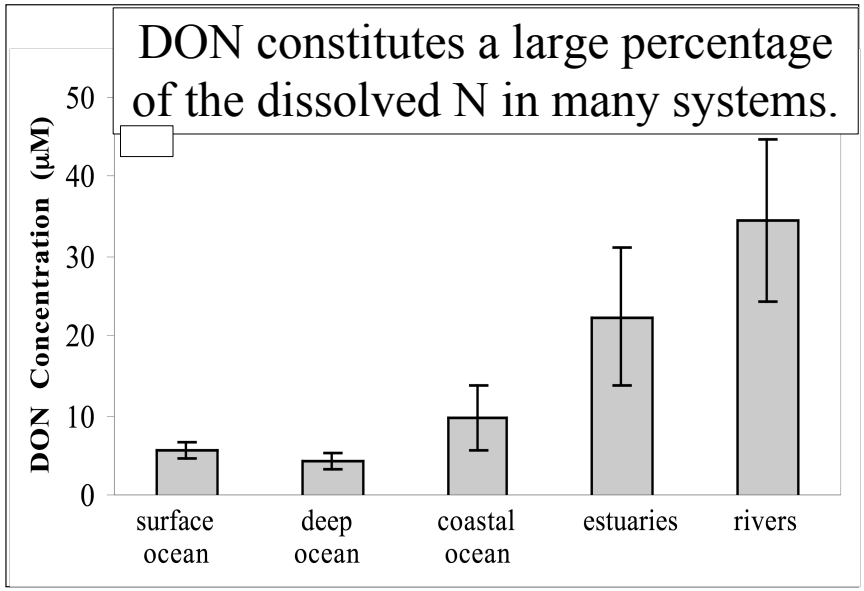
DON sinks

Deborah A. Bronk
Department of Physical Sciences

- DON sinks
  Autochthonous vs allochthonous
- Mechanisms of use DON
- Who is using what?

Traditional Dogma

DON is refractory!



Bronk 2002 Book chapter

Allochthonous sources:

- **Rivers**
- **Terrestrial runoff**
  - **Agricultural**
  - **Urban**
  - **Forested**
- **Combined sewage overflows**
- **Sewage effluent**
- **Atmospheric deposition**

Methods for studying release:

1. **Bioassays**
2. **Radioactive tracers**
3. **Stable isotope tracers**
   a. **Direct measures**
   b. **Isotope dilution**

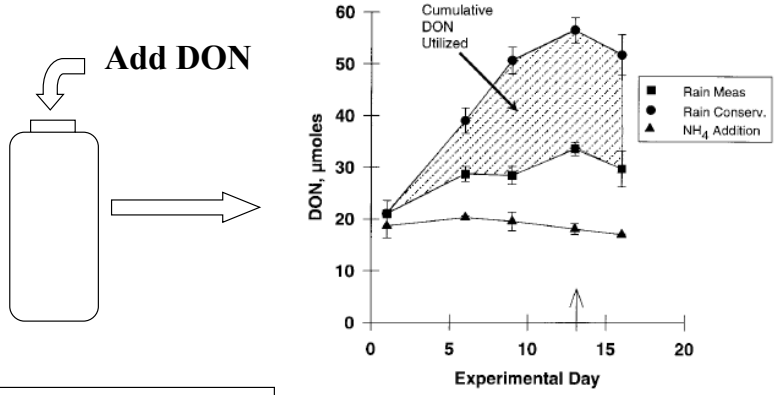
2 - 84% of N in atmospheric deposition is DON

Seitzinger and Sanders 1999 L&O

14 - 90% of N in rivers is DON

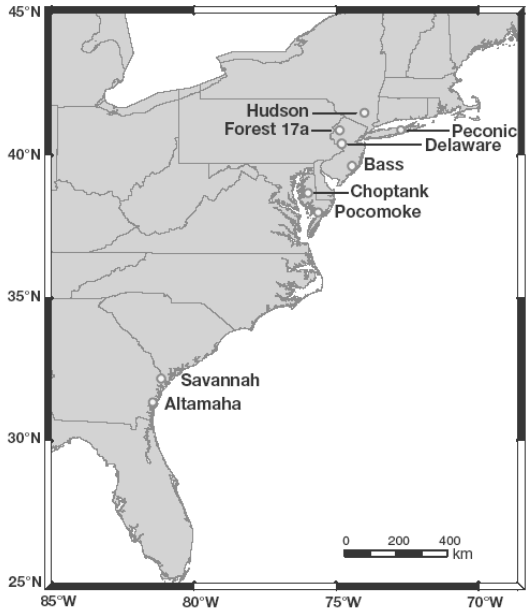
Seitzinger and Sanders 1997 MEPS

Atmospheric DON



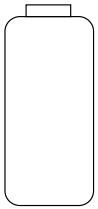
45 to 75% of the DON was consumed

Seitzinger and Sanders 1999 L&O

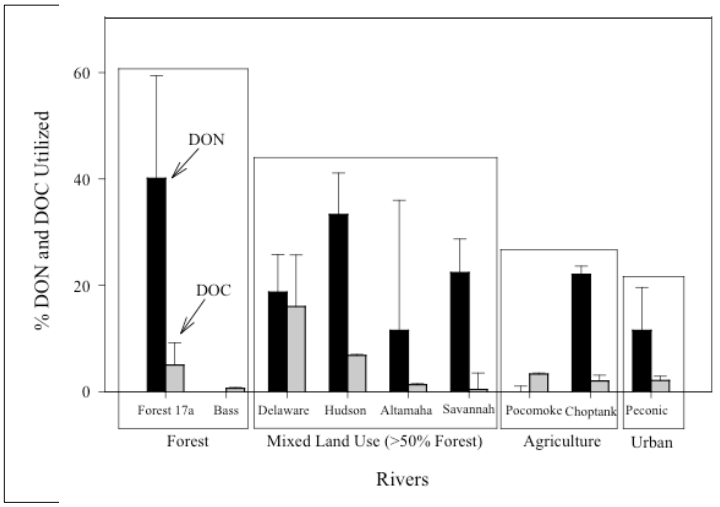


Riverine DON

Add DON



Wiegner et al. 2006 AME

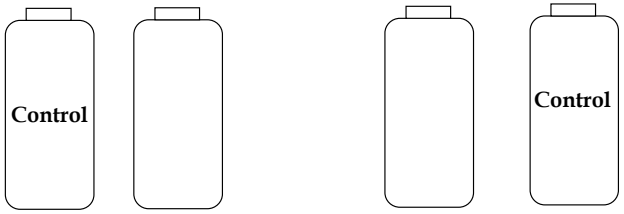


Up to 60% of the DON was consumed in 6 days

Wiegner et al. 2006 AME

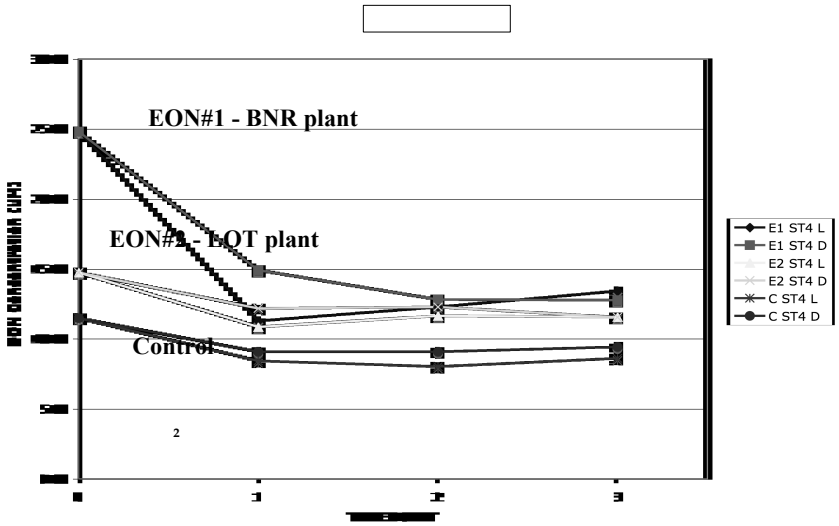
Water collected at 5, 16 and 28 ‰

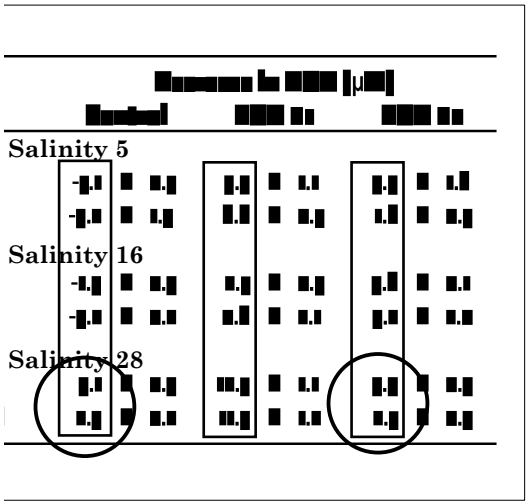
Add EON



Mulholland et al. in prep.

Incubated for ~2, 4, and 7 days - monitored nutrient and biomass parameters.



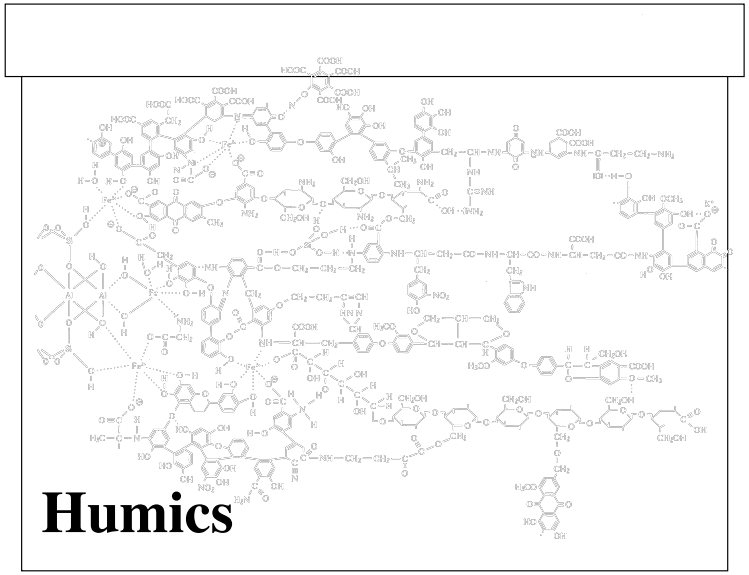


52% 27%

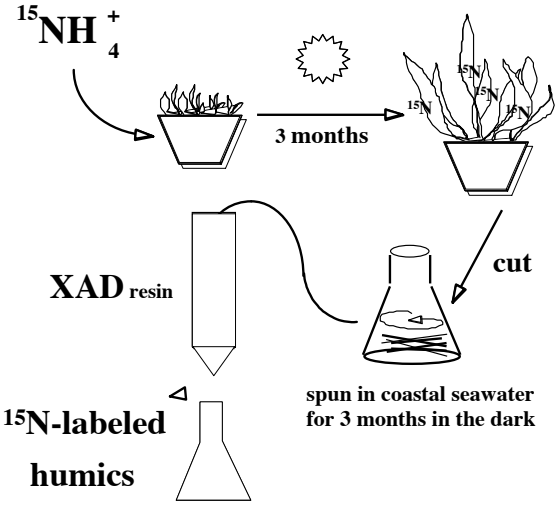
Response varied with salinity

+ EON = net consumption

Control - production and consumption

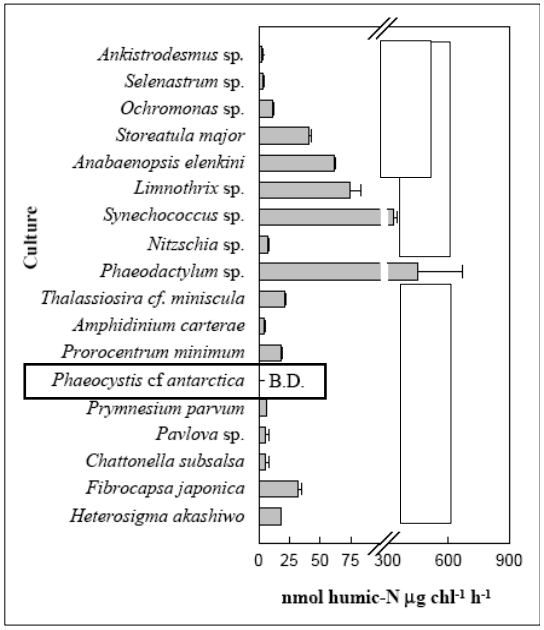


Making ^{15}N-labeled humics



Use Killed Controls!

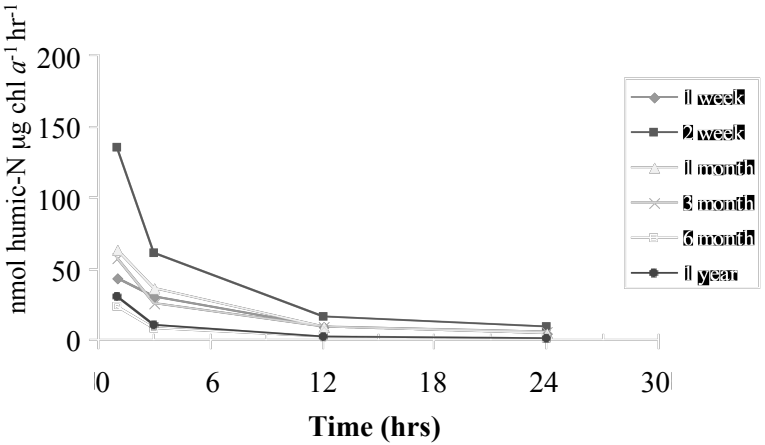
Humic uptake in culture



See et al. 2006 L&O

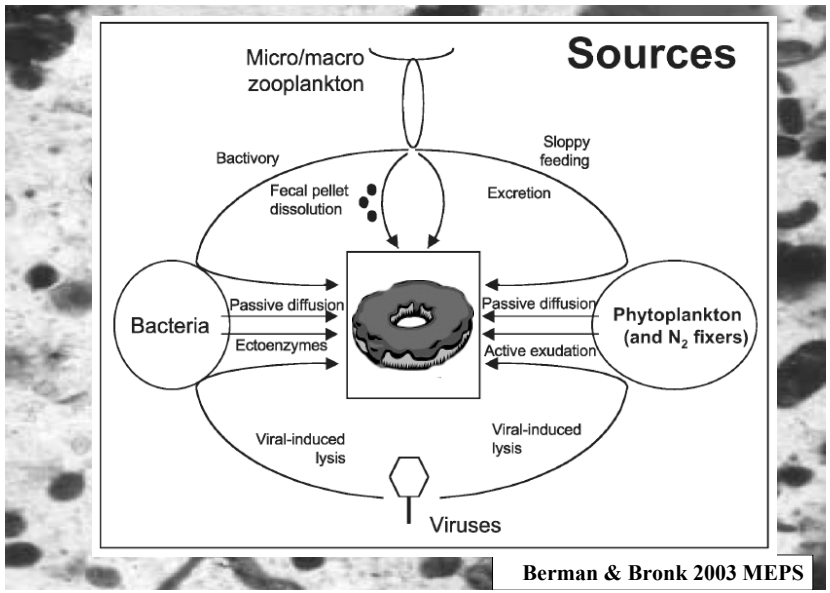
Humic Uptake Rates

Thalassiosira cf. miniscula

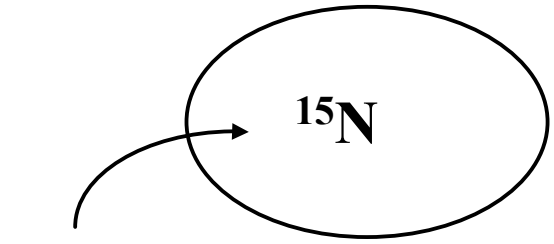


See et al. 2006 L&O

Autochthonous sources of DON



Berman & Bronk 2003 MEPS

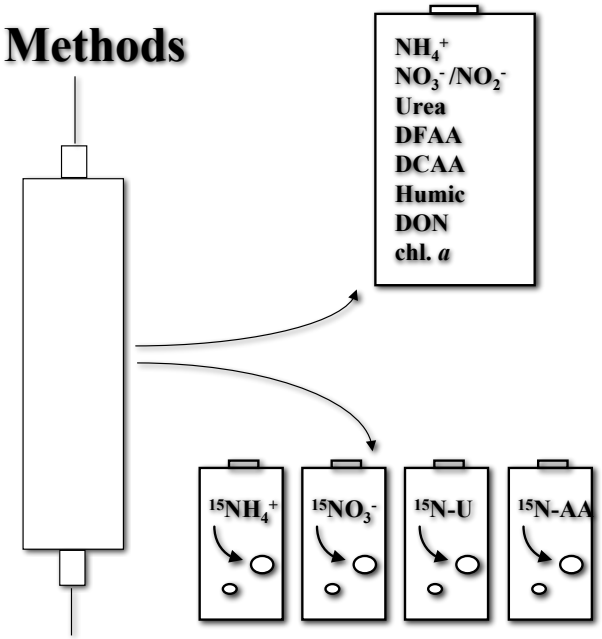


^{15}N-urea

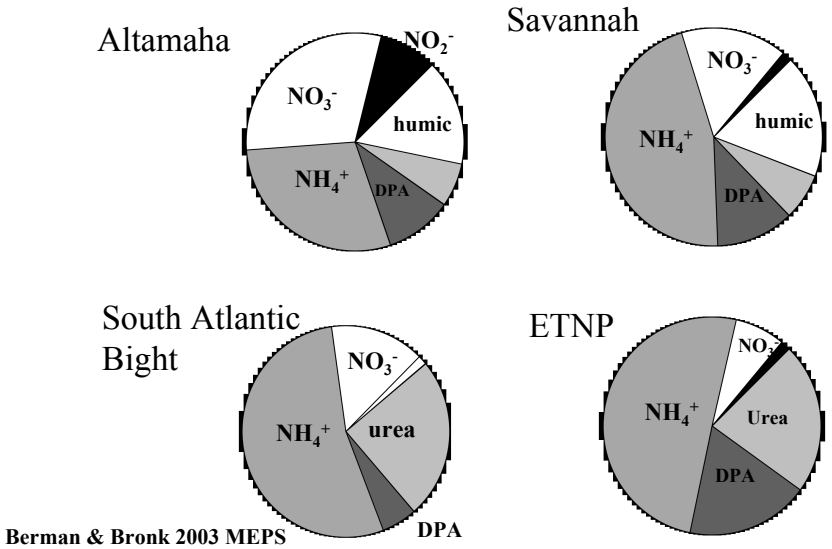
Drawbacks:

- DON pool of unknown composition
- Few commercially available tracers
- $$$$

Field Methods

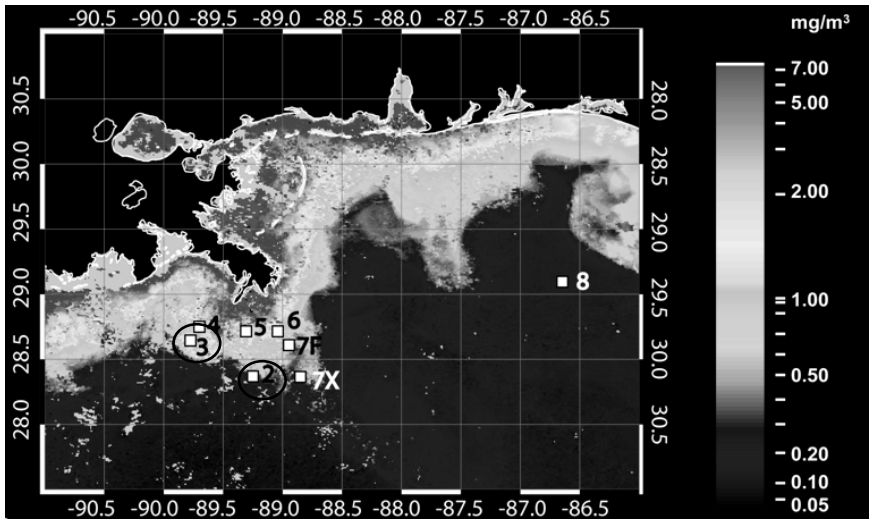


Uptake characterization

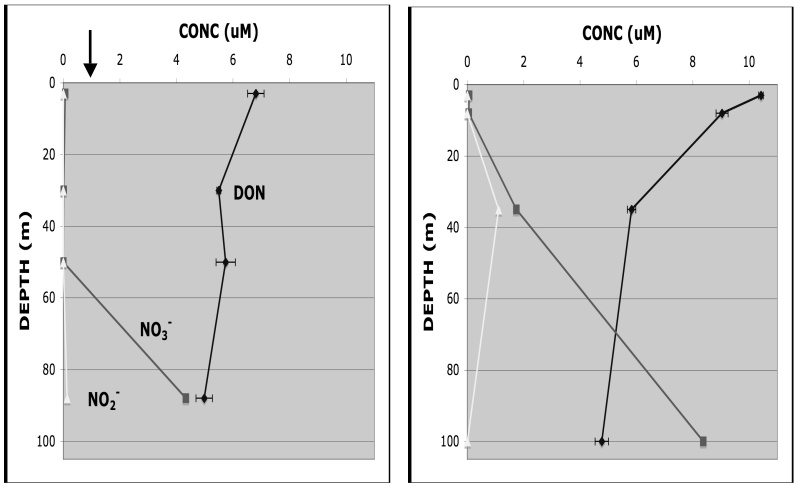


Berman & Bronk 2003 MEPS

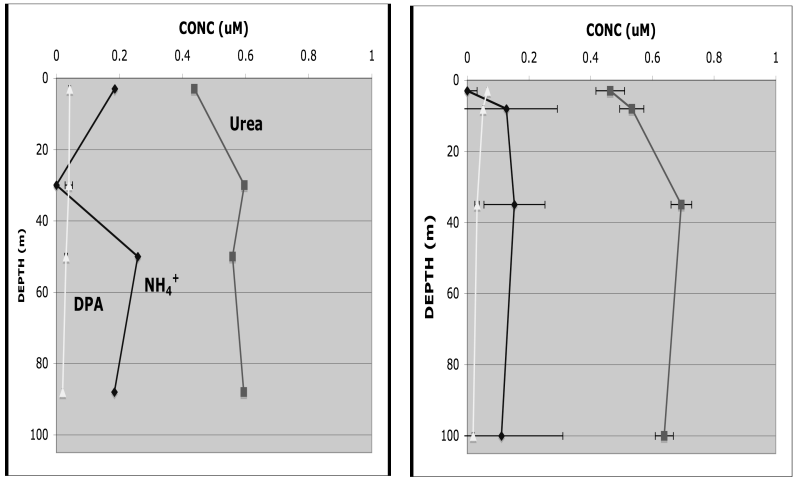
Mississippi River Plume - July 2005



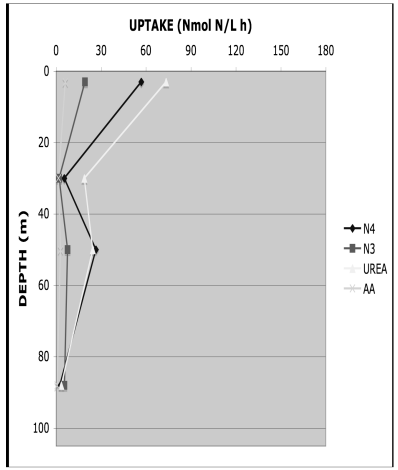
Outside Plume **Inside Plume**



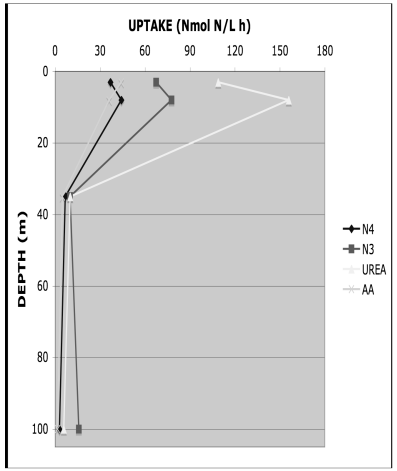
Outside Plume **Inside Plume**



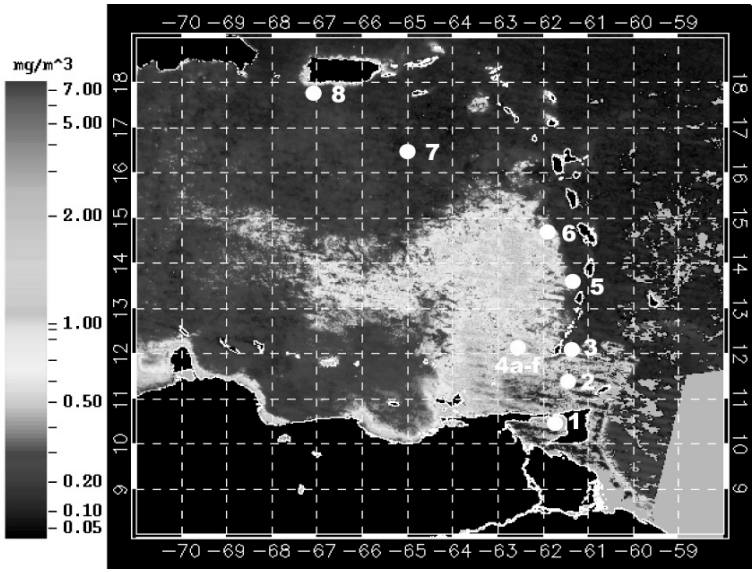
Outside Plume



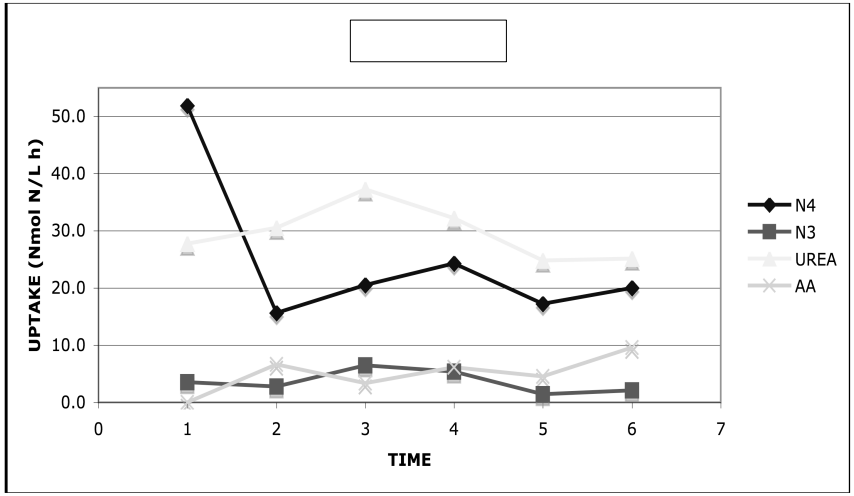
Inside Plume



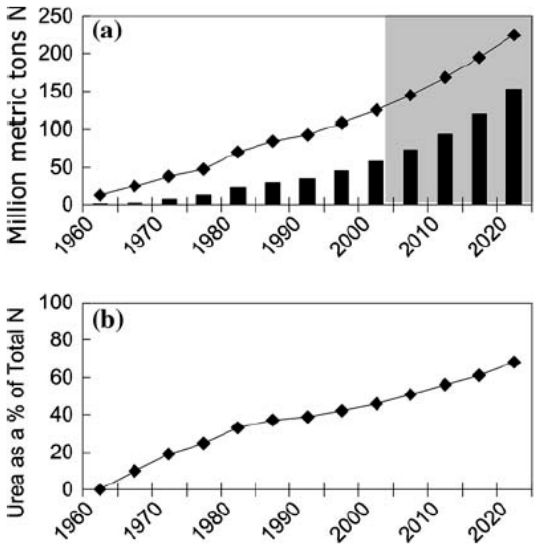
Orinoco River Plume - Oct 2006



Orinoco River Plume



The rise of urea

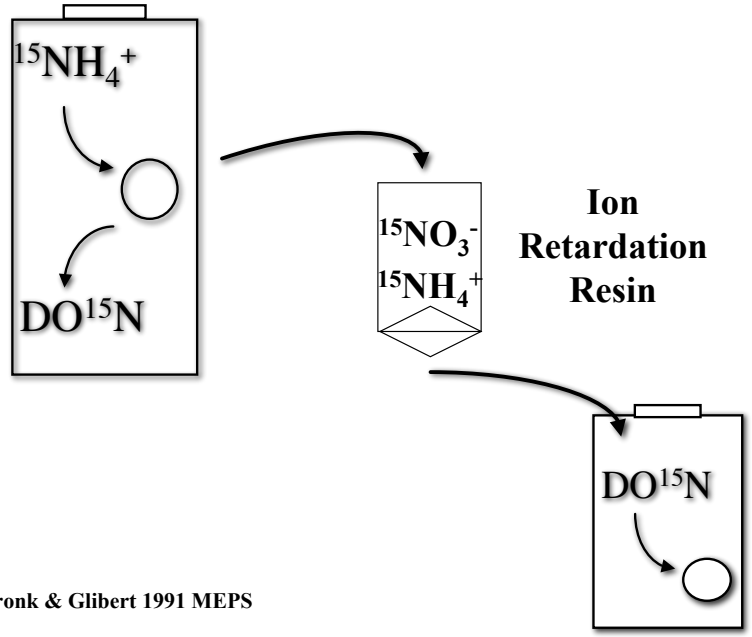


Glibert et al. 2006 Biogeosciences

$$\text{f-ratio} = \frac{\text{New production}}{\text{New + Regenerated Production}}$$

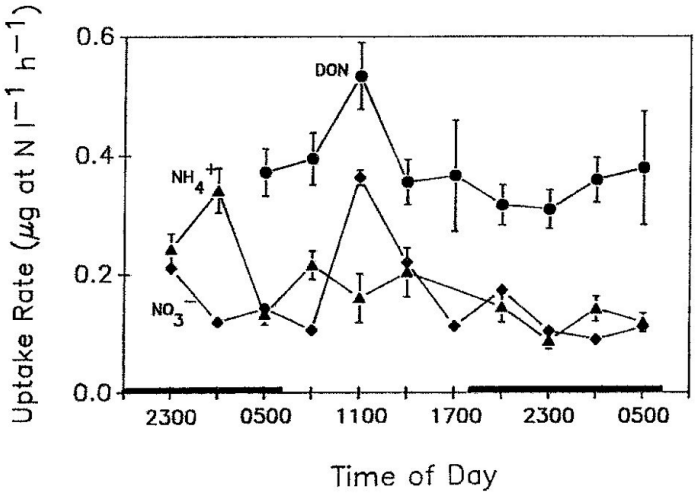
$$\text{f-ratio} = \frac{NO_3^- \text{ uptake}}{NH_4^+ + NO_3^- + U + \text{DPA uptake}}$$

Is the urea really regenerated?
Is the NO_3^- really new?



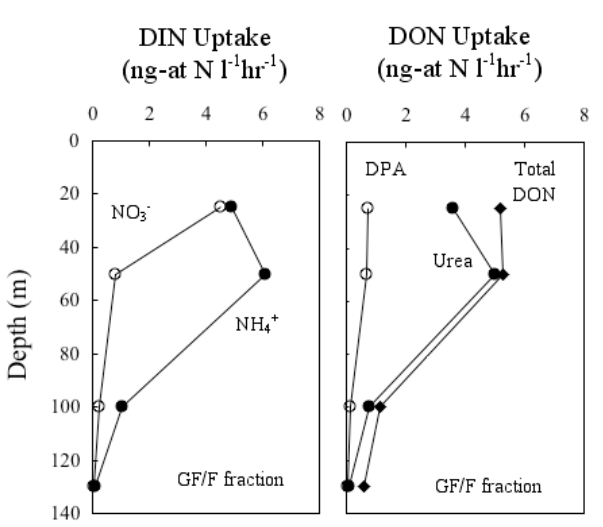
Bronk & Glibert 1991 MEPS

Chesapeake Bay - August



Bronk and Glibert 1993 Mar Biol

South Pacific

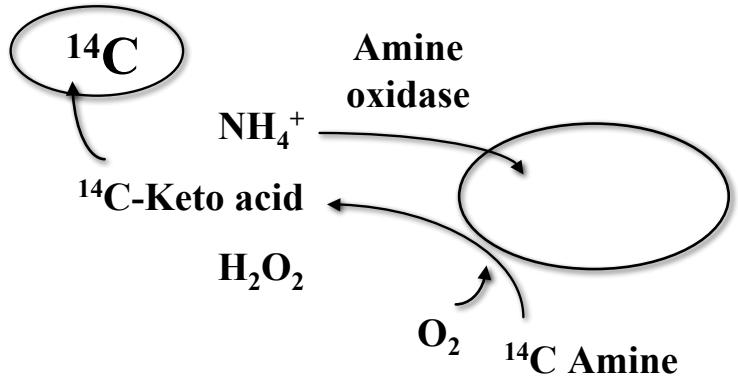


Bronk & Campbell In prep.

Phytoplankton mechanisms to access organic N:

Organic oxidases
Peptide hydrolysis
Pinocytosis
Phagocytosis
Photochemical processes
Adsorption - Desorption

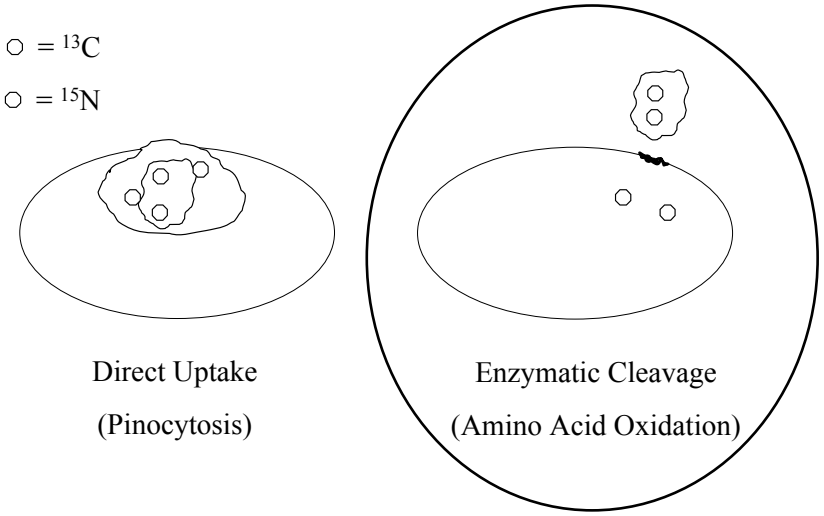
Cell Surface Enzymes



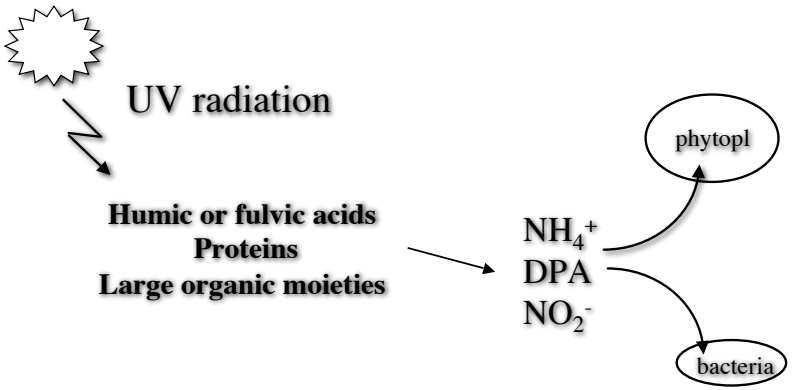
Palenik et al. 1988

Farming nitrogen from "refractory" compounds!

Humic Uptake Mechanisms?

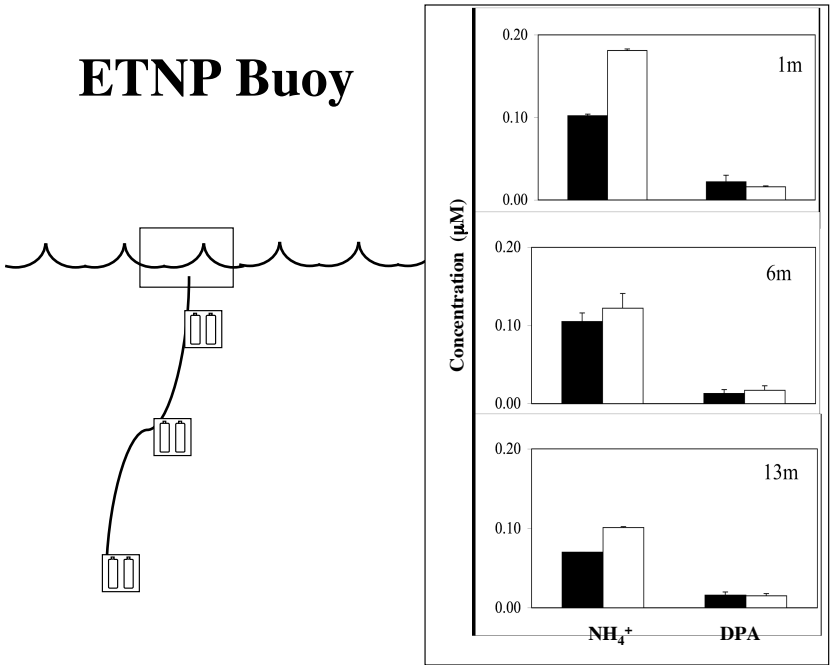


Photoproduction of labile N

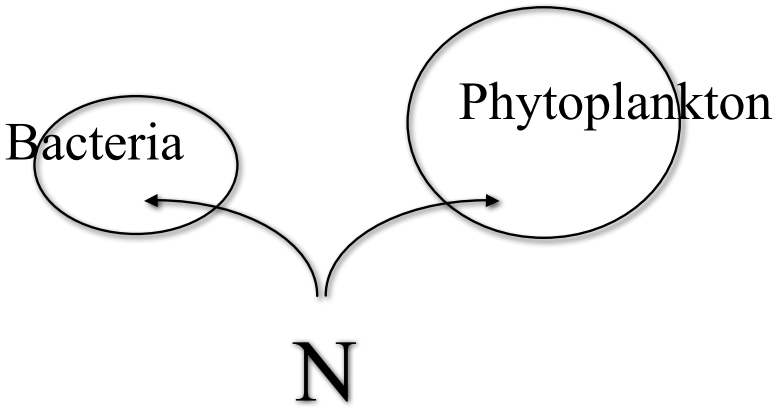


Based on Bushaw et al. 1996 Nature

ETNP Buoy

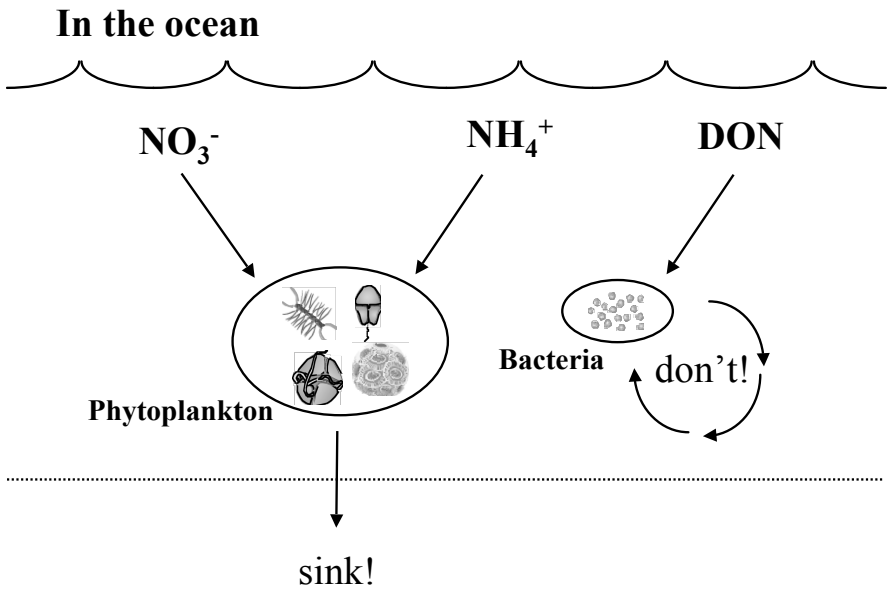


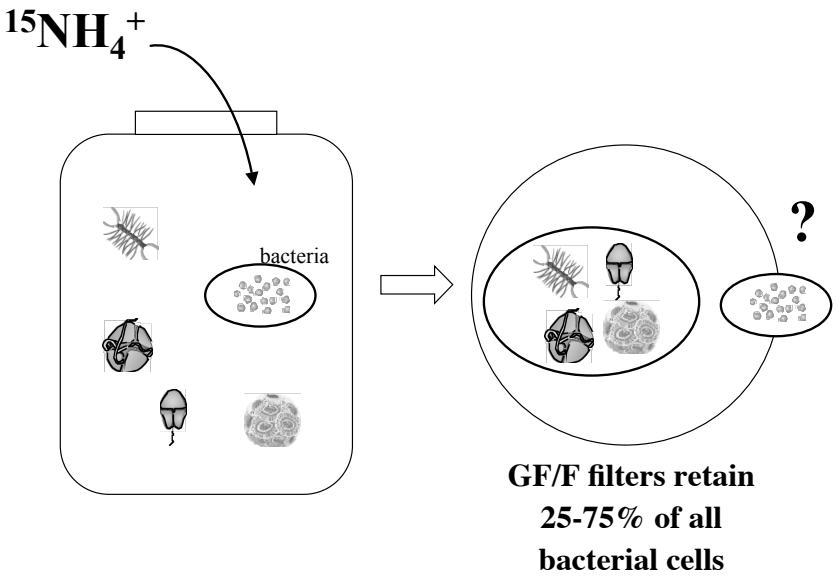
Who uses what?



Who cares?
In estuararies and lakes…

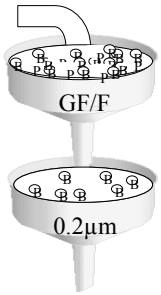
- Phytoplankton → O_2
- Bacteria take up O_2 → CO_2
- Phytoplankton → higher trophic levels
- Phytoplankton can → HABs





Phytoplankton vs. Bacteria N Uptake

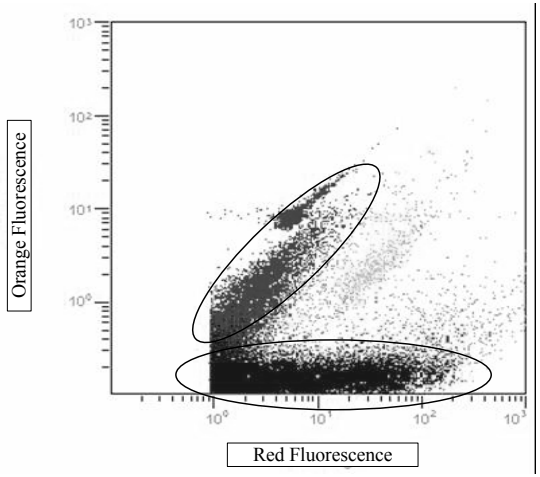
Size fractionation



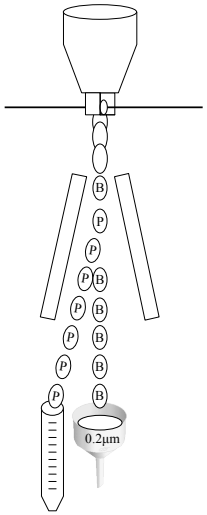
GF/F filters retain
50-65% of all bacterial cells

Flow Cytometric Sorting

Lipschultz (1995) – ^{15}N
Zubkov et al. (2004) – ^{35}S

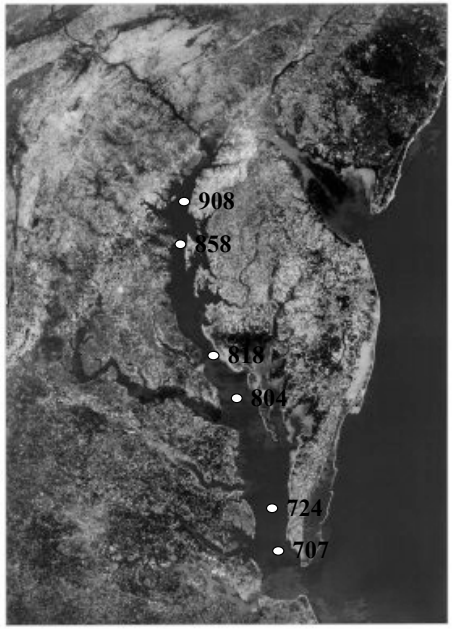


Flow Cytometric Sorting

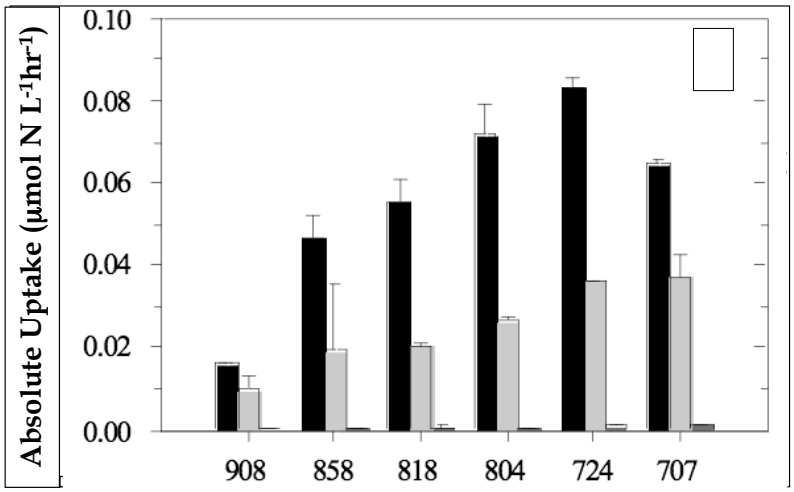


Chesapeake Bay

July 2004

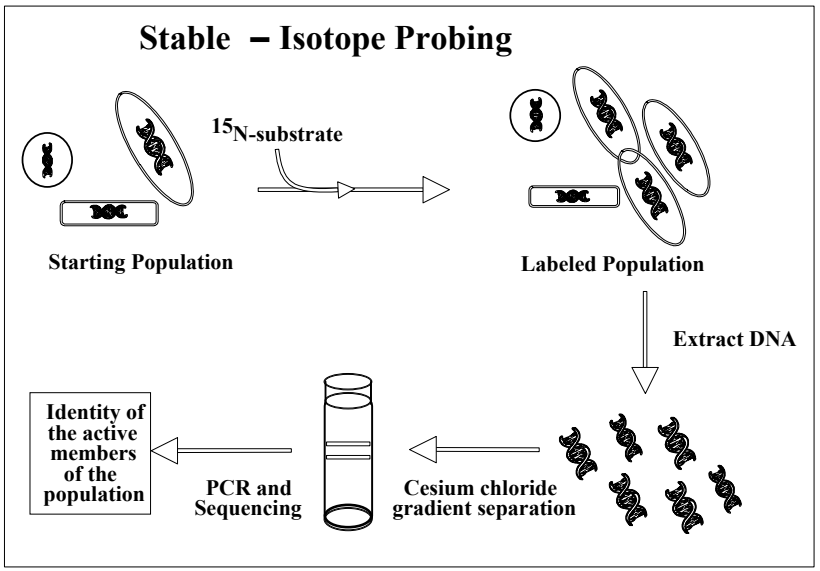


Chesapeake Bay - AA uptake



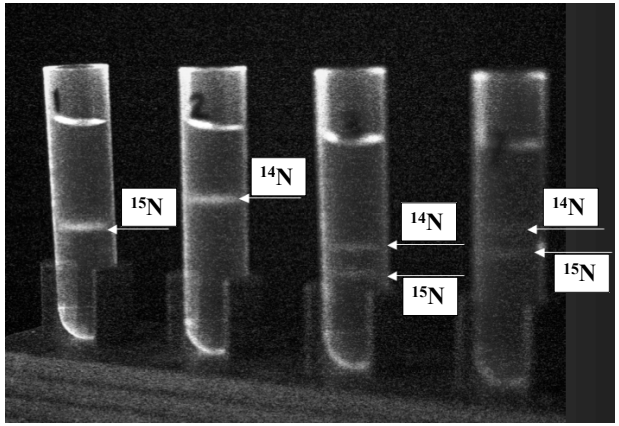
Bradley & Bronk In prep

Stable – Isotope Probing



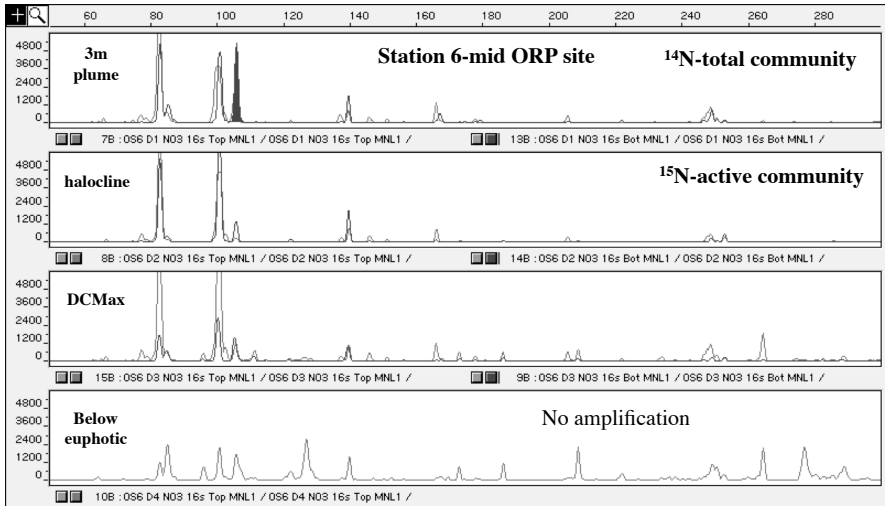
Modified from figure by Craig Phelps - Lee Kerkoff

Cesium Chloride (CsCl) Gradient



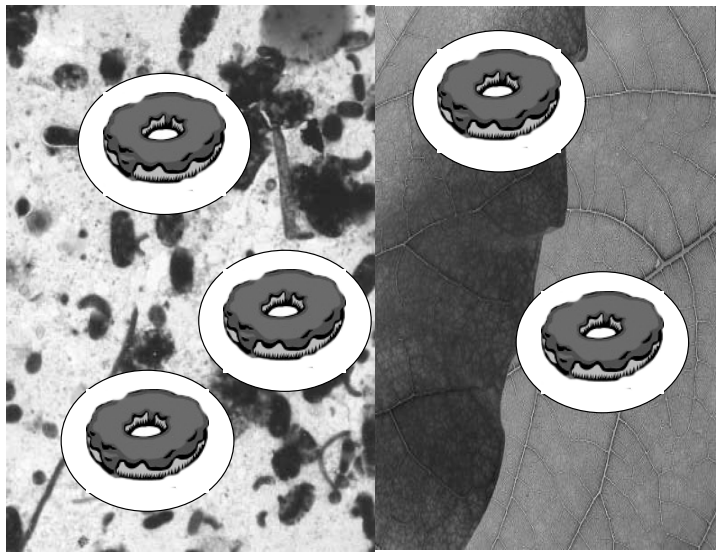
Modified from figure by Lee Kerkhoff

16S rRNA gene profiles of bacterial $^{15}NO_3^-$ uptake



Lee Kerkhoff et al. In prep.

DON



- A significant fraction of both autothonous and allochthonous DON is labile on time scales of days.

- Both bacteria AND phytoplankton use DON.

Big Question:
Who is using what?

- Acknowledgments:
  Marta Sanderson and Quinn Roberts
  Paul Bradley and Jason See

River stuff: David John, John Paul, Jorge Corredor, Julio Morell, Lee Kerkhoff

EON stuff: Margie Mulholland, Nancy Love, Liz Canuel