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													Changes in Survival Needed to Achieve Survival and Recovery Criteria				
Upper Columbia Spring Chinook	**Abundance (10 yr. geomean)**	**20 yr. avg. % natural**	**20 yr. R/S**	**10 yr. R/S**	**20 yr. λ**	**12 yr. λ**	**1980-current trend**	**1990-current trend**	**Risk (QET=1)**	**Risk (QET=1)**	**Risk (QET=1)**	**Risk (QET=50)**	**20 yr. R/S**	**20 yr. λ**	**Long-term Trend**	**Risk (QET=1)**	**Risk (QET=50)**
Wenatchee	226	0.89	0.73	0.71	1.01	1.02	0.89	0.98	0.00	0.00	0.01	0.03	1.37	0.96	1.69	0.13	0.66
Methow	205	0.86	0.74	0.40	1.10	1.08	0.95	0.91	#N/A	#N/A	#N/A	#N/A	1.35	0.65	1.26	#N/A	#N/A
Entiat	63	0.85	0.72	0.82	0.99	1.03	0.97	1.08	0.00	0.00	0.06	0.17	1.39	1.05	1.15	0.31	1.43

Biological Analysis Spreadsheets - Upper Columbia River Chinook

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Upper Columbia Spring Chinook	**Hydro (FCRPS)**	**Hydro (PUDs)**	**Habitat (Trib.)**	**Habitat (Estuary)**	**Avian Predation**	**Hatchery**	**Harvest**	**Adjusted R/S Gap**	**Adjusted 20 yr. λ Gap**	**Adjusted Long-term Trend Gap**	**Adj. Risk (QET=1)**	**Adj. Risk (QET=50)**
Wenatchee	0.97	1.24	1.02	1.003	1.00		1.04	1.07	0.75	1.32	0.10	0.52
Methow	0.97	1.42	1.02	1.003	1.00	1.01	1.04	0.91	0.44	0.85	#N/A	#N/A
Entiat	0.97	1.32	1.02	1.003	1.00		1.04	1.02	0.77	0.84	0.23	1.05

NOTE: All survival estimates are preliminary and in many cases do not represent the full expected benefits from a proposed action.

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									Estimated Future Condition				
Upper Columbia Spring Chinook	**Hydro (FCRPS)**	**Hydro (PUDs)**	**2007-17 Habitat**	**Habitat (Estuary)**	**Avian Predation**	**P-minnow Predation**	**Hatchery**	**Harvest**	**Estimated Future R/S**	**Estimated Future λ**	**Estimated Future Trend**	**Risk Gap (QET=1)**	**Risk Gap (QET=50)**
Wenatchee	1.09	1.01	1.03	1.06	1.02	1.01			1.16	1.12	0.99	0.08	0.42
Methow	1.09	1.02	1.06	1.06	1.02	1.01			1.41	1.27	1.10	#N/A	#N/A
Entiat	1.09	1.02	1.22	1.06	1.02	1.01			1.45	1.16	1.13	0.15	0.71

Note: This draft was developed for discussion purposes only and does not capture every element of the PA/BA/MOA

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Upper Columbia Spring Chinook ESU	ICTRT Gap	ICTRT Gap Multiplier	FCRPS-high relative impact	FCRPS-low relative impact	TRT Gap w/ high hydro	TRT Gap w/ low hydro	Total Survival Change (from previous sheets)	Remaining Framework Gap (high)	Remaining Framework Gap (low)
Wenatchee	1.35	2.35	0.36	0.23	1.36	1.22	1.58	0.86	0.77
Methow	0.98	1.98	0.3	0.17	1.23	1.12	1.90	0.64	0.59
Entiat	1.56	2.56	0.31	0.19	1.34	1.20	2.02	0.66	0.59

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Upper Columbia Spring Chinook ESU	**Prospective Extinction Risk (QET=1)**	**Prospective Extinction Risk (QET=50)**	**R/S**	**Lambda**	**Trend**	**Remaining Framework Gap (high)**	**Remaining Framework Gap (low)**	**Additional Qualitative Survival and Recovery Improvements***
Wenatchee	+	+	+	+	-	+	+	+
Methow	#N/A	#N/A	+	+	+	+	+	+
Entiat	+	+	+	+	+	+	+	+

*** Includes safety net hatcheries, non-federal actions that are reasonably certain to occur, and other Federal actions that have undergone section 7 consultation under the ESA.**

Hypothetical conclusions based on current estimated survival improvements. Additional survival improvements are expected as the action is further developed.

Biological Anaylsis Spreadsheets - Upper Columbia River Steelhead

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												Changes in Survival Needed to Achieve Survival and Recovery Criteria		
Upper Columbia Steelhead	**Abundance (10 yr. geomean)**	**20 yr. avg. % natural**	**20 yr. R/S**	**20 yr. λ**	**12 yr. λ**	**1980-current trend**	**1990-current trend**	**Risk (QET=1)**	**Risk (QET=10)**	**Risk (QET=30)**	**Risk (QET=50)**	**20 yr. R/S**	**20 yr. λ**	**Long-term Trend**
Wenatchee	951	0.24	0.27	1.05	1.03	1.02	1.05	0.00	0.08	0.19	0.29	3.70	0.80	0.91
Methow	309	0.13	0.17	1.06	1.12	1.07	1.06	0.04	0.47	0.76	0.87	5.88	0.77	0.75
Entiat	100	0.24	0.27	1.04	1.03	1.02	1.05	0.08	0.44	0.72	0.83	3.70	0.84	0.91
Okanogan	114	0.09	0.12	#N/A	#N/A	1.06	1.06	0.40	0.91	0.99	1.00	8.33	#N/A	0.76

Biological Anaylsis Spreadsheets - Upper Columbia River Steelhead

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Upper Columbia Steelhead	Hydro (FCRPS)	Hydro (PUDs)	Habitat (Trib.)	Habitat (Estuary)	Avian Predation	Hatchery (low)	Hatchery (high)	Harvest	Adjusted R/S Gap (w/o hatchery)	Adjusted 20 yr. λ Gap (w/o hatchery)	Adjusted Long-term Trend Gap (w/o hatchery)
Wenatchee	1.15	1.06	1.02	1.003	0.997	1.52	2.13	1.08	2.75	0.60	0.68
Methow	1.15	1.25	1.02	1.003	0.997			1.08	3.70	0.48	0.47
Entiat	1.15	1.11	1.02	1.003	0.997	1.56	2.50	1.08	2.64	0.60	0.65
Okanogan	1.15	1.25	1.06	1.003	0.997			1.08	5.05	#N/A	0.46

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										Estimated Future Condition						
Upper Columbia Steelhead	**Hydro (FCRPS)**	**Hydro (PUDs)**	**2007-2017 Habitat (Trib)**	**Habitat (Estuary)**	**Avian Predation**	**P-minnow Predation**	**Hatchery (low)**	**Hatchery (high)**	**Harvest**	**Estimated Future R/S (low hatchery)**	**Estimated Future R/S (high hatchery)**	**Estimated Future R/S (no hatchery)**	**Estimated Future λ (low hatchery)**	**Estimated Future λ (high hatchery)**	**Estimated Future Trend (low hatchery)**	**Estimated Future Trend (high hatchery)**
Wenatchee	1.15	1.14	1.04	1.06	1.03	1.01				0.83	1.16	0.55	1.35	1.45	1.31	1.41
Methow	1.15	1.14	1.04	1.06	1.03	1.01	1.27	2.84		0.51	1.15	0.41	1.36	1.62	1.36	1.63
Entiat	1.15	1.14	1.08	1.06	1.03	1.01				0.92	1.48	0.59	1.37	1.52	1.34	1.49
Okanogan	1.15	1.14	1.14	1.06	1.03	1.01	1.32	3.08		0.43	1.00	0.33	#N/A	#N/A	1.41	1.71

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Upper Columbia steelhead DPS	**ICTRT Gap**	**ICTRT Gap Multiplier**	**FCRPS-high relative impact**	**FCRPS-low relative impact**	**TRT Gap w/ high hydro**	**TRT Gap w/ low hydro**	**Total Survival Change (from previous sheets, w/o hatchery)**	**Remaining Framework Gap (high)**	**Remaining Framework Gap (low)**
Wenatchee	3.33	4.33	0.41	0.31	1.82	1.58	2.02	0.90	0.78
Methow	5.64	6.64	0.36	0.26	1.98	1.64	2.39	0.83	0.69
Entiat	5.31	6.31	0.38	0.28	2.01	1.67	2.19	0.92	0.76
Okanogan	7.69	8.69	0.35	0.26	2.13	1.75	2.72	0.78	0.65

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Upper Columbia Steelhead DPS	Base Extinction Risk (QET=50)	Base Extinction Risk w/Supplementation (QET=50)	R/S (Low Hatchery)	R/S (High Hatchery)	Lambda (Low hatchery)	Trend (Low Hatchery)	Remaining Framework Gap (high)	Remaining Framework Gap (low)	Additional Qualitative Survival and Recovery Improvements*
Wenatchee	-	+	-	+	+	+	+	+	+
Methow	-	+	-	+	+	+	+	+	+
Entiat	-	+	-	+	+	+	+	+	+
Okanogan	-	+	-	+	#N/A	#N/A	+	+	+

*** Includes safety net hatcheries, non-federal actions that are reasonably certain to occur, and other Federal actions that have undergone section 7 consultation under the ESA.**

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Base

													Changes in Survival Needed to Achieve Survival and Recovery Criteria		
Cascade E. Slopes MPG	**Abundance (10 yr. geomean)**	**20 yr. avg. % natural**	**20 yr. R/S**	**10 yr. R/S**	**20 yr. λ**	**12 yr. λ**	**1980-current trend**	**1990-current trend**	**Risk (QET=1)**	**Risk (QET=10)**	**Risk (QET=30)**	**Risk (QET=50)**	**20 yr. R/S**	**20 yr. λ**	**Long-term Trend**
White Salmon R. (*ext.*)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Klickitat R.	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Deschutes R. East	1579	0.61	1.14		#N/A	1.10	1.11	1.11	0.43	0.49	0.53	0.54	0.88	#N/A	0.63
Deschutes R. West	470	0.77	0.91		1.03	1.04	0.99	1.10	0.00	0.00	0.00	0.00	1.10	0.88	1.05
Crooked R. (*ext.)*	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Fifteenmile Cr.	593	1.00	1.21		1.04	1.10	1.04	1.11	0.00	0.00	0.00	0.00	0.83	0.84	0.84
Rock Cr.	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
John Day MPG															
Lower John Day R.	1800	0.94	1.24	1.55	1.02	0.97	0.98	1.04	0.00	0.00	0.00	0.00	0.81	0.91	1.10
S. Fork John Day R.	259	0.95	0.99	1.06	1.14	0.96	0.95	1.01	0.00	0.00	0.01	0.03	1.01	0.55	1.26
M. Fork John Day R.	756	0.95	1.17	1.04	1.02	0.97	0.97	0.98	0.00	0.00	0.00	0.00	0.85	0.91	1.15
N. Fork John Day R.	1740	0.95	1.17	1.75	1.09	1.01	0.99	1.09	0.00	0.00	0.00	0.00	0.85	0.68	1.05
Upper John Day R.	524	0.95	1.07	0.83	1.14	0.96	0.95	0.96	0.00	0.00	0.00	0.00	0.93	0.55	1.26
Walla Walla/Umatilla MPG															
Willow Cr. (*ext.)*	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Umatilla R.	1472	0.77	0.94	0.93	1.06	1.07	1.01	1.07	0.00	0.00	0.00	0.00	1.06	0.77	0.96
Walla Walla R.	1003	0.98	#N/A	0.92	#N/A	1.14	1.04	1.04	0.00	0.00	0.00	0.00	1.09	#N/A	0.84
Touchet R.	624	0.93	#N/A	0.86	#N/A	#N/A	#N/A	0.98	#N/A	#N/A	#N/A	#N/A	1.16	#N/A	1.10
Yakima MPG															
Satus Cr.	568	0.94	0.99	1.24	1.01	1.06	1.00	1.08	0.00	0.00	0.00	0.00	1.01	0.96	1.00
Toppenish Cr.	148	0.94	0.99	1.27	1.01	1.06	1.01	1.09	0.00	0.02	0.14	0.33	1.01	0.96	0.96
Naches R.	462	0.94	0.98	1.26	1.01	1.06	1.00	1.08	0.00	0.00	0.00	0.01	1.02	0.96	1.00
Upper Yakima R.	92	0.98	1.00	1.52	1.01	1.05	1.00	1.09	0.38	0.50	0.58	0.66	1.00	0.96	1.00

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Base-to-Current	**Lifecycle Survival Adjustments for Recent Actions**						**Changes in Survival Needed to Achieve Survival and Recovery Criteria**		
Cascade E. Slopes MPG	**Hydro**	**Habitat (Trib.)**	**Habitat (Estuary)**	**Avian Predation**	**Hatchery**	**Harvest**	**Adjusted R/S Gap**	**Adjusted 20 yr. λ Gap**	**Adjusted Long-term Trend Gap**
Klickitat R.	1.08	1.04	1.003	1.00		1.08	#N/A	#N/A	#N/A
Deschutes R. East	1.08	1.01	1.003	1.00		1.08	0.74	#N/A	0.53
Deschutes R. West	1.08	1.00	1.003	1.00		1.08	0.94	0.75	0.89
Fifteenmile Cr.	1.08	1.00	1.003	1.00		1.08	0.71	0.72	0.72
Rock Cr.			1.003	1.00		1.08	#N/A	#N/A	#N/A
John Day MPG									
Lower John Day R.	1.02	1.00	1.003	1.00		1.08	0.73	0.83	0.99
S. Fork John Day R.	1.02	1.01	1.003	1.00		1.08	0.91	0.50	1.14
M. Fork John Day R.	1.02	1.00	1.003	1.00		1.08	0.77	0.83	1.04
N. Fork John Day R.	1.02	1.00	1.003	1.00		1.08	0.77	0.61	0.95
Upper John Day R.	1.02	1.00	1.003	1.00		1.08	0.85	0.50	1.14
Walla Walla/Umatilla MPG									
Umatilla R.	1.02	1.04	1.003	1.00		1.08	0.93	0.67	0.83
Walla Walla R.	1.09	1.04	1.003	1.00		1.08	0.89	#N/A	0.68
Touchet R.	1.09	1.04	1.003	1.00		1.08	0.95	#N/A	0.89
Yakima MPG									
Satus Cr.	1.09	1.04	1.003	1.00		1.08	0.83	0.78	0.82
Toppenish Cr.	1.09	1.04	1.003	1.00		1.08	0.83	0.78	0.78
Naches R.	1.09	1.04	1.003	1.00		1.08	0.83	0.78	0.82
Upper Yakima R.	1.09	1.04	1.003	1.00		1.08	0.82	0.78	0.82

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Current-to-Prospective	Prospective Lifecycle Survival Adjustments							Estimated Future Condition		
Cascade E. Slopes MPG	**Hydro**	**2007-17 Tr Habitat**	**Habitat (Estuary)**	**Avian Predation**	**P-minnow Predation**	**Hatchery**	**Harvest**	**Estimated Future R/S**	**Estimated Future λ**	**Estimated Futrure Trend**
Klickitat R.	1.04	1.12	1.06	1.03	1.01			#N/A	#N/A	#N/A
Deschutes R. East	1.04	1.03	1.06	1.03	1.01			1.59	#N/A	1.20
Deschutes R. West	1.04	1.01	1.06	1.03	1.01			1.23	1.10	1.06
Fifteenmile Cr.	1.04	1.00	1.06	1.03	1.01			1.63	1.11	1.11
Rock Cr.	1.04		1.06	1.03	1.01			#N/A	#N/A	#N/A
John Day MPG										
Lower John Day R.	1.11	1.01	1.06	1.03	1.01			1.70	1.09	1.05
S. Fork John Day R.	1.11	1.02	1.06	1.03	1.01			1.37	1.23	1.02
M. Fork John Day R.	1.11	1.01	1.06	1.03	1.01			1.60	1.09	1.04
N. Fork John Day R.	1.11	1.01	1.06	1.03	1.01			1.61	1.17	1.06
Upper John Day R.	1.11	1.01	1.06	1.03	1.01			1.46	1.22	1.02
Walla Walla/Umatilla MPG										
Umatilla R.	1.13	1.12	1.06	1.03	1.01			1.51	1.18	1.12
Walla Walla R.	1.13	1.12	1.06	1.03	1.01			1.58	#N/A	1.17
Touchet R.	1.13	1.12	1.06	1.03	1.01			1.48	#N/A	1.11
Yakima MPG										
Satus Cr.	1.13	1.12	1.06	1.03	1.01			1.70	1.14	1.13
Toppenish Cr.	1.13	1.12	1.06	1.03	1.01			1.70	1.14	1.14
Naches R.	1.13	1.12	1.06	1.03	1.01			1.68	1.14	1.13
Upper Yakima R.	1.13	1.12	1.06	1.03	1.01			1.72	1.14	1.13

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mid-Columbia River Steelhead DPS	ICTRT Gap	ICTRT Gap Multiplier	FCRPS-high relative impact	FCRPS-low relative impact	TRT Gap w/ high hydro	TRT Gap w/ low hydro	Total Survival Change (from previous sheets)	Remaining Framework Gap (high)	Remaining Framework Gap (low)
Cascade E. Slopes MPG									
Klickitat R.			0.36	0.26			1.56	0.00	0.00
Deschutes R. East	-0.14	0.86	0.48	0.32	0.93	0.95	1.40	0.67	0.68
Deschutes R. West	0.75	1.75	0.48	0.32	1.31	1.20	1.35	0.97	0.88
Fifteenmile Cr.	0.6	1.6	0.48	0.32	1.25	1.16	1.35	0.93	0.86
Rock Cr.			0.57	0.39			1.24	0.00	0.00
John Day MPG									
Lower John Day R.	0.14	1.14	0.57	0.39	1.08	1.05	1.37	0.79	0.77
S. Fork John Day R.	0.32	1.32	0.57	0.39	1.17	1.11	1.39	0.85	0.80
M. Fork John Day R.	0.21	1.21	0.57	0.39	1.11	1.08	1.37	0.81	0.79
N. Fork John Day R.	-0.47	0.53	0.57	0.39	0.70	0.78	1.38	0.51	0.57
Upper John Day R.	0.21	1.21	0.57	0.39	1.11	1.08	1.37	0.82	0.79
Walla Walla/Umatilla MPG									
Umatilla R.	0.09	1.09	0.57	0.39	1.05	1.03	1.61	0.65	0.64
Walla Walla R.	-0.01	0.99	0.6	0.42	0.99	1.00	1.72	0.58	0.58
Touchet R.			0.6	0.42			1.72	0.00	0.00
Yakima MPG									
Satus Cr.	0.59	1.59	0.60	0.42	1.32	1.22	1.72	0.77	0.71
Toppenish Cr.	0.57	1.57	0.60	0.42	1.31	1.21	1.72	0.76	0.70
Naches R.	1.01	2.01	0.60	0.42	1.52	1.34	1.72	0.88	0.78
Upper Yakima R.	1.50	2.50	0.60	0.42	1.73	1.47	1.72	1.01	0.86

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Mid-Columbia Steelhead DPS	Base Extinction Risk (QET=1)	Base Extinction Risk (QET=50)	R/S	Lambda	Trend	Remaining Framework Gap (high)	Remaining Framework Gap (low)	Additional Qualitative Survival and Recovery Improvements*
Cascade E. Slopes MPG								
Klickitat R.	#N/A	#N/A	#N/A	#N/A	#N/A	N/A	N/A	+
Deschutes R. East	-	-	+	#N/A	+	+	+	+
Deschutes R. West	+	+	+	+	+	+	+	+
Fifteenmile Cr.	+	+	+	-	-	+	+	
Rock Cr.	#N/A	#N/A	#N/A	#N/A	#N/A	N/A	N/A	
John Day MPG								
Lower John Day R.	+	+	+	+	+	+	+	
S. Fork John Day R.	+	+	+	+	+	+	+	+
M. Fork John Day R.	+	+	+	+	+	+	+	+
N. Fork John Day R.	+	+	+	+	+	+	+	+
Upper John Day R.	+	+	+	+	+	+	+	+
Walla Walla/Umatilla MPG								
Umatilla R.	+	+	+	+	+	+	+	
Walla Walla R.	+	+	+	#N/A	+	+	+	+
Touchet R.	#N/A	#N/A	+	#N/A	+	N/A	N/A	
Yakima MPG								
Satus Cr.	+	+	+	+	+	+	+	
Toppenish Cr.	+	-	+	+	+	+	+	
Naches R.	+	+	+	+	+	+	+	
Upper Yakima R.	-	-	+	+	+	-	+	+

Hypothetical conclusions based on current estimated survival improvements. Additional survival improvements are expected as the action is further developed.

*** Includes safety net hatcheries, non-federal actions that are reasonably certain to occur, and other Federal actions that have undergone section 7 consultation under the ESA.**

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											Changes in Survival Needed to Achieve Survival and Recovery Criteria					
Snake River Fall Chinook	**Abundance (10 yr. geomean)**	**20 yr. avg. % natural**	**20 yr. R/S**	**10 yr. R/S**	**20 yr. λ**	**12 yr. λ**	**1980-current trend**	**1990-current trend**	**Risk (QET=1)**	**Risk (QET=50)**	**20 yr. R/S**	**10 yr. R/S**	**20 yr. λ**	**Long-term Trend**	**Risk (QET=1)**	**Risk (QET=50)**
Lower Mainstem	1273.00	0.63	0.82	1.24	1.14	1.31	1.09	1.25	0.00	0.01	1.22	0.81	0.55	0.37	0.00	0.00

Note: This draft was developed for discussion purposes only and does not capture every element of the PA/BA/MOA.

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Snake R. S/S Chinook Base													**Gap in Selected Survival and Recovery Estimates**							
Lower Snake MPG	**Abundance (10 yr. geomean)**	**20 yr. avg. % natural**	**20 yr. R/S**	**10 yr. R/S**	**20 yr. λ**	**12 yr. λ**	**1980-current trend**	**1990-current trend**	**Risk (QET=1)**	**Risk (QET=10)**	**Risk (QET=30)**	**Risk (QET=50)**	**20 yr. R/S**	**20 yr. λ**	**Long-term Trend**	**Risk (QET=1)**	**Risk (QET=10)**	**Risk (QET=30)**	**Risk (QET=50)**
Tucannon R.	88	0.79	0.76	0.67	1.00	1.03	0.89	0.96	0.00	0.02	0.06	0.10	1.32	1.00	1.69	0.42	0.74	1.09	1.35
Asotin Cr. (f.e.)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Grande Ronde/Imnaha MPG																			
Catherine Cr.	89	0.70	0.38	1.21	0.97	1.06	0.93	1.22	0.12	0.29	0.42	0.51	2.63	1.15	1.39	1.41	2.43	3.44	4.13
Lostine R.	276	0.78	0.72	1.49	1.05	1.05	1.01	1.16	0.00	0.03	0.10	0.19	1.39	0.80	0.96	0.48	0.86	1.27	1.61
Minam R.	337	0.79	0.80	1.28	1.05	1.02	1.02	1.12	0.00	0.00	0.02	0.05	1.25	0.80	0.91	0.27	0.51	0.80	1.05
Imnaha R.	395	0.63	0.60	0.80	1.05	1.13	0.98	1.10	0.00	0.01	0.04	0.09	1.67	0.80	1.10	0.43	0.71	0.99	1.21
Wenaha R.	376	0.70	0.66	1.29	1.10	1.05	1.04	1.20	0.00	0.05	0.15	0.25	1.52	0.65	0.84	0.57	0.96	1.39	1.72
Upper GR R.	38	0.70	0.32	0.63	#N/A	#N/A	0.93	0.99	0.00	0.08	0.40	0.68	3.13	#N/A	1.39	0.54	1.12	1.86	2.57
Big Sheep Cr. (f.e.)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Lookingglass (f.e.)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
S. Fork Salmon MPG																			
South Fork	653	0.76	0.87	0.65	1.11	1.06	1.05	1.09	0.00	0.00	0.00	0.00	1.15	0.63	0.80	0.16	0.27	0.36	0.44
Secesh R.	304	0.98	1.04	0.95	1.07	1.09	1.02	1.12	0.00	0.00	0.01	0.03	0.96	0.74	0.91	0.39	0.62	0.78	0.88
East Fork South Fork	321	0.98	0.98	0.65	1.08	1.06	1.03	1.03	0.00	0.00	0.00	0.01	1.02	0.71	0.88	0.33	0.53	0.65	0.75
Little Salmon R.	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Middle Fork Salmon MPG																			
Big Cr.	94	1.00	1.23	1.27	1.09	1.07	1.02	1.14	0.00	0.04	0.23	0.43	0.81	0.68	0.91	0.43	0.97	1.79	2.69
Bear Valley Cr.	188	1.00	1.36	1.33	1.10	1.05	1.05	1.16	0.00	0.00	0.04	0.09	0.74	0.65	0.80	0.26	0.52	0.89	1.24
Marsh Cr.	42	1.00	0.98	0.73	1.08	1.04	1.00	1.11	0.02	0.15	0.38	0.55	1.02	0.71	1.00	0.73	1.57	2.77	4.00
Sulphur Cr.	21	1.00	0.89	0.44	1.05	0.95	1.01	1.00	0.00	0.13	0.44	0.68	1.12	0.80	0.96	0.39	1.58	3.81	6.09
Camas Cr.	28	1.00	0.89	1.23	1.04	1.08	0.98	1.22	#N/A	#N/A	#N/A	#N/A	1.12	0.84	1.10	#N/A	#N/A	#N/A	#N/A
Loon Cr.	51	1.00	1.21	1.54	#N/A	#N/A	1.06	1.34	#N/A	#N/A	#N/A	#N/A	0.83	#N/A	0.77	#N/A	#N/A	#N/A	#N/A
Chamberlain Cr.	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Lower Middle Fork	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Upper Middle Fork	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Upper Salmon MPG																			
Lemhi R.	80	1.00	1.09	1.61	1.02	1.02	0.98	1.12	#N/A	#N/A	#N/A	#N/A	0.92	0.91	1.10	#N/A	#N/A	#N/A	#N/A
Valley Cr.	35	1.00	1.08	1.41	#N/A	#N/A	1.02	1.20	0.00	0.09	0.46	0.72	0.93	#N/A	0.91	0.32	1.21	3.09	5.01
Yankee Fork	13	1.00	0.68	0.55	#N/A	#N/A	1.03	1.12	#N/A	#N/A	#N/A	#N/A	1.47	#N/A	0.88	#N/A	#N/A	#N/A	#N/A
Upper Salmon	268	0.85	1.50	1.90	1.06	1.07	1.01	1.11	0.00	0.00	0.00	0.01	0.67	0.77	0.96	0.09	0.22	0.43	0.64
N. Fk. Salmon	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Lower Salmon	123	1.00	1.23	2.14	1.02	1.07	1.00	1.11	0.00	0.00	0.05	0.19	0.81	0.91	1.00	0.13	0.42	0.99	1.58
East Fork Salmon	169	0.84	1.17	2.31	1.04	1.07	1.01	1.17	0.00	0.00	0.04	0.13	0.85	0.84	0.96	0.11	0.39	0.95	1.55
Pahsimeroi	112	0.60	0.39	0.90	1.08	1.15	1.38	1.34	#N/A	#N/A	#N/A	#N/A	1.11	0.71	0.27	#N/A	#N/A	#N/A	#N/A
Panther (f.e.)									#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

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Base-to-Current	**Lifecycle Survival Adjustments for Recent Actions**						**Remaining Gap in Selected Survival and Recovery Estimates**						
Lower Snake MPG	**Hydro**	**Habitat (Trib.)**	**Habitat (Estuary)**	**Avian Predation**	**Hatchery**	**Harvest**	**Adjusted R/S Gap**	**Adjusted 20 yr. λ Gap**	**Adjusted Trend Gap**	**Adj. Risk (QET=1)**	**Adj. Risk (QET=10)**	**Adj. Risk (QET=30)**	**Adj. Risk (QET=50)**
Tucannon R.	1.18	1.04	1.003	1.00		1.04	1.04	0.79	1.34	0.33	0.59	0.86	1.07
Grande Ronde/Imnaha MPG													
Catherine Cr.	1.18	1.04	1.003	1.00	1.28	1.04	1.62	0.71	0.85	1.11	1.91	2.71	3.25
Lostine R.	1.18	1.01	1.003	1.00	1.07	1.04	1.05	0.61	0.72	0.39	0.70	1.03	1.31
Minam R.	1.18		1.003	1.00	1.22	1.04	0.84	0.54	0.61	0.22	0.42	0.66	0.86
Imnaha R.	1.18	1.01	1.003	1.00		1.04	1.35	0.65	0.89	0.35	0.58	0.80	0.98
Wenaha R.	1.18		1.003	1.00	1.39	1.04	0.89	0.38	0.49	0.47	0.79	1.14	1.41
Upper GR R.	1.18	1.04	1.003	1.00	1.32	1.04	1.86	#N/A	0.83	0.43	0.88	1.47	2.02
S. Fork Salmon MPG													
South Fork	1.18		1.003	1.00		1.04	0.94	0.51	0.66	0.13	0.22	0.29	0.36
Secesh R.	1.18		1.003	1.00		1.04	0.79	0.60	0.75	0.32	0.51	0.64	0.72
East Fork South Fork	1.18		1.003	1.00		1.04	0.84	0.58	0.72	0.27	0.43	0.53	0.61
Middle Fork Salmon MPG													
Big Cr.	1.18		1.003	1.00		1.04	0.67	0.56	0.75	0.35	0.79	1.47	2.20
Bear Valley Cr.	1.18		1.003	1.00		1.04	0.60	0.53	0.66	0.21	0.43	0.73	1.02
Marsh Cr.	1.18		1.003	1.00		1.04	0.84	0.58	0.82	0.60	1.29	2.27	3.28
Sulphur Cr.	1.18		1.003	1.00		1.04	0.92	0.66	0.78	0.32	1.29	3.12	4.99
Camas Cr.	1.18		1.003	1.00		1.04	0.92	0.69	0.90	#N/A	#N/A	#N/A	#N/A
Loon Cr.	1.18		1.003	1.00		1.04	0.68	#N/A	0.63	#N/A	#N/A	#N/A	#N/A
Chamberlain Cr.	1.18		1.003	1.00		1.04	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Lower Middle Fork	1.18		1.003	1.00		1.04	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Upper Salmon MPG													
Lemhi R.	1.18	1.01	1.003	1.00		1.04	0.75	0.75	0.89	#N/A	#N/A	#N/A	#N/A
Valley Cr.	1.18	1.01	1.003	1.00		1.04	0.75	#N/A	0.75	0.26	0.99	2.52	4.08
Yankee Fork	1.18		1.003	1.00		1.04	1.20	#N/A	0.72	#N/A	#N/A	#N/A	#N/A
Upper Salmon	1.18	1.01	1.003	1.00		1.04	0.54	0.63	0.78	0.07	0.18	0.35	0.52
N. Fk. Salmon	1.18		1.003	1.00		1.04	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Lower Salmon	1.18	1.01	1.003	1.00		1.04	0.66	0.75	0.82	0.11	0.34	0.81	1.29
East Fork Salmon	1.18	1.01	1.003	1.00		1.04	0.70	0.68	0.78	0.09	0.32	0.77	1.26
Pahsimeroi	1.18	1.01	1.003	1.00		1.04	0.91	0.58	0.22	#N/A	#N/A	#N/A	#N/A

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Current-to-Prospective	**Prospective Lifecycle Survival Adjustments**							**Estimated Future Condition**						
Lower Snake MPG	**Hydro**	**2007-17 Tr Habitat**	**Habitat (Estuary)**	**Avian Predation**	**P-minnow Predation**	**Hatchery**	**Harvest**	**Estimated Future R/S**	**Estimated Future λ**	**Estimated Future Trend**	**Risk Gap (QET=1)**	**Risk Gap (QET=10)**	**Risk Gap (QET=30)**	**Risk Gap (QET=50)**
Tucannon R.	1.07	1.17	1.06	1.02	1.01			1.31	1.13	1.00	0.25	0.44	0.64	0.79
Grande Ronde/Imnaha MPG														
Catherine Cr.	1.07	1.14	1.06	1.02	1.01			0.82	1.15	1.10	0.85	1.46	2.07	2.48
Lostine R.	1.07	1.18	1.06	1.02	1.01			1.30	1.20	1.15	0.29	0.51	0.76	0.96
Minam R.	1.07		1.06	1.02	1.01			1.38	1.19	1.15	0.19	0.36	0.57	0.75
Imnaha R.	1.07		1.06	1.02	1.01			0.86	1.14	1.06	0.30	0.50	0.70	0.85
Wenaha R.	1.07		1.06	1.02	1.01			1.30	1.28	1.21	0.41	0.68	0.99	1.22
Upper GR R.	1.07	1.07	1.06	1.02	1.01			0.67	#N/A	1.09	0.35	0.72	1.19	1.64
S. Fork Salmon MPG														
South Fork	1.07	1.06	1.06	1.02	1.01			1.31	1.22	1.15	0.11	0.18	0.24	0.30
Secesh R.	1.07	1.06	1.06	1.02	1.01			1.56	1.17	1.12	0.26	0.42	0.52	0.59
East Fork South Fork	1.07		1.06	1.02	1.01			1.39	1.17	1.11	0.23	0.38	0.46	0.53
Middle Fork Salmon MPG														
Big Cr.	1.07	1.07	1.06	1.02	1.01			1.87	1.20	1.12	0.29	0.65	1.19	1.79
Bear Valley Cr.	1.07		1.06	1.02	1.01			1.93	1.19	1.13	0.19	0.37	0.63	0.88
Marsh Cr.	1.07		1.06	1.02	1.01			1.39	1.17	1.08	0.52	1.12	1.97	2.85
Sulphur Cr.	1.07		1.06	1.02	1.01			1.26	1.13	1.09	0.28	1.13	2.71	4.34
Camas Cr.	1.07		1.06	1.02	1.01			1.26	1.12	1.06	#N/A	#N/A	#N/A	#N/A
Loon Cr.	1.07		1.06	1.02	1.01			1.72	#N/A	1.15	#N/A	#N/A	#N/A	#N/A
Chamberlain Cr.	1.07		1.06	1.02	1.01			#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Lower Middle Fork	1.07		1.06	1.02	1.01			#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Upper Salmon MPG														
Lemhi R.	1.07	1.21	1.06	1.02	1.01			1.88	1.15	1.11	#N/A	#N/A	#N/A	#N/A
Valley Cr.	1.07	1.03	1.06	1.02	1.01			1.59	#N/A	1.11	0.22	0.83	2.13	3.45
Yankee Fork	1.07	1.30	1.06	1.02	1.01			1.25	#N/A	1.18	#N/A	#N/A	#N/A	#N/A
Upper Salmon	1.07	1.42	1.06	1.02	1.01			3.04	1.24	1.18	0.04	0.11	0.21	0.32
N. Fk. Salmon	1.07		1.06	1.02	1.01			#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Lower Salmon	1.07	1.03	1.06	1.02	1.01			1.81	1.11	1.09	0.09	0.29	0.68	1.09
East Fork Salmon	1.07	1.03	1.06	1.02	1.01			1.72	1.13	1.10	0.08	0.27	0.65	1.07
Pahsimeroi	1.07	1.43	1.06	1.02	1.01			1.83	1.27	1.57	#N/A	#N/A	#N/A	#N/A

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Snake River spring/summer chinook ESU	ICTRT Gap	ICTRT Gap Multiplier	FCRPS-high relative impact	FCRPS-low relative impact	Framework Gap w/ high hydro	Framework Gap w/ low hydro	Total Survival Change (from previous sheets)	Remaining Framework Gap (high)	Remaining Framework Gap (low)
Lower Snake MPG									
Tucannon R.	0.55	1.55	0.86	0.54	1.46	1.27	1.72	0.85	0.74
Grande Ronde/Imnaha MPG									
Catherine Cr.	2.16	3.16	0.58	0.31	1.95	1.43	2.15	0.91	0.66
Lostine R.	0.88	1.88	0.79	0.47	1.65	1.35	1.81	0.91	0.74
Minam R.	0.55	1.55	0.79	0.47	1.41	1.23	1.73	0.82	0.71
Imnaha R.	0.88	1.88	0.79	0.47	1.65	1.35	1.43	1.15	0.94
Wenaha R.	1.14	2.14	0.86	0.54	1.92	1.51	1.97	0.98	0.76
Upper GR R.	2.97	3.97	0.58	0.31	2.22	1.53	2.08	1.07	0.74
S. Fork Salmon MPG									
South Fork	0.59	1.59	0.86	0.54	1.49	1.28	1.50	0.99	0.85
Secesh R.	0.52	1.52	0.86	0.54	1.43	1.25	1.50	0.95	0.83
East Fork South Fork	0.50	1.50	0.79	0.47	1.38	1.21	1.42	0.97	0.85
Middle Fork Salmon MPG									
Big Cr.	0.65	1.65	0.86	0.54	1.54	1.31	1.52	1.01	0.86
Bear Valley Cr.	0.26	1.26	0.86	0.54	1.22	1.13	1.42	0.86	0.80
Marsh Cr.	1.18	2.18	0.87	0.55	1.97	1.54	1.42	1.39	1.08
Sulphur Cr.	1.03	2.03	0.87	0.55	1.85	1.48	1.42	1.31	1.04
Camas Cr.	1.03	2.03	0.86	0.54	1.84	1.47	1.42	1.30	1.03
Loon Cr.	1.13	2.13	0.87	0.55	1.93	1.52	1.42	1.36	1.07
Chamberlain Cr.			0.86	0.54			1.42	0.00	0.00
Lower Middle Fork			0.87	0.55			1.42	0.00	0.00
Upper Salmon MPG									
Lemhi R.	0.60	1.60	0.58	0.31	1.31	1.16	1.72	0.76	0.67
Valley Cr.	0.96	1.96	0.79	0.47	1.70	1.37	1.47	1.16	0.93
Yankee Fork	1.34	2.34	0.86	0.54	2.08	1.58	1.84	1.13	0.86
Upper Salmon	0.49	1.49	0.79	0.31	1.37	1.13	2.02	0.68	0.56
N. Fk. Salmon			0.87	0.55			1.42	0.00	0.00
Lower Salmon	2.77	3.77	0.58	0.31	2.16	1.51	1.47	1.47	1.03
East Fork Salmon	0.21	1.21	0.79	0.47	1.16	1.09	1.47	0.79	0.74
Pahsimeroi	2.49	3.49	0.79	0.31	2.68	1.47	2.04	1.32	0.72

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Snake River Spring Summer Chinook ESU	Prospective Extinction Risk (QET=1)	Prospective Extinction Risk (QET=50)	Prospective Extinction Risk w/ Continued Supplementation (QET=50)	R/S	Lambda	Trend	Remaining Framework Gap (high)	Remaining Framework Gap (low)	Additional Qualitative Survival and Recovery Improvements*
Lower Snake									
Tucannon R.	+	+		+	+	+	+	+	+
Gr.R./Imnaha									
Catherine Cr.	+	-		-	+	+	+	+	+
Lostine R.	+	+	+	+	+	+	+	+	+
Minam R.	+	+	+	+	+	+	+	+	+
Imnaha R.	+	+	+	-	+	+	-	+	+
Wenaha R.	+	-	+	+	+	+	+	+	+
Upper GR R.	+	-	+	-	#N/A	+	-	+	+
S. Fork Salmon									
South Fork	+	+		+	+	+	+	+	+
Secesh R.	+	+		+	+	+	+	+	+
E.Fork S. Fork	+	+		+	+	+	+	+	+
M. Fork Salmon									
Big Cr.	+	-		+	+	+	-	+	+
Bear Valley Cr.	+	+		+	+	+	+	+	+
Marsh Cr.	+	-		+	+	+	-	-	+
Sulphur Cr.	+	-		+	+	+	-	-	+
Camas Cr.	#N/A	#N/A		+	+	+	-	-	+
Loon Cr.	#N/A	#N/A		+	#N/A	+	-	-	+
Chamberlain C.	#N/A	#N/A		#N/A	#N/A	#N/A	+	+	+
L. Mid. Fork	#N/A	#N/A		#N/A	#N/A	#N/A	+	+	+
Upper Salmon									
Lemhi R.	#N/A	#N/A		+	+	+	+	+	+
Valley Cr.	+	-		+	#N/A	+	-	+	+
Yankee Fork	#N/A	#N/A		+	#N/A	+	-	+	+
Upper Salmon	+	+		+	+	+	+	+	+
N. Fk. Salmon	#N/A	#N/A		#N/A	#N/A	#N/A	+	+	+
Lower Salmon	+	-		+	+	+	-	-	+
E. Fork Salmon	+	-		+	+	+	+	+	+
Pahsimeroi	#N/A	#N/A		+	+	+	-	+	+

Hypothetical conclusions based on current estimated survival improvements. Additional survival improvements are expected as the action is further developed.

*** Includes safety net hatcheries, non-federal actions that are reasonably certain to occur, and other Federal actions that have undergone section 7 consultation under the ESA.**

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														Gap in Selected Survival and Recovery Estimates		
Snake River Steelhead (Base)			**20 yr. avg. % natural**	**20 yr. R/S**	**10 yr. R/S**	**20 yr. λ**	**12 yr. λ**	**1980-current trend**	**1990-current trend**	**Risk (QET=1)**	**Risk (QET=10)**	**Risk (QET=30)**	**Risk (QET=50)**	**20 yr. R/S**	**12 yr. λ**	**Long-term Trend**
Snake River Steelhead	Average "A-Run" Populations		1.00	1.26	1.49	#N/A	1.07	1.01	1.08	0.00	0.02	0.05	0.11	0.79	0.74	0.96
	Avereage "B-Run" Populations		1.00	0.82	0.86	#N/A	1.00	0.96	0.99	#N/A	#N/A	#N/A	#N/A	1.22	1.00	1.20
	Lower Snake	Tucannon (A, below LGR)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		Asotin (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Imnaha River	Imnaha R. (A)	#N/A	#N/A	#N/A	#N/A	#N/A	1.03	1.05	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.88
	Grande Ronde	Upper Mainstem (A)	0.93	1.00	0.96	1.01	0.98	0.99	1.01	0.00	0.00	0.00	0.00	1.00	1.10	1.05
		Lower Mainstem (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		Joseph Cr. (A)	1.00	1.27	1.42	1.05	1.00	1.02	1.05	0.00	0.00	0.00	0.00	0.79	1.00	0.91
		Wallowa R. (A)	1.00	1.29	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.78	#N/A	#N/A
	Clearwater River	Lower Mainstem (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		Lolo Creek (A & B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		Lochsa River (B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		Selway River (B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		South Fork (B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		North Fork - (Extirpated)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A		#N/A	#N/A
	Salmon River	Little Salmon/Rapid (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		Chamberlain Cr. (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		Secesh River (B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		South Fork Salmon (B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		Panther Creek (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		Lower Middle Fork Tribs (B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		Upper Middle Fork Tribs (B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		North Fork (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		Lemhi River (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		Pahsimeroi River (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		East Fork Salmon (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		Upper Mainstem (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

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		Lifecycle Survival Adjustments for Recent Actions						**Remaining Gaps**		
SNAKE RIVER STEELHEAD		**Hydro**	**Habitat (Trib.)**	**Habitat (Estuary)**	**Avian Predation**	**Hatchery**	**Harvest**	**Adjusted R/S Gap**	**Adjusted 12 yr. λ Gap**	**Adjusted Trend Gap**
Average "A-Run" Populations		0.97		1.003	0.997		1.08	0.76	0.71	0.92
Average "B-Run" Populations		0.97		1.003	0.997		1.12	1.13	0.92	1.11
Lower Snake	Tucannon (A, below LGR)	0.97	1.07	1.003	0.997		1.08	#N/A	#N/A	#N/A
	Asotin (A)	0.97	1.09	1.003	0.997		1.08	#N/A	#N/A	#N/A
Imnaha River	Imnaha R. (A)	0.97	1.00	1.003	0.997		1.08	#N/A	#N/A	0.84
Grande Ronde	Upper Mainstem (A)	0.97	1.02	1.003	0.997		1.08	0.94	1.03	0.98
	Lower Mainstem (A)	0.97	1.00	1.003	0.997		1.08	#N/A	#N/A	#N/A
	Joseph Cr. (A)	0.97	1.02	1.003	0.997		1.08	0.74	0.94	0.86
	Wallowa R. (A)	0.97	1.02	1.003	0.997		1.08	0.73	#N/A	#N/A
Clearwater River	Lower Mainstem (A)	0.97	1.03	1.003	0.997		1.08	#N/A	#N/A	#N/A
	Lolo Creek (A & B)	0.97	1.01	1.003	0.997		1.08	#N/A	#N/A	#N/A
	Lochsa River (B)	0.97	1.01	1.003	0.997		1.12	#N/A	#N/A	#N/A
	Selway River (B)	0.97	1.01	1.003	0.997		1.12	#N/A	#N/A	#N/A
	South Fork (B)	0.97	1.02	1.003	0.997		1.12	#N/A	#N/A	#N/A
Salmon River	Little Salmon/Rapid (A)	0.97	1.01	1.003	0.997		1.08	#N/A	#N/A	#N/A
	Chamberlain Cr. (A)	0.97		1.003	0.997		1.08	#N/A	#N/A	#N/A
	Secesh River (B)	0.97		1.003	0.997		1.12	#N/A	#N/A	#N/A
	South Fork Salmon (B)	0.97		1.003	0.997		1.12	#N/A	#N/A	#N/A
	Panther Creek (A)	0.97		1.003	0.997		1.08	#N/A	#N/A	#N/A
	Lower Middle Fork Tribs (B)	0.97		1.003	0.997		1.12	#N/A	#N/A	#N/A
	Upper Middle Fork Tribs (B)	0.97		1.003	0.997		1.12	#N/A	#N/A	#N/A
	North Fork (A)	0.97		1.003	0.997		1.08	#N/A	#N/A	#N/A
	Lemhi River (A)	0.97	1.01	1.003	0.997		1.08	#N/A	#N/A	#N/A
	Pahsimeroi River (A)	0.97	1.07	1.003	0.997		1.08	#N/A	#N/A	#N/A
	East Fork Salmon (A)	0.97	1.01	1.003	0.997		1.08	#N/A	#N/A	#N/A
	Upper Mainstem (A)	0.97	1.01	1.003	0.997		1.08	#N/A	#N/A	#N/A

Note: This draft was developed for discussion purposes only and does not capture every element of the PA/BA/MOA

Biological Analysis Spreadsheets - Snake River Steelhead

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		Prospective Lifecycle Survival Adjustments							Estimated Future Condition		
SNAKE RIVER STEELHEAD		**Hydro**	**2007-2017 Habitat (Trib)**	**Habitat (Estuary)**	**Avian Predation**	**P-minnow Predation**	**Hatchery**	**Harvest**	**Estimated Future R/S**	**Estimated Future λ**	**Estimated Future Trend**
Average "A-Run" Populations		0.91		1.06	1.03	1.01			1.32	1.08	1.02
Average "B-Run" Populations		0.91		1.06	1.03	1.01			0.89	1.02	0.98
Lower Snake	Tucannon (A, below LGR)	0.91	1.11	1.06	1.03	1.01			#N/A	#N/A	#N/A
	Asotin (A)	0.91	1.12	1.06	1.03	1.01			#N/A	#N/A	#N/A
Imnaha River	Imnaha R. (A)	0.91		1.06	1.03	1.01			#N/A	#N/A	1.04
Grande Ronde	Upper Mainstem (A)	0.91	1.09	1.06	1.03	1.01			1.07	0.99	1.00
	Lower Mainstem (A)	0.91		1.06	1.03	1.01			#N/A	#N/A	#N/A
	Joseph Cr. (A)	0.91	1.12	1.06	1.03	1.01			1.53	1.04	1.06
	Wallowa R. (A)	0.91	1.27	1.06	1.03	1.01			1.75	#N/A	#N/A
Clearwater River	Lower Mainstem (A)	0.91	1.04	1.06	1.03	1.01			#N/A	#N/A	#N/A
	Lolo Creek (A & B)	0.91	1.12	1.06	1.03	1.01			#N/A	#N/A	#N/A
	Lochsa River (B)	0.91	1.18	1.06	1.03	1.01			#N/A	#N/A	#N/A
	Selway River (B)	0.91	1.02	1.06	1.03	1.01			#N/A	#N/A	#N/A
	South Fork (B)	0.91	1.14	1.06	1.03	1.01			#N/A	#N/A	#N/A
Salmon River	Little Salmon/Rapid (A)	0.91	1.10	1.06	1.03	1.01			#N/A	#N/A	#N/A
	Chamberlain Cr. (A)	0.91		1.06	1.03	1.01			#N/A	#N/A	#N/A
	Secesh River (B)	0.91	1.06	1.06	1.03	1.01			#N/A	#N/A	#N/A
	South Fork Salmon (B)	0.91	1.06	1.06	1.03	1.01			#N/A	#N/A	#N/A
	Panther Creek (A)	0.91		1.06	1.03	1.01			#N/A	#N/A	#N/A
	Lower Middle Fork Tribs (B)	0.91	1.07	1.06	1.03	1.01			#N/A	#N/A	#N/A
	Upper Middle Fork Tribs (B)	0.91		1.06	1.03	1.01			#N/A	#N/A	#N/A
	North Fork (A)	0.91		1.06	1.03	1.01			#N/A	#N/A	#N/A
	Lemhi River (A)	0.91	1.09	1.06	1.03	1.01			#N/A	#N/A	#N/A
	Pahsimeroi River (A)	0.91	1.27	1.06	1.03	1.01			#N/A	#N/A	#N/A
	East Fork Salmon (A)	0.91	1.06	1.06	1.03	1.01			#N/A	#N/A	#N/A
	Upper Mainstem (A)	0.91	1.18	1.06	1.03	1.01			#N/A	#N/A	#N/A

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Snake River steelhead DPS		**ICTRT Gap**	**ICTRT Gap Multiplier**	**FCRPS-high relative impact**	**FCRPS-low relative impact**	**TRT Gap w/ high hydro**	**TRT Gap w/ low hydro**	**Total Survival Change (from previous sheets)**	**Remaining Framework Gap (high)**	**Remaining Framework Gap (low)**
Average other "A-Run" Populations		0.52	1.52	0.71	0.42	1.35	1.19	#N/A	#N/A	#N/A
Average "B-Run" Populations		0.65	1.65	0.71	0.42	1.43	1.23	#N/A	#N/A	#N/A
Lower Snake	Tucannon (A, below LGR)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Asotin (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Imnaha River	Imnaha R. (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Grande Ronde	Upper Mainstem (A)	-0.52	0.48	0.73	0.29	0.59	0.81	1.07	0.55	0.76
	Lower Mainstem (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Joseph Cr. (A)	-0.59	0.41	0.73	0.43	0.52	0.68	1.20	0.43	0.57
	Wallowa R. (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Clearwater River	Lower Mainstem (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Lolo Creek (A & B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Lochsa River (B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Selway River (B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	South Fork (B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Salmon River	Little Salmon/Rapid (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Chamberlain Cr. (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Secesh River (B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	South Fork Salmon (B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Panther Creek (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Lower Middle Fork Tribs (B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Upper Middle Fork Tribs (B)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	North Fork (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Lemhi River (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Pahsimeroi River (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	East Fork Salmon (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Upper Mainstem (A)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

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Snake River Steelhead DPS		Base Extinction Risk (QET=1)	Base Extinction Risk (QET=50)	R/S	Lambda	Trend	Remaining Framework Gap (high)	Remaining Framework Gap (low)	Additional Qualitative Survival and Recovery Improvements*
Average other "A-Run" Populations		+	+	+	+	+	#N/A	#N/A	+
Average "B-Run" Populations		N/A	N/A	-	+	-	#N/A	#N/A	+
Lower Snake	Tucannon (A, below LGR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Asotin (A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Imnaha River	Imnaha R. (A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Grande Ronde	Upper Mainstem (A)	+	+	+	-	+	+	+	+
	Lower Mainstem (A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Joseph Cr. (A)	+	+	+	+	+	+	+	+
	Wallowa R. (A)	N/A	N/A	+	N/A	N/A	#N/A	#N/A	+
Clearwater River	Lower Mainstem (A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Lolo Creek (A & B)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Lochsa River (B)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Selway River (B)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	South Fork (B)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Salmon River	Little Salmon/Rapid (A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Chamberlain Cr. (A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Secesh River (B)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	South Fork Salmon (B)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Panther Creek (A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Lower Middle Fork Tribs (B)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Upper Middle Fork Tribs (B)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	North Fork (A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Lemhi River (A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Pahsimeroi River (A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	East Fork Salmon (A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Upper Mainstem (A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Hypothetical conclusions based on current estimated survival improvements. Additional survival improvements are expected as the action is further developed.

*** Includes safety net hatcheries, non-federal actions that are reasonably certain to occur, and other Federal actions that have undergone section 7 consultation under the ESA.**

Methods for calculating extinction probability estimates using the Beverton-Holt and Ricker production functions

by

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Summary

Extinction probability estimates are developed for several stream type chinook and steelhead populations in the Columbia Basin. This approach uses the Beverton-Holt production and Ricker functions, which are fit to spawner-recruit (SR) data from brood years 1978 to the present. Because autocorrelation of errors can influence extinction risks, errors were modeled as an autoregressive process of order 1. The estimated Beverton-Holt and Ricker functions were used to project forward populations over a time horizon of 24 years to estimate extinction probability. Alternative quasi-extinction thresholds of 1, 10, 30, and 50 were used. In the projections, extinction was assumed to occur when spawners fall below the quasi-extinction threshold four years running.

Introduction

Population viability analysis is used to gauge the likelihood of extinction of endangered salmon populations in the Columbia River Basin. The 2000 Federal Columbia River Power System (FCRPS) Biological Opinion (2000 Biop) used the Dennis et al. (1991) model to estimate the probability of absolute extinction (the population falling below 1 individual), with an estimation procedure modified to account for measurement error (Holmes 2001). This method was used as a large-scale, multi-species risk assessment of anadromous salmonids in the Columbia River Basin (McClure et al. 2003).

One important element in the estimation of extinction risks is the production function that is used. The production function is the mathematical rule that describes how spawners in one year are related to spawners in subsequent years (recruits). The models described in Holmes (2001) and McClure et al. (2003), which were used in the 2000 Biological Opinion, were linear. That is, it was assumed that the mean population growth rate was constant regardless of spawner abundance. This assumption is contrary to most fisheries models, such as the Ricker or Beverton-Holt models, which assume that the population growth rate declines as spawner numbers increase (Hilborn and Walters 1992). The most recent estimates used by NOAA Fisheries use nonlinear production functions. The nonlinear models include the assumption that populations cannot grow indefinitely, that is, they must level off as spawner numbers increase. Linear production functions do not include this assumption.

The nonlinear model used by the Interior Columbia Technical Recovery Team for estimating extinction risks was the hockey stick model (Barrowman and Myers 2000). The more traditional models, such as Beverton-Holt and Ricker, assume that survival increases with declining population until the last spawner disappears (Hilborn and Walters 1992). For these models, as spawner abundance declines, the number of recruits produced per spawner actually increases. From the perspective of population viability analysis, this assumption of increased survival at low population size may overestimate the resilience of a population and thus lead to underestimates of extinction probability. The hockey stick model addresses this concern by assuming constant recruits produced per spawner when spawner abundance declines below a threshold (Barrowman and Myers 2000). The hockey stick model, however, introduces important estimation issues because the likelihood function includes “kinks” where the derivative is not defined and it often exhibits multiple local maxima.

This methods paper details an approach to estimating extinction probabilities using the Beverton-Holt and Ricker production functions. The hockey stick production model was not used because it creates numerical and statistical difficulties for the parameter estimation. Beverton-Holt and Ricker parameter estimates were obtained by maximizing the likelihood function and extinction probabilities were obtained by projecting forward spawner abundances 24 years into the future. The procedure was applied to several salmon populations from the listed Snake River Spring/Summer Chinook and Upper Columbia River Spring/Summer Chinook ESUs and to several steelhead populations from the Snake River Steelhead, Upper Columbia River Steelhead, Mid-Columbia River Steelhead. The time horizon was set at 24 years, and the quasi-extinction threshold set at 1, 10, 30 and 50 spawners.

Methods

Data

Spring/summer chinook

The data employed were the Snake River and Upper Columbia River stream-type chinook spawner-recruit data (Beamesderfer et al. 1997), which were updated to include estimates through brood year 1998. Spawner estimates were estimates of annual abundance of salmon arriving at the spawning grounds. Recruitment refers to adult progeny returning to the spawning grounds. Stocks considered in this analysis were 21 Snake River stocks (Tucannon Spring Chinook, Lostine River Chinook, Grande Ronde, Upper Mainstem Chinook, Catherine Creek Chinook, Imnaha River Chinook, Minam River Chinook, Wenaha River Chinook, Secesh River Chinook, South Fork Salmon East Fork (inc Johnson Cr.), Big Creek Chinook, Bear Valley Creek, Camas Creek Chinook, Loon Creek Chinook, Marsh Creek Chinook, Sulphur Creek, Pahsimeroi Chinook, Lemhi River Chinook, Valley Creek Chinook, Yankee Fork Salmon River, Lower Mainstem Salmon River (SRLMA), Upper Mainstem Salmon River (SRUMA)), and 3 Upper Columbia River stocks (Wenatchee River Chinook, Methow River Chinook, Entiat River Chinook).

Steelhead

Spawner-recruit data developed for steelhead populations from the Snake River, Mid-Columbia, and Upper Columbia ESUs were also analyzed. Populations from the

Snake River ESU included the Average A-run population, the Average B-run population (which lacked age-structure data), Grande Ronde Upper Mainstem, Joseph Creek Steelhead, and Imnaha River Steelhead (Camp Creek). Populations from the Mid-Columbia ESU included John Day Lower Mainstem, John Day North Fork, John Day Upper Mainstem, John Day Middle Fork, John Day South Fork, Umatilla River, Walla Walla River, Fifteenmile, Deschutes River Westside, Deschutes Eastside, Satus Creek, Toppenish Creek , Naches River, Upper Yakima River. Populations from the Upper Columbia Steelhead ESU included: Wenatchee River, Methow River , Entiat River, and Okanogan River .

The model

The underlying production function used in the population projections were the Beverton-Holt and Ricker models (Hilborn and Walters 1992). The Beverton-Holt model was applied to chinook populations and the Ricker model was applied to steelhead populations. The Beverton-Holt model was not applied to the steelhead populations because valid parameter estimates could not be found from about half of the steelhead populations. Instead, the Ricker model was used because it is guaranteed to yield maximum likelihood estimates. The Beverton-Holt takes the mathematical form:

(1) $$R_t = S_t \exp(a + \phi_t)/(1 + bS_t),$$ (Beverton-Holt)

where R_t is recruitment (the adult progeny of fish spawning in year t), S_t represents the number of spawners in brood year *t*, *a* is the intrinsic productivity which represents the maximum log recruits per spawner, ϕ_t represents a stochastic error term, which follows an autoregressive process of order 1, and *b* is the parameter which describes density dependent growth. The Ricker model takes the mathematical form

(2) $$R_t = S_t \exp(a - bS + \phi_t)\,,$$ (Ricker)

The autoregressive process was used for the error term because extinction probabilities are influenced by autocorrelation (Wichmann et al. 2005). The autoregressive order 1 process is given by

(3) $$\phi_{t+1} = \alpha\phi_t + \varepsilon_{t+1}\,,$$

where α is the autoregressive parameter, which, according to the Yule-Walker equations, is equivalent to the lag-1 autocorrelation coefficient (Box et al. 1994); and the ε_{t+1} are independent and normally distributed random with mean zero and variance σ^2. The ε_t process will be referred to as the white noise process. (The ϕ_t errors represent a red noise process because the errors are positively correlated). The initial production function error, ϕ_1, is set equal to ε_1 (i.e, it is normally distributed with mean zero and variance σ^2).

The parameters were estimated by maximizing the likelihood function. The log likelihood function was formed by taking the log of the joint distribution of the white noise errors, ε_t:

$$l = -\frac{n}{2}\log\left(2\pi\sigma^2\right) - \frac{1}{2\sigma^2}\sum_{t=1}^{n}\varepsilon_t^2 =$$

$$= -\frac{n}{2}\log\left(2\pi\sigma^2\right) - \frac{1}{2\sigma^2}\left\{\left(y_1 - f(a,b,S_1)\right)^2 + \sum_{t=1}^{n-1}\left(y_{t+1} - f(a,b,S_{t+1}) - \alpha\left(y_t - f(a,b,S_t)\right)\right)^2\right\}$$

where n is the number of spawner-recruit observations, y_t represents $\log(R_t / S_t)$, and $f(a,b,S_t)$ is $a - \log(1 + bS_t)$ when the Beverton-Holt production function is used and is equal to $a - bS_t$ when the Ricker production function is used. Notice that when the autoregressive parameter, α, is equal to zero, then the likelihood function is reduced to the usual likelihood function with uncorrelated errors. Altogether, there were four parameters to estimate from this likelihood function: a, b, α, and σ^2. Since the model is nonlinear in the parameters, interior maximum likelihood estimates were not guaranteed to exist.

The nonlinear regression was conducted using the routine *nls* from the R statistical package, which uses a Gauss-Newton algorithm for calculating maximum likelihood estimates (R Development Core Team 2005). Standard errors and *p*-values were calculated for the parameter estimates and correlations between the various estimates were also calculated. The R-code for obtaining the parameter estimates is given in Table 1.

Extinction probabilities

Once the Beverton-Holt or Ricker parameters are estimated, it is then possible to use the production function to estimate probabilities of extinction by projecting forward the spawner numbers. In each simulation of a population, $N = 4000$ 24-year sequences of simulated spawners were generated. The extinction probability was estimated as the fraction of the $N = 4000$ 24-year sequences in which spawners fell below the quasi-extinction threshold (QET) four years running. Extinction probability estimates were obtained using alternative values of QET (1, 10, 30, and 50), and with a time horizon of 24 years. If, during a population projection, the total number of spawners fell below 10, then number of recruits was set to zero (i.e. the reproductive failure threshold was set at 10 spawners). In the case where QET=1, a reproductive failure threshold of 2 spawners was used.

The precise bookkeeping for the prospective simulations is described in the attached R code (Table 2). Once the spawner series was initialized, the stochastic production function was used to build a series of future spawners by allocating recruits to the appropriate spawners in future years. A fixed age structure of recruits was assumed. Age structure was estimated as the average fractions of returns at ages 3, 4 and 5.

Using the Beverton-Holt production function, the projections took the following mathematical form:

(4) $$R_t^* = S_t^* \exp(\hat{a} + \phi_t^*)/(1 - \hat{b}S_t^*)$$

(5) $$S_t^* = \sum_{\tau=1}^{5} \bar{p}_\tau R_{t-\tau}^*$$

where R_t^* was the simulated number of recruits generated from spawners in brood year *t*; S_t^* was the simulated number of spawners in brood year *t*; $\hat{a}$ is the maximum likelihood estimate of the Beverton-Holt density-independent parameter a; ϕ_t^* represented a random draw from the autoregressive error model, which represented the estimated residual variance for the Beverton-Holt production function; $\hat{b}$ was the maximum likelihood estimate of the Beverton-Holt density-dependent parameter b; τ represented age of returning adults; and $\bar{p}_\tau$ represented the average fraction of adults returning at age τ. The projections were initialized by setting the first five spawner numbers in the sequence equal to the spawner observations from brood years 1999-2003. Autocorrelation in the residual error term was not modeled (i.e., the residuals were treated as independent).

A similar method is used when the Ricker model was employed, but in that case the population projections were accomplished using the function

(6) $$R_t^* = S_t^* \exp(\hat{a} - \hat{b}S_t^* + \phi_t^*)$$

instead of the Beverton-Holt form of the production function.

Supplementation

In the extinction probability analysis above, it was assumed that the relative reproductive effectiveness of hatchery-born spawners was equal to that of the wild-born spawners and that supplementation would not continue into the future. As an alternative, some extinction runs were conducted under the assumptions that reproductive effective ness of hatchery-born spawners could differ from that of wild-born spawners and that supplementation would continue at some level into the future.

Within this framework, which recognizes supplementation and differential reproductive effectiveness of hatchery-born spawners, the following model is fit to the retrospective data,

(7) $$R_t = S_t(f_t + (1 - f_t)e_t)\exp(a + \phi_t)/(1 + bS_t)$$

Where f_t represents the fraction of wild-born spawners and e_t represents the relative reproductive success of hatchery-born spawners. In the special case where $e_t = 0$, none of the hatchery-born spawners are contributing to the progeny (recruits) and that is reflected in the above equation. In the case where $e_t = 1$, the model reduces to the model introduced in equation 1, where the fraction of wild-born spawners is irrelevant.

This alternative (supplementation) model will generally produced different estimates of the Beverton-Holt parameters than the model that does not differentiate between hatchery-born and wild-born spawners. Therefore, extinction probability estimates will change. Inclusion of supplementation in the future will also alter extinction probabilities. The population projections with supplementation take the form

(8) $$R_t^* = S_t^*(f_t^* + (1 - f_t^*)e_t^*)\exp(\hat{a} + \phi_t^*)/(1 - \hat{b}S_t^*)$$

(9) $$S_t^* = \left(\sum_{\tau=1}^{5} \bar{p}_\tau R_{t-\tau}^*\right) / f_t^*$$

where e_t^* represented the future values of the relative reproductive effectiveness of hatchery-born spawners, f_t^* represented the future fraction of wild-born spawners, and S_t^* represented the total number of (wild + hatchery-born) spawners. ϕ_t^* represented a random draw from the autoregressive error model, which represented the estimated residual variance for the Beverton-Holt production function; $\hat{b}$ was the maximum likelihood estimate of the Beverton-Holt density-dependent parameter b, Extinction occurs when the total spawners fall below QET four years running. That is, when $\sum_{t=t'+1}^{t'+4} S_t^* / f_t^*$ falls below QET at some time t' within the time horizon of 24 years. A similar methodology was used when the Ricker model was used instead of the Beverton-Holt model.

Survival gap calculations

In the population viability analysis, one may consider extinction probability to be a function of abundance and productivity. Generally, as abundance and productivity (Beverton-Holt a) parameter increase, extinction probability decreases. Whenever extinction probability lies above 5%, a survival gap is considered to exist. This gap may be quantified by calculating the increase in productivity necessary to achieve the 5% extinction risk target. In this sense, extinction probability is considered as a function of productivity, which may be denoted $P(a)$. $P(a)$ represents the probability of extinction when the Beverton-Holt production parameter is set to a. To achieve a 5% extinction probability, one seeks the value of a that makes the value of the function

(10) $$f(a) = P(a) - 0.05$$

equal to zero. This is known as a root finding problem in numerical analysis. The root in this case is the value of the Beverton-Holt *a* parameter that yields an extinction probability of 5%. To solve this problem, the bisection method was used, which cannot fail once an interval that contains a root is identified (Press et al. 1992). The bisection algorithm used was *rtbis*, and the bracketing routine used was *zbrac*, which identifies an interval that contains the root (Press et al. 1992).

Once the root a^* was found numerically, it was a simple matter to calculate the survival gap. The survival gap was given by

(11) $$gap = \exp(a^* - \hat{a}),$$

where $\hat{a}$ represents the maximum likelihood estimate of the Beverton-Holt *a* parameter. Based on this definition, the gap represents a multiplier needed for the current survival needed to achieve a 5% extinction risk. When the multiplier is at or below one, then no increase in survival is necessary (extinction risk is already at or below 5%), but when the multiplier is above one, an increase is necessary to achieve 5% risk.

The underlying assumption that allows this gap calculation to work is that the intrinsic productivity, or recruits per spawner and low abundance given by $\exp(a)$ is proportional to survival. Thus $\exp(a) = k \cdot s$ where k is a constant and s represents survival. If s_0 represents current survival, and s^* represents the survival necessary to achieve the 5% target, then the survival gap is

(12) $$gap = \frac{s^*}{s_0} = \frac{\exp(a^*)/k}{\exp(\hat{a})/k} = \exp(a^* - \hat{a})$$

When the Ricker production function was used, gaps were calculated in the same manner, except, the Ricker-*a* was used in place of the Beverton-Holt *a*.

Acknowledgements

This work was performed for the Bonneville Power Administration under contract #00029587. Thanks to Tom Cooney for supplying the population data and supplying details on a proposed population viability analysis method used by the Interior Columbia River Technical Recovery Team. Thanks to Charlie Paulsen, Tom Cooney, and David Raff for comments on an earlier draft of this manuscript.

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Table 1. *fit.bh* is R code that that estimates of the Beverton-Holt production function parameters.

```
#R-code developed by R. A. Hinrichsen  12-12-06
#recruits – represents the time series of recruits for all years under
#investigation. Missing values (NA) must be included for years with
#missing recruits.
#spawners  - represents the time series of spawners. Again all years of
study must be included. Missing values (NA) must be include for years
with missing spawners.
#astart – an initial estimate of the Beverton-Holt a parameter
#bstart – an initial estimate of the Beverton-Holt b parameter
#alphastart – an initial estimate of the AR(1) parameter.
#a - the maximum likelihood estimate of the BH a parameter
#b - the maximum likelihood estimate of the BH b parameter
#alpha - the maximum likelihood estimate of the AR(1) parameter
#s2 - the maximum likelihood estimate of the white noise variance
#parameter
fit.bh <-function(recruits,spawners,astart,bstart,alphastart){

  yy<-log(recruits/spawners)
  n<-length(yy)
  n2<-n-1
  x<-spawners
  data2<-data.frame(Y=yy,
                  Y2=c(0,yy[1:n2]),
                  SPAWNERS=x,
                  SPAWNERS2=c(0,x[1:n2]),
                  X=c(0,rep(1,n2)))

  iii<-
is.na(data2$Y+data2$SPAWNERS+data2$SPAWNERS2+data2$Y2)|is.infinite(data
2$Y+data2$Y2+data2$SPAWNERS+data2$SPAWNERS2)
  data2<-data2[!iii,]

res<-nls(Y~a-log(abs(1.+b*SPAWNERS))+alpha*(Y2-
a+log(abs(1.+b*SPAWNERS2)))*X,
data=data2,
start=list(a=astart,b=bstart,alpha=alphastart),
na.action=na.omit,
control=list(maxiter=100,tol=1e-05,minFactor=1/1024),
trace=T)

   s2<-summary(res)$sigma^2
   coef<-coefficients(res)
   a<-coef[1];b<-coef[2];alpha<-coef[3]
 return(list(a=a,b=b,alpha=alpha,s2=s2))
}
```

Table 2. *extinct.bh.* R code that calculates the probability of extinction based on estimates of the Beverton-Holt production function. The fitting is accomplished using the R routine *nls* (R Development Core Team 2005).

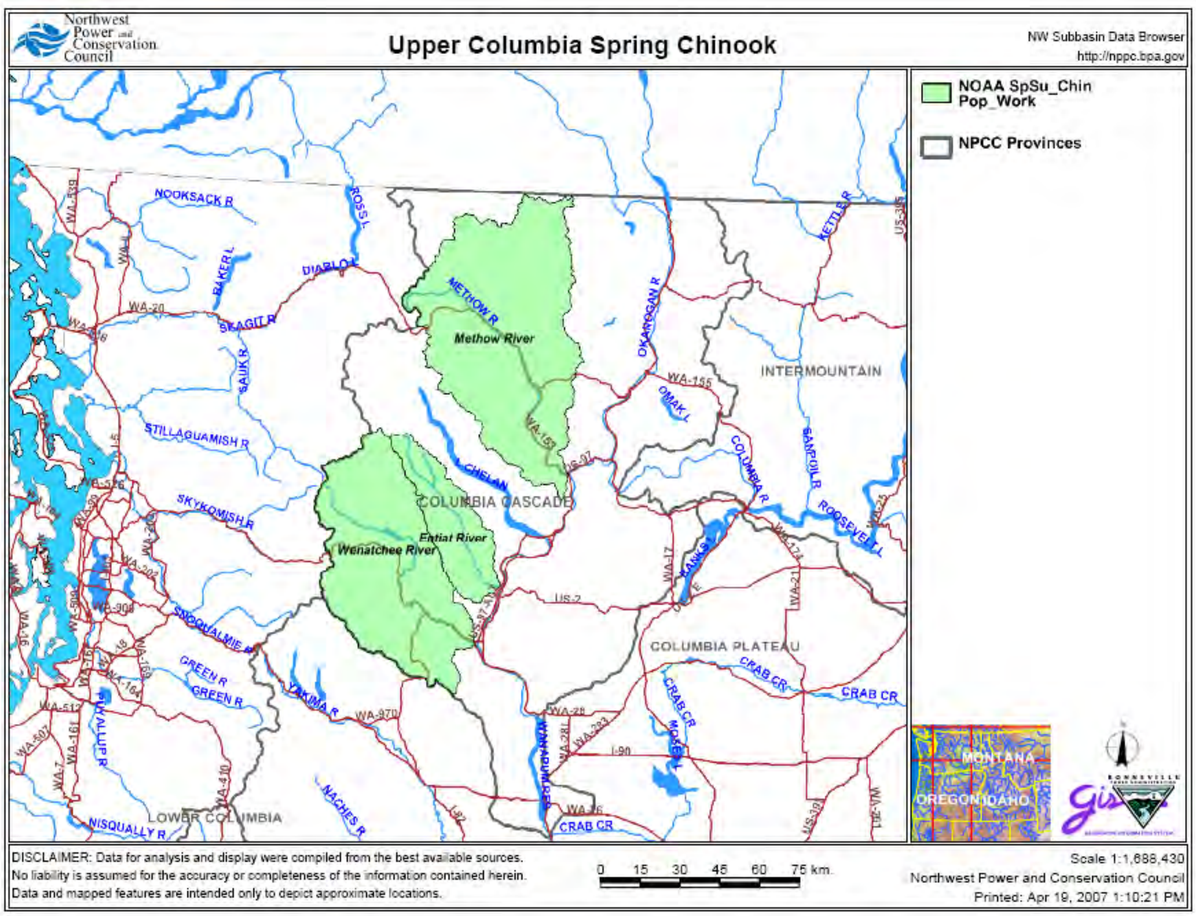
```
# R-code developed by R.A. Hinrichsen 12-12-2006
#Calculates extinction probability using the Beverton-Holt production
#function. Extinction occurs when spawners fall below QET four years
#running. Zero recruits are produced whenever spawners fall below QET.
#qet = quasi extinction threshold
#rft = reproductive failure threshold
#nyears = the time horizon used for extinction
#NTRAJ = the number of trajectories used to estimate the probability of
#extinction
#SINIT = a vector the initial number of spawners over five years
#age = a vector giving the age distribution of recruits
#a = the Beverton-Holt density-independent parameter estimate
#b = the Beverton-Holt density-dependent parameter estimate
#alpha = the autoregressive (AR) parameter estimate
#s2 = the white noise variance estimate for the AR(1) process
extinct.bh<-function(qet,rft,nyears,NTRAJ,SINIT,age,a,b,alpha,s2)
{
 ext<-0
 for(jj in 1:NTRAJ){
  s<-rep(0,nyears+10)
  s[1:5]<-SINIT
  phi<-rnorm(1)*sqrt(s2)
  for(ii in 1:(nyears+5)){
   if(ii>5){
 iii<-s[(ii-3):ii]<qet
 if(sum(iii)==4){ext<-ext+1;break}
   }#if
   y<-a-log(1.+ b*s[ii])
   r<-s[ii]*exp(y+phi)
   phi<-alpha*phi+rnorm(1)*sqrt(s2)
   if(s[ii]<rft){r<-0}
   if((ii+1)>5)s[ii+1]<-s[ii+1]+r*age[1]
   if((ii+2)>5)s[ii+2]<-s[ii+2]+r*age[2]
   if((ii+3)>5)s[ii+3]<-s[ii+3]+r*age[3]
   if((ii+4)>5)s[ii+4]<-s[ii+4]+r*age[4]
   s[ii+5]<-s[ii+5]+r*age[5]
  }#for ii
 }#for jj
 ext<-ext/NTRAJ
 return(ext)
}
```

Note: Extinction occurs whenever spawners fall below the quasi-extinction threshold four years running. Zero recruits are produced when spawners fall below the quasi-extinction threshold. The function call rnorm(1) produces a random standard normal deviate. The returned value, ext, represents the extinction probability based on NTRAJ population projections.

This is not a final federal agency product. Rather, it is a pre-decisional document prepared by the Action Agencies that reflects present understandings of currently available information and analyses, and of the progression of discussions with the sovereigns in the collaborative process. Revisions and refinements are to be expected based on further discussions with the sovereigns over new and modified proposed federal actions upon which the action agencies will ultimately consult. Finally, the information in this product does not constitute an analysis of whether the identified measures would or would not jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Furthermore, this document does not in any way interpret or apply the regulatory definitions of the statutory phrases "jeopardize the continued existence of" and "destruction or adverse modification."

Upper Columbia River Spring Chinook Salmon ESU

Please note that all of the information in this paper is still preliminary. In particular, benefits assessments are still under review. For certain populations additional actions are being considered that might be implemented by the Action Agencies or by others.



ESU Description[1]	
Endangered	Listed under ESA in 1999; reaffirmed in 2005
Hatchery programs included in ESU	Twisp, Chewuch, Methow composite, Winthrop, Chiwawa, White River

[1] Listing determination (70FR37160); Interior TRT July 2003 description of independent populations *www.nwfsc.noaa.gov/trt/col_docs/independentpopchinsteelsock.pdf,* May 2005 update *www.nwfsc.noaa.gov/trt/col_docs/updated_population_delineation.pdf* .

Major Population Groups (Extant)	**Extant Natural Populations**
Eastern Cascades	Entiat River Methow River Wenatchee River

INTRODUCTION

This paper briefly summarizes the current biological analysis developed for this Evolutionarily Significant Unit (ESU). First, it provides an overview of the ESU and the factors limiting its viability, summarizes population-level status information during the 20 year base period used for this analysis, and provides estimates of the "gaps," or needed lifecycle survival improvements, for individual populations to meet certain biological criteria. It summarizes the improvements made to the hydrosystem and in other Hs since about 2000 and estimates the salmonid survival benefits associated with those improvements. Finally, it describes the actions proposed to be implemented into the future and estimates their effects on salmonid survival when aggregated with the environmental baseline and cumulative effects.

Almost all of the metrics used in this analysis are estimates for individual populations within the ESU. The Endangered Species Act is concerned with the status of a species, DPS, or ESU. Individual populations and major population groups (where they exist) obviously contribute to ESU status. However, the status of the ESU is not wholly dependent upon the status of any of the ESU's individual components.

Upper Columbia River spring Chinook salmon spawn and rear in the mainstem Columbia River and its tributaries between Rock Island Dam and Chief Joseph Dam. The primary spawning and rearing habitats are the upper reaches of the watersheds that drain the east slope of the Cascade Mountains. The upriver limit of migration has been Chief Joseph Dam (River Mile 545) since its completion in 1961; prior to that the upriver limit was Grand Coulee Dam which was completed in 1941. Both hydroelectric projects were constructed without fish passage facilities and block migration of anadromous fish. The Interior Columbia Technical Recovery Team (ICTRT) has identified one major population group (MPG) composed of three extant populations (Wenatchee, Entiat, and Methow Rivers) and one extinct population (the Okanogan River). This Evolutionarily Significant Unit (ESU) was first listed as an endangered species on March 24,1999 and reaffirmed as endangered on June 28, 2005.

Unlike the Snake River spring/summer Chinook ESU where both the spring- and summer-run fish are considered a single ESU based on a similar stream-type life history, the Upper Columbia River spring Chinook ESU includes only the spring-run fish. In the upper Columbia River the vast majority of the summer-run fish exhibit an ocean-type life history similar to the fall-run Chinook in both the upper Columbia and the Snake rivers.

Hatchery facilities located in the geographic area occupied by this ESU include the USFWS Leavenworth National Fish Hatchery Complex (which includes the Leavenworth, Winthrop, and Entiat National Fish Hatcheries), and the WDFW-operated Wells and Methow Hatcheries (funded by Douglas Public Utility District (PUD) and Eastbank, Chelan, and Rocky Reach hatcheries and their satellite facilities (funded by Chelan PUD). Additional hatchery facilities are planned for this area as part recent Habitat Conservation Plans developed for the operation of Wells, Rocky Reach and Rock Island Dams, and under recent settlement agreements for the operation of Wanapum and Priest Rapids dams. The implementation of the these programs is under the direction of multi agency committees which include representatives of WDFW, USFWS, NMFS, Colville Tribes, Yakama Nation, and the Chelan, Douglas and Grant PUDs.

The contributions of the hatchery program to the production of spring Chinook salmon in this ESU varies by watershed and individual population. The base period proportion of hatchery-origin fish in the spawning populations (brood years 1979-1998) was about 11 percent for the Wenatchee, 15 percent for the Entiat and 14 percent for the Methow. Hatchery numbers have increased significantly in recent years. The ICTRT estimates the 10-year hatchery fraction of the Wenatchee at about 38 percent, the Entiat at about 31percent, and the Methow at about 48 percent.[2] The 20 year average hatchery fraction for these populations is 11 percent for the Wenatchee, 14 percent for the Methow and 15 percent for the Entiat, indicating increased supplementation in recent years. Both the use of non-native broodstock and significant straying has been a problem associated with some of the hatchery programs affecting this ESU. Most of the spring Chinook salmon hatchery programs in the Upper Columbia transitioned to the use of native broodstock in the late 1990s or early 2000s. The Entiat and Leavenworth NFH are the exceptions.

Upper Columbia River spring Chinook salmon in this ESU are harvested on a sliding scale of 5.5 to 17 percent; the 2000-2004 average was 10.7 percent. These harvests levels are negotiated under the Columbia River Fisheries Compact, and include in-river tribal harvest in Zone 6 and the lower Columbia River commercial and sport harvest. Although considered uncertain by some, the rare recovery of tagged spring Chinook salmon in ocean fisheries suggests minimal ocean harvest impact on this ESU.

The ICTRT has concluded that the populations in this ESU are at high risk for both abundance and productivity and spatial structure/genetic diversity.

Human impacts and current limiting factors for this ESU come from multiple sources: hydro passage, habitat degradation, hatchery effects, fishery management and harvest decisions predation, and other sources.

Key Limiting Factors

Salmon and steelhead have been adversely affected over the last century by many activities including human population growth, introduction of exotic species, over fishing, developments of cities and other land uses in the floodplains, water diversions for all purposes, dams, mining, farming, ranching, logging, hatchery production, predation, ocean conditions, loss of habitat and other causes (Lackey et al.2006)[3].

Natural mortality of these fish throughout their lifecycle is 90 to 95 percent. NMFS identified juvenile fish passage as the most important area where improvements might be made to benefit this ESU. Juvenile outmigrants from this ESU must pass seven to nine mainstem Columbia River dams (Federal- and PUD- owned) during their outmigration to the ocean. It is estimated that survival through this life-stage and migration ranges from about 54-61percent. In addition to juvenile passage, NOAA also identified hatchery practices as the second most important limiting factor affecting this ESU. The use of out-of-ESU stocks early on in the hatchery

[2] Table 3a of ICTRT *Required Survival Rate Changes to Meet Technical Recovery Team Abundance and Productivity Viability Criteria – Interior Columbia Populations*.
[3] Lackey, Robert T, Denise H. Lach, and Sally L Duncan. Wild salmon in Lackey, Robert T, Denise H. Lach, and Sally L Duncan. Wild salmon in western north america: the historical and policy perspective. Pp 13-55. In: Salmon 2100: The future of wild pacific salmon. 2006. Robert T Lackey, Denise H. Lach, and Sally L. Duncan (editors).

programs likely has contributed to declines in this ESU. Summarized below are current key limiting factors for this ESU identified by NOAA in the ESU Overviews for the remand collaboration[4].

Hydro	Upper Columbia spring Chinook salmon migrate through 7 to 9 mainstem Columbia River Dams as yearlings to reach the ocean. Some of these are federal dams and others are owned and operated by PUDs. Survival rates through these dams range from 92.6 percent at John Day dam to 95.9-97.4 percent at Wells dam. According to the Step 4 report, the estimated portion of the human impact attributable to the direct effects of the FCRPS dams (compared to natural river estimates) for each population ranges from 17 to 23 percent. Latent mortality hypotheses, an area of technical differences, would revise this figure to 30 to 35 percent. Hydro impacts include volume, timing and quality of flows that enter the FCRPS action area, including flows from the Snake River at the toe of Hells Canyon Dam, which are impacted by the operation of Reclamation's upper Snake River projects and the mainstem effects of Reclamation's other projects within the Columbia Basin.
Hatcheries	Continued use of out-of-ESU stocks in the Entiat is a primary limiting factor, and legacy impacts of previous hatchery programs are a factor in the Wenatchee and Methow populations. Habitat has limited natural production potential, and high proportions of hatchery fish increases the risk to the populations because natural selective processes are driven by the hatchery environment rather than the natural environment. The recovery goal contemplates a transition from hatchery to natural fish production as natural fish recover. According to the Step 4 report, the estimated portion of the human impact attributable to hatchery effects for each population ranges from 5 to 9 percent. If latent mortality is included, the range associated with hatchery impacts is 9 to 19 percent.
Habitat	The primary tributary habitat problems vary among the three extant populations in this ESU. Degraded stream channel and riparian habitats, primarily in the mainstem, are a key concern for the Wenatchee. The Entiat River is also characterized by losses in mainstem habitat; sedimentation is a second major concern in upper tributary reaches. The primary concern in the Methow Basin is late summer/winter flow conditions in key rearing areas, passage barriers, inadequate irrigation screening and channel habitat loss are also concerns. The Okanogan Basin is highly affected by temperature, flow and sedimentation. High priority locations include the Methow, lower Entiat, and lower Wenatchee. According to the Step 4 report, the estimated portion of the human impact attributable to combined habitat effects in the tributaries and the estuary for each population ranges from 13 to 23 percent If latent mortality is included, the range associated with habitat impacts is 26 to 49 percent.
Harvest	The only harvest above Priest Rapids Dam is mark-select for Leavenworth spring Chinook salmon. In the mainstem, current harvest rates average about 8 percent, though harvest rates since the adoption of a new management regime in 2001 have been higher, averaging about 11 percent. The current 3 year in-river harvest agreement allows for harvest between 5.5 percent and 17 percent, depending upon run strength According to the Step 4 report, the estimated portion of the human impact attributable to combined Tribal and non-Tribal harvest effects for each population ranges from 42 to 1 percent. If latent mortality is included, the range associated with harvest impacts increases to 10 to 16 percent.

[4] Master - Summary of Key ESU Info Int Columbia - table 24oct06, p. 7, (Limiting factors summarized and ranked by Paula Burgess, NOAA Fisheries, utilizing information found in working draft of ESU Overviews, 2005 Pacific Coastal Salmon Recovery Fund Report to Congress and local recovery plans.)

Predation	Predation has been noted as a factor limiting fish survival at mainstem reservoirs and in the Columbia estuary.
Estuary	Predation, levels of toxic substances, and habitat conditions in the plume are potential limiting factors.

BASE STATUS

This section summarizes the average status of this ESU during the base period, which for these populations is a 20 year period beginning in brood year 1979 and ending in brood year 1998. All of the analysis in this paper relies on datasets supplied by the Interior Columbia Technical Recovery Team, which do not include adult return information after 2003. These datasets were relied on, in part, for the sake of consistency with the ICTRT analyses.

ESU Abundance and Trend

The geometric mean abundance of natural-origin spring Chinook salmon returning to the Wenatchee, Methow, and Entiat rivers have averaged 226, 205, and 63, respectively, for the most recent 10-year period for which data are available. The 1994 to 1998 geomean abundance for these populations was 190, 129, and 38, respectively. The 1999 to 2003 geomean abundance for these populations was 467,324, and 103, respectively, indicating a 38 percent improvement in natural-origin spawner abundance for the ESU as a whole between the two periods.

However, longer term abundance trends of natural-origin fish have shown declines for both the 1980 to 2003 and the 1990 to 2003 periods, with the exception of the Entiat, which showed a slight increase for the most recent period.

Abundance and a rolling 5-year geometric mean of abundance for the ESU compared to the NOAA Fisheries interim recovery target are shown in Figure 1.

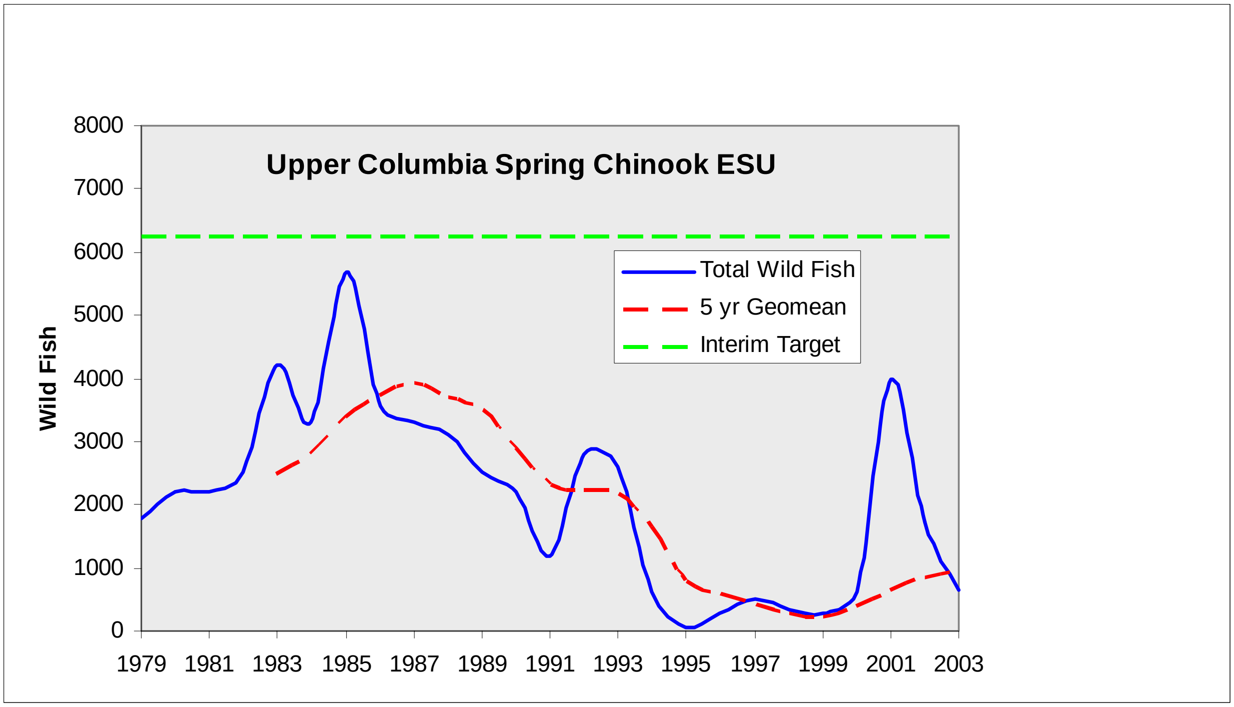


Figure 1 Upper Columbia Spring Chinook Abundance

Extinction Probabilities, Recruit-per-Spawner Productivity and Lambda

The productivity and survival metrics for three populations comprising this ESU are summarized in Table 1. Extinction probability estimates were developed for populations in this ESU using the Beverton-Holt production function, which was fit to spawner-recruit data from brood years 1978 to the present. The estimated Beverton-Holt function was used to project populations over a 24-year time horizon to estimate extinction probability. Alternative quasi-extinction thresholds (QETs) of 1, 10, 30, and 50 spawners were used in the analysis. In the modeling, extinction was assumed to occur when spawners fell below the quasi-extinction threshold for four years running. Reproductive failure was assumed to occur in any year in which spawner numbers fell below ten, except in the case of QET=1, where reproductive failure was assumed when spawners fell below two.[5]

Productivity, as reflected by estimates of recruits per spawner (R/S) using a 20-year time series of data, are less than 1.0 for all three populations. Lambdas are generally greater than 1.0. A metric of 1.0 reflects no gap. In this analysis, a metric of 1.0 reflects no gap. A number below 1.0 reflects a positive condition, while a number above 1.0 reflects a gap. For example, a gap of 1.2 indicates that 20 percent productivity is needed in the future.

[5] Reproductive failure is the assumption that zero progeny are produced in any year where spawner numbers fall below the identified threshold.

Table 1. Base status metrics.

For R/S, lambda and trend, a value >1.0 indicates a growing population; a value <1.0 indicates a population in decline. Extinction probabilities are expressed as percentages, e.g., a value of 0.11 indicates an 11% risk of extinction within 24 years.

Population	20 year R/S	10 year R/S	20 year λ	12 year Λ	1980-current Trend	1990-current Trend	Ext. Risk QET=1	Ext. Risk QET=10	Ext. Risk QET=30	Ext. Risk QET=50
Wenatchee	0.73	0.71	1.01	1.02	0.89	0.98	0.00	0.00	0.01	0.03
Methow	0.74	0.40	1.10	1.08	0.95	0.91	N/A	N/A	N/A	N/A
Entiat	0.72	0.82	0.99	1.03	0.97	1.08	0.00	0.00	0.06	0.17

The 24-year extinction probabilities are displayed for the Wenatchee and Entiat populations at quasi extinction thresholds (QET) of 1, 10, 30 and 50; valid results were not obtained for the Methow population, though an examination of the data suggests that extinction probabilities for the Methow are likely to be similar to those of the other populations in this ESU At QETs of 1 and 10 the 24-year risk was low; at a QET of 30 it was 1 percent and 6 percent for the Wenatchee and Entiat, respectively; and at a QET of 50 it was 3 percent and 17 percent for these same populations.

Based on these base estimates of survival metrics for the Wenatchee, Methow, and Entiat populations, Table 2 summarizes the needed improvements in survival to bring the estimates in line with the proposed survival standard.

Table 2. Base status gaps.

**Note: Gaps are expressed as multipliers. For example, a 1.10 gap indicates a 10 percent survival improvement is necessary to close gap. If gap is ≤ 1.0, no further improvement is necessary to close gap.*

Population	20 year R/S Gap	20 year Λ Gap	Long-term Trend Gap	Ext. Risk Gap QET = 1	Ext. Risk Gap QET = 50
Wenatchee	1.37	0.96	1.69	0.13	0.66
Methow	1.35	0.65	1.26	N/A	N/A
Entiat	1.39	1.05	1.15	0.31	1.43

Spatial Structure and Biological Diversity

Conserving and rebuilding sustainable salmonid populations involves more than meeting abundance and productivity criteria. Accordingly, NOAA Fisheries has developed a conceptual framework defining a Viable Salmonid Population, or VSP (McElhany et al. 2000). In this framework there is an explicit consideration of four key population characteristic or parameters for evaluating population viability status: abundance, productivity (or population growth rate), biological diversity, and population spatial structure. The reason that certain other parameters, such as habitat characteristics and ecological interactions, were not included among the key parameters is that their effects on populations are implicitly expressed in the four key parameters. Based on the current understanding of population attributes that lead to sustainability, the VSP construct is central to the goal of ESA recovery, and warrants consideration in a jeopardy determination. However, it must also be stressed that the ability to significantly improve either a species' biological diversity or its spatial structure and distribution is limited within the timeframe of the Action Agencies' proposed action.

Spatial Structure -- Spatial structure, as the term suggests, refers to the geographic distribution of individuals in a population unit and the processes that generate that distribution. Distributed populations that interact genetically are often referred to as metapopulation. Although the spatial distribution of a population, and thus its metapopulation structure, is influenced by many factors, none are perhaps as important as the quantity, quality, and distribution of habitat. One way to think about the importance or value of a broad geospatial distribution is that a population is less likely to go extinct from a localized catastrophic event or localized environmental perturbations.

Biological Diversity -- Biological diversity within and among populations of salmonids is generally considered important for three reasons. First, diversity of life histories patterns is associated with a use of a wider array of habitats. Second, diversity protects a species against short-term spatial and temporal changes in the environment. And third, genetic diversity is the so-called raw material for adapting to long-term environmental change. The latter two are often described as nature's way of hedging its bets – a mechanism for dealing with the inevitable fluctuations in environmental conditions – long and short-term. With respect to diversity, more is better from an extinction-risk perspective.

The Upper Columbia Spring Chinook ESU consists of three extant populations in a single MPG (Wenatchee River, Methow River, and Entiat River). Additional populations, MPGs, and perhaps ESUs were also historically present in the upper mainstem Columbia, but were extirpated from habitats blocked by the construction of Chief Joseph and Grand Coulee dams. Downstream of Chief Joseph Dam, the population or MPG that historically spawned and reared in the Okanogan basin has also been extirpated. Based on their Spatial Structure and Diversity (SSD) analyses and rating, the ICTRT assigned all three of the extant Upper Columbia populations to the high risk category. This rating is based on the presence of a single remaining MPG containing three populations, all of which have been heavily impacted by hatchery production utilizing out-of-basin broodstock. Although the SSD risk for this ESU will be reduced by current and prospective changes, the degree to which the risk will change is difficult to estimate.

BIOLOGICAL ANALYSIS OF ACTIONS: RECRUITS-PER-SPAWNER, LAMBDA, AND TRENDS WITH CURRENT AND PROSPECTIVE ADJUSTMENTS

As described in detail in Appendix D, the Base Status is the historical status of the ESU, defined as the status of the population based on the *average* of quantitative survival metrics estimated from a time series of abundance data beginning in about 1980. For the most part, longer term averages (generally 20 years) were used where they were available. In the biological analysis, this is the starting point, shown in the tables above.

The next step is Current Status, an adjustment of the initial base estimates to reflect our best estimate of current survivals, as opposed to an average of survivals that prevailed over a period in the past. This would obviously include recent improvements already implemented but not fully reflected in the Base conditions. Current Status is defined as estimated survival metrics adjusted for recently implemented changes in hydropower configuration and operations, hatchery operations, tributary and estuarine habitat improvements, and reduced avian predation. These are actions that have recently been implemented, but their effects are not reflected in the time series of survival data that for the most part started in 1980.

The final step is Prospective Status, which adjusts Current to Prospective Status based on the estimated effects of future actions. The current-to-prospective adjustment is simply an adjustment of the current survival estimates to reflect survival improvements expected from the hydro, habitat, and hatchery changes included in the proposed action, and in particular those that are expected to be implemented in the period 2007 to 2017.

This analysis assumes that future ocean and climate conditions will approximate the average conditions that prevailed during the 20 year base period used for our status assessments. For most populations, that period is about equivalent to the “recent” ocean period used by the ICTRT in its analyses. This period was characterized by relatively poor ocean conditions which presumably contributed to poor early ocean survival of salmonids. To illustrate, the ICTRT’s “pessimistic” ocean condition scenario results in survivals that are about 15 percent lower for Snake River spring/summer Chinook salmon than the “recent’ ocean conditions scenario, and about 36 percent lower for Upper Columbia spring Chinook salmon. Alternatively, ICTRT’s “historic” ocean conditions scenario results in survivals that are about 39 percent higher for both Snake River spring/summer and Upper Columbia spring Chinook salmon.[6] This subject is treated at greater length in the discussion of the effects of potential climate change in Appendix X.

The analysis of status assumes a certain amount of annual take of natural adult fish based on recent harvest levels. As requested in the remand collaboration, a sensitivity analysis showing the additional effects of more selective harvests that minimize take of natural adult fish is presented in Appendix X. In general, this “selective harvest” scenario results in survival that are about 8-18 percent higher than the main analysis, depending on the ESU.

Current Status Analysis

Over this period the action agencies implemented multiple actions to improve fish survival relative to the base period prior to 2000. The percentage improvements in life cycle survival used in the base-to-current adjustments for the Wenatchee, Methow, and Entiat populations are summarized in Table 3. Actions are described in summary below.

Table 3. Estimated survival improvements used in the base-to-current adjustment.

Population	Hydro (FCRPS)	Hydro (PUDs)	Habitat (tributary)	Habitat (estuary)	Avian predation	Hatchery	Harvest[7]
Wenatchee	-3%	24%	2.0%	0.3%	-0.4%		4.0%
Methow	-3%	42%	2.0%	0.3%	-0.4%	1.0%	4.0%
Entiat	-3%	32%	2.0%	0.3%	-0.4%		4.0%

Hydropower Survival Improvements

The estimated percentage improvement in life cycle survival attributable to changes in hydropower operations for the base-to-current period is based on estimated differences in juvenile migrant juvenile during the base period 1980 to 2001 and the more recent period of 2001 to 2006. The configuration and operational changes that contributed to these improvements include:

- Bonneville Powerhouse I minimum-gap turbine runner installations;
- Bonneville Powerhouse II corner collector installation;
- Bonneville II Fish Guidance Efficiency improvements;

[6] Assessing the Impact of Anticipated Hydropower Changes and a Range of Ocean Conditions on the Magnitude of Survival Improvements Needed to Meet TRT Viability Goals Interior Columbia Technical Recovery Team and R. W. Zabel, June 20, 2006
[7] Harvest adjustments represent estimated harvest decreases between the base and current periods. Estimates supplied by A. Nigro (ODF&W) on behalf of an ad hoc US v. OR technical workgroup.

- Bonneville spill operation improvements and 5 additional spillway deflectors;
- Bonneville I JBS screen removal;
- Bonneville II operation as first priority;
- The Dalles spill wall construction;
- The Dalles spill pattern improvements;
- The Dalles adult collection channel improvements;
- The Dalles sluiceway operation improvements;
- John Day spill operation improvements;
- John Day South Fish Ladder improvements;
- McNary spill operation improvements;
- McNary end spillbay deflectors and hoists;
- McNary full flow juvenile PIT tag detection;
- McNary juvenile transport facility bypass piping improvements;
- McNary spare ESBS;
- McNary improved juvenile bypass dewatering screens;
- McNary overhauling AWS pumps; and
- McNary upgrading of adult fish ladders tilting weir controls.

For the Wenatchee, Methow and Entiat populations these improvements totaled 21 percent, 39 percent, and 29 percent, respectively when FCRPS and PUD actions were combined (Table 3). Additional detail on how these percentages were estimated is described in Appendix D. These estimates represent the "best estimates" of NMFS (see Graves spreadsheet dated 09 May 07).

Tributary Habitat Survival Improvements

From 2000 to 2006, BPA and Reclamation implemented actions to address limiting factors for all current populations of this ESU. BPA's annual expenditures for habitat projects in the Upper Columbia subbasins averaged about $500,000 for the 2001 to 2006 time frame. Reclamation's technical assistance during this period cost averaged about $9 million annually during this period. Some of these actions have provided benefits with immediate survival improvements and some will result in long-term benefits with survival improvements accruing into the future. During this time period the Action Agencies, in coordination with multiple partners:

- Increased streamflow through water acquisitions;
- Addressed entrainment by installing or improving fish screens;
- Increased fish passage and access by removing passage barriers;
- Improved mainstem and side channel habitat conditions, and
- Improved water quality and habitat conditions by protecting and enhancing riparian areas.

Survival improvements estimated to result from tributary habitat actions implemented by the Action Agencies in this time period are shown in Table 3. The percentages indicate the incremental survival improvement estimated to accrue by 2006 from the suite of implemented actions. Survival improvements were estimated as described in "Working Draft Tributary Habitat Benefits".

Additional detail of habitat actions implemented by BPA and Reclamation in the 2000 to 2006 time frame is available in the Action Agencies Annual Progress Reports located at *www.salmonrecovery.gov*.

Estuary Habitat Survival Improvements

The estimated survival benefit for Upper Columbia River chinook (stream-type life history) associated with the specific actions discussed above is 0.296 percent. Action Agencies implemented habitat actions through 21 estuary habitat projects. Unrestricted fish passage and approximately 3 miles of access to quality habitat was provided by these specific actions[8]:

- Replaced 3 culverts with full-spanning bridges; provided approximately 10 miles of improved tidal channel connectivity by installing a tide gate retrofit;
- Acquired approximately 473 acres of off-channel and riparian habitats;
- Restored and created 90 acres of marsh and tidal sloughs and approximately 100 acres of riparian forests; protected approximately 55 acres of high-quality riparian and floodplain habitat;
- Restored and preserved approximately 154 acres of off-channel habitat;
- Protected 80 acres of high-value off-channel forested wetland habitat;
- Restored approximately 96 acres of tidal wetlands habitat by replacing undersized culvert that limited fish access; conserved 155 acres of forested riparian and upland habitat;
- Provided partial tidal channel reconnection by tide gate retrofit (acreage unknown at this time); provided integrated pest management (purple loosestrife);
- Reconnected and restored 183 acres of historic floodplain by dike removal;
- Restored 25 acres of historic floodplain by breaching a dike; provided fish passage access to 6 miles of stream habitat by removal of two culverts and replacement with bridges;
- Restored 310 acres of native hardwood riparian forest, 200 acres of seasonally wet slough and 155 acres of degraded riparian habitats; increased circulation in approximately 92 acres of backwater and side-channel habitat by tide gate retrofit;
- Improved embayment circulation for 335 plus acres of marsh/swamp and shallow-water and flats habitat; and
- Preserved 35 acres of historic wetland habitat.

Predator Control Survival Improvements

Avian predation. The estimated relative baseline to current survival of Upper Columbia River Spring Chinook salmon is -.4 percent. This reflects a reduction in survival from the base to current condition, because the tern population was increasing over the base period. Averaging tern consumption of juvenile salmonids across the 20-year base period downplays the actual change in survival that resulted from relocating terns from Rice Island to East Sand Island in 1999. In 1999 tern consumption of juvenile salmonids was at its peak with an estimated 13,790,000 smolts consumed, compared to 8,210,000 in 2000 after relocation.

Piscivorous predation. The ongoing Northern Pikeminnow Management Program (NPMP) has been responsible for reducing predation related juvenile salmonid mortality since 1990. The improvement in life cycle survival attributed to the NPMP is estimated at 2 percent for migrating juvenile salmonids (Friesen and Ward 1999). The northern pikeminnow has been responsible for approximately 8 percent predation-related mortality of juvenile salmonid migrants in the Columbia River basin in the absence of the NPMP (2000 FCRPS BiOp at 9-106). The ongoing NPMP is already accounted for in the estimation of survival improvements modeled within the reservoir mortality life stage. This is because the modeling estimates are calibrated to empirical reach survival estimates that included the ongoing program.

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[8] A more thorough report detailing this evaluation process is: Estimated Benefits for Federal Habitat Projects in the Columbia River Estuary for NWF v NMFS Remand - Sovereign Collaboration Process.

Hatchery Management Survival Improvements

In the early 2000s the lower river out-of-basin Carson stock had been raised at the Winthrop National Fish Hatchery (NFH) and was phased out and replaced with a locally-derived Methow Composite stock, which was primarily, but not exclusively Methow River origin. The Leavenworth NFH program continues to raise out-of-basin Carson stock spring Chinook salmon as mitigation for Grand Coulee, as does the Entiat NFH. The Winthrop NFH also raises upper Columbia River steelhead. Developing and using locally-derived broodstock for the hatchery programs reduces impacts on listed fish in the basin.

From 2000 to 2006, BPA funded the development of Hatchery and Genetic Management Plans (HGMPs) for all federally-funded hatchery programs in the ESU. The objective was to develop the HGMPs for NOAA Fisheries approval and identification of and prioritization of hatchery reform measures by NOAA. We expect NOAA Fisheries to use the HGMPs in their hatchery program ESA Section 7 consultation to identify operational changes that will benefit listed populations.

Current Survival Gaps

Table 4. Current status: Adjusted gaps after base to current adjustment.

Note: Gaps are expressed as multipliers. For example, a 1.10 gap indicates a 10 percent improvement is necessary to close gap. If gap is ≤ 1.0, no further improvement is necessary to close gap.

Population	Adjusted 20 year R/S Gap	Adjusted 20 year λ Gap	Adjusted Long-term Trend Gap	Adjusted Ext. Risk Gap QET = 1	Adjusted Ext. Risk Gap QET = 50
Wenatchee	1.07	0.75	1.32	0.10	0.52
Methow	0.91	0.44	0.85	N/A	N/A
Entiat	1.02	0.77	0.84	0.23	1.05

Improvements of 7 percent and 2 percent are necessary to achieve the R/S criteria for the Wenatchee and Entiat populations respectively; no improvement is needed for the Methow. No improvements are needed to achieve the 20-year λ criterion; a 32 percent improvement is needed for the Wenatchee to meet the 20-year trend criterion. All populations meet the 24-year extinction risk criteria at a QET = 1.0; whereas at a QET =50 the Entiat population still requires a 5 percent improvement in lifecycle survival.

Prospective Status Analysis

As noted above the prospective status is the projected status of the population based on adjustment of the survival metrics for expected improvements associated with the proposed actions. As was the case for the base-to-current adjustment, the improvements for the current-to-prospective are divided into the categories of those expected from changes in hydropower operations and configuration, changes in tributary habitat conditions attributable to actions implemented in the periods 2007 to 2009 and 2010 to 2017, changes in estuarine habitat, reduced impacts of avian predation, and improved hatchery operations.

The percentage improvements in life cycle survival used in the current-to-prospective adjustments for the Wenatchee, Methow, and Entiat populations are summarized in Table 5.

Table 5. Estimated improvements in survival used in the current to prospective adjustment.

Population	Hydro (FCRPS)	Hydro (PUDs)	2007-2017 Habitat (tributary)	Habitat (estuary)	Avian predation	Pikeminnow predation	Hatchery	Harvest
Wenatchee	9.0%	1%	3.0%	6.0%	2.1%	1.0%		
Methow	9.0%	2%	6.0%	6.0%	2.1%	1.0%		
Entiat	9.0%	2%	22.0%	6.0%	2.1%	1.0%		

* The hydro benefit incorporates improvements from the PUDs HCP BiOp.

Hydropower Survival Improvements

The estimated life cycle survival benefit percentage increase attributable to the proposed hydropower operational and configuration improvement actions was estimated based on the difference between the estimated survival under the current operation (defined as the period 2001 to 2006) and estimated survival following implementation of the proposed actions. These increases in life cycle survival range from 10 percent to 11 percent for populations within this ESU when FCRPS and PUD actions are combined (Table 5). These values include the improvements from both the PUD improvements as well as the FCRPS improvements. However, for Upper Columbia spring Chinook prospective analysis, nearly all the benefits are primarily from the FCRPS improvements (100 percent benefits from Wenatchee River and over 90 percent for Entiat and Methow for FCRPS actions. A detailed description of the methods used to generate these estimates can be found in Appendix D; these methods included the use of multiple data sources and the COMPASS model, and represent the “best estimates” of NMFS (see Graves spreadsheet dated 09 May 07). The configuration and operational improvement actions that contribute to these survival increases are organized into strategies. Specific actions contained within these strategies are listed in the Hydrosystem Proposed Action Summary. These strategies include:

1. Operate the FCRPS to more closely approximate the shape of the natural hydrograph and to improve juvenile and adult fish survival;
2. Modify Columbia and Snake River dams to facilitate safe passage;
3. Implement operational improvements at Columbia and Snake River dams; and
4. Operate and maintain juvenile and adult fish passage facilities.

Tributary Habitat Survival Improvements

Table 5 displays estimated population level survival improvement percentages expected to result from Action Agency implementation of actions to address limiting factors in the tributary areas used by this ESU. The survival improvements identified represent an increase in Action Agency tributary habitat effort compared to efforts under the 2000 and 2004 FCRPS BiOps. Survival improvements were estimated as described in ”Working Draft Tributary Habitat Benefits”.

2007 to 2017. BPA will fund and Reclamation will provide technical assistance for projects that implement new actions to address key limiting factors for this ESU in the Wenatchee, Entiat, and Methow subbasins where this ESU is present. BPA will fund projects primarily through its Fish and Wildlife Program; Reclamation will provide technical assistance through annual congressional appropriations. The Action Agencies work with multiple parties for the successful implementation of these actions.

Initial actions. Consistent with its 2007 – 2009 Fish and Wildlife Program funding decision, BPA will fund implementation of 15 projects in the Wenatchee, Entiat, and Methow subbasins. BPA has also dedicated 70 percent of the Columbia Basin Water Transactions Program (CBWTP) $5 million annual budget to secure water acquisitions and riparian easements for anadromous fish, including populations of Upper Columbia spring Chinook. For this time period, the average annual planned budgets (based on BPA Final Decision Letter) for these projects is approximately $3.4 million (not including the CBWTP). The Action Agencies work with multiple parties for the successful implementation of these actions.

The BPA will fund projects in the three subbasins to implement new actions that:

- Increase instream flows;
- Remove fish passage barriers;
- Improve fish passage structures;
- Install fish screens;
- Increase channel complexity;
- protect and enhance riparian habitat, and
- Improve water quality.

Reclamation will provide technical assistance for habitat projects in the Wenatchee, Entiat and Methow subbasins.

Future implementation. BPA will implement new actions similar in scope to those implemented in the 2007 to 2009 time period to address limiting factors for this ESU. BPA will expand the level of effort and increase funding above the 2007 to 2009 period. Project funding decisions will be based on prioritized biological criteria and consistent with recovery plans. Reclamation will continue to provide technical assistance where appropriate with funding consistent with its congressional funding authorizations.

Further detail about Reclamations actions is available in Appendix B-5 to the Tributary Habitat Proposed Action; project level detail of the BPA funded projects is available in Appendix B-1b.

Estuary Habitat Survival Improvements

2007 to 2009. The estimated survival benefit for Upper Columbia River chinook (stream-type life history) associated with the specific actions discussed above is 1.4 percent. The Action Agencies' estimated benefit for 2007 is based on actions that are or will be underway in the very near-term. For 2008 and 2009 the estimated benefit is based on continuing at the same level of effort as 2007[9]. Action agencies are or will be implementing multiple habitat actions through approximately 29 estuary habitat projects. Specific estuary habitat actions:

- Restore partial tidal influence and access to several acres (exact amount unknown at this time) by a tide gate retrofit;
- Improve hydrologic flushing and salmonid access to a lake (Sturgeon Lake is approximately 3,200 acres);

[9] A more thorough report detailing this evaluation process is: *Estimated Benefits of Federal Habitat Projects in the Columbia River Estuary for the NWF v NMFS Remand – Sovereign Collaboration Process.*

- Acquire and protect 40 acres of critical floodplain habitat and 40 acres riparian forest restoration; install 6 to 8 engineered log-jams that will help to slow flood flows, reduce erosion, contribute to sediment storage, enhance fish habitat and contribute wood into the project area; acquire and restore floodplain connectivity to 380 acres of off-channel rearing habitat for juveniles;
- Install fish friendly tide gates to increase tidal flushing and fisheries access to approximately 110 acres;
- riparian planting of up to 210 acres;
- Re-establish hydrologic connectivity to reclaim and improve floodplain wetland functions, increase off-channel rearing and refuge habitat on five acres, plant native vegetation along shoreline and reconstruct slough channels on 2.5 acres of annually inundated off-channel habitat; as part of a long-term 1,500 acres restoration effort: breaching a dike and re-establishing flow to portion of original channel, planting vegetation on 50 acres, removing invasive weeds on 180 acres, planting wetland scrub shrub on 45 acres, and controlling and removing invasive wetland plants on 45 acres;
- Retrofit a tide gate (acreage unknown at this time);
- Protect and restore approximately 5 to 10 acres of emergent wetland and riparian forest habitats;
- Reconnect 45 acres of floodplain by tide gate removal;
- Acquire 45 acre of floodplain with future dike removal;
- Reconnect 50 acres of floodplain;
- Acquire 320 acres of tidelands and 119 acres of riparian/upland forest; and
- Restore 30 acres of riparian habitat.

There will be approximately 15 additional projects and associated actions similar to actions listed above that are undergoing scoping and sponsor development (the number of projects and associated actions is based on the same level of effort as 2007).

2010 to 2017. The survival benefit for Upper Columbia River chinook (stream-type life history) associated with these actions is 4.25 percent. The Action Agencies' estimated benefits for 2010-2017 are based on continuing the same level of effort as 2007-2009. However the level of effort in this time period may increase depending on the outcome of a General Investigation study of Ecosystem Restoration opportunities, depending on Congressional appropriations, future funding scenarios and results of actions. Specific projects have yet to be identified. Actions for this period will be similar in nature to actions implemented in previous periods discussed above. Actions will include protection and restoration of riparian areas, protection of remaining high quality off-channel habitat, breaching or lowering dikes and levees to improve access to off-channel habitat, and reduction of noxious weeds, among others. The estimated numbers of actions are based on continuing the same level of effort as 2007-2009.

Predator Control Survival Improvements

Avian predation. The estimated relative current to future survival of Upper Columbia River Spring Chinook salmon is 2 percent, and this benefit is carried out to 2017 and beyond. This improvement is expected to result through the reduction in estuary tern nesting habitat, and subsequent relocation of terns outside the Columbia basin. Although the base to current shows a reduction in survival, the overall benefit (base to future) is positive.

Piscivorous predation. The percentage improvement in life cycle survival attributable to the proposed continuation of the increase in incentives in the Northern Pikeminnow Management Program and resultant marginal increase in observed exploitation rate is estimated at 1 percent total from 2007-2017. This estimate was derived based on the difference between the estimated benefits from the base NPMP (defined as the period 1990 to 2003) and estimated survival benefits under the increased incentive program (defined as the period of 2004 to present). This rate would generally apply to all juvenile salmonids.

Hatchery Management Survival Improvements

2007 to 2017. The Action Agencies will implement the following hatchery actions to improve survival of UCR spring Chinook:

- Adopt of programmatic criteria for funding decisions on FCRPS mitigation hatchery programs;
- Fund of genetic analyses of spring Chinook in the mainstem Columbia River as part of an alternative broodstock collection protocol to improve the genetic profile of hatchery; production and manage the proportion of wild fish on the spawning grounds. The action will enable tributary-specific population management without degrading overall production objectives;
- Implement high-priority reform actions for Upper Columbia Spring Chinook in the FCRPS Grande Coulee mitigation program (Leavenworth Complex) to reduce potential adverse effects of hatchery operations and hatchery-origin fish on ESA-listed upper Columbia River spring Chinook salmon and steelhead; and
- Implement future additional hatchery reforms identified through Columbia River Hatchery Scientific Review Group's hatchery review process, combined with use of Best Management Practices at FCRPS hatchery facilities to improve productivity, diversity, and/or spatial structure of target populations, depending on the nature of the reform.

Harvest Survival Improvements

The Action Agencies will assist in the development of a plan to add passive integrated transponder (PIT) tag detections in mainstem Columbia fisheries. The potential benefit of this monitoring is providing an independent assessment of harvest impacts and stock composition in mainstem fisheries.

Prospective Survival Status

Comprehensive analyses of the changes in life cycle survival resulting from the proposed FCRPS actions and analysis of how they will change the survival metrics indicate that the Snake River Spring Chinook ESU is likely to survive in the near term (Table 6). Based on the estimate of remaining survival gaps summarized in Table 6, the Entiat population meets all four criteria: 20-year R/S >1, 20-year $\lambda > 1.0$, long-term abundance trend > 1.0 and 24-year extinction risk < 5 percent at both QET = 1 and QET = 50; the Methow meets three of the four, with no results obtained for extinction risk. However, productivity and trend estimates, combined with the expected effects of the proposed action, lead us to conclude that extinction risk for this population is also low. Only the Wenatchee population failed to meet all four criteria; needing a modest improvement in survival to meeting the long-term trend criterion. However, after considering the effects of our action, it is expected that recent positive growth trends will continue.

Prospective status: Adjusted future productivity trends after current-to-prospective analysis.

**Note: Future productivity values represent estimates of future R/S, lambda and trend after consideration of the effects of the proposed action. A value >1.0 indicates a growing population; a value <1.0 indicates a population in decline. A risk gap <1.0 indicates the population meets a <5% risk criterion.*

Population	Estimated Future R/S	Estimated Future λ	Estimated Future Trend	Risk Gap (QET = 1)	Risk Gap (QET = 50)
Wenatchee	1.16	1.12	0.99	0.08	0.42
Methow	1.41	1.27	1.10	N/A	N/A
Entiat	1.45	1.16	1.13	0.15	0.71

Remand Conceptual Framework Analysis

The FCRPS BiOp remand's collaboration among the sovereigns developed a Conceptual Framework approach intended to help the Action Agencies develop their proposed action. The Framework approach attempted to estimate the relative magnitude of mortality factors affecting Interior Columbia basin salmonid populations. That assessment was intended to define the FCRPS' "relative expectation…for recovery."[10] The collaboration's Framework working group developed high and low mortality estimates for all sources of mortality, including the FCRPS. The collaboration's Policy Working Group has not determined where in that range the Action Agencies' proposed action should be assessed. The range of "gaps" that the Framework approach would expect the FCRPS to fill was reviewed and the Action Agencies assessed whether the total survival improvements estimated in this biological analysis would "fill" those gaps. For the purposes of this comparison, the ICTRT gaps were used for "recent" ocean and "base hydro" conditions (corresponding to the base period used for R/S productivity estimation), and the ICTRT's 5 percent risk level.

The Conceptual Framework was intended, among other things, to "provide a clear and complementary link to ongoing recovery planning efforts."[11] As such, it can be understood to represent the collaboration parties' view of the appropriate contribution of the FCRPS toward long term recovery of the listed ESUs in the Interior Columbia River basin. Therefore it provides another "metric" for use in considering the impacts of the proposed action on a listed species' prospects for recovery. The results of this analysis are displayed in Table 7.

[10] 2006 FCRPS BiOp: Conceptual Framework for the Remand Process. First Quarterly Status Report, Documents filed with the court, 01/03/06.

[11] 2006 FCRPS BiOp: Conceptual Framework for the Remand Process. First Quarterly Status Report, Documents filed with the court, 01/03/06.

Table 7. Gap Calculations from the Conceptual Framework
Note: ICTRT gaps are expressed as multipliers. Gaps are for 5 percent risk, recent ocean/base hydro conditions. A "remaining" gap value <1.0 indicates no further improvement is necessary. Total survival changes combine all estimated survival improvements for the base-to-current and current-to-prospective adjustment.

Population	TRT Gap	FCRPS Relative Impact (high)	FCRPS Relative Impact (low)	TRT Gap (high hydro)	TRT Gap (low hydro)	Total Survival Change	Remaining Framework Gap (high)	Remaining Framework Gap (low)
Wenatchee	2.35	0.36	0.23	1.36	1.24	1.58	0.86	0.77
Methow	1.98	0.30	0.17	1.23	1.12	1.90	0.64	0.59
Entiat	2.56	0.31	0.19	1.34	1.20	2.02	0.66	0.59

Briefly, the proposed action (without considering either improvement in the environmental baseline or other actions reasonably certain to occur) more than fills the Framework gaps at both the high and low ends of the range for all three populations in this ESU.

ADDITIONAL ACTIONS TO BENEFIT THE ESU

Other Reasonably Certain to Occur Actions[12]

This analysis does not yet include analysis of non-federal actions that are reasonable certain to occur, developed as part of the remand collaboration. Based on information developed by the remand collaboration, in the upper Columbia River, three sub-basins; the Entiat, the Methow, and the Wenatchee contain non-federal projects that will benefit ESA listed spring Chinook salmon. The Entiat, Methow, and Wenatchee sub-basins will benefit from a combined 121 habitat actions, 5 non-federal hydro actions, and hatchery reform actions.

Other Federal Actions that have completed ESA Consultation

The Action Agencies' review of federal actions that have completed section 7 consultations is not yet complete. The results of the review will be included in the environmental baseline of the Biological Analysis.

OBSERVATIONS

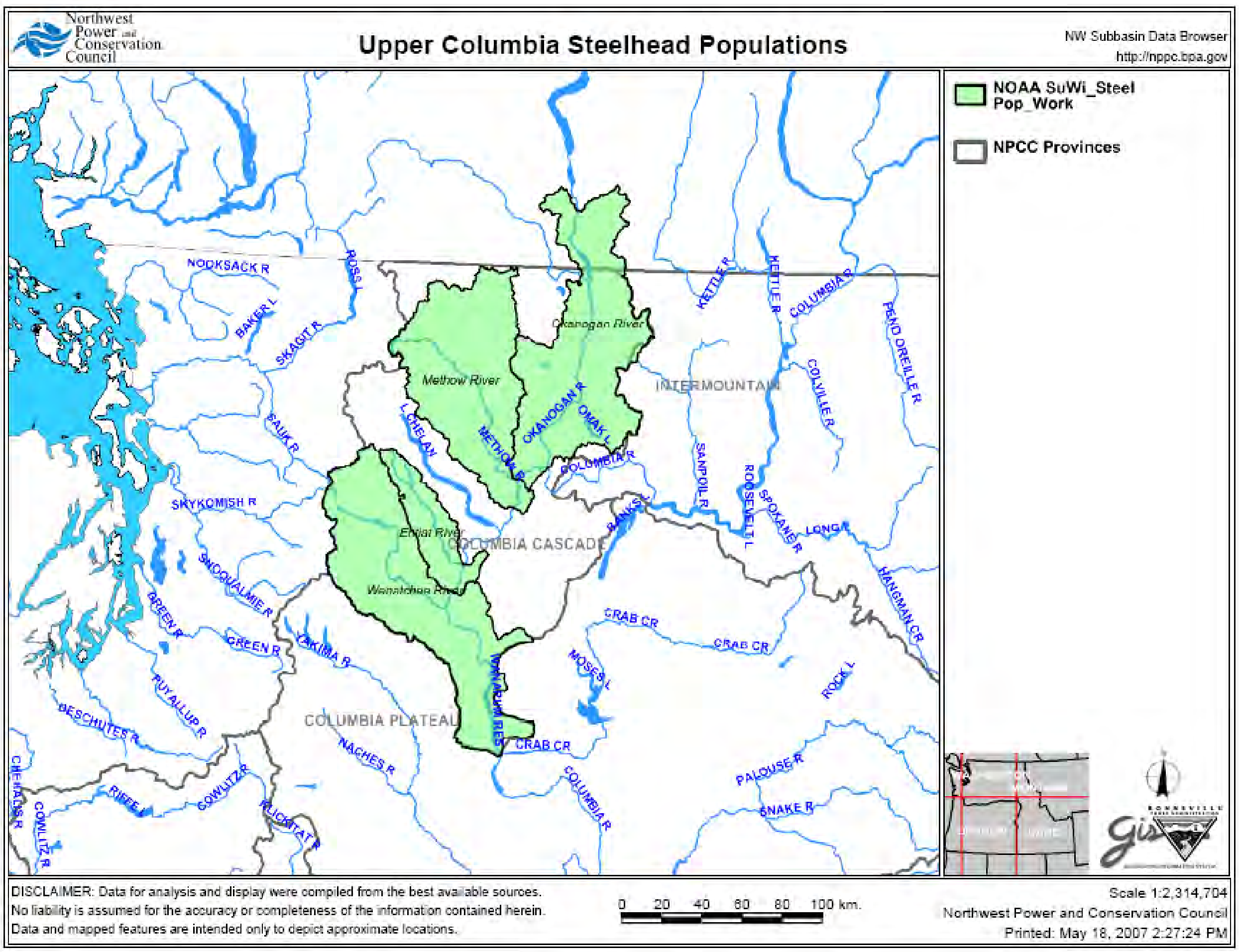
The results of the analysis suggest that 24-year extinction is a low likelihood for all three populations in this ESU. The prospective effects analysis indicates that R/S productivity is likely to be >1.40 for the Entiat and Methow populations, and about 1.16 for the Wenatchee population after the effects of the action are realized. The Framework analysis indicates that the proposed action more than fills both the high and low Framework gaps, providing another indication of the proposed action's effects on this ESU's prospects for recovery.

[12] Many of the actions listed above have a cost-share component with a variety of other federal funding sources and therefore may be properly described as contributing to the status of the environmental baseline rather than cumulative effects. The action agencies will sort the projects described in this paper into the appropriate parts of the biological analysis, but for the purposes of discussion at the April 11, 2007 PWG workshop, believe that the effect on prospective status will be the same.

This is not a final federal agency product. Rather, it is a pre-decisional document prepared by the Action Agencies that reflects present understandings of currently available information and analyses, and of the progression of discussions with the sovereigns in the collaborative process. Revisions and refinements are to be expected based on further discussions with the sovereigns over new and modified proposed federal actions upon which the action agencies will ultimately consult. Finally, the information in this product does not constitute an analysis of whether the identified measures would or would not jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Furthermore, this document does not in any way interpret or apply the regulatory definitions of the statutory phrases "jeopardize the continued existence of" and "destruction or adverse modification."

Upper Columbia River Steelhead DPS

<u>Please note that all of the information in this paper is still preliminary</u>. <u>In particular, benefits assessments are still under review. For certain populations additional actions are being considered that might be implemented by the Action Agencies or by others.</u>



ESU Description[1]	
Threatened	Listed under ESA in 1997; reaffirmed in 2006
Hatchery programs included in ESU	Wenatchee River, Wells hatchery (in Methow and Okanogan Rivers), Winthrop, Omak Creek, Ringold

Major Population Group	**Extant Populations**
Eastern Cascades	Entiat River Methow River Wenatchee River Okanogan

INTRODUCTION

This paper briefly summarizes the current biological analysis developed for this distinct population segment (DPS). First, it provides an overview of the DPS and the factors limiting its viability, summarizes population-level status information during the 20 year base period used for this analysis, and provides estimates of the "gaps," or needed lifecycle survival improvements, for individual populations to meet certain biological criteria. It summarizes the improvements made to the hydrosystem and in other Hs since about 2000 and estimates the salmonid survival benefits associated with those improvements. Finally, it describes the actions proposed to be implemented into the future and estimates their effects on salmonid survival when aggregated with the environmental baseline and cumulative effects.

Almost all of the metrics used in this analysis are estimates for individual populations within the DPS. The Endangered Species Act is concerned with the status of a species, DPS, or Evolutionarily Significant Unit (ESU). Individual populations and major population groups (where they exist) obviously contribute to ESU status. However, the status of the ESU is not wholly dependent upon the status of any of the ESU's individual components.

The Upper Columbia River (UCR) Steelhead Distinct Population Segment (DPS) includes anadromous and resident *O. mykiss* in anadromous-accessible regions of the mainstem Columbia River upstream of Rock Island Dam. UCR steelhead spawn and rear in the middle reaches of the rivers and tributaries draining the eastern slope of the Cascade Mountain Range in this area. The Interior Columbia River Technical Recovery Team (ICTRT) has concluded that the DPS consists of a single Eastern Cascades Major Population Group (MPG) composed of four populations: Wenatchee River, Methow River, Okanogan River, and Entiat River. This DPS was first listed as an endangered species on August 18, 1997. The status was subsequently upgraded to "threatened" on January 5, 2006. This decision was based in part on the hedge against extinction provided by listed hatchery fish in these populations. The ICTRT has concluded that the DPS is at high risk for abundance/productivity and high risk for spatial structure and genetic diversity.

Estimates of the annual returns of UCR steelhead populations are largely based on dam counts, although redd counts are also available for some tributaries. Traditionally, the difference

[1] Listing determination (71FR834); Interior TRT July 2003 description of independent populations *www.nwfsc.noaa.gov/trt/col_docs/independentpopchinsteelsock.pdf* ; May 2005 update *www.nwfsc.noaa.gov/trt/col_docs/updated_population_delineation.pdf.*

between counts at Rock Island and Rocky Reach dams has been assumed to be returns to the Wenatchee River basin. Counts over Wells Dam have been assumed to be returns originating from natural production and hatchery plants in the Methow and Okanogan river watersheds. The annual estimated adult returns above Wells Dam are allocated into hatchery and wild components by applying the ratios of hatchery versus wild fish observed at Wells Dam.

Hatchery returns have dominated natural spawning in all populations in this DPS. Historic broodstock management protocols have included the use of out-of-basin broodstock and the extensive mixing of stocks from different populations within the DPS. The low estimated R/S productivity for these populations is almost certainly attributable in part to decades of poor hatchery practices.

Hatchery programs that are currently operated by WDFW, USFWS, and the Colville Tribes release steelhead in the Wenatchee, Methow, and Okanogan basins. The Federal hatcheries in the Upper Columbia were constructed as mitigation to compensate for the lack of access and loss of spawning and rearing habitat caused by the construction of Grand Coulee Dam. At the time, it was estimated that 85-90 percent of the fish counted at Rock Island Dam originated upstream from Grand Coulee Dam. About half of the steelhead DPS were taken out of production by these dams.[2] Although there are currently no steelhead releases in the Entiat River, there is believed to be an unknown level of straying of hatchery fish into this basin. Empirically documenting the stray rate into the Entiat River is currently a high priority for the Mid Columbia Public Utility Districts (PUDs), who are considering using the Entiat as a natural production reference stream for the purpose of comparisons to supplemented streams in their Hatchery Monitoring and Evaluation Program.

Prior to 1998, most of the hatchery steelhead in these programs were of a co-mingled stock collected either at Priest Rapids or Wells dams. In 1997 WDFW initiated a Wenatchee steelhead program with broodstock collected from the Wenatchee basin. This program is continuing to evolve, with the development of acclimation sites in the Wenatchee basin that are expected to come on line in 2008-2009. The use of in-basin acclimation is expected to greatly increase the fidelity of return to the Wenatchee Basin. The Methow and Okanogan basins continue to use broodstock collected at Wells Dam. However, the potential to develop localized broodstock in the Methow River basin (i.e., Chewuch, Twisp, and Methow rivers) has not been ruled out for the future and is, in fact, indicated as a WDFW-endorsed management alternative in the Methow River summer steelhead hatchery program's Hatchery Genetic Management Plan (August 17, 2005).[3]

Resident *O. mykiss* are abundant in Upper Columbia River tributaries currently accessible to steelhead, as well as in upriver tributaries blocked to anadromous fish access.

Human impacts and current limiting factors for this ESU come from multiple sources: hydro passage, habitat degradation, hatchery effects, fishery management and harvest decisions predation, and other sources.

Key Limiting Factors

Salmon and steelhead have been adversely affected over the last century by many activities including human population growth, introduction of exotic species, over fishing, developments of cities and other land uses in the floodplains, water diversions for all purposes, dams, mining,

[2] Draft Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan, July 2006.
[3] At *http://wdfw.wa.gov/hat/hgmp/*.

farming, ranching, logging, hatchery production, predation, ocean conditions, loss of habitat and other causes (Lackey et al.2006)[4]. Summarized below are current key limiting factors for this ESU identified by NOAA in the ESU Overviews for the remand collaboration[5].

Hatcheries	Historically (pre-1996) the hatchery programs in this DPS held non-local hatchery broodstock on well water. This and other practices selected for hatchery fish that matured earlier than the local stocks. The hatchery stocks and the native stocks interbreed. This combined with previous high harvest rates on the native wild stocks, habitat limitations, and hydro impacts resulted in few natural origin fish being produced. This, combined with relatively high survival of hatchery fish, resulted in high proportions of hatchery fish on the spawning ground over many generations. Over time, production from hatcheries should transition to natural production consistent with recovery goals. According to the Step 4 report, the estimated portion of the human impact attributable to hatchery effects is 6 to 7 percent. If the latent mortality hypothesis is included, the range associated with hatchery impacts is 9 to 13 percent. However, as the Framework Group's Interim Human Mortality Report states, "Relative impacts related to hatchery programs and practices are highly uncertain, it is hoped that a more thorough treatment of this issue will be forthcoming from the Hatchery Workgroup, and that updated estimates can be incorporated into a subsequent version of this report." [6] The hoped for work was never completed by the collaboration's Hatchery and Harvest Workgroup and the Interim Human Mortality Report was left incomplete n this regard.
Predation	Predation has been noted as a factor limiting fish survival for steelhead at mainstem hydro facilities and in the Columbia estuary
Hydro	Mainstem passage conditions result in an average mortality of about two-thirds of the juvenile steelhead. According to the Step 4 report, the estimated portion of the human impact attributable to the FCRPS dams (compared to natural river estimates) is 26 to 31 percent. If the latent mortality hypothesis is included, the range associated with the hydro system is 26 to 48 percent. Hydro impacts include volume, timing and quality of flows that enter the FCRPS action area, including flows from the Snake River at the toe of Hells Canyon Dam, which are impacted by the operation of Reclamation's upper Snake River projects, and the mainstem effects of Reclamation's other projects within the Columbia Basin.
Habitat	In the tributaries, reduced stream flow, unscreened water diversions, altered channel morphology, excessive sediment, and degraded water quality all contribute to poor survival of both juveniles and migrating adults. Rivers in the lower watersheds run through private agricultural lands, where summer water withdrawals result in low flows and, sometimes, dry stream beds in important rearing and holding areas. Upper watersheds in federal ownership where logging roads and unstable slopes have caused heavy sedimentation in the streams. High priority locations include the lower assessment units of the Methow, Entiat, Okanogan and Wenatchee. According to the Step 4 report, the estimated portion of the human impact attributable to combined habitat effects in the tributaries and the estuary is 13 to 22 percent. If the latent mortality hypothesis is included, the human impact

[4] Lackey, Robert T, Denise H. Lach, and Sally L Duncan. Wild salmon in Lackey, Robert T, Denise H. Lach, and Sally L Duncan. Wild salmon in western North America: the historical and policy perspective. Pp 13-55. In: Salmon 2100: The future of wild pacific salmon. 2006. Robert T Lackey, Denise H. Lach, and Sally L. Duncan (editors).
[5] Master - Summary of Key ESU Info Int Columbia - table 24oct06, p. 7, (Limiting factors summarized and ranked by Paula Burgess, NOAA Fisheries, utilizing information found in working draft of ESU Overviews, 2005 Pacific Coastal Salmon Recovery Fund Report to Congress and local recovery plans.)
[6] Interim Report, Relative Magnitude of Human-Related Mortality Factors Affecting Listed Salmonand Steelhead in the Interior Columbia River Basin Framework Work Group of the *NWF v NMFS* Collaboration Process, May 4, 2006.

	associated with habitat degradation is 33 to 40 percent.
Harvest	Harvest of natural-origin fish from Tribal treaty harvest and incidental catch in other Fisheries is 4.5 to 10 percent. Increasingly selective harvest of surplus hatchery origin fish results in incidental take of natural origin steelhead ranging from 0 to 5 percent in the Columbia River and some tributaries. According to the Step 4 report, the estimated portion of the human impact attributable to combined Tribal and non-Tribal harvest effects is 25 to 1 percent. If the latent mortality hypothesis is included, the range associated with the combined harvest impacts is 11 to 14 percent.
Estuary	Predation, levels of toxic substances, and habitat conditions in the plume are potential limiting factors.

BASE STATUS

This section summarizes the average status of this DPS during the base period, which for most populations is a 20 year period beginning in brood year 1980 or 1981, depending on the population. All of the analysis in this paper relies on datasets supplied by the Interior Columbia Technical Recovery Team. Those datasets do not include adult return information for the last one to three years, depending on the population.

DPS Abundance and Trends

Geometric mean abundance since 2001 has substantially increased for the DPS as a whole. Geomean abundance of natural-origin fish for the 2001-2003 period was 3,643 compared to 1,146 for the 1996-2000 period, a 218 percent improvement (all abundance trend information from Fisher and Hinrichsen, 2006). The recent geomean abundance was influenced by exceptional returns in 2002, yet returns of natural-origin adults have been well above the 1996-2000 geomean in other years since 2000. The interim recovery abundance level identified by NOAA for the ESU as a whole is 5,500.[7] The sum of the ICTRT's minimum abundance thresholds for all populations in this ESU is 4,500.[8]

[7] Memo from Bob Lohn to Frank L. Cassidy, Jr., April 4, 2002.
[8] Table 7a, Interim ICTRT Gaps Report, May 17, 1996.

Abundance and a rolling 5-year geometric mean of abundance for the ESU compared to the NOAA Fisheries ESU interim recovery target are shown in Figure 1 below.

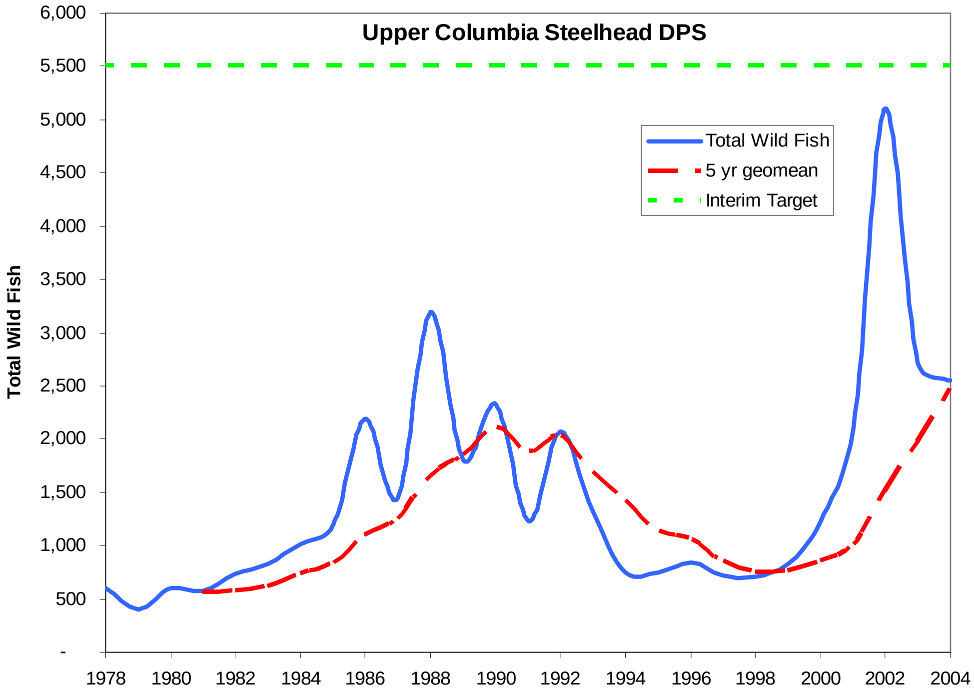


Figure 1. Upper Columbia steelhead population trends. 1978-2004.

The DPS-level abundance trend of natural-origin spawners for 1990-2003 indicates an increasing population over that time. (The slope of the trend line for the ESU as a whole is 1.06 for this period.) The 1980-2003 DPS-level trend indicates slight negative growth (trend line slope of .99 for the DPS). All populations in the ESU show increasing population growth trends in the 1990-recent period

The geometric mean abundance of Upper Columbia steelhead returning to the Wenatchee, Methow, Entiat and Okanogan rivers have averaged 951, 309, 100 and 114, respectively, for the most recent 10-year period for which data are available.

Extinction Probability and Risk

Results of extinction risk modeling are summarized in Table 1a. Extinction probability estimates were developed for populations in this ESU using the Ricker production function, which was fit to spawner-recruit data from brood years 1978 to the present. The estimated Ricker function was used to project populations over a 24-year time horizon to estimate extinction probability. Alternative quasi-extinction thresholds (QETs) of 1, 10, 30, and 50 spawners were used in the analysis. In the modeling, extinction was assumed to occur when spawners fell below the quasi-extinction threshold for four years running. Reproductive failure was assumed to occur in any year in which spawner numbers fell below 10, except in the case of QET=1, where reproductive failure was assumed when spawners fell below two.

This modeling approach examined extinction risk first without future hatchery supplementation of the populations (Table 1a), and then with future supplementation, the more likely prospect for three of the four extant populations (Table 1b). It is expected that supplementation will continue for a number of the populations in this ESU for the foreseeable future. For that reason, we have also modeled extinction probabilities assuming continued supplementation at the average levels seen over the most recent ten years. While modeling shows that supplementation provides a hedge against short-term extinction, we acknowledge that longer term supplementation must be carefully managed to control risks to viability. Supplementation is a strategy to support, not substitute for, self-sustaining natural populations.

Without future supplementation, base case extinction probability results indicate moderate to high probabilities of extinction for 75 percent of the modeled populations in this ESU, assuming QET=50. At QET=1 ("absolute" extinction as used in the 2000 FCRPS BiOp), only one population has a greater than 8 percent probability of extinction. Results at other QETs are displayed below. However, with the more likely scenario of future supplementation, the extinction risk is low for most of the modeled populations. Risk levels are highly dependent upon assumptions about past and future hatchery effectiveness and future numbers of hatchery-origin fish in the spawning populations. Table 1b assumes that management reforms significantly reduce the number of hatchery-origin fish in the spawning populations. Table 1c assumes that recent supplementation levels continue into the future. In both cases, stray rates into the Entiat are assumed to decline to one extent or another from base period levels.

Table 1a. Base status metrics.

For R/S, lambda and trend, a value >1.0 indicates a growing population. Extinction probabilities are expressed as percentages, e.g., a value of 0.11 indicates an 11% risk of extinction within 24 years.

Population	20 year R/S	20 year λ	12 year λ	1980-current Trend	1990-current Trend	Ext. Risk QET=1	Ext. Risk QET=10	Ext. Risk QET=30	Ext. Risk QET=50
Wenatchee	0.27	1.05	1.03	1.02	1.05	0.00	0.08	0.19	0.29
Methow	0.17	1.06	1.12	1.07	1.06	0.04	0.47	0.76	0.87
Entiat	0.27	1.04	1.03	1.02	1.05	0.08	0.44	0.72	0.83
Okanogan	0.12	N/A	N/A	1.06	1.06	0.40	0.91	0.99	1.00

Table 1b. Extinction probability results assuming future supplementation

**Note: Future supplementation levels were assumed to be significantly reduced from recent averages. Specifically, a future wild fraction of .67 was assumed for all populations. Hatchery effectiveness of .2 pre-1998 and .5 post-1998. A time horizon of 24 years. A risk level of 0.01 indicates a 1 percent risk of extinction, assuming that spawner abundance below the QET for four years running results in extinction.*

Population	Ext. Risk QET = 1	Ext. Risk QET = 10	Ext. Risk QET = 30	Ext. Risk QET = 50
Upper Columbia Steelhead -- Wenatchee River	0.00	0.00	0.00	0.00
Upper Columbia Steelhead -- Methow River	0.00	0.00	0.01	0.01
Upper Columbia Steelhead -- Entiat River	0.00	0.01	0.05	0.10
Upper Columbia Steelhead -- Okanogan River	0.00	0.01	0.05	0.12

Table 1c. Extinction probability results with no change in hatchery fraction

**Note: Future supplementation levels were assumed to be equal to the average of the most recent 10 years. Hatchery effectiveness of .2 pre-1998 and .5 post-1998, except for the Entiat where future e=.2. A time horizon of 24 years. A risk level of 0.11 indicates an 11 percent risk of extinction, assuming that spawner abundance below the QET for four years running results in extinction.*

Population	Ext. Risk QET = 1	Ext. Risk QET = 10	Ext. Risk QET = 30	Ext. Risk QET = 50
Upper Columbia Steelhead -- Wenatchee River	0.00	0.00	0.00	0.00
Upper Columbia Steelhead -- Methow River	0.00	0.00	0.00	0.00
Upper Columbia Steelhead -- Entiat River	0.00	0.00	0.00	0.01
Upper Columbia Steelhead -- Okanogan River	0.00	0.00	0.00	0.00

RECRUIT-PER-SPAWNER PRODUCTIVITY AND LAMBDA

The productivity and survival metrics for the four populations comprising this DPS are summarized in Table 1. Productivity, as reflected by estimates of recruits per spawner (R/S) using a 20-year time series of data, are extremely low for all populations, averaging between 0.12 and 0.27. In contrast, 12- and 20-year λ estimates are > 1.0 for the Wenatchee, Methow, and Entiat populations, indicating an increase of total spawners (hatchery and natural-origin); λ estimates have not been derived for the Okanogan population. In considering these results, it should be noted that λ, as calculated by the ICTRT (which is used here) overestimates annual population growth rates for populations with significant numbers of hatchery-origin fish in the spawning population.

Table 2 summarizes the needed improvements in survival to bring the base survival estimates in line with the proposed survival criteria. In this analysis, a metric of 1.0 reflects no gap. A number below 1.0 reflects a positive condition, while a number above 1.0 reflects a gap. For example, a gap of 1.2 indicates that 20 percent productivity is needed in the future.

Table 2. Base status gaps.
** Note: Gaps are expressed as multipliers. For example, a 1.10 gap indicates a 10 percent improvement is necessary to close gap. If gap is ≤ 1.0, no further improvement is necessary to close gap.*

Population	20-year R/S Gap	20-year λ Gap	Long-term Trend Gap
Wenatchee	3.70	0.80	0.91
Methow	5.88	0.77	0.75
Entiat	3.70	0.84	0.91
Okanogan	8.33	N/A	0.76

Spatial Structure and Biological Diversity

Conserving and rebuilding sustainable salmonid populations involves more than meeting abundance and productivity criteria. Accordingly, NOAA Fisheries has developed a conceptual framework defining a Viable Salmonid Population, or VSP (McElhany et al. 2000). In this framework there is an explicit consideration of four key population characteristic or parameters for evaluating population viability status: abundance, productivity (or population growth rate), biological diversity, and population spatial structure. The reason that certain other parameters, such as habitat characteristics and ecological interactions, were not included among the key parameters is that their effects on populations are implicitly expressed in the four key parameters. Based on the current understanding of population attributes that lead to sustainability, the VSP construct is central to the goal of ESA recovery, and warrants consideration in a jeopardy determination. However, it must also be stressed that the ability to significantly improve either a species' biological diversity or its spatial structure and distribution is limited within the timeframe of the Action Agencies' proposed action.

Spatial Structure -- Spatial structure, as the term suggests, refers to the geographic distribution of individuals in a population unit and the processes that generate that distribution. Distributed populations that interact genetically are often referred to as metapopulation. Although the spatial distribution of a population, and thus its metapopulation structure, is influenced by many factors, none are perhaps as important as the quantity, quality, and distribution of habitat. One way to think about the importance or value of a broad geospatial distribution is that a population is less likely to go extinct from a localized catastrophic event or localized environmental perturbations.

Biological Diversity -- Biological diversity within and among populations of salmonids is generally considered important for three reasons. First, diversity of life histories patterns is associated with a use of a wider array of habitats. Second, diversity protects a species against short-term spatial and temporal changes in the environment. And third, genetic diversity is the so-called raw material for adapting to long-term environmental change. The latter two are often described as nature's way of hedging its bets – a mechanism for dealing with the inevitable fluctuations in environmental conditions – long and short-term. With respect to diversity, more is better from an extinction-risk perspective.

The Upper Columbia Steelhead DPS is composed four populations in a single MPG. Although these populations occupy diverse habitats within the accessible habitat downstream of Chief Joseph and Grand Coulee dams, the distribution of steelhead in this region was historically greater, with multiple populations spawning and rearing above these barriers. Whether the extant populations were part of a larger DPS that included these upper river populations is unknown. What is known is that these populations have been markedly impacted by hatchery programs that included the extensive use of homogenized broodstocks. As the result of this and other factors the ICTRT has designated all extant populations in this DPS as at high risk for spatial structure and diversity (SSD). Although the status of this DPS will likely improve as a result of the recently implemented and proposed changes in the FCRPS and the upper Snake, it is unclear how much this will reduce SSD risk. However, particularly significant will be the continuing improvements in hatchery management and the reduced straying expected with locally-adapted broodstocks in the Wenatchee basin. Developing a locally-adapted broodstock for the Okanogan River would also make an important contribution to reduced SSD risk.

Based on the magnitude of the gaps, improvements in survival will be needed to bring the 20-year R/S estimates in line with the survival and trending toward recovery criteria. The low productivity of the four Upper Columbia steelhead population is likely due at least in part to the high proportion of poorly adapted hatchery fish in the historic spawning populations. The same is true of estimated extinction probabilities at all QET sensitivities and for much the same reason. Due to the nature of the model used for estimating extinction probabilities, we were not able to calculate gaps for steelhead populations. In addition to the major survival improvements already implemented and planned for the hydrosystem, we believe that a significant part of the needed productivity improvement for this DPS must come from a combination of ongoing and prospective hatchery management reforms and habitat improvements in the upper Columbia basin.

BIOLOGICAL ANALYSIS OF ACTIONS: RECRUITS-PER-SPAWNER, LAMBDA, AND TRENDS WITH CURRENT AND PROSPECTIVE ADJUSTMENTS

As described in detail in Appendix X, the Base Status is the historical status of the ESU, defined as the status of the population based on the *average* of quantitative survival metrics estimated from a time series of abundance data beginning in about 1980. For the most part, longer term averages (generally 20 years) were used where they were available. In the biological analysis, this is the starting point, shown in the tables above.

The next step is Current Status, an adjustment of the initial base estimates to reflect our best estimate of current survivals, as opposed to an average of survivals that prevailed over a period in the past. This would obviously include recent improvements already implemented but not fully reflected in the Base conditions. Current Status is defined as estimated survival metrics adjusted for recently implemented changes in hydropower configuration and operations, hatchery operations, tributary and estuarine habitat improvements, and reduced avian predation. These are actions that have recently been implemented, but their effects are not reflected in the time series of survival data that for the most part started in 1980.

The final step is Prospective Status, which adjusts Current to Prospective Status based on the estimated effects of future actions. The current-to-prospective adjustment is simply an adjustment of the current survival estimates to reflect survival improvements expected from the hydro, habitat, and hatchery changes included in the proposed action/RPA, and in particular those that are expected to be implemented in the period 2007 to 2017.

This analysis assumes that future ocean and climate conditions will approximate the average conditions that prevailed during the 20 year base period used for our status assessments. For most populations, that period is about equivalent to the "recent" ocean period used by the ICTRT in its analyses. This period was characterized by relatively poor ocean conditions which presumably contributed to poor early ocean survival of salmonids. To illustrate, the ICTRT's "pessimistic" ocean condition scenario results in survivals that are about 15 percent lower for Snake River spring/summer Chinook salmon than the "recent' ocean conditions scenario, and about 36 percent lower for Upper Columbia spring Chinook salmon. Alternatively, ICTRT's "historic" ocean conditions scenario results in survivals that are about 39 percent higher for both Snake River spring/summer and Upper Columbia spring Chinook salmon.[9] This subject is treated at greater length in the discussion of the effects of potential climate change in Appendix X.

The analysis of status assumes a certain amount of annual take of natural adult fish based on recent harvest levels. As requested in the remand collaboration, a sensitivity analysis showing the additional effects of more selective harvests that minimize take of natural adult fish is presented in Appendix X. In general, this "selective harvest" scenario results in survival that is about 8 to 18 percent higher than the main analysis, depending on the ESU.

Current Status Analysis

Over this period the action agencies implemented multiple actions to improve fish survival relative to the base period prior to 2000. The percentage improvements in life cycle survival used in the base-to-current adjustments for the Wenatchee, Methow, Entiat and Okanogan populations are summarized in Table 3. Actions are described in summary below.

Hatchery survival benefit estimates are primarily illustrative. Washington Department of Fish and Wildlife managed PUD summer steelhead hatchery programs in the Upper Columbia are undergoing significant reforms. The estimates in the table below are intended to illustrate the benefits that may already have been realized from reform actions, as well as potential benefits that could result from ongoing and expected future reforms. For simplicity's sake, this analysis combines base-to-current and current-to-prospective survival improvement estimates for hatchery reforms into one value displayed in either the base-to-current adjustment table below (Table 3) or the current-to-prospective table (Table 5). Some of the improvements underlying these estimates may take years or decades yet to realize. The estimates are based on differing assumptions about the past and future relative reproductive effectiveness of hatchery-origin spawners and the degree to which reform efforts succeed in meeting biological objectives

[9] Assessing the Impact of Anticipated Hydropower Changes and a Range of Ocean Conditions on the Magnitude of Survival Improvements Needed to Meet TRT Viability Goals Interior Columbia Technical Recovery Team and R. W. Zabel, June 20, 2006

described in these programs' hatchery genetic management plans.[10] These estimates will be used to help inform a qualitative assessment of the expected future status of this DPS.

Table 3. Estimated survival improvements used in the base-to-current adjustment.

Population	Hydro (FCRPS)	Hydro (PUD)	Habitat (tributary)	Habitat (estuary)	Avian predation	Hatchery (low)	Hatchery (high)	Harvest[11]
Wenatchee	15%	6%	2.0%	0.3%	-0.3%	52.0%	113.0%	1.08
Methow	15%	25%	2.0%	0.3%	-0.3%	-	-	1.08
Entiat	15%	11%	1.5%	0.3%	-0.3%	56.0%	150.0%	1.08
Okanogan	15%	25%	6.0%	0.3%	-0.3%	-	-	1.08

Hydropower Survival Improvements

The estimated percentage improvement in life cycle survival attributable to changes in hydropower operations for the base-to-current period is based on estimated differences in juvenile migrant juvenile during the base period 1980 to 2001 and the more recent period of 2001 to 2006. The configuration and operational changes that contributed to these improvements include:

- Bonneville Powerhouse I minimum-gap turbine runner installations;
- Bonneville Powerhouse II corner collector installation;
- Bonneville II Fish Guidance Efficiency improvements;
- Bonneville spill operation improvements including 5 additional flow deflectors;
- Bonneville I JBS screen removal;
- Bonneville II operation as first priority;
- The Dalles spill wall construction;
- The Dalles spill pattern improvements;
- The Dalles adult collection channel improvements;
- The Dalles sluiceway operation improvements;
- John Day spill operation improvements;
- John Day South Fish Ladder improvements;
- McNary spill operation improvements;
- McNary end spillbay deflectors and hoists;
- McNary full flow juvenile PIT tag detection;
- McNary juvenile transport facility bypass piping improvements;
- McNary spare ESBS;
- McNary improved juvenile bypass dewatering screens;
- McNary adult PIT tag detection in fish ladders;
- McNary overhauling AWS pumps; and
- McNary upgrading of adult fish ladders tilting weir controls.

For the Wenatchee, Methow, Entiat, and Okanogan populations these improvements when FCPRS and PUD actions were combined were 21 percent, 40 percent, 27 percent and 40 percent, respectively (Table 3). Additional detail on how these percentages were estimated is described in Appendix D. These estimates represent the "best estimates" of NMFS (see Graves spreadsheet dated 09 May 07).

[10] Washington Department of Fish and Wildlife Hatchery Genetic Management Plans at http://wdfw.wa.gov/hat/hgmp/.

[11] Harvest adjustments represent estimated harvest decreases between the base and current periods. Estimates supplied by A. Nigro (ODF&W) on behalf of an ad hoc US v. OR technical workgroup.

Tributary Habitat Survival Improvements

From 2000 to 2006 BPA and Reclamation implemented actions to address limiting factors for all current populations in this DPS. BPA's annual expenditures for habitat projects in the Upper Columbia subbasins averaged about $500,000 for the 2001 to 2006 time frame. Reclamation's technical assistance cost averaged about $9 million dollars during this period. Some of these actions provided benefits with immediate survival improvements and some will result in long-term benefits with survival improvements accruing into the future. During this time period the Action Agencies, in coordination with multiple partners:

- Increased streamflow through water acquisitions;
- addressed entrainment by installing or improving fish screens;
- Increased fish passage and access by removing passage barriers;
- Improved mainstem and side channel habitat conditions, and
- Improved water quality and habitat conditions by protecting and enhancing riparian areas.

Survival improvements estimated to result from tributary habitat actions implemented by the Action Agencies in this time period are shown in Table 3. The percentages indicate the incremental survival improvement estimated to accrue by 2006 from the suite of implemented actions. Survival improvements were estimated using as described in "Working Draft Tributary Habitat Benefits".

Estuary Habitat Survival Improvements

The estimated survival benefit for Upper Columbia Steelhead (stream-type life history) associated with the specific actions discussed above is 0.296 percent. Action Agencies implemented multiple habitat actions through 21 estuary habitat projects. Unrestricted fish passage and approximately 3 miles of access to quality habitat was provided these specific actions[12]:

- Replaced 3 culverts with full-spanning bridges;
- Provided approximately 10 miles of improved tidal channel connectivity by installing a tide gate retrofit;
- Acquired approximately 473 acres of off-channel and riparian habitats;
- Restored and created 90 acres of marsh and tidal sloughs and approximately 100 acres of riparian forests
- Protected approximately 55 acres of high-quality riparian and floodplain habitat
- Restored and preserved approximately 154 acres of off-channel habitat;
- Protected 80 acres of high-value off-channel forested wetland habitat;
- Restored approximately 96 acres of tidal wetlands habitat by replacing undersized culvert that limited fish access;
- Conserved 155 acres of forested riparian and upland habitat;
- Provided partial tidal channel reconnection by tide gate retrofit (acreage unknown at this time);
- Provided integrated pest management (purple loosestrife);
- Reconnected and restored 183 acres of historic floodplain by dike removal;
- Restored 25 acres of historic floodplain by breaching a dike;
- Provided fish passage access to 6 miles of stream habitat by removal of two culverts and replacement with bridges;

[12] A more thorough report detailing this evaluation process is: Estimated Benefits for Federal Habitat Projects in the Columbia River Estuary for NWF v NMFS Remand - Sovereign Collaboration Process.

- Restored 310 acres of native hardwood riparian forest, 200 acres of seasonally wet slough and 155 acres of degraded riparian habitats; increased circulation in approximately 92 acres of backwater and side-channel habitat by tide gate retrofit;
- Improved embayment circulation for 335 plus acres of marsh/swamp and shallow-water and flats habitat; and
- Preserved 35 acres of historic wetland habitat.

Predator Control Survival Improvements

Avian predation. The estimated survival change for Upper Columbia River steelhead from the baseline to current condition is -.3 percent. This reflects a reduction in survival from the base to current condition, because the tern population was increasing over the base period. Averaging tern consumption of juvenile salmonids across the 20-year base period downplays the actual change in survival that resulted from relocating terns from Rice Island to East Sand Island in 1999. In 1999 tern consumption of juvenile salmonids was at its peak with an estimated 13,790,000 smolts consumed, compared to 8,210,000 in 2000 after relocation.

Piscivorous predation. The ongoing Northern Pikeminnow Management Program (NPMP) has been responsible for reducing predation related juvenile salmonid mortality since 1990. The improvement in life cycle survival attributed to the NPMP is estimated at 2 percent for migrating juvenile salmonids (Friesen and Ward 1999). The northern pikeminnow has been responsible for approximately 8 percent predation-related mortality of juvenile salmonid migrants in the Columbia River basin in the absence of the NPMP (2000 FCRPS BiOp at 9-106). The ongoing NPMP is already accounted for in the estimation of survival improvements modeled within the reservoir mortality life stage. This is because the modeling estimates are calibrated to empirical reach survival estimates that included the ongoing program.

Hatchery Management Survival Improvements

Considering the significant impacts that hatchery practices have had on this DPS, and the likelihood that poorly adapted hatchery stock have depressed productivity – both demographically and through genetic effects and life history changes – the Action Agencies have attempted to quantitatively estimate a range of potential benefits that should result from past and proposed hatchery reforms. For simplicity, this estimate is combined into single values at the high and low ends of a range and included in the base-to-current or current-to-prospective adjustment tables. This range will be used to inform a qualitative assessment of the likelihood that this DPS will survive and be placed on a trend toward recovery.

The specific assumptions used in the hatchery survival change analysis are based on preliminary guidance from NOAA Fisheries[13] and are as follows. NOAA Fisheries is currently reviewing and revising its guidance, but has not yet provided the Action Agencies with revised information for this analysis.

Wenatchee: In 1998, the goal of the program changed from providing fish for harvest to intending fish to spawn naturally. Before 1998, the program fell into category 1 (HOF<30 percent as effective as NOF). After 1998, the program used local-origin NOF and HOF for broodstock (Category 3) and planted fish in primary steelhead production areas (to promote effectiveness), therefore post-98 hatchery effectiveness is likely to be in the 0.45 to 0.5 range. The “future f” (i.e., fraction of natural spawners) is likely to increase significantly. For this

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[13] Draft NOAA memo from Rob Jones to Jeff Stier, “Estimates of Base-to-Current Productivity Improvements Resulting From Modified Hatchery Practices,” April 5, 2007

analysis, we have assumed a "future f" of 0.67 at the high end of the range. The low end of the survival change range for this population assumes hatchery effectiveness of .2 before 1998 and .45 after. It assumes that the future fraction of natural-origin spawners is equal to the most recent 10 year average (27 percent). The high end of the range assumes hatchery effectiveness of .2 before 1998 and, 5 after. It assumes the future fraction of natural-origin spawners will be .67.

Entiat: The Entiat is being managed as a wild-only reference population. The Entiat hatchery program prior to its termination was most similar to Category 1 with hatchery effectiveness <.30. Broodstock originated from within the ESU (from Priest Rapids, Tumwater and Wells collections). It is not reasonable to assume that any future hatchery strays into this basin would have hatchery effectiveness greater than .30. The goal for other WDFW-managed summer steelhead hatchery programs in the Upper Columbia is to limit straying to below 5 percent.[14] The lower range of the hatchery survival change estimate for the Entiat assumes hatchery effectiveness of .2 for all periods and a stray rate of 50 percent. The upper end of the range assumes that hatchery managers will successfully curtail straying, limiting it to no more than 5 percent.

Methow: In 1998, the goal of the program changed from providing fish for harvest to intending fish to spawn naturally. *Before 1998*, the program fell into category 1 (HOF<30 percent as effective as NOF) AND HOF were planted in areas to accommodate fisheries not promote HOF effectiveness (i.e., the majority of releases were not in prime steelhead production areas). *After 1998*, the program began to use some NOF in the broodstock (Category 3) and altered release locations to include steelhead production areas (to promote effectiveness). The program goal was changed to provide steelhead for both conservation and harvest. In recent years NOF in broodstock has increased to about 30 percent. Additionally, the eggs from earliest maturing broodstock are transferred to the Ringold Program as a hatchery reform measure to promote a synchronized maturation timing between HOR and NOF. Mechanisms are in place to decrease the number of HOF on the spawning grounds when returns of NOF meet identified criteria.

Available information would not support effectiveness estimates greater than 0.3 for HOF before 1998. HOF effectiveness was likely lower than 0.3 based on release practices and the propagation multiple generations of HOF. *After 1998*, HOF effectiveness may be incrementally increasing over time, but is still likely to be quite low in the 0.30 to 0.45 range. The "future f" (i.e., fraction of natural spawners) is likely to increase significantly. For this analysis, we have assumed a "future f" of 0.67 at the high end of the range. The low end of the survival change range for this population assumes hatchery effectiveness of .2 before 1998 and .3 after. It assumes that the future fraction of natural-origin spawners is equal to the most recent 10 year average (8 percent). The high end of the range assumes hatchery effectiveness of .2 before 1998 and 45 after. It assumes the future fraction of natural-origin spawners will be .67.

Okanogan: Similar to the other tributaries in the UCR, the goal of the program was modified in 1998 to promote recovery. Prior to 1998 the program fell into category 1 (hatchery effectiveness<.30). After 1998, the steelhead program at Wells Hatchery increased the use of natural-origin fish for broodstock. Additionally, the Colville Tribes have initiated a hatchery program in Omak Creek to promote local adaptation in the Okanogan Basin. The Action Agencies propose to fund an expansion of this program. Before 1998, hatchery effectiveness was likely lower than 0.3 based on release practices and the propagation multiple generations of HOF. After 1998, hatchery effectiveness may be incrementally increasing over time, but is

[14] Memo from Bob Lohn to Frank L. Cassidy, Jr., April 4, 2002.

still likely to be n the 0.30 to 0.45 range based on current PUD program practices. We include a very conservative estimate of small additional survival improvements from the Colville Tribe's proposal in our high hatchery benefits estimate (below). Actual benefits could be much higher in the long term.

The low end of the hatchery benefits estimate range assumes that hatchery effectiveness was .2 before 1998 and .3 after 1998. For this estimate, the future wild fraction was assumed to be equal to the average of the most recent 10 years (8 percent). The high end of the range assumes hatchery effectiveness of .2 before 1998, hatchery effectiveness of .5 after (partly due to the Colville Tribe's proposal for the Okanogan population), and a future wild fraction of .67.

Current Status Analysis

Over this period the action agencies implemented multiple actions to improve fish survival relative to the base period prior to 2000. The percentage improvements in life cycle survival used in the base-to-current adjustments for the Wenatchee, Methow, and Entiat populations are summarized in Table 4. Actions are described in summary below.

Table 4. Current status: Adjusted gaps after base to current adjustment.
**Note: Gaps are expressed as multipliers. For example, a 1.10 gap indicates a 10 percent improvement is necessary to close gap. If gap is ≤ 1.0, no further improvement is necessary to close gap.*

Population	Adjusted 20 year R/S Gap (w/o hatchery)	Adjusted 20 year λ Gap (w/o hatchery)	Adjusted Long-term Trend Gap (w/o hatchery)
Wenatchee	2.75	0.60	0.68
Methow	3.70	0.48	0.47
Entiat	2.64	0.60	0.65
Okanogan	5.05	N/A	0.46

Prospective Status Analysis

As noted above the prospective status is the projected status of the population based on adjustment of the survival metrics for expected improvements associated with the proposed actions. As was the case for the base-to-current adjustment, the improvements for the current-to-prospective are divided into the categories of those expected from changes in hydropower operations and configuration, changes in tributary habitat conditions attributable to actions implemented in the periods 2007 to 2009 and 2010 to 2017, changes in estuarine habitat, reduced impacts of avian predation, and improved hatchery operations.

Over this period the action agencies implemented and will continue to implement multiple actions to improve fish survival. The percentage improvements in life cycle survival used in the current-to-prospective adjustments for the Wenatchee, Methow, and Entiat populations are summarized in Table 5.

Table 5. Estimated improvements in life cycle survival used in the current-to-prospective adjustment.

Population	Hydro (FCRPS)	Hydro (PUD)	2007-2017 Habitat (trib.)	Habitat (estuary)	Avian predation	Pikeminnow predation	Hatchery (low)	Hatchery (high)
Wenatchee	15%	14%	4.0%	5.8%	3.4%	1.0%	-	-
Methow	15%	14%	4.0%	5.8%	3.4%	1.0%	27%	184%
Entiat	15%	14%	8.0%	5.8%	3.4%	1.0%	-	-
Okanogan	15%	14%	14.0%	5.8%	3.4%	1.0%	32%	208%

* The hydro benefit incorporates improvements from the PUDs HCP BiOp.

Hydropower Survival Improvements

The estimated life cycle survival benefit percentage increase attributable to the proposed hydropower operational and configuration improvement actions was estimated based on the difference between the estimated survival under the current operation (defined as the period 2001 to 2006) and estimated survival following implementation of the proposed actions. These increases in life cycle survival from combined FCPRS and PUD actions are about 28 percent for populations within this DPS (Table 5). These estimates include prospective improvements from both the PUD HCP improvements as well as FCRPS improvements with over 50 percent of the benefits as a result of FCRPS actions A detailed description of the methods used to generate these estimates can be found in Appendix D; these methods included the use of multiple data sources and the COMPASS model, and represent the "best estimates" of NMFS (see Graves spreadsheet dated 09 May 07). Specific actions contained within these strategies are listed in the Hydrosystem Proposed Action Summary. Not all of these specific actions apply to this DPS, as some specific actions are aimed at benefiting Snake River stocks. These strategies include:

1. Operate the FCRPS to more closely approximate the shape of the natural hydrograph and to improve juvenile and adult fish survival;
2. Modify Columbia and Snake River dams to facilitate safe passage;
3. Implement operational improvements at Columbia and Snake River dams;
4. Operate and maintain juvenile and adult fish passage facilities; and
5. Manage FCRPS and Reclamation's upper Snake flow augmentation activities to more closely approximate the natural hydrograph.

Tributary Habitat Survival Improvements

Table 5 displays estimated population level survival improvement percentages expected to result from Action Agency implementation of actions to address limiting factors in the tributary areas used by this DPS. The survival improvements identified represent an increase in Action Agency tributary habitat effort compared to efforts under the 2000 and 2004 FCRPS BiOps. Survival improvements were estimated as described in "Working Draft Tributary Habitat Benefits".

2007 to 2017. BPA will fund and Reclamation will provide technical assistance for projects that implement new actions to address key limiting factors for this DPS. BPA will fund projects primarily through its Fish and Wildlife Program; Reclamation will provide technical assistance through annual congressional appropriations. The Action Agencies work with multiple parties for the successful implementation of these actions.

Initial actions and action expansion. Consistent with its 2007 – 2009 Fish and Wildlife Program funding decision, BPA will fund implementation of 19 projects in the Wenatchee, Okanogan, Entiat, and Methow subbasins where this DPS is present. BPA has also dedicated 70 percent of the Columbia Basin Water Transactions Program (CBWTP) $5 million annual budget to secure water acquisitions and riparian easements for anadromous fish, including populations of Upper Columbia steelhead. For this time period, the average annual planned budgets (based on BPA Final Decision Letter) for these projects is approximately $4.7 million (not including the CBWTP).

Based on biological needs identified in the recent lifecycle biological analyses and input from the remand collaboration process, BPA will also fund a suite of further actions beyond those identified in the 2007 - 2009 Fish and Wildlife Program decision for implementation beginning in the 2008 and 2009 (see Appendix B-4c).

BPA will fund projects in the four subbasins that:

- Increase instream flows;
- Remove fish passage barriers;
- Improve fish passage structures;
- Install fish screens;
- Increase channel complexity;
- Protect and enhance riparian habitat, and
- Improve water quality.

Reclamation will provide technical assistance for habitat projects in the Wenatchee, Entiat, and Methow subbasins.

Further detail about Reclamations actions is available in Appendix B-4 to the Tributary Habitat Proposed Action. Project level detail of the BPA funded projects (and Reclamation technical assistance) is available in Appendix B-1a.

Future implementation. BPA will implement new actions similar in scope to those implemented in the 2007 to 2009 time period to address limiting factors for this DPS. BPA will expand the level of effort and increase funding above the 2007 to 2009 period. Project funding decisions will be based on prioritized biological criteria and consistent with recovery plans. Reclamation technical assistance will be consistent with its congressional funding authorizations.

Estuary Habitat Survival Improvements

2007 to 2009. The estimated survival benefit for Upper Columbia River steelhead (stream-type life history) associated with the specific actions discussed below is 1.4 percent. The Action Agencies' estimated benefit for 2007 is based on actions that are or will be underway in the very near-term. For 2008 and 2009 the estimated benefit is based on continuing at the same level of effort as 2007[15]. Action agencies are or will be implementing multiple habitat actions through approximately 29 estuary habitat projects. Specific estuary habitat actions:

- Restore partial tidal influence and access to several acres (exact amount unknown at this time) by a tide gate retrofit;
- Improve hydrologic flushing and salmonid access to a lake (Sturgeon Lake is approximately 3,200 acres);

[15] A more thorough report detailing this evaluation process is: *Estimated Benefits of Federal Habitat Projects in the Columbia River Estuary for the NWF v NMFS Remand – Sovereign Collaboration Process.*

- Acquire and protect 40 acres of critical floodplain habitat and 40 acres riparian forest restoration; install 6 to 8 engineered log-jams that will help to slow flood flows, reduce erosion, contribute to sediment storage, enhance fish habitat and contribute wood into the project area; acquire and restore floodplain connectivity to 380 acres of off-channel rearing habitat for juveniles;
- Install fish friendly tide gates to increase tidal flushing and fisheries access to approximately 110 acres;
- riparian planting of up to 210 acres;
- Re-establish hydrologic connectivity to reclaim and improve floodplain wetland functions, increase off-channel rearing and refuge habitat on five acres, plant native vegetation along shoreline and reconstruct slough channels on 2.5 acres of annually inundated off-channel habitat; as part of a long-term 1,500 acres restoration effort: breaching a dike and re-establishing flow to portion of original channel, planting vegetation on 50 acres, removing invasive weeds on 180 acres, planting wetland scrub shrub on 45 acres, and controlling and removing invasive wetland plants on 45 acres;
- Retrofit a tide gate (acreage unknown at this time);
- Protect and restore approximately 5 to 10 acres of emergent wetland and riparian forest habitats;
- Reconnect 45 acres of floodplain by tide gate removal;
- Acquire 45 acre of floodplain with future dike removal;
- Reconnect 50 acres of floodplain;
- Acquire 320 acres of tidelands and 119 acres of riparian/upland forest; and
- Restore 30 acres of riparian habitat.

There will be approximately 15 additional projects and associated actions similar to actions listed above that are undergoing scoping and sponsor development (the number of projects and associated actions is based on the same level of effort as 2007).

2010 to 2017. The survival benefit for Upper Columbia River steelhead (stream-type life history) associated with these actions is 4.25 percent. The Action Agencies' estimated benefits for 2010 to 2017 are based on continuing the same level of effort as 2007 to 2009. However the level of effort in this time period may increase depending on the outcome of a General Investigation study of Ecosystem Restoration opportunities, depending on Congressional appropriations, future funding scenarios and results of actions. Specific projects have yet to be identified. Actions for this period will be similar in nature to actions implemented in previous periods discussed above. Actions will include protection and restoration of riparian areas, protection of remaining high quality off-channel habitat, breaching or lowering dikes and levees to improve access to off-channel habitat, and reduction of noxious weeds, among others.

Predator Control Survival Improvements

Avian predation. The estimated survival increase from the current to future condition for Upper Columbia Steelhead is 3.4 percent, and this benefit is carried out to 2017 and beyond. This improvement is expected to result through the reduction in estuary tern nesting habitat, and subsequent relocation of terns outside the Columbia basin. Although the base to current shows a reduction in survival, the overall benefit (base to future) is positive.

Piscivorous predation. The percentage improvement in life cycle survival attributable to the proposed continuation of the increase in incentives in the Northern Pikeminnow Management Program and resultant marginal increase in observed exploitation rate is estimated at 1 percent total from 2007-2017. This estimate was derived based on the difference between the estimated benefits from the base NPMP (defined as the period 1990 to 2003) and estimated survival benefits under the increased incentive program (defined as the period of 2004 to present). This rate would generally apply to all juvenile salmonids.

Hatchery Management Survival Improvements

2007 to 2017. The Action Agencies will implement the following hatchery actions to improve survival of Upper Columbia steelhead:

- Fund the development of a locally-adapted summer steelhead program to supplement natural production in the Okanogan River, as proposed by Colville Tribes. This program will improve abundance, productivity, and genetic diversity and a high level of benefits is expected to accrue during and after the BiOp period;
- Fund a steelhead kelt reconditioning program to increase abundance of steelhead in the Wenatchee, Entiat, and Methow basins, as proposed by WDFW and Yakama Nation. A high level of benefit is expected to accrue during and after the BiOp period;
- Implement high-priority hatchery reform actions, i.e., those needed to address hatchery programs that are considered by NOAA to be major limiting factors, resulting in improved abundance, productivity, diversity, and/or spatial structure of the target populations;
- Future implementation of ESA-relevant hatchery reforms identified through Columbia River Hatchery Scientific Review Group's hatchery review process, combined with use of Best Management Practices at FCRPS hatchery facilities, is expected to improve abundance, productivity, diversity, and/or spatial structure of target populations, depending on the nature of the reform; and
- In collaboration with the U.S. Fish and Wildlife Service (the operator of the LNFH complex), the action agencies will accelerate various reforms or modify operations at the Leavenworth NFH Complex consistent with the "coarse screen" list of hatchery actions developed in the Hatchery/Harvest Workgroup and reviewed by the U.S. v. Oregon policy group. Reforms will reduce potential adverse effects of hatchery operations and hatchery-origin fish on ESA-listed upper Columbia River spring Chinook salmon and steelhead.

In addition to specific changes to certain UCR steelhead hatchery programs being proposed by the Action Agencies, it is expected that additional changes planned and implemented by the WDFW, NMFS, USFWS, and the Colville Tribes will continue to contribute to increasing survival and productivity. Although the aforementioned changes summarized for the base-to-current adjustment have already been factored into this analysis, it is important to recognize that these are estimates, and that the benefits of these actions may well be greater, but will likely take many years to accrue. This is expected to be the case with the development of locally-adaptive broodstocks that were last present more than 60 years ago when Chief Joseph and Grand Coulee dams were constructed.

In the Wenatchee River, the expectation is that in-basin acclimation will markedly increase the fidelity of Wenatchee-origin fish returning to the Wenatchee basin, and hence reduce their straying into other UCR steelhead populations. This is expected to make a significant contribution to reducing straying into the Entiat. In the Methow and Okanogan programs, there are plans by WDFW and the Colville Tribe to develop locally-adapted broodstocks. Not only will the continued development of locally-adapted broodstock contribute to significantly enhanced productivity, but it will also make an important contribution to enhanced biodiversity.

Harvest Survival Improvements

2007 to 2017. The Action Agencies will fund the following harvest actions to improve survival of Upper Columbia steelhead:

- BPA will fund the Colville Tribe project proposal *Evaluation of Live Capture Selective Fishing Gear* through the Fish and Wildlife Program. This project will place selective gear in the Okanogan River where the percentage of known origin fish is high and will aim to remove non-localized stocks to improve TRT life-stage viability criteria. The Colville Tribe proposal describes the potential of up to over 95 percent reduction in harvest impacts to listed species resulting from the implementation of selective gear and methods. The potential reduction in ESA impacts would be for application to fisheries that impact ESA fish; and
- The Action Agencies will also assist in the development of a plan to add passive integrated transponder (PIT) tag detections in mainstem Columbia fisheries. The potential benefit of this monitoring is providing an independent assessment of harvest impacts and stock composition in mainstem fisheries.

Prospective Survival Status

Comprehensive analyses of the changes in life cycle survival resulting from the proposed FCRPS and upper Snake actions and analysis of how they will change the survival metrics indicate that the Upper Columbia Steelhead DPS still requires improvement in lifecycle survival to meet the R/S and extinction risk criteria for survival (Table 6).

Prospective status: Adjusted future productivity metrics after current-to-prospective analysis.

**Note: Future productivity values represent estimates of future R/S, lambda and trend after consideration of the effects of the proposed action. A value >1.0 indicates a growing population; a value <1.0 indicates a population in decline. Low and high hatchery refer to the low and high ends of the range of estimated benefits that could accrue from successful hatchery reforms.*

Population	Estimated Future R/S (low hatchery)	Estimated Future R/S (high hatchery)	Estimated Future R/S (without hatchery)	Estimated Future λ (low hatchery)	Estimated Future λ (high hatchery)	Estimated Future Long-term Trend (low hatchery)	Estimated Future Long-term Trend (high hatchery)
Wenatchee	0.83	1.16	0.55	1.35	1.45	1.31	1.41
Methow	0.51	1.15	0.41	1.36	1.62	1.36	1.63
Entiat	0.92	1.48	0.59	1.37	1.52	1.34	1.49
Okanogan	0.43	1.00	0.33	N/A	N/A	1.41	1.71

Remand Conceptual Framework Analysis

The FCRPS BiOp remand's collaboration among the sovereigns developed a Conceptual Framework approach intended to help the Action Agencies develop their proposed action. The Framework approach attempted to estimate the relative magnitude of mortality factors affecting Interior Columbia basin salmonid populations. That assessment was intended to define the FCRPS' "relative expectation…for recovery."[16] The collaboration's Framework working group developed high and low mortality estimates for all sources of mortality, including the FCRPS. The collaboration's Policy Working Group has not determined where in that range the Action Agencies' proposed action should be assessed with respect to recovery. The range of "gaps" that the Framework approach would expect the FCRPS to fill was reviewed and the Action Agencies assessed whether the total survival improvements estimated in this biological analysis would "fill" those gaps. For the purposes of this comparison, the ICTRT gaps were used for "recent" ocean and "base hydro" conditions (corresponding to the base period used for R/S productivity estimation), and the ICTRT's 5 percent risk level.

[16] 2006 FCRPS BiOp: Conceptual Framework for the Remand Process. Documents filed with the court, etc.

The Conceptual Framework was intended, among other things, to "provide a clear and complementary link to ongoing recovery planning efforts."[17] As such, it can be understood to represent the collaboration parties' view of the appropriate contribution of the FCRPS toward long term recovery of the listed ESUs in the Interior Columbia River basin. Therefore it provides another "metric" for use in considering the impacts of the proposed action on a listed species' prospects for recovery. The results of this analysis are displayed in Table 7.

Table 7. Recovery Gap Calculations from the Conceptual Framework
Note: ICTRT gaps are expressed as multipliers. Gaps are for 5 percent risk, recent ocean/base hydro conditions. A "remaining" gap value <1.0 indicates no further improvement is necessary. Total survival changes combine all estimated survival improvements for the base-to-current and current-to-prospective adjustment.

Population	TRT Gap (as multiplier)	FCRPS Relative Impact (high)	FCRPS Relative Impact (low)	TRT Gap (high hydro)	TRT Gap (low hydro)	Total Survival Change (w/o hatchery)	Remaining Framework Gap (high)	Remaining Framework Gap (low)
Wenatchee	4.33	0.41	0.31	1.82	1.58	2.02	0.90	0.78
Methow	6.64	0.36	0.26	1.98	1.64	2.39	0.83	0.69
Entiat	6.31	0.38	0.28	2.01	1.67	2.19	0.92	0.76
Okanogan	8.69	0.35	0.26	2.13	1.75	2.72	0.78	0.65

* Note: FCRPS impacts are based on river flows that enter the FCRPS action area, including those that enter the Snake River at the toe of Hells Canyon Dam, which are effected by the operation of Reclamation's upper Snake Projects.

Briefly, even assuming no improvements from hatchery reforms, the proposed action fills the Framework gaps at the high and low ends of the range for all populations in this DPS.

ADDITIONAL ACTIONS TO BENEFIT THE DPS

Other Reasonably Certain to Occur Actions[18]

In the upper Columbia River, four sub-basins, the Entiat, the Methow, the Okanogan and the Wenatchee contain non-federal projects that will benefit ESA listed steelhead. The Entiat, Methow, and Wenatchee sub-basins will benefit from a combined 121 habitat actions, 5 non-federal hydro actions, and hatchery reform actions. Specifically, reform efforts are underway in the PUD summer steelhead hatchery programs managed by WDFW. Management objectives are described in Hatchery Genetic Management Plans at *http://wdfw.wa.gov/hat/hgmp/*. Steelhead in the Okanogan sub-basin will benefit from an additional 46 habitat actions.

Other Federal Actions that have completed ESA Consultation

The Action Agencies' review of federal actions that have completed section 7 consultations is not yet complete. The results of the review will be included in the environmental baseline of the Biological Analysis.

[17] 2006 FCRPS BiOp: Conceptual Framework for the Remand Process. First Quarterly Status Report, Documents filed with the court, 01/03/06.
[18] Many of the actions listed above have a cost-share component with a variety of other federal funding sources and therefore may be properly described as contributing to the status of the environmental baseline rather than. The action agencies will sort the projects described in this paper into the appropriate parts of the biological analysis, but for the purposes of discussion at the April 11, 2007 PWG workshop, believe that the effect on prospective status will be the same.

OBSERVATIONS

The impact from historical hatchery practices on this DPS has likely been significant, as has mortality associated with federal and non-federal hydropower projects in the mainstem Columbia River. However, the difference in current status between Upper Columbia spring Chinook salmon and Upper Columbia steelhead populations is telling. Both ESUs pass through the same hydrosystem. Both occupy habitat that has been similarly impacted by human activity. The status of Upper Columbia steelhead, as evidenced by recruit-per-spawner productivity and other base period biological indicators, is generally worse than the status of Upper Columbia spring Chinook salmon. Two factors that distinguish steelhead from spring Chinook salmon populations in the Upper Columbia are the extremely high proportion of hatchery fish in historic steelhead spawning populations and the wholesale homogenization of steelhead broodstock due to past broodstock collection practices. To the extent past hatchery practices have contributed to current low productivities in these populations, present and future hatchery reforms must be expected to help improve the situation.

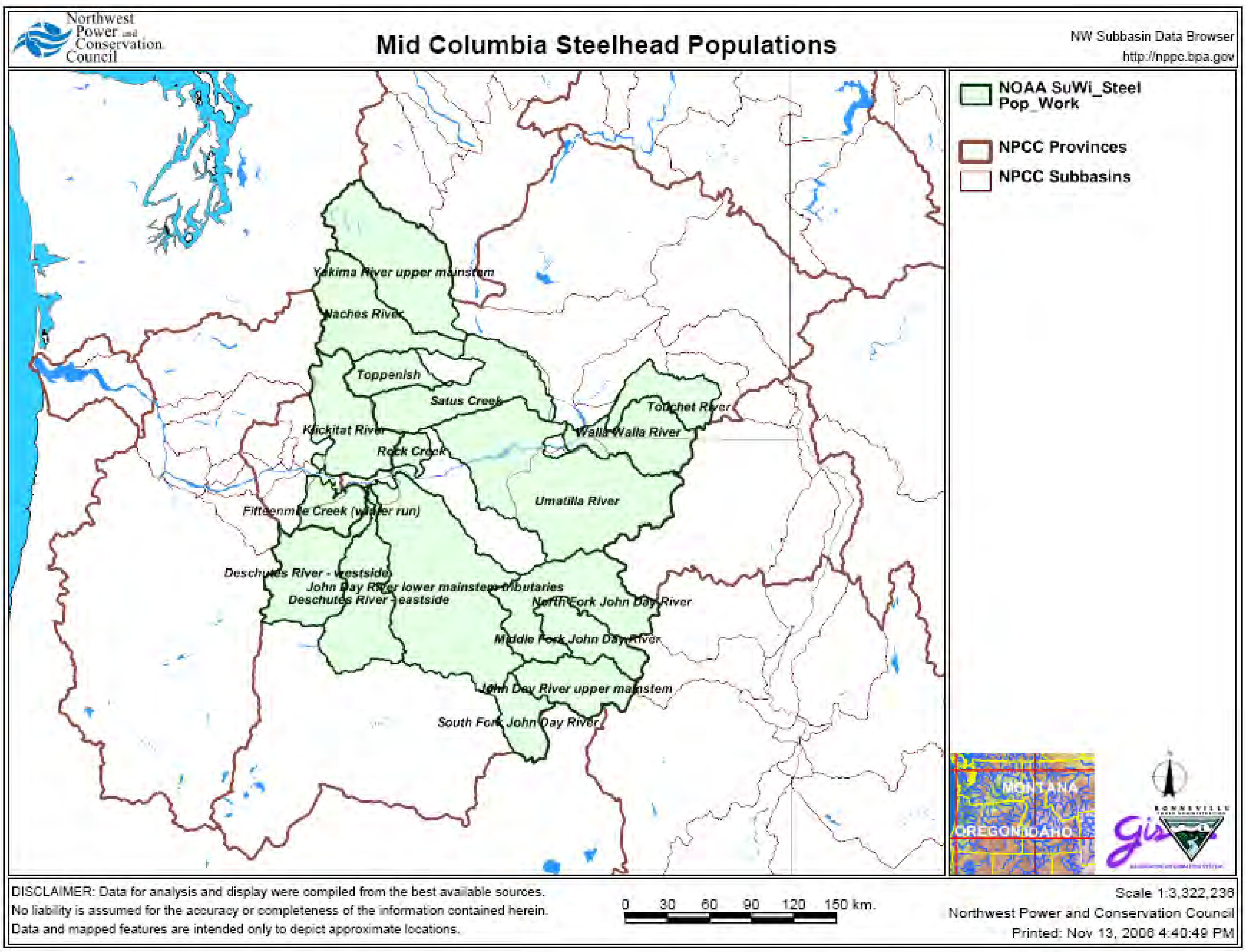
Extinction probabilities assuming no future hatchery supplementation are high for all populations at QET=30 and QET=50. Risks are high for all populations except the Wenatchee at QET=10. However, when future supplementation is assumed, risks become low for all populations. This modeling result is consistent with NOAA Fisheries' 2006 decision to downgrade this DPS's status from endangered to threatened.

Base period recruit-per-spawner productivities are poor for all populations. Assuming the high end of our range for future hatchery reform benefits, all populations would be expected to have recruit-per-spawner productivity greater than or equal to 1.0. Assuming the low end of the range, significant gaps would remain. All of the populations in this DPS have shown increasing trends in abundance of natural-origin spawners between 1980 and 2004 or 2005. These trends are likely due in part to a boost in natural spawner numbers resulting from ongoing supplementation. The boost is provided by the second generation progeny of fish spawned in the hatchery program (so-called F_2 progeny of hatchery-spawned fish). In effect, the hatchery programs for these populations provide not only a hedge against short term extinction risk, they provide an annual "subsidy" for the population – a steady increase in abundance of naturally spawning fish that buys time to address the limiting factors that led to the decline in productivity in the first place – including poor hatchery practices. The proposed action adds to the improvements that have taken place in hydrosystem survival in the last decade. It also increases efforts to address degraded habitat conditions. Significant survival improvements – and gap closure – are anticipated as a result. The collaboration's Conceptual Framework analysis also indicates that gaps are closed at the high and low ends of the Framework range.

This is not a final federal agency product. Rather, it is a pre-decisional document prepared by the Action Agencies that reflects present understandings of currently available information and analyses, and of the progression of discussions with the sovereigns in the collaborative process. Revisions and refinements are to be expected based on further discussions with the sovereigns over new and modified proposed federal actions upon which the action agencies will ultimately consult. Finally, the information in this product does not constitute an analysis of whether the identified measures would or would not jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Furthermore, this document does not in any way interpret or apply the regulatory definitions of the statutory phrases "jeopardize the continued existence of" and "destruction or adverse modification."

Middle Columbia River Steelhead DPS

<u>Please note that all of the information in this paper is still preliminary</u>. <u>In particular, benefits assessments are still under review. For certain populations additional actions are being considered that might be implemented by the Action Agencies or by others.</u>



DPS Description[1]	
Threatened	Listed under ESA in 1999; reclassified as a DPS in 2006
Hatchery programs included in DPS	Touchet endemic; Yakima kelt programs in Toppenish, Satus Creek, Naches River, and Upper Yakima River; Umatilla; Deschutes

Current Major Population Groups	**Current Populations (Naturally Spawning)**
Yakima River Group	Satus Creek Toppenish Creek Naches River Yakima River upper mainstem
John Day River	John Day River lower mainstem Middle Fork John Day River South Fork John Day River John Day River upper mainstem North Fork John Day River
Cascades Eastern Slope Tributaries	Klickitat River Rock Creek Deschutes River - westside Deschutes River - eastside Fifteenmile Creek (winter run)
Umatilla and Walla Walla River	Walla Walla River Touchet River Umatilla River

INTRODUCTION

This paper briefly summarizes the current biological analysis developed for this distinct population segment (DPS). First, it provides an overview of the DPS and the factors limiting its viability, summarizes population-level status information during the 20 year base period used for this analysis, and provides estimates of the "gaps," or needed lifecycle survival improvements, for individual populations to meet certain biological criteria. It summarizes the improvements made to the hydrosystem and in other Hs since about 2000 and estimates the salmonid survival benefits associated with those improvements. Finally, it describes the actions proposed to be implemented into the future and estimates their effects on salmonid survival when aggregated with the environmental baseline and cumulative effects.

Almost all of the metrics used in this analysis are estimates for individual populations within the DPS. The Endangered Species Act is concerned with the status of a species, DPS, or Evolutionarily Significant Unit (ESU). Individual populations and major population groups (where they exist) obviously contribute to ESU status. However, the status of the ESU is not wholly dependent upon the status of any of the ESU's individual components.

The Middle Columbia River Steelhead DPS includes steelhead populations in Oregon and Washington drainages upstream of the Hood and Wind river systems to and including the Yakima River. Snake River Steelhead are not included in this DPS. Major drainages in this

[1]Listing determination (70FR37160); Interior TRT July 2003 description of independent populations *www.nwfsc.noaa.gov/trt/col_docs/independentpopchinsteelsock.pdf*, May 2005 update *www.nwfsc.noaa.gov/trt/col_docs/updated_population_delineation.pdf,*

DPS are the Deschutes, John Day, Umatilla, Walla Walla, Yakima, and Klickitat river systems. Almost all steelhead populations within this DPS are summer-run fish, the exceptions being winter-run components returning to the Klickitat, and Fifteen Mile Creek watersheds. Most of the populations within this DPS are characterized by a balance between 1 and 2 year-old smolt outmigrants. Adults return after one or two years at sea.

The Interior Columbia Technical Recovery Team (ICTRT) has identified four major population groups (MPGs): Cascade East Slopes, John Day, Walla Walla/Umatilla, and Yakima. The Cascade East Slopes MPG includes seven populations of which two are considered extirpated: White Salmon River (extirpated), Klickitat River, Deschutes River East, Deschutes River West Crooked River (extirpated), Fifteen mile Creek, and Rock Creek. The John Day MPG includes five populations: Lower John Day River, South Fork John Day River, Middle Fork John Day River, North Fork John Day River, and the Upper John Day River. The Walla Walla/Umatilla MPG include four populations of which one is considered extirpated: Willow Creek (extirpated), Umatilla River, Walla Walla River, and the Touchet River. The Yakima MPG includes four populations: Satus Creek, Toppenish Creek, Naches River and the Upper Yakima River.

Hatchery facilities are located in a number of drainages within the geographic area of this DPS, although there are also subbasins with little or no direct hatchery influence. The John Day River system, for example, has not been planted with hatchery steelhead. Similarly, hatchery production of steelhead in the Yakima River system was relatively limited historically and has been phased out since the early 1990s. The Umatilla and the Deschutes river systems each have ongoing hatchery production programs based on locally derived broodstocks. Moreover, straying from out-of-basin production programs into the Deschutes River has been identified as a chronic occurrence. The Walla Walla River (three locations in Washington sections) historically received production releases of Lyons Ferry stock summer steelhead from the Lower Snake River Compensation Program (LSRCP). Mill Creek releases were halted after 1998 due to concerns associated with the then pending listing of Middle Columbia River steelhead under the ESA. A new endemic broodstock is under development for the Touchet River release site (beginning with the 1999/2000 return year). Production levels at the Touchet and Walla Walla River release site have been reduced in recent years.

Hatchery programs included in the DPS include the Touchet River Endemic, Yakima River Kelt Reconditioning Program (in Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River), Umatilla River, and the Deschutes River steelhead hatchery programs. The average fraction of hatchery fish in the MPGs has varied over the years, a range of 2 to 6 percent in the Yakima, 8 to10 percent in the John Day, up to 39 percent in the Cascades, and up to 36 percent in the Umatilla/Walla Walla.

Harvest rate on Middle Columbia steelhead average about 4.5 to10 percent, which is similar to that of A-run steelhead in the Snake River.

Blockages have prevented access to sizable steelhead production areas in the Deschutes River and the White Salmon River. In the Deschutes River, Pelton Dam blocks access to upstream habitat historically used by steelhead. Condit Dam, constructed in 1913, blocked access to all but 2-3 miles of habitat suitable for steelhead production in the Big White Salmon River (Rawding 2001). Substantial populations of resident trout exist in both areas.

Human impacts and current limiting factors for this ESU come from multiple sources: hydro passage, habitat degradation, hatchery effects, fishery management and harvest decisions predation, and other sources.

Key Limiting Factors

Salmon and steelhead have been adversely affected over the last century by many activities including human population growth, introduction of exotic species, over fishing, developments of cities and other land uses in the floodplains, water diversions for all purposes, dams, mining, farming, ranching, logging, hatchery production, predation, ocean conditions, loss of habitat and other causes (Lackey et al.2006)[2]. Summarized below are key limiting factors for this DPS identified by NOAA in the DPS Overviews for the remand collaboration[3]

Tributary Habitat and In-basin Hydro	Within the Yakima MPG, fish passage in Yakima tributaries is a limiting factor. At times in the Yakima mainstem, streamflows during juvenile outmigration are a limiting factor. Two hydro projects within the DPS block access to miles of upstream habitat: the Deschutes and the White Salmon. Cle Elum Dam, an irrigation storage facility in the Yakima, blocks access to 20 plus miles of upstream habitat. Current and legacy land uses continue to cause declines in steelhead survival in the tributaries. Of particular concern are reduced complexity of the stream system, water quantity during the summer, and water quality (largely temperature and sediment). In addition to current limiting factors and threats, we need to consider the potential loss of habitat resulting from future development, and the adequacy of regulatory mechanisms to address these threats. According to the Step 4 report, the estimated portion of the human impact attributable to combined habitat effects in the tributaries and the estuary is 20 to 26 percent. If the latent mortality hypothesis is included, the human impact associated with habitat degradation is 30 to 62 percent.
Mainstem Hydro	Fish passage is a limiting factor for Middle Columbia steelhead; they migrate through one to four mainstem Columbia River Dams as juveniles and as adults. Current juvenile mortality varies substantially, from an average of 16 to 53 percent; depending upon the number of dams they pass. According to the Step 4 report, the estimated portion of the human impact attributable to the FCRPS dams (compared to natural river estimates) is 26 to 42 percent. If the latent mortality hypothesis is included, the range associated with the hydro system is 36 to 78 percent. Hydro impacts include volume, timing and quality of flows that enter the FCRPS action area, including flows from the Snake River at the toe of Hells Canyon Dam, which are impacted by the operation of Reclamation's upper Snake River projects and the mainstem effects of Reclamation's other projects within the Columbia Basin.
Predation	Predation has been noted as a factor limiting fish survival for steelhead at mainstem hydro facilities and in the Columbia estuary.
Hatcheries	A limiting factor for both the Deschutes and the John Day Rivers comes from out-of-basin strays from Snake River hatcheries. In addition, five steelhead hatchery programs operate using the best management practices and are not considered major limiting factors for naturally-spawning steelhead, three are in need of some improvement. According to the Step 4 report, the estimated portion of the human impact attributable to hatchery effects is 1 to 2 percent. If the latent mortality hypothesis is included, the range associated with the hatchery system is 5 to 12 percent.

[2] Lackey, Robert T, Denise H. Lach, and Sally L Duncan. Wild salmon in Lackey, Robert T, Denise H. Lach, and Sally L Duncan. Wild salmon in western north america: the historical and policy perspective. Pp 13-55. In: Salmon 2100: The future of wild pacific salmon. 2006. Robert T Lackey, Denise H. Lach, and Sally L. Duncan (editors).
[3]Master - Summary of Key DPS Info Int Columbia - table 24oct06, p. 7, (Limiting factors summarized and ranked by Paula Burgess, NOAA Fisheries, utilizing information found in working draft of DPS Overviews, 2005 Pacific Coastal Salmon Recovery Fund Report to Congress and local recovery plans.)

Estuary	Predation, levels of toxic substances, and conditions in the plume are limiting factors.
Harvest	As Fisheries have become more stock-specific, direct commercial and recreational harvest of Middle Columbia natural-origin steelhead has been eliminated although catch and release mortality continues to be a factor. Remaining harvest is a result of tribal allocation and incidental catch from other Fisheries, together resulting in 4.5 to 10 percent mortality**.** According to the Step 4 report, the estimated portion of the human impact attributable to combined Tribal and non-Tribal harvest effects is 70 to 2 percent. If the latent mortality hypothesis is included, the range associated with the combined harvest impacts is 17 to 33 percent.

BASE STATUS

This section summarizes the average status of this DPS during the base period, which for most populations is a 20 year period beginning in brood year 1979, 1980 or 1981, depending on the population. All of the analysis in this paper relies on datasets supplied by the Interior Columbia Technical Recovery Team. Those datasets do not include adult return information for the last one to three years, depending on the population.

DPS Abundance and Trends

Geometric mean abundance since 2001 has substantially increased for the DPS as a whole. Geomean abundance of natural-origin fish for the 2001-most recent period was 17,553 compared to 7,228 for the 1996-2000 period, a143 percent improvement (all abundance trend information from Fisher and Hinrichsen, 2006). The interim recovery abundance level identified by NOAA for the DPS as a whole is 55,400.[4] The sum of the ICTRT's minimum abundance thresholds for all populations in this DPS is 22,750.[5]

The DPS-level abundance trend of natural-origin spawners for 1990-2002 indicates an increasing population over that time. (The slope of the trend line for the DPS as a whole is 1.06 for this period.) The 1980-2002 DPS-level trend indicates a declining trend over that time (trend line slope of .99 for the DPS). All but two populations in the DPS show increasing or steady population growth trends in the 1990-recent period though many populations show declines when the longer 1980-recent period is analyzed.

Abundance information on steelhead in the Middle Columbia is in general much better known than is the case for the Snake River populations. Ten-year geometric mean abundances of individual populations and the percent natural-origin spawner are summarized in Table 1. Abundances average over a thousand fish per year in the Deschutes (eastside), the Lower John Day the North Fork John Day, the Umatilla River and the Walla Walla River. With the exception of the Deschutes River (west- and east-side populations) and the Umatilla, the proportion of natural-origin spawner is relatively high, exceeding 90 percent.

[4] Memo from Bob Lohn to Frank L. Cassidy, Jr., April 4, 2002.
[5] Table 5a, Interim ICTRT Gaps Report, May 17, 2006.

Table 1. Ten-year geometric mean abundances and percent natural-origin fish.

MPG	Population	10-year Geometric Mean Abundance	20-year Average Percent Natural-Origin Fish
E. Cascades	Klickitat	N/A	N/A
	Fifteen Mile Creek	593	100
	Deschutes (Westside)	470	77
	Deschutes (Eastside)	1579	61
John Day River	L. John Day	1800	94
	SF John Day	259	95
	MF John Day	756	95
	NF John Day	1740	95
	U. John Day	524	95
Umatilla/Walla Walla	Umatilla	1472	77
	Walla Walla	1003	98
	Touchet	624	93
Yakima River	Satus Creek	568	94
	Toppenish	148	94
	Naches	462	94
	U. Yakima	92	98

Abundance and rolling 5-year geometric mean of abundance for the DPS are shown in Figure 1 below.

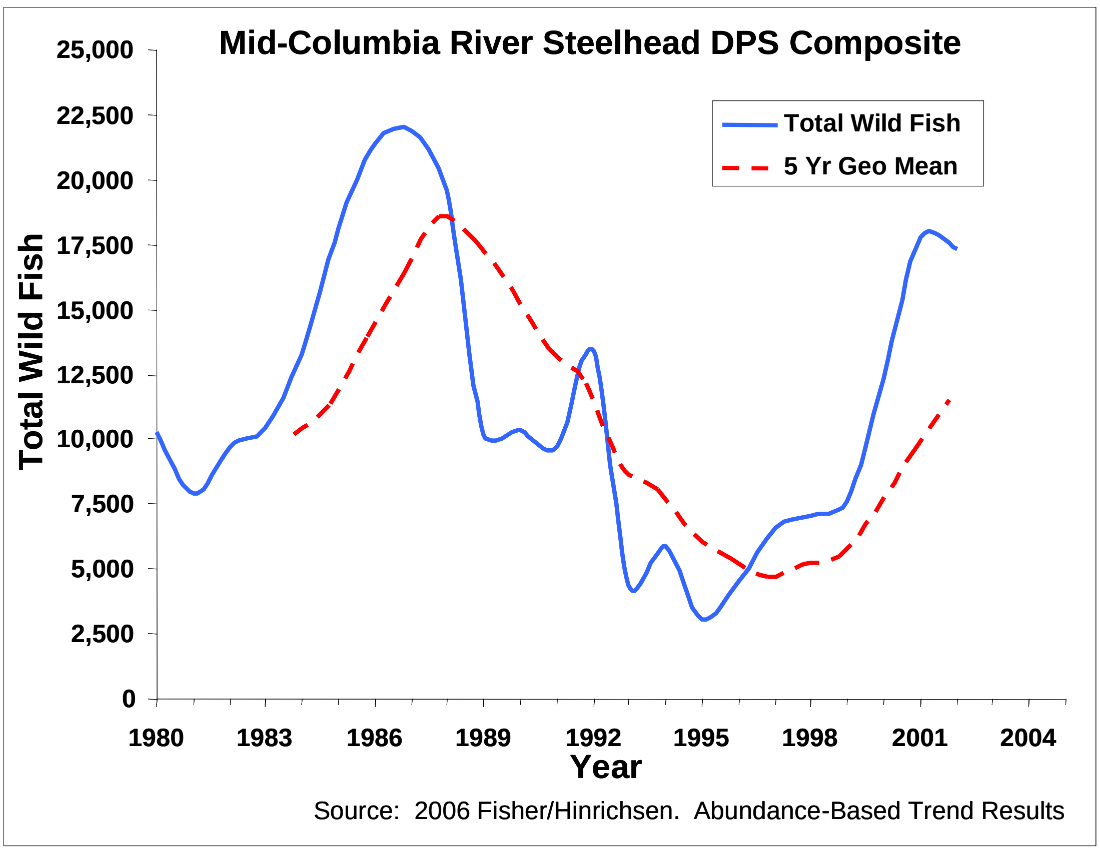


Figure 1 Middle Columbia Steelhead Abundance Trends

Extinction Probability/Risk

The productivity and survival metrics for the 16 extant populations comprising the Middle Columbia DPS are summarized in Table 2. Twenty four-extinction probabilities for the Mid Columbia steelhead populations were estimated at quasi extinction thresholds (QETs) of 1, 10, 30 and 50. Of the 14 Middle Columbia steelhead populations where adequate data exist to estimate extinction risk, 12 show low (< 5 percent at all QET sensitivities) risk of extinction over a 24-year time horizon. The three populations that fail to achieve this criterion are the Deschutes River (Eastside), Toppenish and the Upper Yakima. Extinction risk estimates at QET=1 were 43 percent and 3 percent, respectively.

RECRUIT-PER-SPAWNER PRODUCTIVITY, LAMBDA, AND TRENDS

Productivity, as reflected by estimates of recruits per spawner (R/S) using a 20-year time series of data, are less than 1.0 for six populations: Deschutes (Westside), South Fork of the John Day, the Umatilla River, and three Yakima MPG populations (Satus Creek Toppenish Creek and the Naches River). Median population growth rates (λ) estimated from a 20-year time series are uniformly greater than 1.0 for all populations. However, λ estimated from the most recent 10 years of return data are < 1.0 for four of the five John Day populations (Lower John Day, South Fork John Day, Middle Fork John Day, and Upper John Day). These same four John Day MPG population groups show a declining abundance trends based on a 1980-most recent record of return (generally either 2004 or 2005), but that trend largely becomes positive if estimated from the 1990-most recent data series (the exception was the Middle Fork John Day population). All other populations show positive abundance trends based on both the longer- and shorter-term data sets. This mixed result is not surprising considering the biases inherent in the different metrics (see Appendix D). Table 2 also shows the 24-year extinction probabilities for the Middle Columbia DPS at quasi extinction thresholds (QET) of 1, 10, 30 and 50. At QETs of 1 and 10 the 24-year risk was low (<5 percent) for all populations except the Deschutes River Eastside and the Upper Yakima. At a QET of 30 the estimated extinction risk of the Toppenish Creek population is 14 percent.

Table 2. Base status metrics.

For R/S, lambda and trend, a value >1.0 indicates a growing population; a value <1 indicates a population inn decline. Extinction probabilities are expressed as percentages, e.g., a value of 0.11 indicates an 11 percent risk of extinction within 24 years.

MPG	Population	20 yr. R/S	10 yr. R/S	20 yr. λ	12 yr. λ	1980-current Trend	1990-current Trend	Ext. Risk QET =1	Ext. Risk QET= 10	Ext. Risk QET= 30	Ext. Risk QET= 50
E. Cascades	Klickitat	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Fifteen Mile Creek	1.21	-	1.04	1.10	1.04	1.11	0.00	0.00	0.00	0.00
	Deschutes (westside)	0.91	-	1.03	1.04	0.99	1.10	0.00	0.00	0.00	0.00
	Deschutes (eastside)	1.14	-	N/A	1.10	1.11	1.11	0.43	0.49	0.53	0.54
John Day River	L. John Day	1.24	1.55	1.02	0.97	0.98	1.04	0.00	0.00	0.00	0.00
	SF John Day	0.99	1.06	1.14	0.96	0.95	1.01	0.00	0.00	0.01	0.03
	MF John Day	1.17	1.04	1.02	0.97	0.97	0.98	0.00	0.00	0.00	0.00
	NF John Day	1.17	1.75	1.09	1.01	0.99	1.09	0.00	0.00	0.00	0.00
	U. John Day	1.07	0.83	1.14	0.96	0.95	0.96	0.00	0.00	0.00	0.00

MPG	Population	20 yr. R/S	10 yr. R/S	20 yr. λ	12 yr. λ	1980-current Trend	1990-current Trend	Ext. Risk QET =1	Ext. Risk QET= 10	Ext. Risk QET= 30	Ext. Risk QET= 50
Umatilla/ Walla Walla	Umatilla	0.94	0.93	1.06	1.07	1.01	1.07	0.00	0.00	0.00	0.00
	Walla Walla	N/A	0.92	N/A	1.14	1.04	1.04	0.00	0.00	0.00	0.00
	Touchet	N/A	0.86	N/A	N/A	N/A	0.98	N/A	N/A	N/A	N/A
Yakima River	Satus Creek	0.99	1.24	1.01	1.06	1.00	1.08	0.00	0.00	0.00	0.00
	Toppenish	0.99	1.27	1.01	1.06	1.01	1.09	0.00	0.02	0.14	0.33
	Naches	0.98	1.26	1.01	1.06	1.00	1.08	0.00	0.00	0.00	0.01
	U. Yakima	1.00	1.52	1.01	1.05	1.00	1.09	0.38	0.50	0.58	0.66

Based on these base estimates of survival metrics for the Middle Columbia MPGs, Table 3 summarizes the improvements in survival needed to bring the estimates in line with the proposed trending toward recovery and survival criteria. The model used to estimate extinction probabilities does not lend itself to the estimation of "gaps," or needed survival improvements to meet a given criterion. Therefore, "gap closure" is assessed qualitatively, as well as quantitatively, for all steelhead DPSs. A number below 1.0 reflects a positive condition, while a number above 1.0 reflects a gap. For example, a gap of 1.2 indicates that 20 percent productivity is needed in the future.

Table 3. Base status gaps

**Note: Gaps are expressed as multipliers. For example, a 1.10 gap indicates a 10 percent improvement is necessary to close gap. If gap is ≤ 1.0, no further improvement is necessary to close gap.*

MPG	Population	20 year R/S Gap	20 year λ Gap	Long-term Trend Gap
E. Cascades	Klickitat	N/A	N/A	N/A
	Fifteen Mile Creek	0.83	0.84	0.84
	Deschutes (westside)	1.10	0.88	1.05
	Deschutes (eastside)	0.88	N/A	0.63
John Day River	L. John Day	0.81	0.91	1.10
	SF John Day	1.01	0.55	1.26
	MF John Day	0.85	0.91	1.15
	NF John Day	0.85	0.68	1.05
	U. John Day	0.93	0.55	1.26
Umatilla/Walla Walla	Umatilla	1.06	0.77	0.96
	Walla Walla	1.09	N/A	0.84
	Touchet	1.16	N/A	1.10
Yakima River	Satus Creek	1.01	0.96	1.00
	Toppenish	1.01	0.96	0.96
	Naches	1.02	0.96	1.00
	U. Yakima	1.00	0.96	1.00

Spatial Structure and Biological Diversity

Conserving and rebuilding sustainable salmonid populations involves more than meeting abundance and productivity criteria. Accordingly, NOAA Fisheries has developed a conceptual framework defining a Viable Salmonid Population, or VSP (McElhany et al. 2000). In this framework there is an explicit consideration of four key population characteristic or parameters for evaluating population viability status: abundance, productivity (or population growth rate), biological diversity, and population spatial structure. The reason that certain other parameters, such as habitat characteristics and ecological interactions, were not included among the key parameters is that their effects on populations are implicitly expressed in the four key parameters. Based on the current understanding of population attributes that lead to sustainability, the VSP construct is central to the goal of ESA recovery, and warrants consideration in a jeopardy determination. However, it must also be stressed that the ability to significantly improve either a species' biological diversity or its spatial structure and distribution is limited within the timeframe of the Action Agencies' proposed action.

Spatial Structure -- Spatial structure, as the term suggests, refers to the geographic distribution of individuals in a population unit and the processes that generate that distribution. Distributed populations that interact genetically are often referred to as metapopulation. Although the spatial distribution of a population, and thus its metapopulation structure, is influenced by many factors, none are perhaps as important as the quantity, quality, and distribution of habitat. One way to think about the importance or value of a broad geospatial distribution is that a population is less likely to go extinct from a localized catastrophic event or localized environmental perturbations.

Biological Diversity -- Biological diversity within and among populations of salmonids is generally considered important for three reasons. First, diversity of life histories patterns is associated with a use of a wider array of habitats. Second, diversity protects a species against short-term spatial and temporal changes in the environment. And third, genetic diversity is the so-called raw material for adapting to long-term environmental change. The latter two are often described as nature's way of hedging its bets – a mechanism for dealing with the inevitable fluctuations in environmental conditions – long and short-term. With respect to diversity, more is better from an extinction-risk perspective.

The Middle Columbia steelhead DPS includes 18 extant populations that the ICTRT has clustered in four MPGs. Each of the populations contains at least three populations. Based on their Spatial Structure and Diversity (SSD) analyses and rating of 16 of the populations for which sufficient information were available, the ICTRT assigned a high risk to 6 populations, a moderate risk to 11 populations, and a high risk to only one population, moderate risk to 11, and low risk to five. Considering the wide geographic distribution of this DPS, the diversity of habitats utilized, and the preponderance of populations in the moderate SSD risk category, this DPS is currently at no greater than moderate risk for SSD, and that this status will likely improve as a result of the recently implemented and proposed changes in the FCRPS including improvements to the volume and reliability of flow augmentation from the Bureau of Reclamation's upper Snake projects achieved in the Nez Perce Water Rights Settlement Particularly significant will be the continuing improvements in hatchery management and the reduced straying expected with locally-adapted broodstock.

BIOLOGICAL ANALYSIS OF ACTIONS: RECRUITS-PER-SPAWNER, LAMBDA, AND TRENDS WITH CURRENT AND PROSPECTIVE ADJUSTMENTS

As described in detail in Appendix D, the Base Status is the historical status of the DPS, defined as the status of the population based on the *average* of quantitative survival metrics estimated from a time series of abundance data beginning in about 1980. For the most part, longer term averages (generally 20 years) were used where they were available. In the biological analysis, this is the starting point, shown in the tables above.

The next step is Current Status, an adjustment of the initial base estimates to reflect our best estimate of current survivals, as opposed to an average of survivals that prevailed over a period in the past. This would obviously include recent improvements already implemented but not fully reflected in the Base conditions. Current Status is defined as estimated survival metrics adjusted for recently implemented changes in hydropower configuration and operations, hatchery operations, tributary and estuarine habitat improvements, and reduced avian predation. These are actions that have recently been implemented, but their effects are not reflected in the time series of survival data that for the most part started in 1980.

The final step is Prospective Status, which adjusts Current to Prospective Status based on the estimated effects of future actions. The current-to-prospective adjustment is simply an adjustment of the current survival estimates to reflect survival improvements expected from the hydro, habitat, and hatchery changes included in the proposed action, and in particular those that are expected to be implemented in the period 2007 to 2017.

This analysis assumes that future ocean and climate conditions will approximate the average conditions that prevailed during the 20 year base period used for our status assessments. For most populations, that period is about equivalent to the “recent” ocean period used by the ICTRT in its analyses. This period was characterized by relatively poor ocean conditions which presumably contributed to poor early ocean survival of salmonids. To illustrate, the ICTRT’s “pessimistic” ocean condition scenario results in survivals that are about 15 percent lower for Snake River spring/summer Chinook salmon than the “recent’ ocean conditions scenario, and about 36 percent lower for Upper Columbia spring Chinook salmon. Alternatively, ICTRT’s “historic” ocean conditions scenario results in survivals that are about 39 percent higher for both Snake River spring/summer and Upper Columbia spring Chinook salmon.[6] This subject is treated at greater length in the discussion of the effects of potential climate change in Appendix X.

The analysis of status assumes a certain amount of annual take of natural adult fish based on recent harvest levels. As requested in the remand collaboration, a sensitivity analysis showing the additional effects of more selective harvests that minimize take of natural adult fish is presented in Appendix X. In general, this “selective harvest” scenario results in survival that is about 8 to18 percent higher than the main analysis, depending on the ESU or DPS.

Current Status Analysis

Over this period the action agencies implemented multiple actions to improve fish survival relative to the base period prior to 2000. The percentage changes in life cycle survival used in the base-to-current adjustments for the Middle Columbia steelhead DPS are summarized in Table 4. Actions are described in summary below:

Table 4. Estimated survival improvements used in the base-to-current adjustment.

MPG	Population	Hydro	Habitat (tributary)	Habitat (estuary)	Avian predation	Harvest[7]
Eastern Cascades	Klickitat	8.4%	4.0%	0.3%	-0.3%	8.0%
	Fifteen Mile Creek	8.4%	0.1%	0.3%	-0.3%	8.0%
	Deschutes (westside)	8.4%	0.2%	0.3%	-0.3%	8.0%
	Deschutes (eastside)	8.4%	1.0%	0.3%	-0.3%	8.0%

[6] Assessing the Impact of Anticipated Hydropower Changes and a Range of Ocean Conditions on the Magnitude of Survival Improvements Needed to Meet TRT Viability Goals
Interior Columbia Technical Recovery Team and R. W. Zabel, June 20, 2006
[7] Harvest adjustments represent estimated harvest decreases between the base and current periods. Estimates supplied by A. Nigro (ODF&W) on behalf of an ad hoc US v. OR technical workgroup.

MPG	Population	Hydro	Habitat (tributary)	Habitat (estuary)	Avian predation	Harvest[8]
John Day River	L. John Day	2.0%	0.2%	0.3%	-0.3%	8.0%
	SF John Day	2.0%	0.7%	0.3%	-0.3%	8.0%
	MF John Day	2.0%	0.2%	0.3%	-0.3%	8.0%
	NF John Day	2.0%	0.3%	0.3%	-0.3%	8.0%
	U. John Day	2.0%	0.2%	0.3%	-0.3%	8.0%
Umatilla/Walla Walla	Umatilla	2.0%	4.0%	0.3%	-0.3%	8.0%
	Walla Walla	9.0%	4.0%	0.3%	-0.3%	8.0%
	Touchet	9.0%	4.0%	0.3%	-0.3%	8.0%
Yakima River	Satus Creek	9.0%	4.0%	0.3%	-0.3%	8.0%
	Toppenish	9.0%	4.0%	0.3%	-0.3%	8.0%
	Naches	9.0%	4.0%	0.3%	-0.3%	8.0%
	U. Yakima	9.0%	4.0%	0.3%	-0.3%	8.0%

Hydropower Survival Improvements

Hydropower configuration and operational improvements implemented in recent years are estimated to have resulted in varying degrees of improved survival for all populations within the DPS depending on where each population enters the mainstem Columbia River (Table 4). These survival increases were estimated with COMPASS using the 2006 hydrosystem configuration operating under the 2004 BiOp specified operation for each dam. Specific configuration and operation improvements included in this estimate are:

- Bonneville Powerhouse I minimum-gap turbine runner installations (all MPGs);
- Bonnneville Powerhouse I JBS screen removal (all MPGs);
- Bonneville Powerhouse II corner collector installation (all MPGs);
- Bonneville II Fish Guidance Efficiency improvements (all MPGs);
- Bonneville II operation as first priority (all MPGs);
- Bonneville spill operation improvements including 5 additional flow deflectors (all MPGs);
- The Dalles spill wall construction (all MPGs excluding Klickitat and Fifteen Mile populations);
- The Dalles spill pattern improvements (all MPGs excluding Klickitat and Fifteen Mile populations);
- The Dalles sluiceway operation improvements (all MPGs excluding Klickitat and Fifteen Mile populations);
- The Dalles adult collection channel improvements (all MPGs excluding Klickitat and Fifteen Mile populations);
- John Day spill operation improvements (John Day, Umatilla/Walla Walla, and Yakima MPGs);
- John Day South Fish Ladder improvements (John Day, Umatilla/Walla Walla, and Yakima MPGs);
- McNary spill operation improvements (Umatilla/Walla Walla (excluding Umatilla population) and Yakima MPGs);
- McNary end spillbay deflectors and hoists (Umatilla/Walla Walla (excluding Umatilla population) and Yakima MPGs);
- McNary full flow juvenile PIT tag detections (Umatilla/Walla Walla (excluding Umatilla population) and Yakima MPGs);

[8] Harvest adjustments represent estimated harvest decreases between the base and current periods. Estimates supplied by A. Nigro (ODF&W) on behalf of an ad hoc US v. OR technical workgroup.

- McNary juvenile transport facility bypass piping improvements (Umatilla/Walla Walla (excluding Umatilla population) and Yakima MPGs);
- McNary spare ESBS (Umatilla/Walla Walla (excluding Umatilla population) and Yakima MPGs);
- McNary improved juvenile bypass dewatering screens (Umatilla/Walla Walla (excluding Umatilla population) and Yakima MPGs);
- McNary adult PIT tag detection in fish ladders (Umatilla/Walla Walla (excluding Umatilla population) and Yakima MPGs);
- McNary overhauling AWS pumps (Umatilla/Walla Walla (excluding Umatilla population) and Yakima MPGs); and
- McNary upgrading of adult fish ladders tilting weir controls (Umatilla/Walla Walla (excluding Umatilla population) and Yakima MPGs).

Tributary Habitat Survival Improvements

From 2000 to 2006, BPA and Reclamation implemented actions to address limiting factors for populations of the John Day River MPG of this DPS. BPA also funded projects through the NPCC Fish and Wildlife Program to implement habitat actions in the Deschutes, Fifteenmile, Klicikitat, Yakima, Walla Walla and Umatilla subbasins that will improve survival of other Middle Columbia steelhead populations. BPA's annual expenditures for habitat projects in subbasins used by Middle Columbia steelhead averaged about $12 million for the 2001 to 2006 time frame. Reclamation spent over $3 million on technical assistance for habitat projects during this period.

During this time period the Action Agencies, in coordination with multiple partners, implemented the following actions for John Day River MPG populations:

- Increased streamflows through water acquisitions;
- Improved water quality and habitat conditions by protecting and enhancing riparian areas;
- Increased fish passage and access by removing passage barriers;
- Improved water quality;
- Addressed entrainment by installing or improving fish screens, and
- Improved channel habitat complexity and conditions.

Survival improvements estimated to result from tributary habitat actions implemented by the Action Agencies in this time period are shown in Table 4. The percentages indicate the incremental survival improvement estimated to accrue by 2006 from the suite of implemented actions. Survival improvements were estimated as described in "Working Draft Tributary Habitat Benefits".

For the Eastern Cascades MPG, BPA funded habitat actions to address limiting factors for the Klickitat River, Fifteen Mile Creek, Westside and Eastside Deschutes and Rock Creek populations. Actions to address limiting factors for all populations in the Yakima River Group and Walla Walla and Umatilla Rivers MPGs were also implemented. Although estimates of survival improvements are shown for these populations, the actions will contribute to the recovery of this ESU. Additional detail of habitat actions implemented by BPA and Reclamation in the 2000 to 2006 time frame is available in the Action Agencies Annual Progress Reports located at *www.salmonrecovery.gov.*

Estuary Habitat Survival Improvements

The estimated survival benefit for Snake River steelhead (stream-type life history) associated with the specific actions discussed above is about 0.3 percent. Action Agencies implemented multiple habitat actions through 21 estuary habitat projects. Unrestricted fish passage and approximately 3 miles of access to quality habitat was provided these specific actions[9]:

- Replaced 3 culverts with full-spanning bridges;
- Provided approximately 10 miles of improved tidal channel connectivity by installing a tide gate retrofit;
- Acquired approximately 473 acres of off-channel and riparian habitats;
- Restored and created 90 acres of marsh and tidal sloughs and approximately 100 acres of riparian forests
- Protected approximately 55 acres of high-quality riparian and floodplain habitat
- Restored and preserved approximately 154 acres of off-channel habitat;
- Protected 80 acres of high-value off-channel forested wetland habitat;
- Restored approximately 96 acres of tidal wetlands habitat by replacing undersized culvert that limited fish access;
- Conserved 155 acres of forested riparian and upland habitat;
- Provided partial tidal channel reconnection by tide gate retrofit (acreage unknown at this time);
- Provided integrated pest management (purple loosestrife);
- Reconnected and restored 183 acres of historic floodplain by dike removal;
- Restored 25 acres of historic floodplain by breaching a dike;
- Provided fish passage access to 6 miles of stream habitat by removal of two culverts and replacement with bridges;
- Restored 310 acres of native hardwood riparian forest, 200 acres of seasonally wet slough and 155 acres of degraded riparian habitats; increased circulation in approximately 92 acres of backwater and side-channel habitat by tide gate retrofit;
- Improved embayment circulation for 335 plus acres of marsh/swamp and shallow-water and flats habitat; and
- Preserved 35 acres of historic wetland habitat.

Predator Control Survival Improvements

Avian predation. The estimated survival change for Middle Columbia River steelhead from the baseline to current condition is -3 percent. This reflects a reduction in survival from the base to current condition, because the tern population was increasing over the base period. Averaging tern consumption of juvenile salmonids across the 20-year base period downplays the actual change in survival that resulted from relocating terns from Rice Island to East Sand Island in 1999. In 1999 tern consumption of juvenile salmonids was at its peak with an estimated 13,790,000 smolts consumed, compared to 8,210,000 in 2000 after relocation.

Piscivorous predation. The ongoing Northern Pikeminnow Management Program (NPMP) has been responsible for reducing predation related juvenile salmonid mortality since 1990. The improvement in life cycle survival attributed to the NPMP is estimated at 2 percent for migrating juvenile salmonids (Friesen and Ward 1999). The northern pikeminnow has been responsible for approximately 8 percent predation-related mortality of juvenile salmonid migrants in the Columbia River basin in the absence of the NPMP (2000 FCRPS BiOp at 9-106). The ongoing NPMP is already accounted for in the estimation of survival improvements modeled within the

[9] A more thorough report detailing this evaluation process is: Estimated Benefits for Federal Habitat Projects in the Columbia River Estuary for NWF v NMFS Remand - Sovereign Collaboration Process.

reservoir mortality life stage. This is because the modeling estimates are calibrated to empirical reach survival estimates that included the ongoing program.

Hatchery Management Survival Improvement

From 2000 to 2006, BPA implemented the following hatchery actions to benefit Middle Columbia steelhead:

- Funded a steelhead kelt reconditioning program to increase abundance and spatial structure of steelhead in the Yakima River. This provided a medium level of survival benefits for the Yakima River Upper Mainstem, Naches River, Toppenish, and Status Creek populations of this DPS;
- Funded the Middle Columbia River steelhead conservation program at the Umatilla hatchery to improve abundance and genetic diversity. This provided a high level of survival benefit for the Umatilla River population of this DPS; and
- BPA funded the development of Hatchery and Genetic Management Plans (HGMPs) for all federally-funded hatchery programs in the DPS. The objective was to develop the HGMPs for NOAA Fisheries approval and identification of and prioritization of hatchery reform measures by NOAA. NOAA Fisheries is expected to use the HGMPs in their hatchery program ESA Section 7 consultation to identify operational changes that will benefit listed populations. This planning process provided low benefits to the DPS.

Current Status Gaps

Based on these estimated improvements in the life cycle survival from the above changes, the improvements still needed to achieve the survival criteria are summarized in Table 5. Improvements of 1 percent and 3 percent respectively are needed for the Deschutes (eastside) and Touchet populations to meet R/S criteria of 1.0 or greater. Five of the 16 populations require life cycle survival improvements to meet a long-term trend criterion of 1.0 or greater. As noted earlier, gap closure for modeled extinction risks is assessed qualitatively.

Table 5. Current Status: Adjusted gaps after base–to-current adjustment.
**Note: Gaps are expressed as multipliers. For example, a 1.10 gap indicates a 10 percent improvement is necessary to close gap. If gap is ≤ 1.0, no further improvement is necessary to close gap.*

MPG	Population	Adjusted 20-year R/S Gap	Adjusted 20-year λ Gap	Adjusted Long-term Trend Gap
Eastern Cascades	Klickitat	N/A	N/A	N/A
	Fifteen Mile Creek	0.71	0.72	0.72
	Deschutes (Westside)	0.94	0.75	0.89
	Deschutes (Eastside)	0.74	N/A	0.53
John Day River	L. John Day	0.73	0.83	0.99
	SF John Day	0.91	0.50	1.14
	MF John Day	0.77	0.83	1.04
	NF John Day	0.77	0.61	0.95
	U. John Day	0.85	0.50	1.14
Umatilla/Walla Walla	Umatilla	0.93	0.67	0.83
	Walla Walla	0.89	N/A	0.68
	Touchet	0.95	N/A	0.89
Yakima River	Satus Creek	0.83	0.78	0.82
	Toppenish	0.83	0.78	0.78
	Naches	0.83	0.78	0.82
	U. Yakima	0.82	0.78	0.82

Prospective Status Analysis

As noted above the prospective status is the projected status of the population based on adjustment of the survival metrics for expected improvements associated with the proposed actions. As was the case for the base-to-current adjustment, the improvements for the current-to-prospective are divided into the categories of those expected from changes in hydropower operations and configuration, changes in tributary habitat conditions attributable to actions implemented in the periods 2007 to 2009 and 2010 to 2017, changes in estuarine habitat, reduced impacts of avian predation, and improved hatchery operations.

Over this period the action agencies will implement multiple actions to improve fish survival relative to the current period. The percentage improvements in life cycle survival used in the current-to-prospective adjustments for the Middle Columbia steelhead populations are summarized in Table 6. Actions are described in summary below:

Table 6. Current-to-prospective estimated improvements in life cycle.

MPG	Population	Hydro	2007-2017 Habitat (tributary)	Habitat (estuary)	Avian predation	Pikeminnow predation	Hatchery
Eastern Cascades	Klickitat	3.7%	12.0%	6.0%	3.4%	1.0%	
	Fifteen Mile Creek	3.7%	0.3%	6.0%	3.4%	1.0%	
	Deschutes (Westside)	3.7%	1.0%	6.0%	3.4%	1.0%	
	Deschutes (Eastside)	3.7%	3.0%	6.0%	3.4%	1.0%	
John Day River	L. John Day	13.4%	1.0%	6.0%	3.4%	1.0%	
	SF John Day	13.4%	2.0%	6.0%	3.4%	1.0%	
	MF John Day	13.4%	1.0%	6.0%	3.4%	1.0%	
	NF John Day	13.4%	1.0%	6.0%	3.4%	1.0%	
	U. John Day	13.4%	1.0%	6.0%	3.4%	1.0%	
Umatilla/Walla Walla	Umatilla	13.4%	12.0%	6.0%	3.4%	1.0%	
	Walla Walla	16.9%	12.0%	6.0%	3.4%	1.0%	
	Touchet	16.9%	12.0%	6.0%	3.4%	1.0%	
Yakima River	Satus Creek	16.9%	12.0%	6.0%	3.4%	1.0%	
	Toppenish	16.9%	12.0%	6.0%	3.4%	1.0%	
	Naches	16.9%	12.0%	6.0%	3.4%	1.0%	
	U. Yakima	16.9%	12.0%	6.0%	3.4%	1.0%	

Hydropower Survival Improvements

The estimated life cycle survival benefit percentage increase attributable to the proposed hydropower operational and configuration improvement actions was estimated based on the difference between the estimated survival under the current operation (defined as the period 2001 to 2006) and estimated survival following implementation of the proposed actions. These increases in life cycle survival range from 3.7 percent for the Eastern Cascades MPG up to 16.9 percent for the Yakima River MPG (Table 6). A detailed description of the methods used to generate these estimates can be found in Appendix D; these methods included the use of multiple data sources and the COMPASS model, and represent the “best estimates” of NMFS (see Graves spreadsheet dated 22 Mar 07). The configuration and operational improvement actions that contribute to these survival increases are organized into strategies. Specific actions contained within these strategies are listed in the Hydrosystem Proposed Action Summary. Not all of these specific actions apply to all populations in this DPS, as populations within this DPS enter the Columbia River at different locations above different dams. These strategies include:

1. Operate the FCRPS to more closely approximate the shape of the natural hydrograph and to improve juvenile and adult fish survival;
2. Modify Columbia and Snake River dams to facilitate safe passage;
3. Implement operational improvements at Columbia and Snake River dams;
4. Operate and maintain juvenile and adult fish passage facilities; and
5. Provide flow augmentation from the Bureau of Reclamation’s upper Snake projects in accordance with the Nez Perce Water Rights Settlement with potential improvements addressed in Reclamation’s Biological Assessment.

Tributary Habitat Survival Improvements

Table 6 displays estimated population level survival improvement percentages expected to result from Action Agency implementation of actions to address limiting factors in the tributary areas used by this DPS. The survival improvements identified represent an increase in Action Agency tributary habitat effort compared to efforts under the 2000 and 2004 FCRPS BiOps. Survival improvements were estimated as described in “Working Draft Tributary Habitat Benefits”.

2007 to 2017. BPA will fund projects that implement new actions to address key limiting factors and improve survival for this DPS. BPA will fund projects primarily through its Fish and Wildlife Program and Reclamation will provide technical assistance through annual congressional appropriations.

Initial actions. Consistent with its funding decisions for the NPCC 2007 – 2009 Fish and Wildlife Program, BPA will fund the implementation of 36 projects in the Deschutes, Fifteenmile, John Day, Klicikitat, Yakima, Walla Walla and Umatilla subbasins where this DPS is present. BPA has also dedicated 70 percent of the Columbia Basin Water Transactions Program (CBWTP) $5 million annual budget to secure water acquisitions and riparian easements for anadromous fish, including populations of Middle Columbia steelhead. The BPA average annual planned budgets (based on BPA Final Decision Letter) for the 36 projects is approximately $13.7 million (not including the CBWTP). The Action Agencies work with multiple parties for the successful implementation of new actions. BPA will fund projects and Reclamation will provide technical assistance to:

- Increase instream flows;
- Remove passage barriers;
- Improve fish passage structures;
- Install fish screens;
- Increase channel complexity;
- Protect and enhance riparian habitat;
- Enhance floodplains, and
- Improve water quality.

Future implementation. BPA will implement new actions similar in scope to those implemented in the 2007 to 2009 time period to address limiting factors for populations of this DPS. BPA funding commitments will be consistent with those in the 2007 to 2009 period.

Project funding decisions will be based on prioritized biological criteria and consistent with recovery plans.

Reclamation will provide planning and design technical assistance for projects that:

- Improve channel access and channel complexity, address entrainment, protect riparian areas, and increase streamflows for the John Day Middle Fork, and John Day Upper Mainstem populations.

Further detail about Reclamations actions is available in Appendix B-5 to the Tributary Habitat Proposed Action; project level detail of the BPA funded projects is available in Appendix B-2.

Estuary Habitat Survival Improvements

2007 to 2009. The estimated survival benefit for Middle Columbia River steelhead (stream-type life history) associated with the specific actions discussed below is 1.4 percent. The Action Agencies' estimated benefit for 2007 is based on actions that are or will be underway in the very near-term. For 2008 and 2009 the estimated benefit is based on continuing at the same level of effort as 2007[10]. Action agencies are or will be implementing multiple habitat actions through approximately 29 estuary habitat projects. Specific estuary habitat actions:

- Restore partial tidal influence and access to several acres (exact amount unknown at this time) by a tide gate retrofit;
- Improve hydrologic flushing and salmonid access to a lake (Sturgeon Lake is approximately 3,200 acres);
- Acquire and protect 40 acres of critical floodplain habitat and 40 acres riparian forest restoration; install 6 to 8 engineered log-jams that will help to slow flood flows, reduce erosion, contribute to sediment storage, enhance fish habitat and contribute wood into the project area; acquire and restore floodplain connectivity to 380 acres of off-channel rearing habitat for juveniles;
- Install fish friendly tide gates to increase tidal flushing and fisheries access to approximately 110 acres;
- Riparian planting of up to 210 acres;
- Re-establish hydrologic connectivity to reclaim and improve floodplain wetland functions, increase off-channel rearing and refuge habitat on five acres, plant native vegetation along shoreline and reconstruct slough channels on 2.5 acres of annually inundated off-channel habitat; as part of a long-term 1,500 acres restoration effort: breaching a dike and re-establishing flow to portion of original channel, planting vegetation on 50 acres, removing invasive weeds on 180 acres, planting wetland scrub shrub on 45 acres, and controlling and removing invasive wetland plants on 45 acres;
- Retrofit tide gates (acreage unknown at this time);
- Protect and restore approximately 5 to 10 acres of emergent wetland and riparian forest habitats;
- Reconnect 45 acres of floodplain by tide gate removal;
- Acquire 45 acre of floodplain with future dike removal;
- Reconnect 50 acres of floodplain;
- Acquire 320 acres of tidelands and 119 acres of riparian/upland forest; and
- Restore 30 acres of riparian habitat.

There will be approximately 15 additional projects and associated actions similar to actions listed above that are undergoing scoping and sponsor development (the number of projects and associated actions is based on the same level of effort as 2007).

[10] A more thorough report detailing this evaluation process is: *Estimated Benefits of Federal Habitat Projects in the Columbia River Estuary for the NWF v NMFS Remand – Sovereign Collaboration Process.*

2010 to 2017. The survival benefit for Middle Columbia River steelhead (stream-type life history) associated with these actions is about 4.5 percent. The Action Agencies' estimated benefits for 2010-2017 are based on continuing the same level of effort as 2007-2009. However the level of effort in this time period may increase depending on the outcome of a General Investigation study of Ecosystem Restoration opportunities, depending on Congressional appropriations, future funding scenarios and results of actions. Specific projects have yet to be identified. Actions for this period will be similar in nature to actions implemented in previous periods discussed above. Actions will include protection and restoration of riparian areas, protection of remaining high quality off-channel habitat, breaching or lowering dikes and levees to improve access to off-channel habitat, and reduction of noxious weeds, among others.

Predator Control Survival Improvements

Avian predation. The estimated survival increase from the current to future condition for Middle Columbia Steelhead is 3.2 percent, and this benefit is carried out to 2017 and beyond. This improvement is expected to result through the reduction in estuary tern nesting habitat, and subsequent relocation of terns outside the Columbia basin. Although the base to current shows a reduction in survival, the overall benefit (base to future) is positive.

Piscivorous predation. The percentage improvement in life cycle survival attributable to the proposed continuation of the increase in incentives in the Northern Pikeminnow Management Program and resultant marginal increase in observed exploitation rate is estimated at 1 percent total from 2007-2017. This estimate was derived based on the difference between the estimated benefits from the base NPMP (defined as the period 1990 to 2003) and estimated survival benefits under the increased incentive program (defined as the period of 2004 to present). This rate would generally apply to all juvenile salmonids.

Hatchery Management Survival Improvements

2007 to 2017. The Action Agencies will implement the following hatchery actions to improve survival of Middle Columbia steelhead:

- BPA will continue to fund a steelhead kelt reconditioning program to increase abundance and spatial structure of steelhead in the Yakima River. This will provide a medium level of survival benefits for the Yakima River Upper Mainstem, Naches River, Toppenish, and Status Creek populations of this DPS;
- BPA will continue to fund the Middle Columbia River steelhead conservation program at the Umatilla hatchery to improve abundance and genetic diversity. This will provide a high level of survival benefit for the Umatilla River population of this DPS; and
- The Action Agencies will adopt programmatic criteria for funding decisions on mitigation programs for the FCRPS that incorporate best management practices as outlined in NOAA guidance on hatchery operation and as defined in final, NOAA-approved Hatchery Genetic Management Plans (HGMPs) completed during site-specific hatchery consultations to be initiated and conducted by hatchery operators with the Action Agencies as cooperating consulting parties.

Prospective Status

Table 7. Prospective status: Adjusted future productivity trends after current-to-prospective analysis.
**Note: Future productivity values represent estimates of future R/S, lambda and trend after consideration of the effects of the proposed action. A value >1.0 indicates a growing population; a value <1 indicates a population in decline.*

MPG	Population	Estimated Future R/S	Estimated Future λ	Estimated Future Trend
Eastern Cascades	Klickitat	N/A	N/A	N/A
	Fifteen Mile Creek	1.63	1.11	1.11
	Deschutes (westside)	1.23	1.10	1.06
	Deschutes (eastside)	1.59	N/A	1.20
John Day River	L. John Day	1.70	1.09	1.05
	SF John Day	1.37	1.23	1.02
	MF John Day	1.60	1.09	1.04
	NF John Day	1.61	1.17	1.06
	U. John Day	1.46	1.22	1.02
Umatilla/Walla Walla	Umatilla	1.51	1.18	1.12
	Walla Walla	1.58	N/A	1.17
	Touchet	1.48	N/A	1.11
Yakima River	Satus Creek	1.70	1.14	1.13
	Toppenish	1.70	1.14	1.14
	Naches	1.68	1.14	1.13
	U. Yakima	1.72	1.14	1.13

Remand Conceptual Framework Analysis

The FCRPS BiOp remand's collaboration among the sovereigns developed a Conceptual Framework approach intended to help the Action Agencies develop their proposed action. The Framework approach attempted to estimate the relative magnitude of mortality factors affecting Interior Columbia basin salmonid populations. That assessment was intended to define the FCRPS' "relative expectation…for recovery."[11] The collaboration's Framework working group developed high and low mortality estimates for all sources of mortality, including the FCRPS. The collaboration's Policy Working Group has not determined where in that range the Action Agencies' proposed action should be assessed. The range of "gaps" that the Framework approach would expect the FCRPS to fill was reviewed and the Action Agencies assessed whether the total survival improvements estimated in this biological analysis would "fill" those gaps. For the purposes of this comparison, the ICTRT gaps were used for "recent" ocean and "base hydro" conditions (corresponding to the base period used for R/S productivity estimation), and the ICTRT's 5 percent risk level.

The Conceptual Framework was intended, among other things, to "provide a clear and complementary link to ongoing recovery planning efforts."[12] As such, it can be understood to represent the collaboration parties' view of the appropriate contribution of the FCRPS toward long term recovery of the listed ESUs in the Interior Columbia River basin. Therefore, it

[11] 2006 FCRPS BiOp: Conceptual Framework for the Remand Process. First Quarterly Status Report, Documents filed with the court, 01/03/06.
[12] 2006 FCRPS BiOp: Conceptual Framework for the Remand Process. First Quarterly Status Report, Documents filed with the court, 01/03/06.

provides another “metric” for use in considering the impacts of the proposed action on a listed species’ prospects for recovery. The results of this analysis are displayed in Table 8.

Table 8. Gap Calculations from the Conceptual Framework

Note: ICTRT gaps are expressed as multipliers. Gaps are for 5 percent risk, recent ocean/base hydro conditions. A “remaining” gap value <1.0 indicates no further improvement is necessary. Total survival changes combine all estimated survival improvements for the base-to-current and current-to-prospective adjustment.

MPG	Population	TRT Gap	FCRPS Relative Impact (high)	FCRPS Relative Impact (low)	TRT Gap (high hydro)	TRT Gap (low hydro)	Total Survival Change	Remaining Framework Gap (high)	Remaining Framework Gap (low)
E. Cascades	Klickitat		0.36	0.26			1.56		
	Fifteen Mile Creek	1.60	0.48	0.32	1.25	1.16	1.35	0.93	0.86
	Deschutes (westside)	1.75	0.48	0.32	1.31	1.20	1.35	0.97	0.88
	Deschutes (eastside)	0.86	0.48	0.32	0.93	0.95	1.40	0.67	0.68
John Day River	L. John Day	1.14	0.57	0.39	1.08	1.05	1.37	0.79	0.77
	SF John Day	1.32	0.57	0.39	1.17	1.11	1.39	0.85	0.80
	MF John Day	1.21	0.57	0.39	1.11	1.08	1.37	0.81	0.79
	NF John Day	0.53	0.57	0.39	0.70	0.78	1.38	0.51	0.57
	U. John Day	1.21	0.57	0.39	1.11	1.08	1.37	0.82	0.79
Umatilla Walla Walla	Umatilla	1.09	0.57	0.39	1.05	1.03	1.61	0.65	0.64
	Walla Walla	0.99	0.60	0.42	0.99	1.00	1.72	0.58	0.58
	Touchet		0.60	0.42			1.72		
Yakima River	Satus Creek	1.59	0.60	0.42	1.32	1.22	1.72	0.77	0.71
	Toppenish	1.57	0.60	0.42	1.31	1.21	1.72	0.76	0.70
	Naches	2.01	0.60	0.42	1.52	1.34	1.72	0.88	0.78
	U. Yakima	2.50	0.60	0.42	1.73	1.47	1.72	1.01	0.86

Note: FCRPS impacts are based on river flows that enter the FCRPS action area, including those that enter the Snake River at the toe of Hells Canyon Dam, which are affected by the operation of Reclamation’s upper Snake Projects.

Briefly, the proposed action (without considering either improvements in the environmental baseline or other actions reasonably certain to occur) fills Framework gaps at the low end of the range for all populations in this DPS, and leaves only very small gaps at the high end of the range for two of the14 populations for which the ICTRT had calculated gaps in its Interim Gaps Report.

ADDITIONAL ACTIONS TO BENEFIT THE ESU

Other Reasonably Certain to Occur Actions[13]

This analysis does not yet include analysis of non-federal actions that are reasonable certain to occur, developed as part of the remand collaboration. Based on information developed by the remand collaboration, steelhead populations in the Middle Columbia DPS will benefit from a combined 253 non-federal habitat actions in the Klickitat, Yakima (3 WRIAS), and Walla Walla sub-basins.

Other Federal Actions that have completed ESA Consultation

The Action Agencies' review of federal actions that have completed section 7 consultations is not yet complete. The results of the review will be included in the environmental baseline of the Biological Analysis.

OBSERVATIONS

Eastern Cascades Major Population Group

There are seven populations in this MPG; however two are considered by the ICTRT to be functionally extirpated (White River and Crooked River). Of the five remaining populations, data are available to estimate extinction risk and estimate productivity metrics for Fifteen Mile Creek, the Deschutes River (Westside), and the Deschutes River (Eastside). Data is lacking for Rock Creek and the Klickitat River.

Base period 24-year extinctions probabilities are negligible for the Fifteen Mile Creek and Deschutes River (Westside) populations at all modeled QETs. In contrast, the base 24-year extinction probabilities for the Deschutes River (Eastside) are above the less than 5 percent criterion at all QETs.

All metrics indicative of recovery are expected to be well above 1.0 after the effects of the action are considered. Conceptual Framework gaps are expected to be filled at both the high and low ends of the range.

John Day River Major Population Group

The John Day River MPG consists of five populations: the Lower John Day River, South Fork John Day River, Middle Fork John Day River, North Fork John Day River, and the Upper John Day River. All were considered viable by the ICTRT, and results of extinction risk modeling demonstrate that all have a negligible risk of extinction at all tested QETs.

All metrics indicative of recovery are expected to be well above 1.0 after the effects of the action are considered. Conceptual Framework gaps are expected to be filled at both the high and low ends of the range.

Umatilla/Walla Walla Major Population Group

[13] Many of the actions listed above have a cost-share component with a variety of other federal funding sources and therefore may be properly described as contributing to the status of the environmental baseline rather than cumulative effects. The action agencies will sort the projects described in this paper into the appropriate parts of the biological analysis, but for the purposes of discussion at the April 11, 2007 PWG workshop, believe that the effect on prospective status will be the same.

The Umatilla/Walla Walla MPG consists of four populations: Umatilla River, Walla Walla River, Touchet River, and Willow Creek. The ICTRT determined that the Willow Creek population was extirpated. Although the lack of spawner counts for several years limits the ability to estimate a full suite of survival and productivity metrics for all extant populations, estimates can be made in several instances. In the case of extinction risk, modeling indicates that both the Umatilla River and Walla Walla River populations are at negligible risk over 24-years at all tested QETs. Insufficient data are available to estimate extinction probability for the Touchet population.

Base 20-year R/S estimates for all three populations are less than 1.0, but a combination of current and prospective improvements in life cycle survival is expected to raise these estimates to greater than 1.0. Where sufficient data are available, the base lambda estimates are all greater than 1.0. Likewise, the base long- and short-term trend estimates are greater than 1.0 for all three populations. Conceptual Framework gaps are expected to be filled at both the high and low ends of the range.

Yakima River Major Population Group

This MPG is composed of four populations: Satus Creek, Toppenish Creek, Naches River and Upper Yakima River. Both the Satus Creek and Naches River populations are at negligible risk of extinction at all QETs modeled; however, the Toppenish Creek population is at increased 24-year risk of extinction when modeled at QET 30 and 50; the Upper Yakima population is at elevated risk of extinction at all tested QETs.

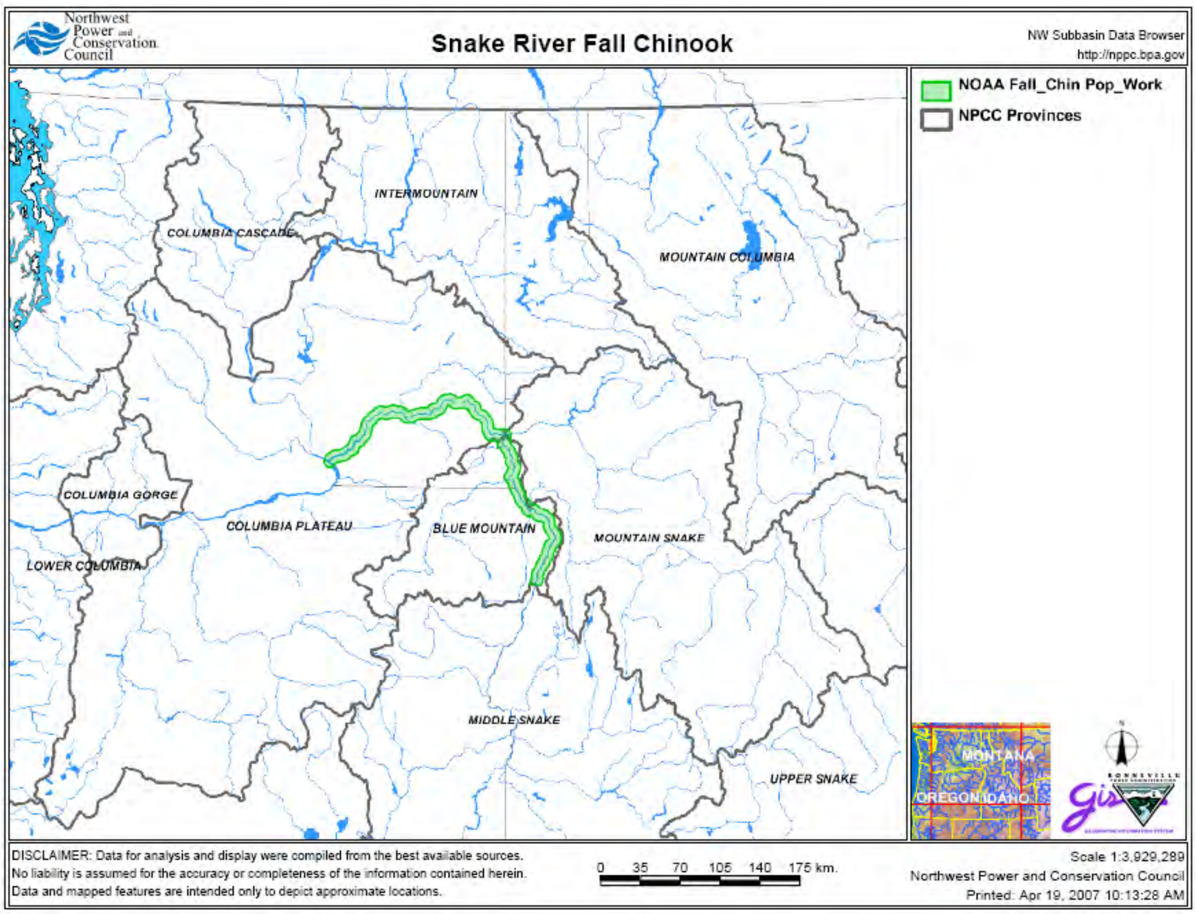
Base 20-year R/S estimates for three of the four populations are less than 1.0, but 10-year estimates are all greater than 1.0. Expected improvements in life cycle survival expected from recent improvements in the FCRPS (base-to-current adjustment) elevates the 20-year R/S estimates to well above 1.0. Both the base 12-and 20-year lambda estimates and the long- and short-term trend estimate are greater than 1.0.

Extinction risk probability modeling suggests the Toppenish Creek and Upper Yakima River populations are at heightened risk of extinction, but all three productivity metrics for these populations indicate that they are rebuilding. Conceptual Framework gaps are expected to be filled at both the high and low ends of the range, except in the case of the Upper Yakima River population, where a 1percent Framework gap exists at the high end of the range.

This is not a final federal agency product. Rather, it is a pre-decisional document prepared by the Action Agencies that reflects present understandings of currently available information and analyses, and of the progression of discussions with the sovereigns in the collaborative process. Revisions and refinements are to be expected based on further discussions with the sovereigns over new and modified proposed federal actions upon which the action agencies will ultimately consult. Finally, the information in this product does not constitute an analysis of whether the identified measures would or would not jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Furthermore, this document does not in any way interpret or apply the regulatory definitions of the statutory phrases "jeopardize the continued existence of" and "destruction or adverse modification."

Snake River Fall Chinook Salmon ESU

Please note that all of the information in this paper is still preliminary. In particular, benefits assessments are still under review. For certain populations additional actions are being considered that might be implemented by the Action Agencies or by others.



ESU Description[1]	
Threatened	Listed under ESA in 1992; reaffirmed in 2005
1 current major population group	1 current population
Hatchery programs included in ESU	Lyons Ferry, Fall Chinook Acclimation Ponds, Nez Perce Tribal Hatchery, Oxbow Hatchery

[1] Listing determination (70FR37160); Interior TRT July 2003 description of independent populations *www.nwfsc.noaa.gov/trt/col_docs/independentpopchinsteelsock.pdf* ; May 2005 update *www.nwfsc.noaa.gov/trt/col_docs/updated_population_delineation.pdf.*

Major Population Group	Population
Snake River Mainstem	Lower Snake River Mainstem

INTRODUCTION

This paper briefly summarizes the current biological analysis developed for this Evolutionarily Significant Unit (ESU). First, it provides an overview of the ESU and the factors limiting its viability, summarizes population-level status information during the 20 year base period used for this analysis, and provides estimates of the "gaps," or needed lifecycle survival improvements, for individual populations to meet certain biological criteria. It summarizes the improvements made to the hydrosystem and in other Hs since about 2000 and estimates the salmonid survival benefits associated with those improvements. Finally, it describes the actions proposed to be implemented into the future and estimates their effects on salmonid survival when aggregated with the environmental baseline and cumulative effects.

Almost all of the metrics used in this analysis are estimates for individual populations within the ESU. The Endangered Species Act is concerned with the status of a species, DPS, or Evolutionarily Significant Unit (ESU). Individual populations and major population groups (where they exist) obviously contribute to ESU status. However, the status of the ESU is not wholly dependent upon the status of any of the ESU's individual components.

The Snake River fall Chinook ESU is composed of a single population that spawns and rears in the mainstem Snake River and tributaries, from the confluence of the Snake and Columbia rivers in the Tri-Cities area of Washington State to the tailrace of Hell Canyon Dam in Idaho. Based on life history and genetic differences, fall-run Chinook salmon in the Snake River are distinct from the spring/summer-run in the Snake basin (Waples et al. 1991). Snake River fall Chinook salmon are also considered separately from those assigned to the upper Columbia River summer and fall run ESU because of considerable differences in habitat characteristics and adult ocean distribution and less definitive, but still significant, genetic differences. There is, however, some information concern that suggests that recent introgression from Columbia River hatchery strays is causing the Snake River population to lose the qualities that made it distinct for ESA purposes.

Historic abundance of this ESU is estimated to have been 400,000 to 500,000. By the late 1930s and 1940s, as a result of a combination of heavy fishing pressure since the 1890s and the blocking of 150 miles of important habitat by the construction of Swan Falls Dam in 1901, abundance was estimated at 72,000. After completion of the Hells Canyon Complex and inundation of Snake River mainstem spawning habitat, only 10 to15 percent of the former range of fall Chinook salmon remains; the remaining area is the least productive area historically occupied by this ESU.

Unlike the other listed Chinook salmon ESUs in the Interior Columbia River Basin, this ESU historically exhibited primarily an ocean-type life history, with fish rearing only briefly in their natal area, outmigrating as subyearlings, and returning to spawn in September and October. However, recent research shows that a relatively high proportion of returning Snake River adult fall Chinook salmon have adapted a yearling life history. These juveniles spend their first winter in one or more reservoirs and migrate to the ocean as yearlings. This relatively novel life history pattern for ocean-type Chinook salmon may be fostered by mainstem flow and temperature conditions. Fall Chinook salmon in general spawn in mainstem rivers at relatively low elevations and appear to be able to adapt to modified habitat relatively quickly, as occurred after the removal of the Lewiston Dam in 1974.

Hatcheries have played a major role in the production of Snake River fall Chinook salmon since the early1980s (Busack 1991). There are three hatchery populations that are considered part of this ESU: Lyons Ferry, Nez Perce Tribal, and Oxbow hatcheries[2]. The Federal Columbia River Power System (FCRPS) funded Lyons Ferry Hatchery, a mitigation program for construction of the Lower Snake River dams, began operating in the early 1980s, and the BPA funded Nez Perce hatchery program for dam mitigation began in the late 1990s. Over the past 10 years, hatchery contribution to Snake River escapement has been estimated at nearly 60 percent. Because artificial propagation of Snake River fall Chinook is a relatively recent contributor to production, it is believed that the cumulative genetic changes associated with it may be limited. Presently, natural-origin fish are incorporated into the brood stock each year, which should reduce divergence from the natural population. Also the release of yearling smolts has been curtailed in recent years. The greater emphasis on the release of subyearling fish is expected to minimize the differences in mortality patterns between hatchery and wild populations that can lead to genetic change (Waples 1999). (See NMFS [1999a] for further discussion of the Snake River fall Chinook salmon supplementation program.)

National Oceanographic and Atmospheric Administration (NOAA) Fisheries, in its 2004 Biological Opinion (BiOp), concluded that the artificial propagation programs have provided benefits to the ESU in terms of abundance, spatial distribution, and diversity in recent years, although the contribution of these programs to overall ESU productivity is uncertain and the artificial propagation programs are not sufficient to substantially reduce the long-term risk of extinction. Depending upon the assumptions made about the likelihood of the progeny of hatchery fish returning as productive adults, long- and short-term trends in productivity are at or above replacement. Thus, NOAA Fisheries proposed to retain the current listing of this species as threatened (i.e., likely to become an endangered species within the foreseeable future) even though it is not likely to go extinct in the near future. Actions under the 2000 FCRPS Biological Opinion and improvements in hatchery practices have provided some encouraging signs in addressing the factors for decline. The quality of data available to managers is considered to be moderate for juveniles in the mainstem, poor for juveniles in the tributaries, and moderate-poor for adults. Natural mortality of these fish throughout their lifecycle is 90-95 percent. The amount of human impact relates to several factors: hydro, habitat, hatcheries, harvest, and predation.

Snake River fall Chinook salmon are similar in life history and appearance to the unlisted "upriver bright" fall Chinook salmon, which include several large, healthy populations of hatchery- and naturally-produced fish in the Hanford Reach of the Columbia River. Because Snake River fish mix with these other populations in the Columbia River, as well as with healthy stocks of Alaska Chinook salmon in the ocean, they are heavily harvested in ocean, mixed-stock treaty tribal and non-tribal fisheries. The harvest rate of Snake River fall Chinook averaged approximately 65 percent from 1980 to 1995; however, current agreement under the Columbia River Compact limits harvest to 54 percent or less. The 2000-2003 harvest rates have averaged 44 percent.

A transportation program to barge fall Chinook salmon smolts (as well as for spring/summer Chinook and steelhead) past the Snake and Columbia River Dams was initiated in 1968. At the time this program was implemented a comprehensive evaluation of the effects of transportation

[2] FR 70, #123, June 28, 2005, p.37160-37216

on life cycle survival was put into place for the spring-migrating fish. However, this was not the case for the summer-migrating fall Chinook salmon subyearling migrants. Although widely believed at the time to be an important tool for enhancing survival, the small size of this population made rigorous scientific evaluation of potential benefits of the program for the most part impossible. More recently, questions about delayed mortality have created uncertainty about these putative benefits. In addition, the recent findings regarding the existence of a reservoir life history and the propensity for some portion of each brood year to remain in the river an additional year before migrating adds even more uncertainty mix. Clearly, a summer transportation program would have dubious benefit for a smolt that would “naturally” migrate the following year and enter the ocean at age one in the spring, and may even e harmful. Needless to say there are many uncertainties regarding the life of Snake River fall Chinook salmon and the efficacy of smolt transportation as a tool to increase survival.

Human impacts and current limiting factors for this ESU come from multiple sources: hydro passage, habitat degradation, hatchery effects, fishery management and harvest decisions predation, and other sources.

Key Limiting Factors

Salmon and steelhead have been adversely affected over the last century by many activities including human population growth, introduction of exotic species, over fishing, developments of cities and other land uses in the floodplains, water diversions for all purposes, dams, mining, farming, ranching, logging, hatchery production, predation, ocean conditions, loss of habitat and other causes (Lackey et al.2006)[3]. Summarized below are current key limiting factors for this ESU identified by NOAA in the ESU Overviews for the remand collaboration[4].

Mainstem Hydro	Snake River fall Chinook salmon migrate through 8 mainstem Columbia and Snake River Dams as juveniles or are transported in barges. Estimates of current in-river juvenile mortality average 83 percent. Hells Canyon and other upstream dams limit spawning and rearing capacity by blocking access to habitat and alter historic temperature profile, gravel recruitment, and hydrograph in the remaining habitat. According to the Step 4 report, the estimated portion of the human impact attributable to the FCRPS dams (compared to natural river estimates) is 57 to 61 percent. If the latent mortality hypothesis is omitted, the human impact associated with the hydro system is 35 percent. Hydro impacts include volume, timing and quality of flows that enter the FCRPS action area, including flows from the Snake River at the toe of Hells Canyon Dam, which are impacted by the operation of Reclamation's upper Snake River projects and the mainstem effects of Reclamation's other projects within the Columbia Basin.
Predation	Predation has been noted as a factor limiting survival at mainstem hydro facilities and in the Columbia estuary. The portion of Snake River fall Chinook salmon that exhibit a yearling life history and overwinter may be susceptible to higher predation rates, but when they resume their migration the larger size they have achieved may help them avoid many of the predators that traditionally prey on fall Chinook salmon sub-yearlings.

[3] Lackey, Robert T, Denise H. Lach, and Sally L Duncan. Wild salmon in Lackey, Robert T, Denise H. Lach, and Sally L Duncan. Wild salmon in western north america: the historical and policy perspective. Pp 13-55. In: Salmon 2100: The future of wild pacific salmon. 2006. Robert T Lackey, Denise H. Lach, and Sally L. Duncan (editors).
[4] Master - Summary of Key ESU Info Int Columbia - table 24oct06, p. 7, (Limiting factors summarized and ranked by Paula Burgess, NOAA Fisheries, utilizing information found in working draft of ESU Overviews, 2005 Pacific Coastal Salmon Recovery Fund Report to Congress and local recovery plans.)

Harvest	The combined ocean and freshwater harvest rate has been between 35 to 45 percent for the last 6 years. According to the Step 4 report, the estimated portion of the human impact attributable to combined Tribal and non-Tribal harvest effects is 51 to 54 percent. If the latent mortality hypothesis is omitted, the range associated with the combined harvest impacts is 11 to 20 percent.
Hatcheries	Out-of-basin hatchery fish, primarily from the Umatilla Hatchery, stray into this area to spawn. In addition, it appears that supplementation programs have increased the number of natural spawners from several hundred to several thousand; continued operation could be managed to minimize risk to the natural component of the ESU. According to the Step 4 report, the estimated portion of the human impact attributable to hatchery effects is 4 percent If the latent mortality hypothesis is omitted, the human impact associated with the hatchery system is 1 percent.
Estuary	The condition of the estuary is important for fall Chinook salmon because they may potentially spend months. The estuary is especially important to Snake River fall Chinook salmon that exhibit a yearling life history and over-winter below Bonneville Dam. Quantity and quality of habitat, predation, toxins, and the plume are potential limiting factors.
Habitat	Habitat quality in currently accessible areas is strongly affected by water management upstream of these areas. Construction of the Hells Canyon Complex of Dams blocked access to 97 percent of suitable spawning habitat previously available to fall chinook salmon (Battelle, 2000). Water quality in the upper Snake River plain is degraded compared to historic conditions. The dams act as a settling pond, so that while temperature and pollution are still an issue, the river below the dam does support fall Chinook salmon. Degraded estuary habitat affects subyearling juvenile rearing and the physiological transition from freshwater to saltwater. According to the Step 4 report, the estimated portion of the human impact attributable to combined habitat effects in the tributaries and the estuary is 21 to 23 percent. If the latent mortality hypothesis is omitted, the human impact associated with habitat degradation is 13 percent.

BASE STATUS

ESU Abundance and Trends

The 10-year geometric mean abundance of Snake River fall Chinook is 1273 natural-origin spawners. The 5-year geomean abundance is 2958 natural-origin spawners, which exceeds the interim recovery target for this ESU. Both 1980-recent and 1990-recent abundance trends for natural-origin spawners are greater than 1.0 indicating a growing population over those periods. Adult return numbers have declined since their recent peaks. However, this analysis focuses on longer term trends consistent with the principle that a longer time series provides better estimates.[5]

[5] See for example Dennis, B., Munholland, P.L, and Scott, J.M. 1991. Estimation of growth and extinction parameters for endangered species. Ecol. Monogr., 61:115-143.

ESU abundance and a rolling 5 year geometric mean of abundance are shown relative to the NOAA Fisheries interim recovery target in Figure 1.

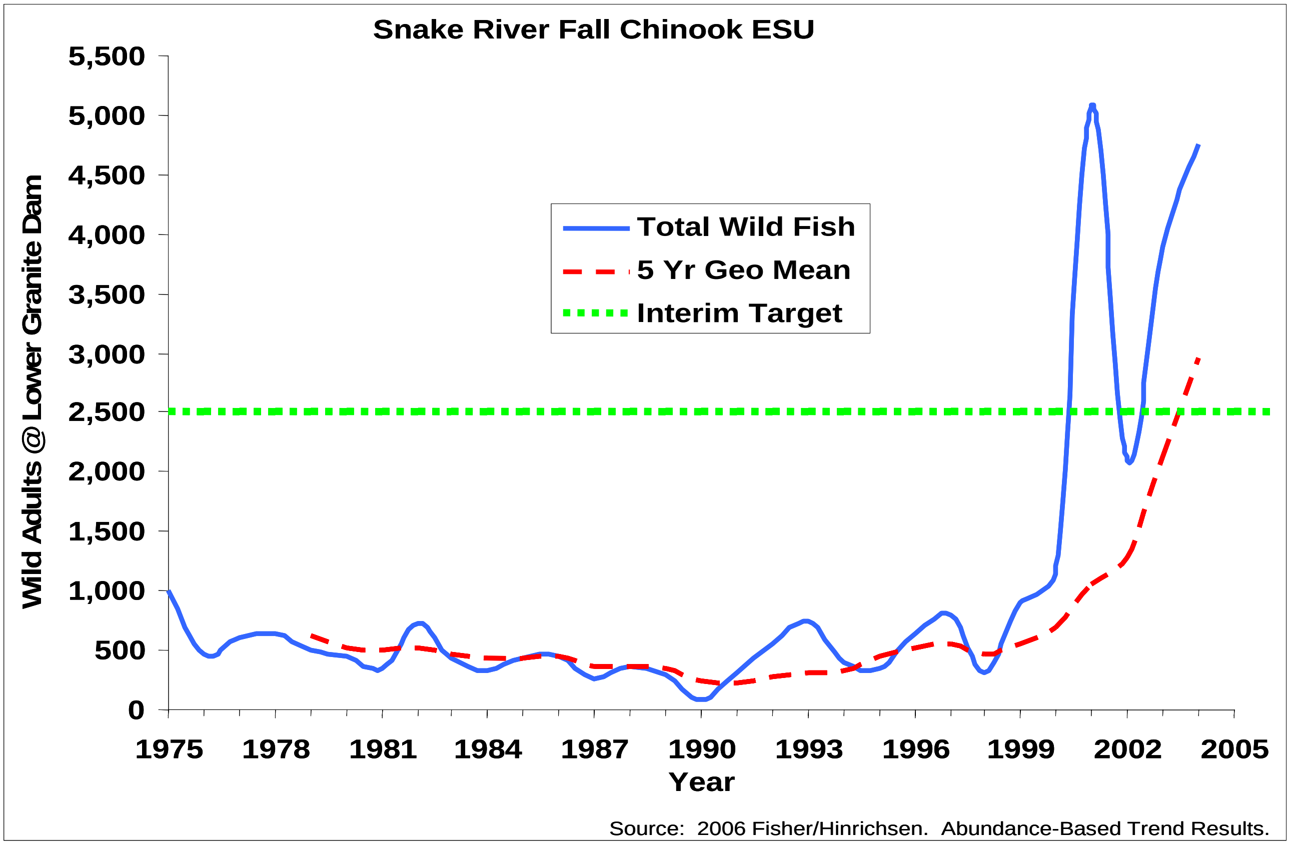


Figure 1 Snake River Fall Chinook Abundance Trends

EXTINCTION PROBABILITIES, RECRUIT-PER-SPAWNER PRODUCTIVITY, AND LAMBDA

Base productivity and survival metrics for the single population comprising this ESU are summarized in Table 1. Productivity, as reflected by estimates of recruits-per-spawner (R/S), is < 1.0 if estimated from the full 20-year time series of data, but is >1.0 if estimated from the most recent 10-year period (0.82 and 1.24, respectively). It is not possible to model hydrosystem survival improvements for this ESU due to life history uncertainties. Therefore, this biological assessment uses the 10-year R/S productivity value as its base case in the view that the10-year R/S value best represents current survivals resulting from significant hydrosystem improvements over the past decade. The 10-year R/S value is 1.24, indicating a trend toward recovery for this ESU. A trend toward recovery is also indicated by the 20- and 10-year estimates of median population growth rate (λ) that average 1.14 and 1.31, respectively; and the both 20-and10-year trend estimates 1.09 and 1.25, respectively. 24-year extinction risk estimates are low (< 5 percent) at all QETs. In this analysis, a metric of 1.0 reflects no gap. A number below 1.0 reflects a positive condition, while a number above 1.0 reflects a gap. For example, a gap of 1.2 indicates that 20 percent productivity is needed in the future.

Table 1. Base status metrics.

For R/S, lambda and trend, a value >1.0 indicates a growing population. Extinction probabilities are expressed as percentages, e.g., a value of 0.01 indicates a 1% risk of extinction within 24 years.

Population	10-year R/S	20-year λ	12-year λ	1980-current Trend	1990-current Trend	Ext. Risk QET= 1	Ext. Risk QET= 50
Lower mainstem	1.24	1.14	1.31	1.09	1.25	0.00	0.01

Based on consideration of these metrics, the survival gaps that need to be closed to achieve the survival and recovery criteria, before recent and prospective actions are taken into account, are summarized in Table 2. The only metric suggesting a need for life cycle improvement is the 20-year R/S estimate where a 22 percent increase in survival would bring it in line with a survival and trending toward recovery criterion of 1.0.

Table 2. Base status gaps.

** Note: Gaps are expressed as multipliers. For example, a 1.10 gap indicates a 10 percent improvement is necessary to close gap. If gap is ≤ 1.0, no further improvement is necessary to close gap.*

Population	10-year R/S Gap	20-year λ Gap	Long-term Trend Gap	Ext. Risk Gap QET = 1	Ext. Risk Gap QET = 50
Lower mainstem	0.81	0.56	0.37	0.00	0.00

Spatial Structure and Biological Diversity

Conserving and rebuilding sustainable salmonid populations involves more than meeting abundance and productivity criteria. Accordingly, NOAA Fisheries has developed a conceptual framework defining a Viable Salmonid Population, or VSP (McElhany et al. 2000). In this framework there is an explicit consideration of four key population characteristic or parameters for evaluating population viability status: abundance, productivity (or population growth rate), biological diversity, and population spatial structure. The reason that certain other parameters, such as habitat characteristics and ecological interactions, were not included among the key parameters is that their effects on populations are implicitly expressed in the four key parameters. Based on the current understanding of population attributes that lead to sustainability, the VSP construct is central to the goal of ESA recovery, and warrants consideration in a jeopardy determination. However, it must also be stressed that the ability to significantly improve either a species' biological diversity or its spatial structure and distribution is limited within the timeframe of the Action Agencies' proposed action.

Spatial Structure -- Spatial structure, as the term suggests, refers to the geographic distribution of individuals in a population unit and the processes that generate that distribution. Distributed populations that interact genetically are often referred to as metapopulation. Although the spatial distribution of a population, and thus its metapopulation structure, is influenced by many factors, none are perhaps as important as the quantity, quality, and distribution of habitat. One way to think about the importance or value of a broad geospatial distribution is that a population is less likely to go extinct from a localized catastrophic event or localized environmental perturbations.

Biological Diversity -- Biological diversity within and among populations of salmonids is generally considered important for three reasons. First, diversity of life histories patterns is associated with a use of a wider array of habitats. Second, diversity protects a species against short-term spatial and temporal changes in the environment. And third, genetic diversity is the so-called raw material for adapting to long-term environmental change. The latter two are often described as nature's way of hedging its bets – a mechanism for dealing with the inevitable fluctuations in environmental conditions – long and short-term. With respect to diversity, more is better from an extinction-risk perspective.

The Snake River fall Chinook ESU consists of a single MPG and a single population that the ICTRT has designated as at high risk for spatial structure and diversity (SSD). The loss of access to some 70 plus percent of its historic habitat after construction of the Hells Canyon Complex, and the current existence of a single population are the primary factors for this high risk status. However, the increasing abundance and productivity of this ESU are positive factors that help offset this risk. An additional contributor to reducing this risk, and in particular the risk to the biological diversity and uniqueness of this ESU, has been the systematic efforts of fishery managers to minimize the introduction of outside hatchery strays. These efforts have included the removal of marked hatchery fish at the Lower Granite Dam adult trap, and modifications to the Umatilla program to increase homing fidelity to the Umatilla River. The results of these changes have been biologically significant. Prior to 1998/1999 NMFS status reviews, the 5-year average contribution of outside stocks to the escapement over Lower Granite Dam exceeded 26 percent. More recently, the 1997-2011 5-year average was reduced to 12 percent, with the 2001 proportion just over 8 percent.

BIOLOGICAL ANALYSIS OF ACTIONS: RECRUITS-PER-SPAWNER, LAMBDA, AND TRENDS WITH CURRENT AND PROSPECTIVE ADJUSTMENTS

As described in detail in Appendix D, the Base Status is the historical status of the ESU, defined as the status of the population based on the *average* of quantitative survival metrics estimated from a time series of abundance data beginning in about 1980. For the most part, longer term averages (generally 20 years) were used where they were available. In the biological analysis, this is the starting point, shown in the tables above.

The next step is Current Status, an adjustment of the initial base estimates to reflect our best estimate of current survivals, as opposed to an average of survivals that prevailed over a period in the past. This would obviously include recent improvements already implemented but not fully reflected in the Base conditions. Current Status is defined as estimated survival metrics adjusted for recently implemented changes in hydropower configuration and operations, hatchery operations, tributary and estuarine habitat improvements, and reduced avian predation. These are actions that have recently been implemented, but their effects are not reflected in the time series of survival data that for the most part started in 1980.

The final step is Prospective Status, which adjusts Current to Prospective Status based on the estimated effects of future actions. The current-to-prospective adjustment is simply an adjustment of the current survival estimates to reflect survival improvements expected from the hydro, habitat, and hatchery changes included in the proposed action, and in particular those that are expected to be implemented in the period 2007 to 2017.

This analysis assumes that future ocean and climate conditions will approximate the average conditions that prevailed during the 20 year base period used for our status assessments. For most populations, that period is about equivalent to the "recent" ocean period used by the ICTRT in its analyses. This period was characterized by relatively poor ocean conditions which presumably contributed to poor early ocean survival of salmonids. To illustrate, the ICTRT's "pessimistic" ocean condition scenario results in survivals that are about 15 percent lower for

Snake River spring/summer Chinook salmon than the “recent’ ocean conditions scenario, and about 36 percent lower for Upper Columbia spring Chinook salmon. Alternatively, ICTRT’s “historic” ocean conditions scenario results in survivals that are about 39 percent higher for both Snake River spring/summer and Upper Columbia spring Chinook salmon.[6] This subject is treated at greater length in the discussion of the effects of potential climate change in Appendix X.

The analysis of status assumes a certain amount of annual take of natural adult fish based on recent harvest levels. As requested in the remand collaboration, a sensitivity analysis showing the additional effects of more selective harvests that minimize take of natural adult fish is presented in Appendix X. In general, this “selective harvest” scenario results in survival that is about 8 to18 percent higher than the main analysis, depending on the ESU.

Current Status Analysis

Over this period the action agencies implemented multiple actions to improve fish survival relative to the base period prior to 2000. The percentage changes in life cycle survival used in the base-to-current adjustments for the Lower Mainstem Snake River fall Chinook salmon population are summarized in Table 3. Actions are described in summary below.

Table 3. Estimated survival improvements used in the base-to-current adjustment (5/9/07 spreadsheet).

Population	Hydro	Habitat (tributary)	Habitat (estuary)	Avian predation	Hatchery
Lower mainstem	N/A	N/A	0.7%	2.1%	

Hydropower Survival Improvements

As noted, it is not possible at this time model hydrosystem survival improvements for this ESU due to life history uncertainties. Therefore, estimate lifecycle survival improvements attributable to hydrosystem improvements are not estimated. Additional detail on how these percentages were estimated is described in Appendix D. The configuration and operational and maintenance changes to fish passage facilities and other project areas that contributed to these improvements include:

- Bonneville Powerhouse I minimum-gap turbine runner installations;
- Bonneville Powerhouse II corner collector installation;
- Bonneville II Fish Guidance Efficiency improvements;
- Bonneville spill operation improvements and 5 additional flow deflectors;
- Bonneville I JBS screen removal;
- Bonneville II operation as first priority;
- The Dalles spill wall construction;
- The Dalles spill pattern improvements;
- The Dalles adult collection channel improvements;
- The Dalles sluiceway operation improvements;
- John Day spill operation improvements;
- John Day South Fish Ladder improvements;

[6] Assessing the Impact of Anticipated Hydropower Changes and a Range of Ocean Conditions on the Magnitude of Survival Improvements Needed to Meet TRT Viability Goals
Interior Columbia Technical Recovery Team and R. W. Zabel, June 20, 2006

- McNary spill operation improvements;
- McNary end spillbay deflectors and hoists;
- McNary full flow juvenile PIT tag detection;
- McNary juvenile transport facility bypass piping improvements;
- McNary spare ESBS;
- McNary improved juvenile bypass dewatering screens;
- McNary adult PIT tag detection in fish ladders;
- McNary overhauling AWS pumps;
- McNary upgrading of adult fish ladders tilting weir controls;
- Ice Harbor RSW installation and spill operation improvements;
- Ice Harbor full flow juvenile PIT tag detection;
- Ice Harbor AWS improvements north shore adult fishway;
- Ice Harbor replaced adult fishway entrance weirs;
- Ice Harbor new bulkhead system for maintenance of south shore AWS pumps;
- Ice Harbor upgraded AWS hydraulic systems;
- Lower Monumental end spillbay deflectors, parapet walls, and stilling basin repair;
- Lower Monumental spill operations improvements;
- Lower Monumental juvenile fish separator improvement;
- Lower Monumental fish barge loading improvements;
- Lower Monumental rehabbed adult fish pumps;
- Lower Monumental replaced north shore adult fish counting station;
- Little Goose spill operations improvements;
- Little Goose ESBS improvements;
- Lower Granite RSW installation;
- Lower Granite ESBS improvements;
- Lower Granite modifications to adult transition pool to improve adult passage;
- Snake River projects summer spill program;
- Improved total dissolved gas monitoring program and equipment; and
- Extended barging season for fish under the juvenile fish transportation program.

Tributary Habitat Survival Improvements

Snake River fall Chinook are spawn in the mainstem and would not directly benefit from tributary habitat improvements.

Estuary Habitat Survival Improvements

The estimated survival benefit for Snake River fall Chinook (ocean-type life history) associated with the specific actions discussed above is .744 percent. Action Agencies implemented habitat actions through 21 estuary habitat projects. Unrestricted fish passage and approximately 3 miles of access to quality habitat was provided these specific actions[7]:

- Replaced 3 culverts with full-spanning bridges;
- Provided approximately 10 miles of improved tidal channel connectivity by installing a tide gate retrofit;
- Acquired approximately 473 acres of off-channel and riparian habitats;
- Restored and created 90 acres of marsh and tidal sloughs and approximately 100 acres of riparian forests
- Protected approximately 55 acres of high-quality riparian and floodplain habitat
- Restored and preserved approximately 154 acres of off-channel habitat;

[7] A more thorough report detailing this evaluation process is: Estimated Benefits for Federal Habitat Projects in the Columbia River Estuary for NWF v NMFS Remand - Sovereign Collaboration Process.

- Protected 80 acres of high-value off-channel forested wetland habitat;
- Restored approximately 96 acres of tidal wetlands habitat by replacing undersized culvert that limited fish access;
- Conserved 155 acres of forested riparian and upland habitat;
- Provided partial tidal channel reconnection by tide gate retrofit (acreage unknown at this time);
- Provided integrated pest management (purple loosestrife);
- Reconnected and restored 183 acres of historic floodplain by dike removal;
- Restored 25 acres of historic floodplain by breaching a dike;
- Provided fish passage access to 6 miles of stream habitat by removal of two culverts and replacement with bridges;
- Restored 310 acres of native hardwood riparian forest, 200 acres of seasonally wet slough and 155 acres of degraded riparian habitats; increased circulation in approximately 92 acres of backwater and side-channel habitat by tide gate retrofit;
- Improved embayment circulation for 335 plus acres of marsh/swamp and shallow-water and flats habitat; and
- Preserved 35 acres of historic wetland habitat.

Predator Control Survival Improvements

Avian predation. The estimated survival increase for Snake River fall Chinook from the baseline to current condition is 2.1 percent. This estimate errors strongly on the conservative side because averaging tern consumption of juvenile salmonids across the 20-year base period downplays the actual change in survival that resulted from relocating terns from Rice Island to East Sand Island in 1999. In 1999 tern consumption of juvenile salmonids was at its peak with an estimated 13,790,000 smolts consumed, compared to 8,210,000 in 2000 after relocation.

Piscivorous predation. The ongoing Northern Pikeminnow Management Program (NPMP) has been responsible for reducing predation related juvenile salmonid mortality since 1990. The improvement in life cycle survival attributed to the NPMP is estimated at 2 percent for migrating juvenile salmonids (Friesen and Ward 1999). The northern pikeminnow has been responsible for approximately 8 percent predation-related mortality of juvenile salmonid migrants in the Columbia River basin in the absence of the NPMP (2000 FCRPS BiOp at 9-106). The ongoing NPMP is already accounted for in the estimation of survival improvements modeled within the reservoir mortality life stage. This is because the modeling estimates are calibrated to empirical reach survival estimates that included the ongoing program.

Hatchery Management Survival Improvements

Straying of out-of-basin hatchery fall Chinook into the Snake River has been a problem for several decades. In 1989, for example, an estimated 40 percent of the adults used for broodstock at Lyons Ferry Hatchery were out-of-basin hatchery strays. In the last decade, however, returns of Snake River-origin fall Chinook salmon have increased disproportionately to outside hatchery strays. Prior to the 1998-1999 NOAA status reviews, the 5-year average contribution of outside stocks to the escapement over Lower Granite Dam exceeded 26.2 percent. The most recent 5-year average (1977-2001) was 12.4 percent, with the contribution in 2001 being just over 8 percent. The drop in relative contribution by outside stocks reflects the disproportionate increase in returns of the Lyons Ferry Hatchery component, the systematic removal of marked hatchery fish at the Lower Granite Dam trap, and modifications to the Umatilla program to increase homing of fall-run Chinook salmon release groups intended to return to the Umatilla River (NOAA Updated Status Review 2005). The Lower Granite Dam adult trap improvements completed in 2007 will enable trapping of more natural-origin broodstock to improve broodstock management in the Lyons Ferry and Nez Perce Tribal Hatchery fall Chinook programs. The improved trap will also facilitate the trapping and removal of more non-ESU hatchery strays, preventing them from passing above Lower Granite Dam and possibly breeding with ESU fish.

2000 to 2006. BPA funded the development of Hatchery Genetic Management Plans (HGMPs) for all federally funded hatchery programs in this ESU. No survival improvements from this planning processes is estimated for the 2000 to 2006 time period, though low benefits are expected as NOAA Fisheries uses the HGMPs in their hatchery program ESA Section 7 consultations. Other BPA funded hatchery actions implemented with benefits for this ESU in 2000 to 2006 include:

- Three fall Chinook acclimation programs and the fall Chinook production program at Nez Perce Tribal Hatchery increase fish spawning naturally and improve spatial structure; These programs are important to sustaining and preventing extirpation of the ESU and provide high benefits for abundance, productivity, and genetic diversity; and
- Installation, operation, and maintenance of the Lower Granite Dam adult salmon and steelhead trap improvements with benefits accruing for this ESU beginning in 2007.

Current Status Gaps

Over this period the action agencies implemented multiple actions to improve fish survival relative to the base period prior to 2000. The percentage improvements in life cycle survival used in the base-to-current adjustments for fall Chinook are summarized in Table 4.

Table 4. — Current status: Adjusted gaps after base-to-current adjustment.

** Note: Gaps are expressed as multipliers. For example, a 1.10 gap indicates a 10 percent improvement is necessary to close gap. If gap is ≤ 1.0, no further improvement is necessary to close gap.*

Population	Adjusted 10 year R/S Gap	Adjusted 20 year λ Gap	Adjusted Long-term Trend Gap	Adjusted Ext. Risk Gap QET = 1	Adjusted Ext. Risk Gap QET = 50
Lower mainstem	0.78	0.54	0.36	0.00	0.00

Prospective Status Analysis

As noted above the prospective status is the projected status of the population based on adjustment of the survival metrics for expected improvements associated with the proposed actions. As was the case for the base-to-current adjustment, the improvements for the current-to-prospective are divided into the categories of those expected from changes in hydropower operations and configuration, changes in tributary habitat conditions attributable to actions implemented in the periods 2007 to 2009 and 2010 to 2017, changes in estuarine habitat, reduced impacts of avian predation, and improved hatchery operations.

Hydro benefits were not calculated for the current or prospective survival analysis for fall Chinook. The current COMPASS model is not yet capable for estimating survival due to the complex life histories exhibited by fall Chinook. However, significant configuration and operation actions have occurred in recent years and are projected to continue into the future. The key unknown is the effect of recent actions to leave more fish in-river (RSW and spill) compared to past operations that primarily relied on transport. This is a key uncertainty being addressed in RM&E.

The prospective status is projected based expected survival improvements associated with actions in 2007 to 2017. Over this period the action agencies will implement multiple actions to improve fish survival relative to the current period. The percentage changes in life cycle survival used in current-to-prospective adjustments are summarized in Tables 5. Actions are summarized below.

Table 5. Estimated improvements in survival used in the current-to-prospective adjustment.

Population	Hydro	2007-17 Habitat	Habitat (estuary)	Avian predation	Pikeminnow predation	Hatchery
Lower mainstem	N/A	N/A	9%	0.7%	1.0%	

Note: FCRPS impacts are based on river flows that enter the FCRPS action area, including those that enter the Snake River at the toe of Hells Canyon Dam, which are affected by the operation of Reclamation's upper Snake Projects.

Hydropower Survival Improvements

The Action Agencies have formulated a broad array of hydropower actions to further increase the survival of this ESU during migration through the hydrosystem. Specific survival benefits for each action were derived using best professional judgment and are based on a per project basis. However, due to the life history complexity, it is not possible to generate COMPASS survival estimates at this time. The configuration and operational improvement actions that contribute to these survival increases are organized into strategies. Specific actions contained within these strategies are listed in the Hydrosystem Proposed Action Summary. These strategies include:

1. Operate the FCRPS to more closely approximate the shape of the natural hydrograph and to improve juvenile and adult fish survival;
2. Modify Columbia and Snake River dams to facilitate safe passage;
3. Implement operational improvements at Columbia and Snake River dams;
4. Operate and maintain juvenile and adult fish passage facilities; and
5. Continue to evaluate the best passage management strategy for fall Chinook (i.e. transport vs. in-river).

Tributary Habitat Survival Improvements

The Action Agencies are not proposing tributary habitat improvements for Snake River fall Chinook.

Estuary Tributary Habitat Survival Improvements

2007 to 2009. The estimated survival benefit for Snake River Fall Chinook (ocean-type life history) associated with the specific actions described below is 1.874. The Action Agencies' estimated benefit for 2007 is based on actions that are or will be underway in the very near-term. For 2008 and 2009 the action agencies estimated benefit is based on continuing at the same level of effort as 2007[8]. Action agencies are or will be implementing multiple habitat actions through approximately 29 estuary habitat projects. Specific estuary habitat actions:

[8] A more thorough report detailing this evaluation process is: *Estimated Benefits of Federal Habitat Projects in the Columbia River Estuary for the NWF v NMFS Remand – Sovereign Collaboration Process.*

- Restore partial tidal influence and access to several acres (exact amount unknown at this time) by a tide gate retrofit; improve hydrologic flushing and salmonid access to a lake (Sturgeon Lake is approximately 3,200 acres);
- Acquire and protect 40 acres of critical floodplain habitat and 40 acres riparian forest restoration;
- Install 6 to 8 engineered log-jams that will help to slow flood flows, reduce erosion, contribute to sediment storage, enhance fish habitat and contribute wood into the project area; acquire and restore floodplain connectivity to 380 acres of off-channel rearing habitat for juveniles;
- Install fish friendly tide gates to increase tidal flushing and fisheries access to approximately 110 acres; riparian planting of up to 210 acres;
- Re-establish hydrologic connectivity to reclaim and improve floodplain wetland functions, increase off-channel rearing and refuge habitat on five acres, plant native vegetation along shoreline and reconstruct slough channels on 2.5 acres of annually inundated off-channel habitat;
- As part of a long-term 1,500 acres restoration effort: breaching a dike and re-establishing flow to portion of original channel, planting vegetation on 50 acres, removing invasive weeds on 180 acres, planting wetland scrub shrub on 45 acres, and controlling and removing invasive wetland plants on 45 acres;
- Retrofit a tide gate (acreage unknown at this time); protect and restore approximately 5 to 10 acres of emergent wetland and riparian forest habitats
- Reconnect 45 acres of floodplain by tide gate removal;
- Acquire 45 acres of floodplain with future dike removal;
- Reconnect 50 acres of floodplain;
- Acquire 320 acres of tidelands and 119 acres of riparian/upland forest; and
- Restore 30 acres of riparian habitat.

There are be approximately 15 additional projects and associated actions similar to actions listed above that are undergoing scoping and sponsor development (the number of projects and associated actions is based on the same level of effort as 2007).

2010 to 2017. The survival benefit for Snake River Fall Chinook (ocean-type life history) associated with these actions is 4.99 percent. The action agencies estimated benefits for 2010 to 2017 are based on continuing the same level of effort as 2007 to 2009. However the level of effort in this time period may increase depending on the outcome of a General Investigation study of Ecosystem Restoration opportunities, depending on Congressional appropriations, future funding scenarios and results of actions. Specific projects have yet to be identified, but actions for this period will be similar in nature to actions implemented in previous periods discussed above. Actions will include protection and restoration of riparian areas, protection of remaining high quality off-channel habitat, breaching or lowering dikes and levees to improve access to off-channel habitat, and reduction of noxious weeds, among others.

Predator Control Survival Improvements

Avian predation. The estimated increase in Snake River fall Chinook salmon survival from the current to future condition is 0.7 percent, and this benefit is carried out to 2017 and beyond. This improvement is expected to result through the reduction in estuary tern nesting habitat, and subsequent relocation of terns to outside the Columbia basin.

Piscivorous predation. The percentage improvement in life cycle survival attributable to the proposed continuation of the increase in incentives in the Northern Pikeminnow Management Program and resultant marginal increase in observed exploitation rate is estimated at 1 percent total from 2007 to 2017. This estimate was derived based on the difference between the estimated benefits from the base NPMP (defined as the period 1990 to 2003) and estimated survival benefits under the increased incentive program (defined as the period of 2004 to present). This rate would generally apply to all juvenile salmonids.

Hatchery Management Survival Improvements

2007 to 2017. The Action Agencies will:

- Continue to fund the three fall Chinook acclimation programs and the fall Chinook production program at Nez Perce Tribal Hatchery to increase fish spawning naturally and improve spatial structure. These programs are important to sustain and prevent extirpation of the ESU and provide high benefits for abundance, productivity, and genetic diversity;
- Continue to fund the operation and maintenance of the Lower Granite Dam adult salmon and steelhead trapping facility; and
- Further expand the Lower Granite Dam adult salmon and steelhead trapping facility to enable collection of more natural-origin broodstock, trapping and removal or more out-of-basin stray fall Chinook, and improve run reconstruction and research data collection. These actions will provide low to medium benefits for abundance, productivity, and genetic diversity of the ESU.

Prospective Status

Comprehensive analyses of the changes in life cycle survival resulting from the proposed FCRPS actions and analysis of how they will change the survival metrics indicate that the Snake River Fall Chinook ESU will survive in the near-term. Based on the estimated remaining gaps summarized in Table 6, the single population comprising the Snake River Fall Chinook requires no additional improvements in life cycle survival to achieve the survival and trending toward recovery criteria. Based on the productivity metrics used in this analysis, the population is growing and will likely continue to do until it remaining habitat is fully seeded.

Table 6. Prospective status: Adjusted future productivity trends after current-to-prospective analysis.

**Note: Future productivity values represent estimates of future R/S, lambda and trend after consideration of the effects of the proposed action. For R/S, lambda and trend a value >1.0 indicates a growing population. A risk gap of 0.00 indicates a <5% risk criterion has been exceeded.*

Population	Prospective 10 year R/S	Prospective 20 year λ	Prospective Long-term Trend	Prospective Risk Gap QET = 1	Prospective Risk Gap QET = 50
Lower mainstem	1.41	1.17	1.29	0.00	0.00

Biological Diversity and Spatial Distribution

The loss of access to some 70 plus percent of its historic habitat after construction of the Hells Canyon Complex, and the current existence of a single population, are both factors that contribute to a high risk of extinction for the Snake River fall Chinook ESU. However, the increasing abundance and productivity of this ESU are positive factors that help offset this risk. An additional contributor to reducing this risk, and particular the risk to the biological diversity and uniqueness of this ESU, has been the systematic efforts of fishery managers to minimize the introduction of outside hatchery strays. These efforts have included the removal of marked hatchery fish at the Lower Granite Dam adult trap, and modifications to the Umatilla program to increase homing fidelity to the Umatilla River. The results of changes have been biologically significant. Prior to 1998/1999 NMFS status reviews, the 5-year average contribution of outside stocks to the escapement over Lower Granite Dam exceeded 26 percent. More recently, the 1997 to 2011 5-year average was reduced to 12 percent, with the 2001 proportion just over 8 percent.

With regard to the high risk associated with limited spatial distribution, there is little that can be done for the Snake River fall Chinook ESU short of re-establishing juvenile and adult fish passage at the Hells Canyon Complex, and making major changes in water management above these dams. Both of these actions are outside the authority and responsibility of the FCRPS.

Remand Conceptual Framework Analysis

The FCRPS BiOp remand's collaboration among the sovereigns developed a Conceptual Framework approach intended to help the Action Agencies develop their proposed action. The Framework approach attempted to estimate the relative magnitude of mortality factors affecting Interior Columbia basin salmonid populations. That assessment was intended to define the FCRPS' "relative expectation…for recovery."[9] The collaboration's Framework working group developed high and low mortality estimates for all sources of mortality, including the FCRPS. The collaboration's Policy Working Group has not determined where in that range the Action Agencies' proposed action should be assessed. The range of "gaps" that the Framework approach would expect the FCRPS to fill was reviewed and the Action Agencies assessed whether the total survival improvements estimated in this biological analysis would "fill" those gaps. For the purposes of this comparison, the ICTRT gaps were used for "recent" ocean and "base hydro" conditions (corresponding to the base period used for R/S productivity estimation), and the ICTRT's 5 percent risk level.

The ICTRT gap for the 1990 to1999 period was used to correspond to the 10 year geomeans R/S productivity estimate. The Conceptual Framework was intended, among other things, to "provide a clear and complementary link to ongoing recovery planning efforts."[10] As such, it can be understood to represent the collaboration parties' view of the appropriate contribution of the FCRPS toward long term recovery of the listed ESUs in the Interior Columbia River basin. Therefore it provides another "metric" for use in considering the impacts of the proposed action on a listed species' prospects for recovery. The results of that analysis are displayed in Table 8.

Table 8. Gap Calculations from the Conceptual Framework.
Note: ICTRT gaps are expressed as multipliers. Gaps are for 5 percent risk, recent ocean/base hydro conditions. A "remaining" gap value <1.0 indicates no further improvement is necessary. Total survival changes combine all estimated survival improvements for the base-to-current and current-to-prospective adjustment.

MPG	TRT Gap	FCRPS Relative Impact (high)	FCRPS Relative Impact (low)	TRT Gap (high hydro)	TRT Gap (low hydro)	Total Survival Change	Remaining Framework Gap (high)	Remaining Framework Gap (low)
Lower Mainstem (1977-1999)	1.47	0.57	0.35	1.25	1.14	1.13	1.10	1.01
Lower Mainstem (1990-1999)	1.38	0.57	0.35	1.20	1.12	1.13	1.06	0.99

[9] 2006 FCRPS BiOp: Conceptual Framework for the Remand Process. First Quarterly Status Report, Documents filed with the court, 01/03/06.
[10] 2006 FCRPS BiOp: Conceptual Framework for the Remand Process. First Quarterly Status Report, Documents filed with the court, 01/03/06.

The proposed action (without considering either improvement in the environmental baseline or other actions reasonably certain to occur) leaves a 1 percent gap at the low end of the Framework range and a 10 percent gap at the high end. However, considering a reasonable qualitative assessment of likely hydrosystem survival improvements, it seems reasonable to suppose that Framework gaps would be filled at the high and low ends of the range.

ADDITIONAL ACTIONS TO BENEFIT THE ESU

Other Reasonably Certain to Occur Actions[11]

This analysis does not yet include analysis of non-federal actions that are reasonable certain to occur, developed as part of the remand collaboration.

Other Federal Actions that have completed ESA Consultation

The Action Agencies' review of federal actions that have completed section 7 consultations is not yet complete. The results of the review will be included in the environmental baseline of the Biological Analysis.

OBSERVATIONS

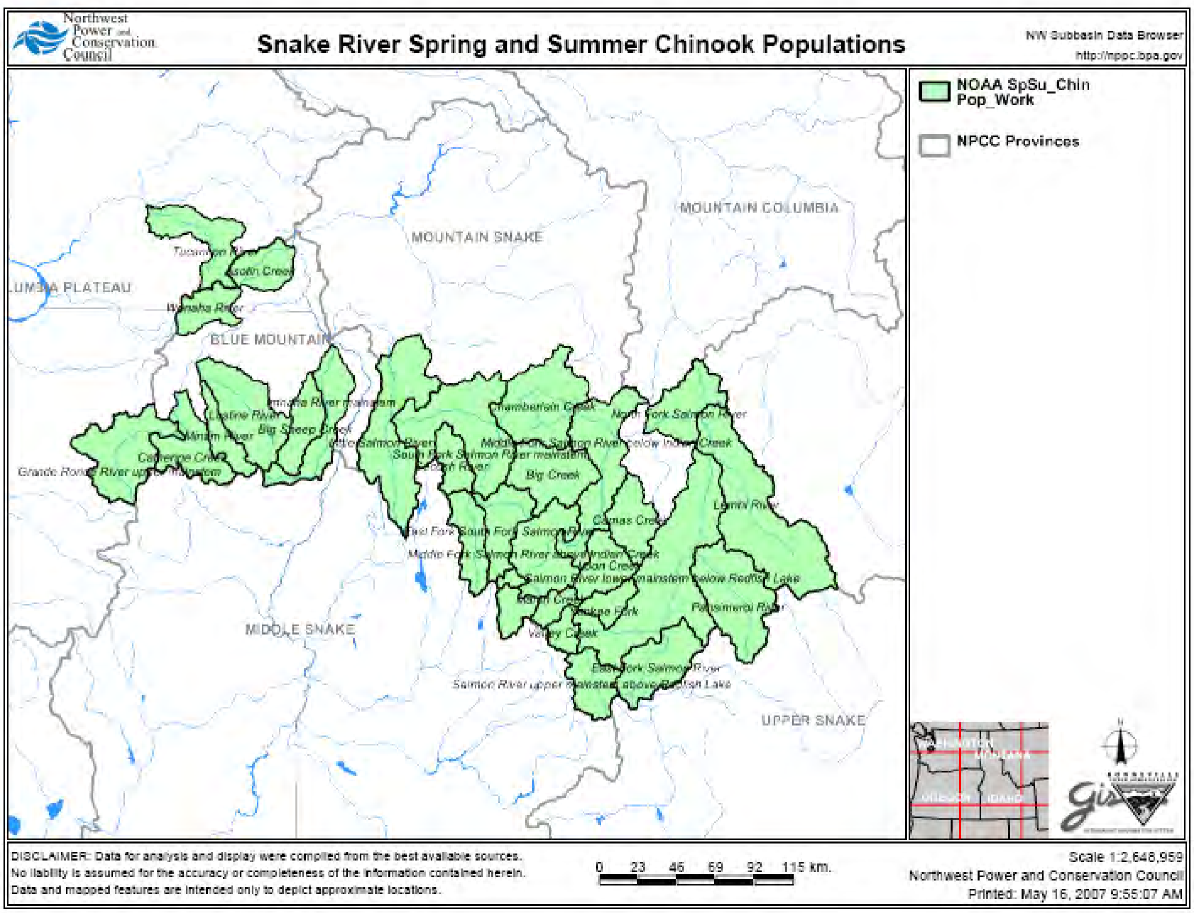
After considering recently implemented actions and the likely effects of the proposed action, all three metrics of productivity (recruit-per-spawner, λ, and long-term trends) are expected to be greater than 1.0, indicating that this population will replace itself and grow. Moreover, extinction risk for this population is negligible.

[11] Many of the actions listed above have a cost-share component with a variety of other federal funding sources and therefore may be properly described as contributing to the status of the environmental baseline rather than cumulative effects. The action agencies will sort the projects described in this paper into the appropriate parts of the biological analysis, but for the purposes of discussion at the April 11, 2007 PWG workshop, believe that the effect on prospective status will be the same.

This is not a final federal agency product. Rather, it is a pre-decisional document prepared by the Action Agencies that reflects present understandings of currently available information and analyses, and of the progression of discussions with the sovereigns in the collaborative process. Revisions and refinements are to be expected based on further discussions with the sovereigns over new and modified proposed federal actions upon which the action agencies will ultimately consult. Finally, the information in this product does not constitute an analysis of whether the identified measures would or would not jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Furthermore, this document does not in any way interpret or apply the regulatory definitions of the statutory phrases "jeopardize the continued existence of" and "destruction or adverse modification."

Snake River Spring and Summer Chinook Salmon ESU

Please note that all of the information in this paper is still preliminary. In particular, benefits assessments are still under review. For certain populations additional actions are being considered that might be implemented by the Action Agencies or by others.



ESU Description	
Threatened	Listed under ESA in 1992; reaffirmed 2005
5 current major population groups	28 current populations (1 to 9 populations per MPG)
Hatchery programs included in ESU	Conventional and captive broodstock programs: Tucannon, Lostine River, Catherine Creek, Upper Grande Ronde, Lookingglass, Imnaha River, Big Sheep Creek, South Fork Salmon River, Johnson Creek, Lemhi , East Fork Salmon River,

	West Fork Yankee Fork, Sawtooth, McCall, and Pahsimeroi

Major Population Groups	Populations
Grande Ronde/Imnaha	Catherine Creek Grande Ronde River upper mainstem Imnaha River mainstem Lostine River/Wallowa River Minam River Wenaha River
Lower Snake	Tucannon River
Middle Fork Salmon River	Bear Valley Creek Big Creek Camas Creek Chamberlain Creek Loon Creek Marsh Creek Middle Fork Salmon River above Indian Creek Middle Fork Salmon River below Indian Creek Sulphur Creek
South Fork Salmon River	East Fork South Fork Salmon River Little Salmon River Secesh River South Fork Salmon River mainstem
Upper Salmon River	East Fork Salmon River Lemhi River North Fork Salmon River Pahsimeroi River Salmon River lower mainstem below Redfish Lake Salmon River upper mainstem above Redfish Lake Valley Creek Yankee Fork

INTRODUCTION

This paper briefly summarizes the current biological analysis developed for this Evolutionarily Significant Unit (ESU). First, it provides an overview of the ESU and the factors limiting its viability, summarizes population-level status information during the 20 year base period used for this analysis, and provides estimates of the "gaps," or needed lifecycle survival improvements, for individual populations to meet certain biological criteria. It summarizes the improvements made to the hydrosystem and in other Hs since about 2000 and estimates the salmonid survival benefits associated with those improvements. Finally, it describes the actions proposed to be implemented into the future and estimates their effects on salmonid survival when aggregated with the environmental baseline and cumulative effects.

Almost all of the metrics used in this analysis are estimates for individual populations within the ESU. The Endangered Species Act is concerned with the status of a species, DPS, or ESU. Individual populations and major population groups (where they exist) obviously contribute to ESU status. However, the status of the ESU is not wholly dependent upon the status of any of the ESU's individual components.

The Snake River spring and summer Chinook salmon ESU is composed of multiple populations that spawn and rear in the tributaries of the Snake River between the confluence of the Snake and Columbia rivers and the Hells Canyon Dam. The Interior Columbia Technical Recovery Team (ICTRT) has identified 28 existing populations and four functionally extirpated populations for this ESU. These populations are organized into five major population groups: Lower Snake, Grande Ronde/Imnaha, South Fork Salmon River, Middle Fork Salmon River, and Upper Salmon. They are all considered stream-type, typically migrating to the ocean as yearlings after a year in fresh water, returning to freshwater during spring and summer after 2 or 3 years in the ocean, and spawning in late summer. Spawning areas are the mid to upper reaches of most accessible tributaries. The ESU includes current returns to the Tucannon River, the Grande Ronde River system, the Imnaha River, and the Salmon River. The Interior Columbia Technical Recovery Team (ICTRT) has defined a hierarchical population structure for this ESU composed of 32 demographically independent populations, four of which are considered functionally extirpated. These populations are organized into five major population groups: Lower Snake, Grande Ronde/Imnaha, South Fork Salmon River, Middle Fork Salmon River, and Upper Salmon. This ESU was listed as threatened on April 22, 1992 and reaffirmed as threatened on June 28, 2005.

The total annual production of natural spring and summer Chinook from the Snake River was likely in excess of 1.5 million fish during the late 1800s. The Salmon River alone produced up to 45 percent of all Columbia River spring and summer Chinook. Since then, Snake River spring and summer Chinook have suffered dramatic declines as a result of intensive commercial harvest, loss of habitat, and/or degradation of habitat caused by logging, grazing, mining, irrigation diversions, and early barrier dams. The declines continued with the construction of the hydropower system on the Snake and Columbia Rivers, including four Federal dams on the Snake River and the Idaho Power Company's three-dam Hells Canyon Complex, which was constructed without fish passage.

Another major impact on salmon numbers and productivity occurred during the mid-1970s. A "cool" Pacific Decadal Oscillation (PDO) regime in the North Pacific Ocean shifted to a warm regime that lasted at least through the mid-1990s. A cool regime is strongly correlated with enhanced ocean productivity off the West Coast of the U.S. (and improved Columbia basin salmon survival); a warm PDO regime is correlated with poor ocean productivity off the West Coast of the U.S. (and poor Columbia basin salmon survival). The combination of harvest rates during the 1960s and early 1970s that exceeded 60 percent of the total run in some years, the construction of major federal and private hydropower projects in the Snake River basin during the 1950s and into the early 1970s, and the regime shift in the Pacific Ocean in the mid-1970s contributed to a steep decline in numbers of salmon returning to the Snake River basin to spawn. Since hitting a trough in the early 1990s, Snake River spring and summer Chinook salmon numbers have increased significantly (see Figure 1).

Spring and summer-run Chinook salmon are produced at a number of artificial production facilities in the Snake River basin. Much of the production was begun under the Lower Snake River Compensation Plan. Historically, a number of hatchery programs used broodstock originating from outside the Snake River basin. Broodstock from the Carson National Fish Hatchery were used to supplement populations in Catherine Creek and the Grande Ronde River during the 1980s and into the 1990s. This practice was phased out in the 1990s due to concerns about high stray rates and the negative effects non-native, domesticated broodstock could have on wild populations. Concerns were raised in the 1998 status review (Myers et al. 1998) regarding the use of Rapid River hatchery stock reared at the Lookingglass hatchery in the Grande Ronde River basin. The Rapid River hatchery stock was originally developed from broodstock collected from spring-run Chinook returns to historical production areas above the Hells Canyon Dam complex. Use of Rapid River stock was similarly phased out in the late 1990s.

In-river harvest of Snake River spring and summer Chinook salmon is managed under the Columbia River Fishery Compact on a sliding scale of 5.5 to 17 percent. The average 2000-2004 harvest averaged 10.7 percent. Harvest occurs both in a commercial and recreational fishery in the lower Columbia River, and in a tribal fishery in Zone 6. Based on the rare observation of tagged fish in mixed stock ocean fisheries it is generally believed that ocean harvest contributes little to harvest mortality. The ICTRT considers all extant populations in this ESU to be at high risk for abundance and productivity and from low to high risk for spatial structure and genetic diversity.

Human impacts and current limiting factors for this ESU come from multiple sources: hydro passage, habitat degradation, hatchery effects, fishery management and harvest decisions predation, and other sources.

Key Limiting Factors

Salmon and steelhead have been adversely affected over the last century by many activities including human population growth, introduction of exotic species, over fishing, developments of cities and other land uses in the floodplains, water diversions for all purposes, dams, mining, farming, ranching, logging, hatchery production, predation, ocean conditions, loss of habitat and other causes (Lackey et al.2006)[1]. Summarized below are current key limiting factors for this ESU identified by NOAA in the ESU Overviews for the remand collaboration[2].

Hydro	The direct in-river survival rate for smolts passing through the FCRPS is currently about 50 percent. According to the Step 4 report, the estimated portion of the human impact attributable to the FCRPS dams (compared to natural river estimates) is 74 to 95 percent. Several hypotheses attributing additional or latent mortality to hydrosystem passage have been formulated and are currently under independent scientific review. Latent mortality is defined as any mortality expressed in a life stage subsequent to where a direct effect occurs (e.g., stress due to poor rearing habitat results in additional mortality during downstream migration). If latent mortality is omitted, the range associated with the hydro system is 38 to 43 percent. Hydro impacts include volume, timing and quality of flows that enter the FCRPS action area, including flows from the Snake River at the toe of Hells Canyon Dam, which are impacted by the operation of Reclamation's upper Snake River projects and the mainstem effects of Reclamation's other projects within the Columbia Basin.
Predation	Predation has been noted as a factor limiting fish survival at mainstem hydro facilities and in the Columbia estuary.
Harvest	Current harvest rates (almost exclusively in mainstem Columbia River fisheries) average about 8 percent, though harvest rates since the adoption of a new management regime in 2001 have been higher, average in about 11

[1] Lackey, Robert T, Denise H. Lach, and Sally L Duncan. Wild salmon in Lackey, Robert T, Denise H. Lach, and Sally L Duncan. Wild salmon in western north america: the historical and policy perspective. Pp 13-55. In: Salmon 2100: The future of wild pacific salmon. 2006. Robert T Lackey, Denise H. Lach, and Sally L. Duncan (editors).
[2] Master - Summary of Key ESU Info Int Columbia - table 24oct06, p. 7, (Limiting factors summarized and ranked by Paula Burgess, NOAA Fisheries, utilizing information found in working draft of ESU Overviews, 2005 Pacific Coastal Salmon Recovery Fund Report to Congress and local recovery plans.)

	percent. The current 3 year in-river harvest agreement allows for harvest between 5.5 percent and 17 percent, depending upon run strength. According to the Step 4 report, the estimated portion of the human impact attributable to combined Tribal and non-Tribal harvest effects is 37 to 69 percent. If latent mortality is omitted, the range associated with the combined harvest impacts is 14 to 15 percent.
Estuary	Predation, levels of toxic substances, and habitat conditions in the plume are potential limiting factors.
Hatcheries	Eleven spring and summer Chinook salmon hatchery programs operate within the ESU: 10 of these currently operate with appropriate conservation practices and are not considered a major limiting factor for naturally-spawning spring and summer Chinook salmon; Rapid River Hatchery is operated as an isolated program that may not have a large affect natural populations. The recovery goal contemplates a transition from hatchery to natural production as natural fish recover. According to the Step 4 report, the estimated portion of the human impact attributable to hatchery effects is 6 to 11 percent. If latent mortality is omitted, the human impact associated with the hatchery system is 1 percent.
Habitat	Eleven of the Snake River spring and summer Chinook salmon natural populations spawn in wilderness, where habitat is in good to excellent condition, but their survival and productivity are still very low. For others, habitat is degraded in the lower tributaries, where the fish – both juveniles and adults – need cold, clean water, in varying amounts and flow rates at different life stages. Reduced vegetation on the hills and in the riparian corridor, combined with summer temperatures, increases water temperature. In addition to current limiting factors and threats, we need to consider the threat of additional loss of habitat resulting from future development, and the adequacy of regulatory mechanisms to address these threats. According to the Step 4 report, the estimated portion of the human impact attributable to combined habitat effects in the tributaries and the estuary is 33 to 62 percent. If latent mortality is omitted, the human impact associated with habitat degradation is 15 to 16 percent.

BASE STATUS

This section summarizes the average status of this ESU during the base period, which for most populations is a 20 year period beginning in brood year 1979, 1980 or 1981, depending on the population. All of the analysis in this paper relies on datasets supplied by the Interior Columbia Technical Recovery Team. Those datasets do not include adult return information for the last one to three years, depending on the population.

ESU Abundance and Trends

Geometric mean abundance since the late 1990s has substantially increased for the ESU as a whole. Geomean abundance of natural-origin fish for the 2001 to 2005 period was 25,957 compared to 4,840 for the 1996-2000 period, a 436 percent improvement (all abundance trend information from Fisher and Hinrichsen, 2006). The interim recovery abundance level identified by NOAA for the ESU as a whole is 41,900.[3] The sum of the ICTRT's minimum abundance thresholds for all populations in this ESU is 26,500[4].

The ESU-level abundance trend of natural-origin spawners for 1990-2005 indicates an increasing population over that time. (The slope of the trend line for the ESU as a whole is 1.10 for this period.) Even the 1980-2005 ESU-level trend indicates positive growth (trend line slope of 1.02 for the entire ESU). All populations in the ESU show increasing or steady population growth trends in the 1990-recent period though many populations show declines when the longer 1980-recent period is analyzed.

Adult return numbers have recently declined from their peaks in 2001 and the years immediately following. However, this analysis focuses on longer term trends consistent with the principle that a longer time series provides better estimates.

Abundance and a rolling 5-year geometric mean of abundance for the ESU compared to the NOAA Fisheries ESU interim recovery target are shown in Figure 1.

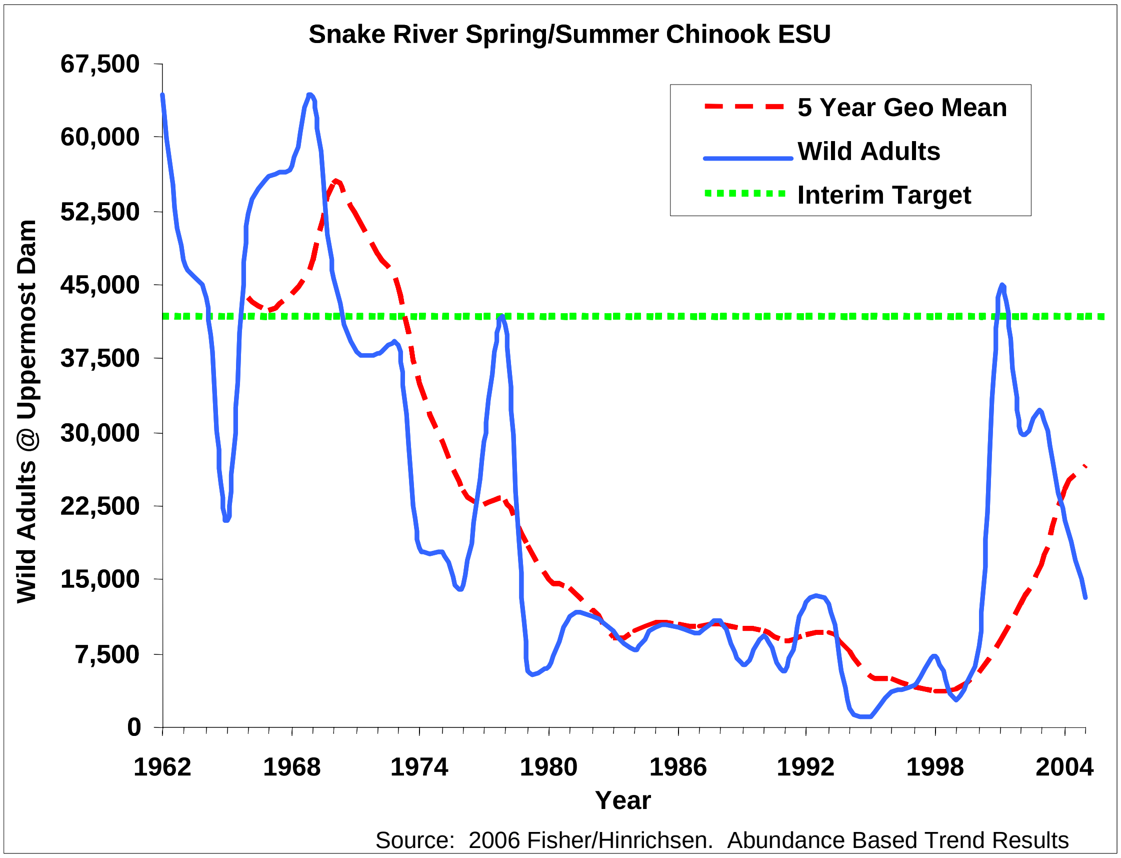


Figure 1 Snake River Spring Summer Chinook Abundance Trends

Extinction Probability/Risk

Results of extinction risk modeling are summarized in Table 1a. Extinction probability estimates were developed for populations in this ESU using the Beverton-Holt production function, which was fit to spawner-recruit data from brood years 1978 to the present. The estimated Beverton-

[3] Memo from Bob Lohn to Frank L. Cassidy, Jr., April 4, 2002.
[4] Table 2a, Interim ICTRT Gaps Report, April 5, 2006.

Holt function was used to project populations over a 24-year time horizon to estimate extinction probability. Alternative quasi-extinction thresholds (QETs) of 1, 10, 30, and 50 spawners were used in the analysis. In the modeling, extinction was assumed to occur when spawners fell below the quasi-extinction threshold for four years running. Reproductive failure was assumed to occur in any year in which spawner numbers fell below ten, except in the case of QET=1, where reproductive failure was assumed when spawners fell below two.[5]

This modeling approach examined extinction risk first without future hatchery supplementation of the populations (Table 1a), and then with future supplementation, the more likely prospect for some populations (Table 1b). It is expected that supplementation will continue for a number of the populations in this ESU for the foreseeable future, in part to support the ESU and in part to support harvest opportunity. For that reason, we have also modeled extinction probabilities assuming continued supplementation at the average levels seen over the most recent ten years. While modeling shows that supplementation provides a hedge against short-term extinction, we acknowledge that longer term supplementation must be carefully managed to control risks to viability. Supplementation is a strategy to support, not substitute for, self-sustaining natural populations.

Without future supplementation, base case extinction probability results indicate moderate to high probabilities of extinction for 75 percent of the modeled populations in this ESU, assuming QET=50. At QET=1 (“absolute” extinction as used in the 2000 FCRPS BiOp), only one population has a greater than 5 percent probability of extinction. Results at other QETs are displayed below. However, with the more likely scenario of future supplementation, the extinction risk is low for most of the modeled populations.

It also should be noted that these extinction probability results assume continued harvest at the average levels that prevailed during the base period. If a population were truly going extinct, these harvest levels might not be expected to continue, at least for natural-origin spawners, until natural fish numbers increased. Assuming future harvest reductions relative to the base period would reduce extinction probabilities.

Table 1a. Extinction probability results assuming no future supplementation.

**Note: A risk level of 0.11 indicates an 11 percent risk of extinction, assuming that spawner abundance below the QET for four years running results in extinction.*

MPG	Population	Ext. Risk QET = 1	Ext. Risk QET = 10	Ext. Risk QET = 30	Ext. Risk QET = 50
Lower Snake	Tucannon	0.00	0.02	0.06	0.10
Grande Ronde/ Imnaha	Catherine Cr.	0.12	0.29	0.42	0.51
	Lostine R.	0.00	0.03	0.10	0.19
	Minam R.	0.00	0.00	0.02	0.05
	Imnaha R.	0.00	0.01	0.04	0.09
	Wenaha R.	0.00	0.05	0.15	0.25
	Upper GR R.	0.00	0.08	0.40	0.68
S. Fork Salmon R.	South Fork	0.00	0.00	0.00	0.00
	Secesh R.	0.00	0.00	0.01	0.03
	E. Fork S. Fork.	0.00	0.00	0.00	0.01

[5] Reproductive failure is the assumption that zero progeny are produced in any year where spawner numbers fall below the identified threshold.

Middle Fork Salmon R.	Big Cr.	0.00	0.04	0.23	0.43
	Bear Valley Cr.	0.00	0.00	0.04	0.09
	Marsh Cr.	0.02	0.15	0.38	0.55
	Sulphur Cr.	0.00	0.13	0.44	0.68
	Camas Cr.	N/A	N/A	N/A	N/A
	Loon Cr.	N/A	N/A	N/A	N/A
	Chamberlain Cr.	N/A	N/A	N/A	N/A
	Lower Mid. Fork	N/A	N/A	N/A	N/A
Upper Salmon	Lemhi R.	N/A	N/A	N/A	N/A
	Valley Cr.	0.00	0.09	0.46	0.72
	Yankee Fork	N/A	N/A	N/A	N/A
	Upper Salmon	0.00	0.00	0.00	0.01
	N.F. Salmon	N/A	N/A	N/A	N/A
	Lower Salmon	0.00	0.00	0.05	0.19
	E. Fork Salmon	0.00	0.00	0.04	0.13
	Pahsimeroi	N/A	N/A	N/A	N/A

Table 1b summarized extinction risk under the assumption of continued supplementation. As expected, near-term extinction probabilities decline for those populations where hatchery supplementation is assumed to continue. Note that populations in the Middle Fork Salmon major population group (MPG) with high extinction probabilities at some QETs are not presently supplemented and are not likely to be supplemented in the future. Further discussion of extinction probability results for these populations can be found below.

Table 1b. Extinction probability results assuming future supplementation

**Note: Future supplementation levels were assumed to be equal to the average of 1996-present. Hatchery effectiveness of .2 pre-1998 and .5 post-1998. A time horizon of 24 years. A risk level of 0.11 indicates an 11 percent risk of extinction, assuming that spawner abundance below the QET for four years running results in extinction.*

Population	Ext. Risk QET = 1	Ext. Risk QET = 10	Ext. Risk QET = 30	Ext. Risk QET = 50
Lostine River Chinook	0.00	0.00	0.00	0.00
Grande Ronde Upper Mainstem Chinook	0.00	0.00	0.01	0.06
Catherine Creek Chinook	0.00	0.00	0.07	0.24
Imnaha River Chinook	0.00	0.00	0.00	0.00
Minam River Chinook	0.00	0.00	0.00	0.00
Wenaha River Chinook	0.00	0.00	0.00	0.01

RECRUIT-PER-SPAWNER PRODUCTIVITY, LAMBDA, AND TRENDS

Base status metrics of productivity and trend are summarized in Table 1c. This provides a historical snapshot of the ESU since before listing until the present. Recruit-per-spawner productivity (R/S) counts hatchery fish as spawners, but not recruits, with implications discussed below. Lambda or median annual population growth rate (the metric relied on for the 2000 FCRPS BiOp) integrates both the hatchery and natural component of the ESU. Abundance trends are the slope of the regression of log-transformed natural-origin spawner counts versus time. The trend is shown only for natural-origin spawners, though hatchery supplementation likely influences this metric, as well. Values greater than 1.0 indicate a population that is increasing over time.

The time series of data used to develop these estimates were the same as those used by the ICTRT. R/S and lambda are calculated over 20-year and 10-year periods beginning in brood years 1979, 1980 or 1981, depending on the population. In the case of the Pahsimeroi, we use an 11-year dataset beginning in brood year 1990 (see discussion of the Pahsimeroi population below).

Base period R/S productivity is less than 1.0 for about one-half of the extant populations in this ESU, indicating a declining trend over the period used for the analysis. In contrast, only one of the 17 populations with adequate data had a 20-year lambda estimate of < 1.0 (Catherine Creek). In the case of long-term trend (1980 to present), estimates < 1.0 were evident for six of 20 populations

The Action Agencies used the lambda calculations provided by the ICTRT. Lambda, as currently calculated by the ICTRT, tends to overstate annual population growth rates for populations with significant numbers of hatchery-origin fish in the spawning population. Therefore we place less emphasis on lambda estimates for these populations. Lambda is, on the other hand, an acceptable measure of median annual population growth for populations that are not supplemented by hatchery fish. Twenty- year lambda estimates are greater than 1.0 for all non-supplemented populations in this ESU, indicating growing populations over that time period.

Table 1c. Base status metrics.

For R/S, lambda and trend, a value >1.0 indicates a growing population; a value <1.0 indicates a declining population.

MPG	Population	20 year R/S	10 year R/S	20 year λ	12 year λ	1980-current Trend	1990-current Trend
Lower Snake	Tucannon	0.76	0.67	1.00	1.03	0.89	0.96
Grande Ronde/ Imnaha	Catherine Cr.	0.38	1.21	0.97	1.06	0.93	1.22
	Lostine R.	0.72	1.49	1.05	1.05	1.01	1.16
	Minam R.	0.80	1.28	1.05	1.02	1.02	1.12
	Imnaha R.	0.60	0.80	1.05	1.13	0.98	1.10
	Wenaha R.	0.66	1.29	1.10	1.05	1.04	1.20
	Upper GR R.	0.32	0.63	N/A	N/A	0.93	1.00
S. Fork Salmon R.	South Fork	0.87	0.65	1.11	1.06	1.05	1.09
	Secesh R.	1.04	0.95	1.07	1.09	1.02	1.12
	E. Fork S. Fork.	0.98	0.65	1.08	1.06	1.03	1.03
Middle Fork Salmon R.	Big Cr.	1.23	1.27	1.09	1.07	1.02	1.14
	Bear Valley Cr.	1.36	1.33	1.10	1.05	1.05	1.16
	Marsh Cr.	0.98	0.73	1.08	1.04	1.00	1.11
	Sulphur Cr.	0.89	0.44	1.05	0.95	1.01	1.00
	Camas Cr.	0.89	1.23	1.04	1.08	0.98	1.22
	Loon Cr.	1.21	1.54	N/A	N/A	1.06	1.34
	Chamberlain Cr.	N/A	N/A	N/A	N/A	N/A	N/A
	Lower Mid. Fork	N/A	N/A	N/A	N/A	N/A	N/A

MPG	Population	20 year R/S	10 year R/S	20 year λ	12 year λ	1980-current Trend	1990-current Trend
Upper Salmon	Lemhi R.	1.09	1.61	1.02	1.02	0.98	1.12
	Valley Cr.	1.08	1.41	N/A	N/A	1.02	1.20
	Yankee Fork	0.68	0.55	N/A	N/A	1.03	1.12
	Upper Salmon	1.50	1.90	1.06	1.07	1.01	1.11
	N.F. Salmon	N/A	N/A	N/A	N/A	N/A	N/A
	Lower Salmon	1.23	2.14	1.02	1.07	1.00	1.11
	E. Fork Salmon	1.17	2.31	1.04	1.07	1.01	1.17
	Pahsimeroi	0.39	0.90	1.08	1.15	1.38	1.34

Based on consideration of these metrics, the survival gaps needed to achieve the survival criteria, before recent and prospective actions are taken into account, are summarized in Table 2. Note that in this analysis, a metric of 1.0 reflects no gap. A number below 1.0 reflects a positive condition, while a number above 1.0 reflects a gap. For example, a gap of 1.2 indicates that 20 percent productivity is needed in the future.

Table 2. Base status gaps.

**Note: Gaps are expressed as multipliers. A gap of 1.32 indicates that a 32 percent survival improvement is needed to meet the criterion. A gap less than 1 indicates no further improvement is needed.*

MPG	Population	20-year R/S Gap	20-year λ Gap	Long-term Trend Gap	Ext. Risk Gap QET = 1	Ext. Risk Gap QET = 10	Ext. Risk Gap QET = 30	Ext. Risk Gap QET = 50
Lower Snake	Tucannon	1.32	1.00	1.69	0.42	0.74	1.09	1.35
Grande Ronde/ Imnaha	Catherine Cr.	2.63	1.15	1.39	1.41	2.43	3.44	4.13
	Lostine R.	1.39	0.80	0.96	0.48	0.86	1.27	1.61
	Minam R.	1.25	0.80	0.77	0.27	0.51	0.80	1.05
	Imnaha R.	1.67	0.80	1.10	0.43	0.71	0.99	1.21
	Wenaha R.	1.52	0.65	0.84	0.57	0.96	1.39	1.72
	Upper GR R.	3.13	N/A	1.39	0.54	1.12	1.86	2.57
S. Fork Salmon R.	South Fork	1.15	0.63	0.80	0.16	0.27	0.36	0.44
	Secesh R.	0.96	0.74	0.91	0.39	0.62	0.78	0.88
	E. Fork S. Fork.	1.02	0.71	0.88	0.33	0.53	0.65	0.75
Middle Fork Salmon R.	Big Cr.	0.81	0.68	0.92	0.43	0.97	1.79	2.69
	Bear Valley Cr.	0.74	0.65	0.80	0.26	0.52	0.89	1.24
	Marsh Cr.	1.02	0.71	1.00	0.73	1.57	2.77	4.00
	Sulphur Cr.	1.12	0.80	0.96	0.39	1.58	3.81	6.09
	Camas Cr.	1.12	0.84	1.05	N/A	N/A	N/A	N/A
	Loon Cr.	0.83	N/A	0.74	N/A	N/A	N/A	N/A
	Chamberlain Cr.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Lower Mid. Fork	N/A	N/A	N/A	N/A	N/A	N/A	N/A

MPG	Population	20 year R/S	10 year R/S	20 year λ	12 year λ	1980-current Trend	1990-current Trend	MPG
Upper Salmon	Lemhi R.	0.92	0.91	1.10	N/A	N/A	N/A	N/A
	Valley Cr.	0.93	N/A	0.92	0.32	1.21	3.09	5.01
	Yankee Fork	1.47	N/A	0.88	N/A	N/A	N/A	N/A
	Upper Salmon	0.67	0.77	1.15	0.09	0.22	0.43	0.64
	N.F. Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Lower Salmon	0.81	0.91	1.00	0.13	0.42	0.99	1.58
	E. Fork Salmon	0.86	0.84	N/A	0.11	0.39	0.95	1.55
	Pahsimeroi	1.11	0.71	0.27	N/A	N/A	N/A	N/A

Spatial Structure and Biological Diversity

Conserving and rebuilding sustainable salmonid populations involves more than meeting abundance and productivity criteria. Accordingly, NOAA Fisheries has developed a conceptual framework defining a Viable Salmonid Population VSP (McElhany et al. 2000). In this framework there is an explicit consideration of four key population characteristic or parameters for evaluating population viability status: abundance, productivity (or population growth rate), biological diversity, and population spatial structure. The reason that certain other parameters, such as habitat characteristics and ecological interactions, were not included among the key parameters is that their effects on populations are implicitly expressed in the four key parameters. Based on the current understanding of population attributes that lead to sustainability, the VSP construct is central to the goal of ESA recovery, and warrants consideration in a jeopardy determination. However, it must also be stressed that the ability to significantly improve either a species' biological diversity or its spatial structure and distribution is limited within the timeframe of the Action Agencies' proposed action.

Spatial Structure -- Spatial structure, as the term suggests, refers to the geographic distribution of individuals in a population unit and the processes that generate that distribution. Distributed populations that interact genetically are often referred to as metapopulation. Although the spatial distribution of a population, and thus its metapopulation structure, is influenced by many factors, none are perhaps as important as the quantity, quality, and distribution of habitat. One way to think about the importance or value of a broad geospatial distribution is that a population is less likely to go extinct from a localized catastrophic event or localized environmental perturbations.

Biological Diversity -- Biological diversity within and among populations of salmonids is generally considered important for three reasons. First, diversity of life histories patterns is associated with a use of a wider array of habitats. Second, diversity protects a species against short-term spatial and temporal changes in the environment. And third, genetic diversity is the so-called raw material for adapting to long-term environmental change. The latter two are often described as nature's way of hedging its bets – a mechanism for dealing with the inevitable fluctuations in environmental conditions – long and short-term. With respect to diversity, more is better from an extinction-risk perspective.

The Snake River spring and summer Chinook ESU consists of 29 extant populations in five MPGs. With the exception of the Lower Snake River MPG, each of the MPGs is comprised of four or more populations. Based on their Spatial Structure and Diversity (SSD) analyses and rating of 23 of the populations for which sufficient information was available, the ICTRT assigned a high risk to 6 populations, a moderate risk to 11 populations, and a low risk to 6 populations. With exception of the Lower Snake River MPG, with its single extant population (Tucannon River), all MPGs contained populations with a mix of risk ratings. Considering the wide geographic distribution of this ESU, the diversity of habitats utilized, and the preponderance of populations in the moderate SSD risk category, we conclude that this ESU is currently at no greater than moderate risk for SSD, and that this status will likely improve as a result of the recently implemented and proposed changes in the FCRPS, including improvements to the volume and reliability of flow augmentation from the Bureau of Reclamation's upper Snake projects achieved in the Nez Perce Water Rights Settlement. Particularly significant will be the continuing improvements in hatchery management and the resulting reduction in negative effects from hatchery- and natural-origin fish.

BIOLOGICAL ANALYSIS OF ACTIONS: RECRUITS-PER-SPAWNER, LAMBDA, AND TRENDS WITH CURRENT AND PROSPECTIVE ADJUSTMENTS

As described in detail in Appendix X, the Base Status is the historical status of the ESU, defined as the status of the population based on the *average* of quantitative survival metrics estimated from a time series of abundance data beginning in about 1980. For the most part, longer term averages (generally 20 years) were used where they were available. In the biological analysis, this is the starting point, shown in the tables above.
The next step is Current Status, an adjustment of the initial base estimates to reflect our best estimate of current survivals, as opposed to an average of survivals that prevailed over a period in the past. This would obviously include recent improvements already implemented but not fully reflected in the Base conditions. Current Status is defined as estimated survival metrics adjusted for recently implemented changes in hydropower configuration and operations, hatchery operations, tributary and estuarine habitat improvements, and reduced avian predation. These are actions that have recently been implemented, but their effects are not reflected in the time series of survival data that for the most part started in 1980.

The final step is Prospective Status, which adjusts Current to Prospective Status based on the estimated effects of future actions. The current-to-prospective adjustment is simply an adjustment of the current survival estimates to reflect survival improvements expected from the hydro, habitat, and hatchery changes included in the proposed action, and in particular those that are expected to be implemented in the period 2007 to 2017.

This analysis assumes that future ocean and climate conditions will approximate the average conditions that prevailed during the 20 year base period used for our status assessments. For most populations, that period is about equivalent to the "recent" ocean period used by the ICTRT in its analyses. This period was characterized by relatively poor ocean conditions which presumably contributed to poor early ocean survival of salmonids. The ICTRT's "pessimistic" ocean condition scenario results in survivals that are about 15 percent lower for Snake River spring and summer Chinook salmon than the "recent' ocean conditions scenario, and about 36 percent lower for Upper Columbia spring Chinook salmon. Alternatively, ICTRT's "historic" ocean conditions scenario results in survivals that are about 39 percent higher for both Snake

River spring and summer and Upper Columbia spring Chinook salmon.[6] This subject is treated at greater length in the discussion of the effects of potential climate change in Appendix X.

The analysis of status assumes a certain amount of annual take of natural adult fish based on recent harvest levels. As requested in the remand collaboration, a sensitivity analysis showing the additional effects of more selective harvests that minimize take of natural adult fish is presented in Appendix X. In general, this "selective harvest" scenario results in survival that is about 8 to18 percent higher than the main analysis, depending on the ESU.

Current Status Analysis

Over this period the action agencies implemented multiple actions to improve fish survival relative to the base period prior to 2000. The percentage changes in life cycle survival used in the base-to-current adjustments for the Snake River spring and summer Chinook salmon ESU are summarized in Table 3. Actions are described in summary below.

Table 3. Estimated survival improvements used in the base-to-current adjustment.

MPG	Population	Hydro	Habitat (tributary)	Habitat (estuary)	Avian predation	Hatchery	Harvest[7]
Lower Snake	Tucannon	17.5%	3.5%	0.3%	-0.4%		4.0%
Grande Ronde/ Imnaha	Catherine Cr.	17.5%	4.0%	0.3%	-0.4%	28.0%	4.0%
	Lostine R.	17.5%	1.0%	0.3%	-0.4%	7.0%	4.0%
	Minam R.	17.5%		0.3%	-0.4%	23.0%	4.0%
	Imnaha R.	17.5%	1.0%	0.3%	-0.4%		4.0%
	Wenaha R.	17.5%		0.3%	-0.4%	39.0%	4.0%
	Upper GR R.	17.5%	4.0%	0.3%	-0.4%	32.0%	4.0%
S. Fork Salmon R.	South Fork	17.5%		0.3%	-0.4%		4.0%
	Secesh R.	17.5%		0.3%	-0.4%		4.0%
	E. Fork S. Fork.	17.5%		0.3%	-0.4%		4.0%
Middle Fork Salmon R.	Big Cr.	17.5%		0.3%	-0.4%		4.0%
	Bear Valley Cr.	17.5%		0.3%	-0.4%		4.0%
	Marsh Cr.	17.5%		0.3%	-0.4%		4.0%
	Sulphur Cr.	17.5%		0.3%	-0.4%		4.0%
	Camas Cr.	17.5%		0.3%	-0.4%		4.0%
	Loon Cr.	17.5%		0.3%	-0.4%		4.0%
	Chamberlain Cr.	17.5%		0.3%	-0.4%		4.0%
	Lower Mid. Fork	17.5%		0.3%	-0.4%		4.0%

[6] Assessing the Impact of Anticipated Hydropower Changes and a Range of Ocean Conditions on the Magnitude of Survival Improvements Needed to Meet TRT Viability Goals.
Interior Columbia Technical Recovery Team and R. W. Zabel, June 20, 2006.

[7] Harvest adjustments represent estimated harvest decreases between the base and current periods. Estimates supplied by A. Nigro (ODF&W) on behalf of an ad hoc US v. OR technical workgroup.

MPG	Population	Hydro	Habitat (tributary)	Habitat (estuary)	Avian predation	Hatchery	Harvest[8]
Upper Salmon	Lemhi R.	17.5%	0.5%	0.3%	-0.4%		4.0%
	Valley Cr.	17.5%	0.5%	0.3%	-0.4%		4.0%
	Yankee Fork	17.5%		0.3%	-0.4%		4.0%
	Upper Salmon	17.5%	0.5%	0.3%	-0.4%		4.0%
	N.F. Salmon	17.5%		0.3%	-0.4%		4.0%
	Lower Salmon	17.5%	0.5%	0.3%	-0.4%		4.0%
	E. Fork Salmon	17.5%	0.5%	0.3%	-0.4%		4.0%
	Pahsimeroi	17.5%	0.5%	0.3%	-0.4%		4.0%

Hydropower Survival Improvements

Several hydropower configuration and operational and maintenance improvements to fish passage facilities and other project areas were implemented in 2000 to 2006 and are estimated to have resulted in a 17.5 percent increase in survival over the baseline for all populations in this ESU (Table 3). This survival increase was estimated with COMPASS using the 2006 hydrosystem configuration operating under the 2004 BiOp specified operation for each dam. Specific configuration and operation improvements included in this estimate are:

- Bonneville Powerhouse I minimum-gap turbine runner installations;
- Bonneville Powerhouse II corner collector installation;
- Bonneville II Fish Guidance Efficiency improvements;
- Bonneville spill operation improvements;
- Bonneville I JBS screen removal;
- Bonneville II operation as first priority;
- The Dalles spill wall construction;
- The Dalles spill pattern improvements;
- The Dalles adult collection channel improvements;
- The Dalles sluiceway operation improvements;
- John Day spill operation improvements;
- John Day South Fish Ladder improvements;
- McNary spill operation improvements;
- McNary end spillbay deflectors and hoists;
- McNary full flow juvenile PIT tag detection;
- McNary juvenile transport facility bypass piping improvements;
- McNary spare ESBS;
- McNary improved juvenile bypass dewatering screens;
- McNary overhauling AWS pumps;
- McNary upgrading of adult fish ladders tilting weir controls;
- Ice Harbor RSW installation and spill operation improvements;
- Ice Harbor full flow juvenile PIT tag detection;
- Ice Harbor AWS improvements north shore adult fishway;
- Ice Harbor replaced adult fishway entrance weirs;
- Ice Harbor new bulkhead system for maintenance of south shore AWS pumps;

[8] Harvest adjustments represent estimated harvest decreases between the base and current periods. Estimates supplied by A. Nigro (ODF&W) on behalf of an ad hoc US v. OR technical workgroup.

- Ice Harbor upgraded AWS hydraulic systems;
- Lower Monumental end spillbay deflectors, parapet walls, and stilling basin repair;
- Lower Monumental spill operations improvements;
- Lower Monumental juvenile fish separator improvement;
- Lower Monumental fish barge loading improvements;
- Lower Monumental rehabbed adult fish pumps;
- Lower Monumental replaced north shore adult fish counting station;
- Little Goose spill operations improvements;
- Little Goose ESBS improvements;
- Lower Granite RSW installation;
- Lower Granite ESBS improvements;
- Lower Granite modifications to adult transition pool to improve adult passage;
- Improved total dissolved gas monitoring program and equipment; and
- Delayed/staggered start of juvenile fish transportation program.

Tributary Habitat Survival Improvements

BPA and Reclamation implemented actions to address limiting factors for a number of populations in this ESU. BPA's annual expenditures for habitat projects in subbasins used by Snake River ESUs/DPs averaged about $5.4 million for the 2001 to 2006 time frame. Reclamation spent over $6 million to provide technical for habitat projects in this period. Some of these actions provided benefits with immediate survival improvements and some will result in long-term benefits with survival improvements accruing into the future. During this time period the Action Agencies, in coordination with multiple partners:

- Increased streamflow through water acquisitions;
- Addressed entrainment by installing or improving fish screens;
- Increased fish passage and access by removing passage barriers;
- Improved channel habitat complexity and conditions; and
- Improved water quality and habitat conditions by protecting and enhancing riparian areas.

Survival improvements estimated to result from tributary habitat actions implemented by the Action Agencies in this time period are shown in Table 3. The percentages indicate the incremental survival improvement estimated to accrue by 2006 from the suite of implemented actions. Survival improvements were estimated as described in "Working Draft Tributary Habitat Benefits".

BPA also implemented actions to improve habitat in areas used by the Big Sheep Creek, Chamberlain Creek, Lapwai/Big Canyon, Lawyer Creek, Lochsa River, Lolo Creek, Meadow Creek, Polatch River, and Upper South Fork Clearwater populations. Although estimates of survival improvements are shown for these populations, the actions will contribute to the recovery of this ESU. Additional detail of habitat actions implemented by BPA and Reclamation in the 2000 to 2006 time frame is available in the Action Agencies Annual Progress Reports located at *www.salmonrecovery.gov*.

Estuary Habitat Survival Improvements

Survival benefit for Snake River spring and summer chinook (stream-type life history) associated with the specific actions discussed below was 0.296 percent. Action Agencies implemented habitat actions through 21 estuary habitat projects. Unrestricted fish passage and approximately 3 miles of access to quality habitat was provided by the following specific actions[9]:

- Replaced 3 culverts with full-spanning bridges;
- Provided approximately 10 miles of improved tidal channel connectivity by installing a tide gate retrofit;
- Acquired approximately 473 acres of off-channel and riparian habitats;
- Restored and created 90 acres of marsh and tidal sloughs and approximately 100 acres of riparian forests;
- Protected approximately 55 acres of high-quality riparian and floodplain habitat; restored and preserved approximately 154 acres of off-channel habitat; protected 80 acres of high-value off-channel forested wetland habitat;
- Restored approximately 96 acres of tidal wetlands habitat by replacing undersized culvert that limited fish access;
- Conserved 155 acres of forested riparian and upland habitat; provided partial tidal channel reconnection by tide gate retrofit (acreage unknown at this time);
- Provided integrated pest management (purple loosestrife);
- Reconnected and restored 183 acres of historic floodplain by dike removal;
- Restored 25 acres of historic floodplain by breaching a dike;
- Provided fish passage access to 6 miles of stream habitat by removal of two culverts and replacement with bridges;
- Restored 310 acres of native hardwood riparian forest, 200 acres of seasonally wet slough and 155 acres of degraded riparian habitats;
- Increased circulation in approximately 92 acres of backwater and side-channel habitat by tide gate retrofit;
- Improved embayment circulation for 335 plus acres of marsh/swamp and shallow-water and flats habitat; and preserved 35 acres of historic wetland habitat.

Predator Control Survival Improvements

Avian predation. The estimated change from baseline to current survival of Upper Columbia River Spring Chinook salmon is -.4 percent. This reflects a reduction in survival from the base to current condition, because the tern population was increasing over the base period. Averaging tern consumption of juvenile salmonids across the 20-year base period downplays the actual change in survival that resulted from relocating terns from Rice Island to East Sand Island in 1999. In 1999 tern consumption of juvenile salmonids was at its peak with an estimated 13,790,000 smolts consumed, compared to 8,210,000 in 2000 after relocation.

Piscivorous predation. The ongoing Northern Pikeminnow Management Program (NPMP) has been responsible for reducing predation related juvenile salmonid mortality since 1990. The northern pikeminnow has been responsible for approximately 8 percent predation-related mortality of juvenile salmonid migrants in the Columbia River basin in the absence of the NPMP (2000 FCRPS BiOp at 9-106). The improvement in life cycle survival attributed to the NPMP is estimated at 2 percent for migrating juvenile salmonids (Friesen and Ward 1999). The ongoing NPMP is already accounted for in the estimation of survival improvements modeled within the reservoir mortality life stage. This is because the modeling estimates are calibrated to empirical reach survival estimates that included the ongoing program.

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[9] A more thorough report detailing this evaluation process is: Estimated Benefits for Federal Habitat Projects in the Columbia River Estuary for NWF v NMFS Remand - Sovereign Collaboration Process.

Hatchery Management Survival Improvements

Hatchery-origin salmon and steelhead had lower reproductive success relative to natural-origin fish in almost all of the studies reviewed by Berejikian and Ford (2004). The difference in relative reproductive success was greatest for non-local, domesticated hatchery stocks, which would be unlikely to be well adapted to the environmental conditions at their release location. This was the case in the Grande Ronde River watershed for much of the base period used for this analysis. Hatchery reforms instituted in the mid- to late-1990s both reduced straying of non-native fish into certain watersheds (Wenaha and Minam Rivers) and emphasized the use of locally-adapted broodstock. These changes have likely contributed to increased R/S productivity for the population as a whole. Guidance from NOAA Fisheries was used to set assumptions regarding relative reproductive effectiveness of hatchery fish before and after these reforms to arrive at the survival improvement estimates in Table 3. A more thorough description of the methods used can be found in Appendix D. Specific actions included:

- BPA funded (required in a RPA in the 2000 FCRPS BiOp) the development of Hatchery and Genetic Management Plans (HGMPs) for all federally-funded hatchery programs in the ESU While the estimated survival benefit was low in the near term, it was potentially moderate to high in the long term. The objective was to develop the HGMPs for NOAA Fisheries approval and identification of and prioritization of hatchery reform measures by NOAA;
- BPA funded the Safety-Net Artificial Propagation Program (SNAPP) planning process to identify any additional spring and summer Chinook populations at high risk of extinction that would benefit from implementation of a safety-net hatchery program;
- Lower Snake, Tucannon River - BPA funded the Tucannon River Spring Chinook Captive Broodstock Program (a safety-net program) from 2000 through 2006 to increase abundance and reduce the extinction risk of the target population;
- Upper Salmon; East Fork, West Fork Yankee Fork, and Lemhi River - BPA funded the Salmon River Captive Rearing Program (a safety-net program) from 2000 through 2006 to increase abundance and reduce extinction risk of the target populations;
- Grande Ronde/Imnaha; Upper Grande Ronde, Catherine Creek, and Lostine River - BPA funded the Grande Ronde Captive Broodstock Program (a safety-net program) and the Grande Ronde Recovery Program (a conventional supplementation program) from 2000 through 2006 to increase abundance and reduce extinction risk of the target populations;
- Grande Ronde/Imnaha, Lostine and Imnaha River - BPA funded development of a Master Plan and other planning and design for the Northeast Oregon Hatchery from 2000 through 2006; and
- South Fork Salmon, Johnson Creek - BPA funded the Johnson Creek Artificial Propagation and Enhancement Program (a safety-net program) from 2000 through 2006 to increase abundance and reduce extinction risk of the target population.

Current Status Gaps

Table 4. Current status: Adjusted gaps after base to current adjustment.
**Note: Gaps are expressed as multipliers. A gap of 1.11 indicates that an 11 percent survival improvement is needed to meet the criterion. A gap less than 1.0 indicates no further improvement is needed.*

MPG	Pop.	Adjusted 20-year R/S Gap	Adjusted 20-year λ Gap	Adjusted Long-term Trend Gap	Adjusted Ext. Risk Gap QET = 1	Adjusted Ext. Risk Gap QET = 10	Adjusted Ext. Risk Gap QET = 30	Adjusted Ext. Risk Gap QET = 50
Lower Snake	Tucannon	1.04	0.79	1.34	0.33	0.59	0.86	1.07
Grande Ronde/ Imnaha	Catherine Cr.	1.62	0.71	0.85	1.11	1.91	2.71	3.25
	Lostine R.	1.05	0.61	0.72	0.39	0.70	1.03	1.31
	Minam R.	0.84	0.54	0.61	0.22	0.42	0.66	0.86
	Imnaha R.	1.35	0.65	0.89	0.35	0.58	0.80	0.98
	Wenaha R.	0.89	0.38	0.49	0.47	0.79	1.14	1.41
	Upper GR R.	1.86	N/A	0.83	0.43	0.88	1.47	2.02
S. Fork Salmon R.	South Fork	0.94	0.51	0.66	0.13	0.22	0.29	0.36
	Secesh R.	0.79	0.60	0.75	0.32	0.51	0.64	0.72
	E. Fork S. Fork.	0.84	0.58	0.72	0.27	0.43	0.53	0.61
Middle Fork Salmon R.	Big Cr.	0.67	0.56	0.75	0.35	0.79	1.47	2.20
	Bear Valley Cr.	0.60	0.53	0.66	0.21	0.43	0.73	1.02
	Marsh Cr.	0.84	0.58	0.82	0.60	1.29	2.27	3.28
	Sulphur Cr.	0.92	0.66	0.78	0.32	1.29	3.12	4.99
	Camas Cr.	0.92	0.69	0.90	N/A	N/A	N/A	N/A
	Loon Cr.	0.68	N/A	0.63	N/A	N/A	N/A	N/A
	Chamberlain Cr.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Lower Mid. Fork	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Upper Salmon	Lemhi R.	0.75	0.75	0.89	N/A	N/A	N/A	N/A
	Valley Cr.	0.75	N/A	0.75	0.26	0.99	2.52	4.08
	Yankee Fork	1.20	N/A	0.72	N/A	N/A	N/A	N/A
	Upper Salmon	0.54	0.63	0.78	0.07	0.18	0.35	0.52
	N.F. Salmon	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Lower Salmon	0.66	0.75	0.82	0.11	0.34	0.81	1.29
	E. Fork Salmon	0.70	0.68	0.78	0.09	0.32	0.77	1.26
	Pahsimeroi	0.91	0.58	0.22	N/A	N/A	N/A	N/A

Prospective Status Analysis

As noted above the Prospective Status is the projected status of the population based on adjustment of the survival metrics for expected improvements associated with the proposed actions. As was the case for the base-to-current adjustment, the improvements for the current-to-prospective are divided into the categories of those expected from changes in hydropower operations and configuration, changes in tributary habitat conditions attributable to actions implemented in the periods 2007 to 2009 and 2010 to 2017, changes in estuarine habitat, reduced impacts of avian predation, and improved hatchery operations.

Over this period the action agencies will implement multiple actions to improve fish survival relative to the current period. The percentage improvements in life cycle survival used in the current-to-prospective adjustments for the Snake River spring and summer Chinook salmon populations are summarized in Table 5. Actions are summarized below.

Table 5. Estimated improvements in survival used in the current-to-prospective adjustment.

Pop.	Hydro	2007-2017 Habitat (tributary)	Habitat (estuary)	Avian predation	P. minnow predation	Hatchery	Harvest
Tucannon	6.5%	17.0%	6.0%	2.1%	1.0%		
Catherine Cr.	6.5%	14.0%	6.0%	2.1%	1.0%		
Lostine R.	6.5%	18.0%	6.0%	2.1%	1.0%		
Minam R.	6.5%		6.0%	2.1%	1.0%		
Imnaha R.	6.5%		6.0%	2.1%	1.0%		
Wenaha R.	6.5%		6.0%	2.1%	1.0%		
Upper GR R.	6.5%	7.0%	6.0%	2.1%	1.0%		
South Fork	6.5%	6.0%	6.0%	2.1%	1.0%		
Secesh R.	6.5%	6.0%	6.0%	2.1%	1.0%		
E. Fork S. Fork.	6.5%		6.0%	2.1%	1.0%		
Big Cr.	6.5%	7.0%	6.0%	2.1%	1.0%		
Bear Valley Cr.	6.5%		6.0%	2.1%	1.0%		
Marsh Cr.	6.5%		6.0%	2.1%	1.0%		
Sulphur Cr.	6.5%		6.0%	2.1%	1.0%		
Camas Cr.	6.5%		6.0%	2.1%	1.0%		
Loon Cr.	6.5%		6.0%	2.1%	1.0%		
Chamberlain Cr.	6.5%		6.0%	2.1%	1.0%		
Lower Mid. Fork	6.5%		6.0%	2.1%	1.0%		
Lemhi R.	6.5%	21.0%	6.0%	2.1%	1.0%		
Valley Cr.	6.5%	3.0%	6.0%	2.1%	1.0%		
Yankee Fork	6.5%	30.0%	6.0%	2.1%	1.0%		
Upper Salmon	6.5%	42.0%	6.0%	2.1%	1.0%		
N.Fk Salmon	6.5%		6.0%	2.1%	1.0%		
Lower Salmon	6.5%	3.0%	6.0%	2.1%	1.0%		
E. Fork Salmon	6.5%	3.0%	6.0%	2.1%	1.0%		
Pahsimeroi	6.5%	43.0%	6.0%	2.1%	1.0%		

Hydropower Survival Improvements

The Action Agencies have formulated a broad array of hydropower actions to further increase the survival of this ESU during migration through the hydrosystem. Specific survival benefits for each action were derived using best professional judgment, then input into COMPASS for calculating an estimated overall survival benefit that the specified actions may provide to this ESU. The resultant estimated overall survival benefit to the ESU from these specific actions is 6.5 percent (Table 5). The configuration and operational improvement actions that contribute to these survival increases are organized into strategies. Specific actions contained within these strategies are listed in the Hydrosystem Proposed Action Summary. These strategies include:

1. Operate the FCRPS to more closely approximate the shape of the natural hydrograph and to improve juvenile and adult fish survival;

2. Modify Columbia and Snake River dams to facilitate safe passage;
3. Implement operational improvements at Columbia and Snake River dams;
4. Operate and maintain juvenile and adult fish passage facilities; and
5. Provide flow augmentation from the Bureau of Reclamation's upper Snake projects in accordance with the Nez Perce Water Rights Settlement with potential improvements addressed in Reclamation's Biological Assessment.

Tributary Habitat Survival Improvements

Table 5 displays estimated population level survival improvement percentages expected to result from Action Agency implementation of actions to address limiting factors in the tributary areas used by this DPS. The survival improvements identified represent an increase in Action Agency tributary habitat effort compared to efforts under the 2000 and 2004 FCRPS BiOps. Survival improvements were estimated as described in "Working Draft Tributary Habitat Benefits".

2007 to 2017. BPA will fund and Reclamation will provide technical assistance for projects that implement new actions to address key limiting factors and improve survival of this ESU. BPA will fund projects primarily through its Fish and Wildlife Program; Reclamation will provide technical assistance through annual congressional appropriations. The Action Agencies work with multiple parties for the successful implementation of these actions.

Initial actions and action expansion. Consistent with its 2007 to 2009 Fish and Wildlife Program funding decision, BPA will fund implementation of 16 projects in the Tucannon, Asotin, Grande Ronde, Imnaha, and Salmon subbasins. BPA has also dedicated 70 percent of the Columbia Basin Water Transactions Program (CBWTP) $5 million annual budget to secure water acquisitions and riparian easements for anadromous fish, including populations of Snake River spring and summer Chinook. The BPA average annual planned budgets (based on BPA Final Decision Letter) for the 16 projects is approximately $6.7 million (not including the CBWTP).

Based on biological needs identified in the recent lifecycle biological analyses and input from the remand collaboration process, BPA will also fund a suite of further actions beyond those identified in the 2007 to 2009 Fish and Wildlife Program decision for implementation beginning in the 2008 and 2009 (see Appendix B-4a).

BPA will fund projects to implement new actions that:

- Increase instream flows;
- Remove passage barriers;
- Improve fish passage structures;
- Install fish screens;
- Increase channel complexity;
- Protect and enhance riparian habitat;
- Enhance floodplains, and
- Improve water quality.

Reclamation will provide technical assistance for habitat projects in the Grande Ronde, Upper Salmon, and Lemhi subbasins.

Future implementation. BPA will implement new actions similar in scope to those implemented in the 2007 to 2009 time period to address limiting factors for this ESU. BPA will expand the level of effort and increase funding above the 2007 to 2009 time period. Project funding decisions will be based on prioritized biological criteria and consistent with recovery plans. Reclamation will continue to provide technical assistance where appropriate with funding consistent with its congressional funding authorizations.

Further detail about Reclamations actions is available in Appendix B-5 to the Tributary Habitat Proposed Action; project level detail of the BPA funded projects is available in Appendix B-3b.

Estuary Habitat Survival Improvements

2007 to 2009. The estimated survival benefits for Snake River spring and summer chinook (stream-type life history) associated with the specific actions discussed above is 1.4 percent. The estimated benefit for 2007 is based on actions that are underway or will be underway in the very near-term. For 2008 and 2009 the AA's estimated benefit is based on continuing at the same level of effort as 2007[10]. Specific estuary actions are:

- Restore partial tidal influence and access to several acres (exact amount unknown at this time) by a tide gate retrofit;
- Improve hydrologic flushing and salmonid access to a lake (Sturgeon Lake is approximately 3,200 acres);
- Acquire and protect 40 acres of critical floodplain habitat and 40 acres riparian forest restoration; install 6 to 8 engineered log-jams that will help to slow flood flows, reduce erosion, contribute to sediment storage, enhance fish habitat and contribute wood into the project area;
- Acquire and restore floodplain connectivity to 380 acres of off-channel rearing habitat for juveniles; install fish friendly tide gates to increase tidal flushing and fisheries access to approximately 110 acres;
- Riparian planting of up to 210 acres;
- Re-establish hydrologic connectivity to reclaim and improve floodplain wetland functions, increase off-channel rearing and refuge habitat on five acres, plant native vegetation along shoreline and reconstruct slough channels on 2.5 acres of annually inundated off-channel habitat;
- As part of a long-term 1,500 acres restoration effort: breaching a dike and re-establishing flow to portion of original channel, planting vegetation on 50 acres, removing invasive weeds on 180 acres, planting wetland scrub shrub on 45 acres, and controlling and removing invasive wetland plants on 45 acres;
- Tide gate retrofit (acreage unknown at this time);
- Protect and restore approximately 5 to 10 acres of emergent wetland and riparian forest habitats;
- Reconnect 45 acre floodplain by tide gate removal;
- Acquire 45 acre floodplain with future dike removal;
- Reconnect 50 acres of floodplain;
- Acquire 320 acres of tidelands and 119 acres of riparian/upland forest; and
- Restore 30 acres of riparian habitat.

There will be approximately 15 additional projects and associated actions similar to actions listed above that are undergoing scoping and sponsor development (the number of projects and associated actions is based on the same level of effort as 2007).

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[10] A more thorough report detailing this evaluation process is: *Estimated Benefits of Federal Habitat Projects in the Columbia River Estuary for the NWF v NMFS Remand – Sovereign Collaboration Process.*

Further detail about Reclamations actions is available in Appendix B-5 to the Tributary Habitat Proposed Action project level detail of the BPA funded projects is available in Appendix B-3b.

Estuary Habitat Survival Improvements

2010-2017. The estimated survival benefit for Snake River spring and summer chinook (stream-type life history) associated with these actions is 4.25 percent. The estimated benefits for 2010 to 2017 are based on continuing the same level of effort as 2007 to 2009. However the level of effort in this time period may increase depending on the outcome of a General Investigation study of Ecosystem Restoration opportunities, depending on Congressional appropriations and future funding scenarios. Specific projects have yet to be identified. Actions for this period will be similar in nature to actions implemented in previous periods discussed above. Actions will include protection and restoration of riparian areas, protection of remaining high quality off-channel habitat, breaching or lowering dikes and levees to improve access to off-channel habitat, and reduction of noxious weeds, among others. The estimated number of actions are based on continuing the same level of effort as in q2007 to 2009.

Predator Control Survival Improvements

Avian predation. The survival attributed to improved management of Caspian tern populations in the lower Columbia are estimated at 2.1 percent for yearling Chinook. The benefits out beyond 2017 are the same; there are no further actions, and therefore no further benefits.

Piscivorous predation. The percentage improvement in life cycle survival attributable to the proposed continuation of the increase in incentives in the Northern Pikeminnow Management Program and resultant marginal increase in observed exploitation rate is estimated at 1 percent total from 2007 to 2017. This estimate was derived based on the difference between the estimated benefits from the base NPMP (defined as the period 1990 to 2003) and estimated survival benefits under the increased incentive program (defined as the period of 2004 to present). This rate would generally apply to all juvenile salmonids.

Hatchery Management Survival Improvements

2007 to 2017. Qualitatively assessed survival and recovery benefits are gained through these specific actions:

- Adopt programmatic criteria for funding decisions on FCRPS mitigation hatchery programs;
- Artificial propagation safety-net programs to reduce extinction risk for Tucannon River, East Fork, West Fork, Yankee Fork, Upper Grande Ronde, Catherine Creek, Lostine River, and Johnson Creek populations in the Snake River spring and summer Chinook ESU. Programs will positively affect abundance, spatial scale, and genetic diversity and provide high benefits to the natural populations;
- Conservation hatchery programs to increase abundance of target populations in Snake River spring and summer Chinook ESU;
- Future implementation of additional ESA-relevant hatchery reforms identified through Columbia River Hatchery Scientific Review Group’s hatchery review process, combined with use of Best Management Practices at FCRPS hatchery facilities; and
- Fund construction of Northeast Oregon Hatchery (NEOH) and future O&M of NEOH, pending recovery benefits determination.

Harvest Survival Improvements

From 2007 to 2017 there are no survival benefits from harvest actions estimated for this ESU.

Prospective Status

Comprehensive analyses of the changes in life cycle survival resulting from the proposed FCRPS and upper Snake actions and analysis of how they will change the survival metrics are summarized in Table 6.

Table 6. Prospective status: Adjusted future productivity trends after current-to-prospective analysis.

**Note: Future productivity values represent estimates of future R/S, lambda and trend after consideration of the effects of the proposed action. A value >1.0 indicates a growing population; a value <1.0 indicates a population in decline. A risk gap <1.0 indicates no further improvement is necessary to meet a <5% risk criterion.*

MPG	Population	Estimated Future R/S	Estimated Future λ	Estimated Future Trend	Risk Gap (QET=1)	Risk Gap (QET=10)	Risk Gap (QET=30)	Risk Gap (QET=50)
Lower Snake	Tucannon	1.31	1.13	1.00	0.25	0.44	0.64	0.79
Grande Ronde/ Imnaha	Catherine Cr.	0.82	1.15	1.10	0.85	1.46	2.07	2.48
	Lostine R.	1.30	1.20	1.15	0.29	0.51	0.76	0.96
	Minam R.	1.38	1.19	1.15	0.19	0.36	0.57	0.75
	Imnaha R.	0.86	1.14	1.06	0.30	0.50	0.70	0.85
	Wenaha R.	1.30	1.28	1.21	0.41	0.68	0.99	1.22
	Upper GR R.	0.67	#N/A	1.09	0.35	0.72	1.19	1.64
S. Fork Salmon R.	South Fork	1.31	1.22	1.15	0.11	0.18	0.24	0.30
	Secesh R..	1.56	1.17	1.12	0.26	0.42	0.52	0.59
	E. Fork S. Fork.	1.39	1.17	1.11	0.23	0.38	0.46	0.53
Middle Fork Salmon R.	Big Cr.	1.87	1.20	1.12	0.29	0.65	1.19	1.79
	Bear Valley Cr.	1.93	1.19	1.13	0.19	0.37	0.63	0.88
	Marsh Cr.	1.39	1.17	1.08	0.52	1.12	1.97	2.85
	Sulphur Cr.	1.26	1.13	1.09	0.28	1.13	2.71	4.34
	Camas Cr.	1.26	1.12	1.06	N/A	N/A	N/A	N/A
	Loon Cr.	1.72	#N/A	1.15	N/A	N/A	N/A	N/A
	Chamberlain Cr.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Lower Mid. Fork	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Upper Salmon	Lemhi R.	1.88	1.15	1.11	#N/A	#N/A	#N/A	#N/A
	Valley Cr.	1.59	#N/A	1.11	0.22	0.83	2.13	3.45
	Yankee Fork	1.25	#N/A	1.18	#N/A	#N/A	#N/A	#N/A
	Upper Salmon	3.04	1.24	1.18	0.04	0.11	0.21	0.32
	N.F. Salmon	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Lower Salmon	1.81	1.11	1.09	0.09	0.29	0.68	1.09
	E. Fork Salmon	1.72	1.13	1.10	0.08	0.27	0.65	1.07
	Pahsimeroi	1.83	1.27	1.57	#N/A	#N/A	#N/A	#N/A

Remand Conceptual Framework Analysis

The FCRPS BiOp remand's collaboration among the sovereigns developed a Conceptual Framework approach intended to help the Action Agencies develop their proposed action. The Framework approach attempted to estimate the relative magnitude of mortality factors affecting Interior Columbia basin salmonid populations. That assessment was intended to define the

FCRPS' "relative expectation…for recovery."[11] The collaboration's Framework working group developed high and low mortality estimates for all sources of mortality, including the FCRPS. The collaboration's Policy Working Group has not determined where in that range the Action Agencies' proposed action should be assessed. The range of "gaps" that the Framework approach would expect the FCRPS to fill was reviewed and the Action Agencies assessed whether the total survival improvements estimated in this biological analysis would "fill" those gaps. For the purposes of this comparison, the ICTRT gaps were used for "recent" ocean and "base hydro" conditions (corresponding to the base period used for R/S productivity estimation), and the ICTRT's 5 percent risk level.

The Conceptual Framework was intended, among other things, to "provide a clear and complementary link to ongoing recovery planning efforts."[12] As such, it can be understood to represent the collaboration parties' view of the appropriate contribution of the FCRPS toward long term recovery of the listed ESUs in the Interior Columbia River basin. Therefore it provides another "metric" for use in considering the impacts of the proposed action on a listed species' prospects for recovery. The results of this analysis are displayed in Table 8.

Table 7. Gap Calculations from the Conceptual Framework

Note: ICTRT gaps are expressed as multipliers. Gaps are for 5 percent risk, recent ocean/base hydro conditions. A "remaining" gap value <1.0 indicates no further improvement is necessary. Total survival changes combine all estimated survival improvements for the base-to-current and current-to-prospective adjustment EXCEPT the estimated hatchery improvements in the base-to-current table.

MPG	Population	TRT Gap	FCRPS Relative Impact (high)	FCRPS Relative Impact (low)	Framework Gap (high hydro)	Framework Gap (low hydro)	Total Survival Change	Remaining Framework Gap (high)	Remaining Framework Gap (low)
Lower Snake	Tucannon R.	1.55	0.86	0.54	1.46	1.27	1.72	0.85	0.74
Grande Ronde/ Imnaha	Catherine Cr.	3.16	0.58	0.31	1.95	1.43	2.15	0.91	0.66
	Lostine R.	1.88	0.79	0.47	1.65	1.35	1.81	0.91	0.74
	Minam R.	1.55	0.79	0.47	1.41	1.23	1.73	0.82	0.71
	Imnaha R.	1.88	0.79	0.47	1.65	1.35	1.43	1.15	0.94
	Wenaha R.	2.14	0.86	0.54	1.92	1.51	1.97	0.98	0.76
	Upper GR R.	3.97	0.58	0.31	2.22	1.53	2.08	1.07	0.74
S. Fork Salmon R.	South Fork	1.59	0.86	0.54	1.49	1.28	1.50	0.99	0.85
	Secesh R.	1.52	0.86	0.54	1.43	1.25	1.50	0.95	0.83
	East Fork South Fork	1.50	0.79	0.47	1.38	1.21	1.42	0.97	0.85
Middle Fork Salmon R.	Big Cr.	1.65	0.86	0.54	1.54	1.31	1.52	1.01	0.86
	Bear Valley Cr.	1.26	0.86	0.54	1.22	1.13	1.42	0.86	0.80

[11] 2006 FCRPS BiOp: Conceptual Framework for the Remand Process. First Quarterly Status Report, Documents filed with the court, 01/03/06.

[12] 2006 FCRPS BiOp: Conceptual Framework for the Remand Process. First Quarterly Status Report, Documents filed with the court, 01/03/06.

MPG	Population	TRT Gap	FCRPS Relative Impact (high)	FCRPS Relative Impact (low)	Framework Gap (high hydro)	Framework Gap (low hydro)	Total Survival Change	Remaining Framework Gap (high)	Remaining Framework Gap (low)
	Marsh Cr.	2.18	0.87	0.55	1.97	1.54	1.42	1.39	1.08
	Sulphur Cr.	2.03	0.87	0.55	1.85	1.48	1.42	1.31	1.04
	Camas Cr.	2.03	0.86	0.54	1.84	1.47	1.42	1.30	1.03
	Loon Cr.	2.13	0.87	0.55	1.93	1.52	1.42	1.36	1.07
	Chamberlain Cr.		0.86	0.54			1.42	0.00	0.00
	Lower Middle Fork		0.87	0.55			1.42	0.00	0.00
Upper Salmon	Lemhi R.	1.60	0.58	0.31	1.31	1.16	1.72	0.76	0.67
	Valley Cr.	1.96	0.79	0.47	1.70	1.37	1.47	1.16	0.93
	Yankee Fork	2.34	0.86	0.54	2.08	1.58	1.84	1.13	0.86
	Upper Salmon	1.49	0.79	0.31	1.37	1.13	2.02	0.68	0.56
	N. Fk. Salmon		0.87	0.55			1.42	0.00	0.00
	Lower Salmon	3.77	0.58	0.31	2.16	1.51	1.47	1.47	1.03
	East Fork Salmon	1.21	0.79	0.47	1.16	1.09	1.47	0.79	0.74
	Pahsimeroi	3.49	0.79	0.31	2.68	1.47	2.04	1.32	0.72

Note: FCRPS impacts are based on river flows that enter the FCRPS action area, including those that enter the Snake River at the toe of Hells Canyon Dam, which are effected by the operation of Reclamation's upper Snake Projects.

Briefly, the proposed action (without considering either improvements in the environmental baseline or other actions reasonably certain to occur) fills Framework gaps at the low end of the range for 18 of the 23 populations in this ESU for which the ICTRT has calculated gaps in its Interim Gaps Report. Gaps of between 3 percent and 8 percent remain at the low end of the Framework range for four populations in the Middle Fork Salmon MPG and 1 population in the Upper Salmon MPG. Interestingly, for the two populations in the Grande Ronde/Imnaha MPG for which the largest gaps remain in the Action Agencies' biological analysis (Catherine Creek and Upper Grande Ronde), the Framework analysis shows no gap at the high end of the range for Catherine Creek and only a 7 percent gap at the high end of the range for Upper Grande Ronde. On the other hand, gaps remain at both the high and low ends of the Framework range for nearly all of the populations in the Middle Fork Salmon MPG.

ADDITIONAL ACTIONS TO BENEFIT THE ESU

Other Reasonably Certain to Occur Actions[13]

This analysis does not yet include analysis of non-federal actions that are reasonable certain to occur, developed as part of the remand collaboration. Based on information developed in the remand collaboration, ESA listed populations of Snake River spring and summer Chinook salmon and steelhead in the Asotin and Tucannon sub-basins will benefit from a combined 68 non-federal habitat improvement actions.

Other Federal Actions that have completed ESA Consultation

The Action Agencies' review of federal actions that have completed section 7 consultations is not yet complete. The results of the review will be included in the environmental baseline of the Biological Analysis.

OBSERVATIONS

Lower Snake Major Population Group

There are two populations in this MPG, the Tucannon River and Asotin Creek populations. However, the ICTRT has determined that the Asotin Creek population is functionally extirpated. The Tucannon River population has a low risk of extinction at all modeled QET sensitivities.

The 20- and 12-year lambda estimates for the Tucannon River population are greater than 1.0; however, the presence of hatchery fish in the spawning population causes this indicator to overestimate annual population growth.

Extinction probability modeling suggests that the only extant population in this MPG is at a low risk of extinction. This conclusion is consistent with the estimated future values of other biological indicators, such as R/S productivity and abundance trends.

Base period trends of natural-origin spawners are less than 1.0. Base period R/S is also less than 1.0. However, after considering recently implemented actions and the likely effects of the proposed action, we estimate that all three recovery indicators will be well above 1.0. Conceptual Framework gaps are filled at the high and low ends of the range.

Grande Ronde/Imnaha MPG

Of the eight populations in this MPG, Big Sheep Creek and Lookingglass Creek are considered by the ICTRT to be functionally extirpated. After considering recently implemented actions and the likely effects of the proposed action, all other populations are at a low risk of extinction at QET=1. All populations except Catherine Creek are at low risk of extinction at QET=10. However, 1 of the 7 extant populations modeled are at moderate to high risk at QET=30, and 3 of the 7 populations are at moderate to high risk at QET=50. The populations at moderate to high risk at higher QETs are all supported by “safety net” hatchery programs that are expected to ameliorate short-term extinction risk while limiting factors that have led to the decline of these

[13] Many of the actions listed above have a cost-share component with a variety of other federal funding sources and therefore may be properly described as contributing to the status of the environmental baseline rather than cumulative effects. The action agencies will sort the projects described in this paper into the appropriate parts of the biological analysis, but for the purposes of discussion at the April 11, 2007 PWG workshop, believe that the effect on prospective status will be the same.

populations are addressed. Indeed, when supplementation is assumed to continue into the future, only the Catherine Creek population has a moderate to high risk at the higher QETs, while the Upper Grande Ronde population is estimated to have a 6 percent risk at QET=50.

Even with significant efforts to improve tributary habitat for the Catherine Creek and Upper Grande Ronde River populations, three of the six populations in this MPG fail to meet our criterion for R/S, when we assume only the survival improvements from our habitat actions that will accrue during the 10 year BiOp period. However, two of the three (Imnaha River and Catherine Creek) have shown increasing trends in abundance since 1990, while Upper Grande Ronde R. has been flat (1.0). This trend is likely due in part to a boost to natural spawner numbers resulting from ongoing supplementation from a hatchery program. The boost is provided by the second generation progeny of fish spawned in the hatchery program (so-called F_2 progeny of hatchery-spawned fish). In effect, the hatchery programs for these populations provide not only a hedge against short term extinction risk, they also provide an annual “subsidy” to the population that results in a steady increase in abundance of naturally spawning fish. This increase buys time to address the limiting factors that led to the decline in productivity in the first place. Making the needed productivity improvements for Catherine Creek and the Upper Grande Ronde populations, in particular, is expected to take a decades long effort on the part of the federal government working with state, tribal and local interests, public and private.

In addition, the Action Agencies propose to fund numerous hatchery actions to continue and improve supplementation efforts for the Catherine Cr., Imnaha R., and Upper Grande Ronde R. populations. These efforts are expected to boost abundance in the near term and, combined with broader efforts to improve survival, provide a boost to the recovery prospects for these populations. And though we have not attempted to quantitatively estimate the productivity improvements that might accrue to the naturally-spawning populations as a result of these efforts, it is likely that there will be improvements to population productivity as we continue to address negative genetic, ecological, demographic, and facility effects of past hatchery practices.

On the other hand, Conceptual Framework gaps are filled at the low end of the range for all populations in this MPG, and at the high end of the range for all but two populations.

South Fork Salmon MPG

There are four extant populations in this MPG, South Fork Salmon, Secesh R., the East Fork of the South Fork Salmon and the Little Salmon River. Spawner-recruit data are not available for the Little Salmon River population. All populations are at a low risk of extinction for all modeled QETs.

Average 20-year R/S productivity is 0.78 for the South Fork Salmon population and .98 for Secesh R. and the East Fork South Fork. Short- and long-term lambda and abundance trends of natural-origin spawners are greater than1.0 for all populations. Only the South Fork Salmon population has a significant number of hatchery-origin fish in the spawning population (24 percent over the 20-year period used to estimate R/S). Therefore lambda is a useful measure of annual population growth for at least two of the populations.

After considering the effects of the proposed action, it is estimated that R/S productivity will be well above replacement (1.0) for all populations and that positive population growth rates will continue into the future. Conceptual Framework gaps are filled at the high and low ends of the range for all populations in this MPG.

Middle Fork Salmon MPG

There are nine populations in this MPG. Spawner-recruit data is lacking for three of those populations: Chamberlain Creek, Lower Middle Fork Salmon, and Upper Middle Fork Salmon. Further, data limitations preclude estimation of several of the metrics for Loon and Camas creeks.

All four populations for which valid results were obtained have a low risk of extinction at QET=1. Big Creek and Bear Valley Creek have low risk at QET=10. However Marsh Cr. has a gap at this sensitivity of 1.12 (an additional 12 percent survival improvement needed to meet the criterion) and Sulphur Cr. has a remaining gap of 1.13. Three of four populations fail to meet the criterion at QET=30 and QET=50.

All of the populations in this MPG – with the exception of Bear Valley Cr. – are currently at relatively low levels of abundance. The 10-year geometric mean abundance is below 50 fish for three populations, just above 50 for one population and below 100 for one population. Bear Valley Cr. is the exception, with a 10-year geomean abundance of 188 fish.

A population will naturally have much higher modeled extinction risk when the population's current abundance is already below (or only slightly above) the model's quasi-extinction threshold. In fact, of the six populations in this MPG for which good data is available, three have fallen below the 50 spawner for four consecutive years modeling threshold within the last 20 years, yet are *not* extinct. Two others have fallen below the threshold in three consecutive years during the mid-1990s. The significant rebounds in abundance experienced by these populations between 2001 and 2003 indicate a resilience that is not captured by the most conservative modeling assumptions.
Higher QETs used for recovery planning purposes are probably not appropriate for short-term extinction risk modeling, particularly for relatively small populations. Therefore we consider the full range of modeled sensitivities in concert with other productivity and population growth rate indicators in considering extinction risk for individual populations.

For instance, recent (1990-2005) trends in abundance of natural-origin spawners indicate positive growth trends for all of the populations in this MPG, including the populations with moderate-to-high risk at higher QETs. After considering the effects of the proposed action, these trends are expected to continue and improve, suggesting that short-term extinction is less likely than the model might suggest. The same can be said for recruit-per-spawner productivity and lambda.

It should also be noted that the ICTRT's gap analysis estimates significantly *smaller* gaps for most of the populations at risk in this MPG than our analysis indicates. The ICTRT estimates a needed survival improvement (at the 5 percent risk level) of 65 percent for the Big Creek population, 26 percent for Bear Valley Creek, 118 percent for Marsh Creek, and 103 percent for Sulphur Creek. These are the improvements the ICTRT suggests would be needed for full recovery of these populations. Our analysis indicates needed survival improvements to achieve the 5 percent risk level (at QET=50) of 169 percent for Big Creek, 24 percent for Bear Valley Creek, 300 percent for Marsh Creek, and 509 percent for Sulphur Creek. The significant disparity between these analytic results suggests that the results are driven by the models and represent, in part, the high degree of uncertainty in modeling extinction probabilities.

Lambda estimates for the most recent 12- and 20-year periods are greater than 1.0 indicating growing populations in the Middle Fork Salmon MPG. After considering recently implemented actions and the likely effects of the proposed action, future lambda estimates indicate populations that would be expected to grow at rates of between 12 percent and 21 percent each year, until a state of equilibrium is approached. R/S productivity is expected to be greater than 1.0 for populations in this MPG, as well. Conceptual Framework gaps are filled at the high and low ends of the range for one of the six populations for which ICTRT gaps have been estimated. Remaining gaps at the low end of the range are between 3% and 8%, and at the high end between 30% and 39%.

Upper Salmon MPG

There are nine populations in this MPG. However, Panther Creek is believed to be functionally extirpated. Spawner-recruit data are lacking for the N. Fork Salmon population.

All modeled populations have acceptably low risk of extinction at QET=1. Three of four modeled populations have acceptably low risk at QET=10 and QET=30. Only the Yankee Fork population fails to meet the criterion at these sensitivities. Three of the four populations fail to meet the criterion at QET=50. Of those, Yankee Fork has a 10-year geomean abundance at or below the 50 spawner QET, which explains (in part) the modeling results at QET=50. Valid results were not obtained for the Lemhi River, Yankee Fork, Pahsimeroi and North Fork Salmon populations.

Base period R/S productivity for all populations except Yankee Fork is greater than 1.0. The Pahsimeroi is treated as a special case and is explained below. After considering the effects of our action, R/S productivity is expected to be well above 1.0 (replacement rate) for all populations.

Recent trends in abundance of natural-origin spawners (1990-2003, 2004 or 2005, depending on the population) are expected to continue and improve after the effects of the proposed action are considered. Lambda estimates for those populations with little known hatchery influence have been >1.0 for both 20-and 12-year periods. These population growth rates are expected to continue and improve into the future. Conceptual Framework gaps are filled at the low end of the range for all populations except the Lower Salmon, which has a remaining gap of 3%. Framework gaps are filled at the high end of the range for three of seven populations.

The Pahsimeroi River population was largely managed as a hatchery population until at least 1986. The ICTRT reports no natural spawners prior to 1986, though the Pahsimeroi hatchery is reported to have allowed fish to pass their weir and spawn naturally upstream prior to that time. Until about 1985, the Pahsimeroi hatchery was using a non-native spring-run broodstock. In 1985 IDFG discontinued the stock and began to use the native Pahsimeroi summer run Chinook as broodstock. Beginning that year through 1990 the hatchery program didn't use the early returning, non-native fish for broodstock (most were outplanted to the Yankee Fork, but the disposition of many is unknown). In 1991 the hatchery used all returns for broodstock and continues to do so, allowing the excess adults to escape past the weir.[14] Beginning in about 1990 the population as a whole grew steadily (this was likely due in large part to the change to a native summer-run broodstock). The population's growth was impressive during the 1990s, a period when many other populations in this ESU struggled. Average R/S productivity since the

[14] E-mail correspondence from Tim Fisher relating a conversation with Paul Abbott, Idaho Power Company, 4/3/07

1990 brood year has been 0.90. The trend in abundance for natural-origin spawners has been 1.33 during that period.

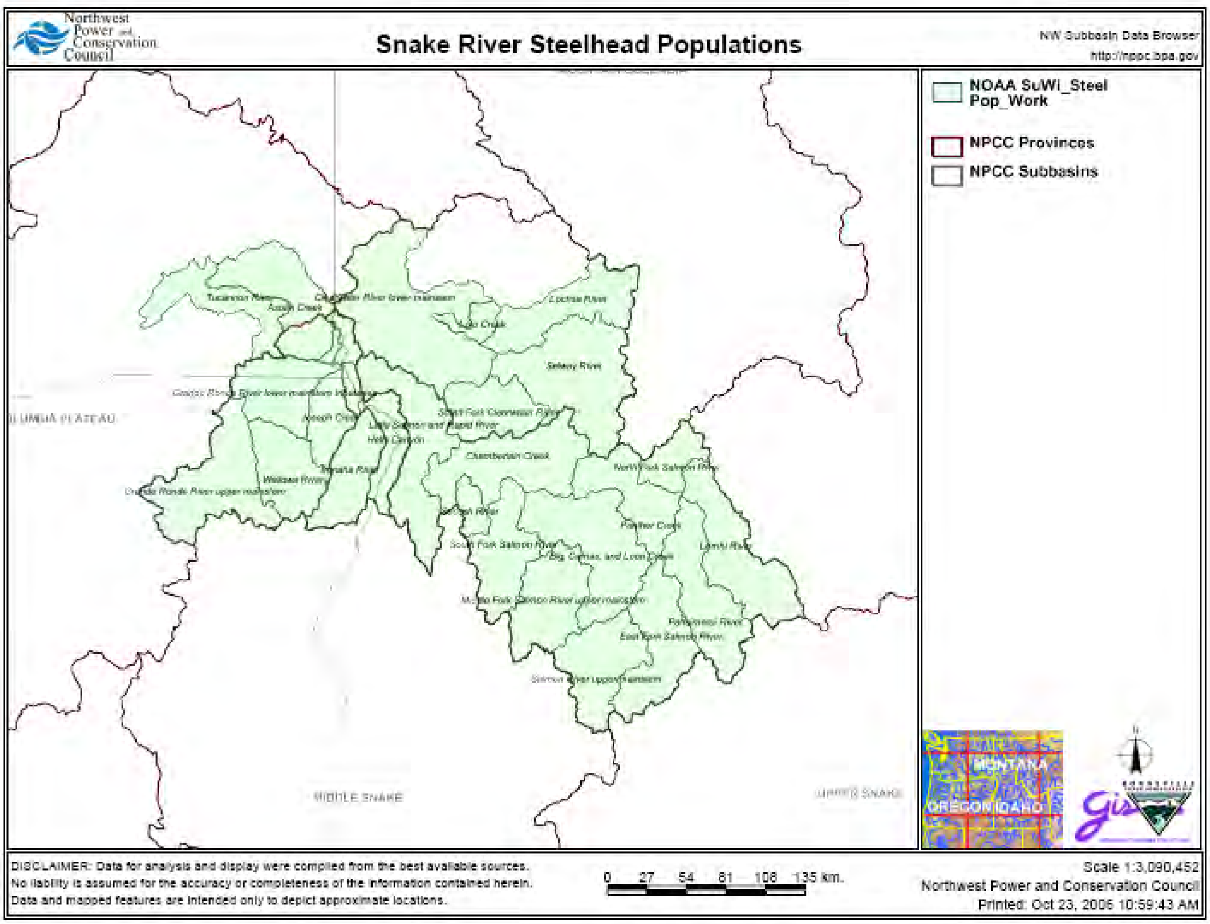
We conclude that the first four years of data after the change to a native broodstock (and this population's *de facto* reintroduction into the wild) are not representative of the population's dynamics. This conclusion is supported by the fact that the Pahsimeroi population's 15-year geomean R/S (brood years 1986-2000) is more than 2 standard deviations below the mean of the ESU as a whole, which is considered exceptional. However, when the first four years of observations are ignored, the geomean R/S of the Pahsimeroi population is not exceptional.

The ICTRT reports a 15-year R/S estimate of .39 for the Pahsimeroi population. This BA uses an 11 yr. R/S estimate of 0.90 as its base period estimate.

This is not a final federal agency product. Rather, it is a pre-decisional document prepared by the Action Agencies that reflects present understandings of currently available information and analyses, and of the progression of discussions with the sovereigns in the collaborative process. Revisions and refinements are to be expected based on further discussions with the sovereigns over new and modified proposed federal actions upon which the action agencies will ultimately consult. Finally, the information in this product does not constitute an analysis of whether the identified measures would or would not jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Furthermore, this document does not in any way interpret or apply the regulatory definitions of the statutory phrases "jeopardize the continued existence of" and "destruction or adverse modification."

Snake River Steelhead DPS

Please note that all of the information in this paper is still preliminary. In particular, benefits assessments are still under review. For certain populations additional actions are being considered that might be implemented by the Action Agencies or by others.



DPS Description[1]	
Threatened	Listed under ESA in 1997; reaffirmed in 2006
5 - 6 current major population groups (*key research needed to determine if fish occupying several small tributaries in Hells Canyon are hatchery strays*)[2]	24 – 25 current populations
Hatchery programs included in DPS	Tucannon, Dworshak, Lolo Creek, North Fork Clearwater, East Fork Salmon, Little Sheep/Imnaha

Major Population Groups	**Populations**
Clearwater River	Clearwater River lower mainstem Clearwater River south fork Lochsa River Lolo Creek Selway River
Grande Ronde River	Grande Ronde River lower mainstem tributaries Grande Ronde River upper mainstem Joseph Creek Wallowa River
Hells Canyon	Hells Canyon *(key research needed to determine if fish occupying several small tributaries in Hells Canyon are remnants of this MPG or hatchery strays)*[3]
Imnaha River	Imnaha River
Lower Snake	Asotin Creek Tucannon River
Salmon River	Lower Middle Fork (Big, Camas, and Loon Creek) Chamberlain Creek East Fork Salmon River Lemhi River Little Salmon and Rapid River Middle Fork Salmon River upper mainstem North Fork Salmon River Pahsimeroi River Panther Creek Salmon River upper mainstem Secesh River South Fork Salmon River

INTRODUCTION

This paper briefly summarizes the current biological status of this distinct population segment (DPS). However, due to the lack of population-specific information for the majority of the populations comprising this DPS, the quantitative aspect of this analysis is limited to the three

[1] Listing determination (71FR834); Interior TRT July 2003 description of independent populations www.nwfsc.noaa.gov/trt/col_docs/independentpopchinsteelsock.pdf ; May 2005 update www.nwfsc.noaa.gov/trt/col_docs/updated_population_delineation.pdf
[2] January 2008 ICTRT memo Scenarios for MPG and ESU viability consistent with TRT viability criteria
[3] January 8, 2007 memo from ICTRT to NMFS Northwest Regional Office re: Scenarios for MPG and ESU viability consistent with TRT viability criteria.

populations for which information is available, as well as the estimated effects on two “average” population profiles developed by the Interior Columbia Technical Recovery Team (ICTRT). Given the uncertainties regarding the current status of most of these populations, the assessments in this analysis will be primarily qualitative. Without a reasonable basis for estimating base period status for individual populations, it is not possible to perform the detailed gap analysis undertaken for other Interior Columbia evolutionarily significant units (ESUs). Almost all of the metrics used in this analysis are estimates for individual populations within the DPS. The Endangered Species Act is concerned with the status of a species, DPS, or Evolutionarily Significant Unit (ESU). Individual populations and major population groups (where they exist) obviously contribute to ESU status. However, the status of the ESU is not wholly dependent upon the status of any of the ESU’s individual components.

Snake River Steelhead spawn and rear in the mainstem Snake River and its tributaries between Ice Harbor Dam and the Hells Canyon Hydropower Complex. The primary spawning and rearing habitats are in the middle to lower upper reaches of the numerous rivers and tributaries in the states of Washington, Oregon, and Idaho. The upriver limit of migration has been Hells Canyon Dam (Snake River Mile 250) since it was completed in 1961. Built without adequate fish passage facilities, the Idaho Power Company’s Hells Canyon Dam complex blocked migration of all anadromous salmonids and eliminated access to historically-occupied upriver habitat. Whether the populations previously utilizing the blocked habitat would be considered part of the current distinct population segment (DPS) is unknown.

The Interior Columbia Technical Recovery Team (ICTRT) has identified 20 extant populations occupying tributaries of the mainstem Snake River, the Grand Ronde River, the Clearwater River and the Salmon River. The ICTRT has organized these populations into five major population groups (MPGs): the Lower Snake River, Imnaha River, Grande Ronde River, Clearwater River, and Salmon River MPGs. The Lower Snake River MPG includes two populations: the Tucannon River and Asotin Creek; the Imaha River MPG contains a single population: the Imnaha River; the Grande Ronde MPG contains four populations: the Upper Mainstem, Lower Mainstem. Joseph Creek and Wallowa River; the Clearwater River MPG includes five extant and one extirpated populations: the Lower Mainstem, Lolo Creek, Lochsa River, Selway River, South Fork, and the North Fork (extirpated); and the Salmon River MPG includes 12 populations: the Little Salmon/Rapid River, Chamberlain Creek, Secesh River, South Fork Salmon River, Panther Creek, Lower Middle Fork Tributaries, Upper Middle Fork Tributaries, North Fork Salmon River, Lemhi River, Pahsimeroi River, East Fork Salmon River, and Upper Mainstem Salmon River.

Inland steelhead of the Columbia River Basin, and especially the Snake River DPS, are commonly referred to as either A-run *or* B-run*.* These designations are based on the observation of a bimodal migration of adult steelhead at Bonneville Dam (Columbia River Mile 147) and differences in age-at-return (1- versus 2-ocean) and adult size observed among Snake River steelhead. Adult A-run steelhead enter fresh water from June to August; as defined, the A-run passes Bonneville Dam before 25 August (CBFWA 1990, IDFG 1994). Adult B-run steelhead enter fresh water from late August to October, passing Bonneville Dam after 25 August (CBFWA 1990, IDFG 1994). Above Bonneville Dam (e.g., at Lower Granite Dam on the Snake River, 695 km from the mouth of the Columbia River), run-timing separation is not observed, and the groups are separated based on ocean age and body size (IDFG 1994). A-run steelhead are defined as predominately age-1-ocean, while B-run steelhead are defined as age-2-ocean (IDFG 1994). Adult B-run steelhead are also thought to be on average 75-100 mm larger than A-run steelhead of the same age; this is attributed to their longer average residence in salt water (Bjornn 1978, CBFWA 1990, CRFMP TAC, 1991). It is unclear, however, if the life history and body size differences observed upstream have been correlated back to the groups forming the bimodal migration observed at Bonneville Dam. Furthermore, the relationship between patterns observed at the dams and the distribution of adults in spawning areas throughout the Snake River Basin is not well understood. A-run steelhead are believed to occur throughout the steelhead-bearing streams of the Snake River Basin; additionally, inland Columbia River steelhead outside of the Snake River Basin are also considered A-run (IDFG 1994). B-run steelhead are thought to be produced only by populations in the Clearwater River MPG and by selected populations in the Salmon River MPG (i.e., Secesh, South Fork, Lower Middle Fork, and Upper Middle Fork). Significant uncertainties in the available information make a quantitative analysis problematic for this DPS.

Resident *O. mykiss* are believed to be present in many of the watersheds used by Snake River steelhead. Very little is known about interaction between co-occurring resident and anadromous forms within this DPS.

Hatchery programs operating in the geographic area occupied by the Snake River steelhead DPS and listed as part of the DPS include the WDFW's Tucannon Hatchery, USFWS Dworshak NFH, Lolo Creek, North Fork Clearwatwer, East Fork Salmon, and Little Sheep/Imnaha. These hatchery programs were derived using broodstock from local, natural populations and produce roughly half a million smolts annually. Other hatchery programs within the geographic area of the DPS but not listed include Lyons Ferry, Cottonwood Pond - Wallowa stock, Wallowa Hatchery and Big Canyon satellite pond, Lower Snake and Hells Canyon Mitigation, Pahsimeroi Hatchery, Dworshak B stock, and Sawtooth Hatchery A stock. These hatchery programs produce about 5 million smolts annually.

Harvest of Snake River steelhead is managed independently for A- and B-run steelhead under the Columbia River Fisheries Compact. A-run fish are harvested on a sliding scale (depending on estimated run sized) between 4.5 and 10 percent. B-run fish are harvested up to a 17 percent limit. The 2000 to 2003 combined harvest rates have averaged 12.4 percent. The majority of this harvest occurs in the tribal gill net fisheries in Zone 6 and in sport fisheries in Idaho.

NOAA's Biological Review Team recently confirmed this DPS's Threatened status in its June 2005 status review, while noting that adult returns had generally improved in recent years relative to the 1990s. For the purposes of recovery planning, the Interior Columbia TRT assigns the "average" A-run steelhead population a "Medium" risk rating for abundance and productivity. The "average" B-run population is assigned a "High" risk rating for abundance and productivity.

Human impacts and current limiting factors for this ESU come from multiple sources: hydro passage, habitat degradation, hatchery effects, fishery management and harvest decisions predation, and other sources.

Key Limiting Factors

Salmon and steelhead have been adversely affected over the last century by many activities including human population growth, introduction of exotic species, over fishing, developments of cities and other land uses in the floodplains, water diversions for all purposes, dams, mining, farming, ranching, logging, hatchery production, predation, ocean conditions, loss of habitat and other causes (Lackey et al.2006)[4]. Summarized below are key limiting factors for this ESU identified by NOAA in the ESU Overviews for the remand collaboration[5].

Hydro	Snake River Basin steelhead migrate through four Columbia River Dams and two to four Snake River Dams as juveniles and as adults. Efforts to improve survival through flow management, project modifications, and transportation of smolts have improved survival through the dams to around 50 percent and declines have slowed. According to the Step 4 report, the estimated portion of the human impact attributable to the FCRPS dams (compared to natural river estimates) is 71 to 88 percent. If the latent mortality hypothesis is omitted, the human impact associated with the hydro system is 42 percent. Hydro impacts include volume, timing and quality of flows that enter the FCRPS action area, including flows from the Snake River at the toe of Hells Canyon Dam, which are impacted by the operation of Reclamation's upper Snake River projects and the mainstem effects of Reclamation's other projects within the Columbia Basin.
Predation	Predation has been noted as a factor limiting fish survival for steelhead in the mainstem reservoirs and in the Columbia estuary. In recent years, avian predators at Crescent Island have taken from 7to14 percent of the PIT tagged steelhead released from Lower Monumental dam. Avian predators also take significant numbers of steelhead in the estuary.
Habitat	Many of the historically productive populations such as the Wenaha and Minam, Selway, Lochsa, Chamberlain, and upper and lower Middle Fork Salmon lie within designated wilderness where habitat conditions are mostly pristine. This being the case, there is probably little opportunity to improve productivity for these populations through habitat improvements. Current and legacy land uses continue to cause declines in steelhead survival in some tributaries. Of particular concern are reduced complexity of the stream system, water quantity during the summer, and water quality (mostly temperature and sediment). Some populations would benefit from these types of habitat improvements, including the lower Snake MPG, lower Clearwater A-run, upper Grande Ronde and upper Salmon River. According to the Step 4 report, the estimated portion of the human impact attributable to combined habitat effects in the tributaries and the estuary is 20 to 26 percent. If the latent mortality hypothesis is omitted, the human impact associated with habitat degradation is 14 percent.
Harvest	As fisheries have become more stock-specific, direct commercial harvest of Snake River Basin steelhead has been eliminated. The remaining harvest is a reduced tribal allocation and the incidental catch from other fisheries. Any impact from the catch and release recreational fishery is low. Together these result in a 5 to 20 percent mortality rate. This harvest rate has been reduced from 40 to 60 percent historically, but may still be a factor in decline of some populations. According to the Step 4 report, the estimated portion of the human impact attributable to combined Tribal and non-Tribal harvest effects is 17 to 19 percent. If the latent mortality hypothesis is omitted, the range associated with the combined harvest impacts is 31 to 1 percent.

[4] Lackey, Robert T, Denise H. Lach, and Sally L Duncan. Wild salmon in Lackey, Robert T, Denise H. Lach, and Sally L Duncan. Wild salmon in western north america: the historical and policy perspective. Pp 13-55. In: Salmon 2100: The future of wild pacific salmon. 2006. Robert T Lackey, Denise H. Lach, and Sally L. Duncan (editors).
[5] Master - Summary of Key ESU Info Int Columbia - table 24oct06, p. 7, (Limiting factors summarized and ranked by Paula Burgess, NOAA Fisheries, utilizing information found in working draft of ESU Overviews, 2005 Pacific Coastal Salmon Recovery Fund Report to Congress and local recovery plans.)

Hatcheries	Planned steelhead smolt production in the Snake River Basin totals just over 10 million fish annually. Most steelhead production is based on non-listed stocks that are released for harvest augmentation and mitigation. Most hatchery production is managed to be isolated from natural spawning areas; most of the releases are made at weirs and acclimation ponds or in stream sections where hatchery-origin adults are not likely to spawn successfully. Supplementation programs exist in the Tucannon and East Fork Salmon Rivers; Little Sheep Creek on the Imnaha are exceptions to this rule. According to the Step 4 report, the estimated portion of the human impact attributable to hatchery effects is 4 to 6 percent. If the latent mortality hypothesis is omitted, the human impact associated with the hatchery system is 1 percent.

BASE STATUS

Methods for Estimating Snake River Steelhead Average A-run and B-run Population Profiles

The method used to estimate the average A-run and B-run population profiles is briefly described in the ICTRT Interim Gaps Report.[6] To quote from the report: "We developed estimates for two average populations representing the remaining populations within this ESU, each representing a major run type (A and B). For B run steelhead populations, productivity and abundance characteristics were estimated for an average population, assuming that natural origin returns over Lower Granite Dam were allocated proportionally among populations. The Grand Ronde populations with specific data series are classified as A-run steelhead. Estimated natural origin returns accounted for in the Grand Ronde populations [*Joseph Creek, Upper Grande Ronde and Wallowa Rivers*] were subtracted from the count of natural origin A-run steelhead at Lower Granite Dam." The ICTRT assume that returns not accounted for in the available population sets were distributed among the remaining populations in proportion to available habitat. Average population profiles were developed accordingly.

DPS Abundance and Trends

As noted, population specific adult abundance trend data sets are generally not available for Snake River steelhead populations. The estimated 10 year geomeans abundance for the average A-run population is 456 natural-origin spawners. The 10 year geomean abundance for the average B-run population is estimated to be 272 natural-origin spawners. Five year estimates of geomean abundance are, respectively, 1311 and 383 natural-origin spawners, indicating an improvement in recent years. 1980 to most recent and 1990 to most recent abundance trends are both greater than 1.0 for the average A-run population and less than 1.0 for the average B-run population.

Extinction Probabilities

It was only possible to develop extinction probability results for the ICTRT's average A-run population, and two actual populations: the Grande Ronde Upper Mainstem and Joseph Creek A-run steelhead populations. Extinction probability estimates were developed for populations in this DPS using the Ricker production function, which was fit to spawner-recruit data from brood years 1978 to the present. The estimated Ricker function was used to project populations over

[6] Required Survival Changes to Meet Technical Recovery Team Abundance and Productivity Viability Criteria, Interior Columbia TRT, May 17, 2006

a 24-year time horizon to estimate extinction probability. Alternative quasi-extinction thresholds (QETs) of 1, 10, 30, and 50 spawners were used in the analysis. In the modeling, extinction was assumed to occur when spawners fell below the quasi-extinction threshold for four years running. Reproductive failure was assumed to occur in any year in which spawner numbers fell below 10, except in the case of QET=1, where reproductive failure was assumed when spawners fell below 2.[7] It was not possible to calculate gaps for this metric.

Twenty-four year extinction probabilities were quite low at all modeled QETs for the Grande Ronde Upper Mainstem and Joseph Creek populations. Base period risks are low at QETs, 1, 10, and 30 for the average A-run population and moderate at QET=50. It is assumed that base period extinction probabilities are generally higher for B-run populations.

RECRUIT-PER-SPAWNER PRODUCTIVITY, LAMBDA, AND TRENDS

The steelhead populations in this DPS are all summer run, spawning in late spring and early summer. As a result of environmental conditions during the spawning period, it can be difficult to conduct representative surveys of the number of spawners within specific populations using redd counts or fish counts.

As noted, detailed abundance trend and run reconstruction information is only available for the Grande Ronde Upper Mainstem and Joseph Creek populations. A dataset for two index reaches in the Wallowa River population has been developed by the ICTRT. This dataset was used to estimate R/S productivity for the Wallowa River population. All of these populations have relatively high natural abundance and productivity levels.

The productivity and survival metrics for the average A-run and B-run populations and the three populations for which information is available are summarized in Tables 1a and 1b. Productivity, as reflected by estimates of recruits per spawner (R/S) using a 20-year time series of data, average 1.26 for the A-run populations, indicating that these populations are on a trend toward recovery. In contrast, the R/S average 0.82 for the B-run population, indicating a needed survival improvement of at least 18 percent over the base period to meet the R/S criteria. No 20-year estimates of median population growth rate (λ) are available for the majority of the populations. Twelve year λ estimates for both A-and B-run populations averaged 1.0 or greater.

Table 1a. Base status metrics.

* Note: *A- or B-run classification in parentheses. For R/S, lambda and trend, a value >1.0 indicates a growing population; a value <1.0 indicates a population in decline.*

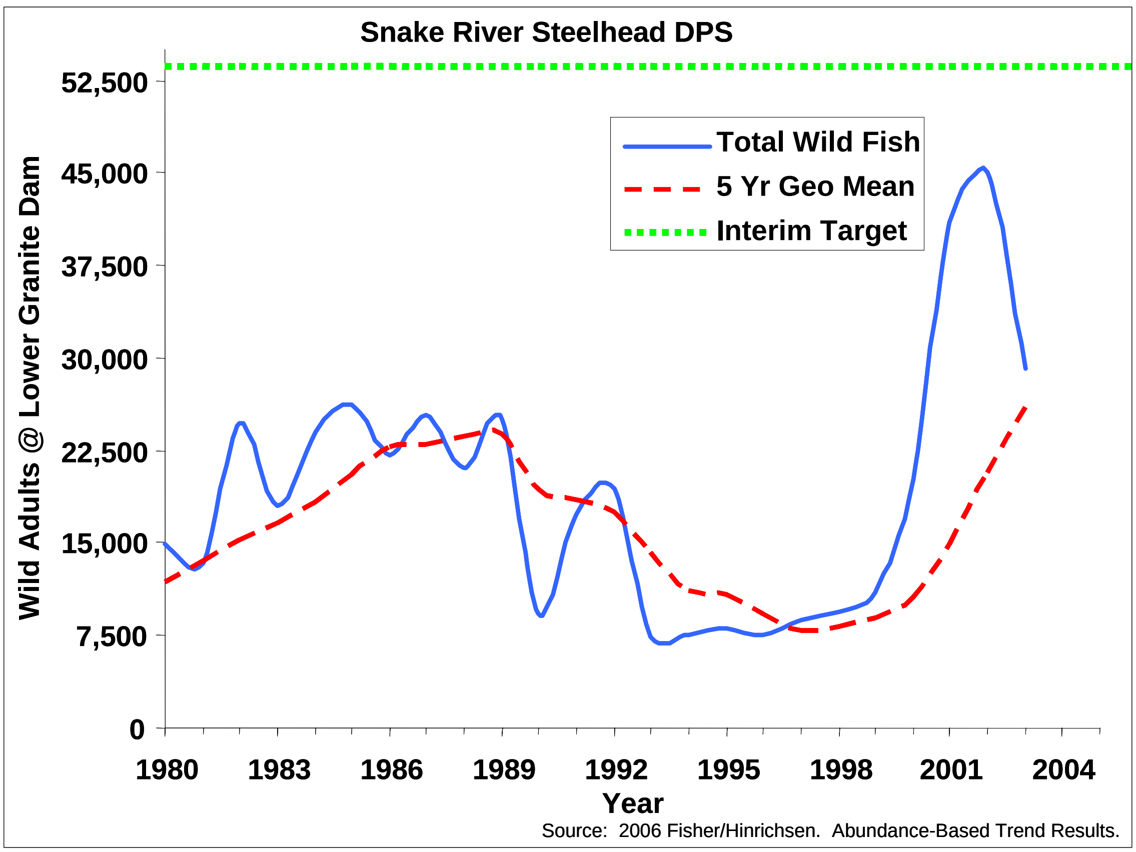
MPG	Population[a]	20 year R/S	10 year R/S	20 year λ	12 year λ	1980-current Trend	1990-current Trend
	Average A-run population	1.26	1.49	N/A	1.07	1.01	1.08
	Average B-run population	0.82	0.86	N/A	1.00	0.95	0.99
Grande Ronde	Upper Mainstem (A)	1.00	0.96	1.01	0.98	0.99	1.01
	Joseph Cr. (A)	1.27	1.42	1.05	1.00	1.02	1.05
	Wallowa R. (A)	1.26	1.49	N/A	1.07	1.01	1.08
All other MPGs	All other populations	N/A	N/A	N/A	N/A	N/A	N/A

[7] Reproductive failure is the assumption that zero progeny are produced in any year where spawner numbers fall below the identified threshold.

Table 1b. Estimated extinction risk.
Note: A risk level of 0.11 indicates an 11percent risk of extinction, assuming that spawner abundance below the QET for four years running results in extinction.

MPG	Population	Ext. Risk QET = 1	Ext. Risk QET = 10	Ext. Risk QET = 30	Ext. Risk QET = 50
	Average A-run population	0.00	0.02	0.05	0.11
	Average B-run population	N/A	N/A	N/A	N/A
Grande Ronde	Upper Mainstem (A)	0.00	0.00	0.00	0.00
	Joseph Cr. (A)	0.00	0.00	0.00	0.00
All other MPGs	All other populations	N/A	N/A	N/A	N/A

Abundance and a rolling 5-year geometric mean of abundance for the DPS compared to NOAA Fisheries' interim recovery target are shown in **Error! Reference source not found.**.



Based on these base estimates of survival metrics for the 25 Snake River steelhead populations, Table 2 summarizes the needed improvements in life cycle survival to bring the estimates in line with the proposed survival standard. Note that gap estimates for the average A-run and B-run populations are rough approximations and should not be understood to represent the actual condition of any specific population in this DPS. A metric of 1.0 reflects no gap. A number below 1.0 reflects a positive condition, while a number above 1.0 reflects a gap. For example, a gap of 1.2 indicates that 20 percent productivity is needed in the future.

Table 2. Base status gaps.
**Note: Gaps are expressed as multipliers. For example, a 1.10 gap indicates a 10 percent improvement is necessary to close gap. If gap is ≤ 1.0, no further improvement is necessary to close gap.*

MPG	Population	20 year R/S Gap	12 year λ Gap	Long-term Trend Gap
	Average A-run population	0.79	0.74	0.96
	Average B-run population	1.22	1.00	1.20
Grande Ronde	Upper Mainstem(A)	1.00	1.10	1.05
	Joseph Cr. (A)	0.79	1.00	0.91
	Wallowa R. (A)	0.78	N/A	N/A
All other MPGs	All other populations	N/A	N/A	N/A

Spatial Structure and Biological Diversity

Conserving and rebuilding sustainable salmonid populations involves more than meeting abundance and productivity criteria. Accordingly, NOAA Fisheries has developed a conceptual framework defining a Viable Salmonid Population, or VSP (McElhany et al. 2000). In this framework there is an explicit consideration of four key population characteristic or parameters for evaluating population viability status: abundance, productivity (or population growth rate), biological diversity, and population spatial structure. The reason that certain other parameters, such as habitat characteristics and ecological interactions, were not included among the key parameters is that their effects on populations are implicitly expressed in the four key parameters. Based on the current understanding of population attributes that lead to sustainability, the VSP construct is central to the goal of ESA recovery, and warrants consideration in a jeopardy determination. However, it must also be stressed that the ability to significantly improve either a species' biological diversity or its spatial structure and distribution is limited within the timeframe of the Action Agencies' proposed action.

Spatial Structure -- Spatial structure, as the term suggests, refers to the geographic distribution of individuals in a population unit and the processes that generate that distribution. Distributed populations that interact genetically are often referred to as metapopulation. Although the spatial distribution of a population, and thus its metapopulation structure, is influenced by many factors, none are perhaps as important as the quantity, quality, and distribution of habitat. One way to think about the importance or value of a broad geospatial distribution is that a population is less likely to go extinct from a localized catastrophic event or localized environmental perturbations.

Biological Diversity -- Biological diversity within and among populations of salmonids is generally considered important for three reasons. First, diversity of life histories patterns is associated with a use of a wider array of habitats. Second, diversity protects a species against short-term spatial and temporal changes in the environment. And third, genetic diversity is the so-called raw material for adapting to long-term environmental change. The latter two are often described as nature's way of hedging its bets – a mechanism for dealing with the inevitable fluctuations in environmental conditions – long and short-term. With respect to diversity, more is better from an extinction-risk perspective.

The ICTRT has divided the Snake River steelhead DPS into 20 extant populations distributed across six MPGs. Because of the paucity of demographic and other data on the individual populations, the ICTRT did not classify these populations based on spatial structure and diversity (SSD) risk. What information is available does suggest that A-run populations in most

MPGs occupy a diverse array of habitats and are performing well (i.e., are mostly replacing themselves). The situation is less clear for B-run populations which, based on sparse data, appear to be on a downward trend in all their habitats. The long-term status of this DPS from both an abundance/productivity and SSD perspective is at this time unclear. Developing the information to better understand the status of this DPS is a priority for more intensive monitoring and evaluation.

Biological Analysis of Actions: Recruits-per-Spawner, Lambda, and Trends with Current and Prospective Adjustments

As described in detail in Appendix D, the Base Status is the historical status of the ESU, defined as the status of the population based on the *average* of quantitative survival metrics estimated from a time series of abundance data beginning in about 1980. For the most part, longer term averages (generally 20 years) were used where they were available. In the biological analysis, this is the starting point, shown in the tables above.
The next step is Current Status, an adjustment of the initial base estimates to reflect our best estimate of current survivals, as opposed to an average of survivals that prevailed over a period in the past. This would obviously include recent improvements already implemented but not fully reflected in the Base conditions. Current Status is defined as estimated survival metrics adjusted for recently implemented changes in hydropower configuration and operations, hatchery operations, tributary and estuarine habitat improvements, and reduced avian predation. These are actions that have recently been implemented, but their effects are not reflected in the time series of survival data that for the most part started in 1980.

The final step is Prospective Status, which adjusts Current to Prospective Status based on the estimated effects of future actions. The current-to-prospective adjustment is simply an adjustment of the current survival estimates to reflect survival improvements expected from the hydro, habitat, and hatchery changes included in the proposed action, and in particular those that are expected to be implemented in the period 2007 to 2017.

This analysis assumes that future ocean and climate conditions will approximate the average conditions that prevailed during the 20 year base period used for our status assessments. For most populations, that period is about equivalent to the “recent” ocean period used by the ICTRT in its analyses. This period was characterized by relatively poor ocean conditions which presumably contributed to poor early ocean survival of salmonids. To illustrate, the ICTRT’s “pessimistic” ocean condition scenario results in survivals that are about 15 percent lower for Snake River spring/summer Chinook salmon than the “recent’ ocean conditions scenario, and about 36 percent lower for Upper Columbia spring Chinook salmon. Alternatively, ICTRT’s “historic” ocean conditions scenario results in survivals that are about 39 percent higher for both Snake River spring/summer and Upper Columbia spring Chinook salmon.[8] This subject is treated at greater length in the discussion of the effects of potential climate change in Appendix X.

The analysis of status assumes a certain amount of annual take of natural adult fish based on recent harvest levels. As requested in the remand collaboration, a sensitivity analysis showing the additional effects of more selective harvests that minimize take of natural adult fish is

[8] Assessing the Impact of Anticipated Hydropower Changes and a Range of Ocean Conditions on the Magnitude of Survival Improvements Needed to Meet TRT Viability Goals
Interior Columbia Technical Recovery Team and R. W. Zabel, June 20, 2006

presented in Appendix X. Snake River steelheads are harvested at a relatively high rate, particularly the B-run fish whose adult migration coincides with that of Hanford Reach and Snake River fall chinook. No non-tribal commercial harvest is allowed under the current harvest management plan; in-river harvest is limited to tribal harvest and sport fishing. Tribal harvest levels of B-run steelhead during the base period (adult returns corresponding to brood years 1986-1998) was about 18.6 percent. Harvest levels since 2001 averaged about 11.6 percent.

It should be noted that some unaccounted steelhead harvest in state sport fisheries above McNary Dam is currently an issue being discussed between the salmon managers and NOAAF. There is a potential that this harvest, once accounted for, may impact the trend and supporting analysis of this ESU.

Current Status Analysis

Over this period the action agencies implemented multiple actions to improve survival for all populations on this DPS. The percentage improvements in life cycle survival used in the base-to-current adjustments for Snake River steelhead populations are summarized in Table 3. Gaps are not shown for populations for which specific data is not available. However, population-specific survival improvements are noted, reflecting estimated benefits from projects already implemented. Actions are described in summary below:

Table 3. Estimated survival improvements used in the base-to-current.

MPG	Population	Hydro	Habitat (tributary)	Habitat (estuary)	Avian predation	Hatchery	Harvest[9]
Lower Snake	Tucannon	-3.4%	6.5%	0.3%	-0.3%		8.0%
	Asotin	-3.4%	8.5%	0.3%	-0.3%		8.0%
Imnaha River	Imnaha	-3.4%	0.1%	0.3%	-0.3%		8.0%
Grande Ronde	Upper Mainstem	-3.4%	2.0%	0.3%	-0.3%		8.0%
	L.ower mainstem	-3.4%	0.1%	0.3%	-0.3%		8.0%
	Joseph Cr.	-3.4%	2.0%	0.3%	-0.3%		8.0%
	Wallowa R.	-3.4%	2.0%	0.3%	-0.3%		8.0%
Clearwater R.	Lower mainstem	-3.4%	2.5%	0.3%	-0.3%		8.0%
	Lolo Cr.	-3.4%	0.5%	0.3%	-0.3%		8.0%
	Lochsa R.	-3.4%	0.5%	0.3%	-0.3%		12.0%
	Selway R.	-3.4%	0.7%	0.3%	-0.3%		12.0%
	South Fork	-3.4%	1.5%	0.3%	-0.3%		12.0%
	North Fork (ext.)						
Salmon R.	Little Salmon/Rapid	-3.4%	0.5%	0.3%	-0.3%		8.0%
	Chamberlain Cr.	-3.4%		0.3%	-0.3%		8.0%
	Secesh R.	-3.4%		0.3%	-0.3%		12.0%
	S. Fork Salmon	-3.4%		0.3%	-0.3%		12.0%
	Panther Cr.	-3.4%		0.3%	-0.3%		8.0%
	Lower M.F. Tribs	-3.4%		0.3%	-0.3%		12.0%
	Upper M.F. Tribs	-3.4%		0.3%	-0.3%		12.0%
	N. Fork	-3.4%		0.3%	-0.3%		8.0%
	Lemhi R.	-3.4%	0.5%	0.3%	-0.3%		8.0%
	Pahsimeroi R.	-3.4%	6.5%	0.3%	-0.3%		8.0%
	E. Fork Salmon	-3.4%	0.5%	0.3%	-0.3%		8.0%
	Upper Mainstem	-3.4%	0.5%	0.3%	-0.3%		8.0%

[9] Harvest adjustments represent estimated harvest decreases between the base and current periods. Estimates supplied by A. Nigro (ODF&W) on behalf of an ad hoc US v. OR technical workgroup.

Hydropower Survival Improvements

The percentage improvement in life cycle survival attributable to changes in hydropower operations for the base-to-current period is the estimated differences in juvenile migrant juvenile during the base period 1980 to 2001 and the more recent period from 2001 to 2005. These changes are expected to have uniformly decreased life cycle survival of the Snake River steelhead populations by 3.4 percent. Additional detail on how these percentages were estimated is described in Appendix D. The current estimates of survival are primarily based on changes in transport operations in recent years. These estimates represent the "best estimates" of NMFS (see Graves spreadsheet dated 9 May 07). The configuration and operational and maintenance changes to fish passage facilities and other projects areas that contributed to these effects include:

- Bonneville Powerhouse I minimum-gap turbine runner installations;
- Bonneville Powerhouse II corner collector installation;
- Bonneville II Fish Guidance Efficiency improvements;
- Bonneville spill operation improvements;
- Bonneville I JBS screen removal;
- Bonneville II operation as first priority;
- The Dalles spill wall construction;
- The Dalles spill pattern improvements;
- The Dalles adult collection channel improvements;
- The Dalles sluiceway operation improvements;
- John Day spill operation improvements;
- John Day South Fish Ladder improvements;
- McNary spill operation improvements;
- McNary end spillbay deflectors and hoists;
- McNary full flow juvenile PIT tag detection;
- McNary juvenile transport facility bypass piping improvements;
- McNary spare ESBS;
- McNary improved juvenile bypass dewatering screens;
- McNary overhauling AWS pumps;
- McNary upgrading of adult fish ladders tilting weir controls;
- Ice Harbor RSW installation and spill operation improvements;
- Ice Harbor full flow juvenile PIT tag detection;
- Ice Harbor AWS improvements north shore adult fishway;
- Ice Harbor replaced adult fishway entrance weirs;
- Ice Harbor new bulkhead system for maintenance of south shore AWS pumps;
- Ice Harbor upgraded AWS hydraulic systems;
- Lower Monumental end spillbay deflectors, parapet walls, and stilling basin repair;
- Lower Monumental spill operations improvements;
- Lower Monumental juvenile fish separator improvement;
- Lower Monumental fish barge loading improvements;
- Lower Monumental rehabbed adult fish pumps;
- Lower Monumental replaced north shore adult fish counting station;
- Little Goose spill operations improvements;
- Little Goose ESBS improvements;
- Lower Granite RSW installation;
- Lower Granite ESBS improvements;
- Lower Granite modifications to adult transition pool to improve adult passage;
- Improved total dissolved gas monitoring program and equipment; and
- Delayed/staggered start of juvenile fish transportation program.

Tributary Habitat Survival Improvements

BPA and Reclamation implemented actions to address limiting factors for a number of populations in this ESU. BPA's annual expenditures for habitat projects in subbasins used by Snake River ESUs/DPs averaged about $5.4 million for the 2001 to 2006 time frame. Reclamation spent over $6 million to provide technical for habitat projects in this period. Some of these actions provided benefits with immediate survival improvements and some will result in long-term benefits with survival improvements accruing into the future. During this time period the Action Agencies, in coordination with multiple partners:

- Increased streamflow through water acquisitions;
- Addressed entrainment by installing or improving fish screens;
- Increased fish passage and access by removing passage barriers;
- Improved mainstem and channel habitat conditions; and
- Improved water quality and habitat conditions by protecting and enhancing riparian areas.

Additional detail of habitat actions implemented by BPA and Reclamation in the 2000 to 2006 time frame is available in the Action Agencies Annual Progress Reports located at *www.salmonrecovery.gov*.

Survival improvements estimated to result from tributary habitat actions implemented by the Action Agencies in this time period are shown in Table 3. The percentages indicate the incremental survival improvement estimated to accrue by 2006 from the suite of implemented actions. Survival improvements were estimated as described in "Working Draft Tributary Habitat Benefits".

Estuary Habitat Survival Improvements

From 2000 to 2006 the estimated survival benefit for Snake River steelhead (stream-type life history) associated with the specific actions discussed above is 0.3 percent. Action Agencies implemented multiple habitat actions through 21 estuary habitat projects. Unrestricted fish passage and approximately 3 miles of access to quality habitat was provided these specific actions[10]:

- Replaced 3 culverts with full-spanning bridges;
- Provided approximately 10 miles of improved tidal channel connectivity by installing a tide gate retrofit;
- Acquired approximately 473 acres of off-channel and riparian habitats;
- Restored and created 90 acres of marsh and tidal sloughs and approximately 100 acres of riparian forests
- Protected approximately 55 acres of high-quality riparian and floodplain habitat
- Restored and preserved approximately 154 acres of off-channel habitat;
- Protected 80 acres of high-value off-channel forested wetland habitat;
- Restored approximately 96 acres of tidal wetlands habitat by replacing undersized culvert that limited fish access;
- Conserved 155 acres of forested riparian and upland habitat;
- Provided partial tidal channel reconnection by tide gate retrofit (acreage unknown at this time);
- Provided integrated pest management (purple loosestrife);
- Reconnected and restored 183 acres of historic floodplain by dike removal;

[10] A more thorough report detailing this evaluation process is: Estimated Benefits for Federal Habitat Projects in the Columbia River Estuary for NWF v NMFS Remand - Sovereign Collaboration Process.

- Restored 25 acres of historic floodplain by breaching a dike;
- Provided fish passage access to 6 miles of stream habitat by removal of two culverts and replacement with bridges;
- Restored 310 acres of native hardwood riparian forest, 200 acres of seasonally wet slough and 155 acres of degraded riparian habitats; increased circulation in approximately 92 acres of backwater and side-channel habitat by tide gate retrofit;
- Improved embayment circulation for 335 plus acres of marsh/swamp and shallow-water and flats habitat; and
- Preserved 35 acres of historic wetland habitat.

Predator Control Survival Improvements

Avian predation. The estimated survival change for Snake River steelhead from the baseline to current condition is -0.3 percent. This reflects a reduction in survival from the base to current condition, because the tern population was increasing over the base period. Averaging tern consumption of juvenile salmonids across the 20-year base period downplays the actual change in survival that resulted from relocating terns from Rice Island to East Sand Island in 1999. In 1999 tern consumption of juvenile salmonids was at its peak with an estimated 13,790,000 smolts consumed, compared to 8,210,000 in 2000 after relocation.

Piscivorous predation. The ongoing Northern Pikeminnow Management Program (NPMP) has been responsible for reducing predation related juvenile salmonid mortality since 1990. The improvement in life cycle survival attributed to the NPMP is estimated at 2 percent for migrating juvenile salmonids (Friesen and Ward 1999). The northern pikeminnow has been responsible for approximately 8 percent predation-related mortality of juvenile salmonid migrants in the Columbia River basin in the absence of the NPMP (2000 FCRPS BiOp at 9-106). The ongoing NPMP is already accounted for in the estimation of survival improvements modeled within the reservoir mortality life stage. This is because the modeling estimates are calibrated to empirical reach survival estimates that included the ongoing program.

Hatchery Management Survival Improvements

From 2000 to 2006 as required by the 2000 BiOp RPA, BPA funded the development of Hatchery Genetic Management Plans (HGMPs) for all federally funded hatchery programs in this DPS. BPA also funded the Safety-Net Artificial Propagation Program (SNAPP) planning process to identify an6y additional steelhead populations at high risk of extinction that would benefit from implementation of a safety net hatchery program. No survival improvements from these planning processes are estimated for the 2000 to 2006 time period, though low benefits are expected as NOAA Fisheries uses the HGMPs in their hatchery program ESA Section 7 consultations.

Current Status Survival Gaps

Table 4. Current Status: Adjusted gaps after base to current adjustment.

** Note: Gaps are expressed as multipliers. For example, a 1.10 gap indicates a 10 percent improvement is necessary to close gap. If gap is ≤ 1.0, no further improvement is necessary to close gap.*

MPG	Population	Adjusted 20-year R/S Gap	Adjusted 12-year λ Gap	Adjusted Long-term Trend Gap
	Average A-run population	0.76	0.71	0.92
	Average B-run population	1.13	0.92	1.11
Grande Ronde	Upper mainstem (A)	0.94	1.03	0.98
	Joseph Cr (A)	0.74	0.94	0.86
	Wallowa R (A)	0.73	N/A	N/A
All other MPGs	All other populations	N/A	N/A	N/A

Prospective Status Analysis

As noted above the prospective status is the projected status of the population based on adjustment of the survival metrics for expected improvements associated with the proposed actions. As was the case for the base-to-current adjustment, the improvements for the current-to-prospective are divided into the categories of those expected from changes in hydropower operations and configuration, changes in tributary habitat conditions attributable to actions implemented in the periods 2007 to 2009 and 2010 to 2017, changes in estuarine habitat, reduced impacts of avian predation, and improved hatchery operations.

Over this period the action agencies implemented and will continue to implement multiple actions to improve fish survival. The percentage improvements in life cycle survival used in the current-to-prospective adjustments for Snake River steelhead populations are summarized in Table 5. Actions are described in summary below:

Table 5. Estimated improvements in survival used in the current-to-prospective adjustment.

MPG	Pop.	Hydro	2007-17 Habitat	Habitat (est.)	Avian pred.	P.minnow Pred.	Hatchery	Harvest
Lower Snake River	Tucannon	-9.0%	12.0%	6.0%	3.4%	1.0%		
	Asotin	-9.0%	11.0%	6.0%	3.4%	1.0%		
Imnaha River	Imnaha	-9.0%		6.0%	3.4%	1.0%		
Grande Ronde	Upper Mainstem	-9.0%	9.0%	6.0%	3.4%	1.0%		
	Lower mainstem	-9.0%		6.0%	3.4%	1.0%		
	Joseph Cr.	-9.0%	12.0%	6.0%	3.4%	1.0%		
	Wallowa R.	-9.0%	27.0%	6.0%	3.4%	1.0%		
Clearwater River	Lower mainstem	-9.0%	4.0%	6.0%	3.4%	1.0%		
	Lolo Cr.	-9.0%	12.0%	6.0%	3.4%	1.0%		
	Lochsa R.	-9.0%	18.0%	6.0%	3.4%	1.0%		
	Selway R.	-9.0%	2.0%	6.0%	3.4%	1.0%		
	South Fork	-9.0%	14.0%	6.0%	3.4%	1.0%		
	North Fork (ext.)				3.4%	1.0%		

MPG	Pop.	Hydro	2007-17 Habitat	Habitat (est.)	Avian pred.	P.minnow Pred.	Hatchery	Harvest
Salmon River	Little Salmon/Rapid	-9.0%	10.0%	6.0%	3.4%	1.0%		
	Chamberlain Cr.	-9.0%		6.0%	3.4%	1.0%		
	Secesh R.	-9.0%	6.0%	6.0%	3.4%	1.0%		
	S. Fork Salmon	-9.0%	6.0%	6.0%	3.4%	1.0%		
	Panther Cr.	-9.0%		6.0%	3.4%	1.0%		
	Lower M.F. Tribs	-9.0%	7.0%	6.0%	3.4%	1.0%		
	Upper M.F. Tribs	-9.0%		6.0%	3.4%	1.0%		
	N. Fork	-9.0%		6.0%	3.4%	1.0%		
	Lemhi R.	-9.0%	9.0%	6.0%	3.4%	1.0%		
	Pahsimeroi R.	-9.0%	27.0%	6.0%	3.4%	1.0%		
	E. Fork Salmon	-9.0%	6.0%	6.0%	3.4%	1.0%		
	Upper Mainstem	-9.0%	18.0%	6.0%	3.4%	1.0%		

Hydropower Survival Improvements

The percentage change in life cycle survival attributable to the proposed hydropower operation was estimated based on the difference between the estimated survival under the current operation (defined as the period 1999 to 2005) and estimated survival under the improved conditions. A detailed description of the methods used to generate these estimates can be found in Appendix D; these methods included the use of multiple data sources and the COMPASS model, and represent the “best estimates” of NMFS (see Graves spreadsheet dated 22 Mar 07). The configuration and operational improvement actions that contribute to these survival increases are organized into strategies. Specific actions contained within these strategies are listed in the Hydrosystem Proposed Action Summary. Not all of these specific actions apply to this DPS, as some specific actions are aimed at benefiting Snake River stocks. These strategies include:

1. Operate the FCRPS to more closely approximate the shape of the natural hydrograph and to improve juvenile and adult fish survival;
2. Modify Columbia and Snake River dams to facilitate safe passage;
3. Implement operational improvements at Columbia and Snake River dams;
4. Operate and maintain juvenile and adult fish passage facilities;

For the 25 Snake River steelhead populations the change was a uniform 9.0 percent reduction in smolt to adult returns. This decrease in survival results from changes in transport operation. Currently the biological information suggests that reducing transport numbers will reduce life cycle survival of this DPS. The strategy for changing transport operations is based on balancing the needs for other ESU’s that have exhibited a different response to transport such as Snake River spring/summer chinook. Adaptive management will be informed with RM&E to further refine our transportation or in-river operation during the course of the BiOp.

Tributary Habitat Survival Improvements

Table 5 displays estimated population level survival improvement percentages expected to result from Action Agency implementation of actions to address limiting factors in the tributary areas used by this DPS. The survival improvements identified represent an increase in Action Agency tributary habitat effort compared to efforts under the 2000 and 2004 FCRPS BiOps. Survival improvements were estimated as described in ”Working Draft Tributary Habitat Benefits”.

2007 to 2017. BPA will fund and Reclamation will provide technical assistance for projects that implement actions to address key limiting factors for this DPS. BPA will fund projects primarily through its Fish and Wildlife Program; Reclamation will provide technical assistance through annual congressional appropriations. The Action Agencies work with multiple parties for the successful implementation of these actions.

Initial actions and action expansion. Consistent with its 2007 – 2009 Fish and Wildlife Program funding decision, BPA will fund implementation of 26 projects in the Asotin, Clearwater, Grande Ronde, Imnaha, Salmon, and Tucannon subbasins. BPA has also dedicated 70 percent of the Columbia Basin Water Transactions Program (CBWTP) $5 million annual budget to secure water acquisitions and riparian easements for anadromous fish, including populations of Snake River steelhead. For this time period, the average annual planned budgets (based on the BPA Final Decision letter for the 26 projects is approximately $9.3 million (not including the CBWTP).

Based on biological needs identified in the recent lifecycle biological analyses and input from the remand collaboration process, BPA will also fund a suite of further actions beyond those identified in the 2007 - 2009 Fish and Wildlife Program decision for implementation beginning in the 2008 and 2009 (see Appendix B-4b).

BPA will fund projects to implement new actions that:

- Increase instream flows;
- Remove passage barrier;
- Improve fish passage structures;
- Install fish screens;
- Increase channel complexity;
- Protect and enhance riparian habitat, and
- Improve water quality.

Reclamation will provide technical assistance for habitat projects in the Grande Ronde, Upper Salmon, and Lemhi subbasins.

Future implementation. BPA will implement new actions similar in scope to those implemented in the 2007 to 2009 time period to address limiting factors for this ESU. BPA will expand the level of effort and increase funding above the 2007 to 2009 time period. Project funding decisions will be based on prioritized biological criteria and consistent with recovery plans. Reclamation will continue to provide technical assistance where appropriate with funding consistent with its congressional funding authorizations.

Further detail about Reclamations actions is available in Appendix B-5 to the Tributary Habitat Proposed Action; project level detail of the BPA funded projects is available in Appendix B-3a.

Estuary Habitat Survival Improvements

2007 to 2009. The estimated survival benefit for Snake River steelhead (stream-type life history) associated with the specific actions discussed below is 0.852 percent. The Action Agencies' estimated benefit for 2007 is based on actions that are or will be underway in the very near-term. For 2008 and 2009 the estimated benefit is based on continuing at the same level of ffort as 2007[11]. Action agencies are or will be implementing multiple habitat actions through approximately 29 estuary habitat projects. Specific estuary habitat actions:

- Restore partial tidal influence and access to several acres (exact amount unknown at this time) by a tide gate retrofit;
- Improve hydrologic flushing and salmonid access to a lake (Sturgeon Lake is approximately 3,200 acres);
- Acquire and protect 40 acres of critical floodplain habitat and 40 acres riparian forest restoration; install 6 to 8 engineered log-jams that will help to slow flood flows, reduce erosion, contribute to sediment storage, enhance fish habitat and contribute wood into the project area; acquire and restore floodplain connectivity to 380 acres of off-channel rearing habitat for juveniles;
- Install fish friendly tide gates to increase tidal flushing and fisheries access to approximately 110 acres;
- riparian planting of up to 210 acres;
- Re-establish hydrologic connectivity to reclaim and improve floodplain wetland functions, increase off-channel rearing and refuge habitat on five acres, plant native vegetation along shoreline and reconstruct slough channels on 2.5 acres of annually inundated off-channel habitat; as part of a long-term 1,500 acres restoration effort: breaching a dike and re-establishing flow to portion of original channel, planting vegetation on 50 acres, removing invasive weeds on 180 acres, planting wetland scrub shrub on 45 acres, and controlling and removing invasive wetland plants on 45 acres;
- Retrofit a tide gate (acreage unknown at this time);
- Protect and restore approximately 5 to 10 acres of emergent wetland and riparian forest habitats;
- Reconnect 45 acres of floodplain by tide gate removal;
- Acquire 45 acre of floodplain with future dike removal;
- Reconnect 50 acres of floodplain;
- Acquire 320 acres of tidelands and 119 acres of riparian/upland forest; and
- Restore 30 acres of riparian habitat.

There will be approximately 15 additional projects and associated actions similar to actions listed above that are undergoing scoping and sponsor development (the number of projects and associated actions is based on the same level of effort as 2007).

2010-2017. The survival benefit for Snake River steelhead (stream-type life history) associated with these actions is 2.272 percent. The Action Agencies' estimated benefits for 2010-2017 are based on continuing the same level of effort as 2007 to 2009. However the level of effort in this time period may increase depending on the outcome of a General Investigation study of Ecosystem Restoration opportunities, depending on Congressional appropriations, future funding scenarios and results of actions. Specific projects have yet to be identified. Actions for this period will be similar in nature to actions implemented in previous periods discussed above. Actions will include protection and restoration of riparian areas, protection of remaining high quality off-channel habitat, breaching or lowering dikes and levees to improve access to off-channel habitat, and reduction of noxious weeds, among others.

[11] A more thorough report detailing this evaluation process is: *Estimated Benefits of Federal Habitat Projects in the Columbia River Estuary for the NWF v NMFS Remand – Sovereign Collaboration Process.*

Predator Management Survival Improvements

Avian predation. The estimated relative current to future survival benefit attributed to Snake River Steelhead salmon is 3.4 percent, and this benefit is carried out to 2017 and beyond. This improvement is expected to result through the reduction in estuary tern nesting habitat, and subsequent relocation of terns outside the Columbia basin. Although the base to current shows a reduction in survival, the overall benefit (base to future) is positive.

Piscivorous predation. The percentage improvement in life cycle survival attributable to the proposed continuation of the increase in incentives in the Northern Pikeminnow Management Program and resultant marginal increase in observed exploitation rate is estimated at 1 percent total from 2007 to 2017. This estimate was derived based on the difference between the estimated benefits from the base NPMP (defined as the period 1990 to 2003) and estimated survival benefits under the increased incentive program (defined as the period of 2004 to present). This rate would generally apply to all juvenile salmonids.

Hatchery Management Survival Improvement

2007 to 2017. BPA will continue to fund the ongoing, small-scale program trapping locally returning steelhead in the East Fork Salmon River for a local broodstock supplementation program. This program provides a medium level of benefits for abundance, productivity, and genetic diversity for this DPS.

Prospective Survival Status

Comprehensive analyses of the changes in life cycle survival resulting from the proposed FCRPS and upper Snake actions and analysis of how they will change the survival metrics indicate that the only A-run population that requires additional improvement in survival is the Upper Mainstem population of the Grande Ronde MPG, where a 5 percent improvement remains to meet the survival criteria for λ and long-term trend. All other A-run populations are expected to meet all criteria.

Analysis for average B-run population suggests additional improvements in survival may be needed to meet the survival criteria for both 20-year R/S and long-term trend. As noted, a lack of information prevents a gap analysis for most individual populations in this DPS. Generally, it appears that A-run populations will fare better than B-run populations after considering the effects of the proposed action. Of the 24 extant populations in this DPS, 16 are believed to be A-run, seven are believed to be B-run and one is thought to be a mixed A- and B-run population.

Table 6. Prospective status: Adjusted future productivity trends after current-to-prospective analysis.

**Note: Future productivity values represent estimates of future R/S, lambda and trend after consideration of the effects of the proposed action. A value >1.0 indicates a growing population; a value <1.0 indicates a population in decline.*

MPG	Population	Estimated Future R/S[12]	Estimated Future λ	Estimated Future Trend
	Average A-run population	1.32	1.08	1.02
	Average B-run population	0.89	1.02	0.98

[12] Future R/S. lambda and trend estimates for average population profiles do not include benefits for tributary habitat improvements.

Grande Ronde	Upper mainstem (A)	1.07	0.99	1.00
	Joseph Cr (A)	1.53	1.04	1.06
	Wallowa R (A)	1.75	N/A	N/A
All other MPGs	All other populations	N/A	N/A	N/A

Remand Conceptual Framework Analysis

The FCRPS BiOp remand's collaboration among the sovereigns developed a Conceptual Framework approach intended to help the Action Agencies develop their proposed action. The Framework approach attempted to estimate the relative magnitude of mortality factors affecting Interior Columbia basin salmonid populations. That assessment was intended to help define the FCRPS' "relative expectation…for recovery."[13] The collaboration's Framework working group developed high and low mortality estimates for all sources of mortality, including the FCRPS. The collaboration's Policy Working Group has not determined where in that range the Action Agencies' proposed action should be assessed. The range of "gaps" that the Framework approach would expect the FCRPS to fill was reviewed and the Action Agencies assessed whether the total survival improvements estimated in this biological analysis would "fill" those gaps. For the purposes of this comparison, the ICTRT gaps were used for "recent" ocean and "base hydro" conditions (corresponding to the base period used for R/S productivity estimation), and the ICTRT's 5 percent risk level.

The Conceptual Framework was intended, among other things, to "provide a clear and complementary link to ongoing recovery planning efforts."[14] It can be seen as the Policy Working Group's view of an appropriate level of effort for the FCRPS in the context of ongoing regional recovery planning. As such, it provides another "metric" for use in considering the impacts of the proposed action on a listed species' prospects for recovery.

Since the Framework's estimate of relative impact varies from population to population, and since the benefits of tributary habitat projects are unevenly distributed, we have displayed the Framework results by population in Table 7.

Table 7. Recovery Gap Calculations from the Conceptual Framework

Note: ICTRT gaps are expressed as multipliers. Gaps are for 5 percent risk, recent ocean/base hydro conditions. A "remaining" gap value <1.0 indicates no further improvement is necessary. Total survival changes combine all estimated survival improvements for the base-to-current and current-to-prospective adjustment.

Population	ICTRT Gap	FCRPS Relative Impact (high)	FCRPS Relative Impact (low)	ICTRT Gap (high hydro)	ICTRT Gap (low hydro)	Total Survival Change[15]	Remaining Framework Gap (high)	Remaining Framework Gap (low)
Average A-run	1.52	0.71	0.42	1.35	1.19	#N/A	#N/A	#N/A
Average B-run	1.65	0.80	0.48	1.43	1.23	#N/A	#N/A	#N/A
Upper Mainstem (A)	0.48	0.73	0.29	0.59	0.81	1.07	0.55	0.76
Joseph Cr. (A)	0.41	0.73	0.43	0.52	0.68	1.18	0.55	0.76

[13] 2006 FCRPS BiOp: Conceptual Framework for the Remand Process. First Quarterly Status Report, Documents filed with the court, 01/03/06.
[14] Id.
[15] Final Framework gaps not calculated due to inability to include habitat and other improvements for ICTRT average population profiles.

ADDITIONAL ACTIONS TO BENEFIT THE DPS

Other Reasonably Certain to Occur Actions[16]

In the State of Idaho, two sub-basins have benefited from completed and on-going habitat improvements. In the Clearwater sub-basin, populations of the Snake River steelhead DPS have benefited from 28 projects that have provided over 74,000 acres of habitat improvements. These habitat improvements have occurred in both riparian and upland areas. Populations of both Snake River steelhead and Chinook salmon have benefited from 52 projects providing over 2,000 acres of similar habitat improvements.

Other Federal Actions that have completed ESA Consultation

The Action Agencies' review of federal actions that have completed section 7 consultations is not yet complete. The results of the review will be included in the environmental baseline of the Biological Analysis.

OBSERVATIONS

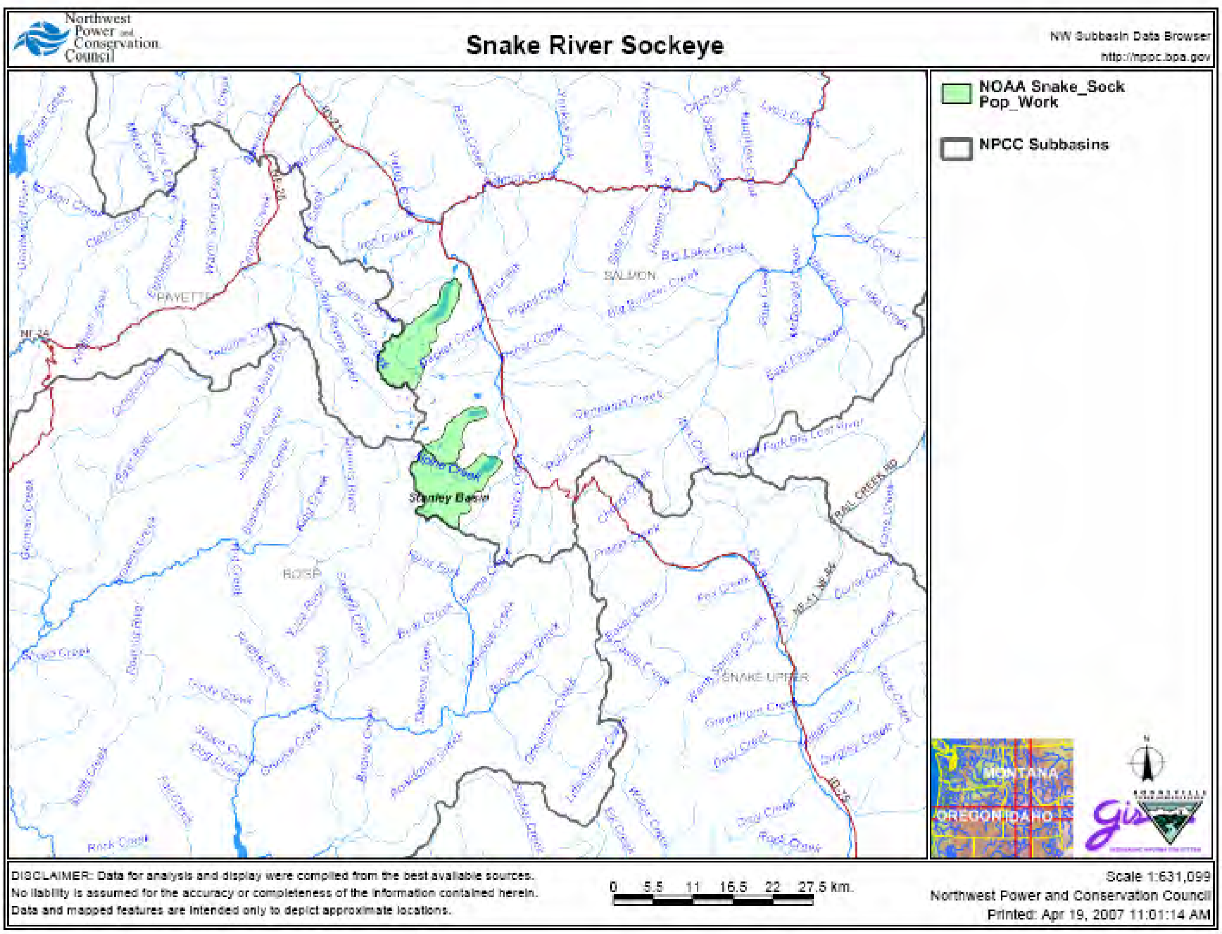
It is not possible to fully evaluate the effects of the proposed action for most individual populations in this DPS. Generally, it appears that A-run steelhead populations in this DPS will be at a low risk of extinction, after considering recently implemented actions and the likely effects of the proposed action. Data is too poor to allow extinction probabilities to be modeled for B-run populations. Likewise, metrics indicative of recovery are expected to be positive for most A-run populations and less so for B-run populations, though again the lack of population-specific information makes this assessment highly uncertain. Given the high degree of uncertainty regarding the status of this DPS – particularly the B-run populations – a robust research and monitoring effort in order to better understand status and limiting factors for these populations, combined with targeted improvements in tributary habitat seems to best course in the face of significant uncertainty regarding this DPS.

[16] Many of the actions listed above have a cost-share component with a variety of other federal funding sources and therefore may be properly described as contributing to the status of the environmental baseline rather than cumulative effects. The action agencies will sort the projects described in this paper into the appropriate parts of the biological analysis, but for the purposes of discussion at the April 11, 2007 PWG workshop, believe that the effect on prospective status will be the same.

This is not a final federal agency product. Rather, it is a pre-decisional document prepared by the Action Agencies that reflects present understandings of currently available information and analyses, and of the progression of discussions with the sovereigns in the collaborative process. Revisions and refinements are to be expected based on further discussions with the sovereigns over new and modified proposed federal actions upon which the action agencies will ultimately consult. Finally, the information in this product does not constitute an analysis of whether the identified measures would or would not jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Furthermore, this document does not in any way interpret or apply the regulatory definitions of the statutory phrases "jeopardize the continued existence of" and "destruction or adverse modification."

Snake River Sockeye Salmon ESU

Please note that all of the information in this paper is still preliminary. In particular, benefits assessments are still under review. For certain populations additional actions are being considered that might be implemented by the Action Agencies or by others.



ESU Description[1]	
Endangered	Listed under ESA in 1991; reaffirmed in 2005
Hatchery programs included in ESU	Captive Broodstock Program – Eagle, Oxbow, Burley Creek and Manchester Research Station

[1] Listing determination (70FR37160); Interior TRT July 2003 description of independent populations *www.nwfsc.noaa.gov/trt/col_docs/independentpopchinsteelsock.pdf* ; May 2005 update *www.nwfsc.noaa.gov/trt/col_docs/updated_population_delineation.pdf*

Major Population Group	Population
Stanley Lakes Basin	Redfish Lake

INTRODUCTION

This paper briefly summarizes the current biological analyses developed for this evolutionarily significant unit (ESU). It describes Base and Prospective recovery status and identifies actions that will benefit the ESU.

This ESU was listed as endangered in 1991, and is currently a hatchery-based ESU. Although sockeye salmon were historically numerous in many areas of the Snake Basin prior to the westward expansion, the only remaining population now resides in Redfish Lake in the Stanley Basin, and even here the population is a remnant run (56 FR 58619; November 20, 1991). At the time of listing, the preceding three year abundance was 1 fish, 1 fish, and zero fish respectively, and some contended that the ESU was "functionally extinct." However, NOAA determined to proceed with listing "to make a conservative decision in this circumstance." (Waples et al, Status Review for Snake River Sockeye Salmon, 1991) Even now, after over 10 years of intense effort, the numbers of returning adult fish annually total only about 30 fish.

The low numbers of sockeye salmon are the legacy of over a hundred years of actions and inaction. Beginning in the late nineteenth century, anadromous sockeye salmon were reduced in abundance by heavy harvest pressures, unscreened irrigation diversions, and dam construction (TRT 2003). This includes construction of 30-foot-high Sunbeam Dam on the mainstem Salmon River in 1910, which effectively blocked fish passage until its partial removal in the 1930s. Fishery management decision also played a role in the near elimination of sockeye salmon from the Snake River. In the 1950s and 1960s, the Idaho Department of Fish & Game (IDFG) actively eradicated sockeye salmon and other fish from some locations (Pettit, Yellowbelly, and Stanley lakes) and managed fisheries for resident fish populations.

Key Limiting Factors

Salmon and steelhead have been adversely affected over the last century by many activities including human population growth, introduction of exotic species, over fishing, developments of cities and other land uses in the floodplains, water diversions for all purposes, dams, mining, farming, ranching, logging, hatchery production, predation, ocean conditions, loss of habitat and other causes (Lackey et al.2006)[2]. For sockeye salmon, the legacy effects described above, which have left only a remnant run, largely control the condition of the ESU. Summarized below are key current limiting factors for this ESU identified by NOAA in the ESU Overviews for the remand collaboration[3].

Hydro Adult sockeye salmon loss through the hydro system is estimated at 22 percent, high compared to other species. Survival studies from the upper Columbia River have shown that juvenile sockeye salmon survival through

[2] Lackey, Robert T, Denise H. Lach, and Sally L Duncan. Wild salmon in Lackey, Robert T, Denise H. Lach, and Sally L Duncan. Wild salmon in western north america: the historical and policy perspective. Pp 13-55. In: Salmon 2100: The future of wild pacific salmon. 2006. Robert T Lackey, Denise H. Lach, and Sally L. Duncan (editors).
[3] Master - Summary of Key ESU Info Int Columbia - table 24oct06, p. 7, (Limiting factors summarized and ranked by Paula Burgess, NOAA Fisheries, utilizing information found in working draft of ESU Overviews, 2005 Pacific Coastal Salmon Recovery Fund Report to Congress and local recovery plans.)

	dams can vary by project. Dam survival has been lower than Chinook salmon or steelhead at some projects but higher at others. Hydro impacts include volume, timing and quality of flows that enter the FCRPS action area, including flows from the Snake River at the toe of Hells Canyon Dam, which are impacted by the operation of Reclamation's upper Snake River projects and the mainstem effects of Reclamation's other projects within the Columbia Basin.
Habitat	With regard to habitat, the Redfish Lake Watershed lies within designated wilderness and the non-wilderness lake area habitat conditions are considered excellent.
Harvest	The legacy effects of harvest and resource management decisions are still affecting this ESU's prospects today. Nevertheless, more recent harvest management decisions have reduced effects on the ESU, but not all harvest has been eliminated, despite the poor condition of the sockeye population. The remaining harvest is a reduced tribal allocation and incidental catch from these other fisheries. Incidental catch in zone 1-5 is 0-1percent and tribal incidental take ranges from 2.8 to 7 percent. NOAA Fisheries assumes ocean by catch to be less than 1percent.

BASE STATUS

Artificially propagated sockeye salmon from the Redfish Lake Captive Broodstock Program are now the core of this ESU. Only 16 naturally produced adults have returned to Redfish Lake since the Snake River sockeye salmon ESU was listed. All have been taken into the Redfish Lake Captive Broodstock Program, which was initiated as an emergency measure in 1991. The return of over 250 adults in 2000 was encouraging; however, subsequent returns from the captive program from 2001 and 2006 have been fewer than 30 fish per year. A total of 39 adults, virtually all hatchery origin, have returned to Redfish Lake from 1999 to2006.

Harvest levels have been reduced and only incidental catch and tribal fisheries are now allowed for listed sockeye. The harvest rate is now in the range of 5-7 percent. The FCRPS has also implemented improved operations to benefit listed fish starting in the early 1990s. Since the 1970s, land use practices also have begun to change to reduce impacts on fish released into the habitat. In spite of the beneficial changes that have occurred to date, however, Snake River sockeye salmon have remained at very low levels.

Spatial Structure and Biological Diversity

Conserving and rebuilding sustainable salmonid populations involves more than meeting abundance and productivity criteria. Accordingly, NOAA Fisheries has developed a conceptual framework defining a Viable Salmonid Population, or VSP (McElhany et al. 2000). In this framework there is an explicit consideration of four key population characteristic or parameters for evaluating population viability status: abundance, productivity (or population growth rate), biological diversity, and population spatial structure. The reason that certain other parameters, such as habitat characteristics and ecological interactions, were not included among the key parameters is that their effects on populations are implicitly expressed in the four key parameters. Based on the current understanding of population attributes that lead to sustainability, the VSP construct is central to the goal of ESA recovery, and warrants consideration in a jeopardy determination. However, it must also be stressed that the ability to significantly improve either a species' biological diversity or its spatial structure and distribution is limited within the timeframe of the Action Agencies' proposed action.

Spatial Structure -- Spatial structure, as the term suggests, refers to the geographic distribution of individuals in a population unit and the processes that generate that distribution. Distributed populations that interact genetically are often referred to as metapopulation. Although the spatial distribution of a population, and thus its metapopulation structure, is influenced by many factors, none are perhaps as important as the quantity, quality, and distribution of habitat. One way to think about the importance or value of a broad geospatial distribution is that a population is less likely to go extinct from a localized catastrophic event or localized environmental perturbations.

Biological Diversity -- Biological diversity within and among populations of salmonids is generally considered important for three reasons. First, diversity of life histories patterns is associated with a use of a wider array of habitats. Second, diversity protects a species against short-term spatial and temporal changes in the environment. And third, genetic diversity is the so-called raw material for adapting to long-term environmental change. The latter two are often described as nature's way of hedging its bets – a mechanism for dealing with the inevitable fluctuations in environmental conditions – long- and short-term. With respect to diversity, more is better from an extinction-risk perspective.

The Snake River sockeye salmon ESU is comprised of a single MPG and single population spawning and rearing in Redfish Lake in the Stanley Basin. The ICTRT has designated this population as at high risk for spatial diversity and diversity. Considering that this is the last remaining population of a group of what were likely independent populations occupying the Stanley Basin Lakes, this designation is readily justified. Moreover, the extremely low abundance of the population and the fact that a captive broodstock program was implemented in 1992 as a last ditch attempt to avoid extinction clearly speaks to the high degree of risk faced by this population. At the present time it is uncertain whether the BPA-funded captive broodstock program will be successful reviving this population

BIOLOGICAL ANALYSIS OF ACTIONS

Historical abundance of Snake River sockeye salmon was estimated to have been between 40,000 and nearly 60,000 adult returns[4]. Between 1954 and 1991, when this ESU was listed as endangered, adult returns peaked above 4,000 returns in the mid-1950's but declined to near zero (see figure below). Recent returns have been comprised of virtually 100 percent hatchery-origin adults, with a few unmarked adults that could be naturally-produced offspring of adults released in Redfish Lake, mis-marked juvenile hatchery releases, or adults resulting from outplants of hatchery produced eggs. The 250 adult returns in 2001 marked a recent peak in adult returns, but other then 2001, adult returns have been less than 30 individuals per year. Abundance trends are slightly higher than replacement, but overall abundance remains very low. Between 1999 and 2006, only 339 adults in total have returned to the Redfish Lake region.

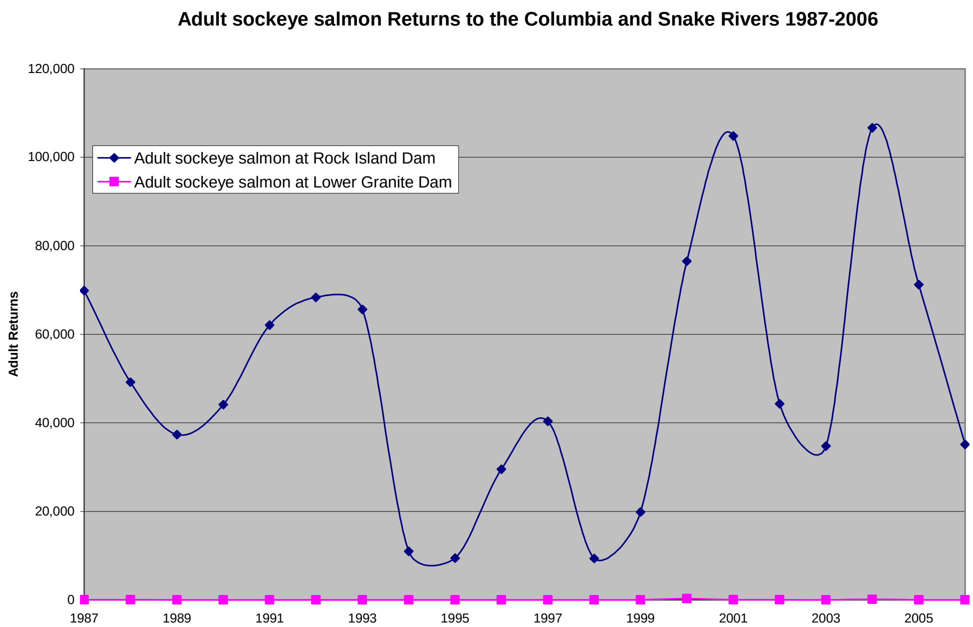
Snake River sockeye salmon cannot be evaluated in the same manner as many other ESUs for their recovery and survival status. As noted above, they are a unique case, consisting of only about 30 or fewer adult fish returning each year (since the recent peak in 2000) supported by a captive broodstock program. Although this program is currently avoiding extinction and providing a base for recovery efforts, the legacy effects of past actions are presenting many challenges. An examination of other sockeye stocks in the upper Columbia Basin and other safety net programs may indicate that possible genetic limitations (possible reduced fitness due

[4] *http://www.nwr.noaa.gov/Salmon-Recovery-Planning/PCSRF/Index.cfm*

to a population bottleneck) or other factors, not the FCRPS, may be a limiting sockeye recovery.

Sockeye salmon in the Okanogan and Wenatchee tributaries of the Upper Columbia, which experience life history impacts similar to those experienced by to Snake River sockeye, are in fluctuating condition over the last two decades, but have maintained a run size of at least 10,000 fish, with two peaks of over 100,000 fish (Figure 1.), and are not listed under the ESA. (Although there is currently some hatchery augmentation of the run through the Wenatchee sockeye program (started 1989) and the Okanogan sockeye program (started 1992), these programs probably account for only a small portion of the run (estimated ~2,800 fish), based on annual releases of 200,000 juveniles per program and an average release-to-adult return rate of 0.7 percent.)[5] The common impacts include passage through multiple dams and the estuary, as well as some harvest pressure. (NOAA Status Review of Sockeye Salmon from Washington and Oregon, 1997; 63 F.R. 11757, March 10, 1998) Recent abundance of Upper Columbia sockeye, shown below, is markedly higher than for Snake River sockeye. Upper Columbia sockeye migrate through the hydro system (four FCRPS and three to five public utility dams) between the end of June and about August 3, with peak migration in early July. Harvest has been in the general range of 5 percent to 7 percent of the run. The harvest rate of fisheries conducted by Columbia River Treaty tribes is based on run size at Priest Rapids, with a 5 percent harvest rate when the run is <50,000, and 7 percent when the run size is between 50,000 and 75,000.[6]

This comparison may point to legacy effects and possible genetic limitations, FCRPS passage, as a limit to the current recovery efforts for Snake River sockeye.



[5] NMFS and seven co-authors. 1998. Biological Assessment and Management Plan. Mid-Columbia River Hatchery Program. Available from Chelan County PUD, Wenatchee. WA
[6] US v. OR Parties. 2005. 2005-2007 Interim Management Agreement for Upriver Chinook, Sockeye, Steelhead, Coho, and White Sturgeon. Available from Columbia River Inter-Tribal Fish Commission, Portland, OR

The safety net program for sockeye has been moderately successful. For example, smolt-to-adult return rates (SAR) for Redfish Lake sockeye for adult return years 2000-2002 ranged from a high of 0.66 percent (eyed egg and pre-spawn adult release strategies combined) to a low of 0.04 percent (for Sawtooth Hatchery-reared presmolt and smolt release strategies combined) in two different years, 2000 and 2001.[7] In comparison, the Grande Ronde Chinook captive broodstock program, SARs for the 1998 cohort were 0.76 percent, 0.20 percent, and 1.99 percent for Catherine Creek, Grande Ronde River, and Lostine River fish, respectively.[8] However, higher SARs would be expected for Grande Ronde captive brood Chinook due to their shorter migration pathway.

The ISRP recently recommended an end to funding the captive broodstock program based on, in their opinion, its disappointing results to date. They noted that “juvenile life stages of captive individuals that were re-introduced did not successfully emigrate to the marine environment and return and reproduce in sufficient numbers to meaningfully affect the viability and aid in the recovery of a self-sustaining Snake River sockeye ESU.” They also pointed out that “the fish themselves are likely to be changing as a result of intensive propagation and rearing procedures so that there viability even under restored conditions is increasingly in doubt.” (ISRP, Preliminary Review of Proposals, 2007).

Prospective Status

At the time of listing, as now, this ESU consisted only of handful of natural origin adult fish. Currently, this ESU is maintained through a “safety net” captive broodstock program, consistent with the draft recovery plan. The Action Agencies’ strategy for Snake River sockeye involves changes in the current captive broodstock program, combined with improvements in the hydro corridor, predator control, and estuary habitat. The avoidance of extinction and the future prospects for recovery are both dependent on this two-pronged program.

The Action Agencies agree with the conclusions in a recent peer-reviewed paper regarding the sockeye program, which indicates that the current program has had a 20 fold benefit. The current efforts to prevent extinction of Redfish Lake sockeye salmon have provided a large measure of success, between 1999 and 2002, more than 312 adults returned from the ocean from captive broodstock releases – an amplification of almost 20 times the wild fish that returned in the 1990s. Important lineages of Redfish Lake sockeye salmon are being maintained in culture as preserves for genetic variability and for numerical and demographic amplification of the extant wild population. Most importantly, the broodstock program has prevented extinction and allowed some rebuilding of Redfish Lake sockeye salmon.[9]

Changes are being proposed by the Action Agencies in an effort to improve the captive broodstock program. For all the other Hs – hydro, harvest, and predator management – Action

[7] Hebdon, J. L., P. Kline, D. Taki, and T. A. Flagg. 2004. Evaluating reintroduction strategies for Redfish Lake sockeye salmon captive broodstock progeny. Pages 401-413 *in* M. J. Nickum, P. M. Mazik, J. G. Nickum, and D. D. MacKinlay, editors. Propagated fish in resource management. American Fisheries Society, Symposium 44, American Fisheries Society, Bethesda, Maryland.
[8] Hoffnagle, T. L., R. W. Carmichael, and W. T. Noll. 2003. Grande Ronde Basin spring Chinook salmon captive broodstock program. 1995 – 2002 Project Status Report. Fish Research and Development; Northwest Region Oregon Dept. Fish and Wildlife,
[9] Flagg, T. A., W. C. McAuley, P.A. Kline, M. S. Powell, D. Taki, and J. C. Gislason. 2004. Application of captive broodstocks to preservation of ESA-listed stocks of Pacific Salmon: Redfish Lake sockeye salmon case example. Pages 387-400 *in* M. J. Nickum, P. M. Mazik, J. G. Nickum, and D. D. MacKinlay, editors. Propagated fish in resource management. American Fisheries Society, Symposium 44, American Fisheries Society, Bethesda, Maryland.

agency actions for this ESU will be similar to those for Snake River spring/summer Chinook. Experience with upper Columbia, sockeye salmon has shown that they migrate through the upper water column and use surface passage routes when available, indicating that our RSW and surface bypass action will be beneficial for sockeye. Sockeye salmon appear to pass via surface routes at a higher rate than Chinook, but other passage metrics are very similar to spring/summer Chinook making them a suitable surrogate.

OBSERVATIONS

Based on the "diagnosis" provided by the preceding information, the Action Agencies strategy for Snake River sockeye is heavily weighted toward changes in the captive broodstock program. For all the other Hs – hydro, harvest, and predator management – Action Agency actions for this ESU will be similar to those for Snake River spring/summer Chinook. The avoidance of extinction and the future prospects for recovery are both dependent on this two-pronged program.

Changes are being proposed by the Action Agencies in an effort to improve the captive broodstock program. The safety net program will be continued through the period of the new Biological Opinion and enhance current broodstock by:

1) Examining the early release mortality of sockeye before they reach the Snake River and undertake a study of possible sources and locations of mortality; and
2) Expanding of the current program capacity to produce between 500,000 and 1 million smolts to determine whether possibility that higher numbers of smolt production may be necessary for meaningful adult returns.

As a contingency if the experimental expanded smolt program fails to meet performance standards, the Action Agencies will consider funding implementation of other alternative actions, including, but not limited to, reintroduction of Snake River sockeye into Wallowa Lake or establishment of a Snake River sockeye hatchery program below Bonneville Dam that would serve as an "egg bank".

In addition, the Action Agencies will explore the feasibility of truck transport of a number of returning sockeye adults from Lower Granite Dam to natural or artificial spawning locations in the Stanley Basin. If feasible, a transport plan will be developed and serve as guidance for implementation activities.

Remand Conceptual Framework Analysis

[Placeholder]

ADDITIONAL ACTIONS TO BENEFIT THE ESU

Other Reasonably Certain to Occur Actions[10]

[Placeholder]

[10] Many of the actions listed above have a cost-share component with a variety of other federal funding sources and therefore may be properly described as contributing to the status of the environmental baseline rather than cumulative effects. The action agencies will sort the projects described in this paper into the appropriate parts of the biological analysis, but for the purposes of discussion at the April 11, 2007 PWG workshop, believe that the effect on prospective status will be the same.

Other Federal Actions that have completed ESA Consultation

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OBSERVATIONS

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In the upper Columbia, sockeye salmon have been shown to migrate through the upper water column and use surface passage routes when available. Sockeye salmon appear to pass via surface routes at a higher rate than Chinook, but other passage metrics are very similar to spring/summer Chinook making them a suitable surrogate.

The Action Agencies agree with the conclusions in a recent peer-reviewed paper regarding the sockeye program, which indicates that the current program has had a 20 fold benefit. The current efforts to prevent extinction of Redfish Lake sockeye salmon have provided a large measure of success, between 1999 and 2002, more than 312 adults returned from the ocean from captive broodstock releases – an amplification of almost 20 times the wild fish that returned in the 1990s. Important lineages of Redfish Lake sockeye salmon are being maintained in culture as preserves for genetic variability and for numerical and demographic amplification of the extant wild population. Most importantly, the broodstock program has, at least for the short-term, prevented extinction of Redfish Lake sockeye salmon.[11]

[11] Flagg, T. A., W. C. McAuley, P.A. Kline, M. S. Powell, D. Taki, and J. C. Gislason. 2004. Application of captive broodstocks to preservation of ESA-listed stocks of Pacific Salmon: Redfish Lake sockeye salmon case example. Pages 387-400 *in* M. J. Nickum, P. M. Mazik, J. G. Nickum, and D. D. MacKinlay, editors. Propagated fish in resource management. American Fisheries Society, Symposium 44, American Fisheries Society, Bethesda, Maryland.