Indirect benefits of habitat restoration on juvenile salmon*: results from the

and flux

landscape-scale action effectiveness study

Laurie Weitkamp, Kym Jacobson, Brian Beckman, Don Van Doornik, Kurt Fresh, Curtis Roegner

Northwest Fisheries Science Center, NOAA Fisheries

Angelica Munguia and Jessica Miller

Oregon State University

*Includes steelhead

Today’s talk

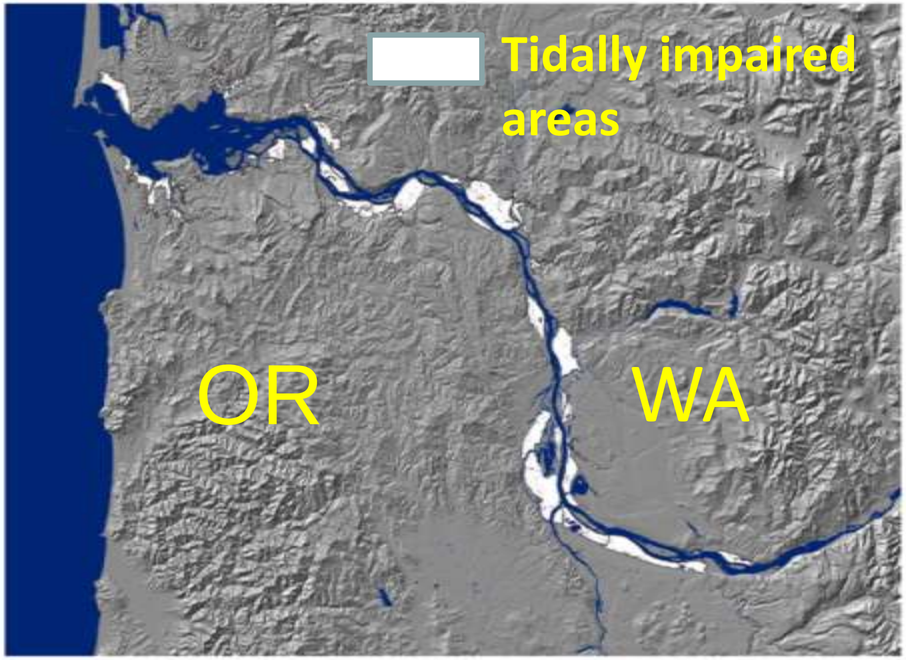
- Background on the Action Effectiveness Monitoring and Research (AEMR) project
- Study components
- Methods and results from the landscape-scale study
- Methods and results from the flux study
- Summary and conclusions

Columbia Estuary Ecosystem Restoration Program (CEERP)

<u>Stated goal</u>

"To undertake the activities necessary to evaluate, protect, monitor, and restore fish and wildlife habitat in the Columbia River estuary" (rkm 0–234)

Under CEERP, BPA and USACE have restored 1,000s of acres of tidal marsh habitat



Key Question: Are the estuary habitat restoration actions achieving expected biological and environmental benefits?

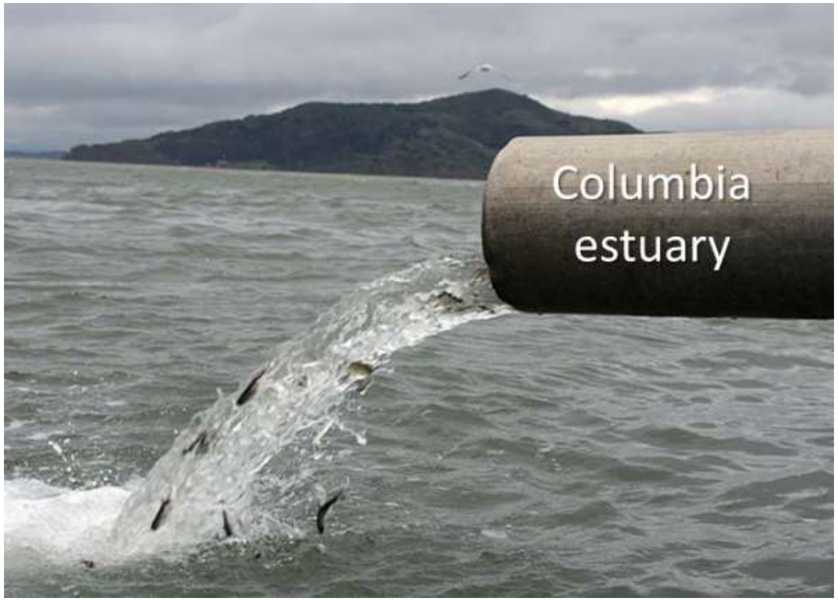
Is the Columbia River estuary a "pipe" for interior stocks of salmon?

<u>The old paradigm</u>:

As interior juvenile salmon move through the estuary, they don't:

- Feed
- Grow
- Slow or stop

Is this true?



Action Effectiveness Monitoring & Research (AEMR) Project

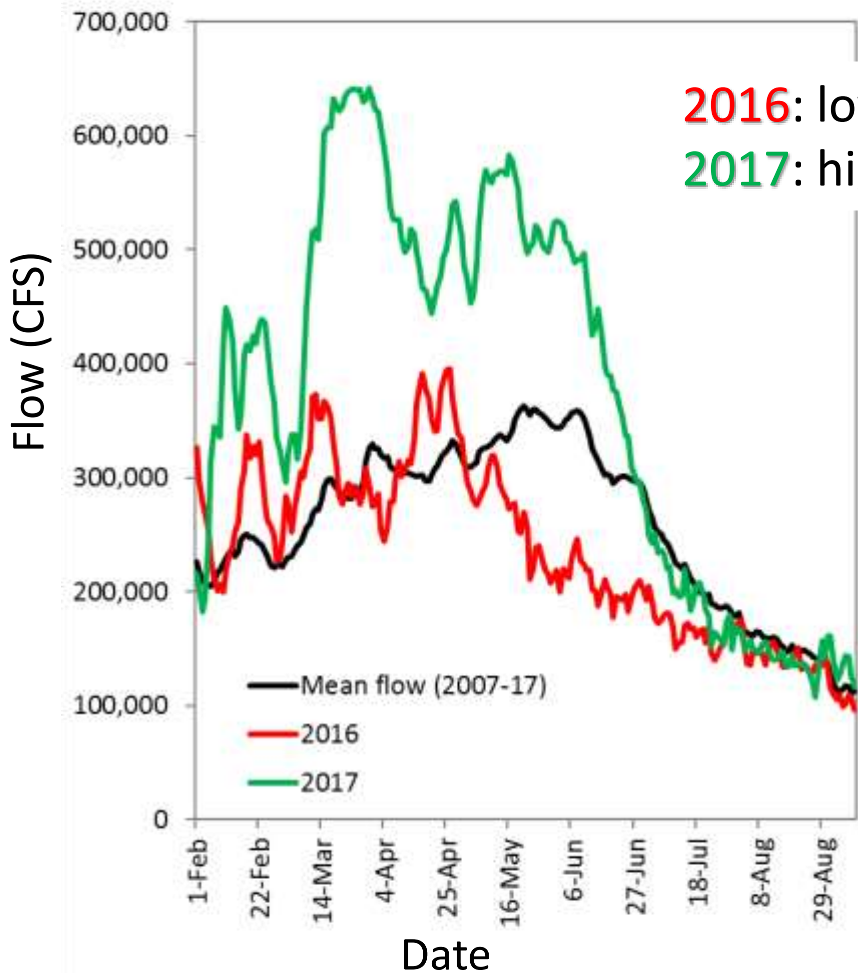
- Funded by U.S. Army Corps of Engineers
  - Two field seasons (2016, 2017), final report (2019)
- Addresses the question:

  Does marsh habitat restoration in the Columbia River estuary benefit juvenile salmon, especially interior stocks?

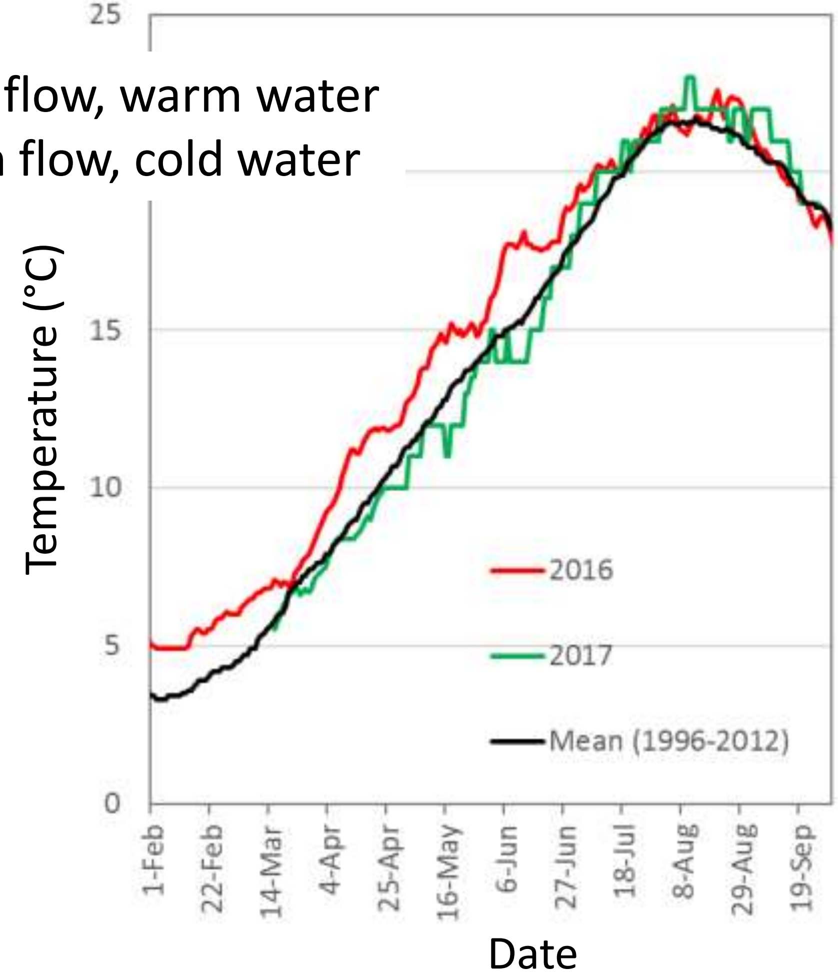
- Four integrated components:
  - Landscape-scale
  - Flux
  - Site-scale
  - Fish detections
- Common suite of fish and habitat metrics
  - Study components directly comparable

Two field years (2016 and 2017) were very different

Flow at Beaver Army Terminal



Temperature at the Dalles Dam



2016: low flow, warm water

2017: high flow, cold water

USGS Station 14246900

http://waterdata.usgs.gov/

USGS Station 453712121071200

Project Components

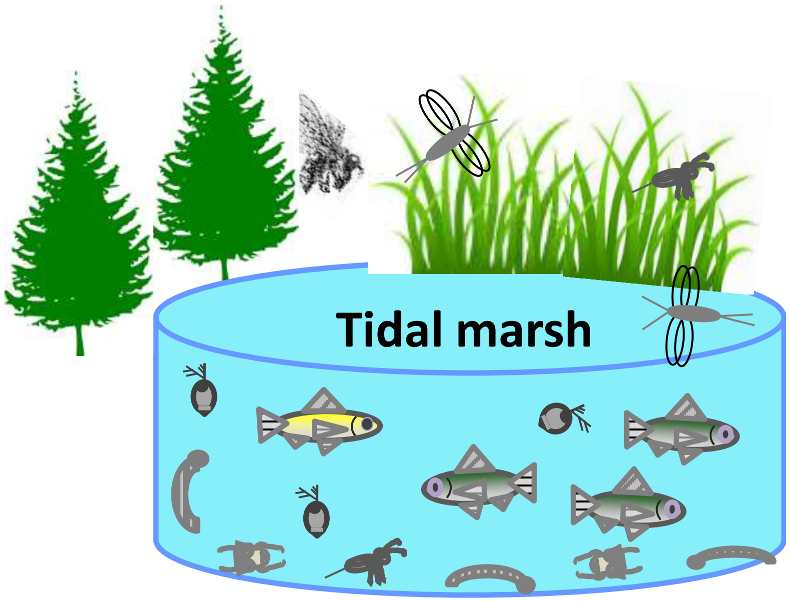
1) **Landscape Scale** – Investigate the effectiveness of habitat restoration on interior juvenile salmon at the landscape scale (outside wetlands). (indirect benefits)

2) **Flux Study** – Quantify the export of material out of wetlands to the mainstem (carbon, nutrients, insects)

3) **Site Scale** – Evaluate the effectivenes[illegible]lected restoration actions at the sit[illegible] benefits).

4) **Fish detectio**[illegible]ntennae to detect interior stocks entering/e[illegible] marsh habitats (direct use)

Conceptual model: Prey production in restored tidal wetlands benefit juvenile salmon directly onsite and indirectly offsite



<u>Direct benefits</u>: Restored tidal wetlands provide refuge and prey resources for juvenile salmon (**site-scale**)

<u>Fish detections</u>: PIT Tagged salmon detected entering restored tidal wetlands

Effectiveness Indicators

- Species composition
- Juvenile salmon density
- Genetic stock
- Fish condition (length, weight, ratio)
- Diet/gut fullness
- Stable isotopes (prey, juvenile salmon)
- Growth physiology markers (IGF-1)
- Otoliths (growth, timing)

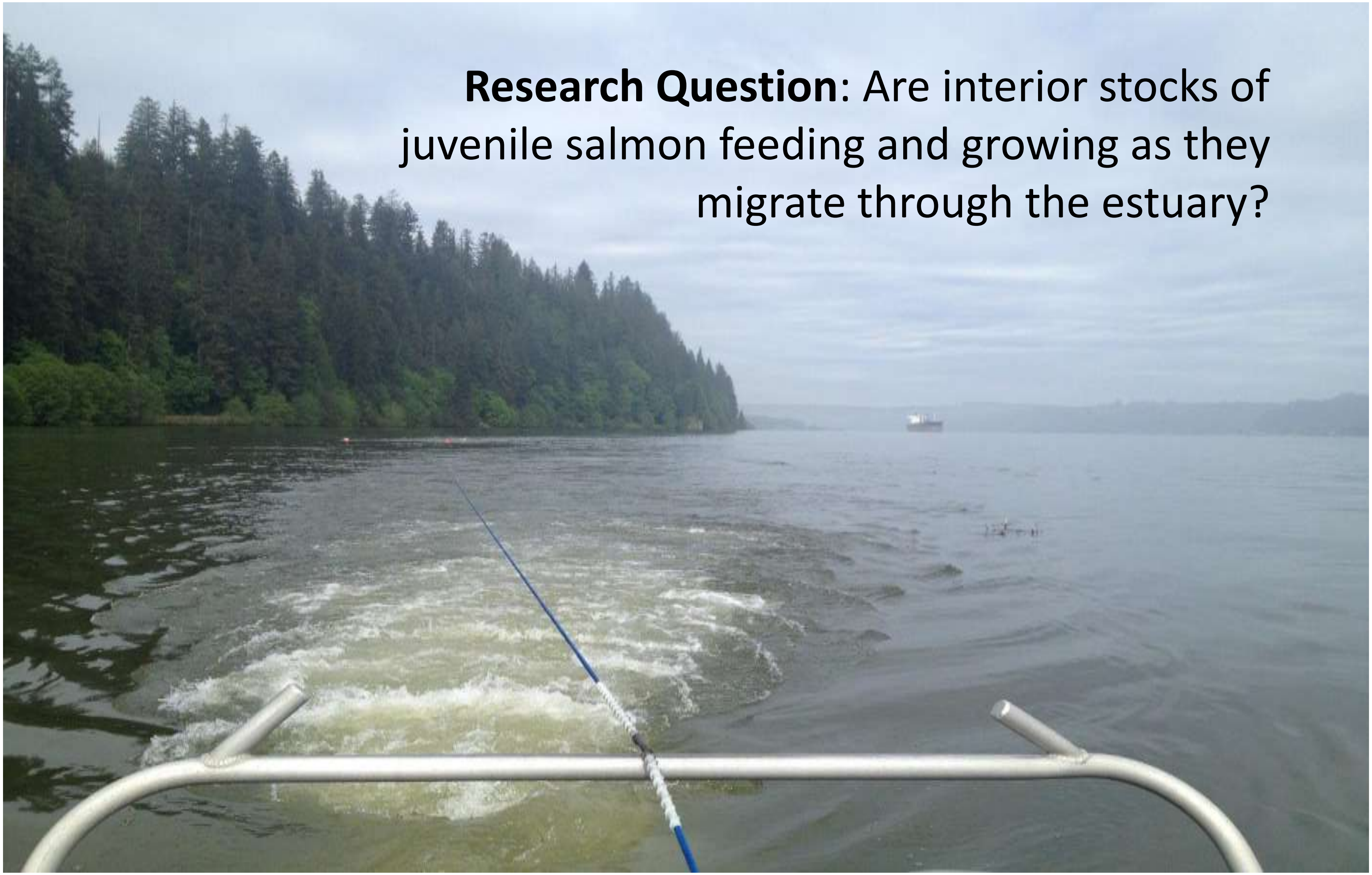
This talk (landscape)

Nikki's talk (site)

Angie's talk

Brian's talk

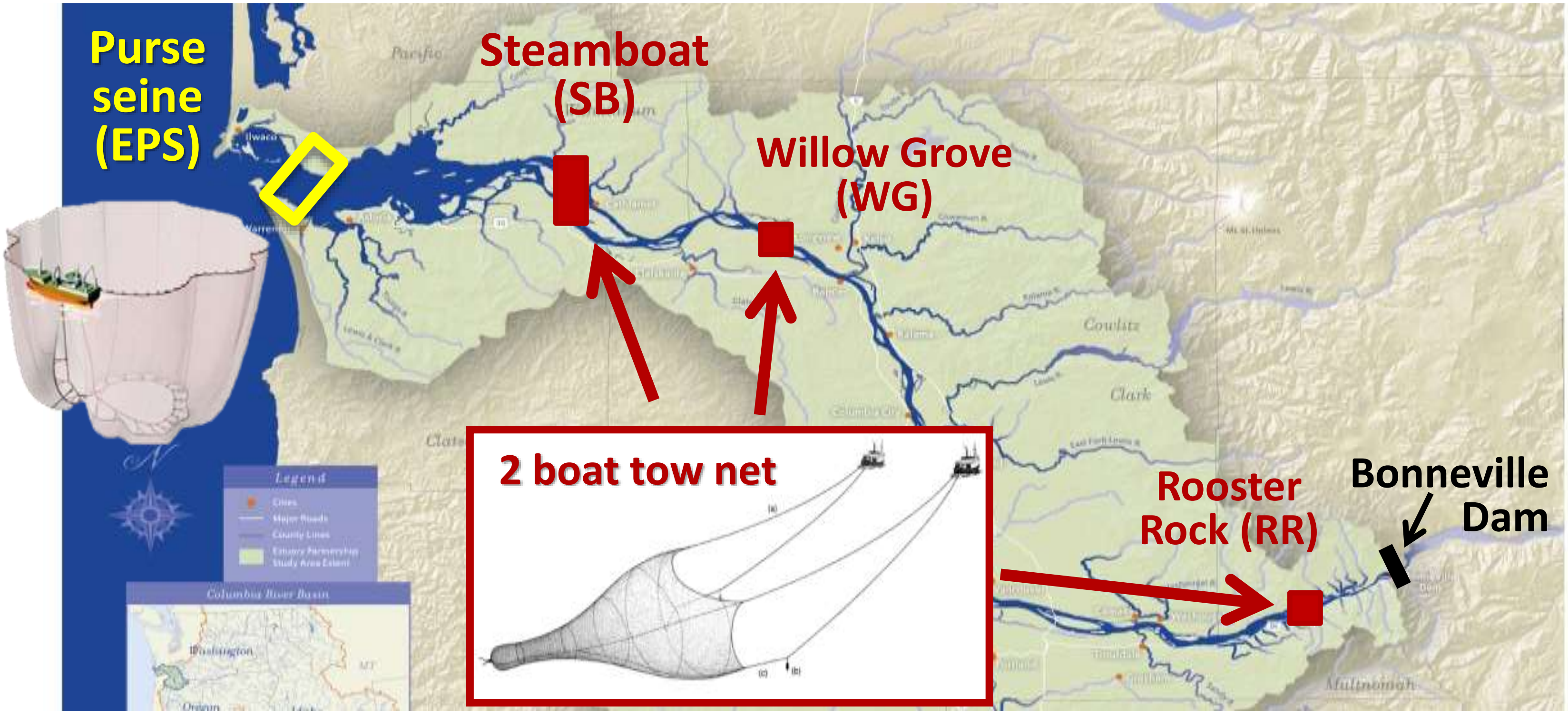
Landscape-scale methods



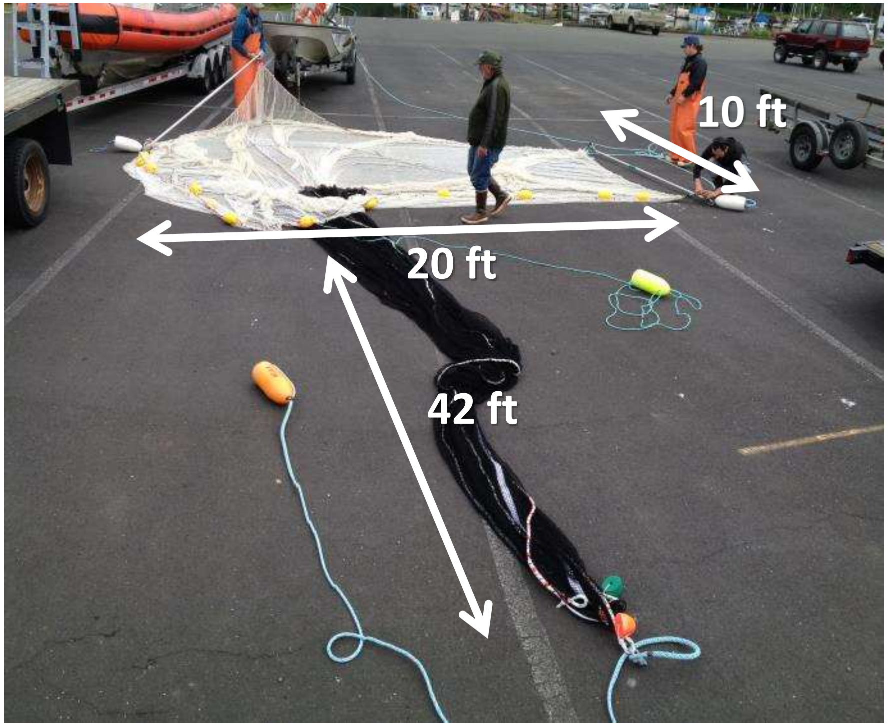
Research Question: Are interior stocks of juvenile salmon feeding and growing as they migrate through the estuary?

AEMR Landscape-scale study

Each site sampled monthly



Two-boat tow net

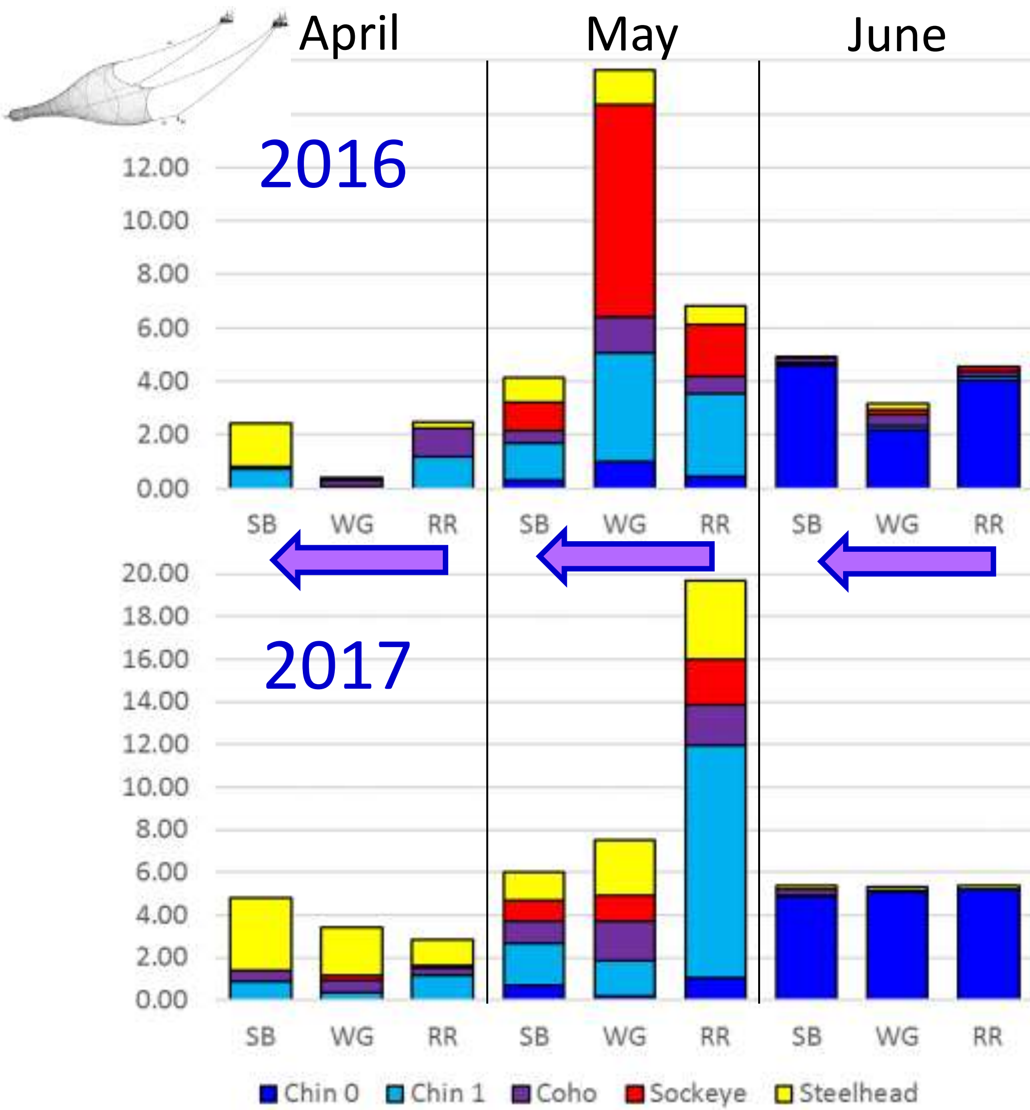


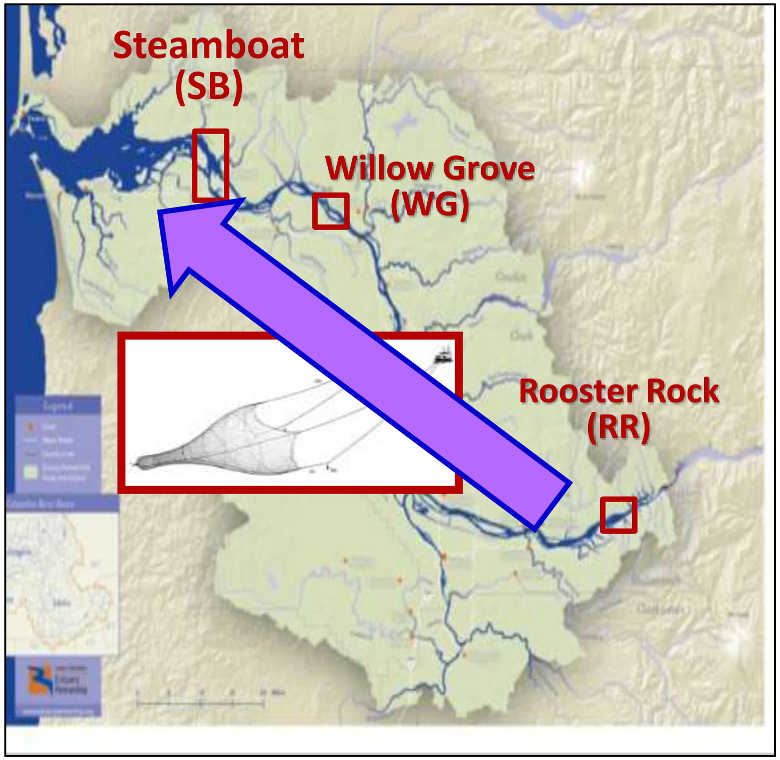
Tow net sites

Purse seining

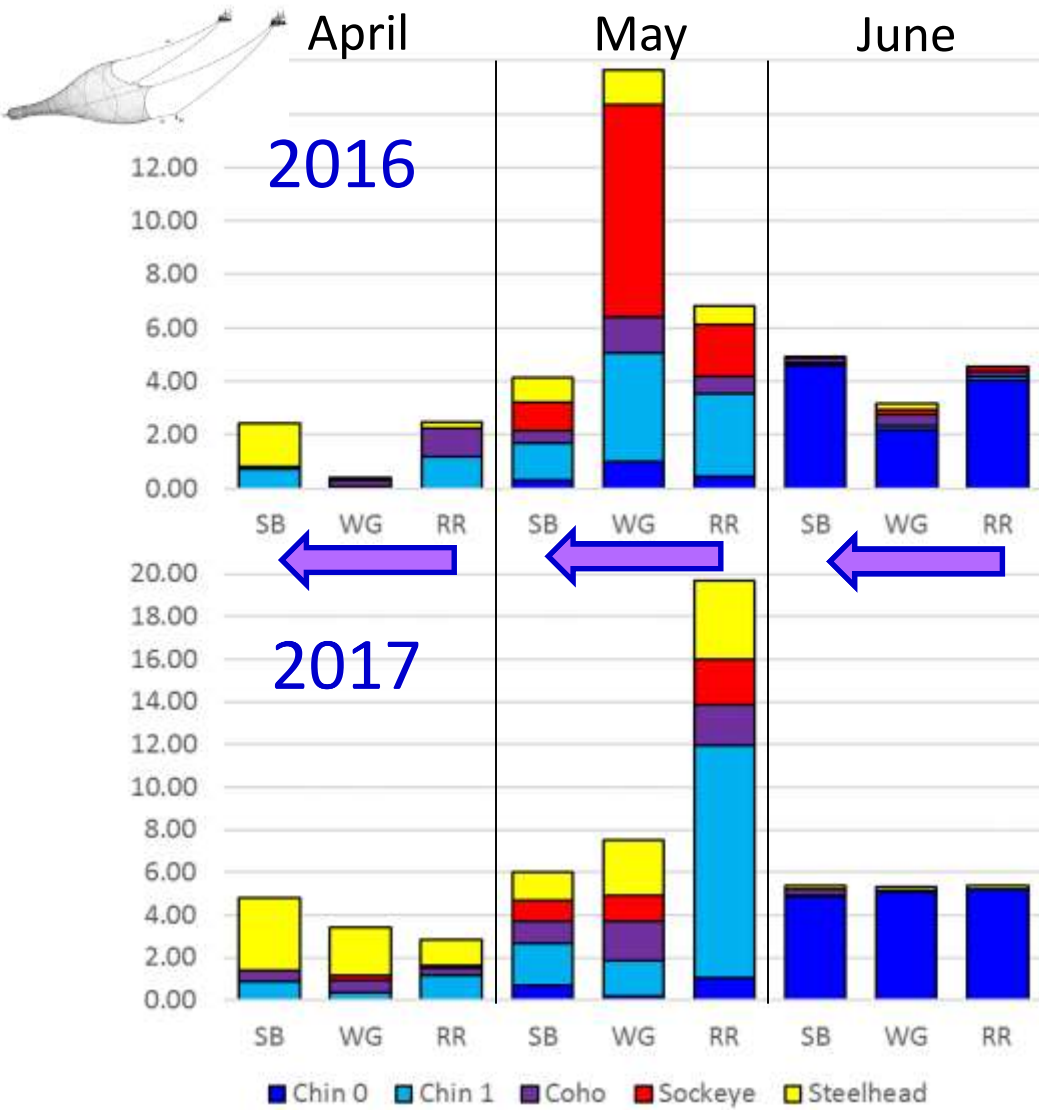
Neuston
(surface plankton net)

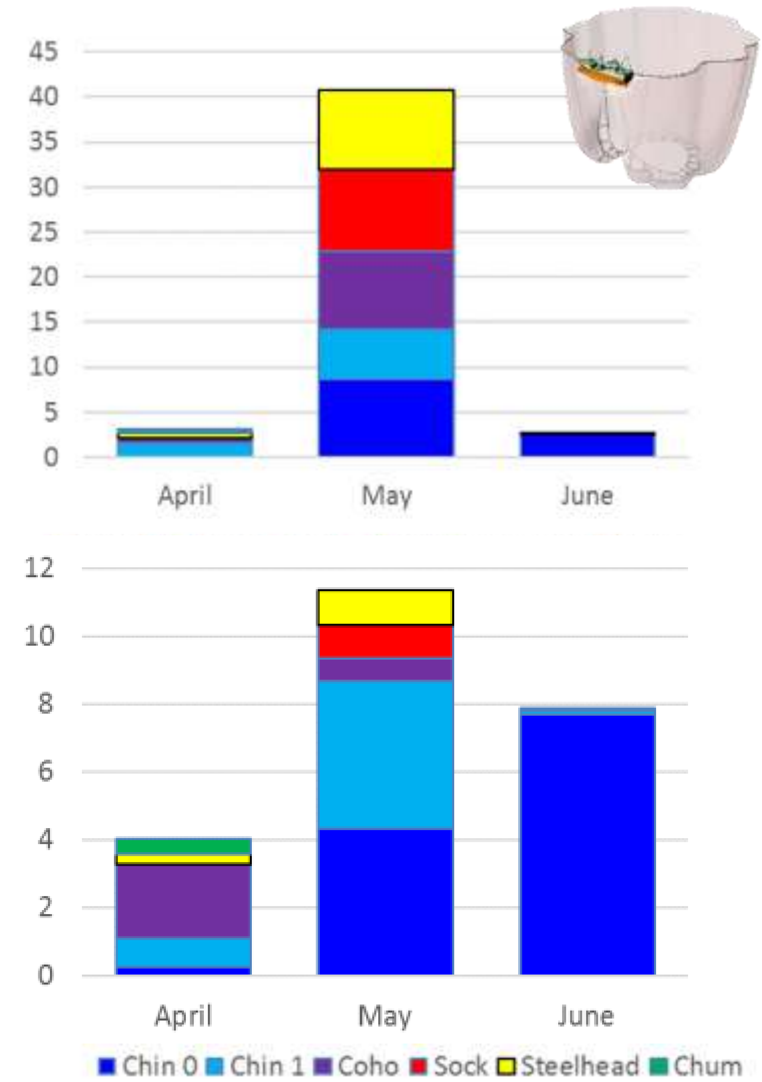
Townet catches were similar in 2016 & 2017



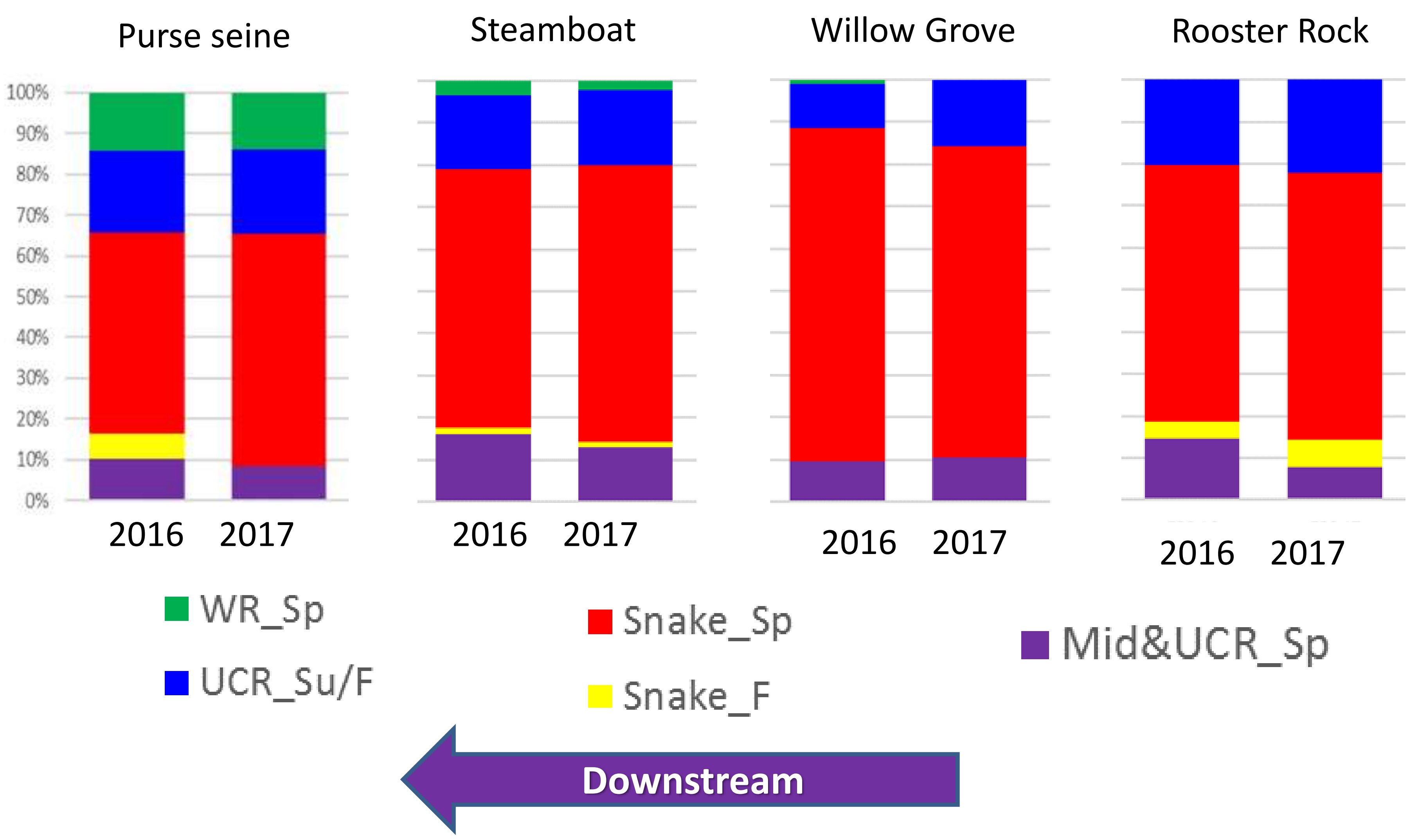


Purse seine catches were also similar in 2016 & 2017

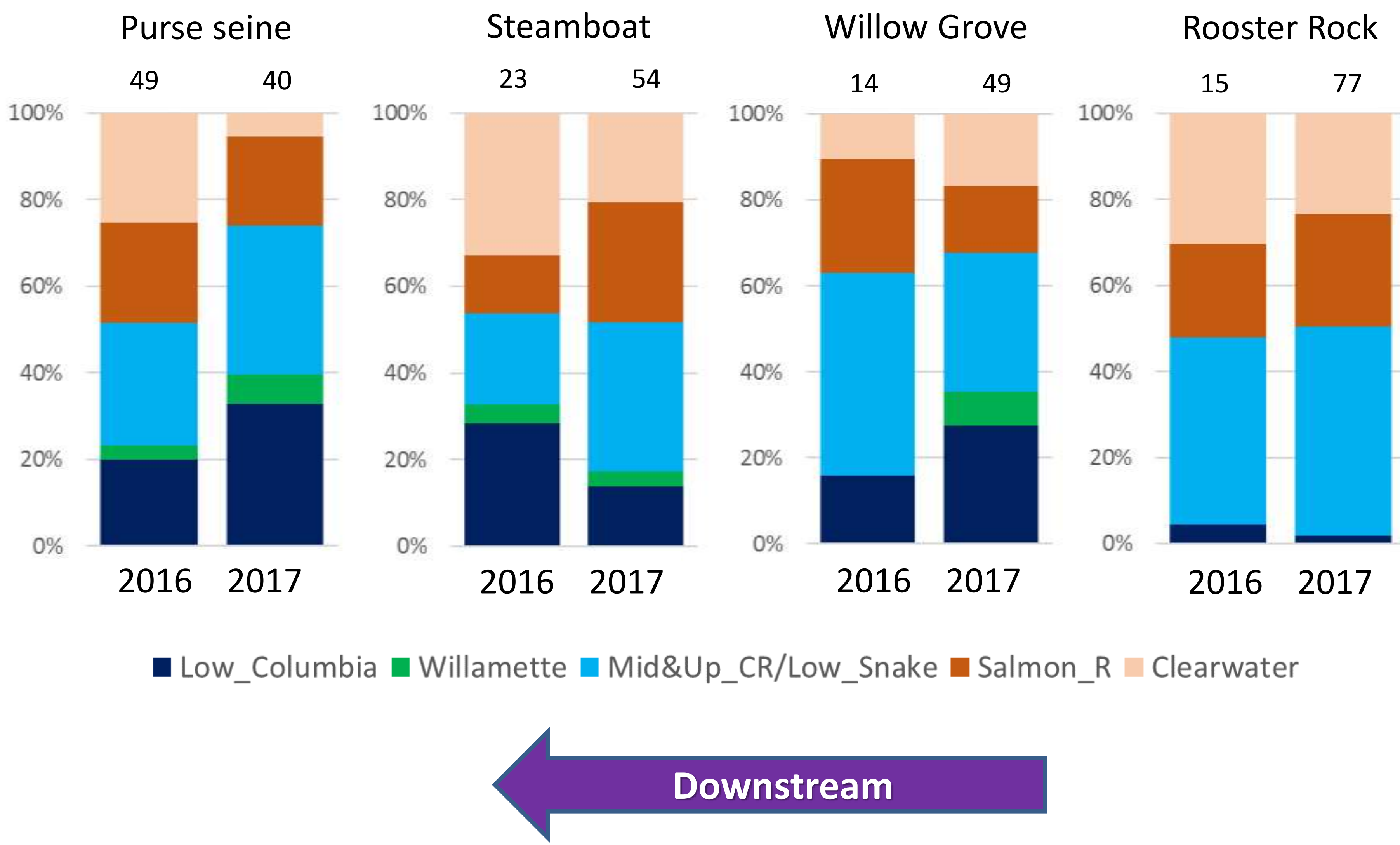




Yr Chinook stocks were amazingly consistent between years

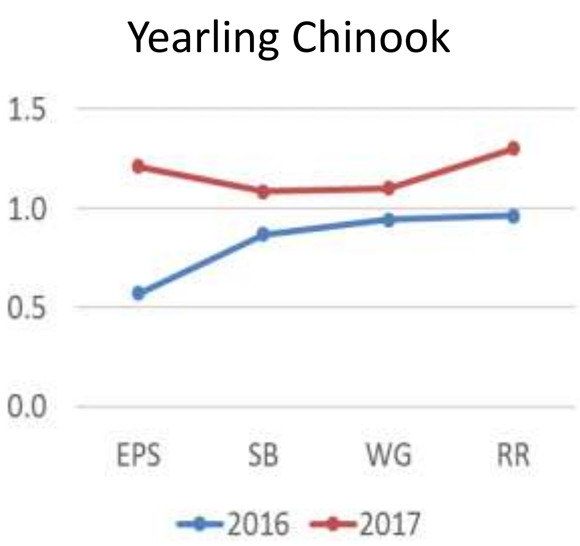


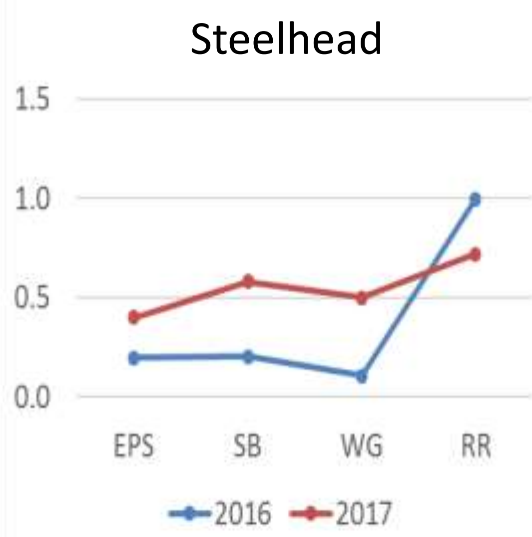
Steelhead stocks were also very consistent between years

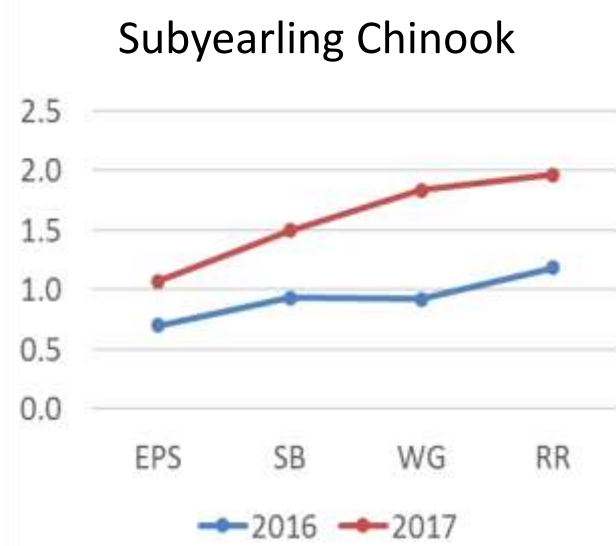


Stomach fullness across the estuary

Stomach fullness as % body weight







Downstream

Flux study

Research Question: How many and what types of potential prey are exported from restored and reference marsh habitats?

High water in 2017

Flux study methods

INSECT SAMPLES W/ PLANKTON NET

INVERTEBRATE SPECIES

- COUNT
- WEIGHT
- VOUCHER SPECIMENS FOR EDNA

FLOW AND CROSS-SECTIONAL AREA W/ ADCP

TIME SERIES

- WATER ELEVATION
- CROSS-SECTIONAL WETTED AREA m^2
- MEAN VELOCITY m/s
- FLOW m^3/s
- TEMPERATURE

Flux Study: Samples collected 2016-2017

Location	Site	Type	Dates	Plankton
Steamboat (SB)	Main Ch	RES	3	35
	Primary Ch*	RES	2	24
	Secondary Ch	RES	3	18
Karlson (Kl)	Res	RES	4	27
	Ref inside	REF	5	40
	Marsh E	REF	3	23
	Marsh W	REF	6	33
	Forested E	REF	3	26
	Forested W	REF	3	31
Welsh (Wl)	Ref	REF	3	18
	Primary Ch*	REF	2	15
			37	290

Long term ADCP deployments

DATE	DOY	SITE ID	STATION	TRT	Duration
18-Apr-17	108	Karlson	FORESTED E	REFERENCE	13
4-May-17	124	Karlson	FORESTED W	REFERENCE	12
2-Jun-17	153	Karlson	MARSH W	REFERENCE	24
20-Jun-17	171	Steamboat	PRIMARY	IMPACT	38
24-Jul-17	205	Karlson	FORESTED E	REFERENCE	22
24-Jul-17	205	Karlson	MARSH E	REFERENCE	22

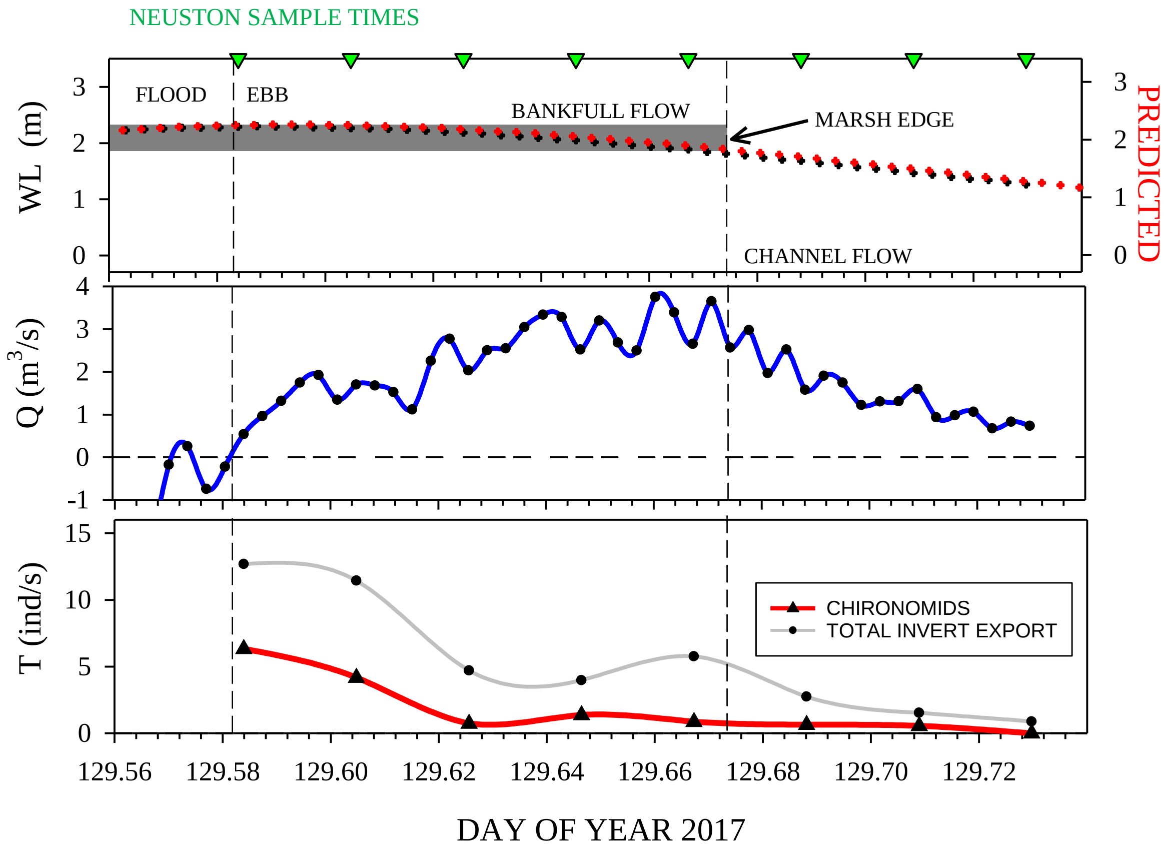
Flux Results

MEASURING PREY EXPORT FROM TIDAL CHANNELS: KARLSON IS. MARSH EAST

SAMPLE PREY CONCENTRATION (C) DURING EBBING TIDE

MEASURE DISCHARGE Q = VELOCITY x AREA (U x A)

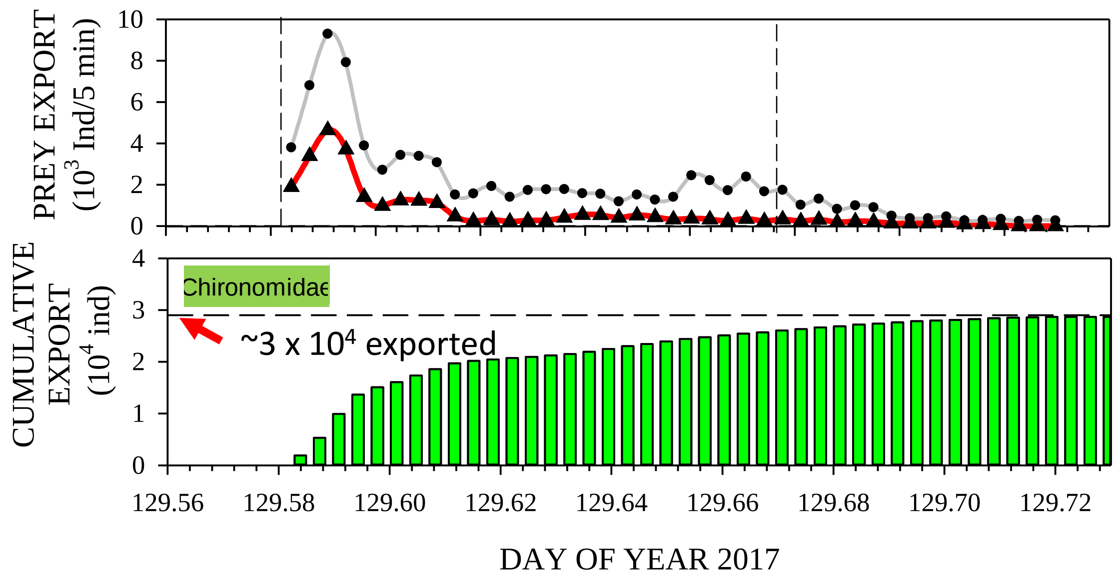
CALCULATE TRANSPORT T = PREY CONCENTRATION x DISCHARGE (C x Q)



MODELING PREY EXPORT FROM TIDAL CHANNELS:
ENERGY RATION = SALMON ENERGY EQUIVALENTS

COMPUTE T OVER SAMPLE INTERVAL (PREY/s x 300 s)

INTEGRATE OVER EBB TO YIELD TOTAL PREY EXPORTED/ TIDE



CALCULATE SALMON ENEGRY EQUIVALENTS (SEE) = NUMBER OF SALMON SUPPORTED BY EXPORTED CHIRONOMIDS / tide

SALMON RATION
50 kJ/ kg/d
- SUBYEARLING (80 mm= 5 g = 0.25 kJ/d)
- YEARLING (180 mm = 60 g = 3 kJ/d)

ASSUMING
- 1 CHIRONOMID = 0.001 g
- ENERGY DENSITY = 10 kJ/g.
- 3 x 10^4 chir exported x 10^{-3} g/chir x 10 kJ/g = 300 kJ

=

SEE
- 1200 SUB
- 100 YRLG

IN ONE TIDE!

Summary and conclusions

- Despite very different river conditions in 2016 and 2017, the catch of juvenile salmon at the landscape-scale was surprisingly similar with respect to abundance, and species and stock composition.
- Flux of prey (dominated by chironomid insects) from marsh habitats was unexpectedly large!
- The estuary is not a pipe! Juvenile salmon in the mainstem were actively feeding and growing in 2016 and 2017.
- More results to come
  - Short term: Peterson, Munguia, Sather and Beckman talks
  - Long term: Integration among studies (progress and final reports)

Acknowledgements

Field crew: Jake Biron, Wayne Haines, Dave Beugli

Boat operators: Brian Kelly, Kaya Johnson

Fish bleeder: Meredith Journey

Vision: Gary Johnson and Kurt Fresh

Funding by USACE

Comparison of effort & catch: 2016 & 2017

Attribute	2016	2017
Sampling season	Apr-Jul	Mar-Jun
Tow net sets	252	204
Purse seine sets	45	37
Total juvenile salmon caught	2,365	1,729
Yr Chinook (bled)	611 (289)	446 (303)
Steelhead (bled)	347 (217)	506 (369)
Subyr Chinook (bled)	898 (0)	364 (60)
Sockeye	290	133
Coho	198	261
Chum	20	18