

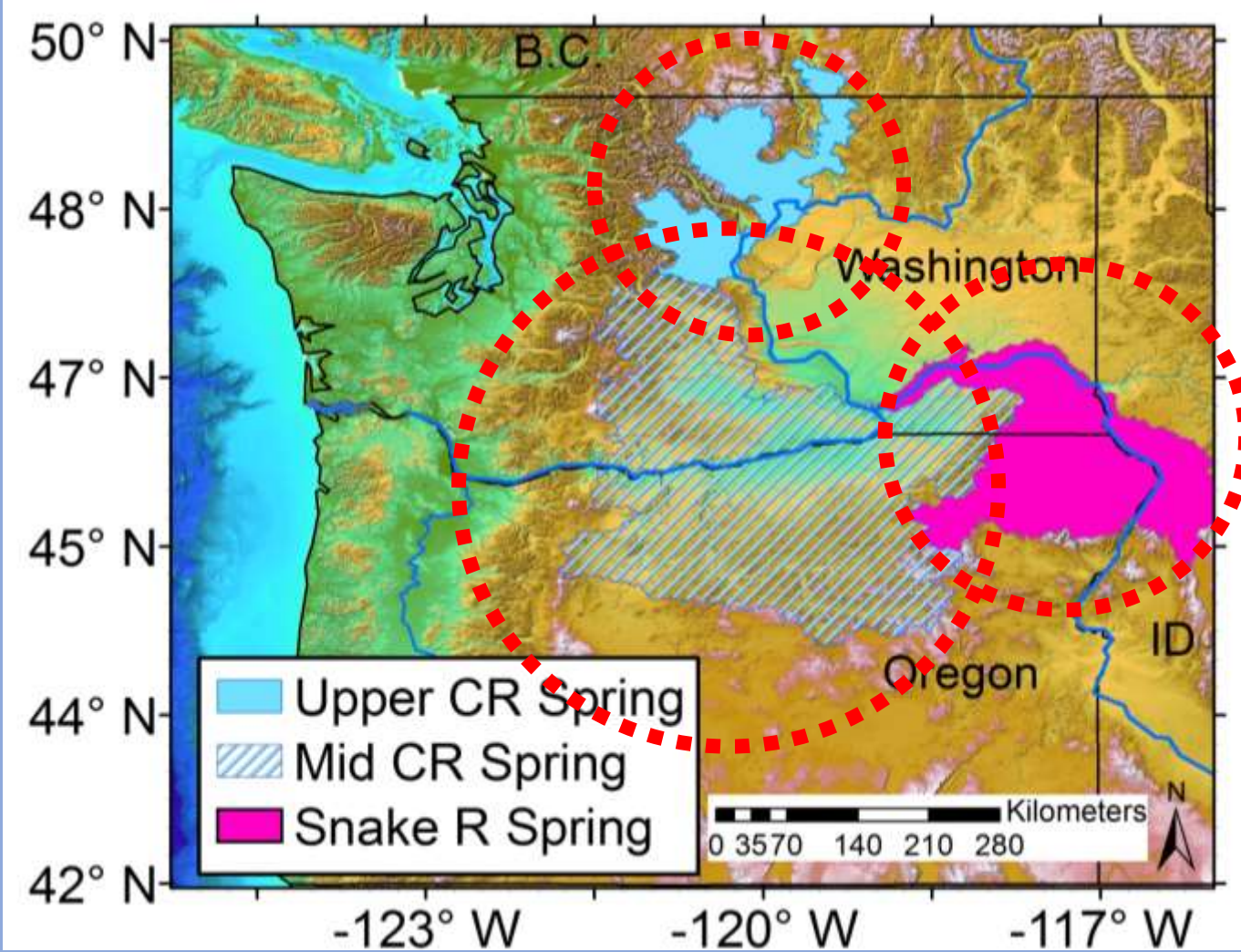
Salmon size, growth, and selective mortality in Columbia River Chinook Salmon

Craig Norrie*, Cheryl Morgan, Brian Burke, Brain Beckman, Laurie Weitkamp, & Jessica Miller



*cnorrie@uw.edu

Juvenile interior Columbia River Spring Chinook Salmon



Important to understand factors which may be impacting population abundance

- Early ocean residence is a critical period in the life history of salmon
 - Period of high and variable mortality
- During this period some phenotypes confer a survival advantage
 - Size and growth are thought to play an important role – **size selective mortality**



Research questions

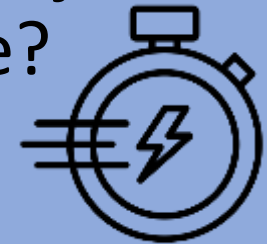
BETWEEN YEARS:

Which individual traits are important for Interior Columbia River Spring Chinook Salmon population survival?



WITHIN YEARS:

Do we detect evidence for size- or growth-selection of juvenile Chinook salmon during early ocean residence?



Research questions

BETWEEN YEARS:

Which individual traits are important for Interior Columbia River Spring Chinook Salmon population survival?



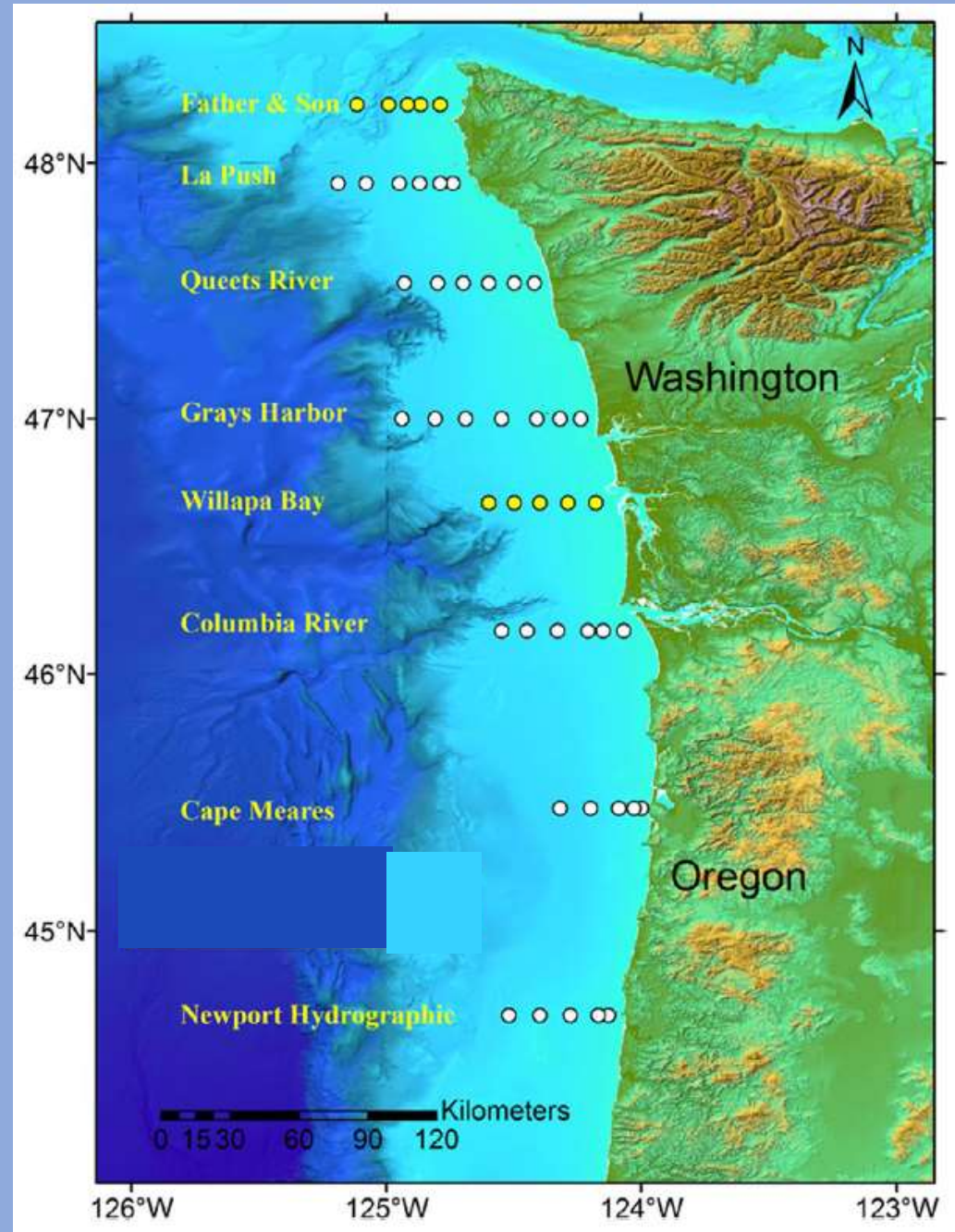
WITHIN YEARS:

Do we detect evidence for size- or growth-selection of juvenile Chinook salmon during early ocean residence?



Which individual traits are important for survival?

- Sampled in May 2007, 2008, 2011, 2015-2019 (JSOES)
- Split fish into three groups based on residence time (<5 days, >7 days, and all fish)



Individual traits



Size at capture

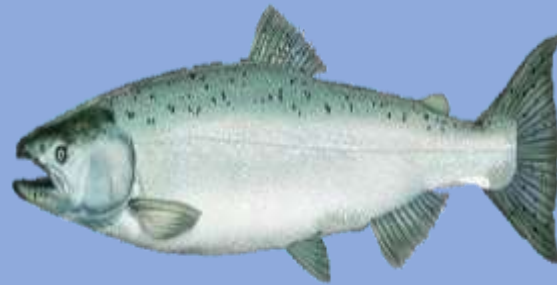




Individual traits

Size at capture

Condition (Fulton's k)



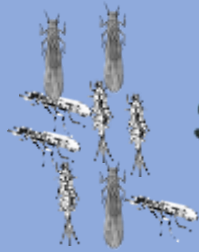


Individual traits

Size at capture

Condition (Fulton's k)

Stomach fulness





Individual traits

Size at capture

Condition (Fulton's k)

Stomach fulness

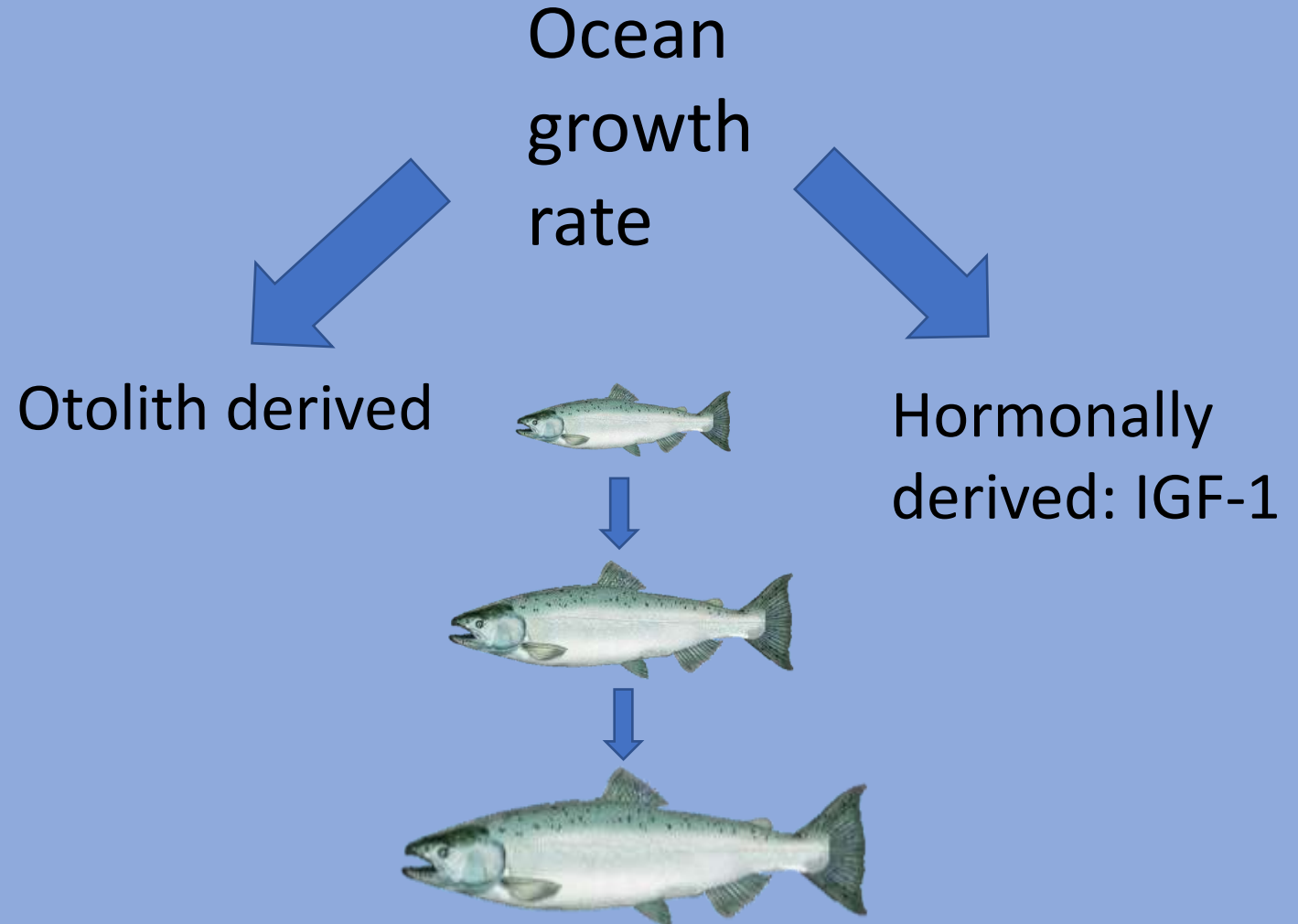
Timing of ocean entry



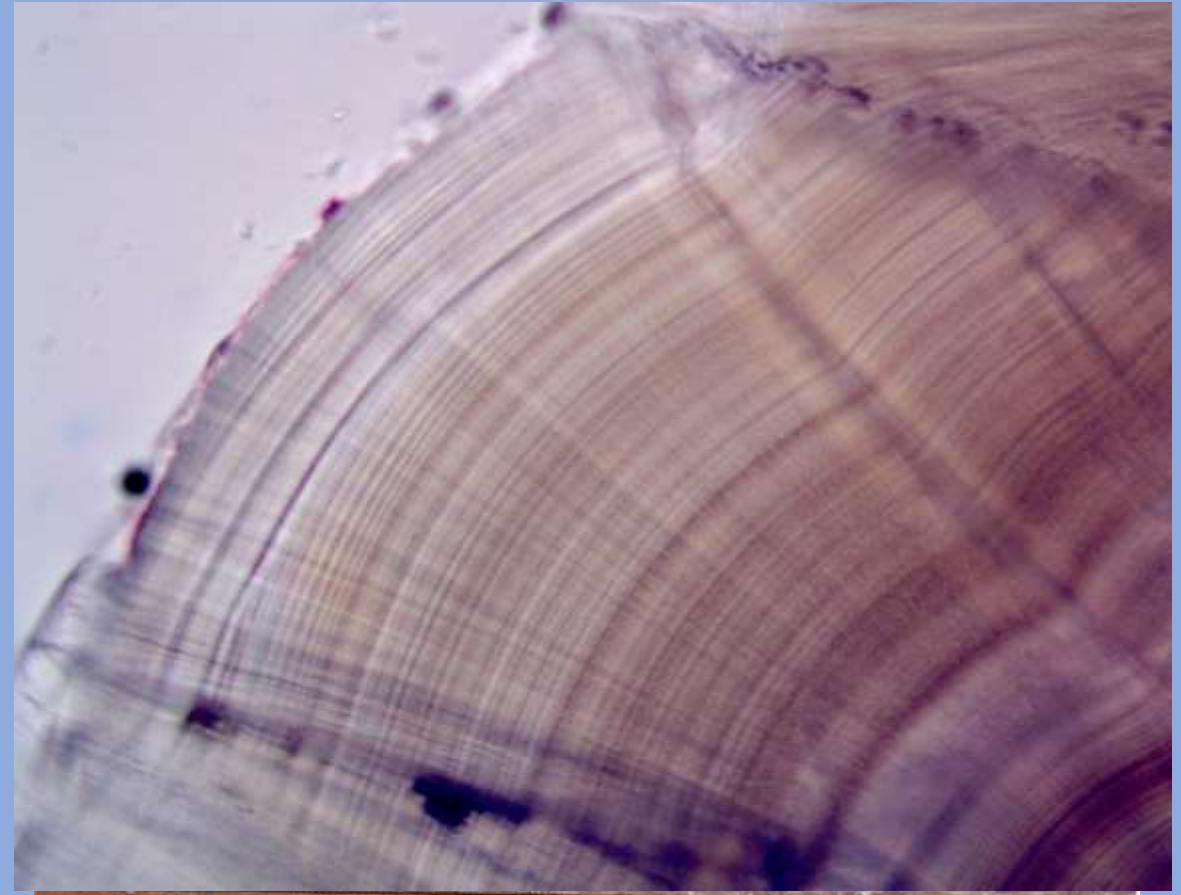
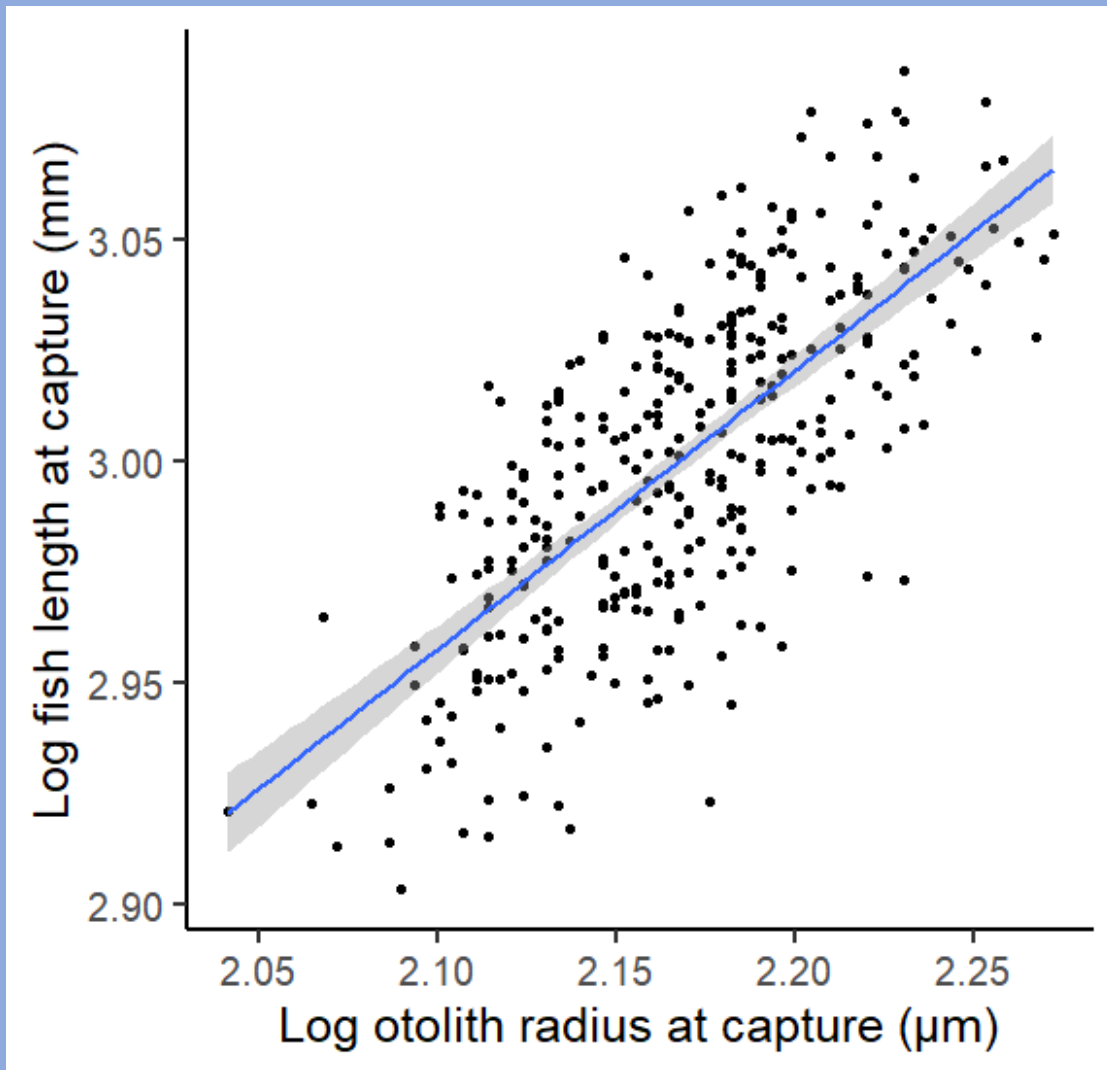


Individual traits

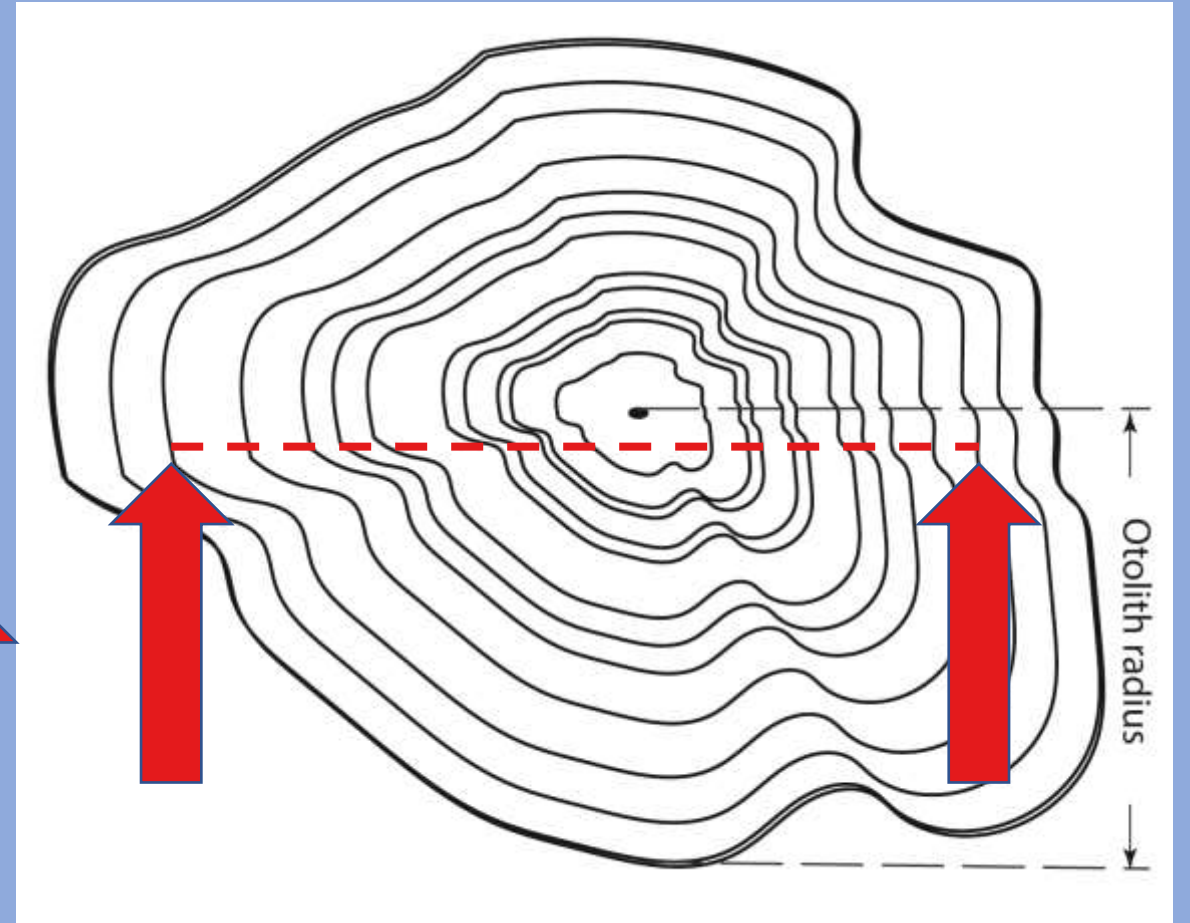
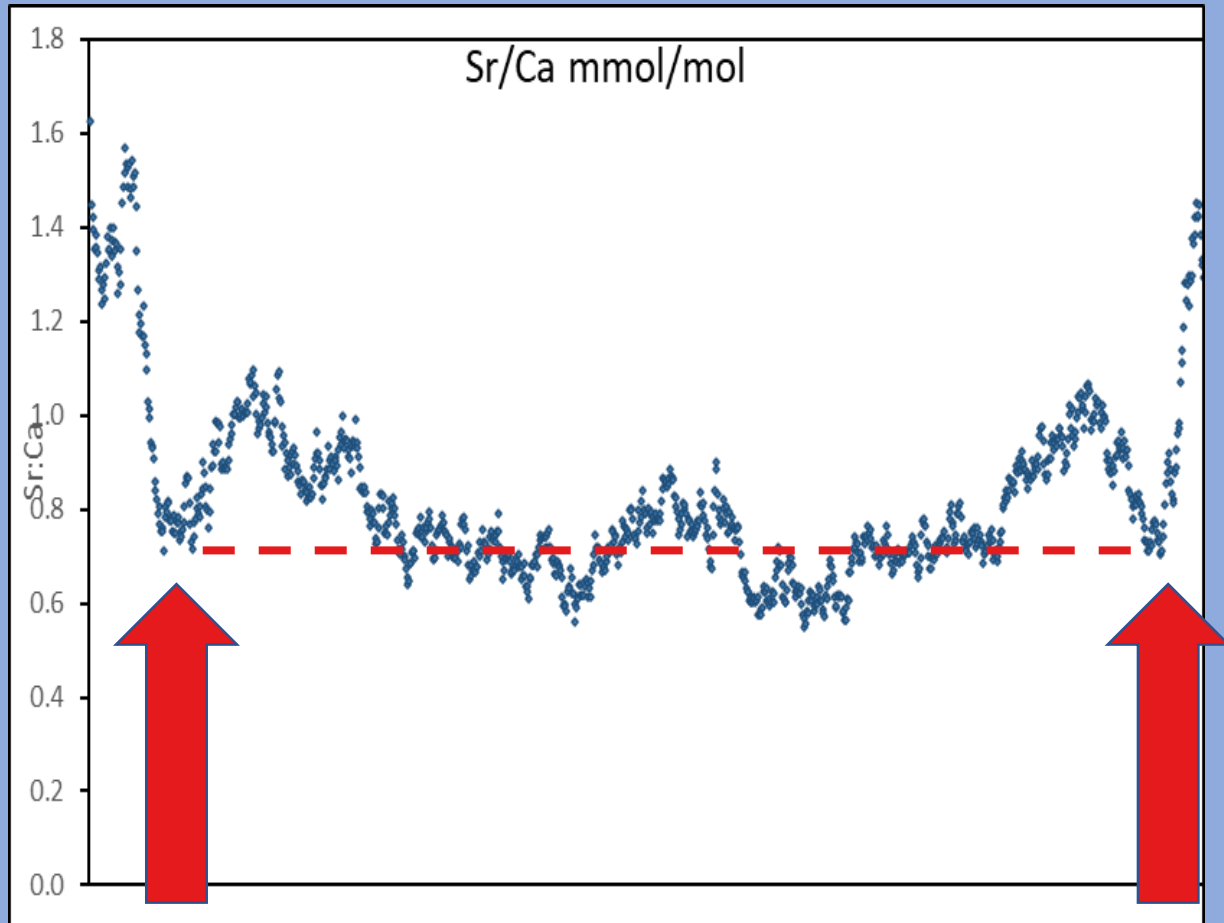
- Size at capture
- Condition (Fulton's k)
- Stomach fulness
- Timing of ocean entry



Otolith derived growth



Otolith analysis for size and growth reconstruction – establishing ocean entry



Which individual traits are important for survival?



- Averaged individual traits for hatchery and presumed wild fish
- Examined relationships with survival using linear models
- Examined average all individual factors and all possible two-way interactions
- Compared models using ΔAIC

Size at capture

Condition (Fulton's k)

Stomach fulness

Timing of ocean entry

Ocean growth rate

Otolith

IGF



SURVIVAL (SAR)

Years in which fish were larger and in better condition after 7 days in the ocean had higher survival.

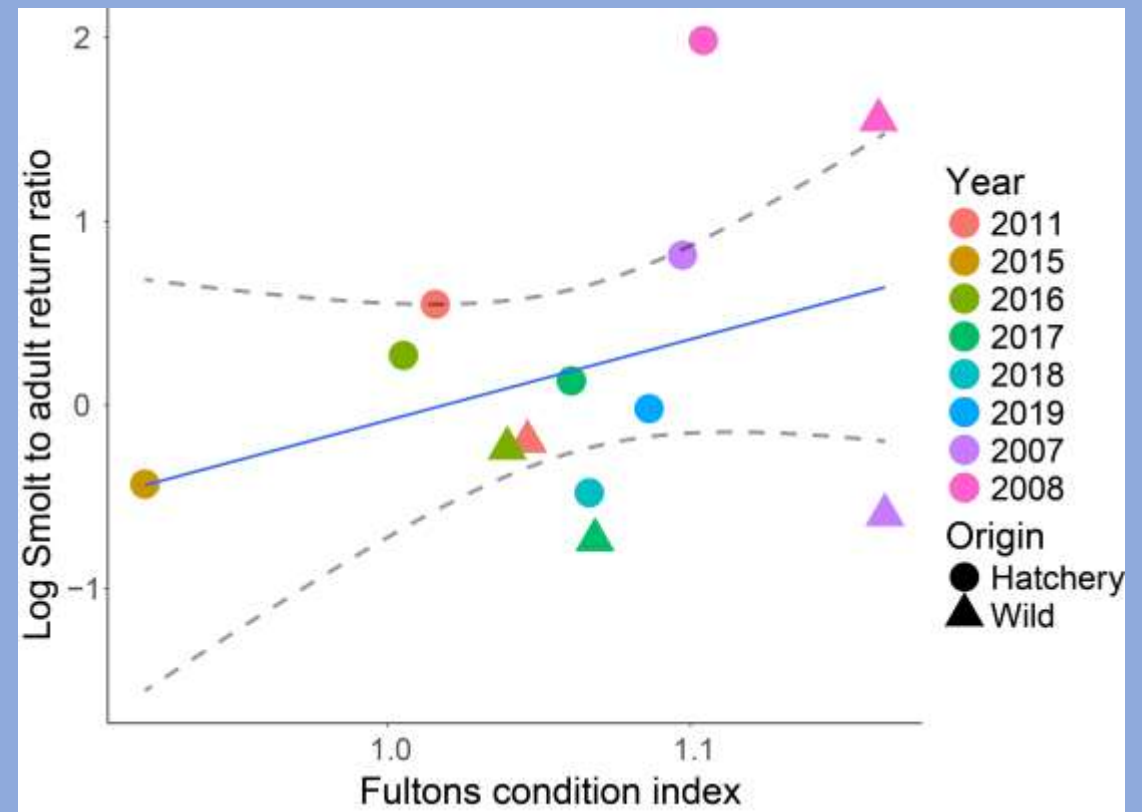
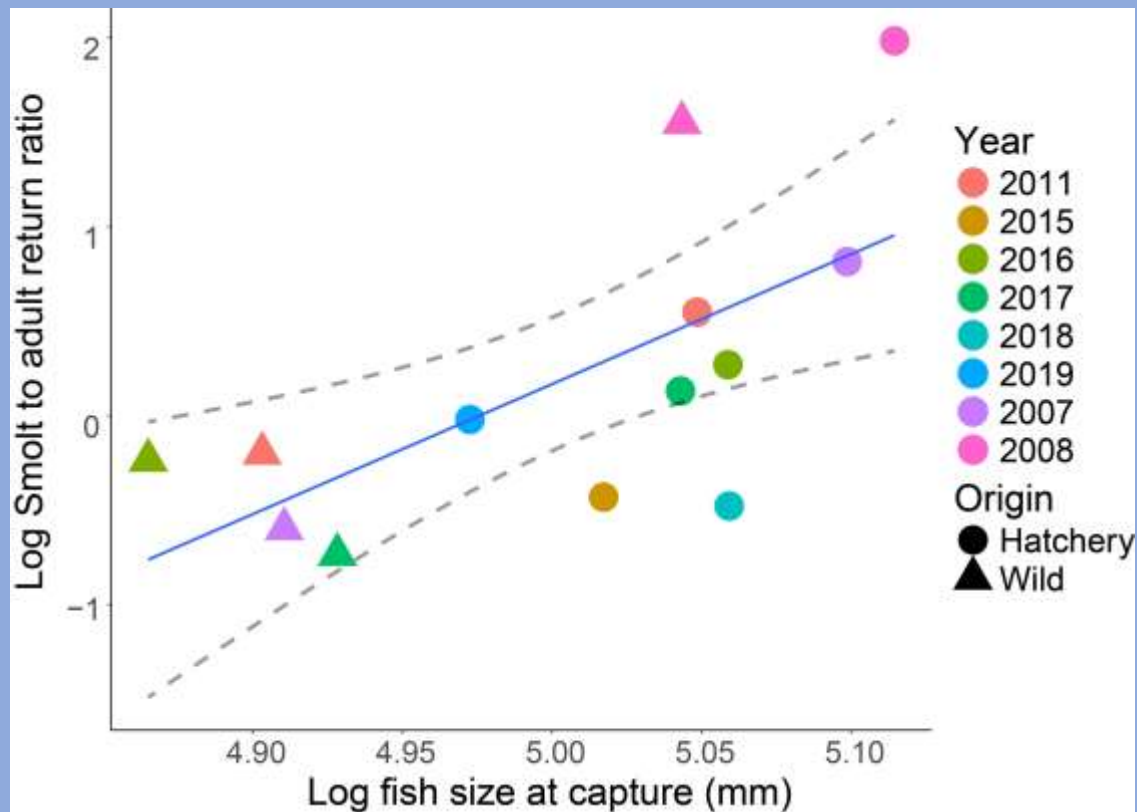


- The 2 most parsimonious models included fish that had been in the ocean for over a week
- The most parsimonious model included an size at capture and an interaction between size at capture and futons condition ($r^2=0.62$, $p=0.007$)

Years in which fish were larger and in better condition had higher survival.



- The 2 most parsimonious models included fish that had been in the ocean for over a week



Which individual factors are important for Interior Columbia River Spring Chinook Salmon population survival?

- Processes occurring during the first week of ocean residence are important for survival
- Years in which fish are larger and in better condition after the first week have higher survival

Research questions

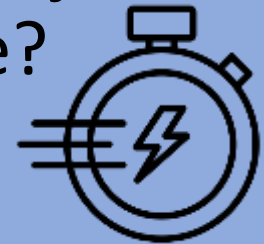
BETWEEN YEARS:

Which individual traits are important for Interior Columbia River Spring Chinook Salmon population survival?



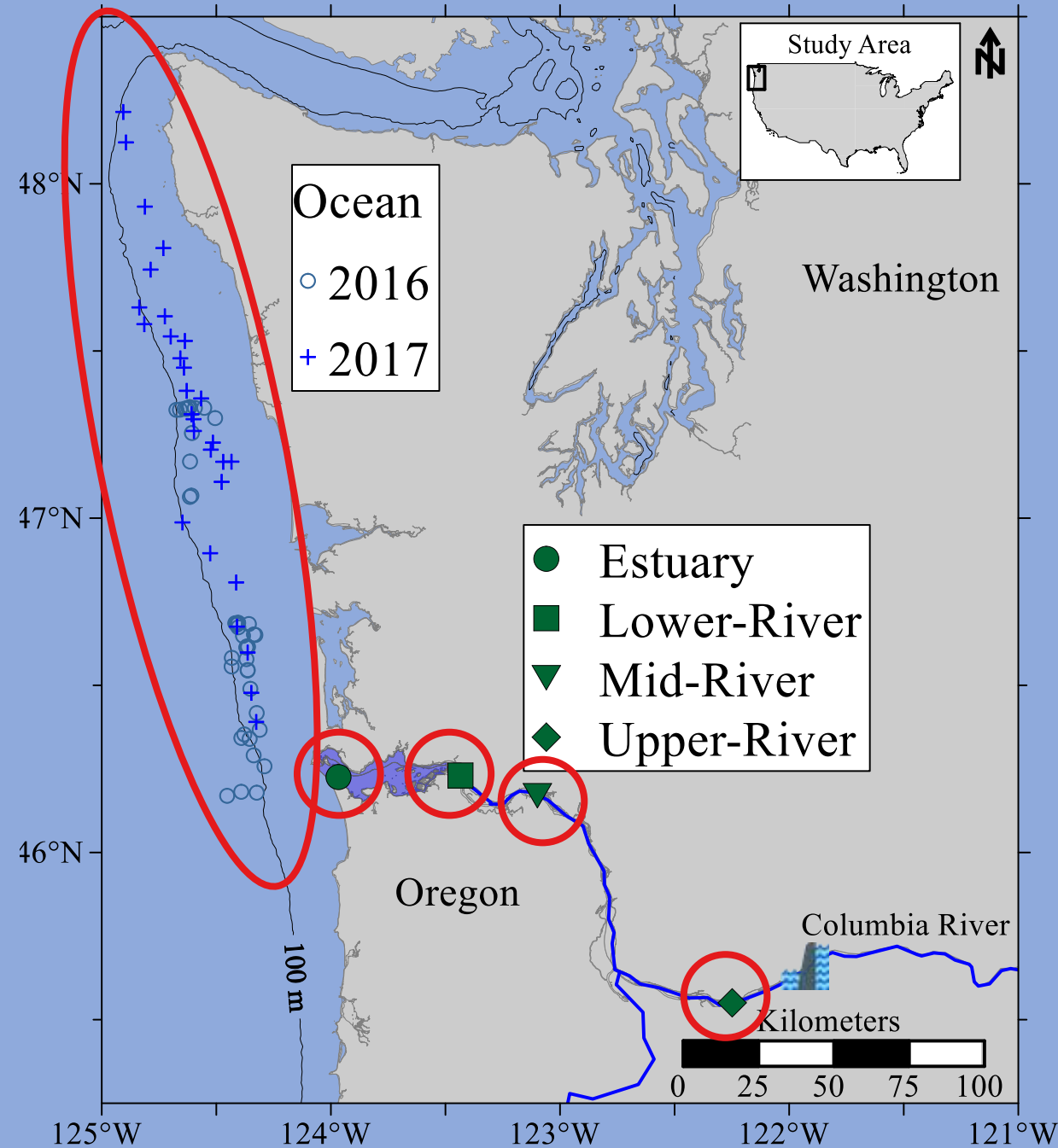
WITHIN YEARS:

Do we detect evidence for size- or growth-selection of juvenile Chinook salmon during early ocean residence?

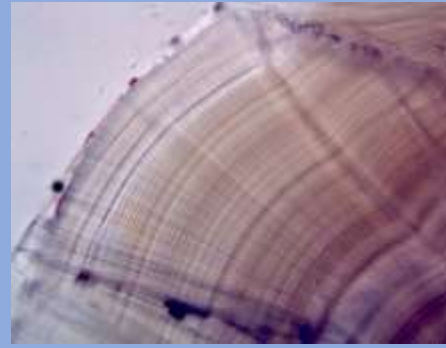


Sampled freshwater and marine habitats

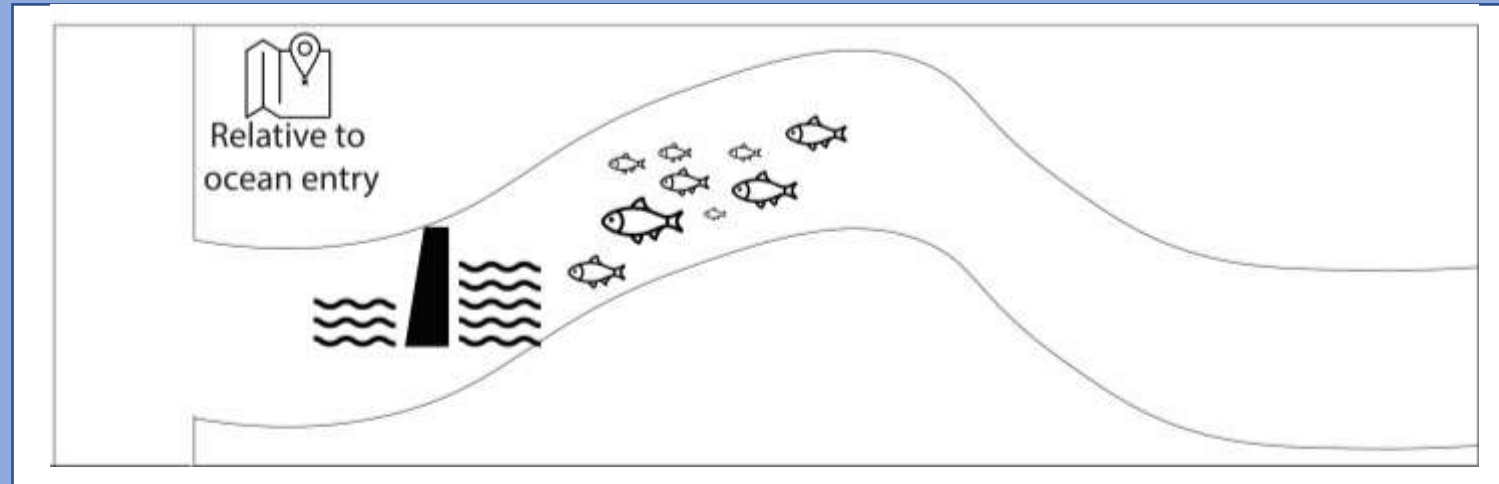
- 2016 and 2017
- 4 locations in the Lower Columbia River and Estuary
- Repeatedly sampled the same cohort



Common points of comparison



- Compared growth and size relative to ocean entry





Common points of comparison

- Size

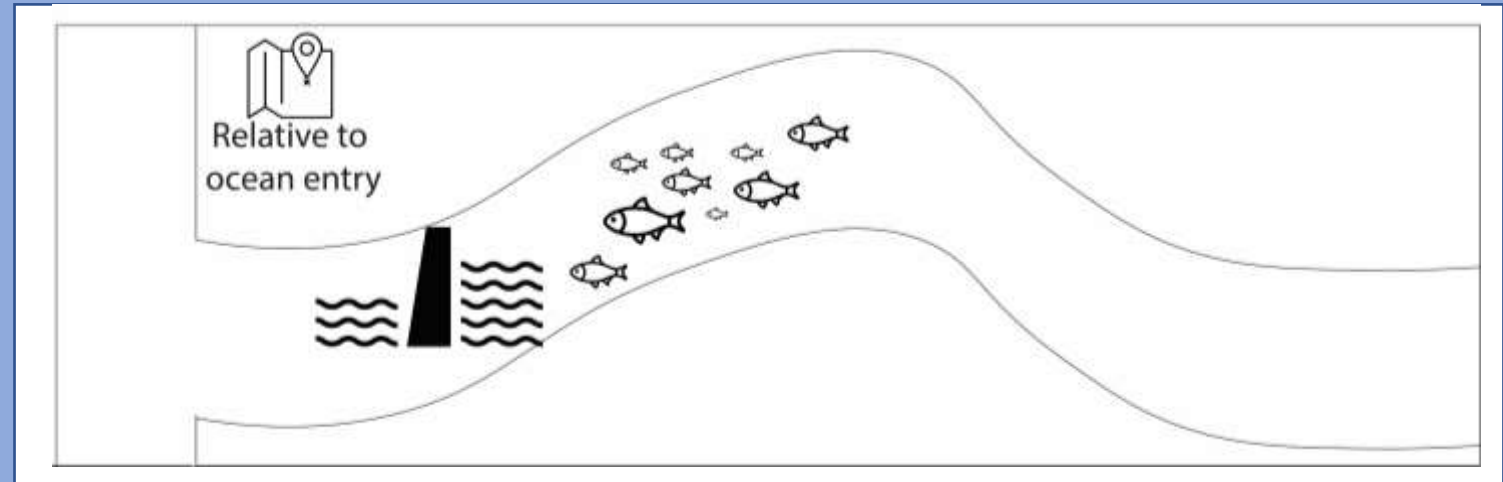


3 days prior to ocean entry

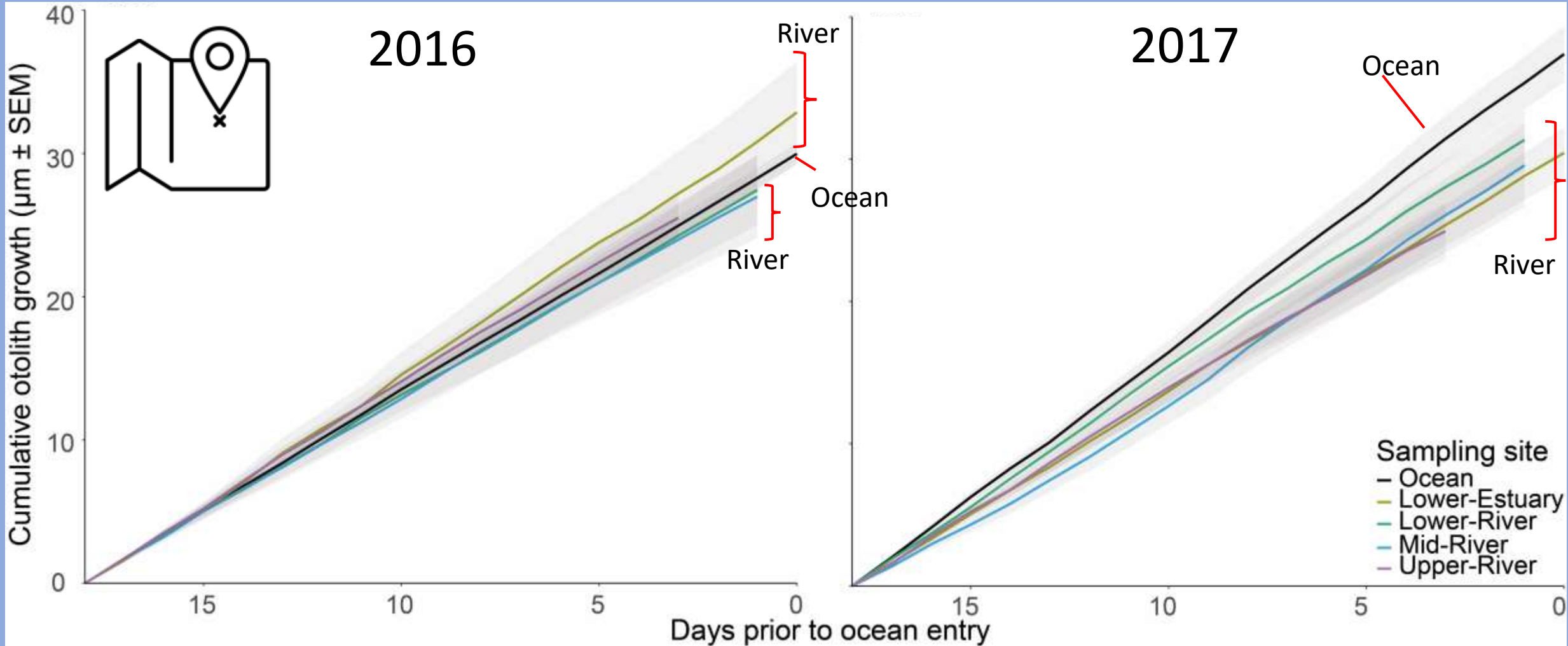
- Growth



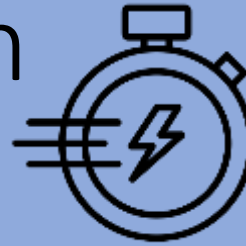
Two weeks prior to ocean entry



Growth selection detected prior to ocean entry in 2017



Higher overall survival in 2016



- Both years were broadly similar in terms of ocean conditions
- Smolt adult returns to Bonneville dam were higher in 2016 than in 2017
 - 2017 – 0.76%
 - 2016 – 1.18%
- 2017 ocean CPUE was among the lowest of recorded for these surveys BUT CPUE was similar in the river in both years

ECOSYSTEM INDICATORS		2016	2017
CLIMATE & ATMOSPHERIC	PDO (SUM; Dec-Mar)	poor	poor
	PDO (SUM; May-Sep)	poor	fair
	ONI (AVG; Jan-Jun)	poor	fair
LOCAL PHYSICAL	SST NDBC Buoys (°C; May-Sep)	poor	fair
	Upper 20 m T (°C; Nov-Mar)	poor	poor
	Upper 20 m T (°C; May-Sep)	fair	fair
	Deep Temp (°C; May-Sep)	fair	poor
	Deep Salinity (May-Sept)	fair	fair
LOCAL BIOLOGICAL	Copepod richness	poor	poor
	N copepod biomass	poor	poor
	S copepod biomass	poor	poor
	Biological transition	poor	poor
	Nearshore Ichthyoplankton	fair	fair
	Nearshore & offshore Ichthyoplankton	poor	poor
	Chinook salmon juvenile catch	poor	poor
	Coho salmon juvenile catch	fair	poor
MEANS & RANKS	Mean of ranks	18.9	17.2
	Rank of the mean rank	poor	poor



Do we detect evidence for size- or growth-selection of juvenile Chinook salmon during early ocean residence?

- Selection occurred in the ocean but this selection is based on what happened in freshwater (in 2017)
- We only detected evidence for selection within years when survival was lower

Both the river and the ocean are
important for population survival!

Thanks to

- Elizabeth Daly
- Thomas Murphy
- Donald Van Doornik
- Bonneville Power Administration (1998-014-00)
- Army Corps of Engineers Northwestern Division's Anadromous Fish Evaluation Program (study EST-P-15-01)
- Crew of the FV *Frosti*

Bonneville
POWER ADMINISTRATION





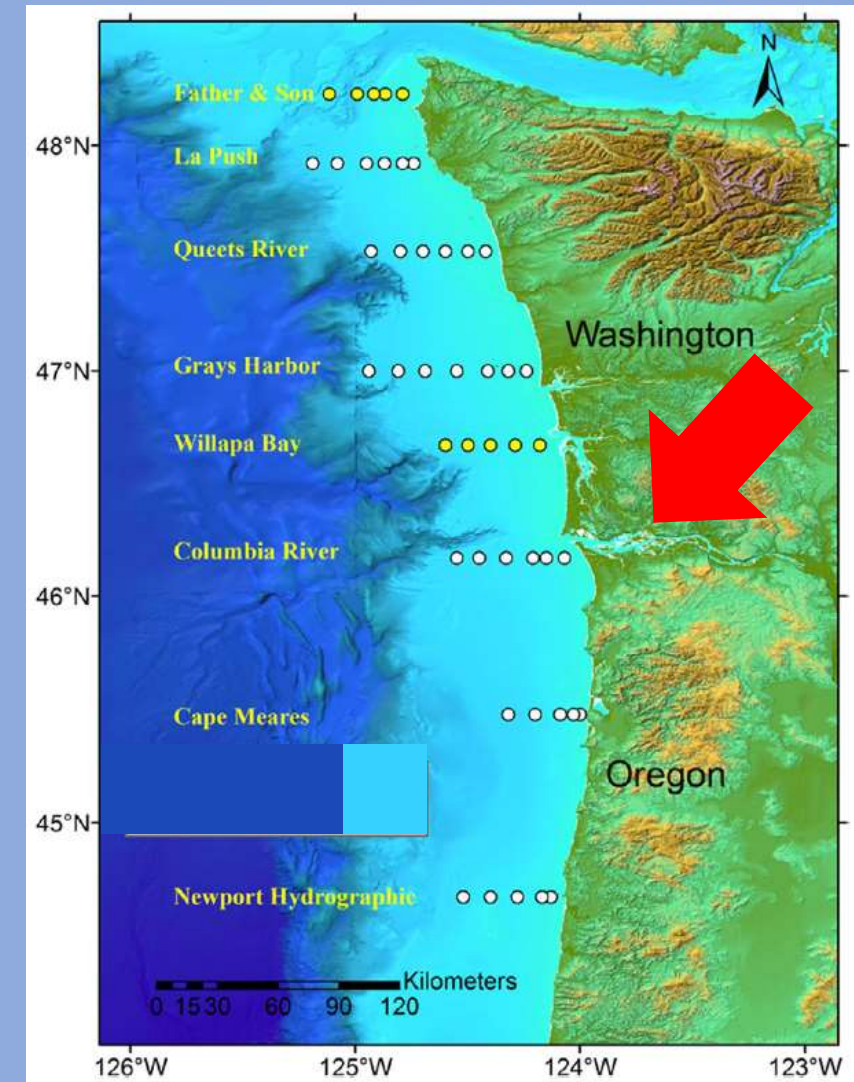
THANK YOU FOR LISTENING!

cnorrie@uw.edu

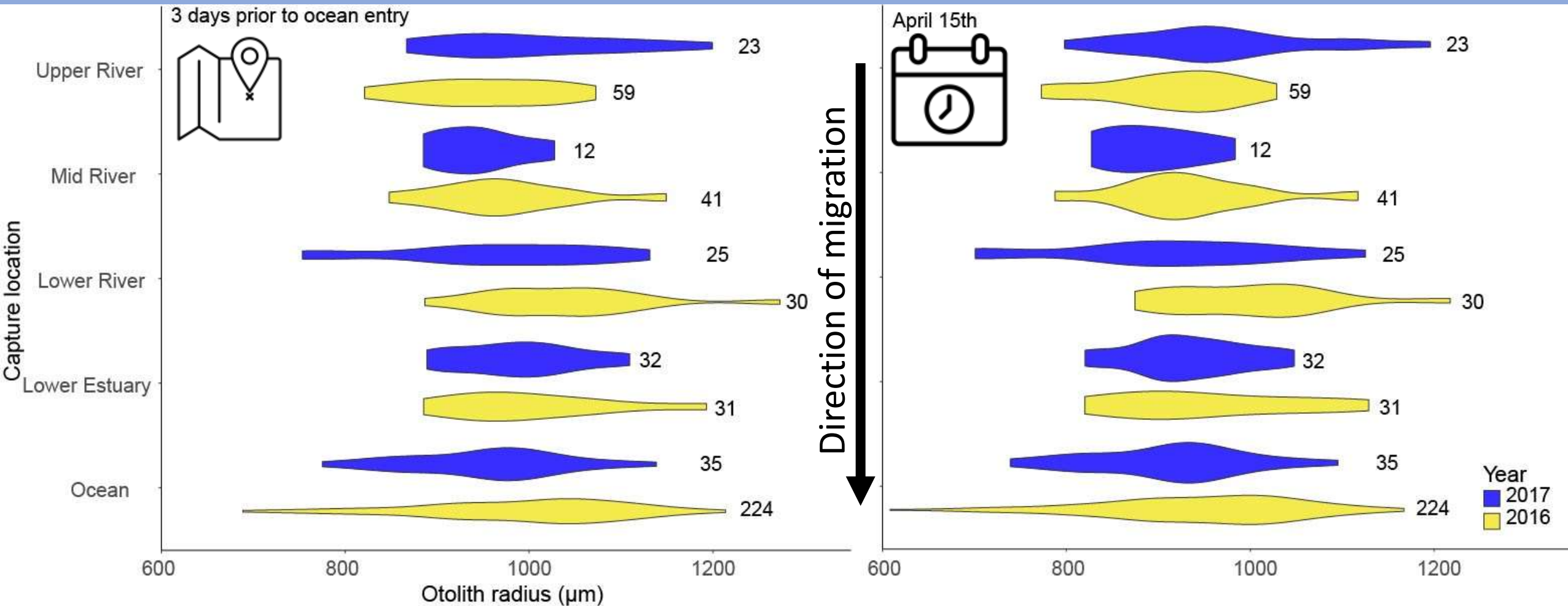


Next steps – what happens after ocean entry?

- We have samples over a longer temporal scale. From 2011 and from 2015-2019
- Change of approach required
 - We only have access to fish which survived the period immediately following marine entry
- Do years in which fish are larger and grow faster during early marine residence correspond to higher survival?



No evidence for size selective mortality



Otolith analysis for size and growth reconstruction

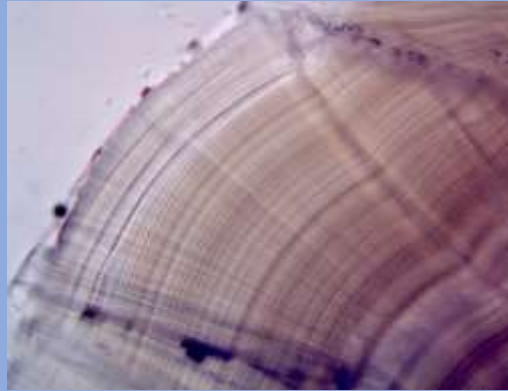


Photo: OSU Fish Lab

