

Life-history diversity and productivity of Lake Washington Chinook salmon

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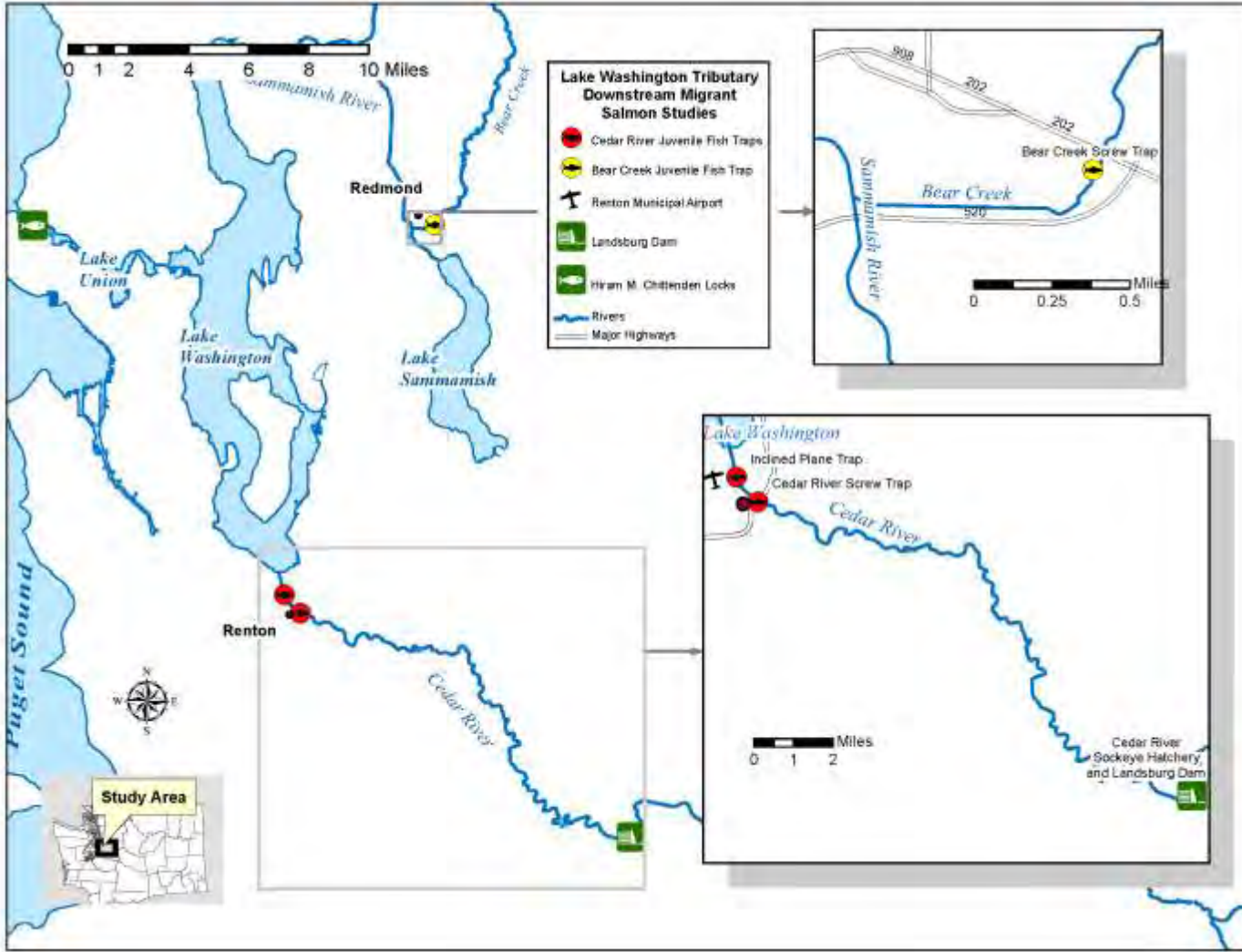
Washington Department of Fish and Wildlife

WRIA 8 Technical workshop

Nov 17, 2015



Lake Washington Basin



Cedar River Incline Plane Trap

January through early May



Cedar River Screw Trap

Mid-April through mid- July

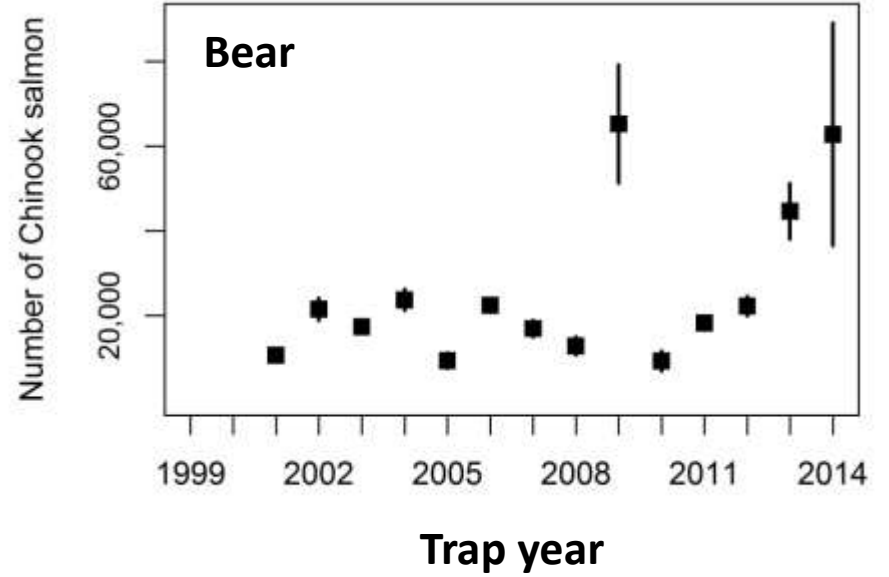
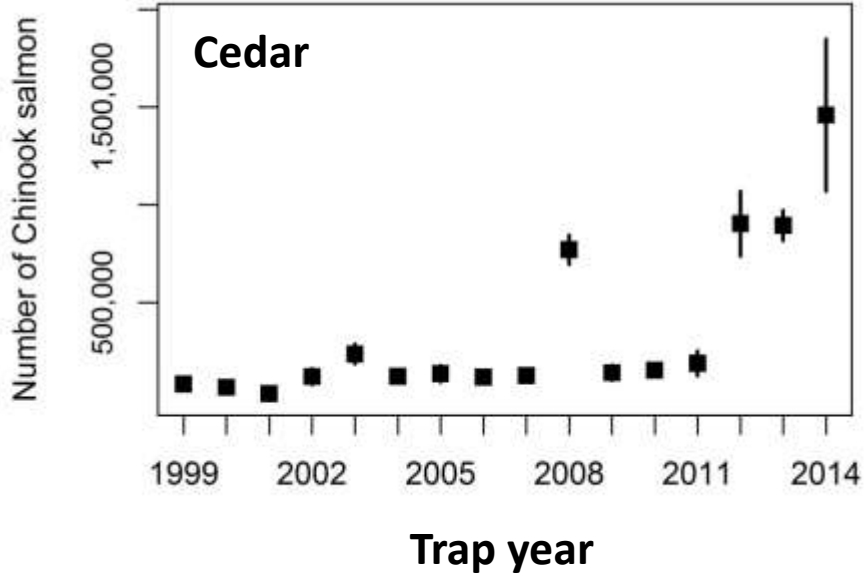


Bear Creek Trap

Early February through mid-July

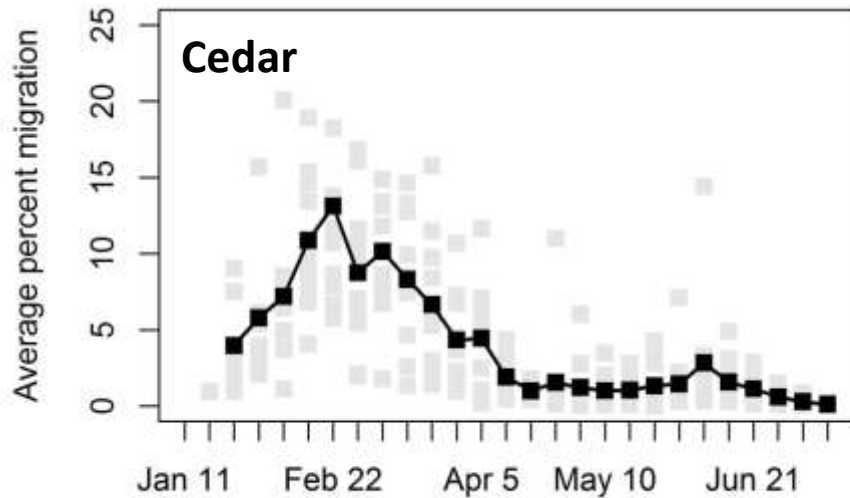


Juvenile Abundance

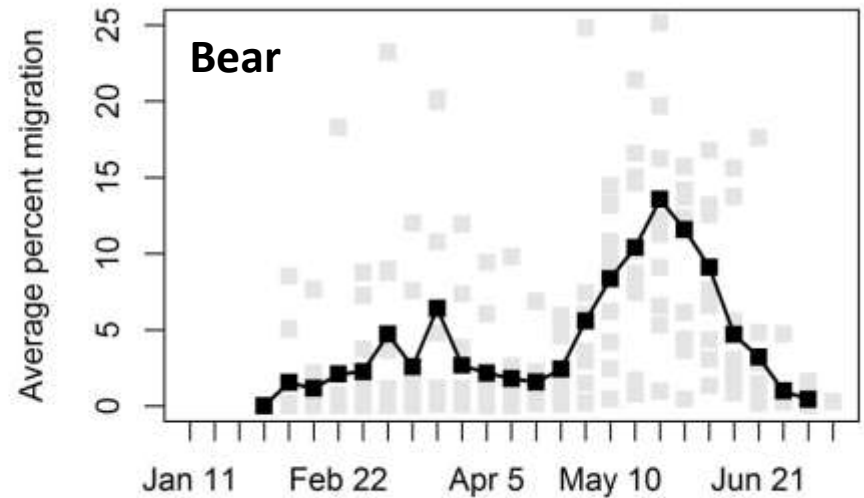


Migration timing

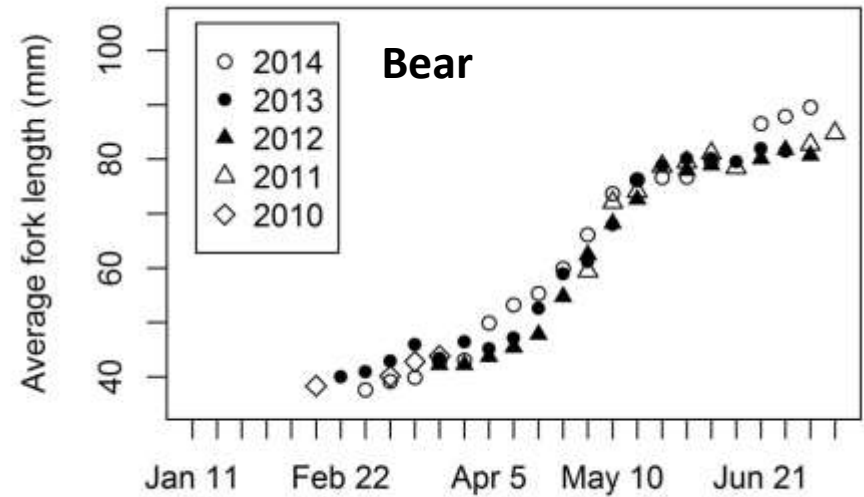
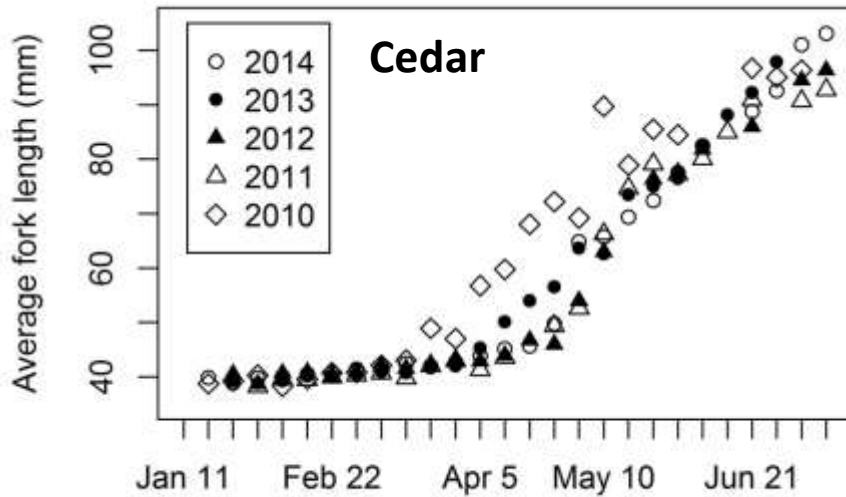
Trap years 2005 - 2014



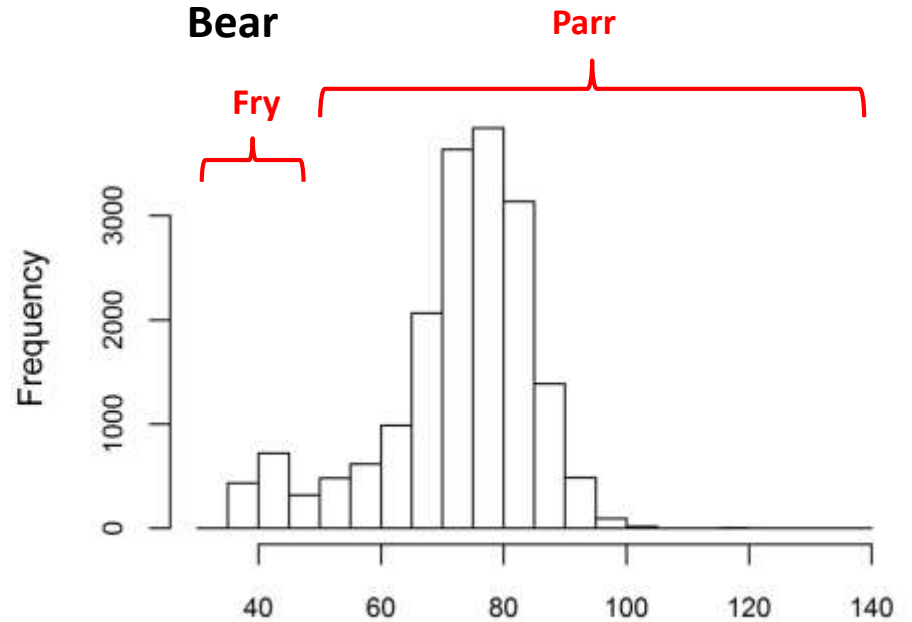
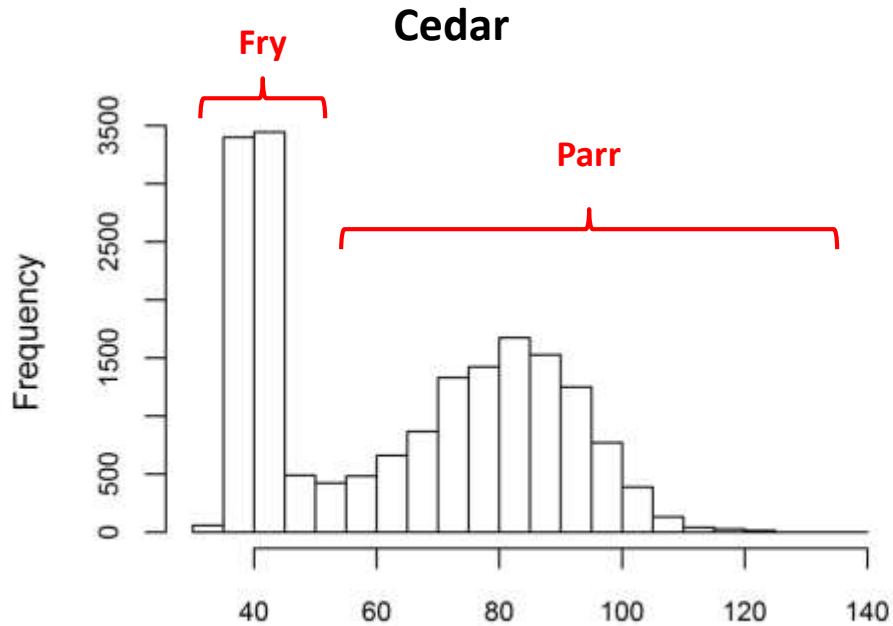
Trap years 2005 - 2014



Body size at outmigration



Body size at outmigration



Fry ≤ 45 mm

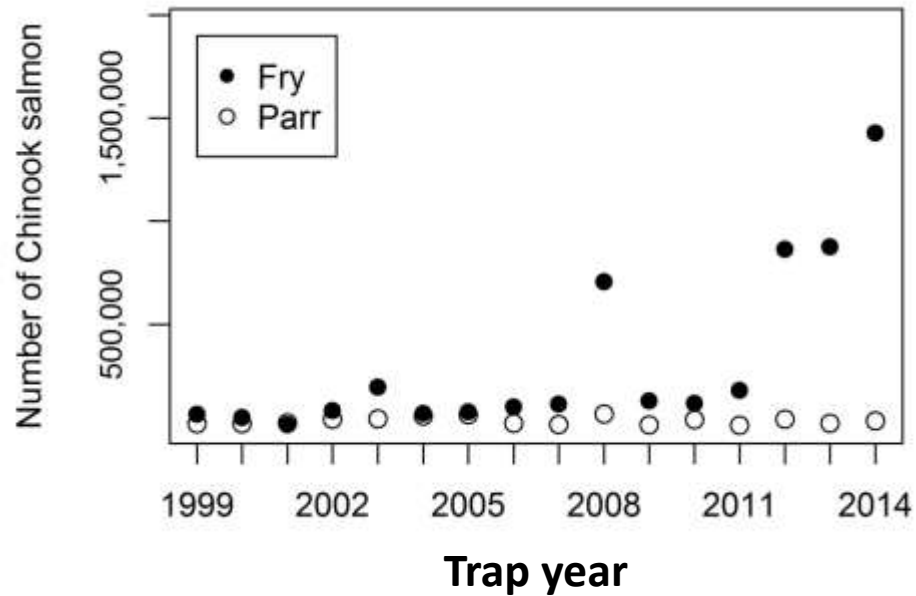


Parr > 45 mm

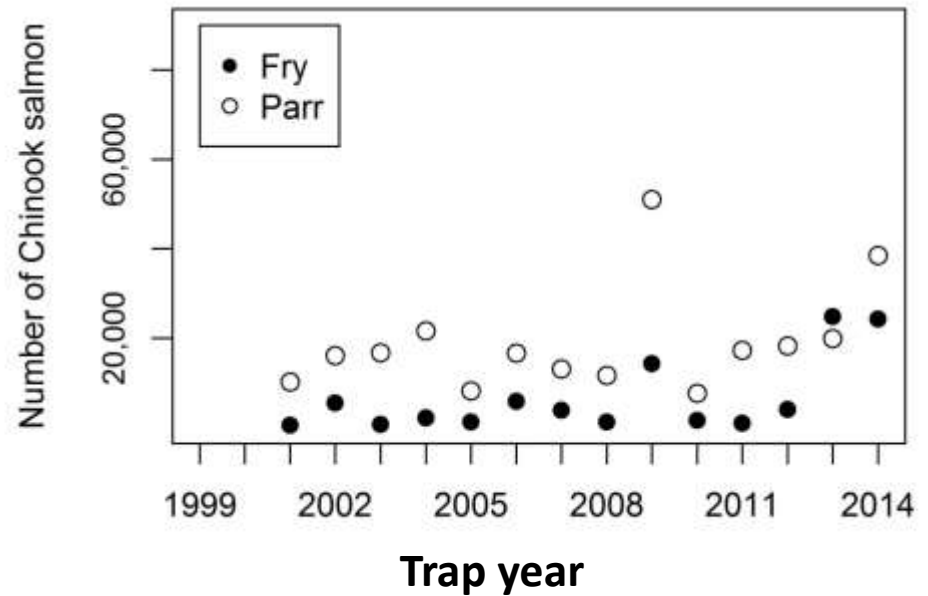


Abundance of two life history strategies

Cedar



Bear



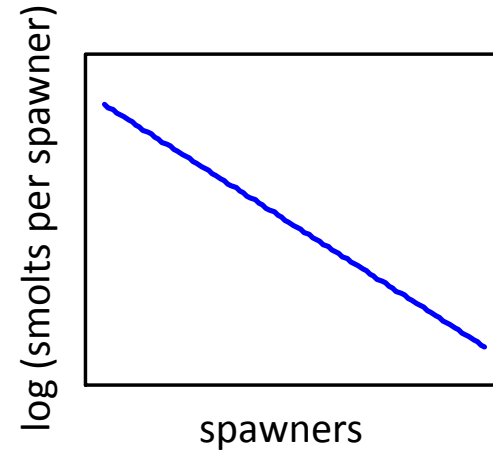
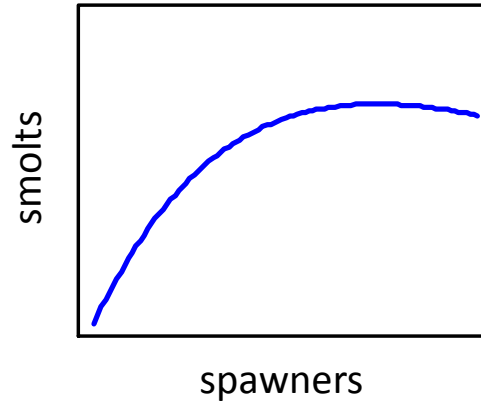
Stock-recruit models

Alternative hypotheses of freshwater productivity

Density dependent model

$$\frac{\text{smolts}}{\text{spawners}} \sim \text{spawners}$$

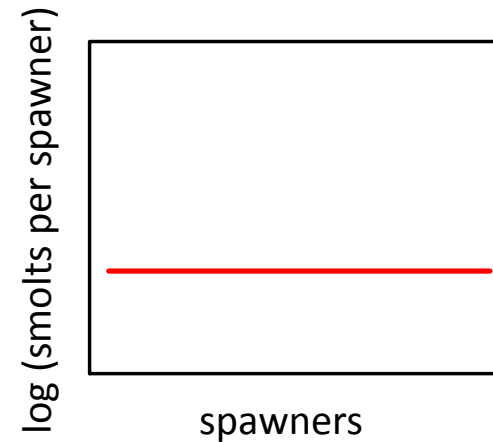
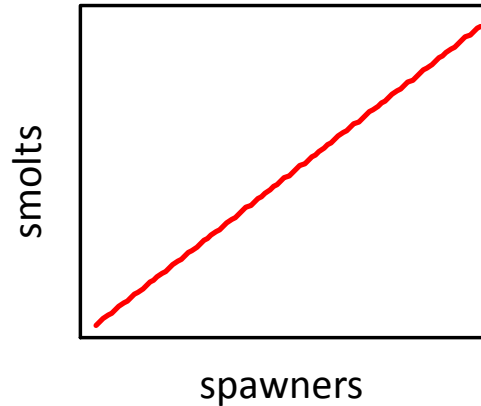
$$\log\left(\frac{\text{smolts}}{\text{spawner}}\right) = a - \frac{a}{b} \times \text{spawners}$$



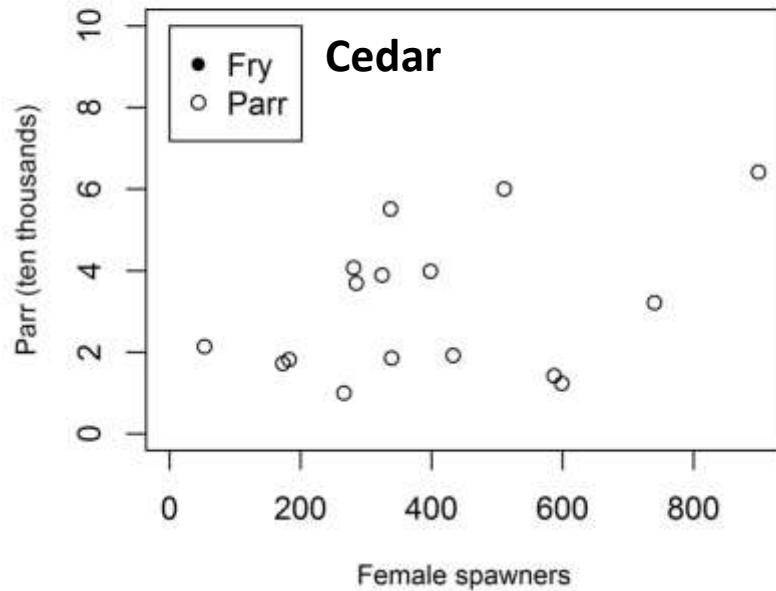
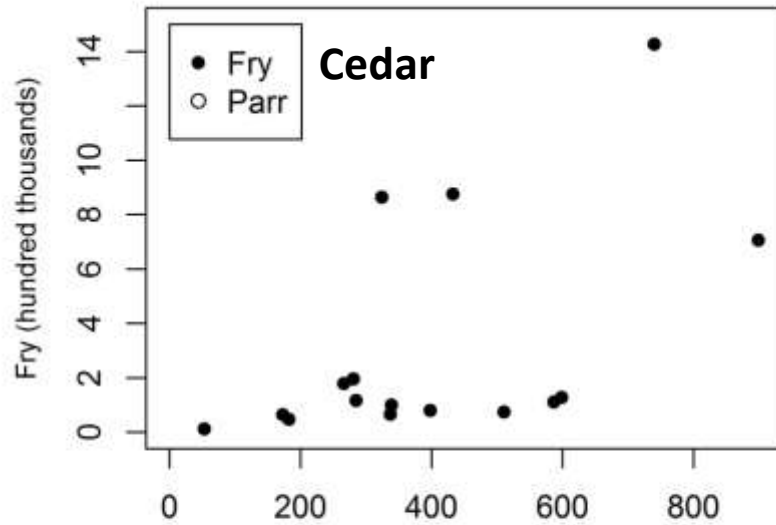
Density independent model

$$\frac{\text{smolts}}{\text{spawners}} \sim \text{constant}$$

$$\log\left(\frac{\text{smolts}}{\text{spawner}}\right) = a$$

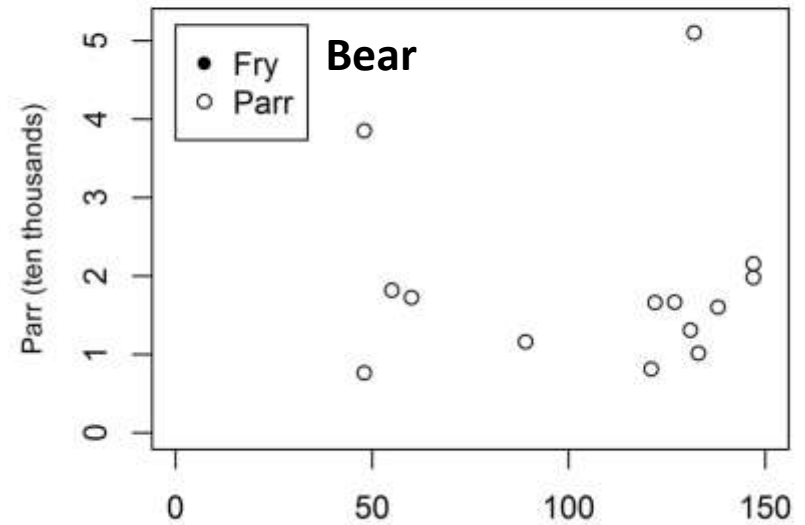
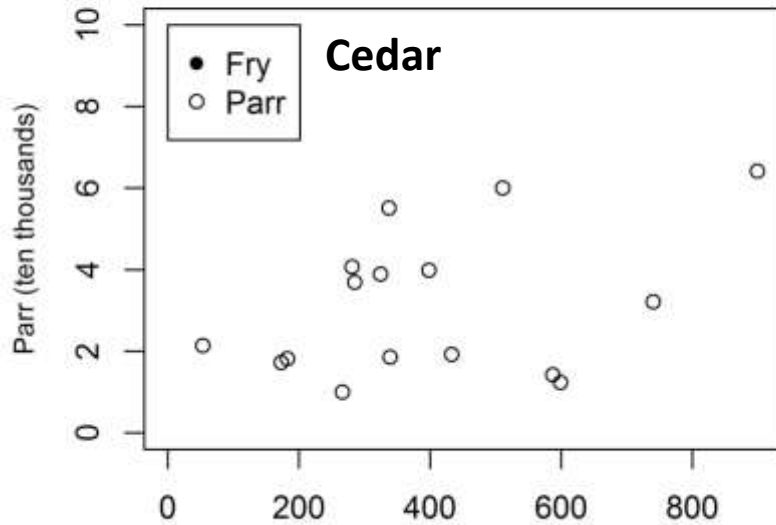
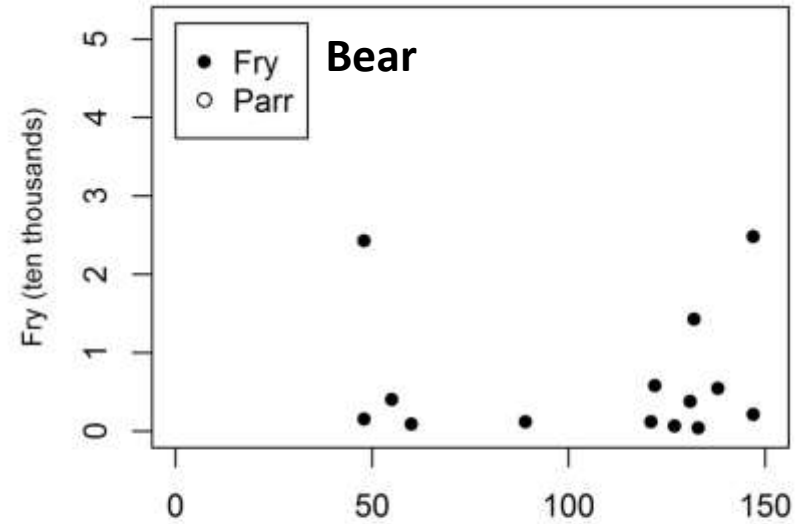
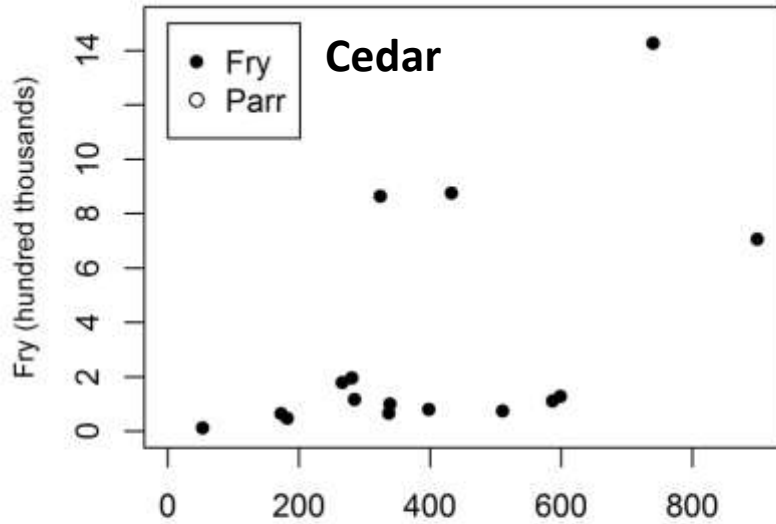


Productivity



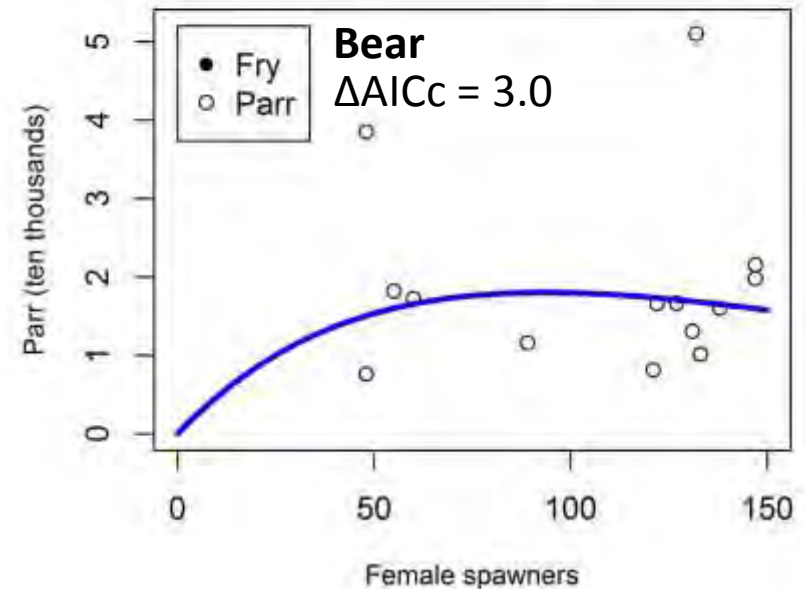
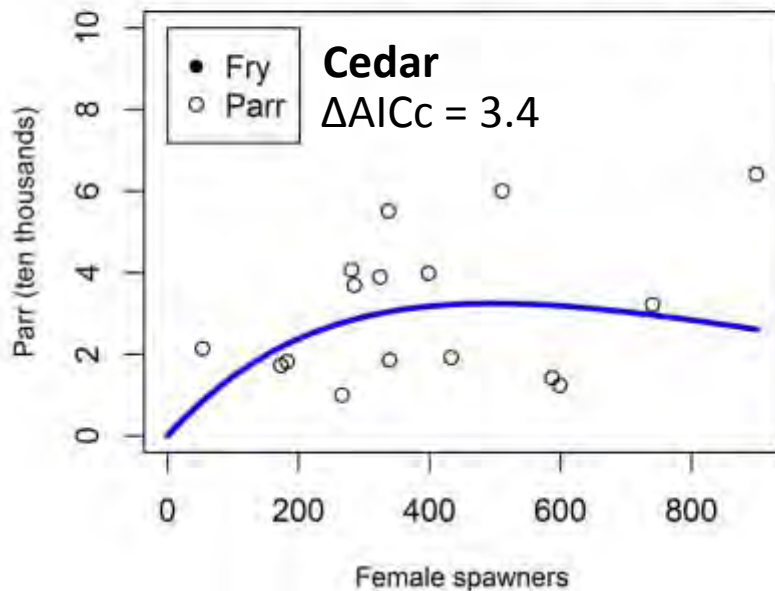
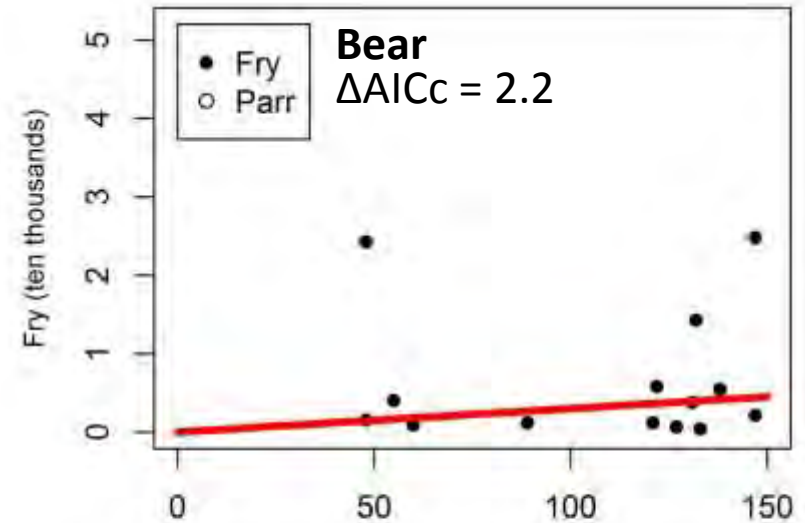
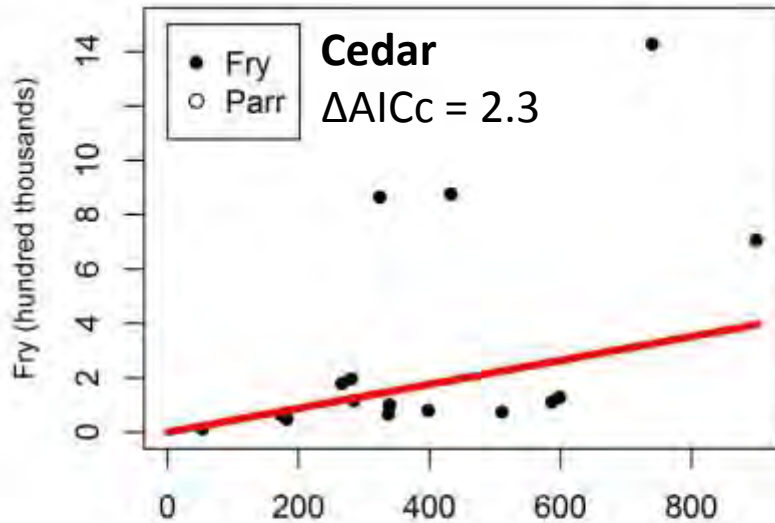
Productivity

Density independent vs density dependent



Productivity

Density independent vs density dependent



What happens when juvenile Chinook get to the lake?

Fry that survive grow rapidly

- Feb – May: Chironomids in littoral zone
- June: Daphnia in limnetic zone
- Feeding close to maximum ration
- Fish in lake larger than fish in river
- Earlier entrants to lake experience faster growth

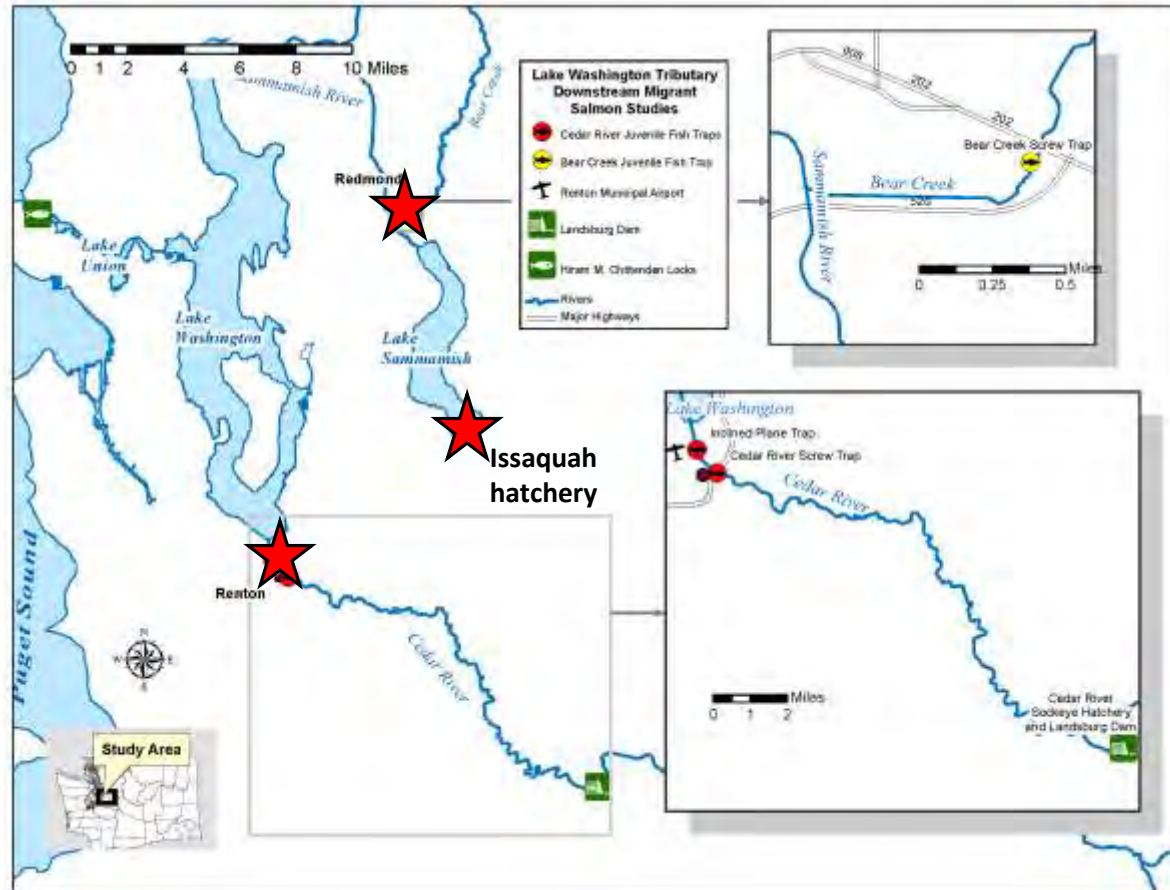
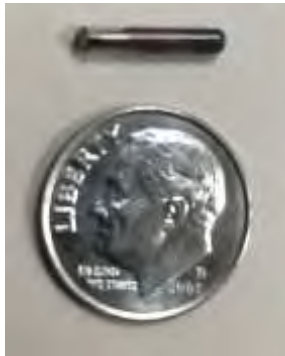


Photo: Richard Bell, UW Press

PIT tagging

Insert tags to measure survival to Ballard Locks

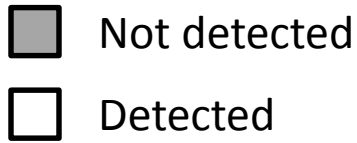
★ Tagging location



Survival to locks

Site	Year	Number tagged	Average size at tagging (mm)	Median date at tagging	Percent detected at locks
Cedar smolt trap	2014	1,994	83.8	6/12	8.8%
	2013	711	81.3	5/26	29.4%
	2012	1,671	84.0	6/6	12.7%
	2011	594	87.3	6/22	19.5%
	2010	2,232	84.2	5/24	21.6%
Bear smolt trap	2014	1,968	77.6	6/1	16.5%
	2013	1,858	79.3	5/28	27.9%
	2012	2,721	75.2	5/23	11.6%
	2011	2,316	79.9	6/9	14.6%
	2010	589	77.9	5/24	17.5%
Issaquah hatchery	2014	5,000	81.6	5/23	2.7%

Size and survival

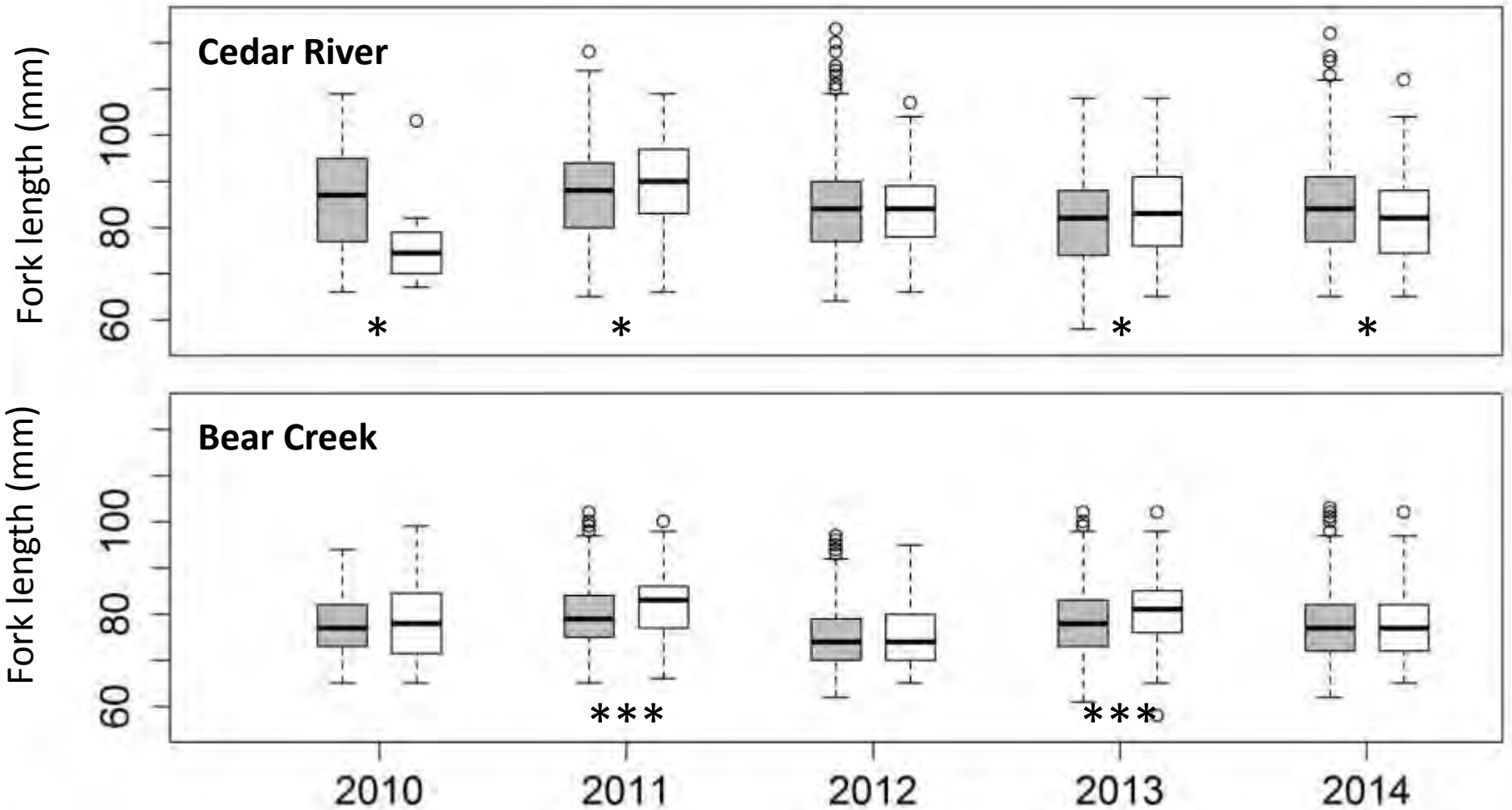


Logistic regression

*** $p < 0.001$

** $p < 0.01$

* $P < 0.05$



Migration date and survival

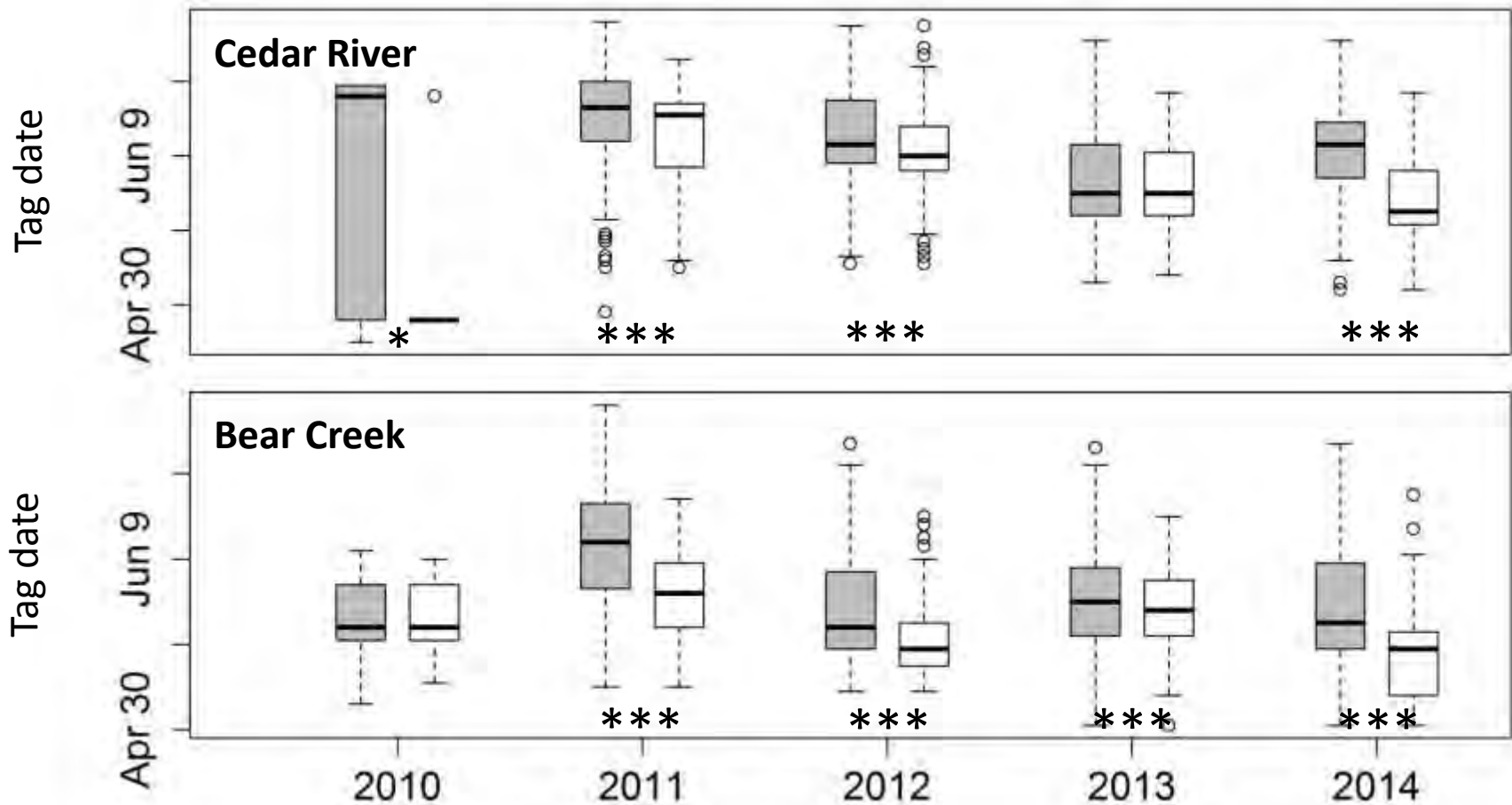
■ Not detected
□ Detected

Logistic regression

*** $p < 0.001$

** $p < 0.01$

* $P < 0.05$



Conclusions

- Two juvenile life history strategies
 - Fry migrate early at a small size
 - Parr migrate later, after rearing and growing in the river
- Fry typically more numerous than parr in Cedar River
- Parr typically more numerous than fry in Bear Creek
- Fry exhibit density independent productivity from the river
- Parr exhibit density dependent productivity from the river
- For PIT tagged parr, detection at the Ballard locks appears linked to
 - Larger size at tagging
 - Early migration from river

Implications for recovery

Rainbow bend levee setback



- Fish in / fish out data indicate Cedar River Chinook freshwater productivity is limited by rearing habitat
- Recovery efforts that increase quality and quantity of juvenile rearing habitat will benefit population
- Long term monitoring data essential to
 - identifying limiting life stage
 - evaluating success



Acknowledgements

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