

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

Frederick Feyrer
U.S. Bureau of Reclamation

on behalf of the OCAP Technical Support Team:

U.S. Fish and Wildlife Service

Cay Goude
Ryan Olah
Steve Detwiler
Victoria Poage
Derek Hilts

U.S. Bureau of Reclamation

Mike Chotkowski
Lenny Grimaldo
Fred Feyrer
Shane Hunt

California Department of Fish and Game

Matt Nobriga

U.S. Environmental Protection Agency

Bruce Herbold

U.S. Geological Survey

Pete Smith

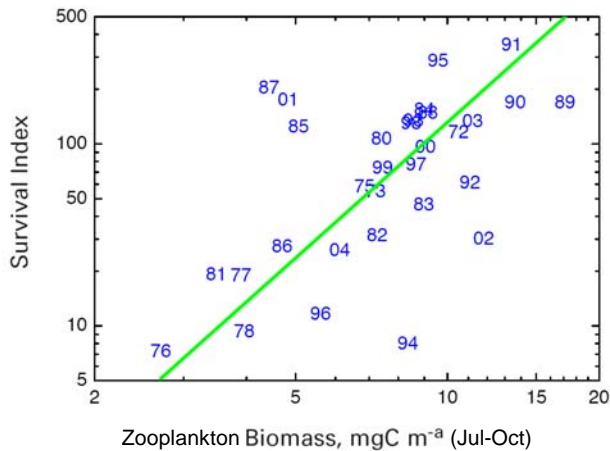
U.C. Davis

Michael Johnson

Background

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

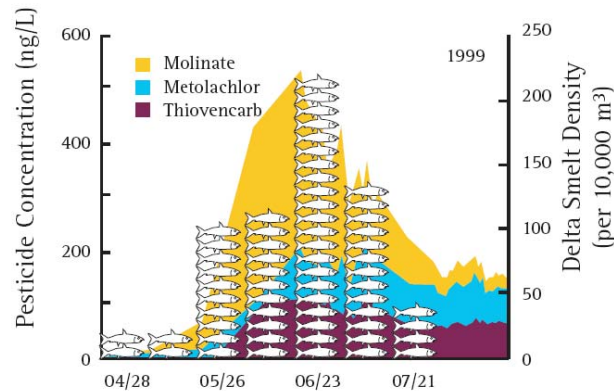
Food



Kimmerer (2008)

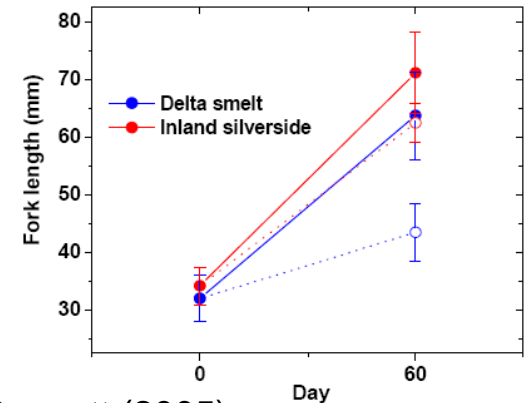
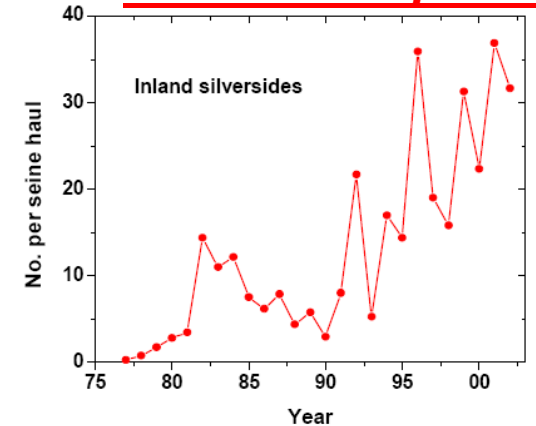
Contaminants

Pesticide Concentration and Delta Smelt Abundance at Confluence



Bennett (2005)

Non-native species



Bennett (2005)

Background

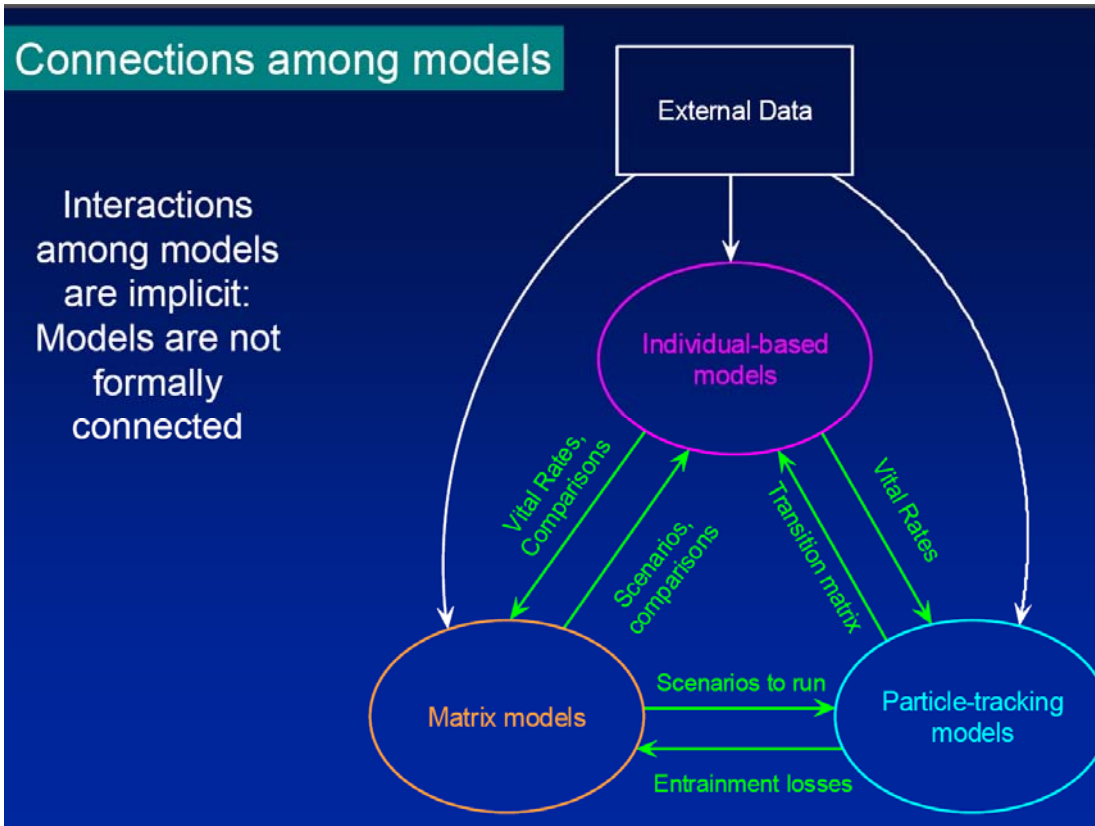
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- Decline of delta smelt cannot be solely explained by CVP/SWP operations
- Direct effects – entrainment
- Indirect effects – hydrodynamic conditions

Background

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

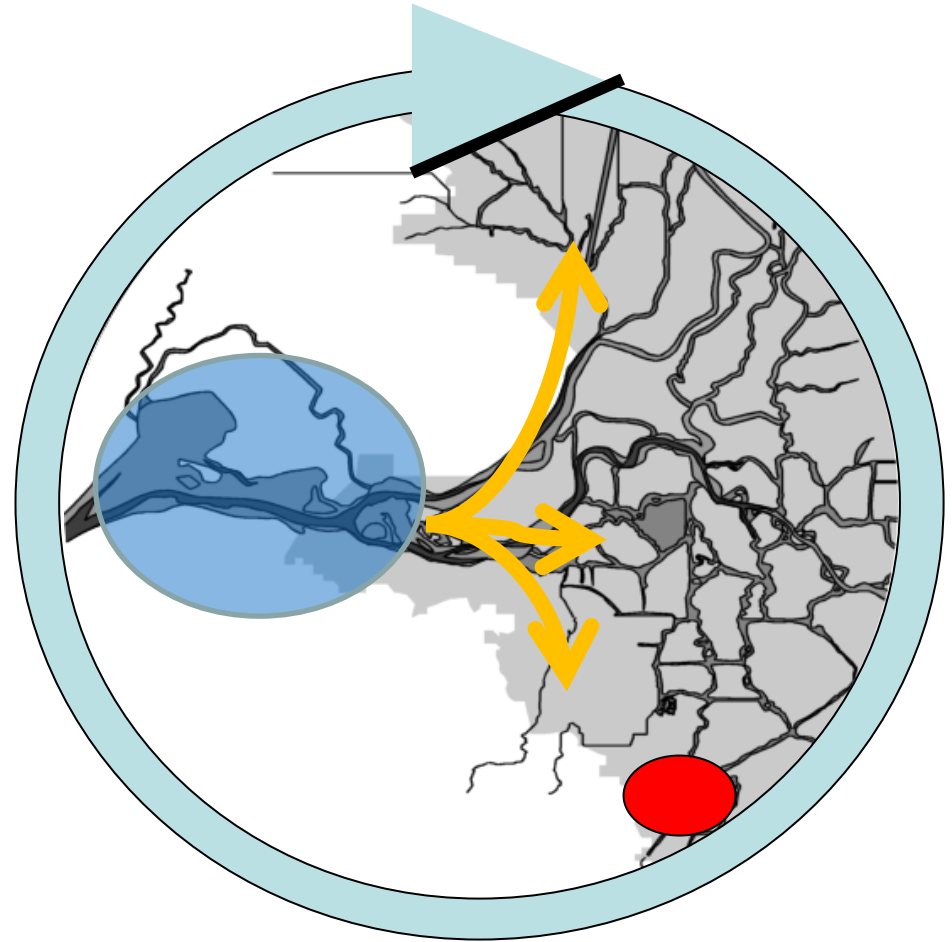
Matrix models

Bill Bennett

Particle tracking model

Stephen Monismith

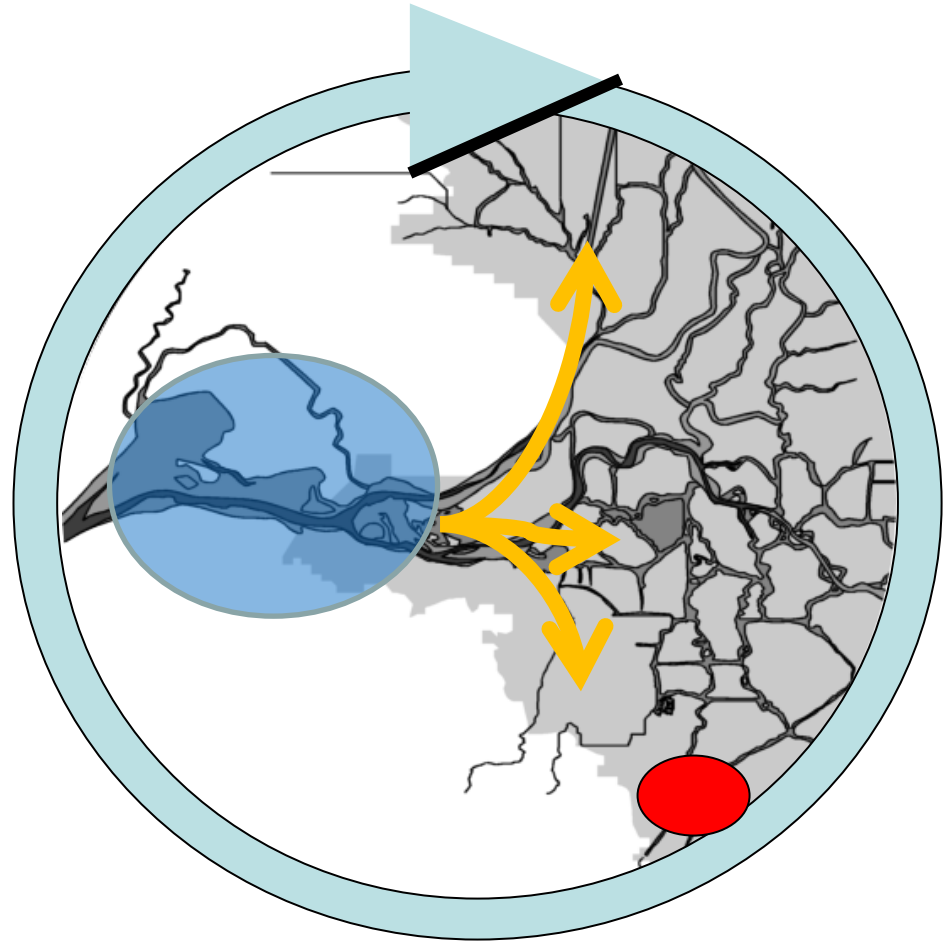
Organization of the effects analysis



Organization of the effects analysis

Winter:

- Entrainment of migratory and spawning adults



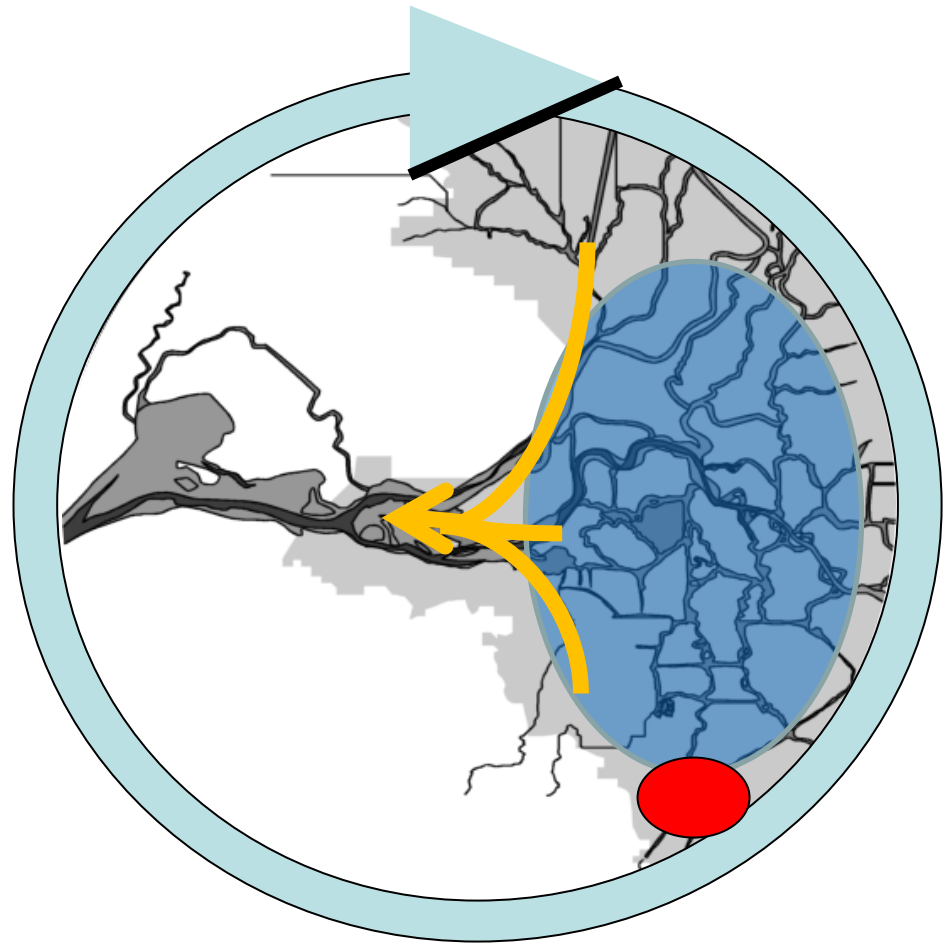
Organization of the effects analysis

Winter:

- Entrainment of migratory and spawning adults

Spring & Summer:

- Entrainment of larvae and juveniles



Organization of the effects analysis

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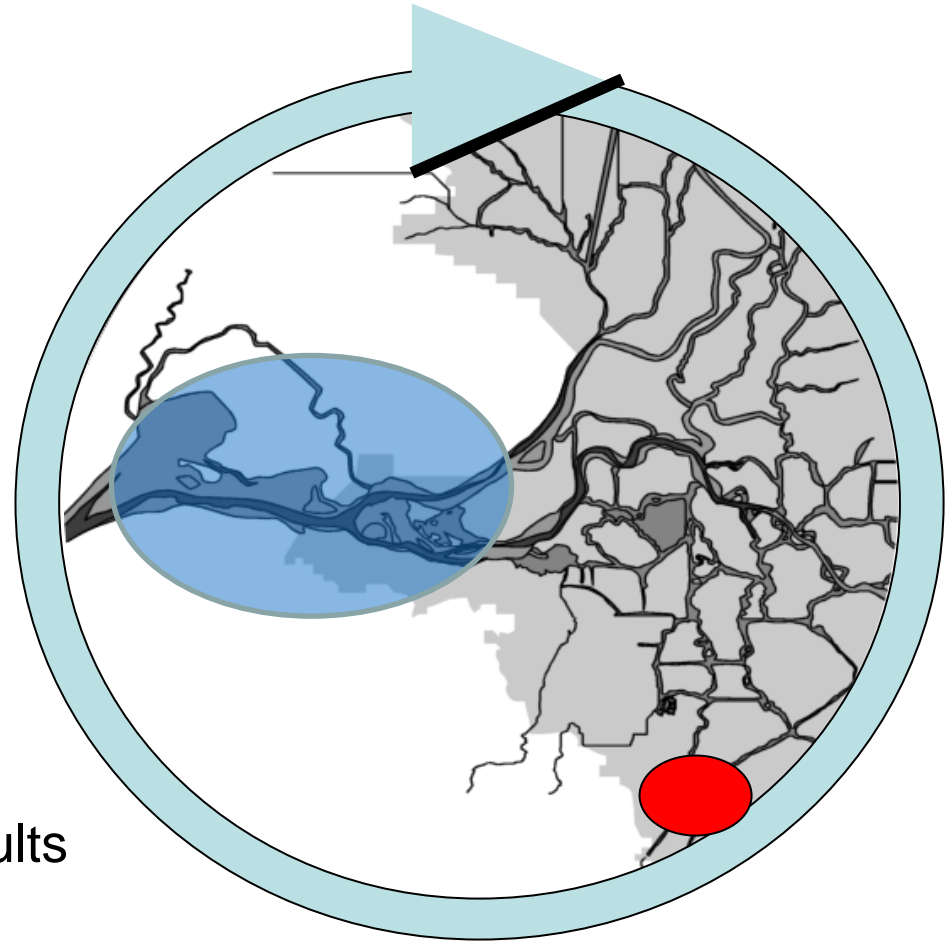
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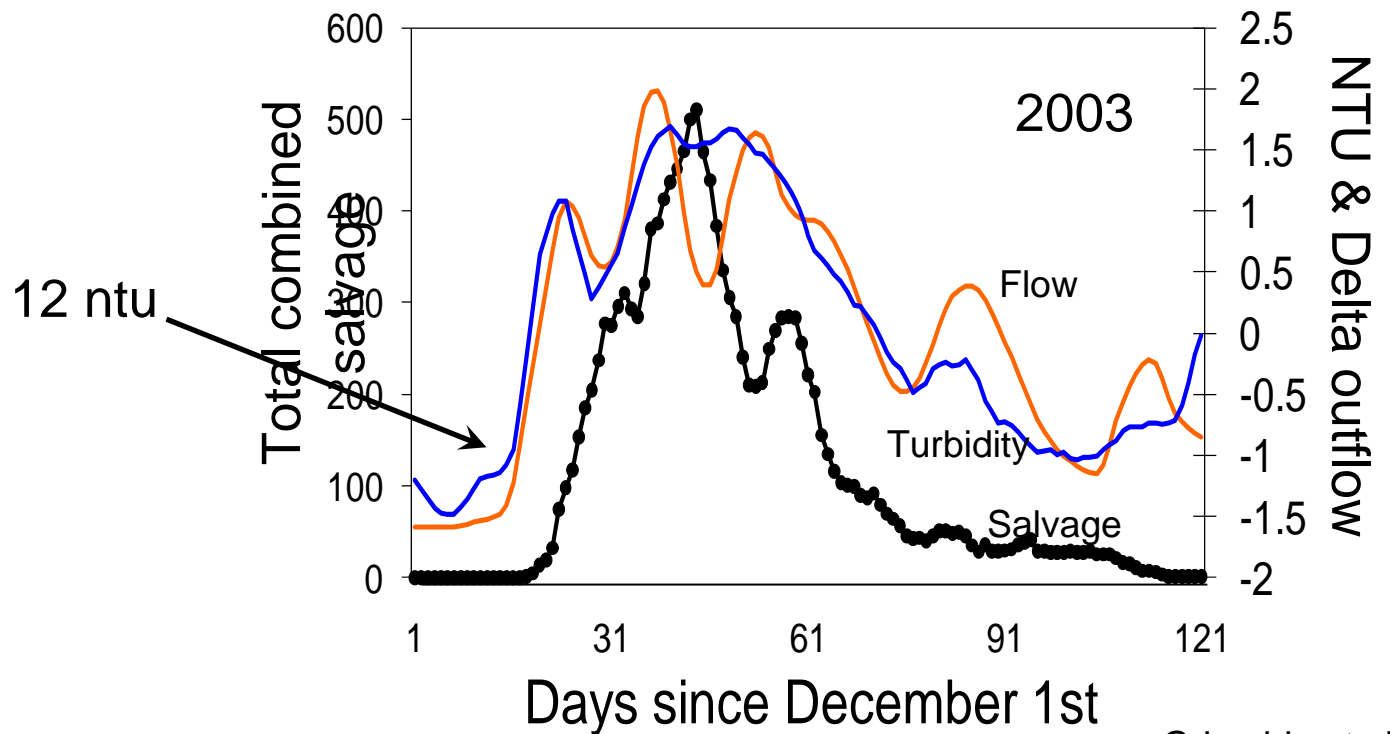
- Rearing habitat of maturing pre-adults



Winter (December-March)

Entrainment of migratory and spawning adults

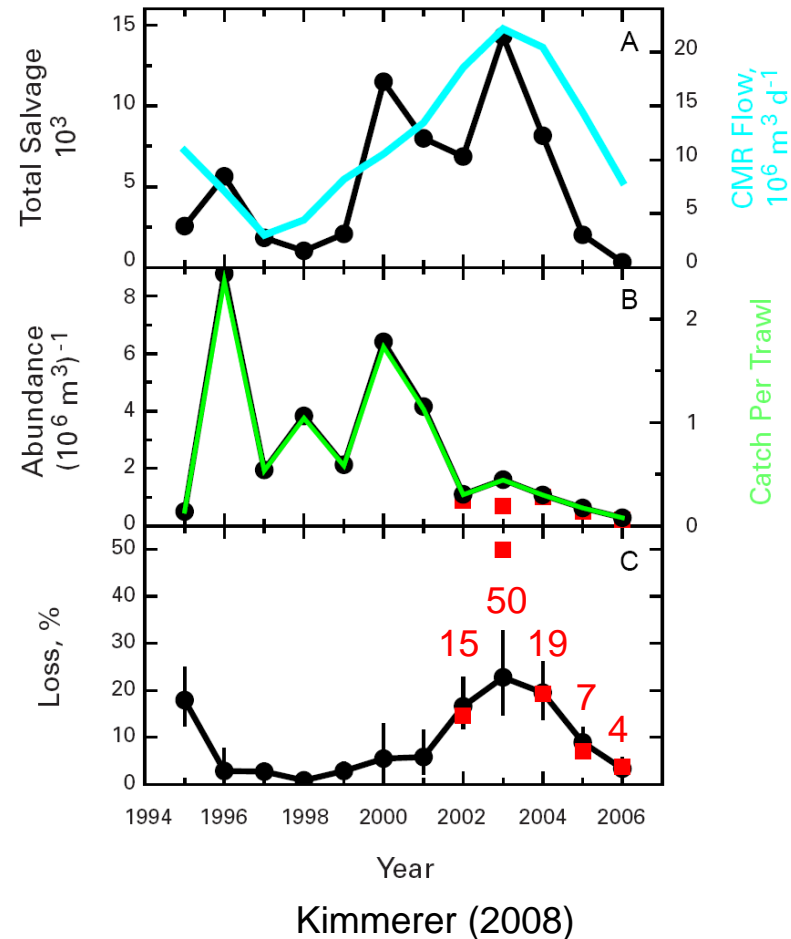
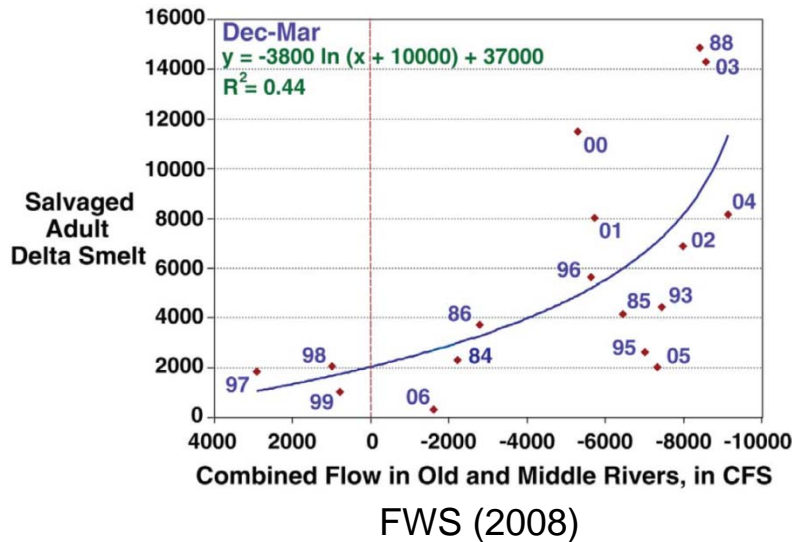
- First flush and turbidity trigger migration (Grimaldo et al. 2009)



Winter (December-March)

Entrainment of migratory and spawning adults

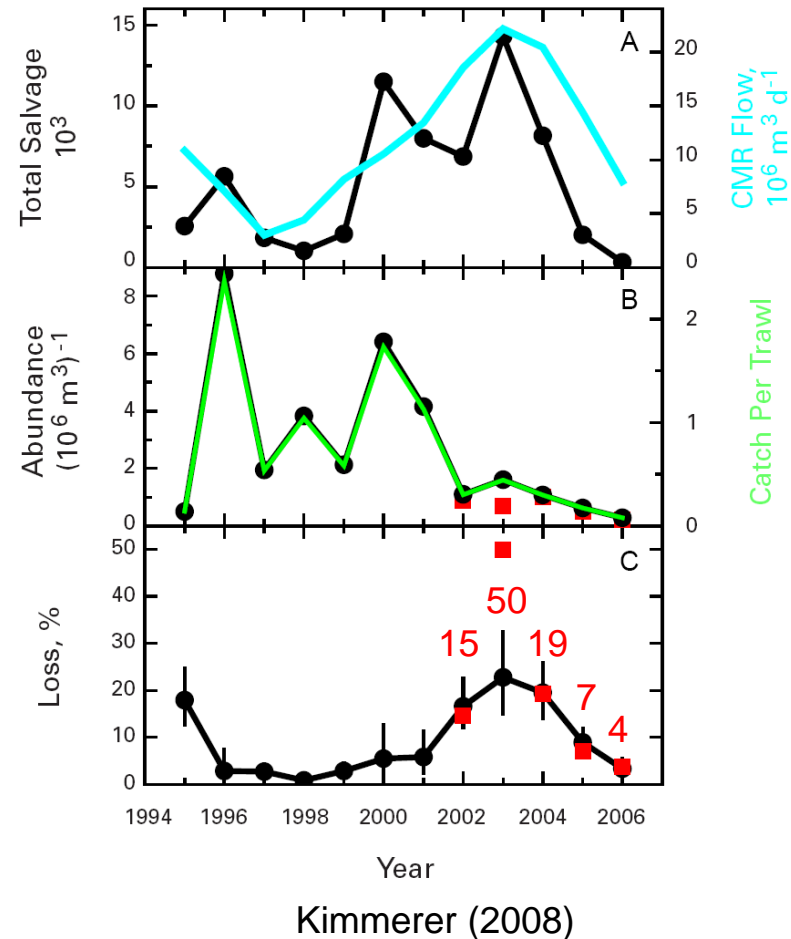
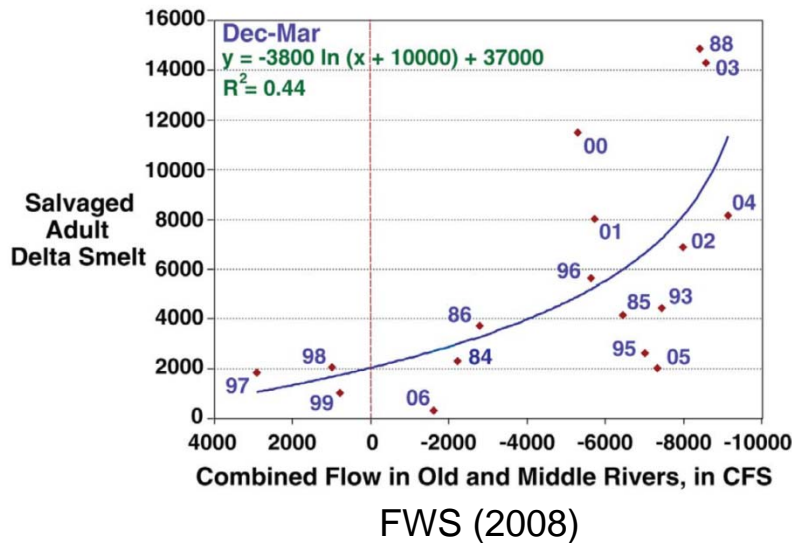
- First flush and turbidity trigger migration (Grimaldo et al. 2009)
- Salvage patterns reflect Old and Middle River flow (Kimmerer 2008; Grimaldo et al. 2009)



Winter (December-March)

Entrainment of migratory and spawning adults

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



Model Scenarios

- Empirical

- Study 7.0 – present day

- Study 7.1 – near future

} Near future

- Study 8.0 – future (2030 development)

- Study 9.0 – future (2030 development)

} Far future

- Study 9.1 – 0.33-meter sea level rise

- Study 9.2 – wetter and warmer

- Study 9.3 – wetter and warmer still

- Study 9.4 – drier and warmer

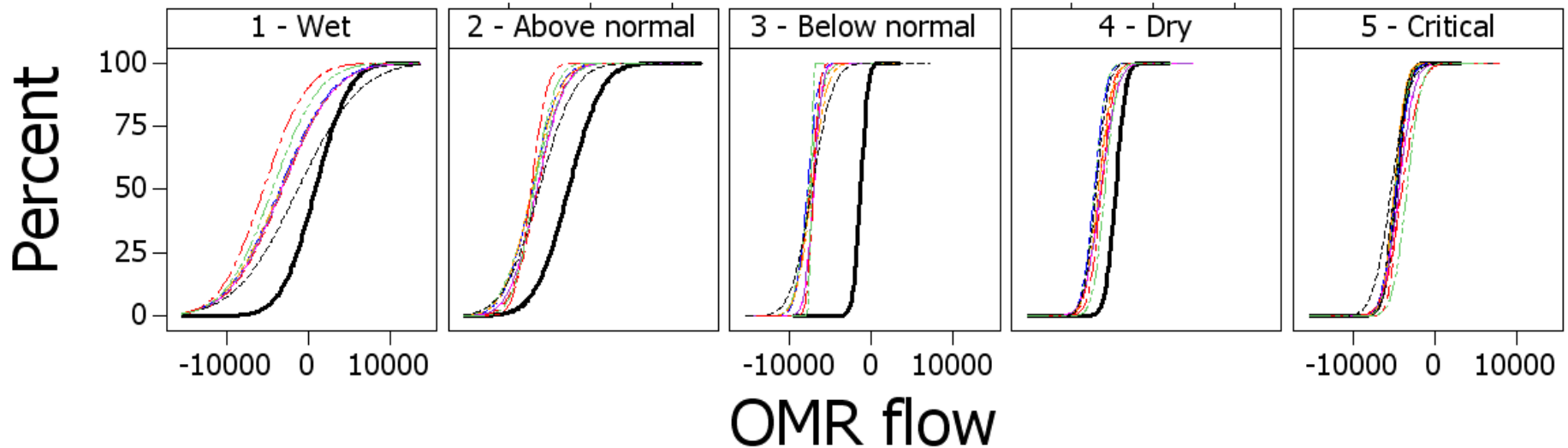
- Study 9.5 – drier and warmer still

} Climate change

Winter (December-March)

Entrainment of migratory and spawning adults

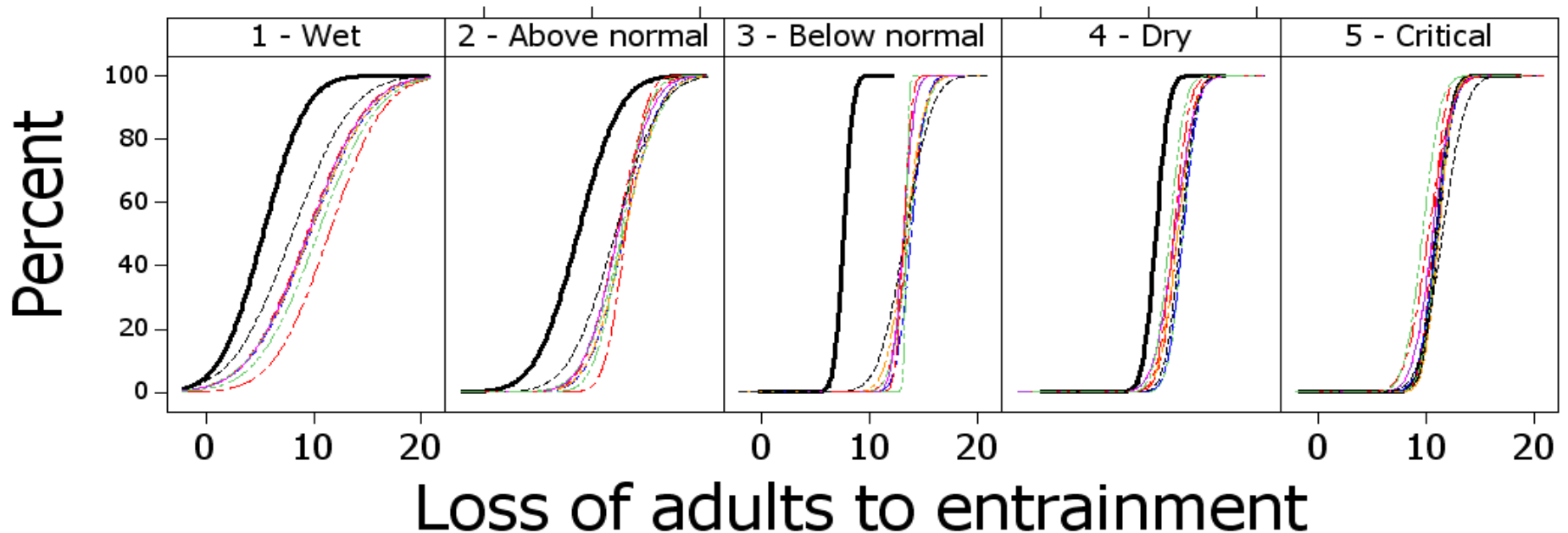
- Effects of modeled CVP/SWP operations (FWS 2008):
 - A) Increased frequency of more negative Old and Middle River flow



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

Spring & Summer (April-June)

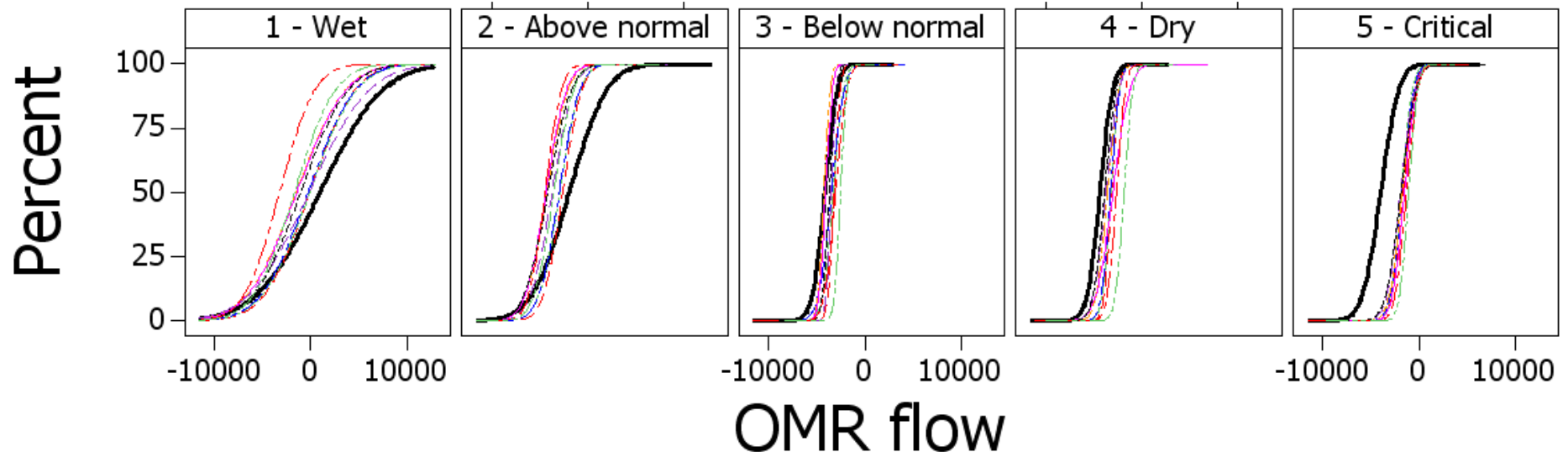
Entrainment of larvae and juveniles

- Salvage patterns reflect Old and Middle River flow
(Kimmerer 2008; Grimaldo et al. 2009)
- Variable cumulative proportional loss of population
(Kimmerer 2008)

Spring & Summer (April-June)

Entrainment of larvae and juveniles

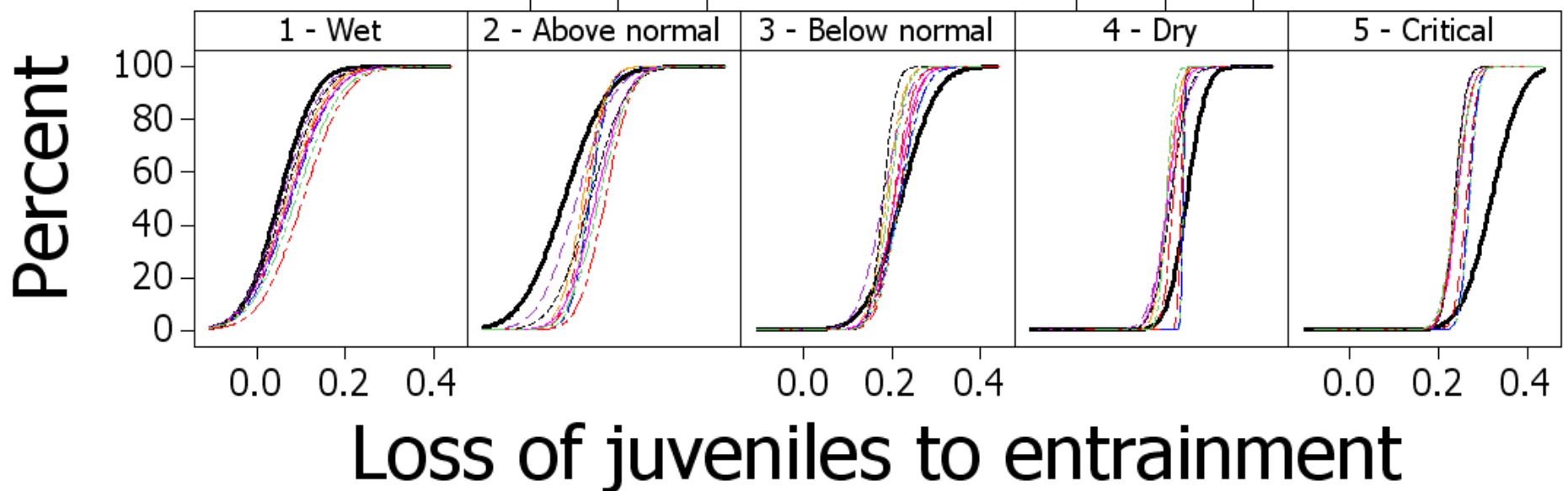
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Spring & Summer (April-June)

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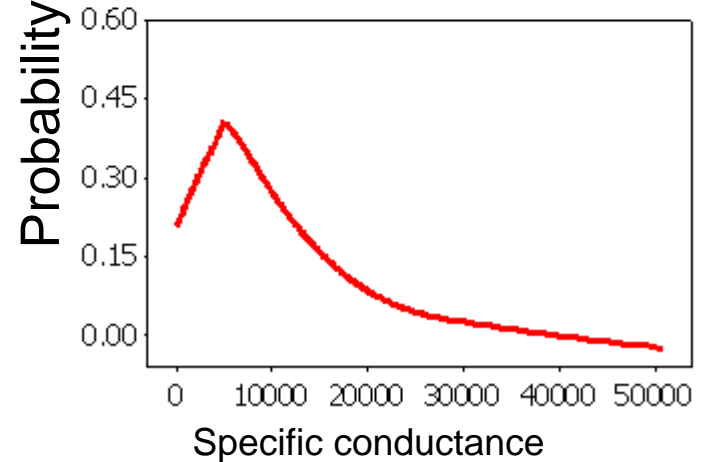
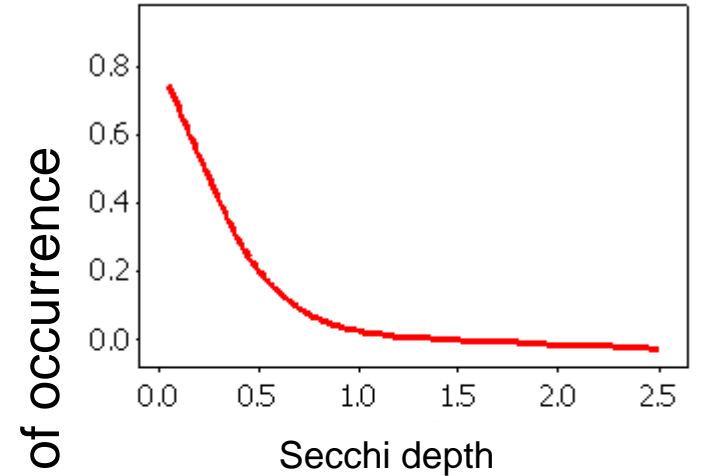
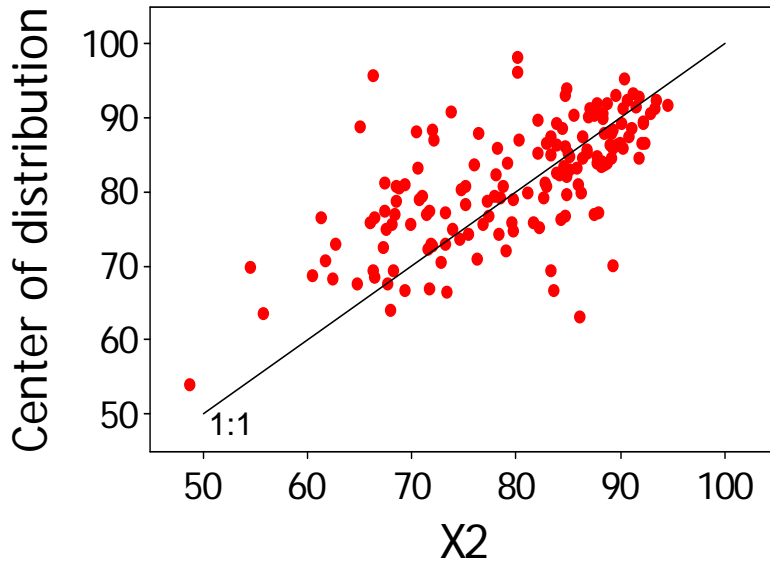
Fall (September-December)

Rearing habitat of maturing pre-adults

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

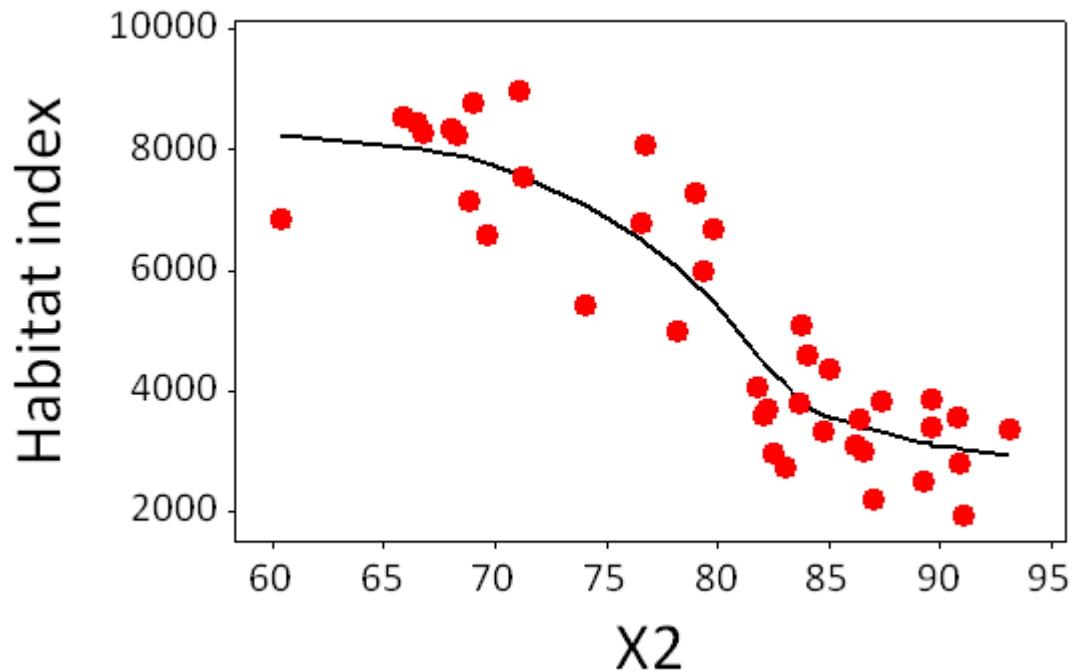


Feyrer et al. (2007)

Fall (September-December)

Rearing habitat of maturing pre-adults

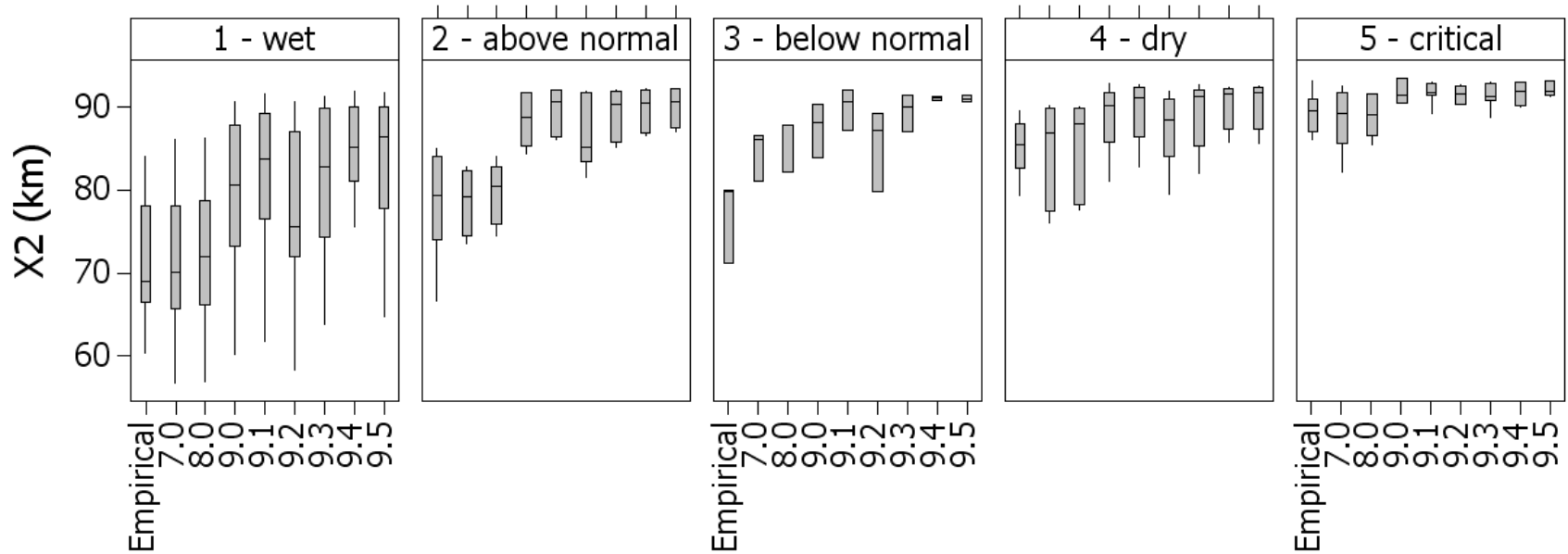
- Delta smelt habitat is related to salinity and turbidity (Bennett 2006; Feyrer et al. 2007; Kimmerer et al. 2009)
- Suitable habitat is related to X2 (Feyrer et a



Fall (September-December)

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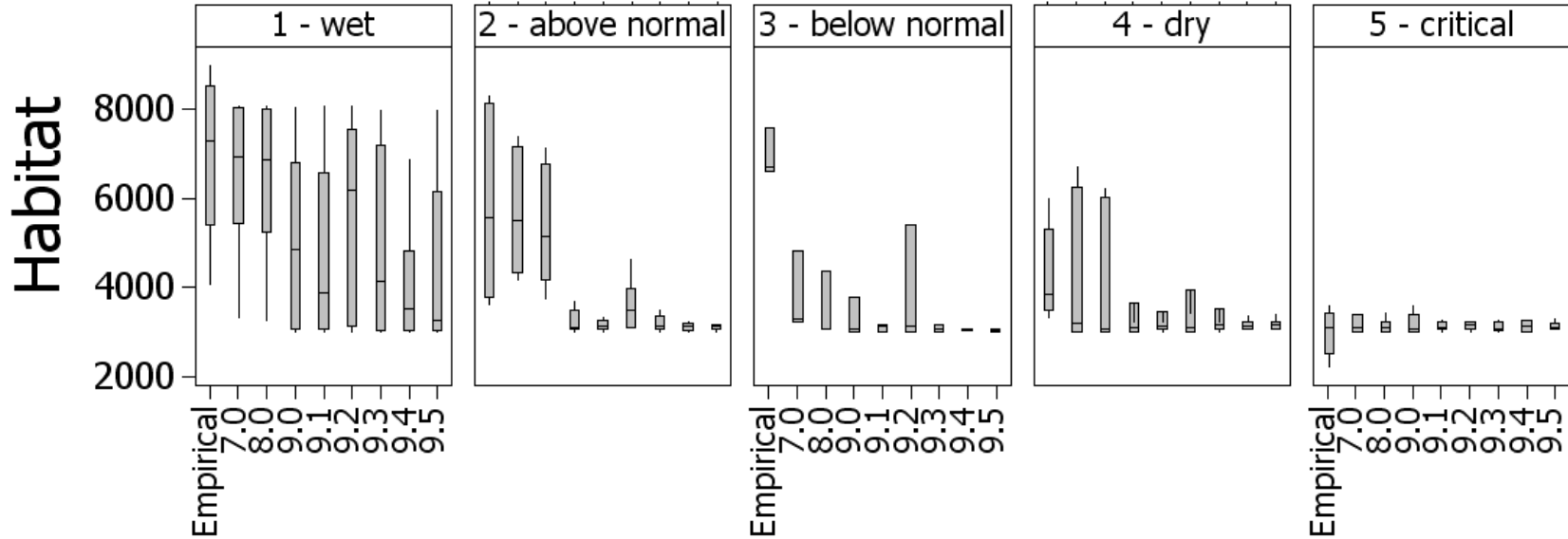
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A) X2 shift upstream



Fall (September-December)

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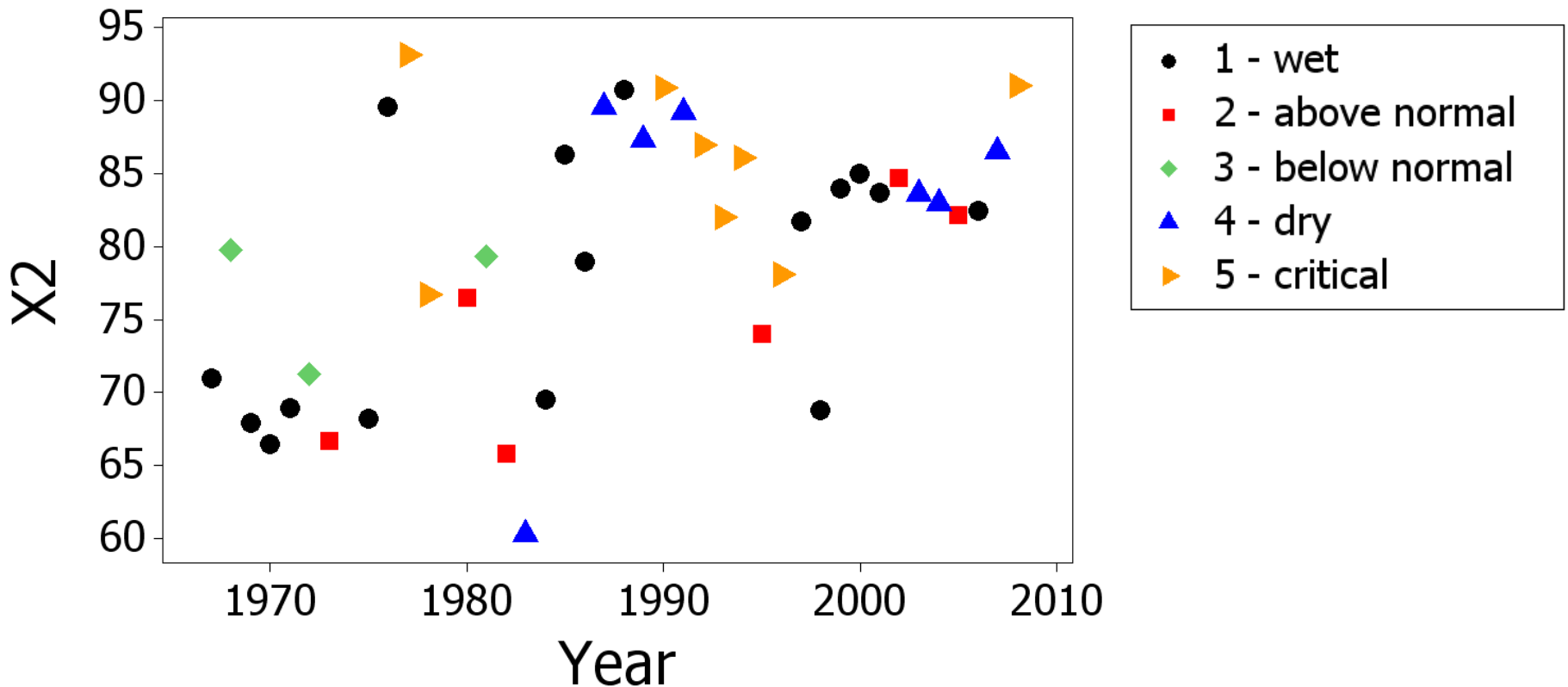
- Effects of modeled CVP/SWP operations (FWS 208):
 - A) X2 shift upstream
 - B) Habitat space reduced



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)