Trophic Landscape of Seeps and Their Environs

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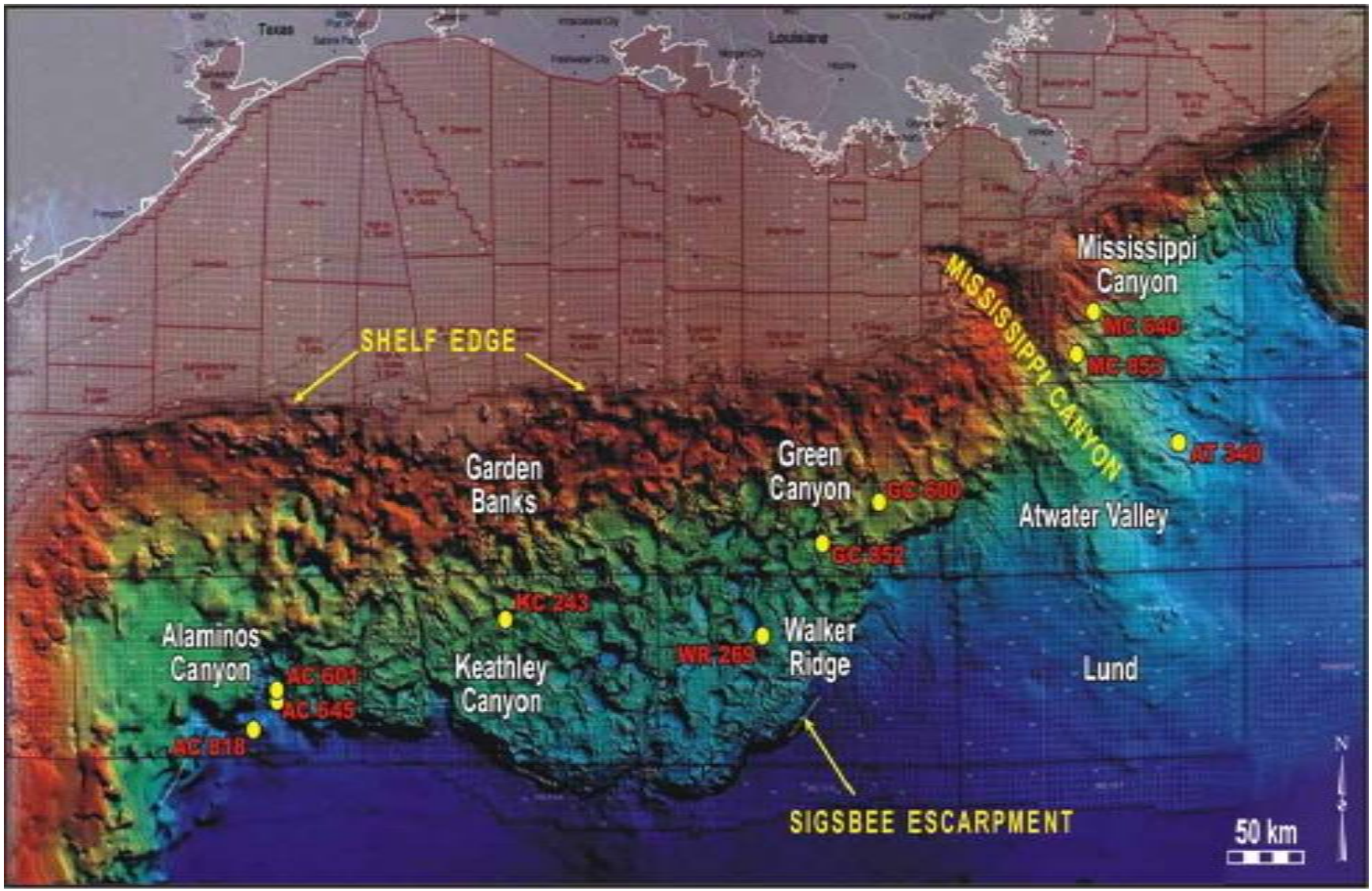
The Question: Seep Abundance vs Slope Limitation

- Exponential decrease in benthic biomass from shelf to abyss is attributed to similar decrease in labile phyto-detritus influx.
- Measured influx seems insufficient to meet biological demand, although methods are problematic.
- Therefore, it is widely accepted that food is limiting.
- Seeps represent a a seemingly rich food source independent of phyto-detritus.
- ? – Does exploitation of seeps by background fauna increase down slope?

Lower Slope Investigation



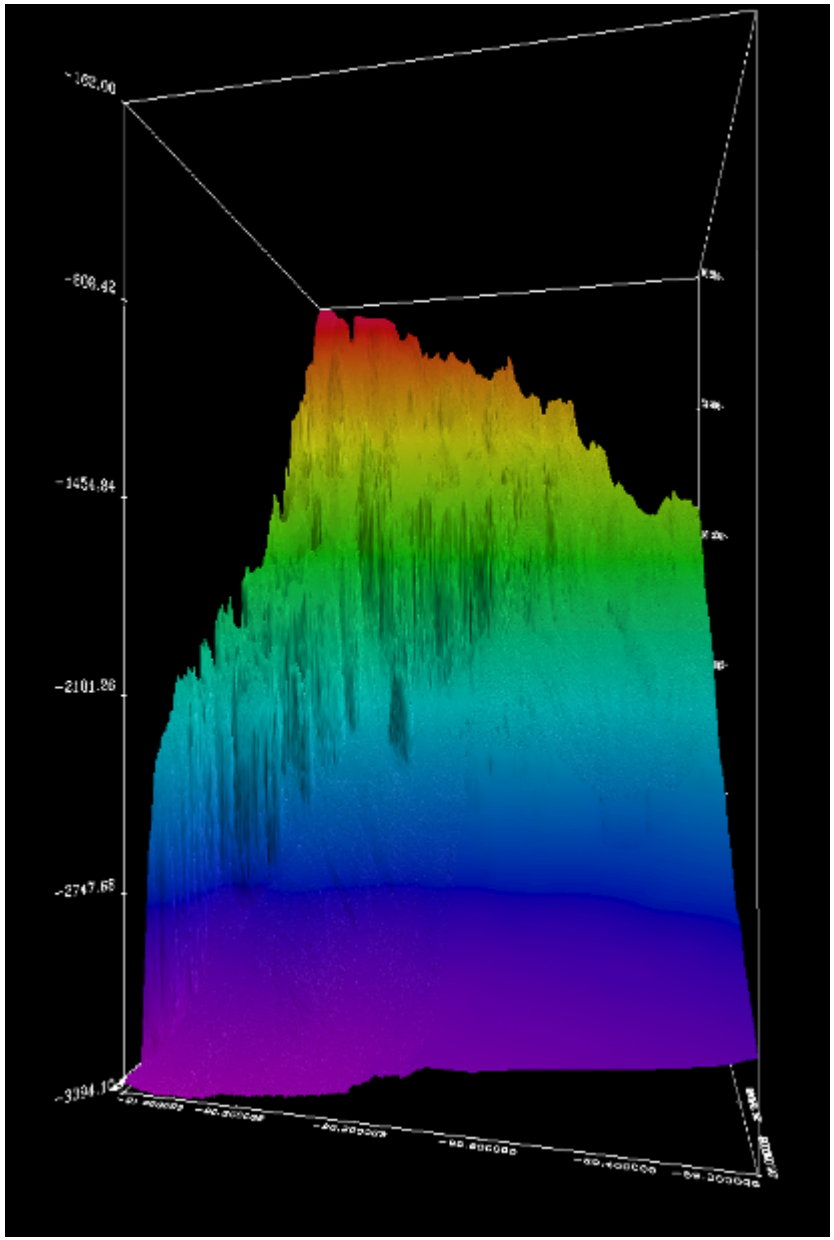
Approaches to Trophic Assessment

- Catch what you can
  - Good when prior knowledge is limited
  - Practical
  - Wide taxonomic breadth rather than depth
  - Raises problems of appropriate statistical comparison
- Targeted Taxa
  - Requires high level of prior knowledge
  - Limited practicality
  - Narrow taxonomic breadth with greater depth
  - Within-taxa comparisons better justified analyses

Seep Food Production

- Foundation metazoa biomass
  - Lethal and sub-lethal predation
- Foundation metazoa exuvia
  - Gametes, pseudofeces, feces
- Seep-associate heterotroph biomass & exuvia
  - As above
- Free-living microbes
  - Detritus and microbial films
- Microbial “rain” from hydrocarbon plume
  - Detritus at distance

Down-Slope Ecological Changes



Biomass & phytodetritus influx decrease ~ 1 order magnitude

Decapod crabs decrease in diversity and abundance

Hagfish decrease

Elasipod holothuroids increase in diversity and abundance

Other Echinoderms increase in abundance

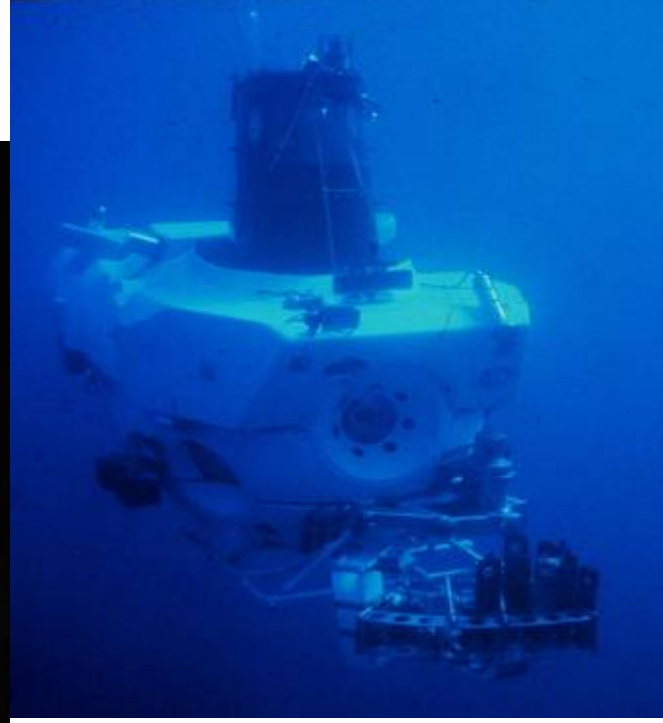
Caused by pressure, food influx, water mass, etc.

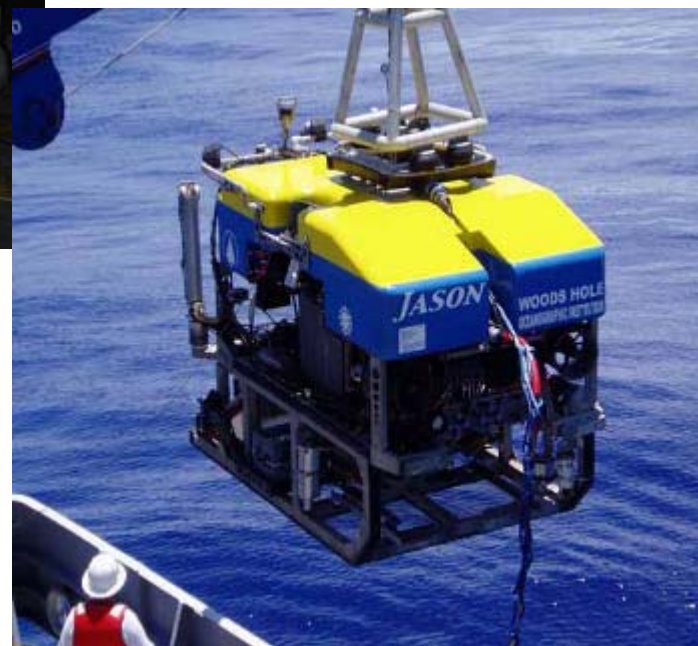
Methods

- Collect fauna
  - In, Near (5km), Far
- Tissue consistency
  - Muscle if possible
  - Asteroid whole arm
    - 2 N HCL wash & spin
- U.C. Davis Stable Isotope Facility
  - 1,000 mg samples

    δ ppm versus standard

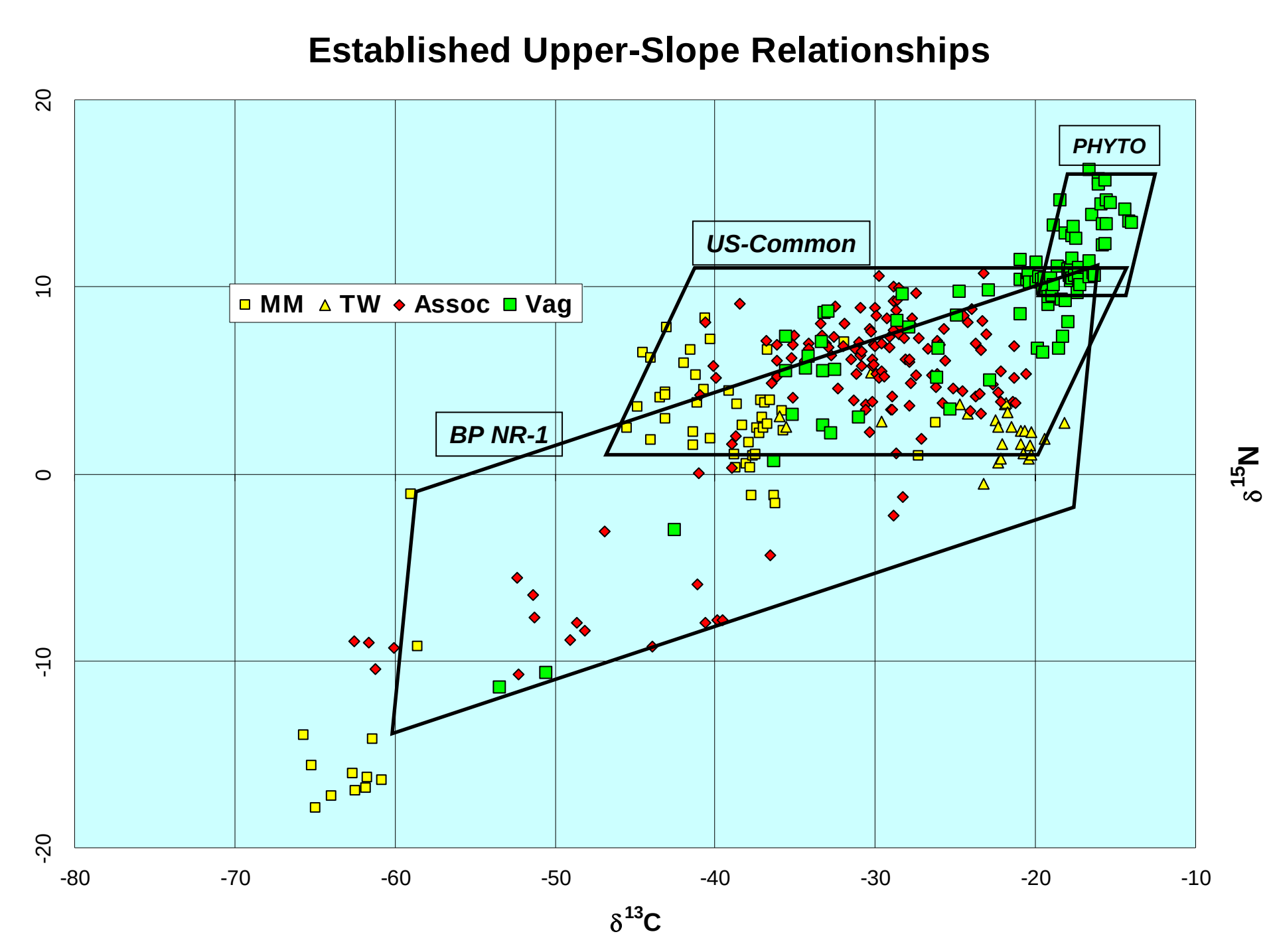
    PDB ^{13}C & Air ^{15}N





Sampling Effort

- Recon Cruise
  - 3 Otter Trawl Samples
- ALVIN Cruise
  - 10 Beam Trawl Samples
  - 16 Alvin Dives
- JASON Cruise
- Megafauna collected on 8 deployments


Established Upper-Slope Relationships
MM
TW
Assoc
Vag
PHYTO
US-Common
BP NR-1
20
10
0
-10
-20
-80
-70
-60
-50
-40
-30
-20
-10
δ13C
δ15N

Porcupine Abyssal Plain

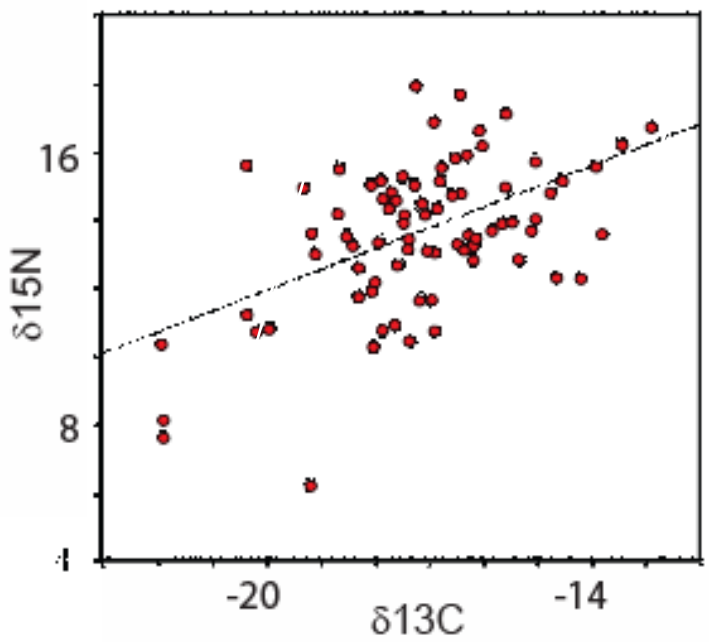
Iken et al. 2001

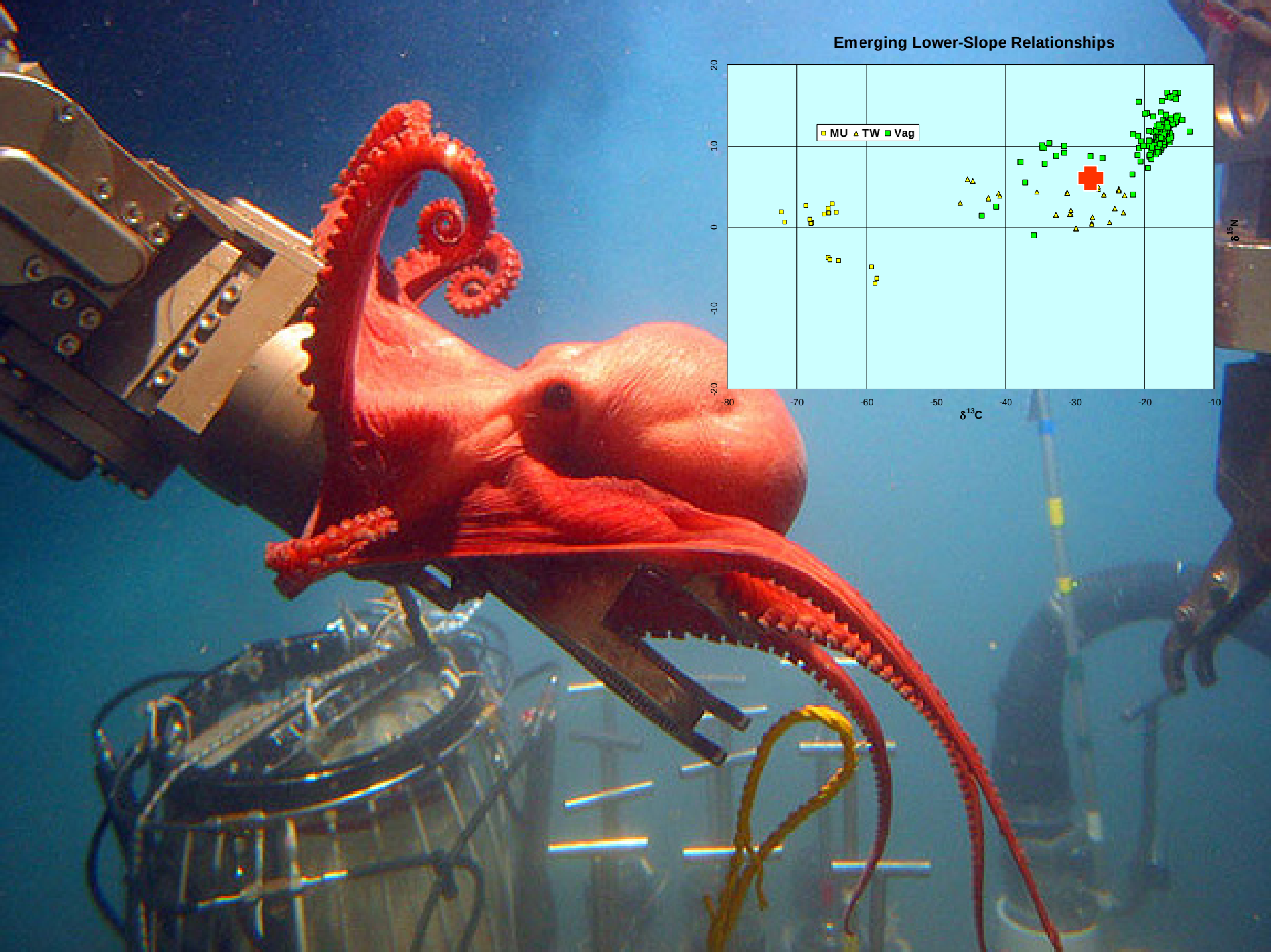
~ 800 specimens

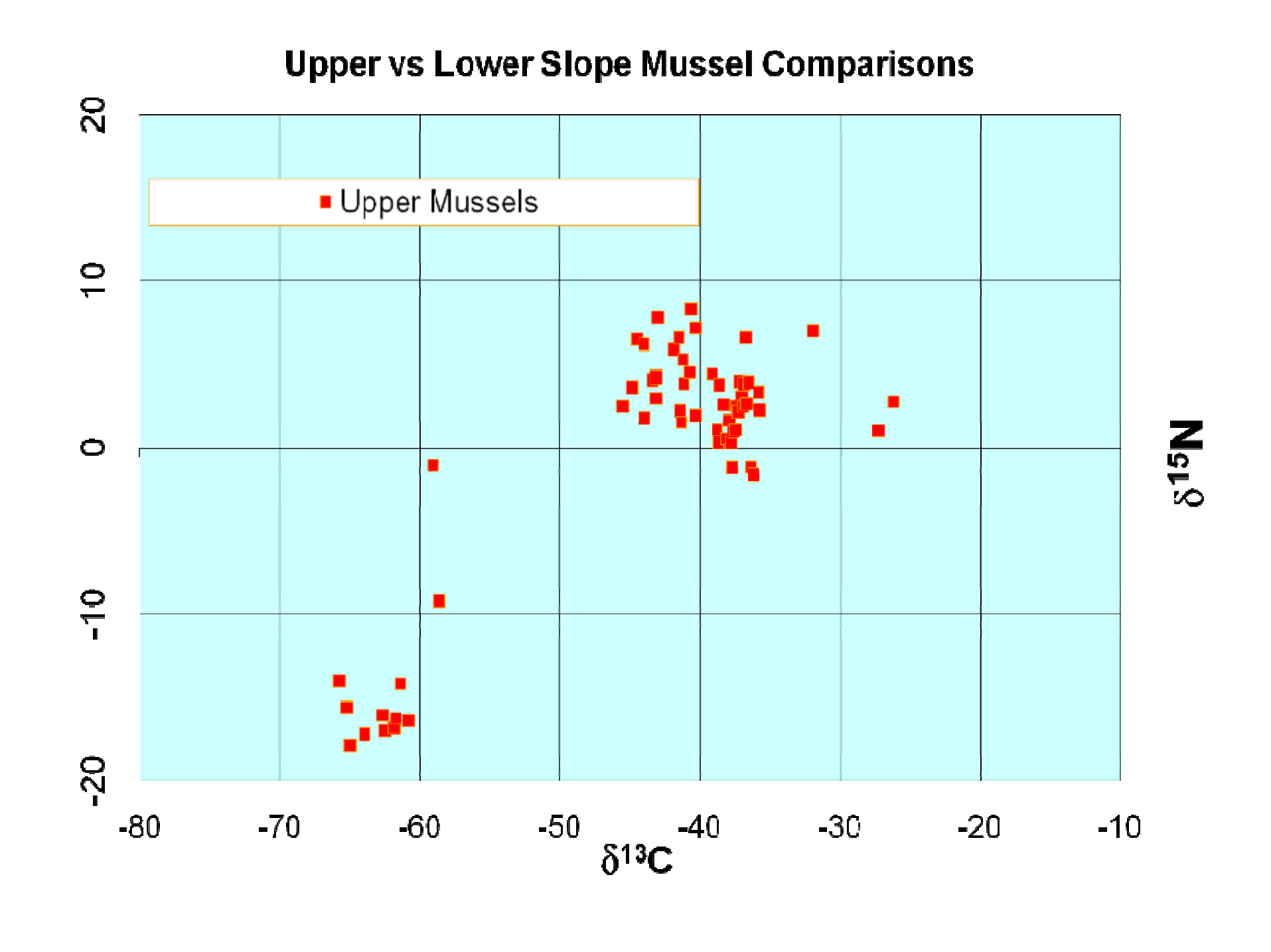
~ 200 determinations on pooled tissue

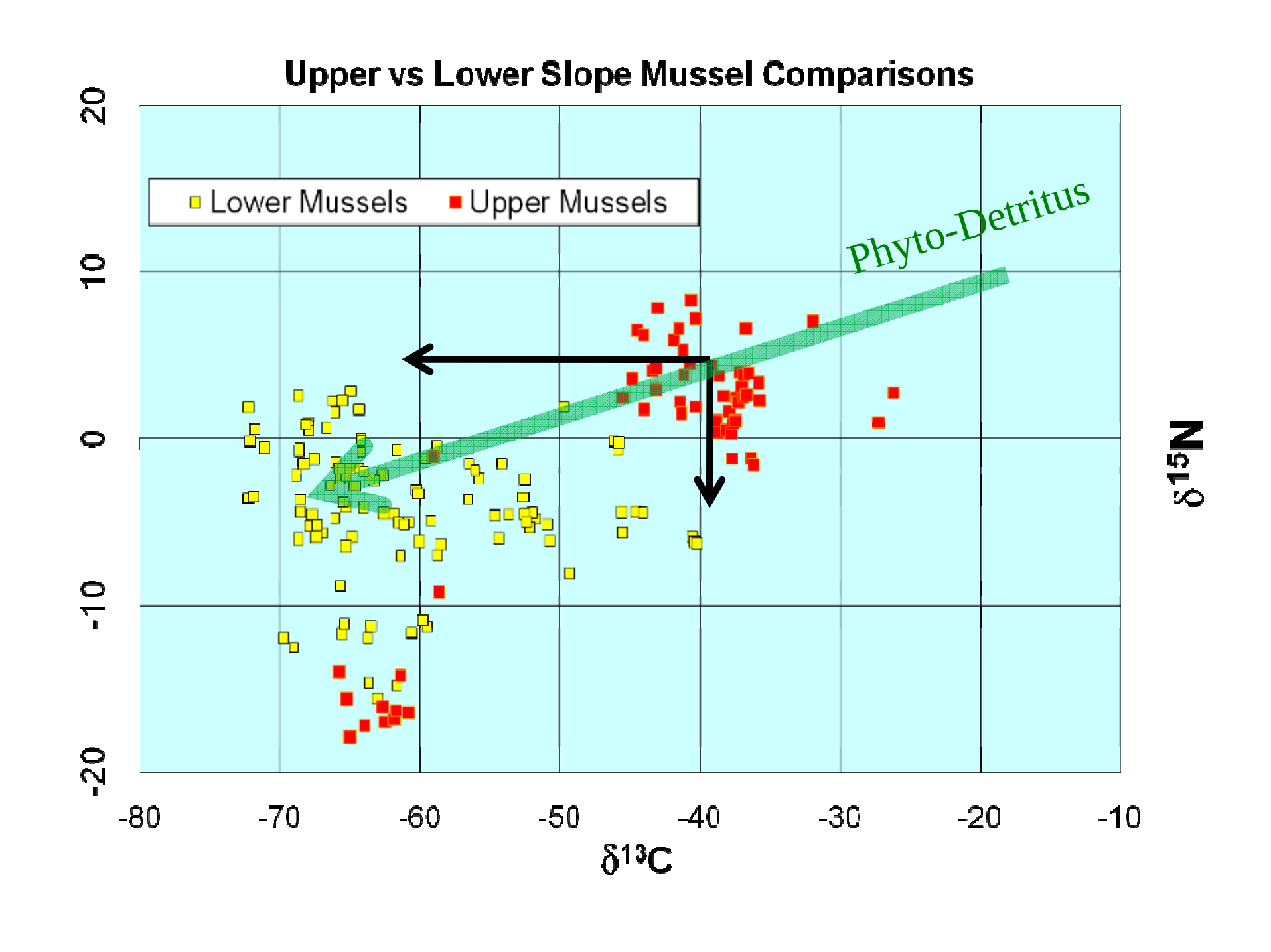
4,048m deep holothuroid-dominated fauna

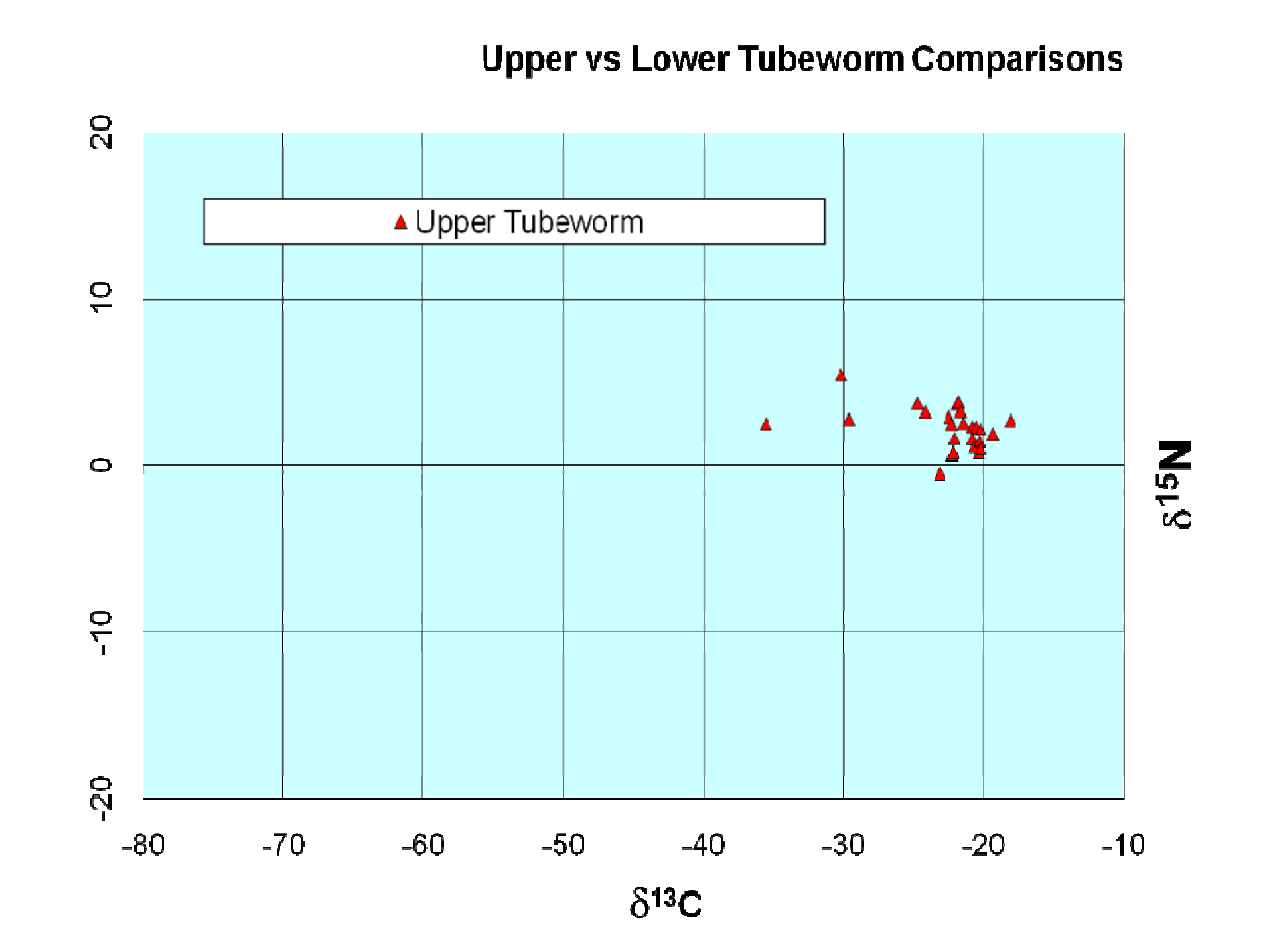
Found basically same thing as in Gulf of Mexico. Interpret as phyto-detritus driven system. Method differences make excessive comparison problematic

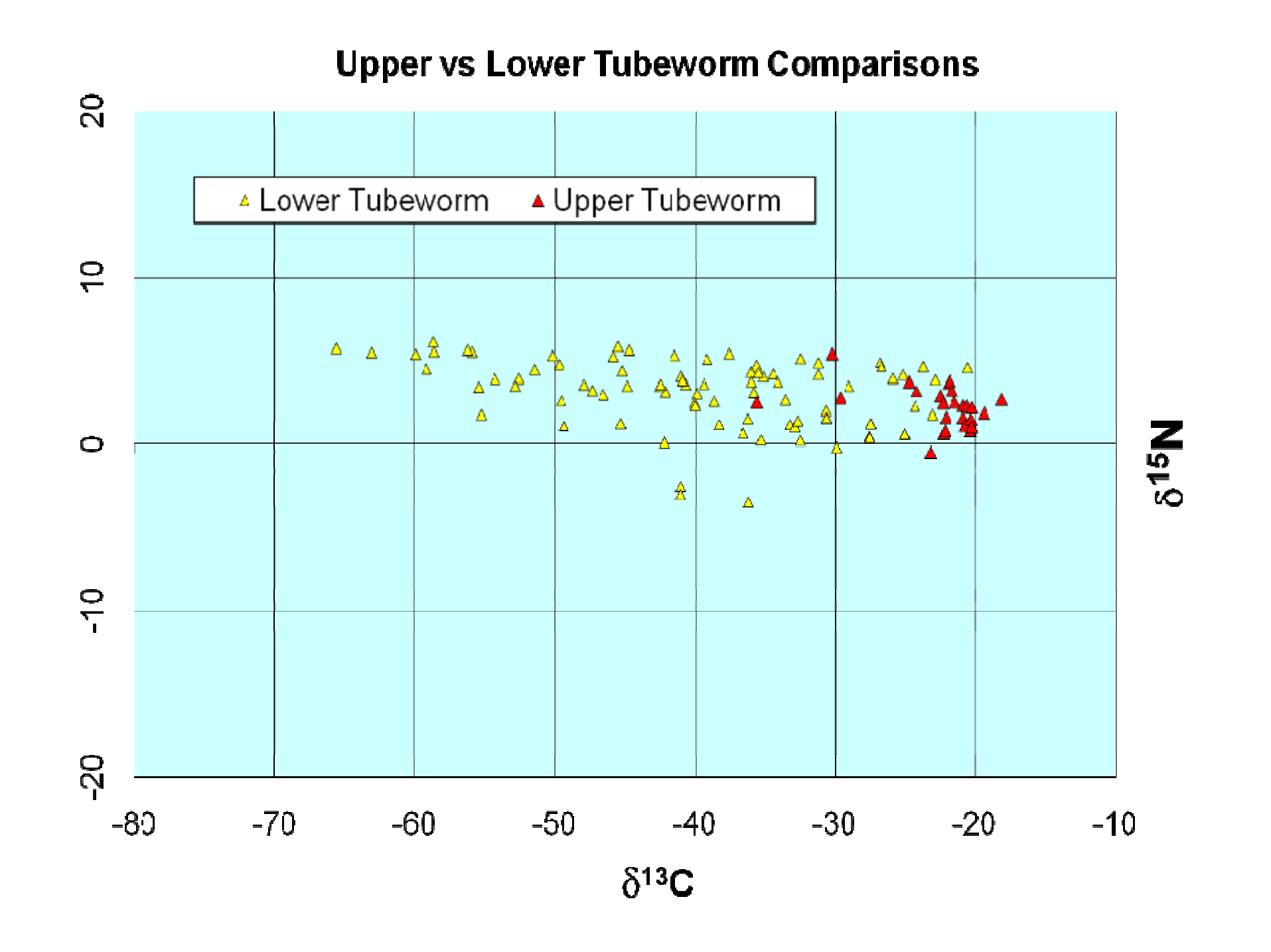



Emerging Lower-Slope Relationships
MU
TW
Vag
20
10
0
-10
-20
-80
-70
-60
-50
-40
-30
-20
-10
δ13C
δ15N


Upper vs Lower Slope Mussel Comparisons
Upper Mussels
20
10
0
-10
-20
-80
-70
-60
-50
-40
-30
-20
-10
δ13C
δ15N

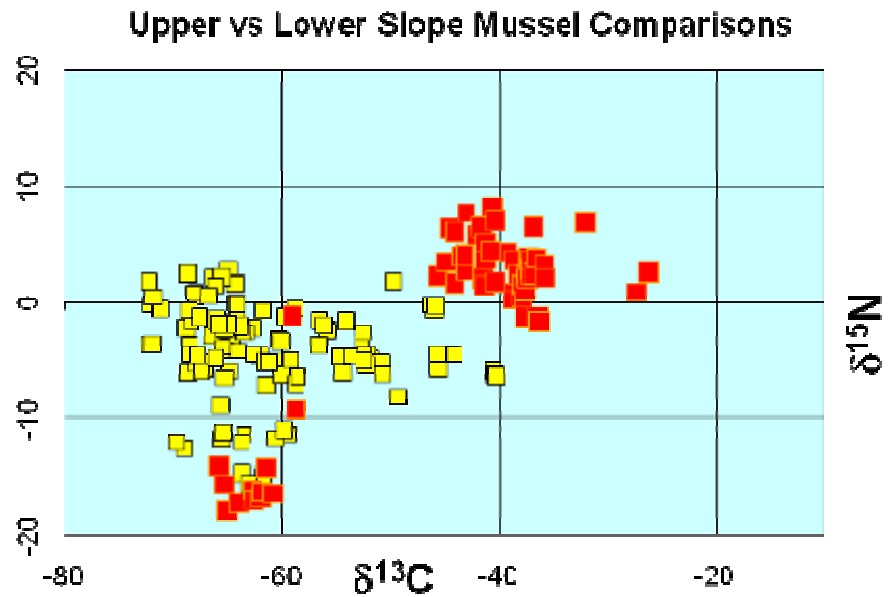

Upper vs Lower Slope Mussel Comparisons
Lower Mussels
Upper Mussels
Phyto-Detritus
20
10
0
-10
-20
-80
-70
-60
-50
-40
-30
-20
-10
δ13C
δ15N

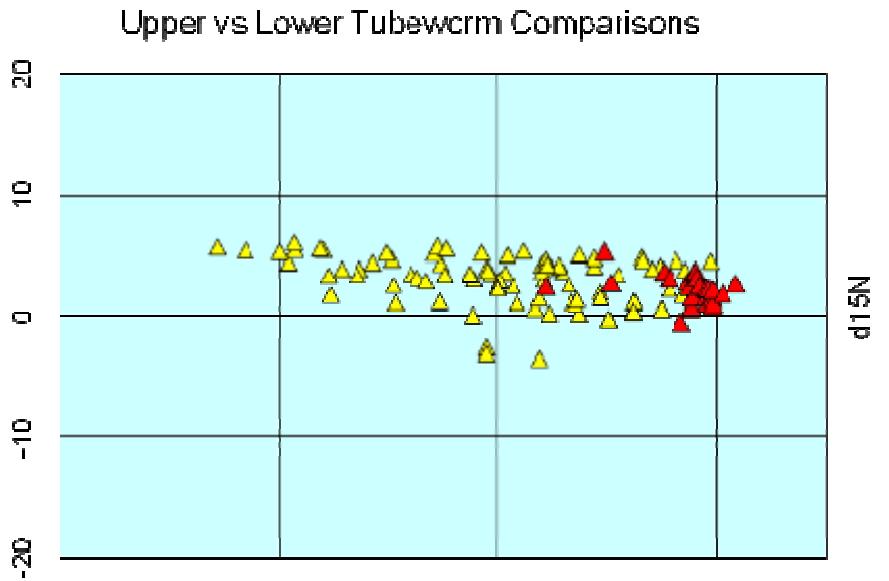

Upper vs Lower Tubeworm Comparisons
Upper Tubeworm
20
10
0
-10
-20
-80
-70
-60
-50
-40
-30
-20
-10
δ13C
δ15N

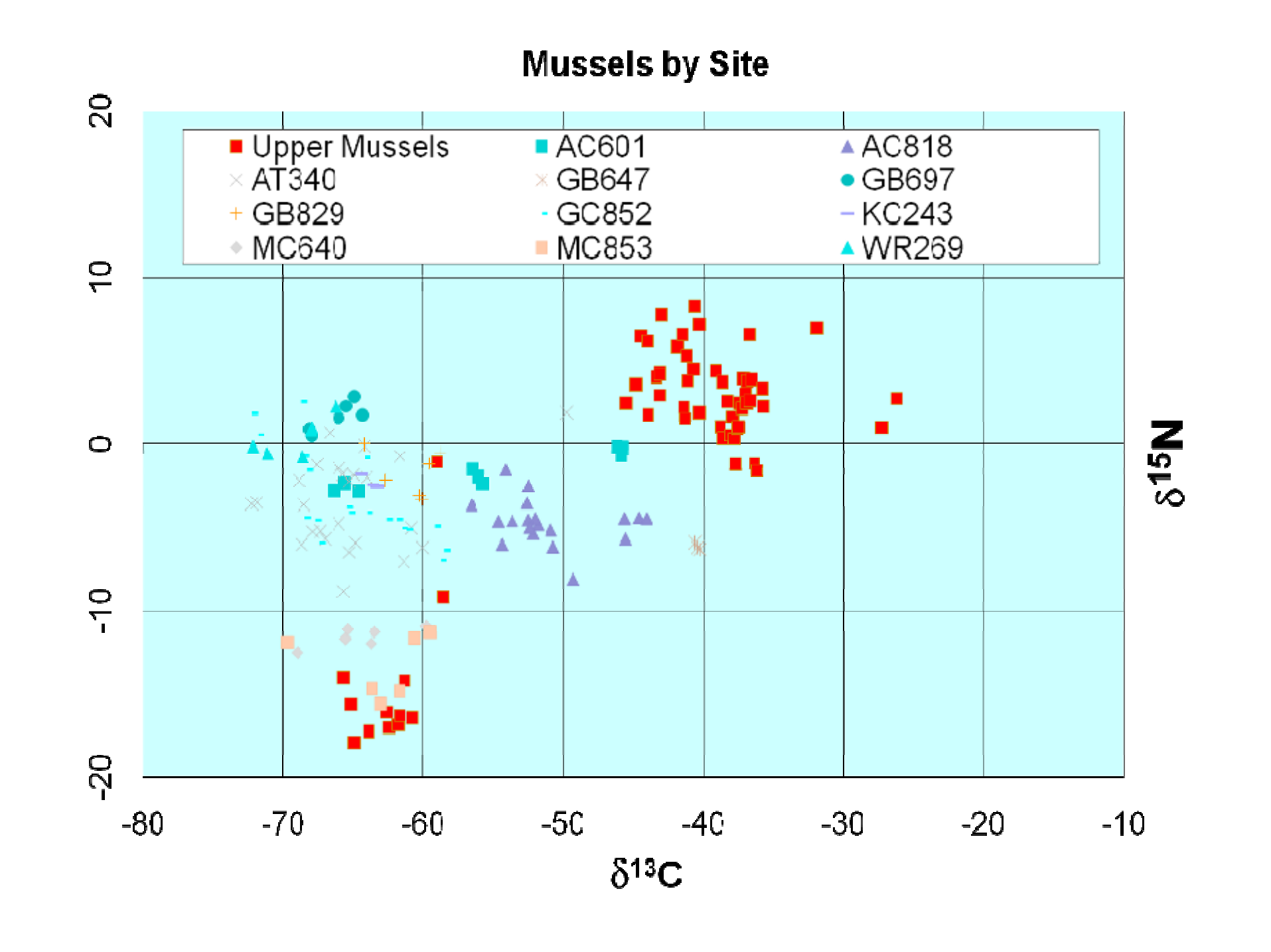

Upper vs Lower Tubeworm Comparisons
Lower Tubeworm
Upper Tubeworm
20
10
0
-10
-20
-80
-70
-60
-50
-40
-30
-20
-10
δ13C
δ15N

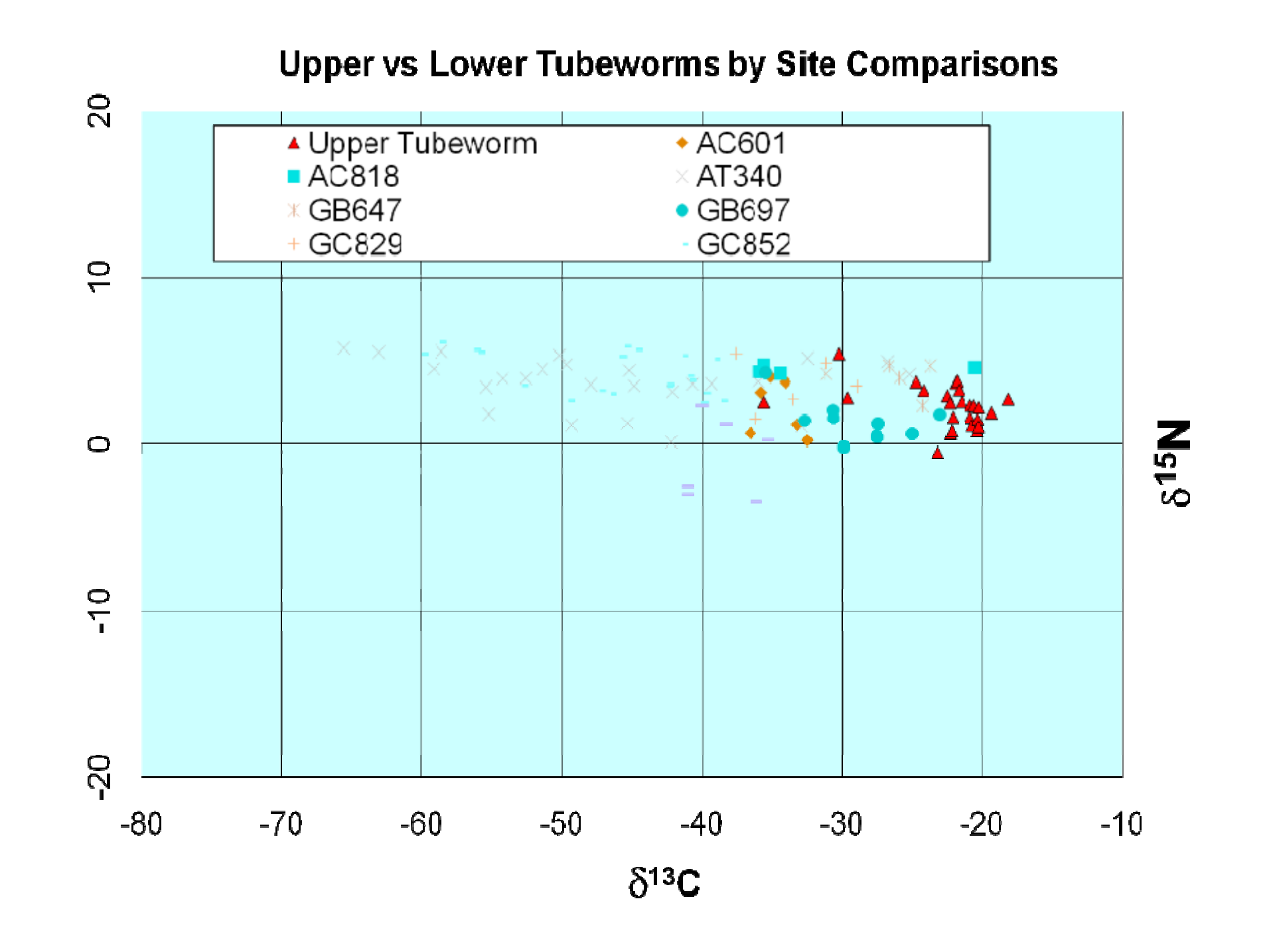
Deep End Member Proxies

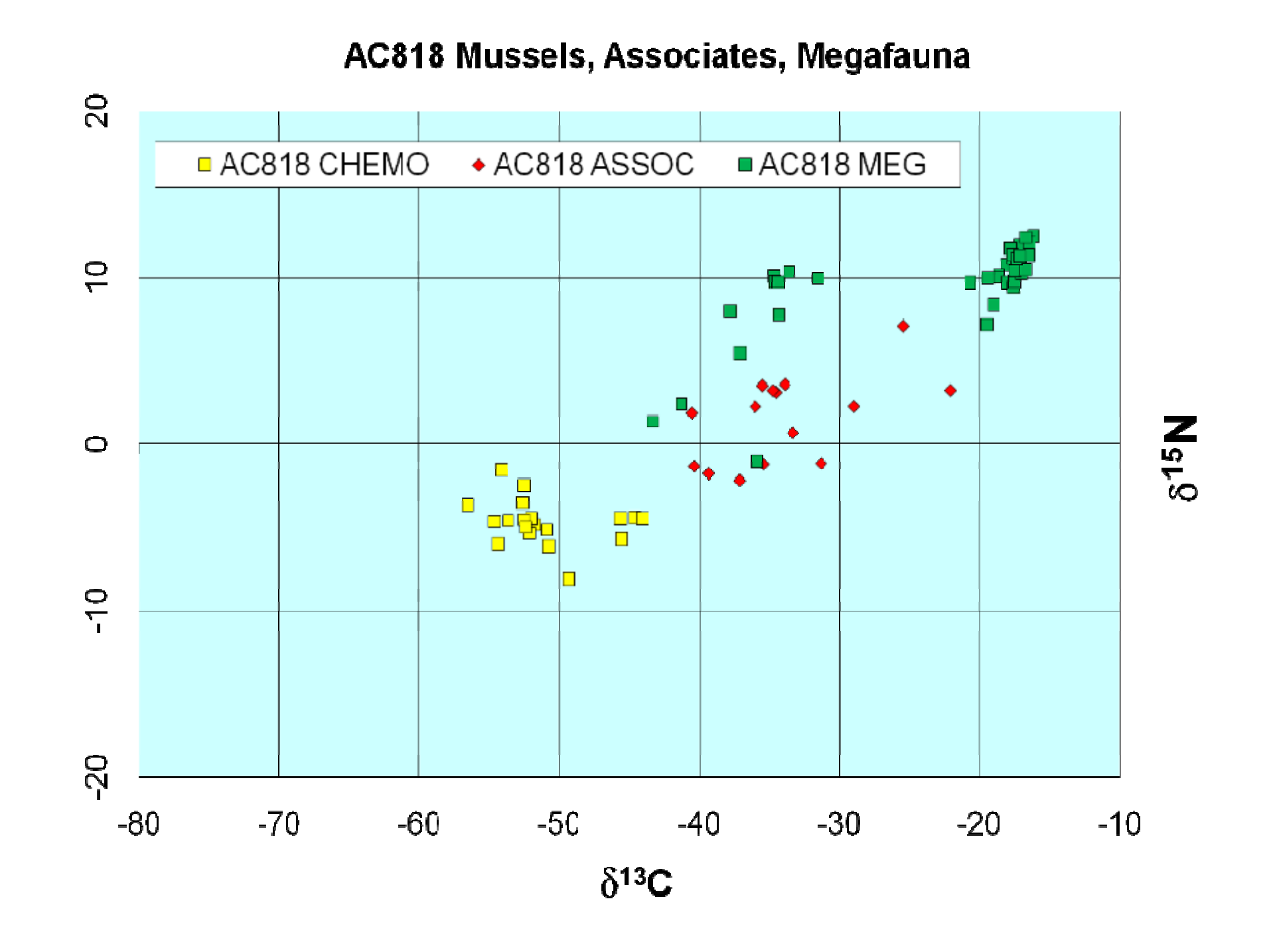
- Mussels
  - Range carbon & nitrogen increased
- Tubeworms
  - Range carbon increased
  - Nitrogen little changed

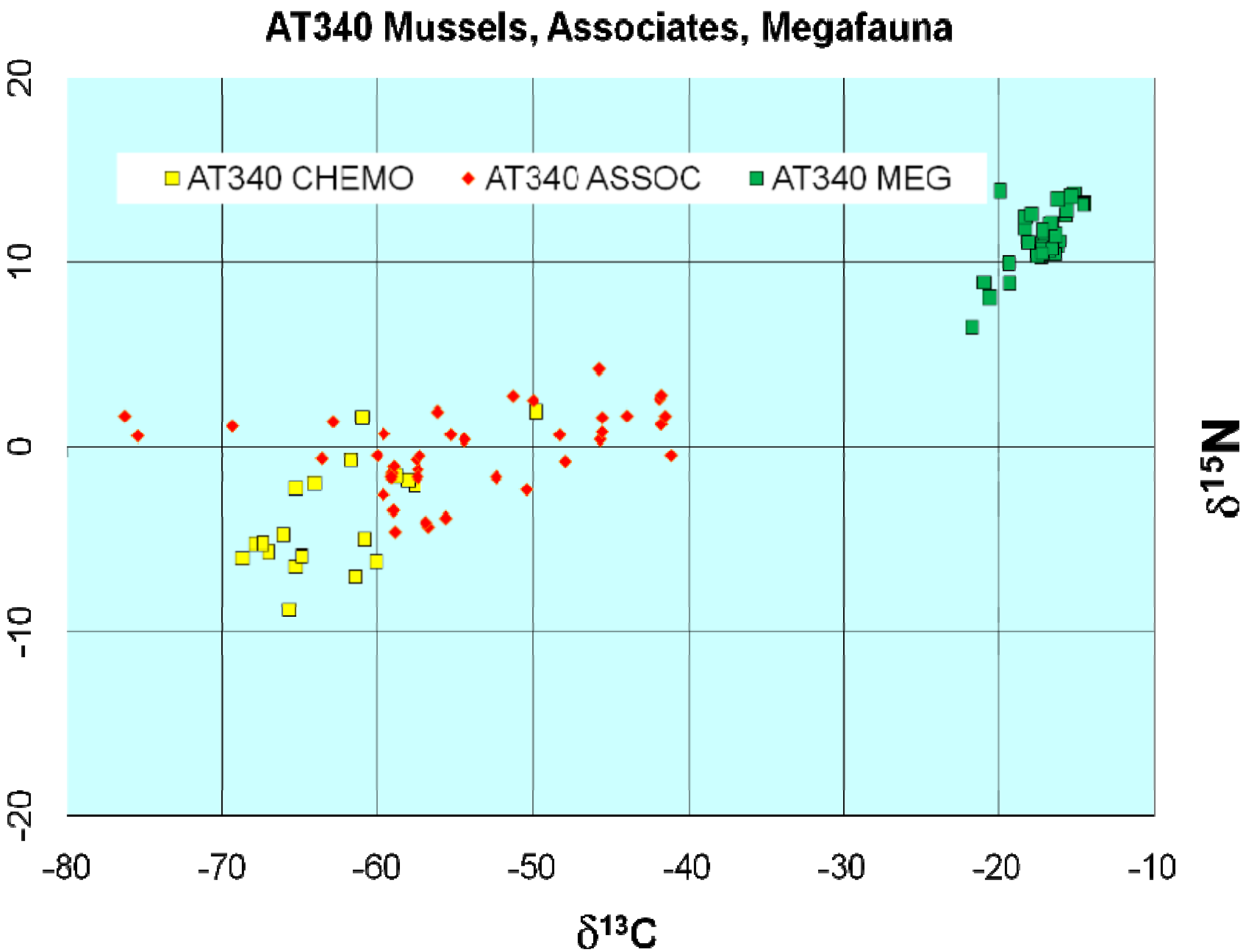


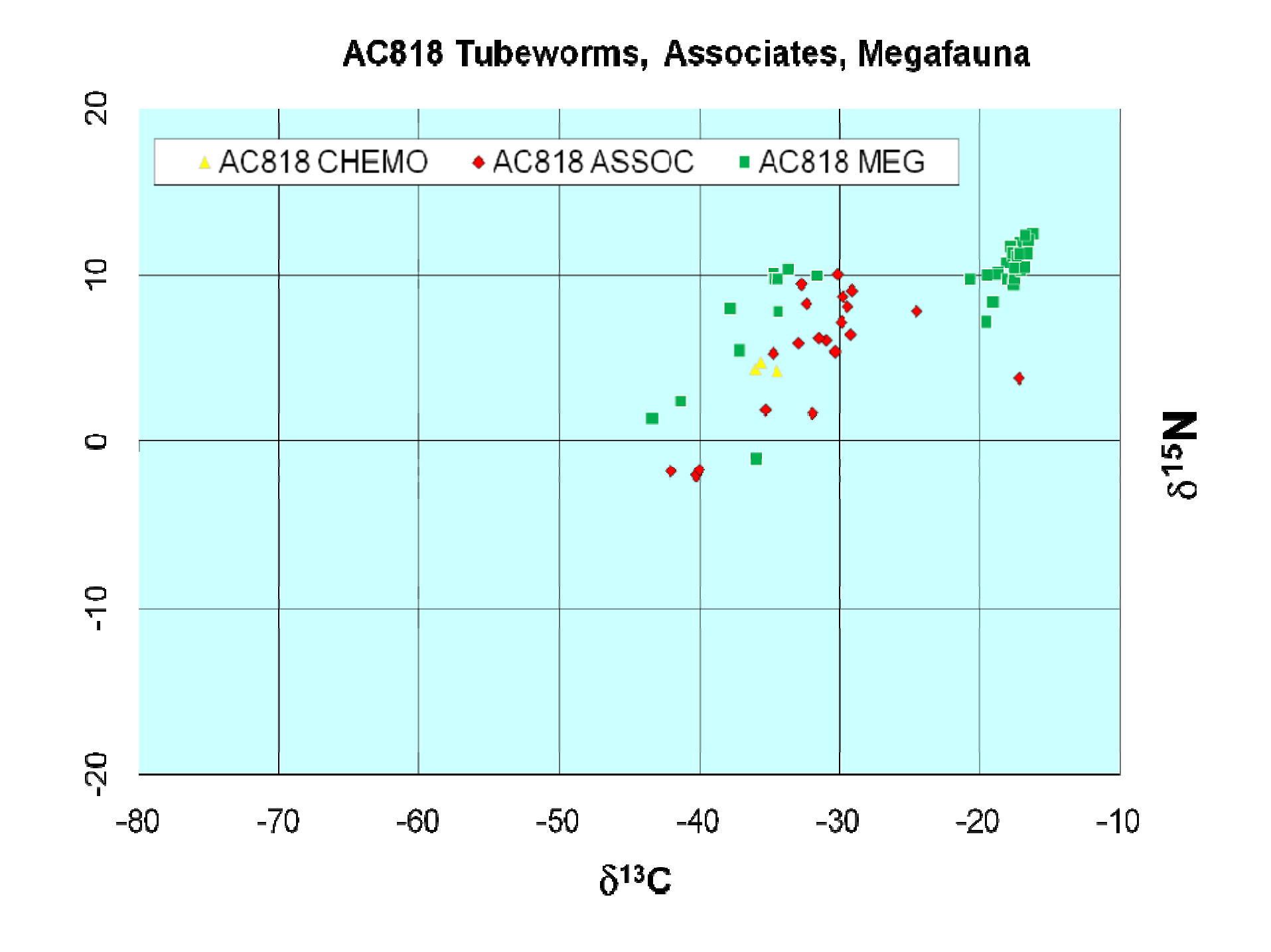



Mussels by Site
Upper Mussels
AC601
AC818
AT340
GB647
GB697
GB829
GC852
KC243
MC640
MC853
WR269
20
10
0
-10
-20
-80
-70
-60
-50
-40
-30
-20
-10
δ13C
δ15N


Upper vs Lower Tubeworms by Site Comparisons
Upper Tubeworm
AC601
AC818
AT340
GB647
GB697
GC829
GC852
20
10
0
-10
-20
-80
-70
-60
-50
-40
-30
-20
-10
δ15N
δ13C


AC818 Mussels, Associates, Megafauna
AC818 CHEMO
AC818 ASSOC
AC818 MEG
20
10
0
-10
-20
-80
-70
-60
-50
-40
-30
-20
-10
δ13C
δ15N

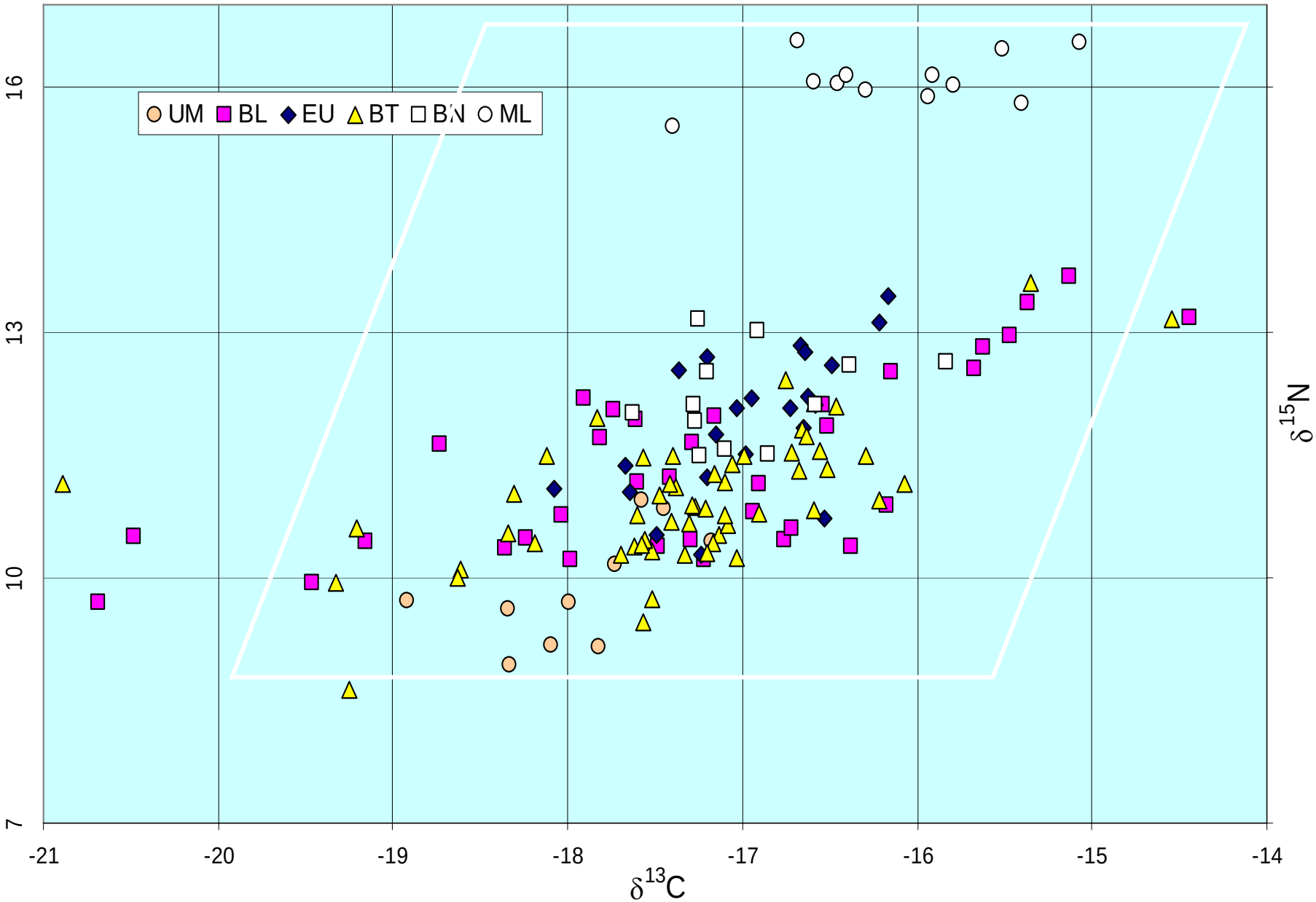

AT340 Mussels, Associates, Megafauna
AT340 CHEMO
AT340 ASSOC
AT340 MEG
20
10
0
-10
-20
-80
-70
-60
-50
-40
-30
-20
-10
δ13C
δ15N

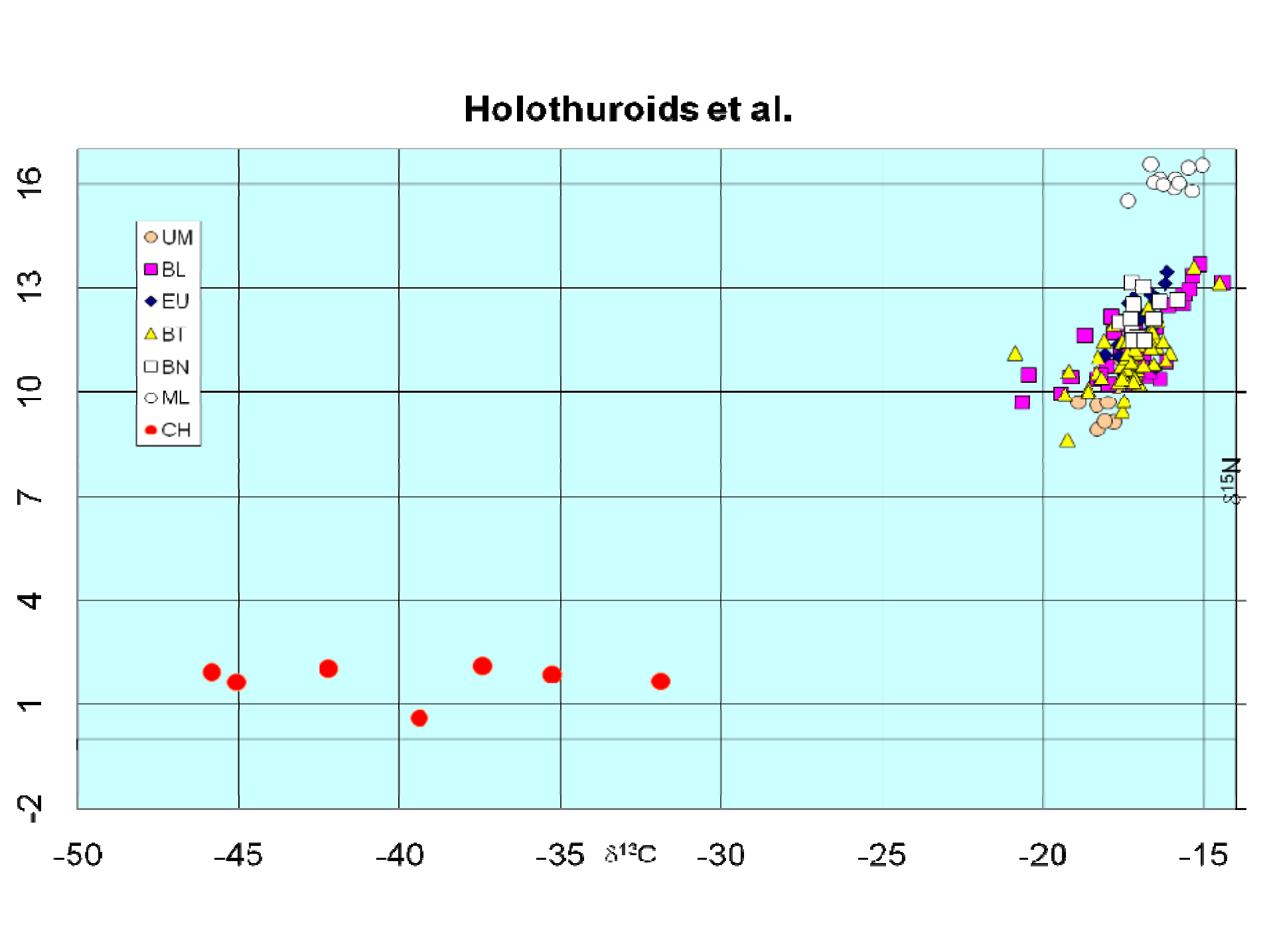

AC818 Tubeworms, Associates, Megafauna
AC818 CHEMO
AC818 ASSOC
AC818 MEG
20
10
0
-10
-20
-80
-70
-60
-50
-40
-30
-20
-10
δ13C
δ15N

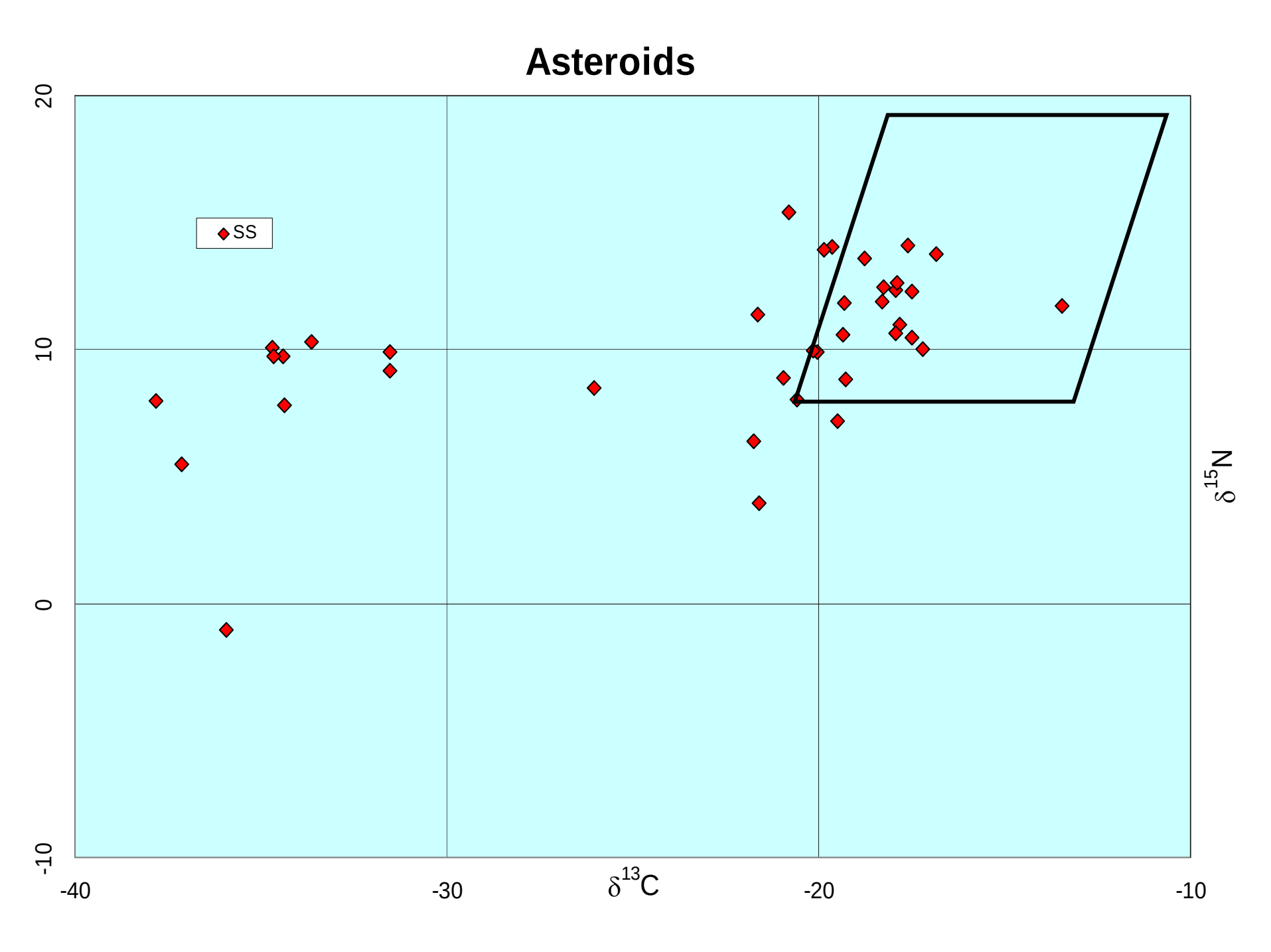
Selective Look at Echinoderms

- Lower slope has conspicuous echinoderm populations
  - Holothuroids mostly Elasipoda
  - Mixed taxa asteroids

Holothuroids et al.




Holothuroids et al.
UM
BL
EU
BT
BN
ML
CH
16
13
10
7
4
1
-2
δ15N
-50
-45
-40
-35
δ13C
-30
-25
-20
-15


Asteroids
SS
20
10
0
-10
-40
-30
-20
-10
δ13C
δ15N

Conclusions (Still Preliminary)

- Proxy Trophic Endpoints show much greater spread than in previous upper-slope studies
- No evidence w/ limited taxa of extensive trophic export.
  - Background detritivore holothurians show no trophic influence of seeps even w/in 50m.
  - Pennatulids at 1–5km show no influence.
- Within-seep exploitation as on upper-slope but fewer participating species.
  - Seastars in and w/in 50m show a mixed diet especially *Ampheraster* sp.
- Assessment of depth-related intensity of exploitation will depend on additional analysis of the seep associates
  - Stay tuned.

Reference

Iken, K., T. Brey, U. Wand, J. Voight, and P. Junghans. 2001. Foods web structure of the benthic community at the Porcupine Abyssal Plain (NE Atlantic): A stable isotope analysis. Progress in Oceanography 50:383–405.