

**Ocean - estuary coupling**

**or**

**how does FW/estuary history affect  
ocean traits?**

**(Hatchery rearing strategies)**

*January 19, 2017*

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Focus on yearling Chinook salmon

# Outline

Brief review of NMFS juvenile salmon survey

Hatchery yearling Chinook salmon vary in the  
Columbia River

Hatchery yearling Chinook salmon vary in the Ocean

Size, growth and ocean variability

Size selective mortality

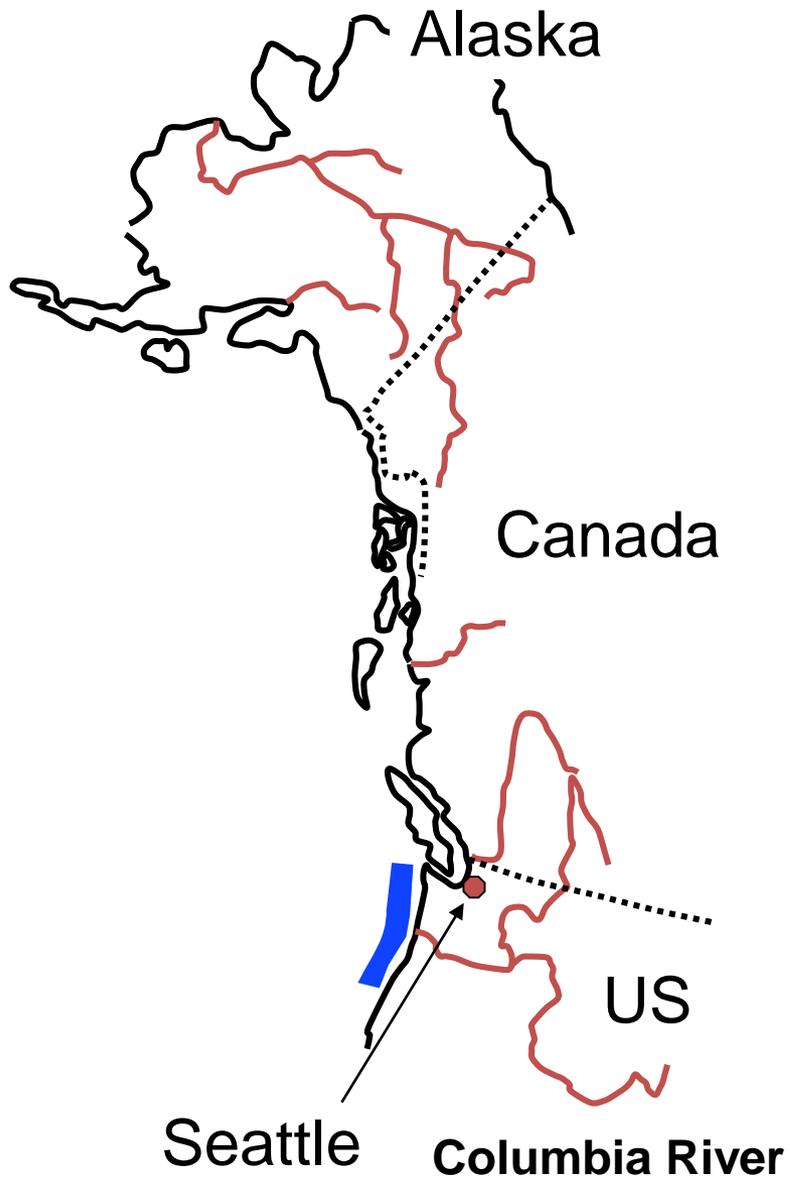
Survival “window”

# NOAA Juvenile Salmon Ocean Survey

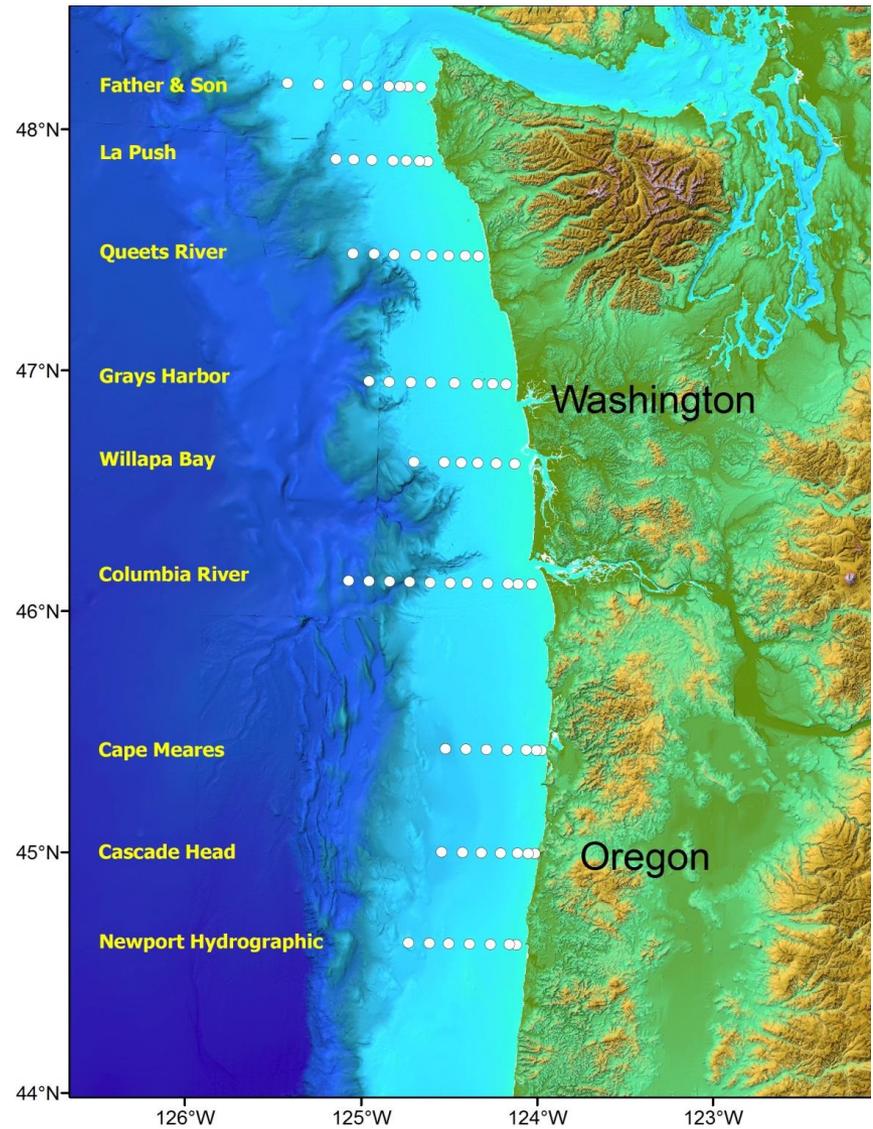




*Pacific Drone*



# Survey Grid



# NMFS/BPA Juvenile salmon - Plume Survey

1998 – test sampling/El Nino

1999 – 2005

May: 3 transects  
June: 5-9 transects  
Sept: 6-9 transects

2006 – 2012

May: 5-7 transects  
June: 8-9 transects  
Sept: 7-9 transects

2013 – 2014

June: 8 transects

2015

May: 4 days  
June: 8 transects

2016

May: 7 days  
June: 8 transects

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**Hatchery yearling Chinook salmon vary in the Ocean**

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## Traits that vary:

Estuary and ocean entrance timing

Estuary, Plume residence time

Migration rate

Size

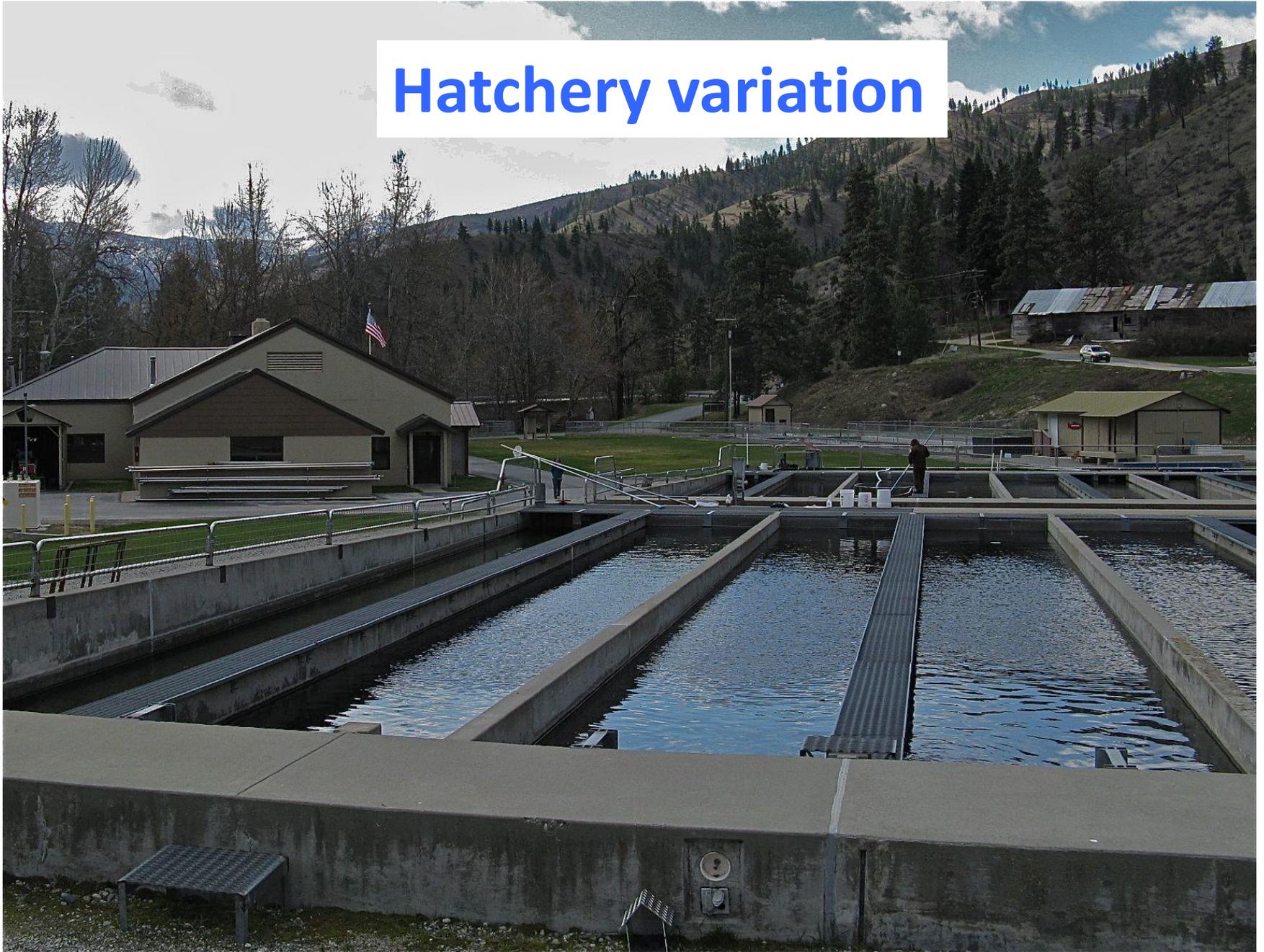
Growth rate

many others.....

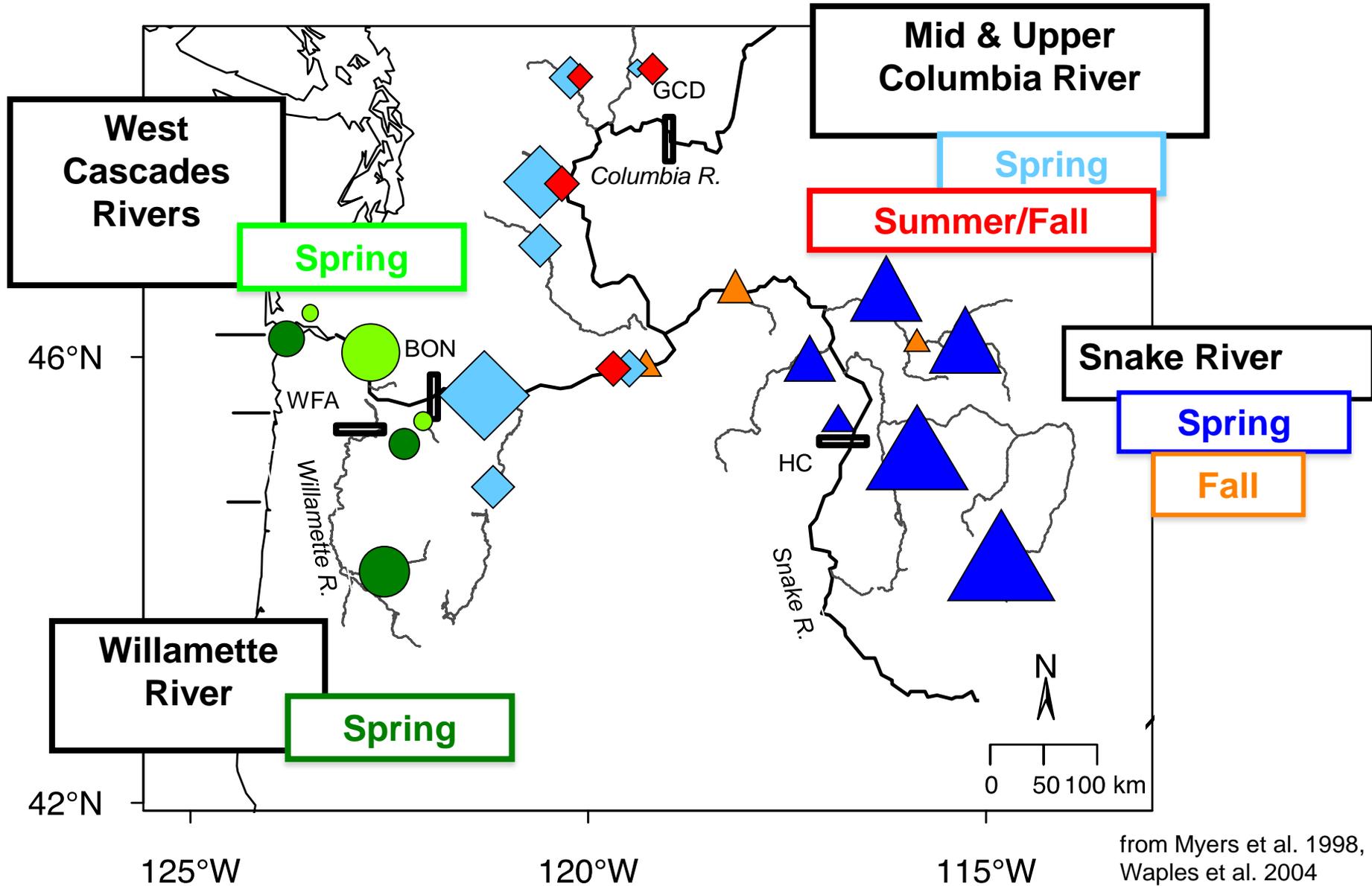
=> survival

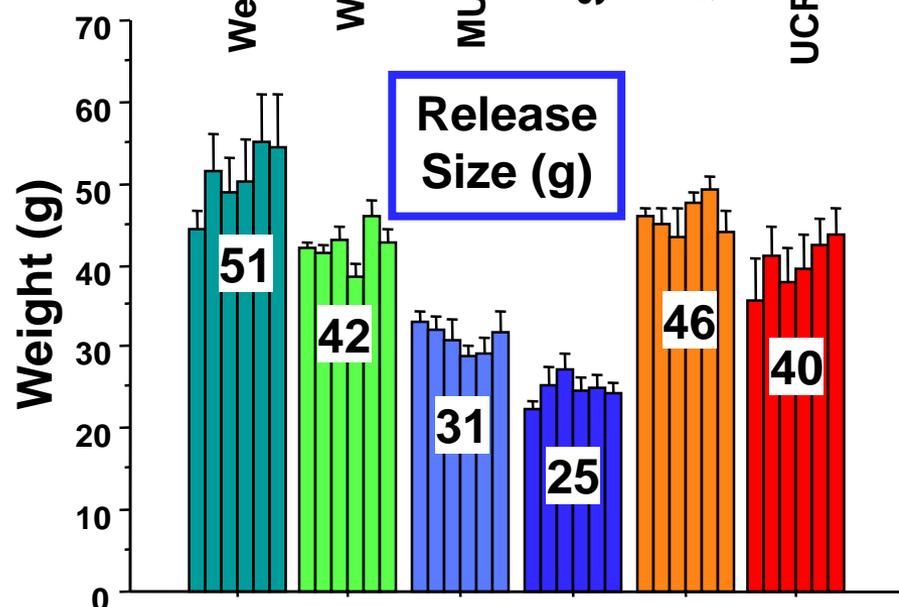
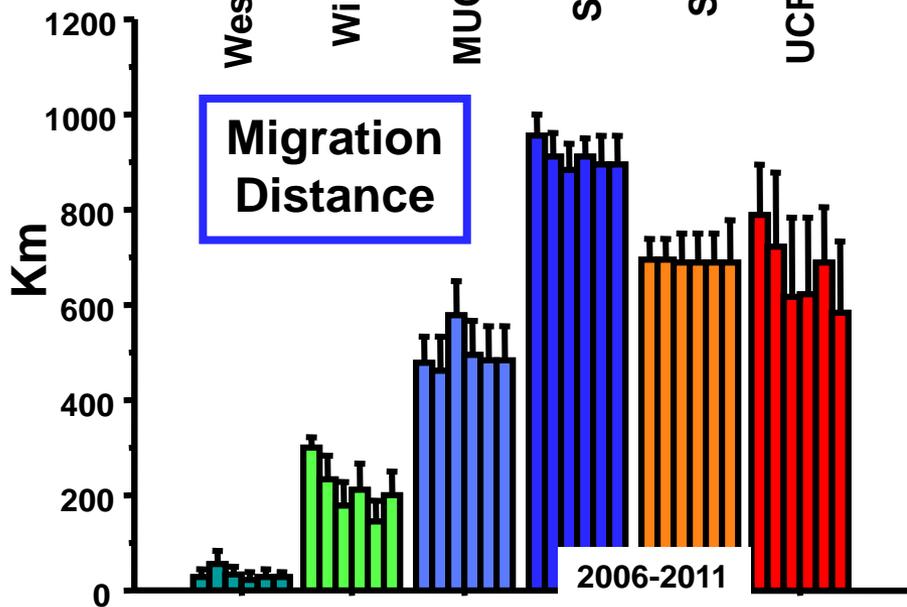
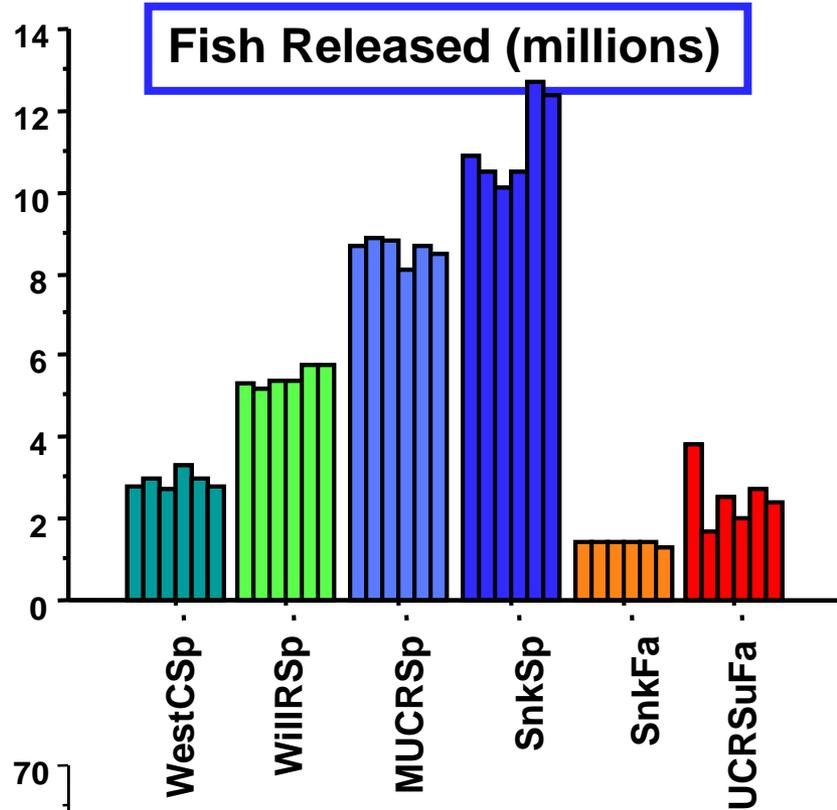
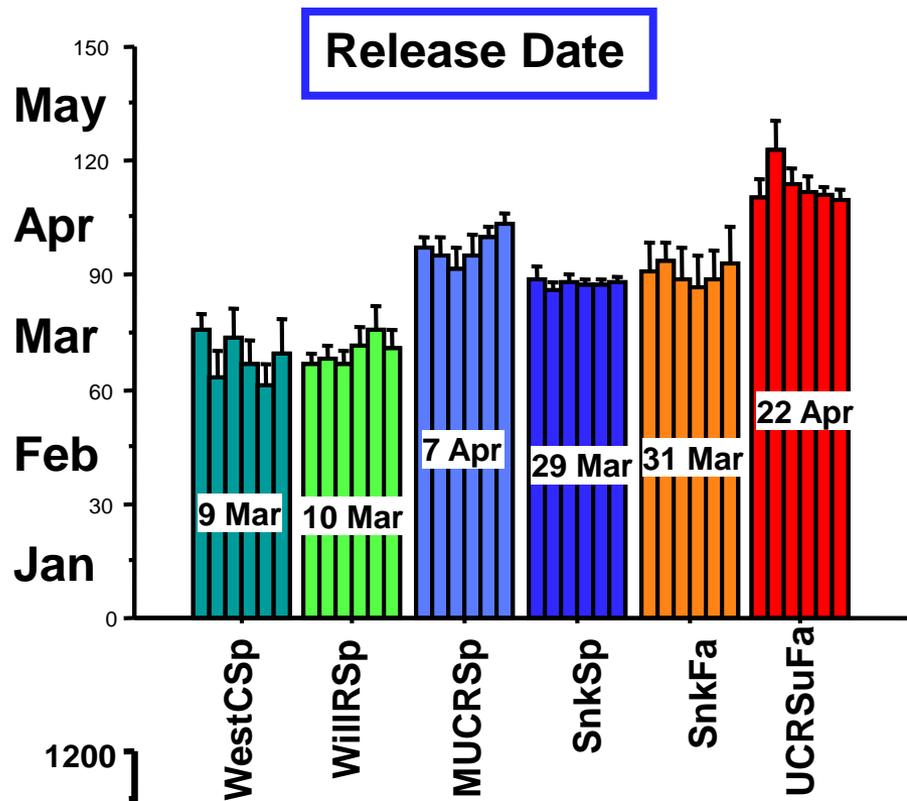
**By stock!**

# Hatchery variation



# Genetic, geographic and phenotypic differences exist between Columbia River Chinook salmon populations

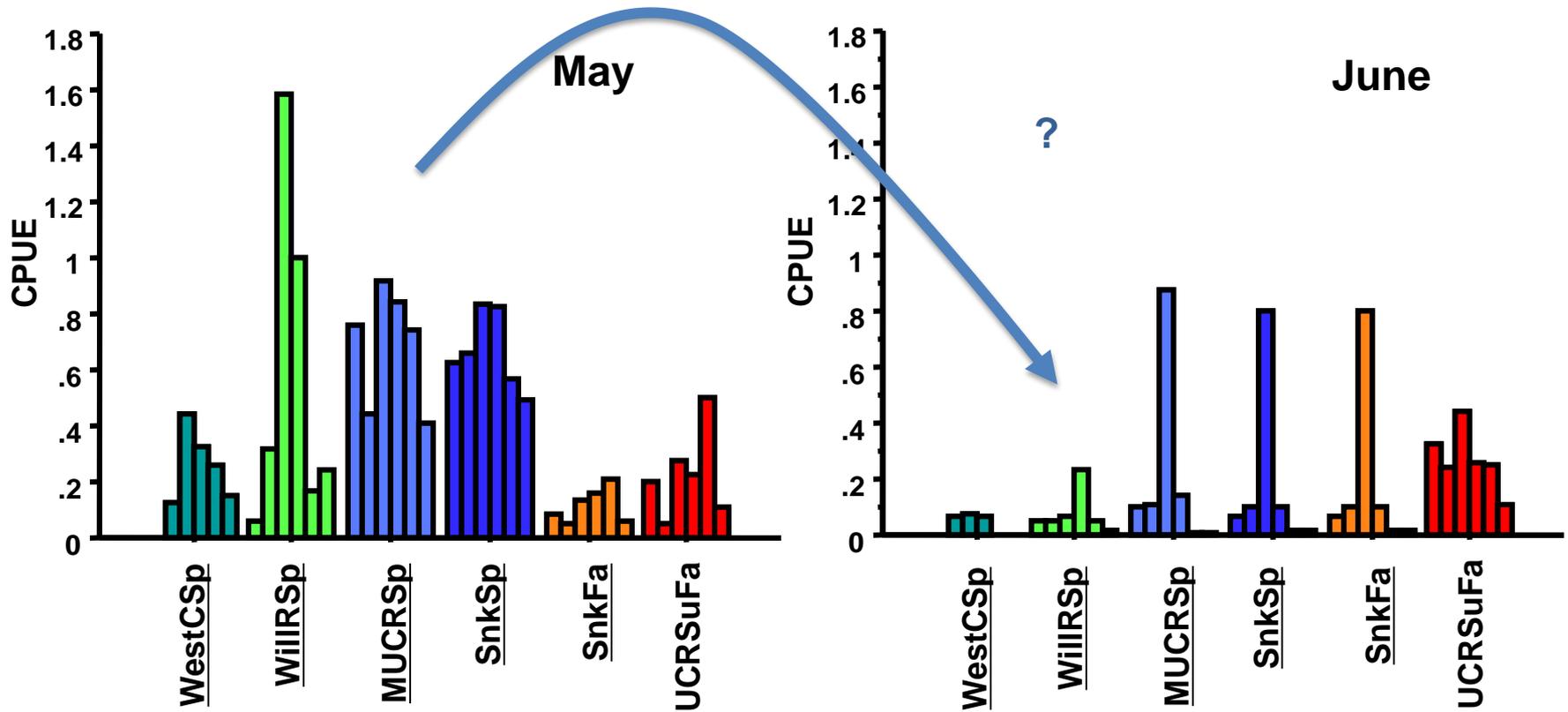




# Ocean variation



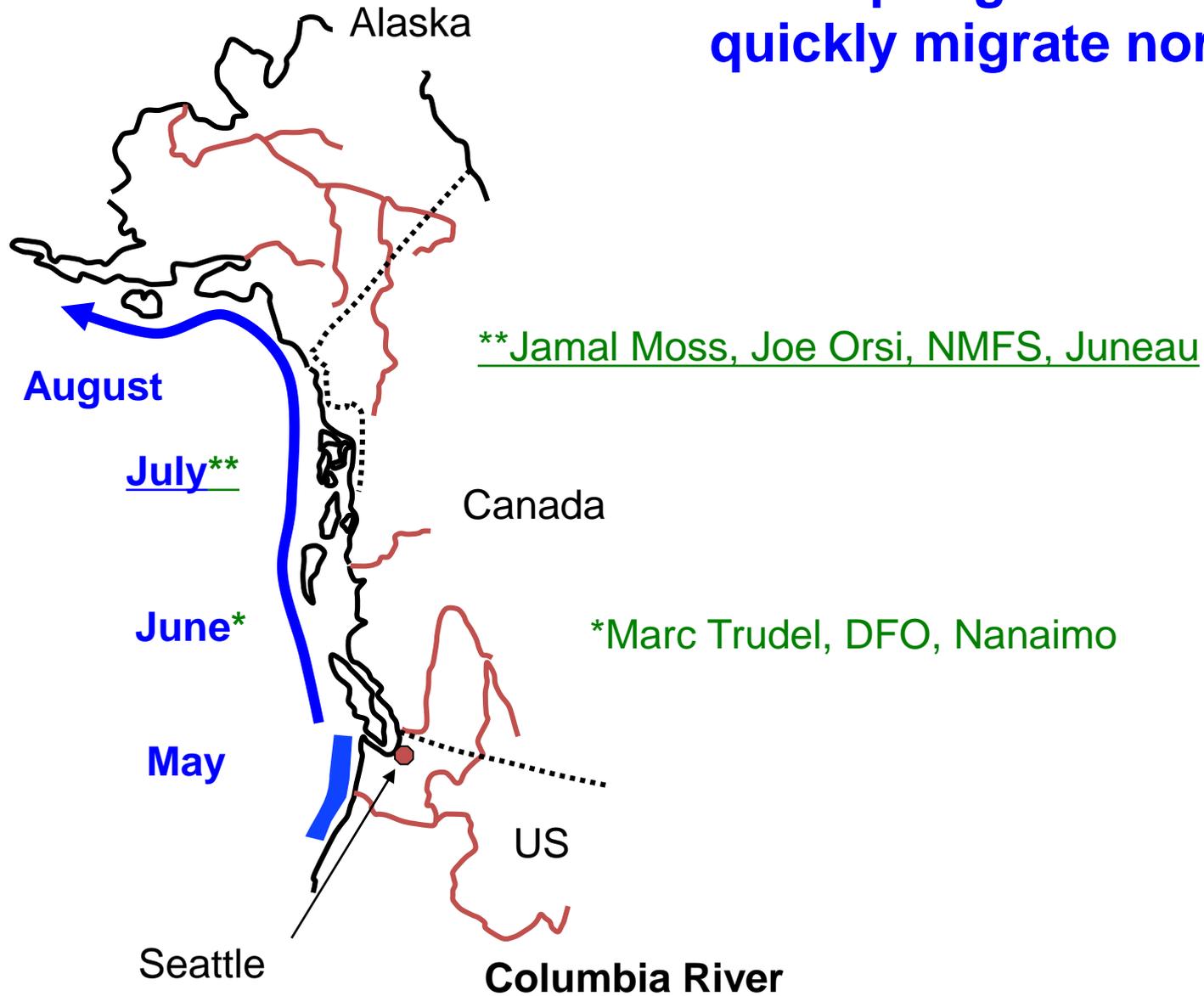
# Yearling Columbia River Chinook salmon\* abundance in the survey varies by month, stock and year



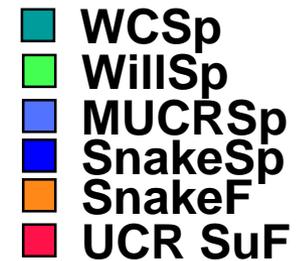
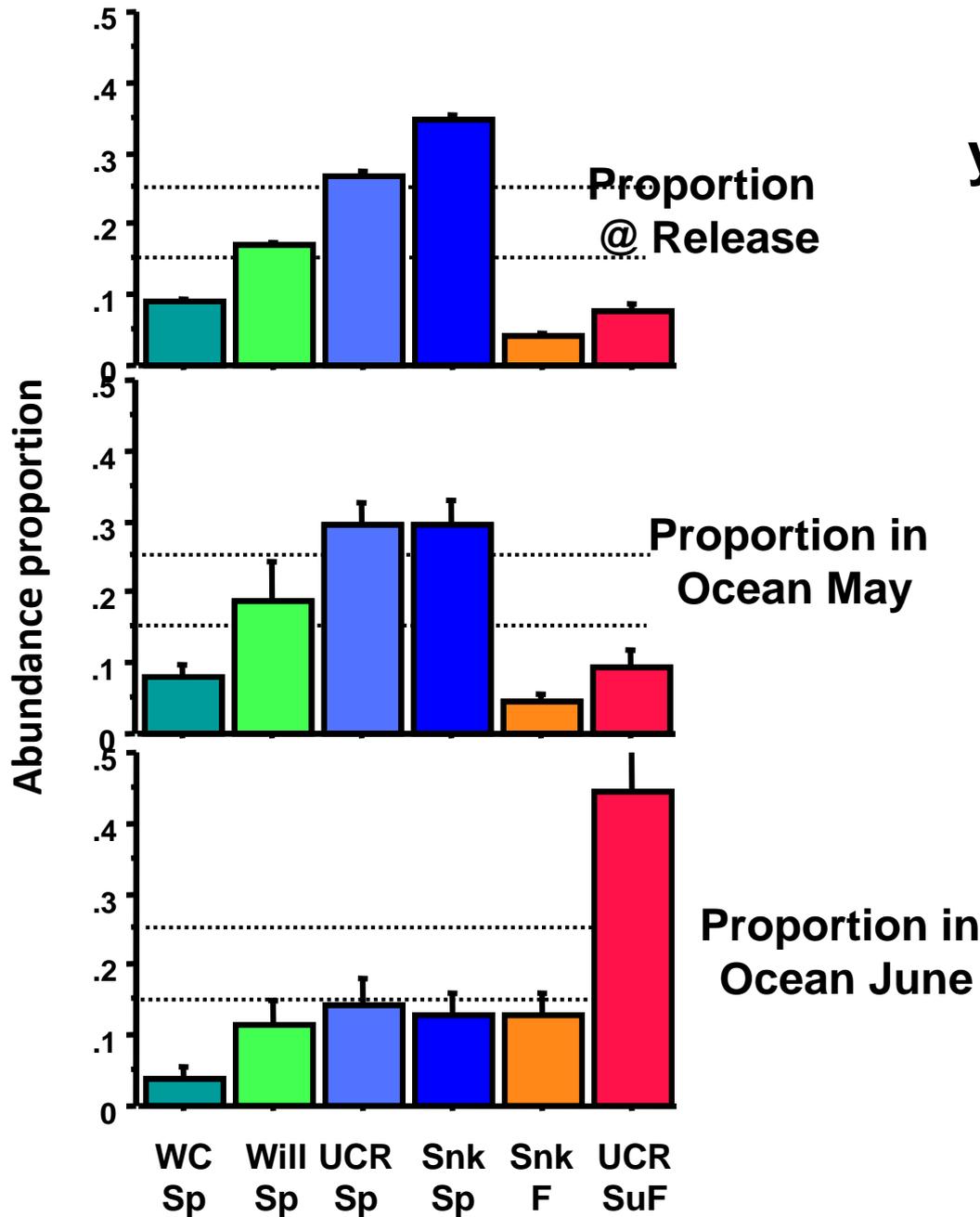
\*6 major stocks of Chinook salmon with yearling migrants  
5 are listed under the Endangered Species Act

2006-2011

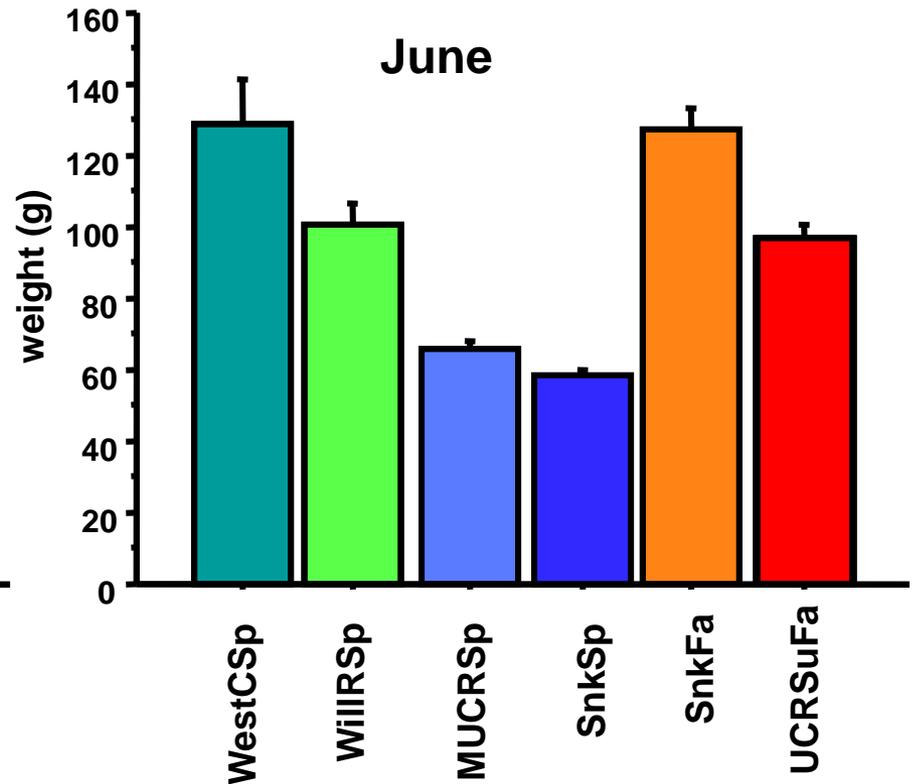
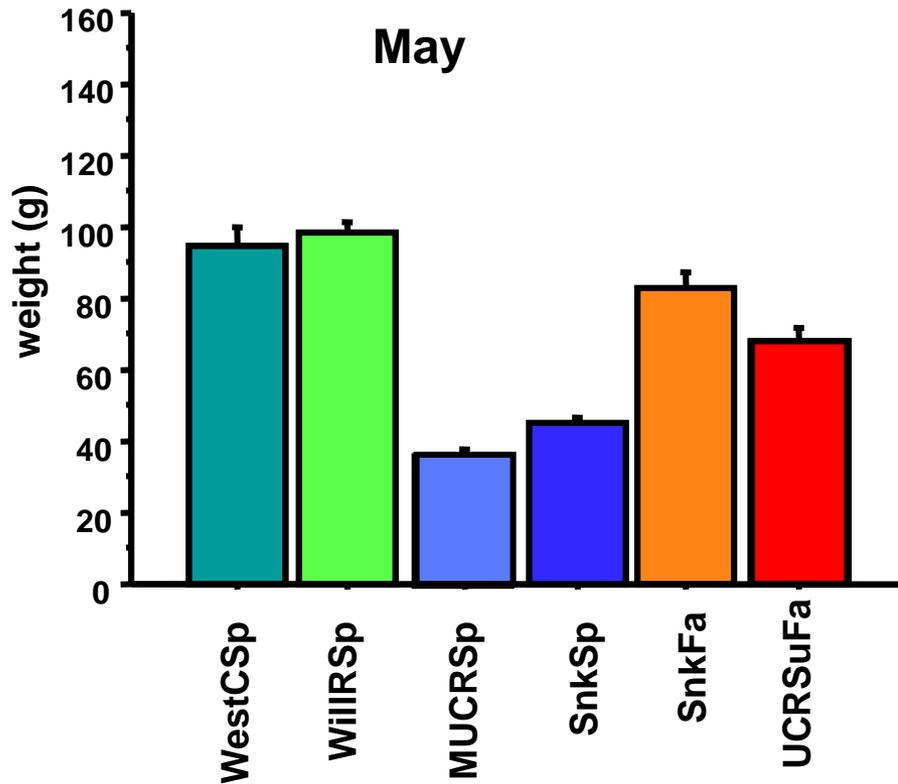
# UCR/Snake spring Chinook salmon quickly migrate north



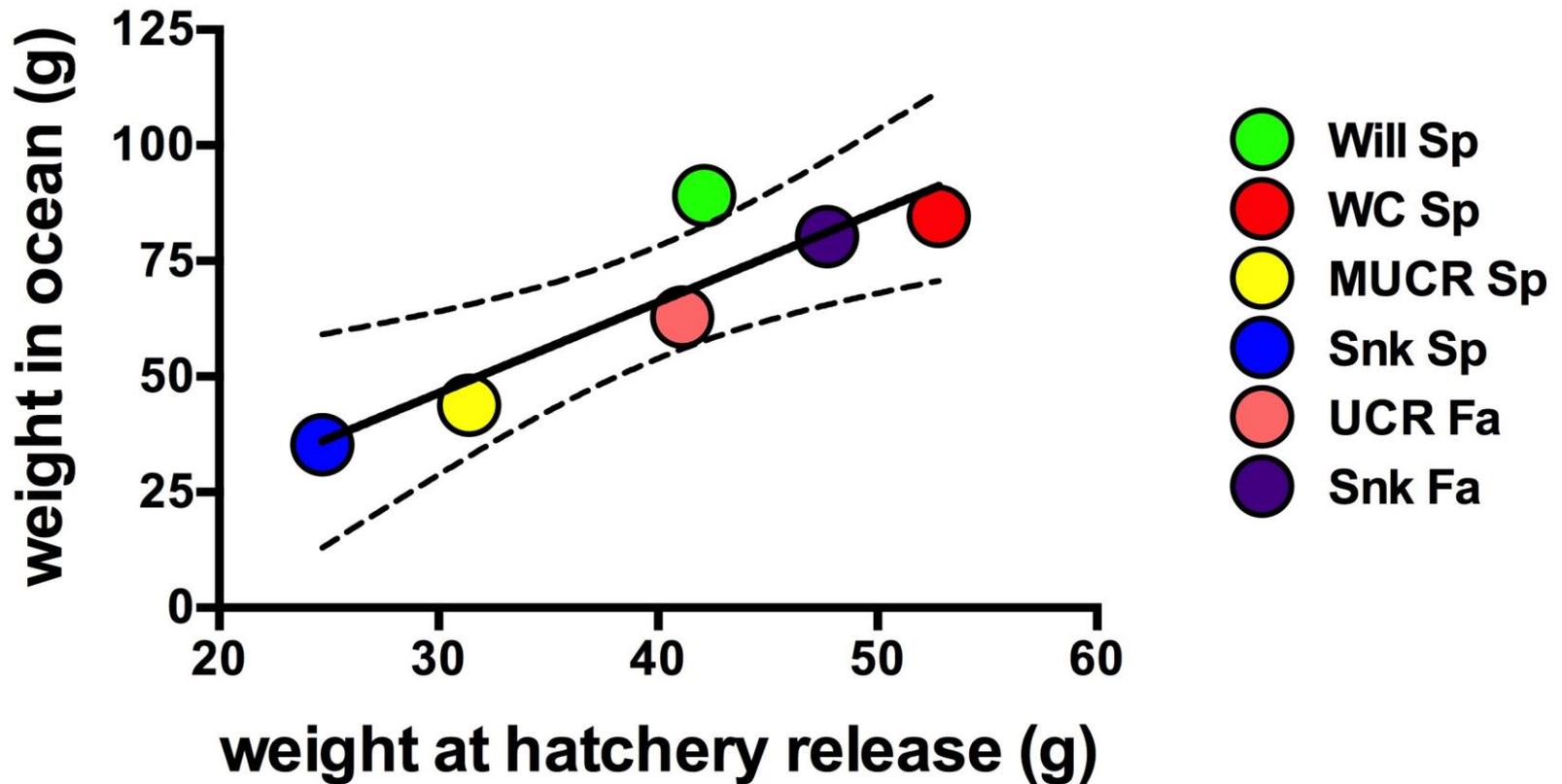
# Relative proportion of yearling Chinook salmon by stock varies by in the ocean



# Weight of fish caught in the ocean varies > 2-fold by stock

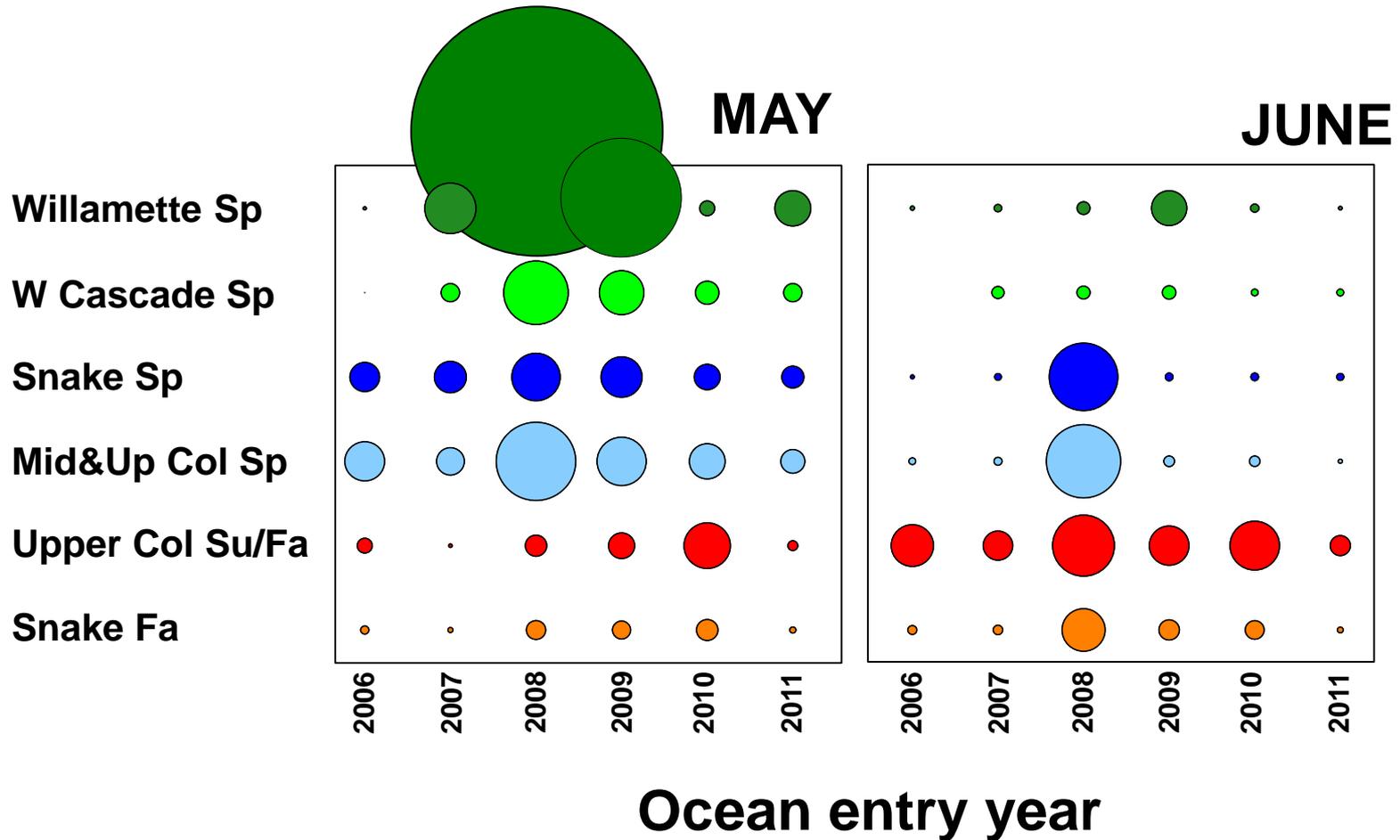


# Size in the ocean is correlated to size at release



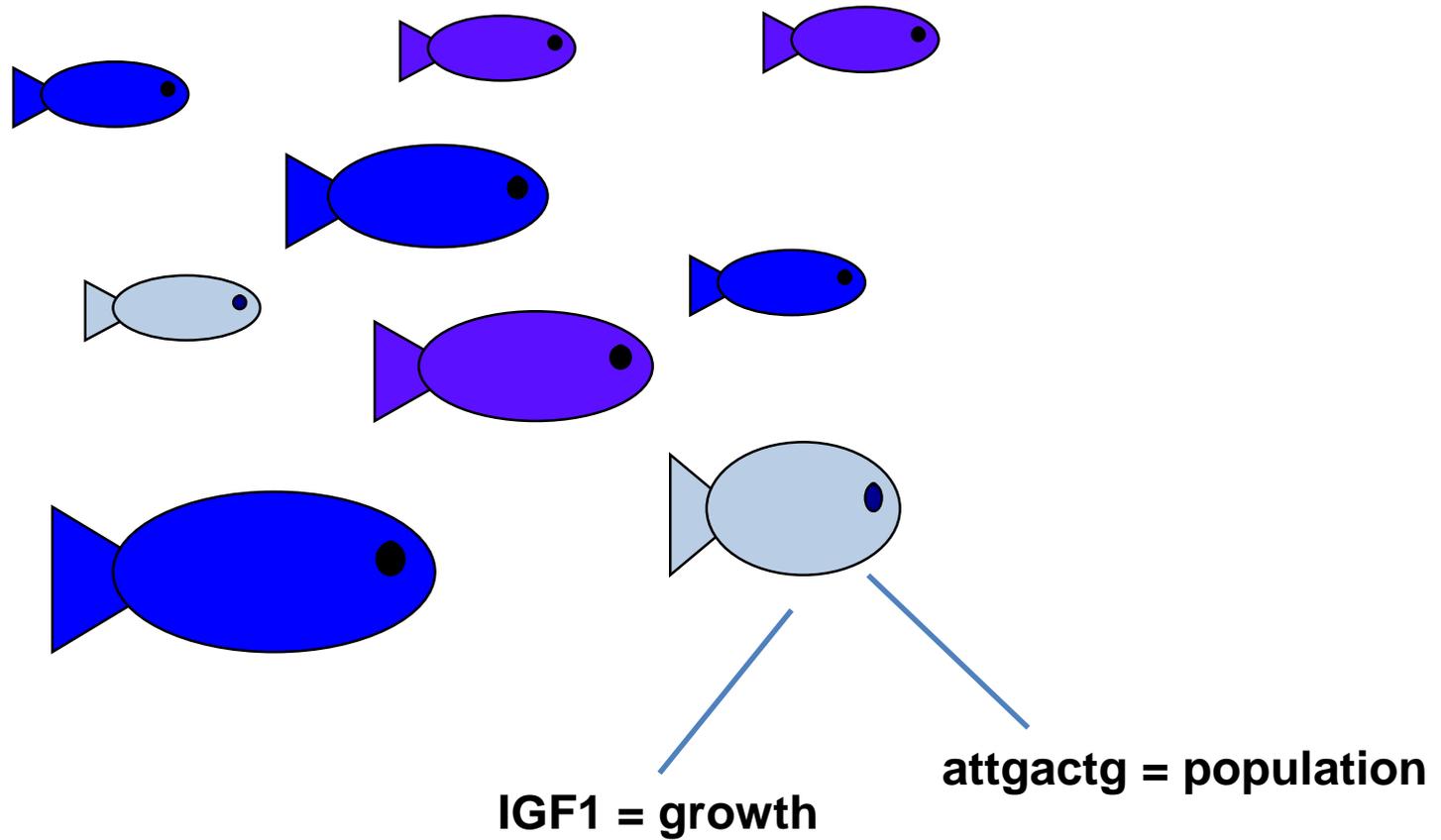
**Management implications ?**

# Biomass (abundance x weight) varies by stock, month and year

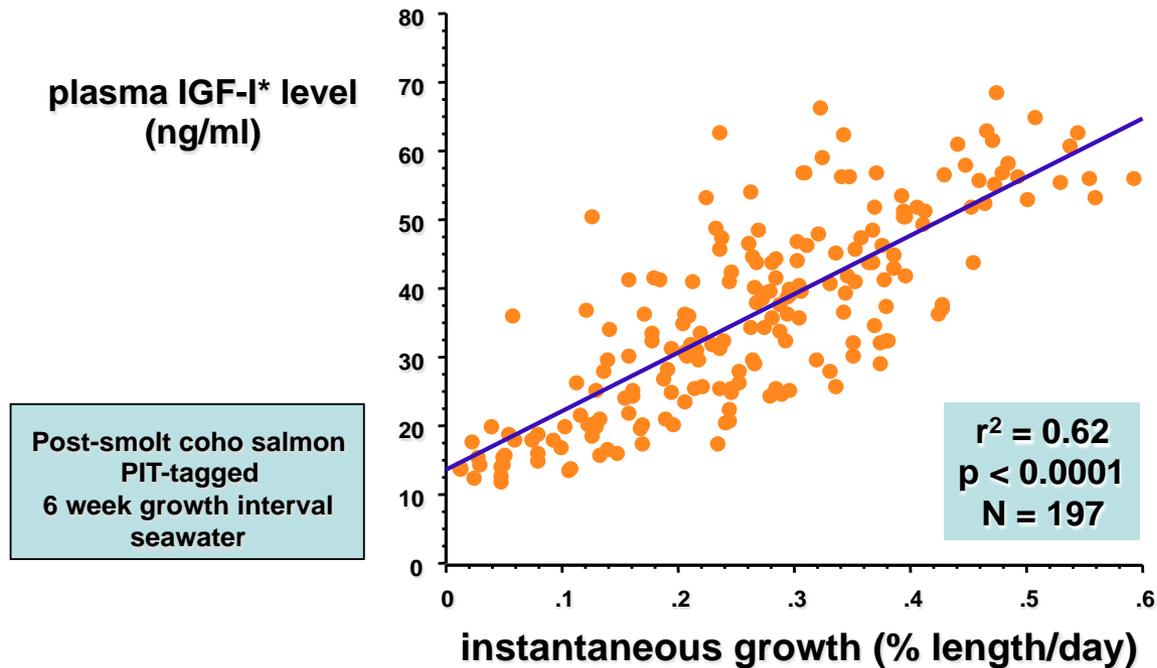


**Management implications ?**

# Technological advances have made it possible to assess growth rate and population of origin from individual fish caught at sea



# The hormone IGF1 is a growth index



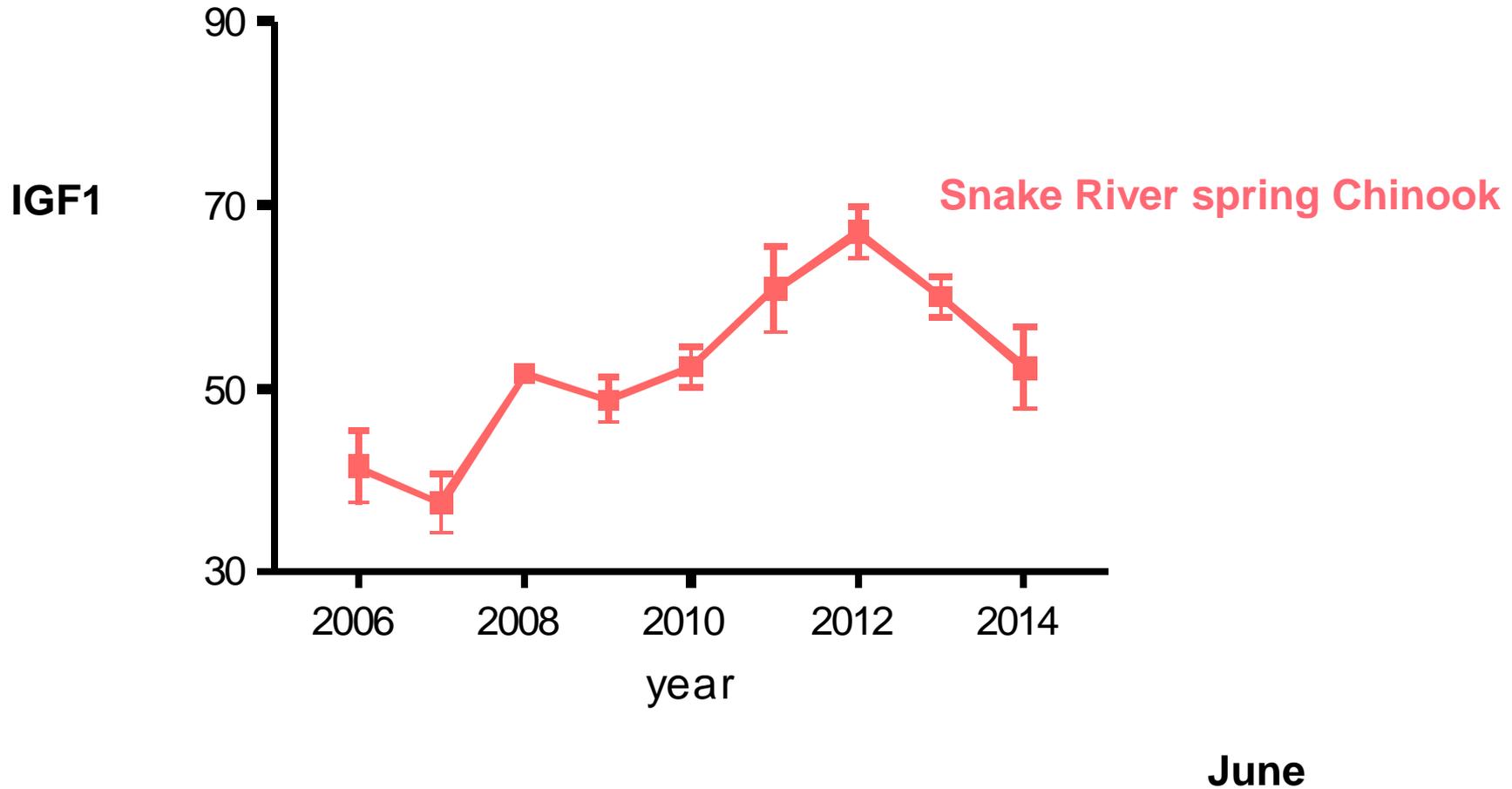
\*TRF immunoassay

Beckman et al. 2004 TAFS

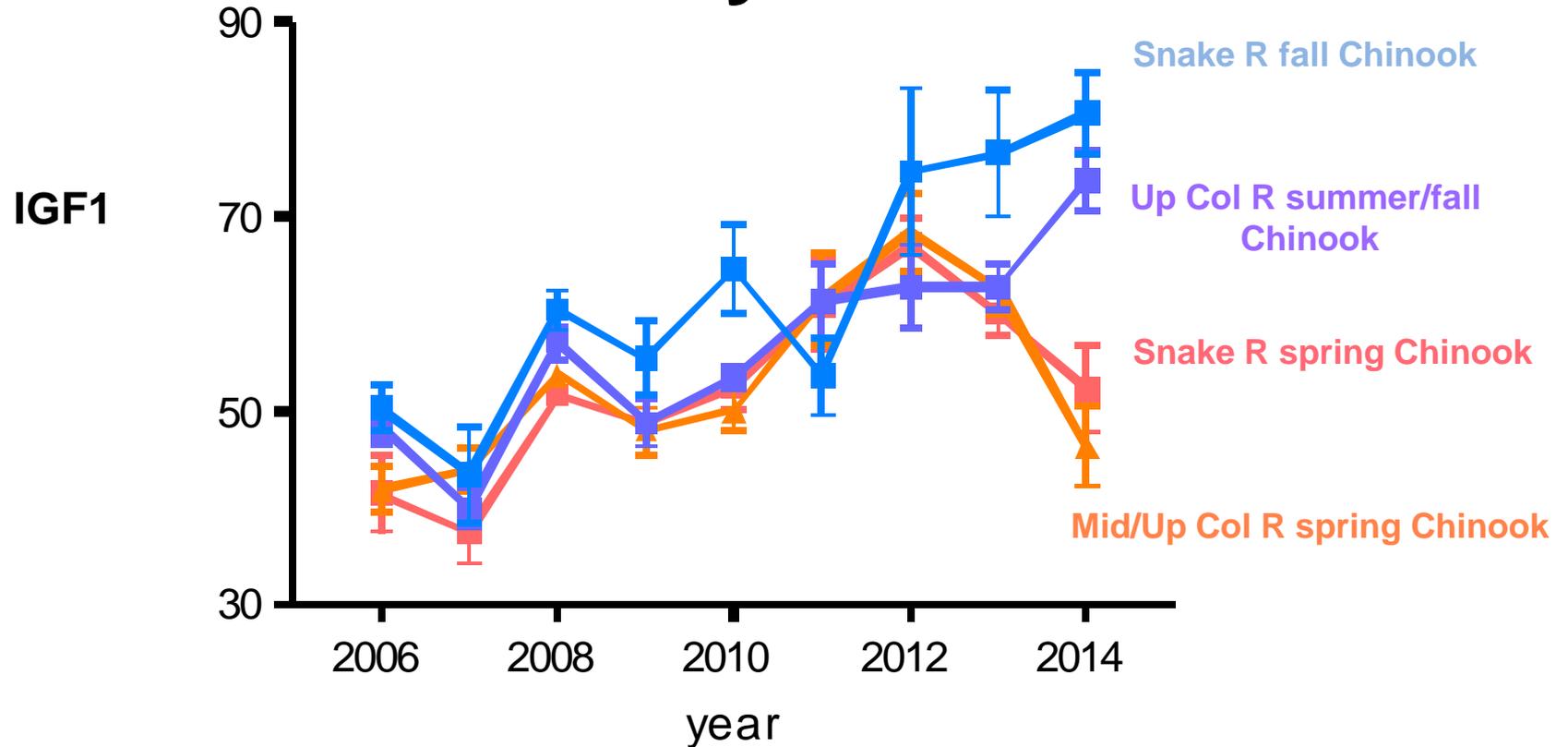
# Growth and survival



# Growth varies inter-annually

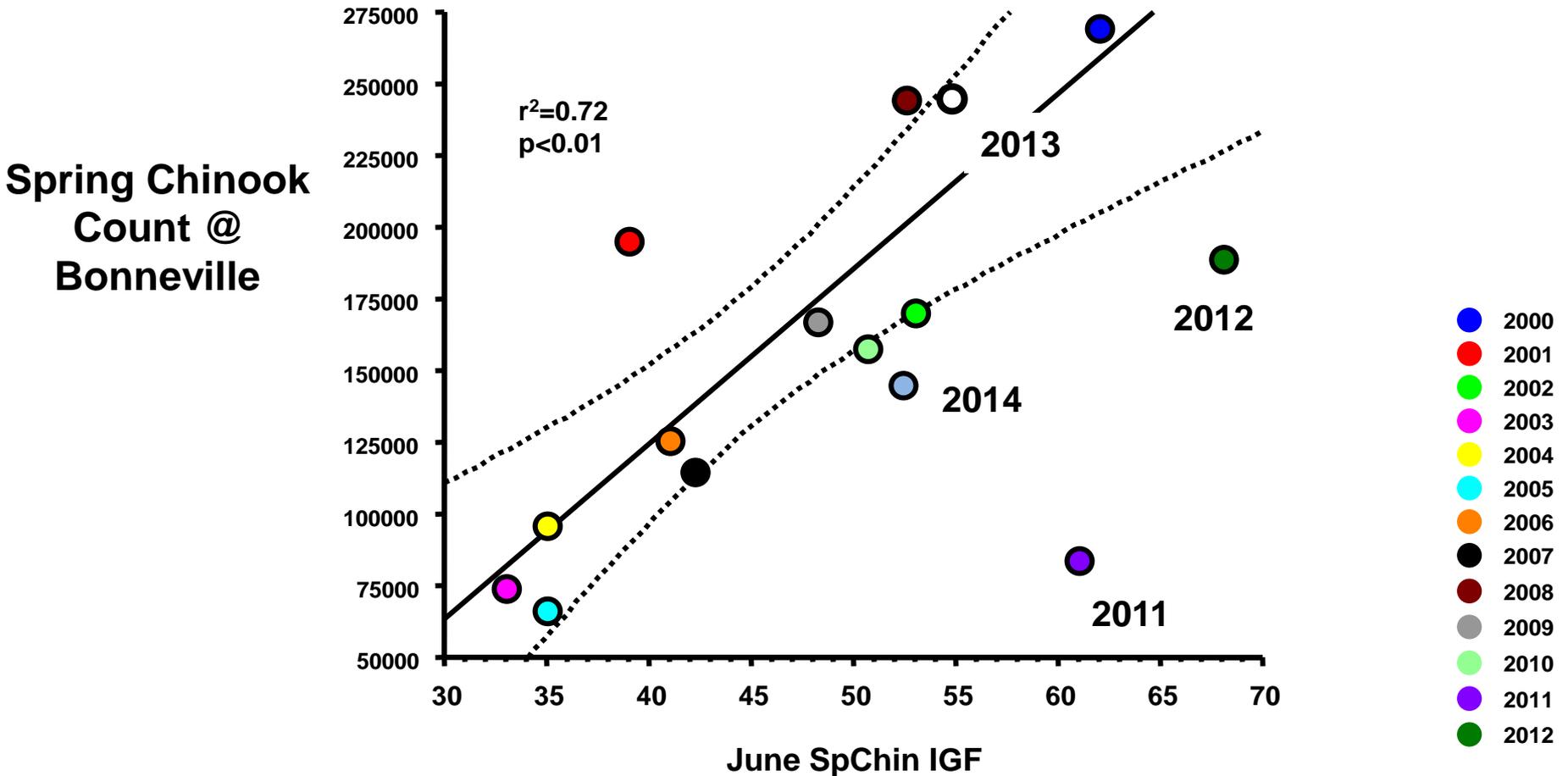


# Growth varies inter-annually and by stock



June

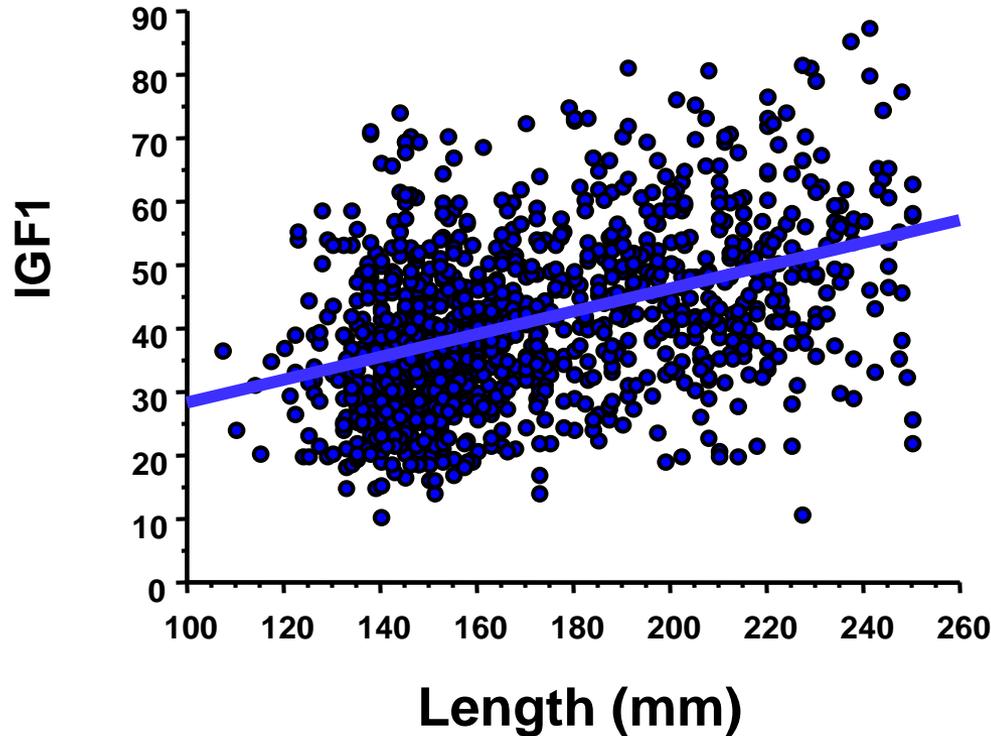
# Growth is related to survival of spring Chinook (most years)



# Size and Growth



# Yearling Columbia R Chinook salmon: marine growth varies with size

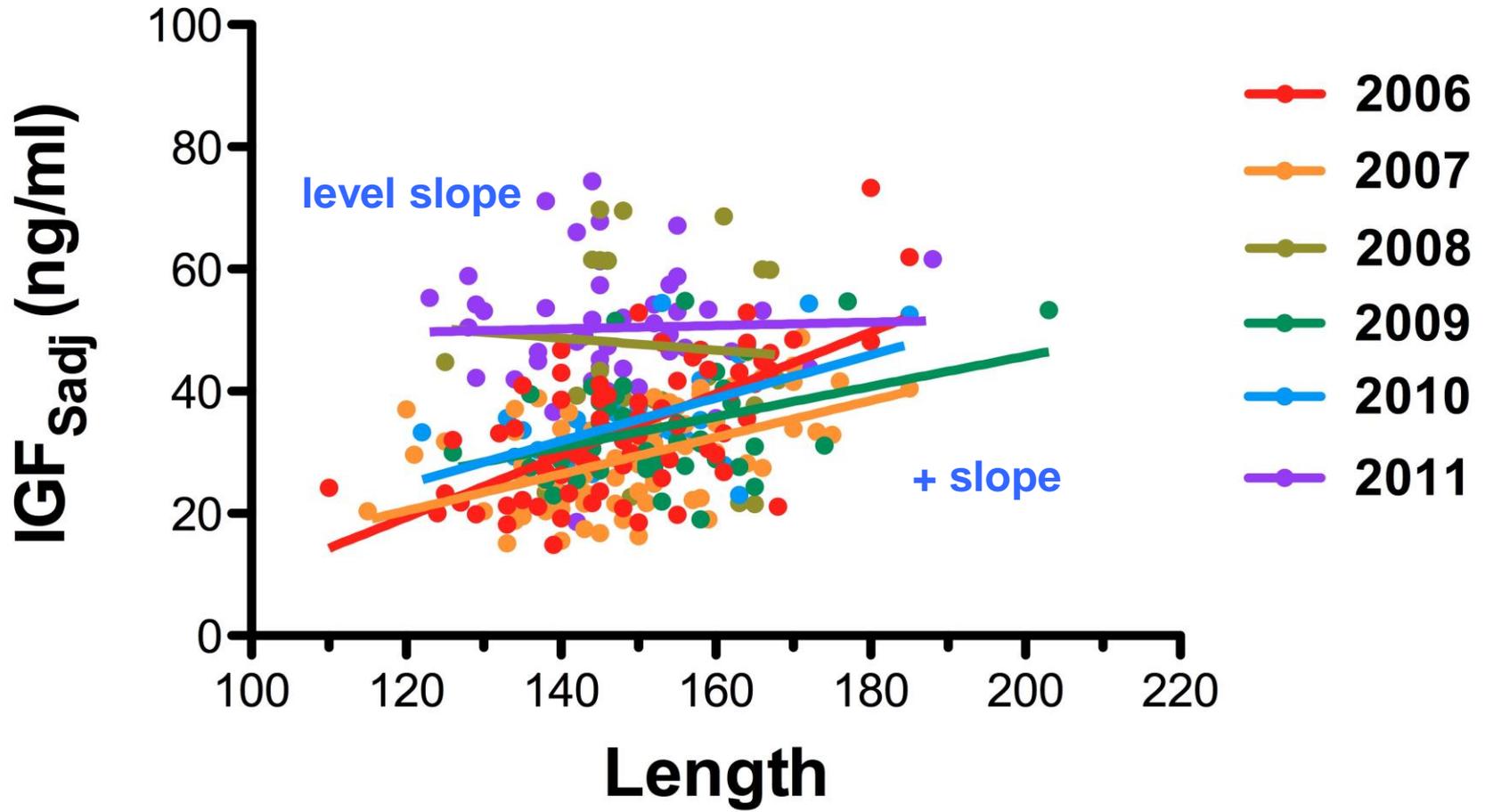


2006 - 2011, May, all stocks

$p < 0.001$ ,  $r^2 = 0.20$

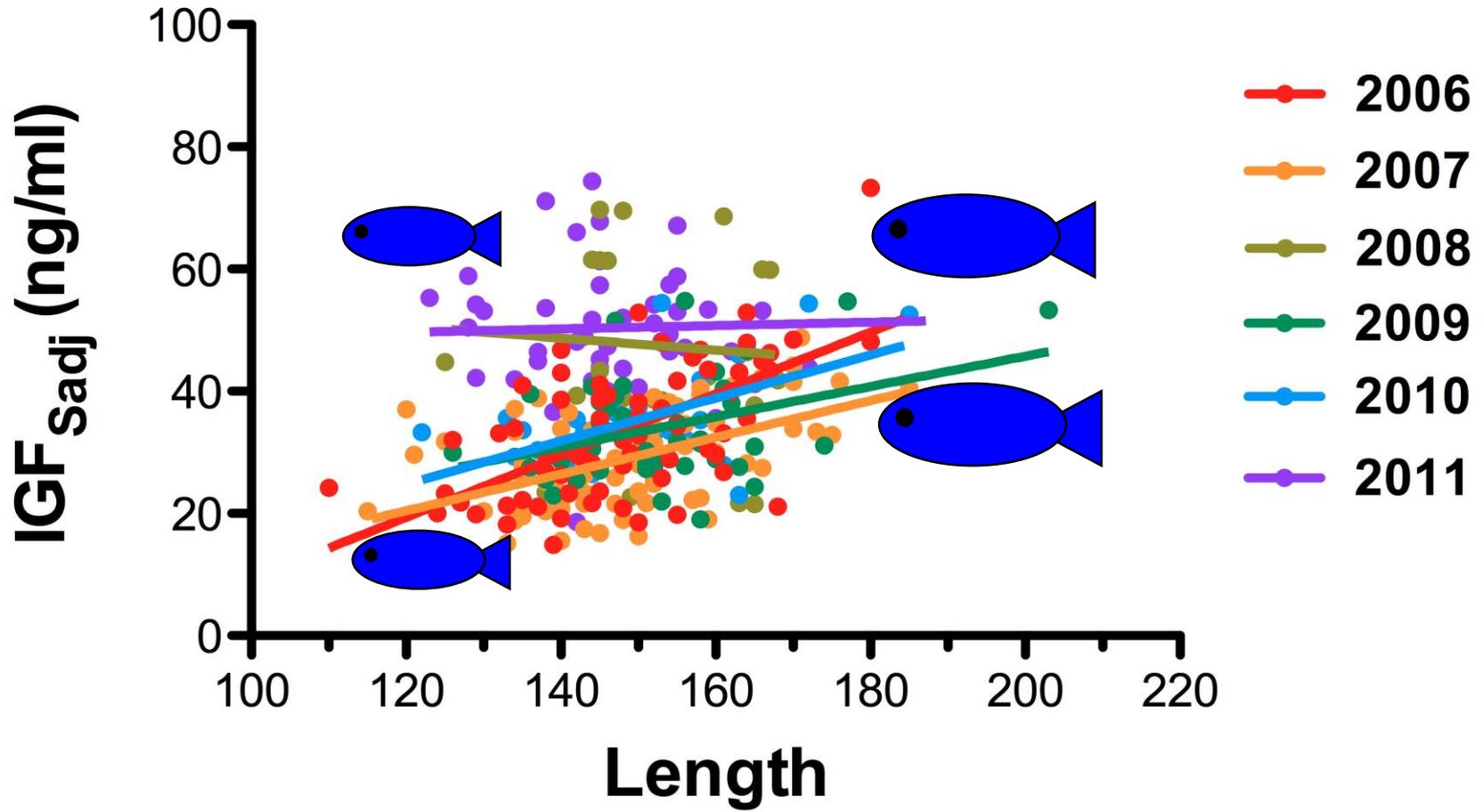
# IGF1 - size relationships vary between years in May

(slope of regression line)



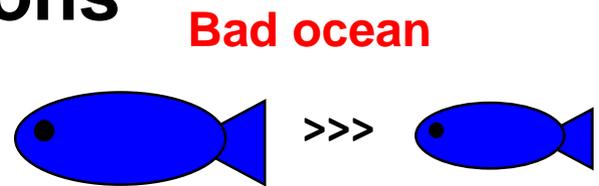
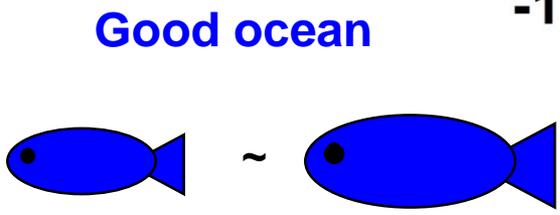
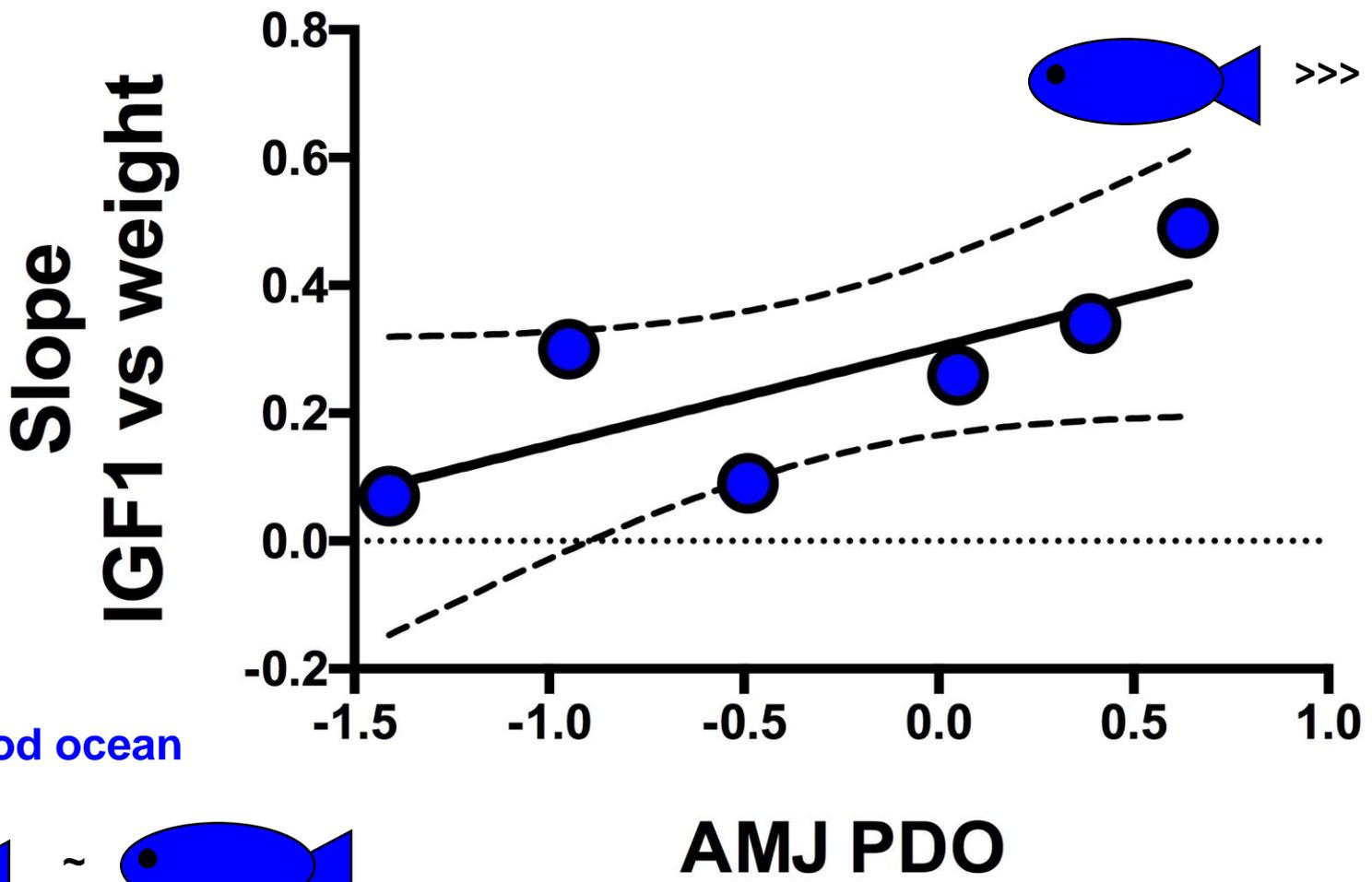
Snake River spring Chinook salmon

# IGF1 - size relationships vary between years due to varying ocean conditions



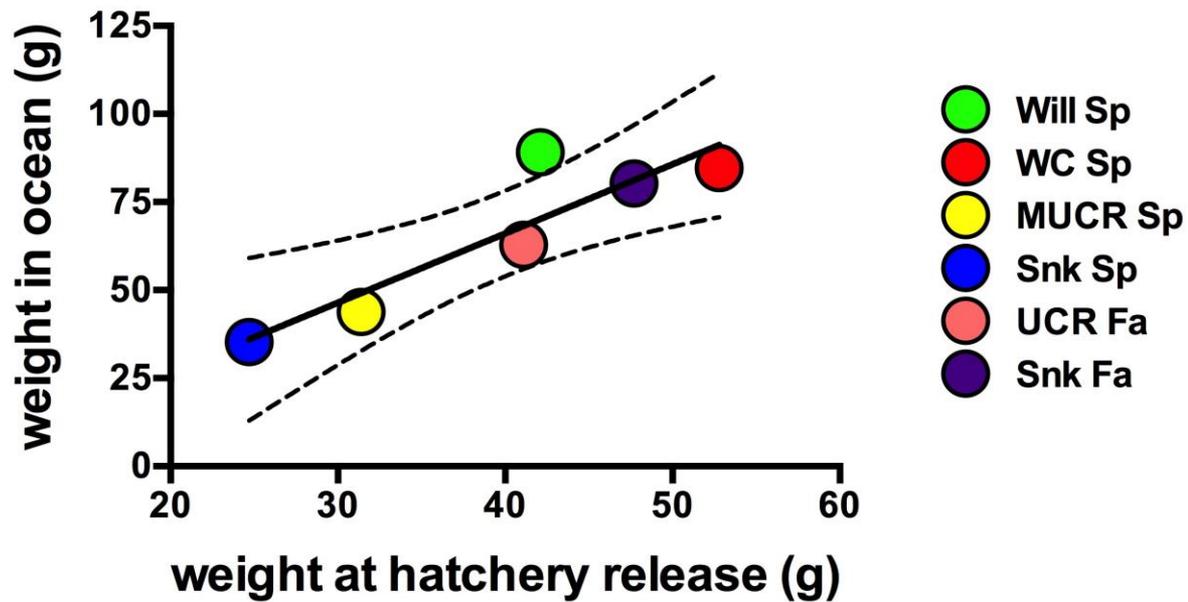
Snake River spring Chinook salmon

# Snake R spring Chinook IGF vs length slope varies with ocean conditions



AMJ PDO

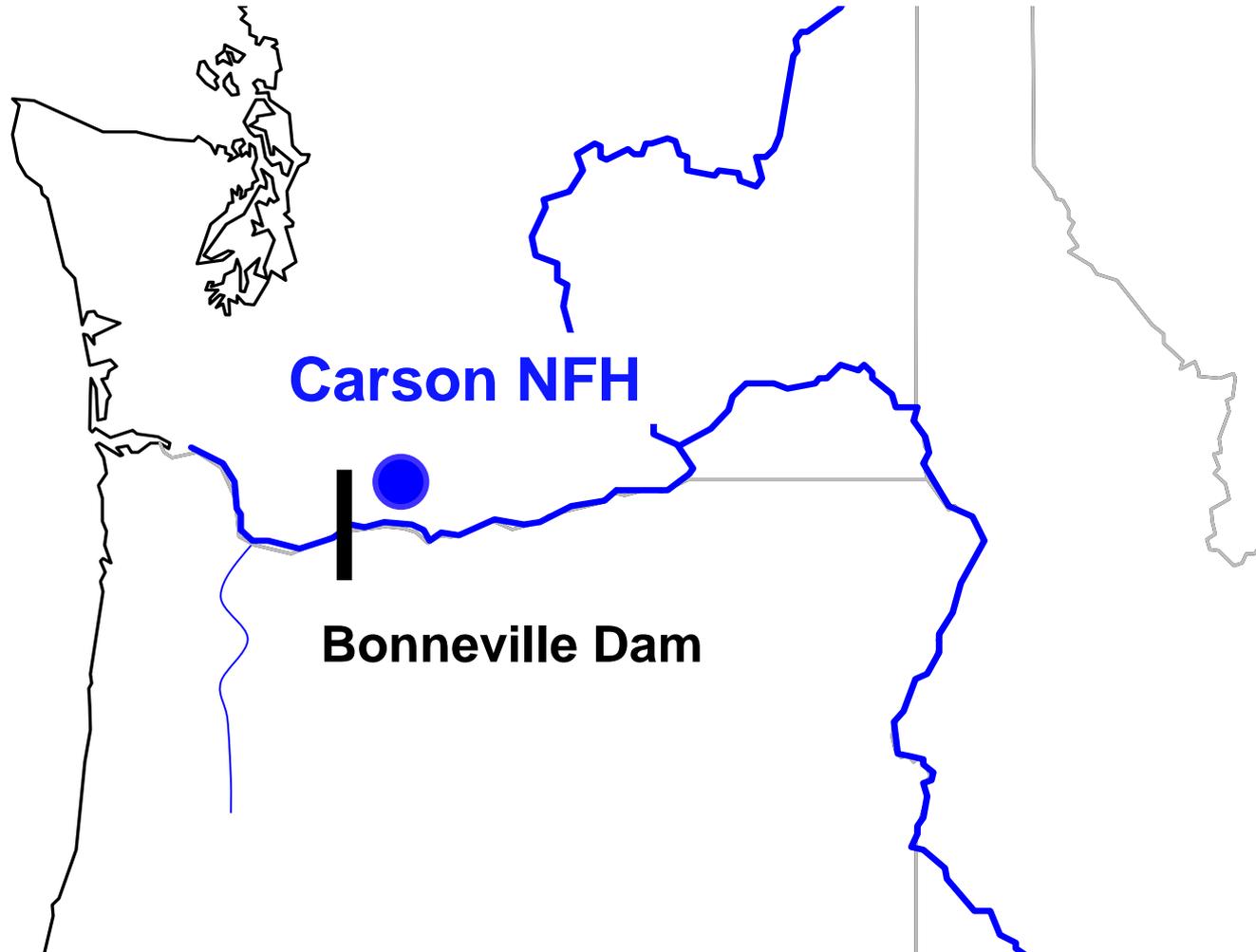
# Management implications ?



# Size selective mortality of hatchery fish

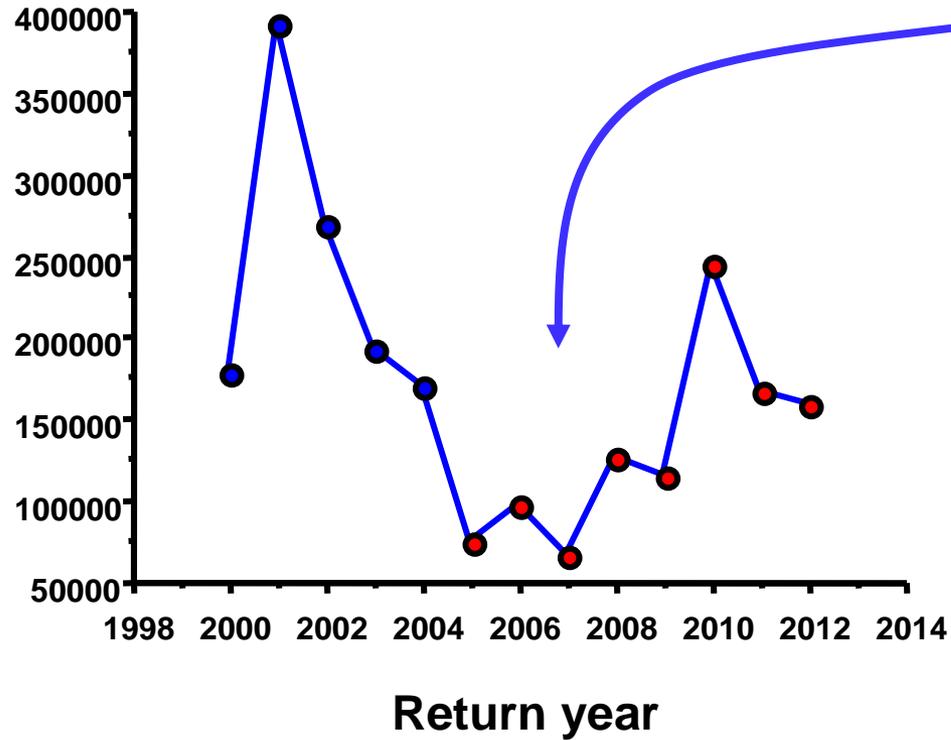


# PIT-tagged spring Chinook are released from Carson NFH



# Carson data

Adult spring  
Chinook  
at Bonneville



## Queried PTAGIS

**PIT-tags at Bonneville Adult Ladder by release year**

**minijacks**

**jacks**

**age 4**

**generated mean size at tagging by release year for surviving adults**

**minijacks**

**jacks**

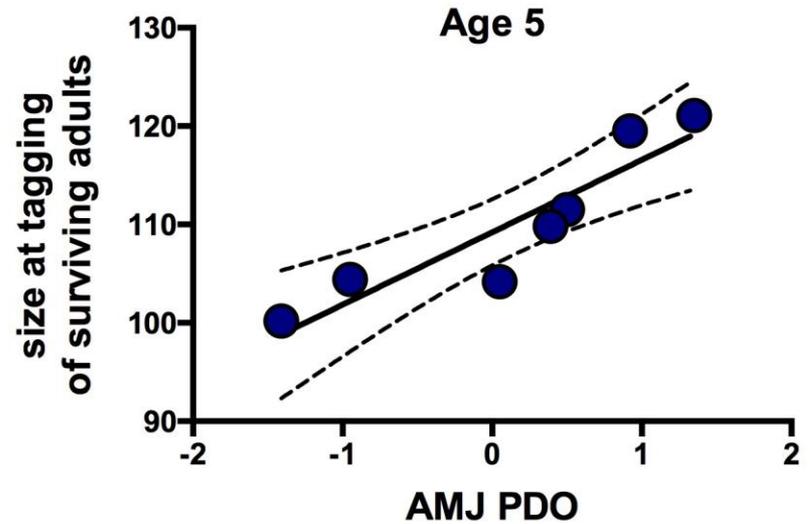
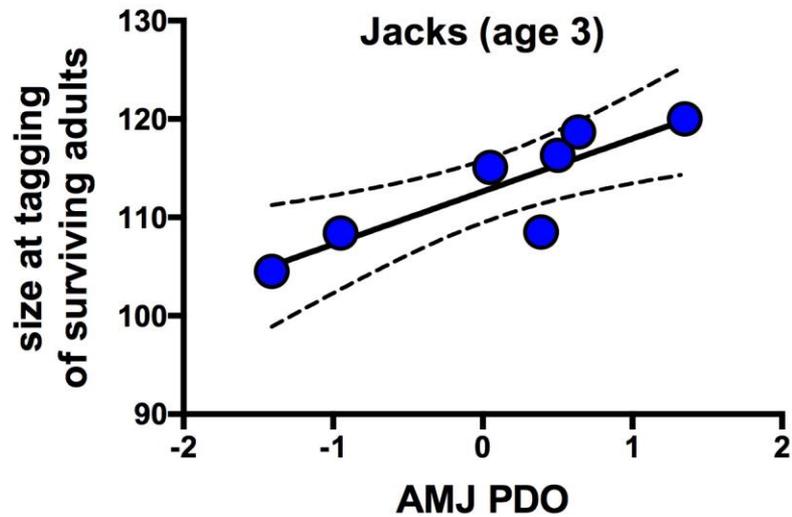
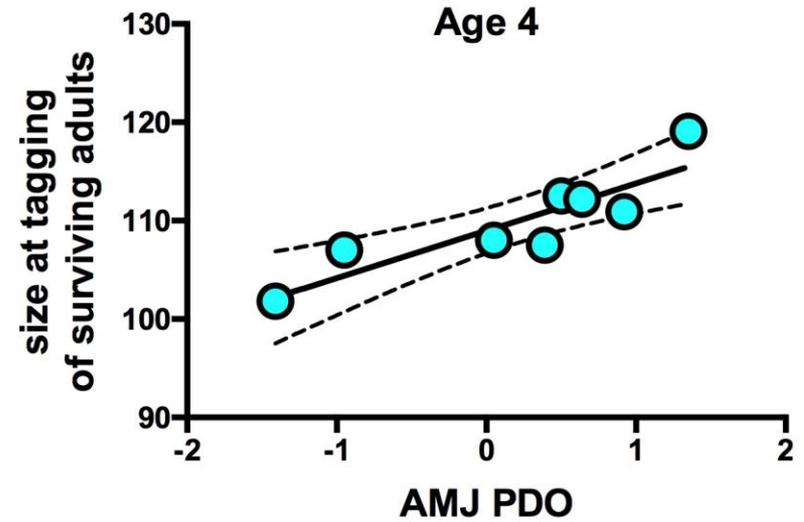
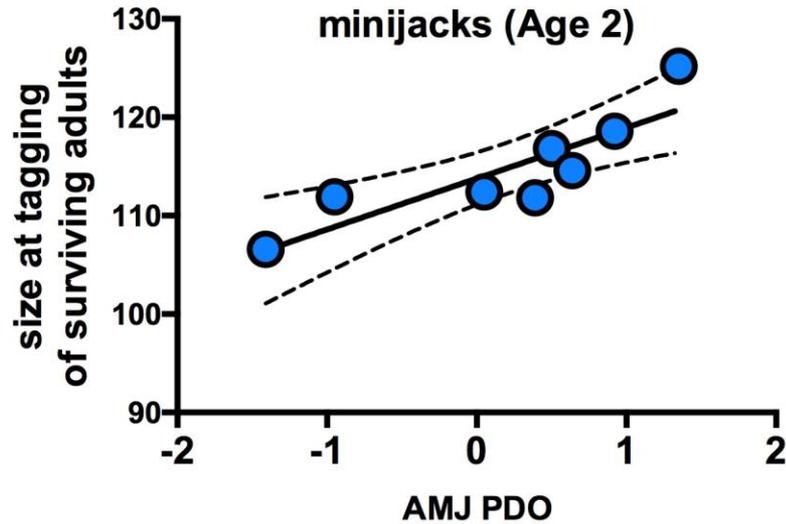
**age 4**

**mean size at tagging is a surrogate for smolt size**

**=> related mean size at tagging of returning adults to ocean conditions**

# Size selective mortality varies with ocean conditions

## Carson sp Chinook



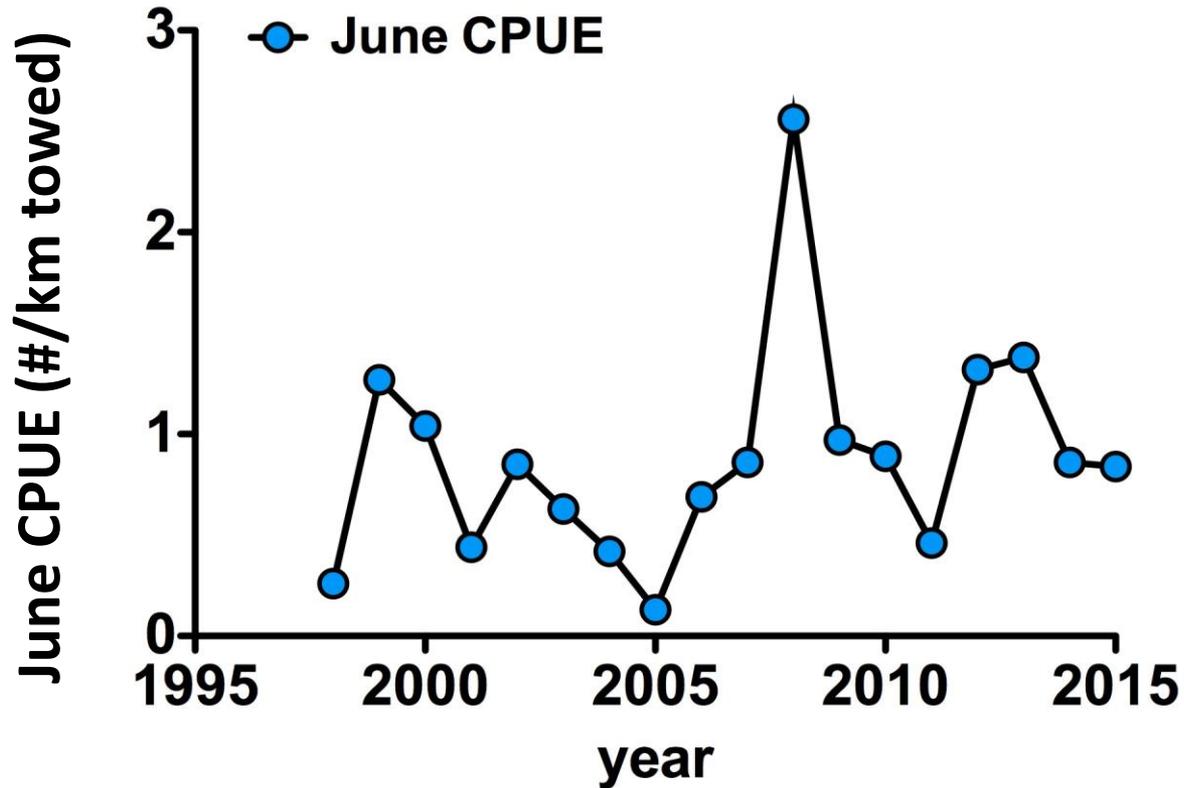
Ocean entry years 2003 - 2010

**Management implications ?**

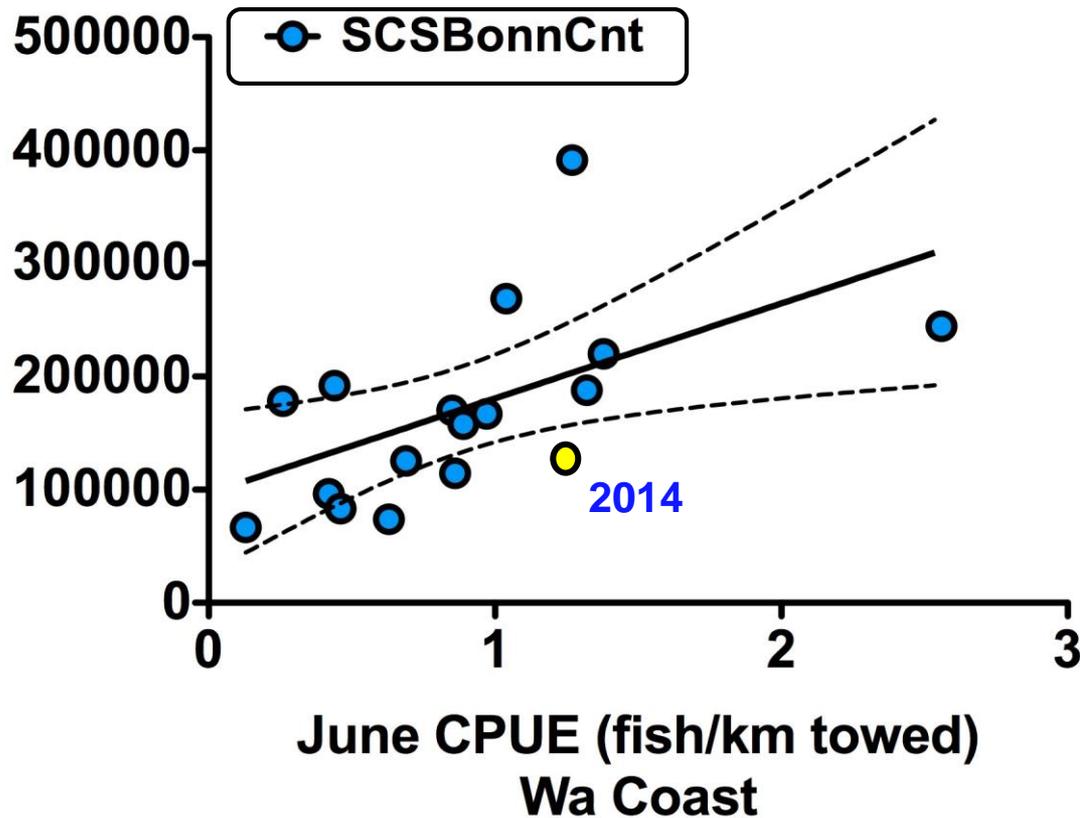
# Survival window



## Catch of yearling Chinook (CPUE) varies in June



# Catch of yearling Chinook is correlated to Adult return (+2), (1998-2013)

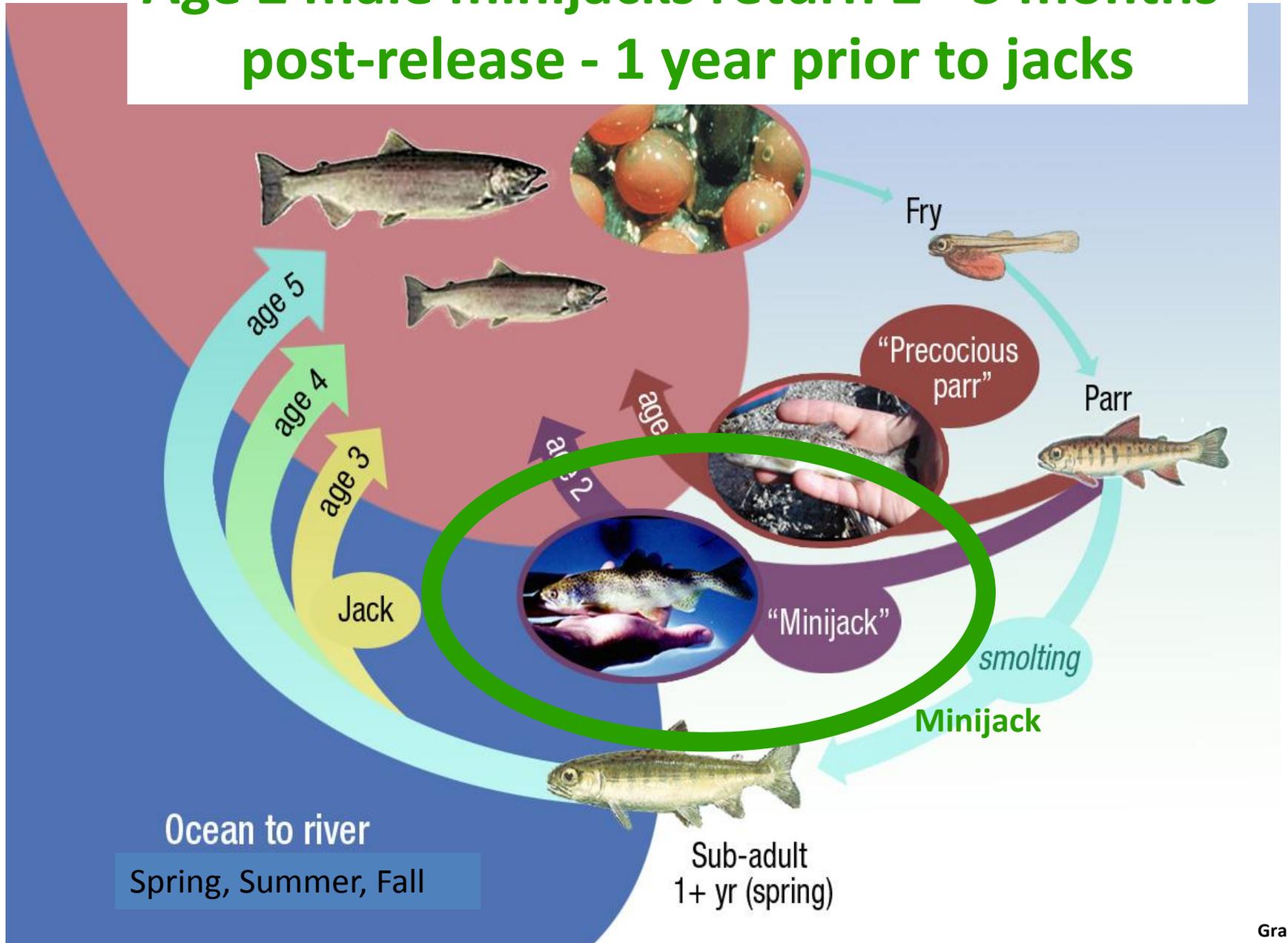


$F=7.2$   
 $p=0.02$   
 $r^2=0.34$

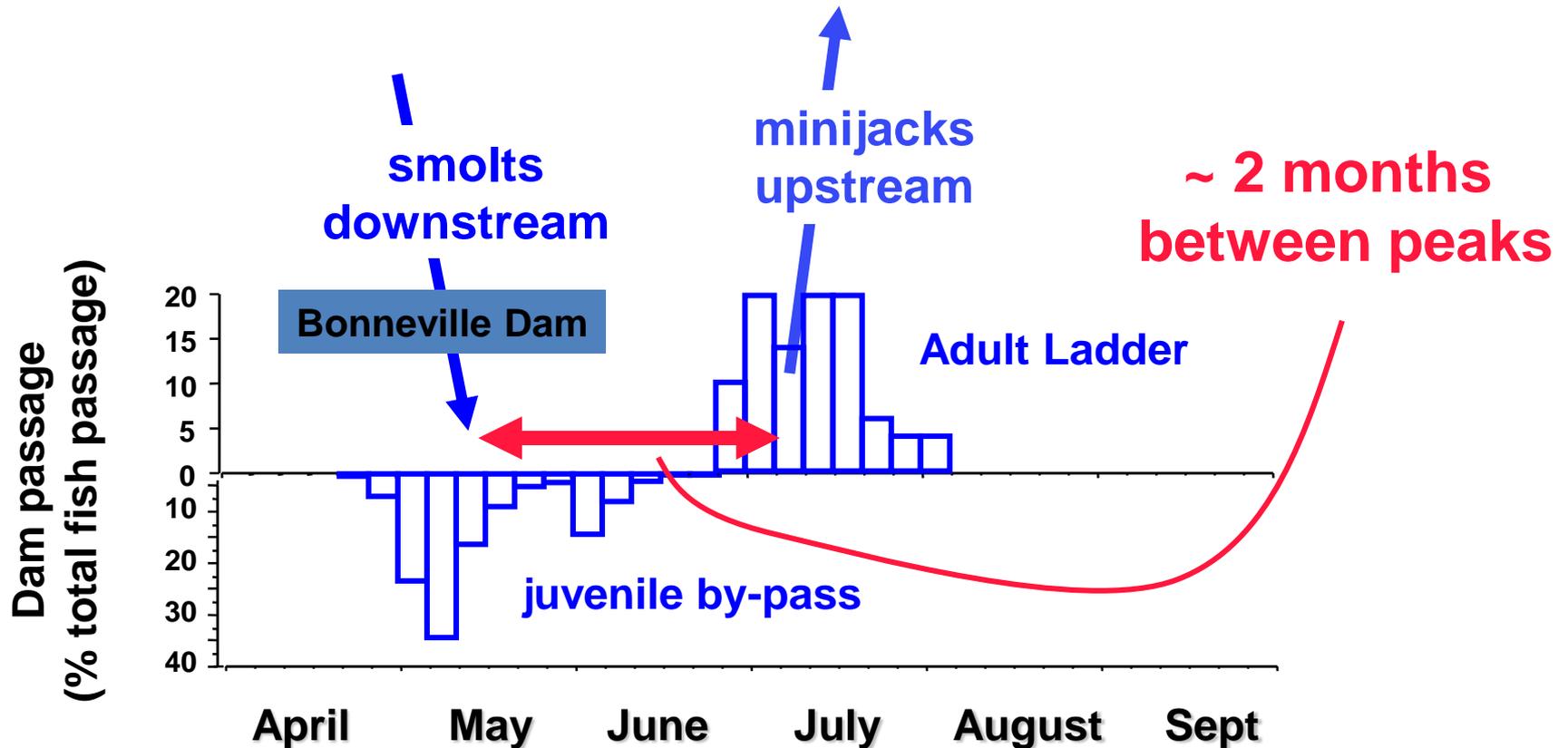
# Survival Window



# Age 2 male minijacks return 2 - 3 months post-release - 1 year prior to jacks



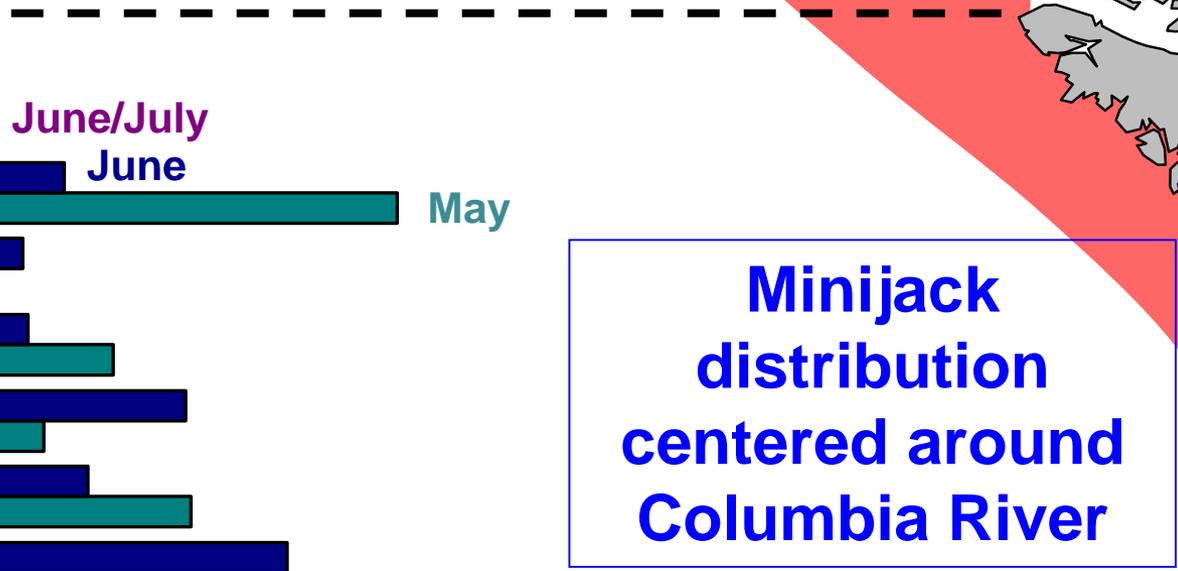
# PIT-tagged minijacks migrate downstream and back upstream the same year they were released



SE AK  
DE  
QCI  
HS  
QCS  
NVI  
MVI  
JF/SVI  
FS  
LP  
QR  
GH  
WB  
CR  
CM  
NH

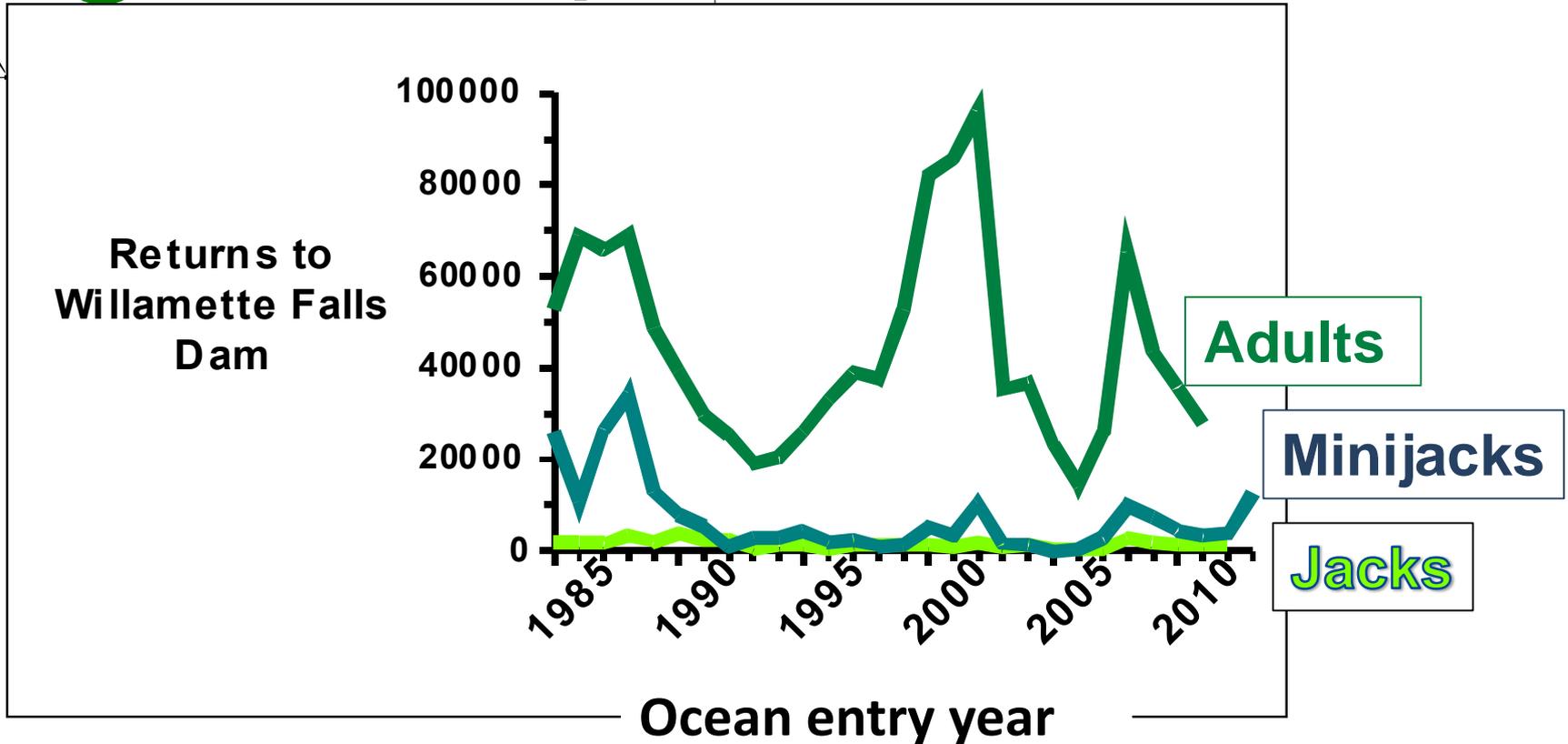
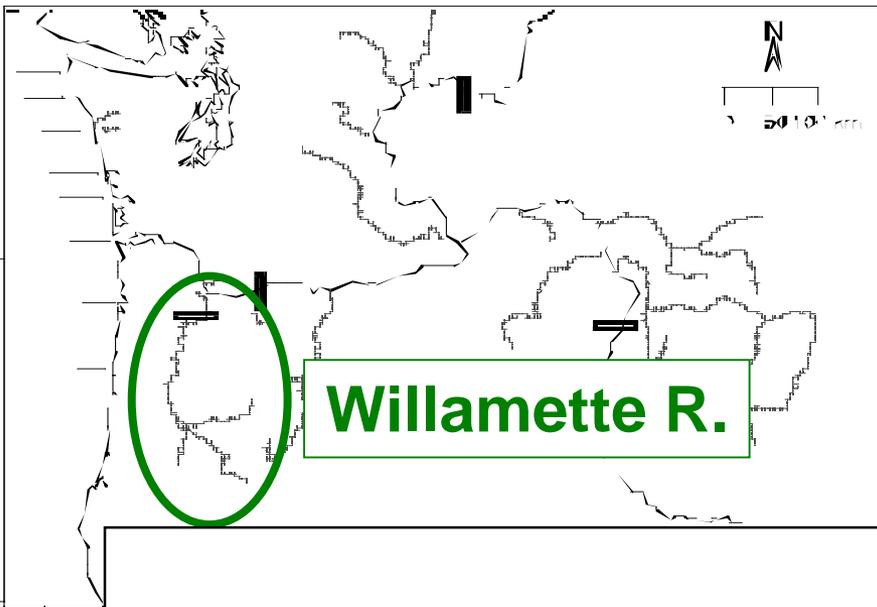
0 minijacks of 314 fish  
caught between  
Vancouver Is. and S.E. AK

0 10 20 30 40 50 60  
% minijack (of males)

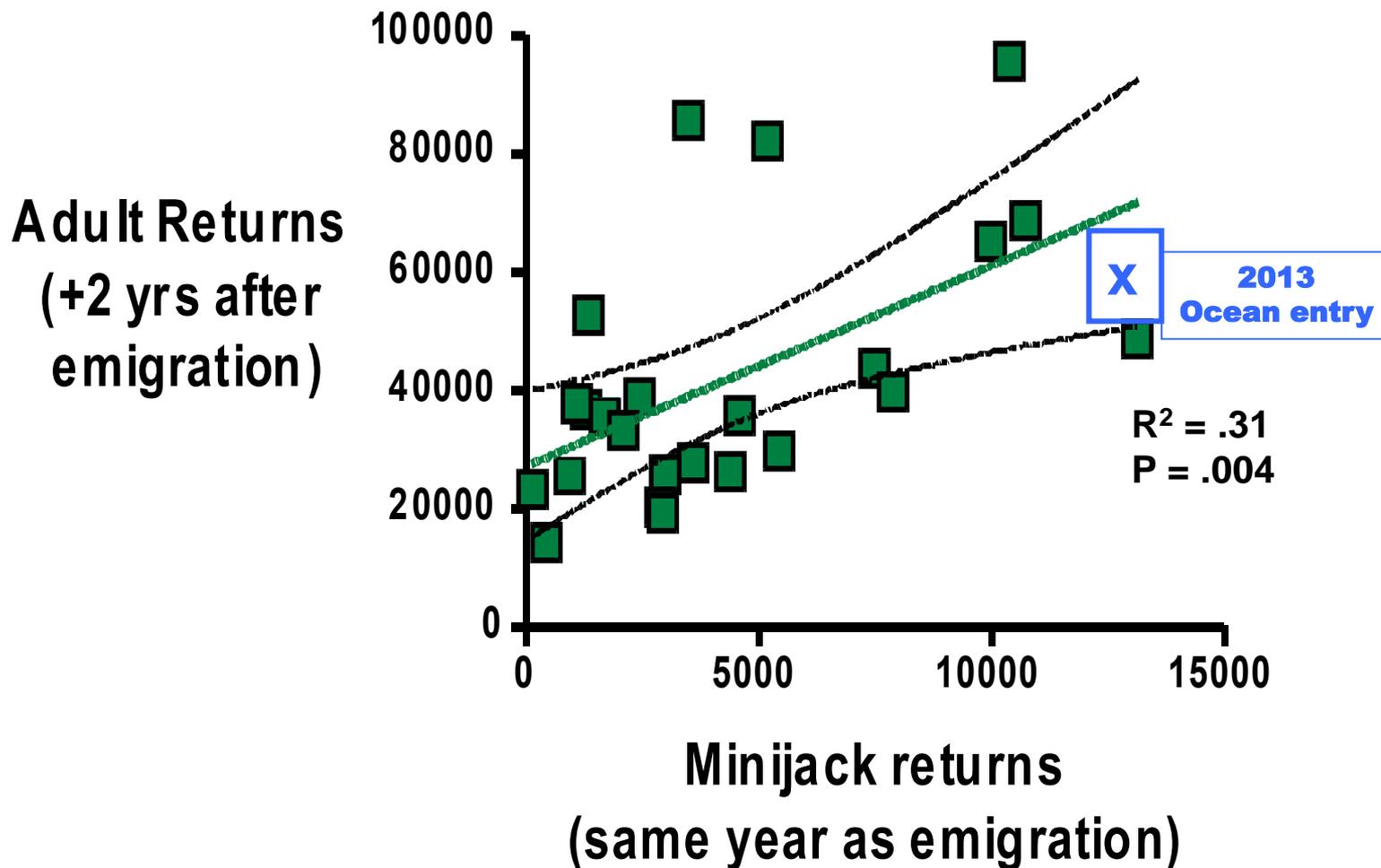


Minijack  
distribution  
centered around  
Columbia River

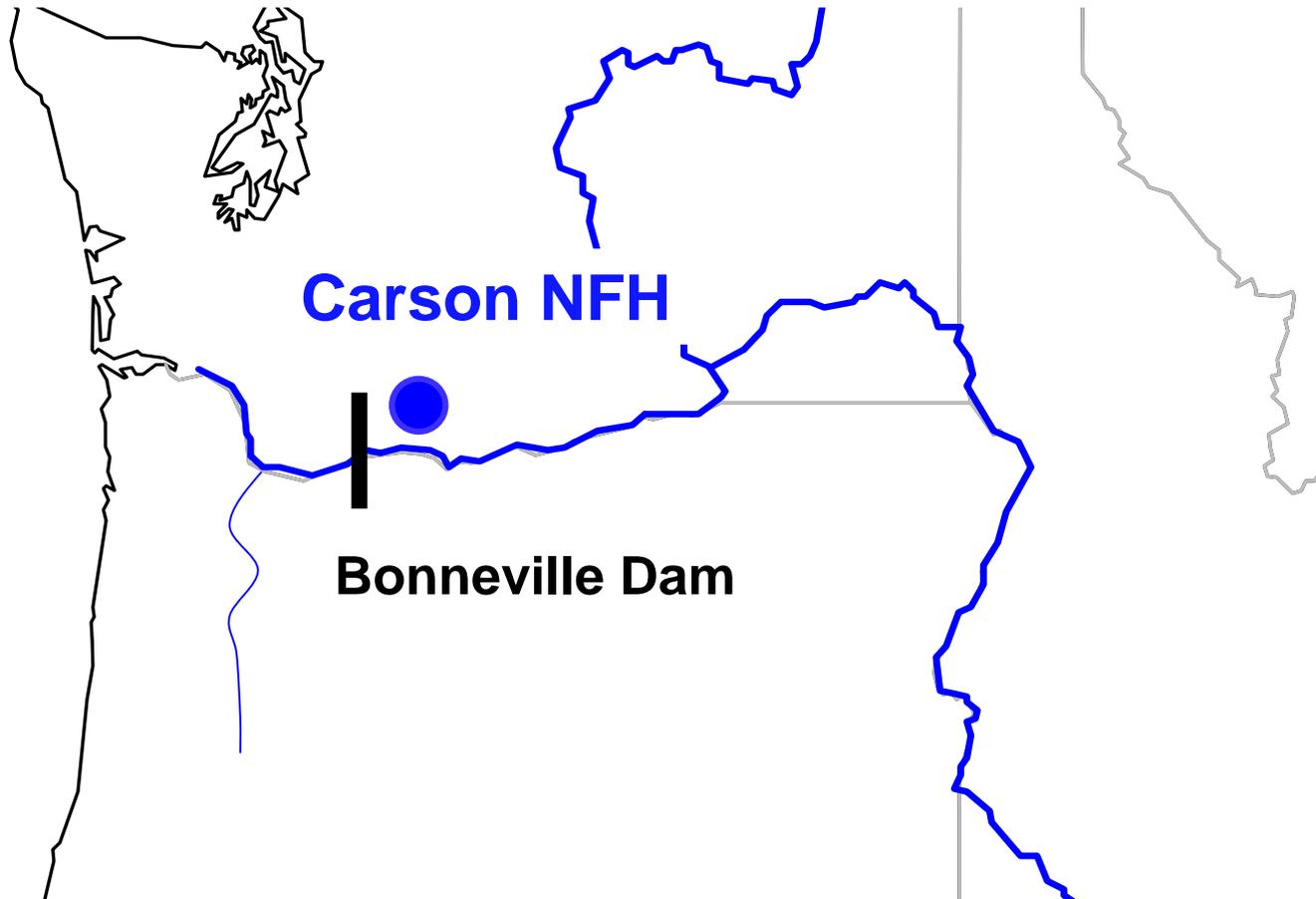
# Willamette River Spring Chinook Salmon returns by age class



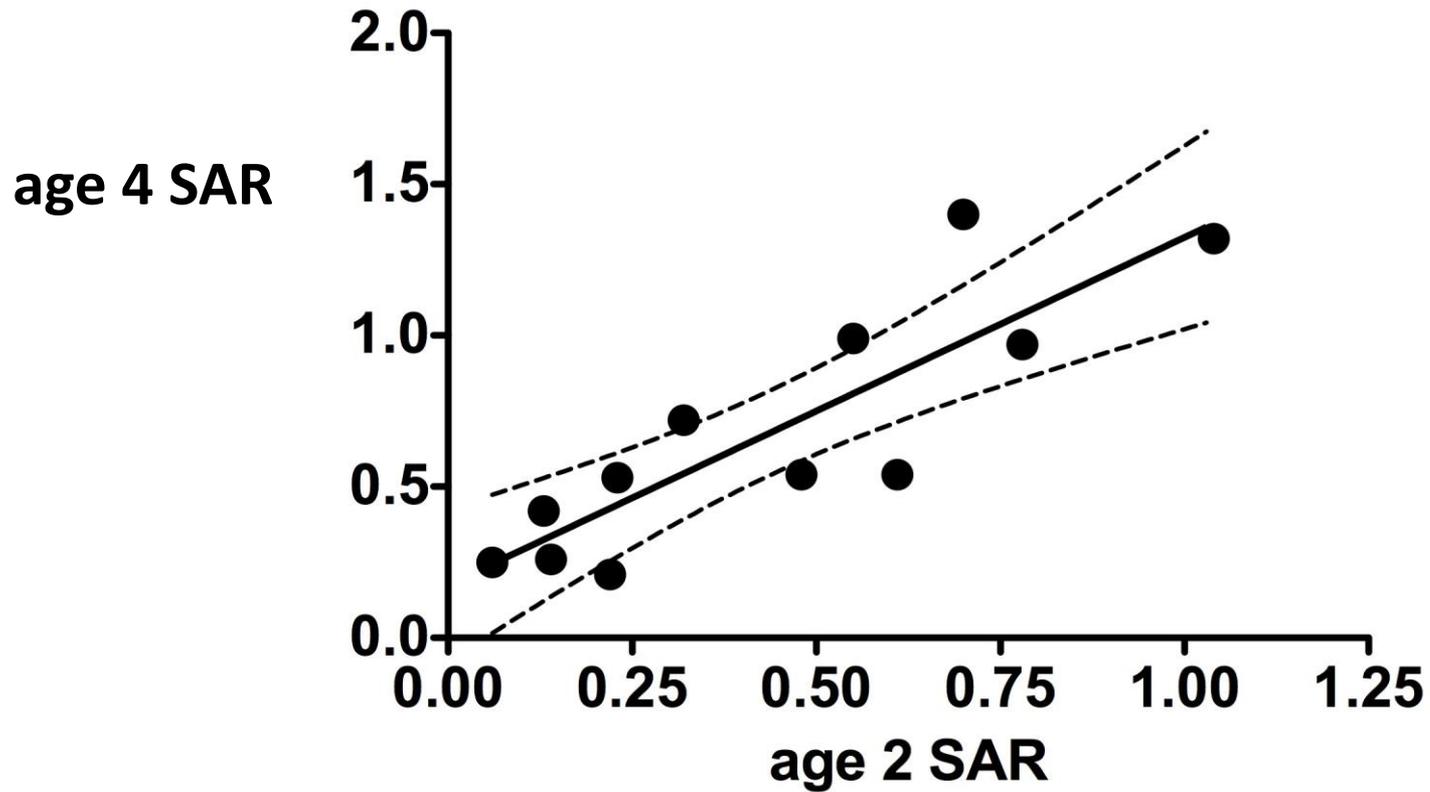
# Minijack counts are related to Adult counts (+2) @ Willamette Falls



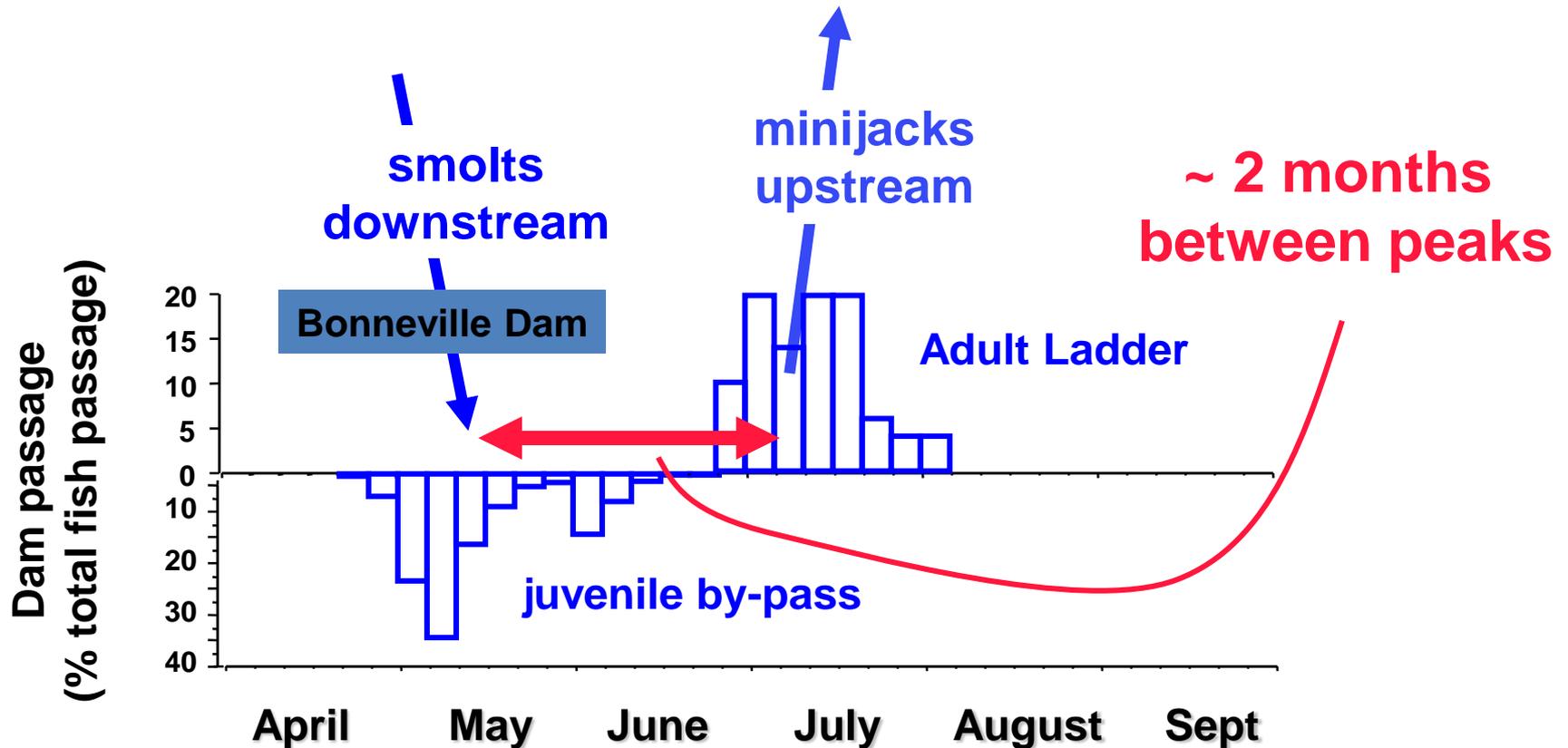
**PIT-tagged spring Chinook are released  
from Carson NFH – possible to calculate  
Smolt to adult return (SAR)**



# Carson minijack SAR is correlated to age 4 SAR (2002 – 2013)



# Survival is set within two months of ocean entrance?



**Management implications ?**

What happens in the estuary?