

Lower Spokane River Redband Rainbow Trout

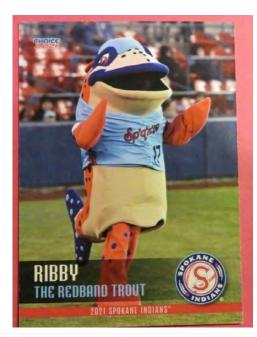
Spokane River Forum

April 26, 2023

Chris Moan, Fisheries Habitat Biologist

Redband Rainbow Trout

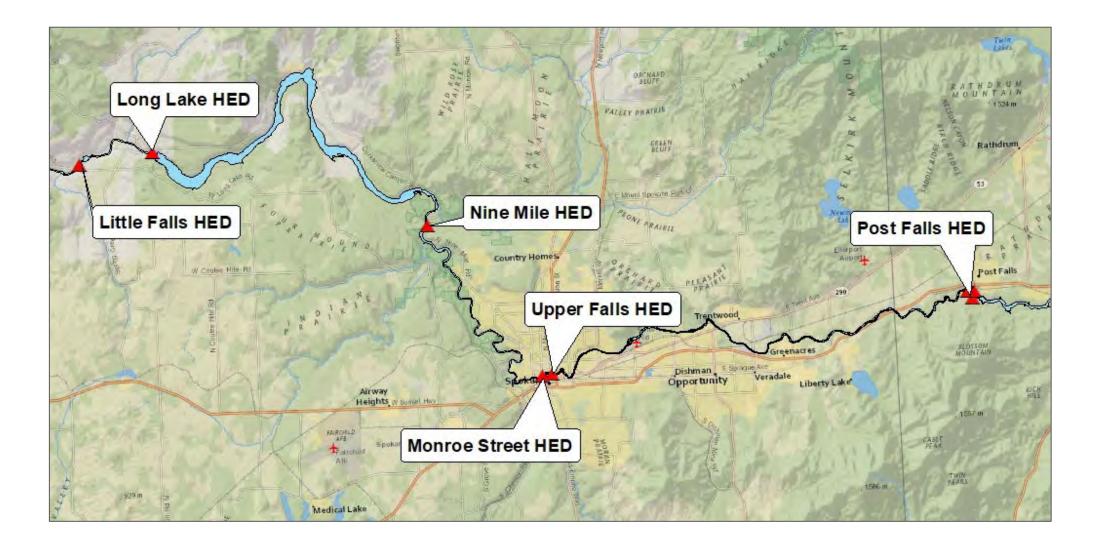
- Species of Greatest Conservation Need, Species of Concern, culturally significant
- Populations throughout the Spokane River, with a valuable spawning habitat in Spokane River below Spokane Falls







Avista's Spokane River Hydroelectric Developments





Avista's Washington 401 Certification

- Goal: Additional information is needed to better understand how the following specific factors relate to trout spawning success between Monroe Street Dam and the Nine Mile Dam Reservoir.
 - a) Quantify the quality and quantity of trout spawning habitat: determine the most productive and least productive spawning areas by developing quality strata at all flow/discharge elevations.
 - **b)**Quantify spawn to emergence success: determine survival from egg to emergence by strata using artificial redd construction. Correlate egg-to-emergence survival for each stratum with corresponding flow/discharge and include velocity, depth, and temperature as variables.
 - c) Quantify redd dewatering at different flow/discharge elevations for each habitat quality stratum.
 - d) Determine redband trout abundance estimates annually (for 10 years) to assess year class association with flow/discharge levels. Correlate year class strength with flow/discharge and egg to emergence survival. Determine overall spawning success with regard to flow/discharge levels and timing.



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Parts a, b, c

 Lower Spokane River Redband Trout Spawning Habitat: Monroe Street to Nine Mile Pool (2011)

• Part d

- Redband Trout Spawning and Fry Emergence Study: Abundance and Year Class Strength (2010-2019)
- Lower Spokane River Redband Rainbow Trout Abundance and Spawning Habitat Data Analysis (2022)



Redband Spawning Habitat

- Largest concentration of spawning patches was around TJ Meenach Bridge
- Average water depth of redds was 3.51 feet and observed at up to 5.3 feet.

	_	_		_							Endin	g Incub	ation D	ischarg	e (cfs)										
Spawning Discharge (cfs)	25,000	24,000	23,000	22,000	21,000	20,000	19,000	18,000	17,000	16,000	15,000	14,000	13,000	12,000	11,000	10,000	9,000	8,000	7,000	6,000	5,000	4,000	3,000	2,000	
25,000	100	100	100	100	100	100	100	100	99	99	98	96	94	92	89	86	81	75	68	61	54	47	41	34	
24,000	100	100	100	100	100	100	100	100	99	99	98	96	94	92	89	86	81	75	69	62	54	47	41	34	
23,000	100	100	100	100	100	100	100	100	99	99	98	96	94	92	89	86	81	75	69	62	55	47	41	34	3
22,000	100	100	100	100	100	100	100	100	99	99	98	96	94	92	89	86	82	76	69	62	55	48	41	34	1
21,000	100	100	100	100	100	100	100	100	99	99	98	96	94	92	89	86	82	76	69	62	55	48	41	34	
20,000	100	100	100	100	100	100	100	100	99	99	98	96	94	92	89	86	82	76	69	62	55	48	41	34	
19,000	100	100	100	100	100	100	100	100	100	99	98	96	94	92	89	86	82	76	69	62	55	48	41	34	1
18,000	100	100	100	100	100	100	100	100	100	99	99	97	94	92	89	86	82	76	70	63	56	48	41	35	
17,000	100	100	100	100	100	100	100	100	100	100	99	97	95	93	90	87	83	77	70	63	56	49	42	35	
16,000	100	100	100	100	100	100	100	100	100	100	99	97	95	93	90	87	83	78	71	64	57	49	42	35	3
15,000	100	100	100	100	100	100	100	100	100	100	100	98	96	94	91	88	84	79	72	65	58	50	43	36	
14,000	100	100	100	100	100	100	100	100	100	100	100	100	98	96	93	90	86	80	73	66	58	51	44	36	
13,000	100	100	100	100	100	100	100	100	100	100	100	100	100	98	95	92	88	81	74	66	59	51	43	36	
12,000	100	100	100	100	100	100	100	100	100	100	100	100	100	100	97	94	89	82	75	67	59	51	43	35	1
11,000	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	97	91	84	75	67	59	51	43	34	
10,000	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	94	85	76	67	59	51	43	34	
9,000	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	91	81	72	63	54	46	36	
8,000	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	89	79	70	61	51	40	
7,000	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	89	80	71	61	49	
6,000	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	91	81	71	57	
5,000	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	90	78	64	
4,000	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	88	73	
3,000	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	84	
2,000	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
1.000	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	

70%

50%

100%

90%

80%

<50%

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Parts a, b, c

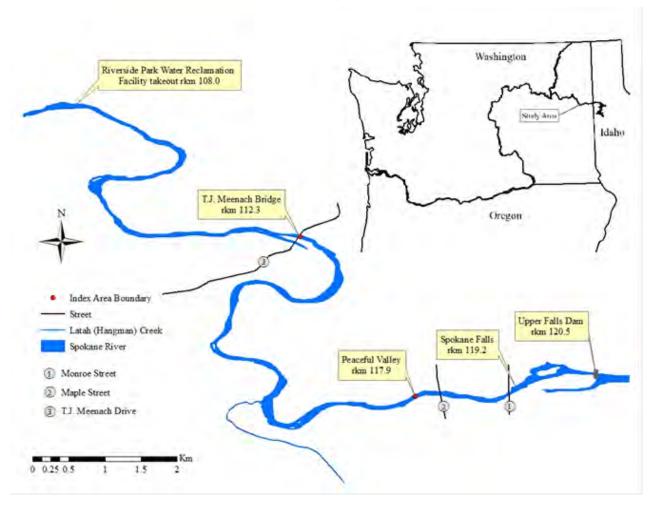
• Lower Spokane River Redband Trout Spawning Habitat: Monroe Street to Nine Mile Pool (2011)

• Part d

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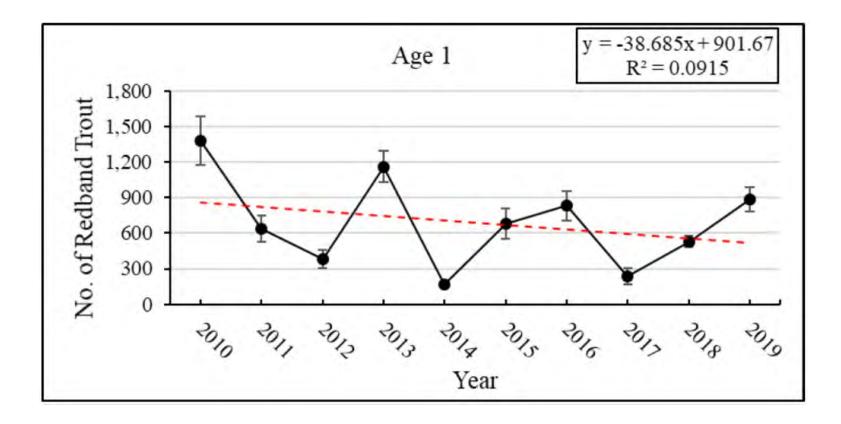
Survey Area



• Peaceful Valley to TJ Meenach Bridge



Redband Age 1 Abundance



 Age 1 abundance has followed a cyclic pattern with relatively strong year classes observed every three years, and subsequent strong year classes observed when abundant cohorts reached maturity



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Parts a, b, c

• Lower Spokane River Redband Trout Spawning Habitat: Monroe Street to Nine Mile Pool (2011)

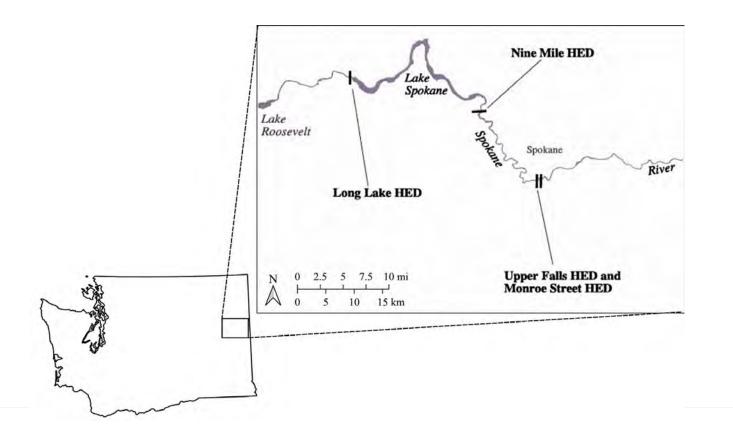
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Objectives

- Relate river flow levels and timing to redband trout spawning and fry emergence success and age-1 abundance (year-class strength)
 - Did not evaluate other variables that affect abundance
- Estimate carrying capacity to compare to the current abundance





Year-Class Strength

• Back-calculated age 0

Cohort method (longitudinal catch-curve method)

- Empirically estimated age 1
- Relationship between year class strength and environmental variables evaluated using regression models.

Variable	Source	Hypothesis
Minimum spawning flow (cfs)	USGS	Spawning habitat availability limits recruitment
Flow variability during incubation (cfs)	USGS	De-watering events limit recruitment
Minimum summer flow (cfs)	USGS	High temperatures and reduced summer habitat increase stress and predation risk
Maximum winter flow (cfs)	USGS	Winter flood events can cause juvenile mortality
Effective habitat available (%)	Addley and Peterson 2011	Habitat limitation during spawning and incubation limit age- 0 recruitment
Spawning habitat available (m ²)	Addley and Peterson 2011	Spawning habitat availability limits recruitment
Incubation habitat available (m ²)	Addley and Peterson 2011	Incubation habitat limits recruitment
Optimal carrying capacity	EDT (Section 2.2)	Age-0 (inactive) carrying capacity limits recruitment
Bedload transfer volume (m ³)	Avista	Monroe St. HED forebay rock relocation may decrease age-0 survival in the year when they occur or could increase egg survival in following year by improving habitat



Year-Class Strength Age 0

- Intercept-only top-ranked model
 - Average value was best predictor
- Effective habitat percent second highest, but not statistically different from zero

Model	Estimate ^a	Mean AIC c	Mean Rank	Mean R ²
Intercept only	8.51 (7.71, 9.29)	0.32	1.3	0
Effective habitat percent	-0.25 (-1.36, 0.89)	2.80	4.2	0.15
Minimum summer flow	-0.18 (-1.11, 0.77)	3.05	4.8	0.13
Spawning habitat area	0.31 (-0.21, 0.79)	3.32	5.1	0.11
Maximum winter flow	-0.30 (-0.73, 0.15)	3.59	5.6	0.09
Optimal carrying capacity	0.17 (-0.67, 1.00)	3.92	6.4	0.06
Incubation habitat area	0.00 (-0.65, 0.67)	3.90	6.4	0.06
Volume dredged material	-0.12 (-0.72, 0.48)	4.04	6.9	0.05
Incubation flow variation	0.00 (-0.71, 0.71)	4.08	7.0	0.05
Minimum spawning flow	0.11 (-0.35, 0.56)	4.17	7.3	0.04



Year-Class Strength Age 1

- Intercept-only top-ranked model
- Effective habitat percent second highest, explaining 22% of the variation in age-1 year-class strength

Model	Estimate ^a	Mean AIC c	Mean Rank	Mean R ²
Intercept only	6.41 (6.30, 6.53)	0.04	1.1	0
Effective habitat percent	0.32 (0.19, 0.46)	1.80	2.4	0.22
Incubation flow variation	0.26 (0.13, 0.4)	2.29	2.9	0.18
Volume dredged material	0.18 (0.1, 0.26)	3.19	4.7	0.11
Incubation habitat area	0.20 (0.09, 0.31)	3.21	5.0	0.10
Optimal carrying capacity	-0.24 (-0.38, -0.11)	3.26	5.2	0.10
Minimum spawning flow	0.07 (-0.02, 0.16)	4. 1 5	8.0	0.02
Spawning habitat area	-0.05 (-0.14, 0.05)	4.20	8.3	0.01
Maximum winter flow	-0.03 (-0.13, 0.08)	4.23	8.7	0.01
Minimum summer flow	0.03 (-0.12, 0.18)	4.23	8.7	0.01

Year-Class Strength

Spawning Discharge (CFS)	13,000 Ente	r Spawning Discharge (CFS) in multiple	es of 1,000 CFS (Range: 1,000 to 25,000 CFS)
ncubation Discharge (CFS)	6,000 Ente	r Ending Incubation Discharge (CFS) in	multiples of 1,000 CFS (Range: 1,000 to 25,00
iffective Spawning Habitat Percentage	66%	Age-1 Prediction with Confidence Intervals	Age-1 Prediction with Prediction Intervals
Age-0 Estimate: Intercept-Only Model		1,800	4,500
Abundance Prediction	4,955	1,400	a) 4,000 pp 3,500 gr 3,000
15% Prediction Interval Lower	183 IV	1,200	
5% Prediction Interval Upper	183 1-1-0-24 134,285 1-2-4	600	7 2,500 9 2,000 9 1,500
	Lov, 200	400 200	91,500 92,1,000 24,500
Age-1 Estimate: Effective Spawning and Incubation Ha	bitat Model	0 10 20 30 40 50 60 70 80 90 100	0 10 20 30 40 50 60 70 80 90 100
bundance Prediction	404	Effective Spawning and Incubation Habitat Percentage	Effective Spawning and Incubation Habitat Percentage
5% Prediction Interval Lower	72		
15% Prediction Interval Upper	2,276		
% of Maximum Predicted Abundance	51%		



Year-Class Strength

spawning Discharge (CFS)	13,000 Ente	er Spawning Discharge (CFS) in multip	oles of 1,000 CFS (Range: 1,000 to 25,000 CFS)
ncubation Discharge (CFS)	10,000 Ente	er Ending Incubation Discharge (CFS)	in multiples of 1,000 CFS (Range: 1,000 to 25,0
ffective Spawning Habitat Percentage	92%	Age-1 Prediction with Confidence Intervals	Age-1 Prediction with Prediction Intervals
Age-0 Estimate: Intercept-Only Model		1,800	4,500
bundance Prediction	4,955	1,400	au 4,000 3,500 3,500 2,500 2,000
5% Prediction Interval Lower	183	1,200	3,000 1 2,500
5% Prediction Interval Upper	134,285	800 600	
	134,285	400 200	9 1,500 9 1,000 500
Age-1 Estimate: Effective Spawning and Incubation Ha	bitat Model	0 10 20 30 40 50 60 70 80 90 10	0 0 10 20 30 40 50 60 70 80 90 10
bundance Prediction	679	Effective Spawning and Incubation Habita Percentage	Effective Spawning and Incubation Habitat Percentage
5% Prediction Interval Lower	135		
5% Prediction Interval Upper	3,416		
of Maximum Predicted Abundance	85%		



- Stock-recruitment framework
 - Beverton-Holt model used
- Abundance by life stage
- Applied optimal life stage density, survival benchmarks, and habitat capacity rules from EDT model

Life Stage	Months of Occurrence	Benchmark Density in Suitable Habitat	Benchmark Survival
Spawning	March to May	0.84 fish/m ²	1
Egg incubation	March to July	500 eggs/ m²	0.7
Fry colonization	June to July	26 fry/ m ²	0.75
0-age resident rearing	June to October	2.52 parr/ m ²	0.78
0-age inactive	November to March	1.51 parr/m ²	0.70
1-age resident rearing	April to November	0.40 fish/m ²	0.85
1-age inactive	November to March	0.21 fish/m ²	0.85
2+-age resident rearing	April to November	0.11 fish/m ²	0.9
2+-age inactive	November to March	0.11 fish/m ²	0.93



 Year-to-year variation in flow conditions, expressed as the geomean of average daily flows per month over the period of record, have a limited effect on optimal carrying capacity.

Reach	Brood Year	Spawners	Egg Incubation	Fry Colonization	0-Age Resident Rearing	0-Age Inactive	1-Age Resident Rearing	1-Age Inactive	2+-Age Resident Rearing	2+-Age Inactive
Spokane	2001	500°	160,875	97,578	44,322	31,237	20,737	13,727	7,931	5,464
River Mainstem	2002	500°	161,387	98,129	44,096	31,847	21,528	13,944	8,017	5,601
18b	2003	5,464	1,432,637	566,917	177,296	87,128	39,311	20,337	10,145	6,355
	2004	5,601	1,466,759	576,829	178,932	89,902	40,972	19,484	9,333	6,069
	2005	6,355	1,603,033	611,475	189,121	87,880	37,895	19,051	9,367	5,887
	2006	6,069	1,562,812	602,126	178,240	86,186	38,193	18,161	8,545	5,593
	2007	5,887	1,523,660	587,290	179,857	82,811	34,801	17,646	8,806	5,889
	2008	5,593	1,452,045	581,284	169,495	81,336	36,278	18,937	9,393	5,847
	2009	5,889	1,516,088	586,029	174,356	86,319	38,468	17,982	8,556	5,498
	2010	5,847	1,505,416	602,118	185,159	83,130	35,101	17,229	8,377	5,616
	2011	5,498	1,452,949	596,998	171,871	79,943	34,512	18,085	9,036	5,879
	2012	5,616	1,472,396	586,860	168,955	83,285	37,215	18,590	8,957	5,882
	2013	5,879	1,516,554	586,737	176,392	84,539	36,531	18,606	9,253	6,019
	2014	5,882	1,532,690	595,173	174,502	84,775	37,898	18,979	9,270	5,859
	2015	6,019	1,502,595	576,668	186,975	88,236	38,245	18,235	8,590	5,537
	2016	5,859	1,510,398	582,990	179,813	83,045	34,972	17,316	8,483	5,677
	2017	5,537	1,454,239	569,978	166,945	79,146	34,740	18,202	9,052	5,862
	2018	5,677	1,462,130	571,465	169,350	83,617	37,218	18,468	8,994	n/a
Spokane	2001	500°	159,661	95,650	41,920	27,805	16,229	10,018	5,487	3,739
River Mainstem	2002	500°	160,040	96,011	40,717	27,612	16,932	10,306	5,581	3,840
18c	2003	3,739	995,673	422,460	128,409	60,830	26,175	13,464	6,620	4,155
	2004	3,840	1,019,402	429,561	127,685	62,012	27,215	12,859	6,070	3,961
	2005	4,155	1,080,017	446,863	135,666	60,484	25,073	12,567	6,080	3,960
	2006	3,961	1,045,312	437,534	125,374	58,856	25,140	12,557	5,670	3,747
	2007	3,960	1,044,292	435,370	131,514	60,293	23,497	11,996	5,757	3,883
	2008	3,747	994,820	425,396	115,099	55,427	23,638	12,526	6,208	3,918
	2009	3,883	1,025,013	430,331	124,163	59,997	26,012	12,275	5,633	3,695



1990 BRADE DE COMPANY	a		wning and Inc			11,000	11,000	8,000	6,000	<u></u>						
elect Representative Flows	Rearing Year	Percentile (of mean annual flow 2001-2020)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	No	v ()ec
or Redband Trout Rearing	Year 0	5th	2001	1	Summer of the	11,000	11,000	8,000				02	916	1,936	2,525	4,3
Stoller interesting	Year 1	10th	2010	3,157	3,254			9,368	12,201	2,887		136	1,374	2,072	3,206	6,3
	Year 2	5th	2001	1,523	1,615	2,385	4,843	10,631	3,640	1,348	1	702	316	1,936	2,525	4,3
	Parameter	Reach	Enter Value				Defir	nition								
	Enter # of Spawners	Spokane Mainstem					Spokane Falls					-				
	Enter Fecundity	Spokane Mainstem		Number of sp Eggs per fem			langman riffle 1001	crest to 1.46 kr	n downstream	of TJ Meenach	n Bridge	-				
inter Spawning Population	Sex Ratio (F/M)			Ratio of fema								1				
	Select Flov-Based Incubation Capacity	Min Max Average		- Average = /	Average of ge	ometric mean	thly flows during monthly flows o nthly flows duri	during spawnin	boined gr							
		Habitat Paramete		-		Select Sca	lar Value				-		Defi	nition		
		Flow	1	1	1	1	1 1	1	1 1	0.99	Effects o	lintra-mon		bility and diel	variation	
			1	1	1	1	1 7	1	1	1	Effects o	substrate	fines, embed	ddedness, ar	nd stability ((seour)
		Substrate												and the last	ulders, etc.)
		Substrate Habitat Complexity	1	1	1		1		1	1	Availabil	ity of cover	(LWD, under	curbank, bo		
Select Life Stage Prod	luctivity Scalars		1	1	1		1	1	1	777				d ground wat		
Select Life Stage Prod	luctivity Scalars	Habitat Complexity	1	1	1			1	1	1 1 1	Effect of	DO levels in	n surface an		ei	
Select Life Stage Proc	luctivity Scalars	Habitat Complexity Dissolved Oxygen	1	1 1 1	1			1	1		Effect of Effects of	DO levels in I maximum	n surface an	d ground wat minimum wir	ei	
Select Life Stage Proc	luctivity Scalars	Habitat Complexity Dissolved Oxygen Temperature Food Competition	1	1	1	1		1	1	1	Effect of Effects of Effect of Effect of	DO levels in f maximum tood availa non-speci	n surface an summer and bility on reari fic competitio	d ground wat I minimum wir ing survival on on rearing	er hter tempera	
Select Life Stage Prod	luctivity Scalars	Habitat Complexity Dissolved Oxygen Temperature Food	1	1 1 1 1 1	1					1 1 1	Effect of Effects of Effect of Effect of	DO levels in f maximum tood availa non-speci	n surface an summer and bility on reari	d ground wat I minimum wir ing survival on on rearing	er hter tempera	
Select Life Stage Proc	luctivity Scalars Reach	Habitat Complexity Dissolved Oxygen Temperature Food Competition	Egg incubation	Fry colonizat	0-age resident rearing	0-age Triactive	1-age resident rearing	1-age Inactive	2+-age resident rearing	1 1 1 1 1 1 2+-age inactive	Effect of Effects of Effect of Effect of	DO levels in f maximum tood availa non-speci	n surface an summer and bility on reari fic competitio	d ground wat I minimum wir ing survival on on rearing	er hter tempera	
	Reach Spokane Mainstem 18c	Habitat Complexity Dissolved Dxygen Temperature Food Competition Predation # of Eggs 275,000	Egg incubation 160,837	colonizat ion 96,332	resident rearing 42,181	inactive 28,504	resident rearing 17,292	inactive 10,197	resident rearing 5,628	inactive 3,857	Effect of Effects of Effect of Effect of	DO levels in f maximum tood availa non-speci	n surface an summer and bility on reari fic competitio	d ground wat I minimum wir ing survival on on rearing	er hter tempera	
	Reach	Habitat Complexity Dissolved Oxygen Temperature Food Competition Predation # of Eggs	Egg incubation	colonizat ion 96,332	resident rearing 42,181	inactive 28,504	resident rearing 17,292	inactive 10,197	resident rearing 5,628	inactive 3,857	Effect of Effects of Effect of Effect of	DO levels in f maximum tood availa non-speci	n surface an summer and bility on reari fic competitio	d ground wat I minimum wir ing survival on on rearing	er hter tempera	



Rearing Year Year 0	0 0004 00001	Representa				1										
	Flow 2001-2020) 25th	tive Year 2003	Jan	Feb	Mar 12.000	Apr 11.000	May 6.000	Jun 4,474	Jul 1,187	Aug	Sep	1.013	Jct	Nov	2,335	ec 3,4
	50th	2003	4,074	4.805	7,554				1,862		213	1,382		368	3,087	4,2
	75th	2008	3,098						4,156		183	1,598		254	2,667	3,8
		14.53														
Parameter	Reach	Enter Value				Defi	nition									
F	Spokane Mainstem	600	Number of sp	awners in inde	s reach from \$	Spokane Falls	to riffle crest 0.	2 km downstre	am of Hangm	an Creek						
Enter • or spawners	Spokane Mainstem	600	Number of sp	awners in inde	steachfrom	langman tiffle	crest to 1.46 k	m downstream	of TJ Meenao	h Bridge						
Enter Fecundity		1,100	Eggs pet fem	ale spawner (d	efault value 1.	,100)										
Sex Ratio (F/M)		0.5														
Select Flow-Based Incubation Capacity	Max Average		- Average = A	Average of get	ometric mean	monthly flows	during spawnin	ng period								
	Habitat Paramete				Select Sca	lar Value		-			_		Definiti		_	
	Flow	1	1	1	Select Sca	lar Value	1	[1	0.99		of intra-mor	nth flow y	ariability	and diel v		
	Flow Substrate	1	1	1	Select Sca	lar Value	1	1	0.99	Effects o	of substrate	th flow v lines, en	ariability nbeddeo	and diel v Iness, and	i stability (s	cour)
	Flow Substrate Habitat Complexity	1	1	1	Select Sca	lar Value 1 1	1	1	0.39	Effects of Availabil	of substrate ity of cover	th How v Tines, en (LWD, ur	ariability nbeddeo ndercut l	and diel v Iness, and bank, bou	l stability (s Iders, etc.)	cour)
	Flow Substrate Habitat Complexity Dissolved Oxygen	1	1 1 1 1	1	Select Sca	lar Value 1 1 1	1	1	0.39 1 1 1	Effects of Availabil Effect of	of substrate lity of cover DD levels i	nth llow v lines, en (LWD, ur n surface	variability mbeddeo ndercut l e and gro	and diel w Iness, and bank, bou bund wate	d stability (s Iders, etc.) r	
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	Enter # of Spawners Enter Fecundity Sex Ratio (F/M) Select Flow-Based	Enter # of Spawners Spokane Mainstem Spokane Mainstem Sex Ratio (F/M) Select Flow-Based Incubation Capacity	Enter # of Spavners Spokane Mainstem 600 Spokane Mainstem 600 Enter Fecundity 1100 Sex Ratio (F/M) 0.5 Select Flow-Based Incubation Capacity	Enter # of Spavners Spokane Mainstem 600 Number of sp Spokane Mainstem 600 Number of sp Enter Fecundity 1,100 Eggs pet fem. 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Enter # of Spawners Spokane Mainstem 600 Number of spawners in index reach from Hangman riffle crest to 146 km Enter Fecundity 1.100 Eggs pet female spawner (default value 1.100) Sex Ratio (F/M) 0.5 Ratio of females to males (default value 0.5) Click button to select flow value used to estimate habitat capacity for s	Enter # of Spawners Spokane Mainstem 600 Number of spawners in index reach from Spokane Fails to riffle crest 0.2 km downstream Enter # of Spawners Spokane Mainstem 600 Number of spawners in index reach from Hangman riffle crest 0.2 km downstream Enter Feoundity 1:00 Eggs pet females to makes (default value 1,100) Sex Ratio (F/M) 0.5 Ratio of females to makes (default value 0.5) Click button to select flow value used to estimate habitat capacity for spawning period -Min = Minimum of geometric mean monthly flows during spawning period Max Average of geometric mean monthly flows during spawning period -Max = Maximum of geometric mean monthly flows during spawning period	Enter # of Spawners Spokane Mainstem 600 Number of spawners in index reach from Spokane Falls to riffle crest 0.2 km downstream of Hangman Spokane Mainstem 600 Number of spawners in index reach from Hangman riffle crest to 1.46 km downstream of TJ Meenaol Enter Feoundity 1:00 Eggs pet females spawner (default value 1.100) Sex Ratio (F/M) 0.5 Ratio of females to males (default value 0.5) Click button to select flow value used to estimate habitat capacity for spawning and incubation: - Min = Minimum of geometric mean monthly flows during spawning period - Maxe - Min = Mainsum of geometric mean monthly flows during spawning period - Maxe = Average of geometric mean monthly flows during spawning period	Enter # of Spawners Spokane Mainstem 600 Number of spawners in index reach from Spokane Fails to riffle crest 0.2 km downstream of Hangman Creek Enter # of Spawners Spokane Mainstem 600 Number of spawners in index reach from Hangman riffle crest to 146 km downstream of TJ Meenach Bridge Enter Fecundity 1.100 Eggs pet female spawners (default value 1.100) Sex Ratio (F/M) 0.5 Ratio of females to males (default value 0.5) Click button to select flow value used to estimate habitat capacity for spawning period - Average = Average of geometric mean monthly flows during spawning period - Max - Max = Maximum of geometric mean monthly flows during spawning period - Max = Maximum of geometric mean monthly flows during spawning period	Enter # of Spawners Spokane Mainstem 600 Number of spawners in index reach from Spokane Falls to riffle crest 0.2 km downstream of Hangman Creek Enter # of Spawners Spokane Mainstem 600 Number of spawners in index reach from Hangman riffle crest to 146 km downstream of TJ Meenach Bridge Enter Fecundity 1:00 Eggs pet females spawner (default value 0.5) Sex Ratio (F/M) 0.5 Ratio of females to males (default value 0.5) Click button to select flow value used to estimate habitat capacity for spawning and incubation: - Min = Minimum of geometric mean monthly flows during spawning period - Maxe - Min = Minimum of geometric mean monthly flows during spawning period - Maxer Mainsum of geometric mean monthly flows during spawning period	Enter # of Spawners Spokane Mainstem 600 Number of spawners in index reach from Spokane Falls to riffle crest 0.2 km downstream of Hangman Creek Enter # of Spawners Spokane Mainstem 600 Number of spawners in index reach from Hangman riffle crest to 1.46 km downstream of TJ Meenach Bridge Enter Feoundity 1:00 Eggs pet females to males (default value 1.00) Sex Ratio (F/M) 0.5 Ratio of females to males (default value 0.5) Click button to select flow value used to estimate habitat capacity for spawning and incubation: Min = Minimum of geometric mean monthly flows during spawning period Max = Maximum of geometric mean monthly flows during spawning period	Enter # of Spawners Spokane Mainstem 600 Number of spawners in index reach from Spokane Falls to riffle crest 0.2 km downstream of Hangman Creek Enter # of Spawners Spokane Mainstem 600 Number of spawners in index reach from Hangman riffle crest to 1.46 km downstream of TJ Meenach Bridge Enter Fecundity 1:00 Eggs pet females to makes (default value 1.00) Sex Ratio (F/M) 0.5 Ratio of females to makes (default value 0.5) Click button to select flow value used to estimate habitat capacity for spawning and incubation: Min = Minimum of geometric mean monthly flows during spawning period Max = Maximum of geometric mean monthly flows during spawning period	Enter # of Spawners Spokane Mainstem 600 Number of spawners in index reach from Spokane Falls to riffle crest 0.2 km downstream of Hangman Creek. 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Conclusions

- Redband abundance is below carrying capacity; Redband population does not currently appear to be affected by density dependence
- Variations in flow during spawning and incubation had a moderate effect on age 1, not age 0
- Generally, incubation flows should be within 2,000 cfs of the spawning flows to maximize age-1 recruitment
- Spawning flows above 18,000 cfs provide no additional habitat or recruitment benefit
- At spawning and incubation flows below 10,000 cfs, age-1 recruitment begins to drop off precipitously



Questions?



