Nutrient Pulsing Study

Elizabeth River Steering Committee
August 2, 2013

HRSD
Cleaning wastewater every day for a better Bay.

OCEAN, EARTH & ATMOSPHERIC SCIENCES

OLD DOMINION UNIVERSITY

Topics

- Relationship to James River Study

- Methods

- Preliminary results

** Conclusions are pending completion of study and associated data analysis **

James River Study

Big picture objectives:

- Re-evaluate the existing chlorophyll a criteria and standards

- Improve related modeling (WSM and CHLA)

- 2017: Provide basis for revised James River 2023 nutrient allocations in the Bay TMDL

James River Study (Lower Estuary Portion)

- Monitoring
  - Dataflow, continuous monitors, fixed sites
- Phytoplankton
  - Identification and enumeration
  - HPLC pigments
- Environmental factors favoring algal blooms
  - **Nutrient pulse (subject for today)**
  - Nutrient uptake
  - Nutrient exchange from bottom sediments
- Effects studies
  - Lab toxicity testing
  - Field studies (oyster cages)
- Modeling improvements
  - Watershed model
  - CHLA / HAB model

All of the above are related and connected to larger objective

Factors promoting algal blooms

Our previous research has shown….

- *Cochlodinium polykrikoides* is dominant summer bloom former (other species also co-exist and bloom at times)
- Summer blooms tend to follow storm events
- Optimal water temperatures
- Quiescent – stagnant conditions
- Stratified water column
- Blooms often initiate in the LAF headwaters and spread to mainstem ER and lower James

Objectives of present study

- Measure stormwater inputs
- Measure effects of storms on the river
  - Continuous monitoring (CMON)
  - Temporally intensive sampling on piers
  - Spatially extensive monitoring by boat
- Relate inputs and storms effects to blooms
- Focus on Lafayette River since headwaters are often the initiation grounds for blooms
- Results should be transferable to similar systems
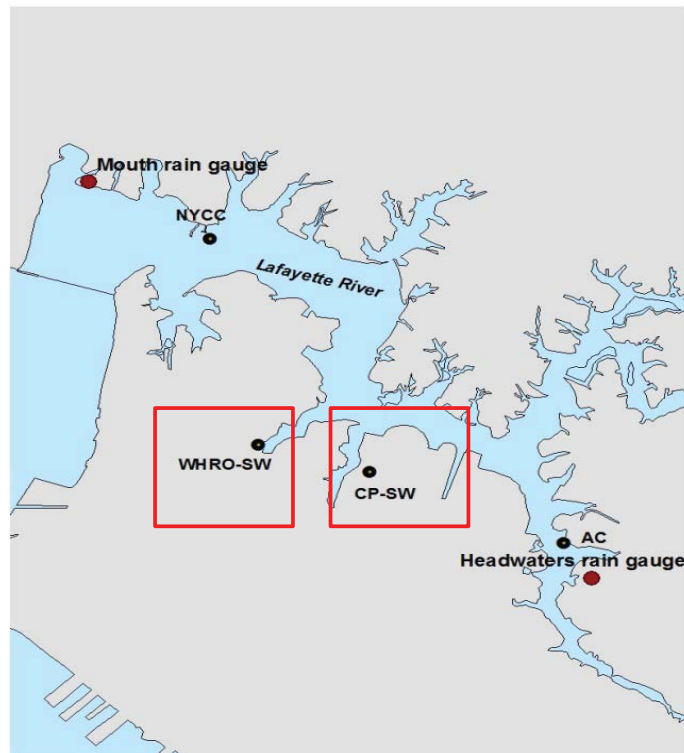
Stormwater

Stormwater – Colonial Place

Gosnold and New York Ave - ~21 acres drainage area
Suburban land use
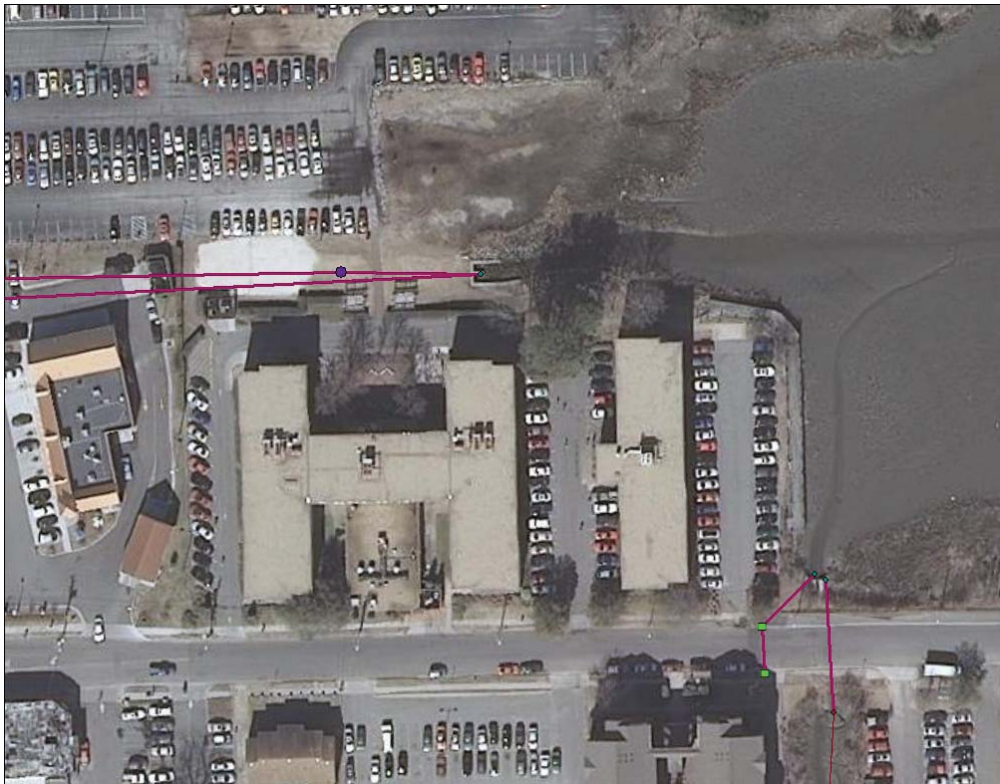
Recent rain gauge additions not shown

Stormwater – WHRO

Near WHRO, behind ODU dorm - ~122 acre drainage area
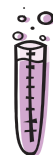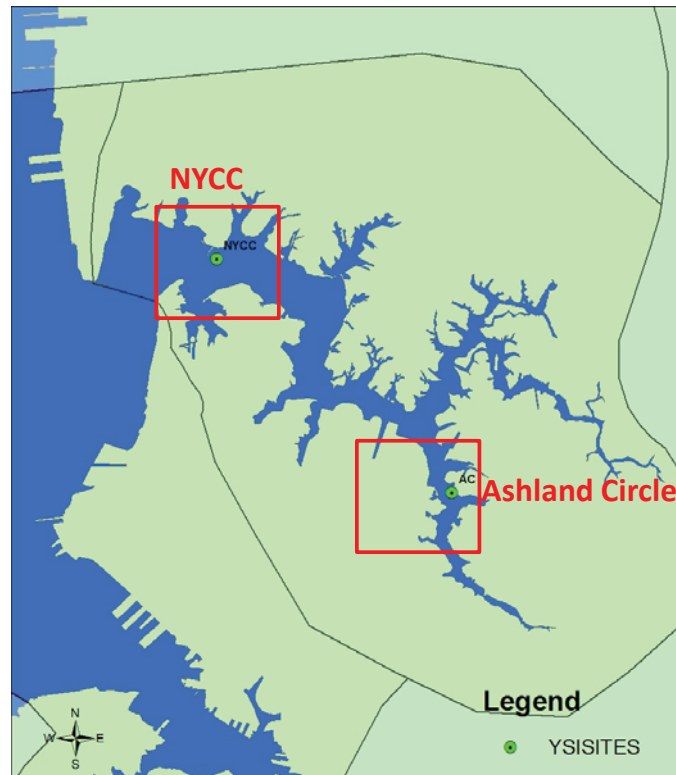Institutional land use

Stormwater – WHRO

ISCO stormwater details

- Equipment is set up when forecasts are favorable (i.e. >=50% chance and >0.1" forecast)
- Samples collected sequentially by time and manually composited by flow (flow weighted)
- Samples collected for TSS, nutrients (TN, TP, NH3, NO3+NO3, OPO4), and salinity

River Sampling : Private pier sites

Norfolk Yacht Club

Near mouth location
~ 18 feet deep (tidal average)

Ashland Circle

**Headwater location
~ 6 feet deep (tidal average)**

Pier sampling details

- ISCO samplers set up when forecasts are favorable (coincides with SW deployment)
- "Prior" samples collected at equipment set up
- Sampler triggers by rain gauge (@0.1"/hr)
- Samples collected sequentially by time intervals @ (0, 30 min, hourly, every 2 hrs, every 4 hrs, every 6 hrs) - out to 48 hours – sometimes extended
  - Idea is to collect samples frequently since nutrients can be rapidly assimilated by phytoplankton
- Parameters: NH4, NO2+NO3, PO4, TDN with analysis by ODU
- Concurrent daily sampling by ODU (nutrients and phytoplankton)

Continuous Monitors

- YSI 6600 V2 EDS
- Weekly sonde exchanges
  - Swap out instruments (requires 2 sondes for each site)
  - Collect QC information
  - Clean and re-calibrate instruments
  - Data review and troubleshooting if needed
- Sonde data is recorded at 15 min intervals for depth, temp, salinity, do, pH, CHLA, and Turb
- Data is validated and reported to VECOS

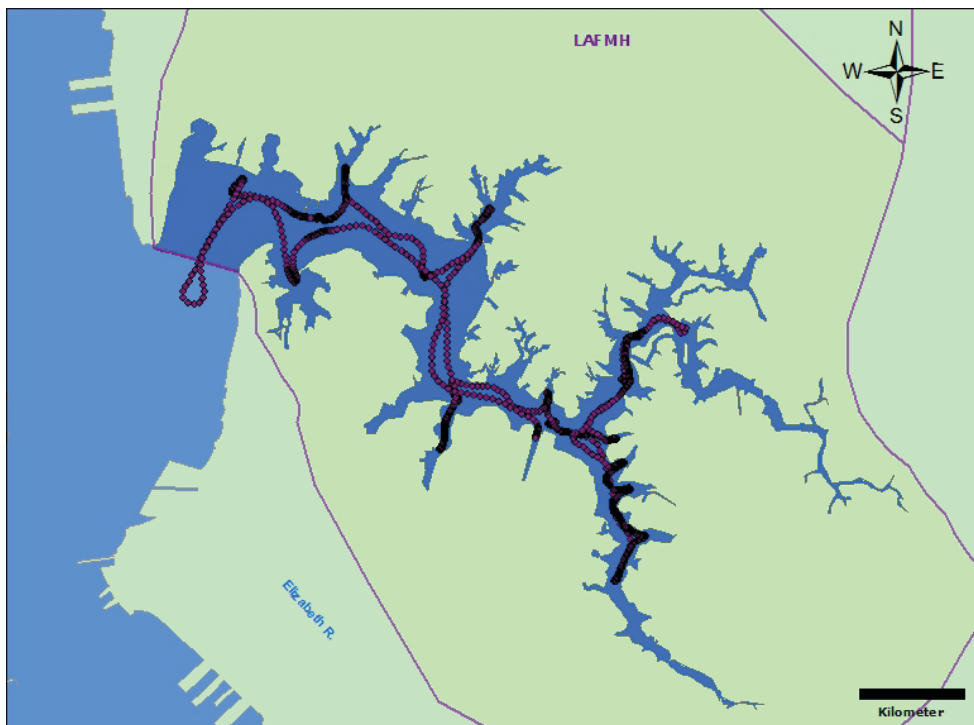# Boat: Dataflow System

Adapted from VIMS – YSI 6600, GPS, fathometer, and LabView platform

Dataflow Cruise Track

Laptop Data Logging Example

Date	Sonde Time	Temperature	Conductivity	Salinity PPT	DO Percent	DO (mg/L)	PH	Turbidity NTU	CHLA (ug/L)	Battery (V)	GPS Time	Lat	Lat Dir	Long	Long Dir	Speed	Heading	GPS Date	Depth
3/24/2006	7:32:15	9.54	30.09	18.59	104	10.53	8.2	7.1	6.7	11.8	123318	3700.936 N		7627.557 W		4.1	287.1	240306	6.4
3/24/2006	7:32:19	9.54	30.16	18.64	104	10.53	8.2	7.1	7.1	11.8	123322	3700.937 N		7627.562 W		4.2	269.8	240306	6.4
3/24/2006	7:32:23	9.53	30.15	18.63	104	10.53	8.2	7.1	7.7	11.8	123326	3700.936 N		7627.568 W		4.1	250.2	240306	6.7
3/24/2006	7:32:27	9.53	18.4	18.4	104.1	10.56	8.2	7.2	7.1	11.7	123330	3700.933 N		7627.573 W		4.3	228.3	240306	7.3
3/24/2006	7:32:31	9.53	29.75	18.36	104.1	10.56	8.2	7.2	6.8	11.8	123334	3700.929 N		7627.577 W		5.4	216.9	240306	7.7
3/24/2006	7:32:35	9.52	29.79	18.39	104.3	10.58	8.2	7.3	6.7	11.9	123338	3700.921 N		7627.584 W		11	213.6	240306	7.6
3/24/2006	7:32:39	9.51	29.68	18.31	104.4	10.6	8.2	7.3	6.4	11.7	123342	3700.908 N		7627.594 W		14.4	211.3	240306	8.1
3/24/2006	7:32:45	9.5	29.37	18.1	104.5	10.63	8.2	7.4	6.1	11.8	123348	3700.882 N		7627.612 W		20.2	208	240306	9.5
3/24/2006	7:32:47	9.49	29.27	18.04	104.8	10.66	8.2	7.4	6	11.8	123350	3700.871 N		7627.619 W		22.5	207.5	240306	9.6
3/24/2006	7:32:51	9.49	29.14	17.95	105	10.69	8.2	7.5	5.2	11.8	123354	3700.847 N		7627.635 W		25	207.9	240306	10.3
3/24/2006	7:32:55	9.48	29.13	17.94	105.4	10.74	8.2	7.5	5	11.8	123358	3700.822 N		7627.652 W		26.1	208.8	240306	11.4
3/24/2006	7:32:59	9.46	29.19	17.98	105.8	10.78	8.2	7.5	4.6	11.8	123402	3700.797 N		7627.67 W		27.1	210.5	240306	11.4
3/24/2006	7:33:03	9.43	29.34	18.08	106.1	10.81	8.2	7.4	4.7	11.7	123406	3700.771 N		7627.69 W		27.4	211.5	240306	12
3/24/2006	7:33:07	9.41	29.31	18.06	106.4	10.84	8.2	7.4	5.2	11.7	123410	3700.744 N		7627.71 W		27.5	211	240306	11.8
3/24/2006	7:33:11	9.38	29.39	18.11	106.6	10.87	8.2	7.3	4.9	11.8	123414	3700.718 N		7627.728 W		26.3	209.2	240306	10.5
3/24/2006	7:33:15	9.36	29.46	18.16	106.6	10.88	8.2	7.2	5	11.8	123418	3700.693 N		7627.746 W		26	209.2	240306	10.2
3/24/2006	7:33:19	9.34	29.51	18.19	106.8	10.89	8.2	7.1	4.7	11.8	123422	3700.667 N		7627.763 W		26.2	208.6	240306	10.1
3/24/2006	7:33:23	9.31	29.6	18.25	106.7	10.89	8.2	7	4.5	11.8	123426	3700.642 N		7627.78 W		26.4	207	240306	11.6
3/24/2006	7:33:27	9.29	29.62	18.27	106.6	10.89	8.2	6.9	4.5	11.8	123430	3700.615 N		7627.796 W		26.6	206.1	240306	11.8
3/24/2006	7:33:31	9.28	29.73	18.34	106.6	10.88	8.2	6.8	4.6	11.9	123434	3700.589 N		7627.813 W		26.4	208.8	240306	11.9
3/24/2006	7:33:35	9.25	29.89	18.45	106.5	10.87	8.2	6.8	4.6	11.7	123438	3700.563 N		7627.831 W		26.2	209	240306	12.3
3/24/2006	7:33:39	9.23	29.99	18.51	106.4	10.86	8.2	6.8	4.7	11.7	123442	3700.538 N		7627.848 W		26.2	207.1	240306	12.5
3/24/2006	7:33:43	9.21	30.09	18.58	106.3	10.85	8.2	6.8	4.7	11.7	123446	3700.511 N		7627.862 W		26.3	199.5	240306	13.1
3/24/2006	7:33:47	9.19	30.33	18.74	106.1	10.83	8.2	6.8	4.7	11.7	123450	3700.483 N		7627.87 W		26.2	189.5	240306	14.5
3/24/2006	7:33:51	9.17	30.55	18.89	106	10.8	8.2	6.8	4.7	11.7	123454	3700.454 N		7627.87 W		25.1	173.2	240306	15.1
3/24/2006	7:33:55	9.16	30.85	19.09	105.8	10.78	8.1	6.8	4.7	11.7	123458	3700.43 N		7627.861 W		20.2	156.5	240306	17

csv file format

Typically ~ 2,500-4,500 records long – depends on travel time

Coordinate system allows for GIS analysis and WQ mapping

Nutrient Sampling - Boat

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Boat sampling details

- Boat was deployed "prior", 1 day after, and 2 days after storms
- Dataflow results were logged
- Fixed site nutrient grabs collected + QC
- Vertical profiling conducted

Nutrient parameters: NH3, NO2, NO3, PO4, and TDN – Analysis by ODU at low level
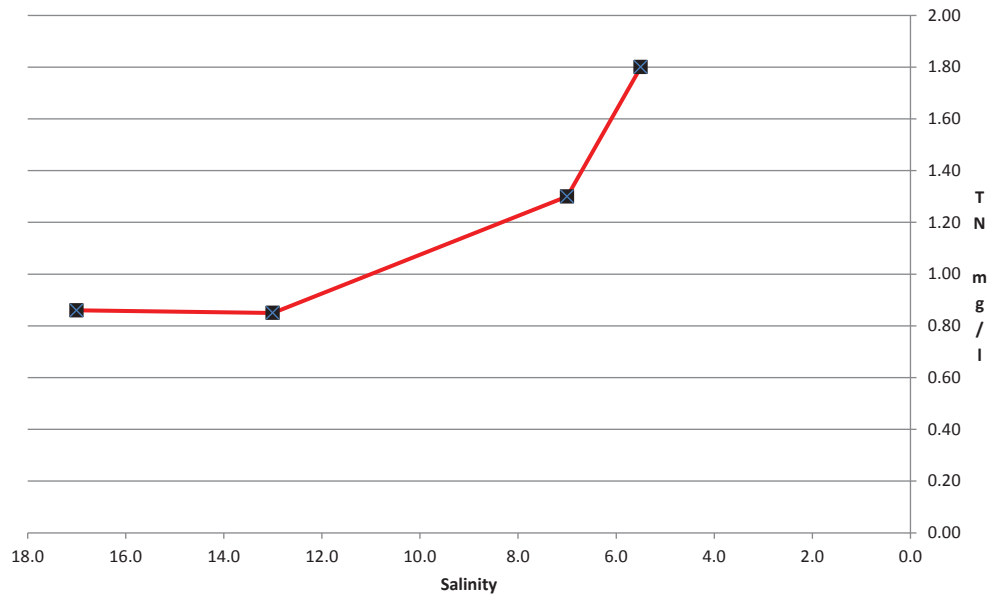
Preliminary Findings

SW averages (2013 thru 7-12)

	Colonial Place	WHRO
TN (mg/l)	1.5	1.2
TDN (mg/l)	0.58	0.50
TP (mg/l)	0.21	0.19
OPO4 (mg/l)	0.122	0.068
TSS (mg/l)	47	78.0
Flow (gal)	13,771	995,874
n	3	4

- TDN calculated as sum of NH3 and NO3+NO3
- 2012 data is available but done by different lab methods
- WHRO samples may be biased low due to tidal intrusion

WHRO SW TN vs Salinity

River sites – piers
Ashland Circle + NYCC

Salinity vs Precip – AC (2012)
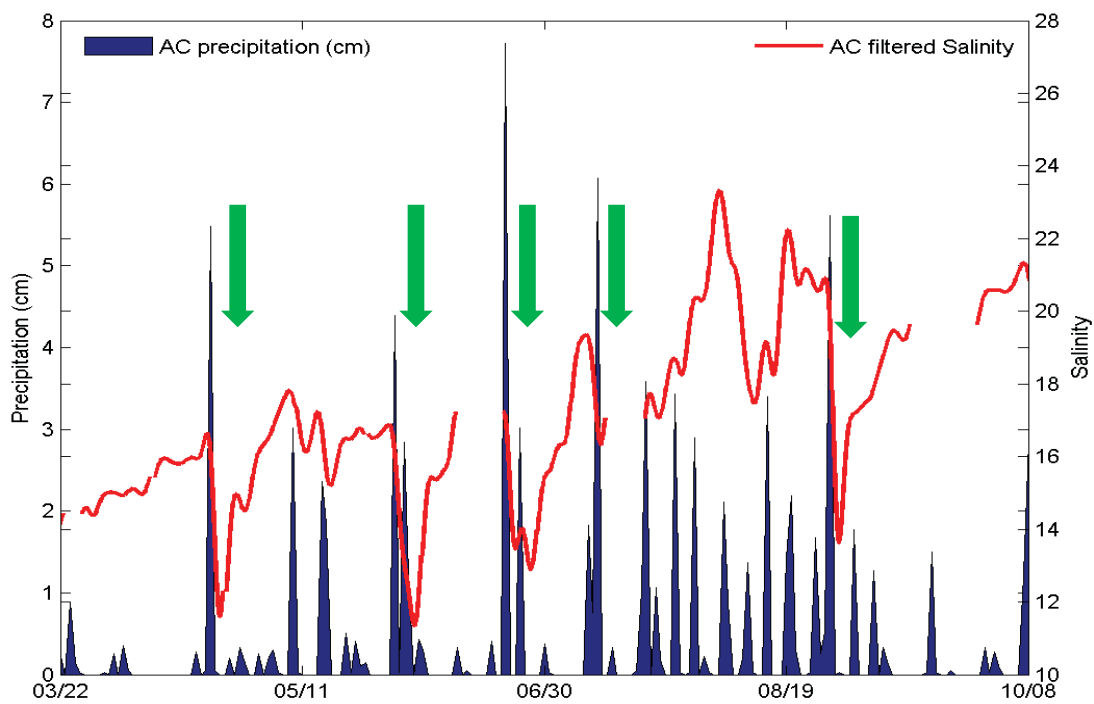
From Mulholland and Filippino (draft)

Salinity vs Precip – NYCC (2012)

From Mulholland and Filippino (draft)

Chlorophyll vs Precip – AC (2012)
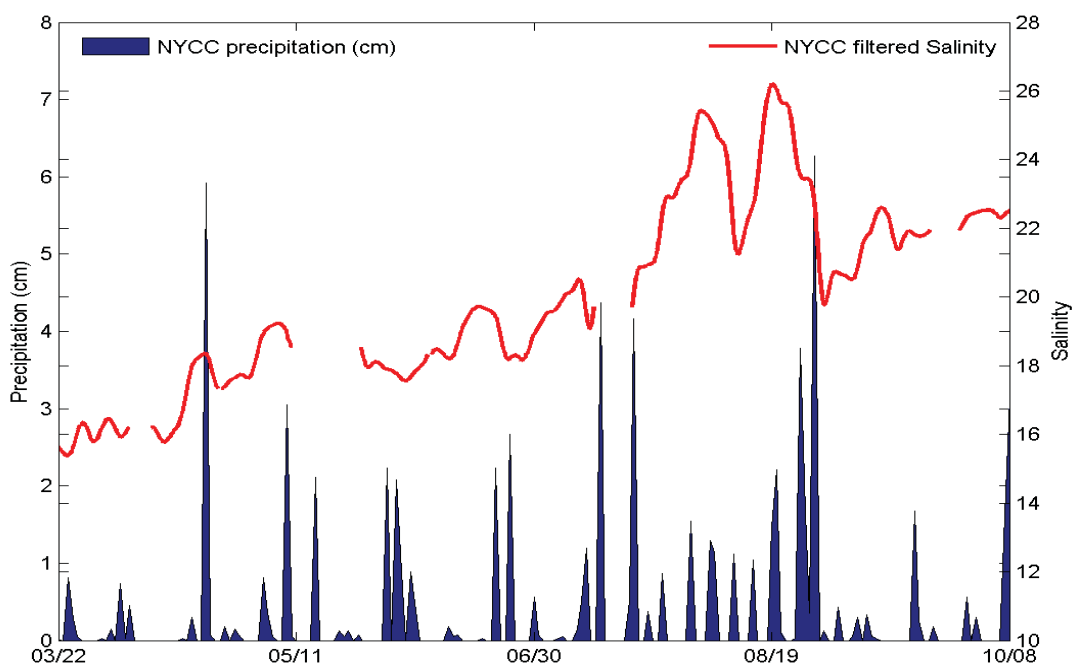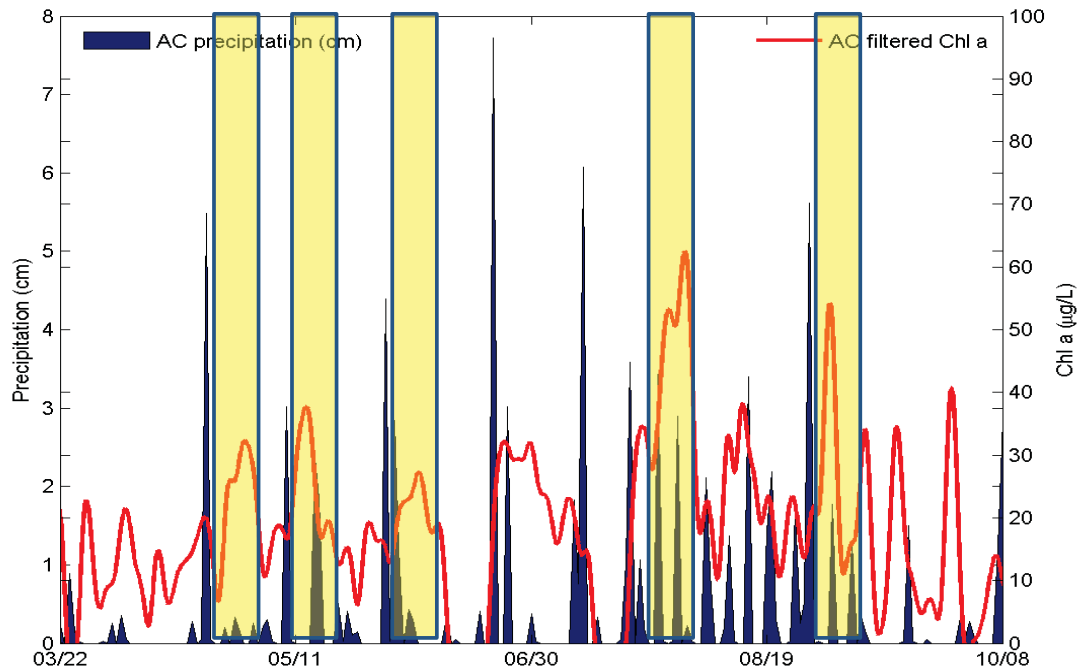
From Mulholland and Filippino (draft)

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Chlorophyll vs Precip – NYCC (2012)
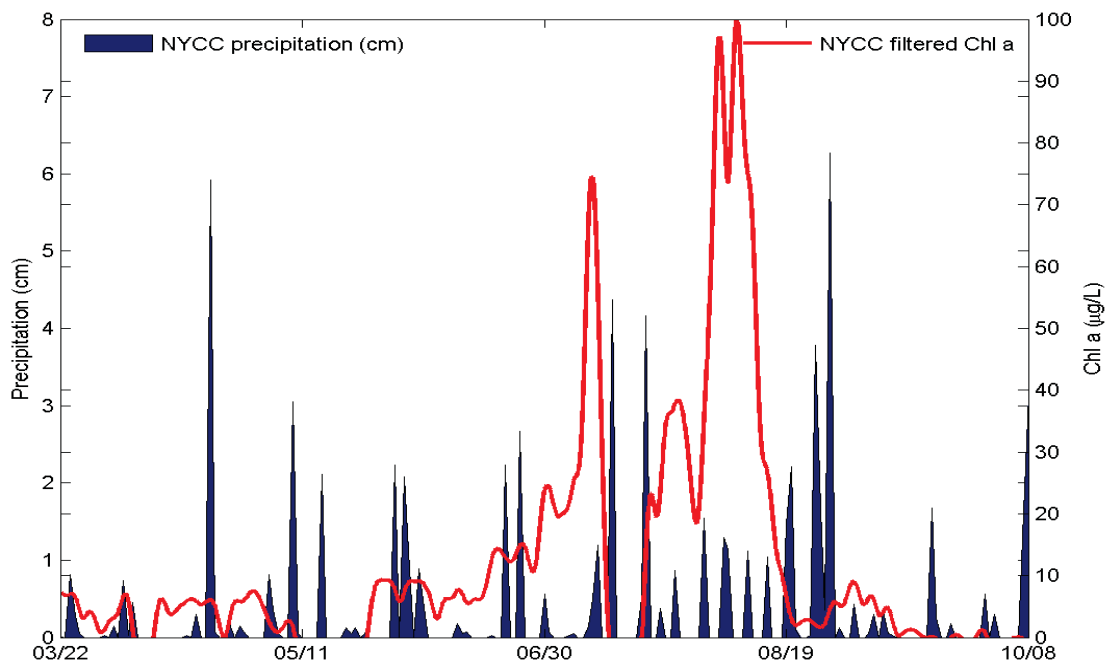
From Mulholland and Filippino (draft)

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River TDN around precip events - AC

A

TDN (umol/L) vs Water depth (m)

TDN — Water depth

Time elapsed (h)
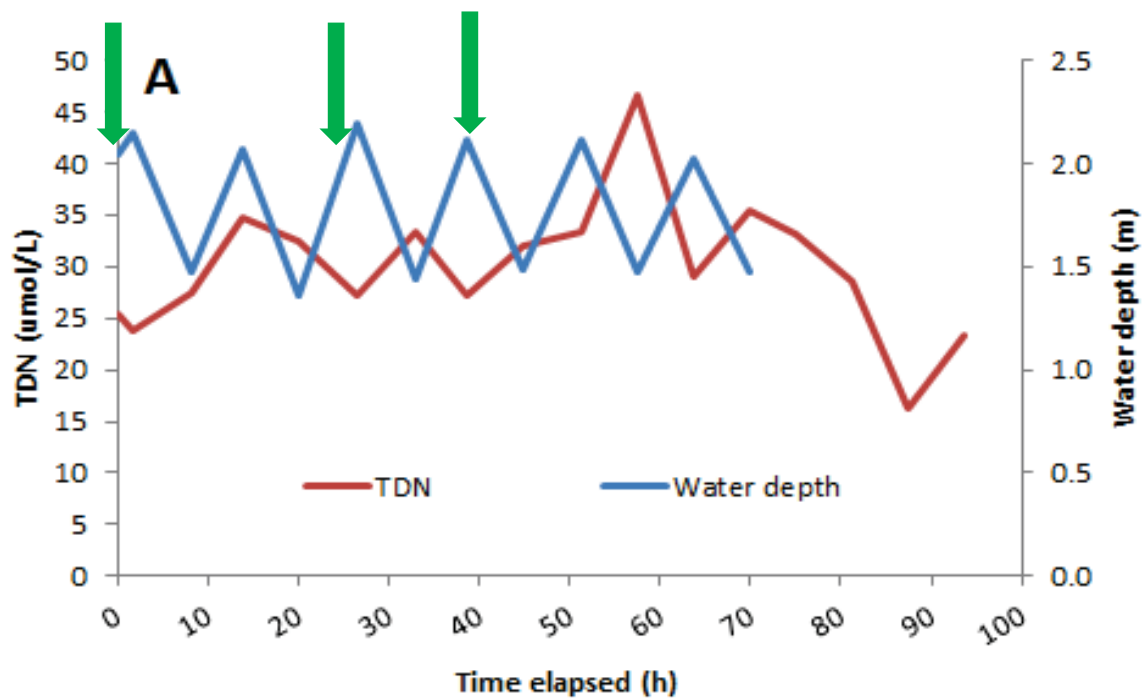
July 9th-July 13, 2012

From Mulholland and Filippino (draft)

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River PO4 around precip events - AC

B

PO4 (umol/L) vs Water depth (m)

PO4 — Water depth

Time elapsed (h)
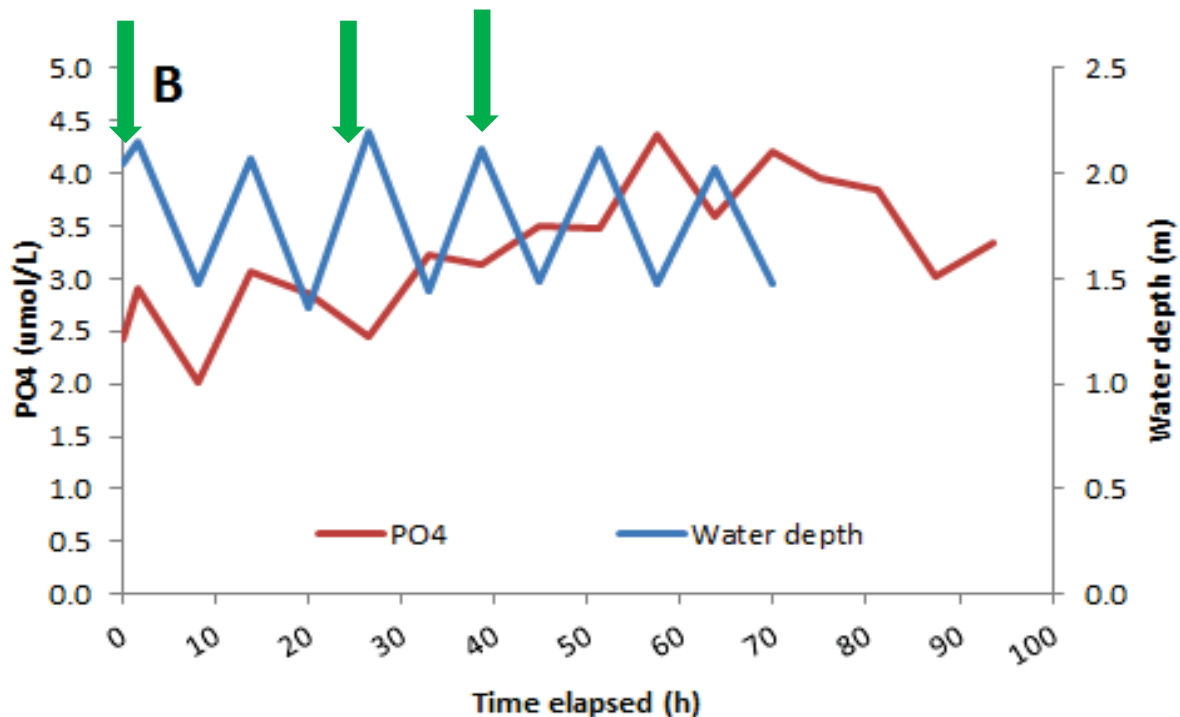
July 9th-July 13, 2012

From Mulholland and Filippino (draft)

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River sites – boat (spatially intensive)
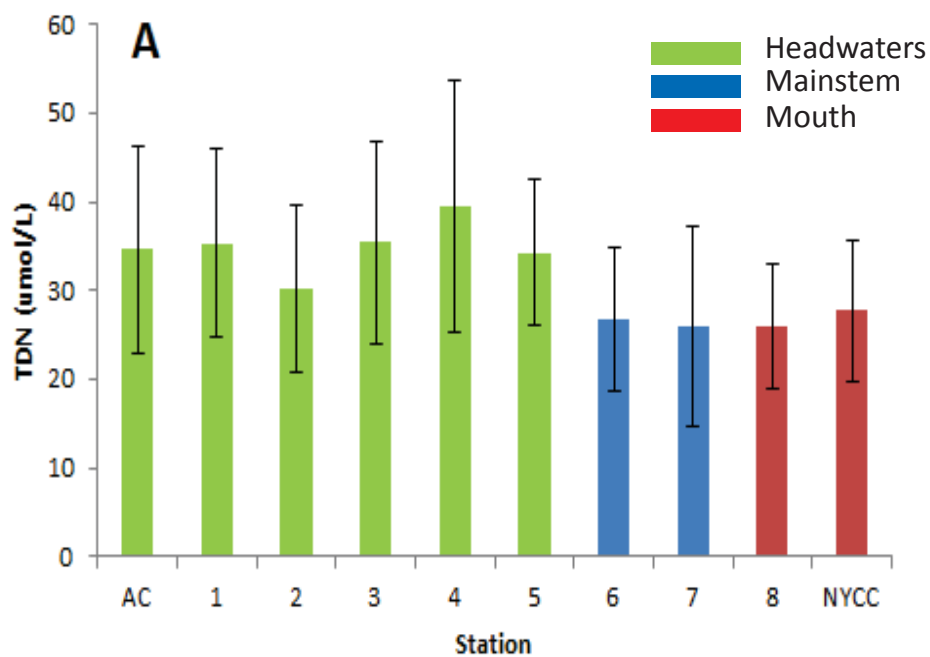
River sampling : TDN

July 12th-Sept 13, 2012

From Mulholland and Filippino (draft)
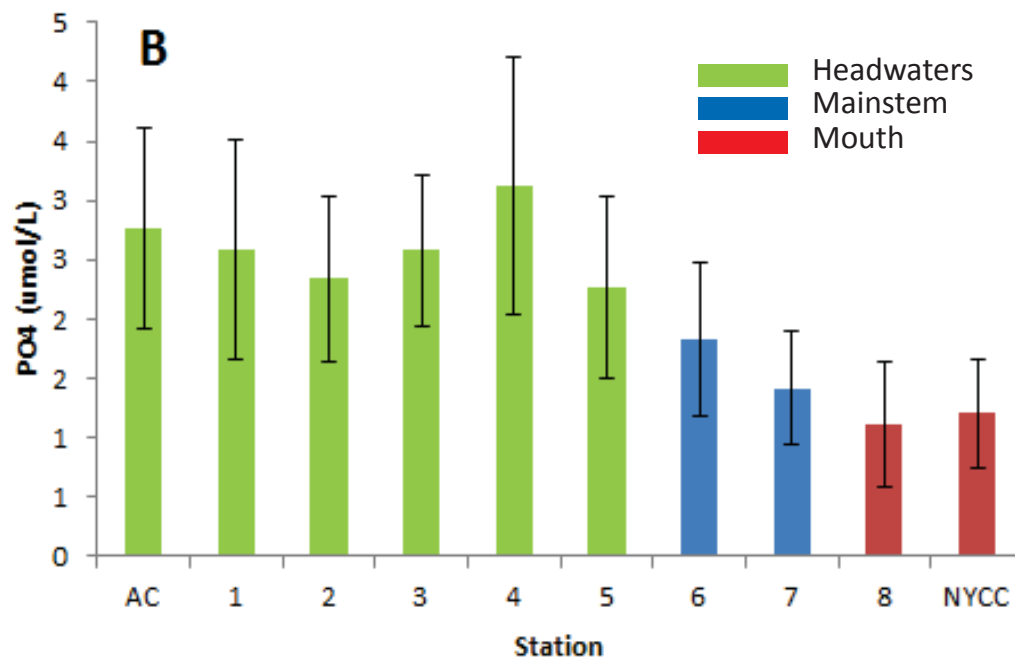
River sampling : PO4

July 12th-Sept 13, 2012

From Mulholland and Filippino (draft)
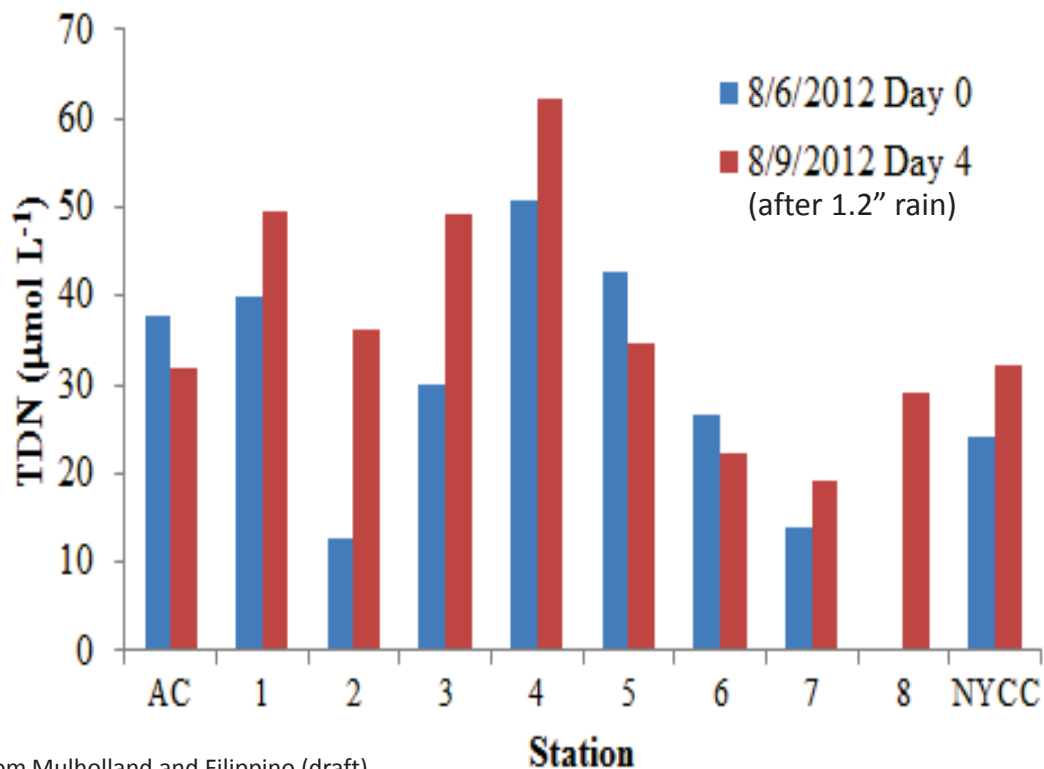
River sampling : TDN

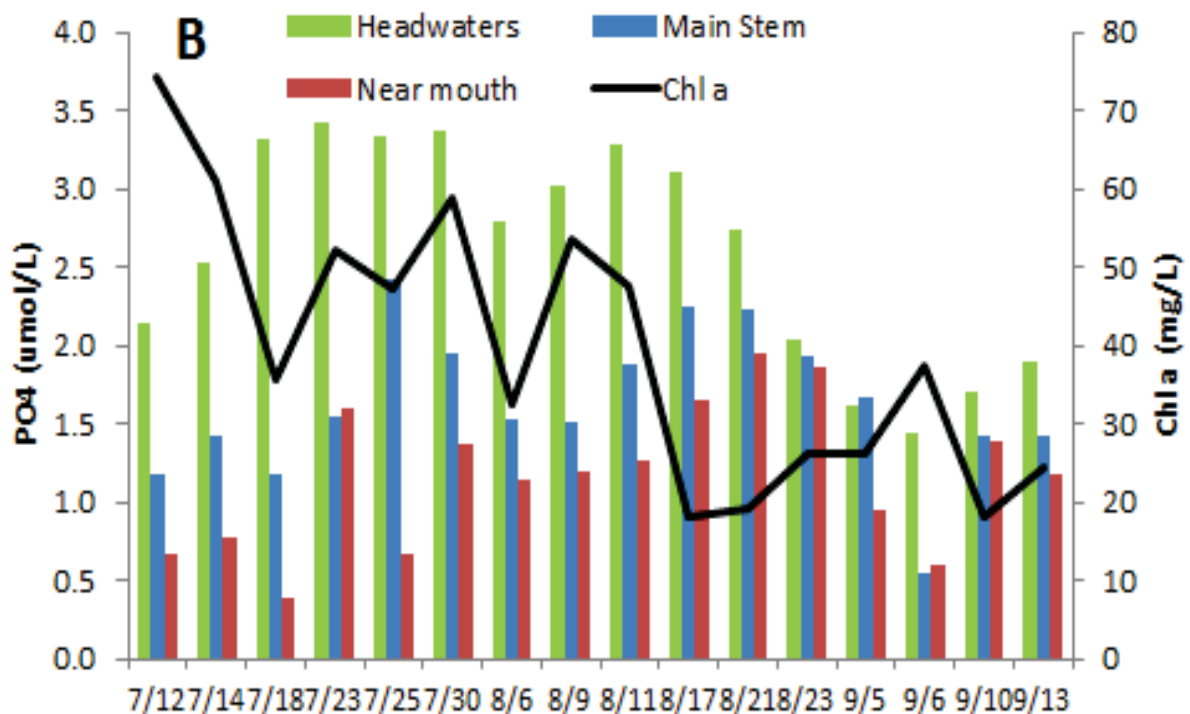From Mulholland and Filippino (draft)

River sampling : TDN+CHLA
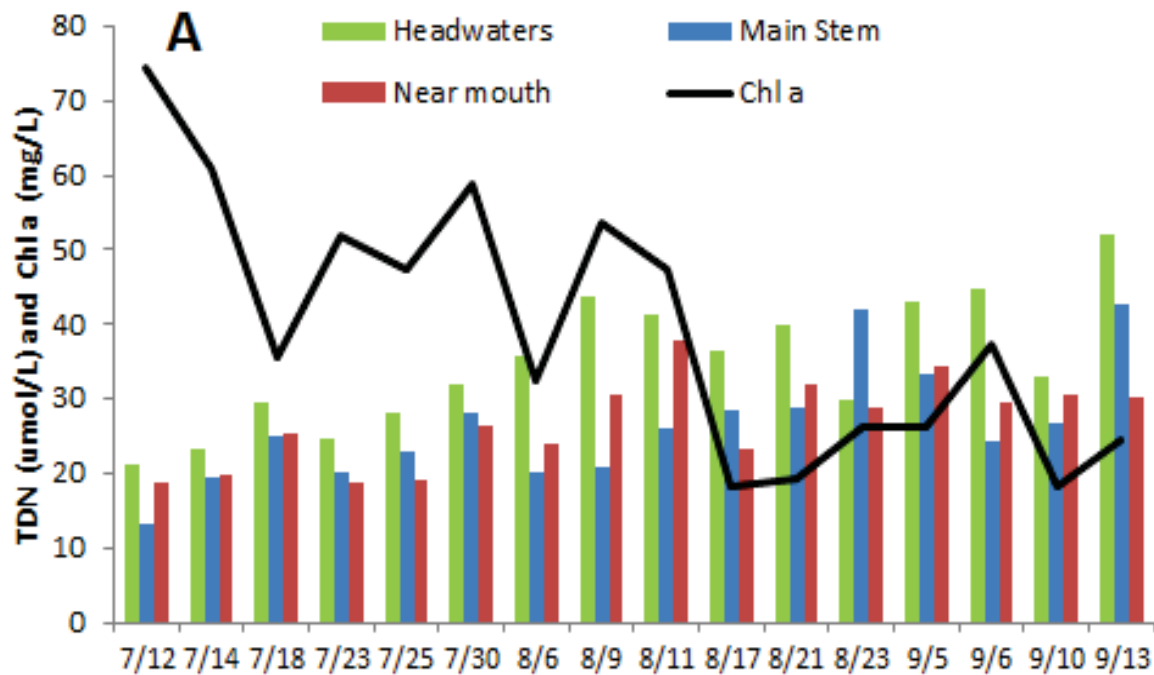
From Mulholland and Filippino (draft)
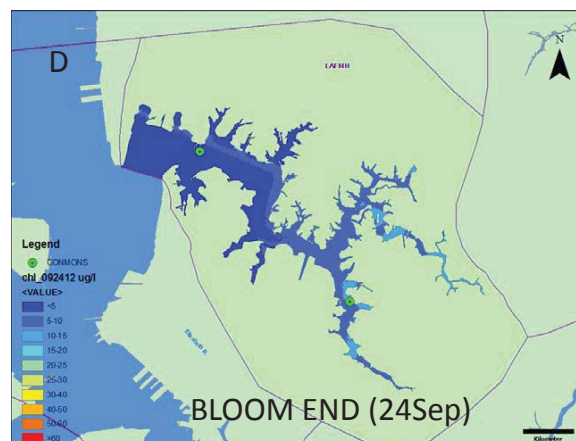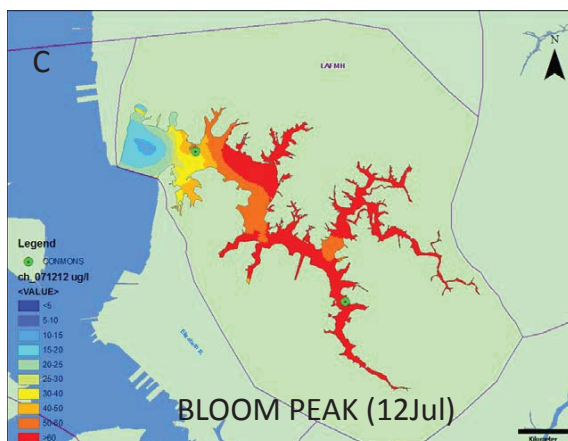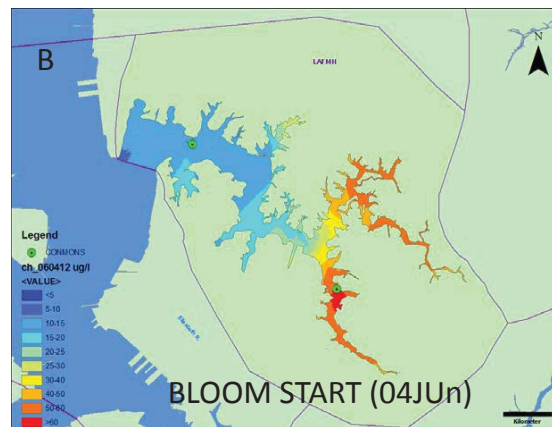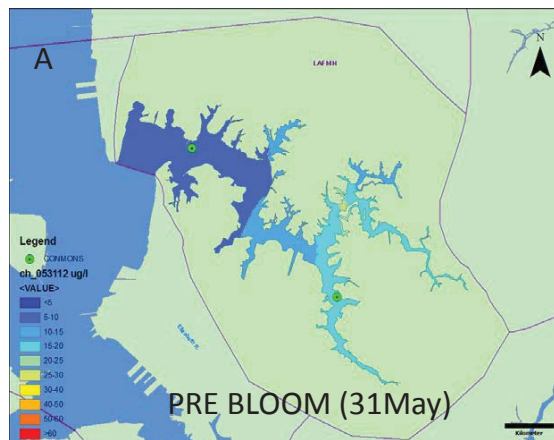
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River sampling : PO4+CHLA

From Mulholland and Filippino (draft)

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Dataflow 2012
(Water Quality Mapping)

A — PRE BLOOM (31May)

B — BLOOM START (04JUn)

C — BLOOM PEAK (12Jul)

D — BLOOM END (24Sep)

Acknowledgements

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Questions?

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