NOAA FISHERIES

NWFSC

EFS Division

6.3 Growth and survival of Columbia River Chinook salmon in the Northern California Current

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- NWR NMFS Biop
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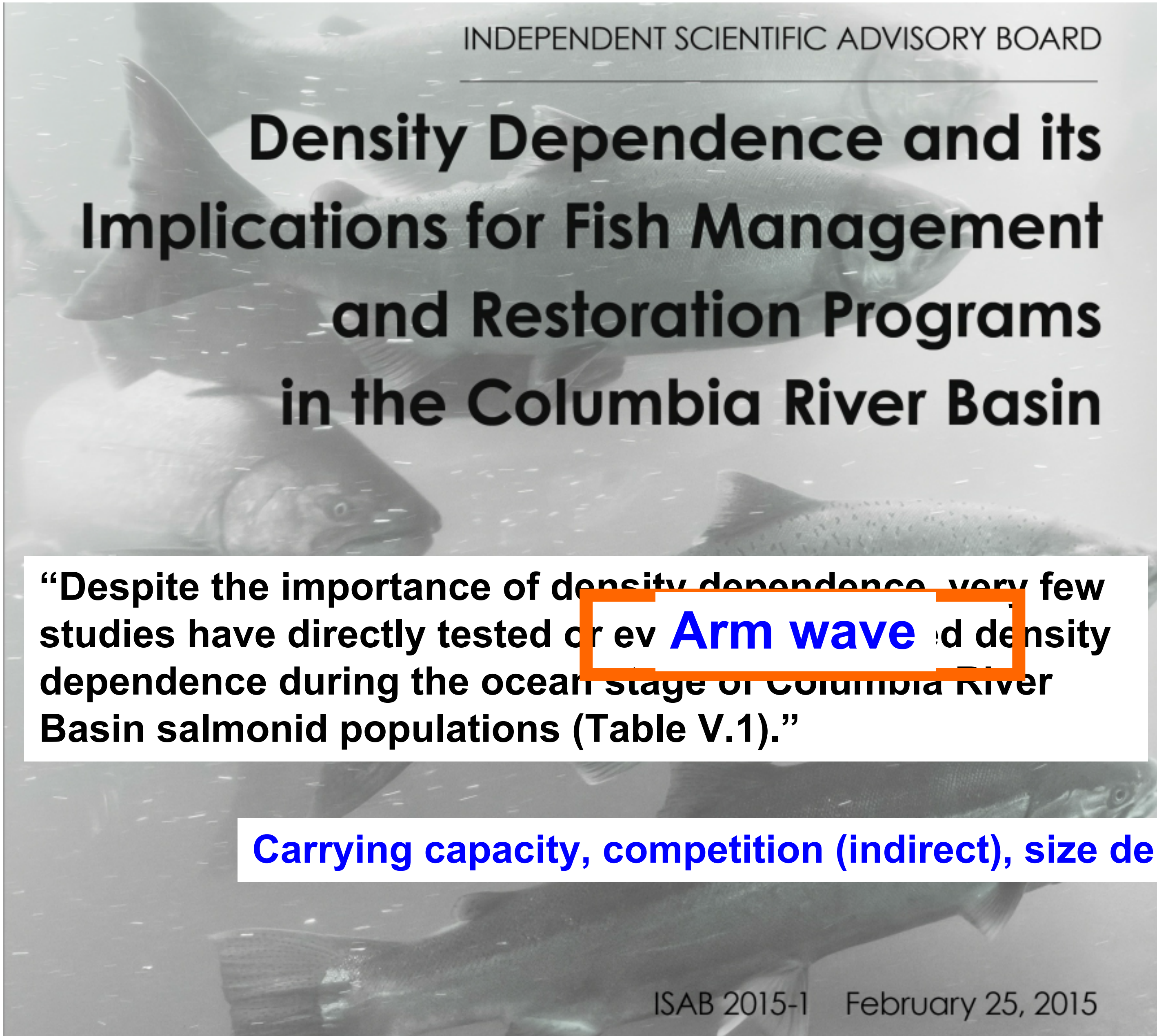
- Pacific Salmon Commission, Southern Fund

May 5, 2015
Protected Fish Species Review



“Despite the importance of density dependence, very few studies have directly tested or ev[illegible]ed density dependence during the ocean stage of Columbia River Basin salmonid populations (Table V.1).”

Arm wave

Carrying capacity, competition (indirect), size dependent

Hypothesis:

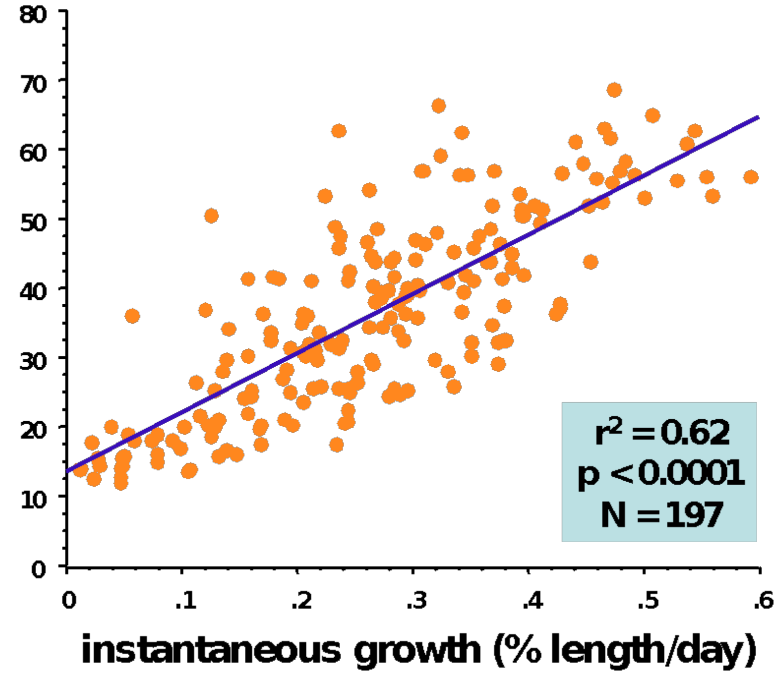
marine survival of juvenile salmon is directly related to early growth in the ocean

(Ocean Ecology of Pacific Salmon, Pearcy 1992)

1. **How can growth in the ocean be measured?**
   Or, why does a physiologist go to sea?
2. **How can fish from different populations be distinguished (Sacramento, Columbia, Fraser)?**

The hormone IGF1 is a growth index

plasma IGF-I* level (ng/ml)

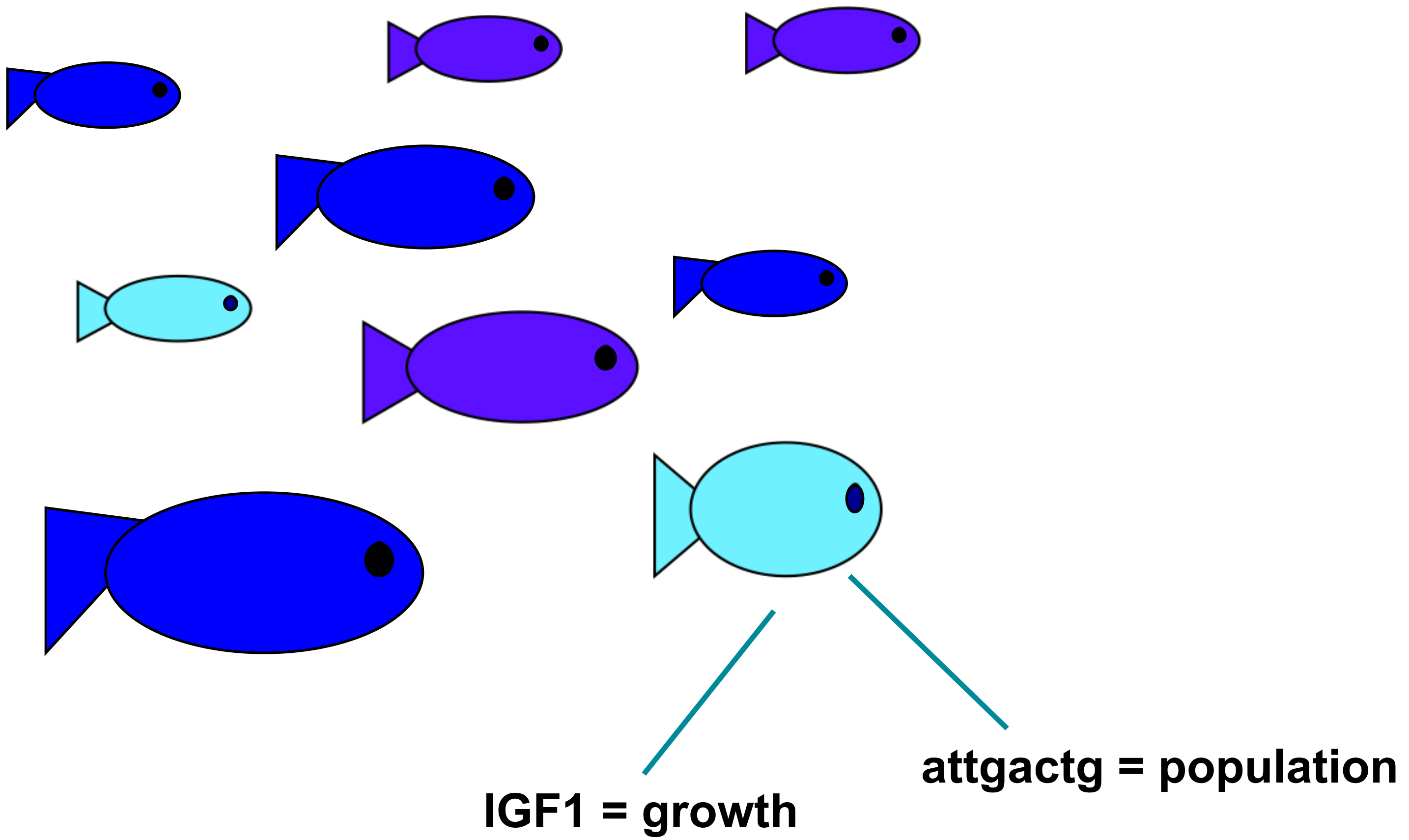


Post-smolt coho salmon
PIT-tagged
6 week growth interval
seawater

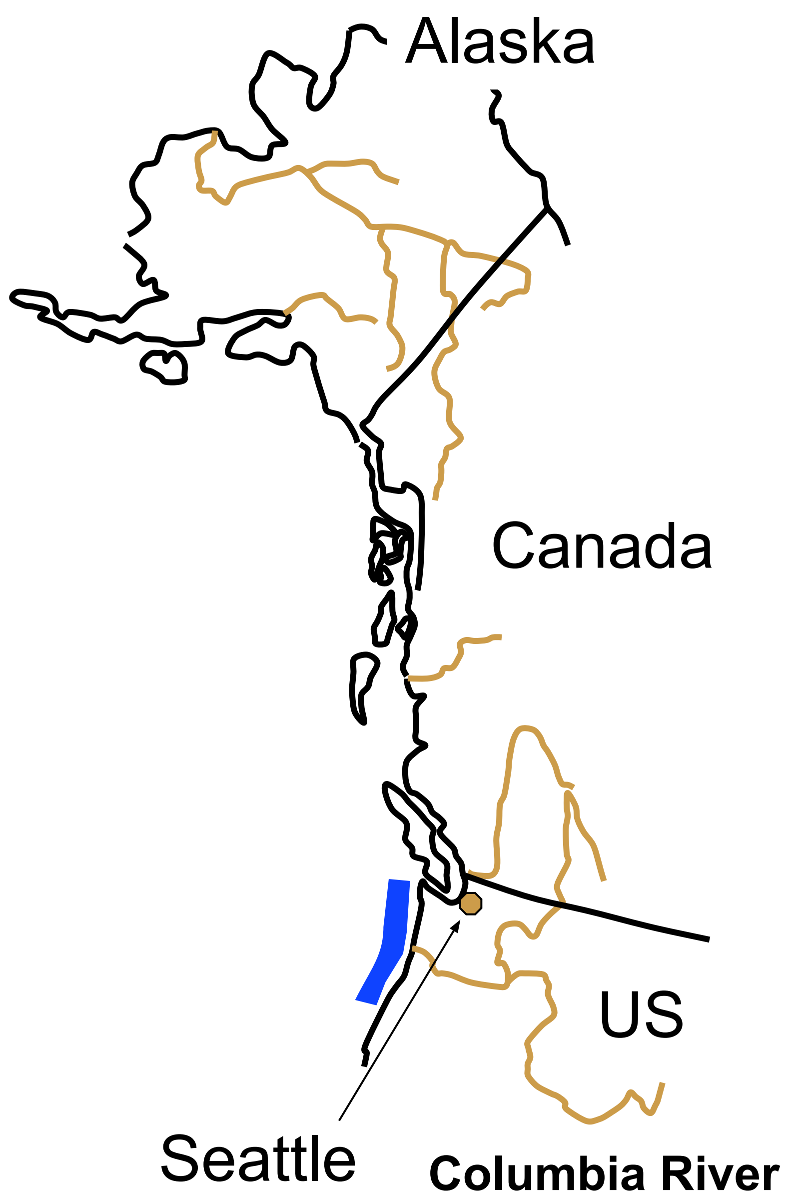
*TRF immunoassay

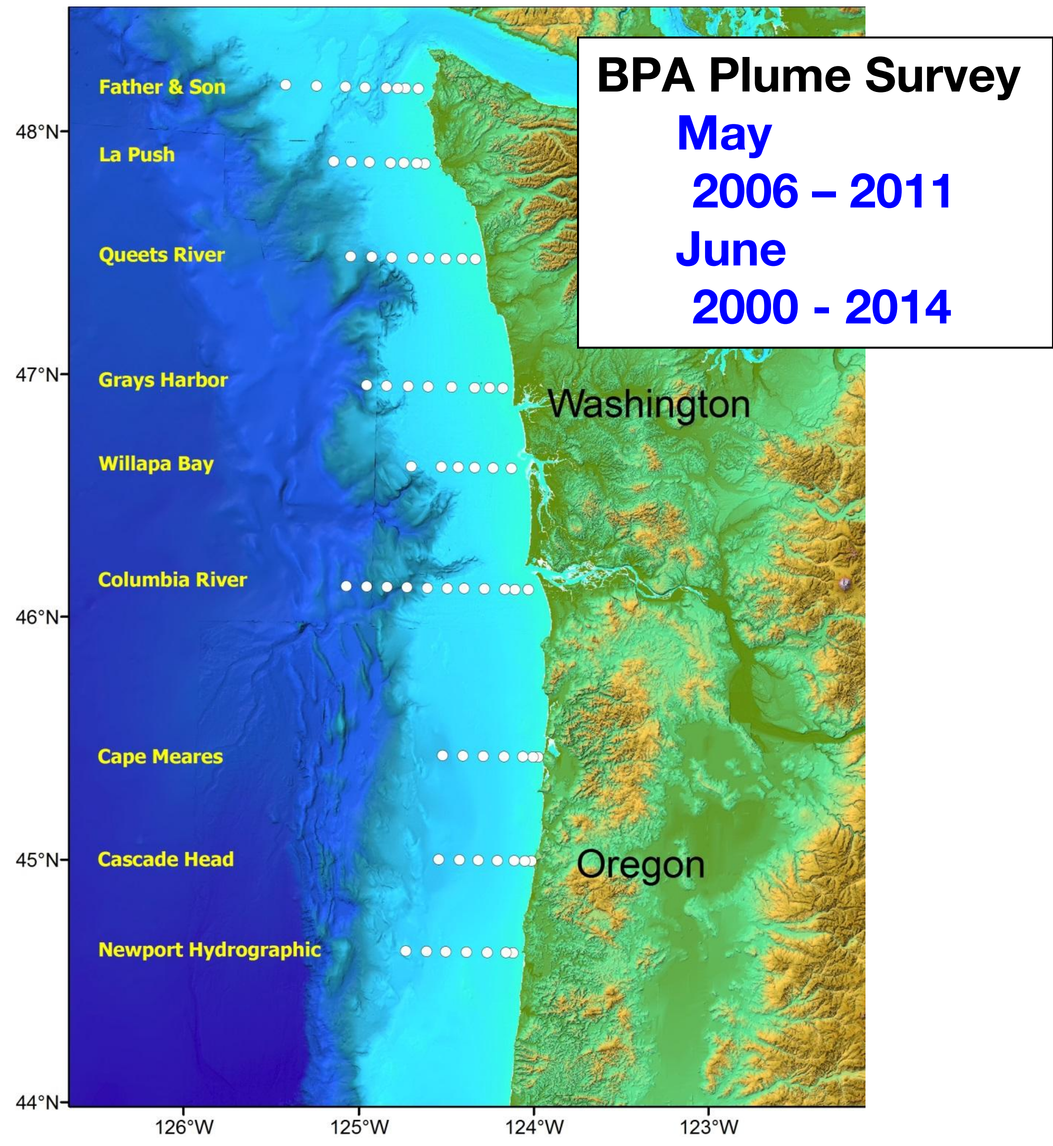
Beckman et al. 2004 TAFS

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

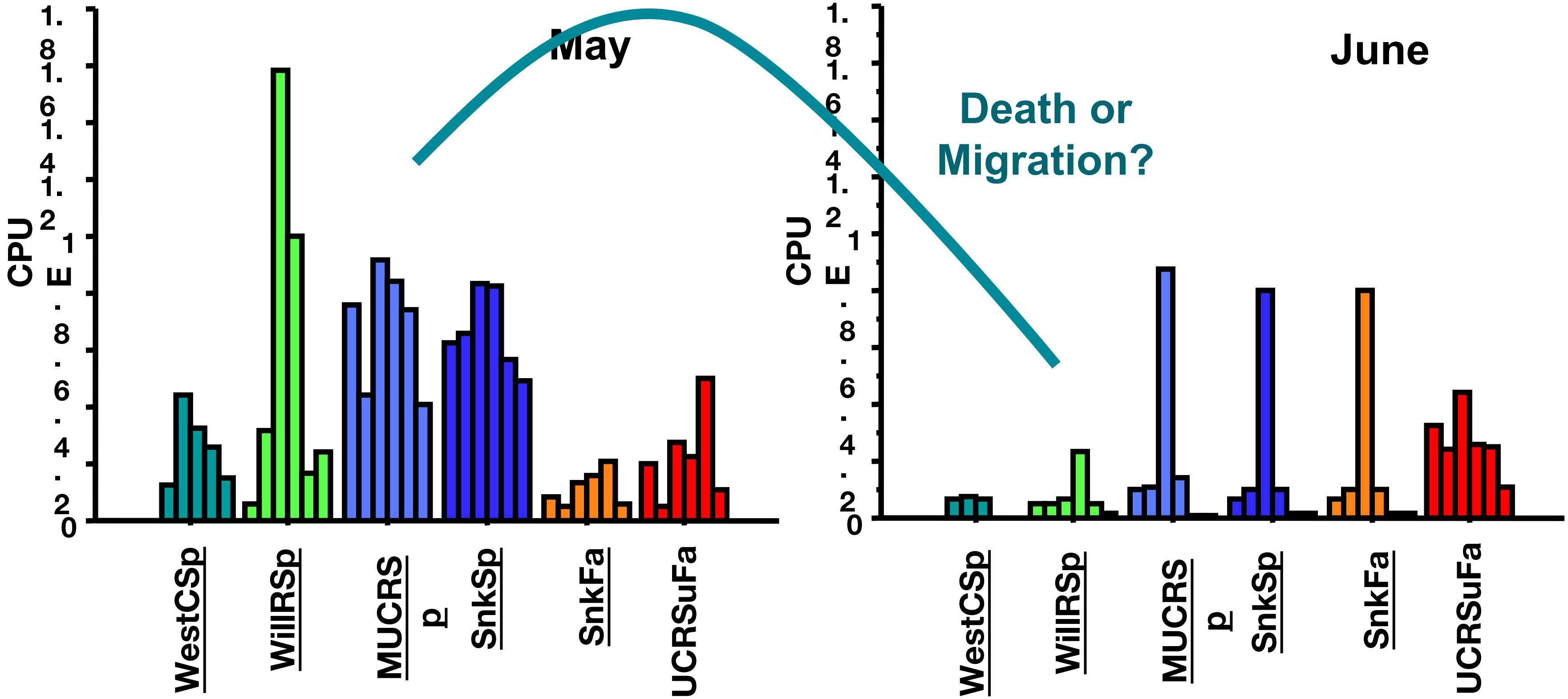


NOAA Juvenile Salmon Ocean Survey


Alaska
Canada
US
Seattle
Columbia River


BPA Plume Survey
May
2006 – 2011
June
2000 - 2014
Father & Son
La Push
Queets River
Grays Harbor
Willapa Bay
Columbia River
Cape Meares
Cascade Head
Newport Hydrographic
Washington
Oregon
48°N
47°N
46°N
45°N
44°N
126°W
125°W
124°W
123°W

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

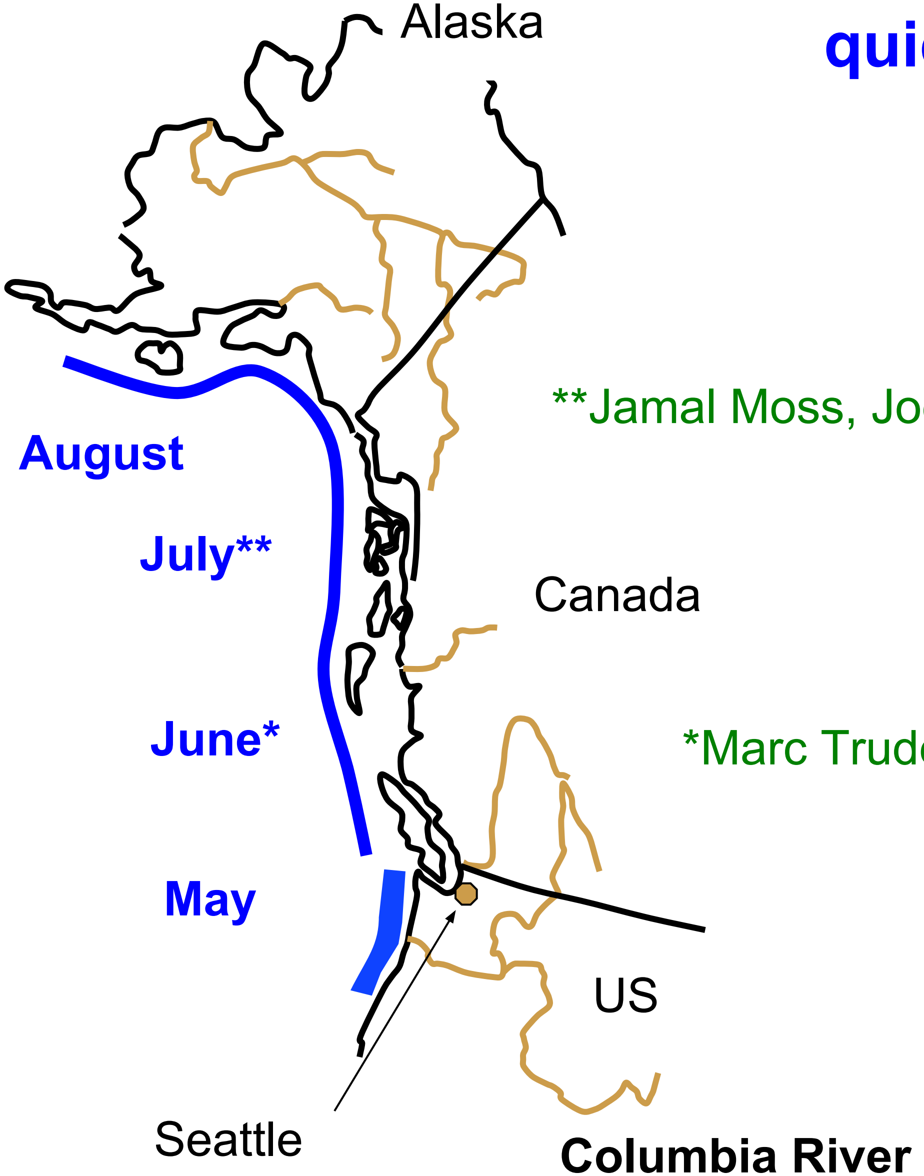


*6 major stocks of Chinook salmon with yearling migrants

2006-2011

<u>5 are listed under the Endangered Species Act</u>

UCR/Snake spring Chinook salmon quickly migrate north



**Jamal Moss, Joe Orsi, NMFS, Juneau

*Marc Trudel, DFO, Nanaimo

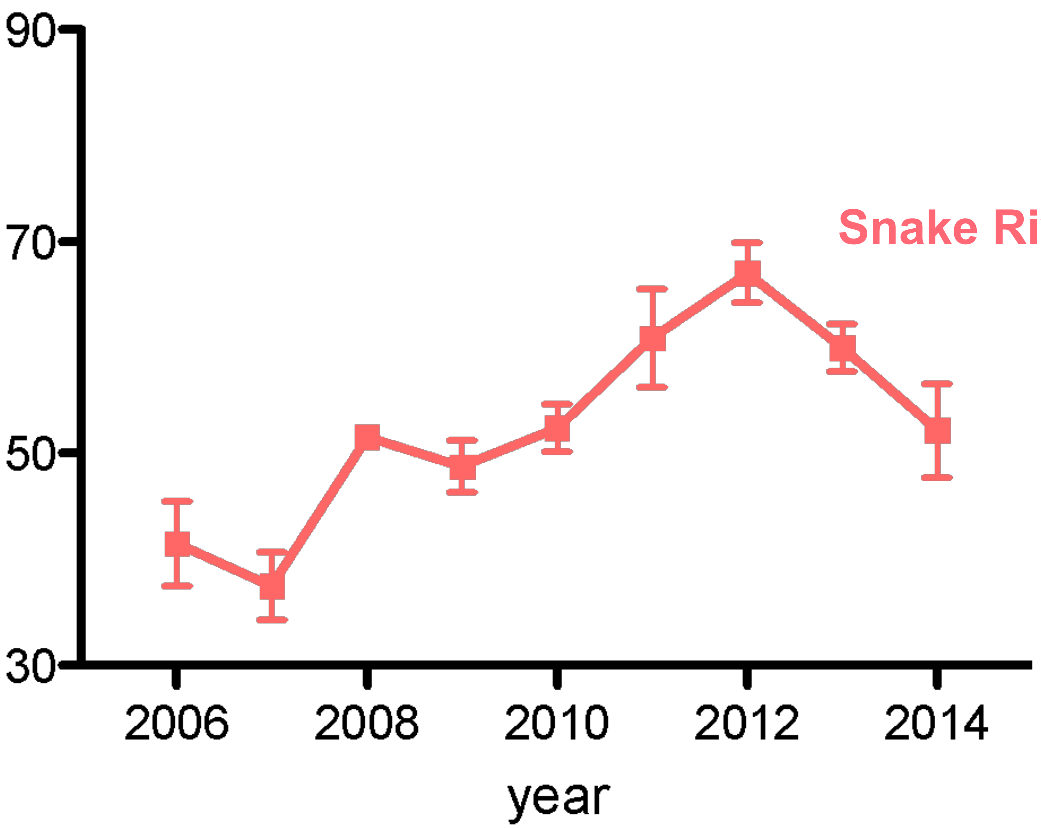
Study of the marine ecology of Columbia River Chinook salmon needs to be spatially and temporally explicit

Outline

1. Do growth & survival vary? Correlated?
2. Do larger fish grow faster than smaller fish?
3. Do smolts from hatchery stocks vary in size?
4. Some data on biomass
5. Implications of the present state of the NCC
6. Summary

Growth varies inter-annually

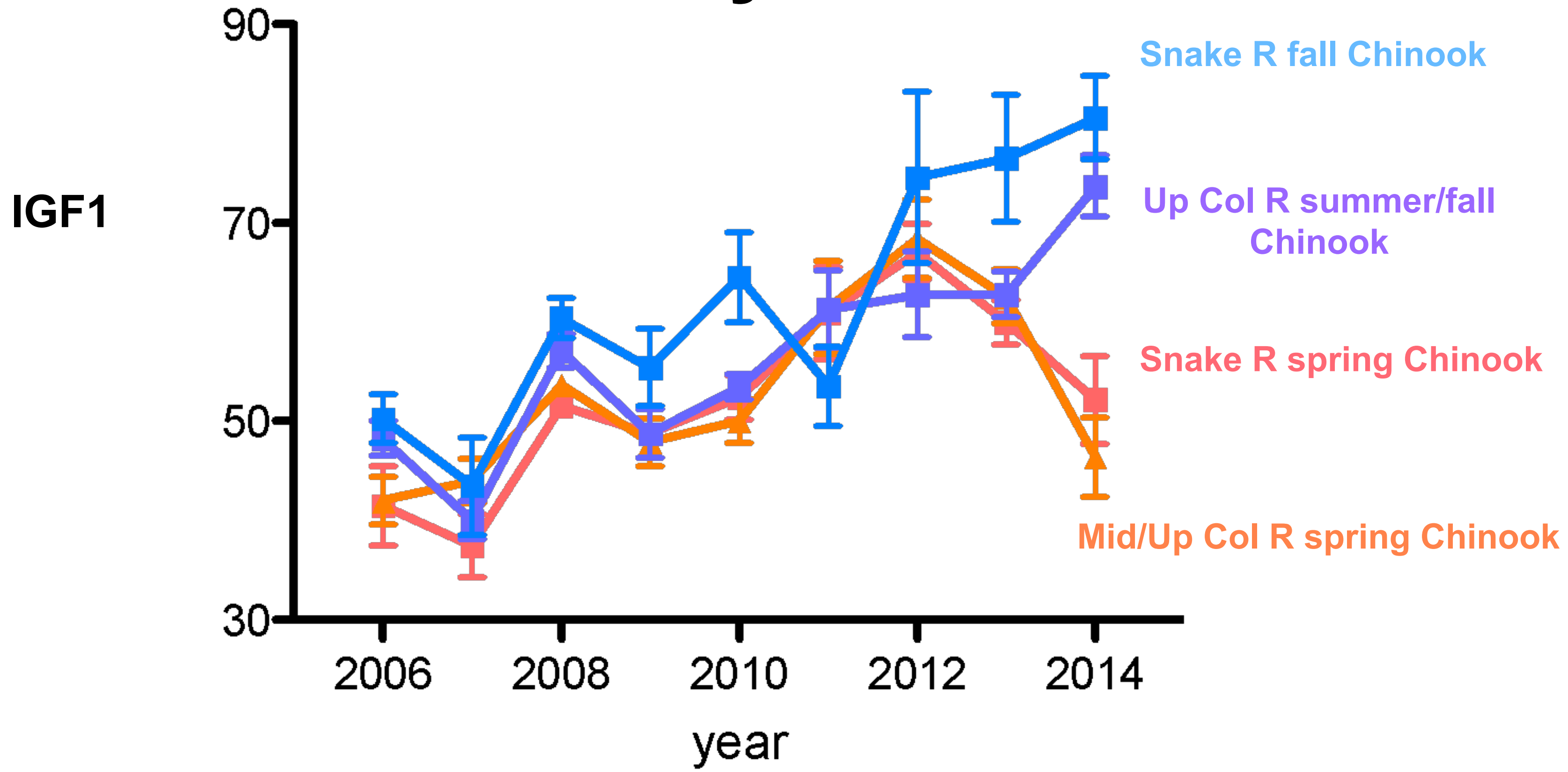
IGF1



Snake River spring Chinook

June

Growth varies inter-annually and by stock

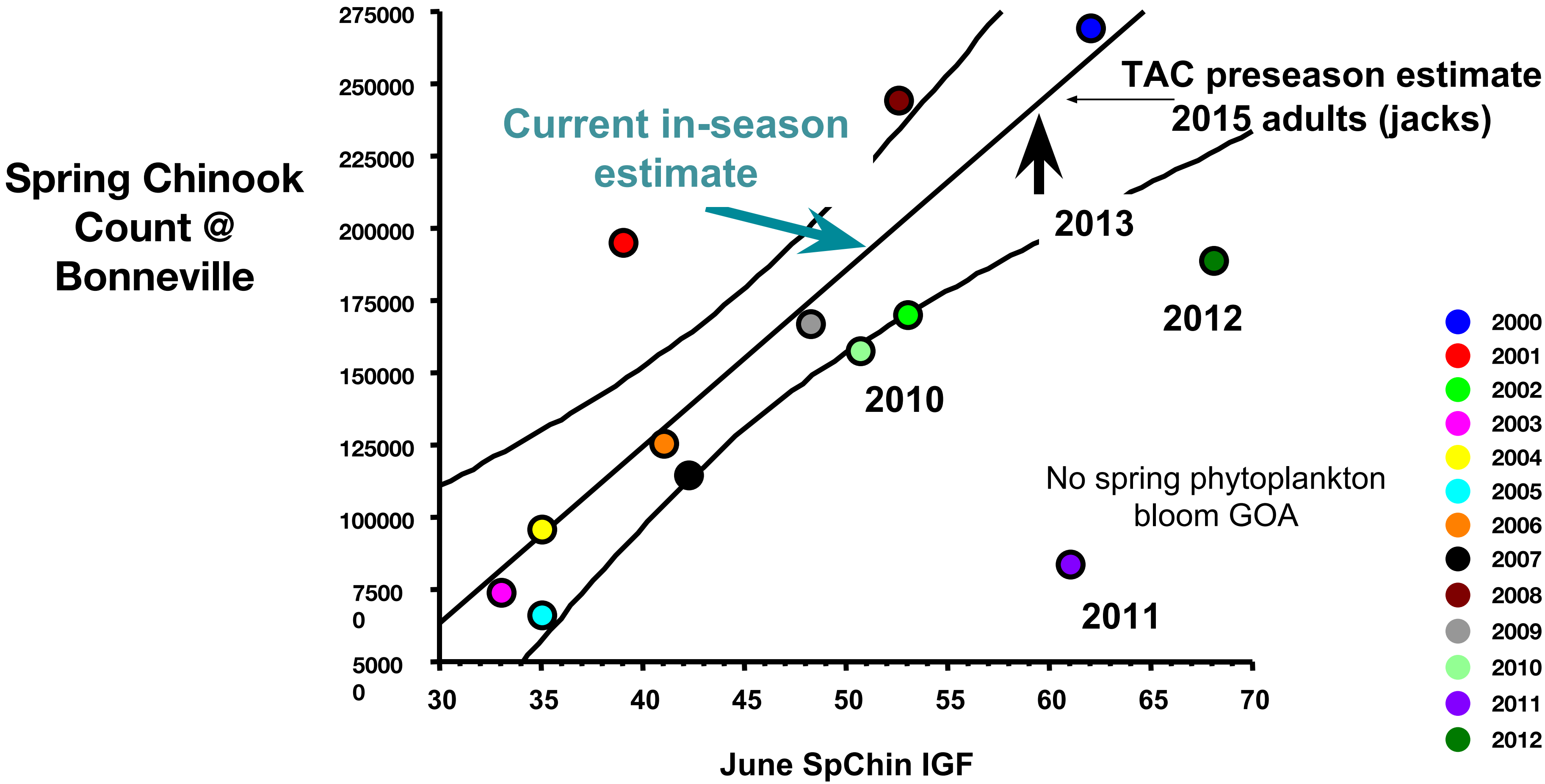


June

Study of the marine ecology of
Columbia River Chinook salmon
needs to be spatially and temporally explicit

**Study of the marine ecology of
Columbia River Chinook salmon
needs to be stock-specific**

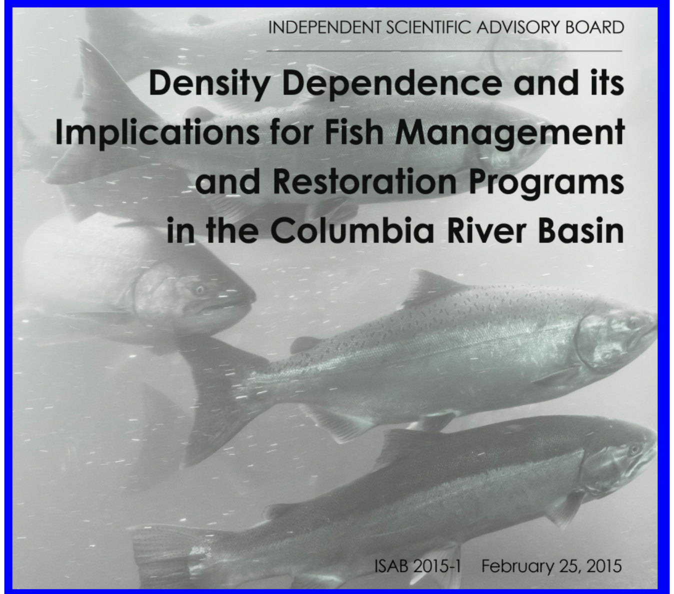
Growth is related to survival of spring Chinook (most years)



Low growth = low survival (always)

High growth = high survival (usually)

=> Pearcy was right (usually)



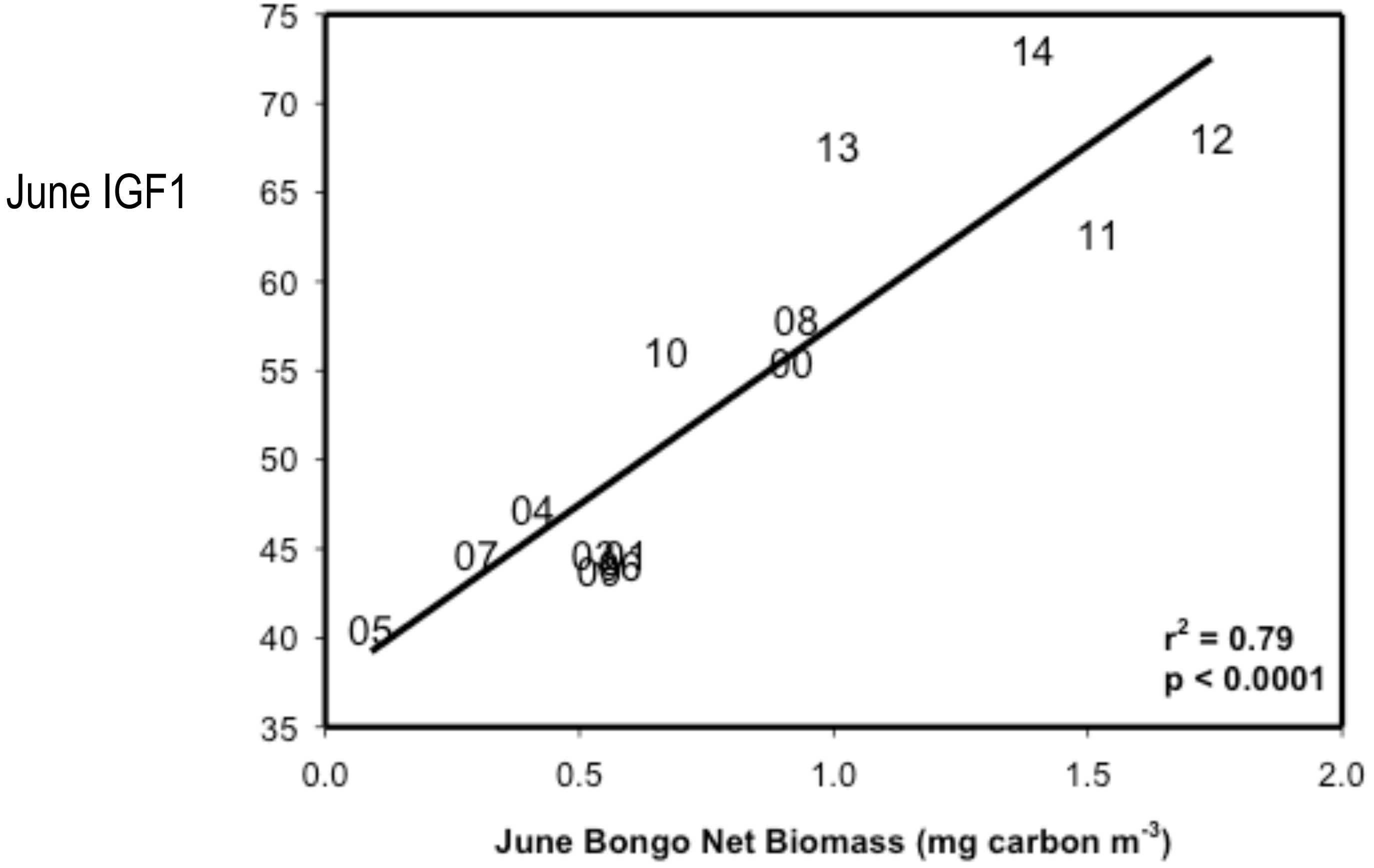
Growth varies (it's not about temperature)

=> Food is limited in some years

If food is limited

=> there is competition for food in some years

IGF1 is correlated with an index of salmon prey (food)



NOAA FISHERIES

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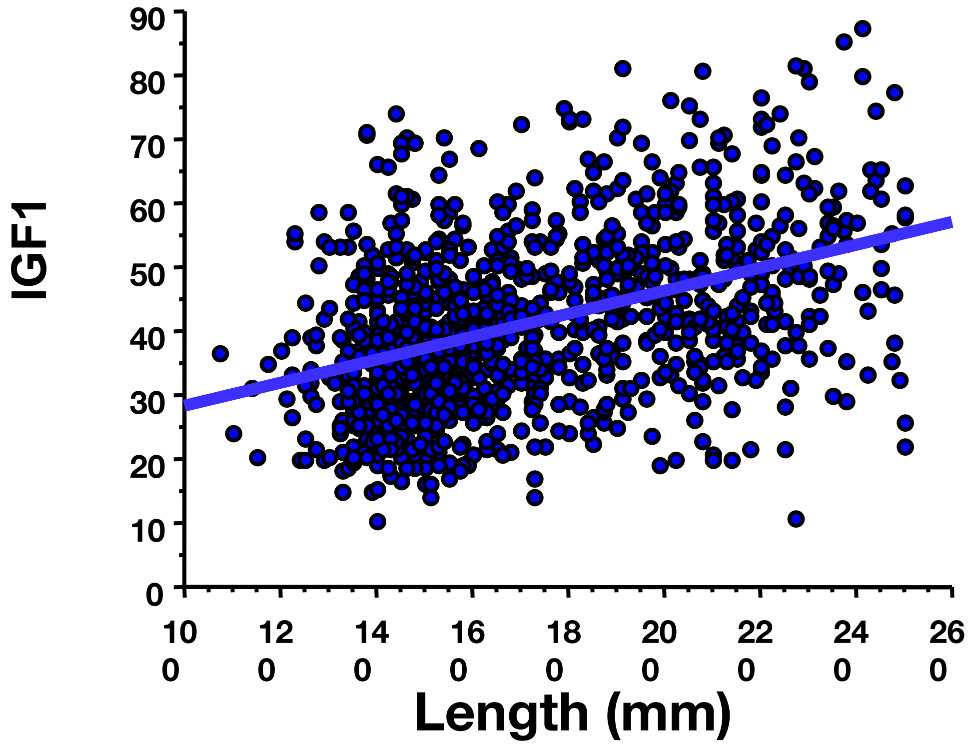
Yearling Columbia R Chinook salmon: marine growth varies with size

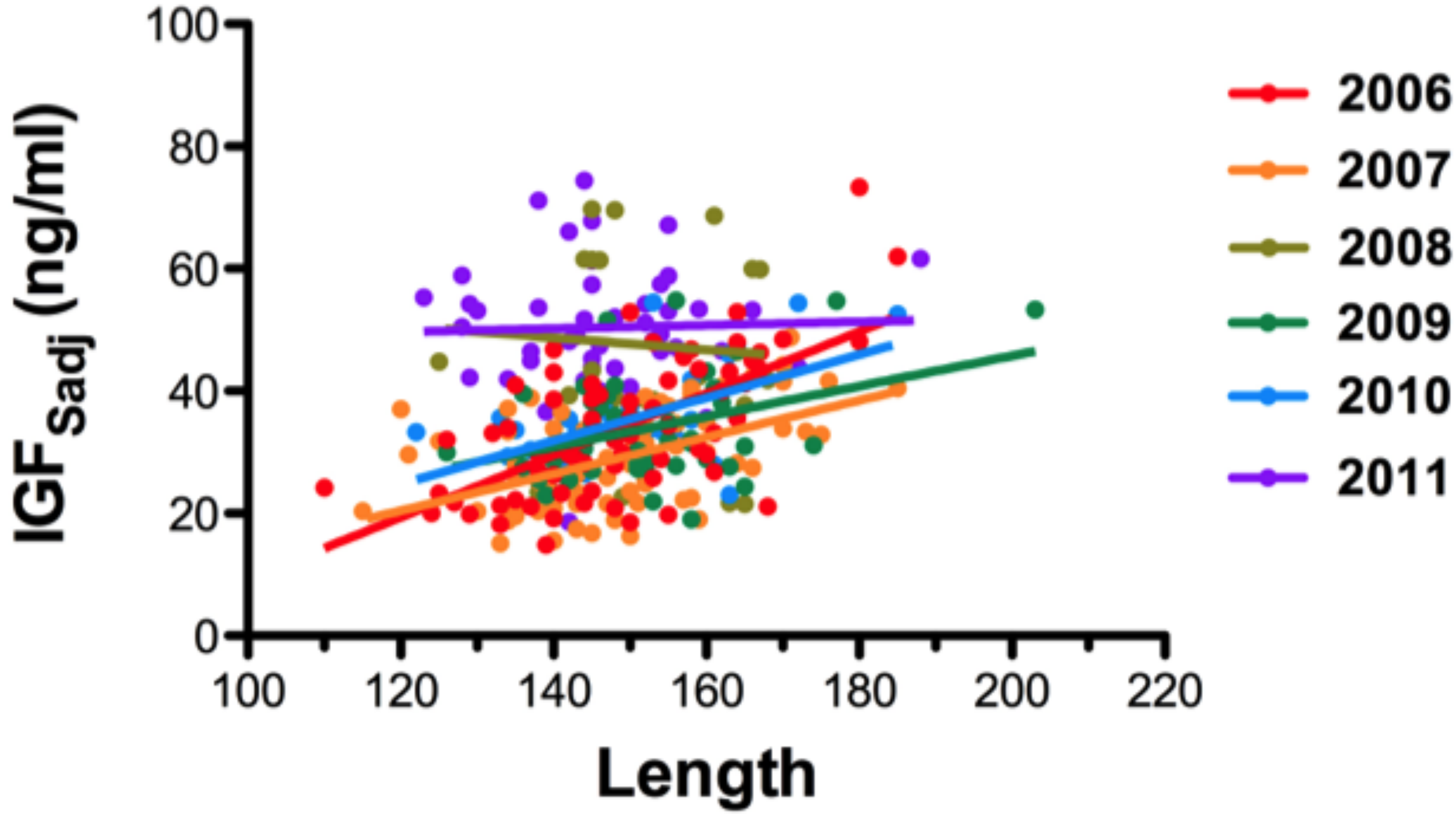


2006 - 2011, May, all stocks

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

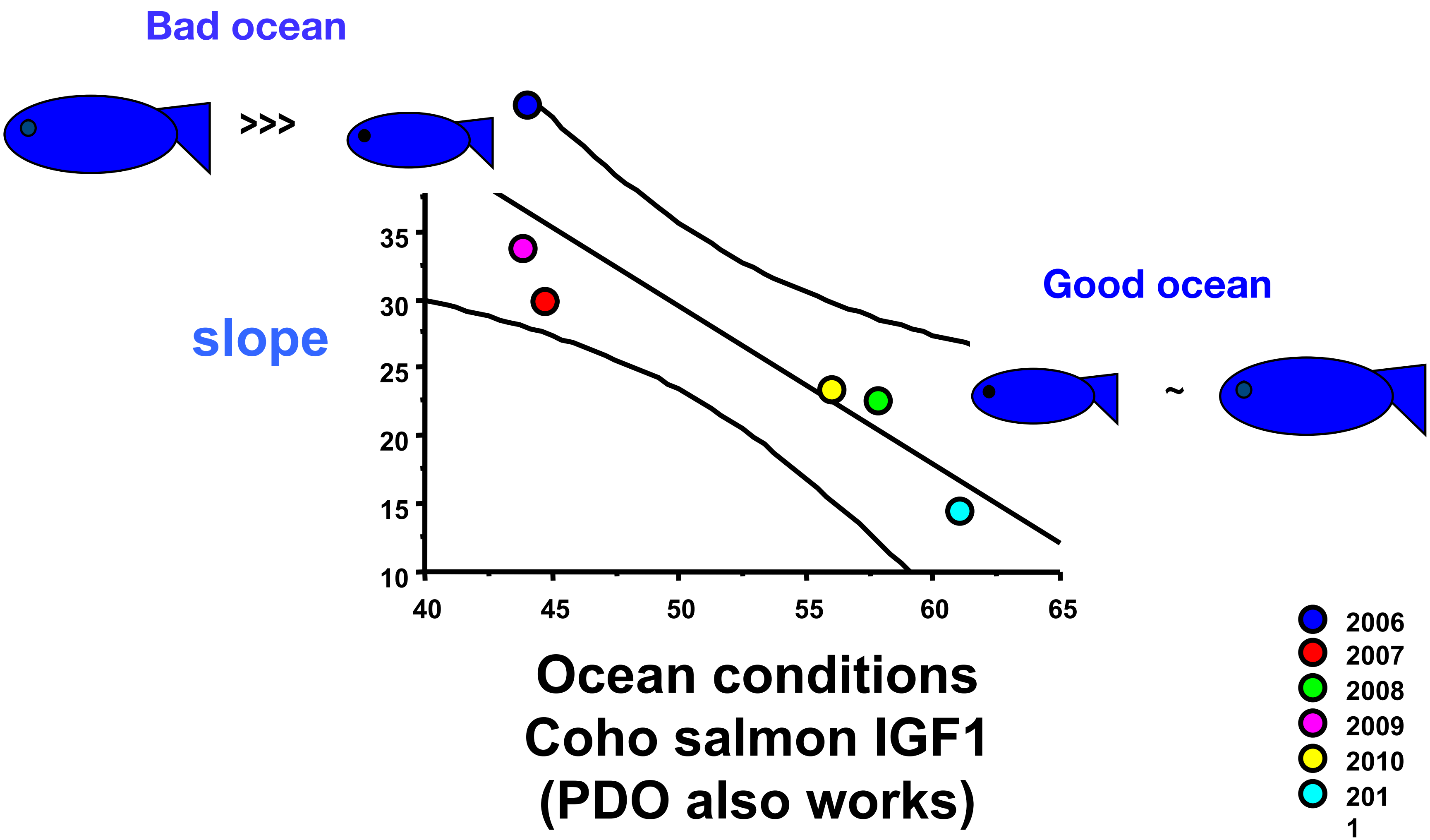
IGF1 - size relationships vary between years in May

(slope of regression line)



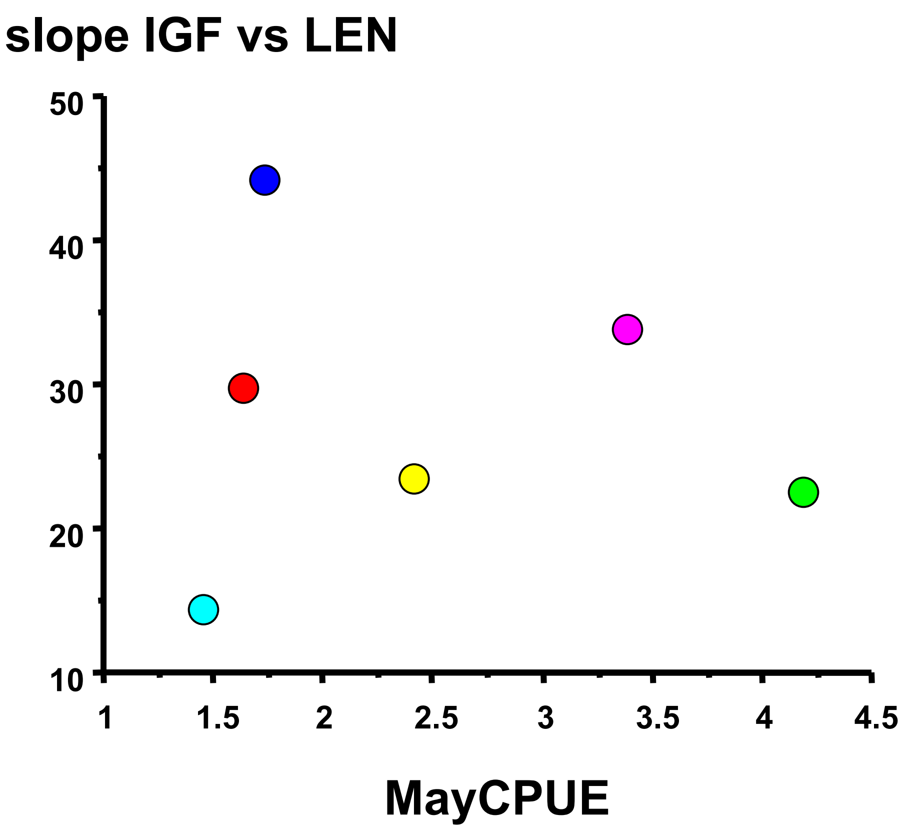
Snake River spring Chinook salmon

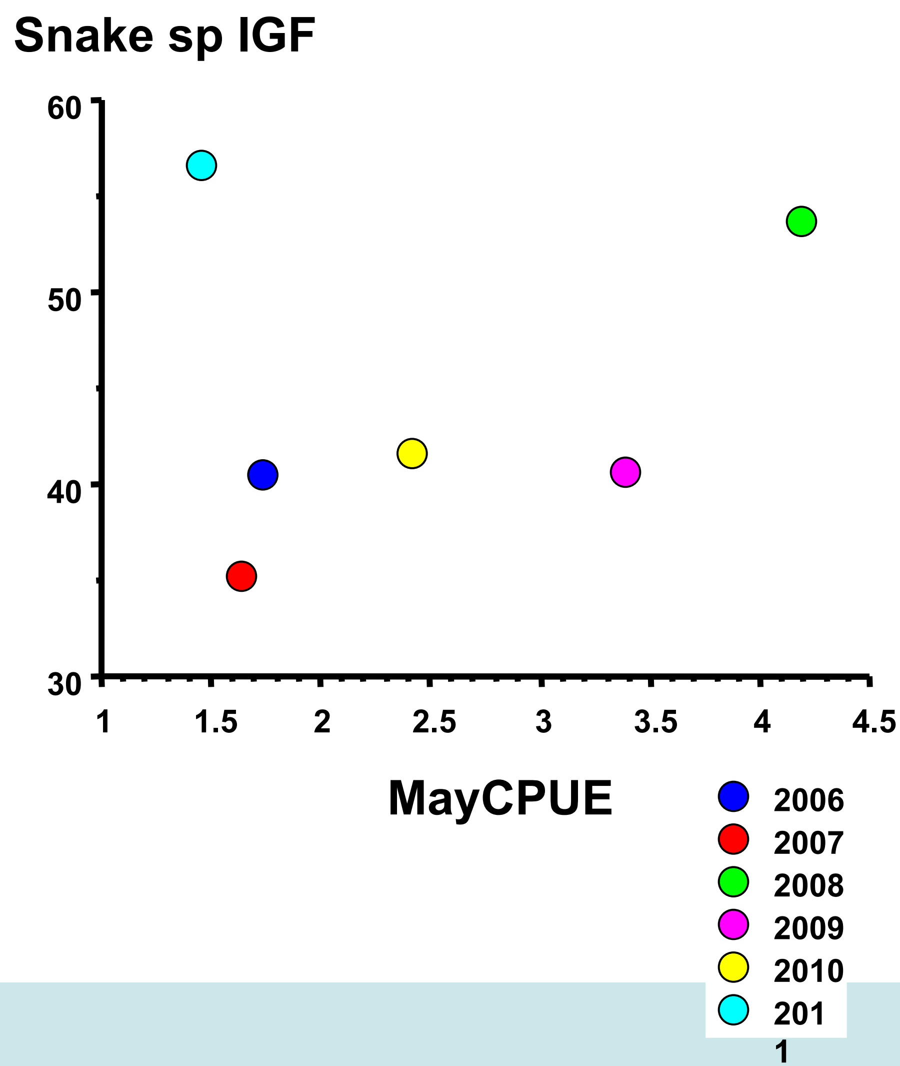
Snake R spring Chinook IGF vs length slope varies with ocean conditions



Ocean conditions
Coho salmon IGF1
(PDO also works)

Neither IGF nor slope IGF vs Length are related to CPUE





Larger fish grow faster than smaller fish in“bad” ocean years

& it’s not related to abundance

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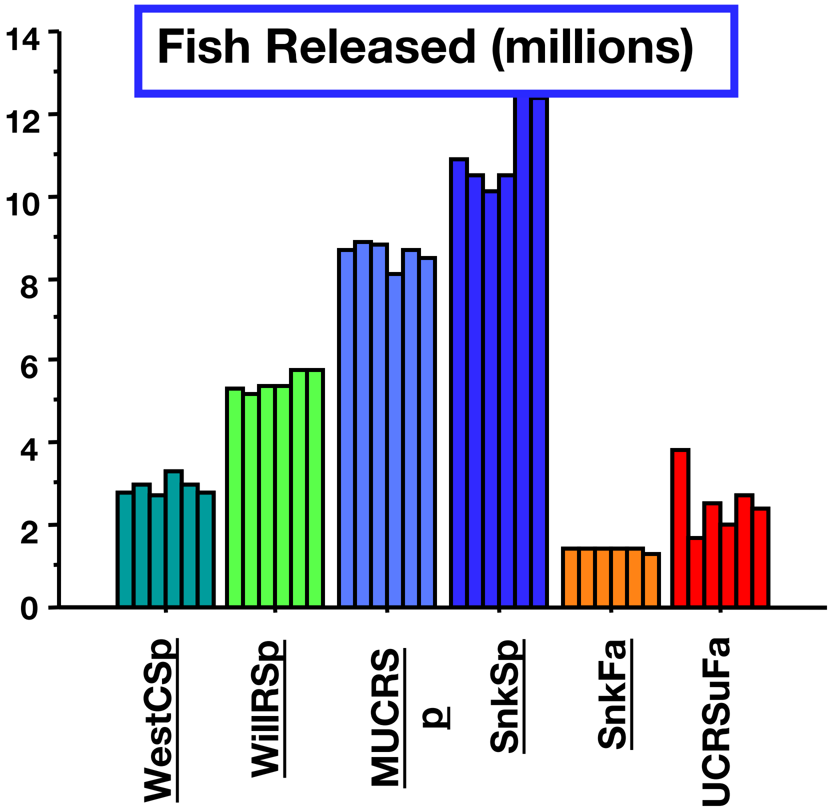
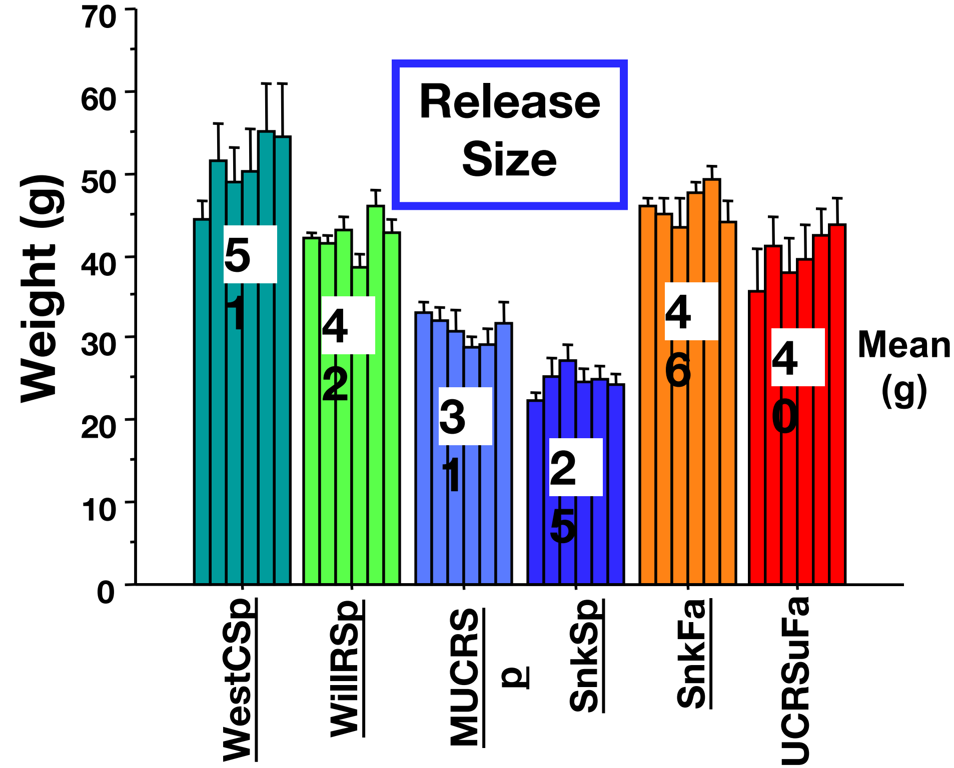
Release size of yearling Chinook salmon varies 2-fold by stock





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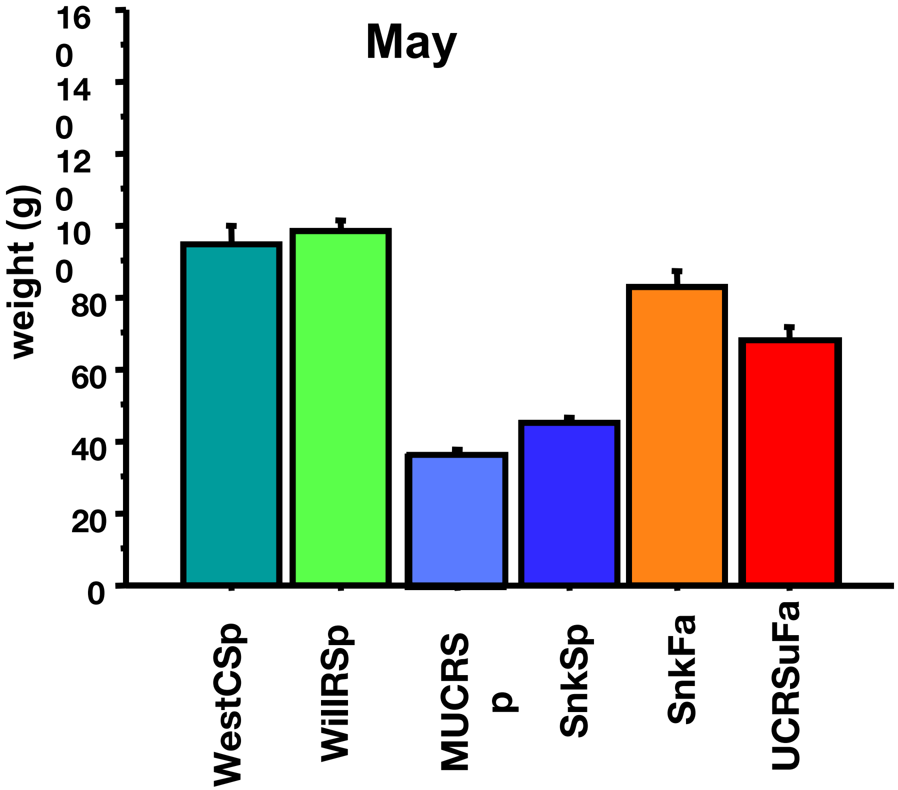
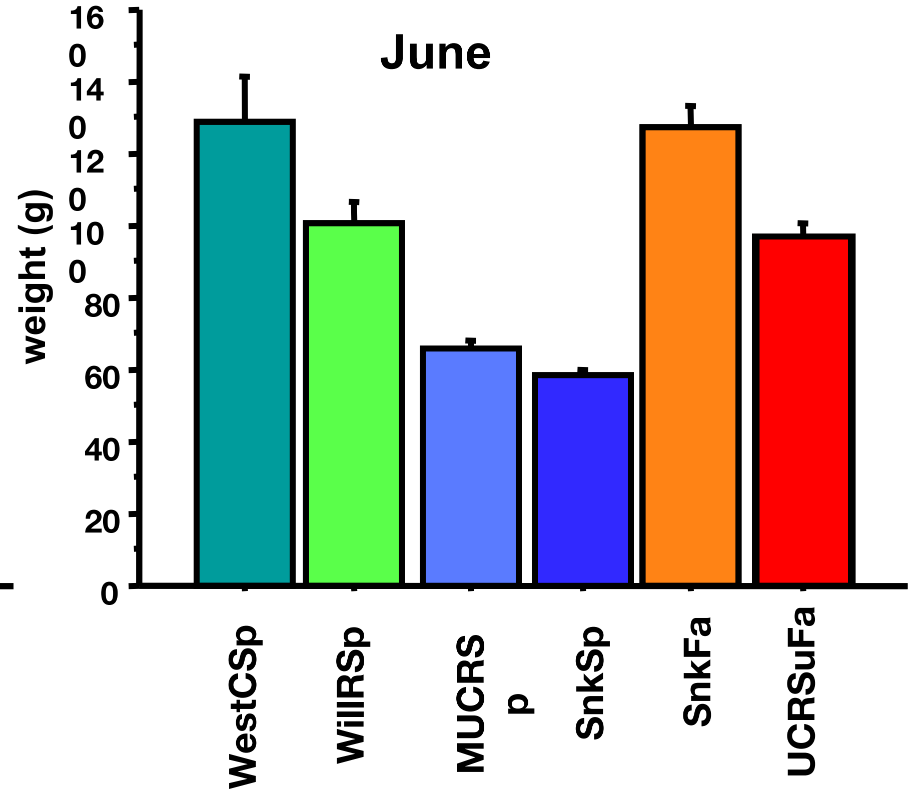
2006 - 2011

Fish Passage Center

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

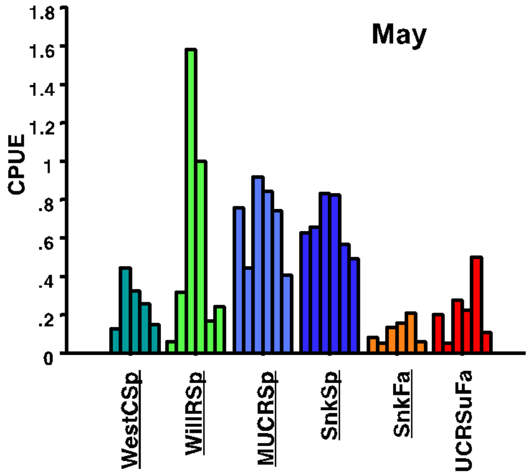
Is there a potential for biased individual competition between fish from different stocks based on hatchery release size?

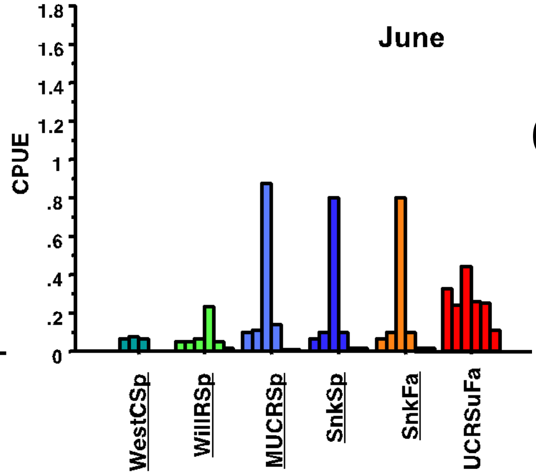




2006-2011

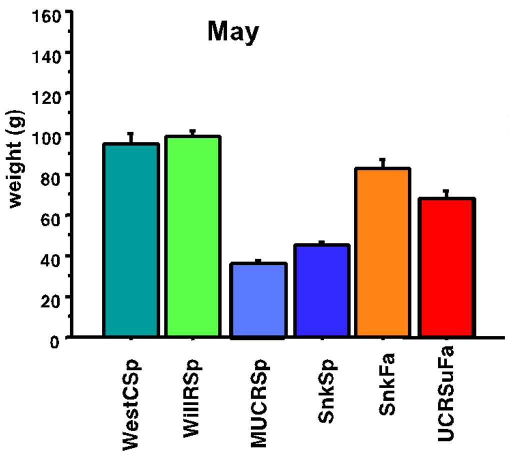
Abundance x Weight = biomass

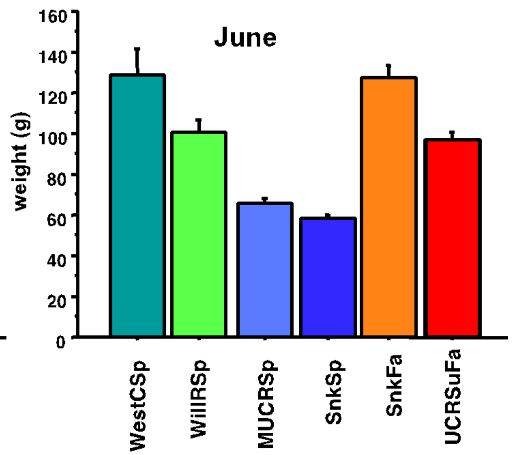




CPUE

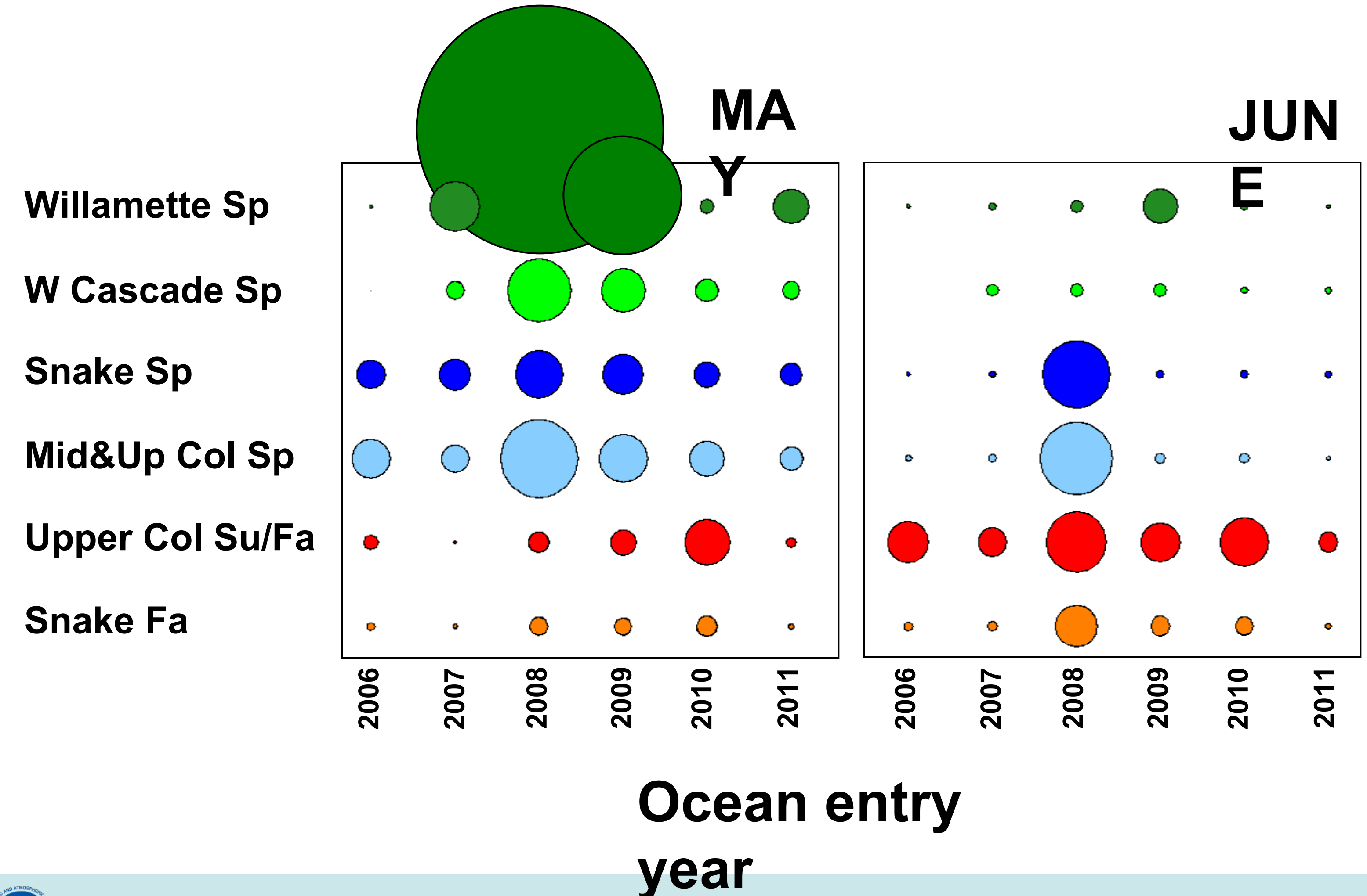
Biomass ~ bioenergetic "load" on ecosystem





Weight

Is there a potential for interactions between different stocks based on ocean biomass?

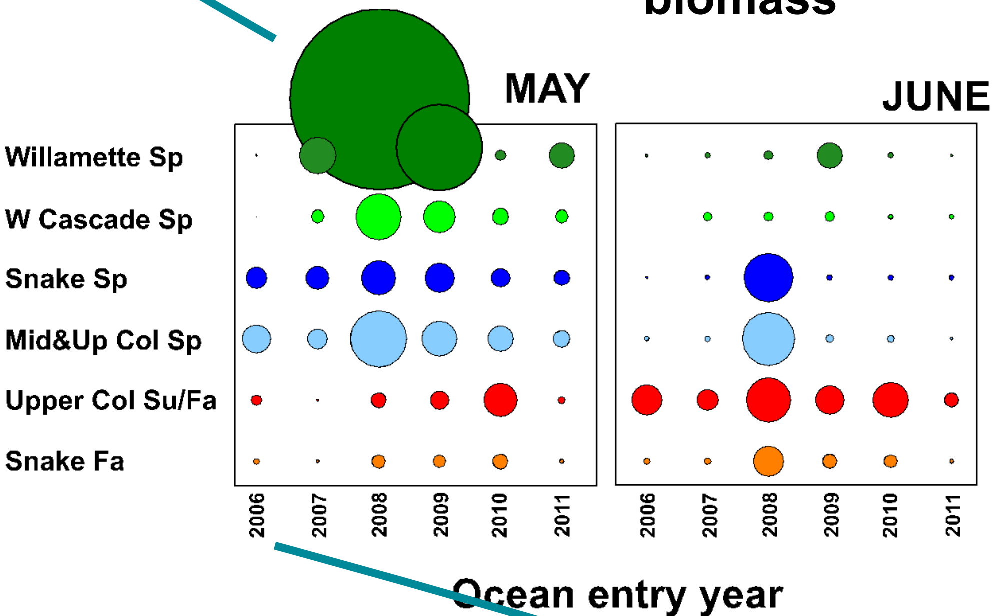


Different stocks have different values:

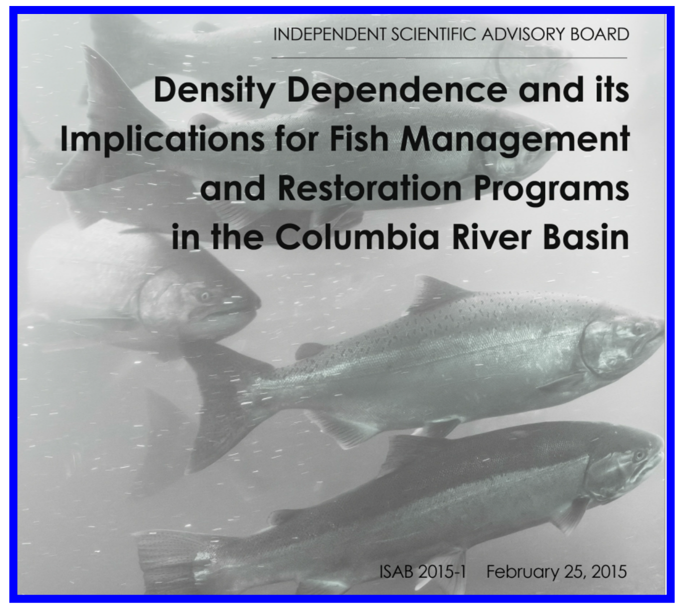
Legal
Economic
Cultural
Recreational

High survival year

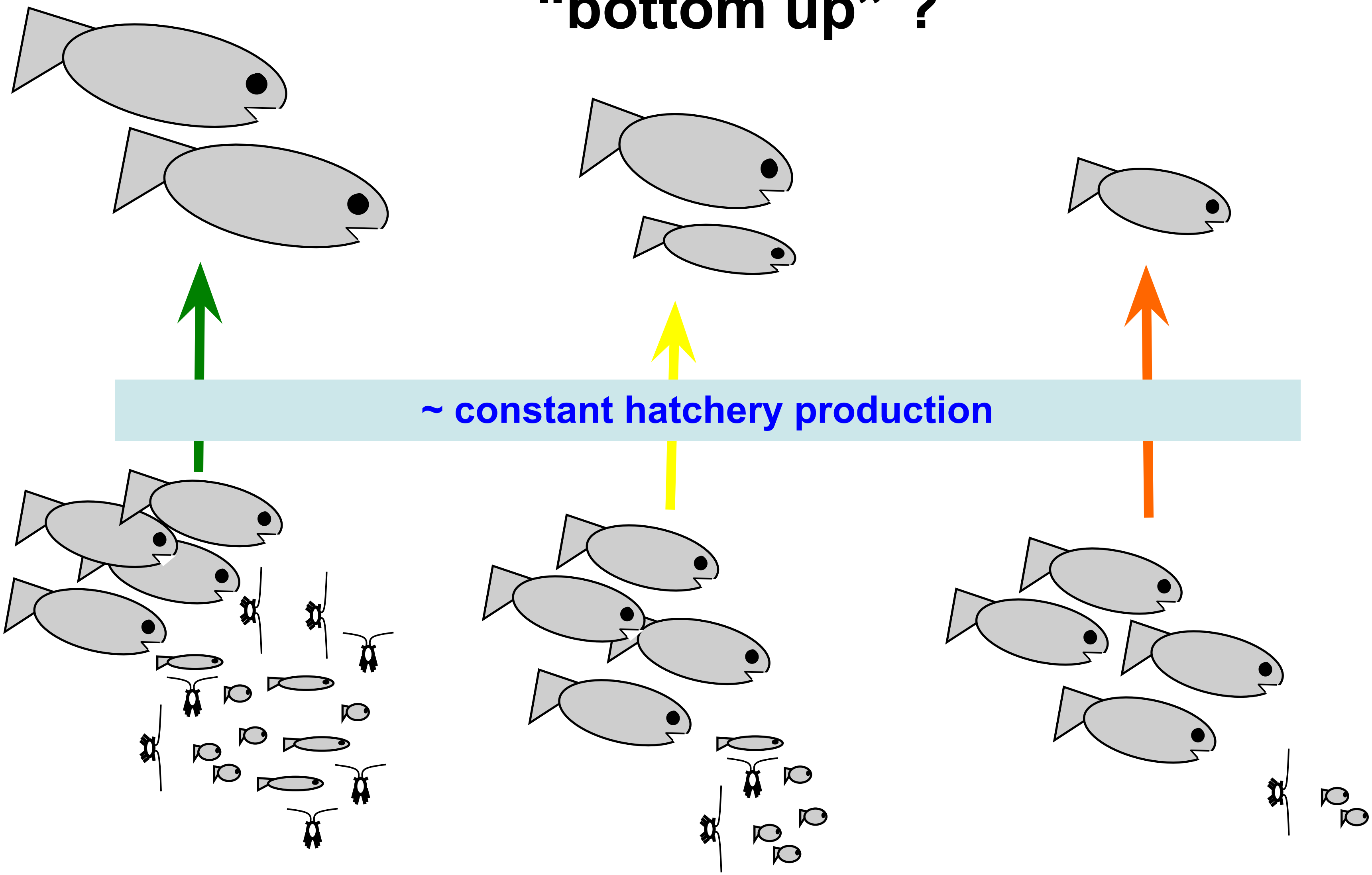
biomass



Low survival year



Density dependence: California Current "bottom up" ?



Varying prey base

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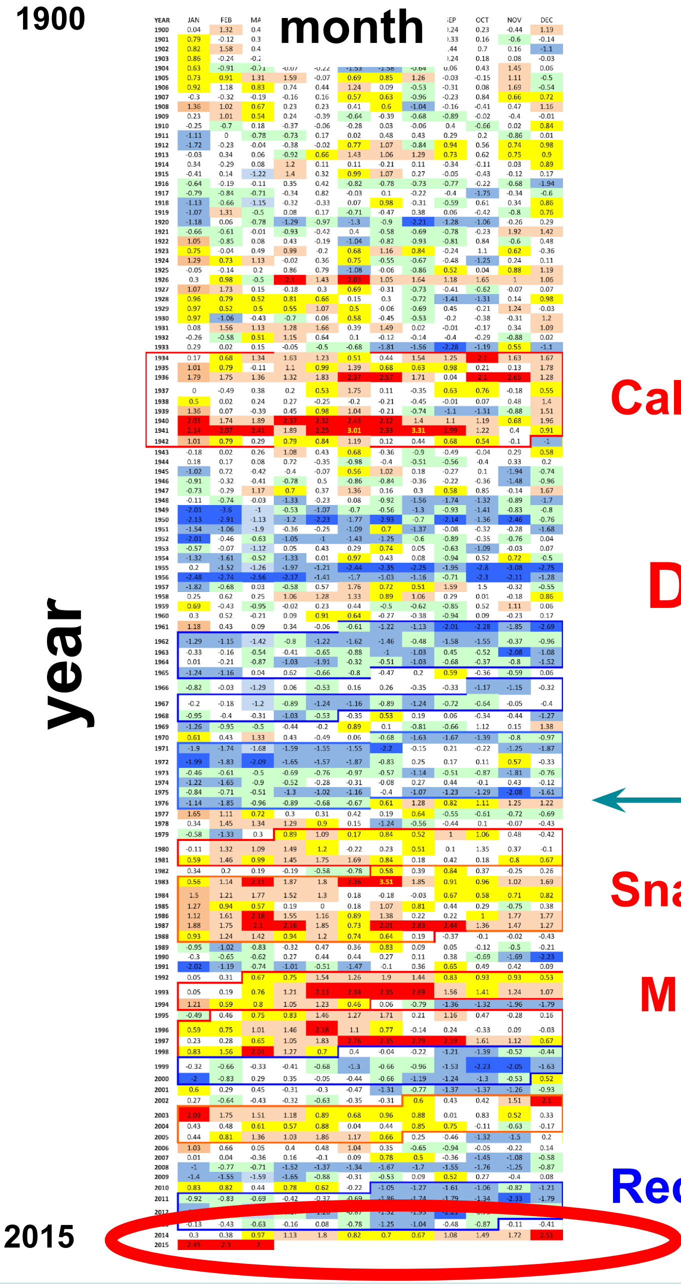
A century of the PDO



California sardine fishery collapses (early 40's)

Dec 14, Jan/Feb 15 – most positive PDO for those months in the record

76/77 regime shift

Snake River coho extinct

Multiple ESA listings West Coast Salmonids

Record returns Col R Chinook & Sockeye

What's happening now (2015)?

Carrying capacity may be significantly reduced

Density dependent processes may be magnified

Size-b **A natural experiment is occurring: how do we take advantage?** **wild)?**

Surviv

NWFSC

- **4 day May survey (1st May survey since 2012)**
- **10 day June survey**
- **AFSC survey in Gulf of Alaska (July)**

Summary

Growth and survival vary

- Correlated in many years

Data suggest it might be worth thinking about density dependence (in some years)

Many management, political and scientific issues to consider along with density dependence

Acknowledgements

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Dave Metzger
Don Larsen
Meredith Journey
Penny Swanson
Walt Dickhoff

Captains & Crew
F/V Frosti