Sediment Oxygen and Nutrient Exchanges Across Strong Estuarine Gradients: A Comparison of Biogeochemical Processes from Multiple Chesapeake Bay Tributaries

Eva Machelor Bailey

Jerry Frank
Frances Rohland
Paul Smail
Robert Stankelis
Walter Boynton

University of Maryland
Center for Environmental Science
Chesapeake Biological Laboratory

Overview

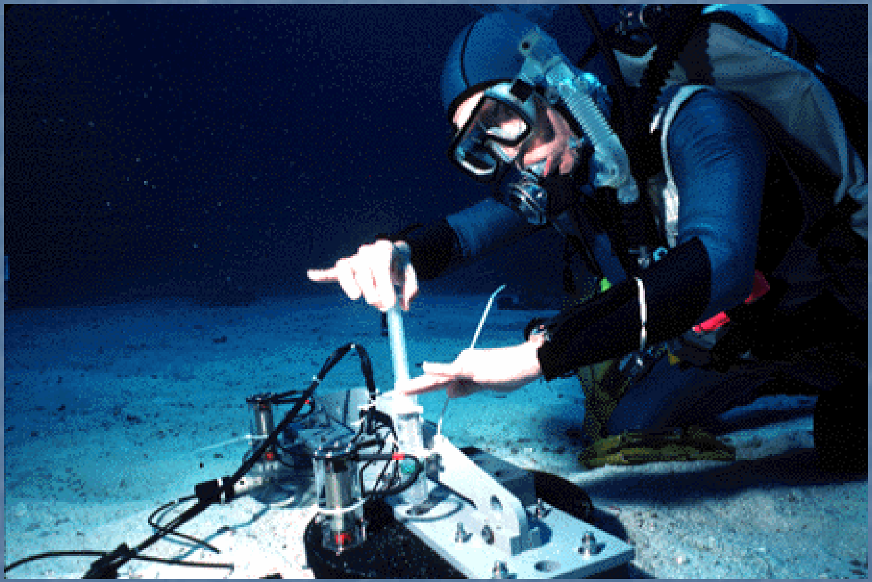
- Background
- Methods
- Site Locations
- General Ranges (Tributary Comparisons)
- Results
- Conclusions
- Acknowledgements

Background

- Numerous studies and modeling exercises have shown tight coupling between benthic and pelagic processes in shallow water ecosystems.
- With growing needs to better manage coastal waters efforts have been increased to understand the pathways of benthic-pelagic coupling.
- In 1985 we began a series of sediment-water flux measurements of oxygen and nutrients (SONE) as part of a long term monitoring program funded by Maryland Dept of Environment, Maryland DNR and NSF.

Methods

- SONE (sediment oxygen and nutrient exchange) experiments are usually conducted using one of two main methods
  - In-situ benthic metabolism chambers



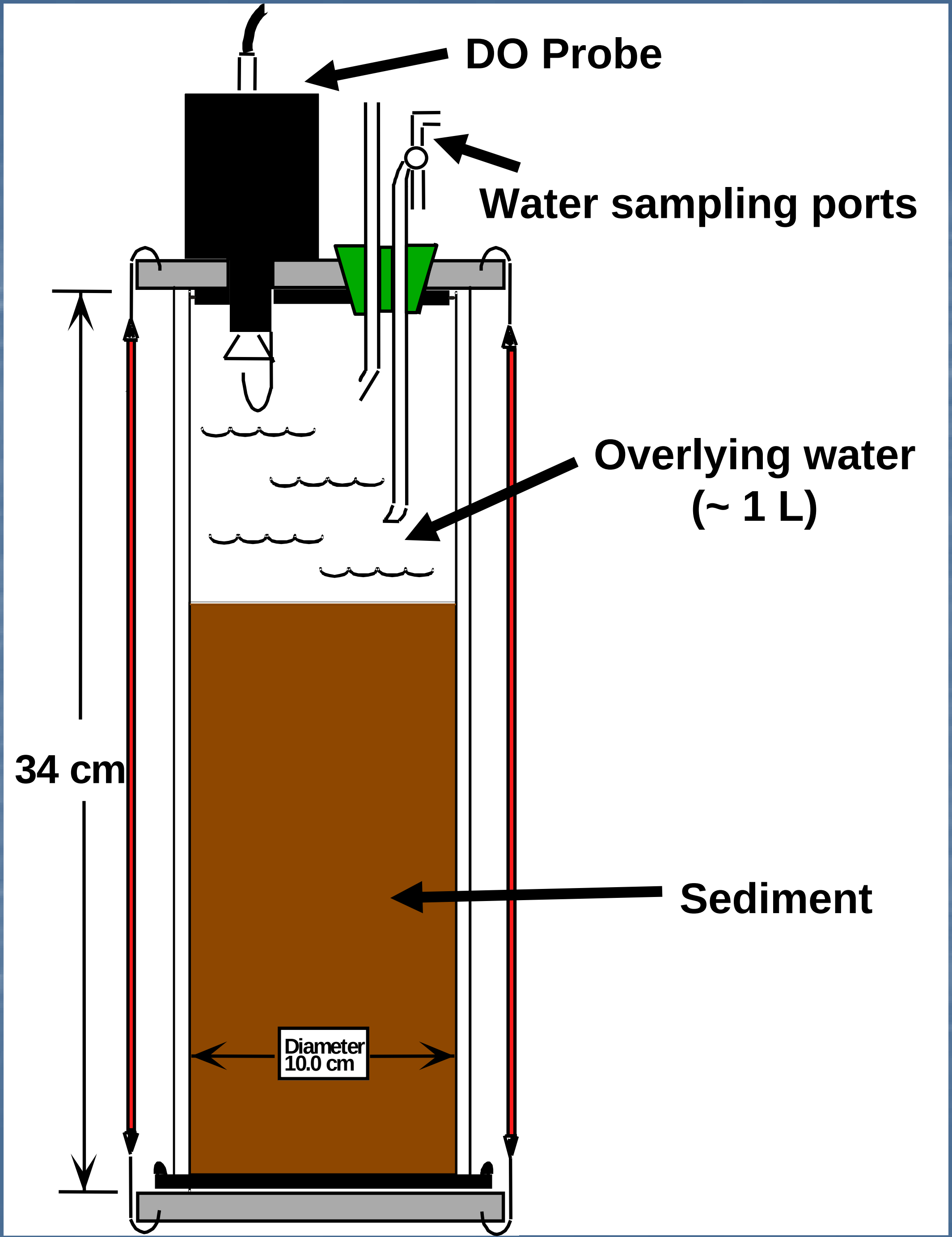
(TAMU)

(Queensland Dept. of Natural Resources and Mines)

- Intact Sediment Core Incubations

Bouma box corer

Plexiglas flux chambers



Flux Measurements

- Dark
- In-situ temperature
- Continuously stirred
- 3 hour incubations
- Hourly samples :
  - Dissolved Oxygen
  - Water Temperature
  - DIN
  - DIP

Flux chamber equipment aboard R/V Aquarius

Site Variables

Water Column

Profiles

- DO, T and S
- Turbidity

Bottom Water

- Water for flux incubations
- DIN and PO4

Sediments

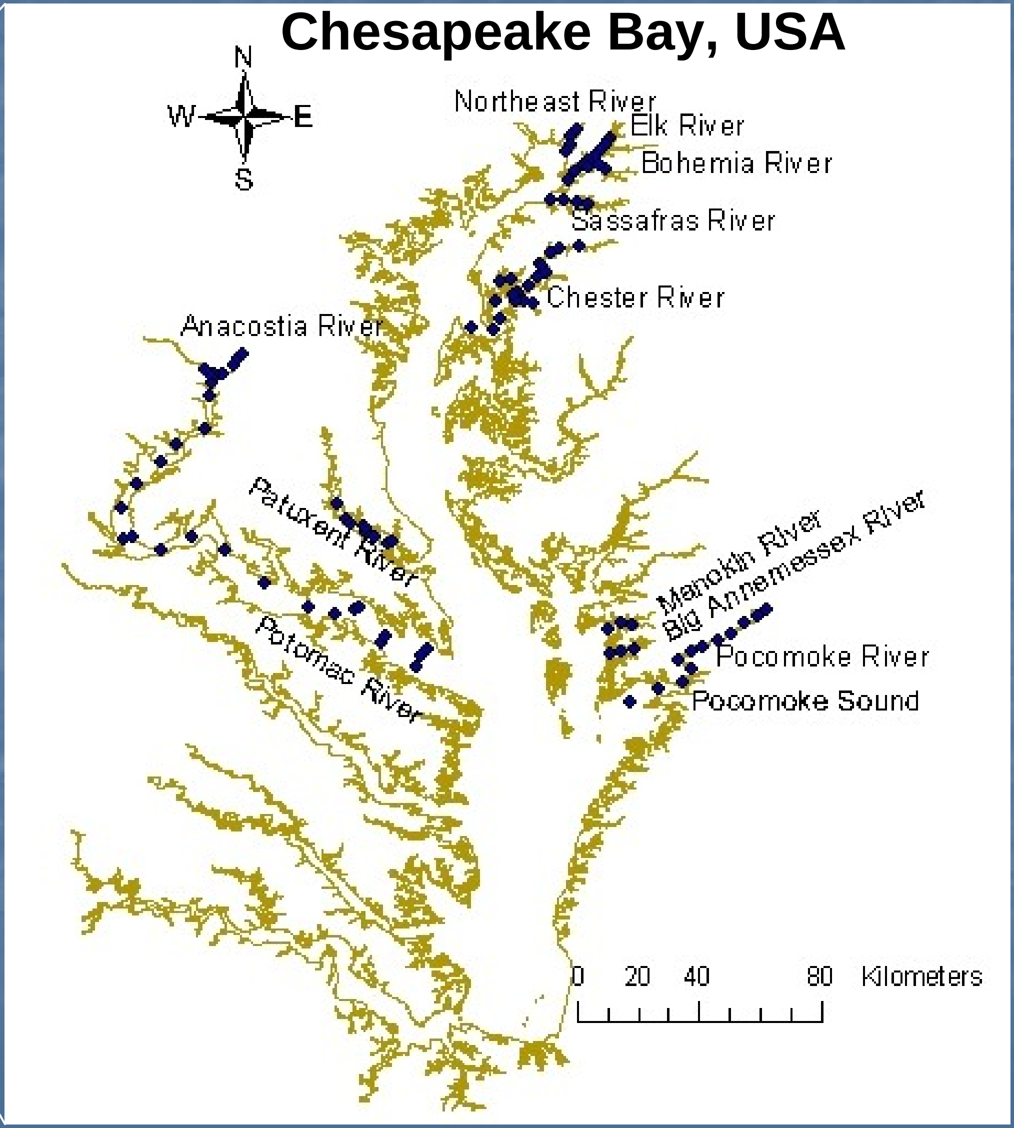
Eh Profiles

- Overlying water
- 1 cm intervals to 10 cm

Surficial Sediments (1 cm depth)

- Chlorophyll-a
- PC, PN, PP

Site Locations



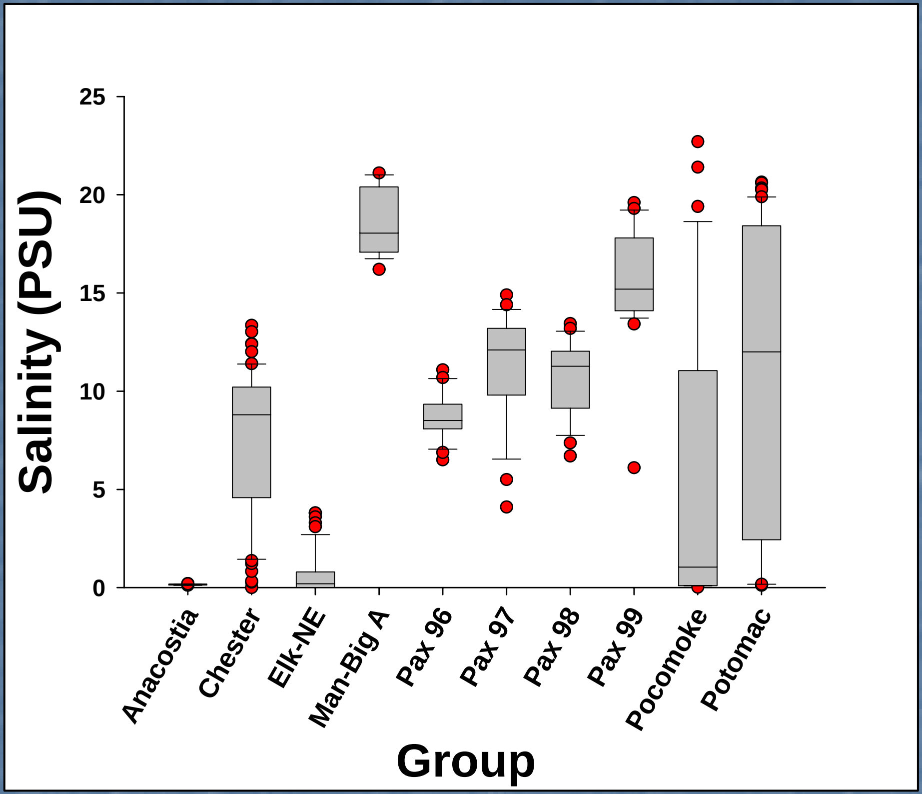
- 12 Tributaries
- 124 Stations

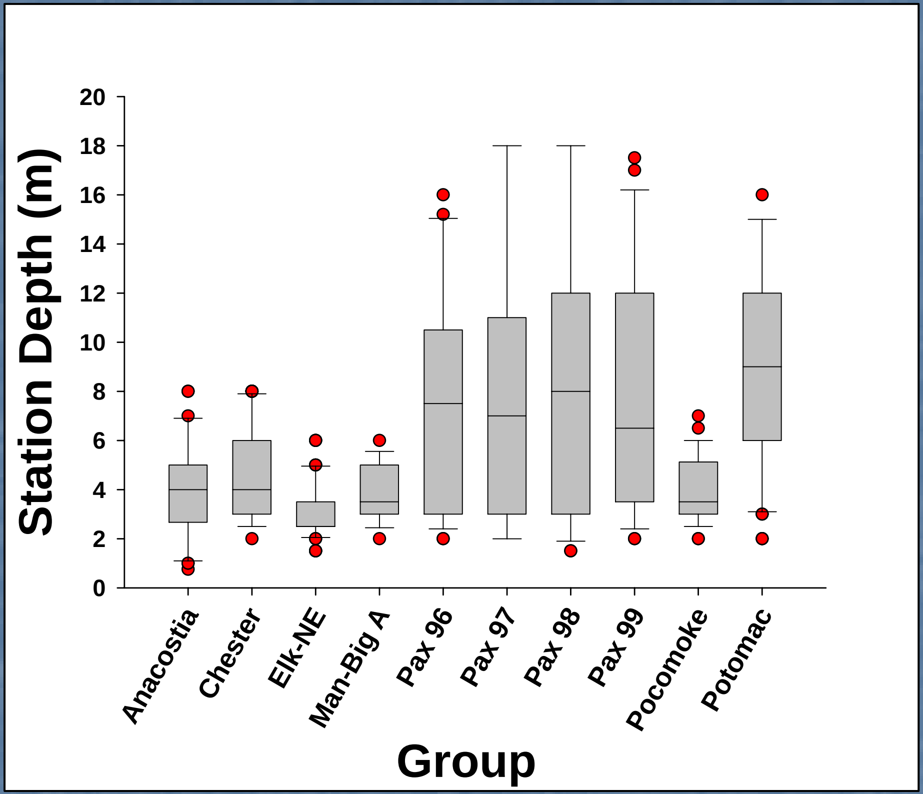
Dataset Groupings

Group	Name	Tributaries	# of Stations
1	Anacostia	Anacostia River	10
2	Chester	Chester River	20
3	Elk-NE	Elk, Bohemia, Sassafras, Northeast Rivers	20
4	Man-Big A	Manokin and Big Annemessex Rivers	6
5	Pax 96	Patuxent River	9
6	Pax 97	Patuxent River	9
7	Pax 98	Patuxent River	9
8	Pax 99	Patuxent River	9
9	Pocomoke	Pocomoke River and Sound	12
10	Potomac	Potomac River	20

N = 372 observations

Site Variable Ranges





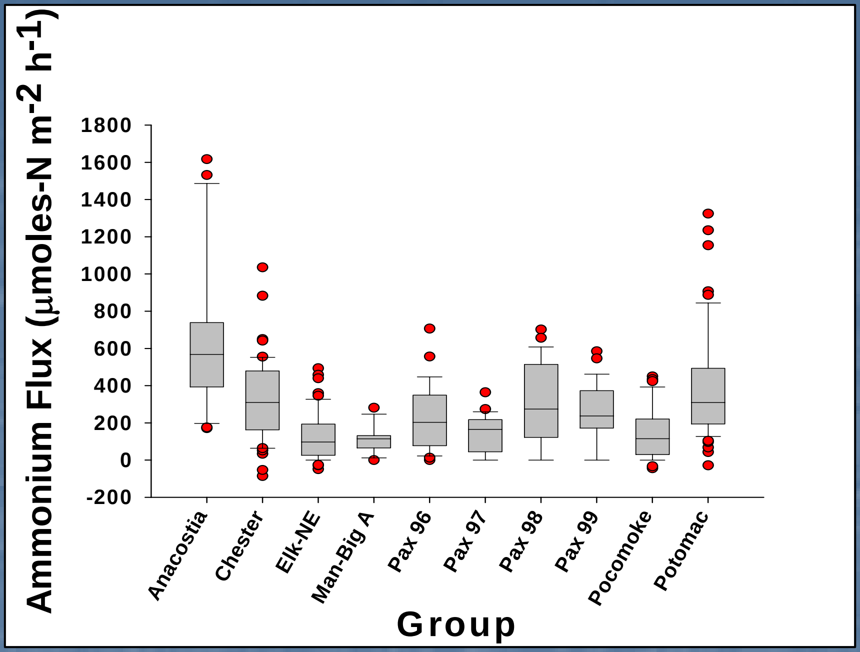
Salinity
(0 to 23 PSU)

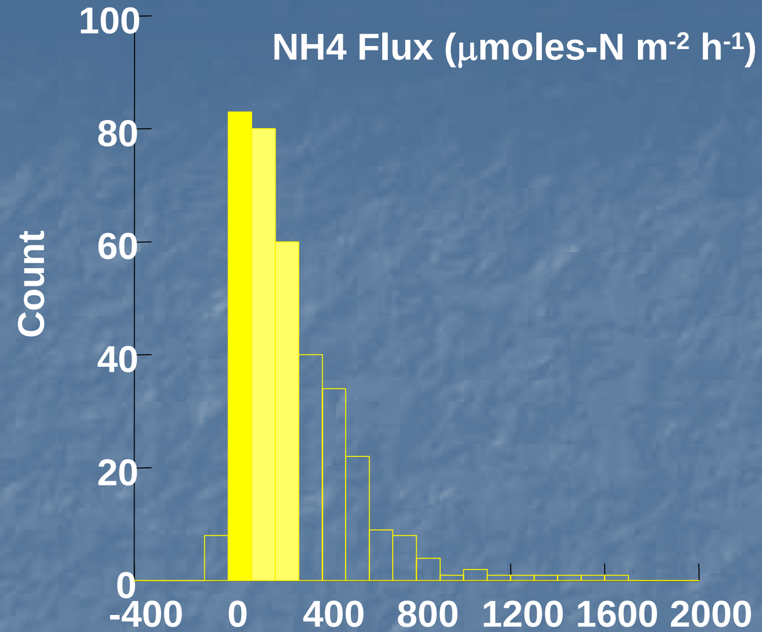
Station Depth
(1 to 18 m)

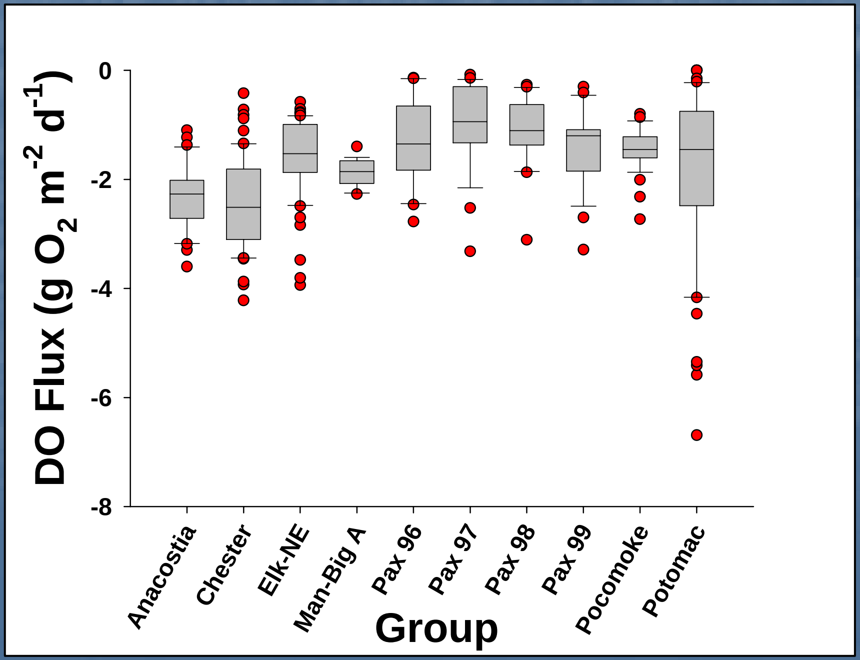
Site Variable Ranges

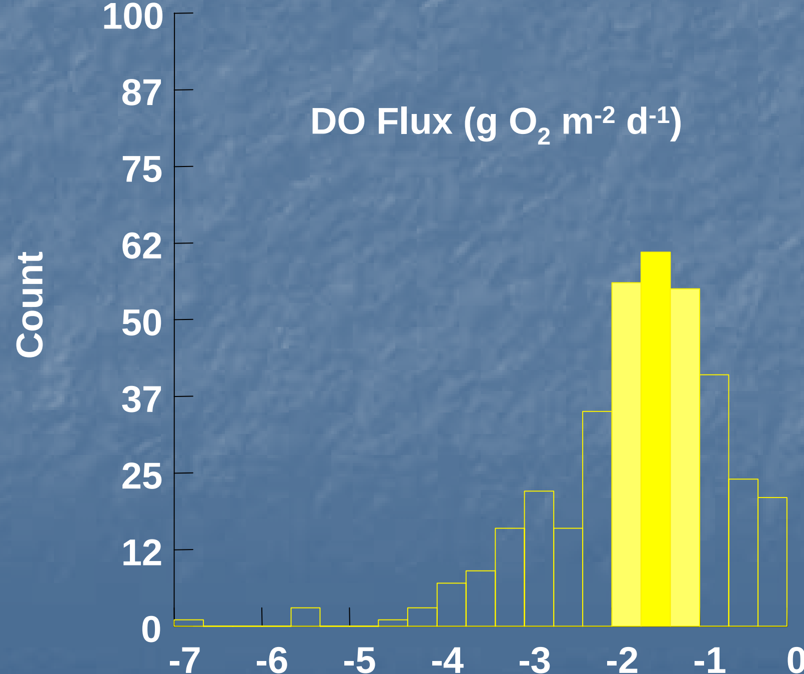
Water Column / Sediment Variable	Range
Temperature	19 to 30 °C
Dissolved Oxygen	0 to 12 mg L^{-1}
Ammonium	0 to 40 μM
Phosphate	0 to 3 μM
Sediment Chlorophyll-a	11 to 223 mg m^{-2}

Flux Measurements

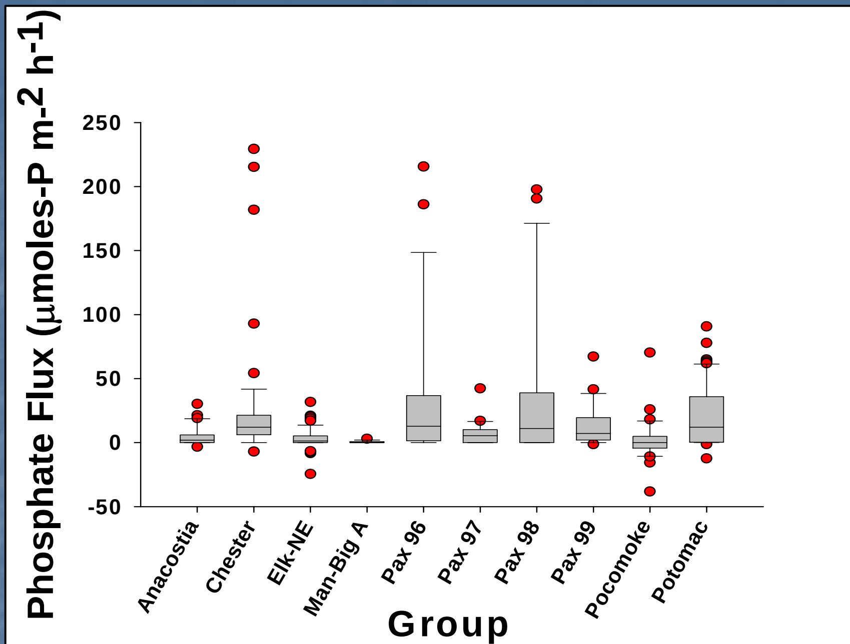


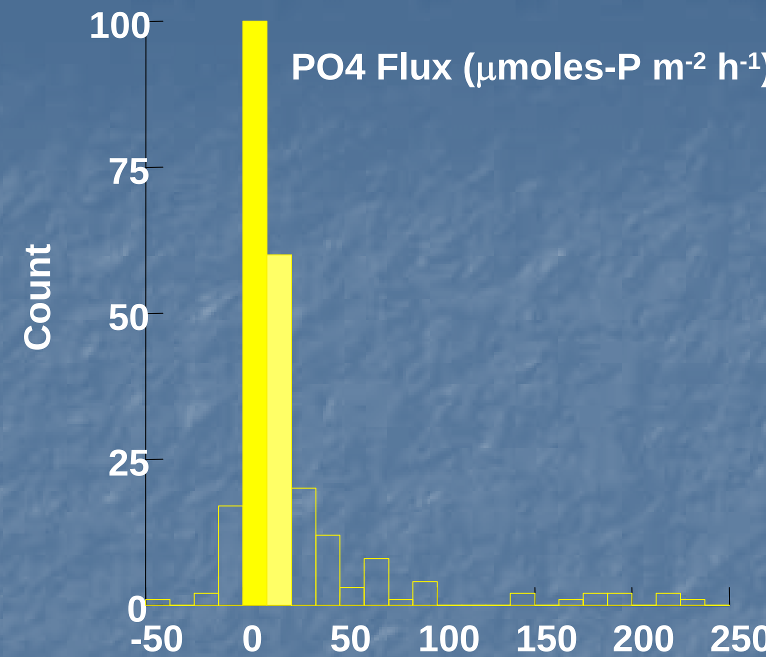


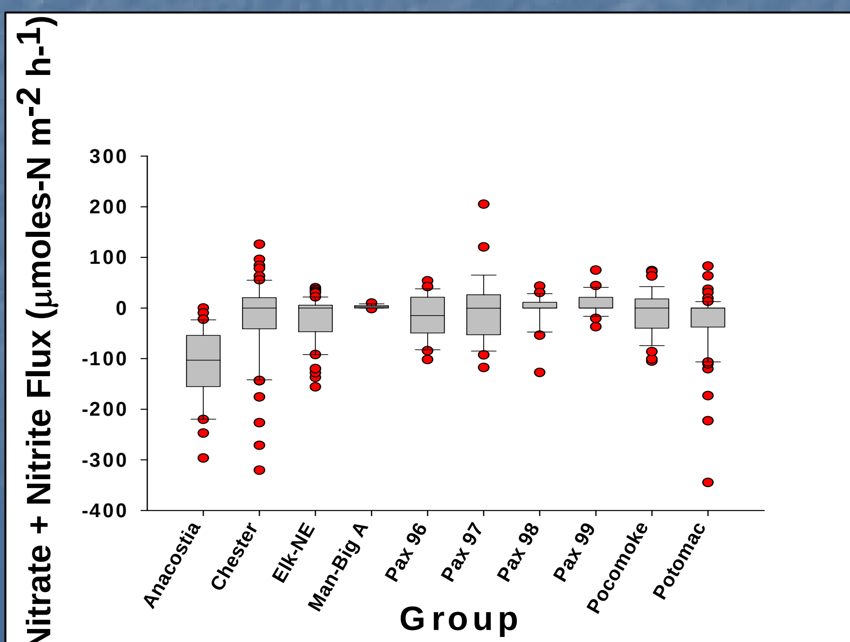


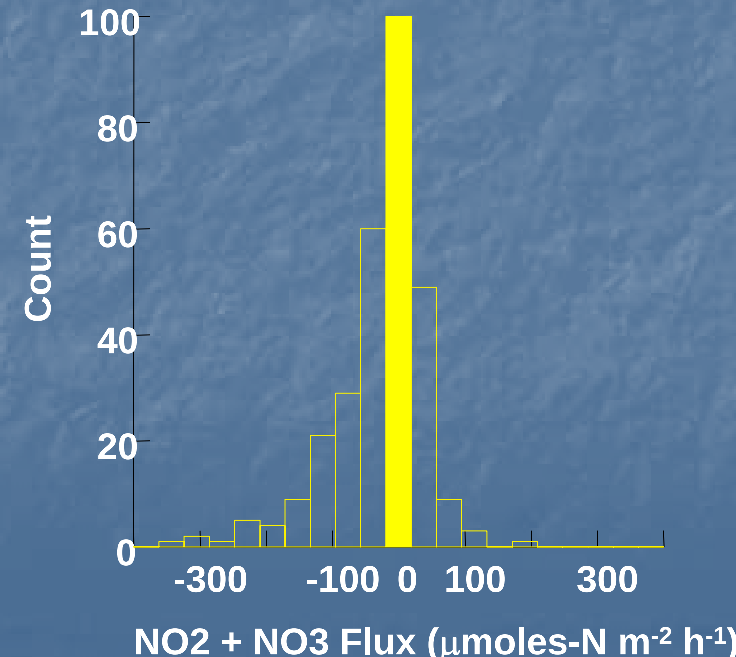


Flux Measurements





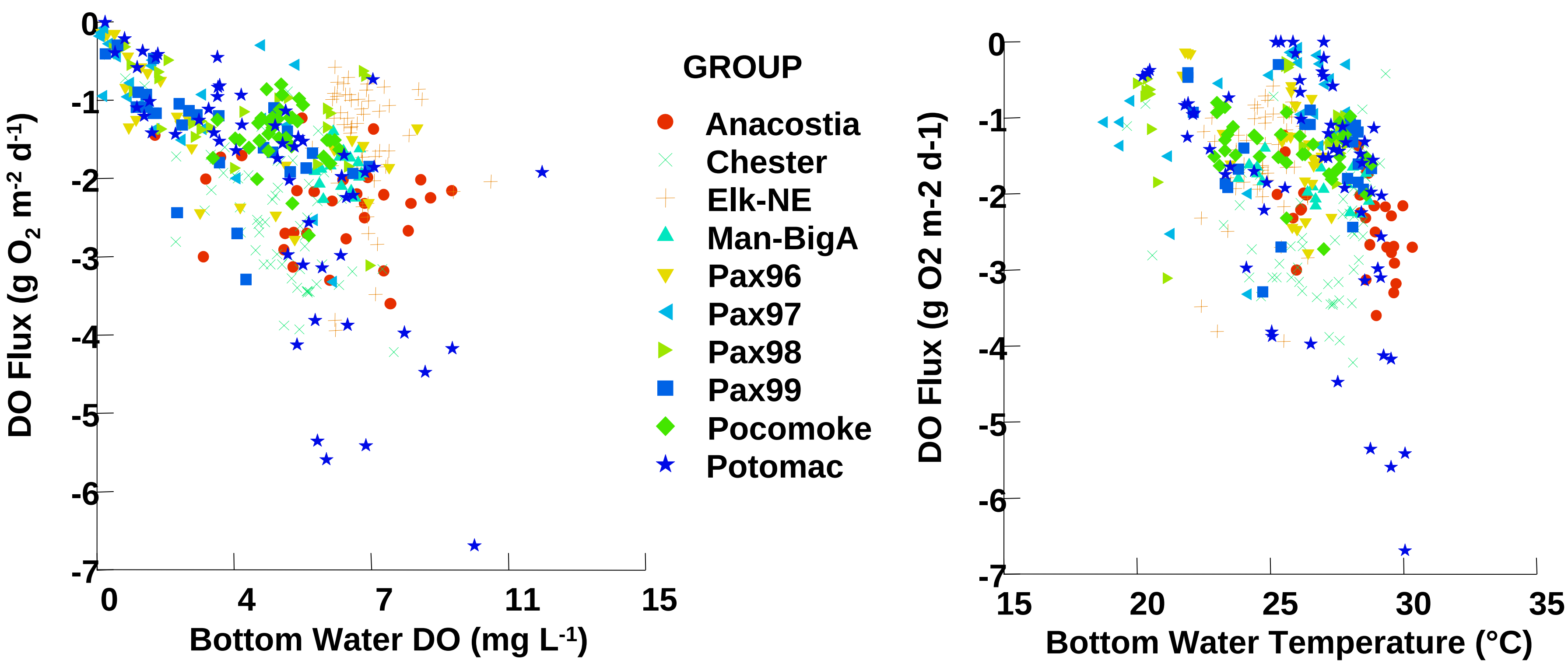




Results

- Previous studies had found good relationships predicting fluxes of dissolved oxygen and nutrients using site variables such as:
  - Total sediment chlorophyll-a
  - Bottom water dissolved oxygen
  - Bottom water temperature
  - Bottom water dissolved nutrients
  - Sediment Eh
- Testing the larger dataset showed that these relationships were more complex; simple linear models did not work!

Results



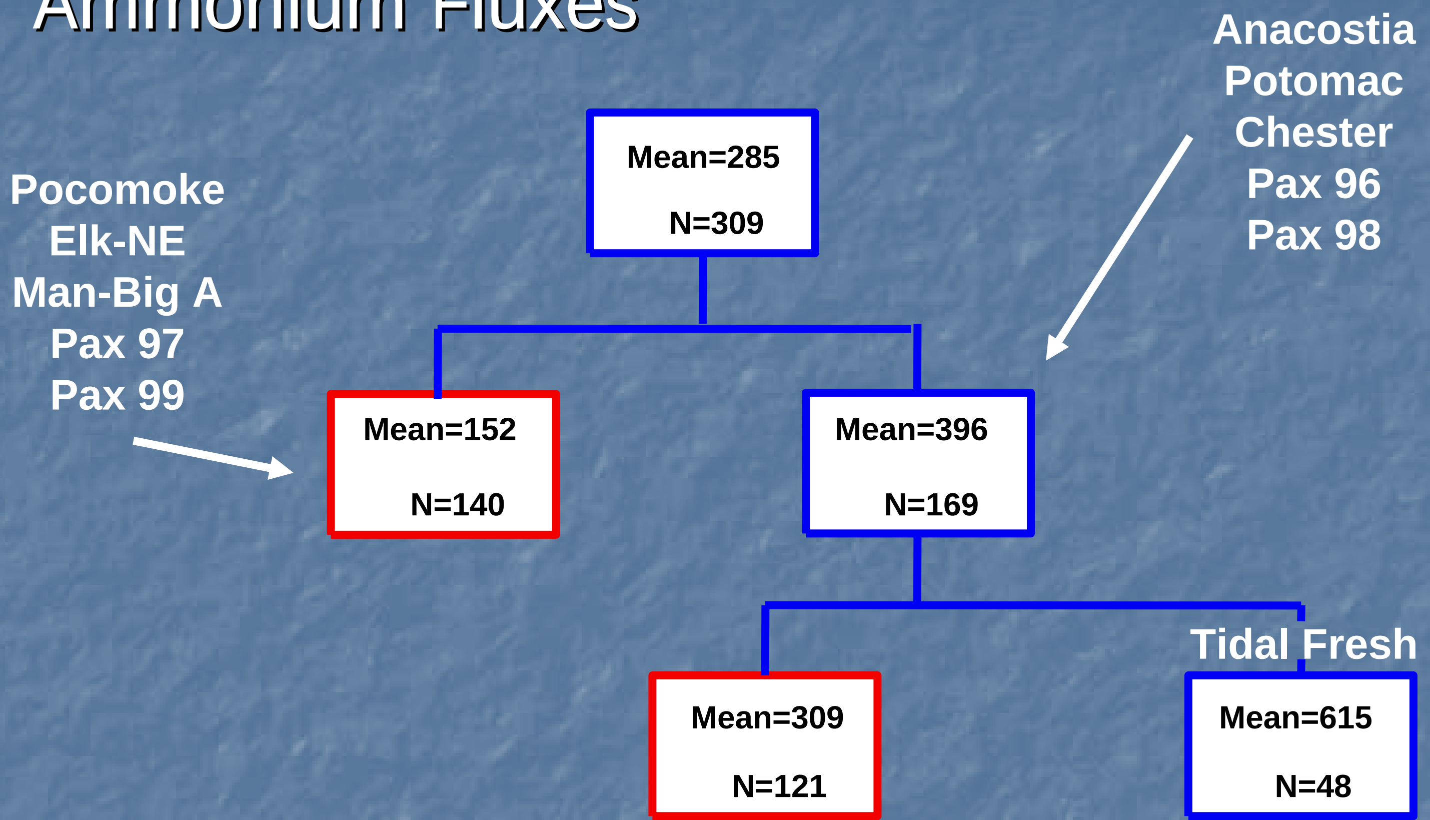
DO Flux (g O2 m-2 d-1)
0
-1
-2
-3
-4
-5
-6
-7
0
4
7
11
15
Bottom Water DO (mg L-1)
GROUP
Anacostia
Chester
Elk-NE
Man-BigA
Pax96
Pax97
Pax98
Pax99
Pocomoke
Potomac
DO Flux (g O2 m-2 d-1)
15
20
25
30
35
Bottom Water Temperature (°C)

Results

- Since complexity is the “name of the game” with this type of data, we decided to take a multivariate approach and utilize a classification and regression tree technique
- This is a nonparametric method and can be used to analyze either categorical (classification) or continuous (regression) data

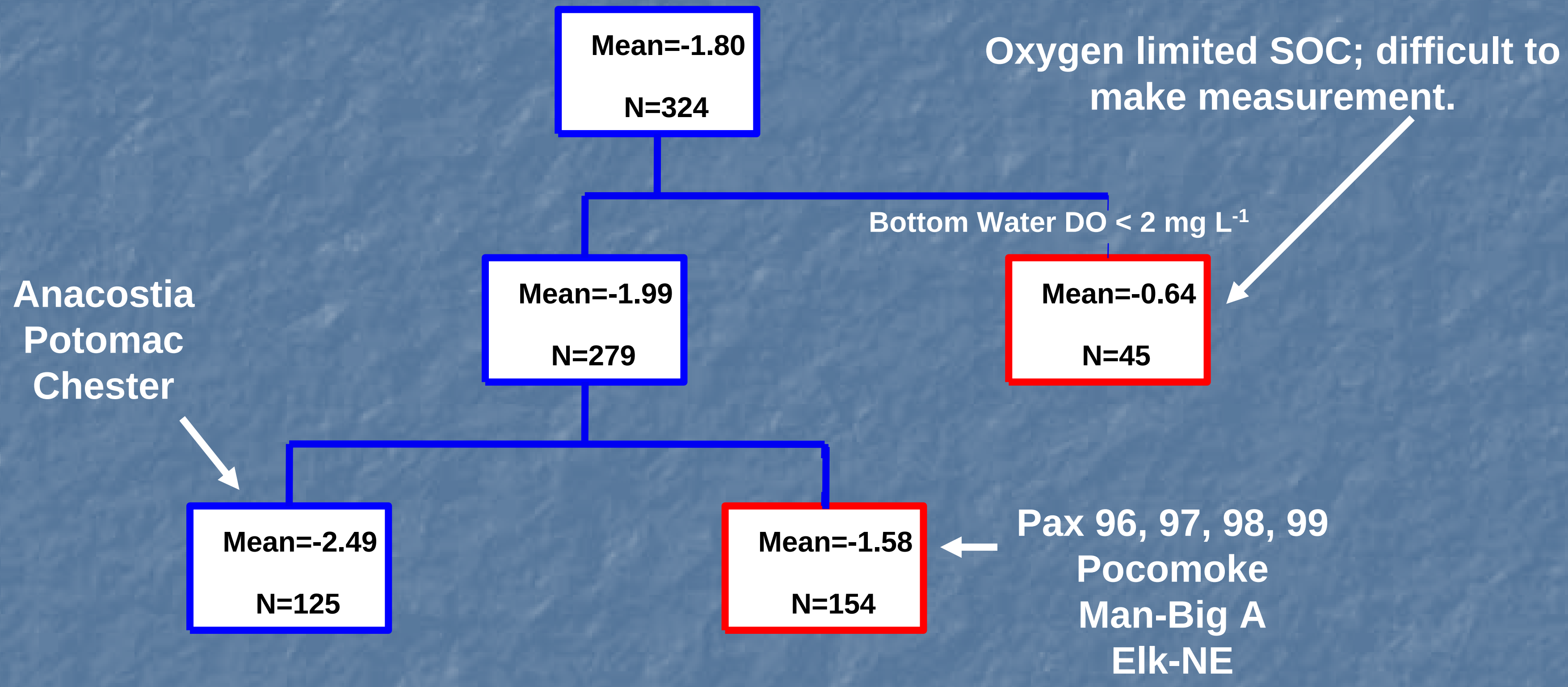
Results

- Ammonium Fluxes



Results

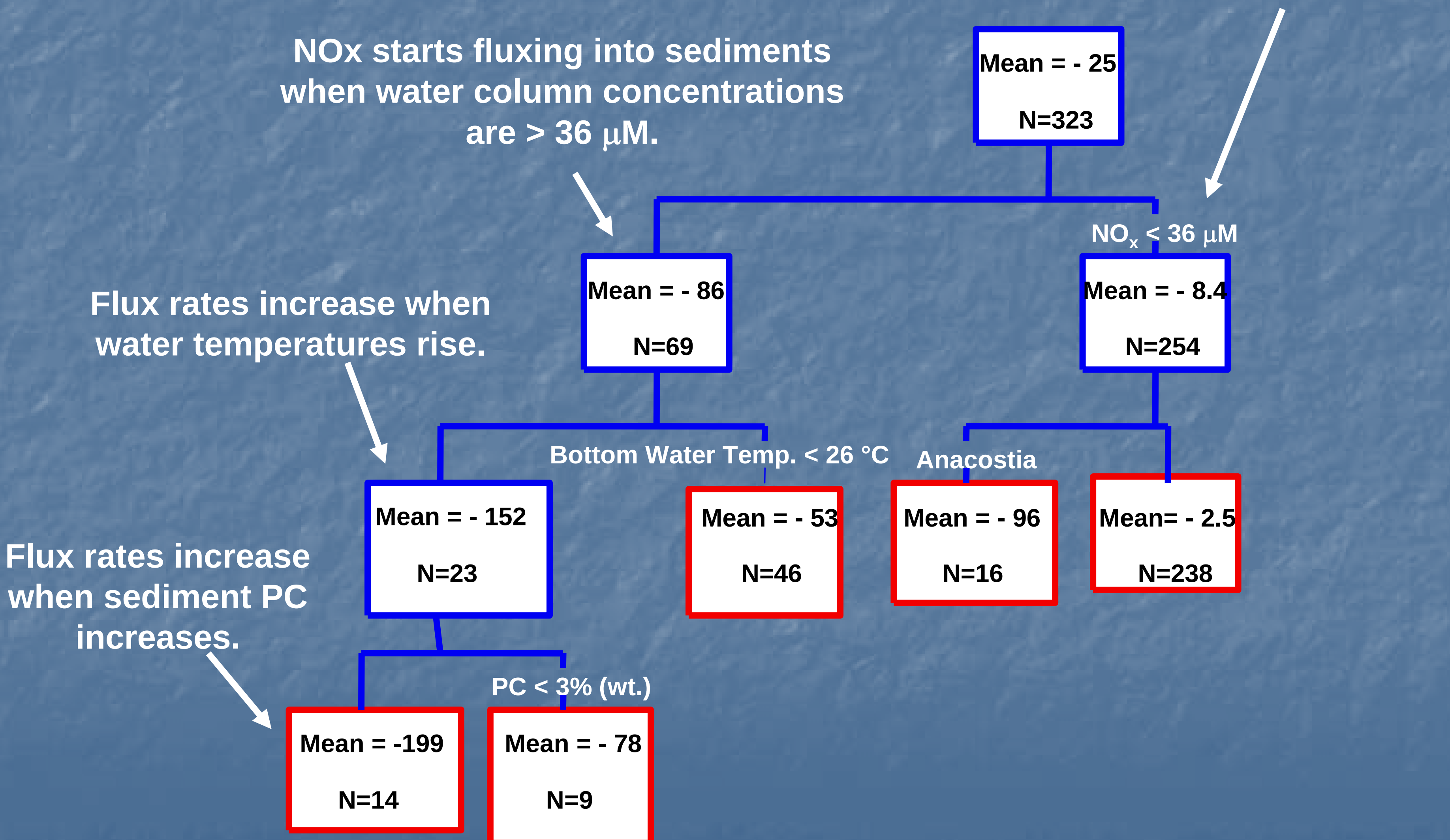
- DO Fluxes



Results

- ## Nitrate + Nitrite Fluxes

Most of the time NO_x concentrations are low and flux rates are low.



Conclusions

- Ammonium fluxes were higher in summer in more enriched systems, in years of higher rainfall and closer to urban areas.
- SOC rates were low or nonexistent when dissolved oxygen levels were low.
- Nitrite and Nitrate fluxes into sediments were related to concentrations in overlying waters (into sediments when concentrations were high).
- Classification and regression tree analyses show promising results for identifying relationships more complex than can be captured by simple linear models.

Acknowledgements

Past GONZO Field Crews
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CBL RFO
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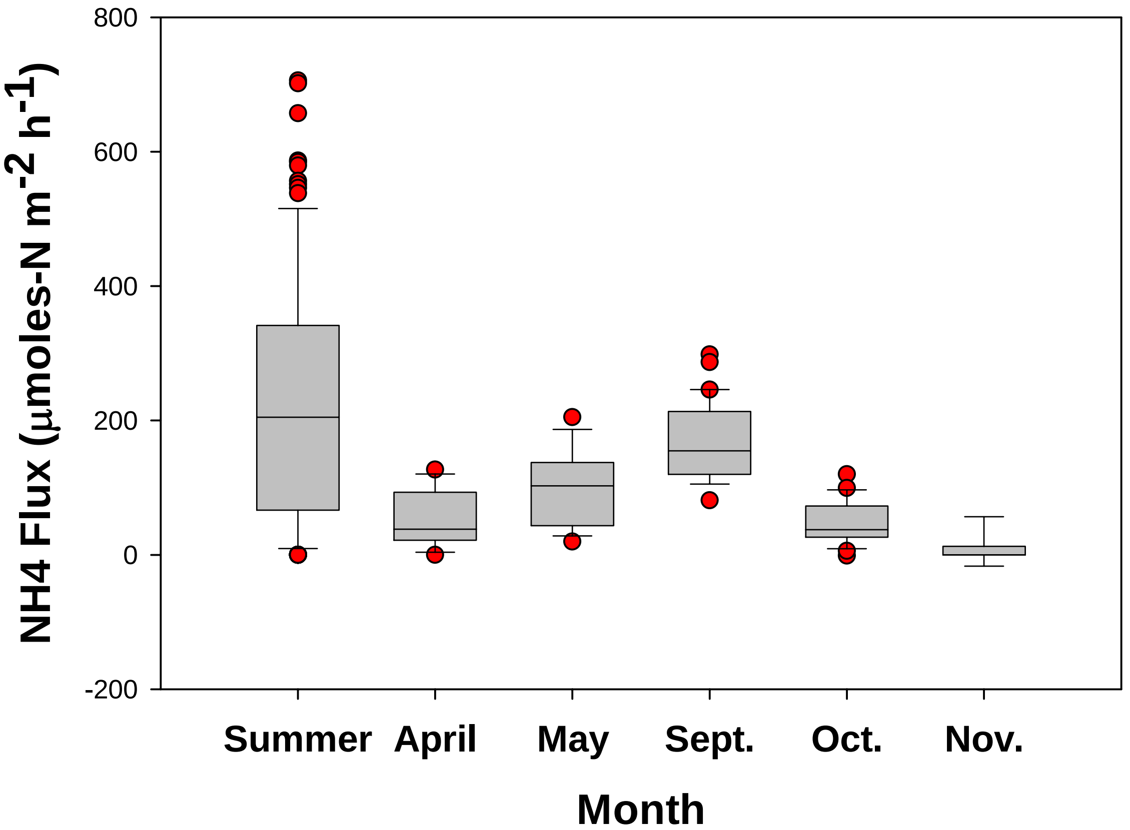
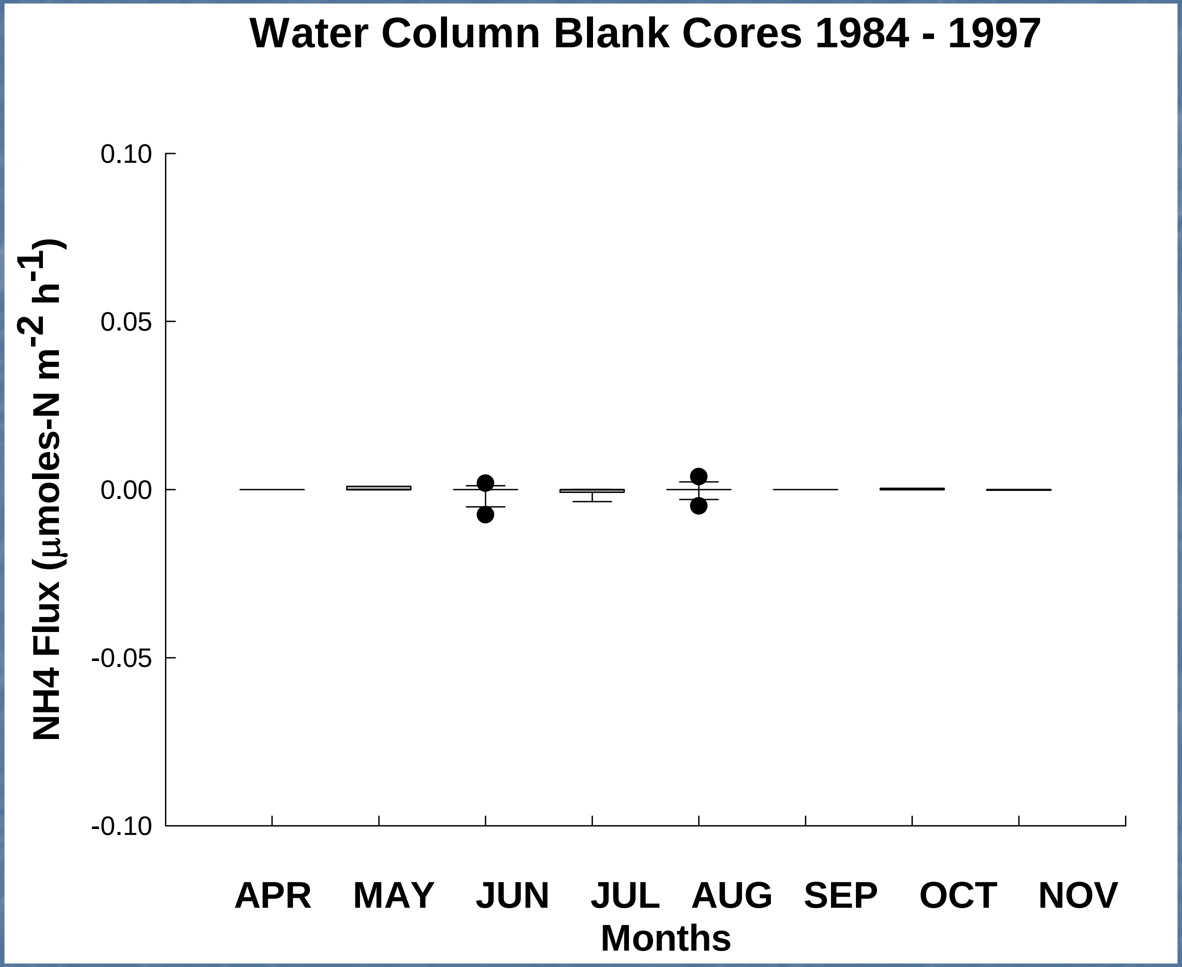
R/V Orion
Jeff Cooke
Brian Elder
Orbisphere
Jack Seabrease
Mr. Frank (Jerry’s dad)
Breakfast Pizza
Seattle’s Best Henry’s
Nitrile Gloves (purple)
MDE
DNR
Government of D.C.
NSF

Patuxent River Ammonium Fluxes




Water Column Blank Cores 1984 - 1997
NH4 Flux (µmoles-N m-2 h-1)
0.10
0.05
0.00
-0.05
-0.10
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
Months