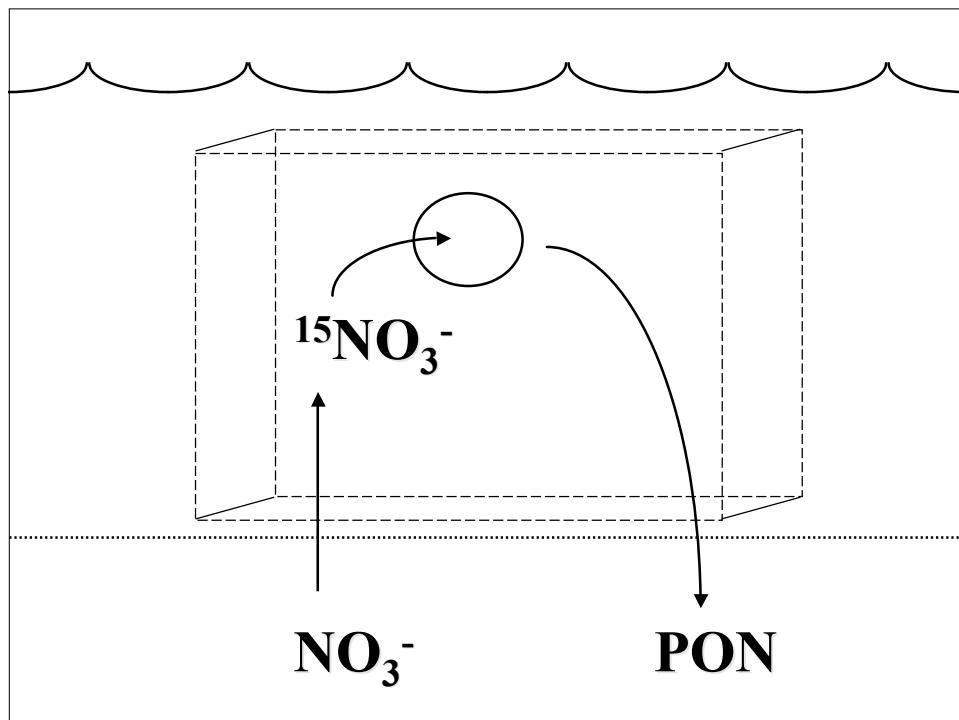
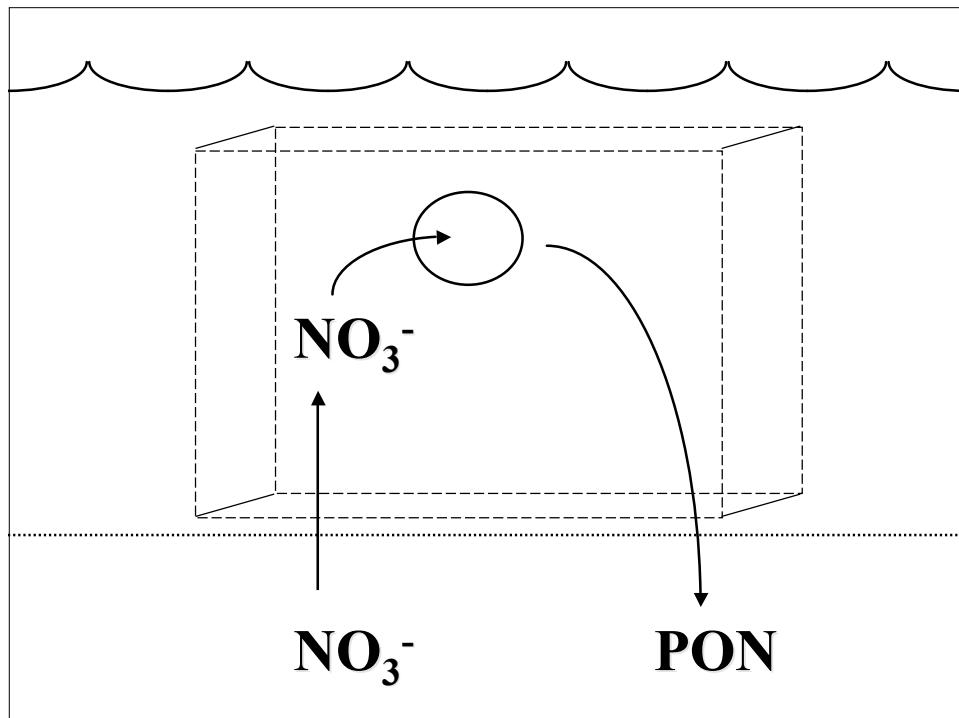


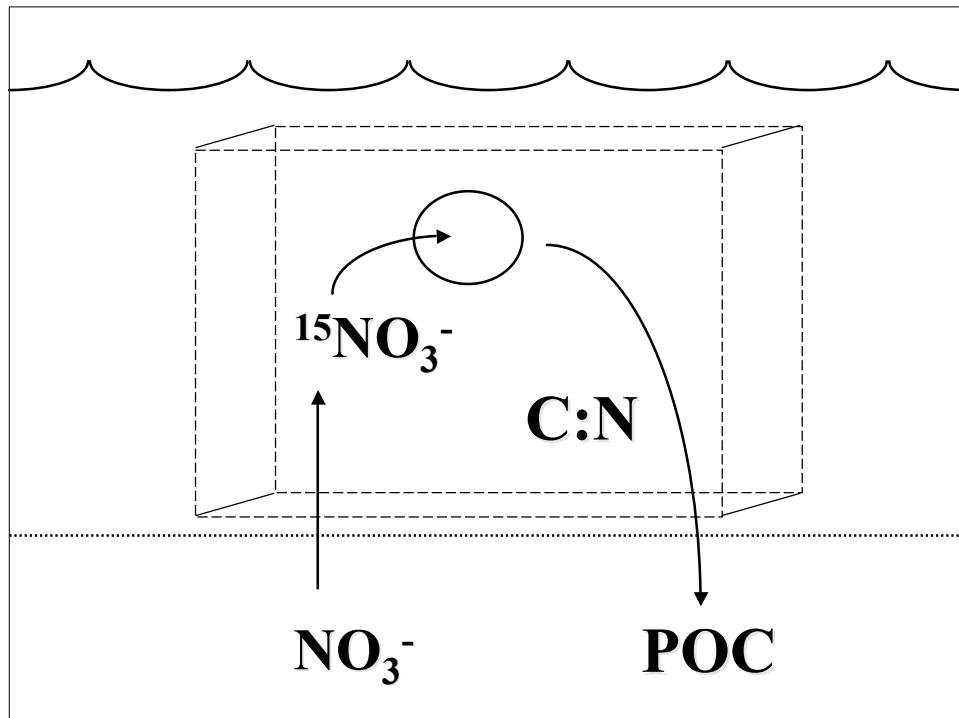
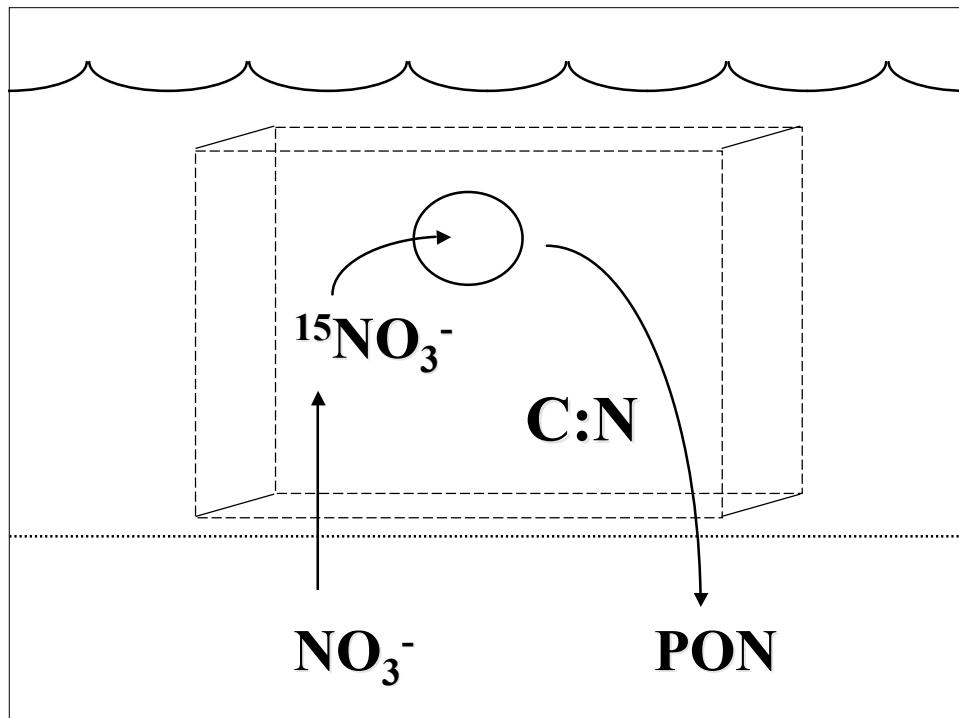
# **The Marine Nitrogen Cycle - Who is doing what?**

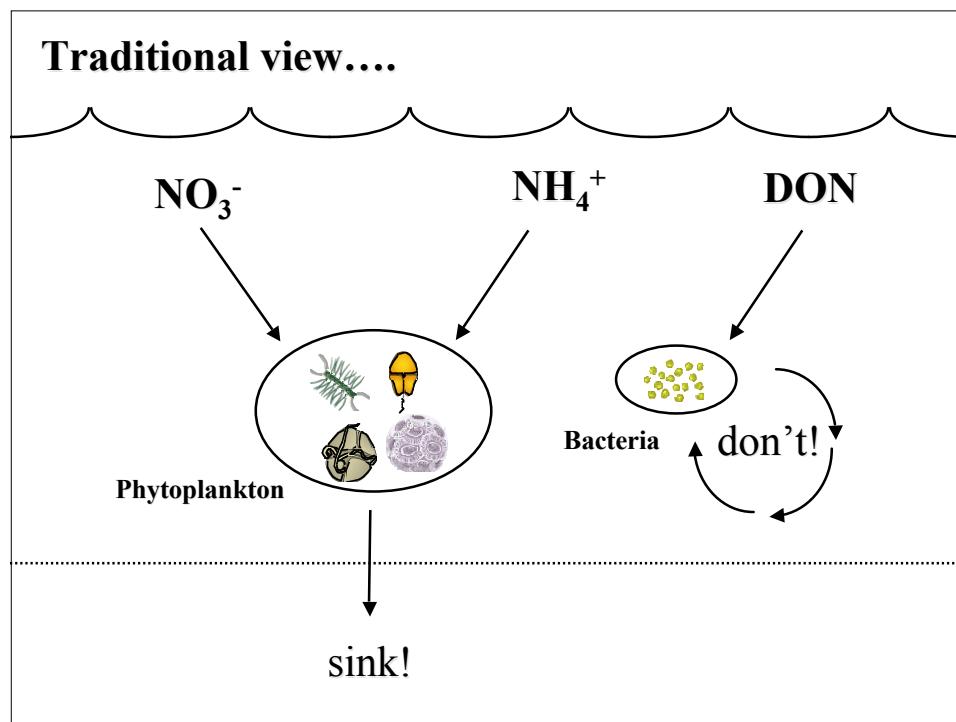
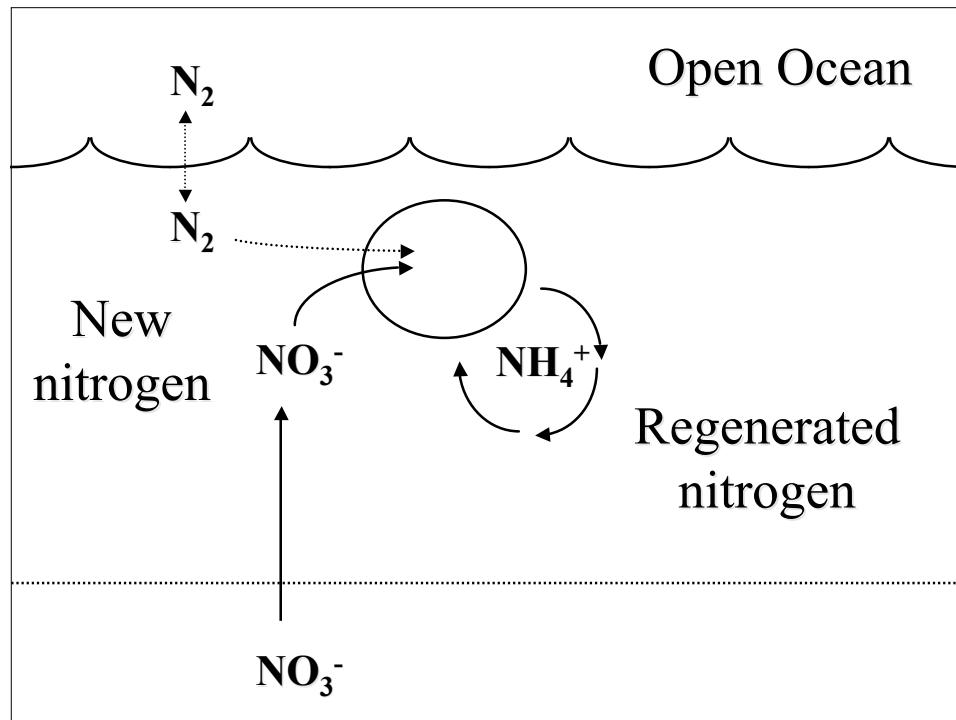
**Deborah A. Bronk  
Department of Physical Sciences  
College of William and Mary/VIMS  
Gloucester Point, VA**



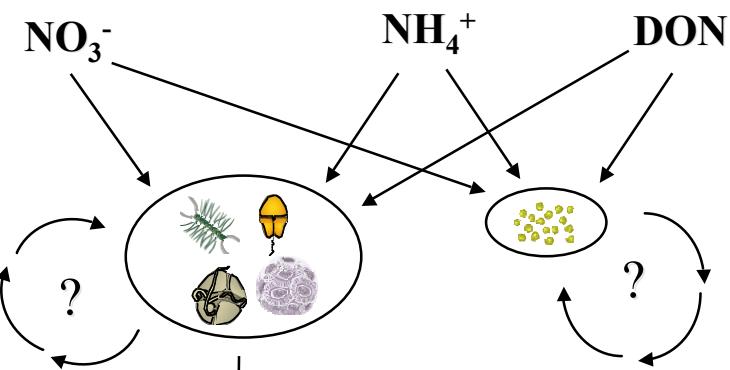
- I. Distinguish between autotrophic and heterotrophic uptake
- II. Dissolved organic N  
Ocean  
Coastal Ocean  
Estuaries



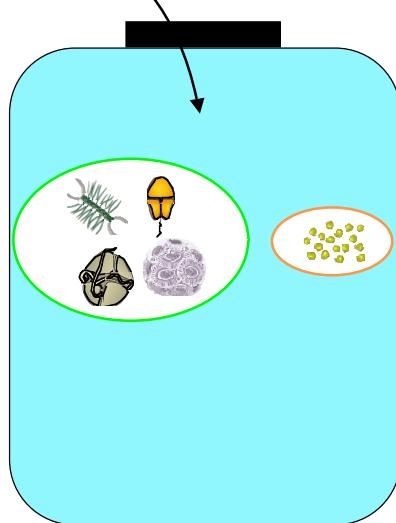




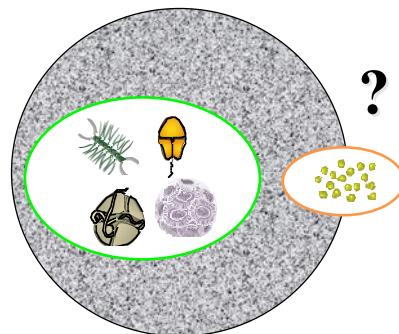
Current view....



Complication #1 - Everyone  
seems to use everything!

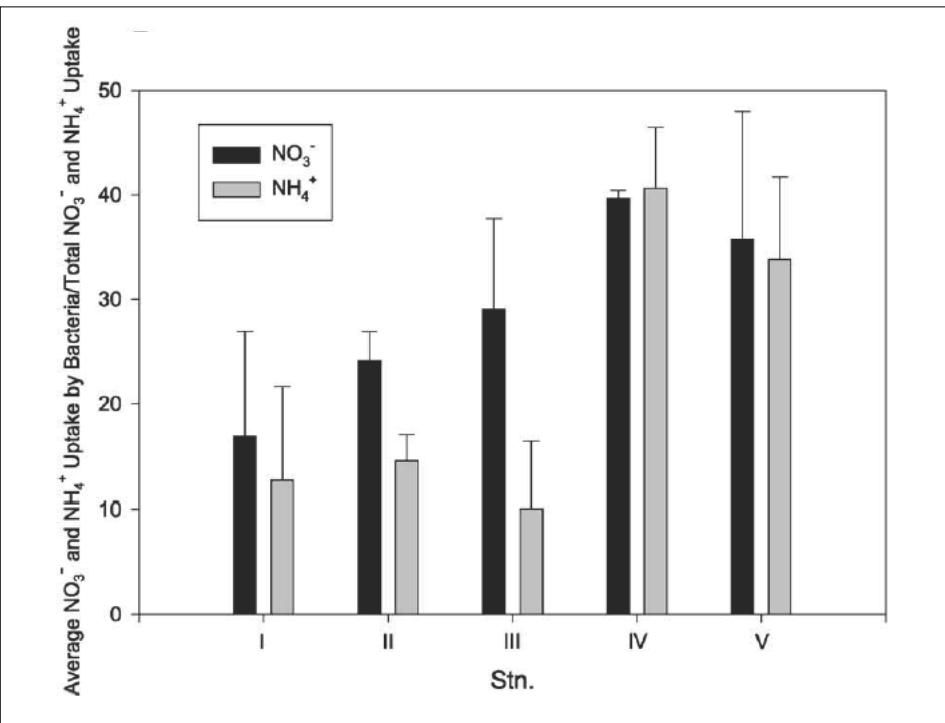
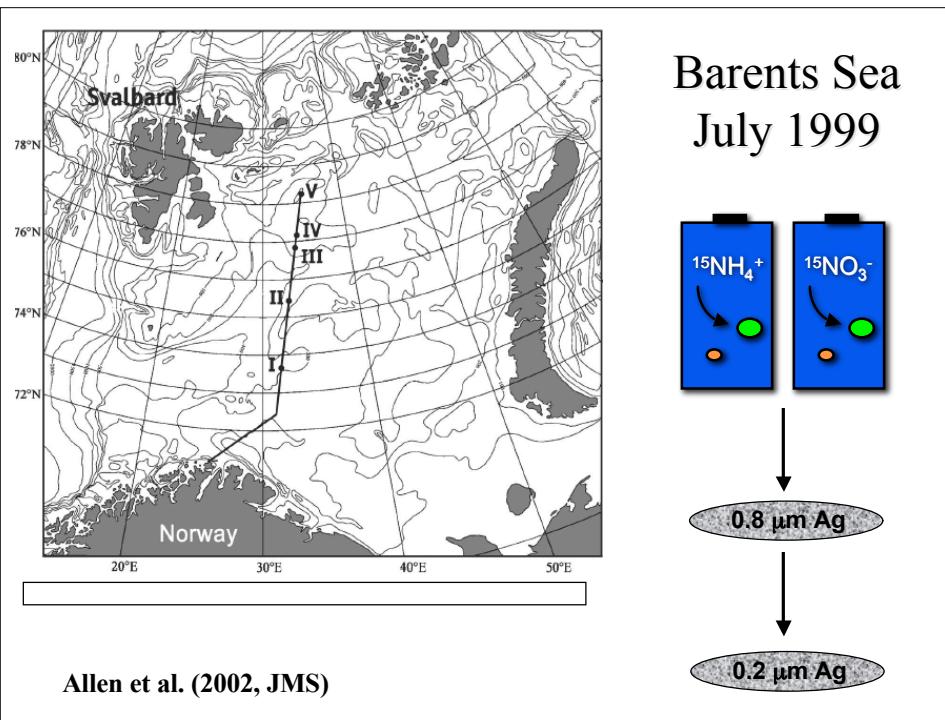


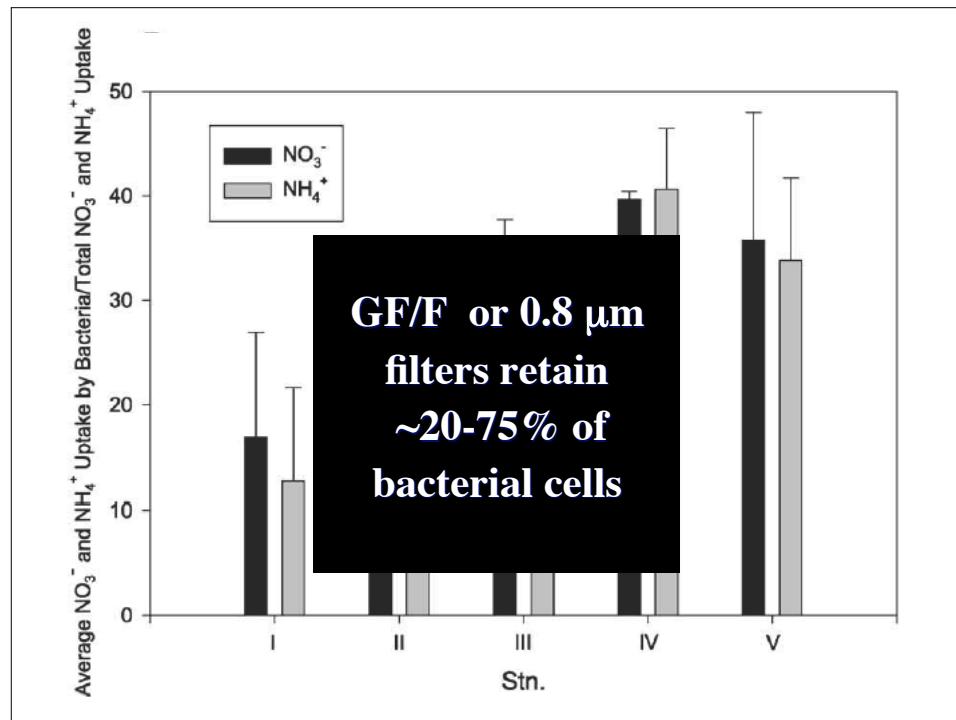
Complication #2 - Common  
protocols confound auto- &  
heterotrophic uptake



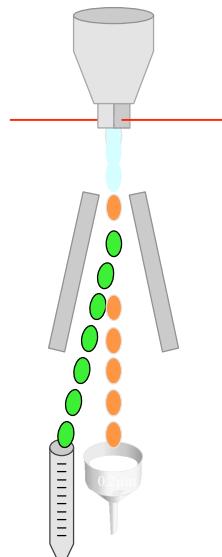
## I. Distinguishing between autotrophic and heterotrophic uptake

1. Size fractionation - KISS
2. Flow cytometric sorting
3. Isotope probing





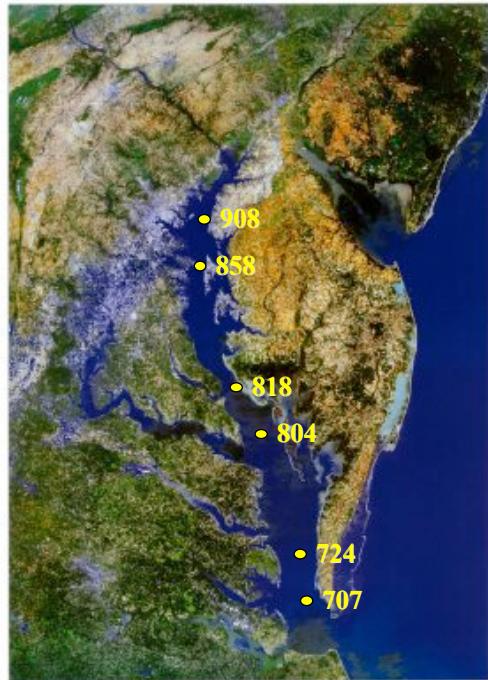
## Flow cytometric sorting



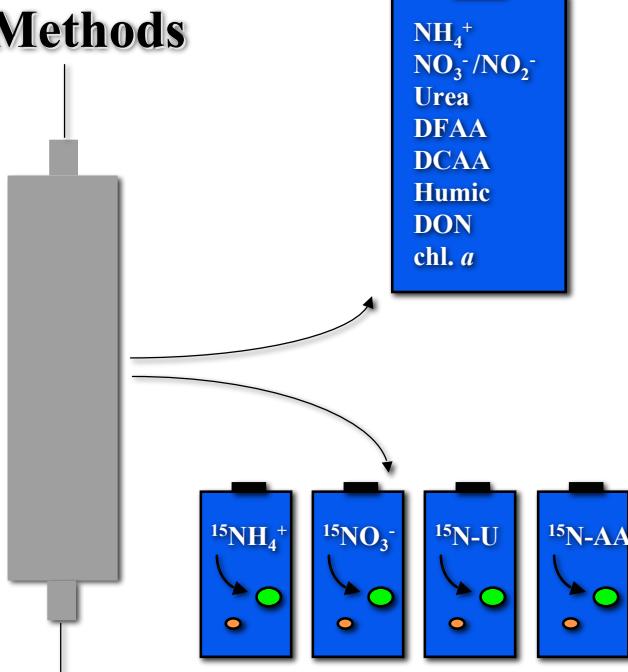
Lipschultz (1995, MEPS) –  $^{15}\text{N}$   
Casey et al. (2007, PNAS) –  $^{15}\text{N}$

# Chesapeake Bay

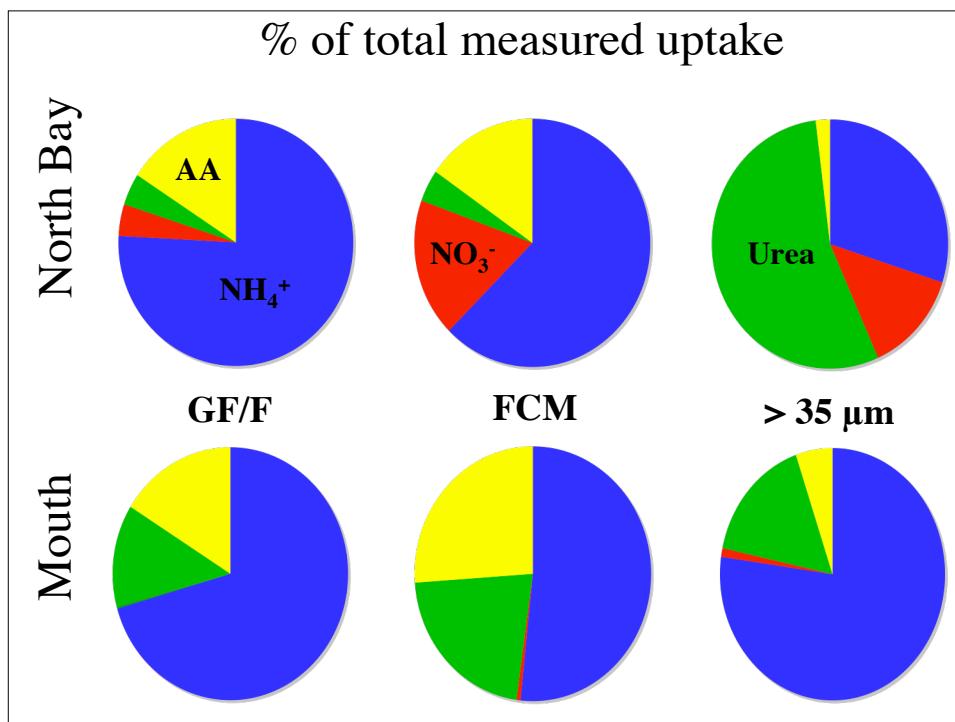
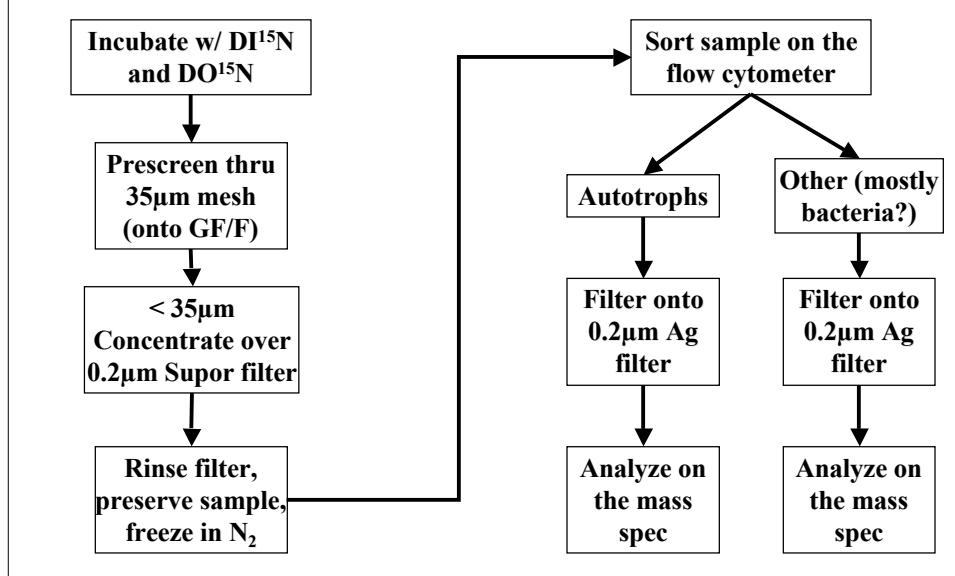
July 2004



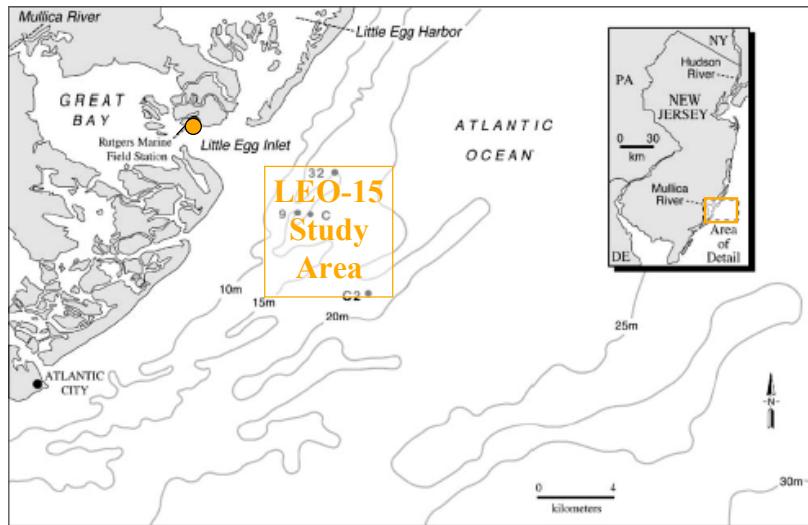
## Field Methods



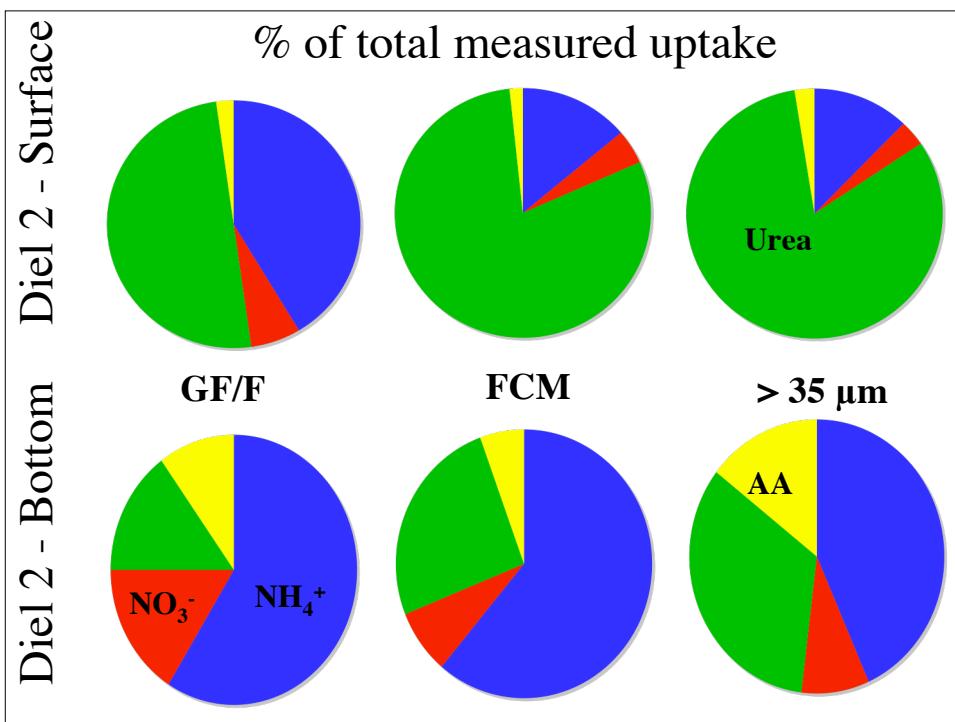
## Methods Flowchart



## Mid-Atlantic Bight (LEO-15)



Laursen & Seitzinger (2002)

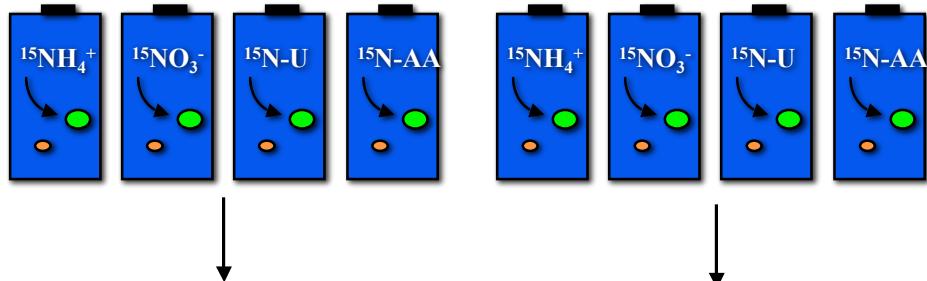


$$f\text{-ratio} = \frac{{}^{15}\text{NO}_3^- \text{ uptake}}{{}^{15}\text{NH}_4^+ + {}^{15}\text{NO}_3^- \text{ uptake}}$$

$$f\text{-ratio} = \frac{{}^{15}\text{NO}_3^- \text{ uptake}}{{}^{15}\text{NH}_4^+ + {}^{15}\text{NO}_3^- + \text{U} + \text{AA uptake}}$$

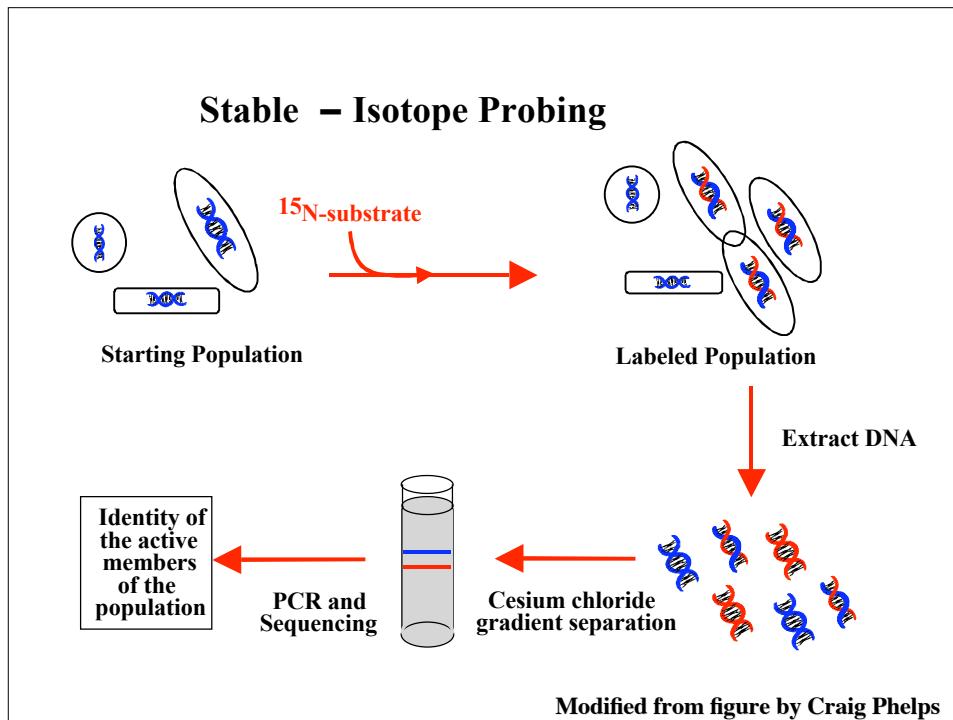
	Traditional GF/F	All substrates GF/F    FCM    35 μm		
North CBay	0.05	0.04	0.18	0.13
LEO - 15	0.39	0.29	0.10	0.14

### Isotope Probing Orinoco Plume - September 2006

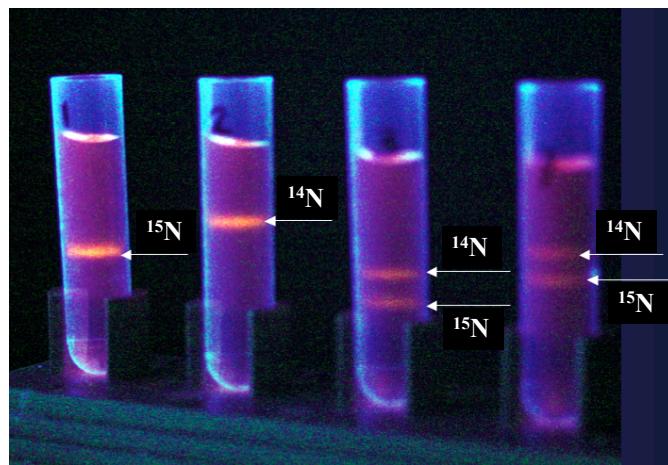


Isotope probing  
(Lee Kerkhoff)

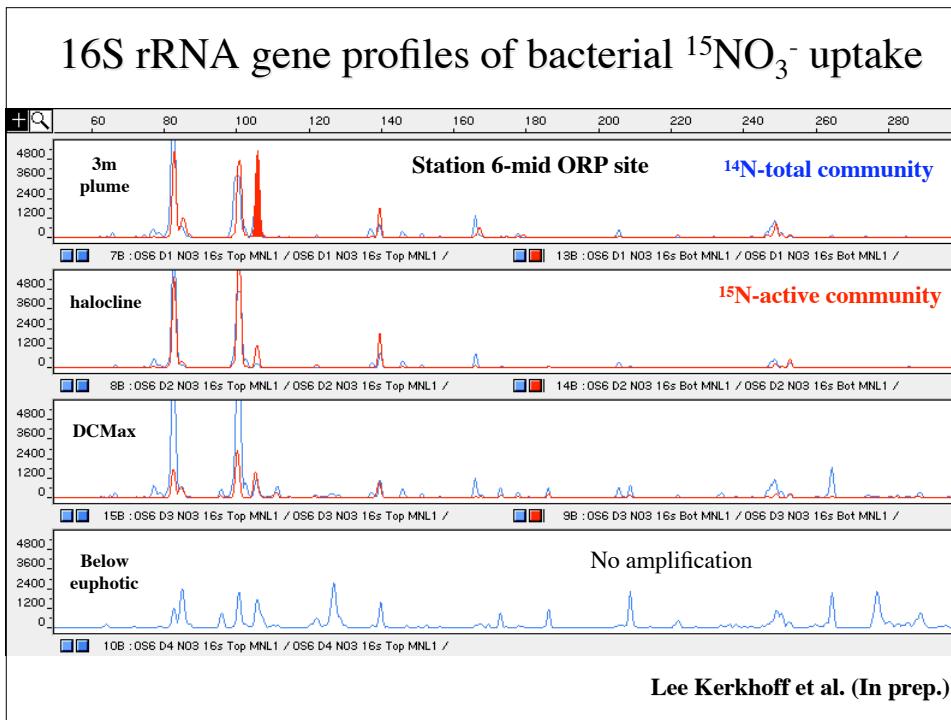
Uptake rates



### Cesium Chloride (CsCl) Gradient



Modified from figure by Lee Kerkhoff



## I. Distinguishing between autotrophic and heterotrophic uptake

Much to be learned from the separation

Open ocean

Coastal & estuarine systems

KISS - FCM - Isotope probing

## **II. DON**

Urea

Amino acids

Amides

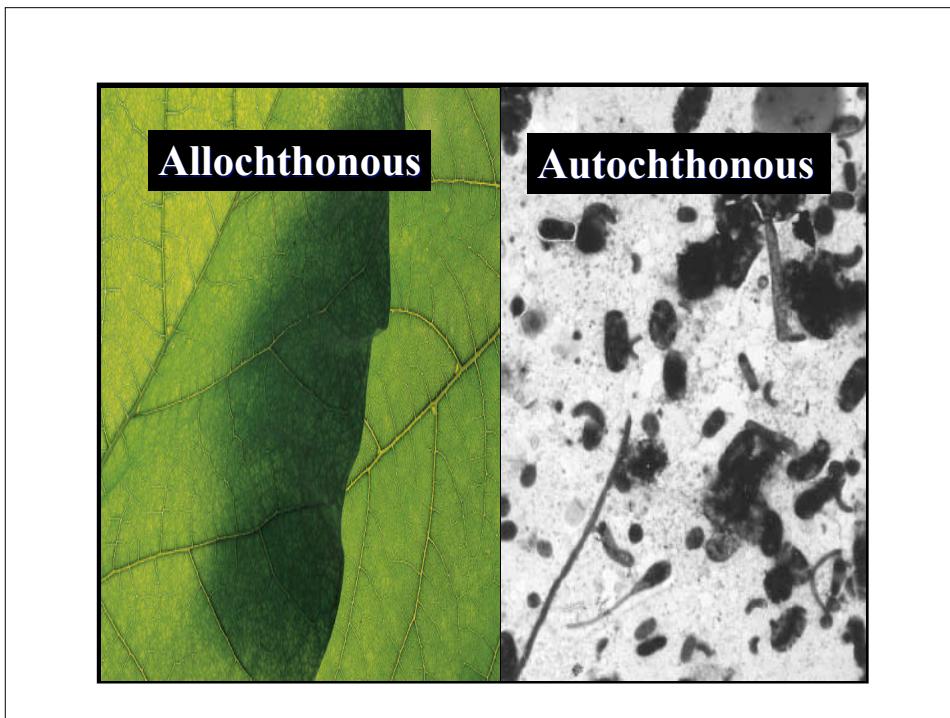
Humic & fulvic acids

Nucleic acids

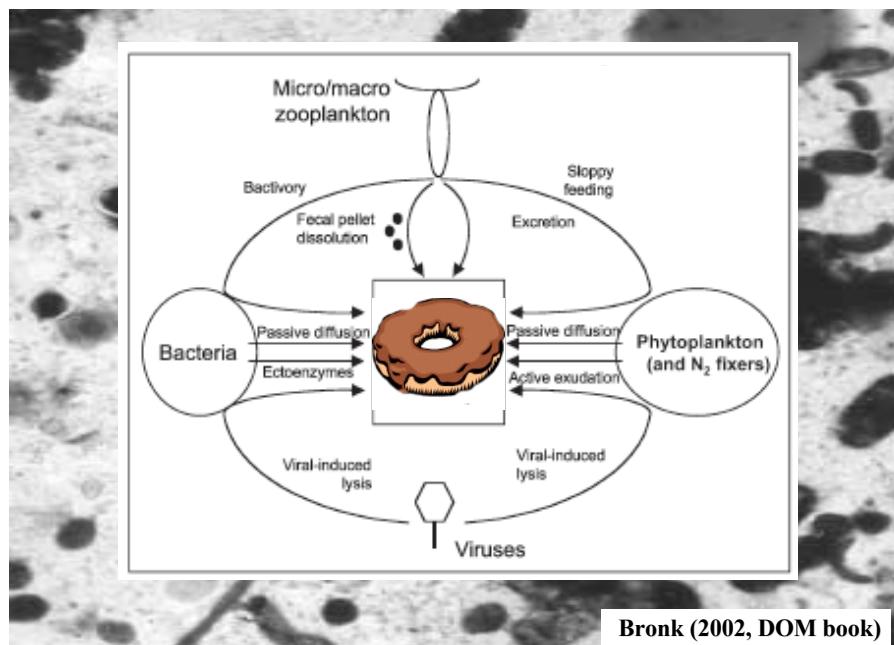
Purines & pyrimidines

Amino sugars

**DON**



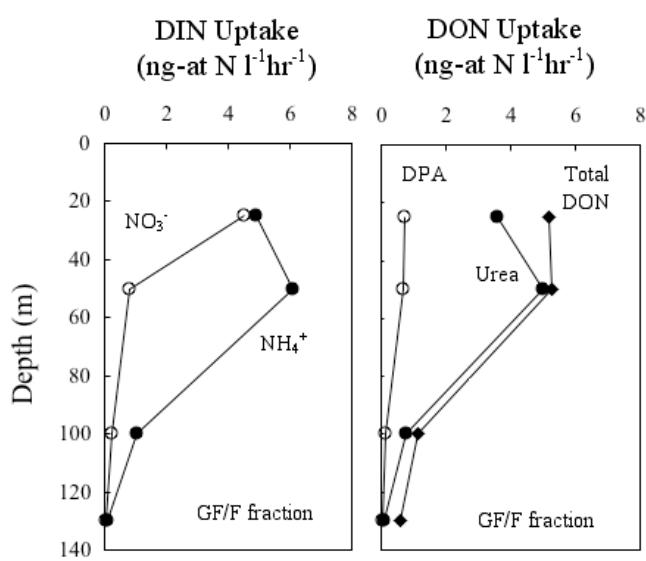
## Autochthonous sources of DON



Bronk (2002, DOM book)

## South Pacific

DON uptake can match and even exceed DIN uptake



Bronk & Campbell (In prep)

Allochthonous sources:  
Rivers  
Atmospheric deposition  
Overland runoff  
Agricultural  
Urban  
Forested  
Combined sewage overflows  
Sewage effluent

## Bioassays

Add DON



Wiegner et al. (2006)

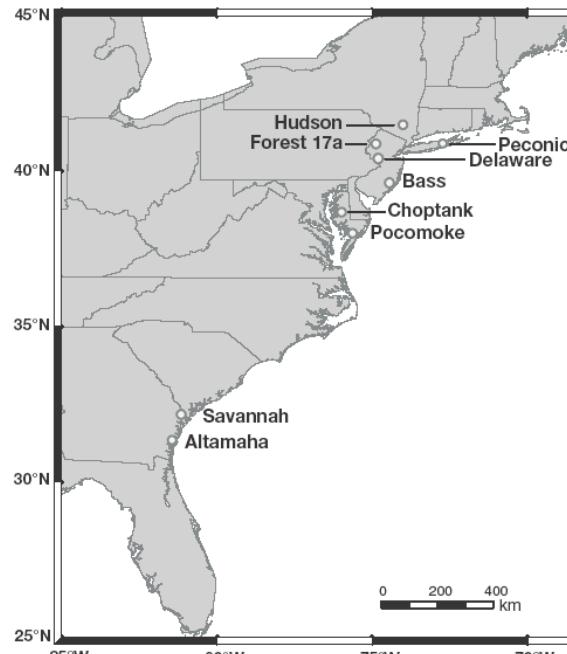
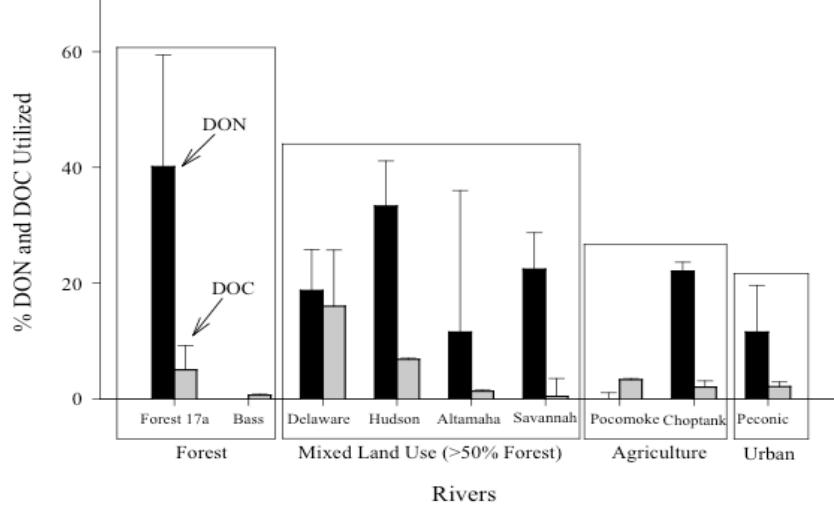


Fig. 1. Map of the 9 river locations, on the east coast of

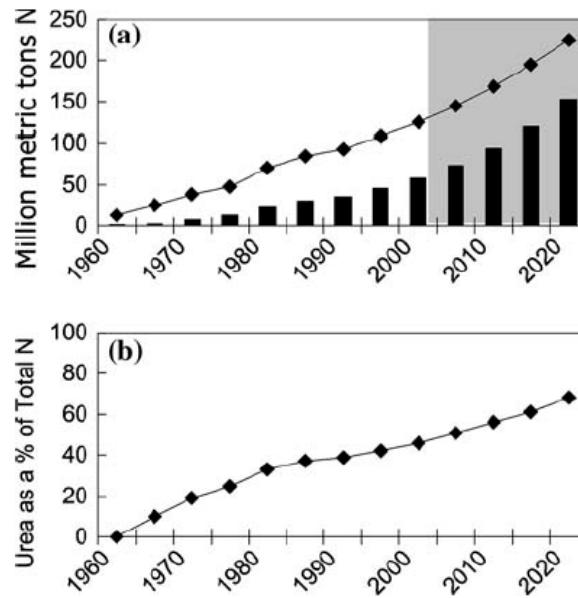


Up to 60% of the DON was  
consumed in 6 days

Wiegner et al. (2006)

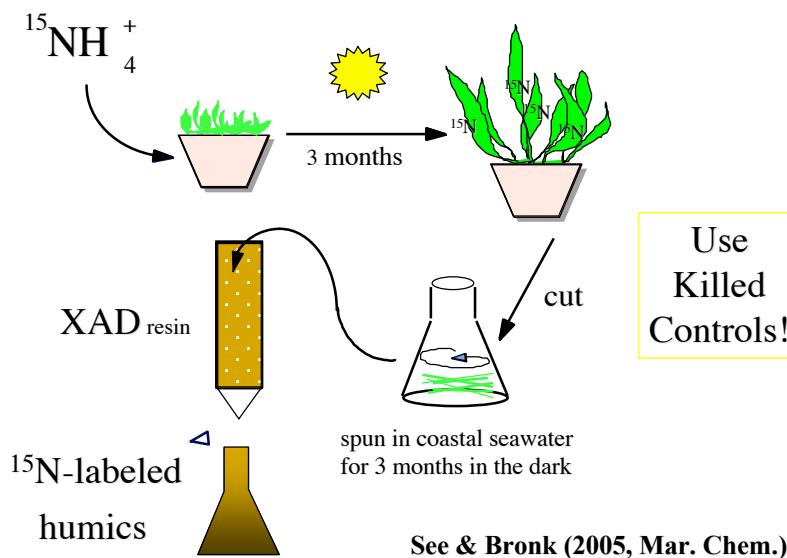
## Tracers

Urea  
DFAA mix



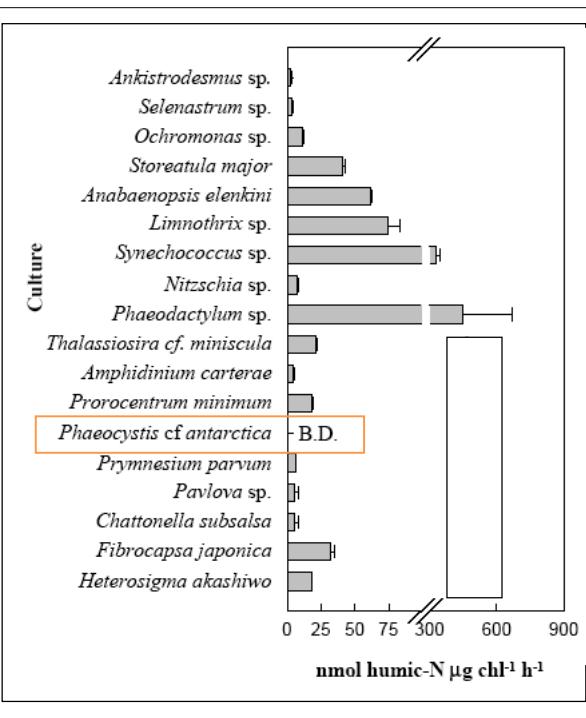
Glibert et al. (2006, Biogeosci.)

## Making $^{15}\text{N}$ -labeled humics



# Humic uptake in culture

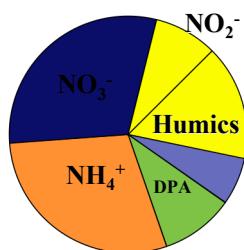
See et al. (2006, L&O)



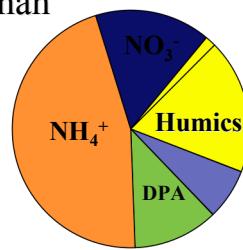
## Uptake characterization

Berman & Bronk (2003, AME)

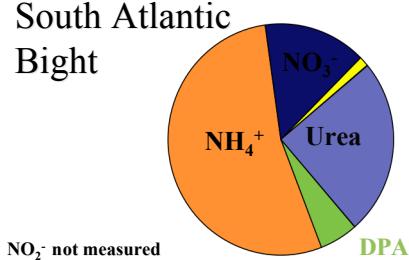
Altamaha



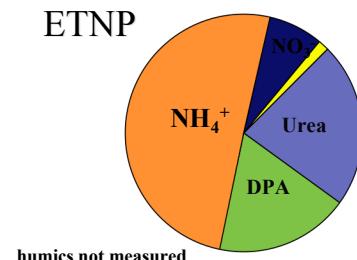
Savannah



South Atlantic Bight



ETNP



Ocean:  
DON uptake can DIN uptake

Coastal zone and estuaries:  
Switch from  $\text{NO}_3^-$  to urea in fertilizer

Terrestrial material is much more labile  
than believed

## Acknowledgements



**Marta Sanderson  
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