Sources and Composition of Dissolved and Particulate Organic Matter in the Delaware Estuary

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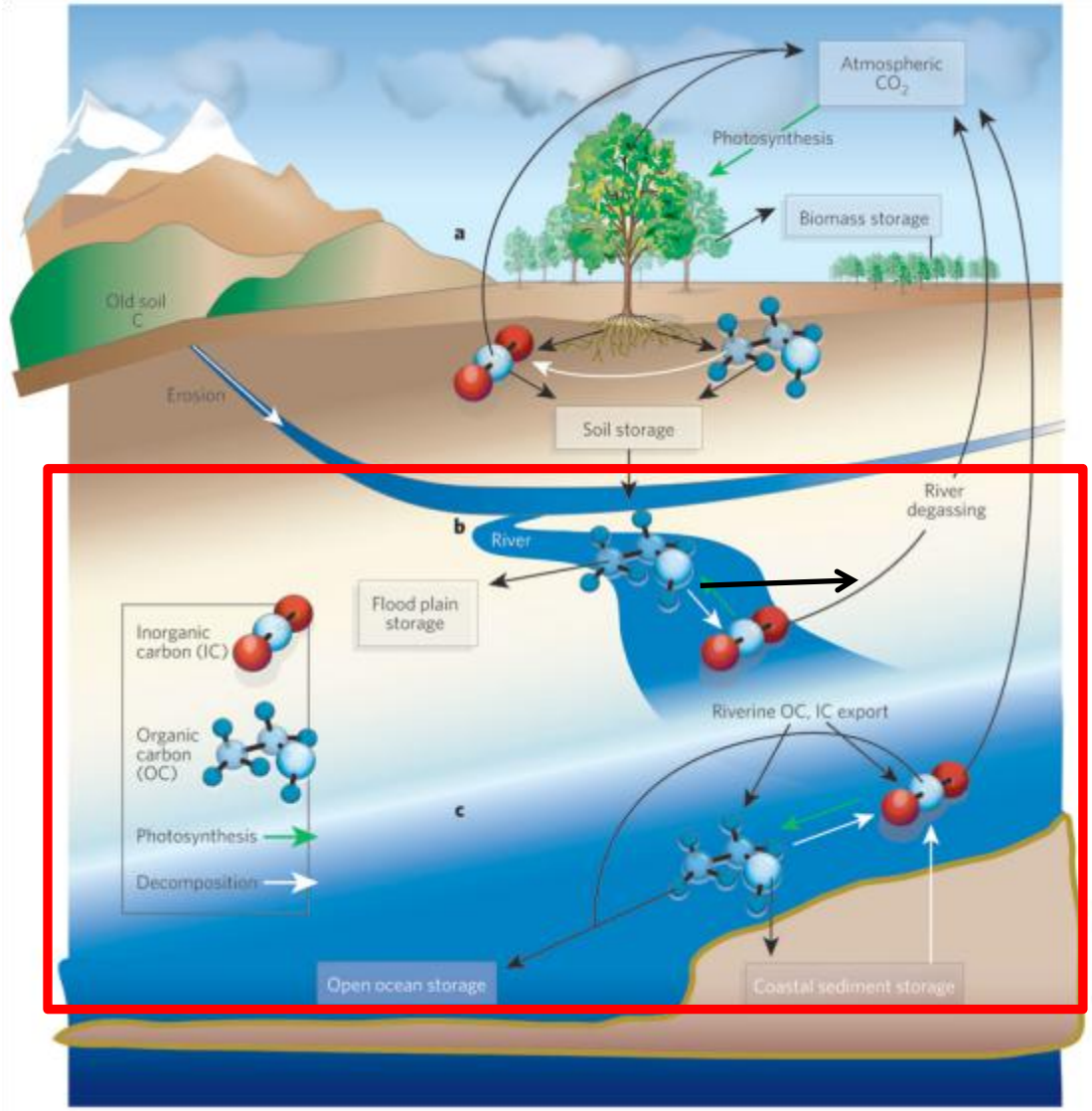
Overview

- Introduction
  - Estuarine Carbon Cycle
- Study Site
  - Delaware River and Bay Watershed
  - Sampling Locations
- Methods
- Results
  - Terrestrial – to – Aquatic Ratio for Fatty Acids
  - Radiocarbon Ages of Lipid Fractions
- Summary

Estuarine Carbon Cycle



Raymond (2005) Nature

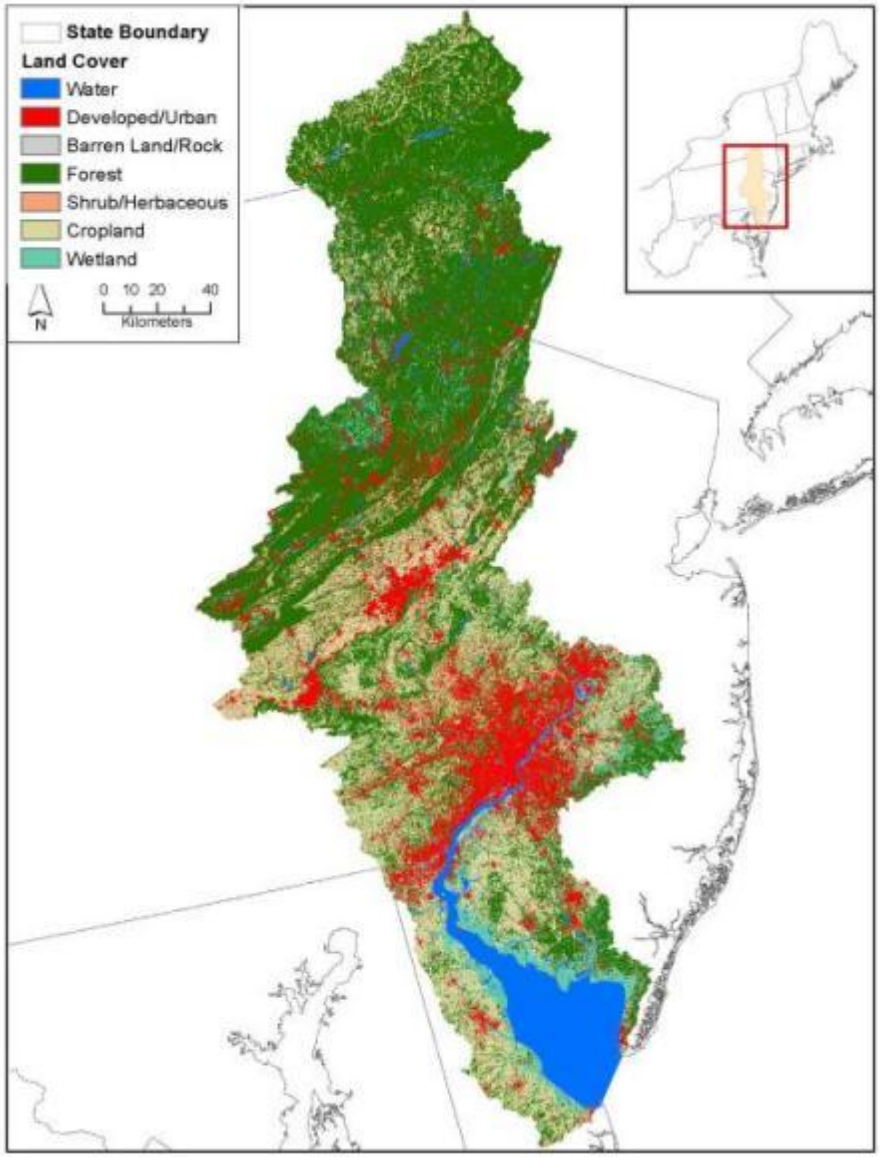
Objectives

- Evaluate the sources and ages of different lipid fractions across the river-estuary-coastal ocean gradient in DE Bay

Approaches Used:

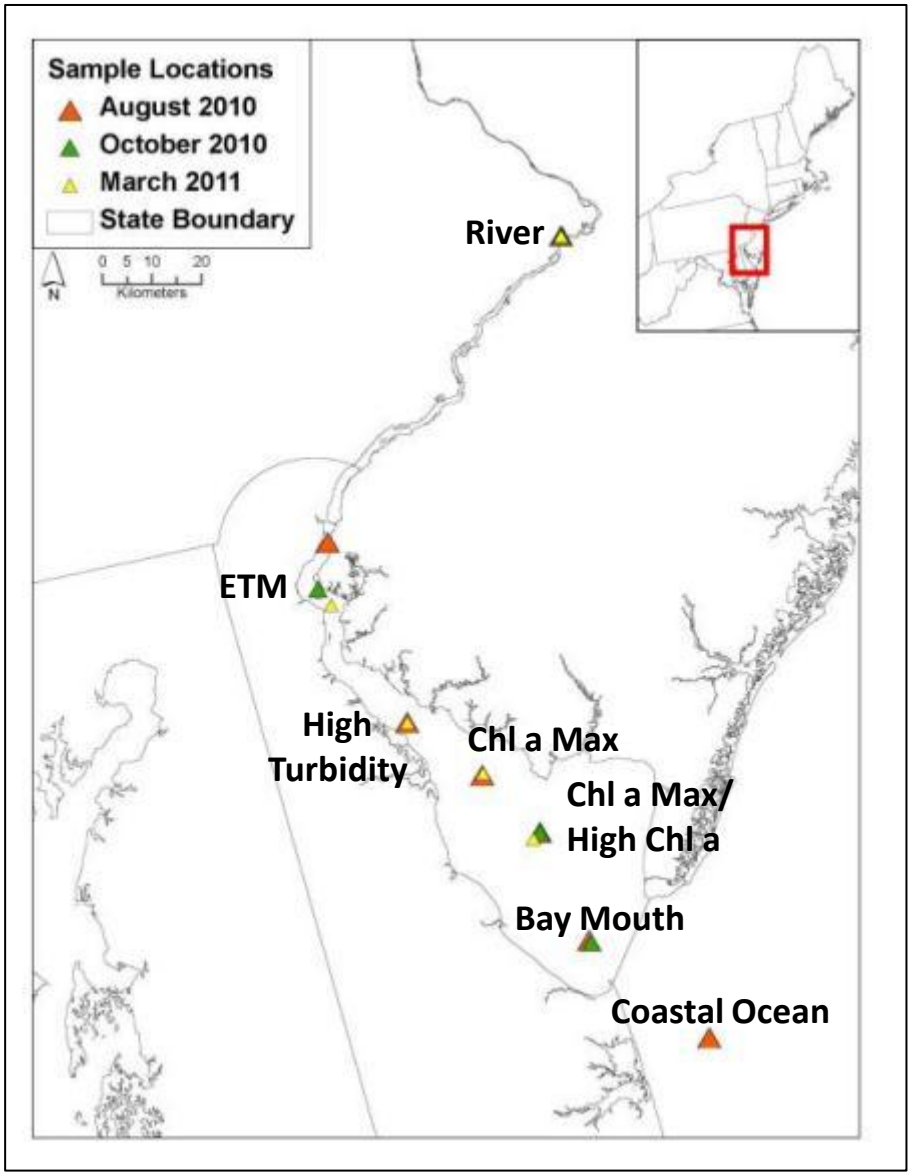
- **Lipid biomarker composition of surface water POM and UDOM**: sources of OM
  - TAR_{FA}
- **Radiocarbon**: identify ages of POM and UDOM
  - Today: neutral and polar total lipid extract (TLE)
  - Still to come: identify ages of POM lipid fractions, source specific biomarkers

Delaware Watershed OM



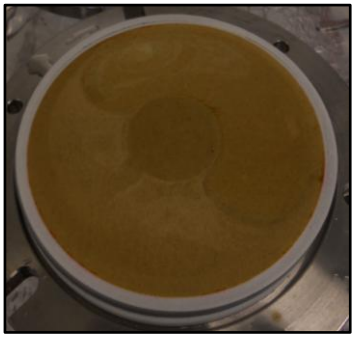
- Potential OM end-members (and ages) include:
  - Estuarine primary production algae and marsh plants (modern)
  - Runoff from pastureland, farmland, and forests (modern/intermediate)
  - Wastewater effluent (intermediate)
  - Marsh sediments (intermediate)
  - re-exposed Pleistocene sediments (ancient)
  - Marcellus Shale and fossil fuels (ancient)

Sampling Locations

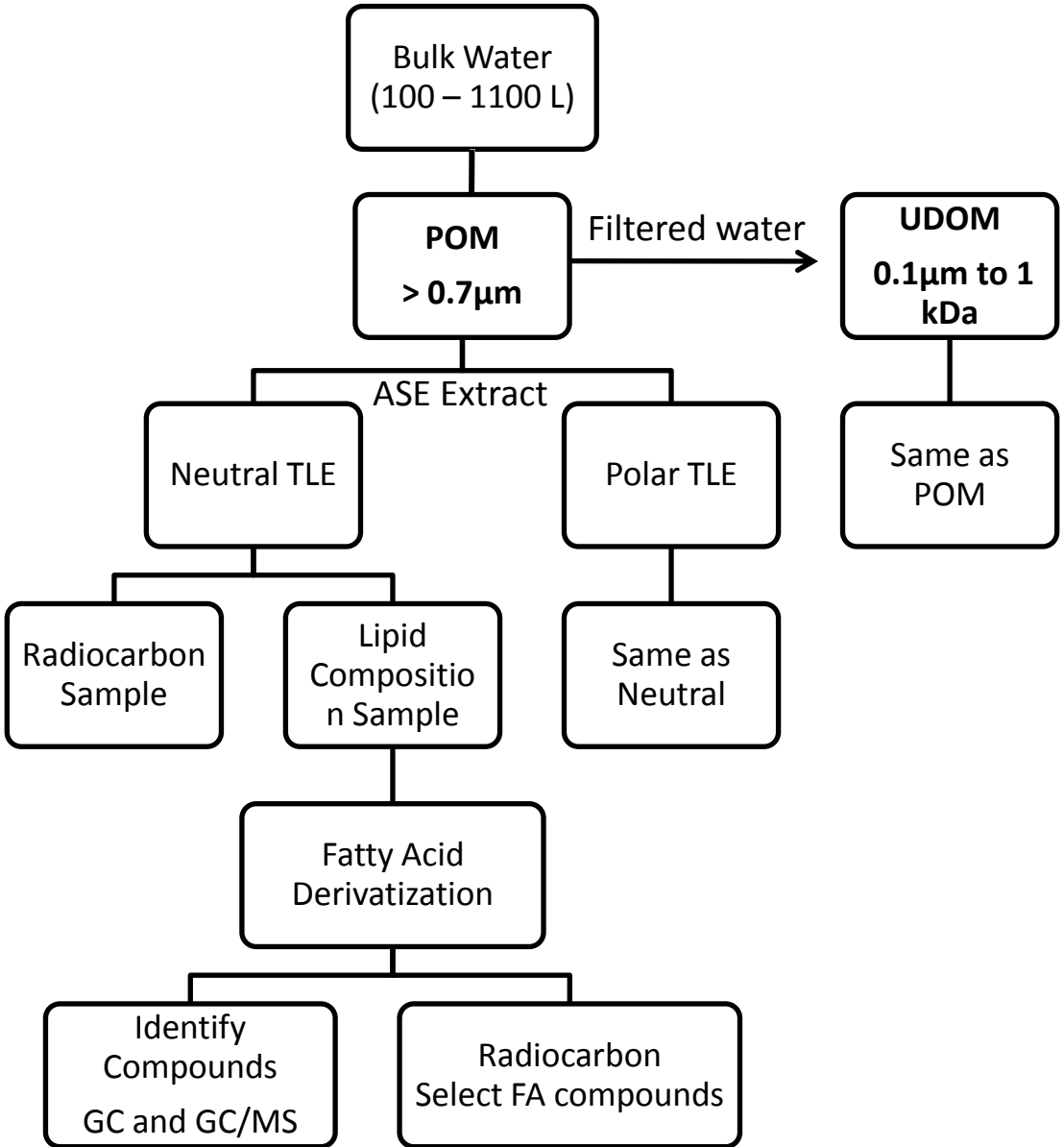


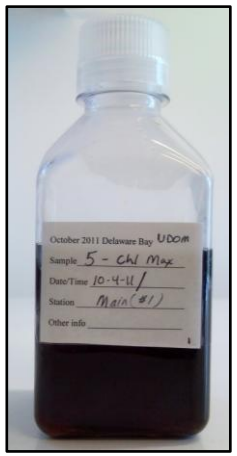
- 5 cruises – Surface water collection
- Fixed Locations
  - River, Bay Mouth, Coastal Ocean
- Variable Locations
  - ETM, Chl a Max, High Chl a

Sample Collection Methods



Filter from Bay Mouth Site
October 2010

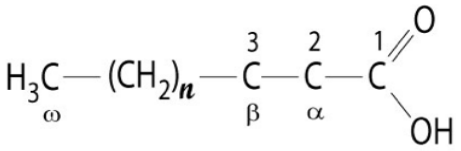




UDOM from Chl a Max Site
October 2011
Photo Courtesy K. Hossler

Lipids as Biomarkers

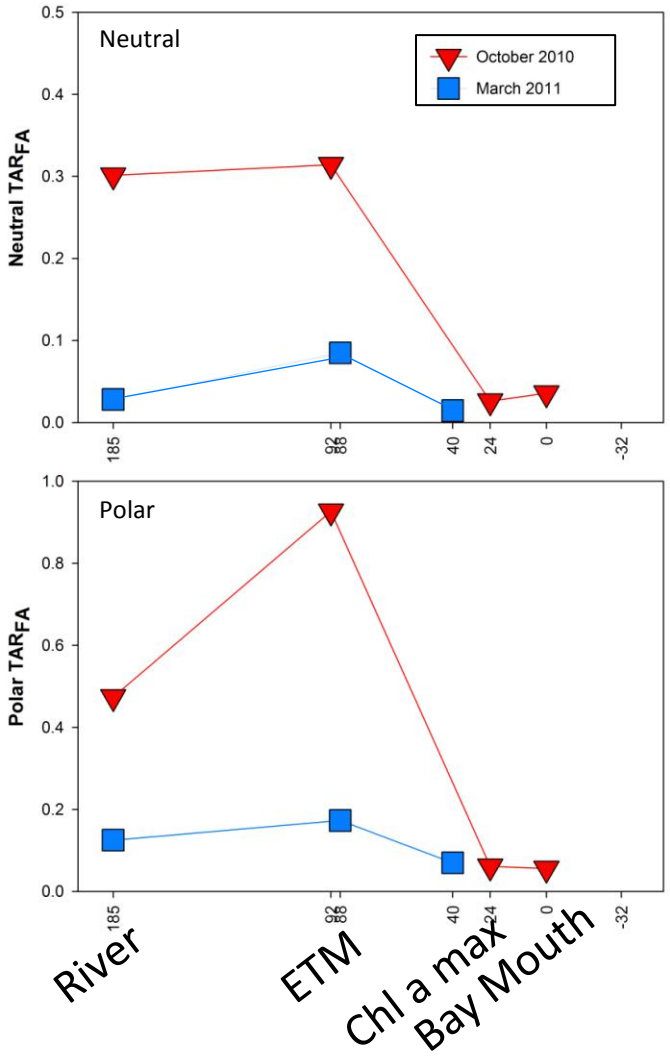
- Biomarkers are used to determine organic matter sources and reactivity
  - Lipid biomarkers = fatty acids



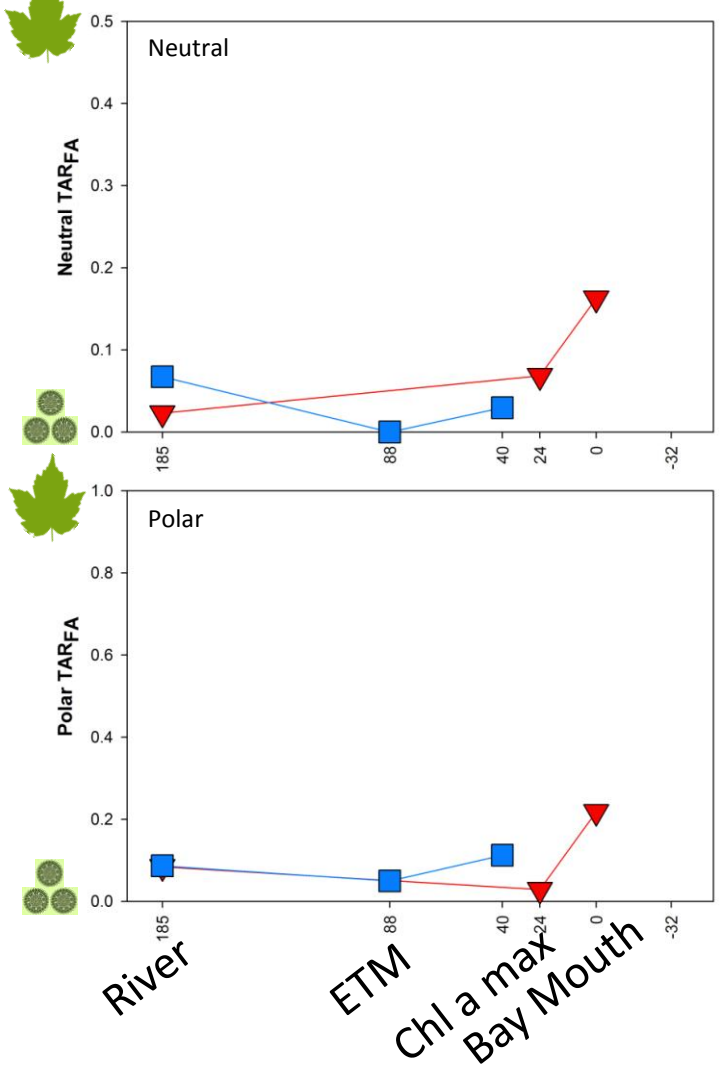
- Terrestrial-to-Aquatic ratio (TAR_{FA}) can show contributions of terrestrial and aquatic OM
  - $TAR_{FA} = \frac{(C_{24:0}+C_{26:0}+C_{28:0})}{(C_{14:0}+C_{16:0}+C_{18:0})}$ (Meyers, 1997)
- TAR_{FA} = 1 equal terrestrial and aquatic FA

Results – Terrestrial – to – Aquatic Ratio$_{FA}$

POM TAR$_{FA}$

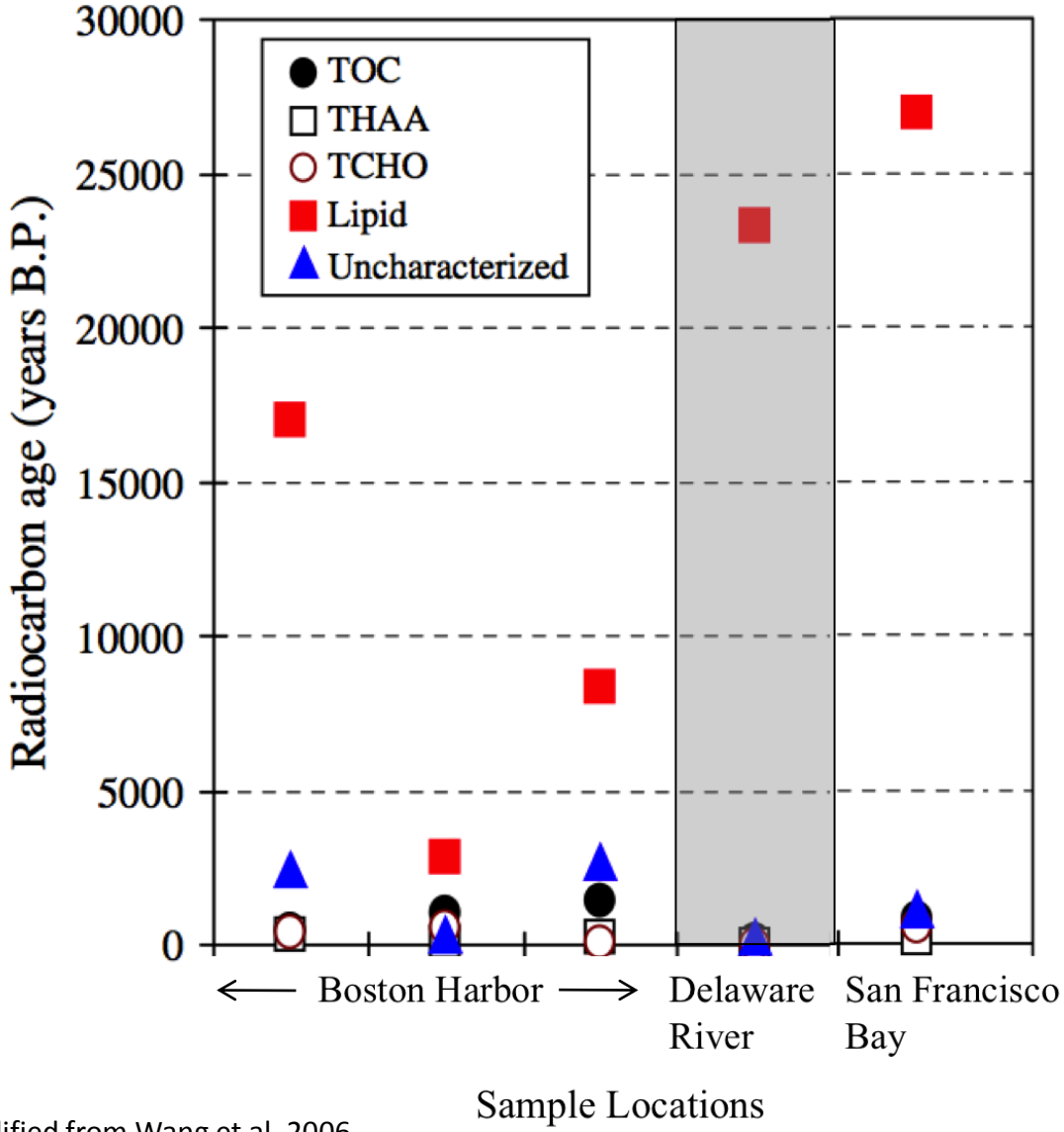


UDOM TAR$_{FA}$



- Surface water POM and UDOM dominated by aquatic OM (i.e., TAR$_{FA}$ <1)
- ↑ TAR$_{FA}$ at River and ETM for POM
- ↑ TAR$_{FA}$ in Oct. 2010 than Mar. 2011

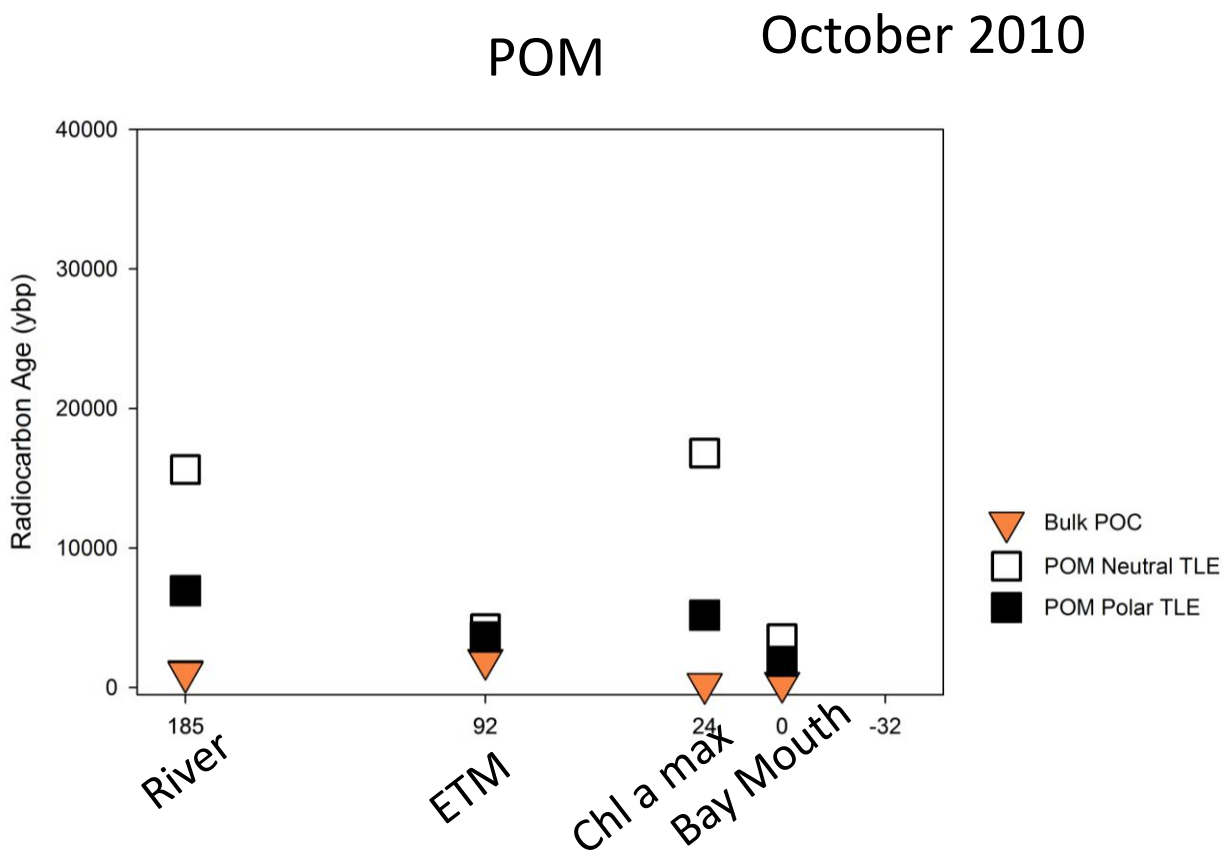
Motivation: Lipid Ages



modified from Wang et al. 2006

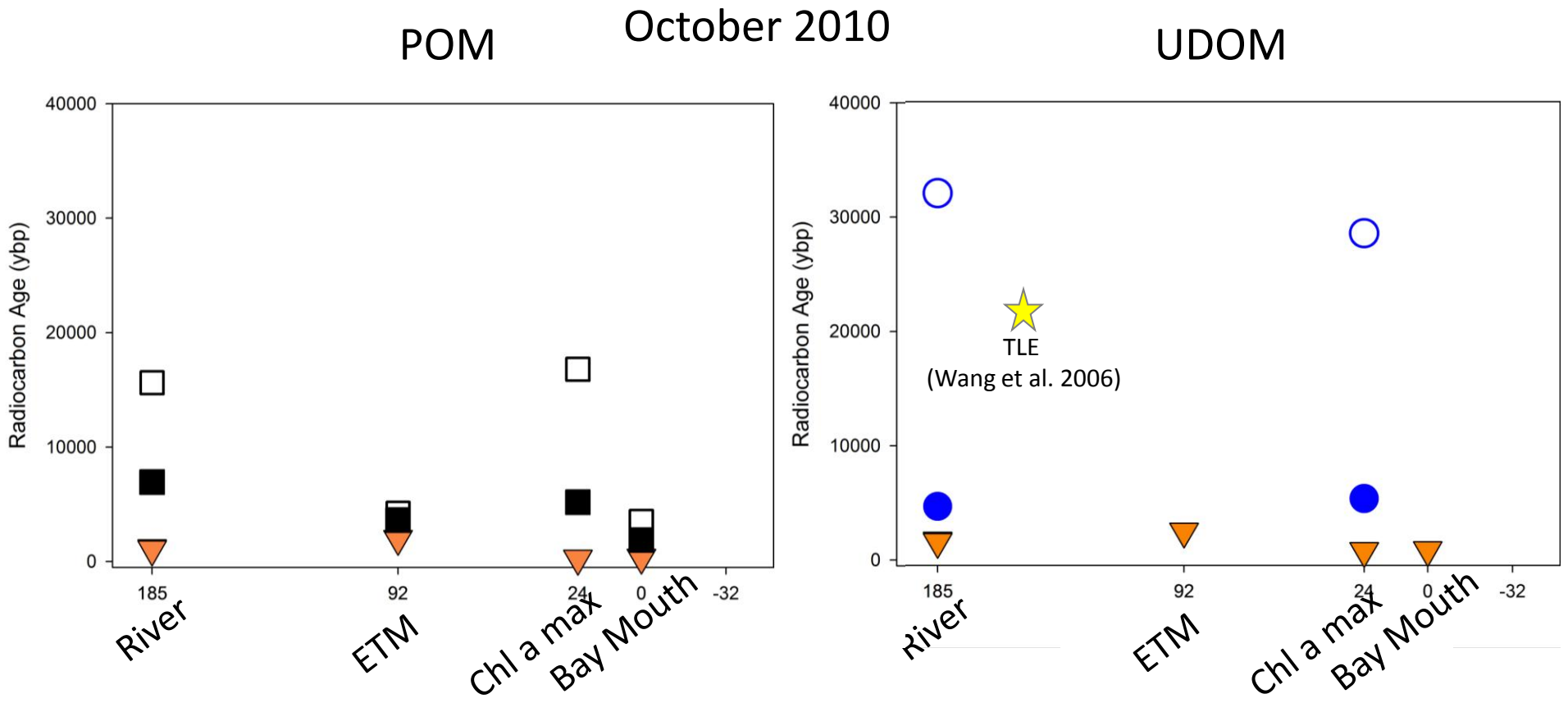
- TOC radiocarbon age reflects average of all biochemical compound classes
- Biochemical classes range in radiocarbon age
- DE River UDOM lipid fraction oldest compound class

Results – Radiocarbon



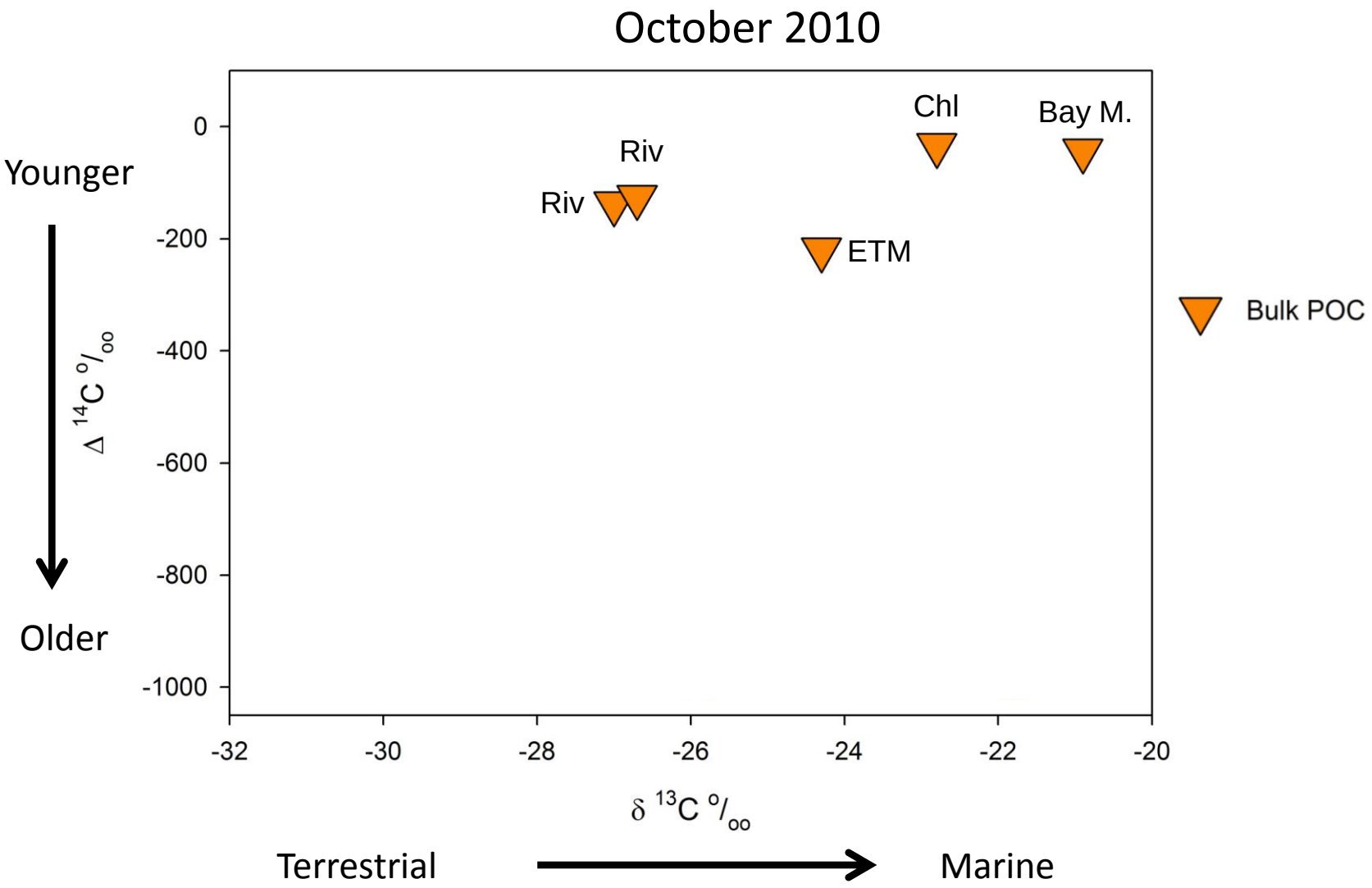
- Lipid older than POC
- Neutral TLE aged relative to Polar TLE

Results – Radiocarbon



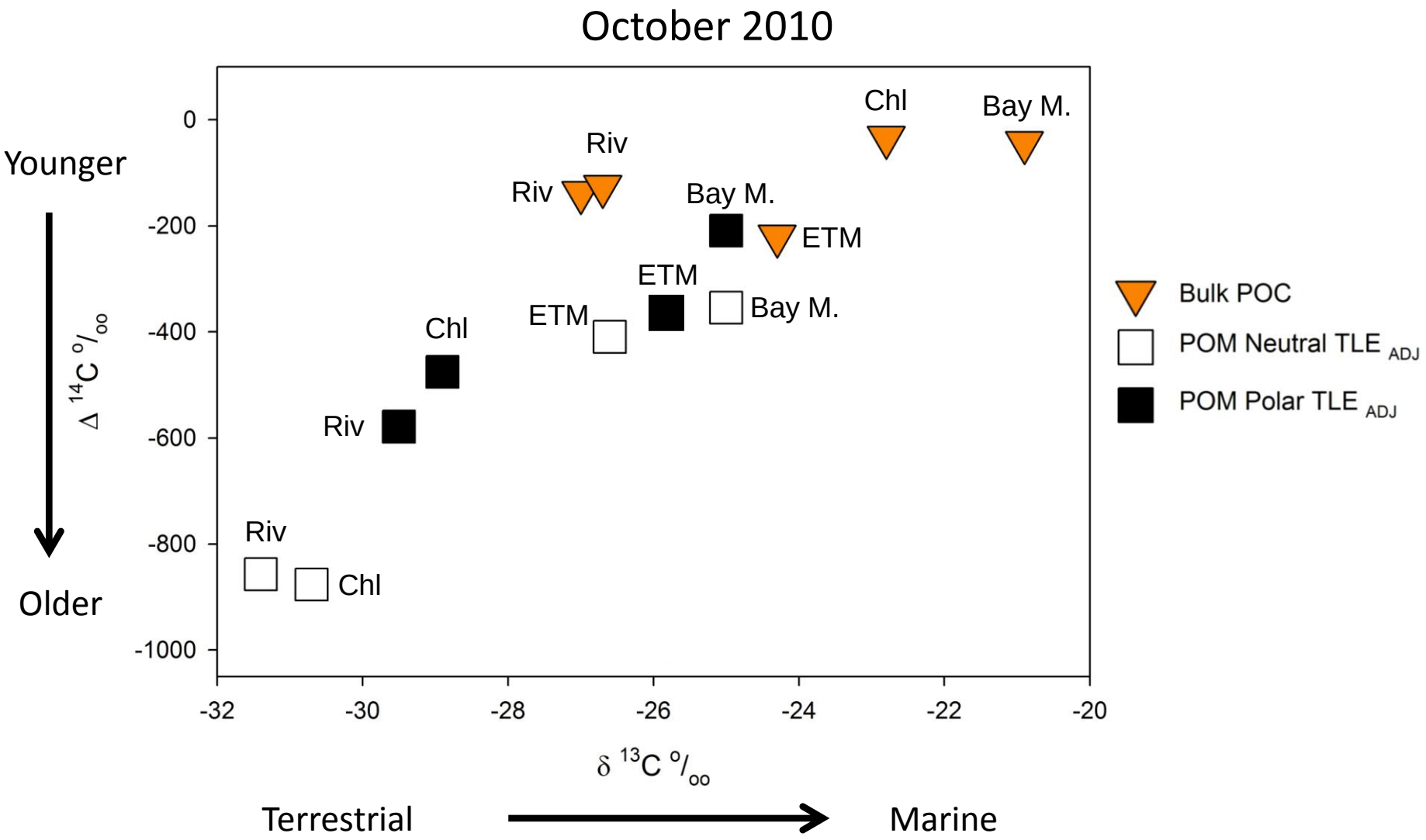
- Lipid older than POC
- Neutral TLE aged relative to Polar TLE
- **POM is younger than UDOM**

Results – Radiocarbon



Endmember boxes based on Loh et al. 2004 and references therein, Griffith et. al 2009

Results – Radiocarbon



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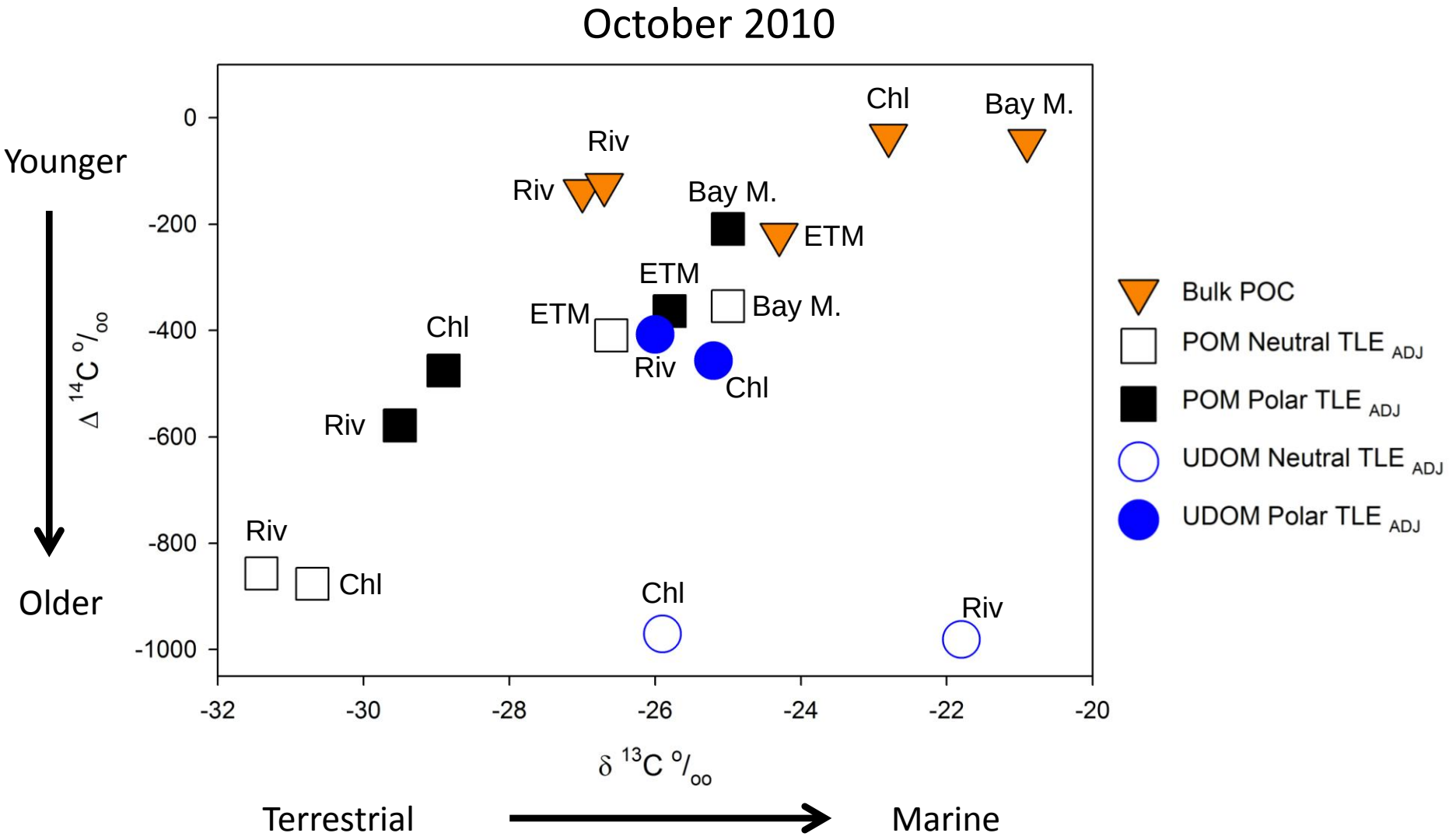

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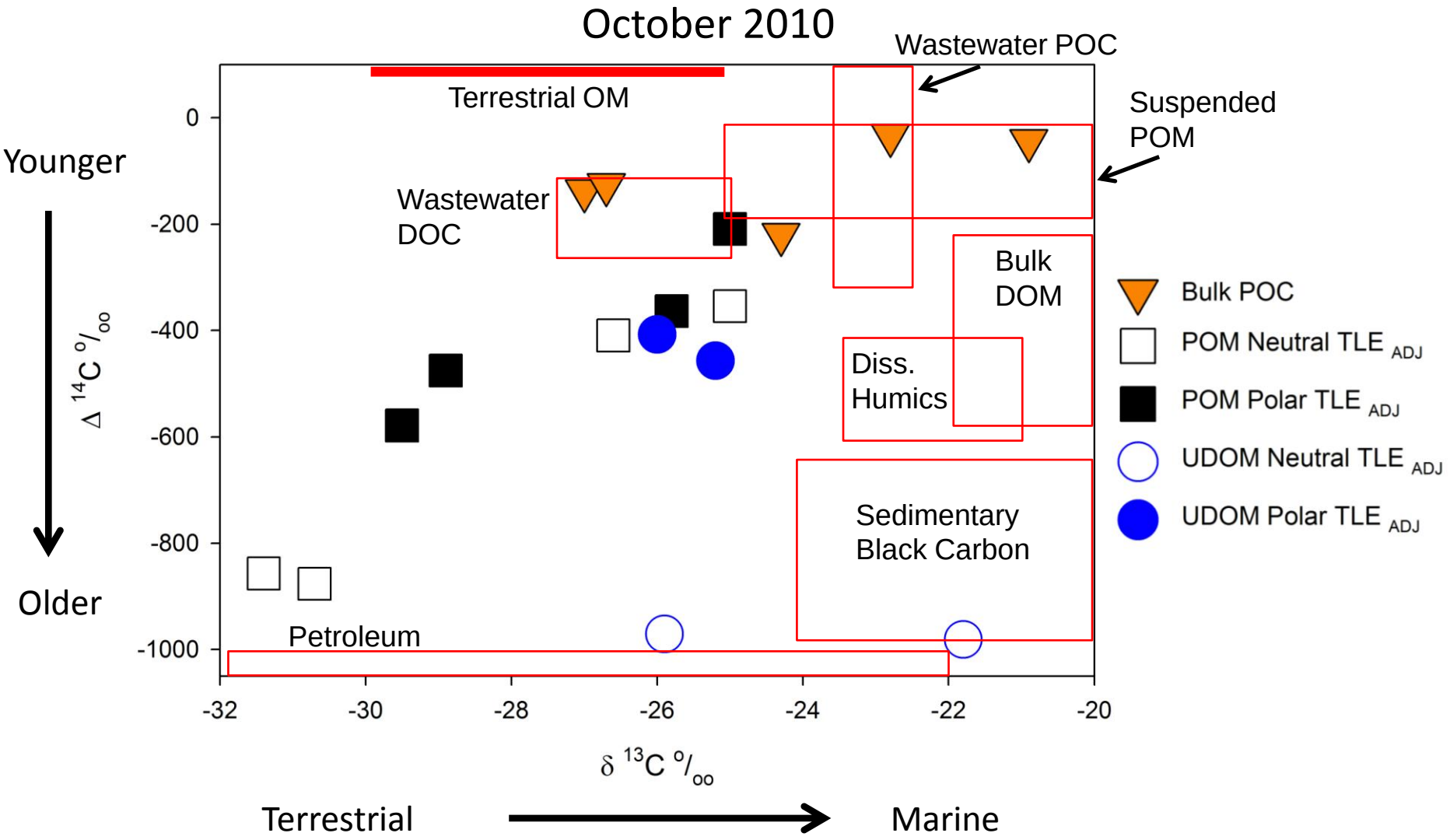

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Summary

- Marine primary production – main contributor to surface water FA
- Greater difference in age between neutral and polar TLE in UDOM than in POM
- Isotope bi-plot suggests bulk POC reflects a mixture of plankton and terrigenous sources along estuary **but** lipids reflect a range of source and age composition
  - POM TLE:
    - ETM/ Bay Mouth – mixture of sources
    - River/ Chl a max – similar to petroleum source
  - UDOM TLE:
    - Neutral TLE – similar to petroleum and black carbon
    - Polar TLE – mixture of sources

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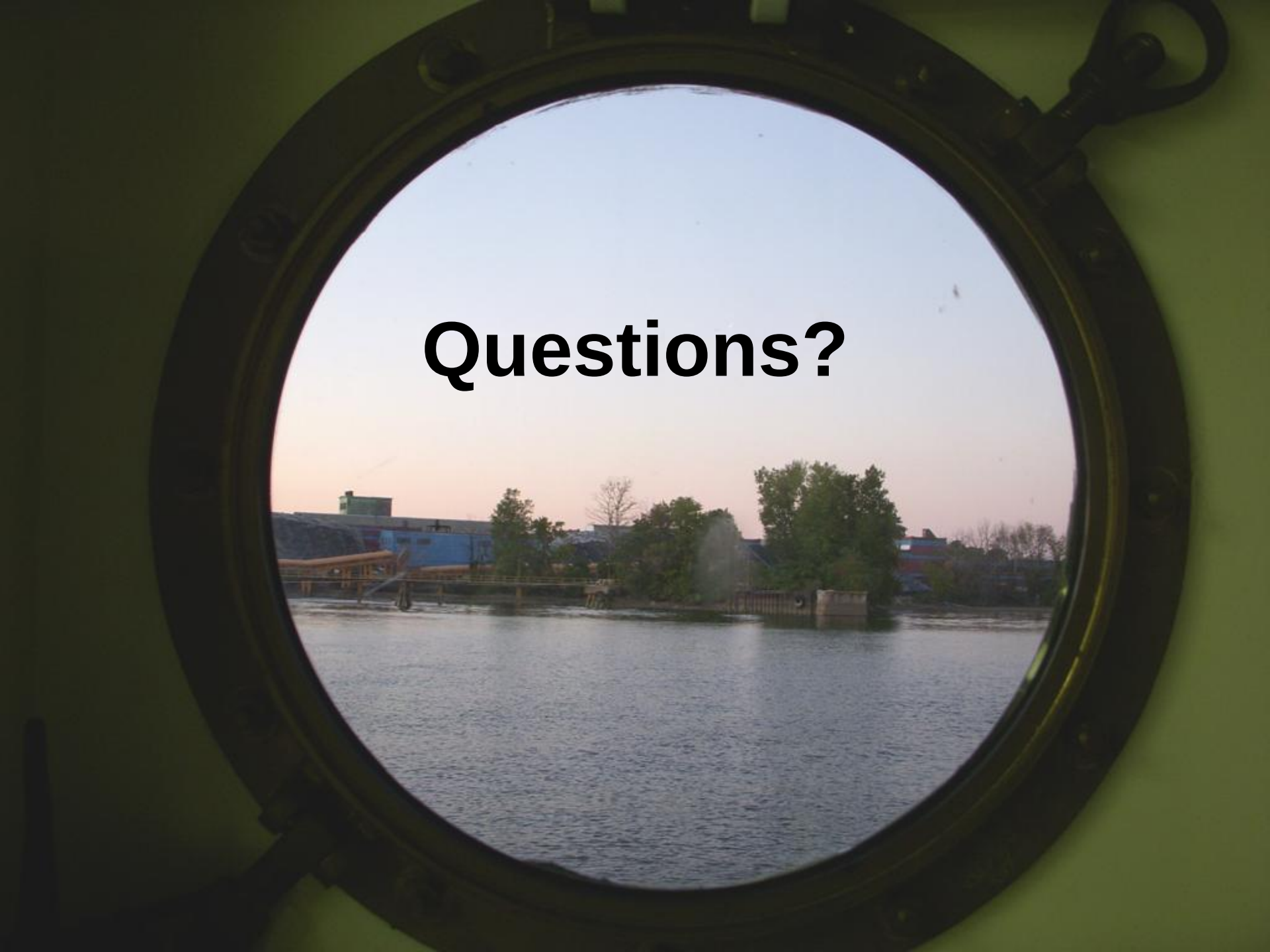
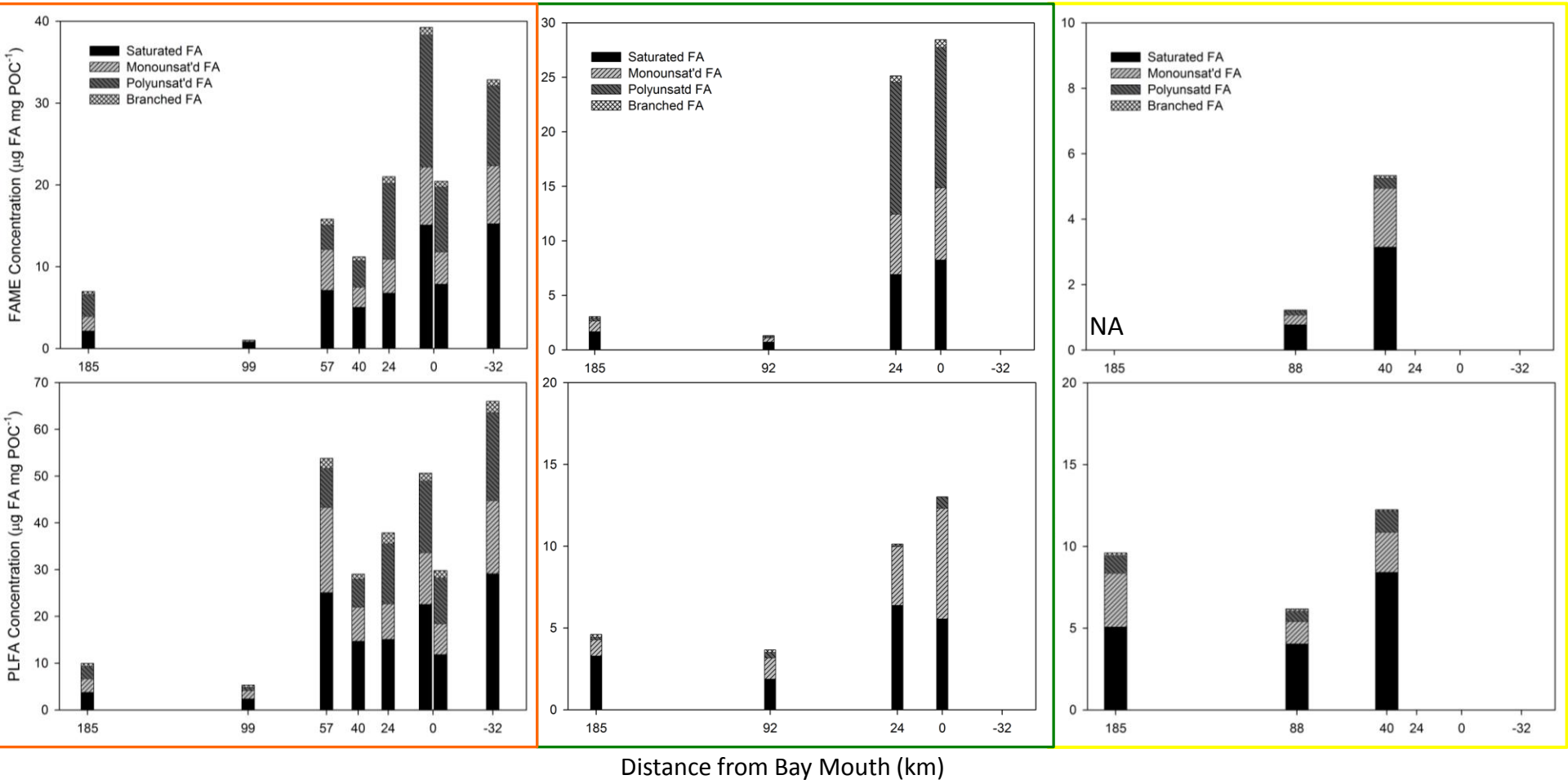

Questions?

Results – POM Fatty Acid Distribution

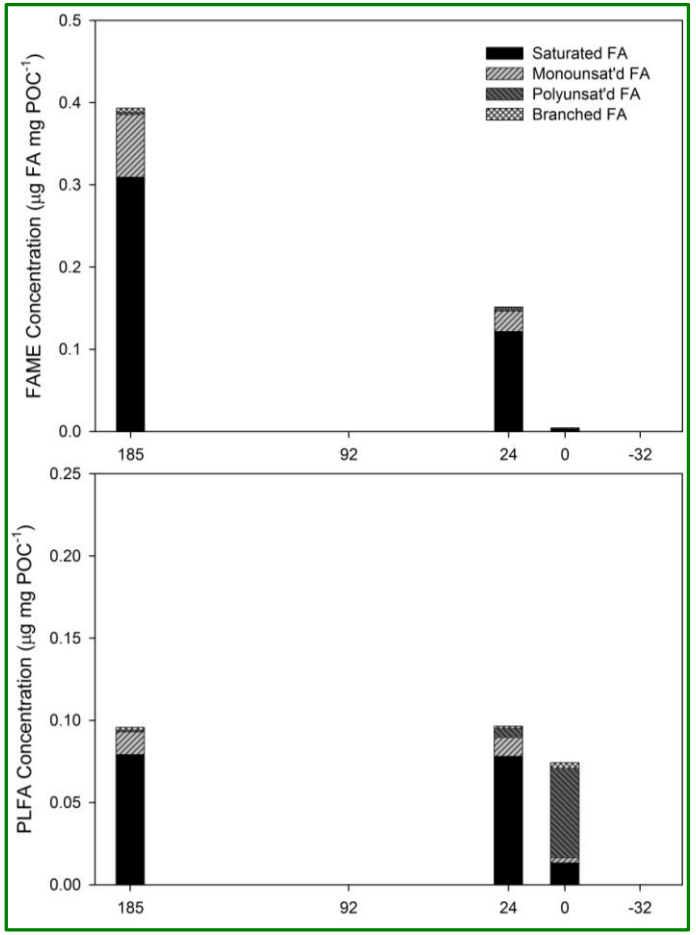
Cruise 1 – August 2010 | Cruise 2 – October 2010 | Cruise 3 – March 2011



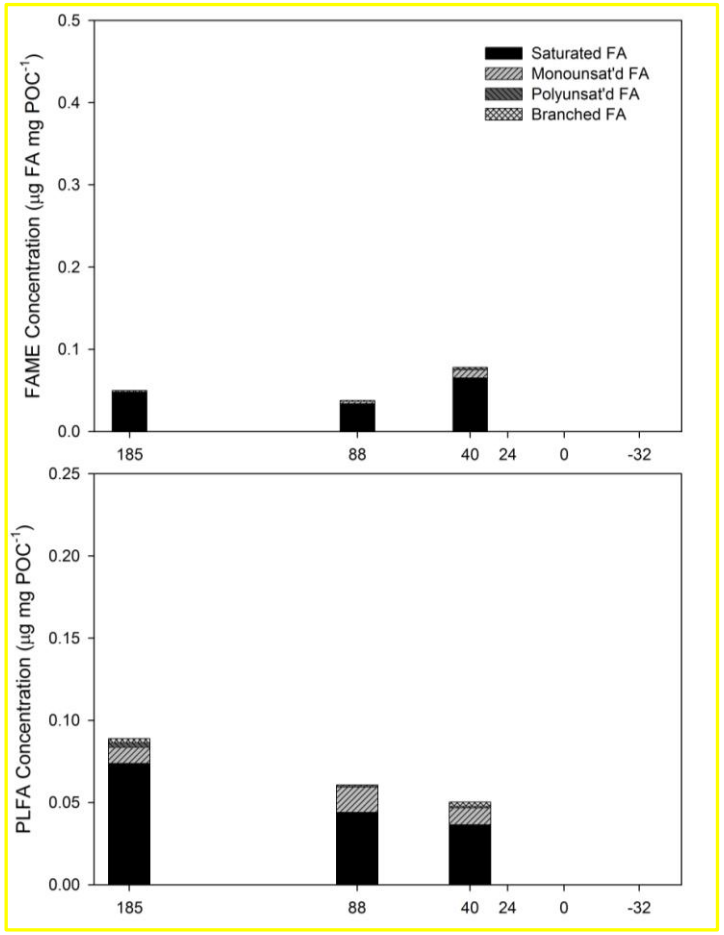
- Saturated and polyunsaturated FA were most abundant

Results – UDOM Fatty Acid Distribution

October 2010



March 2011



Distance from Bay Mouth (km)

- FA Concentrations much lower in UDOM
- Dominated by saturated FA