Survival of Juvenile Chinook Salmon Migrating through the Delta

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Overview

1) Summary of acoustic tag studies
   - Survival through Delta
   - Compare migration routes

2) How river flow affects survival
   - Distribution among routes
   - Survival within routes

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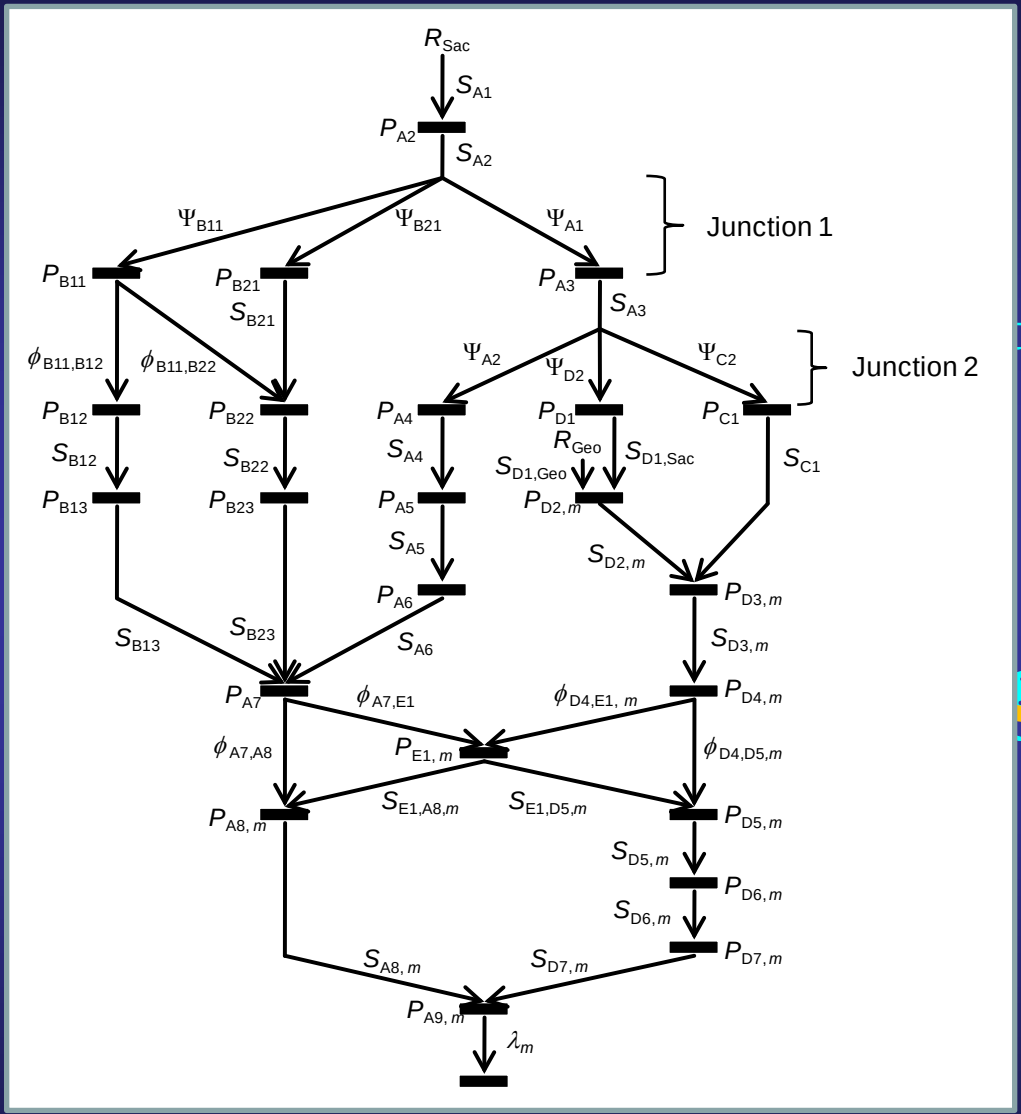
Study Details

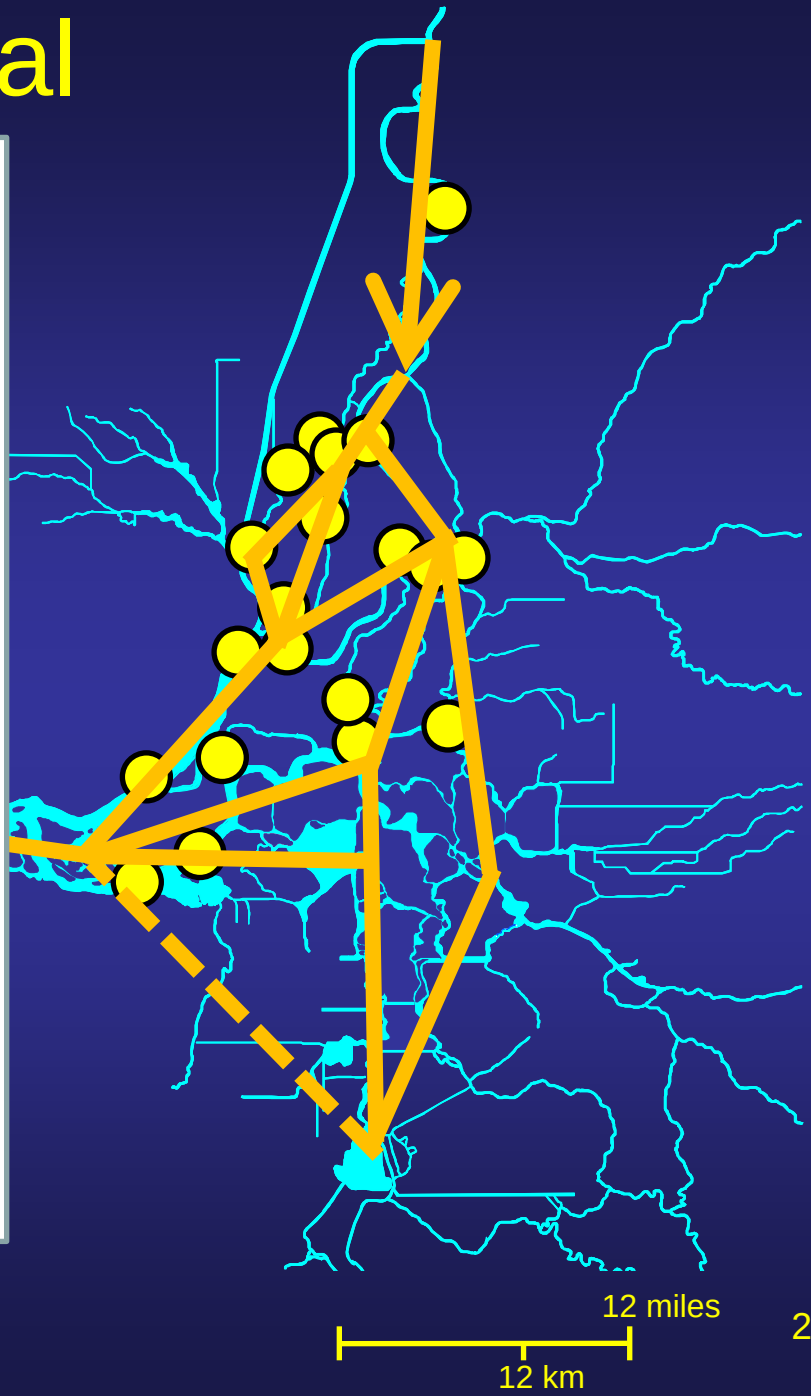
- Study population
  - Late-fall Chinook from Coleman NFH
  - Tag < 5% of body weight
  - > 140 mm

- December - Delta Cross Channel OPEN
- January - Delta Cross Channel CLOSED

Sample Size
2007 – 144
2008 – 419
2009 – 584

Estimating Survival





Perry et al. 2010. N. Am. J. Fish. Manag. 30: 142-156

Delta Survival Defined

USGS

Four Migration Routes

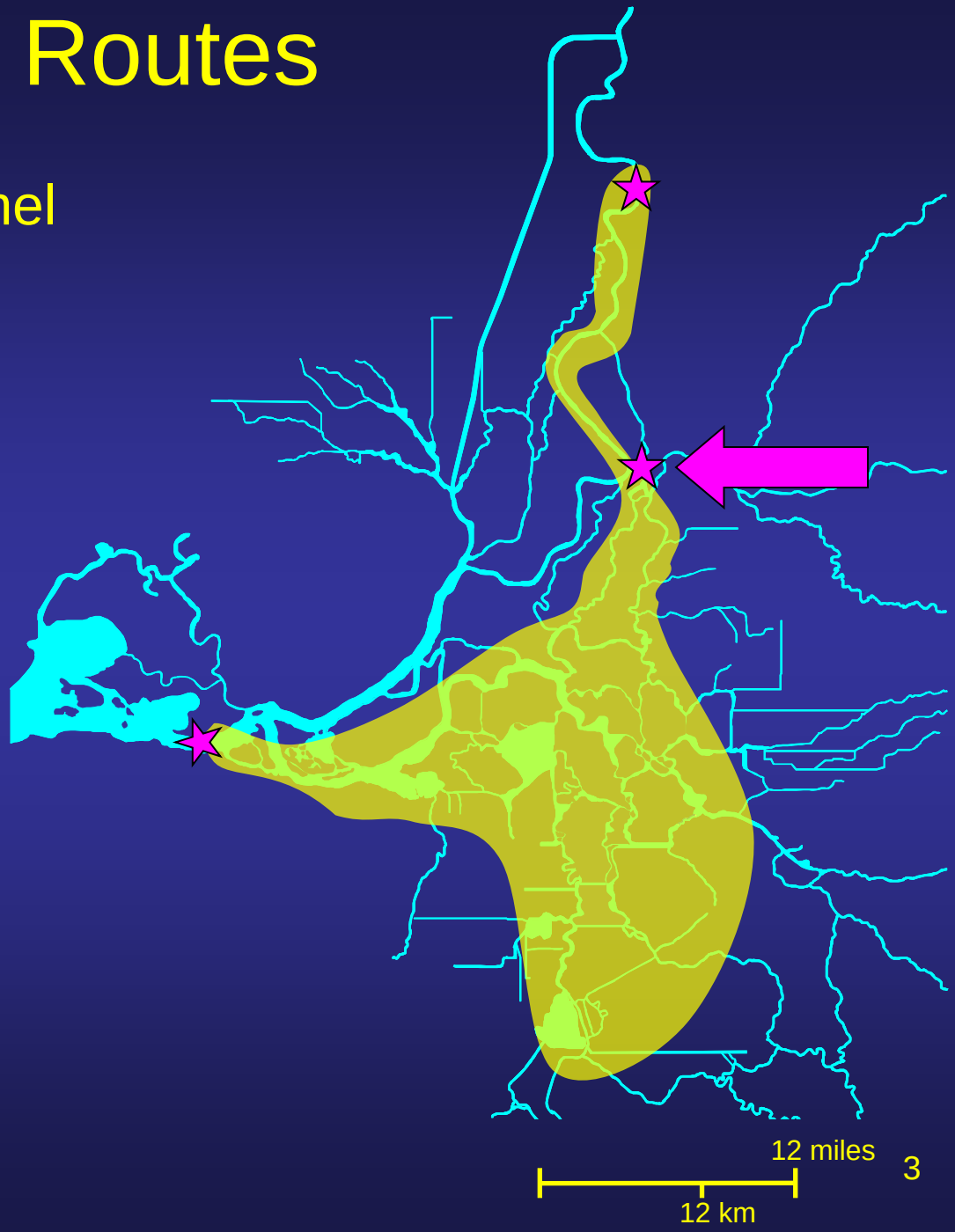
Mainstem Sacramento River

Four Migration Routes

Georgiana Slough

Four Migration Routes

The Delta Cross Channel



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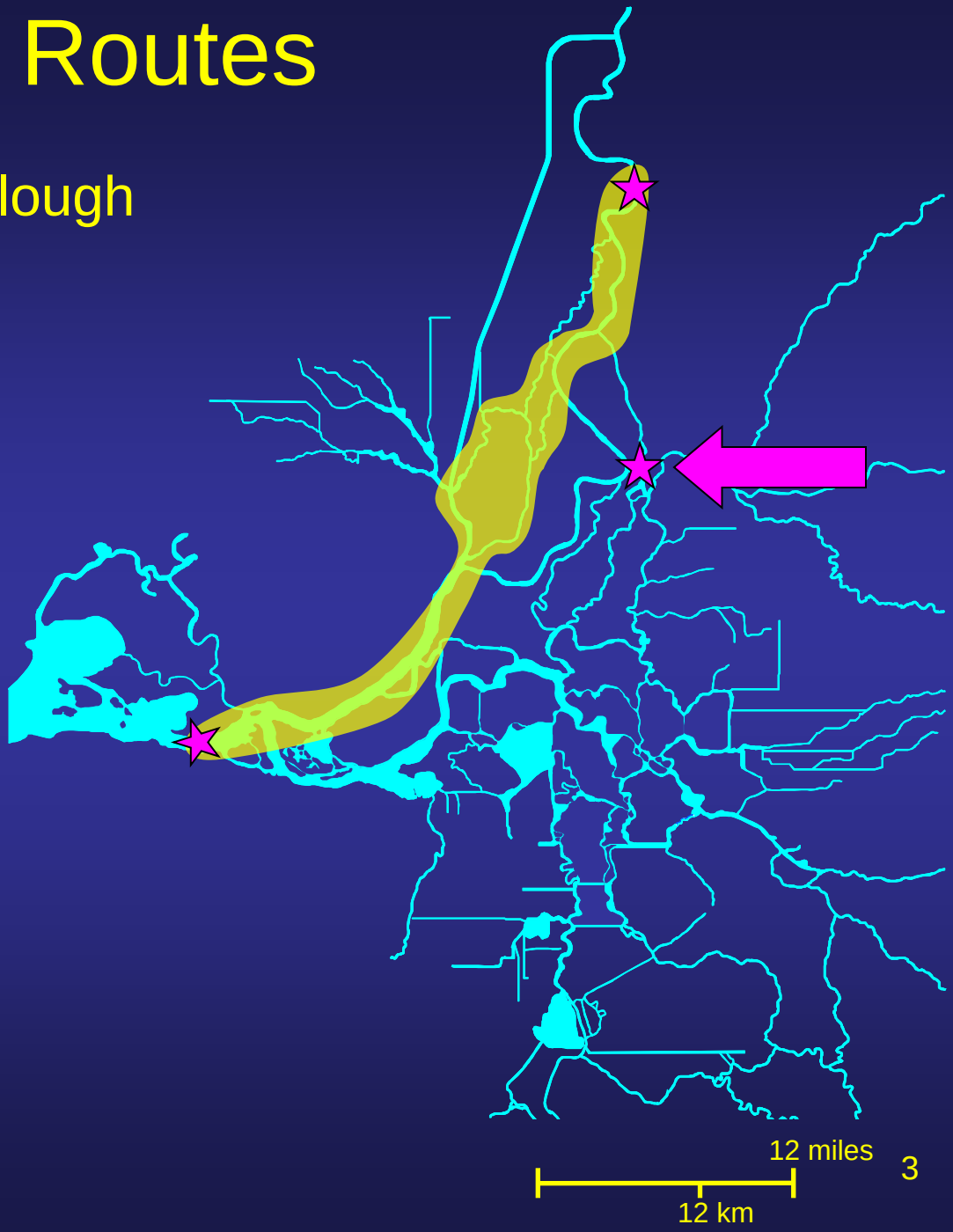
Four Migration Routes

Sutter and Steamboat slough

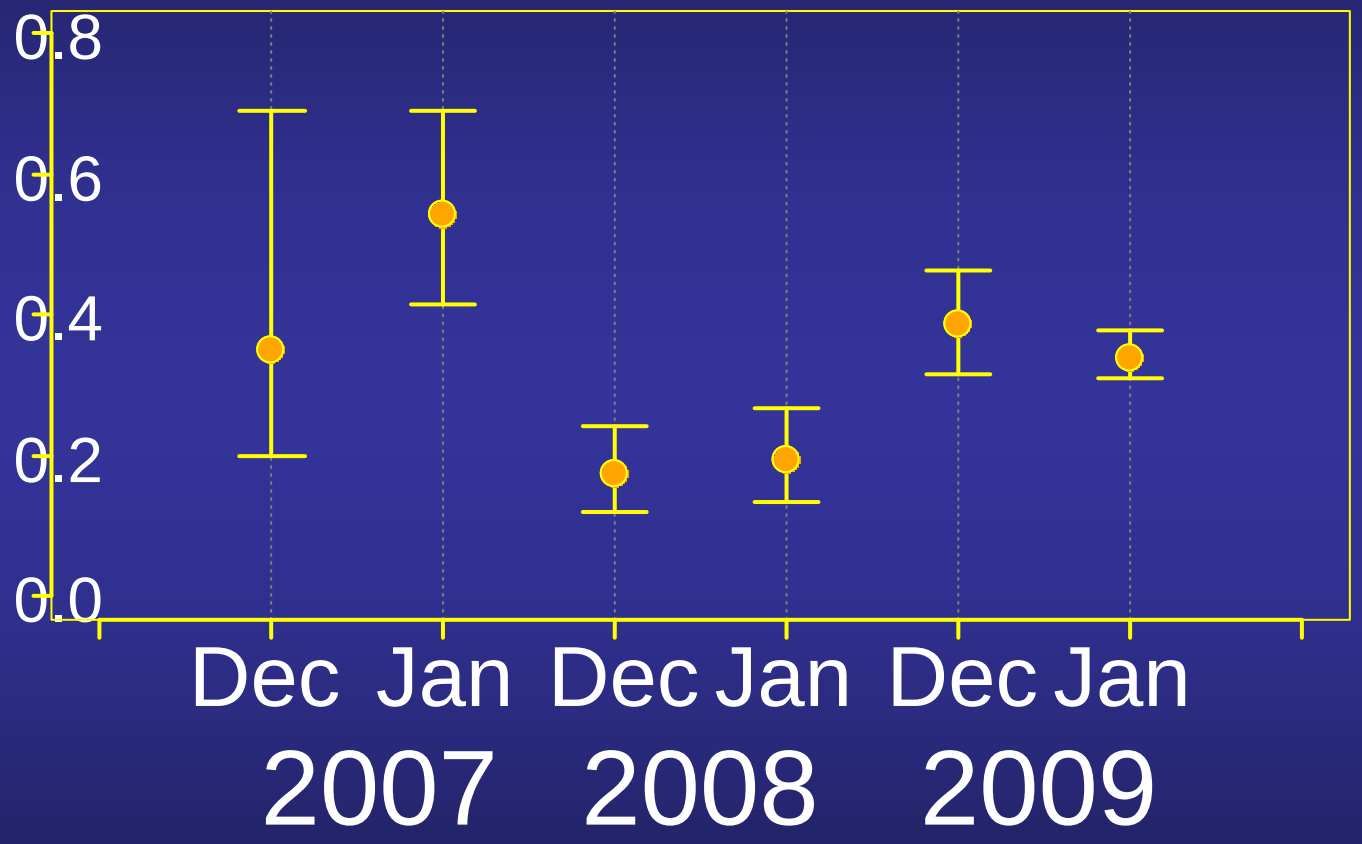


Four Migration Routes

Mainstem Sacramento River

Overall survival through Delta

Delta Survival



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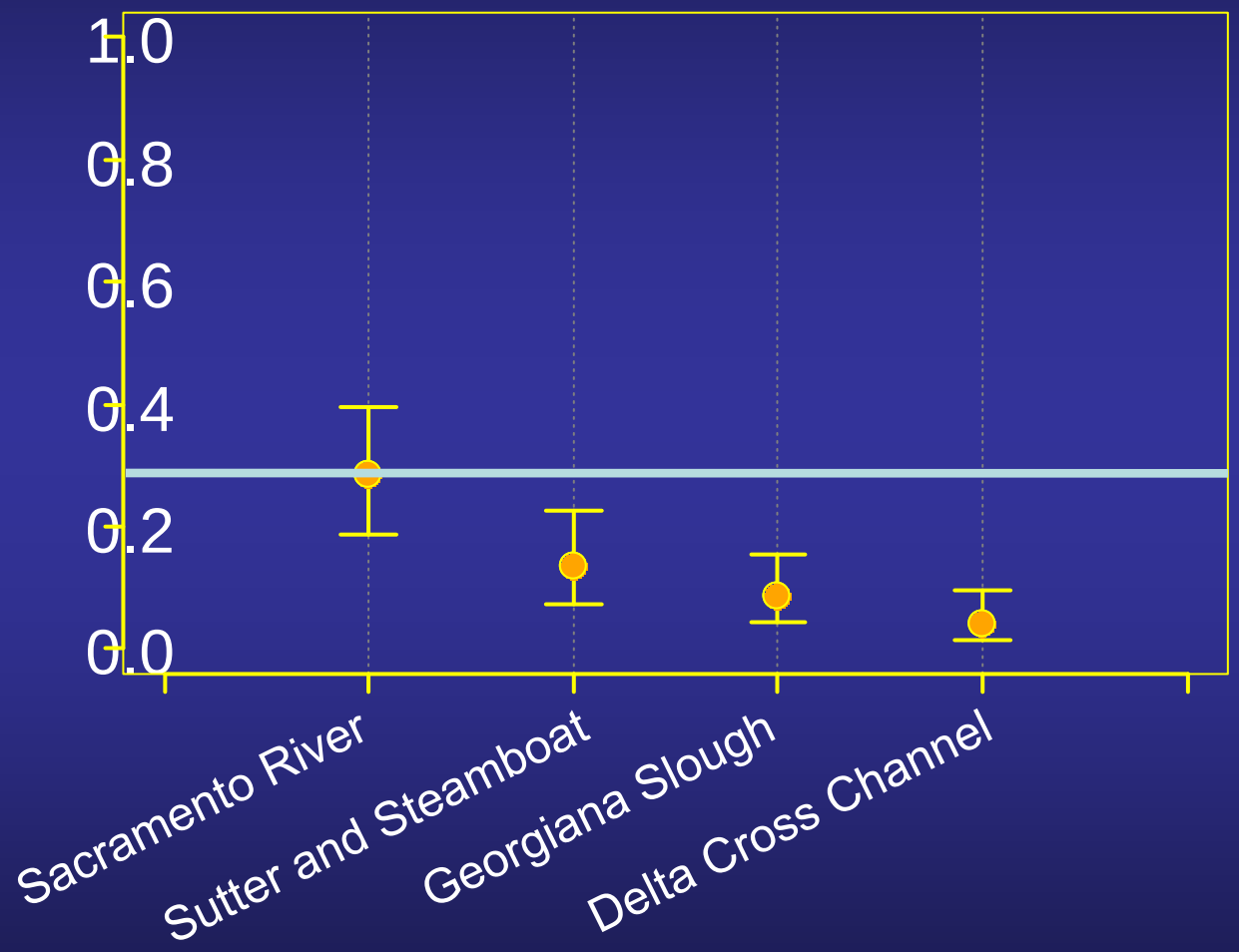
Route-specific survival December 2007

Survival probability



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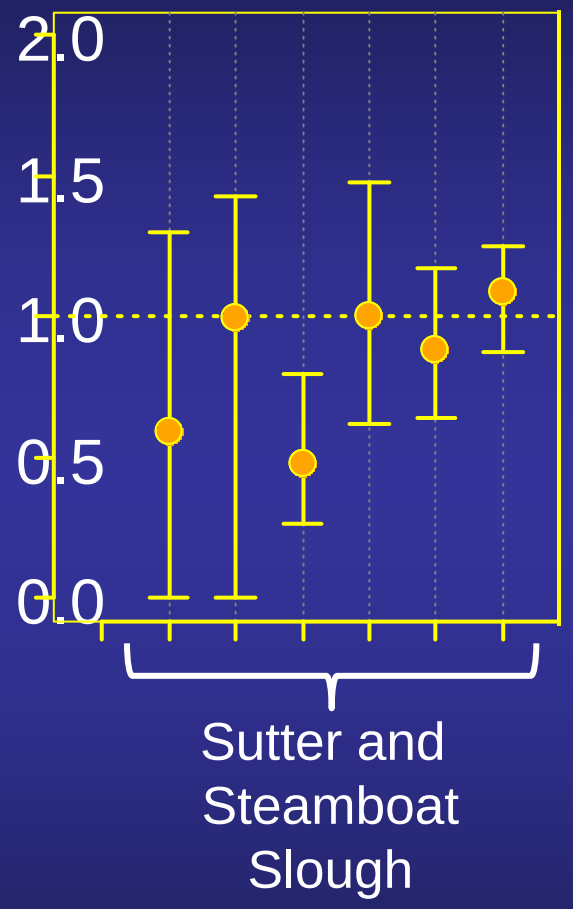
Is Sac R. Survival > other routes?

$$\frac{S_{\text{route}}}{S_{\text{Sac}}} < 1 \qquad S_{\text{route}} < S_{\text{sac}}$$

USGS

Survival Relative to Sacramento R.

$$\frac{S_{route}}{S_{Sac}}$$



Interior Delta

Summary of Survival Estimates

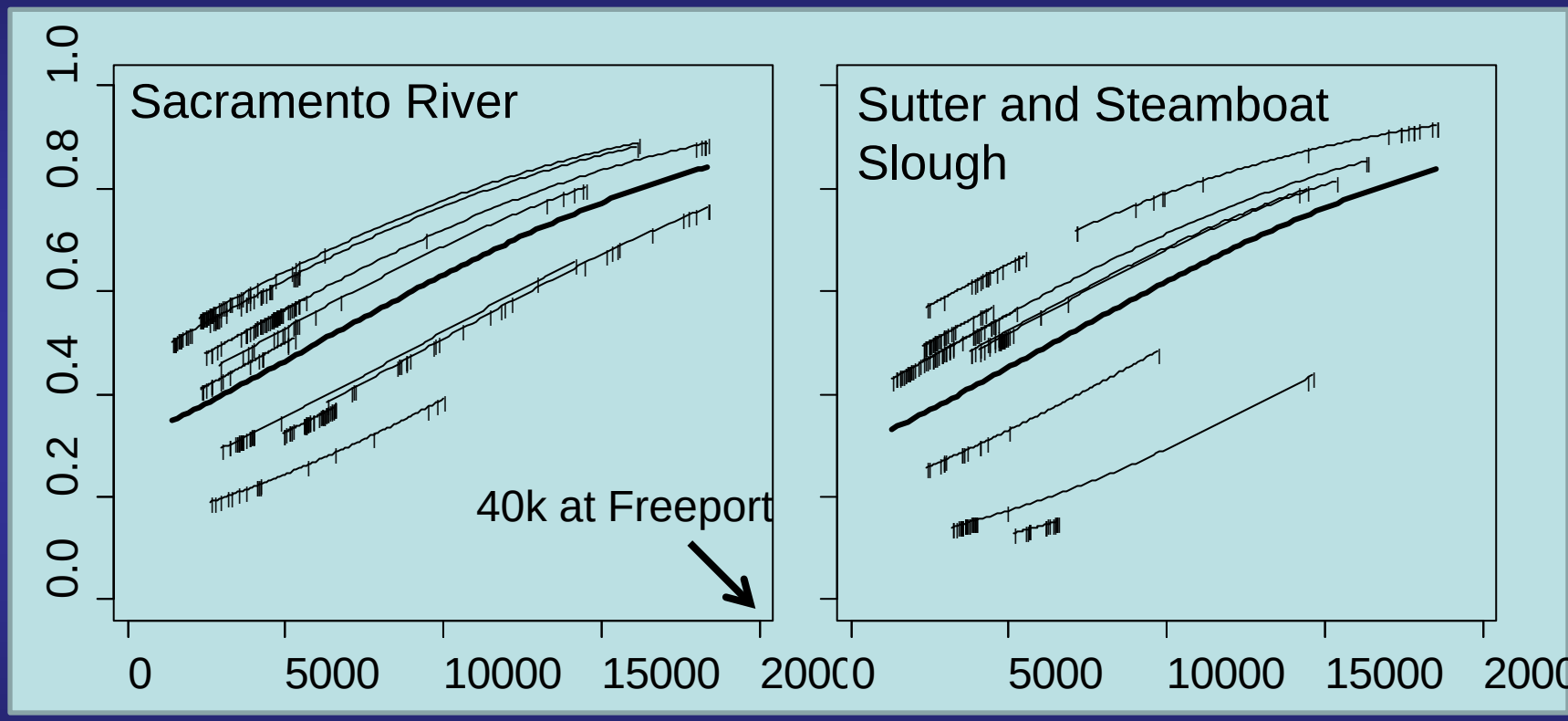
- Survival in Sacramento ≥ all other routes
  - Sutter/Steamboat sometimes lower
  - Interior Delta always lower

- S_{Delta} varied among years

- What factors drive variability in survival?
  - Migration routing
  - Discharge

USGS

Effects of River Flow



Discharge (ft^3/s)
Sacramento River below Georgiana

Perry 2010. PhD Dissertation. University of Washington

Components of population survival

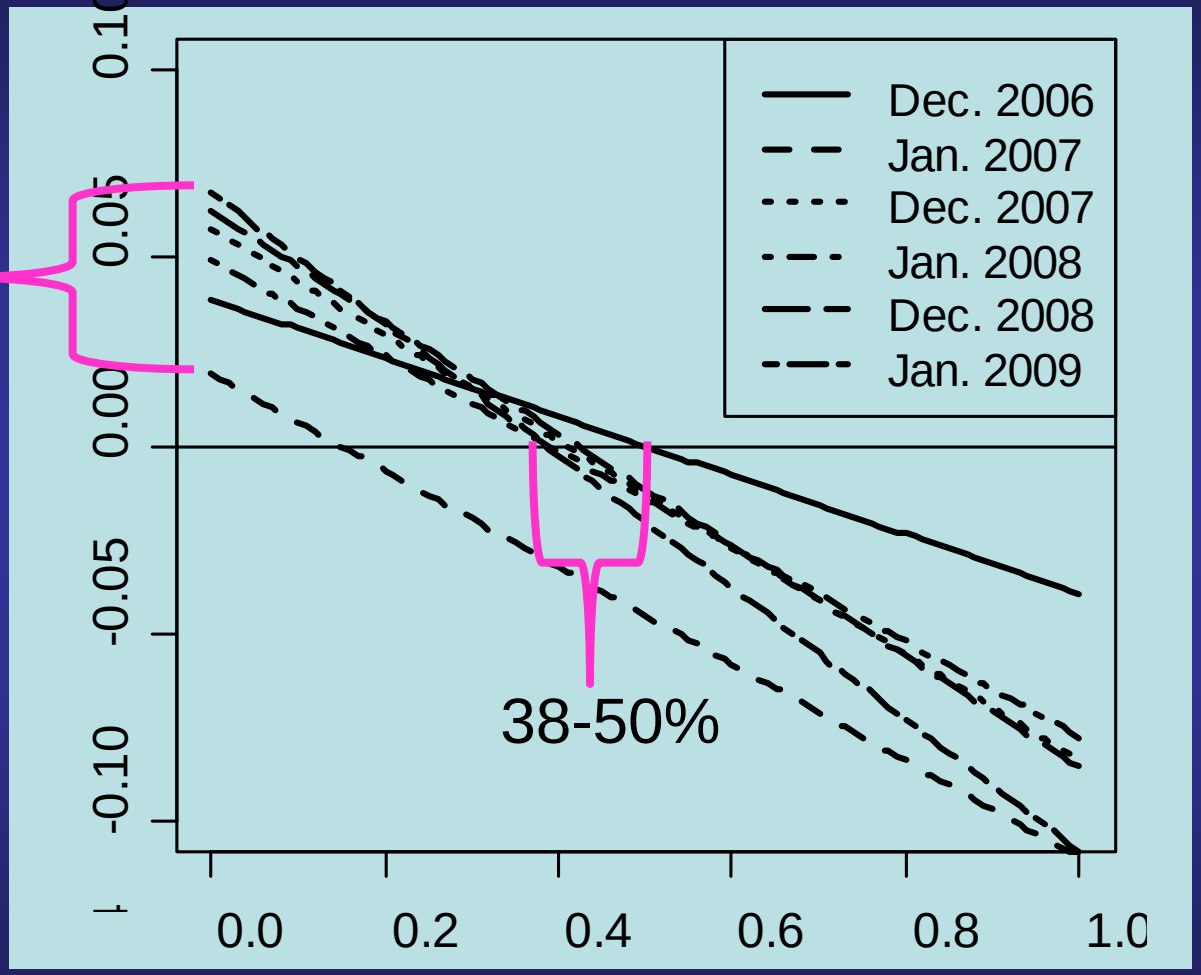
Population Survival =

$$\sum_{\text{routes}} \text{Survival in route} \times \text{\% of Fish in route}$$

Effect of Routing on Survival

2-7 percentage points

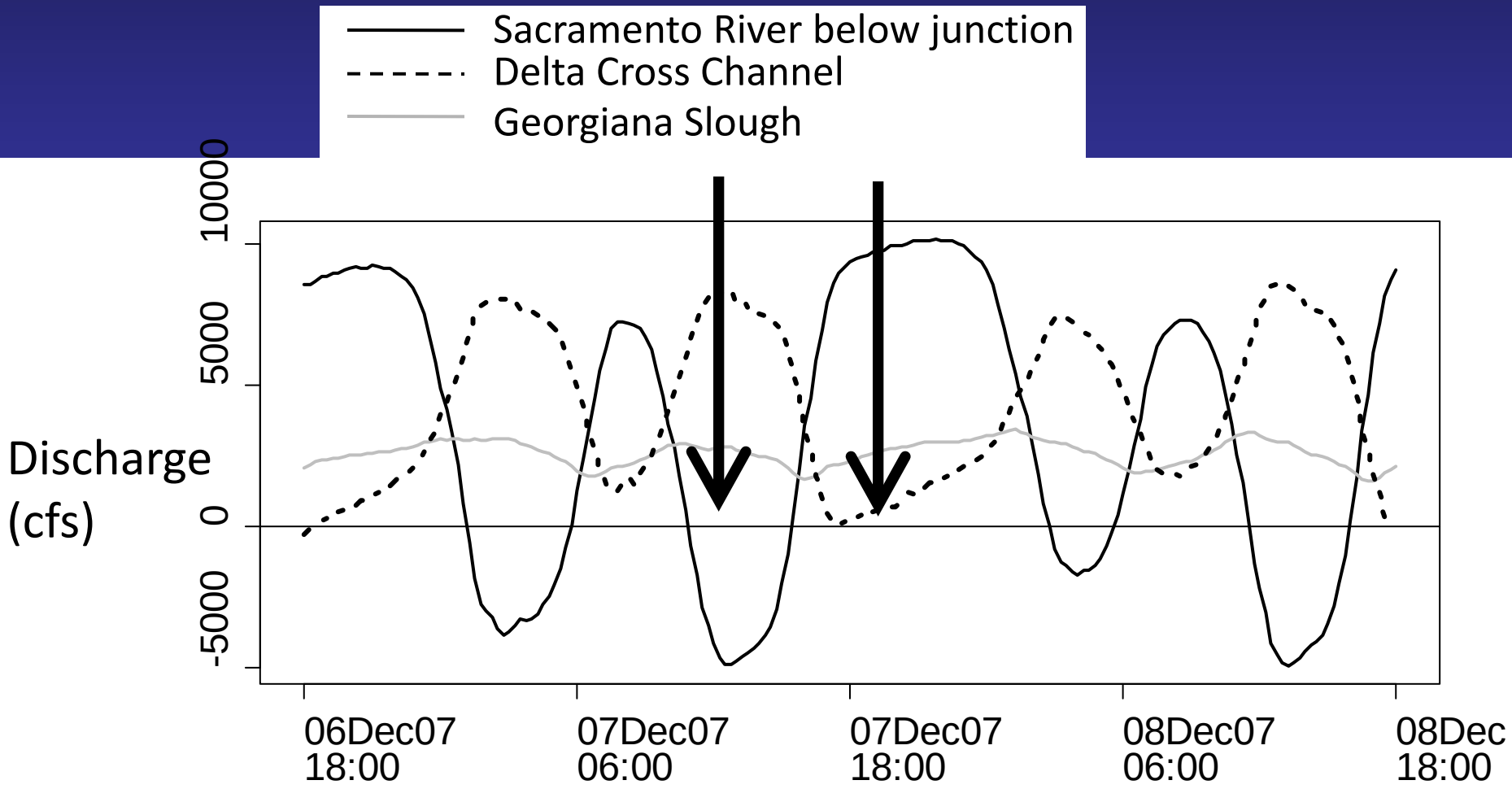
Absolute change in S_{Delta}



Interior Delta entrainment probability

Perry et al. 2013. Env. Biol. Fish. 96:381–392

How does variation in discharge affect probability of entering each channel?



Analysis Methods

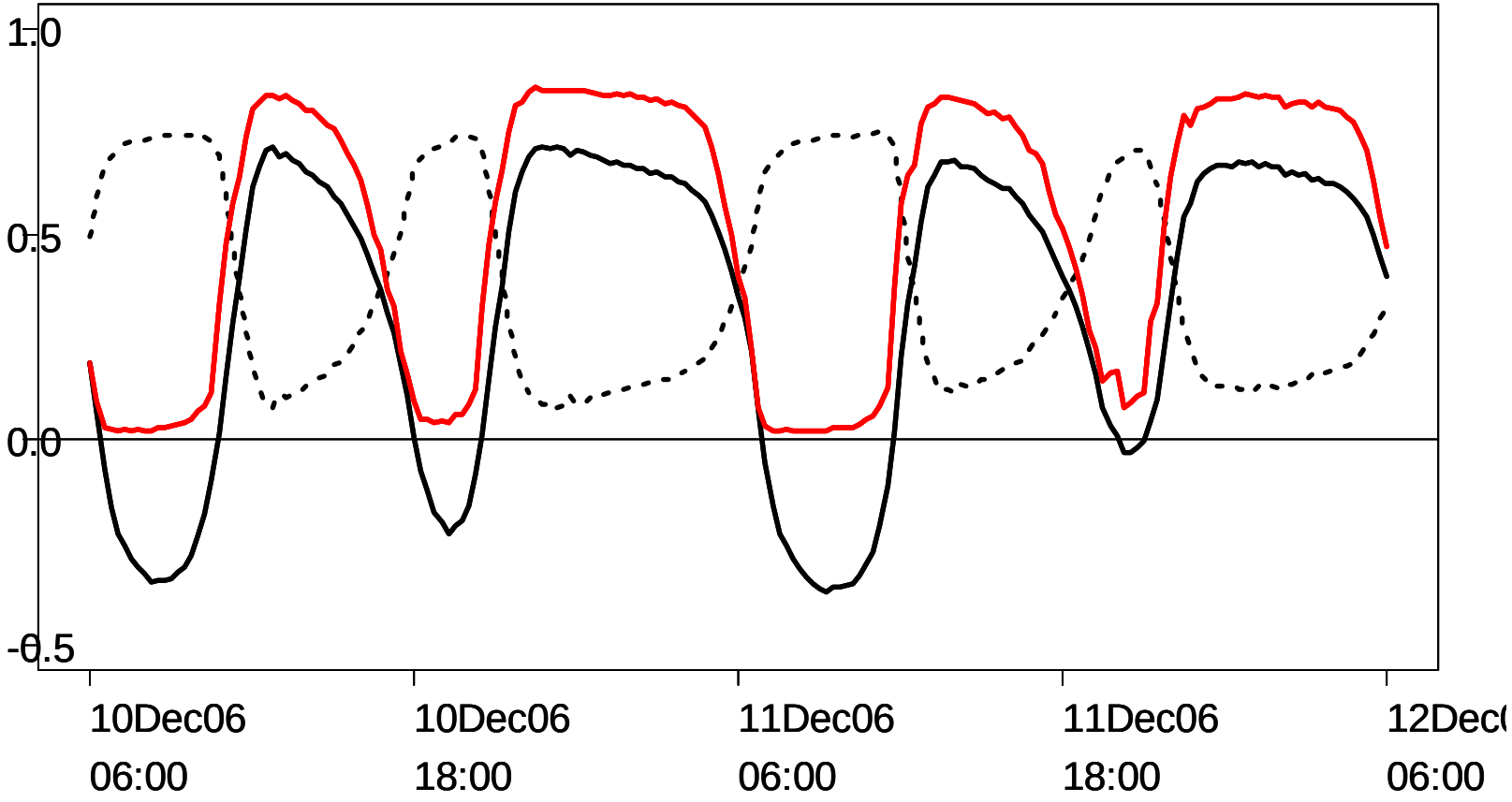
- Multinomial regression model
  - similar to logistic regression
  - 3 categories, not 2
- Entrainment Probabilities
  - Geo, DCC
  - Pr(Sac) = 1 – Pr(Geo) – Pr(DCC)
- Discharge (Q) variables
  - Q_{Sac}
  - Q_{Geo}
  - ΔQ_{Sac} < 0 = ebb to flood transition
  - River flowing upstream? 1 = yes

Variables in best-fit model

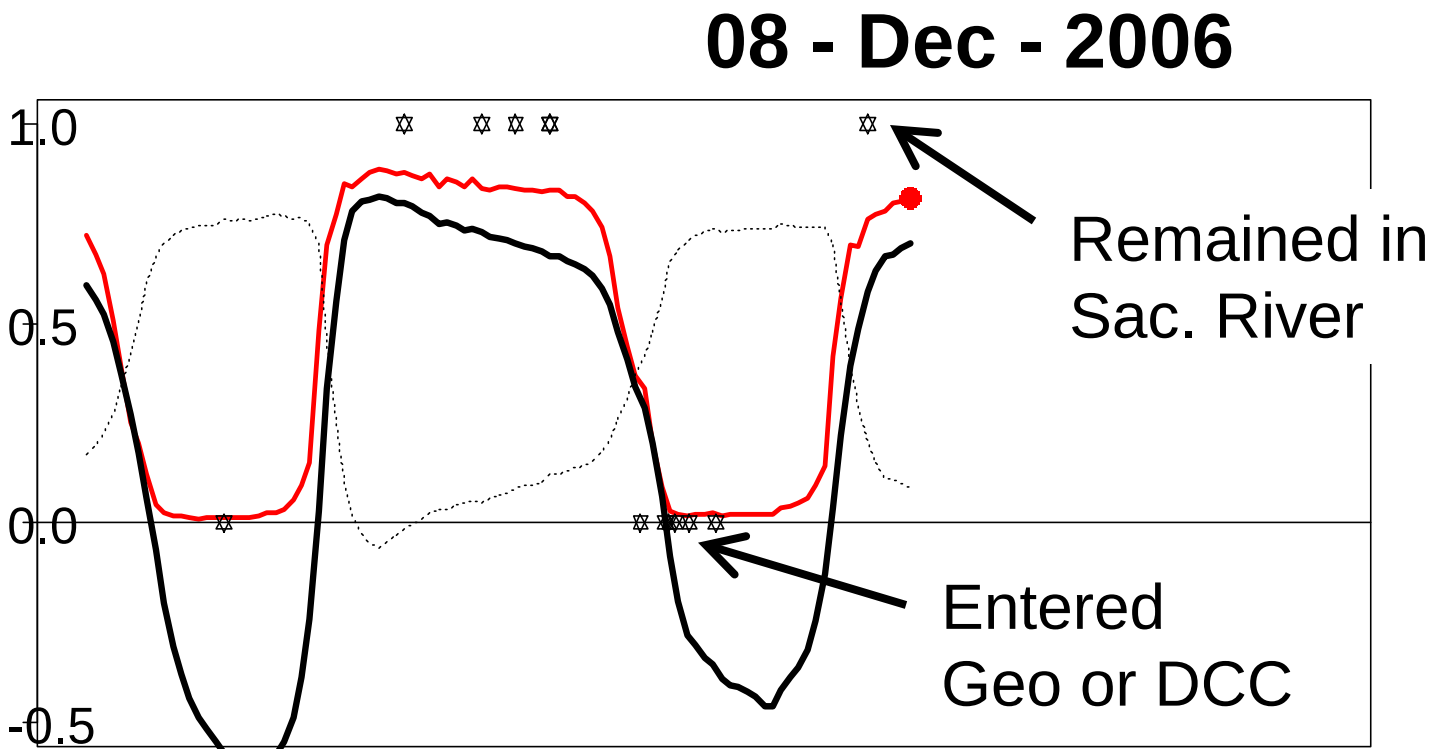
Route	Variable	Effect
Georgiana Slough	Q_{Geo}	+
	Q_{Sac}	–
	Upstream flow	+
Delta Cross Channel	Q_{Sac}	–
	ΔQ_{Sac}	–

Perry 2010. PhD Dissertation. University of Washington

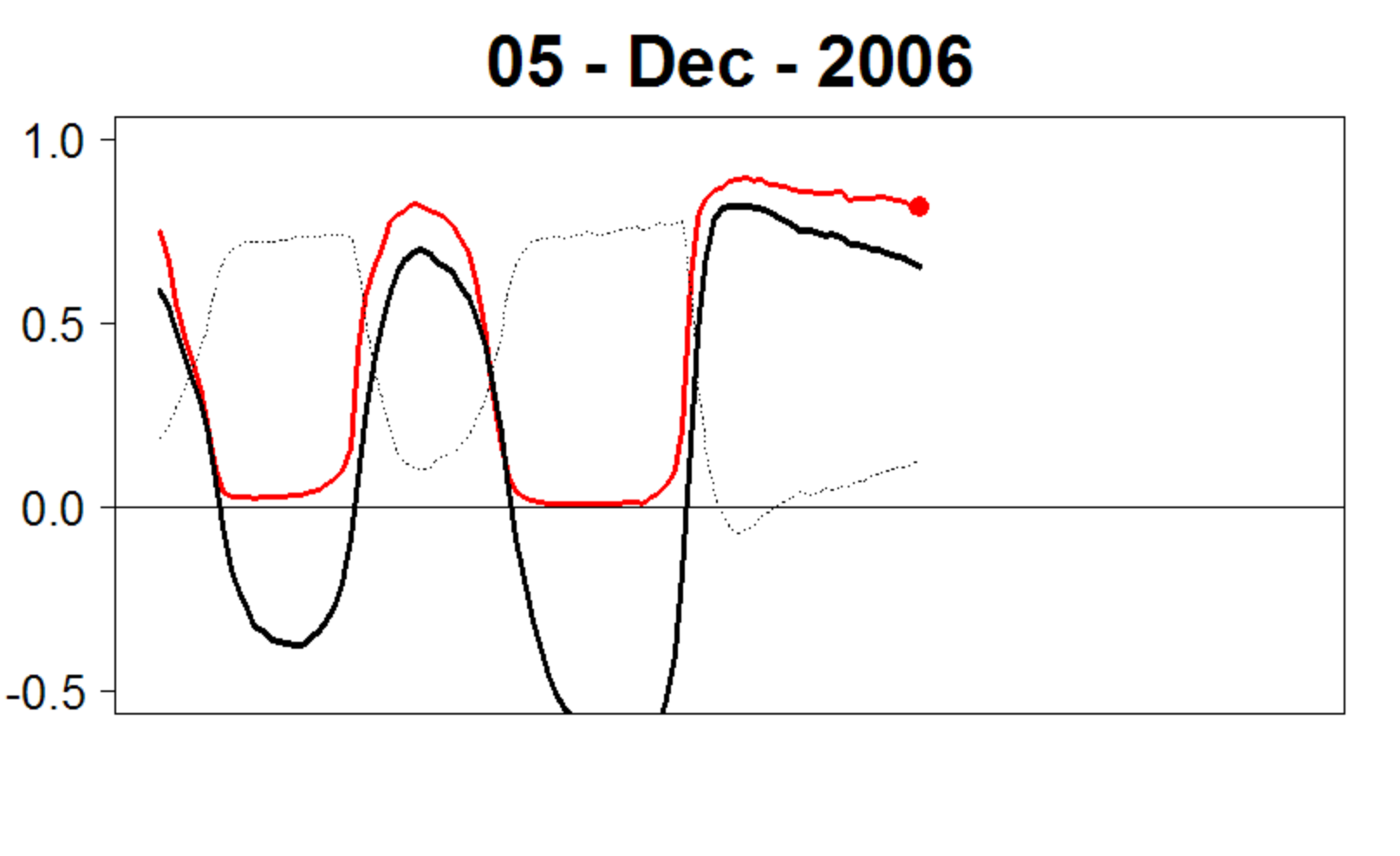
Model Output
Probability of remaining in Sac. R.



Animation against data Sacramento River



Animation against data
Sacramento River



Daily entrainment

Integrating across time

- Predict probabilities at 15-min timescale

- Average probabilities over each day

Delta Cross Channel + Georgiana Slough

Effects of:

Delta Cross Channel

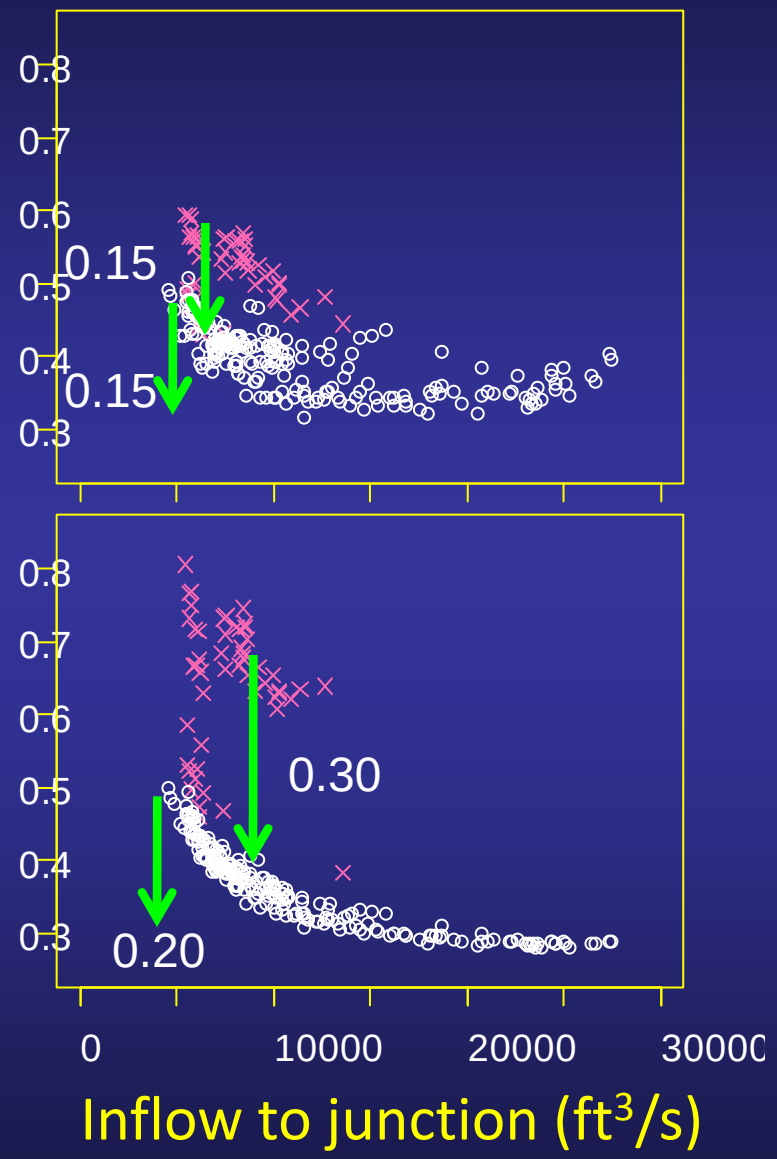
River inputs

Tides

Effects of River Flow and Gate Ops

Daily probability of entering interior Delta

Fraction of discharge entering interior Delta

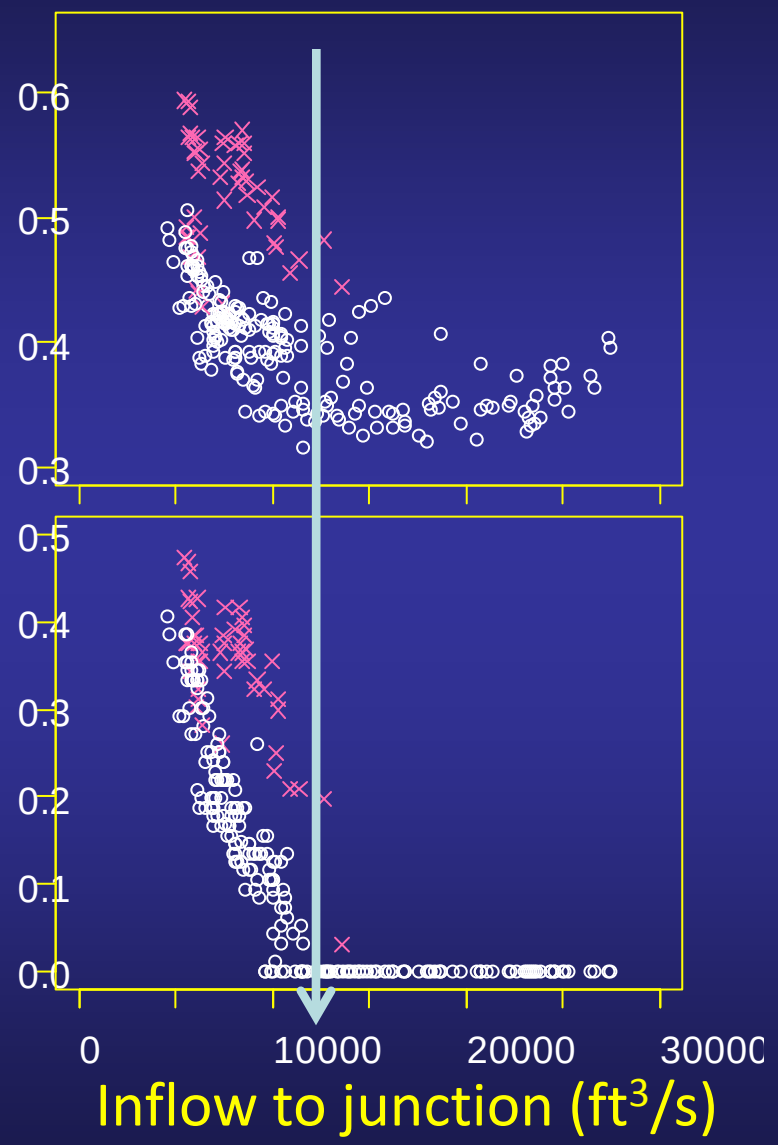


Perry 2010. PhD Dissertation. University of Washington

River Discharge Dampens Effect of Tides

Daily probability of entering interior Delta

Fraction of day with upstream flow



Perry 2010. PhD Dissertation. University of Washington

Conclusions

- Survival varies among routes

- Discharge affects:
  - migration routing
  - route-specific survival

- Compounding effects of reduced inflows
  - Increase proportion entering Interior Delta
  - Decrease survival in North Delta routes

USGS

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USGS
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