Water quality in the Oyster River Watershed: Interactions of storms and land use in headwaters and river

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- McDowell Lab

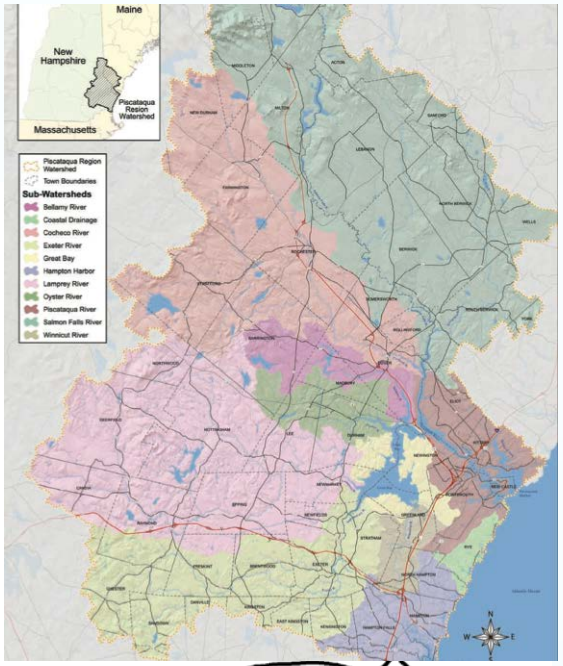
Rationale

- Great Bay is Nitrogen impaired
- EPA is asking communities to reduce N inputs
- Town of Durham and UNH are working together to develop an integrated permit
  - Simultaneously manage point and non-point sources
- Need to better understand non-point sources
  - Grab sampling is infrequent – so do more frequent measurements improve flux estimates? Where and when?
  - Variability with storms – can it indicate what to manage?
  - If we institute mitigation measures – how will we know they work?

Goal

- **Quantify the amount and temporal variation of N fluxes from Oyster River and various sub-watersheds using continuous and high frequency *in situ* measurements in order to establish a baseline of non-point export flux patterns.**

Study Design



Study Design

- Temporally intensive, measurement intensive
  - Satlantic SUNA for nitrate
  - Turner C6 or YSI for fDOM (DOC), Turbidity
  - Hydrolab or YSI Sondes (D.O., Conductivity, pH), Stage
- Temporally intensive
  - Stage, water temperature, and conductivity
- Grab sampling
  - Infrequent but needed for validation
  - Surrogate development
- Synoptic grab sampling
  - Headwater vs. larger tribs and rivers
- Transect grab sampling

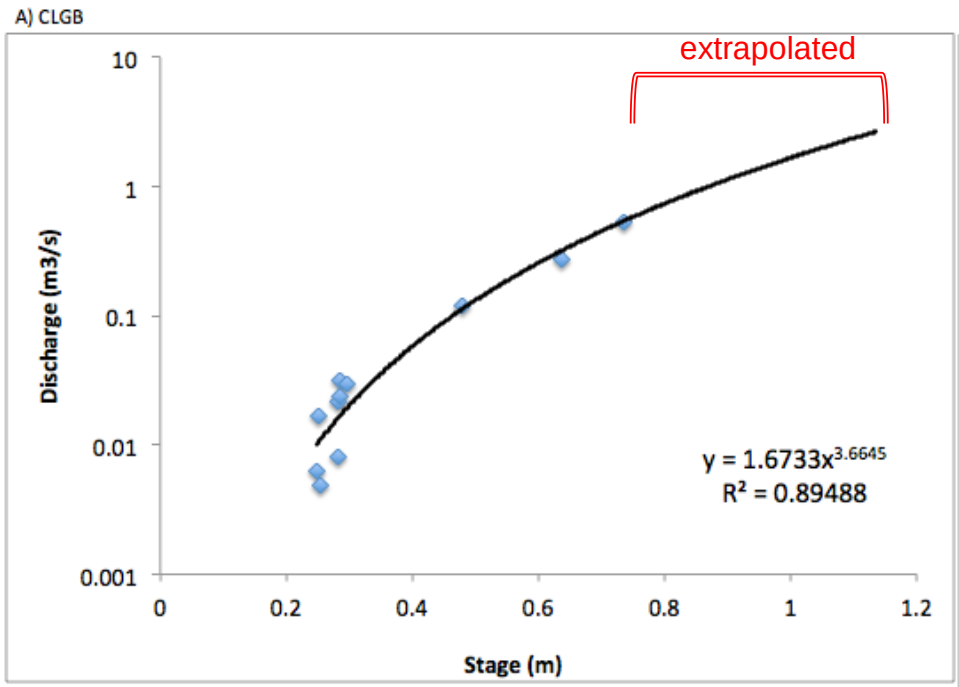
Oyster R. @ Mill Pond

College Br. @ Mill Plaza

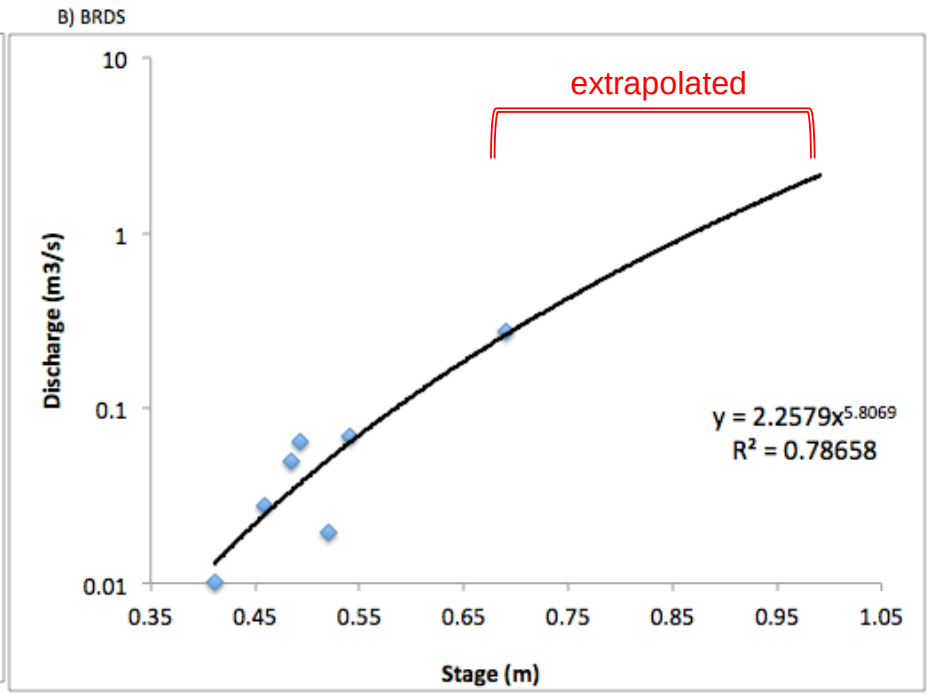
Beards Cr. @ Stolworthy

Discharge Rating Curves

College Br.



Beards Cr.

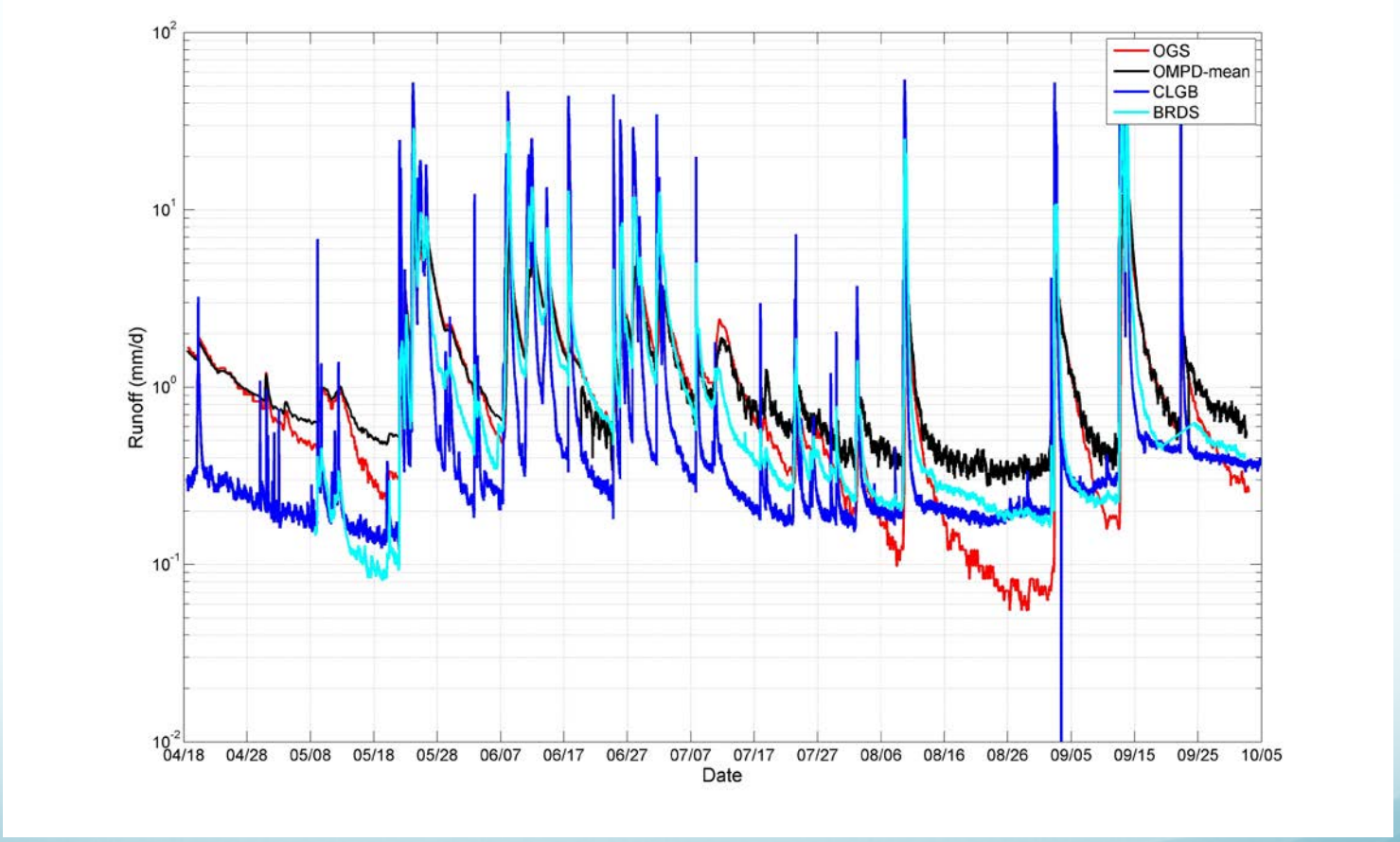


Because we need to extrapolate rating curves, high flow estimates are uncertain.

THEREFORE, flow weighted concentrations and fluxes presented today are preliminary

VERY Preliminary Discharges (standardized for watershed area)

OGS = Oyster USGS gage [[THE GOLD STANDARD FOR FLOW!]]



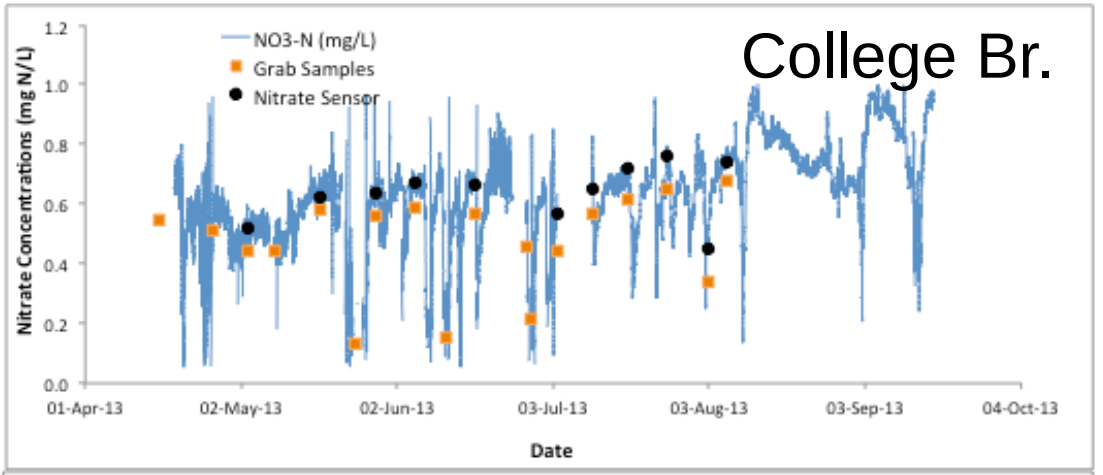
Flow patterns differ (e.g. length of storm event)

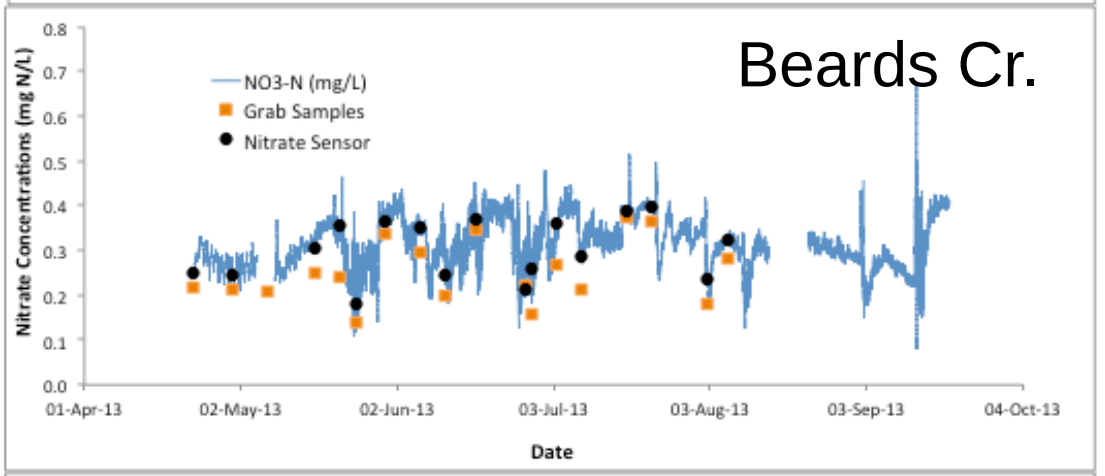
Intensive Nitrate Time Series

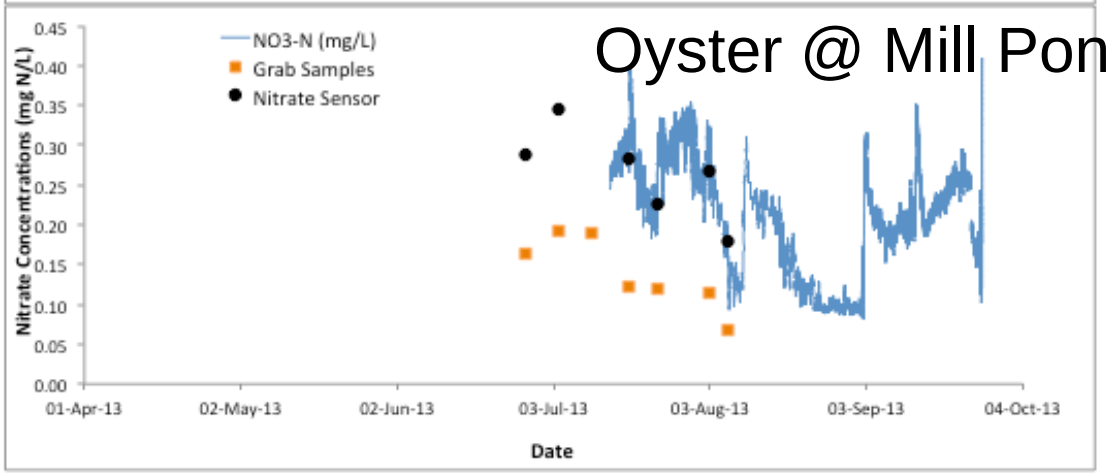
College Br.
-very flashy
-dilutes during storms
- first flush occasional and short term

Beards Cr.
- similar patterns
- lower baseline and less flashy than College

Oyster @ Mill Pond
- lower concentrations
- consistent storm pulses







Calculation of Flow-weighted Concentrations and Flux

Method	Discharge	Concentration	Calculation	Assumptions
Grab*USGS.Q	USGS Oyster R. gage	Weekly to bi-weekly grabs	Flow weighted concentrations * total flow	Assume runoff at measurement site identical to runoff at USGS gage; scale by watershed area
Grab*Local.Q	Local stage with rating curve	Weekly to b-weekly grabs	Flow weighted concentrations * total flow	Rating curve at local site is sufficient
SUNA*Local.Q	Local stage with rating curve	15minute concentrations from sensors, validated	15-minute Concentration * 15-minute flow	Rating curve at local site is sufficient, Instrument calibrated

Does high frequency sampling alter our estimates of flow-weighted concentration? April-October 2013

NO3 (mg N / L)

Technique

Stream	Grab*USGS	Grab*LocalQ	SUNA*LocalQ
College	0.41	0.26	0.38
Beards	0.21	0.14	0.17
Oyster Mill Pd	0.15	0.12	0.12
Oyster Gage	0.07	0.07	NA
Dube	0.07	TBD	NA
Chesley	0.31	TBD	NA
Pettee	0.22	TBD	NA

Concentrations tend to be lower when using local Q and high temporal resolution SUNA data (storm dilution).

How is nitrate concentration related to flow conditions? It depends.

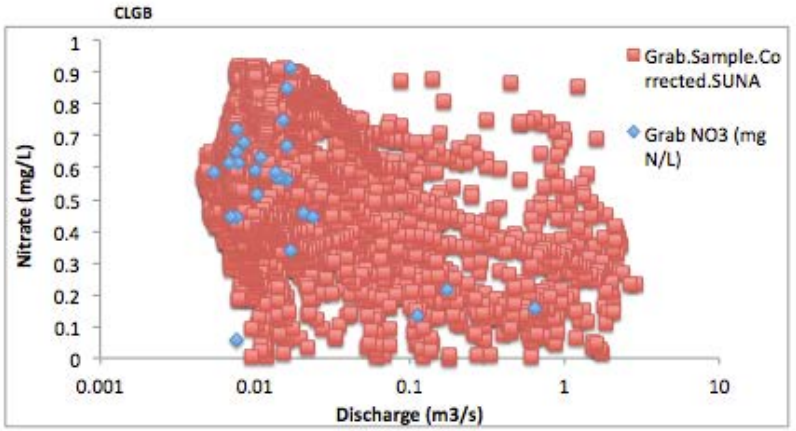
Headwater source areas decline with flow

Oyster mainstem tends to increase with flow

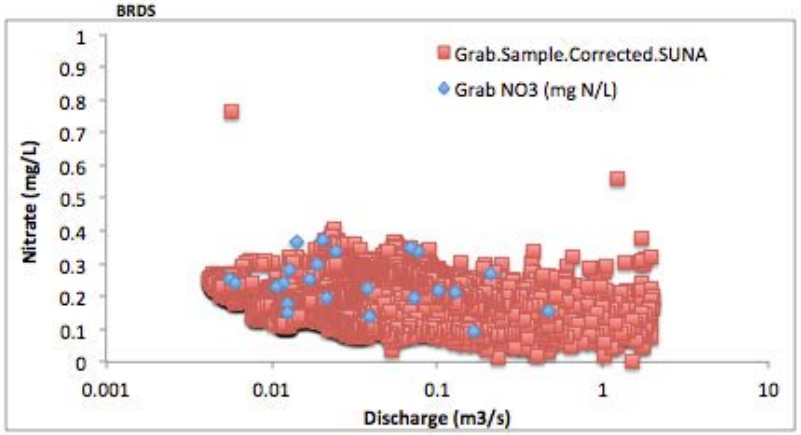
Oyster mainstem approaches the diluted level of the headwaters during storms

In highly variable systems (College), grabs miss a whole quadrat of C vs. Q relationship
- frequency of measurement at each flow level critical

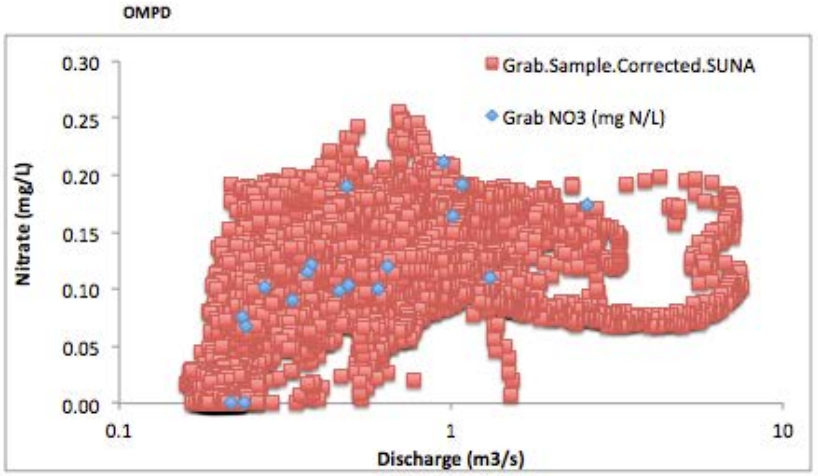
College



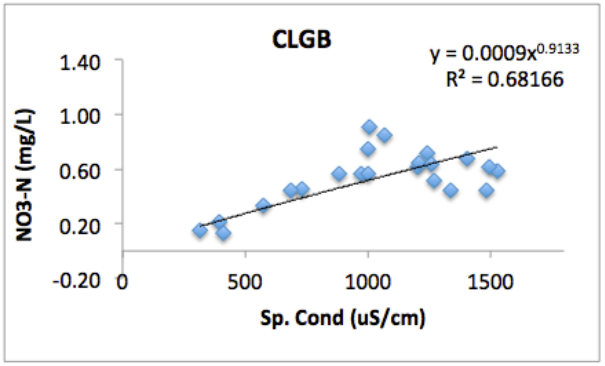
Beards

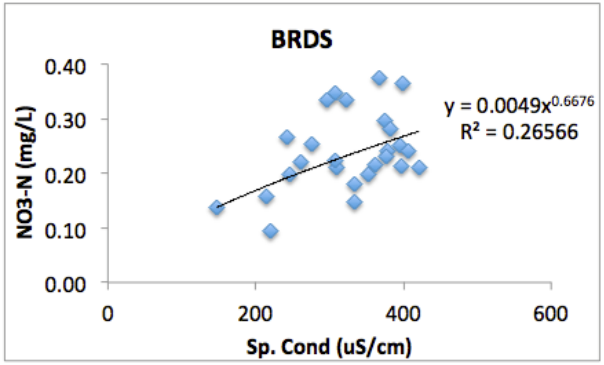


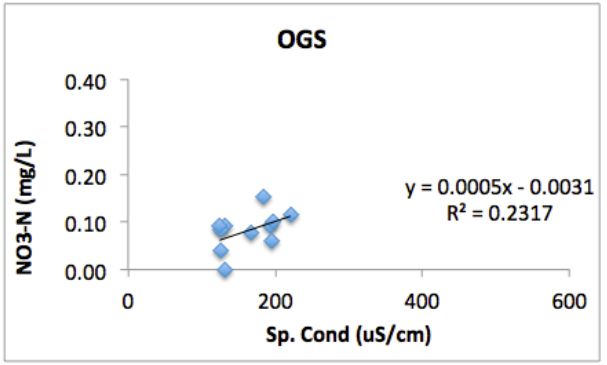
Oyster at Mill Pond

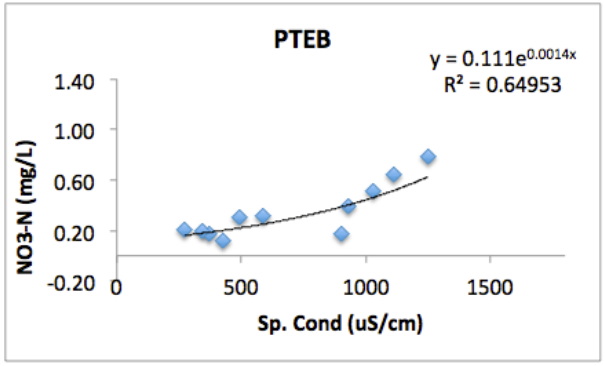


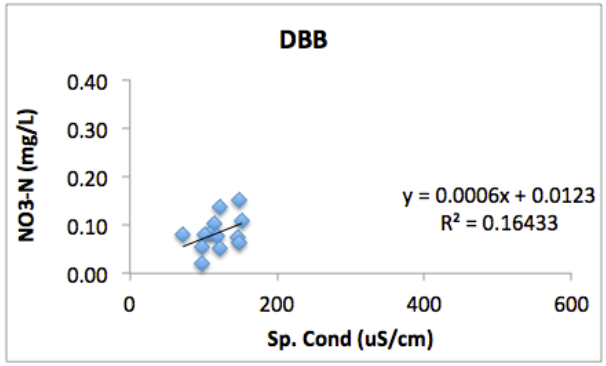
Is conductivity a potential surrogate for nitrate? Sometimes.

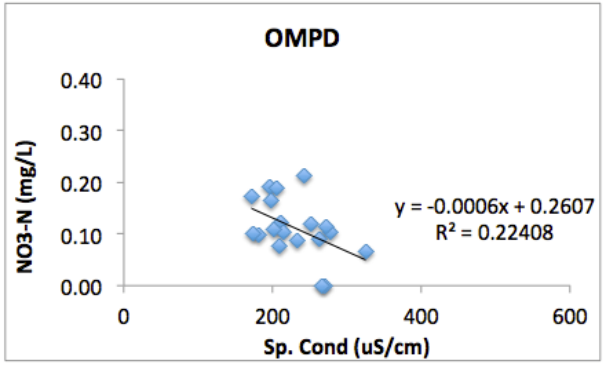


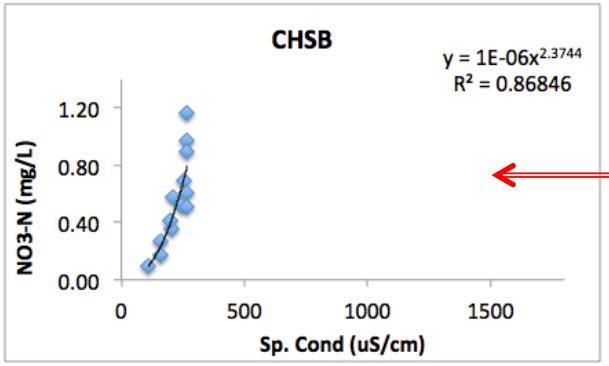












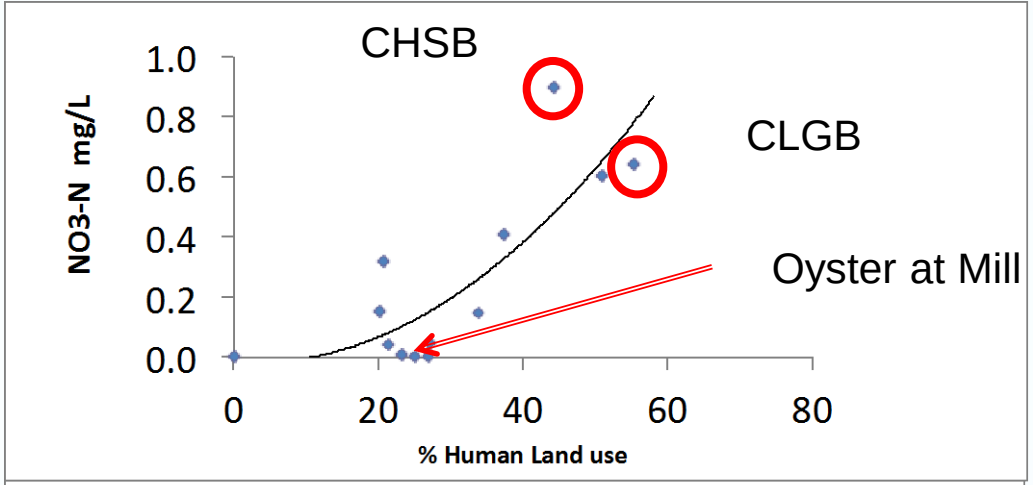
Agriculture dominated catchment (highest NO3)

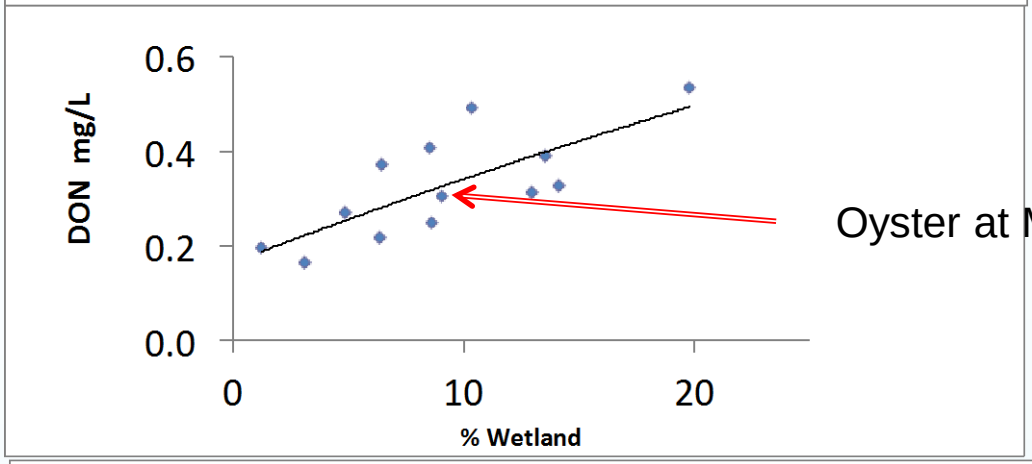
How representative are the intensive sites?

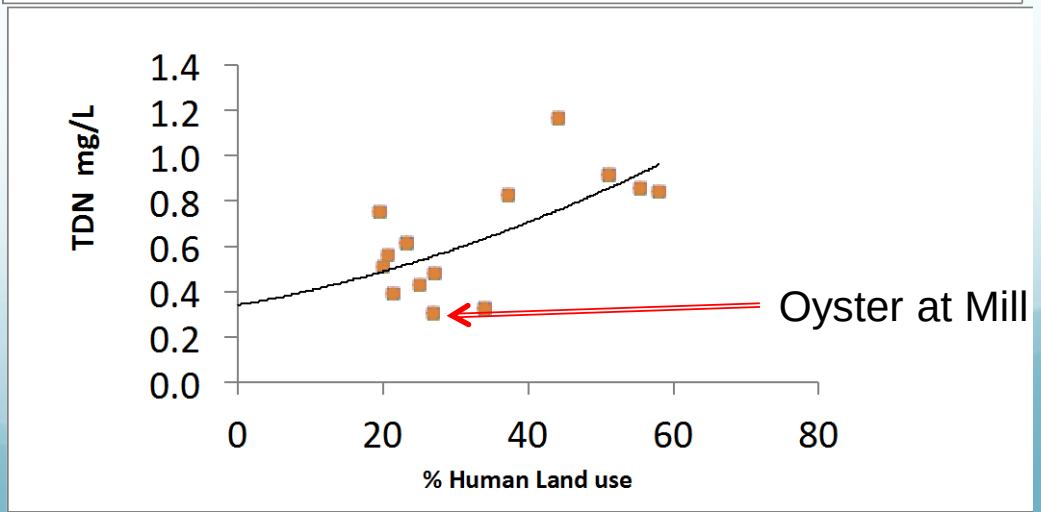
A synoptic snapshot

Low flow conditions Aug 8, 2013

Because NO3 and TDN at mouth is lowest, suggest high inorganic N retention, at least during low flows.







Conclusions

- Temporally intensive measurements reveal unique nitrate dynamics in different types of watersheds
  - Management relevant
- Actual flow-weighted nitrate concentrations are likely lower than estimated by grab samples
  - Storm dilution tendency
- Urban areas are polluted by excess salt and nitrate, while agricultural areas more polluted by excess nitrate
  - Use nitrate to conductivity relationships to improve budgets from other systems
- High retention by river system during low flows
  - Will look at other seasons, flow levels
- Good discharge rating curves are critical

Thank You!

Stream	Watershed Area (km2)	% Urb	%Agric.	% Wetl.
College	3.7	34.4	16.7	4.9
Beards	5.6	39.0	4.8	3.0
Oyster Mill Pd	49.1	19.0	7.9	9.0
Oyster Gage	31.6	-	-	-
Dube	2.1	13.1	7.1	14.1
Chesley	3.9	20.6	23.7	8.7
Pettee	1.6	48.7	6.7	1.3

Why report on the Oyster R. Watershed in a Symposium on the Lamprey?Because its part of the Lamprey! (Via Water Supply)

Time Line of In Situ Nitrate Sensor Deployments

- Lamprey R. initial in situ deployment Fall 2010
  (NHAES)
- Lamprey R. 2011 (April-December)
  (NHAES)
- Lamprey R. and headwaters 2012 (August-present)
  SeaGrant and EPSCoR)
- Oyster R. and headwaters 2013 (April-December)
  (UNH Facilities, Durham, NHAES)

(NH
Cedarholm
Via Wiswall
Dam