Resolving sources of dissolved organic matter in the Sacramento-San Joaquin Delta by radiocarbon dating

James O. Sickman
Soil and Water Science Department, University of Florida

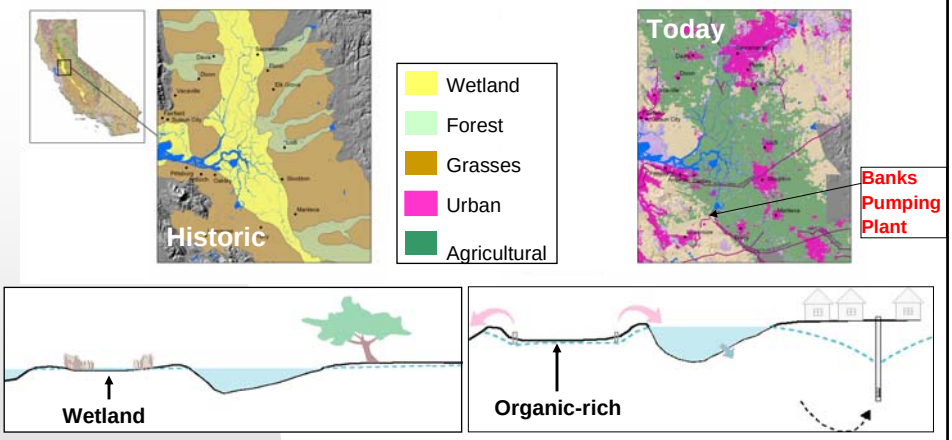
Carol DiGiorgio
California Department of Water Resources

M. Lee Davisson
Lawrence Livermore National Laboratory

Delores Lucero, University of Florida
Erin Waites, Department of Water Resources

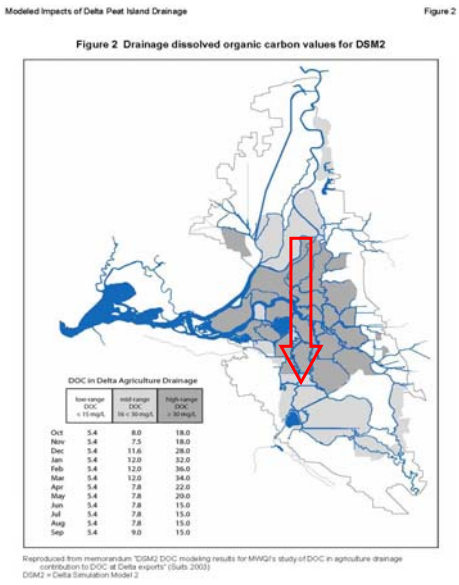
Presented at:
October 2004 CALFED Science Conference

The Dynamic Delta Landscape Presents Unique Challenges for Drinking Water Quality



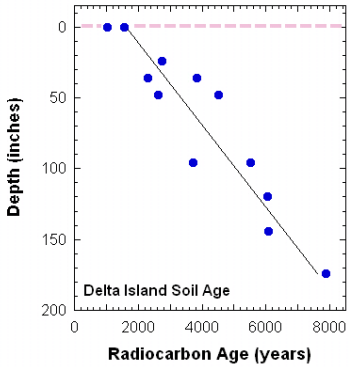
- *DOM is a precursor to disinfection byproducts in finished drinking water*
- *DOM likely originates from modern and historical sources*
- *Relative proportions of different sources will vary during water year*

Determination of Delta Island DOM Influence at Banks



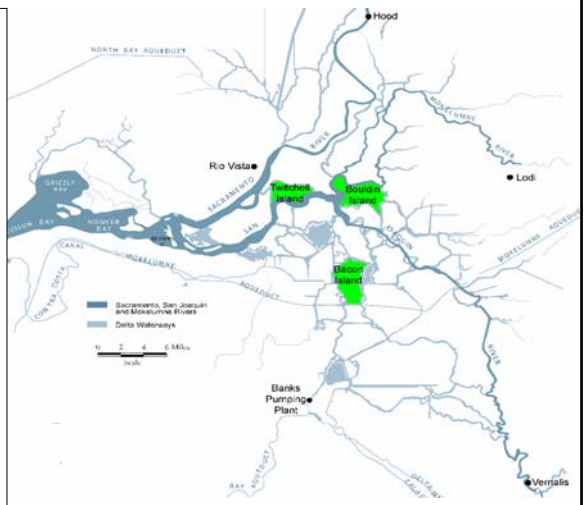
Can Isotopic fingerprinting determine if:

- *Delta island peat is a significant source of C loading to the State Water Project?*
- *C inputs from Delta island peat vary through time depending on seasonal and hydrologic conditions?*



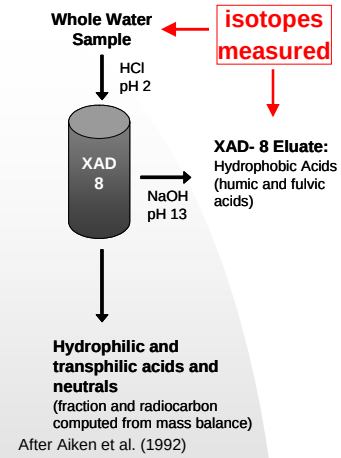
Sampling and Analysis

- Monthly sampling:
  - Rivers
  - Ag drains
- Periodic sampling:
  - Urban runoff
- DOM Fractionation
- Measurements:
  - AMS carbon dating
  - C, N and S isotopes
  - SUVA
  - THMFP
- Water fingerprinting using DSM2 model

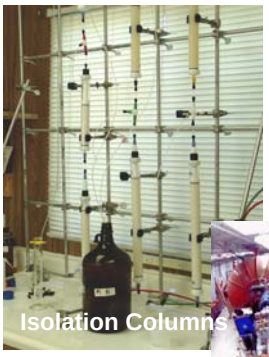


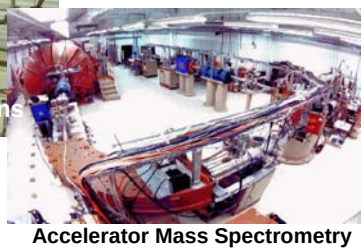
Emphasis to date has been on DOM fractionation and radiocarbon measurements

DOM Fractionation Procedure



After Aiken et al. (1992)

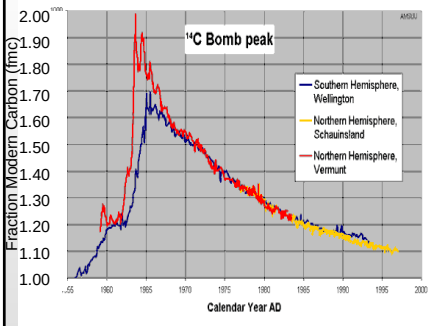




Accelerator Mass Spectrometry

- Fractionation favors isolation of hydrophobic compounds (humics) which tend to be more refractory
- Longer environmental persistence of these hydrophobic compounds may correlate to radiocarbon age.

Radiocarbon Comparison of Surface DOM and Soil Organic Matter



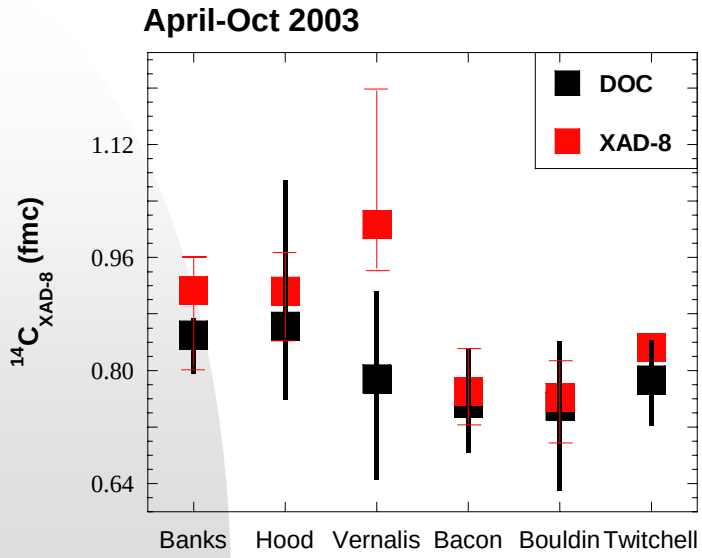
(Fraction Modern Carbon) $$fmc = \frac{\left(\frac{^{14}C}{^{12}C}\right)_{sample}}{\left(\frac{^{14}C}{^{12}C}\right)_{standard}}$$

★Source	fraction modern carbon DOC	XAD-8
Sacramento R	**1.07, 1.10**	
San Joaquin R	**1.09, 1.10**	
Old R	**1.08, 1.53**	
Cache Cr	**0.89**	
Missouri R	0.94-1.14	0.87-0.99
Mississippi R	1.06-1.09	
*Hudson R	0.84-0.96	
Others	1.06-1.11	0.77-1.40
Delta Island Soil Organic Matter		**0.38-0.89**

★ from Davisson (2002)

* from Raymond and Bauer (2000)

River XAD-8 Fractions Are Younger Than Ag Drain Water



Simple Mass Balance Mixing Model Tends to Under-Predict ^{14}C abundance of XAD-8 DOC Fraction

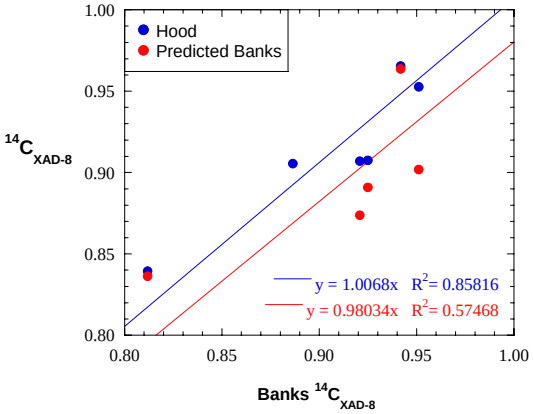
$$^{14}C_{mix} = \left(\frac{X_1 C_1 {}^{14}C_1 + X_2 C_2 {}^{14}C_2 + \ldots}{\sum X_i C_i} \right)$$

linear mixing model

$X_{1\,=}$ fraction of flow
$C_{1\,=}$ DOC concentration

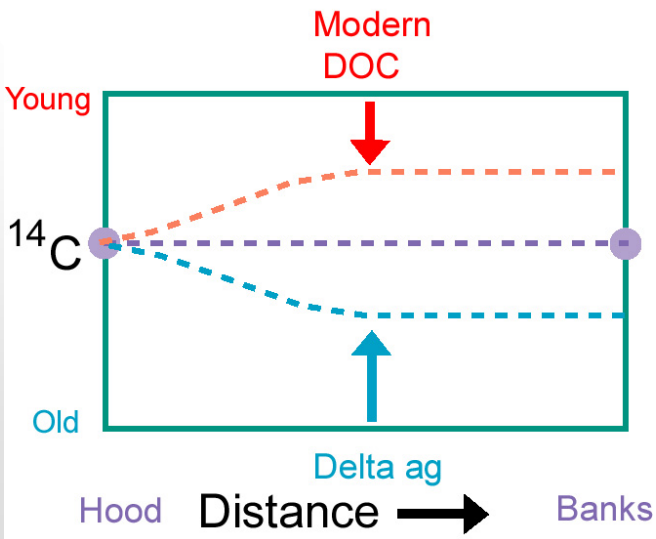
***Input Flows**

- **Sac/Yolo**
- **SJR**
- **Delta ag**
- **Eastside**
- **Mtz**



** Based on DSM2 daily mass flow estimates for all major Delta inflows*

Addition of young and old DOC during Delta transport may explain similar ^{14}C abundance between Hood and Banks



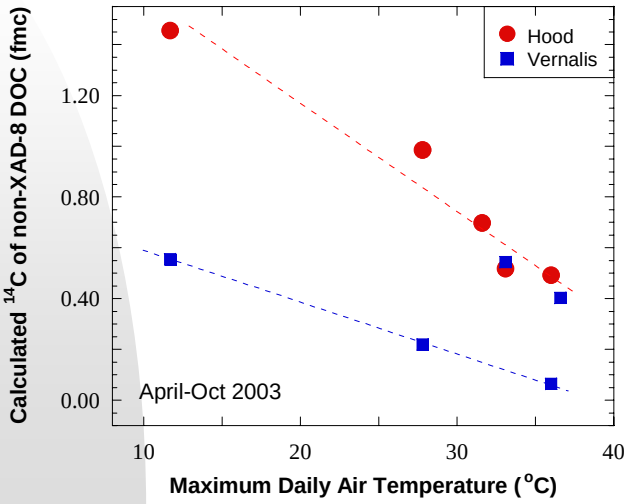
Implications from Simple Mass Balance Modeling

- Delta Island agricultural drainage has no apparent influence on DOC ^{14}C at Banks
- Increasing flow contributions from eastside of Delta or San Joaquin River cannot account for ^{14}C discrepancy
- Modern-aged carbon is likely added to the XAD-8 fraction between Hood and Banks

	SUVA (L/mg-m)	**THMFP** (µmol/mmol C)
Hood	**2.13**	**7.45**
Banks	**2.83**	**9.08**

Calculated ^{14}C abundance in non-XAD-8 DOC fractions indicate old or possibly fossil carbon sources

$$^{14}C_{non-XAD-8} = \frac{^{14}C_{WW} - fDOC_{XAD-8} \times {}^{14}C_{XAD-8}}{1 - fDOC_{XAD-8}}$$



Conclusions

- For Sacramento and San Joaquin rivers, whole water DOM predominantly has lower radiocarbon content than corresponding XAD-8 fractions
- The non-XAD-8 portion of DOM in these river waters suggest old or fossil carbon inputs
- Sacramento River and San Joaquin River have younger XAD-8 fractions than Delta Island agricultural drain waters
- A conservative mixing model for DOM at Banks predicts older carbon than is observed for most samples thus far
- Results suggest young carbon is added between Hood and Banks

Acknowledgements

Funding provided by the CALFED Bay Delta Program, State Water Project Contractors and Department of Water Resources


Twitchell Island


Banks Pumping Plant