FCE ASM 2008

Organic Matter Dynamics

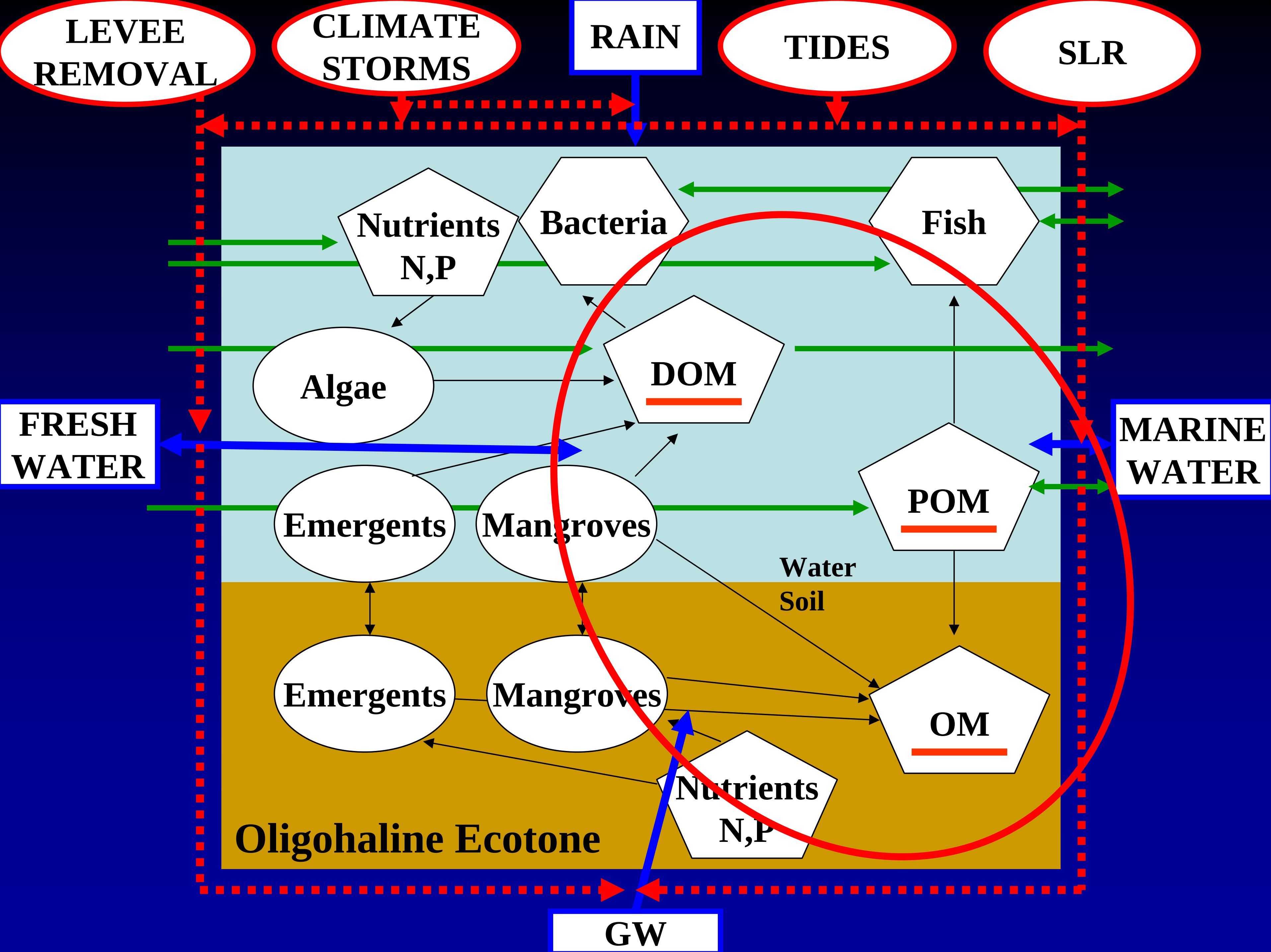
William Anderson, **Randolph Chambers**, Meilian Chen, Josh Cloutier, Carlos Coronado, Min Gao, Erin Hanan, **Rudolf Jaffe**, Krish Jayachandaran, Josette La Hee, Laurel Larsen, Lynn Leonard, Kung-Jen Liu, Jay Munyon, Nagamitsu Maie, Greg Noe, Oliva Pisani, Amanda Quillen, Mark Rains, Victor H. Rivera-Monroy, Michael Ross, Timothy Russell, Colin Saunders, Len Scinto, Fred Sklar, Robert Twilley, Ania Wachnicka, Clayton Williams, Youhei Yamashita

WHERE OM WORKING GROUP FITS INTO FCE CONCEPTUAL MODEL:

In Phase II of the FCE-LTER project, OM WG scientists are studying the sources, transport and fate/accumulation of organic matter in estuarine ecotones.

In estuarine ecotones, organic matter can be produced locally as plant matter decays, or OM can be delivered via freshwater runoff, groundwater discharge, and/or ocean water penetration.

Our study of the quantity and quality of OM in the ecotone will help FCE researchers determine the dynamics of the ecosystem in response to changes in freshwater flow.


LEVEE
REMOVAL
CLIMATE
STORMS
RAIN
TIDES
SLR
Nutrients
N,P
Bacteria
Fish
DOM
Algae
FRESH
WATER
MARINE
WATER
POM
Emergents
Mangroves
Water
Soil
Emergents
Mangroves
OM
Nutrients
N,P
Oligohaline Ecotone
GW

WORKING GROUP CONCEPTUAL MODEL

Differences in freshwater flow control Organic Matter (OM) dynamics in the oligohaline ecotone

CENTRAL QUESTIONS

1. What are the allochthonous vs autochthonous supplies/sources of organic matter in the oligohaline zone and how is supply driven by relative influence of hydrology, ecology and climate?

2. What are chemical characteristics and reactivity of biomass and soil derived OM in the oligohaline zone?

3. How are soil dynamics (nutrient and OM content, peat accumulation, sedimentation) in the oligohaline ecotone controlled by water source and hydrologic residence time?

APPROACH

1. **What are the allochthonous vs autochthonous supplies/sources of organic matter in the oligohaline zone and how is supply driven by relative influence of hydrology, ecology and climate?**

Approach: Determine the relative sources of OM in the oligohaline zone, and assess how source materials might vary with the timing, quantity and quality of freshwater delivery.

METHODS

1.What are the allochthonous vs autochthonous supplies/sources of organic matter in the oligohaline zone and how is supply driven by relative influence of hydrology, ecology and climate?

Method:

- **Determine optical and chemical properties of DOM, Floc, and SPOM at the ecotone.**
- **Determine optical and chemical properties of DOM, Floc, and SPOM upstream and downstream.**
- **Construct mixing model and determine allochthonous and autochthonous sources of OM.**

APPROACH

2. **What are chemical characteristics and reactivity of biomass and soil derived OM in the oligohaline zone?**

Approach: Determine the relative contributions of dissolved OM from plants, from soils, and from discharging groundwater, and assess their bio- and photo-reactivity.

METHODS

2. **What are the chemical characteristics and reactivity of biomass and soil derived OM in the oligohaline zone?**

Methods:

- Collect surface water samples on spatial and temporal scales for DOM characterization.
- Perform microcosm incubations and leaching experiments to determine the characteristics of generated DOM.
- Determine contributions of “new” DOM, “old” DOM, and DOM discharging from groundwater.
- Characterize floc materials using source specific markers.
- Assess bio- and photo-reactivity of such materials

APPROACH

3.How are soil dynamics (nutrient and OM content, peat accumulation, sedimentation) in the oligohaline ecotone controlled by water source and hydrologic residence time?

Approach: On-going and historical changes in supply or diagenesis of OM delivered to soil can be detected via monitoring of bulk soil properties and paleo-environmental assessments respectively.

METHODS

3.How are bulk soil properties and dynamics (nutrient and OM content, peat accumulation, sedimentation) in the oligohaline ecotone controlled by water source and hydrologic residence time?

Method:

- **Synoptic sampling of soils for bulk properties.**
- **Regular sampling for sedimentation/erosion.**
- **Determine changes in soil properties and/or sedimentation/erosion dynamics as a function of changes in hydrology.**
- **Temporal/spatial sampling and characterization of floc (bulk properties, source and reactivity)**
- **Paleo-environmental assessment along nutrient/hydroperiod gradient.**

CRITICAL DATA

Group data:

- **Chemical and optical characteristics of DOM, Floc, POM**
- **Organic matter reactivity data**
- **Bulk soil properties of OM, bulk density, mineral density, total phosphorus**
- **Sedimentation/erosion data**

FCE data:

- **External forcing function data (climate, rainfall, pulse/press info)**
- **Hydrology data (residence times, discharge, freshwater inflow)**

WHERE WE ARE

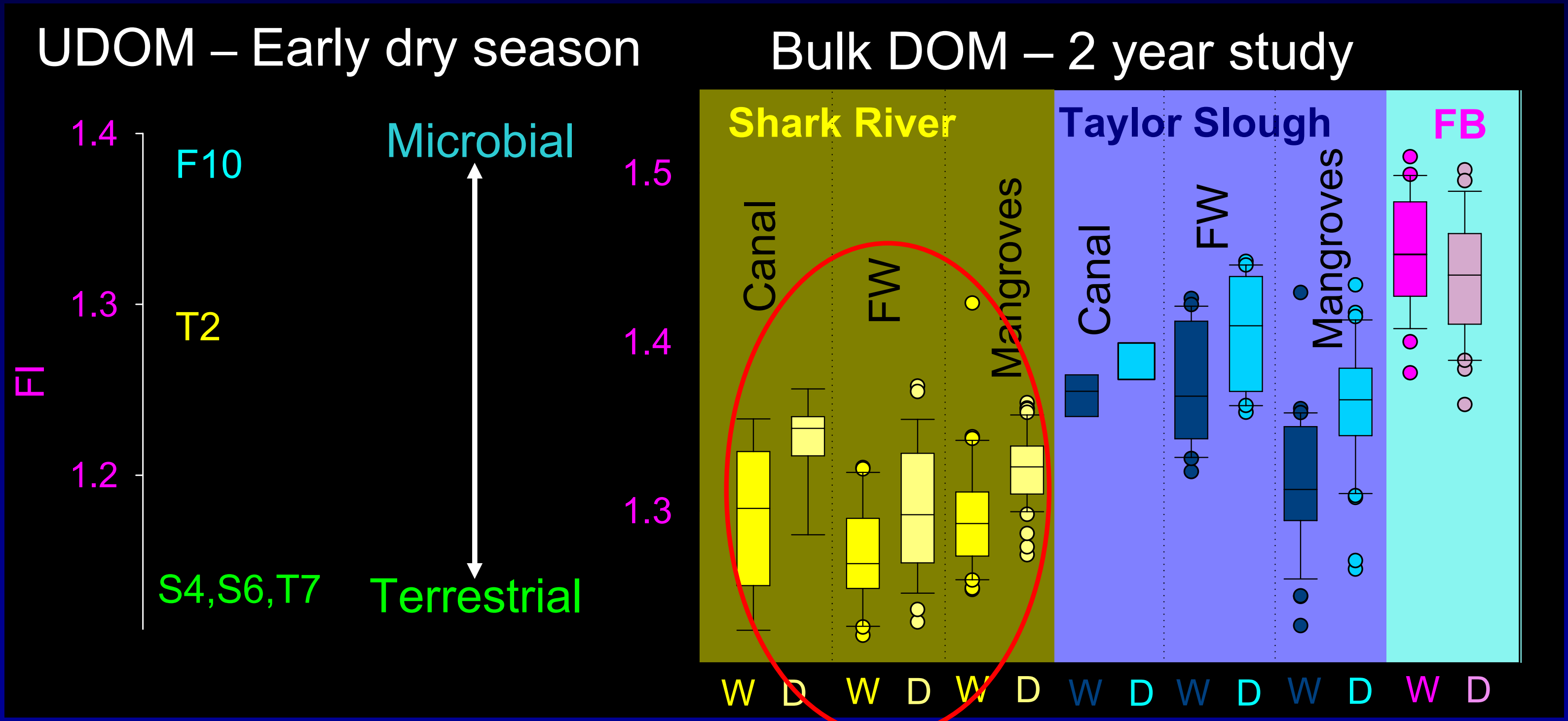
1. **Floc:**
    1. Preliminary characterization and source assessment.
    2. Biomass-specific biomarkers are being fine tuned.
    3. Bulk density and depth data are being collected
2. **DOM:**
    1. Two years (LTER2) of 3D Fluorescence data on temporal and spatial scales are completed and are continuing.
    2. Ground water samples have also been characterized.
    3. Reactivity assessments have been performed
3. **Soil OM:**
    1. Seven years and ongoing measures of bulk soil OM and nutrient content (P, Fe, S) completed at all FCE sites
    2. Paleo-environmental study in freshwater marshes and Fl. Bay have been completed; mangrove study is at advanced state

WHERE WE ARE

Some Results

Fluorescence Index

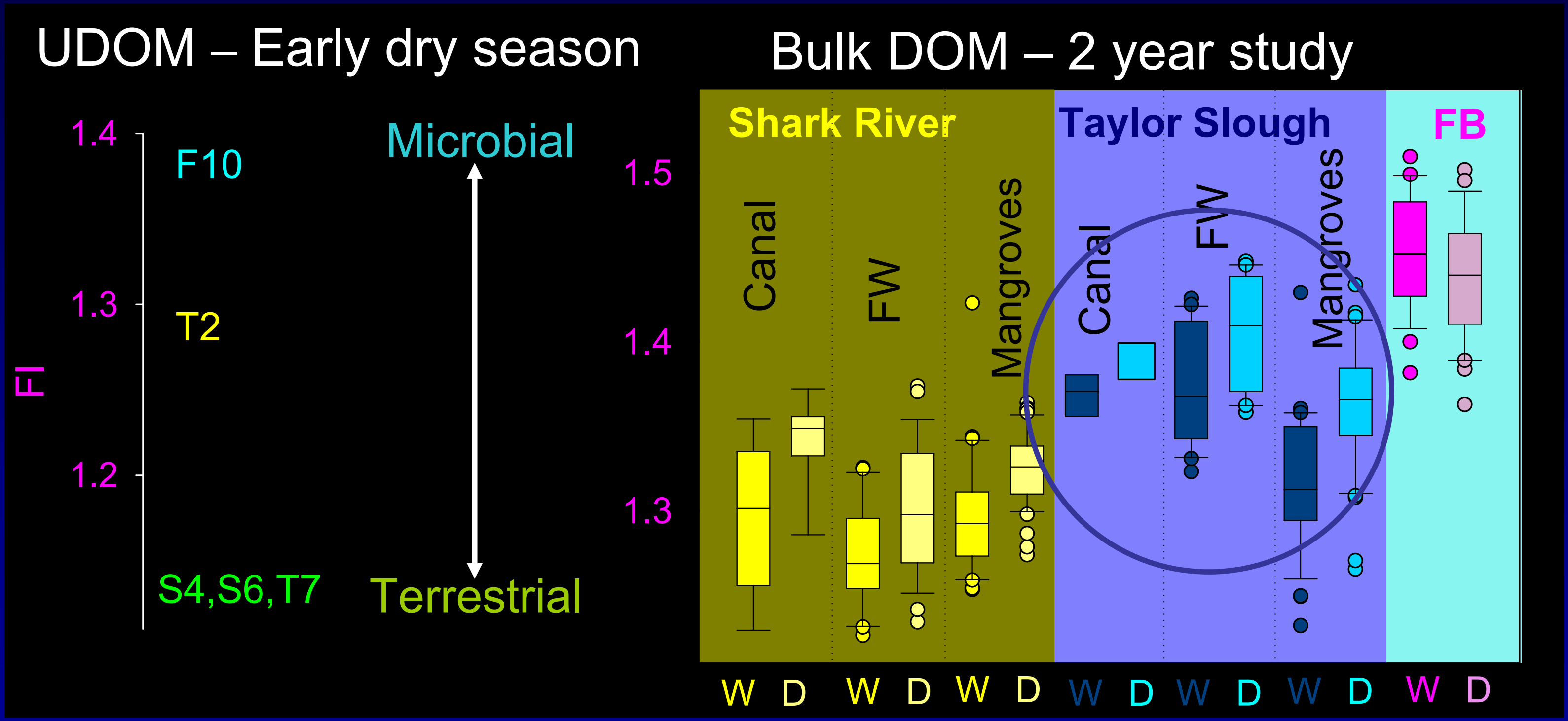
$FI = f_{470}/f_{520}$



All of SRS has relatively low FI – shows importance of peat contributions to DOM quality in this transect.

Fluorescence Index

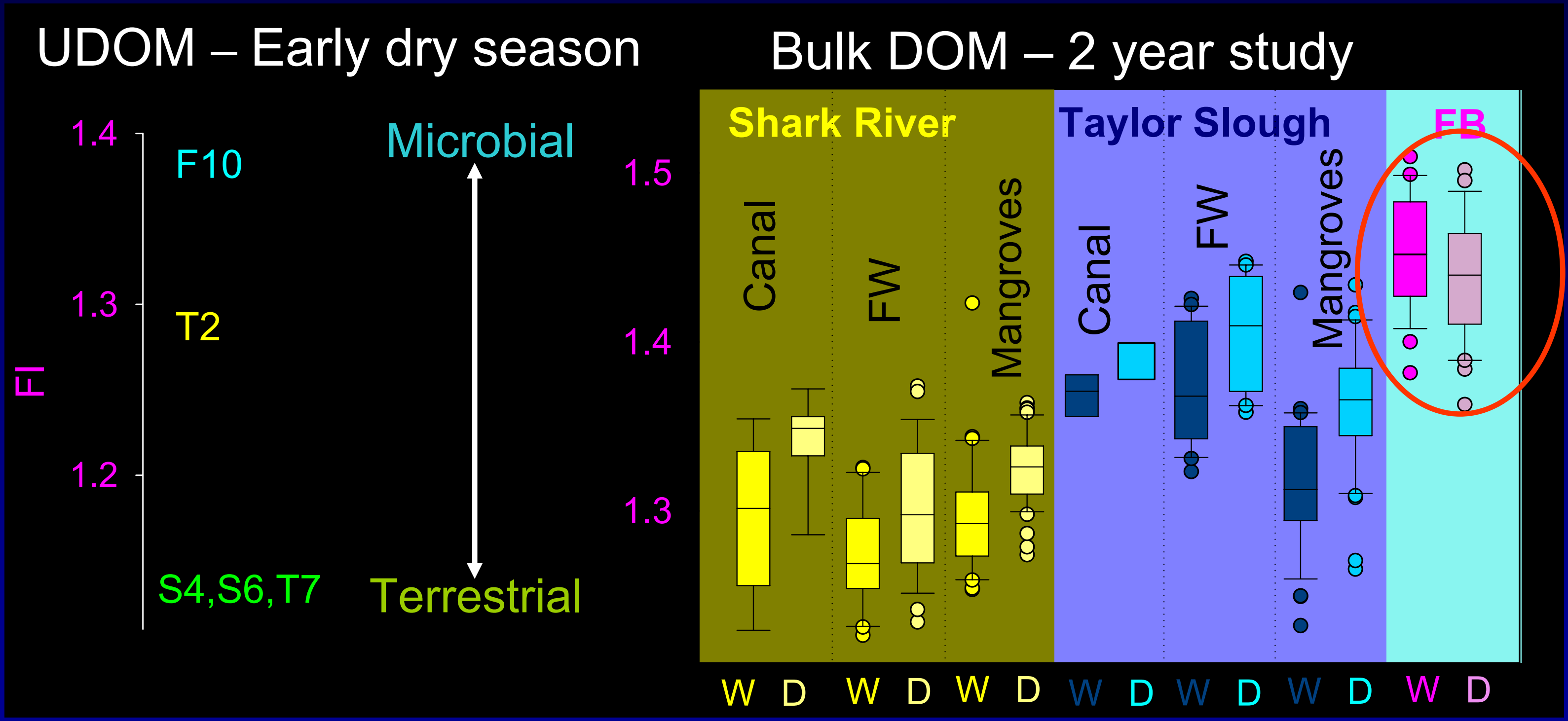
$FI = f_{470}/f_{520}$



Higher FI values in TS suggest higher microbial/periphyton sources.

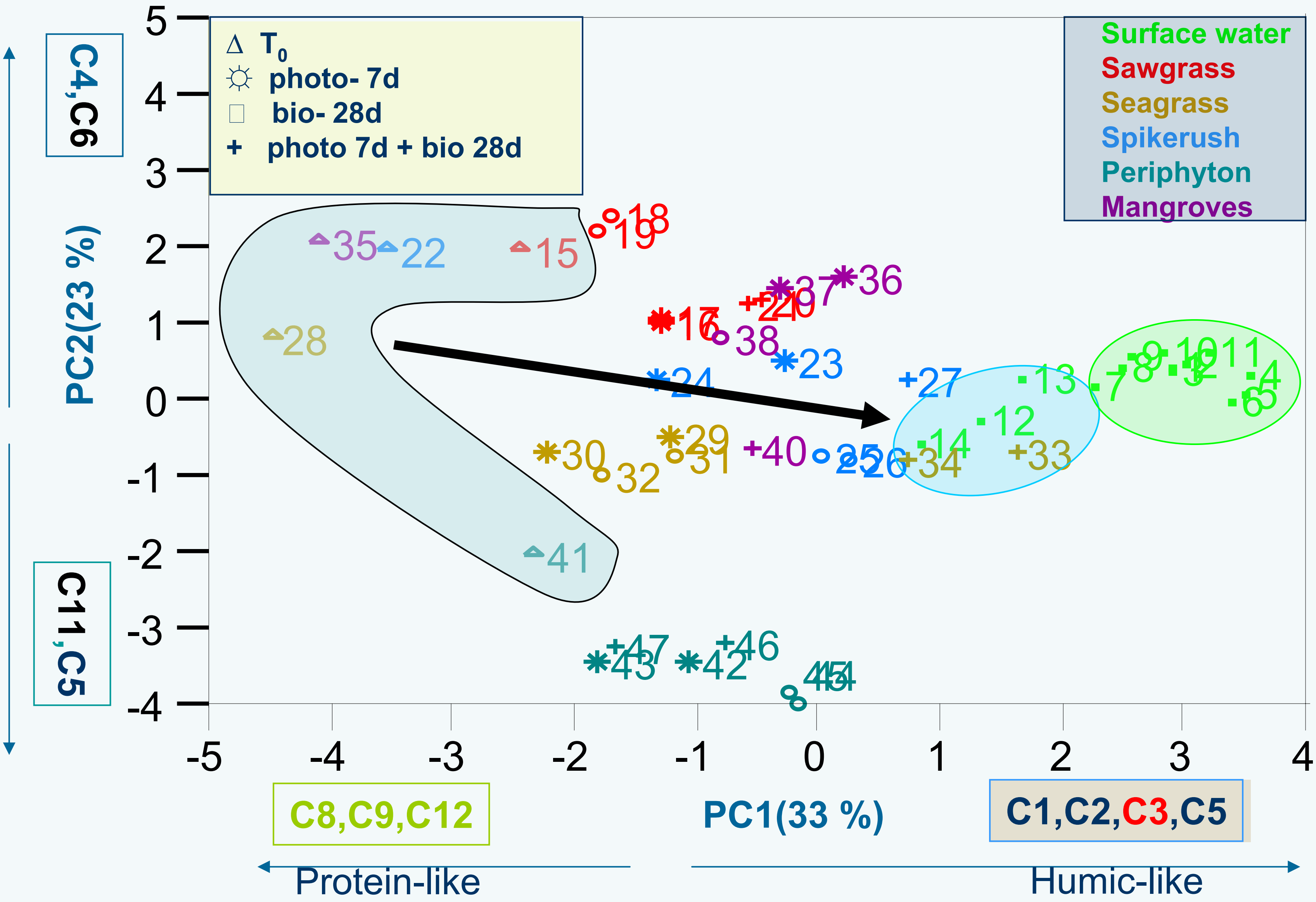
Fluorescence Index

$FI = f_{470}/f_{520}$

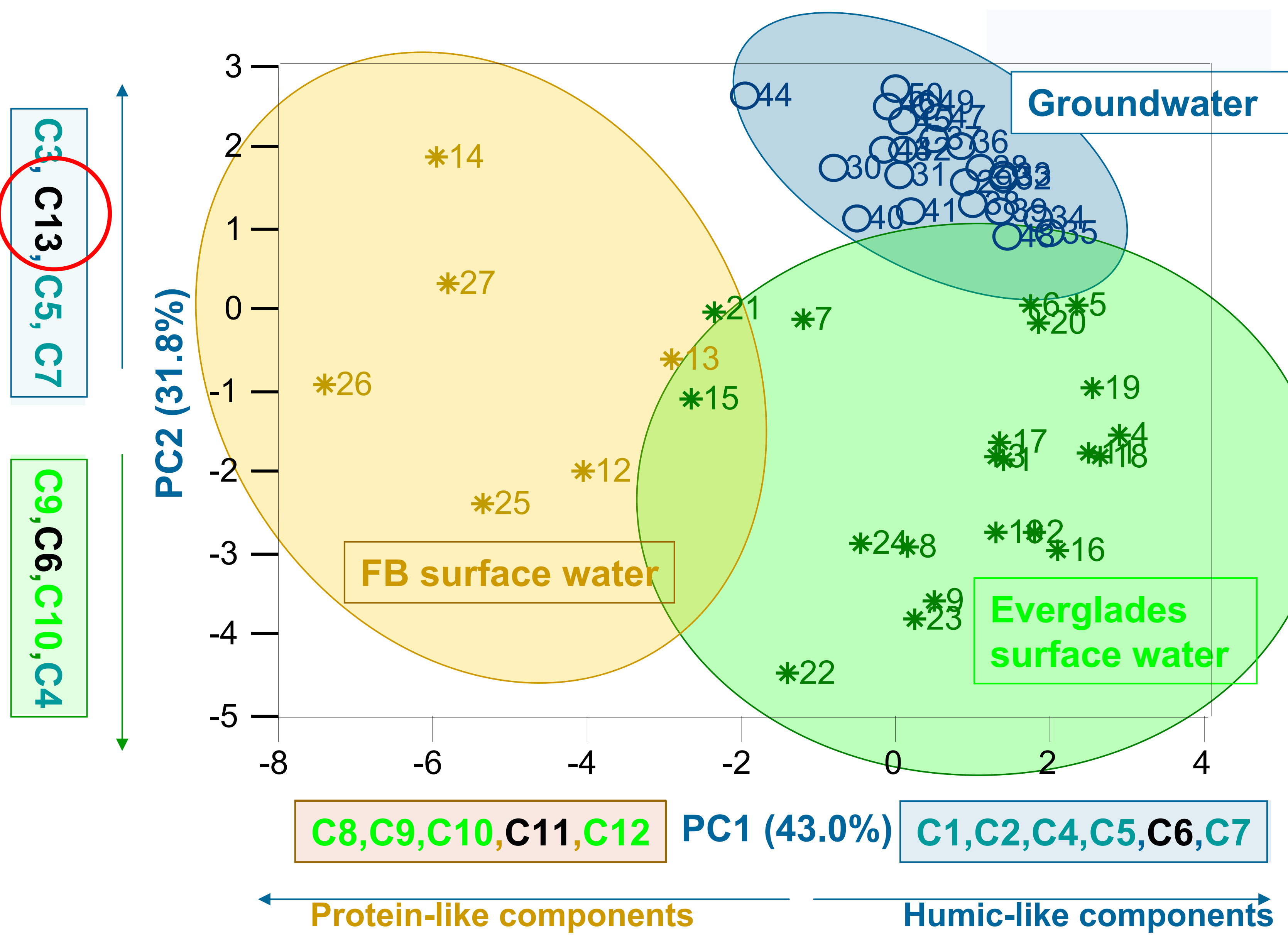


High FI values for Fl. Bay suggest microbial contributions.

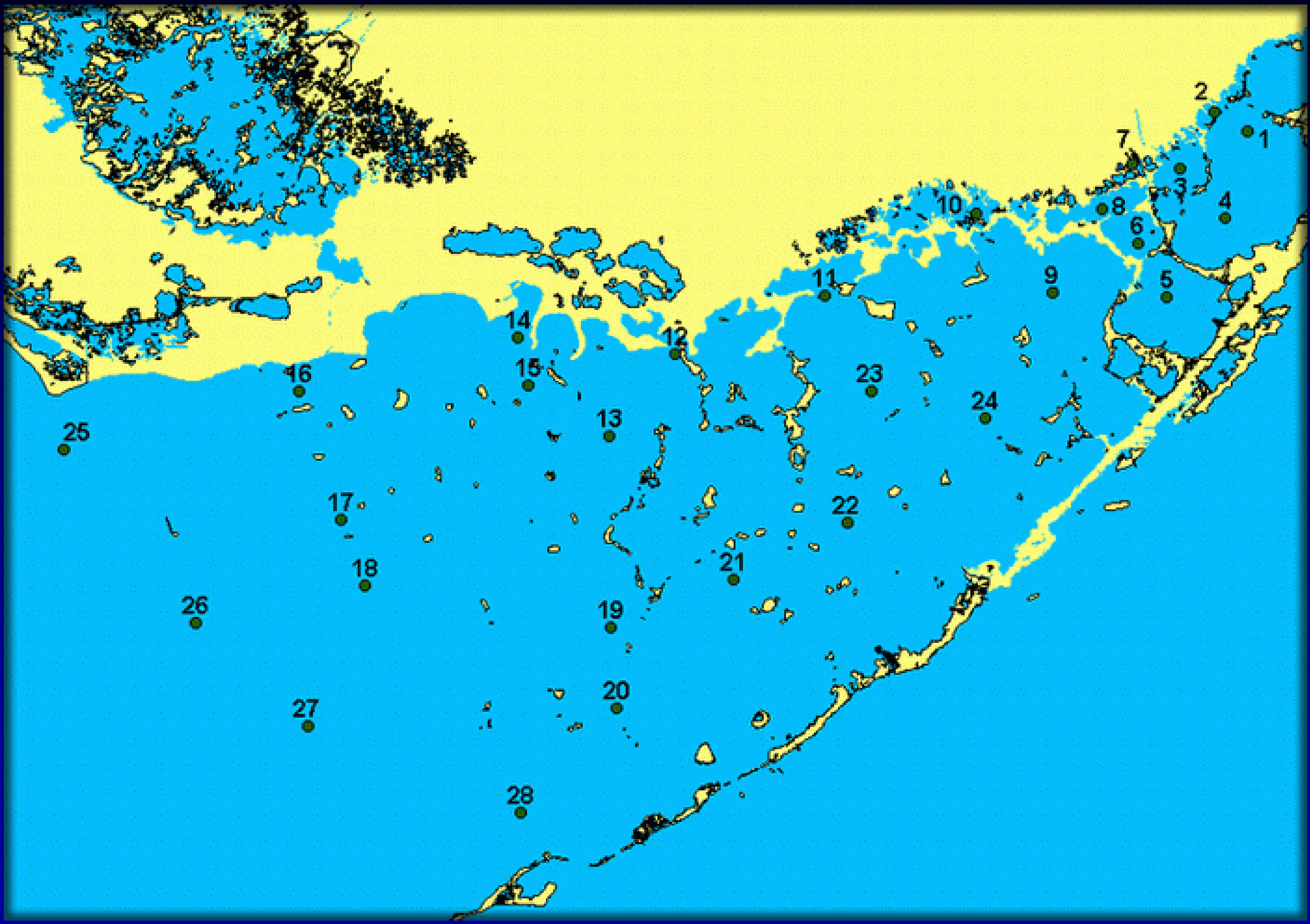
PCA for Leachates vs. Surface water



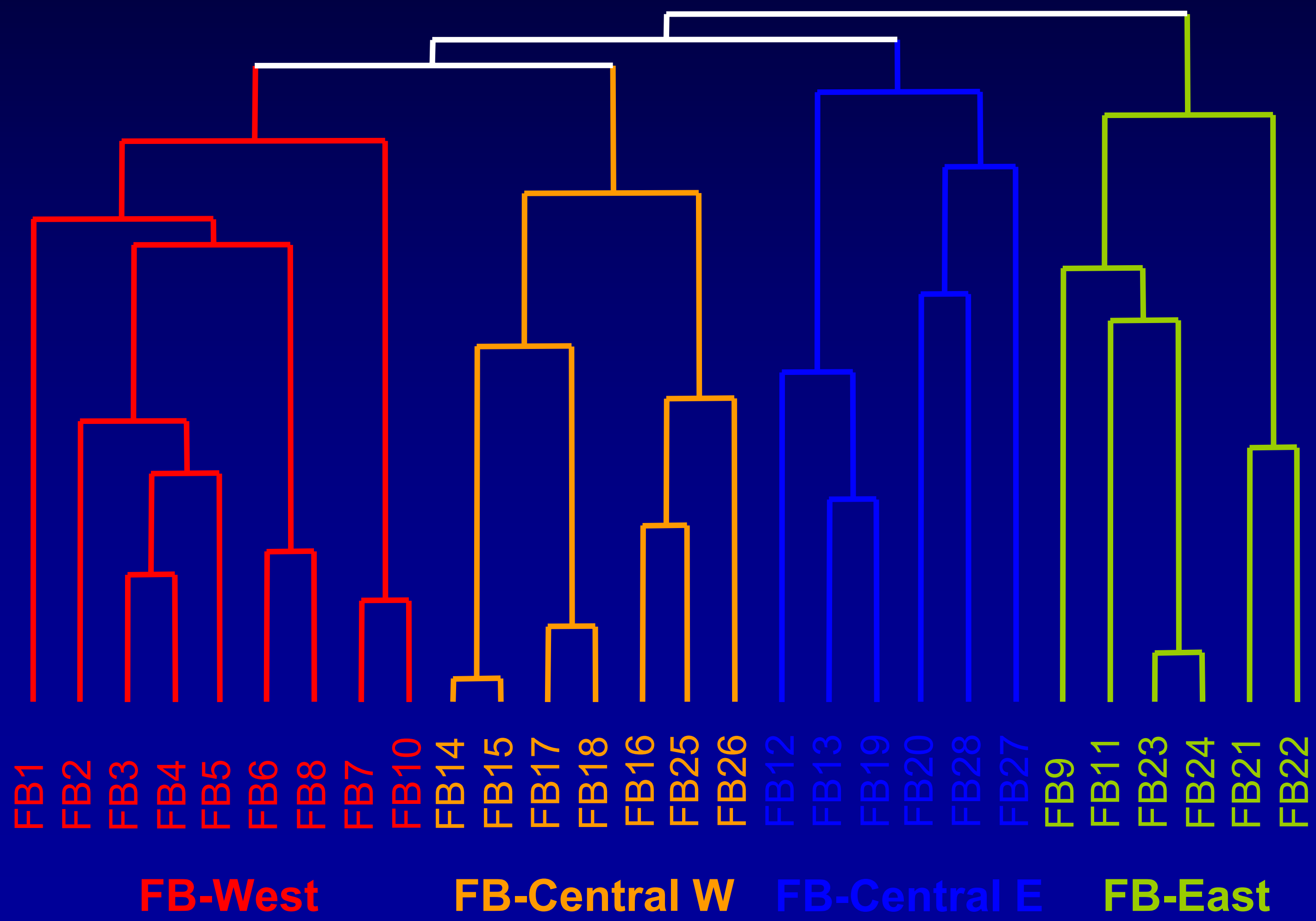
PCA Analysis for Groundwater vs. Surface Water Samples (Aug.& Sep.,2007)



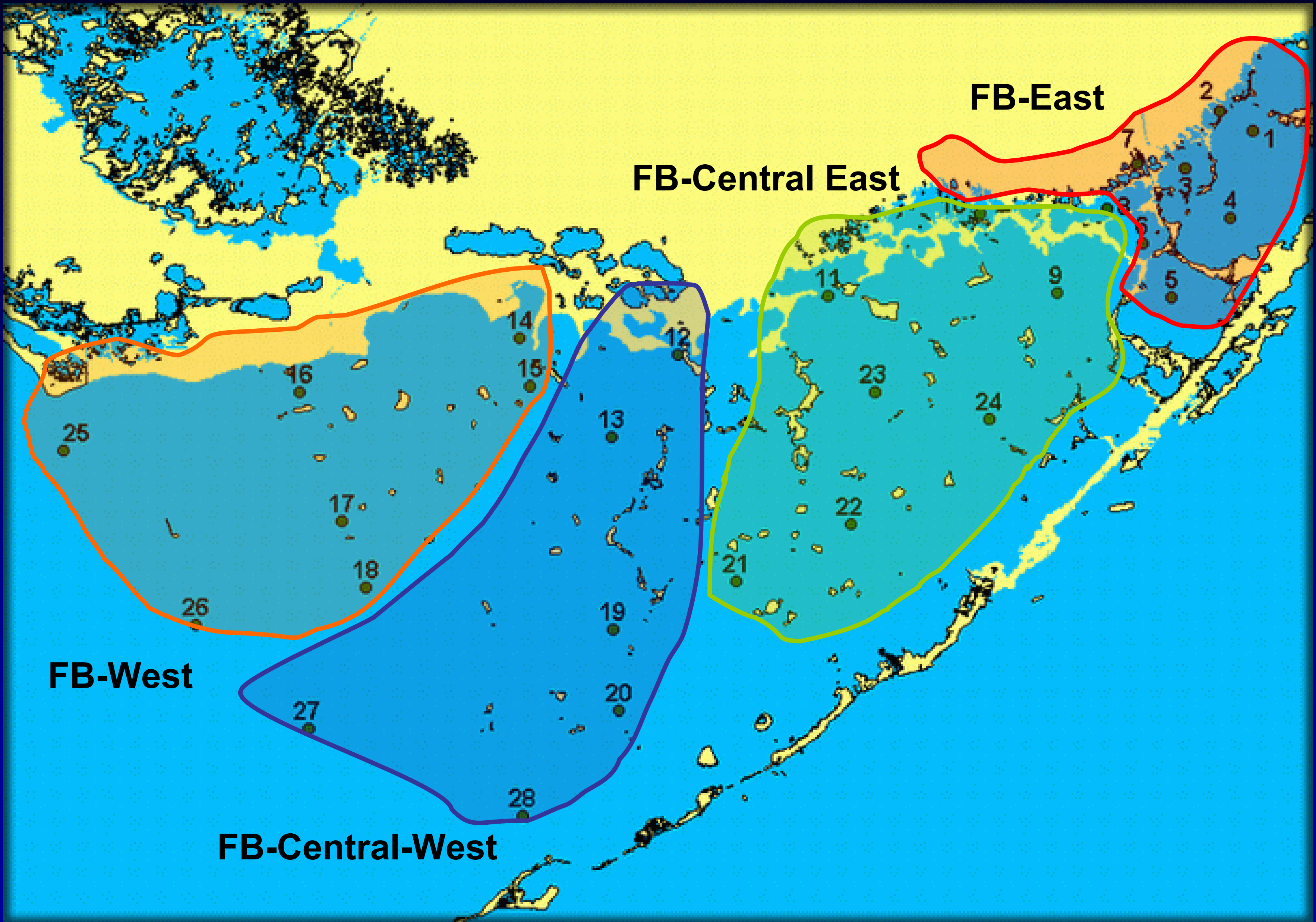
28 Water Quality Monitoring Stations in Florida Bay



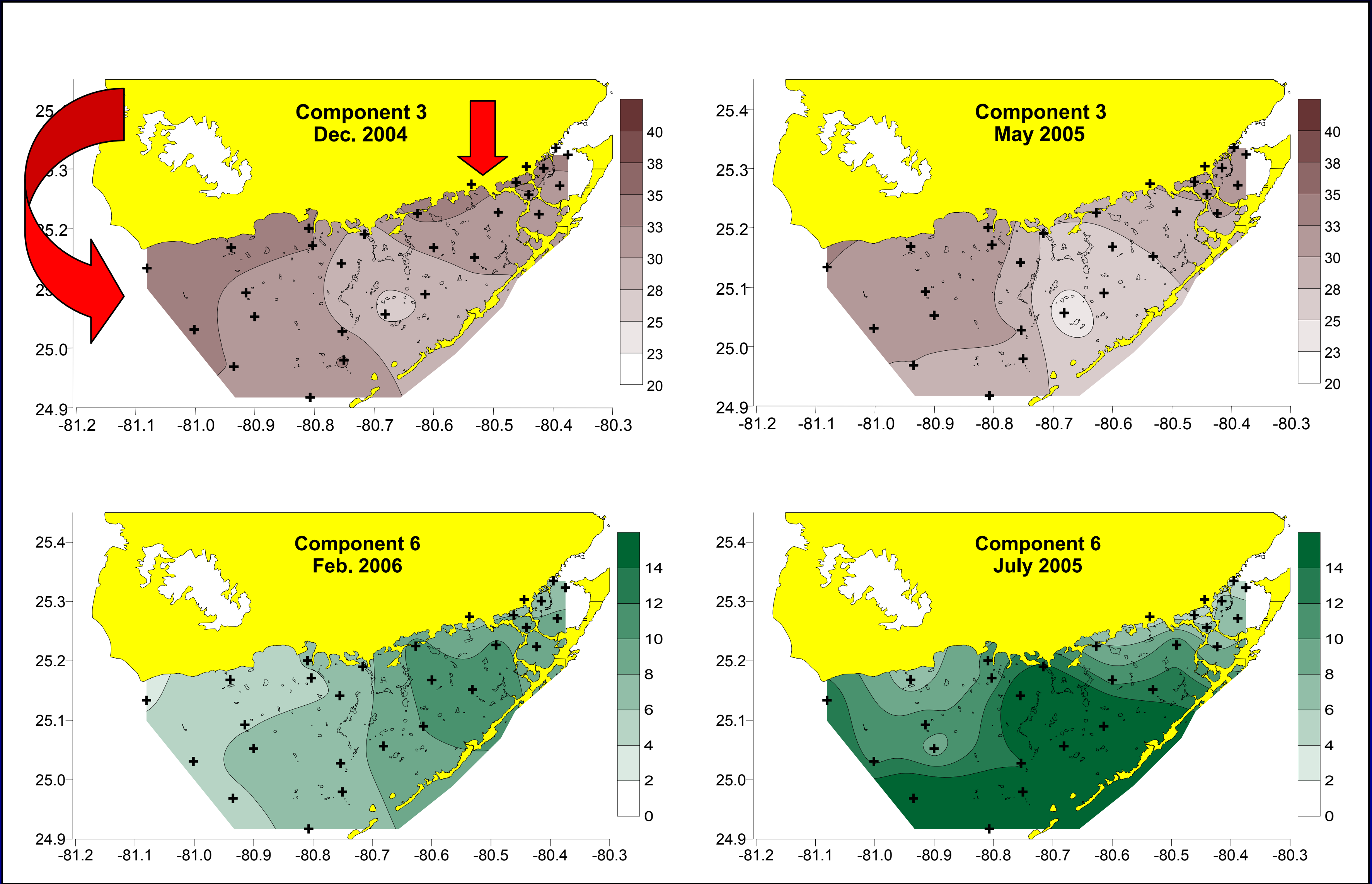
Cluster analysis of water quality monitoring stations based on EEM-PARAFAC analysis



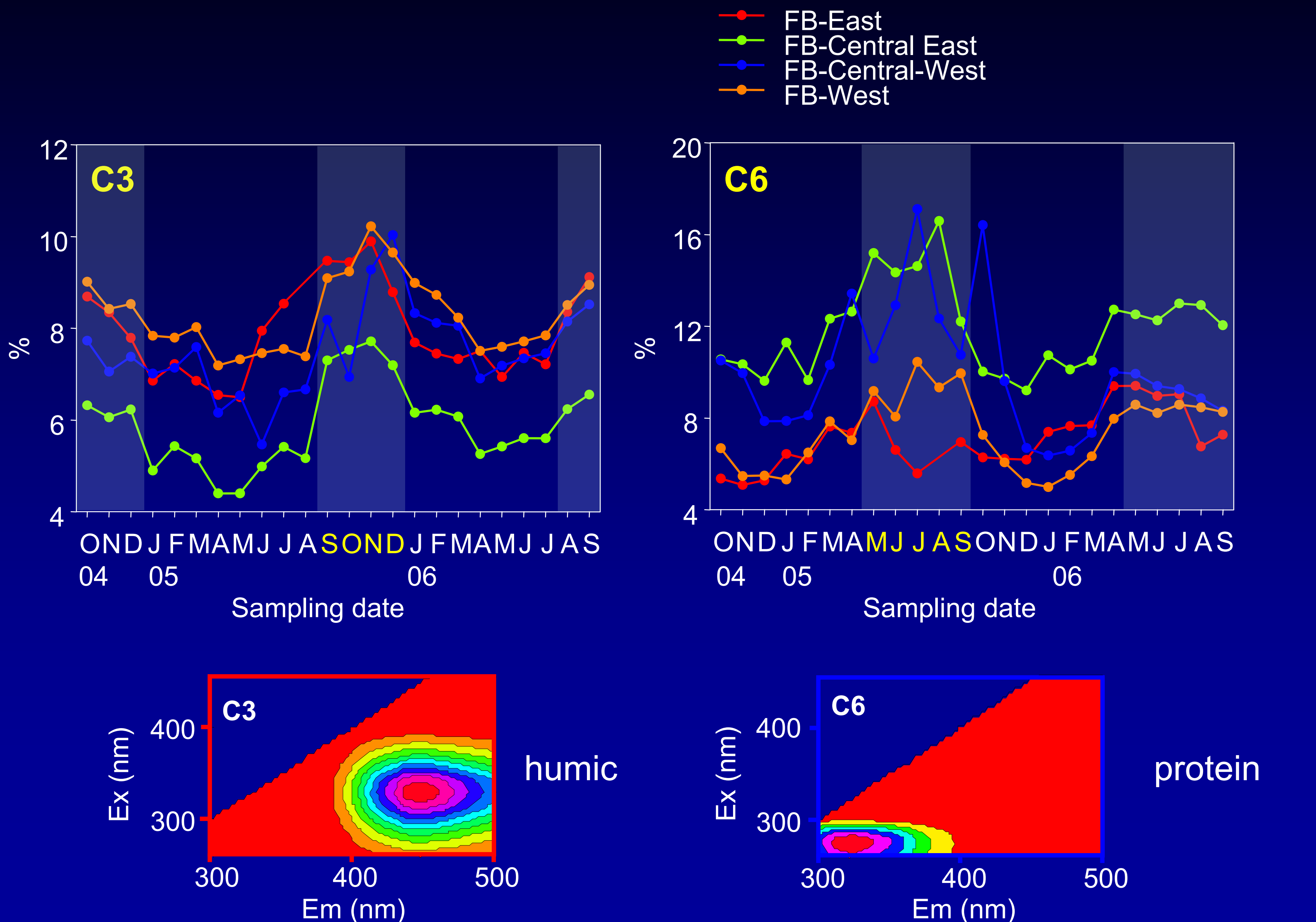
Grouping of water quality monitoring stations in FB based on DOM quality



Spatial/seasonal PARAFAC components distribution



Seasonal variation of fluorescence components by region



FLOC MONITORING-SEASONAL STUDY

Goals:

- ❖ Assessment of sources of floc on spatial and temporal scales.
- ❖ Determine at floc and periphyton dynamics.
- ❖ Determine at floc quality (respiration rates & chemical reactivity).
- ❖ Assess floc derived production of DOM.

Methods:

- ❖ Biomarker composition (GC/MS)
- ❖ Bulk properties (^{13}C, C/N, density, depth)
- ❖ Pigments (HPLC)

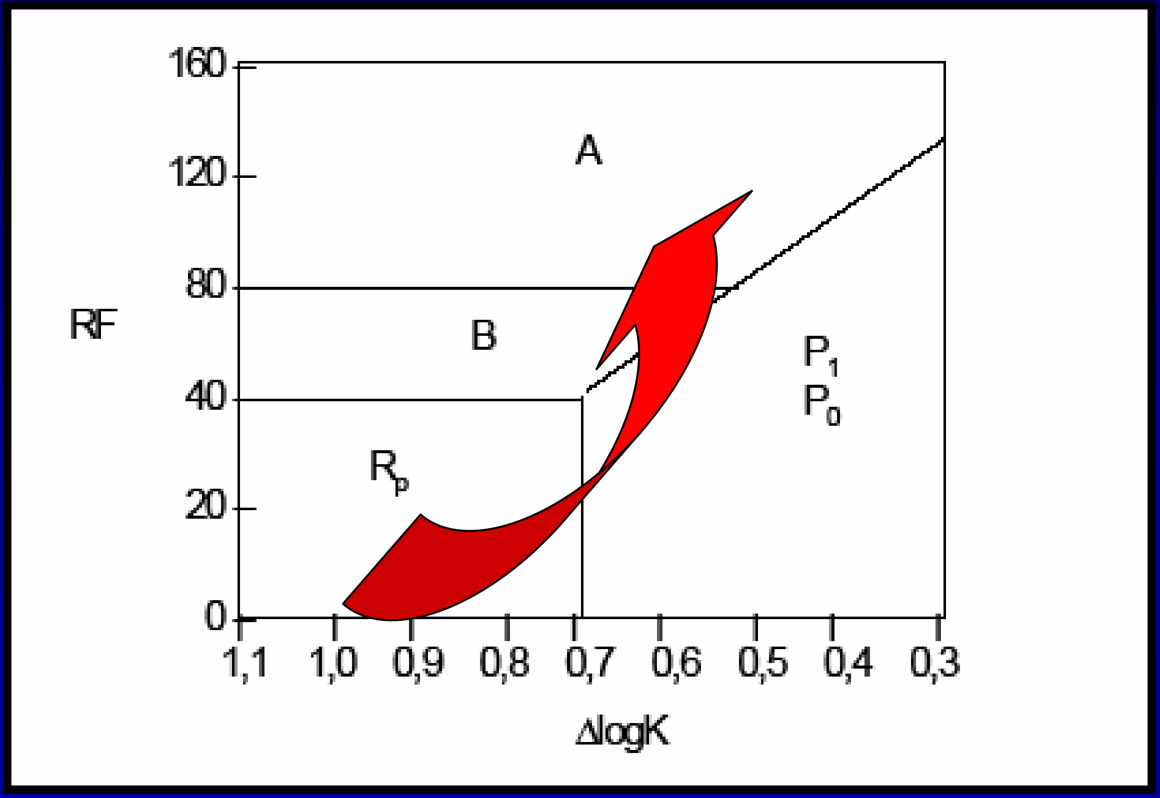
FLOC QUALITY

Spectrophotometric properties of humic acids (UV-Vis)

- Index of degree of humification:

  $RF = A_{600}/C \times 15$

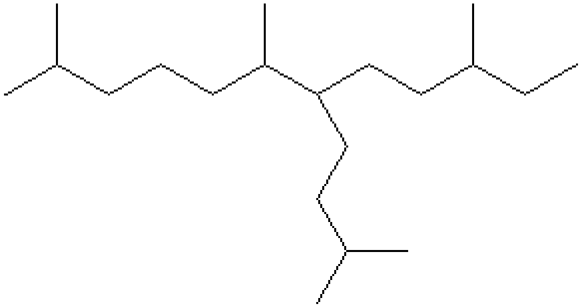
  $\Delta logK = log(A_{400}/A_{600})$



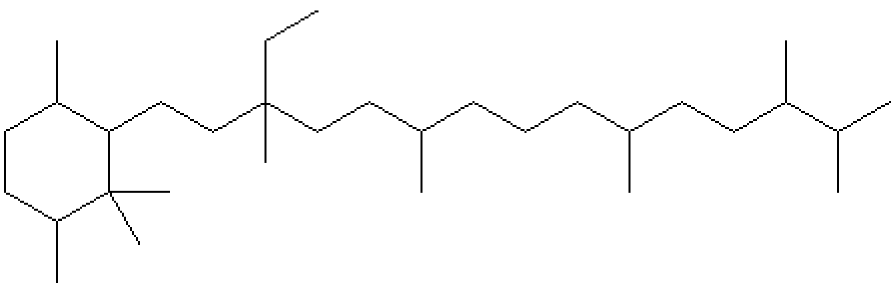
Kumada 1987.

TYPICAL FLOC BIOMARKERS

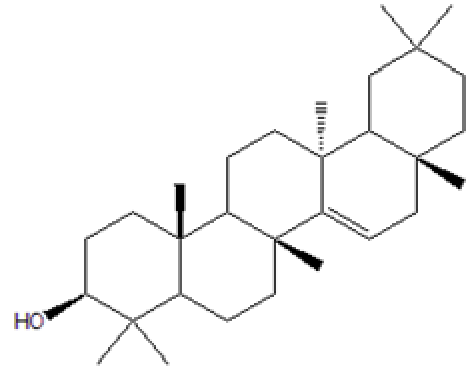
MICROBIAL MARKERS:



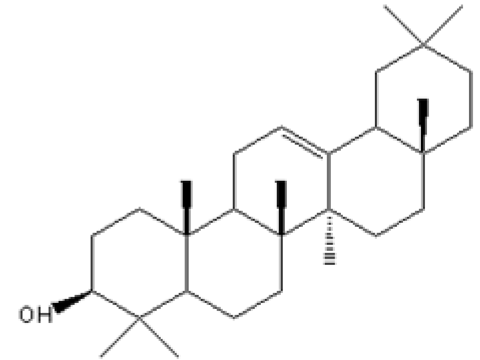
C20 Highly Branched Isoprenoid



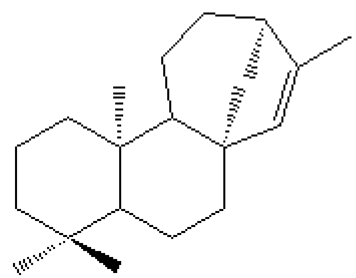
TERRESTRIAL MARKERS:



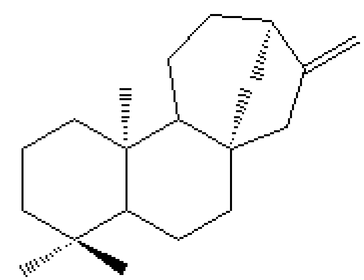
Taraxerol



β-Amyrin



Kaurene



Iso-Kaurene

PUFA:

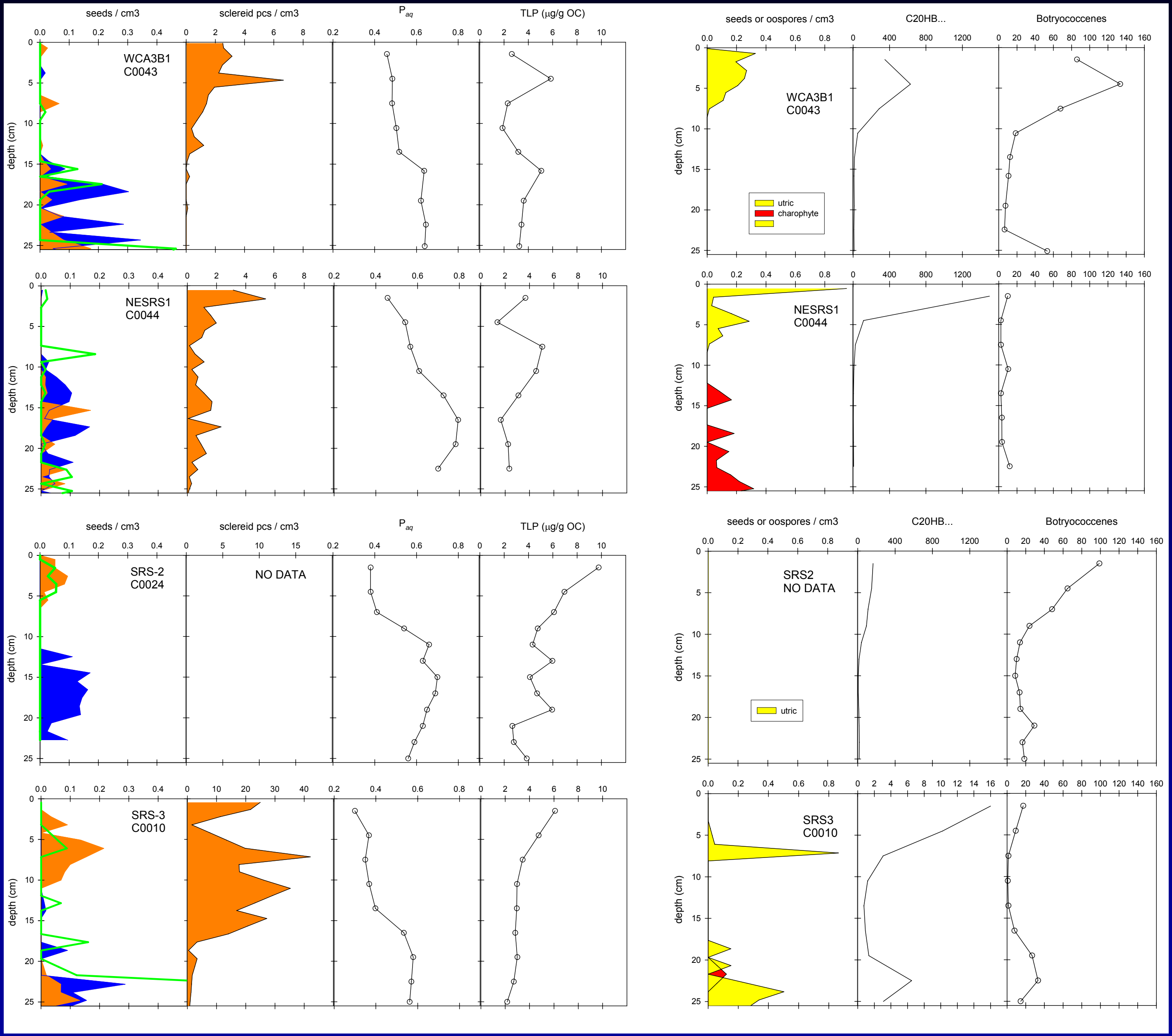
C18:3

C20:5, C22:6

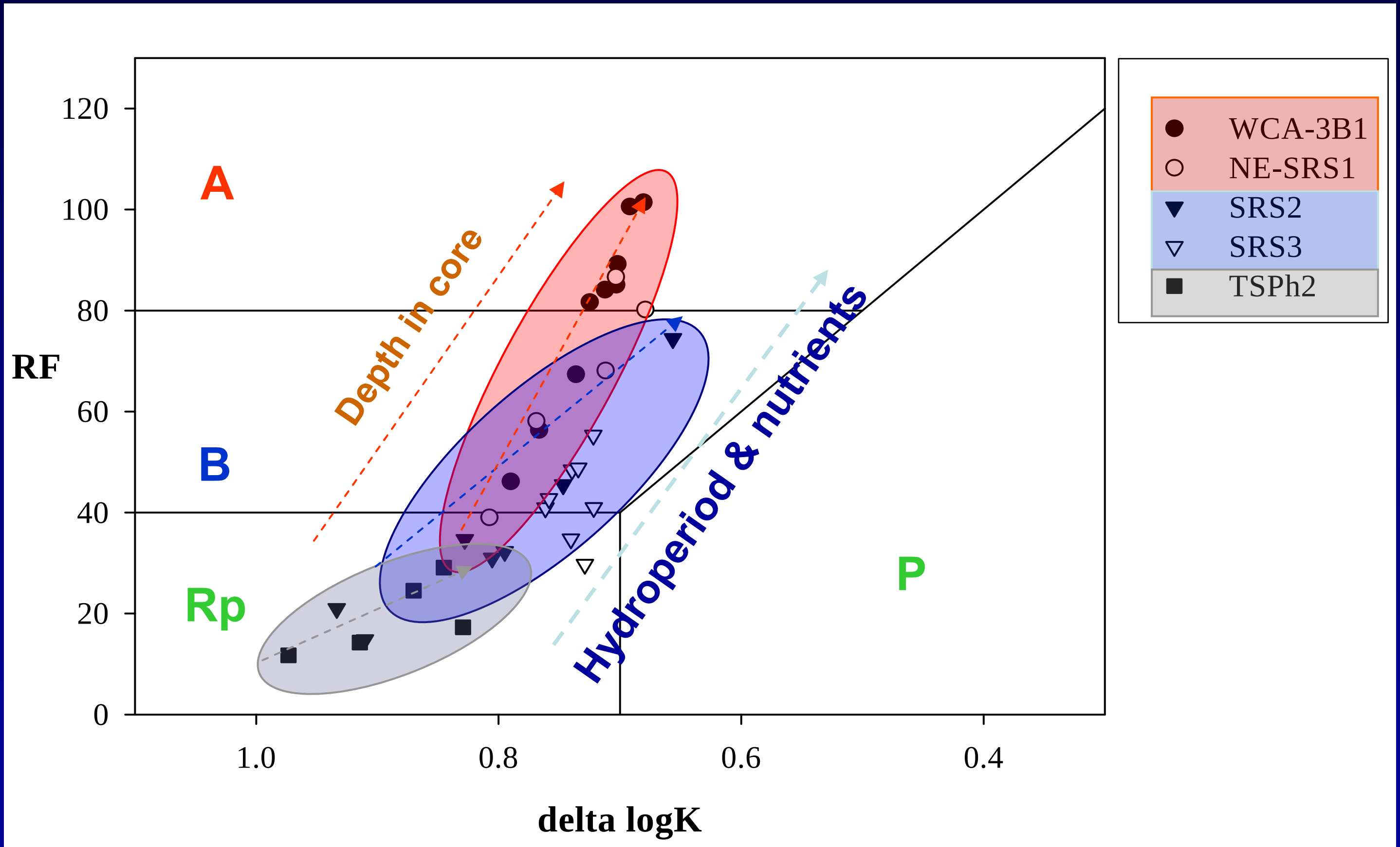
OTHER PROXIES:

$$P_{aq}: \frac{(C_{23}+C_{25})}{(C_{23}+C_{25}+C_{29}+C_{31})}$$

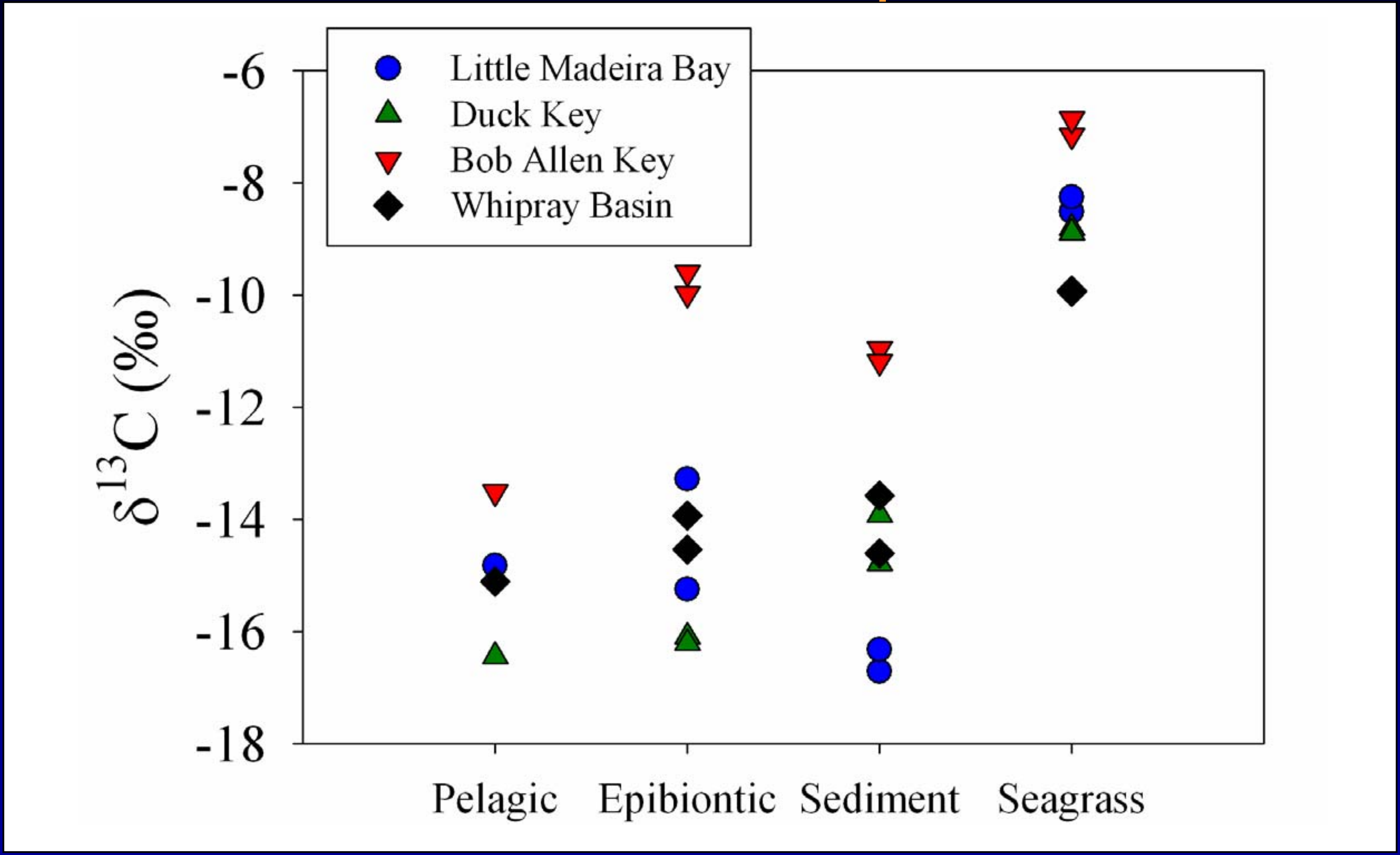
Freshwater Marsh PALEO-ENVIRONMENTAL Assessment



OM preservation in soils – Humic acids as indicators

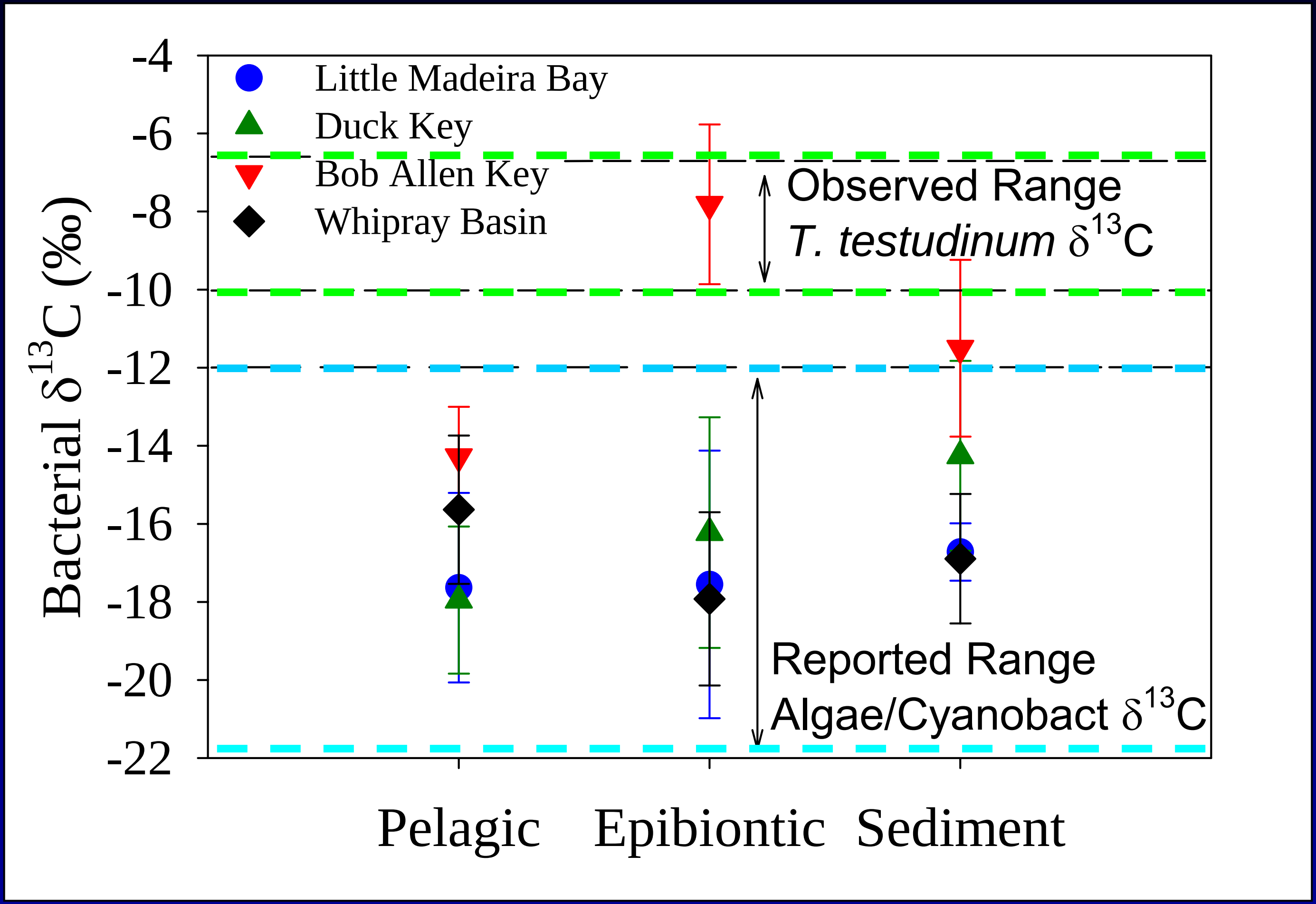


Microbial Carbon Cycling – Fl. Bay Stable Carbon Isotope Values



- Collected May 28, 2007
- All samples decarbonated with 1N HCl

Microbial Carbon Cycling in Florida Bay: Significance of pelagic, benthic, and allochtonous OM



- Each point represents the mean $\delta^{13}C$ value (SD) of br14:0, i15:0, a15:0, 15:0, br17:0, and 17:0 fatty acids.
- Each fatty acid was corrected for a -3‰ depletion due to fatty acid synthesis (Monson & Hayes 1982)
- This makes bacterial values directly comparable to bulk carbon measurements.

PRODUCTS TO DATE

<u>SINCE 2006</u>:

16+ publications
1 PhD, 1 MS
Multiple presentations
One associated proposal

WHERE WE WANT TO BE IN 2009 MID-TERM REVIEW

WHERE WE WANT TO BE IN 2009 MID-TERM REVIEW

General overview of what you think your group can accomplish before the mid-term review including data synthesis, manuscripts, proposals, etc…

1) 10 additional manuscripts in press/submitted
2) One or two related proposals
3) Synthesis of present state of knowledge of OM dynamics

WHERE WE WANT TO BE IN 2009 MID-TERM REVIEW

List at least one synthesis (or question-directed) manuscript with co-authors that you plan to have submitted by the 3rd year review

Tentatively:

"Organic matter dynamics in the Florida Coastal Everglades: Soils"

Chambers, Jaffé, et al. …

OUR VISION FOR DECADAL PLAN

1) The development of specific analytical tools to monitor OM dynamics is at an advanced state at the FCE.
2) These could be applied to aid the integration at the Network level, bridging regional to continental scales.
3) We have performed two inter-LTER collaborations (BNZ & COWEETA) and are working on another five. => effect of climate change and land-use!
4) A NSF proposal to Ecosystem Sciences will be re-submitted in July 2008 for this purpose.

OUR CONTRIBUTION TO CENTRAL HYPOTHESES BY RENEWAL TIME

1. **Increasing inputs of freshwater will enhance oligotrophy in nutrient-poor coastal systems, as long as the inflowing water has low nutrient content; this dynamic will be most pronounced in the oligohaline ecotone.**

List of expected contributions toward this hypothesis:

- **Documentation of decreased bulk soil P in the oligohaline zone**
- **Documentation of decreased soil accumulation in the oligohaline zone**
- **Documentation of changed in DOM delivery and reactivity**
- **Documentation of changes in floc characteristics and reactivity**

OUR CONTRIBUTION TO CENTRAL HYPOTHESES BY RENEWAL TIME

2. An increase in freshwater inflow will increase the physical transport of detrital organic matter to the oligohaline ecotone, which will enhance estuarine productivity. The quality of these allochthonous detrital inputs will be controlled by upstream ecological processes.

List of expected contributions toward this hypothesis:

- Documentation of OM delivery from upstream
- Determination of reactivity of OM delivered from upstream

Any concerns or suggestions for movement toward this goal: We need explicit documentation from hydrology group (or elsewhere) that water flows have increased through the ecotone, to pair with measures of concentration in water and soils.

OUR CONTRIBUTION TO CENTRAL HYPOTHESES BY RENEWAL TIME

3. **Water residence time, groundwater inputs, and tidal energy interact with climatic and disturbance regimes to modify ecological pattern and process in oligotrophic estuaries; this dynamic will be most pronounced in the oligohaline ecotone.**

List of expected contributions toward this hypothesis:

- **Demonstration of predictable changes in sources and reactivity of OM**
- **Demonstration of predictable changes in bulk soil properties**
- **Demonstration of predictable changes in sedimentation/erosion patterns**
- **Historical paleo-environmental evidence**

Any concerns for movement toward this goal: More hydro data!

THANKS!