DOC Contributions from Delta Habitats: A Multi-Tracer Approach

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Determining Delta DOC Contributions

Why is it so challenging?

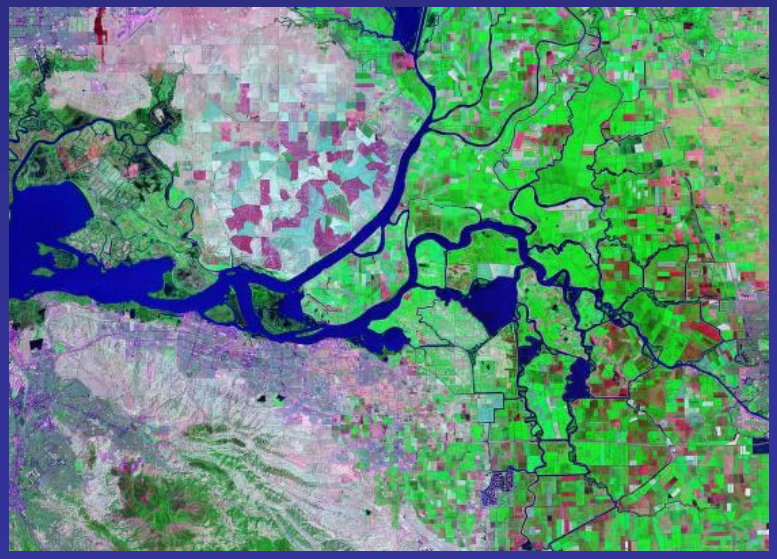
LOAD	=	CONC	x	VOL
(mg)		(mg/L)		(L)

Determining Delta DOC Contributions

Why is it so challenging?

LOAD = CONC x VOL
(mg) (mg/L) (L)

????



<u>Hydrologically Complex</u>

- network of channels
- tidally influenced system
- human influenced system
- numerous island drain input locations
- complex, dendritic wetland configurations

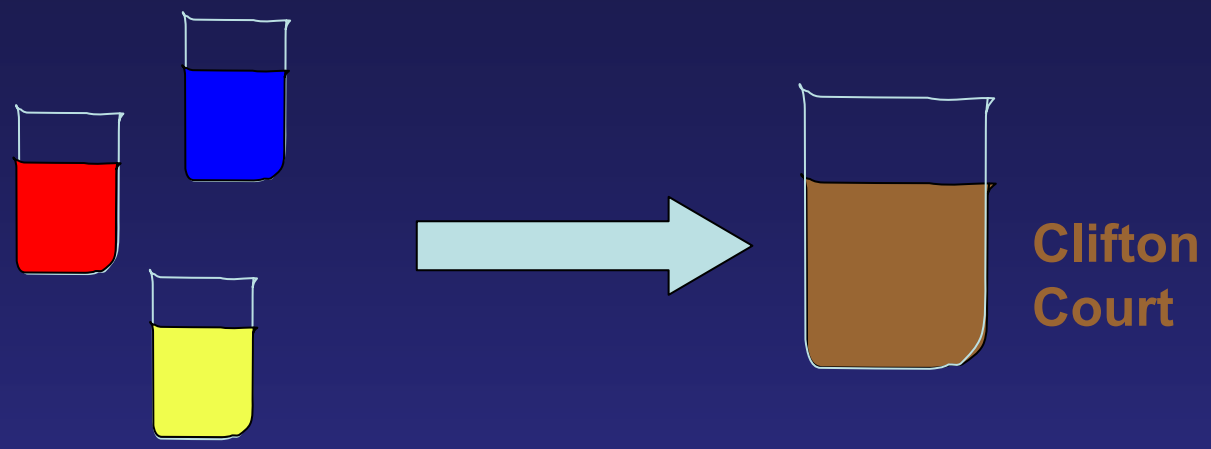
Multi-Tracer Approach (Fingerprinting)

Conceptual Model

Tracer: DOC composition

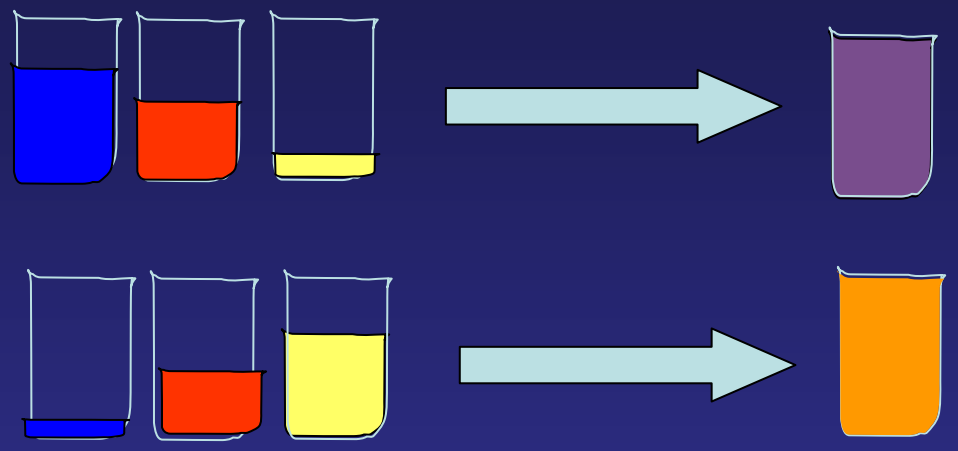
Multi-Tracer Approach

Conceptual Model



Multi-Tracer Approach

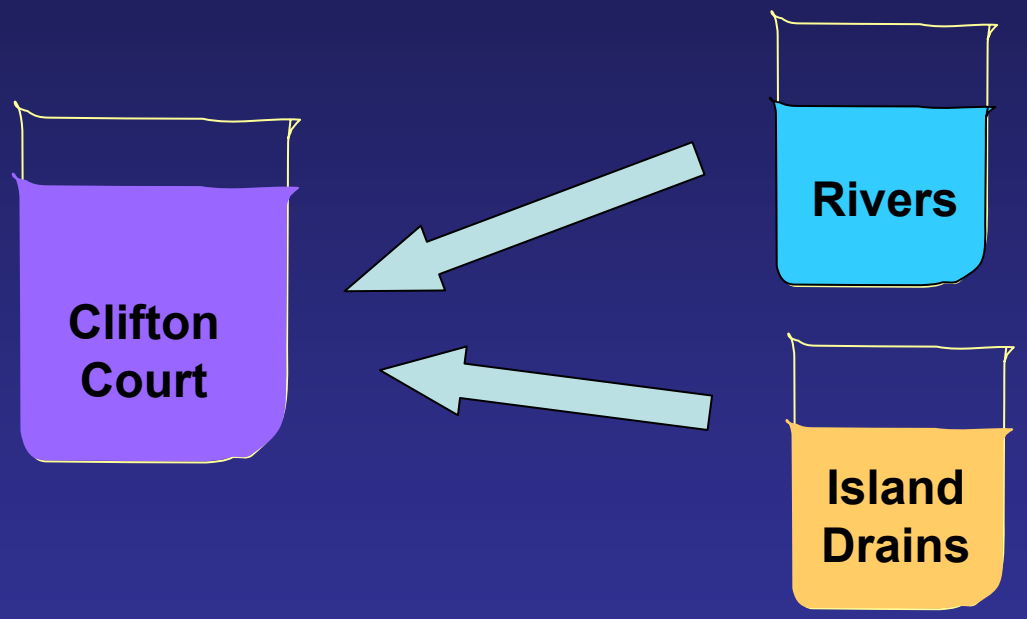
Conceptual Model



Inspiration for this Study

DOC COMPOSITION:

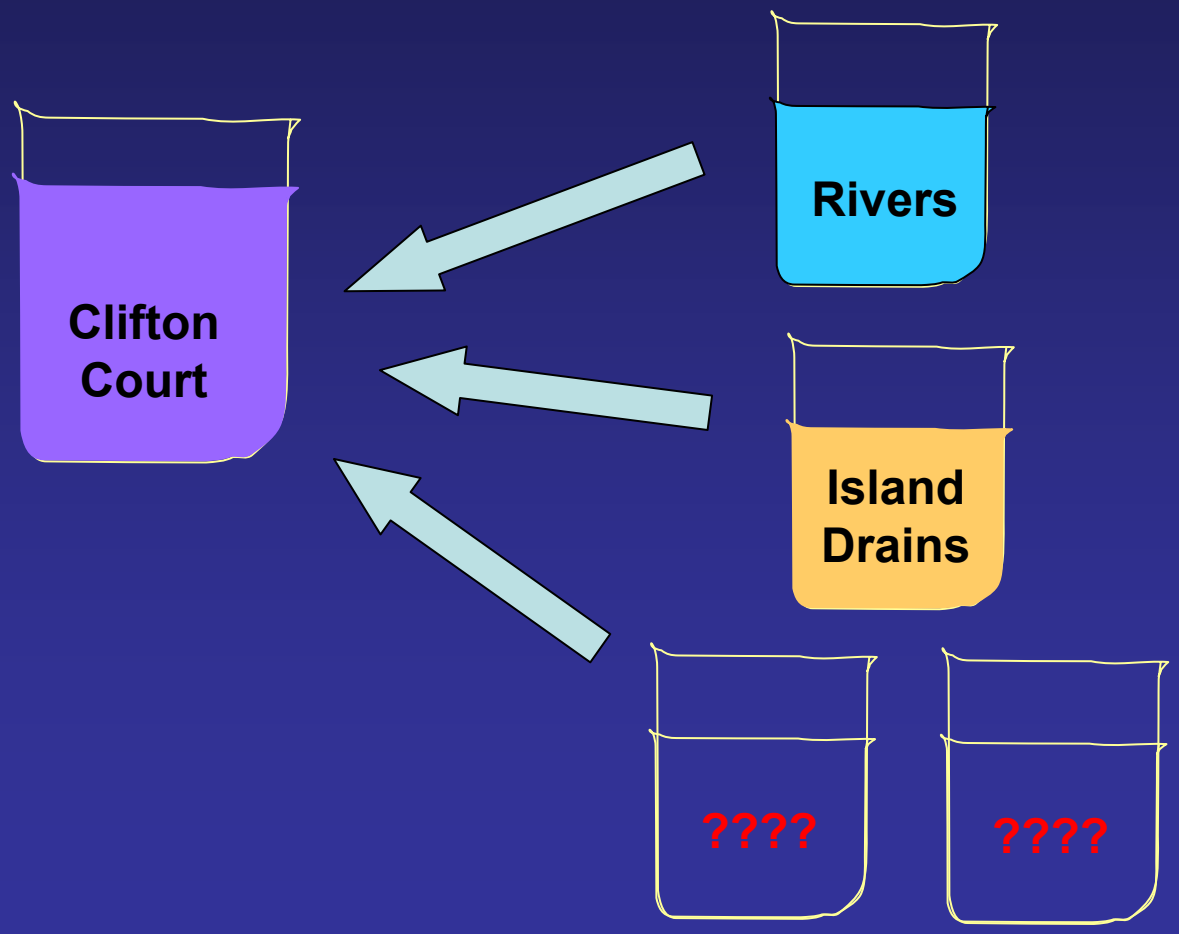
Clifton Court ≠ Rivers + Island Drains



Inspiration for this Study

DOC COMPOSITION:

Clifton Court = Rivers + Island Drains + ???



4 Main Delta Habitats

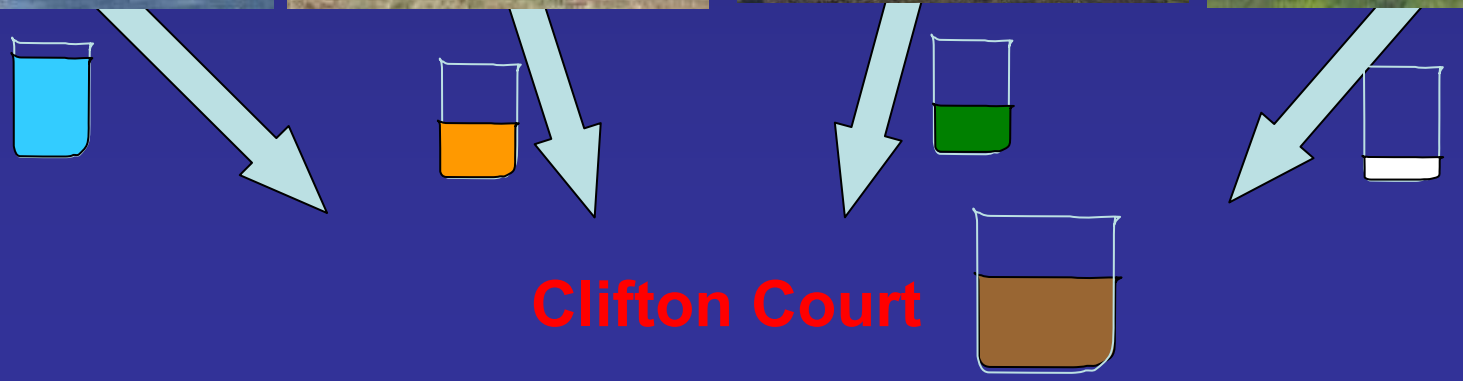
A Multi-Tracer Approach
DOC Composition

Rivers

Island Drains

Shallow Wetlands

Open Water



RELEVANCE of understanding sources of DOC to the Delta?

- Allow us to predict how land use changes will affect DOC dynamics.
- Particularly relevant with proposed large-scale wetland restoration.

Multi-Tracer Approach (Fingerprinting)

Conceptual Model

(A)

(B)

(C)

Multi-Tracer Approach (Fingerprinting)

Conceptual Model

(A) 4 Primary Sources of DOC to Clifton Court (CC)

Rivers – Sacramento and San Joaquin

Open Water Habitats – lake-like habitats, SAV

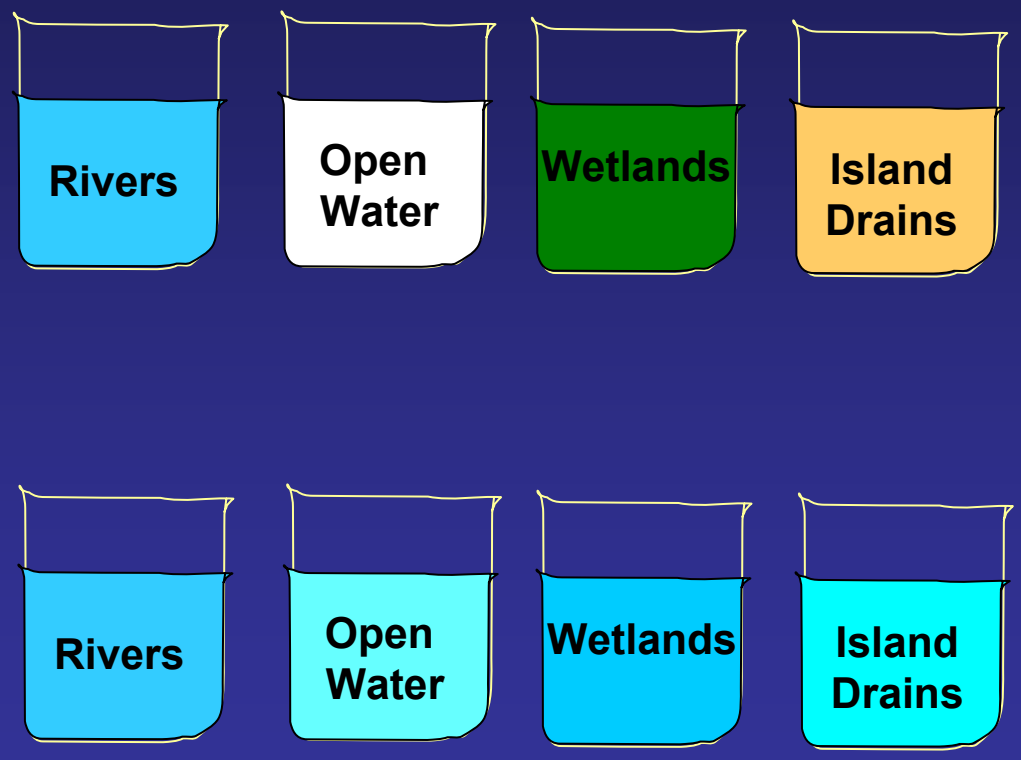
Shallow Wetlands – emergent vegetation

Island Drains – predominantly under agricultural production

Multi-Tracer Approach

Conceptual Model

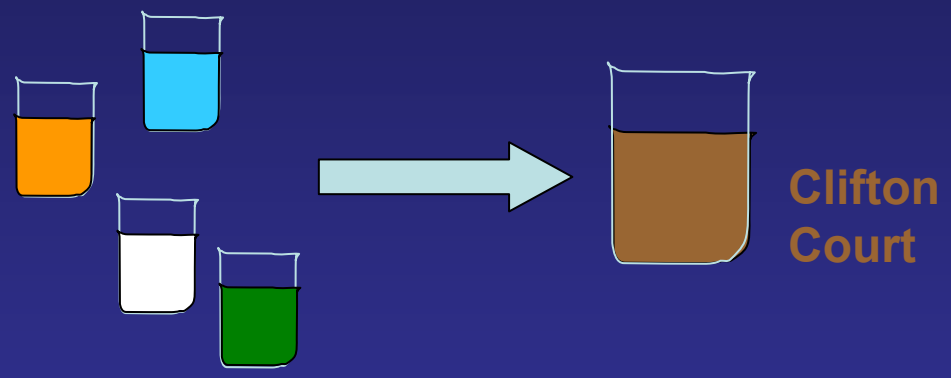
(B) DOC contributed by different sources have unique properties.
These properties are sufficiently conserved during transport.



Multi-Tracer Approach

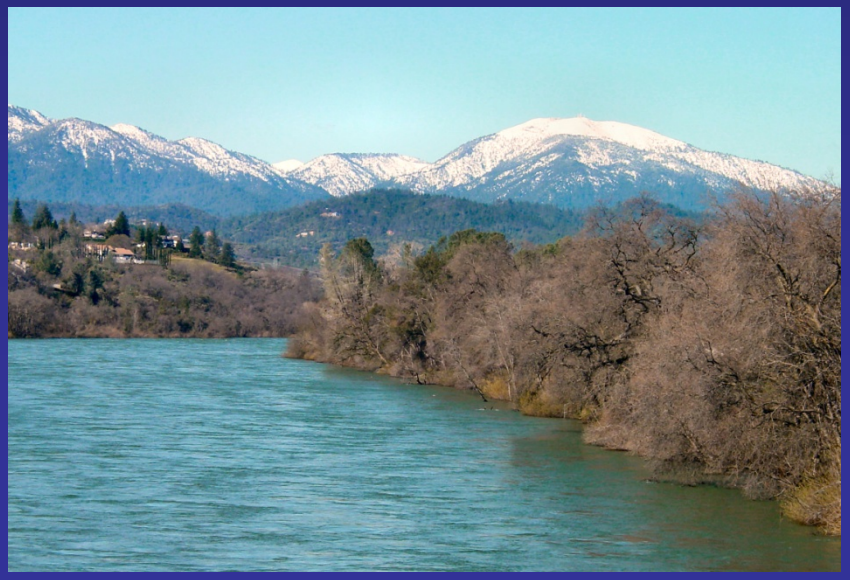
Conceptual Model

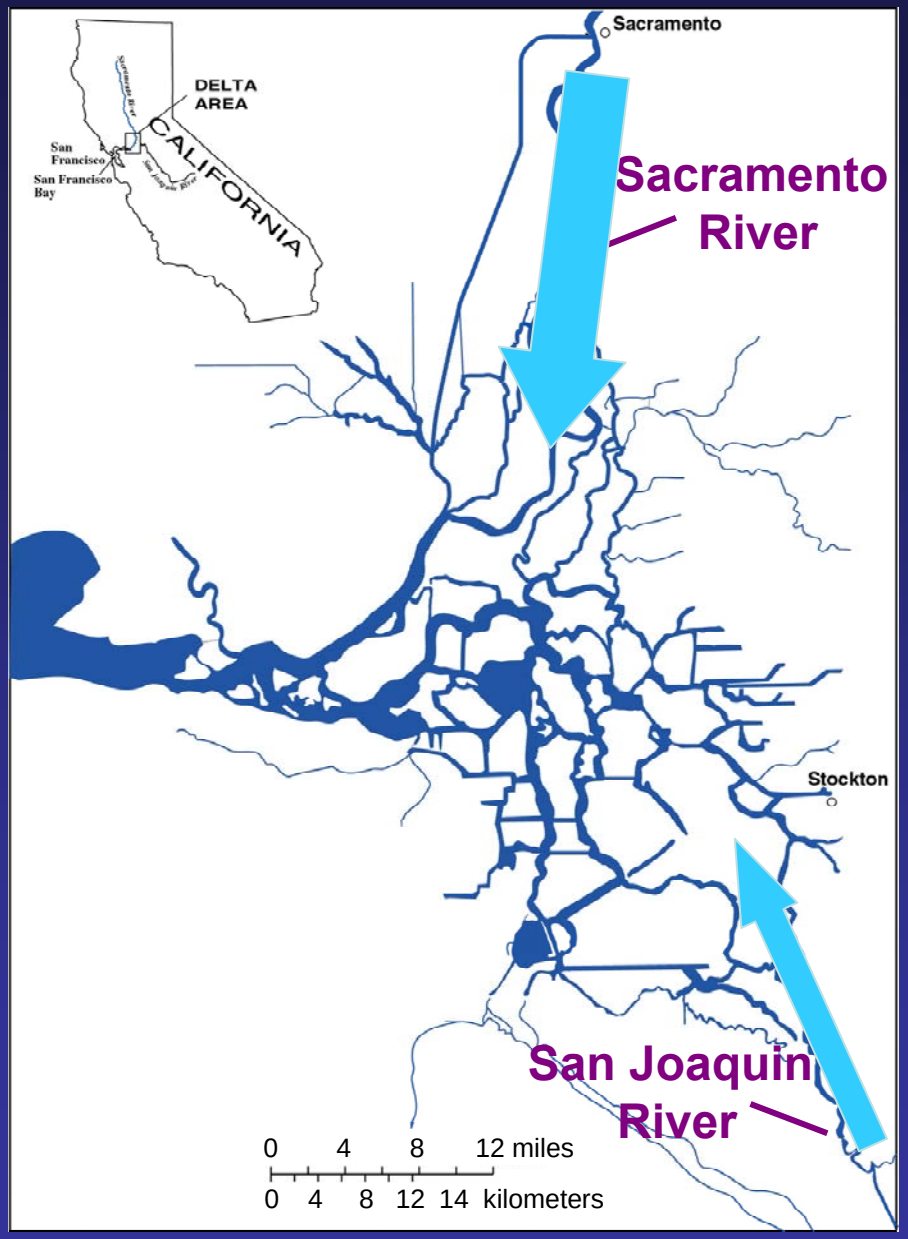
(C) We can use a simple linear mixing model to determine relative contributions of these four sources.



DOC Sources

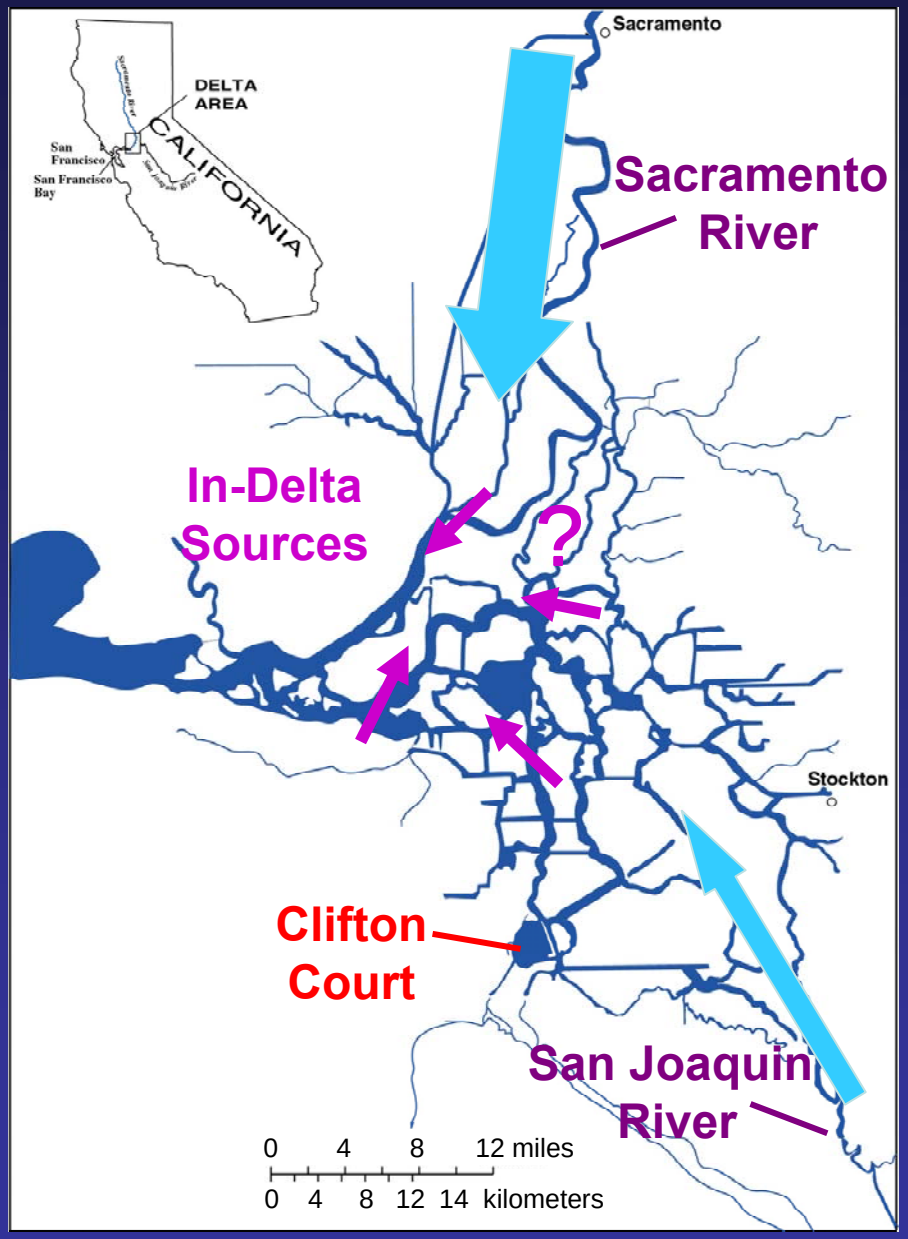
1. River Inflow





DOC Sources

1. River Inflow
2. In-Delta Inputs



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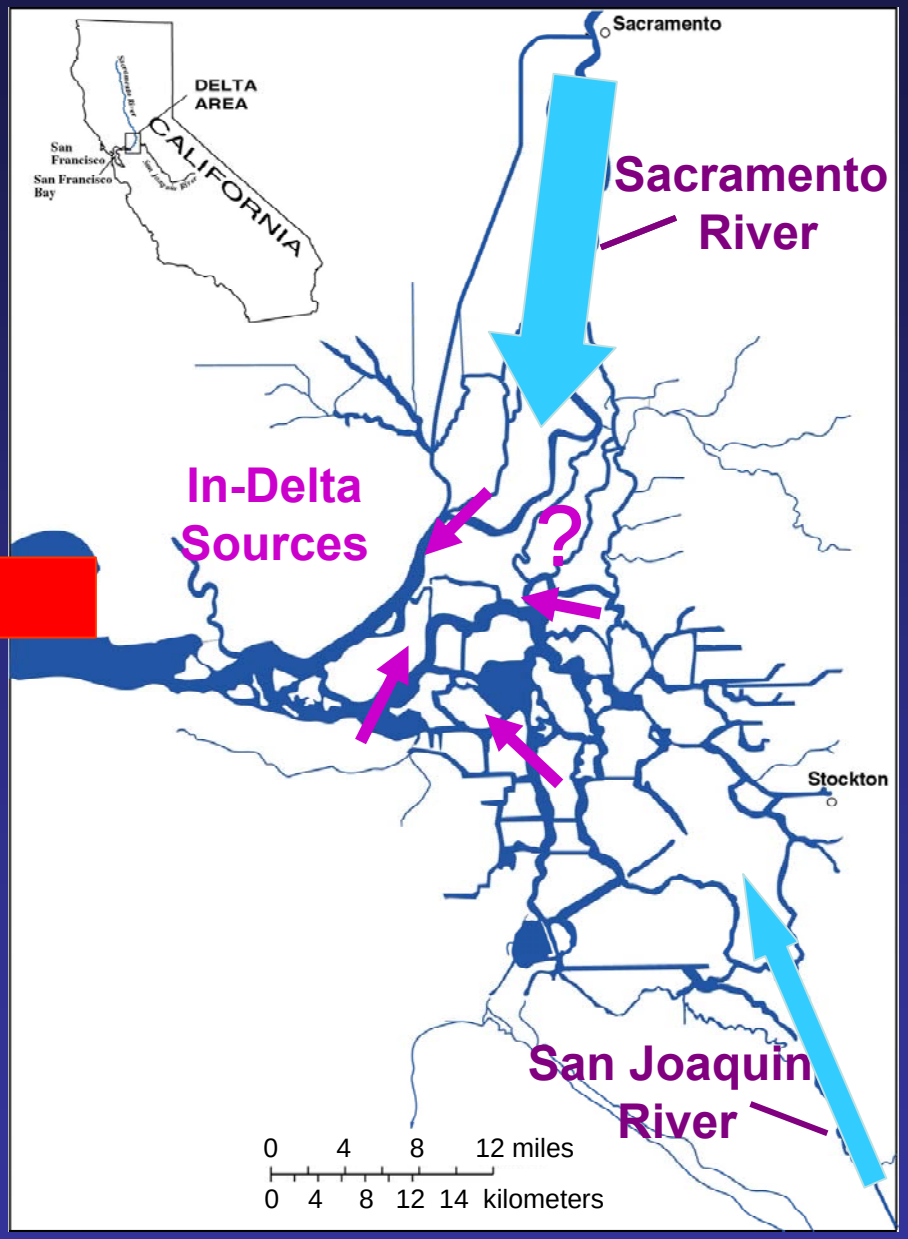
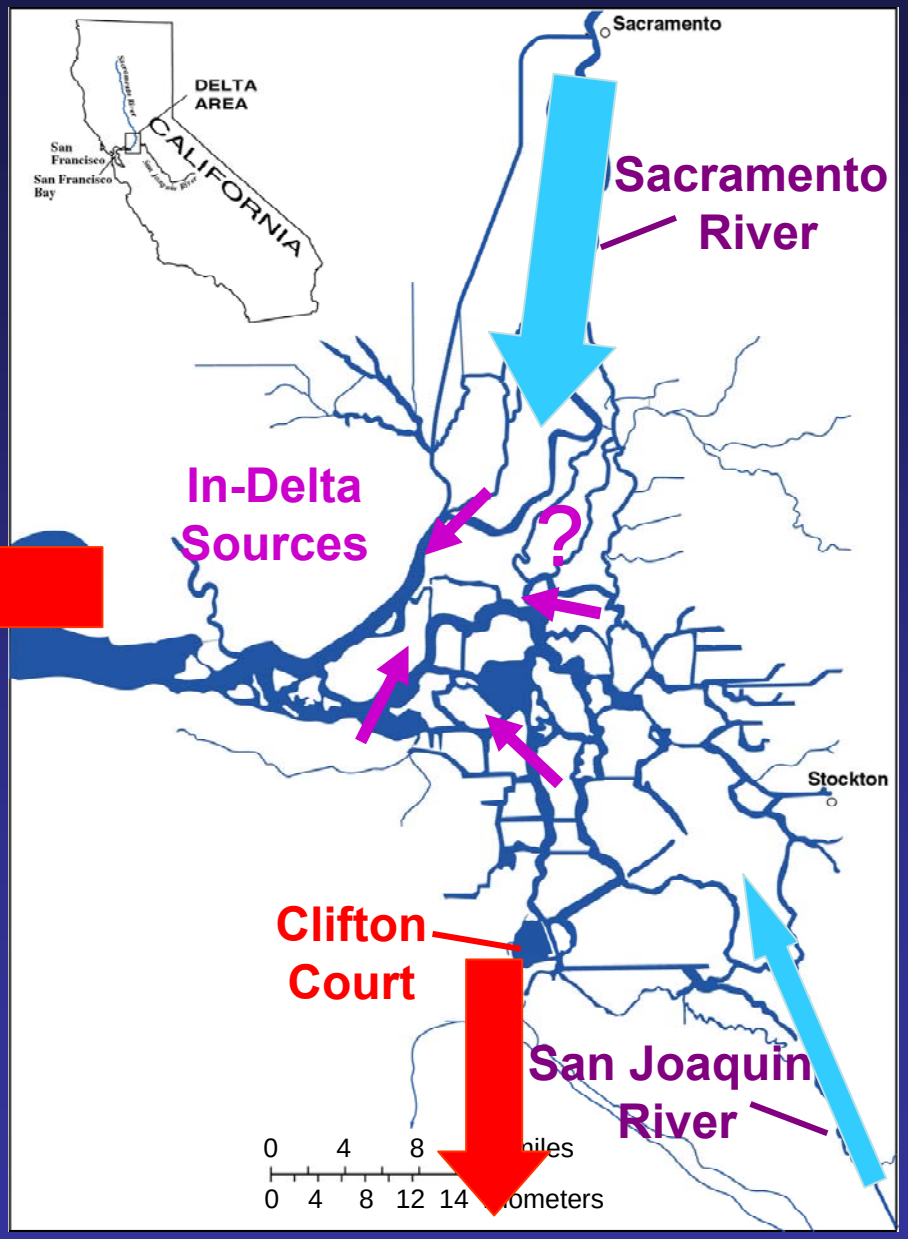


San Francisco Bay

DOC Sources


Sacramento
DELTA AREA
CALIFORNIA
San Francisco
San Francisco Bay
Sacramento River
In-Delta Sources
?
Stockton
Clifton Court
San Joaquin River
0 4 8
0 4 8 12 14

California Aqueduct

Experimental Design

<u>11 Sampling Stations; 6 dates</u>

1. Sacramento River
2. San Joaquin River

Inflows

3. Clifton Court

Export Pumps

4. Prisoners Point

Central Channel

5. Frank's Tract
6. Mildred Island

Open Water

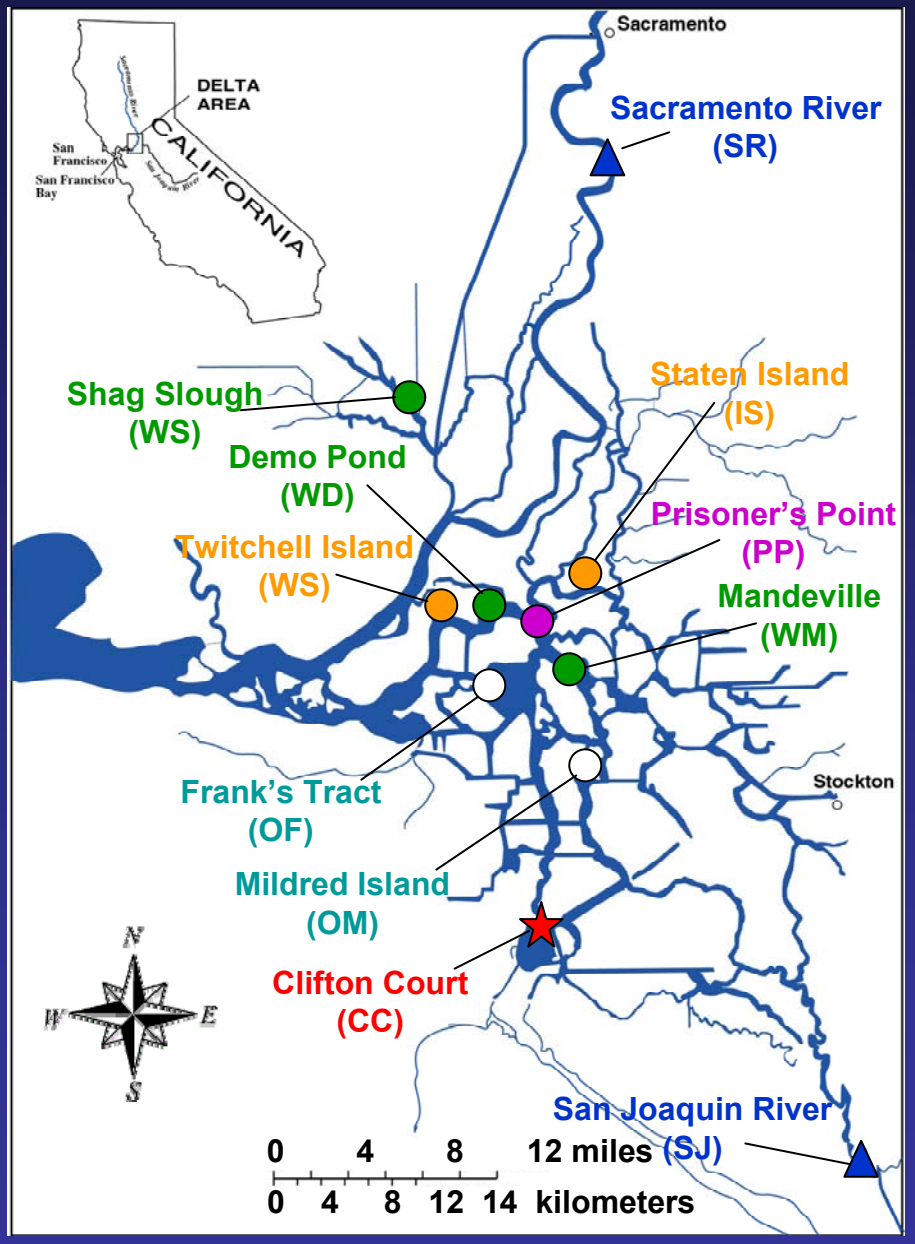
7. Mandeville Tip
8. Shag Slough
9. Demo Pond

Shallow Wetlands

10. Twitchell
11. Staten

Island Drains

6 Dates



Specific Questions

DOC CONCENTRAION

1) **How much DOC is added by the Delta as a whole vs. incoming rivers?**

2) **Is DOC added by specific Delta habitats?**
   - Open Water
   - Shallow Wetlands
   - Island Drains

DOC COMPOSITION

3) **What is the character of the added DOC?**
   - What can this tell us about specific DOC sources?
   - How does this affect DBP precursor content?

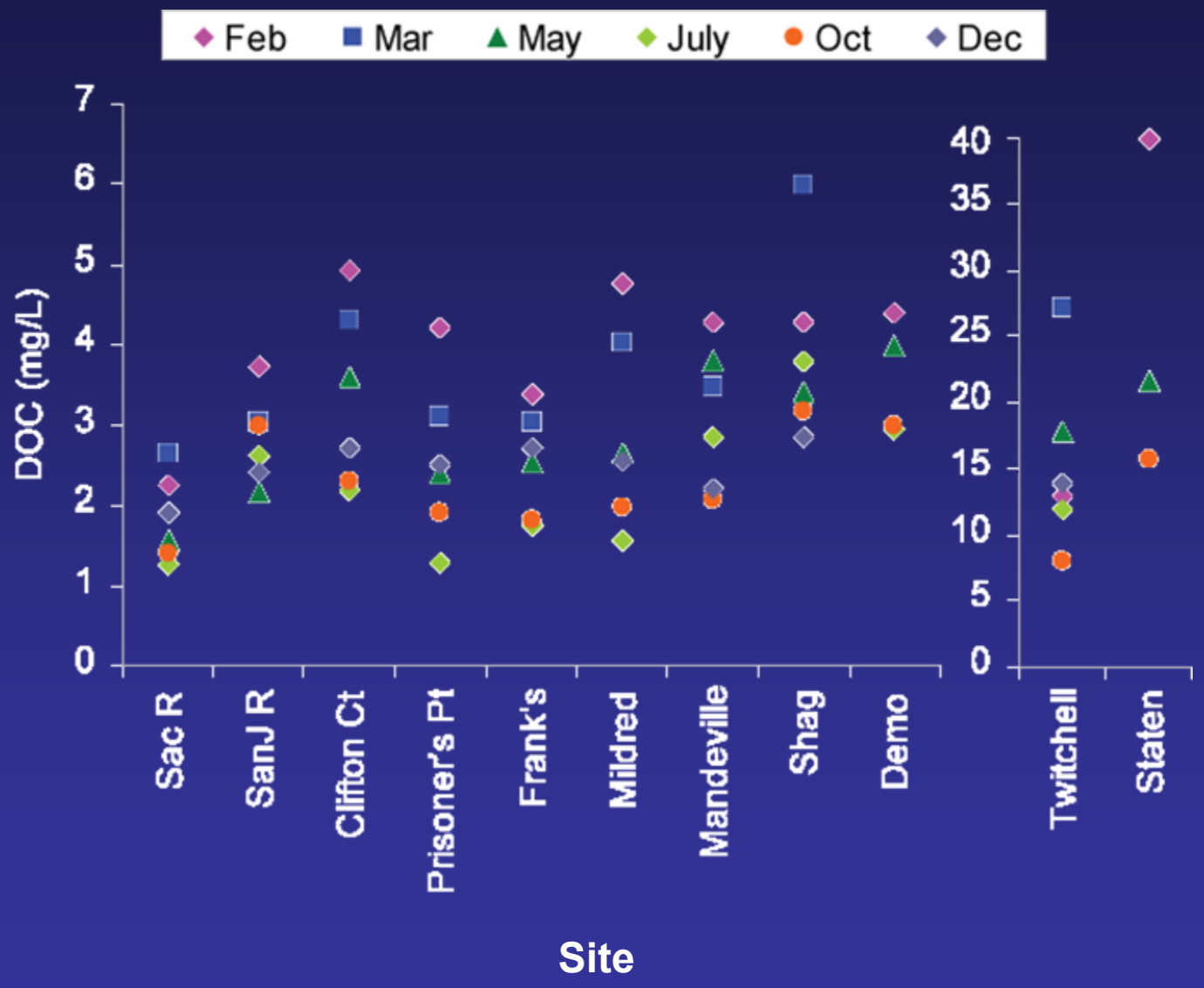
MULTI-TRACER APPROACH

4) **What are the relative contributions from rivers, wetlands, open water, and island drains to DOC arriving at Clifton Court for export into the State Water Project?**

RESULTS

1. **DOC CONCENTRATION**
2. **DOC COMPOSITION**

DOC Concentration by Site and Date



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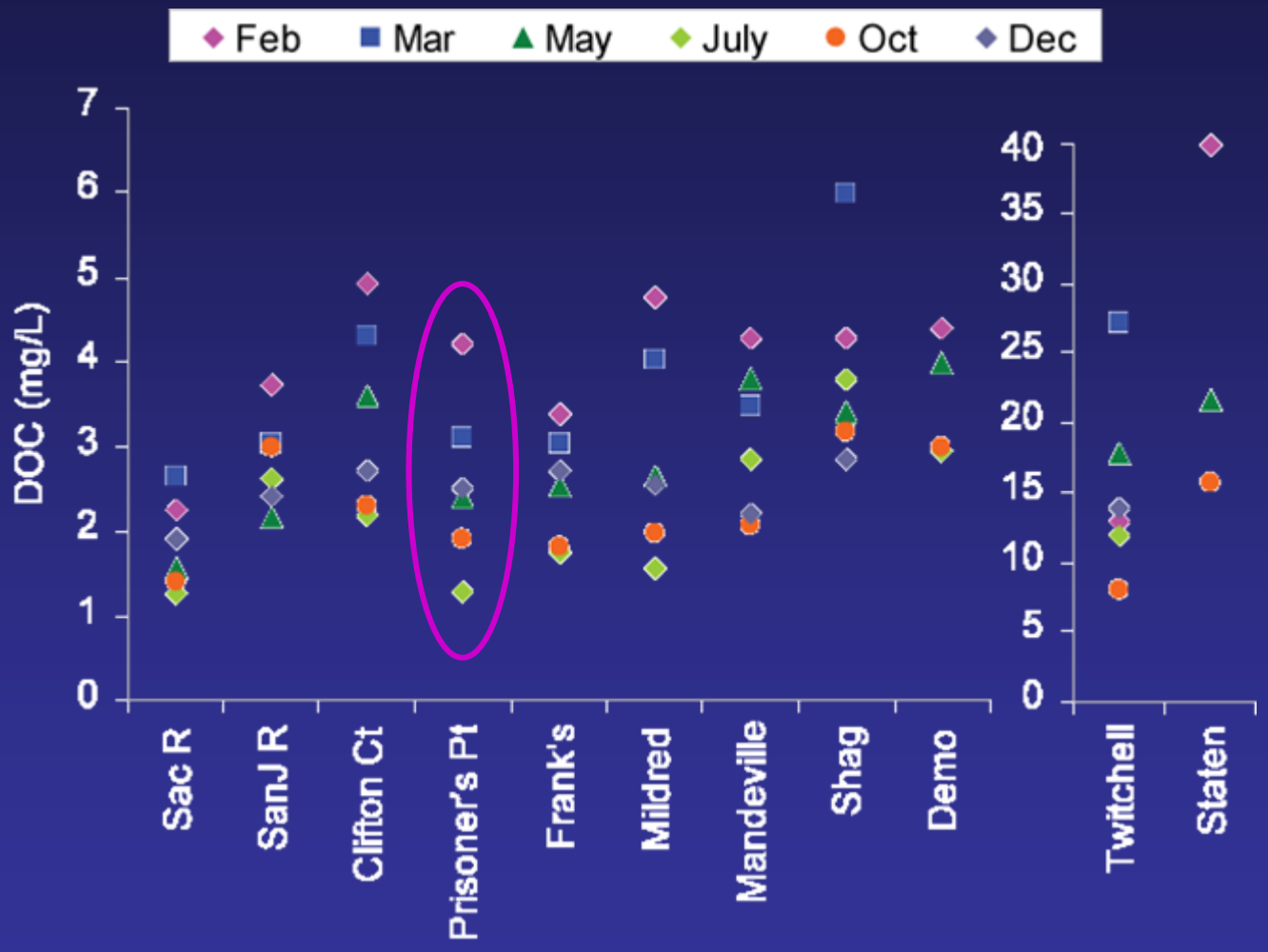

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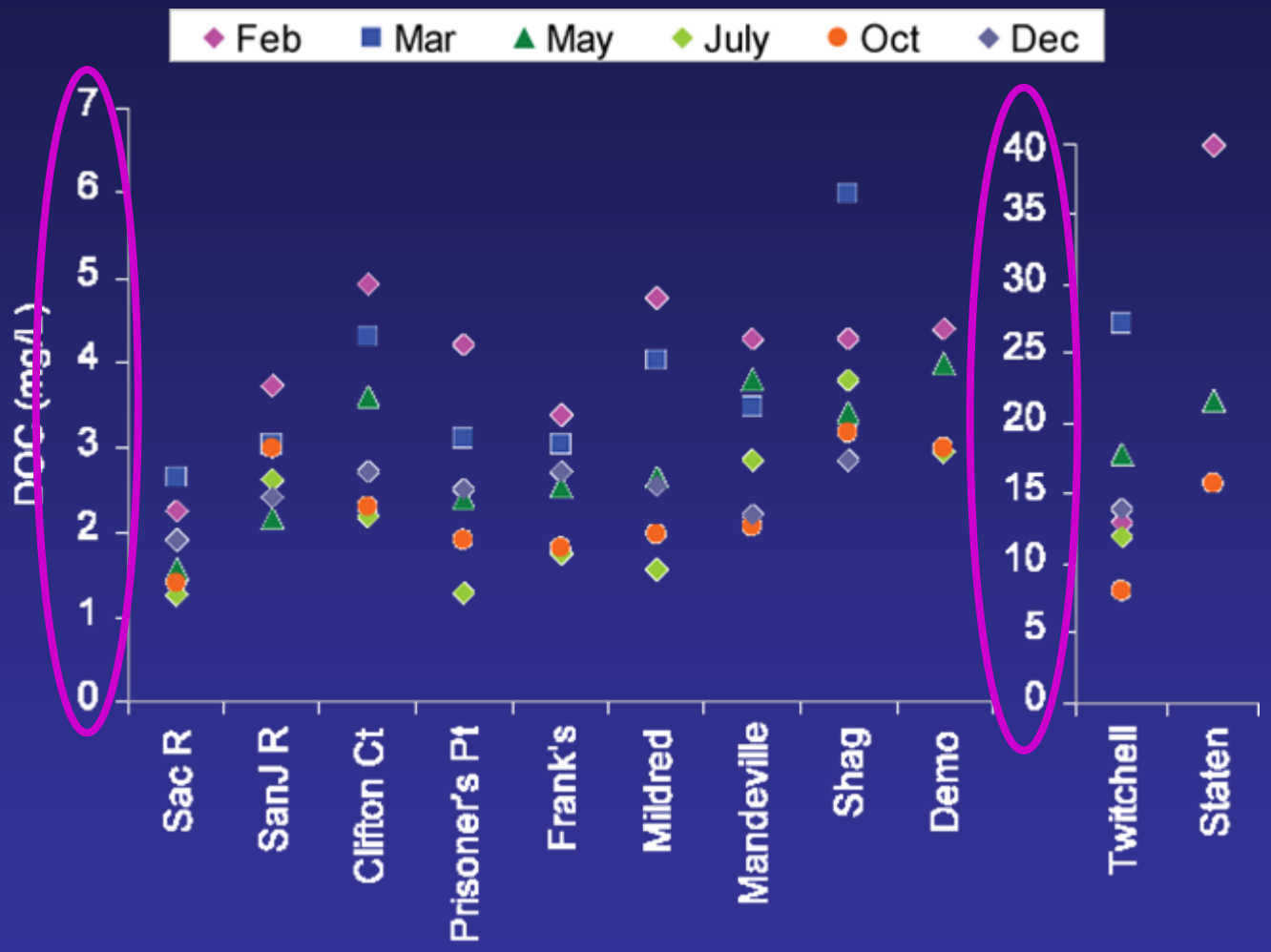

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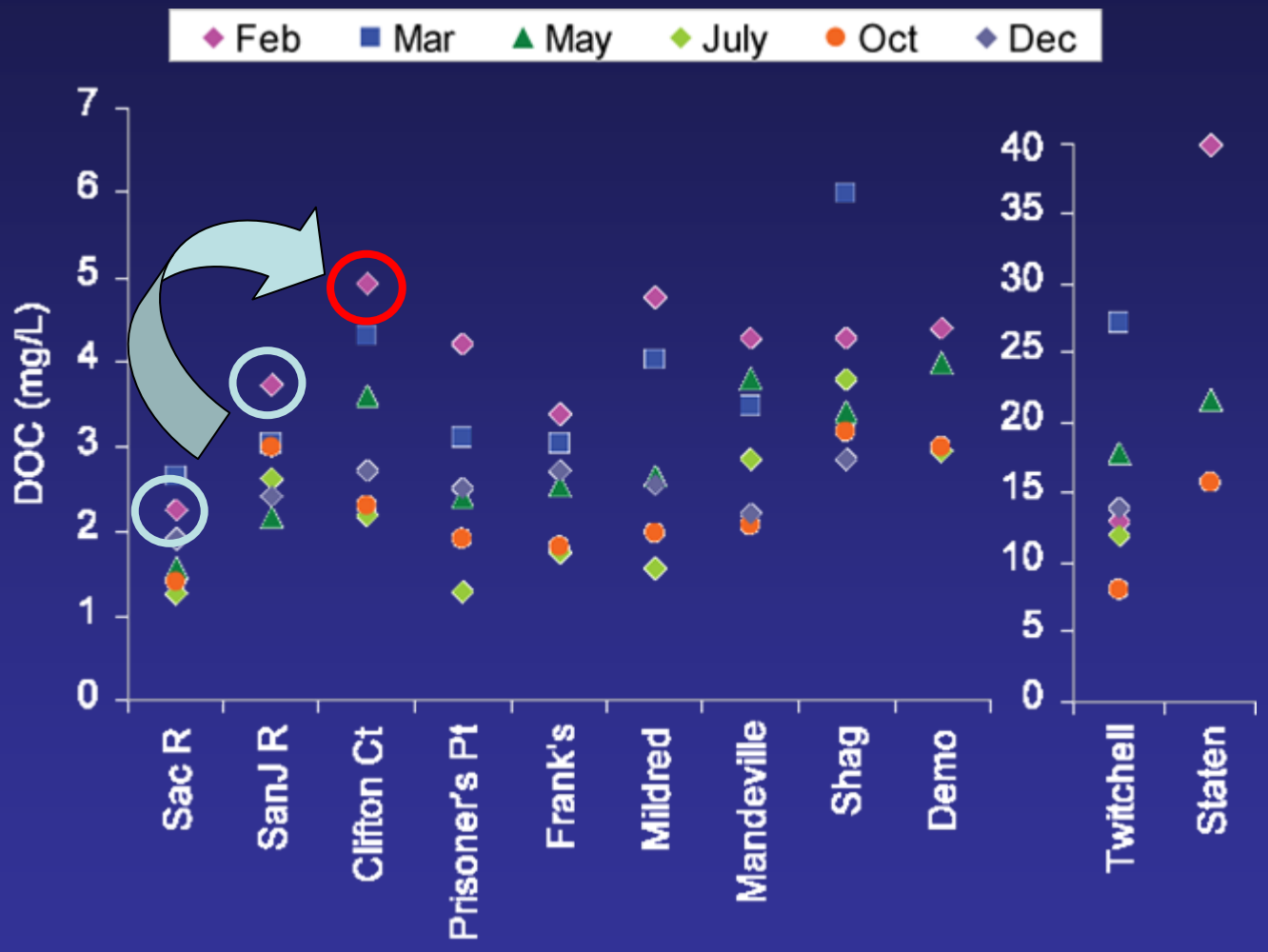
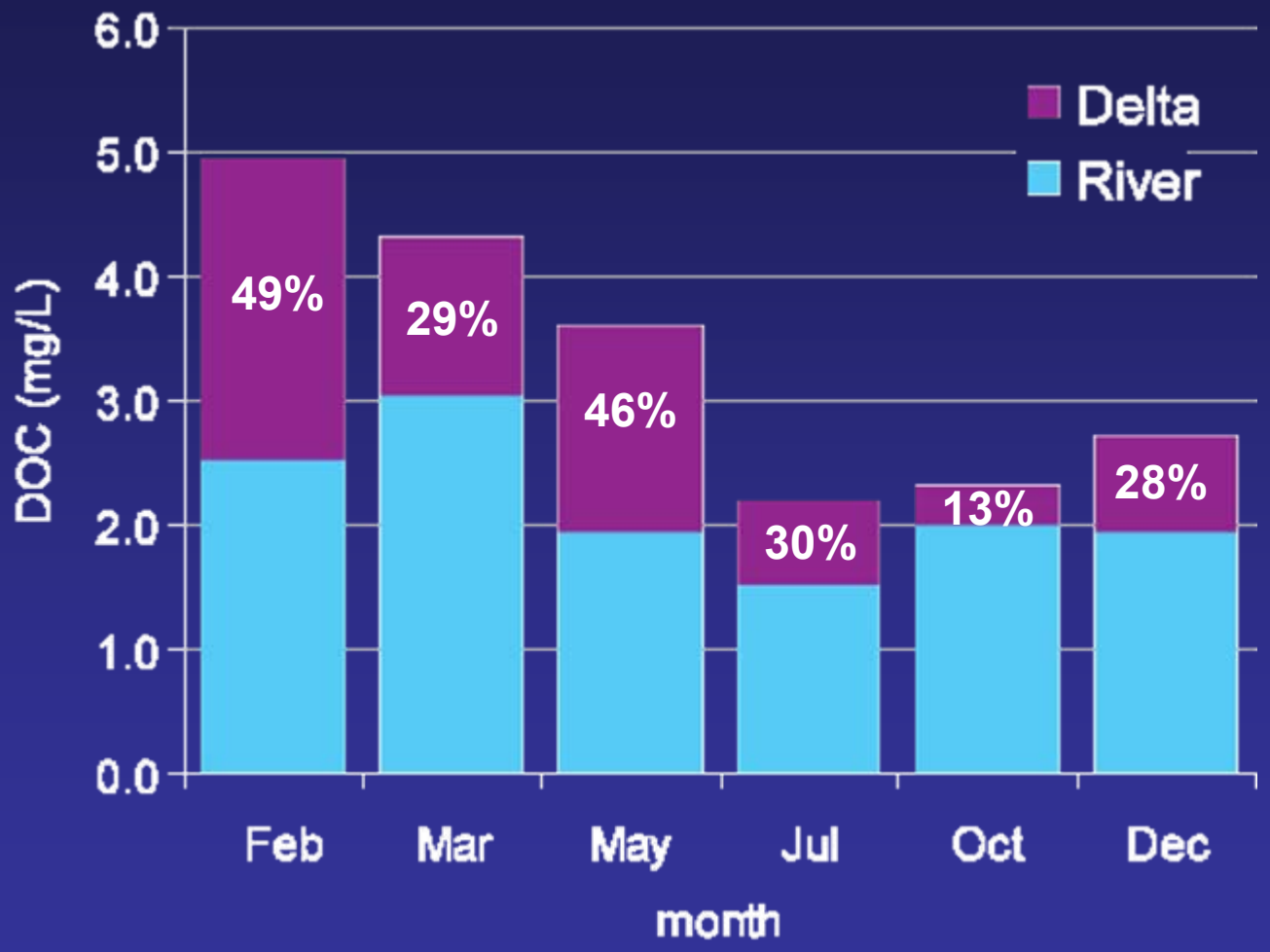


Rivers and Total Delta DOC Contributions to Clifton Court



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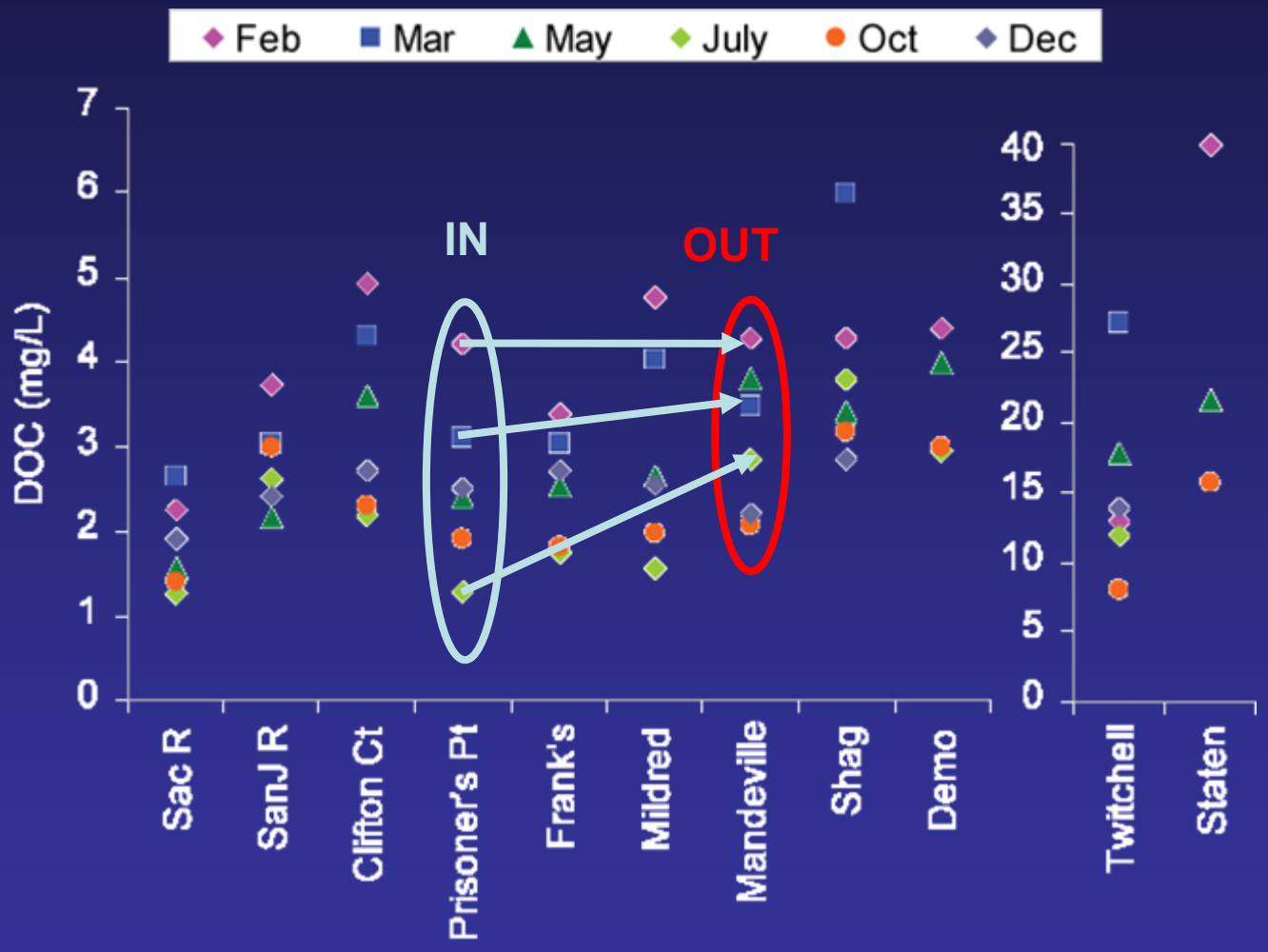
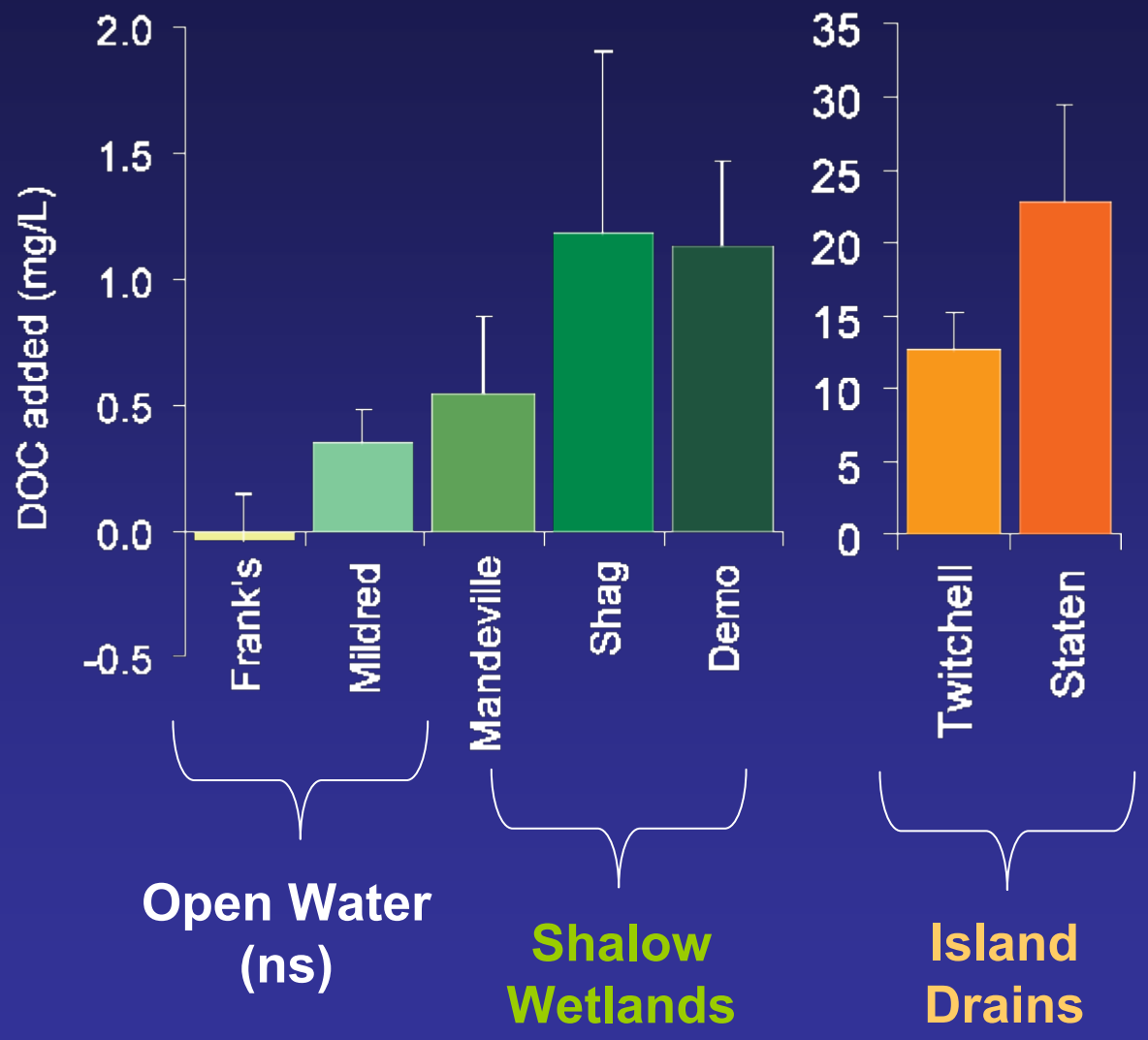


Changes in DOC Concentration



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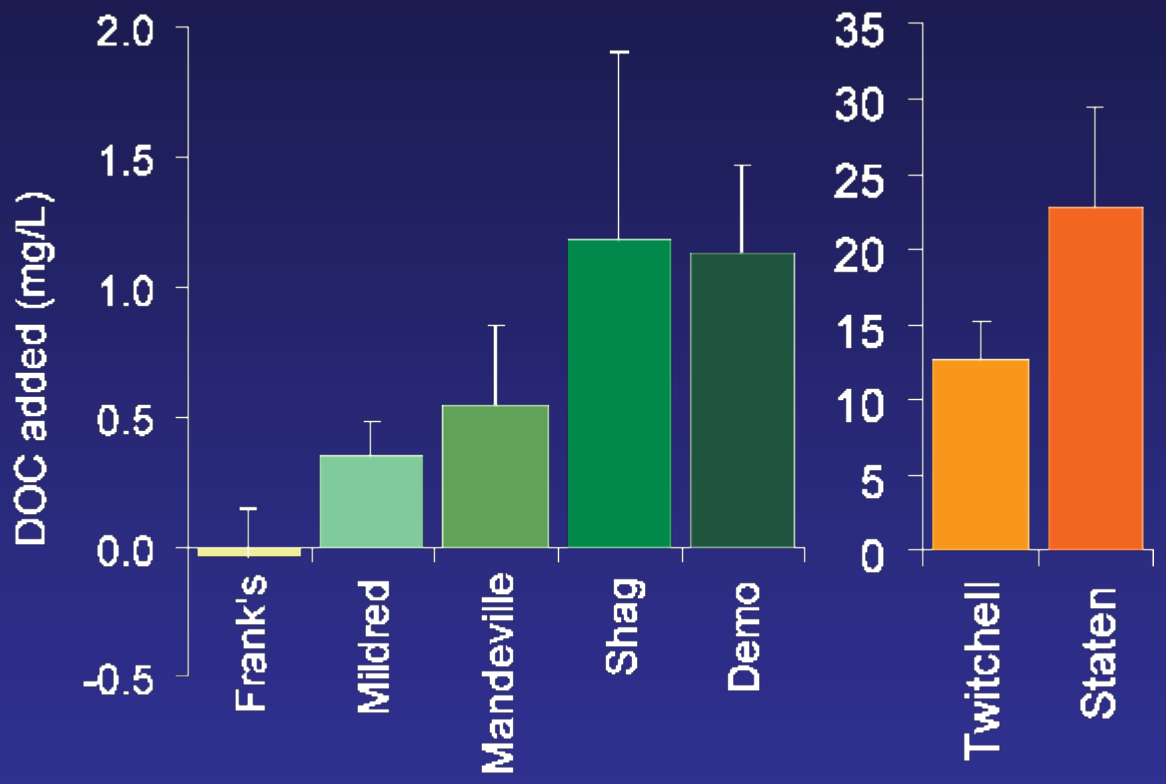


LOADING = CONC x VOL
(mg) (mg/L) (L)

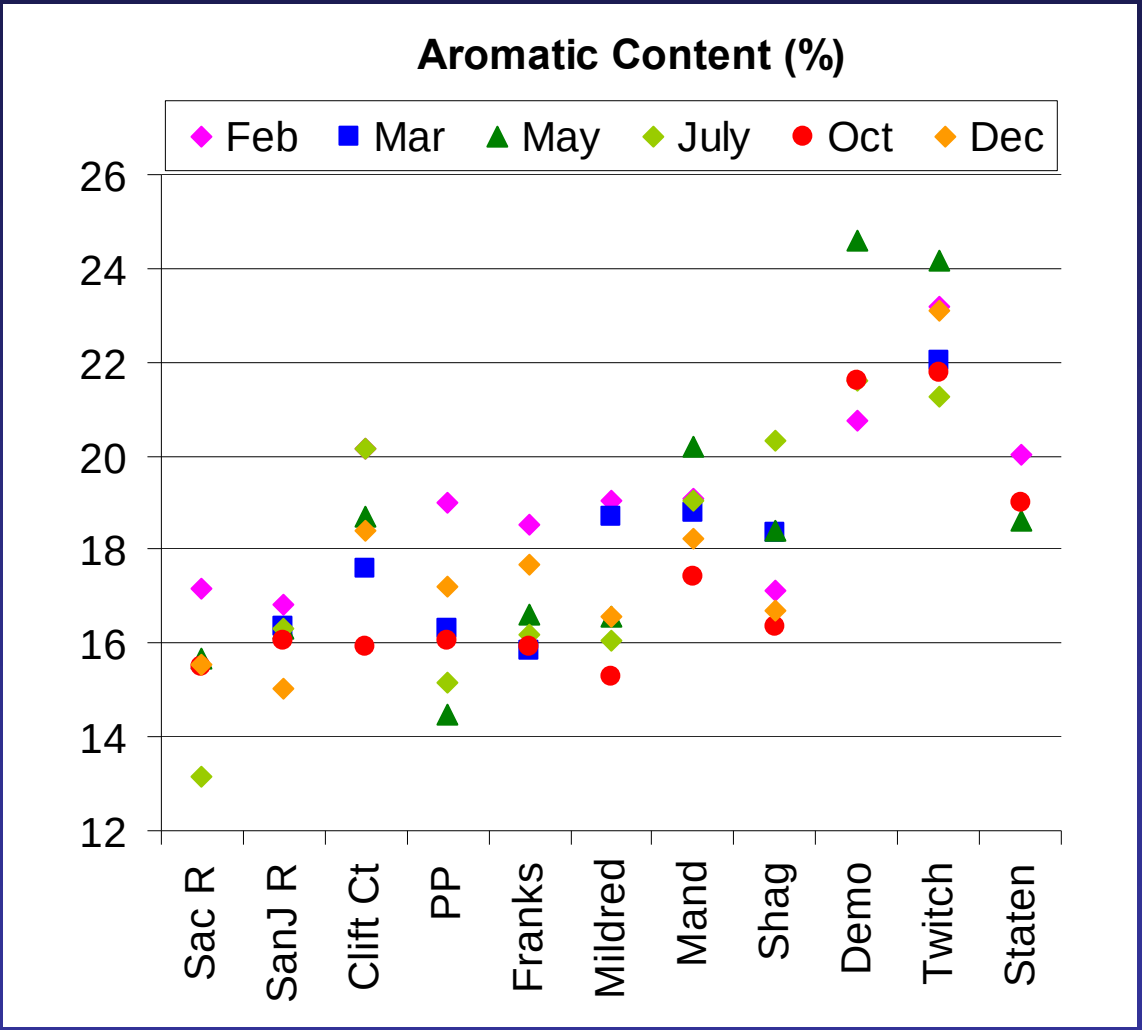
????

DOC Composition

DOC Composition

Variable Group	Parameter	Description
lability	% bioavailable*	measure of DOC lability
isotopic	C:N*	ratio of C to N
	d13C	reflective of DOC source
	d15N	reflective of DOC source
lignin	λ8	measure of lignin content per unit of DOC
	C:V	ratio of cinnamyl to vanillyl phenols
	S:V	ratio of syringyl to vanillyl phenols
structural	% Aliphatic	structural information
	% Heteroaliphatic	structural information
	% Anomeric	structural information
	% Aromatic	structural information
	% Carboxyl*	structural information
	% Ketone*	structural information
absorbance	SUVA 254	reflective of aromatic content
fluorescence (ex/em)	B: 270/310	tyrosine-like, protein-like
	T: 260/340	tryptophan-like, protein-like
	A: 260/450	humic-like
	M: 300/390*	humic-like, possibly marine
	C: 330/445	humic-like
	D: 370/500	soil fulvic acid
	E: 450/521	soil fulvic acid
	N: 280/370	indicative of phytoplankton derived, labile material
	Fluorescence Index (FI)	higher values indicate algal vs. terrestrial derrived DOC
DBPFP	STHMFP	measure of THM precursor content
	SHAAFP	measure of HAA precursor content

DOC Composition: Individual Parameters



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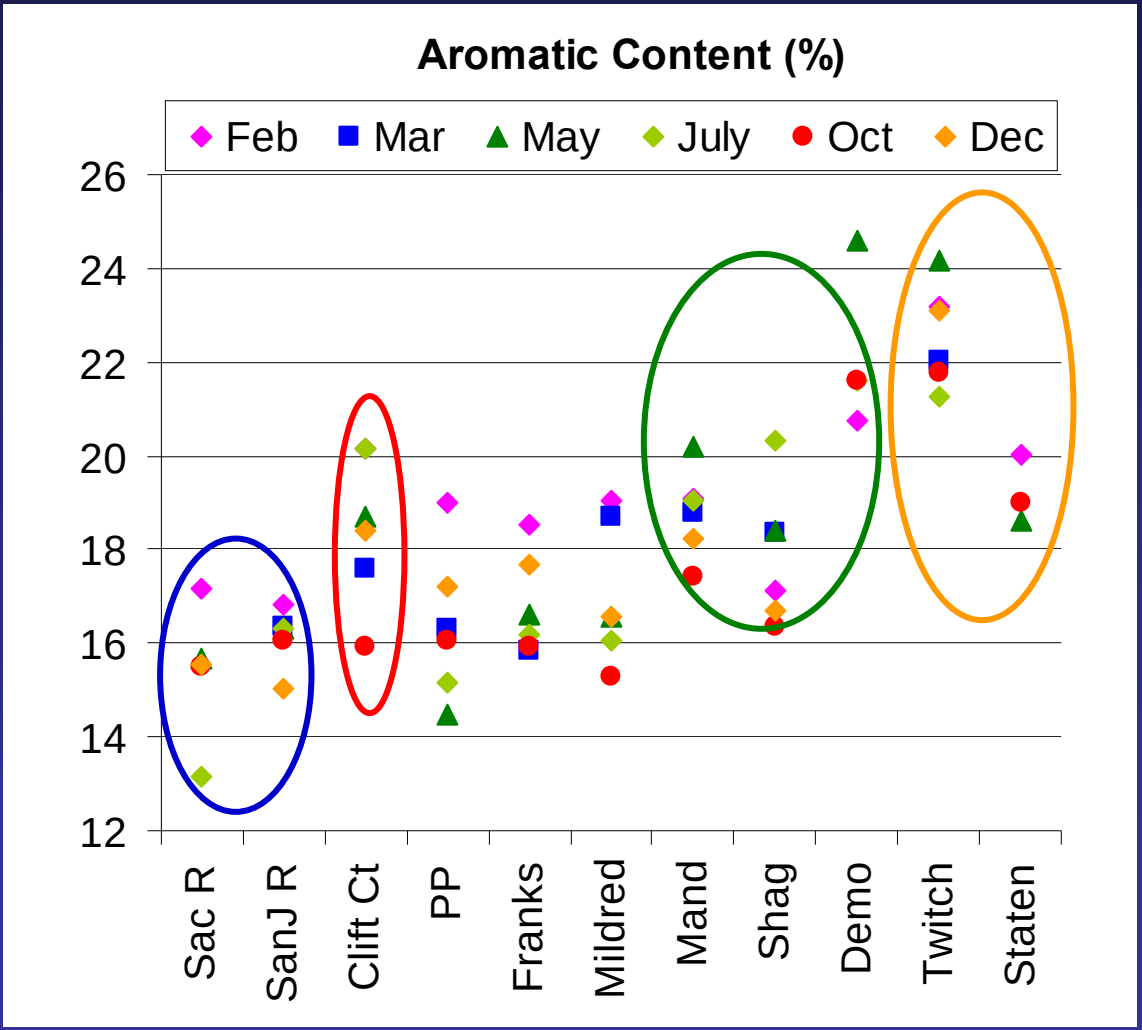
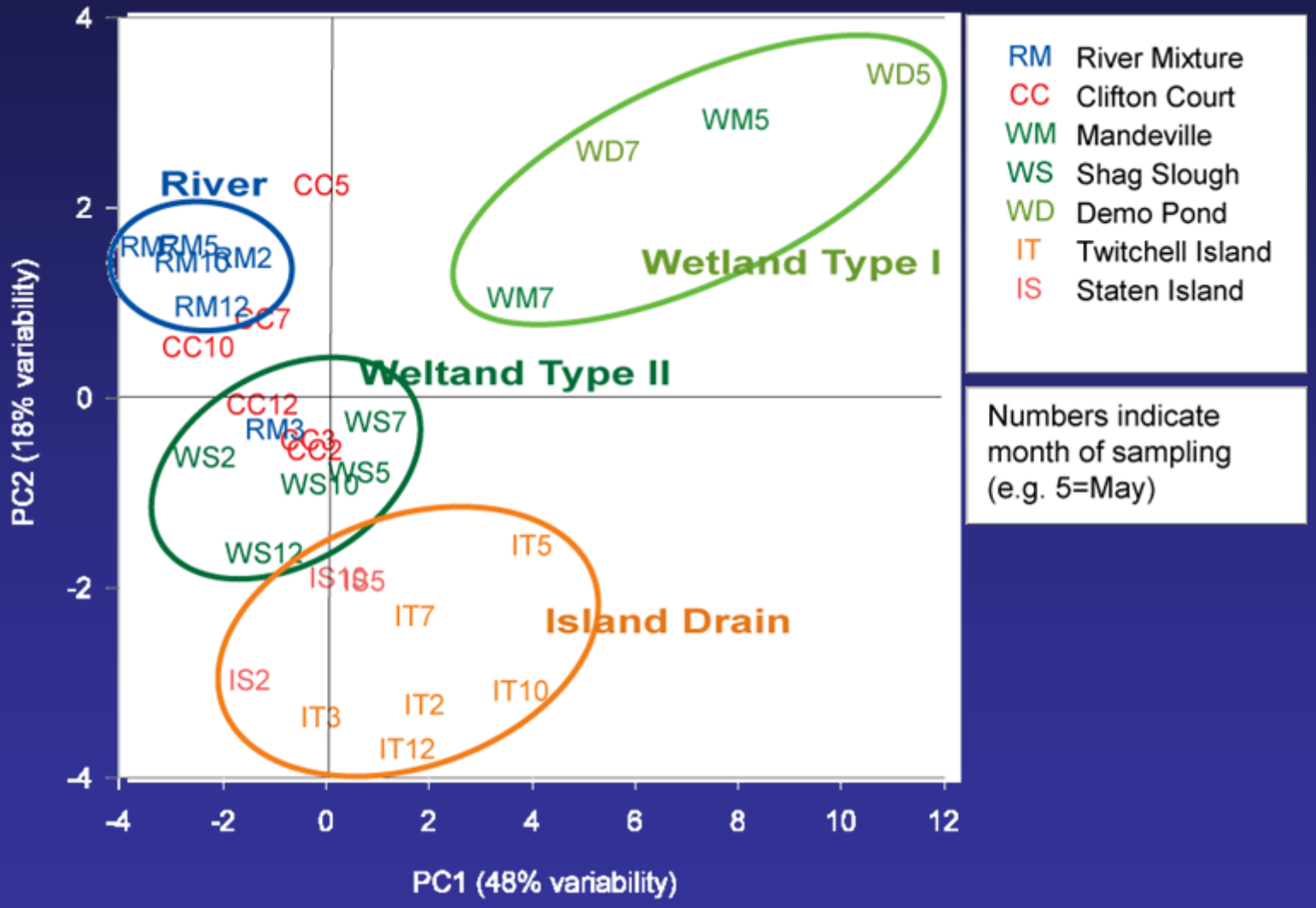


DOC Fingerprint

Principle Component Analysis (PCA)



Conceptual Model

Multi-Tracer Approach

(A) 4 Primary Sources of DOC to Clifton Court (CC)

Rivers – Sacramento and San Joaquin
Open Water Habitats – lake-like habitats, SAV
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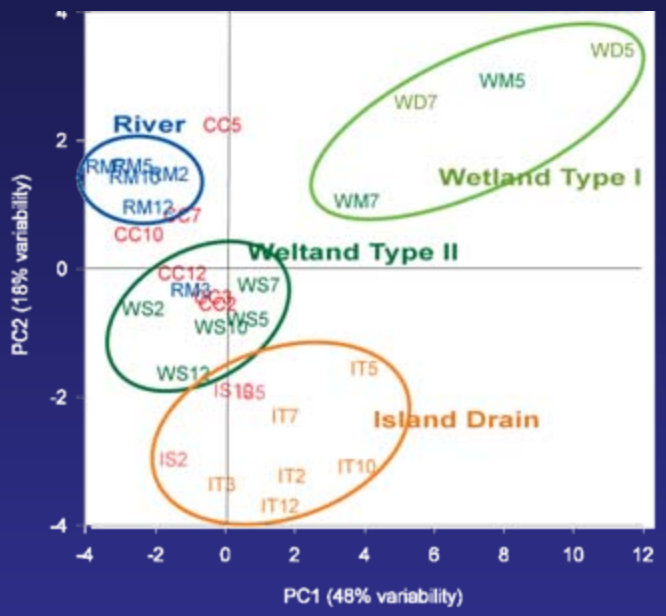
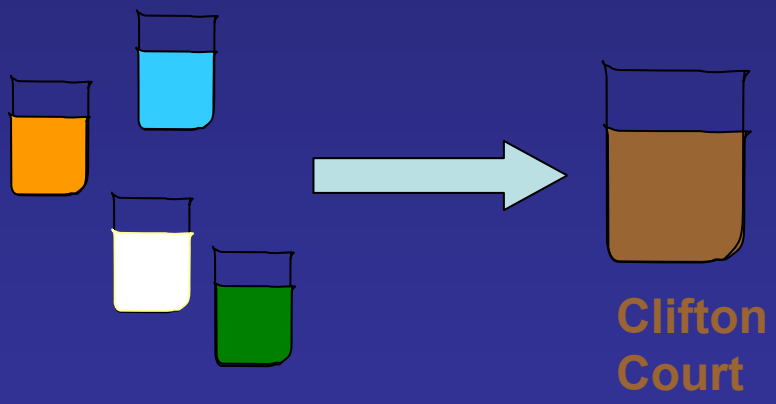


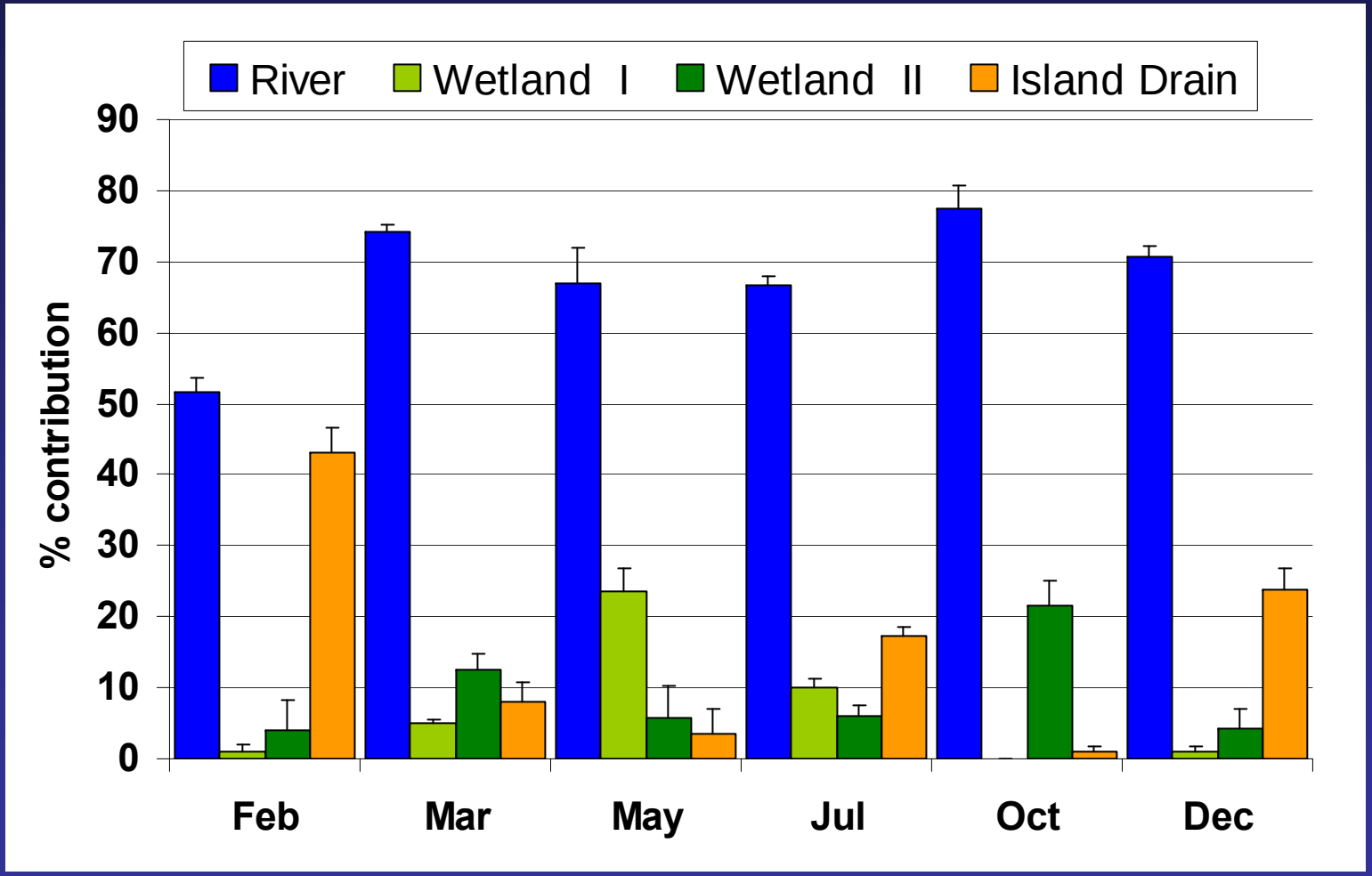
simple linear mixing model

$$\Sigma P_{CC} = \Sigma f_R P_R + \Sigma f_W P_W + \Sigma f_D P_D$$



Relative DOC Contributions to Clifton Court

Linear Mixing Model Results



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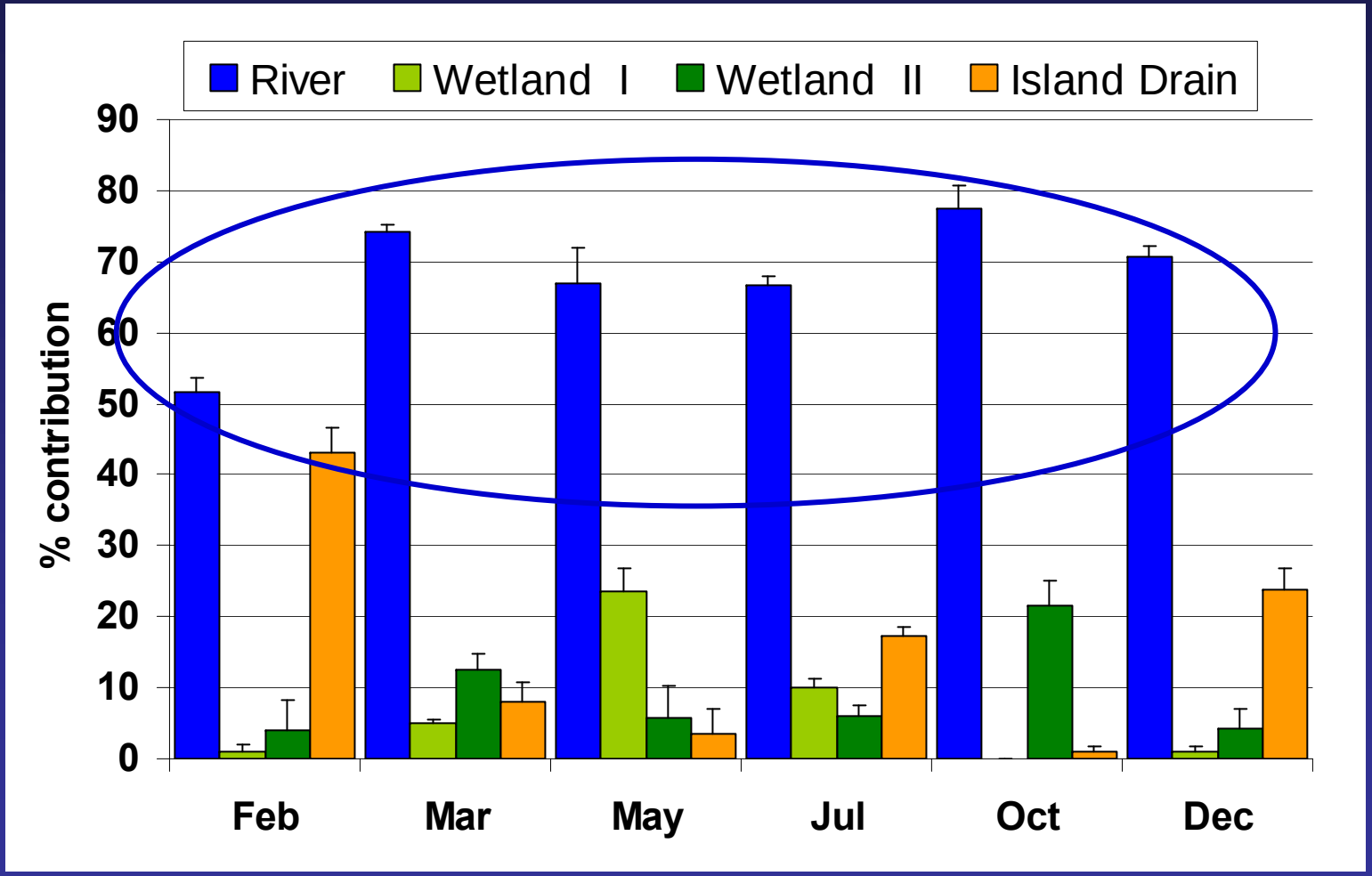

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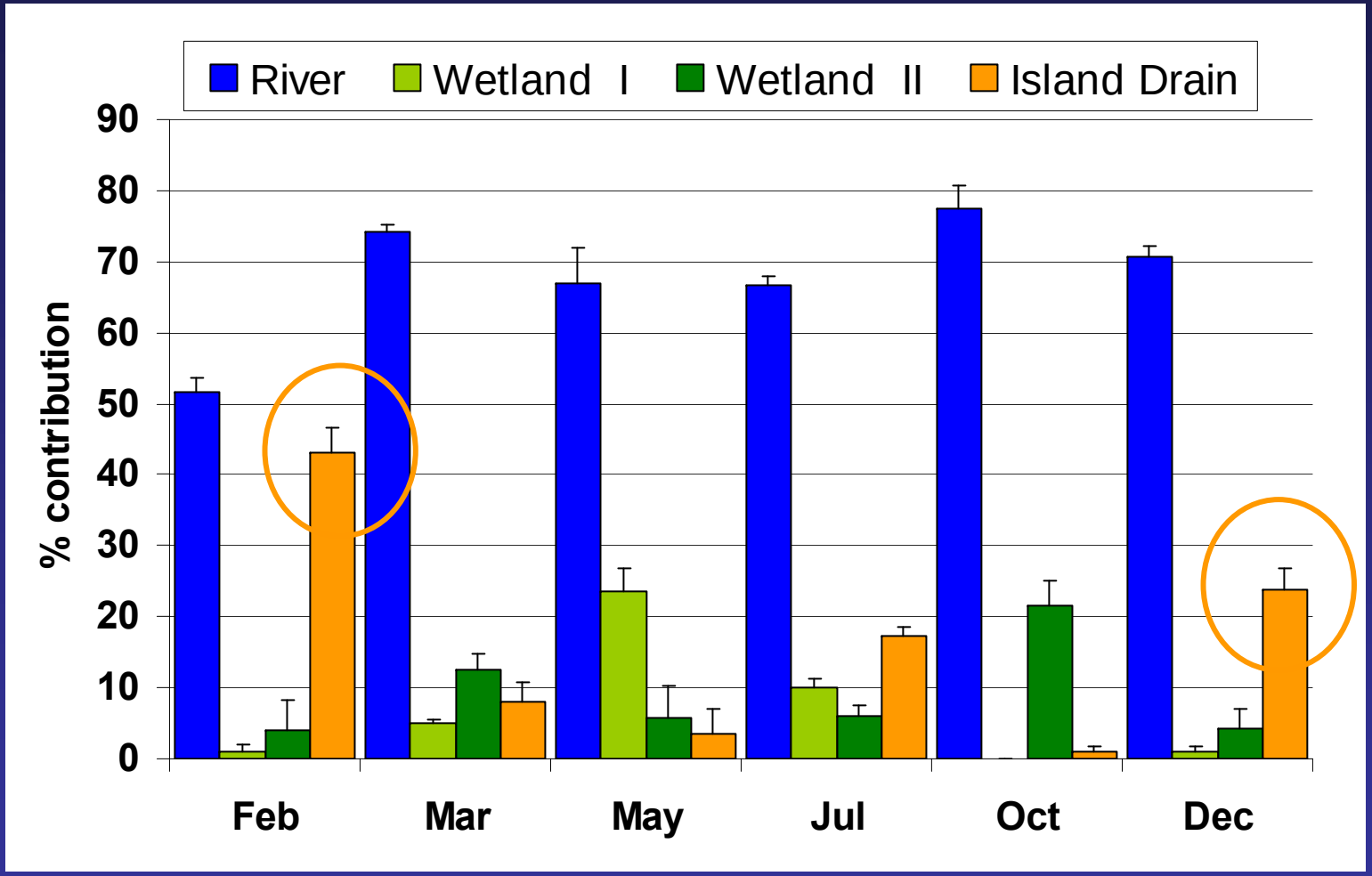

Major Findings
DOC Contributions

Delta As a Whole

- significant source of DOC (10-50%)

Island Drains

- predominantly in the winter.
- high propensity to form HAAs

Wetlands

- mainly the spring/summer
- potential to add DOC with high propensity to form THMs and HAAs

Open Water

- little effect on concentration and composition

Implications for Wetland Restoration

- Wetland restoration has the potential to negatively impact water quality by adding DOC to the Delta, particularly in spring and summer.

- **NOT ALL WETLANDS ARE THE SAME!**
  amount and composition

- Need to understand how wetland configuration affects DOC export
  - Channel Connectivity
  - Hydrologic flow path
  - Flow-through rate
  - Water depth
  - Vegetation
  - Soil type

- Addition of wetland derived DOC may be attenuated by natural processes such as bio and photo degradation.

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Conclusions

- Changes in land use are likely to significantly affect the amount, quality and timing of in-Delta DOC contributions.

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Summary questions

- Are Delta Island drains bad?
- Are wetlands bad?
- Are ag lands bad?
- Are natural uplands bad?
- Are cities bad?

Take-home points

- All organic carbon is not the same.
- There are many sources of organic carbon.
- Organic carbon is reactive in the environment.
- Organic carbon supply and quality changes by season, source, and location
- The benefits and problems with organic carbon depend on specifics of the site
- Organic carbon is not inert – it is modified and consumed quickly in the environment.

THANKS !