

# Conserving salmon at the southern end of their North American range: challenges and opportunities

Steve Lindley, Rachel Johnson, Nate Mantua, Eric Danner, and Tommy Williams

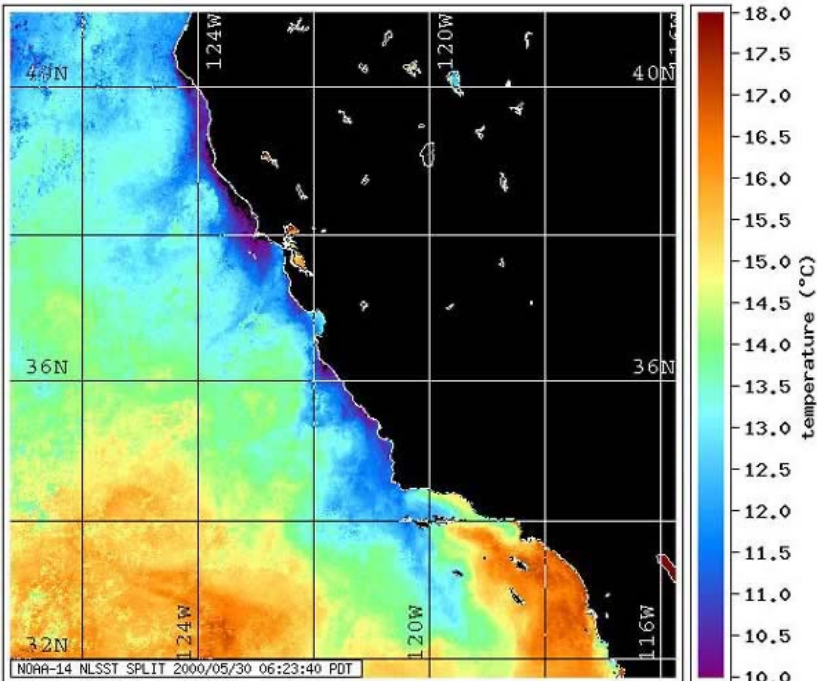
NOAA NMFS Southwest Fisheries Science Center

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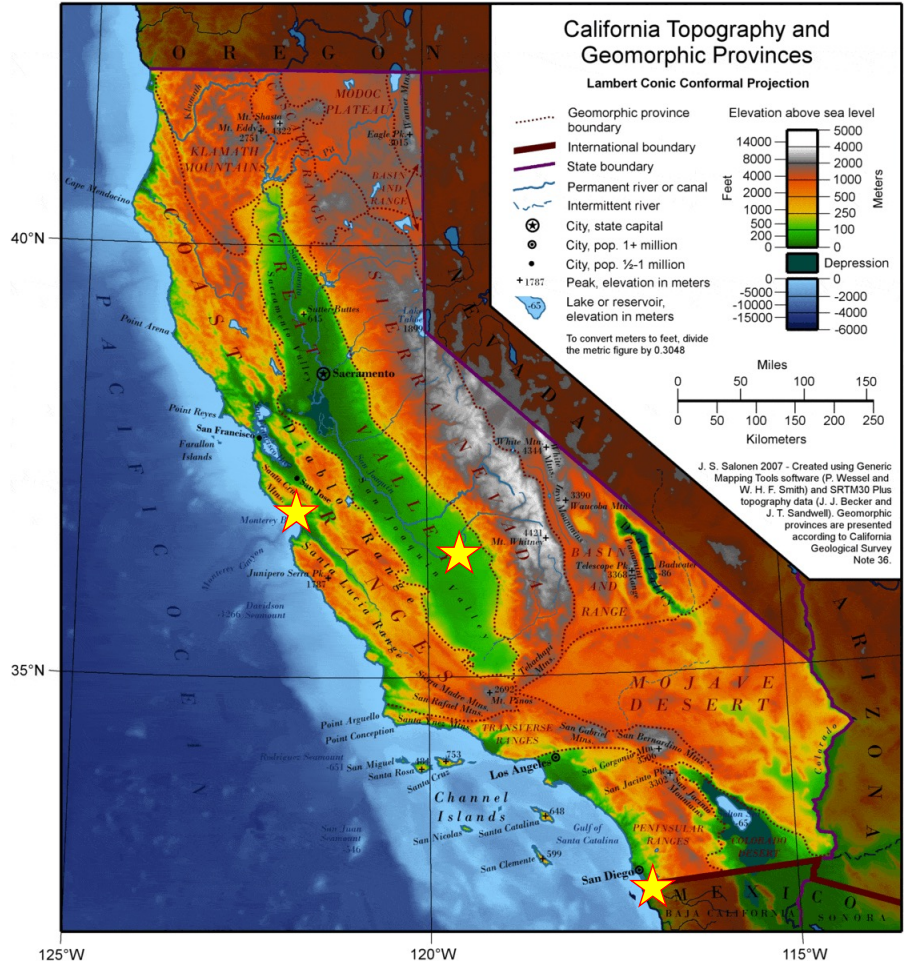
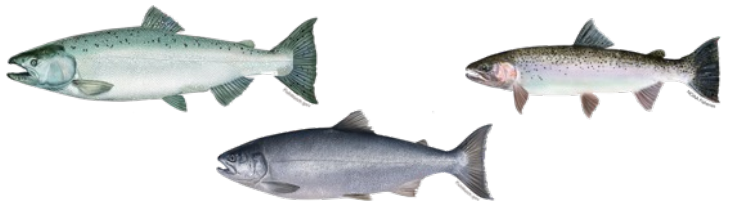
International Year of the Salmon Synthesis Symposium, Oct 4-6 2022



# Oceanographic and geographic setting

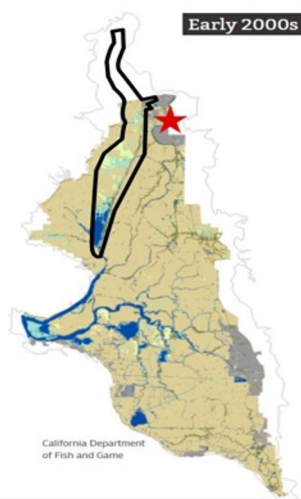
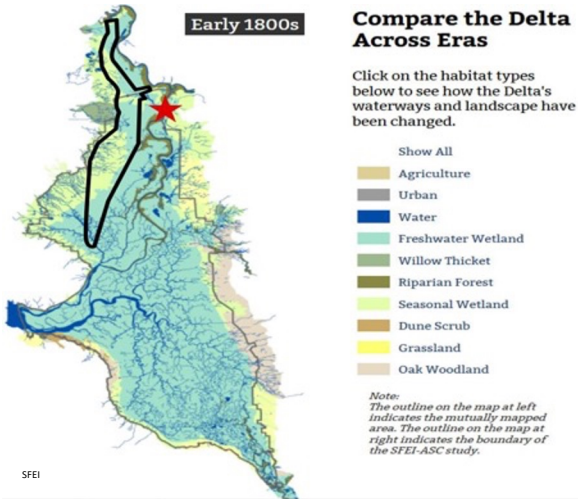


Sanctuary Quest 2002, NOAA/OER - [https://oceanexplorer.noaa.gov/explorations/02quest/background/airwelling/media/Fig2\\_map.html](https://oceanexplorer.noaa.gov/explorations/02quest/background/airwelling/media/Fig2_map.html)



125°W 120°W 115°W

# Salmon conservation has been a challenge for as long as California has been a state



# CV salmon are *the most vulnerable* to changing climate


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RESEARCH ARTICLE

## Climate vulnerability assessment for Pacific salmon and steelhead in the California Current Large Marine Ecosystem

Lisa G. Crozier  Michelle M. McClure, Tim Beechie, Steven J. Bograd, David A. Boughton, Mark Carr, Thomas D. Cooney, Jason B. Dunham, Coraleigh M. Greene, Melissa A. Haltuch, Elliott L. Hazen, Damon M. Holzer, David D. Huff, Rachel C. Johnson, Chris E. Jordan, Isaac C. Kaplan, Steven T. Lindley, Nathan J. Mantua, Peter B. Moyle, James M. Myers, Mark W. Nelson, Brian C. Spence, Laurie A. Weitkamp, Thomas H. Williams, Ellen Willis-Norton [ view less ]

Published: July 24, 2019 • <https://doi.org/10.1371/journal.pone.0217711>

### Mapping Vulnerabilities to Climate Change

NOAA Fisheries assessed the vulnerability of 33 population groups\* of Pacific salmon & steelhead to climate change along the West Coast.

#### Number & Risk Level of Population Groups







#### Vulnerability



F = fall run Sp/Su = spring/summer run  
W = winter run Su = summer run  
Sp = spring run

\*Population groups refer to distinct population segments (DPS) & evolutionarily significant units (ESU).

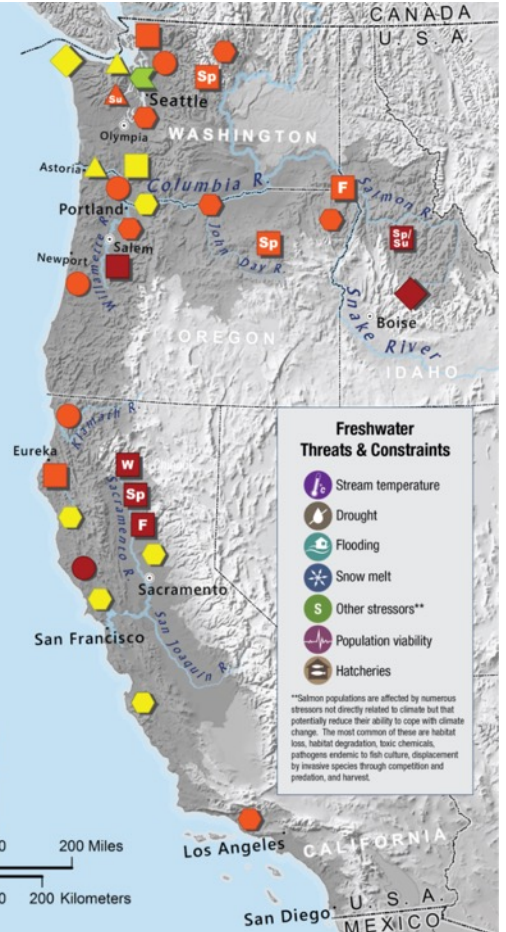
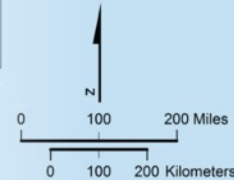
#### Marine Threats

-  Sea surface temperature
-  pH Ocean acidification
-  Sea level rise
-  Upwelling

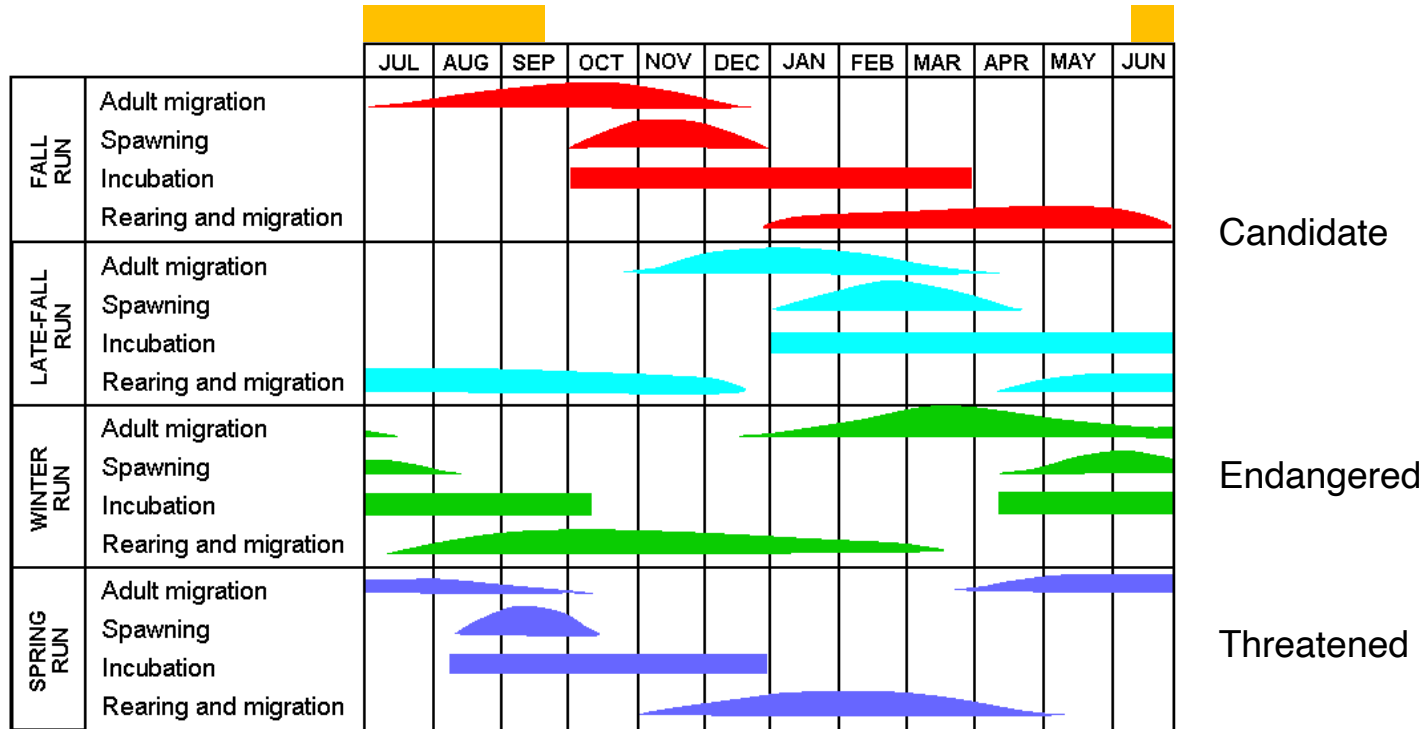
#### Freshwater Threats & Constraints



-  Stream temperature
-  Drought
-  Flooding
-  Snow melt
-  Other stressors\*\*
-  Population viability
-  Hatcheries

\*\*Salmon populations are affected by numerous stressors not directly related to climate but that potentially reduce their ability to cope with climate change. The most common of these are habitat loss, habitat degradation, toxic chemicals, pathogens endemic to fish culture, displacement by invasive species through competition and predation, and harvest.

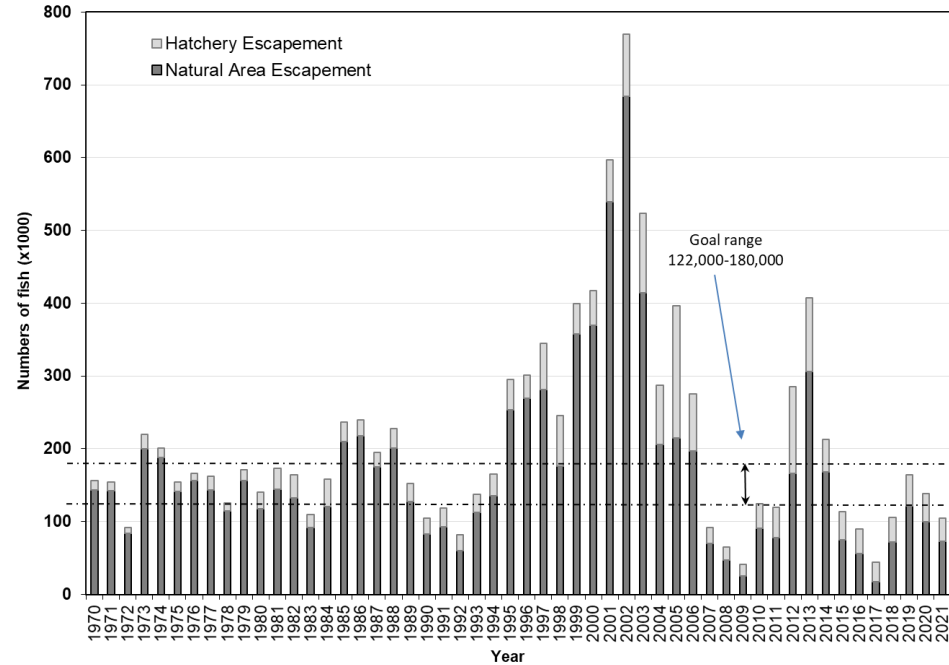
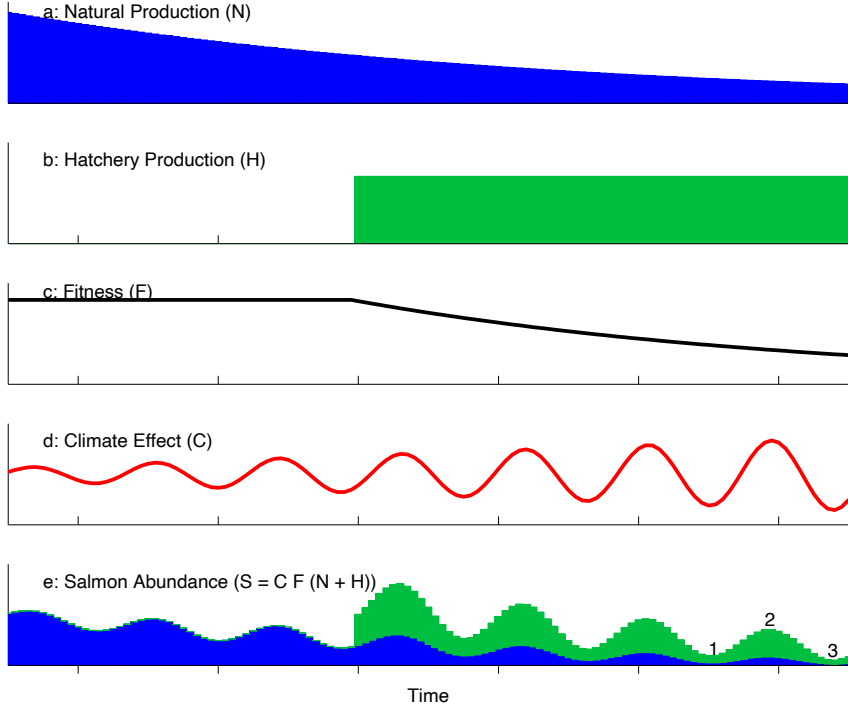


# Life history diversity in CV Chinook salmon

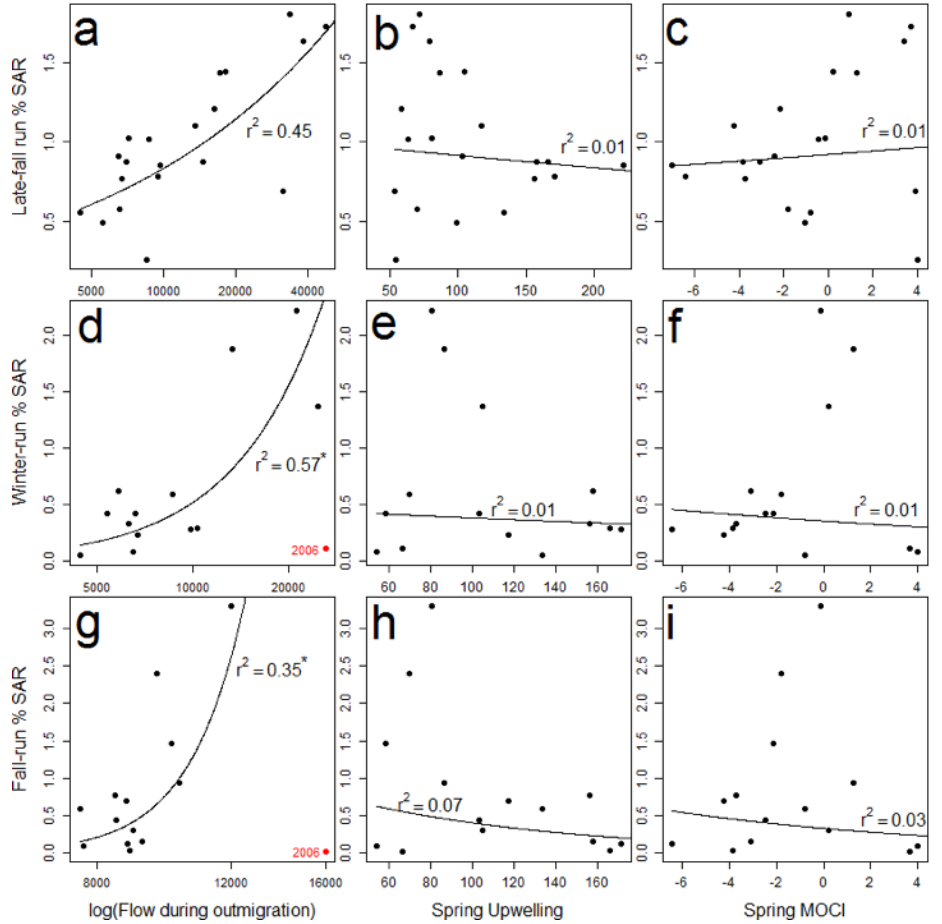
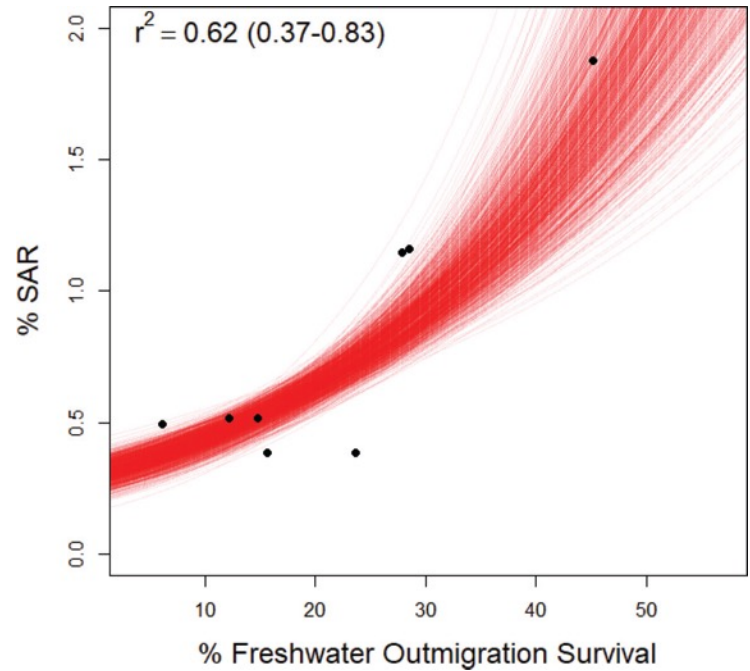


 Denotes presence and relative magnitude  
 Denotes only presence

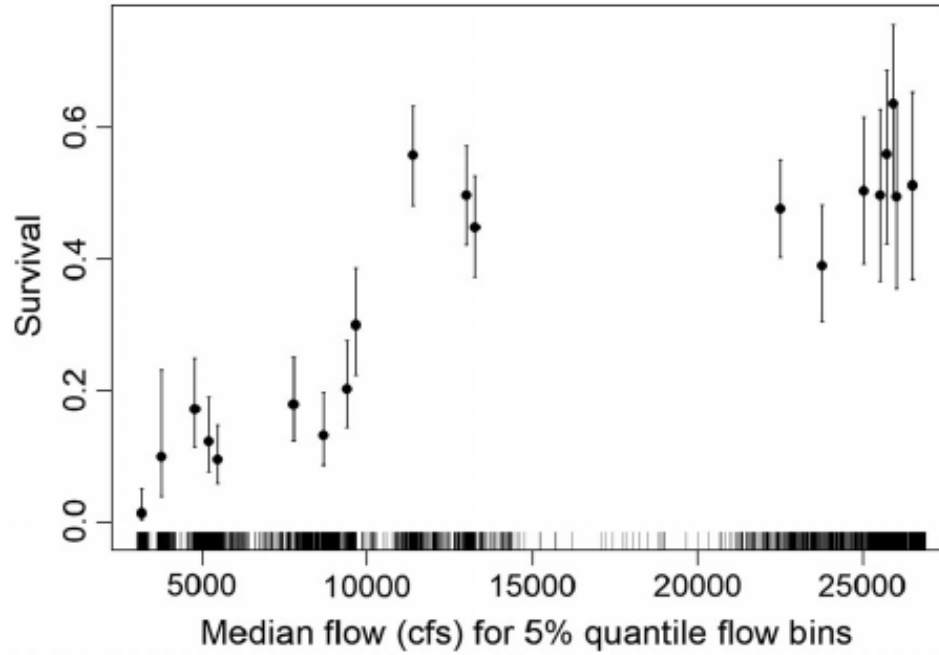
# A conceptual model of salmon declines



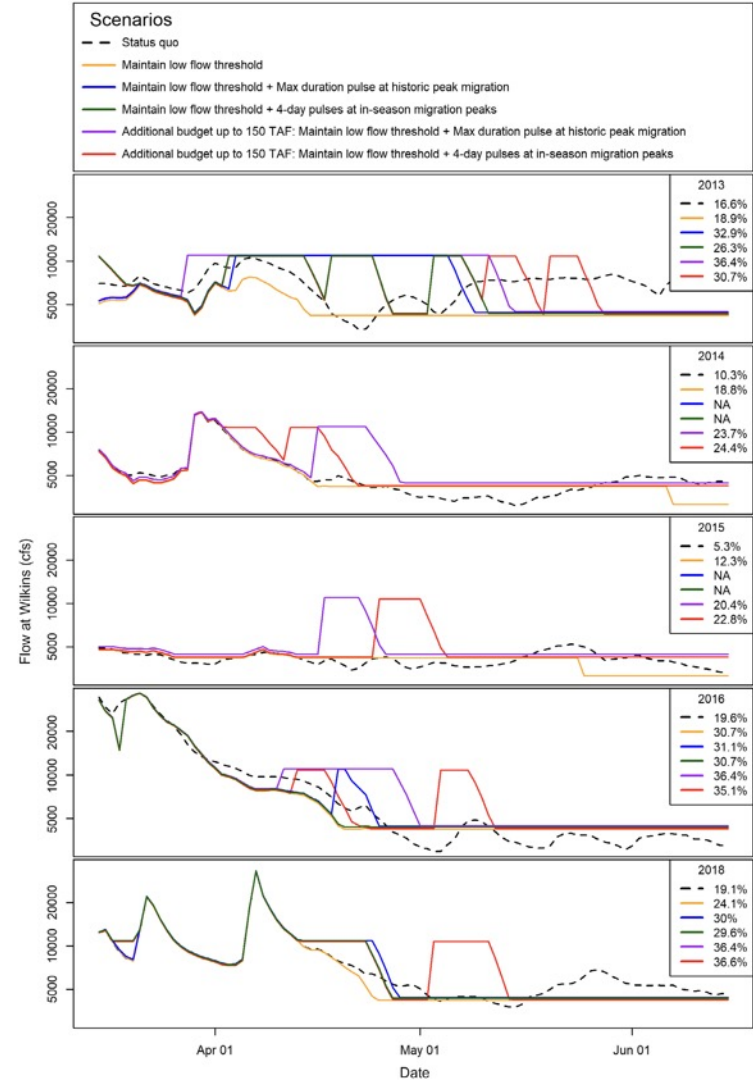
# Smolt-to-adult survival depends strongly on flow, but not on ocean measures



# Salmon survival in the river is a strong, nonlinear function of flow

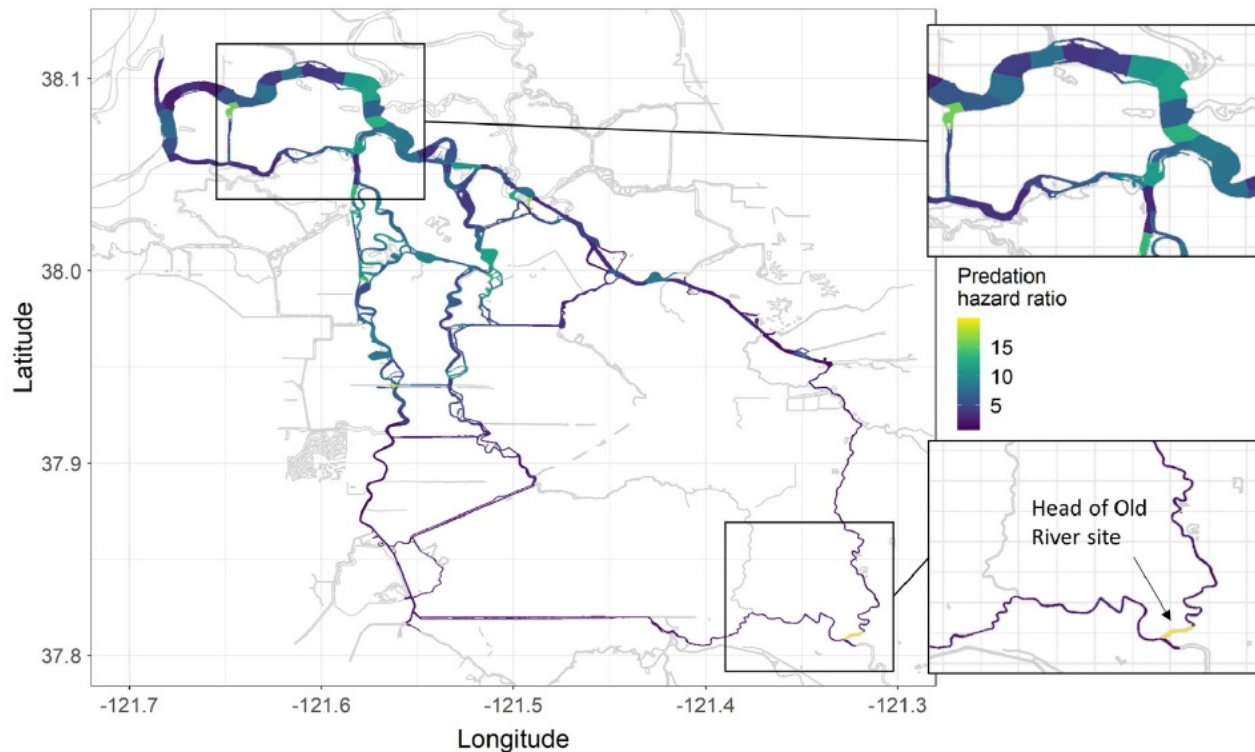
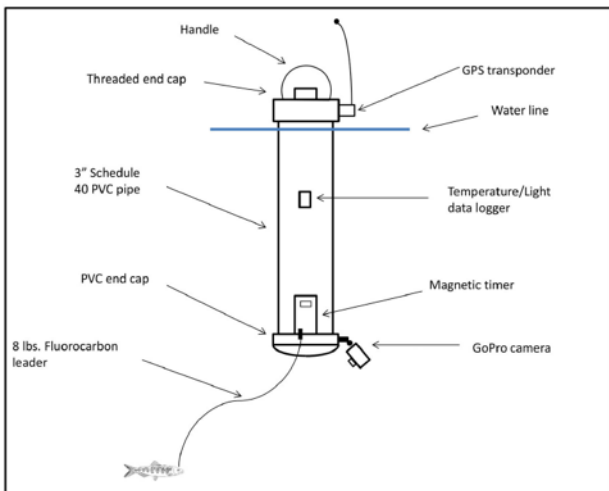


Michel et al, Ecosphere e03498 (2021)



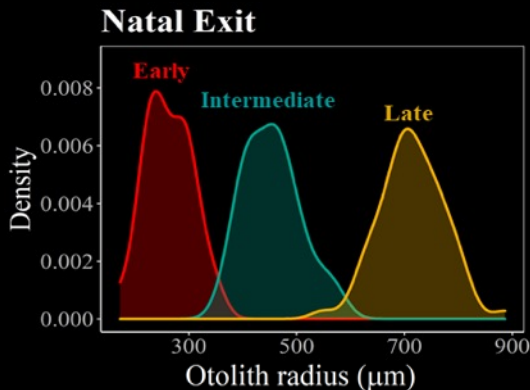


# Salmon survival in the Delta is related to predator distribution and physical features that increase salmon vulnerability to predators

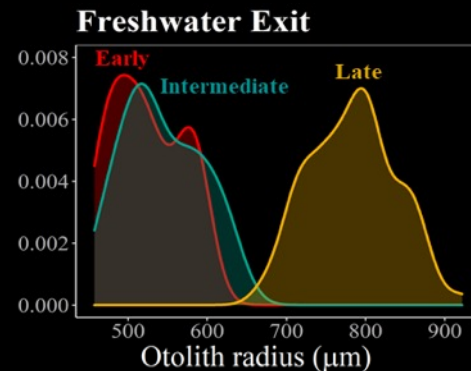


# Life history diversity in spring-run Chinook

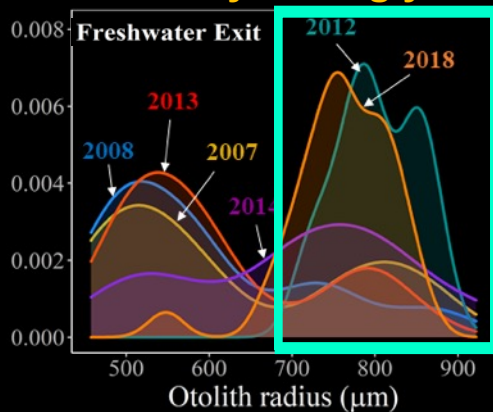
## Diversity in timing



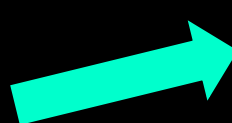
## Diversity rearing habitat



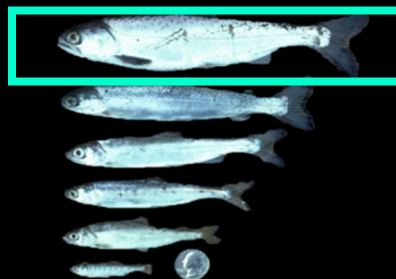
## Diversity among years



## Yearlings Rule Dry years

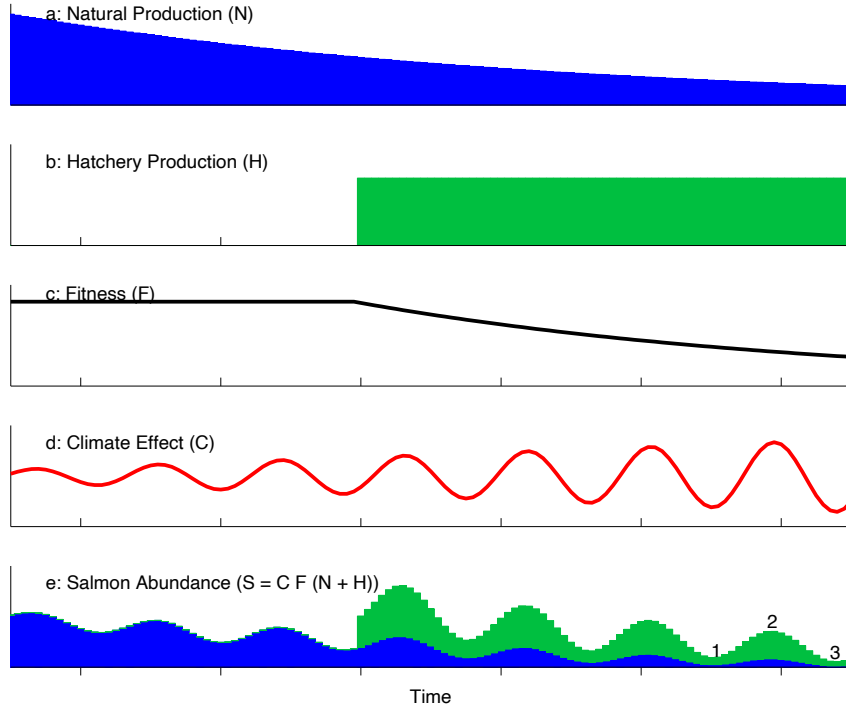


2018 [2015 BY] = CD  
2012 [2009 BY] = D



Life history diversity *is* spreading risk in time & space

# What can be done?



1. Improve and restore access to diverse and functional habitats

2. Reform hatchery practices

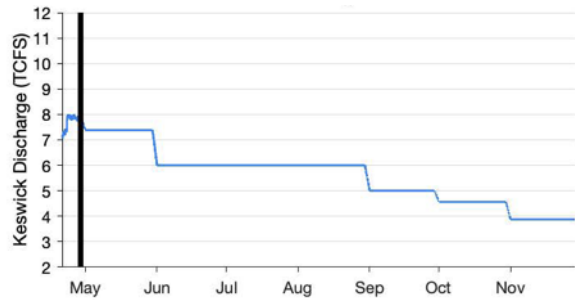
3: 1 and 2, and limit or mitigate GG emissions

# Reintroduction: passage past permanent barriers (Upper Sacramento R.)

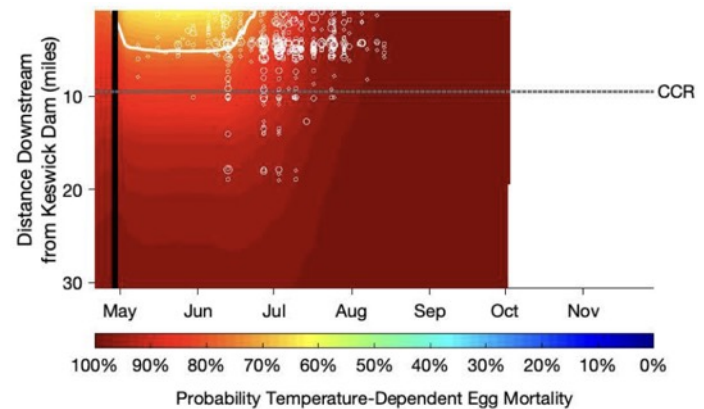
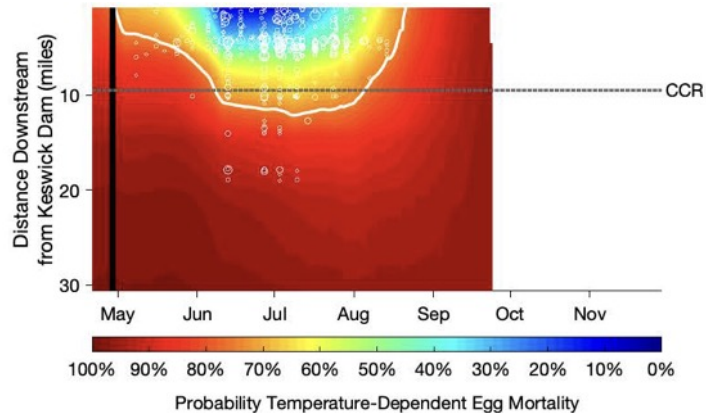
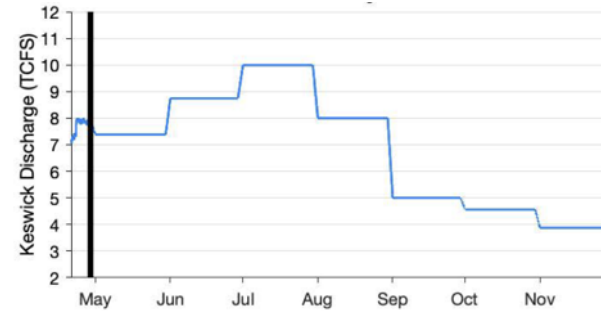


# Improving water management

Conserve cold water for fish: 46% mortality



Deliver more water to farms: 86% mortality



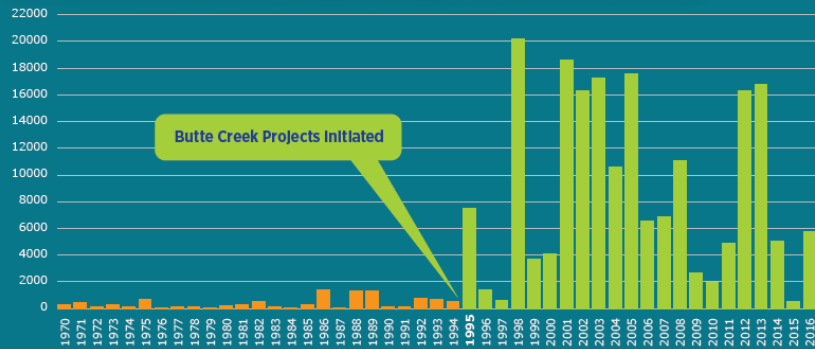
# Floodplain restoration

## Butte Creek Watershed



<https://www.buttecdw.gov>

## BUTTE CREEK SPRING-RUN CHINOOK SALMON POPULATION ESTIMATES

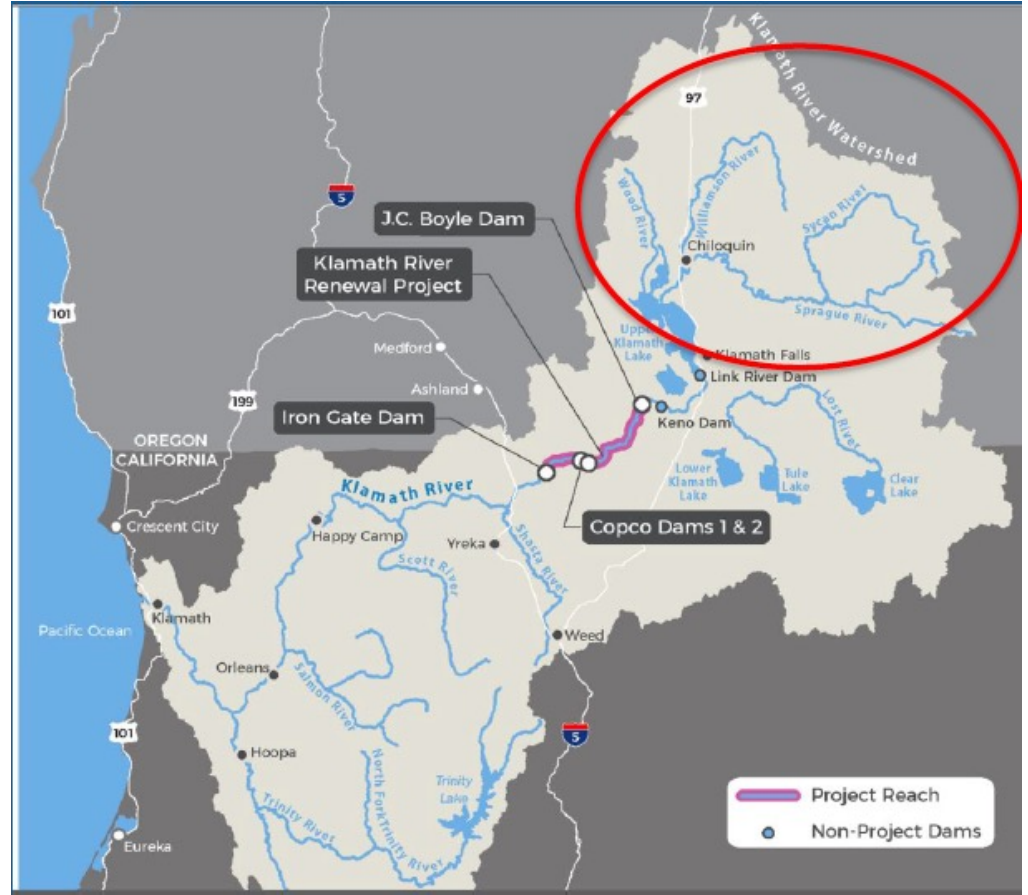


Butte Creek Projects Initiated

Source: CDFW



# Reintroduction: dam removal on Klamath River



Species	Newly Accessible Habitat (rkm)
Chinook	672
Coho	93
Steelhead	672

# California Hatchery Review Report



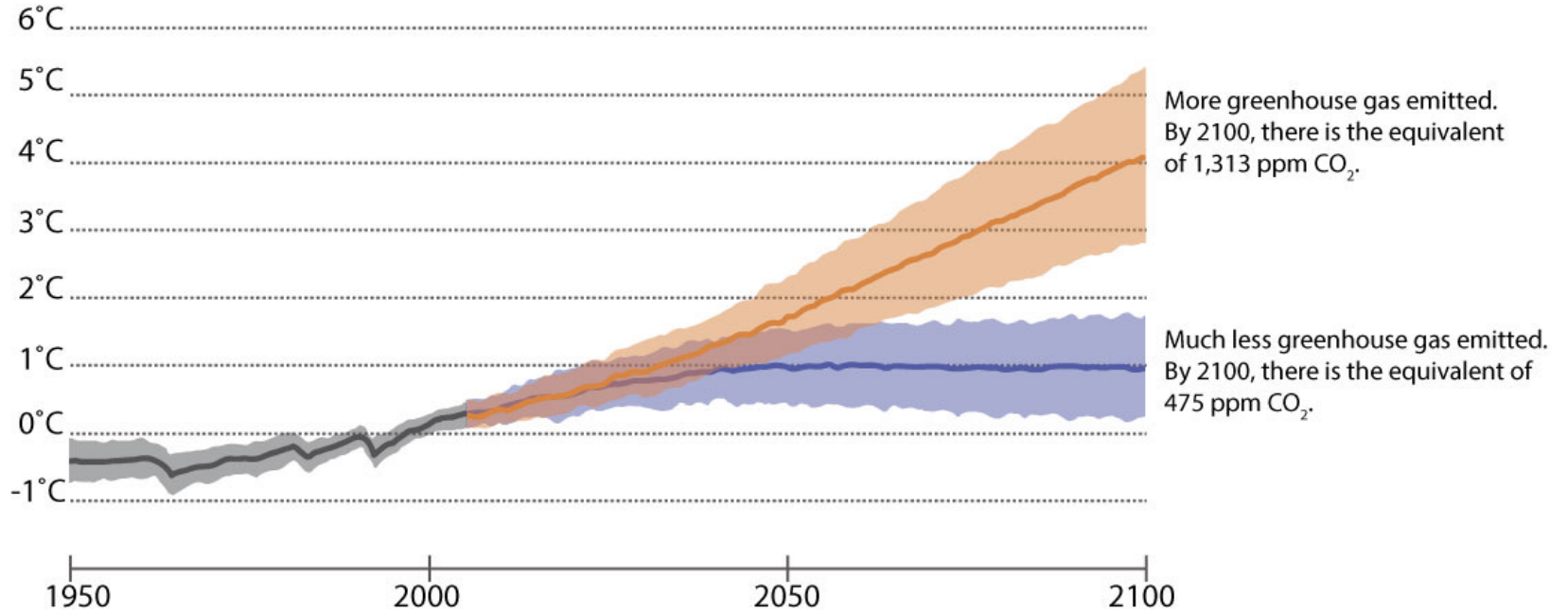
## 14 findings and recommendations (here are 4):

- Serious loss and degradation of habitat limits natural production of salmon and steelhead in California
- Off-site releases promote unacceptable levels of straying
- Marking/tagging programs are needed for real-time identification of all hatchery-origin Chinook salmon returning to hatchery facilities
- Harvest management of Sacramento River Fall Chinook should account for the productivity of naturally-spawning adults



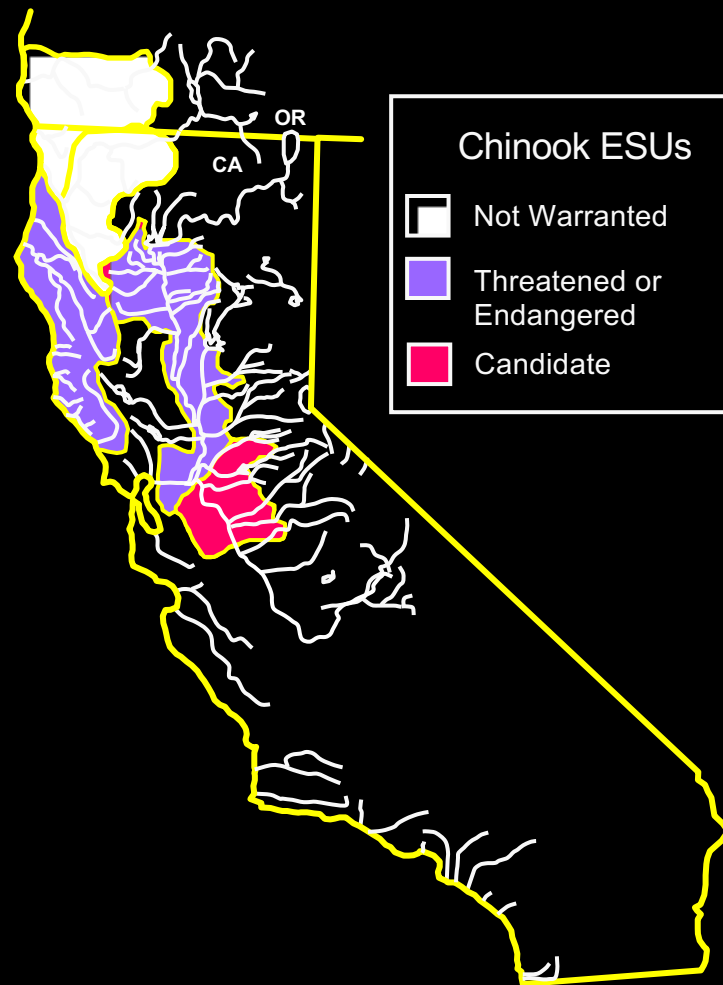


# global average surface temperature change projections



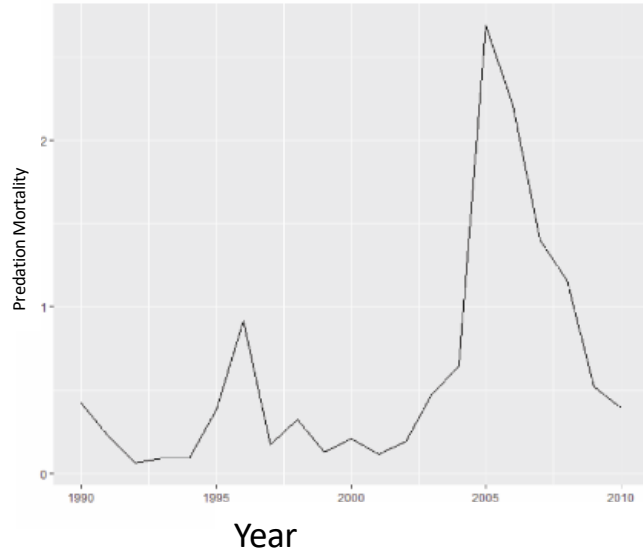
According to model projections, if we reduce greenhouse gas emissions, there will be about a degree of warming over this century (the purple line). If we do not reduce greenhouse gases as much, Earth will warm much more (orange line). The area around the lines indicates the range of model results from these two scenarios. Credit: L.S. Gardiner/UCAR with IPCC (2013) data



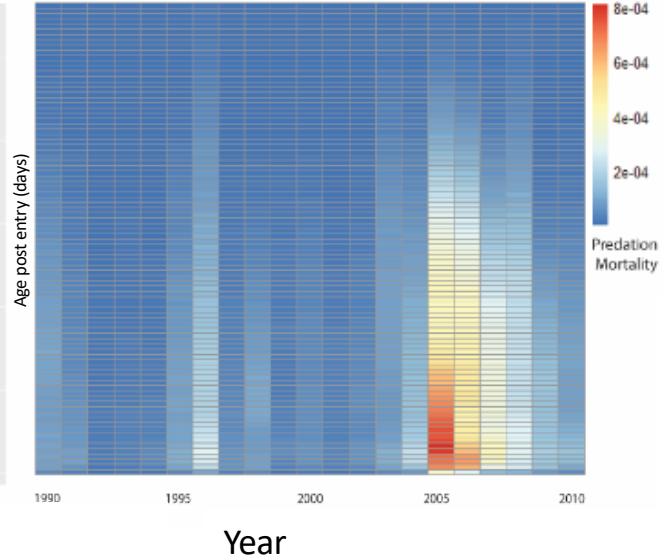


# Environmentally driven mortality modulated by predator distribution, population and diet

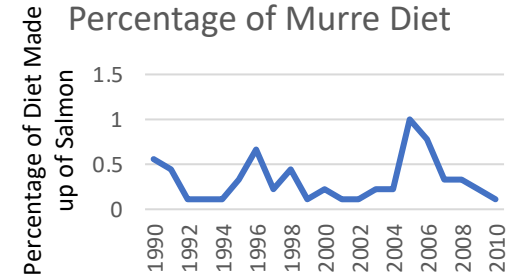
## Predation Mortality by Year



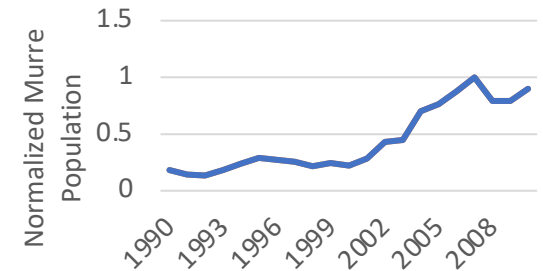
## Predation Mortality by Year and Age



## Weighting by Salmon



## Weighting by Murre Abundance



# Cold water for yearlings in the climate future

May 2005-2015

May 2080

