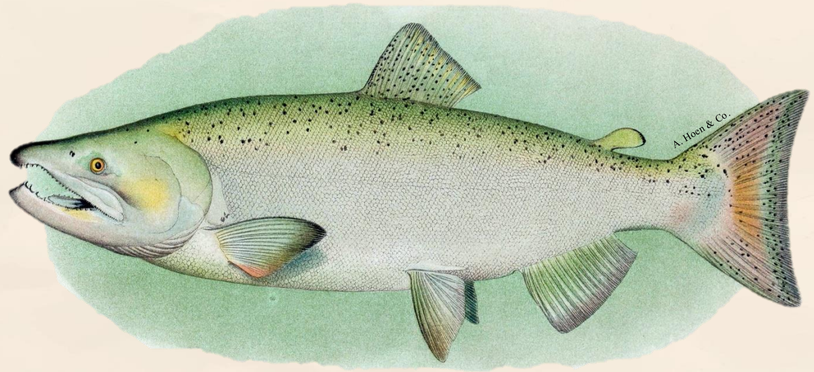
The role of hatchery origin in early marine residence and survival of Interior Columbia River spring and summer Chinook salmon

Rebecca M. Forney[1], Amy A. Wallace[2], Brian J. Burke[3], Cheryl A. Morgan[2], Jessica A. Miller[1]



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[2]Cooperative Institute for Marine Ecosystem and Resources Studies, Oregon State University

[3]Fish Ecology Division, Northwest Fisheries Science Center National Marine Fisheries Service, National Oceanic and Atmospheric Administration

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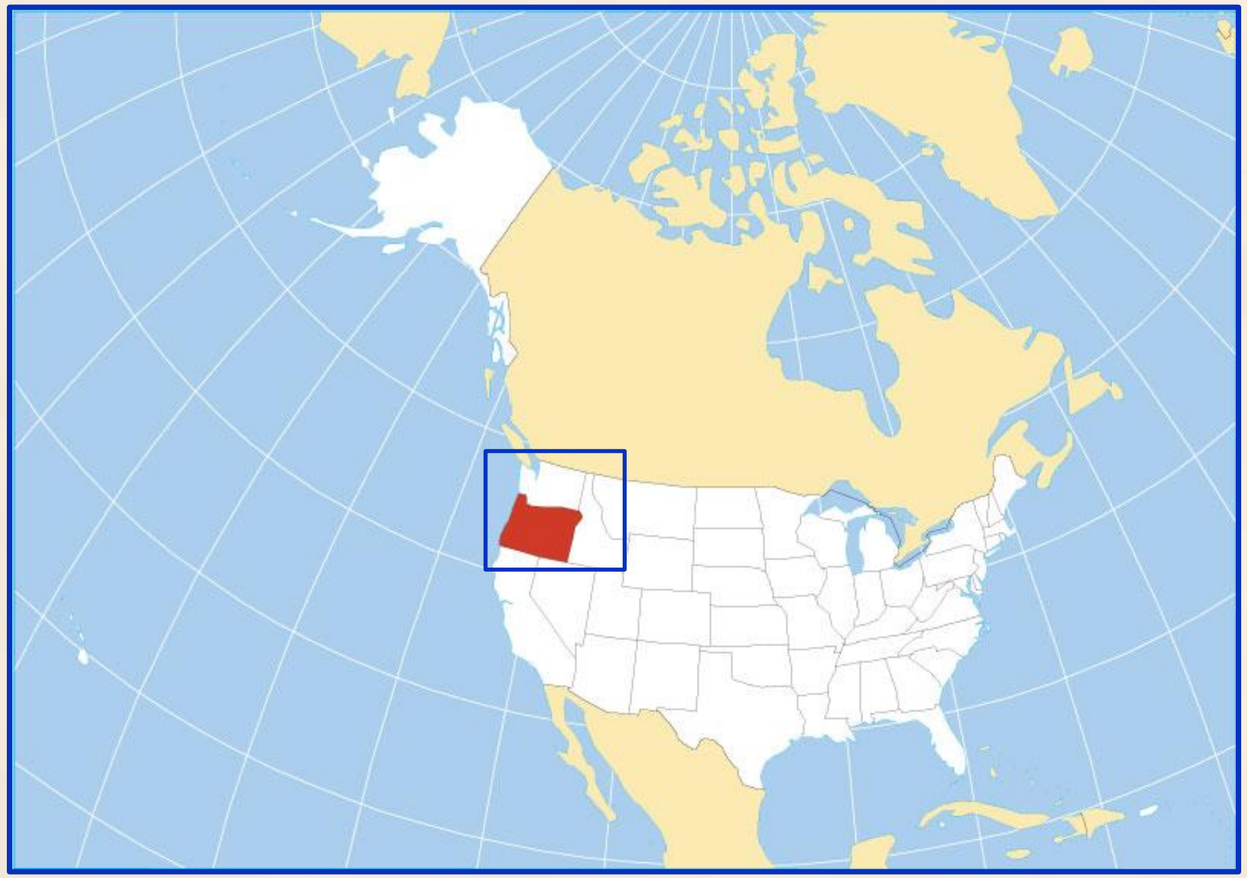
Oregon State University
Coastal Oregon Marine Experiment Station

The Columbia-Snake River System



The Columbia-Snake River System

Originates in British Columbia, Canada

Second largest watershed in North America

Provides flood control, irrigation, navigation, & hydropower to the Pacific Northwest

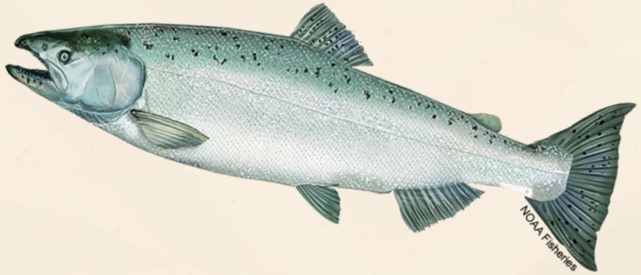


Sacred to the Native American Tribes

Was once the most productive salmon rivers

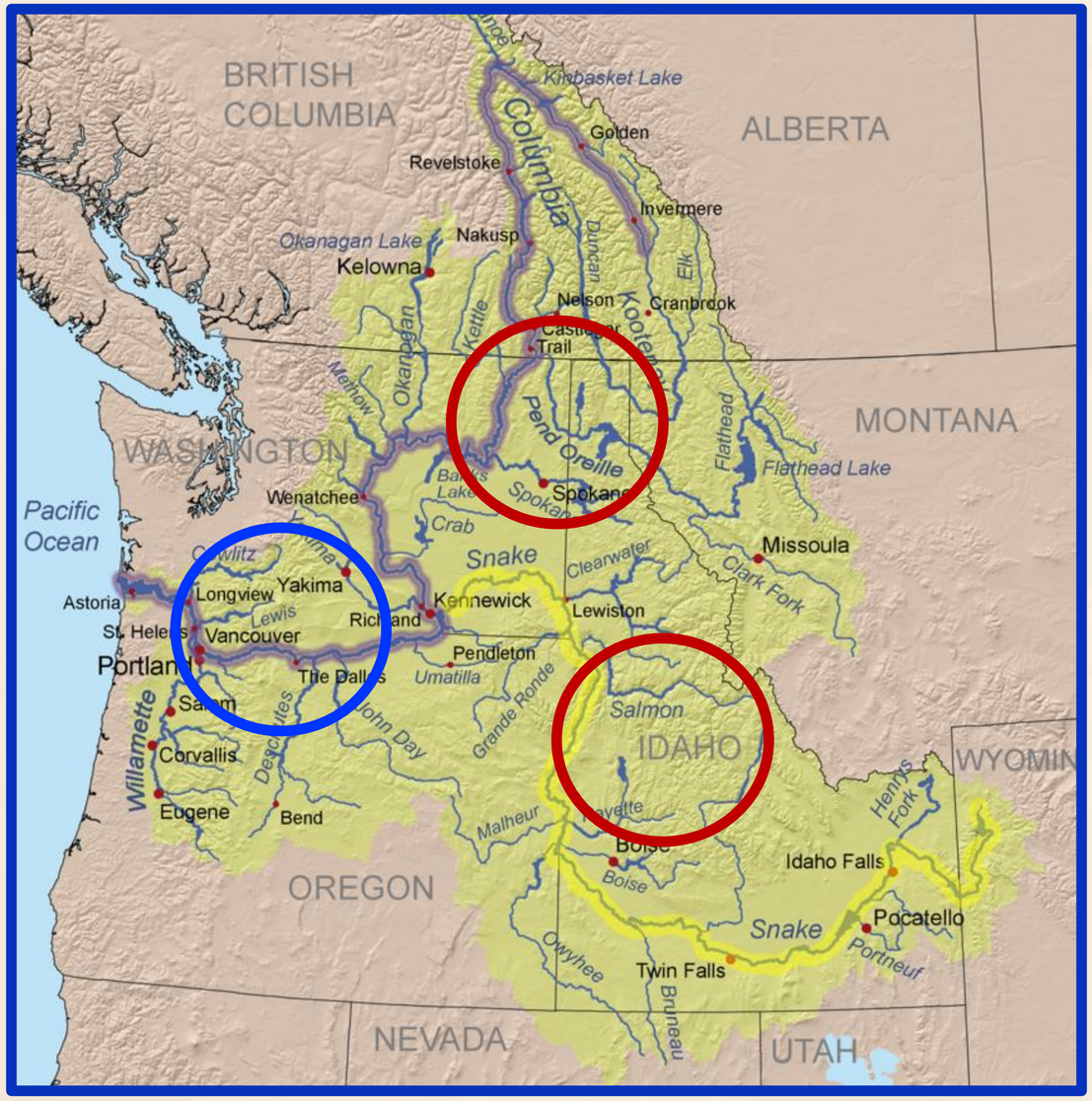
Population declines from habitat fragmentation due to dam construction

Interior Columbia River Spring Summer Chinook Salmon



Upper Columbia River Spring ESU – Endangered

Mid Columbia River Spring Run - Unlisted



Snake River Spring/Summer ESU – Threatened

ESU = Evolutionary Significant Unit

Smolt-to-Adult Returns

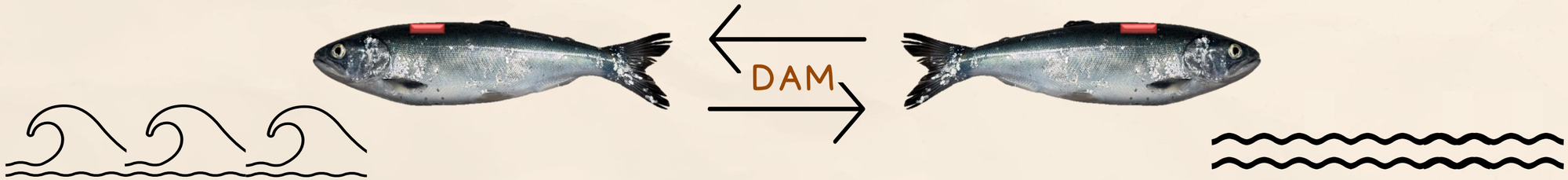
SARs

Smolt-to-Adult Returns

SARs

Number of out-migrating smolts detected at dams

Number of adults detected returning to the river



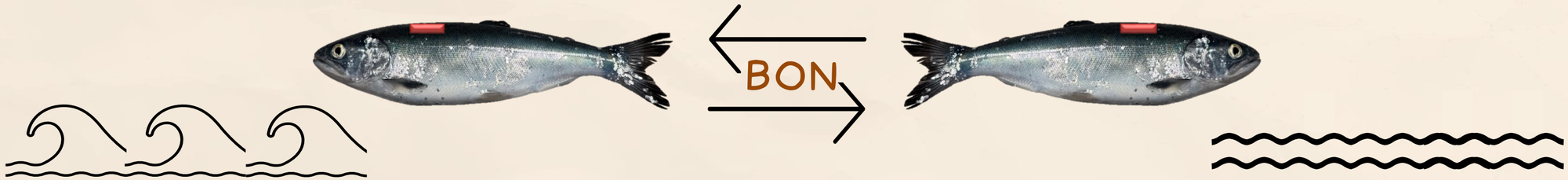
Using PIT-tags (passive integrated transponder)

Smolt-to-Adult Returns

SARs

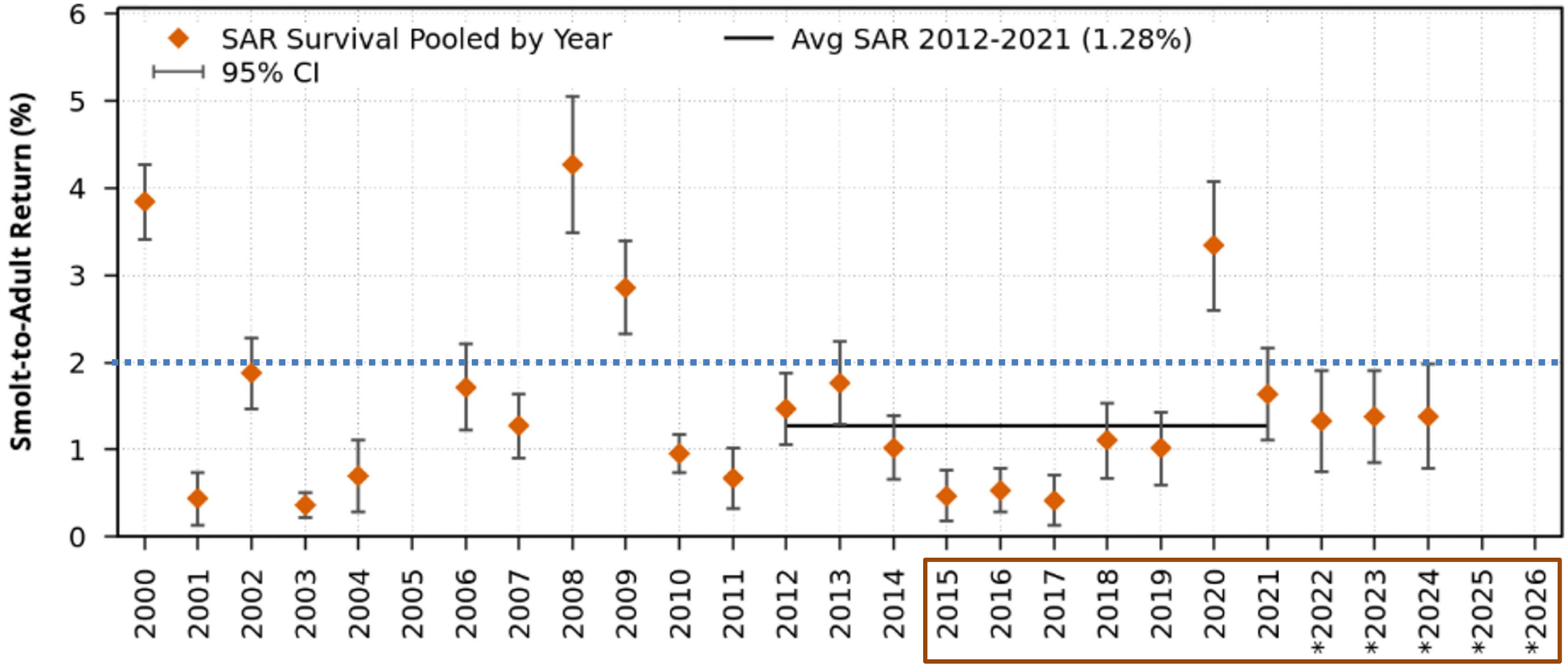
Number of out-migrating smolts detected at dams

Number of adults detected returning to the river



Using PIT-tags (passive integrated transponder)

BON to BON Survival
Snake River Spring/Summer Chinook Salmon ESU (Wild)



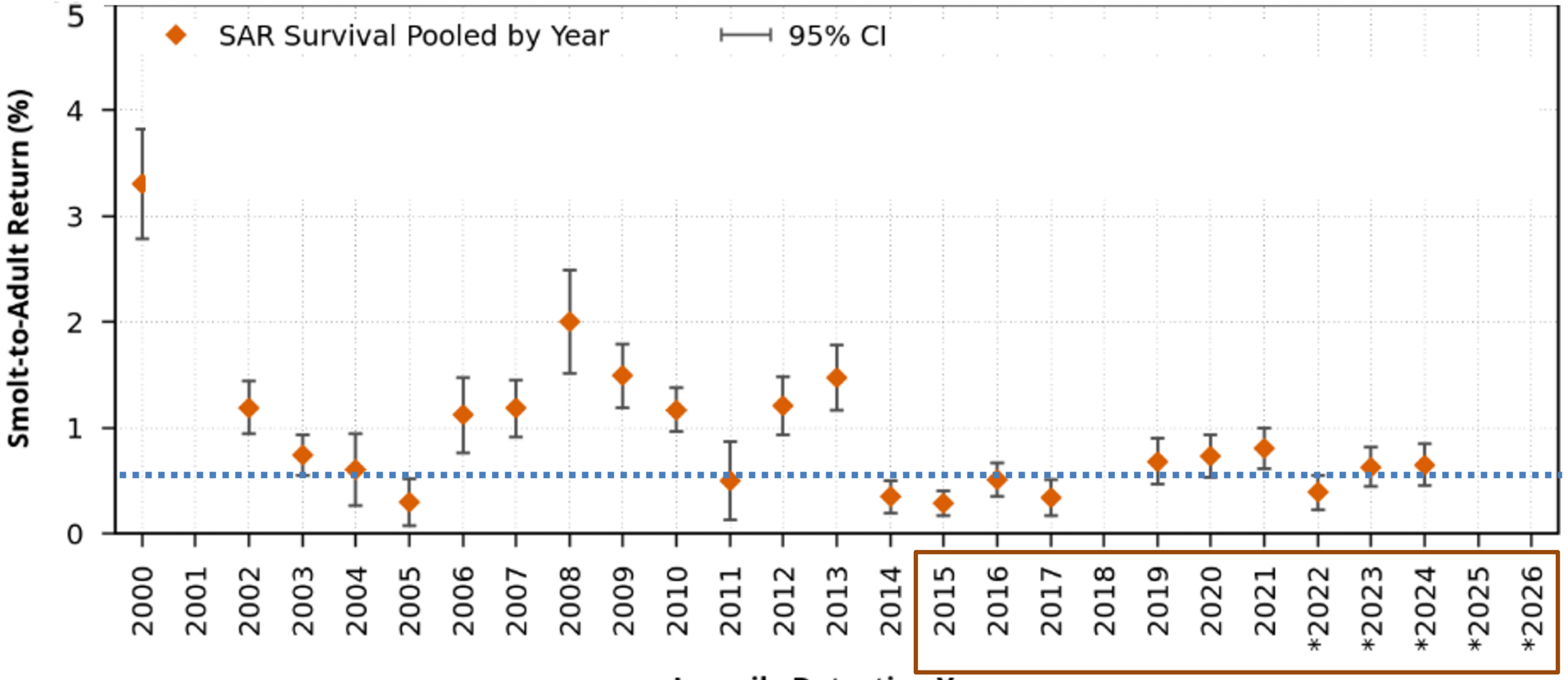
SAR minimum requirement: 7 adults per pooled period
* SAR for Juvenile Detection Year may be Incomplete

www.cbr.washington.edu/dart

12 Oct 2026 13:25:22 PDT

The Northwest Power and Conservation Council set a recovery range of 2-6% SARs for spring/summer Chinook salmon populations

BON to BON Survival
Snake River Spring/summer Chinook salmon ESU (Hatchery)

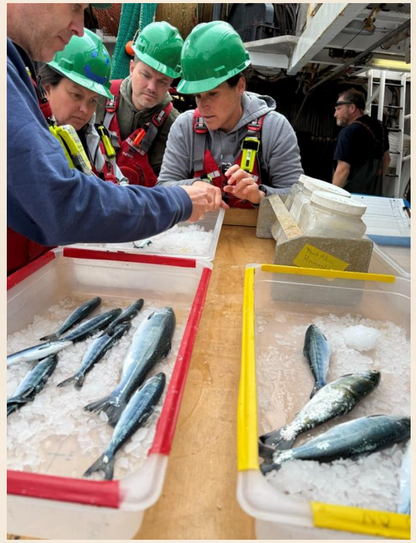


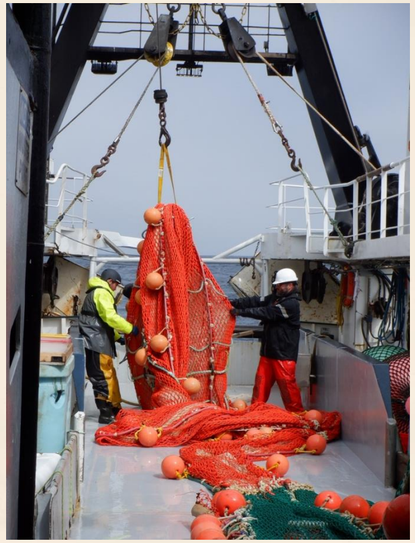
SAR minimum requirement: 7 adults per pooled period
* SAR for Juvenile Detection Year may be Incomplete

www.cbr.washington.edu/dart

12 Oct 2026 13:27:05 PDT

Hatchery specific target range, for the Lower Snake River Compensation Plan, is 0.38-0.97% SARs









The Juvenile Salmon & Ocean Ecosystem Survey

(JSOES)








Inter-annually, larger size & fast early ocean growth related to survival

(Tomaro et al. 2012; Miller et al. 2014)



Over 90% of the fish caught within the last decade are tagged



Since 2015, we started to catch enough **PBT** fish to ask hatchery level questions

parentage-based tagging

BIG QUESTION: Does origin matter?

BIG QUESTION: Does origin matter?

Canadian Journal of Fisheries and Aquatic Sciences

Research Article

The role of hatchery origin in early marine residence and survival of Interior Columbia River spring and summer Chinook salmon (*Oncorhynchus tshawytscha*)

Rebecca M. Forney[a], **Amy A. Wallace**[b], **Brian J. Burke**[c], **Cheryl A. Morgan**[b], **and Jessica A. Miller**[a]

[a]Department of Fisheries, Wildlife, and Conservation Sciences, Coastal Oregon Marine Experiment Station, Oregon State University, Newport, OR, USA; [b]Cooperative Institute for Marine Ecosystem and Resources Studies, Oregon State University, Newport, OR, USA; [c]Fish Ecology Division, Northwest Fisheries Science Center National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, WA, USA

Corresponding author: **Rebecca M. Forney** (email: forneyr@oregonstate.edu)

2015-2021

Abstract

Interior Columbia River spring and summer (ICRSS) Chinook salmon are listed under the Endangered Species Act and experience persistently poor survival, despite low ocean intercept rates. Intra-annual variation in marine survival among hatcheries is often as large as interannual variation. Using parentage-based tagging, we assigned ICRSS yearlings to their hatchery of origin and evaluated how size and condition at capture varied across hatcheries and whether that variation was related to marine survival. We also compared timing and size at marine entry and early ocean growth across hatchery and wild origin yearlings. We observed consistent differences in early marine residence traits among hatcheries, indicating hatchery-specific influences on performance months after release. After accounting for interannual variability, hatchery of origin explained more of the variation (~47%) in marine survival than body length or condition at capture, hatchery distance from the ocean (~16%), or the number of dams passed during migration (~14%). These findings suggest that carry-over effects associated with hatchery of origin may play a substantial role in shaping early marine survival of ICRSS Chinook Salmon.

Key words: parentage-based tagging, otoliths, smolt-to-adult return, carry-over effects, fisheries management

Forney et al. 2026

★ 2015-2021 ★

☑ How variable are survival and migration traits across hatcheries (+ wild)?

Can these differences explain intra-annual marine survival variation? ☑

★TODAY!★

Have these patterns persisted in recent years?

2015-2024

★TODAY!★

Have these patterns persisted in recent years?

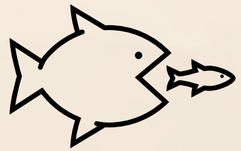
2015-2024



Timing of ocean entry

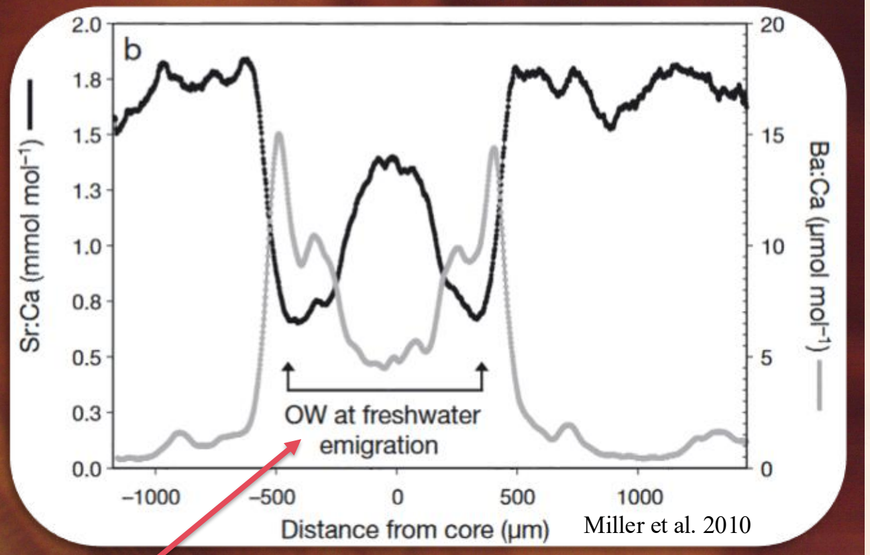


Size at ocean entry



Early marine growth

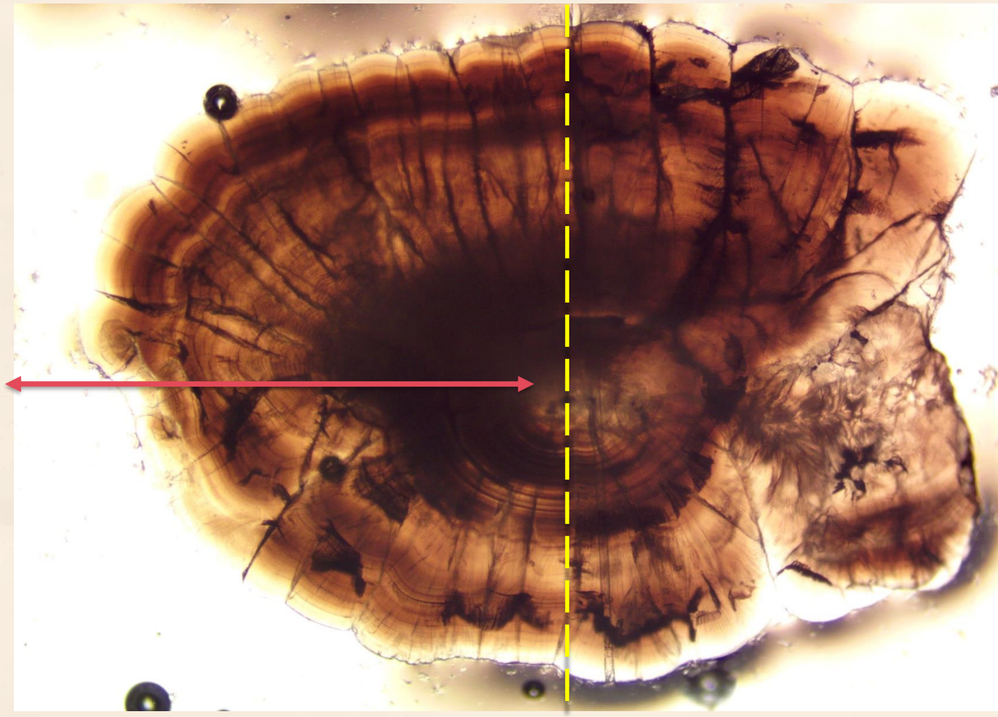
Otolith chemical & structural analysis



Miller et al. 2010

Ocean Entry

Marine Growth





★TODAY!★

Have these patterns persisted in recent years?

2015-2024



Size & condition at capture

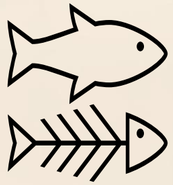
Fish length (FL, mm)

Fulton's K (mass/length^3)

★TODAY!★

Have these patterns persisted in recent years?

2015-2024



Marine Survival

Linear mixed models

★ Linear mixed model:

Hatchery-specific SARs ~ PBT origin * Condition + 1 |Year



★ Linear mixed model:

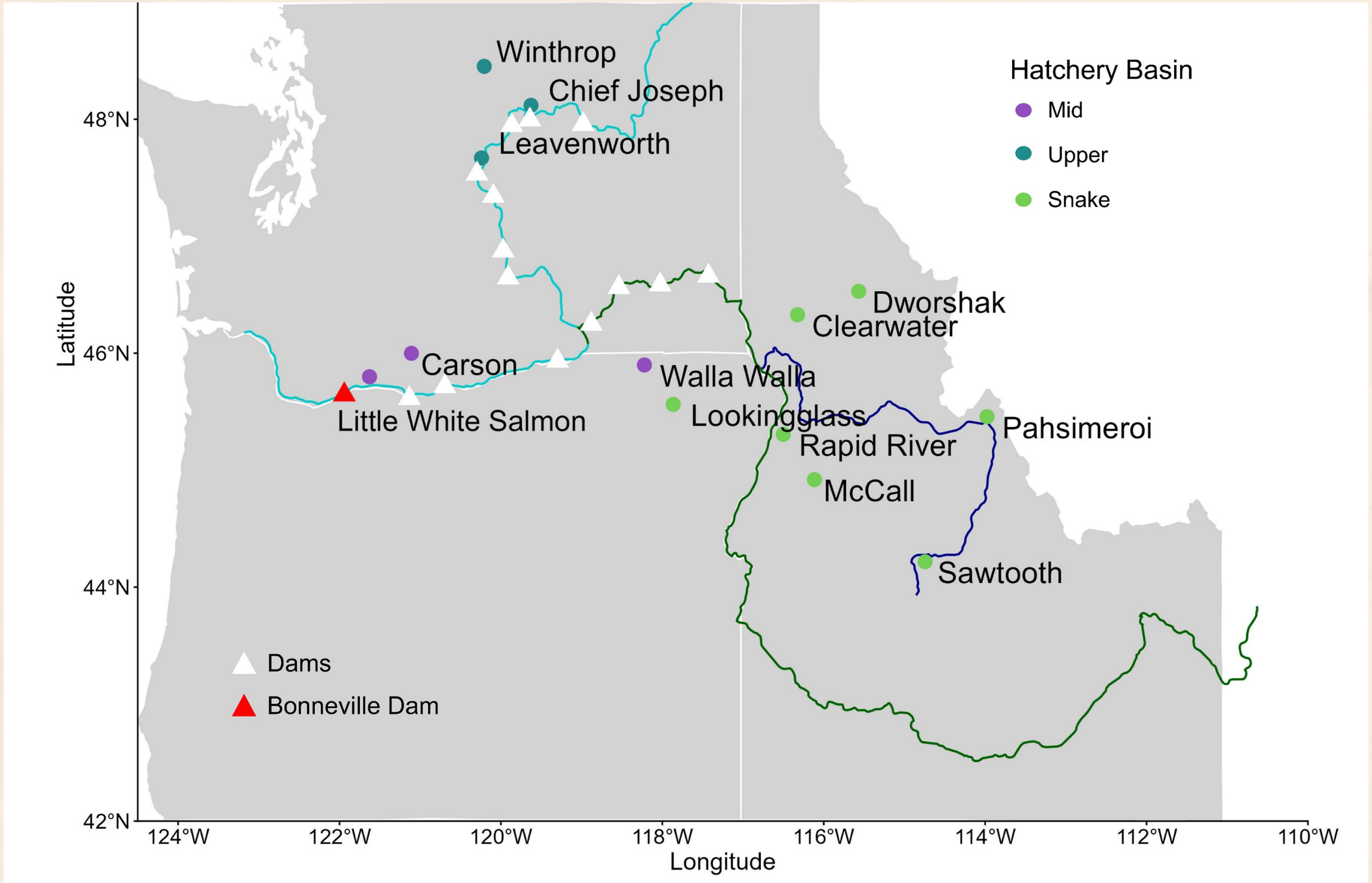
Hatchery-specific SARs ~ PBT origin * Condition + 1 |Year

Hatchery-specific SARs ~ Distance * Condition + 1 |Year

Hatchery-specific SARs ~ Dams * Condition + 1 |Year



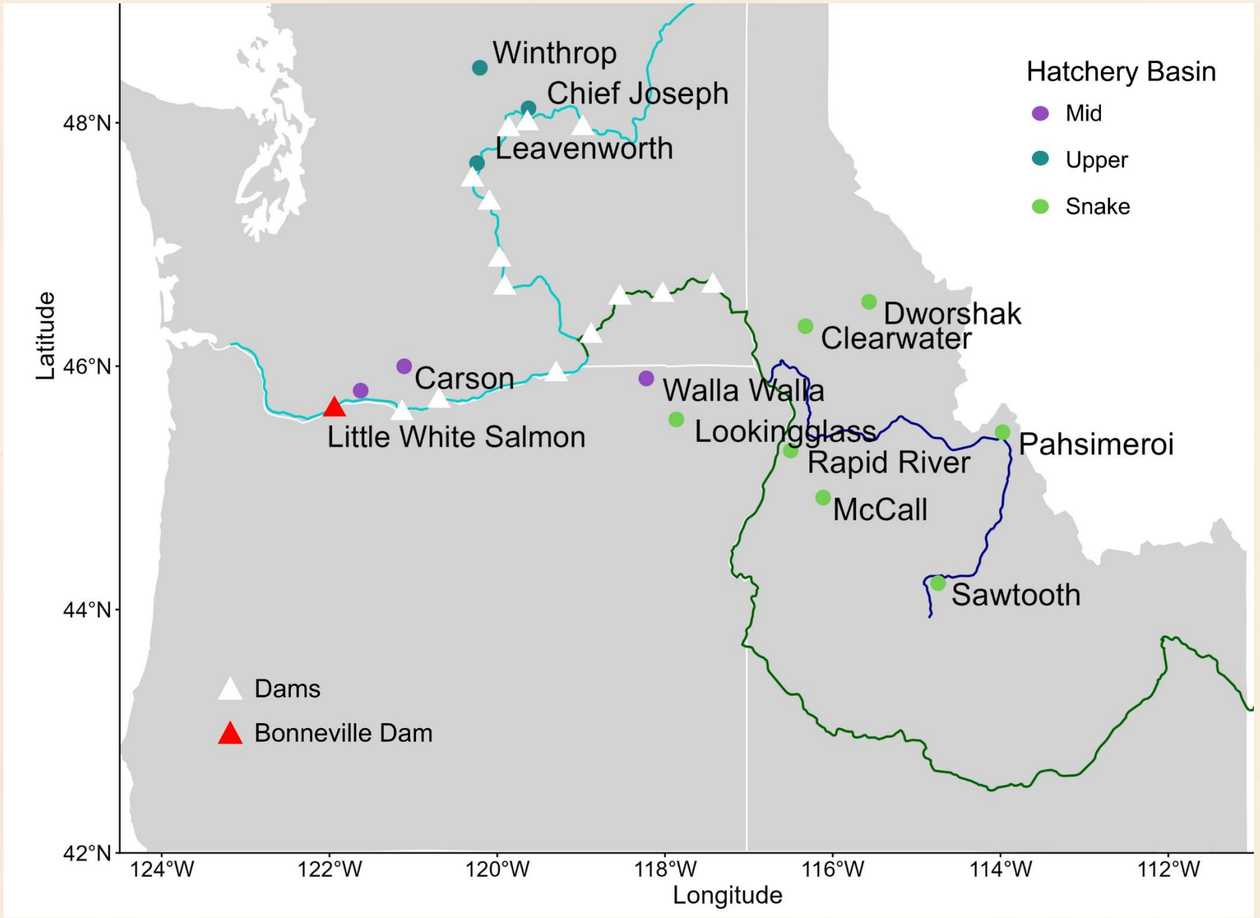
Study Area


Winthrop
Chief Joseph
Leavenworth
Carson
Little White Salmon
Walla Walla
Lookingglass
Dworshak
Clearwater
Rapid River
Pahsimeroi
McCall
Sawtooth
Hatchery Basin
Mid
Upper
Snake
Dams
Bonneville Dam
48°N
46°N
44°N
42°N
Latitude
124°W
122°W
120°W
118°W
116°W
114°W
112°W
110°W
Longitude

Sample Sizes

Variable Sample Sizes				
Basin	**Number of Hatcheries**	**Otolith Data**	**Capture Data**	**Dams**
Mid-Columbia River	4	195	383	1 to 2
Upper-Columbia River	3	17	139	8 to 9
Snake River	7	347	1156	8
Wild	Unmarked	70	153	-

Study Area

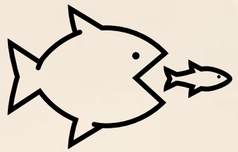




Timing of ocean entry



Size at ocean entry

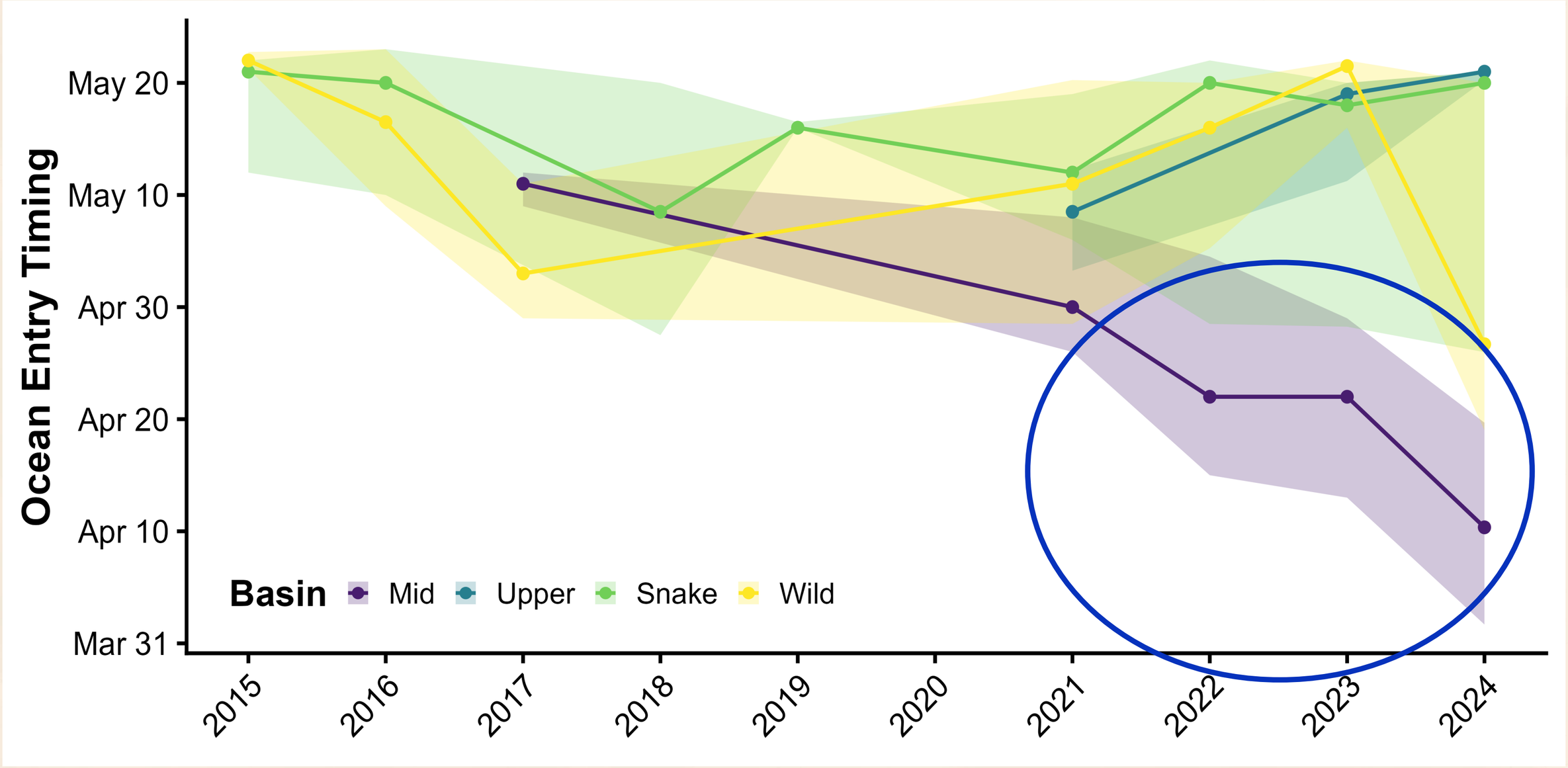


Early marine growth

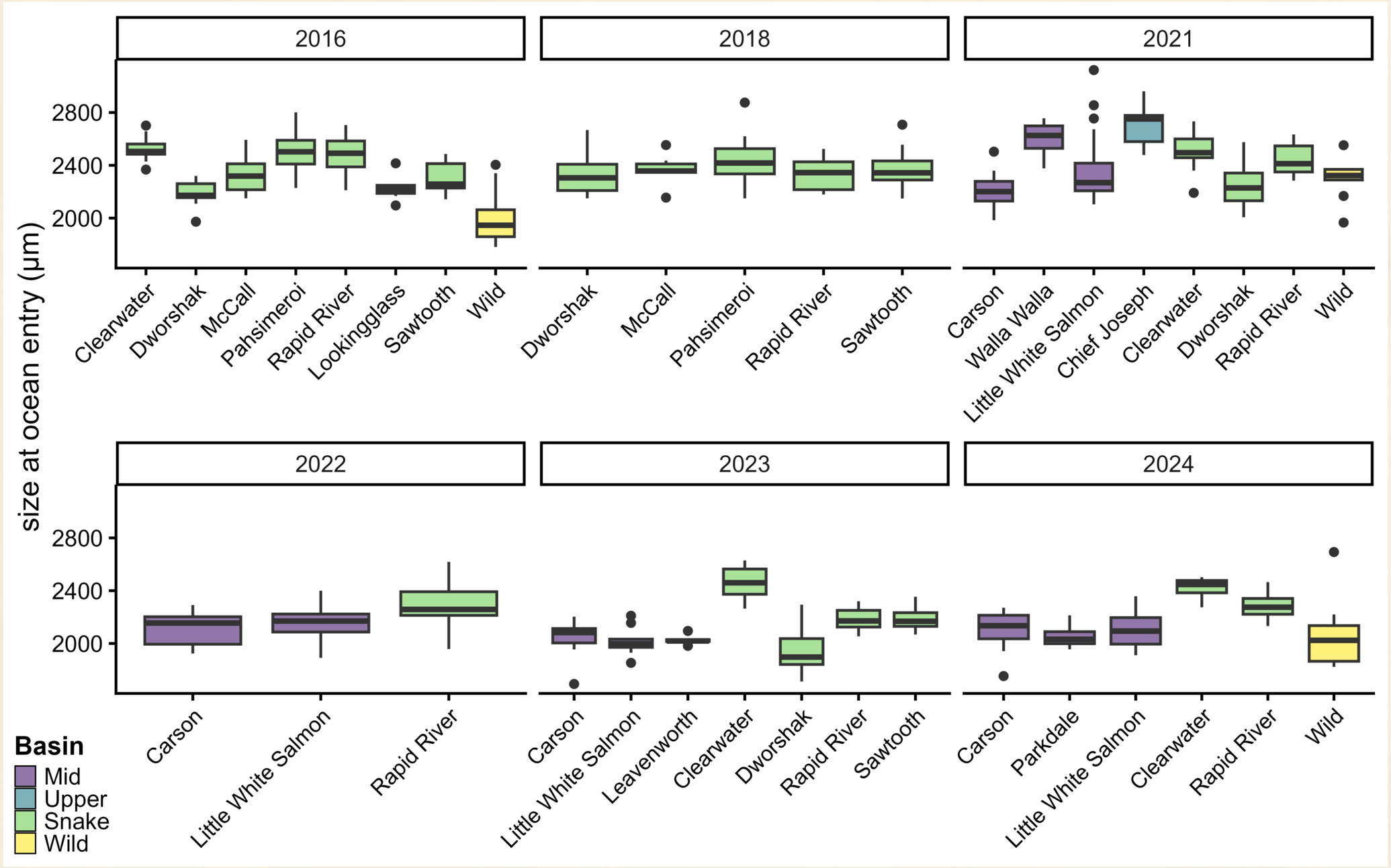
Otolith chemical & structural analysis

Timing of ocean entry

$R^2m = 0.16$
$R^2c = 0.27$
Origin + (1|Year)



Size at Ocean Entry





Size at ocean entry

$R^2m = 0.38$

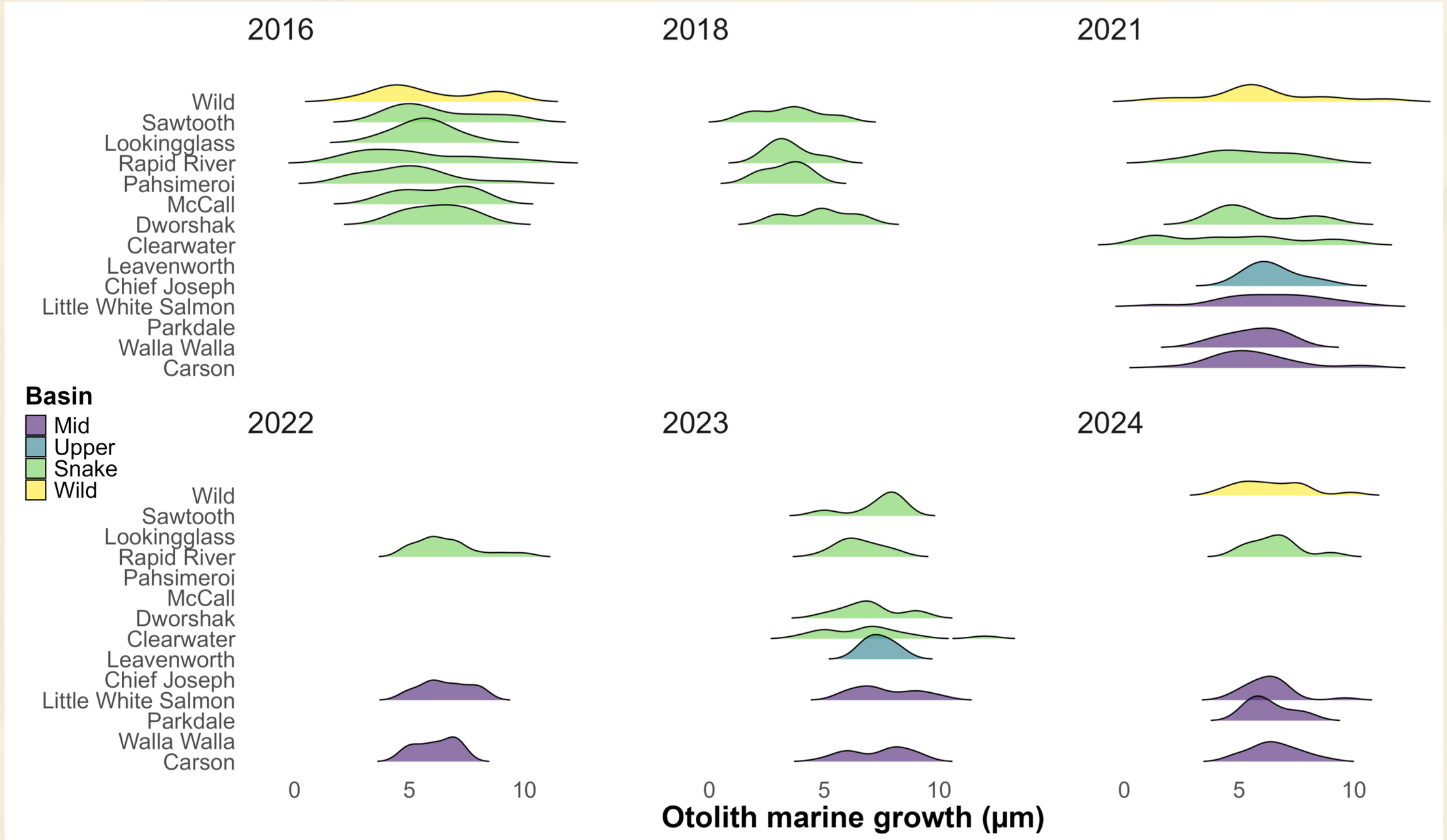
$R^2c = 0.53$

Origin + (1|Year)





Marine Growth





Size at ocean entry

$R^2m = 0.38$

$R^2c = 0.53$

Origin + (1|Year)



Early ocean growth

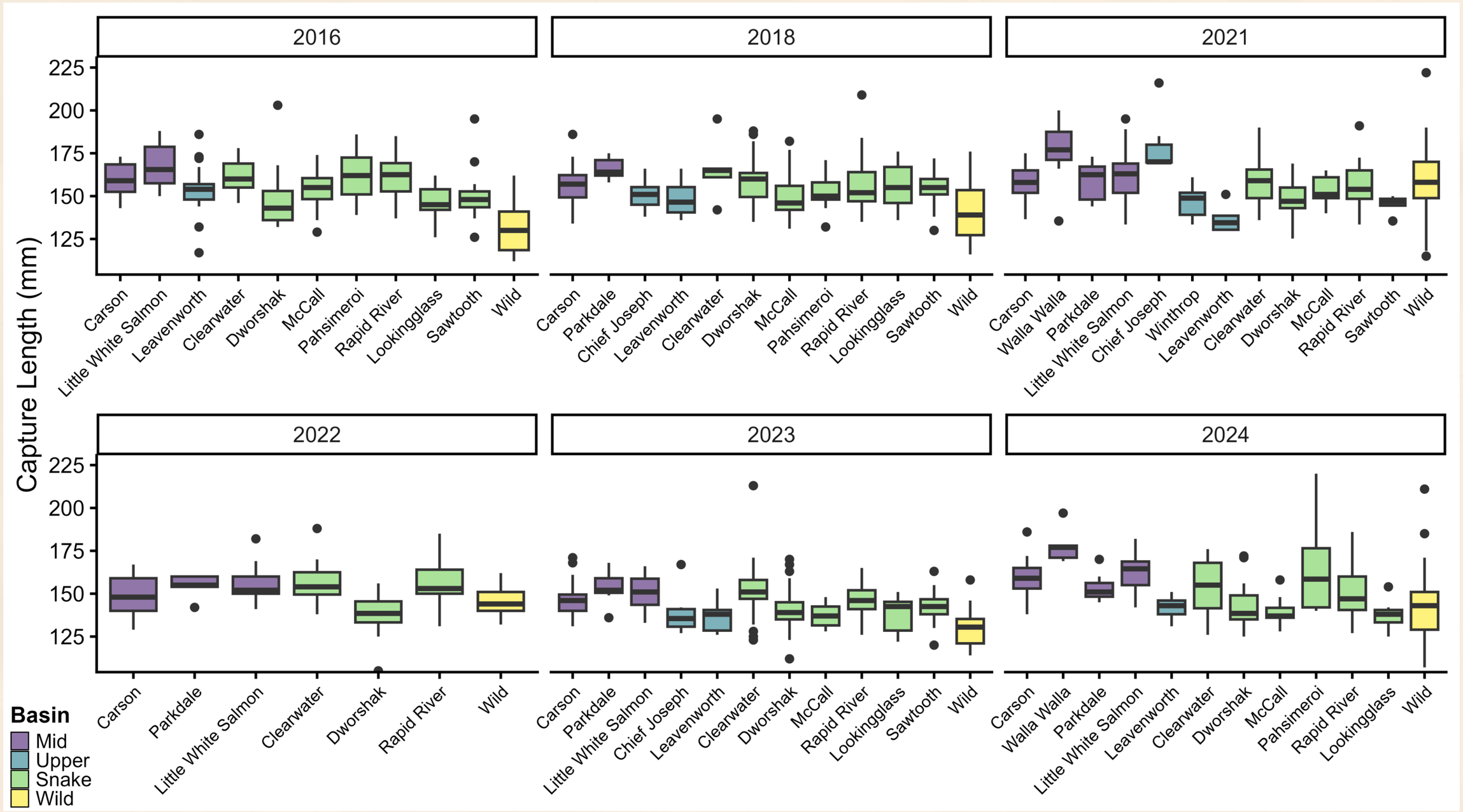
$R^2m = 0.03$

$R^2c = 0.28$

Origin + (1|Year)



Size at Capture





Size at ocean entry

$R^2m = 0.38$

$R^2c = 0.53$

Origin + (1|Year)



Early ocean growth

$R^2m = 0.03$

$R^2c = 0.28$

Origin + (1|Year)



Size at capture

$R^2m = 0.18$

$R^2c = 0.27$

Origin + (1|Year)



Size at ocean entry

$R^2m = 0.38$

$R^2c = 0.53$

Origin + (1|Year)

$r = 0.54 \quad p < 0.001$



Early ocean growth

$R^2m = 0.03$

$R^2c = 0.28$

Origin + (1|Year)



Size at capture

$R^2m = 0.18$

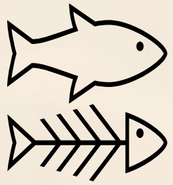
$R^2c = 0.27$

Origin + (1|Year)

Intra-annual variation across origin

Carry-over effect on size

?



Marine Survival

Marine Survival

Hatchery-specific SARs ~ PBT origin * Condition + 1 |Year

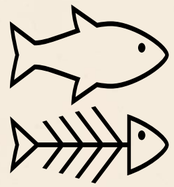
	R^2m	R^2c	AIC
Origin *Condition	0.31	0.61	924.76

Marine Survival

Hatchery-specific SARs ~ PBT origin * Condition + 1 |Year

Hatchery-specific SARs ~ Distance * Condition + 1 |Year

	R^2m	R^2c	AIC
Origin *Condition	0.31	0.61	924.76
Distance *Condition	0.11	0.44	1420.02



Marine Survival

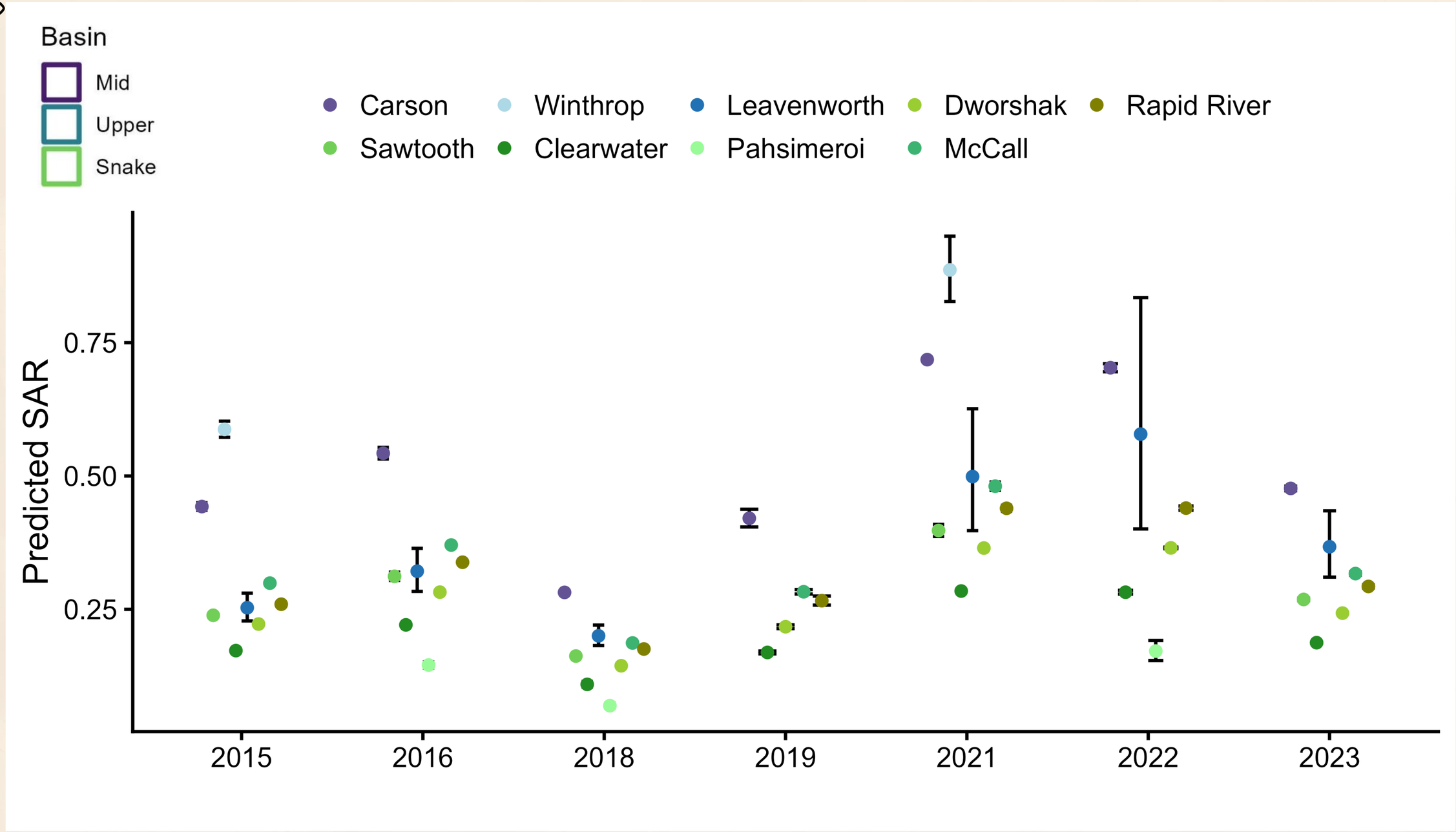
Hatchery-specific SARs ~ PBT origin * Condition + 1 |Year

Hatchery-specific SARs ~ Distance * Condition + 1 |Year

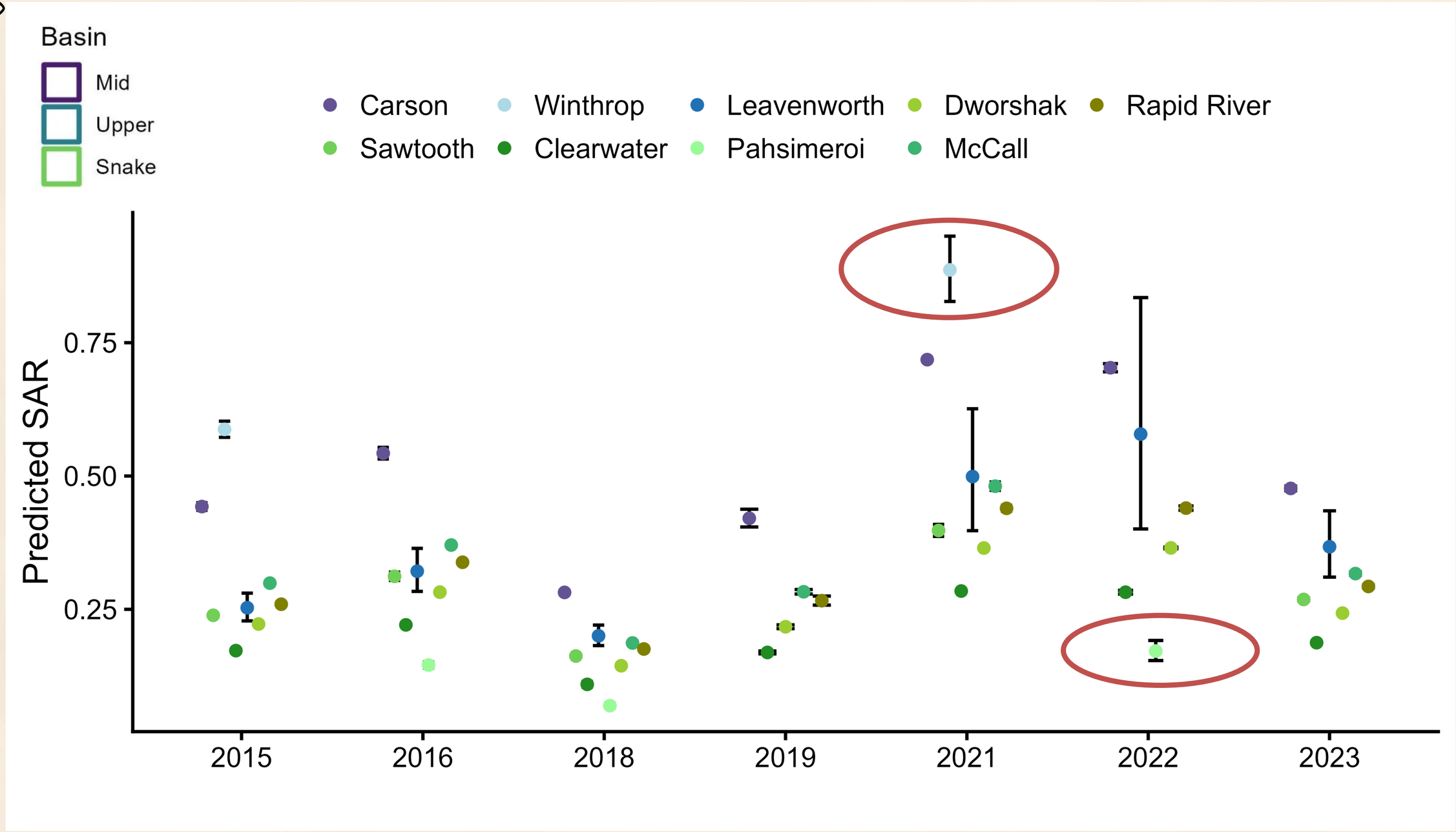
Hatchery-specific SARs ~ Dams * Condition + 1 |Year

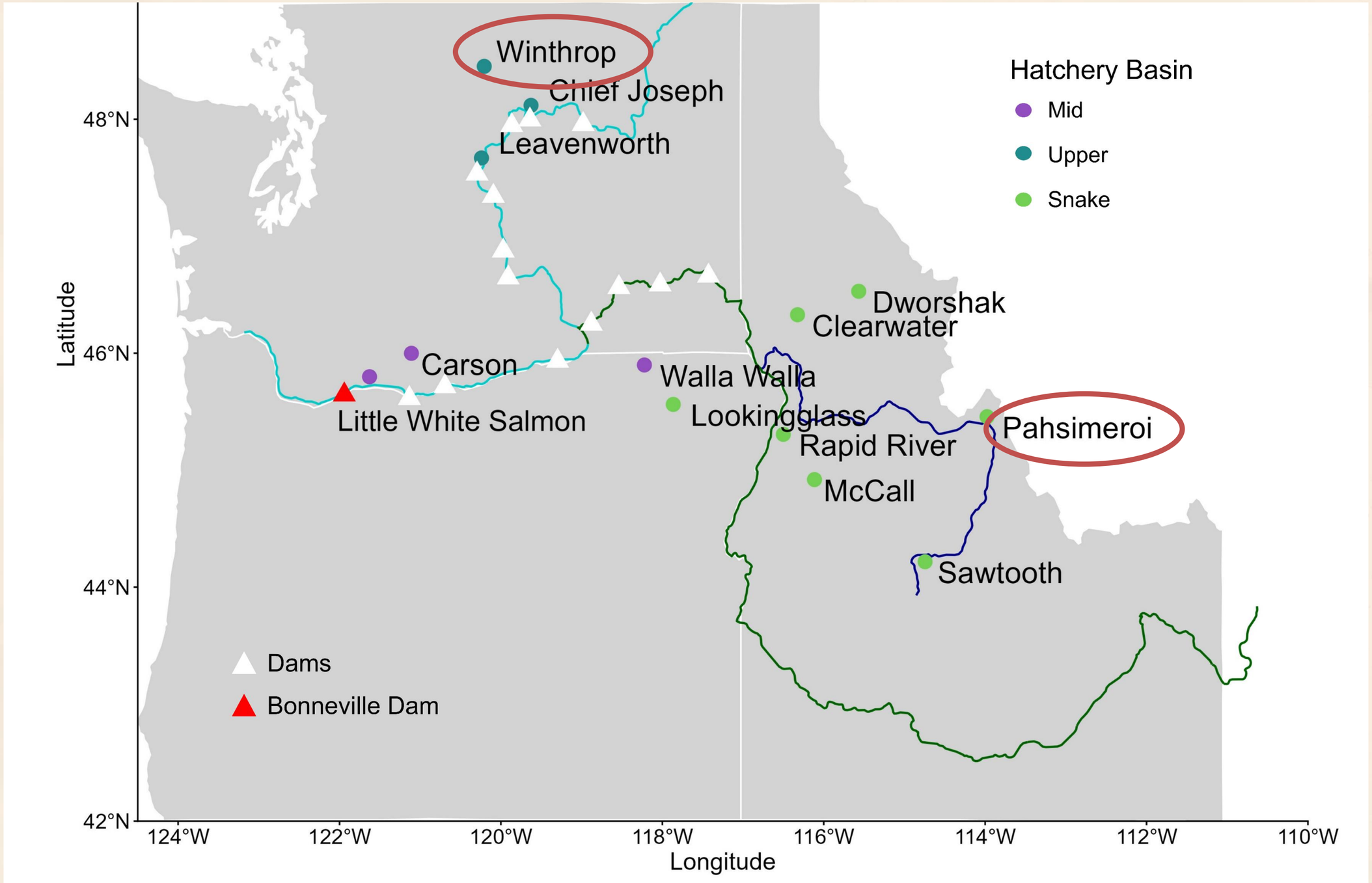
	R^2m	R^2c	AIC
Origin *Condition	0.31	0.61	924.76
Distance *Condition	0.11	0.44	1420.02
Dams *Condition	0.09	0.42	1399.53

Marine Survival



Marine Survival




Winthrop
Chief Joseph
Leavenworth
Carson
Little White Salmon
Walla Walla
Lookingglass
Dworshak
Clearwater
Rapid River
McCall
Pahsimeroi
Sawtooth
Hatchery Basin
Mid
Upper
Snake
Dams
Bonneville Dam
48°N
46°N
44°N
42°N
Latitude
124°W
122°W
120°W
118°W
116°W
114°W
112°W
110°W
Longitude

Origin matters!

Carry-over effects?

- Genetic or broodstock differences
- Rearing conditions
- Release method, timing, location
- Late-stage mortality

Management Implications

Reassess hatchery practices given the changing environment

Facilitate conversation between scientists and hatchery managers

Thank you!

This work was funded by the Bonneville Power Administration

Made possible by the JSOES crew and Frosti fishermen

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Questions



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