Growth of yearling Steelhead smolts in the Columbia River Estuary 2016 – 2017

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Columbia River Estuary Conference, 10 - 12 April, 2018

1. **Think about smolt migration in the Col R estuary**

   (this will be kinda arm wavey)

2. **Steelhead growth in the estuary**

   By stock and migration pattern

3. **Steelhead growth in the plume**

4. **Implications?**

Variability in estuarine/early ocean mortality drives population productivity

Recovery and Management Options for Spring/Summer Chinook Salmon in the Columbia River Basin

Peter Kareiva,[1] Michelle Marvier,[2] Michelle McClure[1]*

Construction of four dams on the lower Snake River (in northwestern United States) between 1961 and 1975 altered salmon spawning habitat, elevated smolt and adult migration mortality, and contributed to severe declines of Snake River salmon populations. By applying a matrix model to long-term population data, we found that (i) dam passage improvements have dramatically mitigated direct mortality associated with dams; (ii) even if main stem survival were elevated to 100%, Snake River spring/summer chinook salmon (*Oncorhynchus tshawytscha*) would probably continue to decline toward extinction; and (iii) modest reductions in first-year mortality or estuarine mortality would reverse current population declines.

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Larger smolt size = increased survival

ECOLOGY
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Regular Article

RELATING SIZE OF JUVENILES TO SURVIVAL WITHIN AND AMONG POPULATIONS OF CHINOOK SALMON

Richard W. Zabel, Stephen Achord

First published: 1 March 2004 Full publication history

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Survival varies with ocean entry timing

Journal of Applied Ecology

Journal of Applied Ecology 2009, **46**, 983–990 doi: 10.1111/j.1365-2664.2009.01693.x

Relating juvenile migration timing and survival to adulthood in two species of threatened Pacific salmon (*Oncorhynchus* spp.)

Mark D. Scheuerell*[1], Richard W. Zabel[1] and Benjamin P. Sandford[2]

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Significant variation in Estuary/Ocean mortality

Size of smolts influences survival

Ocean entry timing influences survival

=> process that influence smolt size and timing of ocean entry will affect survival

The pipe paradigm: The lower river acts as a pipe, conveying fish from Bonneville Dam to the Ocean

Variation in smolt migration and growth through estuary exists on a fast-low vs slow-high continuum

Species: Steelhead vs chum

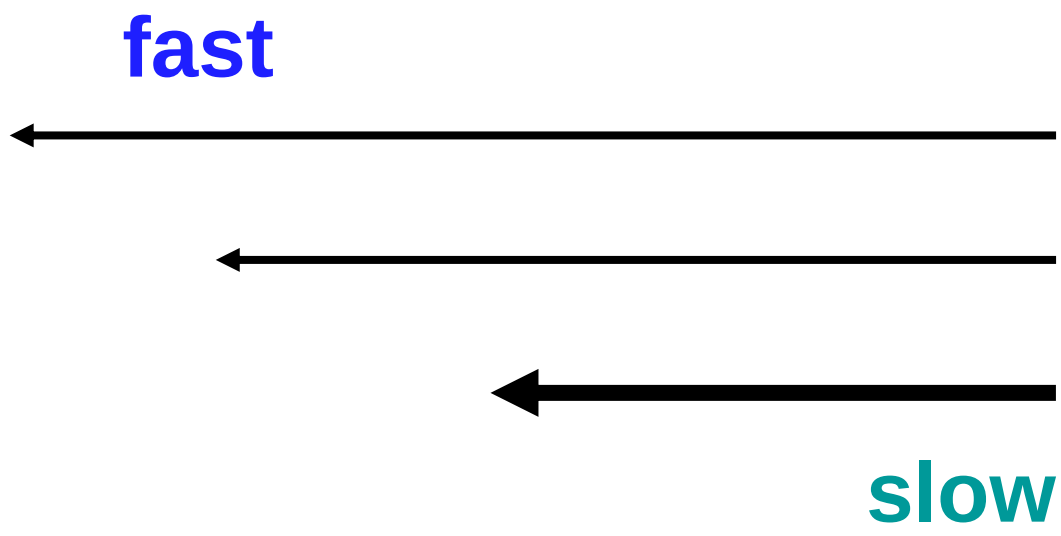
Chinook populations: Snake Riv spring (yearling) vs West Cascade Falls

Not all fish are stuck in a pipe (sub-yearling migrants)

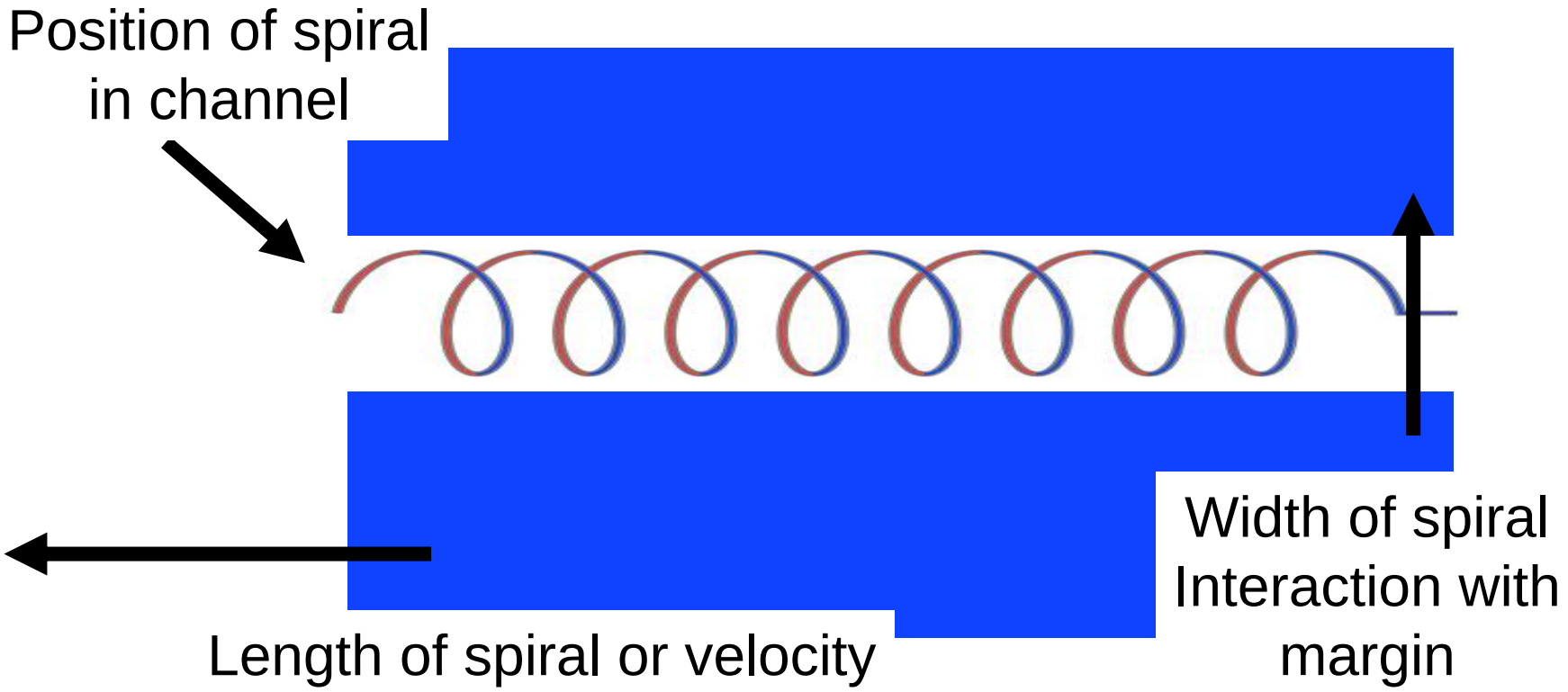
Is there variation in migration between individuals or populations for yearling smolts?

Conceptual model for variation in smolt migration?

Current assessment of migration is based on rates (velocity) - km/day



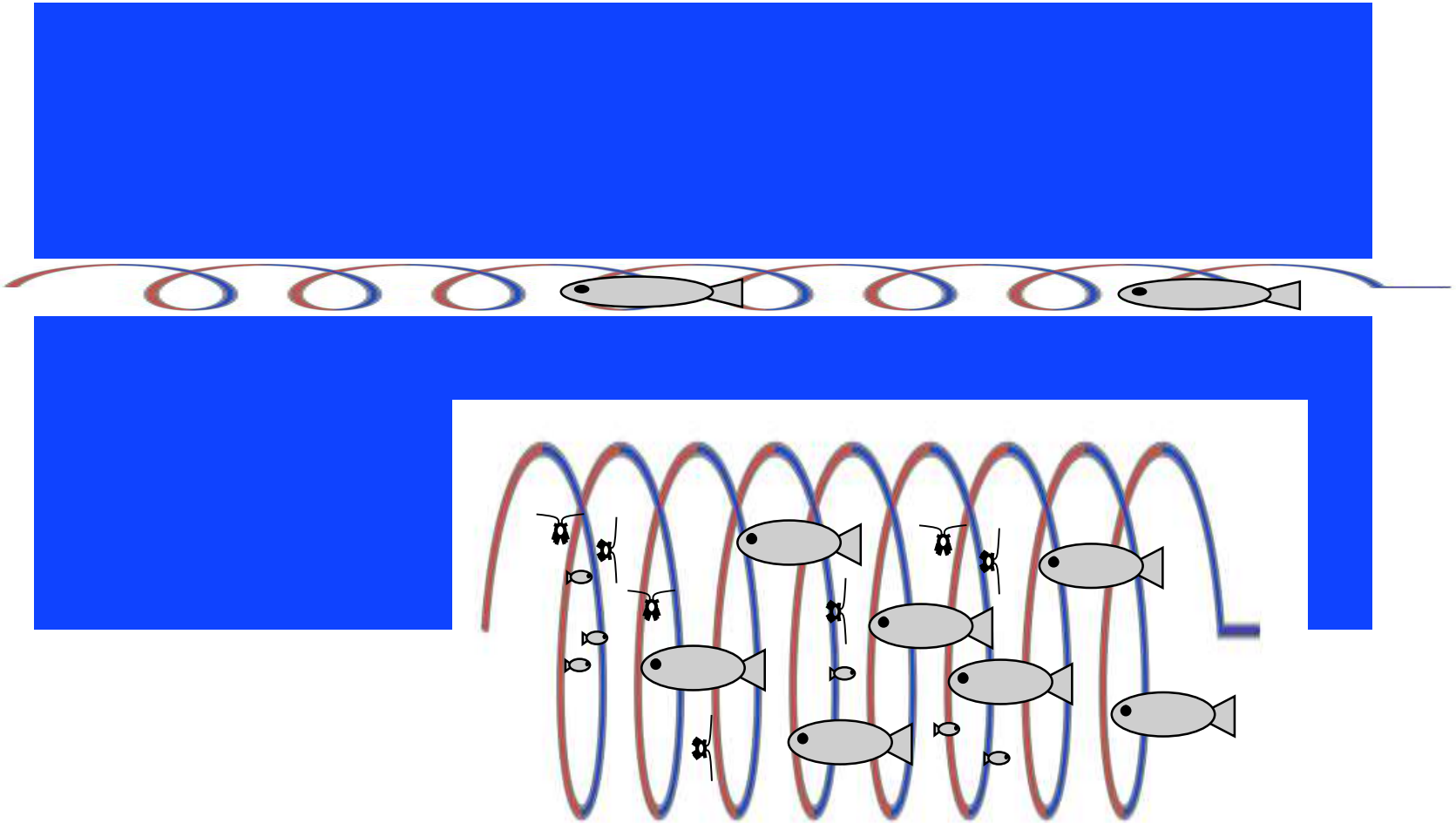
Downstream movement can be conceptualized as a spiral



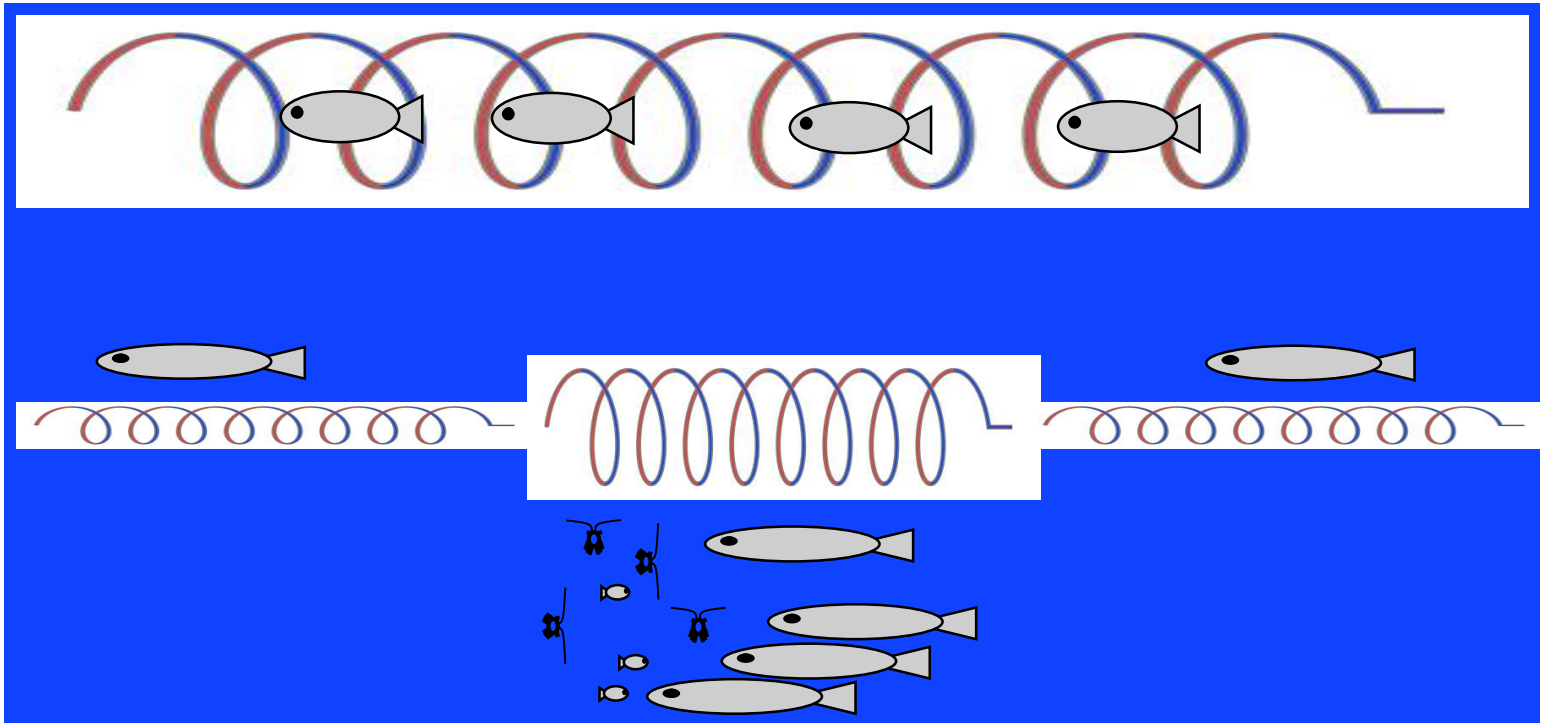
and quantified

Yearling migration = loose/long spiral in middle

sub-yearling migration = tight/short spiral on edge



Intermediate or saltational spiral?



ebb flood ebb

Goal:

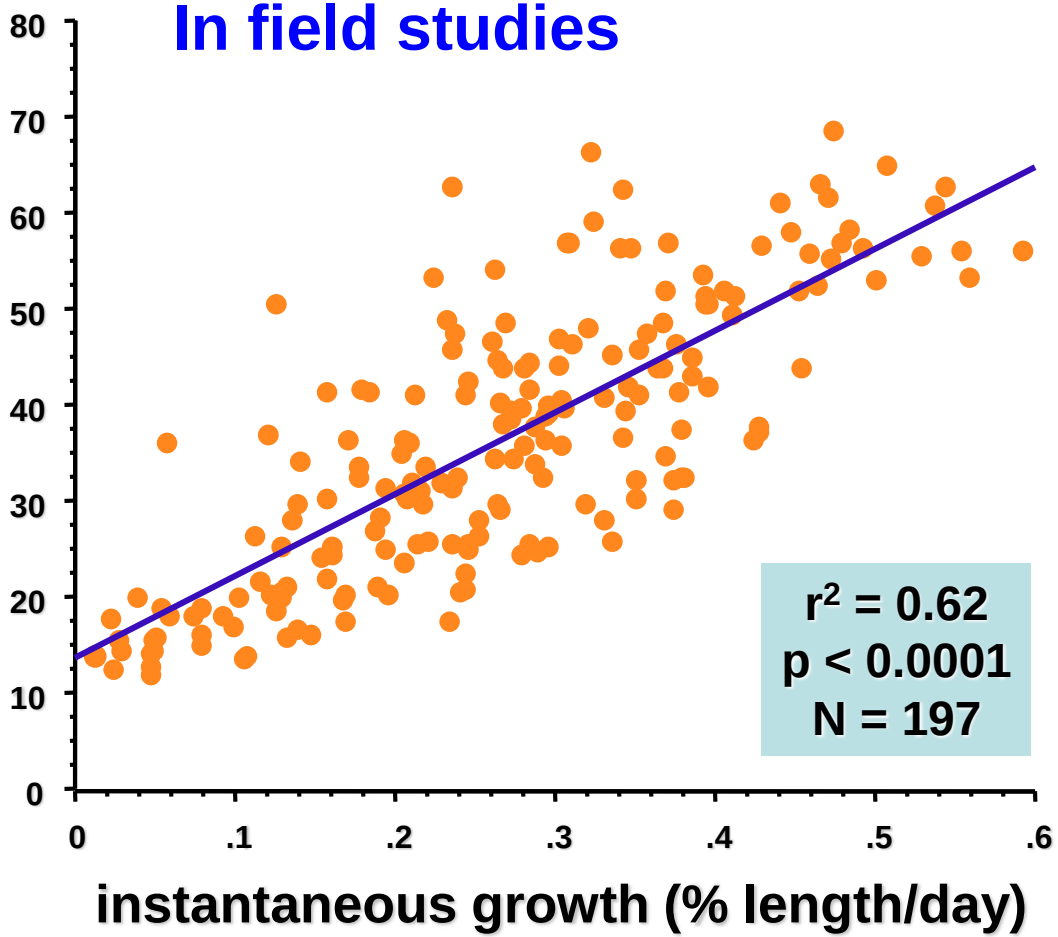
Assess if yearling steelhead smolts interact with estuarine wetland regions.

Test for different migratory patterns?

Presence/absence: traps, nets
Tags: passive, active
Markers: otoliths, scales
Feeding/growth*

The hormone insulin-like growth factor 1 (IGF1) is related to growth

Blood samples for assessment of IGF1 may be obtained In field studies

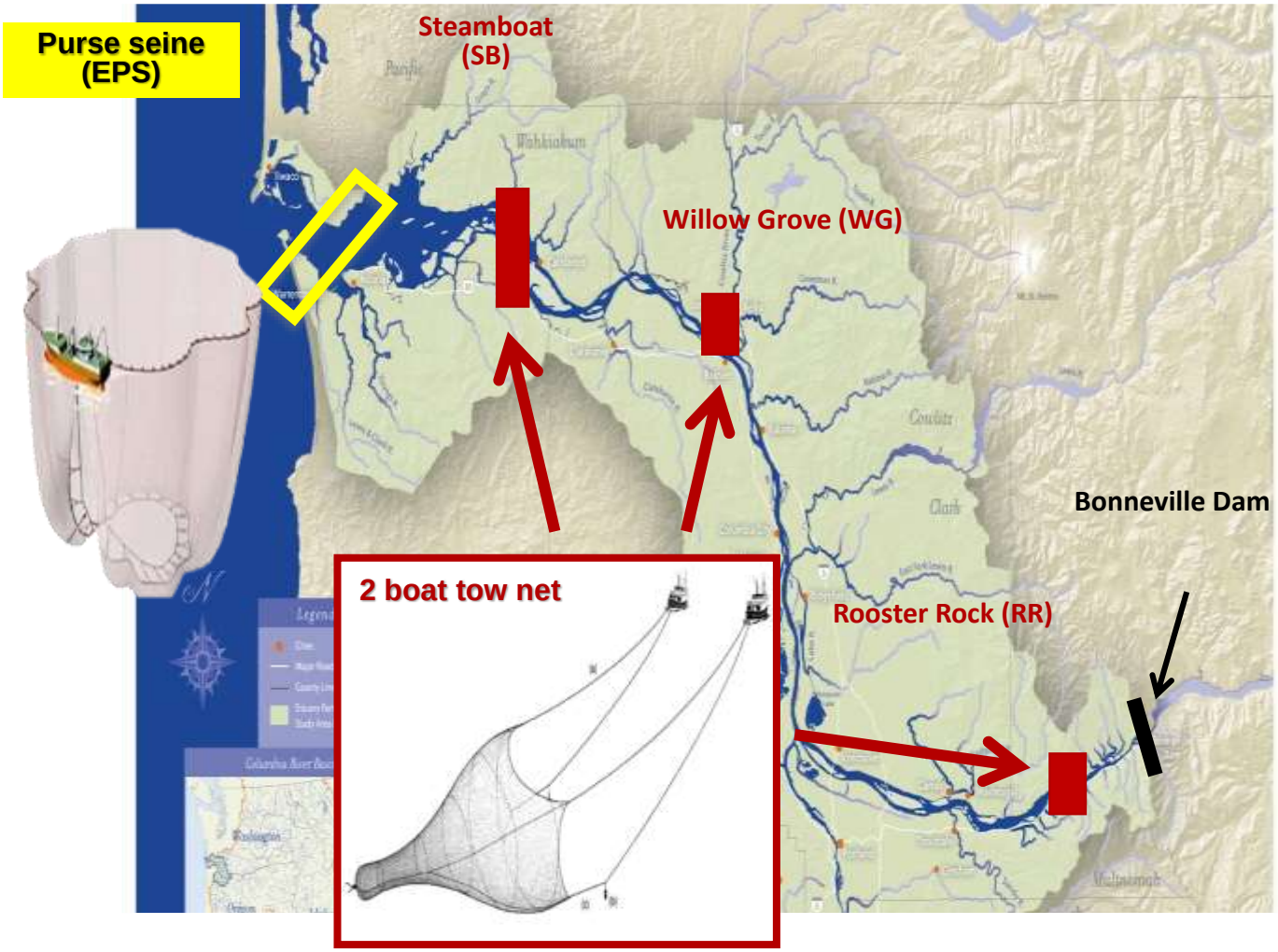


Post-smolt coho salmon
PIT-tagged
6 week growth interval
seawater

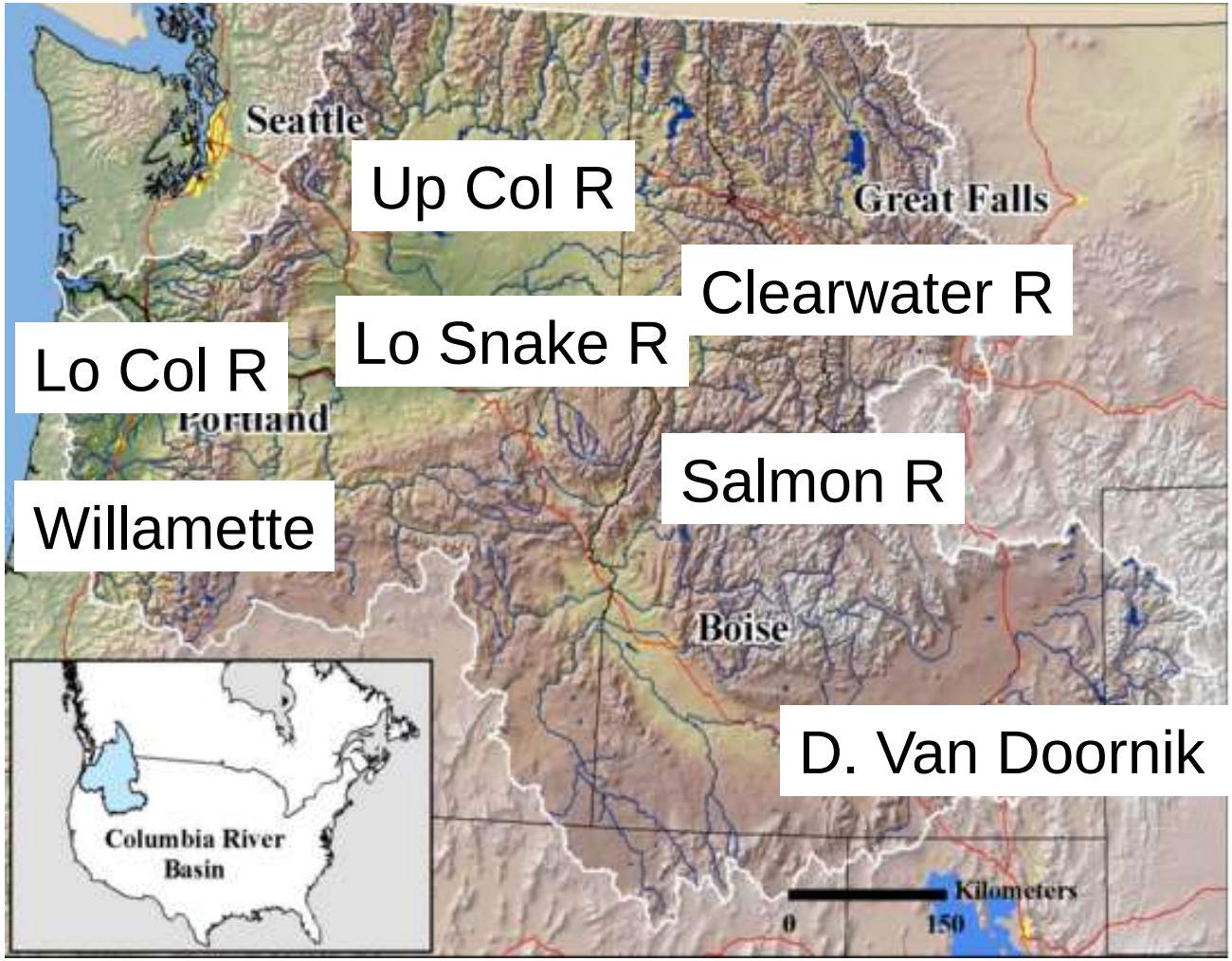
*TRF immunoassay

Beckman et al. 2004 TAFS

AEMR study 2016 and 2017



Columbia Basin Steelhead stocks are distributed in both up-river and lower river locations



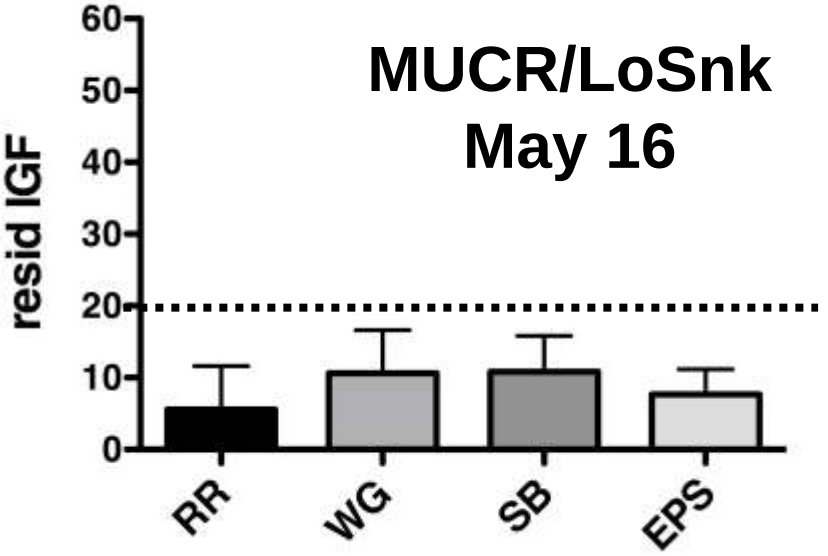
D. Van Doornik in prep

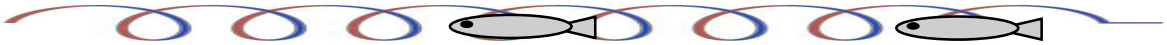
Data!! Does the pipe have leaks?

Growth of steelhead smolts

Pattern 1

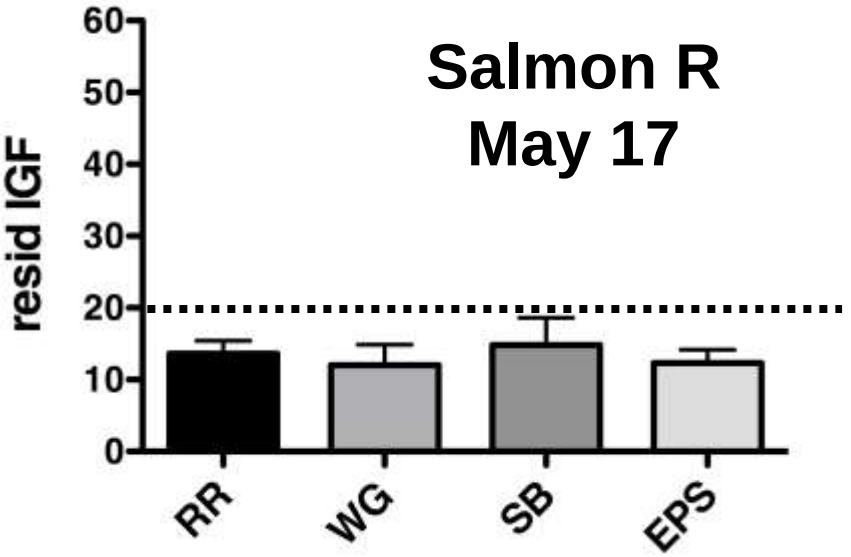
Low IGF1 level
Low variability





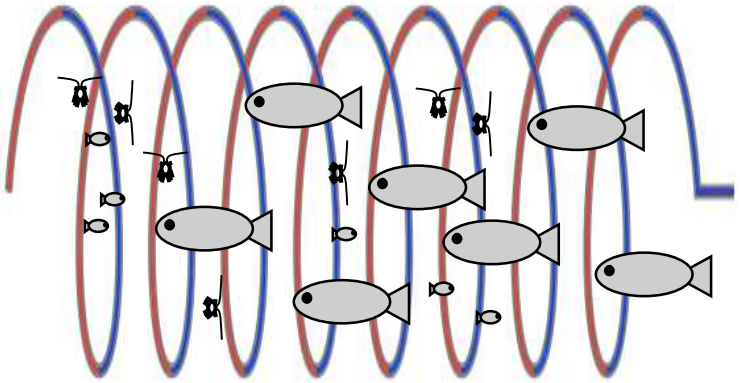
loose/long spiral

Rapid migration
Little feeding/growth



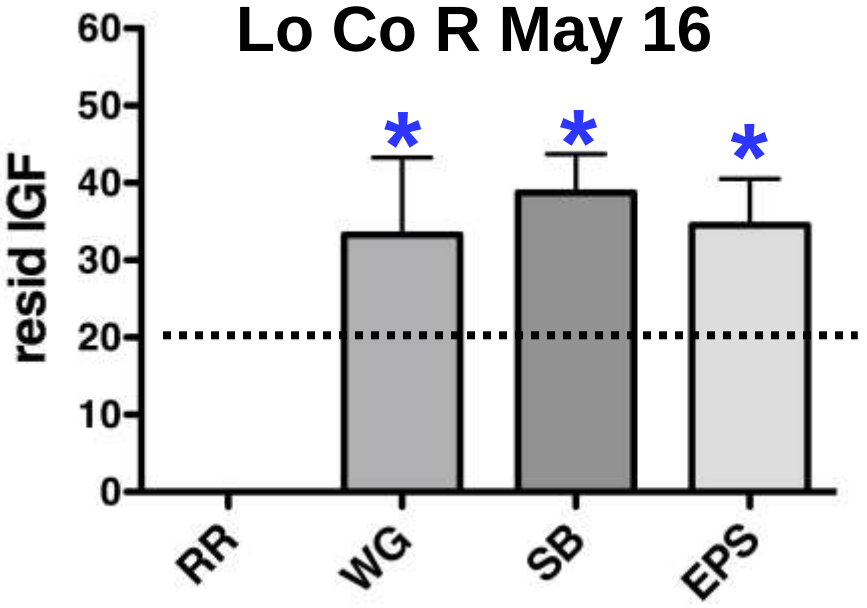
Pattern 2

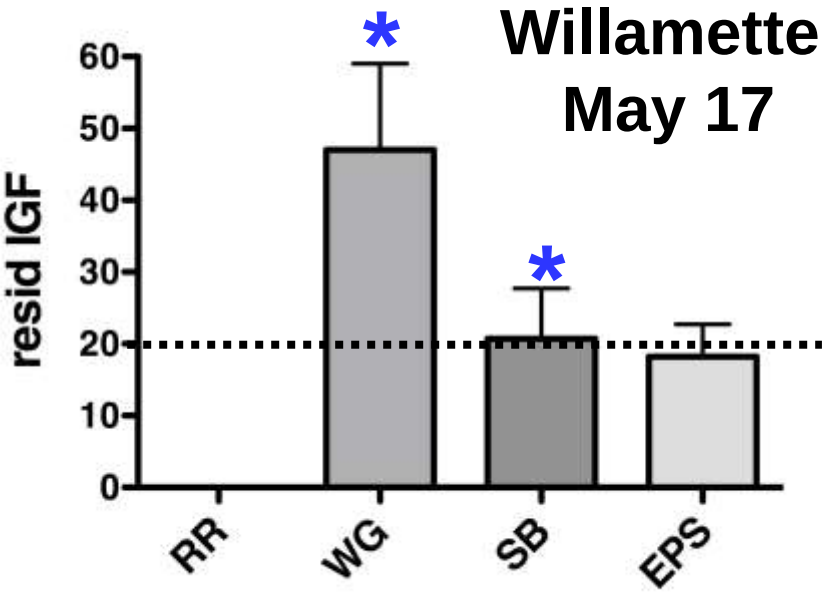
Moderate to high level IGF1



tight/short spiral

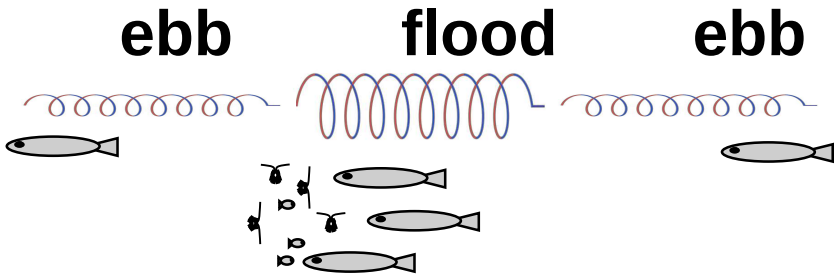
Slow migration
Significant feeding/growth





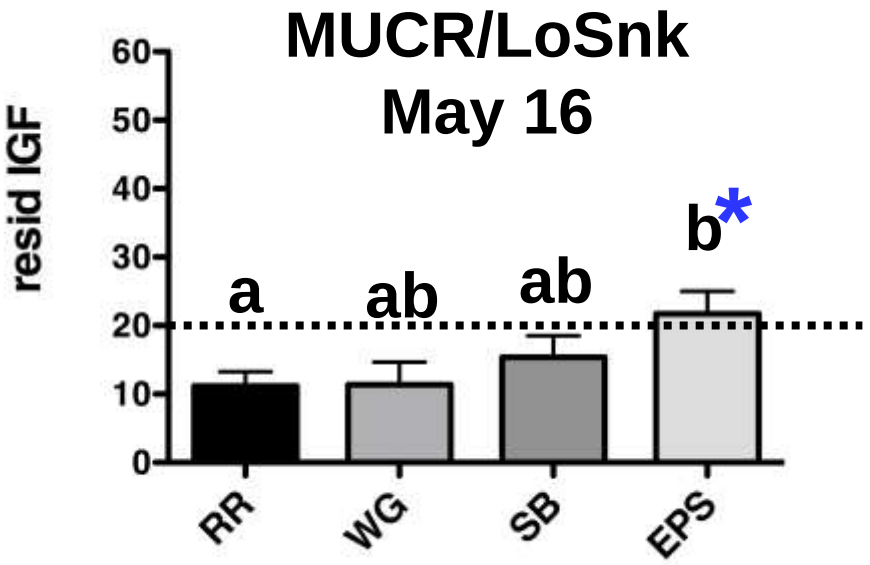
Pattern 3

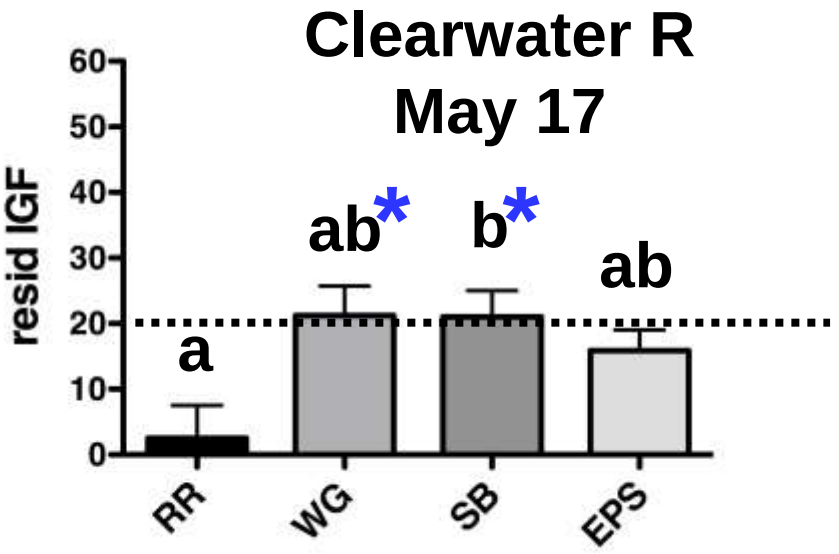
Low to moderate IGF1 level
varies between sites



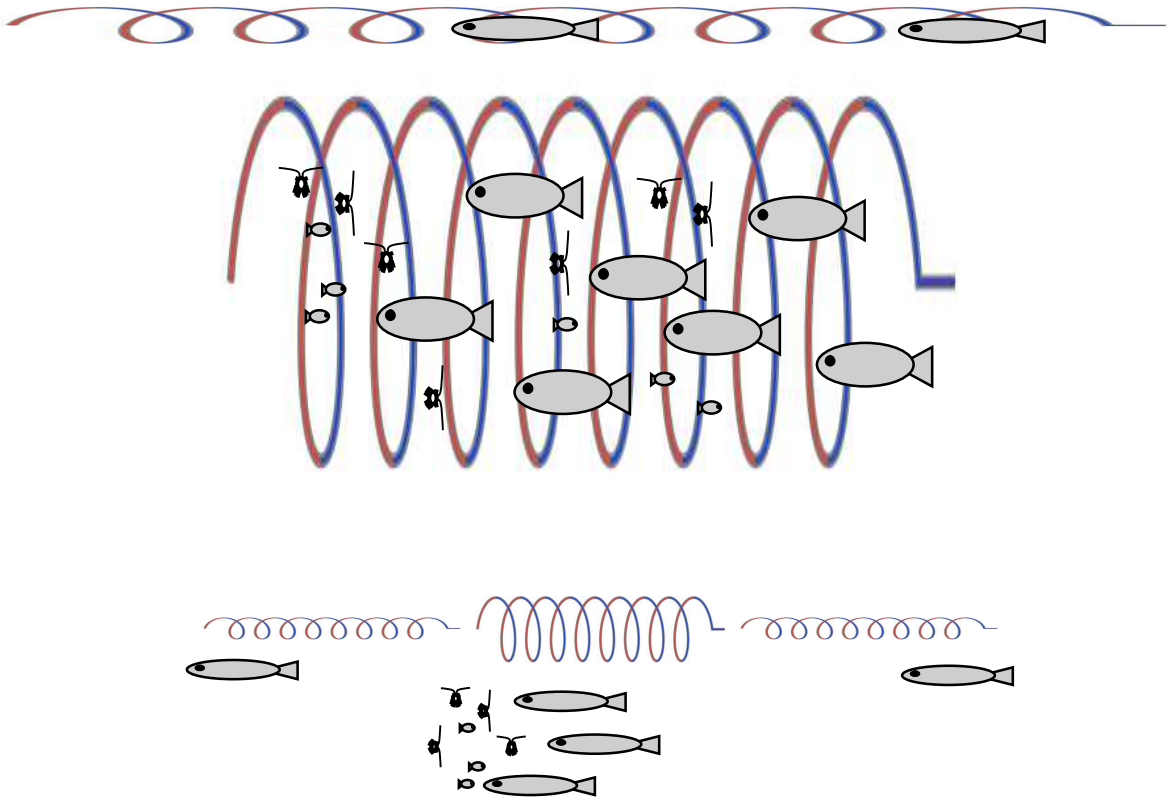
Saltational spiral

Intermediate
Intermittent feeding/growth





Variation in IGF1 pattern within and between stocks: consistent with different migration patterns



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ARTICLE

Stock-Specific Size and Timing at Ocean Entry of Columbia River Juvenile Chinook Salmon and Steelhead: Implications for Early Ocean Growth

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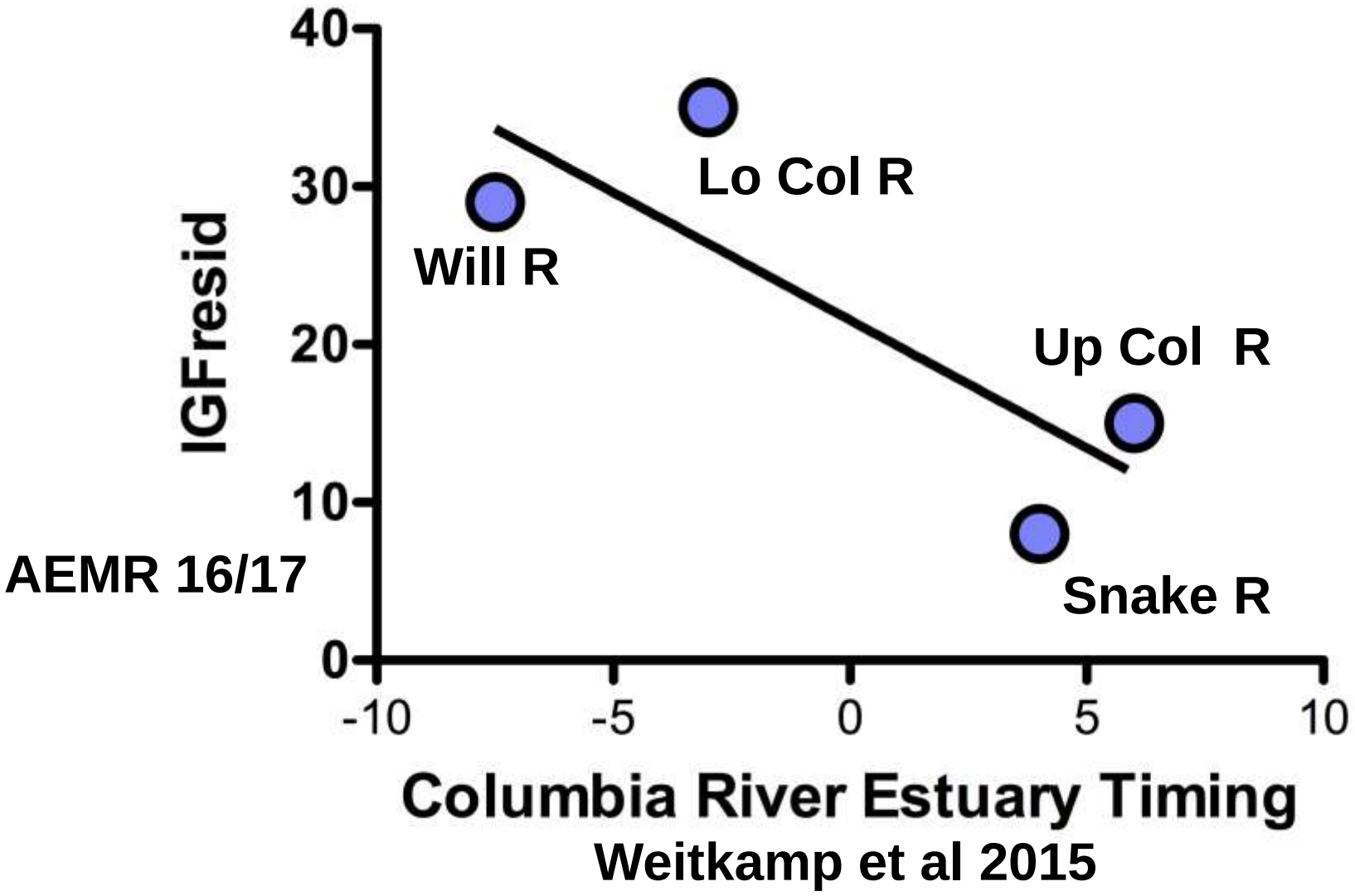
Steelhead migration rate by stock

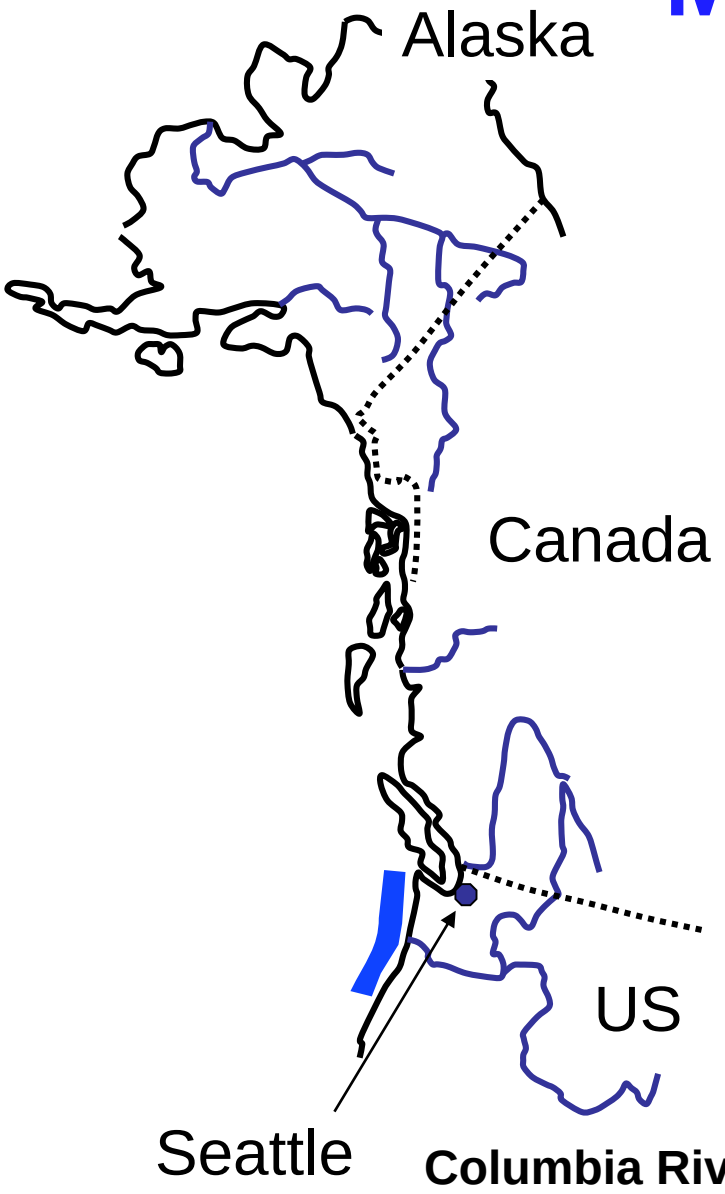
Variation in migration and growth through estuary exists on a fast-low vs slow-high continuum: yearling steelhead smolts AEMR 16/17

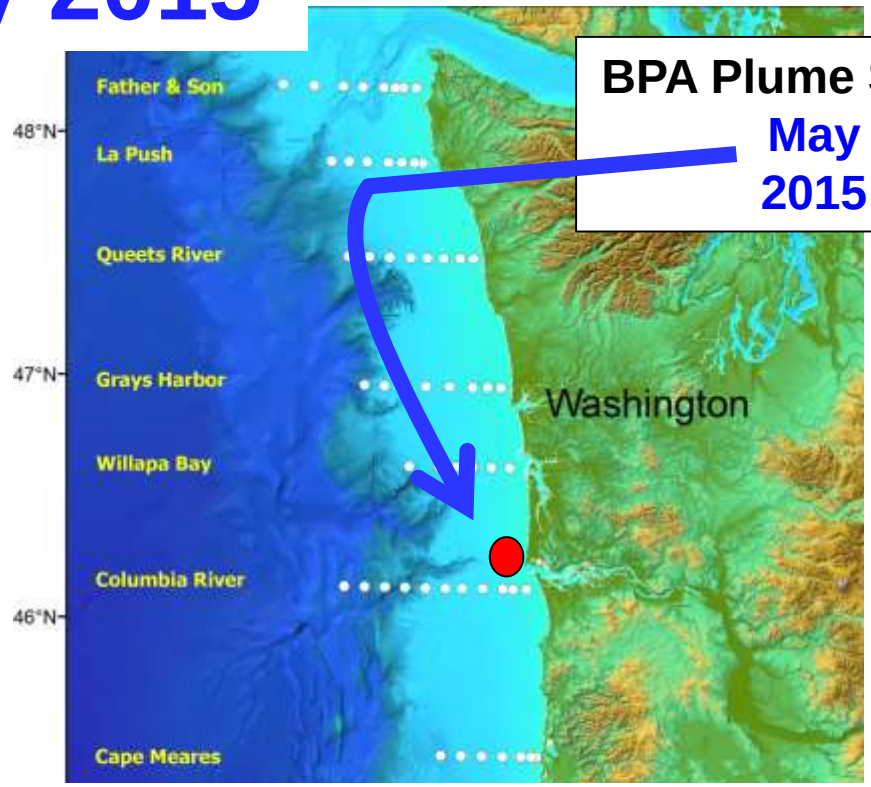


Weitkamp et al 2015


The ocean: May 2015
Photo by Pacific Drone

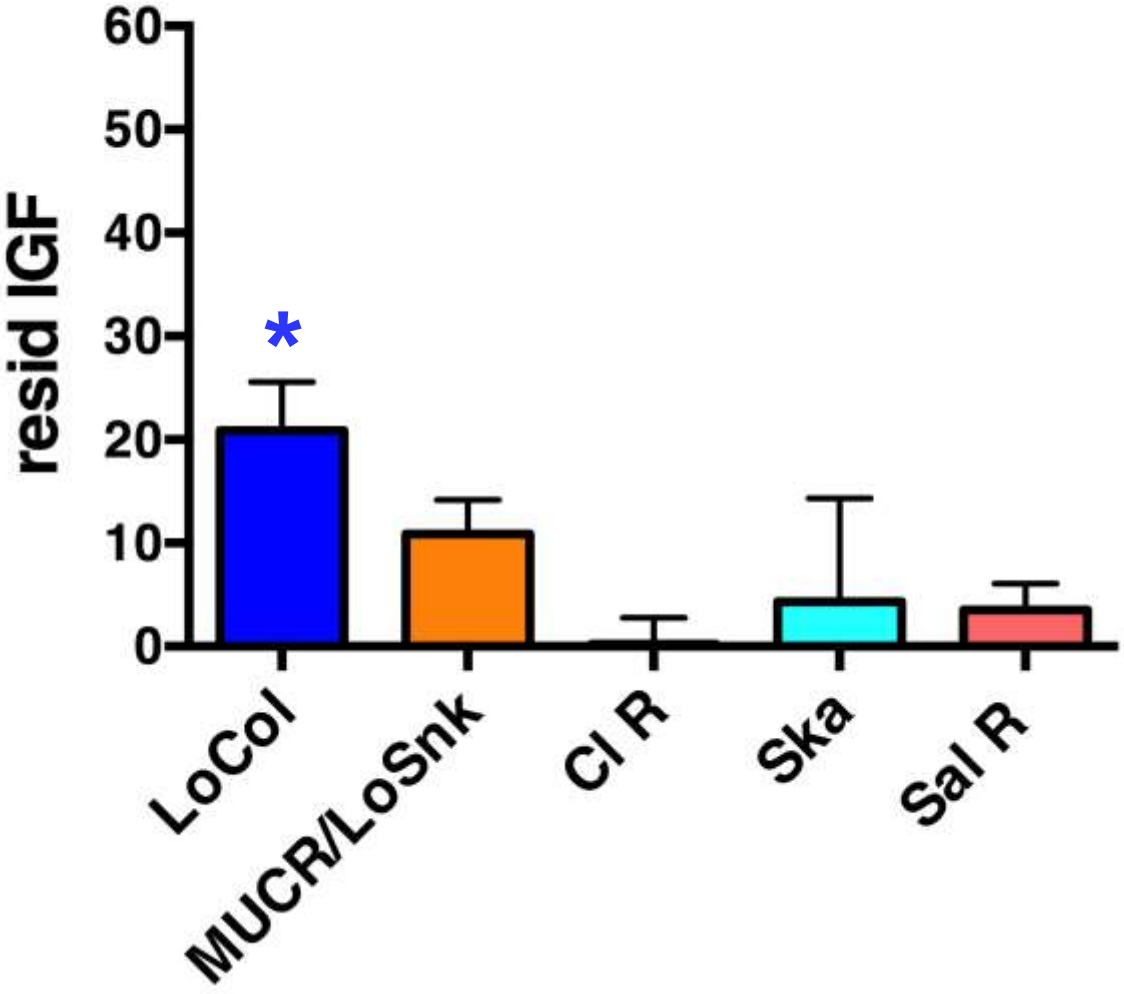
May 2015



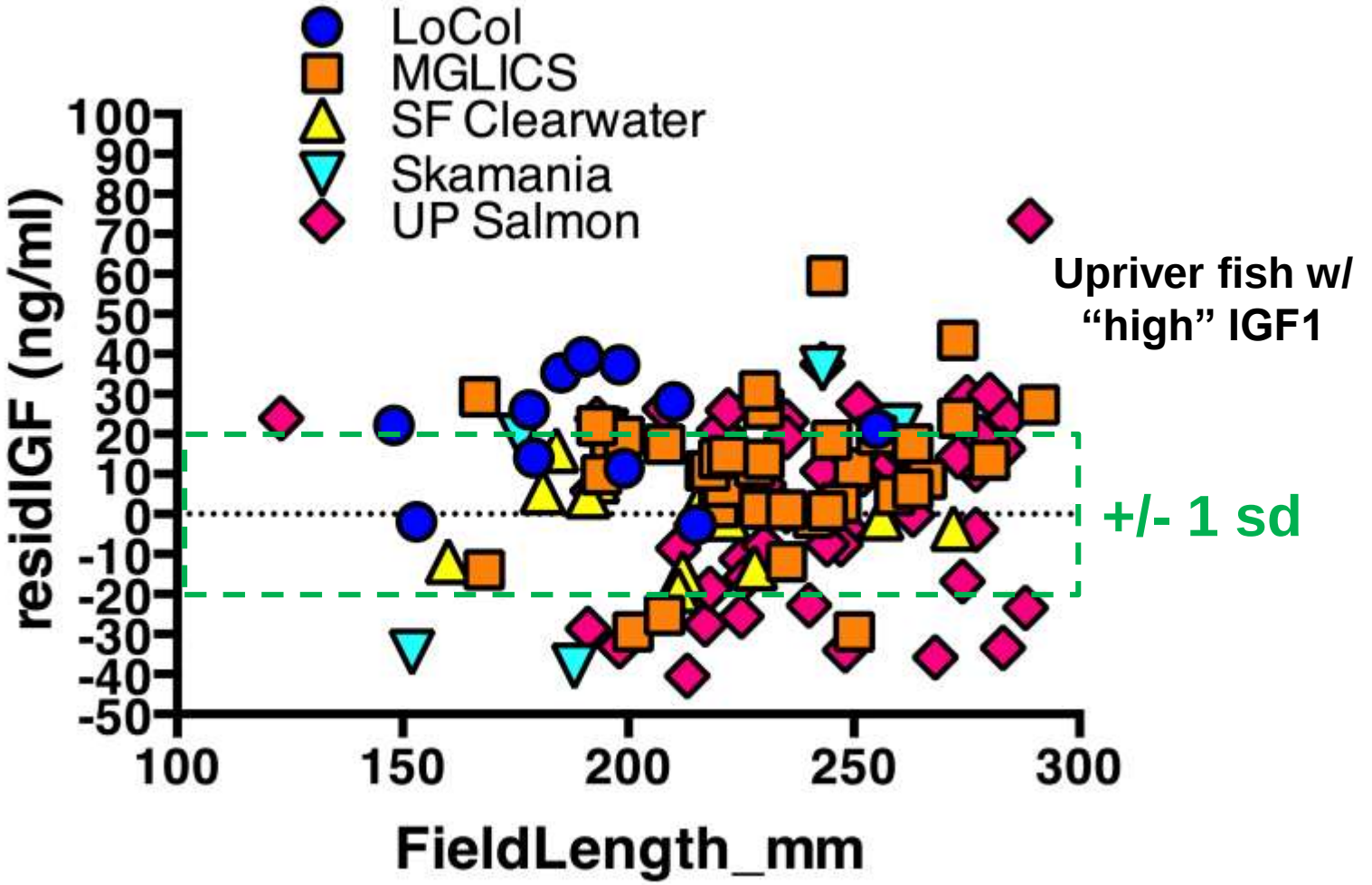


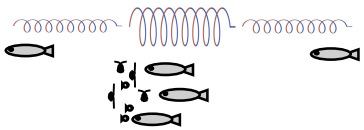
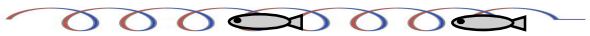
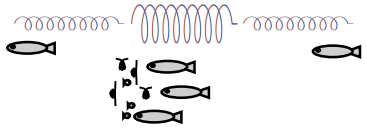
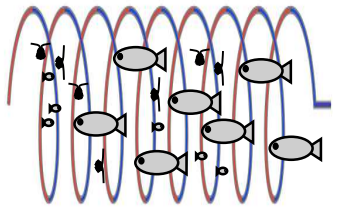
Just outside Col R Mouth
Caught more steelhead in one tow than in the previous 10 years

Growth varies among steelhead stocks entering the plume



Growth varies among individuals between steelhead stocks in the plume



	for given population		
	% < 1 sd	% > 1 sd	
	low	high	
Salmon R			
2015 (plume)	**20**	**25**	
Clearwater R			
2015 (plume)	**7**	**7**	
MUCR/LoSnk R			
2015 (plume)	**8**	**28**	
LoColR			
2015 (plume)	**0**	**64**	

True confessions

Yearling steelhead smolts

Steelhead summary:

Unexpected level of variation in growth

Different patterns of growth

How can these results be shown to be significant on a population level?

Individual traits

1. Can we link estuarine growth, to changes in smolt size, to variation in marine survival?

Size = growth x time

2. What are residence times in the estuary?

Population traits

3. What is the frequency distribution of various residence times?

=> proportion of population that has a “significant” increase in size

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Estuary
Field crew: Jake Biron, Wayne Haines, Dave Beugli
Boat operators: Brian Kelly, Kaya Johnson, Anna Kagley

Plume
Cheryl Morgan, Brian Burke, Shelly Nance, Kurt Fresh,
Captain and crew F/V Frosti

The baseline: migrating smolts in Snake River reservoirs