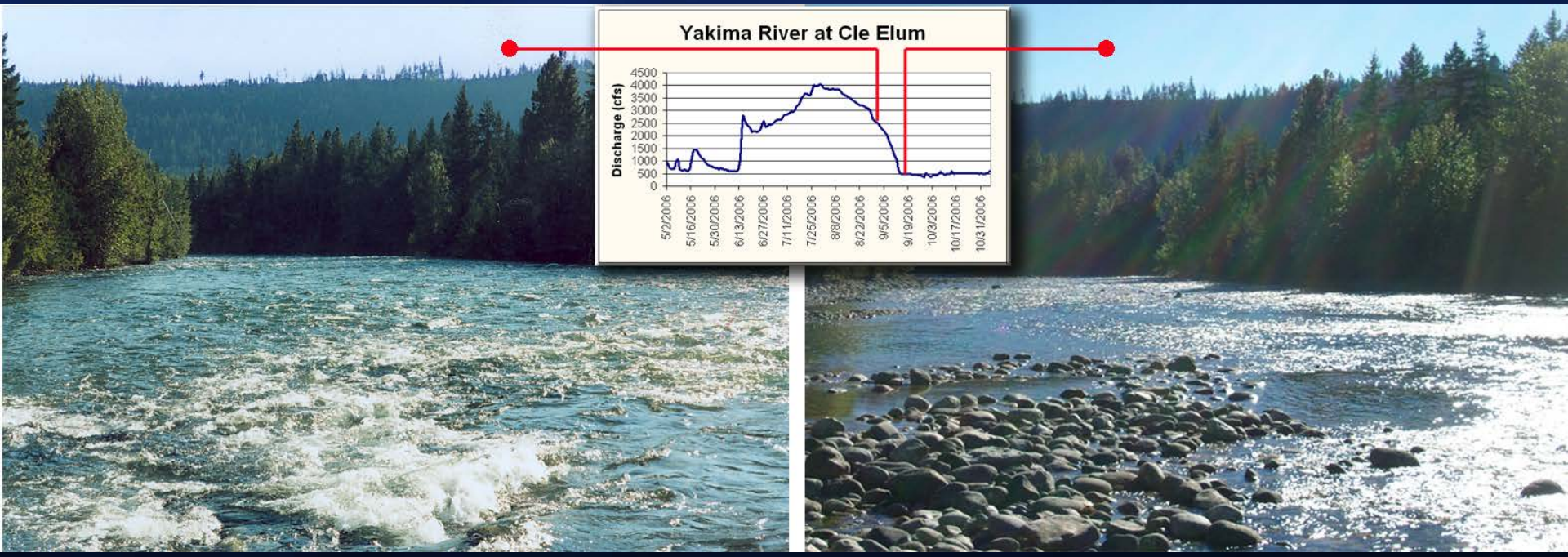
20 Years of Flip Flop:
What Can We Determine About its Effects on Salmonids?



Martin Fox, Ian Courter, Brian Pyper, and Steve Cramer

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Flip-Flop Origins

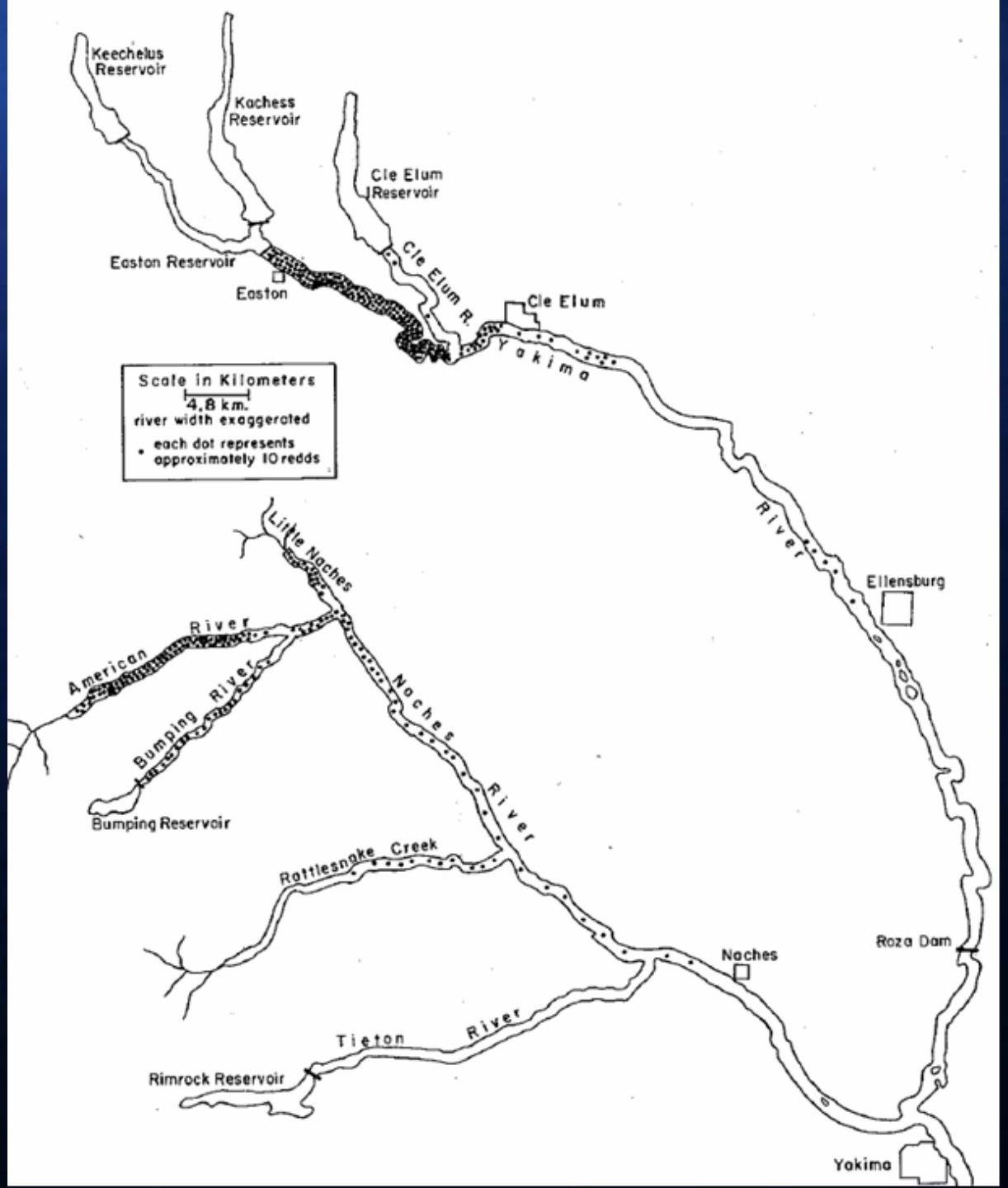
- Major and Mighell (1969) estimated 30-50% mortality of spring chinook eggs from dewatering in upper Yakima River
- 1980 Quackenbush Decision mandated that the Yakima Project be operated to reduce impacts on fish. Minimum of 2 inches of water flowing over redd tailspills
- USBR established SOAC
- Flip-Flop was designed to protect fish and satisfy irrigation deliveries

The Flip-Flop Strategy

- Prevent de-watering of spring Chinook redds below upper Yakima dams
- Underlying assumption: spring Chinook production was limited by egg survival
- Decrease outflow during spring Chinook spawning
- Switch to water from Rimrock Reservoir to supply downstream water needs

Distribution of spring Chinook spawning redds in the Yakima Basin, 1957–1961

(from Major and Mighell 1969)



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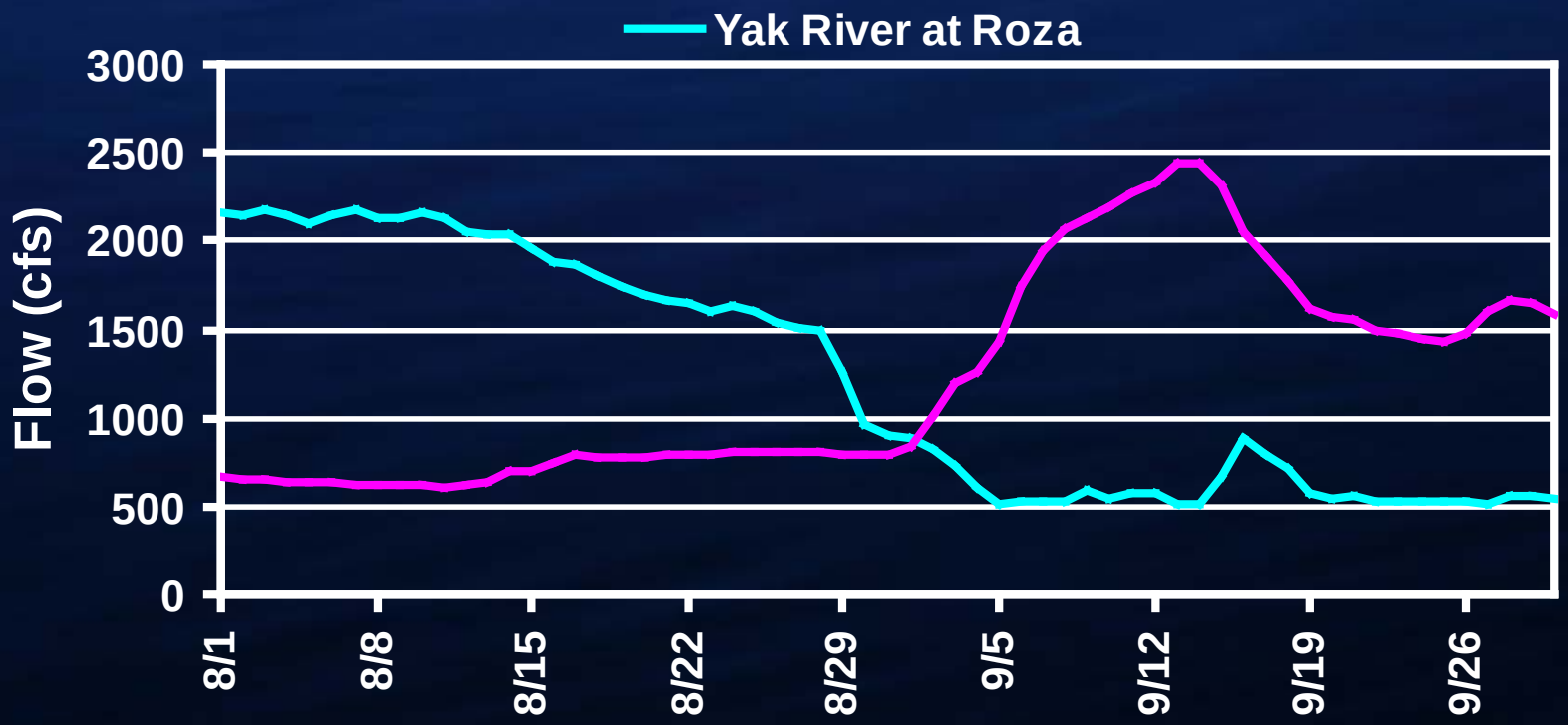
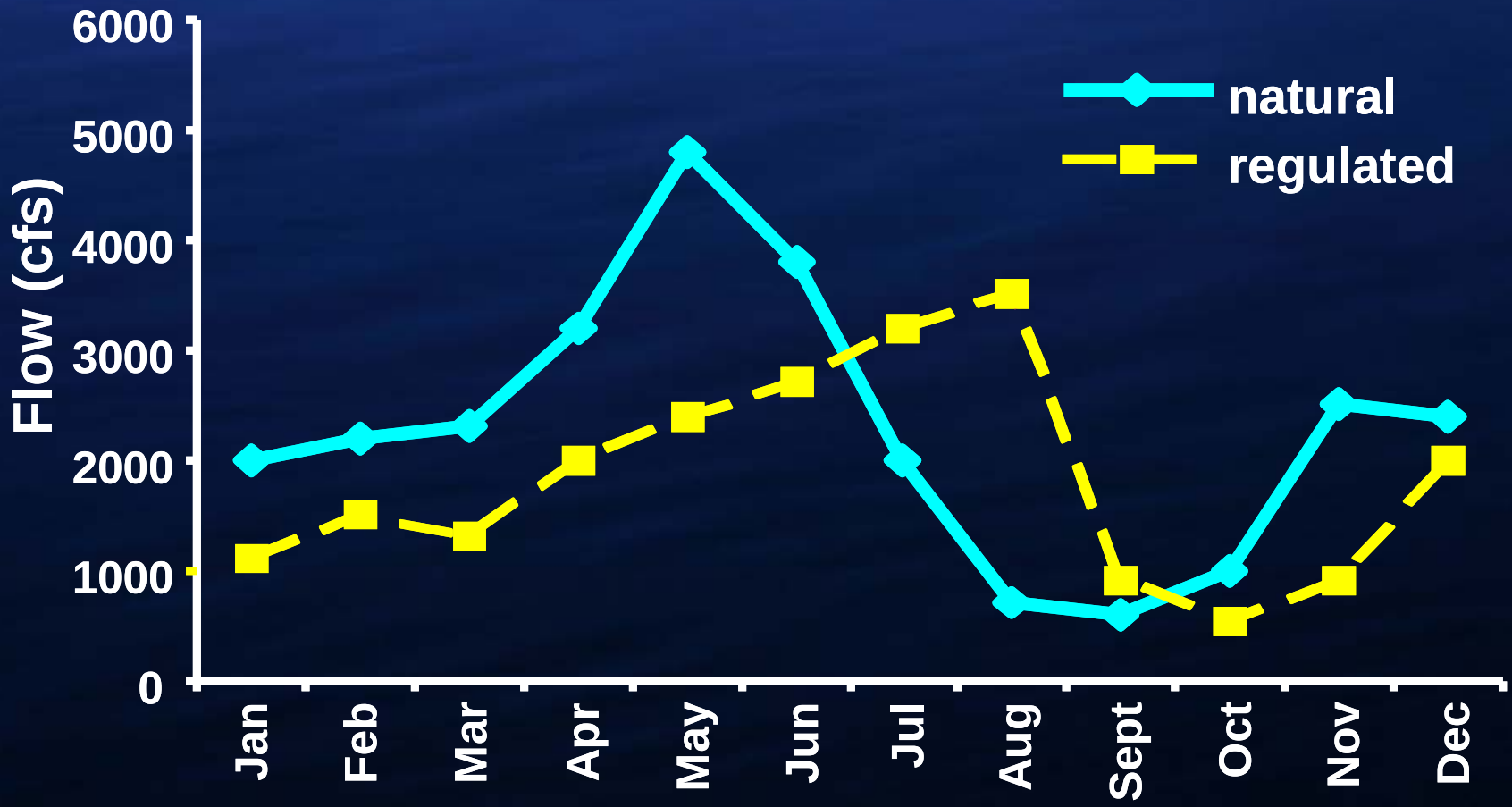
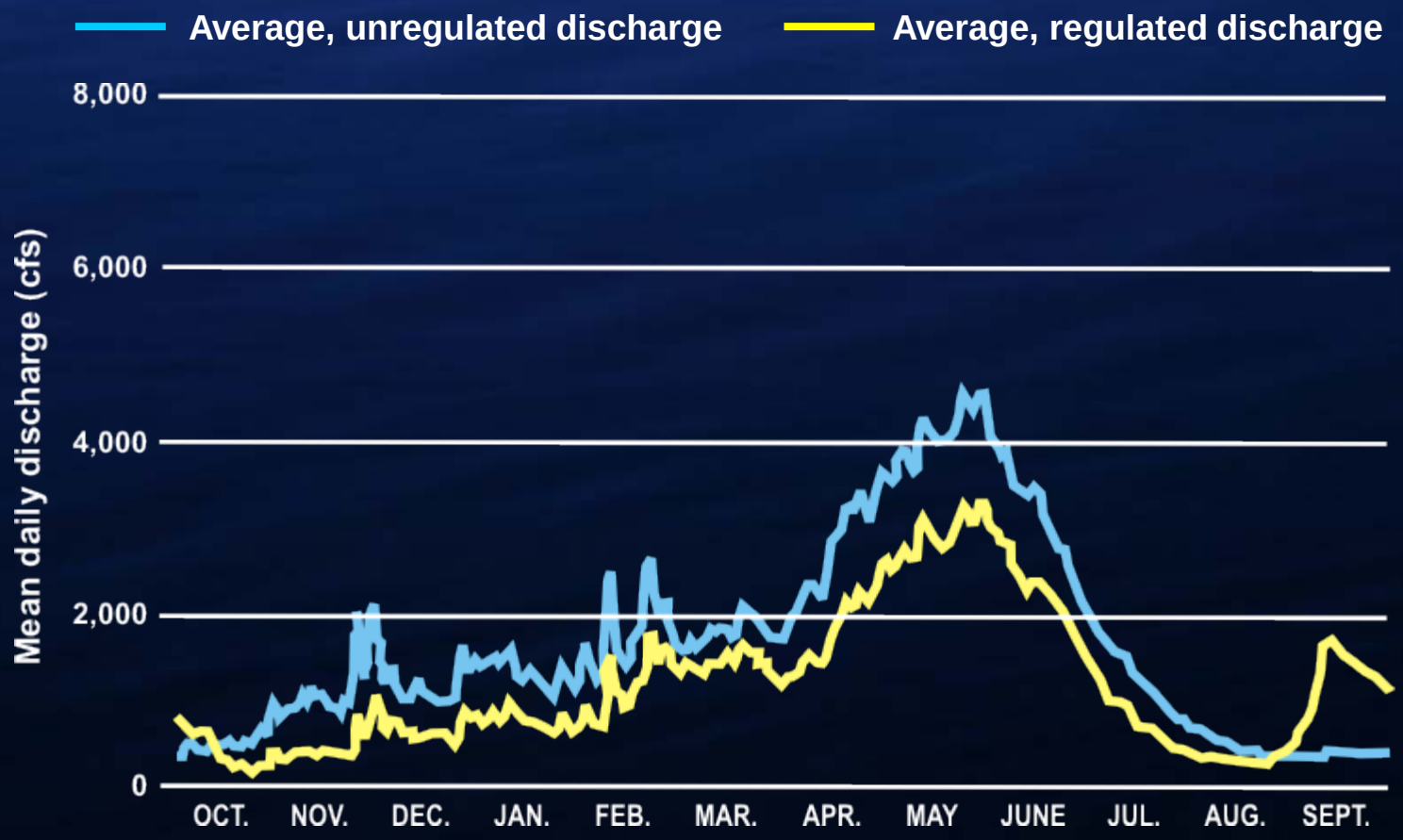
Yakima and Naches Flows (2006)



Yakima River. at Cle Elum



Naches River NR Naches Regulated, Unregulated Discharge Summary Hydrographs



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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
- Identify any needs for studies to fill critical data gaps

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, as well as to water consumption?

- Are there more effective means to support salmonid production and water uses by modifying the Flip-flop operation?

What Information is Available?

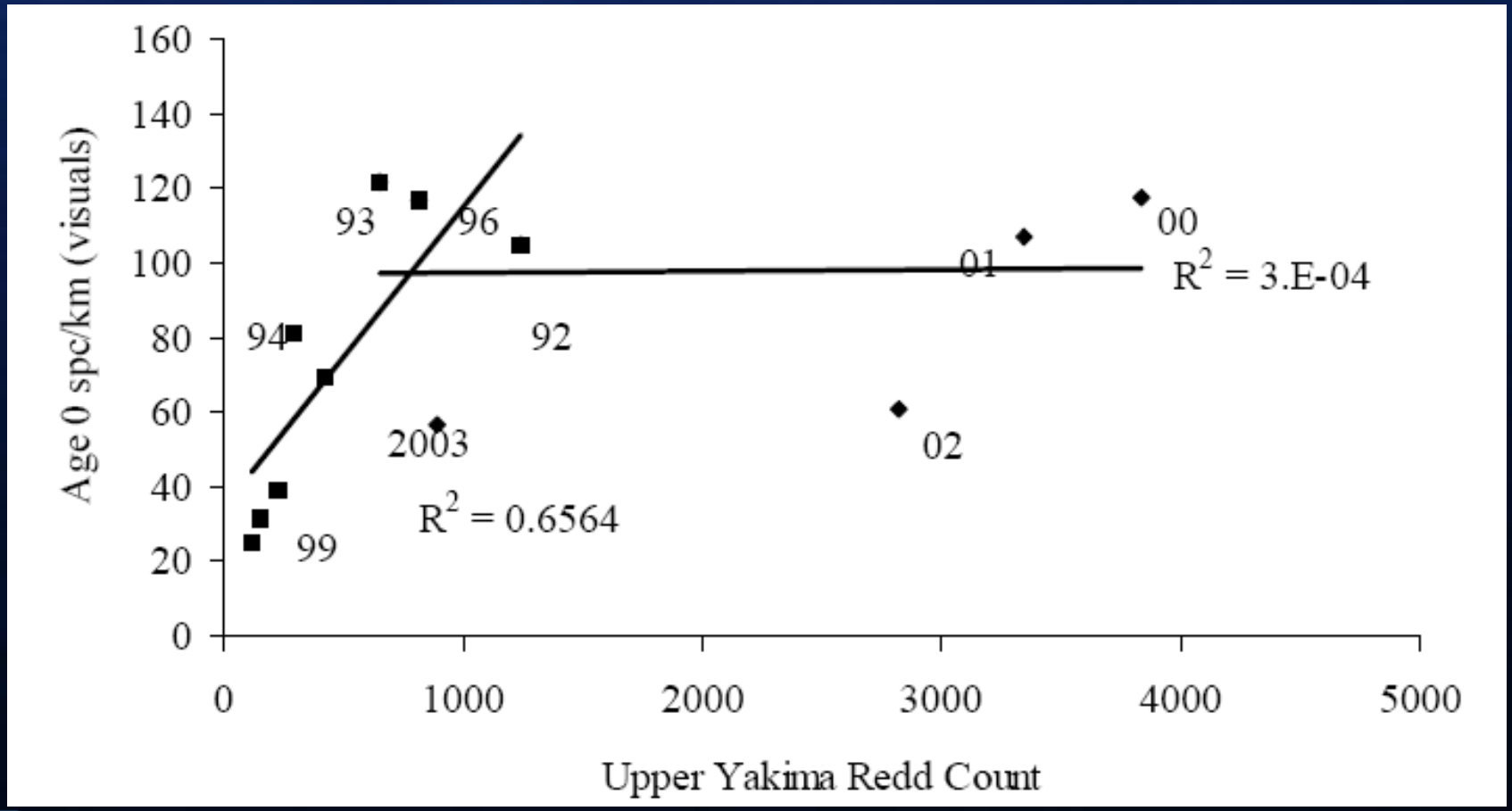
- No estimate of the %redds dewatered as flow drops
- Adult escapement and spawning surveys
- Smolt abundance at Prosser
- Juvenile growth rates in the upper Yakima
- Juvenile habitat use in upper Yakima
- PIT tag detections to estimate smolt migration survival

Potential Tradeoffs

- Spring Chinook eggs gain some level of protection
- Is abundance of fry limiting spring chinook production?
- Is rearing capacity limiting production
- Is migration survival limiting production?
- Is salmonid production in the Naches Basin altered by Flip Flop?

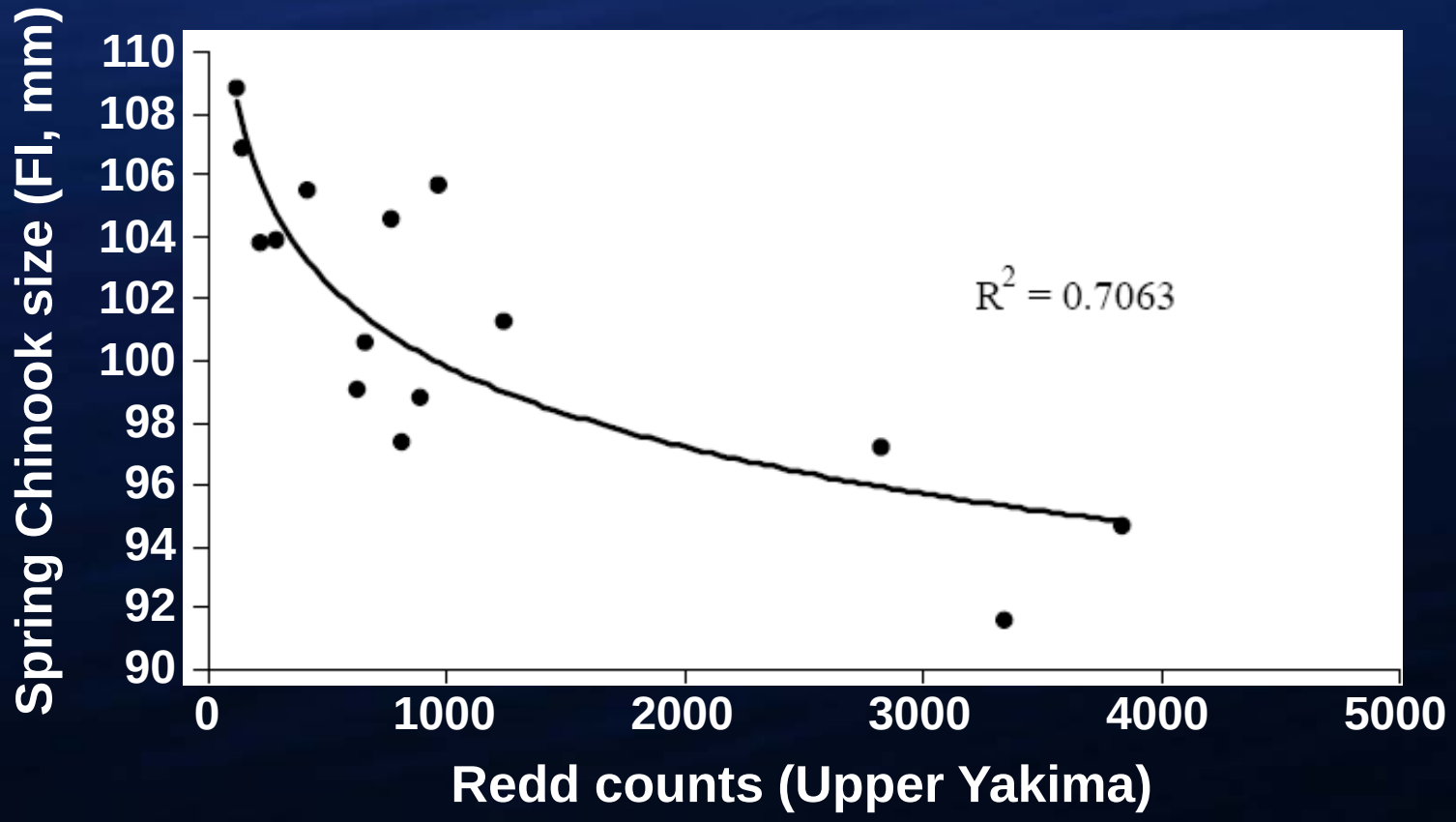
Recruitment of Age-0+ Spring Chinook Rearing in the Upper Yakima River

Pearsons *et al.* (2005)



Age-0+ Spring Chinook Size (Sept-Oct) Versus the Number of Redds the Year Prior

Pearsons *et al.* (2005)



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Potential Tradeoffs

If juvenile rearing is the bottleneck,…

- Can we retrain Flip Flop, but also increase rearing capacity?

OR…

- Can we gain more juvenile habitat by reducing summer flows, such that rearing gains exceed egg losses?

Rearing Habitat vs Flow

Pearsons et al. 2006

- Compared habitable rearing area, based on depth velocities, in three reaches before and after Flip Flop
- Habitable area decreased in two reaches and increased in the third when flows dropped after flip flop

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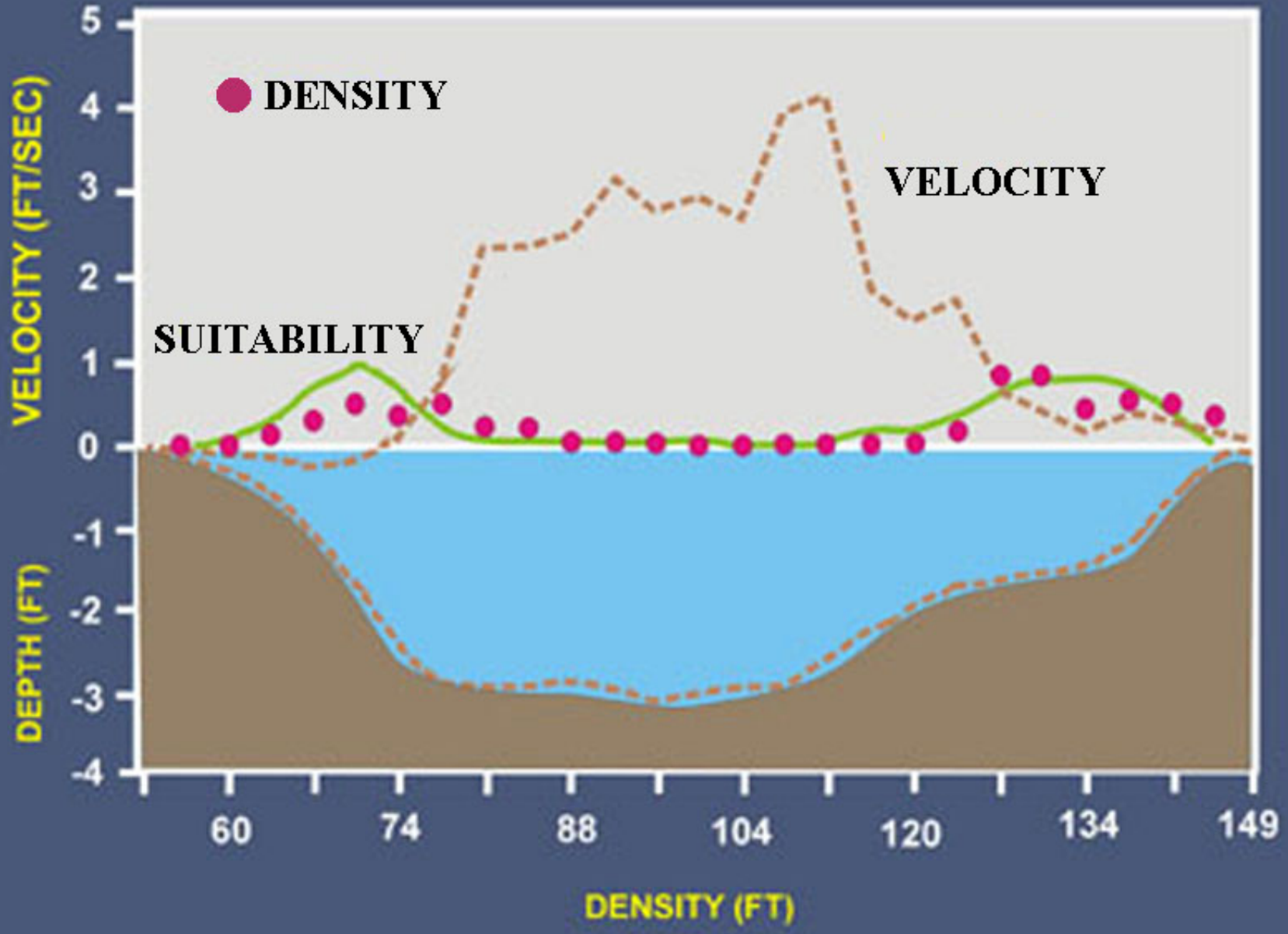
DENSITY
VELOCITY
SUITABILITY
VELOCITY (FT/SEC)
DEPTH (FT)
5
4
3
2
1
0
-1
-2
-3
-4
60
74
88
104
120
134
149
DENSITY (FT)

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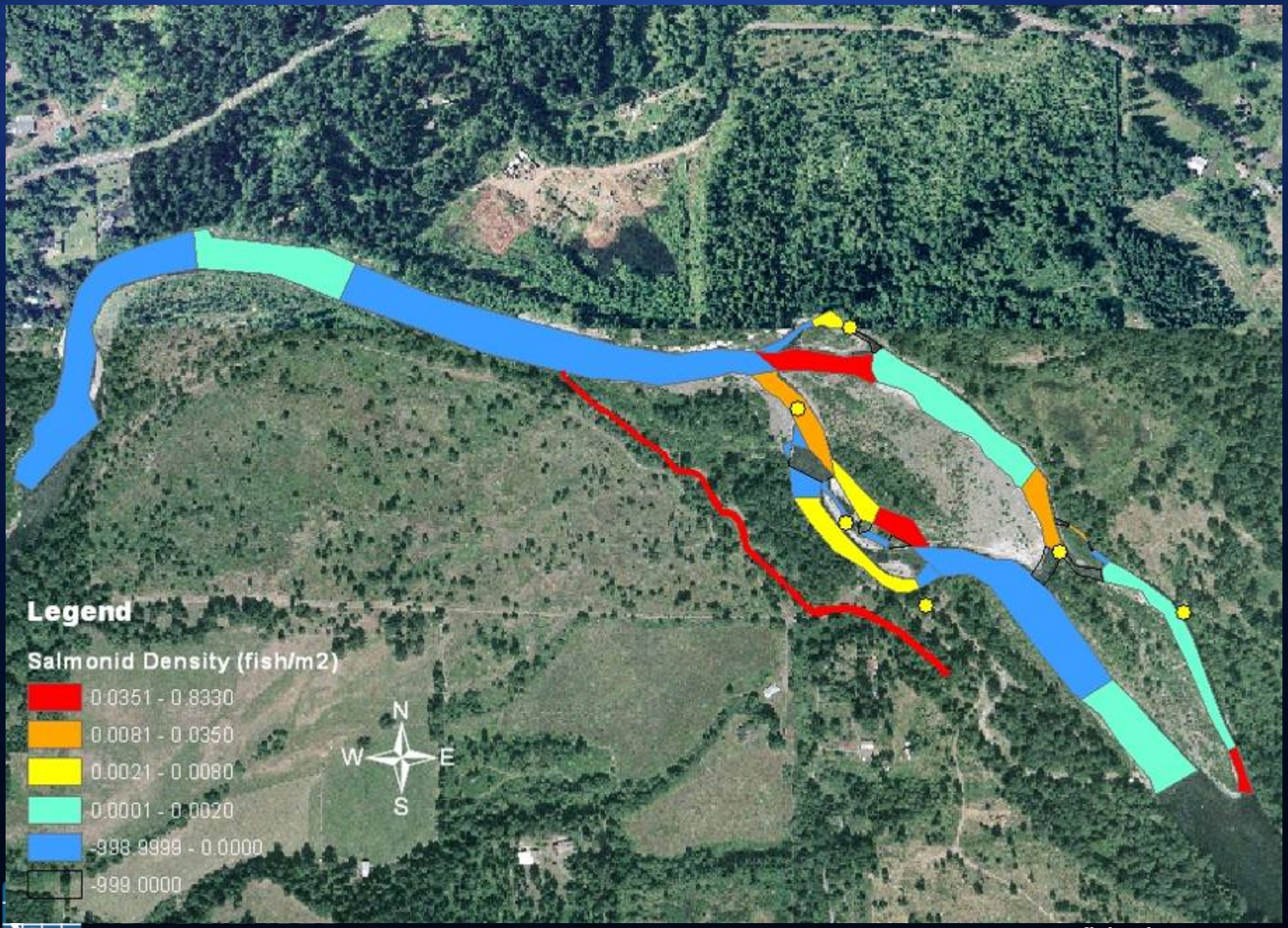
Legend
Salmonid Density (fish/m2)
0.0351 - 0.8330
0.0081 - 0.0350
0.0021 - 0.0080
0.0001 - 0.0020
-998.9999 - 0.0000
-999.0000
N
W
E
S

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Critical Data Gaps

- Determine the relationship of egg-to-fry survival to flows after spawning. How does the timing and magnitude of flow reduction affect egg survival?
- Observation or tracking of juvenile behavior to change in flow at time of Flip Flop. Do they shift habitats? What proportion migrate?
- Determine the relationship of parr habitat capacity to flow
- Estimate freshwater survival for each subbasin with substantial spring Chinook production

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