Appendix B. Summary of estimated population size, parameter estimates, risk of extinction and 90% decline in abundance and needed improvements in λ to reduce risk of decline or extinction in 50 years to below 5%, using all available data post-1965. When no hatchery fraction data were available estimates made using the total (wild + hatchery) spawner count data as described in the text. Estimates are provided for individual stocks only since ESU-level data generally were not available from 1965.

		Pop. Size Est. (TS$_0$)	Population Parameter Estimates						Risk of Extinction			Risk of 90% Decline			
ESU	Stock		μ	σ^2	λ (95% c.i.)	Prob λ <1.0	Prob λ <0.9	Req % inc.	50 yr. (95% c.i.)	Prob. VHER[1]	Req % inc.	50 yr. (95% c.i.)	Prob. VHRD[2]	Req % inc.	Note[3]
Lower Columbia R chinook	Clatskanie R fall	NA	0.01	0.37	1.01 (0.77 - 1.31)	0.47	0.21	0	NA	NA	NA	0.27 (0 - 0.99)	0.55	10	
	Coweman R fall-tule	2923	0.08	0.17	1.09 (0.90 - 1.32)	0.20	0.05	0	0 (0 - 0.07)	0.07	0	0.02 (0 - 0.69)	0.24	0	t
	Cowlitz R fall-tule	NA	-0.02	0.14	0.98 (0.82 - 1.16)	0.59	0.19	2	NA	NA	NA	0.34 (0 - 1)	0.61	7	a
	Klickitat R fall-tule	NA	-0.06	0.30	0.94 (0.73 - 1.22)	0.66	0.36	6	NA	NA	NA	0.57 (0 - 1)	0.73	16	t
	Lewis E Fk fall-tule	853	-0.02	0.05	0.98 (0.88 - 1.09)	0.63	0.10	2	0 (0 - 0.26)	0.12	0	0.25 (0 - 0.97)	0.55	4	
	Lewis R fall-bright	34652	0.01	0.06	1.01 (0.90 - 1.12)	0.43	0.06	0	0 (0 - 0)	0.02	0	0.06 (0 - 0.89)	0.37	1	
	Plympton Cr fall	NA	0.05	0.09	1.05 (0.92 - 1.20)	0.22	0.04	0	NA	NA	NA	0.01 (0 - 0.59)	0.22	0	
	Skamokawa Cr fall-tule	NA	-0.09	0.17	0.91 (0.76 - 1.10)	0.80	0.44	9	NA	NA	NA	0.78 (0.02 - 1)	0.83	16	
	Washougal R fall-tule	NA	0.10	0.11	1.11 (0.95 - 1.28)	0.11	0.02	0	NA	NA	NA	0 (0 - 0.22)	0.13	0	
	White Salmon fall-tule	NA	-0.07	0.09	0.93 (0.81 - 1.06)	0.82	0.33	7	NA	NA	NA	0.74 (0.01 - 1)	0.81	11	
	Wind R fall-tule	NA	-0.05	0.45	0.95 (0.70 - 1.29)	0.62	0.35	5	NA	NA	NA	0.52 (0 - 1)	0.71	18	
	Youngs R fall	NA	0.04	0.66	1.04 (0.73 - 1.48)	0.40	0.20	0	NA	NA	NA	0.23 (0 - 0.98)	0.51	12	
Upper Columbia R spring chinook	Entiat R spr	168	-0.10	0.04	0.90 (0.83 - 0.99)	0.95	0.46	10	0.53 (0 - 1)	0.69	5	0.97 (0.24 - 1)	0.94	11	t,d
	Methow R spr	486	-0.13	0.18	0.88 (0.73 - 1.06)	0.88	0.60	12	0.63 (0 - 1)	0.72	12	0.92 (0.12 - 1)	0.90	21	t,a,d
	Wenatchee R spr	1466	-0.11	0.09	0.89 (0.78 - 1.02)	0.91	0.54	11	0.26 (0 - 0.97)	0.52	4	0.94 (0.15 - 1)	0.92	15	
Snake R spr/sum chinook	Alturas Lake Cr spr	NA	-0.20	0.22	0.82 (0.67 - 1.00)	0.95	0.81	18	NA	NA	NA	0.99 (0.45 - 1)	0.96	31	
	Beaver Cr spr	NA	-0.18	0.19	0.84 (0.68 - 1.02)	0.93	0.75	16	NA	NA	NA	0.98 (0.37 - 1)	0.95	27	

Big Cr spr	NA	-0.06	0.12	0.94 (0.81 - 1.10)	0.74	0.29	6	NA	NA	NA	0.61 (0 - 1)	0.75	10	
Big Sheep Cr spr	NA	-0.10	0.90	0.90 (0.60 - 1.35)	0.70	0.48	10	NA	NA	NA	0.66 (0.01 - 1)	0.80	32	
Camas Cr spr	NA	-0.12	0.09	0.88 (0.77 - 1.01)	0.92	0.60	12	NA	NA	NA	0.97 (0.22 - 1)	0.93	16	
Cape Horn Cr spr	NA	-0.08	0.20	0.92 (0.75 - 1.13)	0.75	0.41	8	NA	NA	NA	0.7 (0.01 - 1)	0.79	15	d
Catherine Cr spr	NA	-0.05	0.11	0.96 (0.83 - 1.10)	0.70	0.22	4	NA	NA	NA	0.49 (0 - 1)	0.70	9	
Catherine Cr N Fk spr	NA	-0.06	0.26	0.94 (0.74 - 1.19)	0.69	0.37	6	NA	NA	NA	0.60 (0 - 1)	0.75	15	a
Catherine Cr S Fk spr	NA	-0.09	0.56	0.91 (0.65 - 1.29)	0.70	0.46	9	NA	NA	NA	0.66 (0.01 - 1)	0.78	25	a
Grande Ronde R spr	NA	-0.10	0.11	0.91(0.79 - 1.04)	0.88	0.47	9	NA	NA	NA	0.87(0.05 - 1)	0.89	14	
Hayden Cr sum	NA	-0.05	0.25	0.95 (0.62 - 1.46)	0.59	0.37	5	NA	NA	NA	0.51 (0 - 1)	0.62	13	
Herd Cr sum	NA	-0.16	0.04	0.85 (0.74 - 0.99)	0.92	0.73	15	NA	NA	NA	1 (0.47 - 1)	0.93	18	a,l
Imnaha R spr	610	-0.06	0.06	0.94 (0.85 - 1.05)	0.82	0.21	6	0.03 (0 - 0.80)	0.26	0	0.65 (0.01 - 1)	0.78	8	
Johnson Cr sum	432	-0.03	0.06	0.97 (0.87 - 1.08)	0.68	0.12	3	0.01 (0 - 0.57)	0.18	0	0.34 (0 - 0.99)	0.61	5	
Knapp Cr spr	NA	-0.18	0.12	0.84 (0.71 - 0.98)	0.96	0.80	16	NA	NA	NA	1 (0.53 - 1)	0.97	24	d
Lake Cr sum	NA	0.00	0.22	1.00 (0.81 - 1.24)	0.49	0.19	0	NA	NA	NA	0.25 (0 - 0.98)	0.54	7	d
Lemhi R spr	NA	-0.06	0.17	0.94 (0.78 - 1.12)	0.73	0.33	6	NA	NA	NA	0.62 (0.01 - 1)	0.76	13	a
Lookingglass Cr spr	NA	-0.17	0.09	0.84 (0.74 - 0.96)	0.97	0.82	16	NA	NA	NA	1 (0.63 - 1)	0.98	22	
Loon Cr sum	NA	-0.06	0.03	0.94 (0.87 - 1.01)	0.91	0.15	6	NA	NA	NA	0.75 (0.03 - 1)	0.83	6	l
Lostine R spr	NA	-0.04	0.06	0.96 (0.87 - 1.07)	0.73	0.13	4	NA	NA	NA	0.41(0 - 0.99)	0.66	5	
Marsh Cr spr	286	-0.08	0.11	0.92 (0.80 - 1.07)	0.82	0.36	8	0.30 (0 - 0.99)	0.53	5	0.76 (0.02 - 1)	0.83	12	
Minam R spr	322	-0.05	0.18	0.95 (0.79 - 1.14)	0.69	0.30	5	0.22 (0 - 0.96)	0.46	4	0.55 (0.01 - 1)	0.73	12	
Minam R Low spr	NA	-0.02	0.30	0.98 (0.78 - 1.25)	0.54	0.24	2	NA	NA	NA	0.35 (0 - 0.99)	0.61	11	
Minam R Up spr	NA	-0.04	0.10	0.96 (0.83 - 1.10)	0.70	0.21	4	NA	NA	NA	0.48 (0 - 1)	0.69	8	
Poverty Cr	951	-0.27	1.73	0.77 (0.43 - 1.36)	0.87	0.74	23	0.88 (0.14 - 1)	0.85	121	0.88 (0.06 - 1)	0.93	70	
Salmon R E Fk spr	NA	-0.14	0.08	0.87 (0.68 - 1.10)	0.82	0.60	13	NA	NA	NA	0.99 (0.01 - 1)	0.85	18	

	Salmon R E Fk sum	NA	-0.10	0.16	0.90 (0.76 - 1.08)	0.84	0.48	10	NA	NA	NA	0.83(0.04 - 1)	0.87	16	
	Salmon R S Fk sum	NA	-0.02	0.11	0.98 (0.85 - 1.13)	0.60	0.15	2	NA	NA	NA	0.31 (0 - 0.99)	0.59	6	d
	Salmon R M Fk spr	NA	-0.13	0.05	0.88 (0.72 - 1.07)	0.83	0.58	12	NA	NA	NA	1 (0.03 - 1)	0.85	15	
	Salmon R Upper spr	NA	-0.09	0.10	0.91 (0.79 - 1.05)	0.86	0.43	9	NA	NA	NA	0.85 (0.05 - 1)	0.87	14	
	Salmon R Upper sum	NA	-0.08	0.19	0.93 (0.76 - 1.13)	0.75	0.39	7	NA	NA	NA	0.69 (0.01 - 1)	0.79	15	
	Secesh R sum	NA	-0.02	0.05	0.98 (0.90 - 1.08)	0.59	0.06	2	NA	NA	NA	0.16(0 - 0.95)	0.47	3	
	Sulphur Cr spr	200	-0.08	0.30	0.92 (0.73 - 1.18)	0.72	0.41	8	0.50 (0 - 1)	0.63	26	0.66 (0.01 - 1)	0.79	18	
	Valley Cr Upper spr	NA	-0.10	0.40	0.90 (0.69 - 1.19)	0.75	0.48	10	NA	NA	NA	0.73 (0.01 - 1)	0.82	23	
	Valley Cr Upper sum	NA	-0.11	0.18	0.90 (0.74 - 1.09)	0.83	0.50	10	NA	NA	NA	0.84 (0.06 - 1)	0.86	18	
	Wallowa Cr spr	NA	-0.11	0.42	0.89 (0.68 - 1.18)	0.78	0.52	11	NA	NA	NA	0.77 (0.03 - 1)	0.84	25	
	Wenaha R S Fk spr	NA	-0.05	0.12	0.95 (0.83 - 1.10)	0.70	0.23	5	NA	NA	NA	0.50 (0 - 1)	0.71	9	
	Yankee Fk sum	NA	-0.18	0.39	0.83 (0.63 - 1.11)	0.88	0.70	17	NA	NA	NA	0.94 (0.15 - 1)	0.92	33	
	Yankee W Fk sum	NA	-0.10	0.15	0.90 (0.76 - 1.08)	0.84	0.49	10	NA	NA	NA	0.86 (0.04 - 1)	0.87	16	
	Yankee W Fk spr	NA	-0.19	0.10	0.83 (0.71 - 0.96)	0.97	0.84	17	NA	NA	NA	1 (0.71 - 1)	0.98	25	
Snake R fall chinook	Snake R	1946	-0.11	0.09	0.89 (0.77 - 1.03)	0.90	0.55	11	0.24 (0 - 0.98)	0.50	4	0.94 (0.08 - 1)	0.91	15	a
Lower Columbia R steelhead	Clackamas R win	1041	-0.04	0.06	0.96 (0.86 - 1.07)	0.72	0.14	4	0 (0 - 0.36)	0.15	0	0.43 (0 - 1)	0.66	6	a
Middle Columbia R steelhead	Bear Cr sum	NA	-0.08	0.09	0.93 (0.81 - 1.06)	0.82	0.35	7	NA	NA	NA	0.76 (0.02 - 1)	0.82	11	t,a
	Fields Cr sum	NA	-0.08	0.26	0.92 (0.74 - 1.14)	0.76	0.42	8	NA	NA	NA	0.70 (0.01 - 1)	0.81	17	
	Kahler Cr sum	NA	-0.03	0.27	0.97 (0.78 - 1.21)	0.58	0.26	3	NA	NA	NA	0.41 (0 - 0.99)	0.65	11	a
	Murderers Cr sum	NA	-0.11	0.16	0.90 (0.75 - 1.07)	0.86	0.51	10	NA	NA	NA	0.86 (0.06 - 1)	0.88	17	t
	Parrish Cr sum	NA	-0.04	0.27	0.96 (0.77 - 1.21)	0.61	0.28	4	NA	NA	NA	0.45 (0 - 1)	0.67	12	

Group	Population														
	Riley Cr sum	NA	-0.06	0.31	0.94 (0.74 - 1.21)	0.66	0.35	6	NA	NA	NA	0.56 (0 - 1)	0.73	16	
	Tex Cr sum	NA	-0.10	0.19	0.90 (0.75 - 1.09)	0.83	0.49	10	NA	NA	NA	0.82 (0.04 - 1)	0.86	18	
	Vance Cr sum	NA	-0.04	0.06	0.96 (0.81 - 1.13)	0.65	0.26	4	NA	NA	NA	0.46 (0 - 1)	0.64	6	
Snake R steelhead	Camp Cr sum A run	NA	-0.03	0.25	0.97 (0.78 - 1.20)	0.59	0.25	3	NA	NA	NA	0.40 (0 - 1)	0.65	11	a
	Crow Cr sum A	NA	-0.04	0.27	0.96 (0.77 - 1.19)	0.63	0.30	4	NA	NA	NA	0.49 (0 - 1)	0.70	13	a
	Devils Run Cr sum A	NA	-0.02	0.25	0.98 (0.80 - 1.22)	0.54	0.22	2	NA	NA	NA	0.34 (0 - 0.99)	0.61	9	a
	Five Points Cr sum A	NA	-0.01	0.08	0.99 (0.88 - 1.11)	0.53	0.09	1	NA	NA	NA	0.18 (0 - 0.94)	0.48	3	
	Fly Cr sum A	NA	-0.04	0.21	0.96 (0.79 - 1.16)	0.65	0.27	4	NA	NA	NA	0.48 (0 - 1)	0.69	11	a
	Mccoy Cr sum A	NA	-0.04	0.25	0.96 (0.77 - 1.19)	0.63	0.29	4	NA	NA	NA	0.48 (0 - 1)	0.70	13	
	Prairie Cr sum A	NA	0.01	0.33	1.01 (0.79 - 1.29)	0.44	0.18	0	NA	NA	NA	0.23 (0 - 0.97)	0.53	8	a
	Spring Cr sum A	NA	0.04	0.04	1.04 (0.90 - 1.20)	0.31	0.10	0	NA	NA	NA	0 (0 - 0.83)	0.30	0	
	Swamp Cr sum A	NA	-0.03	0.15	0.97 (0.82 - 1.14)	0.63	0.21	3	NA	NA	NA	0.41 (0 - 1)	0.65	9	
	Wallowa R sum A	NA	-0.08	0.08	0.92 (0.80 - 1.06)	0.83	0.37	8	NA	NA	NA	0.80 (0.02 - 1)	0.83	11	
Upper Columbia R sum/fall chinook	Hanford Reach fall	NA	0.02	0.10	1.02 (0.88 - 1.18)	0.39	0.08	0	NA	NA	NA	0.08 (0 - 0.90)	0.39	2	a
	Methow R sum	NA	-0.05	0.06	0.95 (0.85 - 1.07)	0.75	0.19	5	NA	NA	NA	0.52 (0 - 1)	0.70	7	a
	Okanogan R sum	NA	0.00	0.11	1.00 (0.86 - 1.18)	0.45	0.12	0	NA	NA	NA	0.15 (0 - 0.97)	0.46	3	a
	Similkameen R sum	NA	0.04	0.08	1.04 (0.91 - 1.19)	0.27	0.05	0	NA	NA	NA	0.02 (0 - 0.73)	0.27	0	a
	Wenatchee R sum	NA	0.01	0.02	1.01 (0.93 - 1.08)	0.39	0.02	0	NA	NA	NA	0.01 (0 - 0.69)	0.24	0	a
Middle Columbia R spring chinook	Bull Run Cr spr	NA	-0.01	0.09	0.99 (0.87 - 1.13)	0.52	0.10	1	NA	NA	NA	0.19 (0 - 0.96)	0.49	4	
	Clear Cr spr	NA	-0.05	0.06	0.95 (0.89 - 1.06)	0.78	0.17	5	NA	NA	NA	0.53 (0 - 1)	0.72	7	
	Granite Cr spr	NA	-0.02	0.03	0.98 (0.91 - 1.05)	0.68	0.05	2	NA	NA	NA	0.19 (0 - 0.95)	0.49	2	
	John Day R spr	NA	0.02	0.04	1.02 (0.94 - 1.12)	0.26	0.02	0	NA	NA	NA	0.01 (0 - 0.44)	0.18	0	

John Day R M Fk spr	NA	0.05	0.08	1.05 (0.93 - 1.18)	0.20	0.03	0	NA	NA	NA	0.01 (0 - 0.50)	0.19	0
John Day R N Fk spr	NA	0.01	0.06	1.01 (0.92 - 1.12)	0.36	0.04	0	NA	NA	NA	0.04 (0 - 0.73)	0.29	0

[1] VHER = Very High Extinction Risk = Probability that extinction risk in 50 years is over 25%

[2] VHRD = Very High Risk of Decline = Probability that risk of 90% decline in 50 years is over 25%

[3] Tests for underlying assumptions were made on the running sums of wild spawner only counts where possible; otherwise total mixed counts were used. The codes designate tests that failed at ($p<.05$). Note that a number of the "fails" are false-fails since the p-value was not adjusted for multiple tests being conducted. If p value is adjusted ($p<.001$) to reduce the probability of a false positive to less than 5%, none of the time series fail the diagnostic tests.

    a. Significant 1st order autocorrelation in $\ln(R_{t+1}/R_t)$ found.

    t. A model with a trend in μ fit the data significantly better than the model with no trend. This indicates that the risk estimates are optimistic.

    l. The variance versus τ plot showed significant non-linearity ($R^2 < 0.7$) indicating an underestimate of σ^2.

    d. A model with depensatory density-dependence fit the data significantly better than model with no density-dependence

This indicates that the risk estimates are pessimistic.