

Stuck in the Middle: Contrasting Effects of Release Size on Early Male Maturation and Survival of spring Chinook salmon Smolts

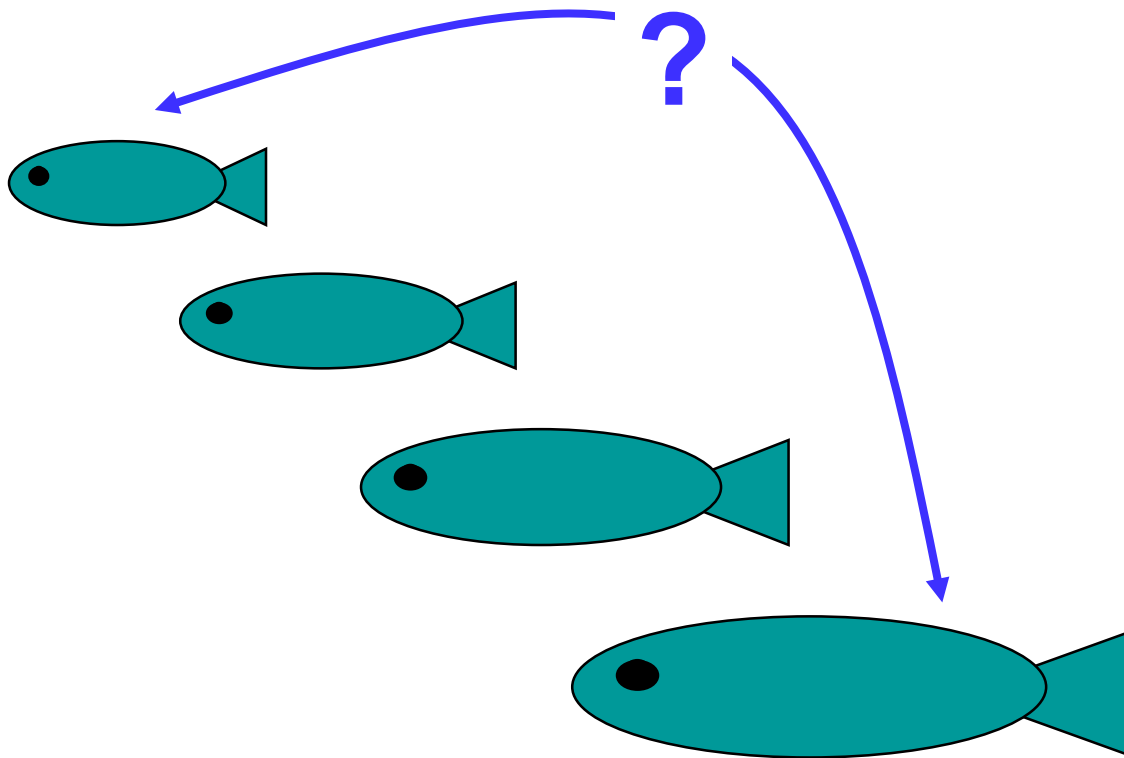
**Brian Beckman, Don Larsen, Todd Pearsons,
Bill Bosch, Curt Knudsen**

**NOAA Fisheries, Grant Co PUD,
Yakama Nation Fisheries, Oncorh Consulting**

Brian.Beckman@noaa.gov

**Most (all?) hatcheries have size @
release targets**

What's the goal for this target?



Management goals?

Adults back to hatchery

Adults to fishery

Adults to spawning grounds

Sex ratio

Age structure/size

(do jacks count?)

(bonus for Age 5?)

pHOS

Straying

Domestication (genetic change)

Size targets have been developed based on:

- tradition**
- rearing capacity and desired release numbers**

(250,000 release/25,000 lb capacity = 10 fish/lb)

- size at release studies (a few)**
- natural smolt size**

Do these size targets help programs meet their management goals?

Why is release size important?

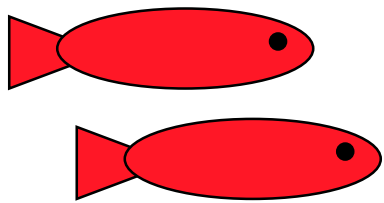
1. Downstream survival of smolts

2. Marine survival

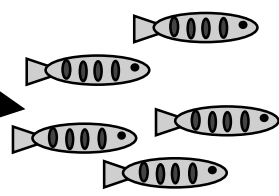
1 + 2 = Adult return rate

**3. Maturation schedule
(age and size of adults)**

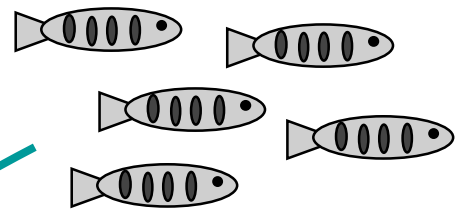
"Spawning - Fall"



emergence

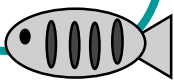


fry

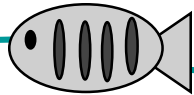


parr

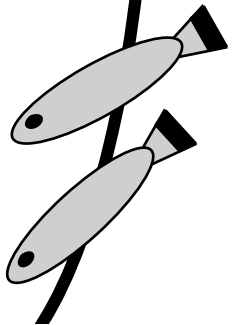
**microJack
age 1**



**miniJack
age 2**



**Age of maturation
is variable**

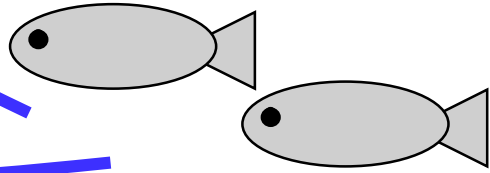


*spring smolting
(age 1+)*

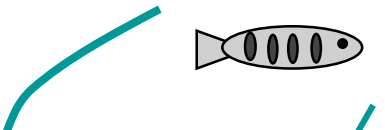
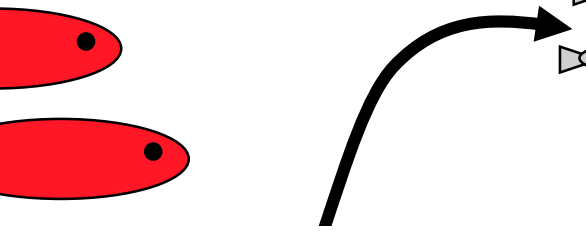
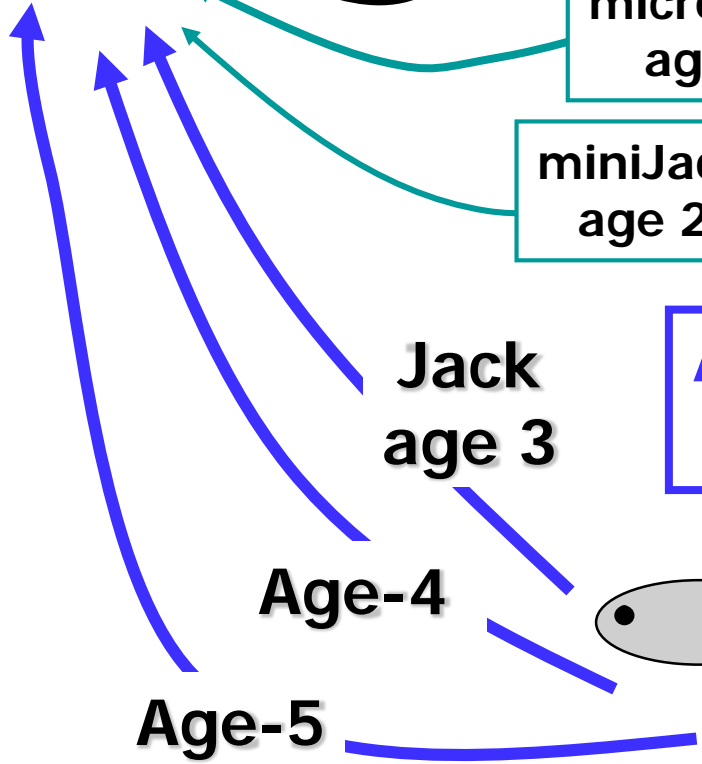
**Jack
age 3**

Age-4

Age-5



ocean rearing



Cle Elum study:

how does release size relate to minijack rate?

Minijack screens prior to release - BYs 00 - 07
(blood sample from 300 smolts/group)

+ Size at release study (at tagging in fall 10 & 15g)

3 brood years (02, 03, 04)

Effect of release size on:

Minijack rate

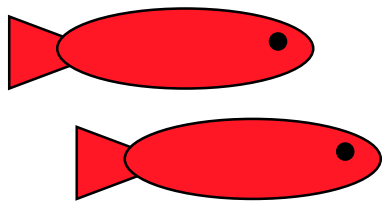
Jack rate

smolt survival

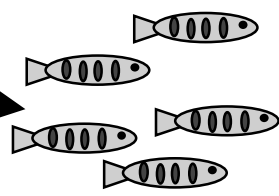
adult return



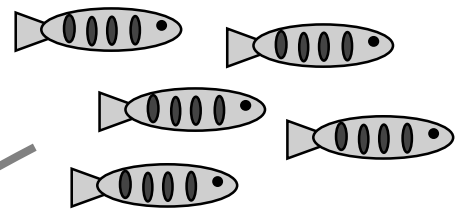
"Spawning - Fall"



emergence

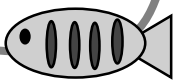


fry

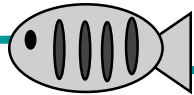


parr

microJack
age 1



miniJack
age 2

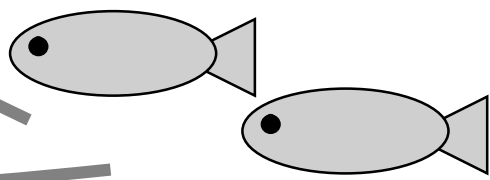


**How does release size
relate to minijack rate?**

Jack
age 3

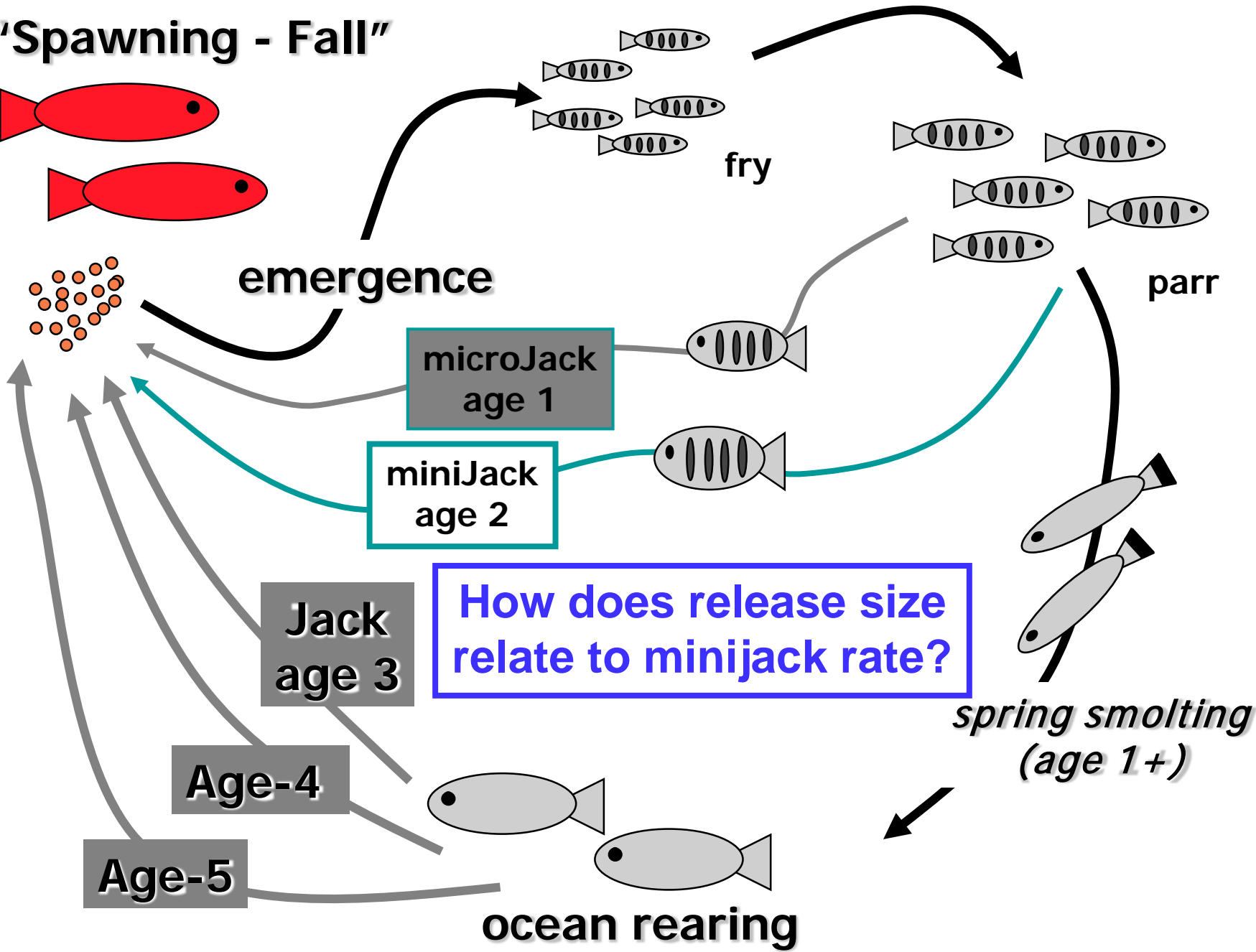
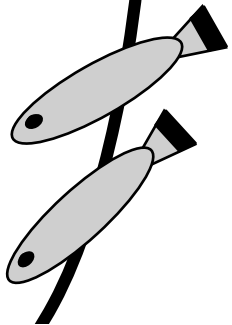
Age-4

Age-5

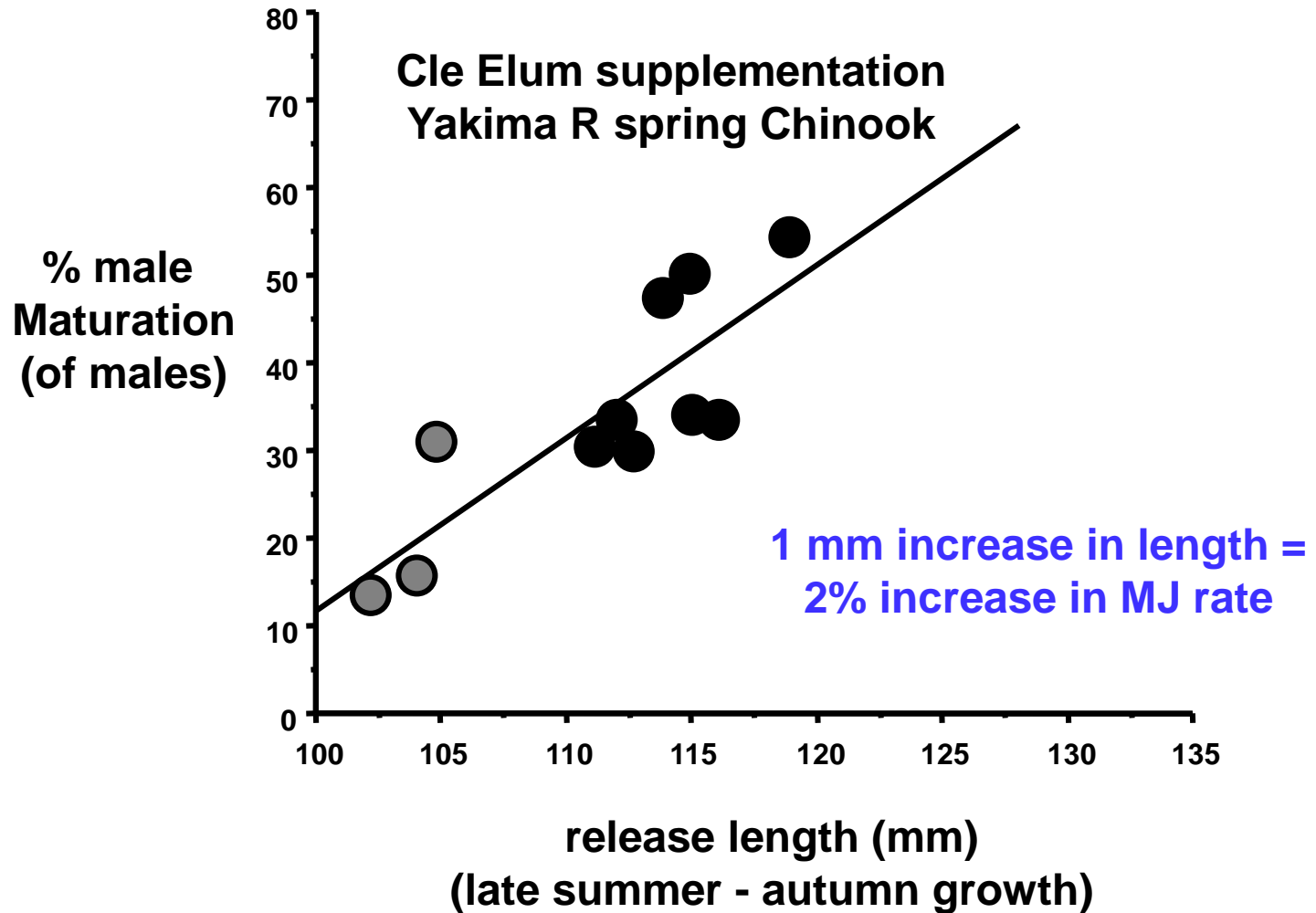


ocean rearing

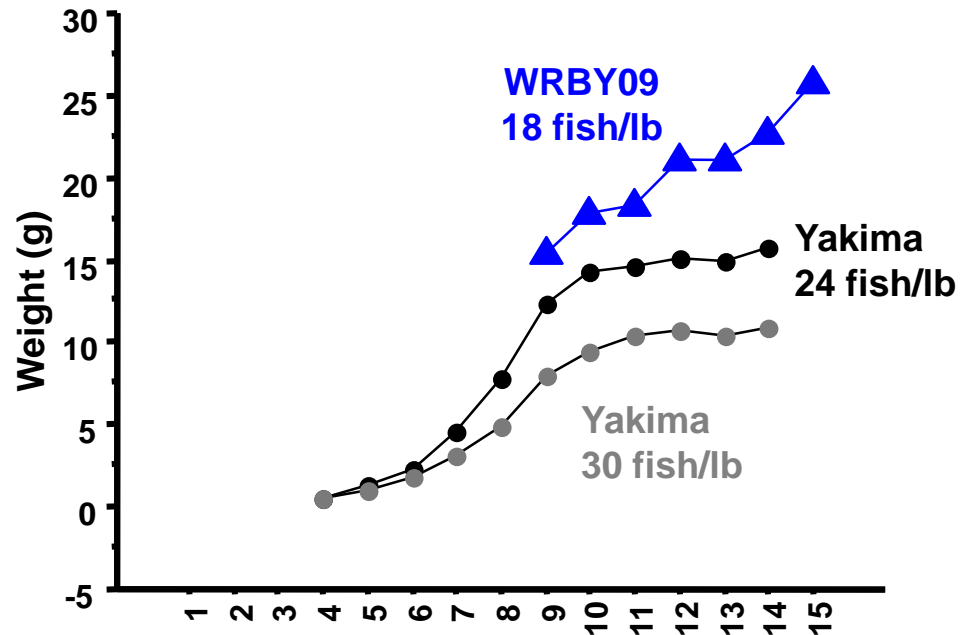
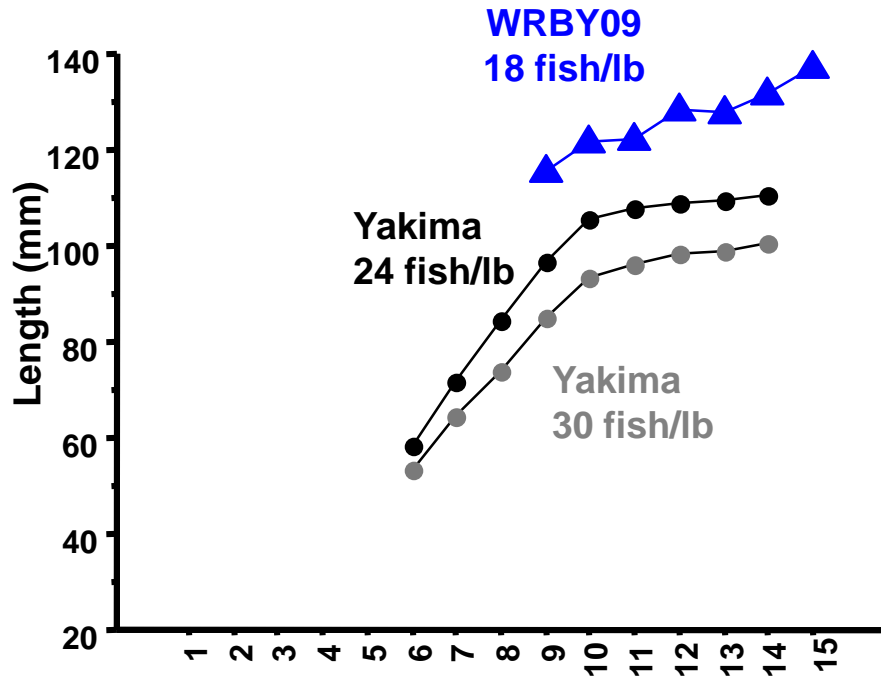
*spring smolting
(age 1+)*



Size at release is directly related to minijack rate @ Cle Elum



We've looked at size vs minijack relations at other hatcheries and different populations

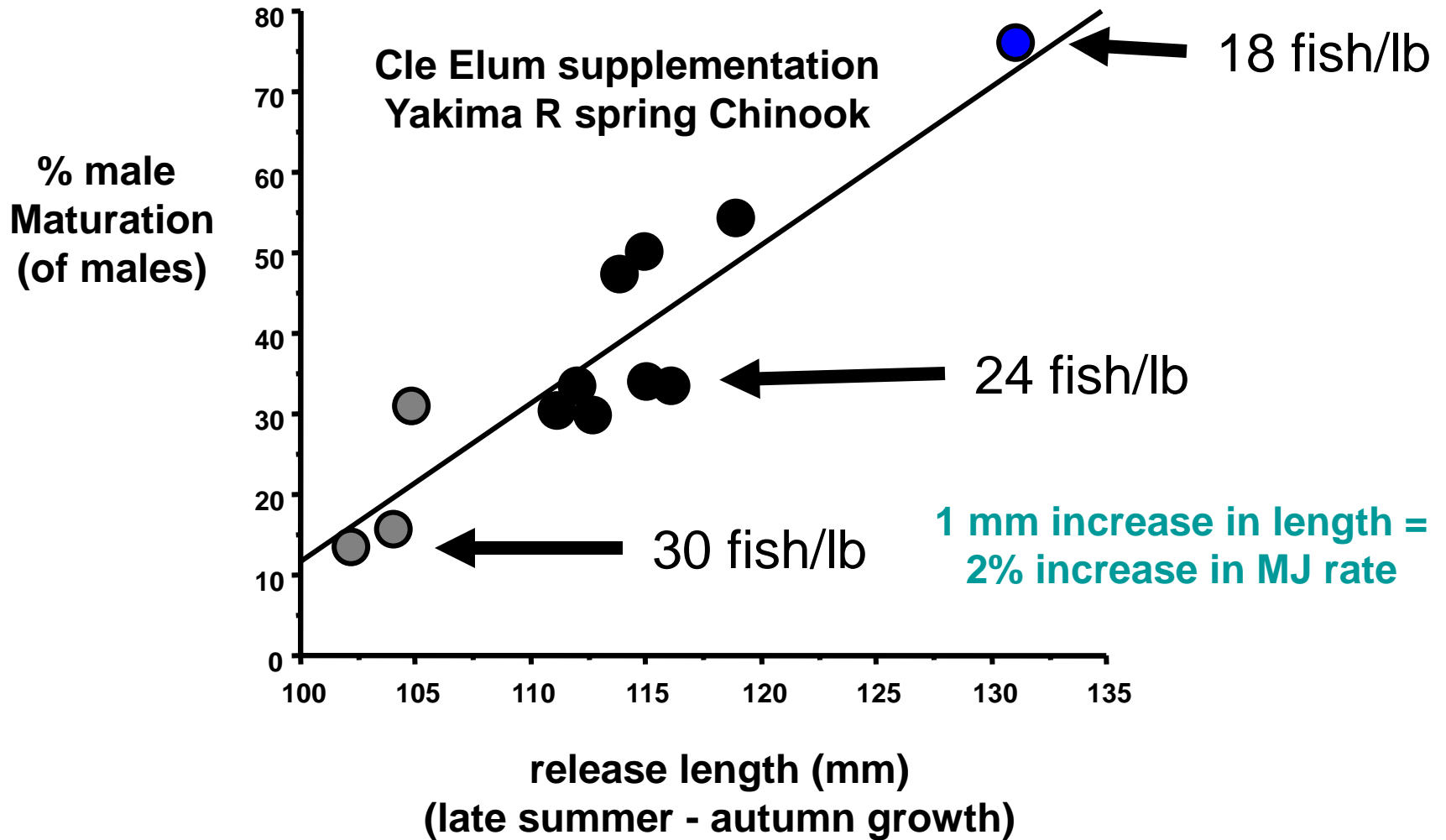


Month

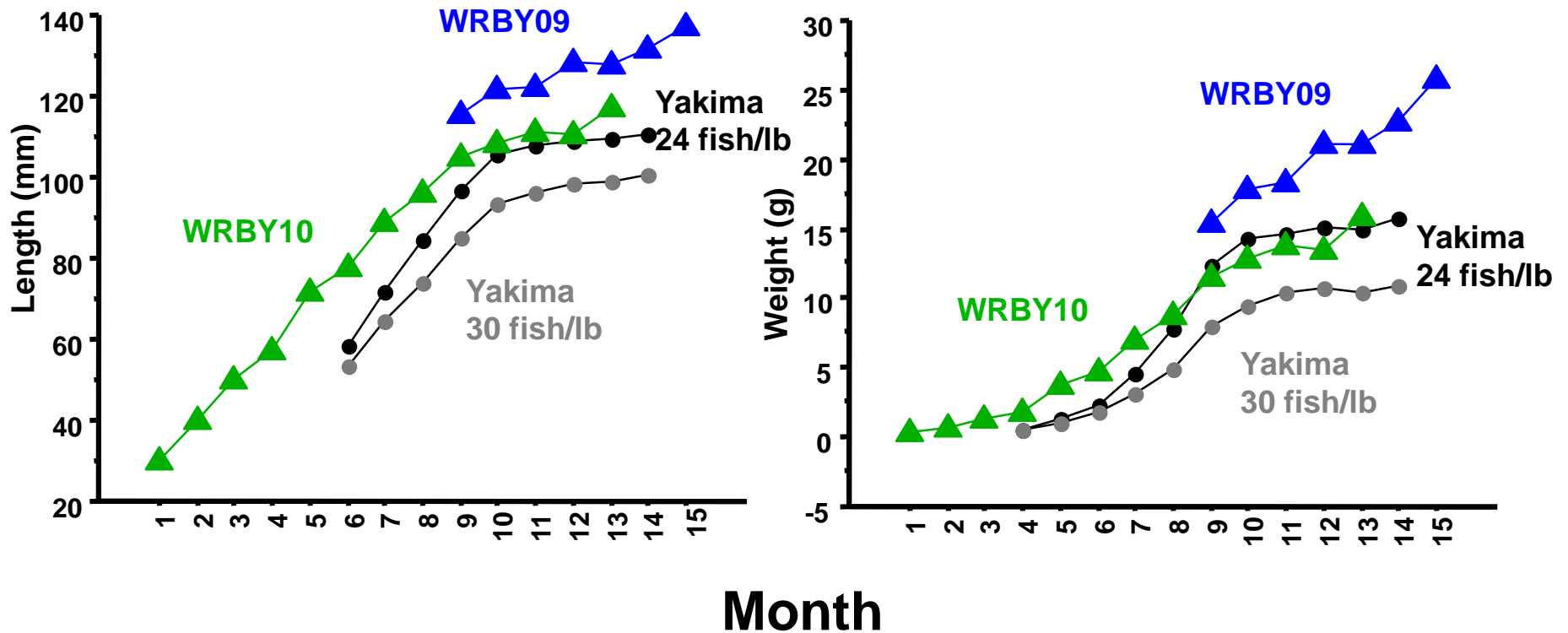
Growth profiles: **White River BY09**, Yakima

Size at release is directly related to minijack rate

White R spring Chinook
Captive broodstock BY09

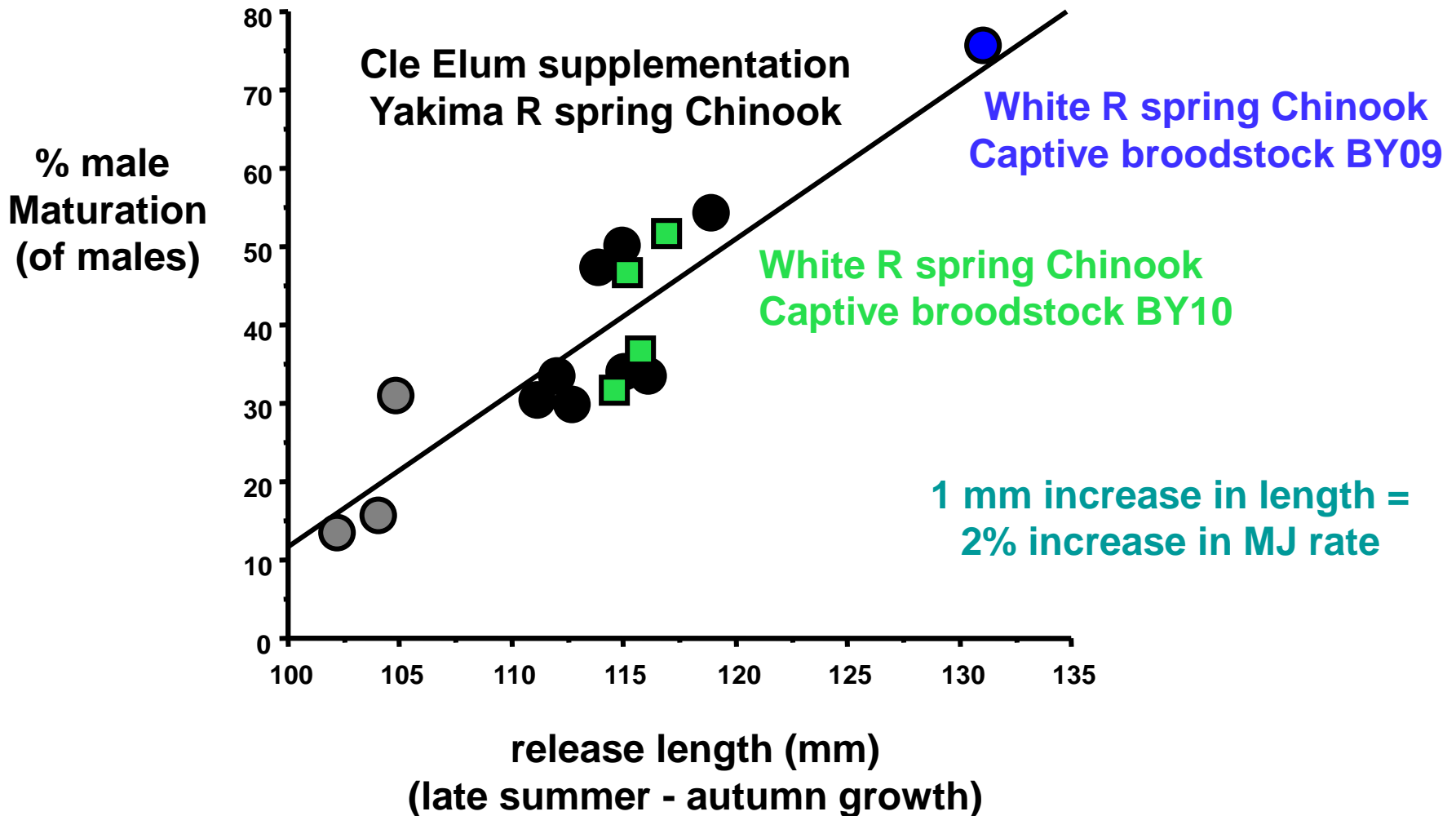


BY10 White River fish were reared at a reduced growth rate and released at a smaller size



Growth profiles: White River BY09, **BY10**, Yakima

Reduced growth rate and smaller release sizes resulted in a reduced minijack rate

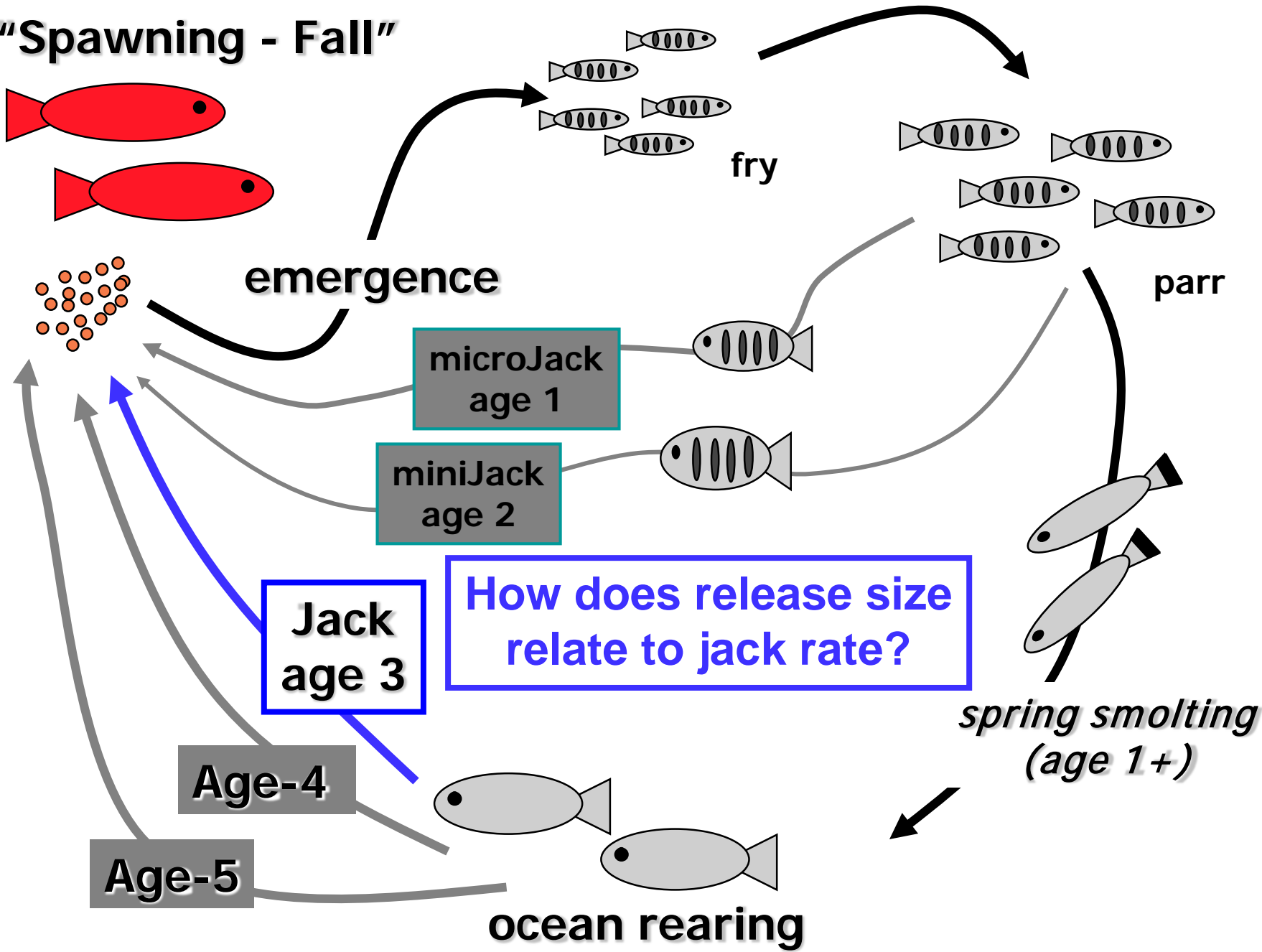


**Up to 35% of the “smolts”
released from production programs
might mature in 6 months at age 2 (~ 200mm)
minijacks**

**Cle Elum program averages ~ 20%
even though smolts are relatively small
(24 fish per pound)**

**High rates of minijack production
meet few (if any) management goals**

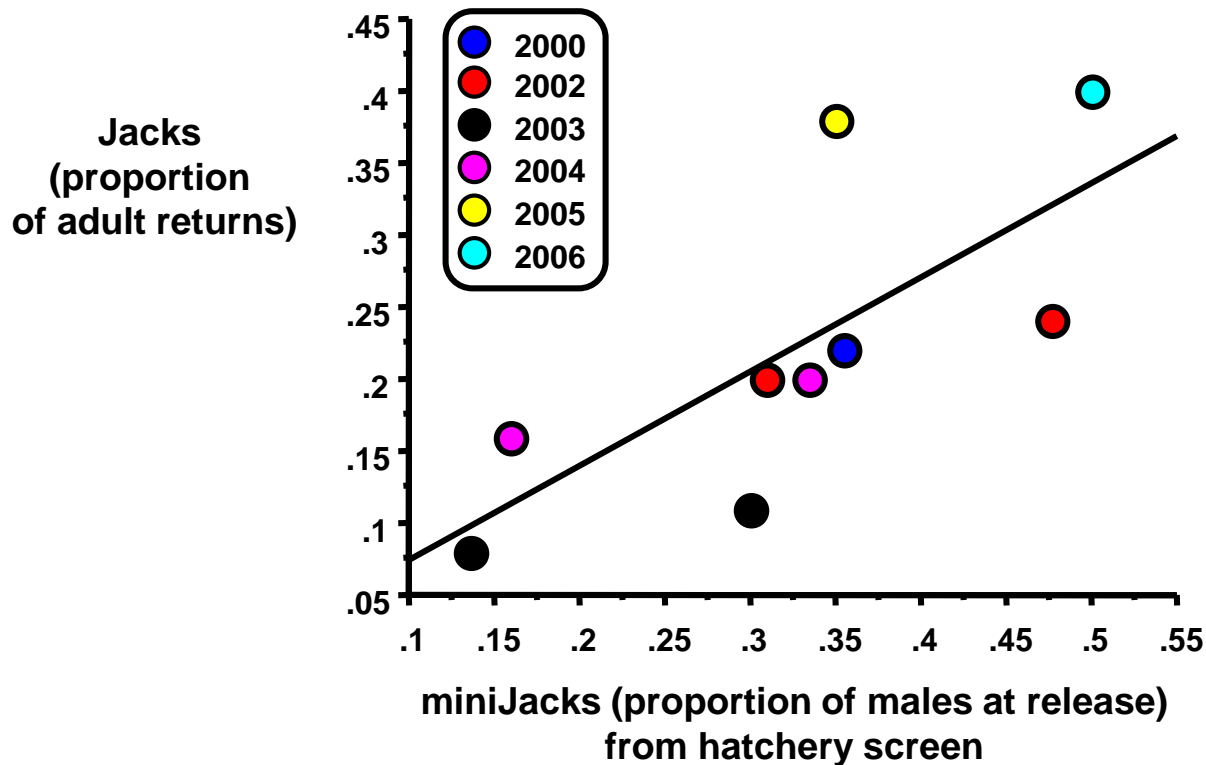
"Spawning - Fall"



Do rearing conditions that result in high minijack rates affect jacking rates?

Minijack prevalence at release predicts jack proportion in adult returns

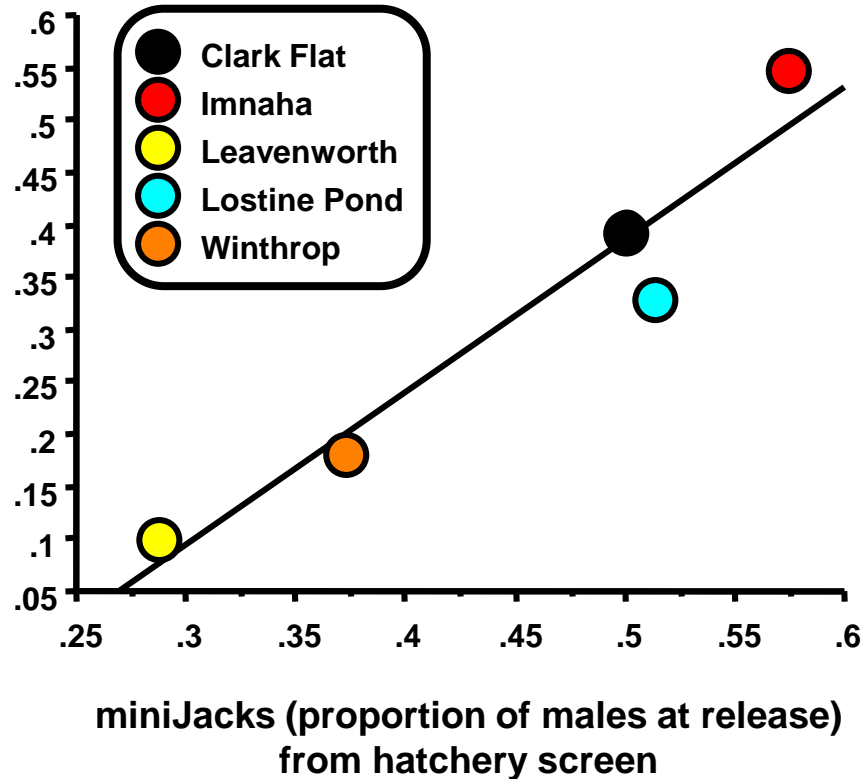
Cle Elum - 6 release years



Larsen et al. 2013
Knudsen et al. in prep
Bosch unpublished

Minijack prevalence at release predicts jack proportion in adult returns 5 hatcheries, release year 2006

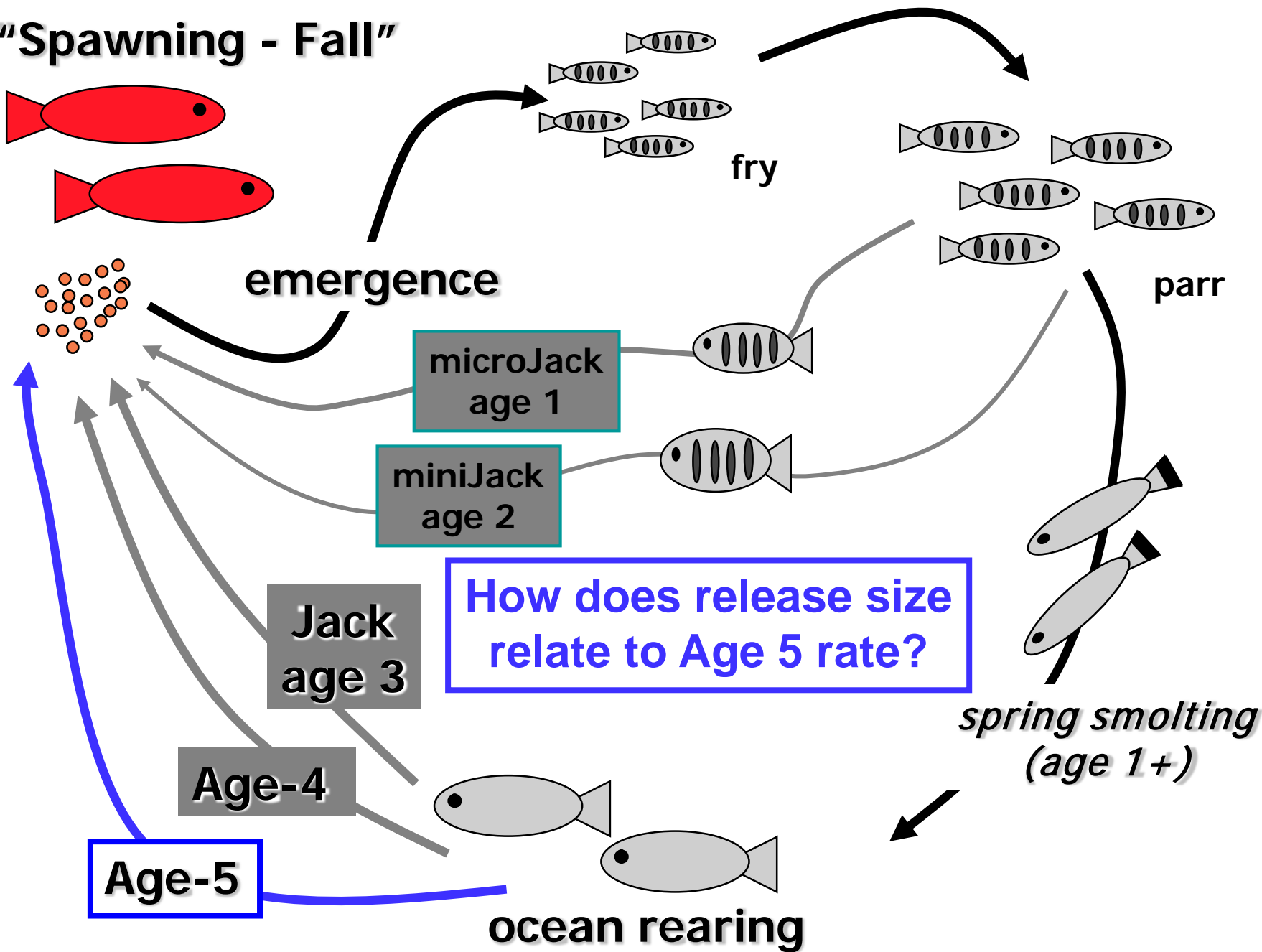
Jacks
(proportion
of adult returns)
PIT-tags @
Bonneville



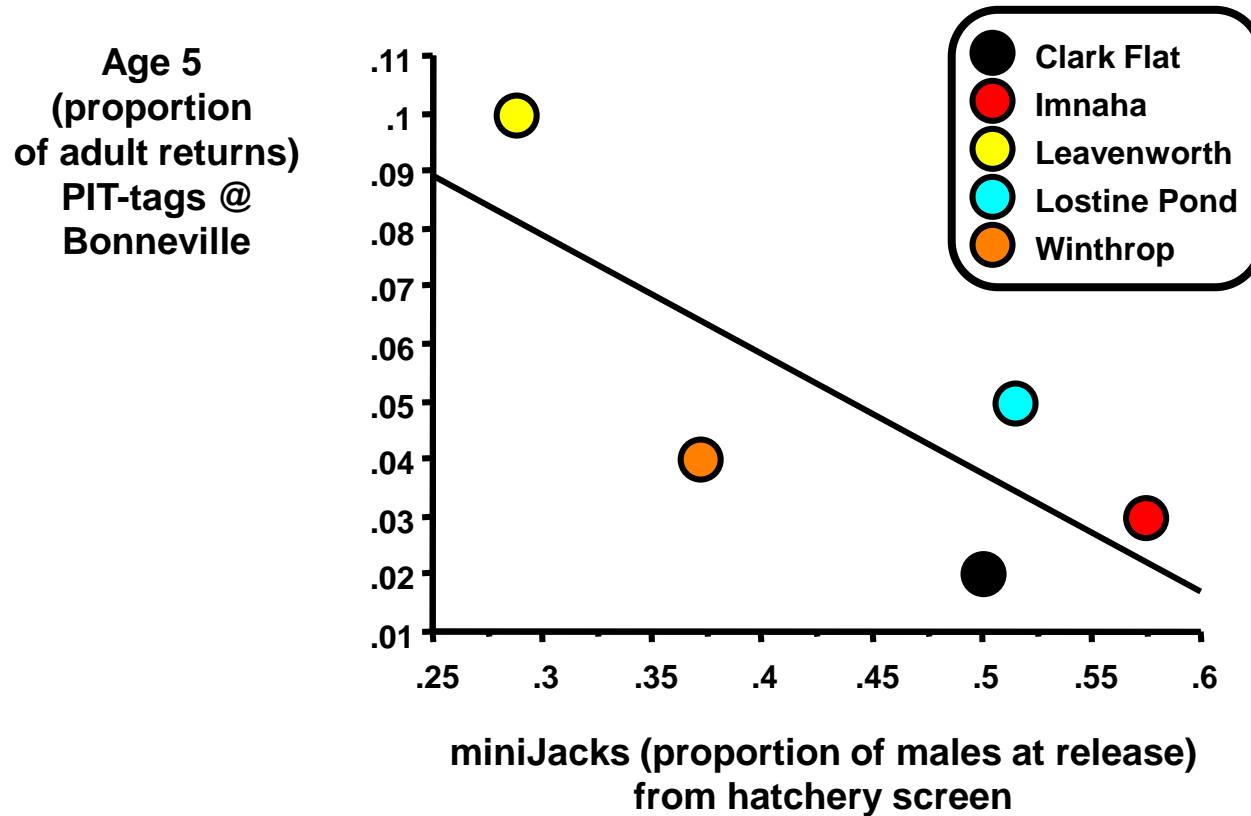
Do rearing conditions that result in high minijack rates affect jacking rates?

**Yes,
conditions that promote minijacks
also appear to promote jacks
(release size)**

"Spawning - Fall"



Minijack prevalence at release is inversely related to Age 5 returns 5 hatcheries, release year 2006



Summary

There is clear evidence that maturation schedule (age/size @ maturity) is influenced by juvenile size/growth rate.

It's not just genetic, it's not fixed, it's variable

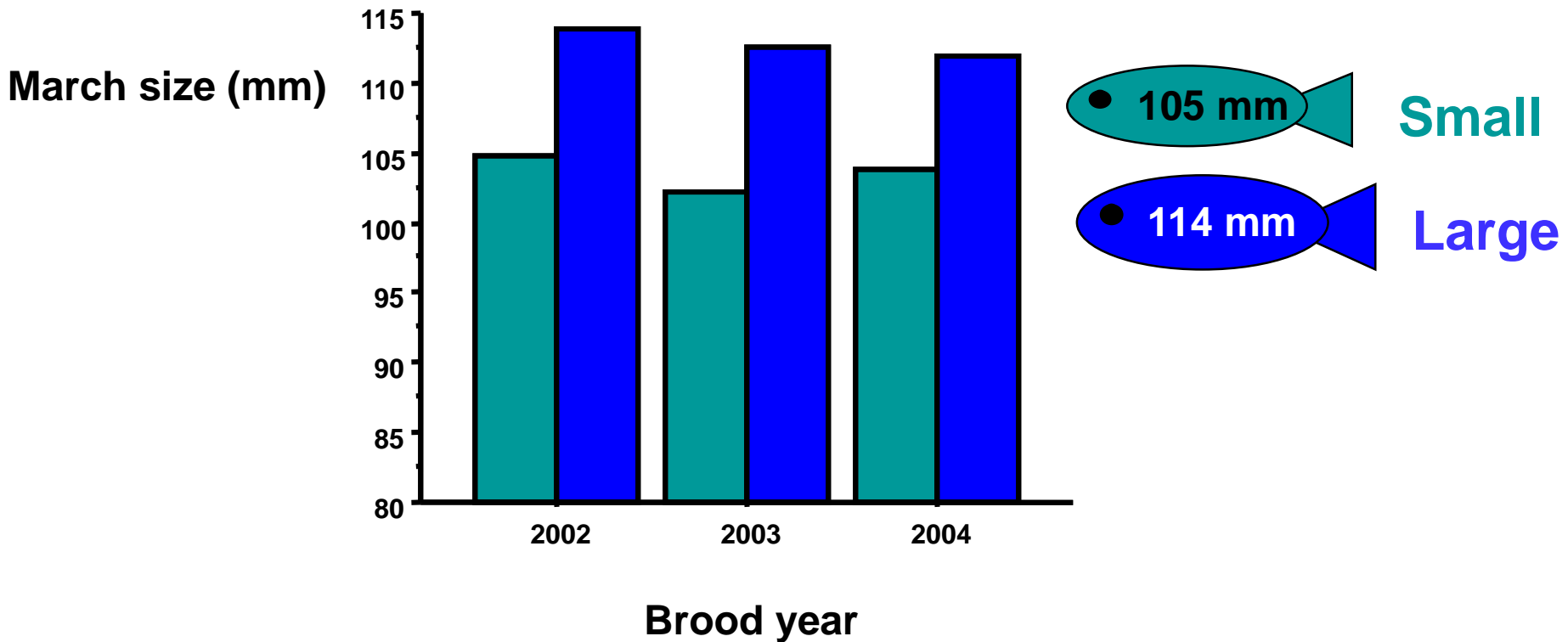
⇒ Smolt size @ release targets can affect Maturation Schedule

What happens in the hatchery does not stay in the hatchery - there are full life cycle consequences of smolt size at release targets

So why not just release small smolts?

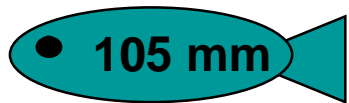
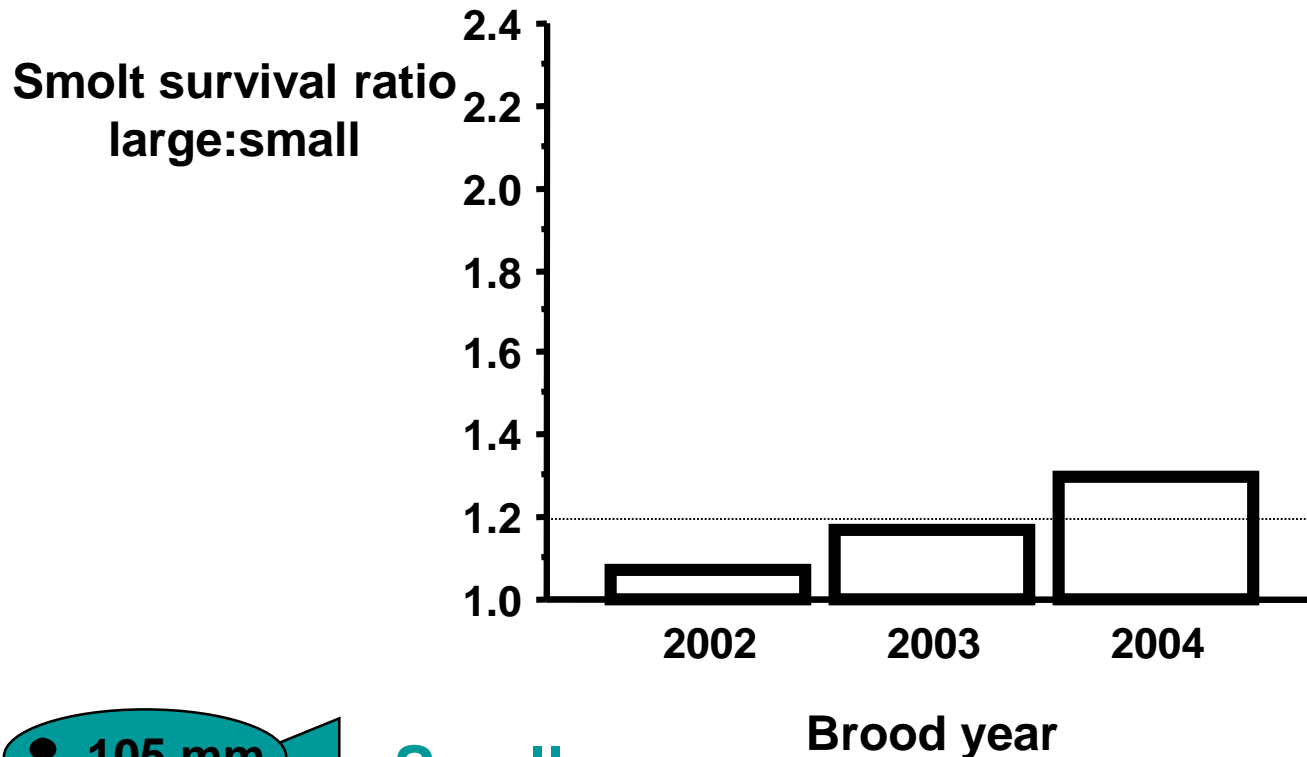
Cle Elum Study

Release size differed by ~ 10mm (early March)



Size of large release group actually not that big
(~24 fish/lb)

Freshwater Smolt survival to McNary is higher for larger smolts avg (3 years): + 1.2 (20%)

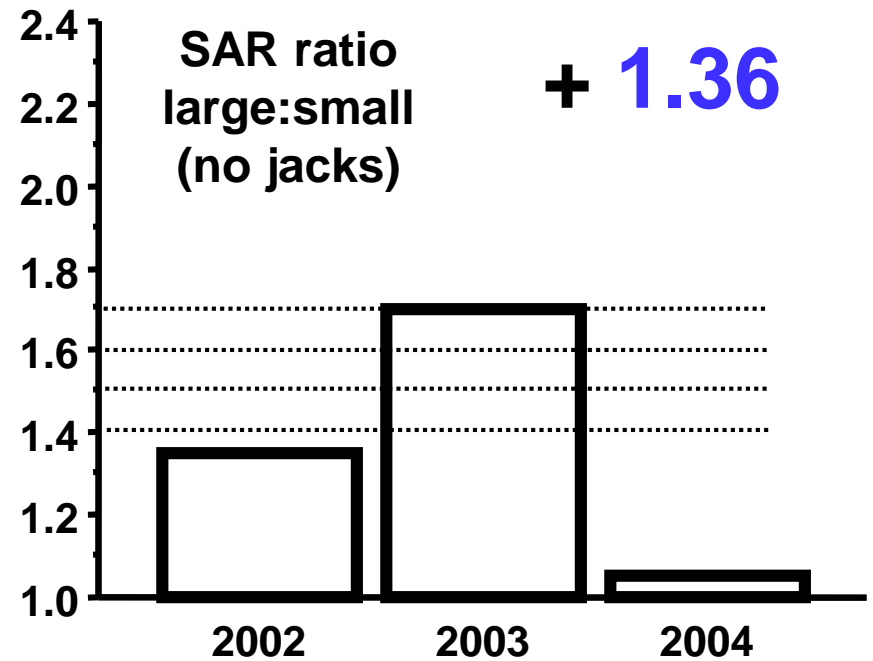
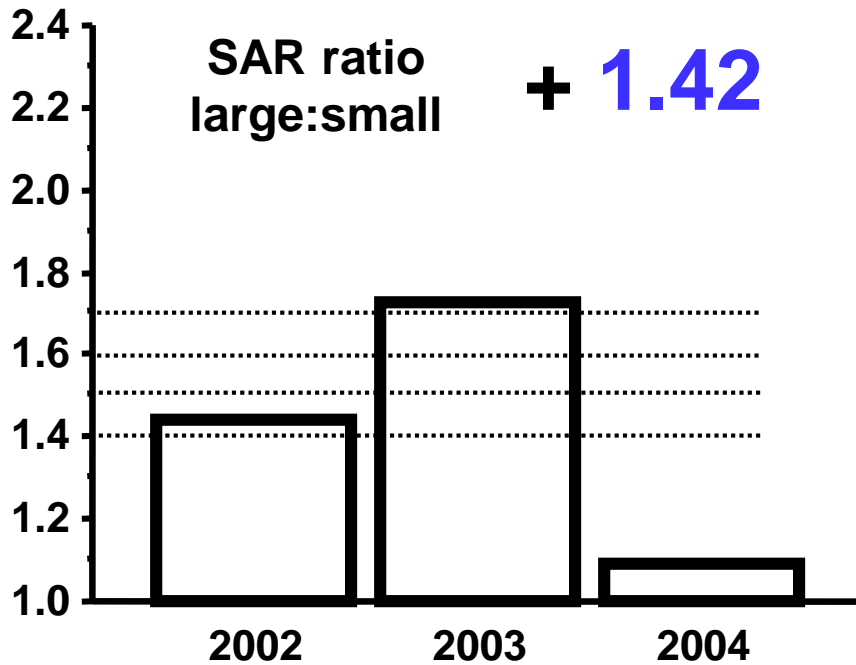


Small



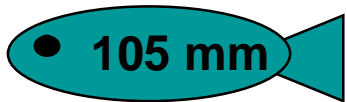
Large

Smolt to Adult return (SAR) is higher for larger smolts



Brood year

Brood year



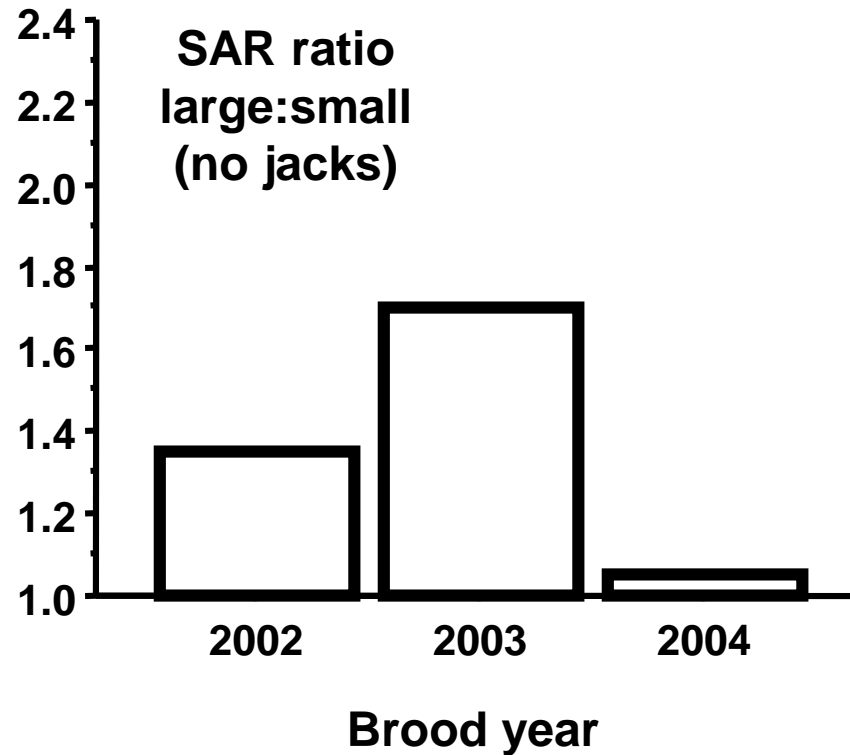
Small



Large

Bill Bosch unpublished

Average difference in SAR, large vs small = + 1.36

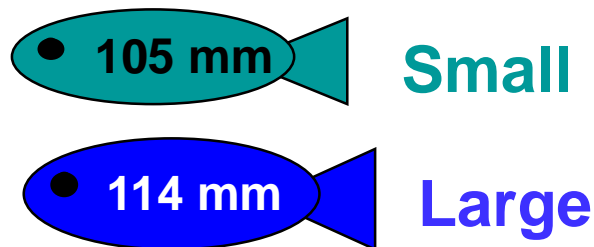
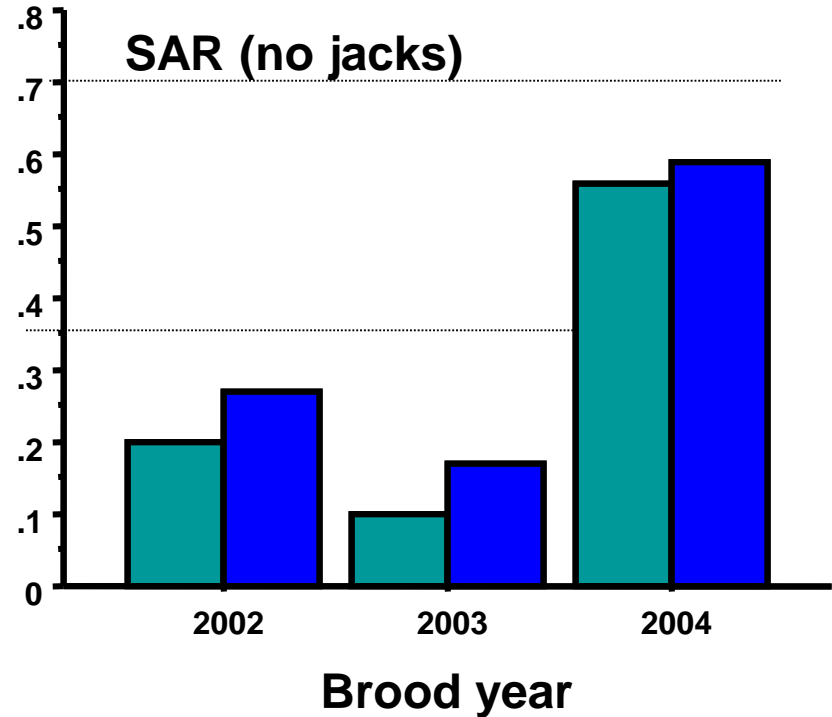
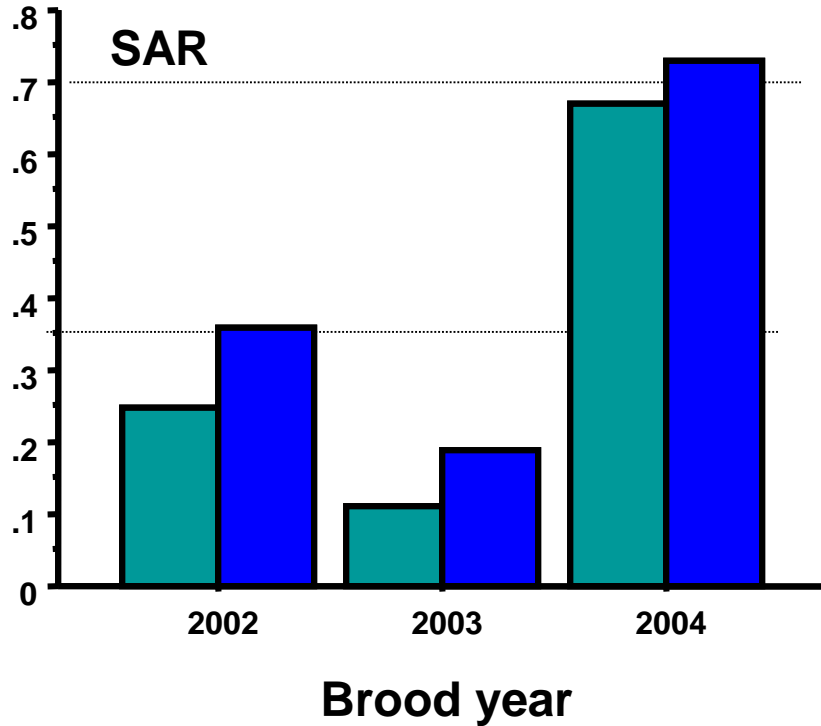


Based on these data many mid/up Columbia River programs have decided to maintain “larger” size at release targets

But wait

Average is not constant

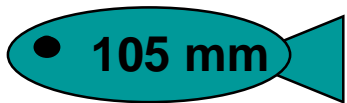
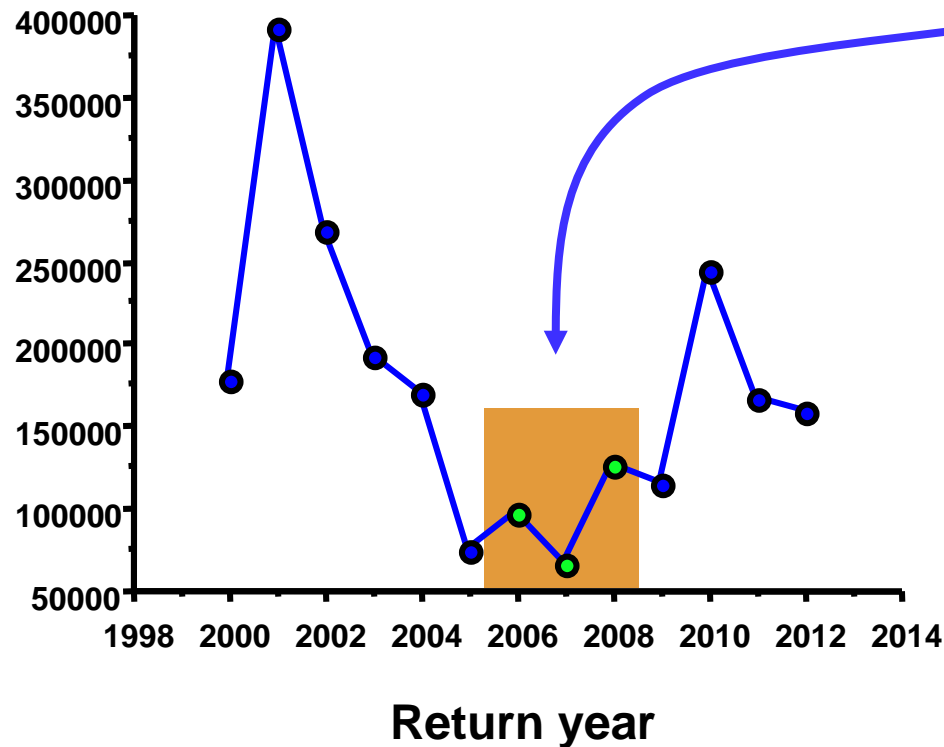
SARs varied > 5-fold between years (actual SAR, not ratio)



Bill Bosch unpublished

Cle Elum Experiment conducted during worst ocean conditions of the last decade

Adult spring
Chinook
at Bonneville



• 105 mm

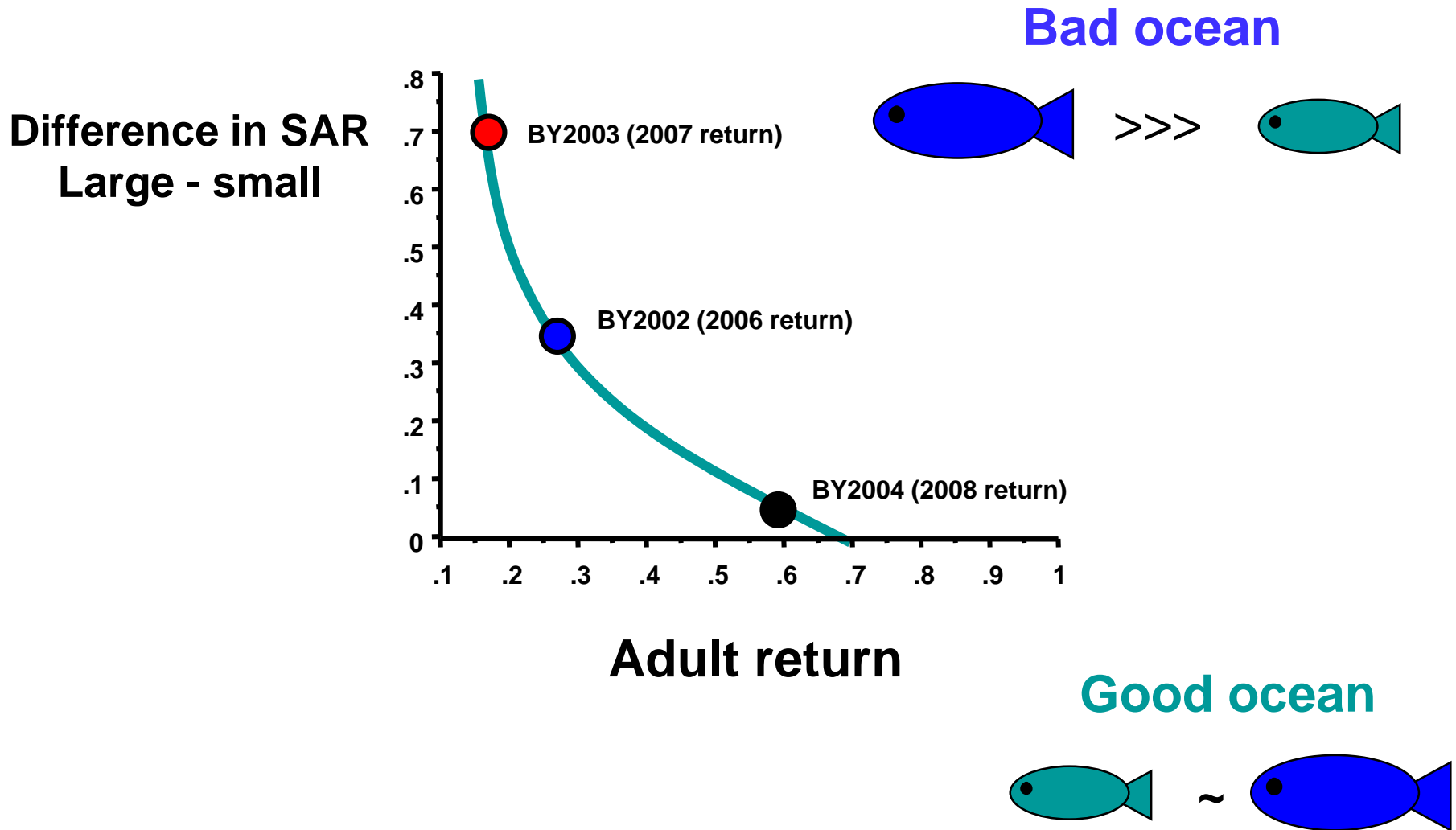
Small



• 114 mm

Large

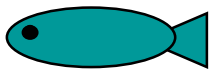
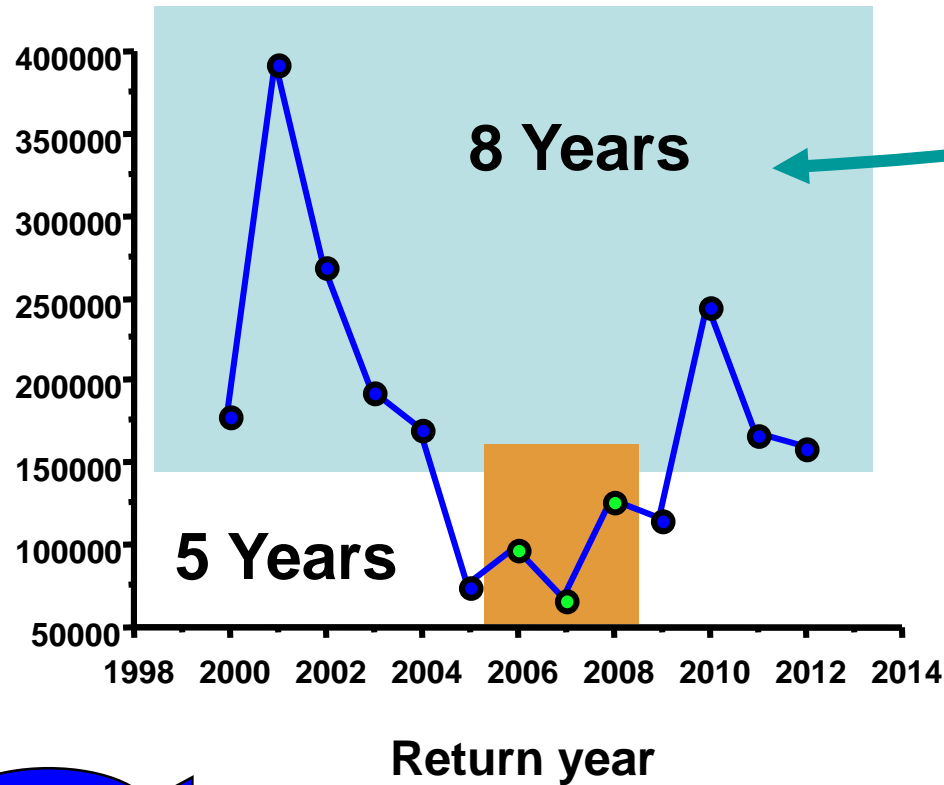
Advantage of large release size most evident in years of poorest returns



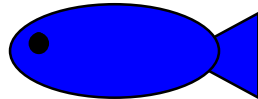
Are results of Cle Elum study relevant to “better” ocean conditions?

What ocean conditions should release size be optimized for?

Adult spring
Chinook
at Bonneville



VS.



Summary

Smolt size at release relates to:

SAR (but not predictably)

Minijack production (direct loss of potential adults)

Jack production (what is the value of a jack?)

Proportion age 5 fish in adult return

Together these traits determine:

adult return

sex ratio adults

average adult size

Questions:

How do managers balance the survival advantages of larger smolts (sometimes) against younger maturation ages (jacks) and lost production (minijacks)?

Or, are larger smolts really an advantage?

Or, what is the size at release target?

Answers:

**You have to do the work -
size at release studies.**

**(stock specific genetic differences maturation,
location specific survival differences)**

**And, you have to assess both SAR
and age structure.**

**And, programs need clear
management goals**

Acknowledgements

BPA (Proj#2002-031-00), Deb Harstad, Dina Spangenberg, Shel Nance, Kathy Cooper, Eric Lauver, Charlie Strom and staff.