Effects of invasive reed canarygrass on juvenile Chinook salmon in the upper Columbia River Estuary

Rachael Klopfenstein, Daniel L. Bottom, Michael Harte, Charles A. Simenstad

Rachael Klopfenstein – M.S. Candidate, Marine Resource Management
College of Earth, Ocean, and Atmospheric Sciences, Oregon State University

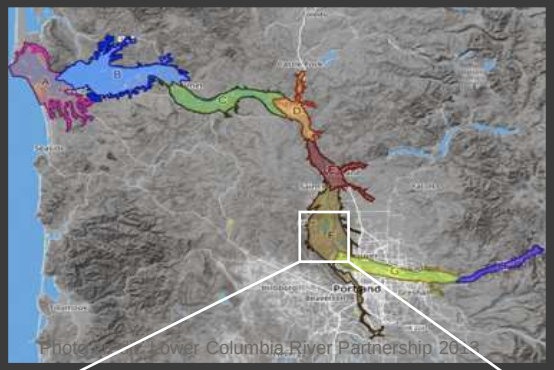
Restoring the Columbia River Estuary

- Endangered Species Act (ESA)
- Invasion of reed canarygrass (*Phalaris arundinacea*) (PHAR)

Photo credit: TNC 2009

Photo credit: USACE

Study Location



- Multnomah Channel Marsh
  - Restored wetland habitat
  - Water control structure
  - Limited access for juvenile salmon

Above (marsh/pond) and below (Multnomah Channel) water control structure, with PIT detectors, at Multnomah Channel Marsh.

Overarching Objective

- Will habitat restoration for juvenile salmon in the Columbia River Estuary succeed in light of systemic changes, such as
  - flow regulation,
  - limited fish access to floodplains, and
  - the spread of PHAR?

Specific Research Questions

- Does PHAR provide **prey resources** to juvenile Chinook salmon that are different from natural emergent vegetation?

- Are there **differences in growth** between juvenile fish reared in natural emergent vegetation versus in PHAR?

Methods

- Macroinvertebrate sampling
- Juvenile Chinook growth experiment
- Stomach content analysis

Typical caddisfly found in macroinvertebrate traps

Net pen, fallout trap, and emergence trap during high water in early spring

Emergence trap during low water in late spring/early summer

Macroinvertebrate Sampling

- Traps in PHAR and natural emergent vegetation
- Counted and identified species to family or lowest taxonomic level feasible

Emergence trap:
- 48 hour deployment
- 0.25 m^2 area
- Captures emerging aquatic insects (e.g. flies)

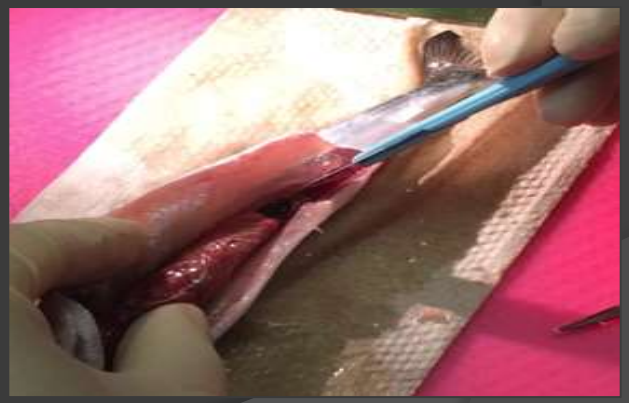
Fallout traps:
- 48 hour deployment
- ~0.25 m^2 sample area
- Captures terrestrial invertebrates (e.g. adult insects)

Growth Experiment & Diet Analysis

- Juvenile Chinook growth
  - Length and weight
  - 3-4 pens per vegetation type
  - April 2015 and 2016

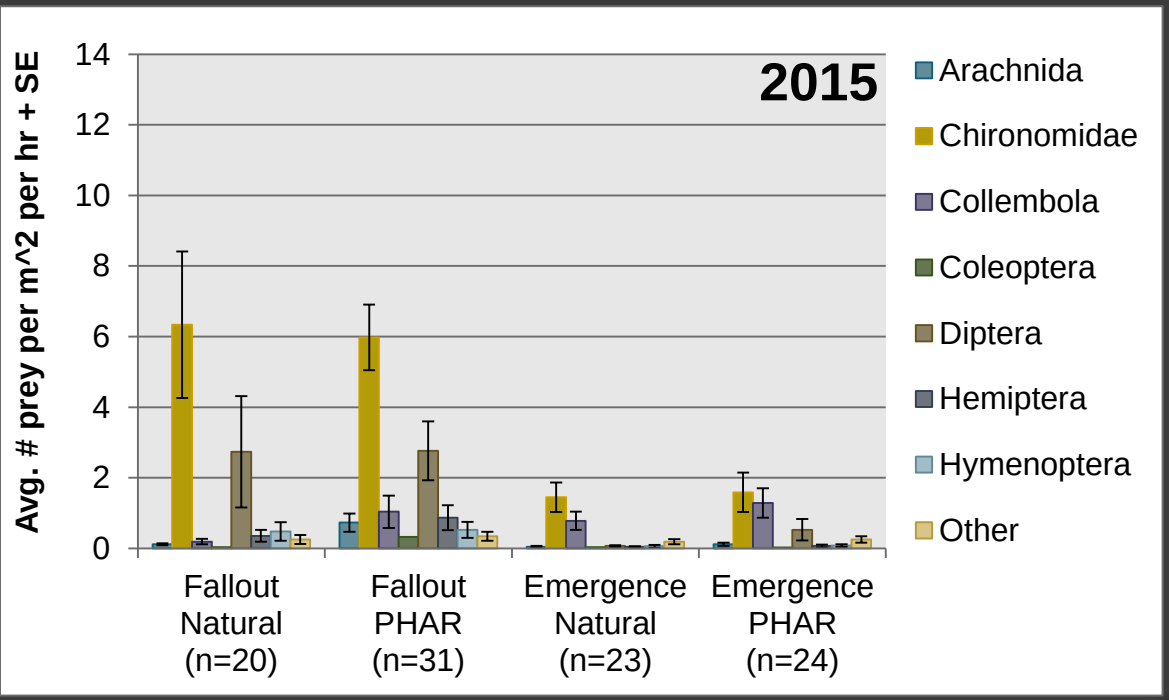
Growth Experiment & Diet Analysis

- Juvenile Chinook growth
  - Length and weight
  - 3-4 pens per vegetation type
  - April 2015 and 2016
- Stomach contents
  - Species ID, weight, count
  - Calculating PSIRI
  - Fish Bioenergetics model



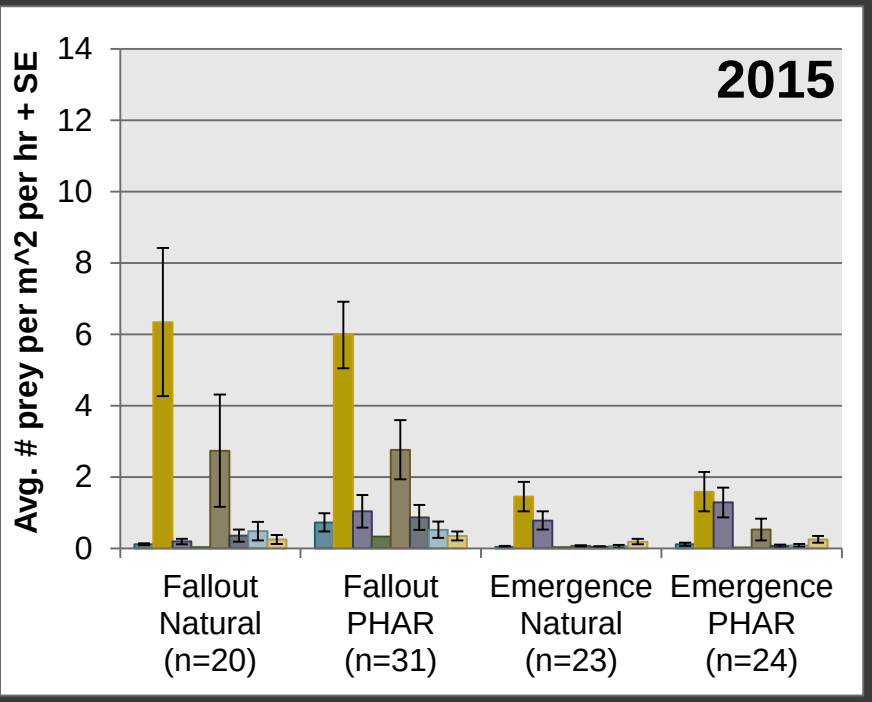
Preliminary Results - Macroinvertebrates

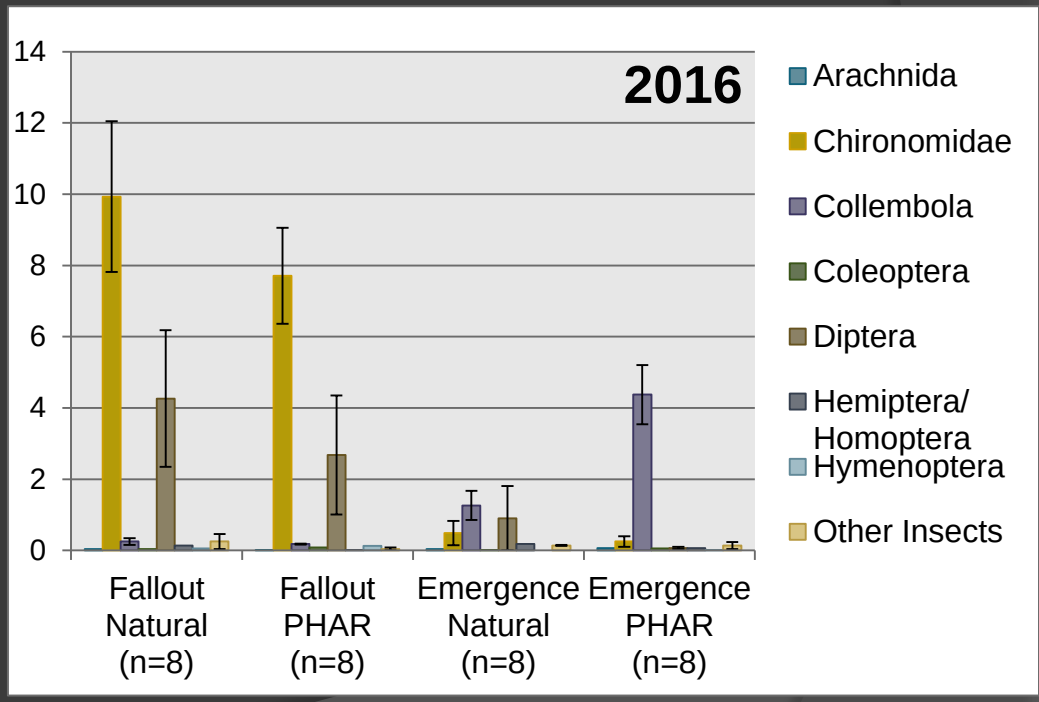
- Similar abundance and diversity of species in invertebrate traps in 2015



Preliminary Results - Macroinvertebrates

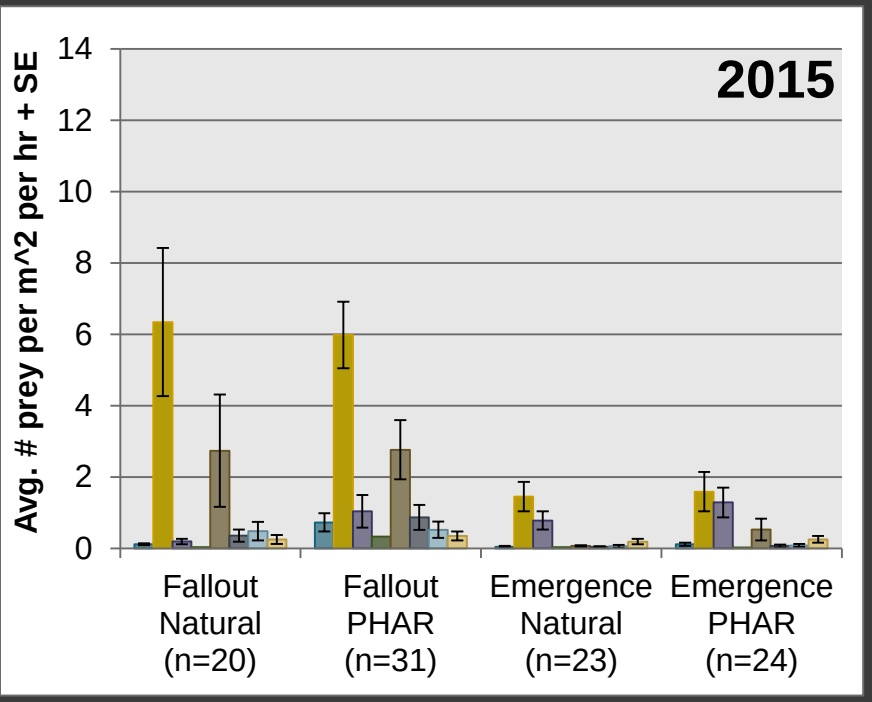
- Similar abundance and diversity of species in invertebrate traps in 2016, except Collembola

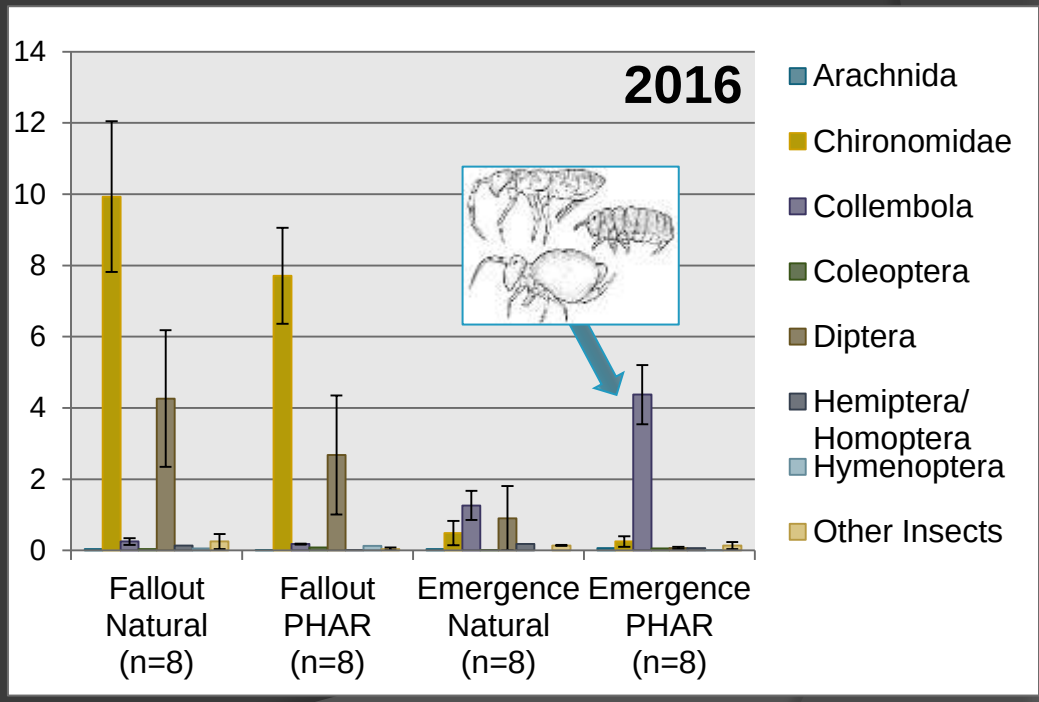




Preliminary Results - Macroinvertebrates

- Similar abundance and diversity of species in invertebrate traps in 2016, except Collembola





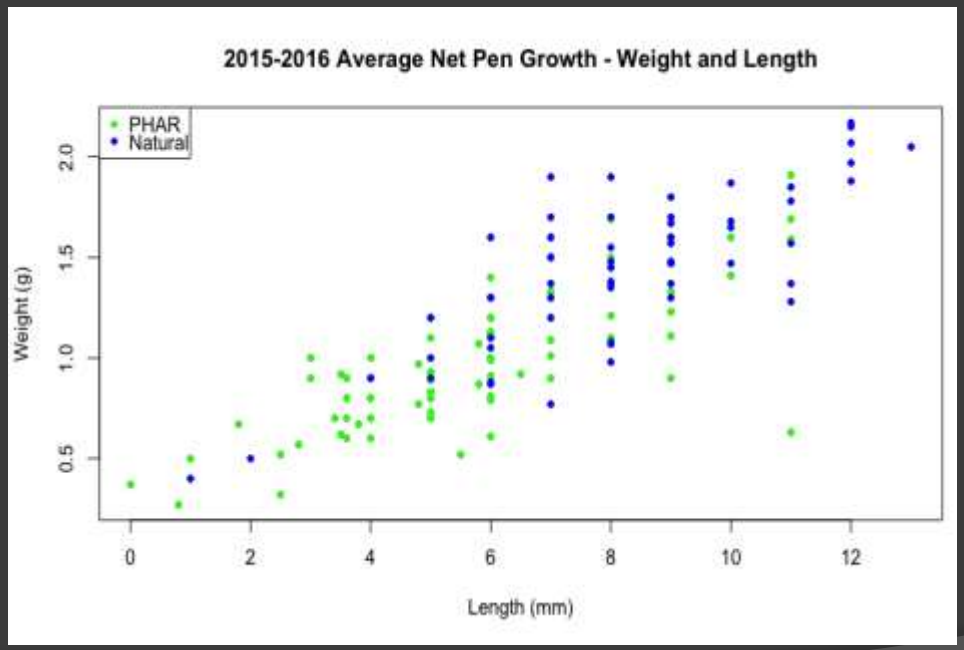
Preliminary Results – Growth

- Juveniles in natural emergent vegetation grew more than in PHAR (p-value: <0.001)
  - 8 vs. 5.6mm
  - 1.4 vs. 1g

Data from: Susan Hinton (NOAA)

Preliminary Results – Growth

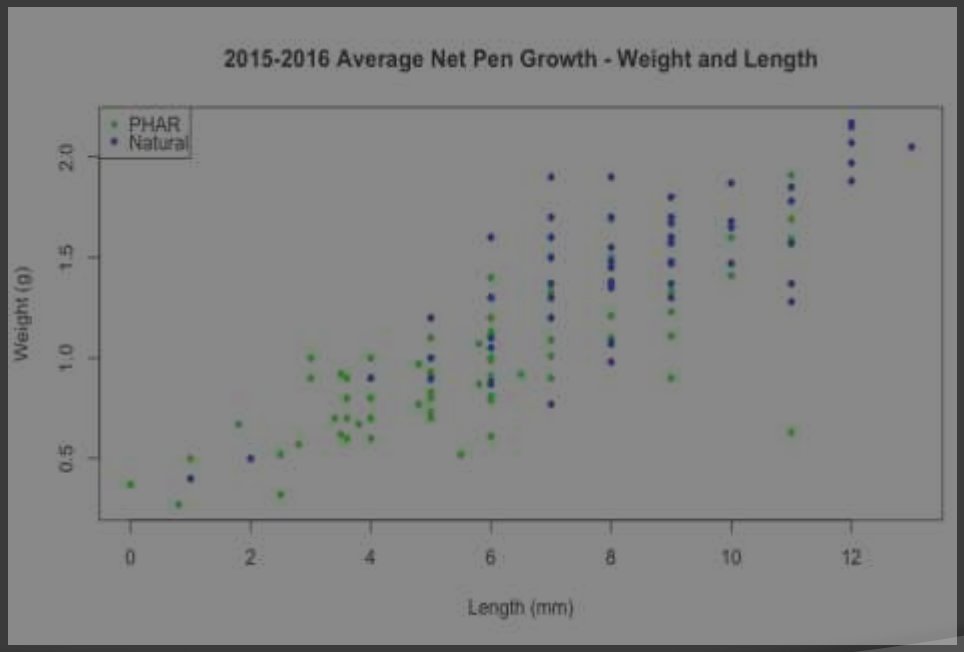
- Juveniles in natural emergent vegetation grew more than in PHAR (p-value: <0.001)
  - 8 vs. 5.6mm
  - 1.4 vs. 1g

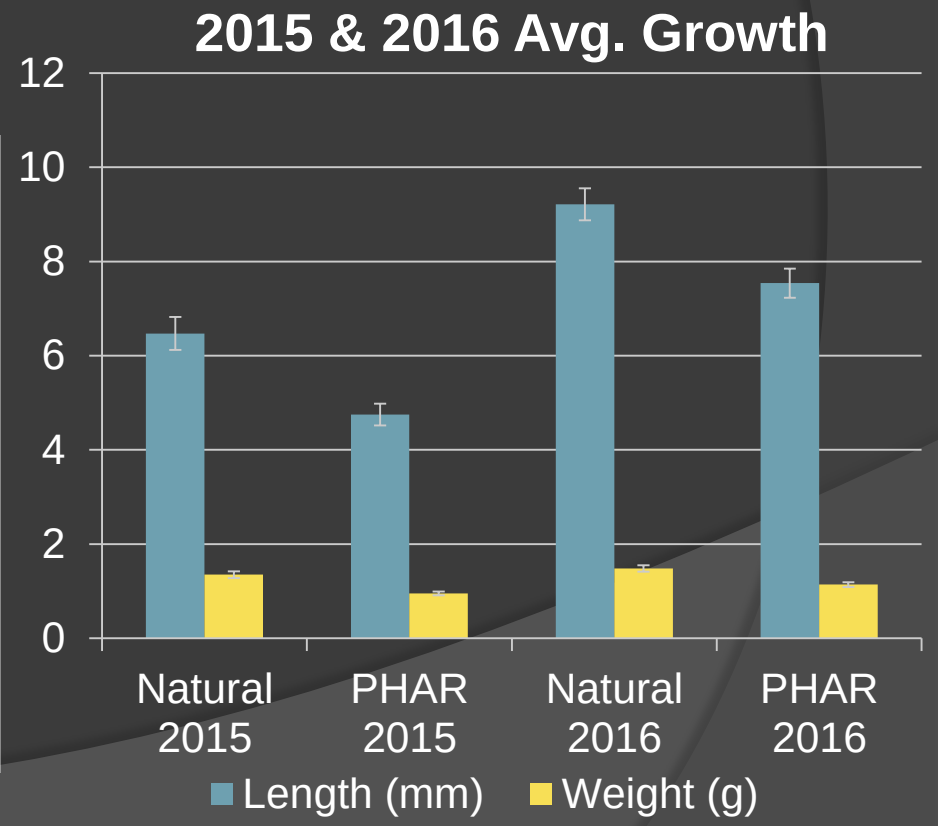


Data from: Susan Hinton (NOAA)

Preliminary Results – Growth

- Juveniles in natural emergent vegetation grew more than in PHAR (p-value: <0.001)
  - 8 vs. 5.6mm
  - 1.4 vs. 1g



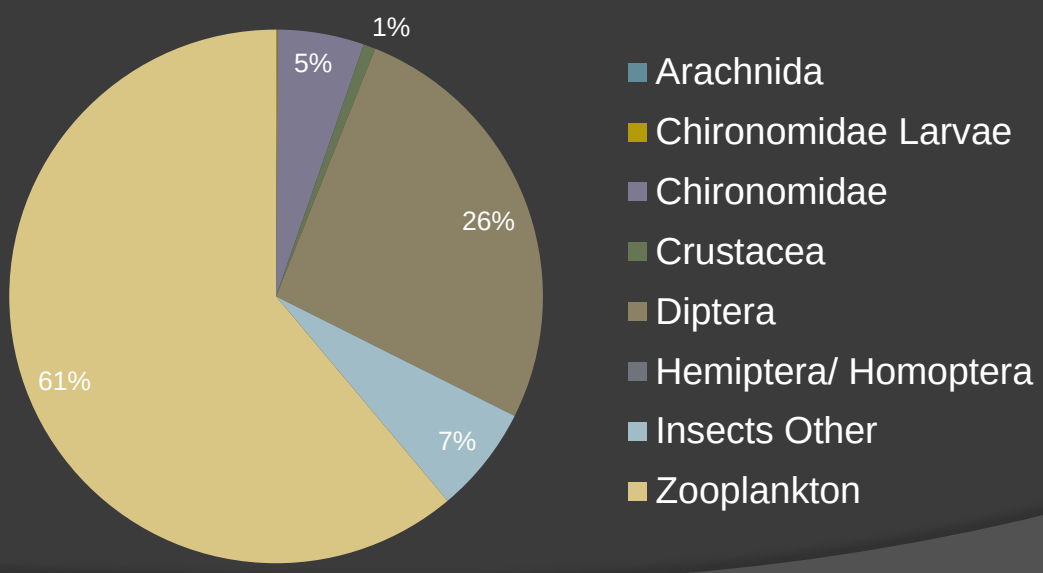


Data from: Susan Hinton (NOAA)

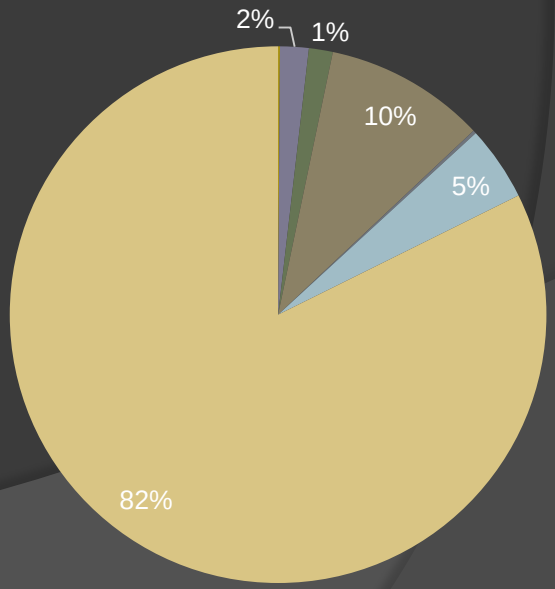
2015 Preliminary Results – Diet

- Slightly more zooplankton and fewer dipterans consumed in PHAR in 2015

Natural – Avg. diet composition by biomass (n=30)

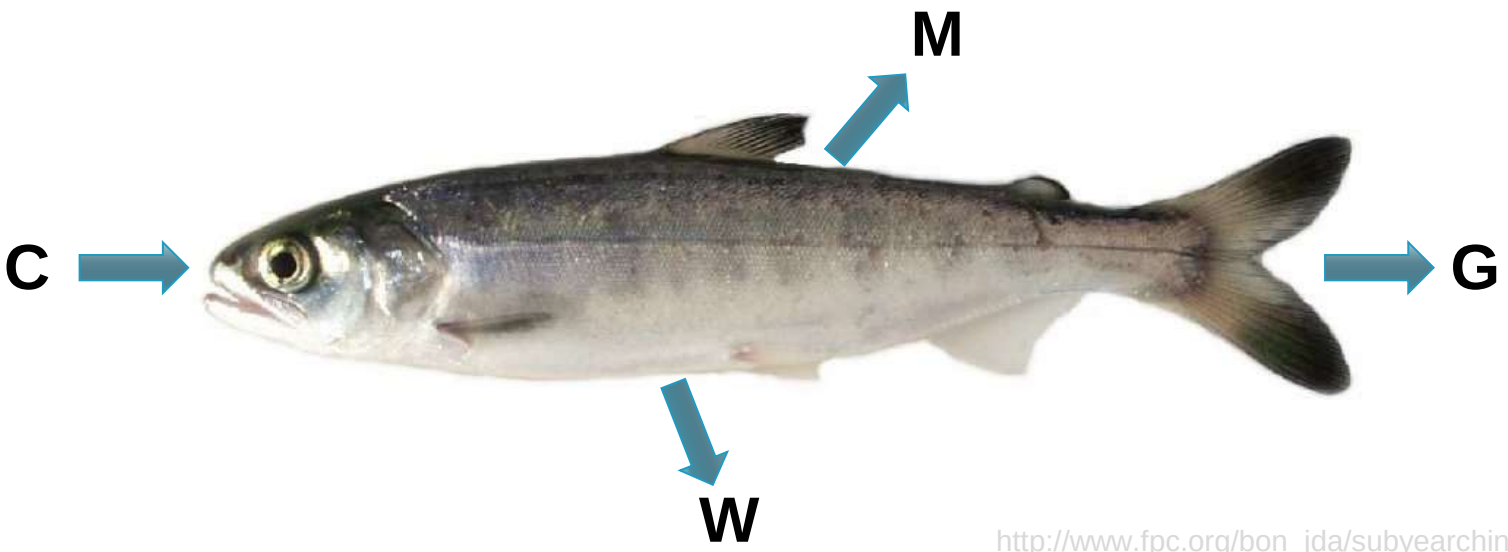


PHAR – Avg. diet composition by biomass (n=27; 1 empty)



Modeling growth (FishBioenergetics4)

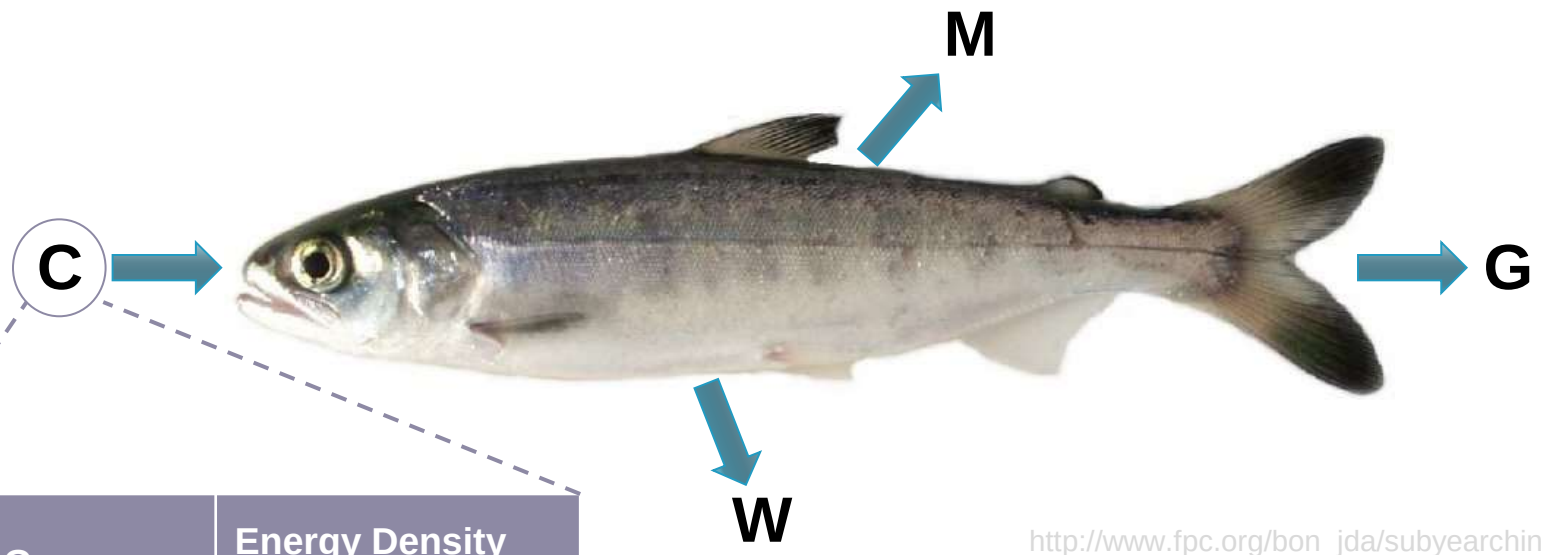
Energy consumed (C) - Metabolism (M) - Waste (W) = Growth (G)



http://www.fpc.org/bon_jda/subyearchinook.html

Modeling growth (FishBioenergetics4)

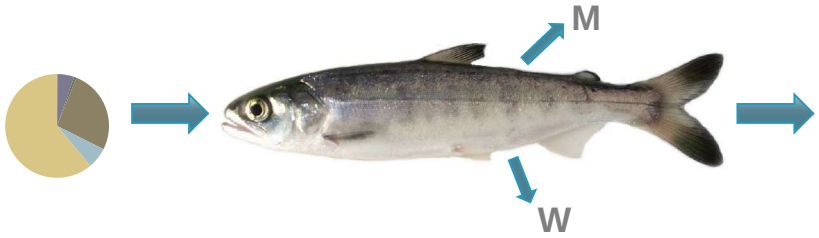
Energy consumed (C) - Metabolism (M) - Waste (W) = Growth (G)



http://www.fpc.org/bon_jda/subyearchinook.html

Prey Group	Energy Density (kJ/g wm)
Cladocera	1.37 
Chironomidae	3.83 
Diptera	8.92 

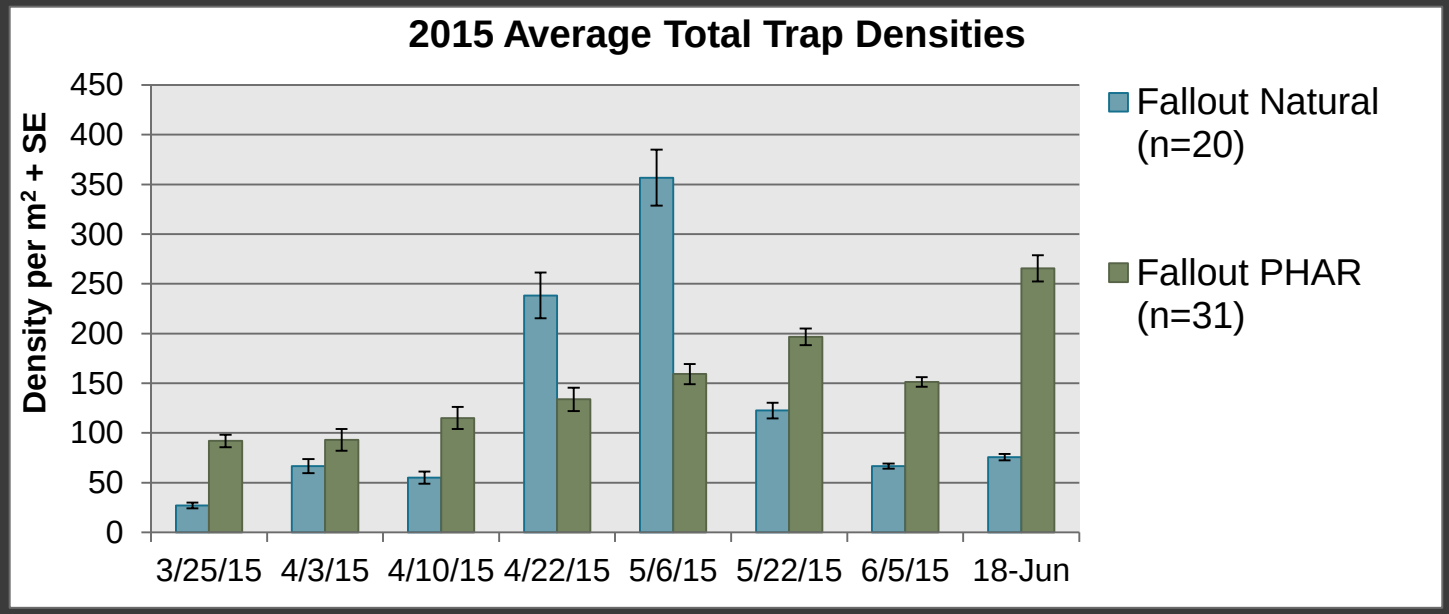
Modeled growth 2015 (FishBioenergetics4)

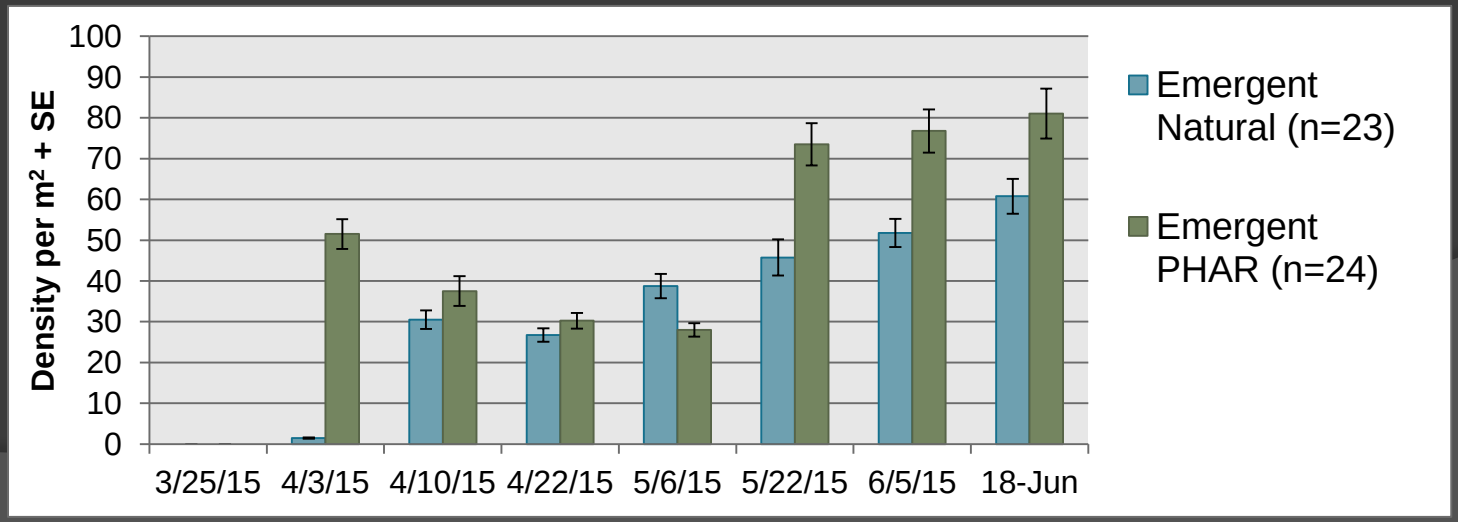
Habitat	Fish Growth	Average growth rate (g/g/d)	Portion of max. consumption (p-value)
Natural		**0.052**	**0.633**
PHAR		0.033	0.496

Macroinvertebrates and Diet

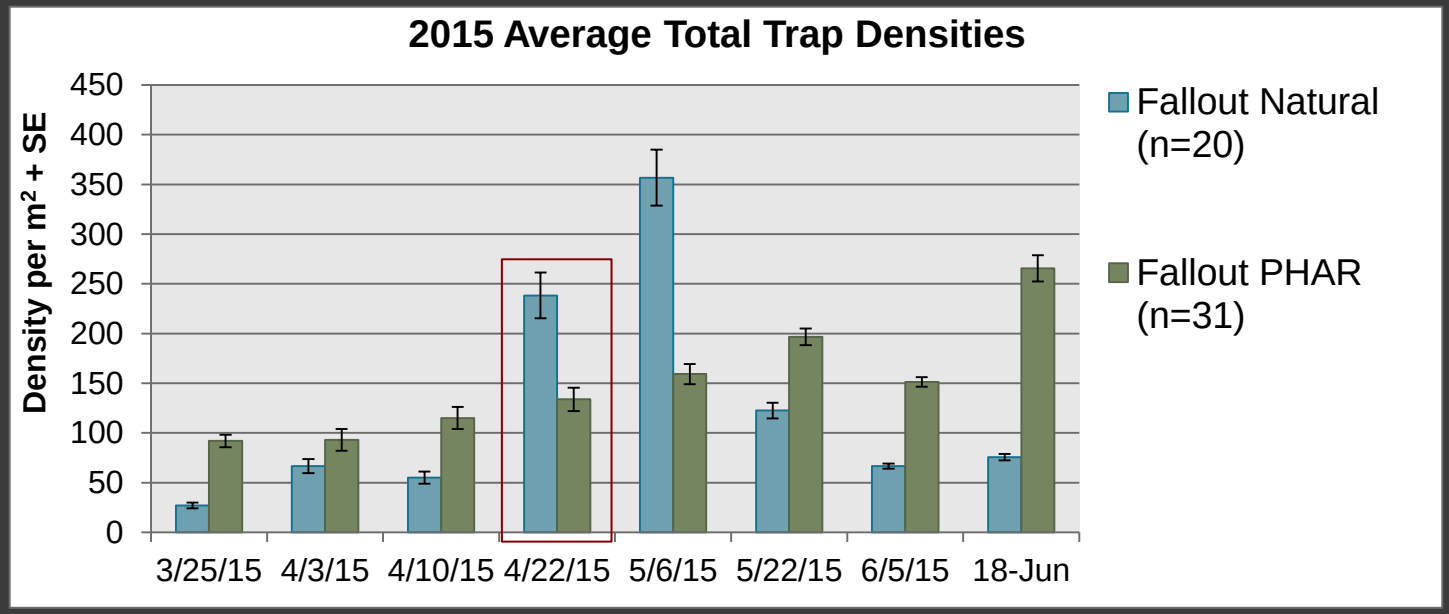
- Inverts and diets sampled on different days
- Diet is only a 24 hour snapshot

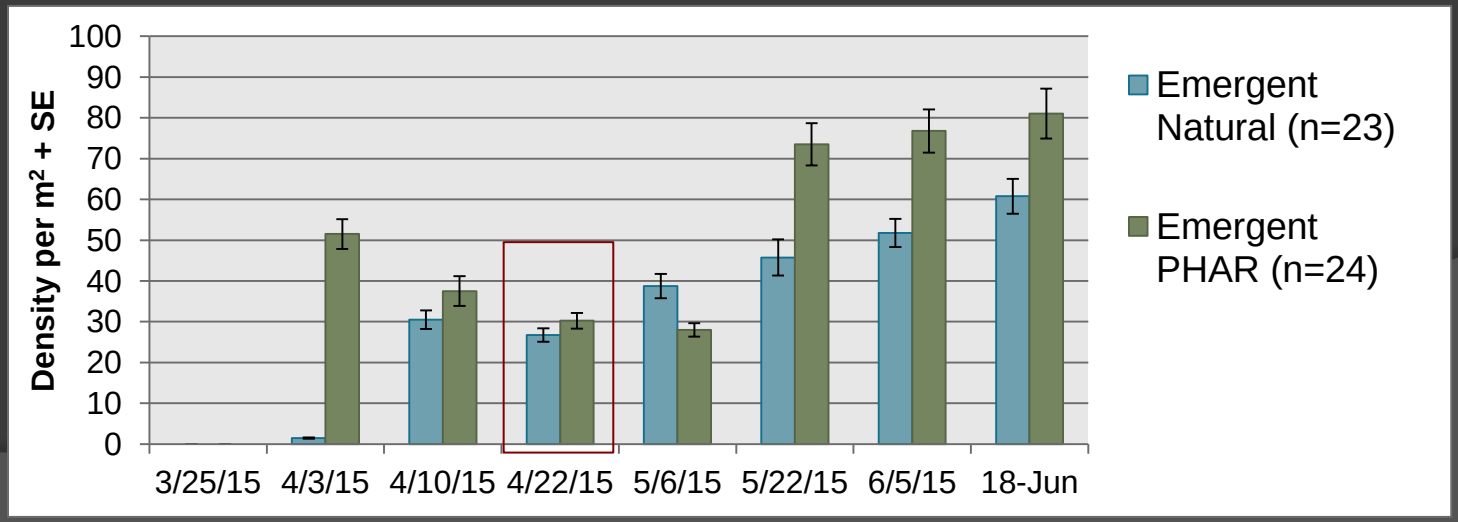
Macroinvertebrates and Diet



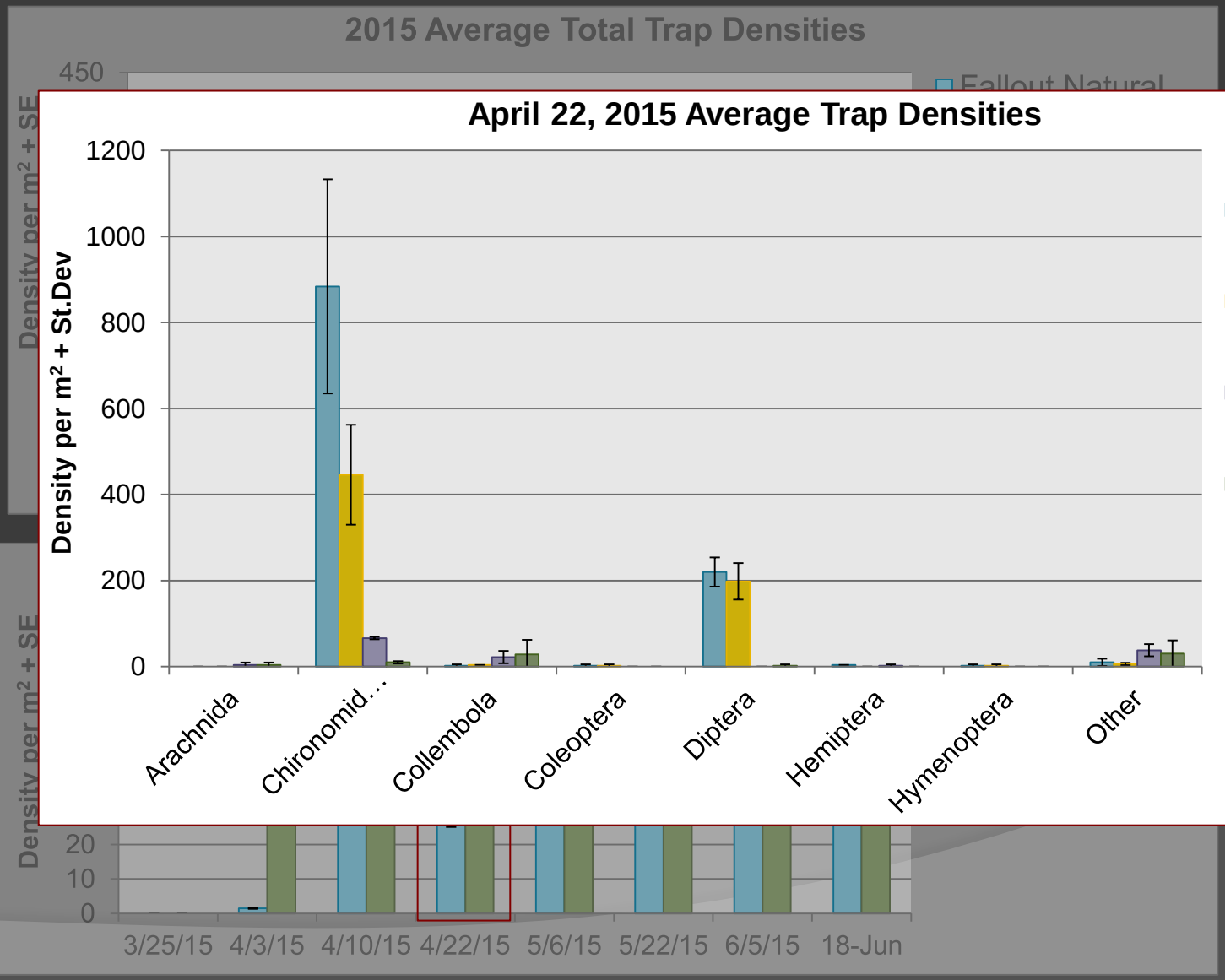


Macroinvertebrates and Diet





Macroinvertebrates and Diet

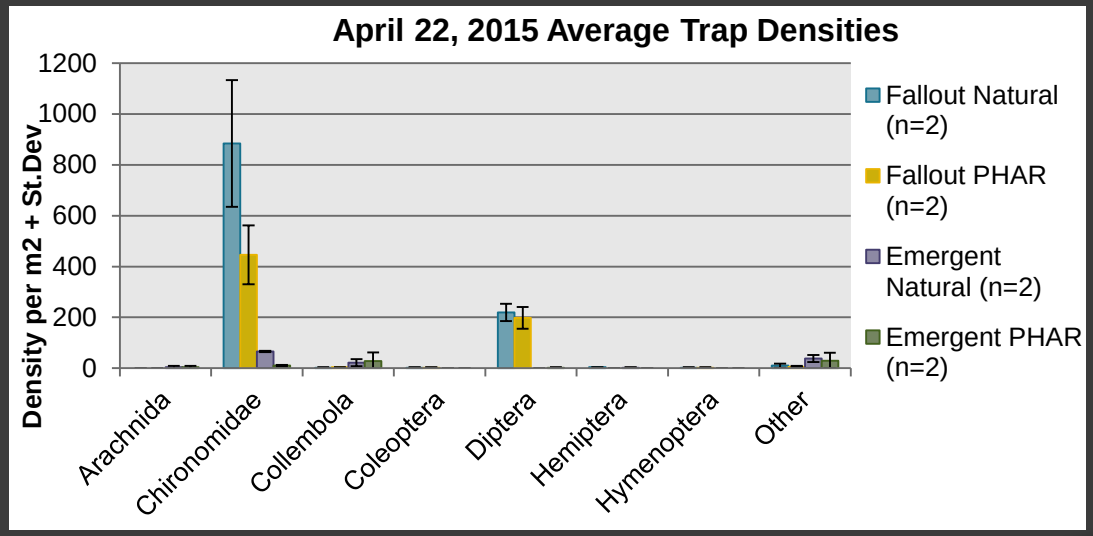


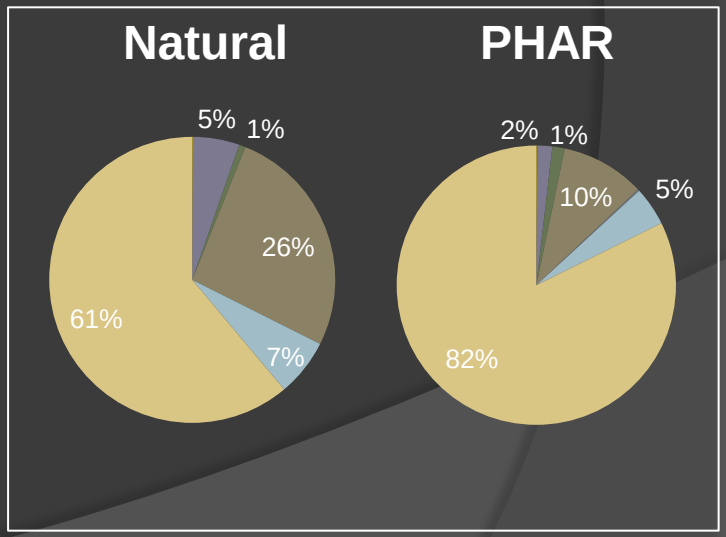
Macroinvertebrates and Diet

2015 Inverts

2015 Diets

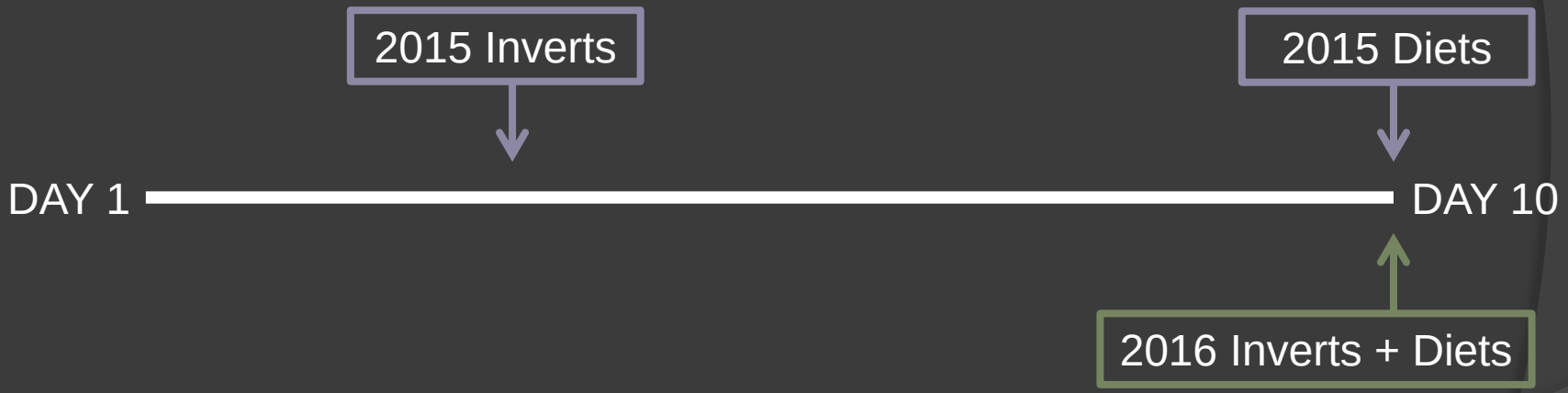
DAY 1 — DAY 10





Macroinvertebrates and Diet

- Inverts and diets sampled on different days
- Diet is only a 24 hour snapshot



Key Findings (so far)

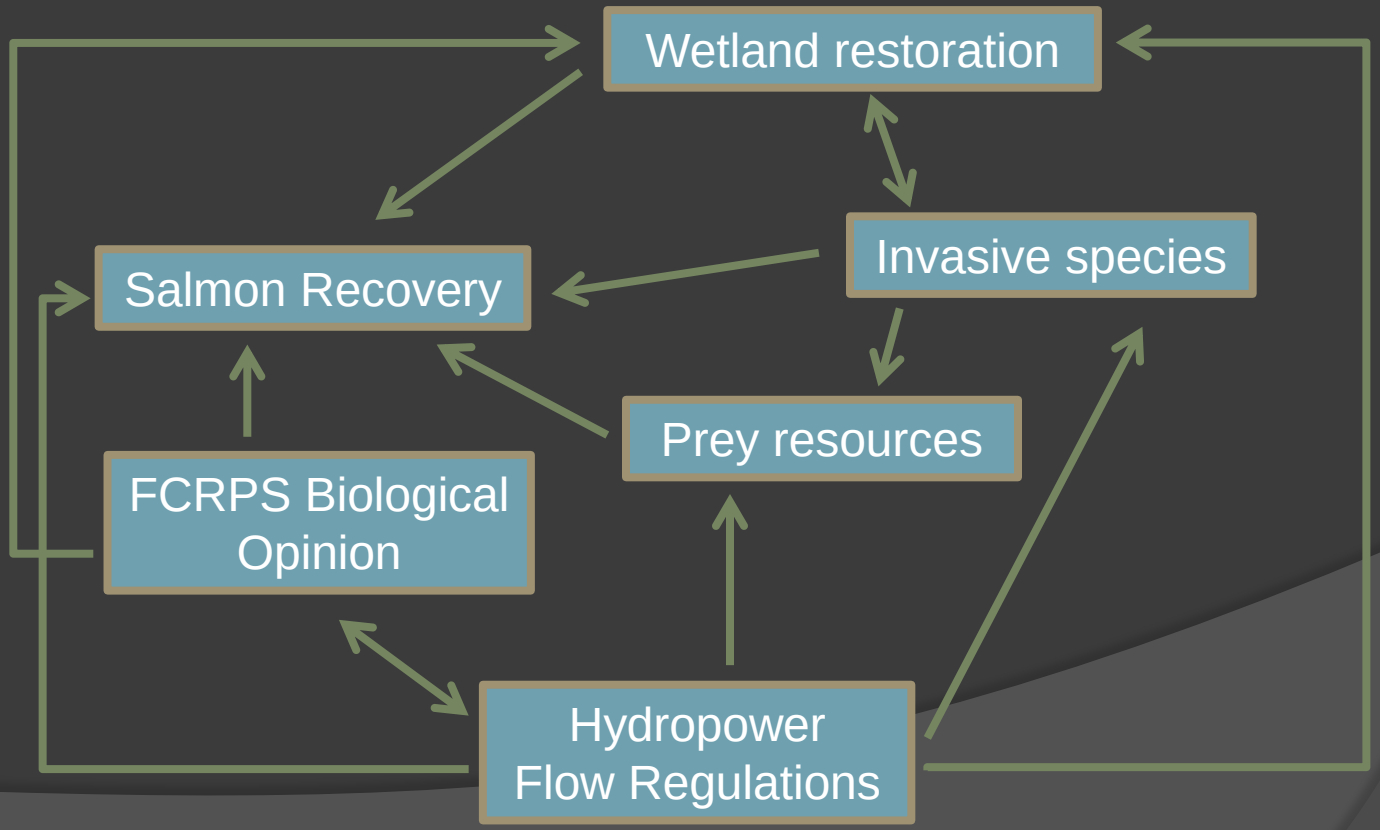
- Prey: Similar abundance and diversity of species in invertebrate traps
- Growth: Juveniles in natural emergent vegetation grew more than in PHAR (p-value: <0.001)
- Diet: Slightly more zooplankton and fewer dipterans consumed in PHAR in 2015
- Bioenergetics: Useful tool to explore when comparing habitats

Next Steps

- 2016 net pen diet analysis
- Analysis of physical factors – dissolved oxygen, temperature, and depth
- Fish Bioenergetics model (growth potential)
  - Temperature
  - Prey energy densities
  - Diet composition

It's ~~simple~~ COMPLEX

- Connections, tradeoffs, and systemic changes in the Columbia River Estuary



Questions?

- Special thanks to:
  - Dan Bottom, Susan Hinton, Regan McNatt, George McCabe (NOAA)
  - Committee Members: Michael Harte and Si Simenstad!
  - Eric Bailey, Sara Aiken, Tom Friesen, Luke Whitman, David Andres (ODFW)
  - Curt Zonick (Portland Metro)
  - The Schreck Lab and Smith Farm Genetics and Performance Lab (OSU)
  - Field volunteers!

References

Bottom, D.L., C.A. Simenstad, J. Burke, A.M. Baptista, D.A. Jay, K.K. Jones, E. Casillas, and M.H. Schiewe. 2005. Salmon at river's end: the role of the estuary in the decline and recovery of Columbia River salmon. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-68, 246 p.

IEAB (Independent Economic Analysis Board). 2005. Economic Effects From Columbia River Basin Anadromous Salmonid Fish Production. Revised Dec 2005.

Lackey, R.T. 2011. Salmon decline in western North America: historical context. Retrieved from http://www.eoearth.org/view/article/155835

NOAA. 2013. Lower Columbia River Recovery Plan for Salmon & Steelhead. NOAA Fisheries. July 2013.

Roegner, C., Bottom, D., Baptista, A., Campbell, L., Claiborne, A., Fresh, K., Hinton, S., McNatt, R., Simenstad, C., Teel, D., and Zabel, R. 2013. The contribution of tidal fluvial habitats in the Columbia River Estuary to the recovery of diverse salmon ESUs. Fish Ecology and Conservation Biology Divisions, Seattle, WA.

The Nature Conservancy – Oregon Field Office. 2004. Reed Canarygrass Control & Management in the Pacific Northwest. TNC Wildland Invasive Species Team.

2015 Sampling Locations

South water control structure

PHAR

Natural Emergent

2016 Sampling Locations

South water control structure

PHAR

Natural Emergent