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

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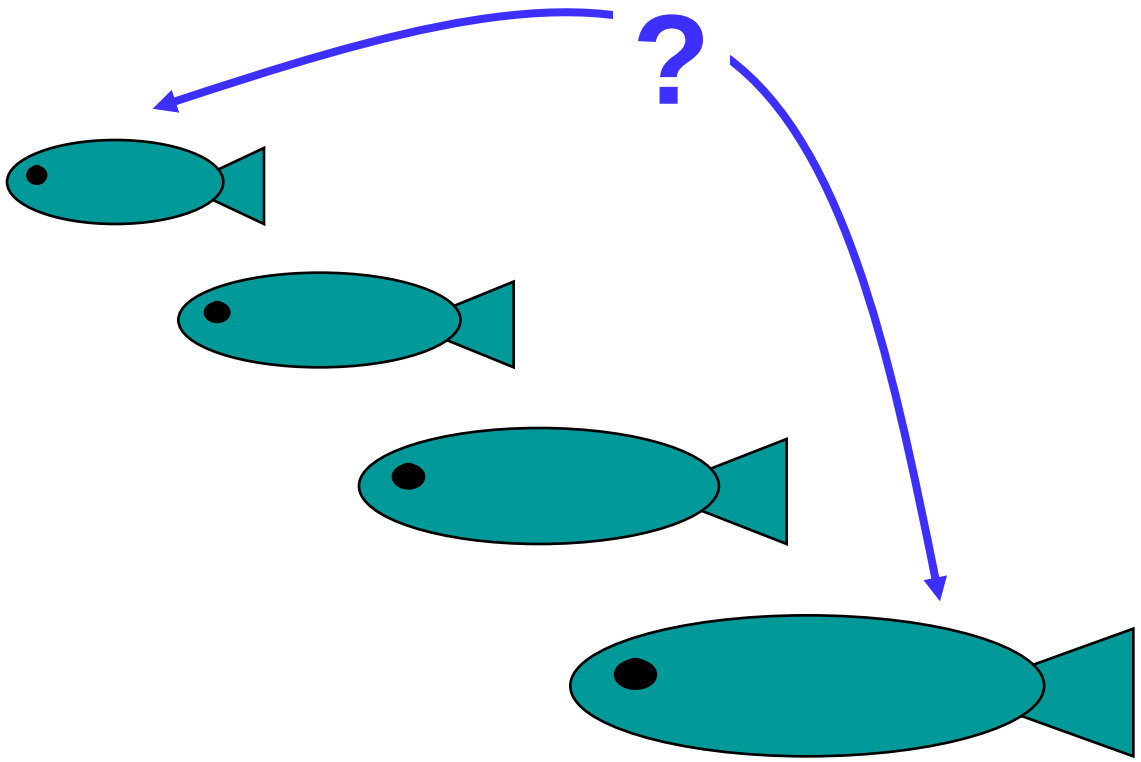
You saw Todd present this talk yesterday



What are the goals for rearing programs?
How are targets set to meet goals?

Most (all?) hatcheries have size @ release targets

What's the goal for this target?



Ultimately, hatchery programs are about producing adult fish

Return =

(# fish released x survival)

- early maturing males*

early maturing males = minijacks

Jacks (?)*

Do Jacks count for 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)

Size targets have been developed based on:

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

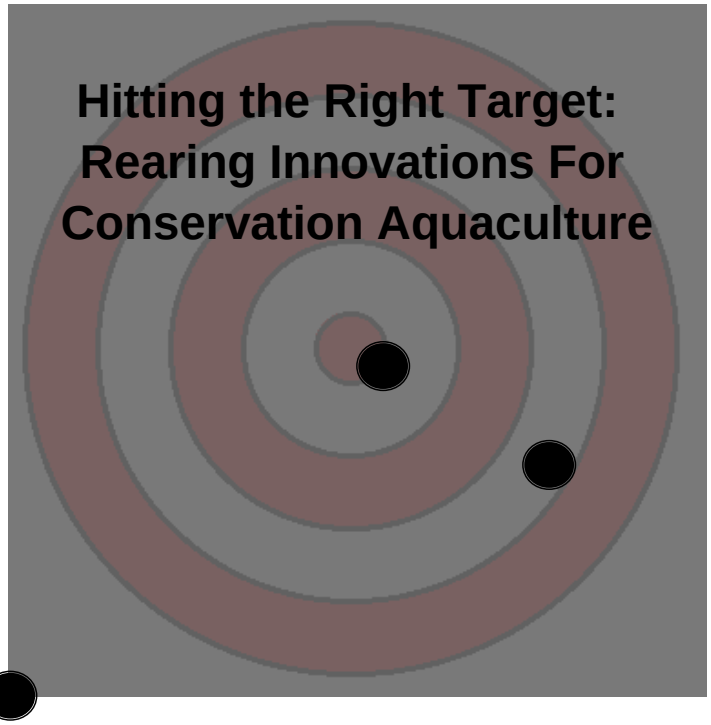
  (250,000 release/10,000 lb capacity = 25 fish/lb)

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

Do these size targets help programs meet their management goals?

Goal of talk:

How might differing release size targets affect reaching conservation aquaculture objectives?



Outline

Cle Elum Hatchery Study (YN, WDFW, NOAA)

- **size at release (large vs small)**
  - **smolt survival (downstream)**
  - **minijacks**
  - **jacks**
  - **adult return**

Smolt size vs Jacks (PIT-tags at Bonneville)

minijacks vs Jacks (11KT screens and PIT-tags)

Cle Elum study: two sizes at release (at tagging in fall 10 & 15g),
3 brood years (02, 03, 04)

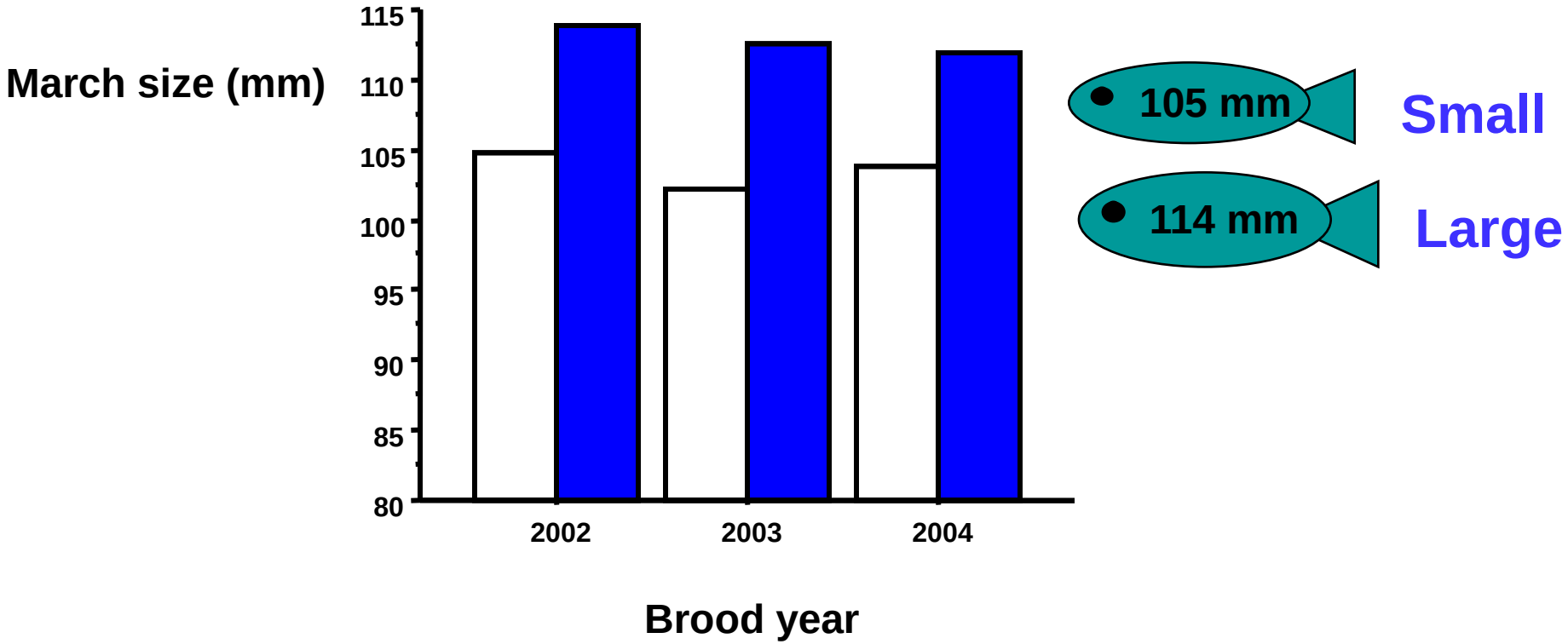
Effect of release size on:

- **minijacks**
- **smolt survival (release to Bonneville)**
- **jacks**
  - **relation of minijacks to Jacks?**
- **adult return**
  - **adjusted for jacks?**



C Strom, manager

Cle Elum Study
Release size differed by ~ 10mm (early March)



Size of large release group actually not that big (~30 fish/lb)

Cle Elum Study:

Data will be expressed as a ratio

Large smolt response/small smolt response

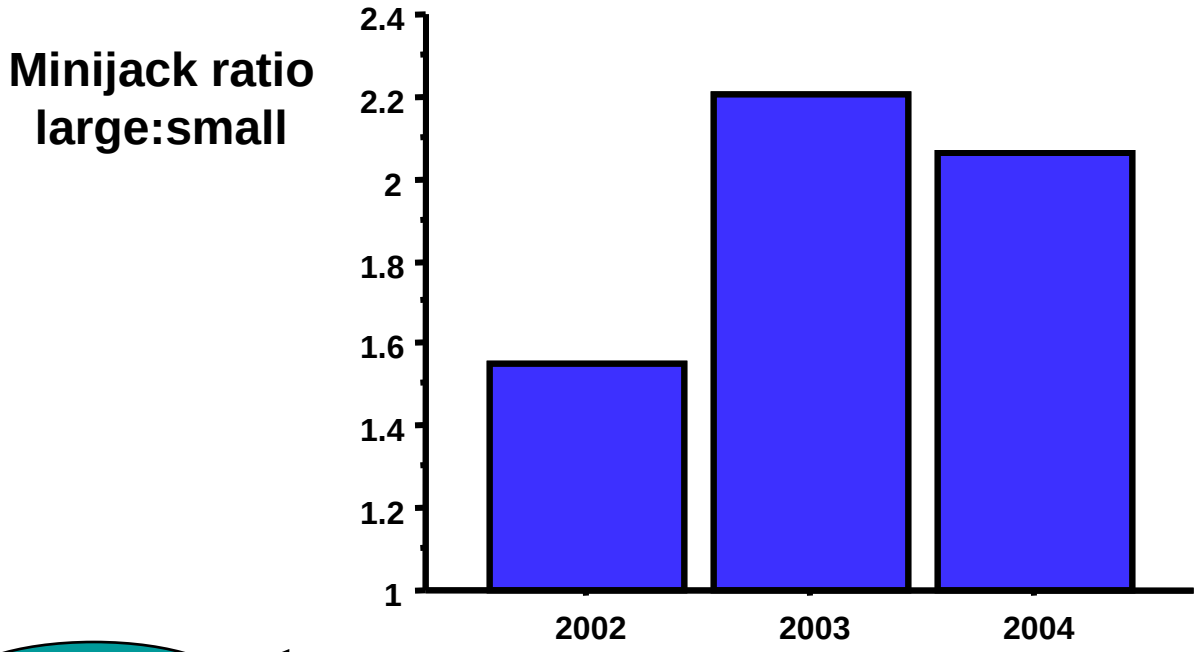
ratio = 1, both the same

Ratio > 1, large smolt response > small smolt response

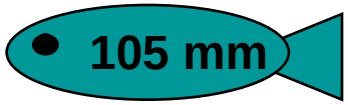
miniJacks
smolt survival (release to Bonneville)
Jacks
SAR

MiniJacks at release

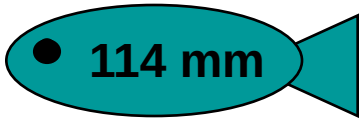
avg (3 years): + 1.9



40% vs 20%



Small

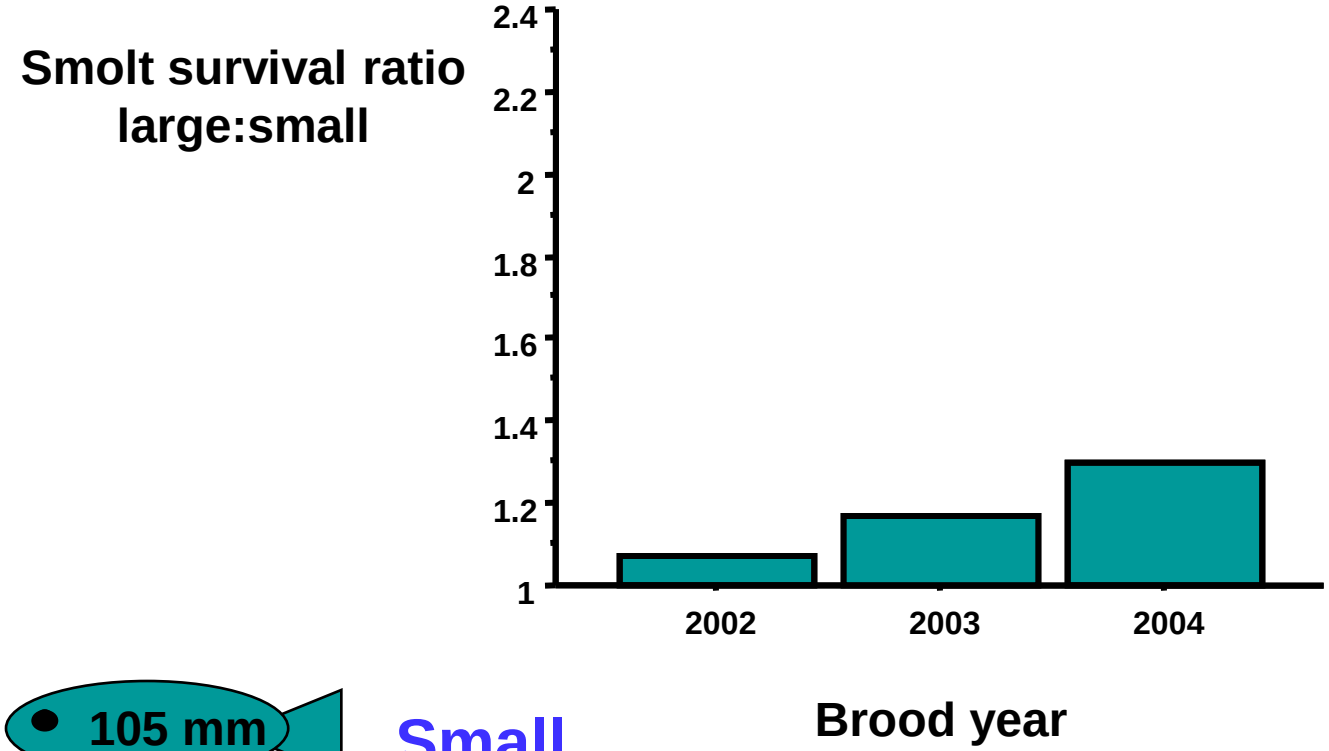


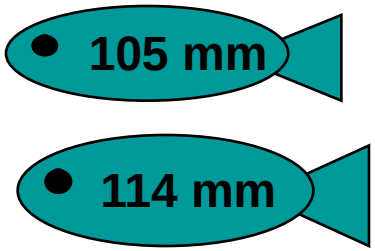
Large

Larsen et al. in press TAFS

Smolt survival to McNary*

avg (3 years): + 1.2

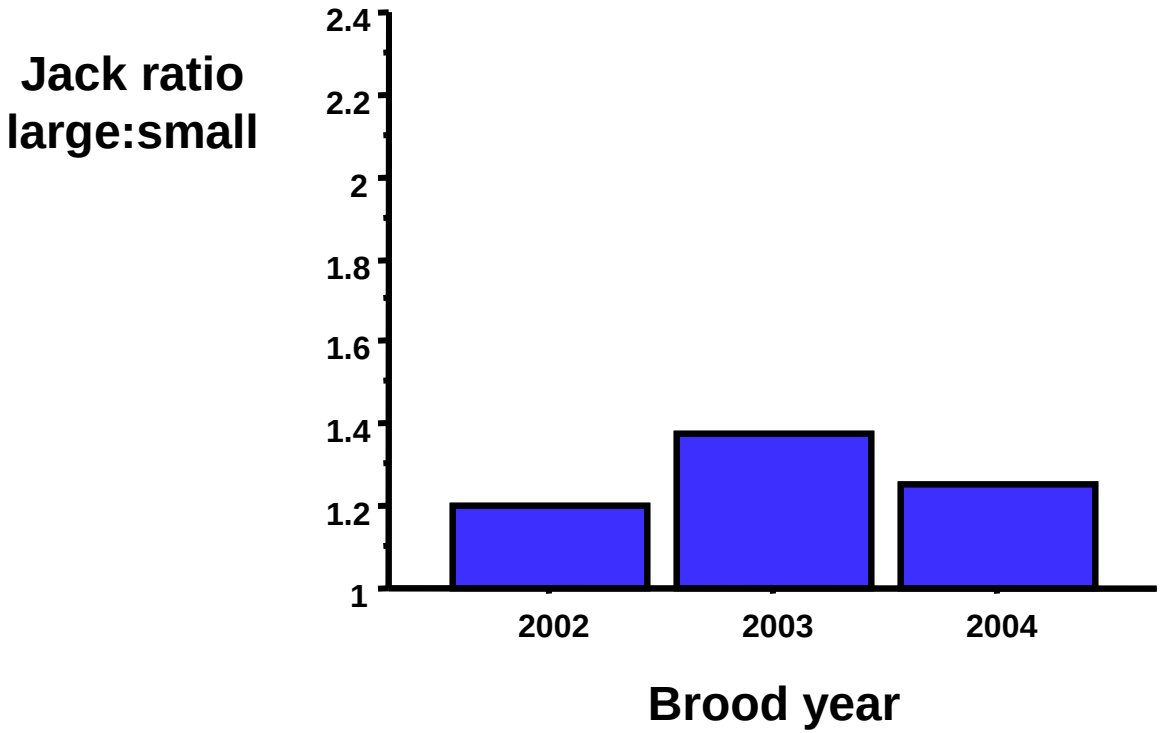


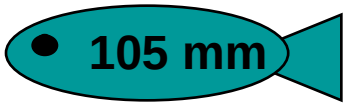


*Doug Neely

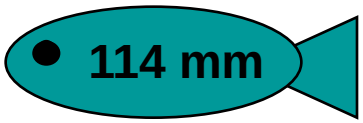
Jacks

avg (3 years): + 1.3





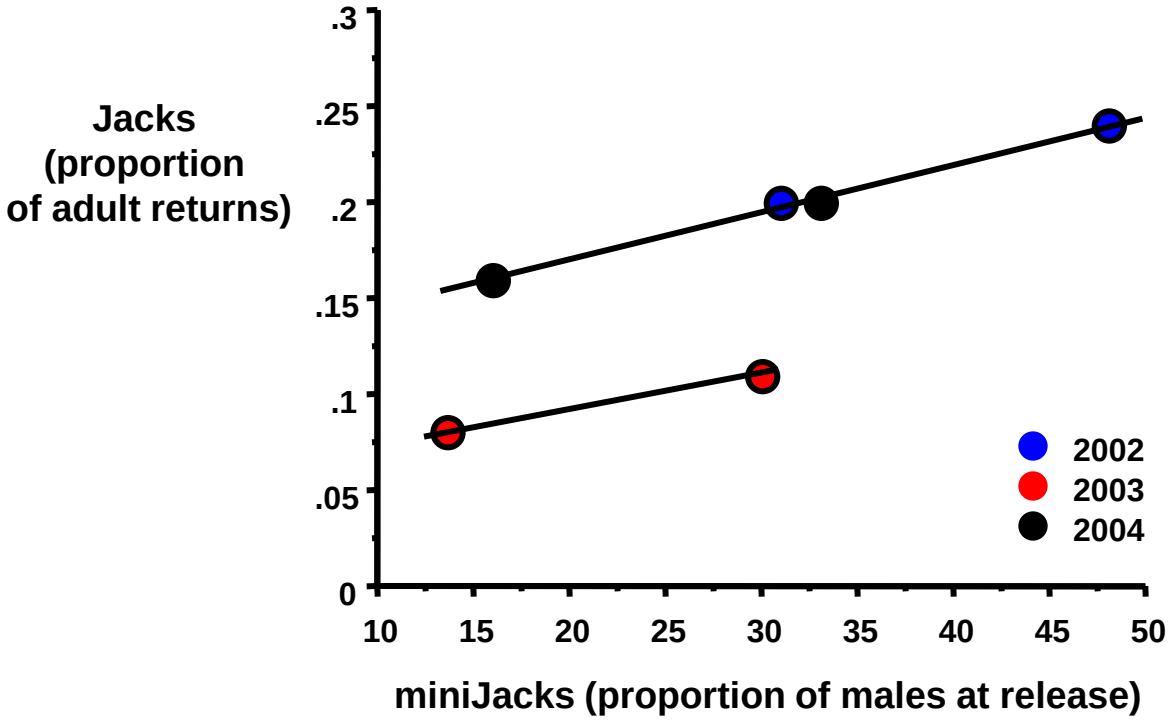
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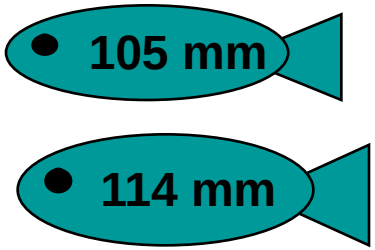


Large

Knudsen et al. in prep

Cle Elum study
More minijacks = more jacks
Early male maturation is additive



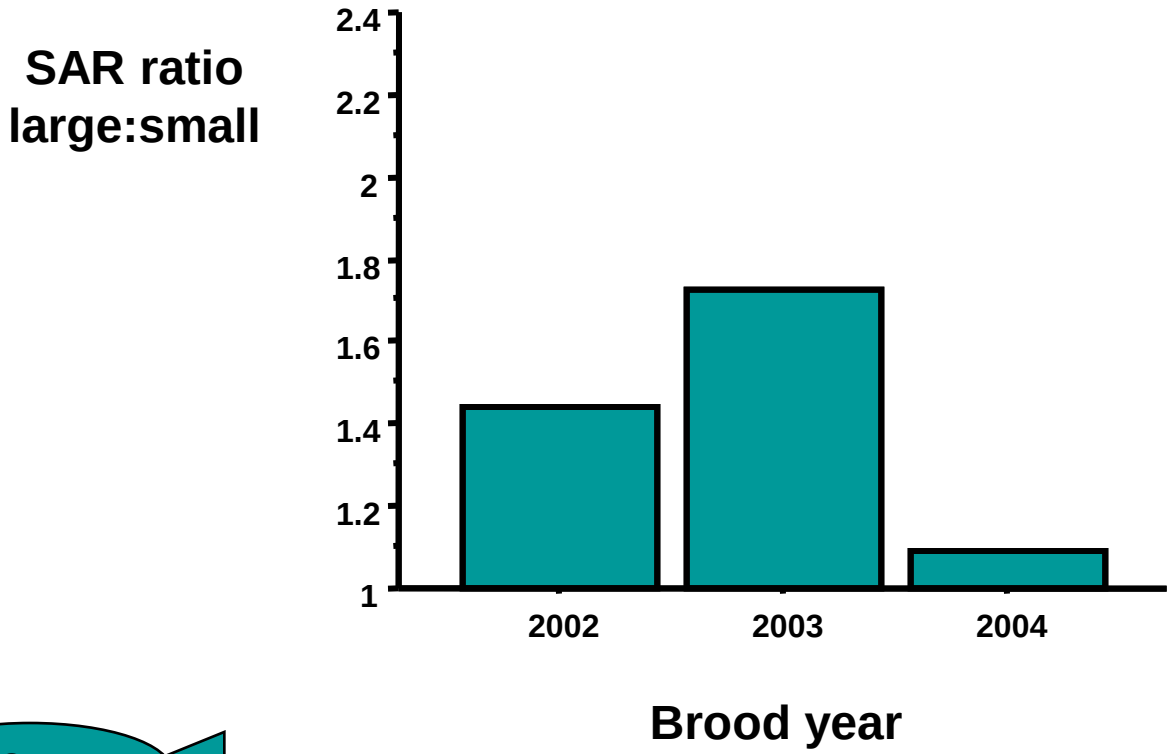


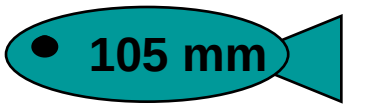
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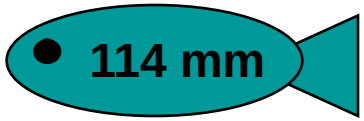
Smolt to Adult return (SAR)

avg (3 years): + 1.42





Small



Large

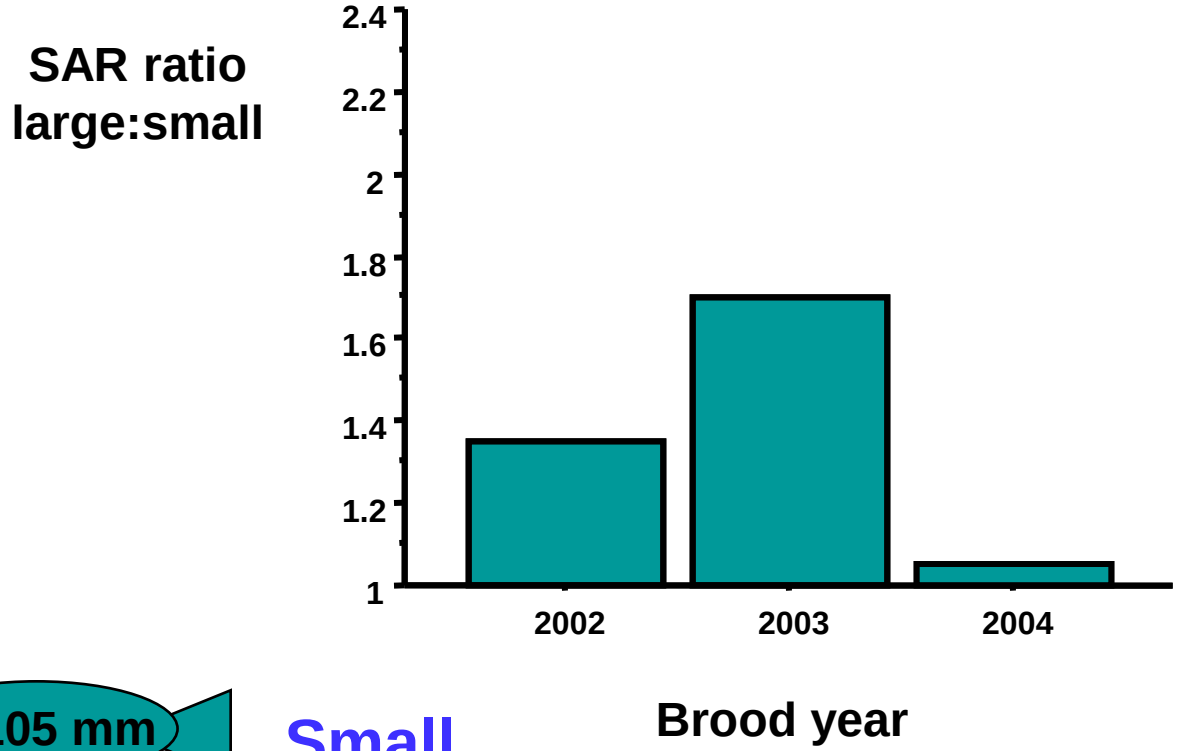
Bill Bosch unpublished


Hitting the Right Target:
Rearing Innovations For
Conservation Aquaculture
Adult return
What about jacks?

Cle Elum Large to Small ratio

SAR (no Jacks)

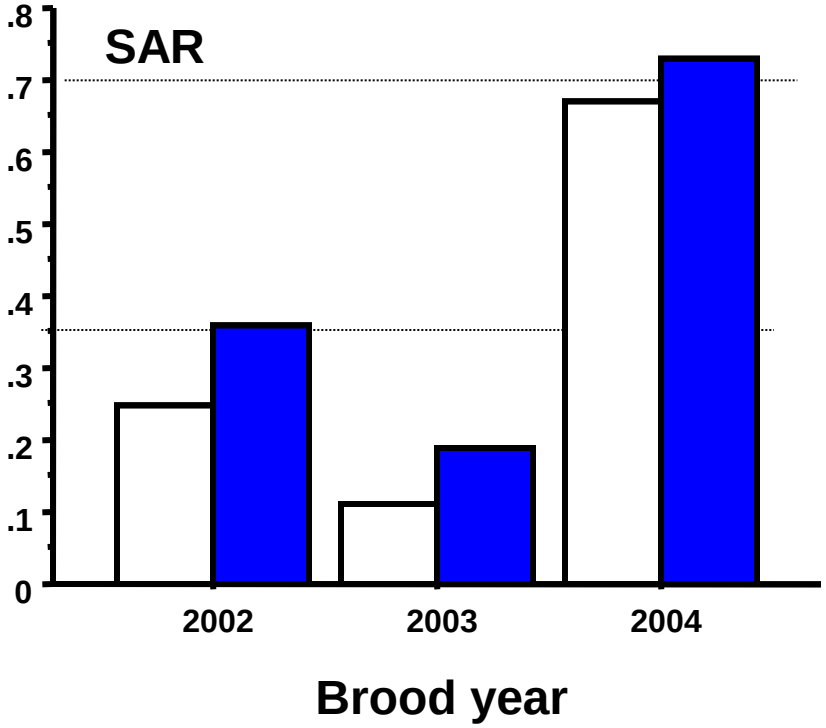
avg (3 years): + 1.36

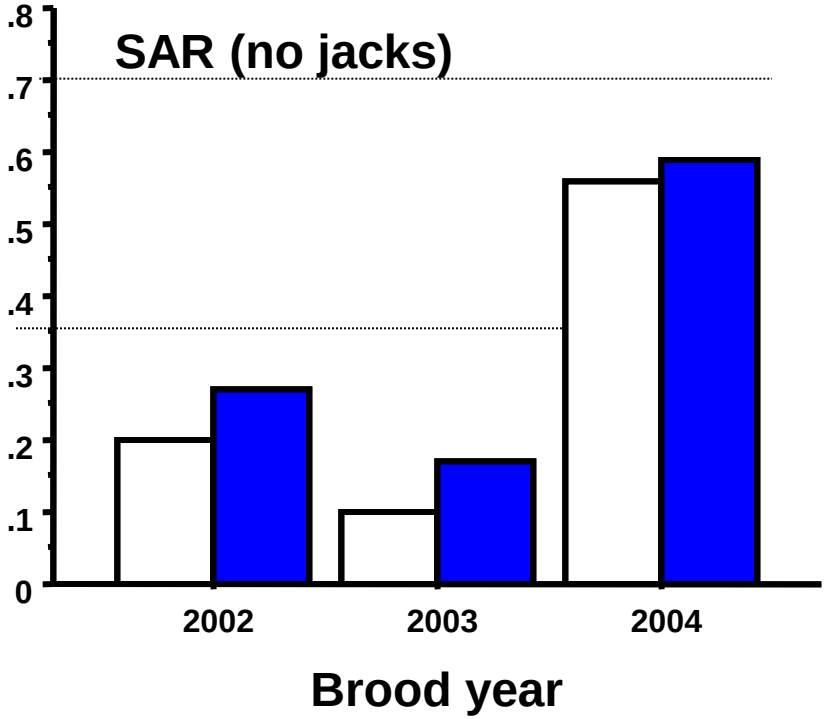


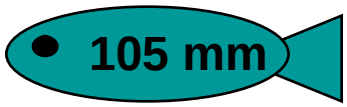
Bill Bosch unpublished

What were the actual return rates? (not ratio)

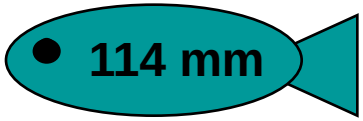
SARs varied > 5-fold between years







Small

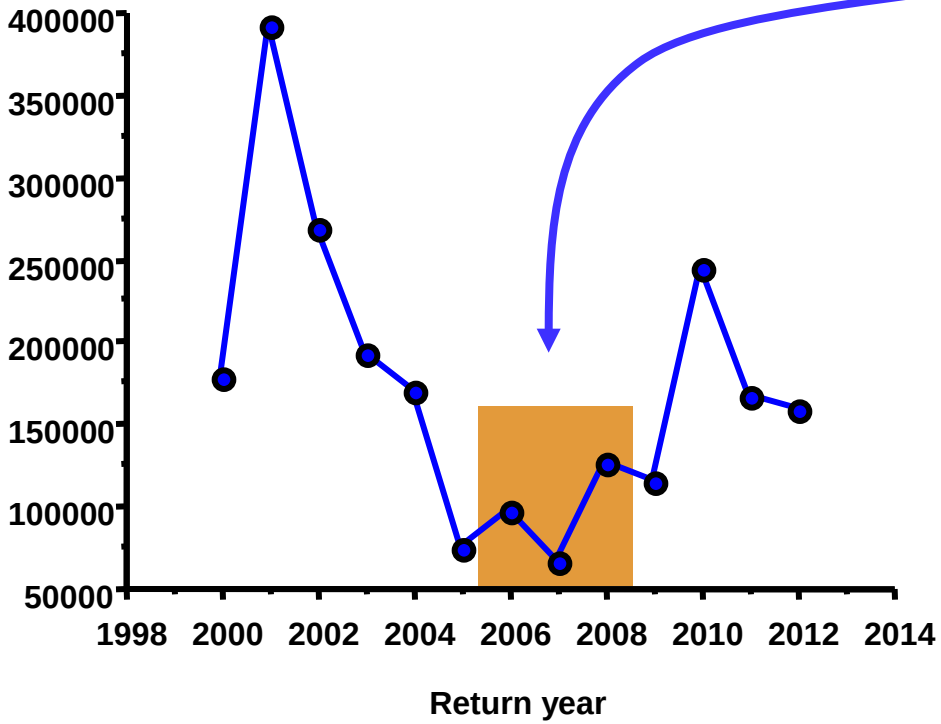


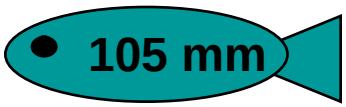
Large

Bill Bosch unpublished

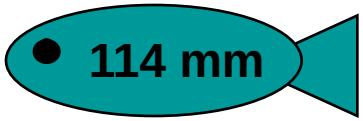
Cle Elum Experiment conducted during worst ocean conditions of the last decade

Adult spring Chinook at Bonneville



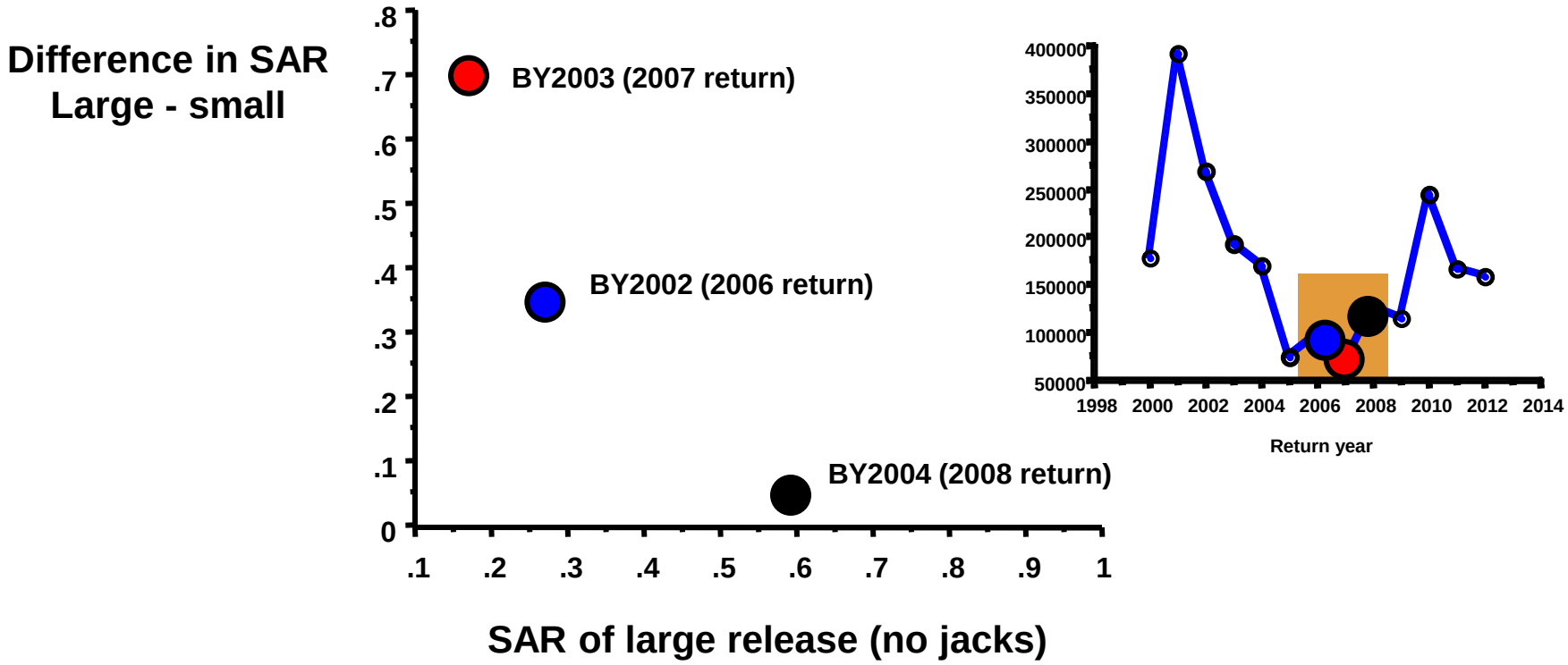


Small



Large

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



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

Should program management be “tuned” to ocean conditions?

Summary Cle Elum study

Larger size = higher survival

*survival advantage is variable

Larger size = more early male maturation

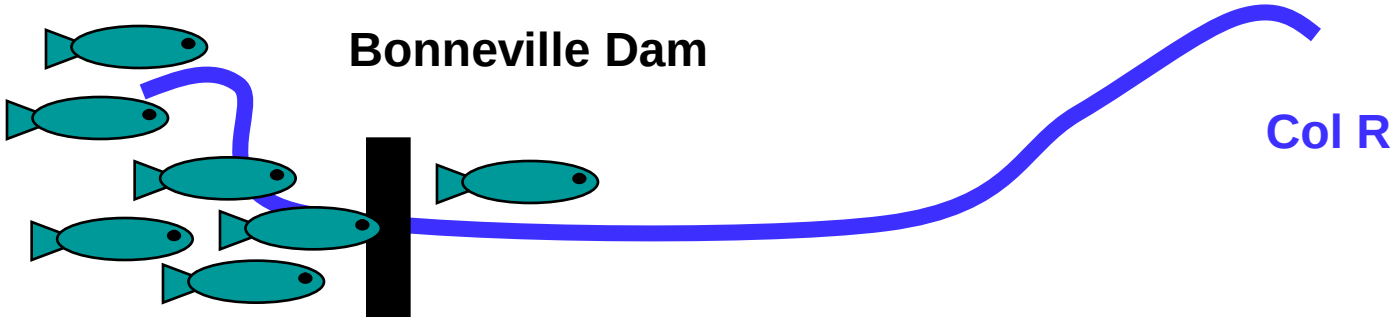
*minijack rate correlated with jack proportion

=> Release size is related to overall maturation schedule

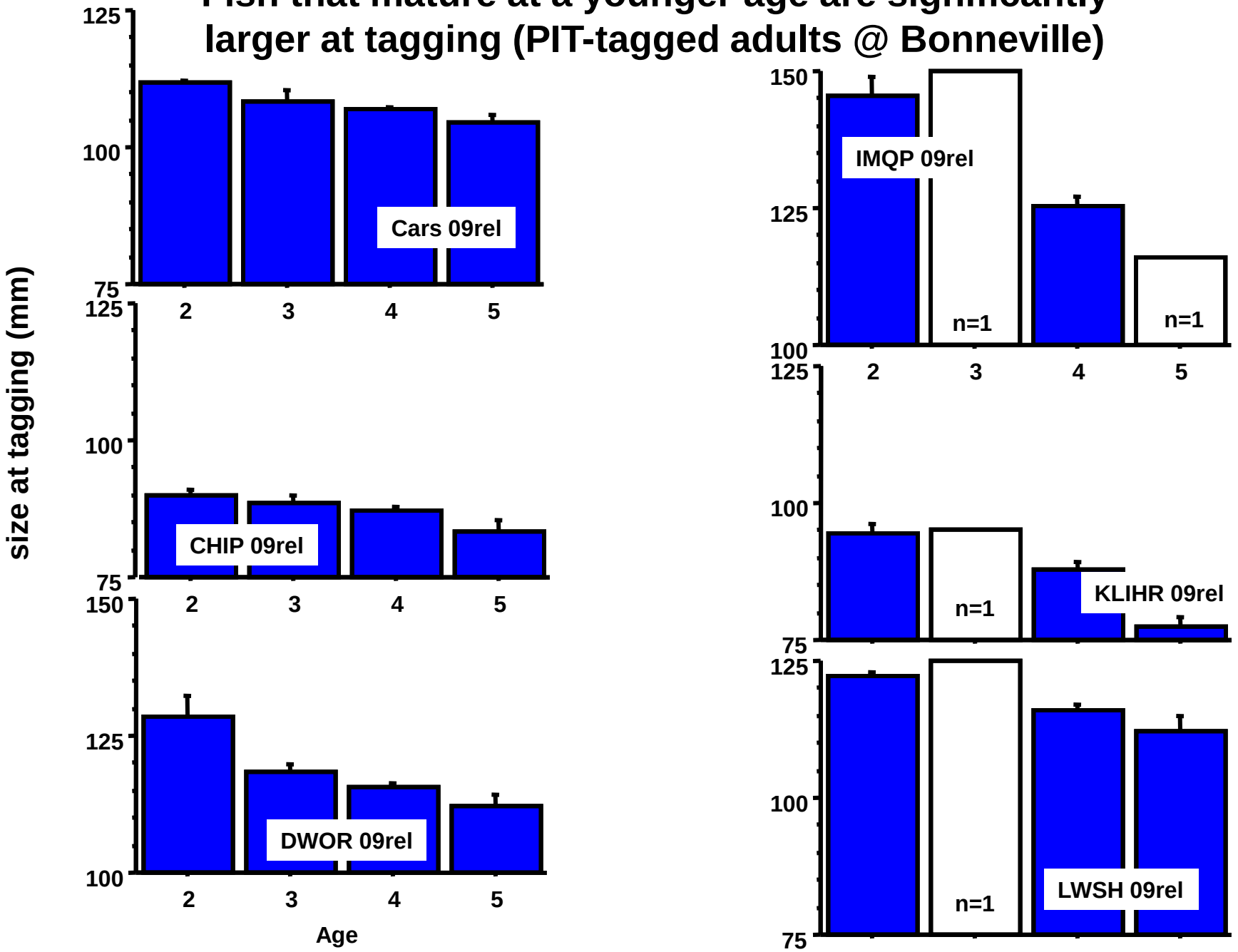
-Is there other evidence that juvenile size relates to age of maturity?

- PIT-tag interrogations of adults @ Bonneville

- age
- release groups
- size @ tagging (some)



Fish that mature at a younger age are significantly larger at tagging (PIT-tagged adults @ Bonneville)



This relation (bigger = younger)
is “everywhere” -
multiple years/release groups/populations

Caveats:

- **not an experiment**
- **genetics (within and between pops)**
- **different tag times**
- **gender confounds size differences**
  - **minijacks & jacks = all male**
  - **age 4 and 5 = males and females**

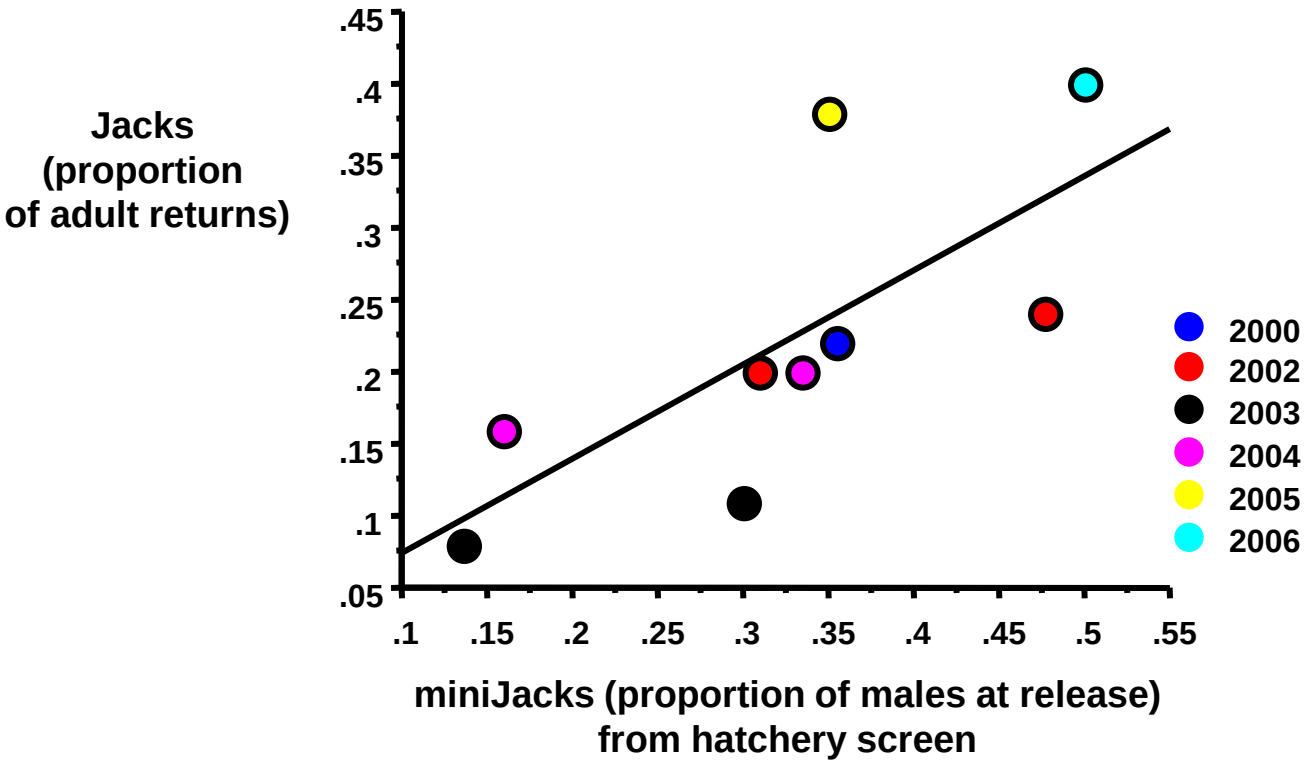
But - it’s irrefutable that age of maturation Is younger in bigger smolts.

Do miniJacks at release relate to Jack return at Cle Elum (multiple release years)?



C Strom, manager

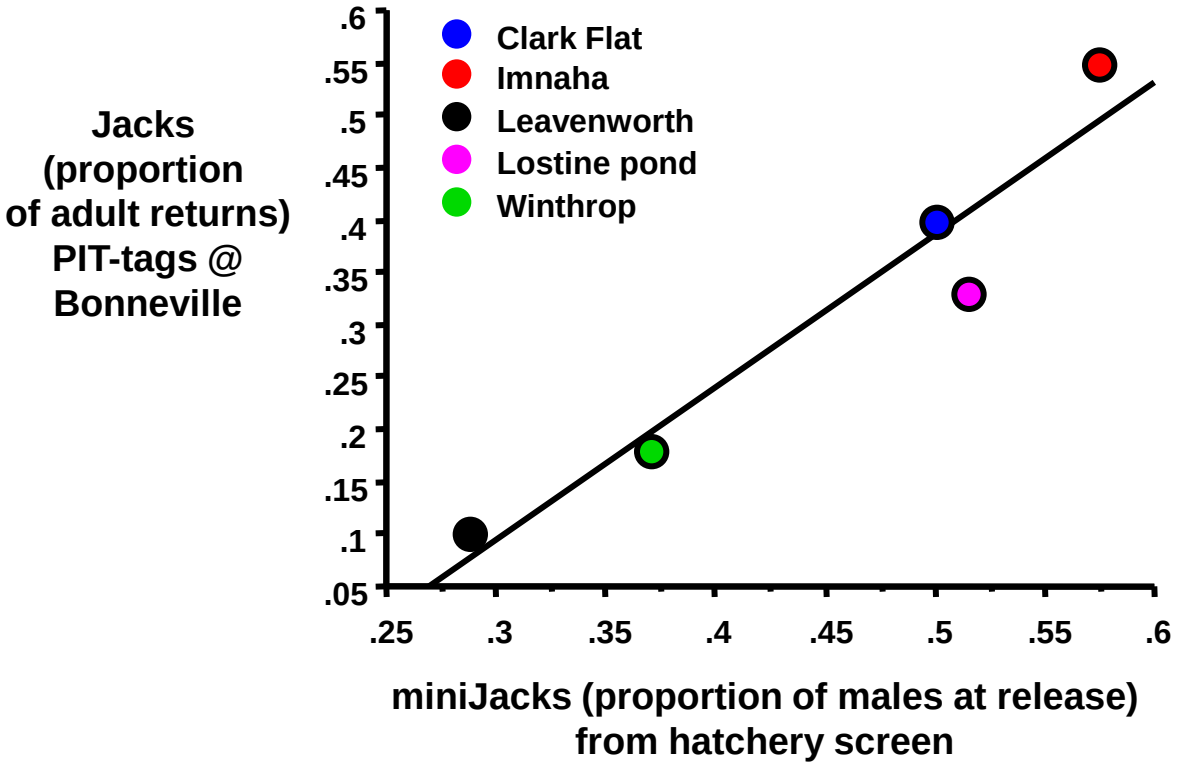
Minijack prevalence at release predicts jack proportion in adult returns Cle Elum - 6 release years



Larsen et al. in press
Knudsen et al. in prep

What about other populations?

Minijack prevalence at release predicts jack proportion in adult returns 5 different spring Chinook populations

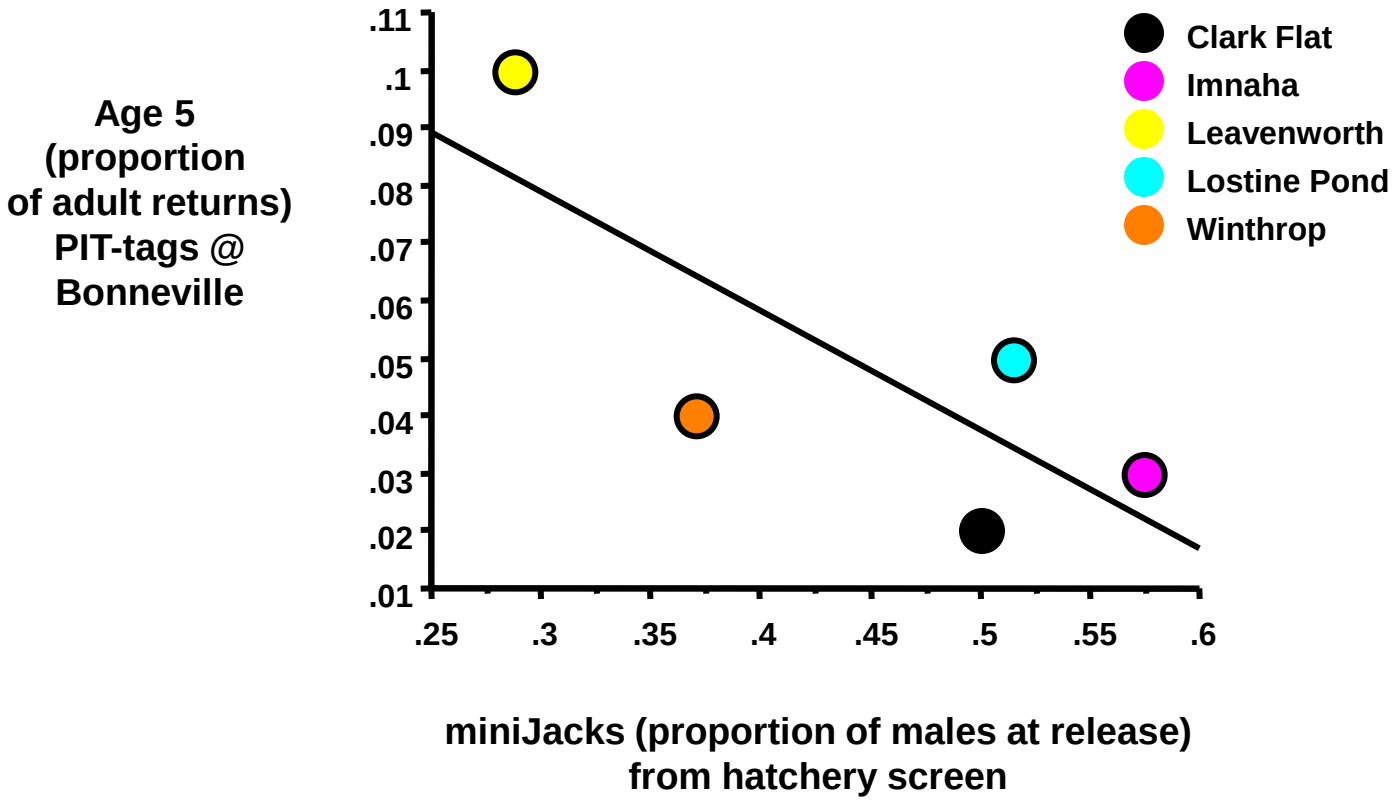


Data limited by minijack screens conducted (NOAA) and PIT-tagged release groups

BY06, 08 release
Harstead et al. in prep

Maturation schedules
What about age 5 fish?

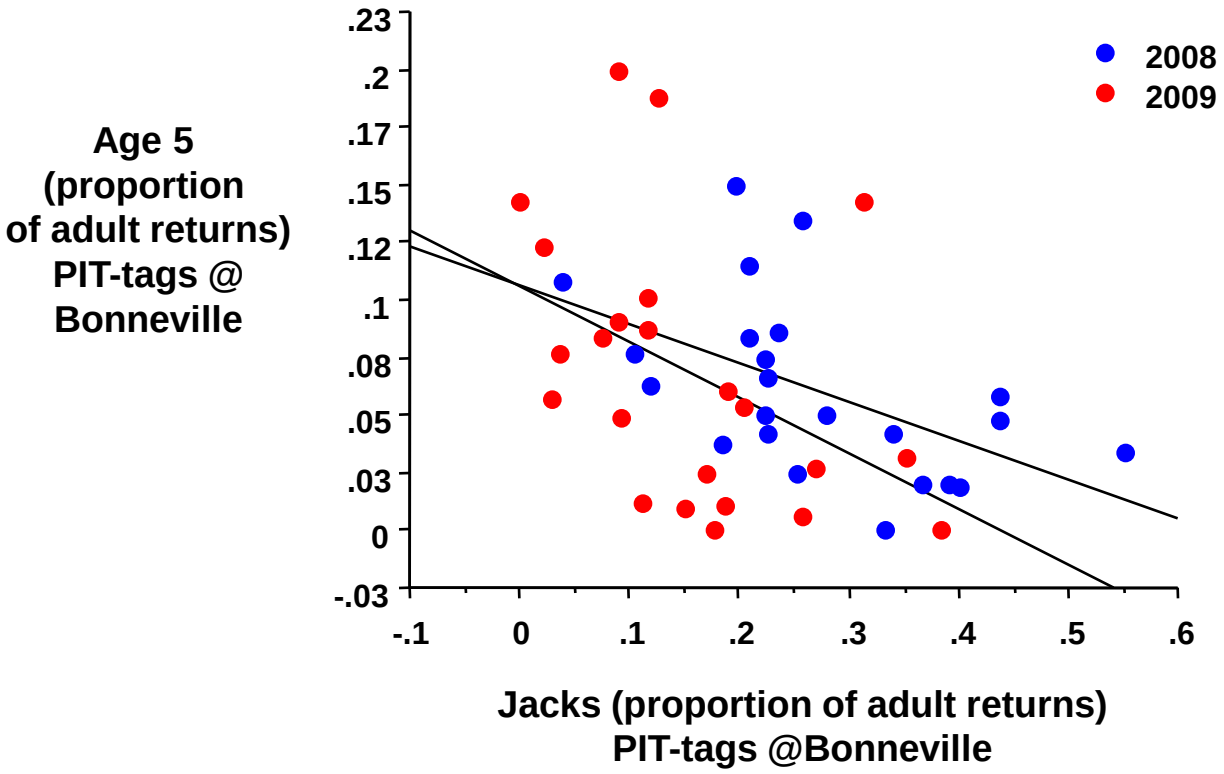
Minijack prevalence at release is negatively related to Age 5 proportion in adult returns 5 different spring Chinook populations



Data limited by minijack screens conducted (NOAA) and PIT-tagged release groups

BY06, 08 release
Harstead et al. in prep

Jack proportion is negatively related to Age 5 proportion in adult returns PIT-tagged adults @ Bonneville 47 release groups



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 consequeces of smolt size at release targets

Further questions:

Is there a clear, consistent survival advantage for larger sizes at release?

Can the size:survival relation be defined (xx g = xx %survival)?

What are the management implications for varying maturation schedule with varying release size?

Is maturation schedule an important management target? (are jacks valuable, what about age 5's?)

Further questions (II):

How do managers balance the survival advantages of larger smolts (undefined) against younger maturation ages (rates undefined)?

Would more size at release studies be useful?

