Using Otoliths to Reconstruct Habitat-Specific Growth Patterns for Endangered Winter-Run Chinook

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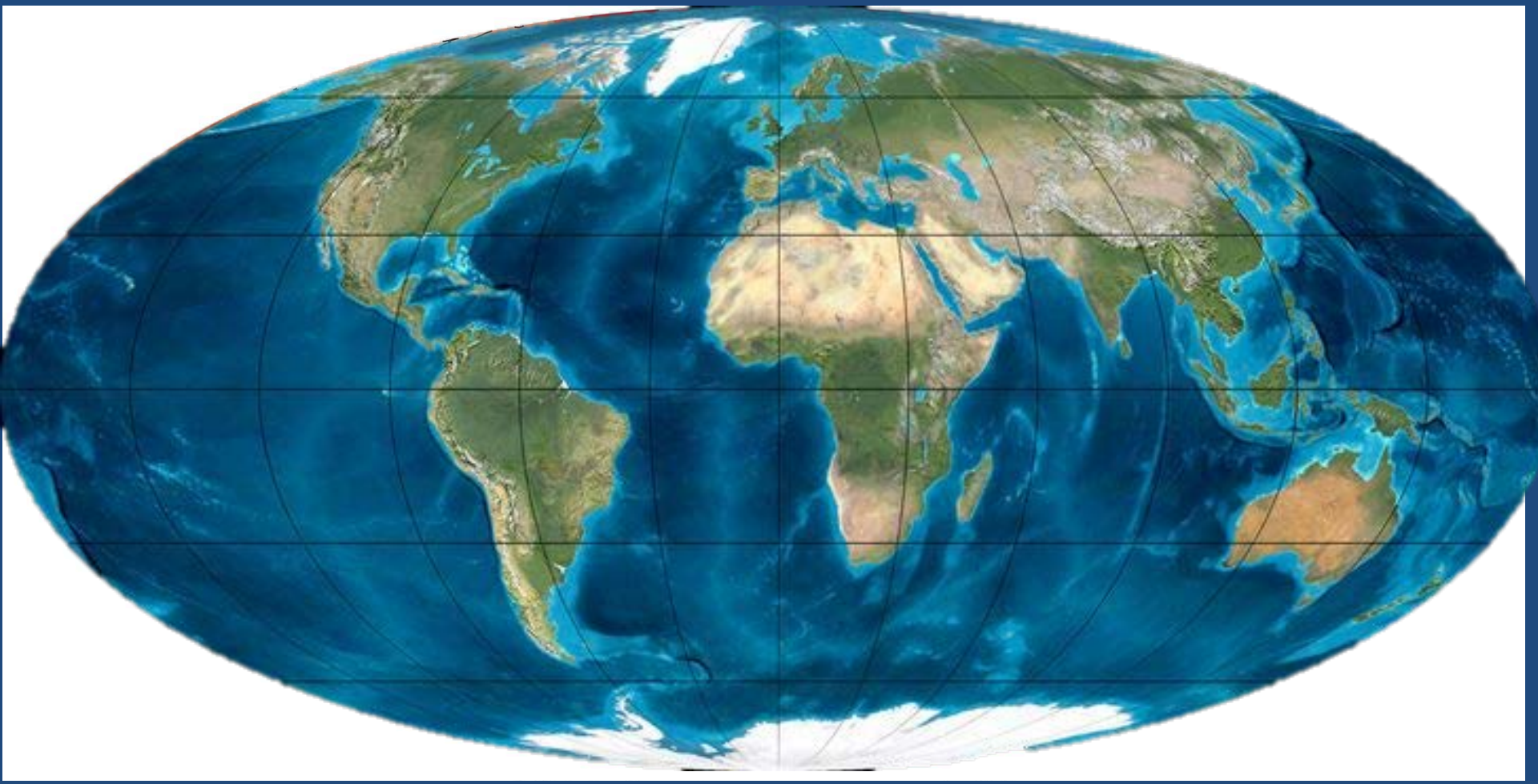
NOAA FISHERIES SERVICE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

UNIVERSITY OF CALIFORNIA SANTA CRUZ

We live in a changing world…



Increased environmental variation

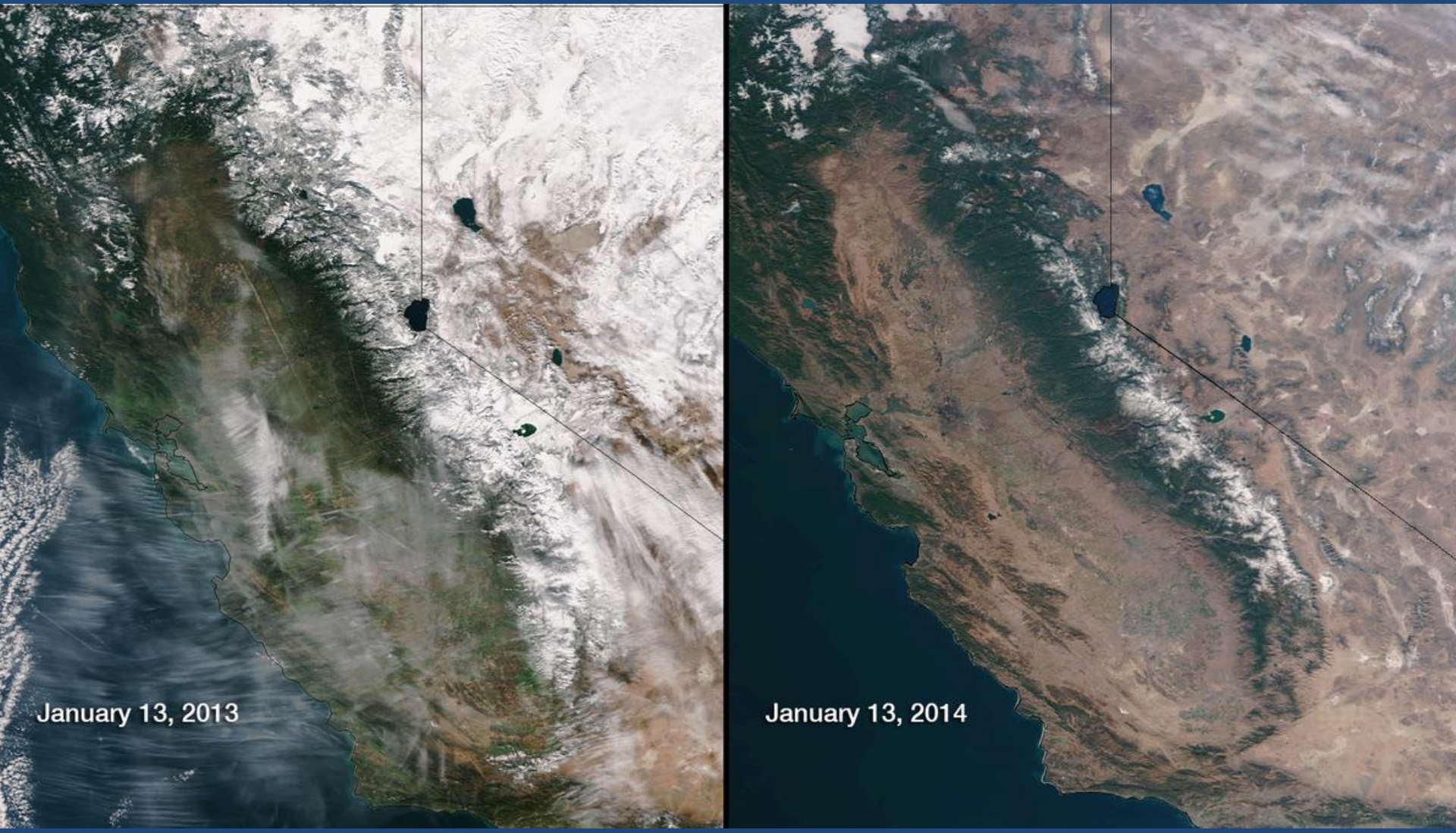


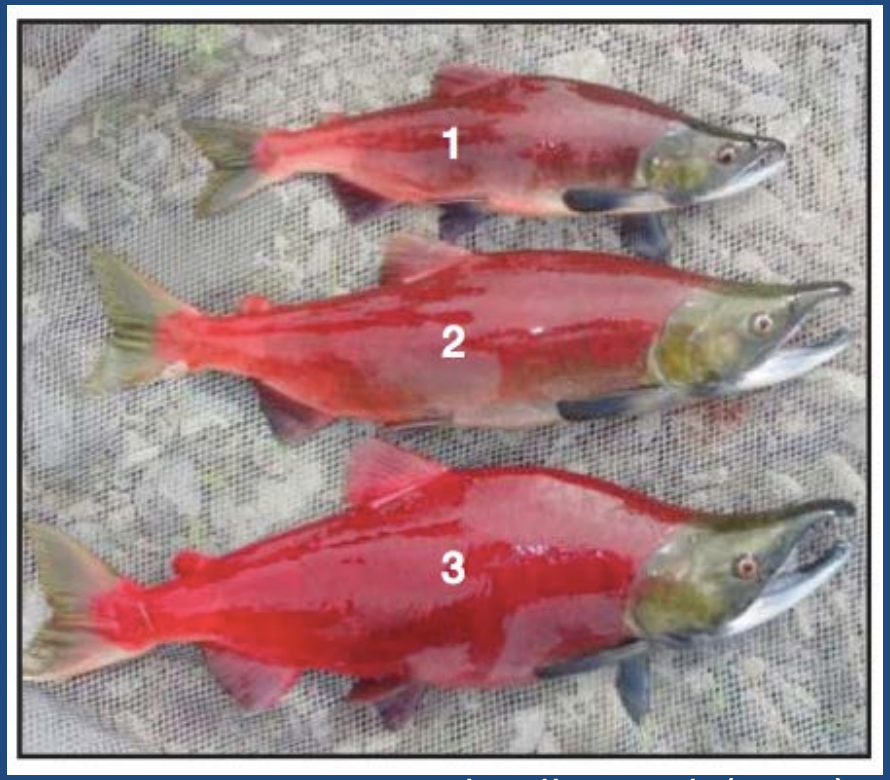
Photo: NASA

Anthropogenic Influences

How will populations cope?

Multiple **life history strategies** and **multiple populations**:

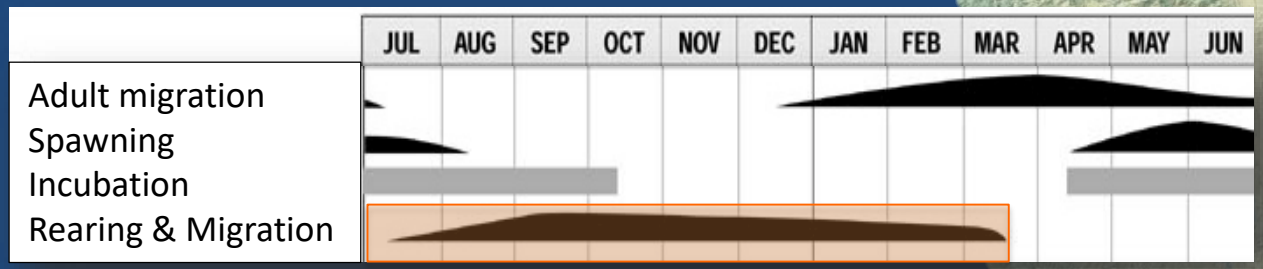
- Dampen interannual variability in abundance
- Provide a measure of stability within a population/species



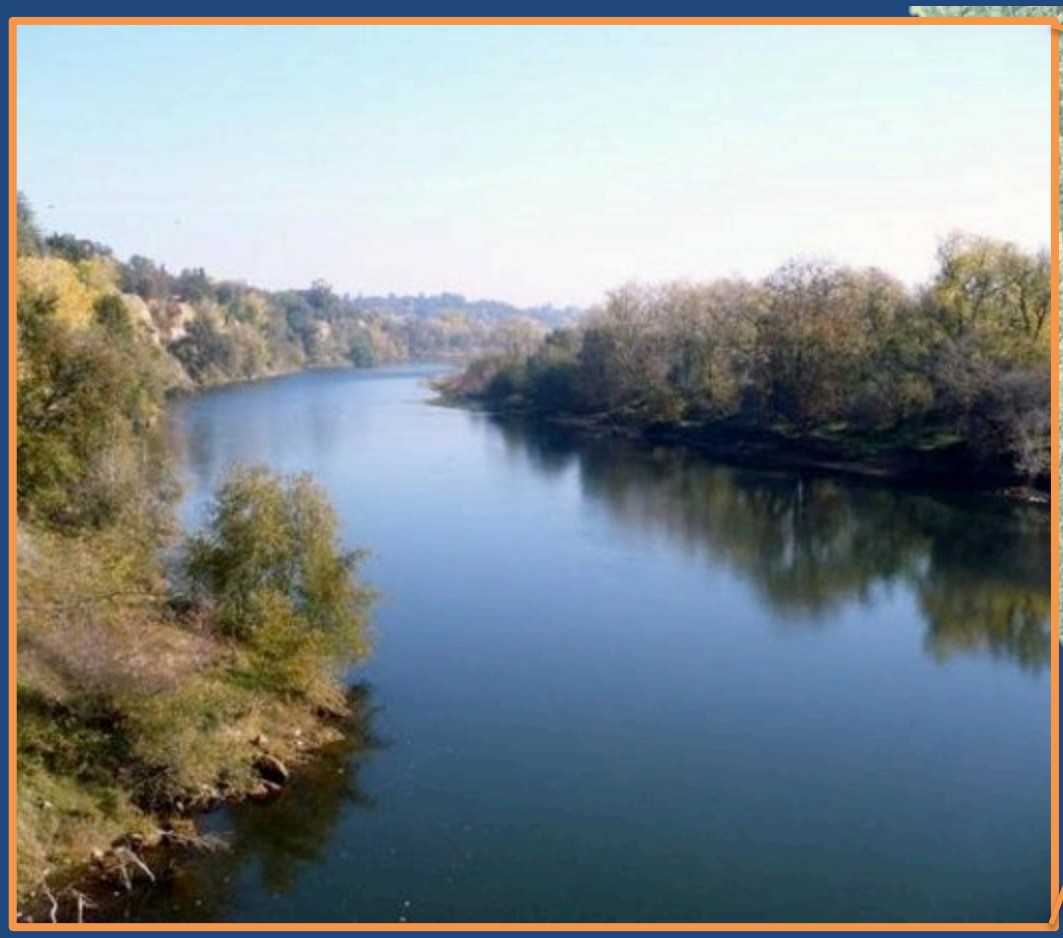
Schindler et al. (2010)

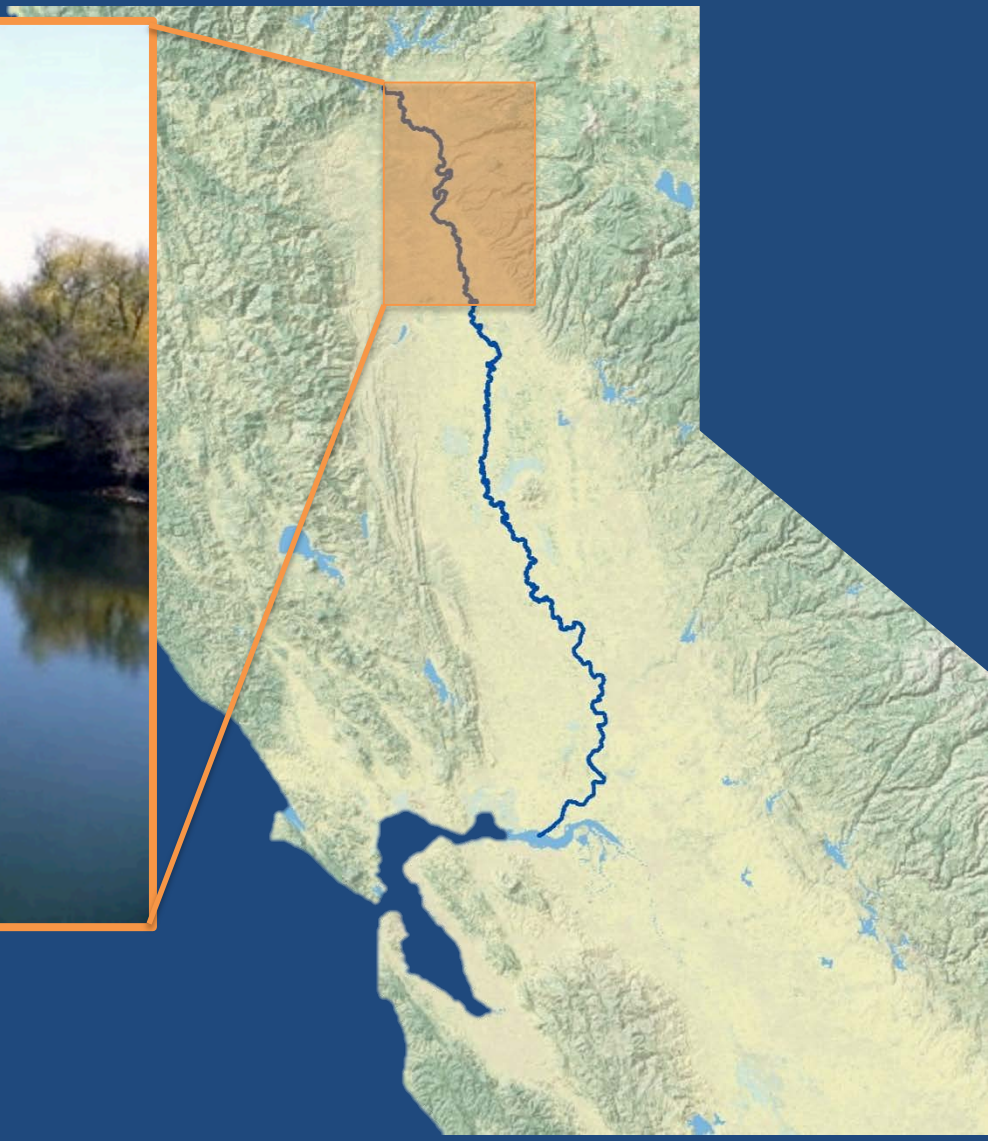
What if you are a winter-run Chinook?

Timing, protraction, & geographic extent



Rearing habitats & movement timing



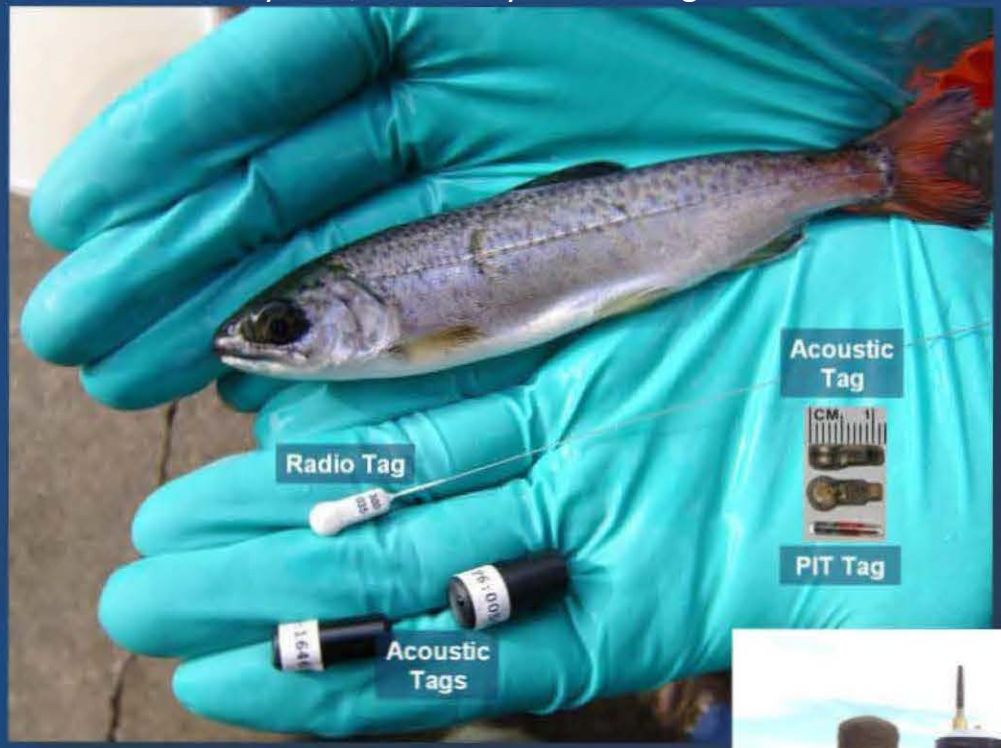


Rearing habitats & movement timing

Growth & survival implications

Jeffres et al (2008) Environmental Biology of Fishes

Photo: M. Melnychuk, University of Washington



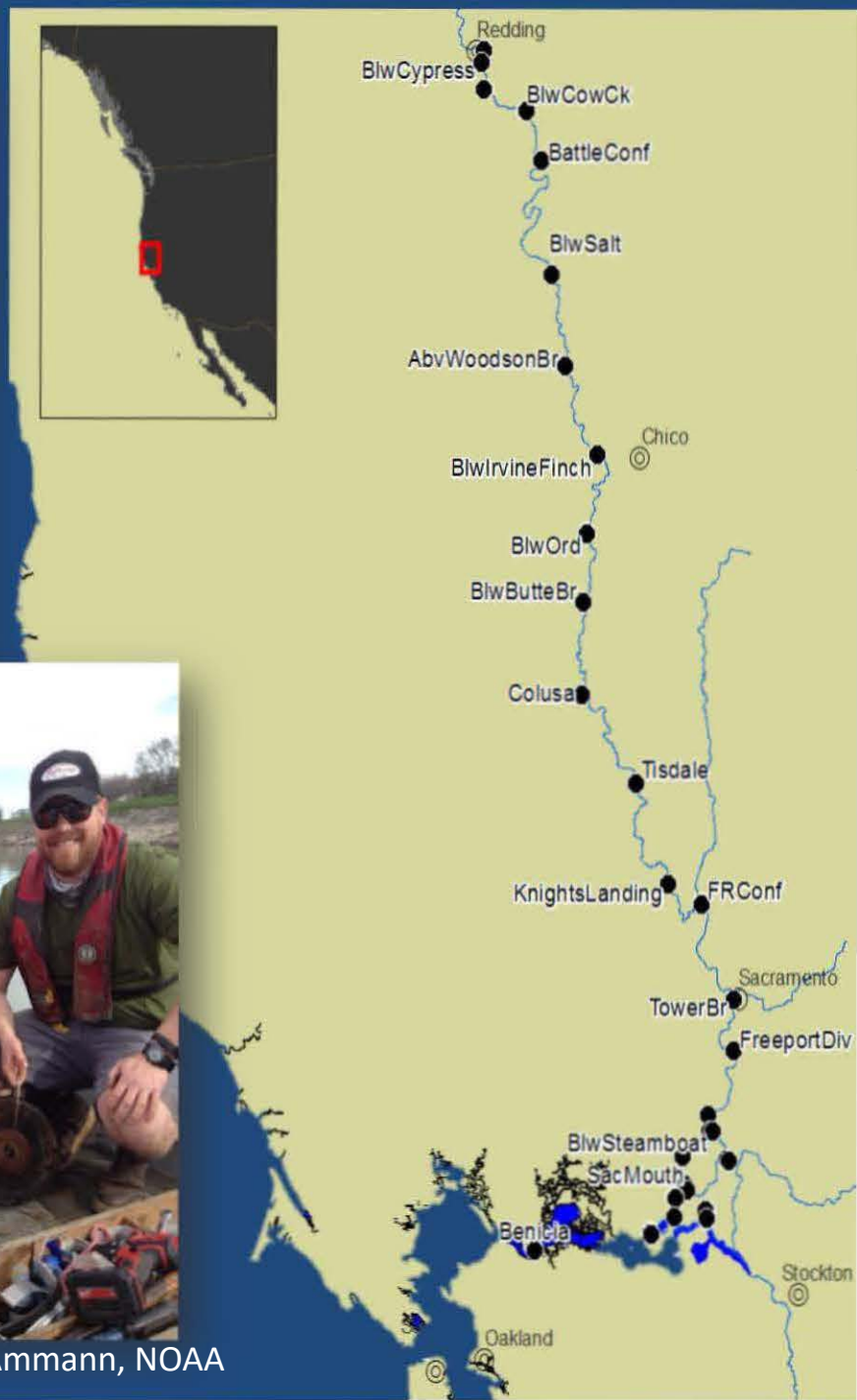


Photo & Map: A. Ammann, NOAA

Otoliths as archival tags

- Daily growth increments
- Metabolically inert
- Incorporate ambient water chemistry into otoliths
- Isotopic gradients within migration corridor

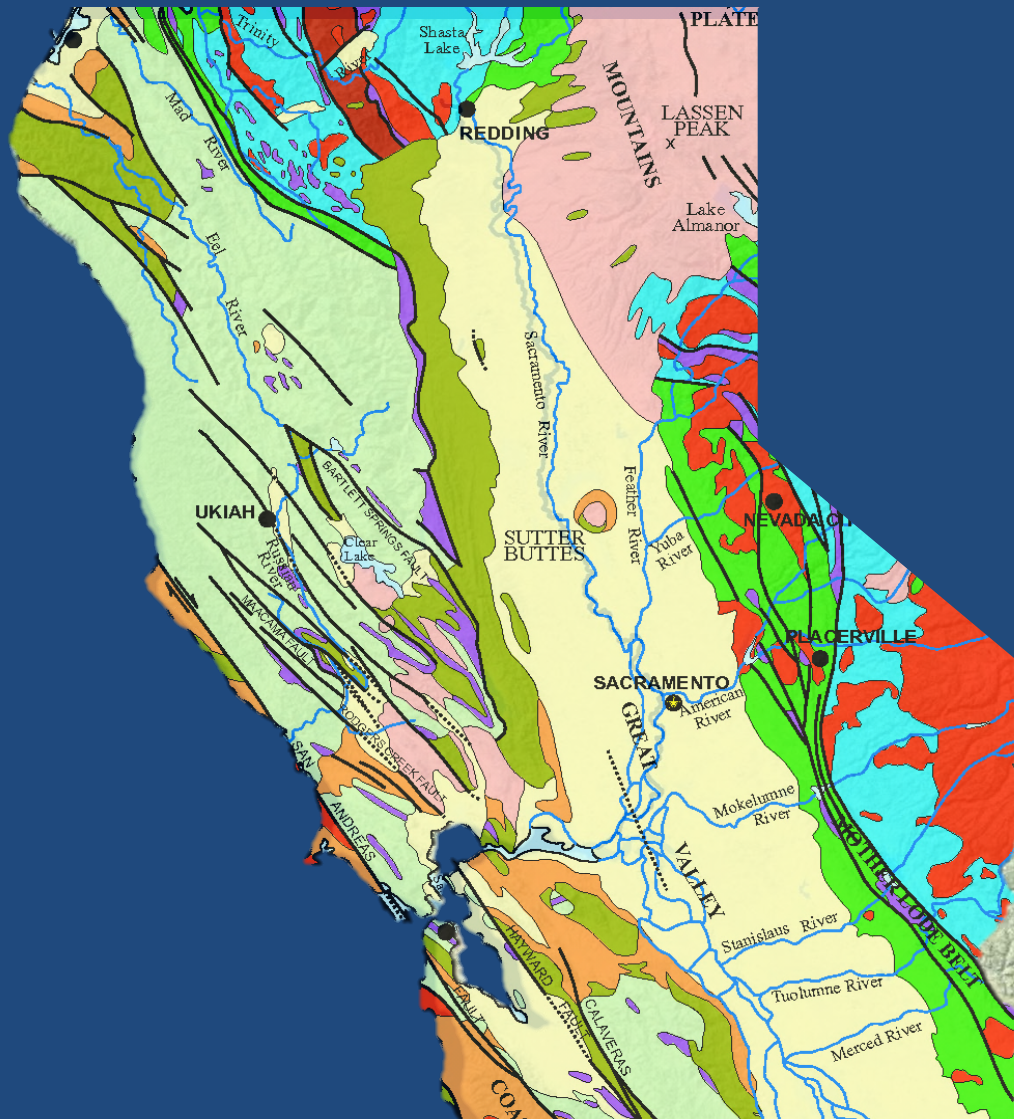
Project Objectives

- Reconstruct juvenile winter-run habitat use & movement patterns
  - How variable are juvenile Sacramento winter-run emigration strategies?
- Examine strategies employed by those individuals that **survived into adulthood to spawn**
- Quantify the relationship between rearing habitats and juvenile growth patterns

Geochemical Markers

Strontium isotope ratio ($^{87}Sr/^{86}Sr$)

- directly reflect ambient environments
- Geologic age of underlying rock

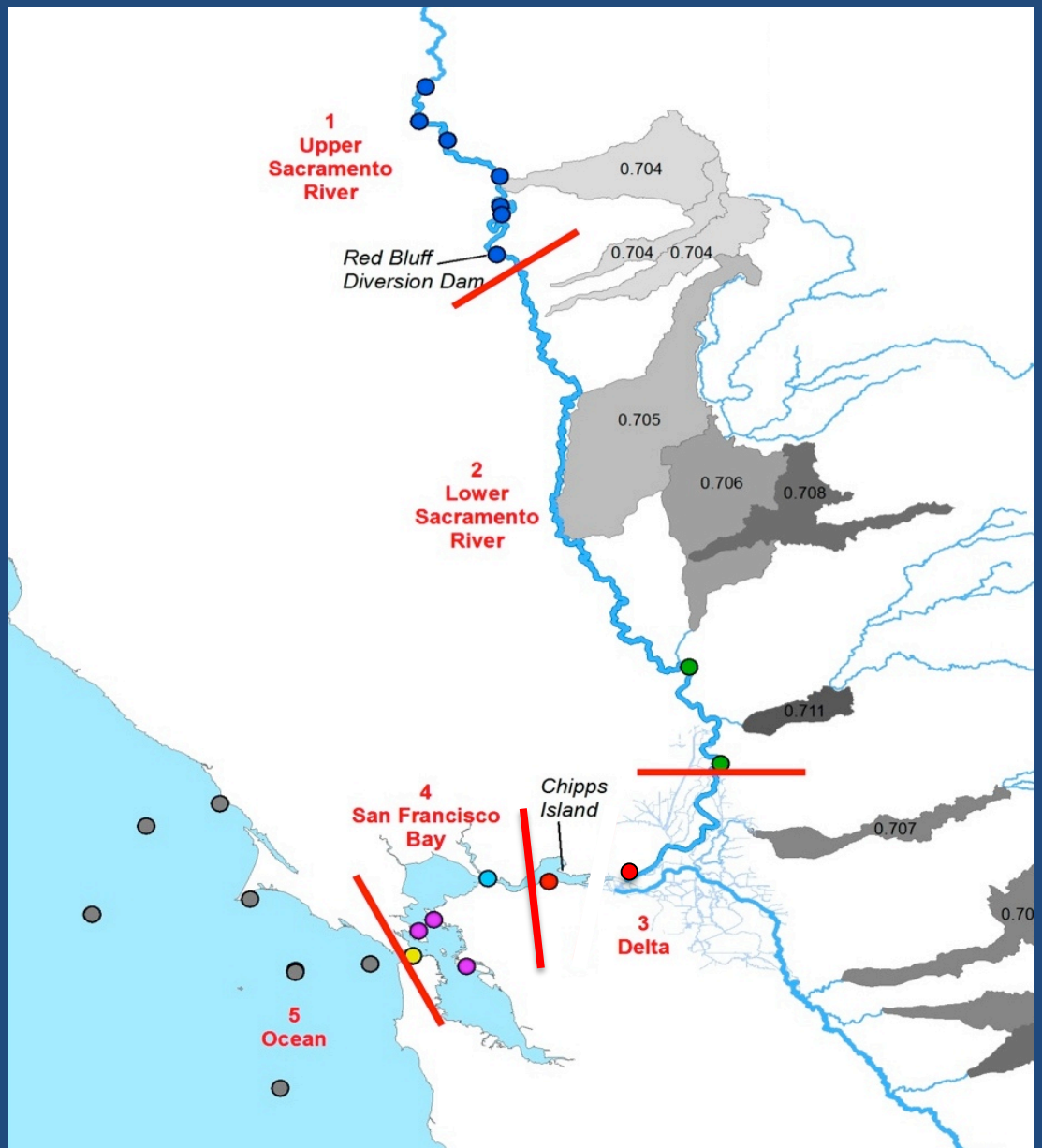


Snapshot of the *isoscape*

Modeled d18O values

- Upper river -25
- Lower river -21
- Delta -14.2
- Carquinez Straight -7.5
- San Francisco Bay -3
- Golden Gate -1
- Ocean 0

Changes with temperature



Sr ratio

0.704

0.711

Constant over time

Adult sampling

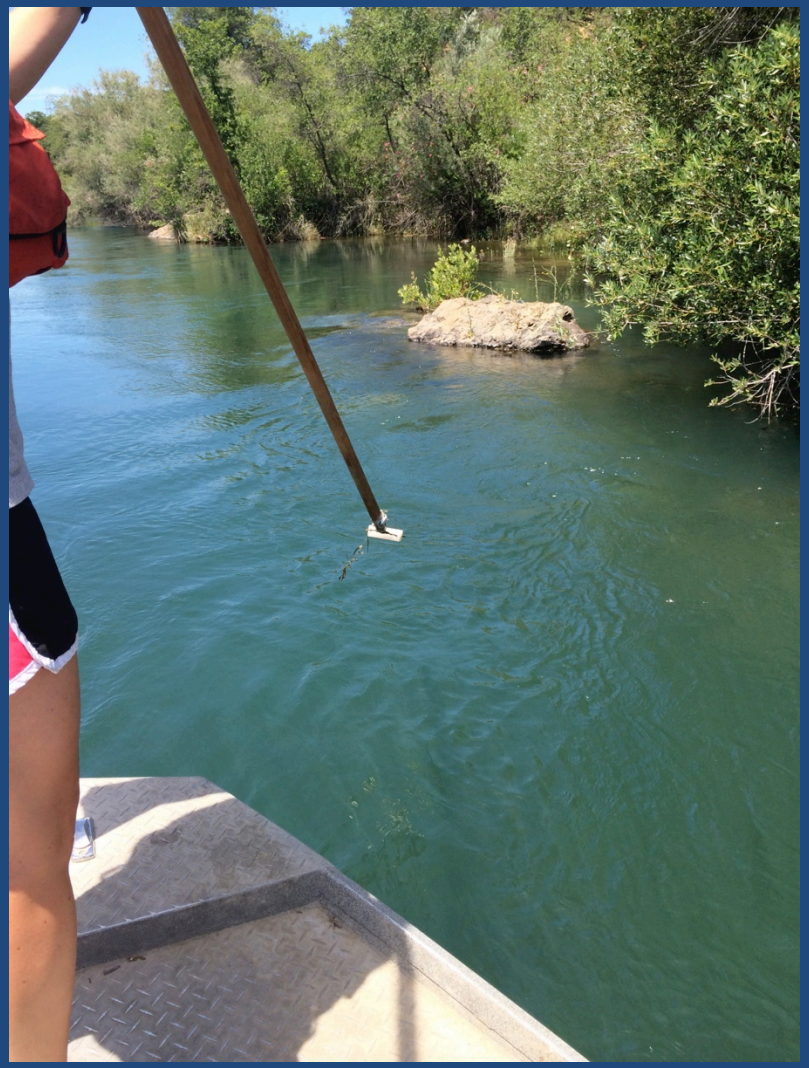
USFWS & CDFW

Carcass surveys in 2012-2013 (2014)

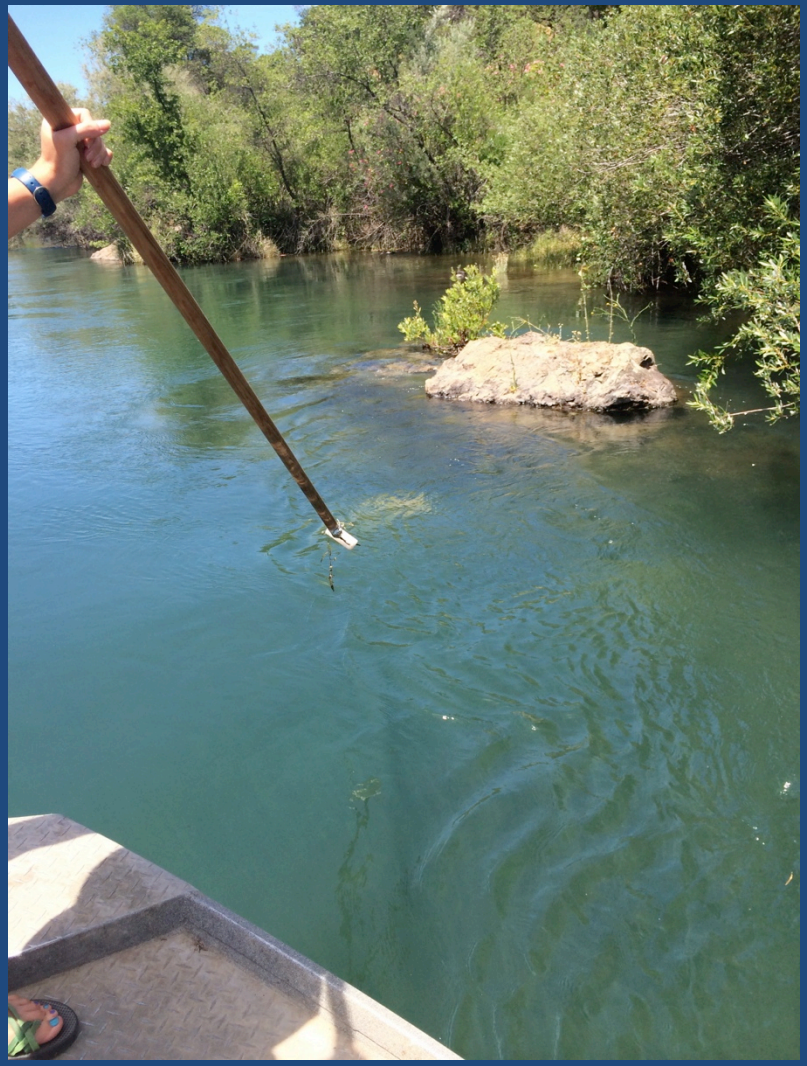
- Natural & hatchery origin
- Represent juvenile cohorts from 2009-2010 (2011)

Carcass Surveys

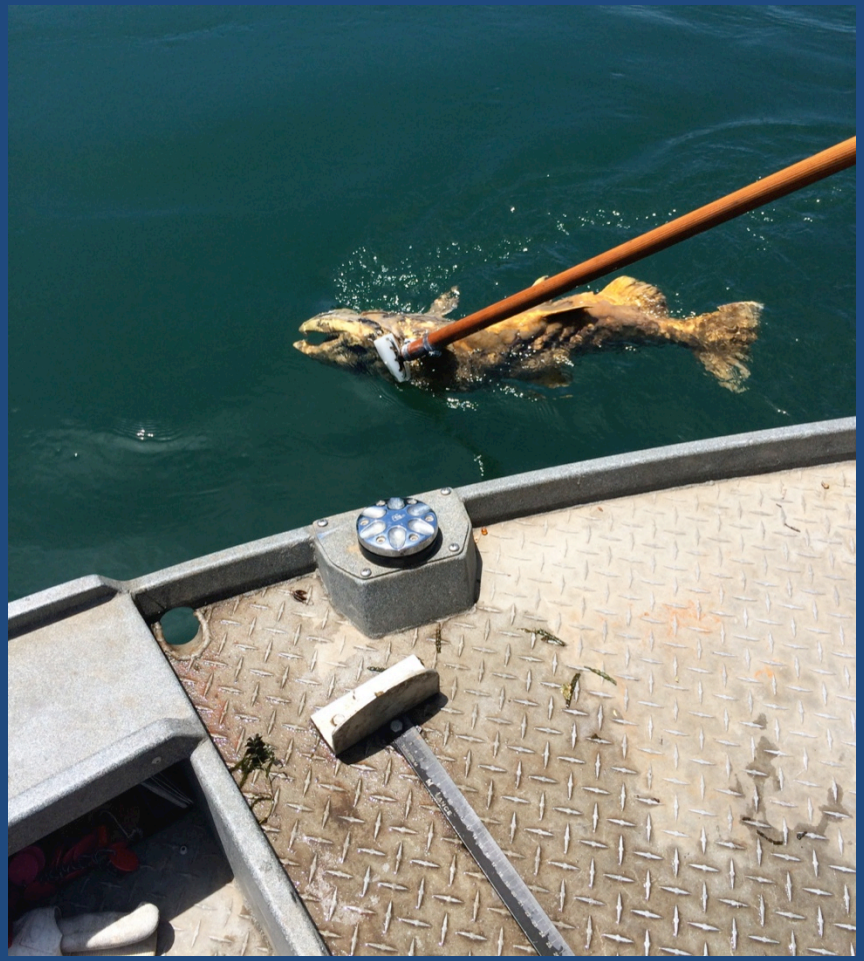
Can you spot it?



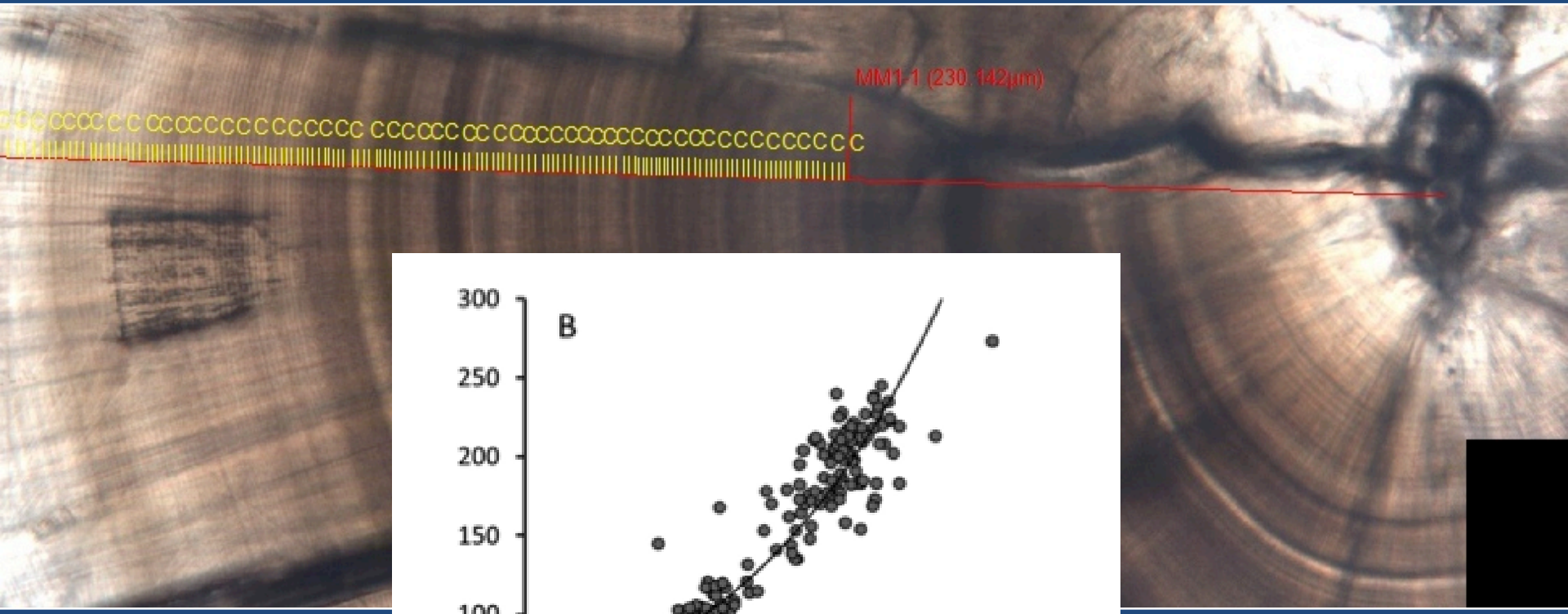
Carcass Surveys



Carcass surveys

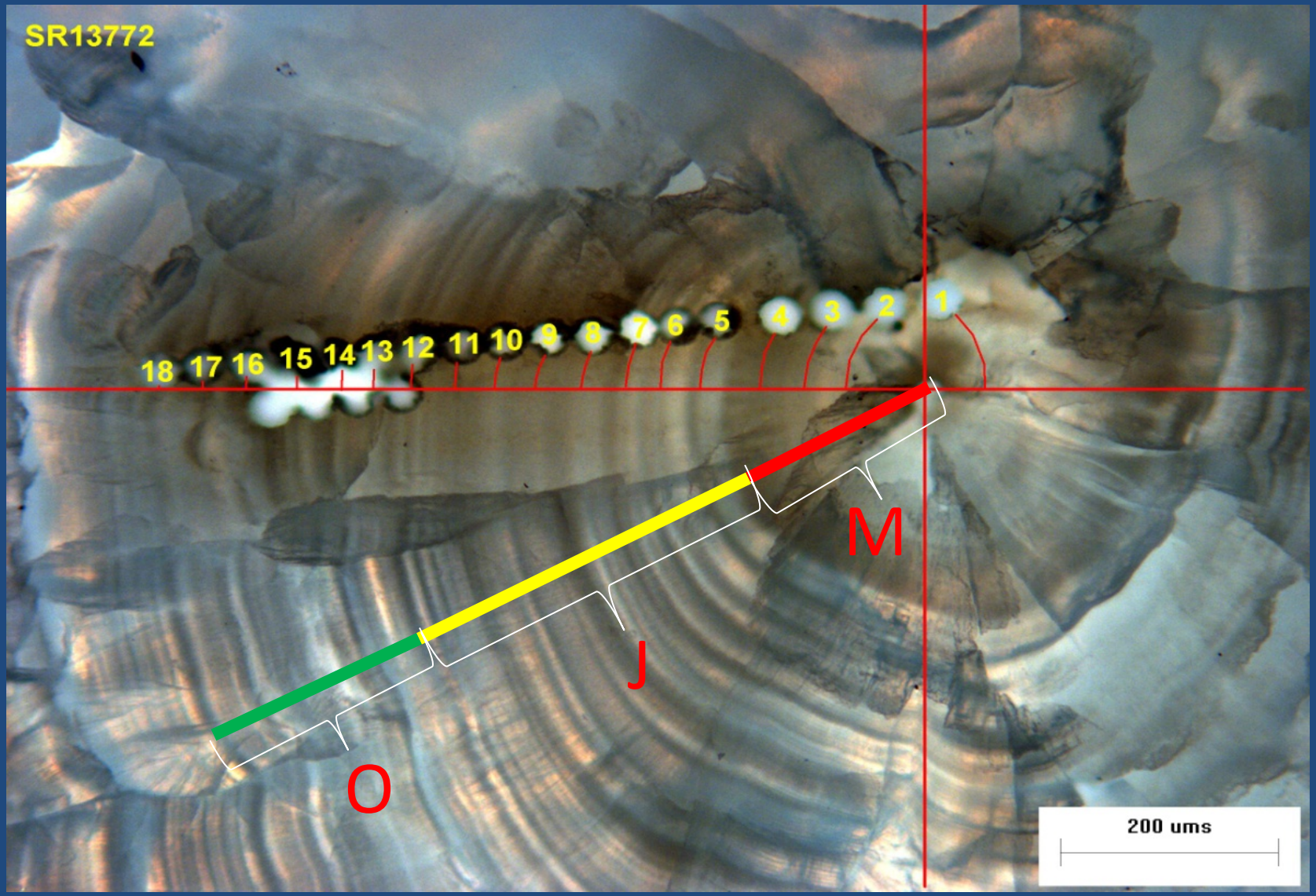


Reconstruct juvenile growth

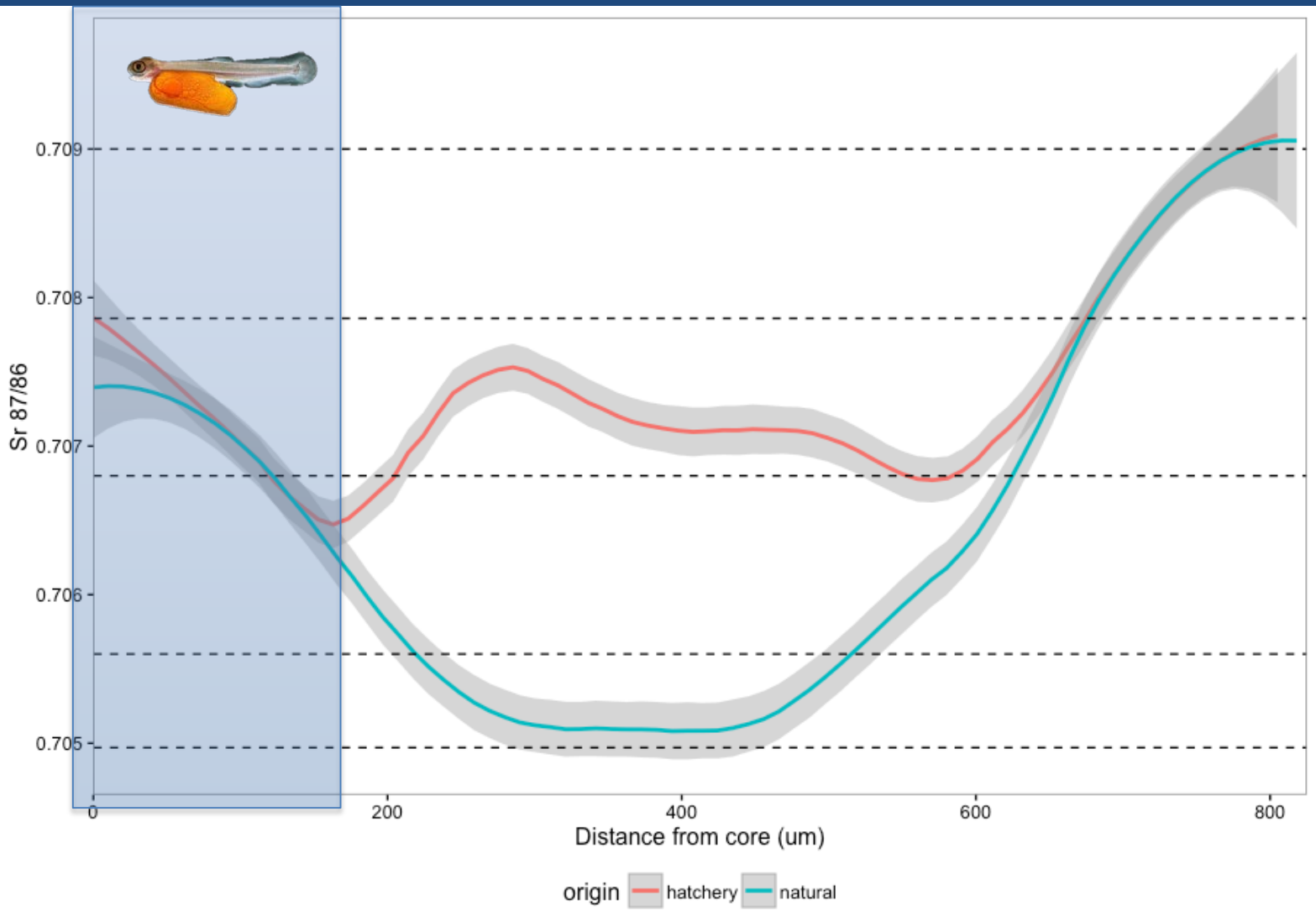


Woodson et al (2013)

Reconstruct migration histories



2009 Cohort:
Natural vs. Hatchery origin migration patterns



Ocean

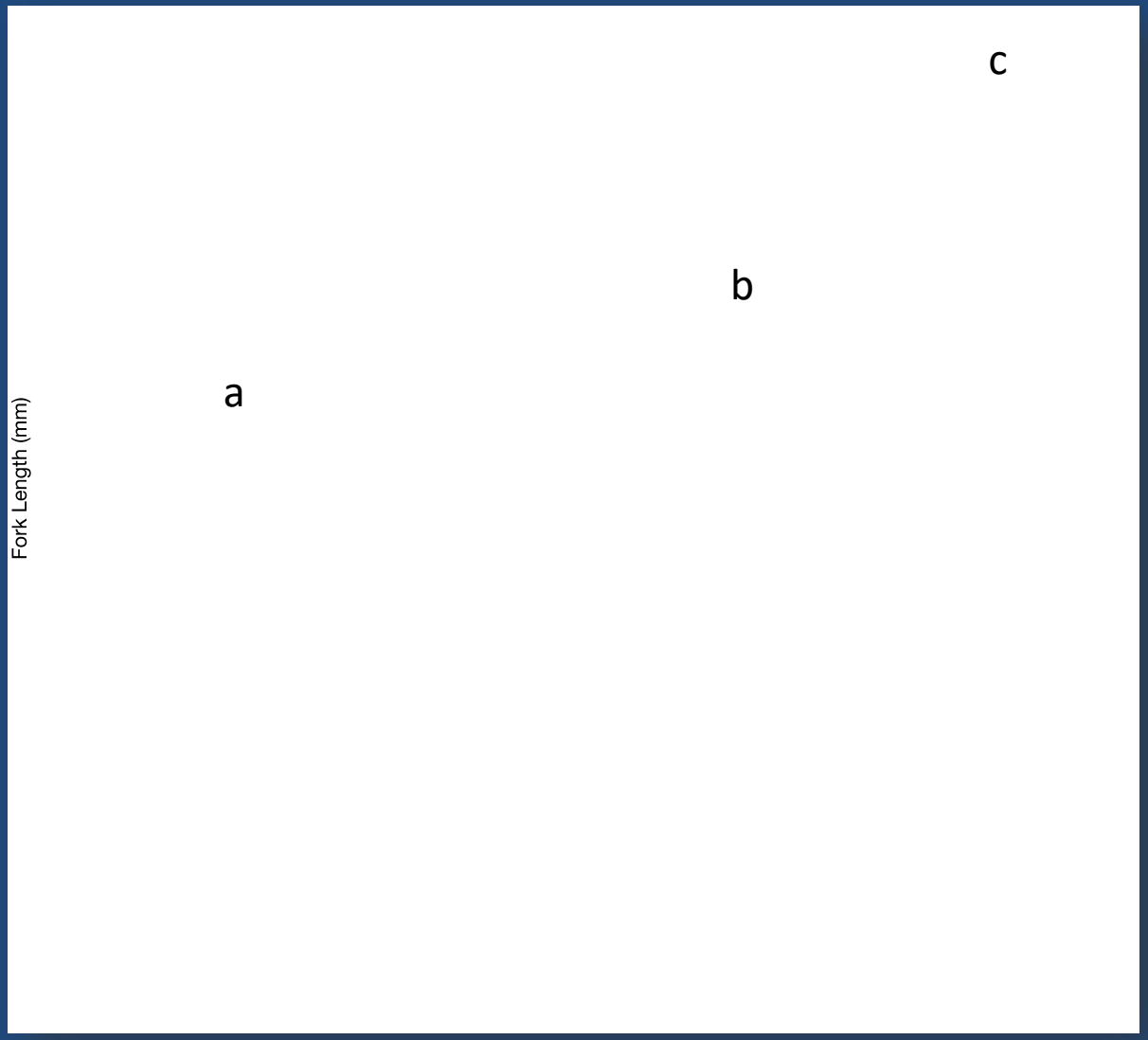
SF Bay

Delta

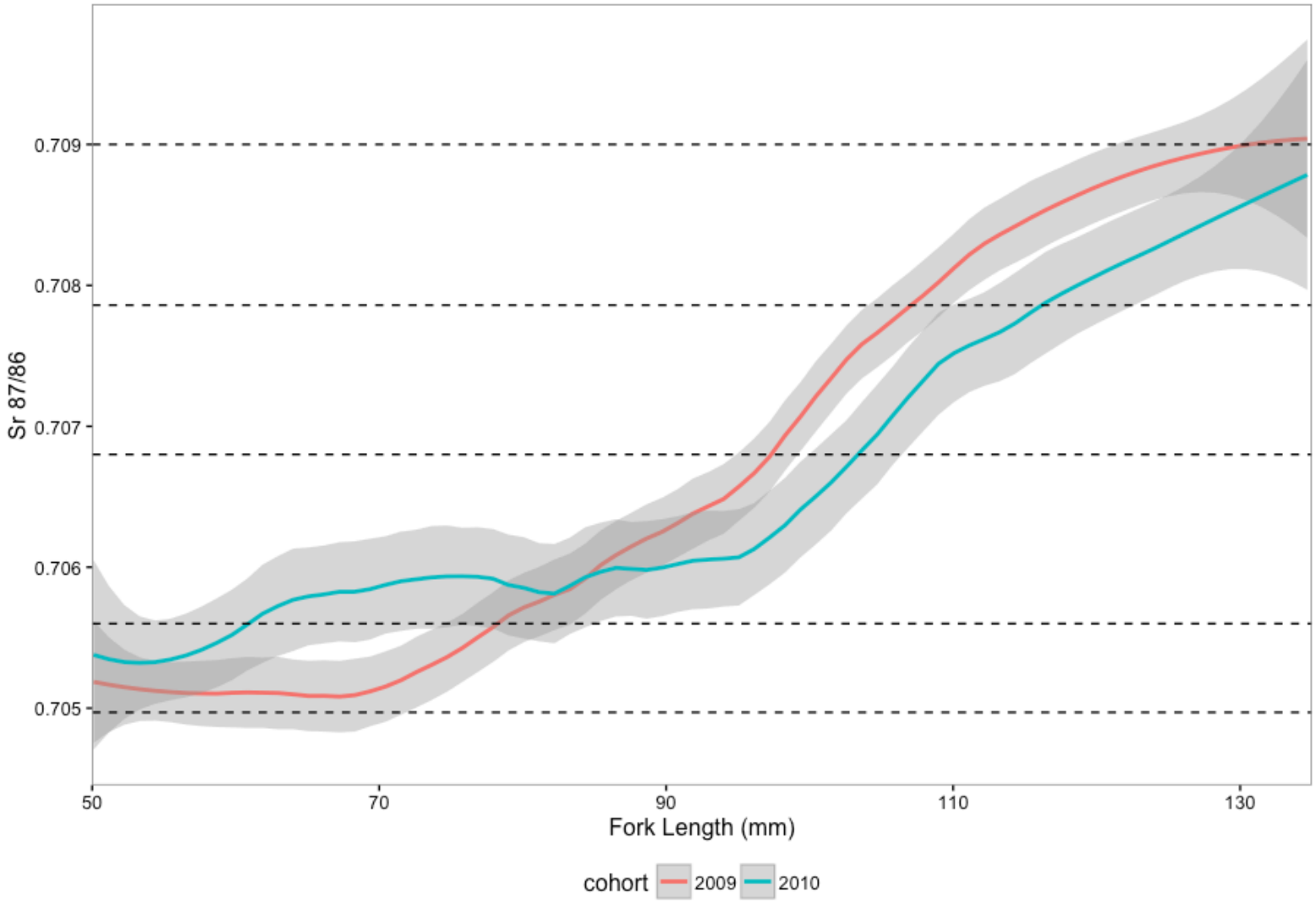
Lower Sacramento

Upper Sacramento

Natural vs. Hatchery size at Ocean Entry



Patterns of movement using $^{87}Sr/^{86}Sr$



Ocean

SF Bay

Delta

Lower Sacramento

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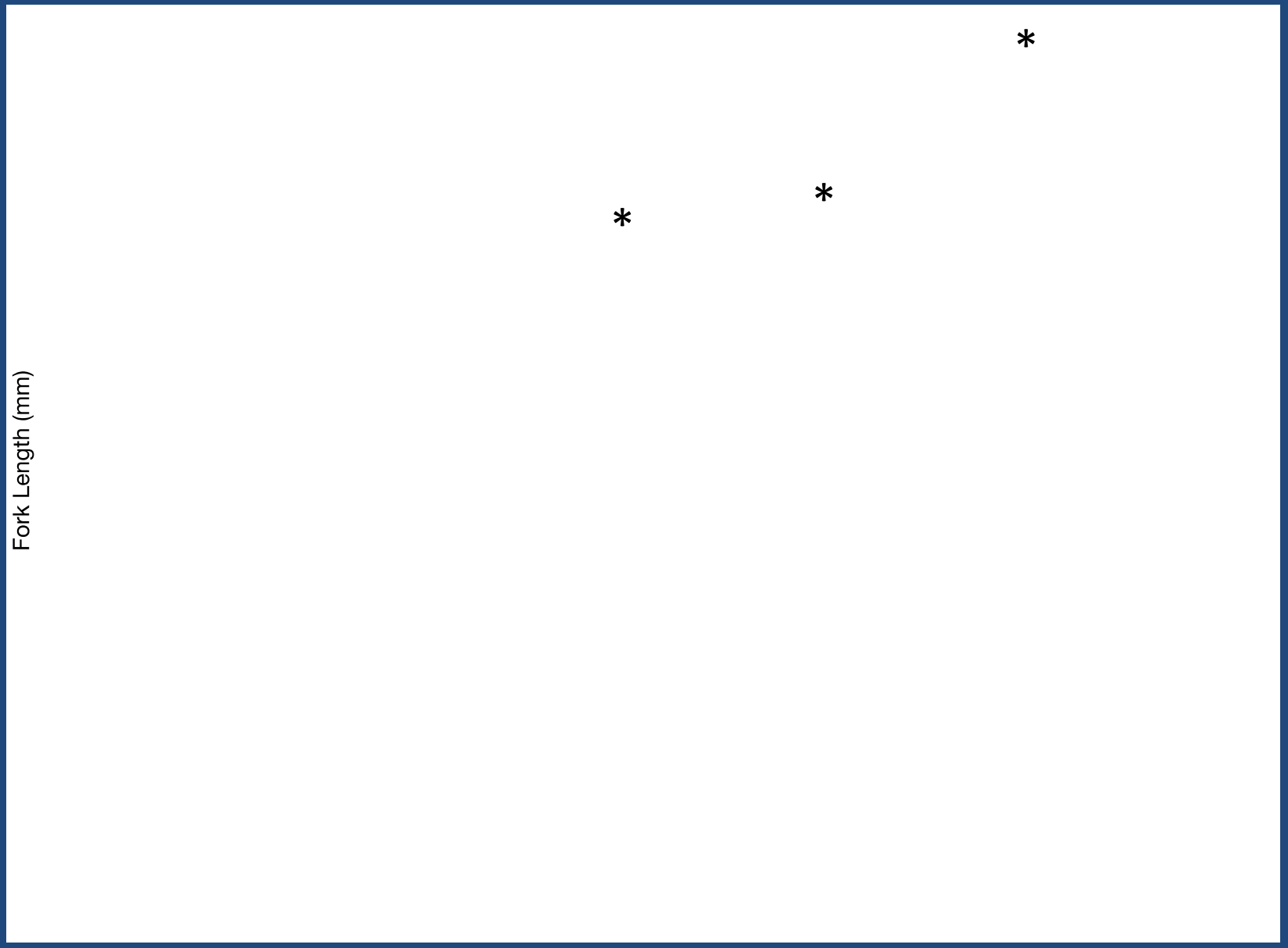
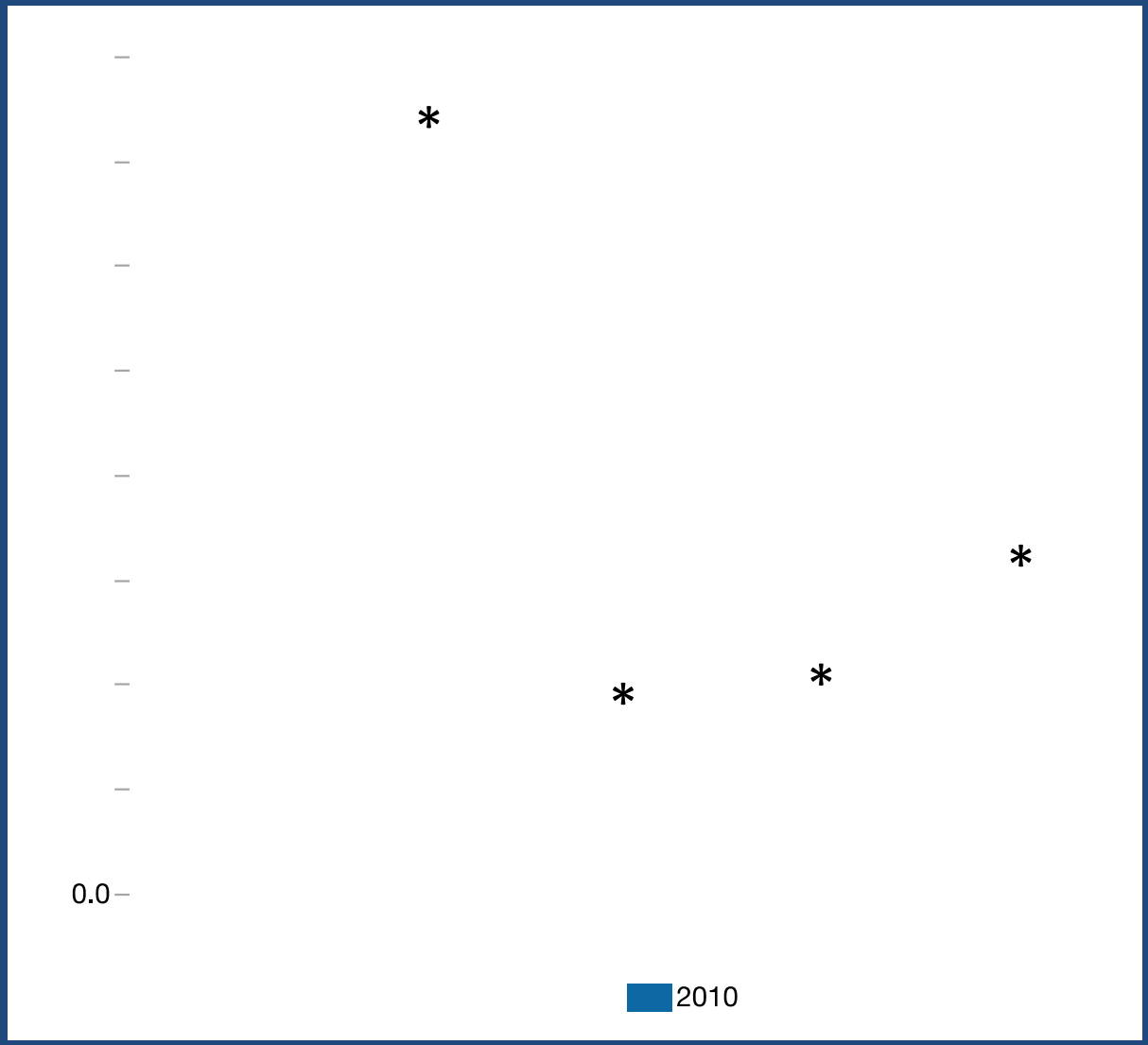
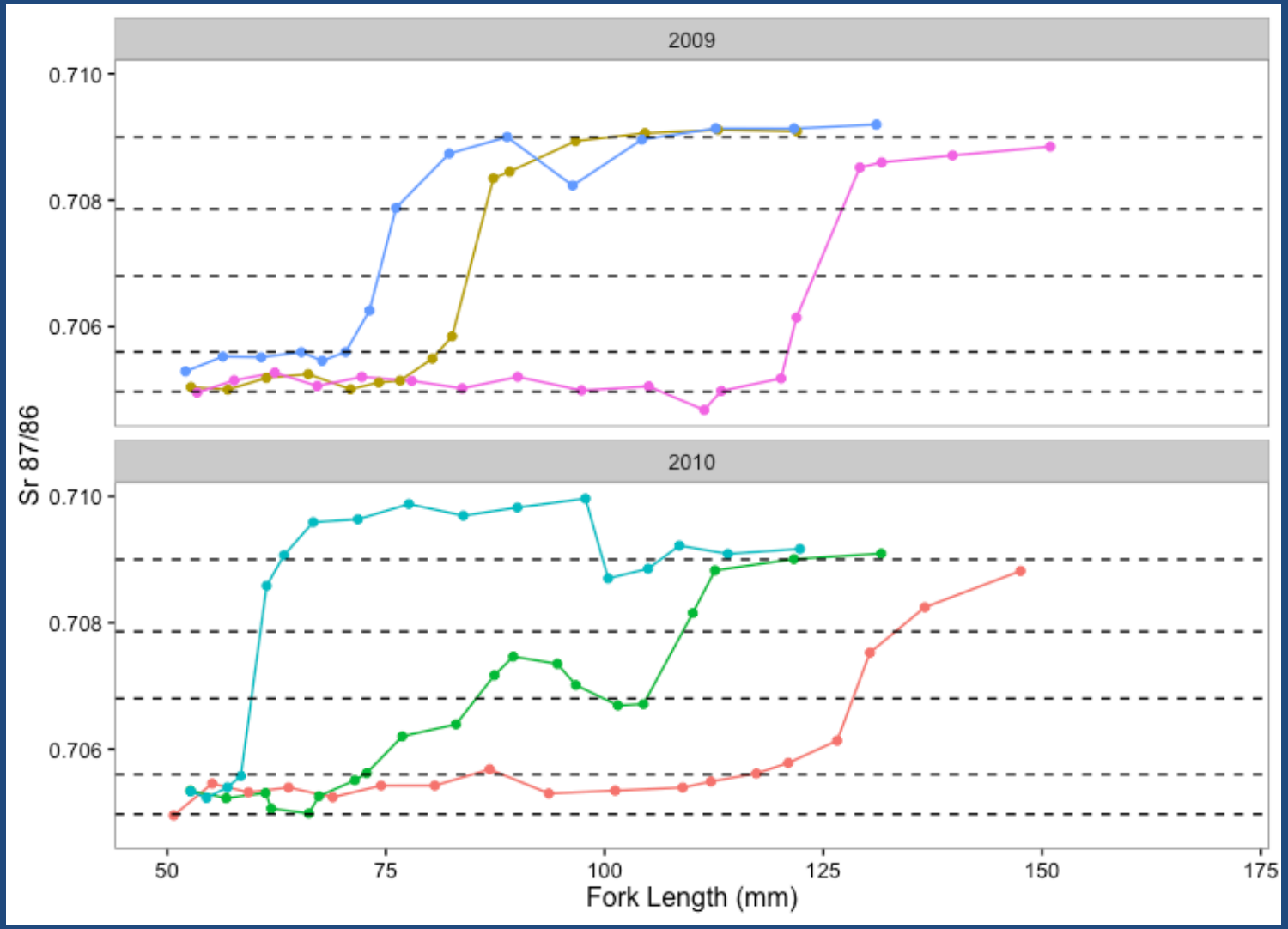
Size at habitat transition



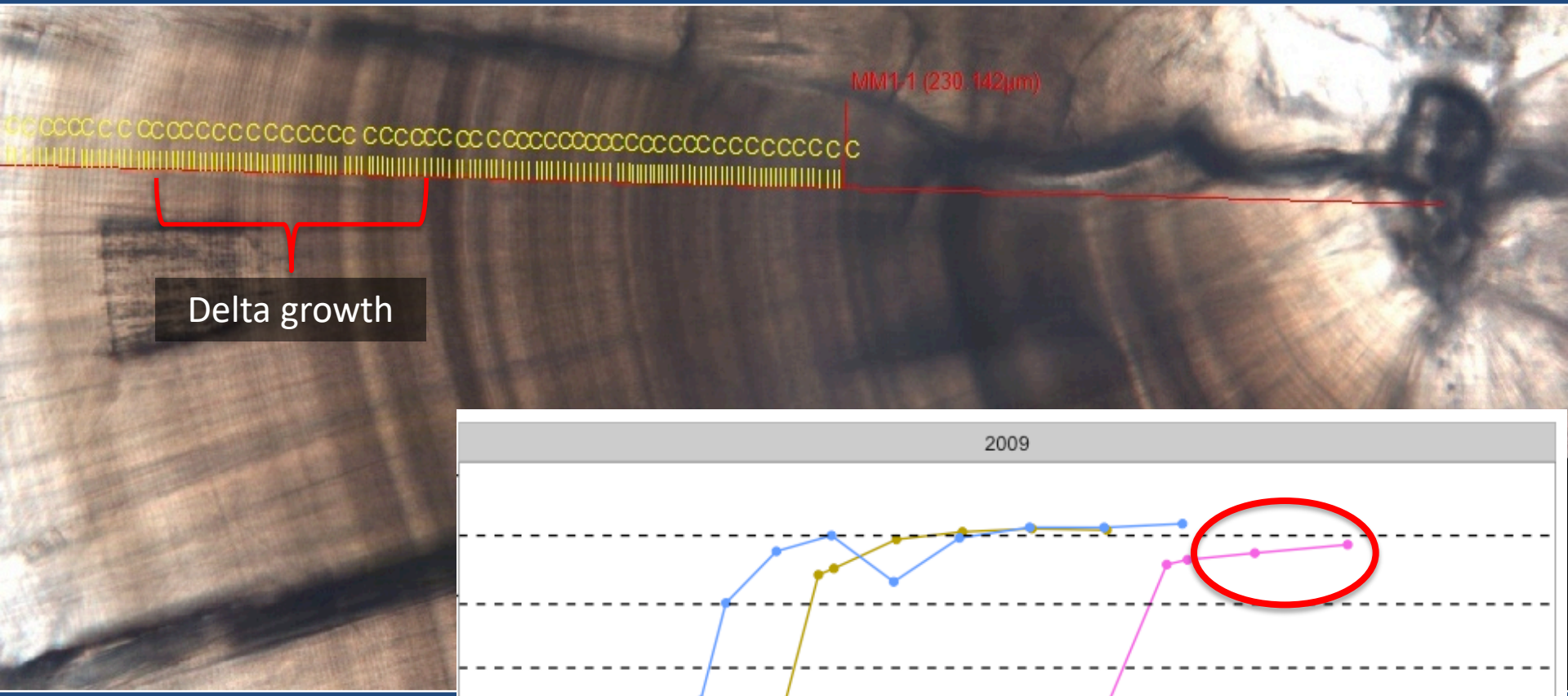
Relative frequency of non-natal rearing



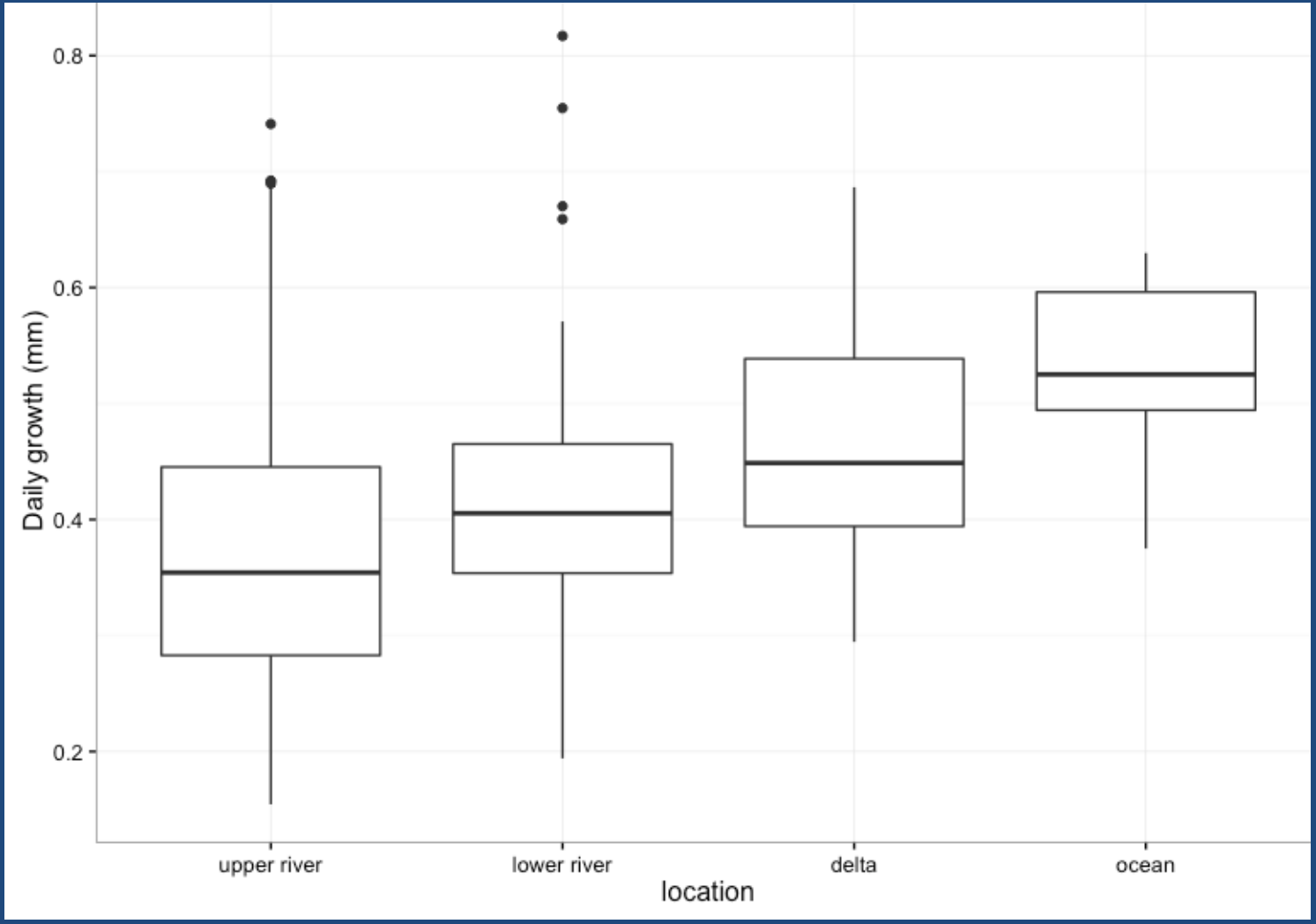
Natural origin- diversity in habitat use



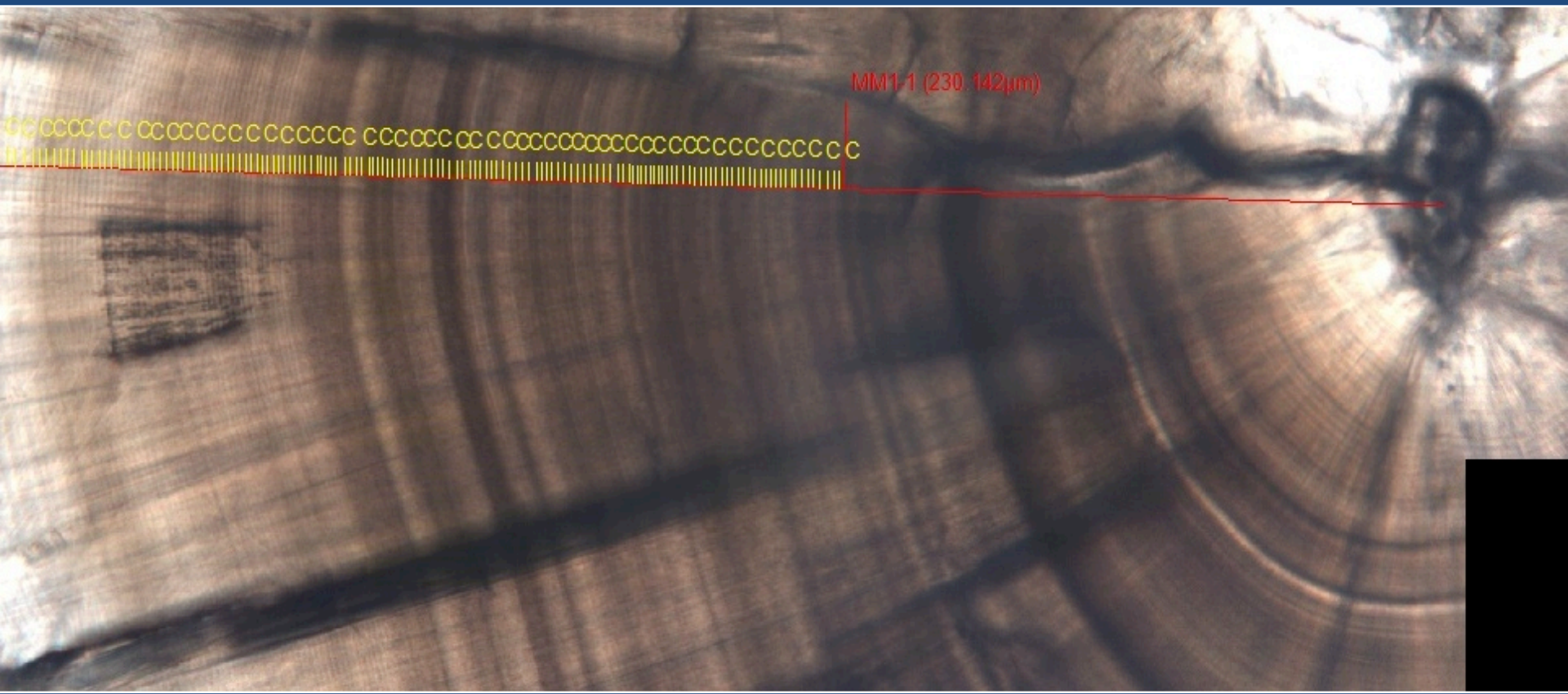
What are the relationships between habitat use and juvenile growth patterns?



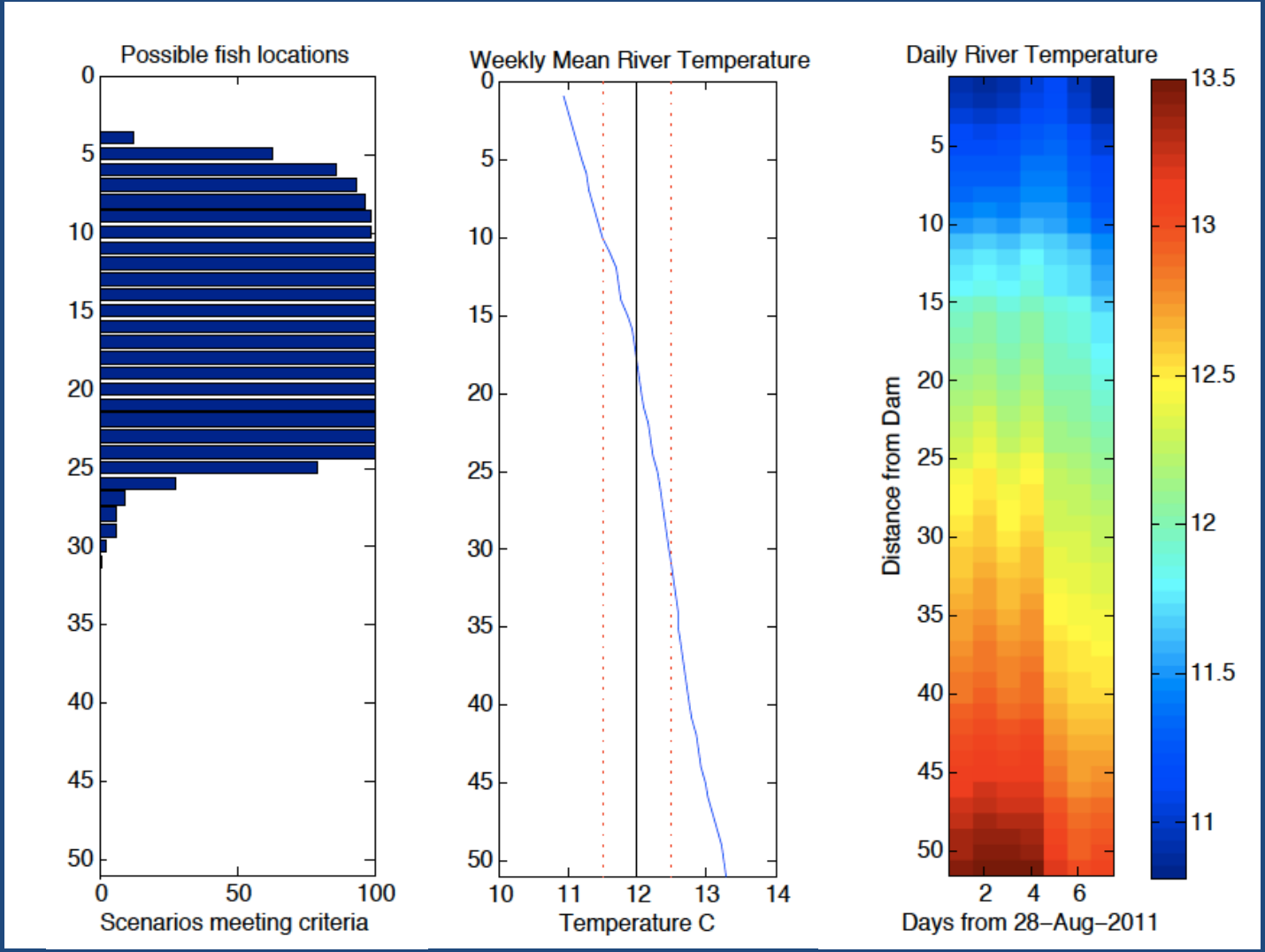
Habitat-specific growth



$^{87}Sr/^{86}Sr$ can tell us where...
Not **when**



$^{87}Sr/^{86}Sr$ can tell us where...
Can $\delta^{18}O$ tell us **when?**



Proposed >10 year time series

BY	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
										BOR			2015	
Return year	2007	2008	2009			2012	2013	2014		2016	2017	2018		
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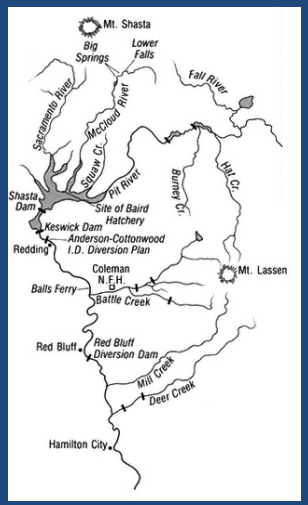
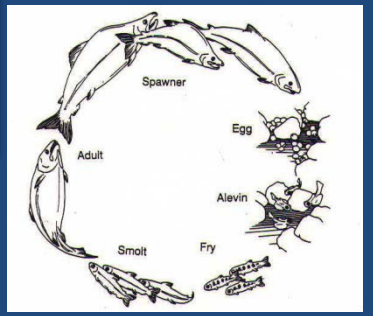
Otolith Chemistry Reveals the Diverse Rearing Habitats of Winter-Run Chinook Salmon
Corey Phillis, MWD

Where They Go and How They Grow: Using Otoliths to Reconstruct Habitat-Specific Growth Patterns for Endangered Winter-Run Chinook
Maya Friedman, UC Santa Cruz*



IEP salmon synthesis SAIL team recommendation:
To monitor life history diversity at multiple life stages of winter run



Summary....

- Different strategies apparent in different water-year types
- Increased frequency of non-natal rearing in 2010 (below normal) vs. 2009 (dry)
- Highest growth rates in delta (BUT…)
- Work will help parameterize life-cycle model currently being developed at NMFS
- Establish relationship between hydrological conditions, habitat quality, & performance of various life-stages

Acknowledgements

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