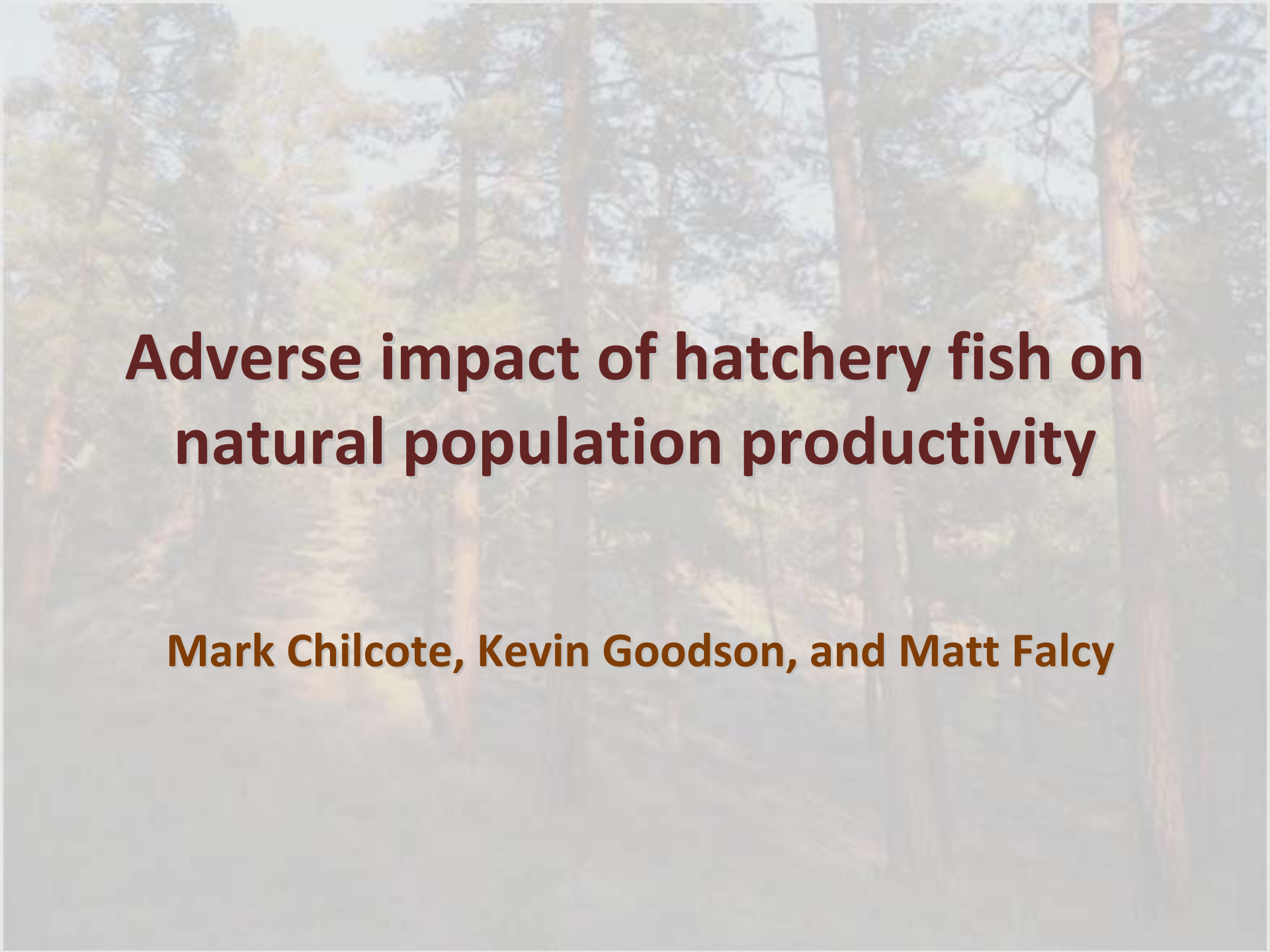




Adverse impact of hatchery fish on natural population productivity

Mark Chilcote, Kevin Goodson, and Matt Falcy

Acknowledgments

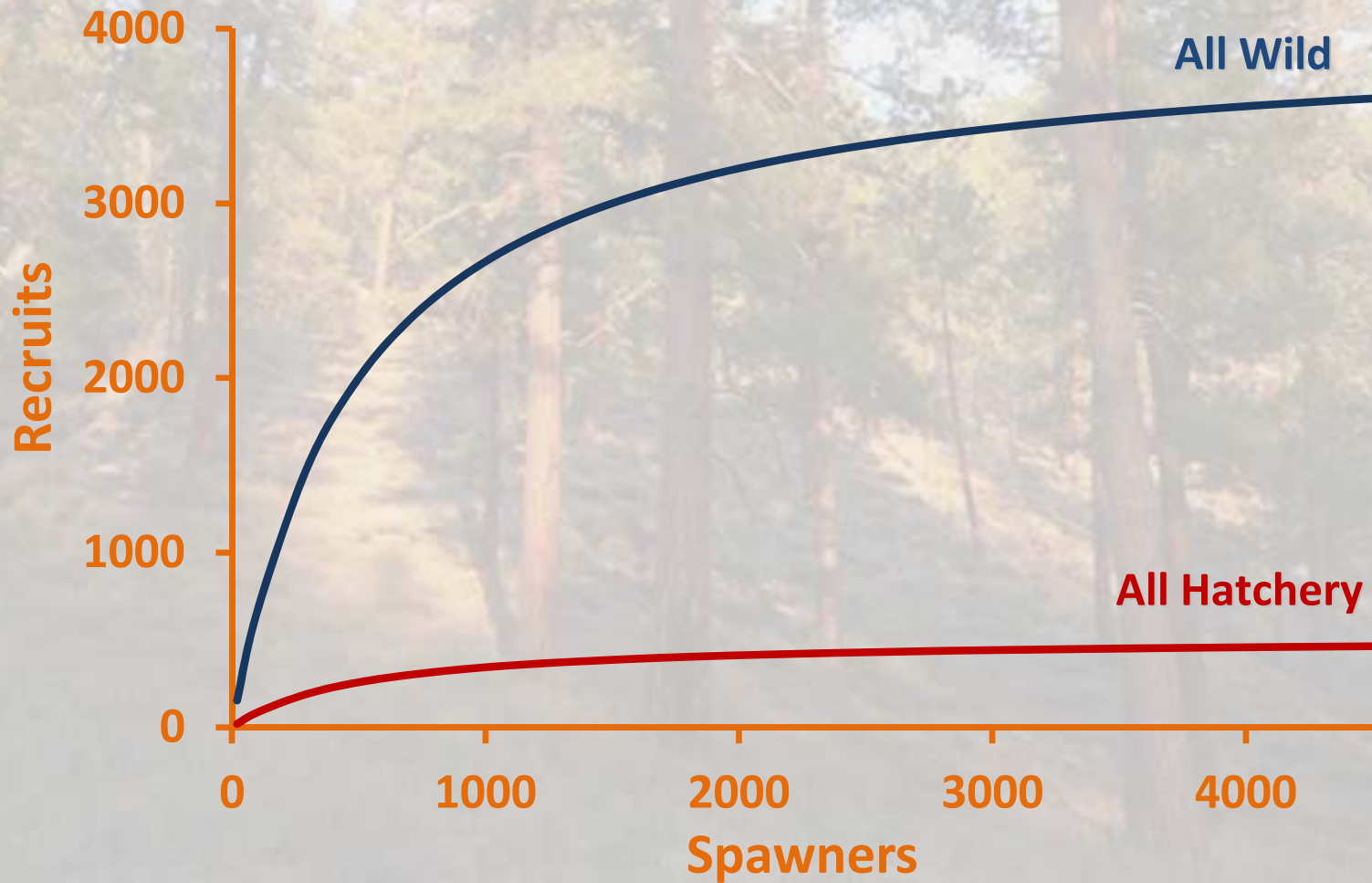
- **Kevin and Matt**
- **ODFW**
 - Support
 - Critical reviewers
- **CJFAS referees**
- **Folks here**

Deep Time

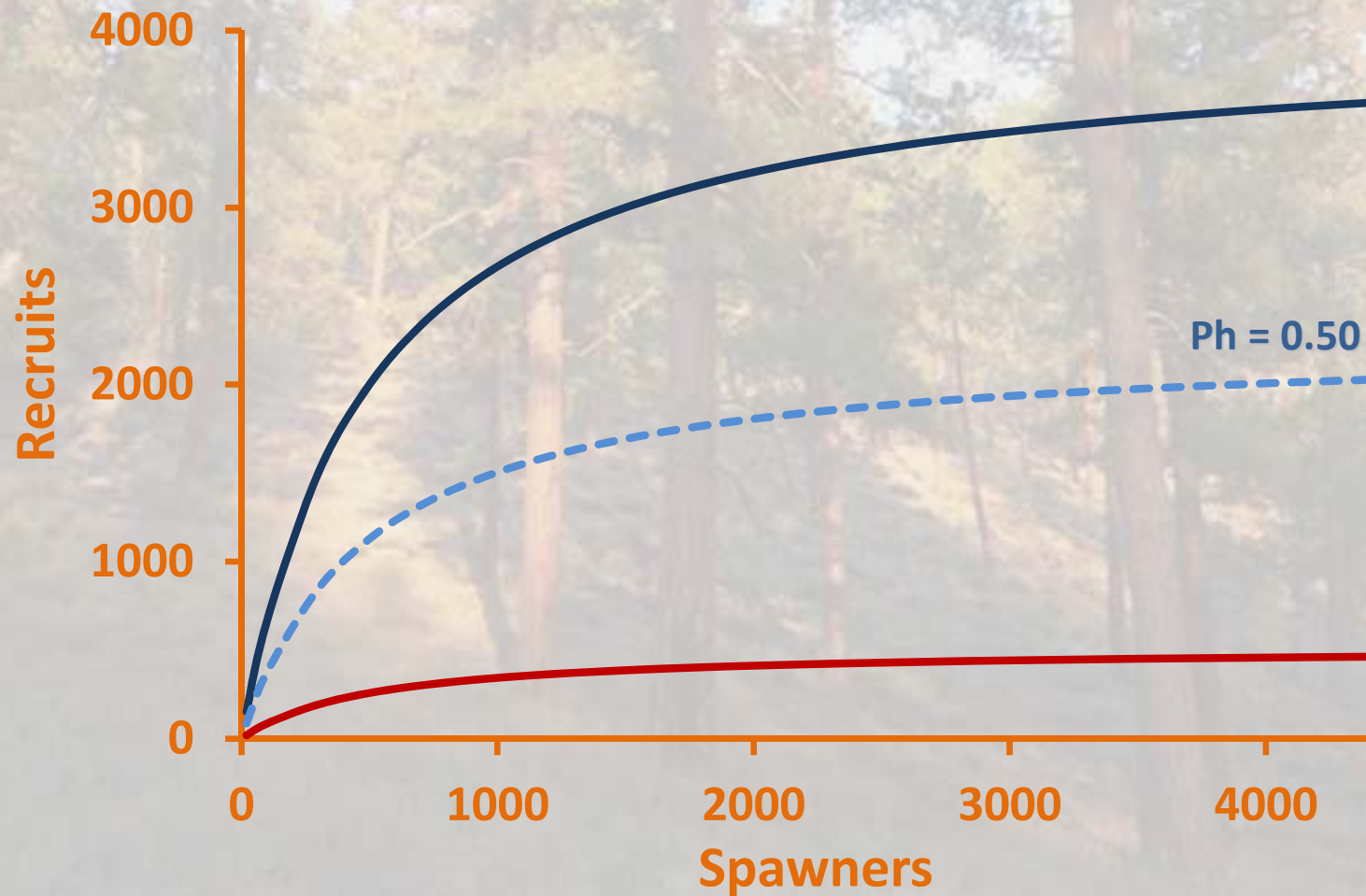
- Kalama R. steelhead study
- Conventional “wisdom”
- Archimedes moment
- Confirmation
- Reactions
- Excuse space



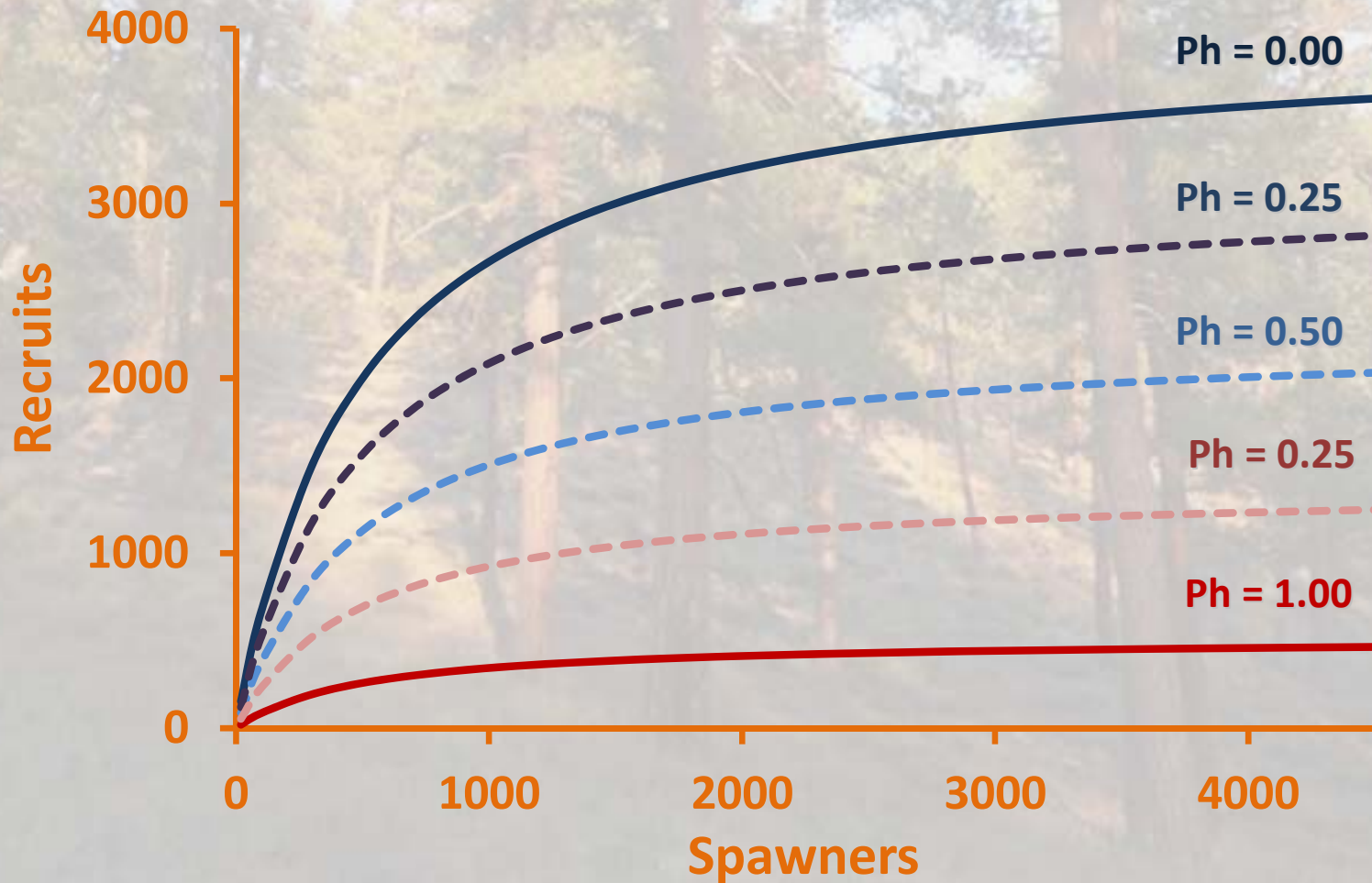
Study Premise



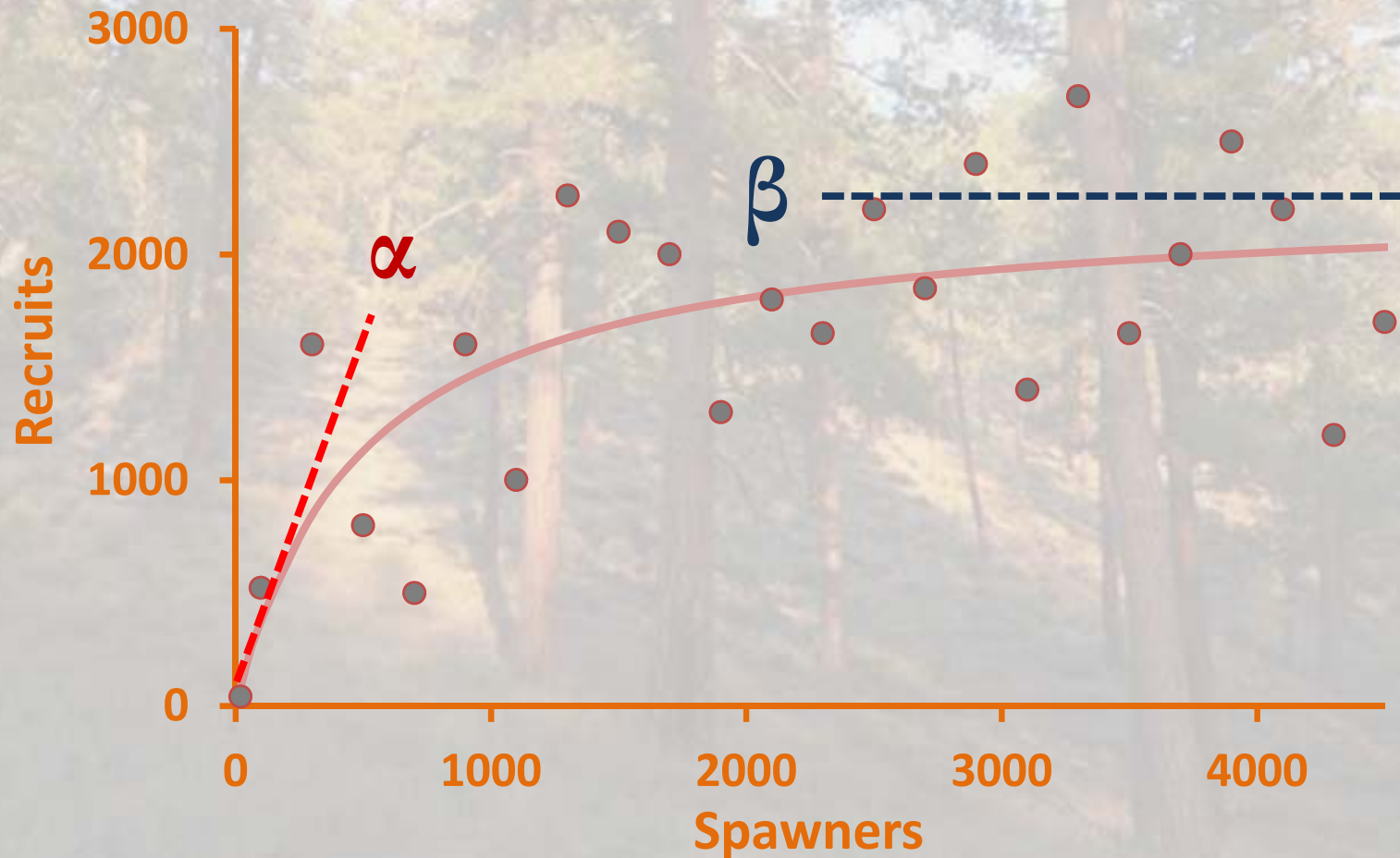
Study Premise



Study Premise

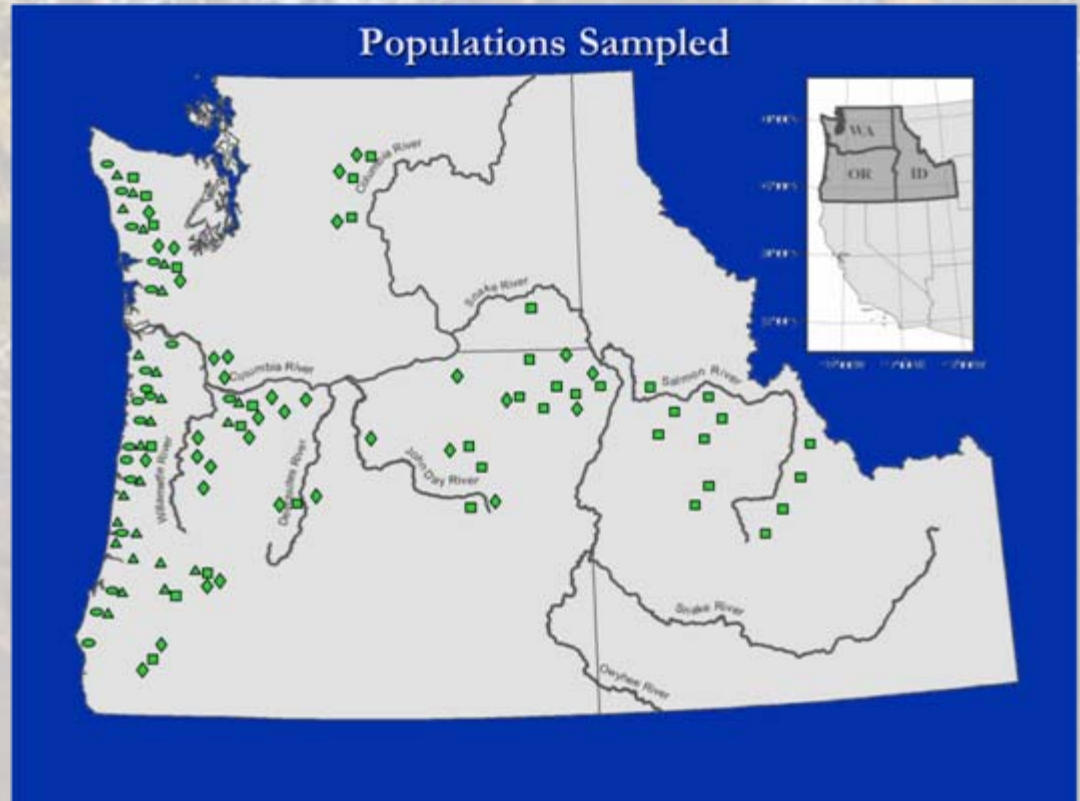


Recruitment Performance Comparable Metric



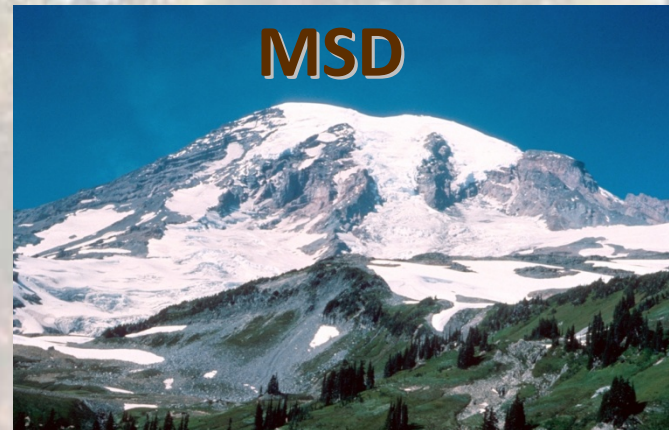
Study Features

- 93 populations
- 3 Species
- 4 to 6 generations
- 2 hatchery types



Estimating Alpha

$$\ln(R_t) = \ln(S_t) + \ln(\alpha) - \beta S_t + \gamma E_{it} + \text{lag}$$



Explaining Alpha

- **Proportion hatchery fish**
- **Species**
- **Hatchery type**
- **Hatchery legacy**
- **Hatchery location**
- **Dams**
- **Interactions**
 - **Ph:Species**
 - **Ph:Hatchery type**

Models Considered

Covariate	Model											
	1	2	3	4	5	6	7	8	9	10	11	12
Ph	X						X	X	X	X	X	X
Species	X	X	X	X	X	X	X	X	X	X	X	X
H type	X	X	X		X	X	X			X		
H legacy	X	X	X	X		X		X		X		
H location	X	X	X	X	X				X	X		X
Dams	X	X		X	X	X	X	X	X			X
Ph:Species	X						X	X	X	X		
Ph:H type											X	

Model 1: $\text{Ln}(\alpha) = \text{Ph} + \text{Species} + \text{H type} + \text{H legacy} + \text{H location} + \text{Dams} + \text{Ph:Species}$

Models Ranked

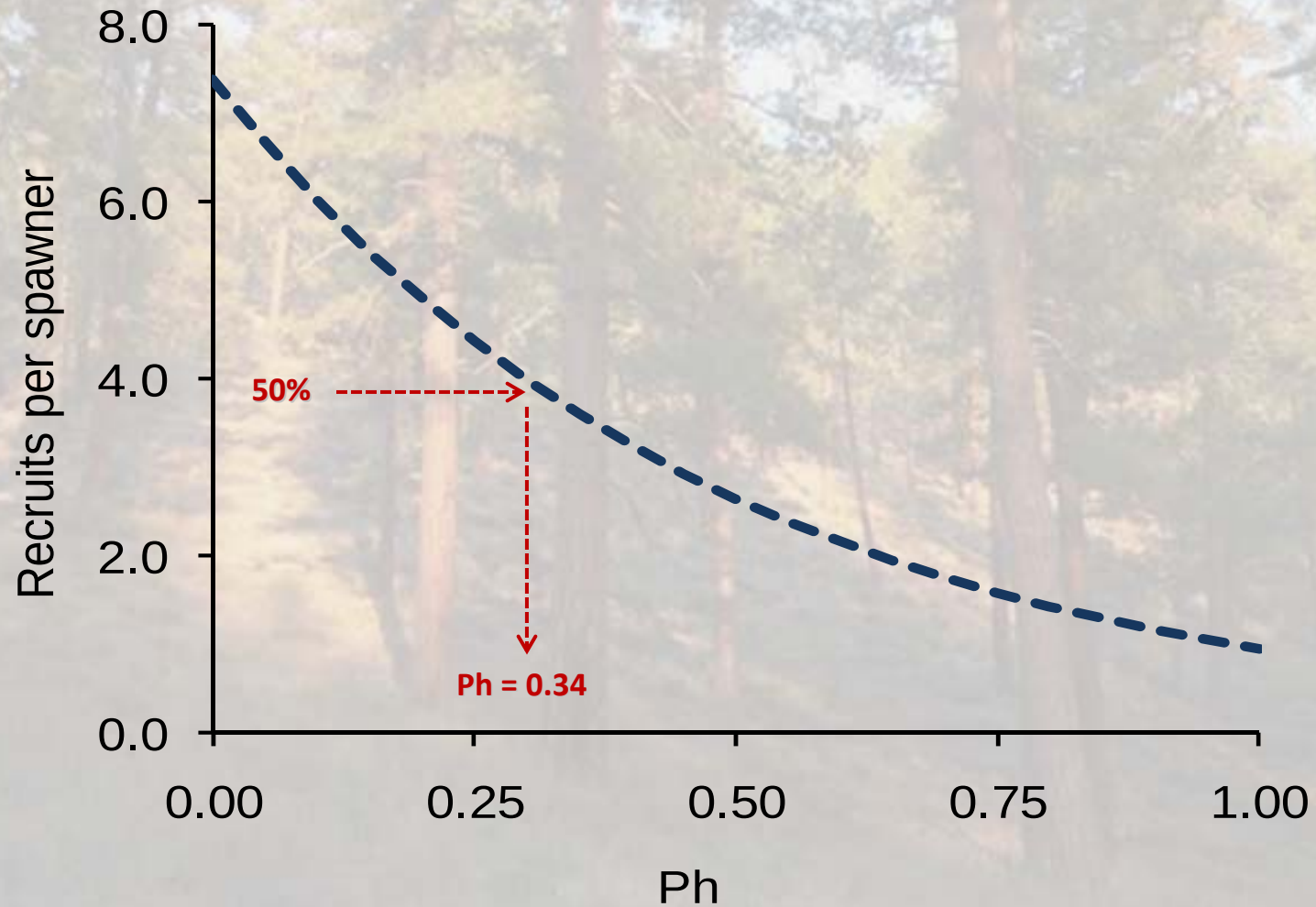
Covariate	Model											
	12	9	1	7	8	11	10	4	2	6	3	5
Ph	X	X	X	X	X	X	X					
Species	X	X	X	X	X	X	X	X	X	X	X	X
H type			X	X			X		X	X	X	X
H legacy			X		X		X	X	X	X	X	
H location	X	X	X				X	X	X		X	X
Dams	X	X	X	X	X			X	X	X		X
Ph:Species		X	X	X	X		X					
Ph:H type						X						
BIC	144	148	157	161	166	170	175	211	215	218	230	239

Best Model

$\text{Ln}(\alpha) = \text{Ph} + \text{Species} + \text{Hatchery location} + \text{Dams}$

Factor	Estimate	Pr (> t)
Intercept	2.00	< 0.001
Ph	-2.05	< 0.001
Species = Chinook	0.00	(intercept)
Species = coho	-0.02	0.892
Species = steelhead	-0.66	< 0.001
Hatchery location = in	0.00	(intercept)
Hatch location = out	-0.36	< 0.001
Dams	-0.07	< 0.001

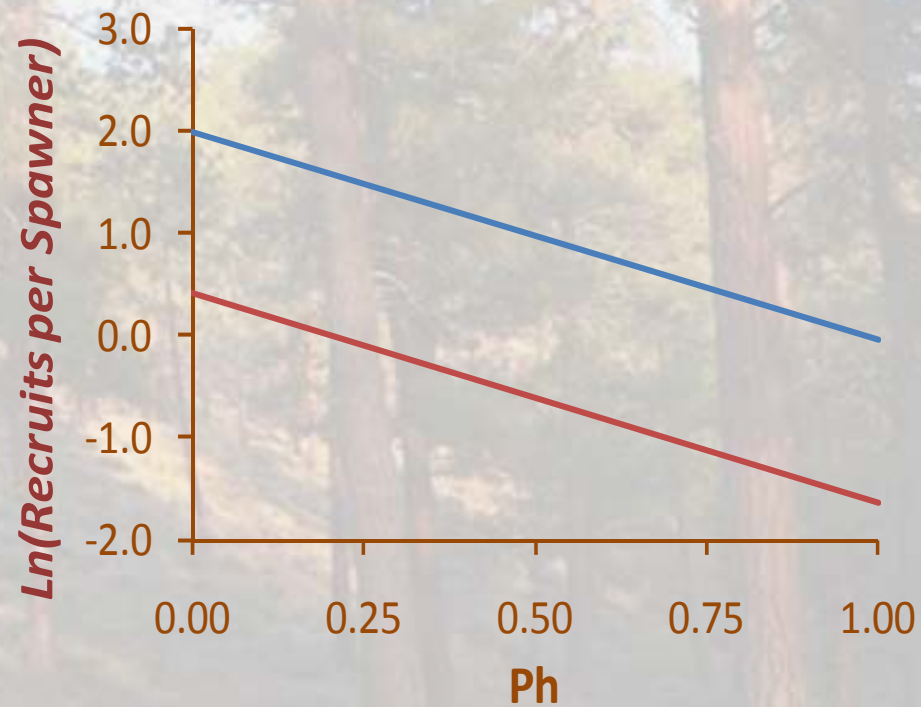
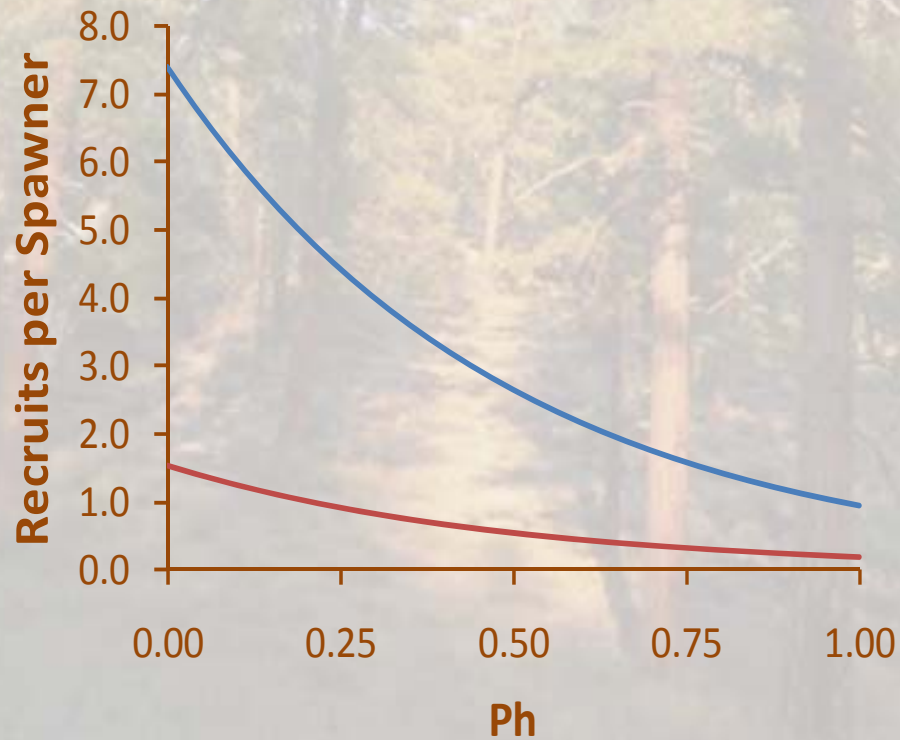
Overall Impact



Range of Response

— Chinook, Inbasin hatchery, no dams

— Steelhead, w/o hatchery, 8 dams



Hatchery Legacy – No Effect

- **Short, medium, and long exposure periods**
- **Why**
 - Change is too quick to detect ?
 - Change is too slow to detect ?
 - Not a genetic mechanism ?
- **Management implications**
 - Too late
 - Too early
 - Doesn't matter

Hatchery Type – No Effect

- Integrated ($> 0.10 P_w$) vs segregated ($< 0.10 P_w$)
- Why
 - Integrated programs in analysis did not follow BMP ?
 - Change is sudden (1 – 2 generations) ?
 - Non-genetic mechanism ?
- Management implications
 - Integrated programs not magic bullet
 - No numerical gains
 - Perhaps long-term genetic legacy gains

Synthesis

- **Hatchery and wild fish don't mix well**
 - Should be no surprise
- **Excuse space has become smaller**
 - No anomaly, pervasive effect for 89 pops(the new default?)
 - Relative response of coho and Chinook, equal to steelhead
 - Impact of hatchery fish from segregated programs no worse than those from integrated programs
 - Insensitive to number of years exposed to hatchery fish
 - Hatcheries are not sited in basins with poor productivity
- **Mechanism uncertain**
 - Genetic, ecological, unknown factor
 - Makes it difficult to craft responsive conservation strategies

A close-up, underwater photograph of several salmon swimming in a river. The fish are silvery with dark spots and are moving towards the right. The water is slightly murky, and the background shows more fish and some rocks.

Questions ?