Upper Yakima River Spring Chinook Competition/Capacity Studies: *Emergence timing*

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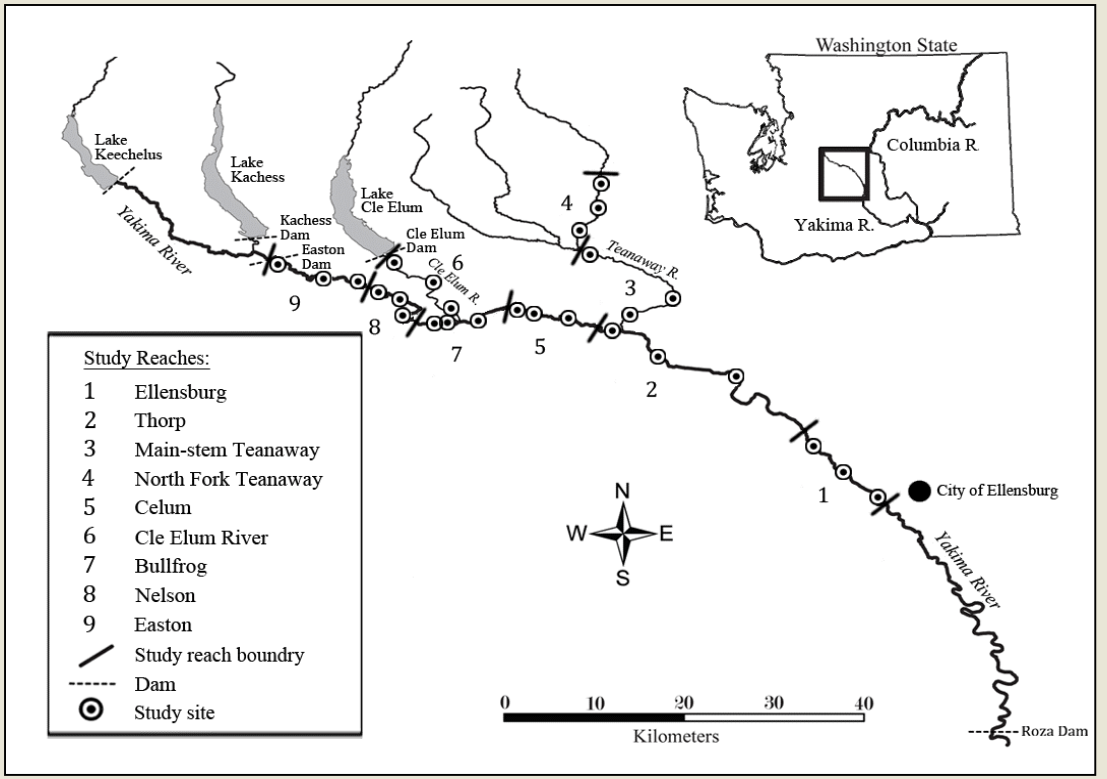
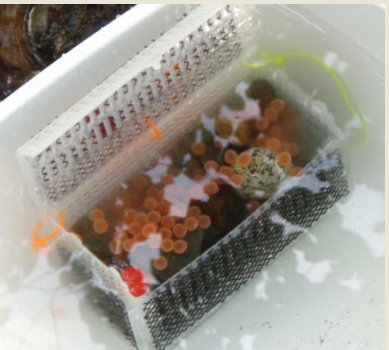
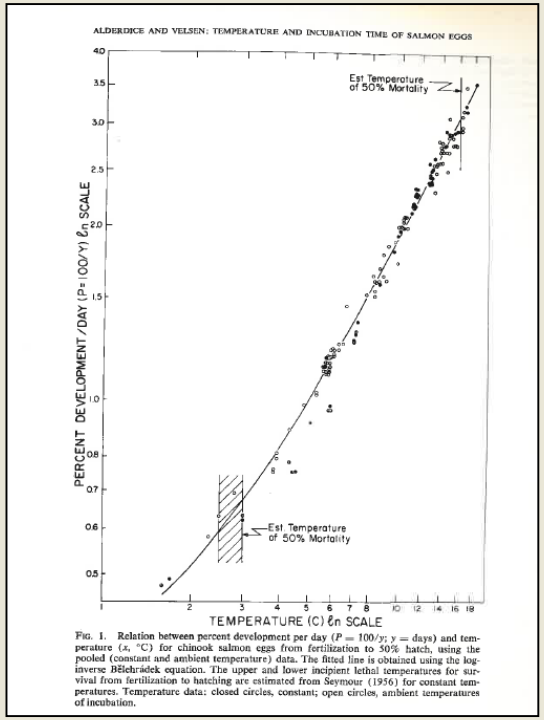
Egg-to-Fry Survival

- Nine study reaches, 2009-2012 brood years. Controlled parental cross, egg deposition, and spawn timing.
- Estimates of survival and developmental stage at approximately 50% emergence based on temperature unit accumulation (ATU)
- Water temperature recorded hourly at 31 locations throughout the upper Yakima River

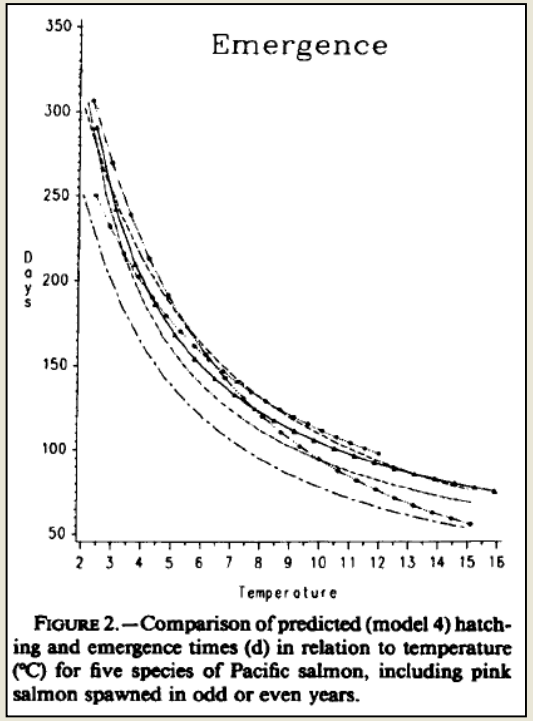




Temperature accumulation, alevin development, and emergence timing



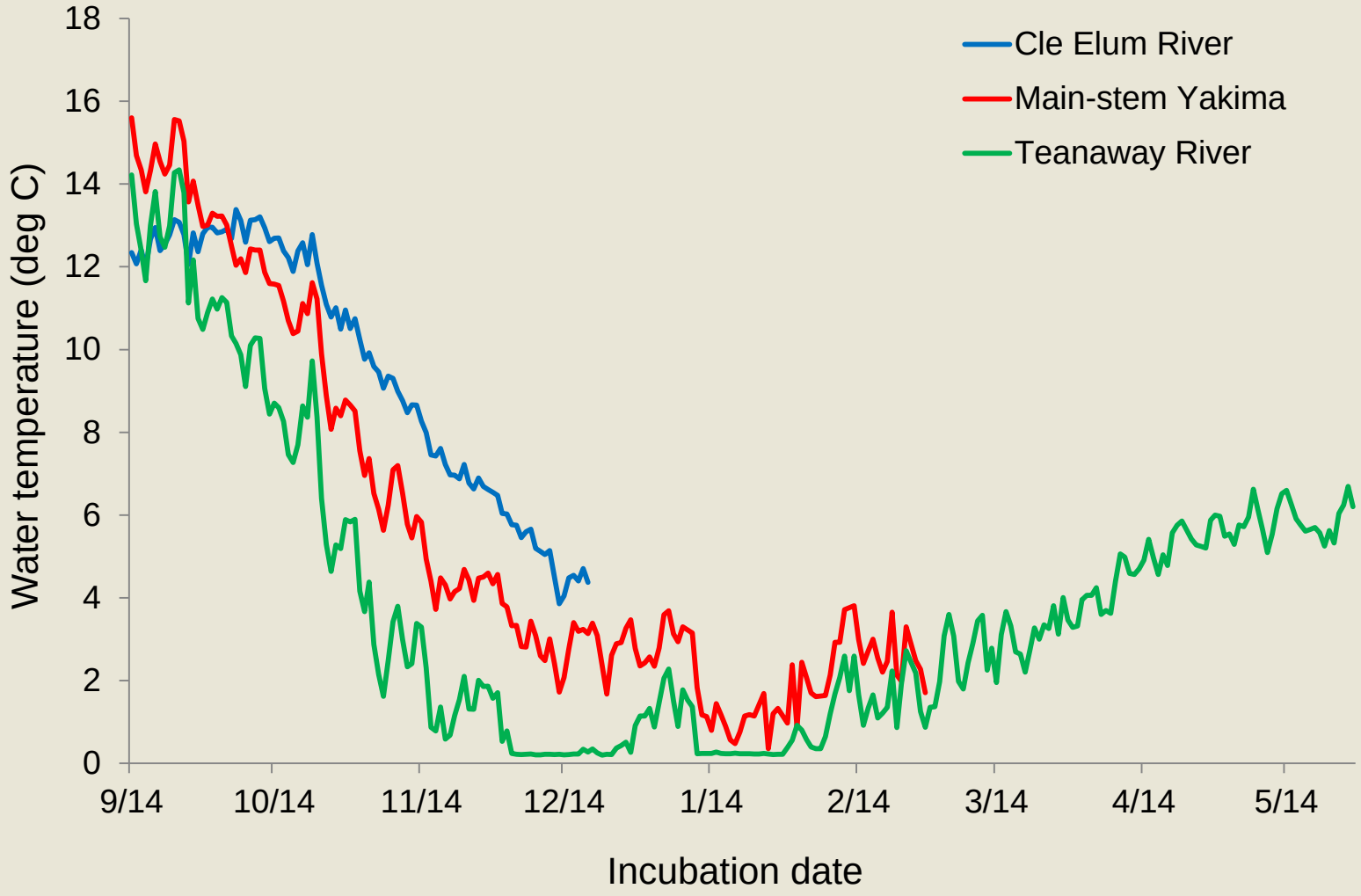
Alderdice and Velsen 1978
Temperature and percent development



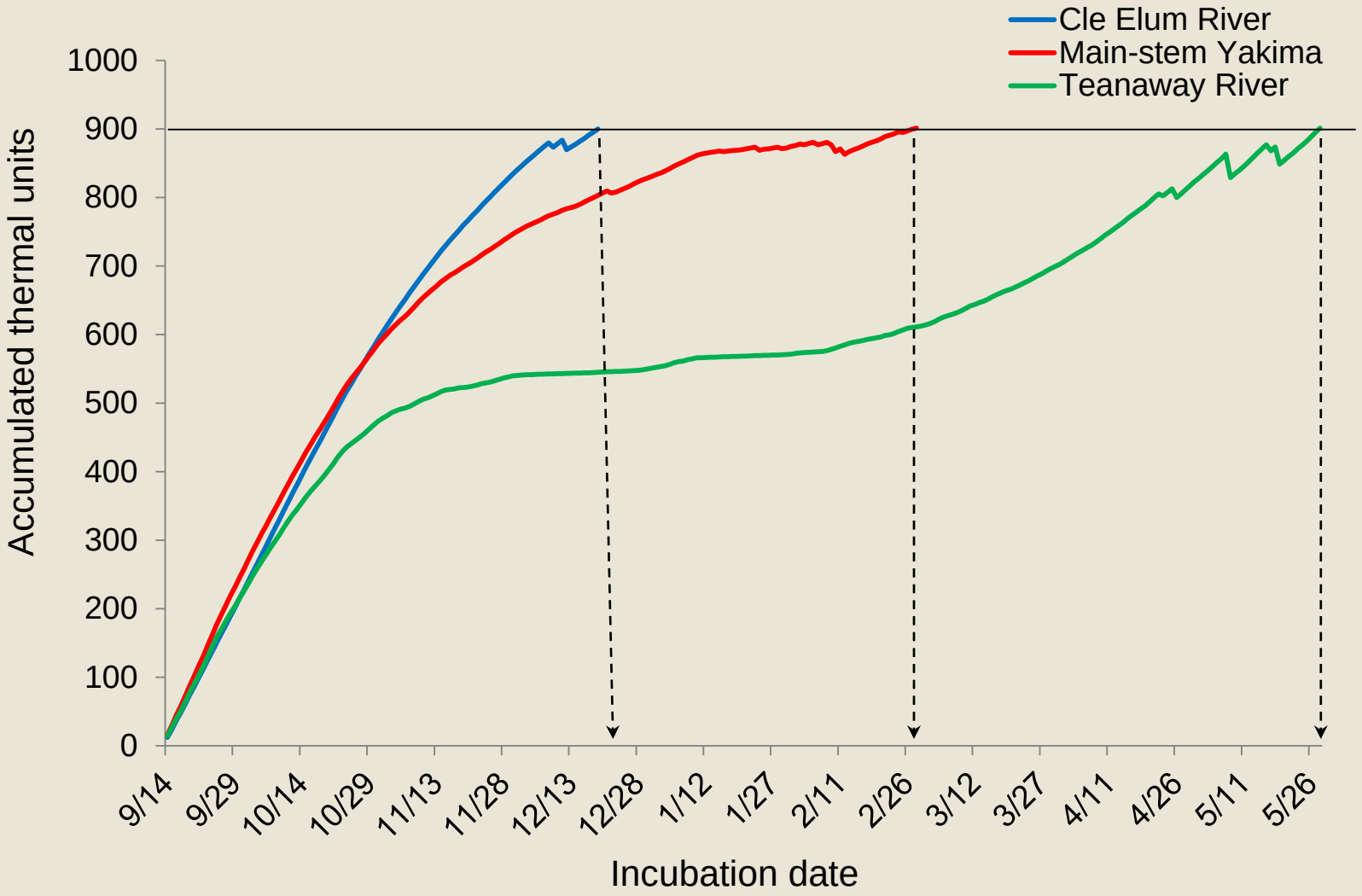
Beacham and Murray 1990
Temperature and days to emergence

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

Upper Yakima Basin Temperature Profile



Temperature Accumulation



Developmental Stage

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

(Bams 1970)

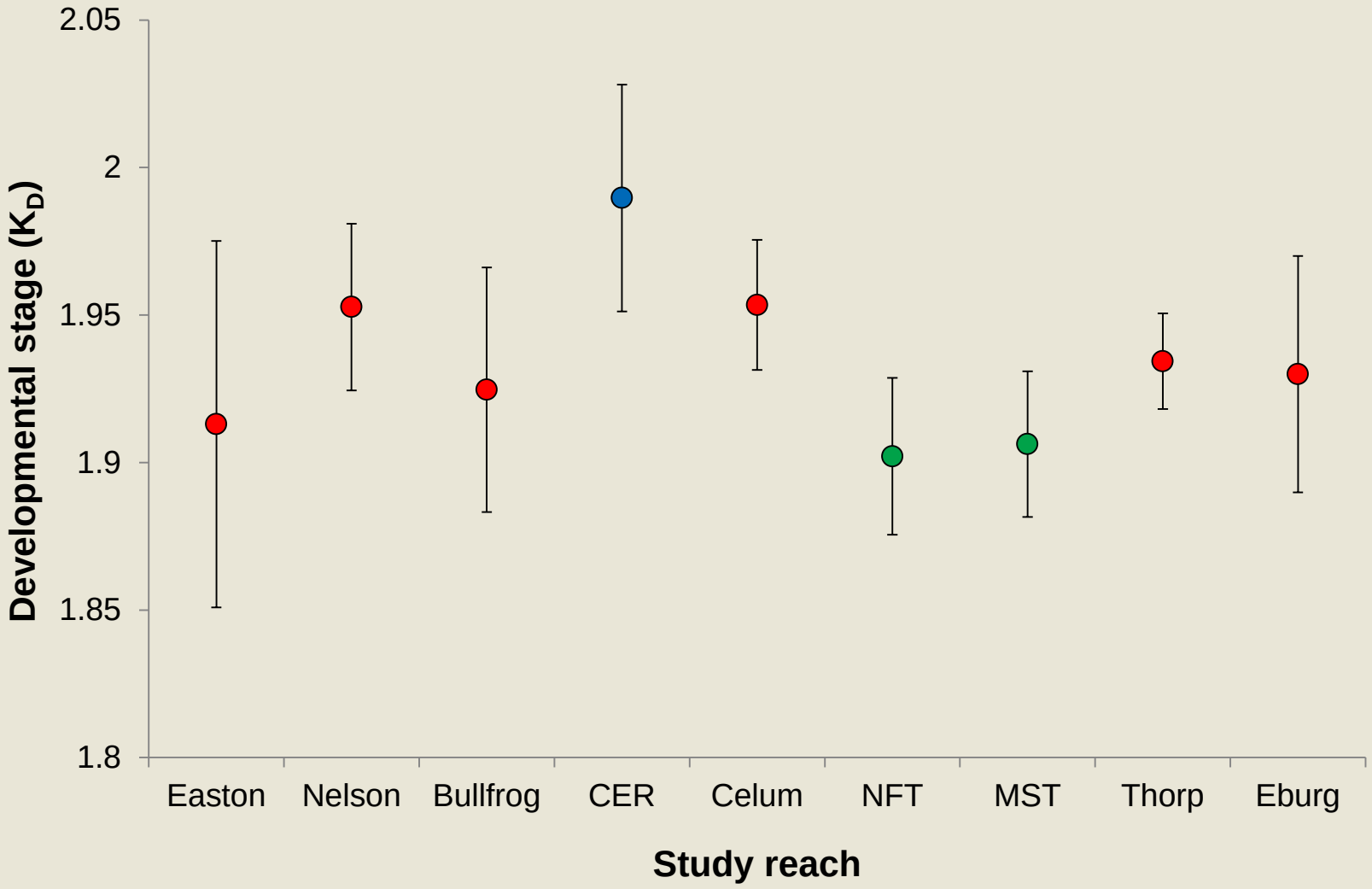
$k_D = 1.9861$

$k_D = 1.9817$

$k_D = 1.9744$

$k_D = 1.8779$

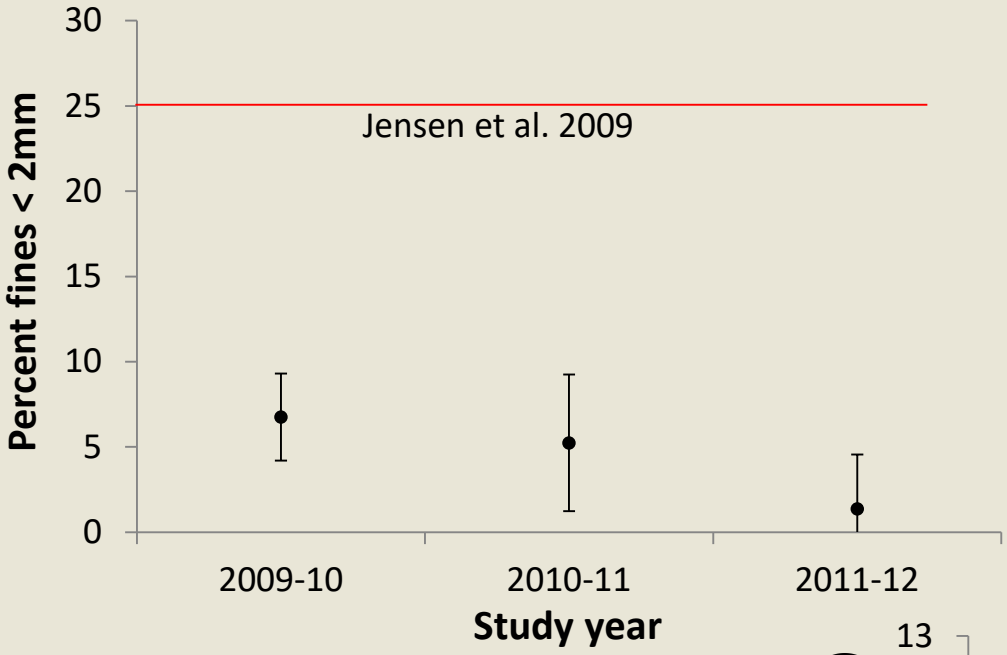
Developmental Stage at 900 Accumulated Thermal Units

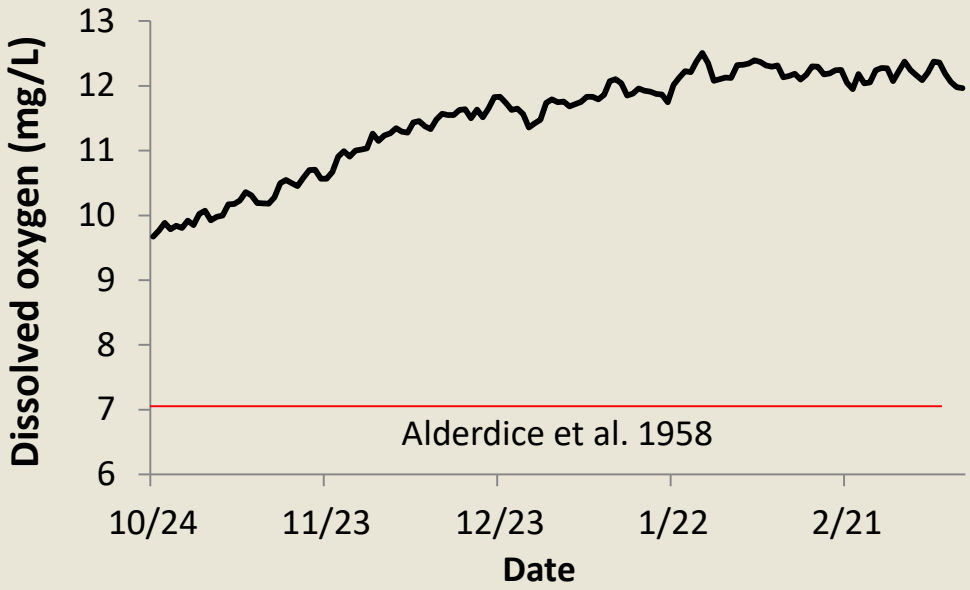


Environmental Factors potentially limiting development

- Fine sediment (Jensen et al. 2009)
- Low dissolved oxygen (Alderdice et al. 1958; Malcolm et al. 2004)

Cle Elum River



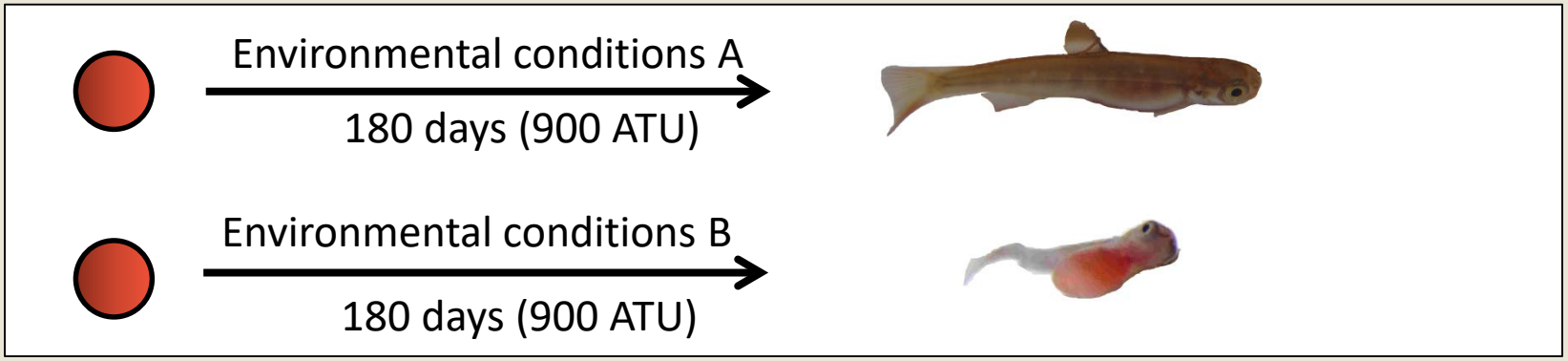


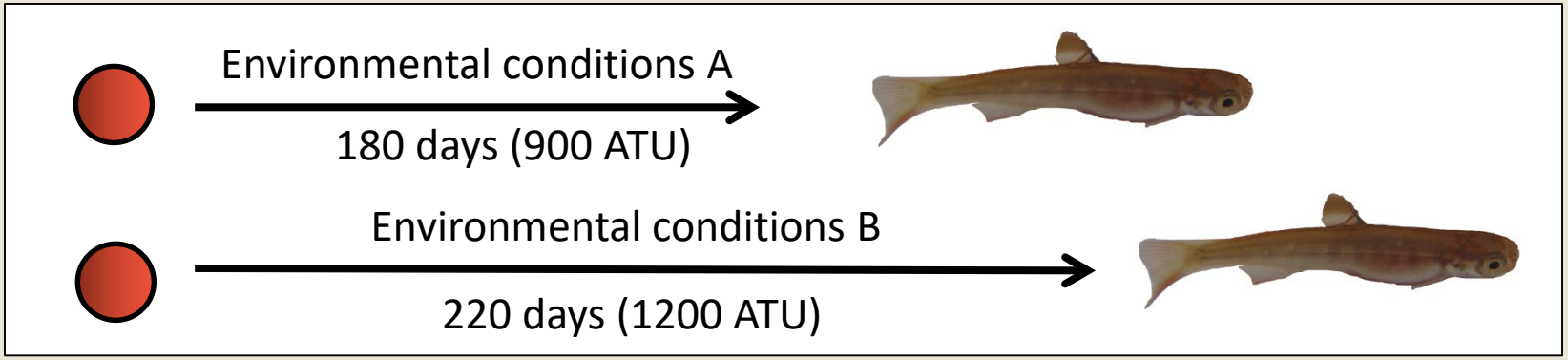
Environmental Factors potentially limiting development

- 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)

Developmental stage at emergence





Emergence timing

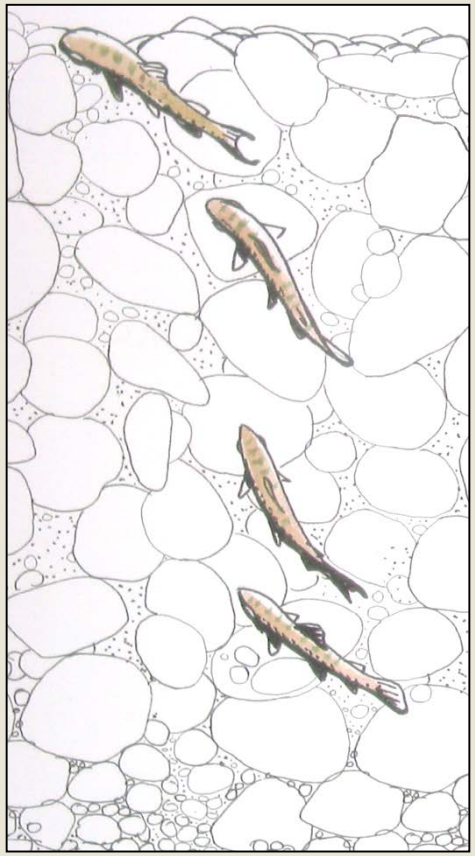


Image: fedflyfishers.org

- Acquisition of habitat
- Competitive ability
- Predator avoidance

Emergence Traps

- Emergence timing
- Survival to emergence (inclusive of swim-up effects)
- Developmental stage, size, and condition following volitional emergence
- Emergence trap vs. egg box comparisons

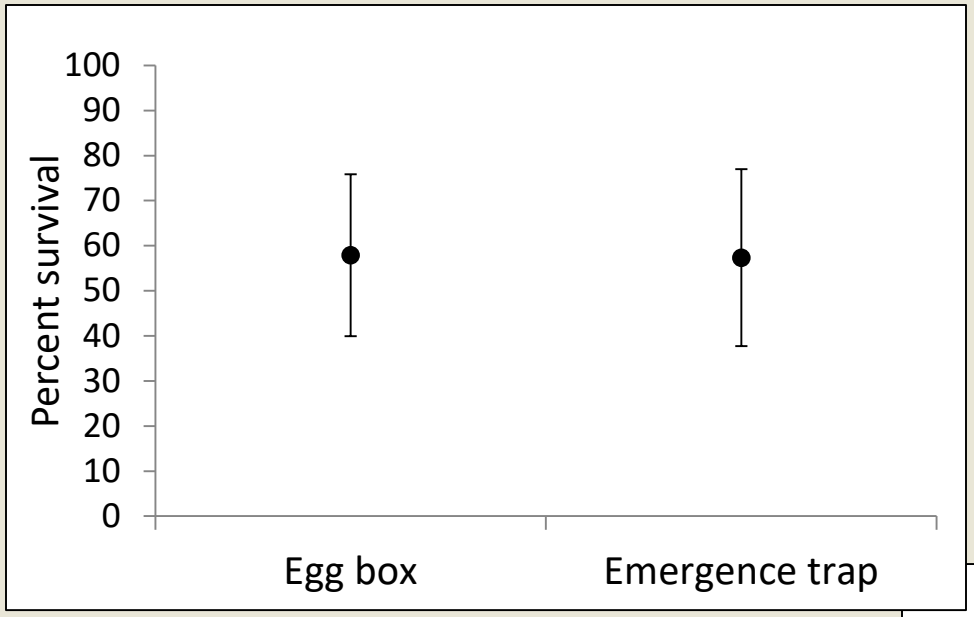


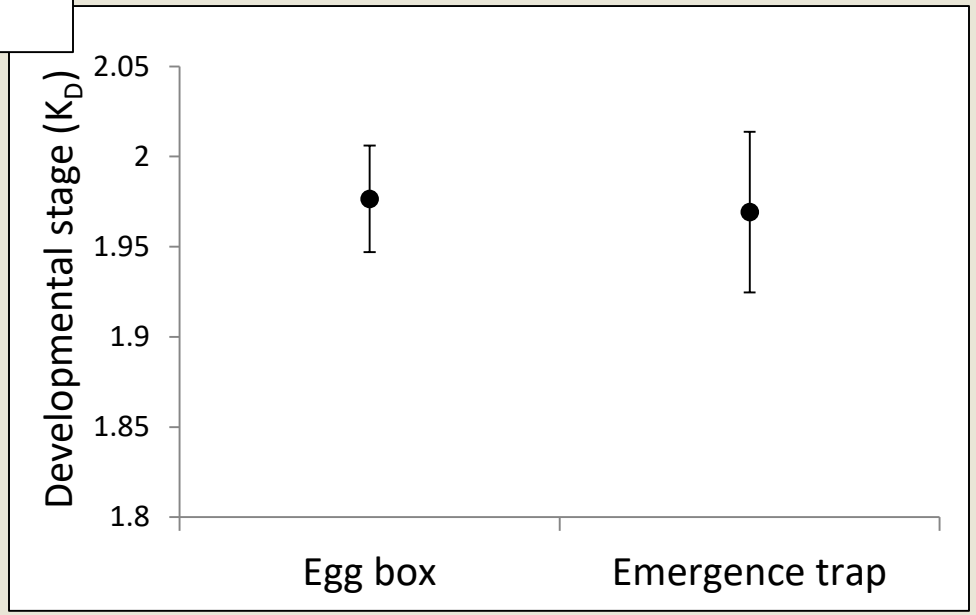

Comparison of trap and egg box survival and developmental stage at 900 ATU

Mating	Egg Box	Emergence Trap
A	n = 3	n = 3
B	n = 3	n = 3
C	n = 3	n = 3

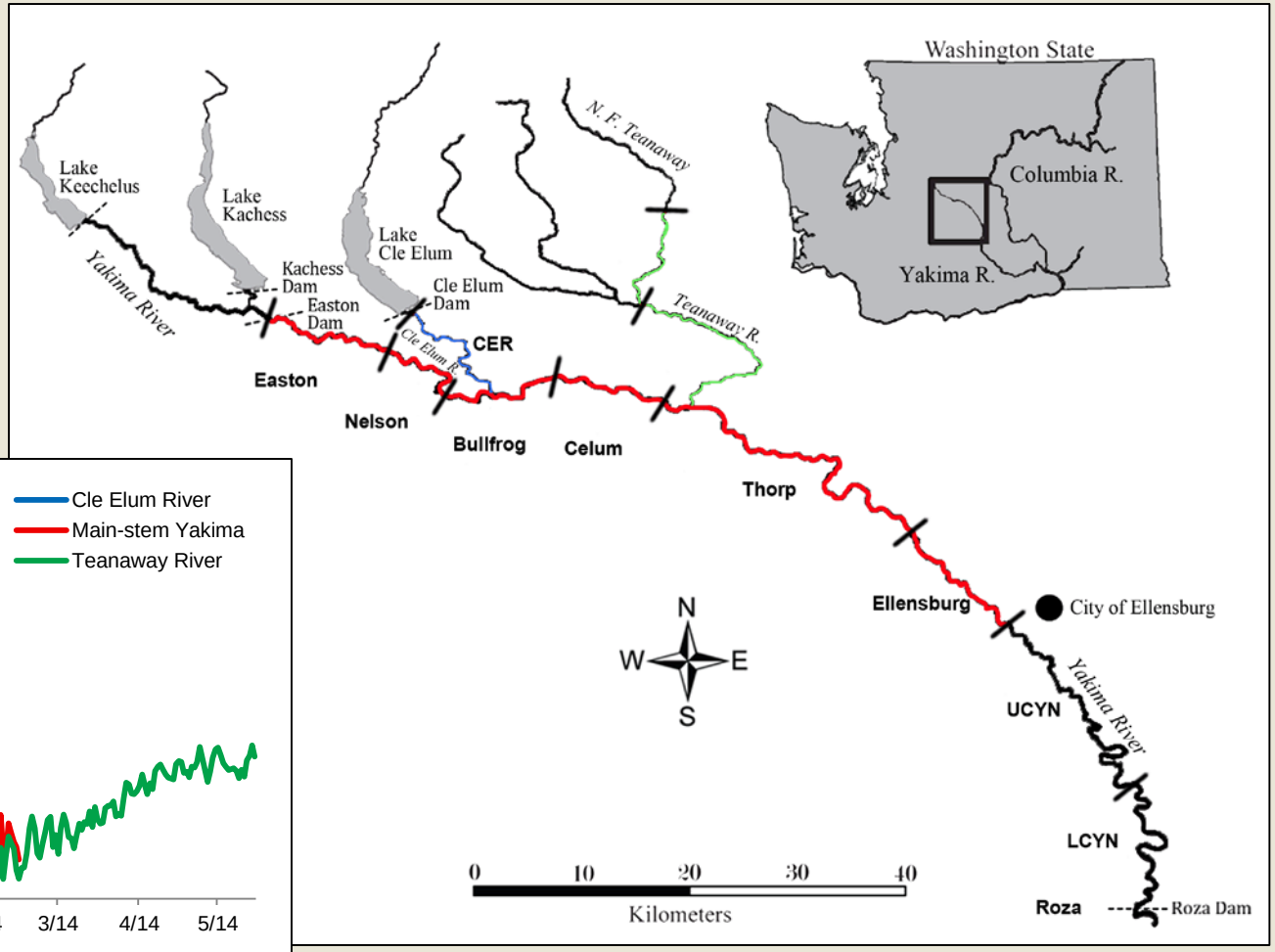


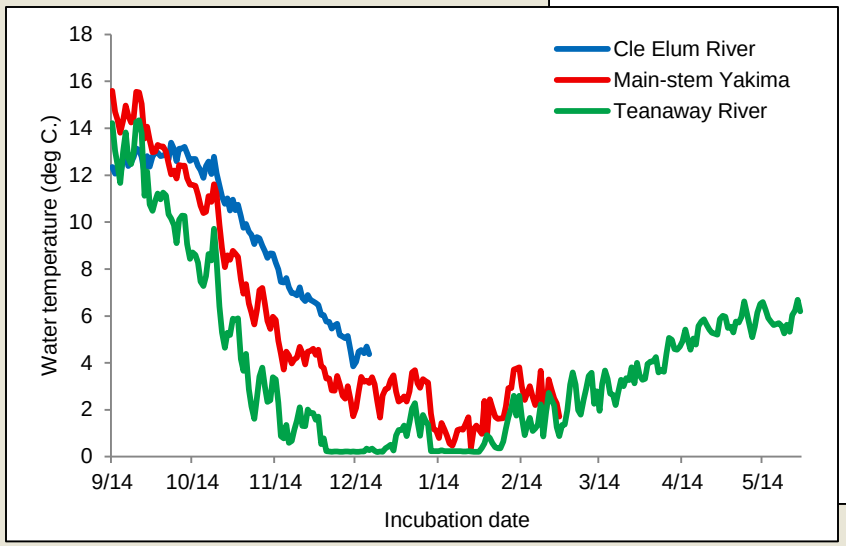
Box vs. Trap Survival: 900 ATU





2013


Washington State
Columbia R.
Yakima R.
Lake Keechelus
Lake Kachess
Lake Cle Elum
N.F. Teanaway
Yakima River
Kachess Dam
Easton Dam
Cle Elum Dam
Cle Elum R.
Teanaway R.
CER
Easton
Nelson
Bullfrog
Celum
Thorp
Ellensburg
City of Ellensburg
Yakima River
UCYN
LCYN
Roza
Roza Dam
N
W
E
S
0 10 20 30 40
Kilometers


Cle Elum River
Main-stem Yakima
Teanaway River
Water temperature (deg C.)
18
16
14
12
10
8
6
4
2
0
9/14
10/14
11/14
12/14
1/14
2/14
3/14
4/14
5/14
Incubation date

Summary

- Temperature profiles suggest a broad range of predicted emergence times among study reaches in the upper Yakima River Basin.
- Differential developmental rates appear to be, in part, attributable to temperature related factors; suggesting the need to evaluate time of emergence at a reach scale.
- Survival and developmental stage at 900 ATU was not significantly different between egg boxes and emergence traps, suggesting they should be appropriate for use in evaluating emergence time over a larger spatial scale.

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End