

# Summary of Central Valley Project and State Water Project Effects on Delta Smelt

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**California Department of Fish and Game**

Matt Nobriga

**U.S. Environmental Protection Agency**

Bruce Herbold

**U.S. Geological Survey**

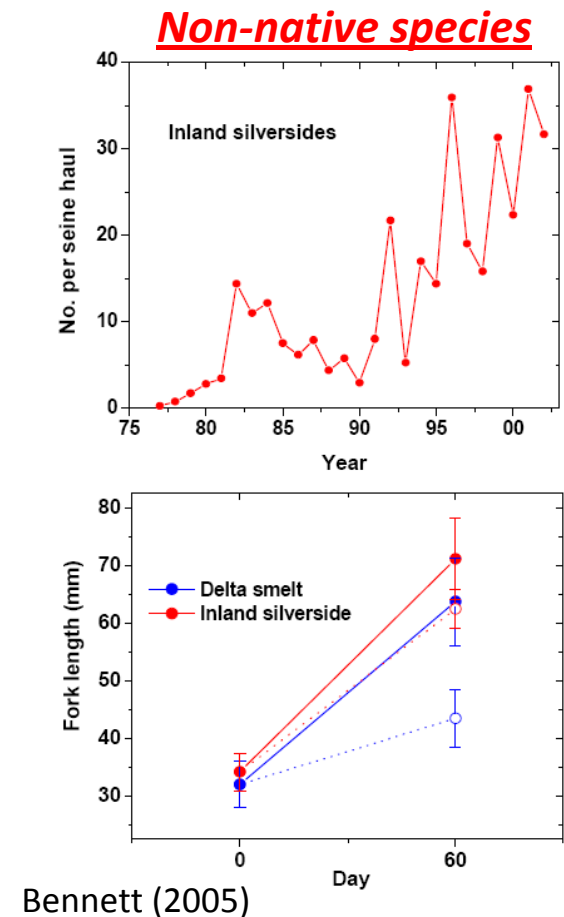
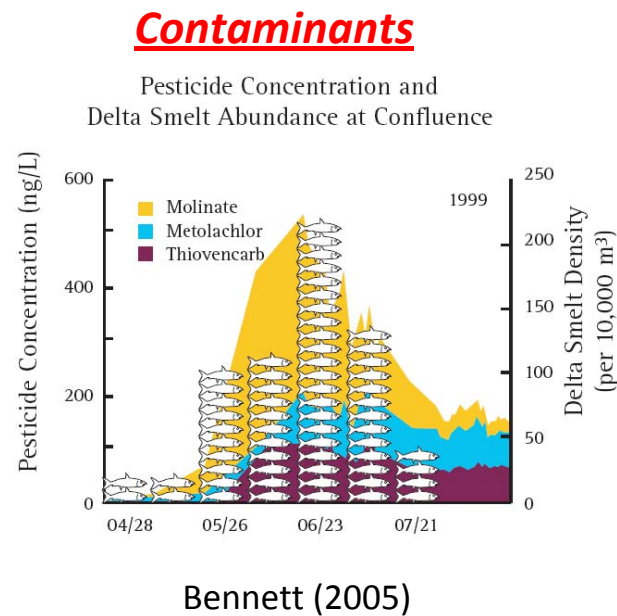
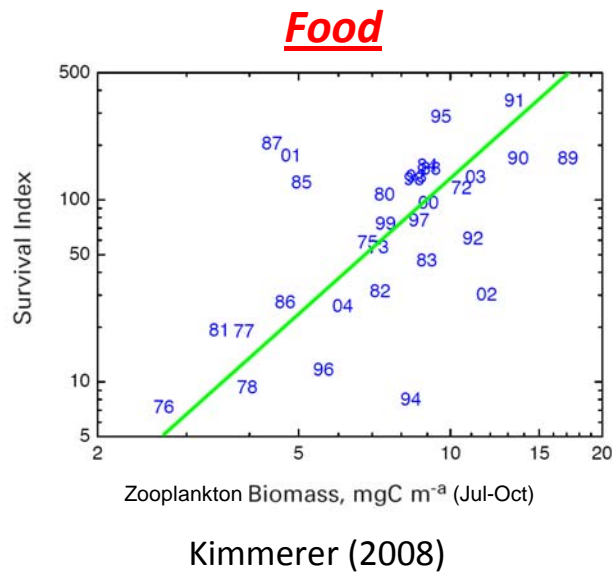
Pete Smith

**U.C. Davis**

Michael Johnson

# Background

- Sacramento-San Joaquin Delta is highly complex
- Decline of delta smelt cannot be solely explained by CVP/SWP operations



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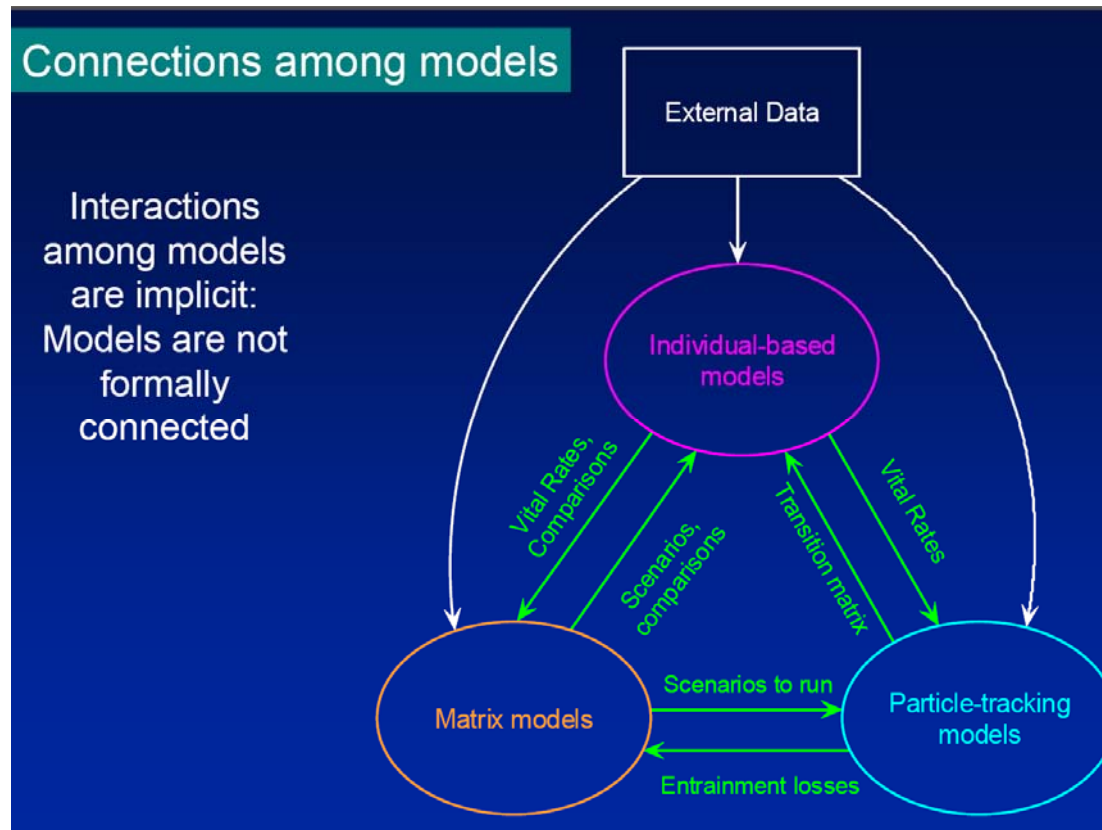
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- Direct effects – entrainment
- Indirect effects – hydrodynamic conditions

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- Decline of delta smelt cannot be solely explained by CVP/SWP operations
- Direct effects – entrainment
- Indirect effects – hydrodynamic conditions

Effects analysis organized by season and life stage

# Quantitative Life Cycle Model Under Development, ... still is



## **Individual-based model**

Kenny Rose

Wim Kimmerer

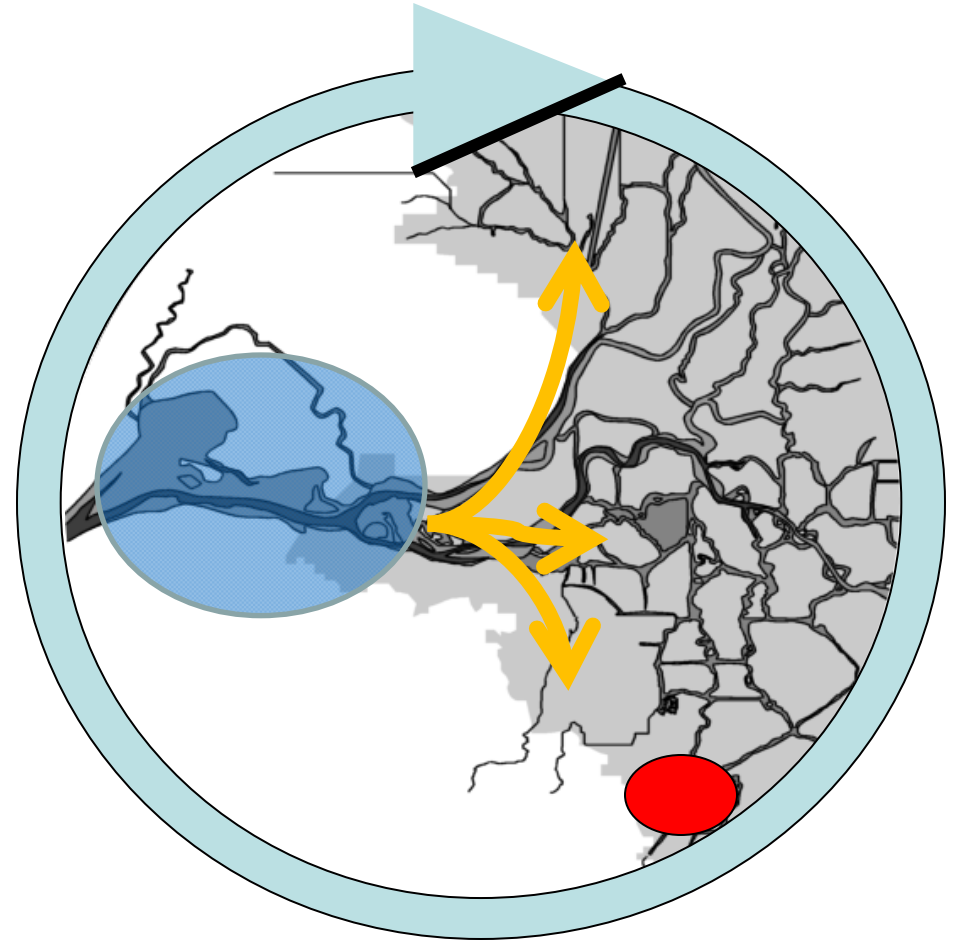
## **Matrix models**

Bill Bennett

## **Particle tracking model**

Stephen Monismith

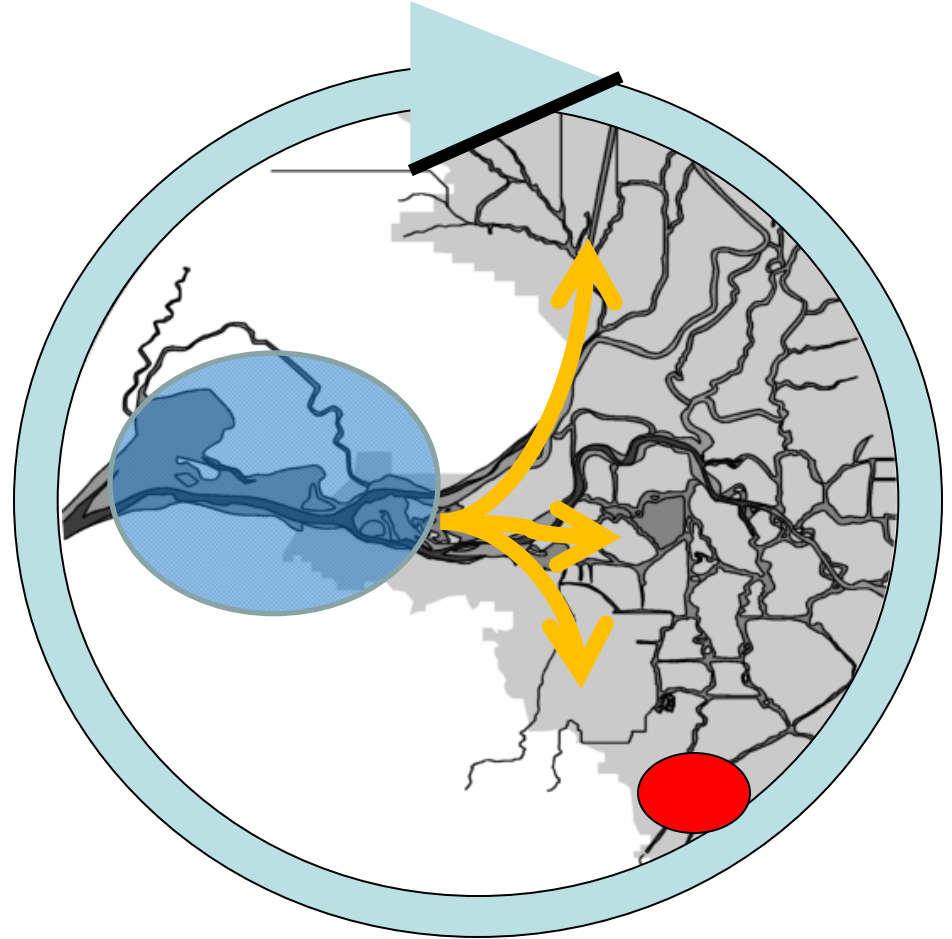
# Organization of the effects analysis



# Organization of the effects analysis

## Winter:

- Entrainment of migratory and spawning adults



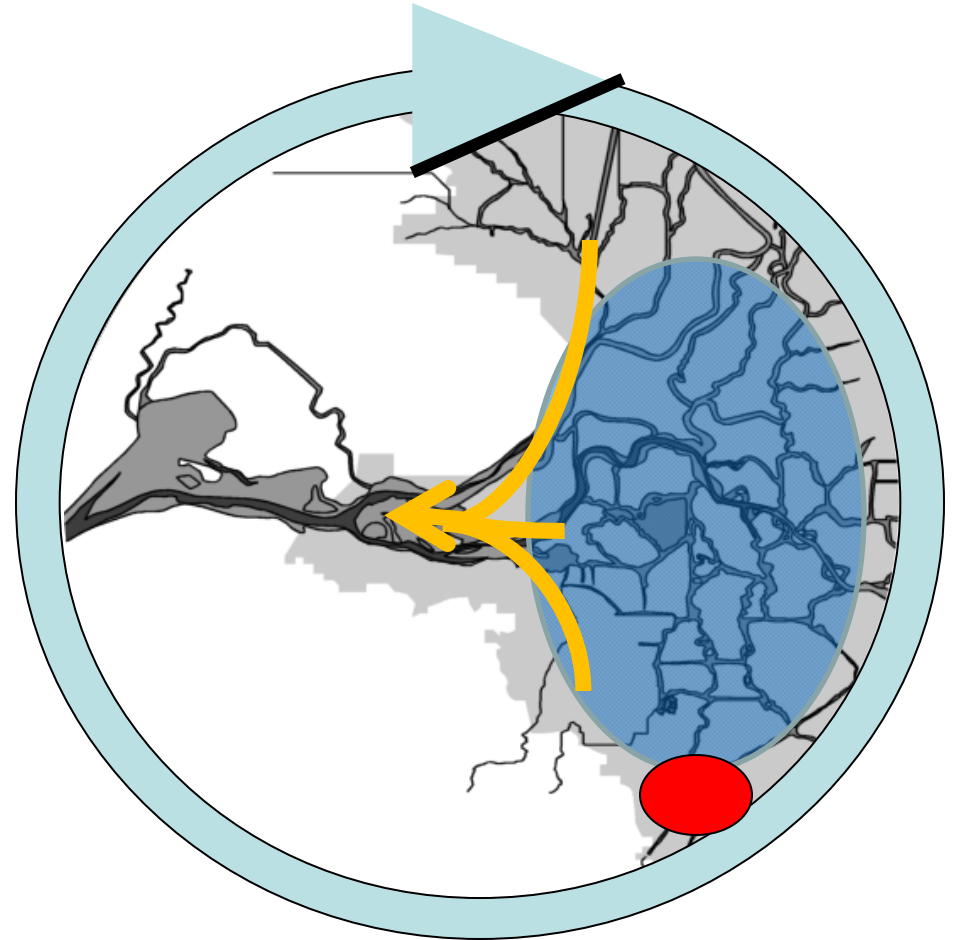
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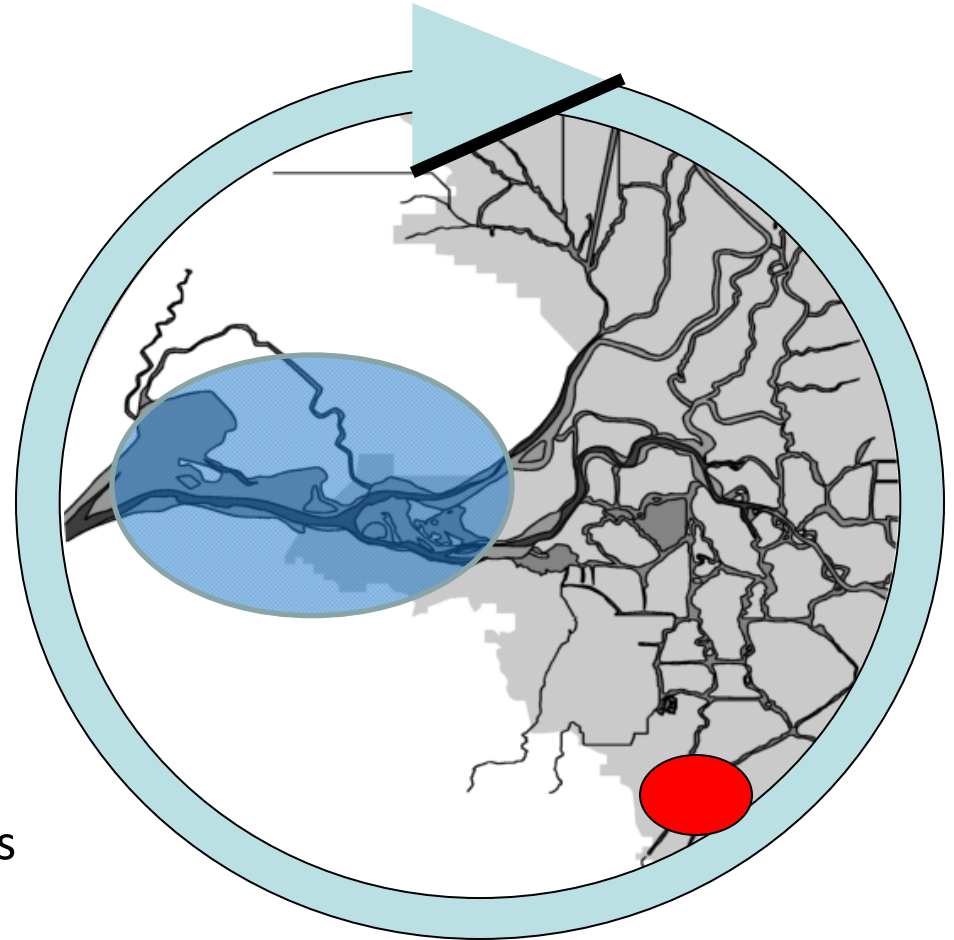
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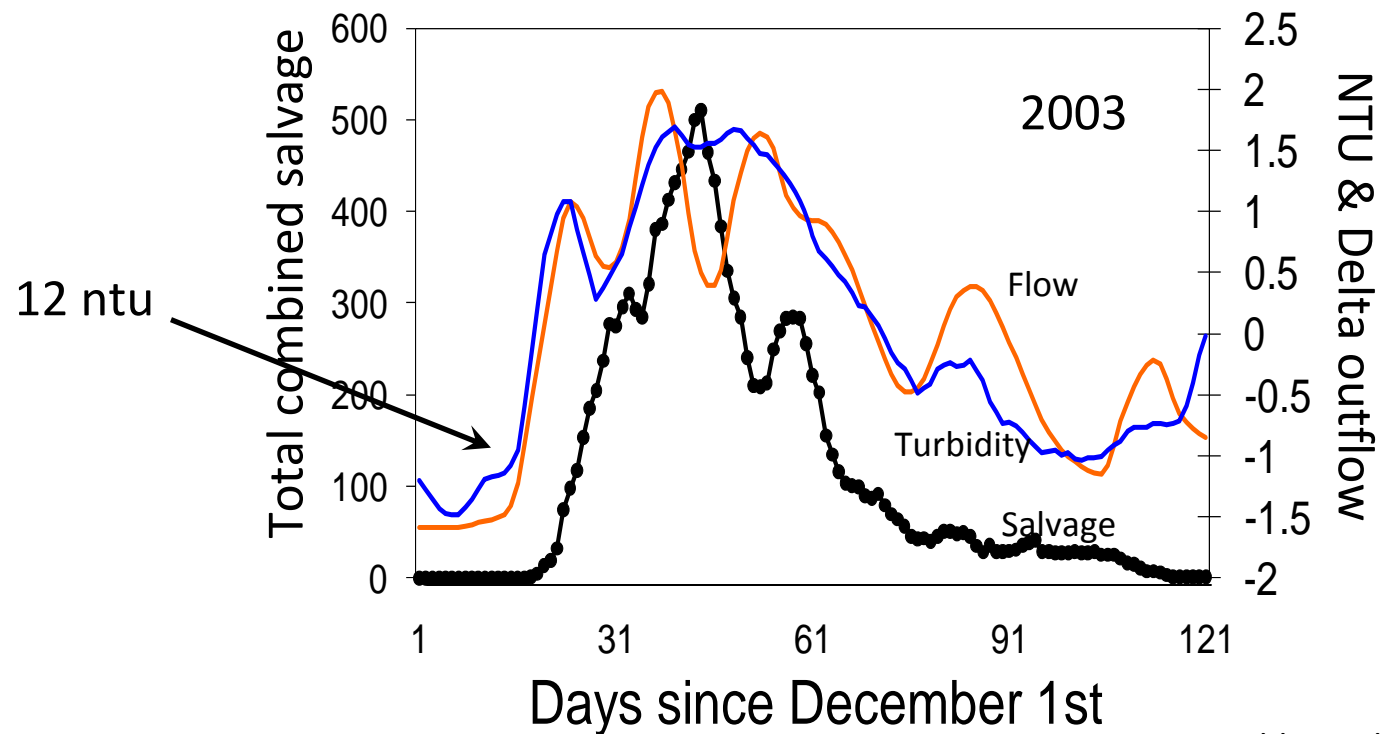
- Rearing habitat of maturing pre-adults



# Winter (December-March)

Entrainment of migratory and spawning adults

- First flush and turbidity trigger migration (Grimaldo et al. 2009)

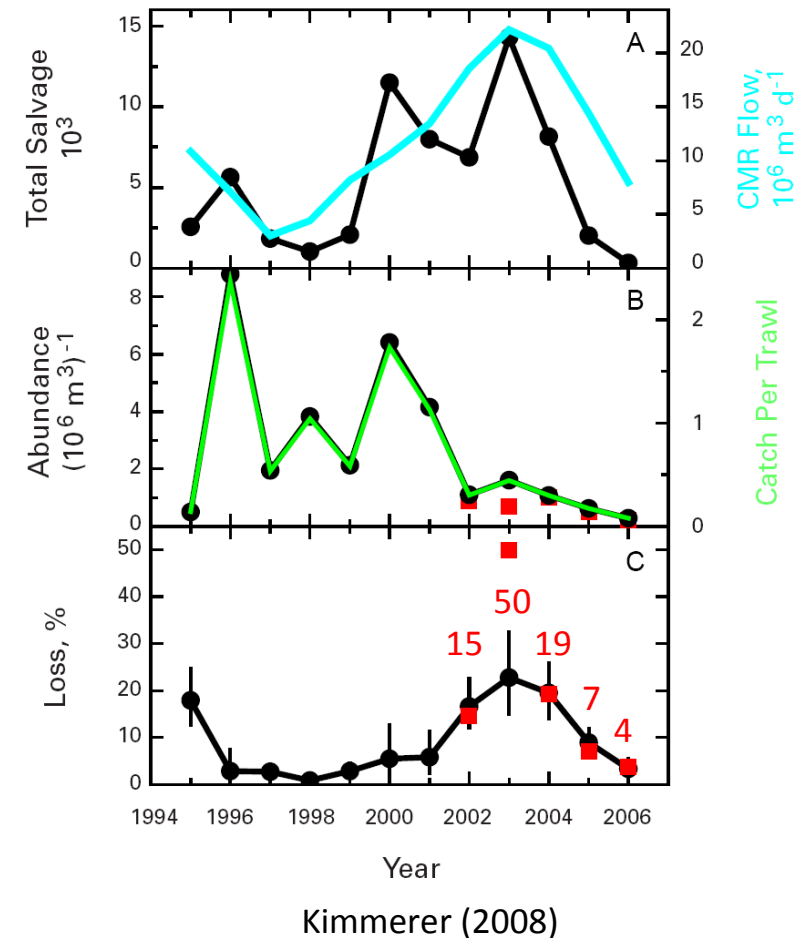
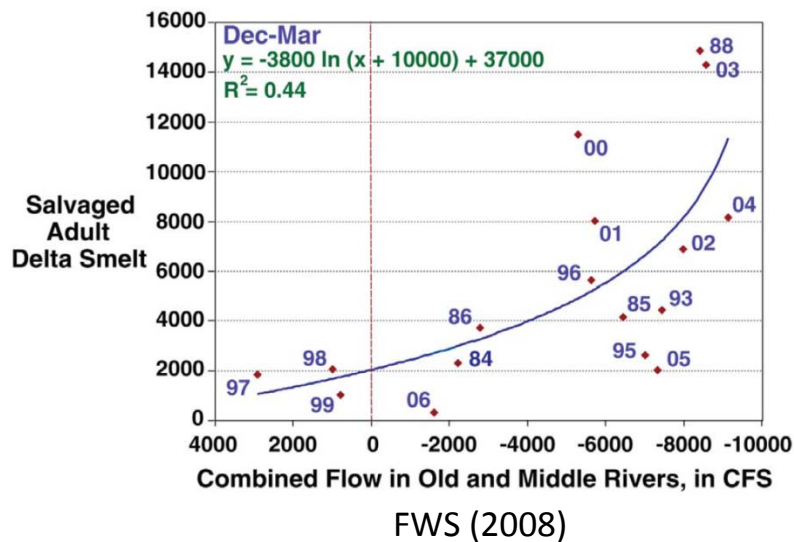


Grimaldo et al. (2009)

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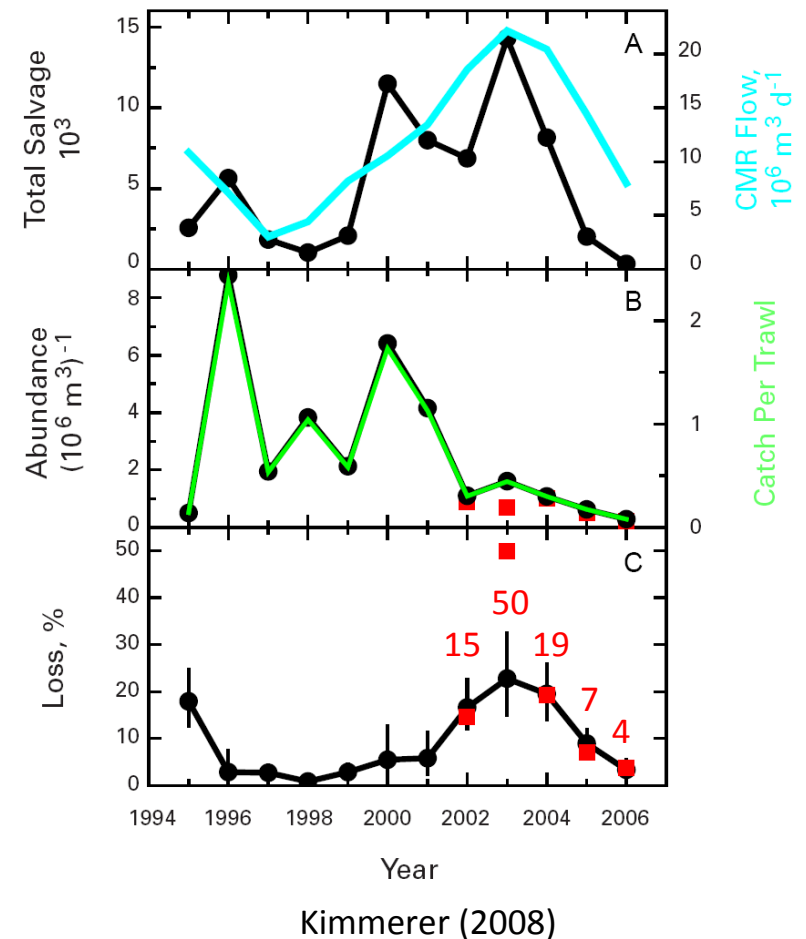
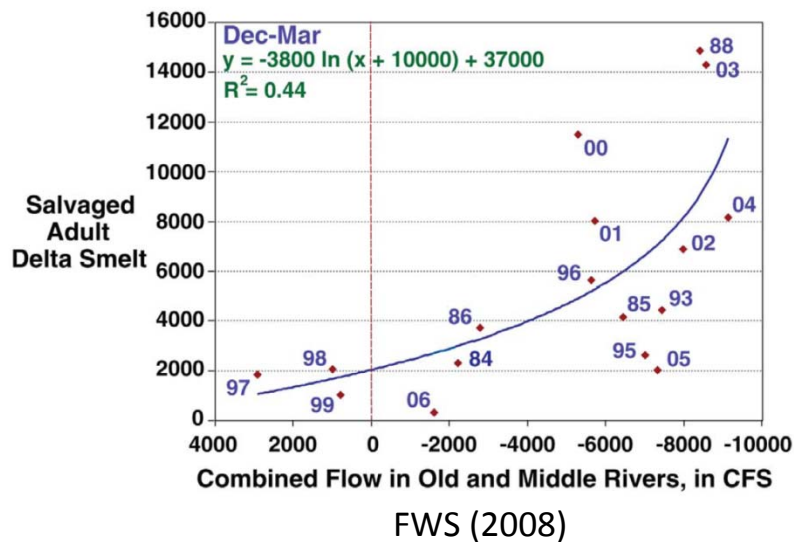
- First flush and turbidity trigger migration (Grimaldo et al. 2009)
- Salvage patterns reflect Old and Middle River flow (Kimmerer 2008; Grimaldo et al. 2009)



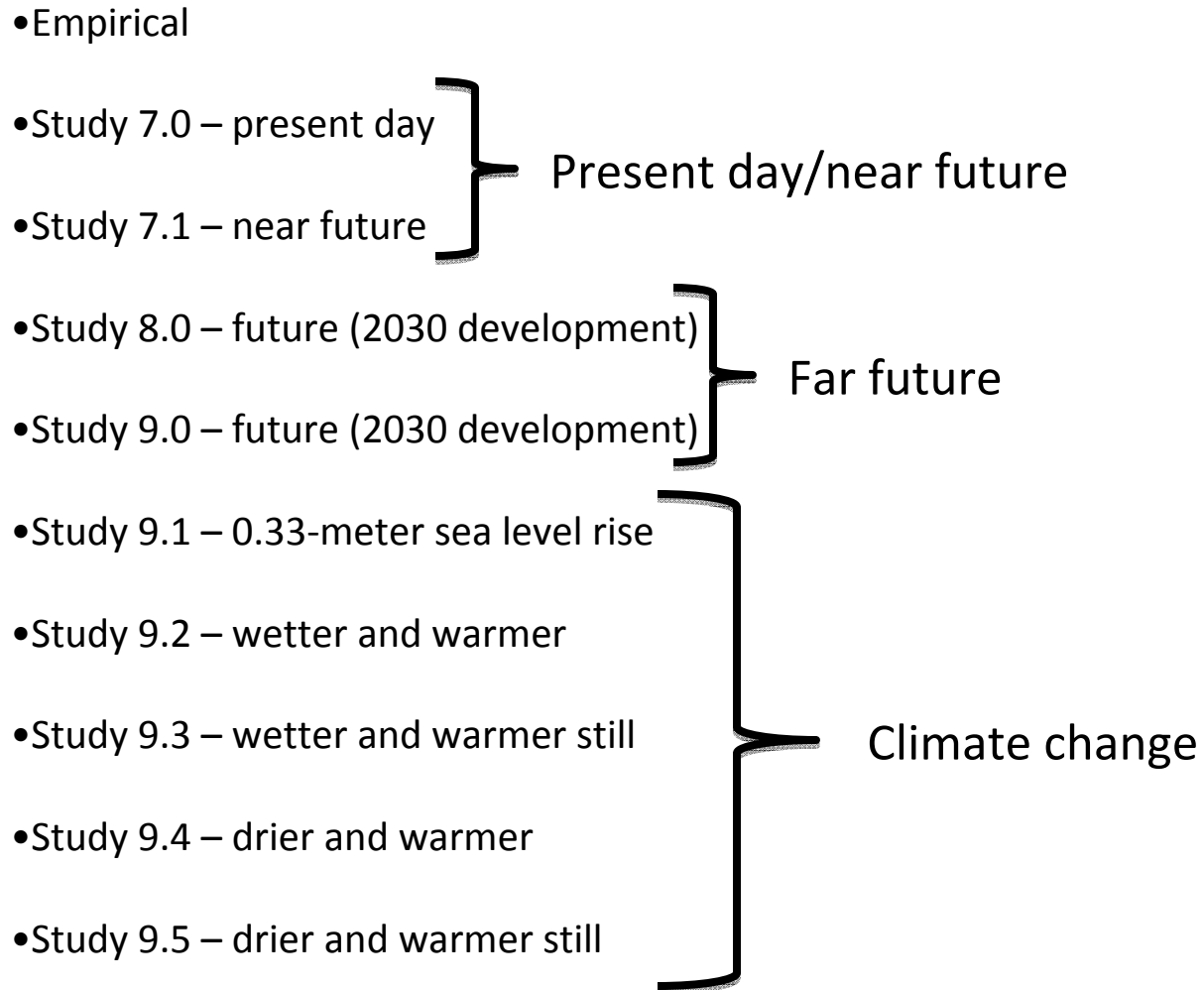
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## Entrainment of migratory and spawning adults

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- Variable cumulative proportional loss of population (Kimmerer 2008)



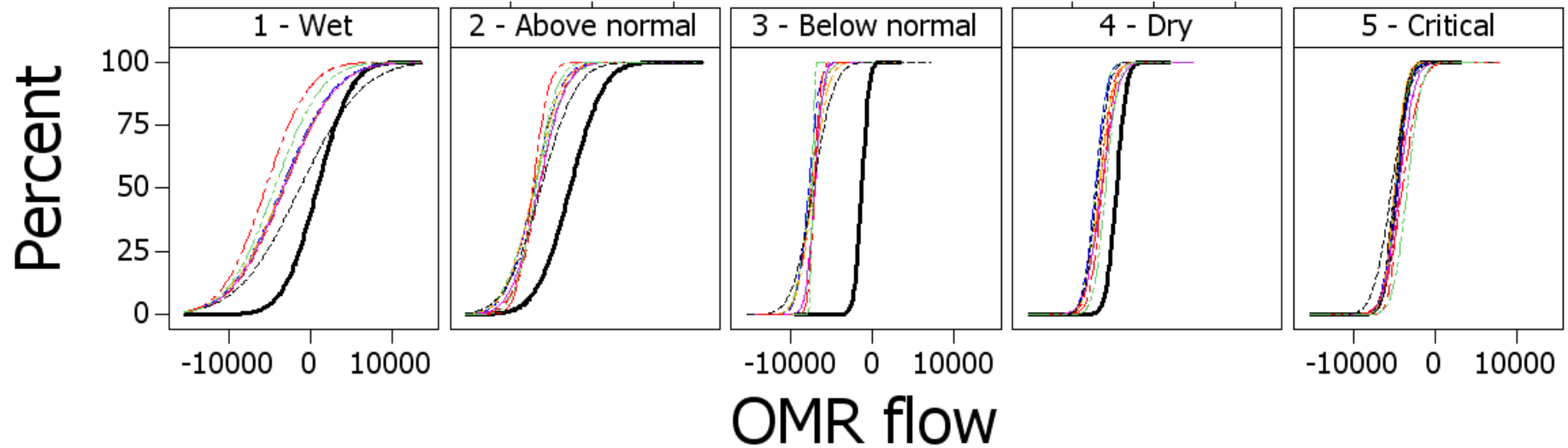
# Model Scenarios



# Winter (December-March)

Entrainment of migratory and spawning adults

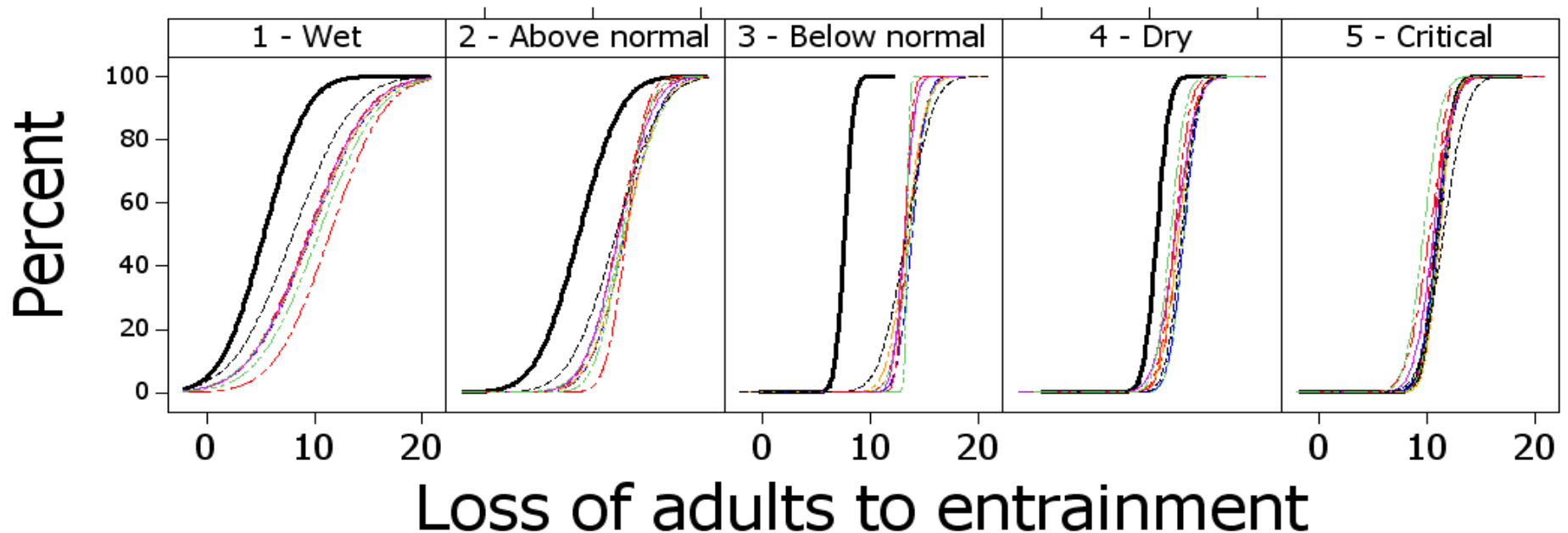
- Effects of modeled CVP/SWP operations (FWS 2008):
  - A) Increased frequency of more negative Old and Middle River flow



# Winter (December-March)

Entrainment of migratory and spawning adults

- Effects of modeled CVP/SWP operations (FWS 2008):
  - A) Increased frequency of more negative Old and Middle River flow
  - B) Increased entrainment



# **Spring & Summer (April-June)**

Entrainment of larvae and juveniles



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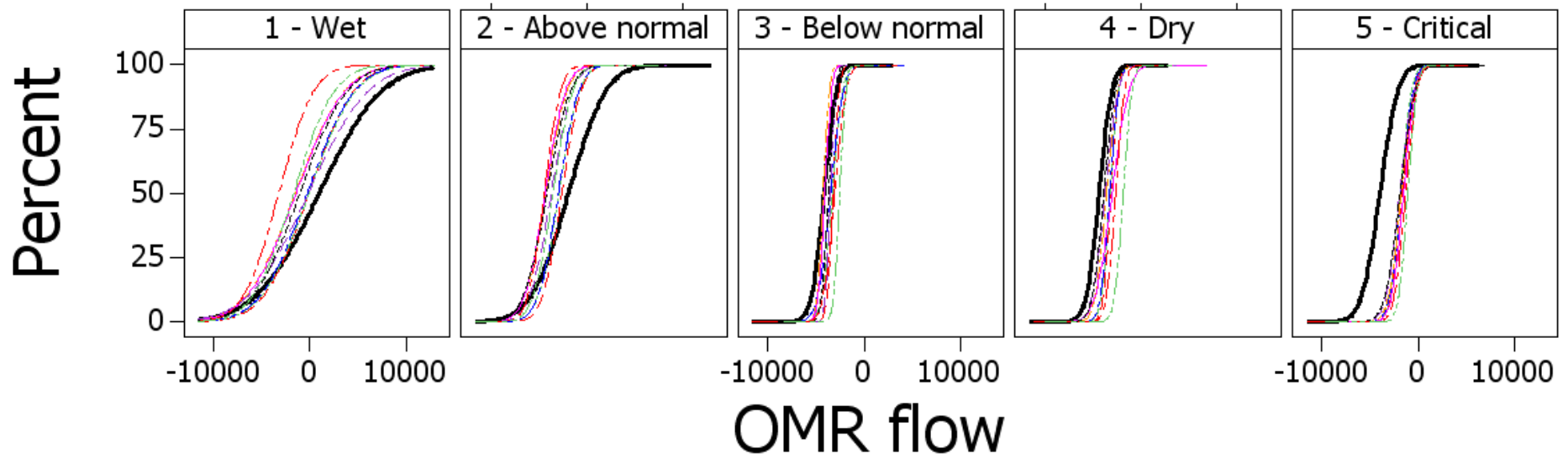
Entrainment of larvae and juveniles

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(Kimmerer 2008; Grimaldo et al. 2009)
- Variable cumulative proportional loss of population  
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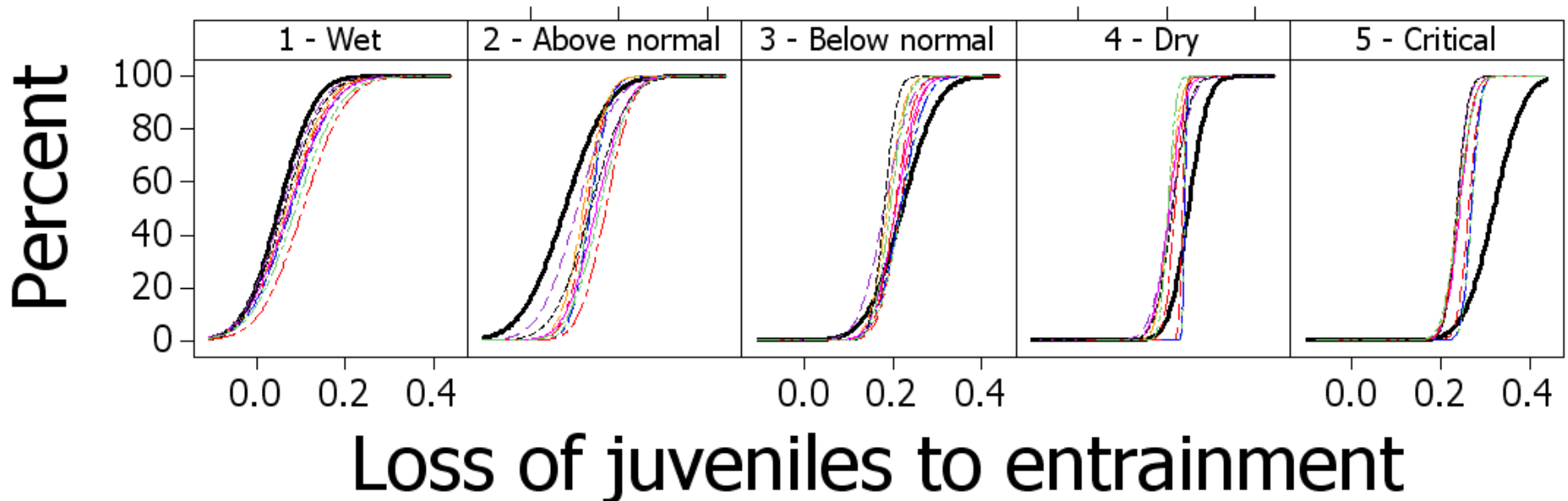
- Effects of modeled CVP/SWP operations (FWS 2008):
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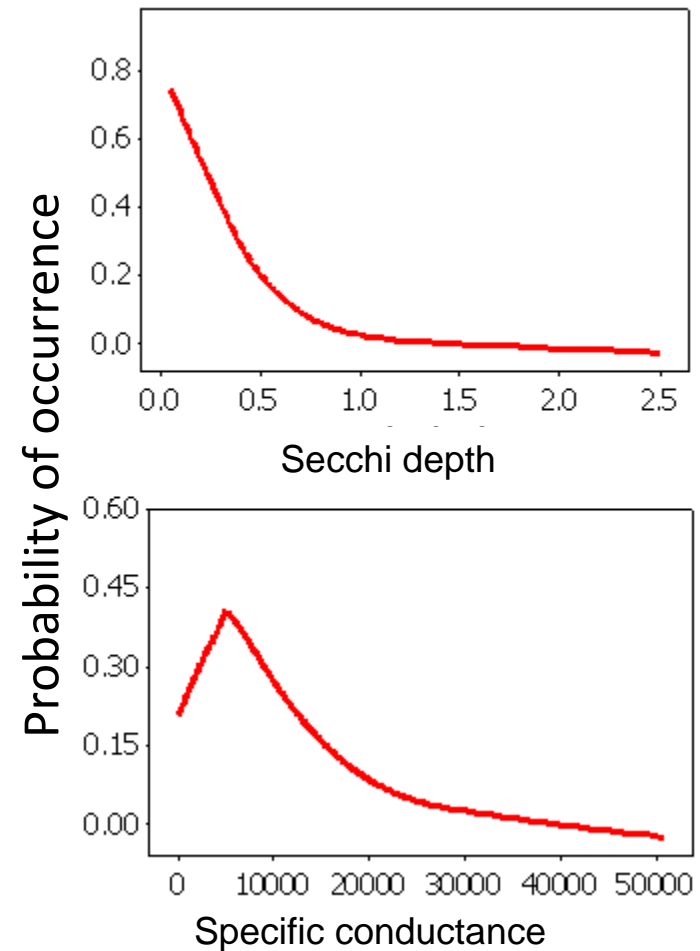
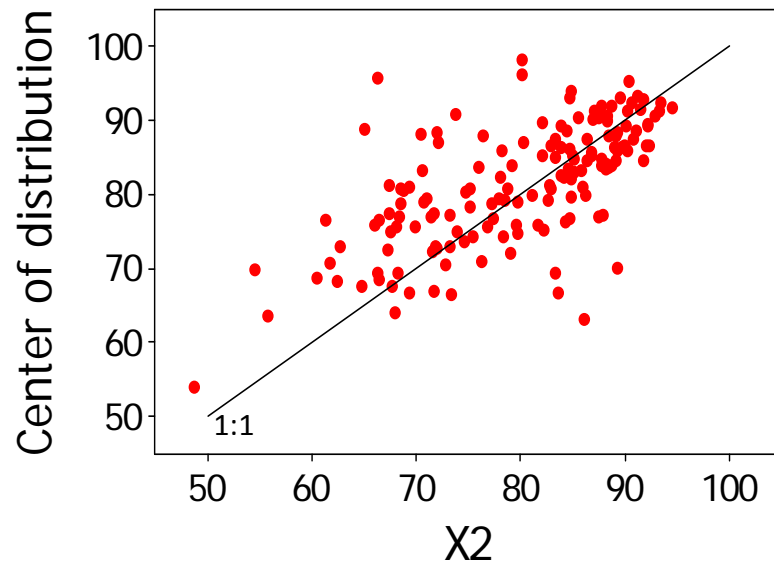
## **Fall (September-December)**

Rearing habitat of maturing pre-adults

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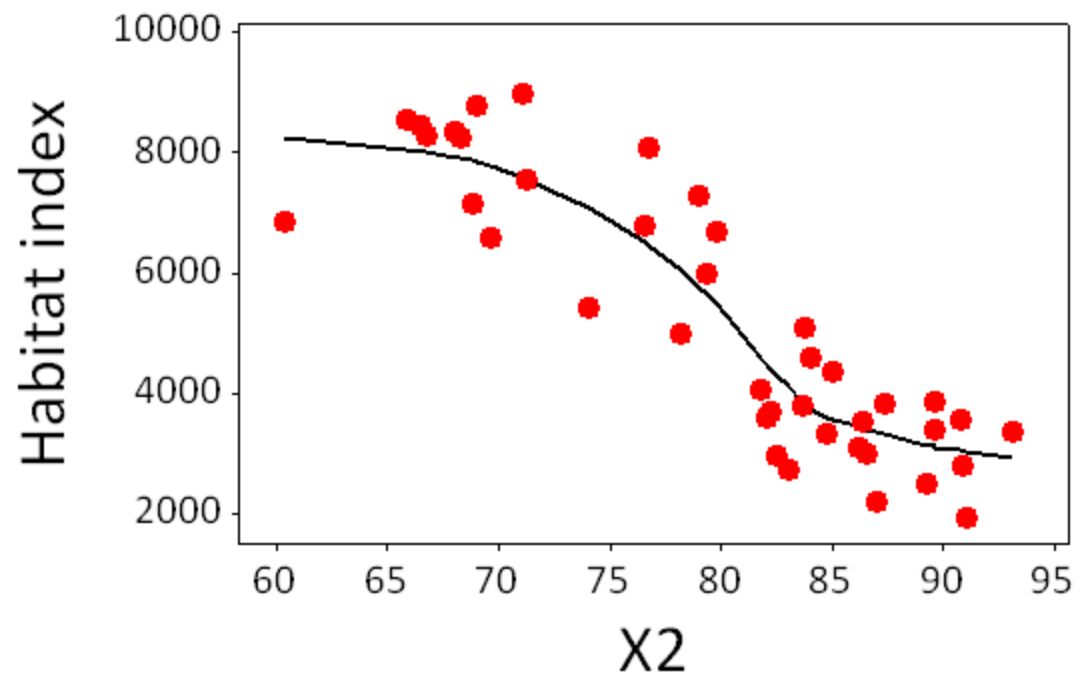


Feyrer et al. (2007)

# Fall (September-December)

Rearing habitat of maturing pre-adults

- Delta smelt habitat is related to salinity and turbidity (Bennett 2006; Feyrer et al. 2007; Kimmerer et al. 2009)
- Suitable habitat is related to X2 (Feyrer et al. 2008)

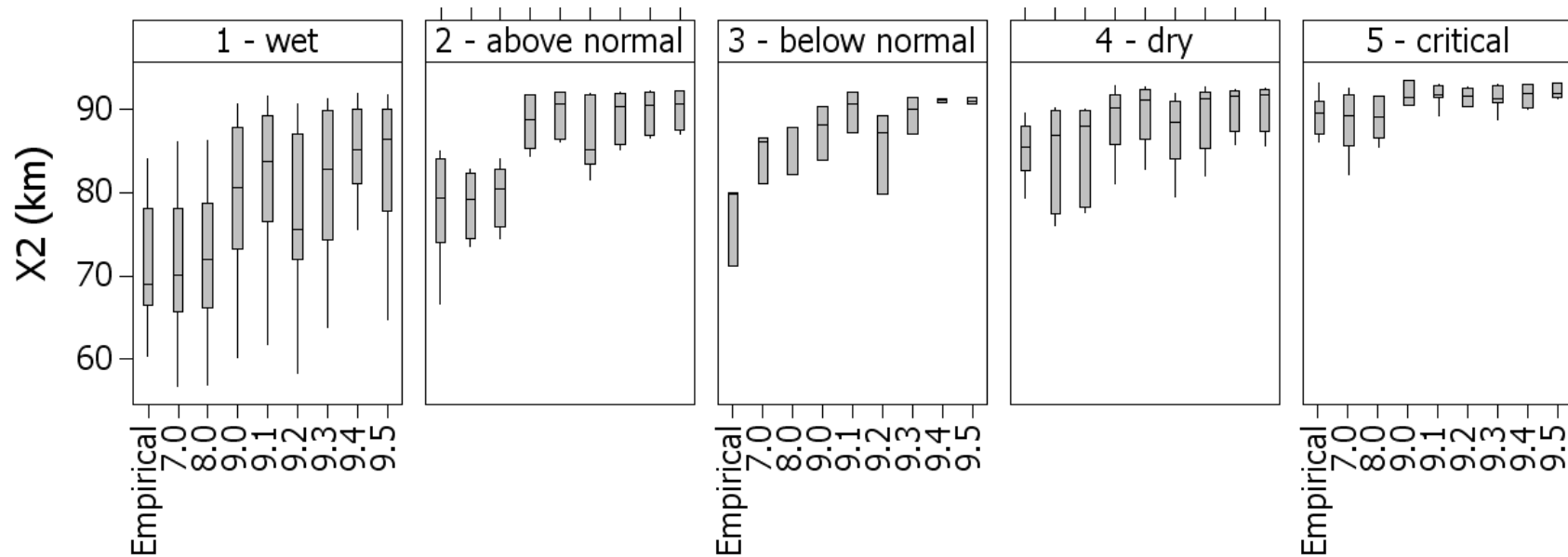


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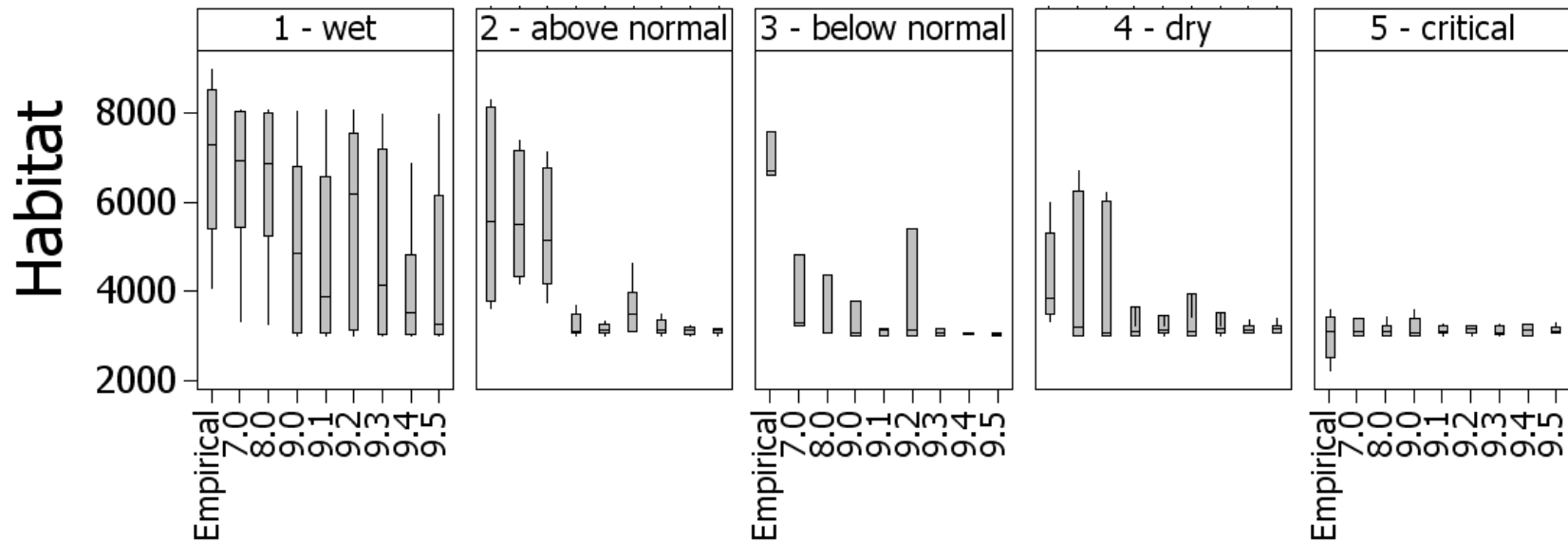
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A) X2 shift upstream



## Rearing habitat of maturing pre-adults

- Effects of modeled CVP/SWP operations (FWS 2008):
  - A) X2 shift upstream
  - B) Habitat space reduced

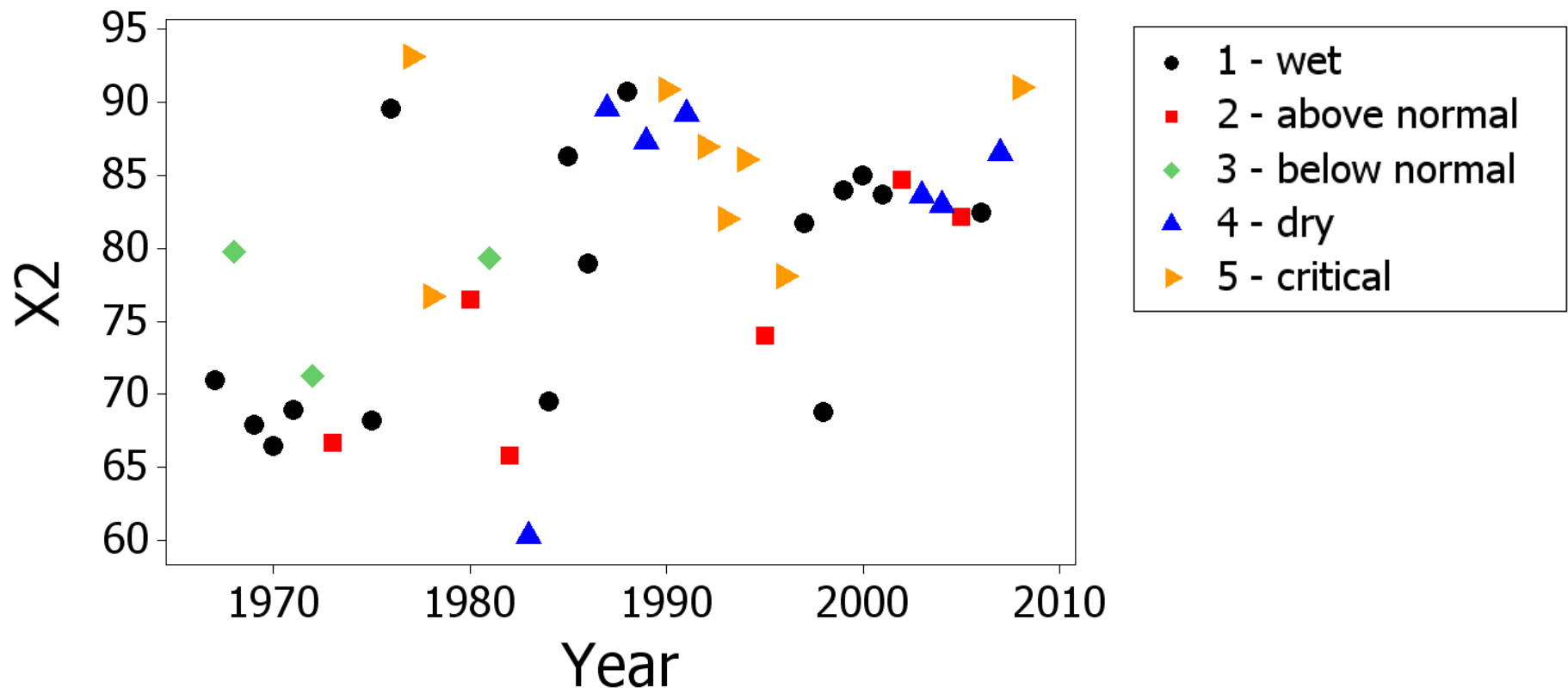




# Fall (September-December)

Rearing habitat of maturing pre-adults

- Effects of modeled CVP/SWP operations (FWS 2008):
  - A) X2 shift upstream
  - B) Habitat space reduced
  - C) Loss of variability



# Summary

**Winter (December-March)** - Entrainment of migratory and spawning adults

A) Increased frequency of more negative Old and Middle River flow

B) Increased entrainment

*-In all but critical years*

**Spring & Summer (April-June)** - Entrainment of larvae & juveniles

A) Increased frequency of more negative Old and Middle River flow

B) Increased entrainment

*-In wet and above normal years*

**Fall (September-December)** - Rearing habitat of maturing pre-adults

A) X2 shift upstream

B) Habitat reduced

C) Loss of variability



# Additional Considerations

- Recent high exports and entrainment coincident with POD (IEP 2008)
- Abundance negatively related to exports \* (Bennett 2005; Thompson et al. 2010)
- Entrainment is not a substantial source of mortality in every year (Bennett 2005; Manly and Chotkowski 2006; IEP 2008; Kimmerer 2008)
- Disproportionate cohort mortality (Bennett 2005)
- Weak statistical link between habitat and abundance (Feyrer et al. 2007)