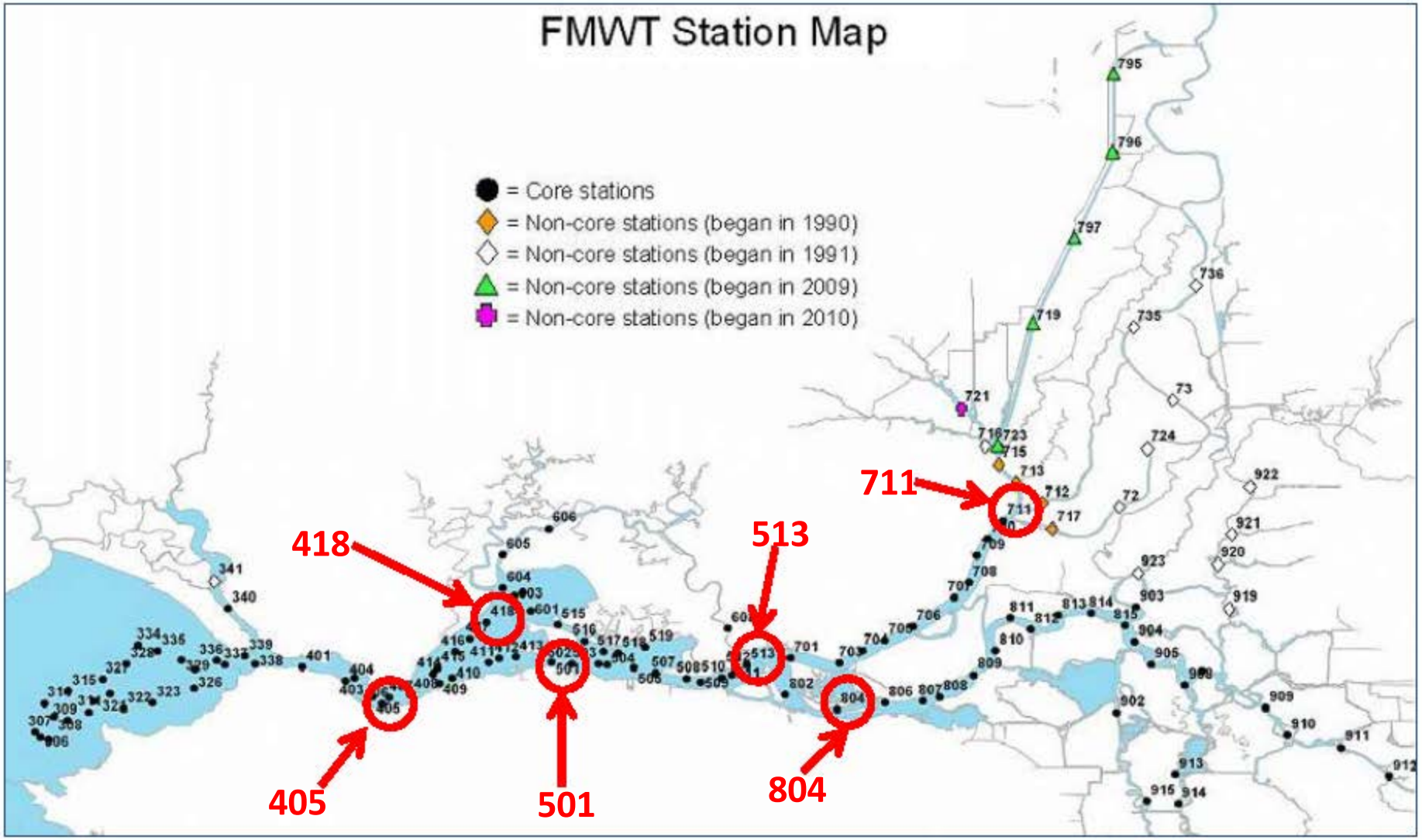
Assessing Food Quality of Non-Algal Particles in the San Francisco Bay Estuary and Delta

Peter Hernes, Rachael Y. Dyda, Hope Fisher, Robert Eckard, Amy Story, Bryan Downing, and Brian Bergamaschi

Funding: U.S. Bureau of Reclamation, UCDavis funding

A Carbon Perspective

- Geochemistry Bible: Sources, processing, sinks
- Carbon mass balance
- Trophic transfers
- Biomarkers – sources and OM quality
- Not a nice, tidy story (yet) – C research on the Delta has been languishing


FMWT Station Map
= Core stations
= Non-core stations (began in 1990)
= Non-core stations (began in 1991)
= Non-core stations (began in 2009)
= Non-core stations (began in 2010)
711
418
513
405
501
804

Foodweb Dynamics

Van den Meersche et al. 2009

Zooplankton diet in a tidal estuary

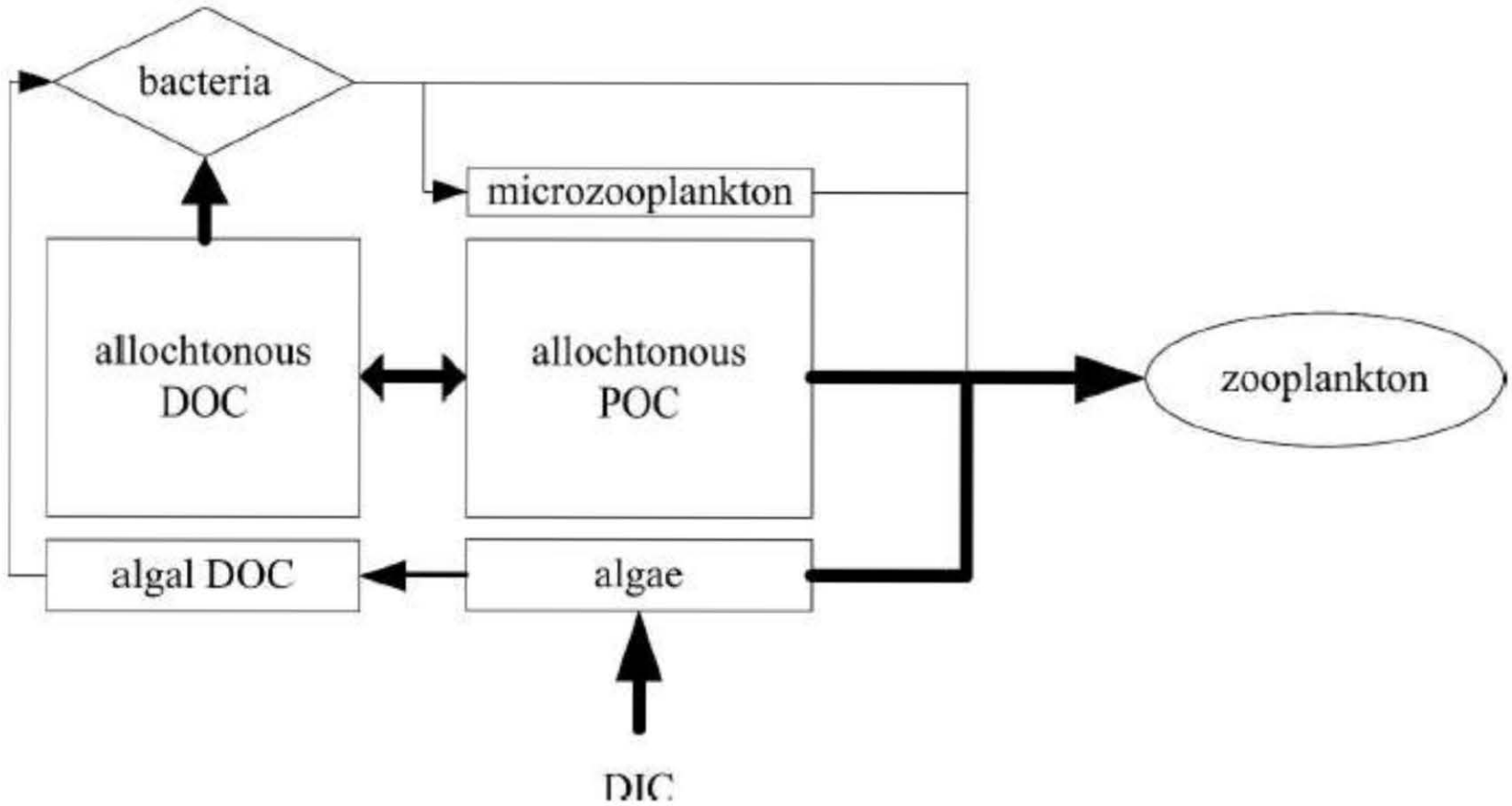


Fig. 7. Schematic picture of the lower plankton food web in the tidal Scheldt River and estuary, including main carbon fluxes to mesozooplankton. Thick arrows represent the most important flow paths.

Various C sources to foodwebs

- Riverine DOC -- bacteria
- Riverine POC (mineral bound) -- mesozooplankton
- Wetland DOC -- bacteria
- Wetland POC (plant fragments) – bacteria, macrozooplankton, amphipods
- Algal OM – macrozooplankton

- (with some combination of macrozooplankton and amphipods as the feedstock for fish)

C loading to the Delta

Riverine DOC: 20-66 Gg C yr^{-1}
Riverine POC: 15-30 Gg C yr^{-1}
Wetland DOC: 5-22 Gg C yr^{-1}
Wetland POC: 2-30 Gg C yr^{-1}???
Primary Production: 6-33 Gg C yr^{-1}

Jassby and Cloern 2000; Jassby et al. 2002; Sonnerup et al. in prep; rough calculations from our POC data (by difference between 711 and 405)

Availability

Riverine DOC: 16%
Riverine POC: <5%??
Wetland DOC: 10-12%
Wetland POC: ??
Primary Production: 90-100%?

Stepanauskas et al. 2005; Sobczak et al. 2002;

Trophic transfer efficiency (example)

Riverine DOC: 1000 g, with only 16% bioavailable, 160 g

↓

Bacteria: 25% assimilation, 40 g

↓

Microzooplankton: 20% assimilation, 8 g

↓

Mesozooplankton: 20% assimilation, 1.6 g

↓

Amphipod: 20% assimilation, 0.32 g

↓

Fish: 20% assimilation, 0.064 g

→ Riverine DOC supports 1-4 X 10^6 g fish C

Our interests

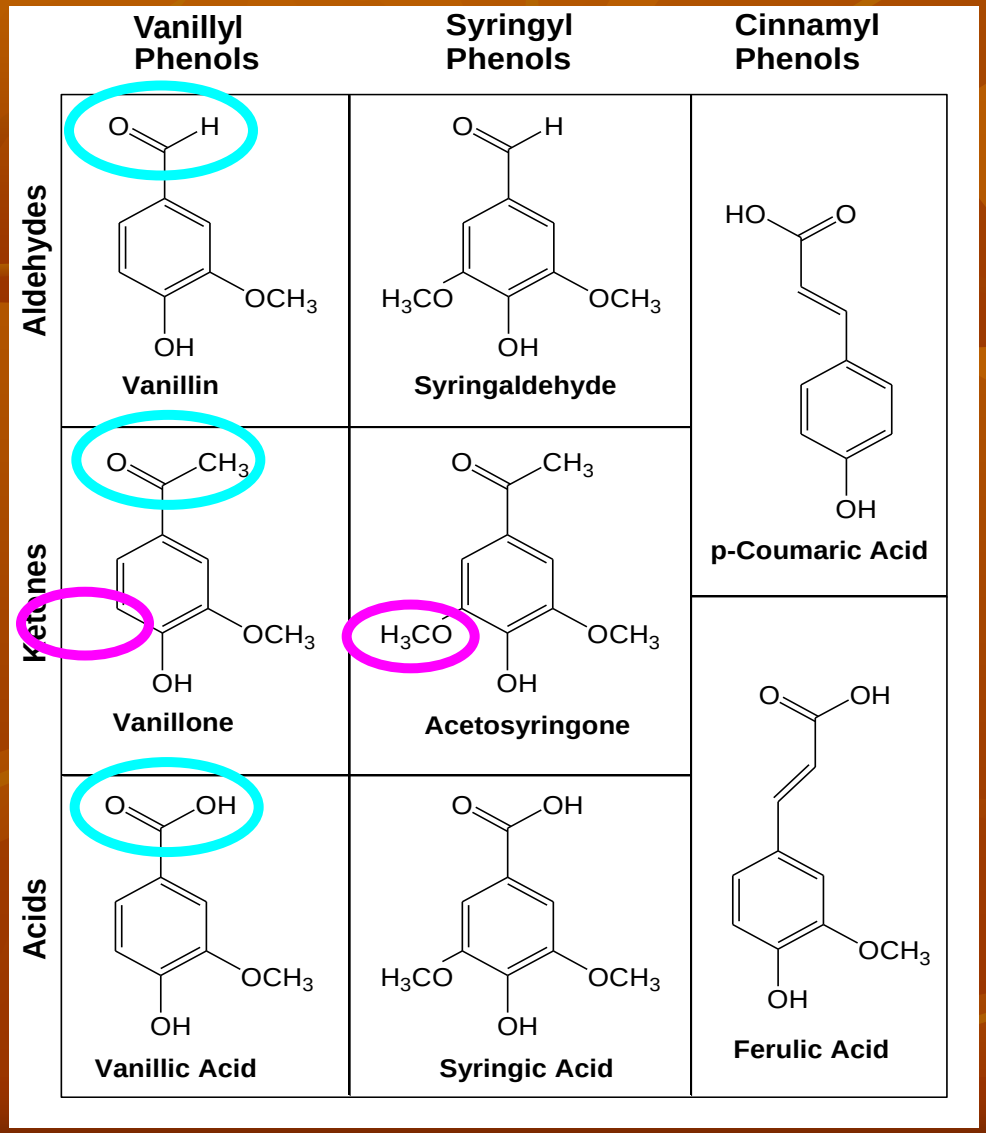
- Non-algal POC cycling as it relates to mesozooplankton!
- Macrozooplankton appears to be quite partial to algal POC (Müller-Solger et al. 2002)

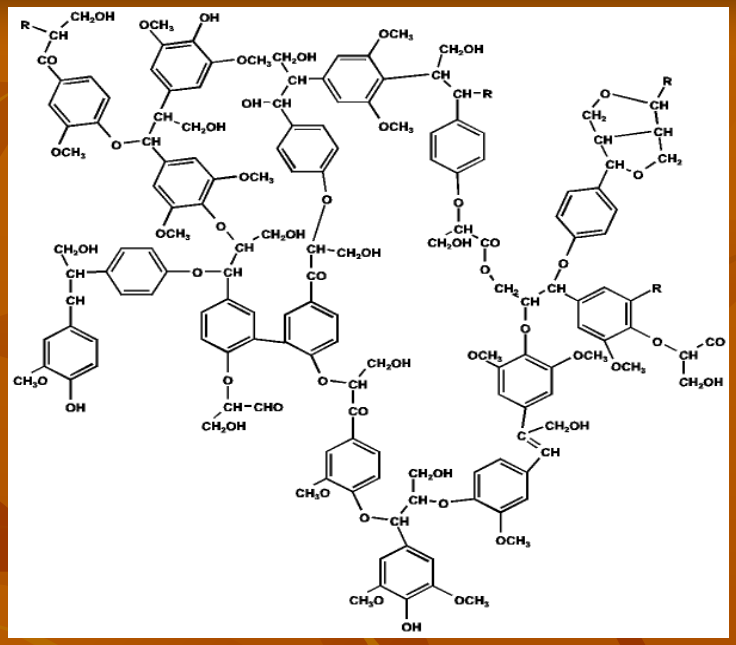
Our tools

- Bulk analyses
- Lignin biomarkers (unique to non-algal POC)
- Potentially UV-Visible absorbance of POC

Lignin Biomarkers

Unique tracers for vascular plants & terrigenous organic matter

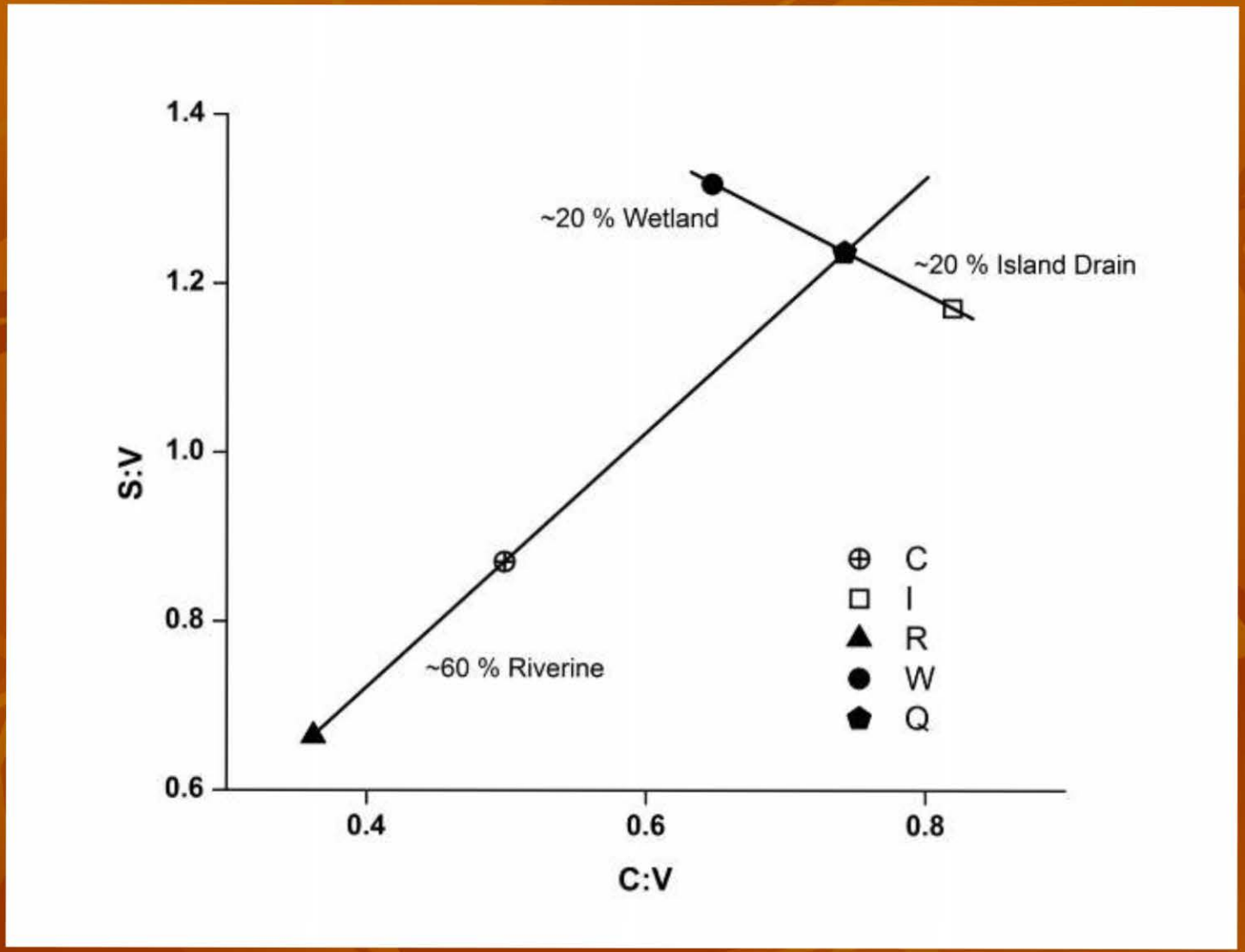




Diagnostic ratios:

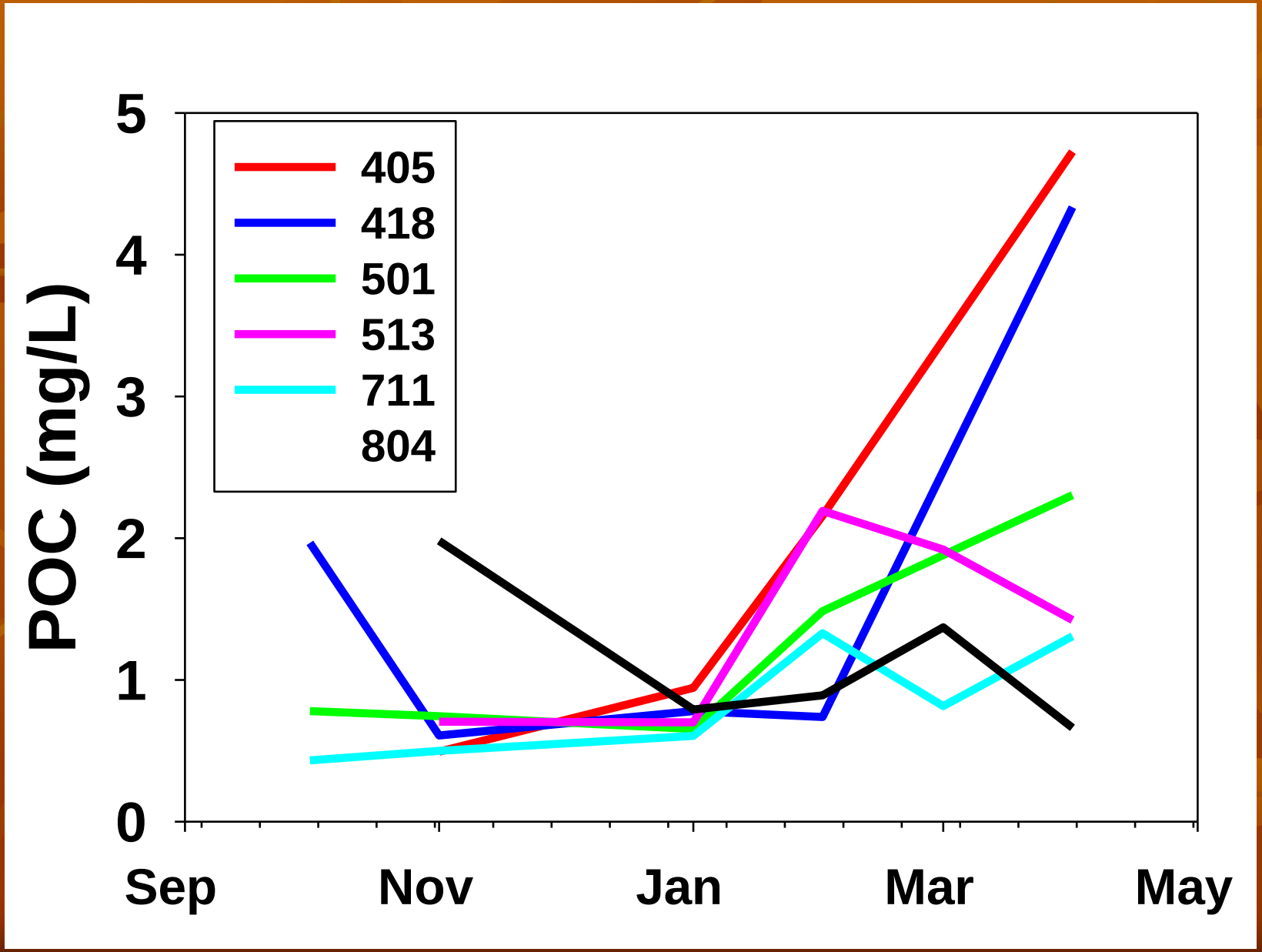
1. Syringyl:Vanillyl (S:V), Unique to Angiosperms
2. Cinnamyl:Vanillyl (C:V), Unique to soft tissues
3. Acid:Aldehyde (Ad:Al)v and (Ad:Al)s

A DOC lignin example

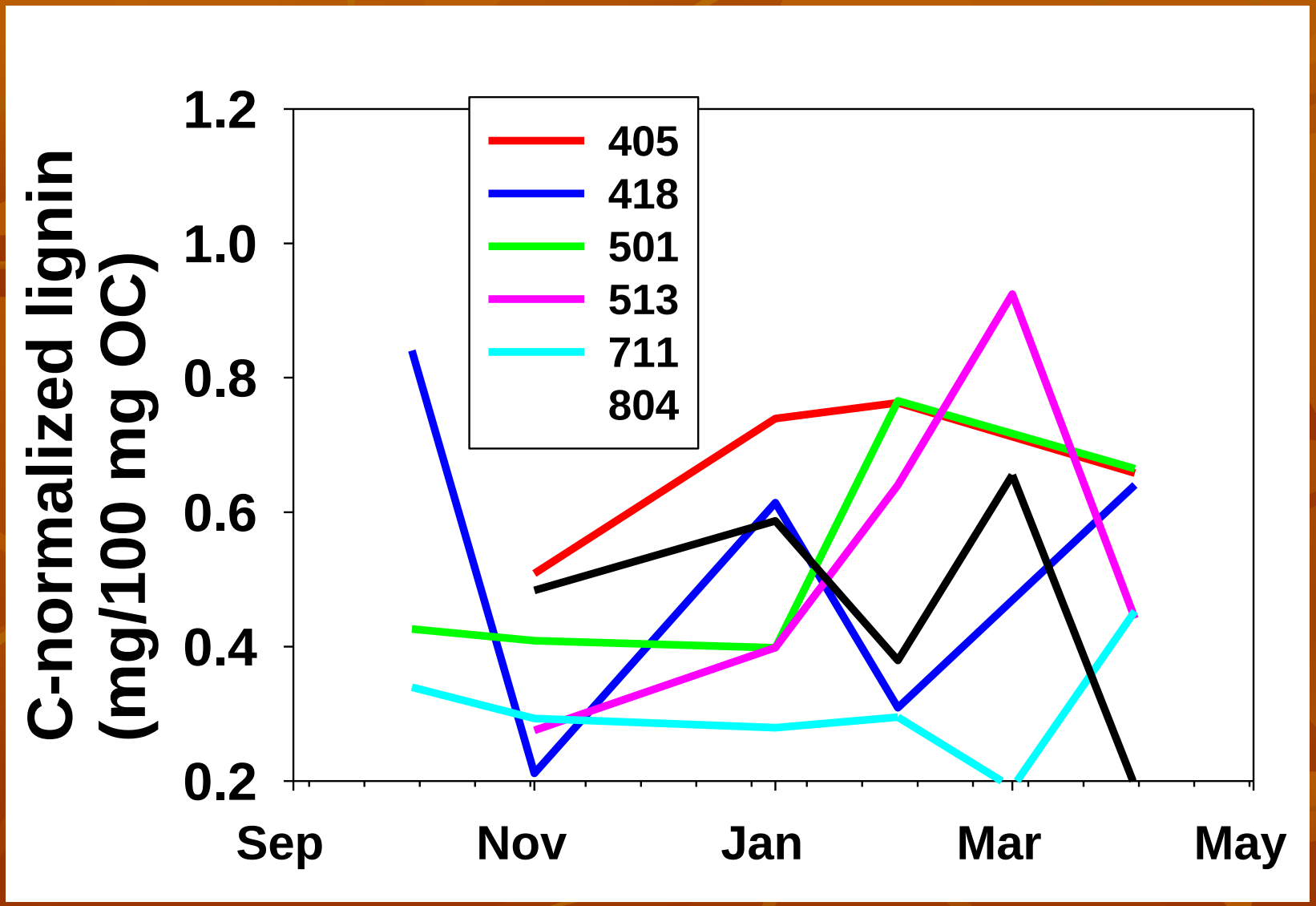


Eckard et al. 2007

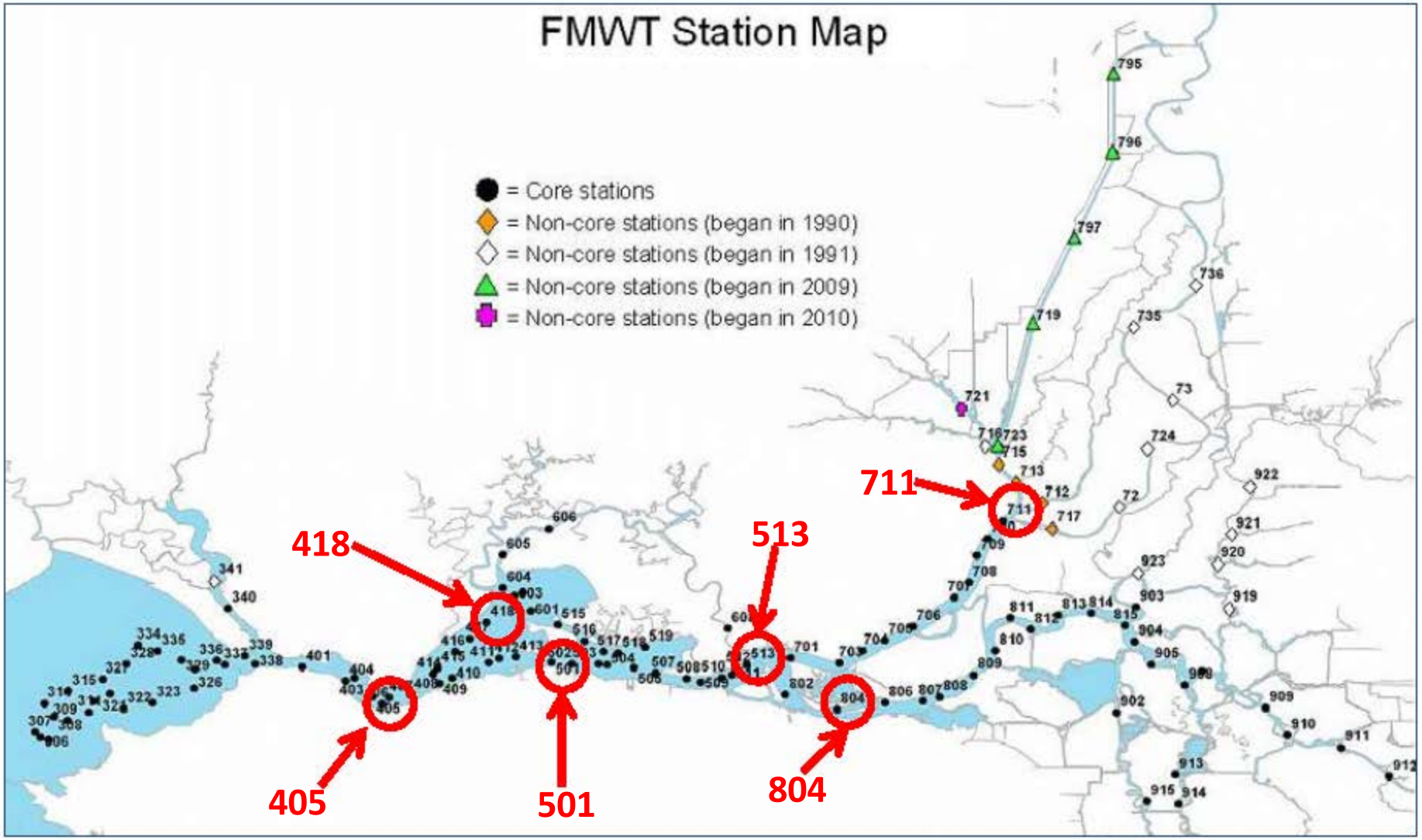
Temporal trends



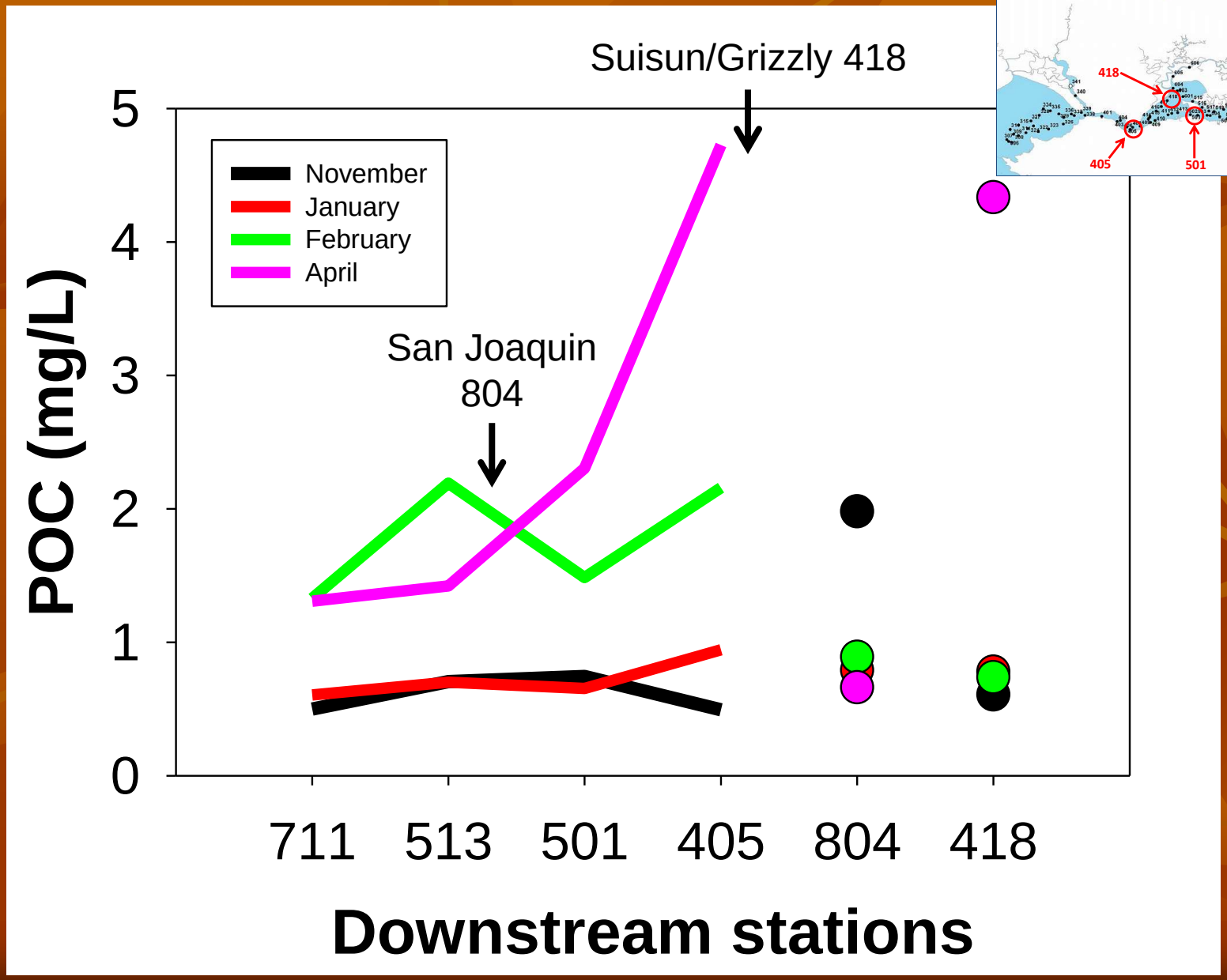
Temporal trends

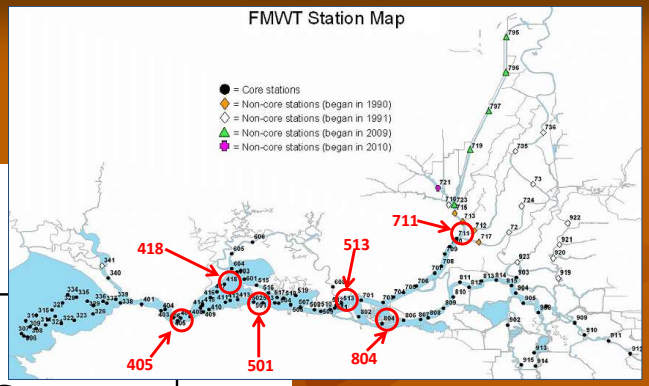


Temporal studies are necessary for constructing budgets, but don’t appear useful for devining any cycling or processing information

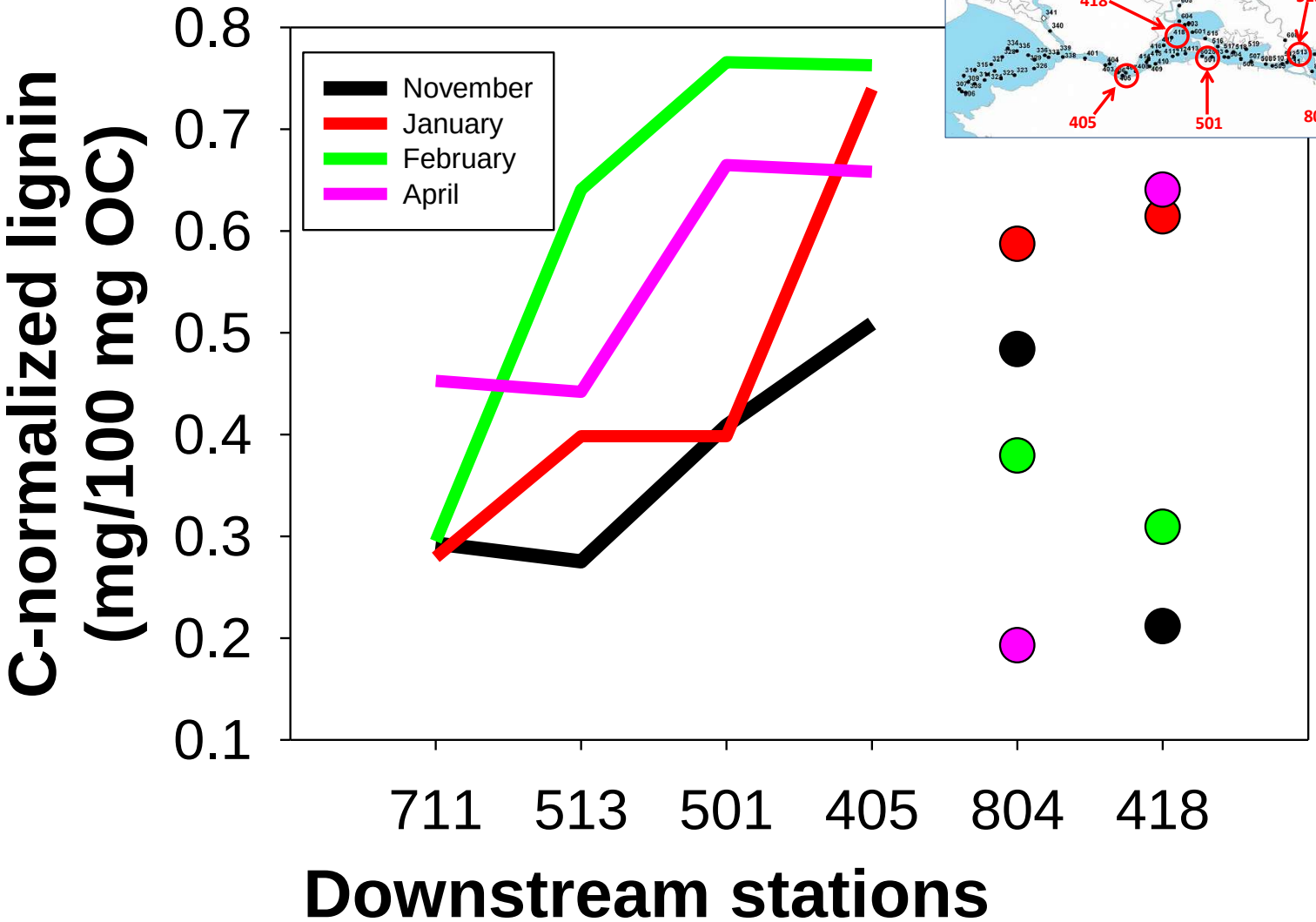

FMWT Station Map
= Core stations
= Non-core stations (began in 1990)
= Non-core stations (began in 1991)
= Non-core stations (began in 2009)
= Non-core stations (began in 2010)
711
418
513
405
501
804

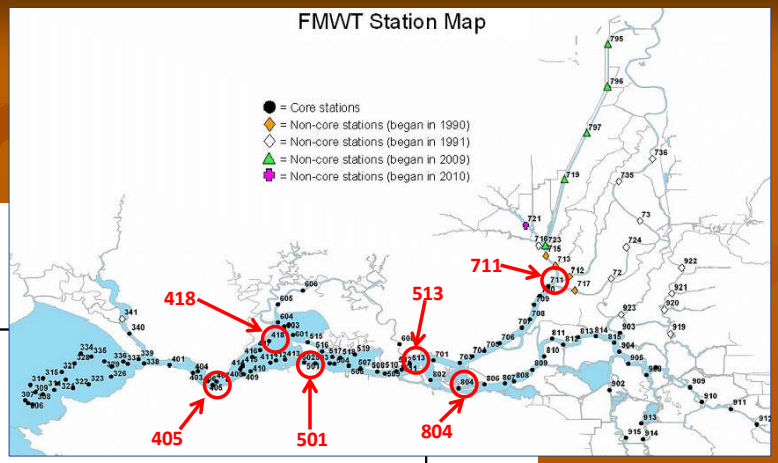
Lagrangian POC



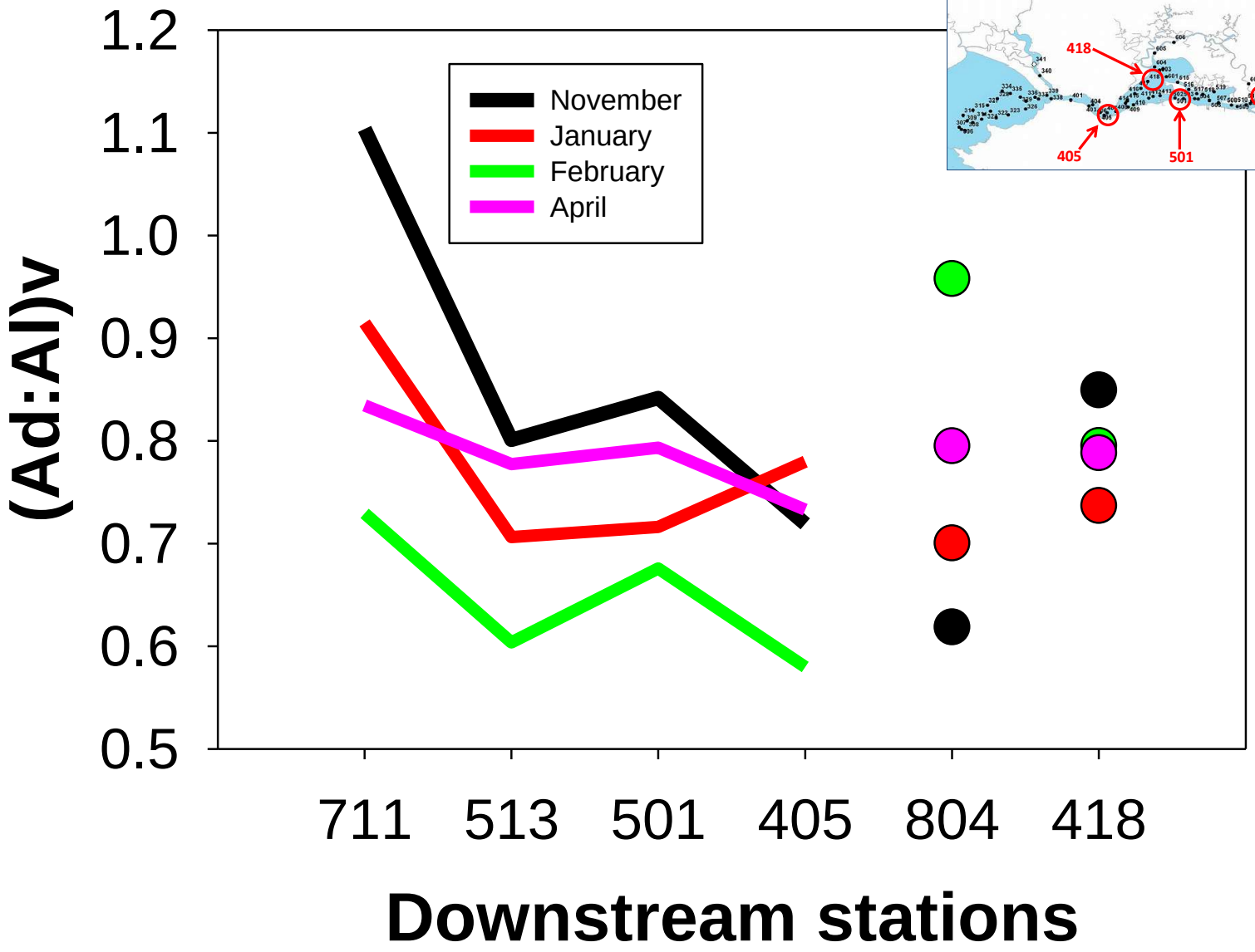


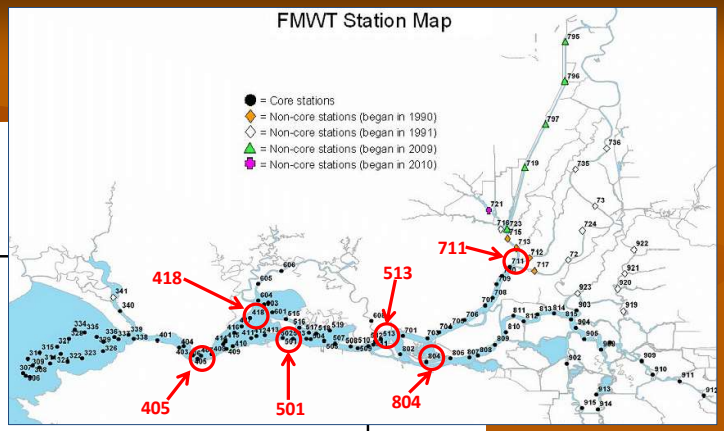
Lagrangian Lignin



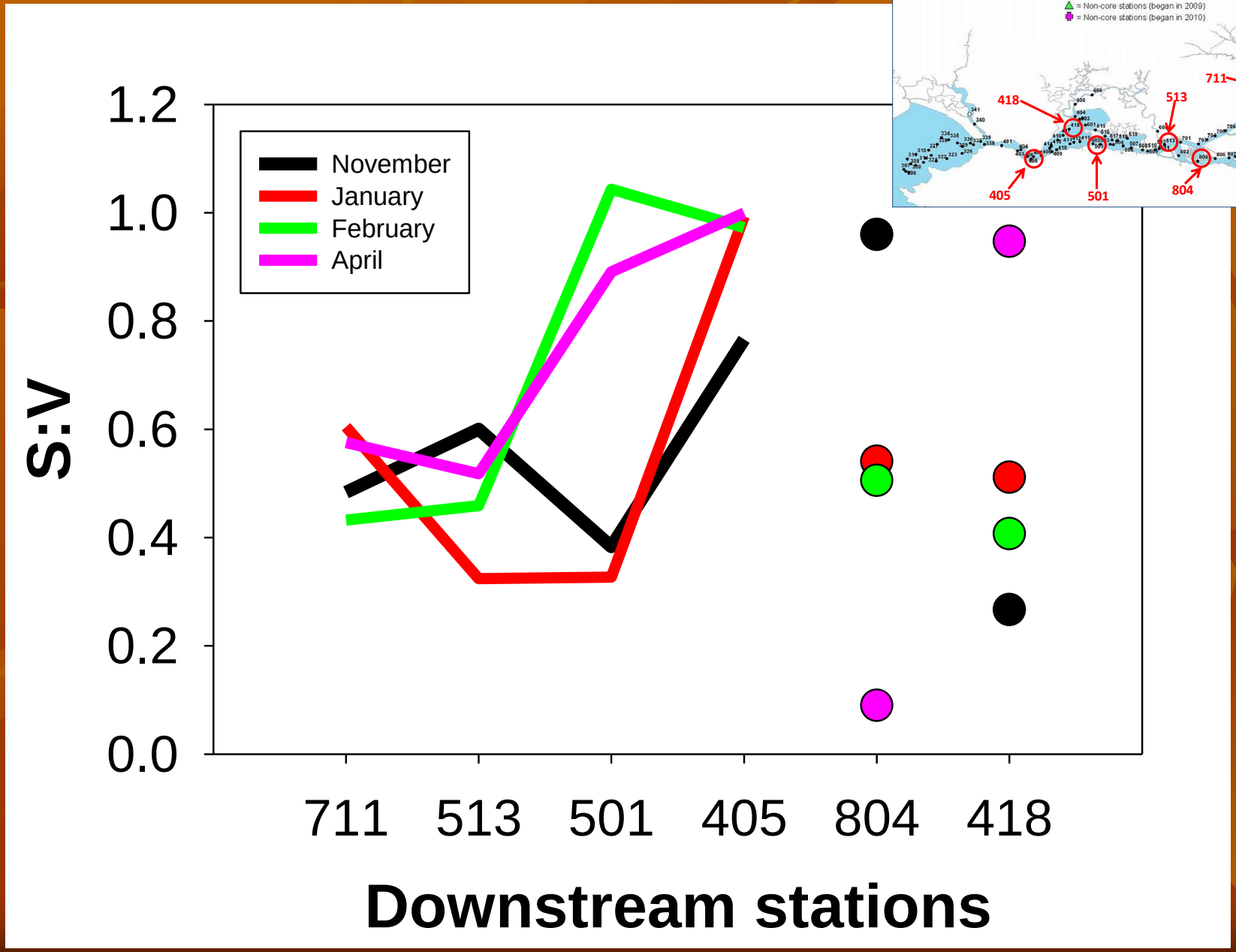


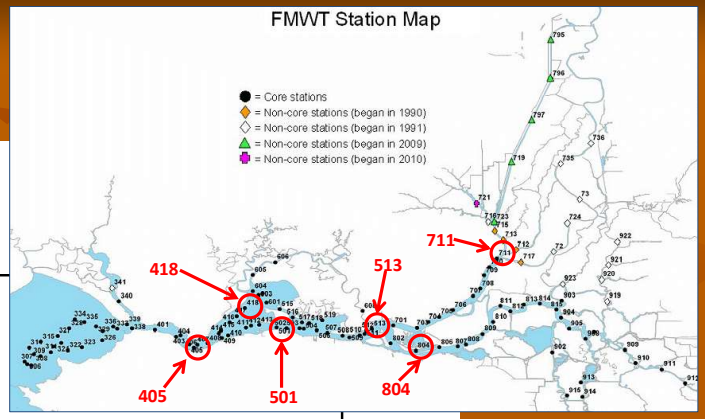
Lagrangian (Ad:Al)v





Lagrangian S:V

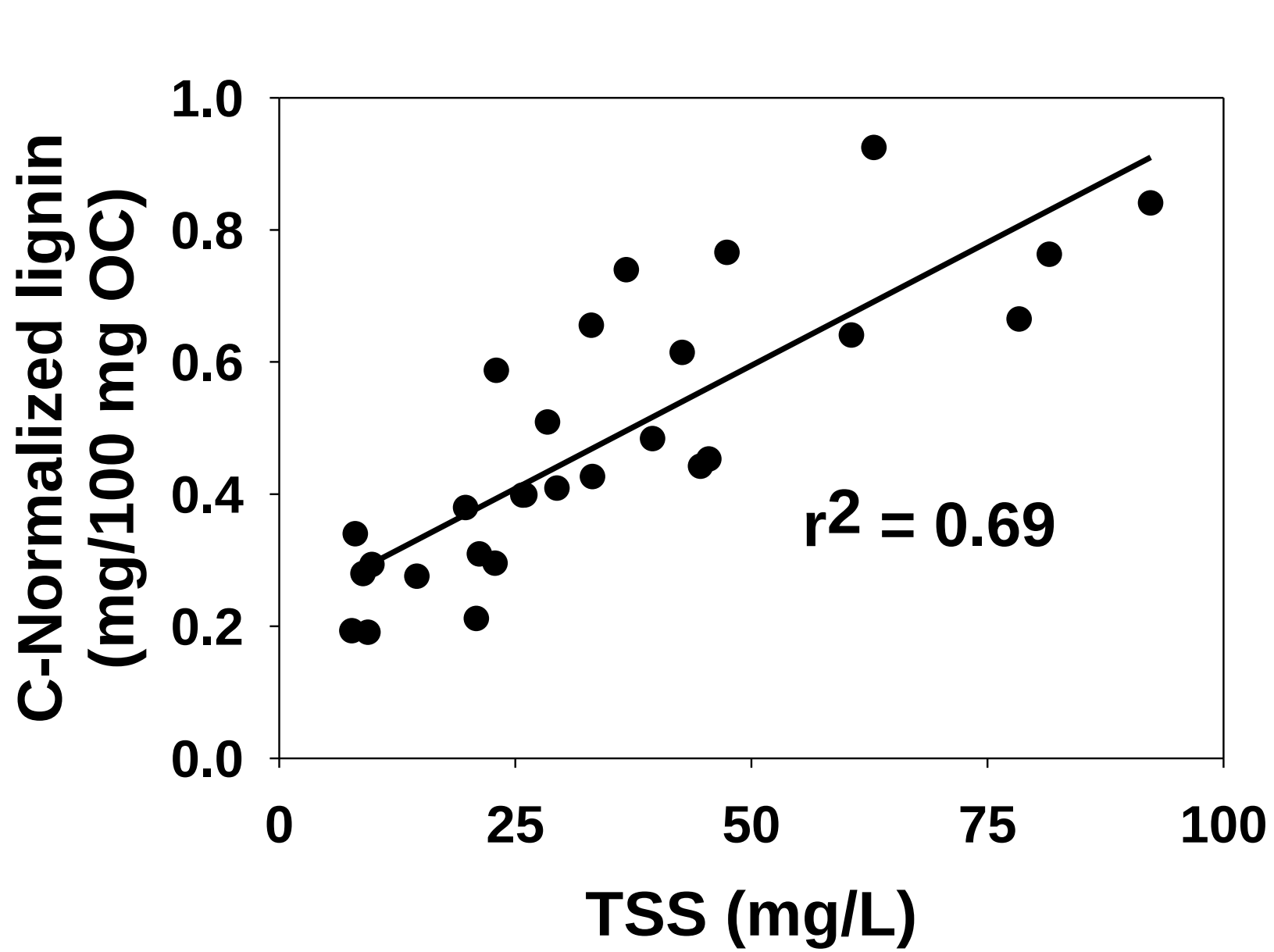




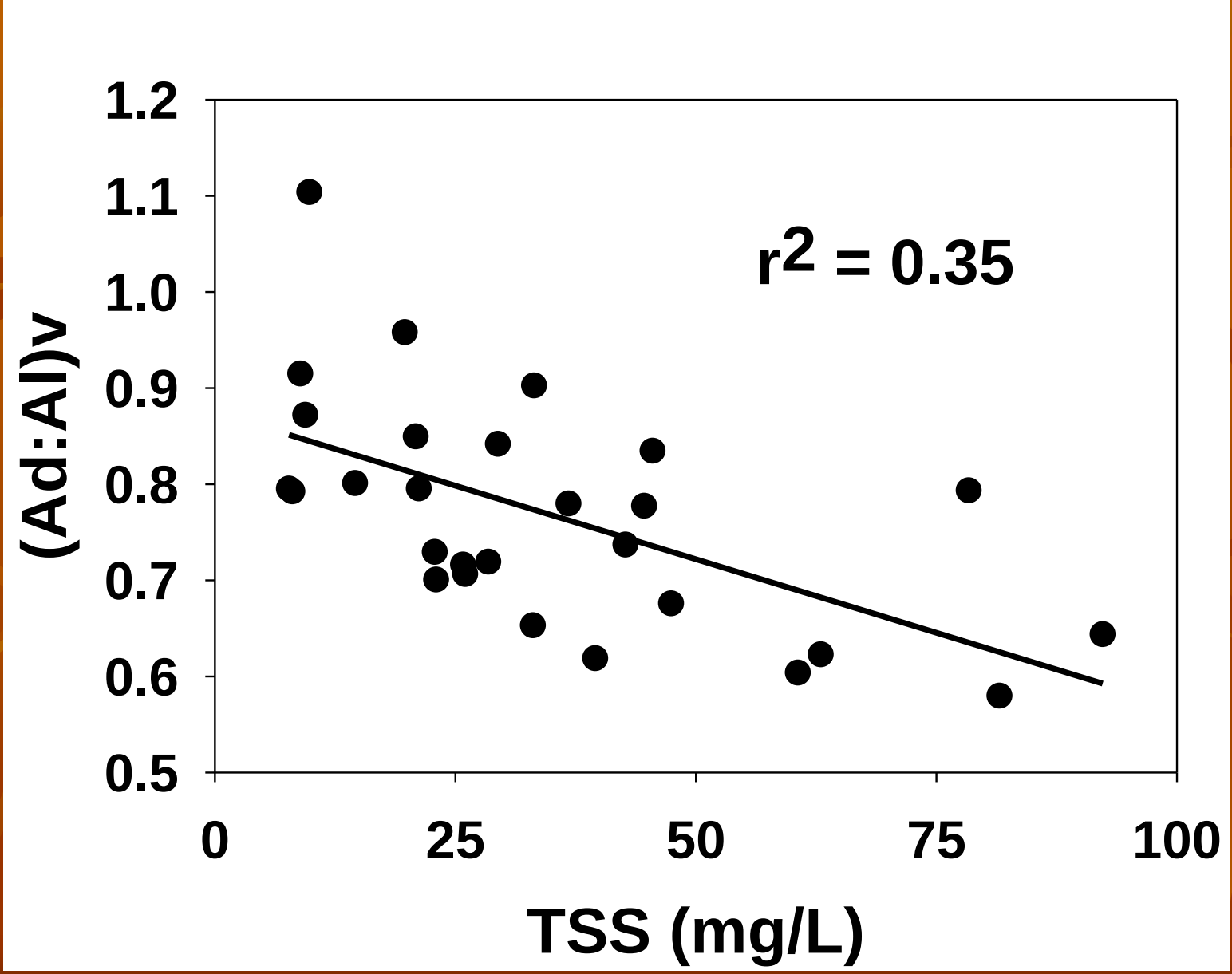
Langrangian summary

1. Particles are evolving during transport
2. Sources of fresh vascular plant carbon
3. Increases in POC concentration can’t solely be from resuspension (see #2)
4. Suisun Marsh via Grizzly Bay seems to be one likely source of POC

General trends: Quality increases with TSS



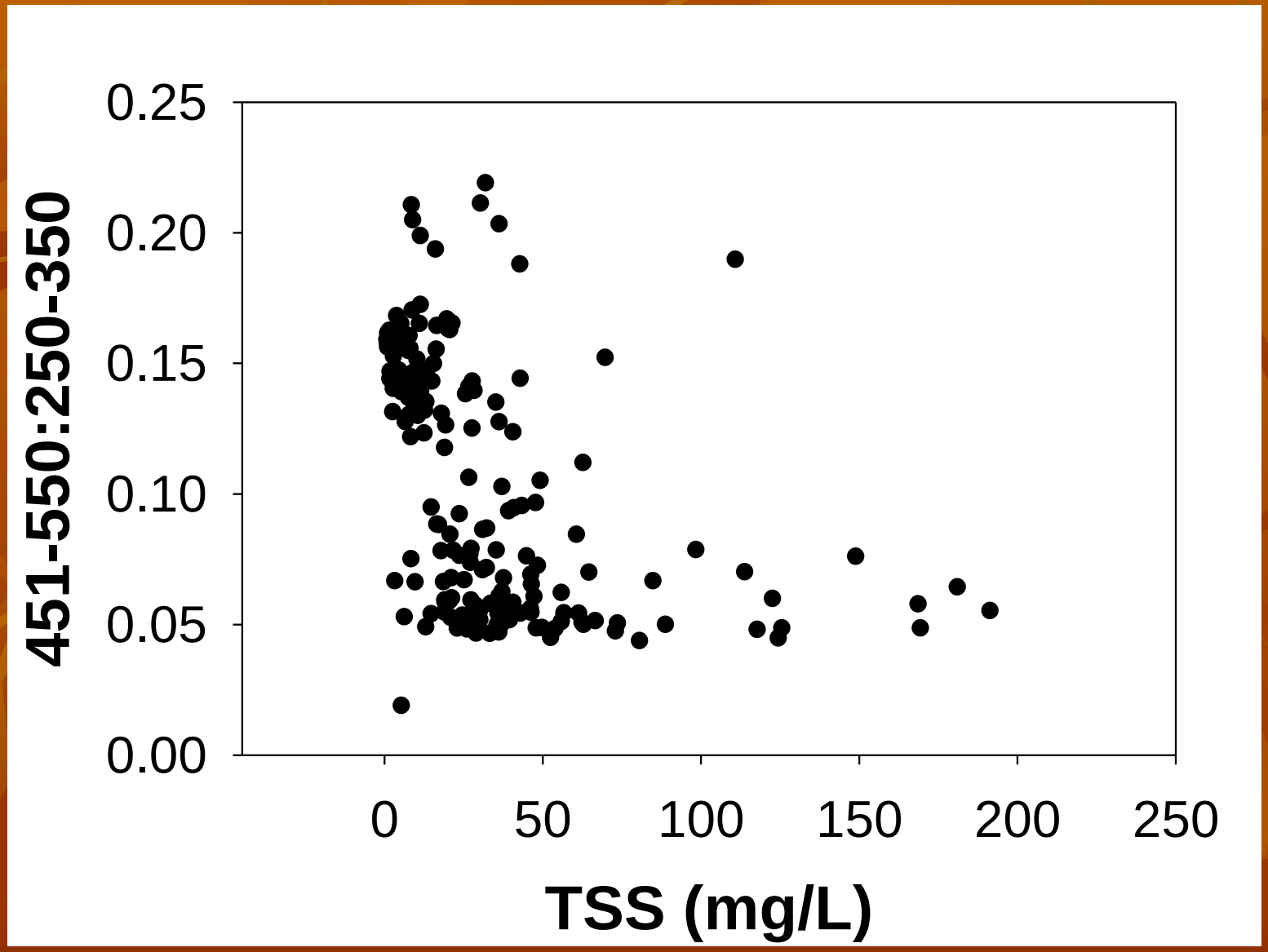
Quality increases with TSS



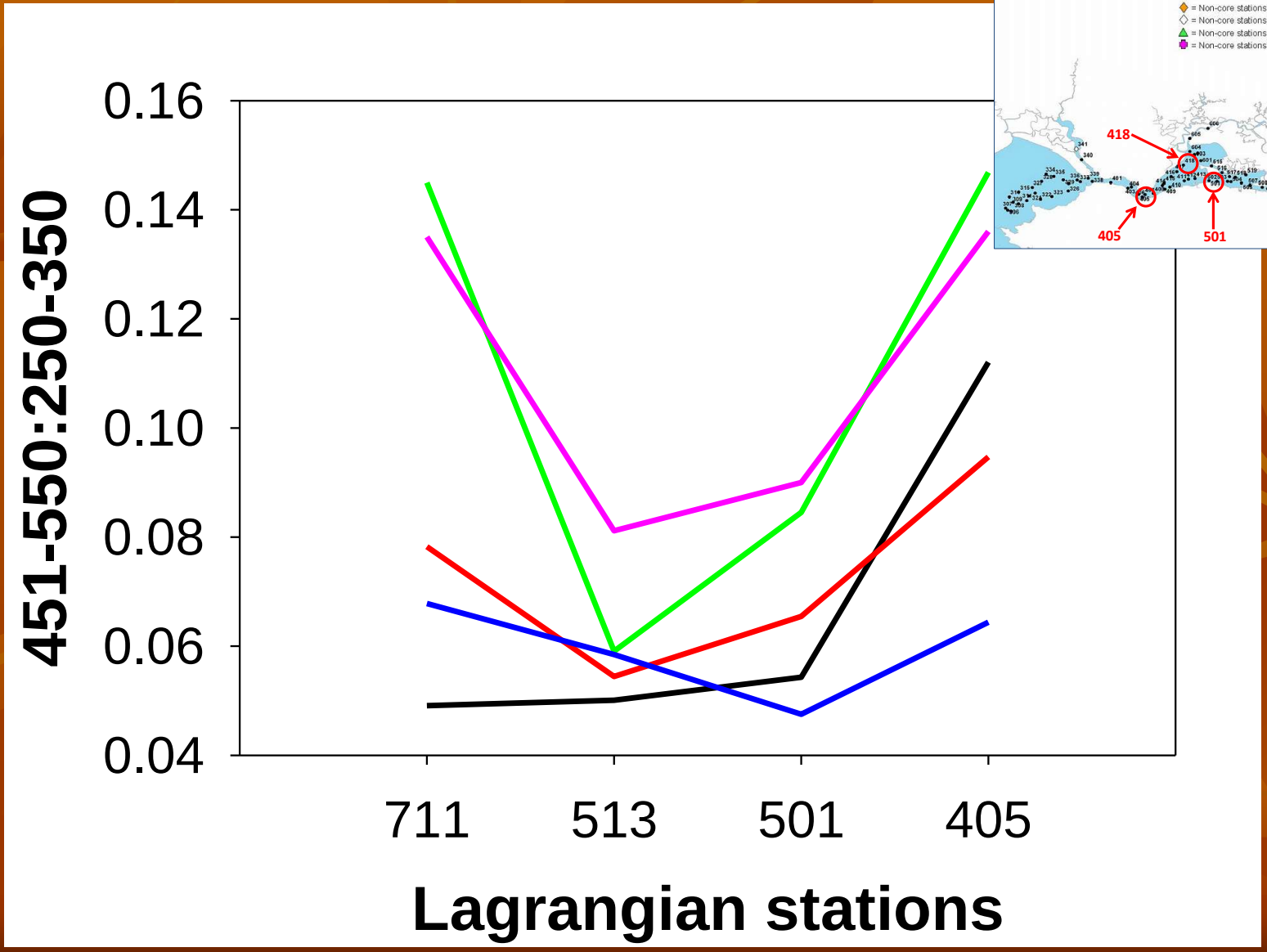
Looking for more expedient tools

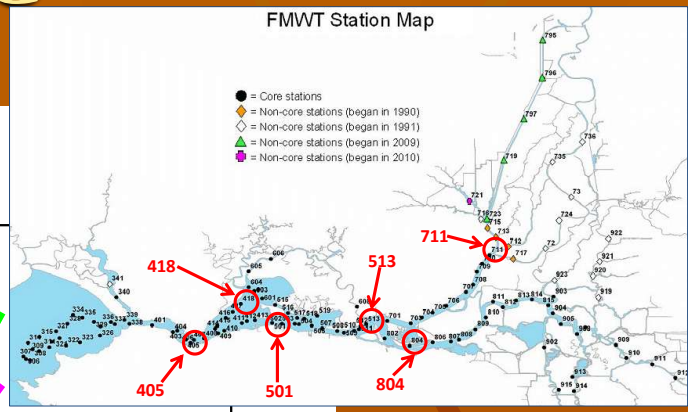
- Lignin analyses expensive and time-consuming
- Optical analyses are much faster/cheaper
- Pigments absorb in the visible range
- Polyphenols (unsaturated compounds absorb in the UV range
- Exploring a simple ratio of pigment aborbance to polyphenol absorbance

UV-Visible absorbance of POC



UV-Visible absorbance of POC





Conclusions

- Clear gradients in non-algal POC, which should manifest itself in foodweb dynamics as well (i.e. the mesozooplankton and fish will follow)
- Need to continue to develop tools to nail down the Delta carbon story