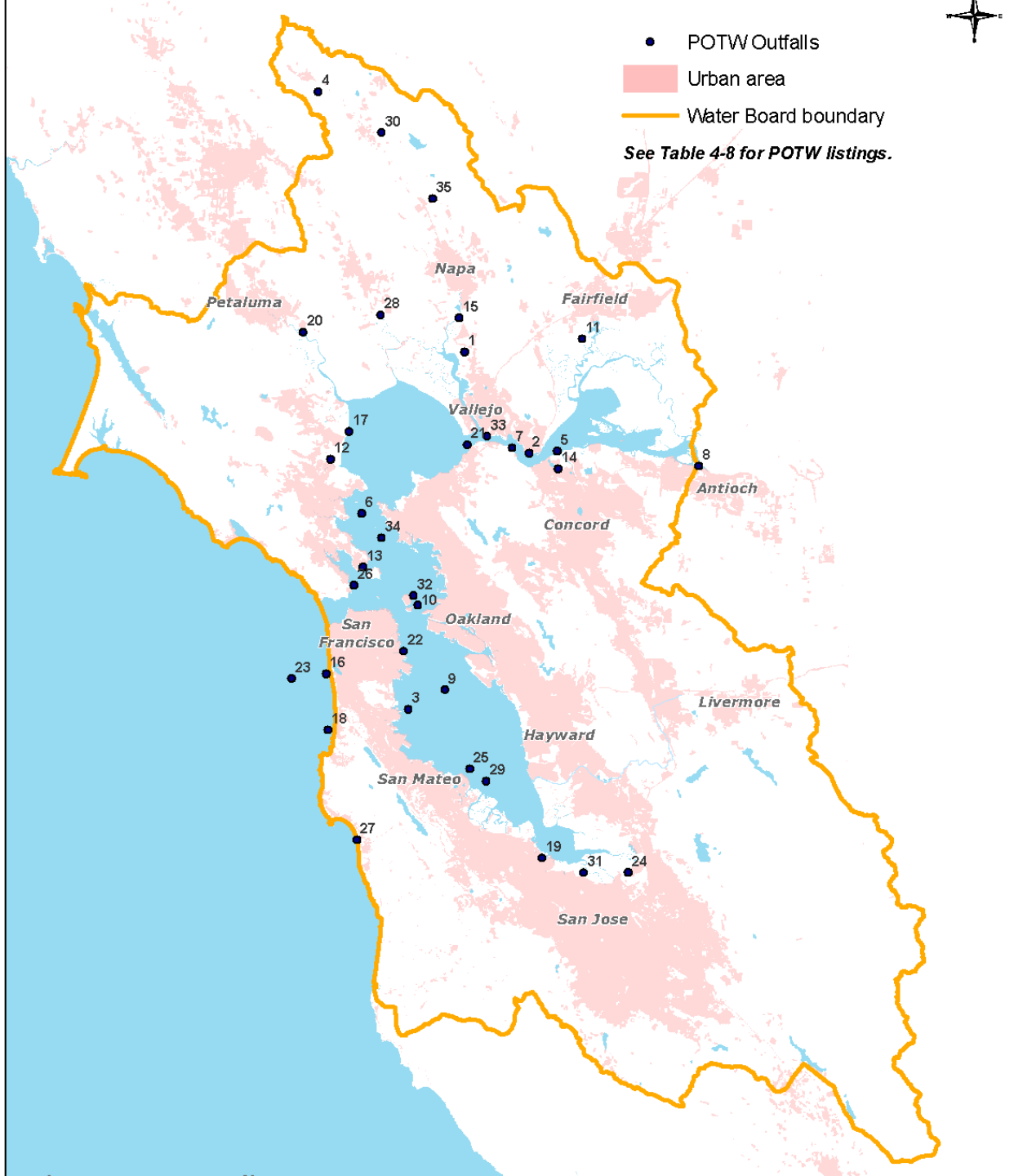
San Francisco Bay Regional Water Quality Control Board

San Francisco Bay Nutrients Watershed Permit

October 2, 2024

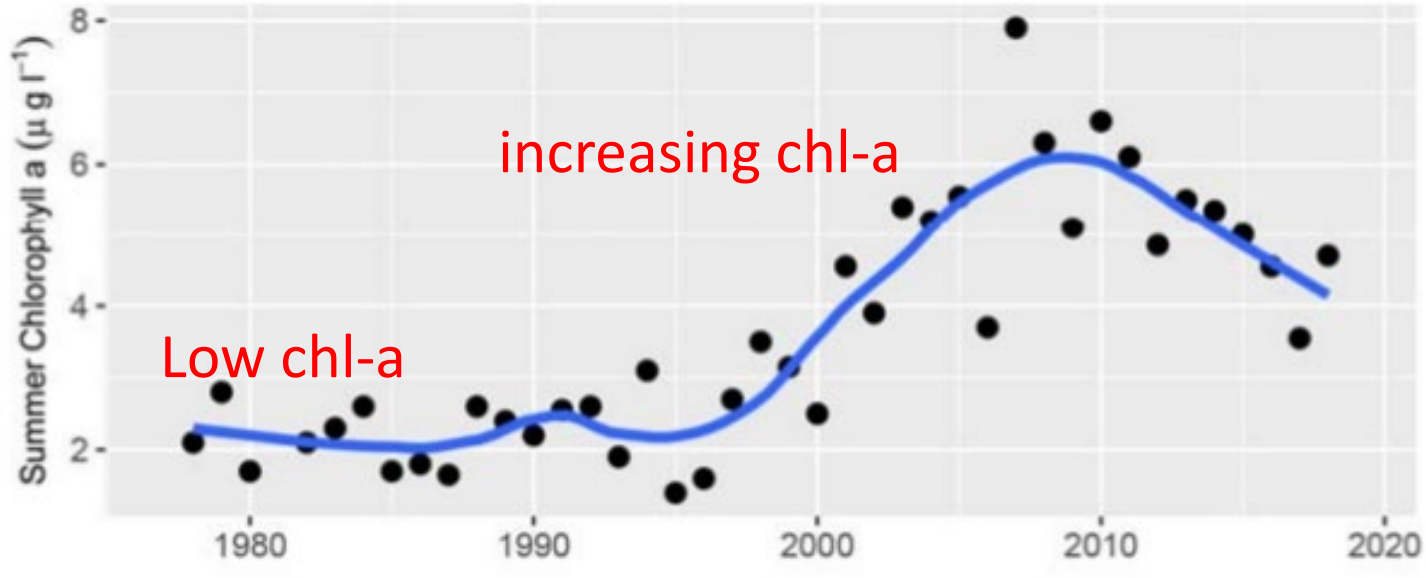
Dry Season – Sources of Total Inorganic Nitrogen

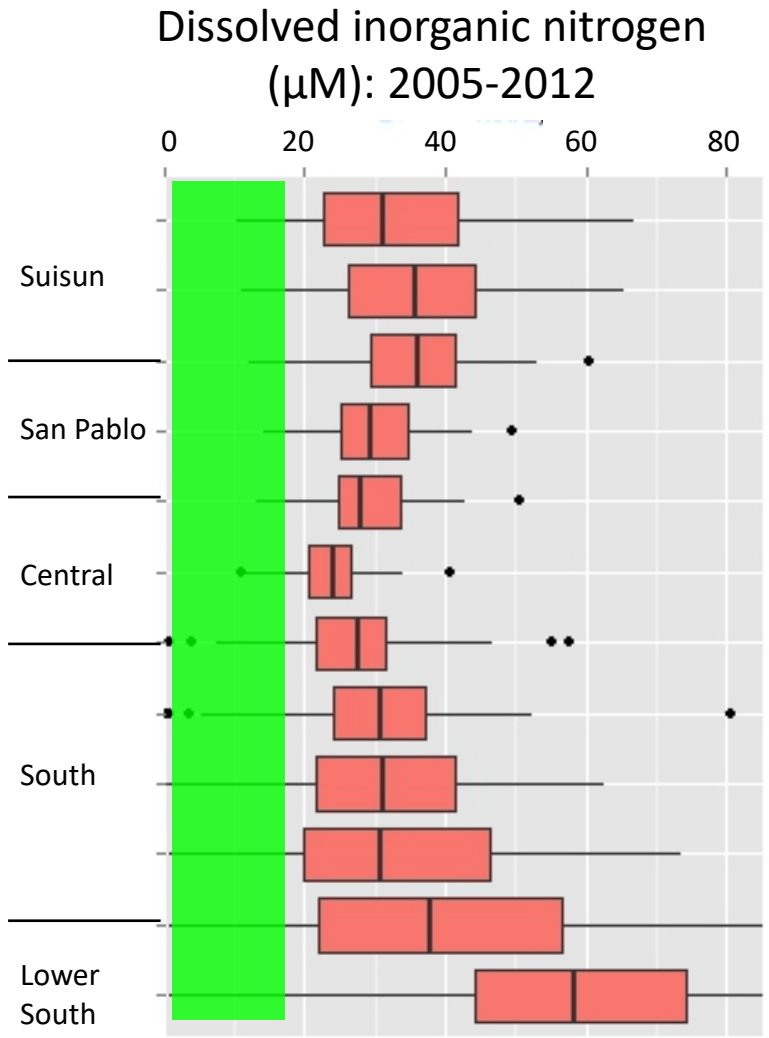
- POTWs discharge about 86 percent
- Delta contributes about 12 percent
- Refineries discharge about 2 percent



San Francisco Bay – trophic status overview

1. High Suspended Sediment
2. Strong Tidal Mixing
3. Filter-feeding clams

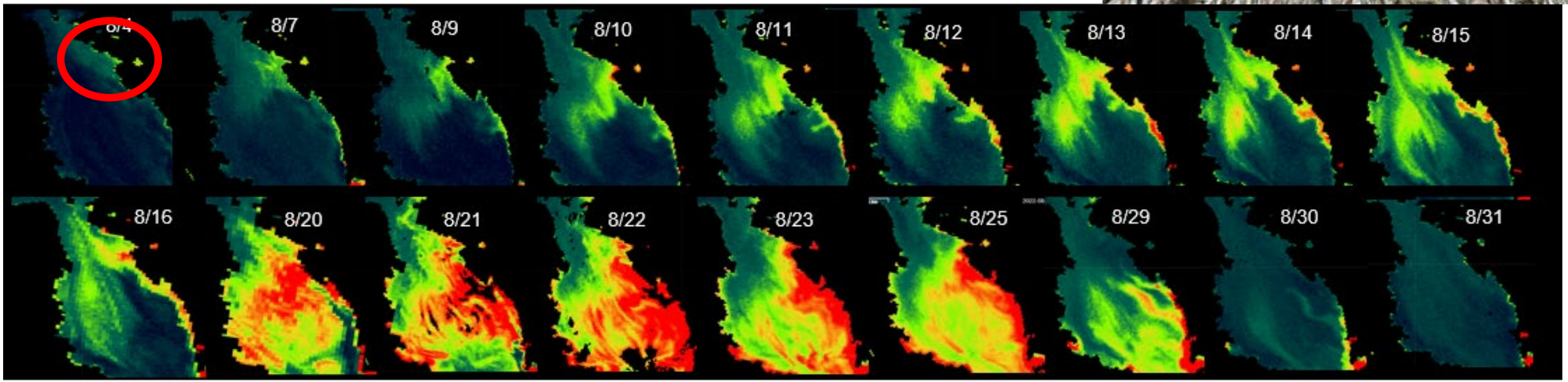




Severe Harmful Algae Bloom (2022)

- Photo by Damon Tighe

Sentinel-3; using UWQV, Zlinszky and Padanyi-Gulyas



Developing Effluent Limits for narrative objective

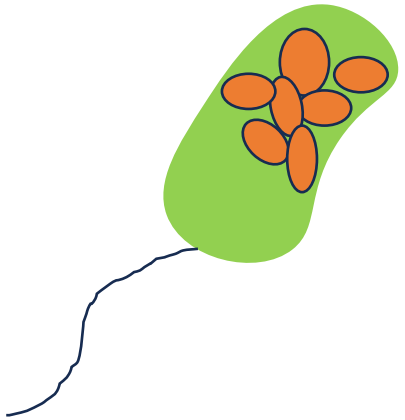
- Reasonable potential
- Numeric effluent limits required
- Calculated criterion for dissolved oxygen and supplemental information used to interpret narrative objective

Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.

Meet the Cast

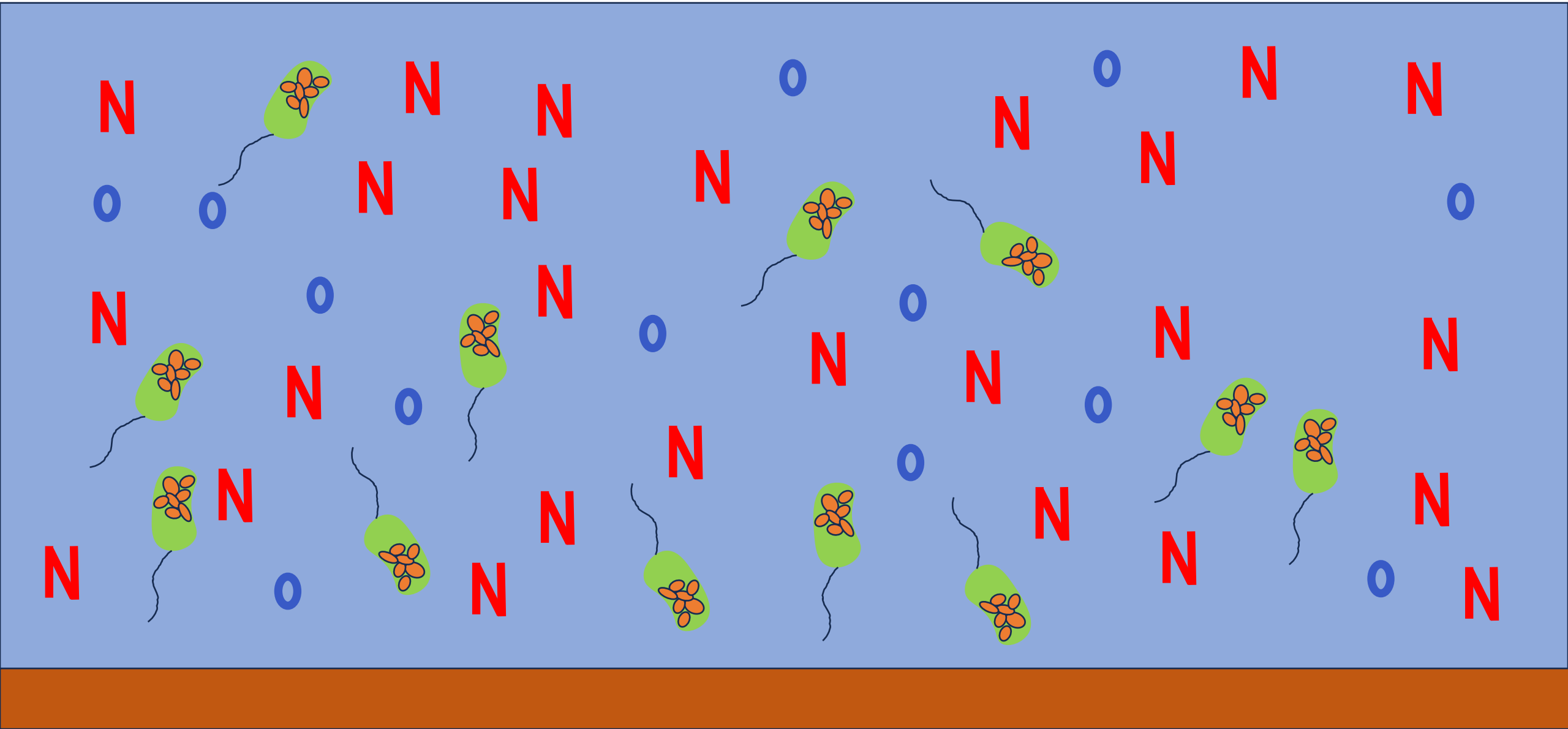
N Nitrogen: the “fuel” for the 2022 algae bloom

O Oxygen: critical for aquatic life, was reduced at end of bloom

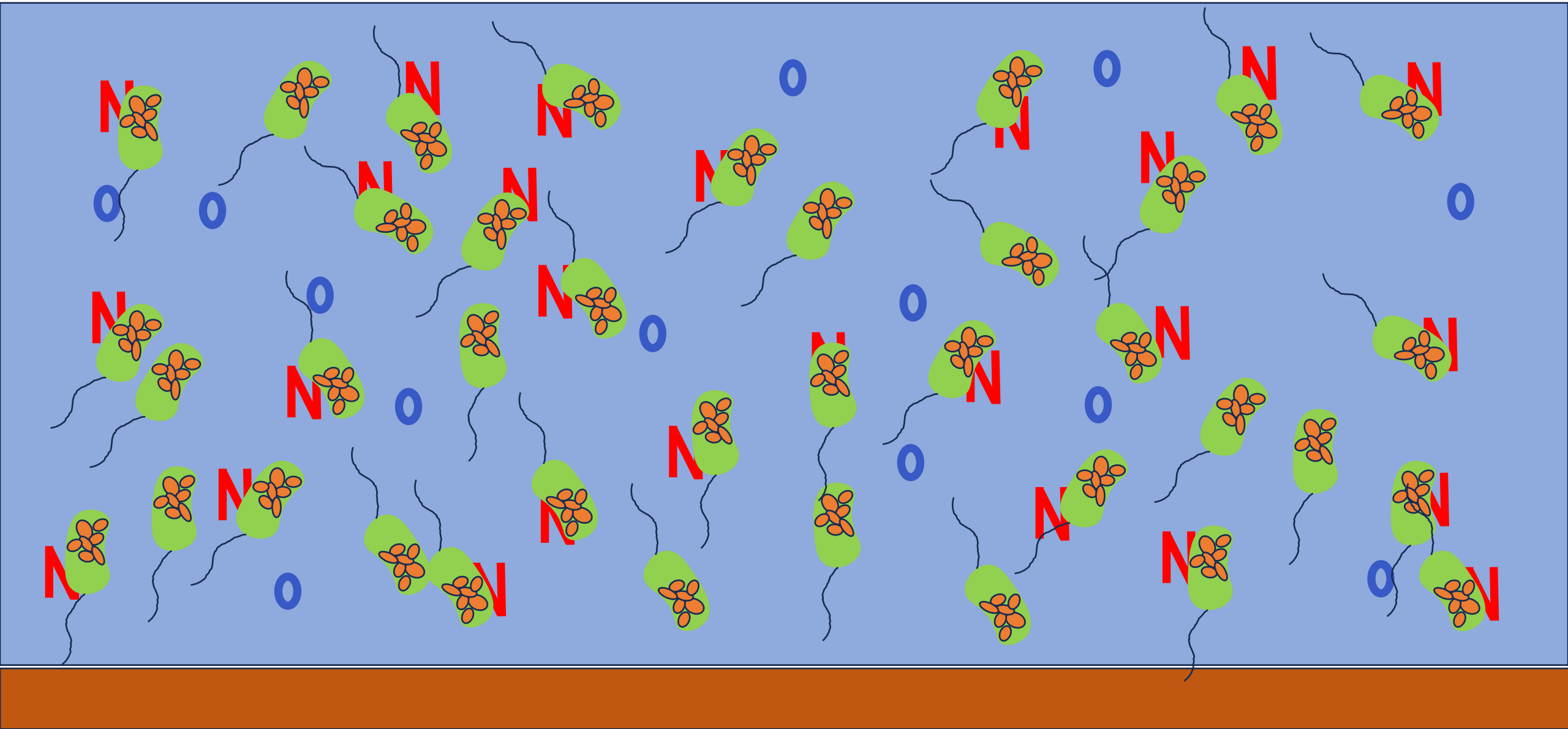


Heterosigma Akashiwo: the harmful algal species involved in the 2022 bloom

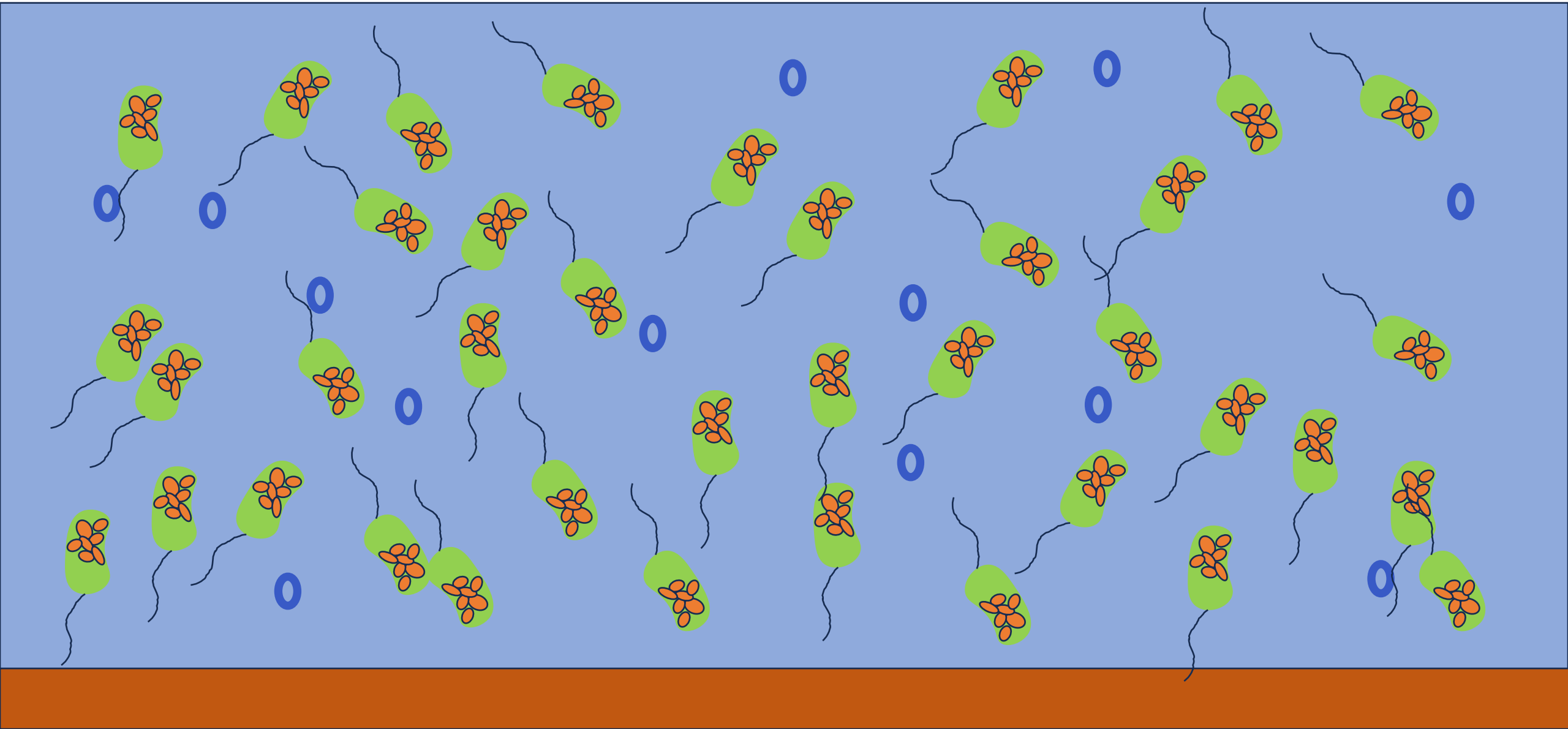
2022 bloom: algae and plentiful nitrogen available



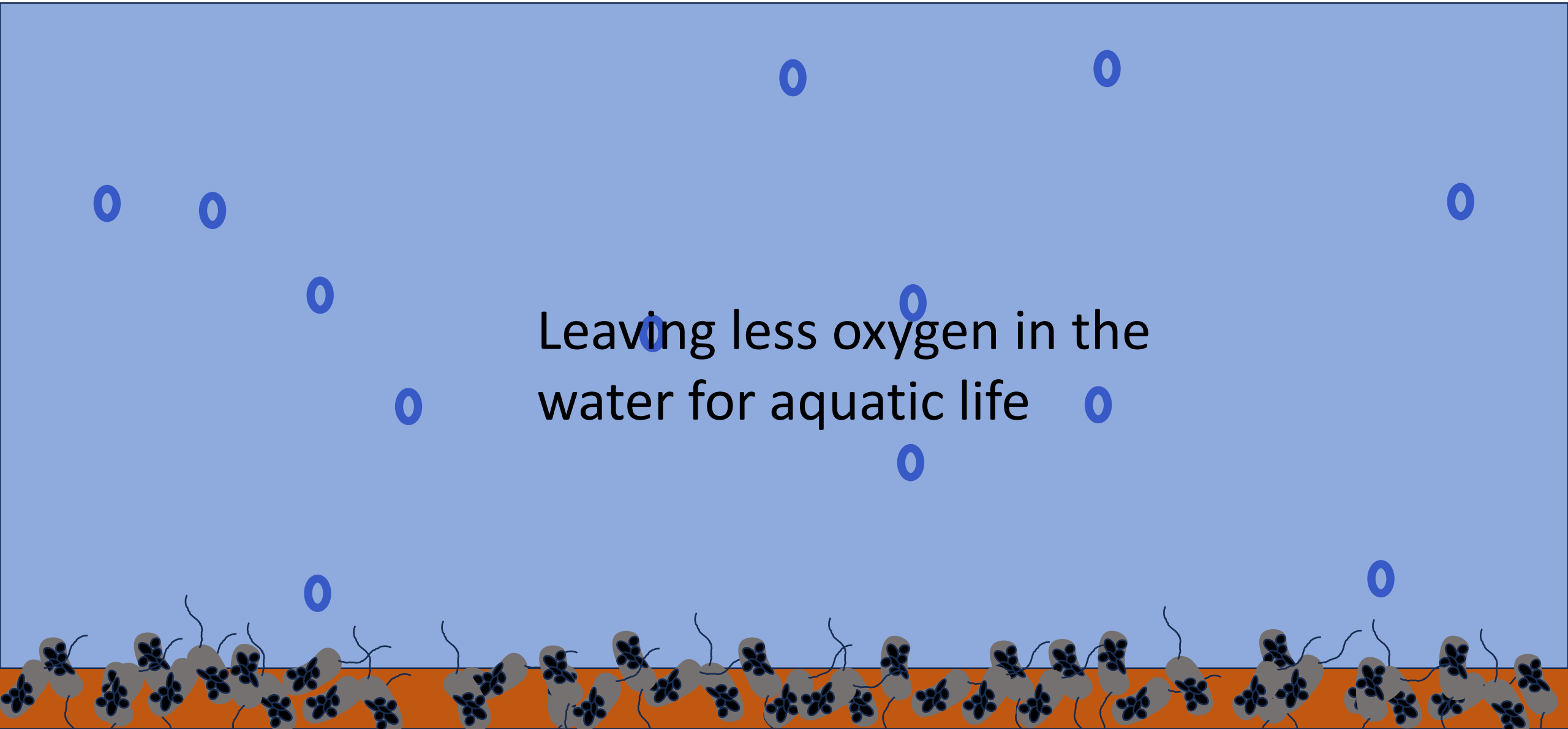
2022 bloom: algae use all nitrogen and multiply



2022 bloom: …..and then algae finally die

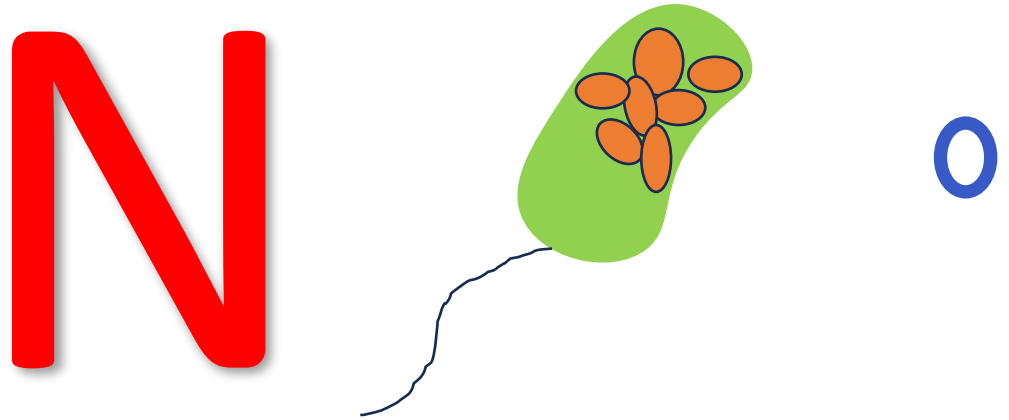


2022 bloom: oxygen consumed during digestion

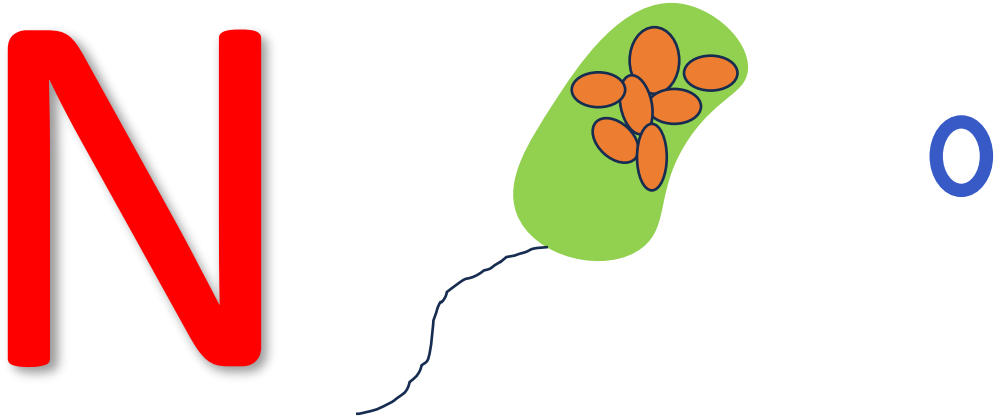


Lower loads → less algae → more oxygen

Current loads fuel large algae growth, and lead to low oxygen when algae die



Reduced nitrogen loads will limit algae growth and increase oxygen concentrations



4 mg/L DO from U.S. EPA calculation methodology

Striped Bass

Sturgeon

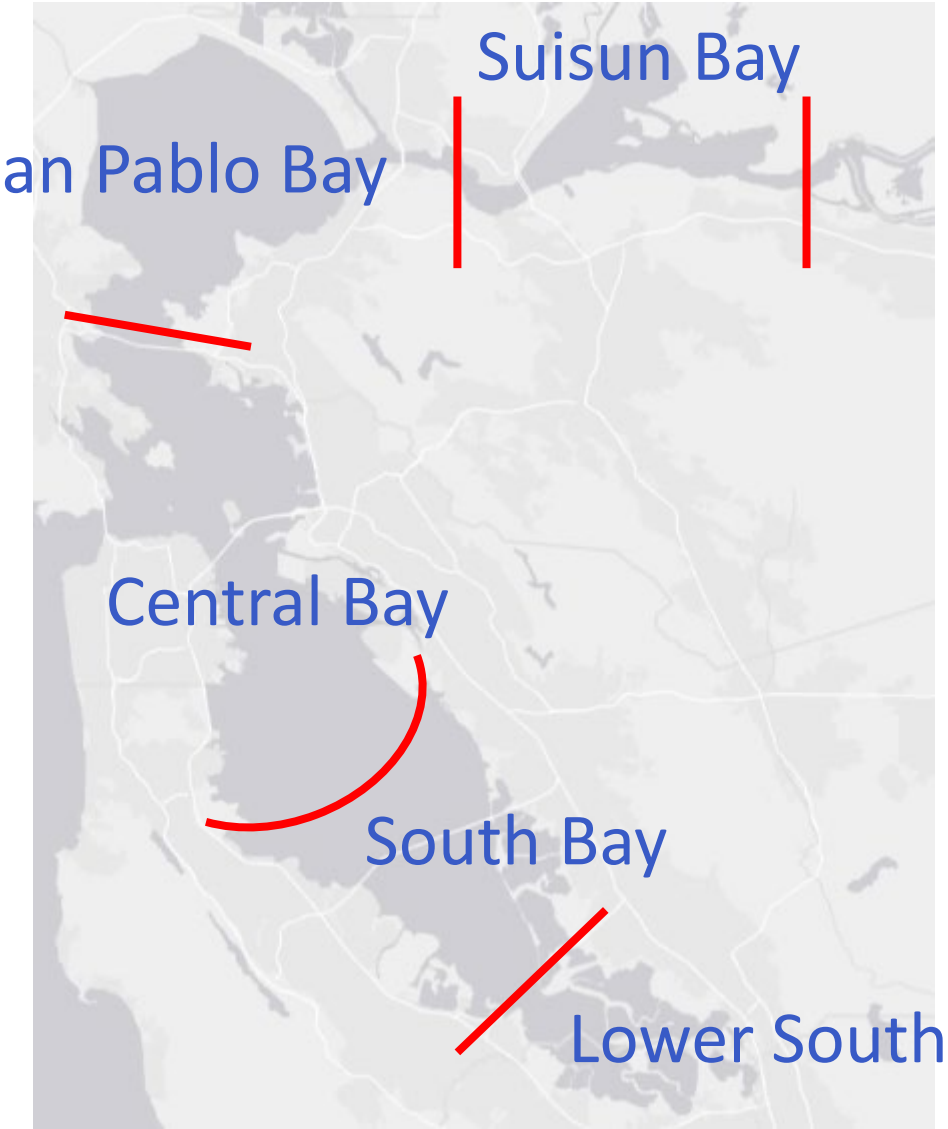
Calculated acute endpoint is less than 4 mg/L

American Shad

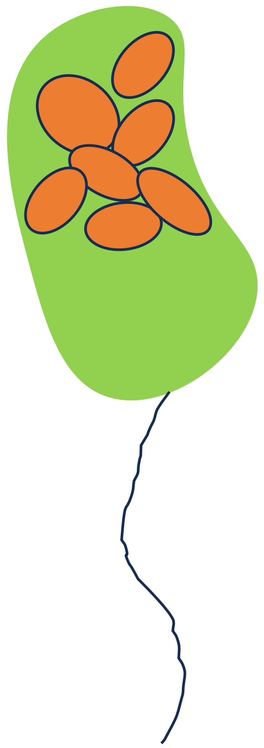
Mississippi Silversides

90% of every part of the Bay must be > 4 mg/L

- U.S. EPA says uses protected even if objectives not met all the time
- U.S. EPA guidance suggests a 10% exceedance frequency for oxygen
- We apply to each part of the Bay



We know chemical composition of algae



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106
carbons

N N N N N N N N N N N N N N N N

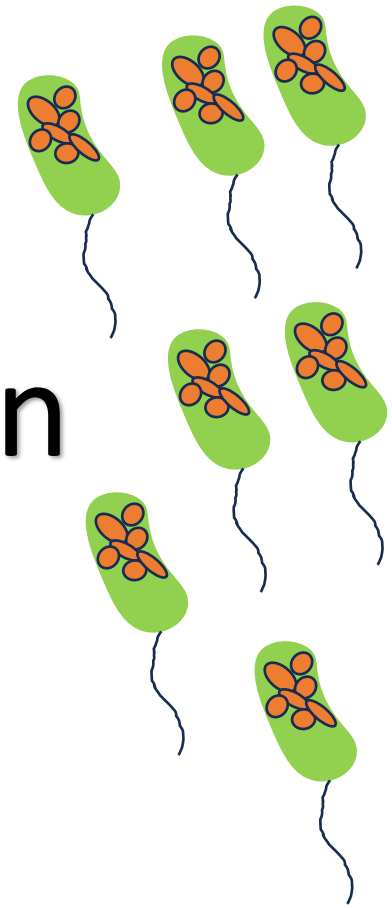
16
nitrogens

P

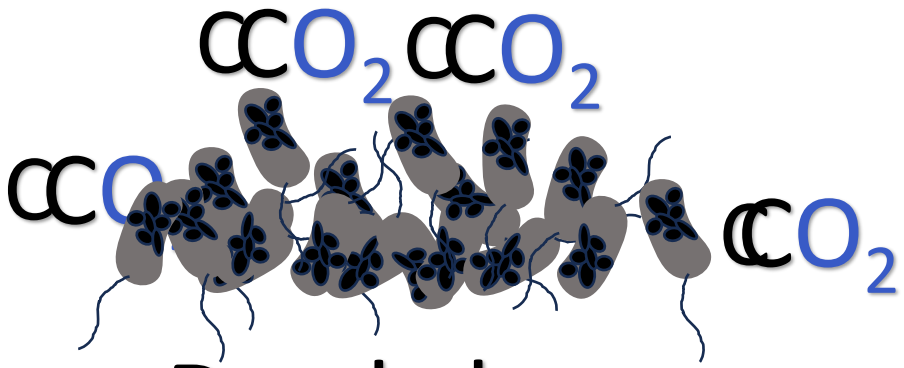
1
phosphorus

Note the 106:16 ratio or
6.6 **carbons** per nitrogen

Nitrogen in the water x 6.6 C:N = carbon in algae



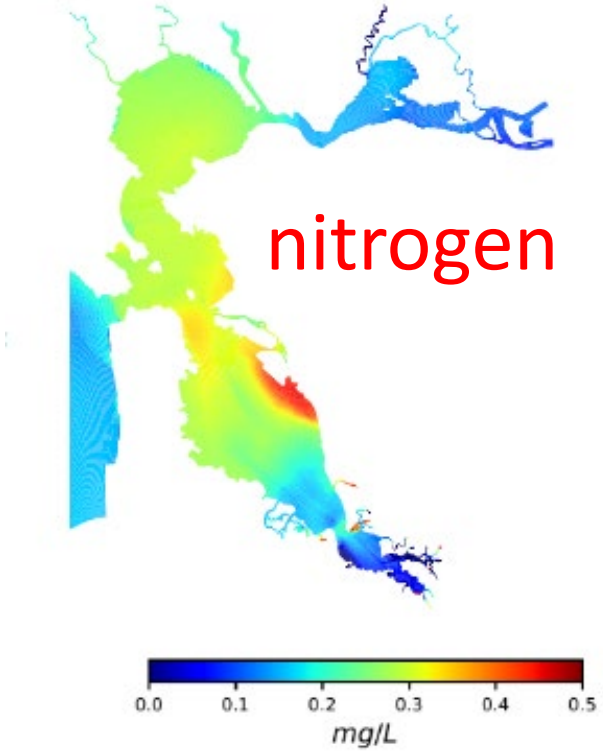
O_2 O_2 O_2 O_2

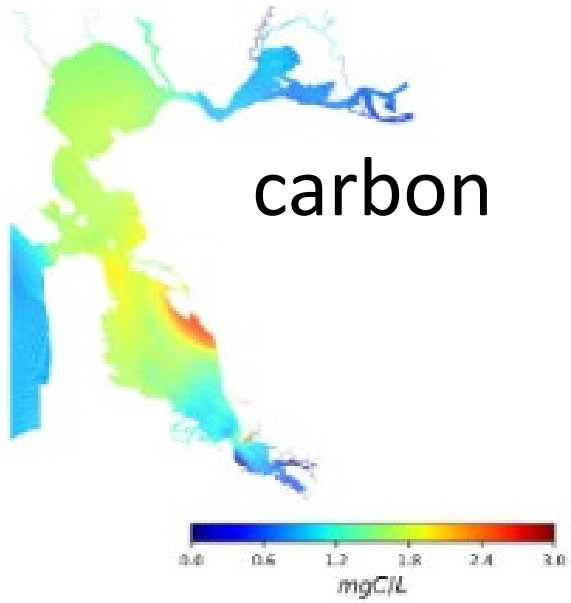


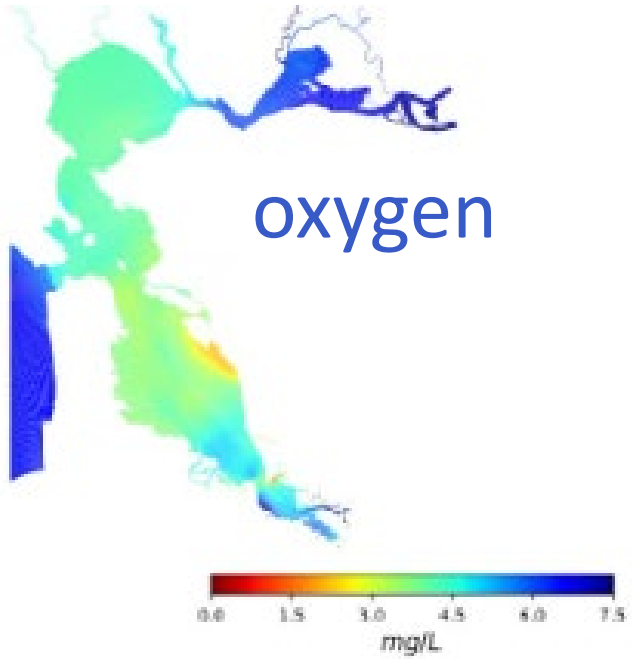
Dead algae

Oxygen debt: during digestion 1 molecule of O_2 is required to produce CO_2 for every carbon in dead algae.

Modeled nitrogen ….to phytoplankton…. to oxygen





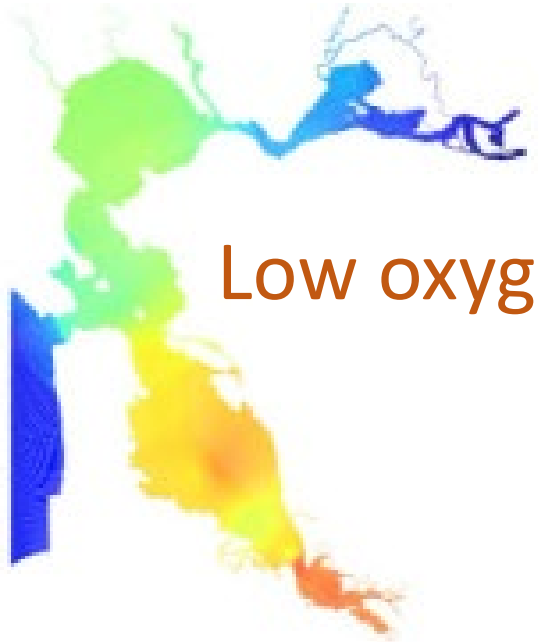


computed dissolved inorganic nitrogen throughout Bay

x 6.6 to get carbon contained in phytoplankton

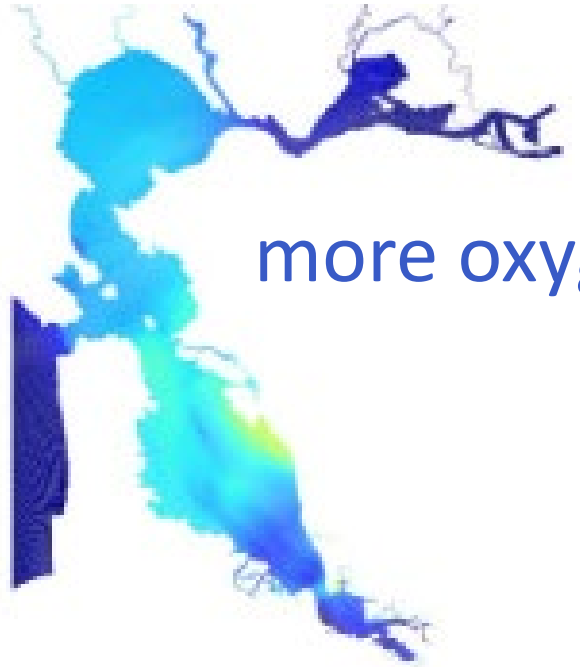
Subtracted the digestion “oxygen debt” from starting oxygen

Reduced nitrogen loads → more oxygen left in water



Low oxygen

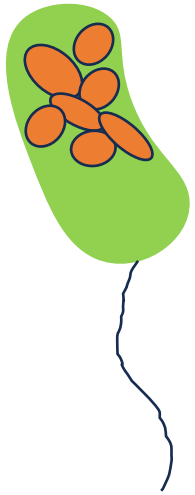
better oxygen



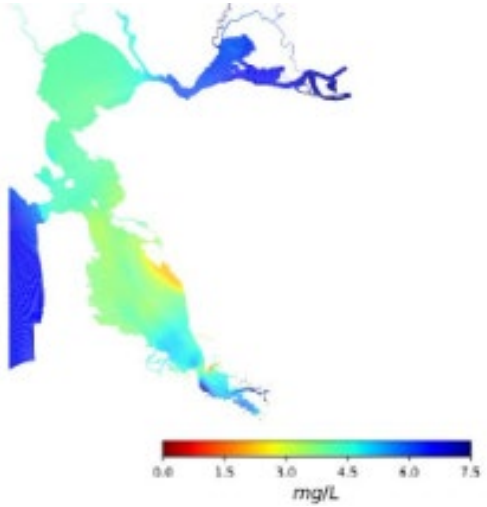
more oxygen

40% Reduction is Enough to Achieve Objective

40% municipal wastewater load reduction



will reduce **nitrogen** available for algae growth during a bloom so that….



even if all **nitrogen** is used by algae, **oxygen** remains > 4 mg/L in 90% of all parts of the Bay