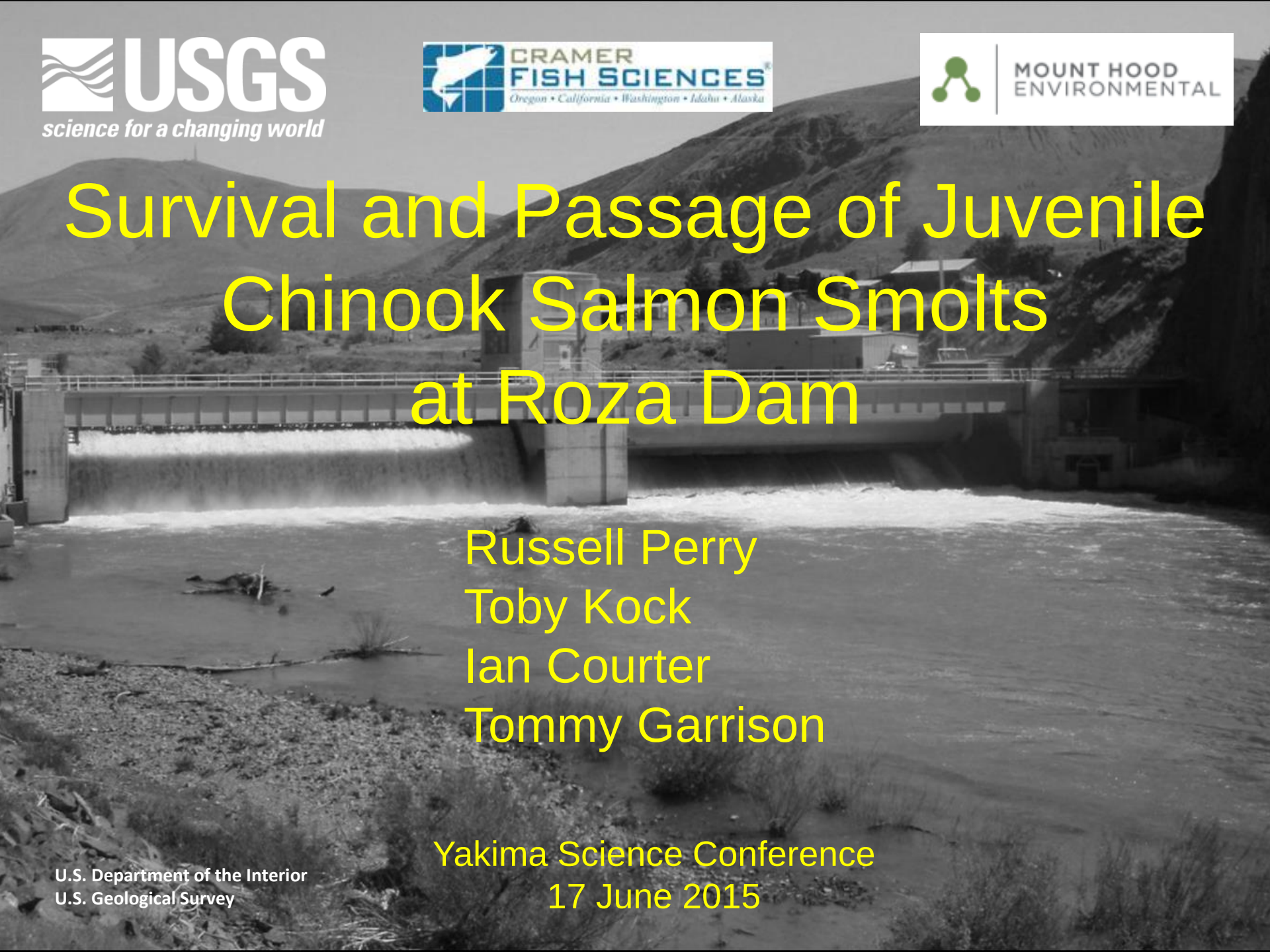


Survival and Passage of Juvenile Chinook Salmon Smolts at Roza Dam

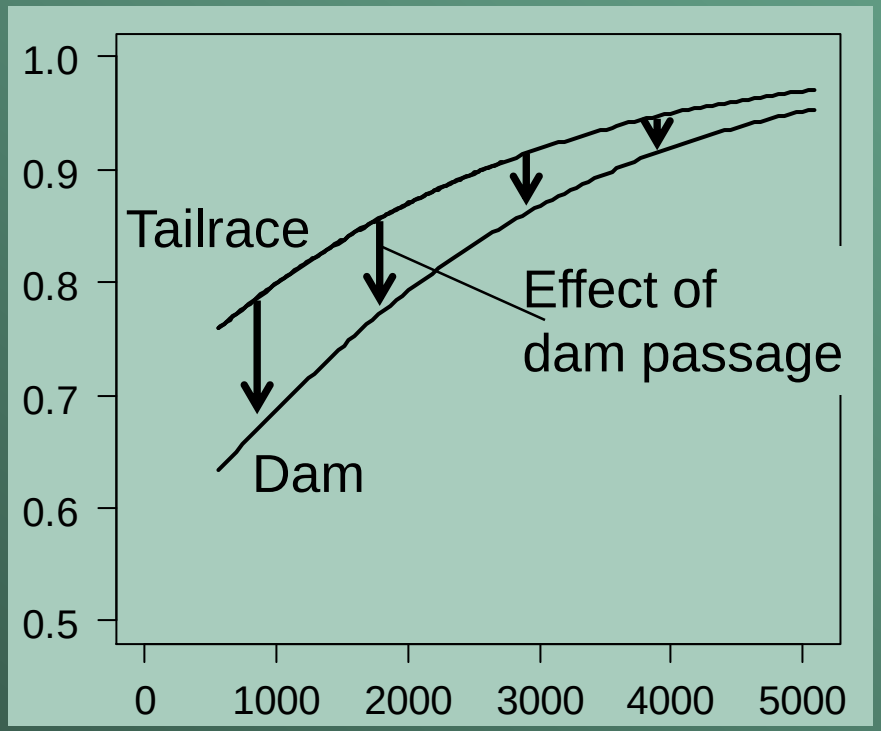
Russell Perry
Toby Kock
Ian Courter
Tommy Garrison

Yakima Science Conference
17 June 2015

U.S. Department of the Interior
U.S. Geological Survey

Quantifying Mortality due to Dam Passage

Survival probability



Roza Reach discharge (cfs)

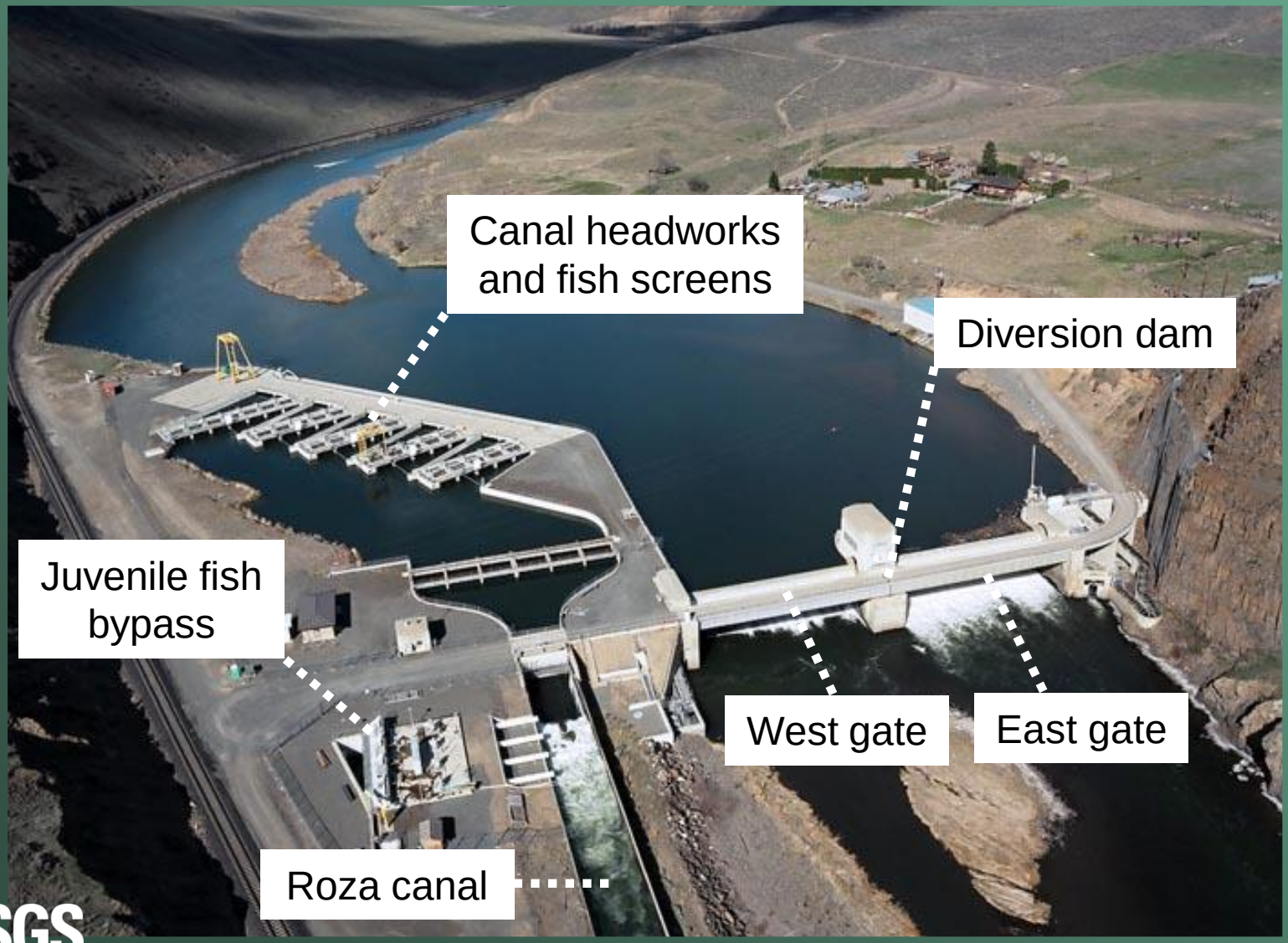
USGS

Overview

- Focus on passage routes at Roza Dam
  - Bypass
  - East Gate
  - West Gate
- Route-specific survival
  - Does effect of discharge differ among routes?
  - Is survival lower for some routes?
- Effect of dam operations on passage
  - Proportion of fish using each route
- Effect of passage on total survival

USGS

Passage routes at Roza Dam



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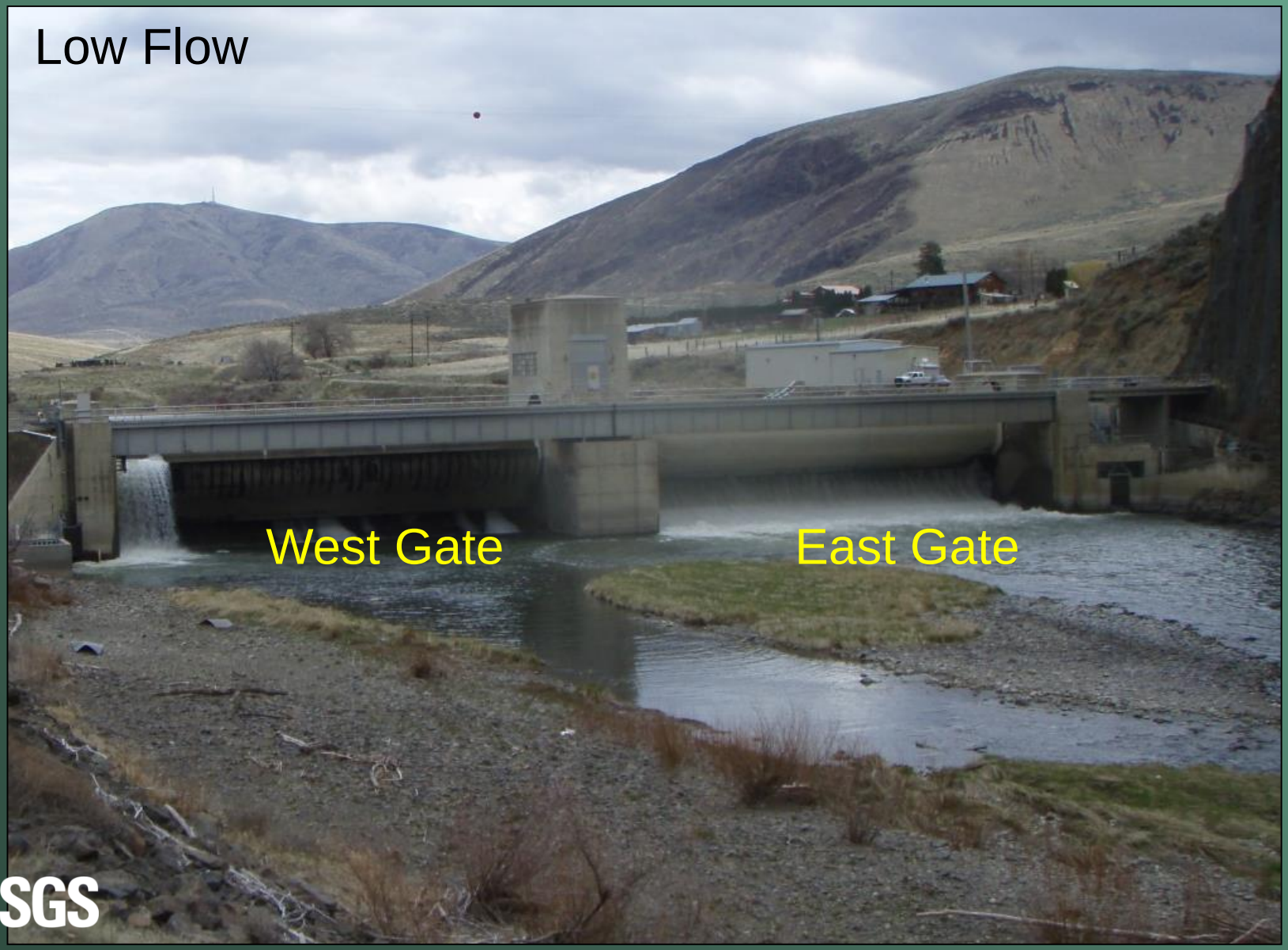
East Gate and West Gate

USGS

East Gate and West Gate



USGS

Route-Specific Survival Methods

- 2013 & 2014 data only

- CJS survival model
  - Only fish detected within passage routes

- Sample sizes
  - West Gate = 338
  - East Gate = 198
  - Bypass = 124

USGS

Model Selection

- Individual covariates
  - Passage route
  - Roza Reach discharge on day of passage

- Alternative models
  1) Passage route only
  2) Discharge only
  3) Route * Discharge

- Used AICc model selection criterion

USGS

Model Selection Results

Model	Number of parameters	AICc	ΔAICc
Route * Discharge	22	1411.5	**0**
Passage route	19	1421.7	**10.3**
Discharge	18	1423.8	**12.3**

- About AICc:
  - Lower is better fitting model
  - ΔAICc > ~2-4 indicates support for lowest AICc model

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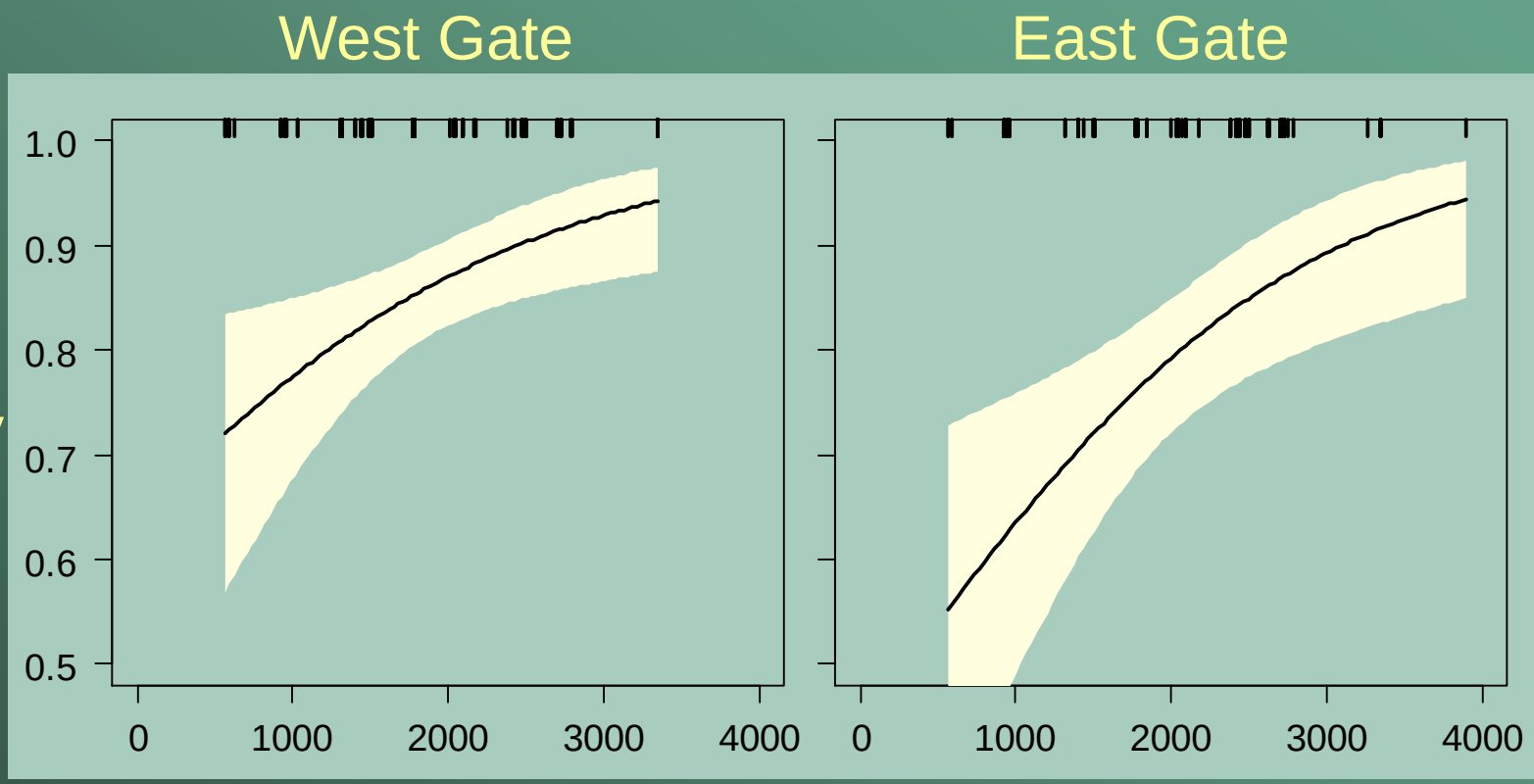
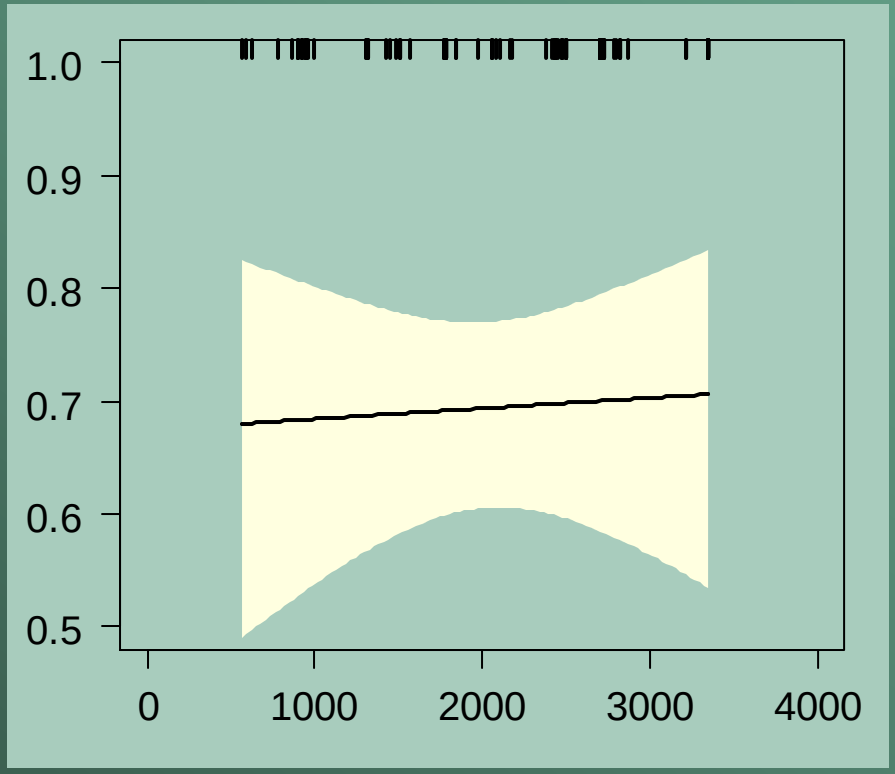
East and West Gate Survival



Bypass Survival

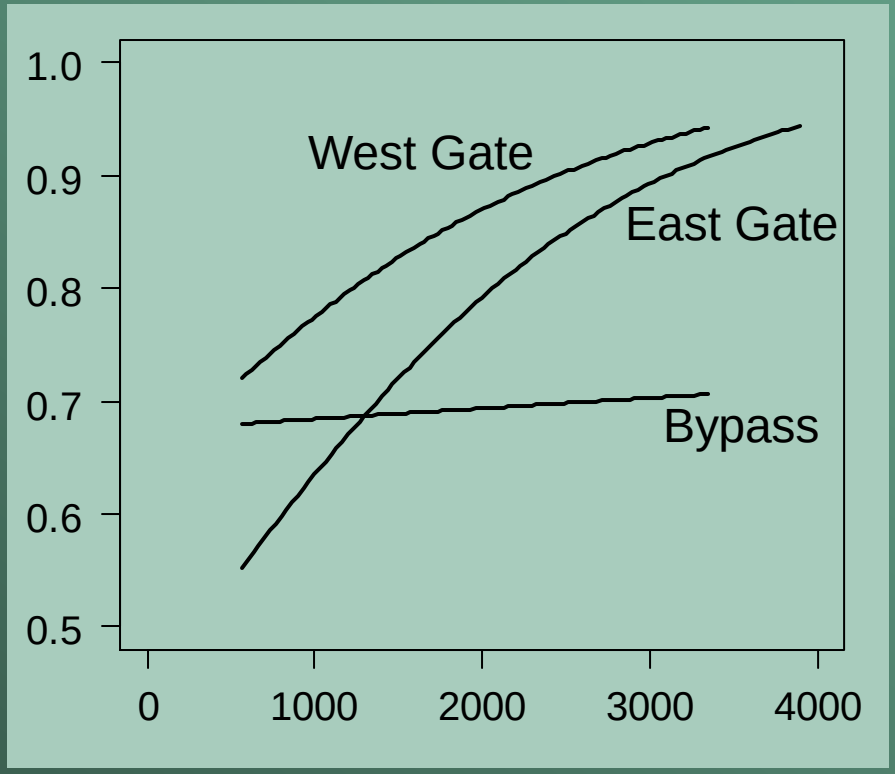
Survival probability



Roza Reach discharge (cfs)

All Passage Routes

Survival probability



Roza Reach discharge (cfs)

Passage Analysis Methods

- Multinomial Regression
  - Analogous to logistic regression
  - 3 events instead of 2
- Probability of passing through each route
  - Bypass, East Gate
  - Baseline category = West Gate
- Individual covariates based on day of passage
  - Bypass + Canal discharge
  - West Gate discharge
  - East Gate discharge
  - Day of year
- Selected among alternative models
  - Show only best fit model

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Variables in Best-Fit Model

Bypass passage probability

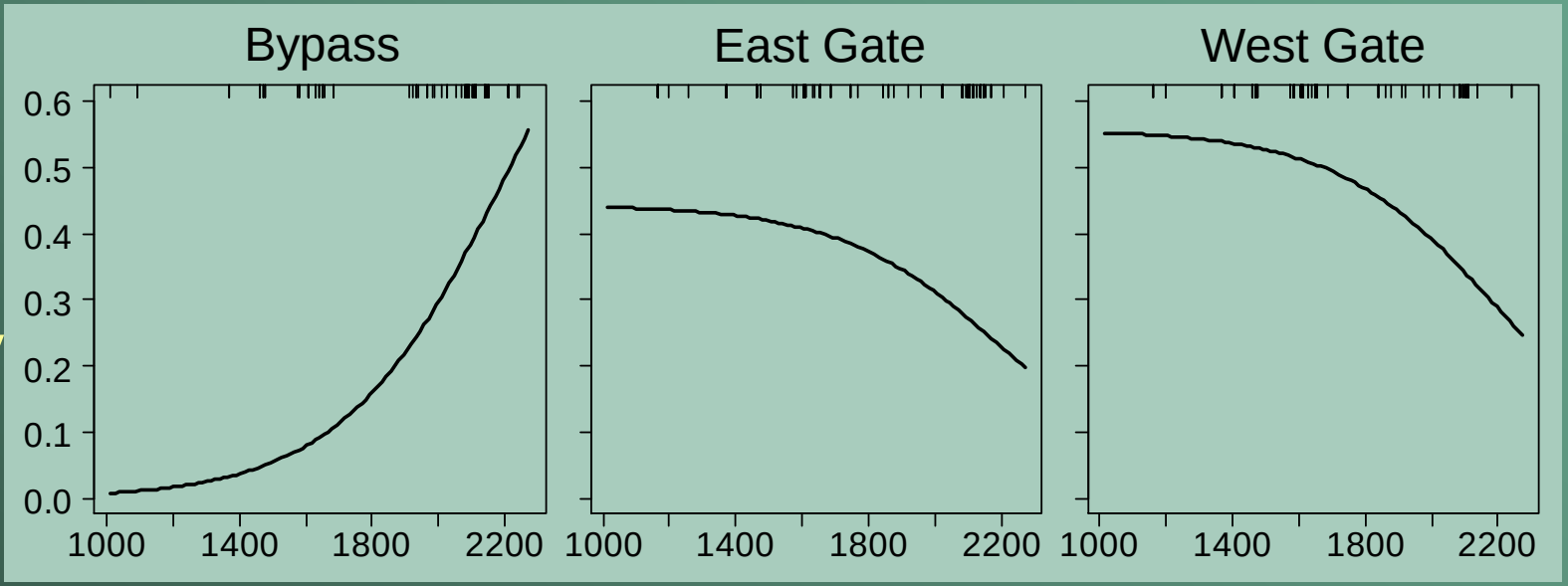
- Bypass discharge (+)
- East Gate discharge (-)

East Gate passage probability

- East Gate discharge (+)
- West Gate discharge (-)
- East x West (-)
- Day of year (+)

Effect of Bypass + Canal Discharge

Passage probability



Bypass + canal discharge (cfs)

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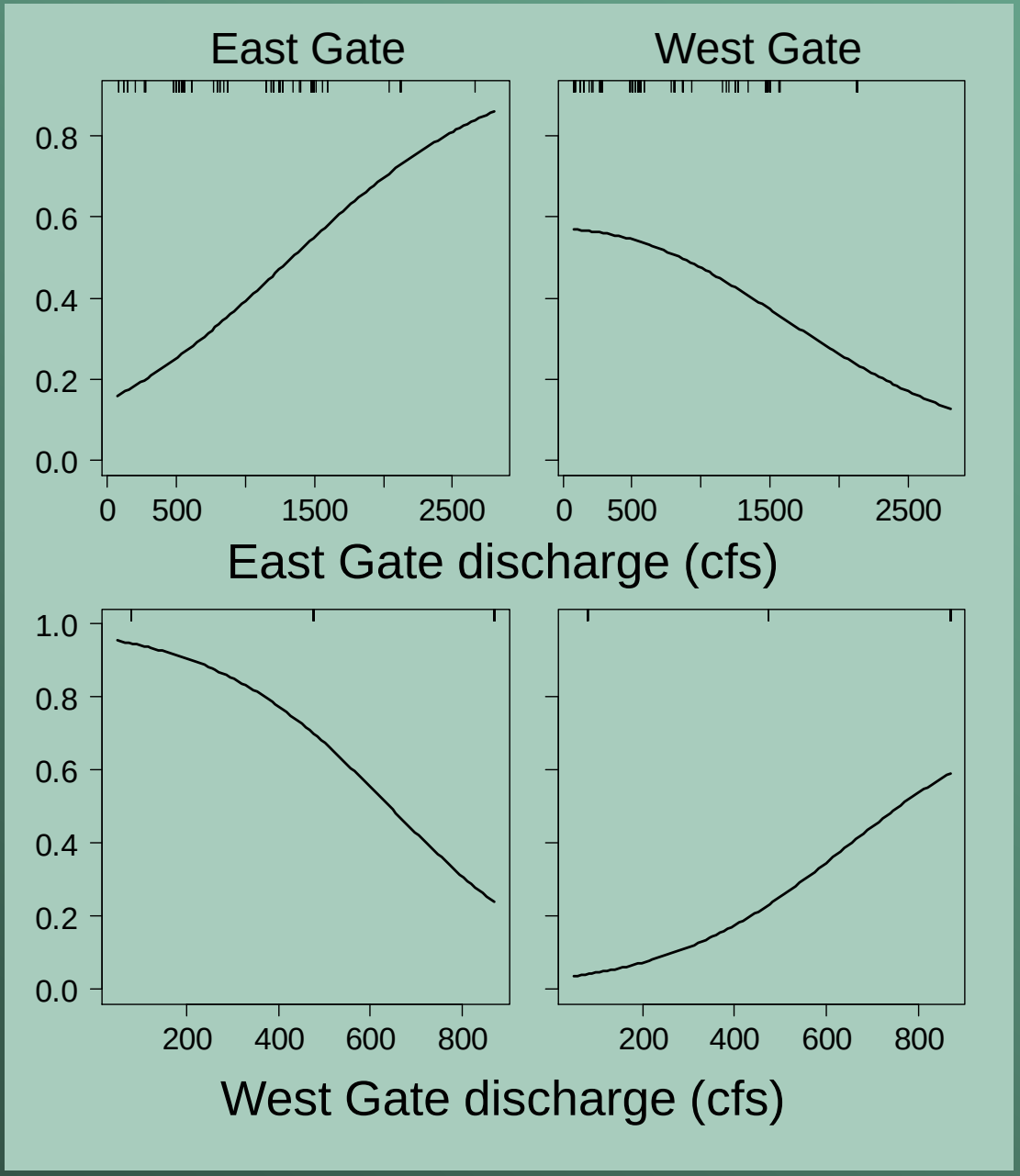
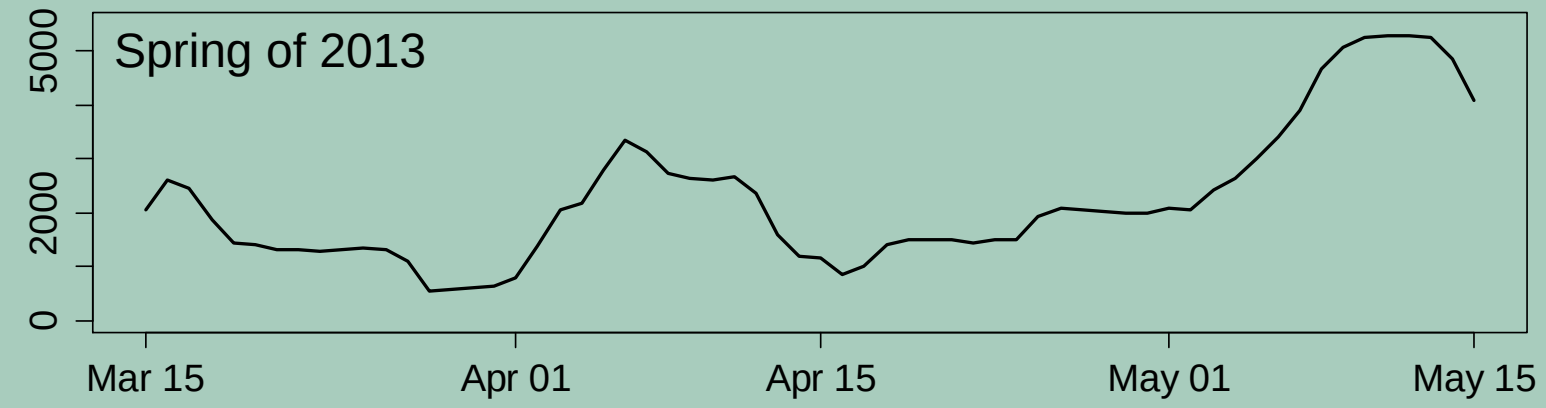
Effect of East and West Gate Discharge

Passage probability

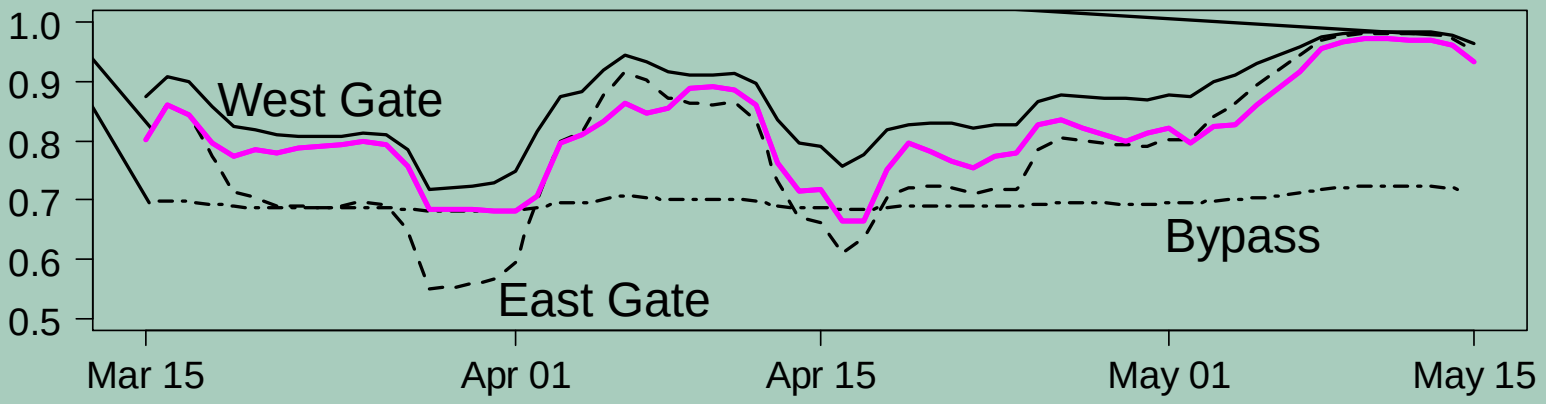


Combining Passage and Survival Models to Predict Daily Dam Survival

Roza Reach discharge (cfs)



Survival probability



Total survival for all routes

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Conclusions

- Flow effects differed among routes
  - Low flow = low survival for all routes
  - High flow increased East and West, but not bypass
- Dam operations affect passage
  - Route discharge increases passage for that route
  - and decreases passage through other routes
- Passage affects total survival
  - Shifts fish among high- and low-survival routes
- Models provide a useful management tool
  - Simulate effects of dam operations on passage and survival

USGS

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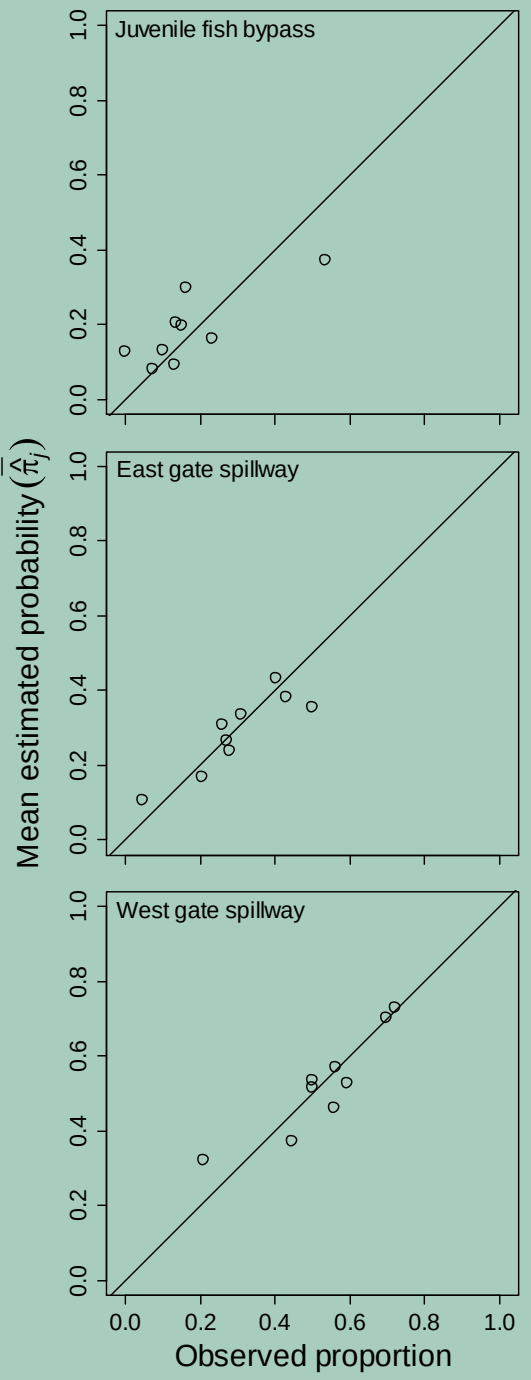
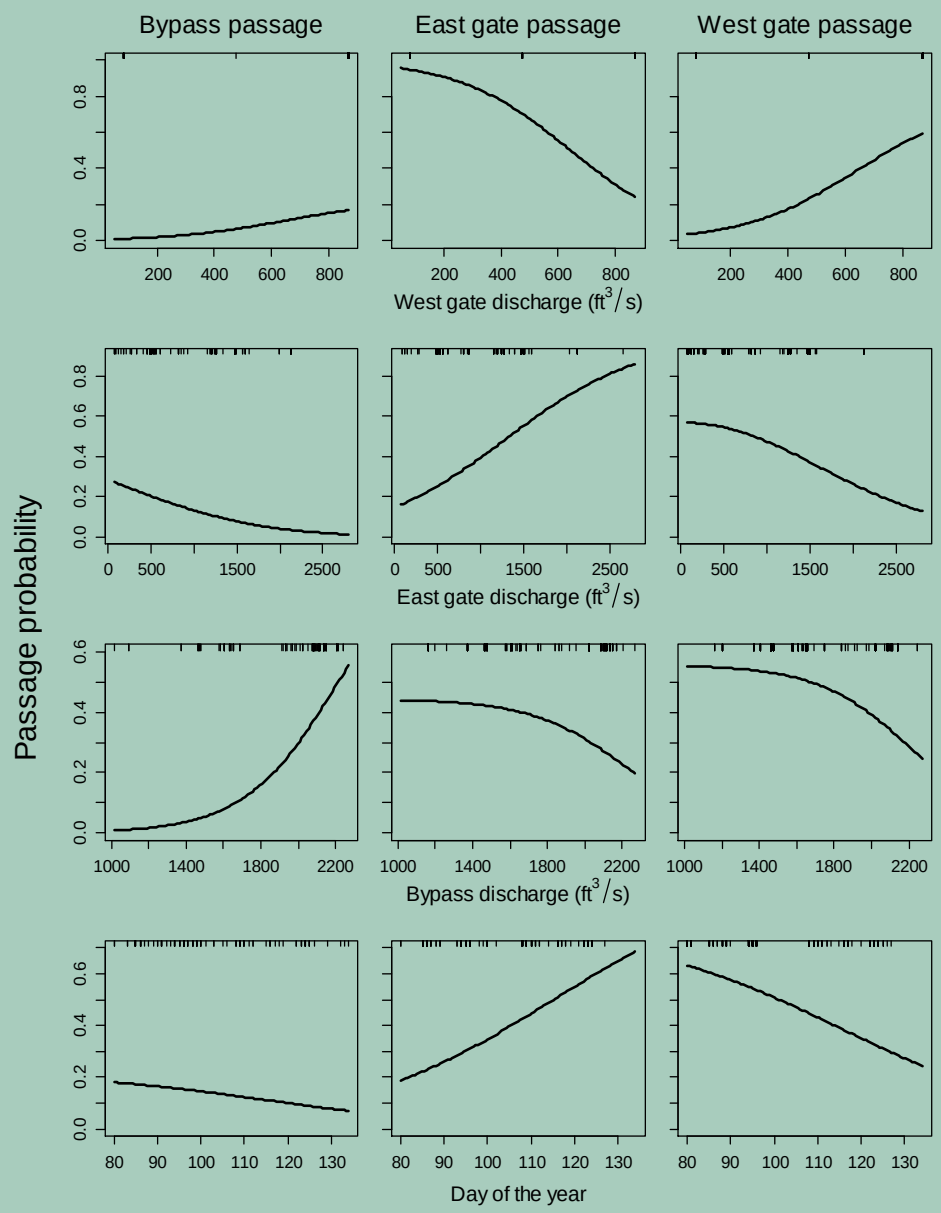
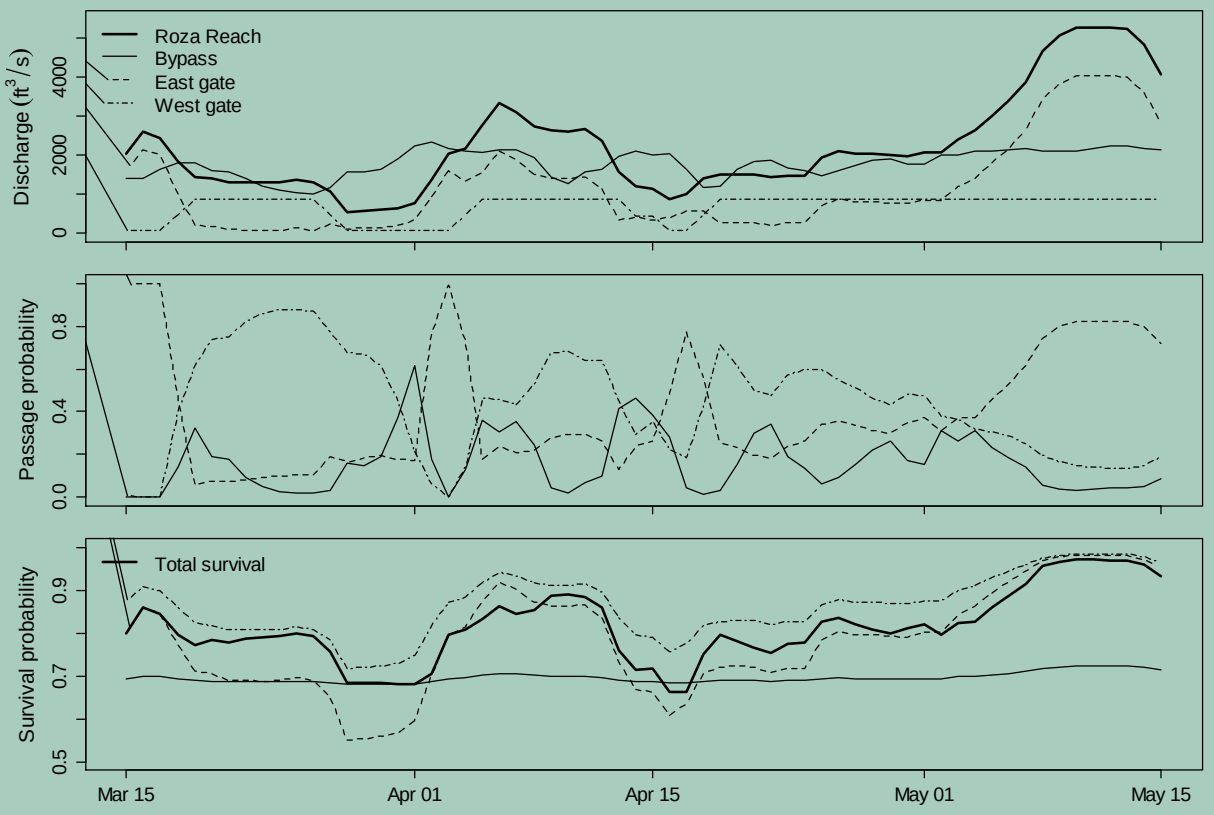

Juvenile fish bypass
East gate spillway
West gate spillway
Mean estimated probability $(\bar{\hat{\pi}}_j)$
Observed proportion
0.0
0.2
0.4
0.6
0.8
1.0


Bypass passage
East gate passage
West gate passage
Passage probability
0.0
0.2
0.4
0.6
0.8
200
400
600
800
West gate discharge (ft3/s)
0
500
1500
2500
East gate discharge (ft3/s)
1000
1400
1800
2200
Bypass discharge (ft3/s)
80
90
100
110
120
130
Day of the year


Roza Reach
Bypass
East gate
West gate
Discharge (ft3/s)
0
2000
4000
Passage probability
0.0
0.4
0.8
Total survival
Survival probability
0.5
0.7
0.9
Mar 15
Apr 01
Apr 15
May 01
May 15