Growth modulation and precocious male maturation in Yakima River Spring Chinook salmon: an update

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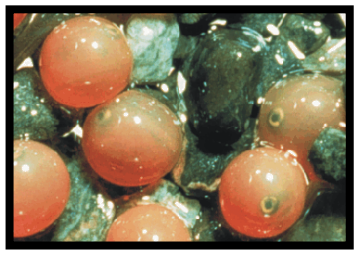
Spring Chinook Salmon

Spawning - Fall



Fry-Parr

Age-1 yr precocious parr M

Age-2 yrs “Minijacks”

?

Jack

Ocean to river in spring

Age-3 M

Age-4

Age-5

Sub-adults

Ocean

1+ yr Spring

Smolting

Variation in Age of Male Maturity

Mature male salmon

Factors Affecting Age of Maturation

- ✓ Genetics
- ✓ Environment
  - temperature
  - food availability
  - food quality

Growth & Body energy stores

The Hatchery environment can significantly influence age of maturation

We've been monitoring the physiology of Cle Elum Hatchery Spring Chinook since implementation in 1997

On average 50% of male Yakima hatchery spring Chinook precociously matured at age-2

BY	Release #	% of males	# Minijacks
1997	386,048	44%	84,931
1998	589,683	72%	211,107
1999	758,789	50%	189,697
2000	834,285	37%	153,508
2001	370,236	52%	95,520
		Avg. 50%	

How do we assess precocious male maturation?

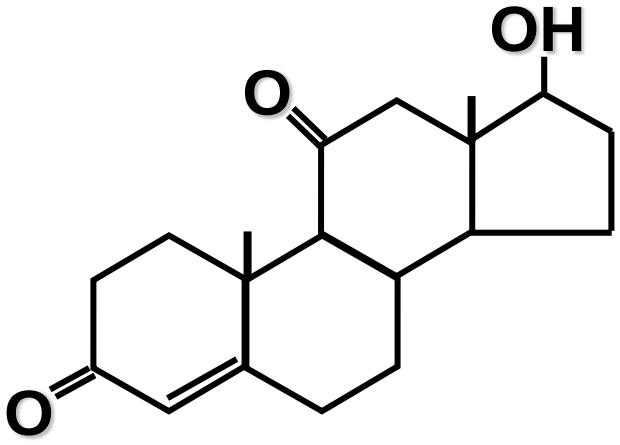
Age-2 immature male chinook salmon

Testes

Age-2 precocious male chinook salmon

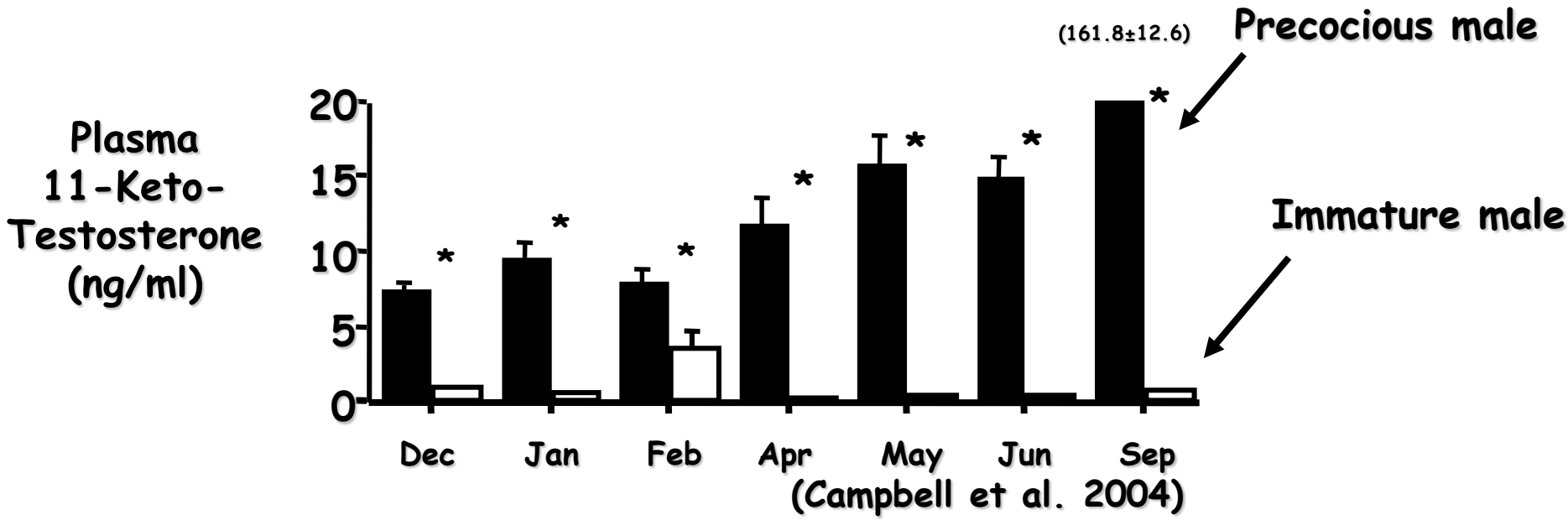
Testes

Plasma 11-ketotestosterone (11-KT)

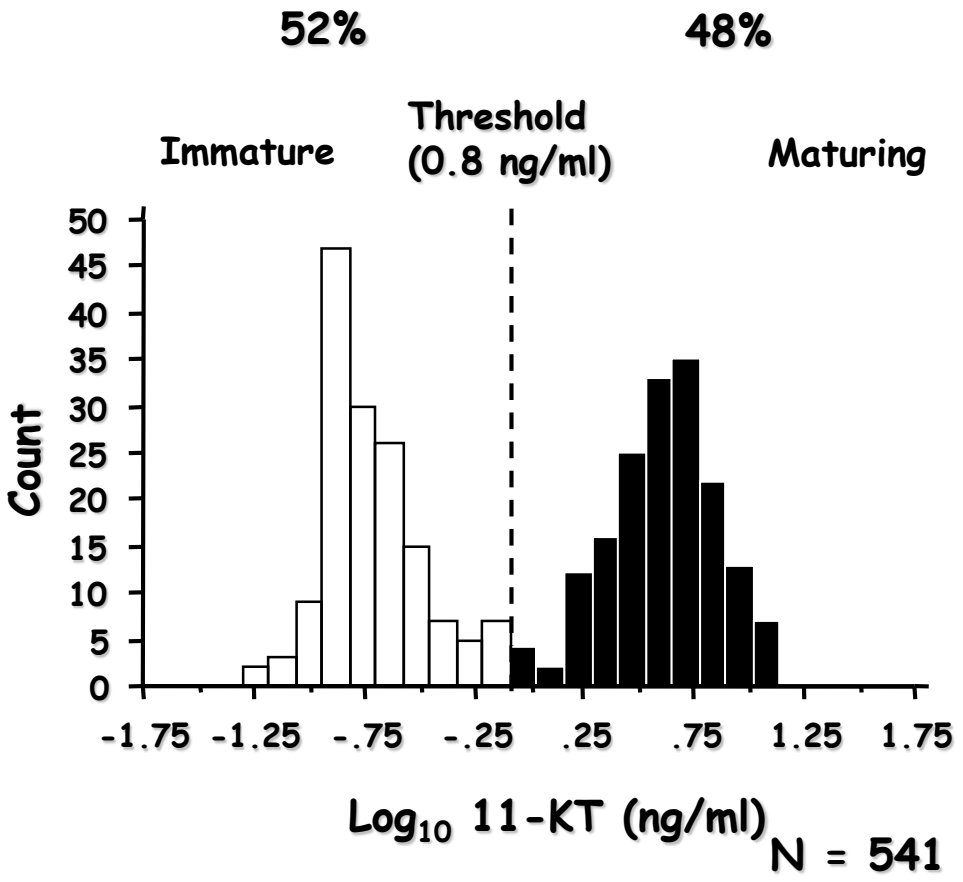


- Major androgen in teleost fish
- Instrumental in the regulation of spermatogenesis

Laboratory based studies have clearly established that 11-ketotestosterone (11-KT) is significantly elevated in precocious males as much as a year prior to mating



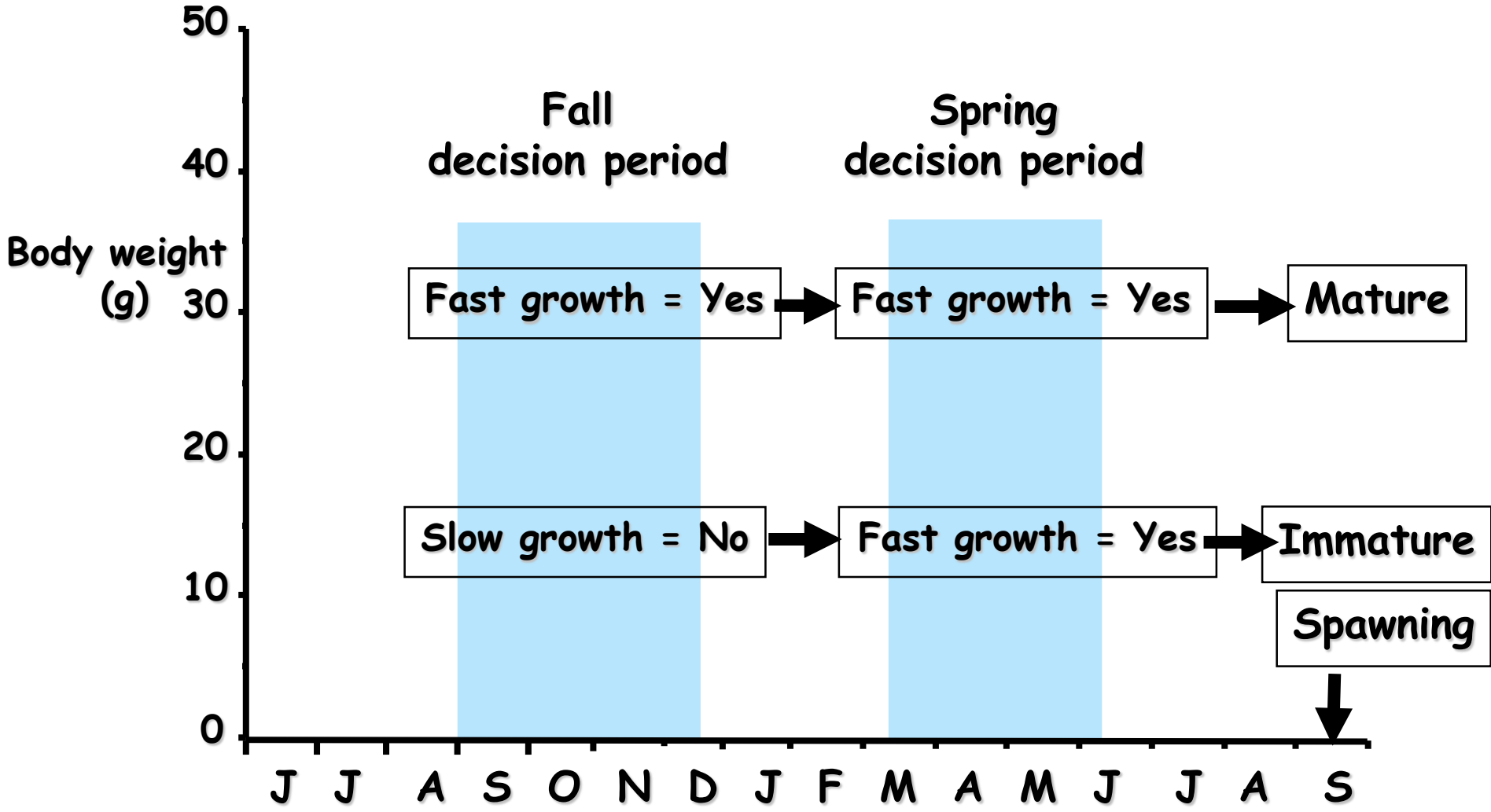
Every March the Yakima Chinook are screened for pathology just prior to volitional release



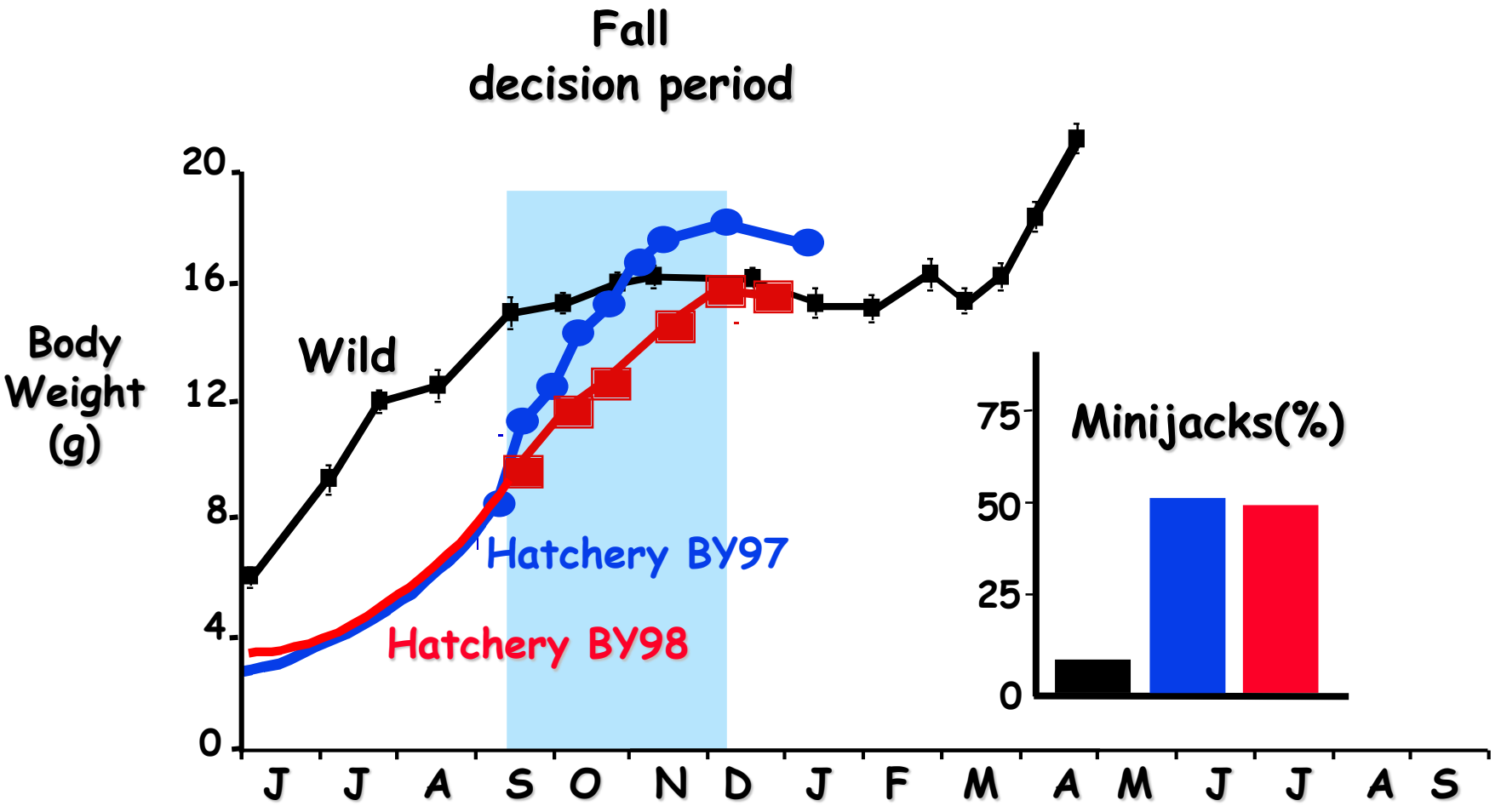
Consequences of high levels of precocious maturation

- Ecological impacts
- Genetic impacts
- Increased straying
- Skewed gender ratio
- Loss of adult producti

Critical periods for maturation decision – based on body size/growth rate



Comparison of wild and hatchery growth and minijack rates



Lab scale studies:

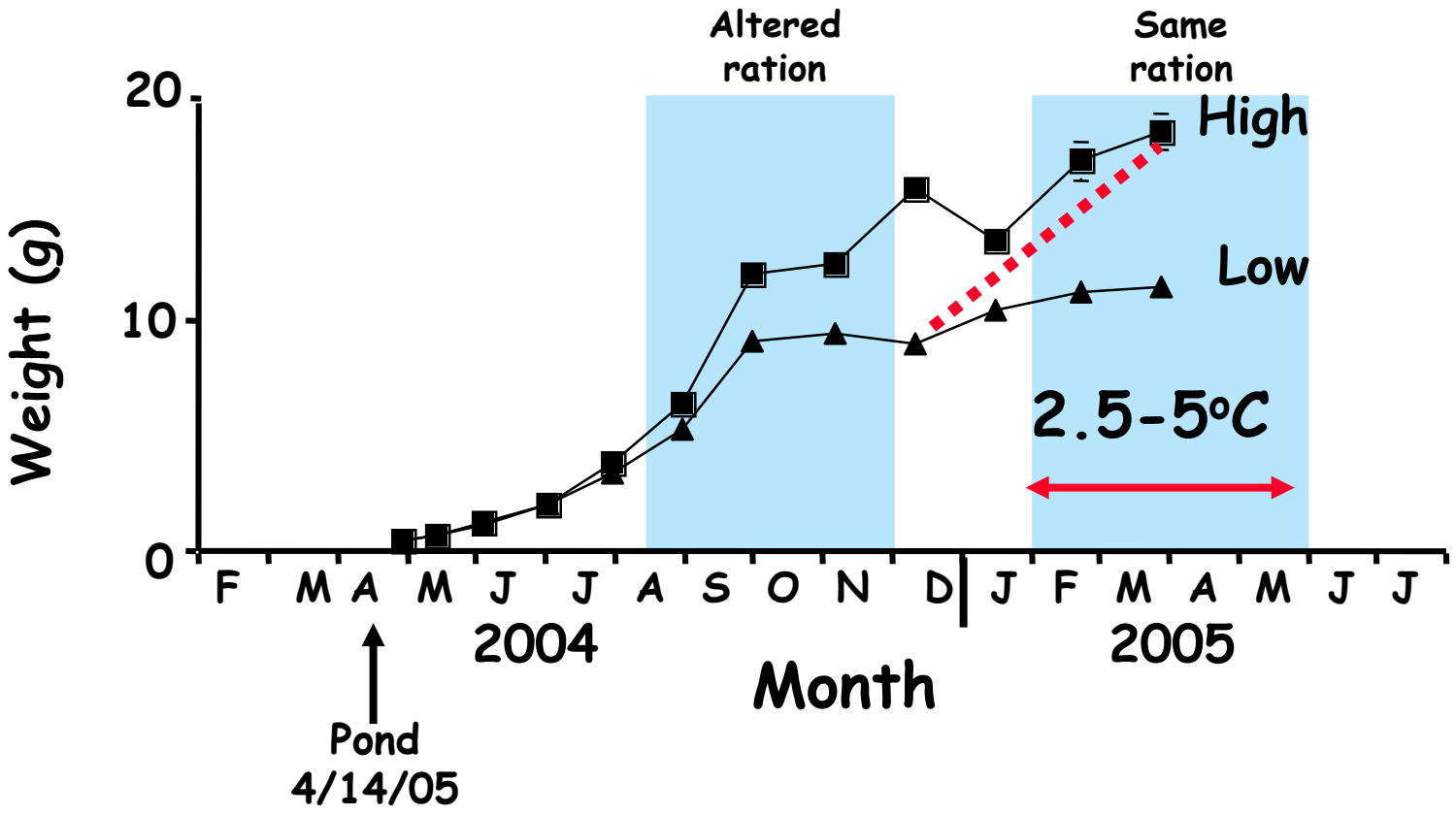
- Autumn Growth Rate
- Body size

*Significant time and effort provided by CESRF staff.

Larsen, D.A., Beckman, B.R., Strom, C.R., Parkins, P.J., Cooper, K.A., Fast, D.E., and Dickhoff, W.W. 2006. Growth modulation alters the incidence of early male maturation and physiological development of hatchery reared spring Chinook salmon: a comparison with wild fish. Transactions of the American Fisheries Society.

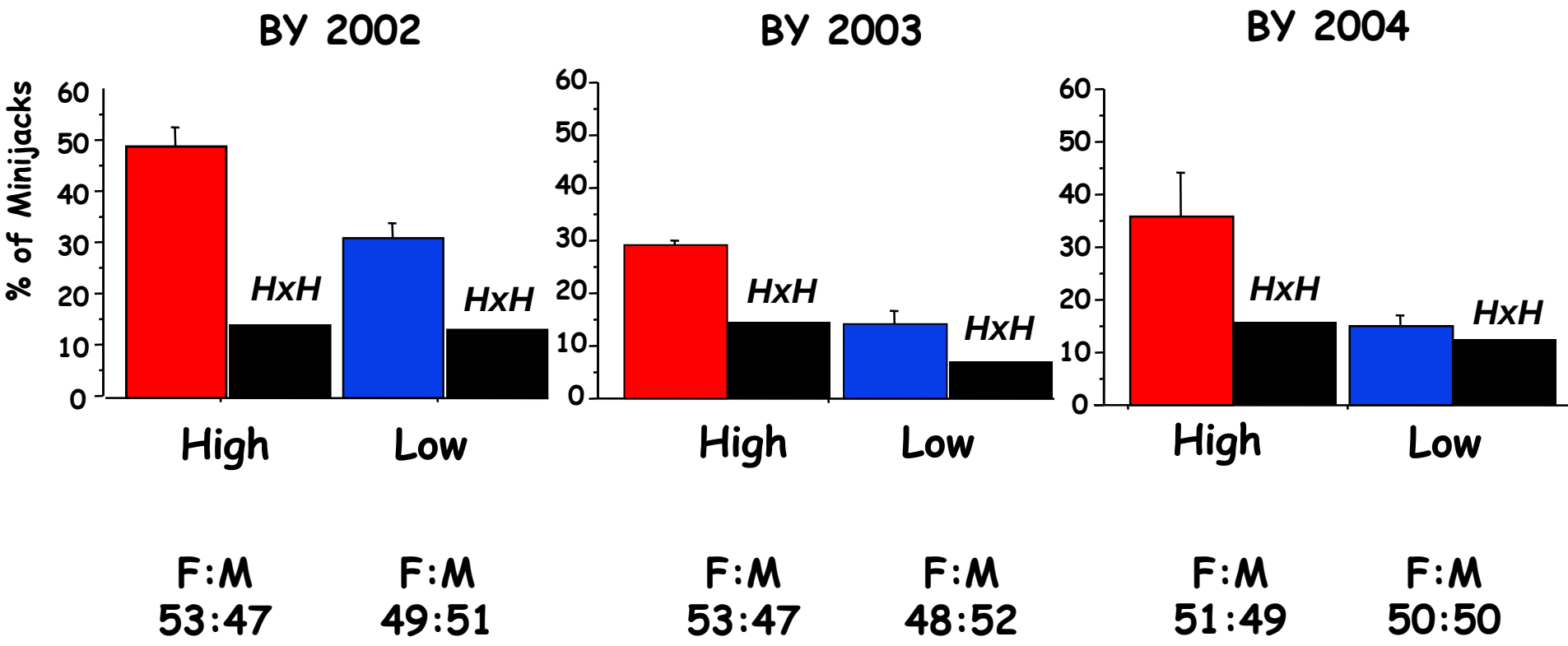
Results from this study provided the basis for production scale rearing regimes (BY 2002-2004)

Growth rate was adjusted via ration (BY 2002-2004)

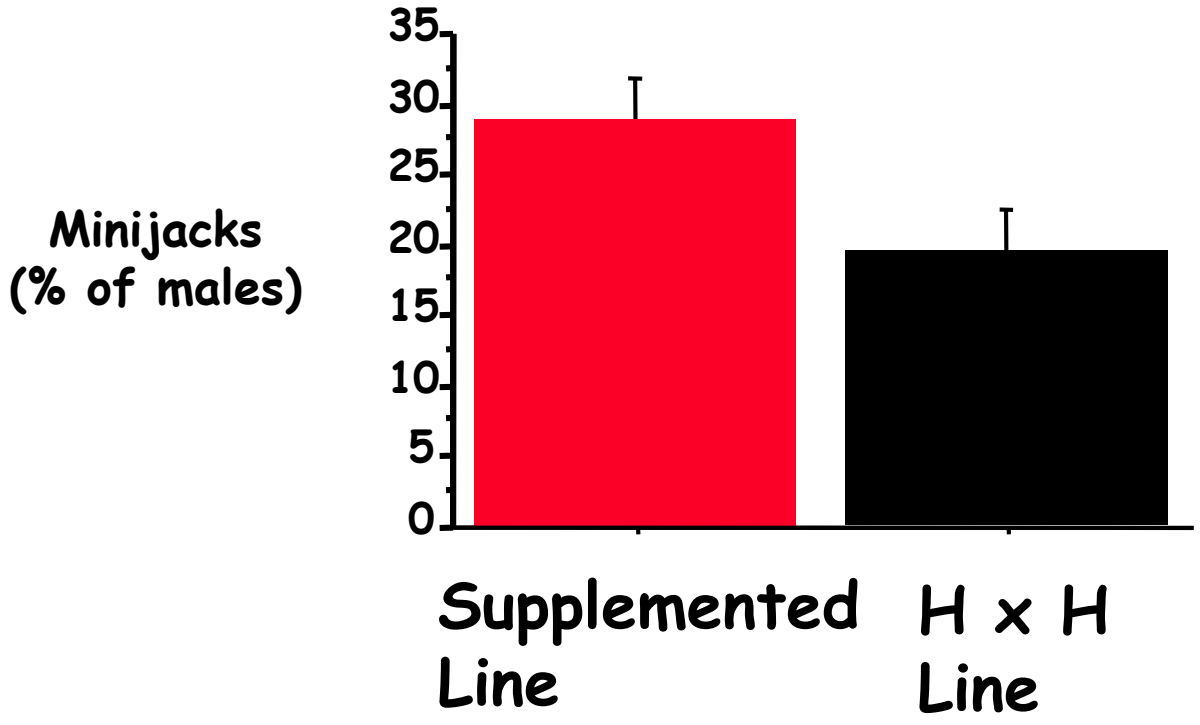


Did Growth Modulation reduce the minijack rate?

Minijack rates before release were consistently lower in the Low growth Trt. (all sites combined)



Minijack rate is lower in Supplemented than HxH Line BY 2005 released in 2007



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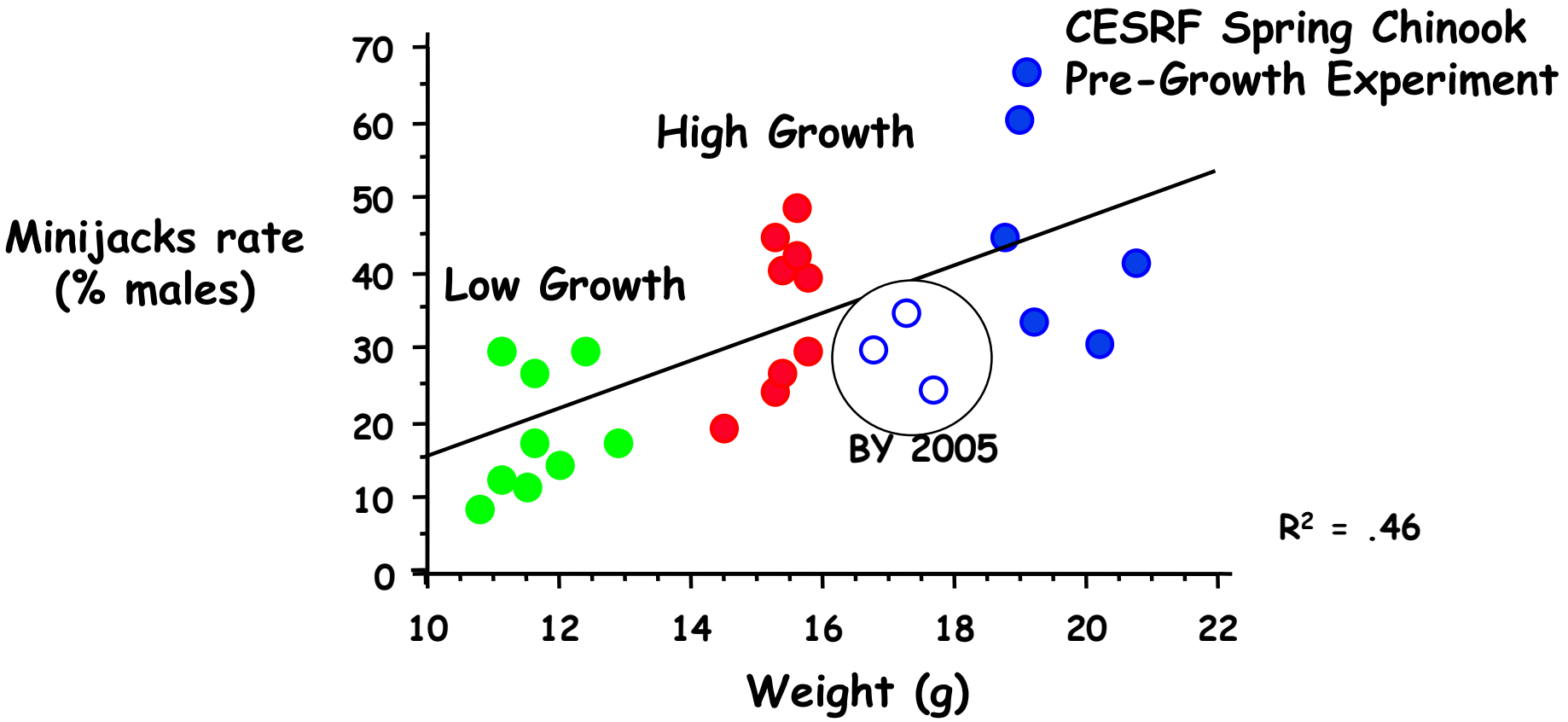
		Avg. 50%	
Growth / Domestication Expt.			
2002	841,233	37%	122,799
2003	827,915	20%	83,527
2004	786,506	24%	93,323
2005	861,204	29%	122,805

The bigger they are at release, the higher the minijack rate

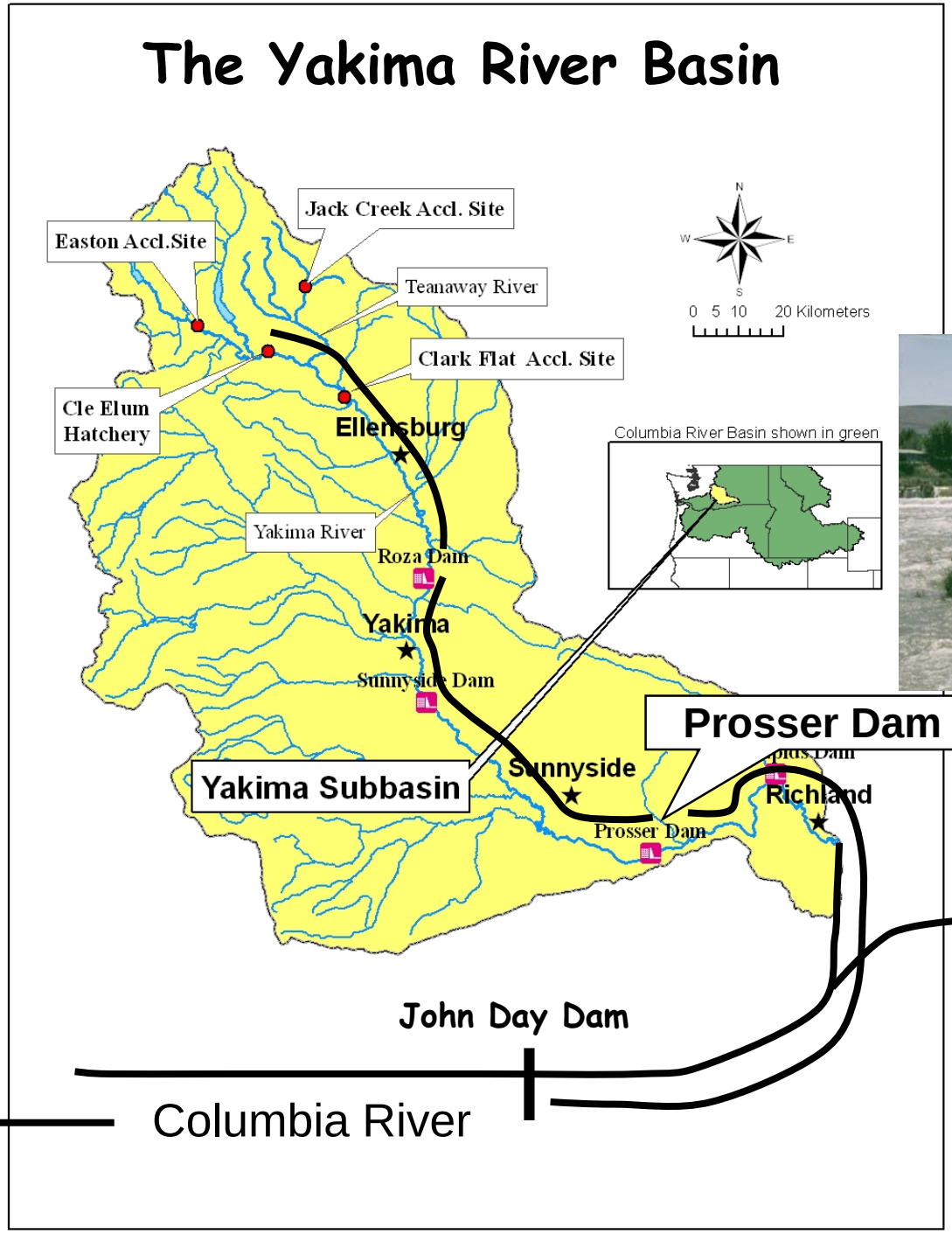
(BY X acc.site, BY 2000-BY 2005)



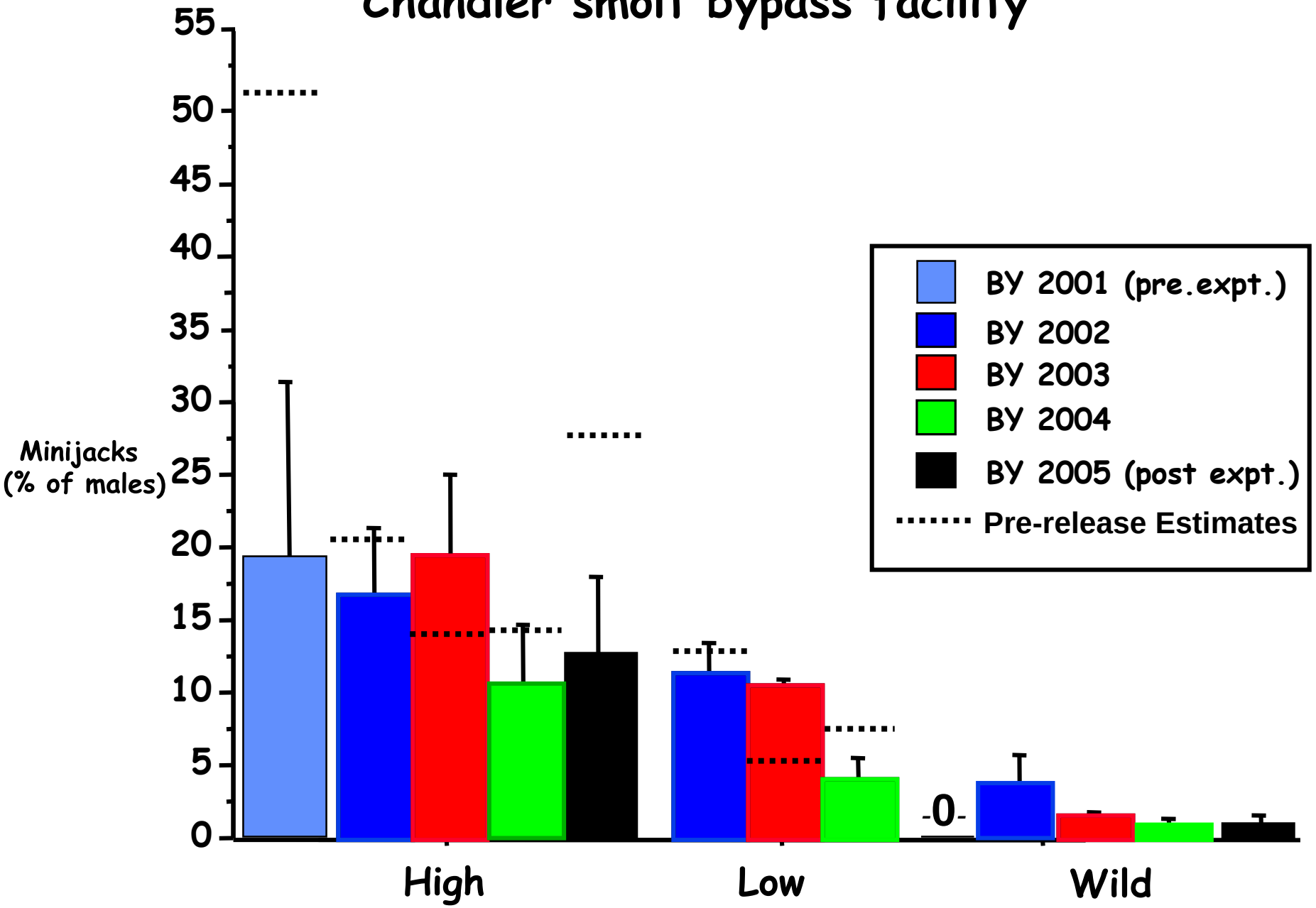
Where do the minijacks go?

How do hatchery rates compare with wild rates?

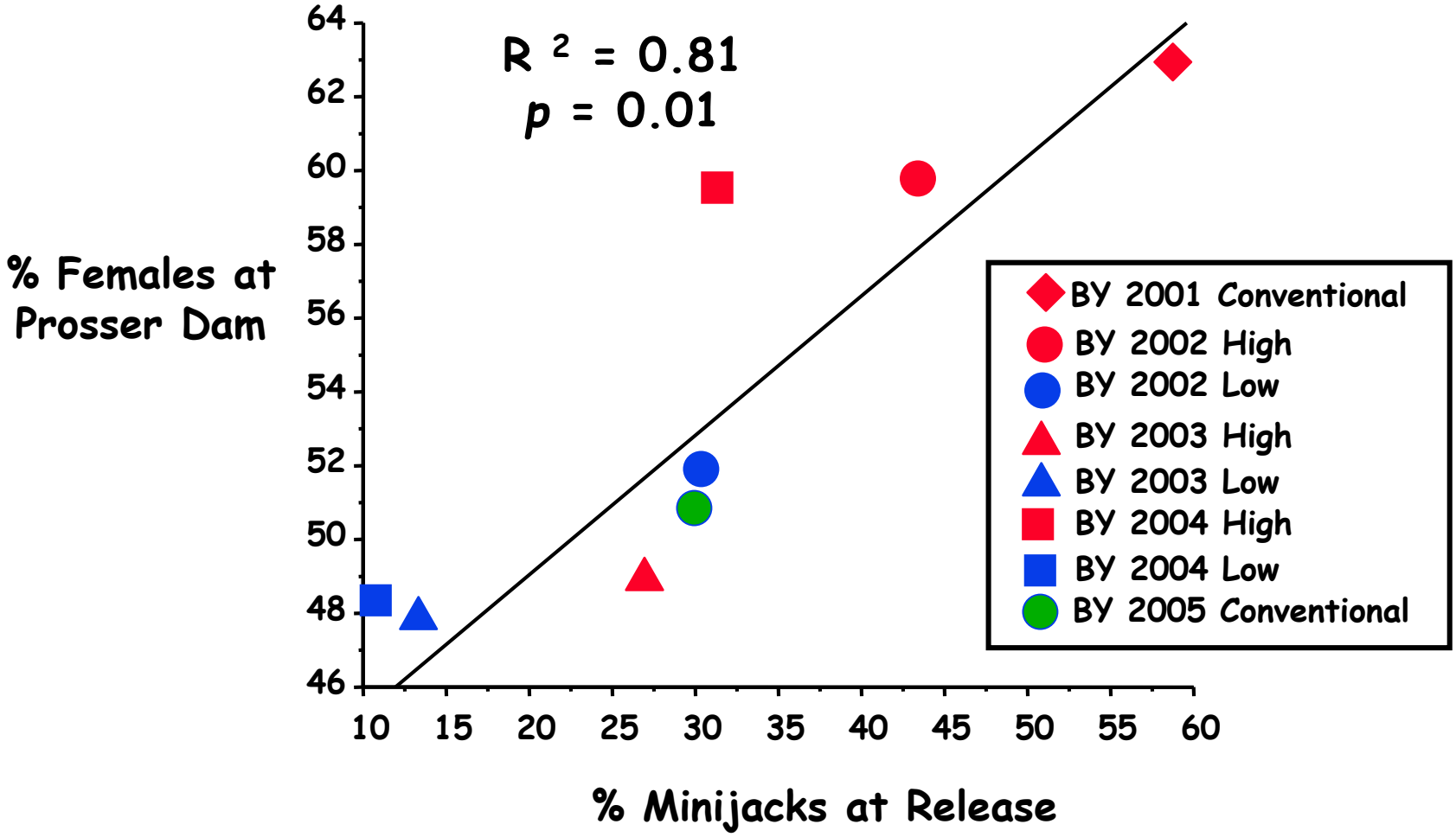
The Yakima River Basin



Minijack rates of migrating hatchery and wild fish - Chandler smolt bypass facility

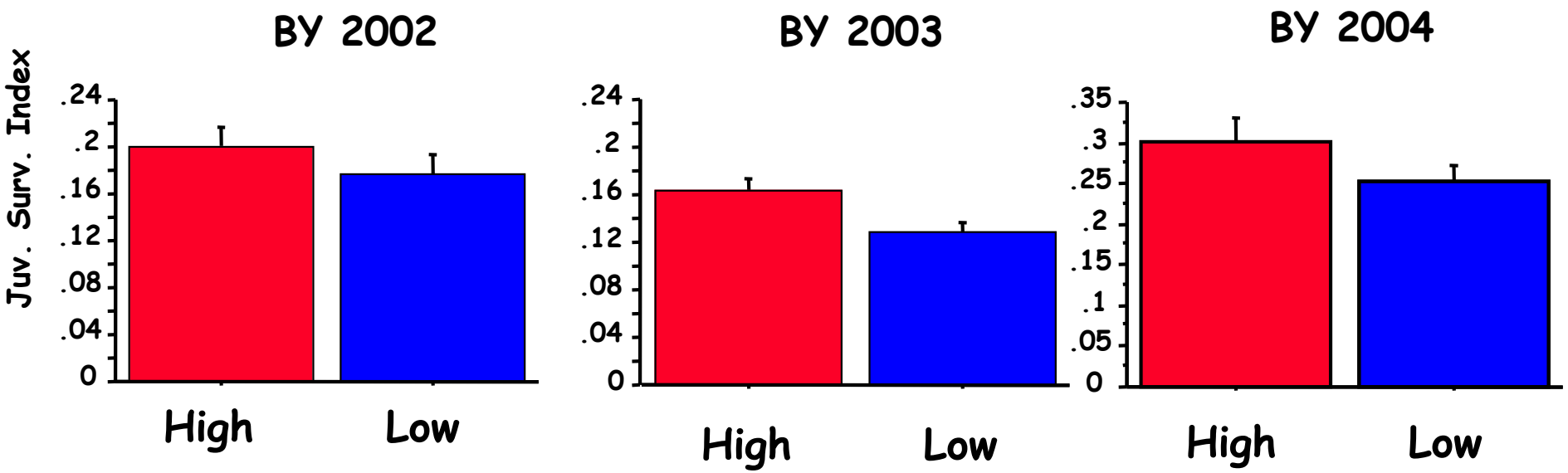


Higher minijack rates at time of release correlate with gender ratios skewed in favor of females during smolt migration



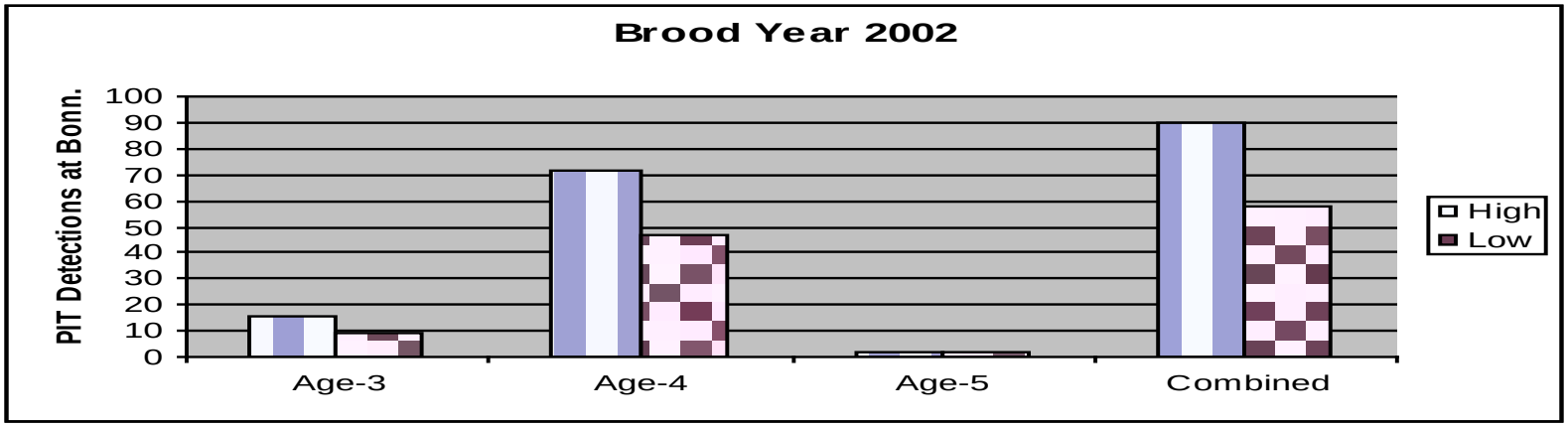
Juvenile and Adult survival

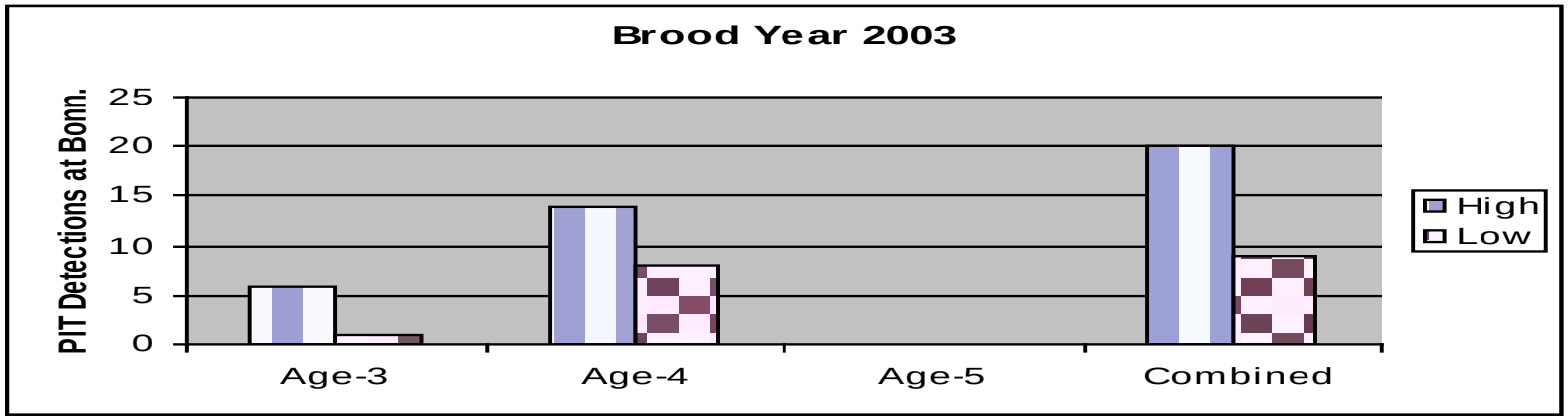
Juvenile Survival Index to McNary Dam is lower for the Low growth fish

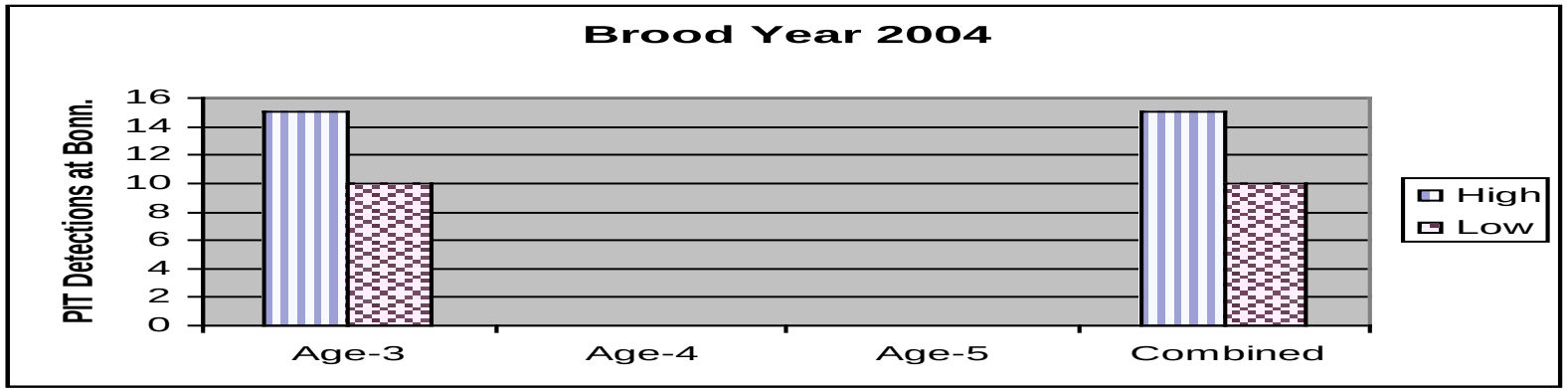


Modified from Neeley 2004-2006

Adult Return, is lower for Low Growth Trt.



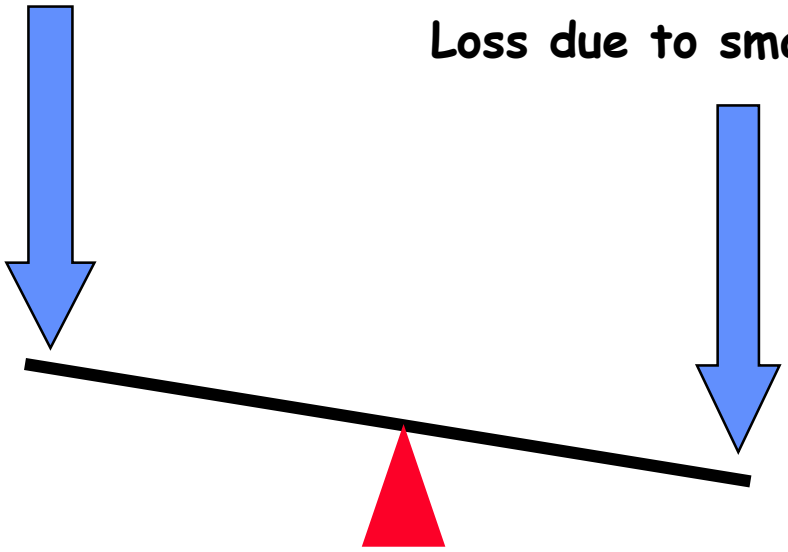




Bosch 2007

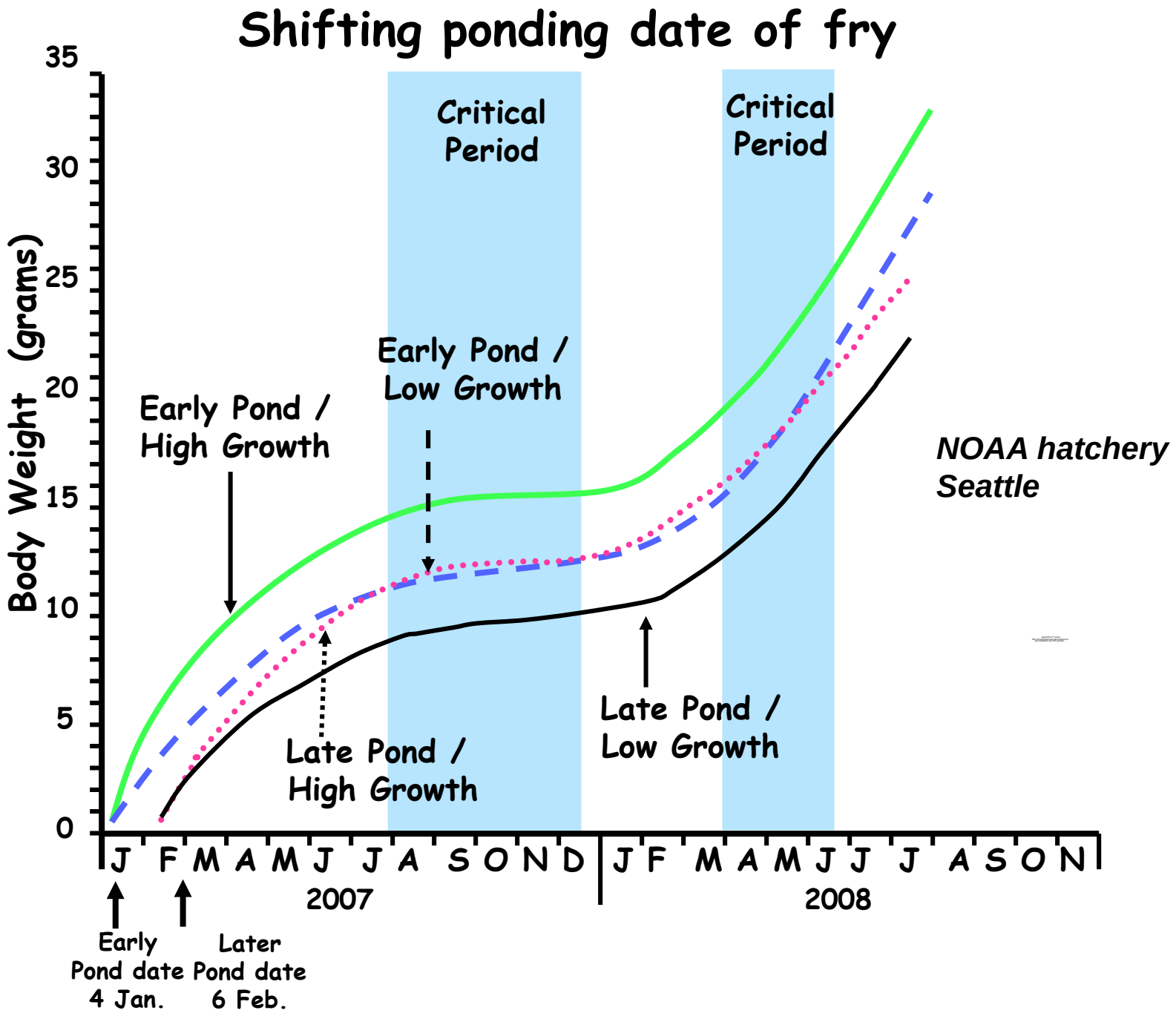
Loss due to
Precocious maturation

Loss due to small smolt size



Question

How do we produce large fish that still grow slow in the autumn maturation initiation period?


Shifting ponding date of fry
Body Weight (grams)
35
30
25
20
15
10
5
0
Critical Period
Critical Period
Early Pond / High Growth
Early Pond / Low Growth
Late Pond / High Growth
Late Pond / Low Growth
NOAA hatchery Seattle
J F M A M J J A S O N D
2007
J F M A M J J J A S O N
2008
Early Pond date 4 Jan.
Later Pond date 6 Feb.

Egg incubation temperature significantly influences life-history composition

	Prec. Parr	Mini-Jack	Tot.
Early/High -MJ sires	32%	40%	72%
	33%	47%	80%
Early Pond / Low Growth	22%	25%	52%
Late Pond / High Growth	17%	31%	48%
Late Pond / Low Growth	13%	22%	35%

Conclusions

- Growth modulation successfully reduced minijack rates
- It also significantly reduced both juvenile and adult survival-size matters
- The Yakima HxH line shows consistently lower minijack rates than the supplemented line.
- High numbers of minijacks appear to migrate downstream in the spring
- Increased egg incubation temperatures significantly alter life-history composition-global climate change effects?
- Further research is needed to develop hatchery rearing protocols that will not alter life-history composition of hatchery stocks