Informing Puget Sound steelhead recovery goals with a life cycle model

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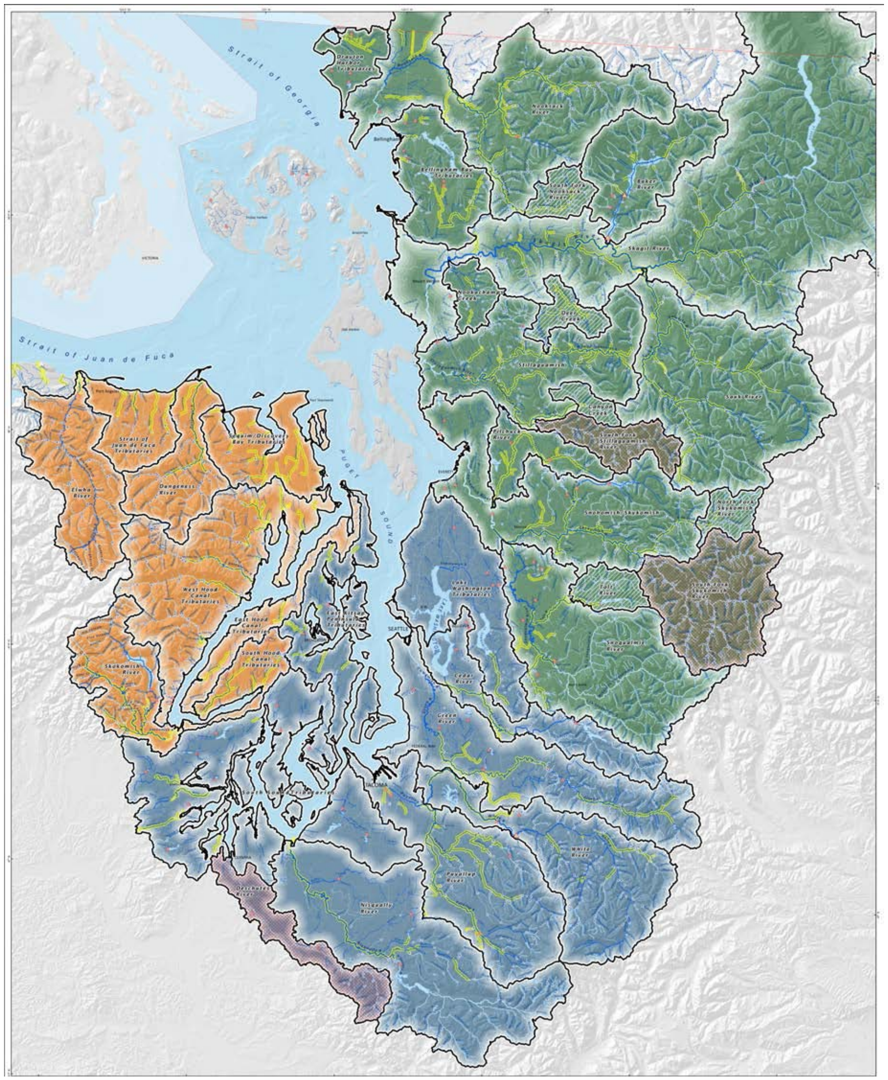
Today's Talk

- Project Objectives
- Emerging approach to recovery goals
- Overview of life cycle model – purpose and structure
- Example population using the online tool

Puget Sound DPS, MPGs, and DIPs



Three Major Population Groups

Hood Canal

8 DIPs

All winter run

Central/South Sound

8 DIPs

All winter run

Northern Cascades

16 DIPs

winter & summer run

Life cycle model project

Project objectives

1. Provide scientific foundation for establishment of recovery goals for all populations
2. Explore various pathways or scenarios by which recovery might be achieved

Guiding principles

1. Based on empirical monitoring data
2. Represent uncertainty
3. Transparency and accessibility

Value of the model is not in the absolute number of fish predicted by the model, but rather in exploring how different combinations of freshwater productivity and marine survival affect population trajectories

Emerging approach to recovery goals

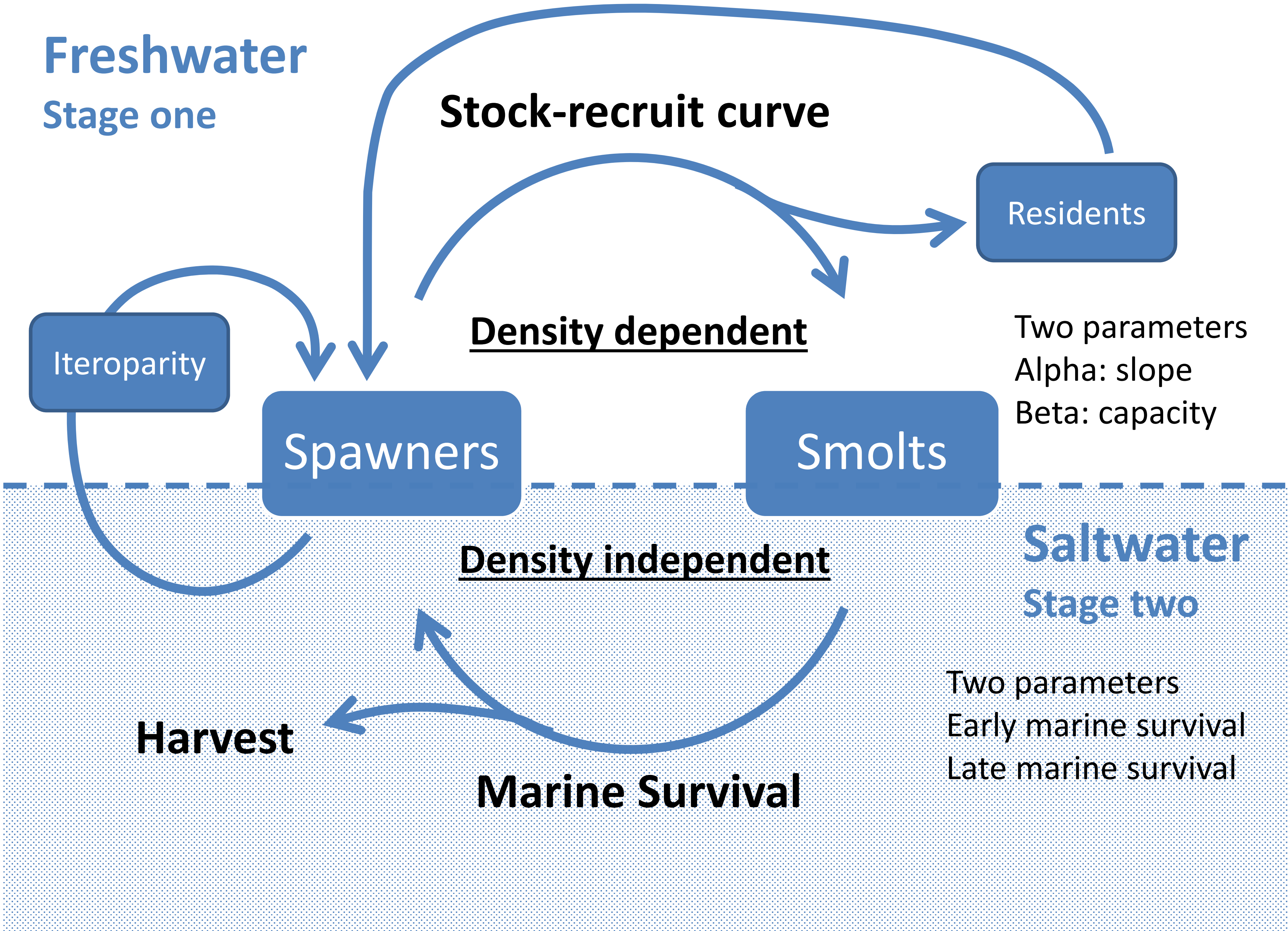
Key points

1. Setting recovery goals is a policy exercise – **What is our desired state?**
2. Recovery goals can exceed viability criteria

Viability Criteria	**Recovery goals**
• Already established by Puget Sound TRT	• Yet to be established
• General: Applied to all populations and MPGs	• Specific: can have specific targets for individual populations
• Focus on biological processes only	• Can include additional recovery goals

Life cycle model

Abundance and productivity - Use life cycle model to establish abundance and productivity goals for each population


Freshwater
Stage one
Stock-recruit curve
Residents
Iteroparity
Density dependent
Two parameters
Alpha: slope
Beta: capacity
Spawners
Smolts
Saltwater
Stage two
Density independent
Two parameters
Early marine survival
Late marine survival
Harvest
Marine Survival

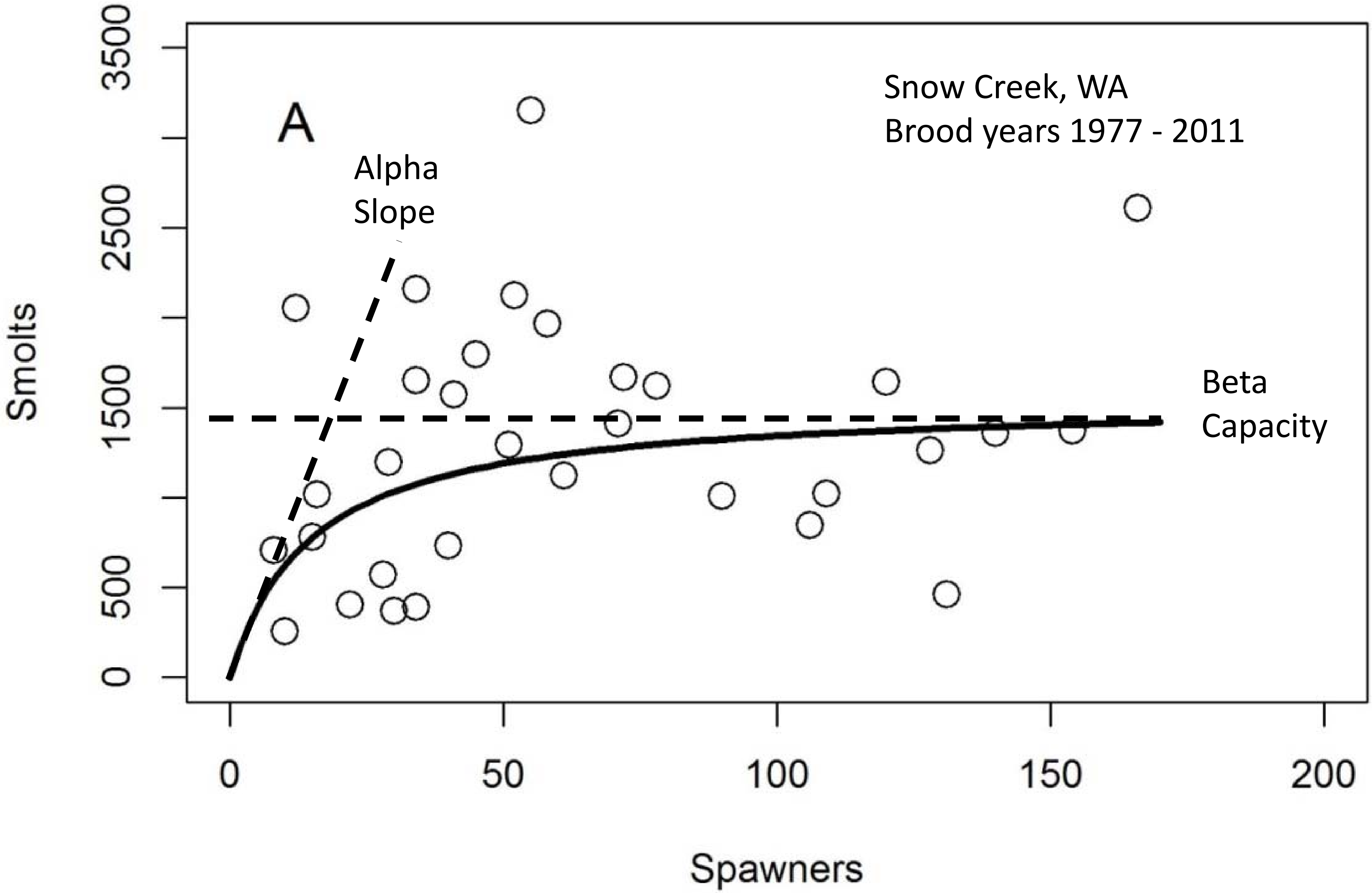
Population Demography

Brood Year	Spawners	Smolts: Total	Smolts: Age-1	Smolts: Age-2	Smolts: Age-3	Smolts: Age-4	Smolt Entry Year	Smolts Entering Marine	Returning Adults: Ocean Age-1	Returning Adults: Ocean Age-2	Returning Adults: Ocean Age-3
1	S_1	N_1	$N_{1,1}$	$N_{1,2}$	$N_{1,3}$	$N_{1,4}$	1				
2	S_2	N_2	$N_{2,1}$	$N_{2,2}$	$N_{2,3}$	$N_{2,4}$	2				
3	S_3	N_3	$N_{3,1}$	$N_{3,2}$	$N_{3,3}$	$N_{3,4}$	3				
4	S_4	N_4	$N_{4,1}$	$N_{4,2}$	$N_{4,3}$	$N_{4,4}$	4				
5	S_5	N_5	$N_{5,1}$	$N_{5,2}$	$N_{5,3}$	$N_{5,4}$	5	$N_{4,1}+N_{3,2}+N_{2,3}+N_{1,4}$	$RA_{5,1}$	$RA_{5,2}$	$RA_{5,3}$
6	S_6	N_6	$N_{6,1}$	$N_{6,2}$	$N_{6,3}$	$N_{6,4}$	6	$N_{5,1}+N_{4,2}+N_{3,3}+N_{2,4}$	$RA_{6,1}$	$RA_{6,2}$	$RA_{6,3}$
7	S_7	N_7	$N_{7,1}$	$N_{7,2}$	$N_{7,3}$	$N_{7,4}$	7	$N_{6,1}+N_{5,2}+N_{4,3}+N_{3,4}$	$RA_{7,1}$	$RA_{7,2}$	$RA_{7,3}$
8	$RA_{7,1}+RA_{6,2}+RA_{5,3}$	**N_8**	Harvest & Iteroparity				8				
9							9				
10							10				

Smolts = $N_{\text{by, age at migration}}$

Return adults = $RA_{\text{ocean entry year, age at return}}$

Stock-Recruit Curve



Additional smolt per spawner data

Consider as a minimum estimate of alpha

Population	Brood Year	Smolts per spawner
Nisqually River	2008	117*
	2009	244*
	2010	29
	2011	272
	2012	172*
Big Beef Creek	2007	25
	2008	15
	2009	32
	2010	85

* Applies average age structure to one or more smolt age classes

Estimating current smolt capacity

Dungeness River

Duckabush River

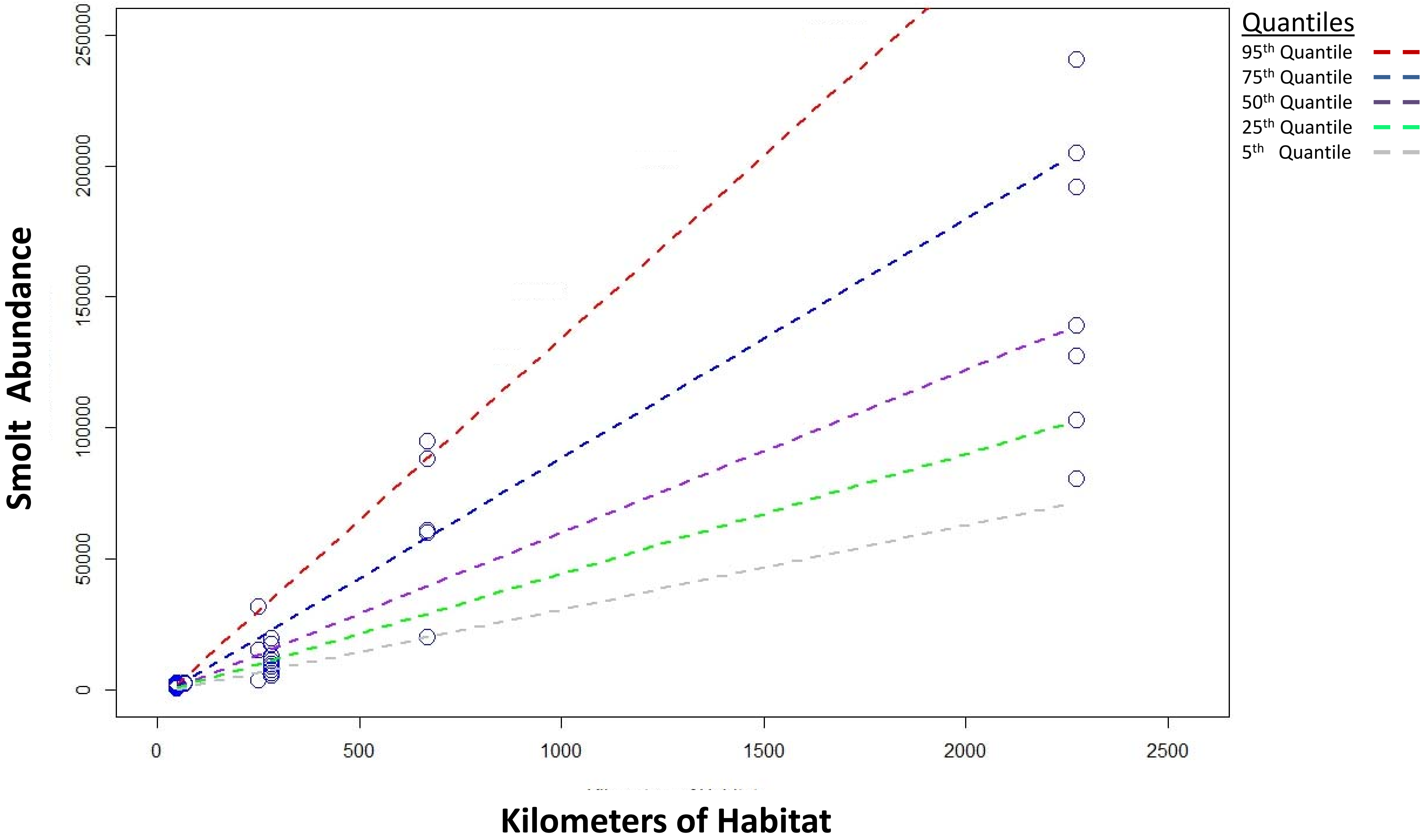
Skagit River

Green River

Big Beef Creek

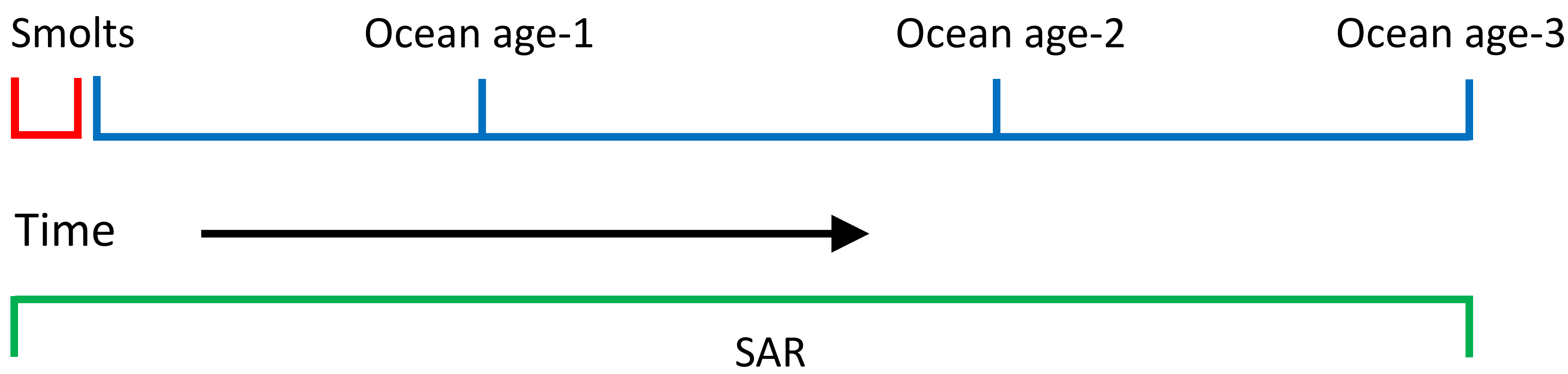
Nisqually River

Puget Sound Steelhead Quantile Regression Capacity Estimate



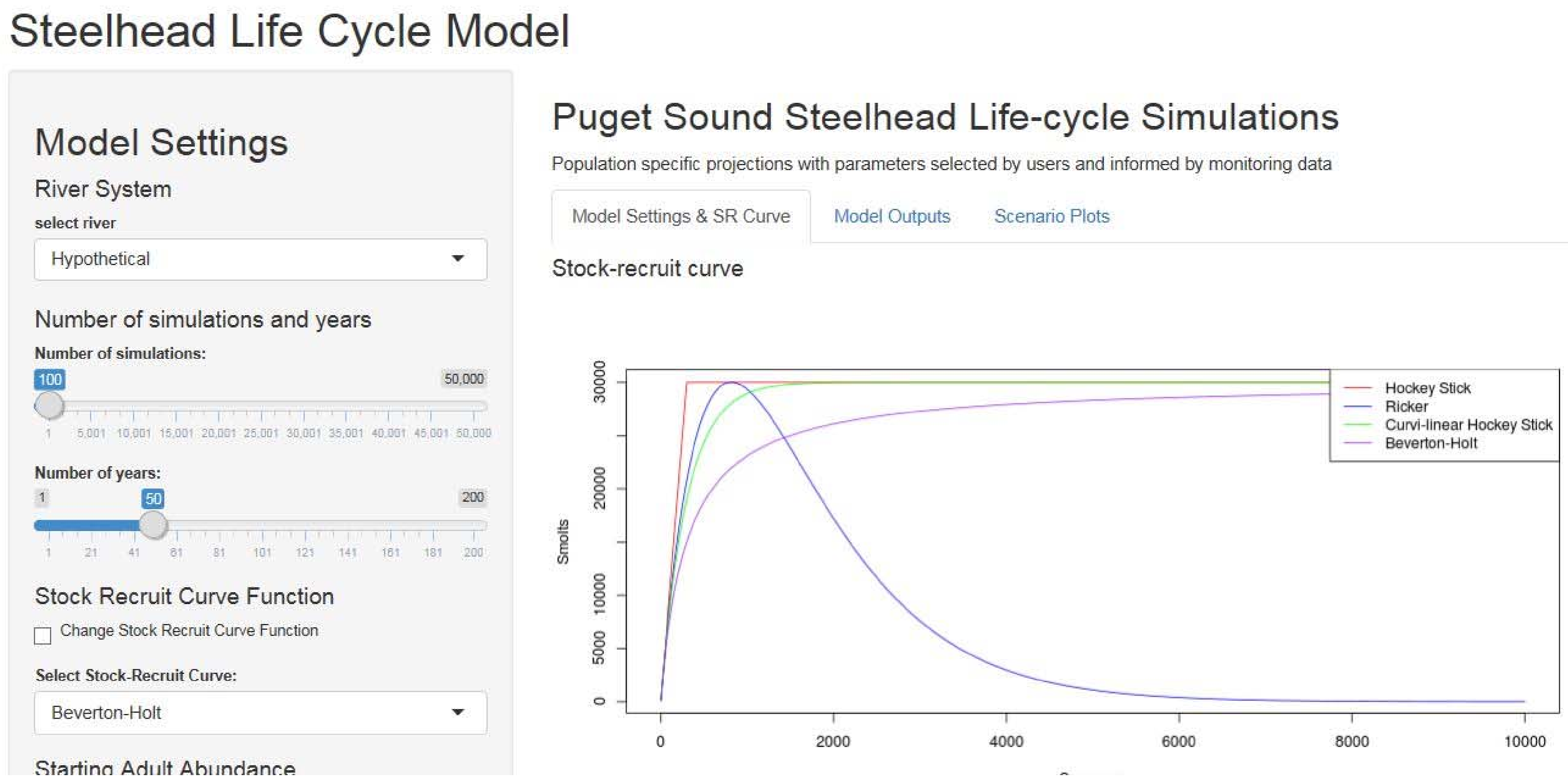
Marine survival

	Early	Late	SAR
Duration	~ 2 weeks	1 – 3 years	Smolt to returning adult
Location	Puget Sound	Strait of Juan de Fuca & North Pacific Ocean	Puget Sound & North Pacific Ocean
Data source	Acoustic telemetry	SAR compensated for early	Smolt to adult return rates



Online Tool

https://pugetsoundlcm.shinyapps.io/Steelhead/



Model Output – Dungeness River

Parameter Settings

Starting abundance: 600

Max recruits/spawner: 100

System Capacity: 42,000

Early marine: 40%

Late marine: 5%

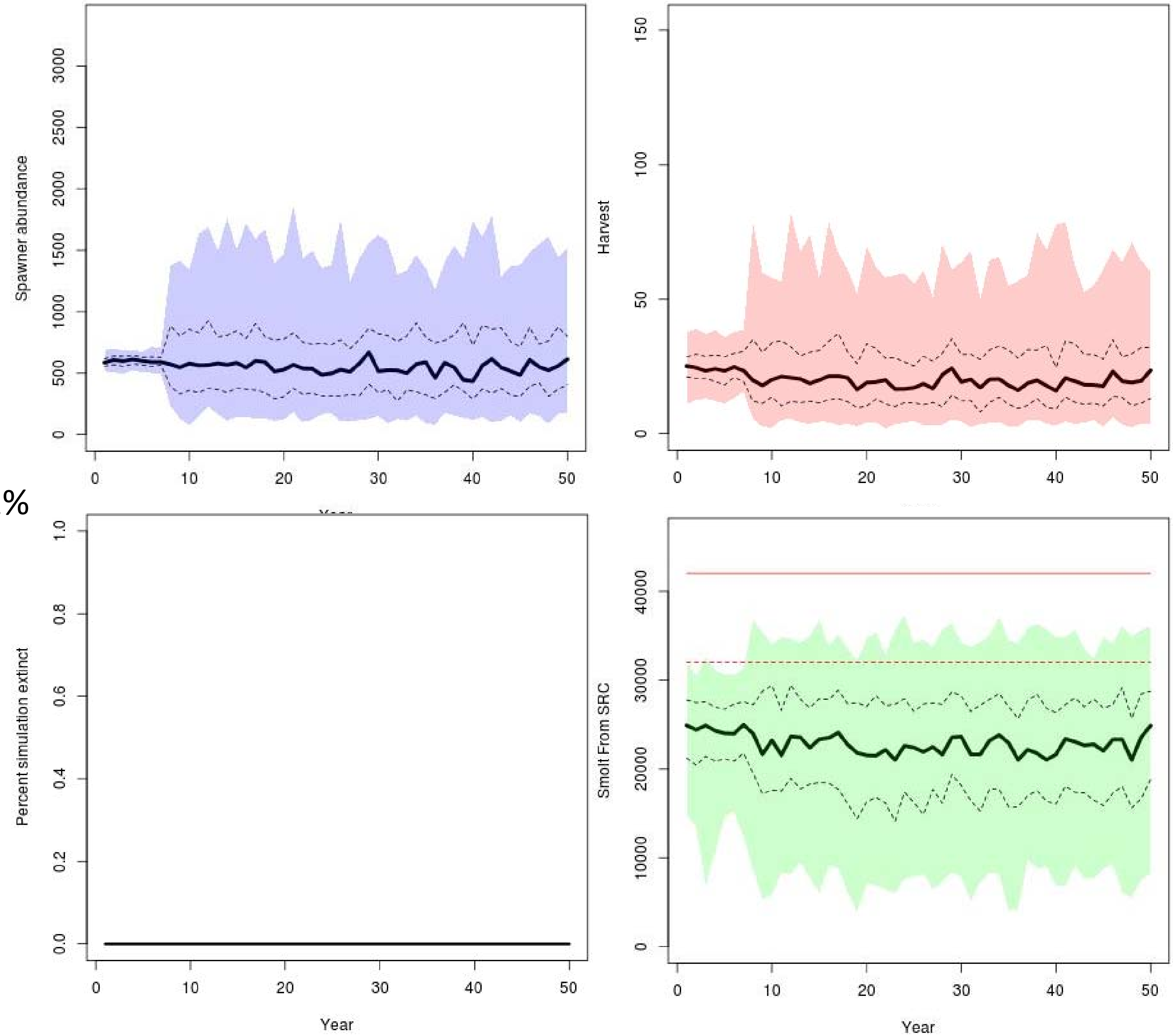
Harvest rate: 4%

Freshwater age: 4%,79%, 16%, 1%

Ocean age: 5%,80%, 15%

Iteroparity: 10%

Quasi-extinction threshold: 65



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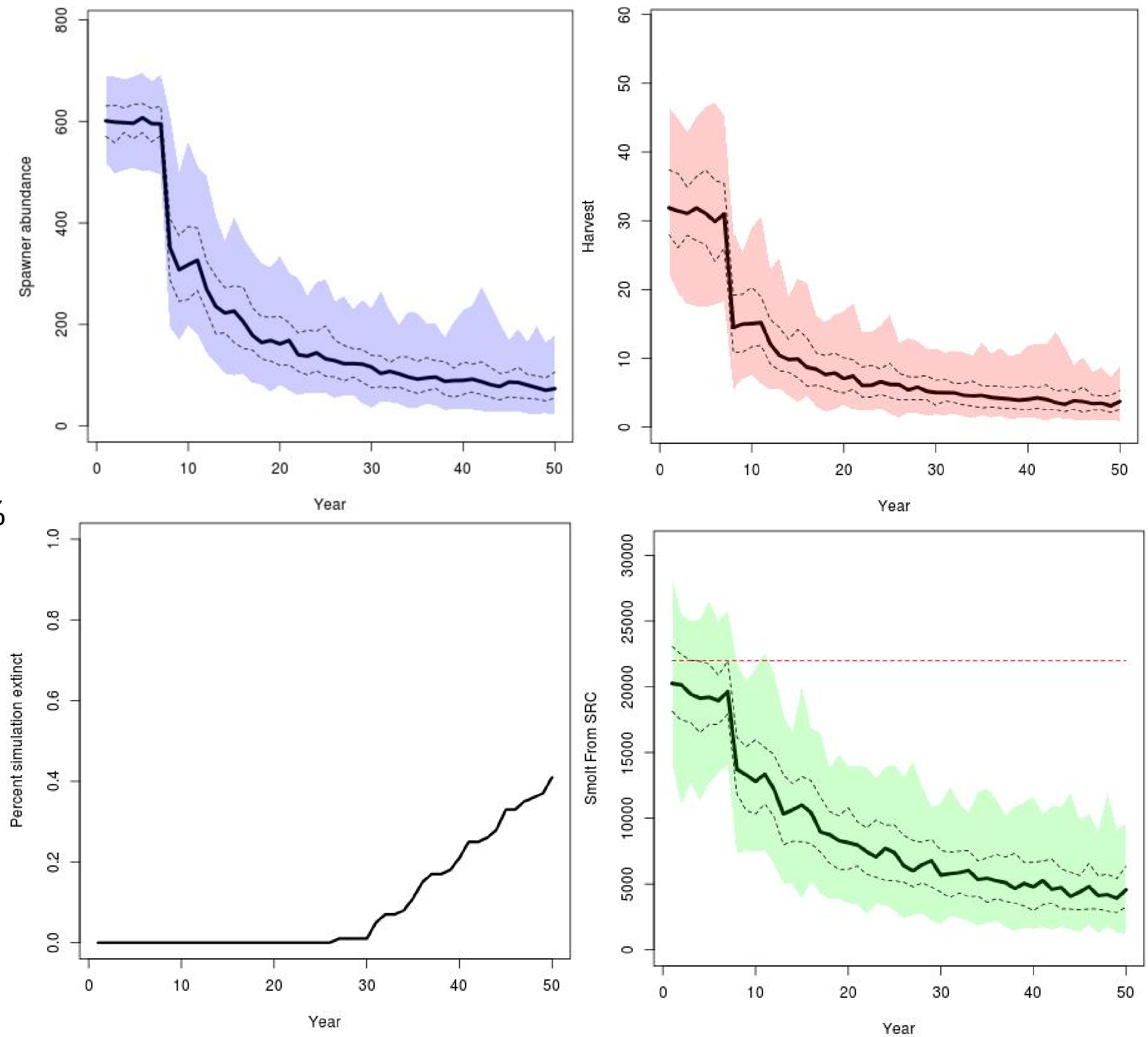
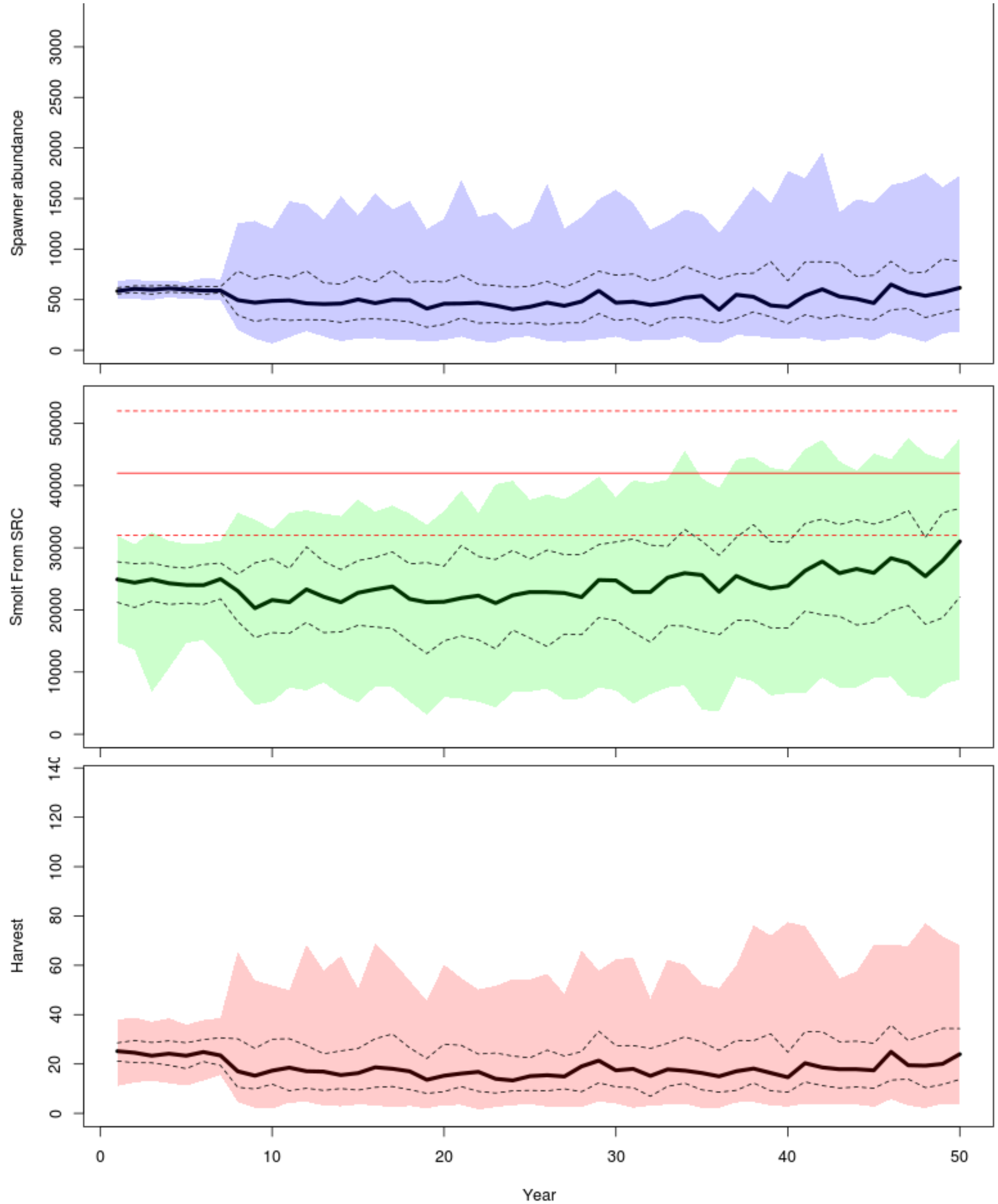


Model Scenarios – Dungeness River



<u>Habitat Restoration</u>

10% increase in juvenile rearing habitat every 10 years

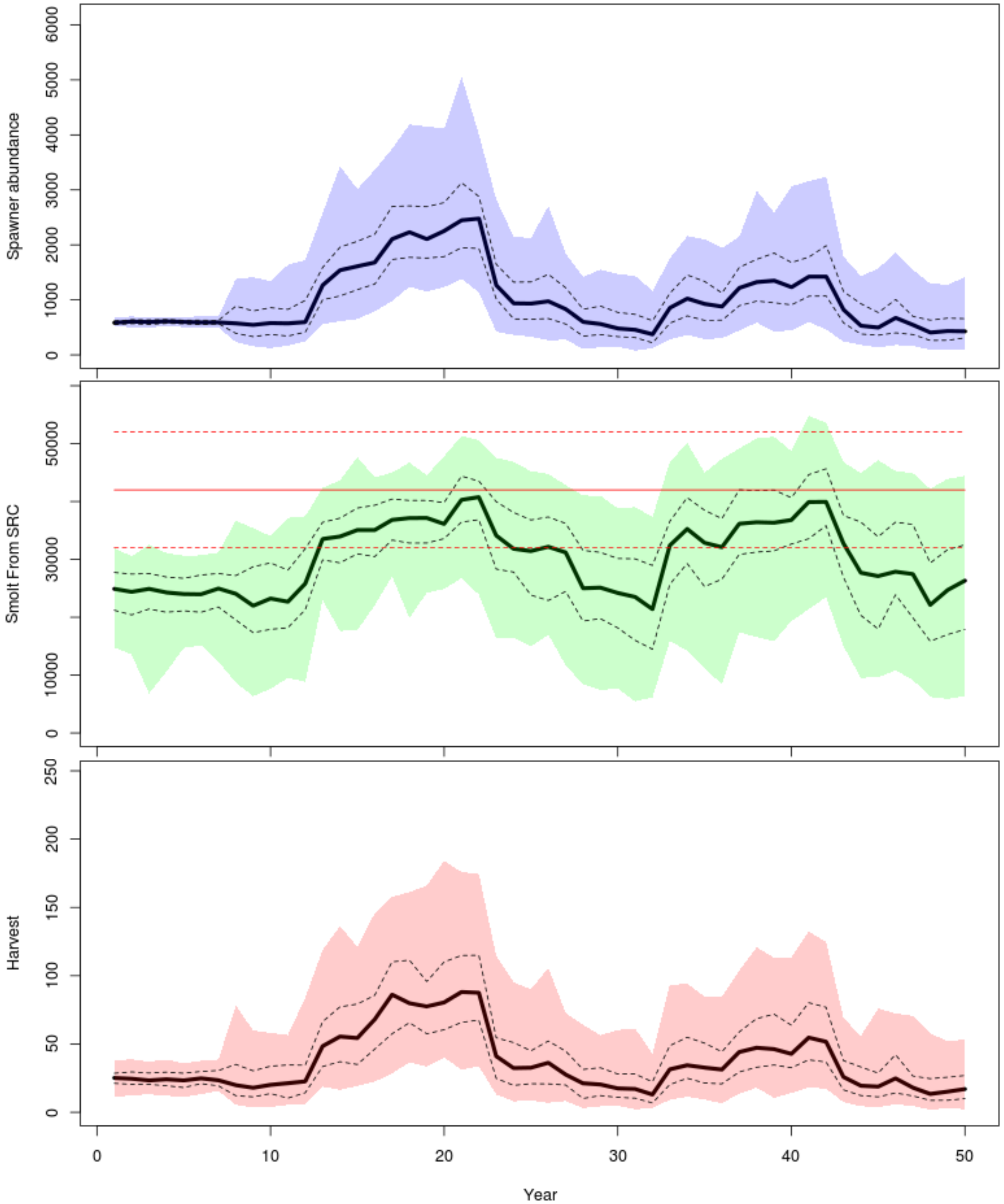
<u>Results</u>

Minimal change in adult abundance

Slow increase in smolt production

Minimal impact on number of fish harvested annually

Model Scenarios – Dungeness River



<u>Habitat restoration</u>

10% increase in juvenile rearing habitat every 10 years

<u>Decreased early marine survival</u>

Major event: At year 25 early marine survival rate reduced by 15%

<u>Increased late marine survival</u>

10% increase in late marine survival rates for 10 year periods

<u>Results</u>

Increased spawner abundances even during low early marine survival period

Smolt abundances near capacity for most simulations in nearly all years

Harvest remains relatively low

Online Tool

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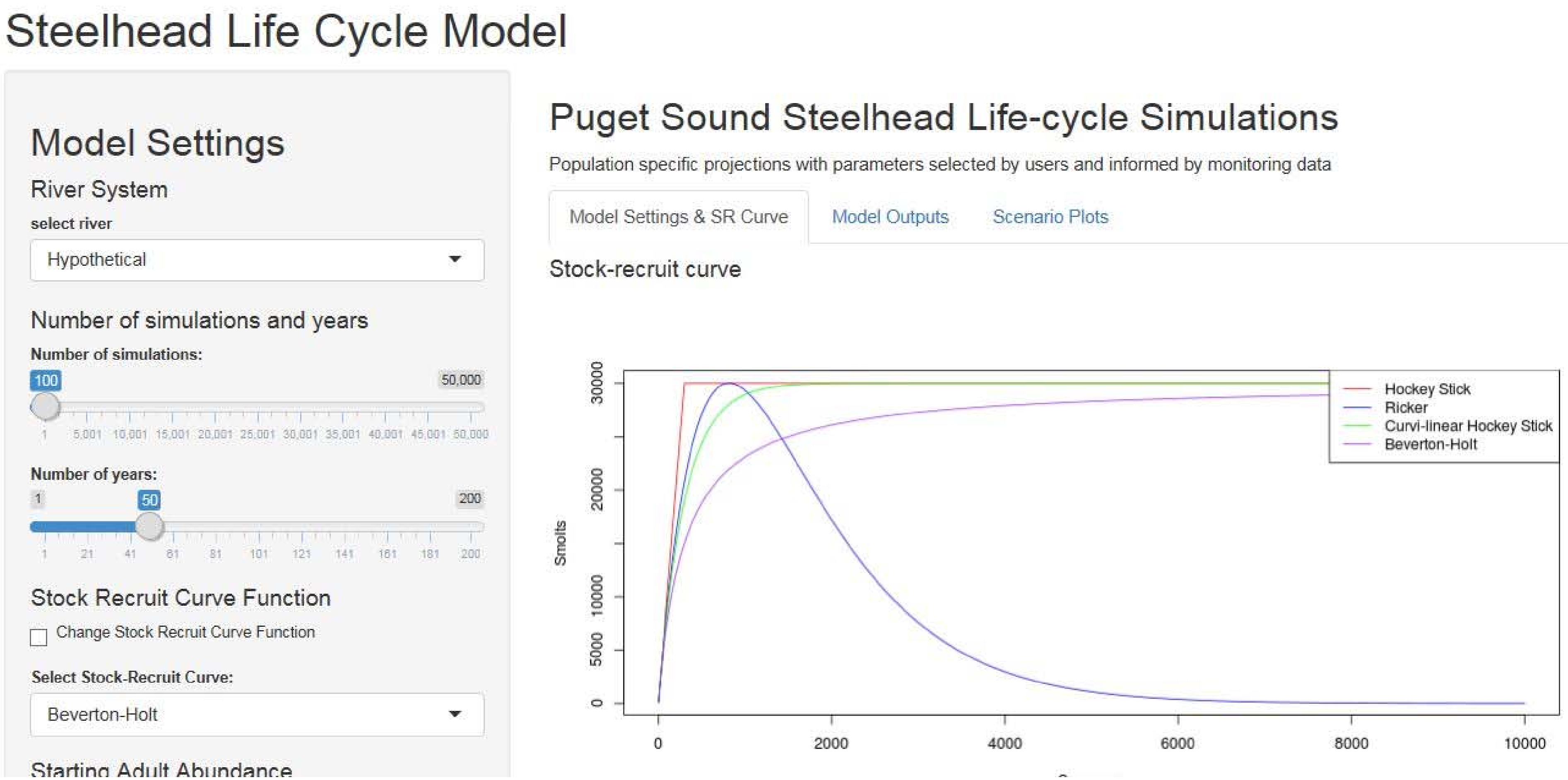

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