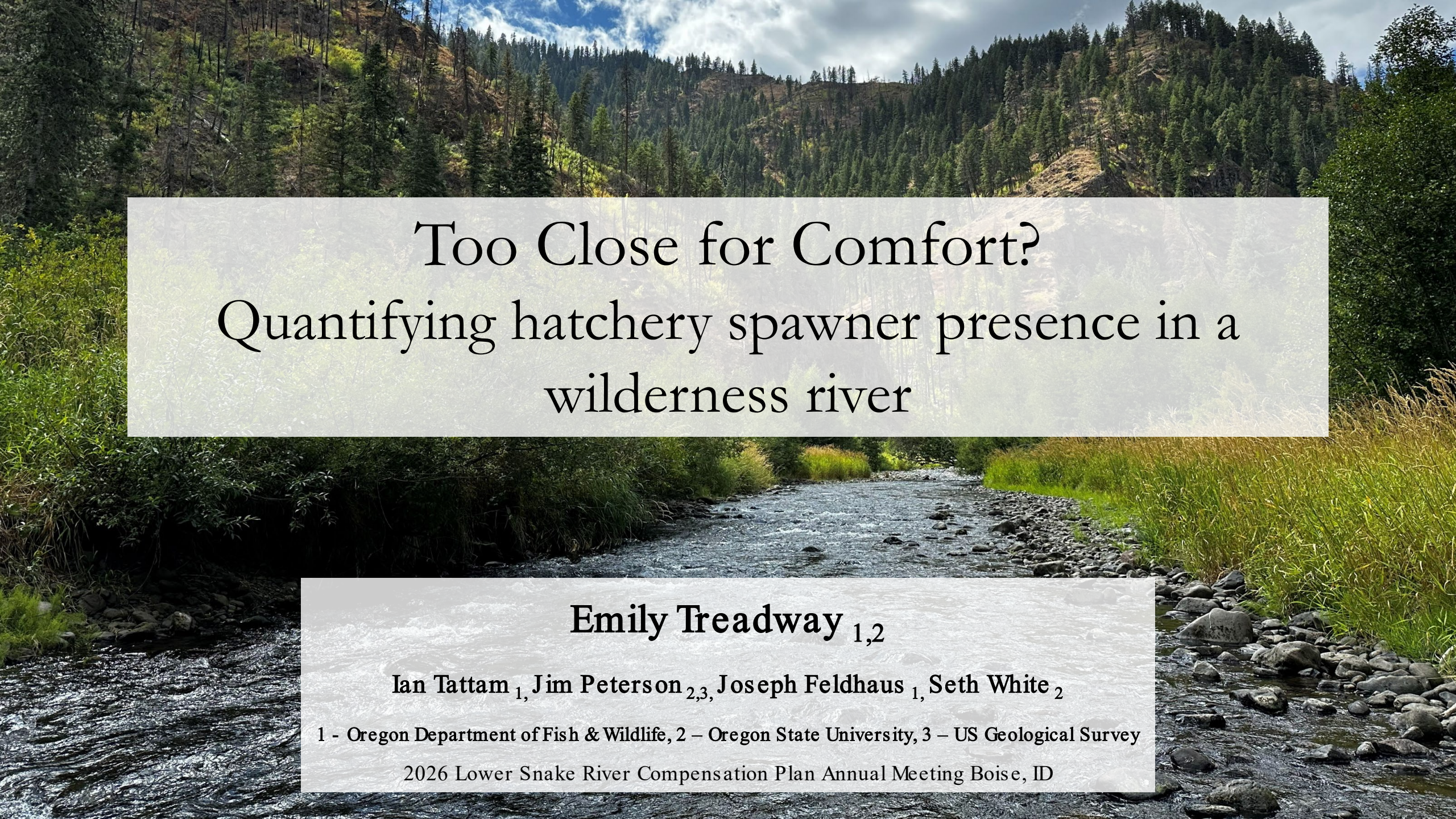




Too Close for Comfort?

Quantifying hatchery spawner presence in a wilderness river

Emily Treadway ^{1,2}

Ian Tattam ¹, **Jim Peterson** ^{2,3}, **Joseph Feldhaus** ¹, **Seth White** ²

1 - Oregon Department of Fish & Wildlife, 2 – Oregon State University, 3 – US Geological Survey

2026 Lower Snake River Compensation Plan Annual Meeting Boise, ID

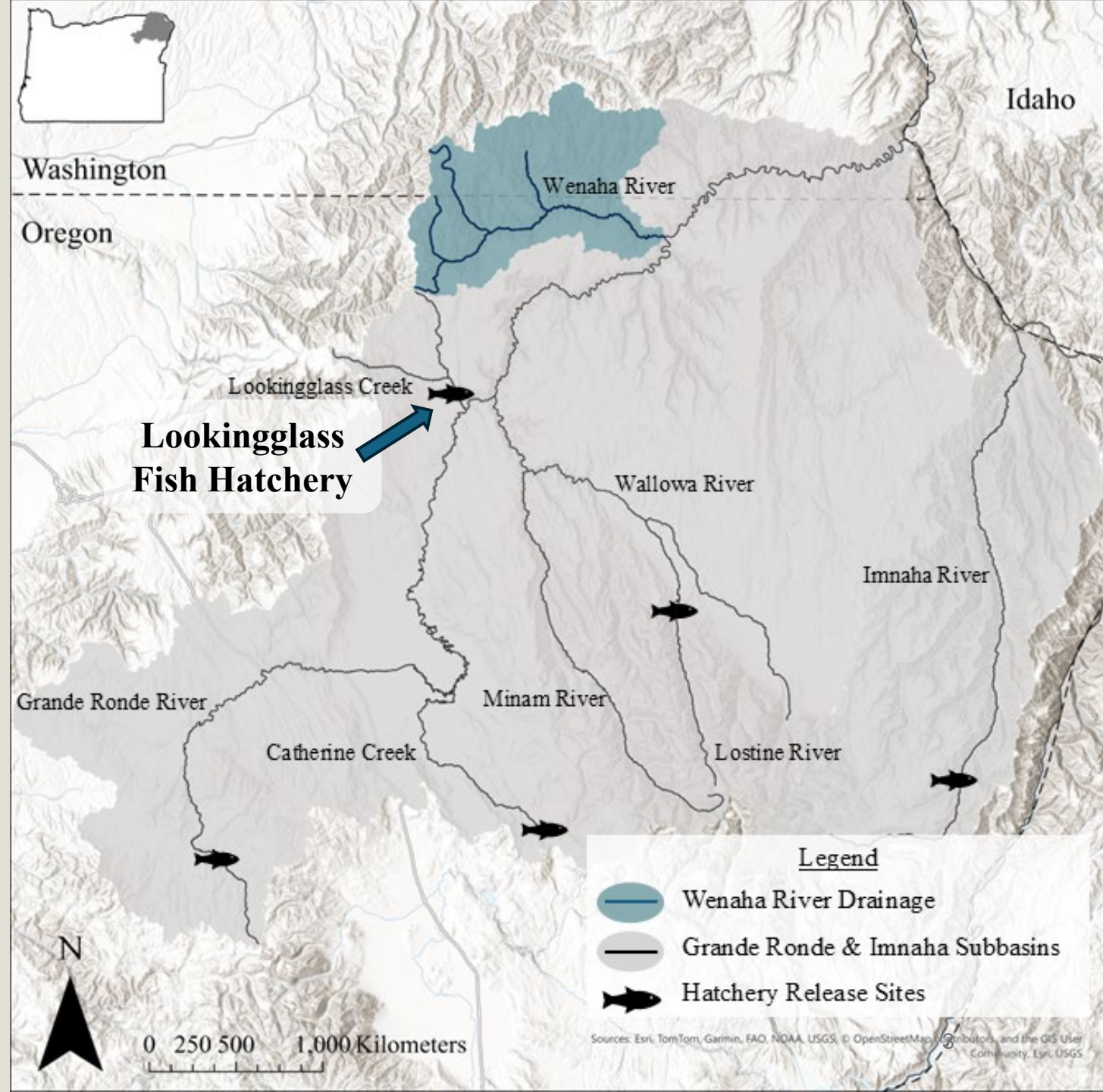
Outline

- ❑ General Introduction
- ❑ Assessing field methods in remote wilderness settings
- ❑ Spatial and temporal distributions of spawners in the Wenaha River
- ❑ Conclusion



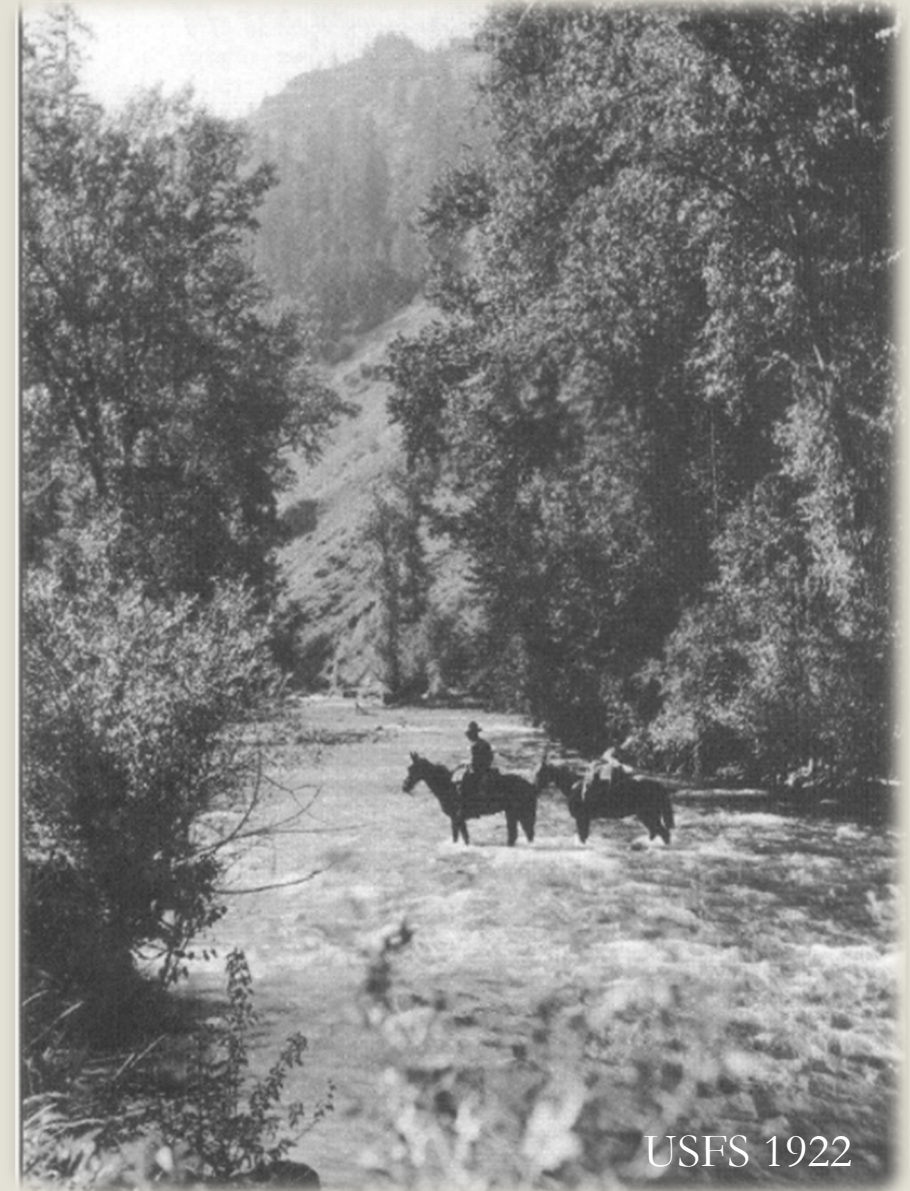
Supplementation Efforts

- ❑ Grande Ronde & Imnaha River subbasins
 - ❑ Spring Chinook Salmon
- ❑ Lookingglass Hatchery – 5 stocks
 - ❑ Conservation based program
 - ❑ Local, integrated broodstock*
 - ❑ Release ~1.4 million smolts annually
- ❑ Wenaha River



The Wenaha River

- ❑ Wild and Scenic River in the Wenaha - Tucannon Wilderness
 - ❑ Endemic population of spring Chinook Salmon
 - ❑ ~250 - 750 annual spawners
 - ❑ "wild fish sanctuary"
- ❑ Annual spawning ground surveys (redds & carcasses)
 - ❑ Logistically difficult
 - ❑ Small sample sizes
 - ❑ Comparative baseline
- ❑ Hatchery strays
 - ❑ proportion of hatchery origin spawners (*pHOS*)
 - ❑ Allowable threshold of 5%
 - ❑ Ecological and genetic impacts on the natural population



USFS 1922

Genetic Monitoring of Threatened Chinook Salmon Populations: Estimating Introgression of Nonnative Hatchery Stocks and Temporal Genetic Changes

North American Journal of Fisheries Management

D.M. Van Doornik
R.S. Waples
T.L. Hoffnagle
P. Moran

D.L. Eddy
S.J. Boe
E.A. Berntson

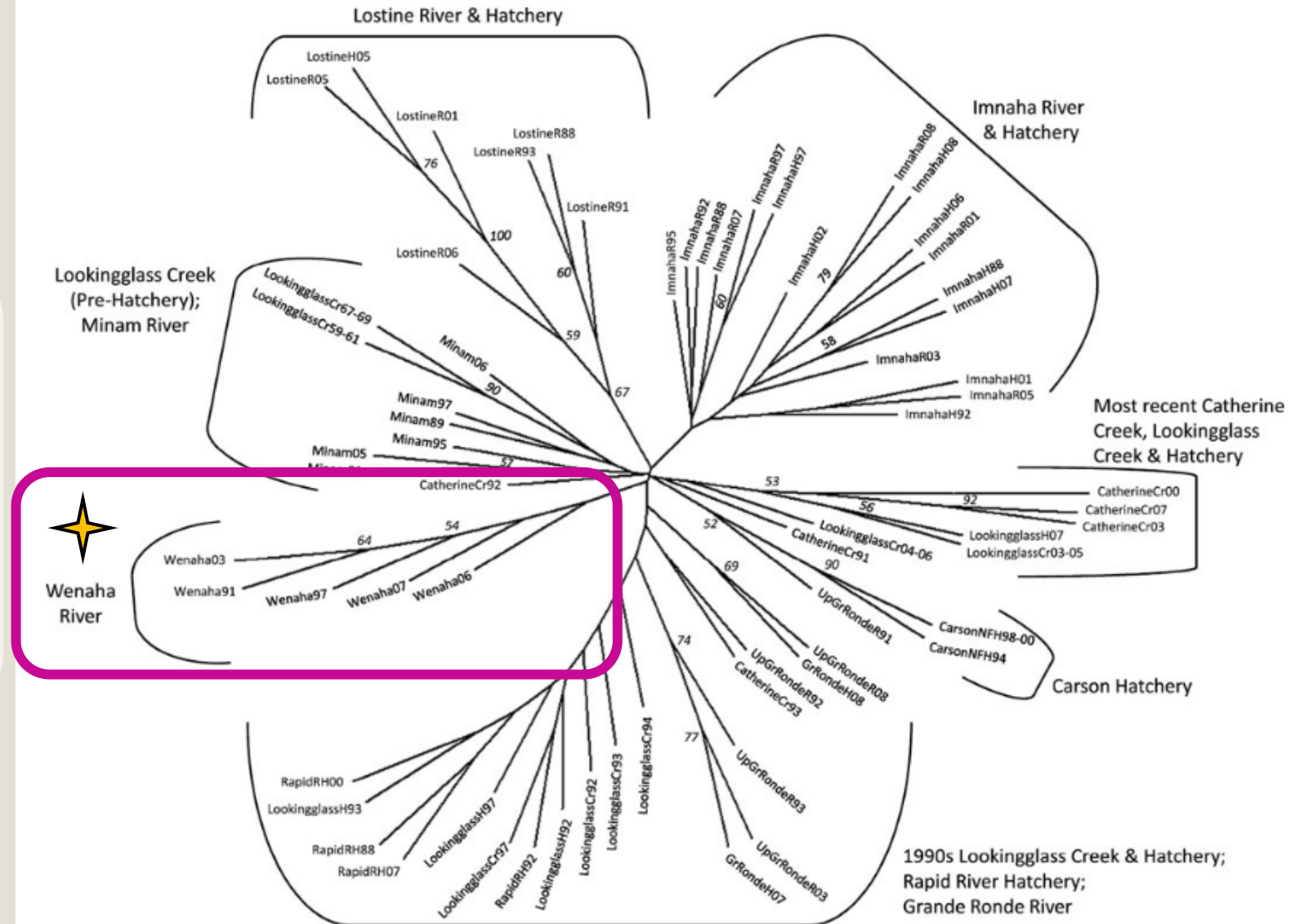
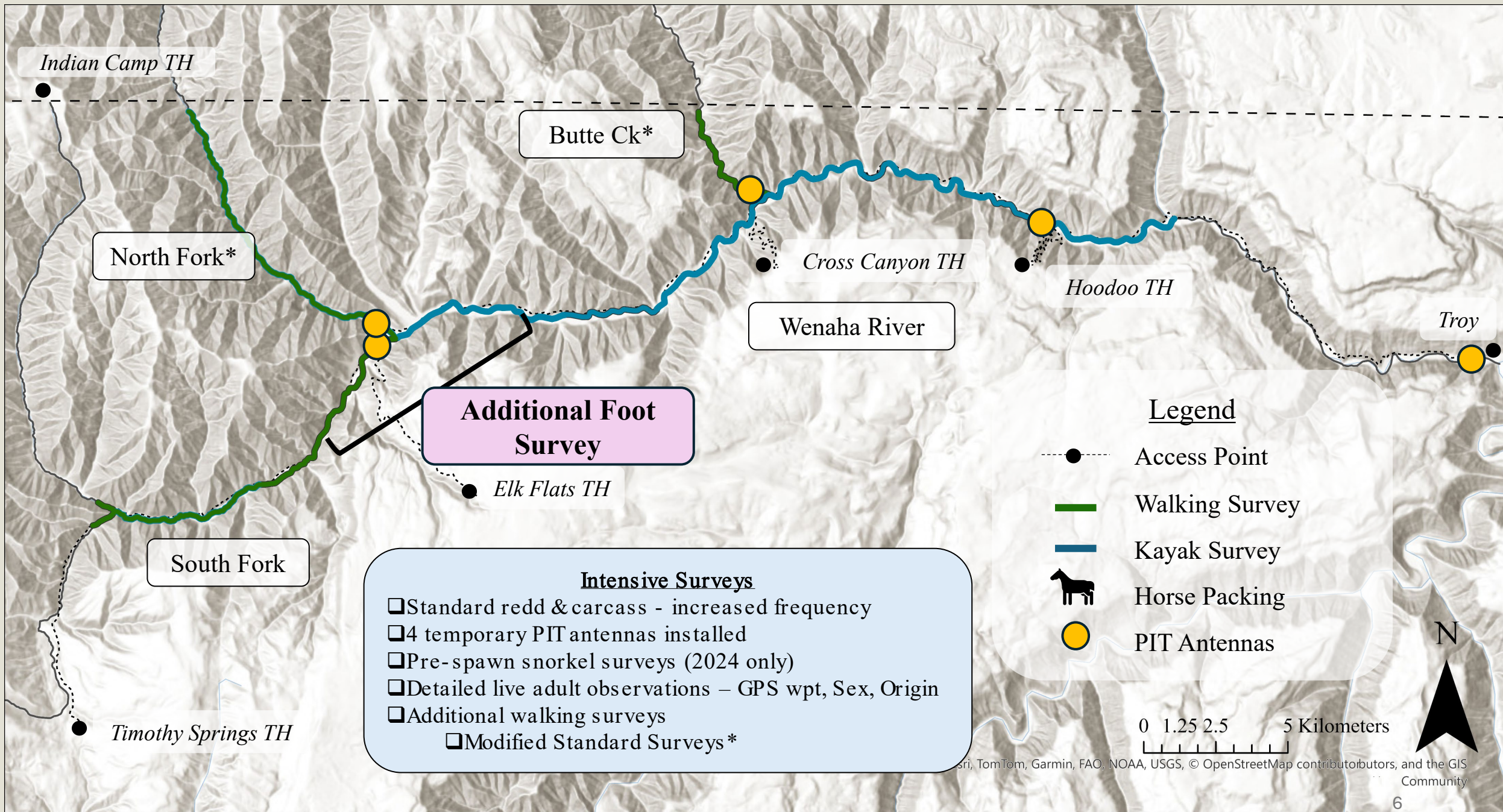


FIGURE 4. A neighbor-joining, consensus tree of Cavalli-Sforza and Edwards (1967) chord distances. Samples are labeled according to population name and the last two digits of the brood year. Major groupings are identified by brackets, and bootstrap values greater than 50% are shown.





Against all odds...
we got the data

Reporting Estimates

Standard

- ❑ Redd based spawner abundance

 - ❑ 3.2 fish per redd

- ❑ Proportion of hatchery origin spawners (pHOS)

$$pHOS = \frac{H}{H + W}$$

Intensive

- ❑ Redd-based spawner abundance

- ❑ PIT tag-based spawner abundance

- ❑ pHOS

 - ❑ PIT tag derived

 - ❑ AD clip origin vs Parentage Based Tagging (PBT) origin

- ❑ Weighted pHOS...

PIT Tag-Based Estimates

- Huggins Closed Capture Model
 - Site Efficiency
 - Detections at three sites
- Deterministic Expansion
 - Abundance
 - Tagging rate per tag group
- Variance of abundance
 - Delta method

2025 Only!

- NOSA = 611 (SE = 28)
- HOSA = 78
- Total Spawner Abundance = 689
- pHOS = 11.3%

Standard ODFW Method

Abundance = 522
pHOS = 18.9%



INFORMATION REPORTS

NUMBER 2019-08



FISH DIVISION

Oregon Department of Fish and Wildlife

Estimating the weighted proportion of hatchery-origin spawners, $pHOS_w$.

North American Journal of Fisheries Management, 2025, 00, 1–8
<https://doi.org/10.1093/najfmt/vqaf110>
Advance access publication: January 19, 2026
Feature Article



Refining indices of risk from salmonid hatcheries

Matthew R. Falcy*

U.S. Geological Survey, Idaho Cooperative Fish and Wildlife Research Unit, Department of Fish and Wildlife Sciences,
University of Idaho, Moscow, Idaho, USA

*Corresponding author: Matthew R. Falcy. Email: mfalcy@uidaho.edu.

ABSTRACT

Objectives: The risk to wild populations from domestication selection in hatcheries is commonly indexed with estimates of the proportion of hatchery-origin spawners ($pHOS$) on natural spawning grounds. Widely used calculations of $pHOS$ are not commensurate with the genetic theory that motivates the use of $pHOS$ as an index of risk from domestication selection.

Methods: I derive an alternative metric of $pHOS$ that is commensurate with the spatiotemporal variability of natural- and hatchery-origin fish and the genetic theory used to index risk. I describe nuances that are associated with indices of hatchery risk, including how to calculate variances.

Results: The widely used calculation of $pHOS$ will overestimate the risk when the densities of breeding natural- and hatchery-origin fish differ in space or time. The analytics provided here will improve the empirical estimation of an index of risk from hatchery-origin fish and the associated uncertainty.

Conclusions: Clarifying the calculations and interpretations of indices of risk to natural-origin fish can help managers balance multiple management goals associated with hatchery production.

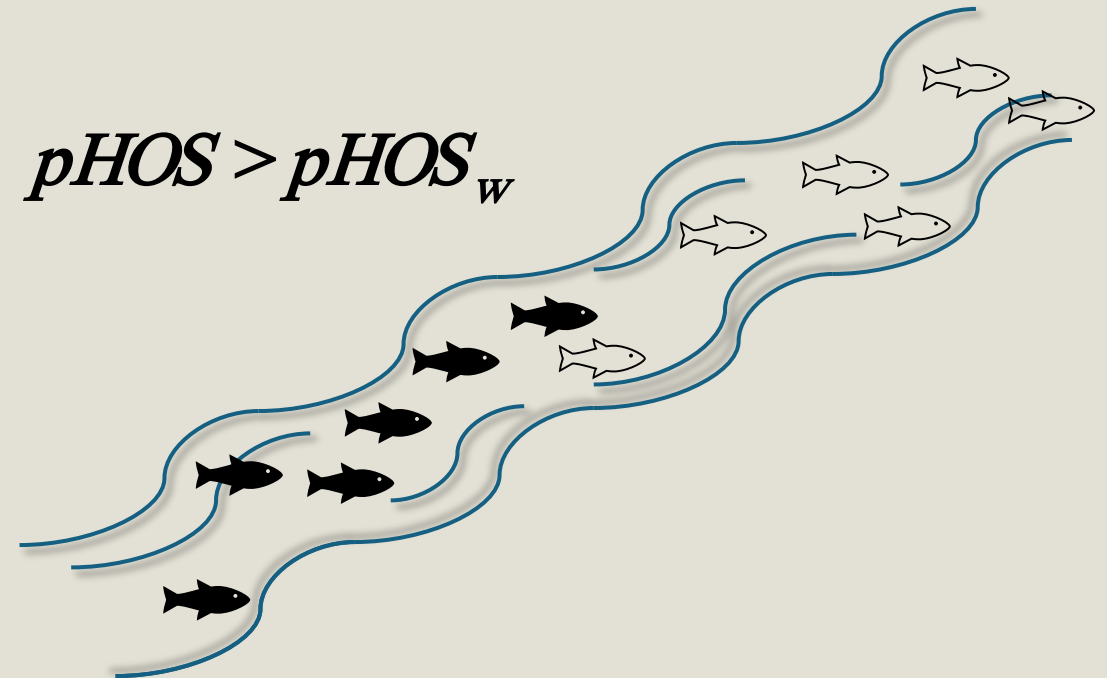
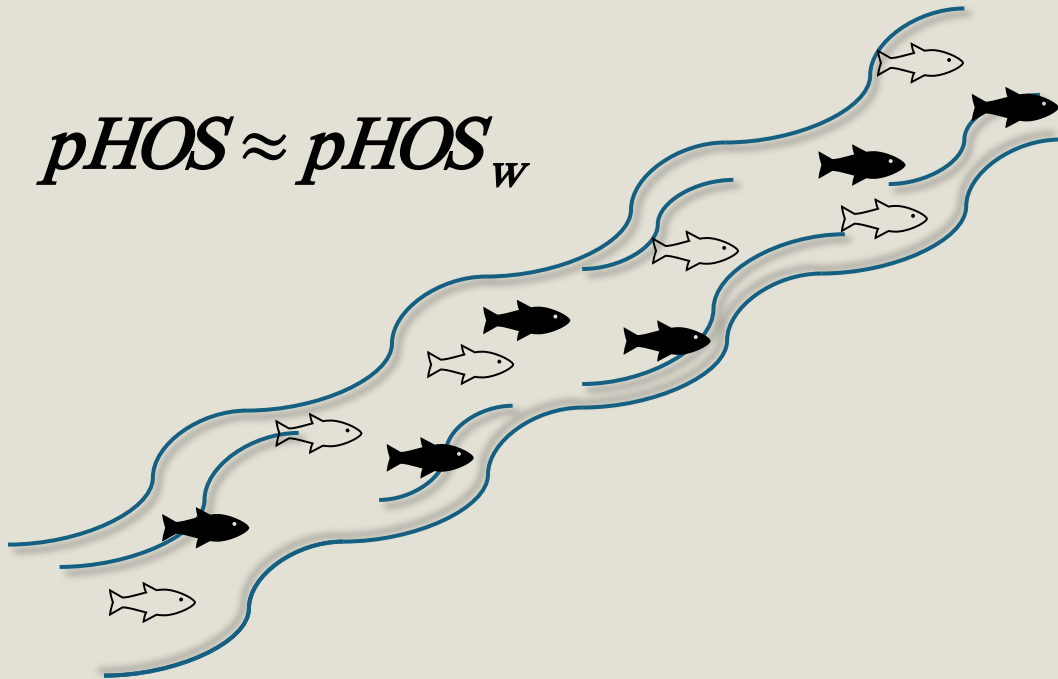
KEYWORDS: domestication, hatchery, $pHOS$, risk, salmon

LAY SUMMARY

The widely used empirical metric of risk to natural salmonid populations from hatchery domestication selection, $pHOS$, is not calculated commensurately with theory. A calculation that is useful when there is assortative mating in space and/or time is provided.

Weighted Proportion of Hatchery Origin Spawners

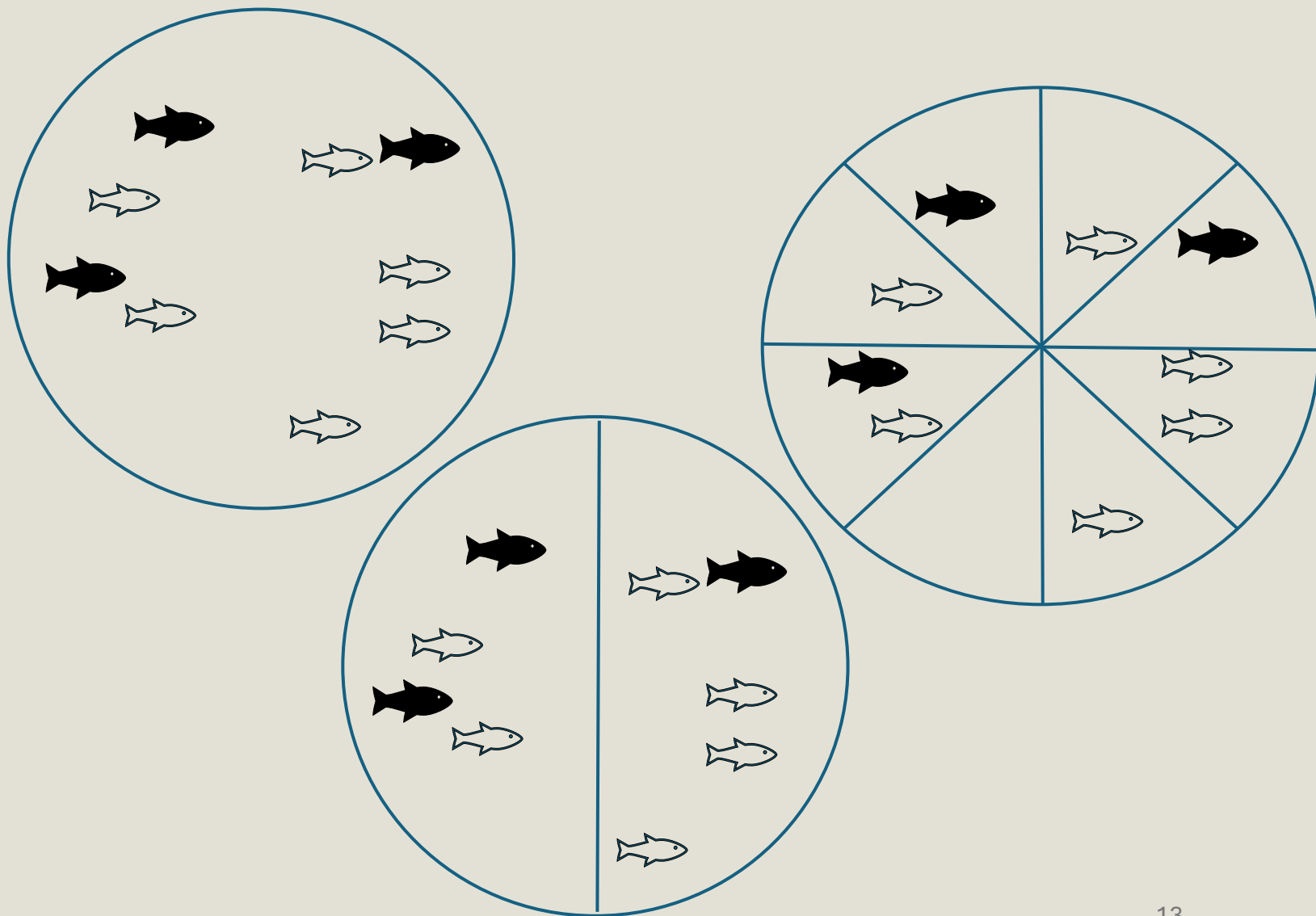
$$pHOS_w = \sum_{i=1}^I \sum_{t=1}^T \left(\frac{H_{i,t}}{H_{i,t} + W_{i,t}} \right) * \left(\frac{W_{i,t}}{\sum_i^I \sum_t^T W_{i,t}} \right)$$



Weighted Proportion of Hatchery Origin Spawners

What are the effects of different spatial and temporal scales?

How to identify an informative scale for the Wenaha River?



Assumptions of $pHOS_w$

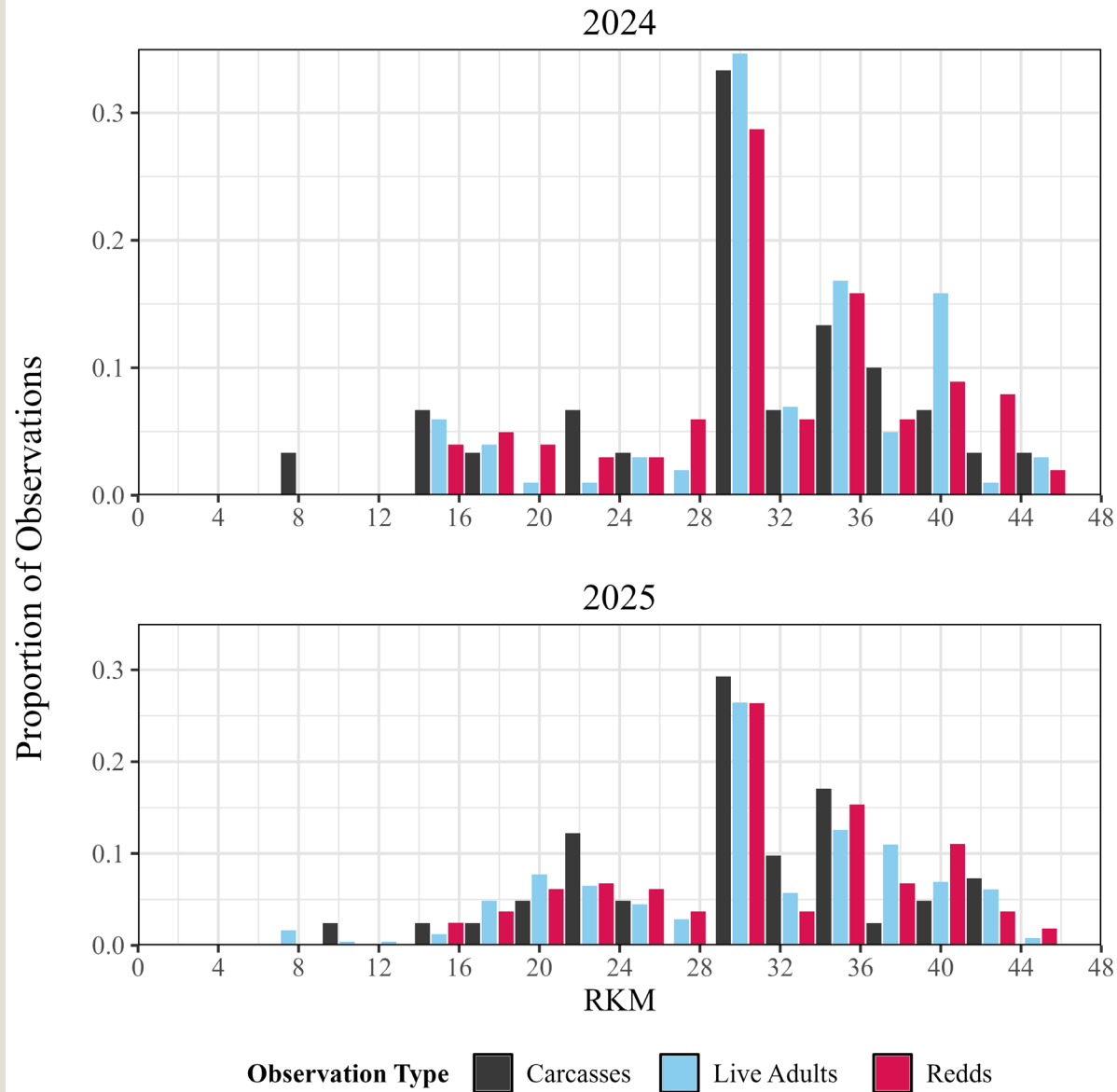
Raw data is unbiased

H & W counts are
proportional to relative
abundance

Estimate is only as
refined as the data
allows



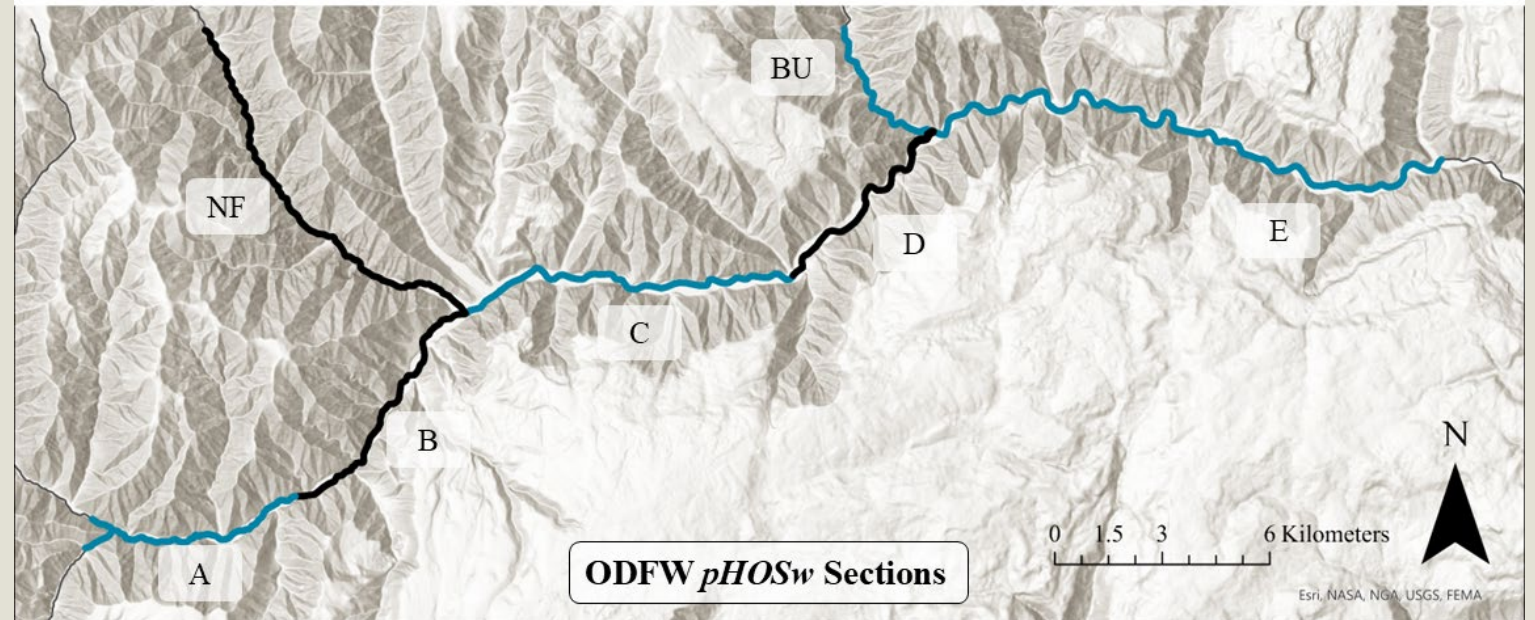
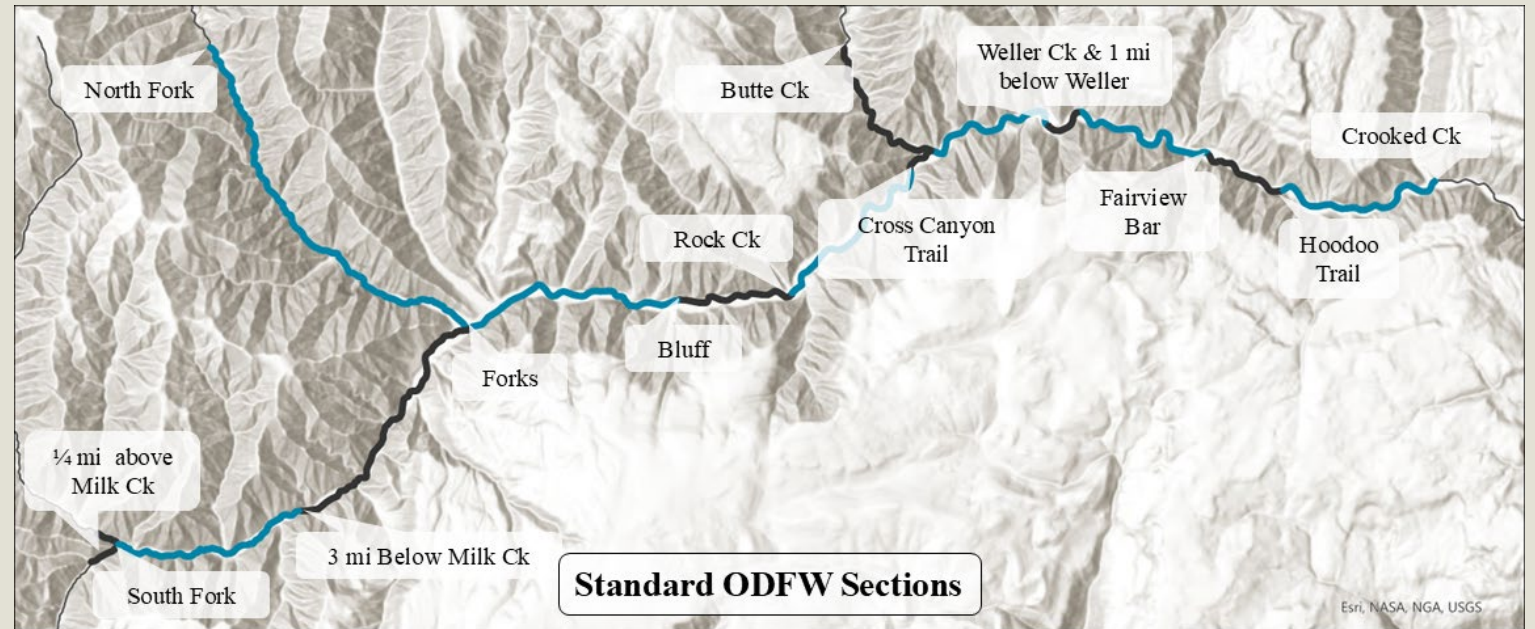
Proportion of observations by data type for 2024 & 2025



Do we “trust” the carcass data?

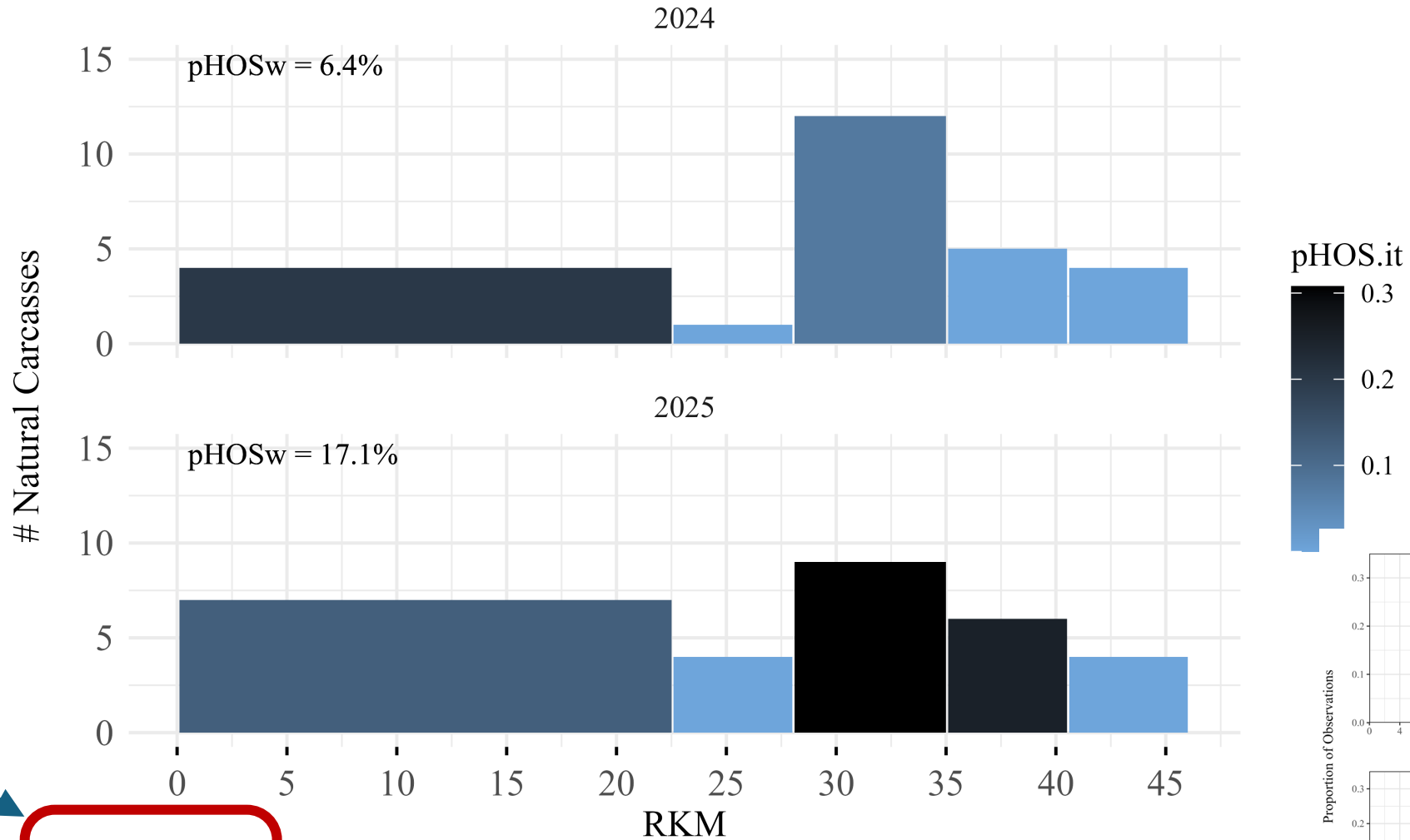
Weighted Proportion of Hatchery Origin Spawners

- ☐ Spatial Grouping – ODFW Groups
- ☐ Time Periods – Weekly or None (spatial only)



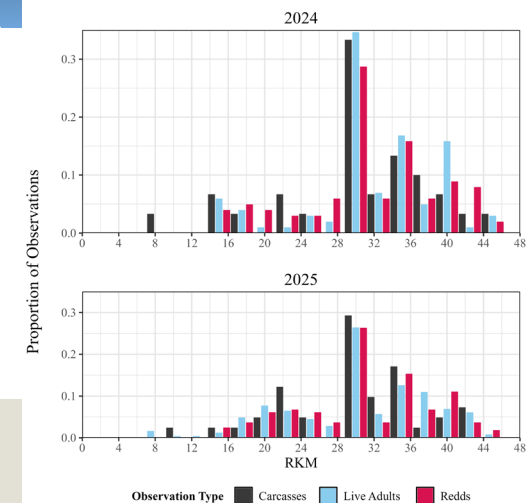
Temporal Consideration: average active spawn timing lasts 7 – 15 days (Baxter 1991; Bowerman et al. 2017)

Comparison of natural carcasses to section based $pHOS_{it}$ values for 2024 & 2025 (ODFW – Eco sections)

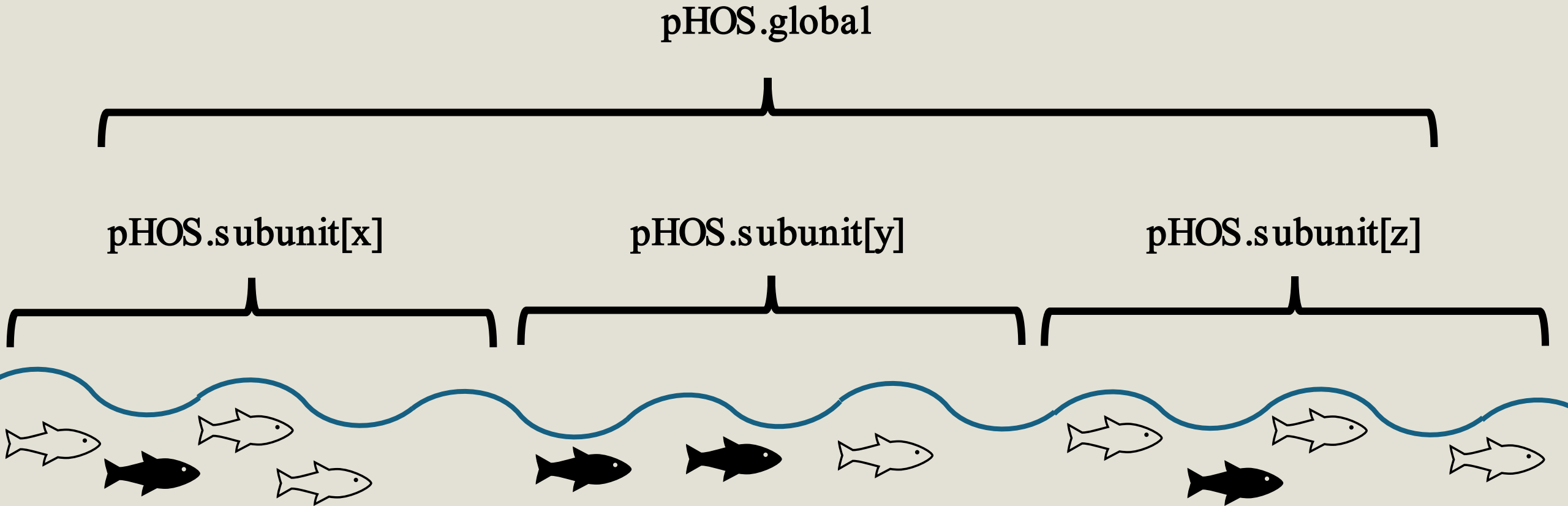


$pHOS_{it}$

$$pHOS_w = \sum_{i=1}^I \sum_{t=1}^T \left(\frac{H_{i,t}}{H_{i,t} + W_{i,t}} \right) \cdot \left(\frac{W_{i,t}}{\sum_i \sum_t W_{i,t}} \right)$$



Model Description $\sim$ Bayesian Hierarchical Model



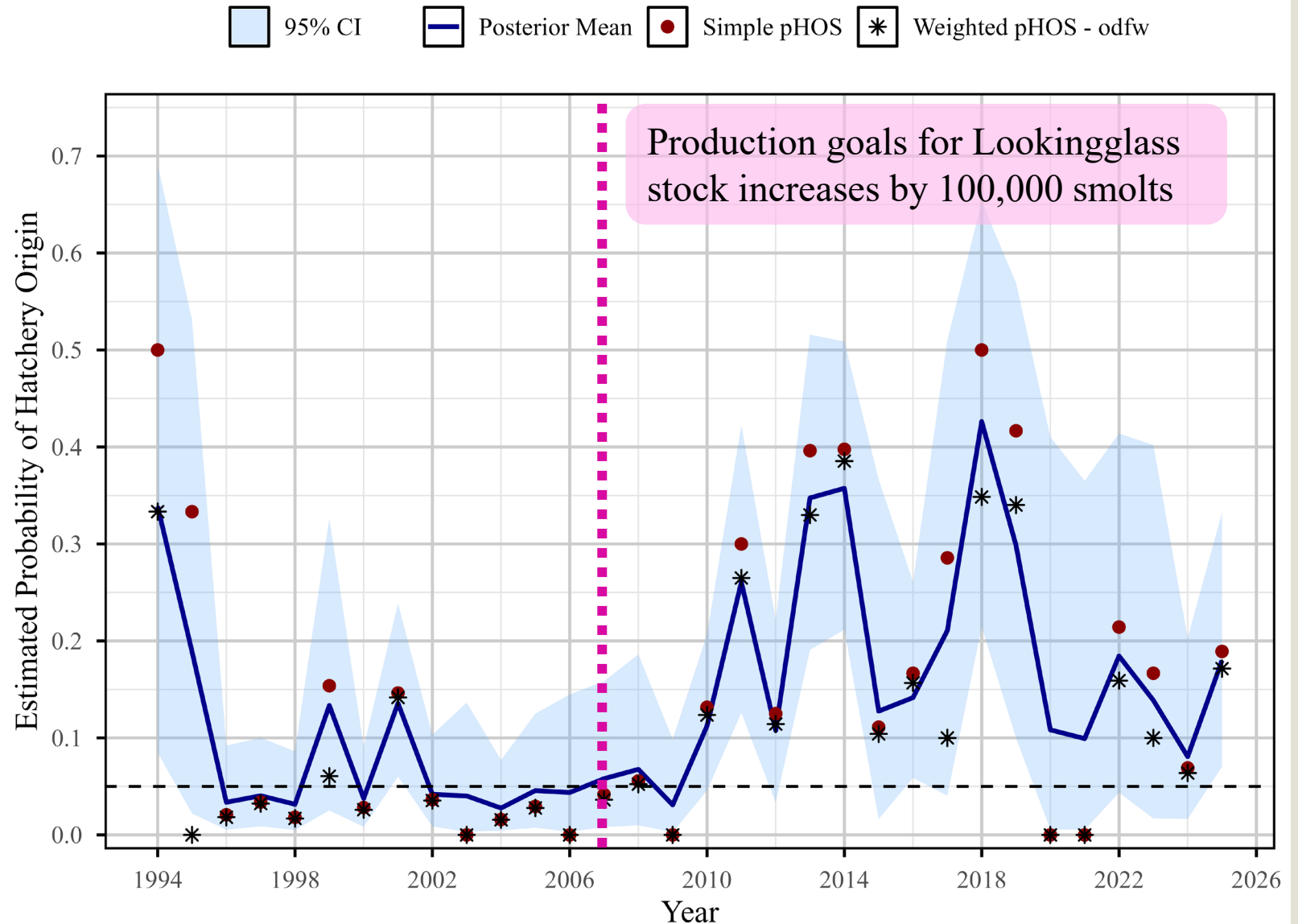
$$\text{logit}(\text{pHOS.prop}[i]) = \text{pHOS.subunit}[\text{subunit.index}[i]]$$

$$\text{is.hatch}[i] \sim \text{dbern}(\text{pHOS.prop}[i])$$

Bayesian Crossed Random Effects Model

- ❑ Hierarchical logistic regression with `eco.odfw` reaches
- ❑ Random effects for Year and Section
- ❑ Pooling across years to help inform years with small sample sizes
- ❑ Flexible for section within and across years

Posterior means of the probability of hatchery origin with 95% credible intervals (1994 – 2025)

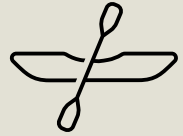


$$\text{logit}(\text{pHOS.prop}[i]) = \text{intercept} + \text{year.effect}[\text{year.index}[y]] + \text{odfw.effect}[\text{odfw.index}[k]]$$

Conclusions

- ❑ Carcass recoveries can be further optimized but standard survey is currently well timed
 - ❑ Additional walking surveys can help reach sample size goals
- ❑ PIT tag data may provide independent estimates of abundance and *pHOS* if replicated and refined
 - ❑ Maintenance of antenna sites difficult and success rate is highly variable
 - ❑ Expansion of hatchery tags needs improvement and is more complicated than natural origin expansion
- ❑ Hatchery and natural origin Chinook Salmon occupy the same areas of the spawning grounds at the same time
 - ❑ Incorporating sex and age of spawners will improve the estimate further (Falcy 2026)
- ❑ Bayesian modeling + historically relevant eco informed river sections is informative and conservative
 - ❑ Incorporate brood year to account for autocorrelation
 - ❑ New covariates (run size, program changes) should be explored

Acknowledgements!!!



Wenaha River Dawgs

Zach Litwiller (Mr. Paddles)

Tayler Arnold (Mr. Simms)

Gerrit Buch (Mr. Pops)

Mitch Kimball (Mr. Boots)

Justin Fisk (Mr. Shorts) 

Cameron Snider (Mr. Bees)

Mike Lance (Mr. Flips) 

Kyle Bratcher (Mr. Noodles)

Anna Ringleman (Ms. Perfect)

Will Sisley (Mr. Tarps)

Jeff Yanke (Mr. Dips)

Brian Simmons (Mr. Fly)

Shane Vatland (Mr. Mouse)

Seth White (Mr. Bear)

Joseph Feldhaus (Mr. Naps) 



Unrewarded Muscle

Joe Dittmer

Mike Greiner

Polly Gibson

Fred Drascic

Jon Ofiara

Brett Howland

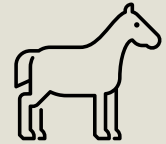
Matt Ashjian

Clay Wilhelm

Nell McGuan

Michael Herr

Jake Farnsworth



Pack Team

Phillip Perrine

Corey Crossley

Brian Ratliff

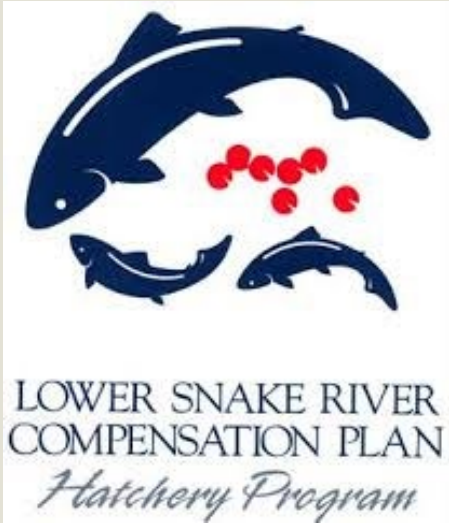
Dusty Dehaan

A collage of four photographs showing a group of people hiking in a mountainous, forested area. The photos include close-ups of hikers smiling and giving thumbs up, a group standing on a rocky trail, and hikers on a steep, rocky slope.









Fish Behaviorscapes Lab



Thank You!

Questions?



Adult Chinook Salmon

2024

- 101 - redds
- 101 - live adults
- 30 - carcasses
- 31 - PIT tags

2025

- 163 - redds
- 246 - live adults
- 40 - carcasses
- 89 - PIT tags

Observed Strays

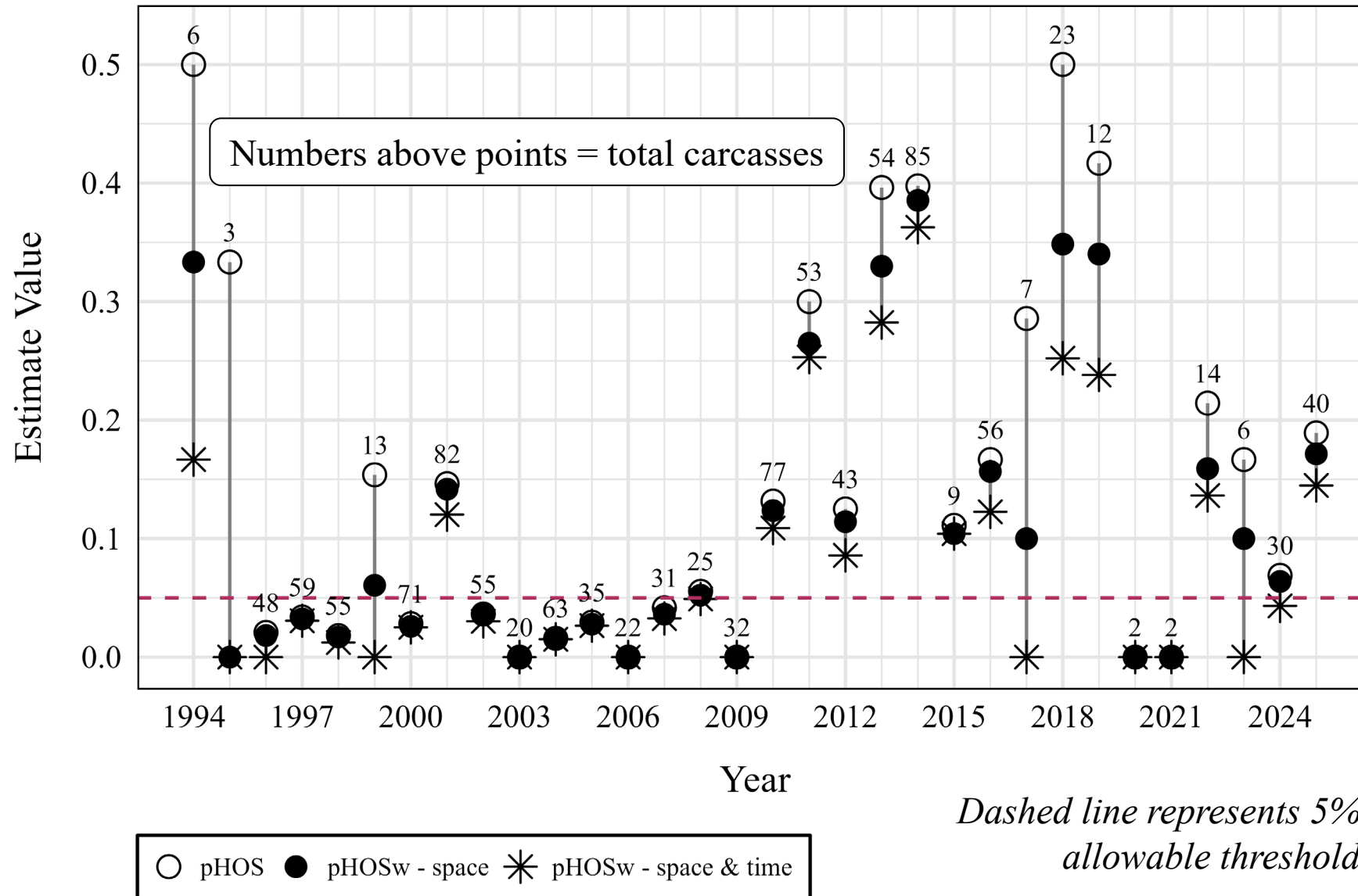
2024

- 1 - Lostine Stock
- 1 - Lookingglass Stock
- 1 - Yakima Sockeye???

2025

- 5 – Lookingglass Stock (Hat)
- 1 – Lookingglass Creek (Nat)
- 1 – Imnaha Stock (Hat)
- 1 – Round Butte Stock (Hat)
- 1 – Little White Salmon Stock (Hat)
- 2 – Unknown Stock (Hat)

Historical Comparison of $pHOS$ and $pHOS_w$ from 1994 - 2025



Models Used

pHOS.Global Distribution	Model Name	Model Levels	pHOS _w Method
Uninformative Prior $pHOS.global \sim dunif(-10, 10)$ $\sigma.subunit \sim dexp(2)$	Eco.Big	Global, Big	pHOS _{big}
	Eco.Mid	Global, Mid	pHOS _{mid}
	Eco.Small	Global, Small	pHOS _{small}
	Eco.ODFW	Global, ODFW	pHOS _{odfw}
Informative Prior $pHOS.global = \text{logit}(pHOS.global.prob)$ $pHOS.global.prob \sim dbeta(alpha, beta)$ $\sigma.subunit \sim dexp(2)$	Eco.Big.Prior	Global, Big	pHOS _{big}
	Eco.Mid.Prior	Global, Mid	pHOS _{mid}
	Eco.Small.Prior	Global, Small	pHOS _{small}
	Eco.ODFW.Prior	Global, ODFW	pHOS _{odfw}

Model Comparison

❑ Leave One Out Information Criteria (LOOIC)

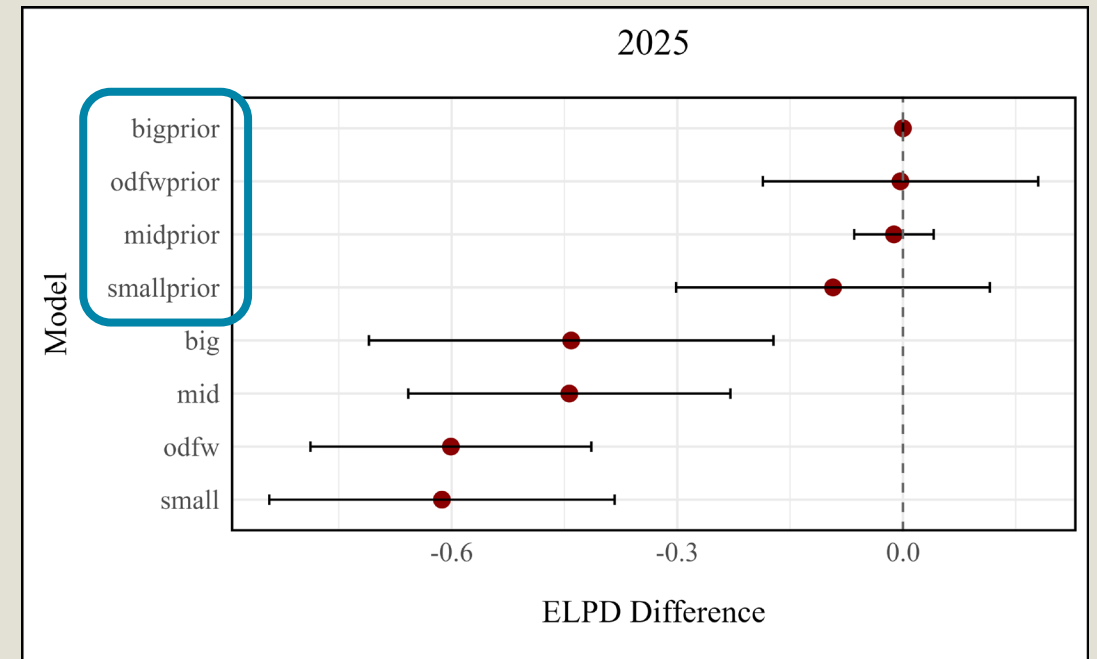
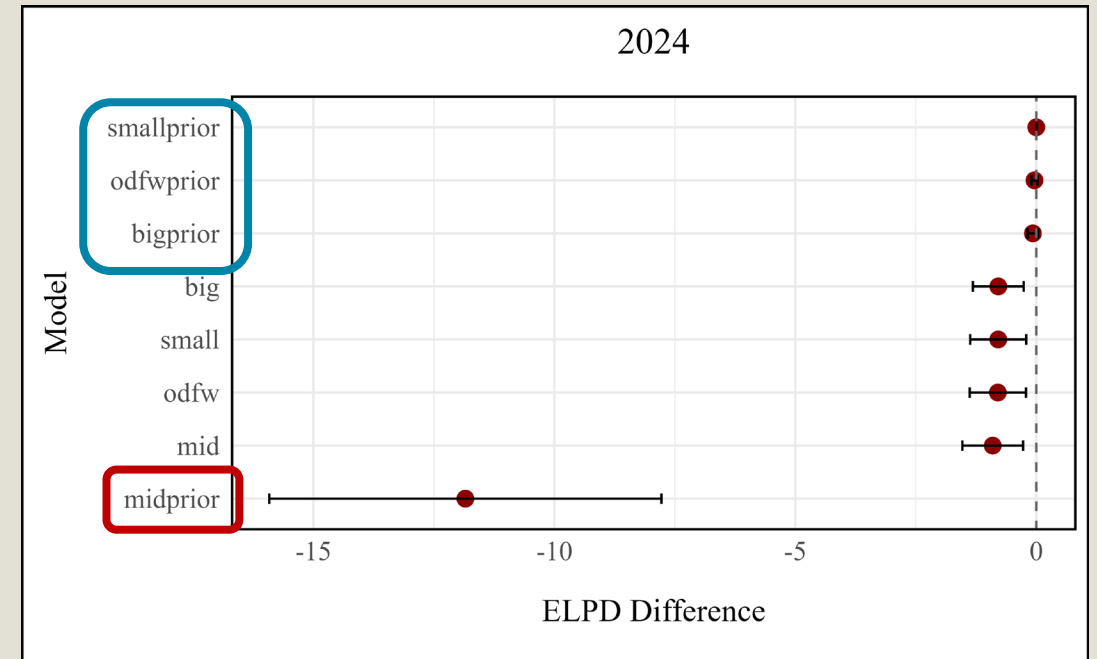
- ❑ Within a single year, all eight models ranked
- ❑ Expected Log Predictive Density shown

❑ No clear winner

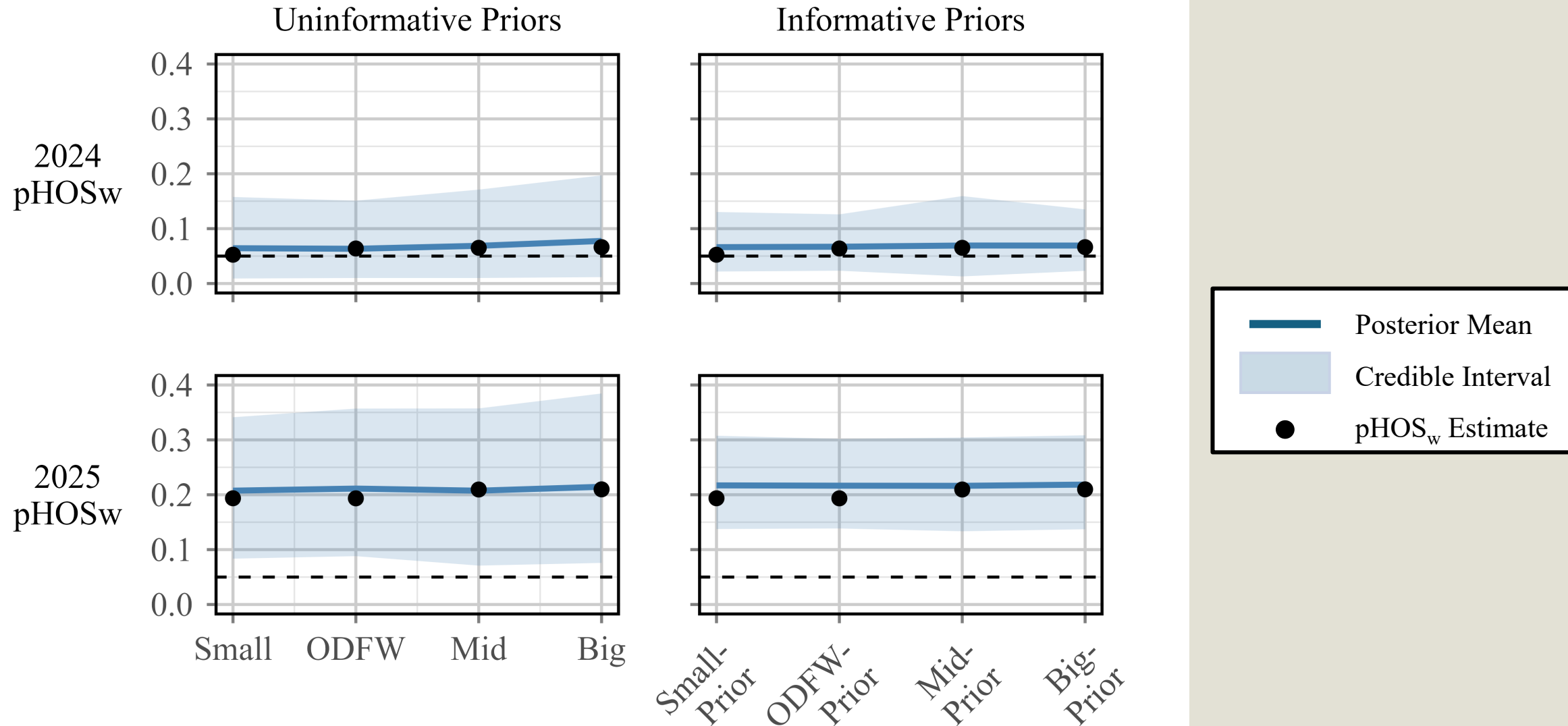
- ❑ But, models with limiting priors were ranked higher

❑ Midprior2024 underperformed

- ❑ Relatively high σ by comparison



Posterior means with 95% credible intervals and calculated estimates of pHOS_w





58 Bighorn Sheep

23 Bears

13 Elk

13 Rattlesnakes

11 Otters & Minks

7 Mountain Goats

3 Sasquatch

1 Moose

Year	Mark Site	Adult		
		Hatchery	Natural	Unknown
2024	Bonneville Dam	-	-	2
	Lower Granite Dam	-	28	-
	Grand Ronde Smolt Trap	-	1	-
2025	Bonneville Dam	-	-	3
	Lower Granite Dam	2	77	-
	Grand Ronde Smolt Trap	-	3	-
	Lookingglass Creek	-	1	-
	Lookingglass Hatchery – Lookingglass Stock	1	-	-
	Lookingglass Hatchery – Imnaha Stock	1	-	-
	South Fork Walla Walla River	1	-	-

Year	Mark Site	Juveniles	
		Hatchery	Natural
2024	Lookingglass Creek	-	1
	Lookingglass Hatchery – Catherine Creek Stock	19	-
	Lookingglass Hatchery – Grande Ronde Stock	5	-
	Lookingglass Hatchery – Lookingglass Stock	3	-
2025	Grande Ronde River	-	1
	Lostine River	-	2
	Lookingglass Hatchery – Catherine Creek Stock	45	-
	Lookingglass Hatchery – Grande Ronde Stock	3	-
	Lookingglass Hatchery – Lostine Stock	4	-

Spatial Breaks		Temporal Breaks				
		None	Monthly	Bi- Weekly	Weekly	Daily
Uniform	None	pHOS	pHOS _{month}	pHOS _{biweek}	pHOS _{week}	pHOS _{day}
	25 km	pHOS ₂₅	pHOS _{25 - month}	pHOS _{25 - biweek}	pHOS _{25 - week}	pHOS _{25 - day}
	12.5 km	pHOS ₁₂	pHOS _{12 - month}	pHOS _{12 - biweek}	pHOS _{12 - week}	pHOS _{12 - day}
	6.25 km	pHOS ₆	pHOS _{6 - month}	pHOS _{6 - biweek}	pHOS _{6 - week}	pHOS _{6 - day}
	3.125 km	pHOS ₃	pHOS _{3 - month}	pHOS _{3 - biweek}	pHOS _{3 - week}	pHOS _{3- day}
Eco Informed	Eco.Big	pHOS _{big}	pHOS _{big - month}	pHOS _{big - biweek}	pHOS _{big - week}	pHOS _{big - day}
	Eco.Mid	pHOS _{mid}	pHOS _{mid - month}	pHOS _{mid - biweek}	pHOS _{mid - week}	pHOS _{mid - day}
	Eco.Small	pHOS _{small}	pHOS _{small- month}	pHOS _{small - biweek}	pHOS _{small - week}	pHOS _{small- day}
	Eco.odfw	pHOS _{odfw}	-	-	pHOS _{odfw - week}	-