Assessment of Scott River salmon performance under historical, current, and restoration scenarios

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Larry Lestelle

Biostream environmental

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Presentation outline

- Conclusions - abstract
- Purpose
- Approach
- Historical overview
- Historical and current baselines
- Diagnosis and prioritization
- Restoration scenario analysis
- Conclusions

Conclusions abstract

- **Diagnostic summary**
  - Extensive, large-scale alterations to watershed processes & habitat functions (CUMULATIVE EFFECTS OF MULTIPLE ISSUES)
  - Massive declines in performance of coho, fall chinook, and spring chinook
- **Prognosis without intervention**
  - Coho – extirpated by mid-century
  - Fall chinook – sharp reductions by mid-century
  - No chance for spring chinook
- **Urgent need for significant intervention**
  - Major, comprehensive, coordinated restoration effort is URGENTLY needed

Conclusions abstract

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BUT ...
Read the
report

Purpose of assessment

- Aimed at answering two questions:
  - What is broken in the watershed with respect to salmon performance?
  - What needs to be fixed
- Answering these is essential to developing an effective restoration and recovery action plan for the subbasin— *if indeed such a plan can be developed and implemented.*
- Guidance is provided on priorities for doing this

Objectives

1. Identify the extent of declines in performance of the coho, fall Chinook, and spring Chinook;

2. Diagnose the major limiting factors affecting salmon populations and prioritize restoration and protection measures;

3. Project the extent of improved population performance under a set of HYPOTHETICAL habitat management scenarios for the subbasin

Approach & methods

- Viable Salmon Population (VSP) framework developed by NMFS – four characteristics
  - Abundance
  - Intrinsic productivity
  - Spatial structure
  - Biological diversity

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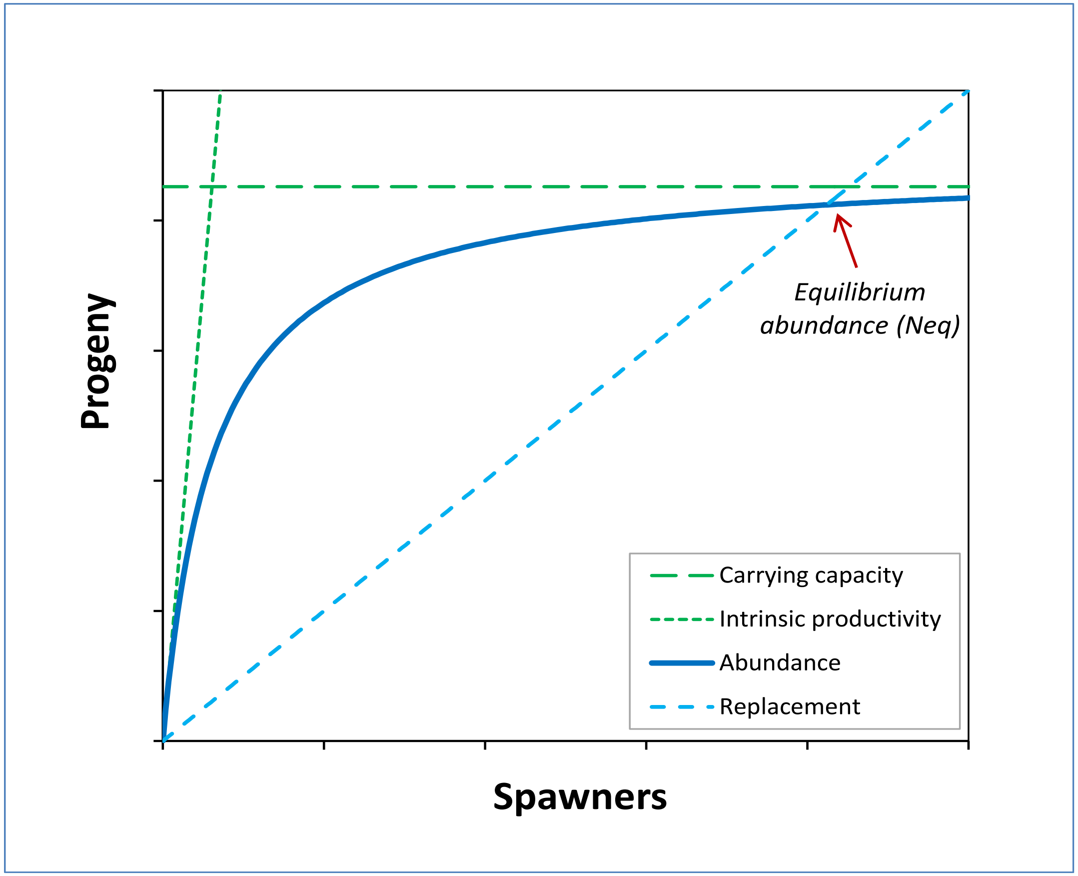
  - Abundance
  - Intrinsic productivity
  - Spatial structure
  - Biological diversity
- The Ecosystem Diagnosis and Treatment (EDT) Method (model)

VSP framework *defines performance*

- Abundance and productivity – illustrated in the spawner-production (S-P) relationship



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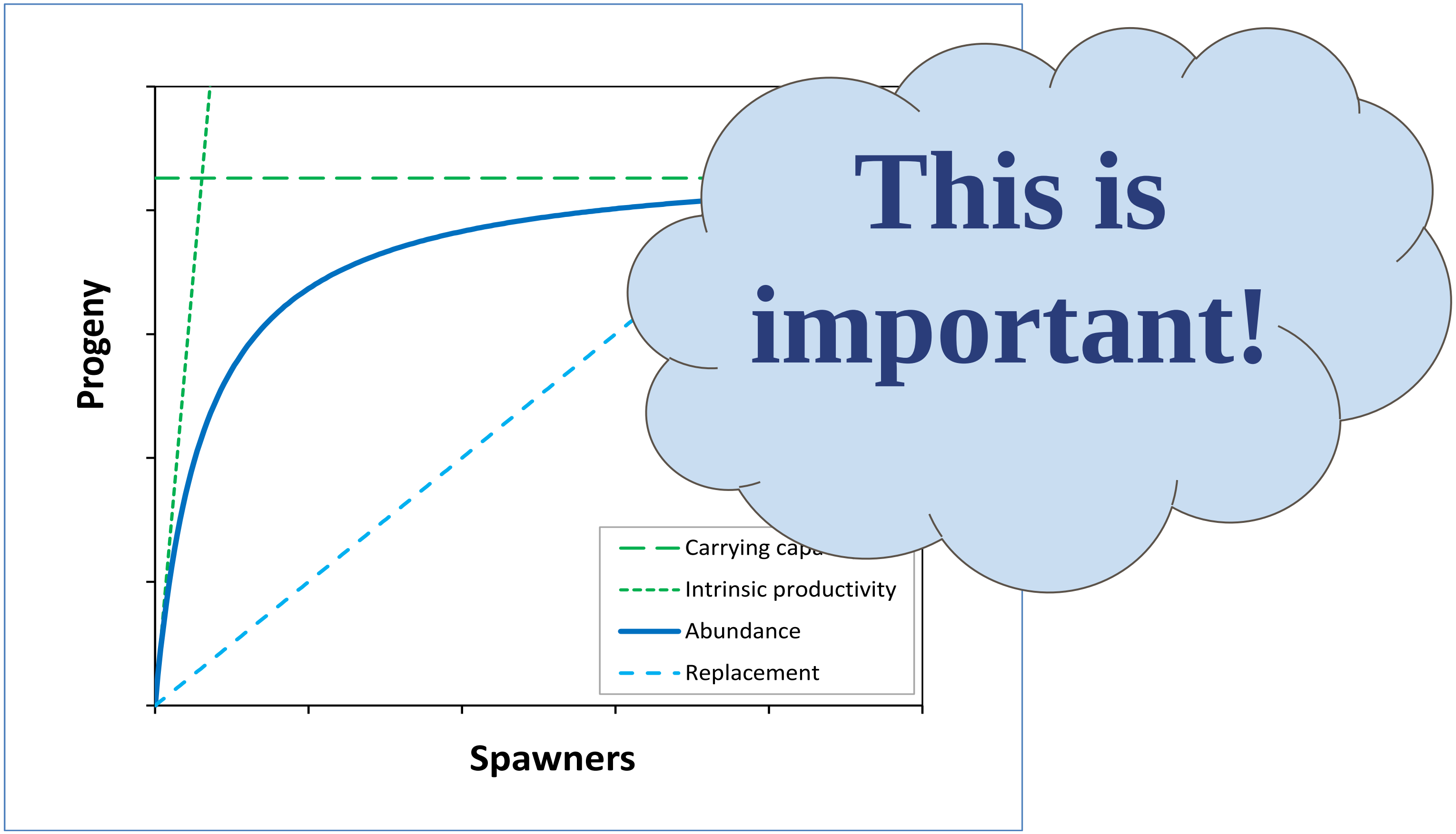
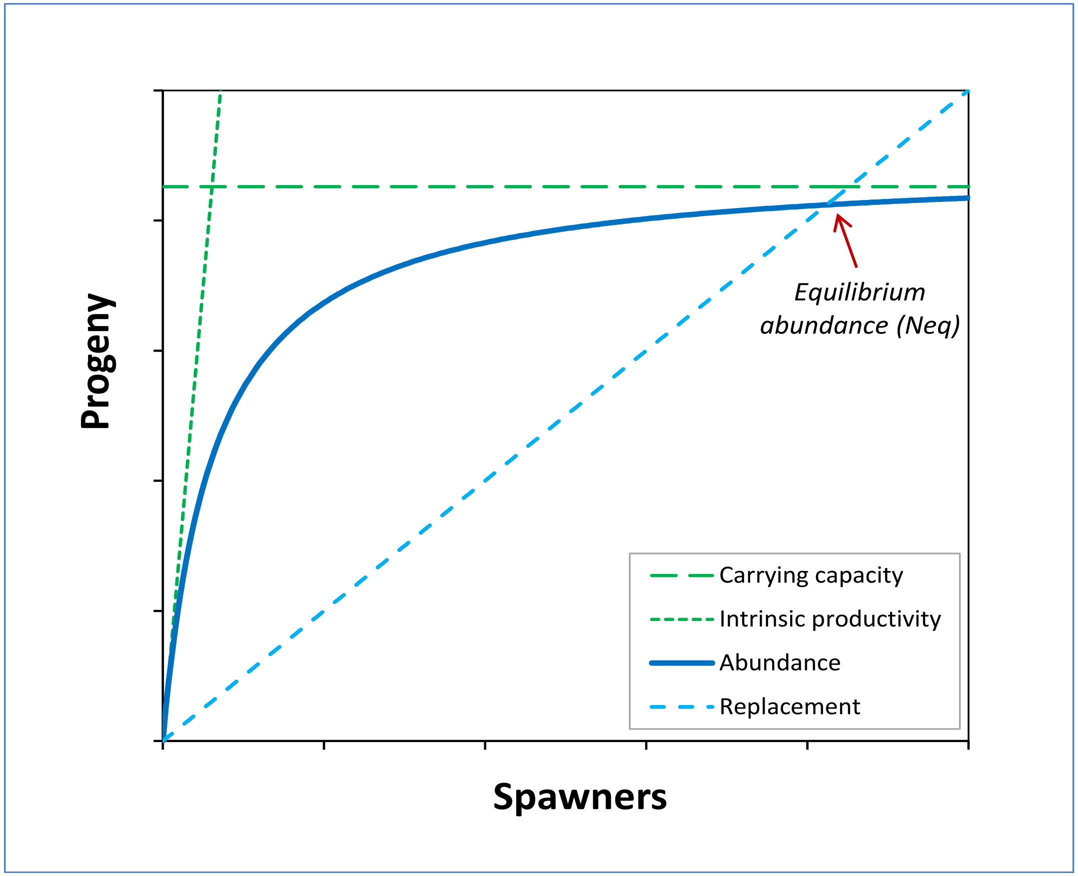


VSP framework *and viability*

- Abundance and productivity – illustrated in the spawner-production (S-P) relationship

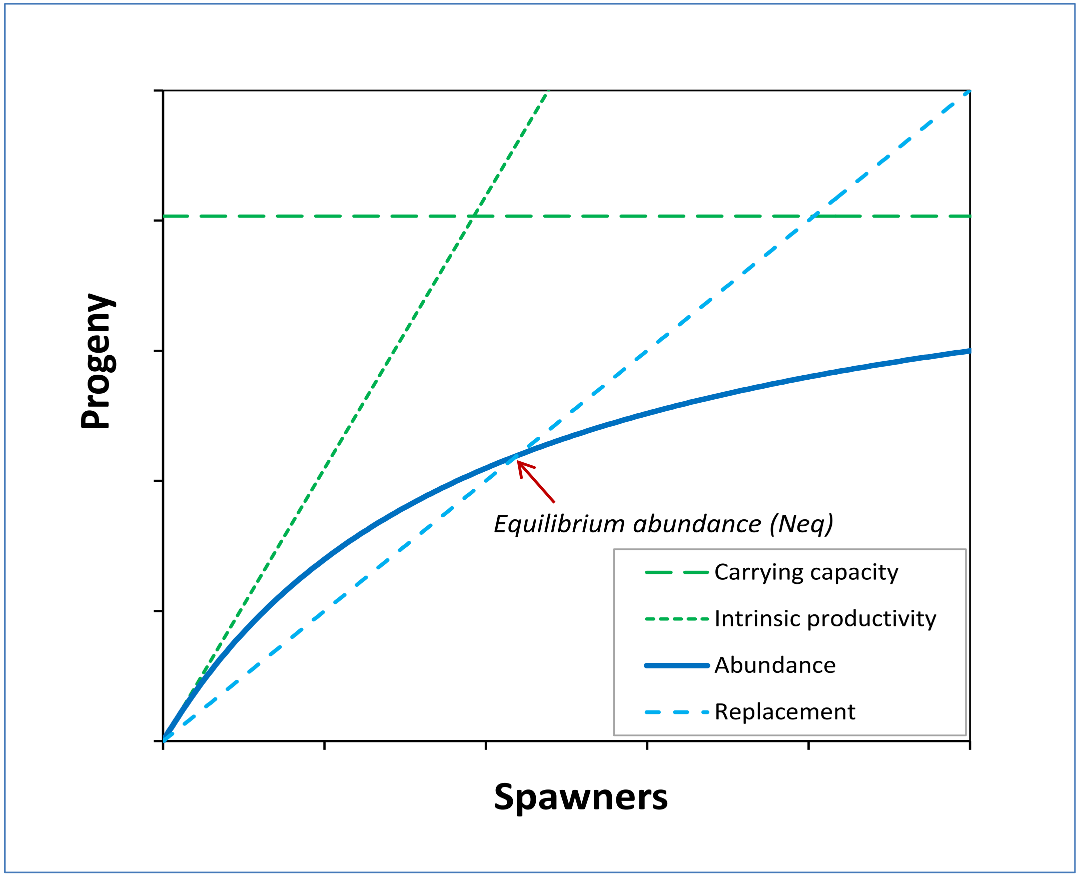


- Productivity – habitat quality & connectivity
- Capacity – habitat quantity and quality
- Equilibrium abundance (Neq)
- Surplus over replacement

Resilience

VSP framework *and viability*

- Reduced productivity – loss in habitat quality & connectivity



- Flattened curve
- Reduced Neq
- Loss in surplus over replacement
- *Comment on loss in capacity*

Loss in resilience

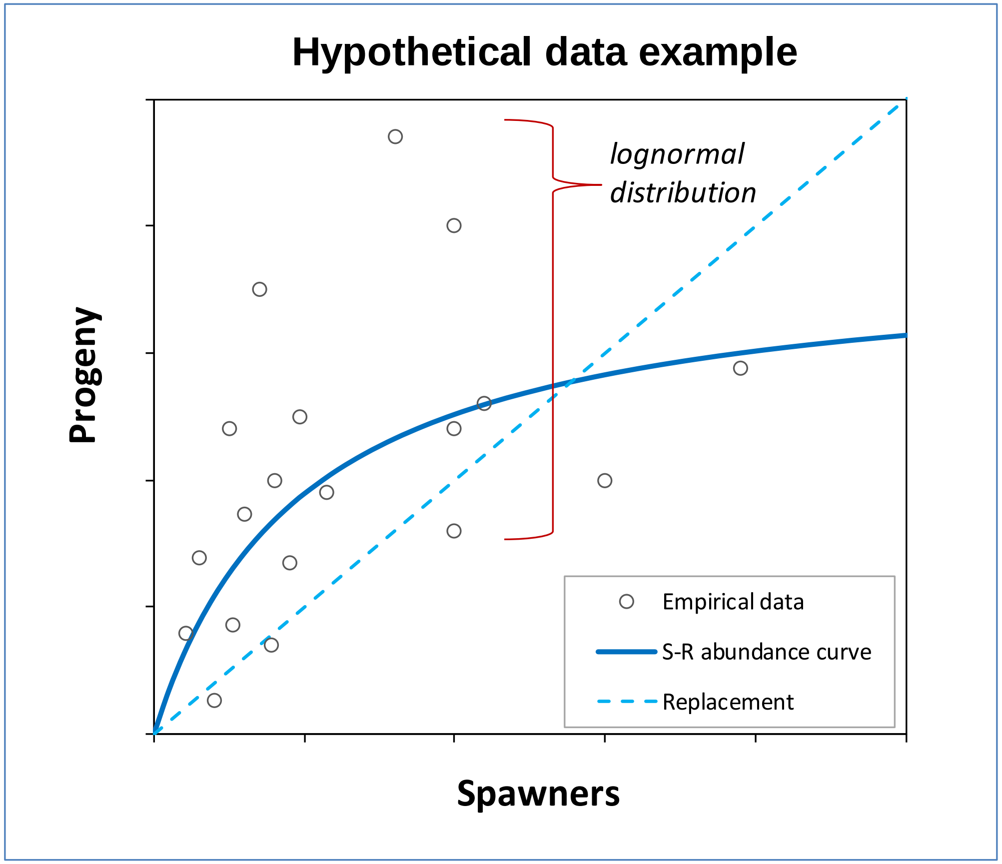
VSP framework *and viability*

- Spatial structure and diversity
  - *Spatial and temporal distribution*
  - *Life history and genetic diversity*

These are critical for resilience!

VSP framework *and viability*

- Importance of variability in performance



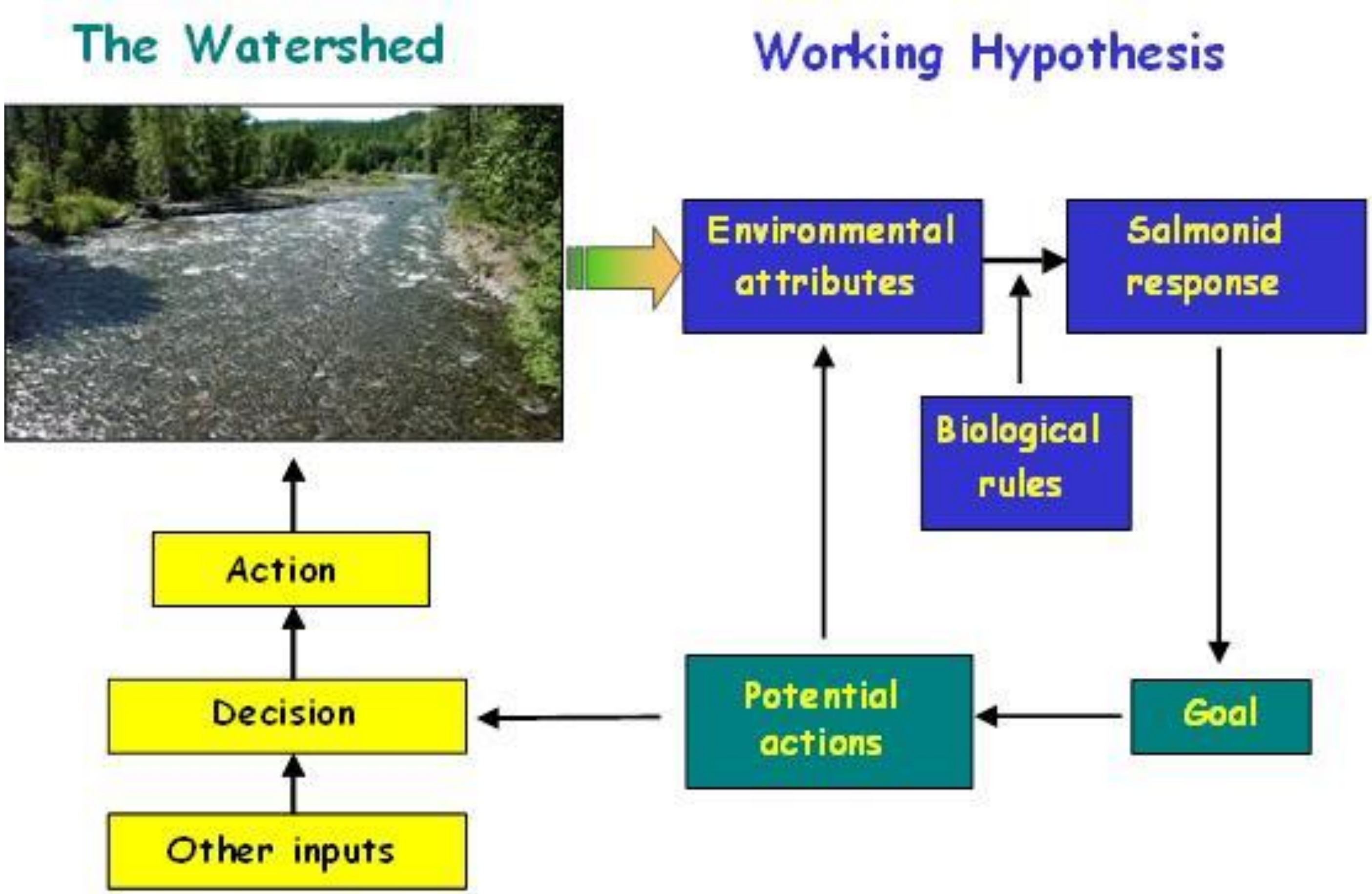
- High variability INCREASES risk of extinction
- Notice "lognormal distribution"

Loss in resilience

EDT Method & model

- Rooted in the VSP framework
- Used in salmon population and environmental assessments, recovery analysis, & restoration planning
- Numerous assessments throughout the Pacific Northwest over the past 25 years

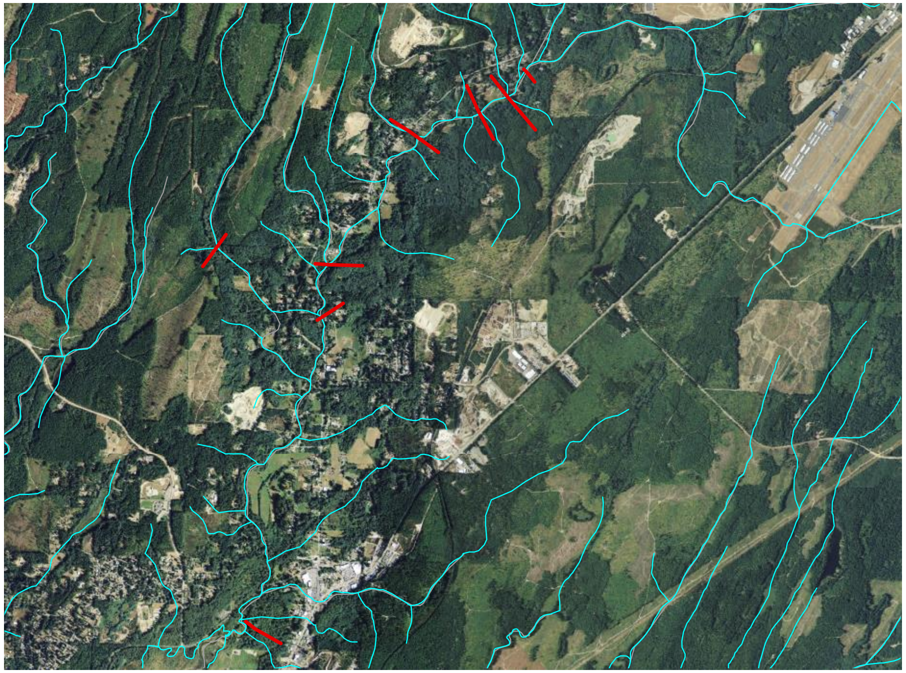
EDT Method & model



EDT modeling components

Inputs

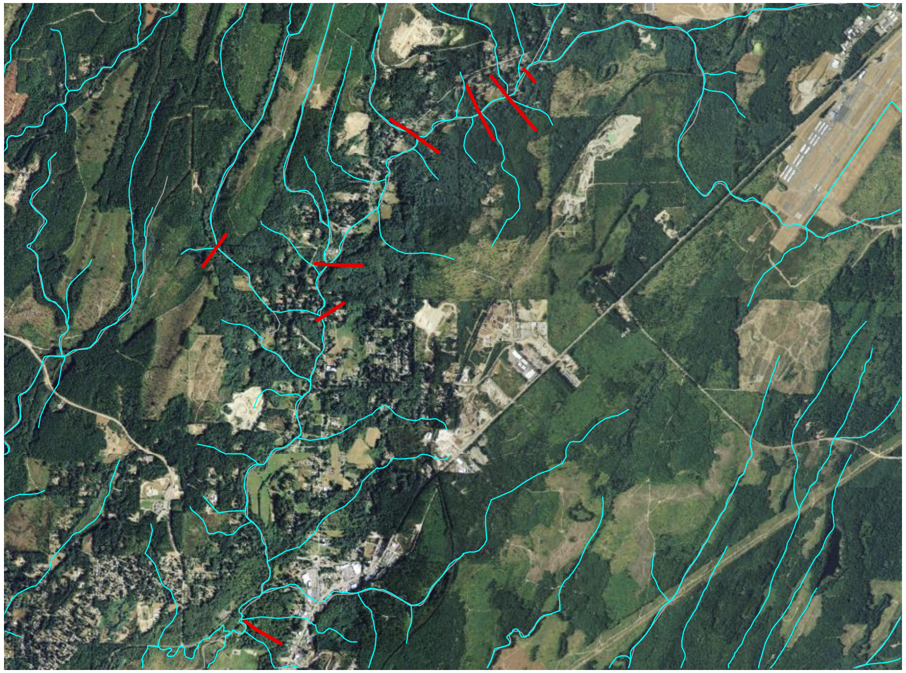
- All stream reaches delineated and defined (by confluences and general characteristics) – these can be as small or large as relevant (zero length reaches can be culverts and barriers)



EDT modeling components

Stream reaches

- 268 reaches identified with length >0 meters in the Scott subbasin
- Another 68 reaches for structures (reach length = 0)
- 336 total reaches



EDT modeling components

Inputs

- All stream reaches characterized by a standard set of habitat attributes

CHANNEL LENGTH AND WIDTH
- Channel length
- Channel month Maximum width (ft)
- Channel month Minimum width (ft)

FLOW RELATED
- Flow - change in interannual variability in high flows
- Flow - changes in interannual variability in low flows
- Flow - Intra daily (diel) variation
- Flow - intra-annual flow pattern
- Hydrologic regime - natural
- Hydrologic regime - regulated
- Water withdrawals

TEMPERATURE
- Temperature - daily maximum (by month)
- Temperature - daily minimum (by month)
- Temperature - spatial variation

CHANNEL/HABITAT CHARACTERISTICS
- Bed scour
- Confinement - Hydromodifications
- Confinement - natural
- Embeddedness
- Fine sediment
- Gradient
- Hatchery fish outplants
- Icing
- Obstructions to fish migration
- Riparian function
- Turbidity
- Wood

MISC. WATER QUALITY/BIOTIC QUALITIES
- Alkalinity
- Benthos diversity and production
- Dissolved oxygen
- Fish community richness
- Fish pathogens
- Fish species introductions
- Harassment
- Metals - in water column
- Metals/Pollutants - in sediments/soils
- Miscellaneous toxic pollutants - water column
- Nutrient enrichment
- Predation risk
- Salmon carcasses

CHANNEL/HABITAT CHARACTERISTICS
- Habitat type - backwater pools
- Habitat type - beaver ponds
- Habitat type - glides
- Habitat type - large cobble/boulder riffles
- Habitat type - off-channel habitat factor
- Habitat type - pool tailouts
- Habitat type - primary pools
- Habitat type - small cobble/gravel riffles

Attribute: *Fine sediment*

Definition: Percentage of fine sediment within riffles.

For each reach and month, a conclusion is made . . .

- [ ] < 6% fines < 0.85 mm
- [X] > 6% and < 11% fines < 0.85 mm
- [ ] > 11% and < 18% fines < 0.85 mm
- [ ] > 18% and < 30% fines < 0.85 mm
- [ ] > 30% fines < 0.85 mm

...*rationale or rule documented*

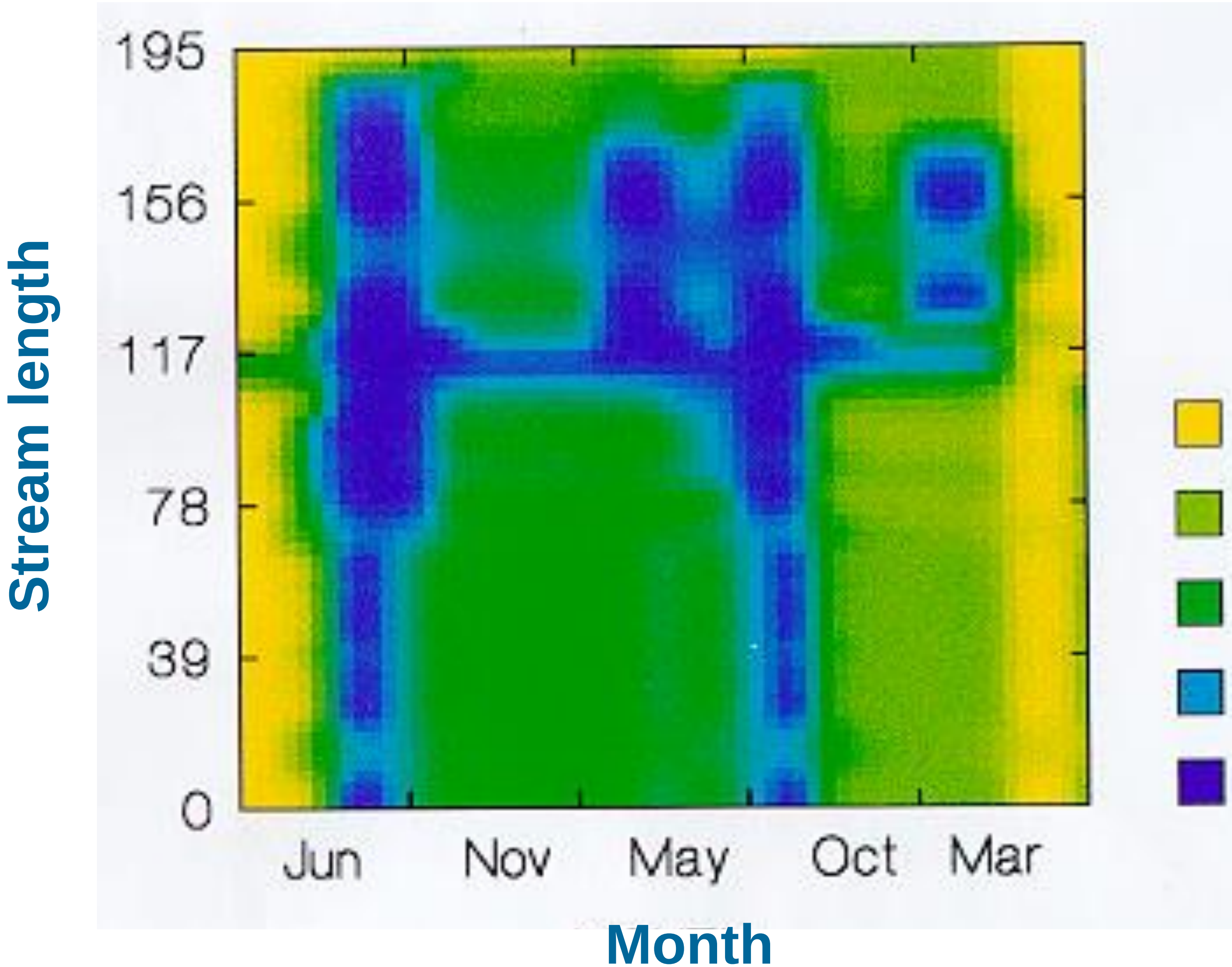
EDT modeling components

Sources for inputs

- Large number of reports, scientific papers, Google Earth

Environmental characteristics	Primary sources	Citations
Sediment load • Fine sediment concentrations in salmon spawning areas in misc. tributaries and Scott R. • Embeddedness values • Characterized for both historical and current conditions	Scott River Basin Granitic Sediment Study; Scott River Watershed Monitoring Program 2005, 2006 & 2007; Scott River Spawning Gravel Evaluation and Enhancement Plan	CDFG (2002a, 2002b, 2002c, 2002d, 2002e, 2002f, 2005, 2008a, 2008b); Sommarstrom et al. (1990); Quigley (2003, 2008); USFS (2000); Cramer Fish Sciences (2010)
Riparian conditions • Riparian condition for all relevant stream reaches in the subbasin • Characterized for both historical and current conditions	Scott River Basin Granitic Sediment Study; Lower Scott Ecosystem Analysis; Google Earth	Sommarstrom et al. (1990); USFS (2000)
Water diversions • Locations of diversions and amounts of water diverted (either at specific sites or approximate aggregated amounts at different locations)	Scott River Watershed CRMP Committee; Scott River Watershed-wide Permitting Program Final Environmental Impact Report FEIR Volume 1: Chapter 3.3; State Water Resources Control Board – maps showing diversions and irrigated lands; Scott River Water Trust reports	Davis (1997); ESA (2009); SWRCB (1979); Yokel (2008, 2009, 2012); Thamer (2013, 2015)

Attribute conditions create a spatial-temporal mosaic of habitat conditions – a survival landscape



Biological performance can then be assessed

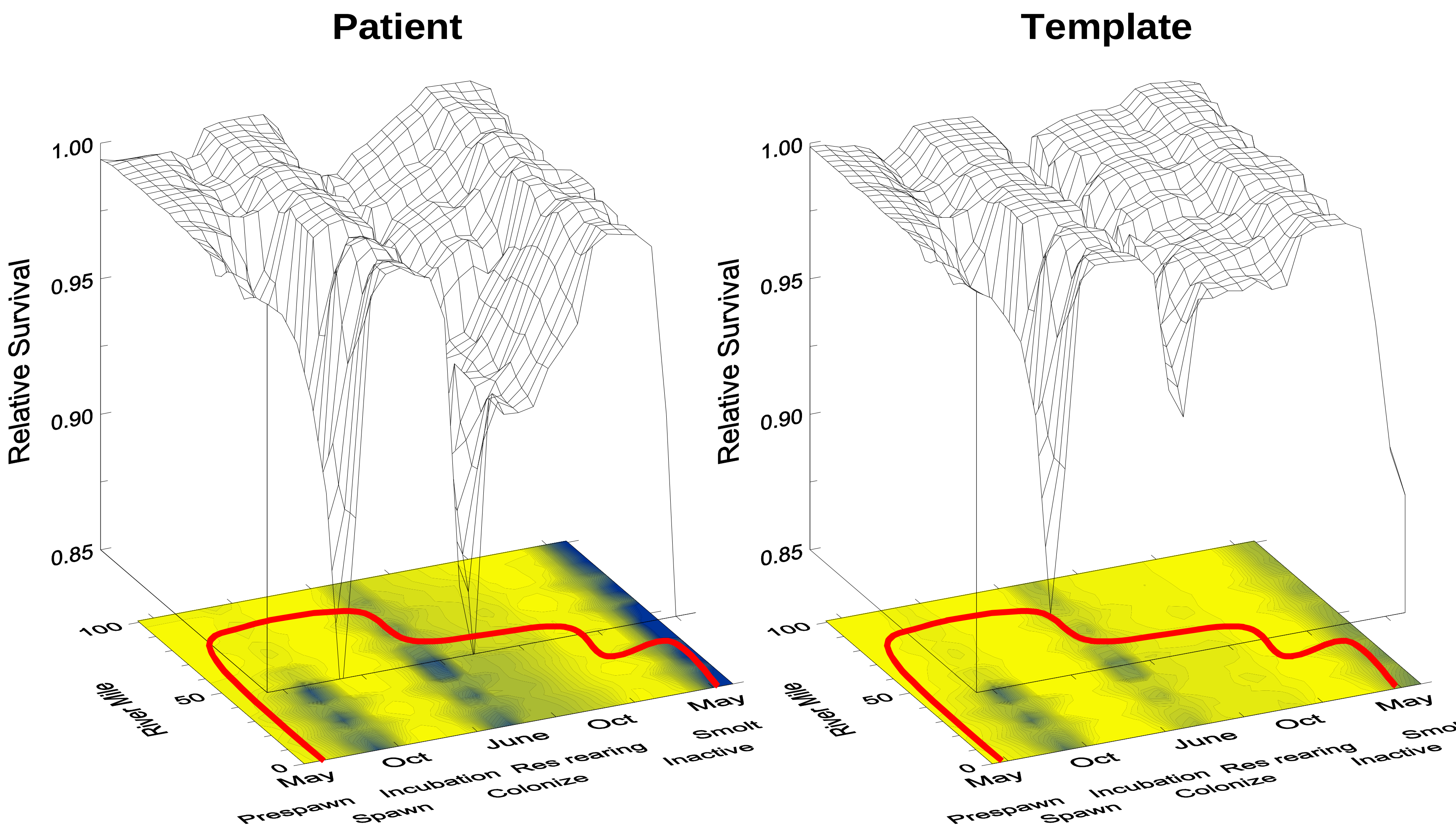
- Survival landscapes integrate conditions of all environmental attributes and associated survival parameters
- Life history analysis based on known life history patterns for species

Habitat characterization done for historic and current conditions

- Historical based on synthesis of available information and assumptions based on stream type and prevailing conditions for area

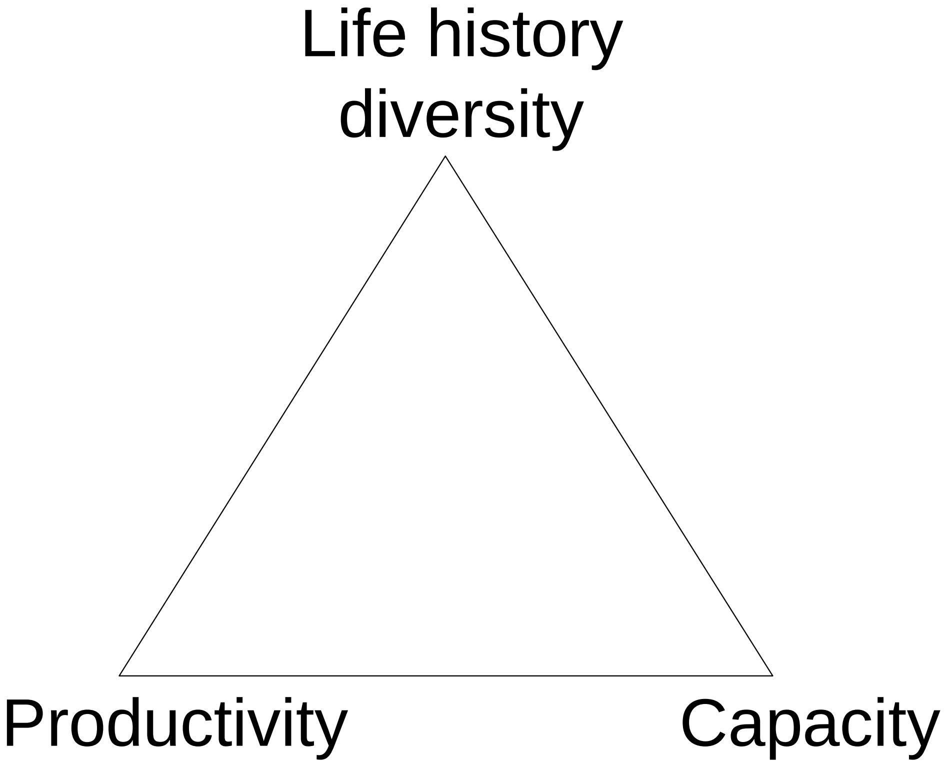
- Current condition based on synthesis of any/all available assessment data

Relative Survival Experienced by
Stream Type Spring Chinook in Lower Deschutes River
(with example life history pathway)



Model output for population performance expressed by three measures ….

Outputs



Diagnosis based on comparison of current conditions to historical…

- Limiting factors (bottlenecks to production)
- Contributing factors (effects of single or groups of factors contributing to cumulative effects)
- Factors prioritized relative to importance in affecting overall performance

Identify strategic priorities through diagnosis

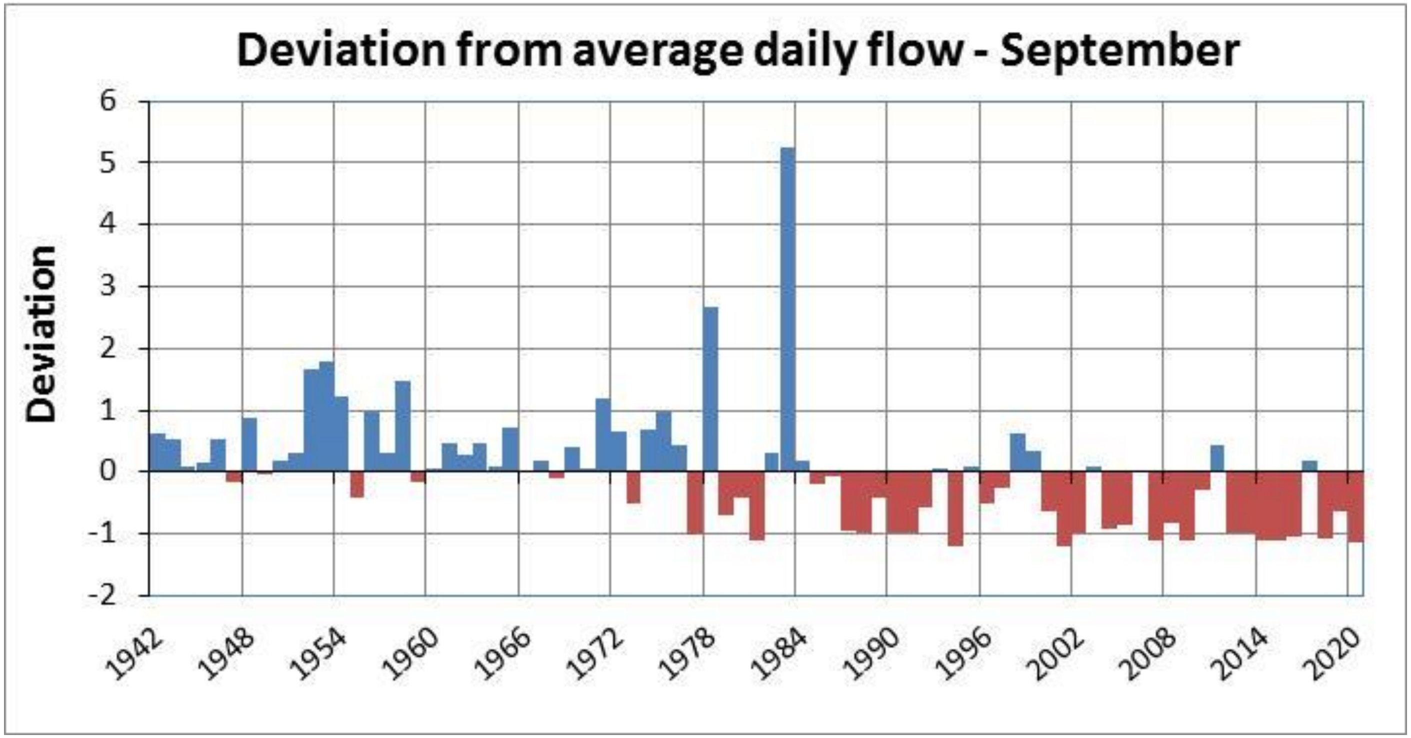
- Restoration benefits identified and ranked according to potential reach contribution
- Protection benefits identified and ranked according to potential reach contribution
- Combined potential restoration and protection benefits can be organized as strategic priorities for identifying suitable actions

Historical overview

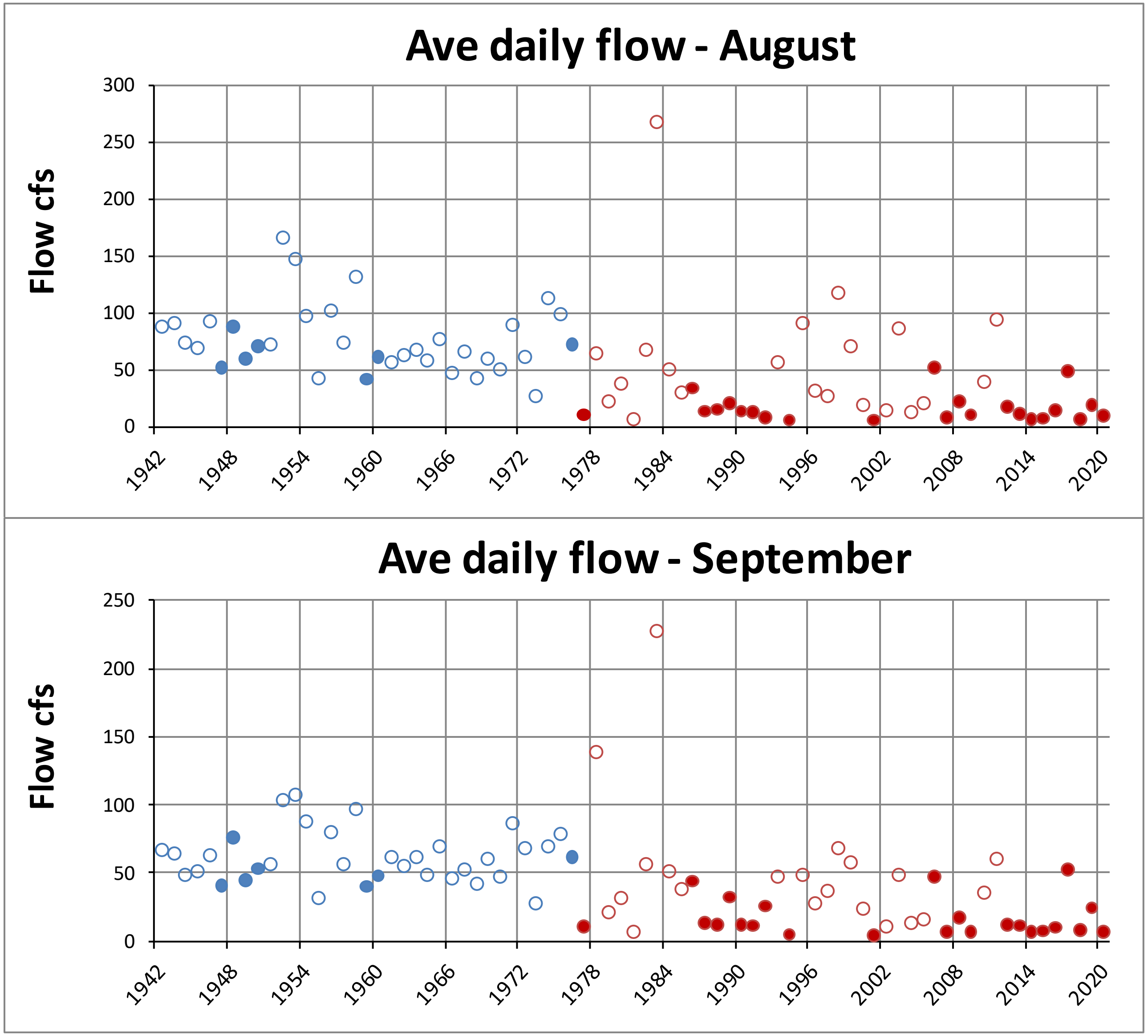
- History of alterations
  - Beaver trapping (channels, flow, floodplains)
  - Gold mining (channels, sediment, floodplains, riparian)
  - Agriculture (channels, sediment, flow, riparian, temperature, wood, floodplains, groundwater)
  - Logging (sediment, wood)
  - Groundwater pumping
  - Climate change

Historical overview

- Changes in flow patterns



Historical overview



- GW prepumping and pumping
- Drought vs non-drought years in CA

Historical overview

- Changes in salmon populations – coho
  - From analysis prepared for Yurok Tribe

	Method	Mean smolt capacity
1	Ackerman	222,700
2	ONCC TRT regression	3,010,800
3	Bradford regression [1/]	506,700
4a	EDT regression - watershed size	892,200
4b	EDT regression - stream length	525,100

Summer flow scenario	Marine survival scenario		
	Low (1%)	Average (4%)	High (8%)
Low	3,265	13,060	26,119
Average	5,251	21,004	42,008
High	7,237	28,948	57,897

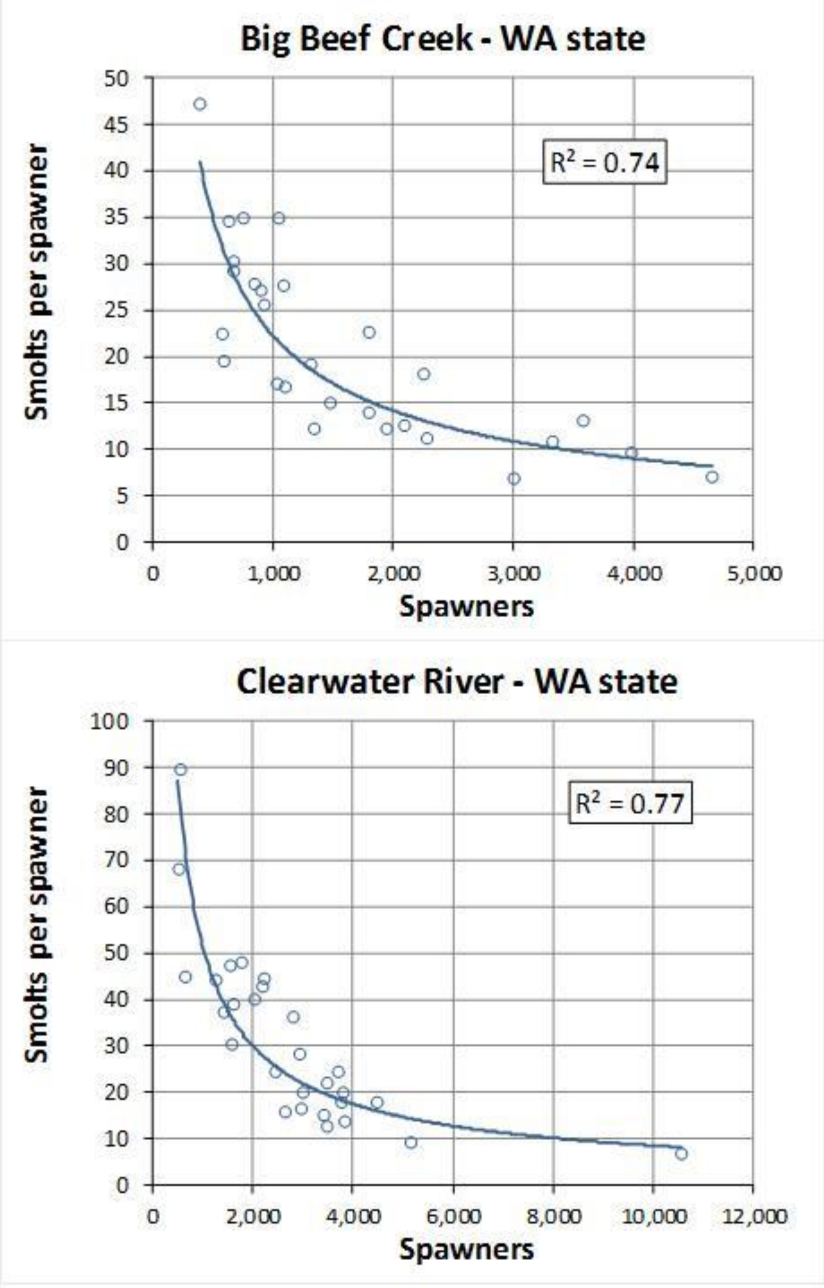
Historical overview

- Changes in salmon populations – coho
    - Current production

Year	Smolts	Adult coho
2003	42,190	
2004		
2005	1,780	
2006	95,815	
2007	3,931	1,622
2008	1,142	58
2009	73,232	75
2010	3,257	913
2011	353	344
2012	63,135	186
2013	9,283	2,631
2014	6,734	383
2015	8,758	188
2016	3,372	226
2017		364
2018	14,628	712
2019	15,707	326
Min	353	58
Max	95,815	2,631
Geometric mean	8,398	356

Historical overview

- Changes in salmon populations – coho
  - Widely variable productivity (density-independent driven)



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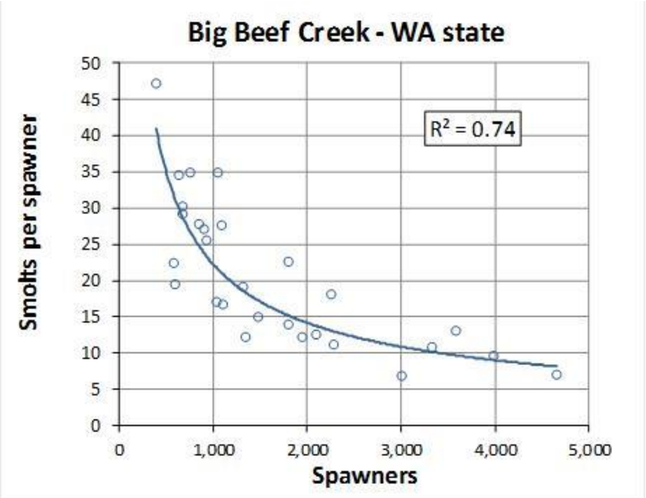
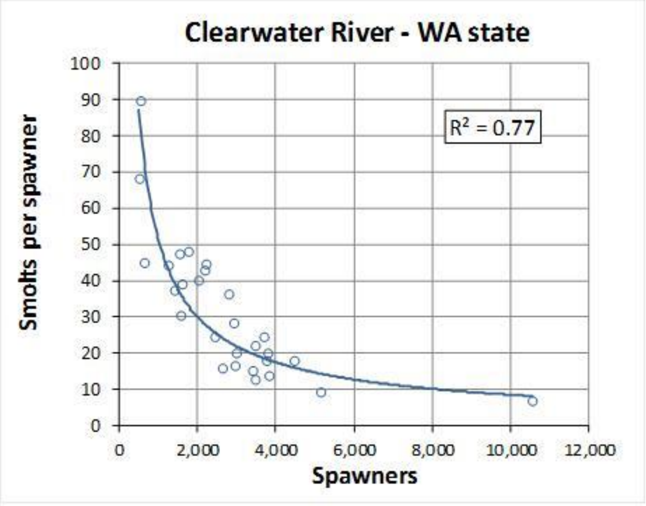
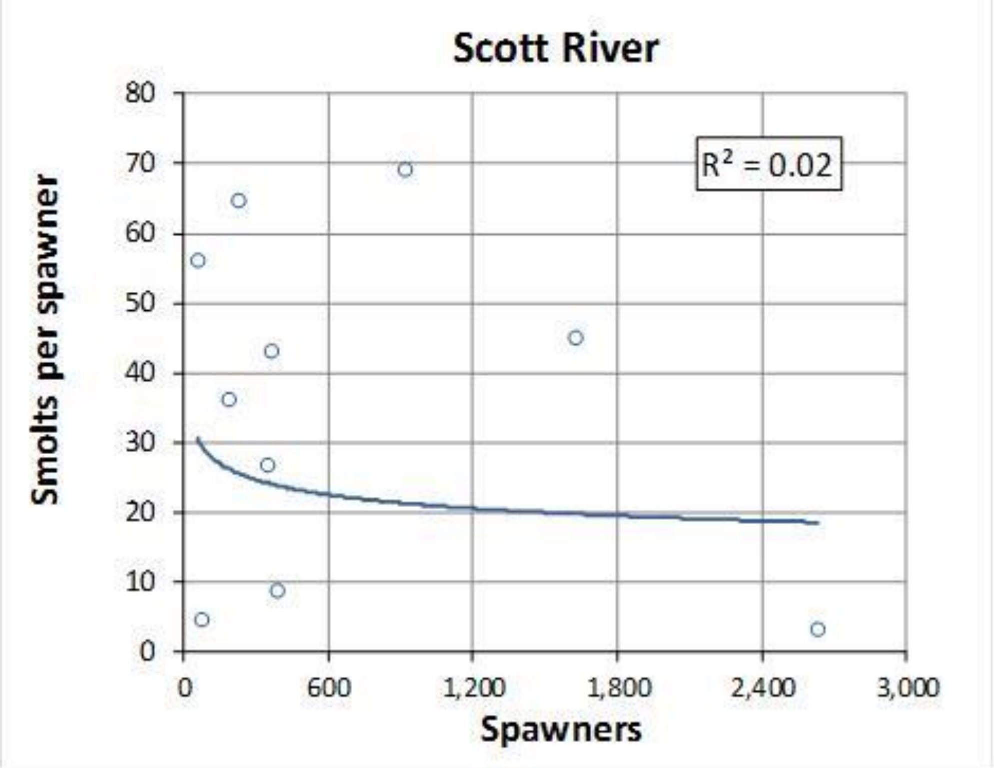






- FLASHING warning signal

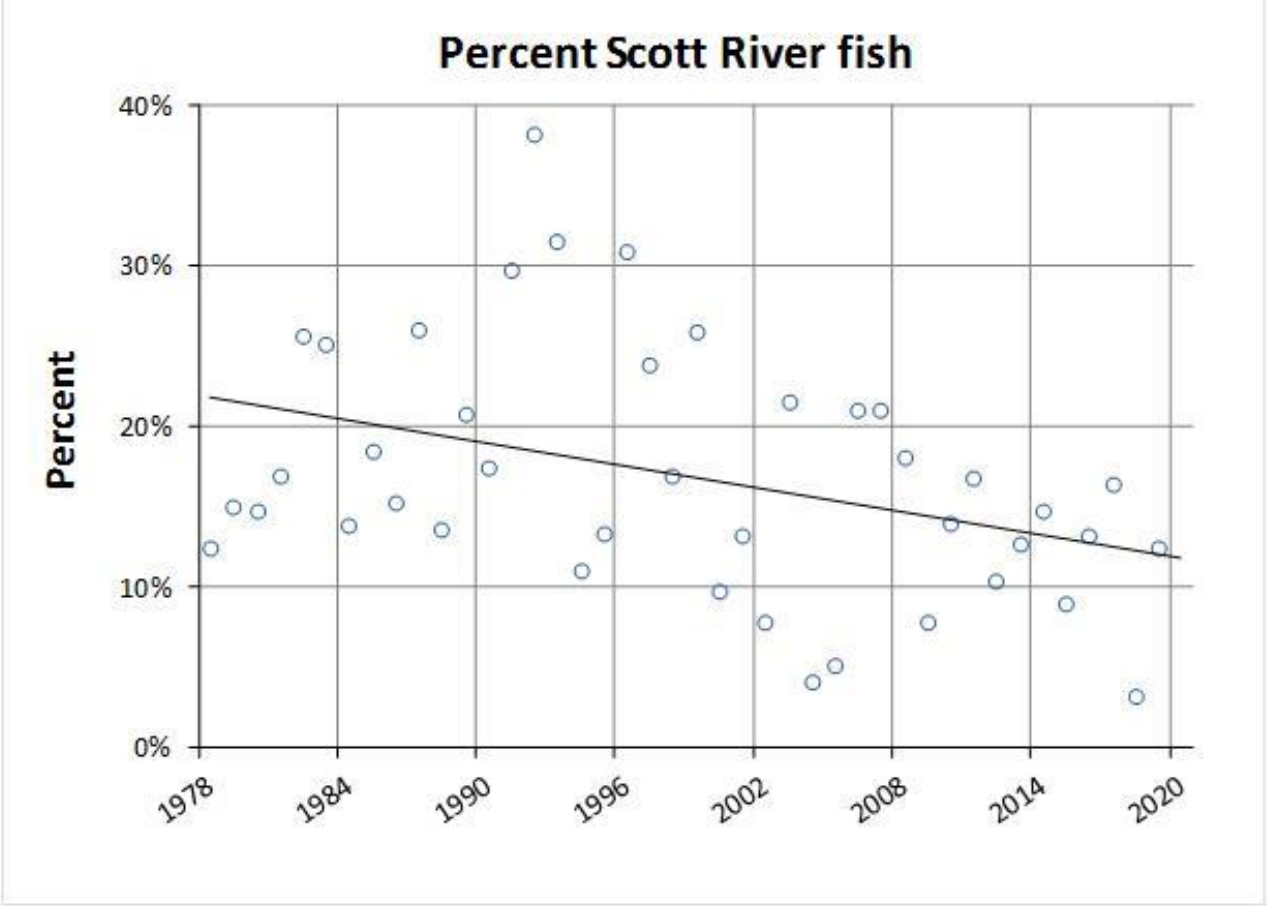
Historical overview

- Changes in salmon populations – fall chinook
  - Current production

Years	Klamath R	Scott R	% Scott R
1978-1983	19,754	3,537	18%
1984-1989	21,112	3,861	18%
1990-1995	23,481	3,977	17%
1996-2001	33,723	6,241	19%
2002-2007	28,245	4,149	15%
2008-2013	30,734	3,725	12%
2014-2019	28,205	3,174	11%

Historical overview

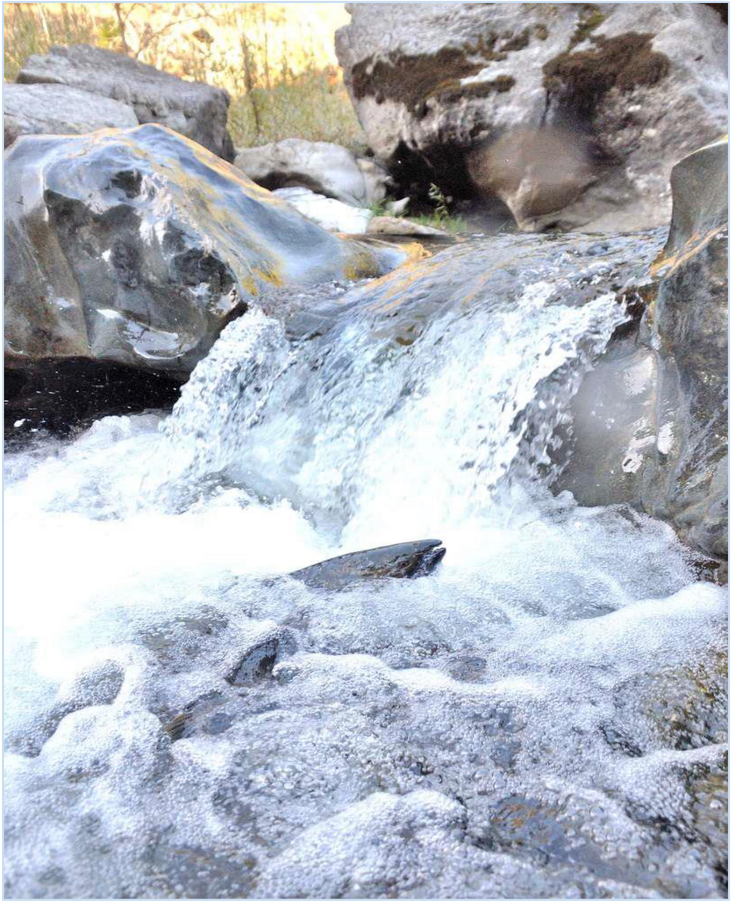
- Changes in salmon populations – fall chinook
  - Current production



- Scott R performance declining relative to the rest of Klamath natural fall chinook
- Trinity and Lower Klamath not applied here
- Warning signal

Historical overview

- Changes in salmon populations – fall chinook
  - Canyon & valley subpopulations



- Entry to the valley getting extremely difficult
- Warning signal

Historical overview

- Changes in salmon populations – spring chinook
- Historical – approximately 5,000 (from Moyle et al. 2008)
- Current – EXTIRPATED…1970s

Modeling baseline performance- Coho

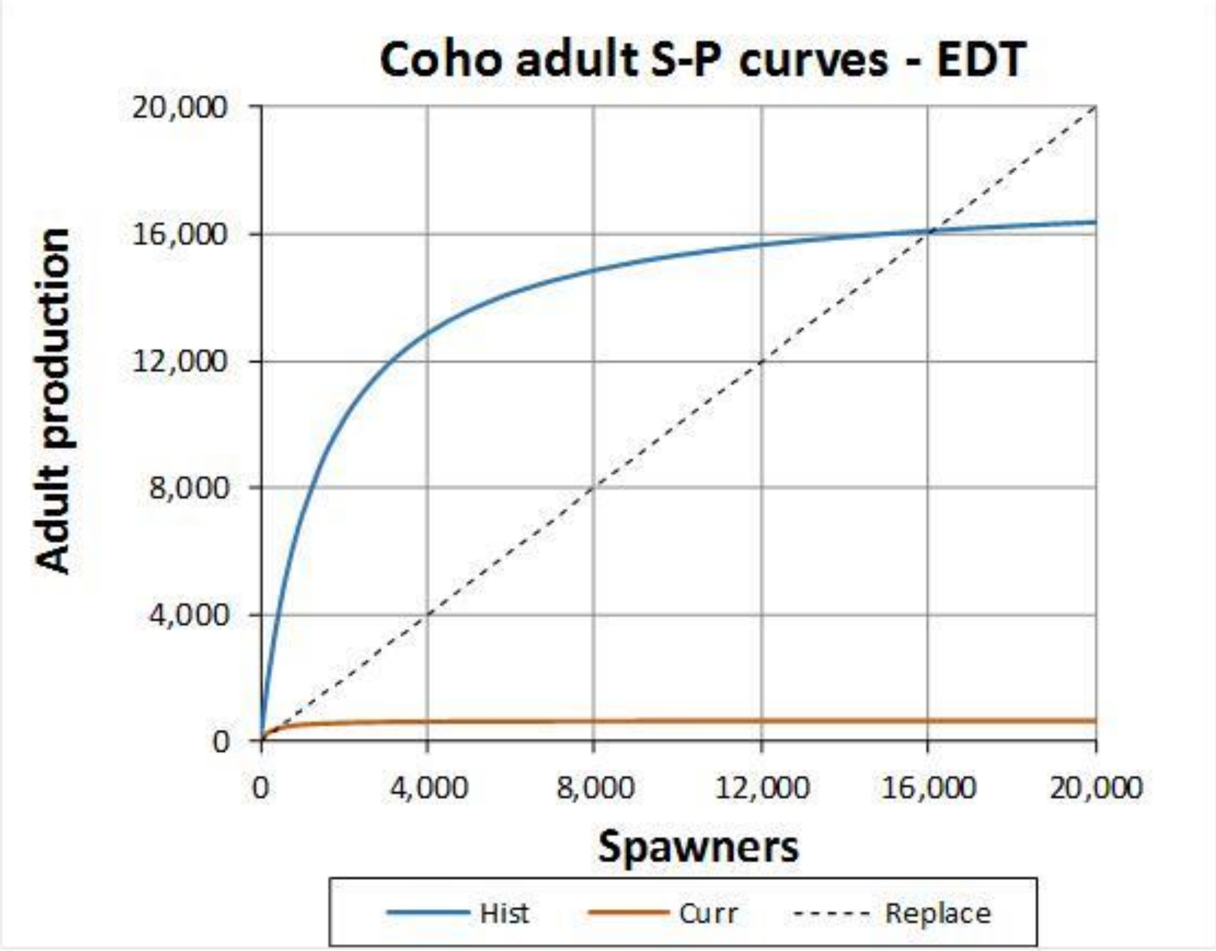
Historical & current baselines - model

- Coho

Population component	Population performance metrics								Percent change from historical to current			
	Historical				Current							
	Neq	Cap	Prod	LHD	Neq	Cap	Prod	LHD	Neq	Cap	Prod	LHD
All	16,071	17,579	12.0	98.5%	415	676	2.7	5.0%	-97.4%	-96.2%	-77.8%	-95.0%
Forks	1,818	1,995	11.3	98.3%	43	83	2.1	0.9%	-97.6%	-95.8%	-81.6%	-99.0%
Upper valley	3,742	4,051	13.1	97.9%	193	303	2.8	14.0%	-94.8%	-92.5%	-79.0%	-85.7%
Lower valley	10,334	11,295	11.8	98.8%	130	244	2.1	1.3%	-98.7%	-97.8%	-81.7%	-98.7%
Canyon	171	237	3.6	6.1%	21	46	1.8	0.1%	-87.7%	-80.4%	-49.2%	-98.4%

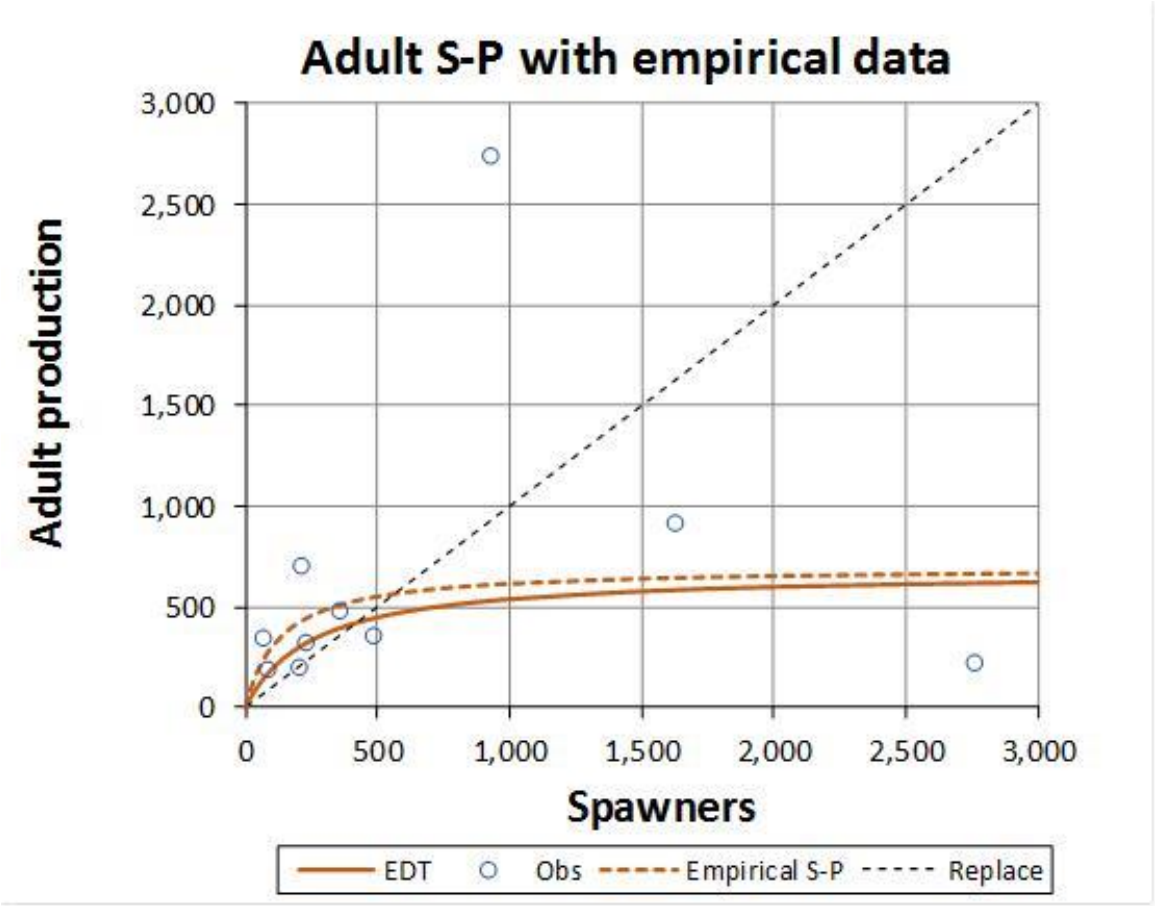
Historical & current baselines - model

- Coho



Historical & current baselines - model

- Coho



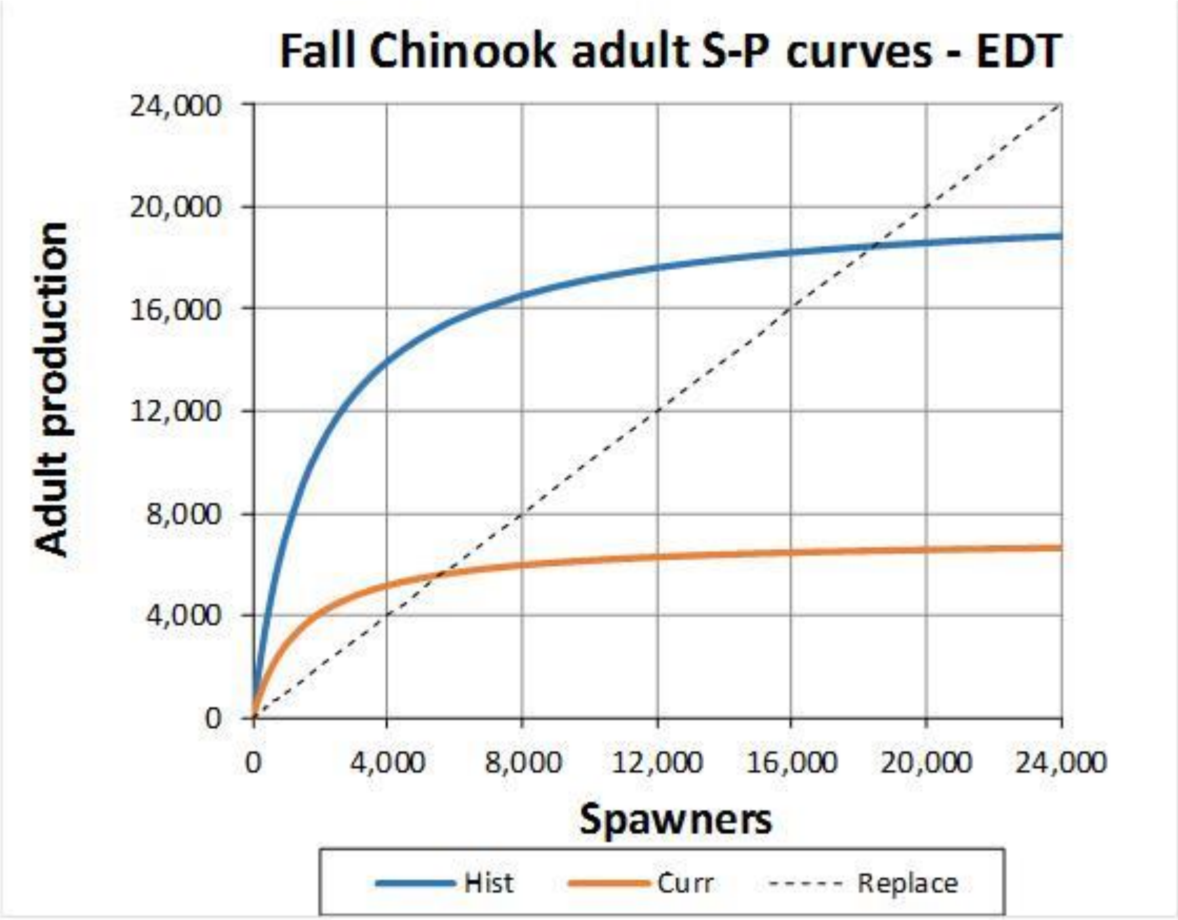
Historical & current baselines - model

- Fall chinook

Population component	Population performance metrics								Percent change from historical to current			
	Historical				Current							
	Neq	Cap	Prod	LHD	Neq	Cap	Prod	LHD	Neq	Cap	Prod	LHD
All	18,451	20,266	11.2	100%	5,596	7,044	4.9	68%	-69.7%	-65.2%	-56.4%	-31.9%
Upper valley	2,034	2,199	13.3	100%	360	498	3.6	81%	-82.3%	-77.3%	-72.9%	-19.1%
Lower valley	11,622	12,781	11.0	100%	2,188	3,087	3.4	51%	-81.2%	-75.8%	-68.9%	-49.3%
Canyon	4,795	5,286	10.8	100%	2,840	3,459	5.6	96%	-40.8%	-34.6%	-48.1%	-4.2%

Historical & current baselines - model

- Fall chinook



Historical & current baselines - model

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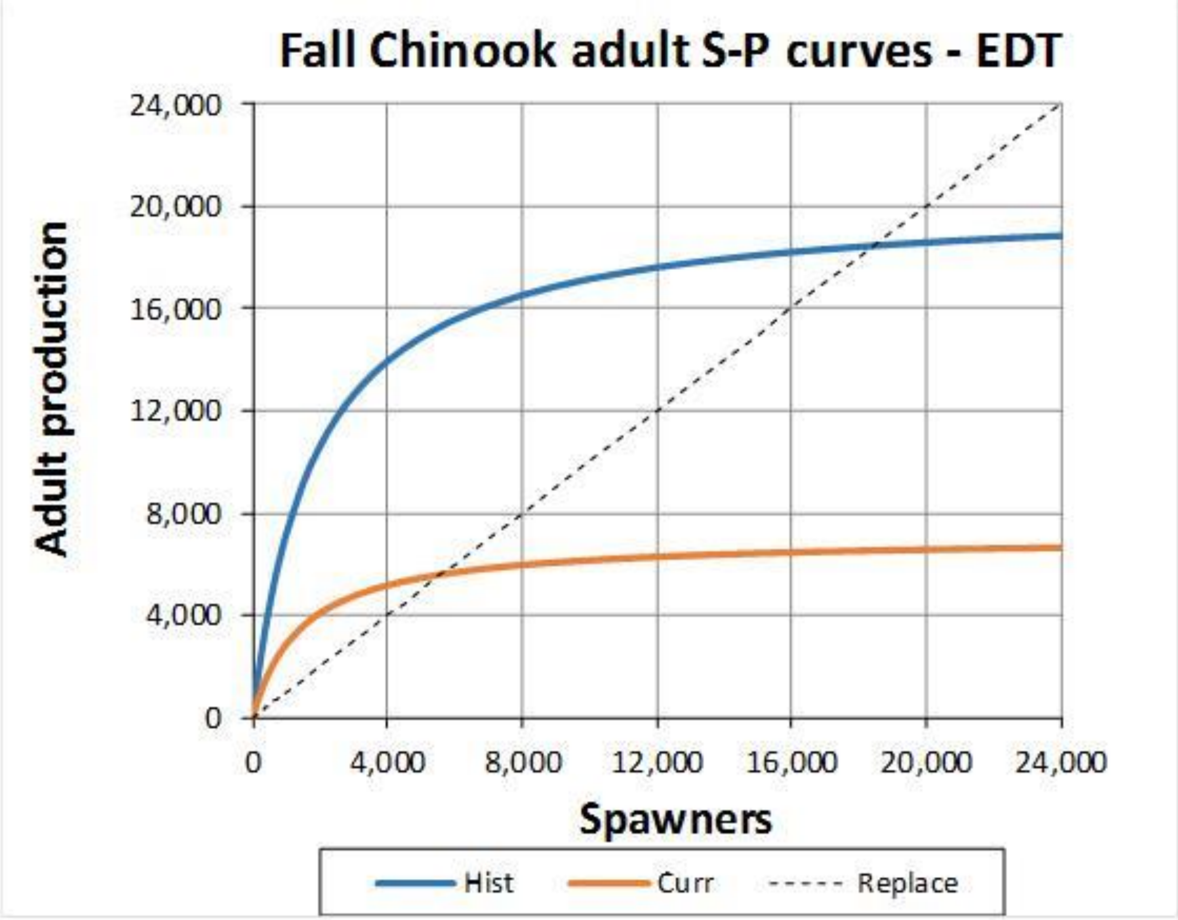


- Fisheries ER ~ 0.48
- Productivity to the valley ~ 3.5
- Accounting for fisheries, productivity ~ 1.8 to the valley (warning)

Diagnosis & prioritization – modeling

- Tornado charts for area prioritization
  - Restoration
  - Protection

- Consumer report-style charts for factors
  - Attribute factor importance

Diagnosis & prioritization - modeling

Geographic areas

- 32 areas prioritized

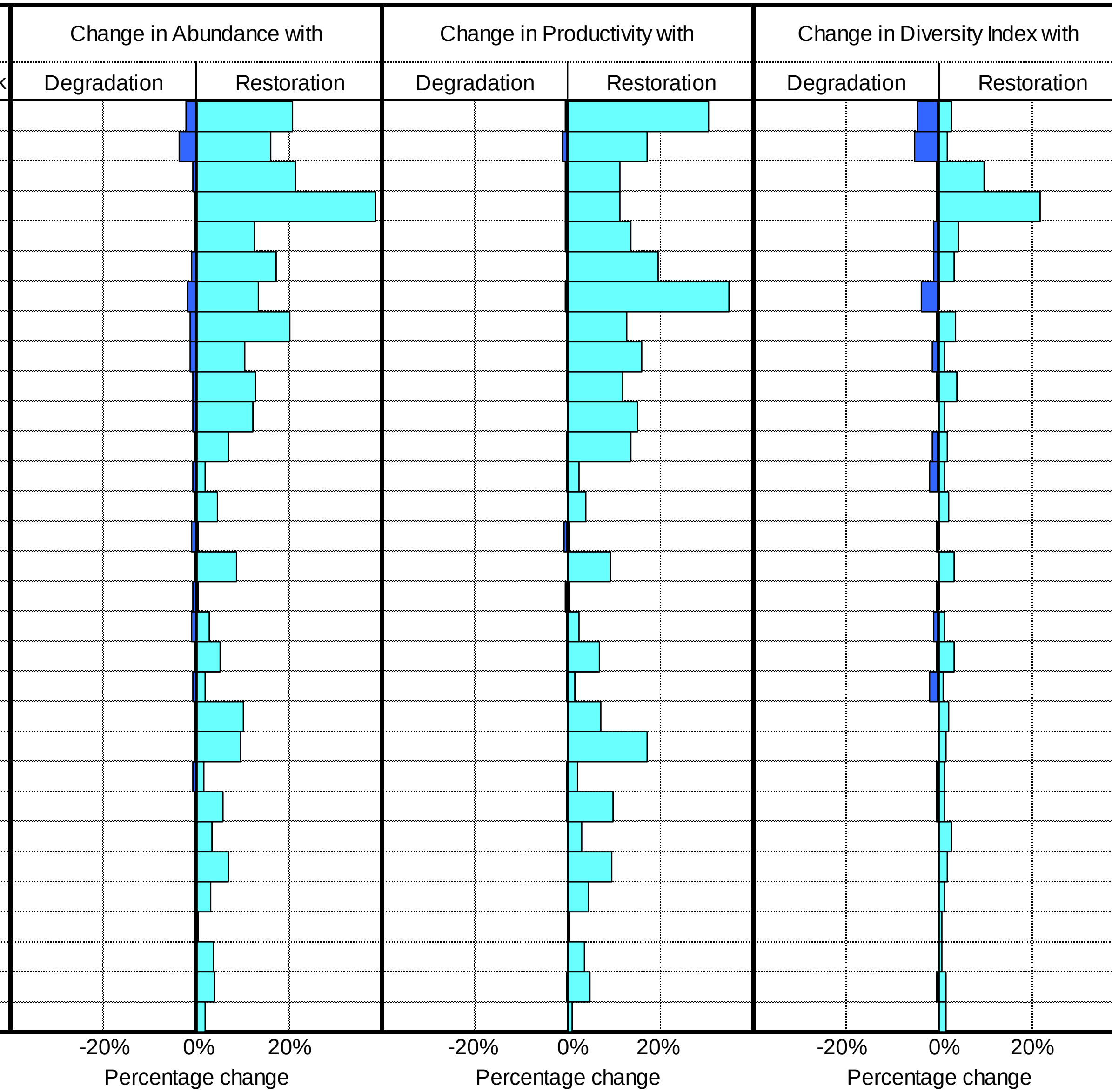
No.	Geographic Area (Diagnostic Unit)	Description
1	SR canyon MS lower	Scott R. mainstem within the canyon from the confluence with Klamath R. (RM 0.0) to Middle Cr. (RM 12.8).
2	SR canyon tribs	Tributaries to Scott R. within the canyon.
3	SR canyon MS upper	Scott R. mainstem within the canyon from Middle Cr. (RM 12.8) to Marilyn Cr. (RM 22.7).
4	SR valley to Kidder Cr	Scott R. mainstem within the valley from Marilyn Cr. (RM 22.7) to Kidder Cr. (RM32.4).
5	East tribs to Ft Jones	All right bank tributaries (east side) to Scott R. upstream of the canyon and downstream of Moffett Cr.
6	Sniktaw Cr	Sniktaw Cr. system.
7	Shackleford Cr	Shackleford Cr. system excluding the Mill-Emigrant Cr. system.
8	Mill-Emigrant Cr	Mill-Emigrant Cr. system (tributary to Shackleford Cr.).
9	Oro Fino Cr	Oro Fino Cr. system.
10	Moffett Cr lower	Lower Moffett Cr. system downstream of Soap Cr. (excluding Soap Cr.).
11	Moffett Cr upper	Upper Moffett Cr. system upstream of Soap Cr. (including Soap Cr.).
12	Kidder lower-Big Slough	Lower Kidder Cr. and Big Slough complex.
13	Patterson Cr	Patterson Cr. system (tributary to Kidder Cr. - Big Slough complex).
14	Crystal-Johnson Cr	Crystal Cr. and Johnson Cr. (tributaries to Kidder Cr. - Big Slough complex).
15	Kidder Cr upper	Upper Kidder Cr. system upstream of the confluence with Big Slough.
16	SR valley to Etna Cr	Scott R. mainstem within the valley from Kidder Cr. (RM 32.4) to Etna Cr (RM 42.5).
17	East Slough	East Slough complex on the right bank (east side) of Scott R. within the valley.
18	Etna Cr	Etna Cr. system.
19	SR valley to tailings	Scott R. mainstem within the valley from Etna Cr. (RM 42.5) to the downstream end of the tailings reach (RM 51.5) .
20	Clark Cr	Clark Cr. system.
21	French Cr lower	Lower French Cr. downstream of Miners Cr.; includes beaver dam complex in tributary near French Cr. mouth.
22	Miners Cr	Miners Cr. system.
23	French Cr upper	French Cr. system upstream of Miners Cr.
24	Wolford Slough	Wolford Slough complex that periodically connects to the right bank tributary to lower French Cr. This slough complex is a relect mainstem channel of Scott R.
25	SR valley to forks	Scott R. mainstem within the valley from the downstream end of the tailings reach (RM 51.5) to the forks (RM 56.8). Includes all of the tailings reaches.
26	Sugar Cr	Sugar Cr. system.
27	Wildcat Cr	Wildcat Cr. system.
28	South Fork MS	South Fork mainstem.
29	South Fork tribs	All South Fork tributaries.
30	East Fork MS lower	East Fork mainstem from the confluence with South Fork to Grouse Cr.
31	East Fork tribs	All East Fork tributaries.
32	East Fork MS upper	East Fork mainstem upstream of Grouse Cr.

Diagnosis & prioritization - coho

Scott River Coho salmon (normalized by reach length)

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit		Restoration benefit	
	Category/rank		Category/rank	
French Cr lower	A	2	A	3
SR valley to tailings	A	1	A	8
SR valley to Etna Cr	B	7	A	4
SR valley to Kidder Cr	B	10	A	1
SR valley to forks	B	6	A	6
Shackleford Cr	B	12	A	1
Wolford Slough	A	2	A	11
Kidder lower-Big Slough	B	10	A	5
Mill-Emigrant Cr	B	8	A	10
East Fork MS lower	C	19	A	7
East Slough	C	16	A	11
Clark Cr	C	18	A	13
Miners Cr	B	8	C	26
South Fork MS	C	16	B	18
SR canyon MS upper	B	4	E	30
East Fork MS upper	C	22	A	13
SR canyon MS lower	B	5	E	31
Sugar Cr	B	12	C	24
Patterson Cr	C	21	B	16
French Cr upper	B	12	D	28
Moffett Cr lower	D	25	B	15
Oro Fino Cr	E	31	A	9
East Fork tribs	C	15	D	27
Sniktaw Cr	C	22	B	20
Crystal-Johnson Cr	D	24	B	19
Kidder Cr upper	D	27	B	17
East tribs to Ft Jones	D	25	C	22
South Fork tribs	C	20	E	29
Moffett Cr upper	D	27	C	23
Etna Cr	D	30	C	21
Wildcat Cr	D	27	C	24



Scott River Coho salmon (normalized by reach length)
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration																
Geographic area	Protection benefit	Restoration benefit	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow characteristics*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Habitat quantity*
SR canyon MS lower	B								C									
SR canyon MS upper	B								C									
SR valley to Kidder Cr	B	A	C				C		B						C			A
East tribs to Ft Jones		C	C				B	C	B	C					C	C		B
Sniktaw Cr	C	B	C				C		B						C			B
Shackleford Cr	B	A					C		A						C			B
Mill-Emigrant Cr	B	A					C		B						C			B
Oro Fino Cr		A	C				B	C	B	C					C			A
Moffett Cr lower		B	C				B	C	B						C			B
Moffett Cr upper		C					C		A						C			B
Kidder lower-Big Slough	B	A	C				C		B						C	C		B
Patterson Cr	C	B					C		A						C			B
Crystal-Johnson Cr		B	C				B		B						C	C		B
Kidder Cr upper		B	C				C		A						C			B
SR valley to Etna Cr	B	A	C				C		B						B			A
East Slough	C	A	C				C	C	B						B	C		A
Etna Cr		C					C		A						C			B
SR valley to tailings	A	A	C				C		B						C			A
Clark Cr	C	A					C	C	B									B
French Cr lower	A	A					C		B						C			B
Miners Cr	B	C					C		B						C			C
French Cr upper	B						C		B									C
Wolford Slough	A	A	C				C	C	C						C			A
SR valley to forks	B	A	C				B	C	A									B
Sugar Cr	B	C					C		B						C			C
Wildcat Cr		C	C				B	C	A						C			C
South Fork MS	C	B					C		A									B
South Fork tribs	C						C		B									
East Fork MS lower	C	A					B	C	A									B
East Fork tribs	C						C		B						C			B
East Fork MS upper	C	A	C				C	C	A									B

Key to strategic priority (corresponding Benefit Category letter also shown)

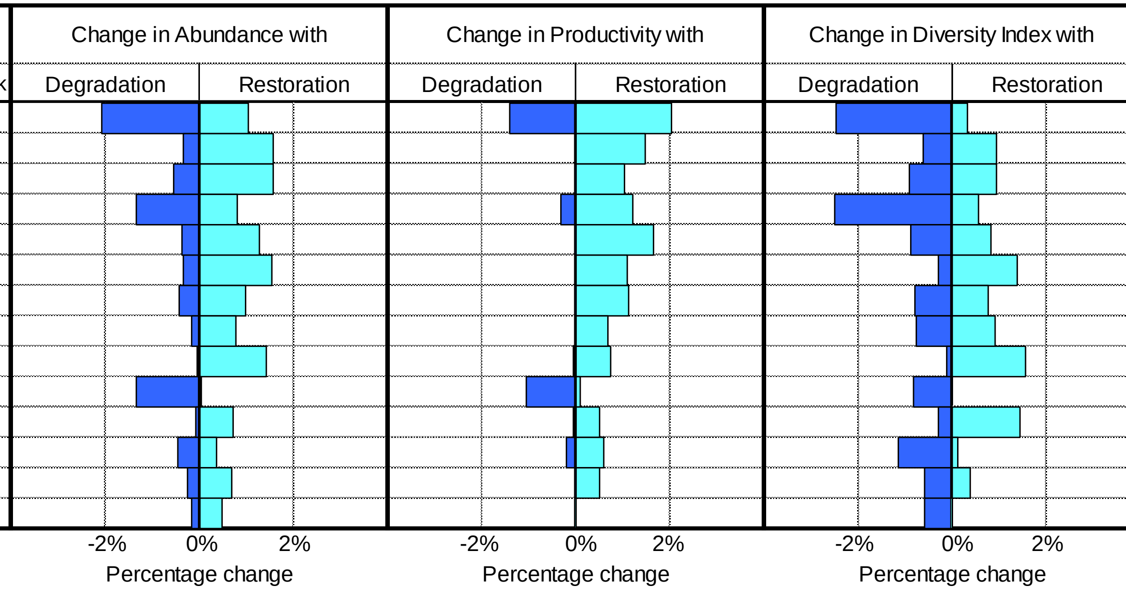
A	B	C	D & E
High	Medium	Low	Indirect or General

Diagnosis & prioritization – Fall Chinook

Scott River Fall Chinook (normalized by reach length)

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category/rank		Restoration benefit Category/rank	
SR canyon MS lower	A	1	A	6
Shackleford Cr	B	7	A	1
SR valley to Kidder Cr	B	5	A	3
SR canyon MS upper	A	2	B	8
SR valley to tailings	B	6	A	5
SR valley to Etna Cr	C	10	A	2
Kidder lower-Big Slough	B	6	B	7
Etna Cr	B	7	B	9
Moffett Cr lower	D	13	A	3
SR canyon tribs	A	3	D	13
Patterson Cr	C	10	B	9
Mill-Emigrant Cr	B	8	C	12
Kidder Cr upper	C	12	C	11
Sniktaw Cr	D	14	D	13



Scott River Fall Chinook (normalized by reach length)
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	**Protection benefit**	**Restoration benefit**	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
SR canyon MS lower	A	A					C		B						C			B
SR canyon MS upper	A	B					C		B						C			B
SR canyon tribs	A								B									
SR valley to Kidder Cr	B	A	C				B		B						C			B
Sniktaw Cr			C				B	C	B									B
Shackleford Cr	B	A					B		A						C			B
Mill-Emigrant Cr	B	C					C		B									B
Moffett Cr lower		A	C				B	C	A						C			B
Kidder lower-Big Slough	B	B	C				C		B						C			B
Patterson Cr	C	B	C				B		A						C			B
Kidder Cr upper	C	C	C				B		B						C			C
SR valley to Etna Cr	C	A	C				B		B						B			B
Etna Cr	B	B	C				B	C	A	C								B
SR valley to tailings	B	A	C				B		B						C			B

Key to strategic priority (corresponding Benefit Category letter also shown)

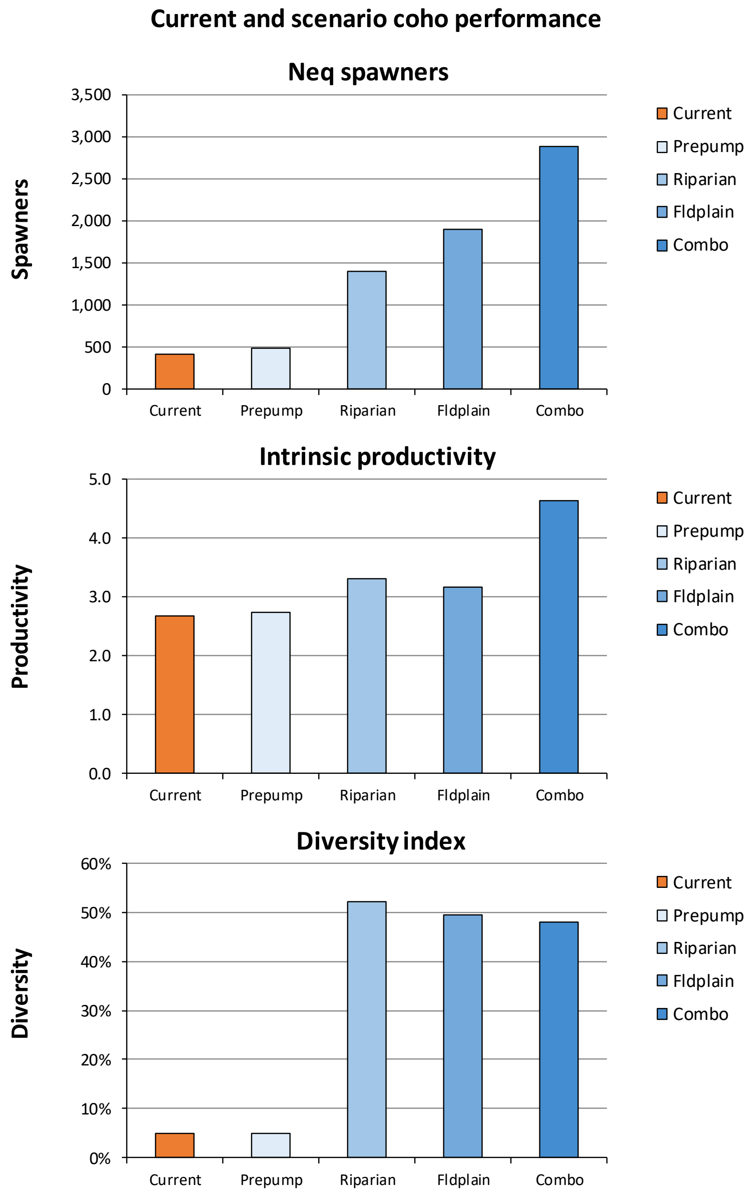
- **A** High
- **B** Medium
- **C** Low
- **D & E** Indirect or General

Restoration scenario analysis – modeling

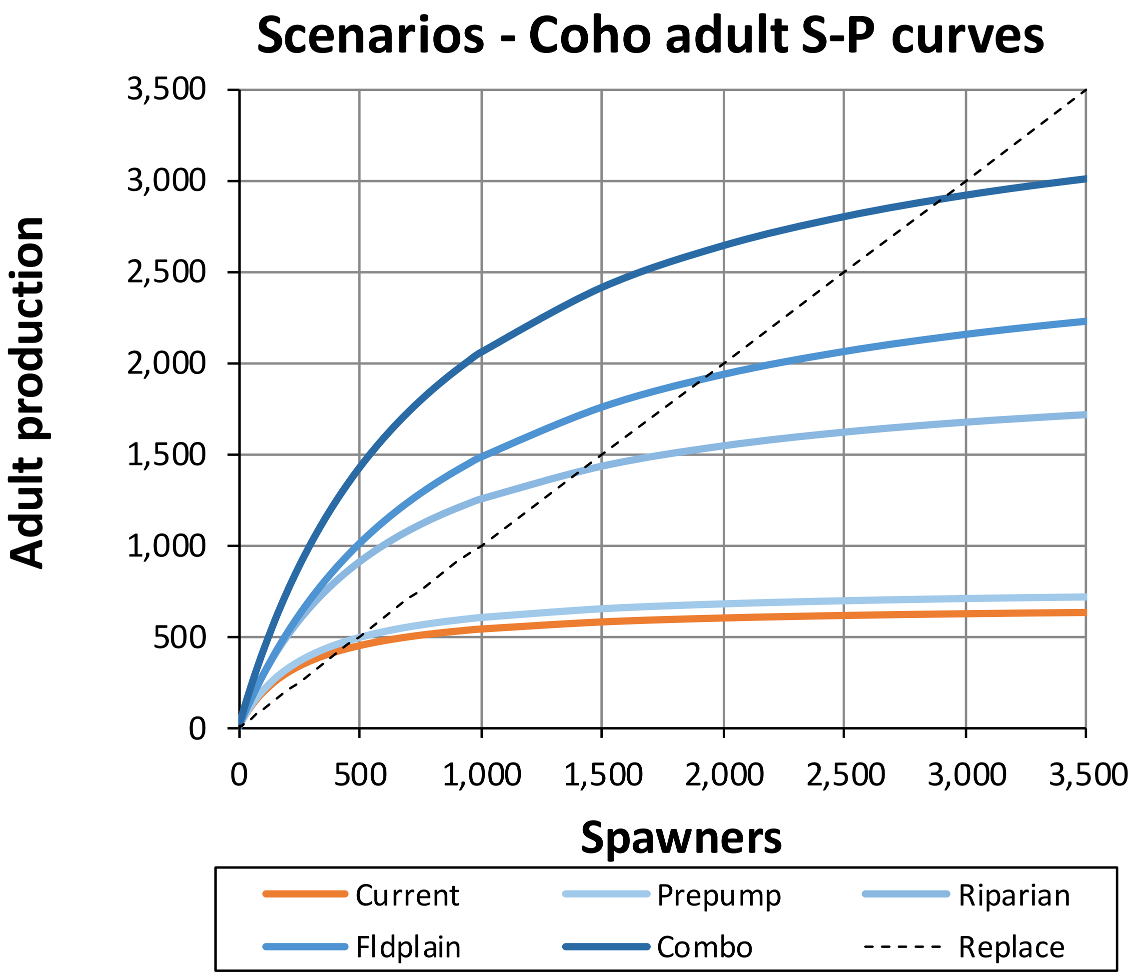
- Four hypothetical scenarios to inform restoration conceptualization

Scenario	Areas affected directly	Description
Restore prepumping flow	All reaches directly affected by major groundwater pumping	Restore surface water flows to levels prior to the onset of major groundwater pumping that began in the early to mid-1970s
Restore riparian	Entire subbasin	Restore all riparian zone conditions to historical characteristics (no changes are assumed for floodplain channels or in-stream channels)
Restore floodplains	Entire subbasin	Restore all floodplain channel conditions to historical characteristics (no changes are assumed for riparian vegetation or in-stream channels)
Combination	All reaches directly affected by major groundwater pumping	Restores a combination of conditions from scenarios above: • Restore ½ of surface flow lost by groundwater pumping • Restore ½ of riparian zone conditions to reaches directly affected by groundwater pumping • Restore ½ of floodplain channel conditions to reaches directly affected by groundwater pumping • Restore ½ of historical wood load to reaches directly affected by groundwater pumping • Restore in-stream channel habitat types to the average of historical and conditions

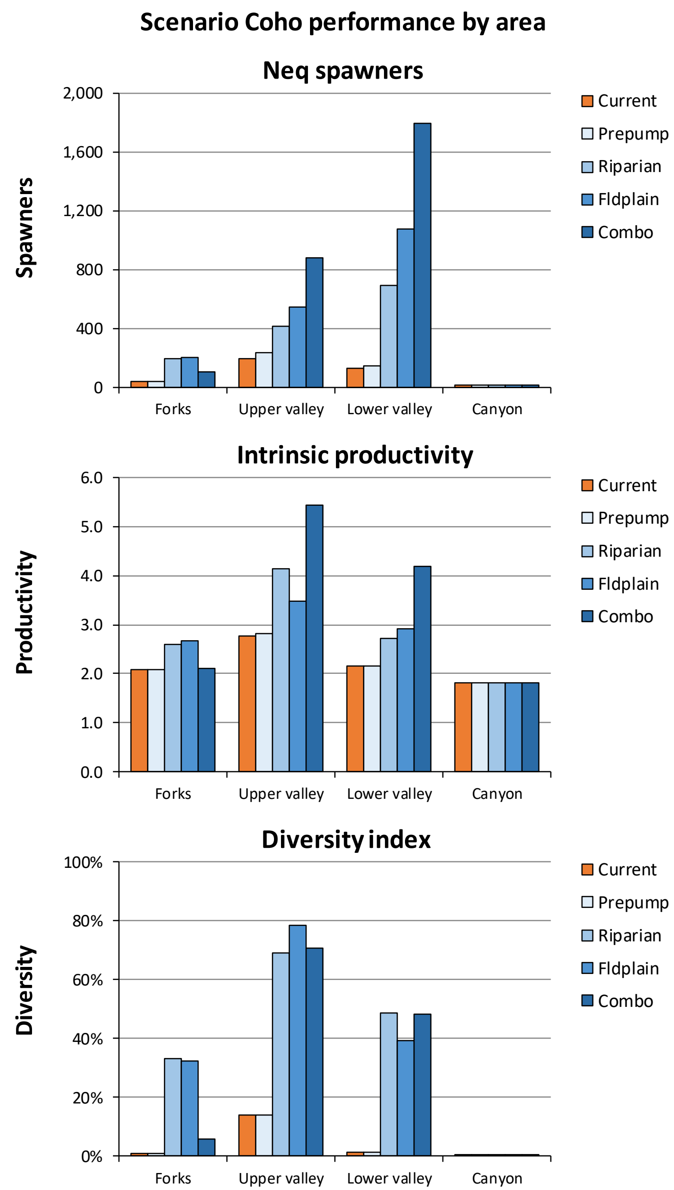
Restoration scenario analysis – coho



Restoration scenario analysis – coho



Restoration scenario analysis – coho



Conclusions

- Diagnostic summary
  - Conclusions not surprising
  - Modeling supported by empirical evidence
  - Multiple reasons for declines - cumulative
- Prognosis without intervention
  - Bleak without major interventions
  - Climate effects (ocean is a wild card)
- Urgency
  - Time is running out on these salmon stocks
  - Comprehensive, integrated plan needed

Questions

"The recovery of the Pacific salmon will be thwarted until at least some of the natural pathways through the riverscape are restored, until we give life to the ghosts of those salmon life histories that were once present in healthy rivers."

- Jim Lichatowich, Salmon Without Rivers