SWAMP: Monitoring Spring Phytoplankton Bloom Progression in Suisun Bay

Romberg Tiburon Center Group

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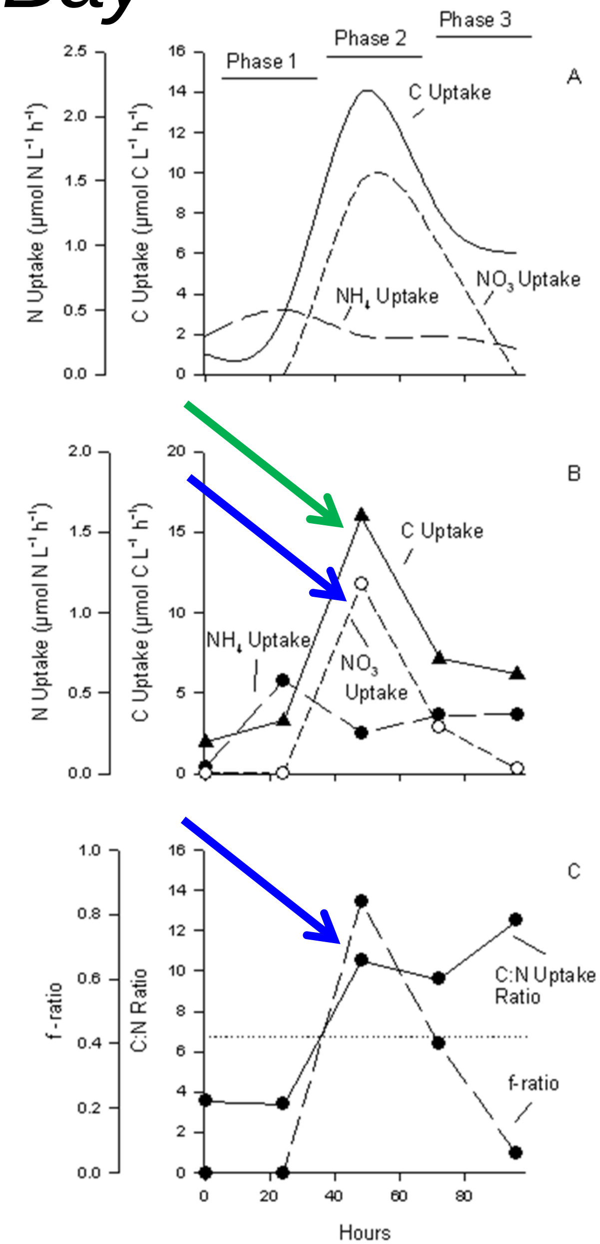
SAG: March 8, 2013

Conceptual model of bloom progression in Suisun Bay



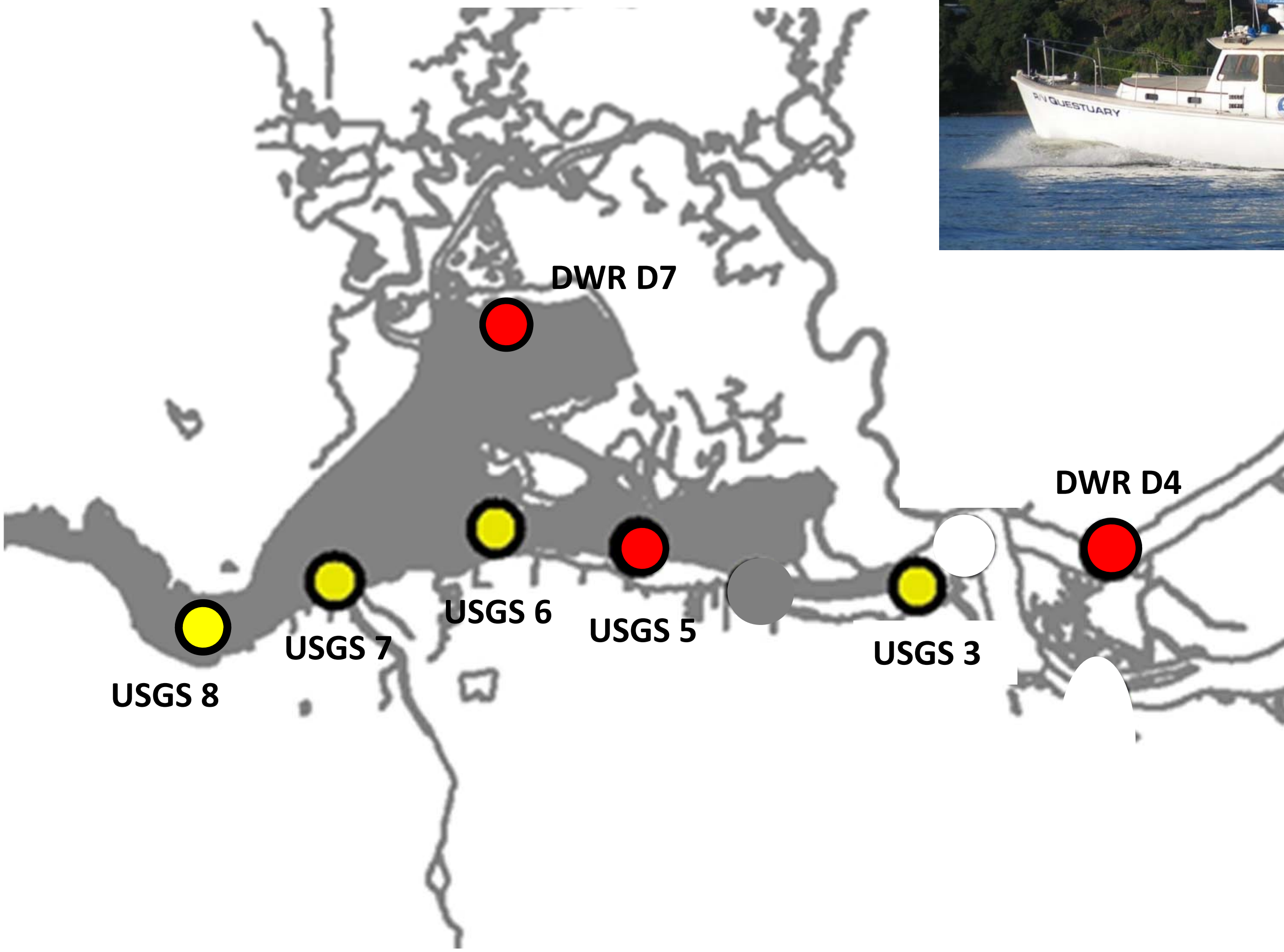
A) Idealized sequence of carbon, NH_4 and NO_3 uptake in enclosure experiments

B) Data from central Bay enclosures: C uptake tracks NO3 uptake

C) Data of C:N uptake ratios and f-ratio

from Parker et al. 2012 ECSS

Study Site



Sampling Design

Sampling weekly in 2010, 2011, 2012 (March – June).

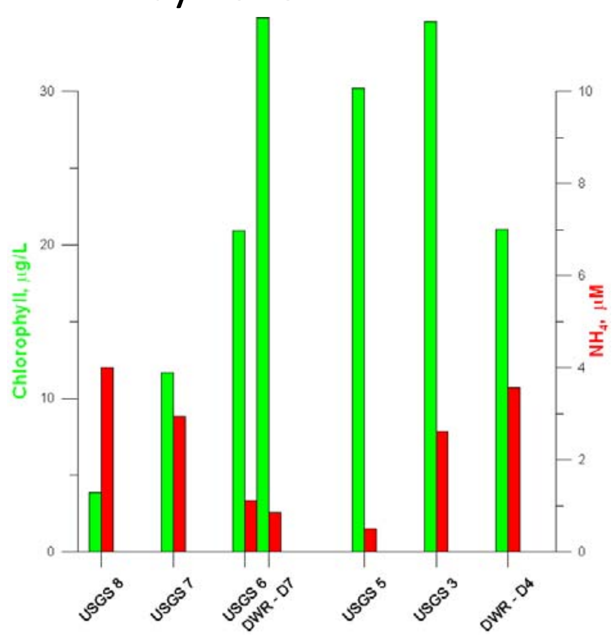
~10 Stations visited Lower Sacramento R. through Suisun Bay. Sampled on outgoing tides.

- Inorganic nutrients
- Chlorophyll-a
- Phytoplankton carbon and nitrogen uptake (incubated at near-surface PAR irradiance).
- CTD - vertical profiles of temperature, salinity (conductivity), turbidity, and PAR

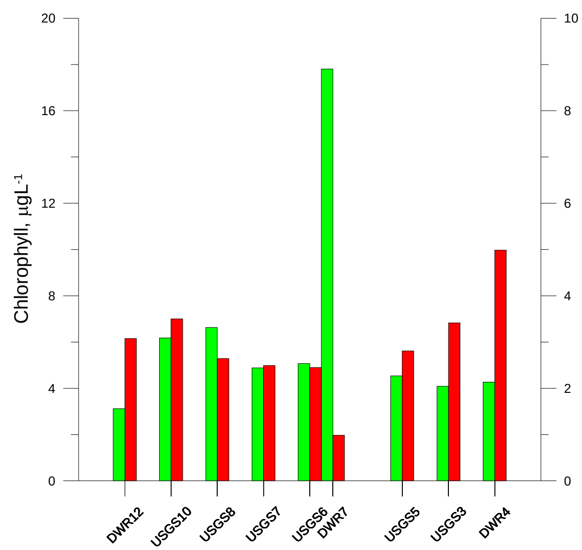
Peak chlorophyll levels observed each spring

- 2010: two blooms with chl > 30 µg L^{-1}
- 2011: highest chl 18 µg L^{-1}
- 2012: highest chl 58 µg L^{-1}
- Highest chlorophyll at very low NH_4

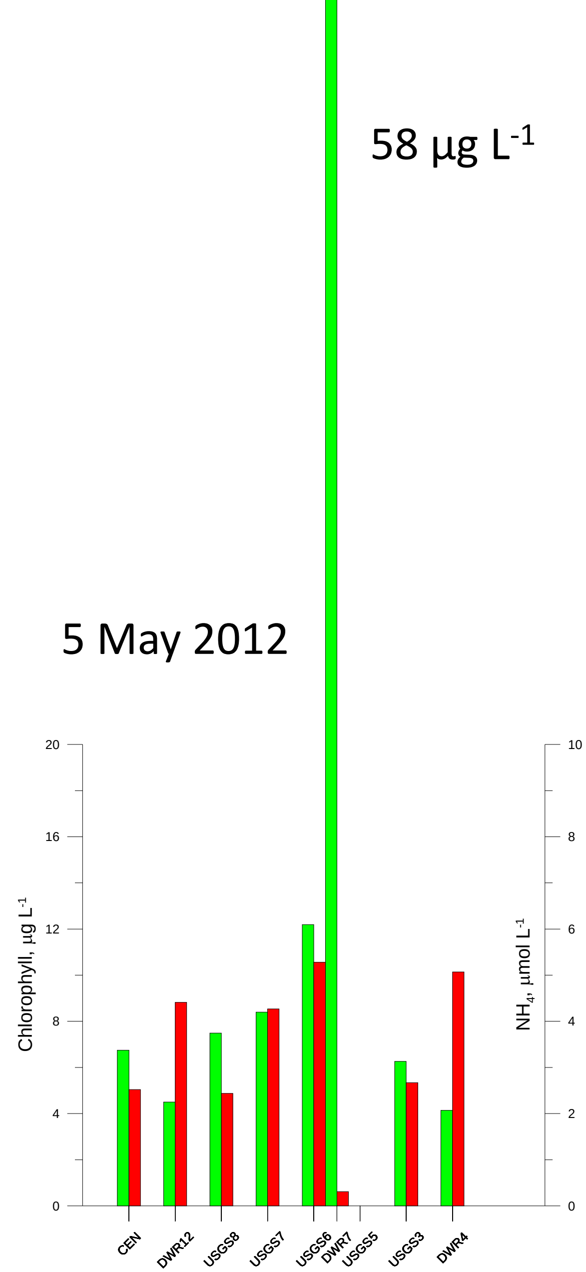
24 May 2010



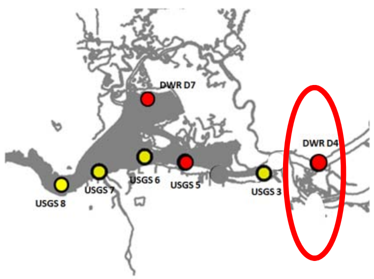
17 May 2011

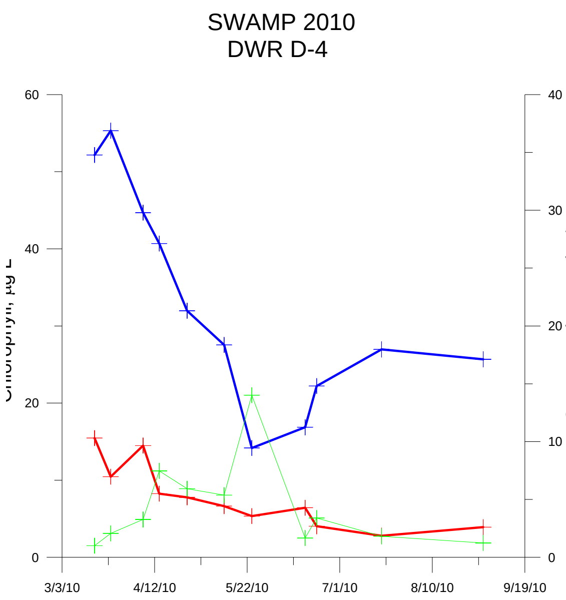


5 May 2012

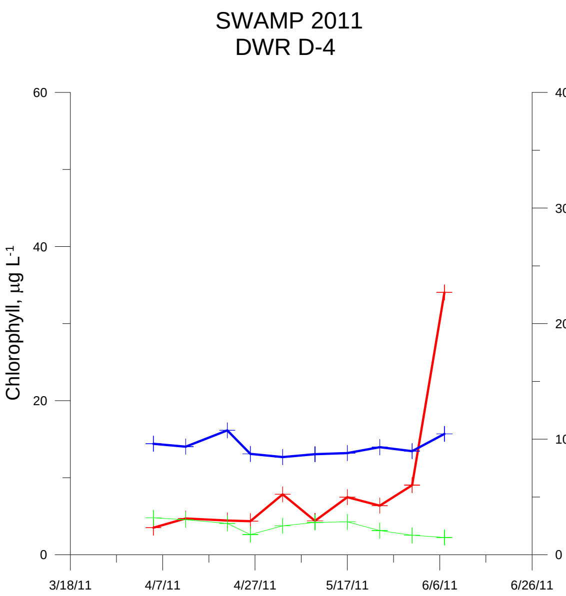


Time series of nutrients (NO$_3$, NH$_4$) and chlorophyll (chl) at DWR D4, by years

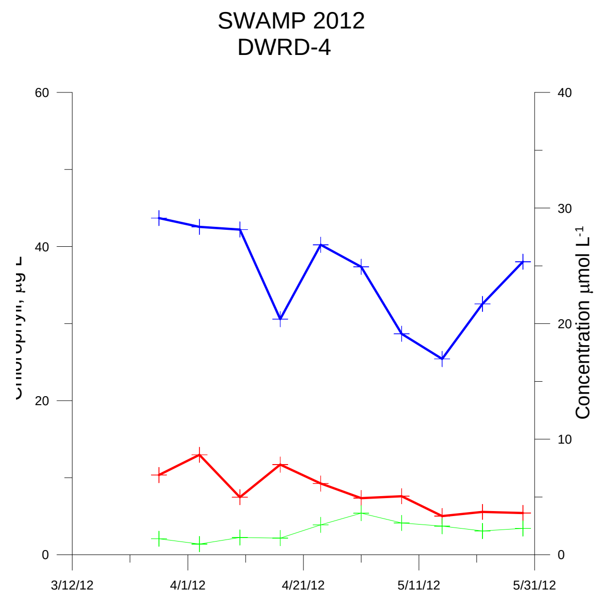




2010

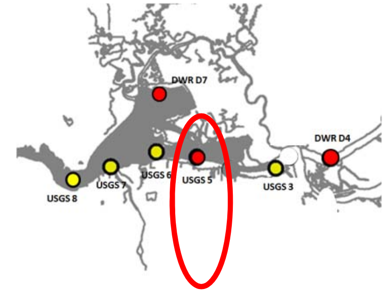


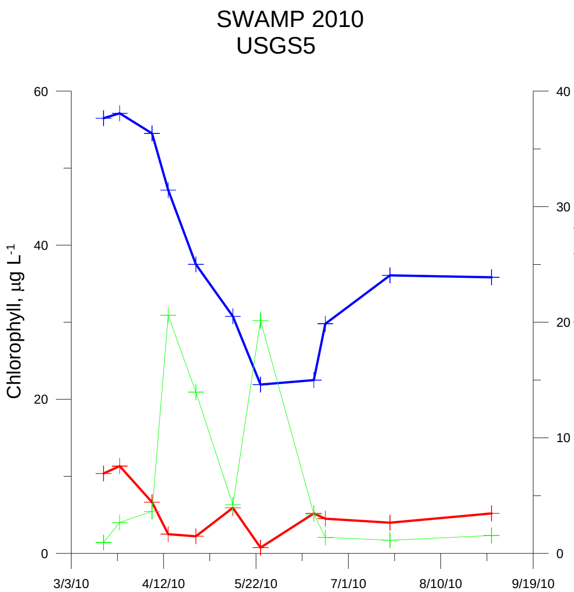
2011

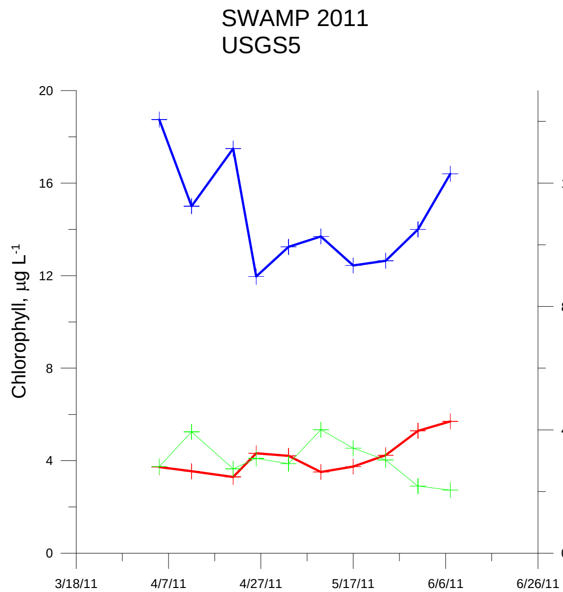


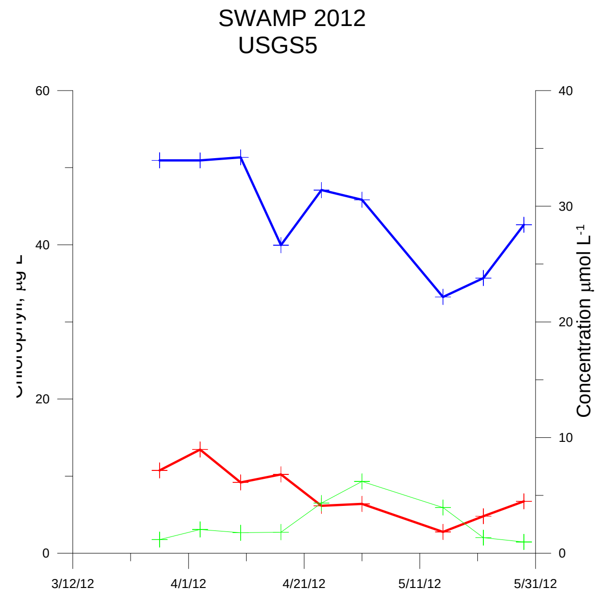
2012

Time series of nutrients (NO_3, NH_4) and chlorophyll (chl) at USGS 5, by years

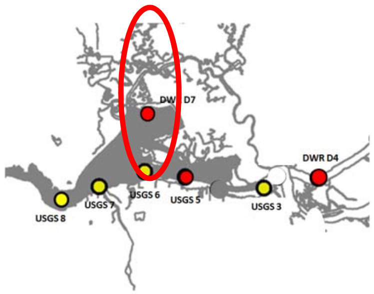


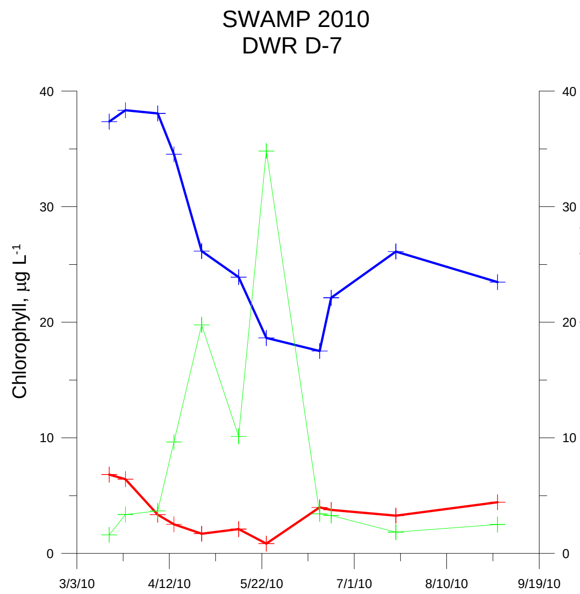


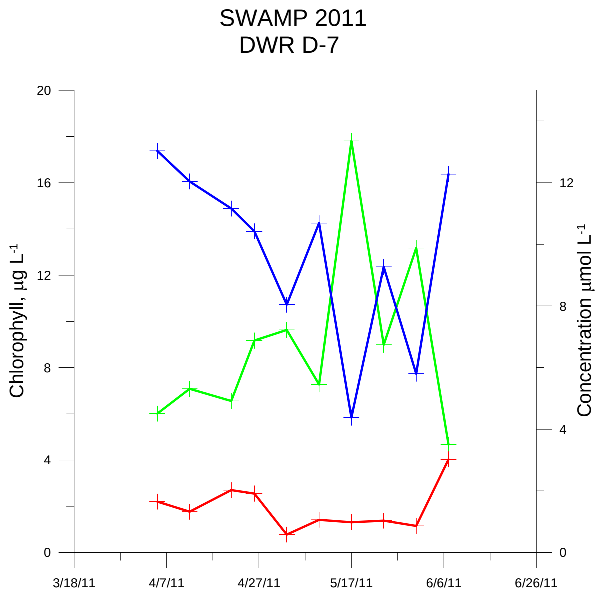


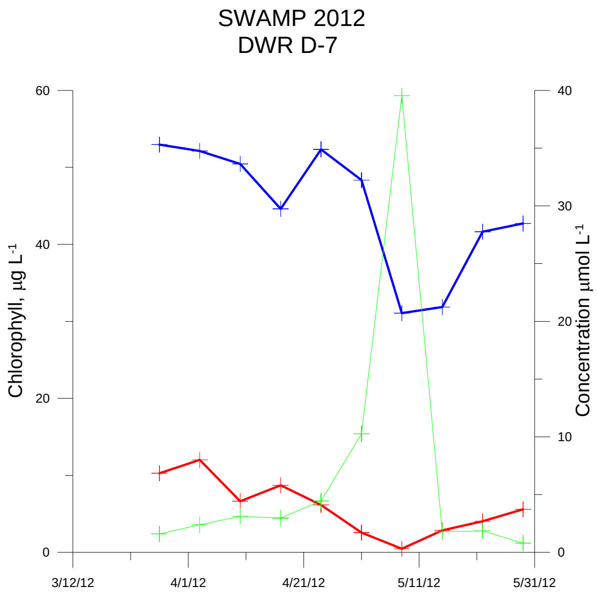


Time series of nutrients (NO$_3$, NH$_4$) and chlorophyll (chl) at DWR D7, by years (Shoal Station)









Comparison of 2010, 2011, 2012 blooms

Station	2010	2011	2012	2010	2011	2012
	Chlorophyll accumulation			*Nitrate drawdown*		
DWR D4	bloom	none	none	yes	no	no
USGS 5	bloom	slight	slight	yes	no	slight
DWR D7	bloom	bloom	bloom	yes	yes	yes

Manuscript describing the 2010 bloom progressions in Suisun Bay

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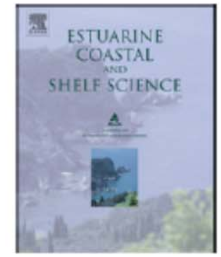

River flow and ammonium discharge determine spring phytoplankton blooms in an urbanized estuary

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A B S T R A C T

Nutrient loadings to urbanized estuaries have increased over the past decades in response to population growth and upgrading to secondary sewage treatment. Evidence from the San Francisco Estuary (SFE) indicates that increased ammonium (NH_4) loads have resulted in reduced primary production, a counter-intuitive finding; the NH_4 paradox. Phytoplankton uptake of nitrate (NO_3), the largest pool of dissolved inorganic nitrogen, is necessary for blooms to occur in SFE. The relatively small pool of ambient NH_4, by itself insufficient to support a bloom, prevents access to NO_3 and bloom development. This has contributed to the current rarity of spring phytoplankton blooms in the northern SFE (Suisun Bay), in spite of high inorganic nutrient concentrations, improved water transparency and seasonally low biomass of bivalve grazers. The lack of blooms has likely contributed to deleterious bottom-up impacts

Questions from SWAMP Workplan

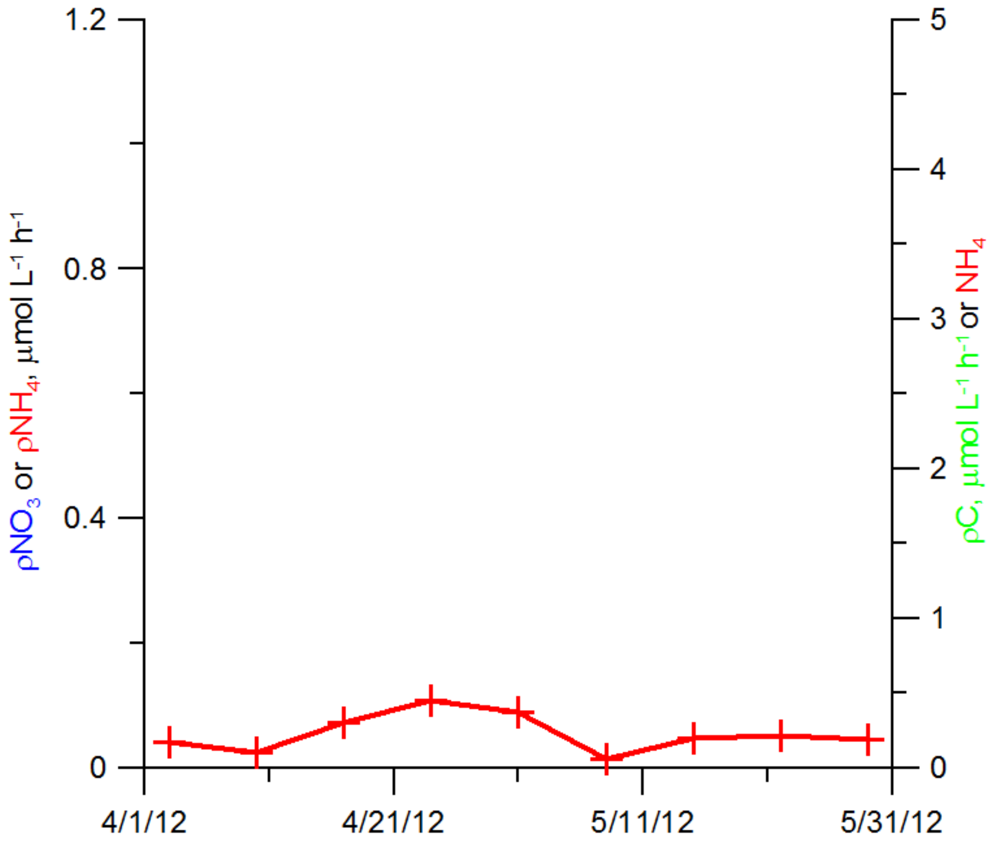
Still at early stage of data analysis for all three years, especially rate data, but can address a few questions from workplan, e.g.

1. Sequence of events leading to a bloom
2. Effect of NH_4 on primary production
3. Shoals as origin of bloom
4. Possible additional sources of NH_4 to Suisun Bay

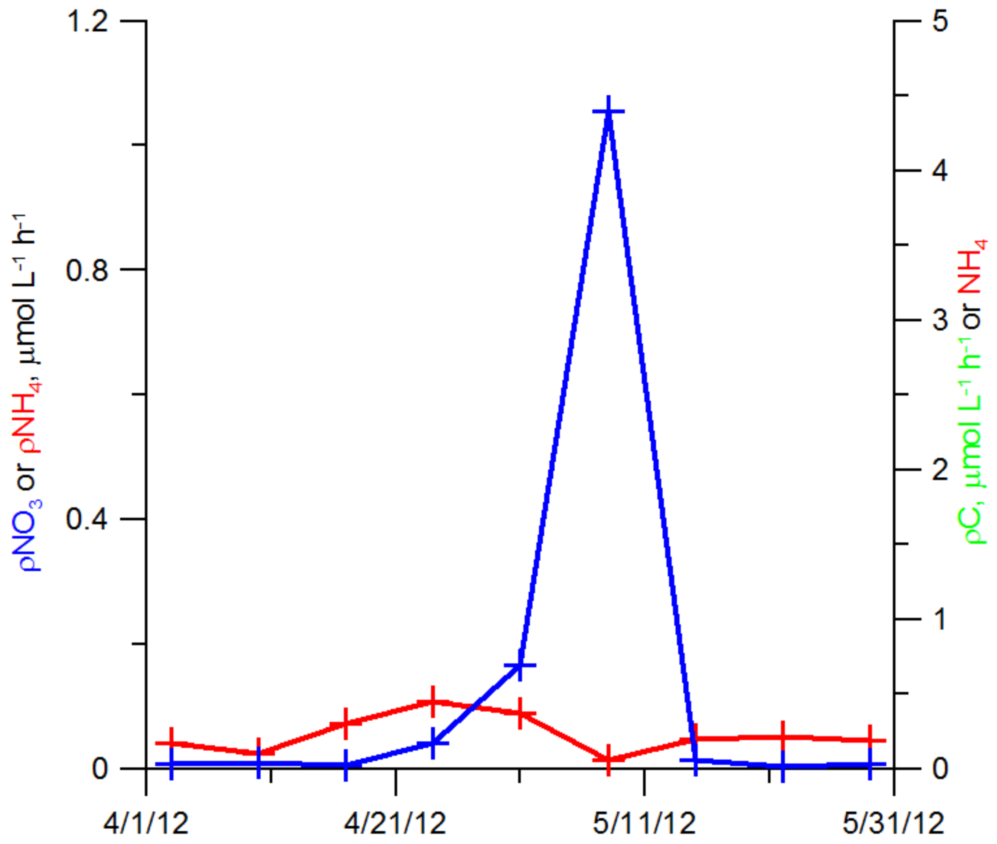
At early stage of data analysis, especially rate data, but can address a few questions from workplan, e.g.

1. Sequence of events leading to a bloom

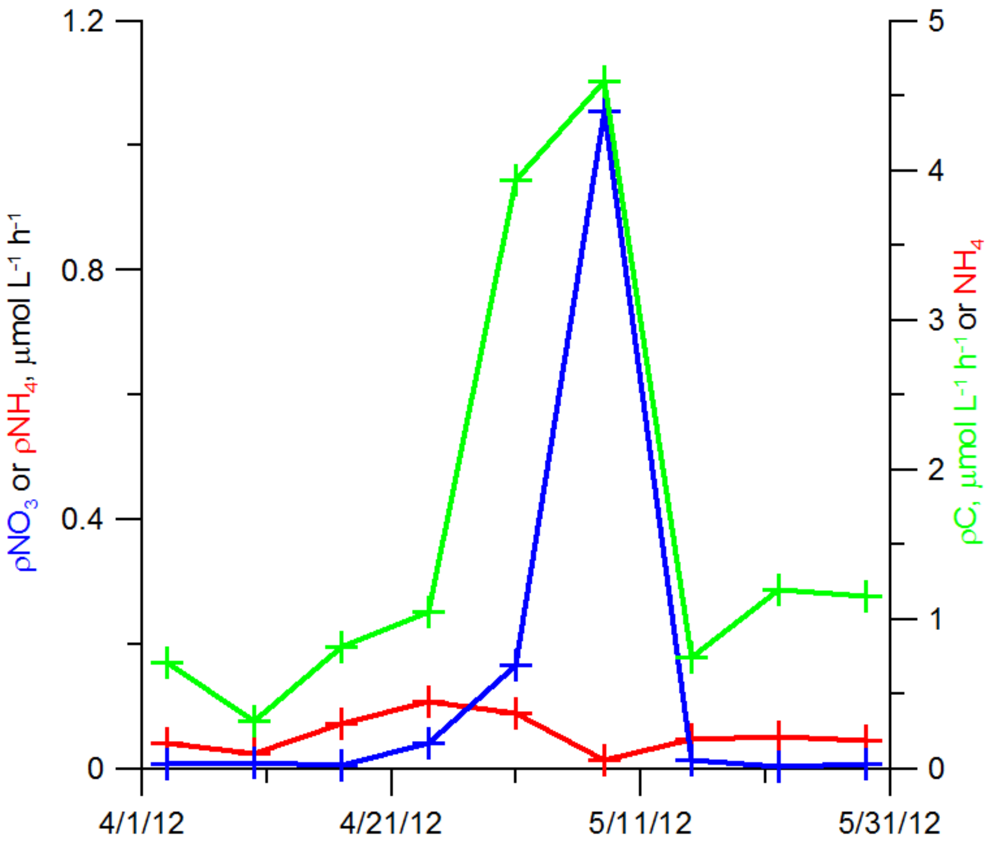
2012 - DWR D7: NH_4 uptake with time



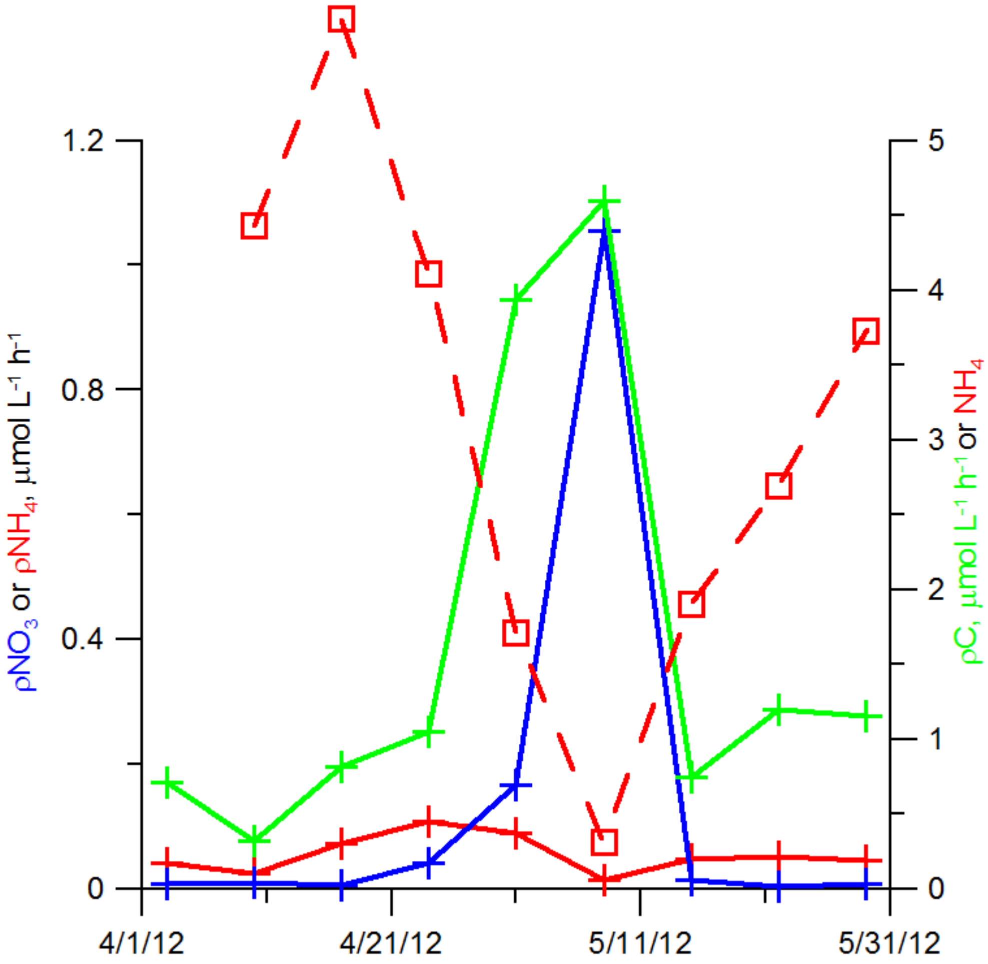
2012 - DWR D7: NO_3 uptake with time



2012 - DWR D7: C uptake with time



2012 - DWR D7: NH_4 with time



Progression of bloom: sequence of events

- NH_4 uptake begins
- NH_4 concentration goes down
- NO_3 uptake once NH_4 lowered to below threshold level
- C uptake accompanies the NO_3 uptake

- Just as envisaged in our conceptual model

At early stage of data analysis, especially rate data, but can address a few questions from workplan, e.g.

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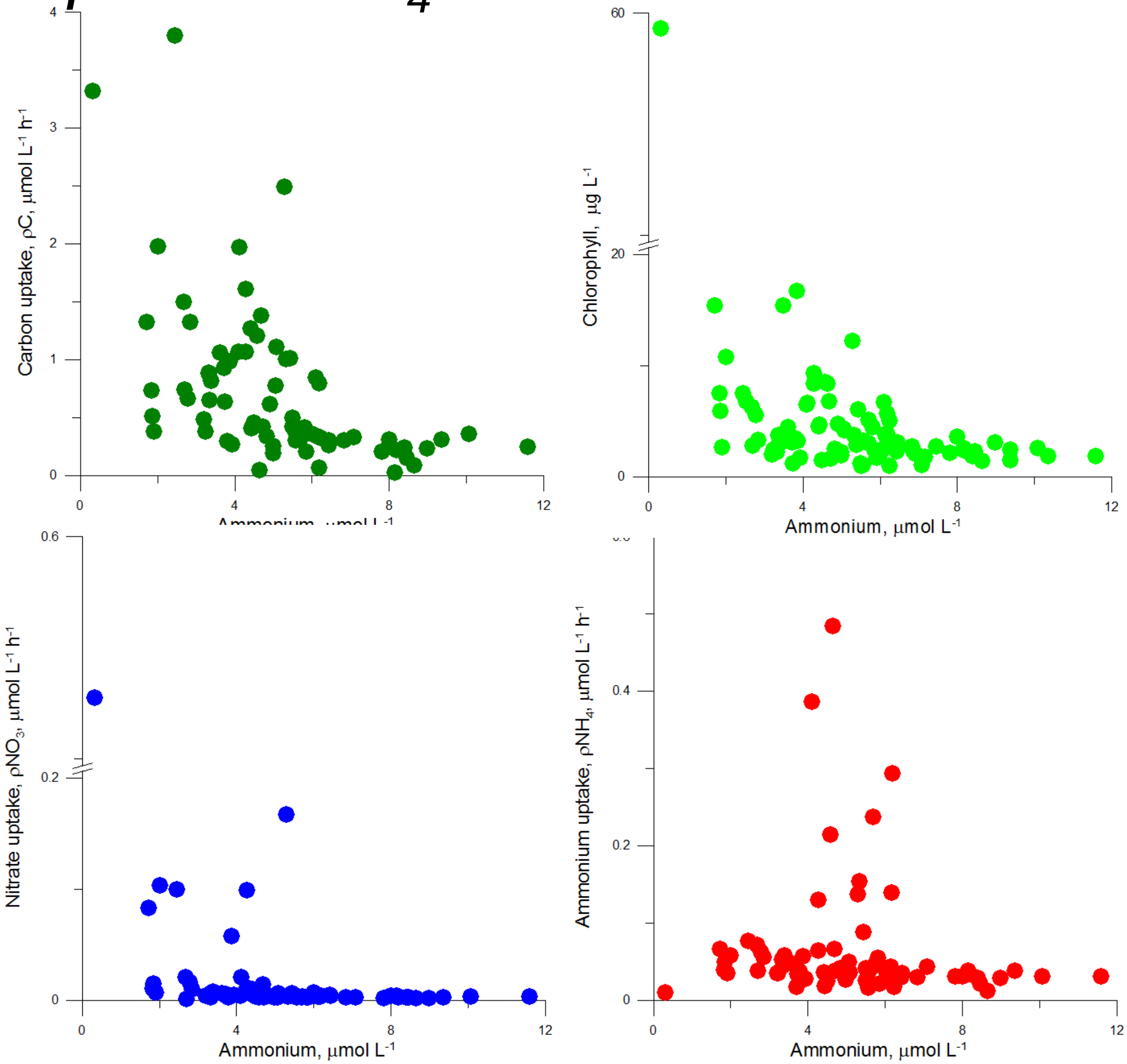
2. Effect of NH_4 on primary production

How C uptake, chlorophyll, NO_3 uptake and NH_4 uptake respond to NH_4 concentration



All 50%LPD uptake data from all stations in 2012

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Do Suisun Blooms Originate in the Shoals?

Answer: Sometimes!

Shoal always blooms by the last week in April, but the 2010 big bloom started in the upstream channel stations in mid April and then spread to the shoal by the last week in April

Overview

•In 2010 (big bloom) started in upstream channel stations in mid April, spread to shoal by last week of April, second bloom in May occurred throughout

•In 2011 DWR D7 (shoal in Grizzly) bloomed at end of April with a second huge bloom in mid May.

•In 2012, upstream and DWR D7 began to bloom at end of April, then huge bloom at DWR D7 and downstream locations the first week of May

At early stage of data analysis, especially rate data, but can address a few questions from workplan, e.g.

1. Sequence of events leading to a bloom
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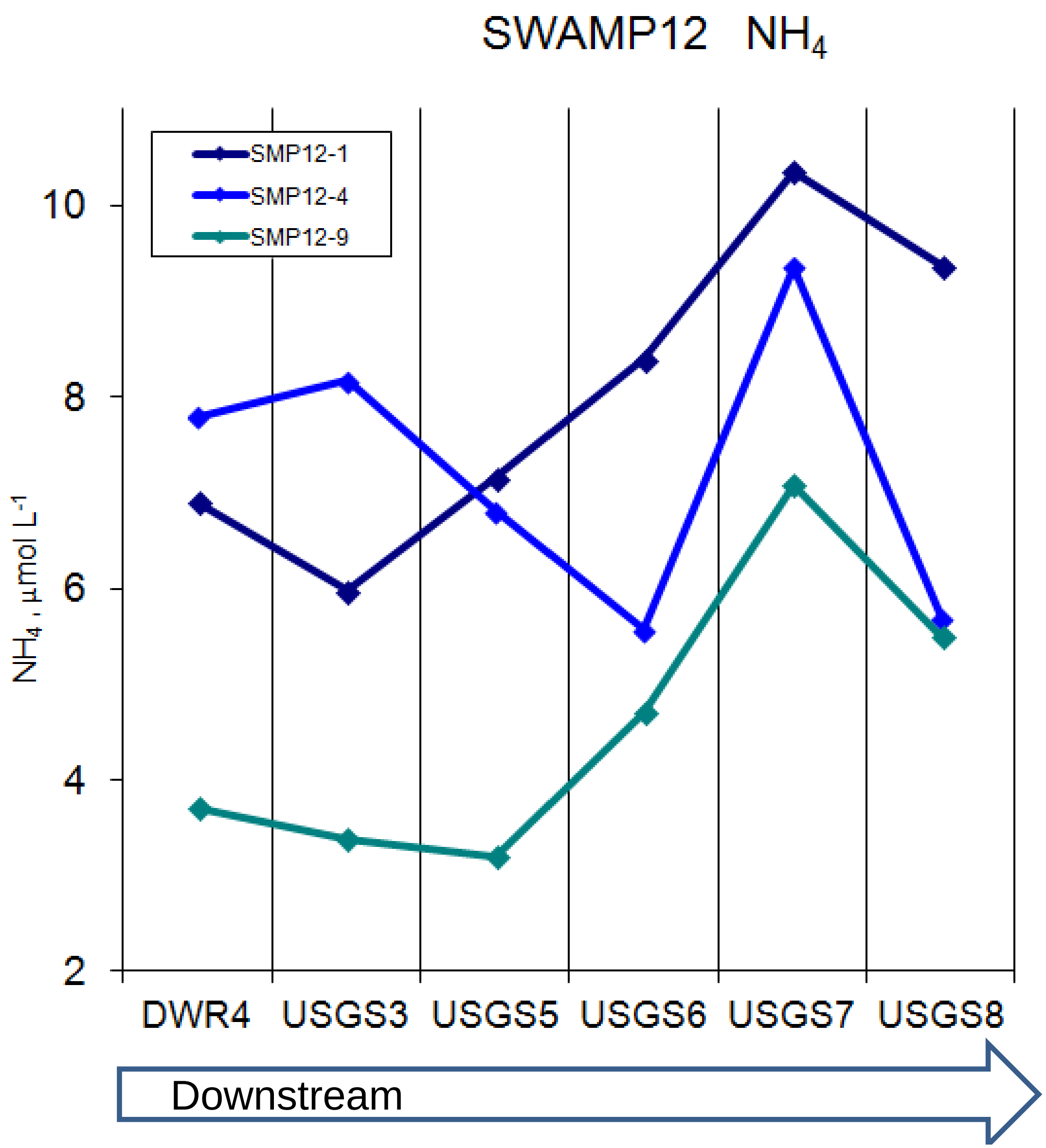
4. Possible additional sources of NH_4 to Suisun Bay

Increase in NH_4 going downstream at USGS 7 – another source of NH_4 to Suisun Bay



To come:

Rate measurements of effect of irradiance on uptake

Manuscript synthesizing the 3 year’s study