

Spring Chinook Carcass Recovery Bias in the Upper Wenatchee Basin



Mike Hughes, Andrew Murdoch (WDFW)
Kevin See (Biomark)



Utilization of Carcass Data

- Carcasses recovered on the spawning grounds are often used to reconstruct the demographics of a spawning population
- Assumes that these collections are truly a random sample of carcasses
- Carcass recovery probabilities have been shown to differ;
 - Sexes
 - Fish Size
- Resulting in a biased spawning population estimates

Study Objectives

- Evaluate carcass recovery rates and the factors that influence them
- Develop a model that predicts carcass recovery probabilities for spring Chinook Salmon in the upper Wenatchee Basin
- Recalculate the demographics of the spawning populations using corrected carcass recovery data
 - Preliminary results for Chiwawa River in 2011 and 2013

Murdoch et al. 2010

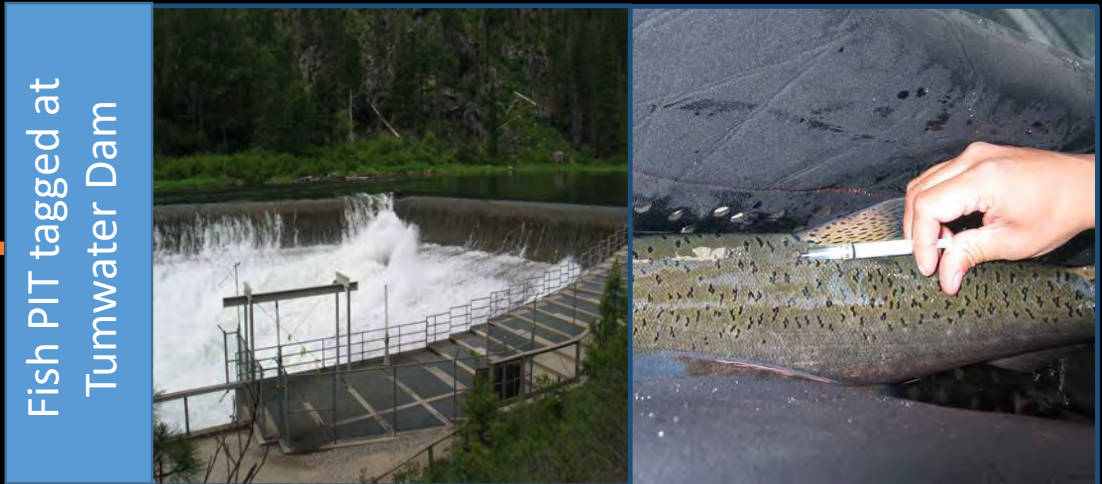
Current approach



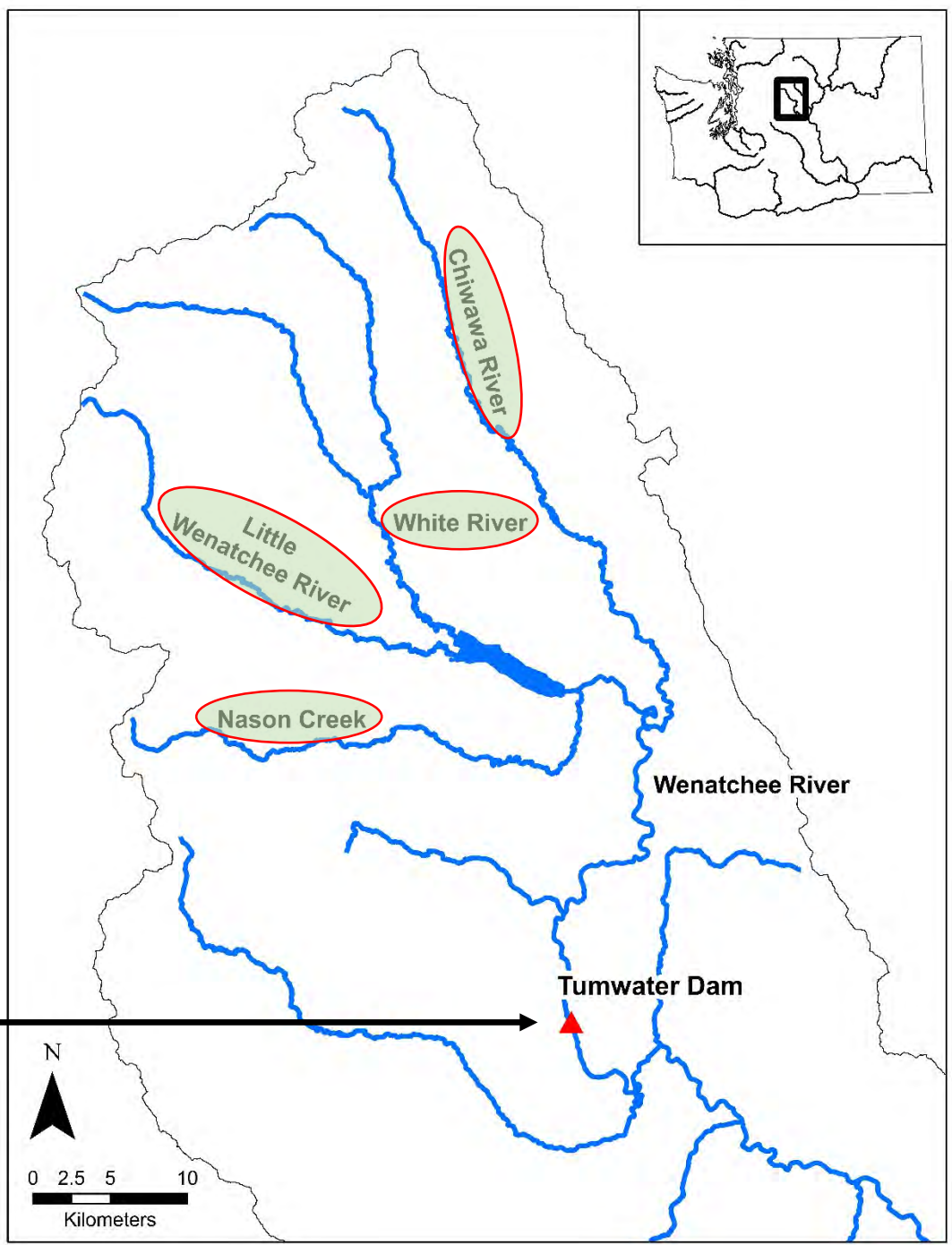
Carcass Recoveries



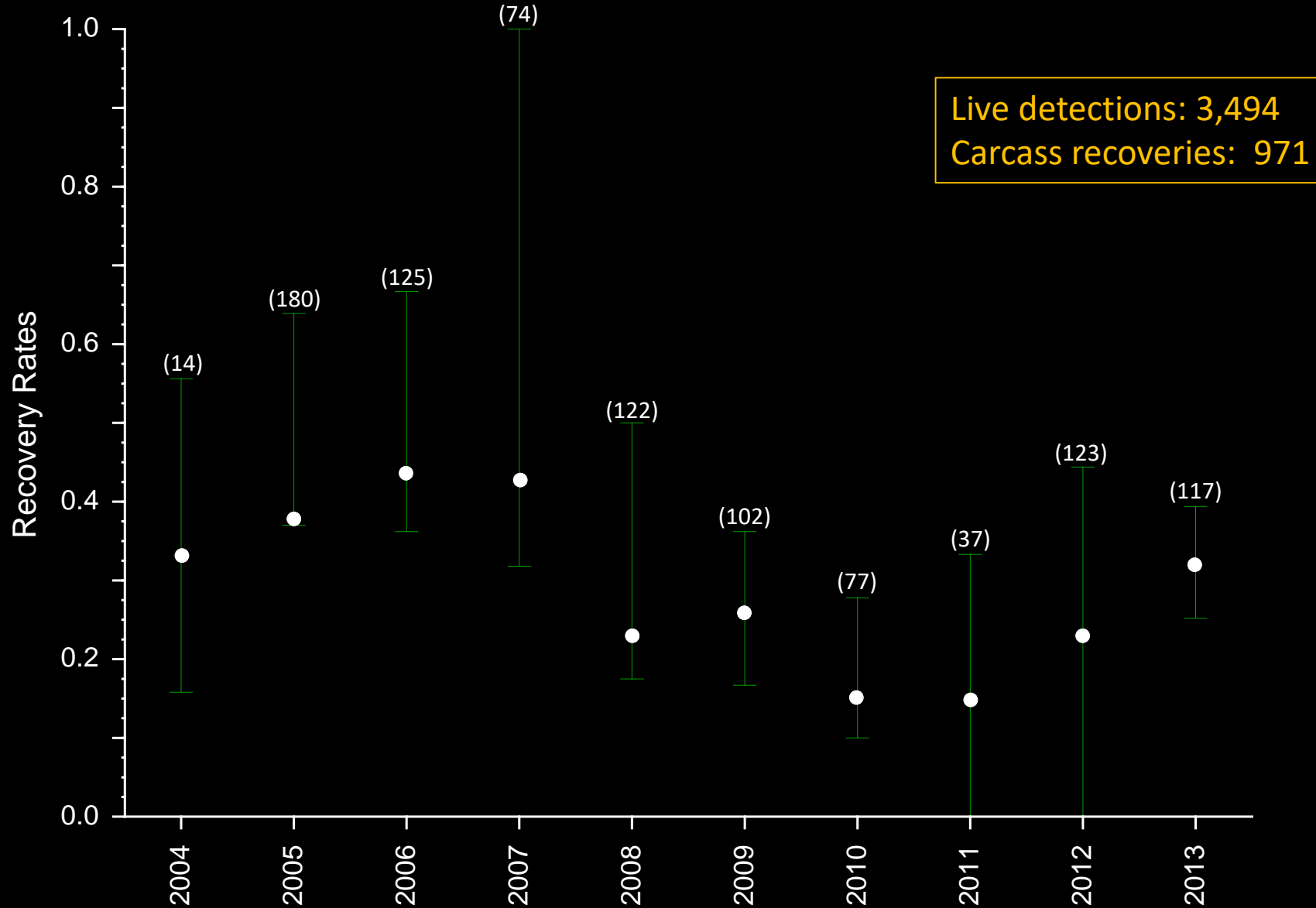
Live detections



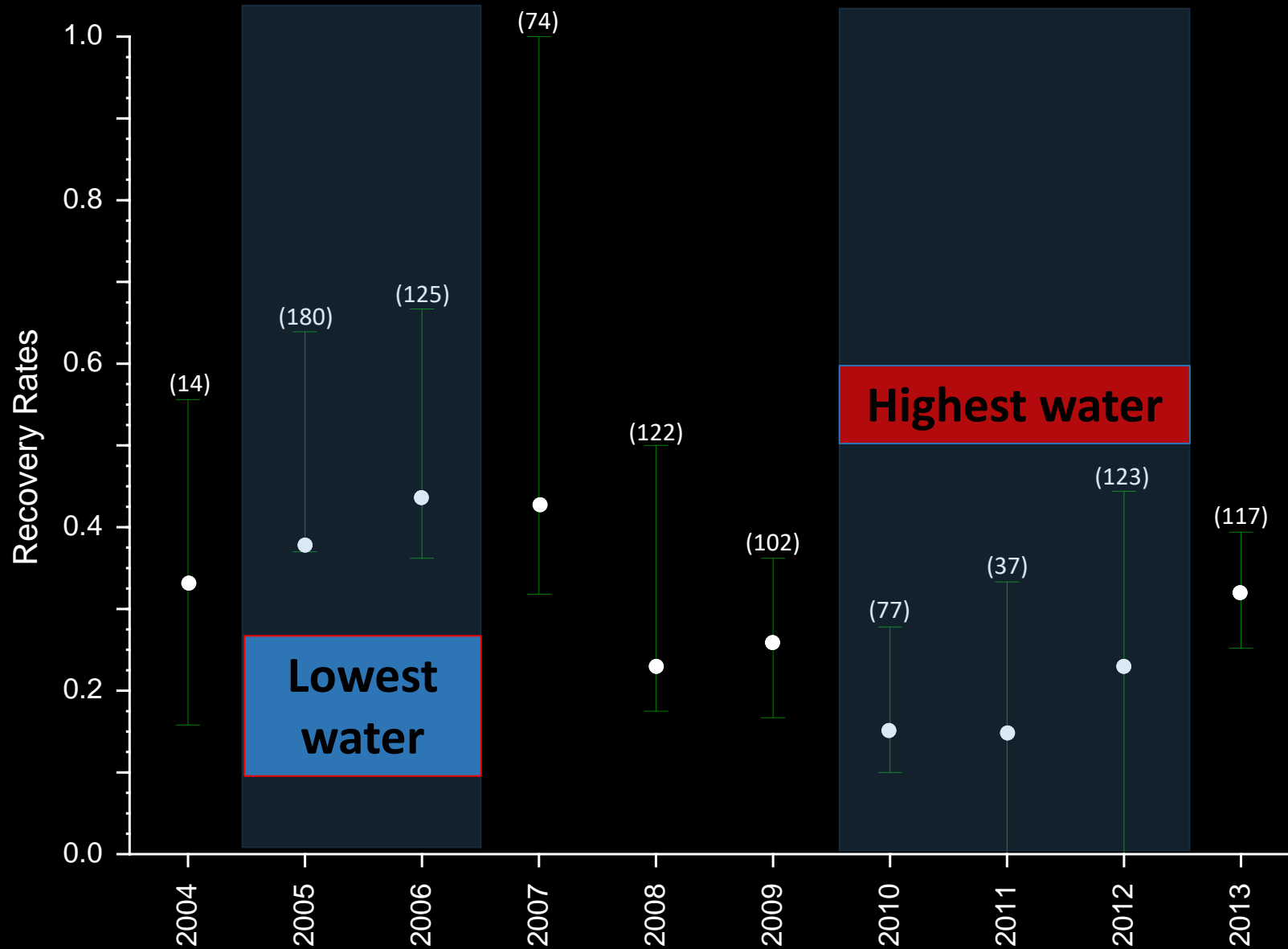
Fish PIT tagged at Tumwater Dam



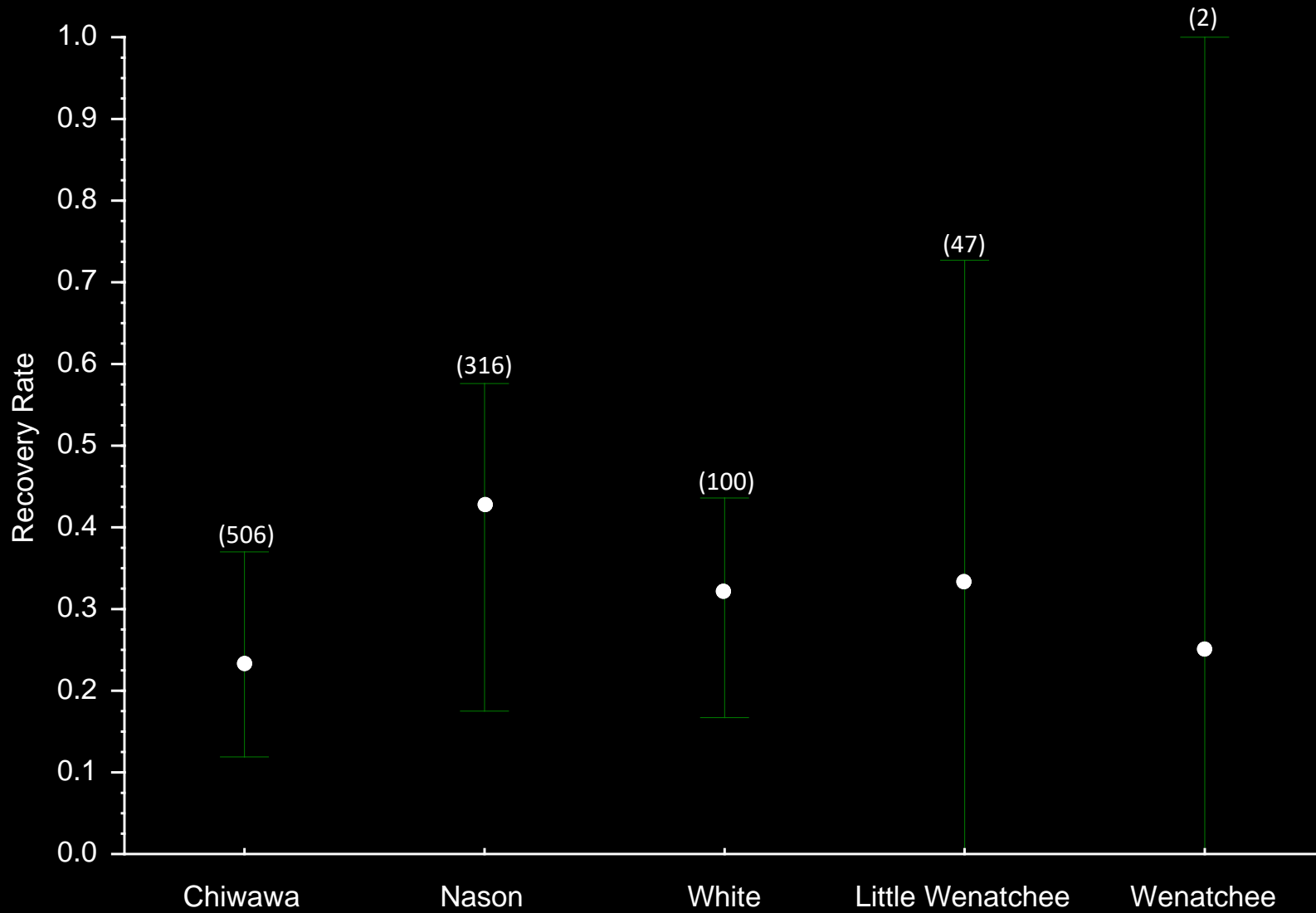
Recovery rates across all tributaries by year



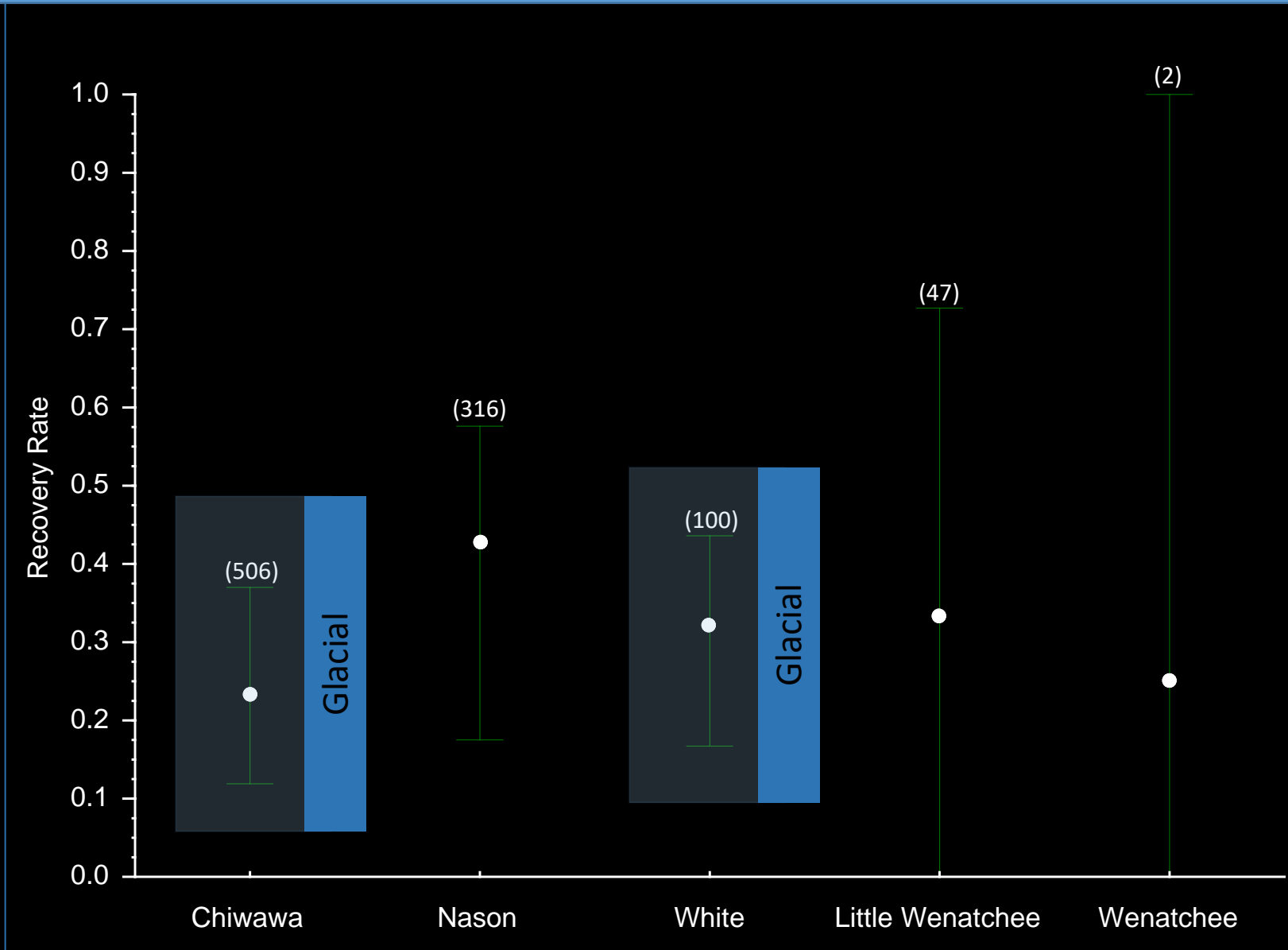
Recovery rates across all tributaries by year



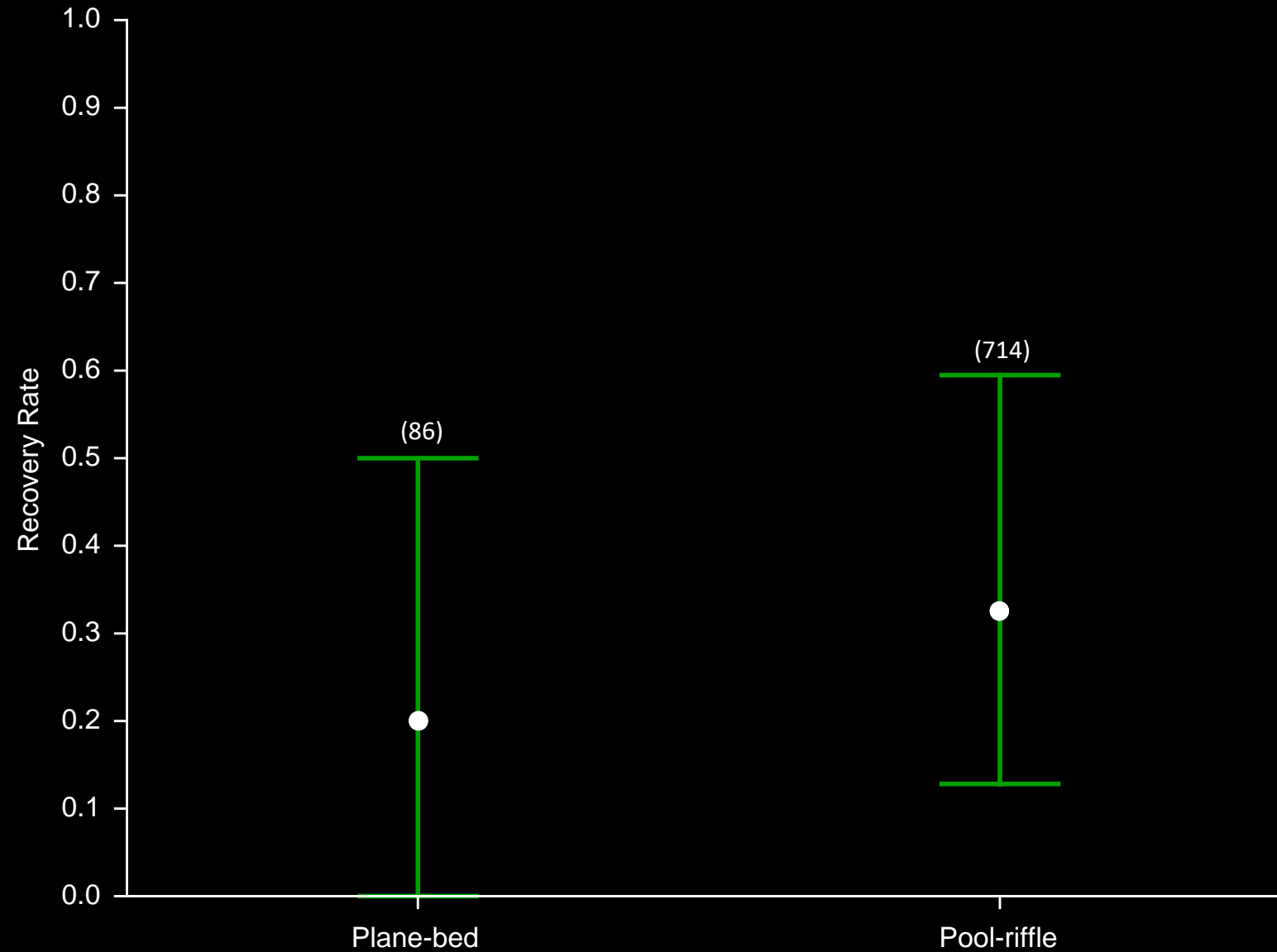
Median recovery rates by tributary



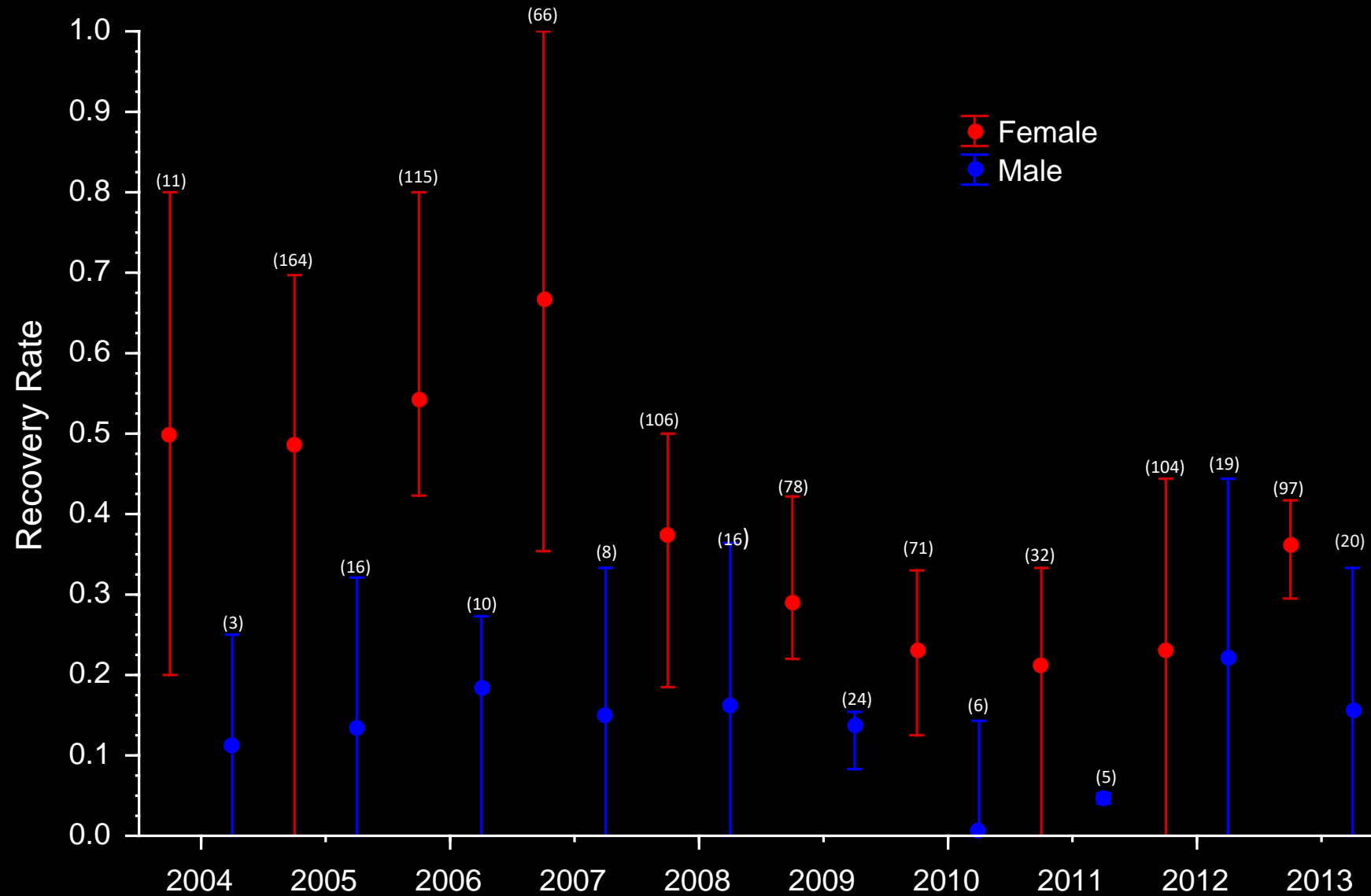
Median recovery rates by tributary



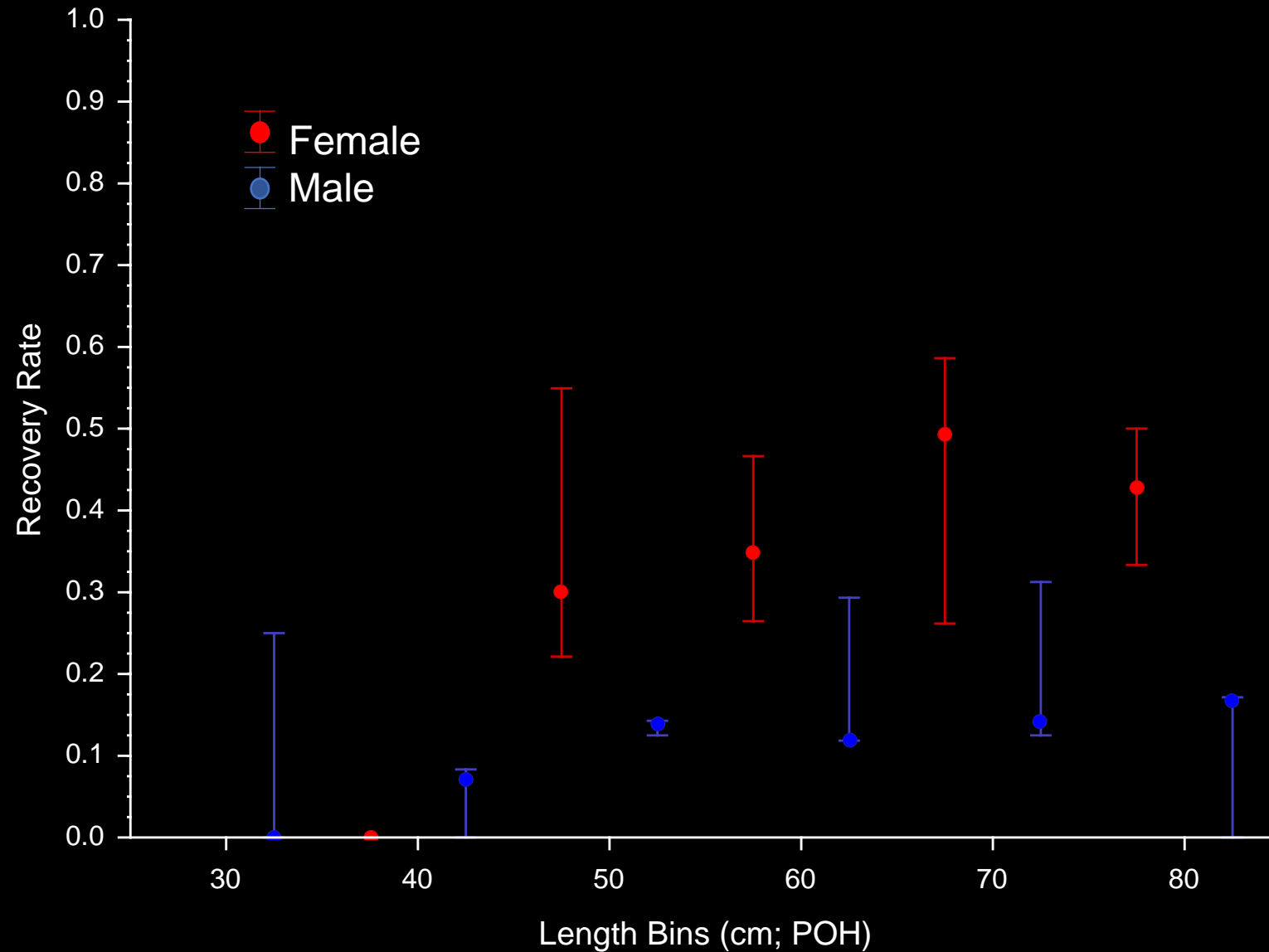
Recovery rates by channel type



Recovery rates by year & sex



Recovery rates by length and sex



Factors that influence recovery rates

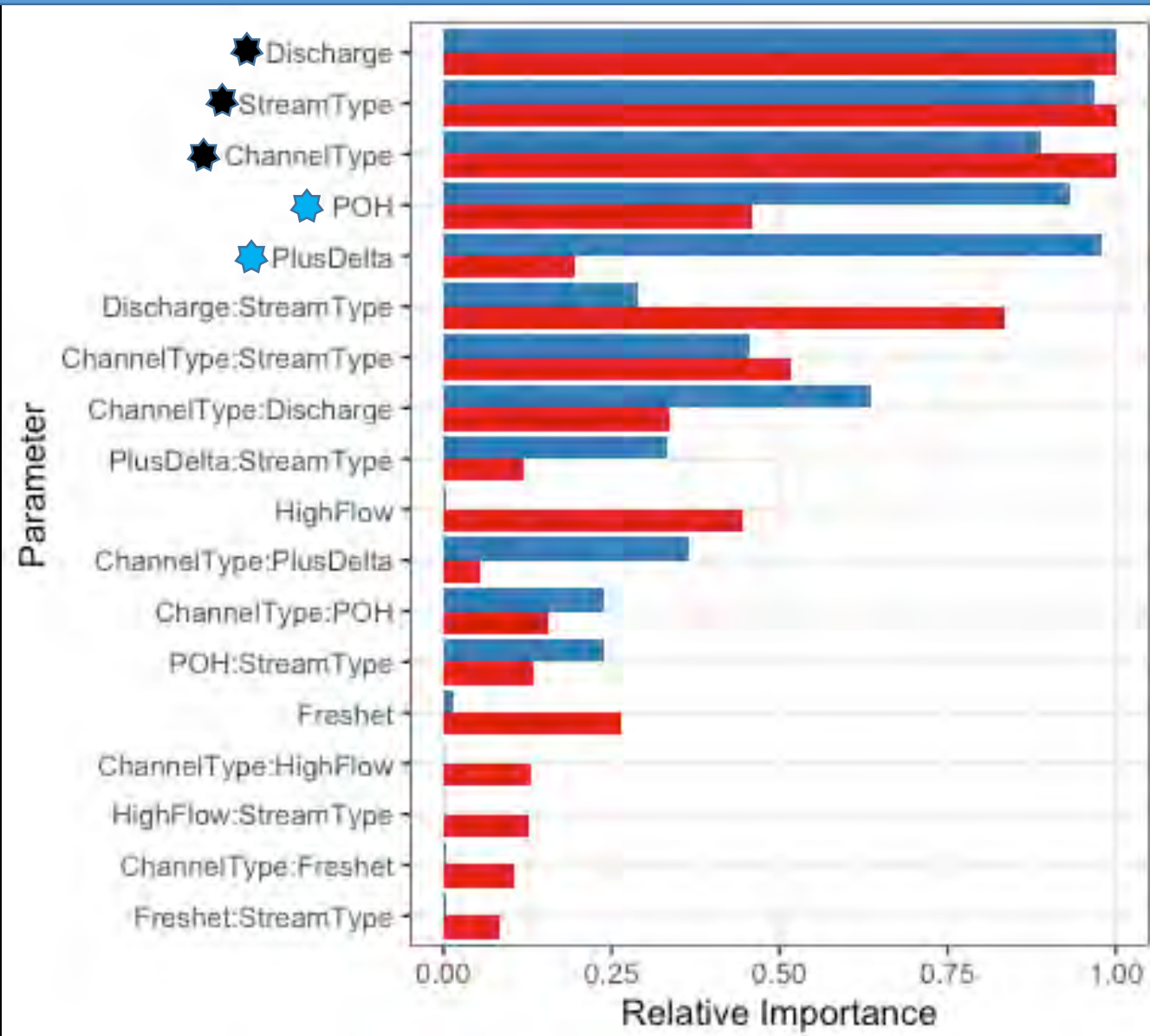
Environmental characteristics

- **River discharge:**
 - Year-to-year variation:
 - Mean discharge
 - Within year variation:
 - Number of freshet events flow increased by greater than 10%
 - Number of days flows elevated by greater than 20%
 - Number of days flows increased relative to the prior day
- **Stream characteristics:**
 - Glacial and non-glacial streams
- **Channel type:**
 - Pool-riffle and plane-bed reaches

Fish characteristics

- **Sex:** spawning behaviors
- **Fish size:** carcass detection and movement
- **Origin:** Size differences and differential spawning distributions

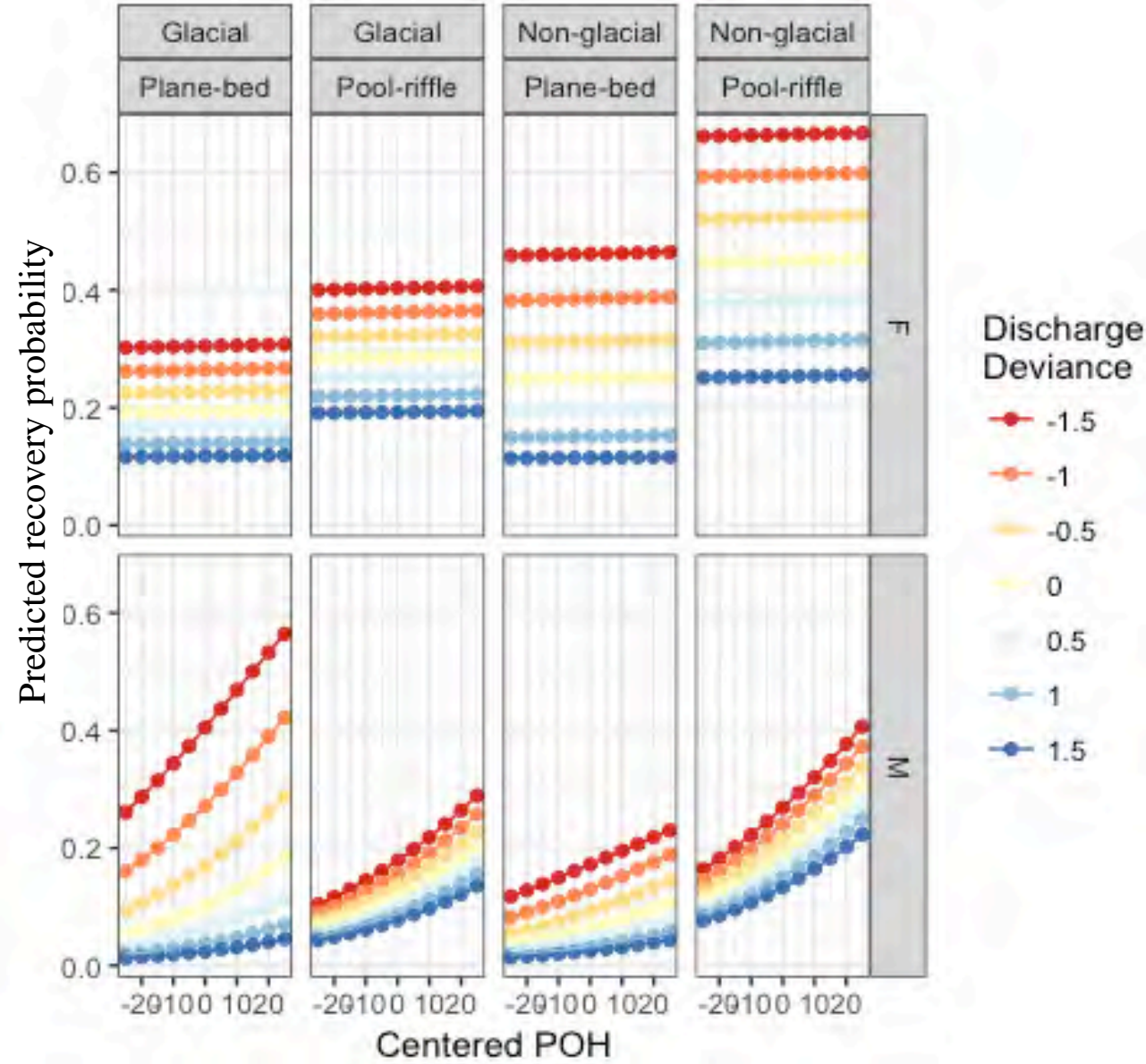
Binomial GLM with logit Link separately by sex: Importance of variables within Models



Predicated recovery probabilities

Recovery probabilities for both sexes were:

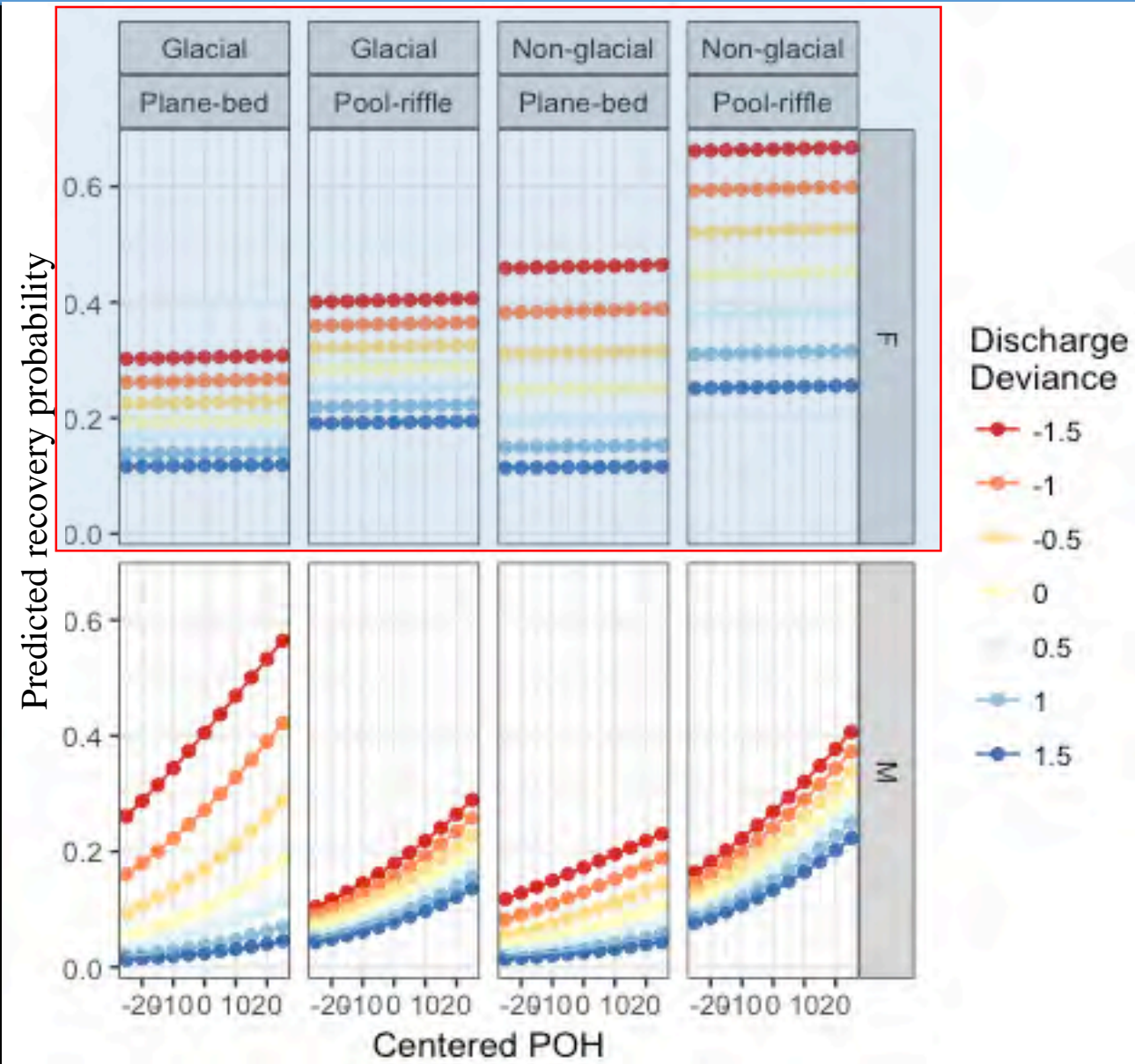
- Lower in years where discharge was higher
- Lower in glacial streams relative to non-glacial streams
- Lower in plane-bed channels compared to pool-riffle



Predicated recovery probabilities

Female recovery probabilities:

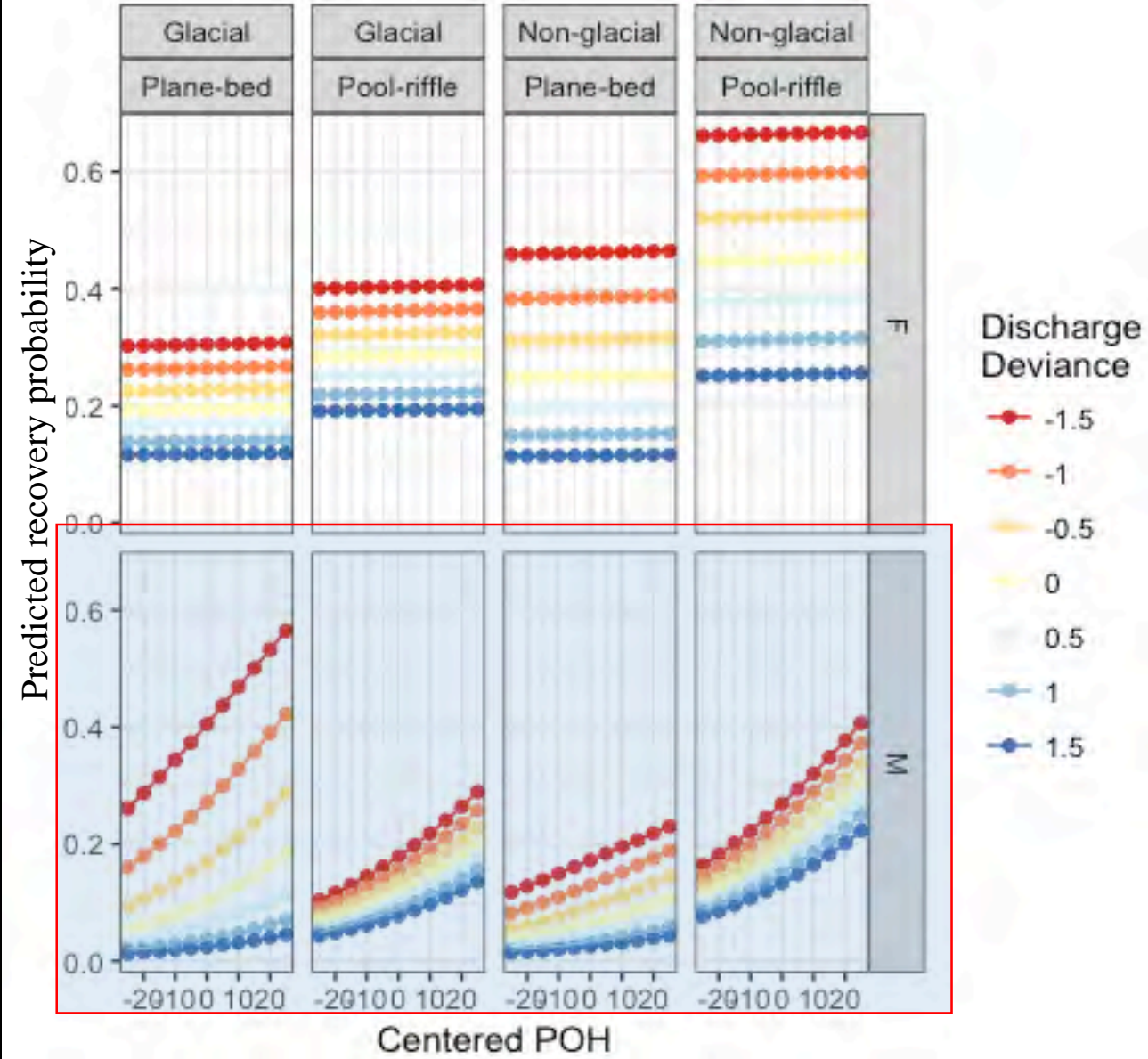
- POH had very little effect on recovery
- Interaction between discharge and stream-type
 - Lower in years where discharge was higher,
 - But decreased at a greater rate in non-glacial stream
- Additionally, recoveries decreased as the number of days that flows were elevated (>20%) increased



Predicated recovery probabilities with modeled average coefficients

Male recovery probabilities were:

- Higher for larger-sized males
- Additionally, recoveries were lower as the number of days discharge increased



Corrected vs non-corrected recoveries: 2011

Sex	Age	Carcass recoveries		Bias (%)
		Observed	Corrected	
Male	3	30	50	-67
	4	21	16	24
	5	31	16	48
Female	3	3	4	-33
	4	44	44	0
	5	34	33	3

Corrected vs non-corrected recoveries: 2013

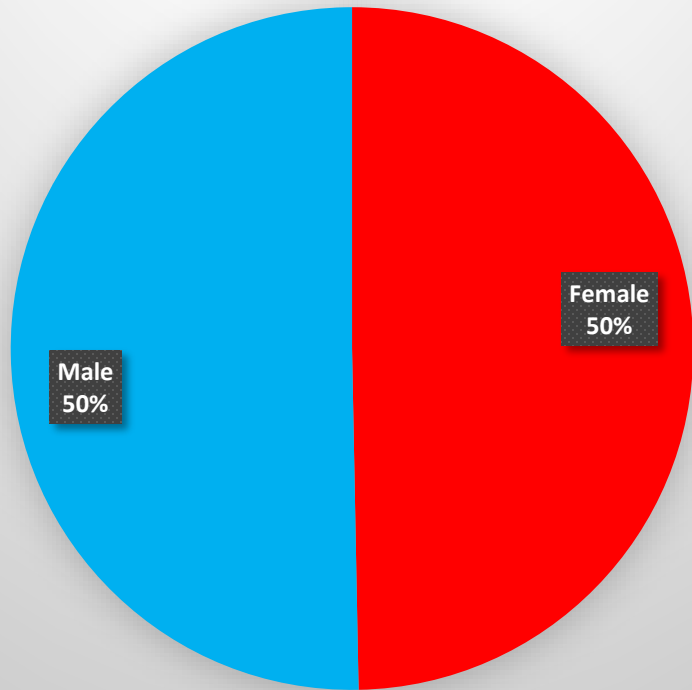
Sex	Age	Carcass recoveries		Bias (%)
		Observed	Corrected	
Male	3	39	53	-36
	4	70	62	11
	5	16	10	38
Female	3	4	4	0
	4	200	202	-1
	5	43	41	5

Fish per redd and spawning abundance

Year	Metric	Population expansion methods		
		Observed carcasses	Corrected carcasses	
			Plane-bed	Pool-Riffle
2011	Redd counts	474	104	370
	Fish per redd	2.01	4.10	1.26
	Spawning escapement	954	894	
2013	Redd counts	687	142	545
	Fish per redd	1.51	1.68	1.43
	Spawning escapement	1037	1,018	

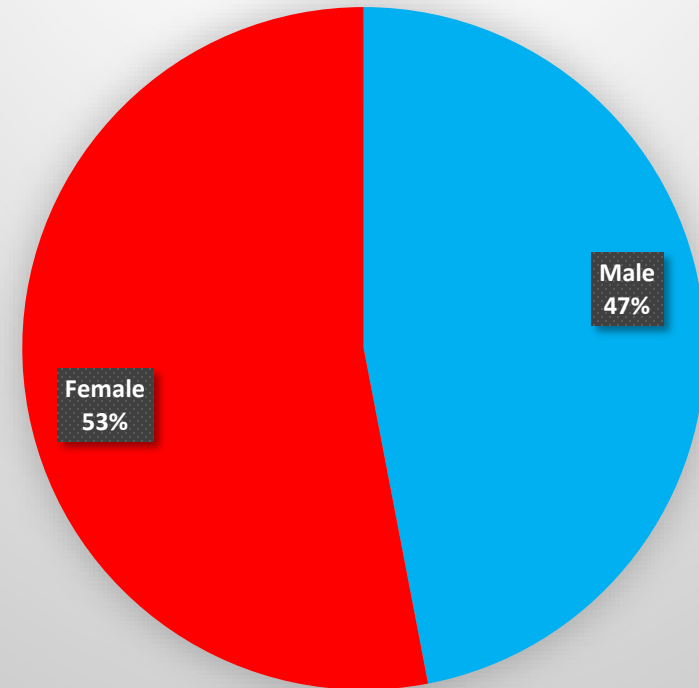
Sex ratios: estimated spawning abundance

Observed



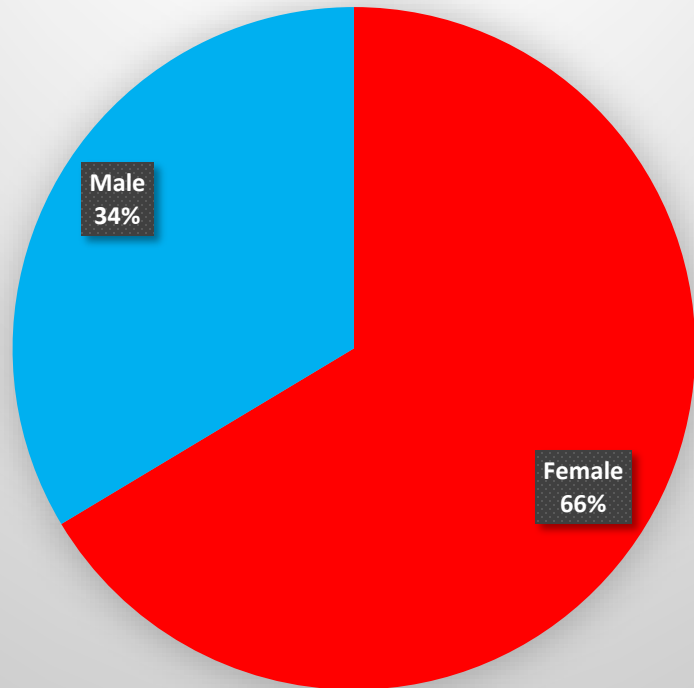
Chiwawa
2011

Corrected



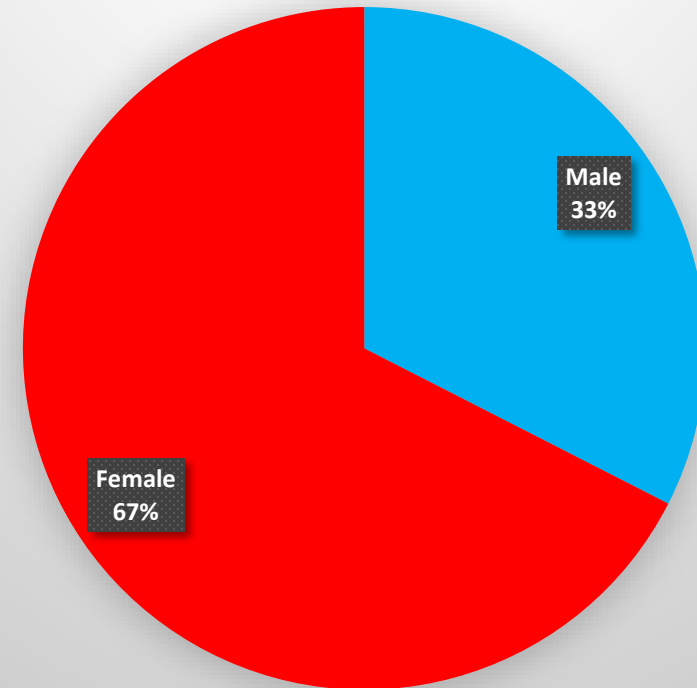
Sex ratios: estimated spawning abundance

Observed

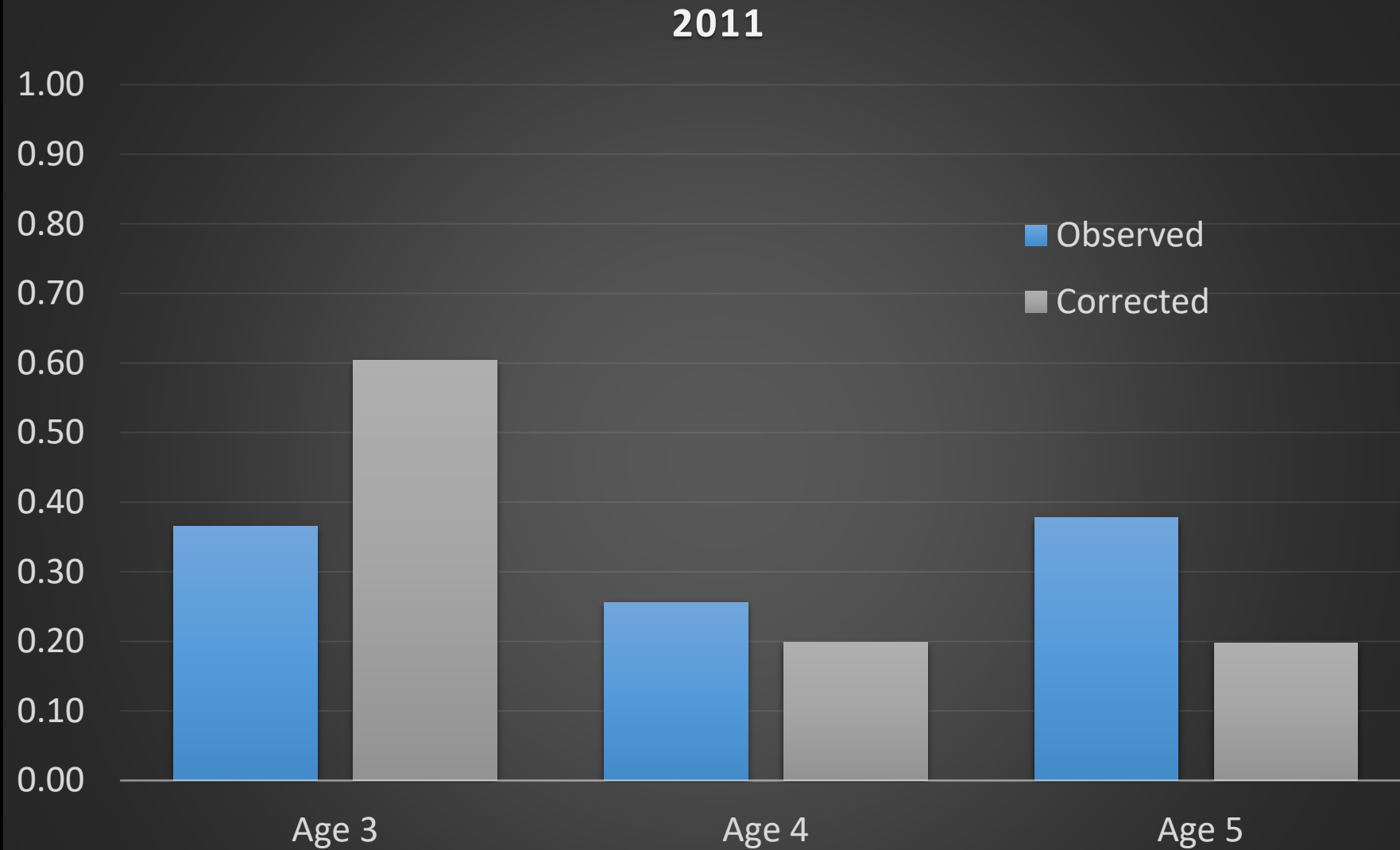


Chiwawa
2013

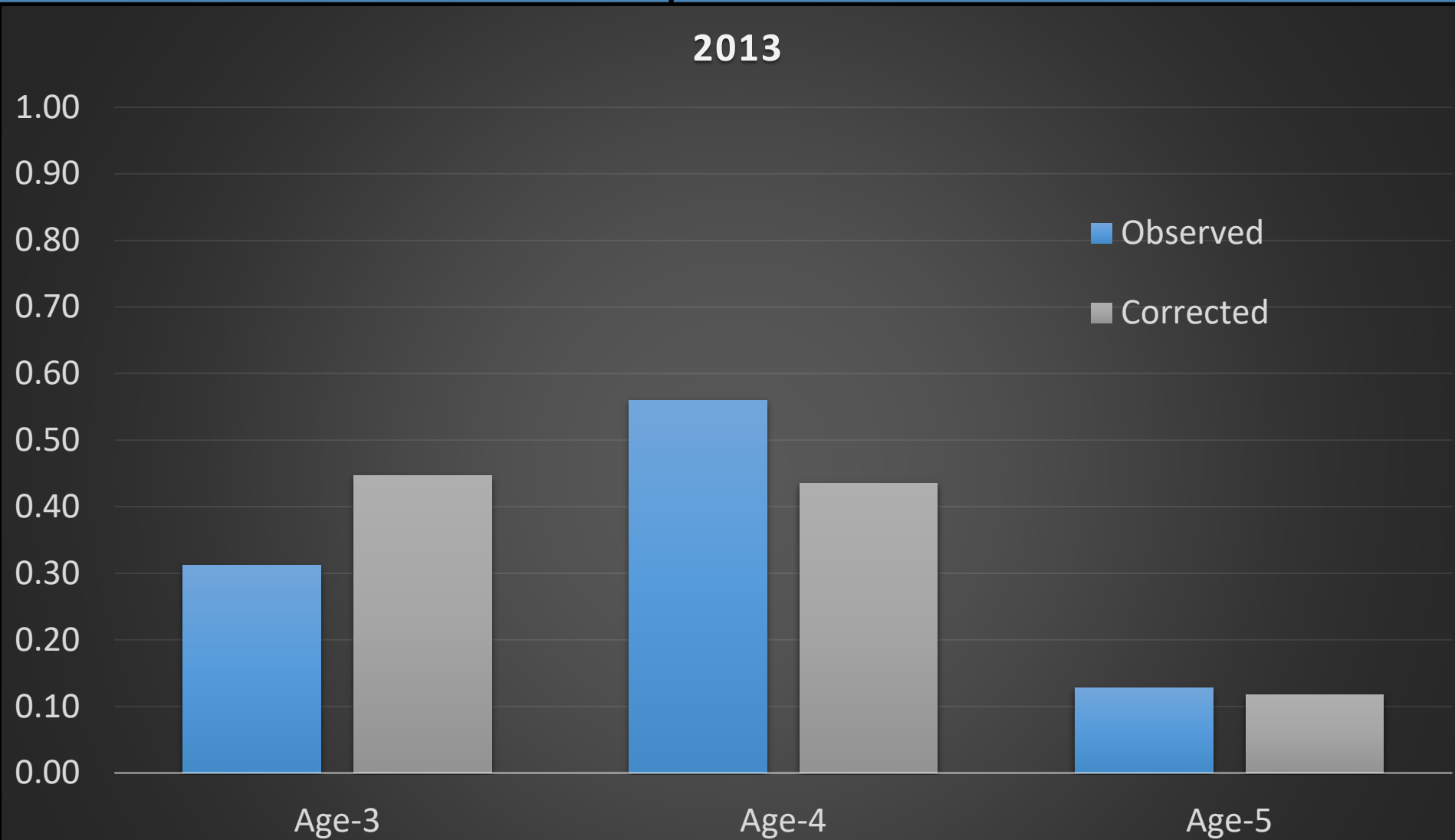
Corrected



Male Ages: estimated spawning abundance

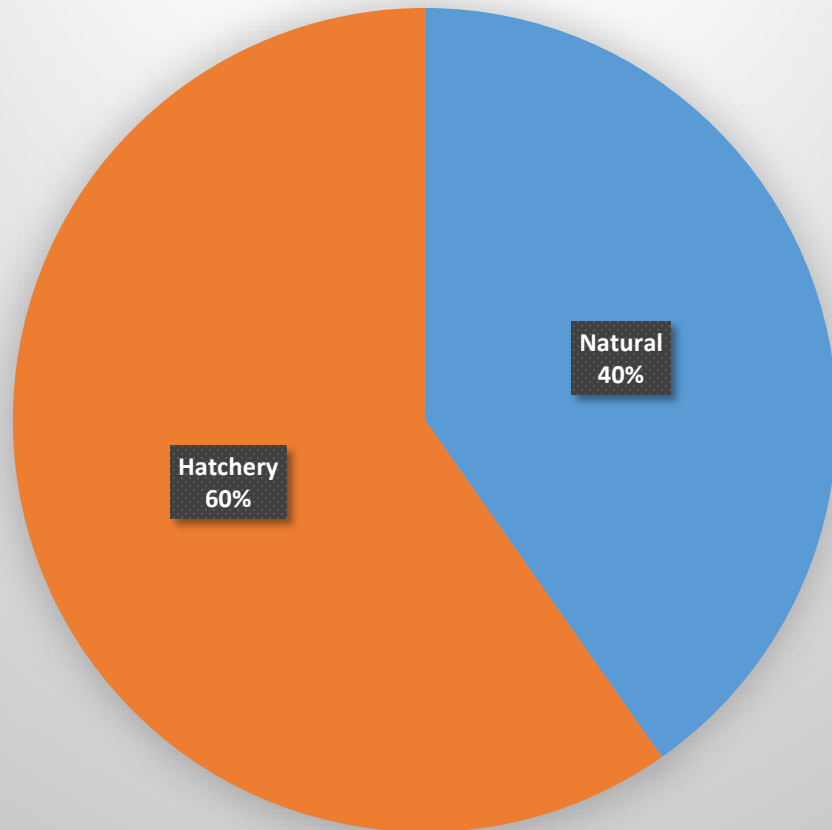


Male Ages: estimated spawning abundance



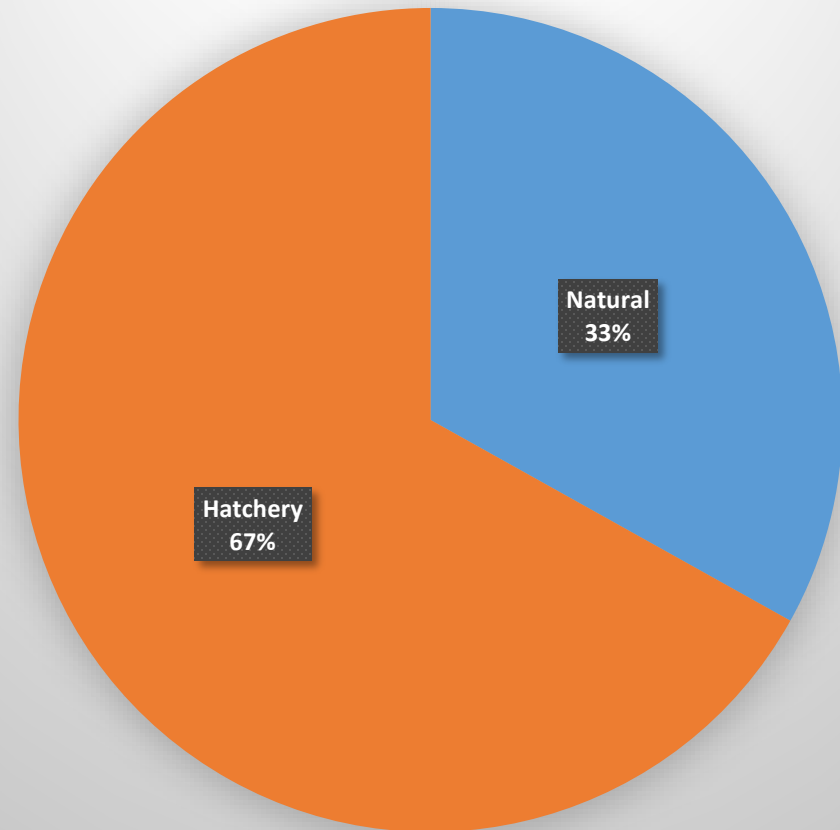
Proportion of spawners by origin: 2011

Observed



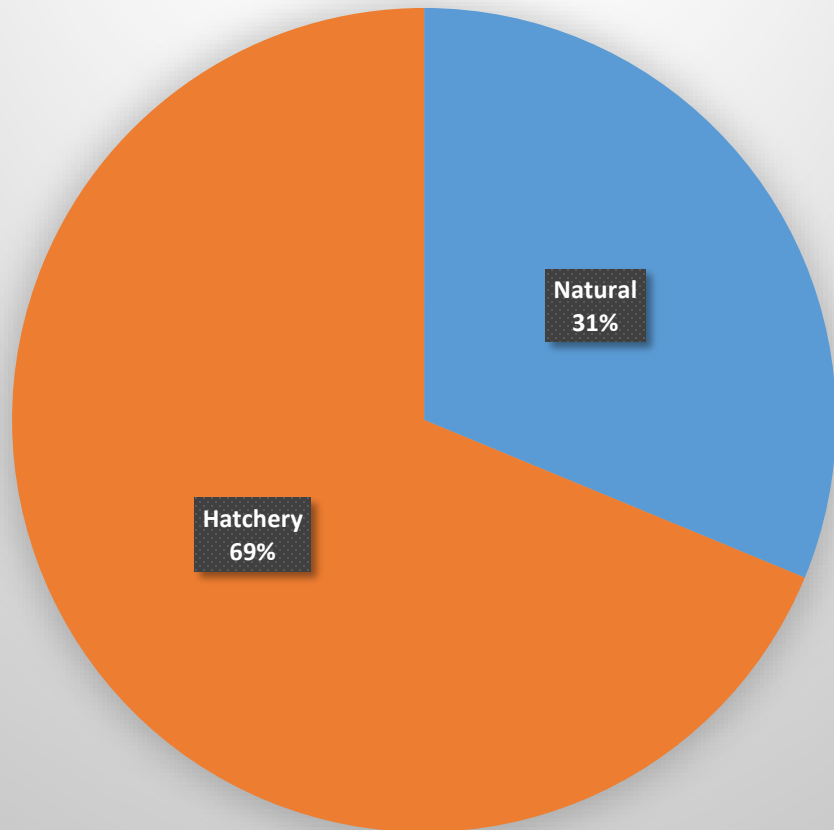
Chiwawa
2011

Corrected



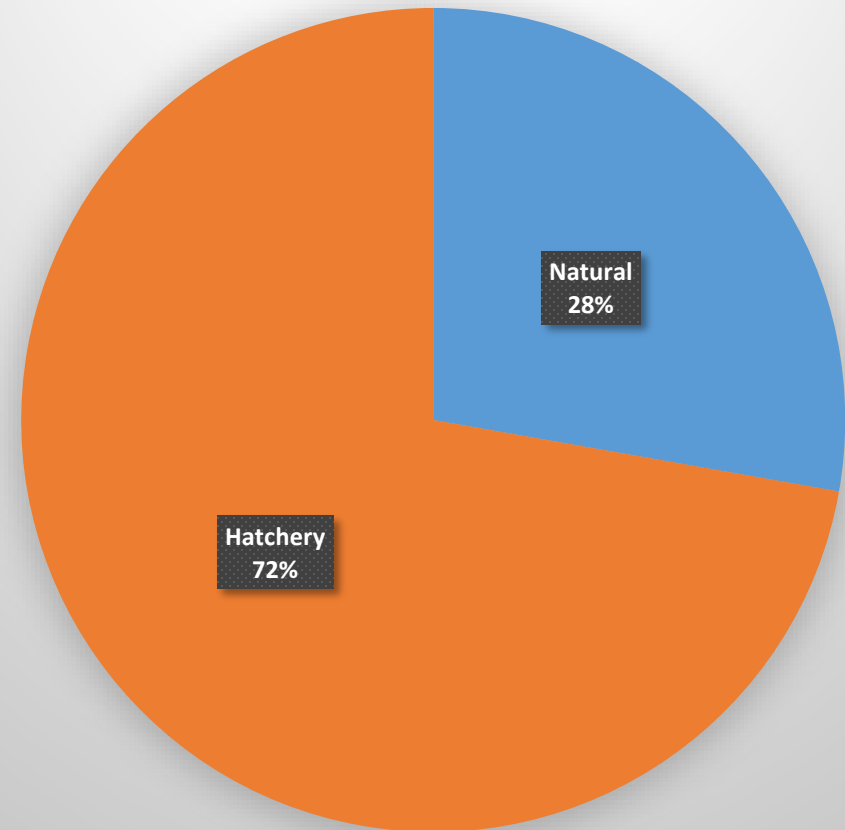
Proportion of spawners by origin

Observed



Chiwawa
2013

Corrected



Take Home

- Carcasses often times are the only method for reconstructing a spawning population
- Observed carcass recovers may be biased toward recovering a greater proportion of females and larger-sized males
- This may be of concern when you have differences in body size and spawning distributions between hatchery and natural spawning fish
- Over-estimating abundance and survival of natural spawning fish and/or over representing older age classes

Acknowledgements

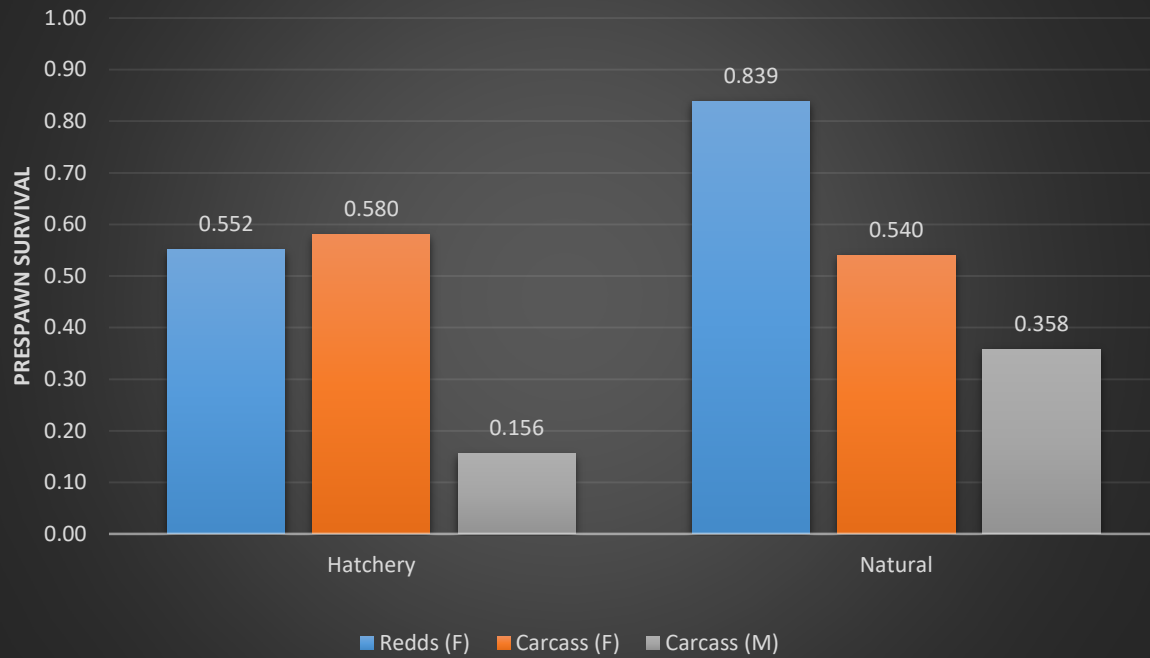
Tumwater & Spawning Ground Data Collection

Beth Brown	Jamie Hallman
Clint Deason	Marshall Kane
Jay Deason	Garrett Rains
Nathan Dietrich	Matt Stillwater
Chad Herring	Diana Pieratt
Todd Miller	Heather Trainer
Steve Schonnings	Eric Boyd
Anthony Zelinski	Chris Jones
Jon Riley	Travis Maitland
Jordan Erlenbach	
Joe LeMoine	



Prespawn Survival

2011



2013

