

# Years in their ears: what can fish earbones tell us about spring-run Chinook success in an increasingly volatile and warming climate?

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**NOAA FISHERIES**  
National Oceanic and Atmospheric Administration



UNIVERSITY OF CALIFORNIA  
**SANTA CRUZ**



# California flood and drought cycles



K, STREET, FROM THE LEVEE.

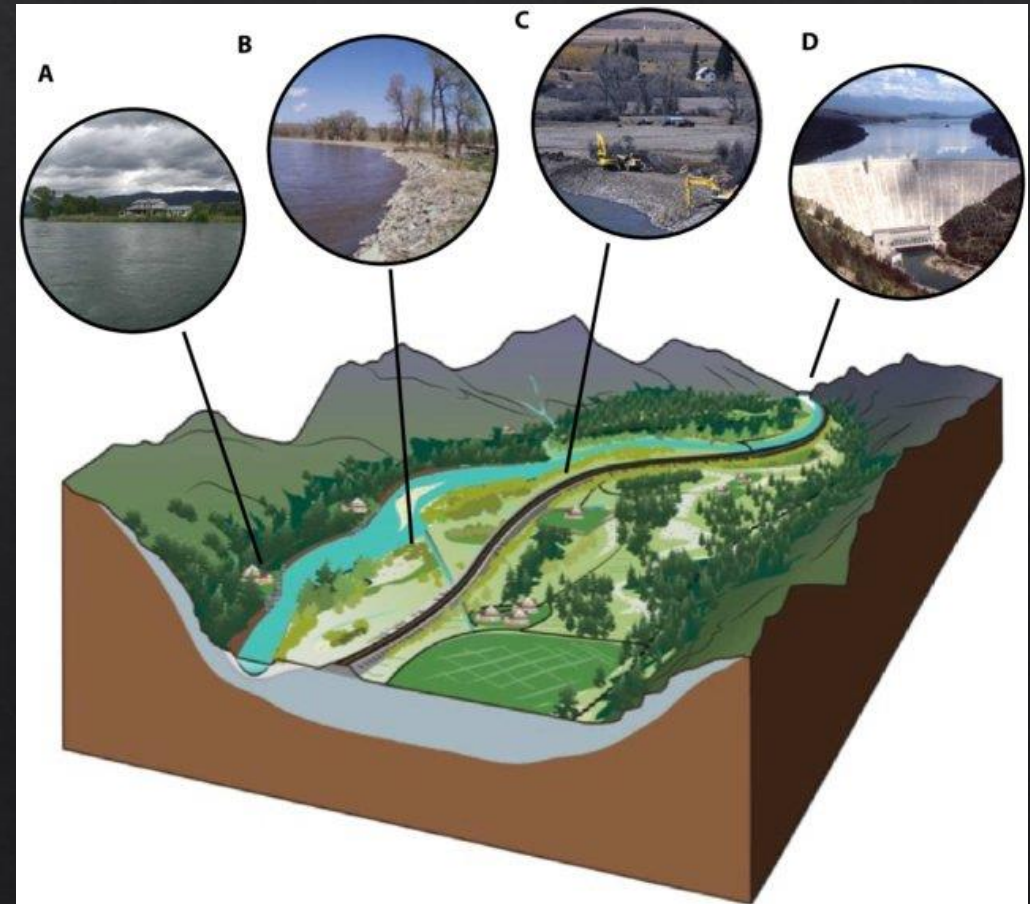
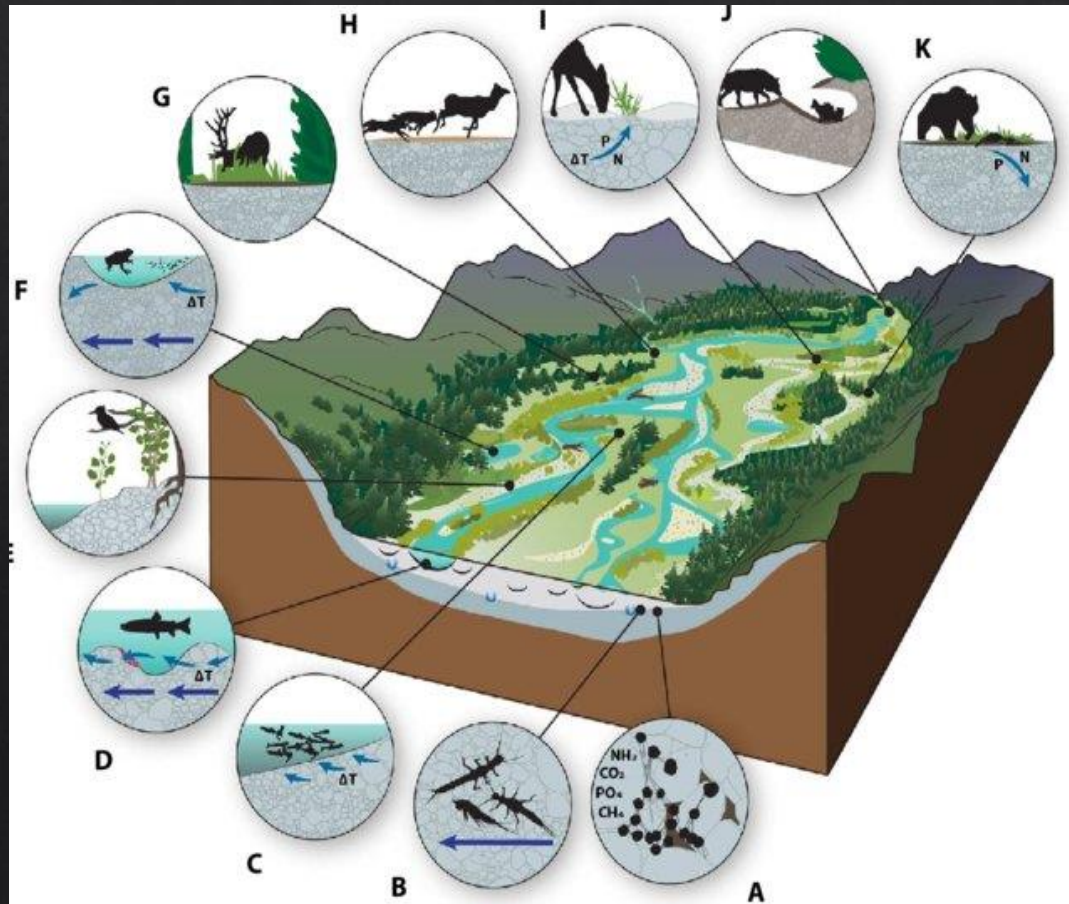
**INUNDATION OF THE STATE CAPITOL,  
City of Sacramento, 1862.**

Published by AROSENFIELD, San Francisco.



# Central Valley habitat changes

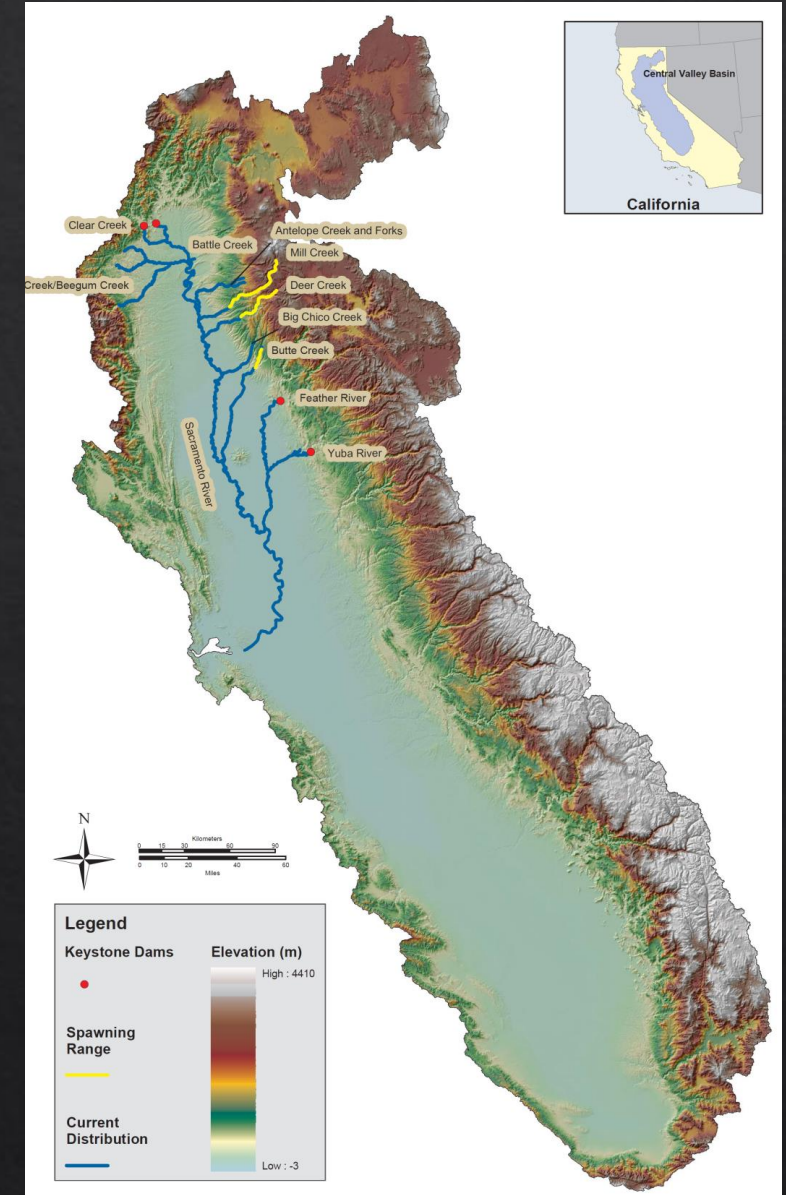
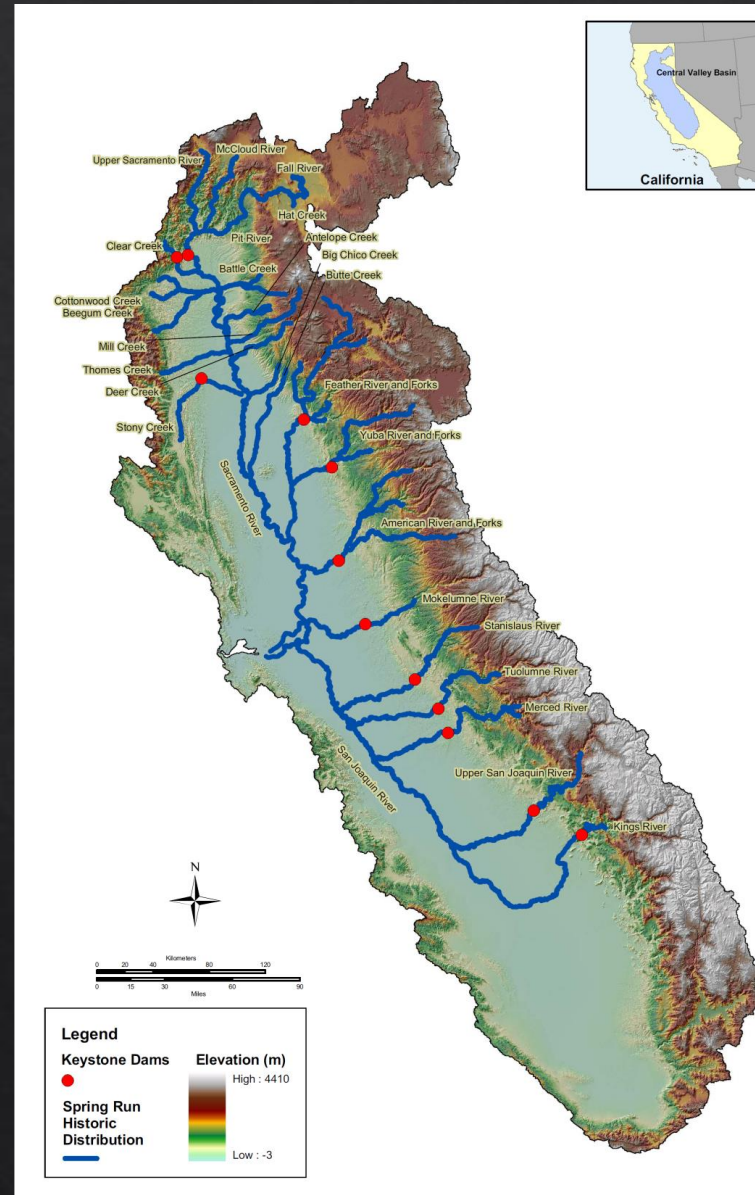
- ✓ 95% floodplain loss
- ✓ Blocked high elevation habitat





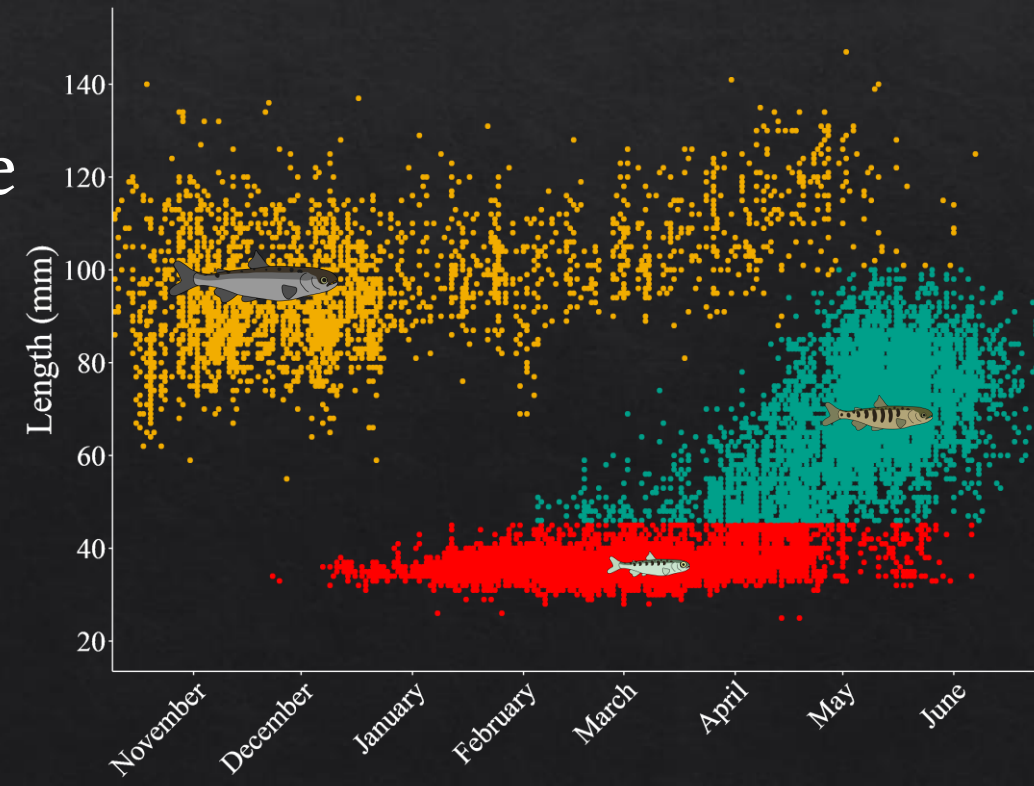
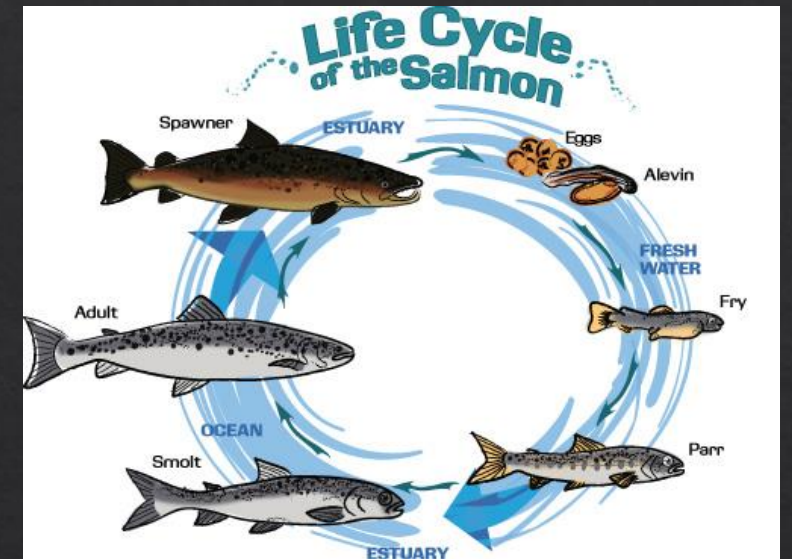
# Spring-run Chinook in the Central Valley

- ✓ Listed as threatened under the federal Endangered Species Act since 1999
- ✓ 3 self-sustaining populations: Mill, Deer, and Butte creeks



# Juvenile life history diversity

- ✓ Large phenotypic plasticity
  - ✓ Different juvenile rearing/migratory strategy
1. Young of the Year that rear for various amount of time in natal reach and migrate downstream as **fry**, **parr** or **smolt**
  2. **Yearling** that stays an entire year in the natal reaches before migrating to the Ocean





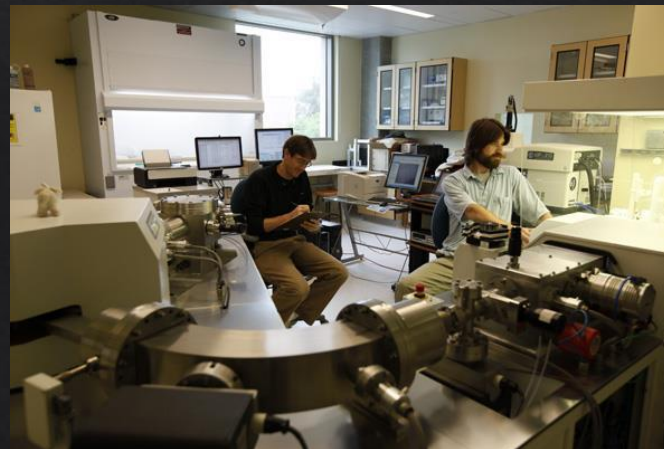
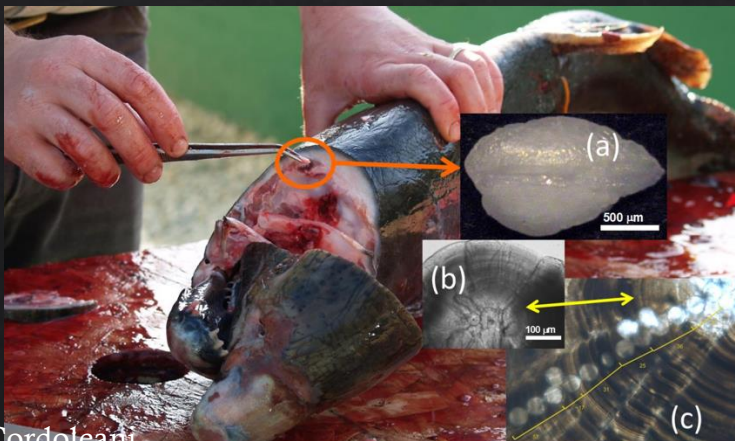


**How could this phenotypic diversity help them cope with the California volatile and warming climate?**

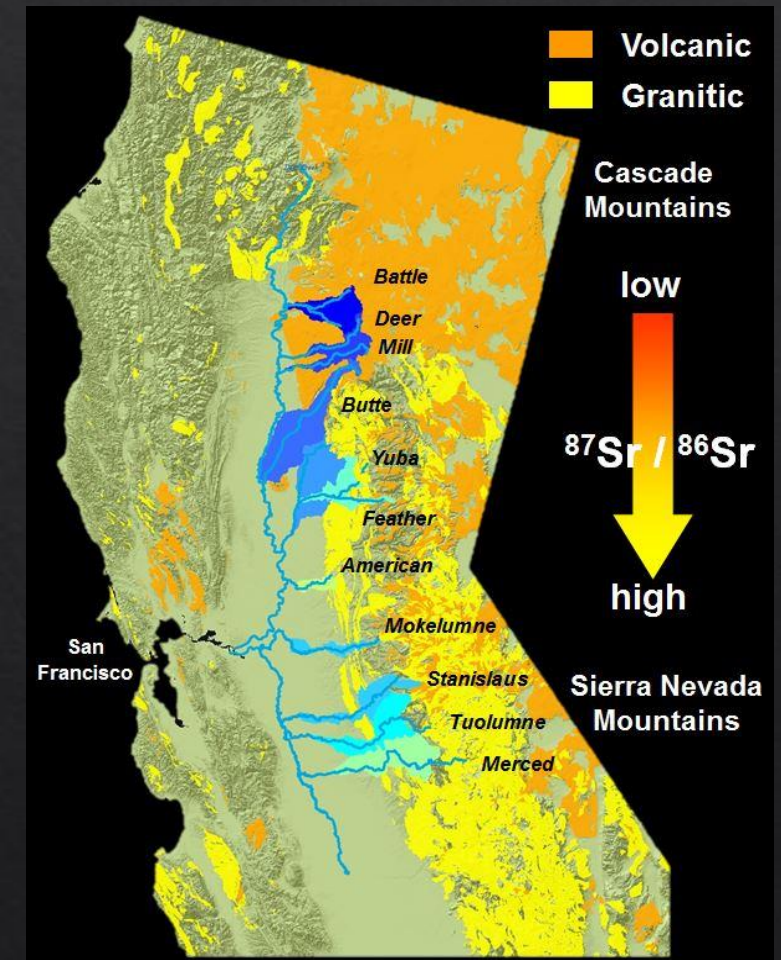
- ✓ Which life history strategy is most represented in adults returning to spawn?
- ✓ How do successful rearing strategies vary among different hydrological years?

# Otoliths collection & analysis

- ✓ Otoliths collected from adult carcasses during carcass surveys conducted by CDFW
- ✓ Juvenile growth estimates from microchemistry
- ✓ Movement reconstruction from strontium isotope analysis performed at the UC Davis Interdisciplinary Center for Inductively-Coupled Plasma Mass Spectrometry



$^{87}\text{Sr}/^{86}\text{Sr}$   
I S O S C A P E



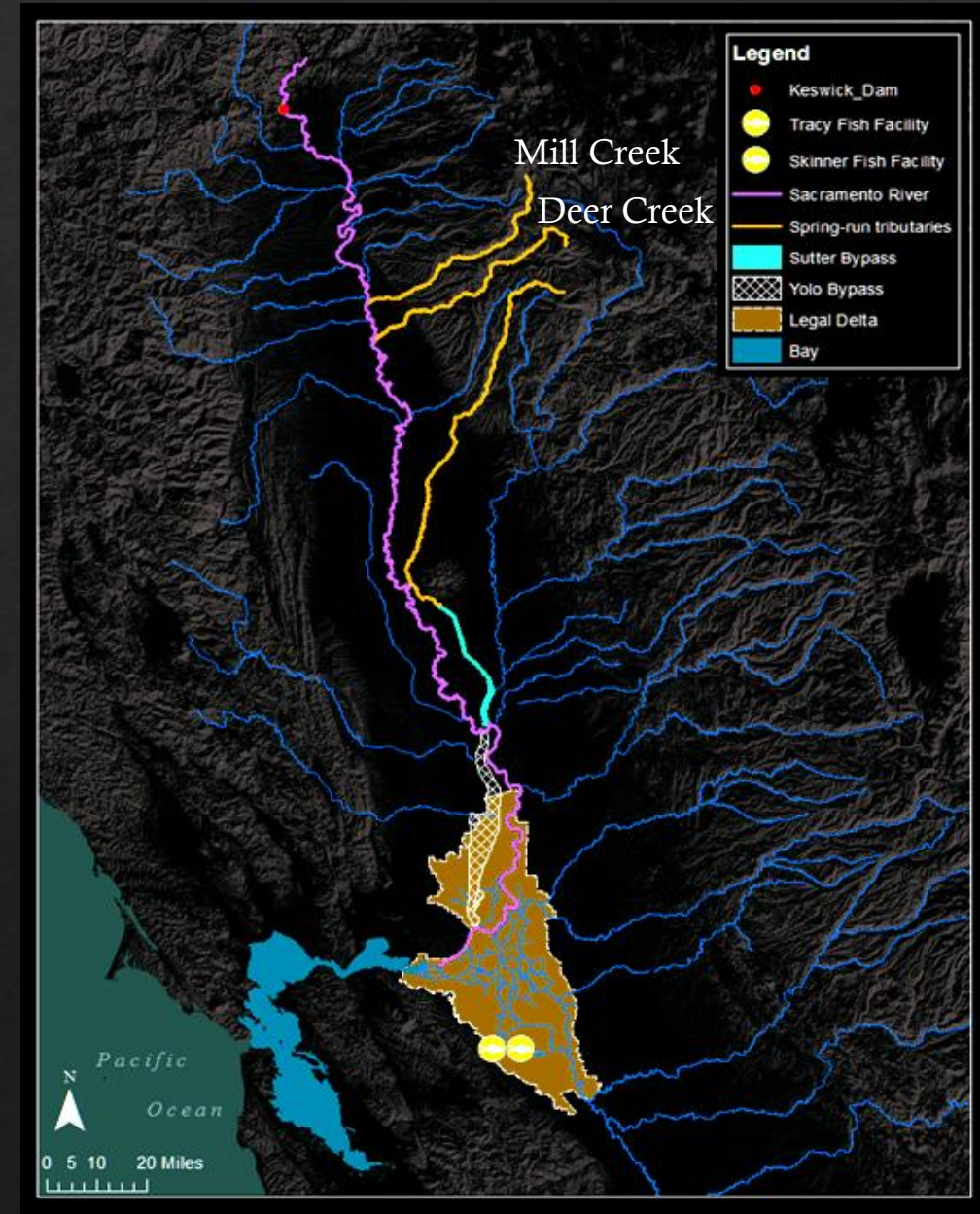
(Source: Hobson, Barnett-Johnson and Cerling, 2009)



# Mill/Deer Creek juvenile strategies

✓ 123 otoliths analyzed across 6 years

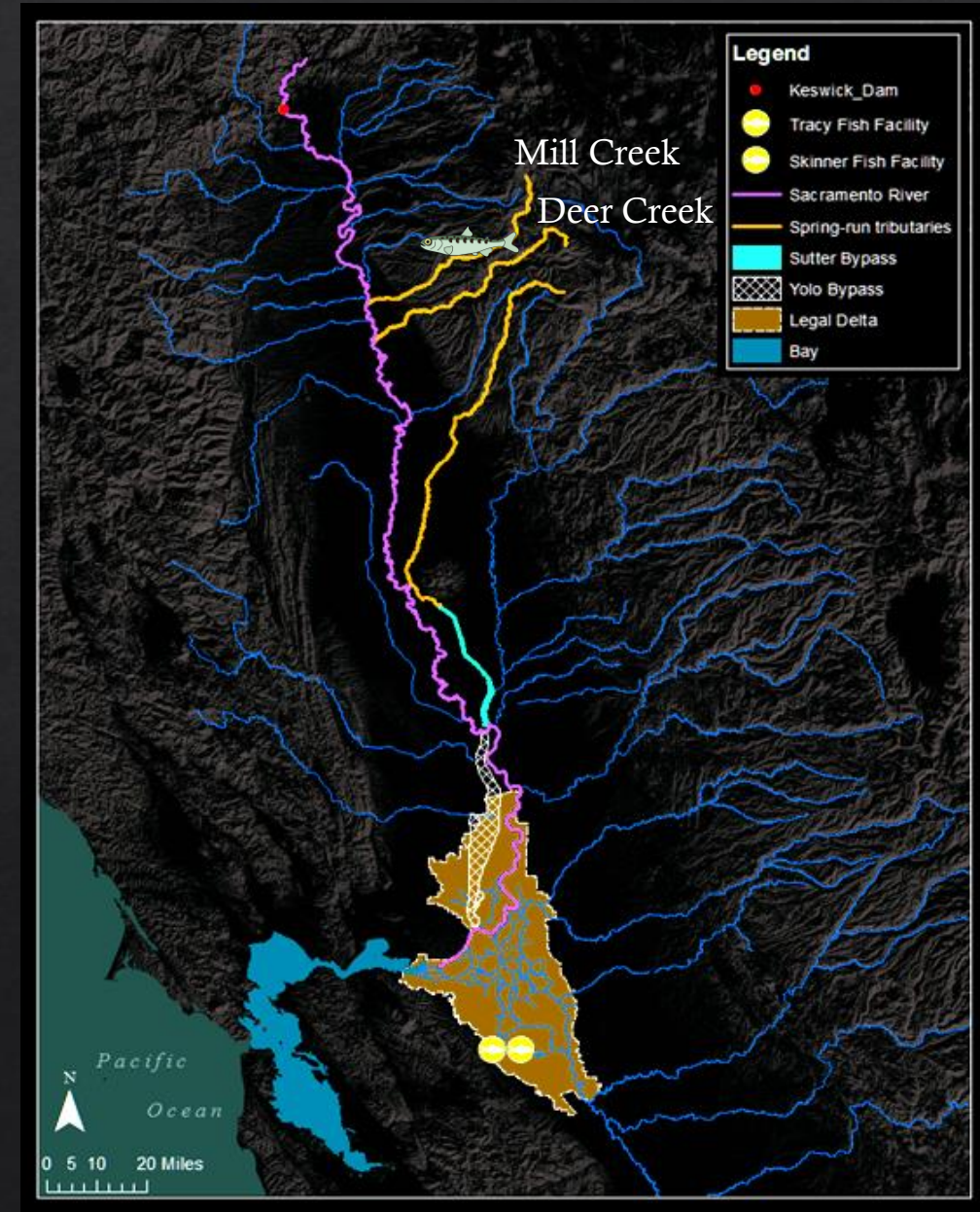
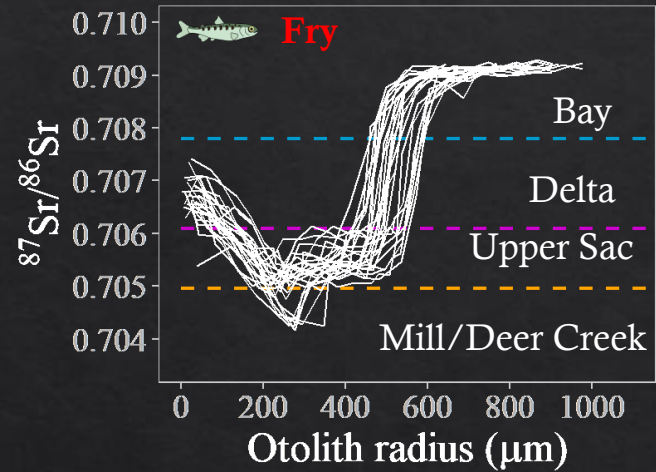
Return Year	N
2007	31
2008	12
2012	11
2013	22
2014	13
2018	34





# Mill/Deer Creek juvenile strategies

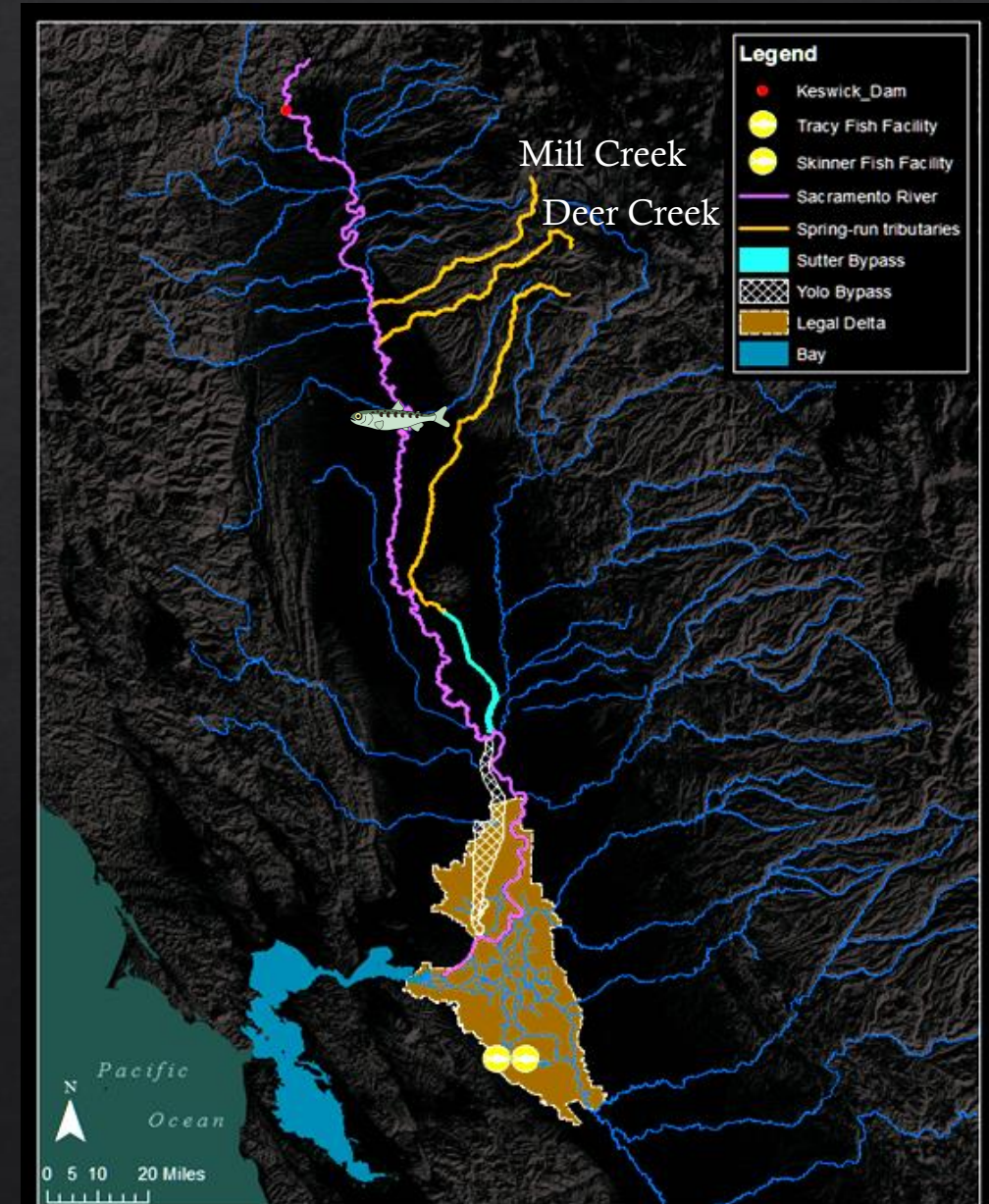
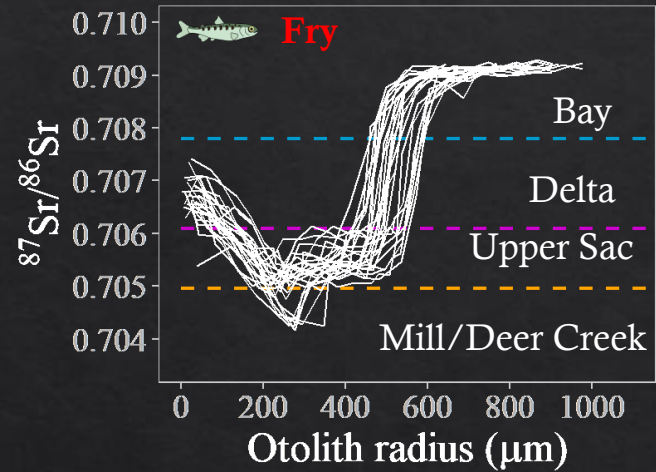
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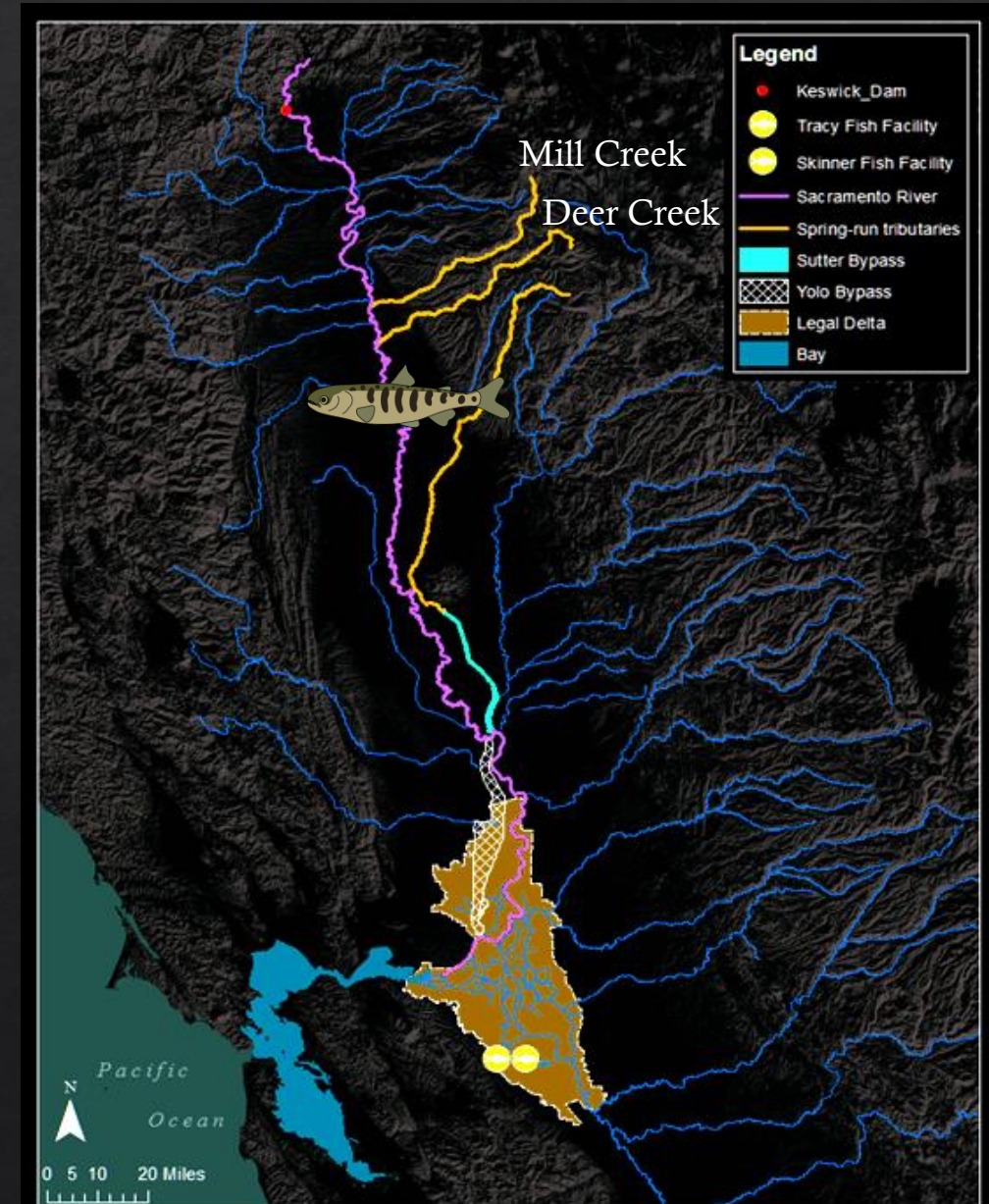
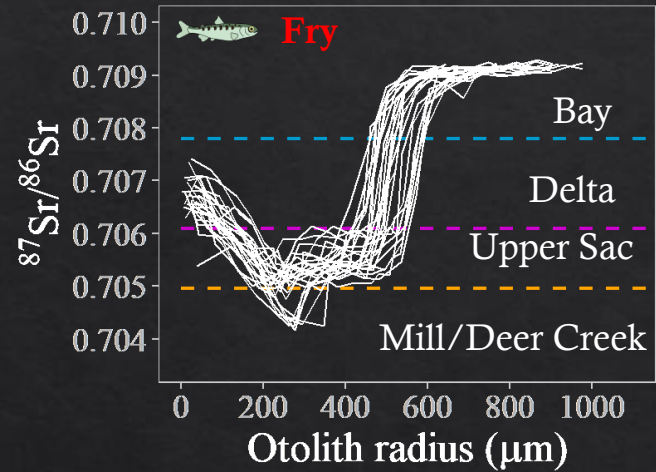
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# Mill/Deer Creek juvenile strategies

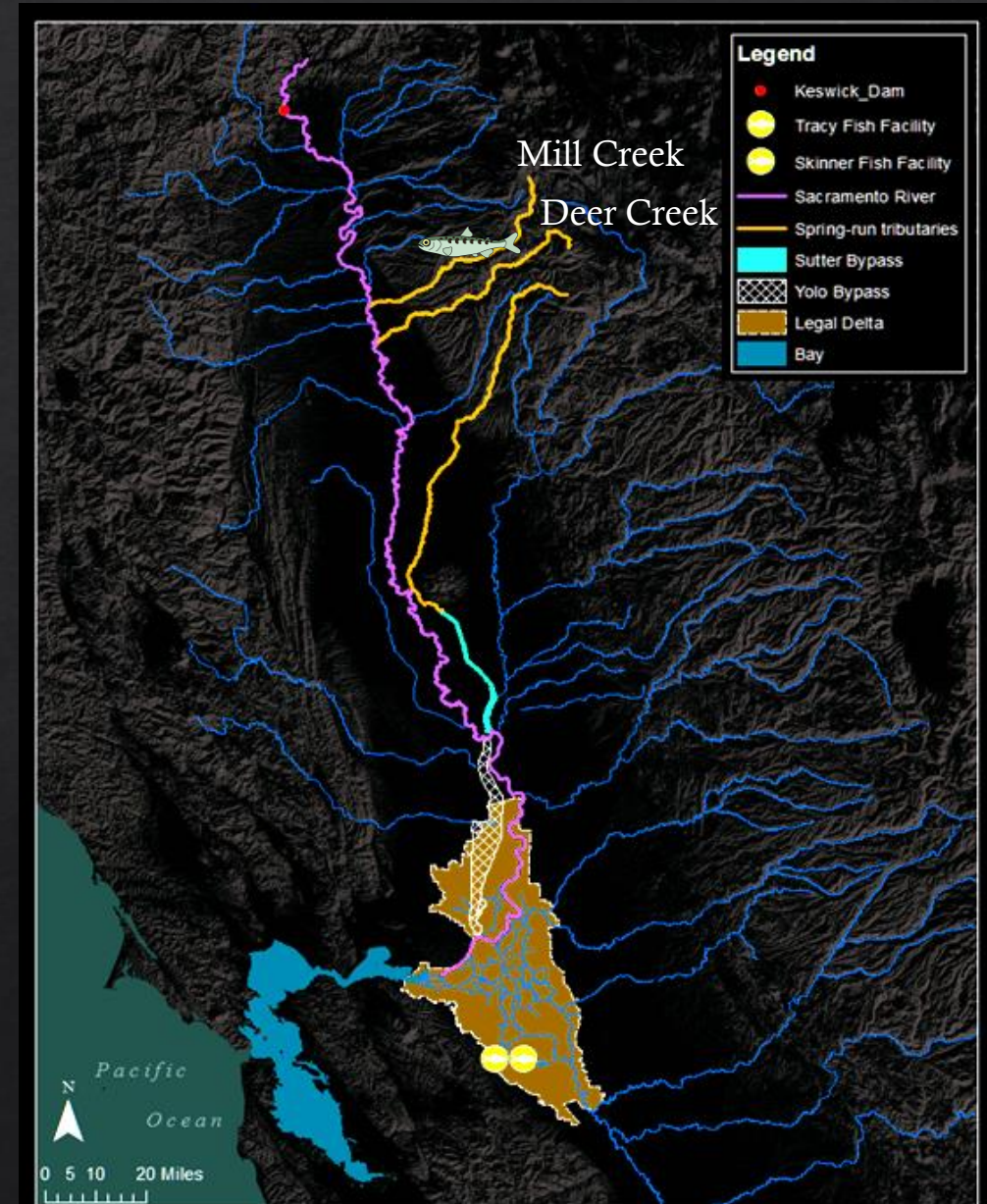
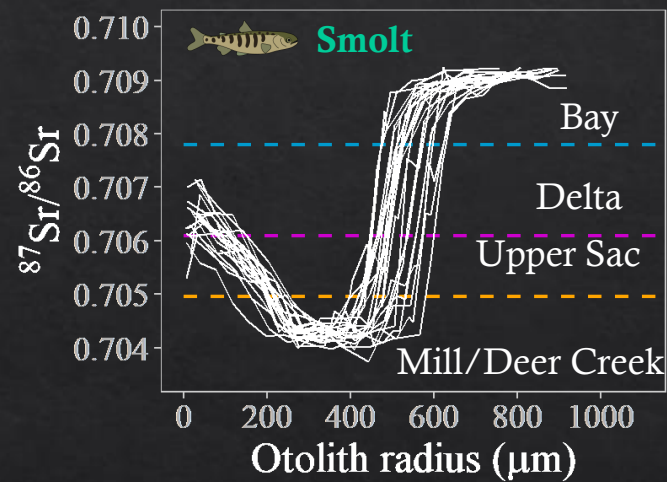
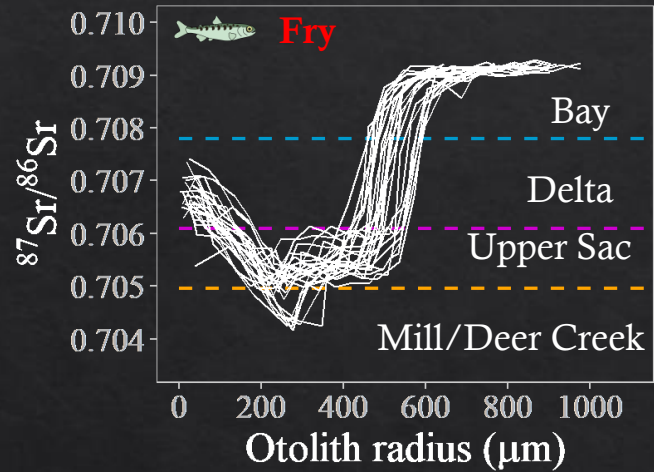
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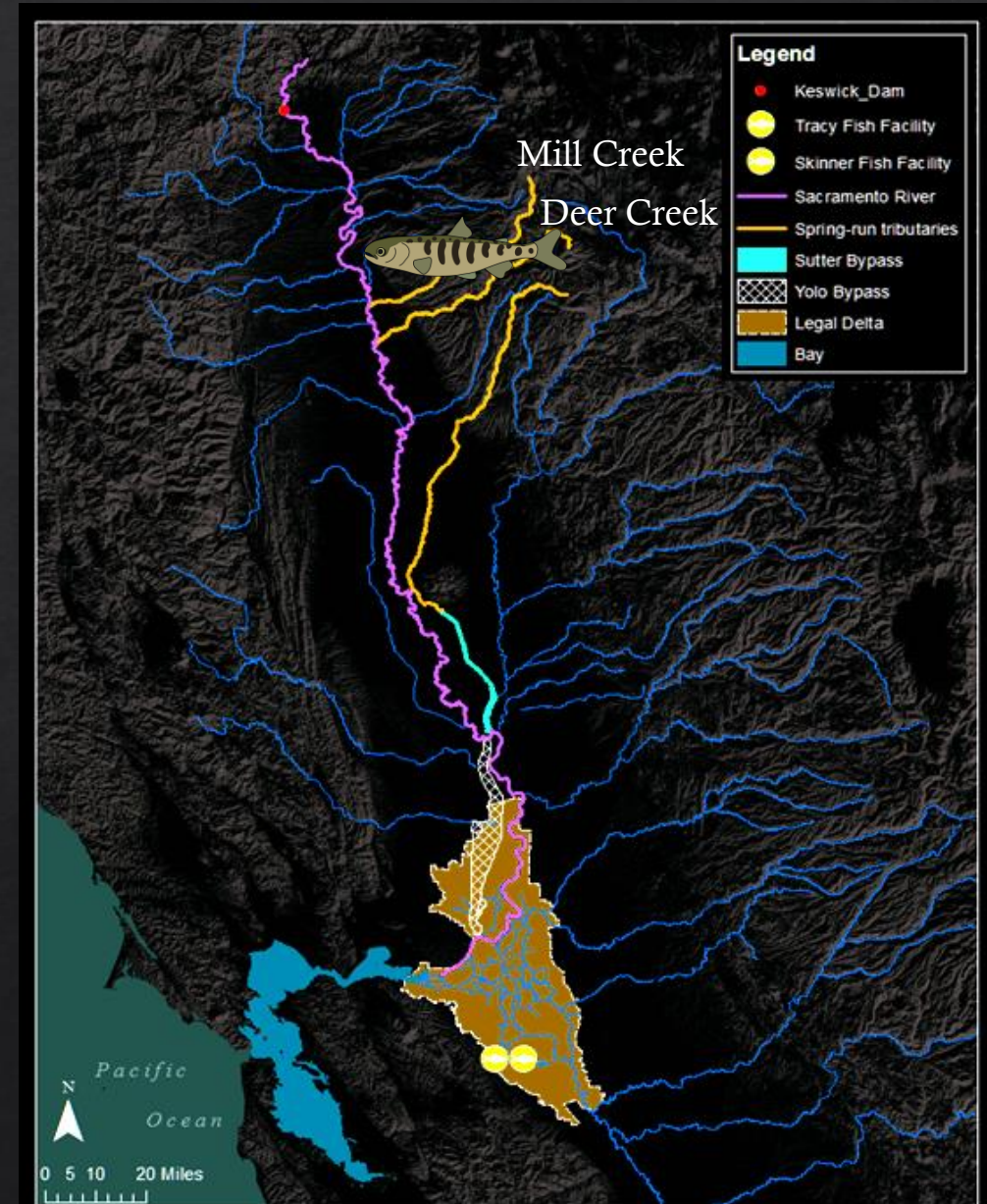
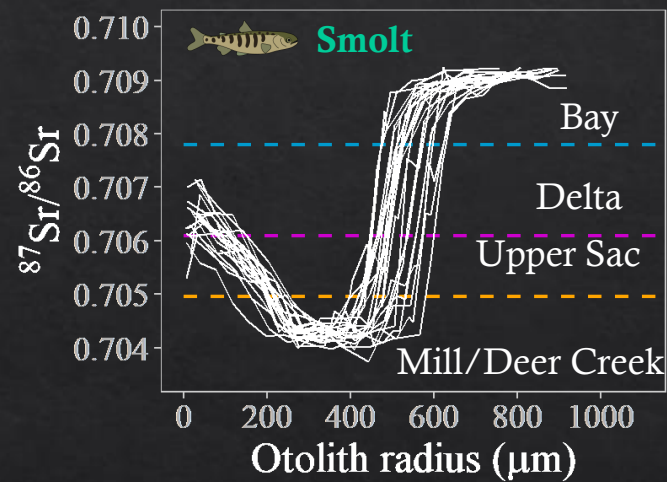
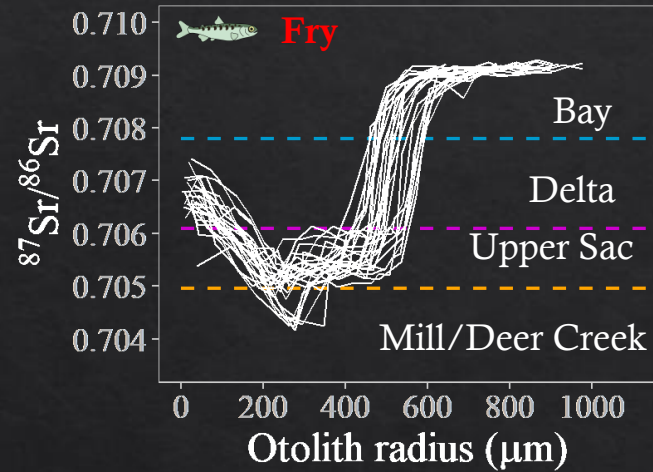
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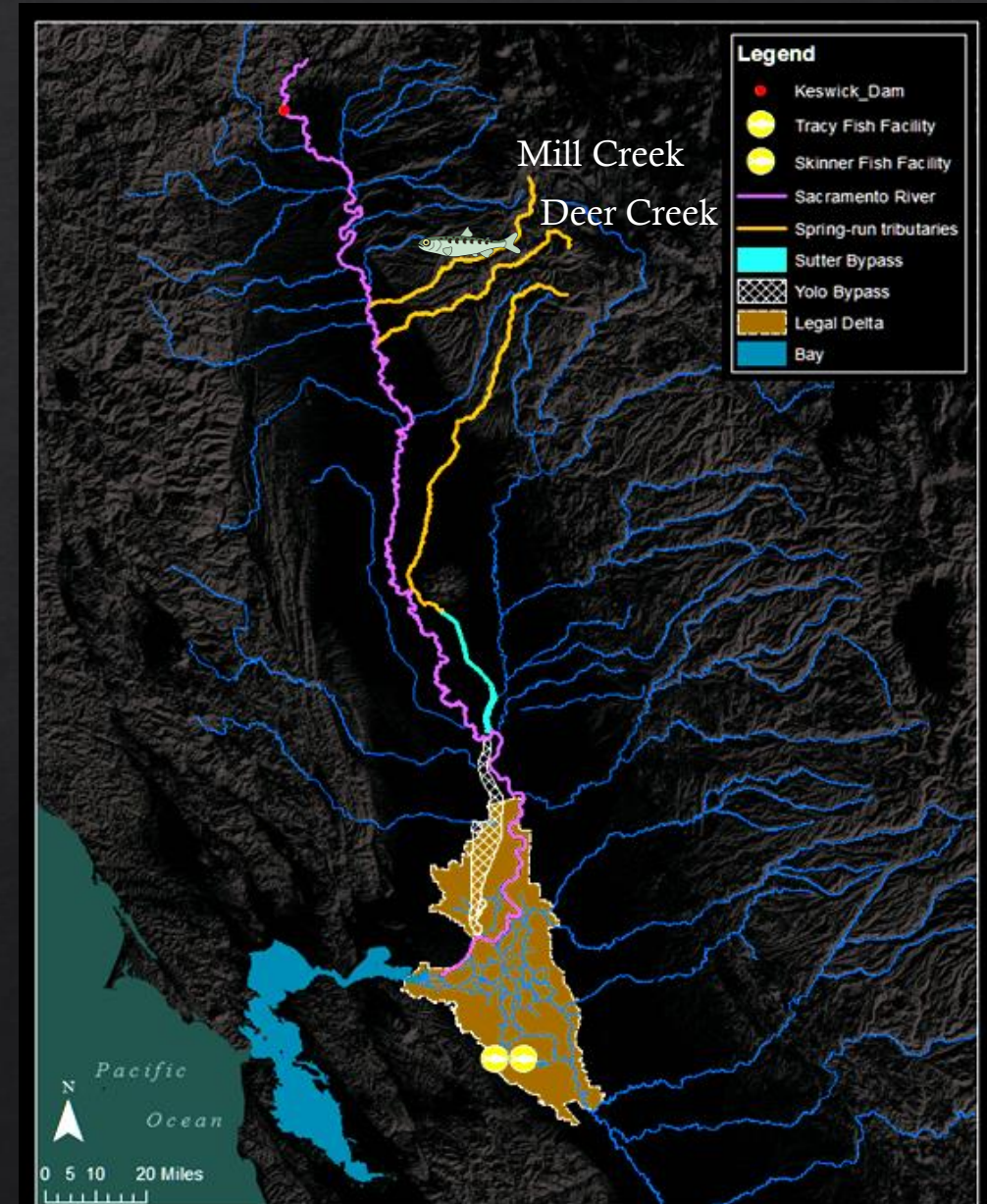
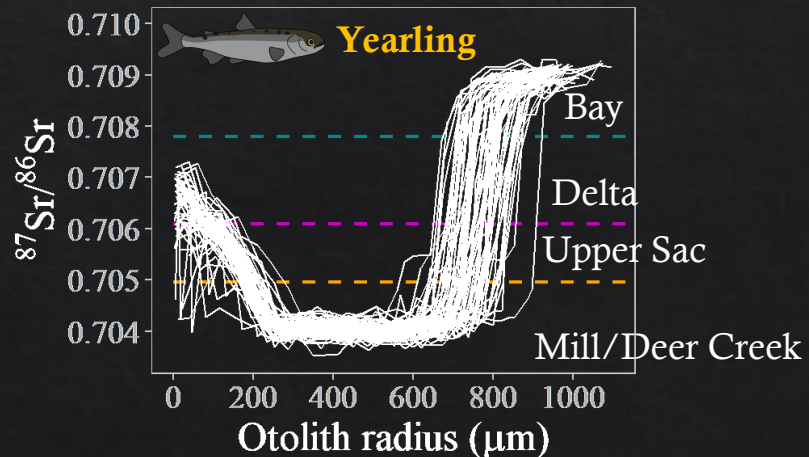
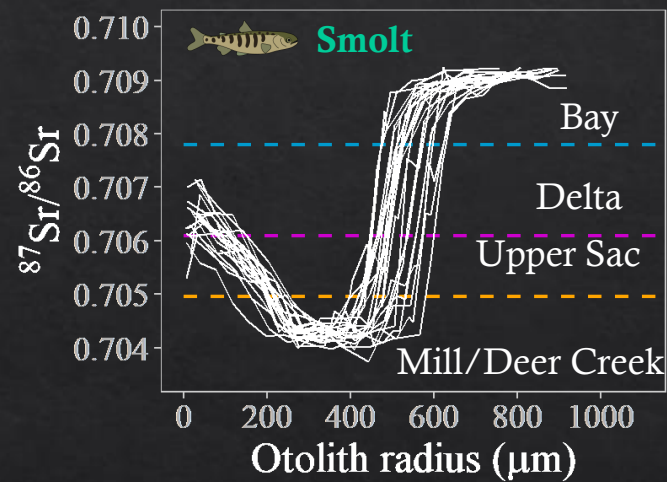
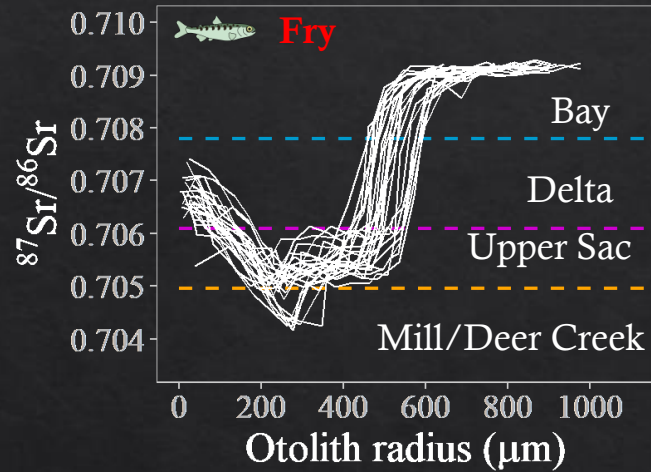
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# Mill/Deer Creek juvenile strategies

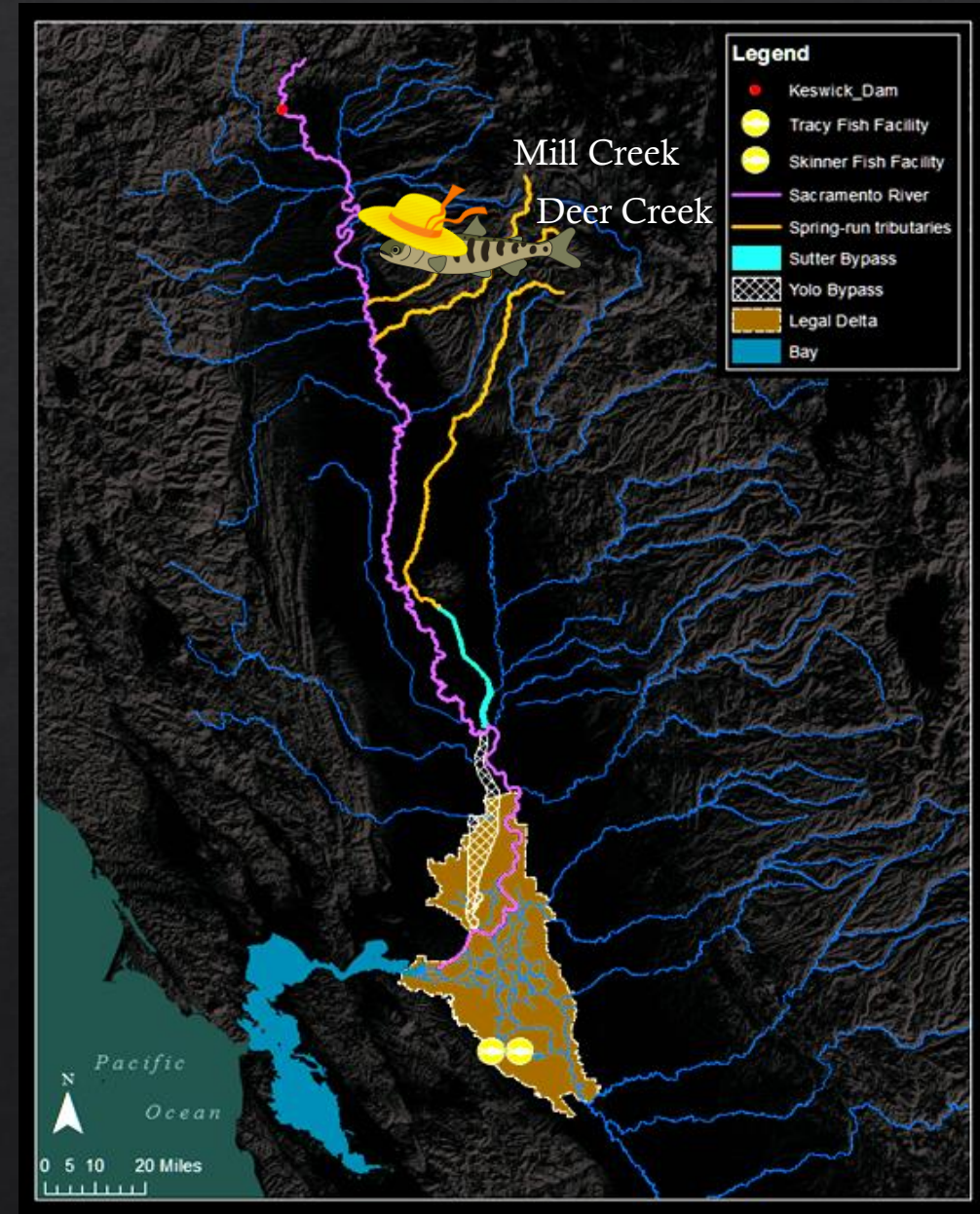
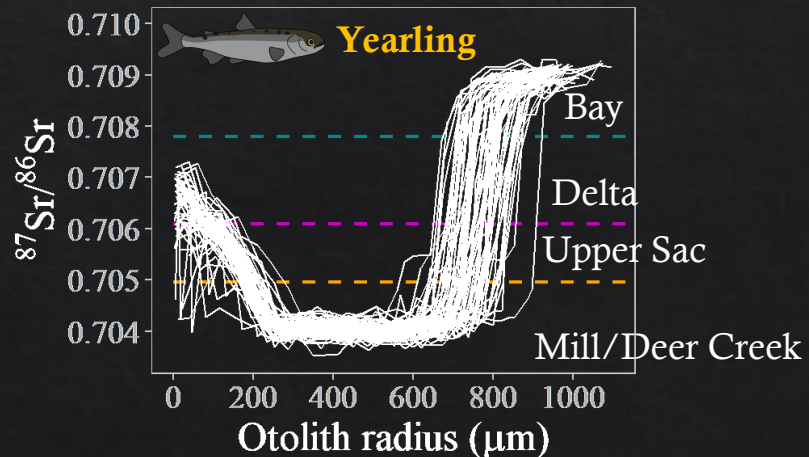
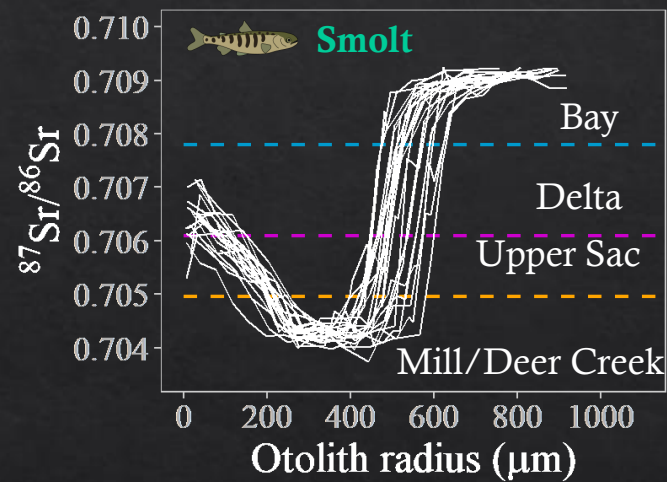
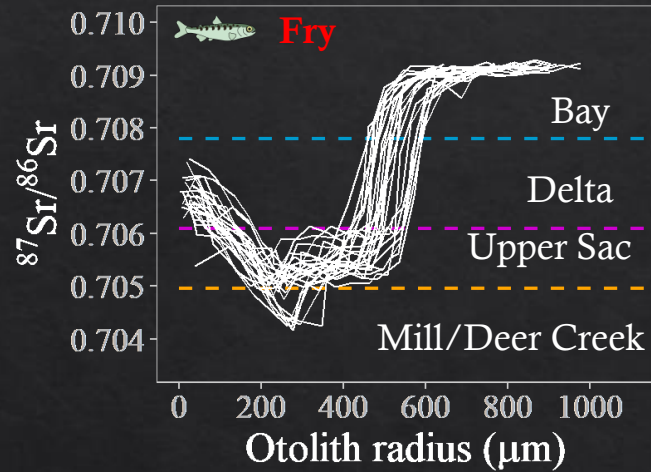
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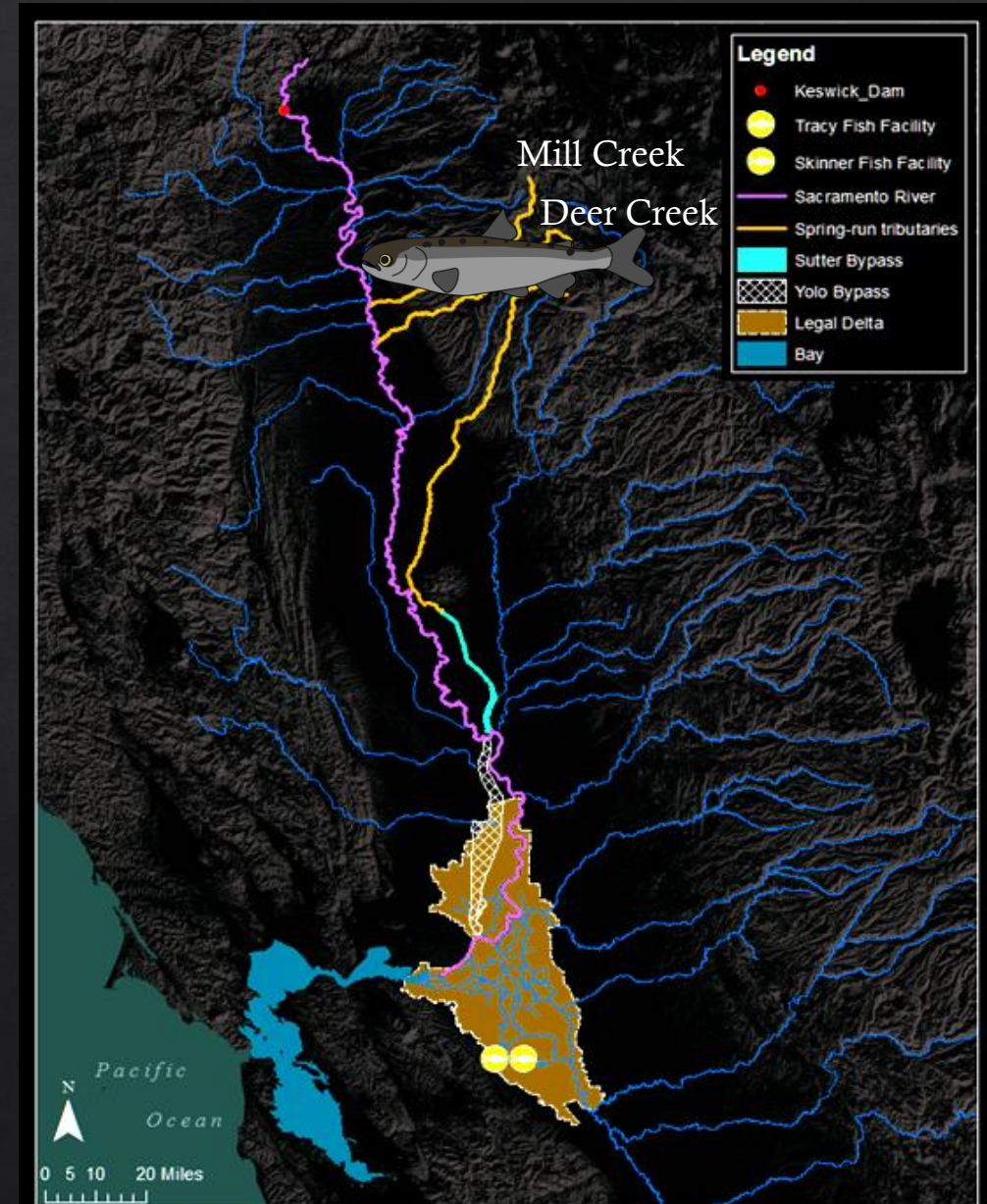
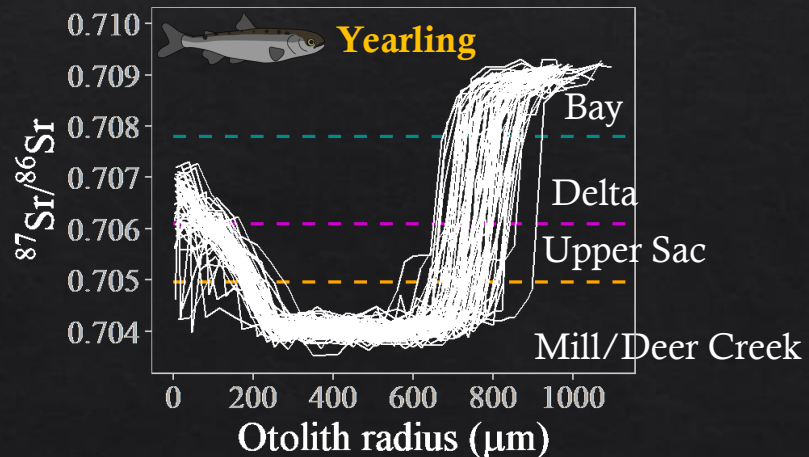
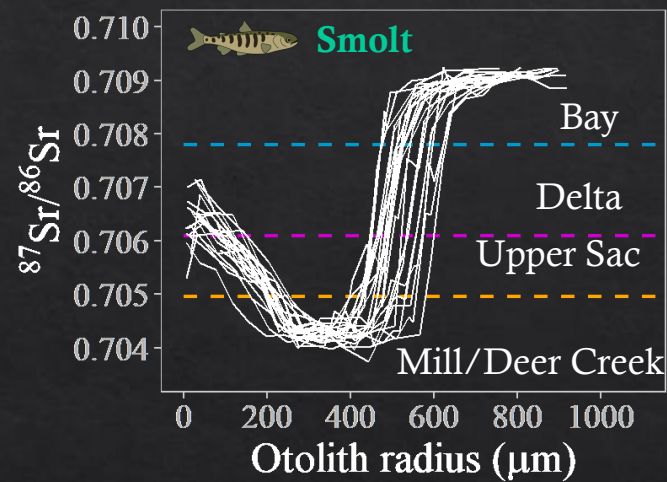
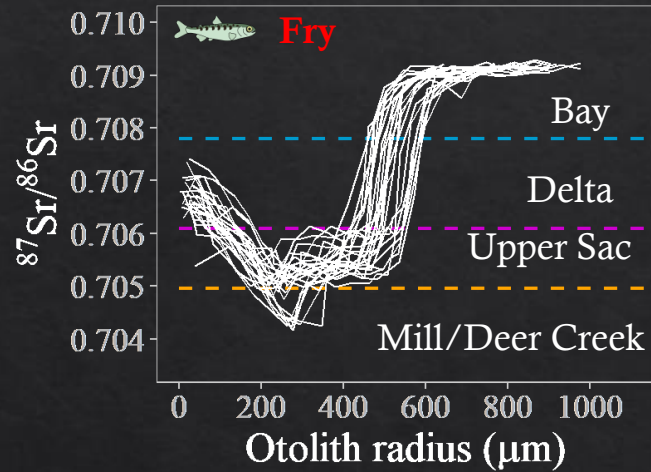




# Mill/Deer Creek juvenile strategies

✓ 123 otoliths analyzed across 6 years

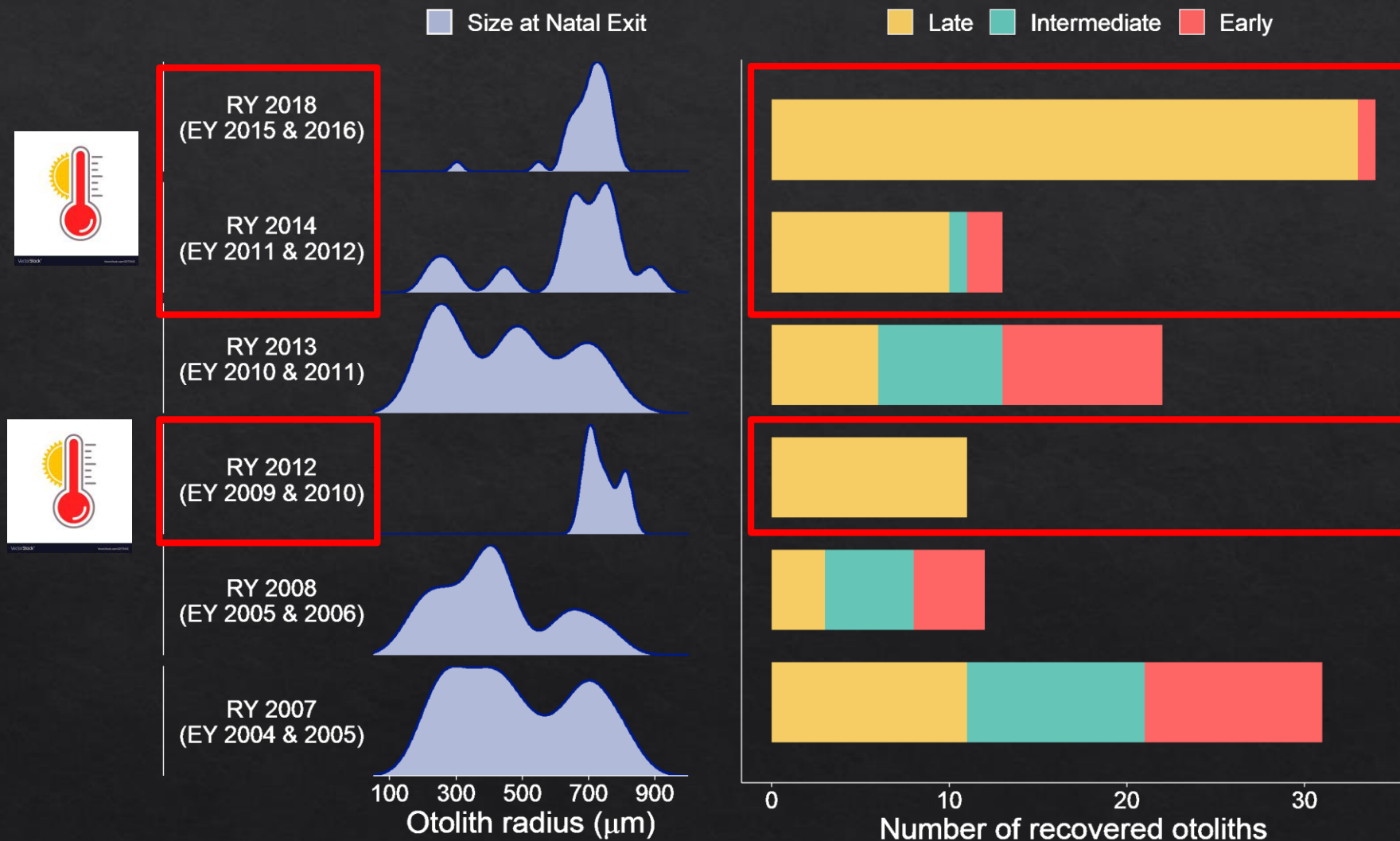
✓ Three migratory strategies





# Life history variability across years

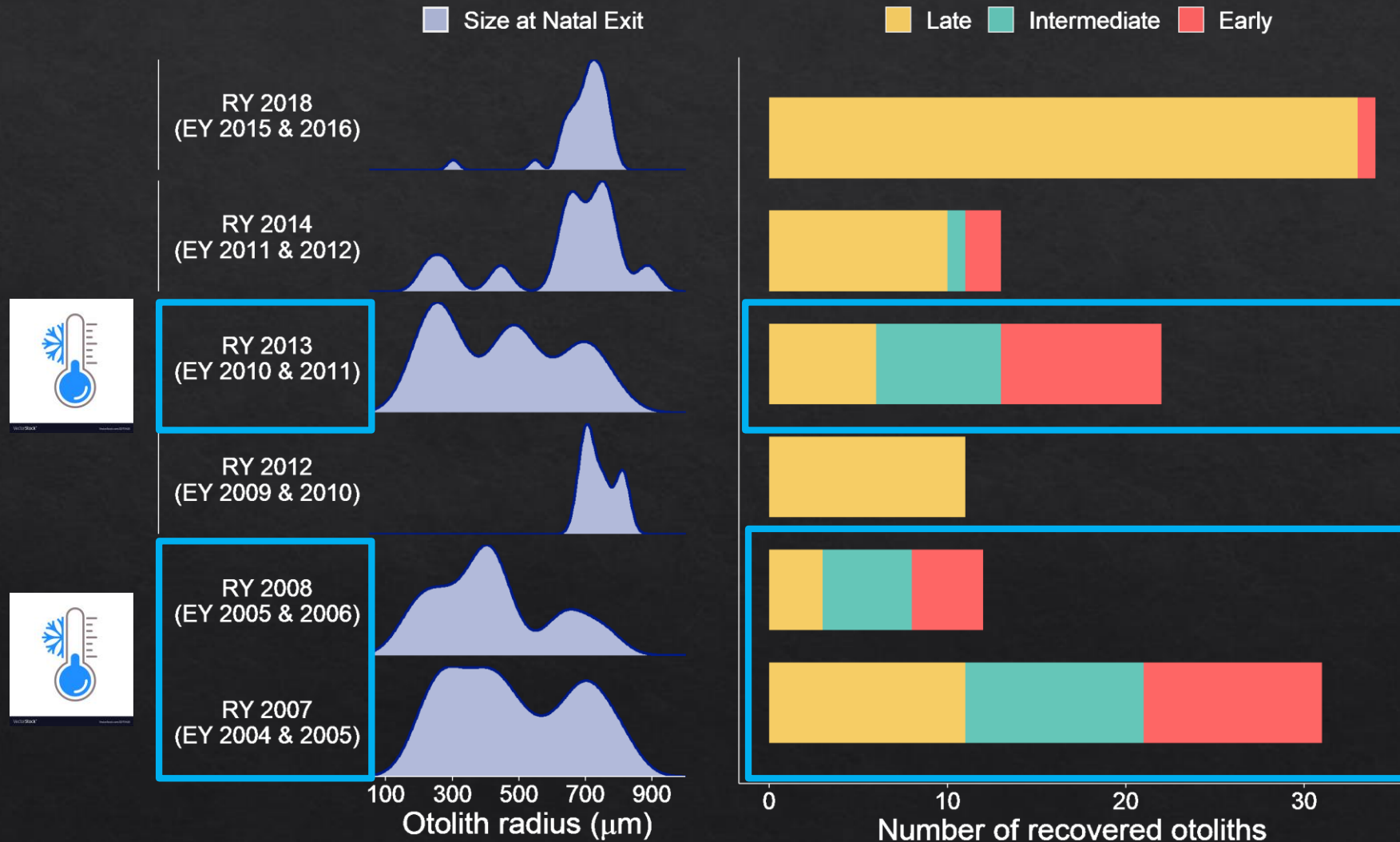
✓ Late migrating strategy dominant during dry emigration years





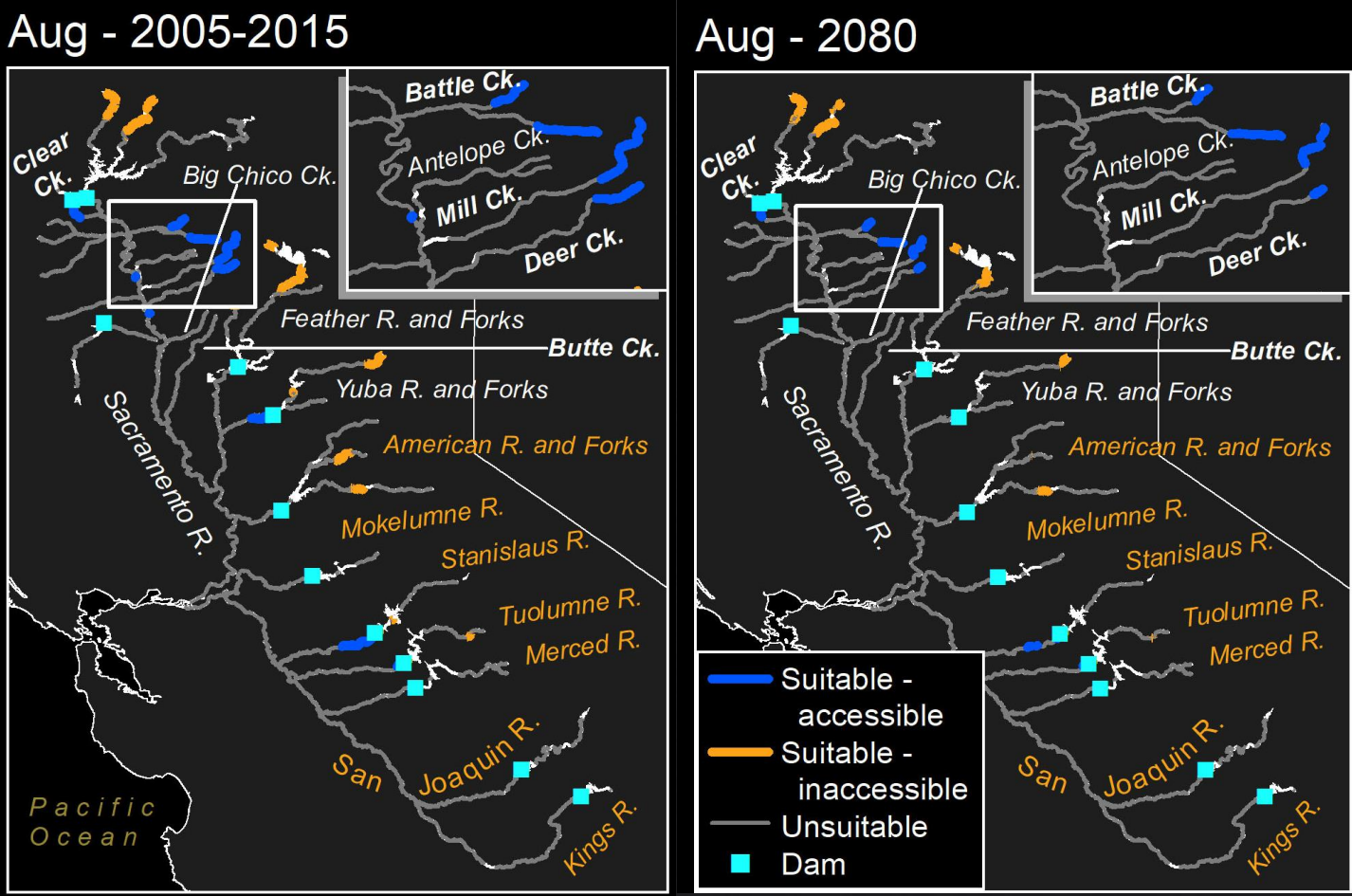
# Life history variability across years

✓ Mix of three strategies during wetter years





# Future warming temperature effects



	August 2005-2015	August 2080
Accessible	171 km	76 km
Accessible & Inaccessible	366 km	201 km

(Cordoleani et al. 2021. Nature Climate Change. DOI: 10.1038/s41558-021-01186-4)

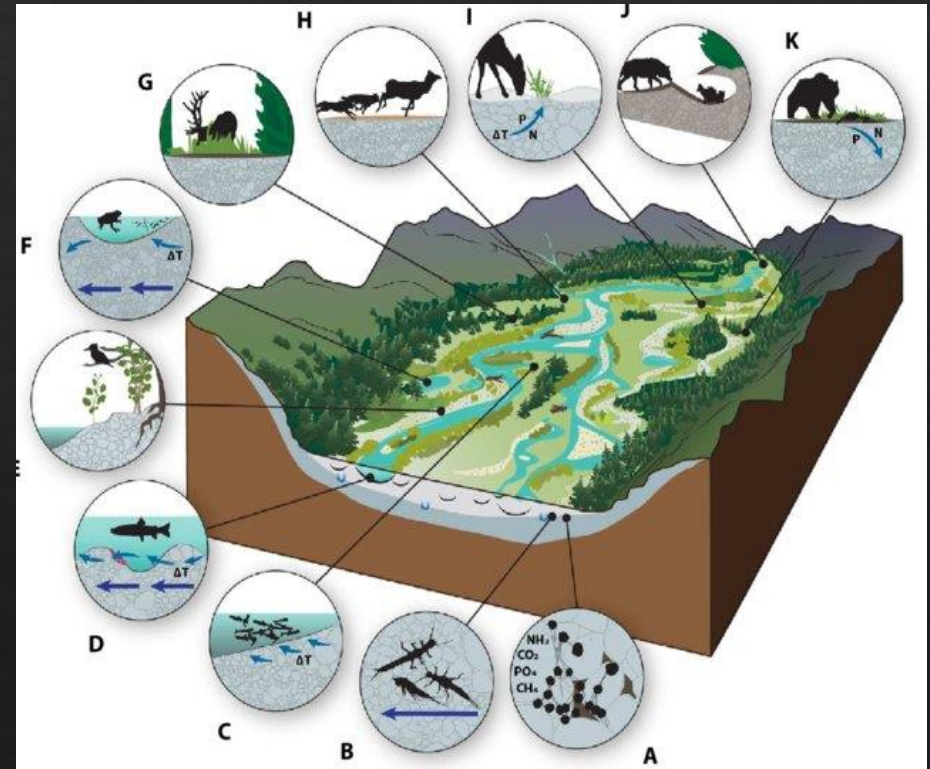


# Spring-run success in future climate

- ✓ Mill/Deer Creek yearling act as an insurance policy against drought
- ✓ Provide a mosaic of habitats to support the different juvenile life history strategies



(Source: Jeremy Notch, UCSC)

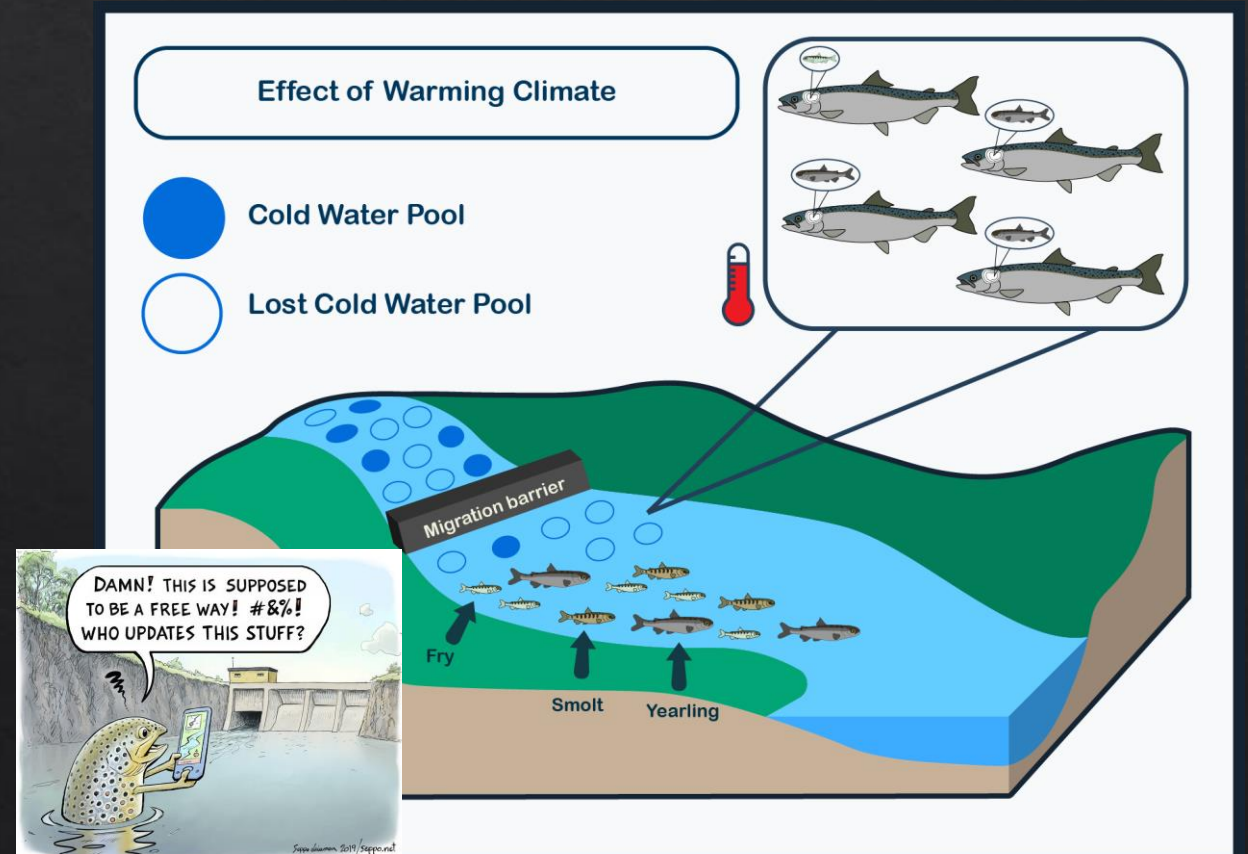


# Spring-run success in future climate

- ✓ Mill/Deer Creek yearling act as an insurance policy against drought
- ✓ Restore access to cold water refugia for oversummer rearing



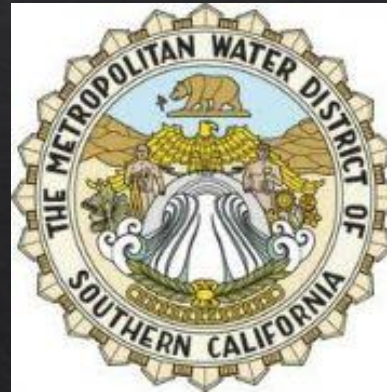
(Source: Jeremy Notch, UCSC)



(Source: Katie Lewis, UCSC)



# Many thanks to



And thank **you** for listening!



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[@Floracordo](https://twitter.com/Floracordo)



Cordoleani F., Phillis C.C. , Sturrock A.M. , FitzGerald A.M. , Malkassian A. , Whitman G.E. , Weber P.K. and Johnson R.C. (2021) Threatened salmon rely on a rare life history strategy in a warming landscape. Nature Climate Change. DOI: 10.1038/s41558-021-01186-4.