



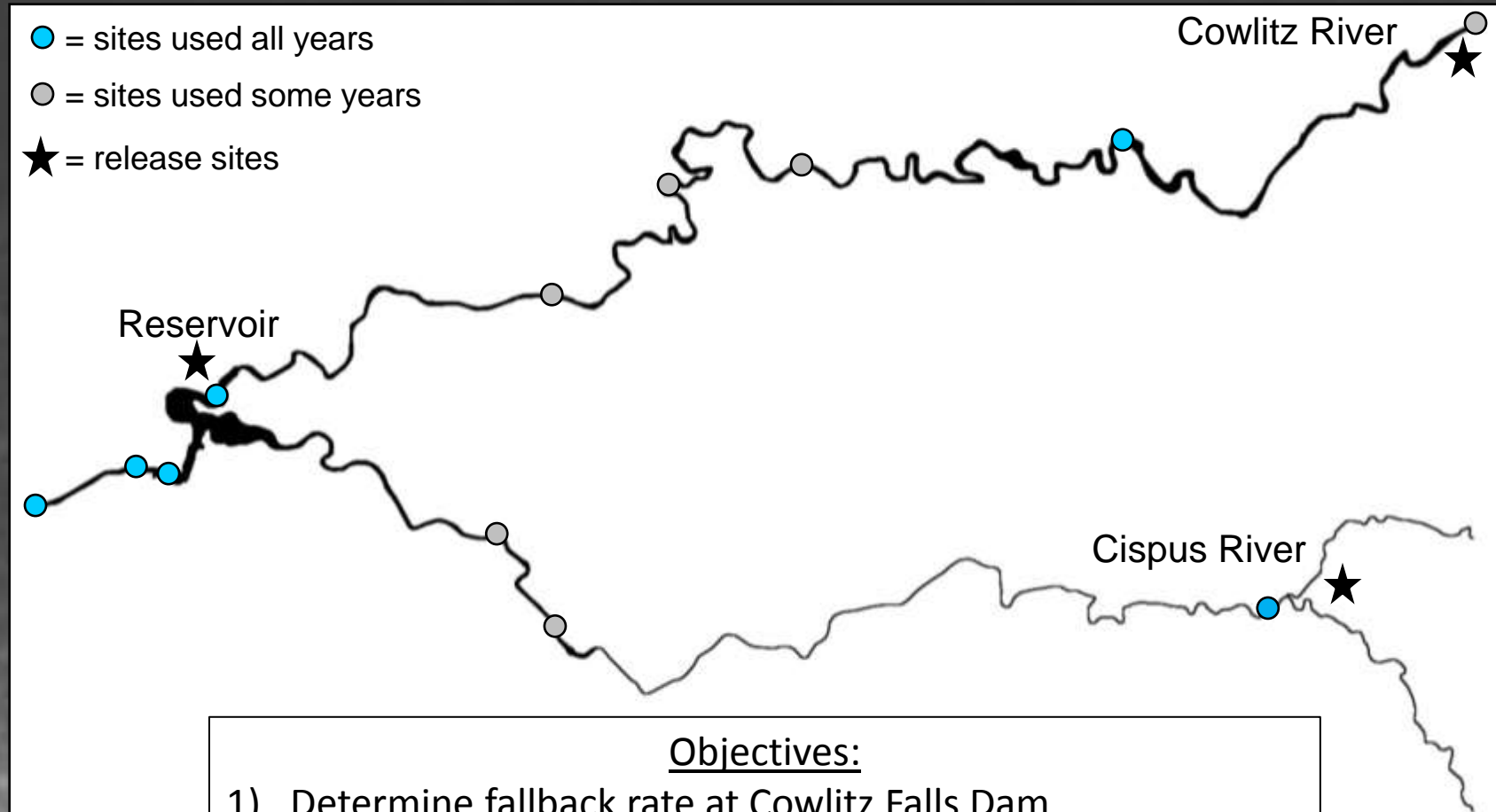
Using a Multistate Model to Describe Responses of Adult Chinook Salmon to Trap-and-Haul in the Upper Cowlitz River Basin

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U.S. Geological Survey

John Serl
Washington Department of Fish and Wildlife

Mike Kohn
Lewis County PUD

Upper Cowlitz River Chinook Salmon



Sample Sizes

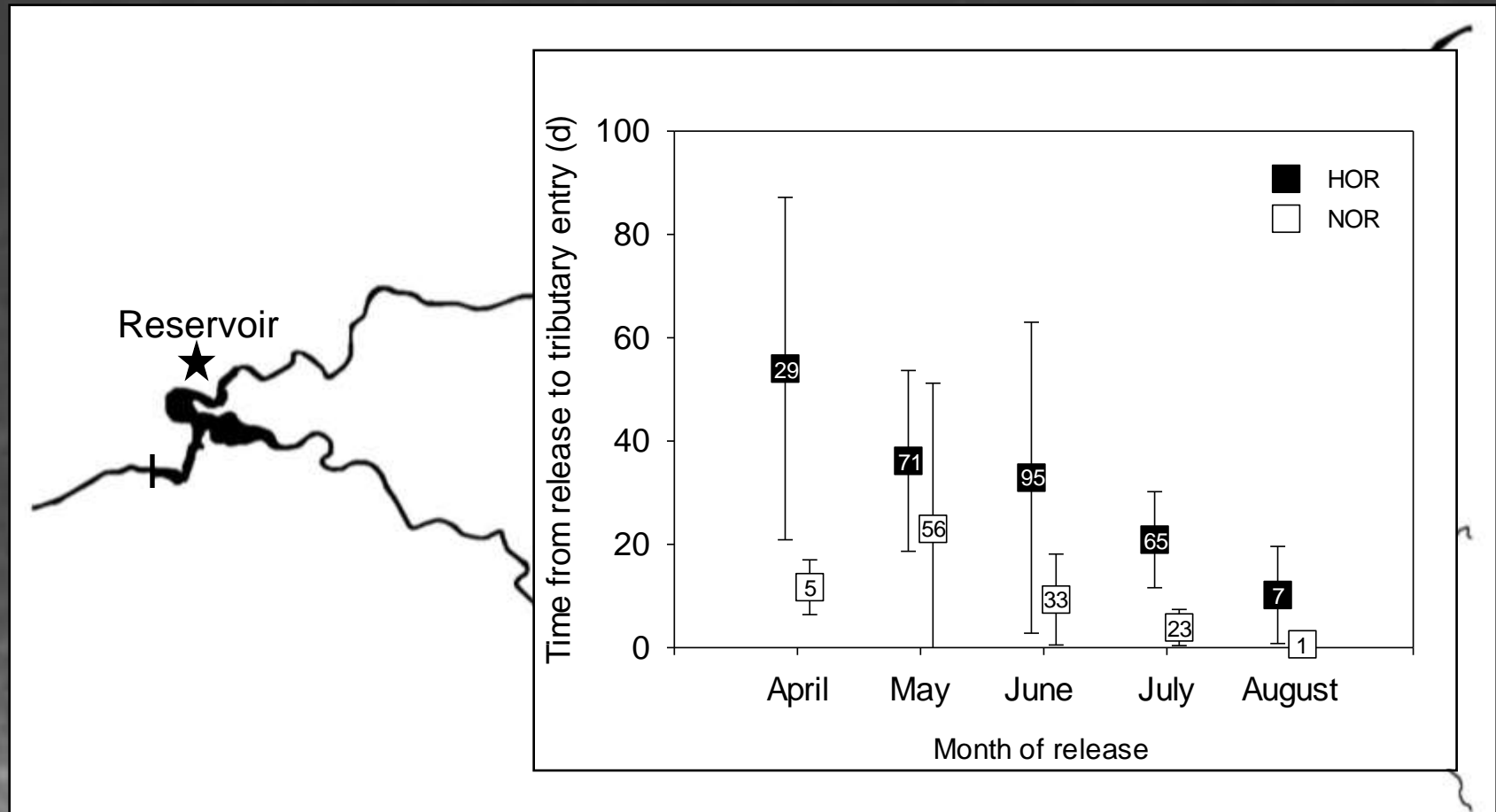
Year	Reservoir	Cowlitz	Cispus	Total
2005	178	21	21	220
2006	138	0	0	138
2007	93	50	52	195
2012	136	81	0	217
Total	545	152	73	770



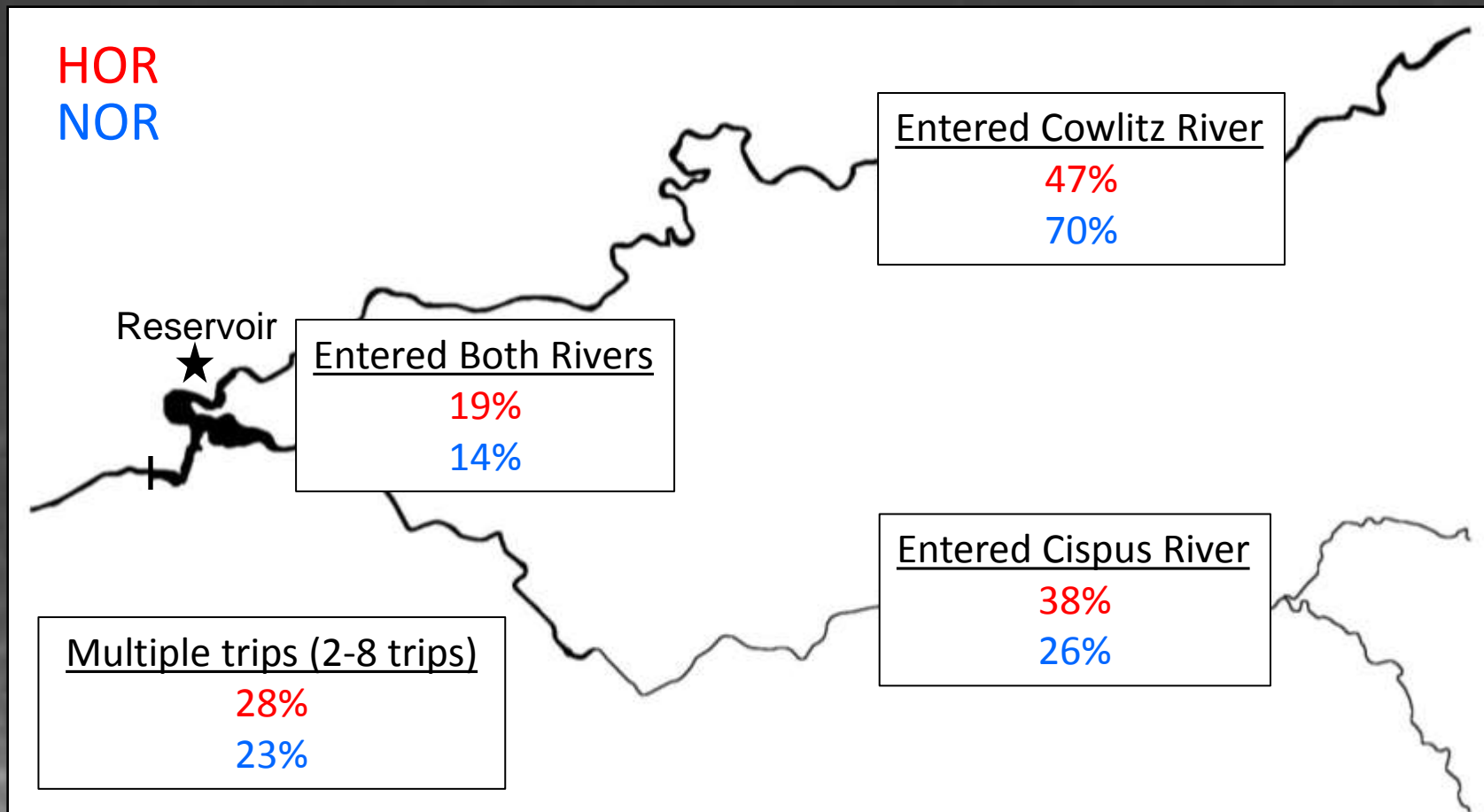
↓
78% HOR (603 fish)
22% NOR (167 fish)

Fish released
April – August

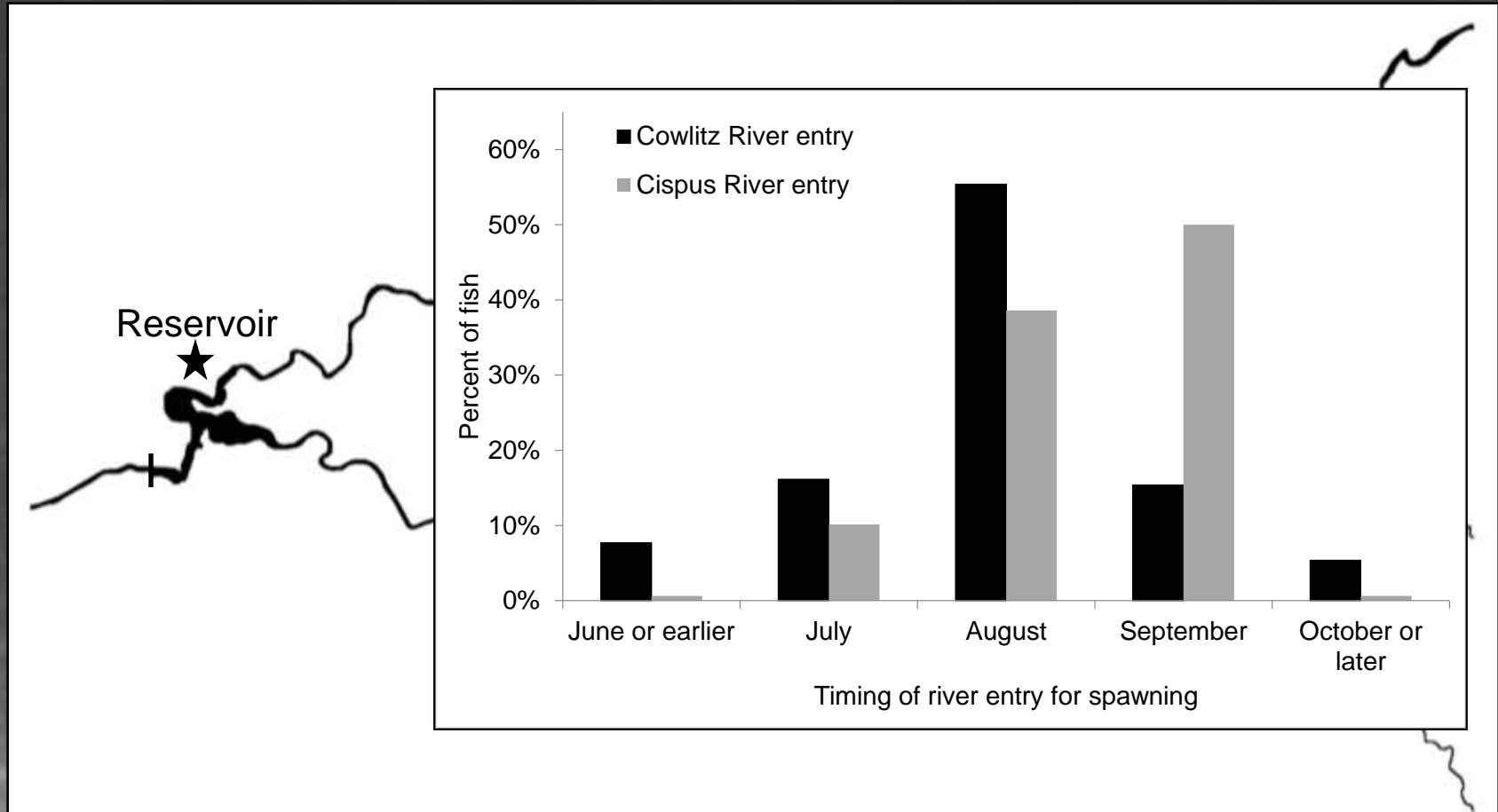
Residence Time in the Reservoir



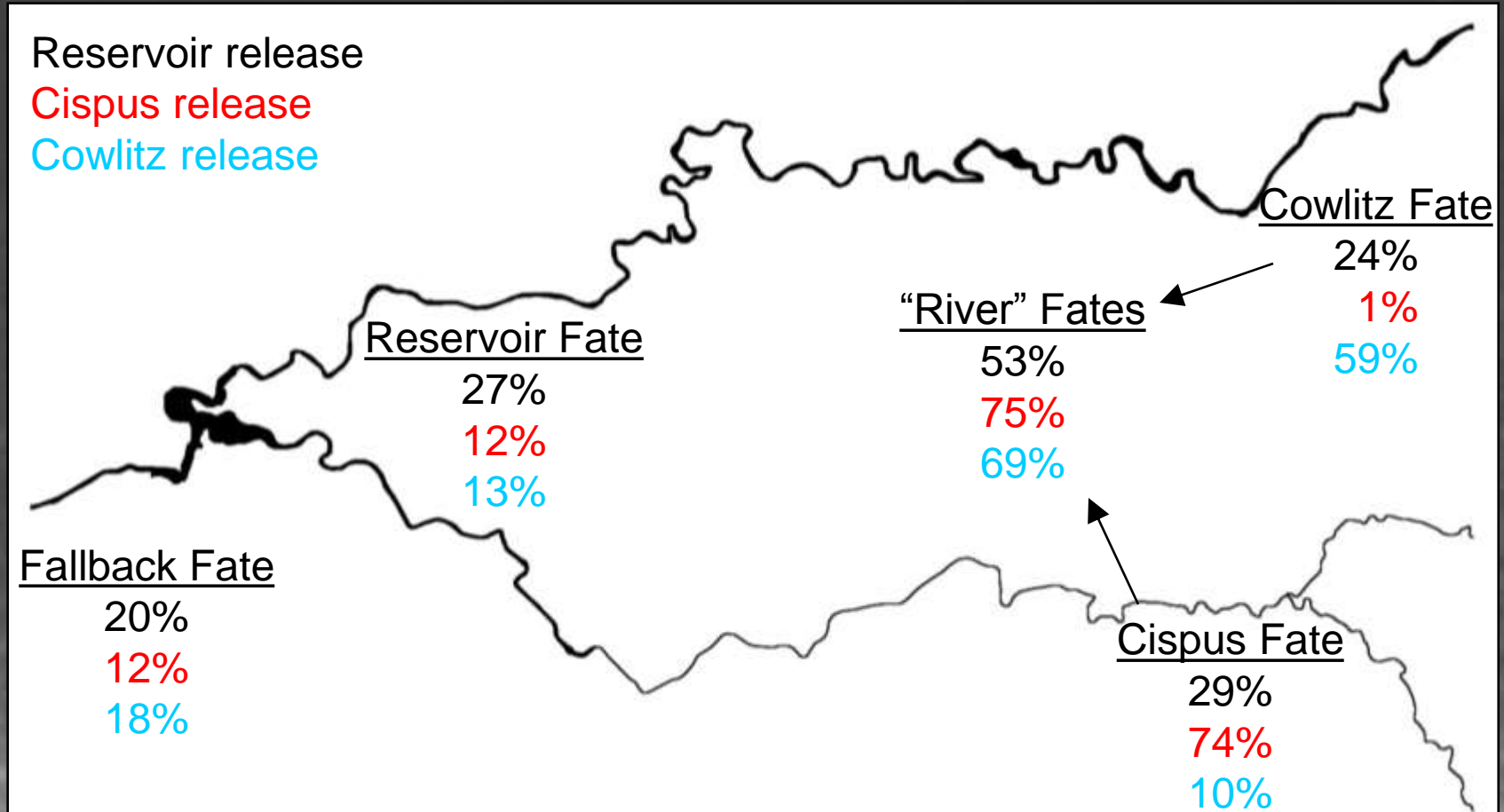
Upstream Movements



Timing of River Entry for Spawning



Final Summary of Fates



Final Summary of Fates

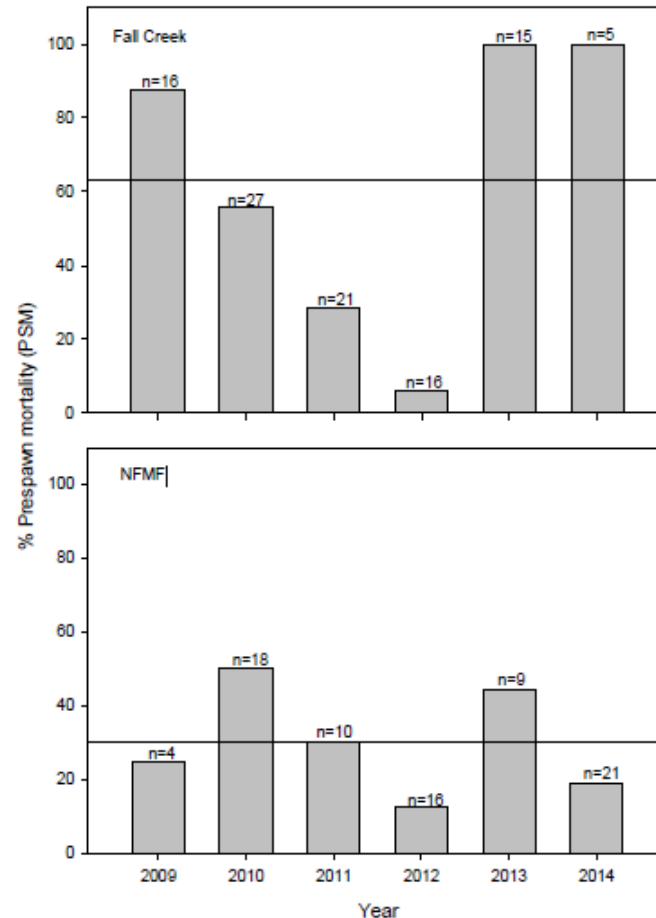
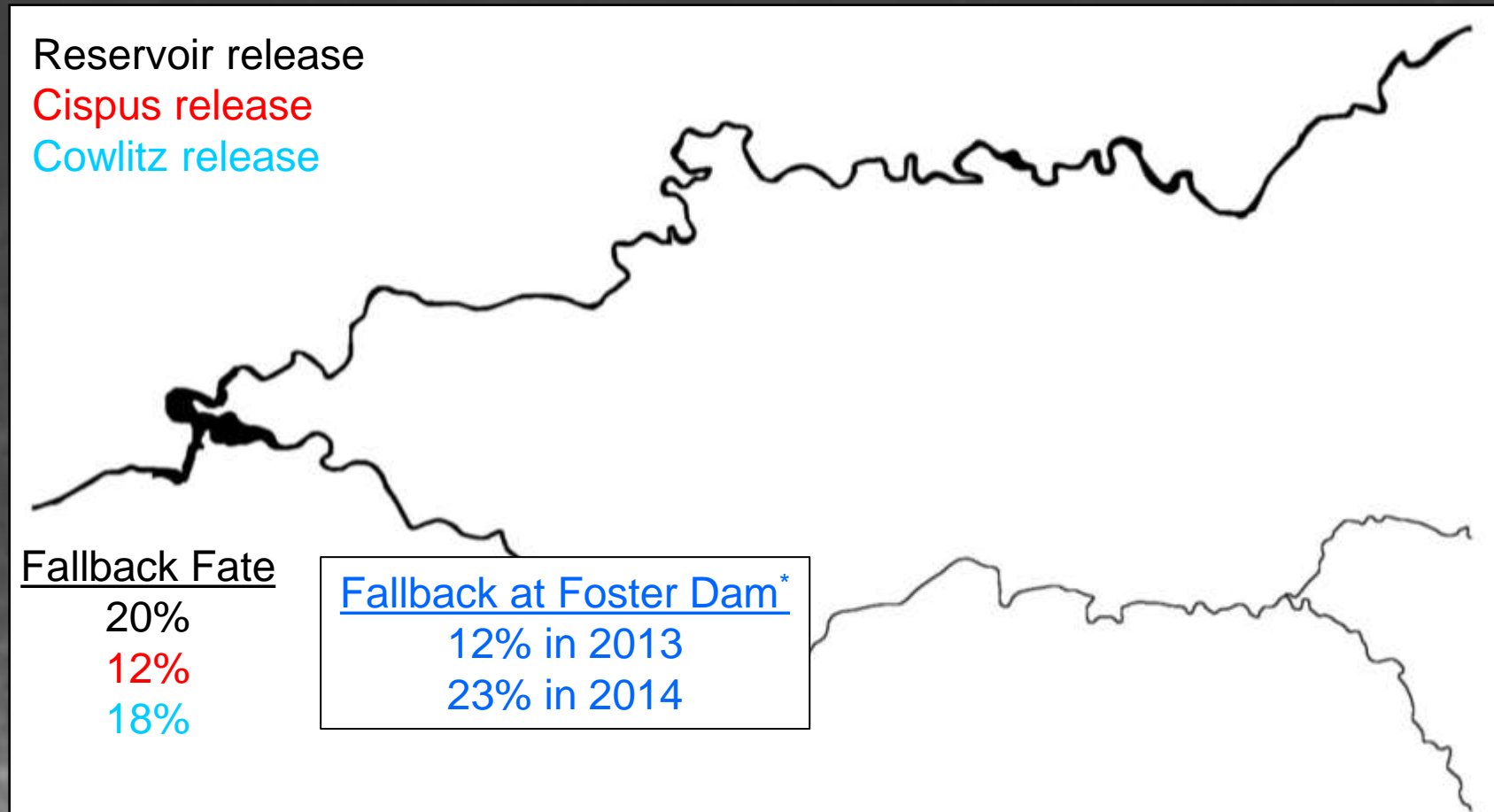


Figure 17. Annual percent PSM for combined PIT- and radio-tagged female Chinook salmon recovered in Fall Creek (top panel) and the NFMF (bottom panel) in 2009-2014. Horizontal line is the mean PSM rate across study years.

Final Summary of Fates



Multistate Model

Models and Covariates

- 11 models developed
- 7 covariates evaluated

Release site

Release day

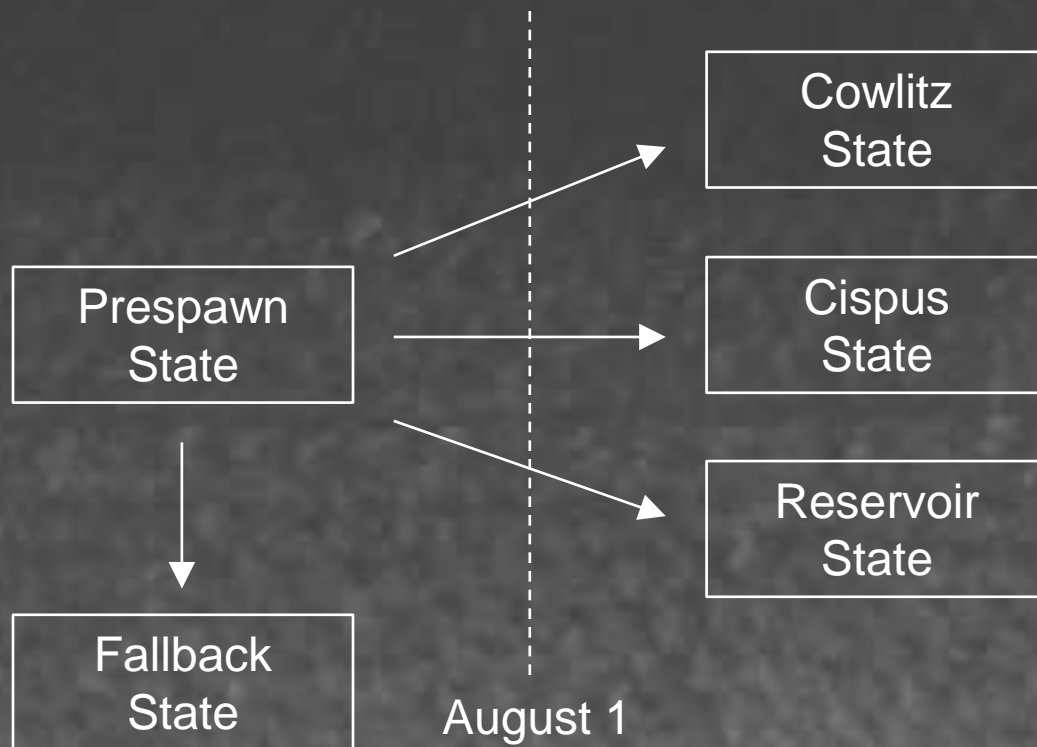
Origin

Sex

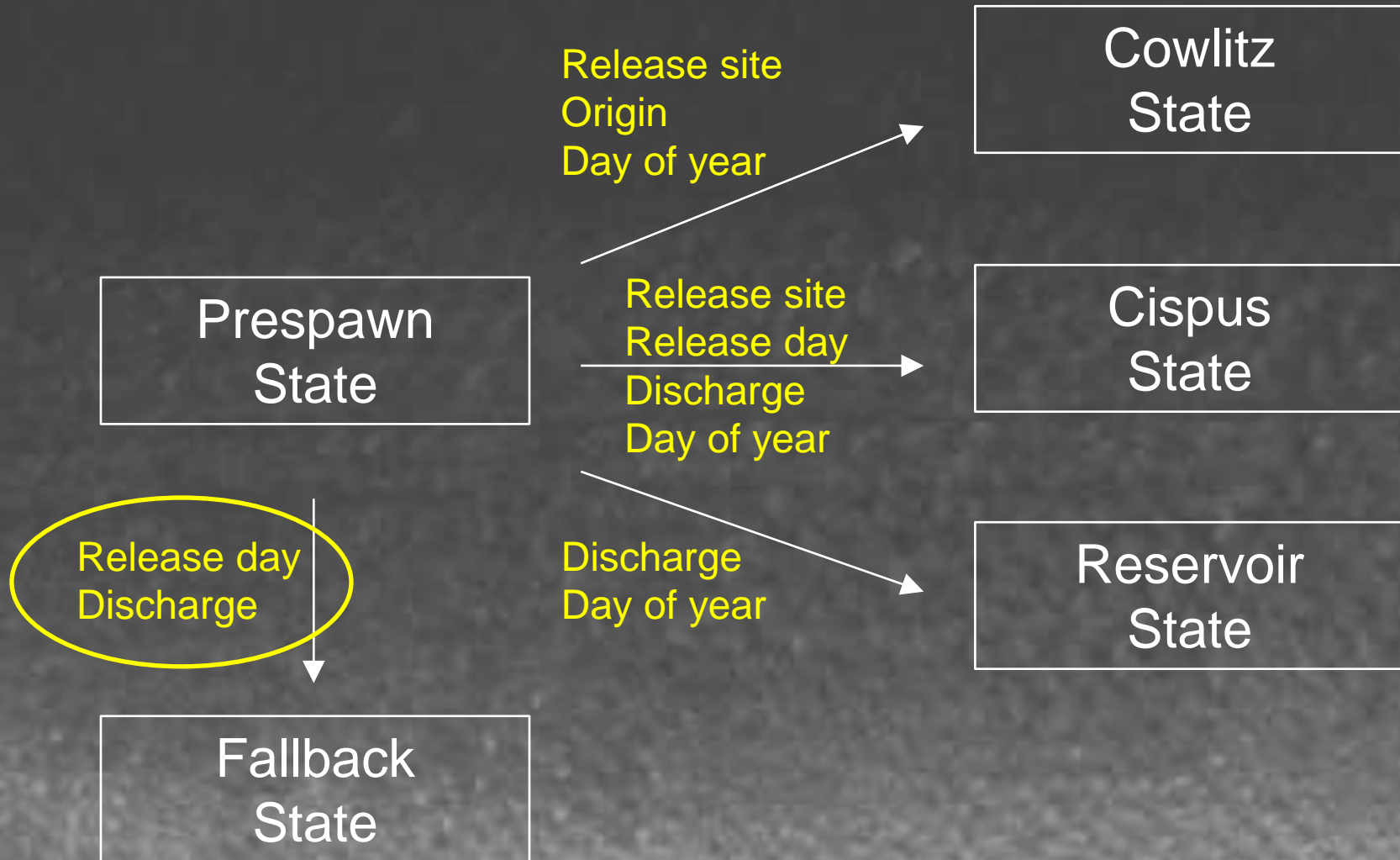
Discharge

Day of year

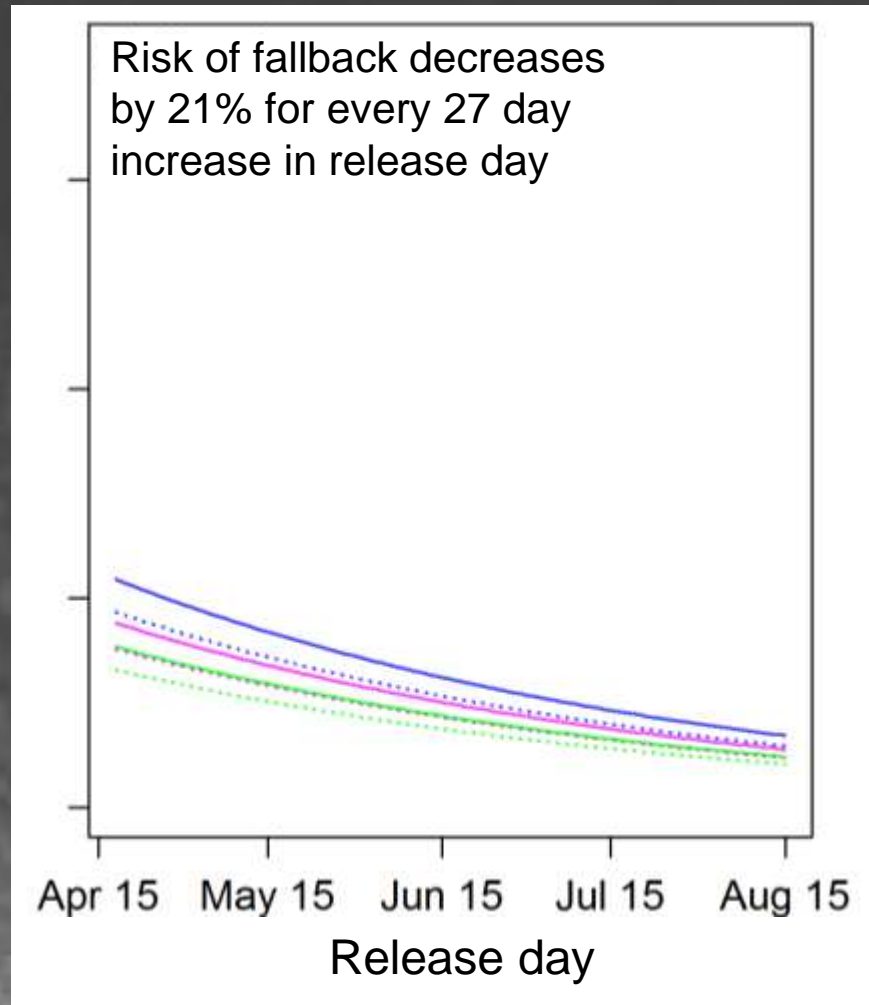
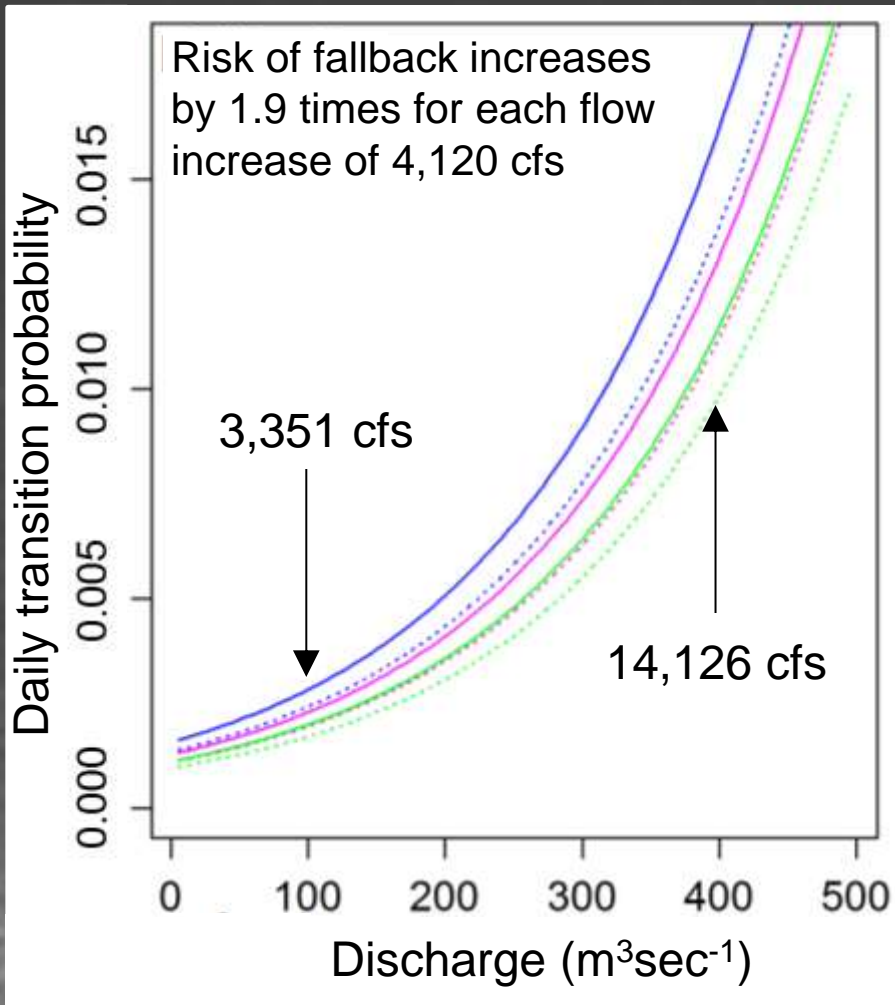
Year



Multistate Model



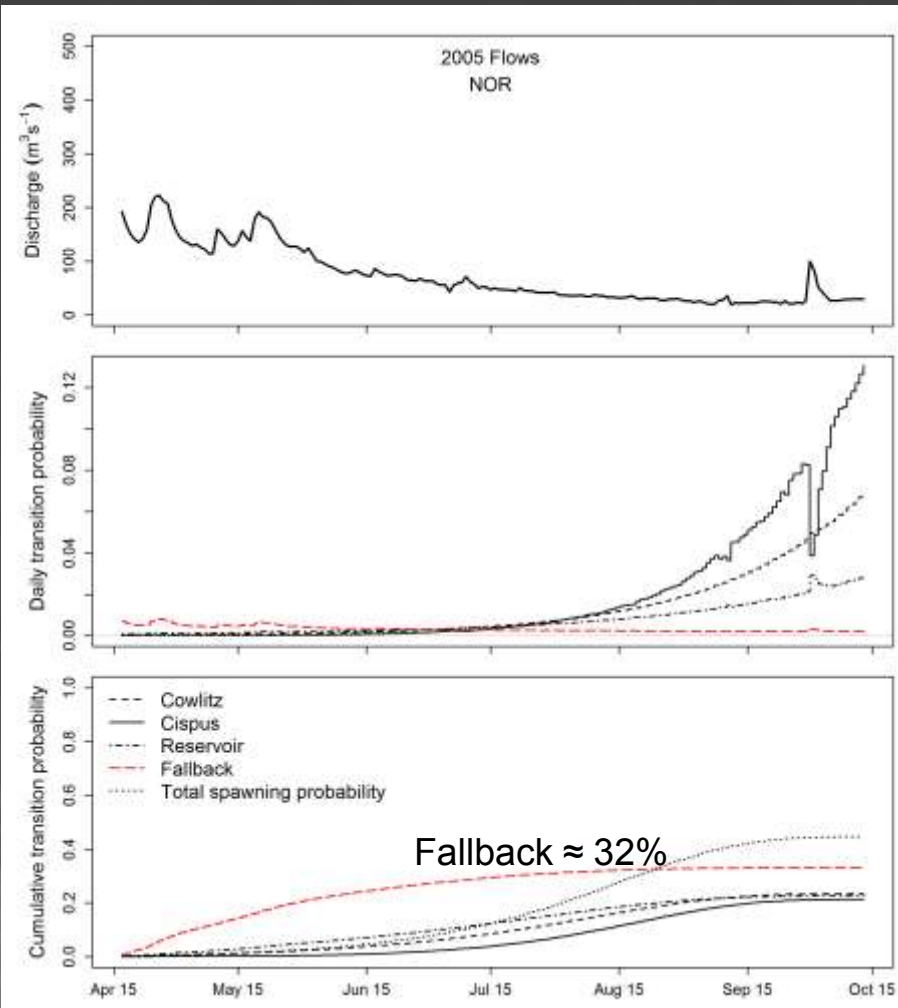
Fallback: MSM Results



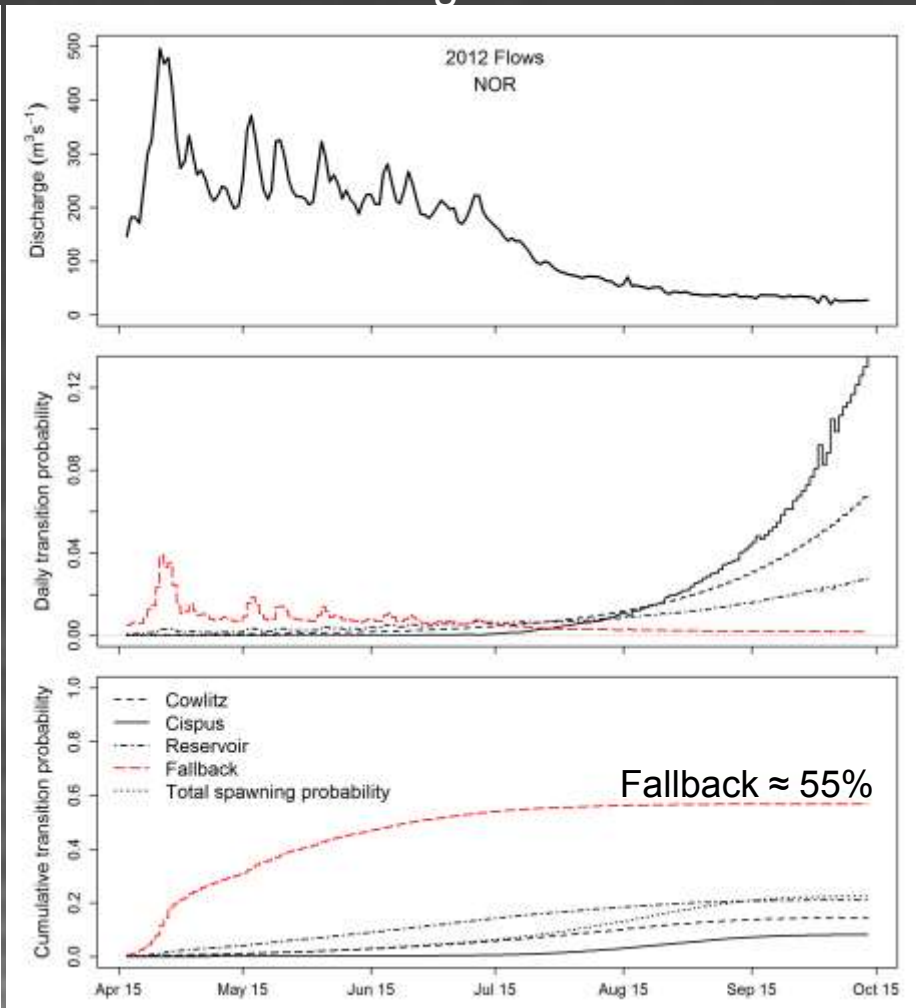
—	HOR	—	Res. release	—	Cis. release
·····	NOR	—	Cow. release		

Fallback: MSM Results

Low Flow

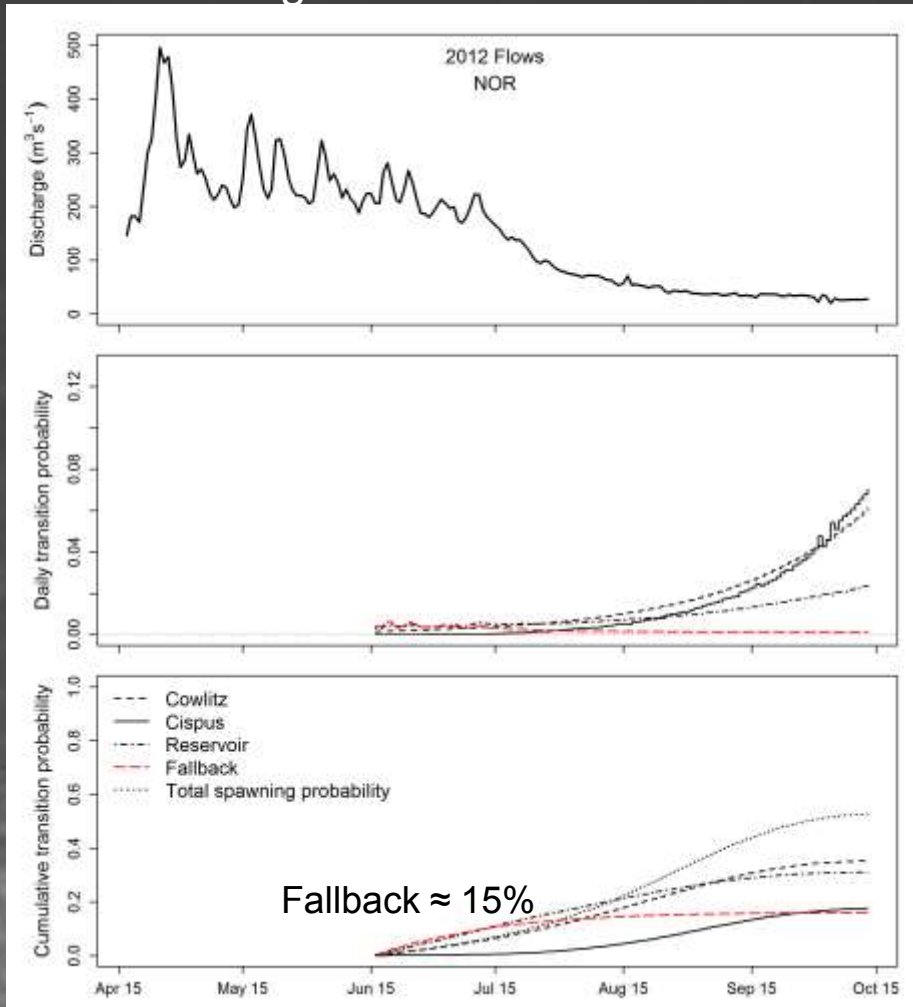


High Flow

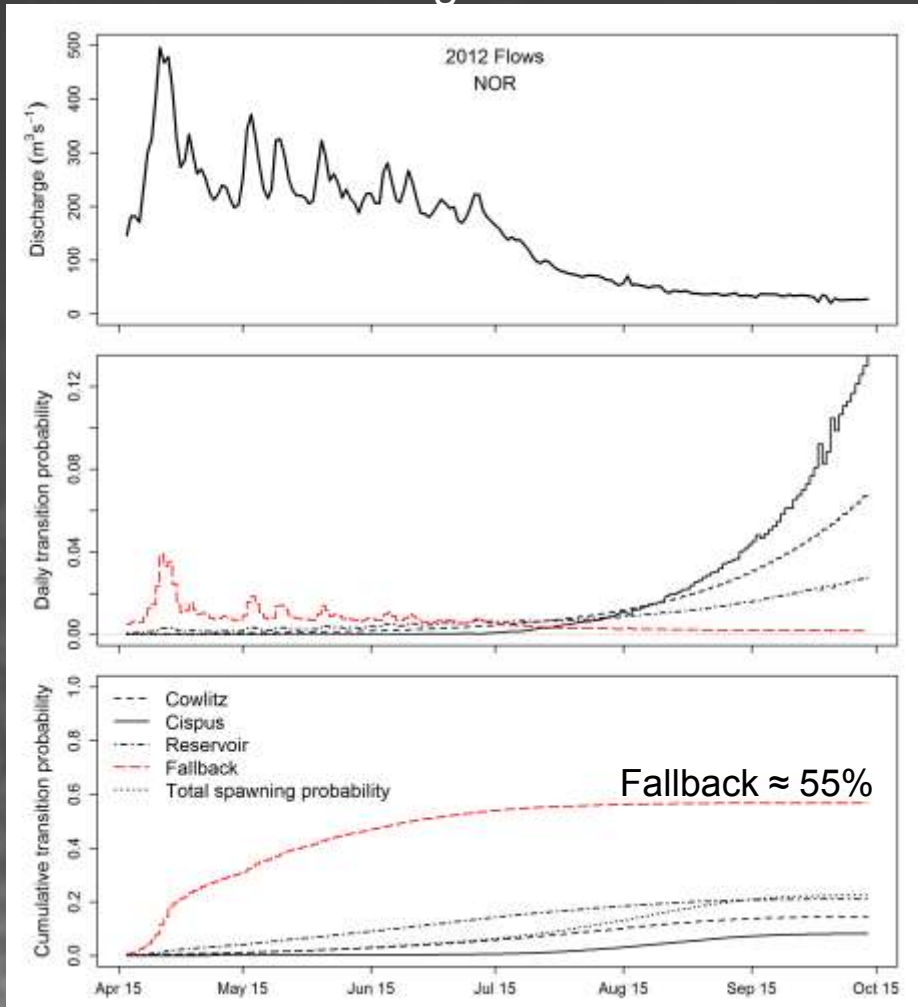


Fallback: MSM Results

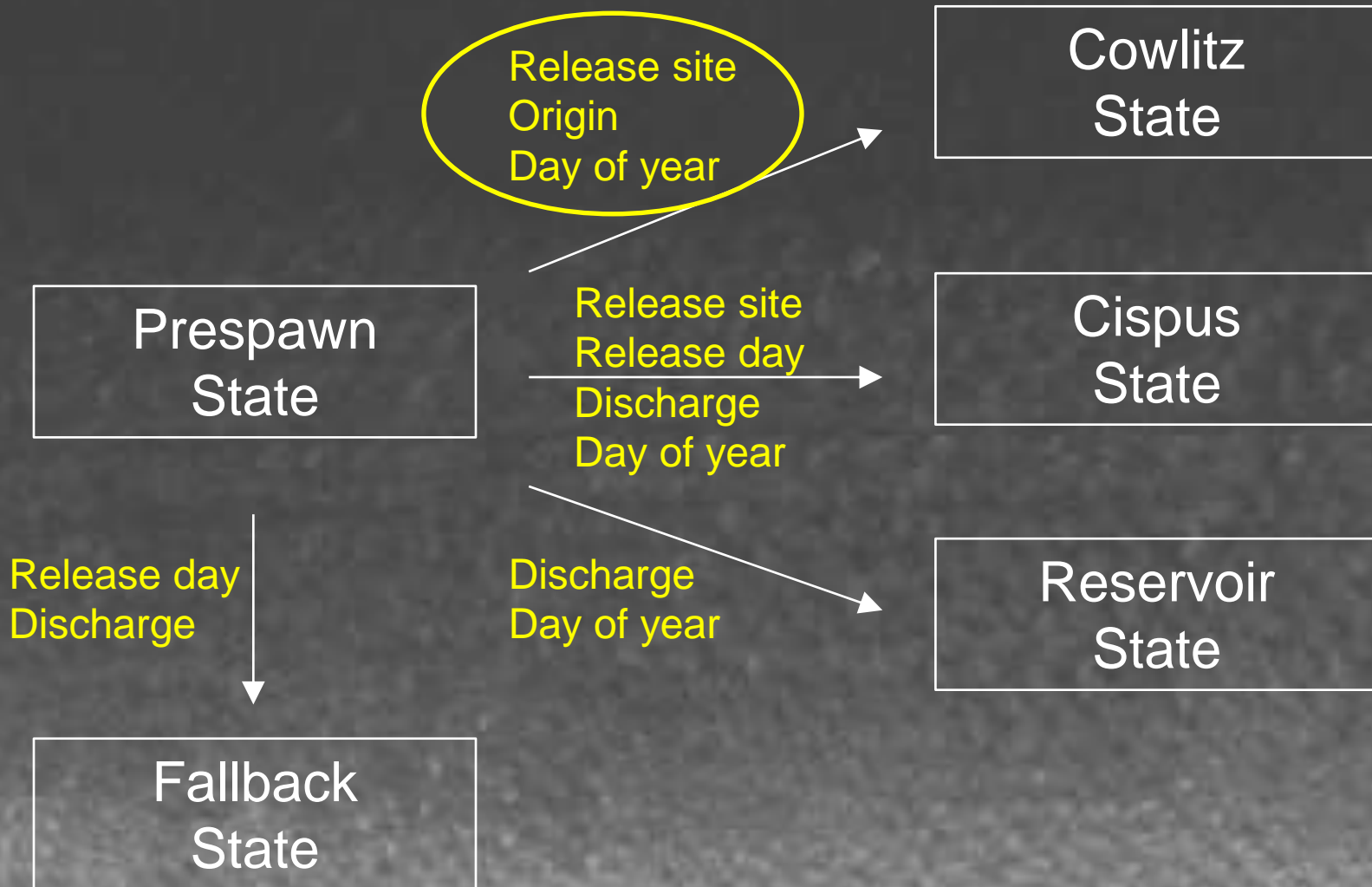
High Flow: June Release



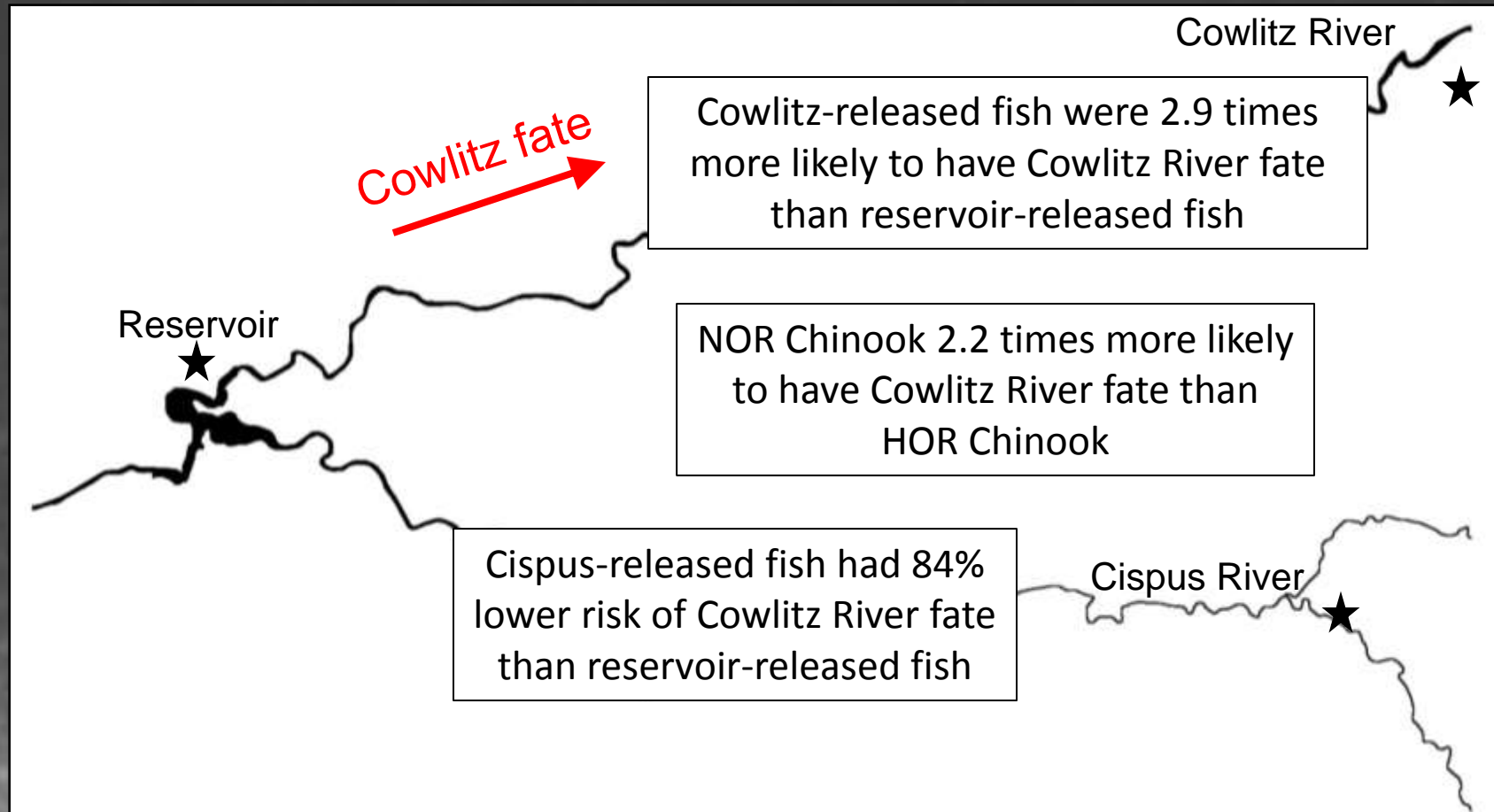
High Flow



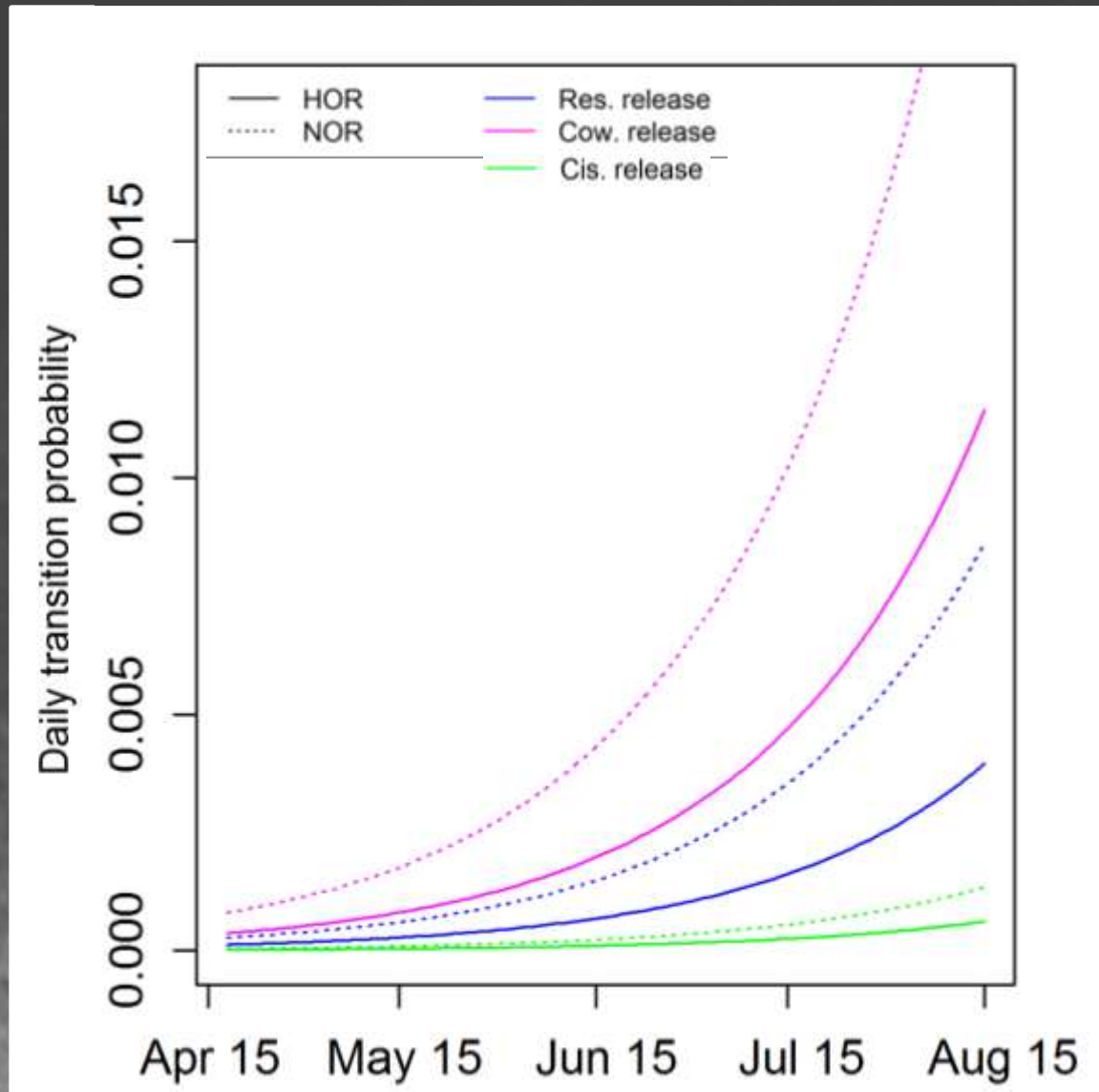
Multistate Model



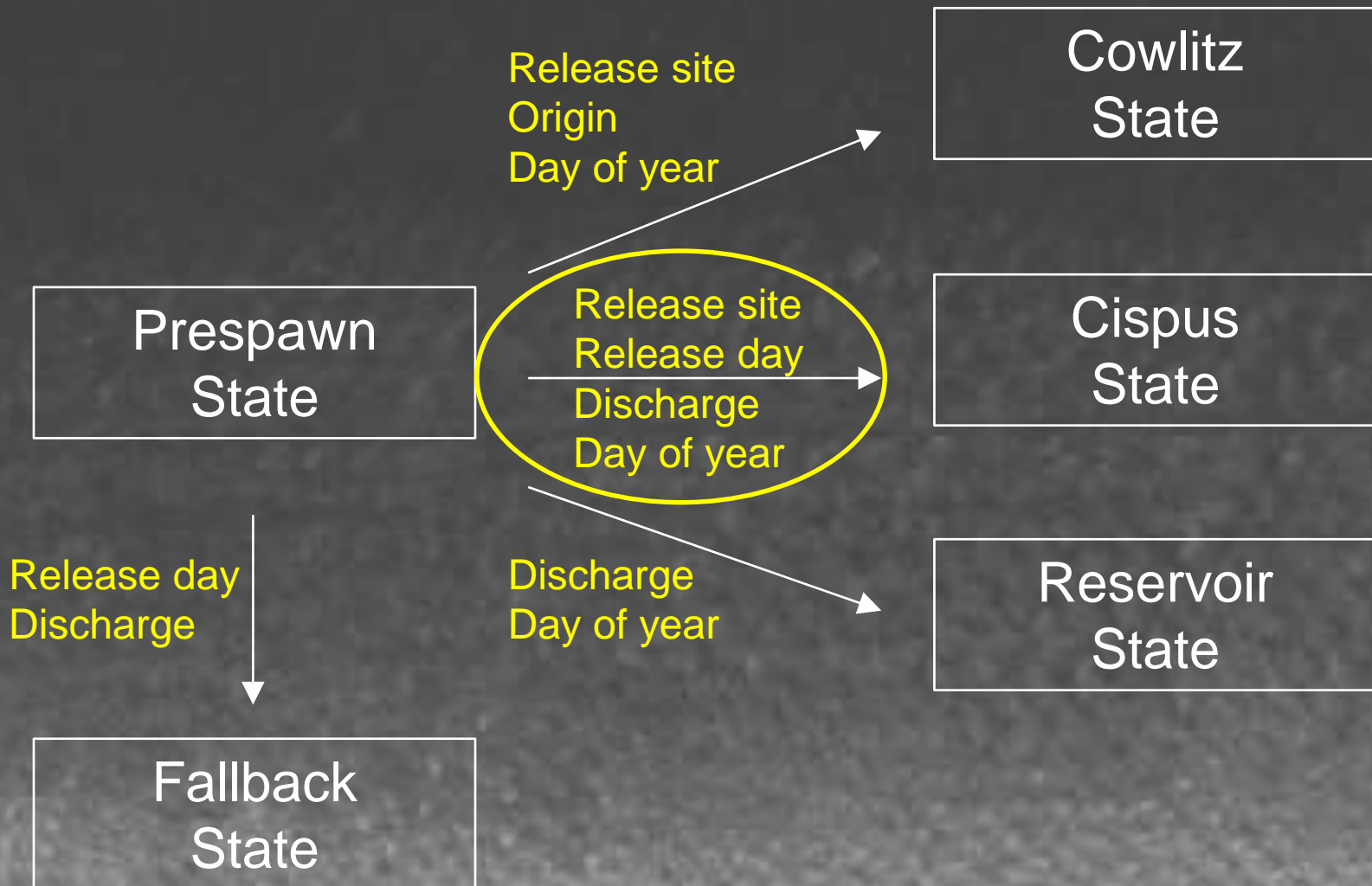
Release Site and Origin Effects: MSM Results



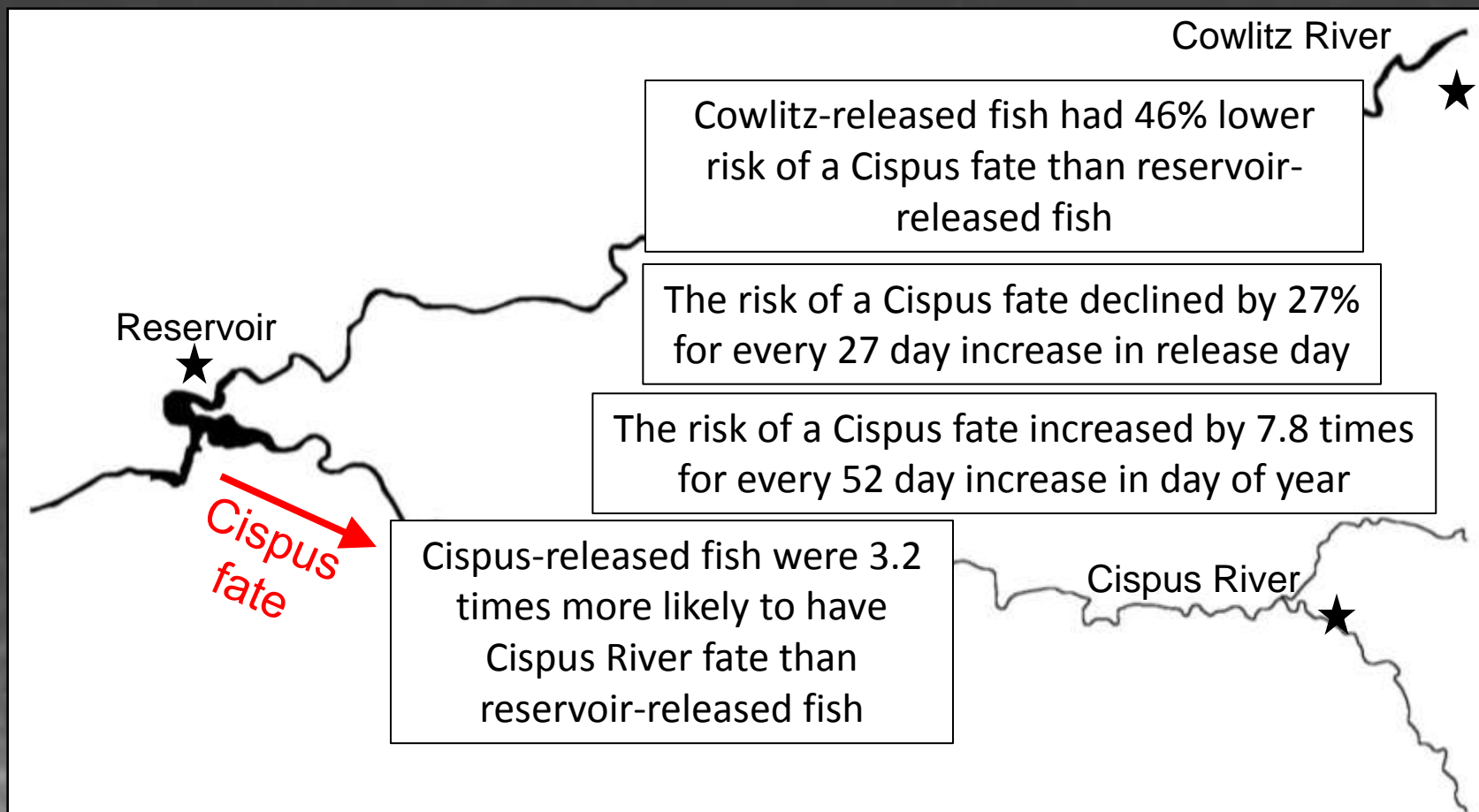
Day of Year Effects: MSM Results



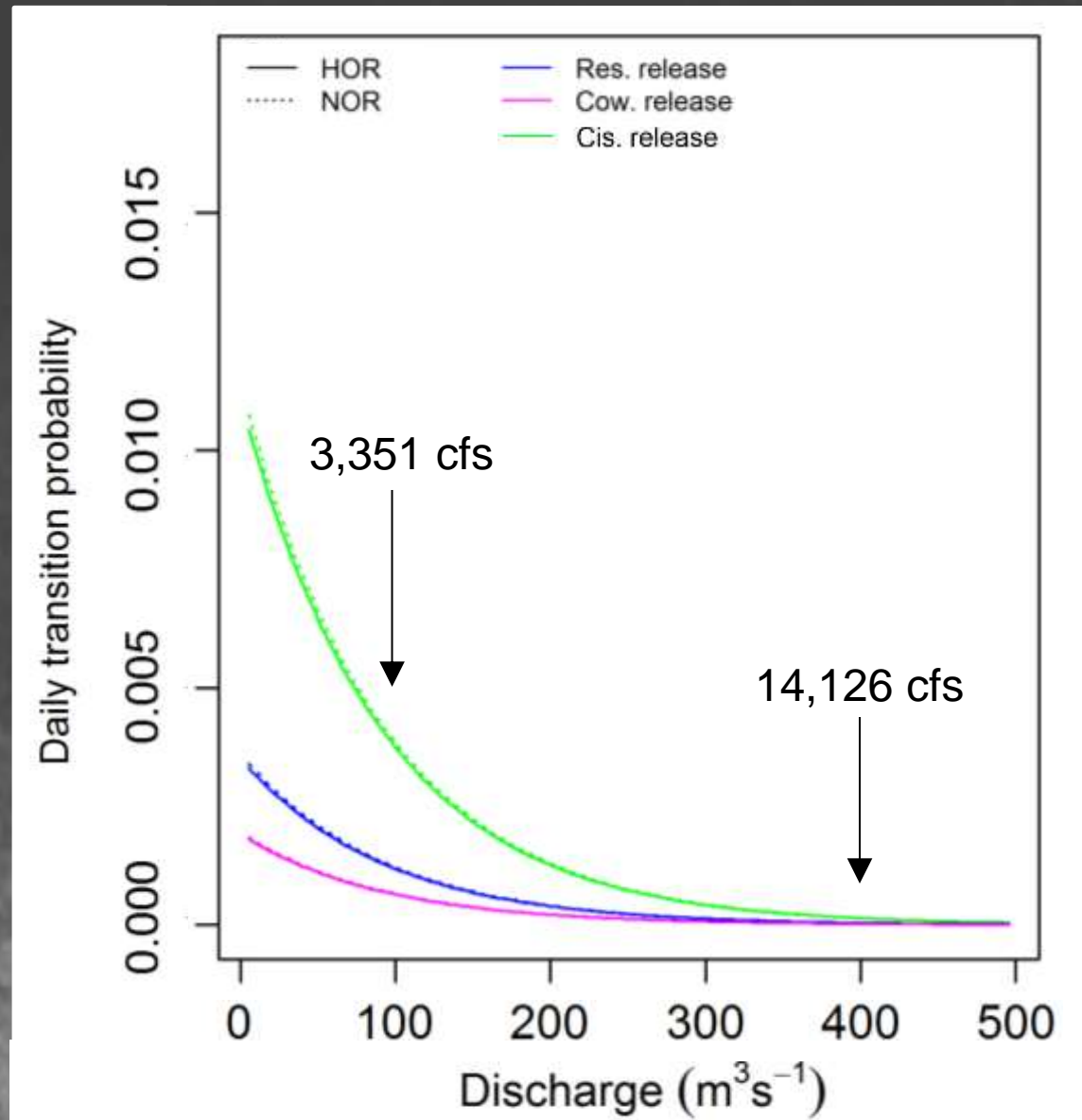
Multistate Model



Release Site and Release Day Effects: MSM Results



Discharge Effects: MSM Results



Summary

Fallback

- Discharge and release date were important predictors
- Release site differences not observed

Cowlitz River

- Release site, origin and day of year were important predictors
- Preferred spawning area for NOR Chinook

Cispus River

- Release site, release day, discharge, and day of year were important predictors

Acknowledgements

Funding:

Washington Department of Fish and Wildlife (recycling study)

Lewis County PUD (Upper Cowlitz adult telemetry study)

Fieldwork and Logistics:

Chris Gleizes, Mike Blankenship and Theresa Fryer
(WDFW)

Scott Gibson, Jamie Murphy, Missy Baier, and Mark LaRiviere
(Tacoma Power)

Wade Heimbigner
(Pacific States Marine Fisheries Commission)



Questions?



Steelhead Recycling Study

Two-year study

- 549 fish recycled in 2012
- 502 fish recycled in 2013

Return rates similar between years

- 48.4% returned to hatchery
- 32.4% remained in river
- 19.2% caught by anglers



Results nearly identical
to Tipping (1998)

Telemetry results

- 2.3% of tagged population
detected in lower Cowlitz River tributaries



Results supported
by WDFW
weir data



Analysis of Recycling Data

Models and Covariates

- 8 models developed
- 7 covariates tested

Discharge

Daily change in discharge

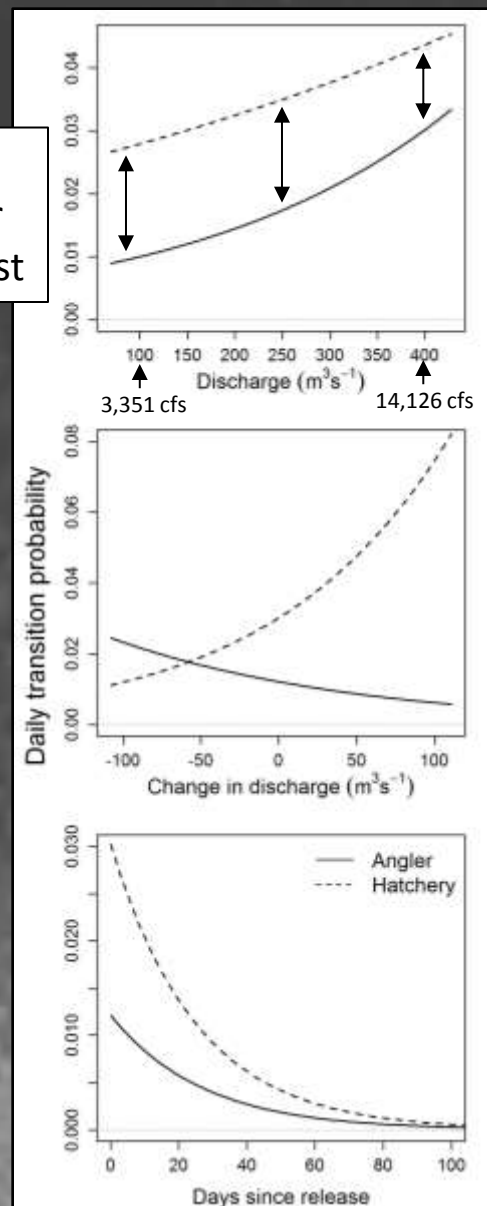
Time since release

Release month

Tag type (radio/Floy vs Floy only)

Day of year

Risk of hatchery return 2-3x higher than angler harvest



Analysis of Recycling Data

Models and Covariates

- 8 models developed
- 7 covariates tested

Discharge

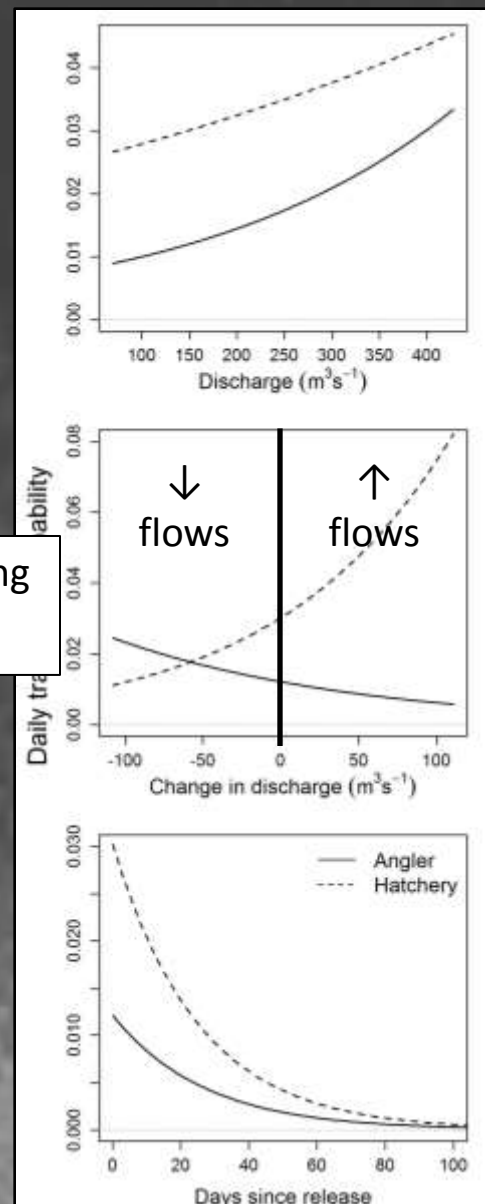
Daily change in discharge

Time since release

Angler harvest risk highest when flows are decreasing
Hatchery return highest when flows are increasing

Tag type (radio/flow vs flow only)

Day of year



Analysis of Recycling Data

Models and Covariates

- 8 models developed
- 7 covariates tested

Discharge

Daily change in discharge

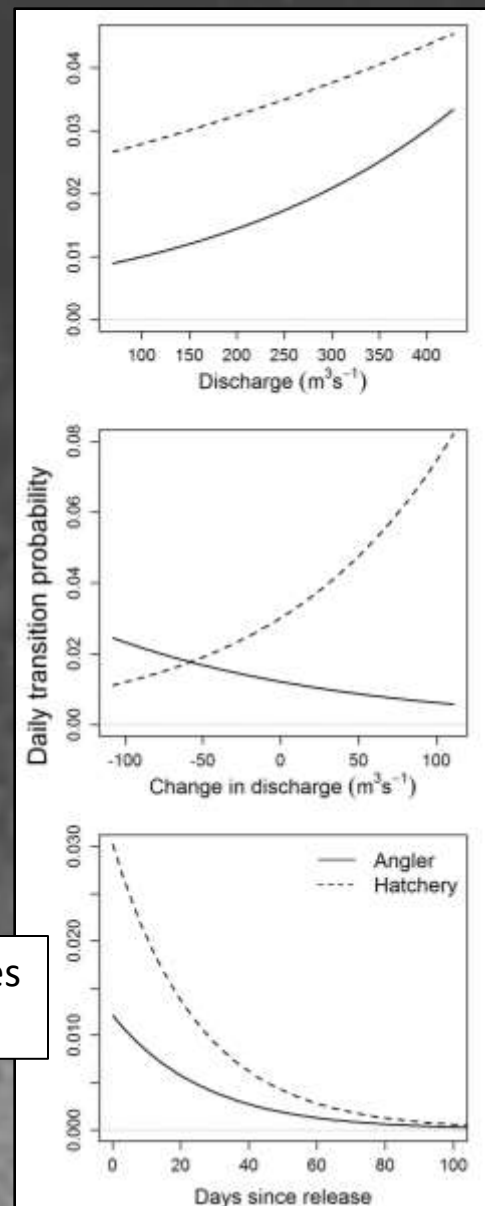
Time since release

Release month

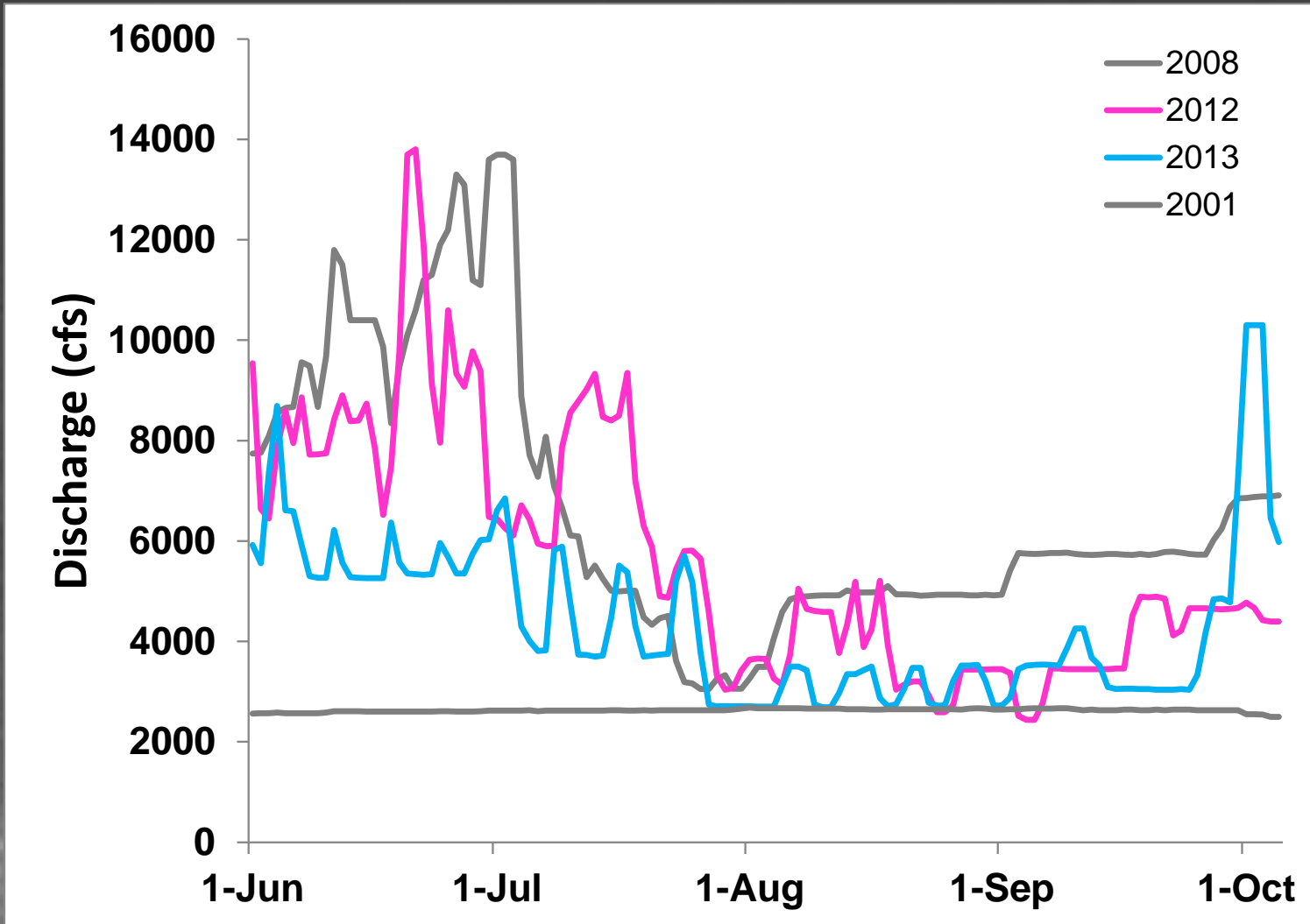
Tag type (radio/Floy vs Floy only)

Day of year

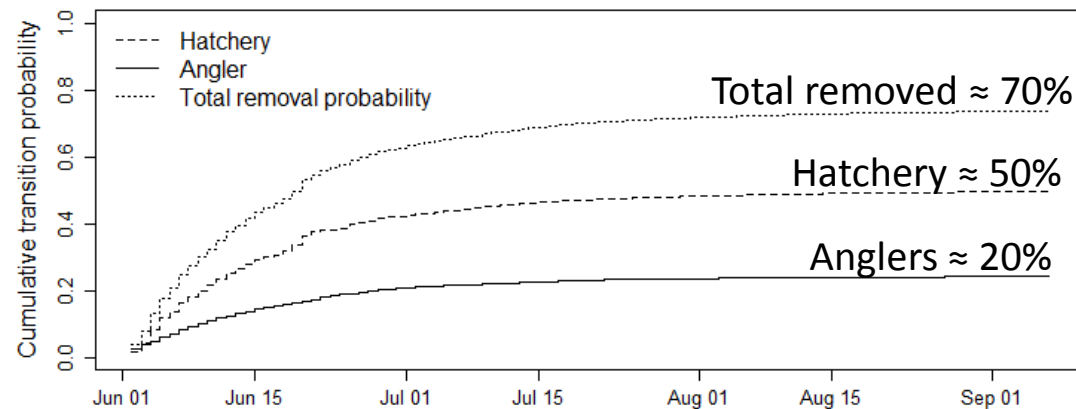
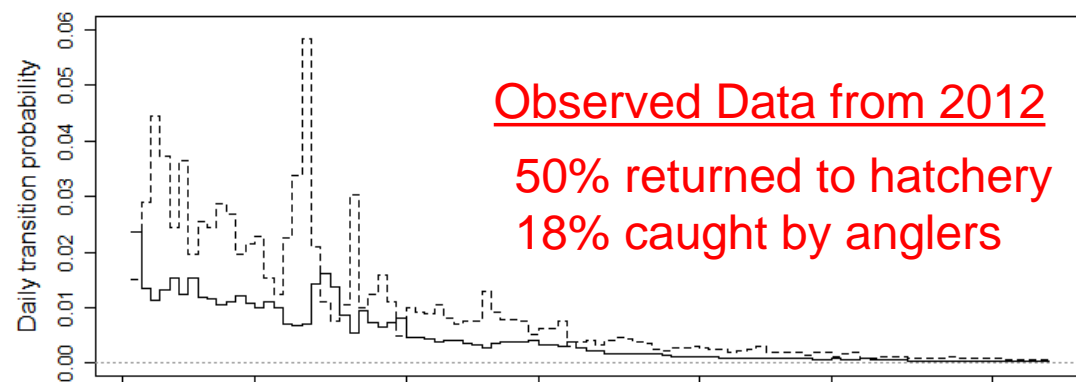
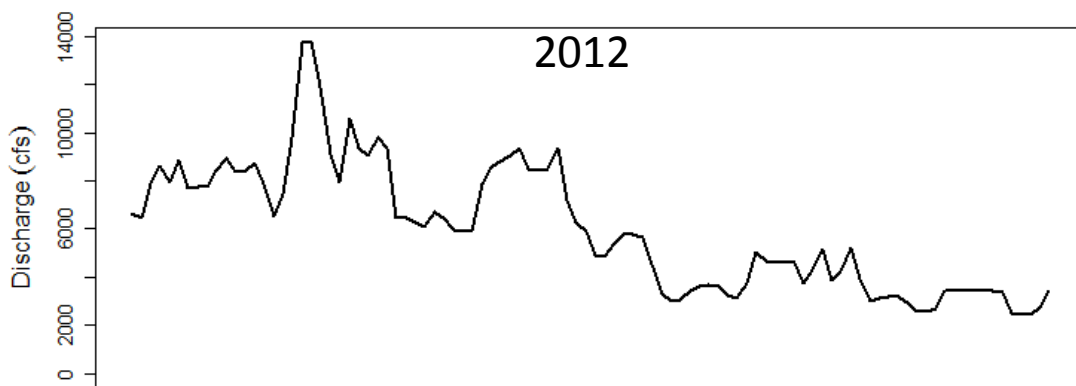
Hatchery return and angler harvest rates are initially high, then decrease rapidly



Lower Cowlitz River Flows 2000-2015

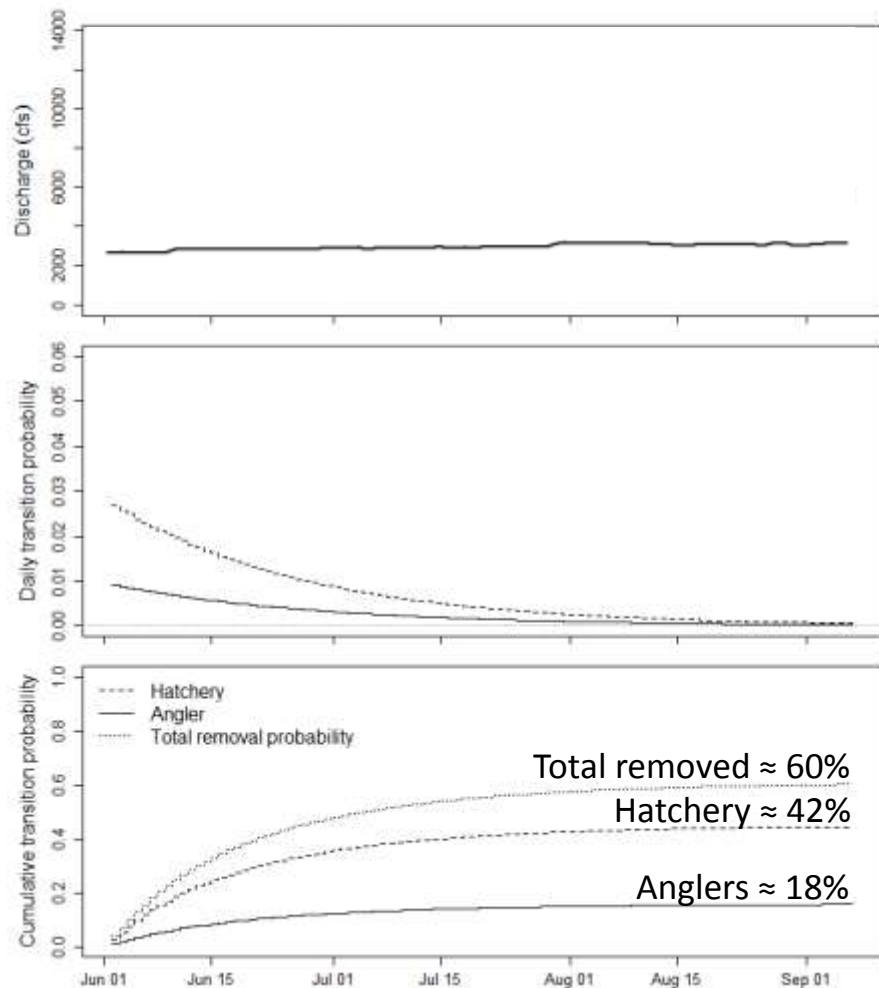


Predicting Recycling Outcomes



Predicting Recycling Outcomes

Low flow: 2001



High flow: 2008

