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Effects of attraction flow on downstream passage rates of PIT-tagged juvenile Chinook and steelhead at Round Butte Dam, Madras, Oregon

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Overview

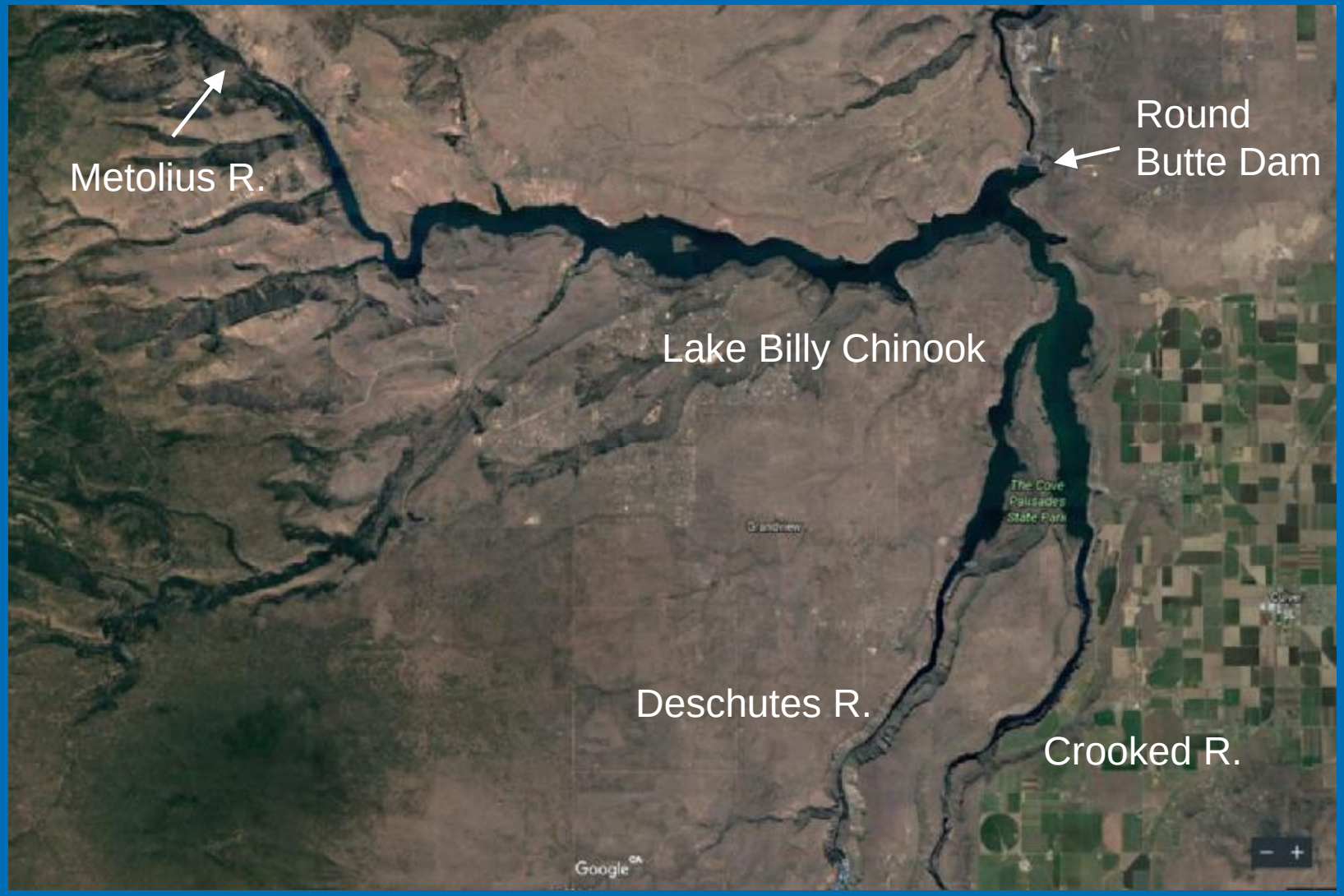
(1) Background

(2) Data and models

(3) Results

(4) Conclusions

Round Butte Dam



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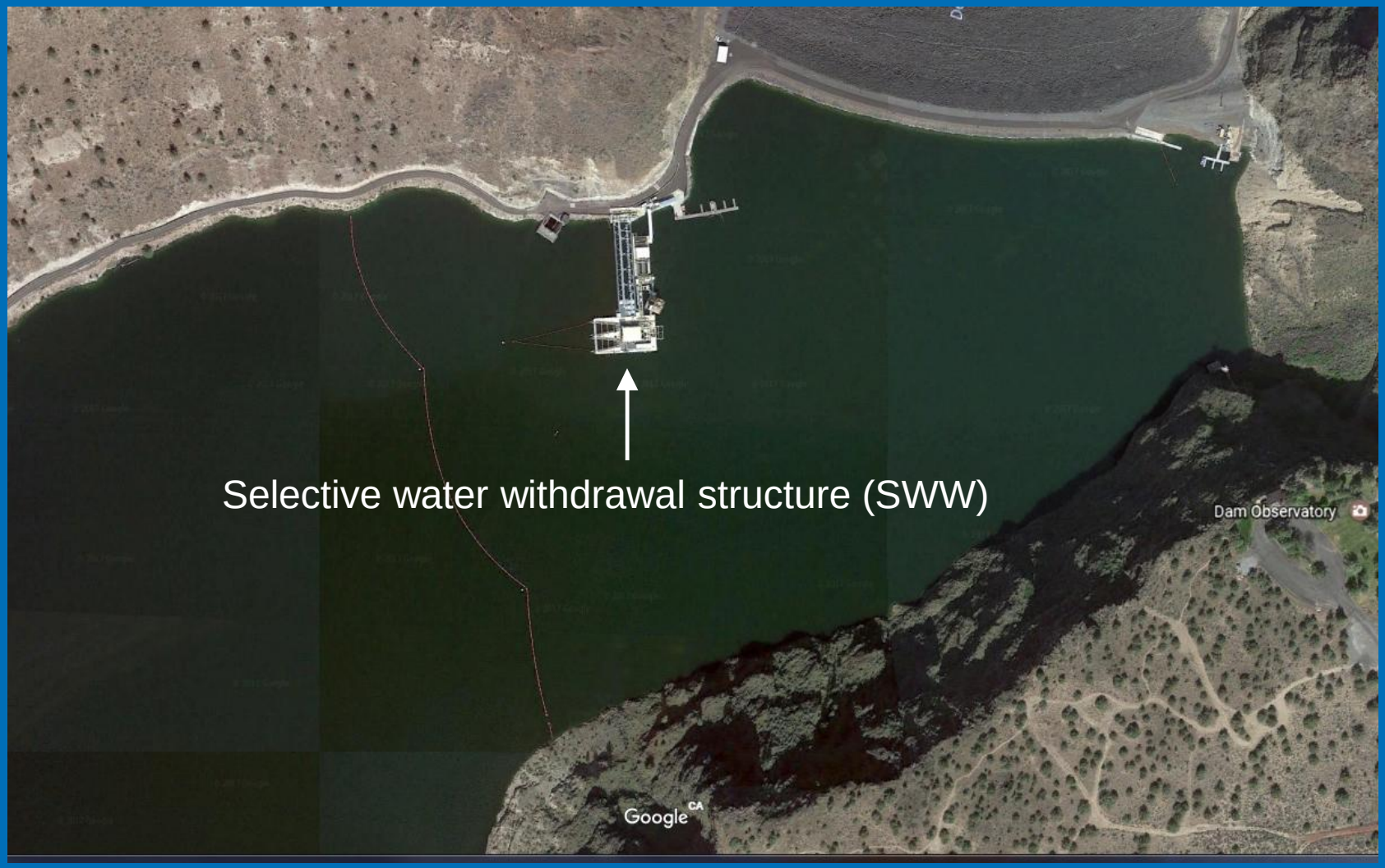
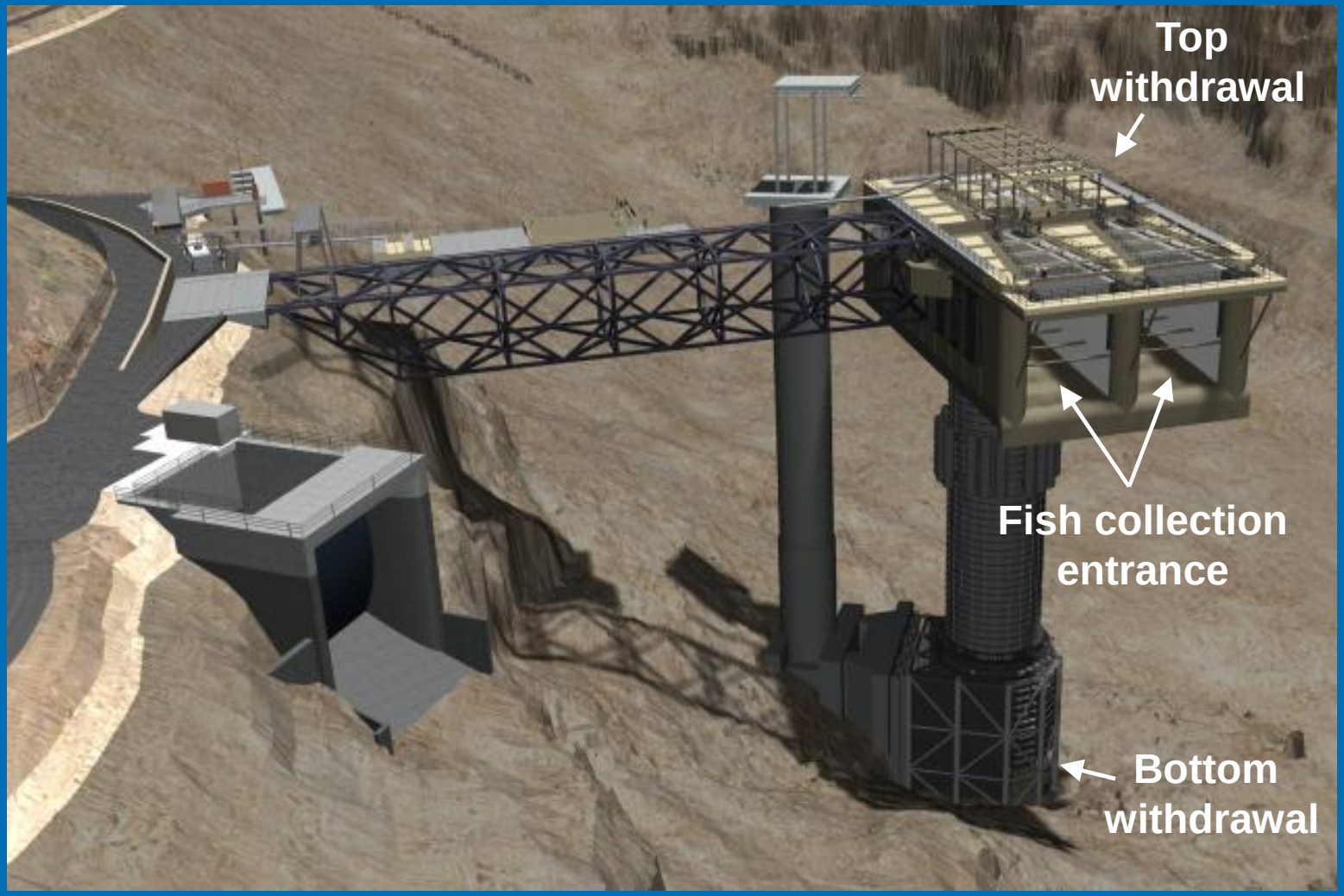


Selective Water Withdrawal (SWW) Structure



Background

- Passage rates of Chinook and steelhead smolts have been lower than expected
- Surface flows have been much more variable than originally planned

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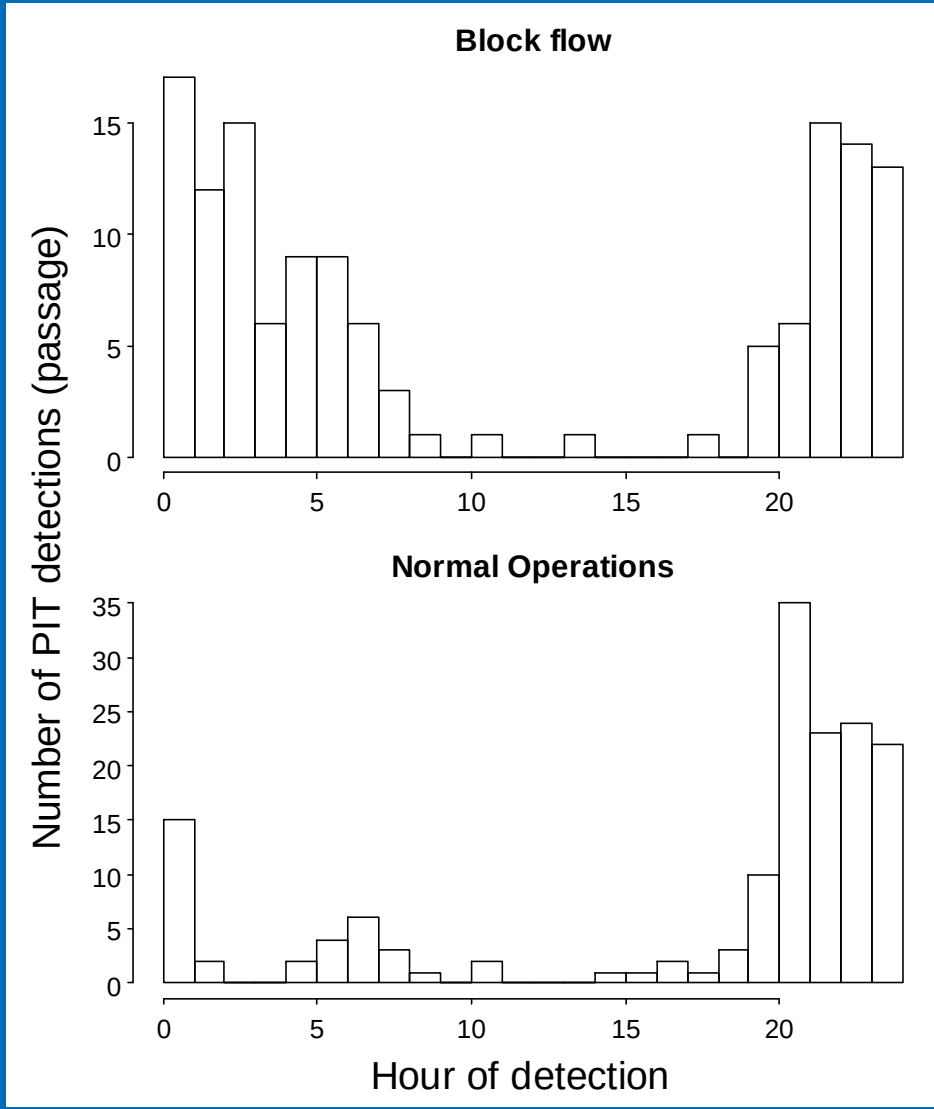
- Passage rates of Chinook and steelhead smolts have been lower than expected.
- Surface flows have been much more variable than originally planned.
- Acoustic telemetry studies (2012-13) provided limited insights regarding flow effects.
- Look at other data sources…

Background

- “Block flows” during 2013 acoustic study
- Adjacent periods of normal operations
- 291 upstream PIT-tagged Chinook smolts passed



Objective

- Use SWW PIT-tag detections of upstream releases to estimate the effects of surface flows on passage rates of Chinook and steelhead smolts.

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- Use SWW PIT-tag detections of upstream releases to estimate the effects of surface flows on passage rates of Chinook and steelhead smolts.
- Non-conventional approach: not interested in proportion detected; rather, interested in the within-day patterns of timing and flow at detection.
- Features that make the approach possible:

  (1) Surface flows variable across hours/days

  (2) Accurate measure of flow at time of passage

  (3) Detection probabilities very high (> 99%)

Smolt Passage Data

- PIT-tag detections for years 2010-2016
- Hatchery-reared smolts released at mouths of Deschutes, Crooked & Metolius rivers
- Naturally-reared smolts (from fry plants) tagged at rotary screw traps in the tributaries

	Chinook			Steelhead
Year	Hatchery	Naturally reared		Pooled
2010	327	581		112
2011	445	125		140
2012	375	135		126
2013	512	177		129
2014	532	143		112
2015	394	130		90
2016	570	--		126
Total	**3155**	**1295**		**835**

Modeling Approach ("Hourly models")

- Detections and mean surface flows were tabulated for each hour of each day across a given migration season

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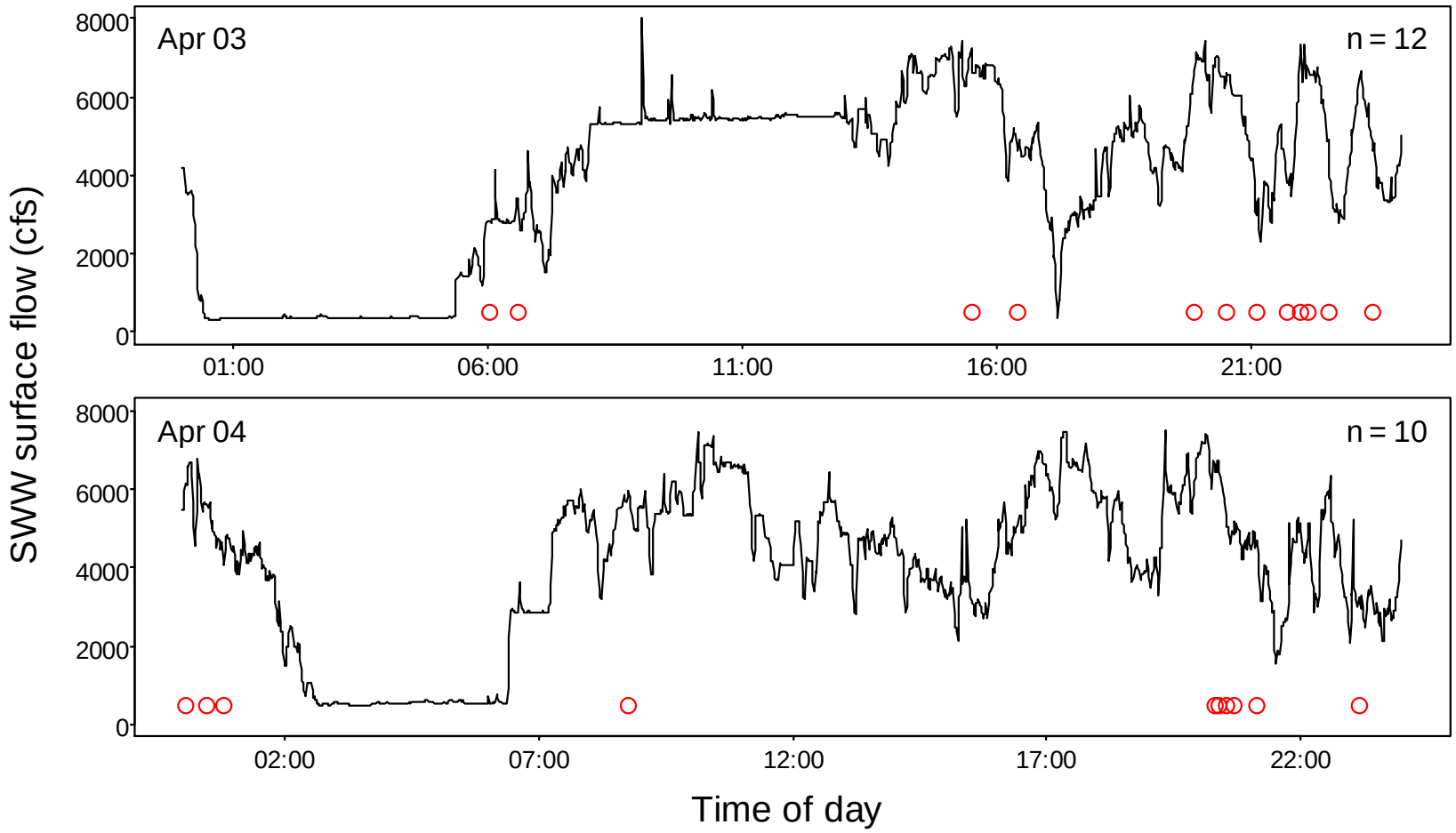
- Detections and mean surface flows were tabulated for each hour of each day across a given migration season
- Fit Poisson regression models:

$$\frac{\text{Detections by hour}}{\text{Total detects by day}} \sim \text{Hour} + \log(\text{Flow})$$

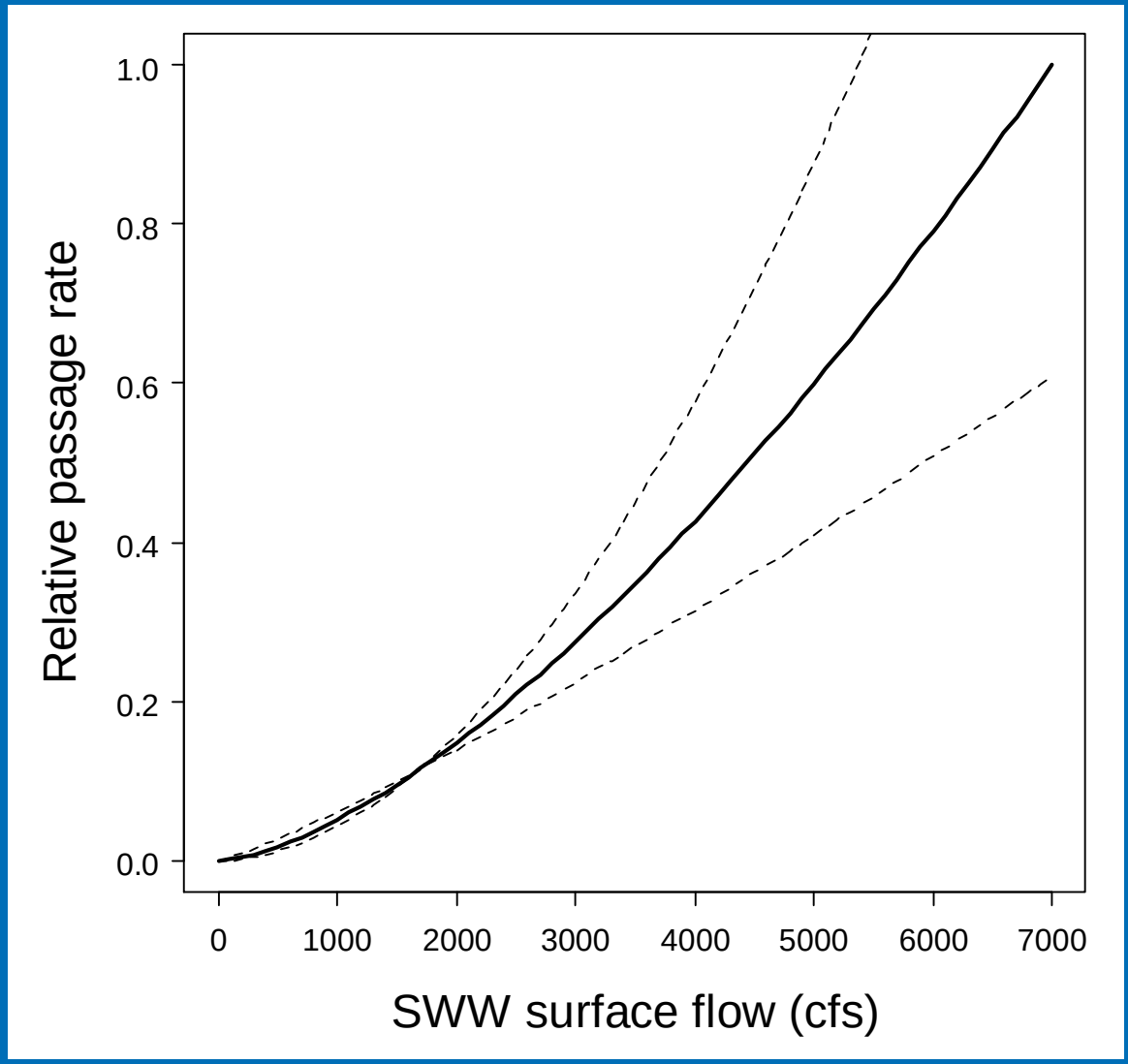
- Key assumptions: flow relationship and diel pattern constant across days

Results: Hatchery Chinook in 2013

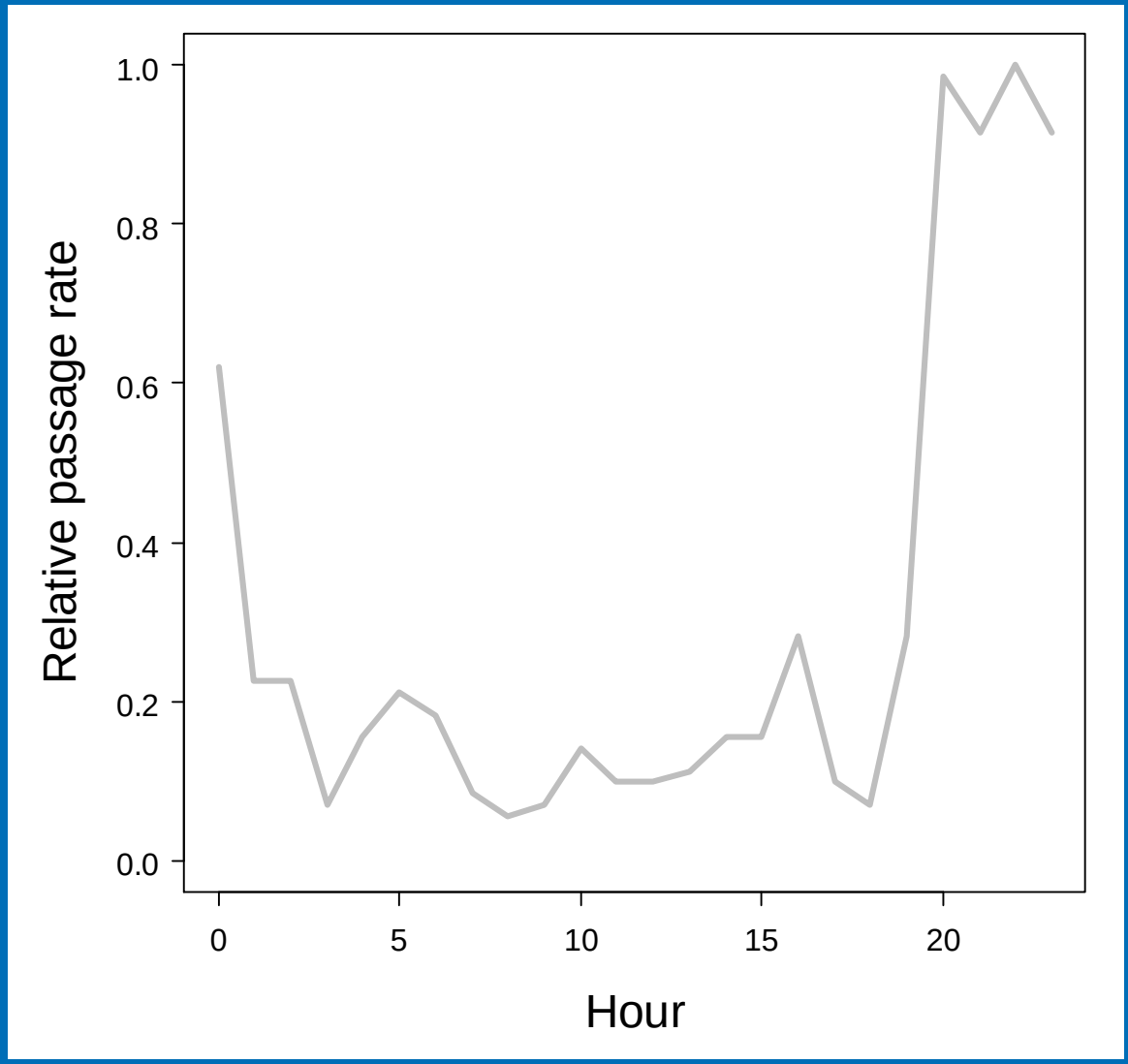
- Total of 512 detections across 92 days (n = 2082 hrs)



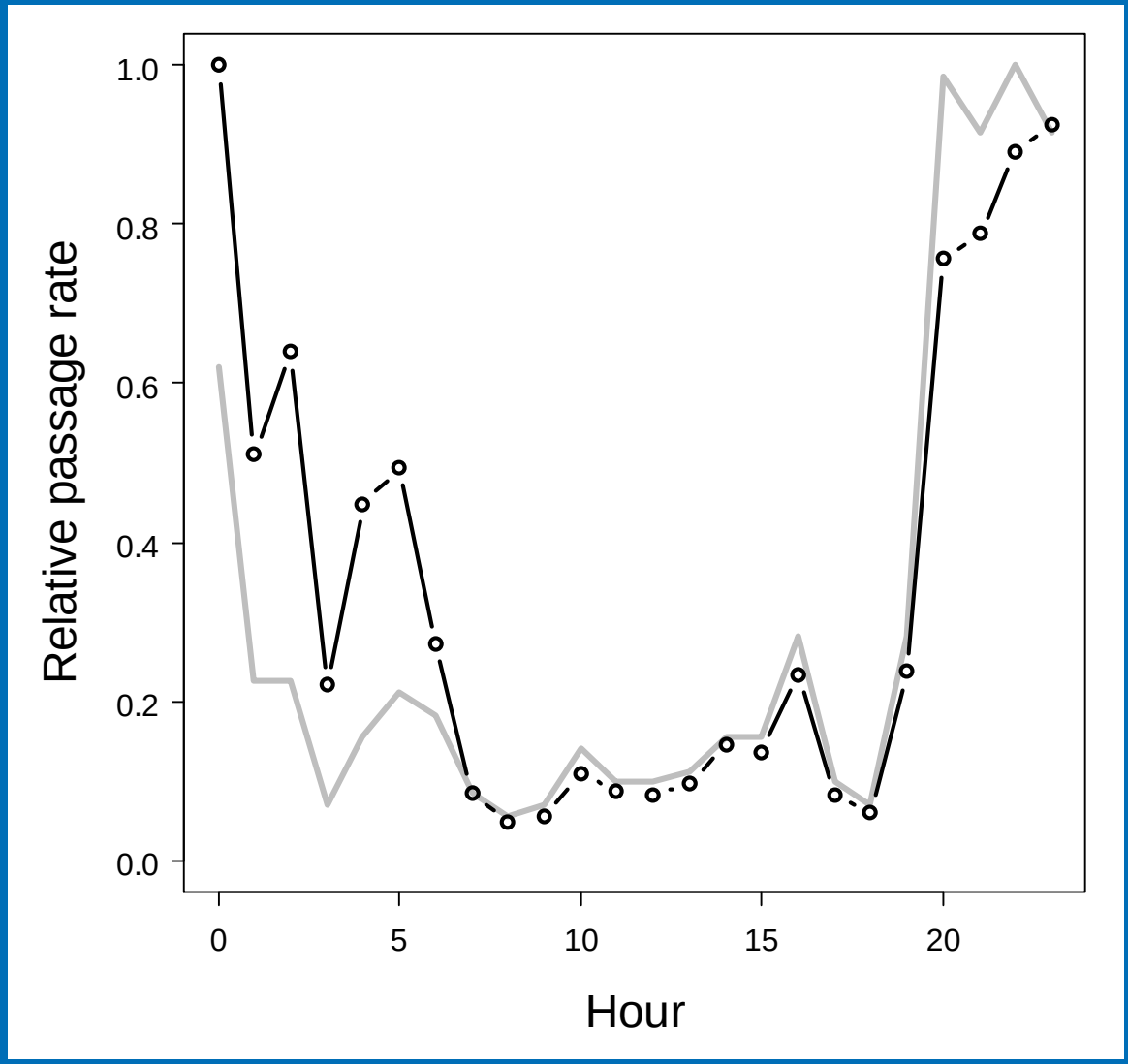
Flow-passage relationship for hatchery Chinook smolts in 2013



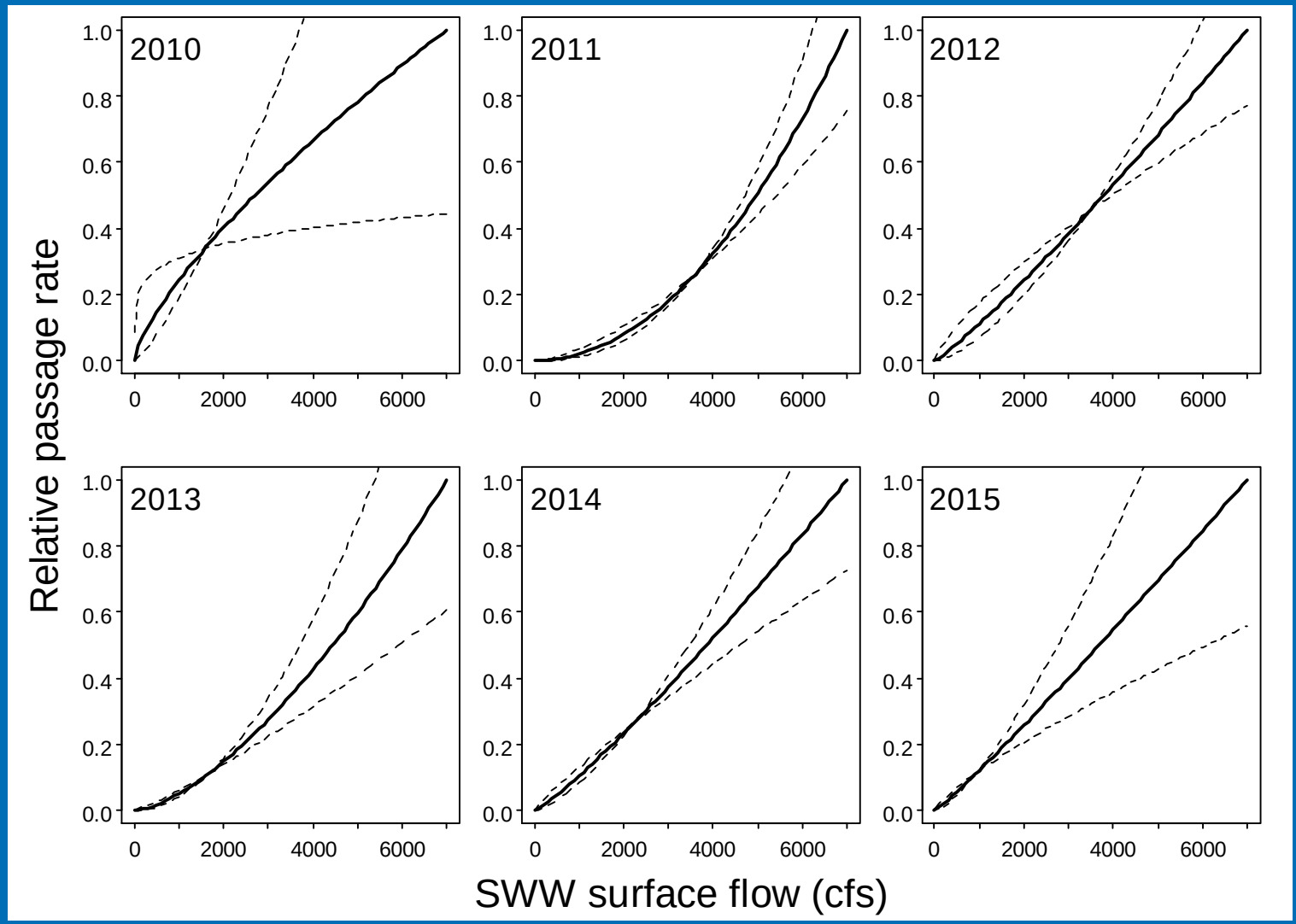
Diel pattern for hatchery Chinook smolts in 2013 (without flow)



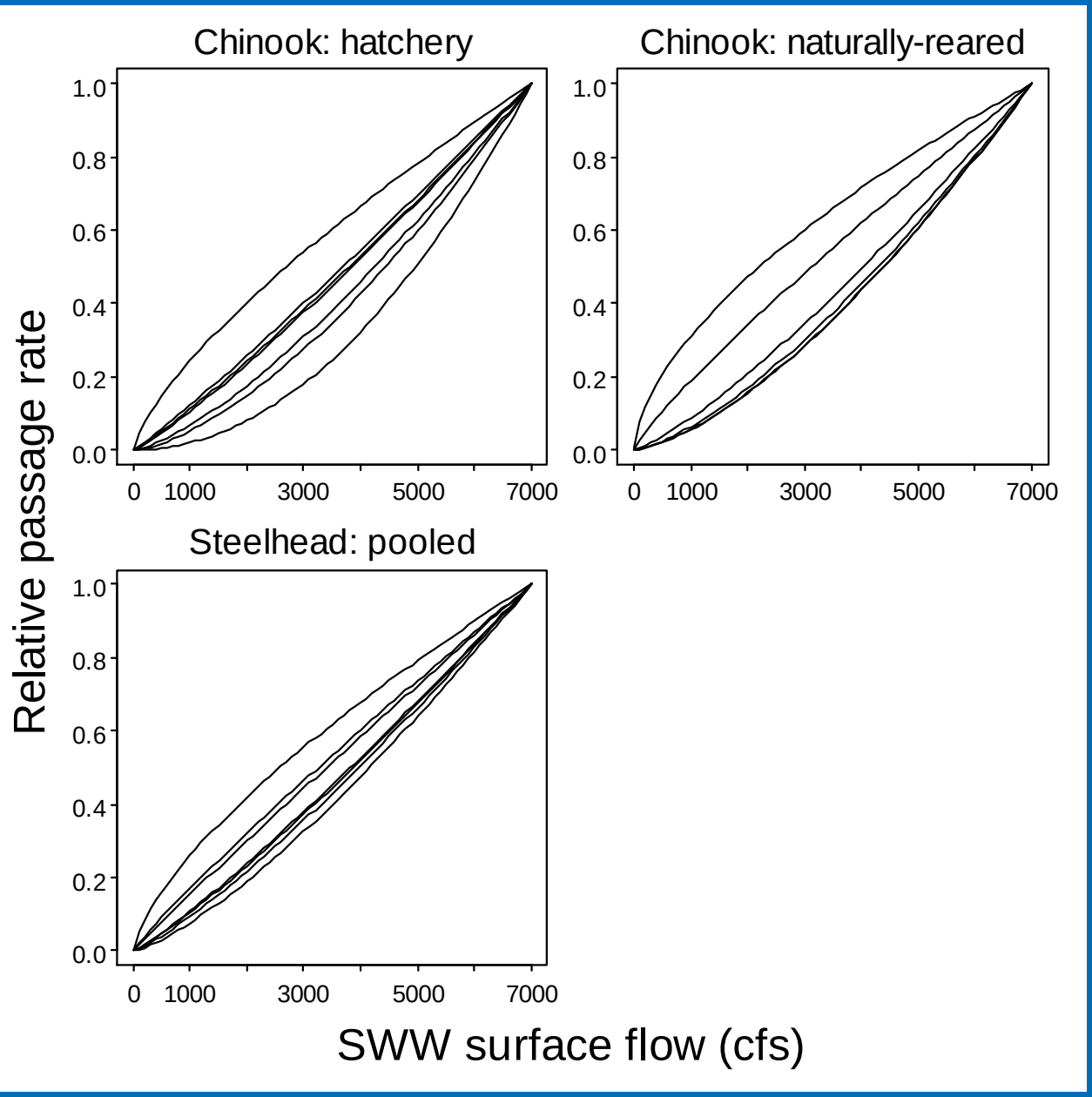
Diel pattern for hatchery Chinook smolts in 2013



Flow-passage relationships for hatchery Chinook smolts (2010-2015)

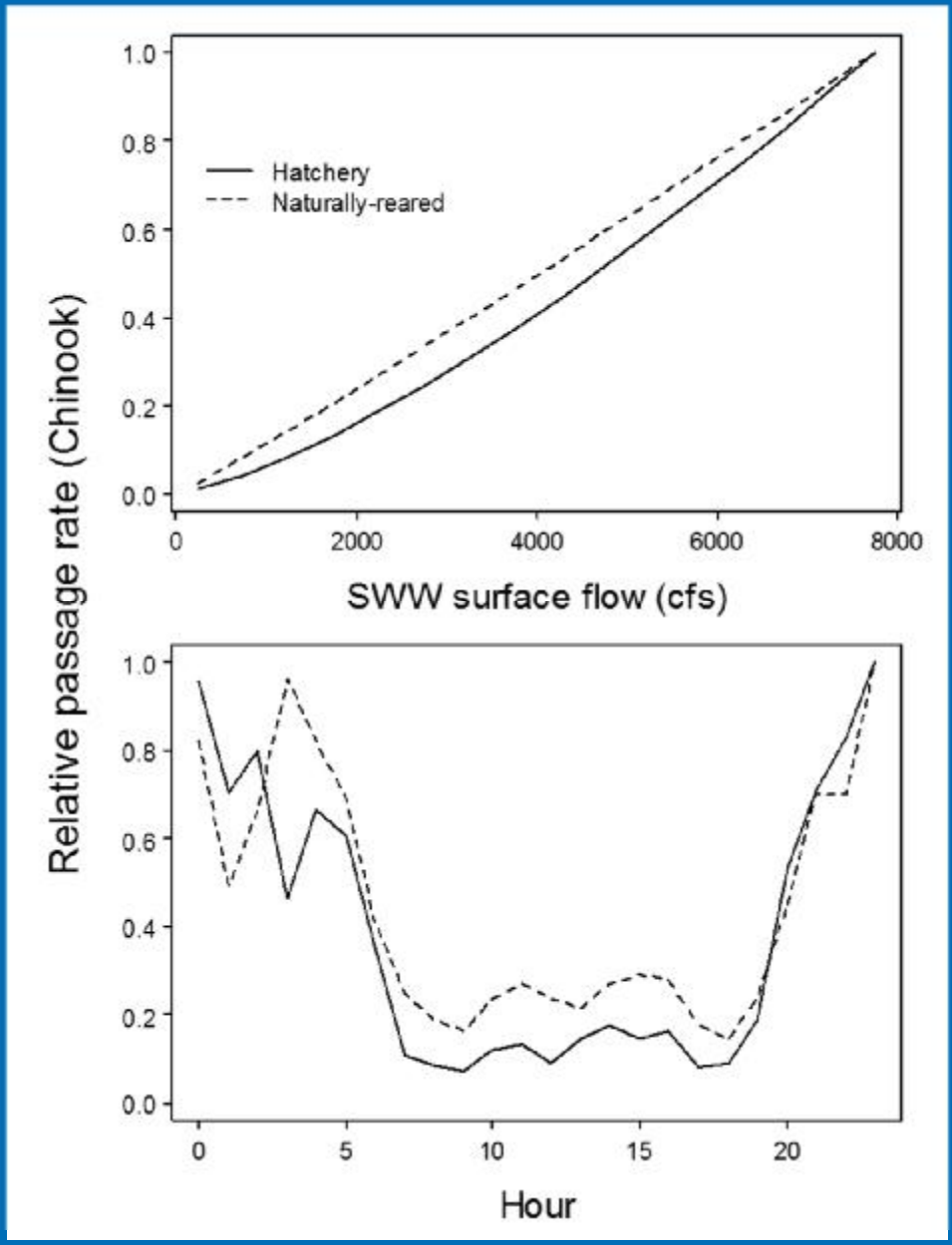


Flow-passage relationships (2010-2016)



Mixed-effects models

- Combine years
- Mean relationships plus year-specific differences (random effects)
- Results suggest flow and diel relationships quite consistent across years



Other Analyses

- Results were shown for passage rates as a function of log(flow), however…
- Other forms examined, included raw flow and nonlinear models (broken-stick and spline)
- Overdispersion addressed
- Model selection criteria used (e.g., QAIC)
- Also examined models comparing flow at detection versus flow available across discrete periods (stronger flow effects)
- Simulation analyses

Conclusions

- Evidence of strong, roughly linear relationships between flow and passage.
- Improved estimates of diel patterns by accounting for flow.

Conclusions

- Evidence of strong, roughly linear relationships between flow and passage.
- Improved estimates of diel patterns by accounting for flow.
- Flow relationships and diel patterns intuitive, and provide key insight into the relative importance and timing of surface flow.
- However, flow effects on absolute passage rates unclear; depends on forebay mortality rates and SWW encounter rates.

Next steps

- Upstream releases of radio-tagged smolts in 2017 (many fish).
- Examine forebay residency and passage timing using time-to-event analysis.