Unraveling sources of food web support in the Sacramento-San Joaquin Delta's marsh ecosystems

Using fatty acid biomarkers and multiple stable isotopes

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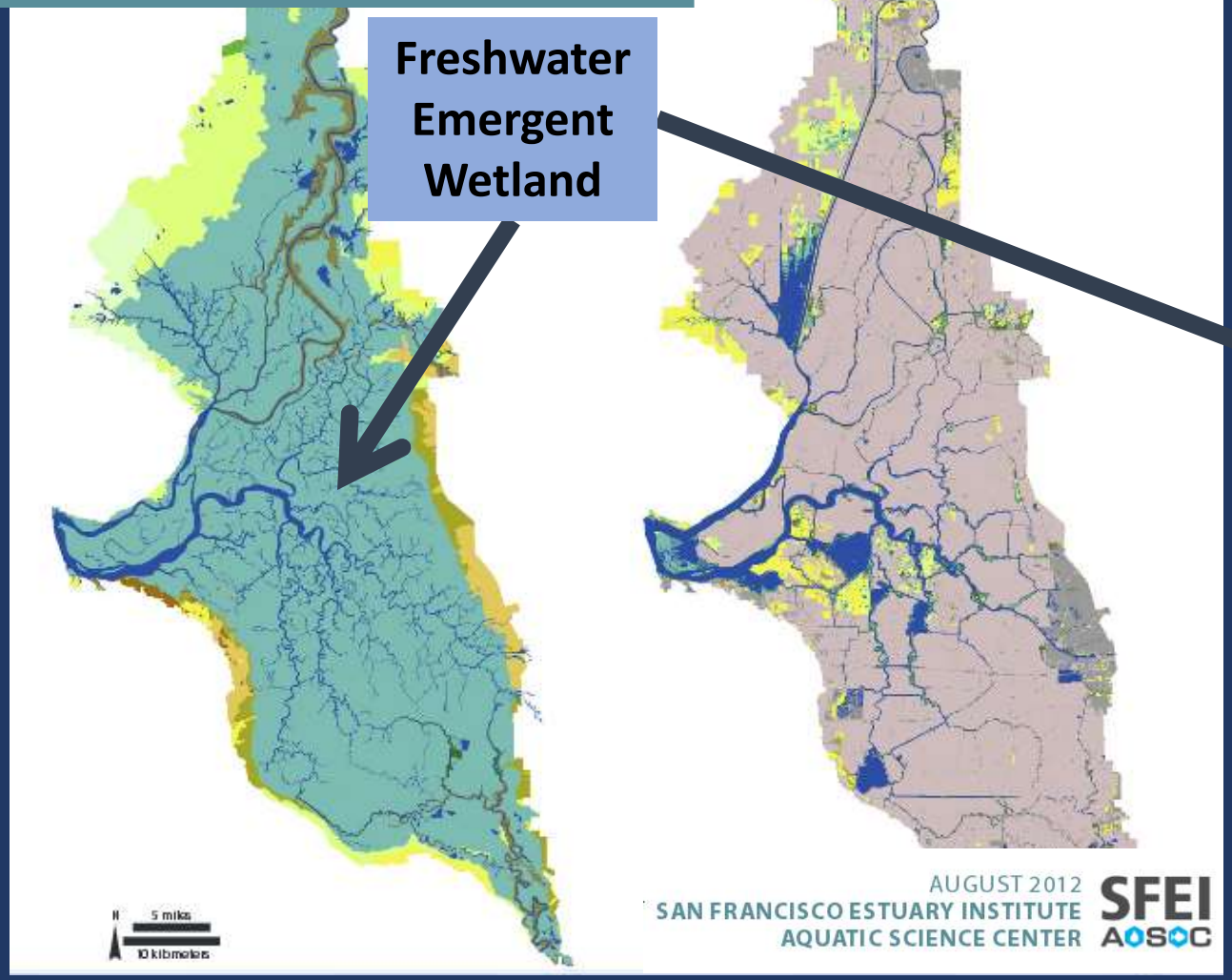
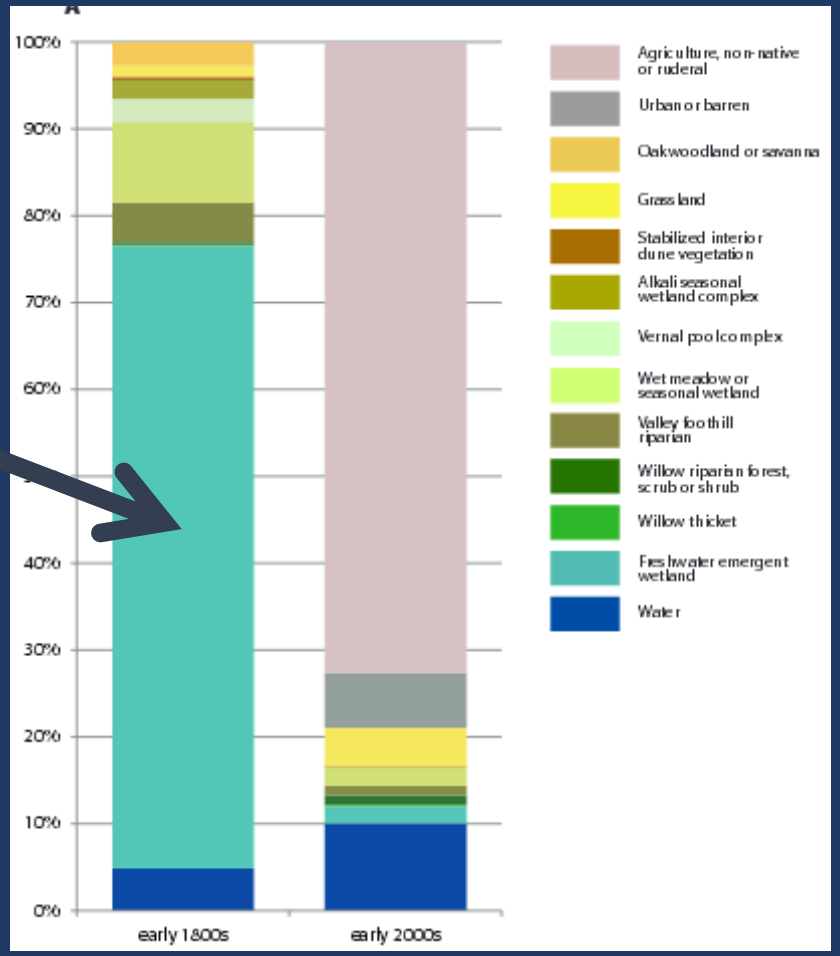
The Delta: A History of Change

Linking Food Webs to Landscapes

The Delta: A History of Change

Sacramento-San Joaquin Delta Historical Ecology Investigation:
EXPLORING PATTERN AND PROCESS





1800's 2000's

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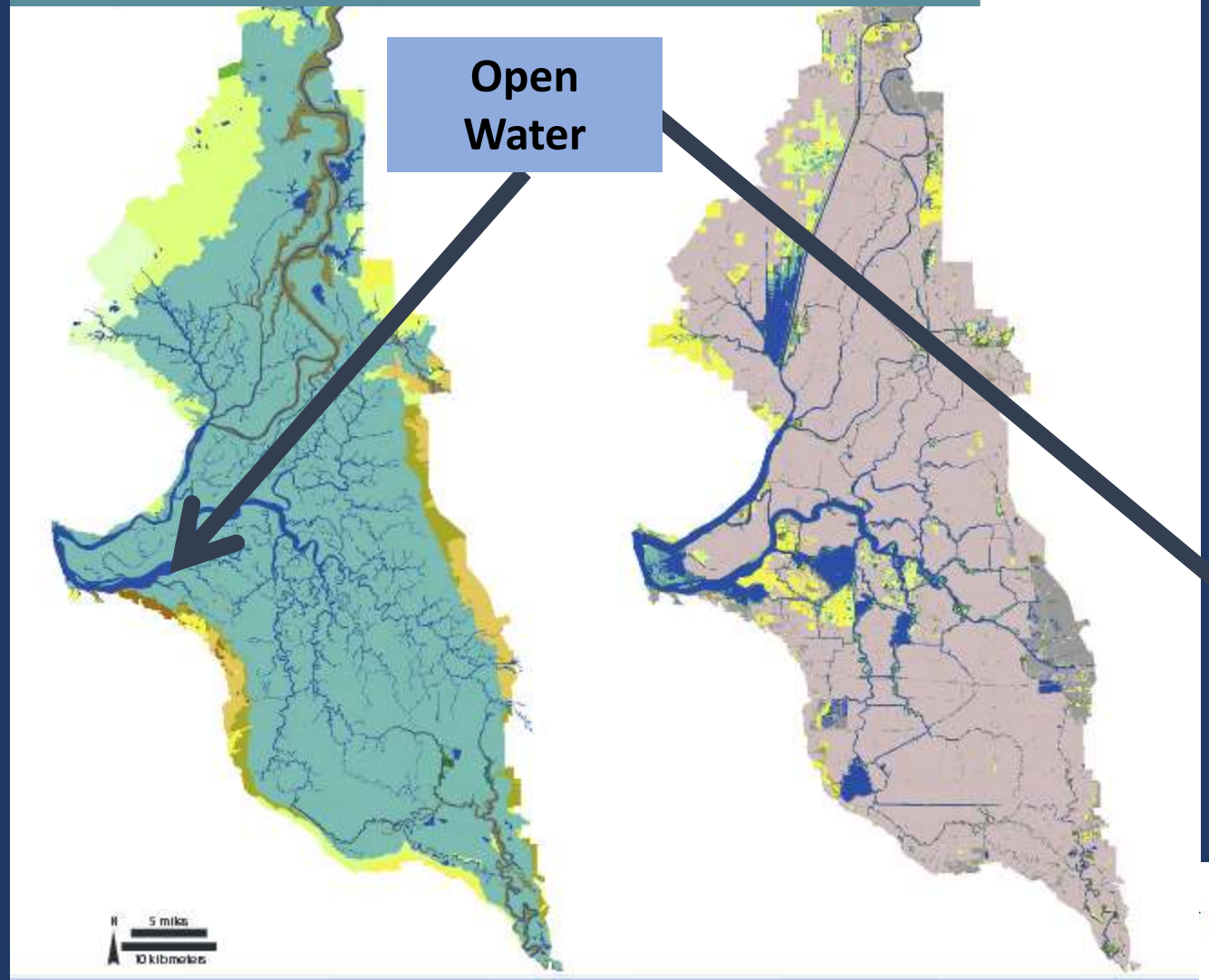

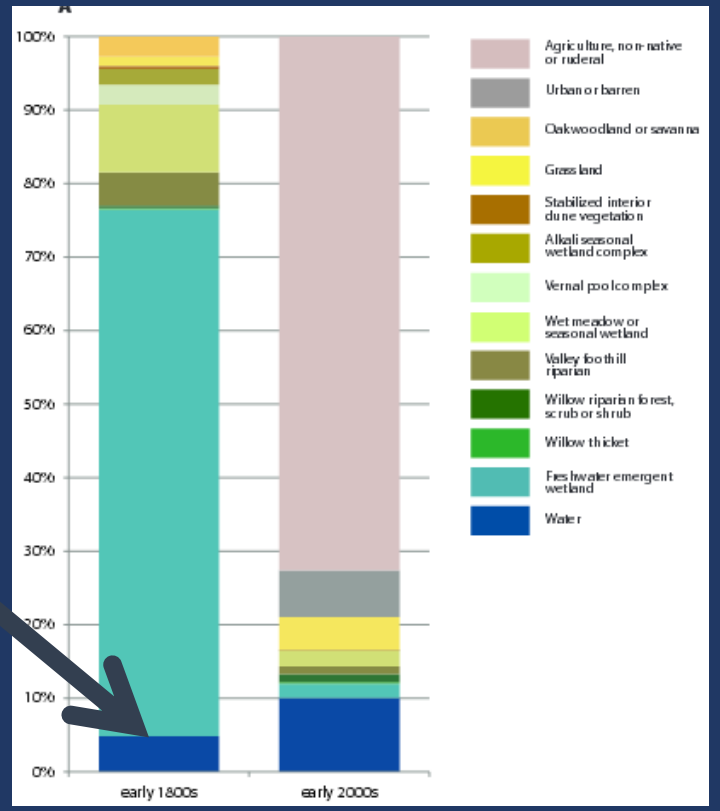

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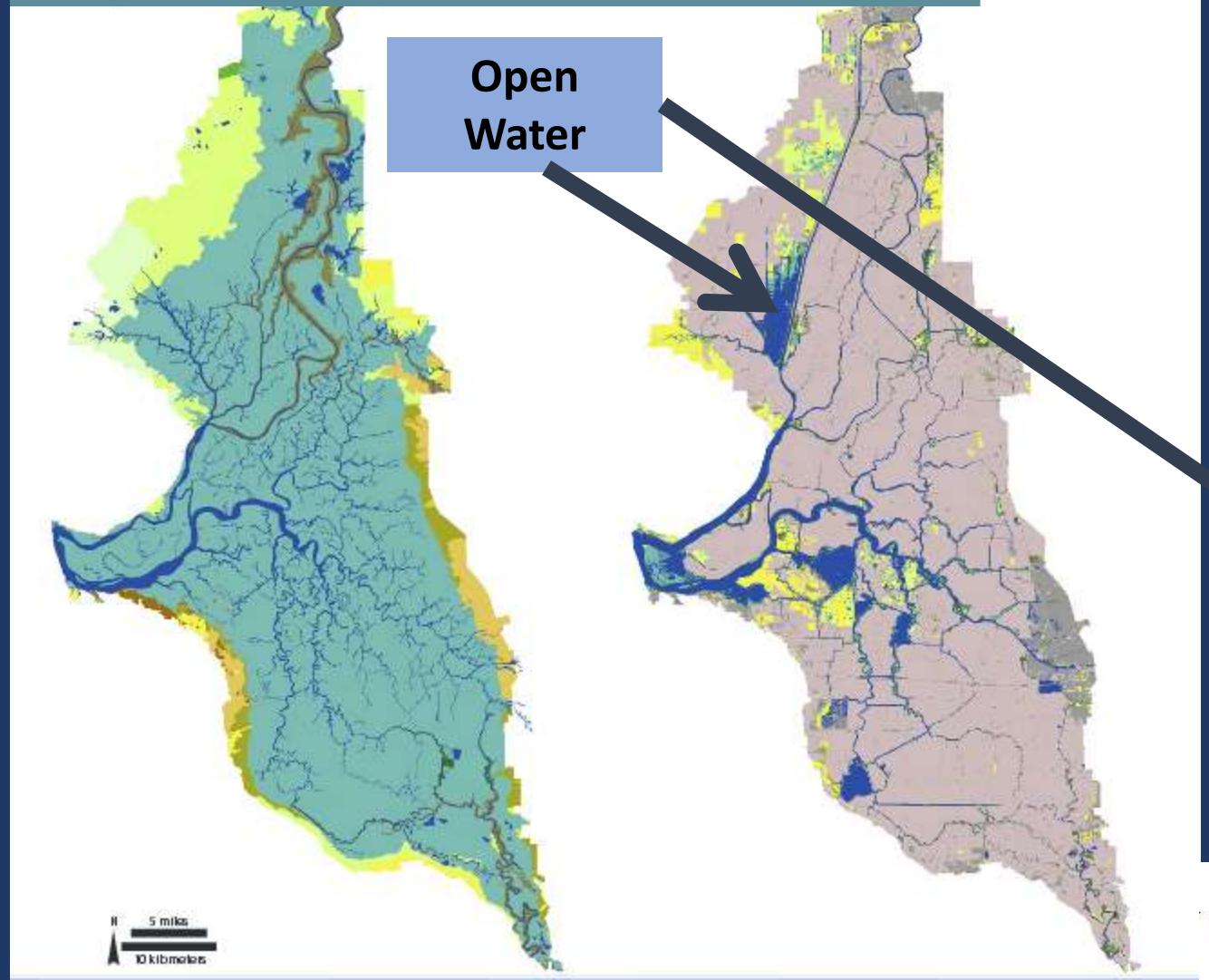

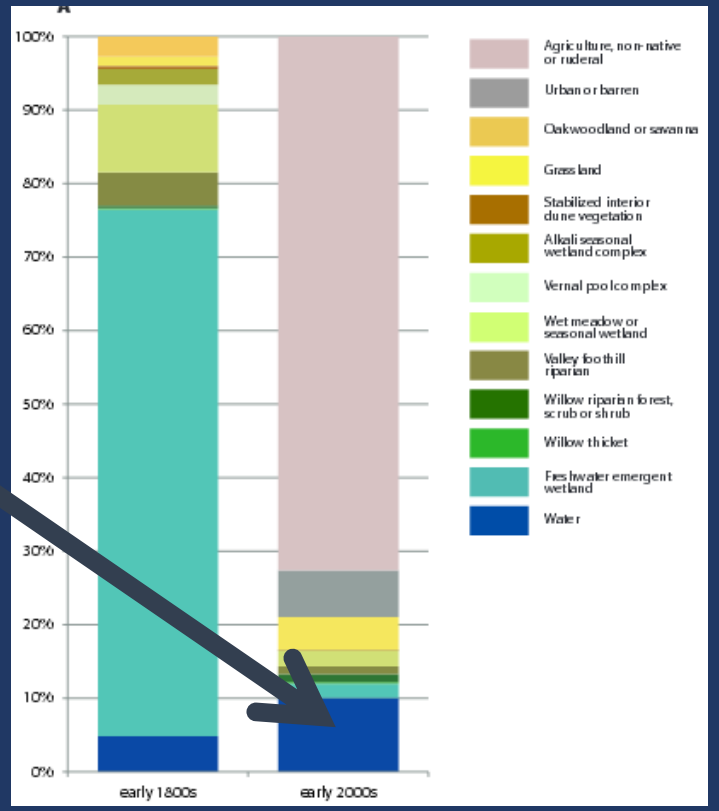

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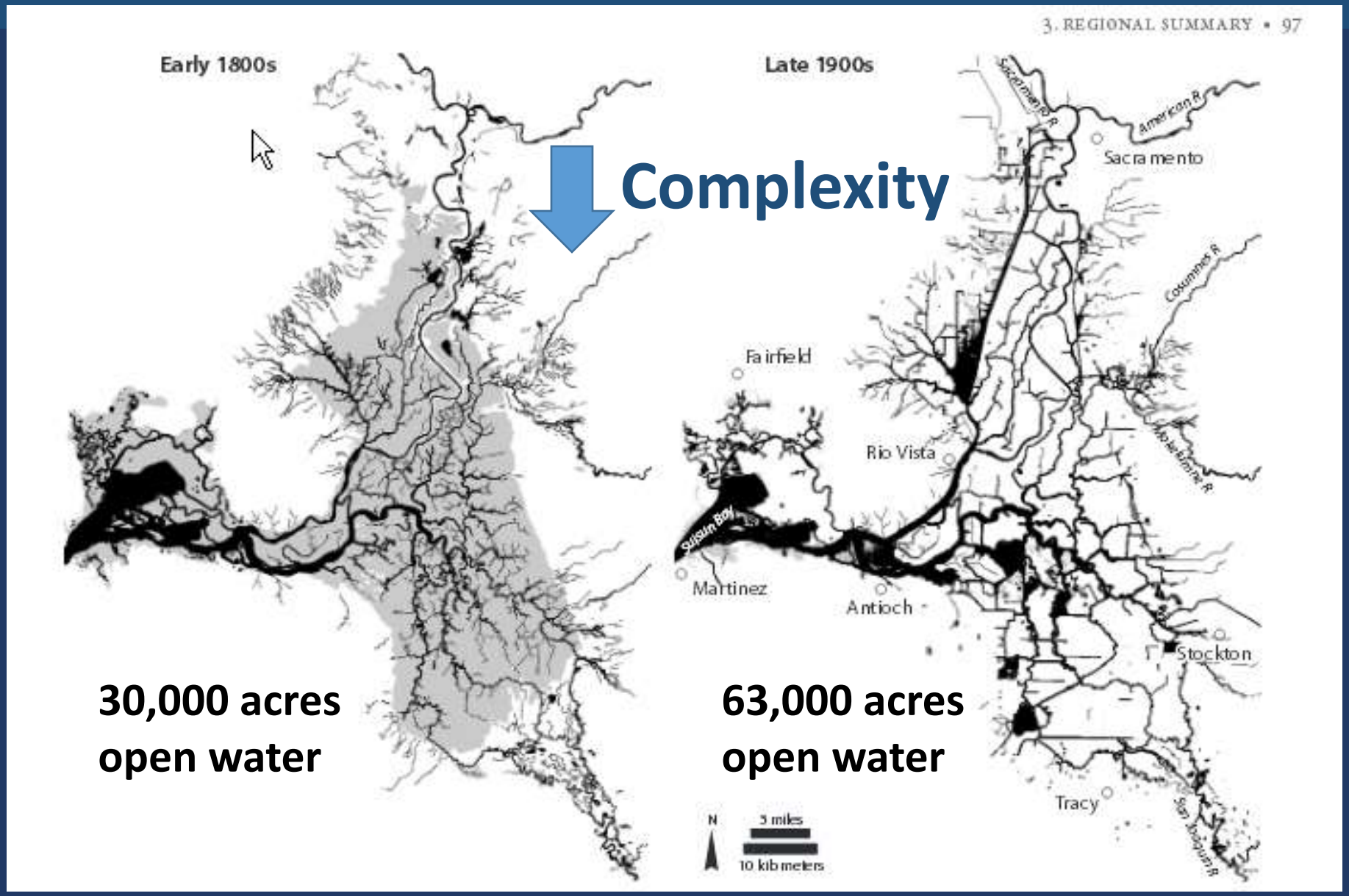
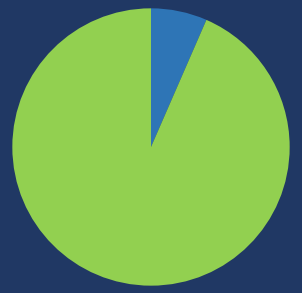


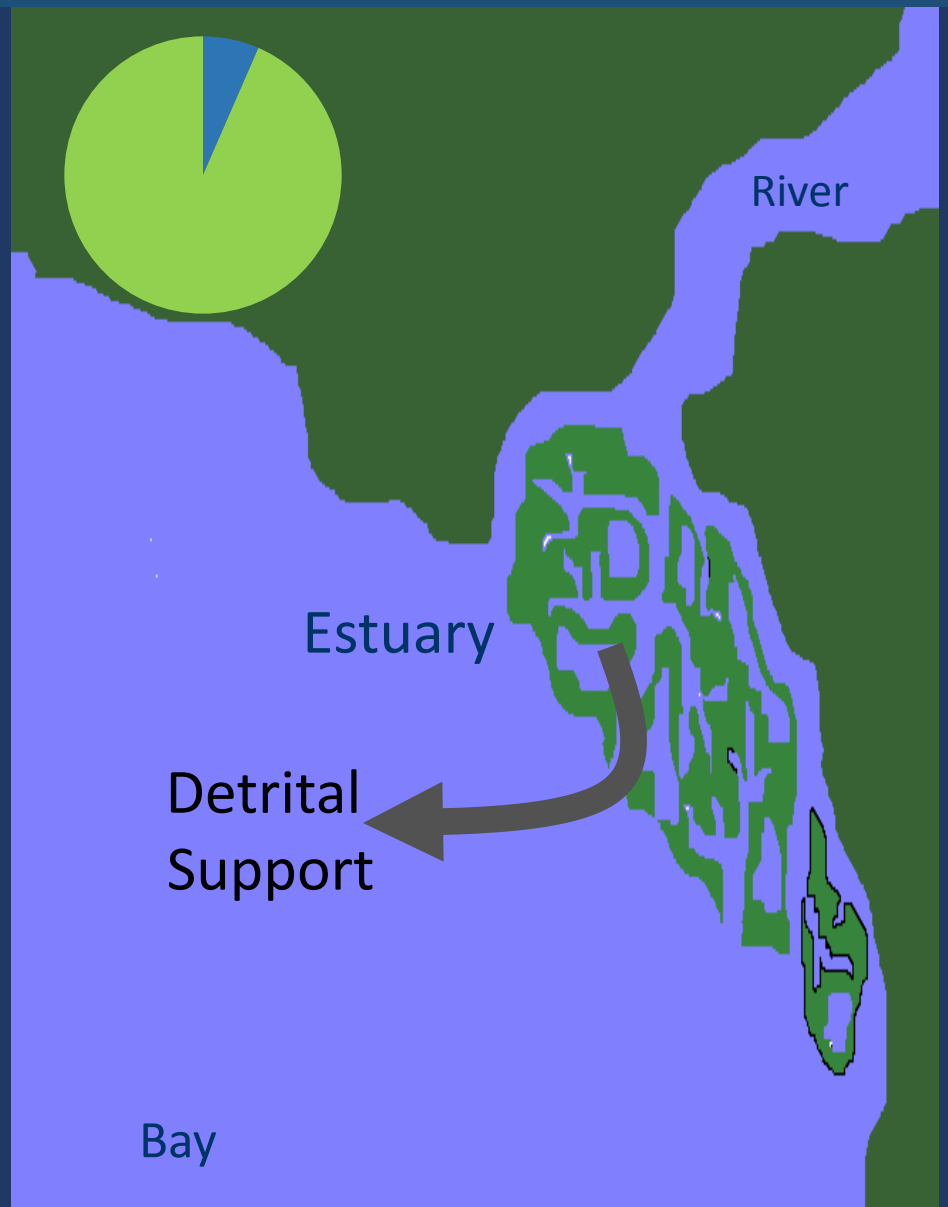
The Delta: A History of Change

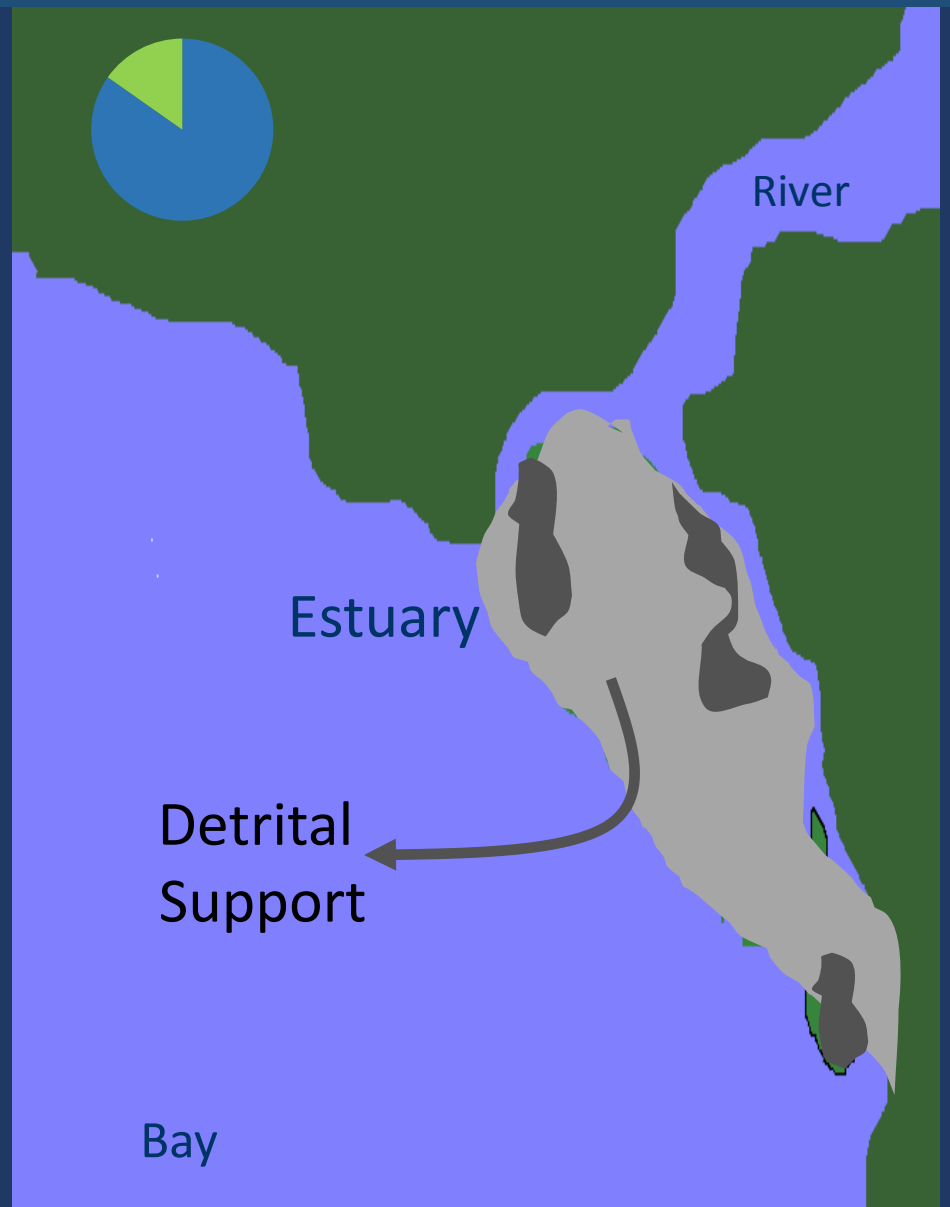
Historical Proportion	Current Proportion
Open water: Wetland	Open water: Wetland
7:100	556:100
30,000 acres water	63,000 acres water



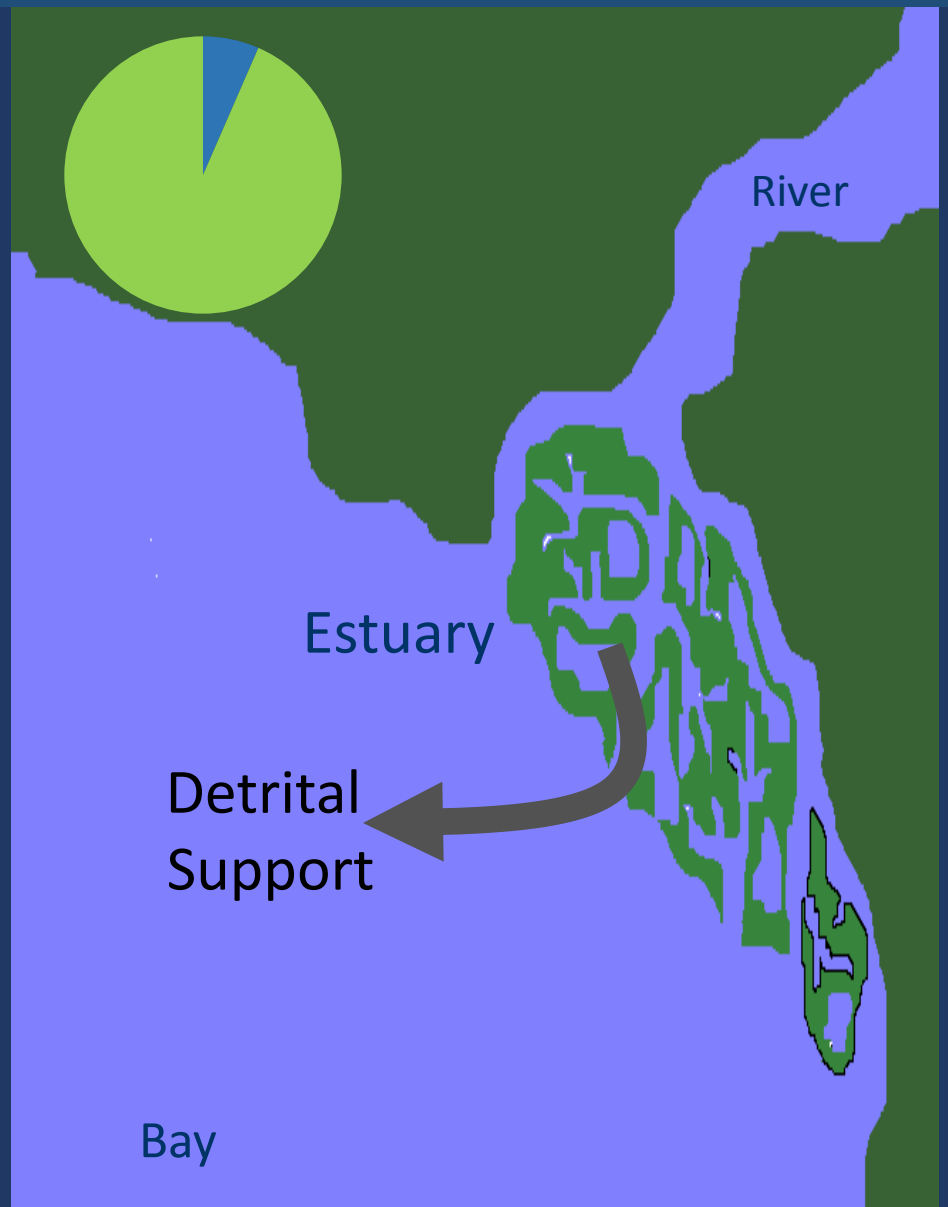
< 3% of historical wetland ecosystems remain in the Delta

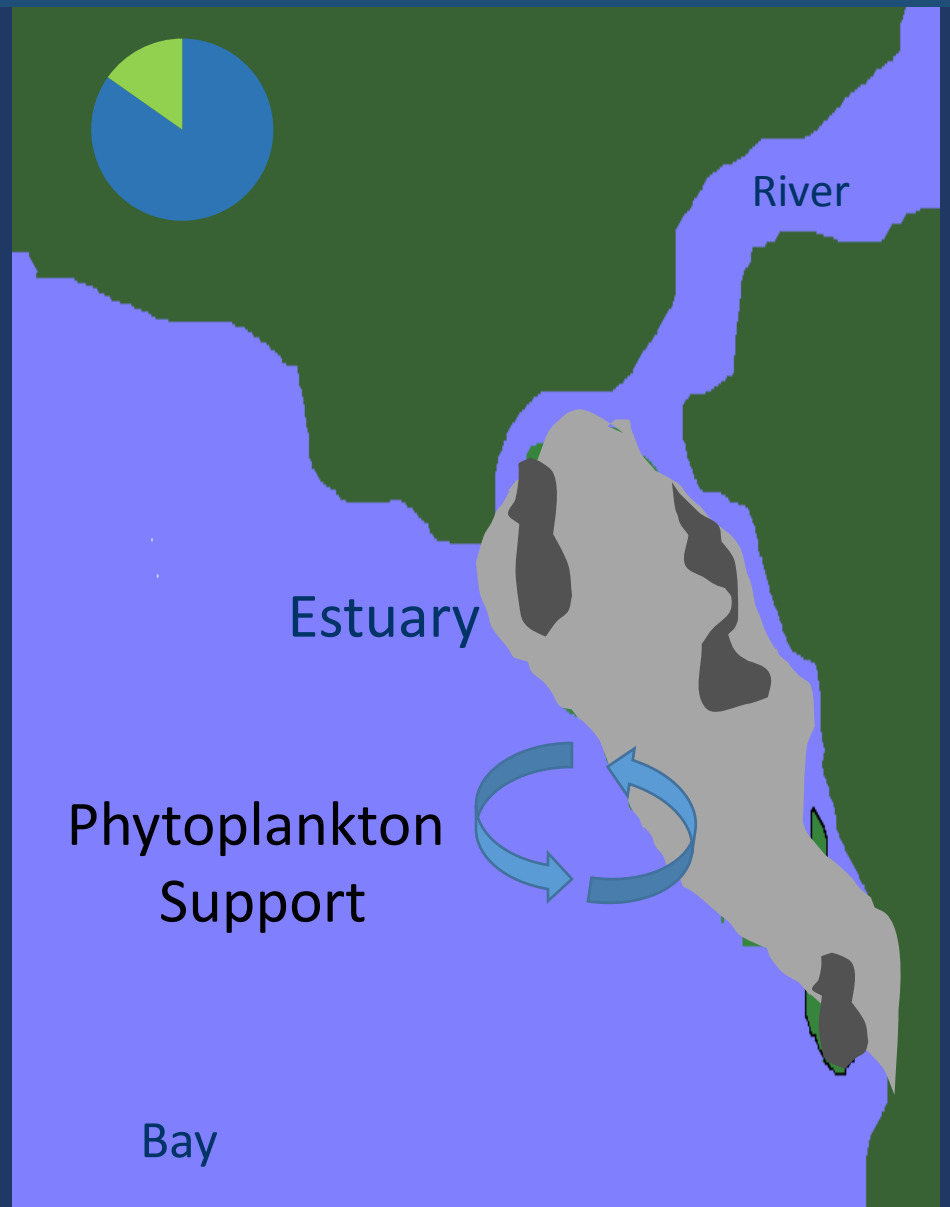
The Delta: Changes in food web support?





The Delta: Changes in food web support?



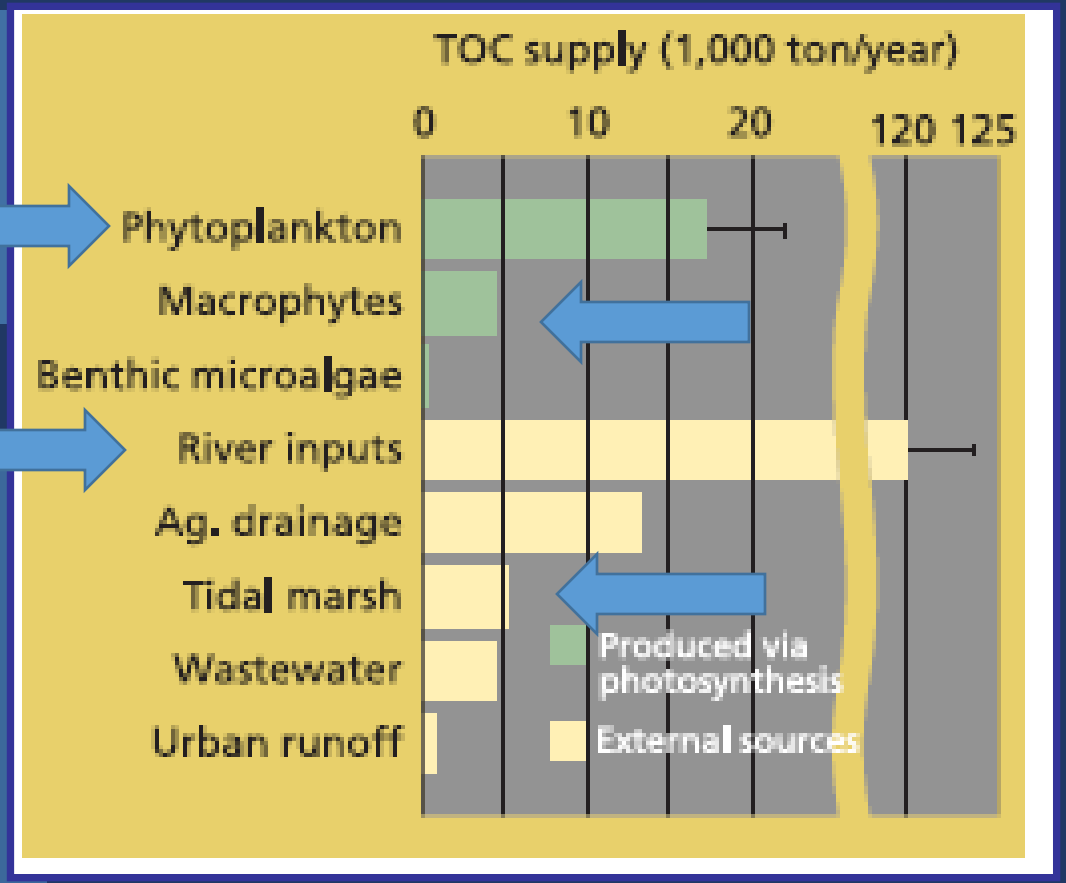


The Delta: Changes in food web support?

Shift to Phytoplankton-Driven Food Web System

Jassby *et al.* (2003):
"Phytoplankton fuels Delta food web"
"Phytoplankton is the dominant food source . . ."

Canuel *et al.* (1995):
-"Phytoplankton sources of POM are important throughout the entire SFB system . . ."
-"Analysis of biomarker compounds in *P. amurensis* indicates that phytoplankton supply a large fraction of the assimilated carbon to clams . . ."



Jassby et al. 2003

The Delta: Changes in food web support

Piecing together an historical shift in support

- Teal 1962, Odum 1980: Most large estuaries depend on detrital pathways to fuel food web
- Valeila 2000: more vegetated, complex channels export more material
- Eldridge & Cifuentes 2005: $\delta^{13}C$ of estuarine POC only reflects marsh inputs when total marsh area exceeds total open water area

The Delta: Changes in food web support

- Carbon delivered to Delta =“pre-aged” (900-1400 yrs) (Canuel et al. 2009)

No wonder nothing wants to eat that stuff!!!

The Delta: Changes in food web support

What happens in areas where marshes are still producing FRESH OM?

Are the Delta's organisms still well adapted to take advantage of this alternative/historical food source?

Delta Food Web: Project Goals

Delta Food Web: Project Goals

Do marsh-associated invertebrates assimilate marsh-derived material?

Could marshes bolster the food web with alternative OM sources?

Delta Food Web: Project Goals

Zooplankton:
Water column grazers

Pseudodiaptomous forbesi
Sinocalanus doerrii
Neomysis mercedis

Benthic/epibenthic:
Suspension feeders

Corbicula fluminea
Americorophium spinicorne

Epibenthic/epiphytic:
Grazers & detritivores

Hyallela azteca
Eogammarus confervicolous
Gammarus daiberi
Gnorimosphaeroma oregonensis

Insects:
Grazers, sap suckers, predators?

Chironomidae
Odonata (Zygoptera)
Aphidiae
Corixidae
Veliidae

Decapoda:
Predators

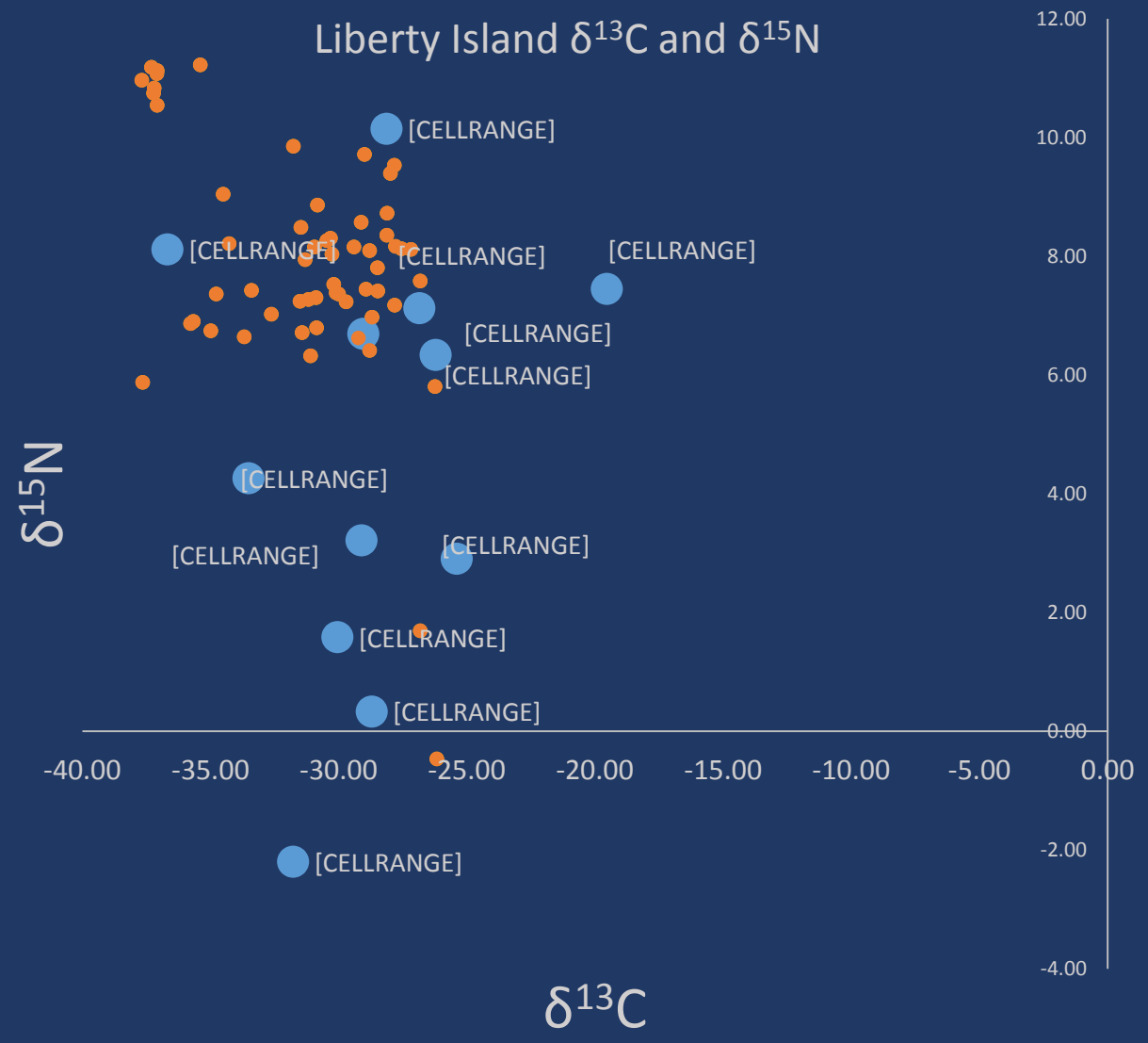
Exopaleomon modestus
Palaemon macrodactylus
Crangon franciscorum

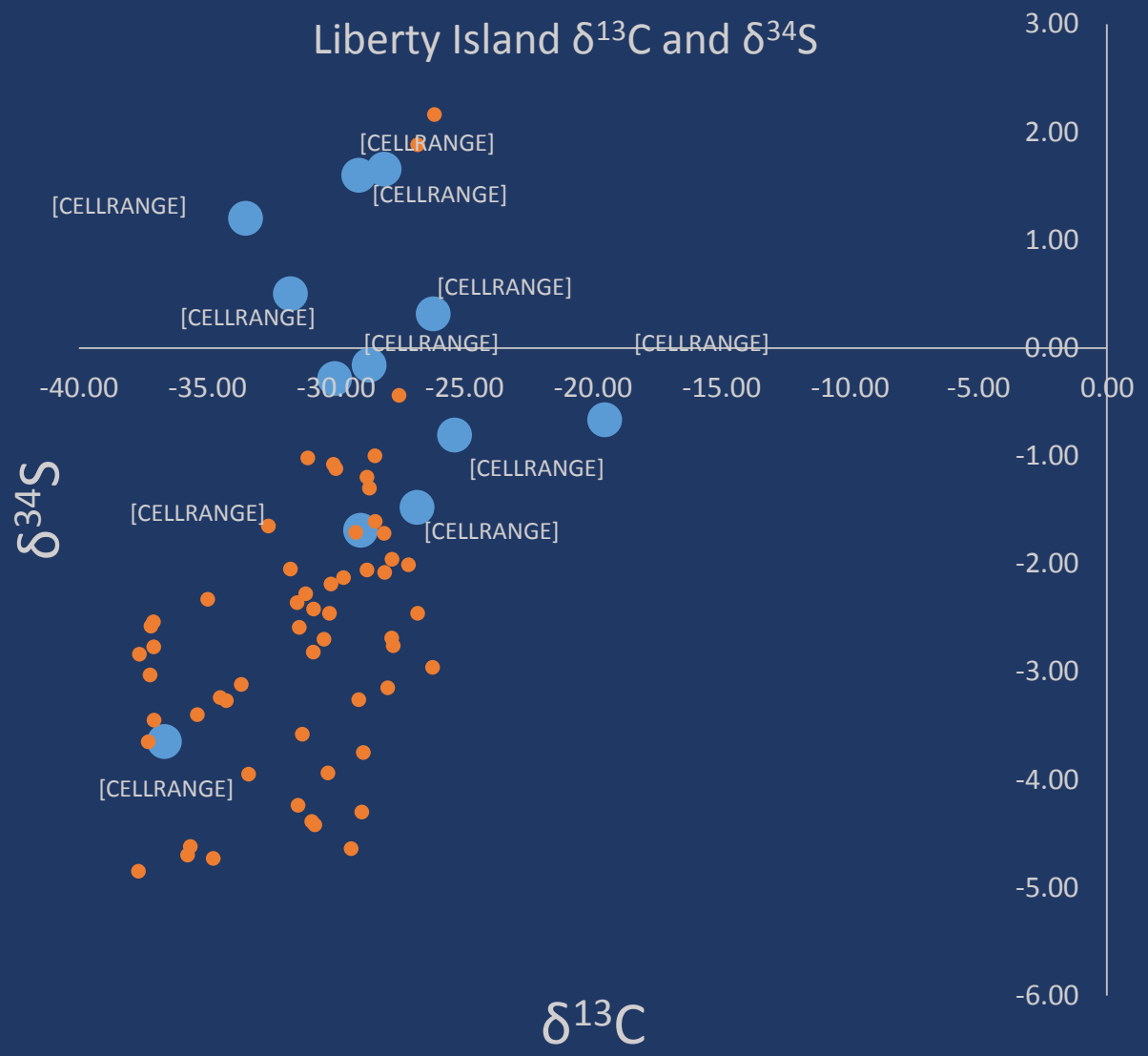
Delta Food Web: Methods for tracking OM sources

- Stable Isotopes ($\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$)
- Essential Fatty Acids Assimilated in proportion to that consumed (Galloway 2013 Dissertation)
- MixSIAR (Bayesian mixing model)

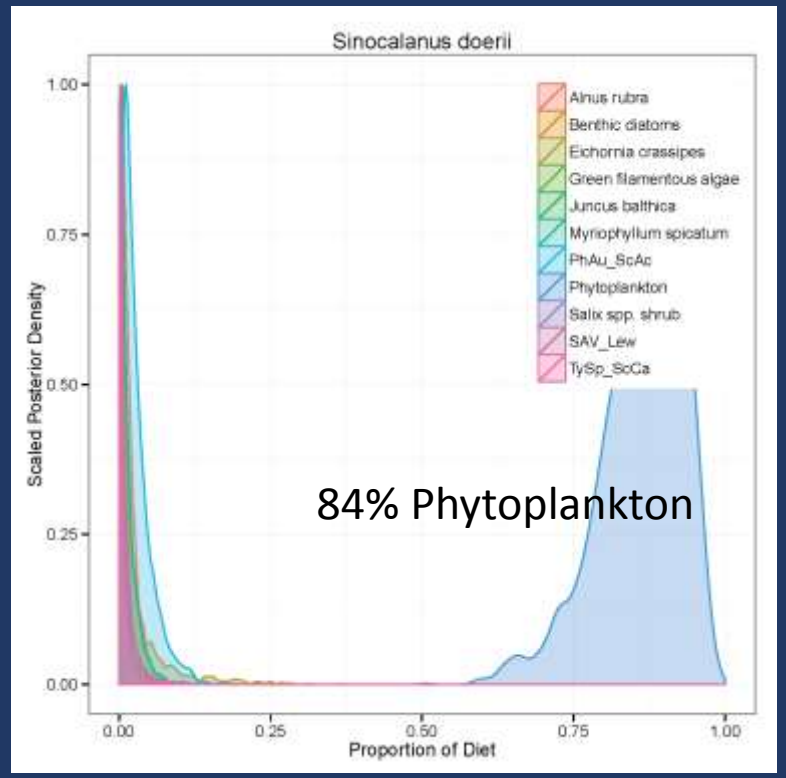
  https://github.com/brianstock/MixSIAR

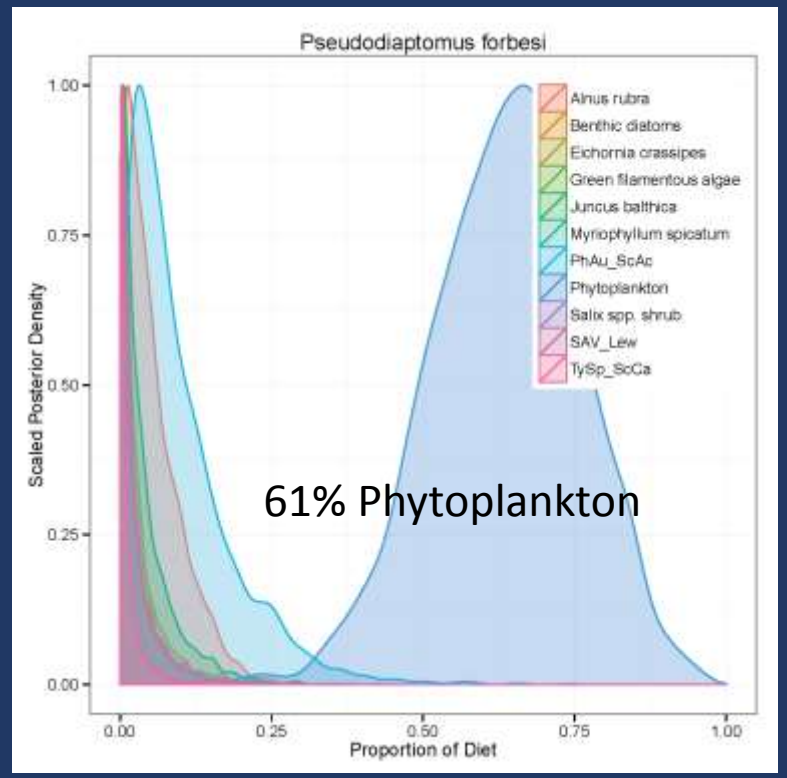
Delta Food Web: Methods for tracking OM sources

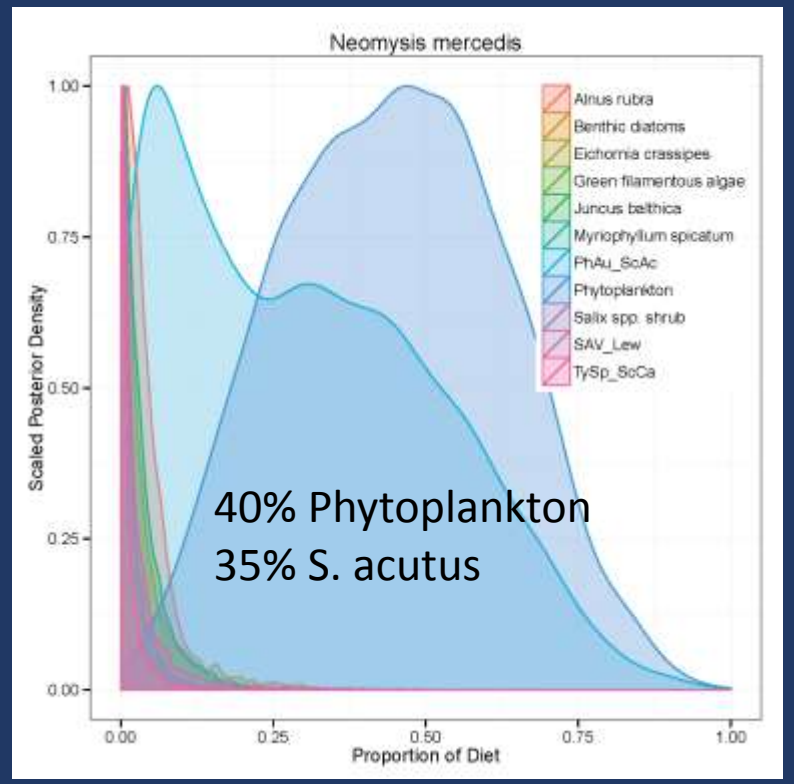




Delta Food Web: Liberty Island Zooplankton





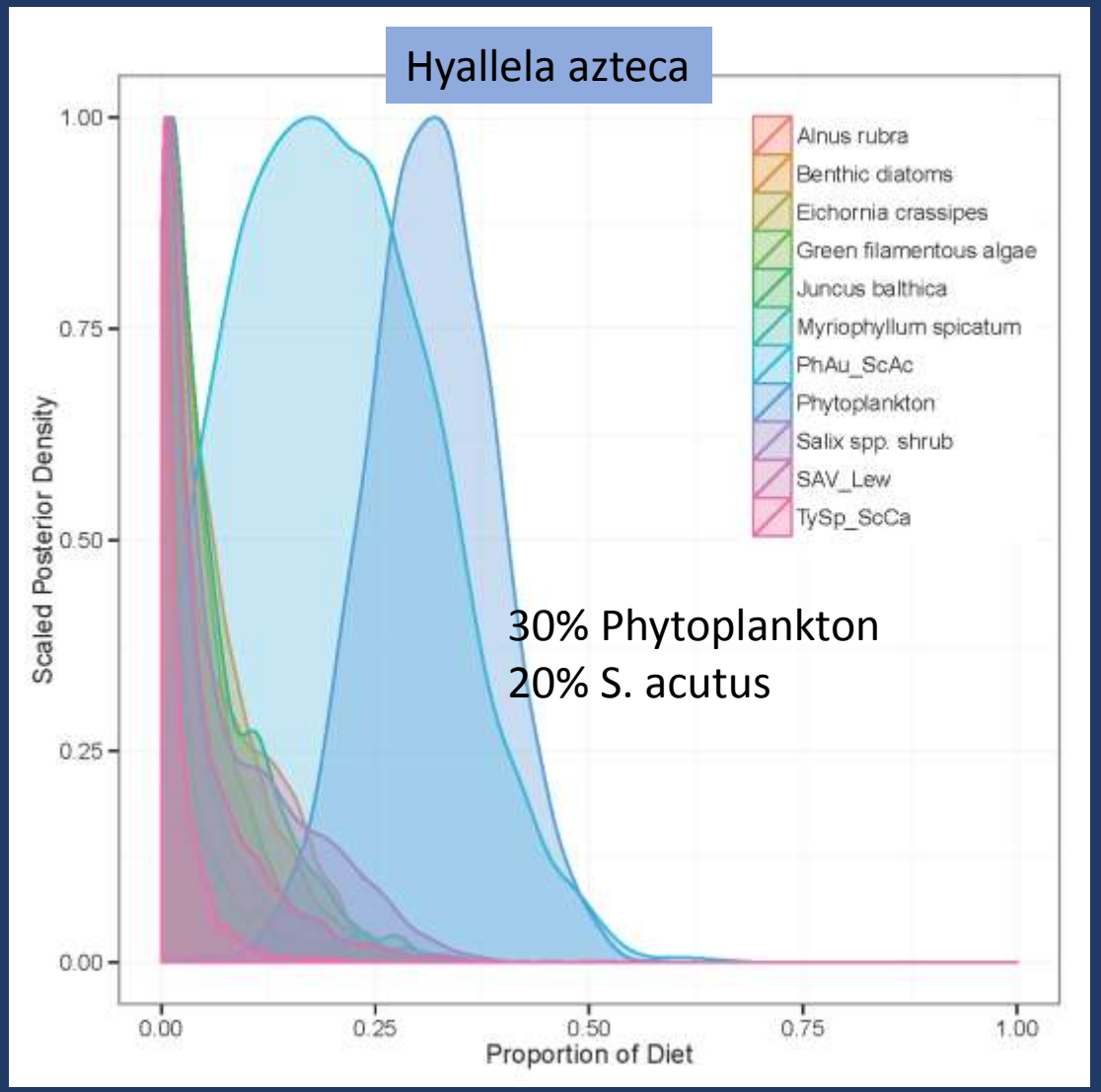


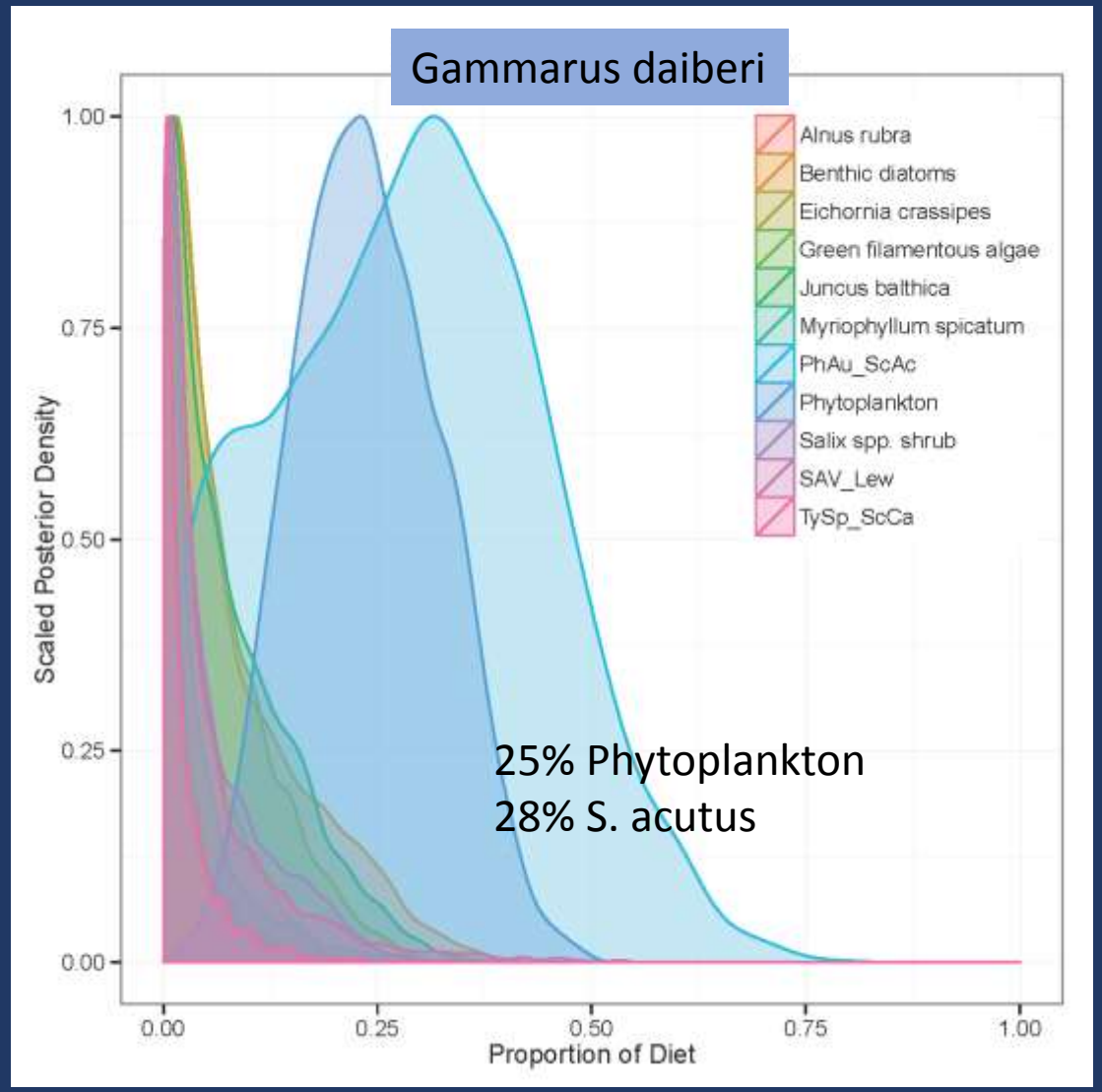
Sinocalanus doerrii

Pseudodiaptomus forbesi

Neomysis mercedis

Delta Food Web: Liberty Island Amphipods

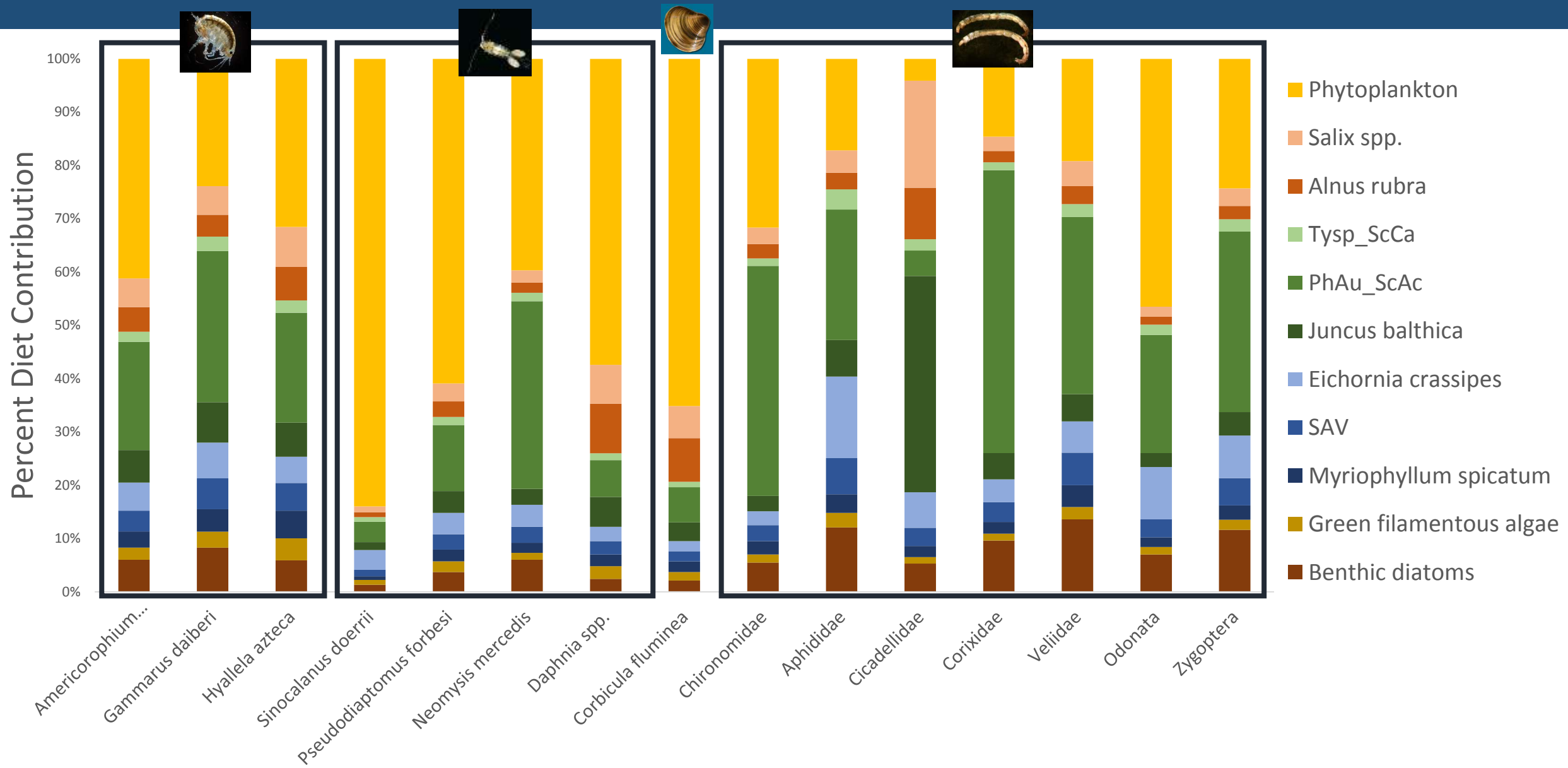




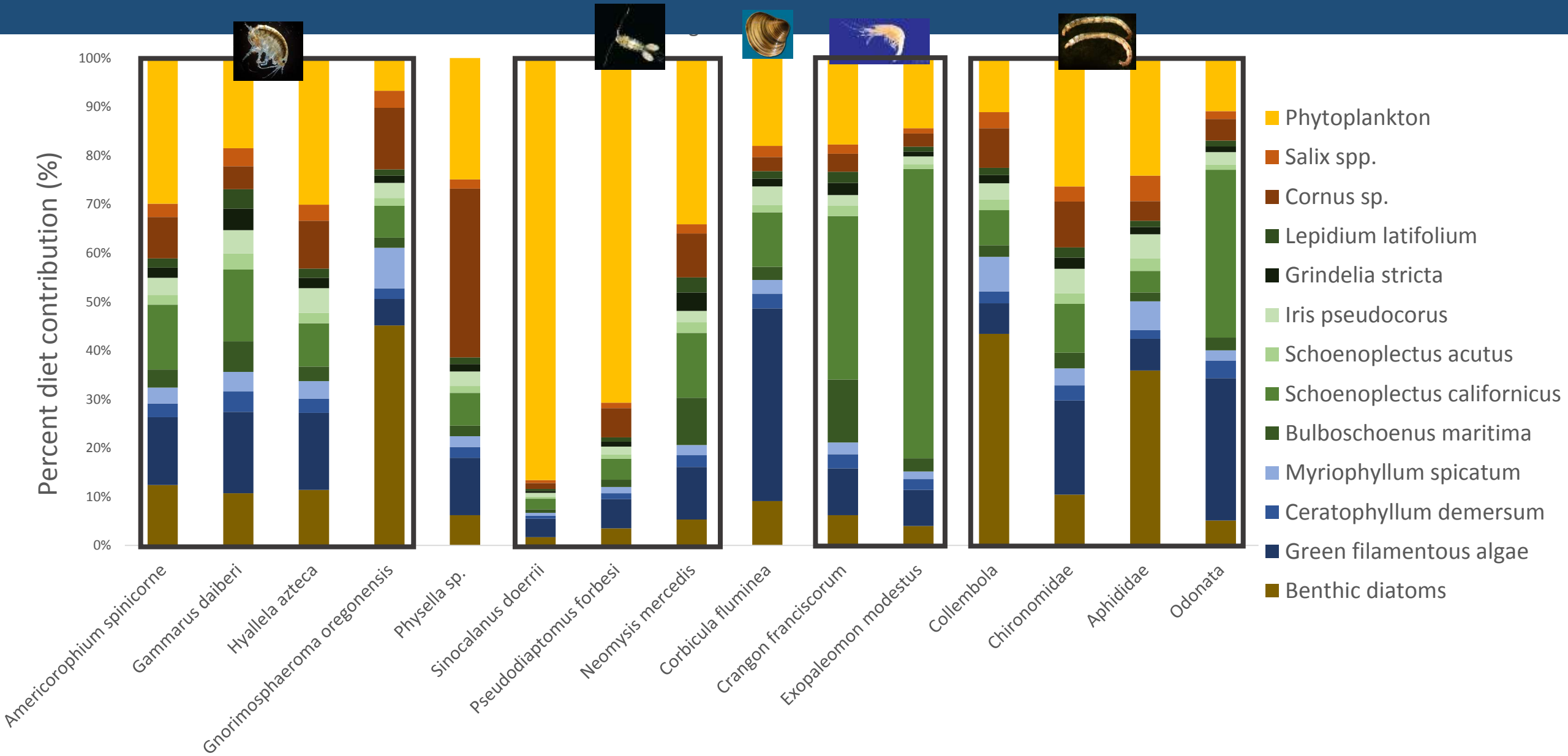
Delta Food Web: OM Source Color Code

- Benthic Diatoms
- Aquatic Vegetation (SAV & FAV)
- Emergent Marsh
- Riparian Vegetation
- Phytoplankton

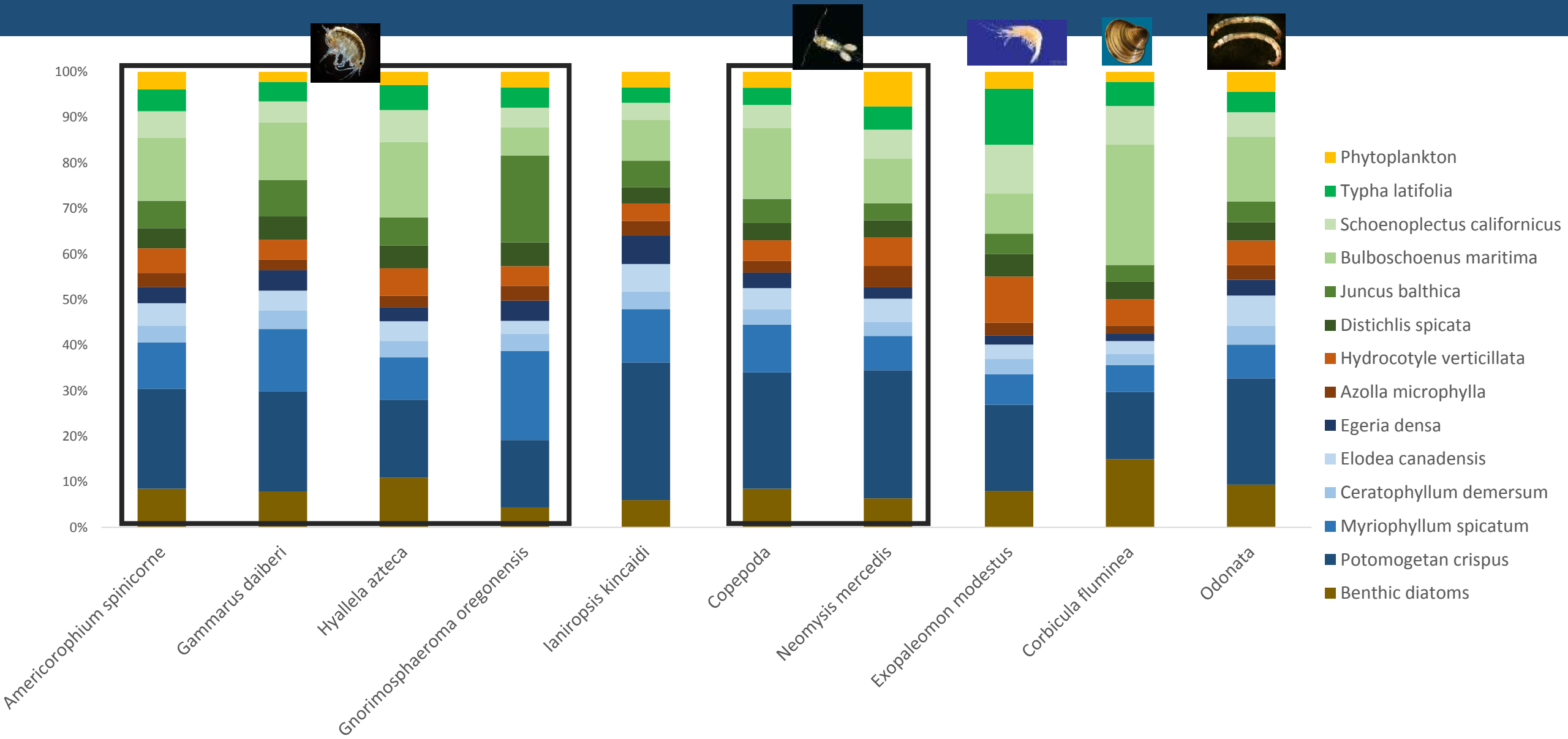
Delta Food Web: Liberty Island



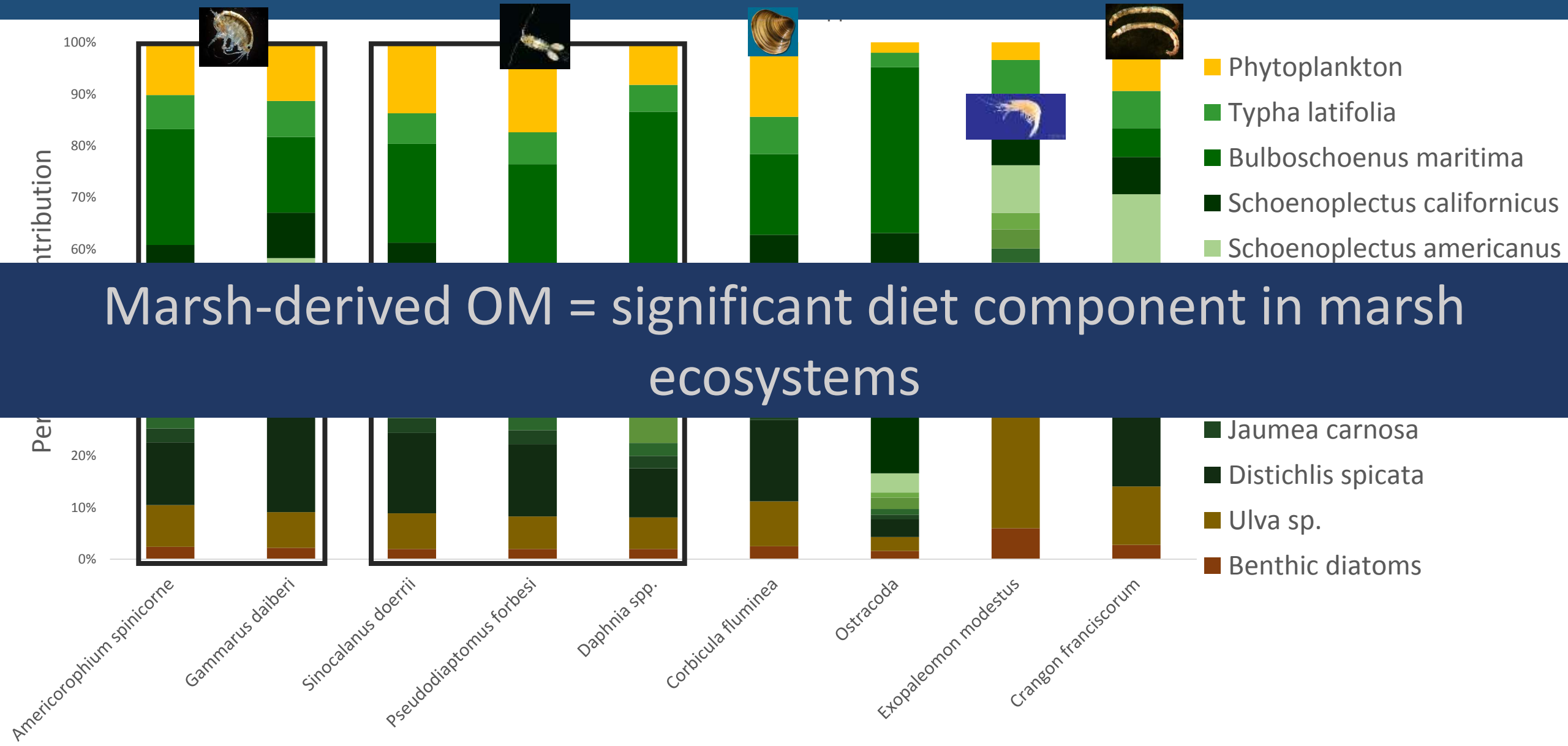
Delta Food Web: Lindsey Slough



Delta Food Web: Browns Island

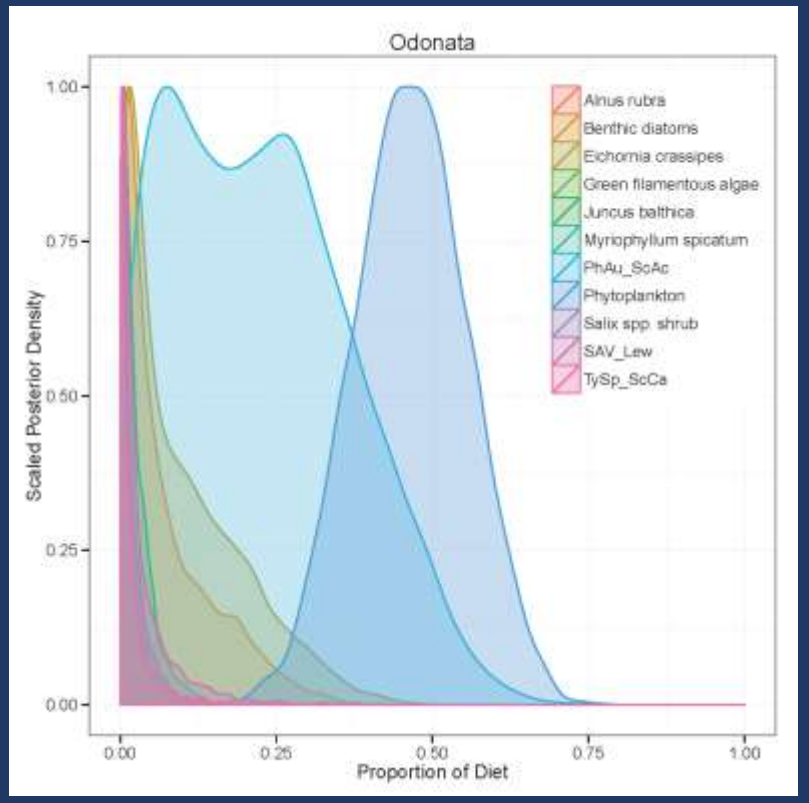


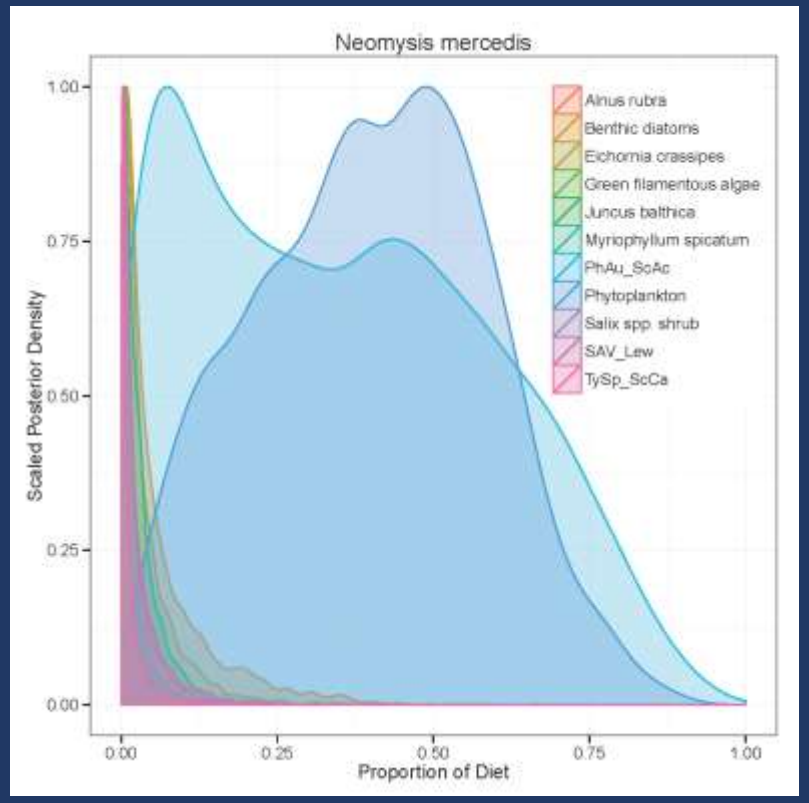
Delta Food Web: Suisun Marsh (Rush Ranch)

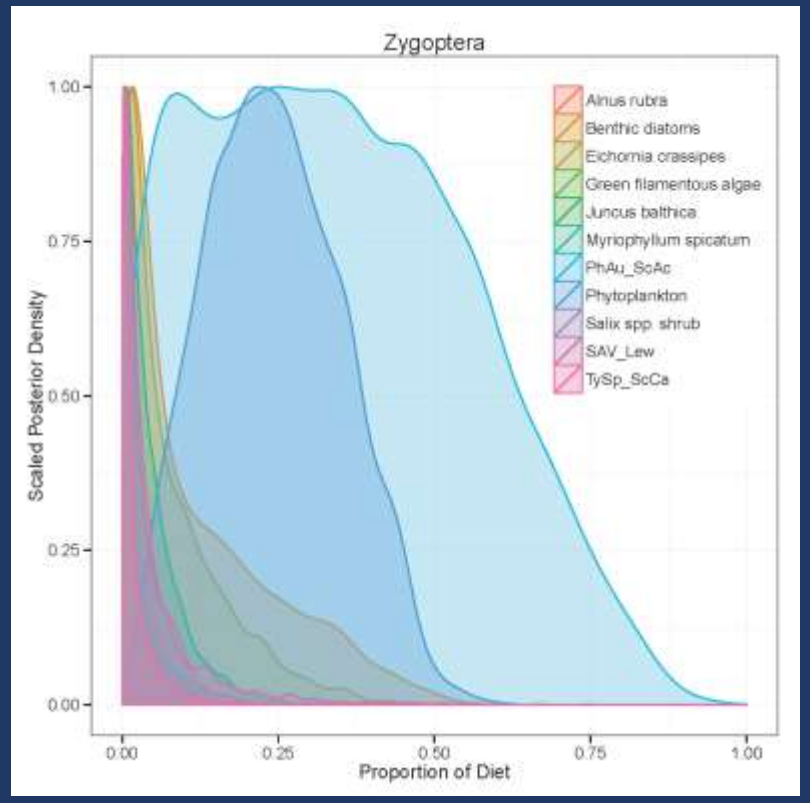


Marsh-derived OM = significant diet component in marsh ecosystems

Delta Food Web: Refining model estimates?

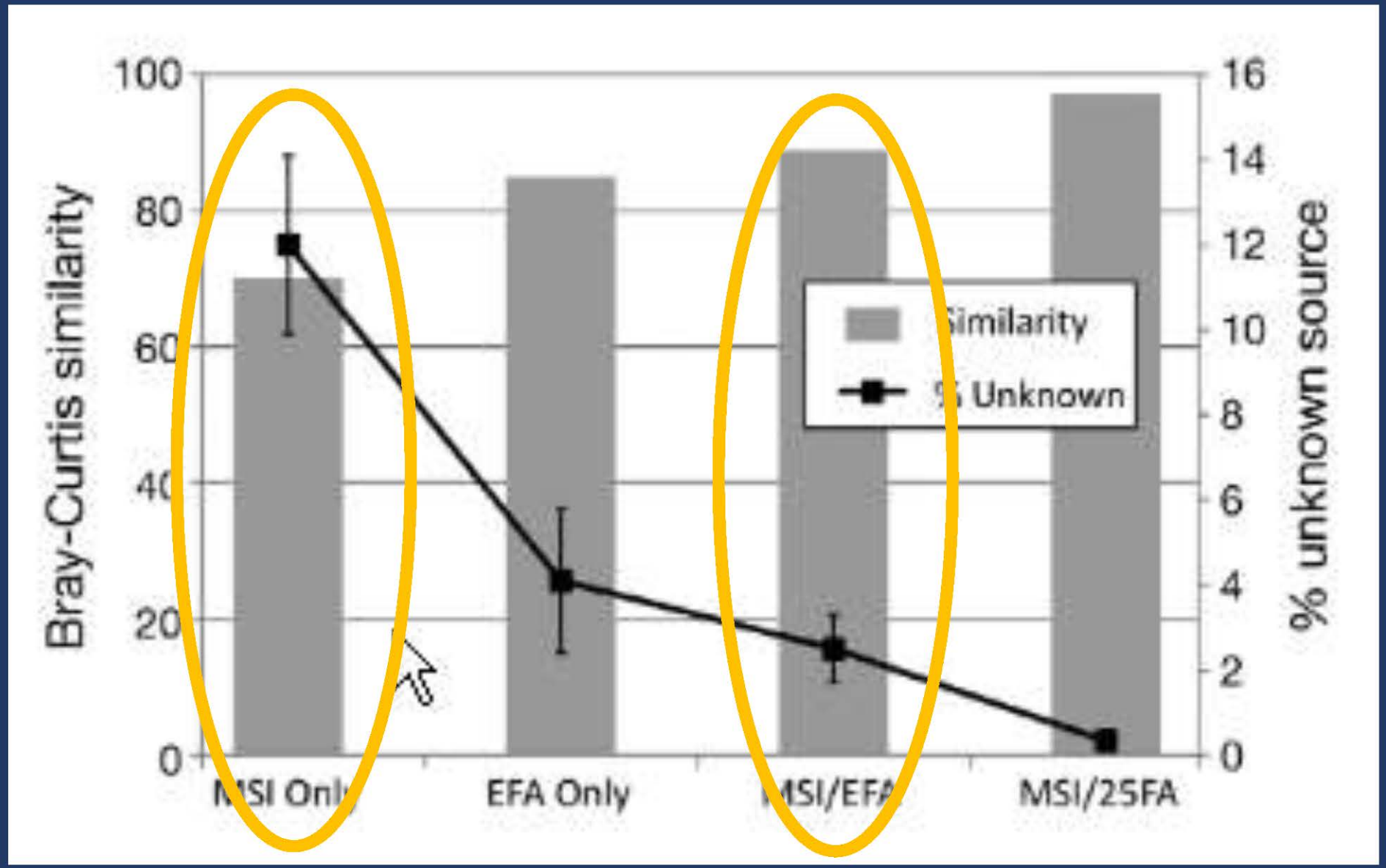






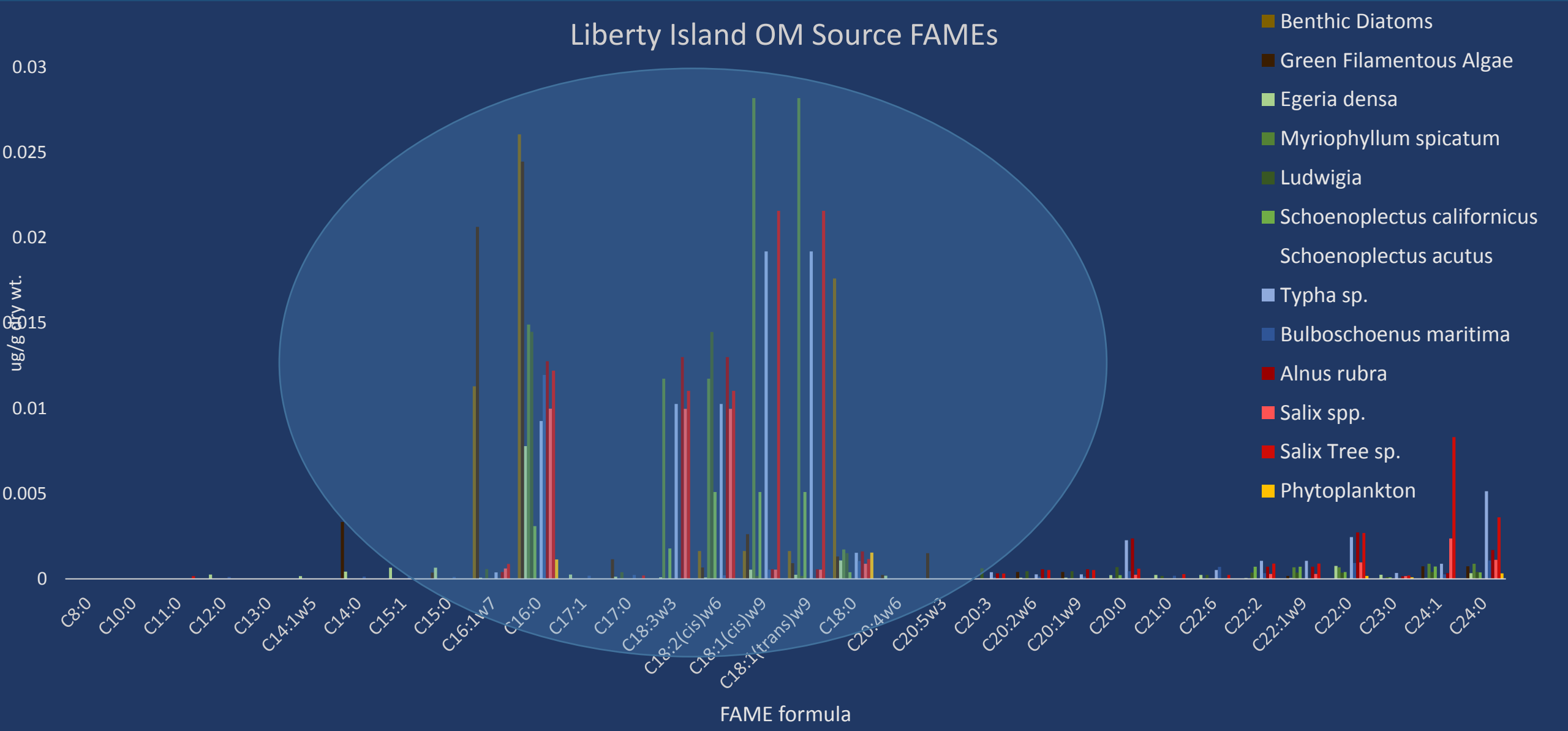
Broad peaks, double peaks . . .

Delta Food Web: Advantages of Fatty Acids



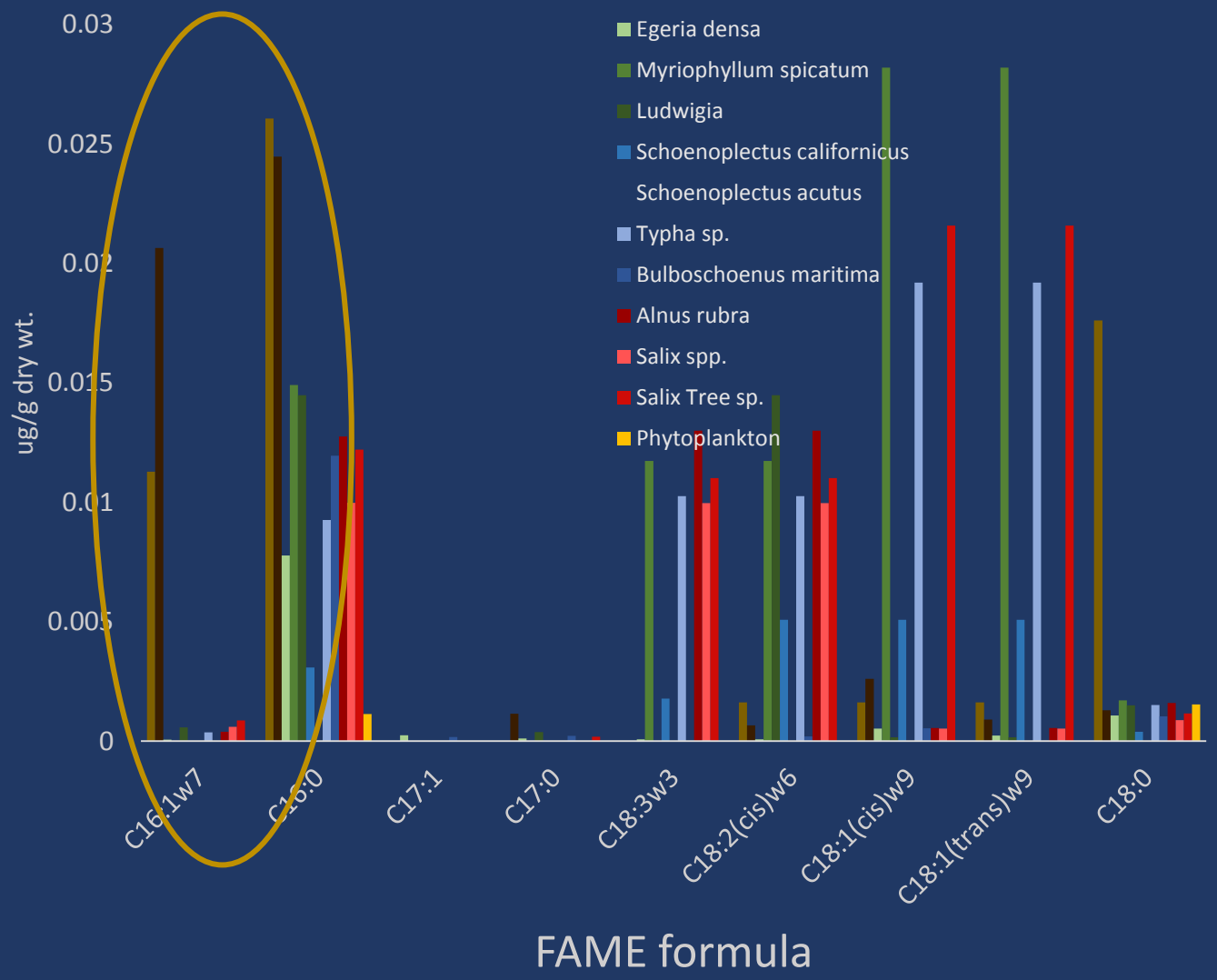
Dethier et al. 2013

Delta Food Web: Advantages of Fatty Acids

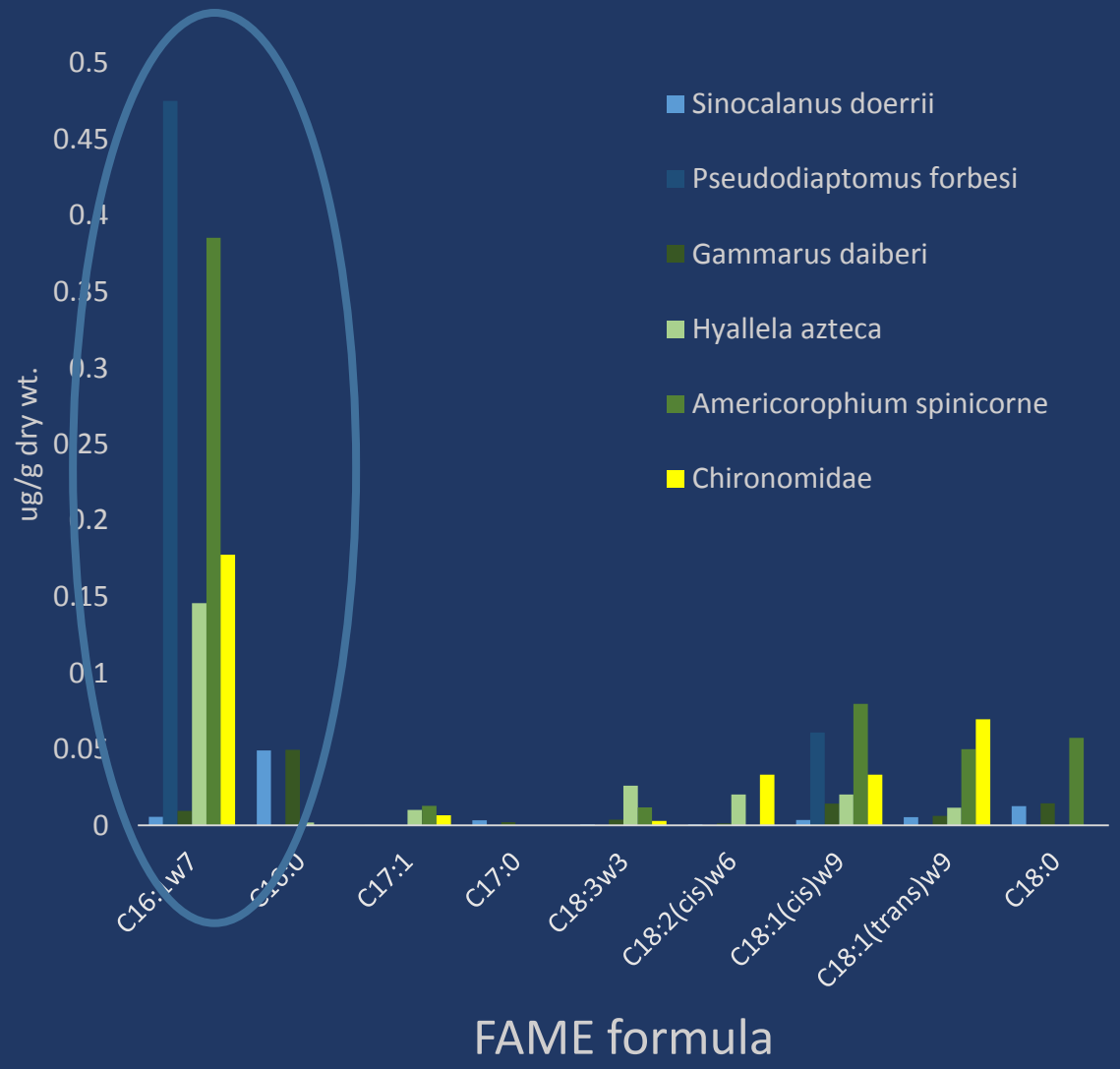


Delta Food Web: Essential Fatty Acid Data

Organic Matter Sources



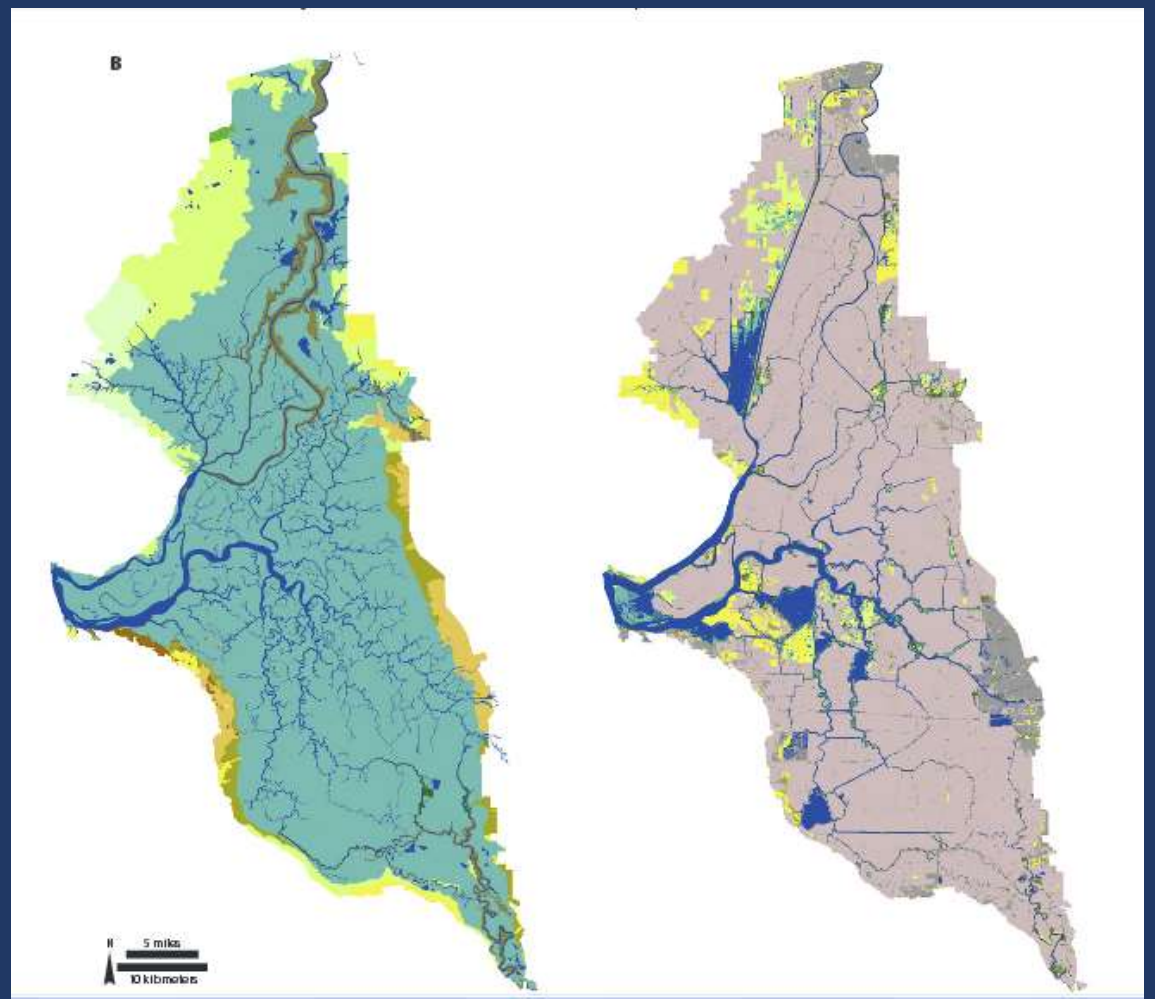
Invertebrates



Delta Food Web: Restoration Options

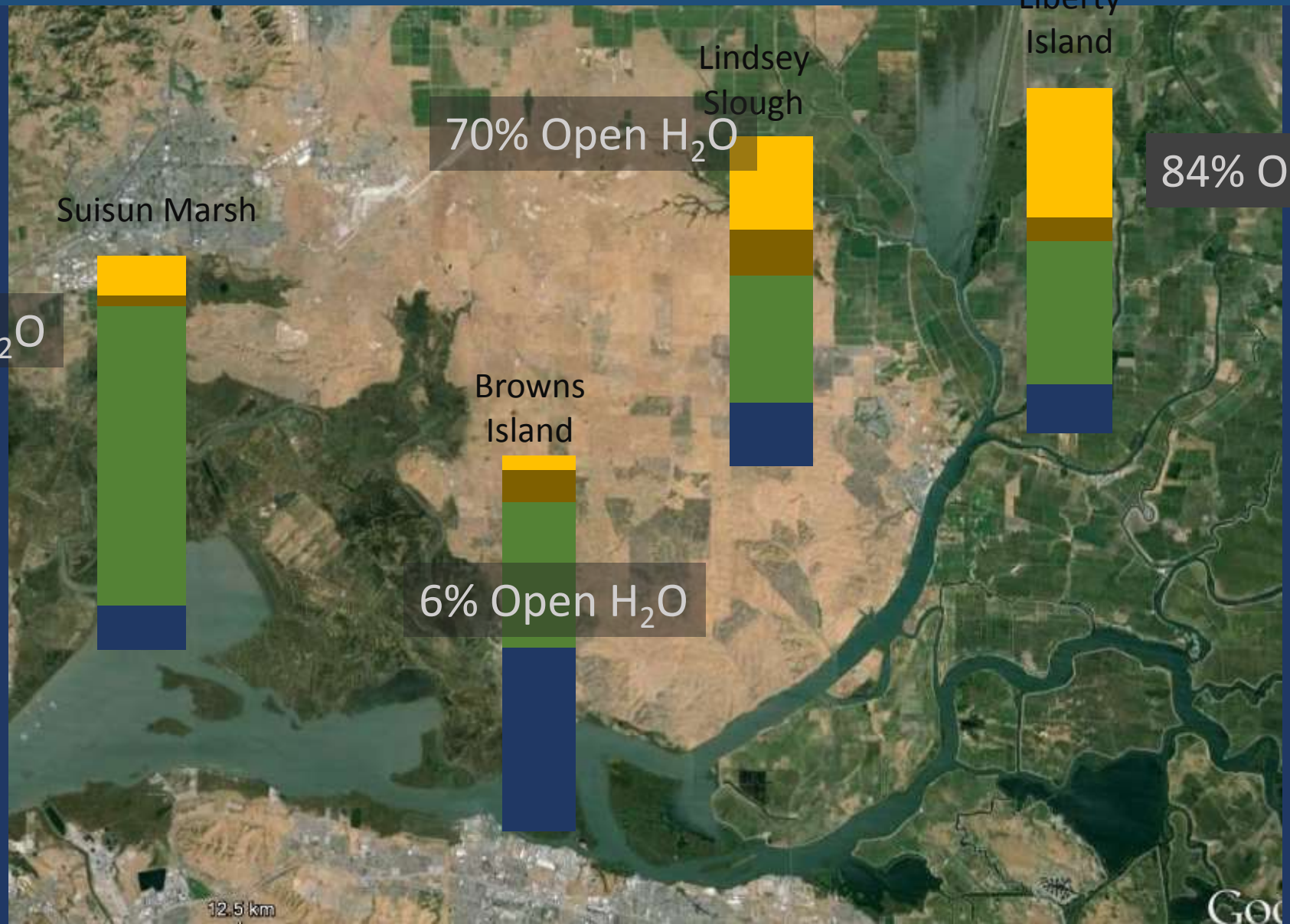
Emergent Marsh or Open Water?

POC $\delta^{13}C$ = marsh signature



POC $\delta^{13}C$ = Phytoplankton signature

Delta Food Web: Food Web Restoration Options



Delta Food Web: Closing Thoughts

- Current SFE food web mostly supported by phytoplankton
- WITHIN remnant marsh ecosystems, invertebrates consume marsh-derived detritus
- Marsh-derived support is not minimal for many consumers
- Community perspective to ecosystem restoration and food web support must include consideration for sources other than phytoplankton

Delta Food Web: Where do we go next?

The Fish!

Matt Young, UC Davis

Young *et al*. Fishes of the North Delta: Trophic Pathways and Habitat Use

Acknowledgements

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