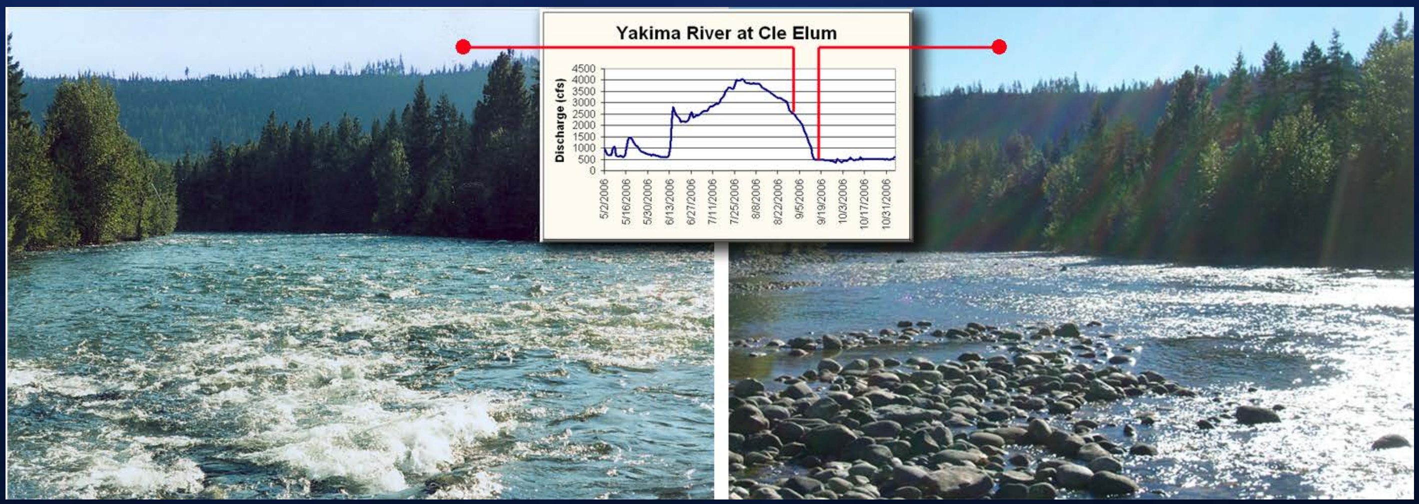
ANALYSIS OF SPRING CHINOOK RECRUITMENT IN RESPONSE TO “FLIP-FLOP” OPERATIONS OF THE YAKIMA PROJECT

DRAFT RESULTS



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[1] Consultant to Cramer Fish Sciences

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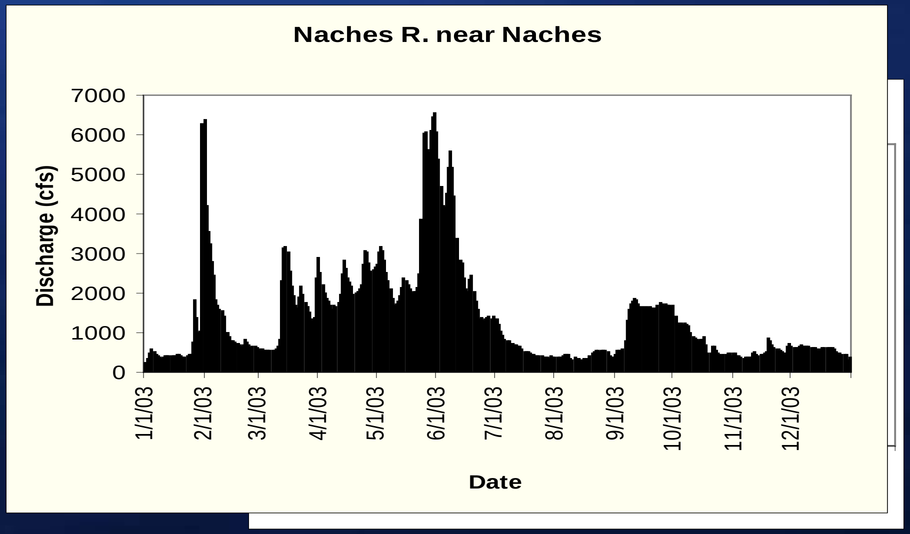
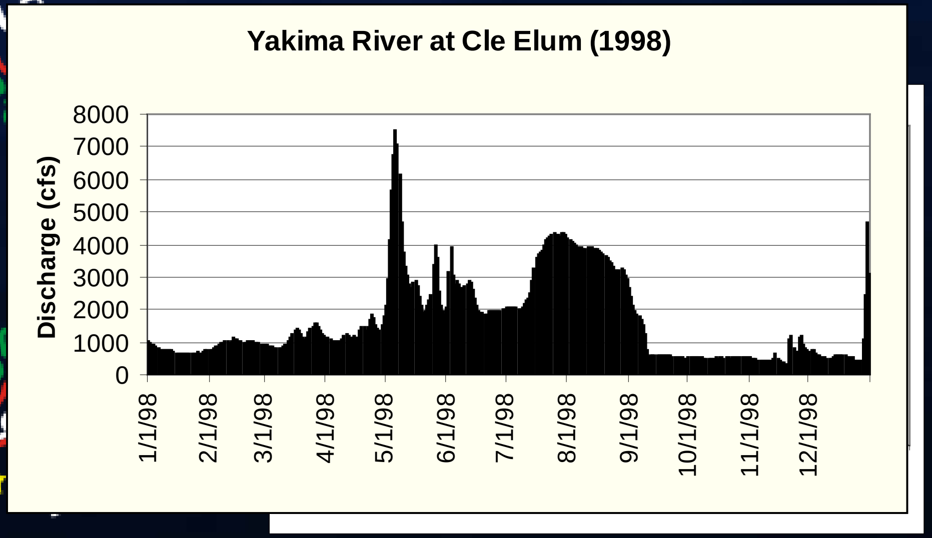
Objectives of this Study

- Review in-basin and out-of-basin research related to the potential effects of Flip-Flop
- Analyze currently available data to quantify the effects of Flip-flop on spring Chinook
- Conduct a cause-and-effect analysis of potential alterations to the Flip-flop flow management strategy if possible
- Identify any needs for studies to fill critical data gaps

Overview of "Flip-flop Operations in the Yakima Basin





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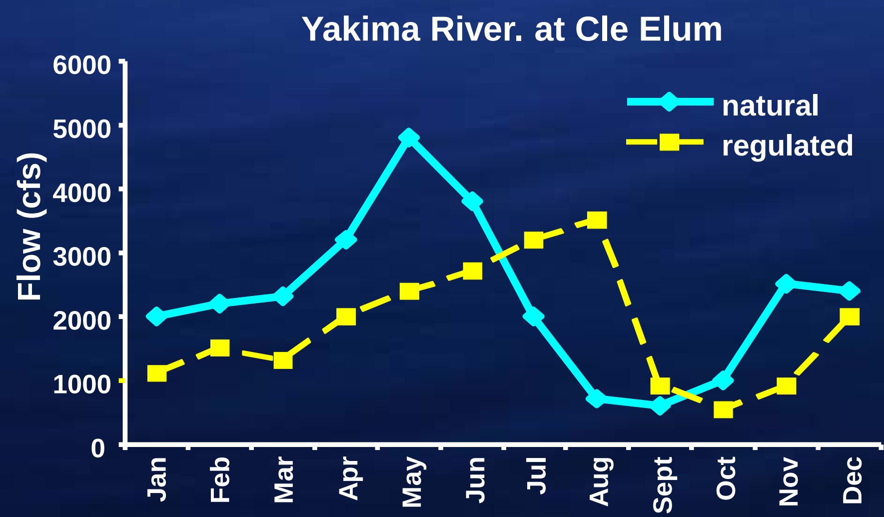
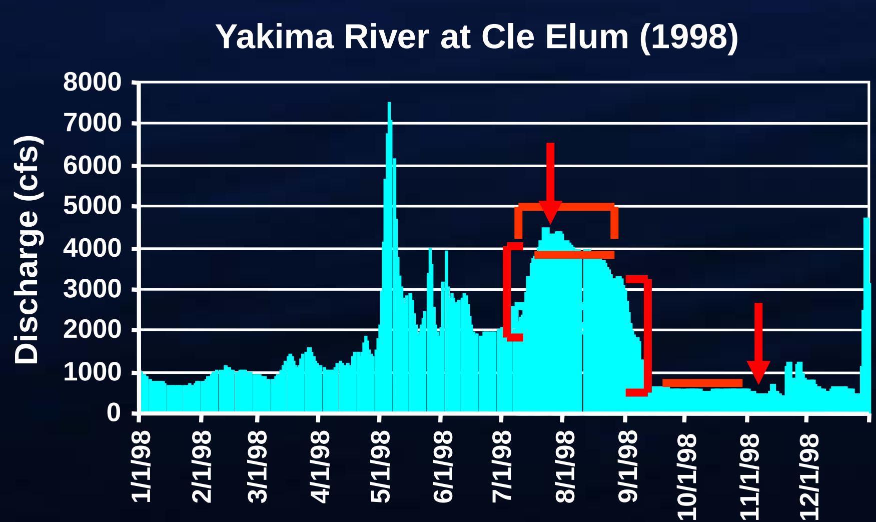
Critical Questions— Over 20 Years of Flip-Flop

- Is the operation successful at sustaining aquatic life while meeting the water demands in the Yakima Basin?
- What are the positive and negative impacts of Flip-flop to Chinook and other salmonids?
- Are there more effective means to support salmonid production and water uses by modifying the Flip-flop operation?

Flip-flop Flow Operations Potentially Affecting Salmon Production

Upper Yakima Subbasin





Flow Variables Potentially Impacting Chinook

- **Mean summer high flow (7/1 to 8/15)**
- **Max. summer high flow (6/1 to 9/1)**
- **Duration (# days of high flow release)**
- **Mean Fall Base flow (9/15 to 11/30)**
- **Min. fall low flow (10/1 to 11/30)**
- **Max ramp-up flow magnitude**
- **Max ramp-down flow magnitude**
- **Max ramp-up ratio (Δcfs/days)**
- **Max ramp-down ratio (Δcfs/days)**

Upper Yakima Subbasin

Upper Yakima Subbasin

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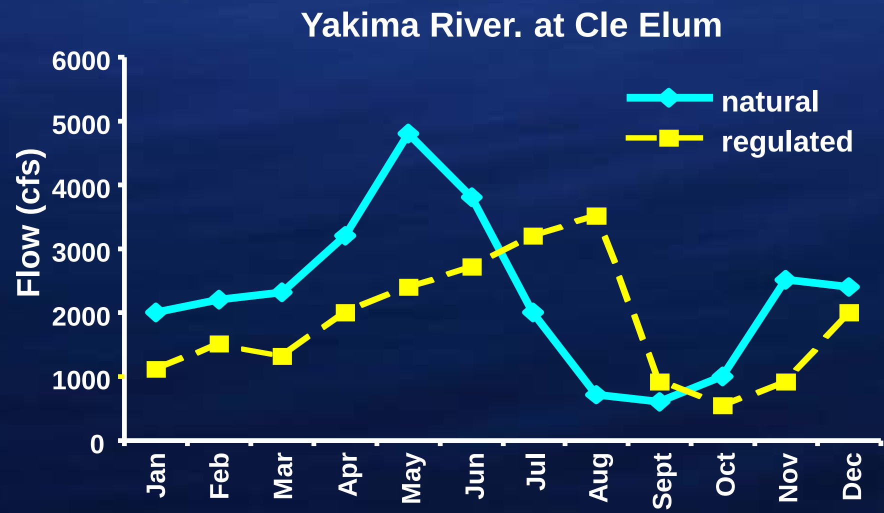
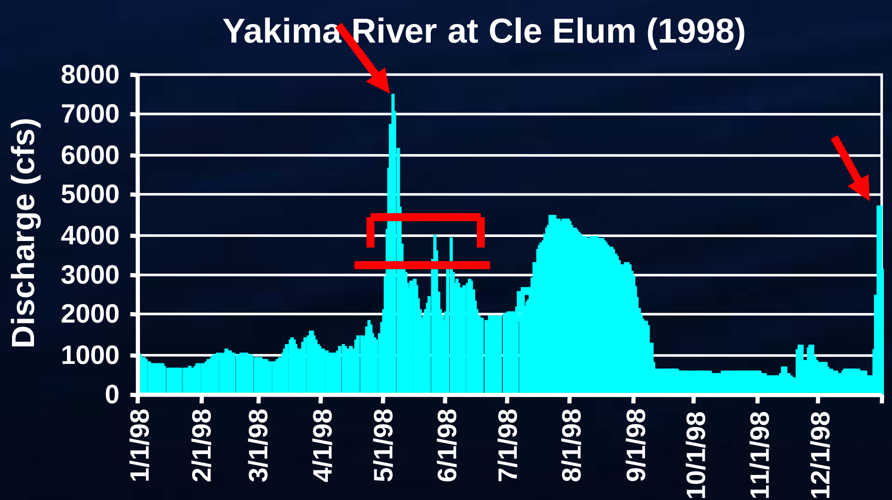
Upper Yakima Subbasin

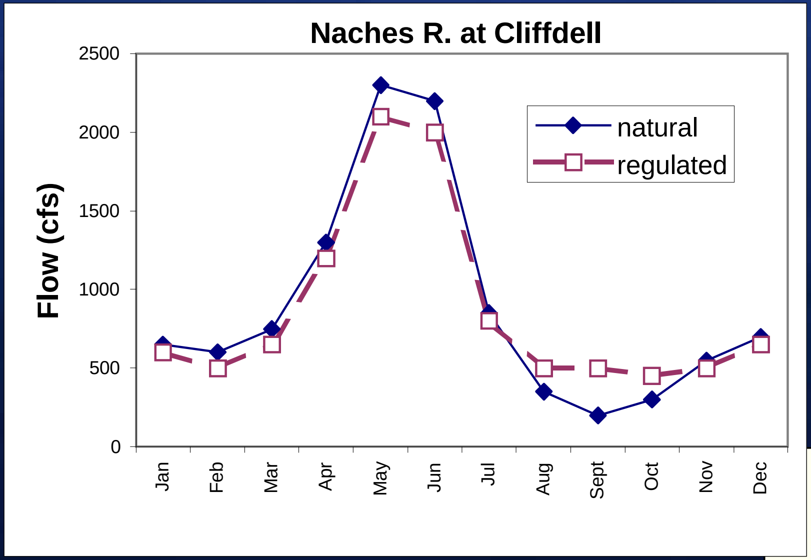




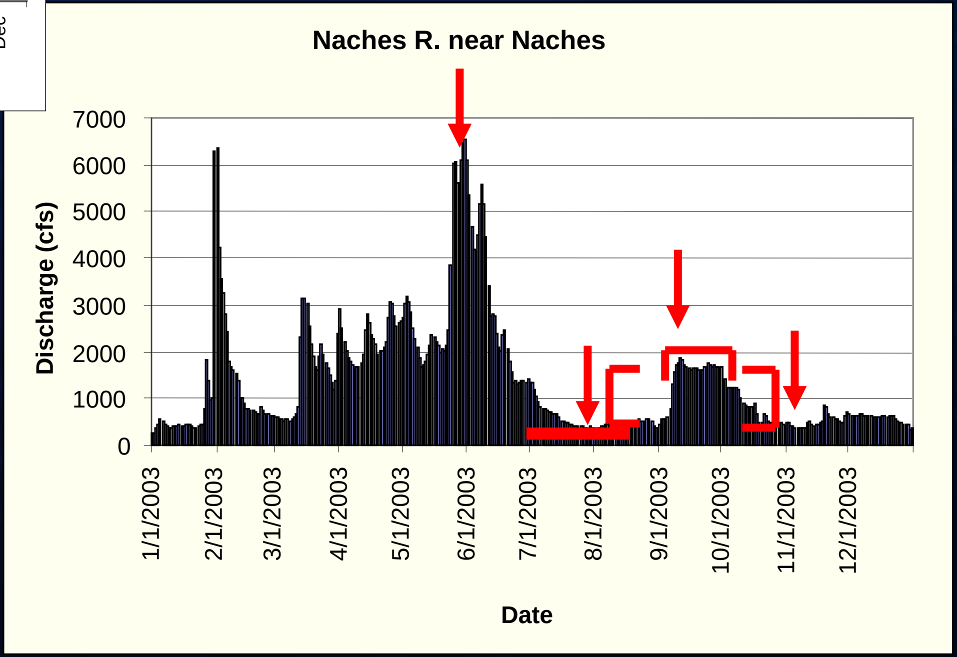
Flow Variables Potentially Impacting Chinook

- Peak winter flood flow for incubation (12/1 to 2/28)
- Peak flow during primary outmigration period (4/1 to 5/30)
- Mean flow during primary outmigration period (4/1 to 5/30)
- Duration of high spring flows (number of days with flows greater than 1500 cfs [60th percentile] occurring during primary outmigration period [4/1 to 5/30]

Naches Subbasin



Flow Variables Potentially Impacting Chinook



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Analysis Of Effects On Fish Production

1) **“Recruits-per-spawner”—estimates for each subbasin***

- Fit to spawner abundance (Ricker stock-recruitment relationship
- Include ocean survival index (‘common-year-effect’)

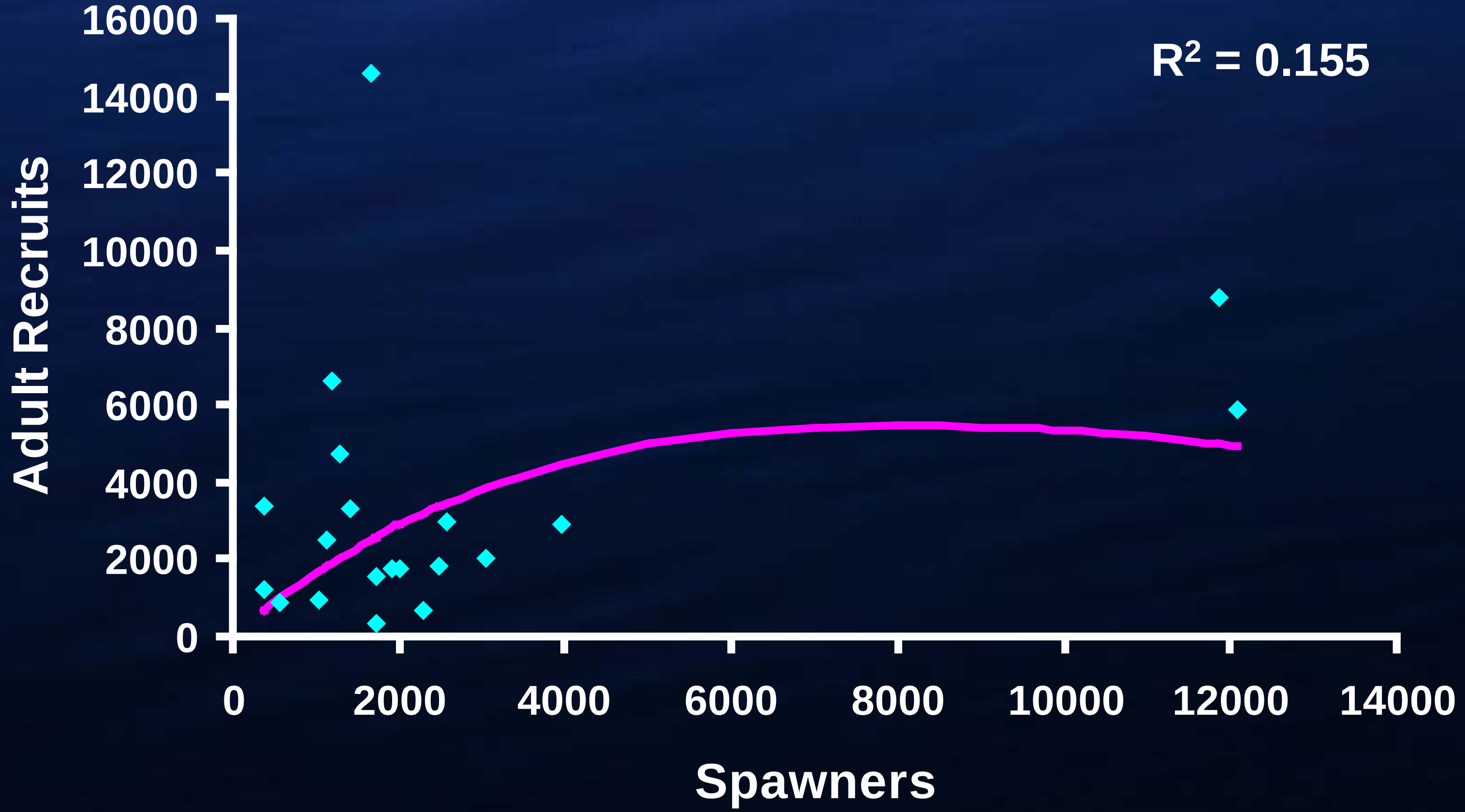
$$\log(R/S) = a + b*S + c*CYE + d*FlowVariable$$

2) **“Smolts-per-spawner” (Yakima and Naches subbasins combined)***

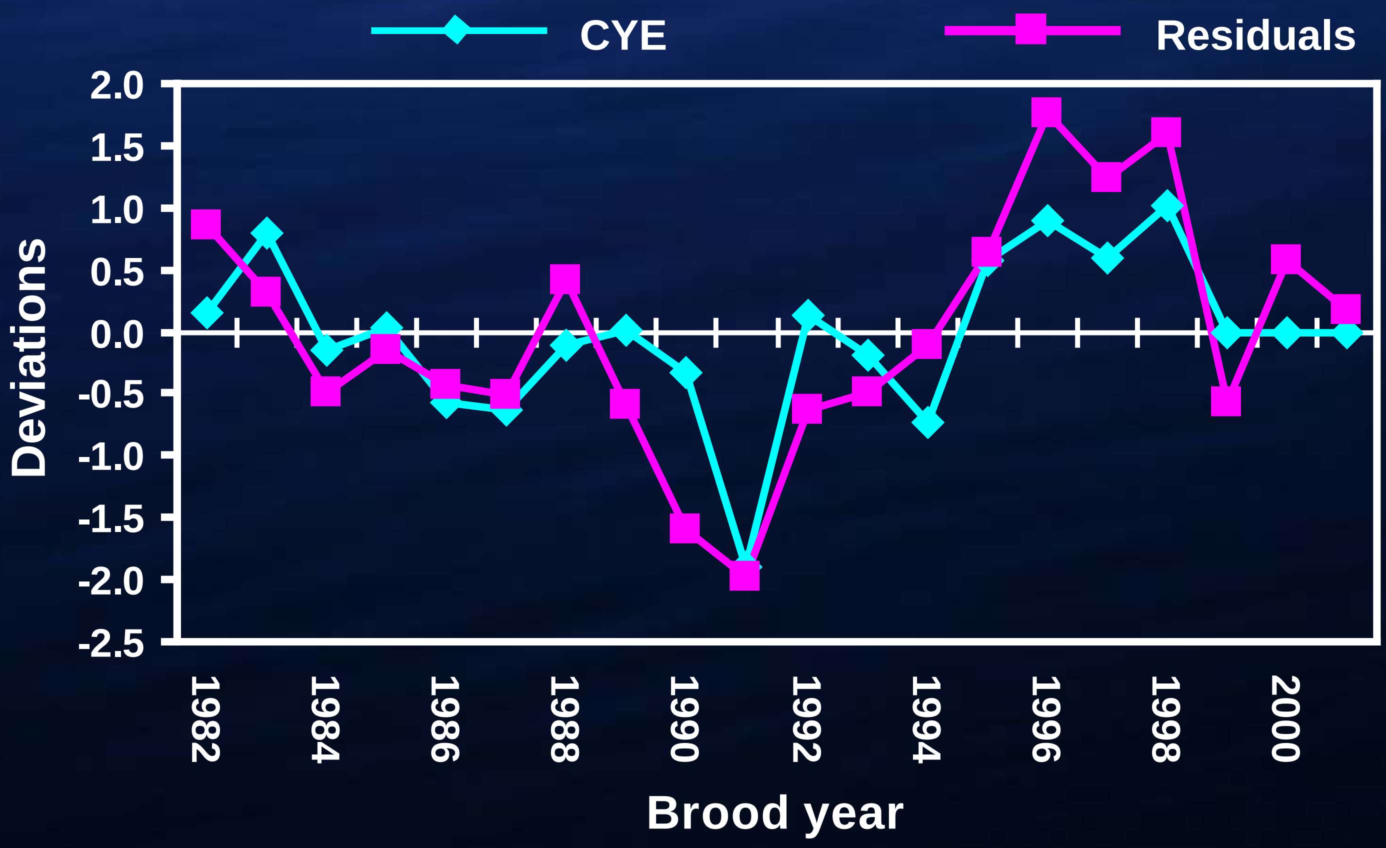
$$\log(Smolts/S) = a + b*S + d*FlowVariable$$

*Data Source: Yakima/Klickitat Fisheries Project-Monitoring and Evaluation (Bosch 2006)

Ricker Stock-Recruitment Relationship for the Upper Yakima Spring Chinook



Common Year Effect and Residuals from Ricker Model by Brood Year



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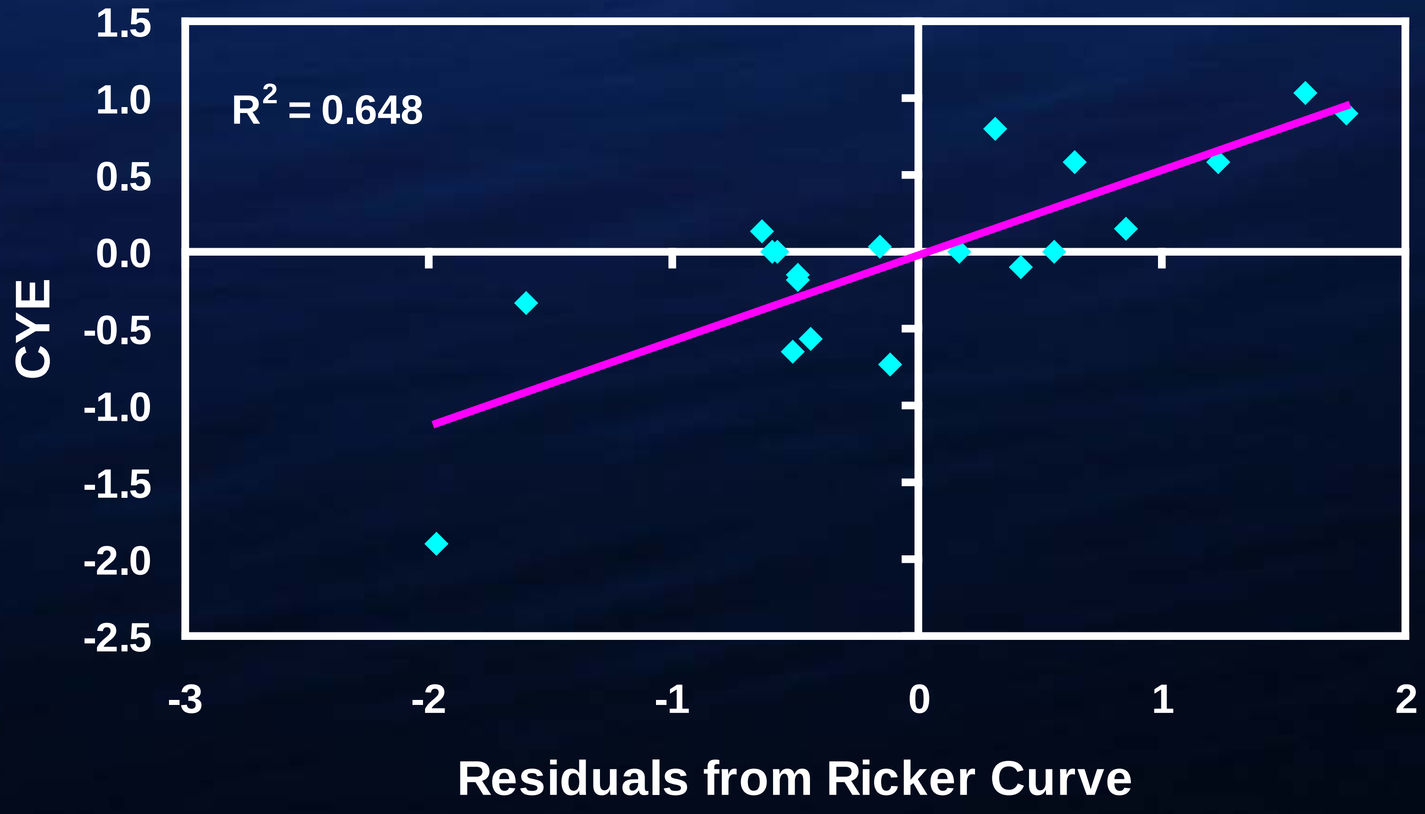
Common Year Effect vs. Residuals

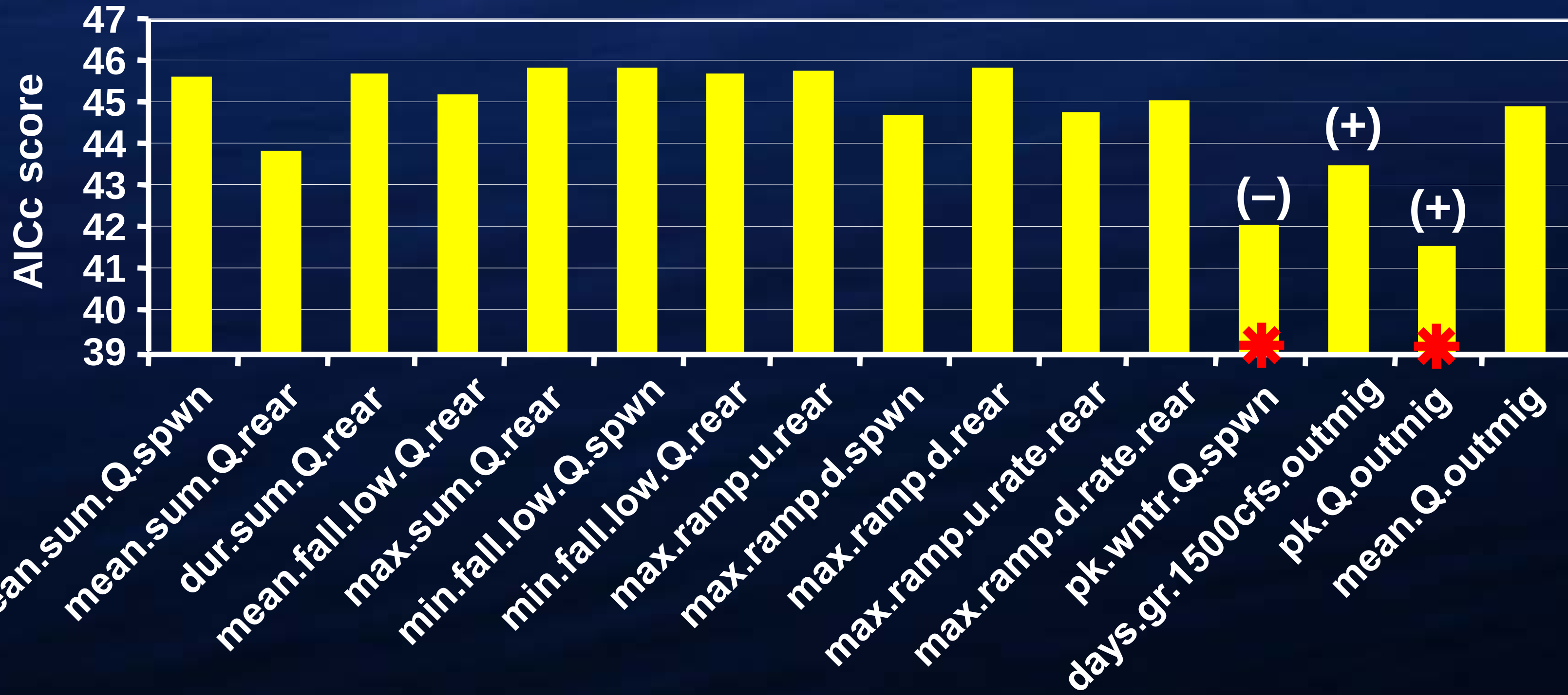


Results

Upper Yakima subbasin

Predicting Recruits per Spawner

Strength of Variable Influence



Flow variables

(+) positive relationship

(–) negative relationship

Lower AICc = stronger influence

✱ -significant (α<0.10)

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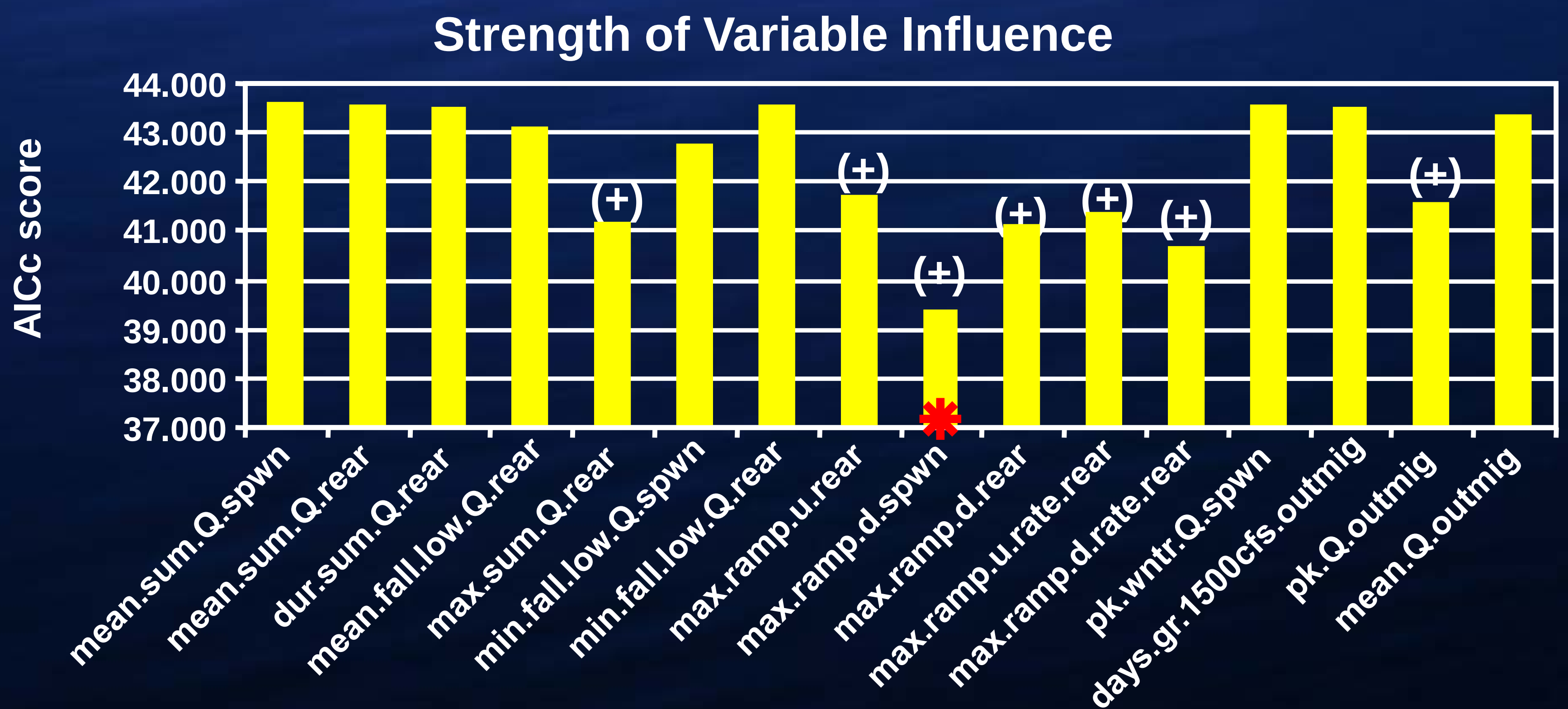
Upper Yakima subbasin

Predicting Recruits per Spawner



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Naches subbasin

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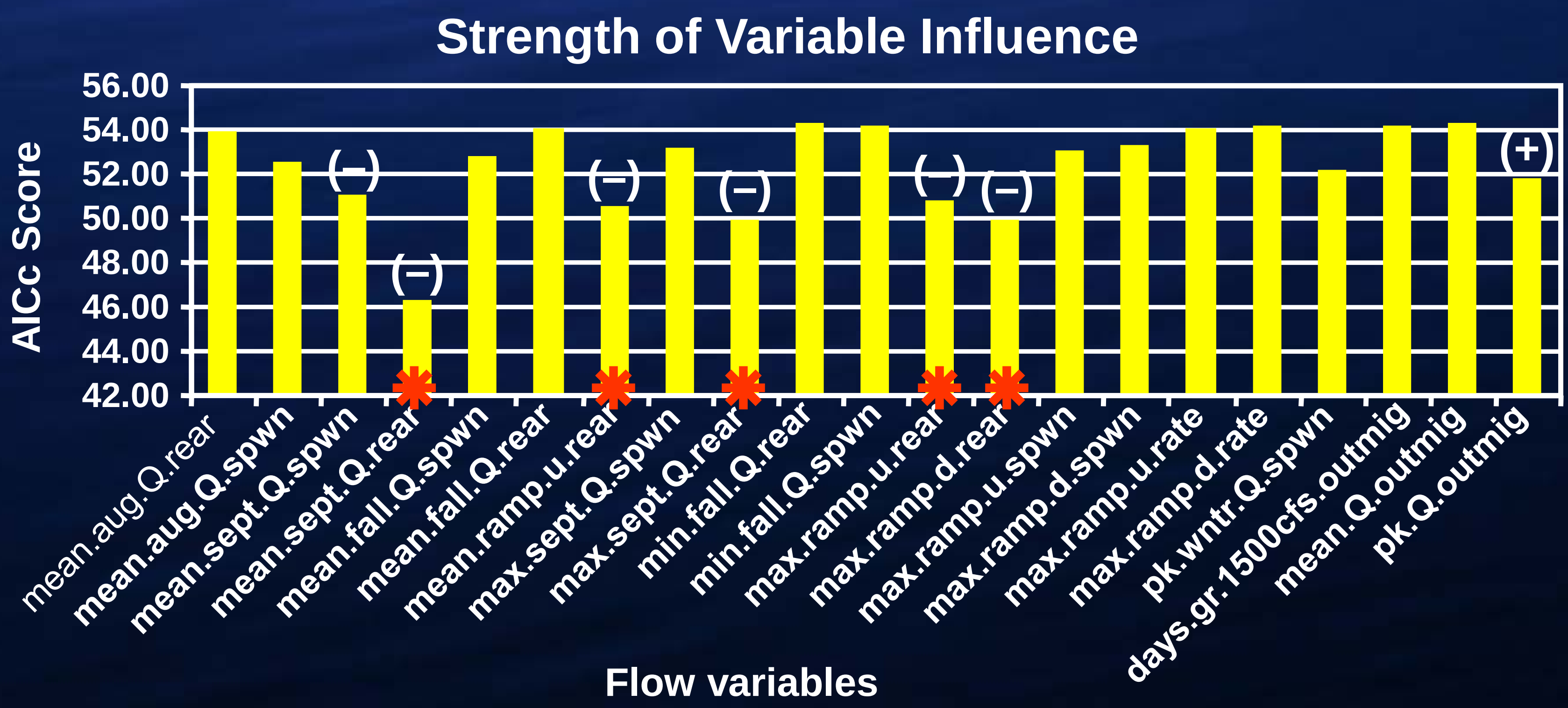

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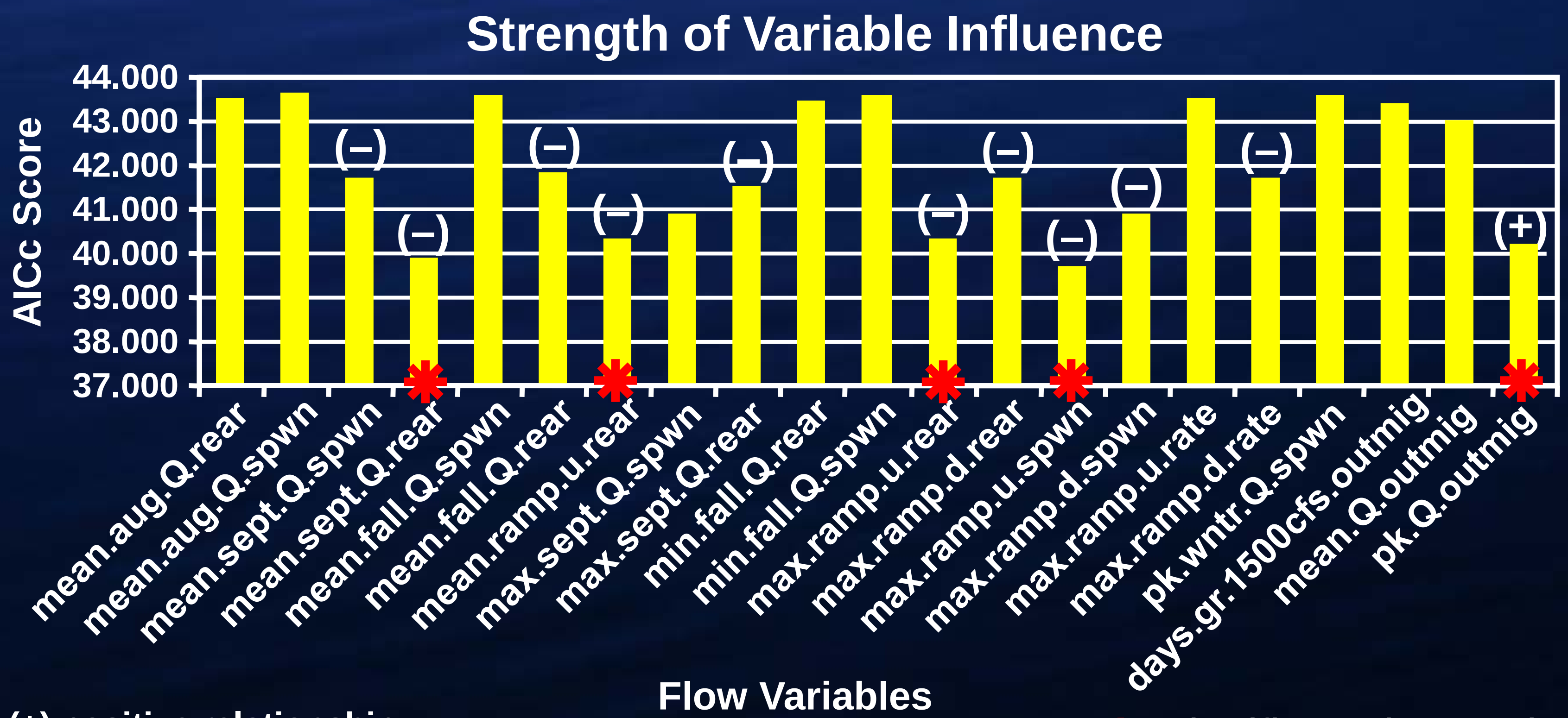
Naches subbasin

Predicting Recruits per Spawner



(+) positive relationship

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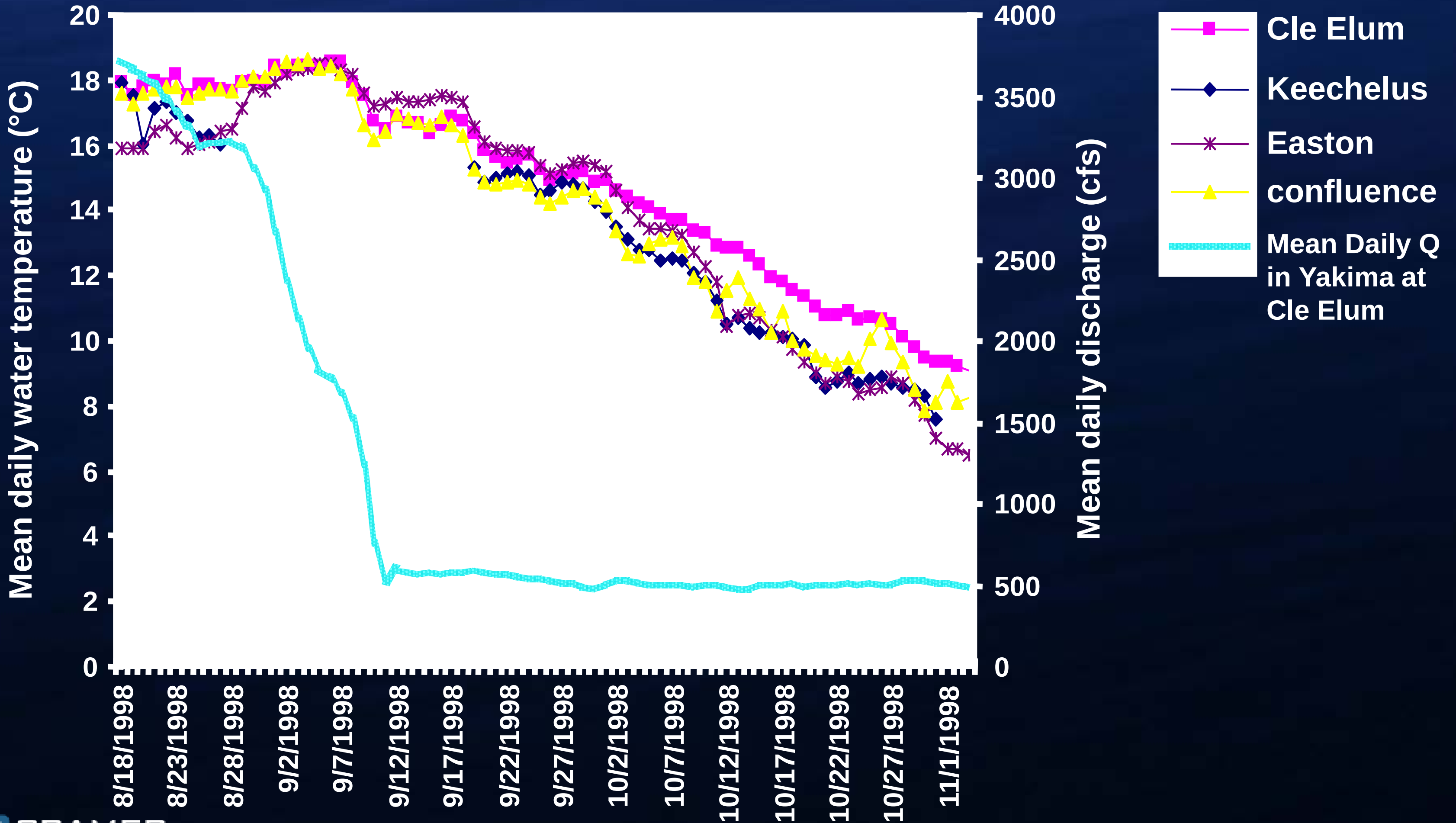
Stream Temperature

Upper Yakima Subbasin



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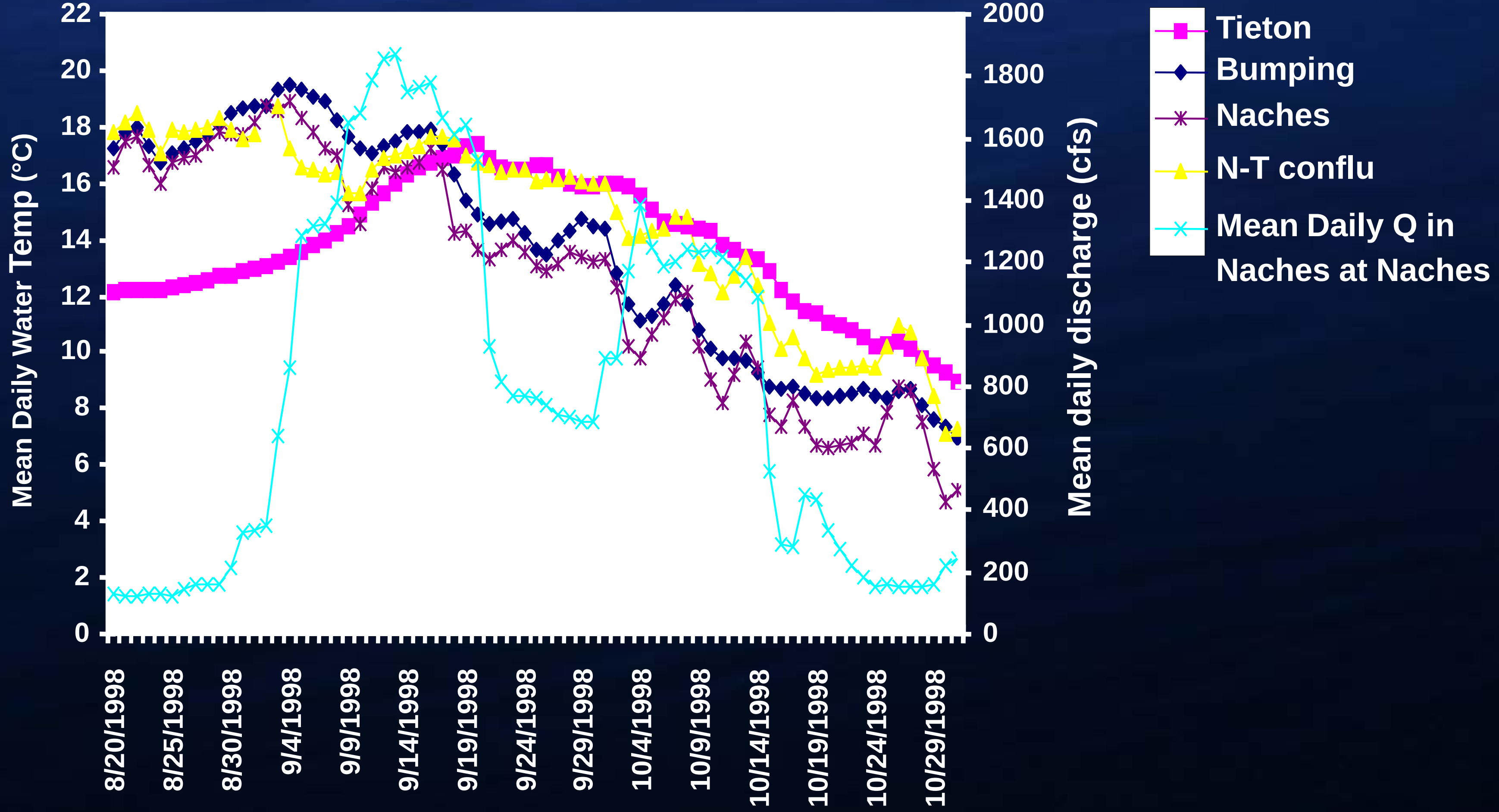
Stream Temperature

Naches Subbasin



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Uncertainty

Recruits-per-spawner

- out-of-Yakima basin influences

Smolts per spawner

- out-of-subbasin influences

Flow Variables

- Within-basin influences

Data Needs

- Can we further pin-point the causal mechanisms Flip-Flop may have upon salmon?
- What information do we need in order to produce an effective remedy?
- What data do we need to have conclusive evidence for modifying the Flip-flop flow operations?
- Collecting information that will link operations to specific impacts to salmon is necessary to make informed choices.

Conclusions

- These coarse metrics for assessing the effects of Flip-flop operations on Chinook survival are suggestive that effects have been neutral in the upper Yakima Basin but may be detrimental to juvenile rearing in the Naches Basin.
- Specific studies will be needed to determine what parameters of the Flip-flop operations are the most influential on Chinook productivity (if any).
- Parsing out impacts will enable managers to explore whether alternatives to the Flip-flop flow operations may produce more salmon while meeting irrigation needs of the basin