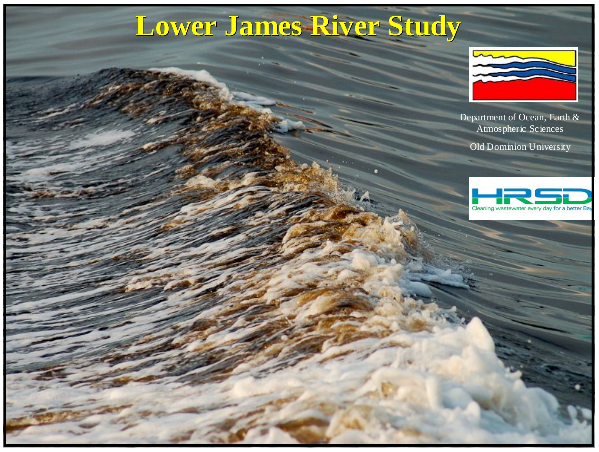
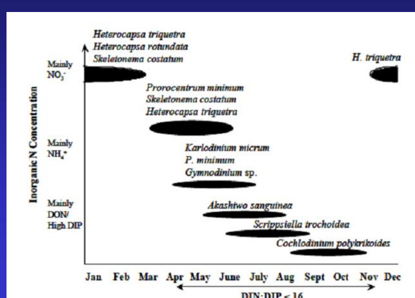
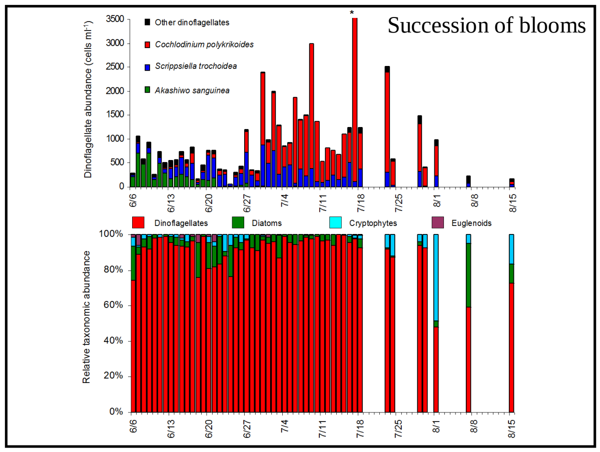


Lower James River

- Lower James River experiences seasonal dinoflagellates blooms - specific species occur with regular seasonality
- Linked with eutrophication and anthropogenic perturbations
- Spread through estuarine circulation
- Nutrients and physical parameters vary on timescales ranging from minutes to years and are important in determining the spatial and temporal extent of blooms.
- Targeted bloom sampling only occurs after bloom has already formed, therefore we can only speculate about causes and initiation of blooms

Bloom Seasonality





Bloom formation vs. maintenance: distinct local conditions and transport at tidal time scales

INITIATION

Growth vs. loss balance

- Nutrients
- Light
- Mixing
- Grazing
- Microbial interactions
- Viruses

MAINTENANCE & PROLIFERATION

Nutrient recycling

Mixotrophy?

Transport

- Tidal advection
- Wind driven
- River flow

Biomass may accumulate in unproductive areas

To identify bloom triggers -

at relevant timescales for bloom initiation

HRSD CMAP platform has been successful for *Cochlodinium*

Sample before, during, and after a bloom to better understand bloom initiation with respect to nutrient uptake dynamics and ambient nutrient concentrations on short timescales

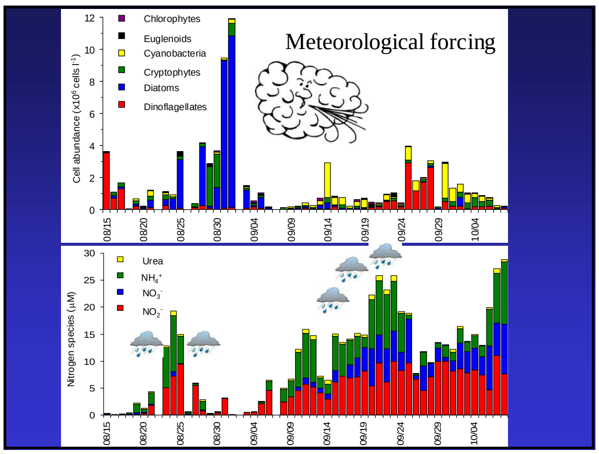
To identify triggers and controls on bloom formation

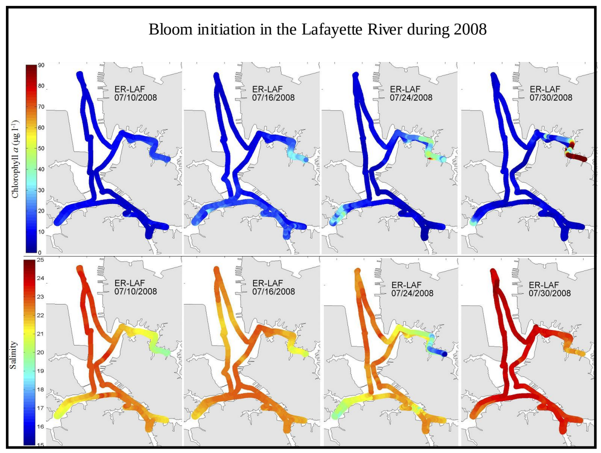
Account for temporal variability - couple continuous monitoring, mapping, and vertical measurements

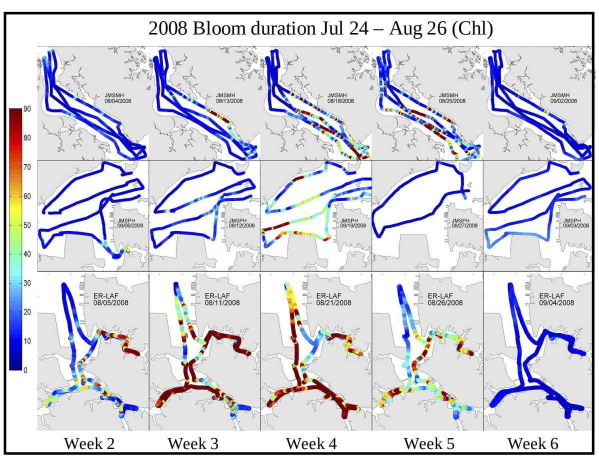
4/3/2003	*Prorocentrum minimum*	17.77	40,000		0.44
4/30/2003	*Prorocentrum minimum*	23.47	11,880	1200	1.98
4/30/2003	*Prorocentrum minimum*	191.89	238,000	1600	0.81
4/30/2003	*Prorocentrum minimum*	11.51	7,100	2000	1.62
4/30/2003	*Prorocentrum minimum*	4.77	682	2400	7.00
5/1/2003	*Prorocentrum minimum*	24.47	9,240	0400	2.65
5/1/2003	*Prorocentrum minimum*	16.10	5,400	0800	2.98
5/6/2003	*Prorocentrum minimum*	9.76	25,000	1200	0.39
5/6/2003	*Prorocentrum minimum*	3.37	858	2400	3.92
5/8/2003	*Prorocentrum minimum*	1.87	25,000		0.07
6/17/2003	*Akashiwo sanguinea*	74.83	5,560	1200	13.50
6/17/2003	*Akashiwo sanguinea*	21.32	1,044	2400	20.40
6/19/2003	*Akashiwo sanguinea*	24.8	976	1200	25.40
6/19/2003	*Akashiwo sanguinea*	221.33	6,206	2400	35.70
5/13/2002	*Akashiwo sanguinea*	27.01	8,900		3.04
5/15/2002	*Akashiwo sanguinea*	29.20	10,000		2.92
5/16/2002	*A. sanguinea, Skeletonema costatum*	16.08	7,800		2.06
9/25/2002	*Cochlodinium sp.*	17.85	10,000		1.78
2/5/2003	*Heterocapsa triquetra*	17.81	2,000		8.90

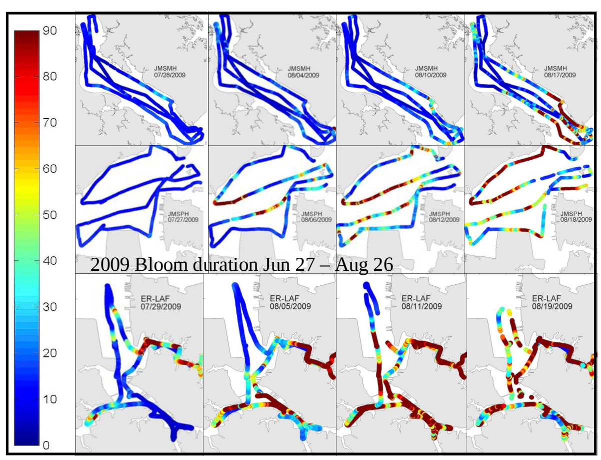
Observations from daily sampling

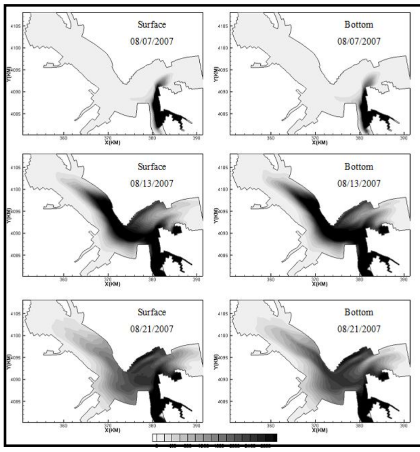
- 2-5 day lagged positive correlations between N and dinoflagellates suggests N affects bloom formation
- The form of N *was* unimportant for dinoflagellate bloom development; total N is important
- Dinoflagellate blooms linked to precipitation and neap tides, low wind speeds, & nutrient inputs
- Nutrients from above (ppt) or below (upflux from seds – Iris)
- Wind speed and direction may determine whether diatom or dinoflagellate bloom forms through their effects on stratification





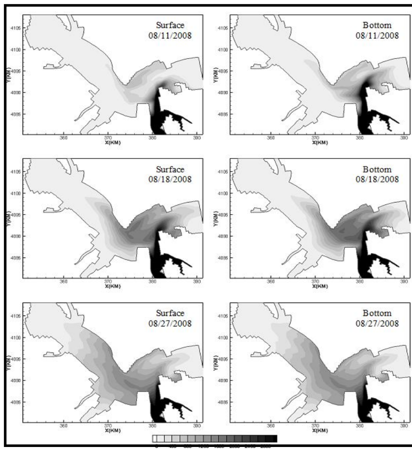






James River 2007 dynamic conditions

Dye released in LAF on 8/6 from 00:00 to 12:00



James River 2008 dynamic conditions

Differences related to flow

Meteorological forcing

- Bloom initiation trigger (and bloom dissipation)
- Localized sites of initiation and growth
- Bloom initiation coincided with intense, highly localized rainfall events prior to/during neap tides
- Blooms dissipated in response to increased wind-driven mixing after entering James R.
- Local conditions (and flow) in the Bay control *amount* of transport in James River, but *extent* of bloom controlled by circulation
- Seasonal rainfall patterns, increased stratification, nutrient loading, spring-neap tidal modulation, and complex estuarine mixing and circulation control blooms

Nutrient triggers

- N inputs from precipitation or sediments
- Inputs versus internal N cycling
  - Bloom initiation vs. maintenance phase
- No single N compound can be implicated in triggering blooms of mixotrophic dinoflagellates

Summary

- Biology and ecology – diverse, chl relationships, nutrients
- Meteorological forcing – stratification, mixing and benthic nutrient injection, rain
- Transport – initiation or accumulation sites? Mapping is a good tool
- Temporal and spatial scales of variability

Plan for 2012-2013

- Apply *Cochlodinium* study to other bloom organisms
- CMAPing starts in Feb vs. April and extends later
- Sampling water quality and hydrographic variables during CTD casts from CMAP platform
- Continuous monitoring in Lafayette at fixed sites – near mouth and up river
- Nutrient mapping – HRSD
- Storm sampling – Lafayette
  - Continuous monitoring coupled with dataflow

Analytes

- Nutrient mapping – NO3, NO2, NH4, urea, TDN, TDP, DIP
- Diagnostic pigments – paired with chl and taxonomic identifications
- Continuous monitoring in Lafayette at fixed sites – near mouth and up river
- Nutrient mapping – HRSD
- Relate to local and regional meteorology
- Storm sampling – Lafayette
  - Continuous monitoring coupled with dataflow

Diagnostic pigments

- Paired with taxonomic identification
- High throughput identification of functional group abundance – diatoms, dinoflagellates, cyanobacteria versus chlorophytes and others
- Possible early warning indicator for blooms or shifts in taxonomic composition
- Possible hot spot indicator
- Mapping the distribution of functional groups with respect to environmental and physical forcing

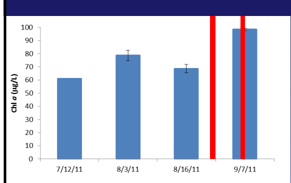
Samples

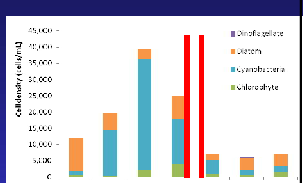
- 2011 paired comparisons being run for bloom samples
- Collection of diagnostic pigment samples on CMAP cruises, from fixed monitoring in Lower James
- Will be getting samples from upriver as well from sites examining taxonomic composition (collaborate with Marshall)

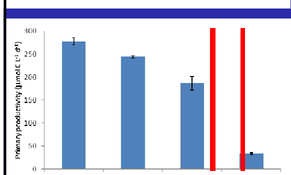
Nutrient uptake study

- Which forms of N are of most concern during bloom initiation versus maintenance
- Contribution of internal N recycling versus external loading

Rice Center

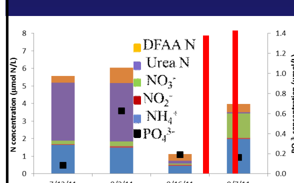


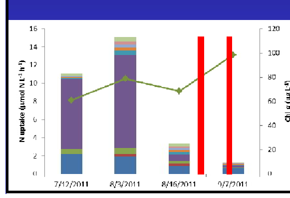




- Cyanobacteria and bloom cleared by storms
- Low primary productivity but high Chl *a* after storms

FW- Nutrients and N uptake





- Urea and ammonium and amino acid uptake dominate, decrease in total N over bloom, inorganic N dominant after storm
- N uptake high during bloom
- Decrease in uptake post-bloom and post-storms but high chlorophyll!