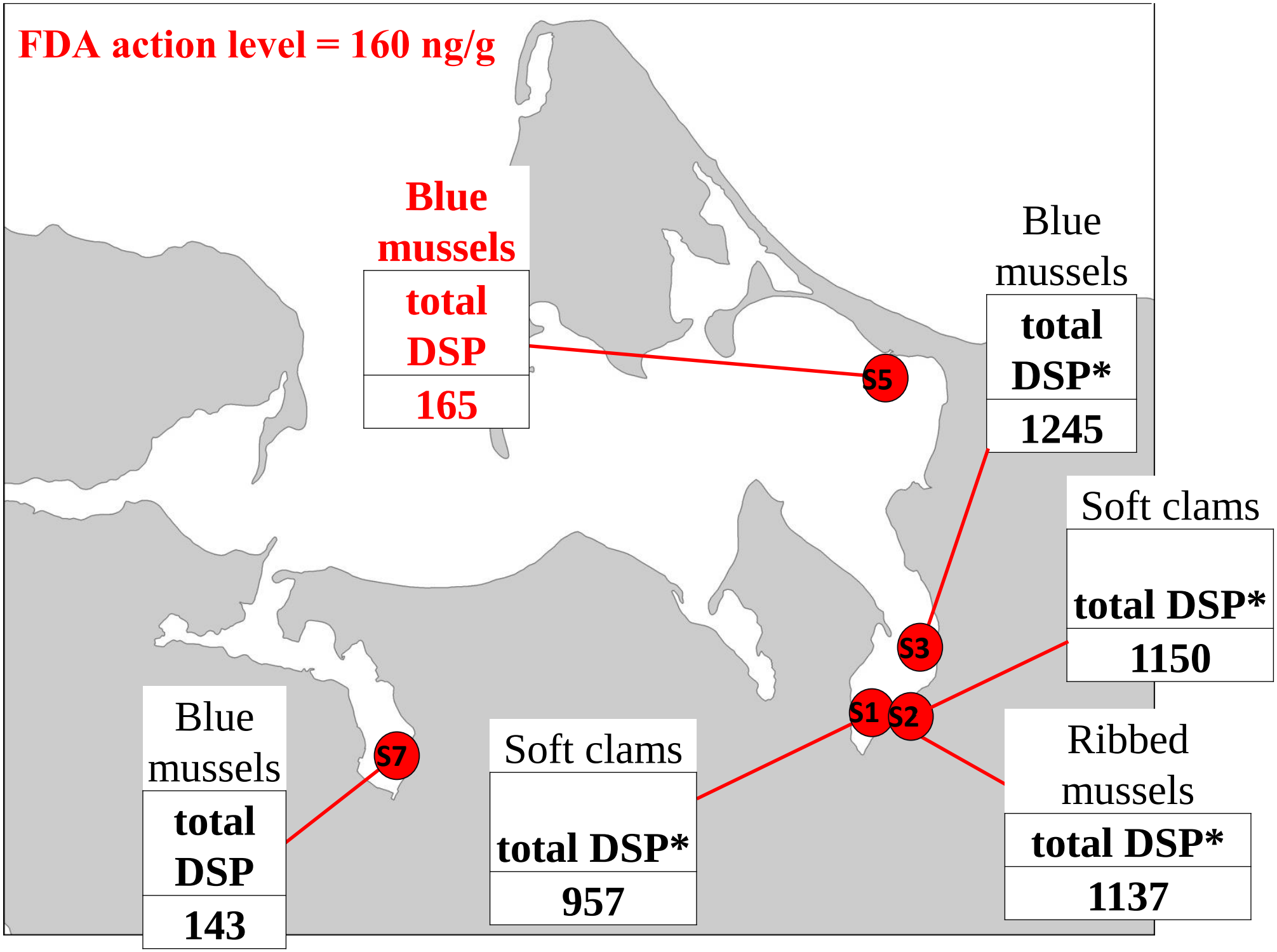
Data courtesy of East Hampton Shellfish Hatchery

Dinophysis acuminata and diarrhetic shellfish poisoning (DSP) due to okadaic acid



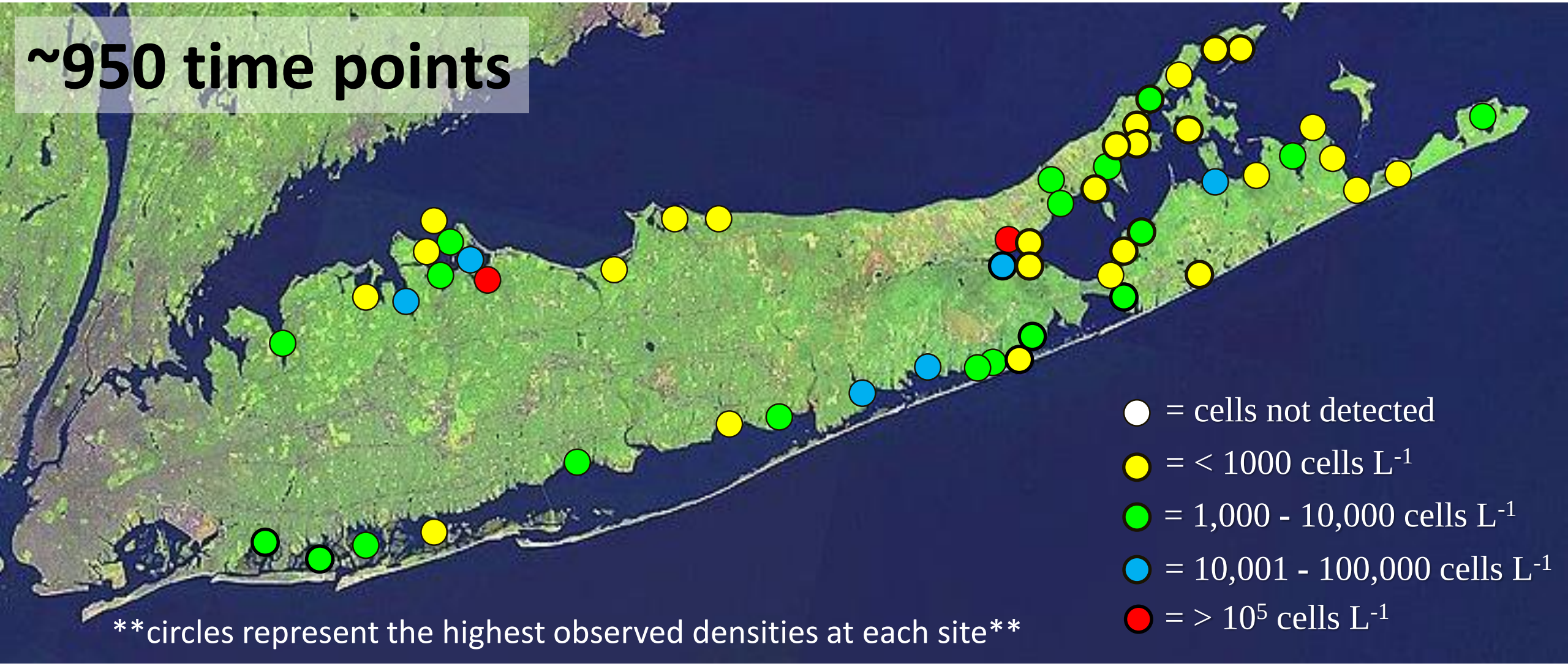


DSP toxins in shellfish, Northport, June 2011 (ng/g)

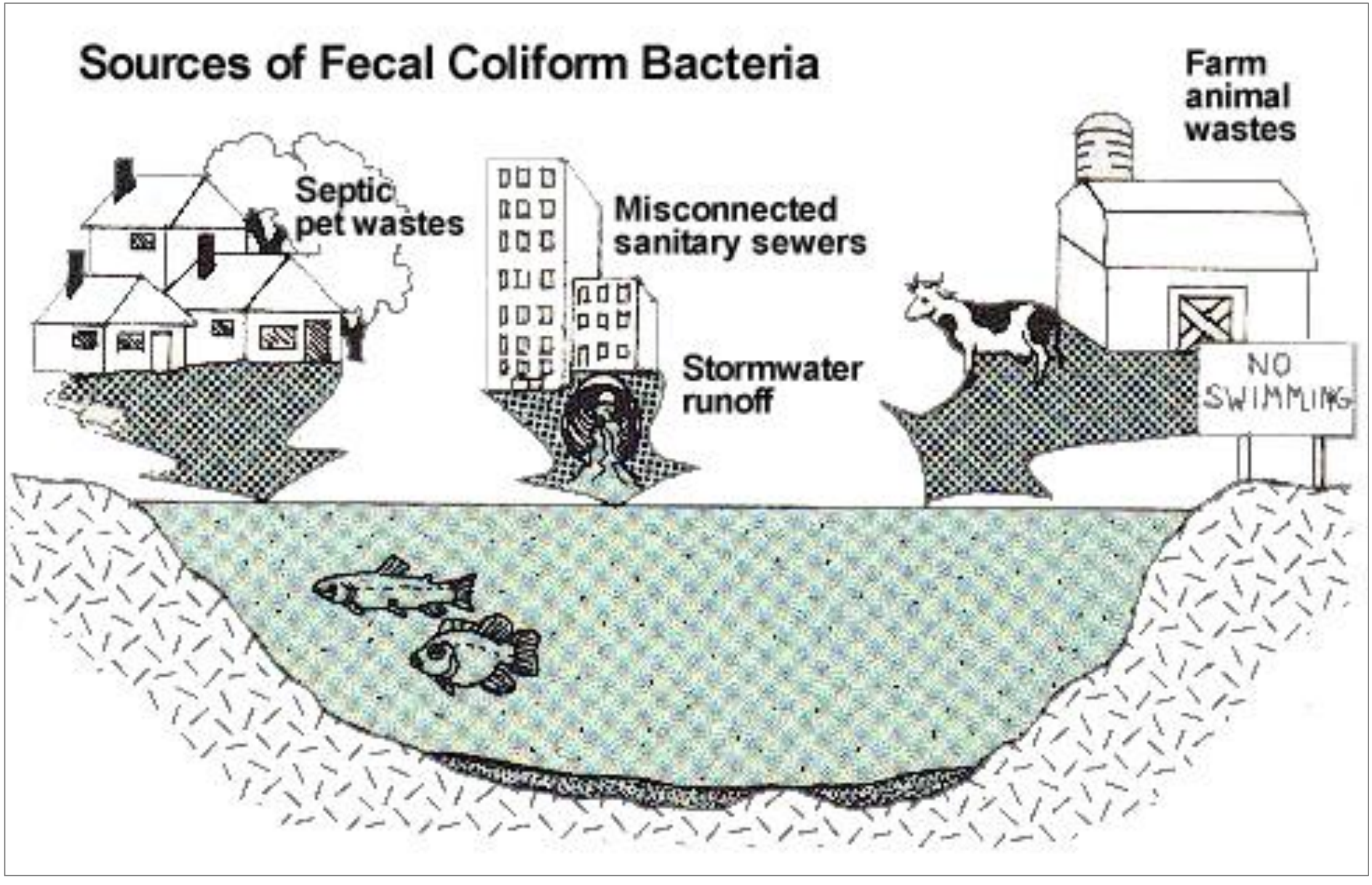


* Region closed to shellfishing

Presence of DSP-producing *Dinophysis* in LIS: 2008-2017



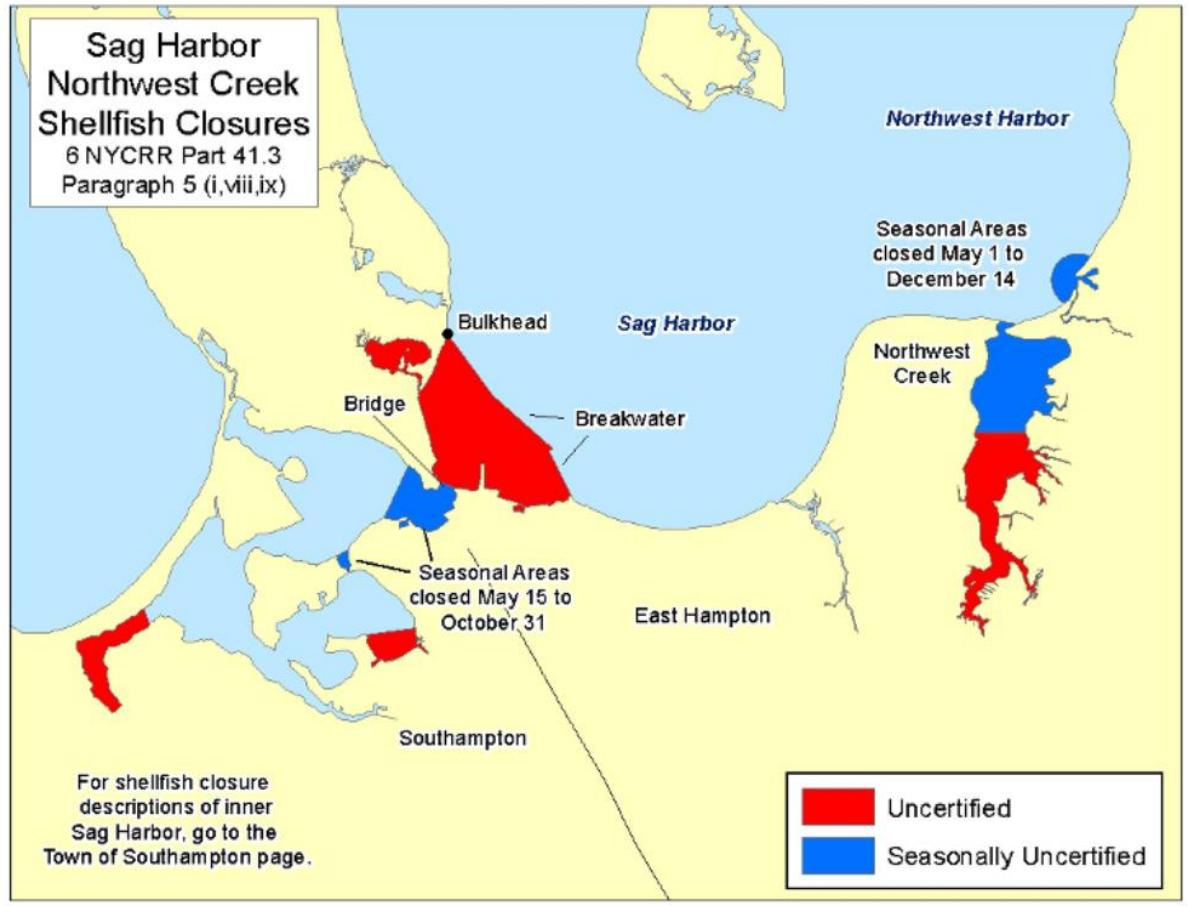
- *Dinophysis* was observed at 54 of 54 sites sampled, and 17% of those sites had higher densities than those reported ~30 years ago (Freudenthal and Jijina, 1988).
- The largest blooms occurred in Northport Bay and Meetinghouse Creek.

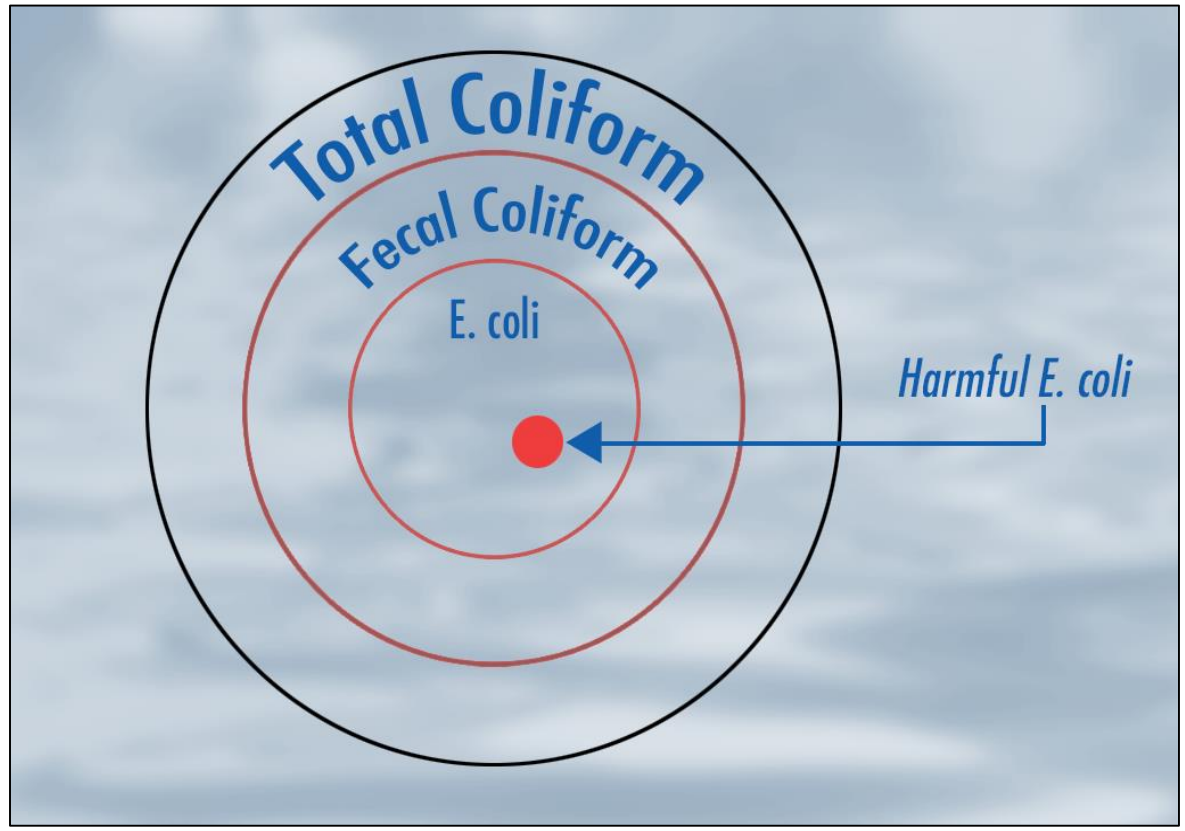

Sources of Fecal Coliform Bacteria
Septic pet wastes
Misconnected sanitary sewers
Stormwater runoff
Farm animal wastes
NO SWIMMING

Shellfish bed closures and pathogenic bacteria

- NYSDEC opens and closes shellfish beds based on levels of 'indicator bacteria' such as **fecal coliform bacteria** are proxies for pathogenic bacteria.

- Temporal and spatial dynamics of these bacteria are poorly understood.

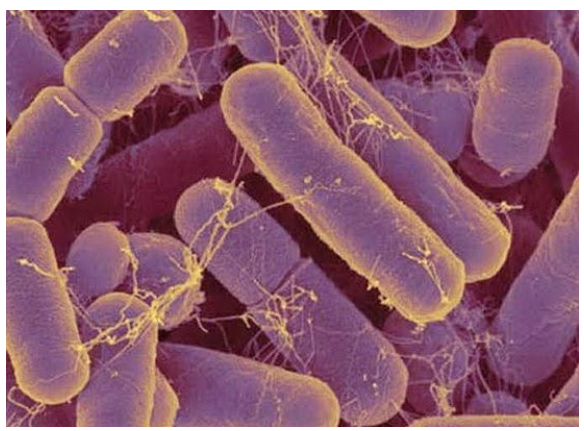




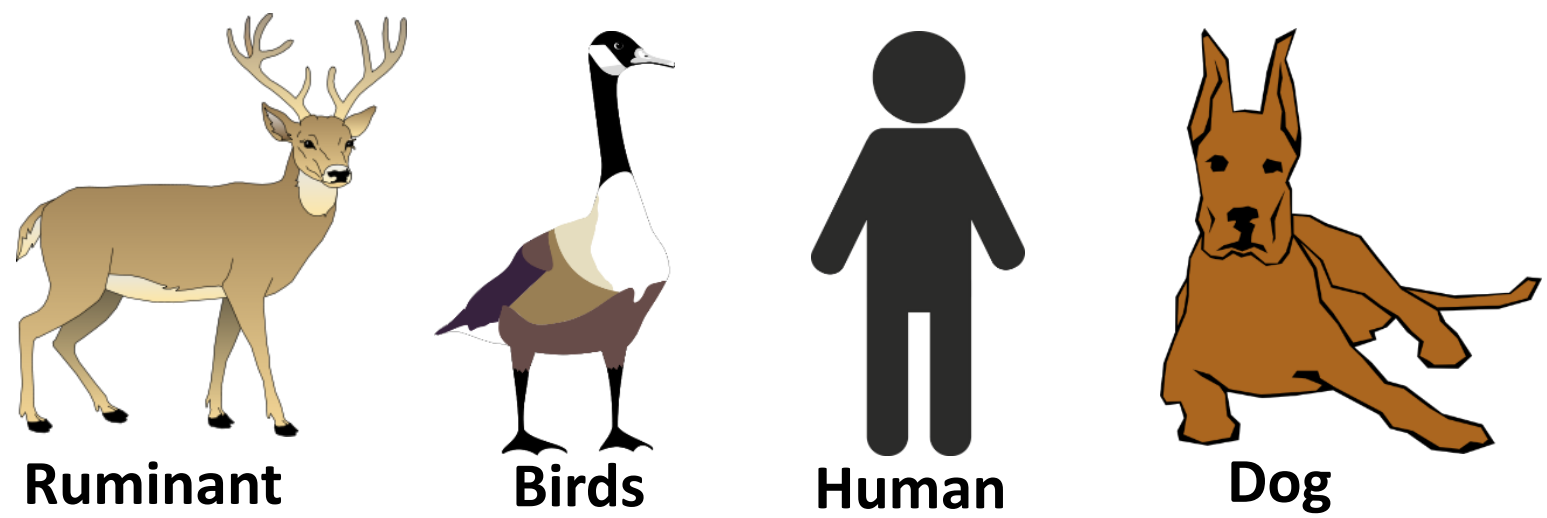
Microbial Source Tracking

- Identify the source of fecal pollution in a watershed
- Provides basis for management strategies and efficient resource allocation

Fecal Bacteria:
Bacteroides



Target Host Organisms:



Genetic Markers:

Objectives:

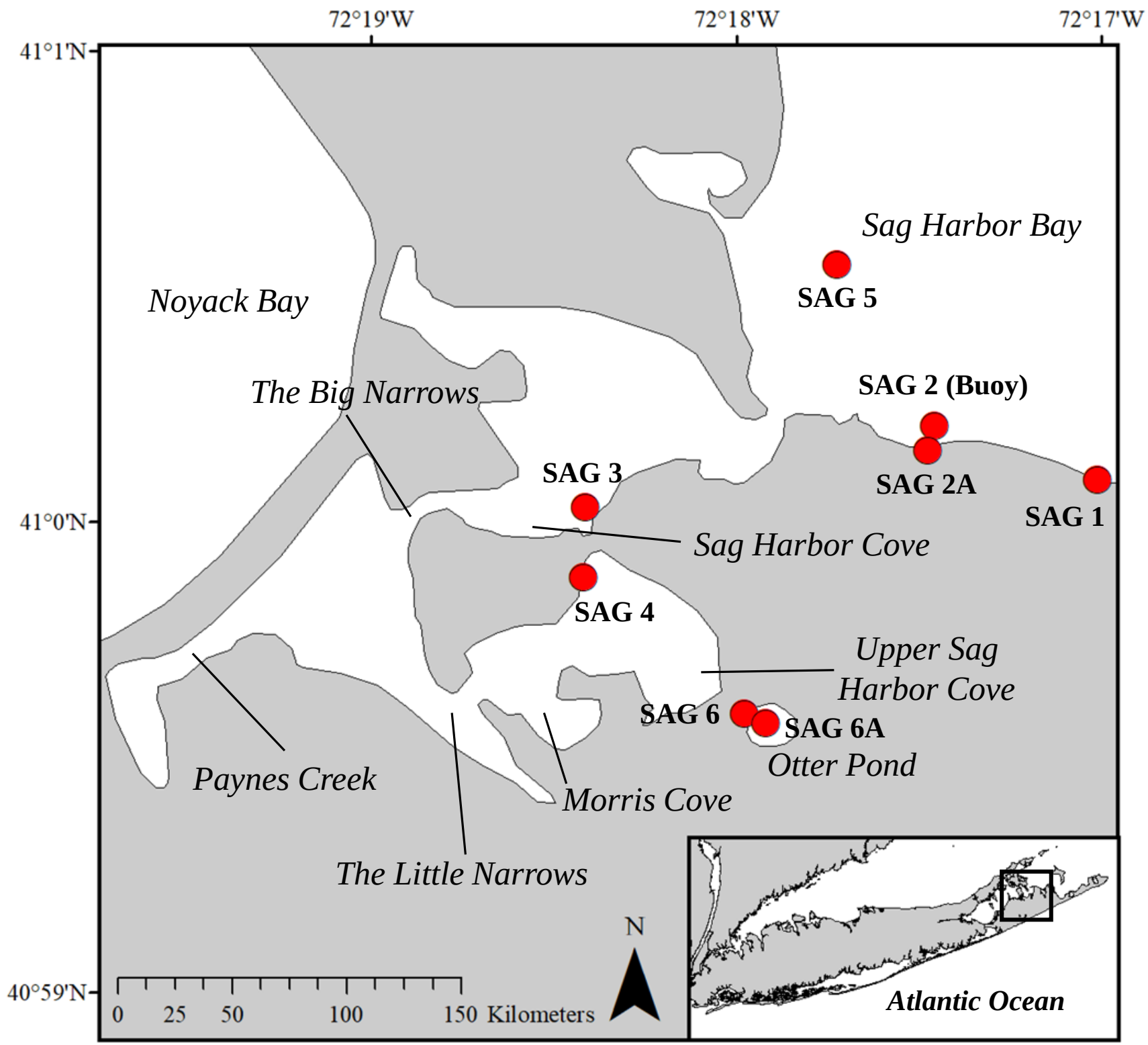
- Assess the temporal and spatial dynamics of the PSP-causing dinoflagellate *Alexandrium*, DSP-causing dinoflagellate, *Dinophysis*, and the ichthyotoxic dinoflagellate, *Cochlodinium*, and fecal coliform bacteria in the Village of Sag Harbor's marine waters.

- Provide fine temporal scale and spatial water quality monitoring in the Village of Sag Harbor's marine waters.

- Microbial source tracking of indicator and pathogenic bacteria.

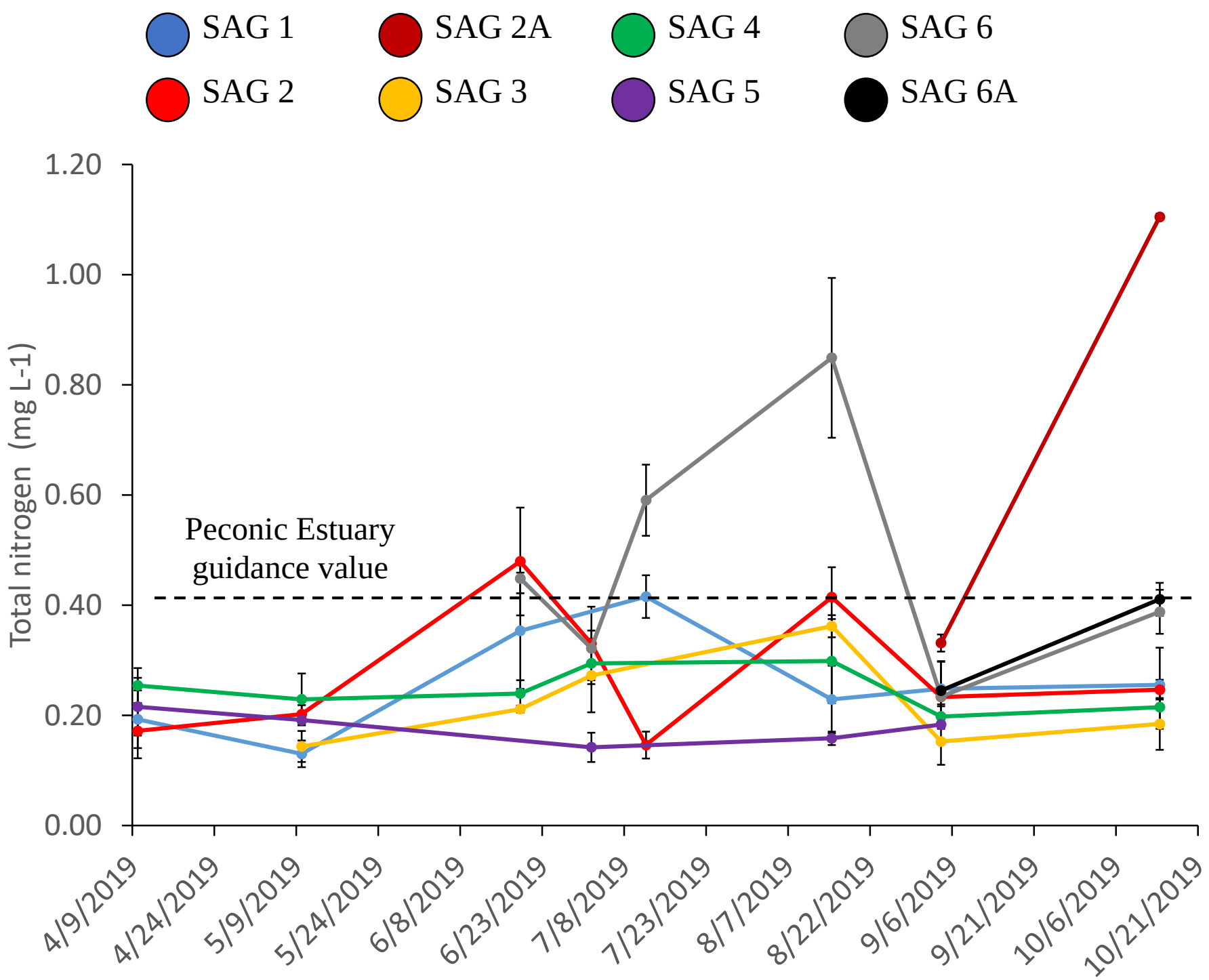
- Assessment of nitrogen loads to Sag Harbor

Location of sampling sites in Sag Harbor Bay, NY

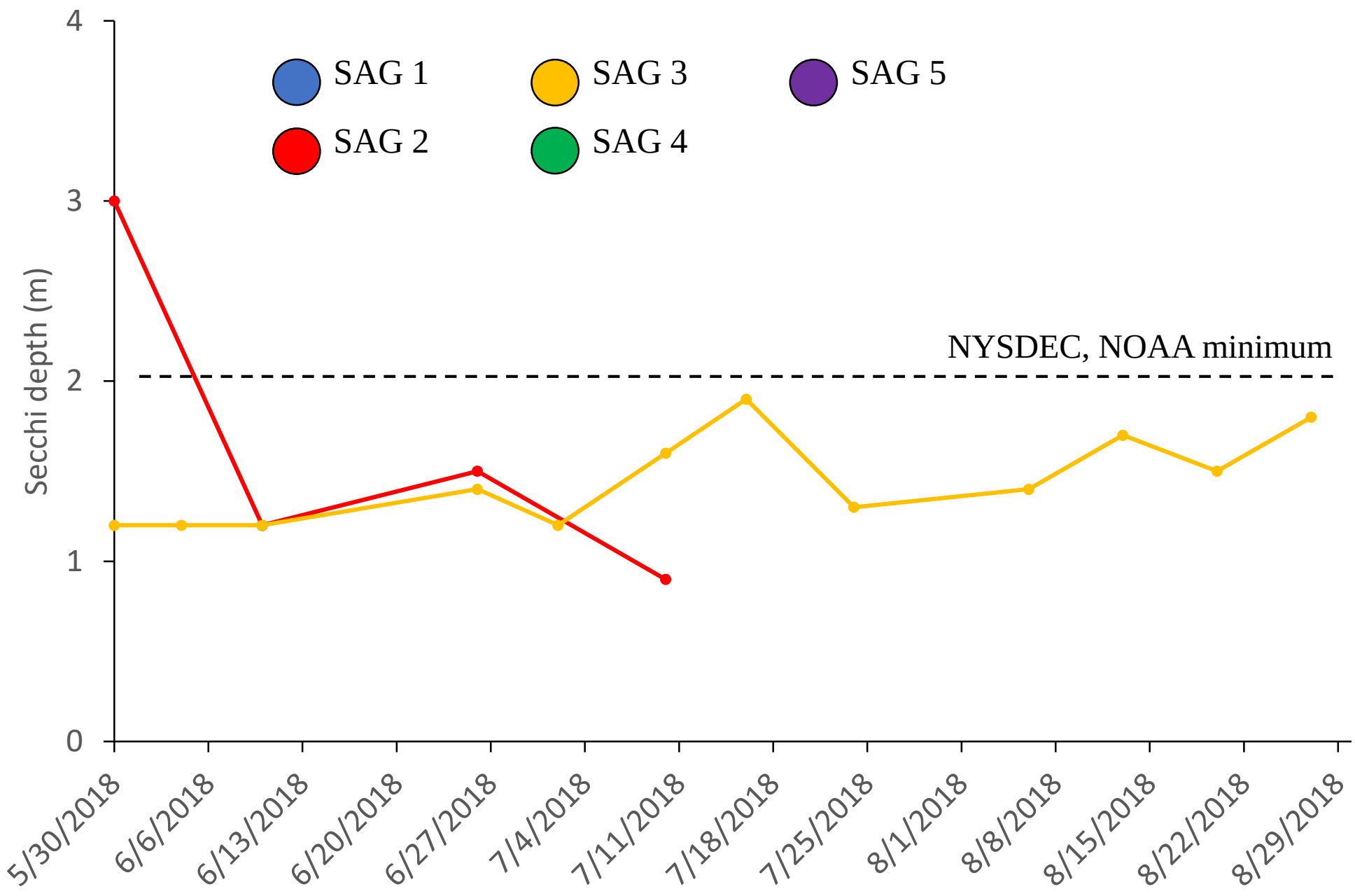


GENERAL WATER QUALITY CONDITIONS

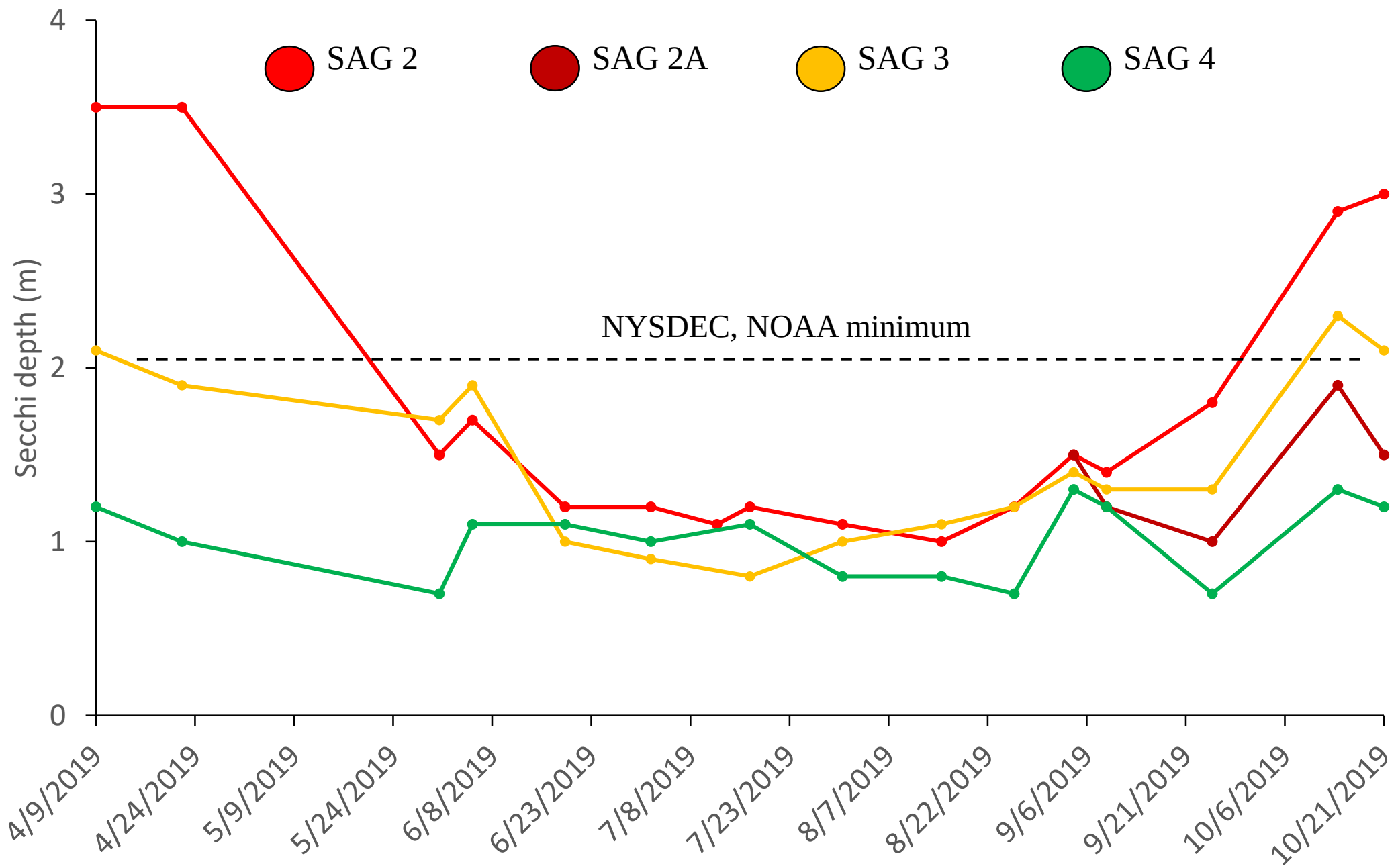
Concentrations of total nitrogen (mg L^{-1})



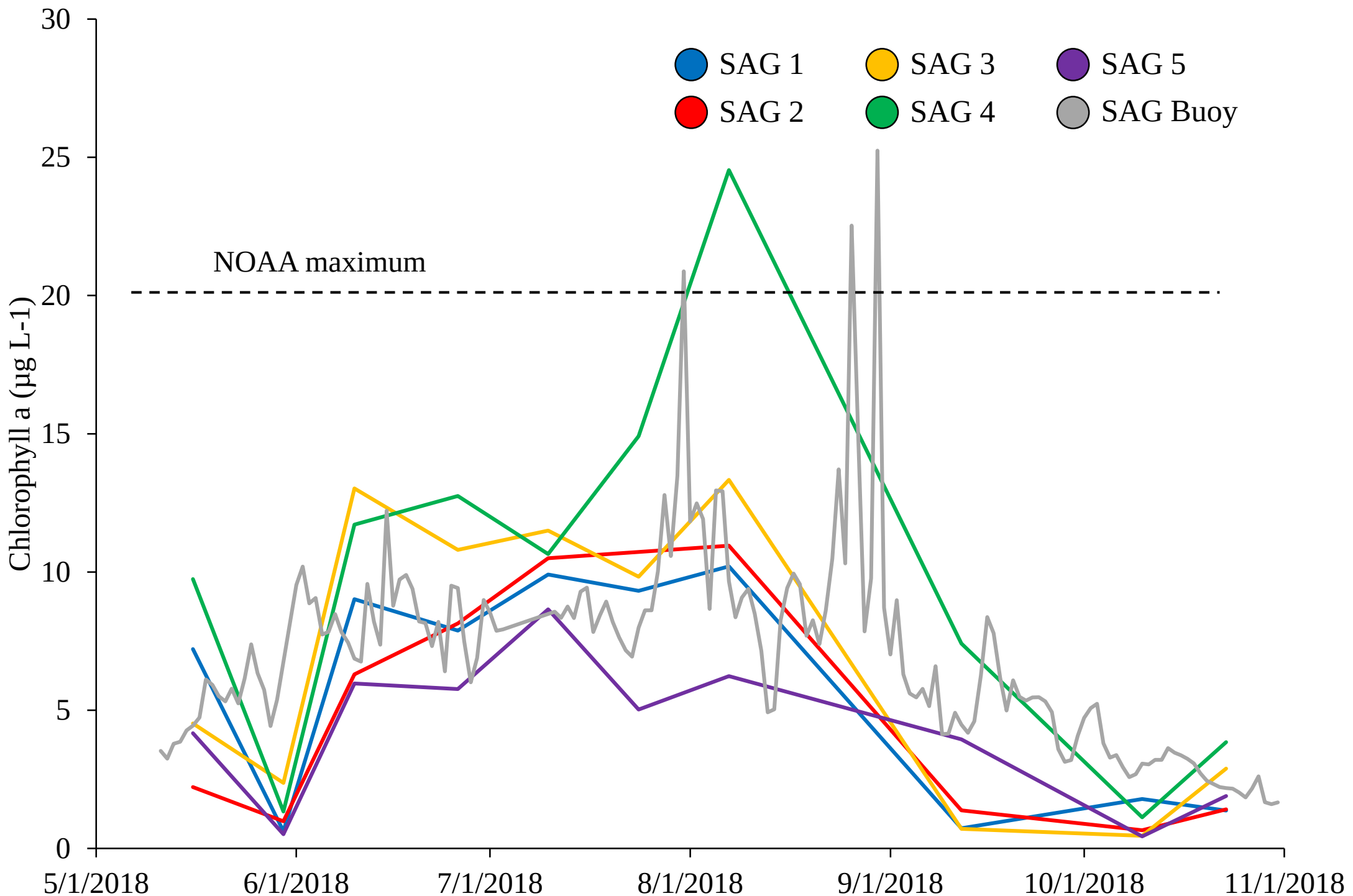
Secchi disk depths (water clarity), 2018



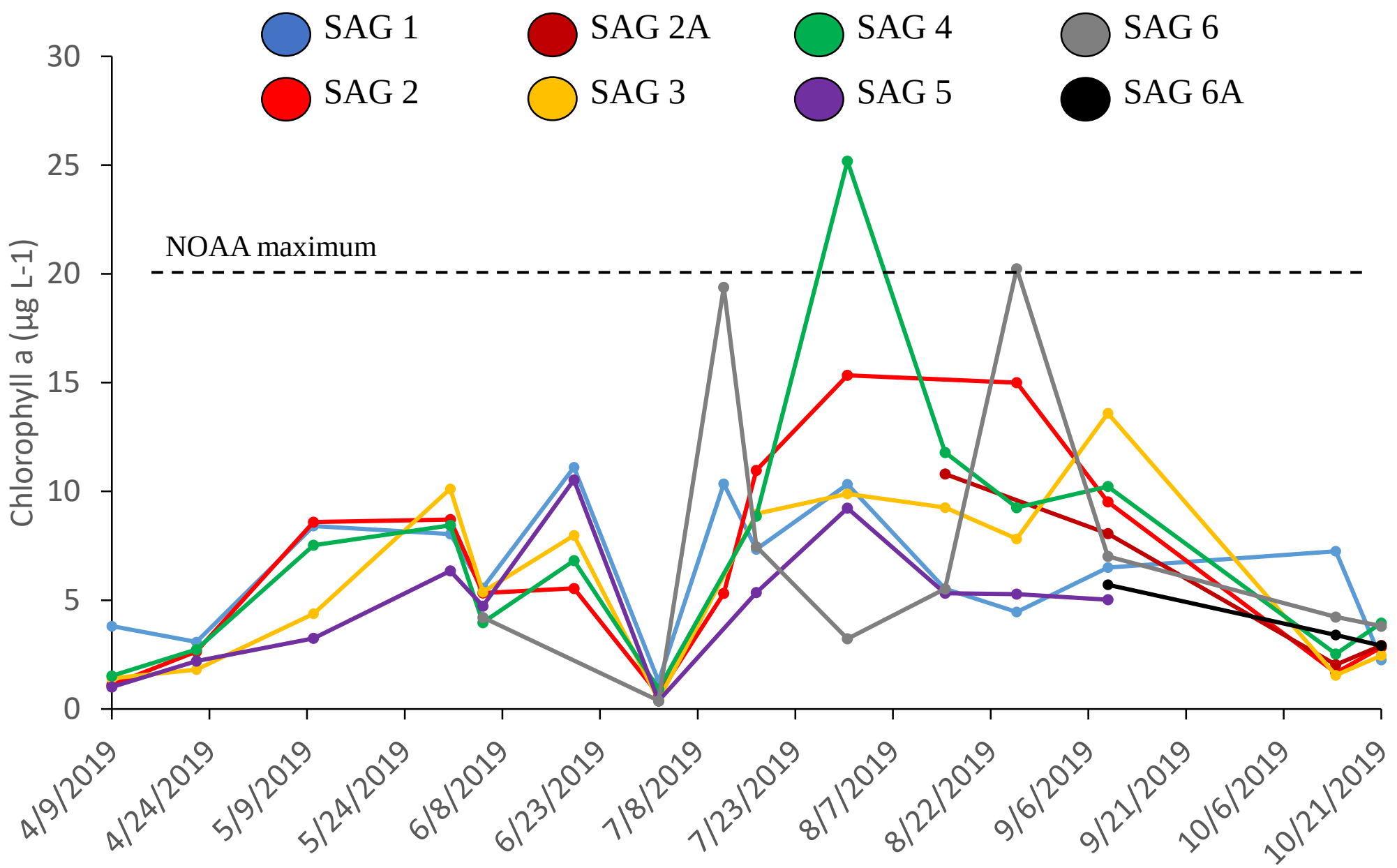
Secchi disk depths (water clarity), 2019



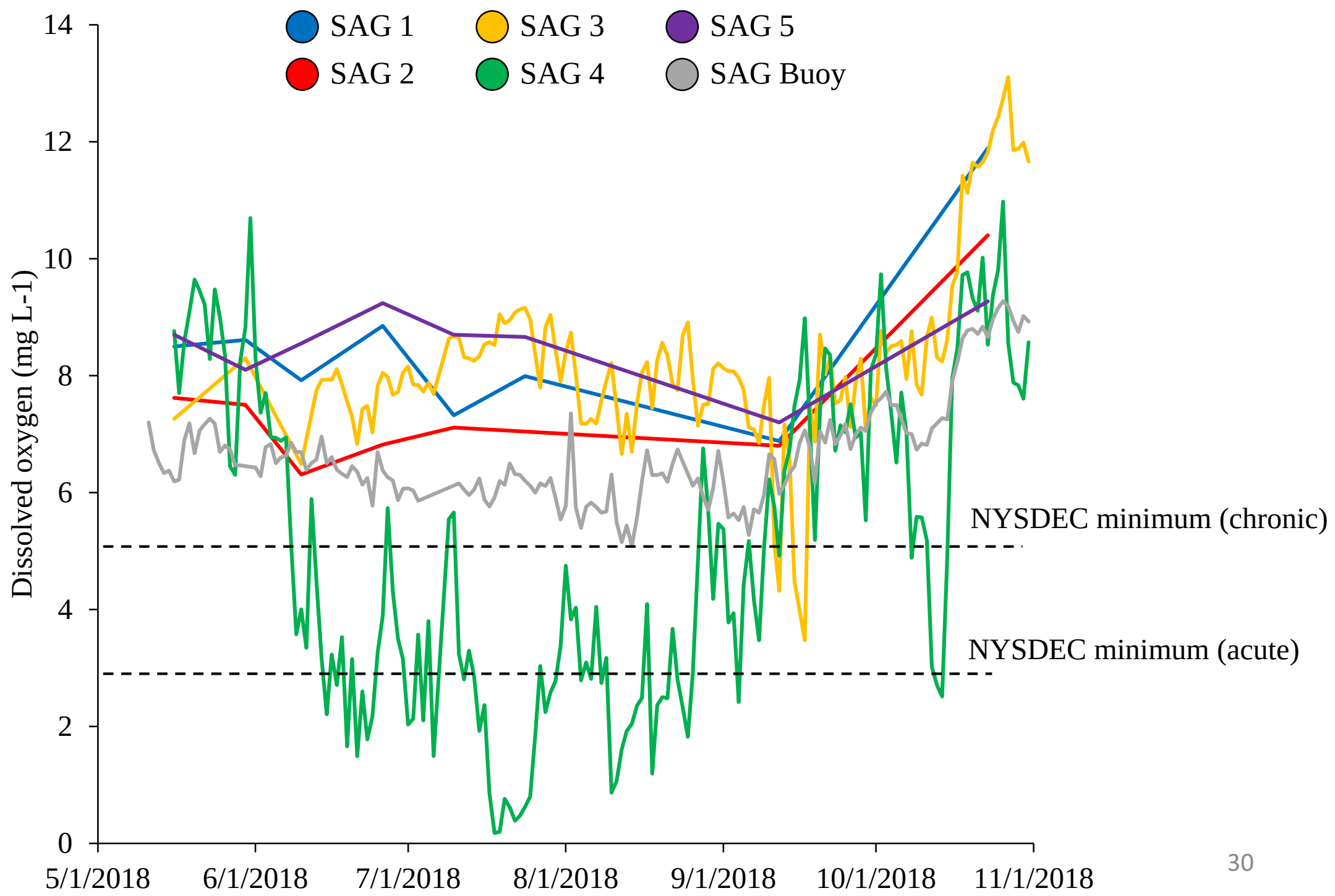
Chlorophyll *a* concentrations (algae) during 2018



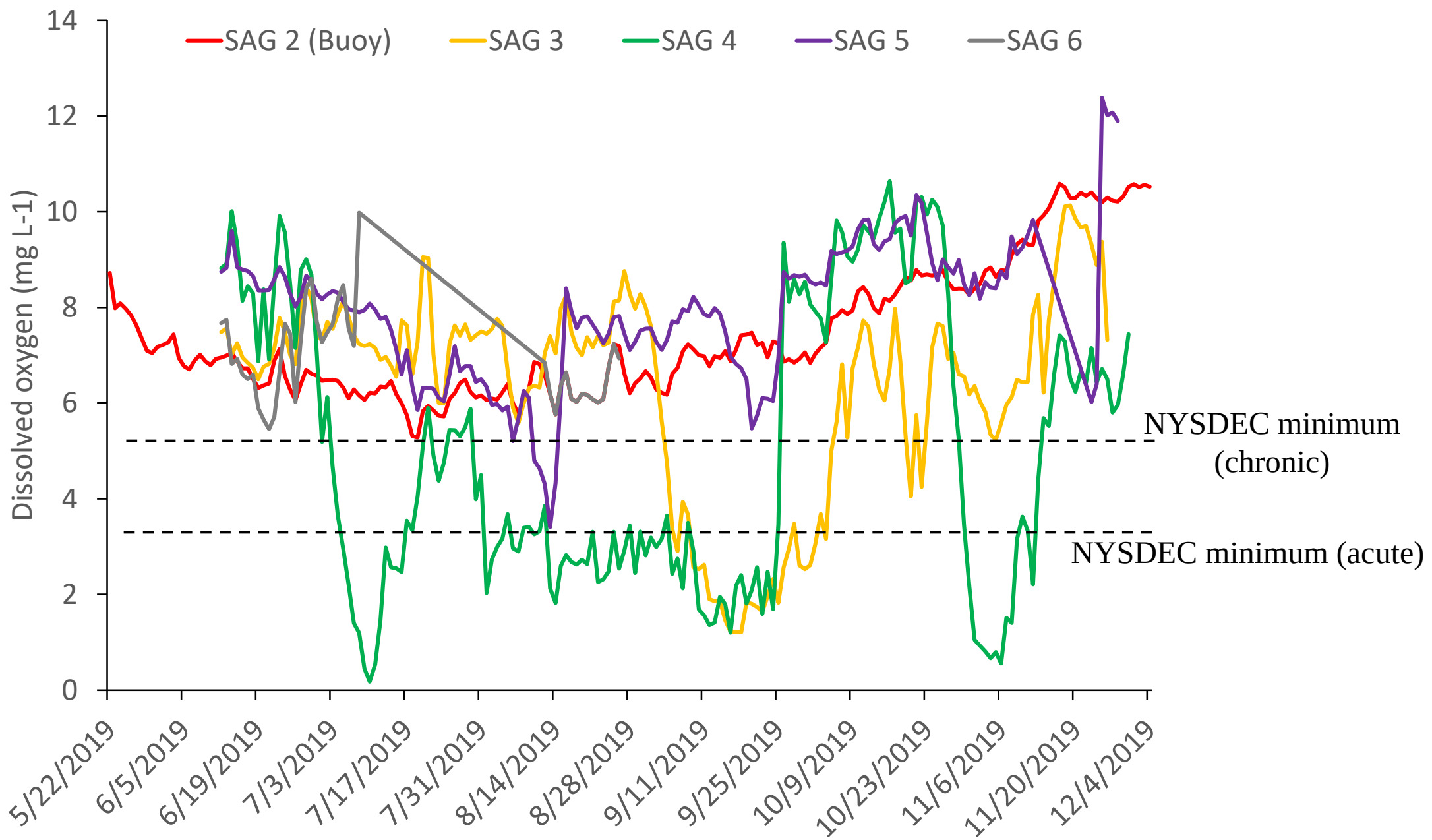
Chlorophyll *a* concentrations (algae) during 2019



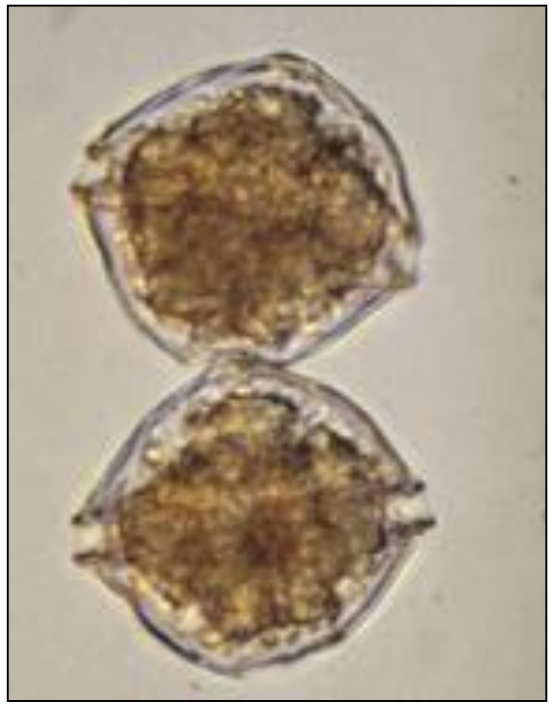
Dissolved oxygen levels during 2018



Dissolved oxygen levels during 2019



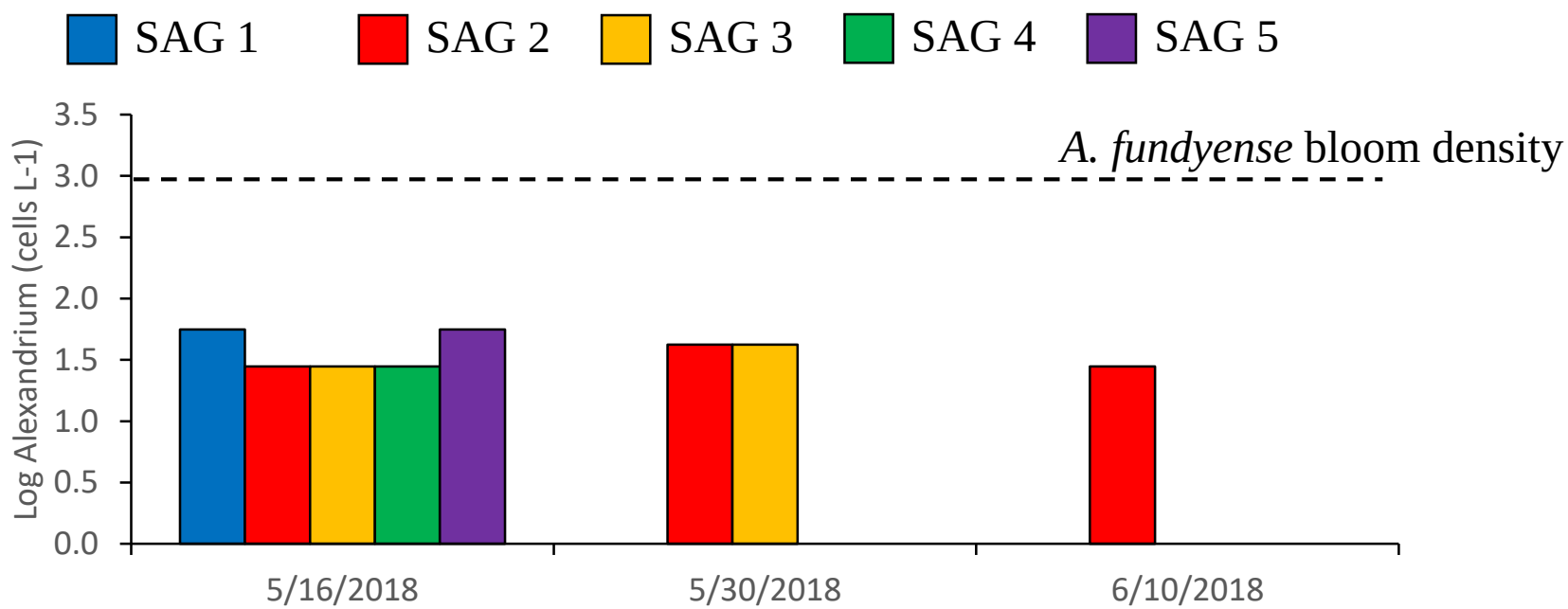
Alexandrium and *Dinophysis*

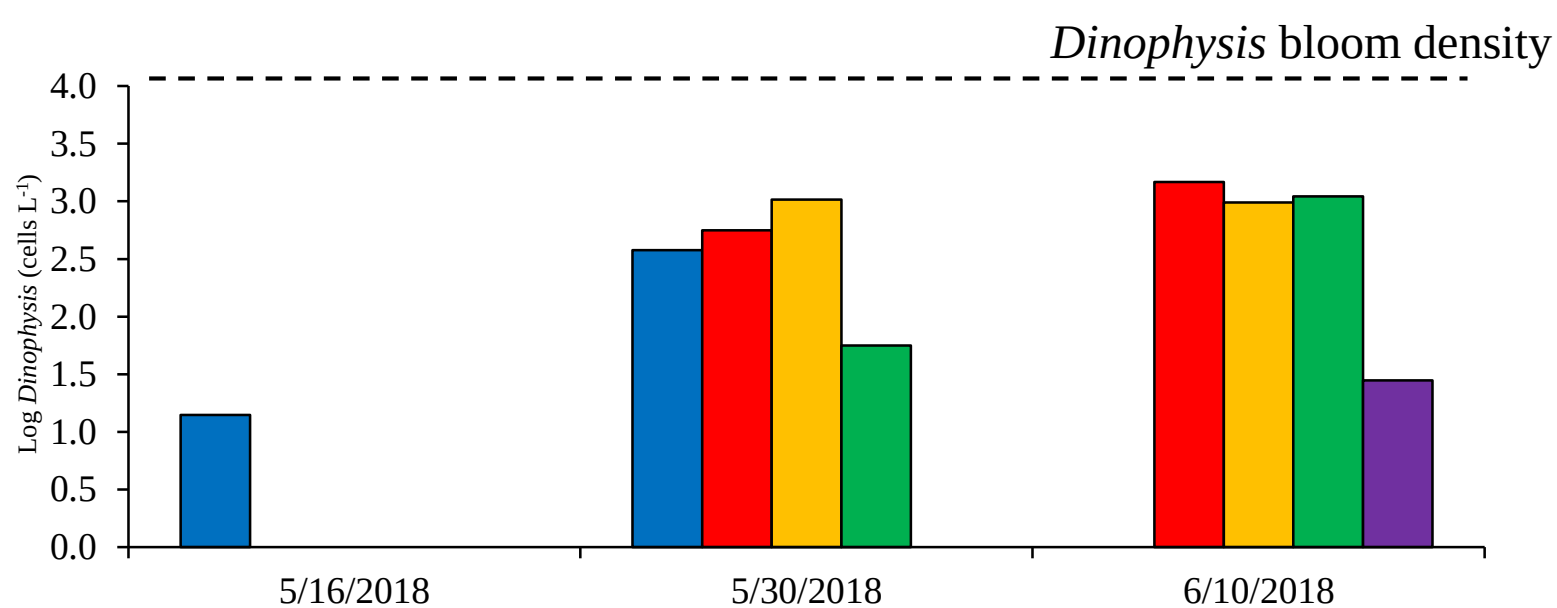


Alexandrium

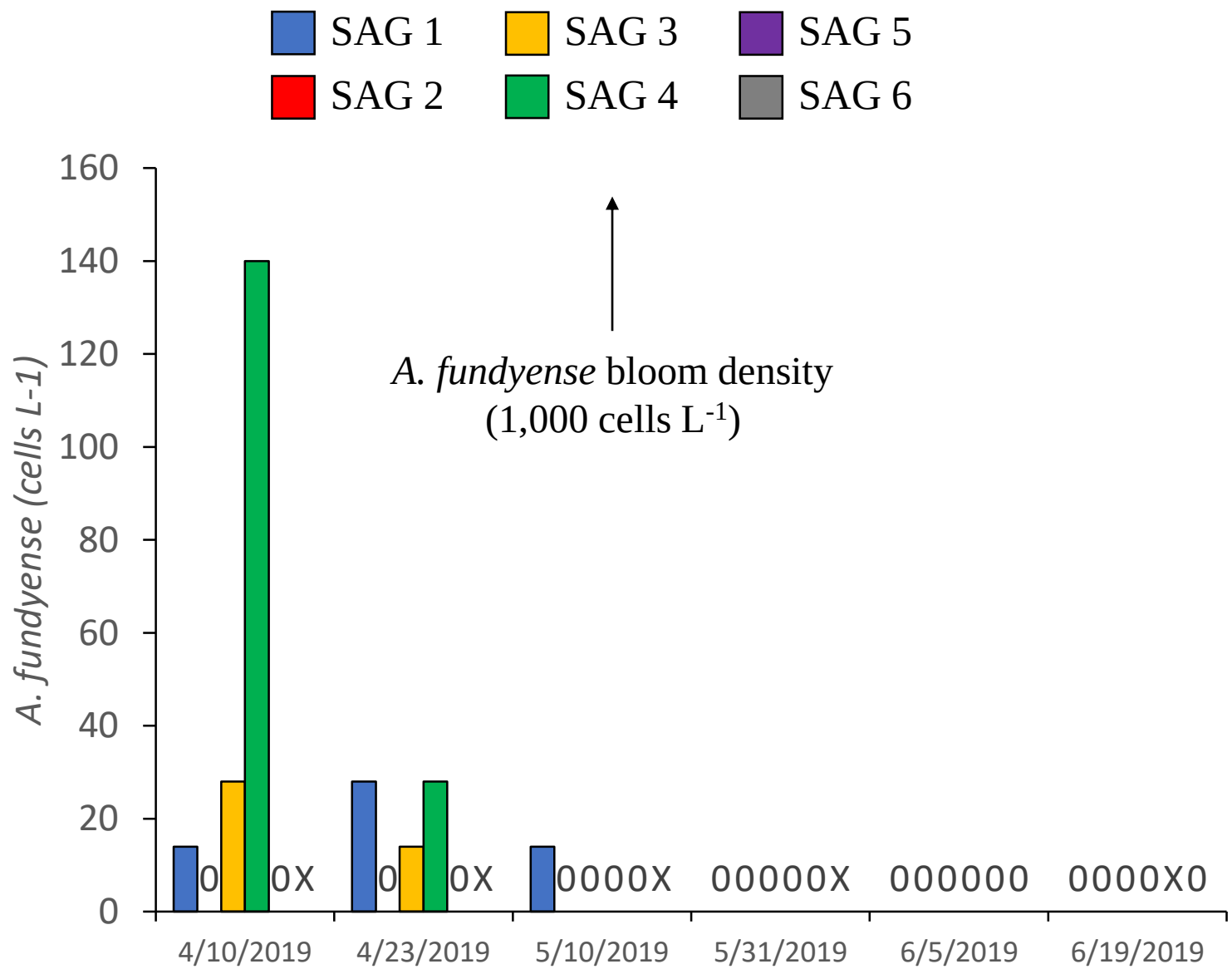
Dinophysis

HABs caused by *Alexandrium* and *Dinophysis* during 2018

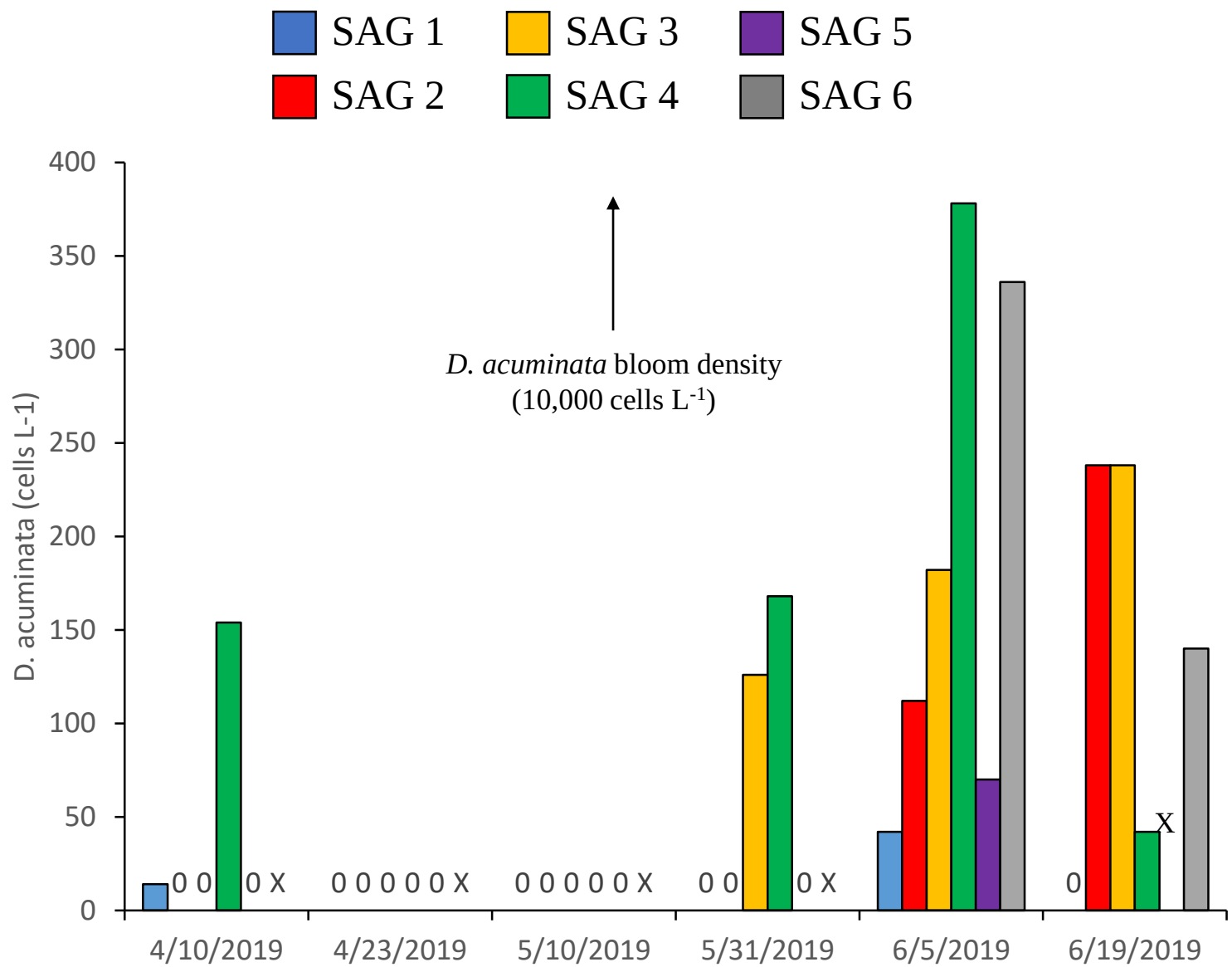




HABs caused by *Alexandrium* during 2019

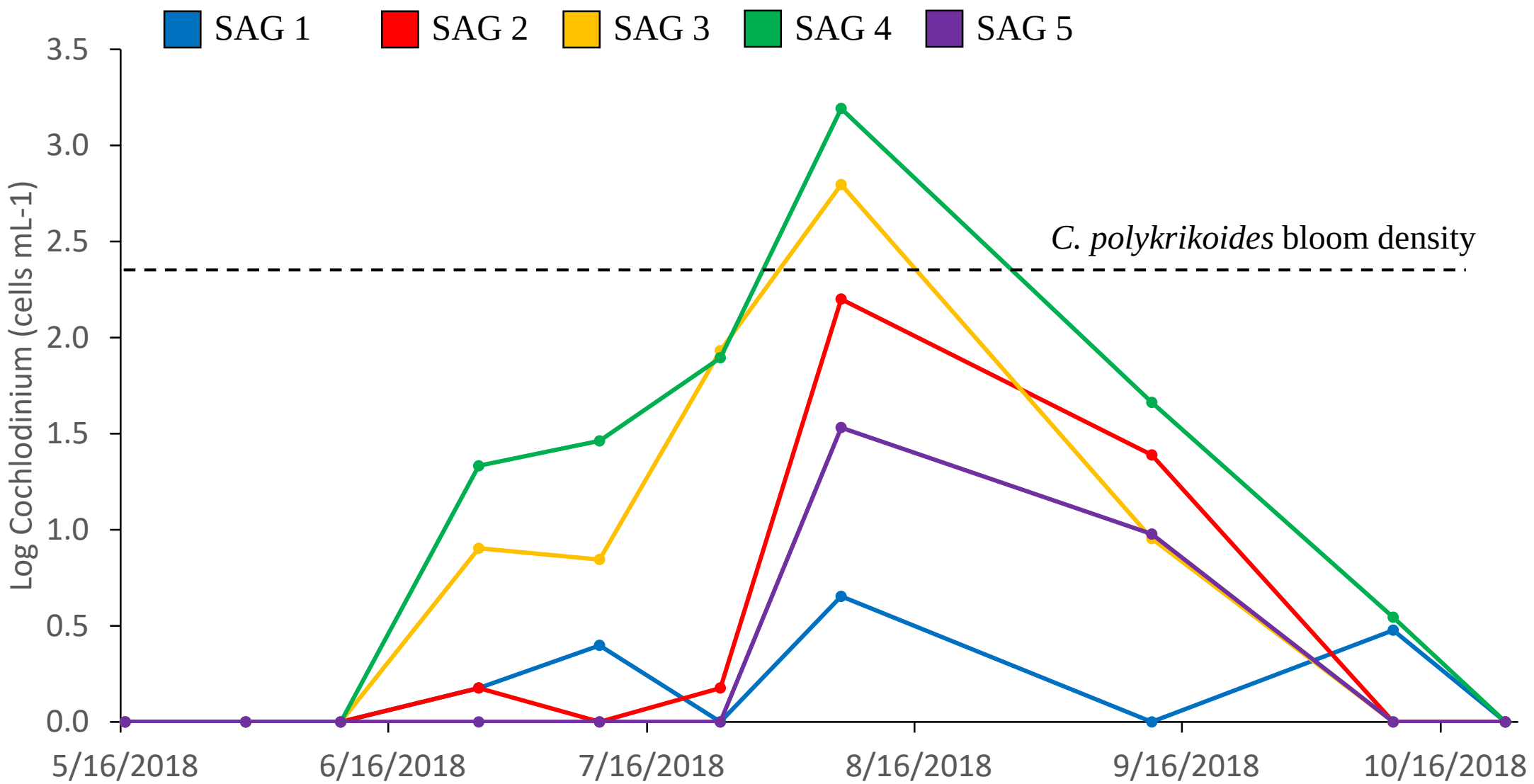


HABs caused by *Dinophysis* during 2019

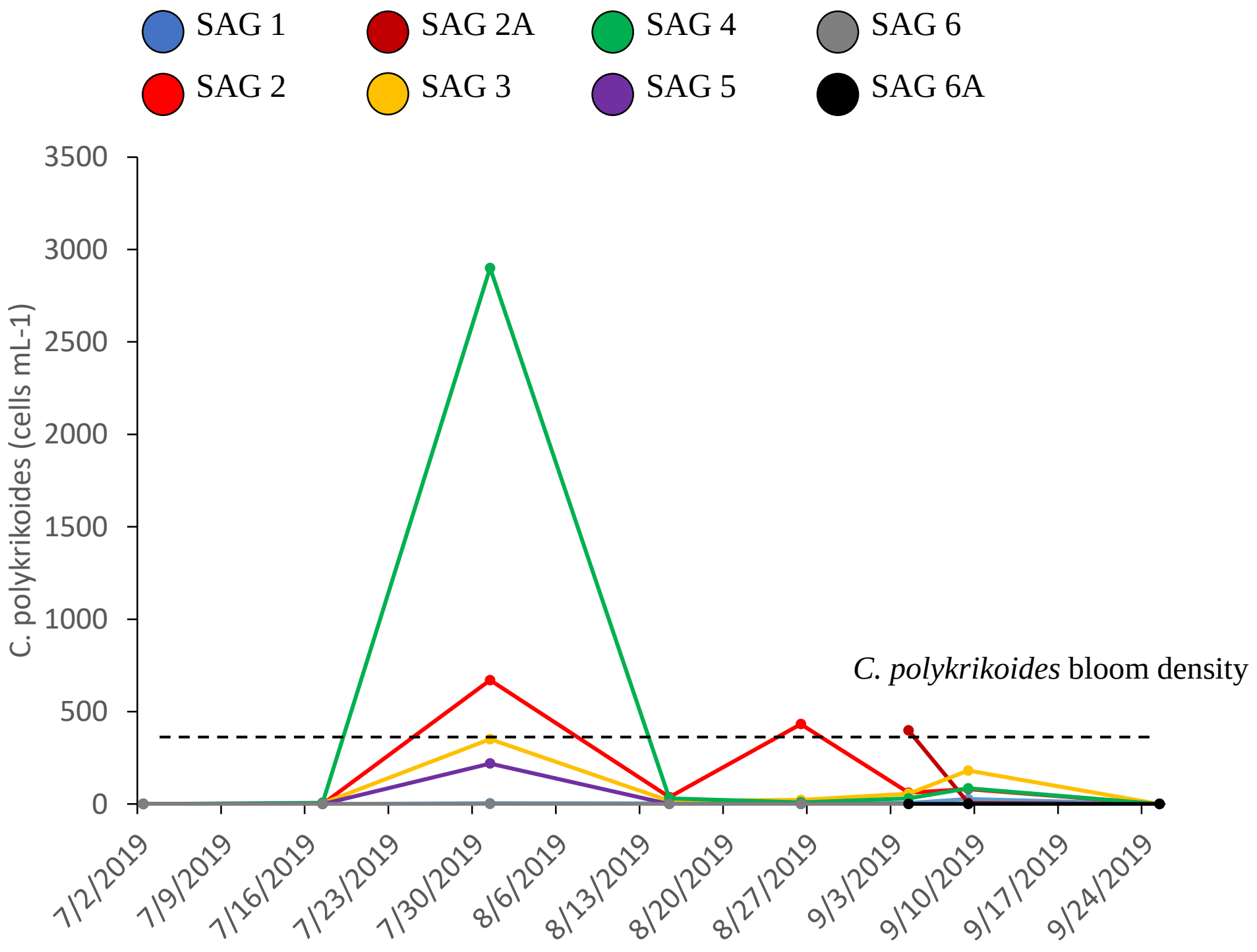


Cochlodinium rust tides

HABs caused by *Cochlodinium* during 2018

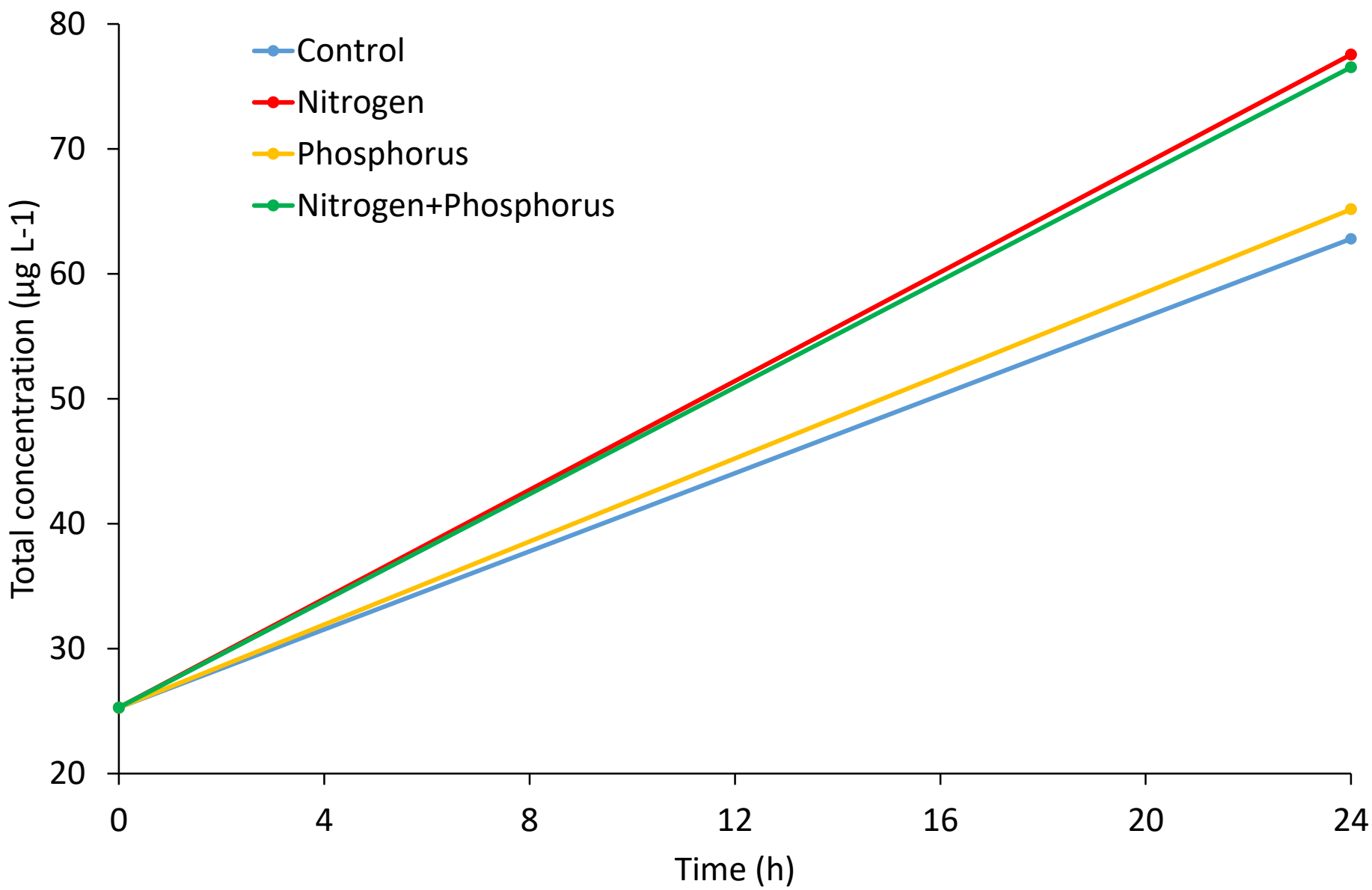


HABs caused by *Cochlodinium* during 2019

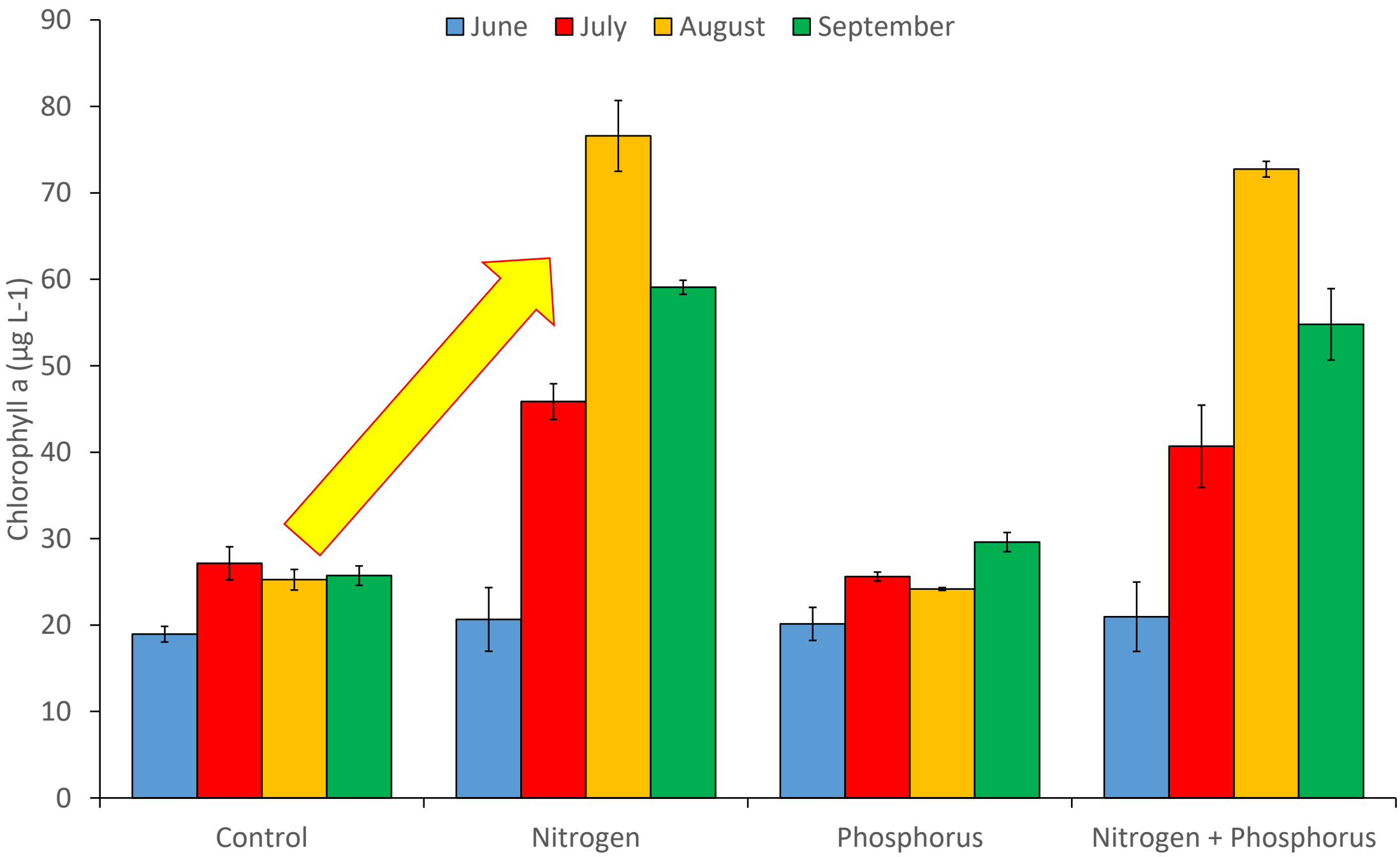


What controls the growth of algae in Sag Harbor?

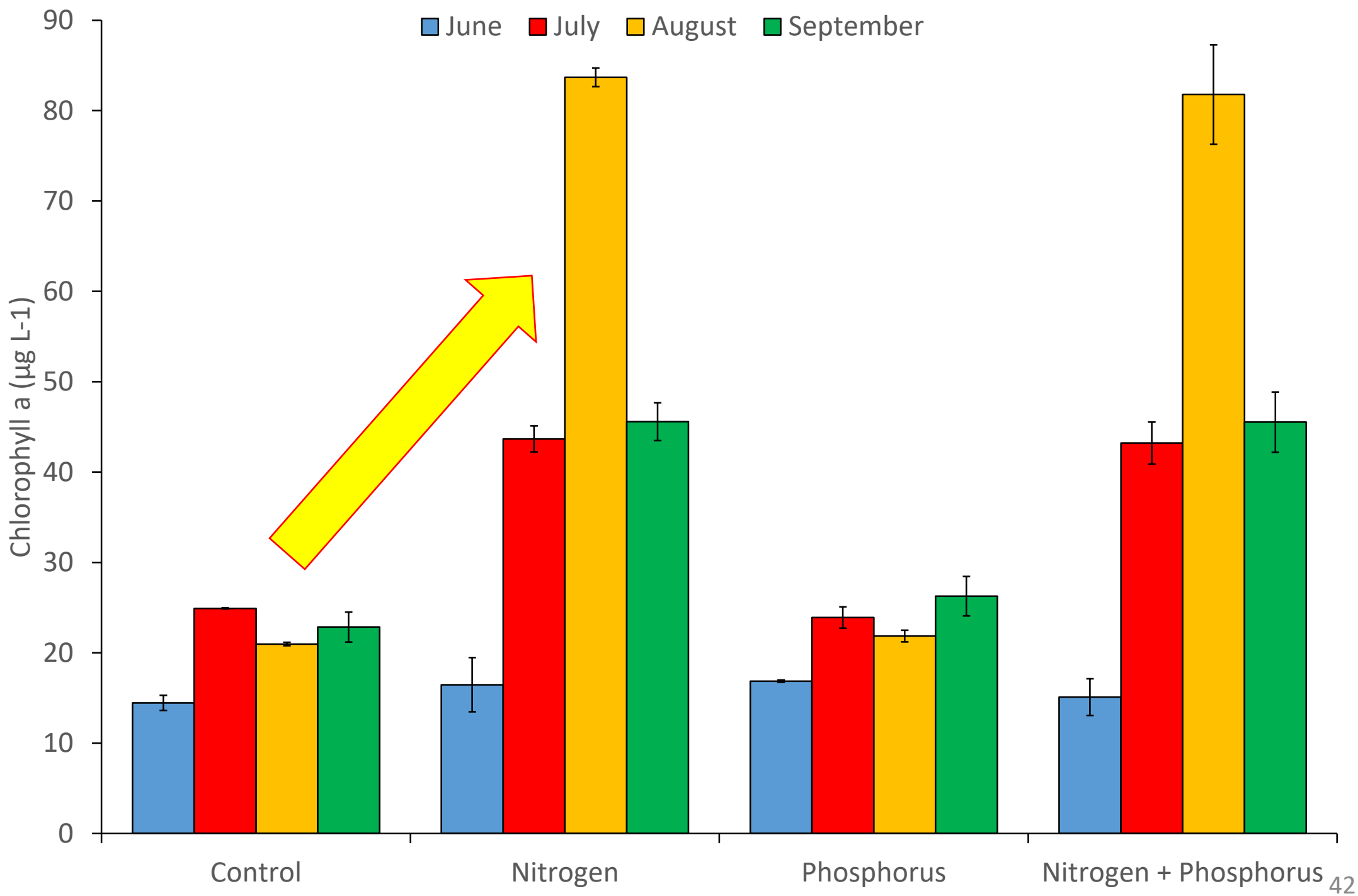
Response of algal populations to nitrogen and phosphorus, 2018



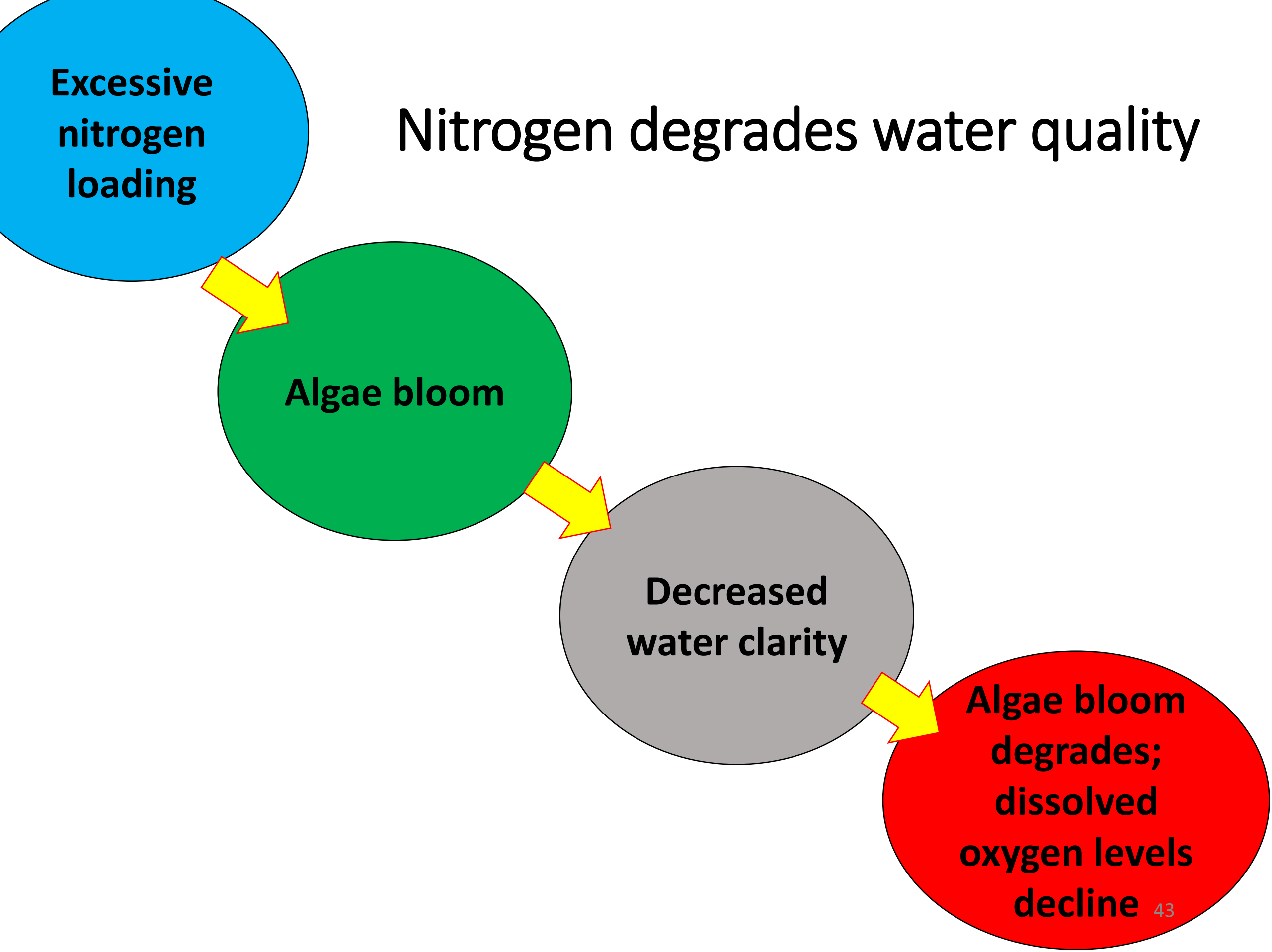
Response of algal populations to nitrogen and phosphorus, Sag Harbor / Sag Harbor Cove 2019



Response of algal populations to nitrogen and phosphorus, Upper Sag Harbor Cove 2019

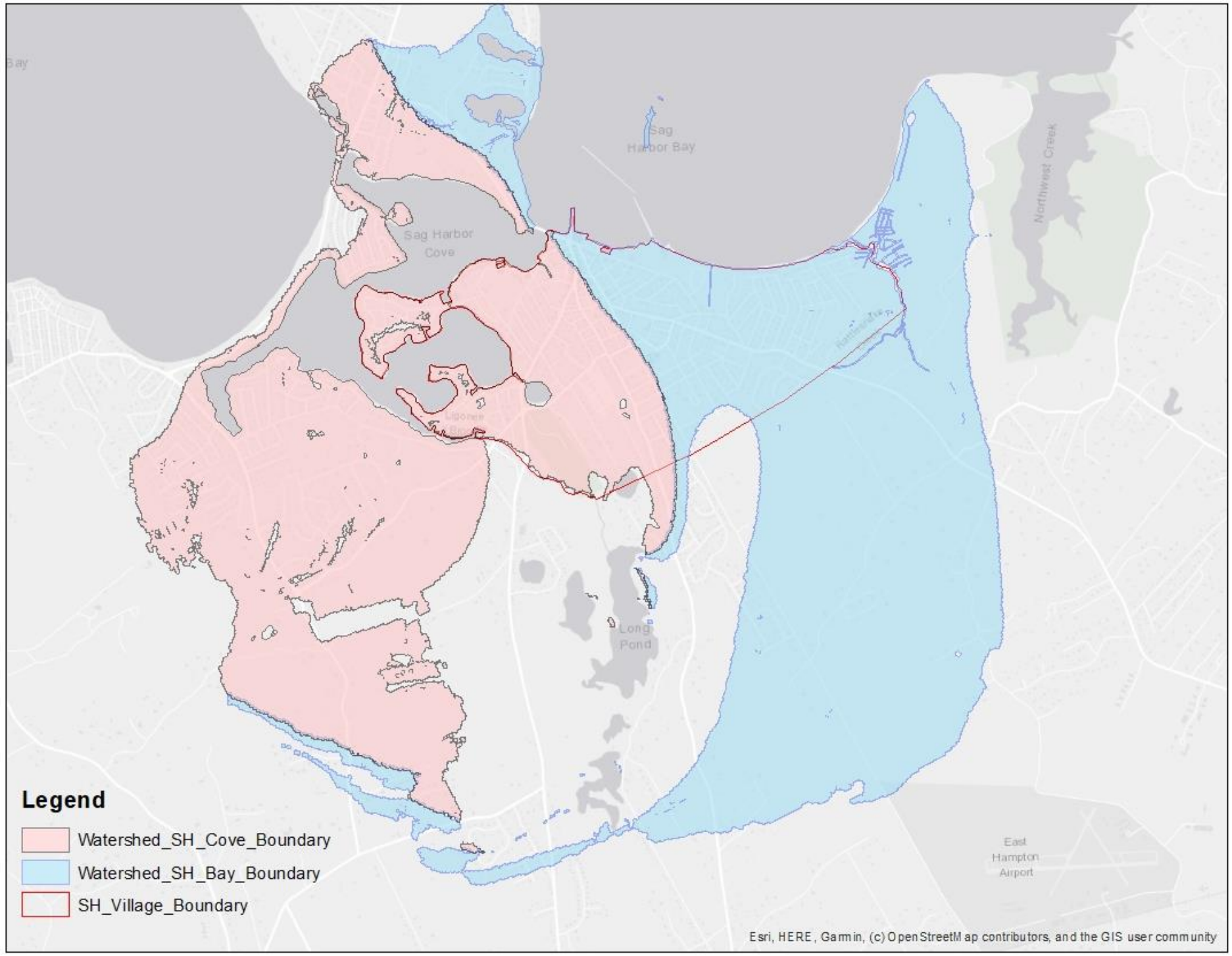


Nitrogen degrades water quality

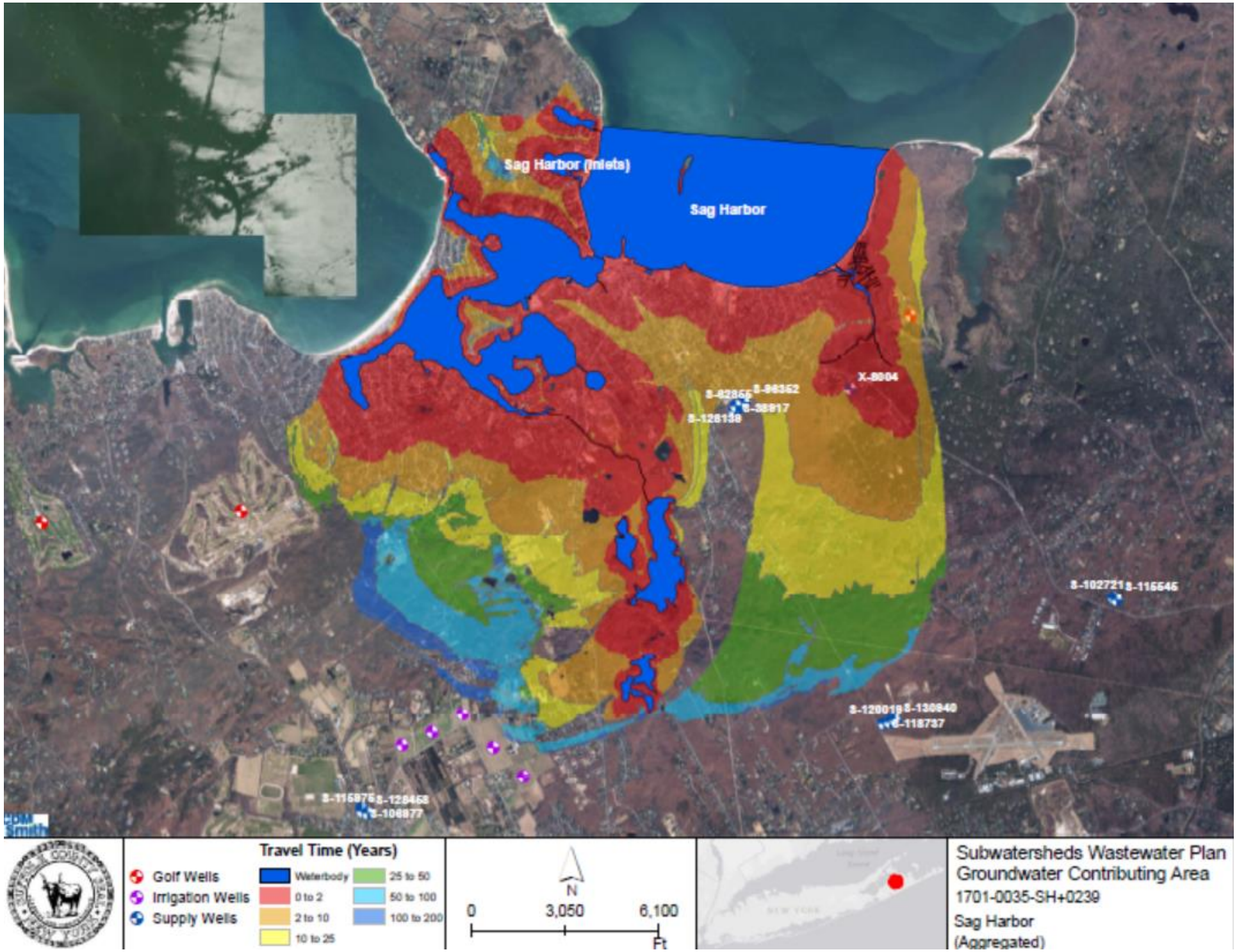


WHAT ARE THE DOMINANT SOURCES OF NITROGEN TO SAG HARBOR?

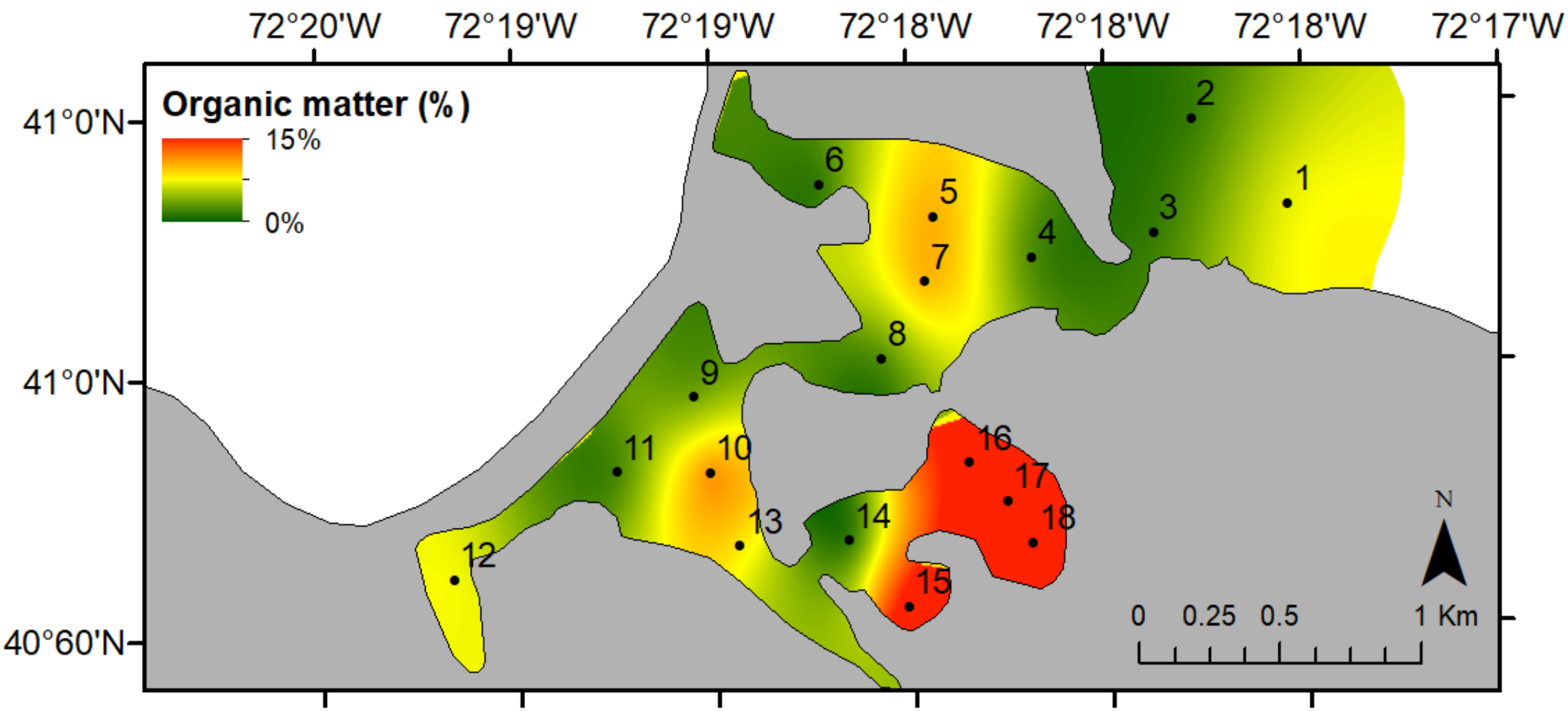
Sag Harbor and Sag Harbor Cove watersheds



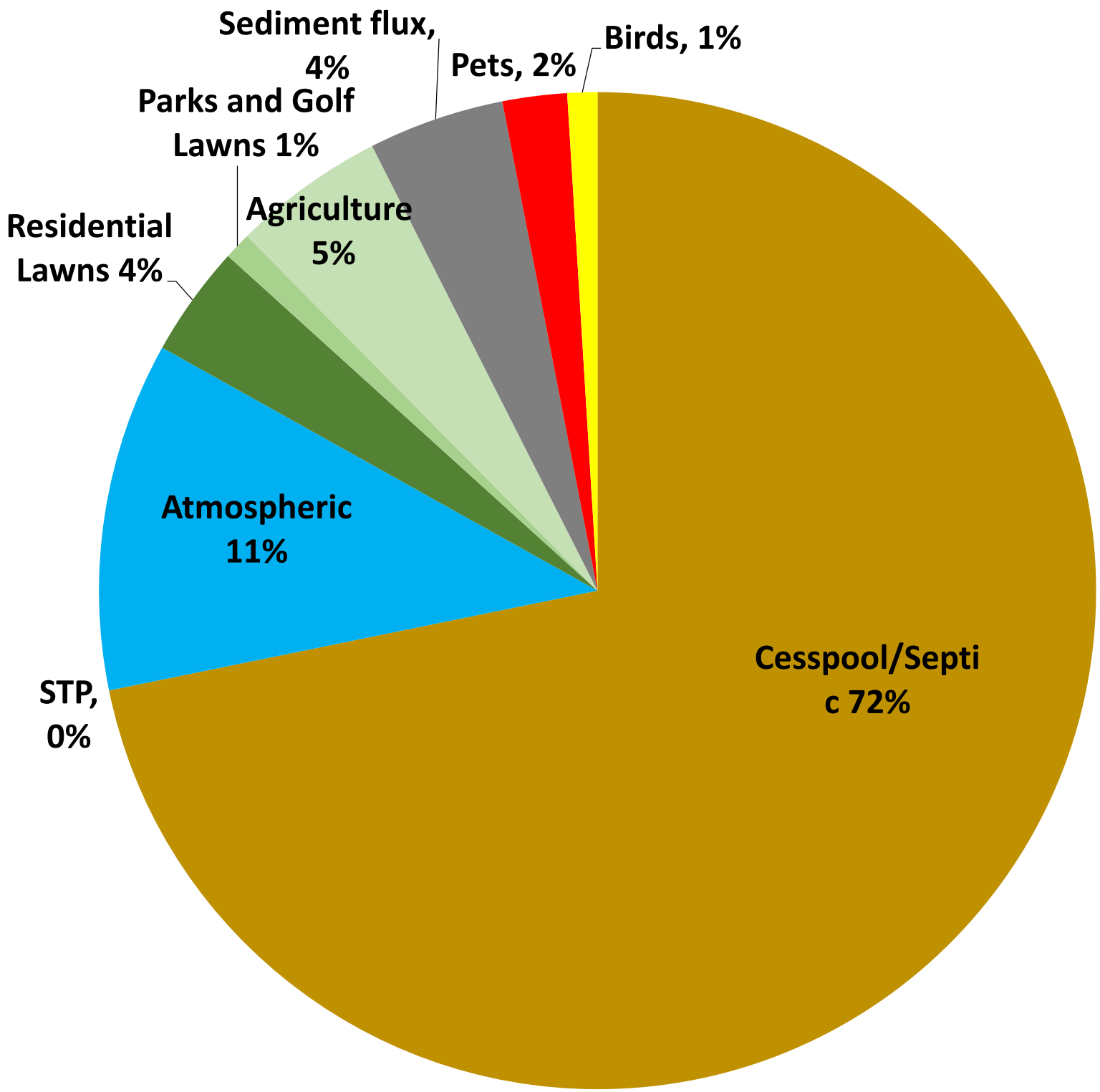
Watersheds and groundwater travel times of Sag Harbor Bay and Sag Harbor Cove.



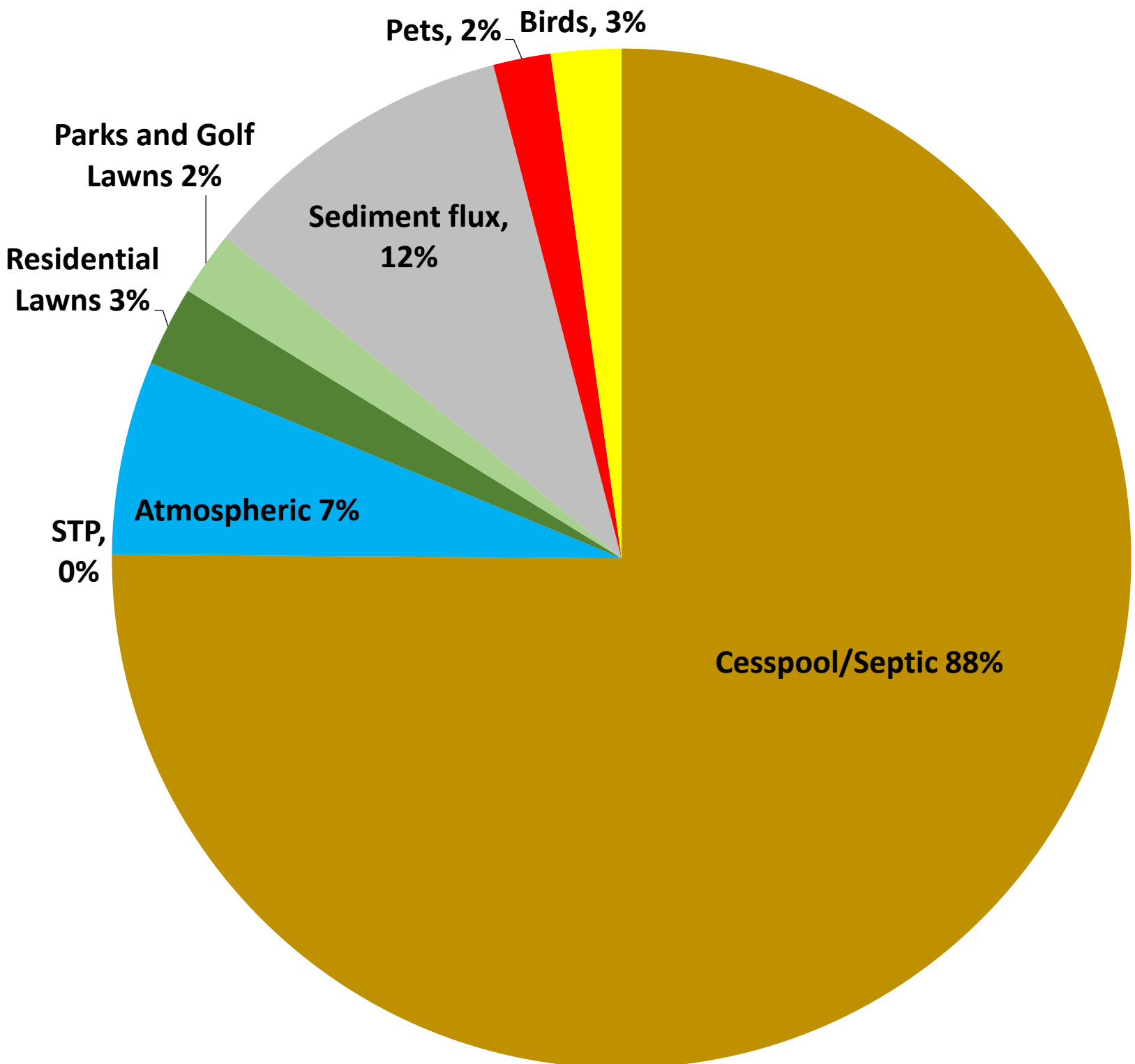
Percent organic matter of sediments across Sag Harbor and Sag Harbor Cove



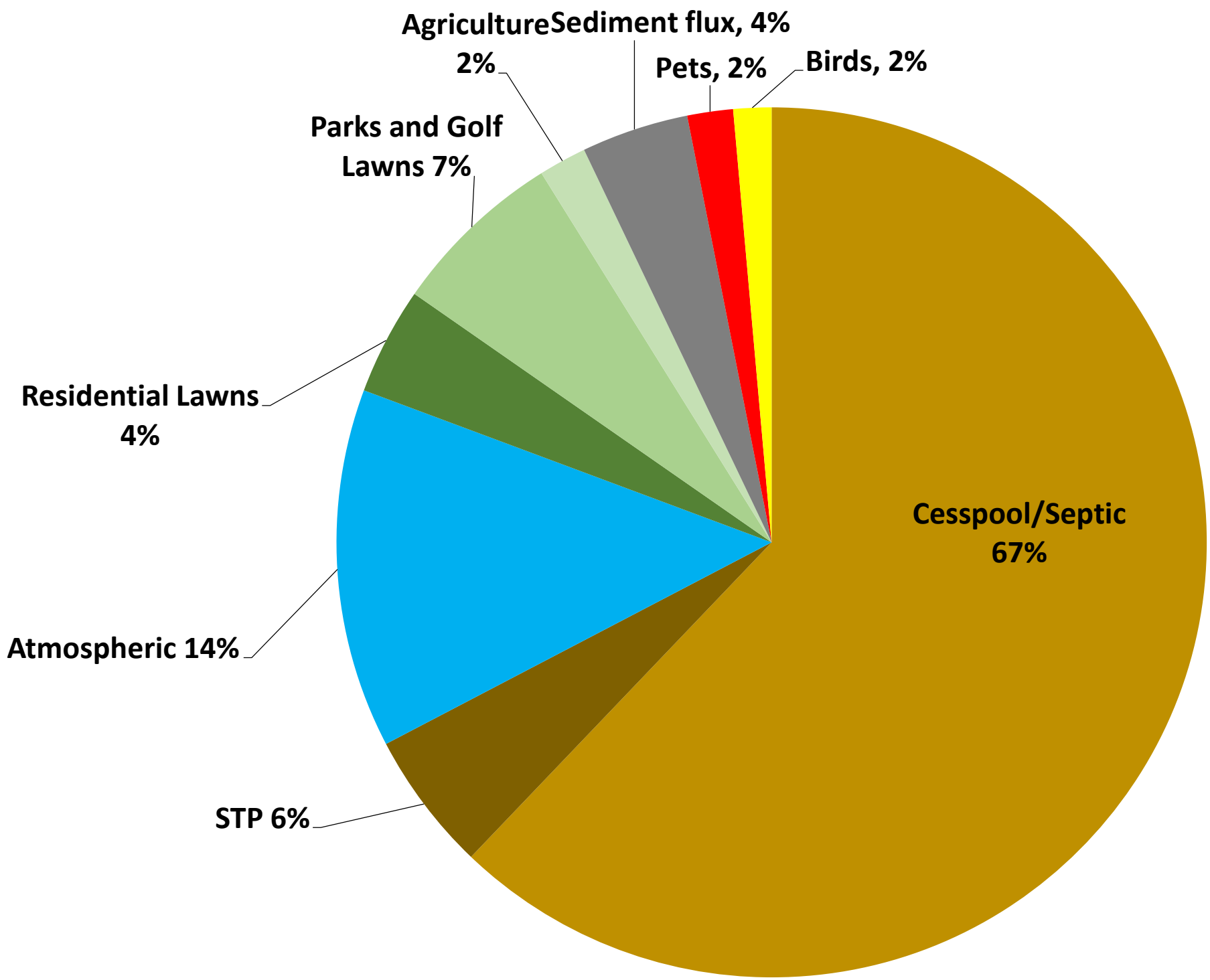
Percent nitrogen loads from various sources to Sag Harbor Cove



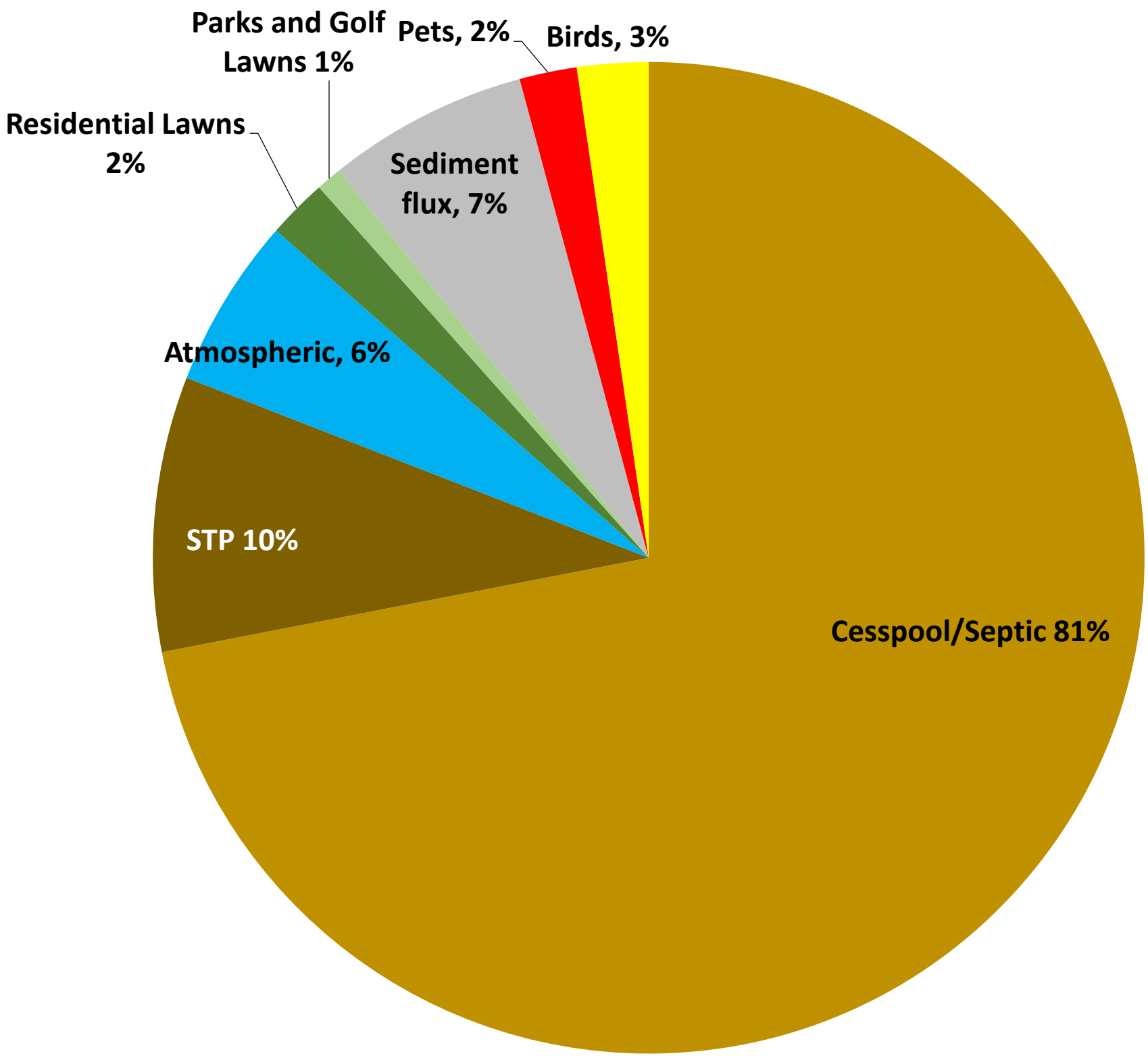
Percent nitrogen loads from various sources to Sag Harbor Cove, Village boundaries only



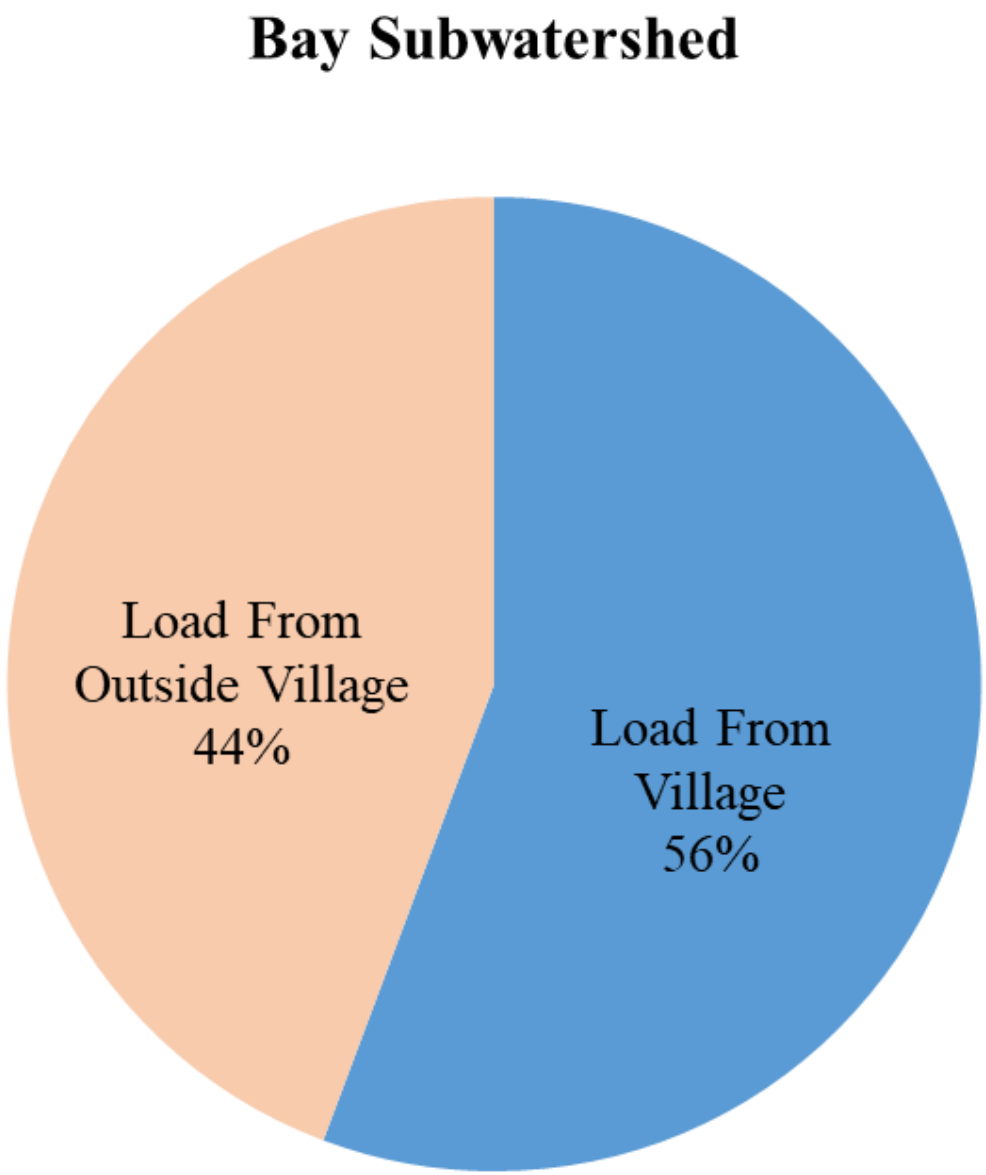
Percent nitrogen loads from various sources to Sag Harbor

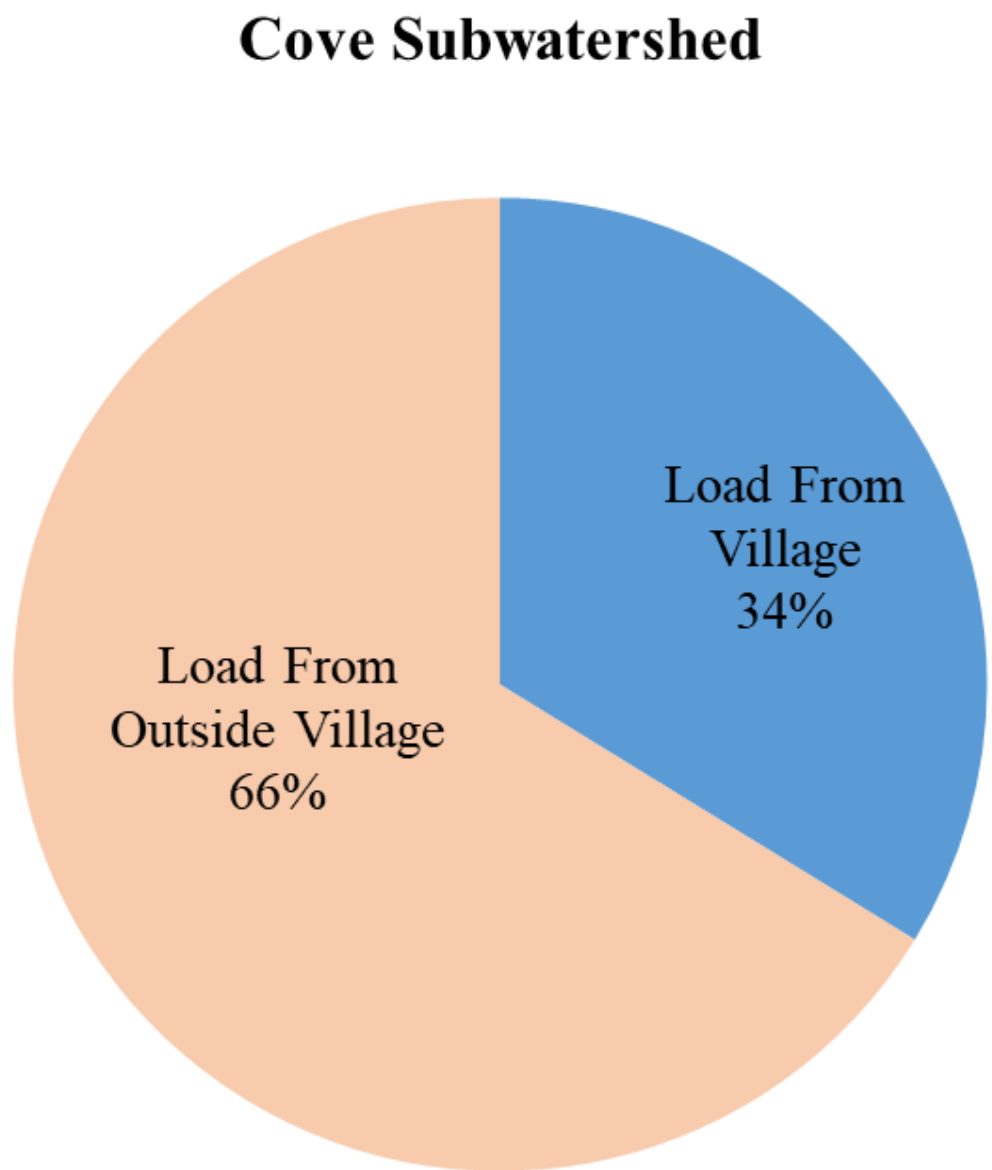


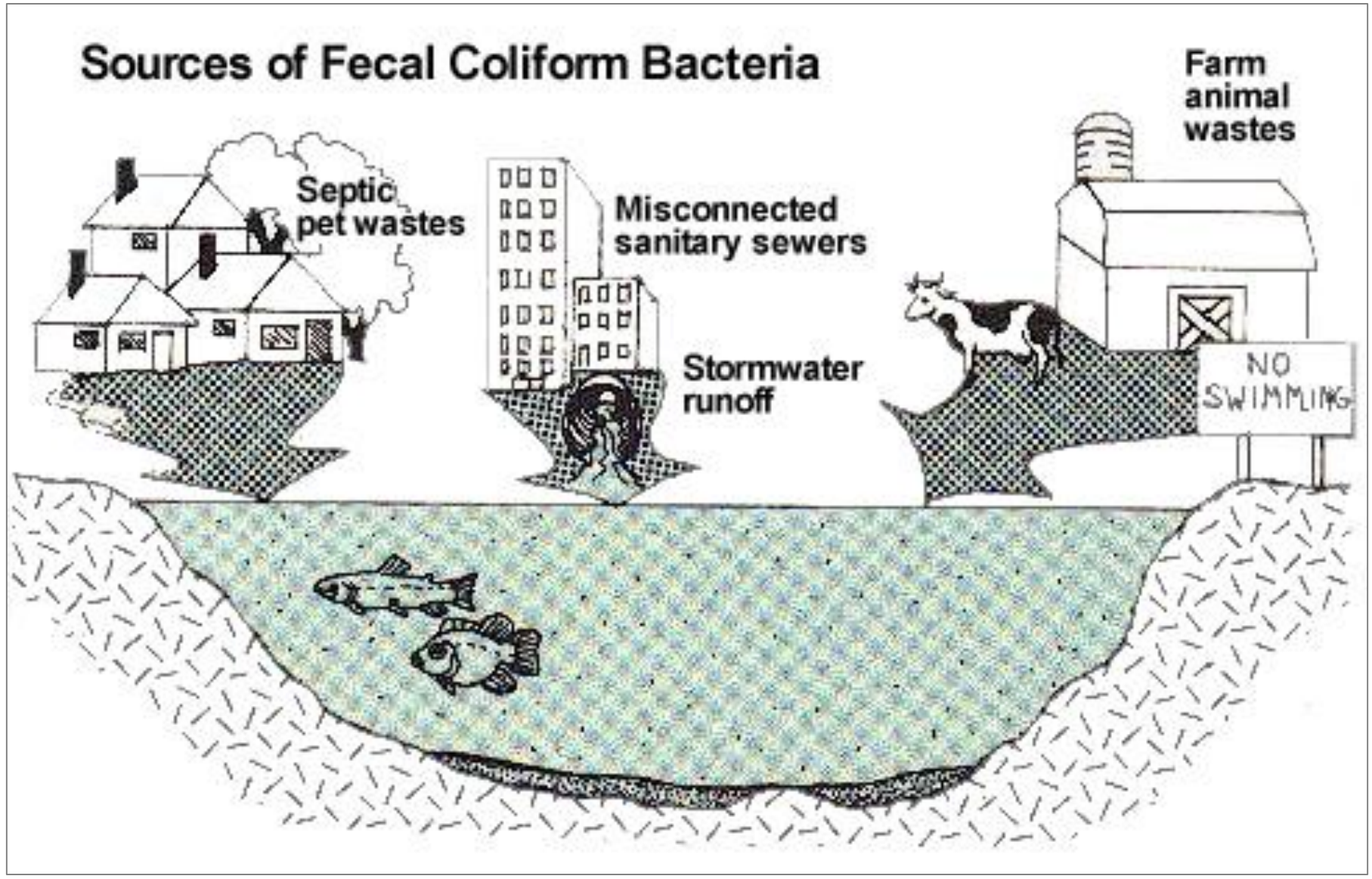
Percent nitrogen loads from various sources to Sag Harbor, Village boundaries only



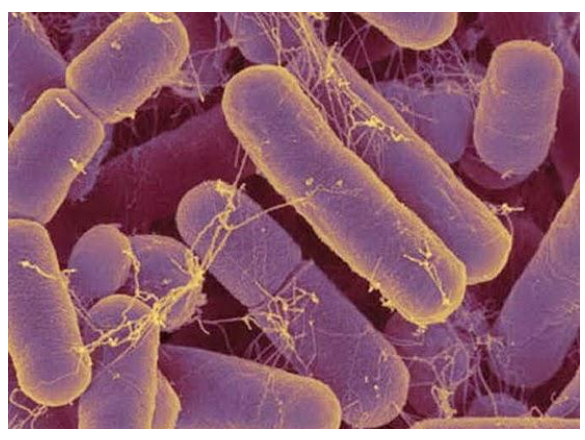
Percent nitrogen loads to Sag Harbor and Sag Harbor Cove, inside and outside of Village boundaries



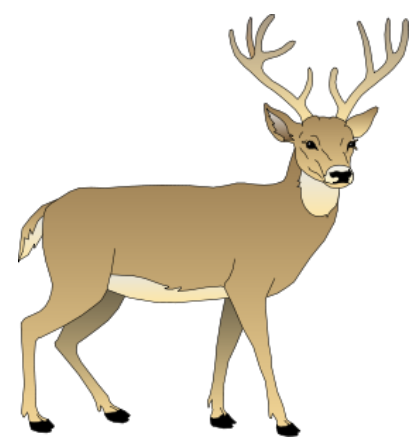




Fecal Bacteria:
Bacteroides

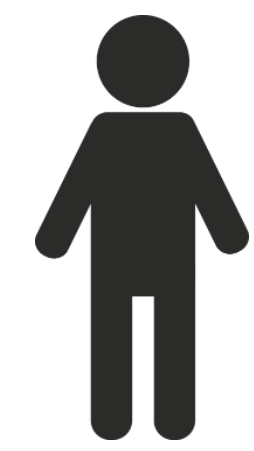


Target Host Organisms:

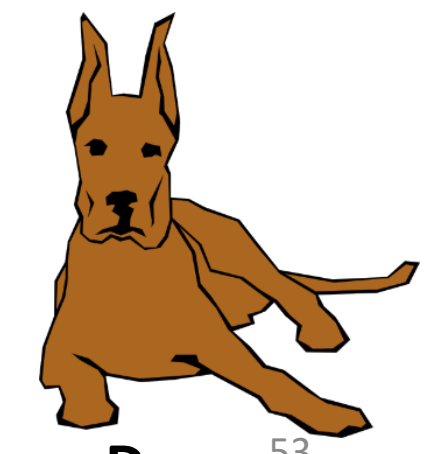


Ruminant

Birds

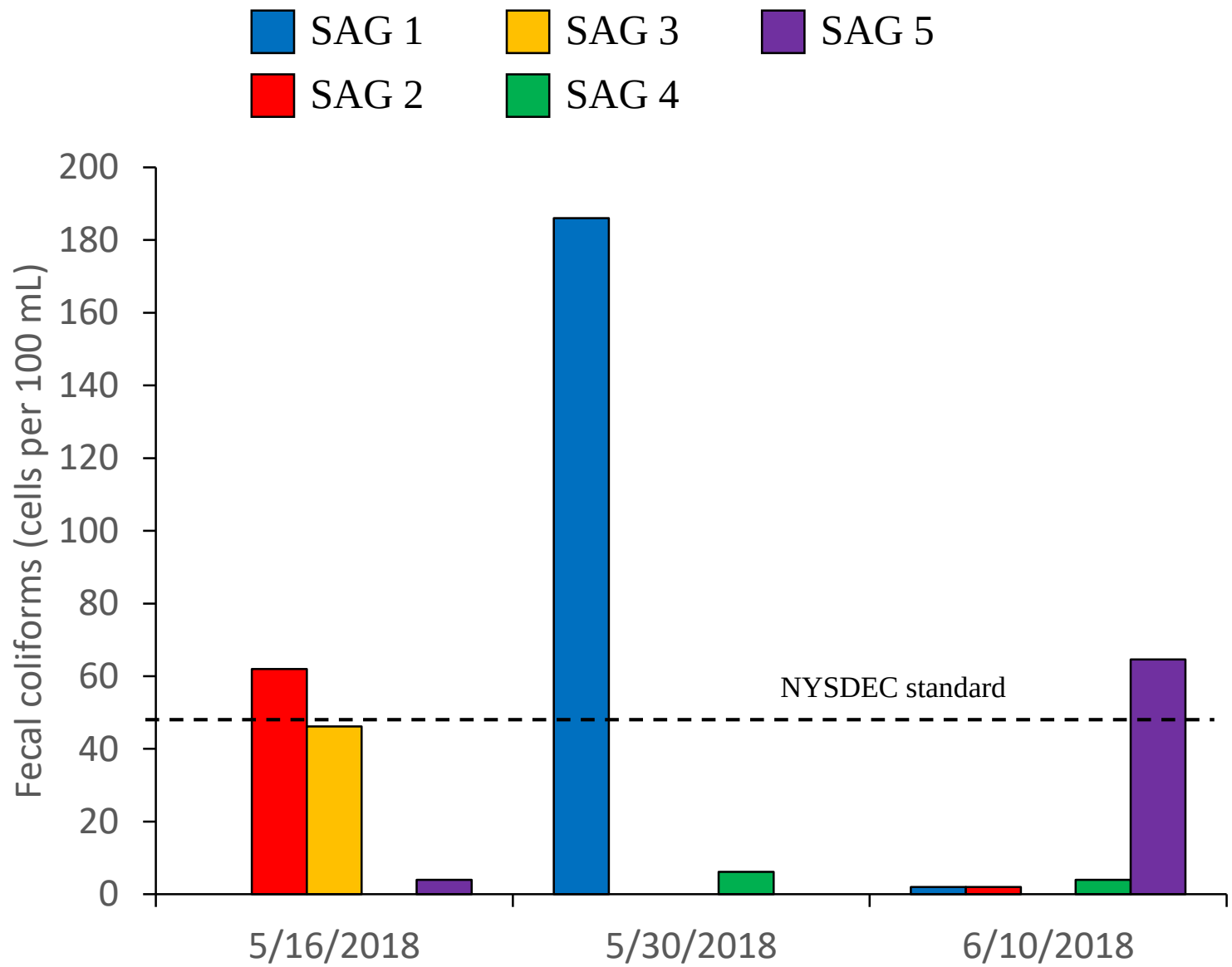


Human

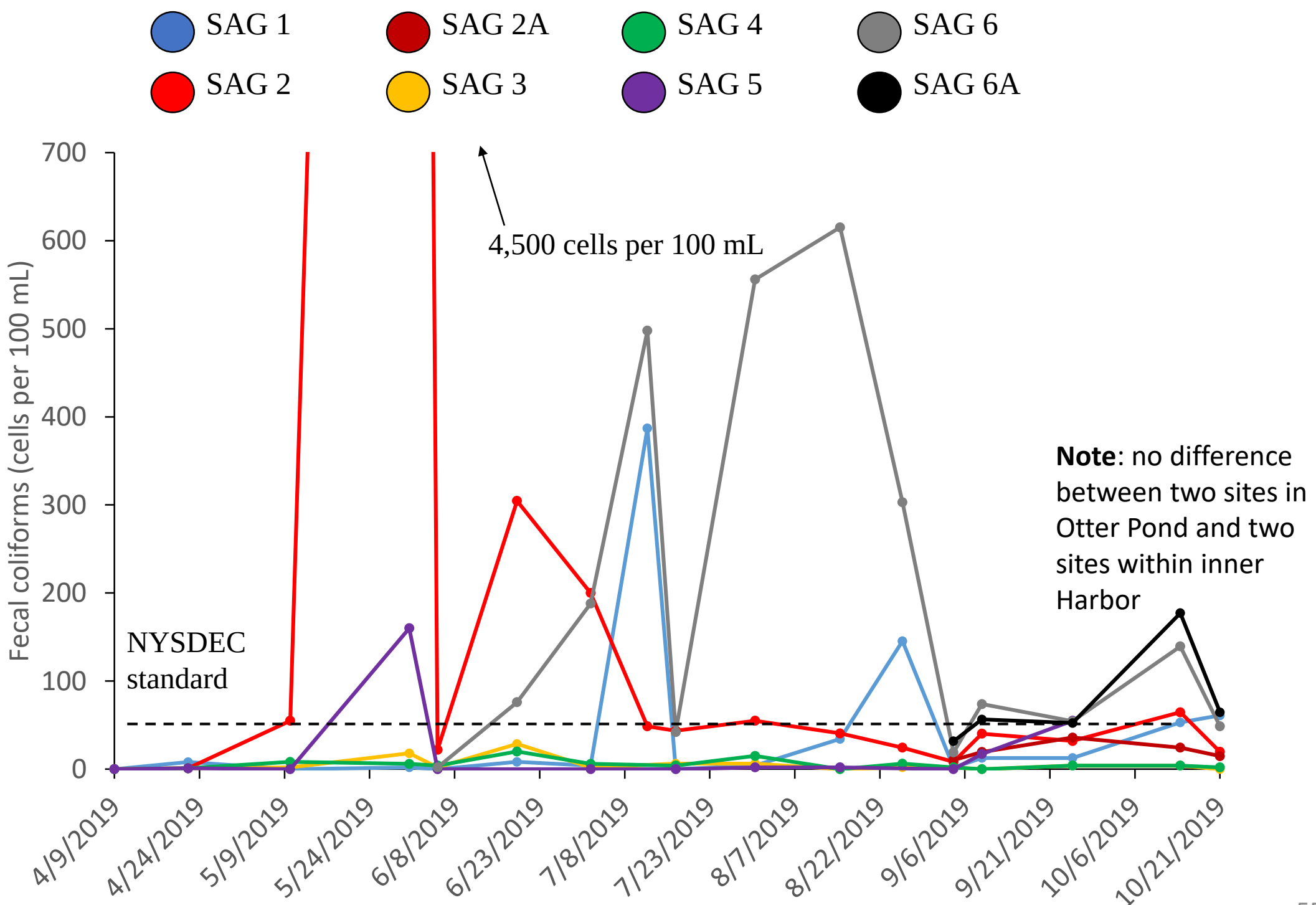


Dog

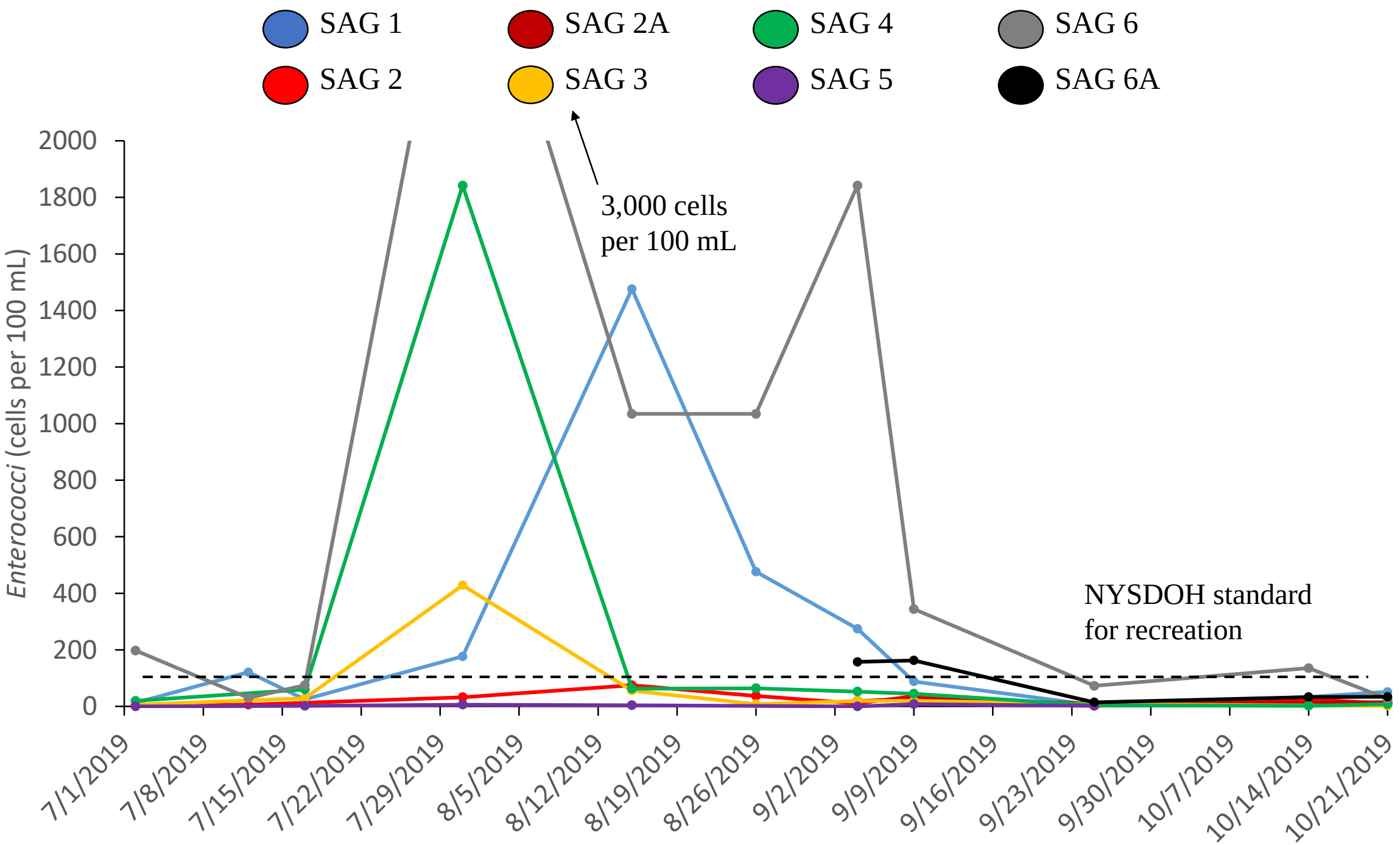
Fecal coliform bacteria during 2018



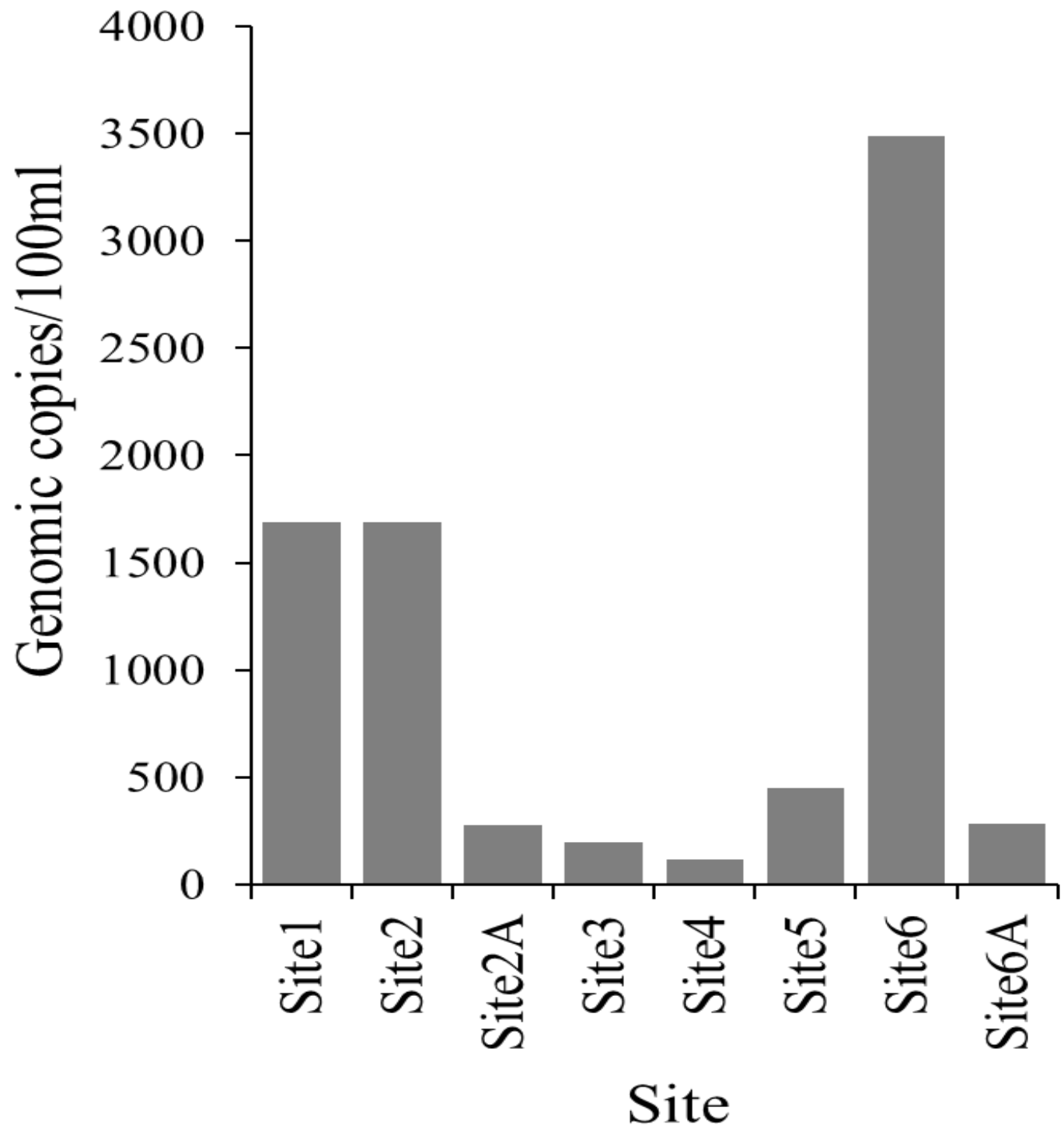
Fecal coliform bacteria during 2019



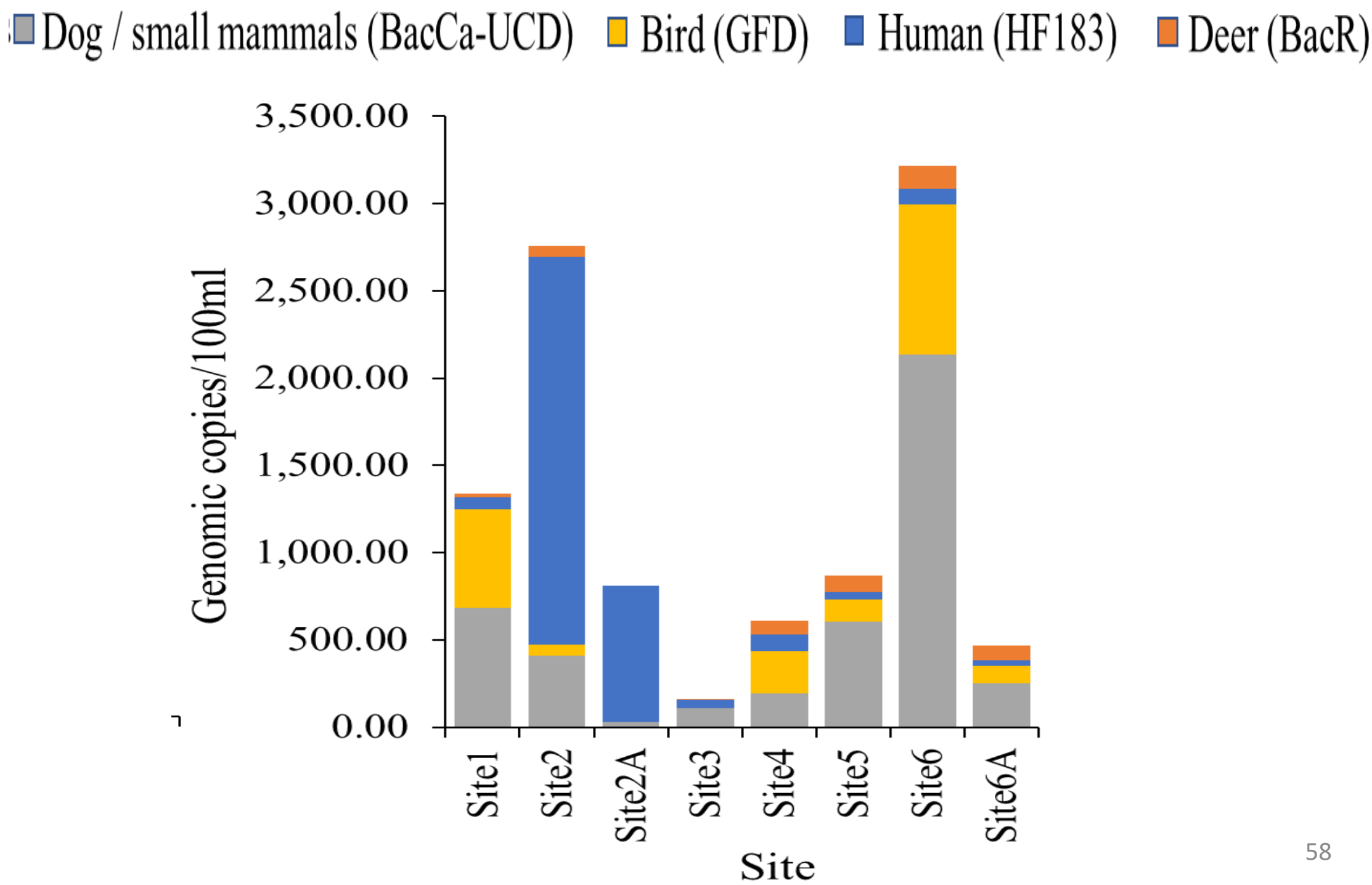
Enterococcus during 2019



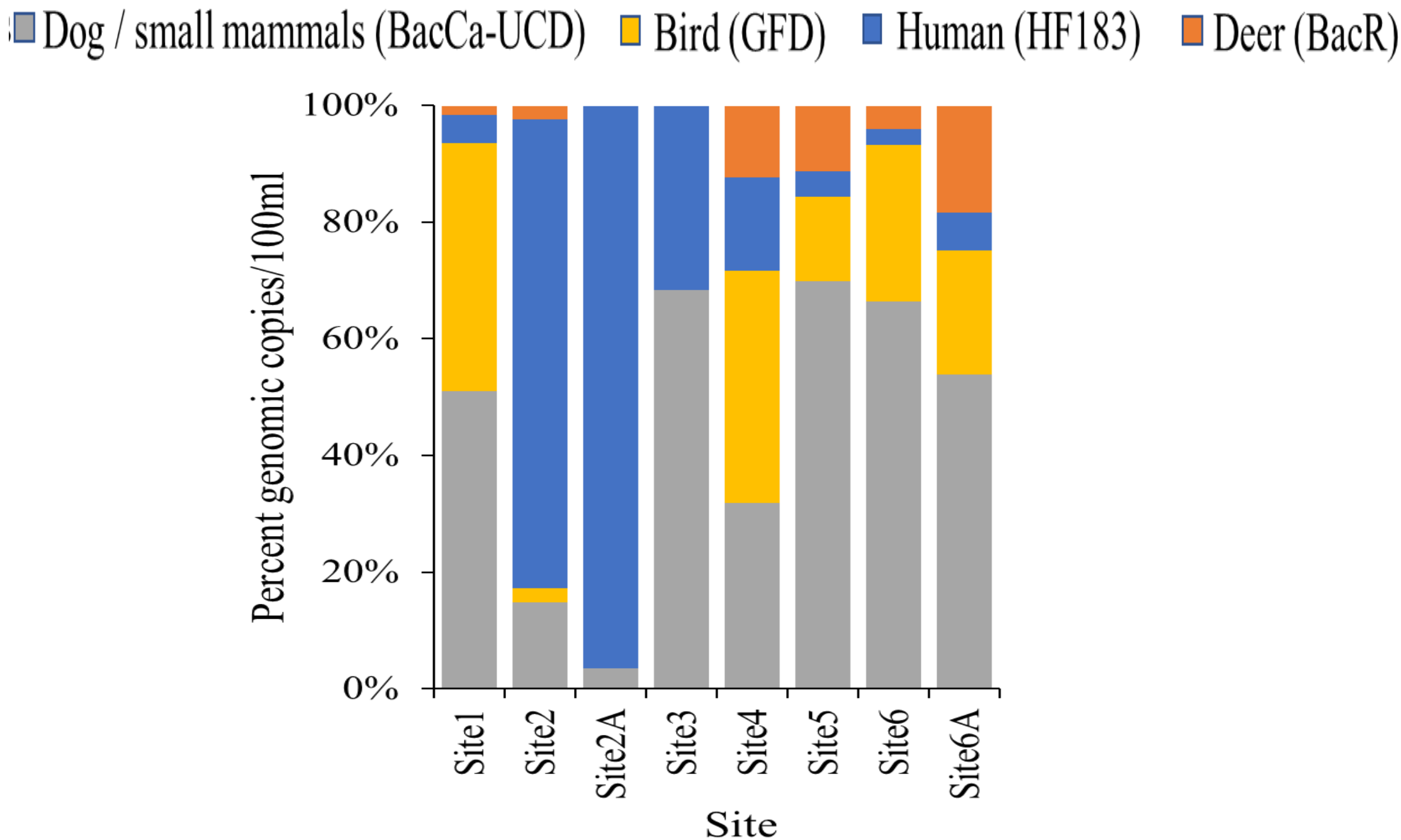
Average *Enterococcus* levels detected via digital PCR



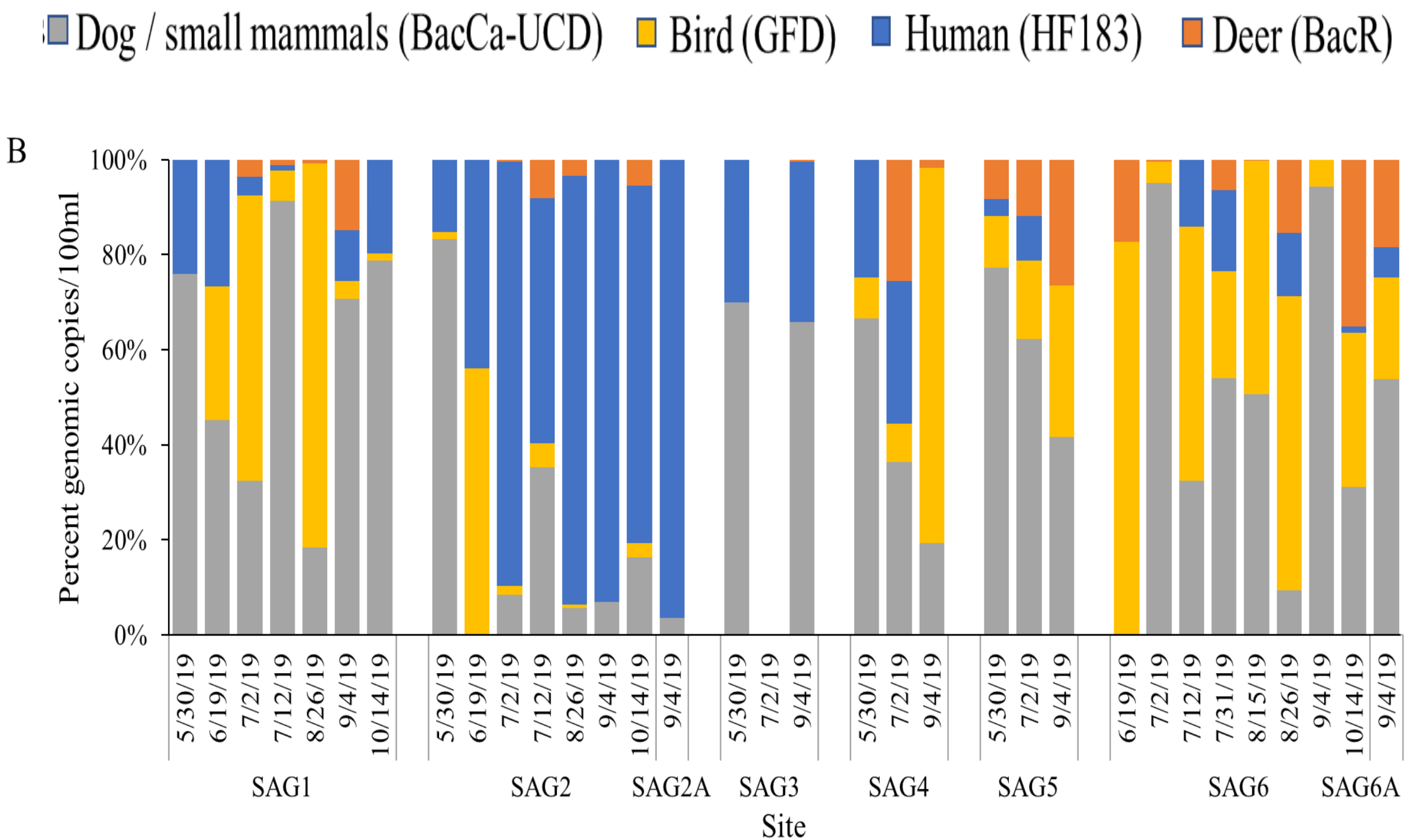
Abundance of fecal bacteria from four sources, digital PCR



Percentages of fecal bacteria from four sources, digital PCR



Percentages of fecal bacteria from four sources, digital PCR



What are the optimal managerial options to improve water quality in Sag Harbor?

Steps to improve water quality

- Nitrogen was the main source of nutrients promoting algal growth and, in turn, rust tides, low water clarity, and low oxygen.
- Wastewater from on-site septic systems was the primary source of nitrogen in Sag Harbor and Sag Harbor Cove.
- Upgrading septic systems and/or connecting homes to the sewage treatment plant will reduced the incidence of rust tide, algal blooms, and hypoxia while improving water clarity.
- A cost and feasibility study should be performed to identify regions ideal for sewering vs regions where advanced on-site systems would be optimal.

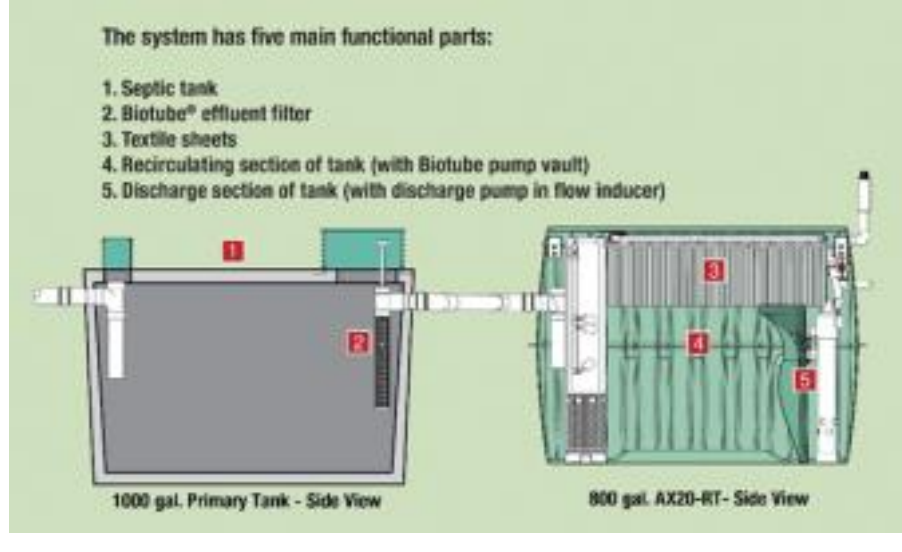
PROVISIONALLY APPROVED LOW N SEPTIC SYSTEMS

Hydro-Action

Fuji Clean System

Norweco Singlair TNT

Norweco Hydrokinetic



Orenco Advantex AX-RT

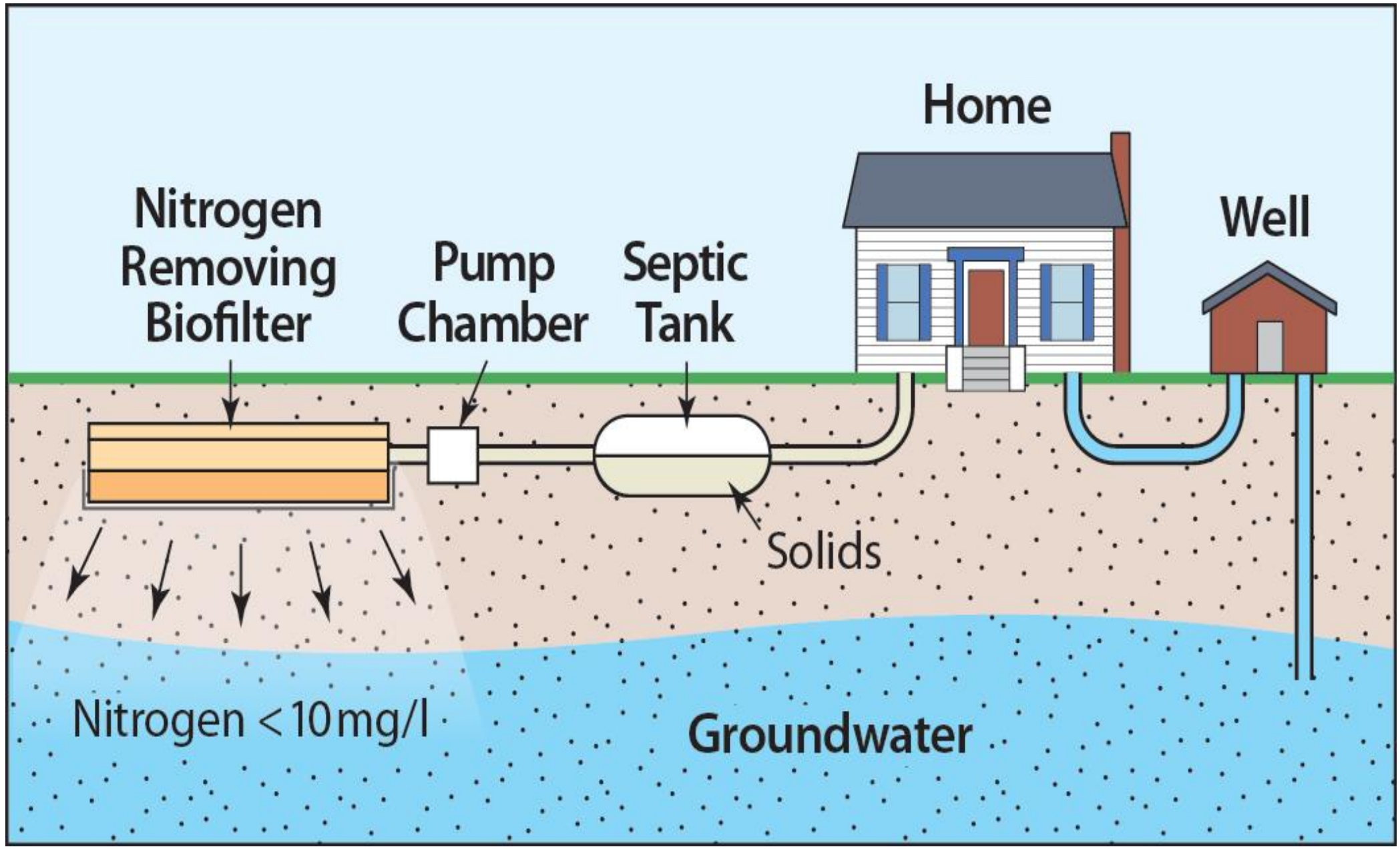
Stony Brook University

New York State Center for Clean Water Technology

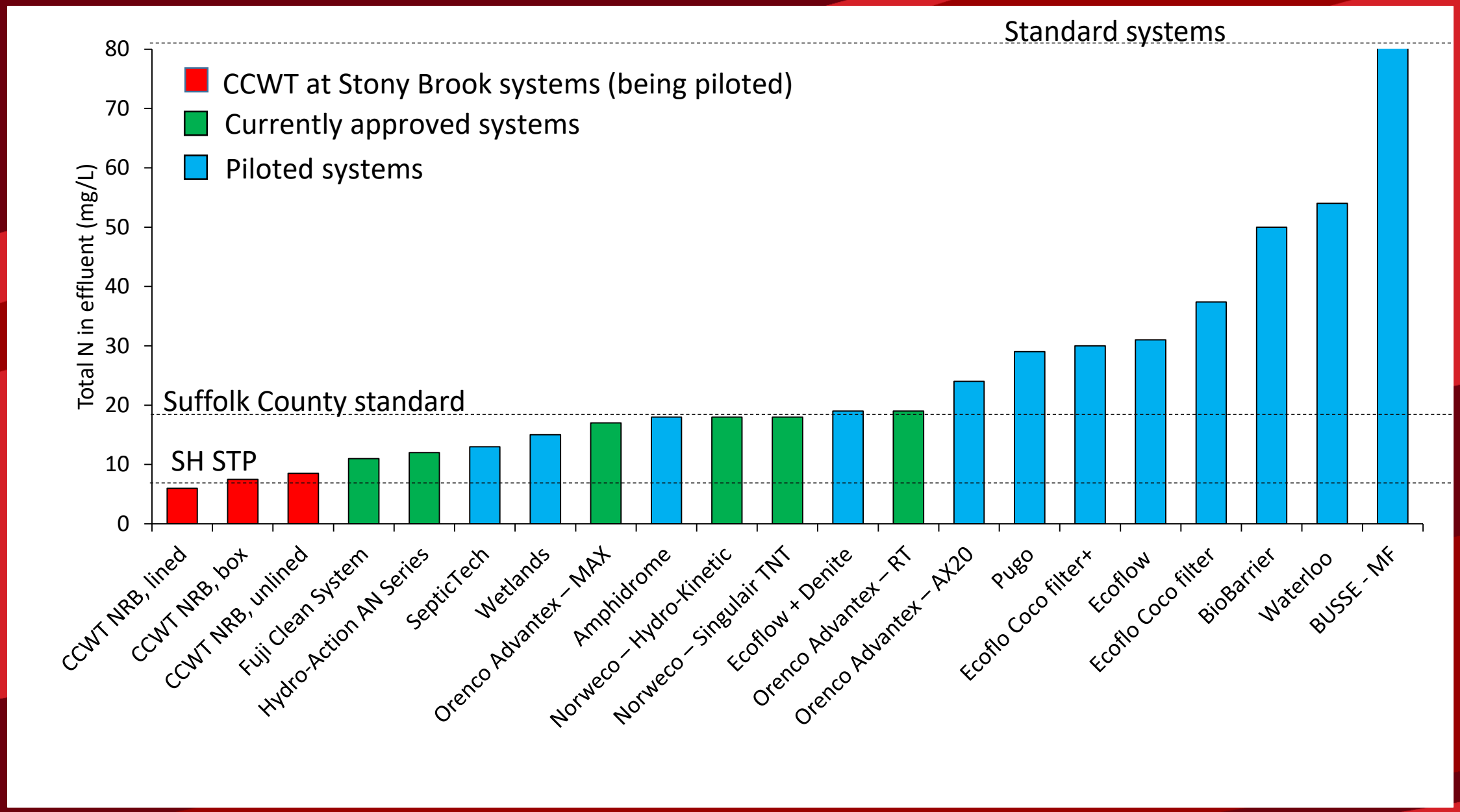
Director, Dr. Chris Gobler

FAR BEYOND

Nitrogen Removing Biofilters (NRB)



Comparison of I/A performance in Suffolk County



Addressing fecal bacteria contamination

- Mitigating surface run-off from land to sea at Haven's Beach to reduce levels of fecal bacteria should be a **priority**; this region is open for **shellfishing and swimming**.

- Otter Pond also requires run-off mitigation, but is likely a lower priority.

- Further study is needed to affirm the source of fecal contamination in the inner Harbor.

- Assuring optimal functioning of the sewage treatment plant and eliminating vessel wastewater discharge would both minimize human fecal contamination.

Conclusions:

- Water quality conditions in Sag Harbor were, on average, good.
- Multiple water quality impairments were observed; Nitrogen, low oxygen, reduced water clarity, algal blooms, rust tides, and pathogenic bacteria were all detected at levels exceeding state and federal guidance values.
- Nitrogen was the nutrient promoting algal growth and, in turn, rust tides, low water clarity, and low oxygen.
- Wastewater from on-site septic systems was the primary source of nitrogen in Sag Harbor and Sag Harbor Cove.
- Human waste was the primary source of fecal bacteria to the inner Harbor, whereas dogs, small mammals, and birds contributed to fecal bacteria near Haven's Beach and Otter Pond.

Conclusions continued…

- Upgrading septic systems and/or connecting homes to the sewage treatment plant will reduced the incidence of rust tide, algal blooms, and hypoxia while improving water clarity.

- Mitigating surface from land to sea at Haven's Beach to reduce levels of fecal bacteria should be a priority; this region is open for shellfishing and swimming.

- Further study is needed to affirm the source of fecal contamination in the inner harbor.

- Assuring optimal functioning of the sewage treatment plant and eliminating vessel wastewater discharge would both minimize human fecal contamination.

Acknowledgements

- Thank you to:
  - **Mary Ann Eddy** for her tireless efforts in organizing and supporting this (*complex*) study.
  - The Sag Harbor Water Quality Committee for their support and patience.
  - All other supporters of the project: East Hampton Town Trustees, Southampton Town Trustees, Southampton Town, Sag Harbor Village, individual donors.
  - Students and scientists from the Gobler Lab including Jen Goleski, Jenn Jankowiak, Craig Young, Ryan Wallace, Craig Schenone, Peter Sylvers, Stephen Tomasetti, Tim Curtin, Mark Lusty, Ann Marie Fallio, Sarah Milinski, Andrew Vernon, and many more…