# The Delta Passage Model: a tool for investigating juvenile salmonid migration and predation mortality in the Delta

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# Presentation Overview

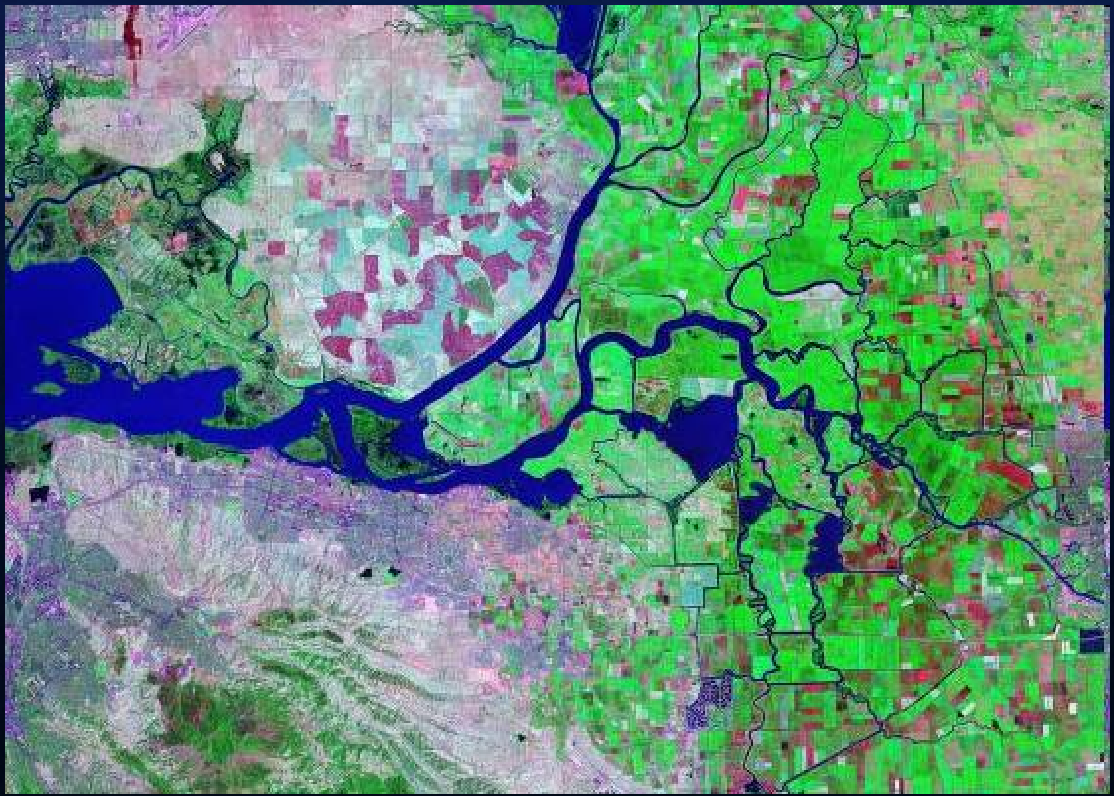
1. Briefly explain the DPM

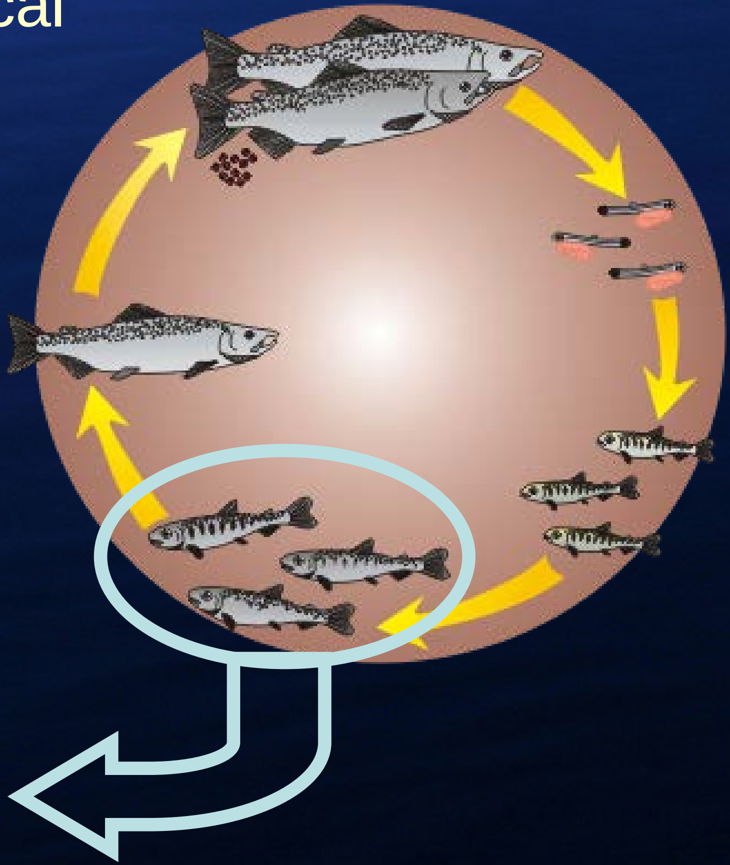
2. Introduce and describe the IB-DPM

3. Predation related IB-DPM applications

# Delta Passage Model (DPM)

Integrates and applies available empirical data from analyses of acoustic and coded wire tag studies in the Delta





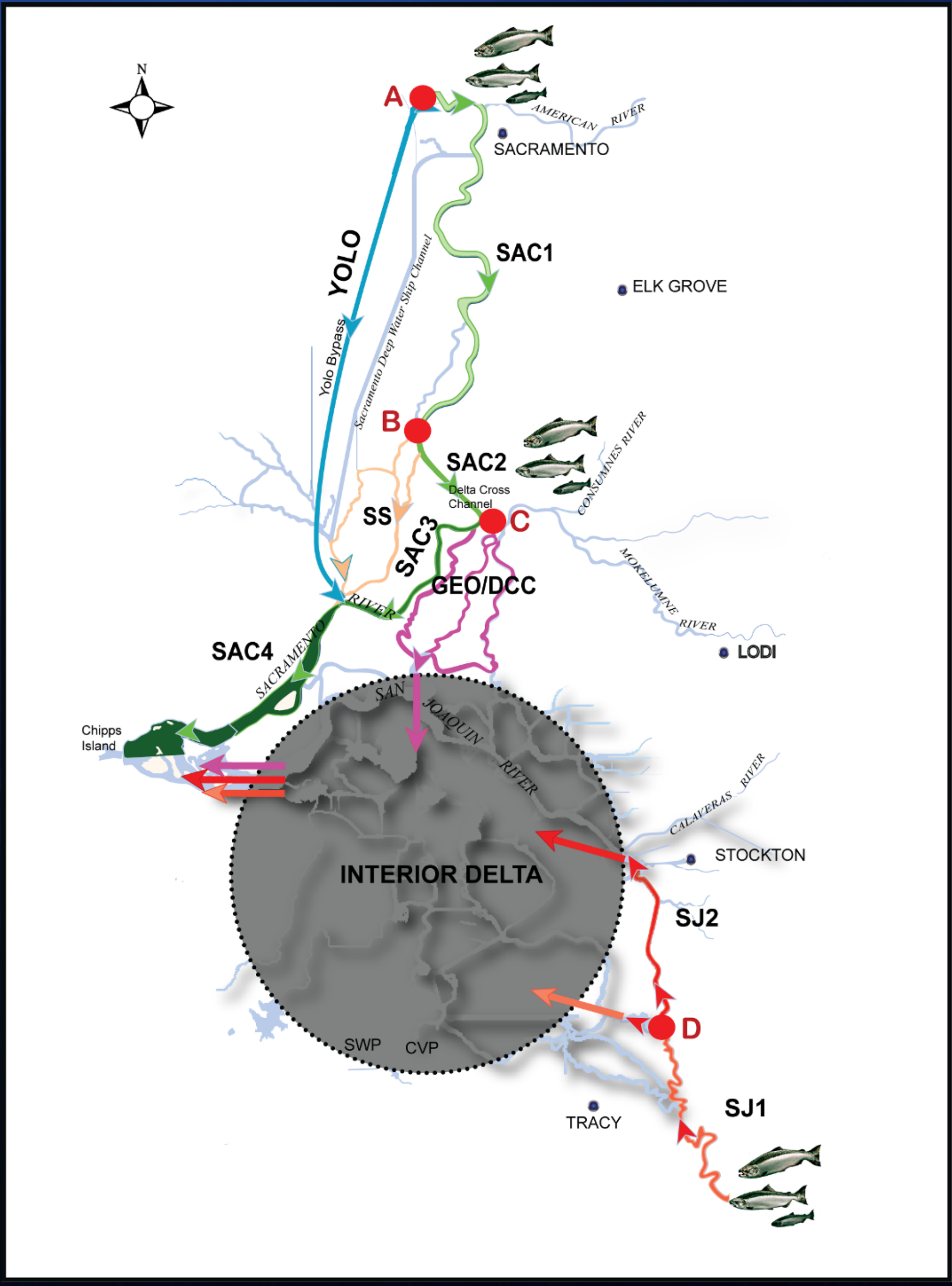
# Delta Passage Model (DPM)

Operates on a daily time step, using daily average flows (DSM2 Hydro) for primary migration routes

Most functional relationships structured as probability distributions

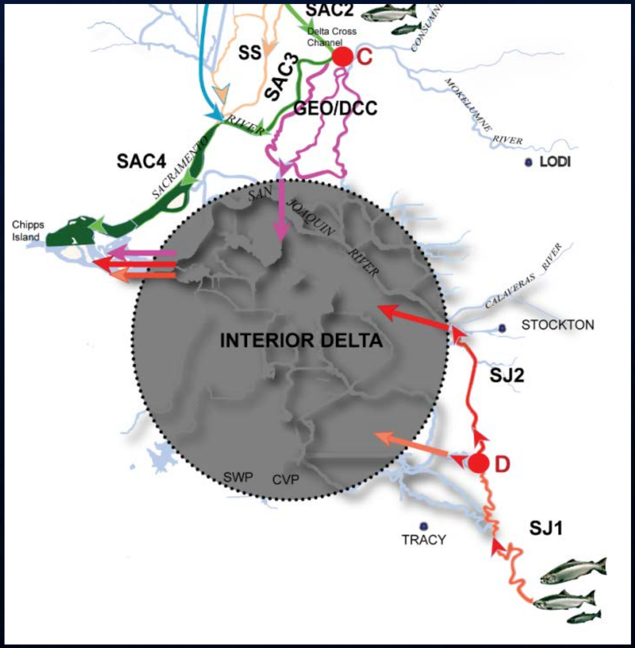
IOS = JPE + DPM + Ocean

*Zeug et al. 2012. "Application of a life cycle simulation model…." Environmental Modeling and Assessment*



# Limitations of the DPM

1. Long reaches, poor spatial and hydro resolution
2. Mortality independent of migration speed
3. Predation mortality not specifically represented
4. Interior Delta "black box"

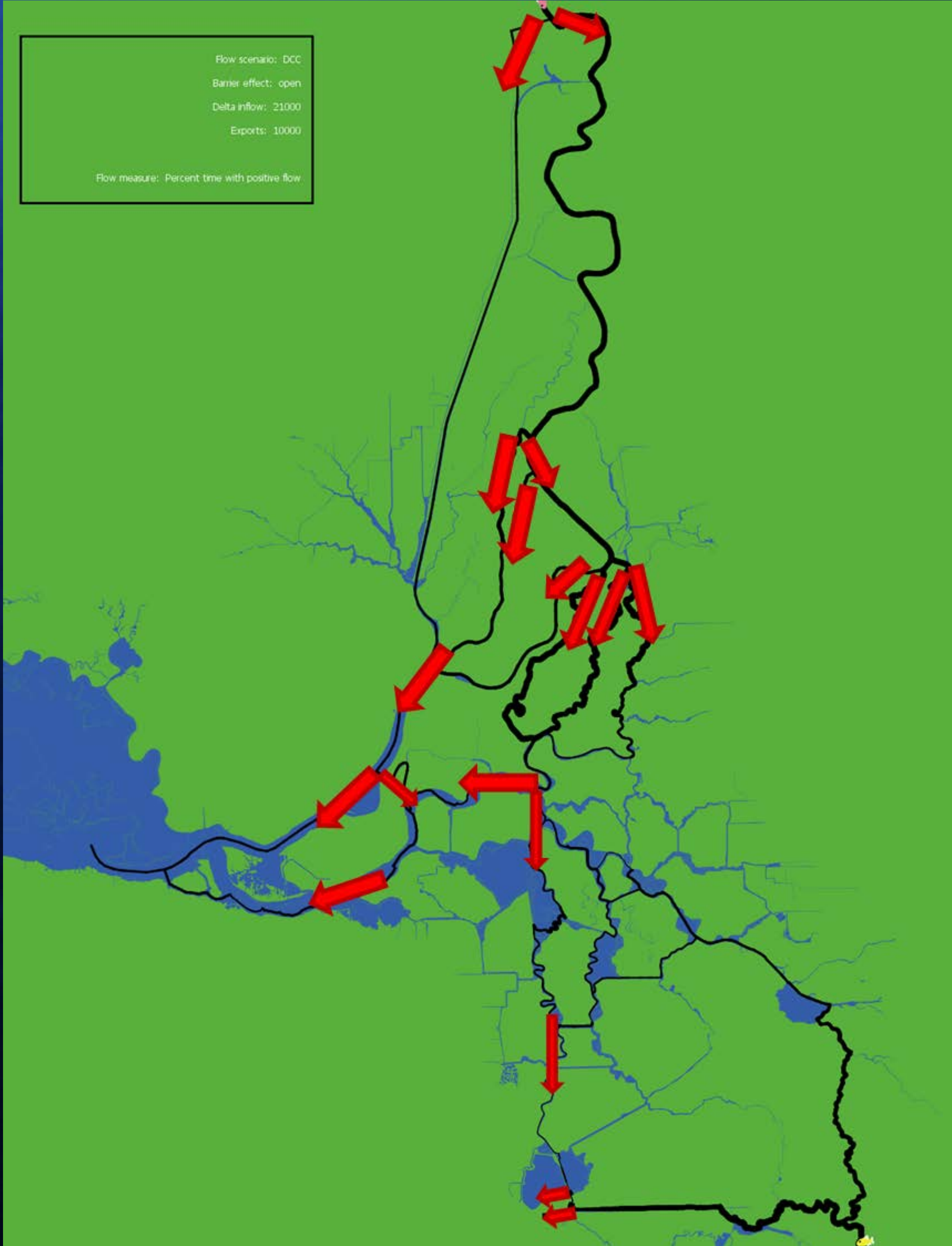


# IB-DPM
# (Individual Based- Delta Passage Model)

- 192 DSM2 Hydro channels
  - No pre-defined reaches, detailed hydrodynamic resolution
- 14 junctions, including DCC and HORB
- Predation mortality is directly represented
- Individual fish navigate a more realistic Delta

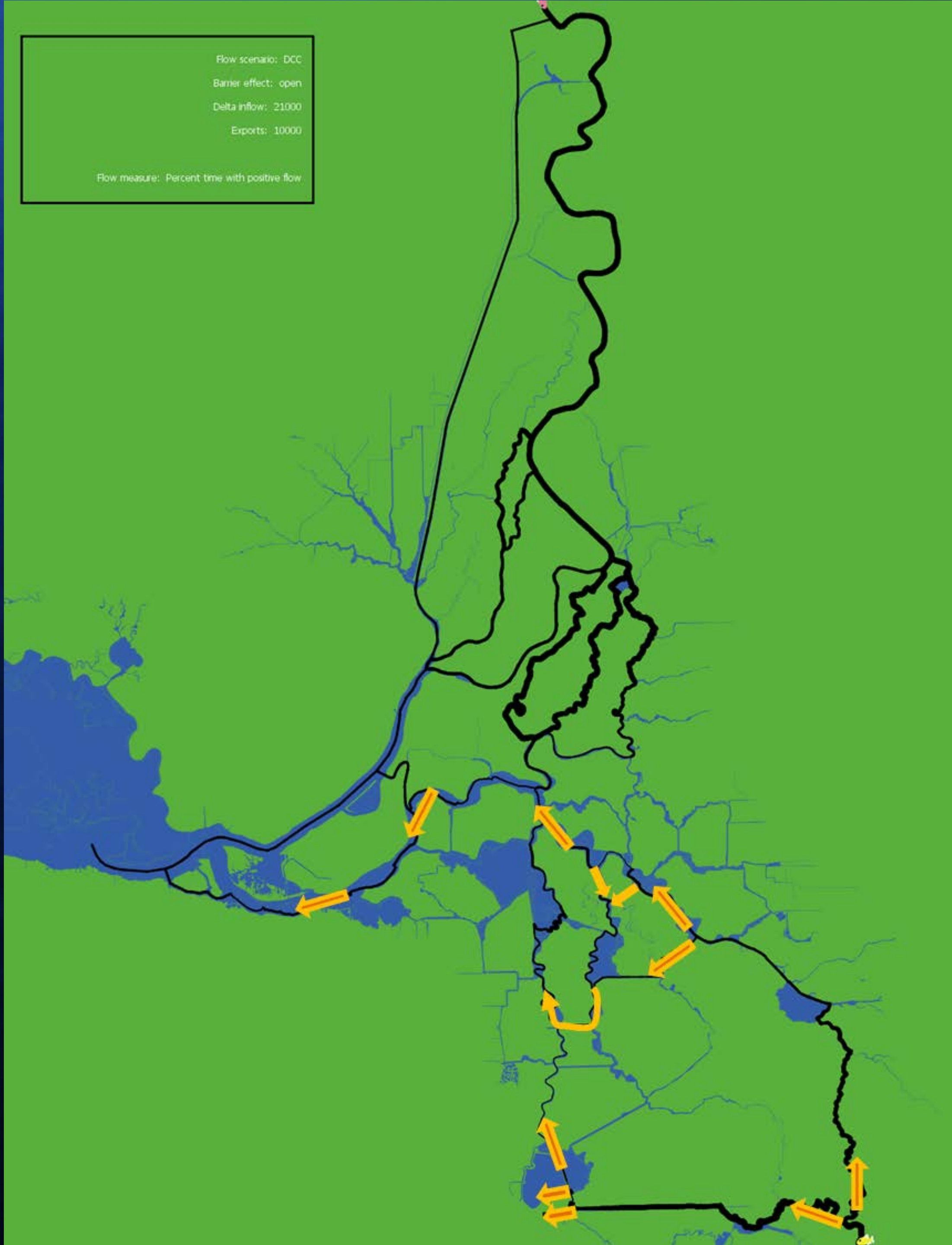
# IB-DPM

Sacramento River routes



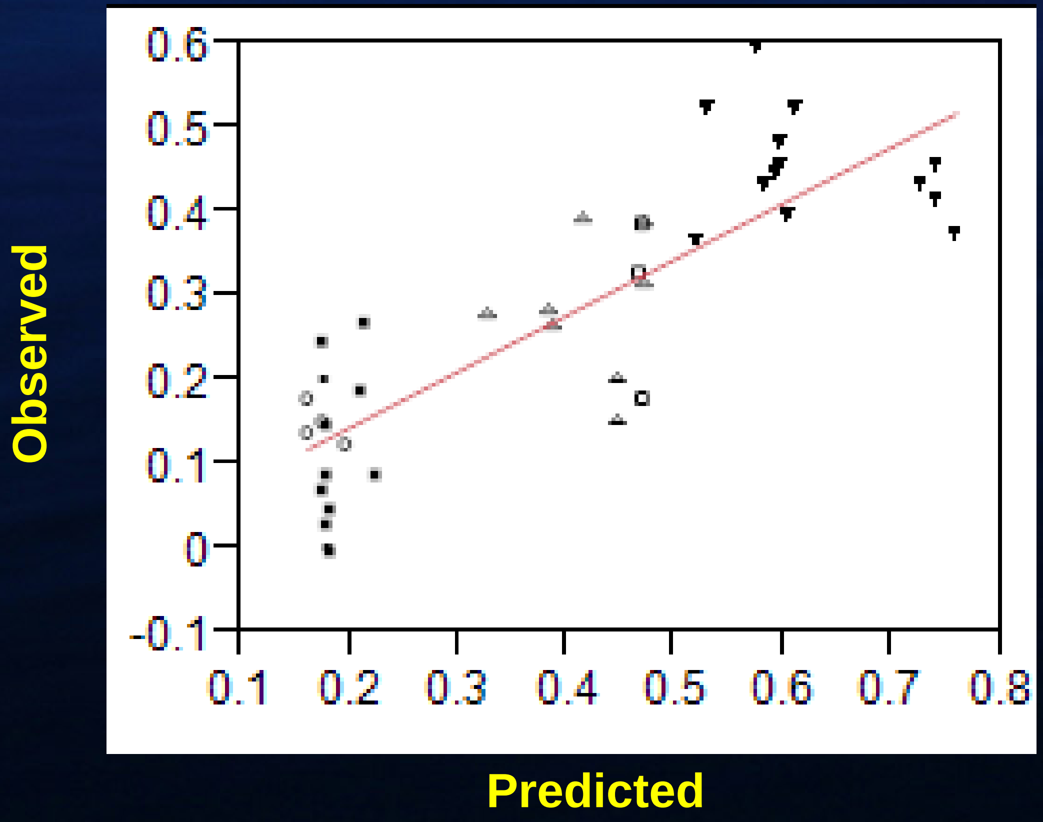
# IB-DPM

San Joaquin River routes



# IB-DPM: Key Functions

- Junction routing probabilities based upon daily flow proportion
  - change as a function of inflows, barriers and exports



# IB-DPM: Key Functions

- Junction routing probabilities based upon daily flow proportion
  - Routing changes as function of exports, inflows, barriers
- Residence time (t) is a function of hydrodynamic conditions in each channel
- Survival is a function of residence time (t) and a predation intensity parameter (ω/λ).

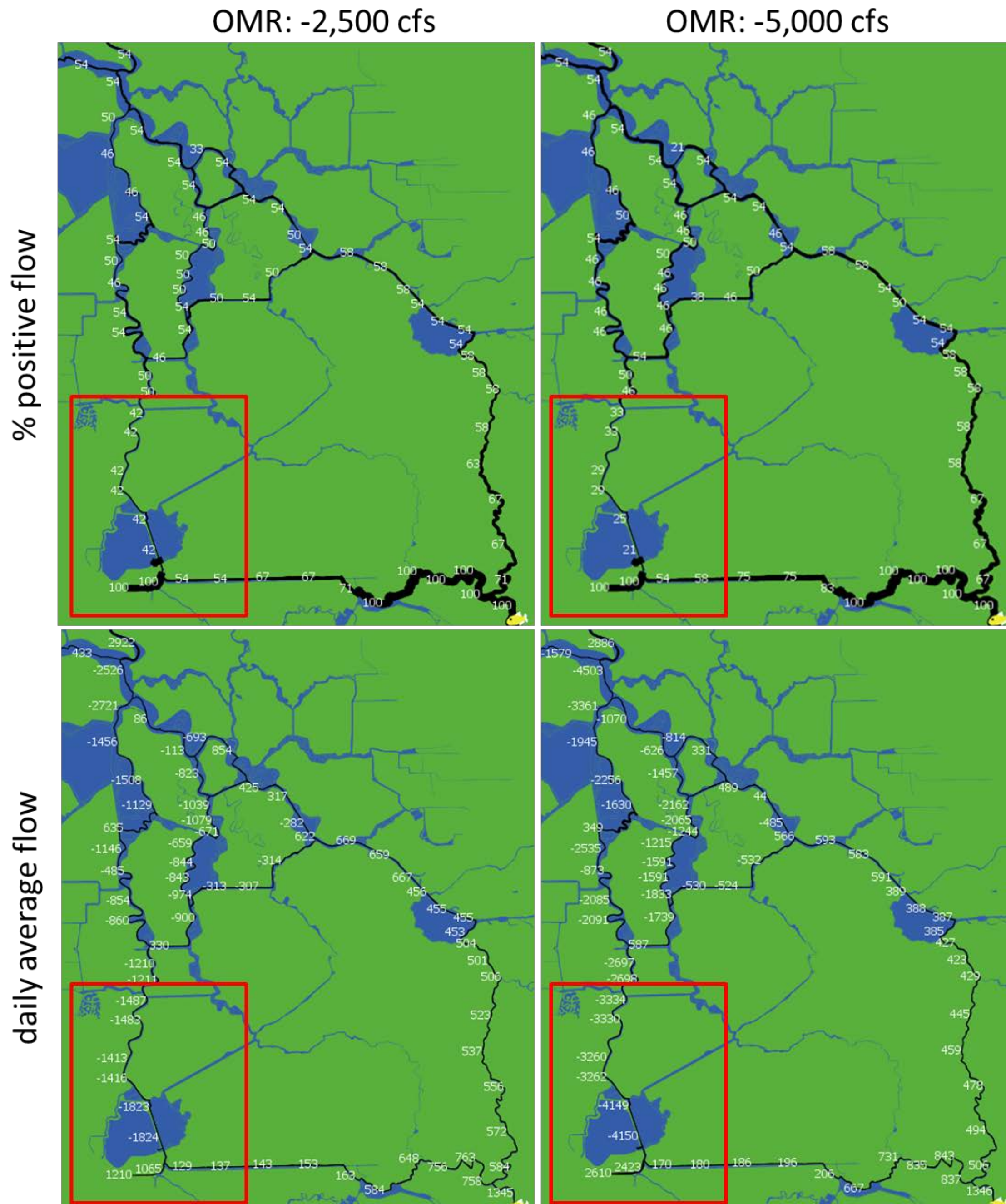
$$S = \exp\left(-\frac{\omega}{\lambda}t\right)$$

From Anderson et al. (2005)

# IB-DPM: Residence time-hydrodynamics

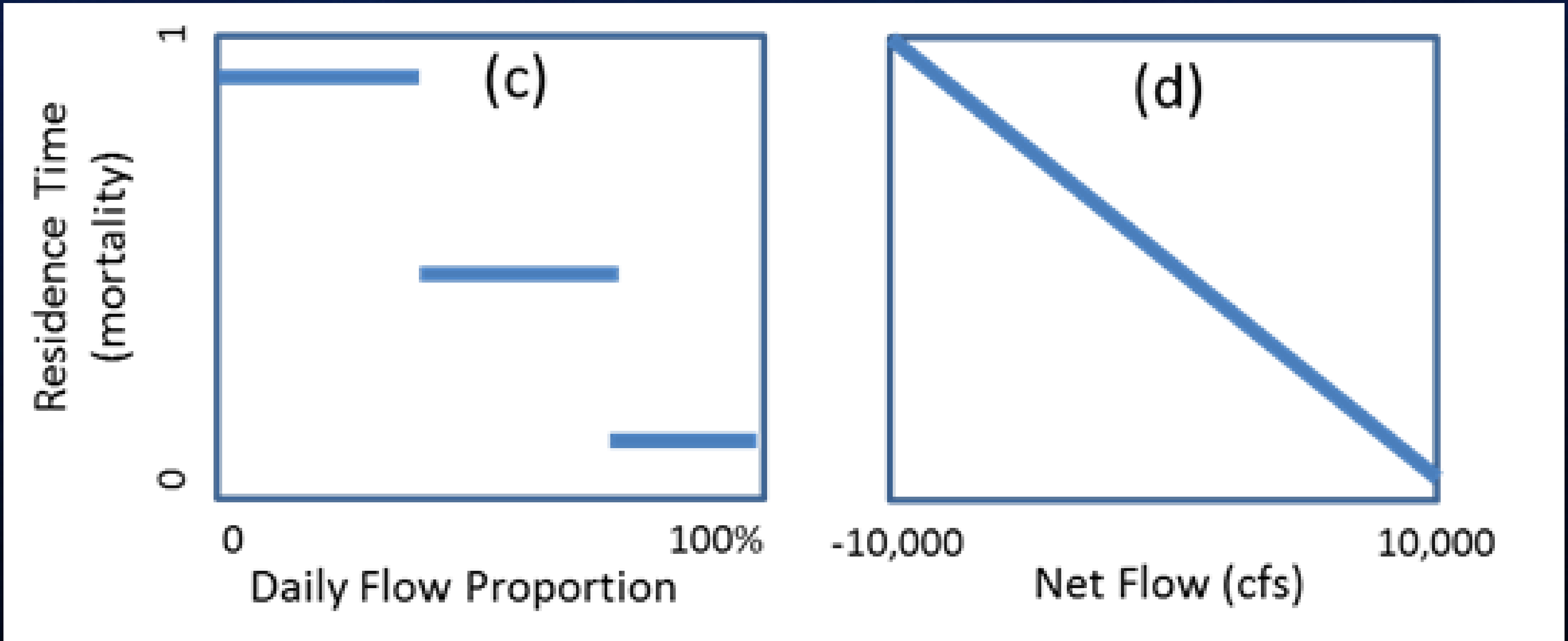
- The influence of hydrodynamics on residence time key for modeling predation mortality
- Hydrodynamic metrics relevant to migrating juvenile salmonids
  - “net” flow and % positive flow

# San Joaquin River Inflow: 1,500 cfs



# IB-DPM: Residence time-hydrodynamics

- The influence of hydrodynamics on residence time is a key scientific uncertainty.
- Example flow metric-relationships

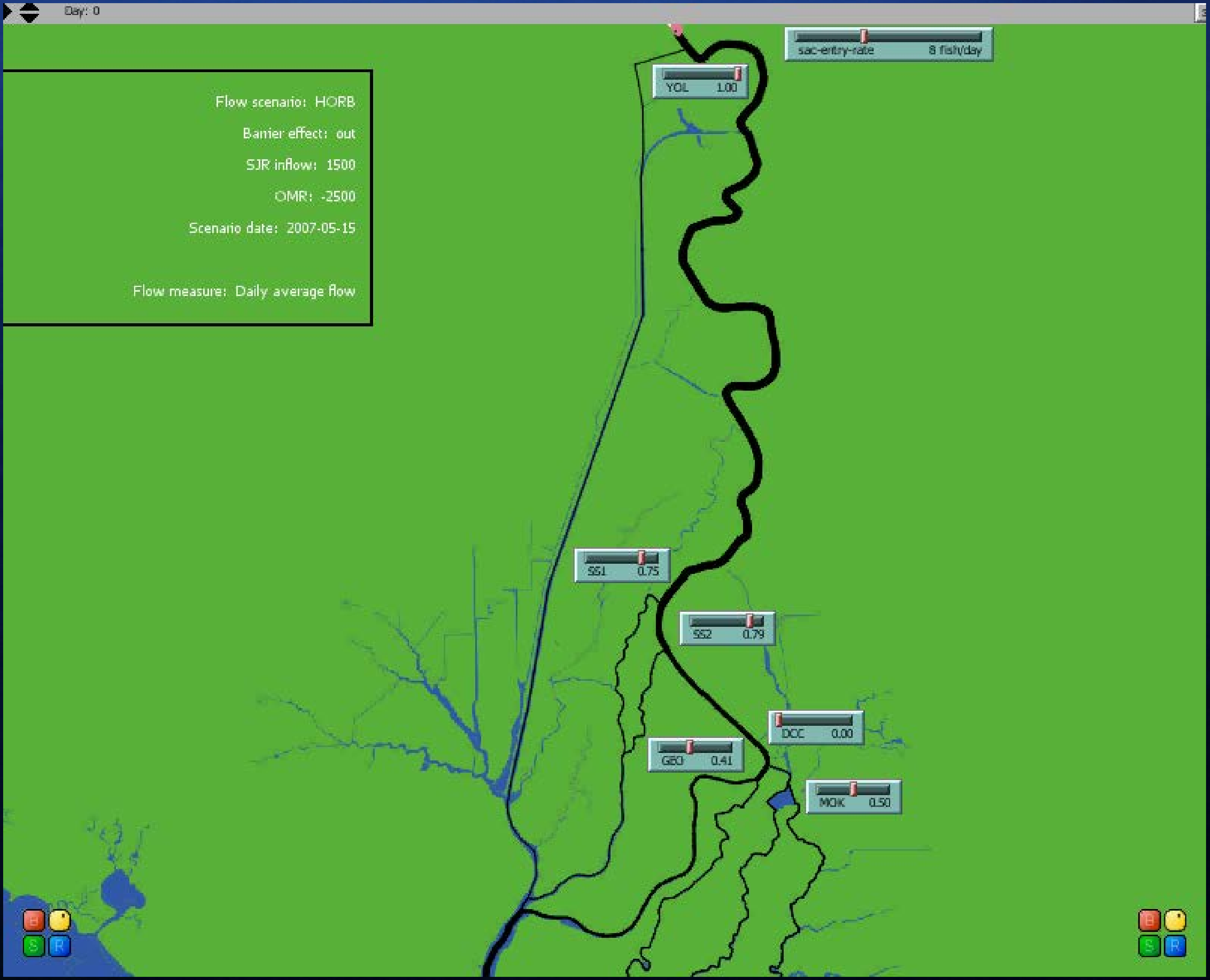


# IB-DPM: Key Functions

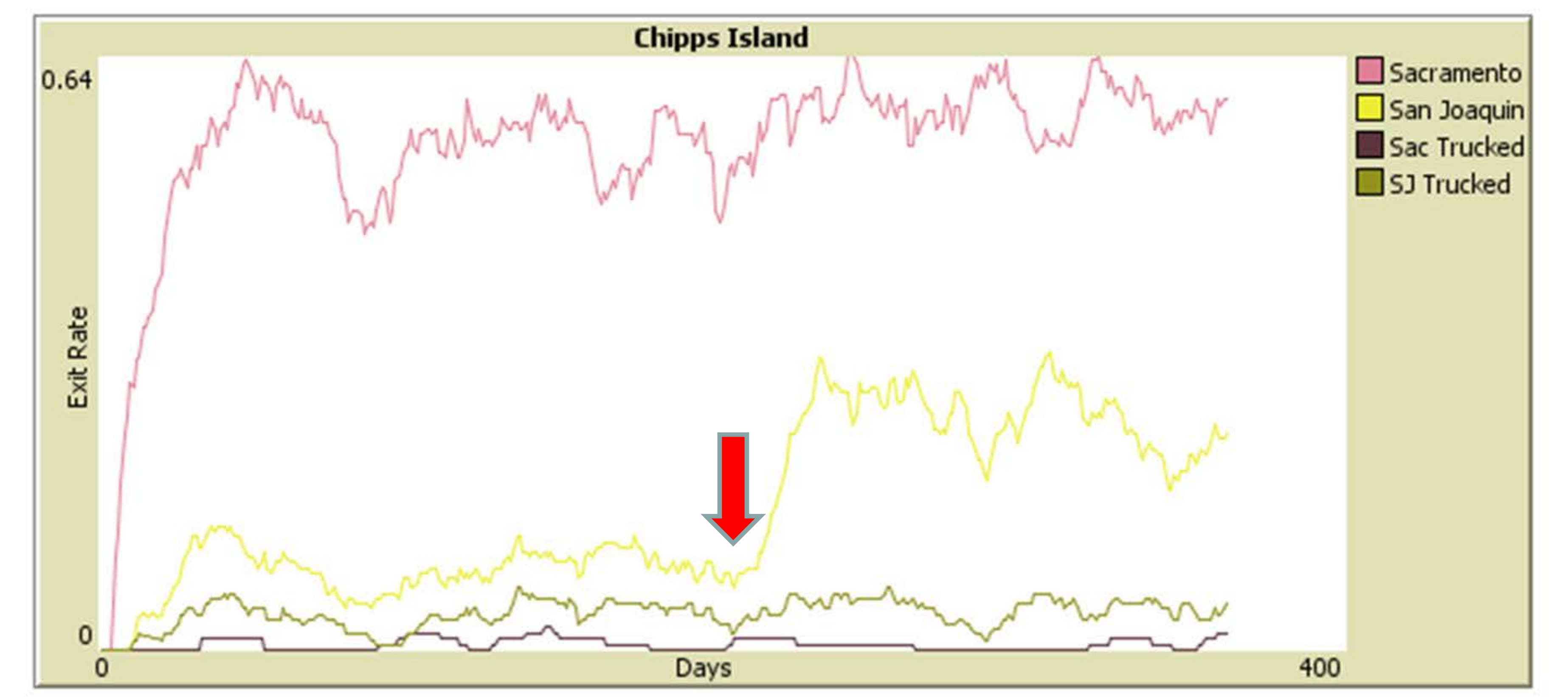
- Entrainment modeled for CVP and SWP facilities
  - Pre-screen mortality, louver efficiency, trucking represented
  - Through-Delta survival via salvage tracked as a result

# IB-DPM
## Demonstration

# IB-DPM: Demonstration



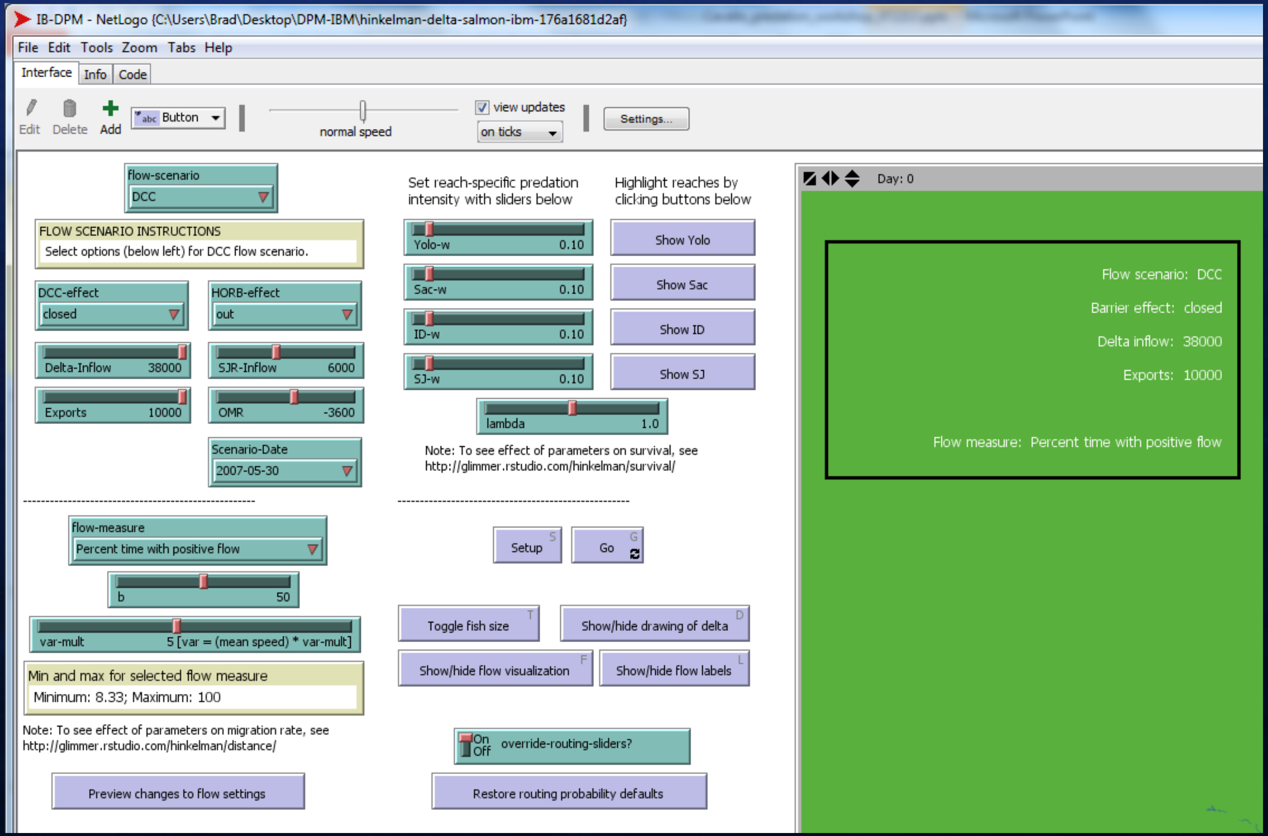
# IB-DPM: Example Results




= 50% reduction in predation intensity parameter (ω/λ).

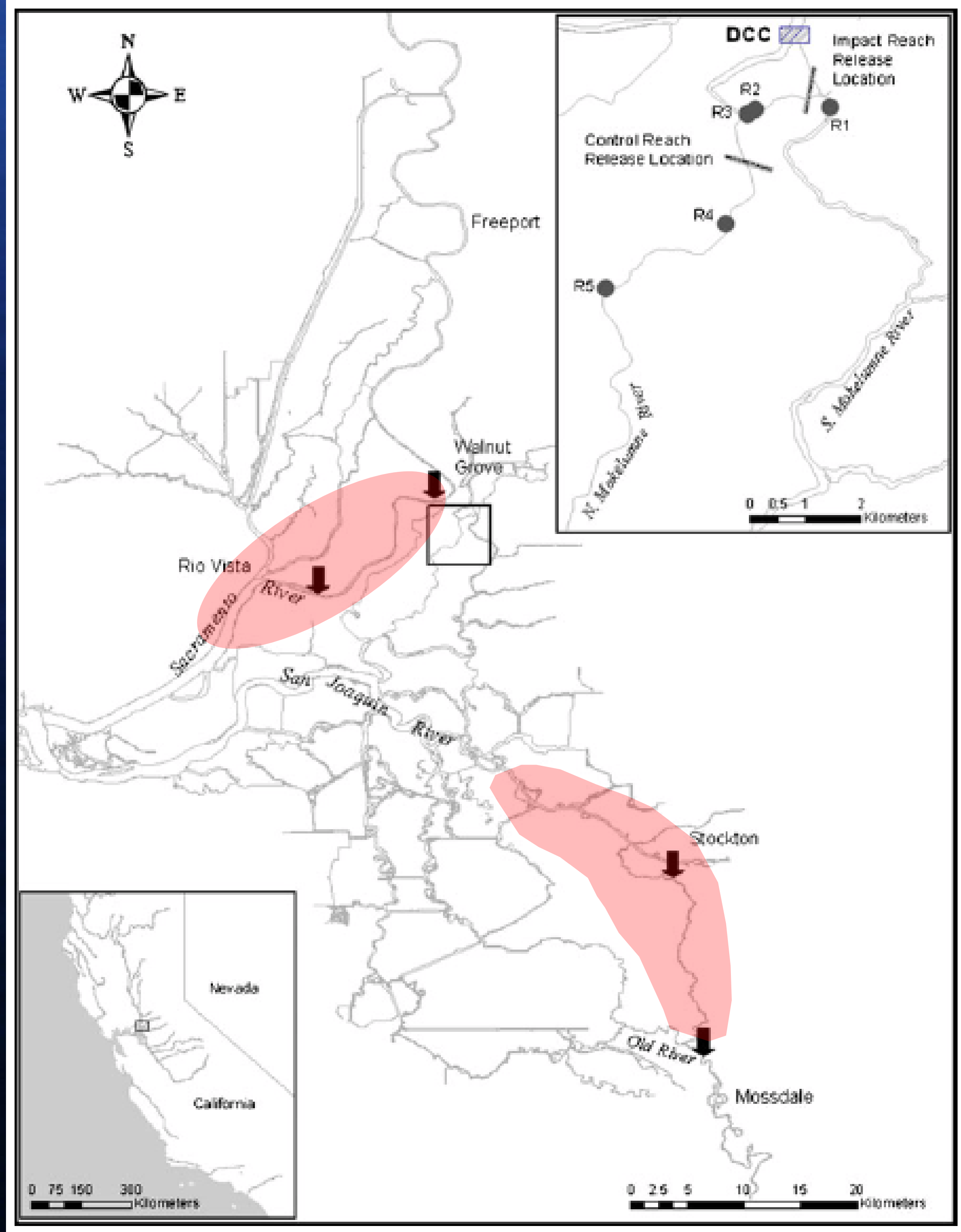
# IB-DPM: Predation Applications

- Explore relative influence of operations, hydrodynamics and predation




- What management actions can change predation intensity($\omega/\lambda$)?
  - Where and by how much?

# Where to make habitat or change predators?

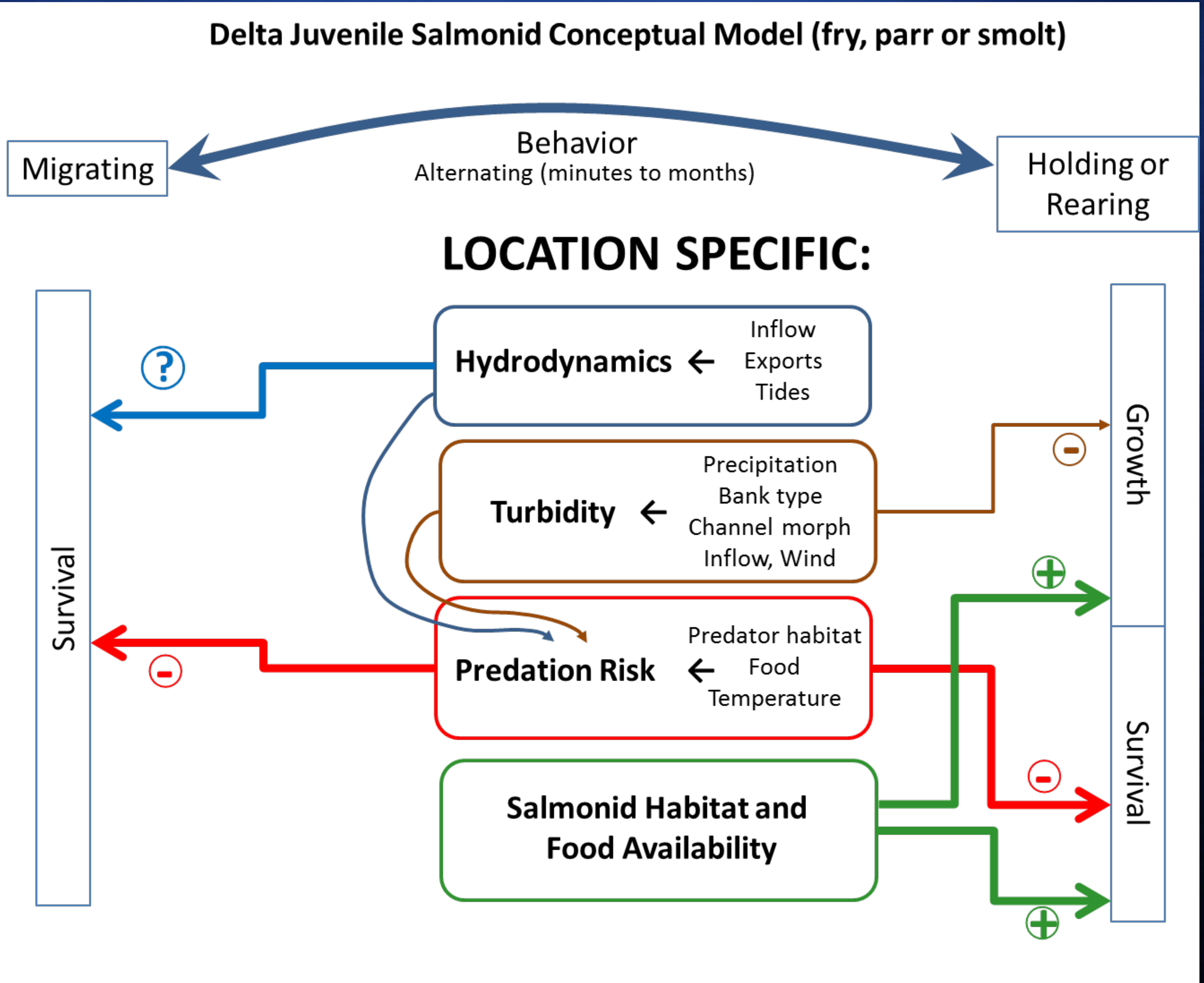



*Cavallo et al. 2012. "Effects of predator and flow manipulation on Chinook salmon…." Environmental Biology of Fishes*

# IB-DPM: What next?

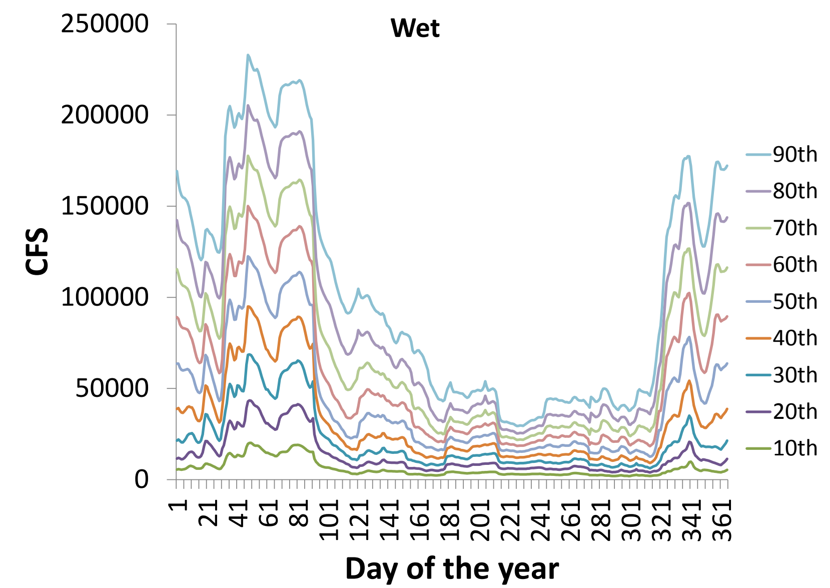
- Identify hydro-residence time hypotheses for testing
- Use hundreds of previous CWT experiments to calibrate
  - estimate parameters
  - test alternative hydro-residence hypotheses
- CWT study responses to be used:
  - Arrival timing at salvage facilities and Chipps Isl.
  - "Loss" at SWP and CVP
  - Estimated number of fish reaching Chipps Isl.

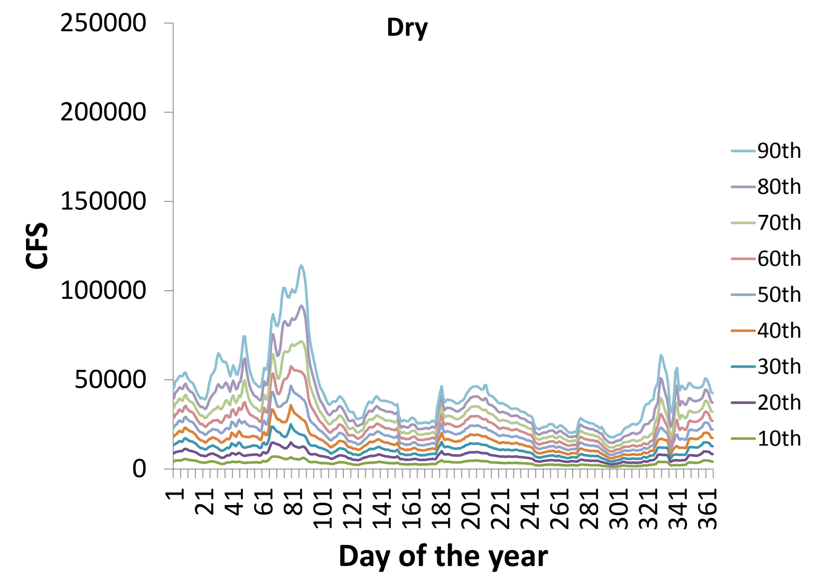
# Extra Slides

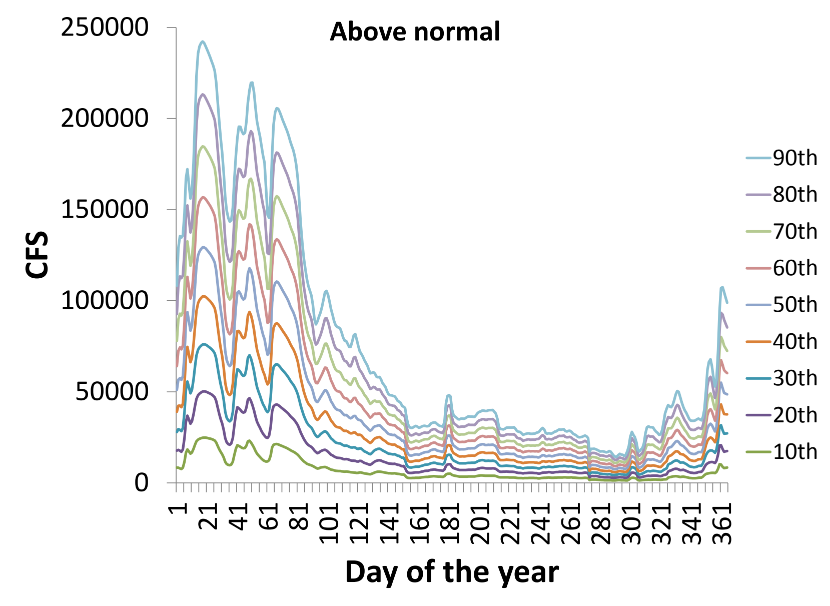


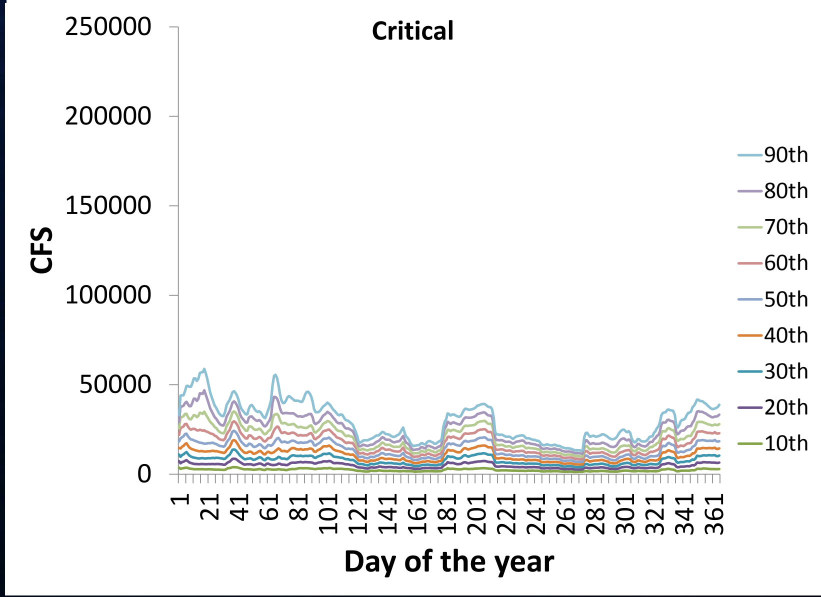
Delta Juvenile Salmonid Conceptual Model (fry, parr or smolt)
Migrating
Behavior
Alternating (minutes to months)
Holding or Rearing
LOCATION SPECIFIC:
Survival
?
Hydrodynamics ←
Inflow
Exports
Tides
Turbidity ←
Precipitation
Bank type
Channel morph
Inflow, Wind
Predation Risk ←
Predator habitat
Food
Temperature
Salmonid Habitat and Food Availability
Growth
Survival

# Sacramento flow

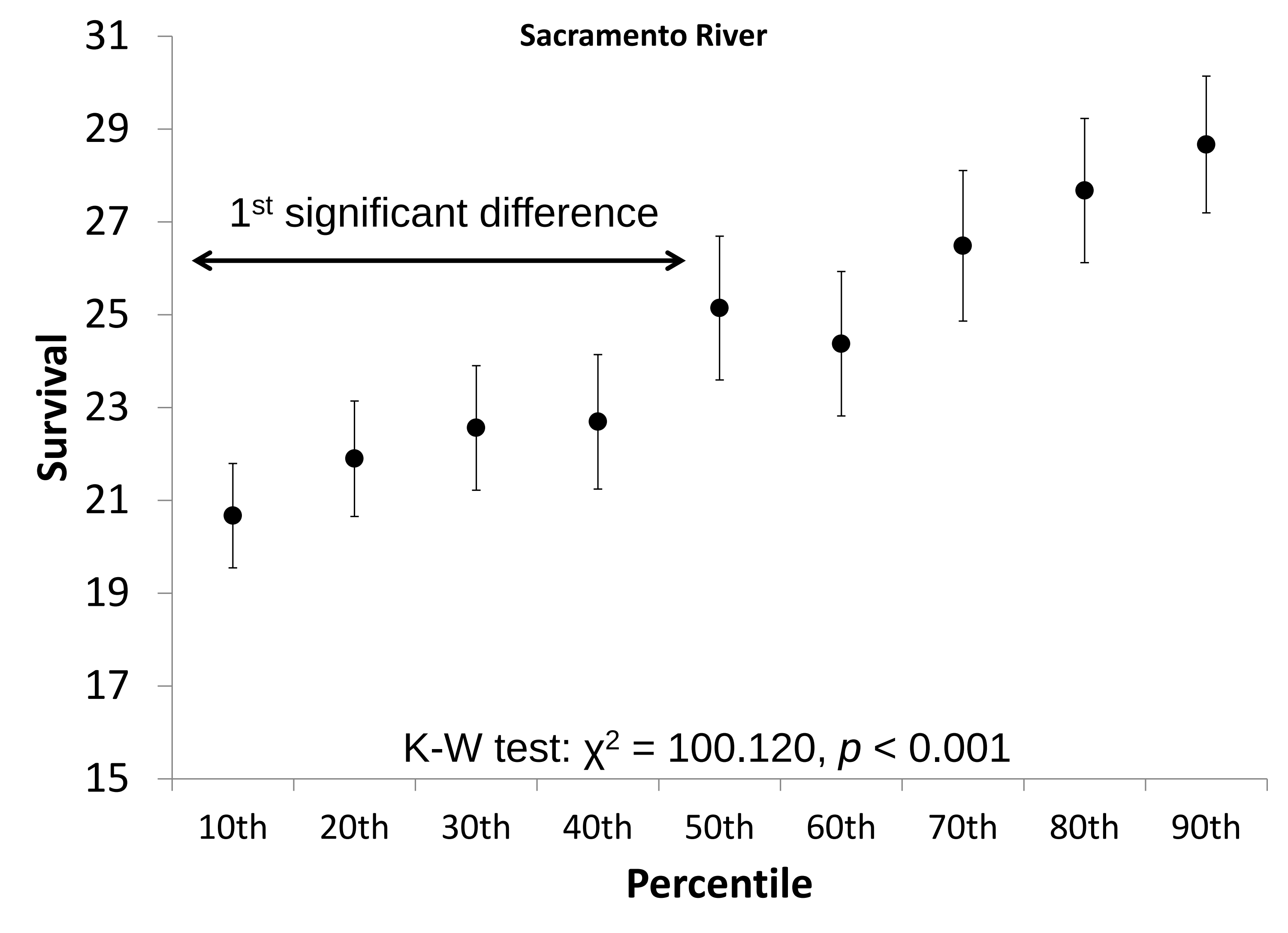


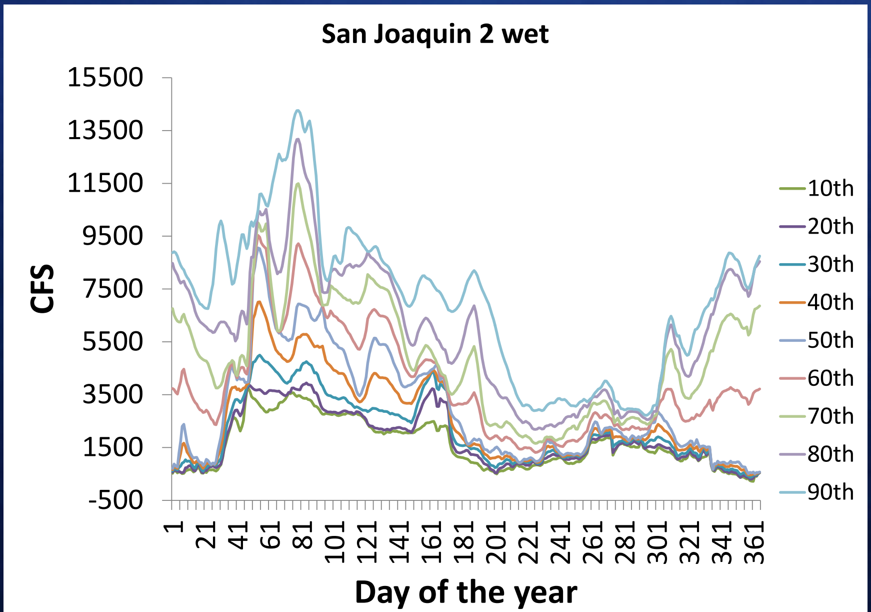



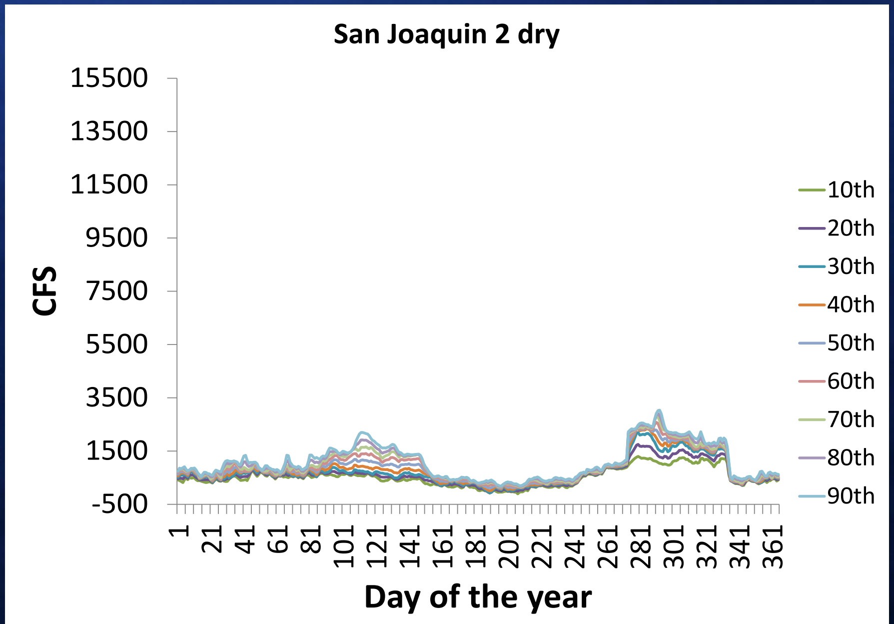



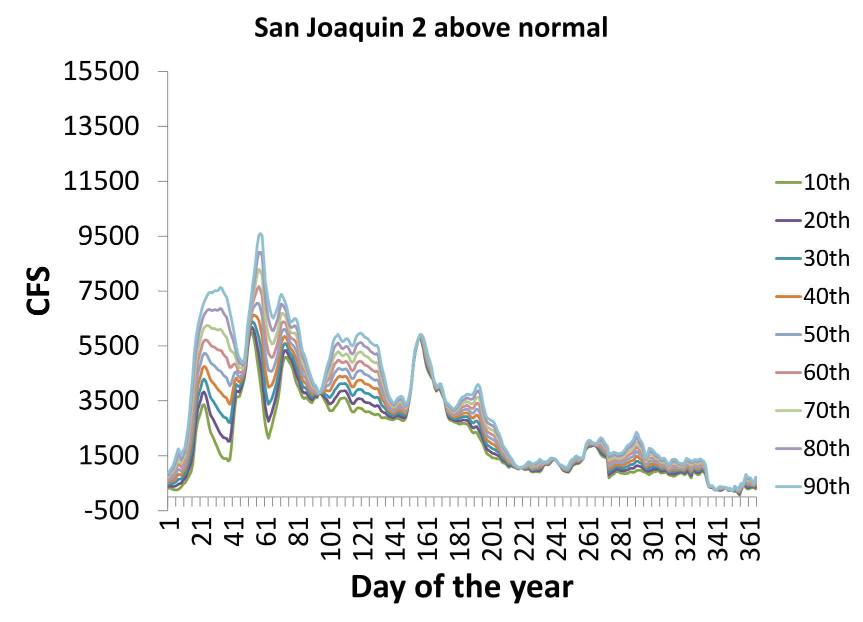
# Flow results (Sacramento)

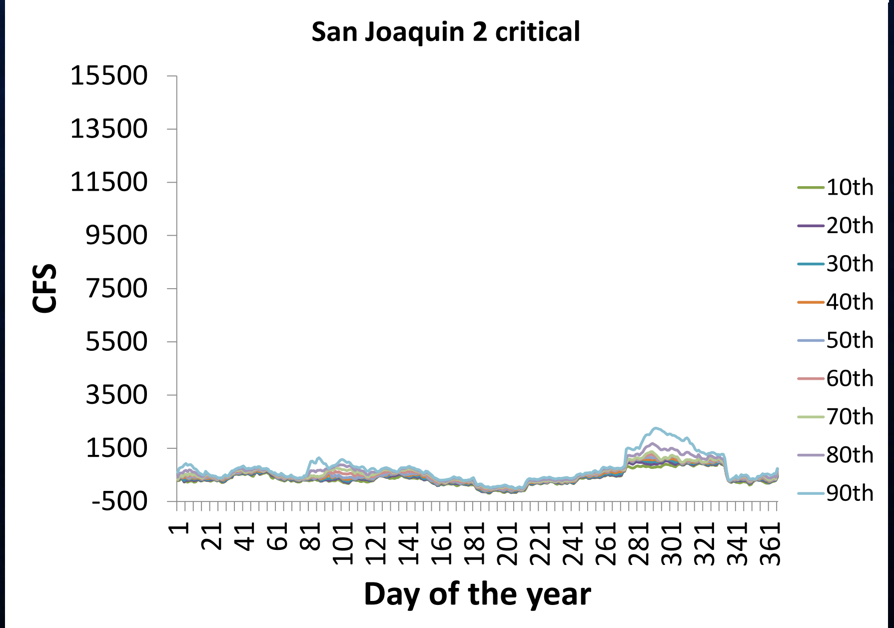


# San Joaquin flow



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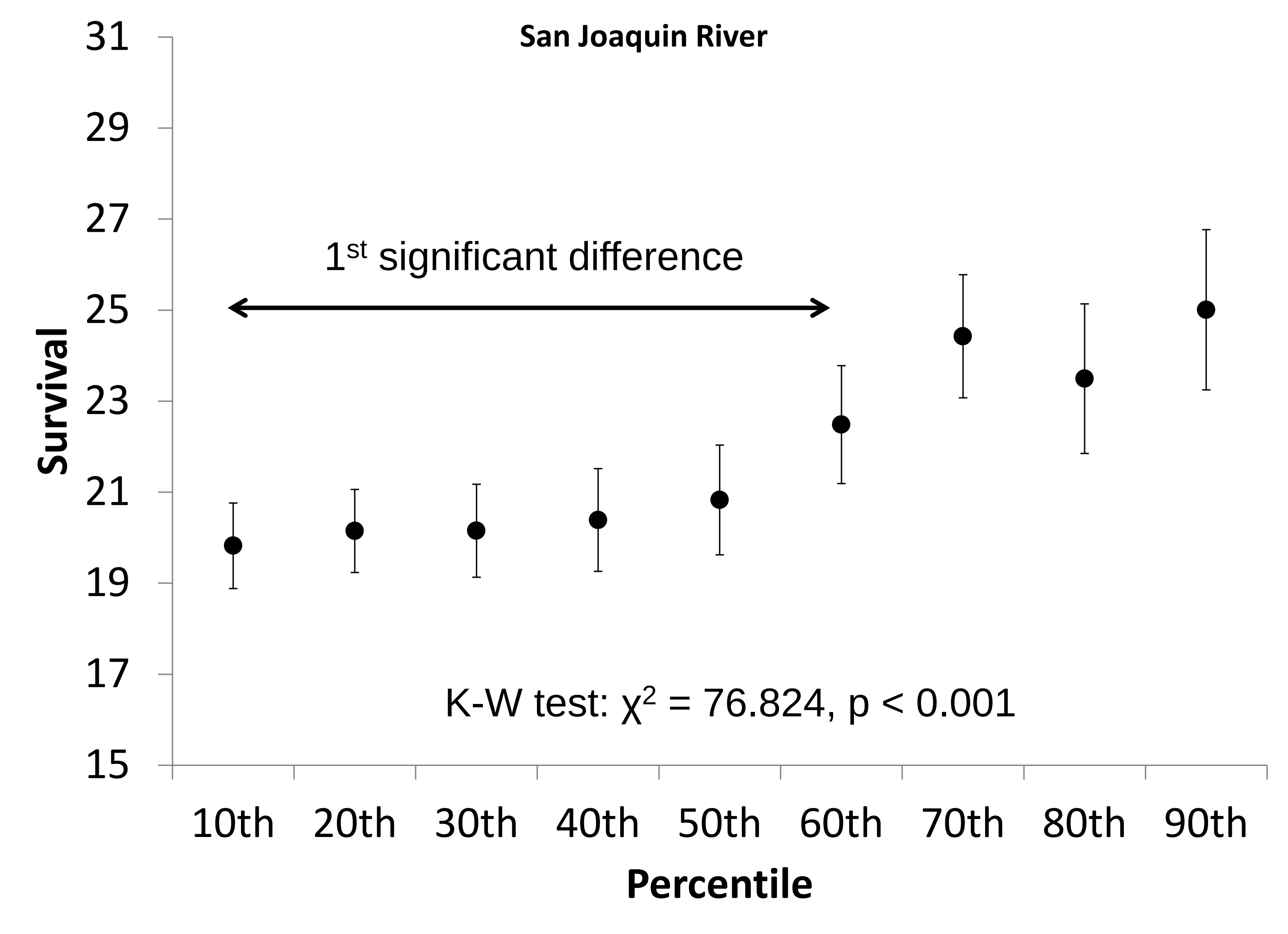
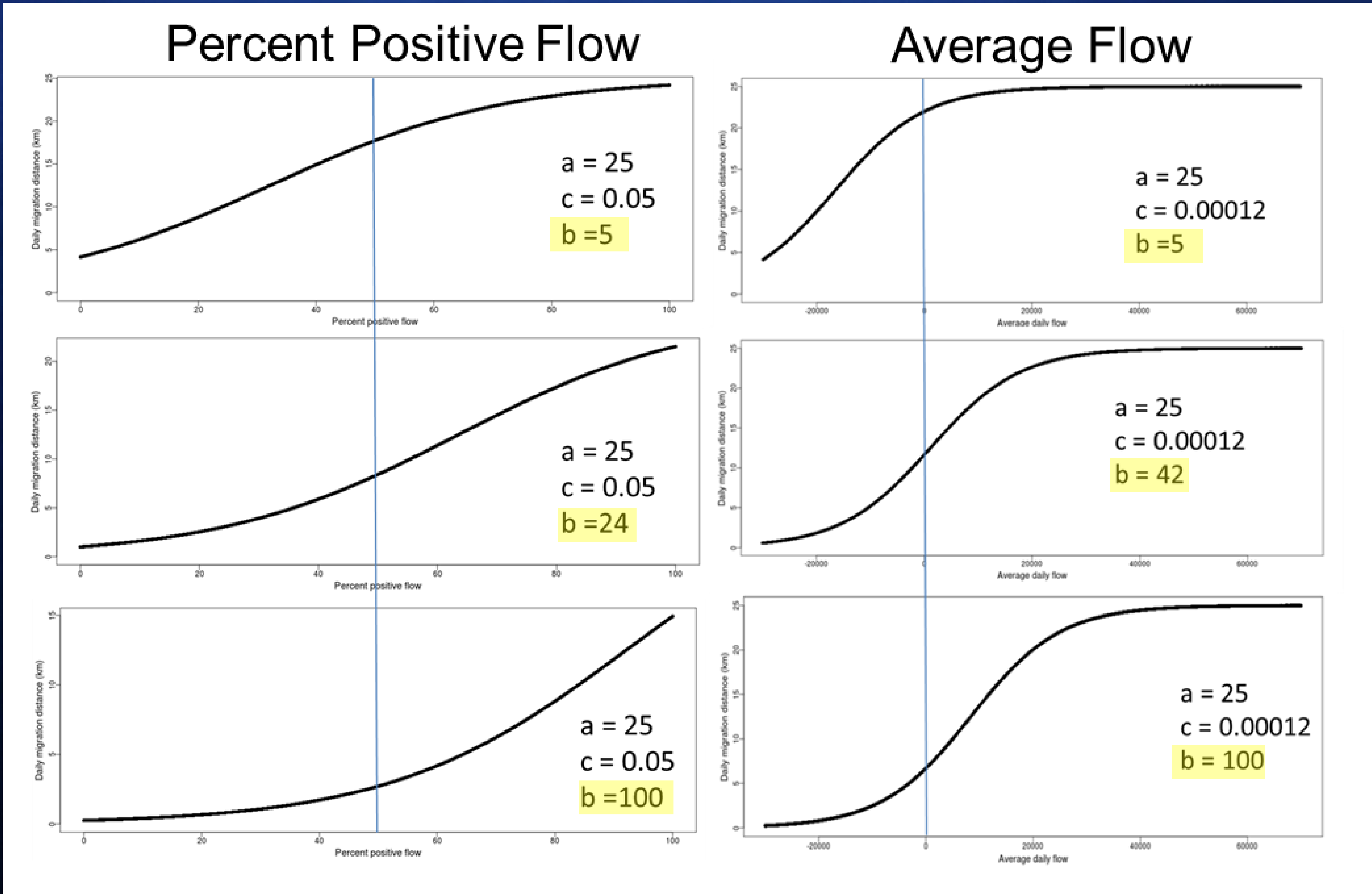
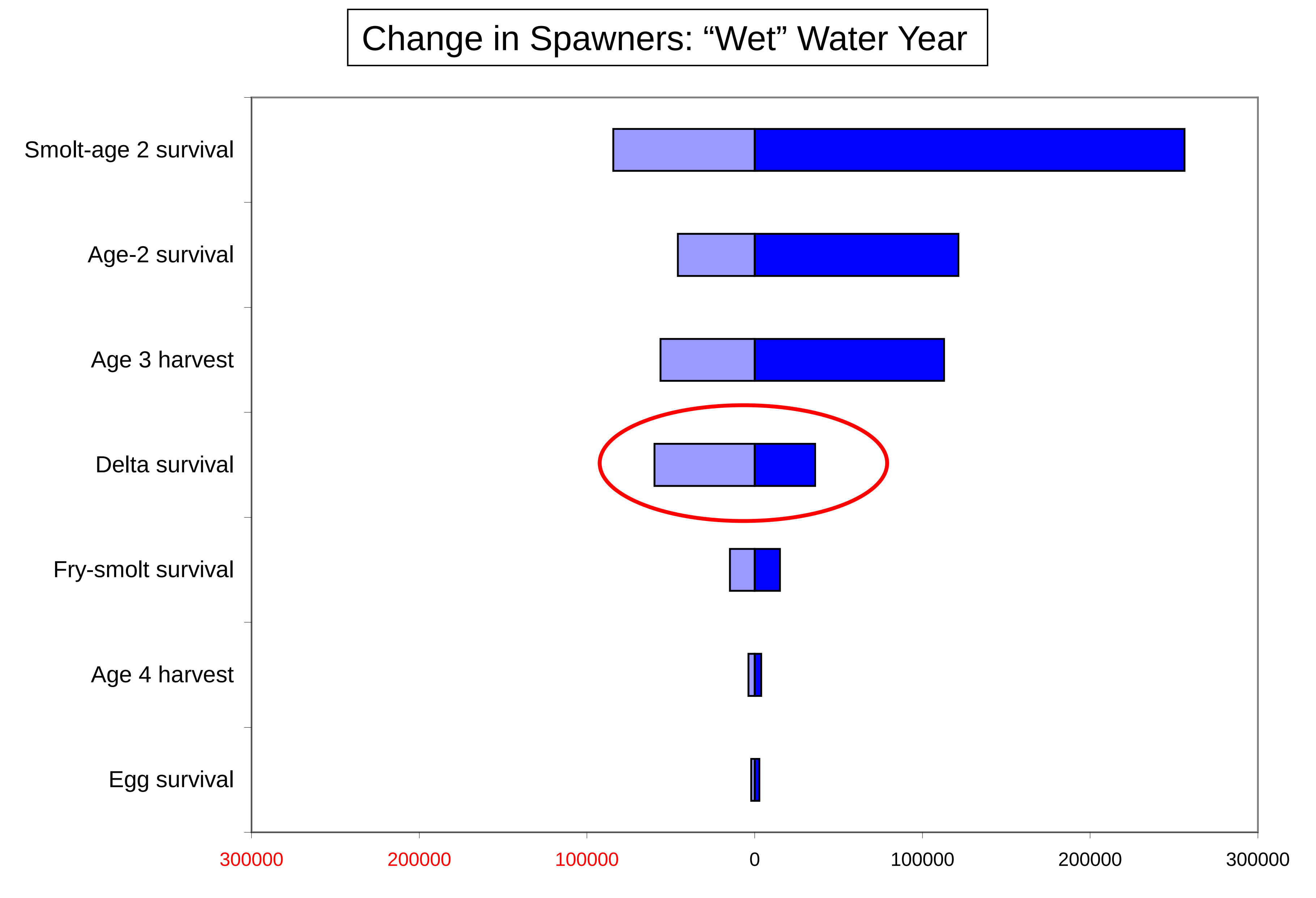


# More on residence time-hydrodynamics



# Sensitivity Analysis: Life Stage Functions



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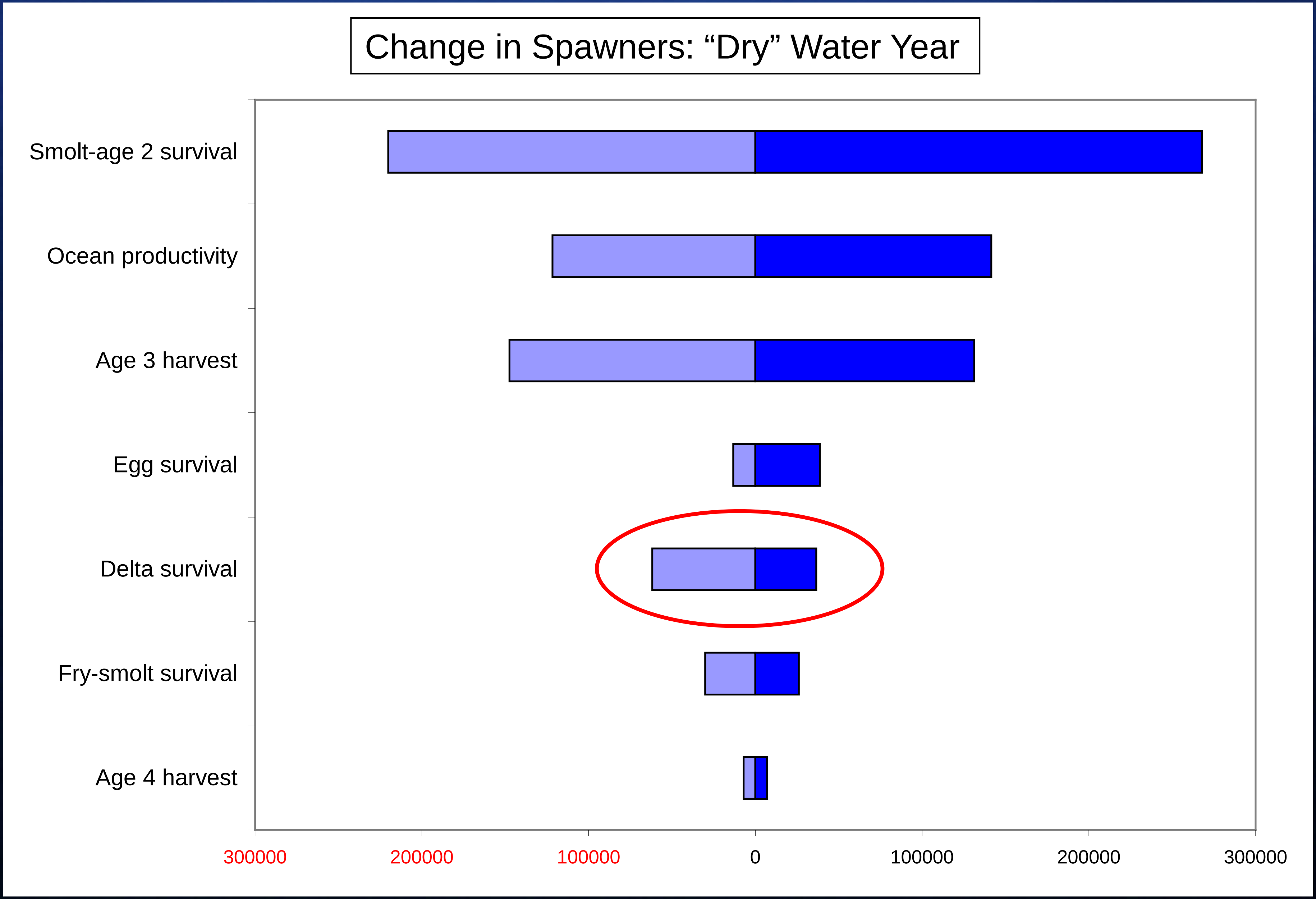
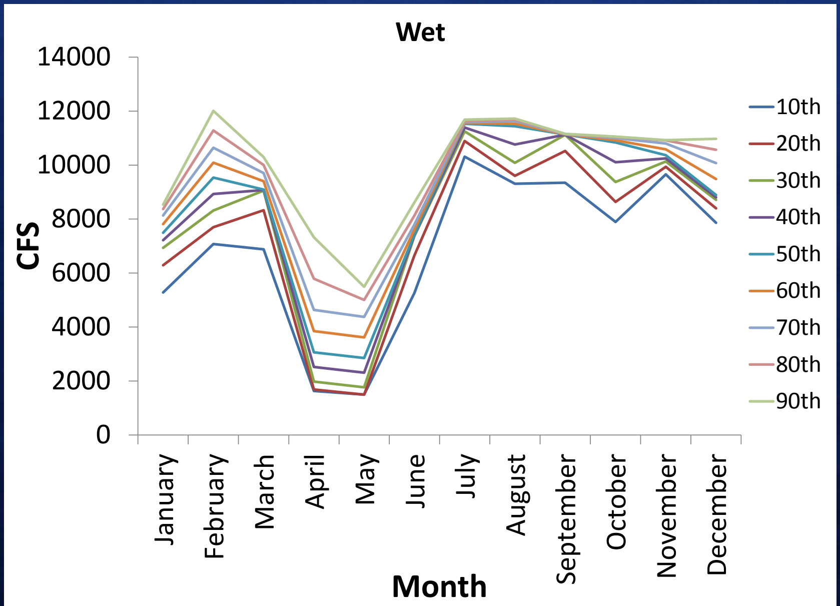


# Exports


Wet
CFS
14000
12000
10000
8000
6000
4000
2000
0
January
February
March
April
May
June
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Month
10th
20th
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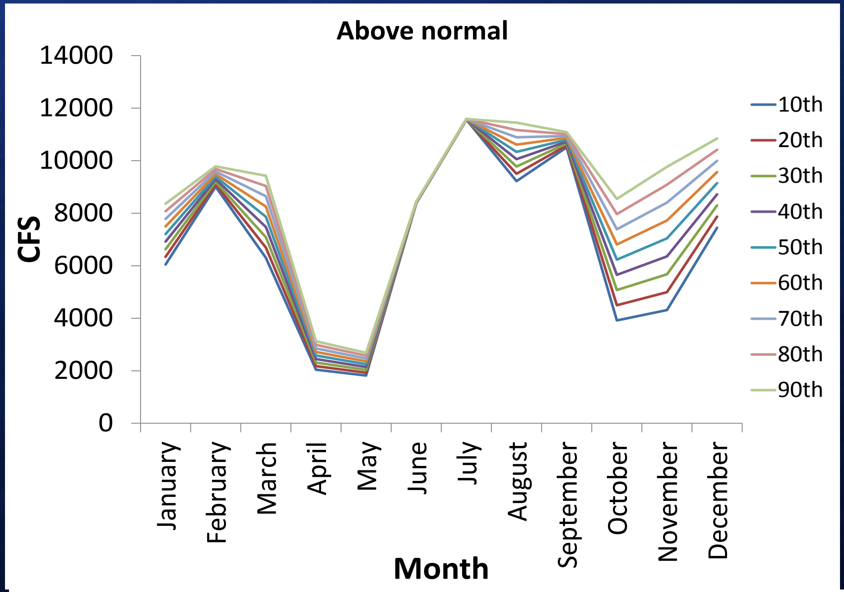
50th
60th
70th
80th
90th


Above normal
CFS
14000
12000
10000
8000
6000
4000
2000
0
January
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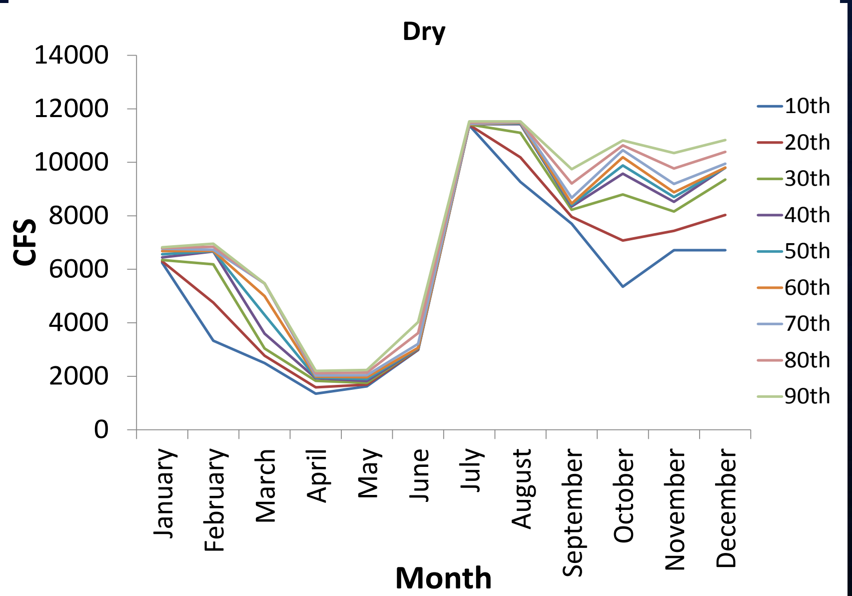
Dry
CFS
14000
12000
10000
8000
6000
4000
2000
0
January
February
March
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November
December
Month
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60th
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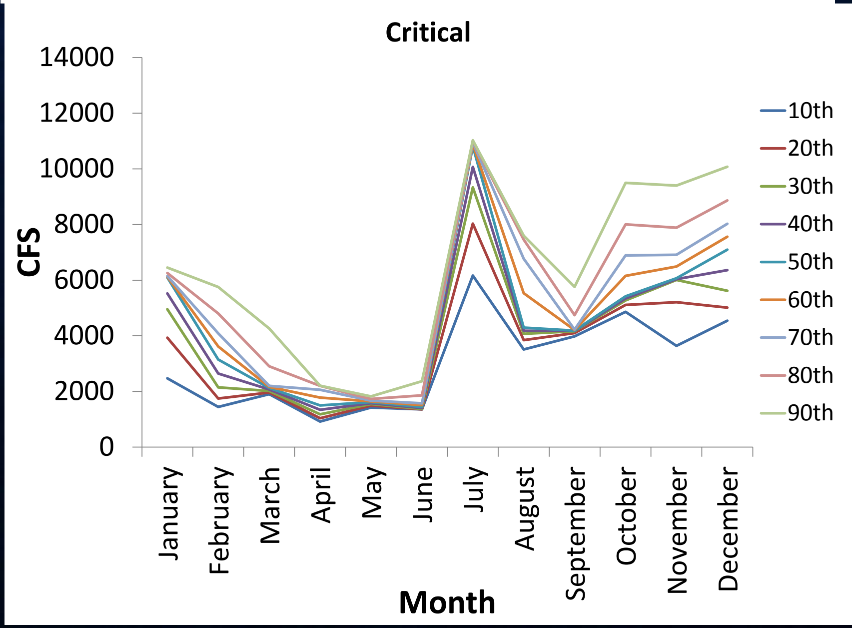
90th


Critical
CFS
14000
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10000
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2000
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January
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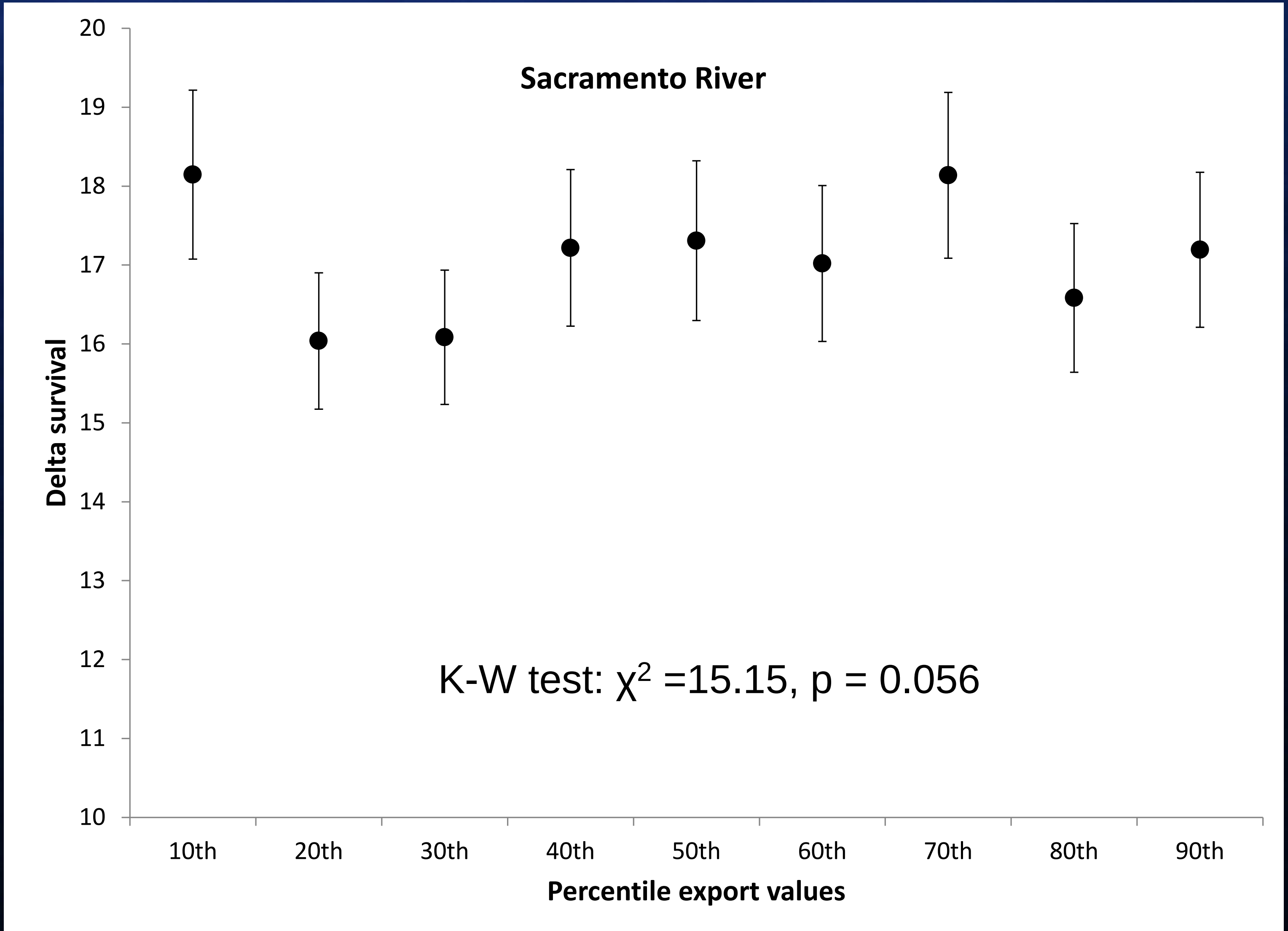
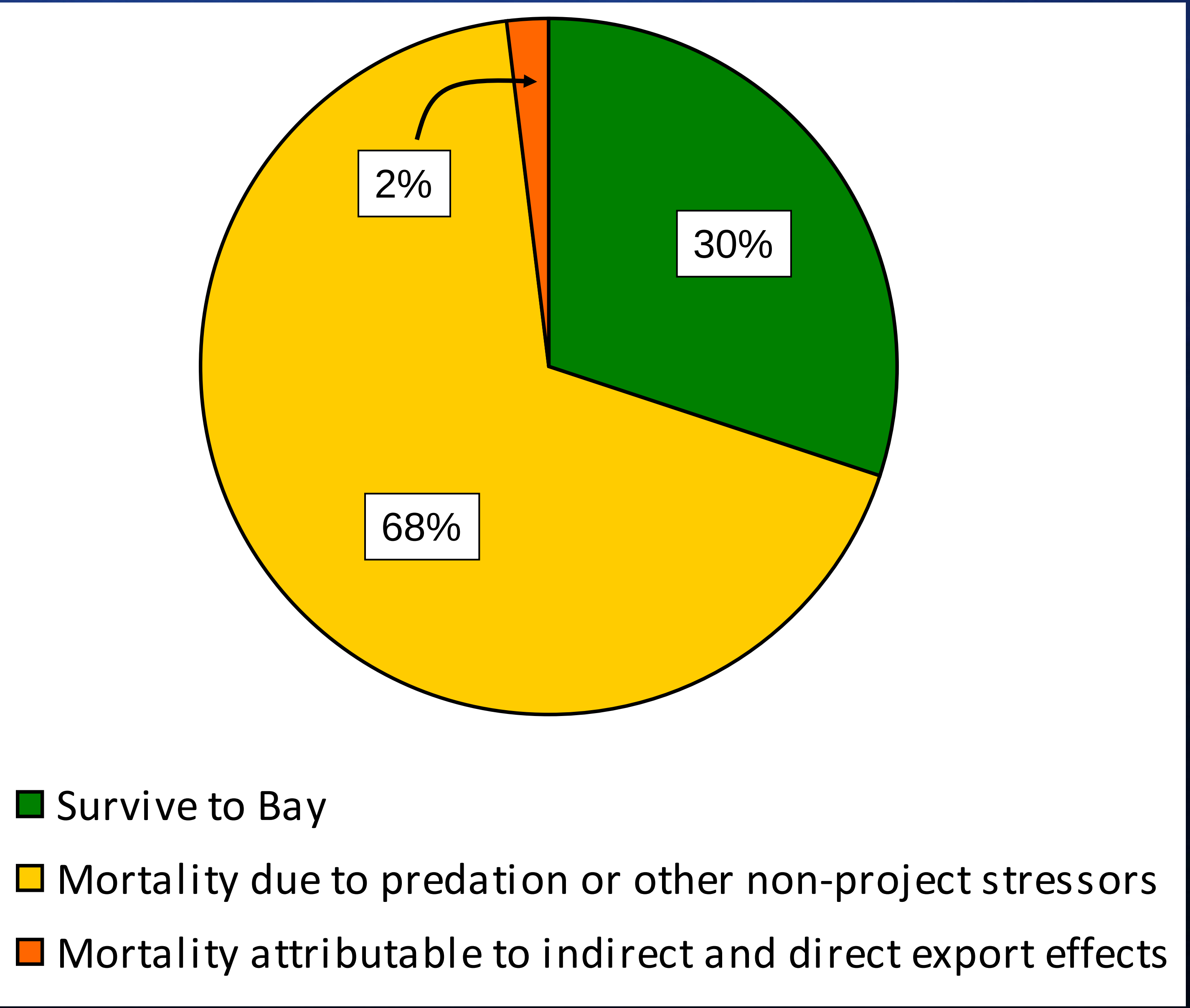
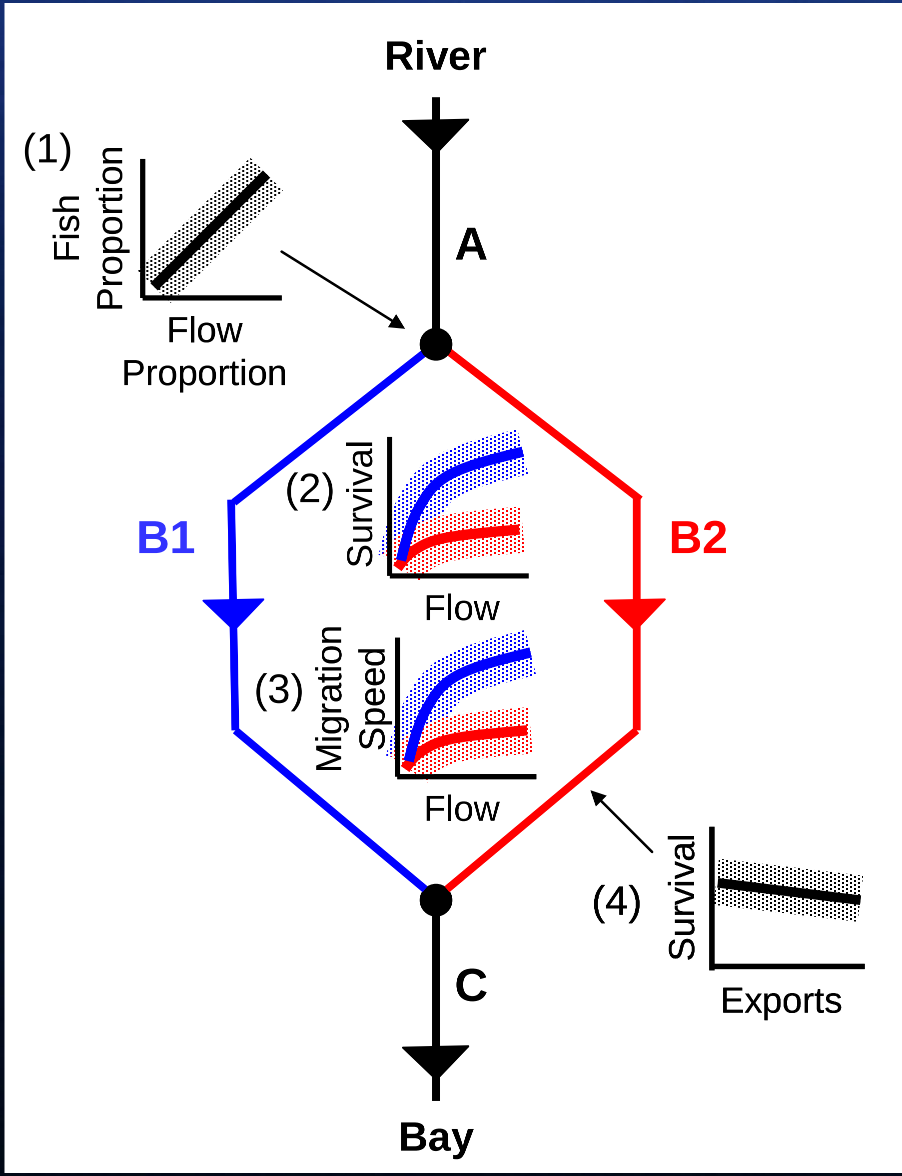
# Export Results (Sacramento River)



# Sensitivity Analysis: Delta Survival

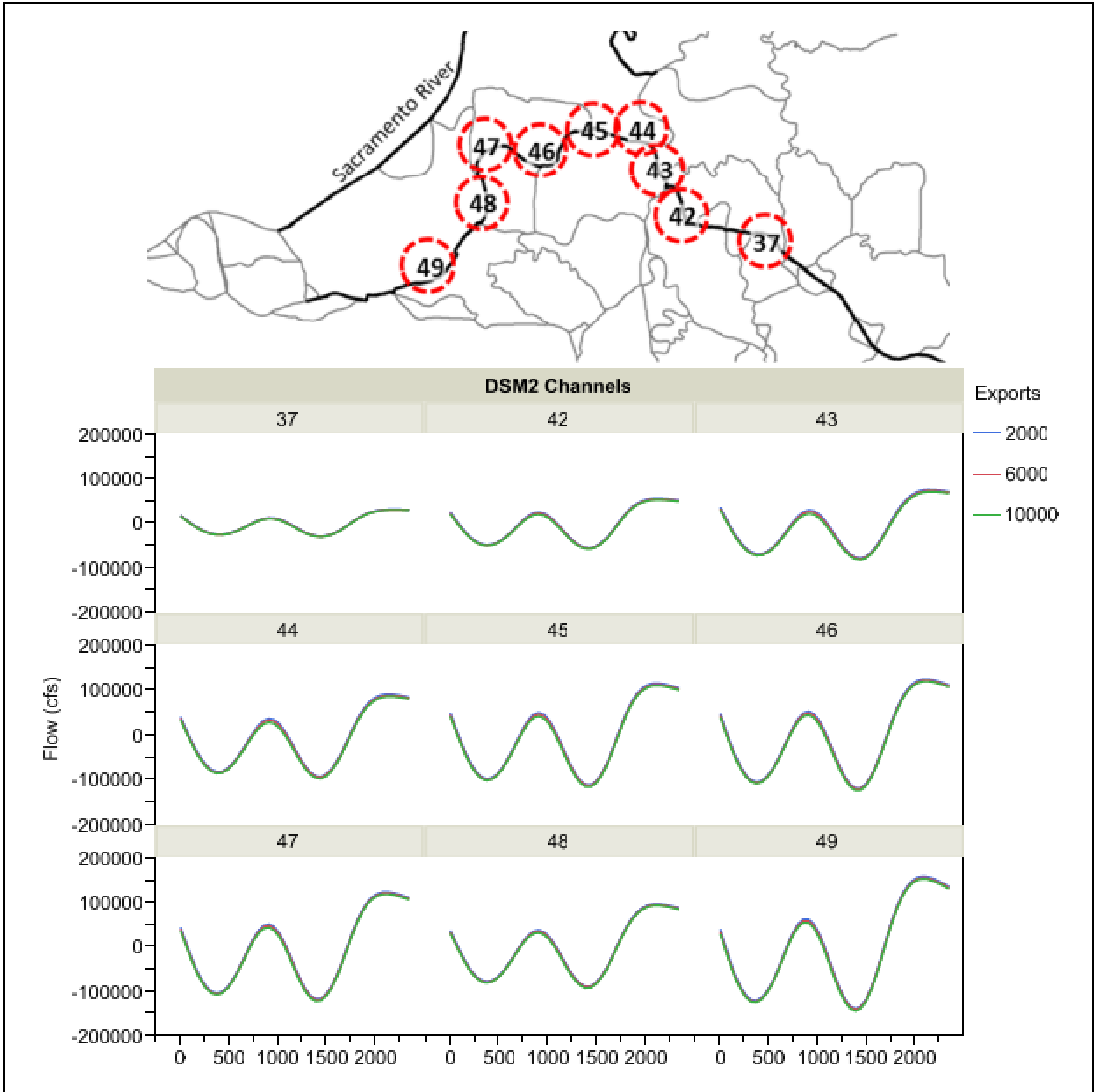


# DPM Conceptual Model




Survival
Migration Speed
Migration Route

~ f( Inflows, Exports, Barriers )



Sacramento River
47
46
45
44
43
48
42
37
49
DSM2 Channels
37
42
43
44
45
46
47
48
49
Exports
2000
6000
10000
Flow (cfs)
200000
100000
0
-100000
-200000
0
500
1000
1500
2000