Winter-run Chinook Salmon Population Analysis 2020-2023

Application of parentage-based designs

Presenter Scott Blankenship Ph.D.

Acknowledgements

Goal

What are we doing?

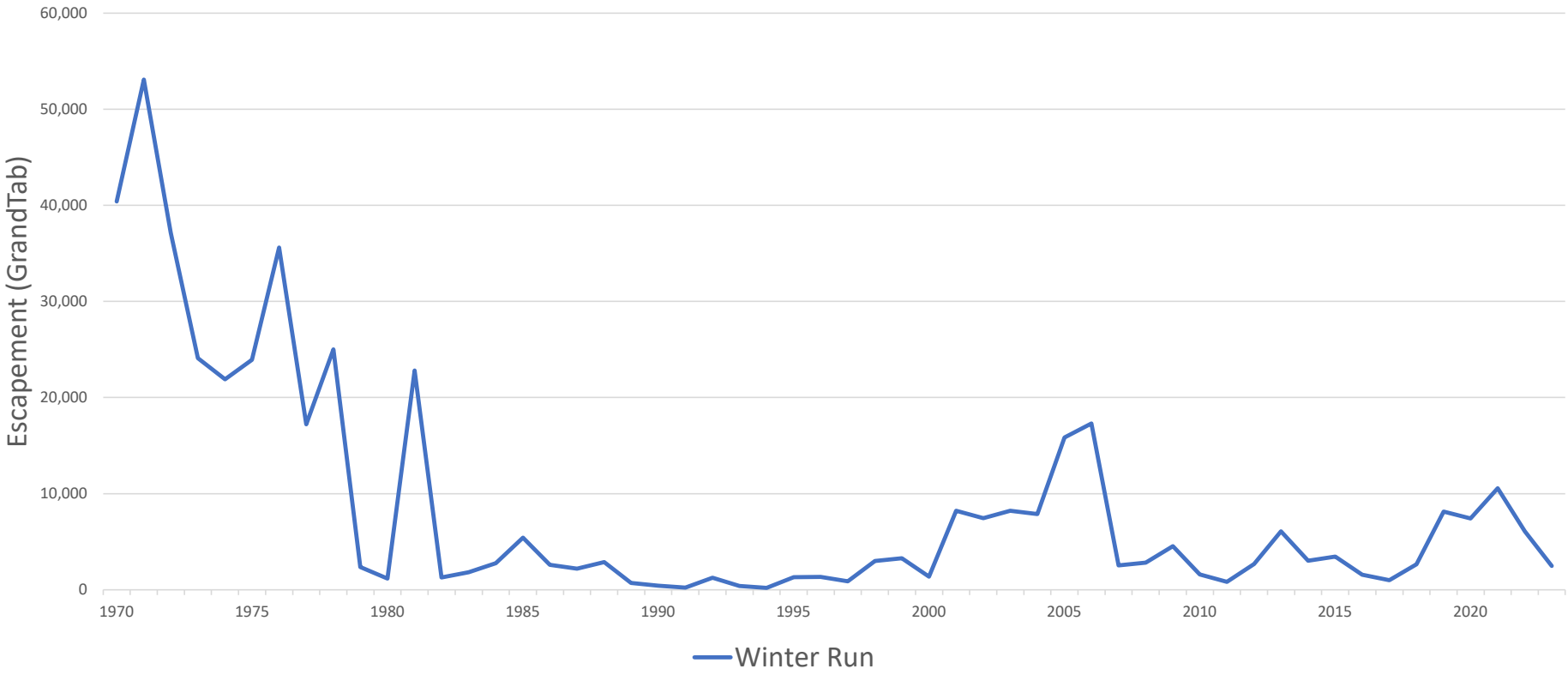
Why are we doing it?

Photo: Josh Gruber

Winter Run Study Metrics

Abundance	Sex ratio	Recruitment rate	egg-to-fry survival
Effective population size	Effective pHOS	Differential recruitment	Genetic diversity

Abundance


60,000
50,000
40,000
30,000
20,000
10,000
0
Escapement (GrandTab)
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Winter Run

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RESEARCH ARTICLE

WILEY

Applying parentage methods to detect gravel augmentation effects on juvenile Chinook Salmon recruitment rates

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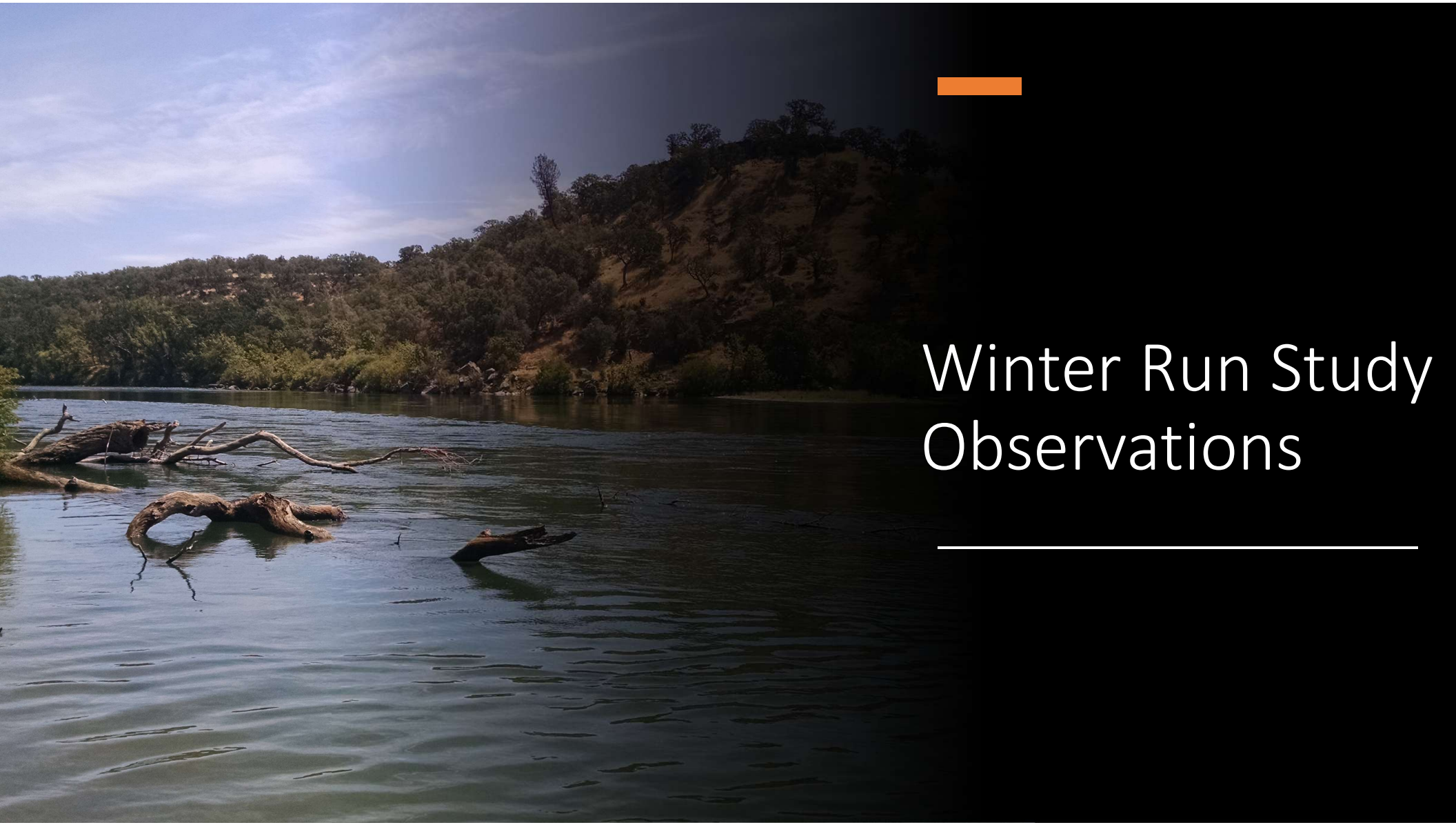

Winter Run Study Observations

Activity #13: Continue exploration of parentage-based tag methods (PBT) to provide information on the reproductive success of individual spawners.

Activity #29: Routinely develop summary brood year assessments.

Relevance to Sacramento River Science Partnership Science Plan

Collections

	Brood Year			
Metric	**2020**	**2021**	**2022**	**2023**
Carcasses sampled	593	800	1000	381
Carcasses analyzed	430 (66)	336 (22)	322 (11)	246 (1)
% of carcass failing QA/QC	27%	58%	68%	35%
Juveniles analyzed	1109	1020	1008	1166

Non-winter carcasses in parenthesis. ~1% juveniles non-winter

Agency Monitoring Metrics

Metric		Brood Year 2020	2021	2022	2023
In-river spawner abundance	CDFW	6195	9956	5443	1920
In-river percent female	CDFW	63.0%	58.8%	47.9%	55.3%
Egg-to-fry survival	USFWS	11.5%	2.4%	2.2%	24.9%
Temperature Dependent Mortality	NMFS	0.9%	73.5%	8.3%	0.0%

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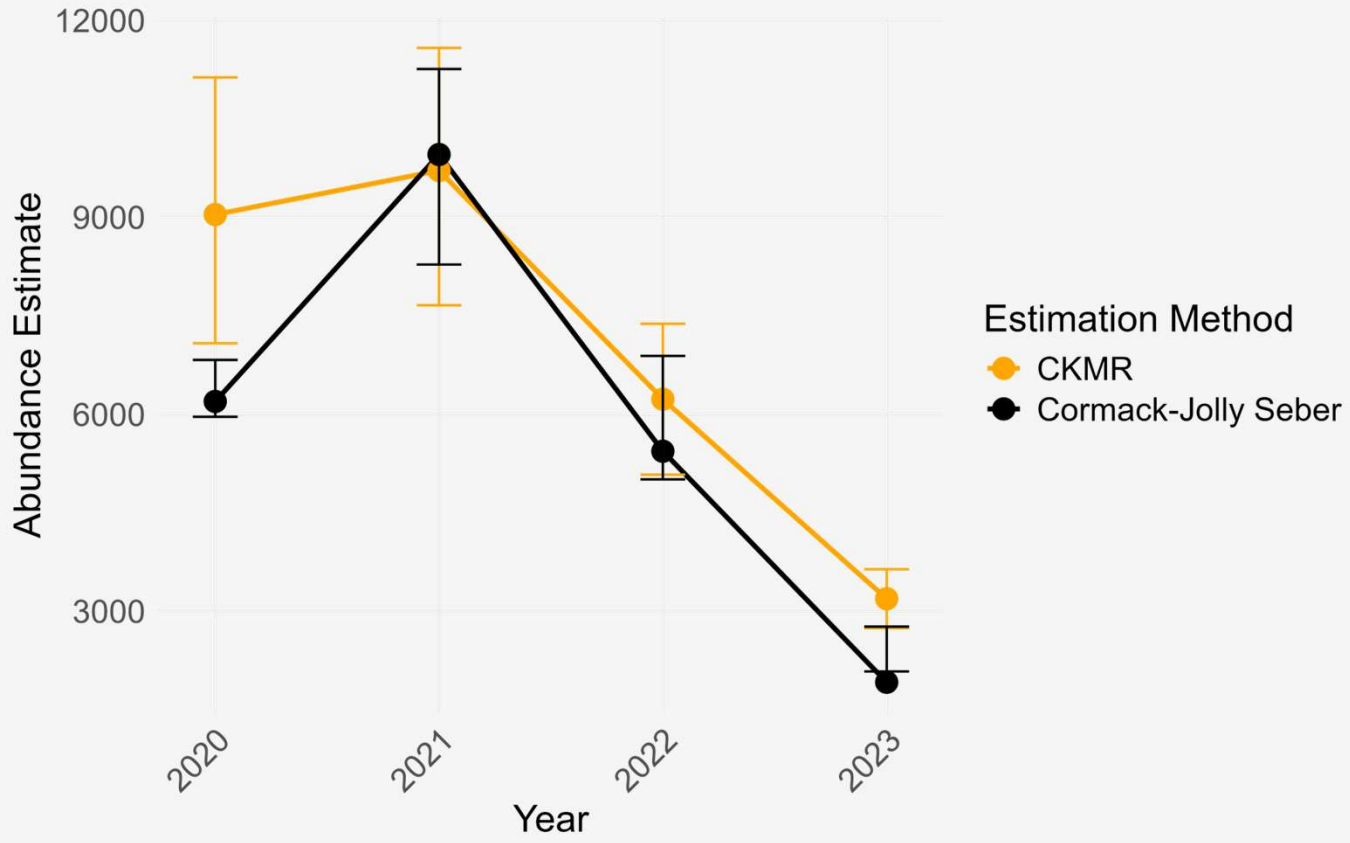
In-river spawner Abundance	CFS	9042	9711	6230	3192
In-river percent female	CFS				
Egg-to-fry survival	CFS				

Spawner Abundance Estimates



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In-river spawner Abundance	CFS	9042	9711	6230	3192
In-river percent female	CFS	55.8%	64.9%	45.1%	
Egg-to-fry survival	CFS	6.5%	3.0%	1.8%	16.2%

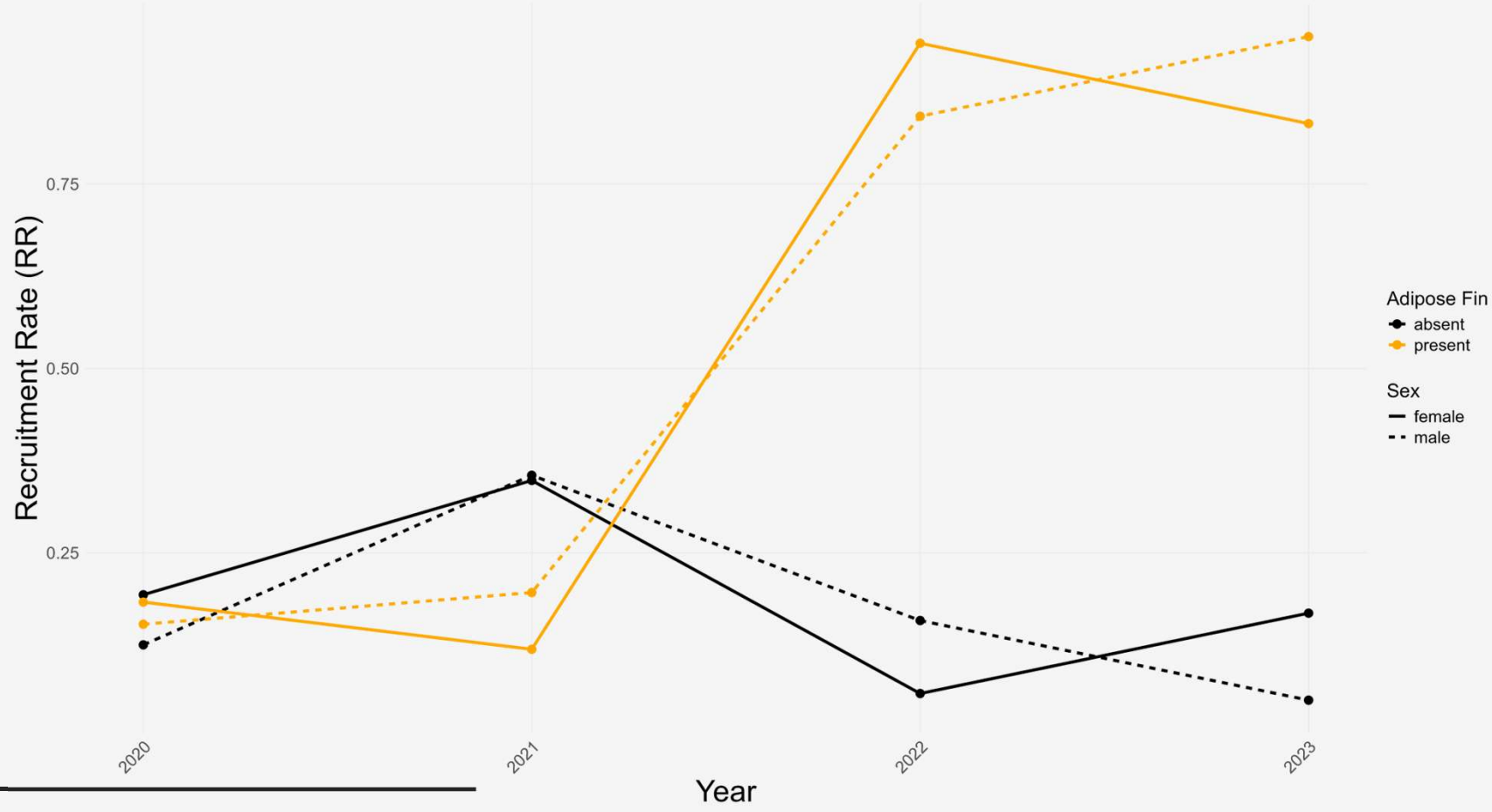
Effective Population Size (N_e)

Brood Year	Effective Breeders (N_b)	95% C.I.
2020	338.4	310.4-369.0
2021	355.9	322.5-393.5
2022	398.5	357.9-444.9
2023	205.8	191.1-221.6

N_e (Generational) = 304.6

Values of N_e are often interpreted in relation to thresholds of the 50/500 rule-of-thumb

Recruitment Rates to Red Bluff



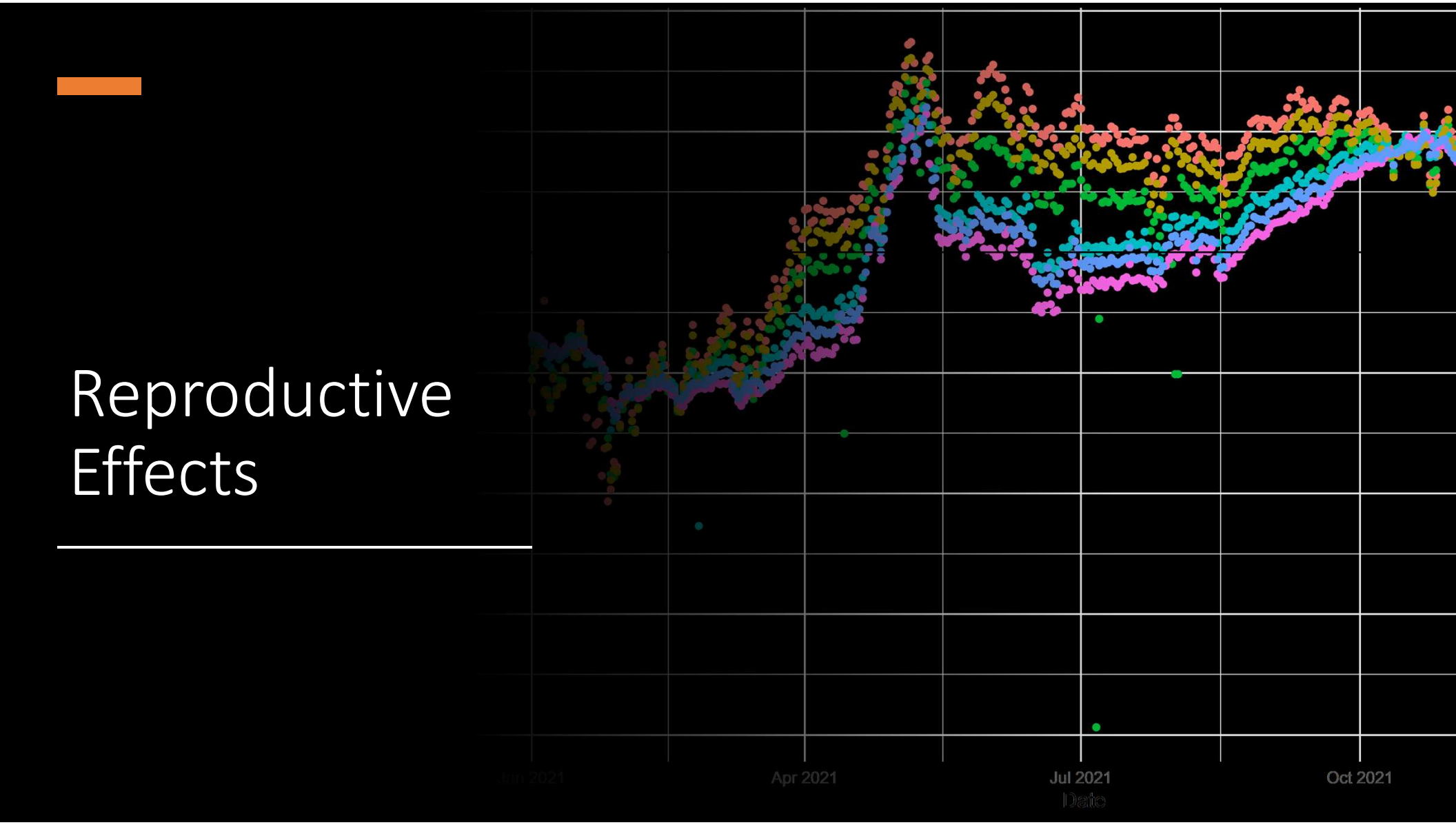
Federal Hatchery Reform

Effective pHOS

Brood Year	Mean RRS	$pHOS_{eff}$	PNI
2020	0.94	0.42	0.70
2021	2.37	0.72	0.58
2022	0.12	0.01	0.99
2023	0.13	0.03	0.97

Mean RRS: If RRS > 1.0, then hatchery recruit rate is higher

Reproductive Effects

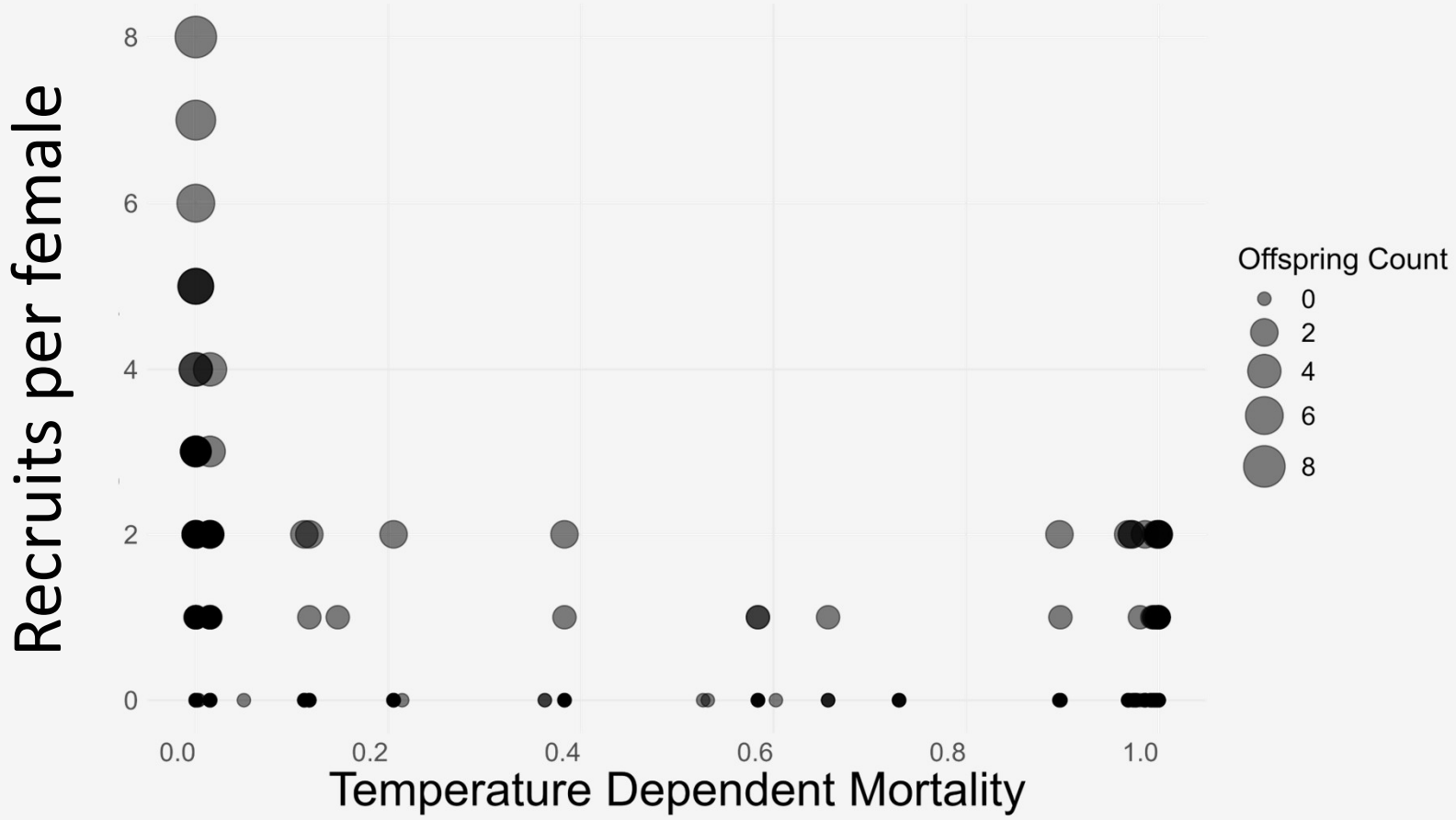


Statistical Modelling

CATEGORY	VARIABLE
Dependent	Offspring count
Predictors	Year 2021
	Year 2022
	Year 2023
	Keswick Recapture (True)
	Fork length
	Adipose fin (present)
	River mile
	TDM

MODEL COMPONENT	FACTOR	ESTIMATE	P
Zero Hurdle	(Intercept)	-1.25769	0.00723 **
	YearID2023	0.78068	0.09356

MODEL COMPONENT	FACTOR	ESTIMATE	P
Count	(Intercept)	-0.84113	0.0543
	YearID2023	0.75912	0.0168 *


Recruits per female
8
6
4
2
0
0.0
0.2
0.4
0.6
0.8
1.0
Temperature Dependent Mortality
Offspring Count
0
2
4
6
8

CLOSE

Carcass tissue quality could be improved

Mean abundance estimates differ, but confidence intervals overlap (2021-2023)

Survival decreased and TDM increased by order of magnitude

ETF_{GMR} dropped 50% in unfavorable water year relative to more favorable

CLOSE

Effective Population Size ~ 300. 2023 was notable lower than other years.

In-river environmental covariates (e.g., temperature, spawning location) did not explain spawning success patterns

TDM did not explain patterns of spawning success

SUPPLEMENTAL

Spawner abundance	*1)* $(J_1, J_2, J_3, J_4) \sim$ Multinomial (p_1, p_2, p_3, p_4) 2) $N_c = \frac{(n_1)(n_2)}{(m_2)}$
Sex ratio	1) % female observed in samples 2) % female estimated (needs a prior)
Recruitment rate	Assignment rate of sampled adults 1) $R = \frac{(m_2)}{(n_1)}$
Egg-to-fry survival	$ETF_{GMR} = \frac{number\ of\ marked\ fry\ at\ RBDD}{number\ of\ marked\ eggs}$

Quantitative Metrics

Effective population size (N_e, N_b)	1) $\widehat{N}_e = \frac{1}{(\hat{r}^2 - 1/S)}$ 2) Probability randomly chosen offspring are related
Effective pHOS	1) $pHOS_{Eff} = RRS * pHOS_{census}$ 2) $PNI = \frac{pNOB}{pNOB + pHOS_{eff}}$
Differential recruitment (effects)	1) General linear models 2) Relative Reproductive Success ($RRS = R_X/R_Y$)

Quantitative Metrics