

Yakima River Basin Spring Chinook Early Development and Emergence Timing

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and Trenton De Boer¹

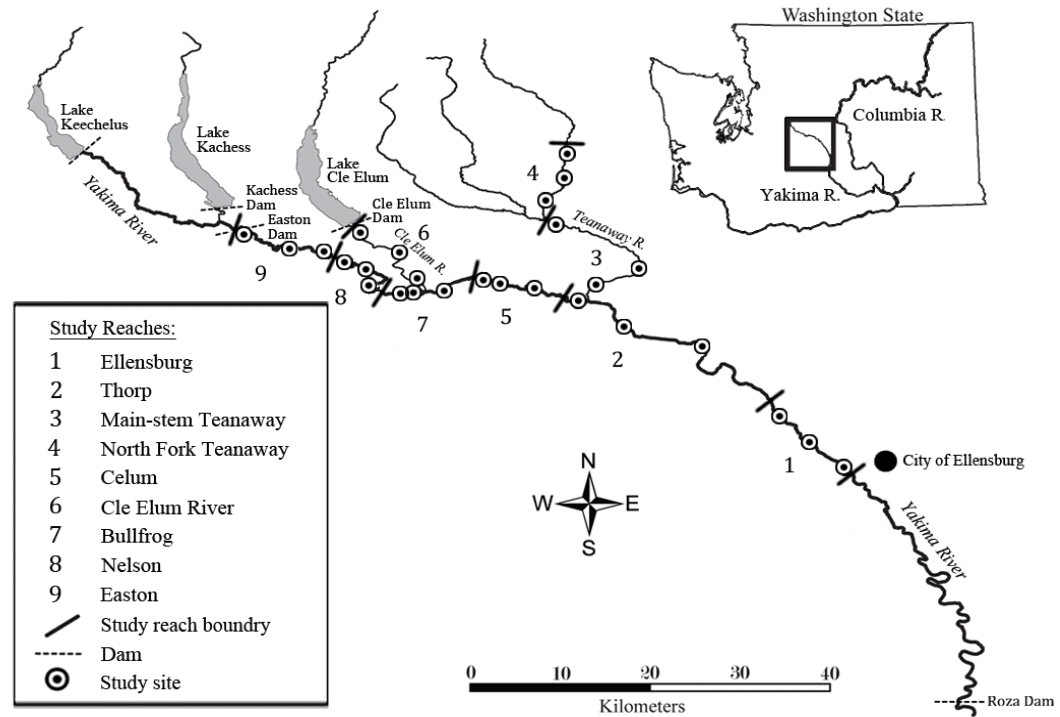
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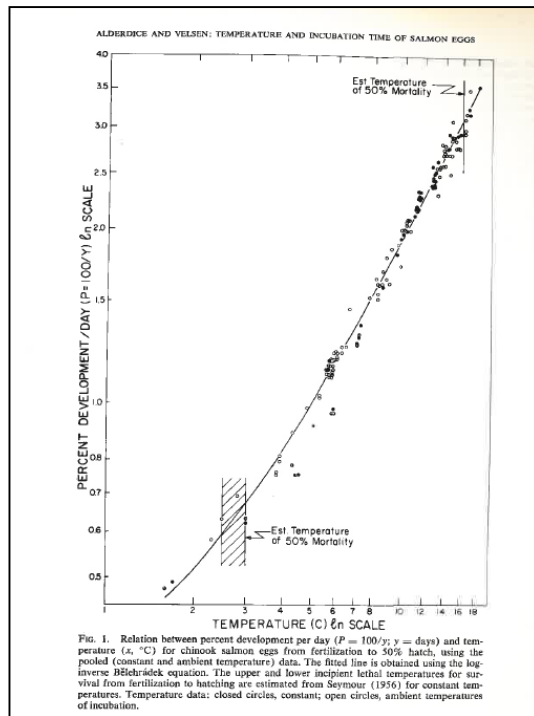
Egg-to-Fry Survival Study 2009-2013

- Nine study reaches, 2009-2013 brood years. Controlled parental cross, egg deposition, and spawn timing.
- Water temperature recorded hourly at 31 locations throughout the upper Yakima River
- Estimates of survival and developmental stage at approximately 50% emergence based on temperature unit accumulation (900 ATU)

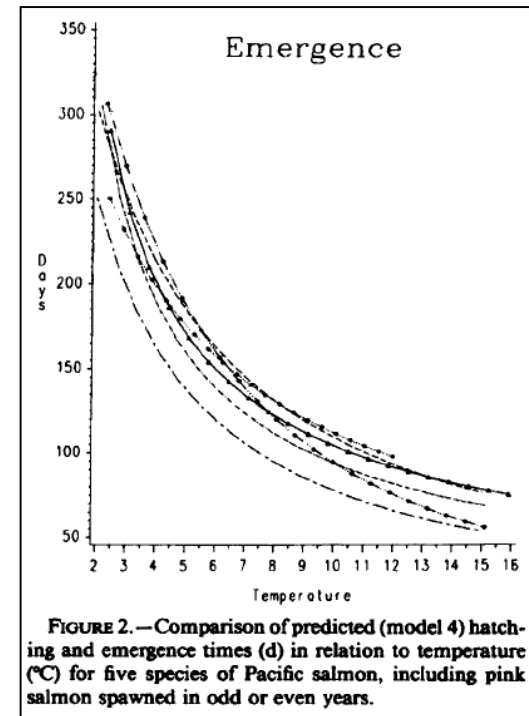


Johnson, C. L. P. Roni, G. R. Pess. 2012. Parental effect as a primary factor limiting egg-to-fry survival of spring Chinook salmon in the upper Yakima River basin. *Transactions of the American Fisheries Society* 141(5):1295-1309

Temperature Accumulation, Alevin development, and Emergence Timing



Alderdice and Velsen 1978
Temperature and percent development



Beacham and Murray 1990
Temperature and days to emergence

“The date of emergence depends on the process of yolk absorption, which depends on temperature and varies among species” –Quinn 2005

Developmental Stage

$$k_D = \frac{10 \cdot \sqrt[3]{\text{Weight in mg}}}{\text{Length in mm}}$$

(Bams 1970)

$k_D = 1.9861$



$k_D = 1.9817$



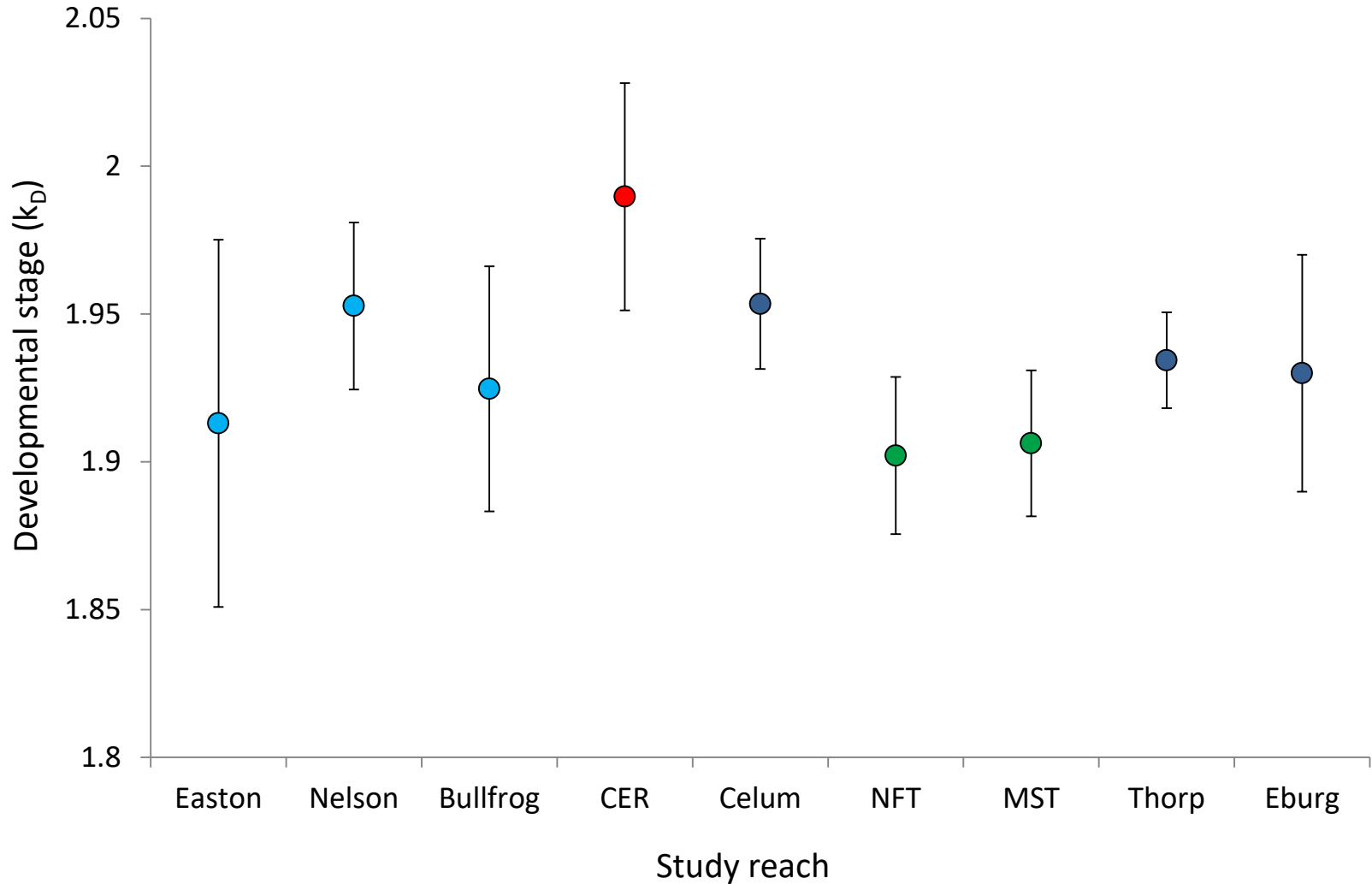
$k_D = 1.9744$



$k_D = 1.8779$



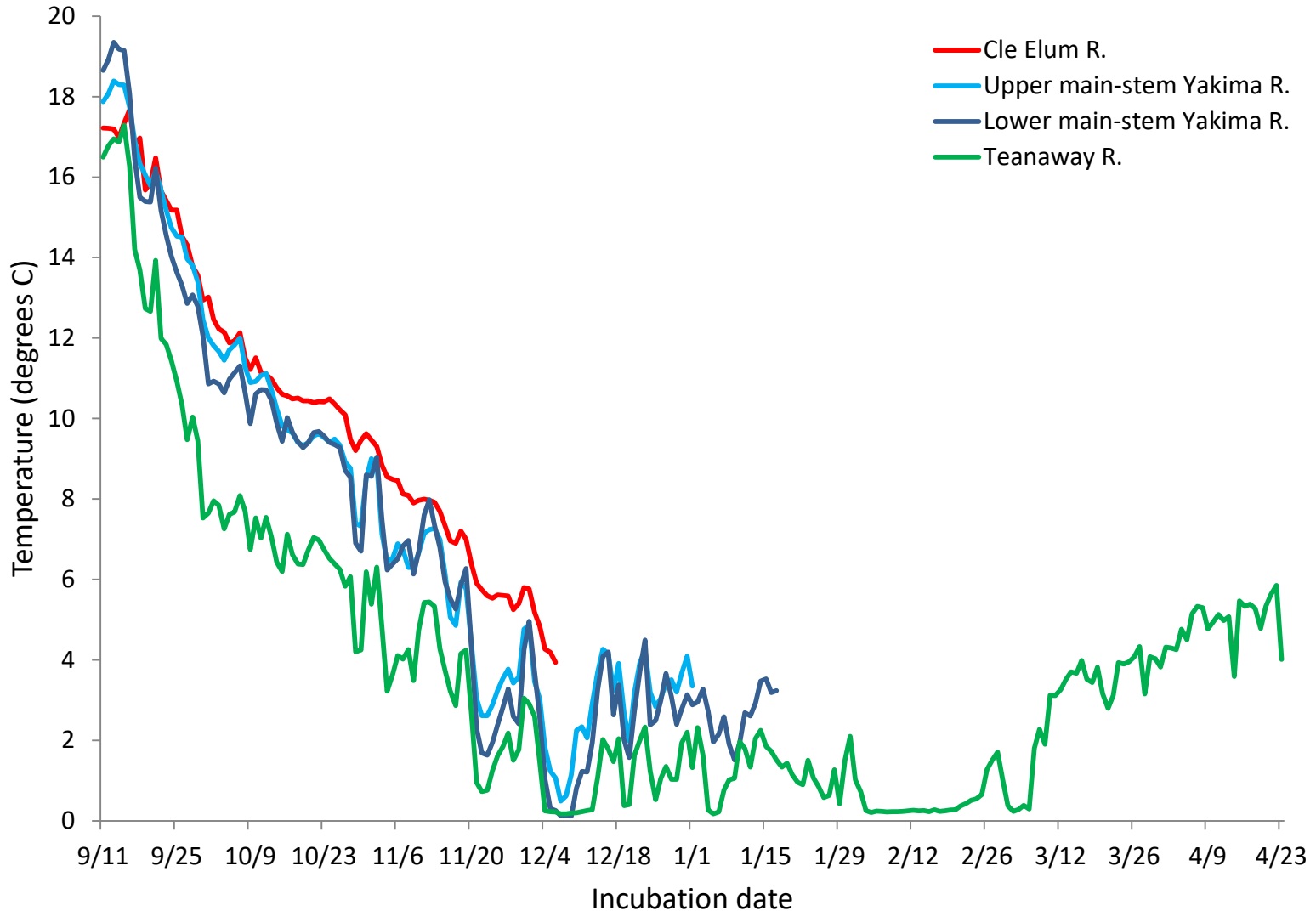
Developmental Stage at 900 Accumulated Thermal Units



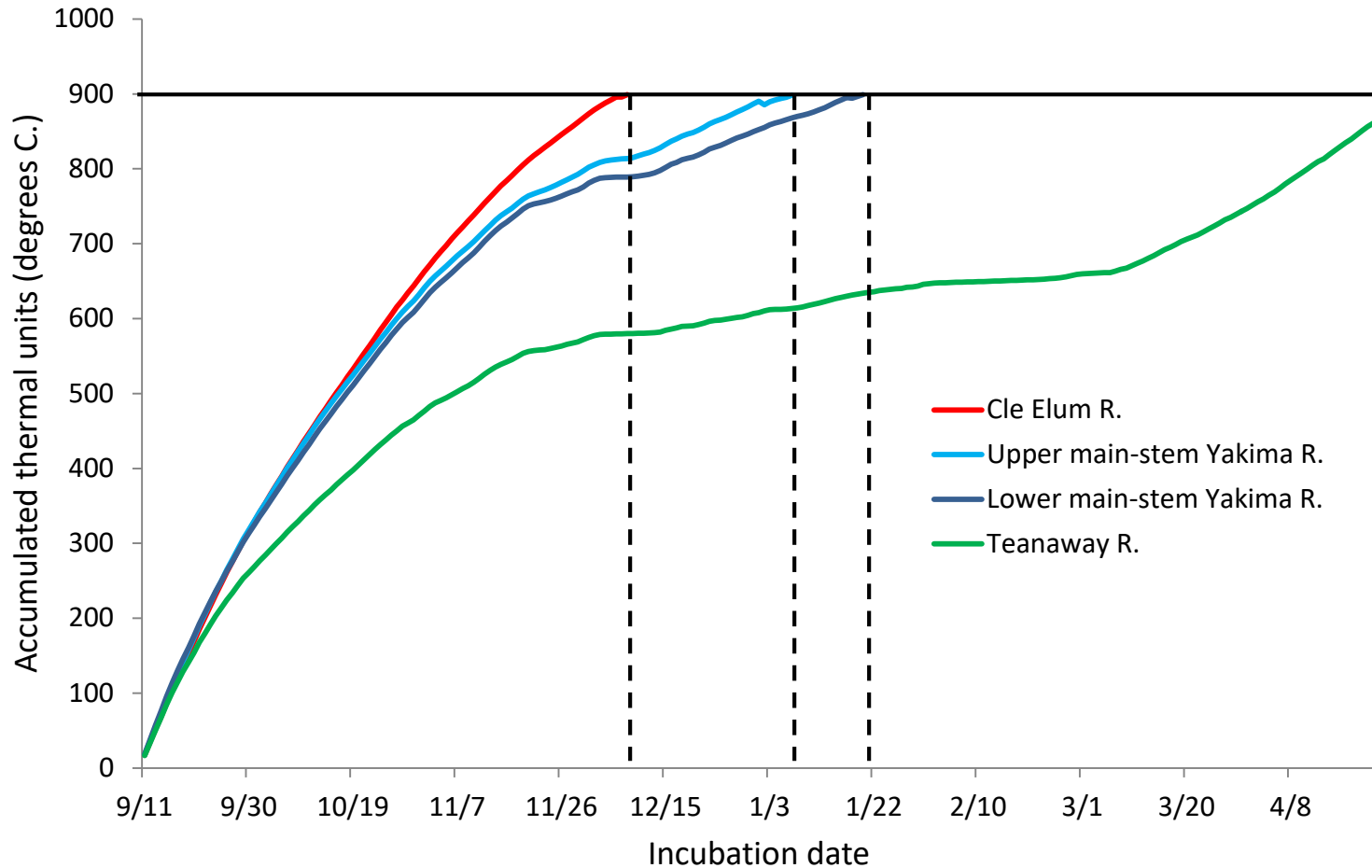
Environmental Factors Potentially Limiting Development

- Fine sediment (Jensen et al. 2009)
- Low dissolved oxygen (Alderdice et al. 1958; Malcolm et al. 2004)
- Decreased developmental efficiency > 10 deg. C (Heming 1982)
- Temperature intolerance < 1 deg. C (Murray and McPhail 1988)
- Thermal variance (Steel et al. 2013)

Upper Yakima River Mean Daily Temperature 2013-14



Upper Yakima River Accumulated Thermal Units 2013-14



Emergence Timing and Developmental Stage at Emergence

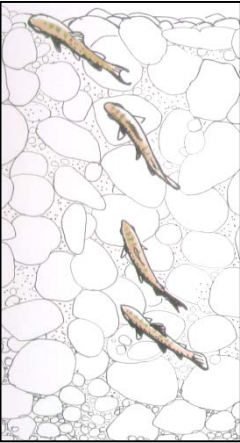


Image: fedflyfishers.org

- Acquisition of habitat¹
- Competitive ability²
- Predator avoidance³
- Post-emergence growth⁴

²Andersson, M. Å., U. W. Khan, Ø. Øverli, H. M Gjøen, and E. Höglund. 2013. Coupling between stress coping style and time of emergence from spawning nests in salmonid fishes: Evidence from selected rainbow trout strains (*Oncorhynchus mykiss*). *Physiology & Behavior* 116:30-34.

²⁻³Brännäs, E. 1995. First access to territorial space and exposure to strong predation pressure: a conflict in early emerging Atlantic salmon (*Salmo salar* L.) fry. *Evolutionary Ecology* 9:411-420.

³Brannon, E. L. 1987. Mechanisms stabilizing salmonid fry emergence timing. p. 120-124. In H. D. Smith, L. Margolis, and C. C. Wood, editors. *Sockeye salmon (*Oncorhynchus nerka*) population biology and future management*. Canadian Special Publication of Fisheries and Aquatic Sciences: 96.

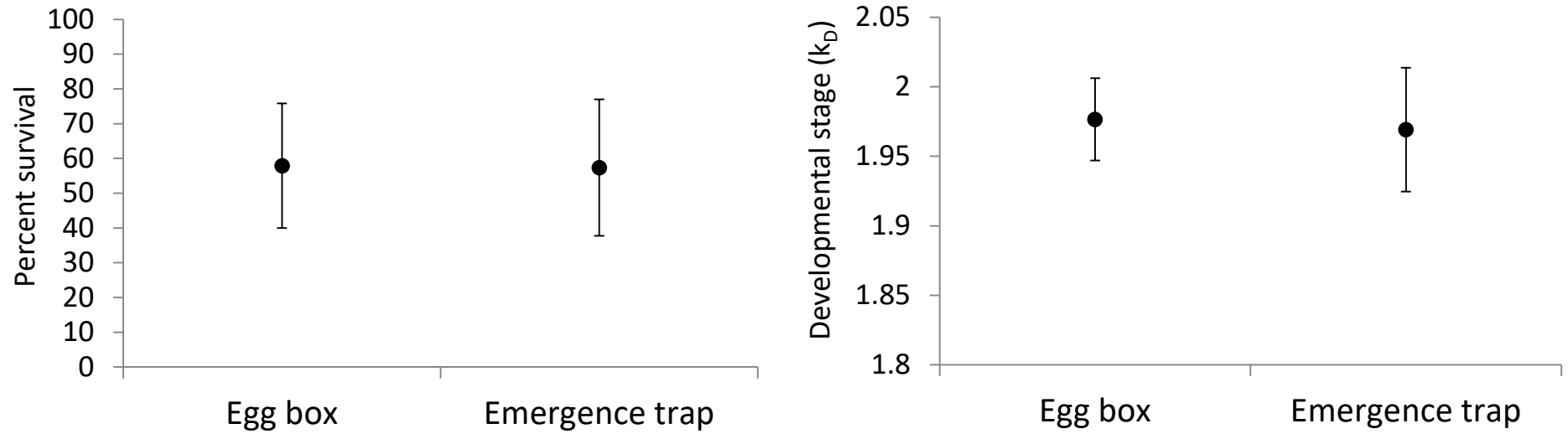
¹⁻⁴Quinn, T. P. 2005. *The behavior and ecology of Pacific salmon and trout*. University of Washington Press, Seattle Washington.

Emergence Traps

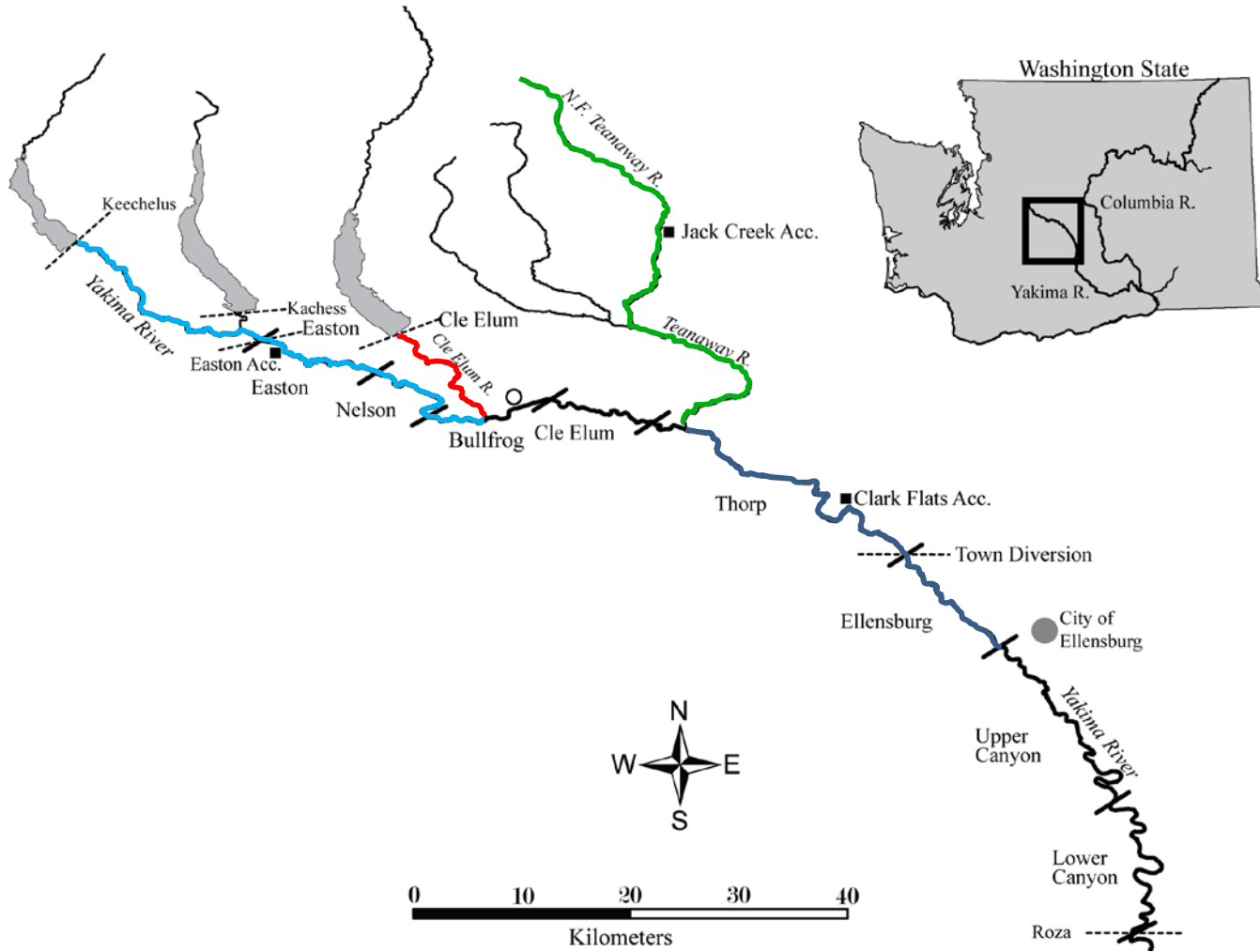
- Emergence timing
- Survival to emergence (inclusive of swim-up effects)
- Developmental stage following volitional emergence



Box vs. Trap Survival: 900 ATU 2013

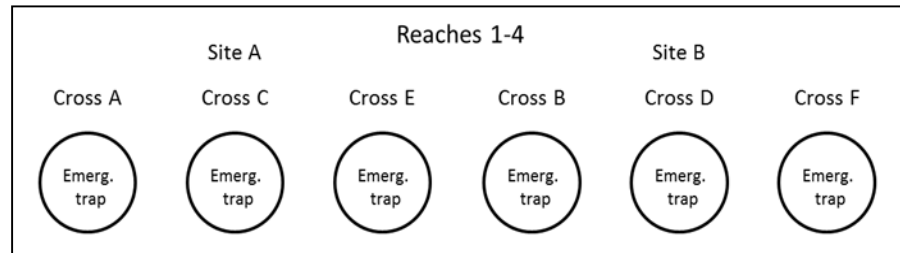
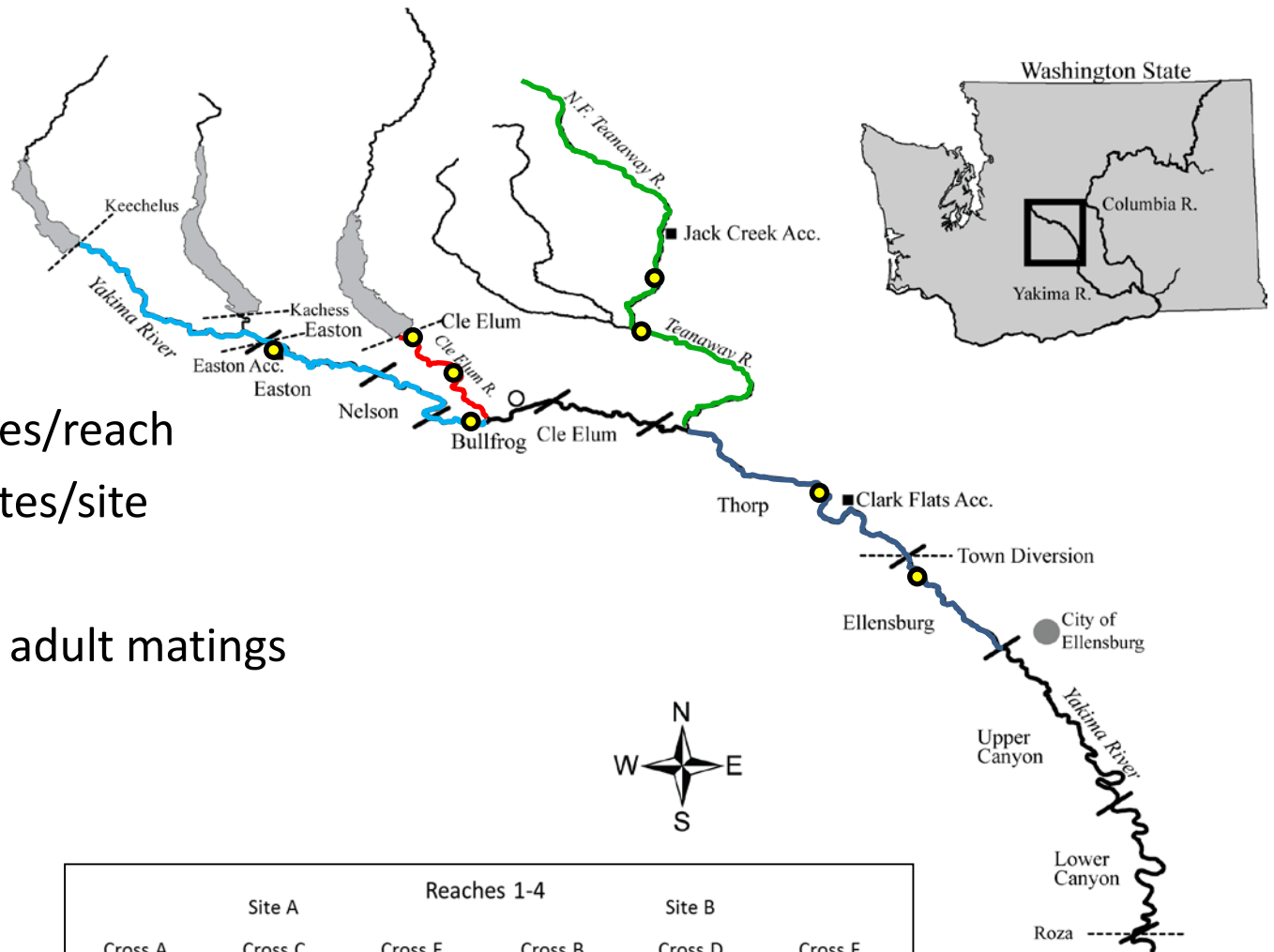


2013-14 Study Area



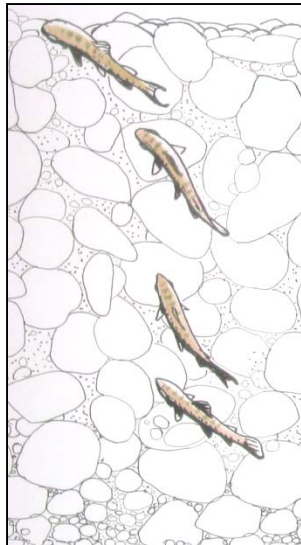
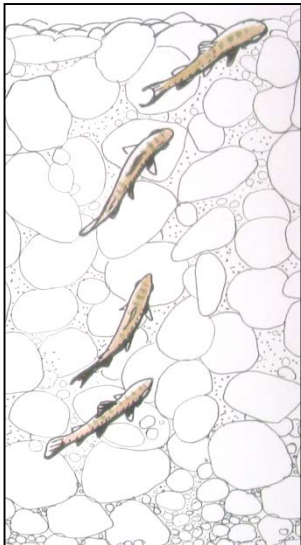
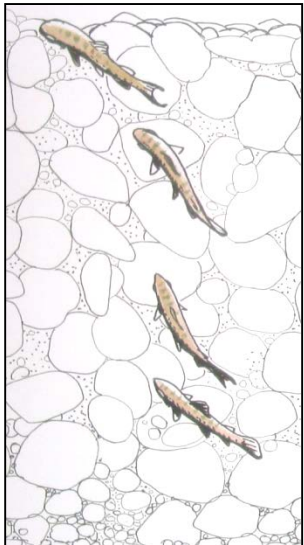
2013-14 Study Design

- Two study sites/reach
- Three replicates/site
- Three weeks
- Standardized adult matings within reach
- N = 24

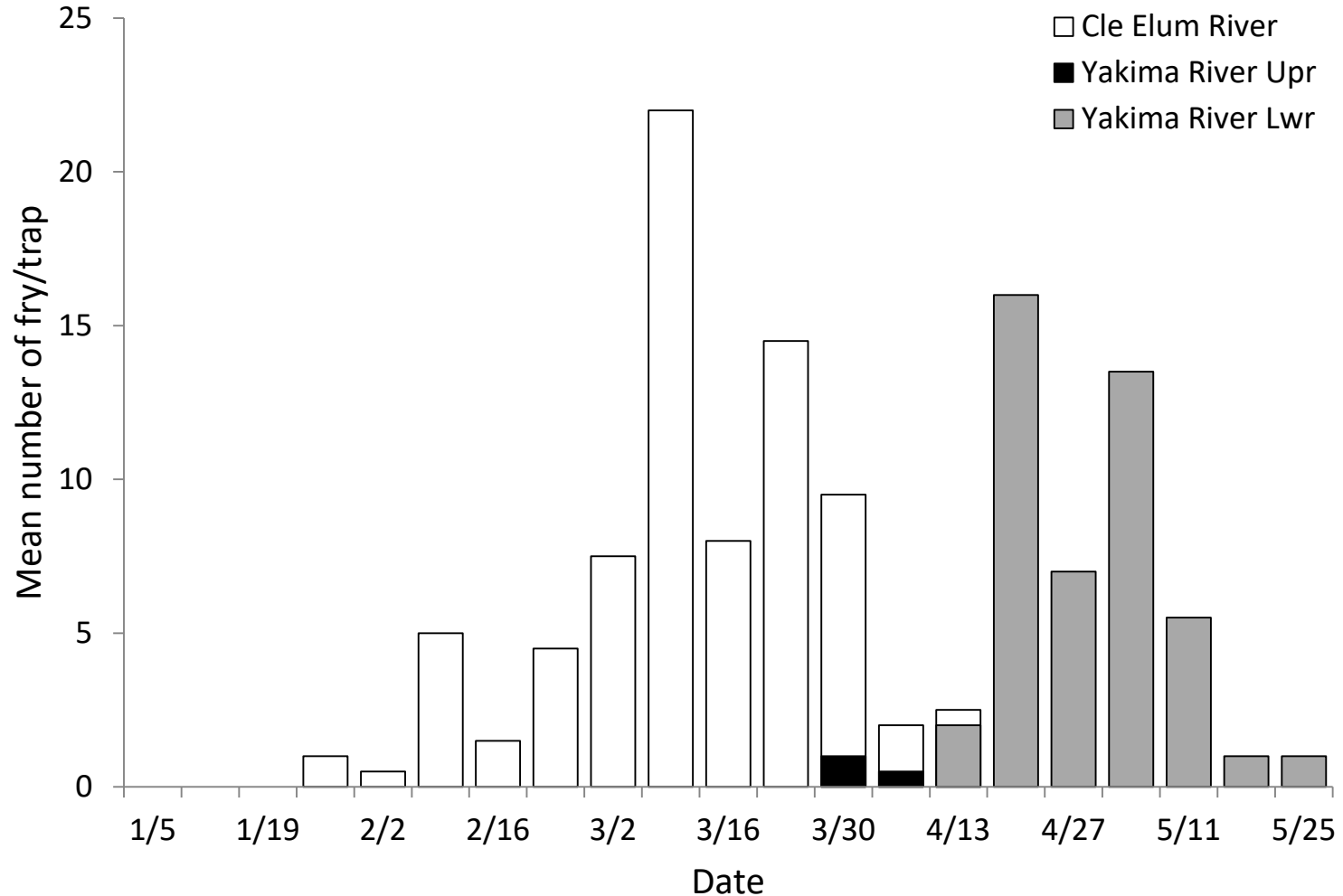


Initial Movement of Naturally Produced Fry

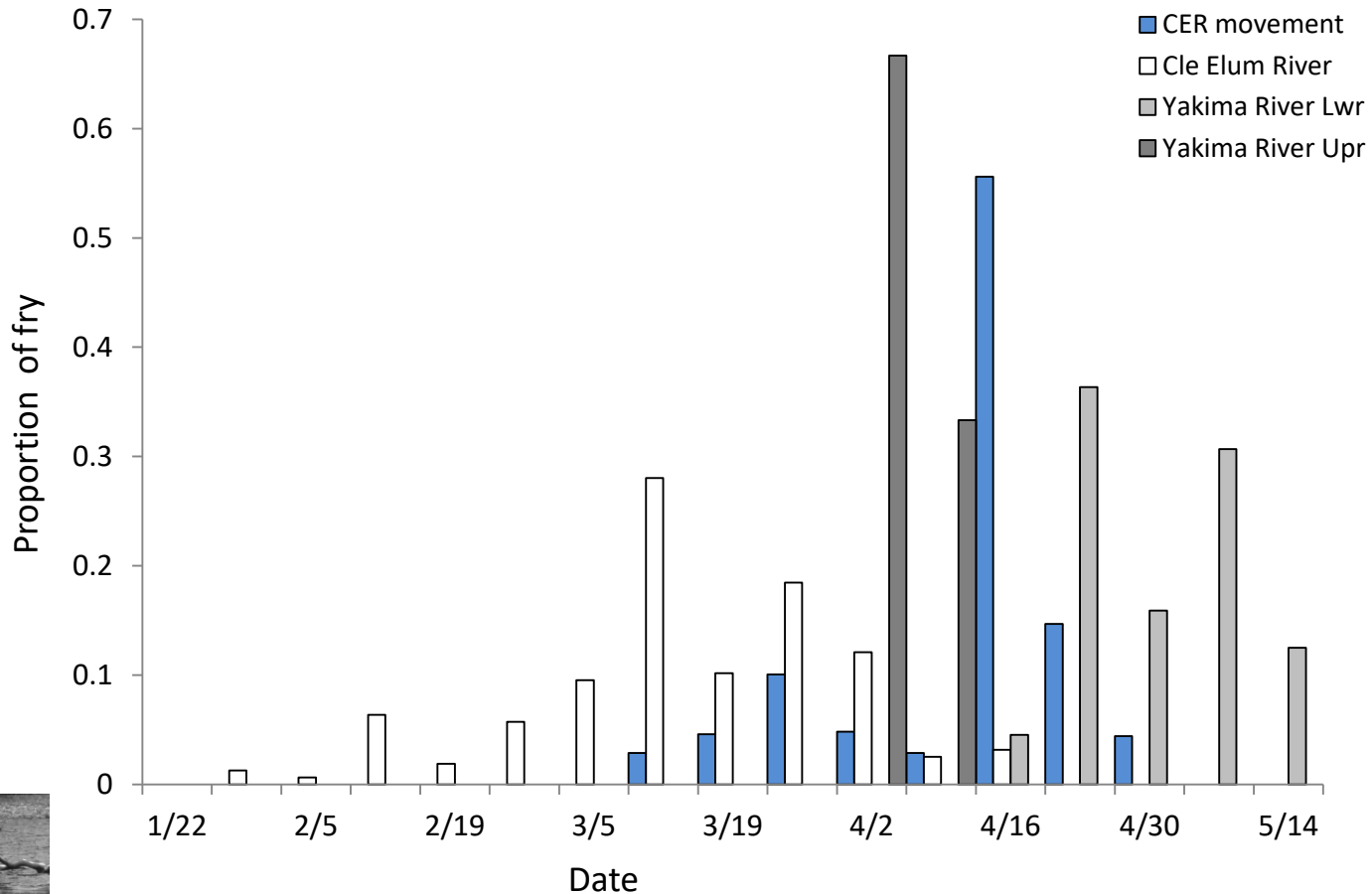
- Five nets, placed in the stream margins
- Cle Elum River study sites (2)
- Deployed January 6th- May 1st



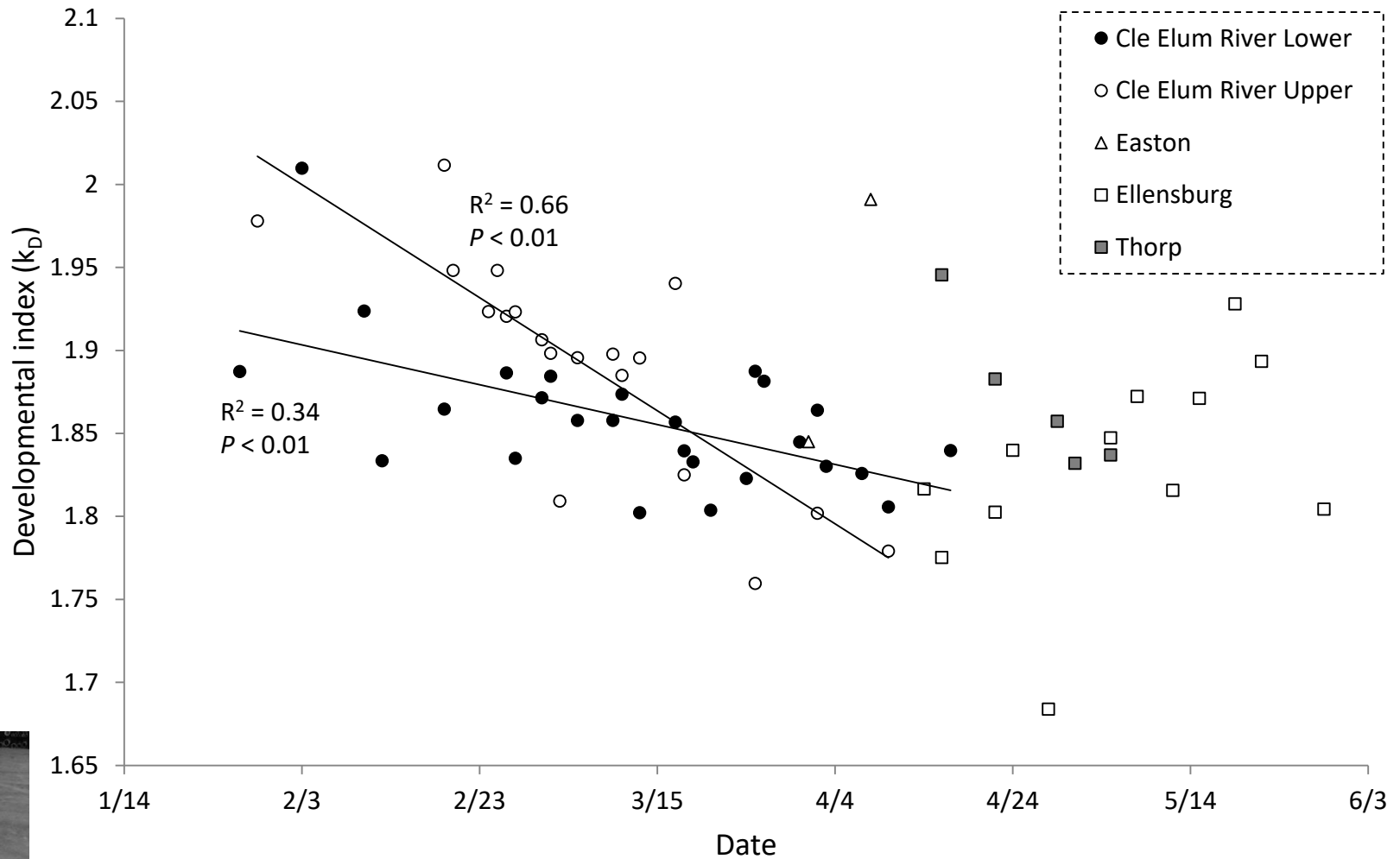
Observed Emergence Timing Traps 2014



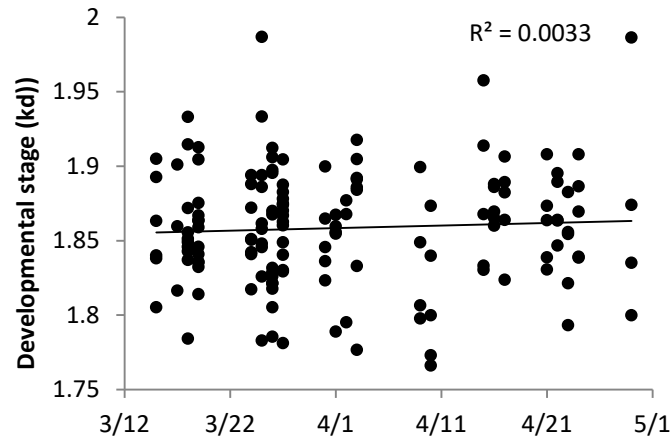
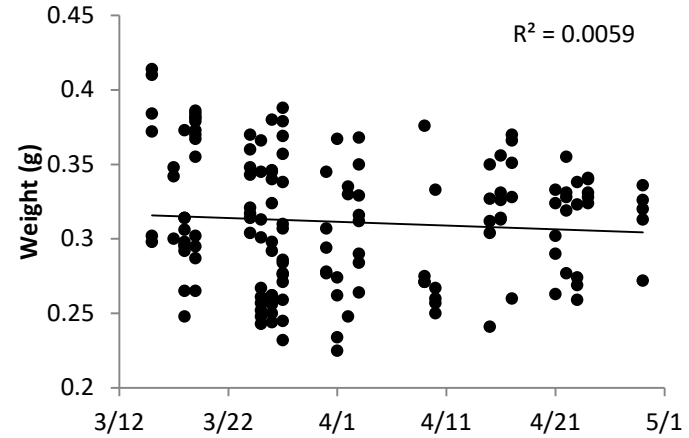
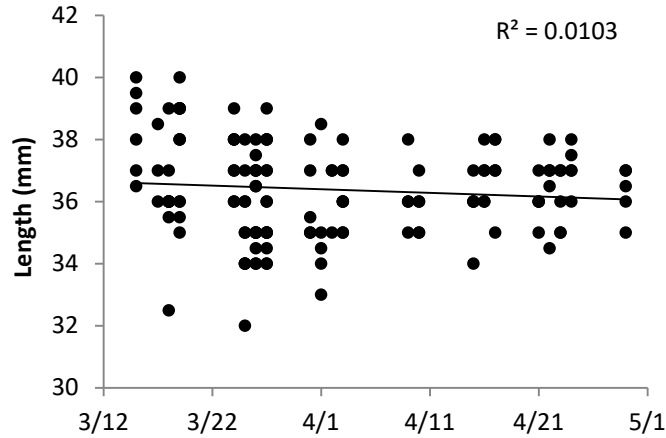
Initial Movement of Naturally Produced Fry



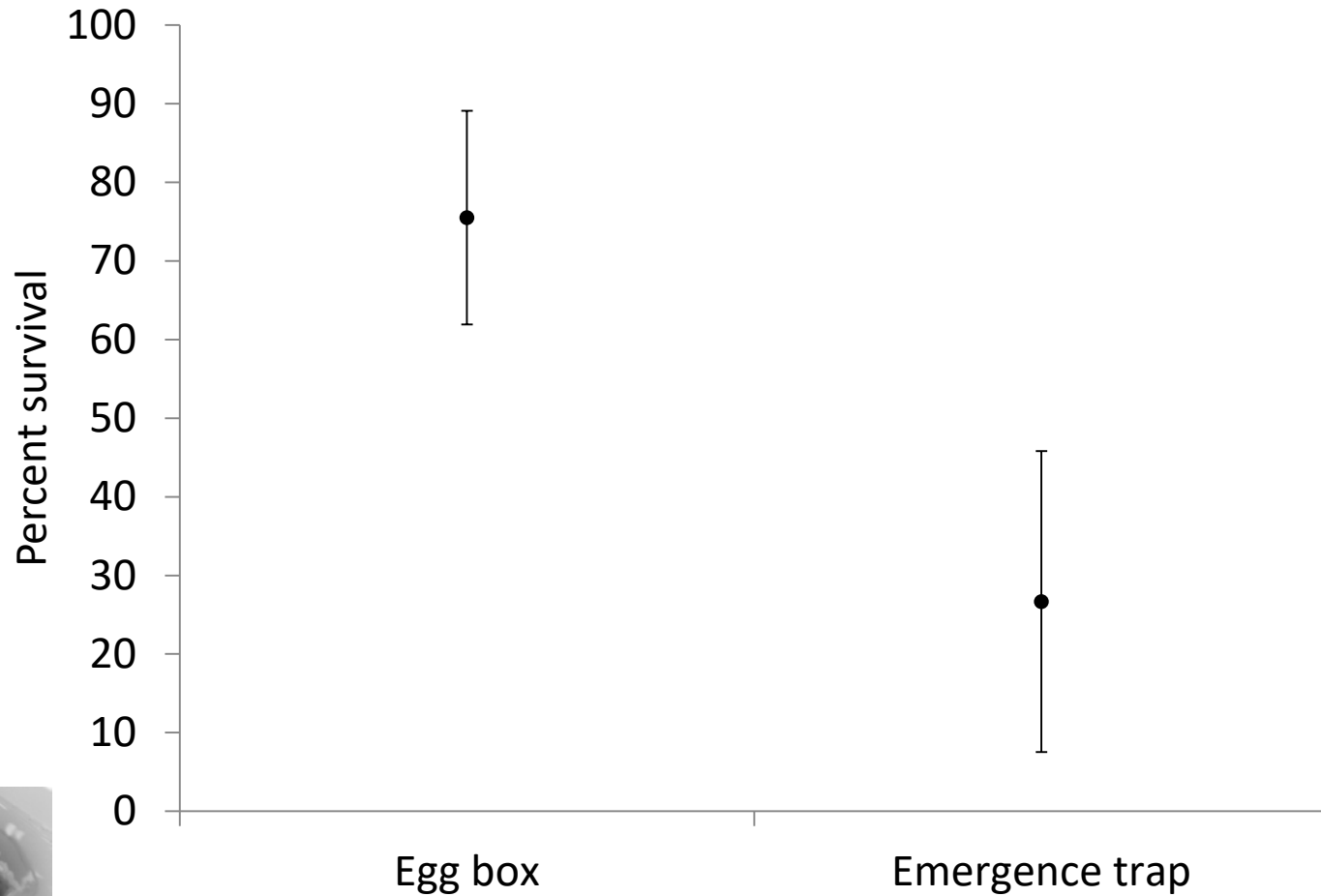
Developmental Stage at Emergence Traps 2014



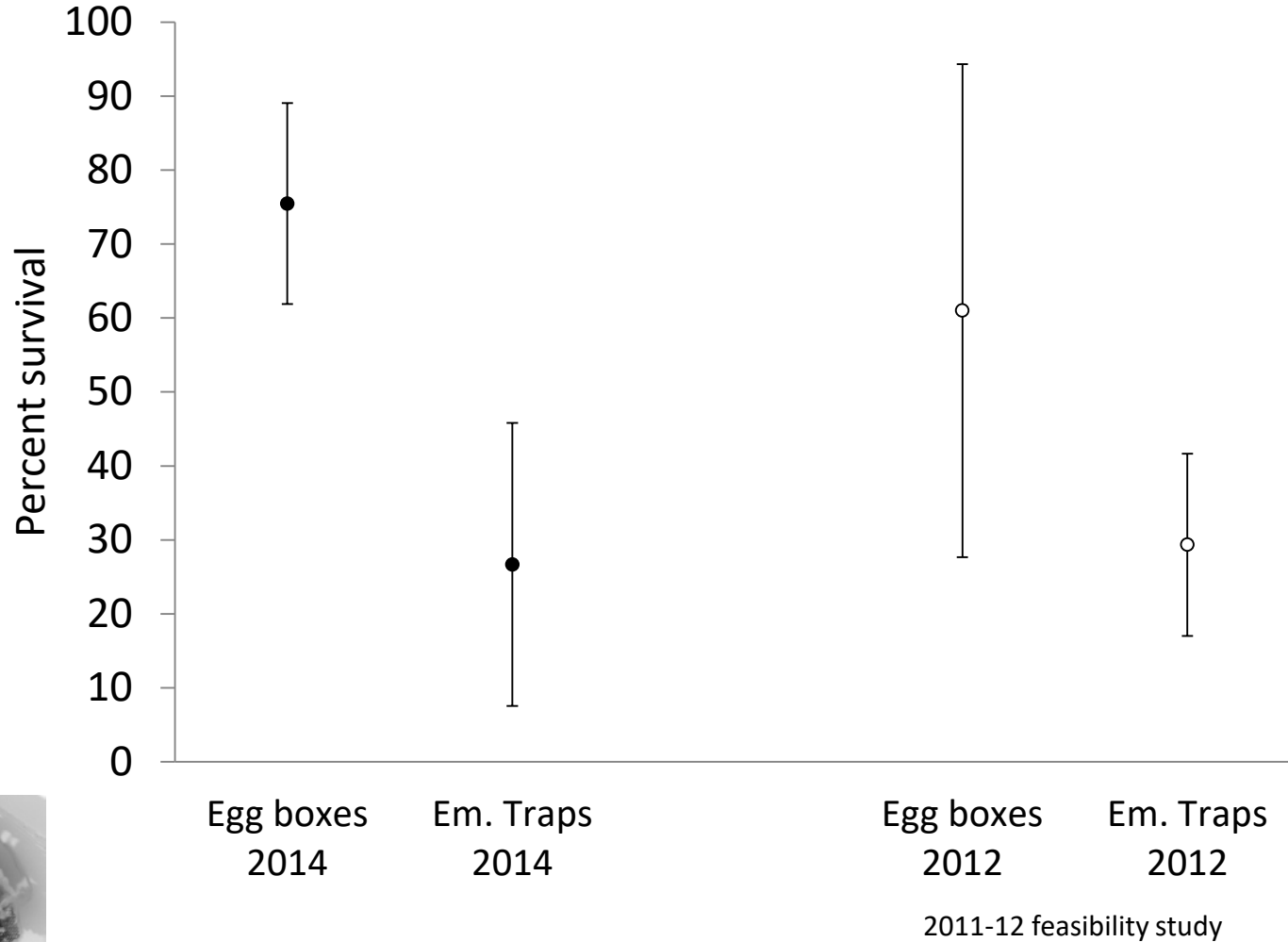
Naturally Produced Fry



Survival to Emergence Cle Elum River 2014



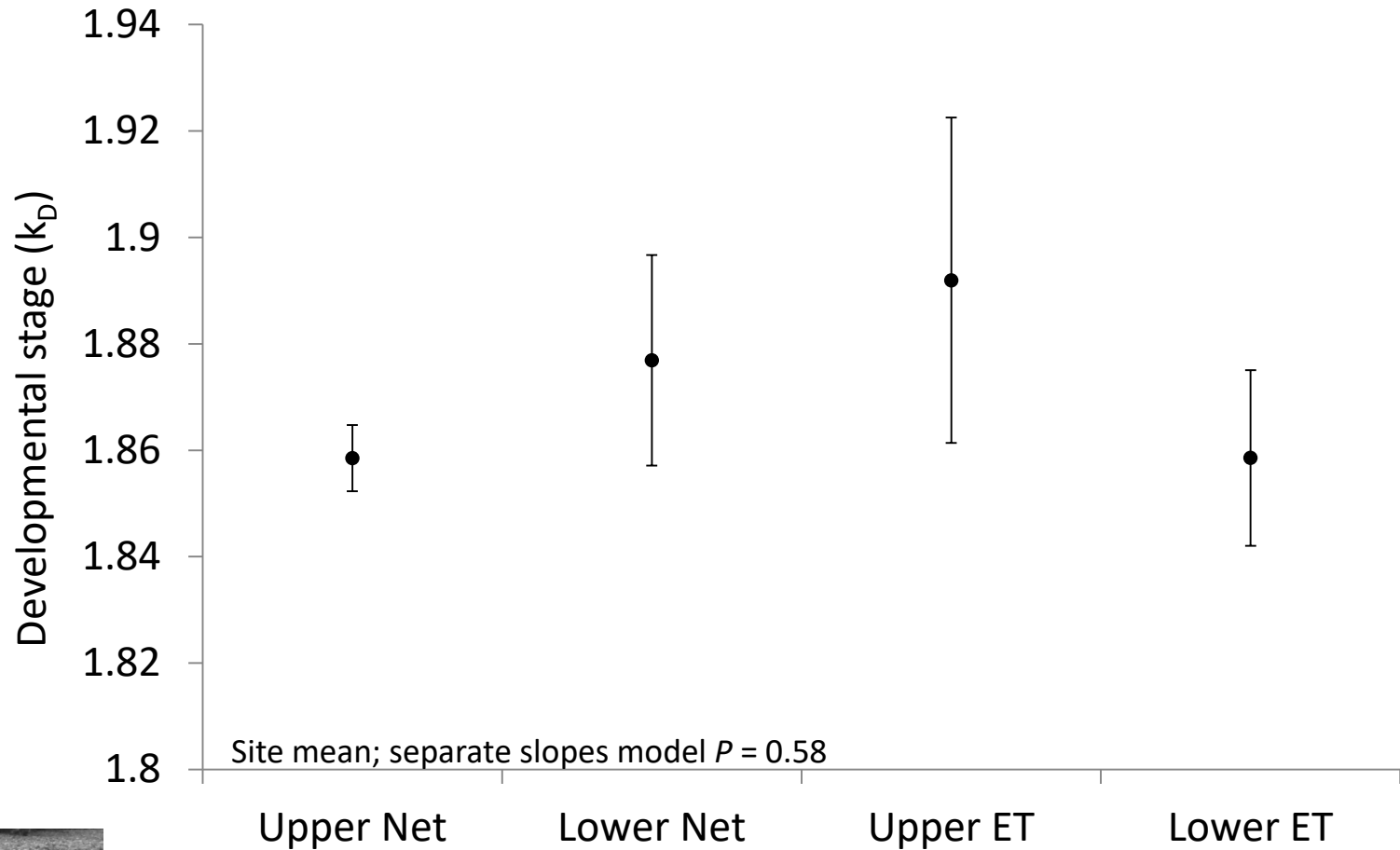
Survival to Emergence Cle Elum River



2011-12 feasibility study



Developmental Stage Natural Origin vs. Emergence Traps Cle Elum River



Summary

- Substantial differences in temperature accumulation and temperature variation among spawning habitats
- Detectable differences in observed emergence timing
- Significantly lower survival through the swim-up stage
- No detectable difference in developmental stage at emergence/first movement between naturally produced fry and those from within emergence traps.
- Some difference in emergence timing observed between traps and naturally produced fry (potentially attributable to spawn timing, parental effects, redd dynamics, post-emergence behavior)

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