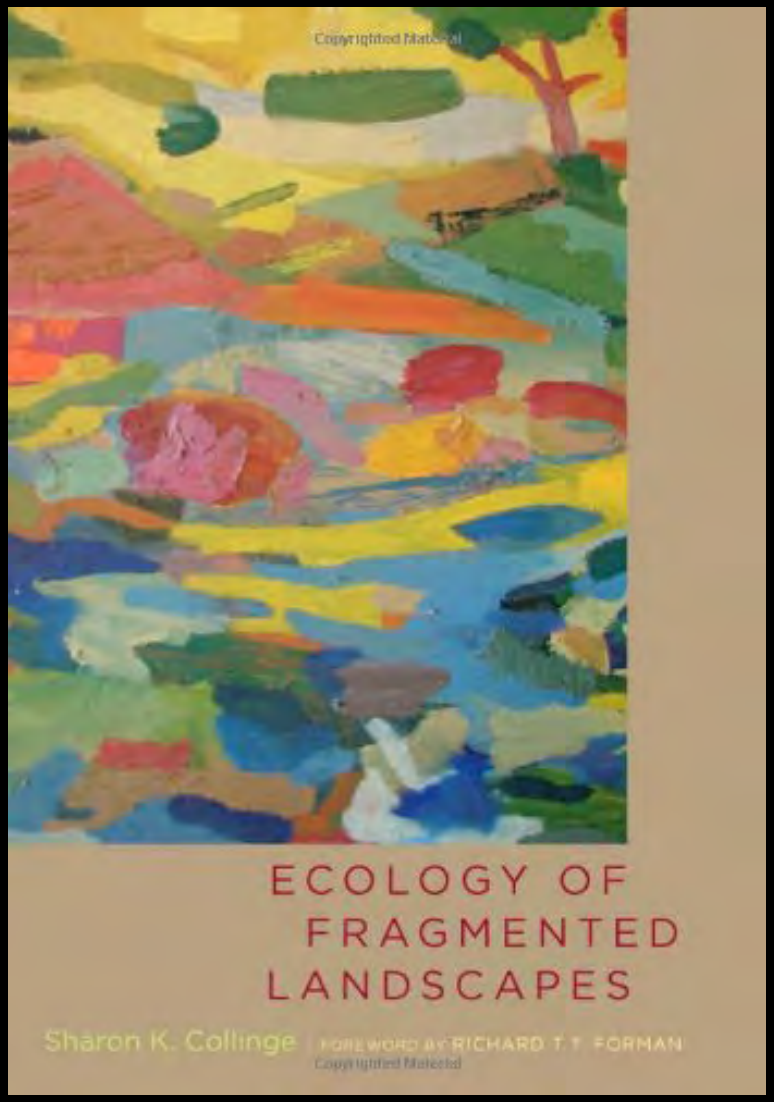
Isotope tools to track floodplain rearing of native fishes

Rachel C. Johnson[1,2] ,Ted Sommer[3], Anna Sturrock[4], Carol Kendall[5], Louise Conrad[3], Jamie Sweeny[6] & Jared Frantzich[3]

1 2 3 4 5 6

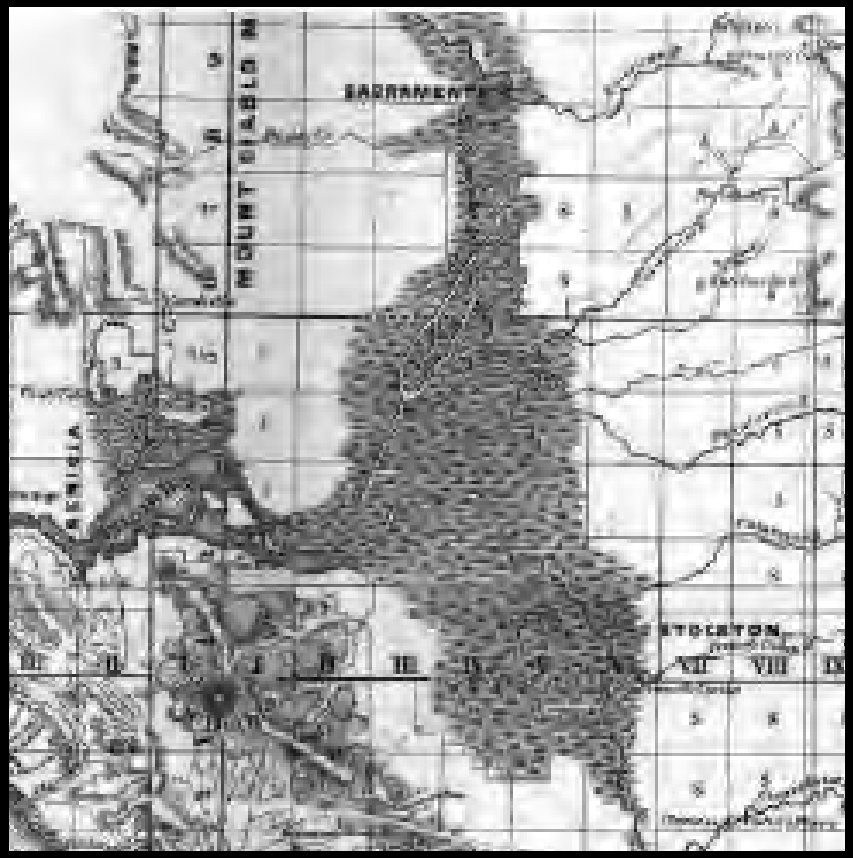
Fragmented landscapes



"The earth is increasingly an archipelago of habitat fragments in a sea of human development"

Altered landscapes

1856



Williams 2006

present

USGS

Sacramento River

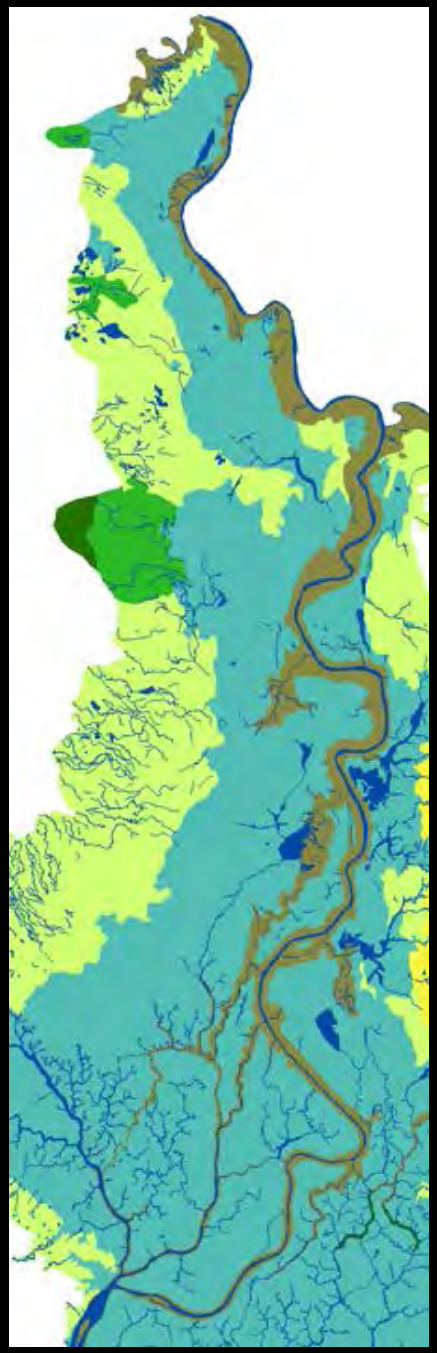
Yolo Bypass

Sacramento River

Sacramento-
San Joaquin Delta

San Francisco Bay

Slide courtesy of T. Sommer (DWR)



Historical Yolo Bypass Landscape

- Freshwater emergent wetland
- Wet meadow/seasonal wetland
- Valley foothill riparian

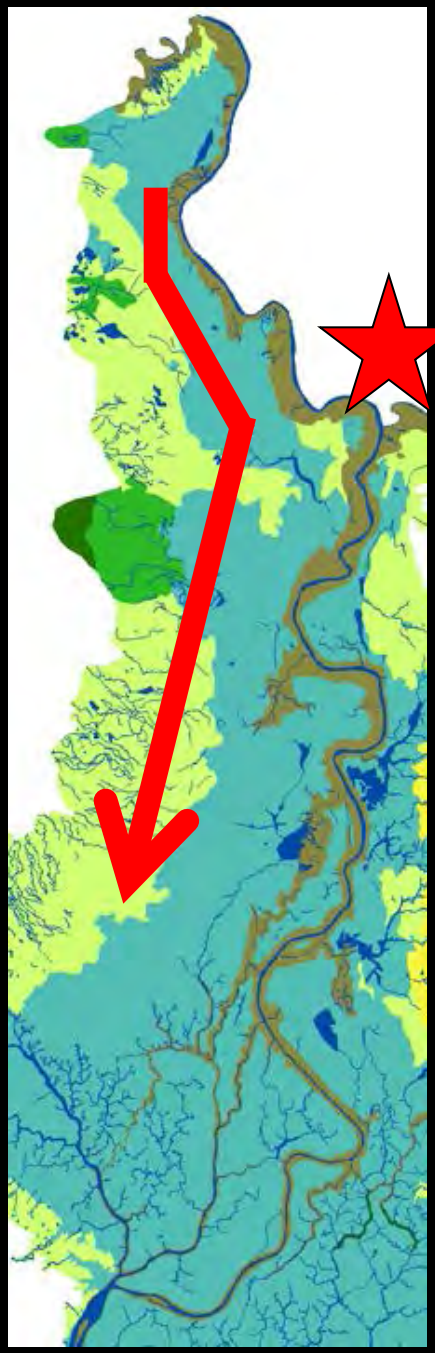
Whipple et al. 2012

K. STREET, FROM THE LEVEE.

INUNDATION OF THE STATE CAPITOL,

City of Sacramento. 1862.

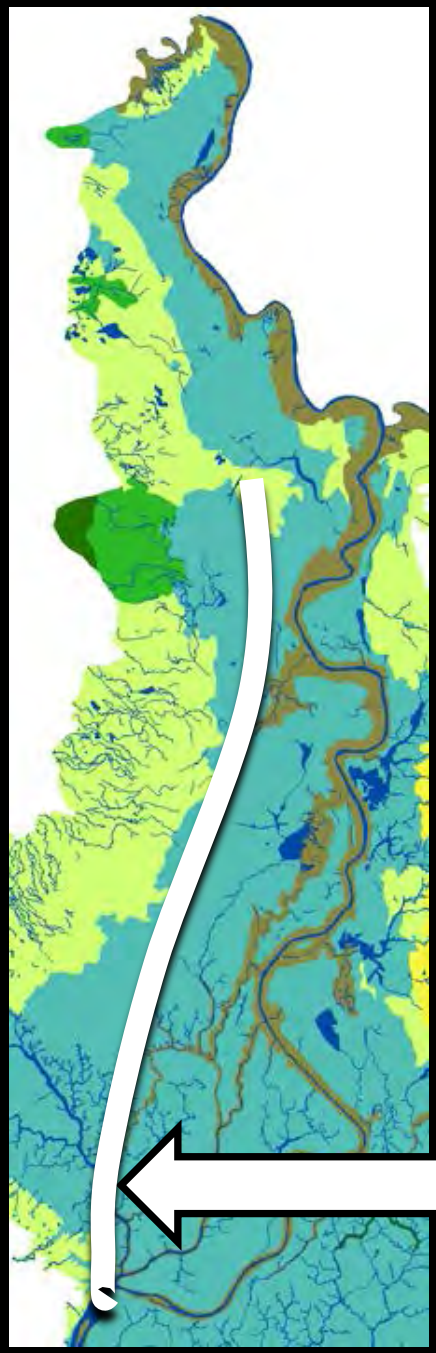
Published by A.H. OMEN PIELD, Sacramento



The Solution:

Guide Flood Waters Away From Valley Communities

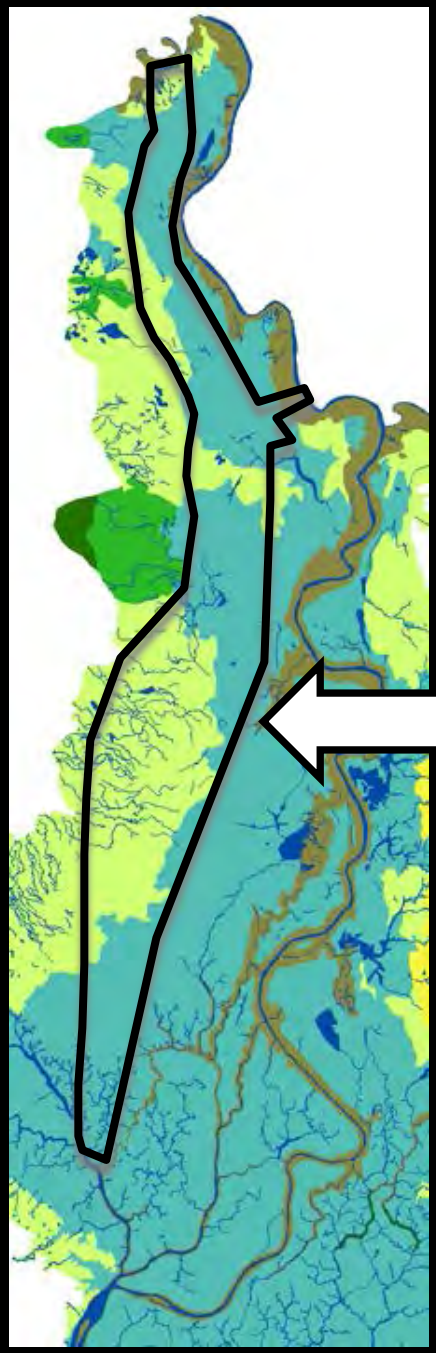
Yolo Bypass



Channelization

Slide courtesy of T. Sommer (DWR)

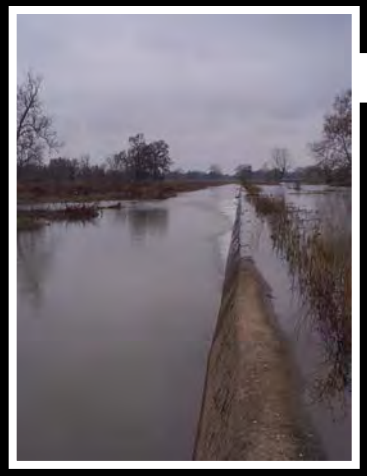
Yolo Bypass

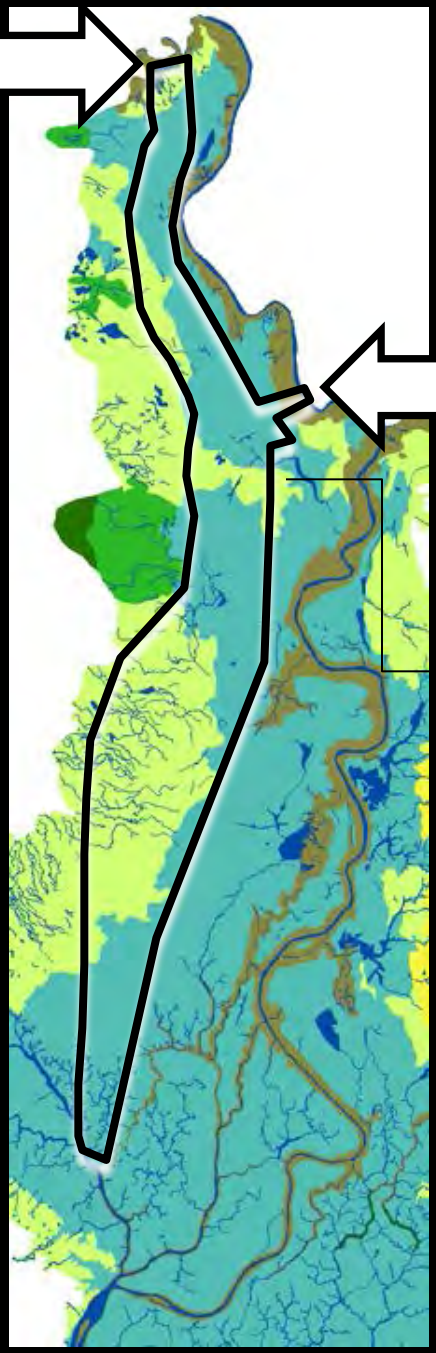


Levees

Channelization

Slide courtesy of T. Sommer (DWR)





Weirs

Levees

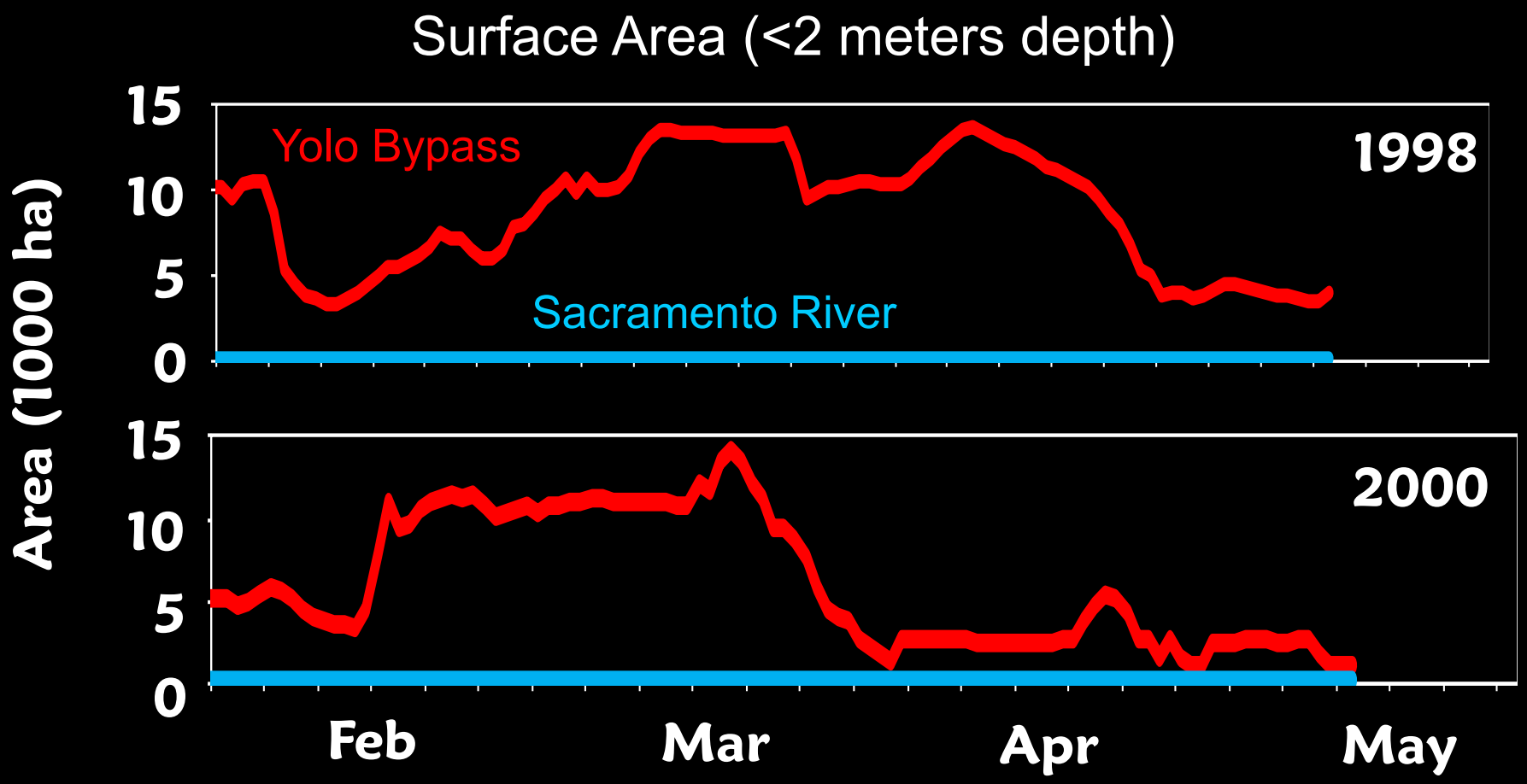
Channelization

Slide courtesy of T. Sommer (DWR)

Current Landscape

Slide courtesy of T. Sommer (DWR)

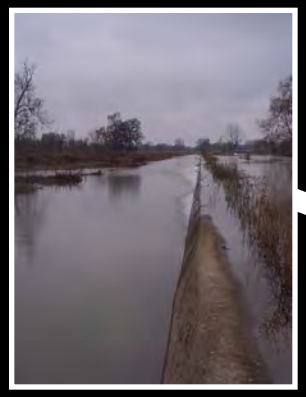
Beyond the Thin Blue Line- Rearing Habitat



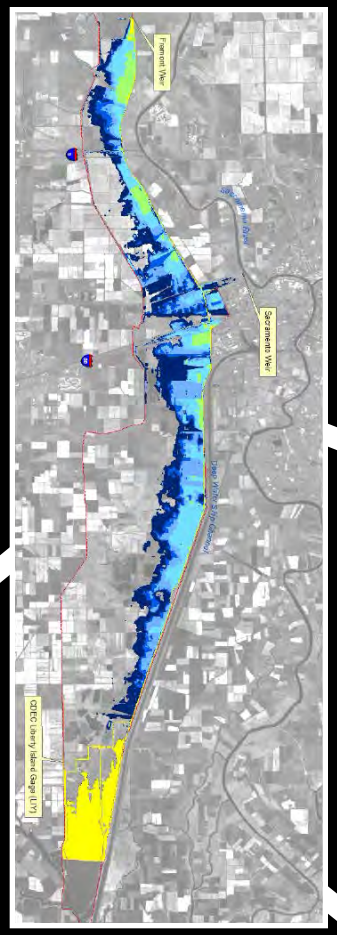
Sommer et al. 2004

Slide courtesy of T. Sommer (DWR)

Benefits of Yolo Bypass Inundation



Flood Conveyance



Fish Migration

Rearing Habitat

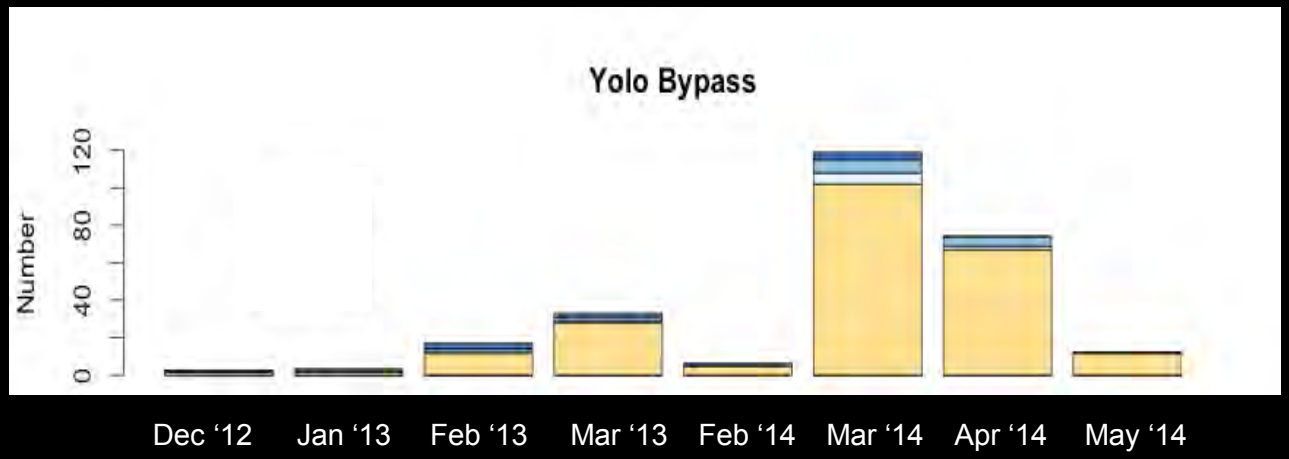
Food Web Exports to Estuary

Slide courtesy of T. Sommer (DWR)

We know A LOT about the Yolo Bypass floodplain

Google scholar search: >1000

Four salmon runs use the floodplain



Genetic ID
Fall
Late Fall
Spring
Winter

Data courtesy of Mariah Meek, UCD

Lots of food on the floodplain

Drowning in bug soup on the Yolo Causeway

Sacramento Bee/José M. Osorio

Fred David of Santa Rosa cleans the bugs off his windshield at the Union 76 station off Mace Boulevard in Davis. The place is buzzing at nightfall, when the swarms attack.

By Matthew Barrows
BEE STAFF WRITER

Back-seat driver

A weekly column about transportation issues in the region

You'd expect the area around the Yolo Causeway to be a bit buggy, what with all the rice fields, duck ponds and standing water to make insects feel right at home.

But travel the causeway between 8:30 and 9:30 p.m. and you quickly realize that "buggy" is an understatement. A better word is "biblical."

About midway across the bridge, motorists are being engulfed by clouds of tiny, winged insects performing kamikaze missions against the windshield.

Truckers pull over to the side of the road to remove thousands of carcasses blocking their view. Motorists desperately turn their wipers to the "full" position in a futile attempt to remove the gooey mess. And everyone wonders what in the name of hellfire and damnation is going on.

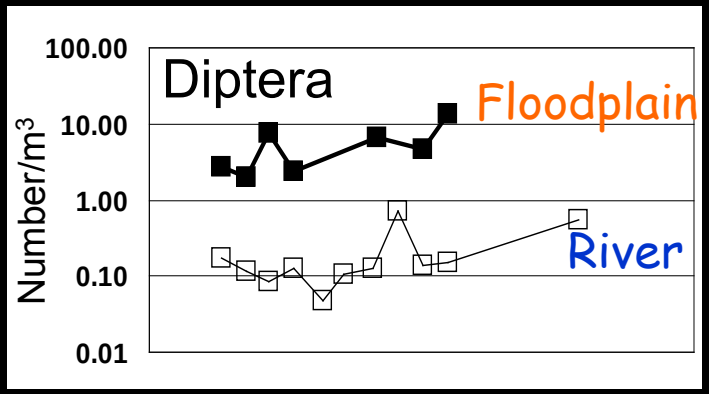
Try as they might, they can't escape the swarm.

The Back-seat Driver witnessed the phenomenon, or at least its grisly aftermath, one day last week at the Union 76 gas station off Mace Boulevard in Davis. (I took one of The Bee's cars, of course.)

The 76 is the first station after the causeway for drivers heading west on Interstate 80, and once the sun goes down, it's buzzing with activity.

About 8:15 p.m., employee Mike Cecil went out to change the soap and water in the squee-

▶ BUGS, page B2



Sommer et al. 2004; Benigno and Sommer 2008

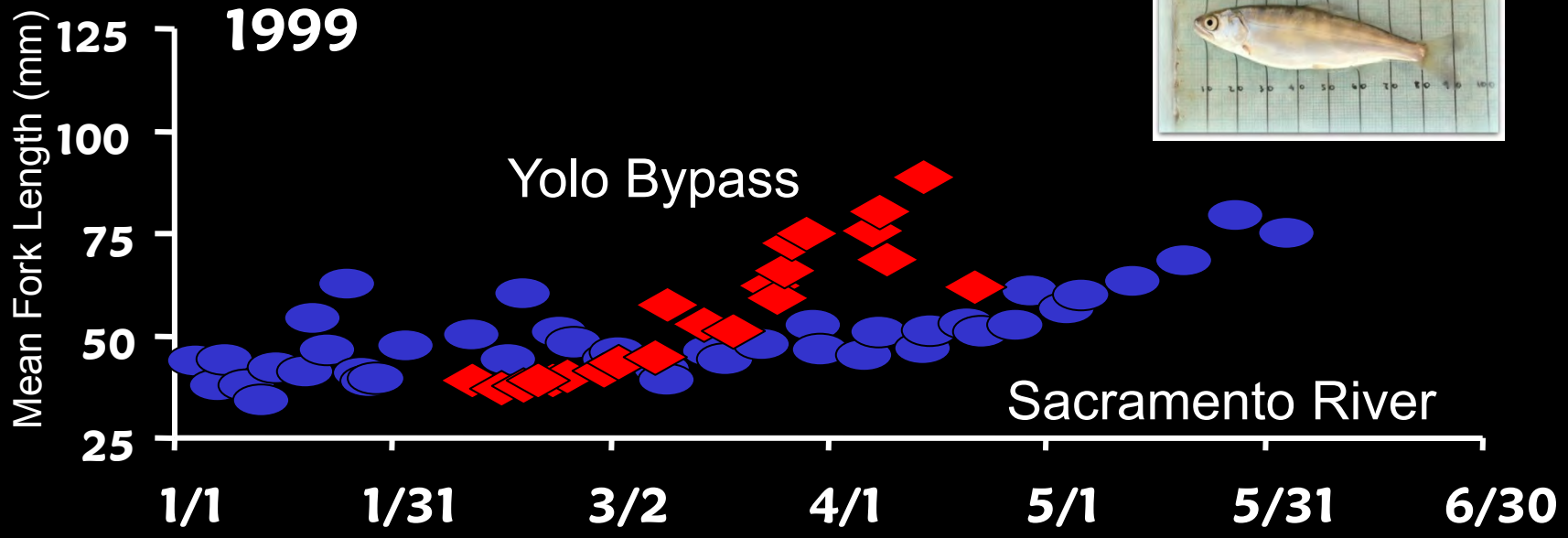
We know A LOT about the Yolo Bypass floodplain

Salmon have higher survival

Floodplain rearing of juvenile chinook salmon: evidence of enhanced growth and survival

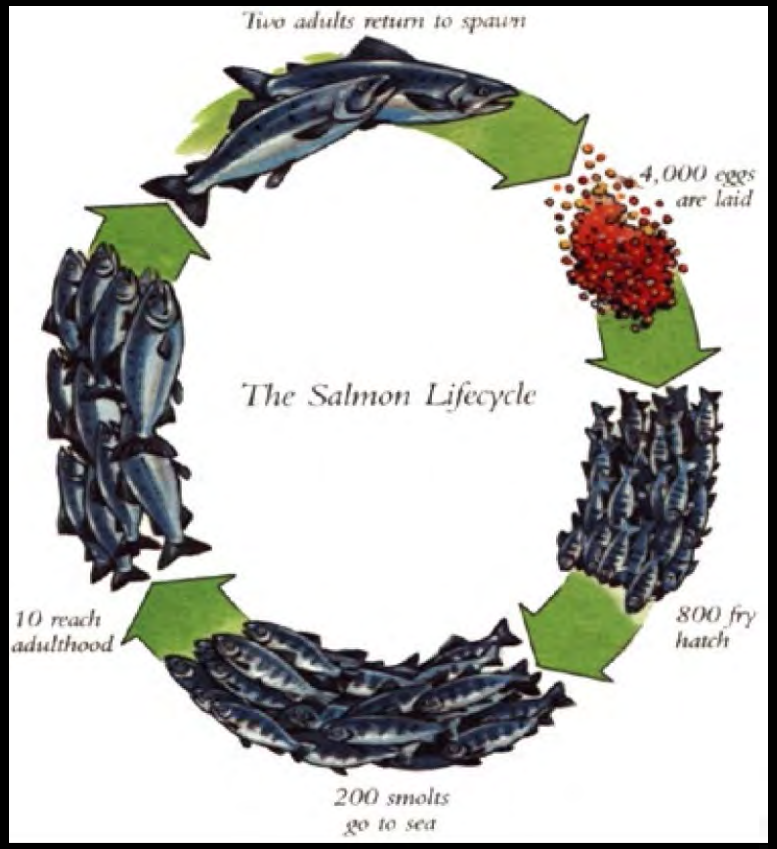
T.R. Sommer, M.L. Nobriga, W.C. Harrell, W. Batham, and W.J. Kimmerer

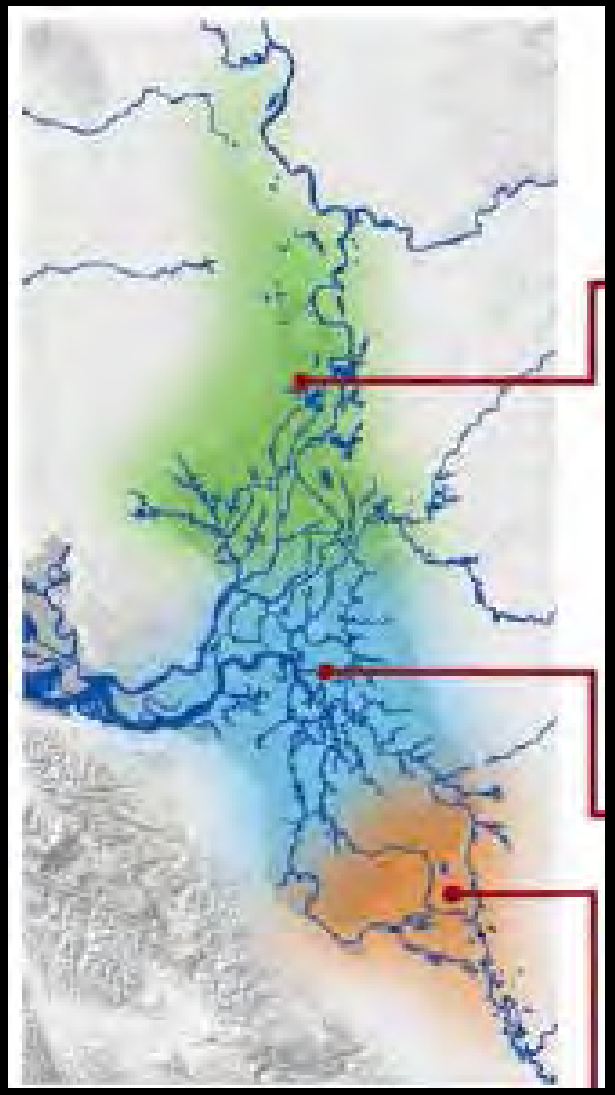
Salmon grow better



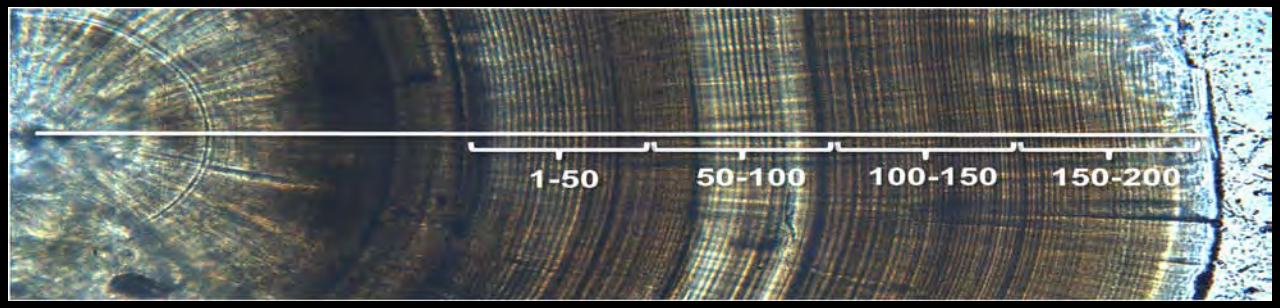
Sommer et al. 2001

Freshwater and marine habitat linkages

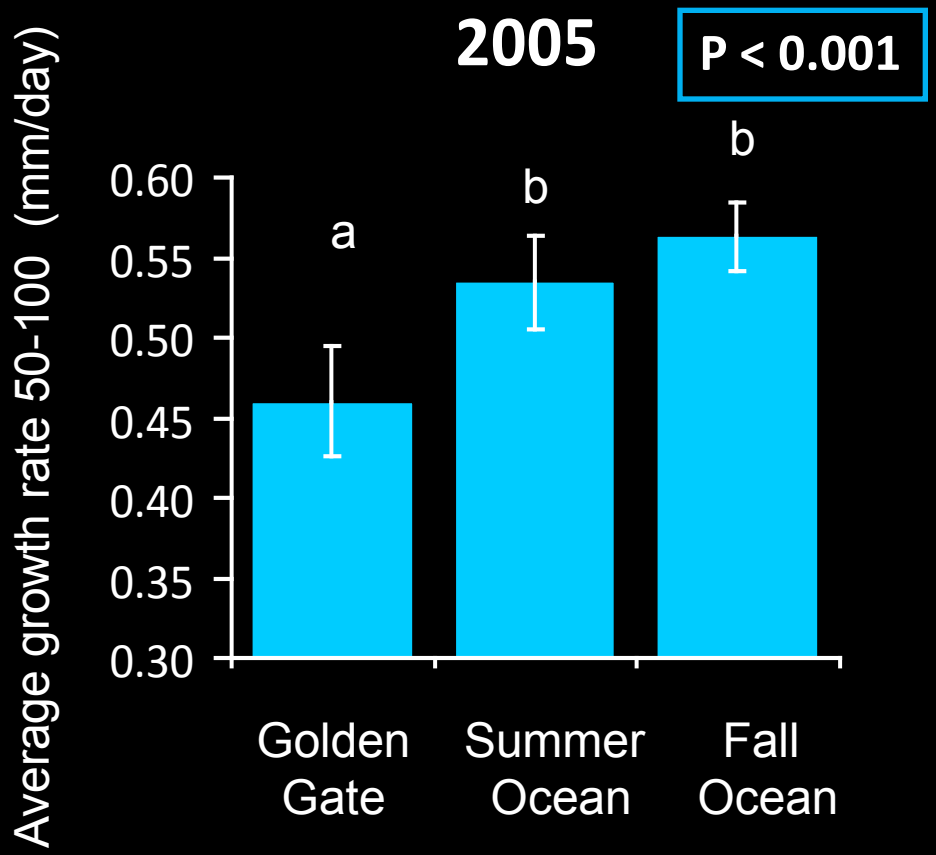




SFEI 2012



Delayed freshwater growth benefits



Woodson et al. 2013

Outstanding Questions

1. Are their delayed survival benefits to floodplain rearing?

2. How can we quantify the benefit of the floodplain over the lifetime of a fish? At a population level?

…….Floodplain marker

Benefit of floodplain marker

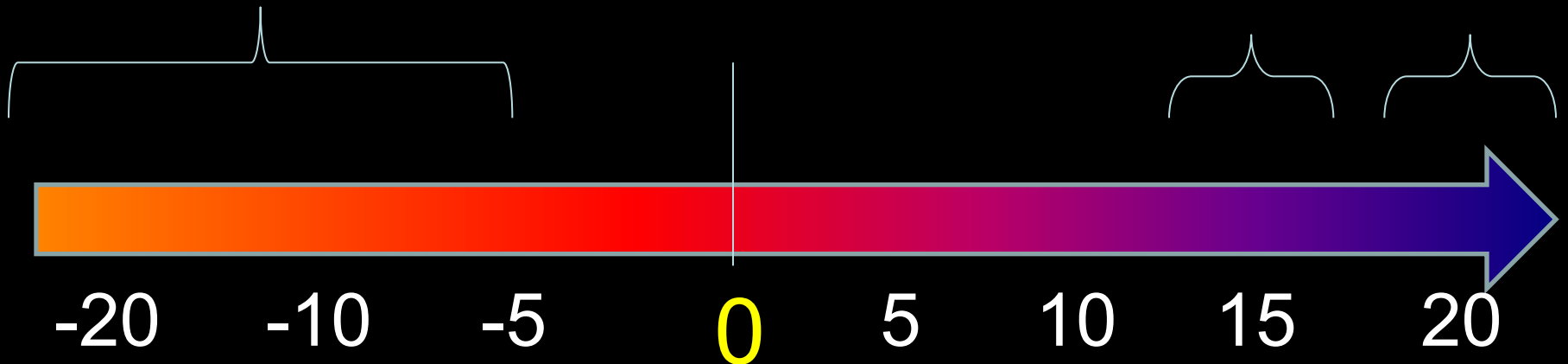
Photos courtesy of USFWS

Inundated rice fields

Conceptual model for sulfur isotopes

Anoxic wetland & rice fields

fertilizer seawater



Sulfur Isotopes in Chinook Salmon Diet

Hatchery

vs.

River

80-90% marine protein

$\delta^{34}S$ ~ +15 ‰

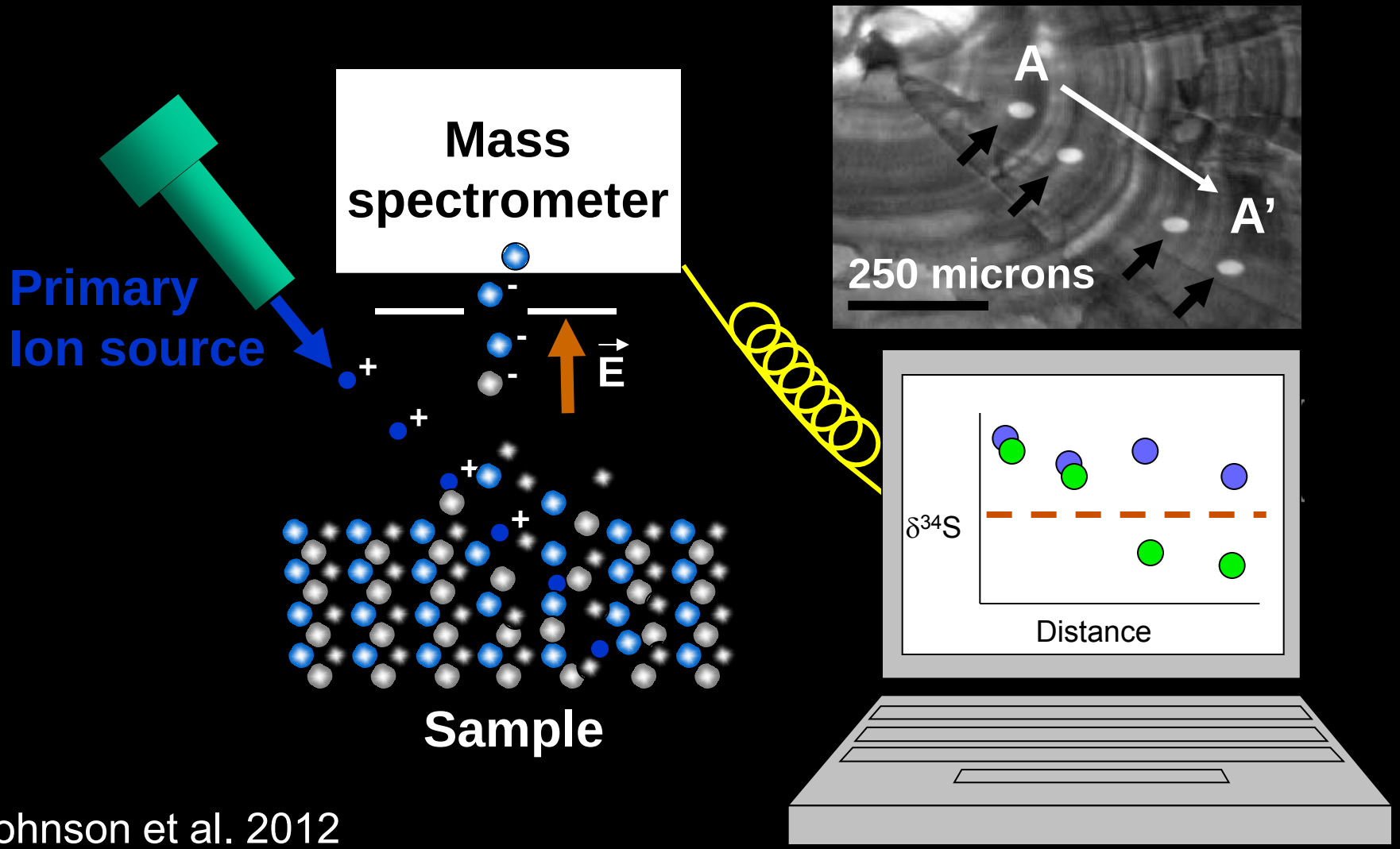
Freshwater prey

$\delta^{34}S$ ~ +2 ‰

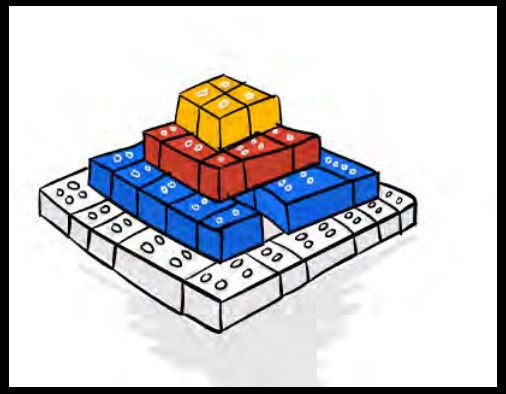
Weber et al. 2002, Johnson et al. 2012

Sulfur Isotopes Otoliths

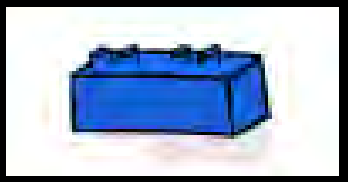
Secondary Ion Mass Spectrometry



Johnson et al. 2012



Questions

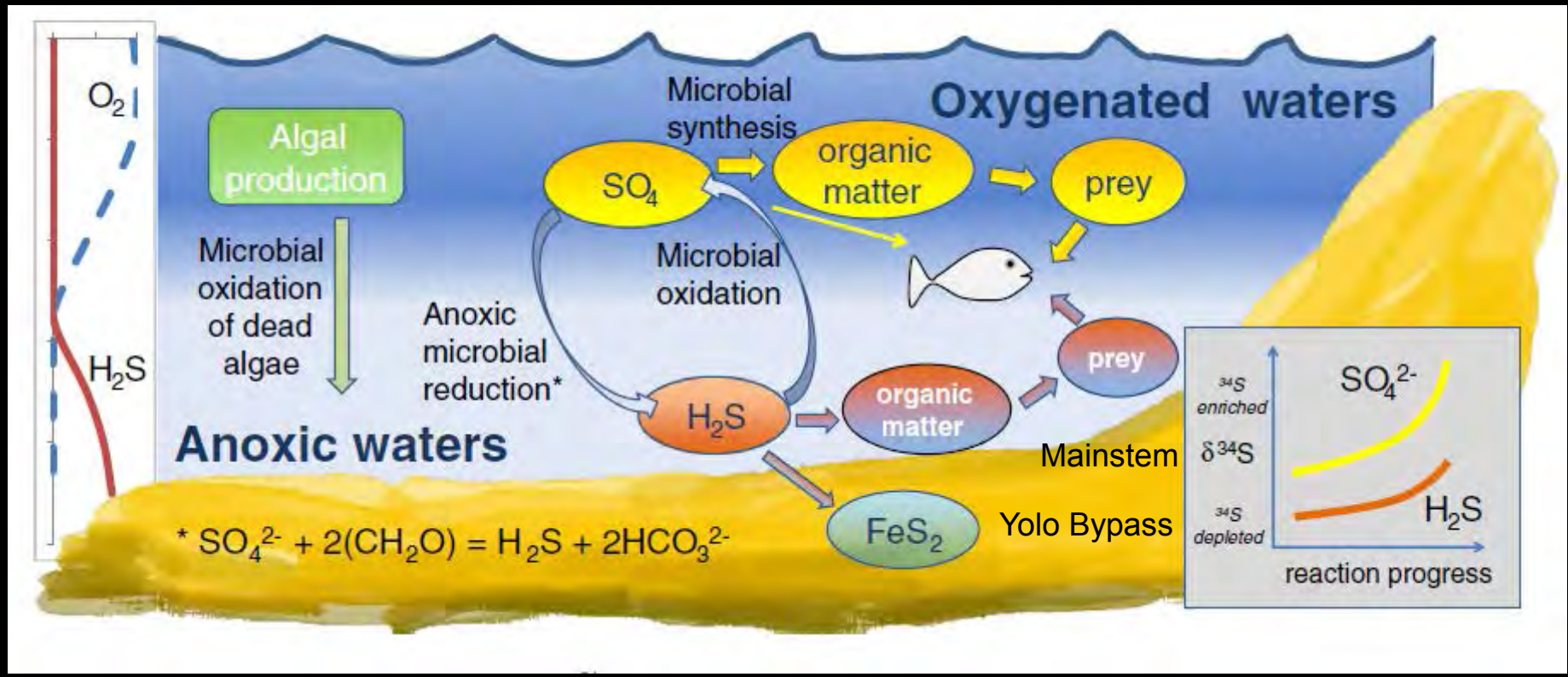


1) Do we see light and distinct $\delta^{34}S$ in the organic matter (POM) from the Yolo Bypass?

2) Do we see light and distinct $\delta^{34}S$ in the stomach contents of salmon on the Yolo Bypass?

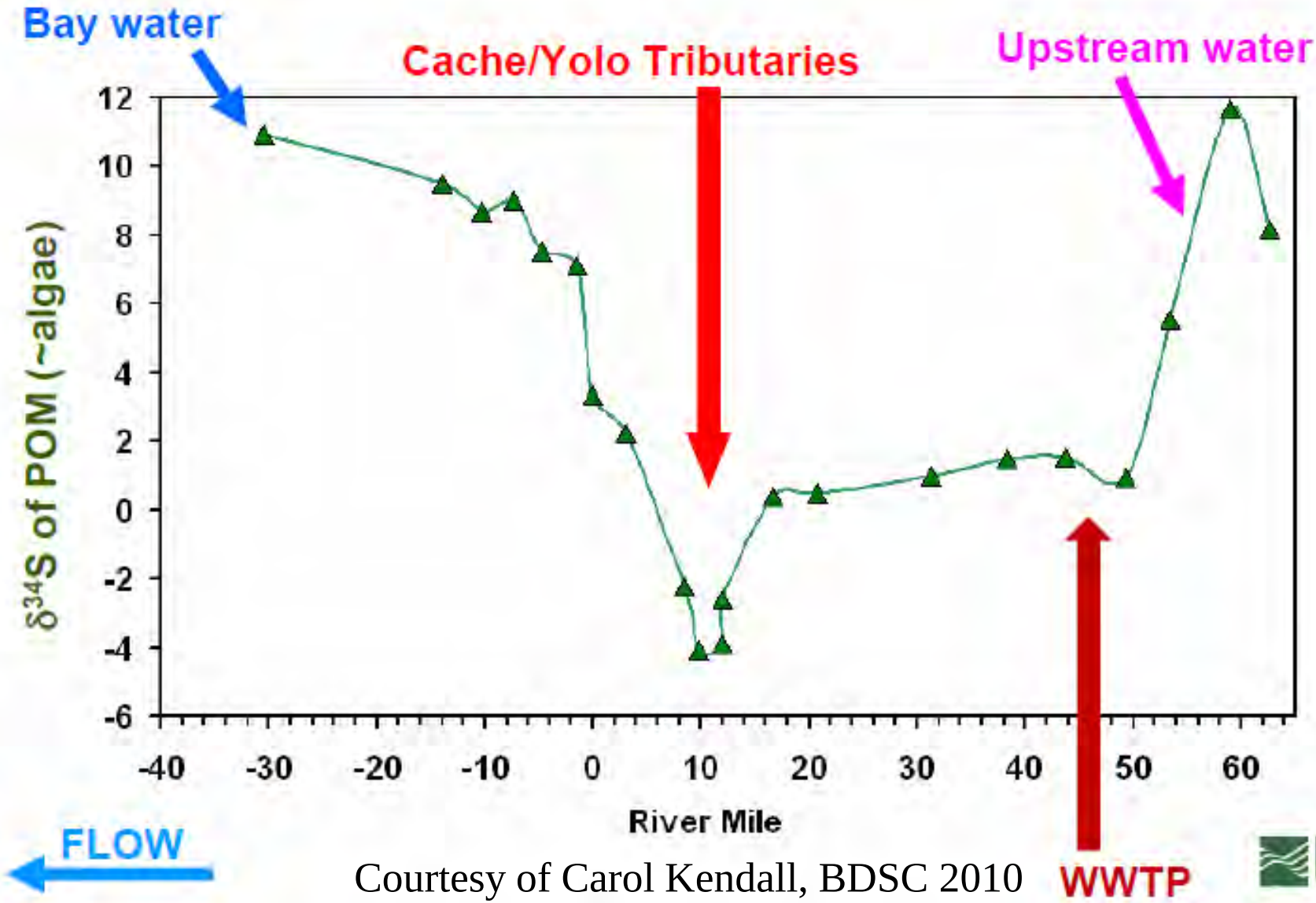
3) Do we see light and distinct $\delta^{34}S$ in the muscle/fin of fish rearing on the Yolo Bypass?

Conceptual model for sulfur isotopes



Limburg et al. 2014

$\delta^{34}S$ is a useful tracer of algae source because the 4 main sources of SO4 have distinctive $\delta^{34}S$ values.



Courtesy of Carol Kendall, BDSC 2010

USGS

Juvenile Chinook salmon sampling

Delta Juvenile Fish Monitoring Program

2012-2014

Yolo Bypass And Its Sources

1 Fremont Weir

2 Cache Creek

3 Sacramento Weir

Verona

Discovery Park

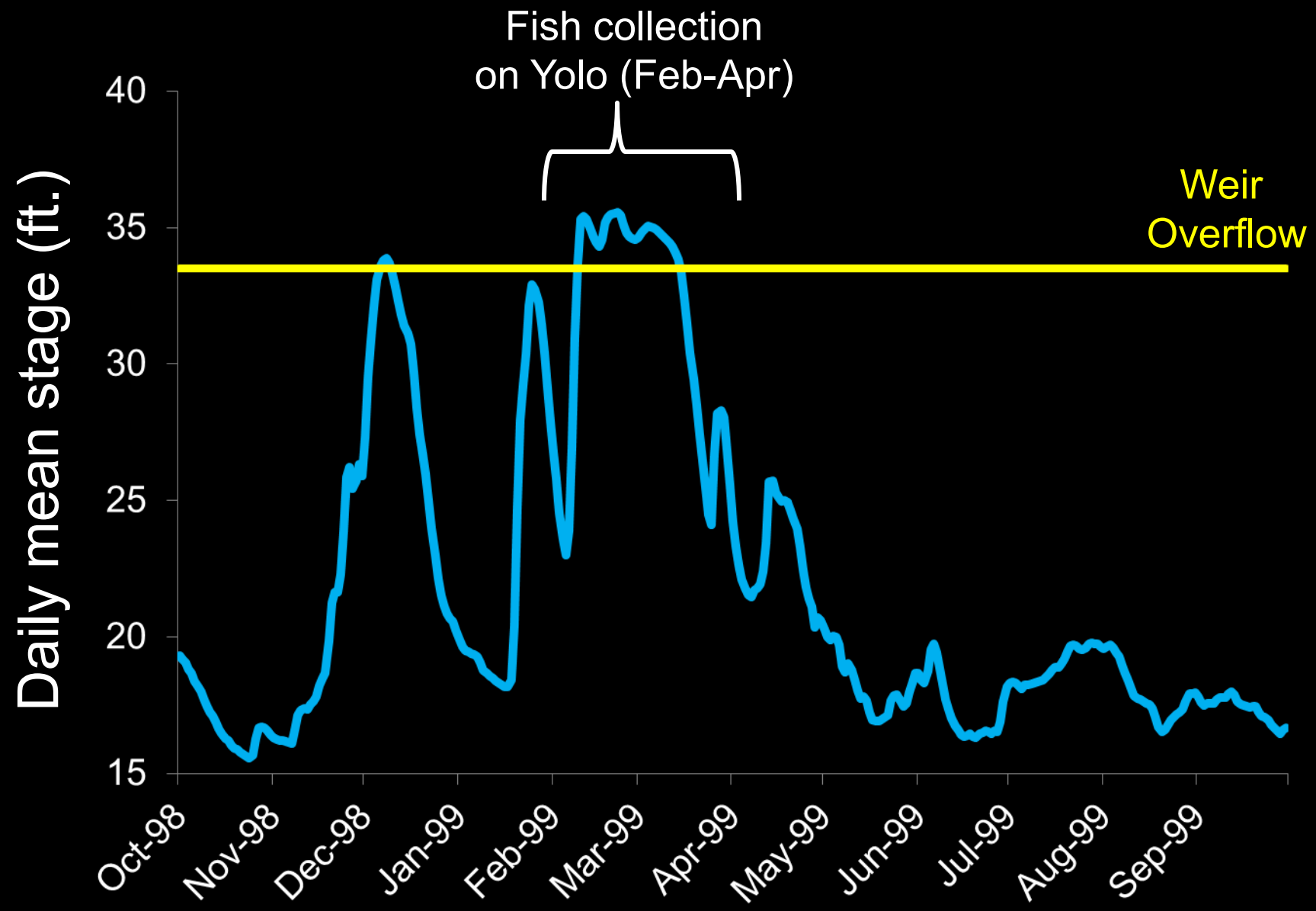
Sherwood Harbor (Sac Trawl)

Garcia Bend

R

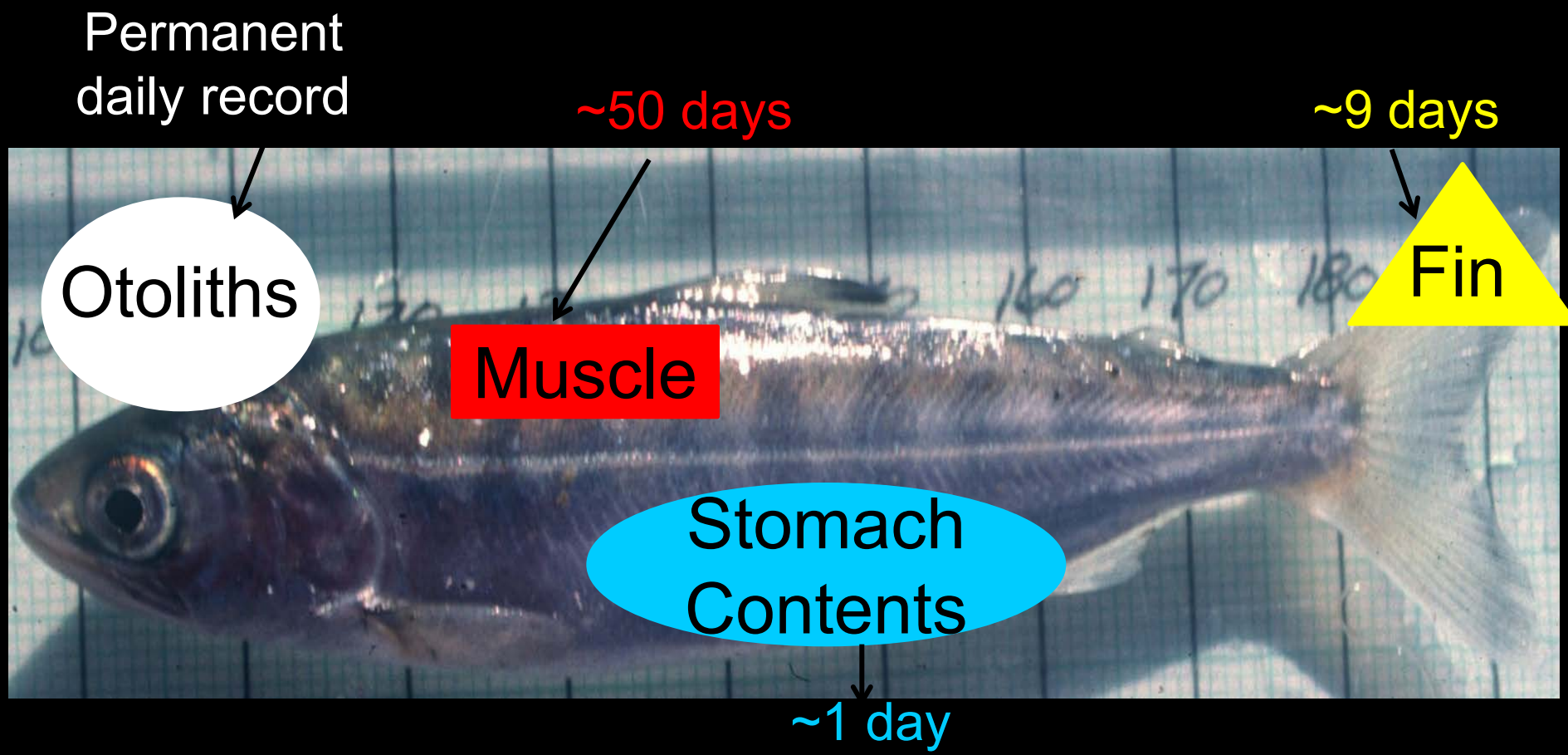
1999

Daily Mean Stage at Fremont Weir



Data source: cdec

Tissue samples collected



Heady and Moore 2012

Stomach contents

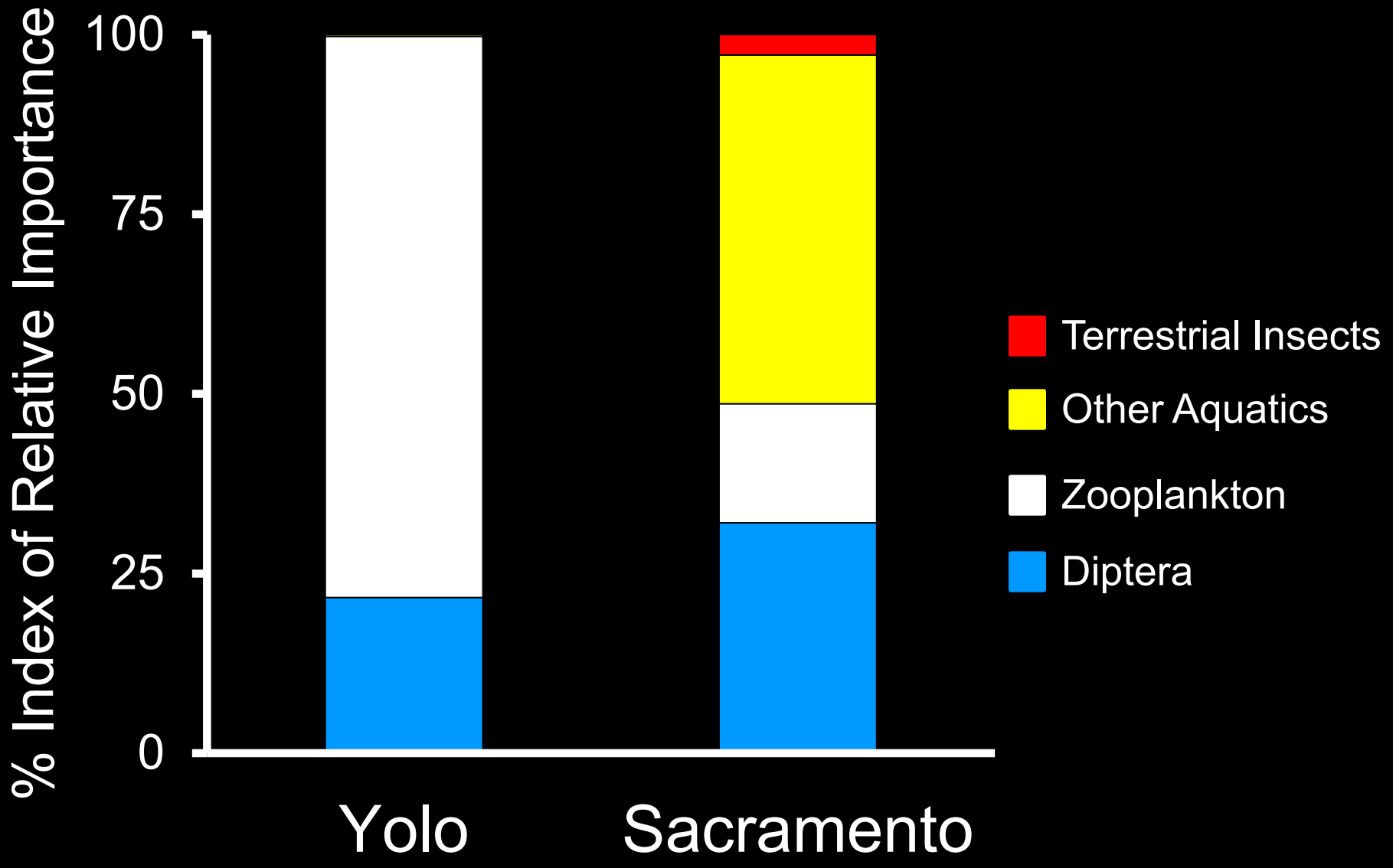
Diptera

Zooplankton

Terrestrial prey

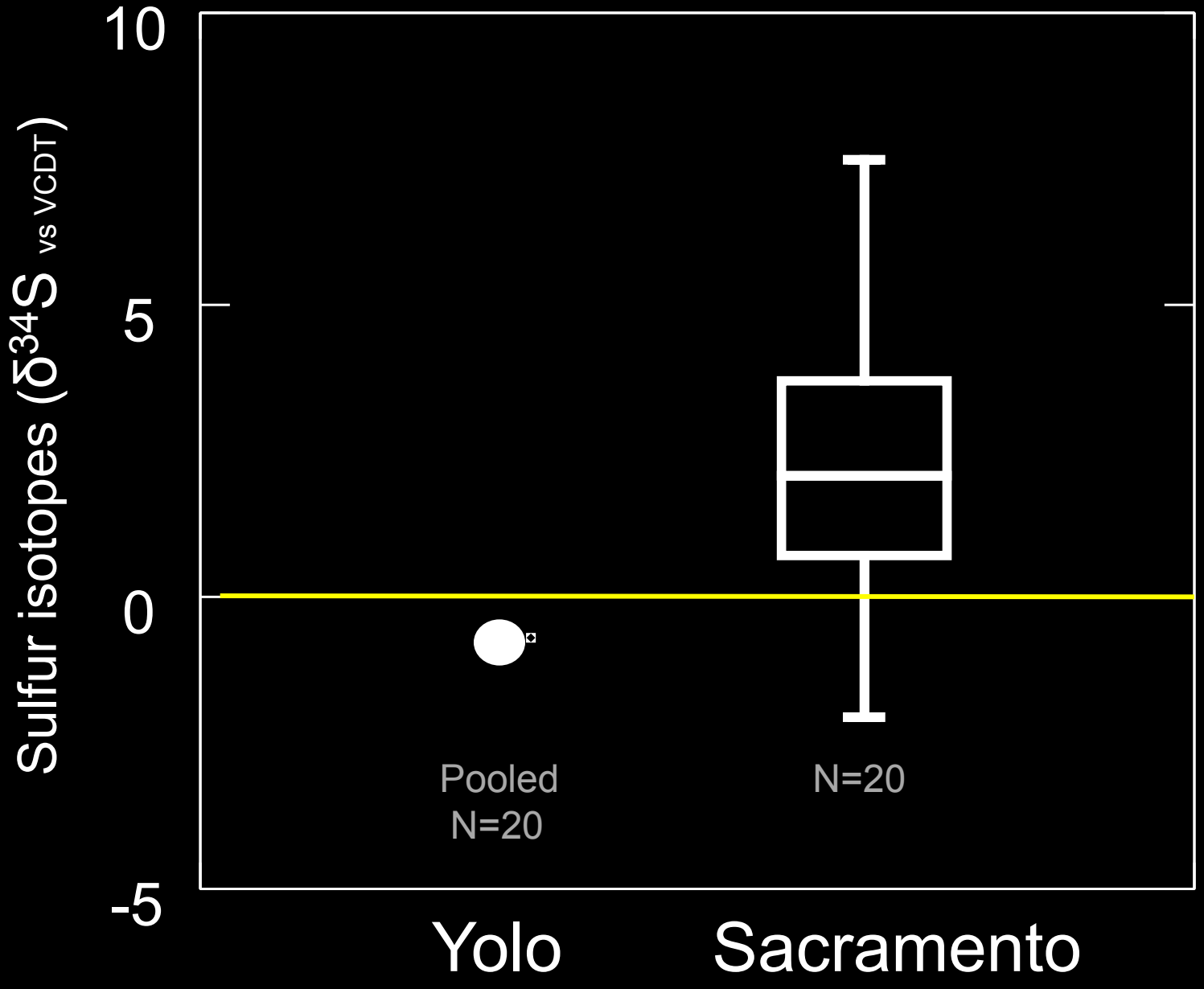
Other aquatic prey

Stomach contents

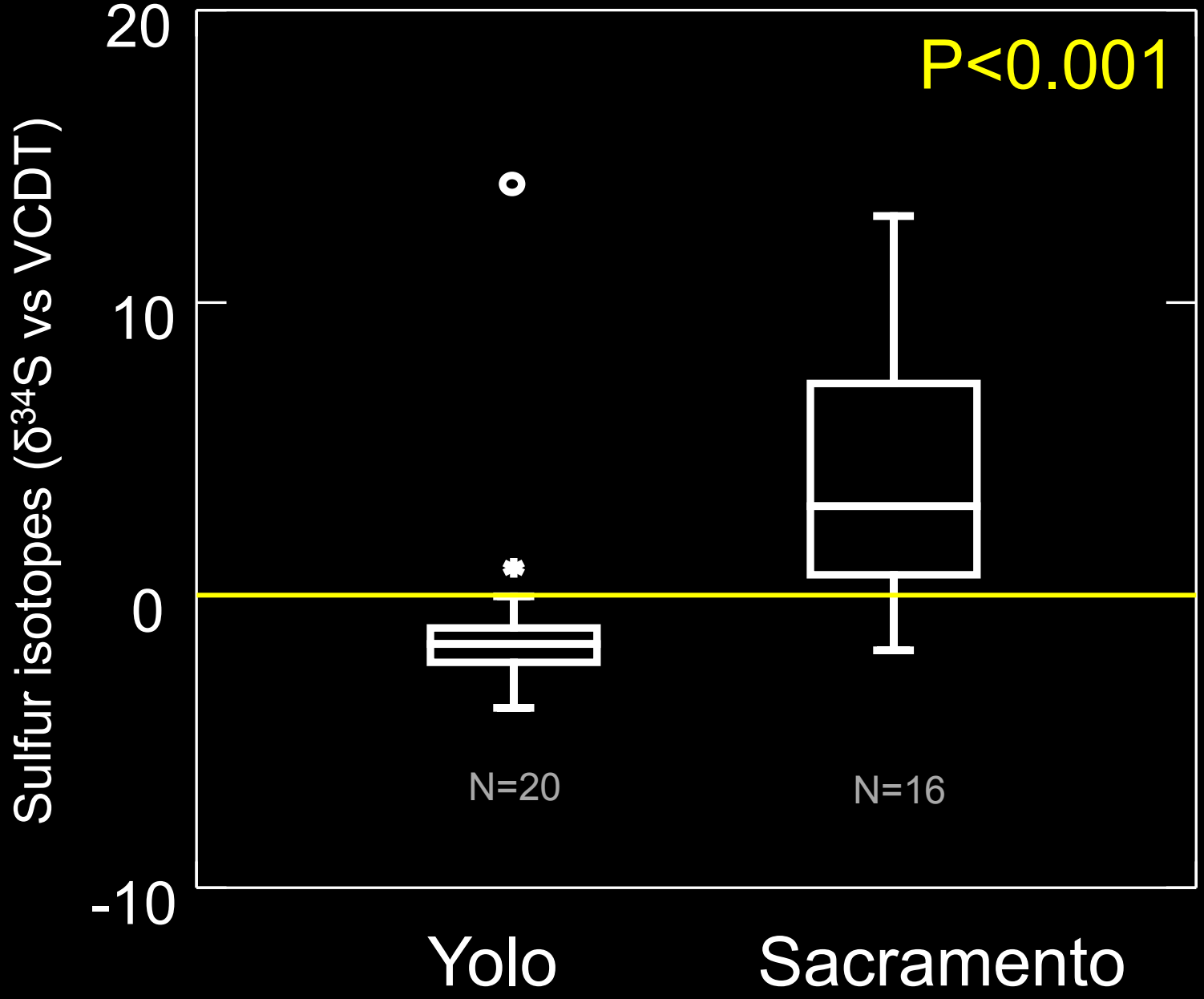


IRI= (% Abundance + % Weight) x Frequency

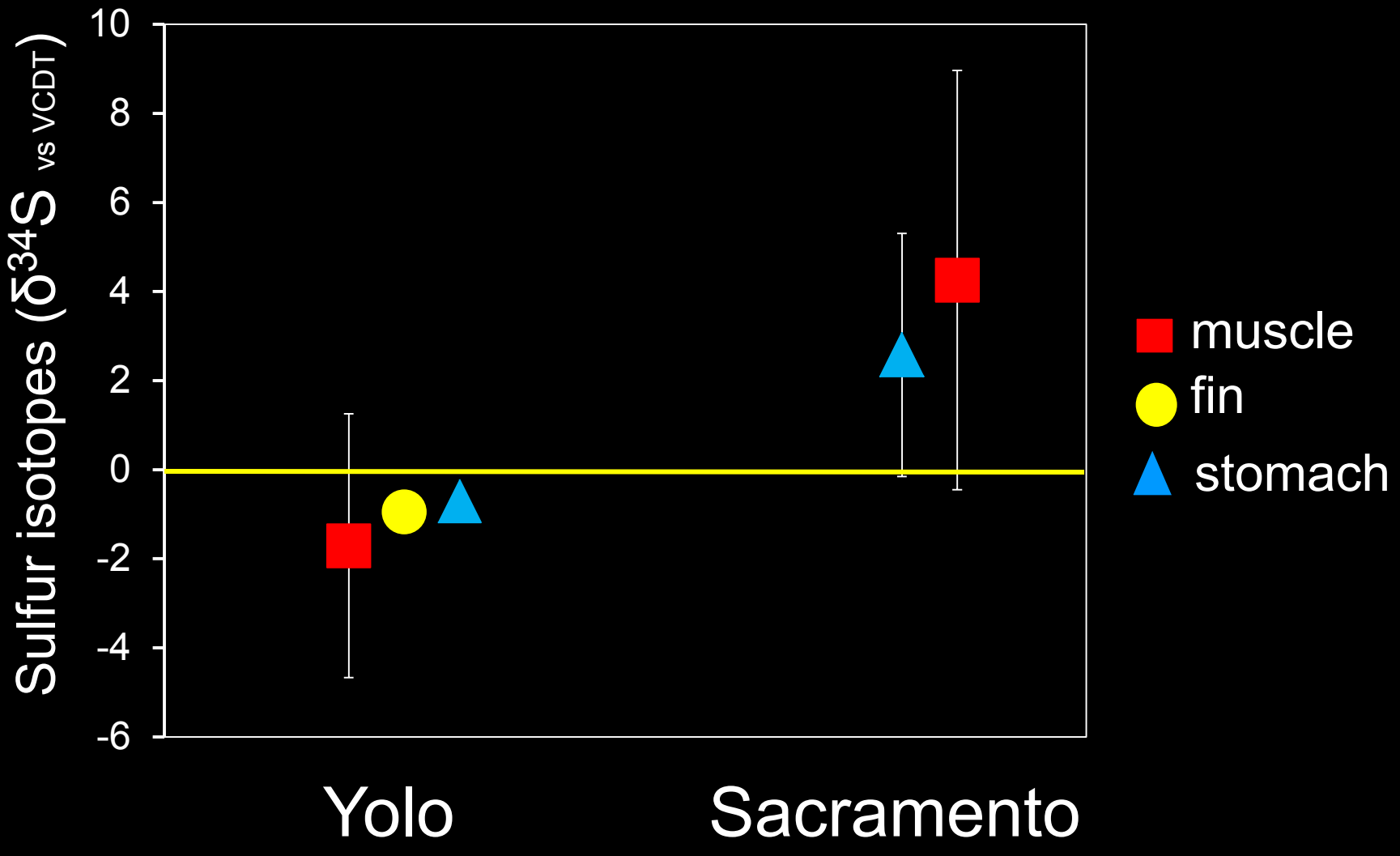
Stomach contents sulfur isotopes



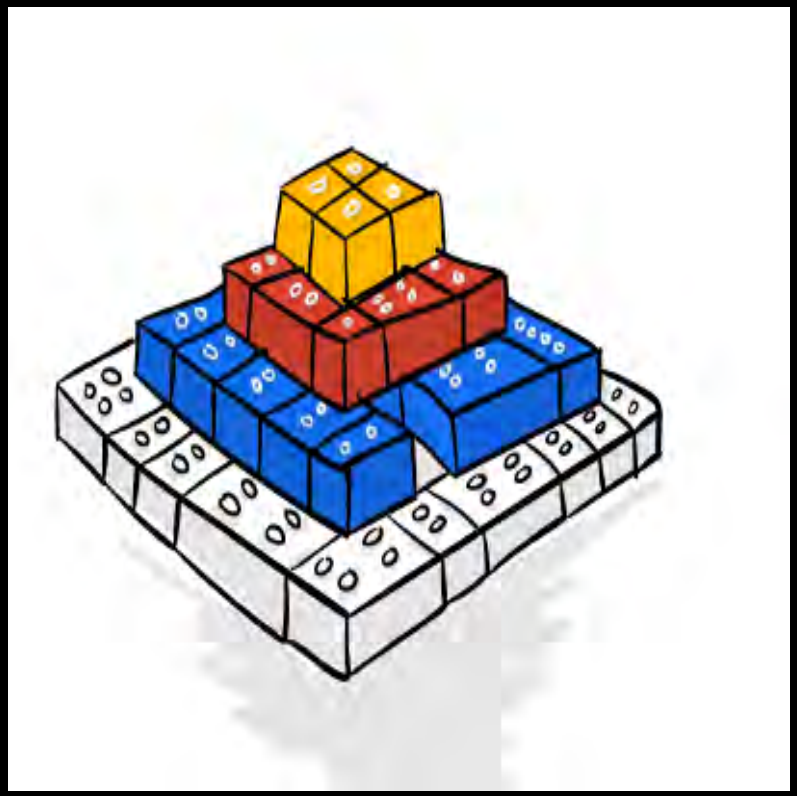
Muscle sulfur isotopes



Tissue sulfur isotopes



Summary & Next Steps



Yolo Bypass has lighter $\delta^{34}S$ than Mainstem Sacramento River in fish tissues!

Expand study- Yolo POM, Knaggs Ranch, San Joaquin River, Sacramento splittail, and hope for RAIN!

$\delta^{34}S$ otolith

Thank you!

Special thanks to: USFWS Delta Juvenile Fish Monitoring Program field crew! Jack Ingram, Denise Barnard, George Whitman (UCD)