The Highs and Lows of 20 Years of Juvenile Winter-run Chinook Salmon Abundance Monitoring at RBDD

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Winter Chinook Carcass Survey Area
(RM 288-302)

≈ 50 miles

Red Bluff Diversion Dam
Site (RM 243)

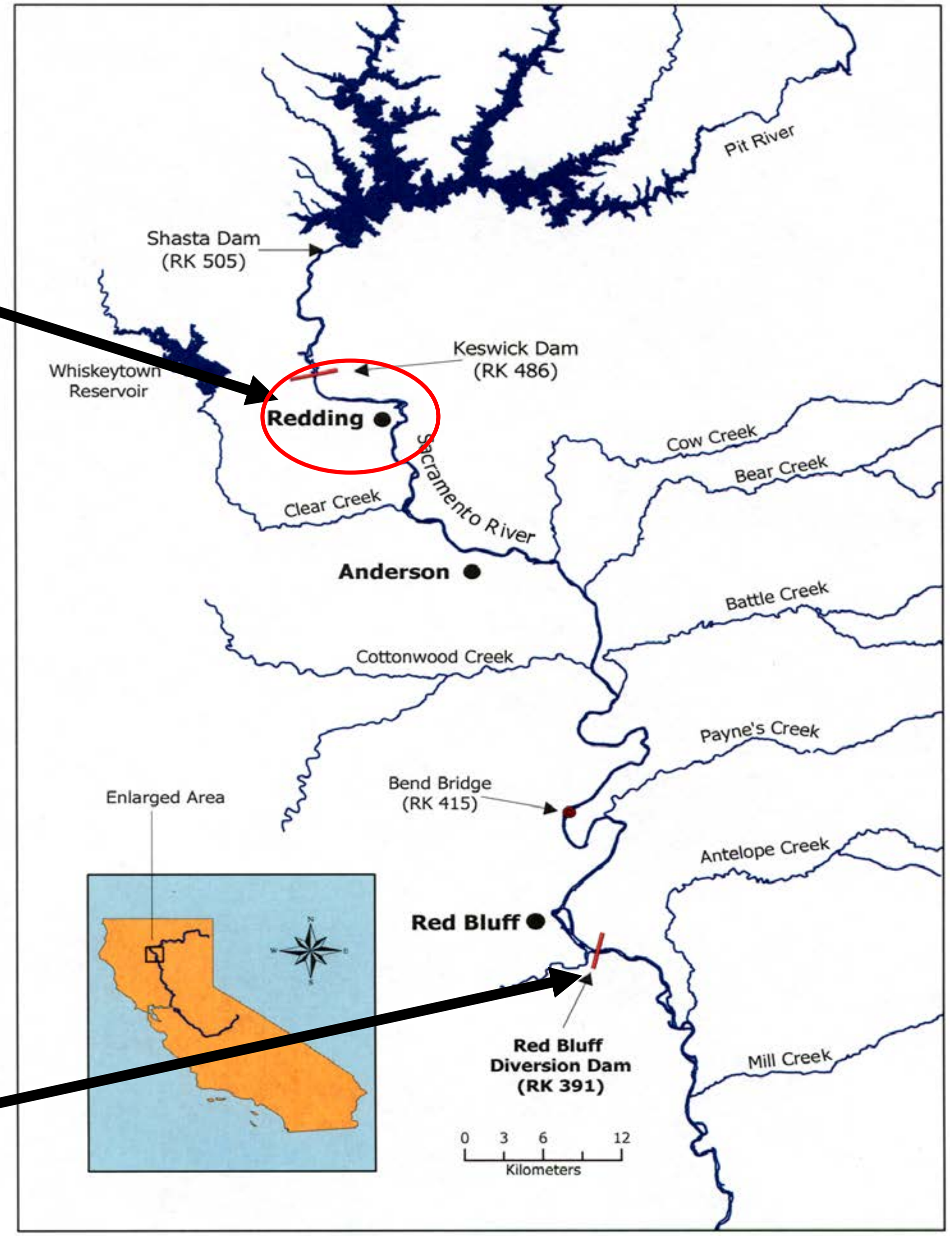
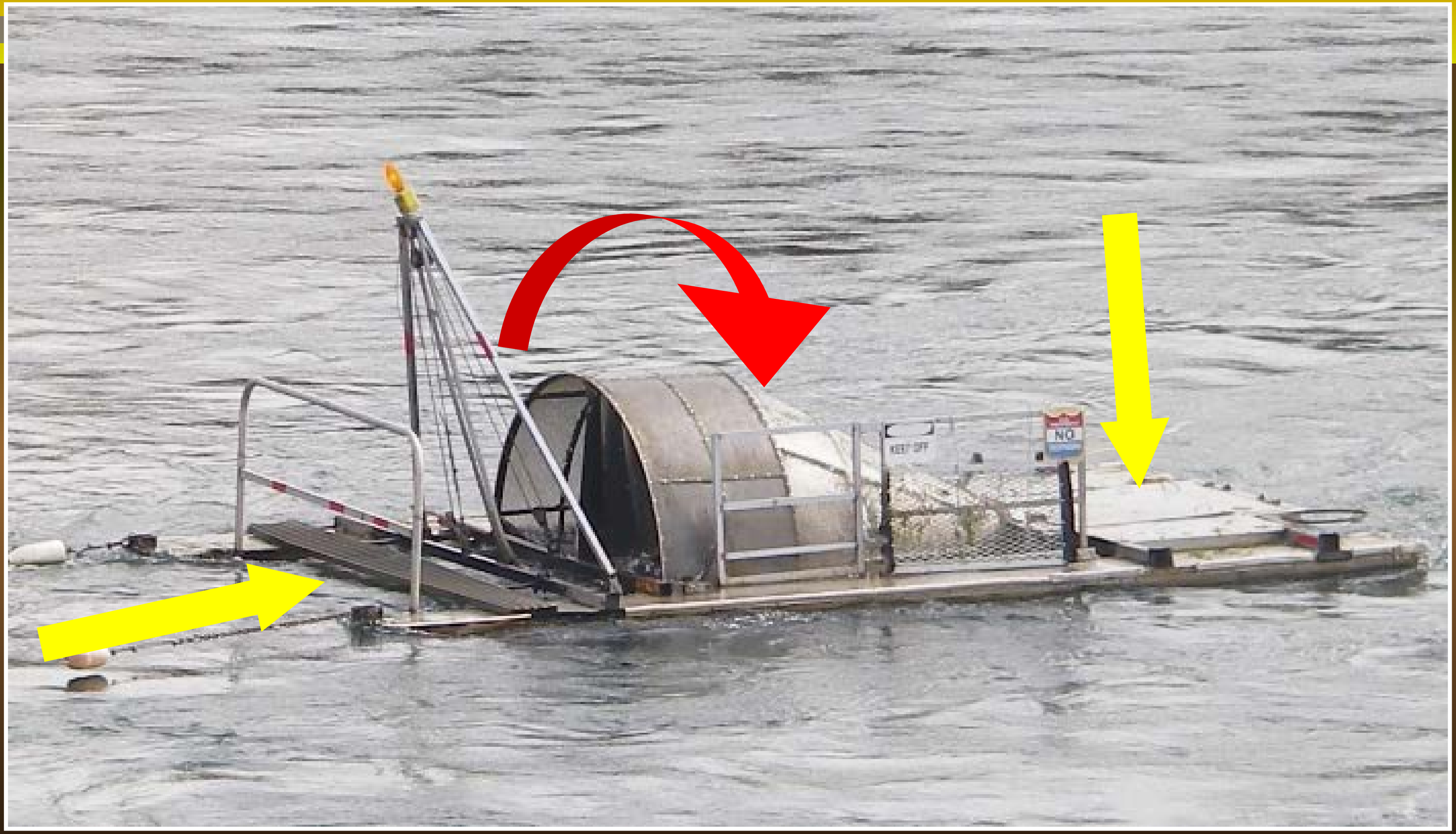
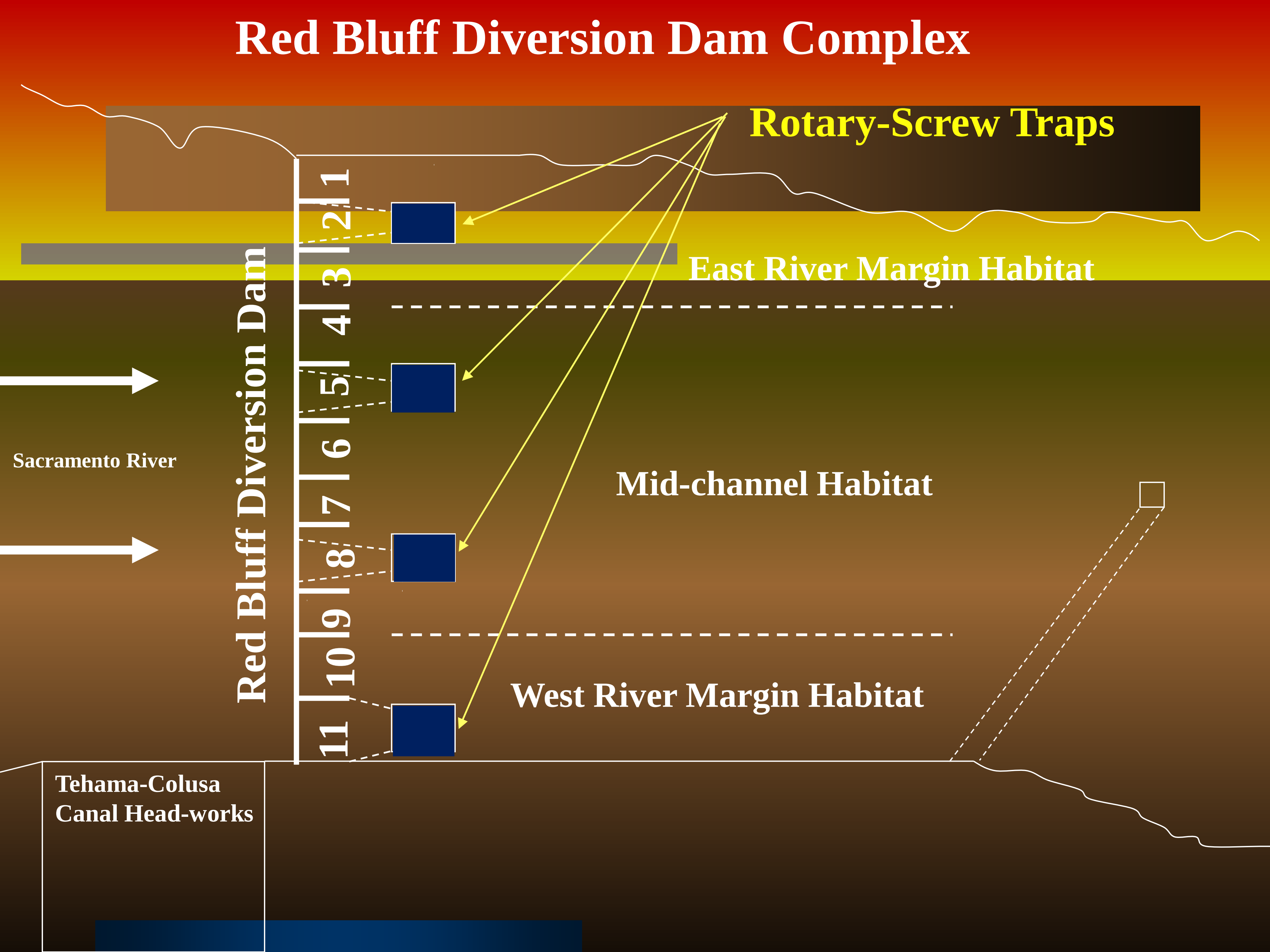


Figure 1. Location of Red Bluff Diversion Dam on the Sacramento River, California at river kilometer 391 (RK 391).

Methods: Sampling Gear (RST)




Red Bluff Diversion Dam Complex
Rotary-Screw Traps
East River Margin Habitat
Mid-channel Habitat
West River Margin Habitat
Sacramento River
Red Bluff Diversion Dam
1
2
3
4
5
6
7
8
9
10
11
Tehama-Colusa
Canal Head-works

Methods: Passage Estimates (JPI's)

$$\hat{P}_d = \frac{C_d}{\hat{T}_d}$$

P_d = estimated daily passage
C_d = number of fish captured
T_d = estimated trap efficiency

$$T_d = (0.0074639(\%Q) + 0.0008745)$$

$\%Q$ = % river discharge sampled

Methods: Trap Efficiency Model

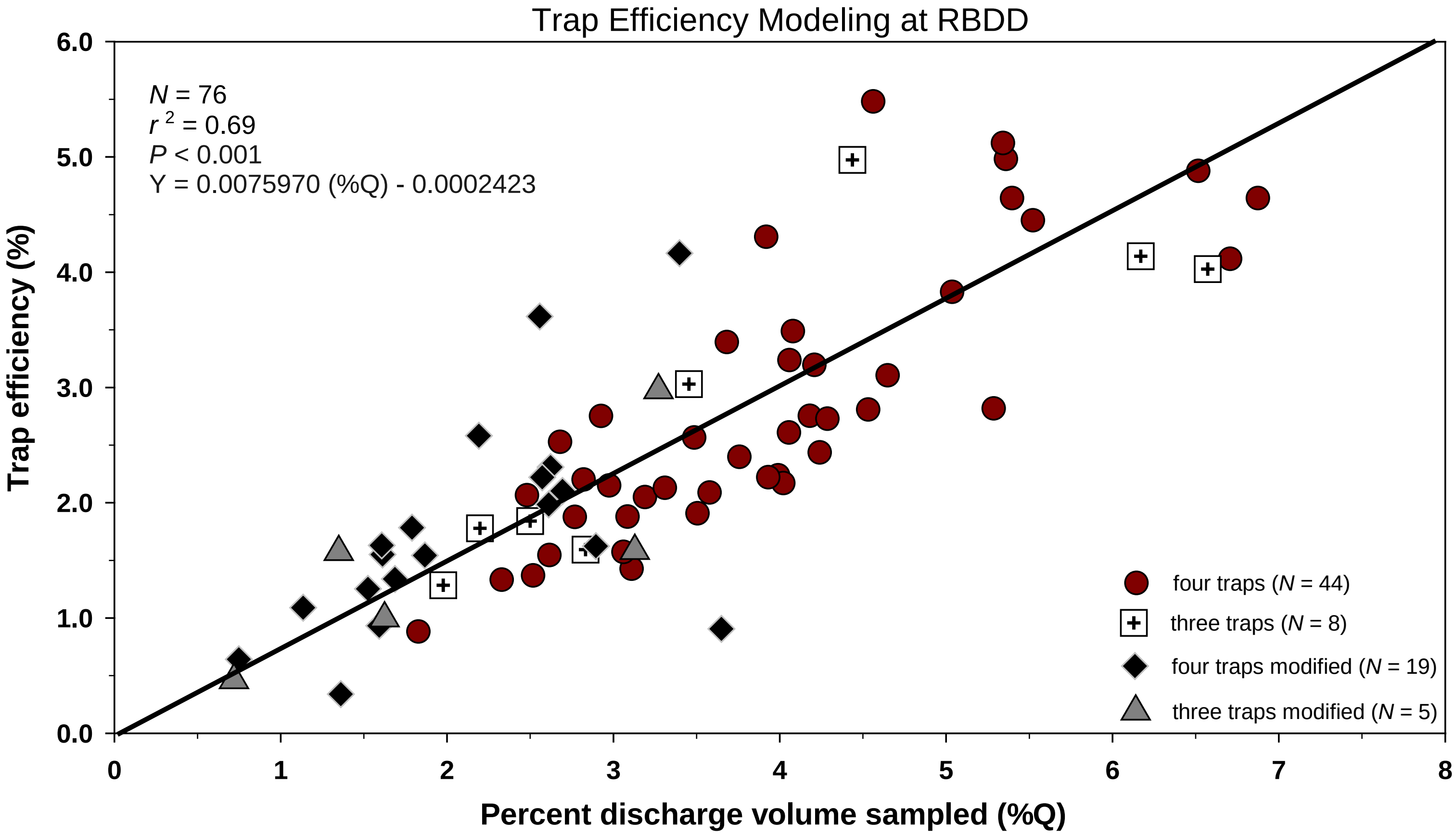


Figure 3. Trap efficiency model for combined 2.4 m diameter rotary-screw traps at Red Bluff Diversion Dam (RK391), Sacramento River, CA. Mark-recapture trials were used to estimate trap efficiencies and trials were conducted using either four traps (*N* = 44), three traps (*N* = 8), or with traps modified to sample one-half the normal volume of water (*N* = 24).

"Simple" Passage Estimates with Confidence Intervals (aka uncertainty)…

$$\hat{P} = \frac{N}{n}\sum_{d=1}^{n}\hat{P}_d$$

$$Var(\hat{P}) = (1-\frac{n}{N})\frac{N^2}{n}s_{Pd}^2 + \frac{N}{n}\left[\sum_{d=1}^{n}\text{var}(\hat{P}_d) + 2\sum_{i\neq j}^{n}\text{cov}(\hat{P}_i,\hat{P}_j)\right]$$

$$s_{\hat{P}_d}^2 = \frac{\sum_{d=1}^{n}(\hat{P}_d - \overline{\hat{P}})}{n-1}$$

$$Var(\hat{P}_d) \doteq \frac{\hat{P}_d(1-\hat{T}_d)}{\hat{T}_d} + \text{var}(\hat{T}_d)\frac{\hat{P}_d(1-\hat{T}_d) + \hat{P}_d\hat{T}_d}{\hat{T}_d^3}$$

$$\text{cov}(\hat{P}_i,\hat{P}_j) = \frac{\text{cov}(\hat{T}_i,\hat{T}_j)\hat{P}_i\hat{P}_j}{\hat{T}_i\hat{T}_j}$$

$$Cov(\hat{T}_i,\hat{T}_j) = \text{var}(\hat{\alpha}) + x_i\,\text{cov}(\hat{\alpha},\hat{\beta}) + x_j\,\text{cov}(\hat{\alpha},\hat{\beta}) + x_i x_j\,\text{var}(\hat{\beta})$$

$$\hat{P} \pm t_{(\alpha/2;n-1)}\sqrt{\text{var}(\hat{P})}$$

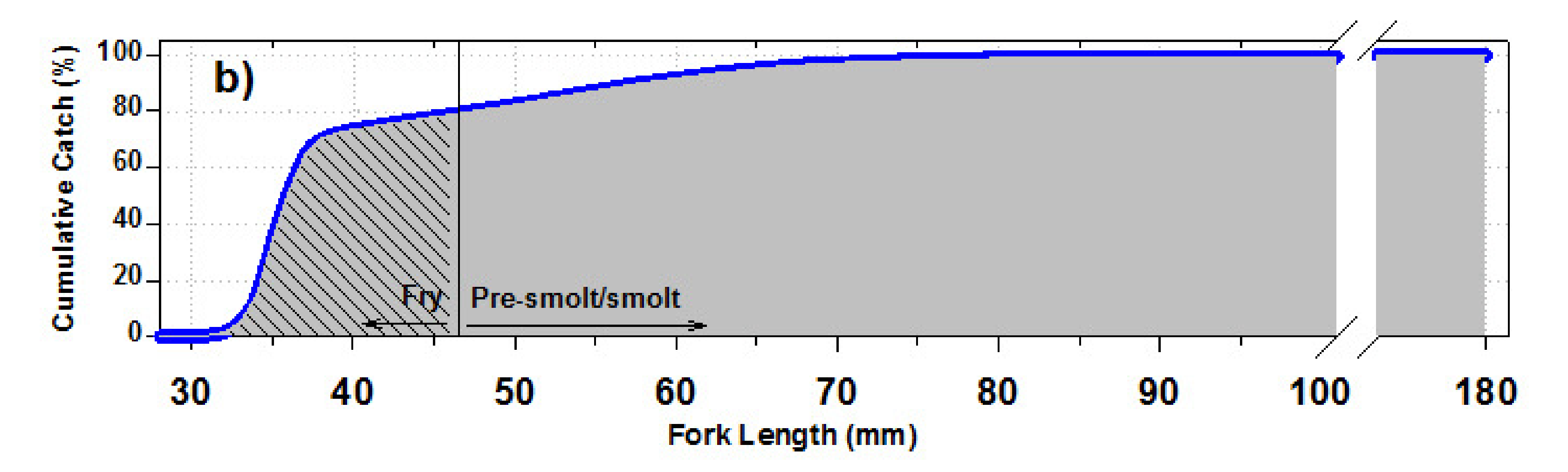
Methods: Run Assignment

- Multiple runs in system each day
- Fork length (FL) equal to age
  - Growth equation developed

    $$Ln\ (FL) = 3.516 + 0.007 \times (age)$$

- Daily lookup of FL to assign run
  - a.k.a. Length-at-date criteria

Multiple Size Classes: fry versus smolt capture



- **WCS catch mostly fry (20 year ave. 75:25)**
- **Fry equivalent calculation used to standardize**
  - **Between years**
  - **Varying abundance levels**

Methods: Fry-Equivalent Production

$$JPI_{fe} = P_f + (P_s * 1.7)$$

JPI_{fe} = fry-equivalent juvenile production index

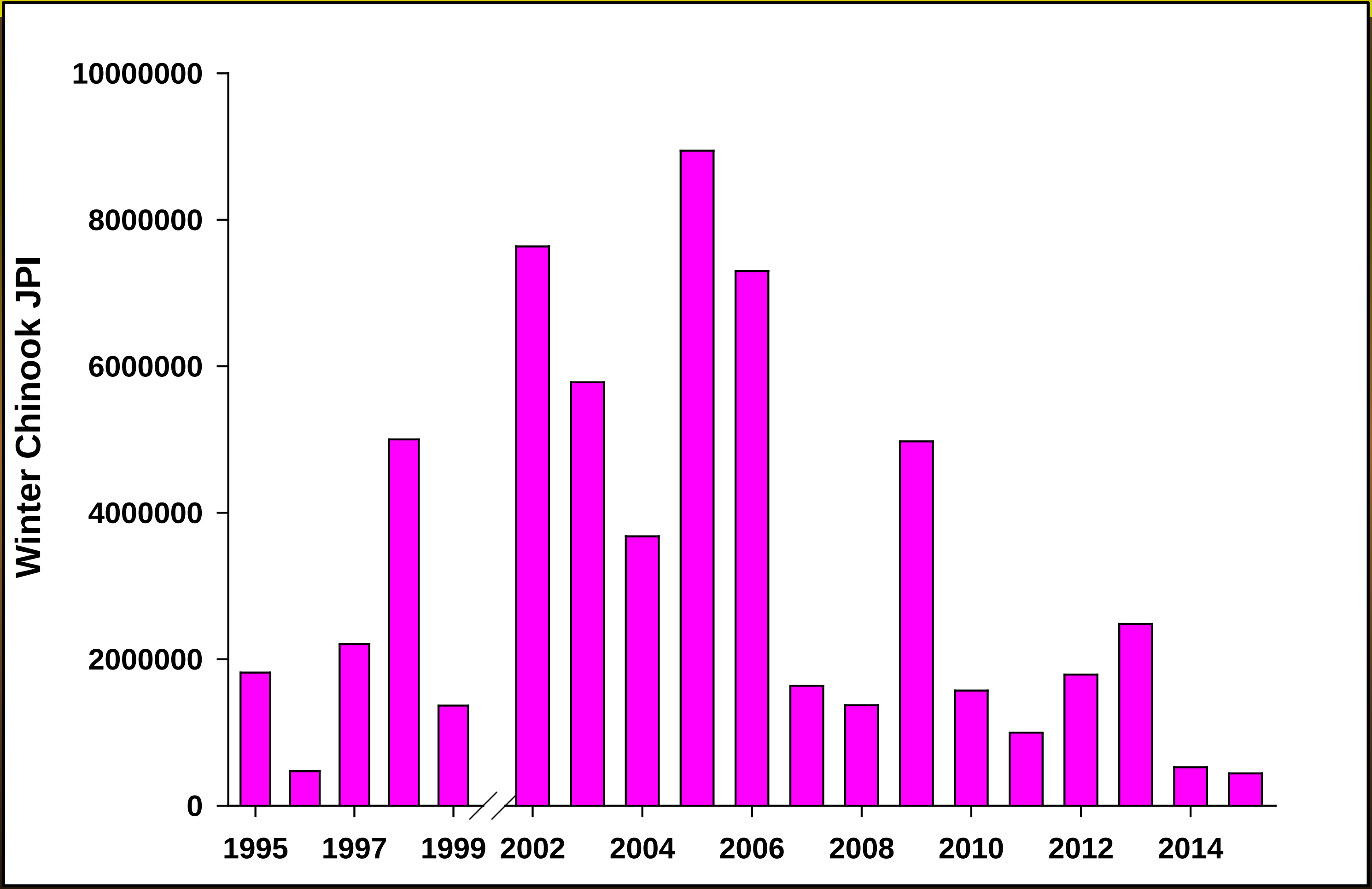
P_f = Fry passage (<46 mm FL)
P_s = Pre-smolt/smolt passage (>45 mm FL)
1.7 = inverse survival constant (59%; Hallock undated)

Methods: Egg-To-Fry Survival Est.

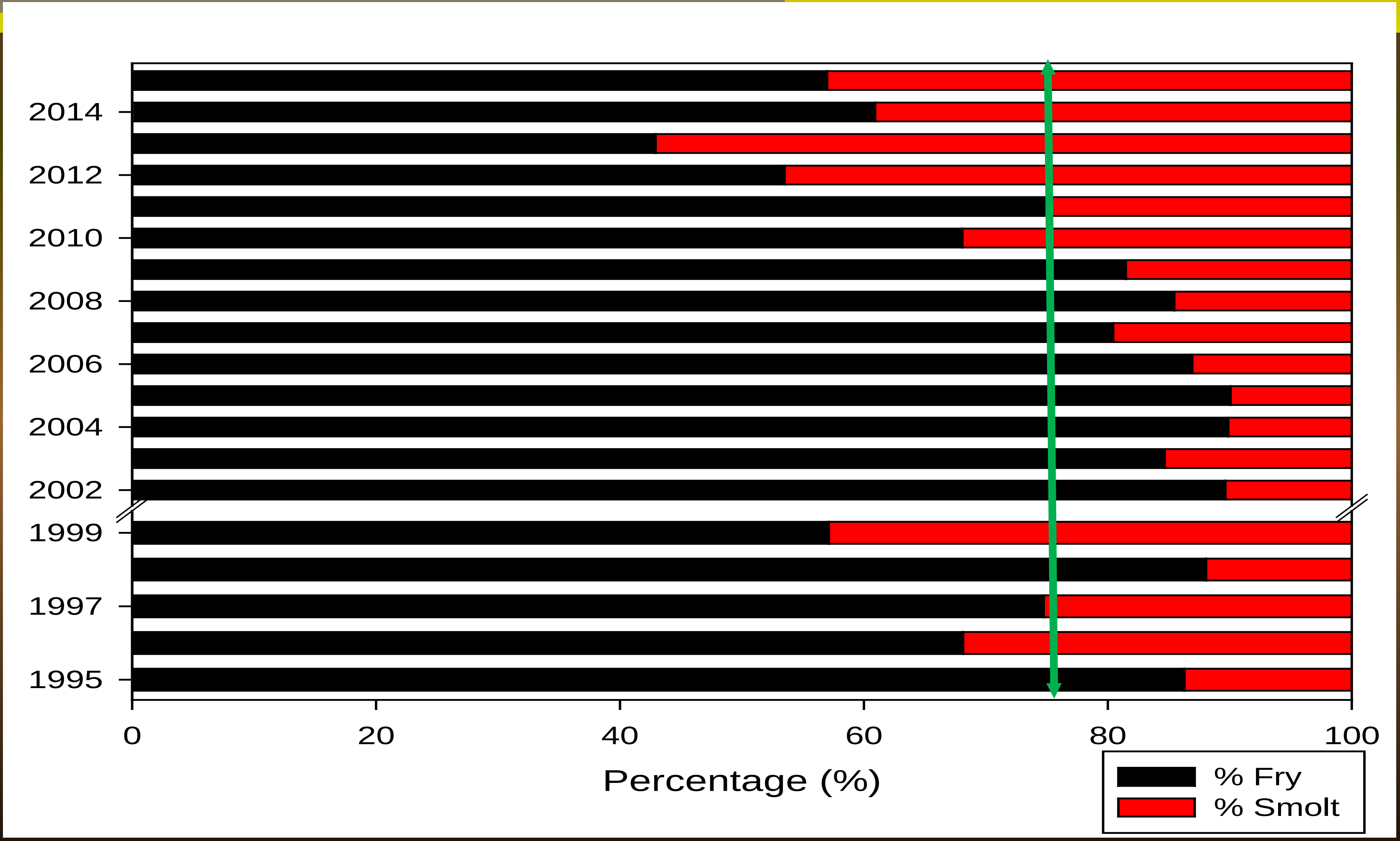
$$\hat{ETF}_w = \frac{\hat{JPI}_{fe}}{\hat{S}_f * (\hat{F}_e)}$$

ETF_w = estimated egg to fry survival (winter run)
JPI_{fe} = Estimated Fry Production (aka Fry Equivalents)
S_f = Estimated Female Spawners (carcass survey data)
F_e = Estimated in-river egg deposition (i.e., Annual fecundity data from LSNFH spawning records)

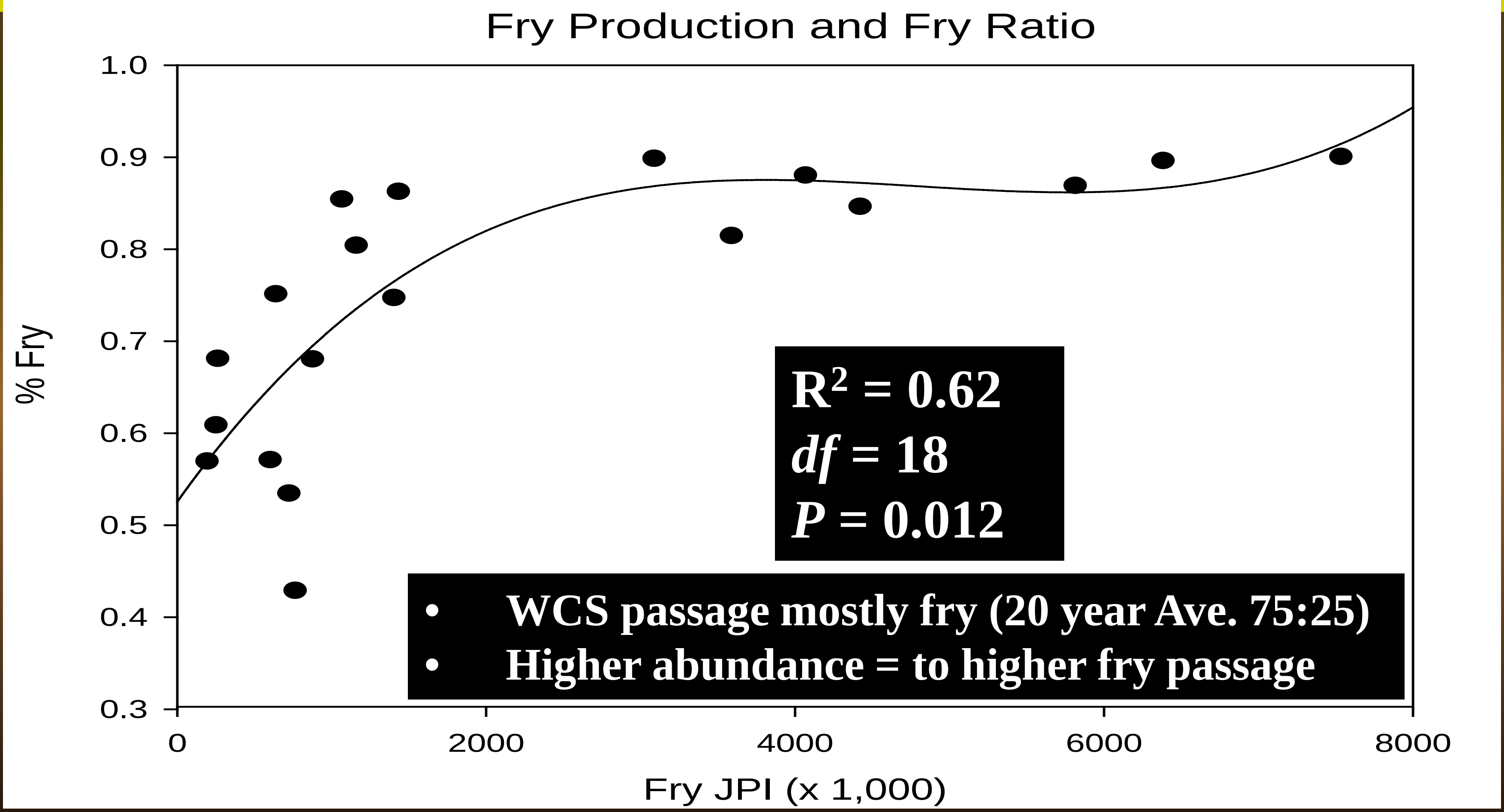
Multi-year abundance trend data…



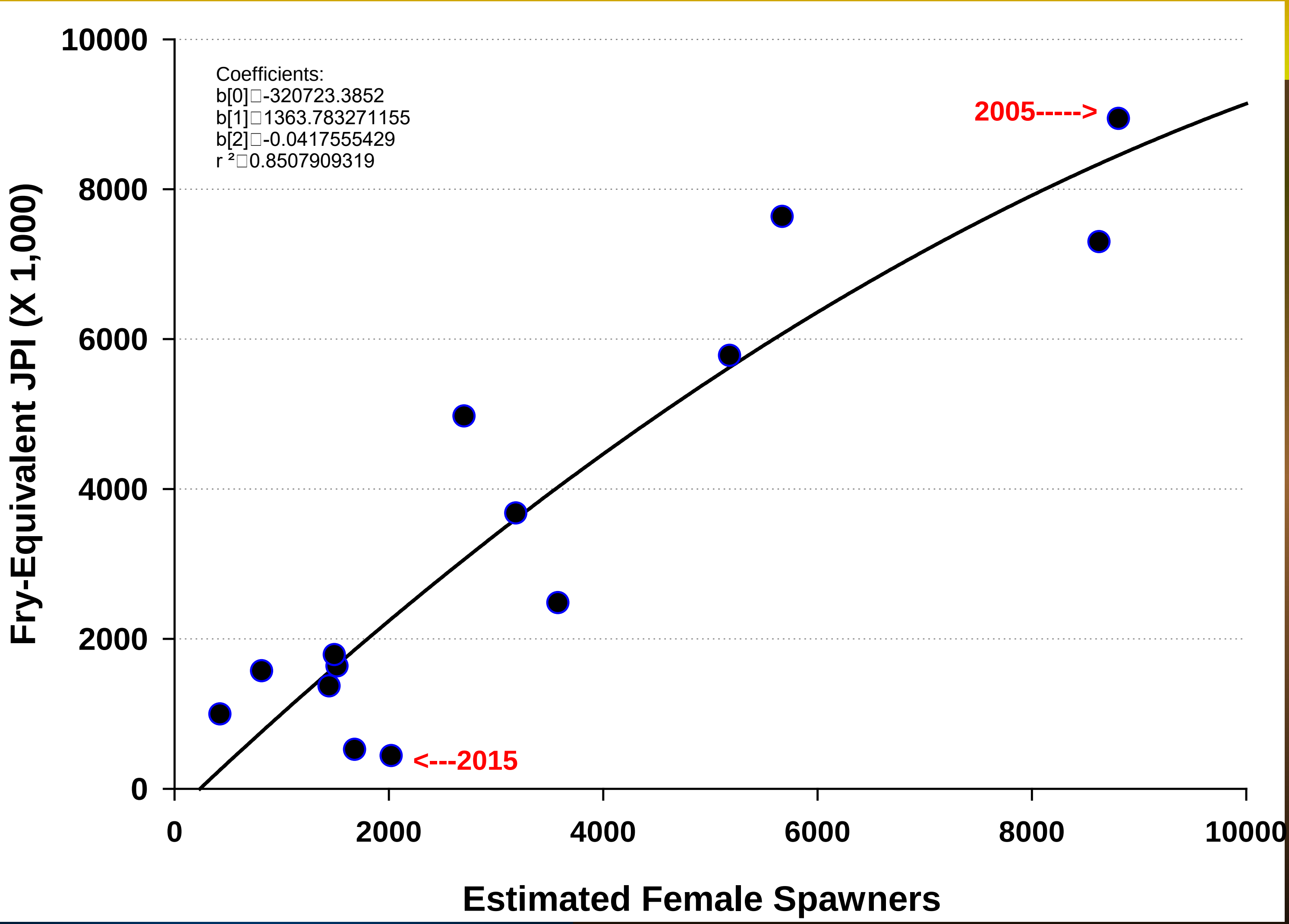
Size Class Data: Fry to Smolt Ratios



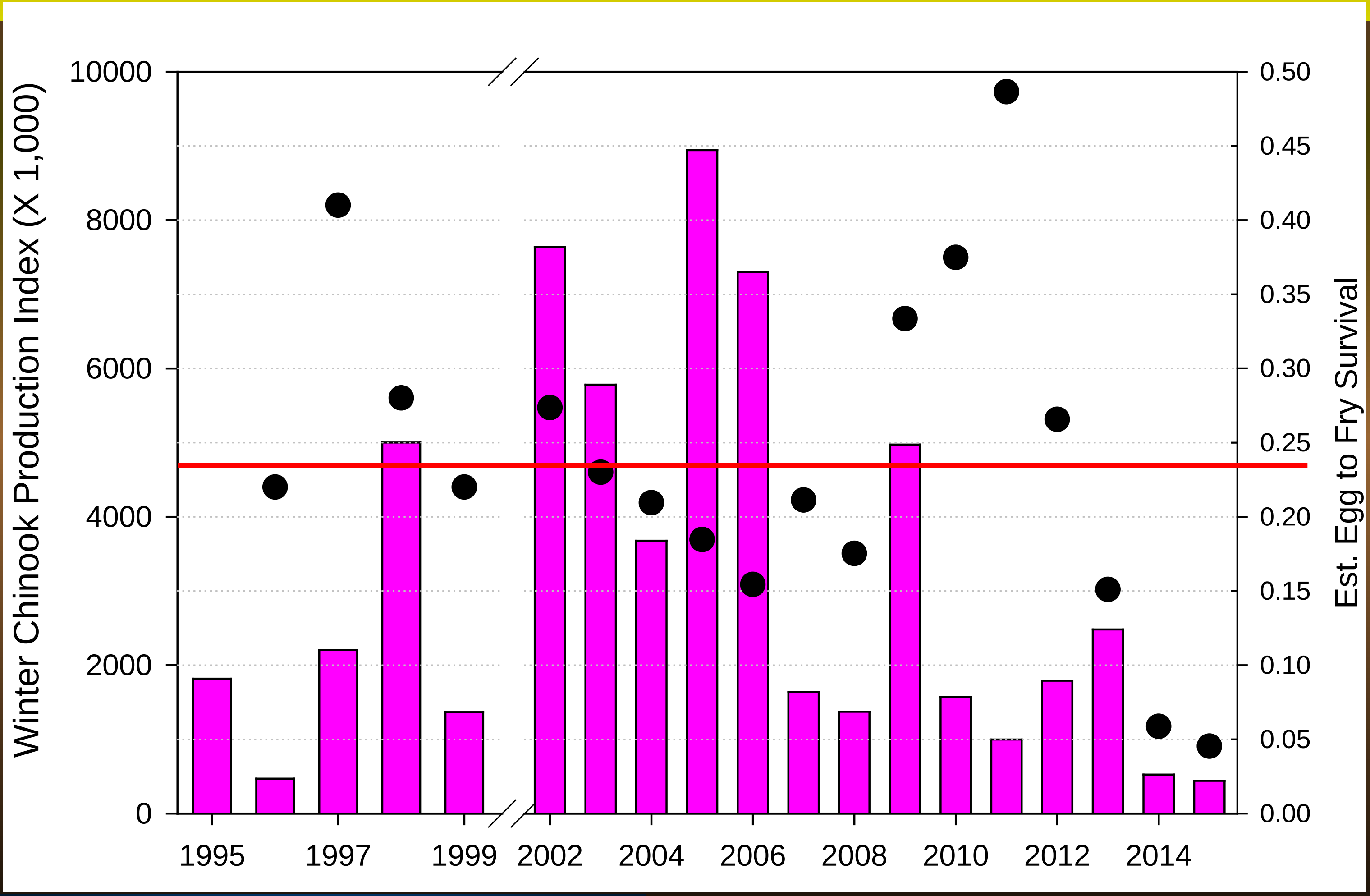
Size class ratio: % fry passage



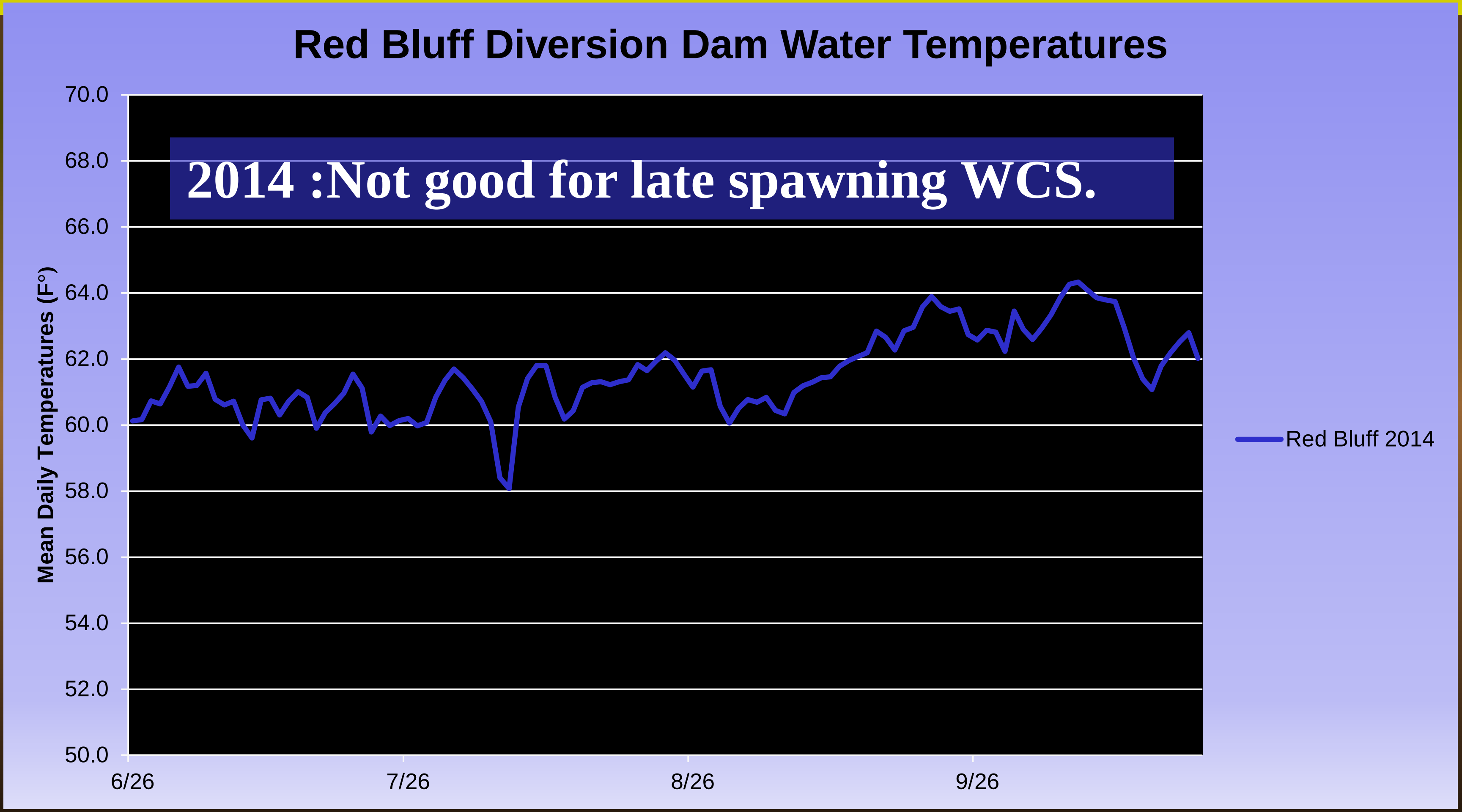
Winter Chinook Spawner to Juvenile Comparisons…



Fry-equivalent production estimates (Y1: bars) with Winter-run egg-to-fry survival estimates (Y2: dots)



Temperature/flow management effects…



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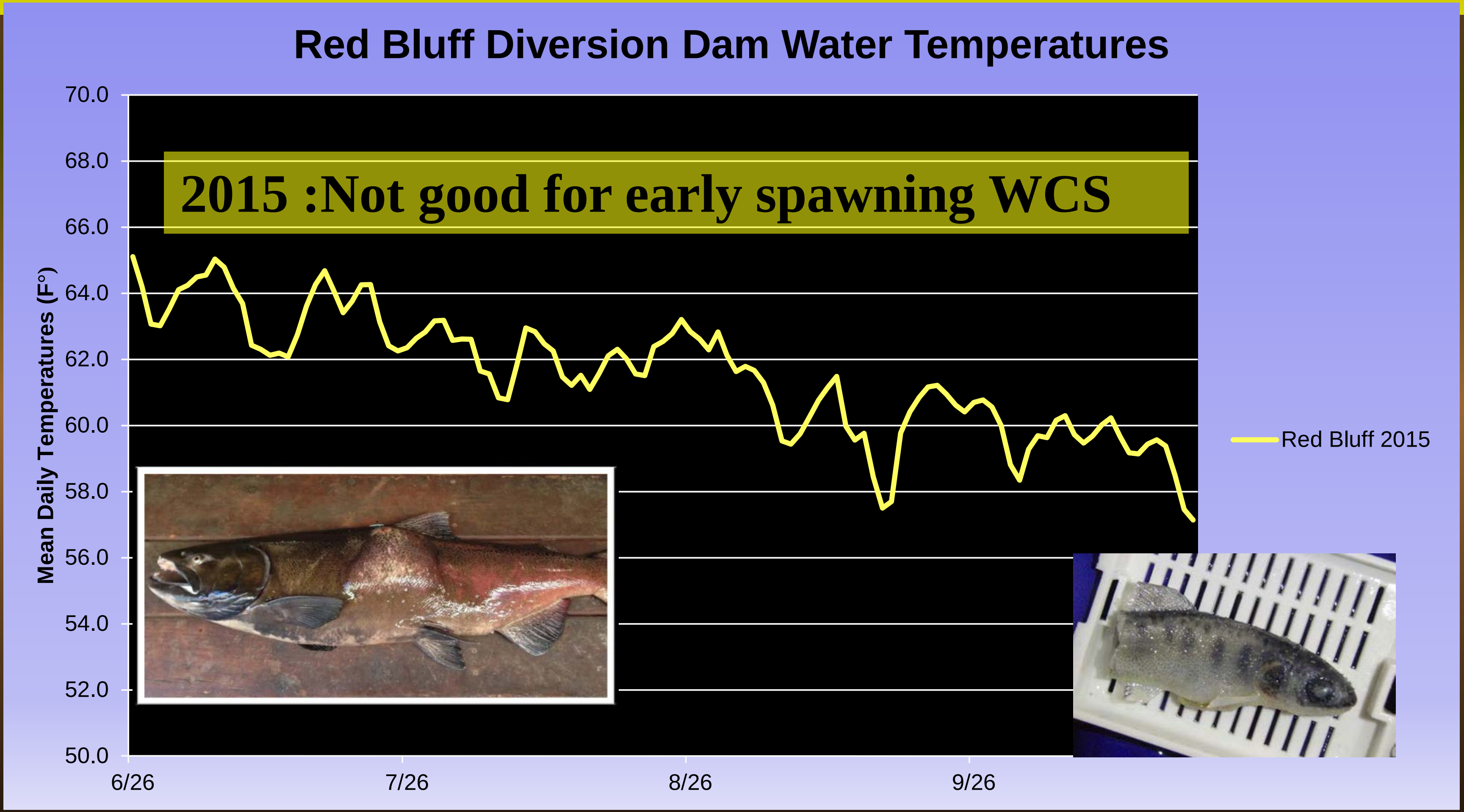

WCS Juvenile Data: High – Low Summary

Parameter (year)	High	Low
Fry-equivalent Production	8.9 M (2005)	0.4 M (2015)
Egg to Fry Survival Est.	48.6% (2011)	4.5% (2015)
Fry:Smolt Passage Ratio	90:10 (2005)	43:57 (2013)*
Recruits per Female	2,002 (2011)	168 (2015)
	*Government shutdown= Next lowest value was	possible sampling bias 54:46 (2012)

Questions?

Photo courtesy of USBR