Owyhee Subbasin Plan

Appendix 4: Appendices for the Owyhee Subbasin Management Plan (Chapter 4)

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Prepared for:
The Northwest Power and Conservation Council

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Disclaimer:
Final approval by the Northwest Power and Conservation Council is contingent upon a favorable review by the Independent Scientific Review Panel and meeting requirements for adoption as an amendment to the Council's Fish & Wildlife Program.

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Appendix 4.1. References.

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§4.2.1 Native American Use – Before and During European Settlement

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[Although this draft document states that it should not be cited or quoted, some of the material in the report is an important improvement to Lazorchak et al. (1998). By not citing the document, it may give the appearance that I improved some of the methods outlined in the Lazorchak et al. report. To avoid this, I feel it necessary to offer credit where credit is due.]

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Appendix 4.2. Cross-reference between technical analysis – Qualitative Habitat Analysis (QHA) for redband trout – and the development of objectives and strategies for the management plan.

§ 4.2.1 Idaho Portion of the Owyhee Subbasin

AppendixTable 4.2.1.1 Idaho QHA link ~ Protection Objectives and Strategies: {Reaches with Quartile 1 and Quartile 2 Protection Scores}

4th Field HUC/ Reach Name	Description	Q-tile	Protection Objectives	Protection Strategies	Min. QHA Score ↦ Limiting Factor(s)
HUC 17050108					
Jordan Cr.-6	BLM boundary upstream of Louse Cr. To BLM boundary section	**2**	Pol II Rip I	1. IIA 2. IA 3. IB	1.0: Pollutants
Jordan Cr.-8	State linelands boundary to headwaters of Jordan Cr.	**1**	Pol II Rip I	1. IIA 2. IA 3. IB 4. IC	1.0: Pollutants
Williams Cr.	BLM segments	**1**	Rip I	1. IA 2. IB 3. IC	2.0: C. Stability H. Diversity ~~L. Flow~~ L. Temp. H. Temp.
Williams Cr.	Including Pole Bridge Cr. And West Cr.	**1**		1. 2. 3.	2.0 H. Diversity L. Temp. H. Temp.
South Mountain Creek	Lower BLM upper put state includes Howl Cr. Cyote Cr.	**2**	Rip I	1. IA 2.IB 3.IC	1.0: H. Diversity

Flint Cr.1	Lower	**2**	Rip I Pol II	1. IC 2.IB 3. IIA	1.5: F. Sediment Pollutants
Flint Cr.2	Upper Includes East Cr.	**2**	Rip I Pol II	1. IC 2. IB 3. IIA	1.5: F. Sediment Pollutants
South Boulder Cr.	From confluence with North Boulder Cr. To confluence with Mill Cr.	**1**	Rip I	1.IA 2.IB 3.IC	1.5: H. Temp.
Bogus Cr.	Upper above section 10 and above	**2**	Rip I	1.IA 2.IB 3.IC	2.5: Riparian C. Stability H. Diversity F. Sediment H. Temp.
Combination Cr.	Lower reach of stream	**2**	Rip I	1. IA 2.IB 3.IC	1.5: Riparian Oxygen
Rose Cr.	Up to state section.	**1**	Rip I	1. IB 2.IC 3.	2.0: Oxygen
Josephine	includes Wickiup and Long Valley and Headwater Josephine	**2**	Rip I	1.IA 2.IB 3.IC	1.5: H. Flow
Lower Rock Cr.-1	From confluence of North Boulder to Meadow Creek.	**1**	Rip I	1. IC 2.IA 3.IB	1.5: H. Flow L. Flow
Rock Cr.-3	BLM portion in Section 26	**1**	Rip I	1.IA 2.IB 3.	1.5: H. Flow L. Flow
Deer Cr.	Confluence with Big Boulder to	**2**	Rip I	1.IA	2.0: F. Sediment

	state section 36			2.IB 3.IC	
Owl Cr.	Includes Minear Cr. (Confluence of Lone Tree to headwaters)	**2**		1. 2. 3.	2.0: H. Diversity F. Sediment
North Boulder-1	From confluence with Big Boulder; BLM reach to Private	**1**	Rip I	1. IA 2.IB 3.IC	2.0: H. Temp.
North Boulder-2	From confluence with Mamouth Cr. To headwaters	**1**		1. 2. 3.	2.0: H. Temp.
Louse Cr.	Includes Cottonwood Cr. From confluence of Jordan Cr. To headwaters	**2**	Rip I Flow IV	1. IVA 2.IB 3.IC	1.0: H. Diversity L. Flow
Upper Trout Cr.	From Split Rock Canyon to headwaters, including Nichols, Wood Canyon creeks	**2**	Rip I	1. IA 2.IB 3.	1.5: L. Flow
Cow Cr.-2	From confluence with Wildcat Canyon Cr. To headwaters	**1**	Pol II Rip I	1.IIA 2.IA 3.IB	2.0: Riparian C. Stability H. Diversity F. Sediment H. Temp. Pollutants
Soda Cr.	From confluence of Cow Cr. To headwaters	**1**	Pol II Rip I	1.IIA 2.IC 3.IB	2.0: H. Diversity F. Sediment Oxygen H. Temp. Pollutants
HUC 17050107					
NF Owyhee 1	Lower; From the Oregon State line to the confluence of Juniper Cr.	**1**	Flow IV Rip	1. IVA 2. IB 3.IA	2.0: L. Flow H. Temp.

NF Owyhee 2	Upper; Headwaters of North Fork , Lower Noon Cr. And Lower Pleasant Valley Cr.	**1**	Flow IV Rip I	1.IVA 2.IA 3.IB	2.5: L. Flow H. Temp.
Upper Pleasant Valley Cr.	From the top of Sec. 7 to headwaters	**2**	Rip I	1.IA 2.IB 3.IC	1.0: C. Stability
Cabin Cr.	From the confluence with Juniper Cr. To the headwaters	**1**	Rip I	1.IA 2.IB 3.IC	2.0: Riparian C. Stability F. Sediment H. Temp. ~~Pollutants~~
Juniper Cr. 1	From the confluence with the North Fork Owyhee to lower private boundary	**1**	Rip I	1.IA 2.IB 3.	2.0: H. Temp. ~~Pollutants~~
Juniper Cr. 2	From the start of the private up to the headwaters	**2**		1. 2. 3.	1.0: L. Flow
Lone Tree Cr.	From Oregon State line to headwaters	**2**	Rip I	1.IA 2.IB 3.IC	1.5: H. Diversity
Cottonwood Cr.	From the upper private boundary (section 18) to headwaters	**2**	Flo IV Rip	1.IVA 2.IA 3.IB	1.5: L. Flow
Squaw Cr. 1	From Oregon State line to lower private boundary (section 13)	**1**	Rip I	1.IA 2.IB 3.	2.0: H. Temp.
Squaw Cr. 2	From the start of private in section 14 to the BLM in the northwest corner of section 31	**1**		1. 2. 3.	2.0: L. Flow H. Temp.

Squaw Cr. 3	From private to headwaters	**1**	Flow IV Rip I	1.IVA 2.IA 3.IB	2.0: Riparian C. Stability H. Diversity F. Sediment L. Flow H. Temp.
Pole Cr.	Oregon State line to headwaters	**2**	Rip I	1.IA 2.IB 3.	2.5: F. Sediment
HUC 17050106					
No quartile #1 and #2 scores for protection objective and strategies in this HUC.					
HUC 17050105					
No quartile #1 and #2 scores for protection objective and strategies in this HUC.					
HUC 17050104					
Shoofly Cr.-1	Confluence to BLM boundary	**--**		1. 2. 3.	1.0: Riparian H. Diversity L. Flow
Shoofly Cr.-2	Private/BLM boundary to Bybee reservoir	**--**	Obs III	1. IIID 2. 3.	1.0: H. Flow L. Flow Obstruction
Owyhee River	DV reservoir border to confluence	**2**	Rip I	1.IA 2.IB 3.	2.0: H. Temp.
Owyhee River DVIR portion	Mouth of canyon to NV state line	**--**		1. 2. 3.	1.0: Riparian C. Stability H. Diversity L. Flow H. Temp.
Battle Cr.-3	State section 36 to headwaters	**--**		1. 2. 3.	1.0: H. Diversity L. Flow
Dry Cr.-1	confluence to reservoir	**--**	Pol II Rip I	1.IIA 2.IA	2.0: Riparian C. Stability H. Diversity F. Sediment

				3.IB	H. Flow L. Flow Oxygen L. Temp. H. Temp. Pollutants
Dry Cr.-2	Reservoir to headwaters	--	Obs III Rip I	1.IIID 2.IIIA 3.IA	1.0: Riparian C. Stability H. Diversity L. Flow H. Temp. Obstruction
Deep Cr.-4	headwaters including:	1	Rip I	1.IA 2.IB 3.IC	1.0: Riparian C. Stability F. Sediment
Stoneman Cr.	Confluence to headwaters	2	Flo IV Rip I	1.IVA 2.IA 3.	1.0: C. Stability L. Flow
Nickel Cr.	Confluence to headwaters including:	2	Rip I	1.IA 2.IB 3.IC	1.0: F. Sediment
Smith Cr.	Confluence to headwaters including:	2	Rip I	1.IA 2.IB 3.IC	1.0: F. Sediment
Beaver Cr.	Confluence to headwaters including:	1	Flo IV Rip I	1.IVA 2.IB 3.IC	2.0: Riparian F. Sediment L. Flow
Red Canyon Cr.	Confluence to headwaters including:	1	Rip I	1.IA 2.IB 3.	1.0: H. Temp.
Pole Cr.-1	Confluence to Camas Cr. Confluence including Camel Cr.	2	Rip I	1.IA 2.IB 3.IC	1.0: H. Temp.

AppendixTable 4.2.1.2 Idaho QHA link ~ Restoration Objectives and Strategies: {Reaches with Quartile 1 and Quartile 2 Restoration Scores}

4th Field HUC/ Reach Name	Description	Q-tile	Restoration Objectives	Restoration Strategies	Min. QHA Score ↦ Limiting Factor(s)
HUC 17050108					
Jordan Cr.-1	Jordan Cr. From OR Boundary to BLM boundary section	**1**		1. 2. 3.	1.0: Riparian C. Stability H. Diversity L. Flow Oxygen L. Temp. H. Temp. Pollutants
Jordan Cr.-2	From end of #2 to Rail Creek	**1**	Pol II	1.IIA 2. 3.	1.0: H. Diversity Pollutants
Jordan Cr.-3	Rail Cr. Confluence to BLM boundary	**2**		1. 2. 3.	1.0: L. Flow Pollutants
Jordan Cr.-4	BLM boundary near Buck Cr. to BLM boundary	**1**	Pol II	1.IIA 2. 3.	1.0: H. Diversity Pollutants
Jordan Cr.-5	BLM boundary section line to BLM boundary upstream of Louse Cr.	**2**		1. 2. 3.	1.0: Pollutants
Williams Cr.	BLM segments	**2**	Rip I	1. IA 2. IB 3.IC	2.0: C. Stability H. Diversity ~~L. Flow~~ L. Temp. H. Temp.
Duck Cr.	All	**1**	Rip I	1.IA	1.5: Riparian C. Stability

				2.IB 3.IC	F. Sediment
South Mountain Creek	Lower BLM upper put state includes Howl Cr. Cyote Cr.	**1**	Rip I	1.IA 2.IB 3.IC	1.0: H. Diversity
Rail Cr.	All	**2**	Rip I	1.IA 2.IB 3.IC	2.0: Riparian C. Stability H. Diversity F. Sediment H. Temp. Pollutants
Indian Cr.	Bogus Cr. (Lower) - confluence with South Fork Boulder to Section 10	**1**	Flo IV	1.IVA 2. 3.	1.0: L. Flow
Combination Cr.	Lower reach of stream	**2**	Rip I	1.IA 2.IB 3.IC	1.5: Riparian Oxygen
Louisa Cr.	From confluence with Rock Cr.	**1**	Obs III	1.IIID 2. 3.	1.0: Obstruction
Rock Cr.-2	From Meadow Creek to BLM	**1**	Flo IV	1.IVA 2. 3.	1.0: Riparian C. Stability H. Diversity L. Flow Oxygen L. Temp. H. Temp.
Rock Cr.-4	From BLM/PVT boundary in Sec. 26 to above Triangle Reservoir.	**1**		1. 2. 3.	1.0: Riparian C. Stability H. Diversity L. Flow Oxygen L. Temp. H. Temp.
Meadow Cr.	Headwaters to confluence with Rock Cr.	**2**	Rip I	1.IA 2.IB	1.0: H. Diversity

				3.IC	
Louse Cr.	Includes Cottonwood Cr. From confluence of Jordan Cr. To headwaters	**1**	Rip I Flo IV	1.IVA 2.IB 3.IC	1.0: H. Diversity L. Flow
Upper Trout Cr.	From Split Rock Canyon to headwaters, including Nichols, Wood Canyon creeks	**2**	Protection objectives	1. 2. 3.	1.5: ~~L. Flow~~
HUC 17050107					
Upper Pleasant Valley Cr.	From the top of Sec. 7 to headwaters	**2**	Rip I	1.IA 2.IB 3.IC	1.0: C. Stability
Cottonwood Cr.	From the upper private boundary (section 18) to headwaters	**2**	Flo IV	1.IVA 2. 3.	1.5: L. Flow
Middle Fork Owyhee	Oregon State line to headwaters	**2**	Rip I	1.IA 2.IB 3.	0.5: Riparian
HUC 17050106					
Little Owyhee	From the Nevada State line to the confluence with South Fork Owyhee	**2**	Pol II Rip I	1.IIA 2.IA 3.IB	1.0: H. Diversity Oxygen L. Temp. H. Temp. Pollutants
HUC 17050105					
South Fork Owyhee	From Nevada State line to the confluence with Owyhee River		Flow IV Rip I	IVA IA IB	1.5: L. Flow H. Temp
HUC 17050104					
Blue Cr.-3	Blue Cr. Reservoir to headwaters	**2**	Flow IV	1.IVA	1.0: L. Flow

				2. 3.	
Shoofly Cr.-1	Confluence to BLM boundary	**1**		1. 2. 3.	1.0: Riparian H. Diversity L. Flow
Shoofly Cr.-2	Private/BLM boundary to Bybee reservoir	**2**	Obs III	1.IIID 2. 3.	1.0: H. Flow L. Flow Obstruction
Owyhee River DVIR portion	Mouth of canyon to NV state line	**1**		1. 2. 3.	1.0: Riparian C. Stability H. Diversity L. Flow H. Temp.
Battle Cr.-2	Section 10 to above state section 36	**1**		1. 2. 3.	1.0: H. Temp.
Battle Cr.-3	State section 36 to headwaters	**1**		1. 2. 3.	1.0: H. Diversity L. Flow
Dry Cr.-1	confluence to reservoir	**1**	Pol II Rip I	1.IIA 2.IA 3.IB	2.0: Riparian C. Stability H. Diversity F. Sediment H. Flow L. Flow Oxygen L. Temp. H. Temp. Pollutants
Dry Cr.-2	Reservoir to headwaters	**1**	Obs III Rip I	1. IIID 2.IIIA 3.IA	1.0: Riparian C. Stability H. Diversity L. Flow H. Temp. Obstruction
Big Springs Cr.-1	confluence to reservoir	**2**	Rip I	1.IA 2.IB	1.0: H. Temp.

				3.	
Big Springs Cr.-3	BLM boundary to private	**2**	Rip I	1.IA 2.IB 3.IC	1.0: Riparian H. Temp.
Deep Cr.-1	Confluence to private	**2**	Rip I	1.IA 2.IB 3.IC	1.0: F. Sediment Oxygen H. Temp.
Deep Cr.-2	Private to mid section 10	**1**	Rip I	1.IA 2.IB 3.IC	1.0: F. Sediment Oxygen H. Temp.
Deep Cr.-3	section 10 to Stoneman Cr. Confluence	**2**	Rip I	1. IA 2.IB 3.IC	1.0: F. Sediment
Deep Cr.-4	headwaters including:	**1**	Rip I	1.IA 2.IB 3.IC	1.0: Riparian C. Stability F. Sediment
Stoneman Cr.	Confluence to headwaters	**2**	Flo IV Rip I	1.IVA 2.IA 3.	1.0: C. Stability L. Flow
Current Cr.	Confluence to headwaters	**1**	Flo IV Rip I	1.IVA 2.IA 3.IB	1.0: C. Stability L. Flow
Smith Cr.	Confluence to headwaters including:	**2**	Rip I	1.IA 2.IB 3.IC	1.0: F. Sediment
Castle Cr.	Confluence to headwaters including:	**1**	Obs III Rip I	1.IIID 2.IA 3.IB	1.0: Riparian F. Sediment H. Flow L. Flow H. Temp. Obstruction

Red Canyon Cr.	Confluence to headwaters including:	**2**	Rip I	1.IA 2.IB 3.	1.0: H. Temp.
Petes Cr.	Confluence to headwaters including:	**1**	Rip I	1.IA 2.IB 3.	1.0: H. Temp.
Pole Cr.-2	Camas confluence to headwaters	**2**		1. 2. 3.	1.0: L. Flow H. Temp.

§ 4.2.2 Nevada Portion of the Owyhee Subbasin

Appendix Table 4.2.2.1 Nevada QHA link to <u>Protection</u> Objectives and Strategies: {Reaches with Quartile 1 and Quartile 2 Protection Scores} Key: Q1= top 25% of rank protection score; Q2= second 25%; Q3= third 25%; Q4= bottom 25%.

4th Field HUC/ Reach Name	Description	Q	Protection Objectives	Protection Strategies	Limiting Factor(s)
HUC 17050104					
Skull Cr		**2**	Rip I	1. ID	Riparian
N.F. of Skull Cr		**2**	Rip I	1. ID	Riparian
E.F. of Skull Cr		**2**	Rip I	1. ID	Riparian
Fawn Cr	USFS RBT occupied for sure 4.8miles	**2**	Rip I	1. IA 2.ID	Riparian H. Temp.
E.F. Owyhee Duck Valley Indian Res border to Patsville (Mill Cr)	U.S.F.S.	**3**	Poll II	1.IIA	Pollutants
Slaughter House Cr	Occupied RBT 2 miles	**1**	Rip I Obs III	1.IA 2.IIIA	C. Stability H. Diversity F. Sediment Obstruction
Brown's Gulch (Slaughter house Trib	2.4 miles RBT occupied	**1**	Rip I	1.IA	C. Stability H. Diversity F. Sediment ~~Obstruction~~
Miller Cr.	3 mile occupied RBT	**2**	Rip I	1.IA	C. Stability H. Diversity F. Sediment ~~Obstruction~~
West Fr. (of Slaughterhouse Cr)	1.5 miles occupied RBT	**1**	Rip I	1.IA	C. Stability

4th Field HUC/ Reach Name	Description	Q	Protection Objectives	Protection Strategies	Limiting Factor(s)
					H. Diversity F. Sediment ~~Obstruction~~
North Fr (trib of California Cr)	No RBT, lack of flow(Drought yr)	**2**	Rip I	1.IA 2. 3.	H. Temp.
Dip Cr	1 mile RBT occupied	**1**	Obs III Rip I	1.IIIB 2.IA	C. Stability H. Diversity F. Sediment Obstruction
Big Springs Cr	Unoccupied (insufficient flow)	**1**	Rip I	1.IA	C. Stability H. Diversity F. Sediment ~~Obstruction~~
South Fr.	2 mile RBT occupied	**2**	Rip I	1.IA	Riparian
Pixley	1 mile RBT occupied	**2**	Poll III	1.IIIB	Obstruction
Upper Mill Cr to Rio tinto Mine	occupied RBT whole distance in none drought years	**1**	Rip I	1.IA	Riparian C. Stability H. Diversity F. Sediment
McCall Cr.	5.5 miles occupied RBT	**1**	Rip I	1.IA	Riparian C. Stability H. Diversity F. Sediment
Trail Cr	8.2 occupied RBT, Brook Trout(MGT concern)	**2**	Obs III	1.IIIA	L. Flow Obstruction

4th Field HUC/ Reach Name	Description	Q	Protection Objectives	Protection Strategies	Limiting Factor(s)
Van Duzer Cr. (Trib to Trail Cr)	5 mile occupied, Brook Trout (MGR concen)	2	Obs III	1.IIIA	L. Flow Obstruction
Lime Cr (trib to Van Duzer)	.3 occupied by RBT, Brook Trout prsnt	1	Rip I	1.IA	C. Stability
Cobb Cr (trib to Van Duzer)	4.5 RBT occupied	1	Rip I	1.IA	Riparian C. Stability H. Diversity F. Sediment
Wood Gulch	Mine prsnt, 2 mile RBT occupied	1	Rip I	1.IA	Riparian C. Stability H. Diversity F. Sediment ~~Obstruction~~
Hutch Cr	1mile RBT occupied, Brook Trout	2	Obs III	1.IIIB	Obstruction
Timber Gulch	0.35 RBT occupied, Brook Trout	2	Obs III	1.IIIB	Obstruction
Sheep cr	2 mile RBT occupied, Brook Trout	1	Rip I	1.IA	Riparian C. Stability H. Diversity F. Sediment ~~Obstruction~~
Road Canyon	1.2 RBT occupied	2	Rip I	1.IA	Riparian C. Stability H. Diversity F. Sediment ~~Obstruction~~

4th Field HUC/ Reach Name	Description	Q	Protection Objectives	Protection Strategies	Limiting Factor(s)
Gravel Cr	Lower 0.1 RBT occupied (spawning ground)	**2**	Rip I	1.IA	Riparian
Badger Cr.	7 miles RBT occupied, some livestock concerns, fair condition, 1600 fish	**1**	Rip I	1.IA	Riparian C. Stability
Beaver Cr.	All occupied by RBT	**1**	Rip I	1.IA 2. 3.	Riparian C. Stability
Penrod	RBT occupied entire way	**2**	Rip I	1.IC	Riparian C. Stability
Martin Cr. (trib to Penrod)	4.5 RBT occupied, Brook Trout	**1**	Rip I	1.IA	C. Stability
Gold Cr. (trib to Martin Cr)	1.8 RBT occupied	**1**	Rip I	1.IA 2.IC	Riparian C. Stability
HUC 17050105					
T41N R49E sec4 to Head Waters	Occupied by RBT year round, 3miles of reach occupied	**2**	Rip I Obs III	1.IC 2.IIIA 3.	C. Stability Obstruction
Indian Cr. (Trib to S.F. Owyhee)	Occupied RBT through National Forest	**2**	Rip I Obs III	1.IC 2.IA 3.IIIA	~~Pollutants~~ Riparian Obstruction
Winters Cr. Trib to Indian Cr	2 miles occupied RBT through National Forest	**2**	Rip I	1.IA 2.IC 3.IIIA	Obstruction Riparian
Mitchell Cr. Trib to Indian Cr	2 miles occupied RBT through National Forest	**2**	Rip I Obs III	1.IA 2.IC 3.IIIA	Obstruction Riparian

4th Field HUC/ Reach Name	Description	Q	Protection Objectives	Protection Strategies	Limiting Factor(s)
Wall Cr. Trib to Indian Cr	1 Mile occupied RBT through National Forest	**2**	Rip I Obs III	1.IA 2.IC 3.IIIA	Obstruction Riparian
Silver Cr. (Trib to S.F. Owyhee)	2 miles occupied RBT through National Forest	**2**	Obs III Rip I	1.IIIA 2.IC 3.IA	Obstruction Riparian
Breakneck Cr	2 miles occupied RBT	**2**	Rip I	1.IC 2.IA 3.	~~Obstruction~~ Riparian
Cap Winn Cr	Occupied RBT,	**2**	Rip I Obs III	1.IA 2.IC 3.IIIC	C. Stability H. Diversity Obstruction
Doby George	Occupied RBT,	**2**	Rip I Obs III	1.IA 2.IC 3.IIIC	C. Stability H. Diversity Obstruction
Columbia Cr	Occupied RBT, Low number (200's), Brook Trout abundant	**1**	Rip I Obs III	1.IA 2.IC 3.IIIC	Obstruction Riparian
Blue Jacket Cr	Occupied RBT (700), Brook Trout	**1**	Obs III Rip I	1.IIIC 2.IC 3.IA	Obstruction Riparian
Harrington Cr	Unsurveyed, Prvt Land, Probable RBT	**2**	Obs III	1.IIIA	Obstruction
Marsh Cr.	Occupied RBT	**1**	Obs III	1.IIIA	Obstruction
Boyd Cr	Occupied RBT	**1**	Obs III	1.IIIA	Obstruction
Scoonover Cr.	Occupied RBT	**1**	Obs III Rip I	1.IIIB 2.IA	Obstruction Riparian
Dorsey	Occupied RBT	**1**	Obs III	1.IIIB	Obstruction

4th Field HUC/ Reach Name	Description	Q	Protection Objectives	Protection Strategies	Limiting Factor(s)
Coffin Cr.	Occupied RBT	1	Obs III	1.IIIB	Obstruction
Jack Cr	Occupied RBT, no brook trout surveyed in last 2yrs(used to be abundant)	1	Obs III	1.IIIA 2.IIIB	Obstruction
Chicken Cr	Occupied RBT,	1	Obs III	1.IIIB	Obstruction
Mill Cr	Occupied RBT, Brook trout, included 3 forks	1	Obs III Rip I	1.IIIB 2.IA	Obstruction Riparian
Snow Canyon Cr	Occupied RBT, 5 mi occupied	1	Obs III	1.IIIA	Obstruction
Burns Cr.(Trib to Jarritt Canyon0	1.5 mile occupied on National Forest, Trout Prsnt	1	Obs III	1.III	Obstruction
Schmidtt Cr.	4 miles occupied	1	Obs III	1.IIIA	Obstruction
McCann Cr	5 mile occupied RBT, low desnity RBT	2	Rip I Obs III	1.IC 2.IB 3.IIIA	C. Stability H. Flow Obstruction
Taylor Canyon Cr (trib to S.F. Owyhee)	2 miles occupied RBT, BT common	2	Obs III	1.IIIA 2.IIIB	Obstruction
Water Pipe Canyon (trib to Taylor Canyon)	2.5 mile occupied RBT	2	Obs III Rip I	1.IIIB 2.IC	Obstruction Riparian

Appendix Table 4.2.2.2 Nevada QHA link to <u>Restoration</u> Objectives and Strategies: {Reaches with Quartile 1 and Quartile 2 Protection Scores} Key: Q1= top 25% of rank protection score; Q2= second 25%; Q3= third 25%; Q4= bottom 25%.

4th Field HUC/ Reach Name	Description	Q	Restoration Objectives	Restoration Strategies	Limiting Factor(s)
HUC 17050104					
E.F. Owyhee ID-NV state line to Paradise Point Diversion	Irrigated hay fields, No RBT habitat	2	Rip I Obs III Poll II Obs III	1.ID 2.IIID 3.II 4.IIIC	C. Stability L. Flow Pollutants Obstruction
E.F. Owyhee Paradise Point to Duck Valley Indian Res border	DVIR	2	Rip I	1.ID	C. Stability H. Diversity
Skull Cr		1	Rip I	1.ID	Riparian
N.F. of Skull Cr		1	Rip I	1.ID	Riparian
E.F. of Skull Cr		1	Rip I	1.ID	Riparian
Jones Cr		1	Rip I	1.ID	Riparian
Granite	probably fishless	1	Rip I	1.ID.	Riparian
E.F. Owyhee Duck Valley Indian Res border to Patsville (Mill Cr)	U.S.F.S.	1	Poll II Obs III	1.IIA 2.IID 3.	Pollutants
California Cr	Min. occupied RBT by headwater of Cr.	1	Obs III	1.IIID	L. Flow
North Fr (trib of California Cr)	No RBT, lack of flow(Drought yr)	1	Obs III	1.IA	H. Temp.
E.F. Owyhee Mill Cr.to Badger Cr	U.S.F.S.	1	Rip I	1.IC	H. Diversity
Lower Mill Cr to S.F Owyhee River	Unoccupied, pollution, mine tailings	1	Poll II	1.IIA	Riparian H. Diversity Pollutants
Allegheny	Native Dace only	1	Rip I	1.IA	L. Flow

4th Field HUC/ Reach Name	Description	Q	Restoration Objectives	Restoration Strategies	Limiting Factor(s)
				2.IC	
Cold Spring (trib to Allegheny)	Native Dace only	1	Rip I	1.IA	L. Flow
Trail Cr	8.2 occupied RBT, Brook Trout(MGT concern)	2	Obs III	1.IIID	L. Flow Obstruction
Van Duzer Cr. (Trib to Trail Cr)	5 mile occupied, Brook Trout (MGR concen)	2	Obs III	1.IIID	L. Flow Obstruction
Hutch Cr	1mile RBT occupied, Brook Trout	2	Obs III	1.IIIB	Obstruction
Timber Gulch	0.35 RBT occupied, Brook Trout	2	Obs III	1.IIIB	Obstruction
E.F. Owyhee Badger Cr. To Wildhorse Res.	U.S.F.S.	2	Obs III	1.IIID	Obstruction
Wildhorse Res		1	Obs III	1.IIID	L. Flow Obstruction
Hay meadow Cr	only native dace present	1	Rip I	1.IC 2.IB	L. Flow
Thompson Cr (hay meadow trib)	no fish present in drough yrs	2	Rip I	1.IC	L. Flow
Sweet Cr	0.5 RBT occupied	1	Rip I	1.IC	L. Flow
Rosebud Cr	Native Dace only	1	Rip	1.IC	L. Flow
Deep Cr trib to Wildhorse (E.F. Owyhee)	1.5 miles occupied RBT, some on prvt land?	2	Obs III	1.IIID	L. Flow
Clear Cr trib to (Deep Cr)	no fish present in drough yrs	2	Obs III	1.IIID	L. Flow
Riffe Cr (Deep Cr)	3 mile occupied RBT, beaver ponds	2	Rip I	1.IA	L. Flow
N.F. of Deep Cr	No RBT, lack of flow(Drought yr)	2	Rip I	1.IA 2.IC	L. Flow
Middle Fork of Deep Cr	2 mile occupied RBT	2	Rip I	1.IA 2.IC	L. Flow

4th Field HUC/ Reach Name	Description	Q	Restoration Objectives	Restoration Strategies	Limiting Factor(s)
S.F of Deep Cr	3 miles RBT occupied	**2**	Rip I	1.IA 2.IC	L. Flow
E. F. Owyhee Above Wildhorse Res to head waters	Spotted Frog habitat	**1**	Rip I	1.IC 2.IB	F. Sediment
Hanks Cr trib to Upper E.F Owyhee	Dace prsnt, habitat concerns (livestocke) no RBT	**1**	Rip I	1.IC	Riparian
HUC 17050105					
Lower boundry of Petan Ranch to Red Cow Cr.	Red Band prsnt seasonally(Spring) during good water yrs when sutiable water temps	**2**	Rip I Obs III	1.IC 2.IB 3.IIID	Riparian C. Stability ~~H. Flow~~ Obstruction
From Red Cow to Hot cr.	RBT Occupied yr round, low density	**2**	Rip I	1.IC 2.IB	~~H. Flow~~ ~~Obstruction~~
hot creek to McCann	Prvt Land, Brook Trout prsnt in Spring Heads, RBT are seasonal, White Fish yr round	**2**	Obs III Non IV	1.IIID 2.IVA	Obstruction
T41N R49E sec4 to Head Waters	Occupied by RBT year round, 3miles of reach occupied	**2**	Rip I Obs III	1.IC 2.IB 3.IIIA 4.IIID	C. Stability Obstruction
Winters Cr.	Recently occupied, but not currently, historic habitat (no record), stocked in 1972 with RBT, ceased in 2000due to fire/livestock grazing	**1**	Rip I	1.IC	C. Stability H. Temp. Obstruction
Sheep Cr. Res to T46n R51E sec 11	Int/Dry, no RBT, spring down	**2**		1.	Obstruction

4th Field HUC/ Reach Name	Description	Q	Restoration Objectives	Restoration Strategies	Limiting Factor(s)
	migration			2. 3.	
T46n R51e sec 11 to head waters		1		1. 2. 3.	Obstruction
Indian Cr. (Trib to S.F. Owyhee)	Occupied RBT through National Forest	2	Rip I	1.IC	Pollutants
Silver Cr. (Trib to S.F. Owyhee)	2 miles occupied RBT through National Forest	2	Obs III	1.?	Obstruction
White Rock Cr.	Unoccupied, probably historic, mining influence	2	Obs III	1.?	Obstruction
Cottonwood Canyon Cr.	Unoccupied, probably historic, mining influence	2		None	Obstruction
Bull Run Cr.-S.F. Owyhee to Bull Run Canyon	Diverted for Agriculture use	2		None	Obstruction
Mouth of Bull Run Canyon to Cap Winn Cr.	probably recruitment from upstream tribs	2		None.	Obstruction
Frost Cr.	Low number of RBT	1	Rip I	1.IC 2.IA	C. Stability H. Diversity Obstruction
Cap Winn Cr	Occupied RBT,	2	Rip I	1.IC 2.IA	C. Stability H. Diversity Obstruction
Doby George	Occupied RBT,	2	Rip I	1.IA 2.IC	C. Stability H. Diversity Obstruction
Deep Cr. Trib to S.F. Owyhee		1	Rip I	1.IC	H. Diversity
S.F Owyhee to Head Waters	Unoccupied, RBT probably present historically	1			N/A (no scores)

4th Field HUC/ Reach Name	Description	Q	Restoration Objectives	Restoration Strategies	Limiting Factor(s)
Red Cow Cr.	Occupied 1mile by RBT	**1**	Rip I	1.IC	C. Stability
Amazon	Ephemerial, no record of RBT, probably historic	**1**	Rip I	1.IC 2.IB	C. Stability ~~Obstruction~~
Big Cottonwood Trib	1mile occupied by RBT	**1**	Rip I	1.IC 2.IB	C. Stability
McCann Cr	5 mile occupied RBT, low desnity RBT	**1**	Rip I Obs III	1.IC 2.IB 3.IIID	C. Stability L. Flow Obstruction
Water Pipe Canyon (trib to Taylor Canyon)	2.5 mile occupied RBT	**2**	Obs III Rip I	1.IIIB 2.IC	Obstruction Riparian

§ 4.2.3 Oregon Portion of the Owyhee Subbasin

Appendix Table 4.2.3.1 Oregon QHA link to Protection Objectives and Strategies.

4th Field HUC/ Reach Name	Description	Q	Protection Objectives	Protection Strategies	Limiting Factor(s)
Owyhee R-1	Mouth to Owyhee Ditch Co Dam (RM14)	- -	Private land (CT) No RedBand Trout present (RP)		Oxygen (CT)
Owyhee R-2	DC Dam to RM28	- -	Grazing management may include season of use, fencing, and rest. (CT) No RedBand Trout present (RP)	1. Implement grazing management appropriate for riparian pastures (CT).	H. Temp. (CT)
Owyhee R-3	Dam to Upstream High Water (RM80)	4	Reservoir		N/A No scores
Dry Creek	Dry Creek upstream to Crowley Road	2	Grazing management may include season of use, fencing, and rest. (CT) Grazing management may include season of use, fencing, and rest. (RP)	1. Implement grazing management appropriate for riparian pastures (CT). 2. Improve riparian to increase vegetative shading. (RP) 3.Improve riparian to increase bank stability (RP)	H. Temp. (CT) C Stability (RP) H diversity (RP) F sediment (RP)
Owyhee R-4	High Water upstream to Jordan Cr	3	Appropriate grazing management has been implemented on BLM reaches. (CT) Appropriate grazing management has been implemented on BLM reaches. (RP)	1. Implement grazing management appropriate for riparian pastures. (CT)	F. Sediment (CT) H. Temp. (CT) Pollutants

4th Field HUC/ Reach Name	Description	Q	Protection Objectives	Protection Strategies	Limiting Factor(s)
					(CT) H diversity (RP) H Flow (RP) L Flow (RP)
Rinehart Creek	Mouth to falls	**1**	No RedBand Trout present (CT) Limiting factors result from natural processes (CT)		F. Sediment (CT)
Jordan Creek	Mouth to State Line	**3**	Primarily private land and agricultural use. (CT) Grazing management may include early season use, fencing, and rest. (CT) Grazing management may include season of use, fencing, and rest. (RP)	1. Implement grazing management appropriate for riparian pastures. (CT) 2. Improve riparian to provide vegetative shading and bank stability.(RP) 3. Screen irrigation diversions. (RP) 4. Passage at irrigation structures. (RP)	L. Flow (CT) H. Temp. (CT) C stability (RP) H diversity (RP) H Flow (RP)
Cow Creek	Mouth to State Line	**3**	Primarily private land and agricultural use. (CT) Grazing management may include early season use, fencing, and rest. (CT) Grazing management may include season of use, fencing, and rest. (RP)	1. Implement grazing management appropriate for riparian pastures. (CT) 2. Improve riparian to provide vegetative shading and	Riparian (CT) L. Flow (CT) H. Temp. (CT) H flow (RP)

4th Field HUC/ Reach Name	Description	Q	Protection Objectives	Protection Strategies	Limiting Factor(s)
				bank stability (RP) 3. Screen irrigation diversions. (RP) 3. Passage at irrigation structures. (RP)	C stability (RP) H diversity (RP)
Owyhee R-5	Confl. Jordan Creek upstream to Sline	**2**	Appropriate grazing management has been implemented on BLM reaches. (CT) Appropriate grazing management has been implemented on BLM reaches (RP)	1. Implement grazing management appropriate for riparian pastures. (CT)	H. Temp. (CT) H diversity (RP) C stability (RP) Riparian C (RP)
NF Owyhee	Mouth to Sline	**2**	Grazing management may include early season use, fencing, and rest. (CT) Grazing management may include season of use, fencing, and rest. (RP)	1. Implement grazing management appropriate for riparian pastures. (CT) 2. Improve riparian to increase vegetative shading. (RP) 3. Improve riparian to increase bank stability. (RP)	Riparian (CT) H. Temp. (CT) H diversity (RP) L flow (RP) C stability (RP)
Middle Fork	Idaho Segment (?)	**2**	Primarily private land. (CT) Grazing management may include season of use, fencing, and rest. (RP)	1. Improve riparian to increase vegetative shading. (RP) 2. Improve riparian to increase bank stability. (RP)	Riparian (CT) C stability (RP) H diversity (RP) L flows (RP)

4th Field HUC/ Reach Name	Description	Q	Protection Objectives	Protection Strategies	Limiting Factor(s)
Antelope Creek R-1	Mouth upstream to corrals (~8 mi)	1	No RedBand Trout present (CT) Limiting factors result from natural processes. (CT) Grazing management may include season of use, fencing, and rest. (RP)	1. Improve riparian to increase vegetative shading. (RP) 2. Improve riparian to increase bank stability. (RP)	F. Sediment (CT) H diversity (RP) C stability (RP) Riparian C (RP)
Antelope Creek R-2	Corrals upstream to Star Valley Road (dry segment)	3	No RedBand Trout present (CT) Limiting factors result from natural processes (lack of perennial flow). (CT) Grazing management may include season of use, fencing, and rest. (RP)	1. Improve riparian to increase vegetative shading (RP) 2.Improve riparian to increase bank stability (RP)	F. Sediment (CT) Obstructions (RP) H flows (RP) L flows (RP)
Antelope Creek R-3	SV Road upstream to Headwaters	4	Grazing management may include early season use, fencing, and rest. (CT) Grazing management may include season of use, fencing, and rest. (RP)	1. Implement grazing management appropriate for riparian pastures. (CT) 2. Improve riparian to increase vegetative shading (RP) 3.Improve riparian to increase bank stability (RP)	Riparian (CT) H. Diversity (CT) Oxygen (CT) H. Temp. (CT) Obstructions (RP) H flows (RP) L Flows (RP)
WLO R-1	Mouth upstream to Anderson Crossing	1	Appropriate grazing management has been implemented (exclusion). (CT)	1. Implement grazing management appropriate for riparian	F. Sediment (CT) H. Temp.

4th Field HUC/ Reach Name	Description	Q	Protection Objectives	Protection Strategies	Limiting Factor(s)
			Appropriate grazing management has been implemented on BLM reaches (RP)	pastures. (CT) 2. Improve riparian to increase vegetative shading (RP) 3. Improve riparian to increase bank stability (RP)	(CT) H diversity (RP) C stability (RP) Riparian C (RP)
WLO R-2	Anderson Crossing to headwaters	**1**	Appropriate grazing management has been implemented (exclusion). (CT) Grazing management may include season of use, fencing, and rest. (RP)	1. Implement grazing management appropriate for riparian pastures. (CT) 2.Improve riparian to increase vegetative shading (RP) 3.Improve riparian to increase bank stability (RP)	H. Temp. (CT) C stability (RP) Riparian C (RP) H diversity (RP)

Appendix Table 4.2.3.2 Oregon QHA link to Restoration Objectives and Strategies.

4th Field HUC/ Reach Name	Description	Q	Restoration Objectives	Restoration Strategies	Limiting Factor(s)
Owyhee R-1	Mouth to Owyhee Ditch Co Dam (RM14)	**3**	No RedBand Trout present (RP)		Oxygen (CT)
Owyhee R-2	DC Dam to RM28	**4**	No RedBand Trout present (RP)		H. Temp. (CT)
Owyhee R-3	Dam to Upstream High Water (RM80)	**2**	Reservoir (RP)		N/A (CT) No scores (CT) N/A (RP) No scores (RP)
Dry Creek	Dry Creek upstream to Crowley Road	**1**	Grazing management may include early season use, fencing, and rest. (CT) Grazing management may include early season use, fencing, and rest. (RP)	1. Implement grazing management appropriate for riparian pastures (CT) 2. Improve riparian to increase vegetative shading (RP) 3. Improve riparian to increase bank stability (RP)	H. Temp. (CT)
Owyhee R-4	High Water upstream to Jordan Cr	**4**	Appropriate grazing management has been implemented on BLM reaches (RP)	1. Improve riparian to increase vegetative shading (RP) 2.Improve riparian to (RP)increase bank stability	F. Sediment (CT) H. Temp. (CT) Pollutants (CT)

4th Field HUC/ Reach Name	Description	Q	Restoration Objectives	Restoration Strategies	Limiting Factor(s)
					F sediment (RP) C complexity (RP) H temps (RP)
Rinehart Creek	Mouth to falls	**2**	No RedBand Trout present (CT) Limiting factors result from natural processes (CT) Appropriate grazing management has been implemented on BLM reaches (RP)		F. Sediment (CT) F sediment (RP) C stability (RP) Riparian c (RP)
Jordan Creek	Mouth to State Line	**1**	No RedBand Trout present (CT) Primarily private land and agricultural use (CT) Grazing management may include early season use, fencing, and rest. (RP) Restore passage for fish movement through this reach (RP)	1.Improve irrigation efficiency (RP) 2. Improve Riparian to stabilize banks (RP) 3.Increase vegetative shading (RP)	L. Flow (CT) H. Temp. (CT) L. Flow (RP) C stability (RP) H. Temp (RP)
Cow Creek	Mouth to State Line	**1**	Primarily private land and agricultural use (CT) Grazing management may include early season use, fencing, and rest. (CT) Grazing management may include early season use, fencing, and rest. (RP) Restore passage for fish movement through this reach (RP)	1. Implement grazing management appropriate for riparian pastures. (CT) 2. Improve irrigation efficiency (RP) 3. Improve riparian condition (RP) 4. Improve	Riparian (CT) L. Flow (CT) H. Temp. (CT) L flows (RP) Riparian (RP) C

4th Field HUC/ Reach Name	Description	Q	Restoration Objectives	Restoration Strategies	Limiting Factor(s)
				Riparian to channel complexity (RP)	complexity (RP)
Owyhee R-5	Confl. Jordan Creek upstream to Sline	**3**	Appropriate grazing management has been implemented (exclusion) (CT) Appropriate grazing management has been implemented on BLM reaches (RP)	1. Implement grazing management appropriate for riparian pastures (CT) 2. Increase vegetative shading (RP) 3. Improve Riparian to channel complexity (RP) 4. Improve Riparian to channel form (RP)	H. Temp. (CT) H. Temp (RP) C complexity (RP) C form. (RP)
NF Owyhee	Mouth to Sline	**3**	Grazing management may include early season use, fencing, and rest. (CT) Grazing management may include early season use, fencing, and rest. (RP)	Implement grazing management appropriate for riparian pastures (CT) 2. Improve riparian condition (RP) 3. Increase vegetative shading (RP) 4. Improve Riparian to channel complexity (RP)	Riparian (CT) H. Temp. (CT) Riparian C (RP) H. Temp (RP) C complexity (RP).
Middle Fork	Idaho Segment (?)	**1**	Primarily private land (CT) Grazing management may include early season use,	1. Improve riparian condition (RP)	Riparian (CT) Riparian C

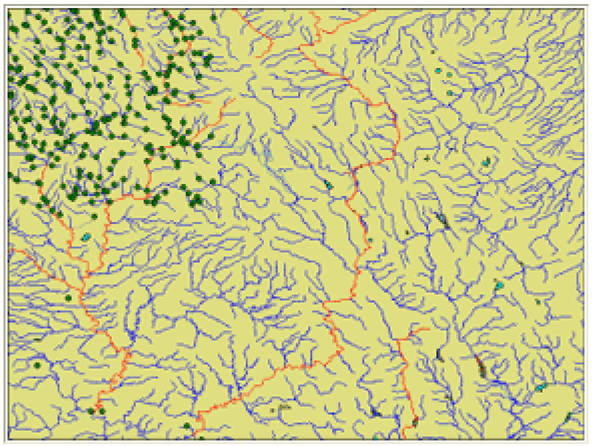
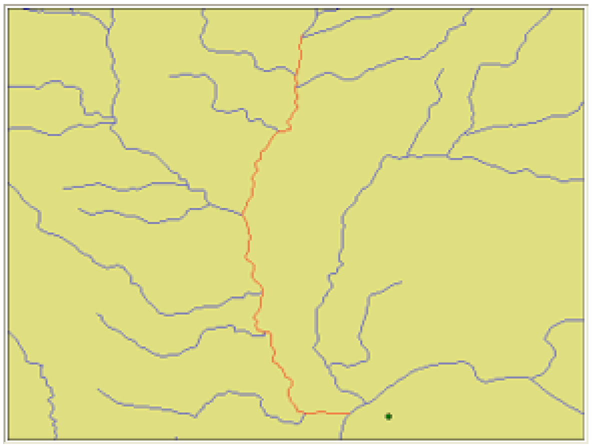
4th Field HUC/ Reach Name	Description	Q	Restoration Objectives	Restoration Strategies	Limiting Factor(s)
			fencing, and rest. (RP)	2. Improve Riparian to reduce sedimentation (RP) 3. Increase vegetative shading (RP)	(RP) F sediment (RP) Oxygen (RP)
Antelope Creek R-1	Mouth upstream to corrals (~8 mi)	**3**	No RedBand Trout present (CT) Limiting factors result from natural processes (CT) Grazing management may include early season use, fencing, and rest. (RP)	1. Improve Riparian to reduce sedimentation 2. Increase vegetative shading (RP)	F. Sediment (CT) F. Sediment (RP) L flow (RP) Oxygen (RP)
Antelope Creek R-2	Corrals upstream to Star Valley Road (dry segment)	**4**	No RedBand Trout present (CT) Limiting factors result from natural processes (lack of perennial flow) (CT) Natural conditions (RP) Grazing management may include early season use, fencing, and rest. (RP)	1. Improve Riparian to reduce sedimentation (RP) 2. Increase vegetative shading (RP)	F. Sediment (CT) H flows (RP) L flows (RP)
Antelope Creek R-3	SV Road upstream to Headwaters		Grazing management may include early season use, fencing, and rest. (CT) Grazing management may include early season use, fencing, and rest. (RP)	1.Implement grazing management appropriate for riparian pastures (CT) 2. Improve Riparian to reduce sedimentation (RP) 3. Increase vegetative shading (RP)	Riparian (CT) H. Diversity (CT) Oxygen (CT) H. Temp. (CT) C complexity (RP)

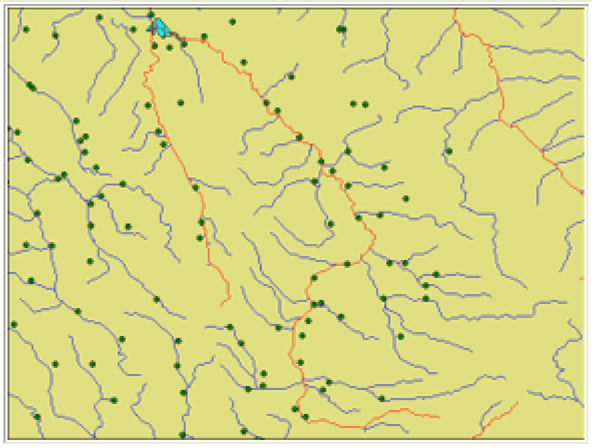
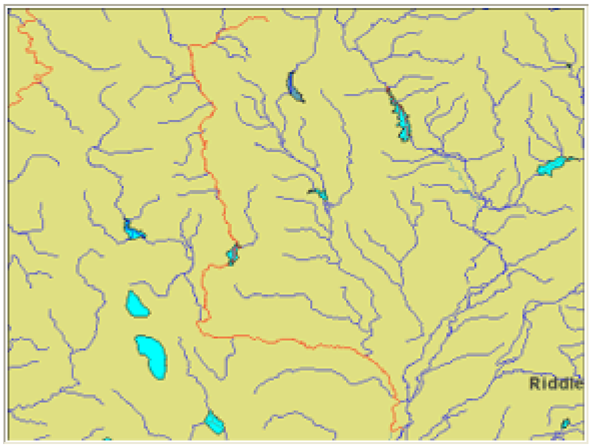
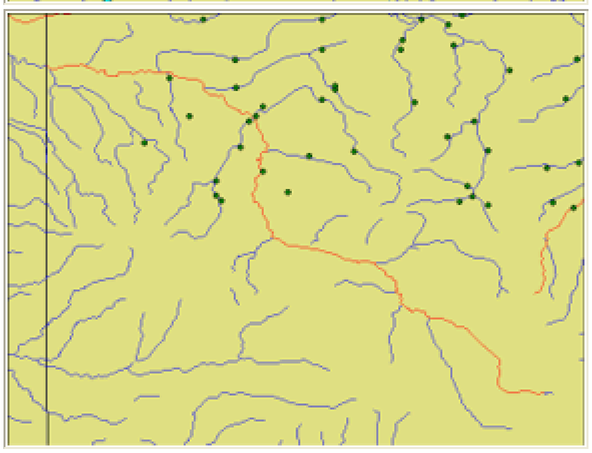
4th Field HUC/ Reach Name	Description	Q	Restoration Objectives	Restoration Strategies	Limiting Factor(s)
					Oxygen (RP) H. Temp. (RP)
WLO R-1	Mouth upstream to Anderson Crossing	**2**	Appropriate grazing management has been implemented (exclusion) (CT) Appropriate grazing management has been implemented on BLM reaches (RP)	1. Implement grazing management appropriate for riparian pastures (CT) 2. Improve Riparian to reduce sedimentation (RP) 3. Increase vegetative shading (RP)	F. Sediment (CT) H. Temp. (CT) F. Sediment (RP) H. Temp (RP) C complexity (RP).
WLO R-2	Anderson Crossing to headwaters	**2**	Appropriate grazing management has been implemented (exclusion) (CT) Grazing management may include early season use, fencing, and rest. (RP)	1. Implement grazing management appropriate for riparian pastures (CT) 2. Improve Riparian to reduce sedimentation (RP) 3. Increase vegetative shading (RP)	H. Temp. (CT) H. Temp (RP) C form (RP) Riparian C. (RP)

Appendix 4.3. Summary of 303(d) waters in the Owyhee Subbasin by 4th Field HUC: Upper Owyhee HUC 17050104; South Fork Owyhee HUC 17050105; East Little Owyhee HUC 17050106; Mid Owyhee HUC 17050107; Jordan HUC 17050108, Crooked Rattlesnake HUC 17050109; and Lower Owyhee HUC 17050110.

Appendix Table 4.3.1. Upper Owyhee HUC 17050104

(Source: http://oaspub.epa.gov/pls/tmdl/waters_list.control?huc=17050104)

State/ Waterbody Name/ LOCATION	**Map of 303(d) Listed Waters (red line)** {Source: **http://oaspub.epa.gov/pls/tmdl** }	**State Identified Impairment(s)**
Idaho BATTLE CREEK HEADWATERS TO OWYHEE RIVER		• BACTERIA Sources of Impairment: 1.
Idaho RED CANYON HEADWATERS TO OWYHEE RIVER		• FLOW ALTERATION • SEDIMENT • TEMPERATURE Sources of Impairment: 1.

Idaho ROCK CREEK HEADWATERS TO TRIANGLE RESERVOIR		• FLOW ALTERATION • SEDIMENT • TEMPERATURE Sources of Impairment: 1.
Idaho SHOOFLY CREEK HEADWATERS TO BLUE CREEK		• BACTERIA Sources of Impairment: 1.
Idaho SQUAW CREEK HEADWATERS TO OREGON LINE		• FLOW ALTERATION • SEDIMENT • TEMPERATURE Sources of Impairment: 1.
Idaho SNAKE RIVER BASIN: OWYHEE R. ABOVE MILL CK.	No map available	• TURBIDITY • IRON • TOTAL PHOSPHORUS • TSS Sources of Impairment: 1.

Idaho SNAKE RIVER BASIN: OWYHEE R. AT BONEY LANE	No map available	• TURBIDITY • IRON • TOTAL PHOSPHORUS • TSS Sources of Impairment: 1.
Idaho SNAKE RIVER BASIN: OWYHEE R. AT CHINA DAM	No map available	• TURBIDITY • TOTAL PHOSPHORUS • TSS Sources of Impairment: 1.

1. There were no potential sources of impairment reported to EPA by the state.

Appendix Table 4.3.2. South Fork Owyhee HUC 17050105

(Source: **http://oaspub.epa.gov/pls/tmdl/waters_list.control?huc=17050105**)

List of Impaired Waters: There were no waters found for the listed criteria.

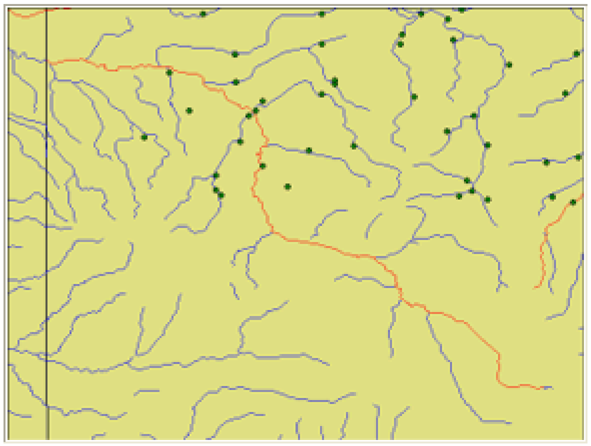
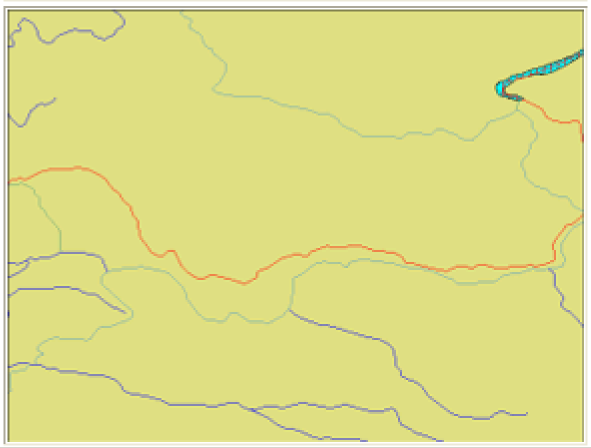
Appendix Table 4.3.3. East Little Owyhee HCC 17050106

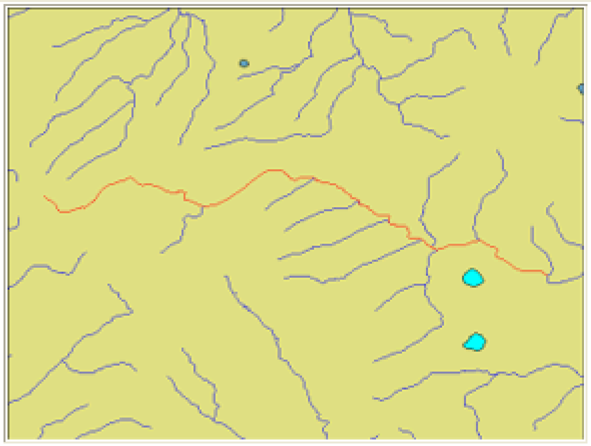
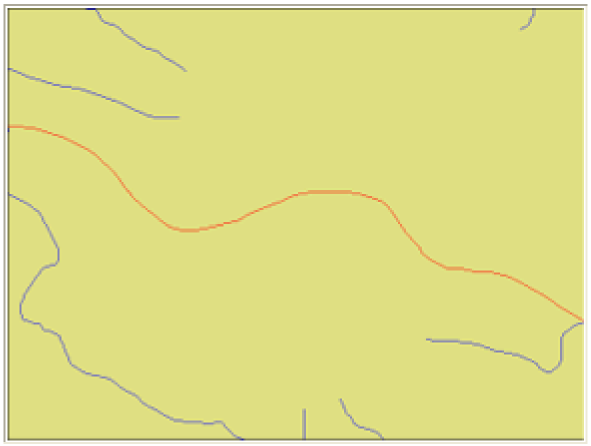
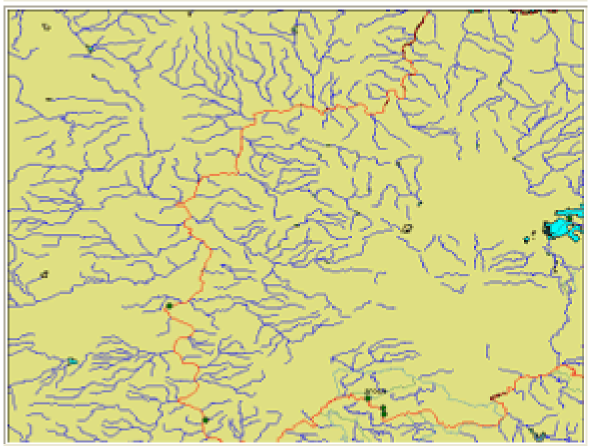
(Source: **http://oaspub.epa.gov/pls/tmdl/waters_list.control?huc=17050106**)

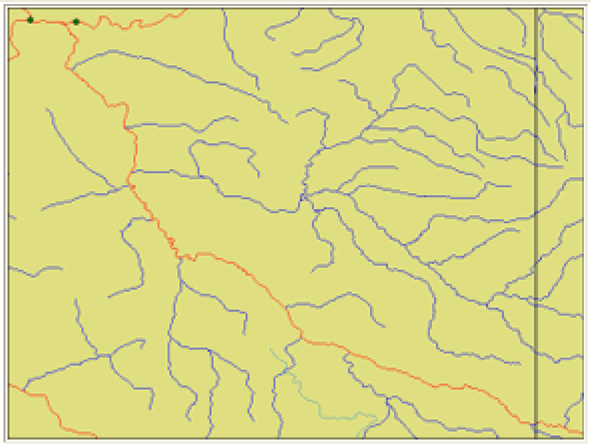
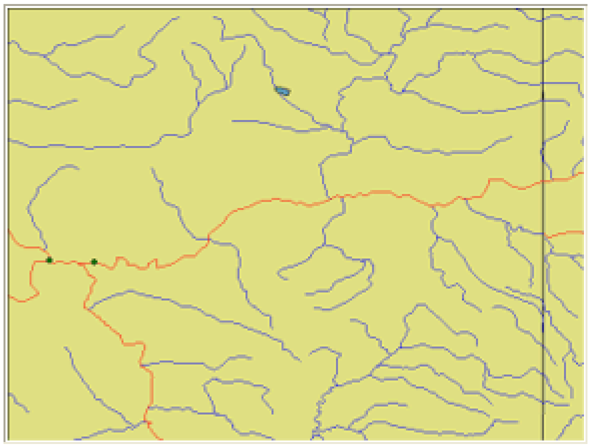
List of Impaired Waters: There were no waters found for the listed criteria!

Appendix Table 4.3.4. Mid Owyhee HUC 17050107

(Source: http://oaspub.epa.gov/pls/tmdl/waters_list.control?huc=17050107)

State/ Waterbody Name/ LOCATION	**Map of 303(d) Listed Waters (red line)** {Source: http://oaspub.epa.gov/pls/tmdl }	**State Identified Impairment(s)**
Idaho SQUAW CREEK HEADWATERS TO OREGON LINE		• FLOW ALTERATION • SEDIMENT • TEMPERATURE Sources of Impairment: 1.
Oregon JORDAN CREEK MOUTH TO HEADWATERS		• FCA(MERCURY) Sources of Impairment: 1.

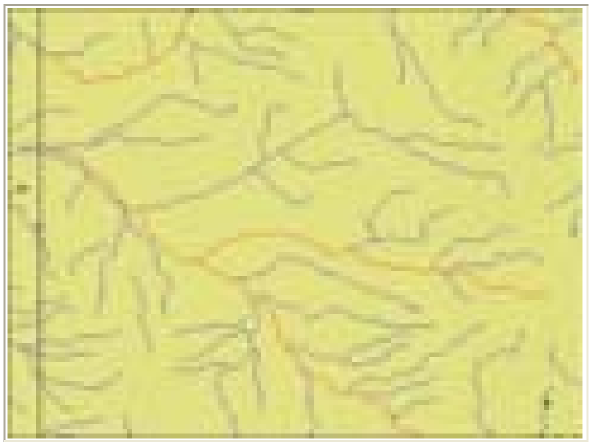
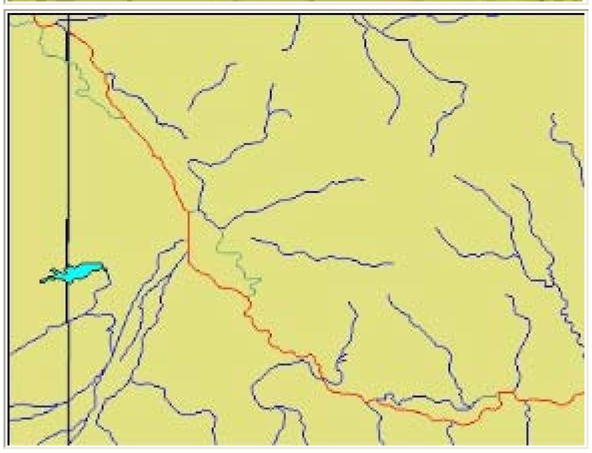
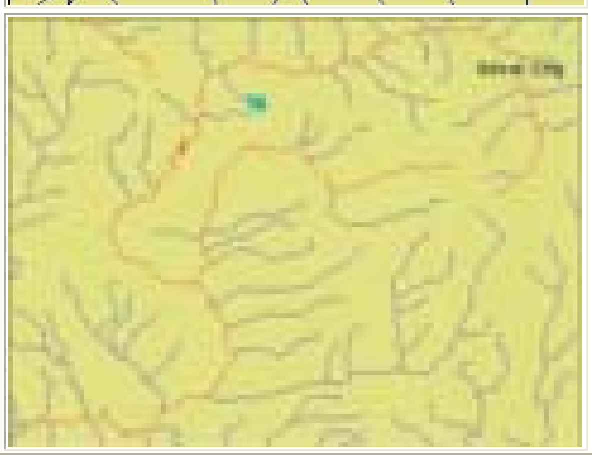
Oregon LITTLE OWYHEE RIVER, WEST RIVER MILE 45 TO HEADWATERS		• TEMPERATURE Sources of Impairment: 1.
Oregon OWYHEE RIVER ROME TO IDAHO BORDER		• TEMPERATURE Sources of Impairment: 1.
Oregon OWYHEE RIVER OWYHEE RESERVOIR TO ROME		• MERCURY • TEMPERATURE Sources of Impairment: 1.

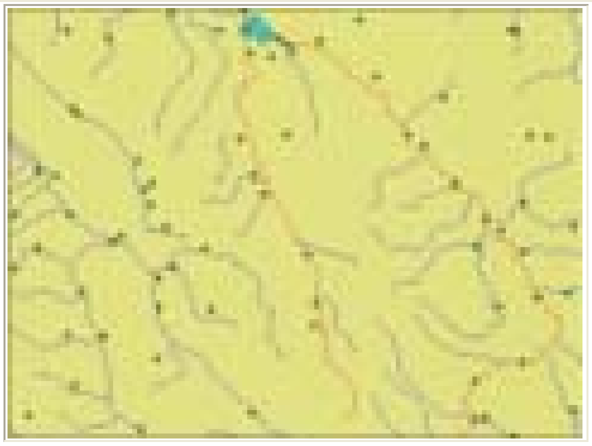
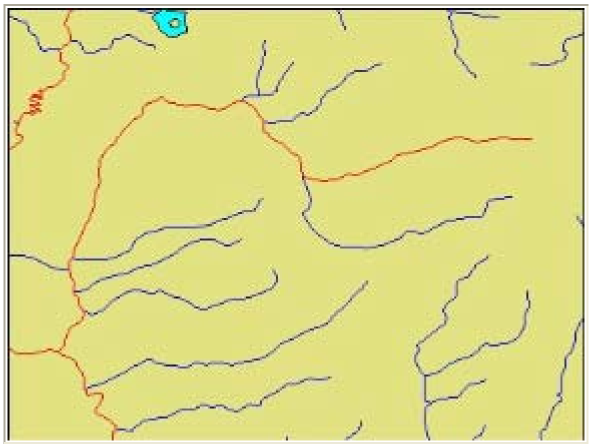
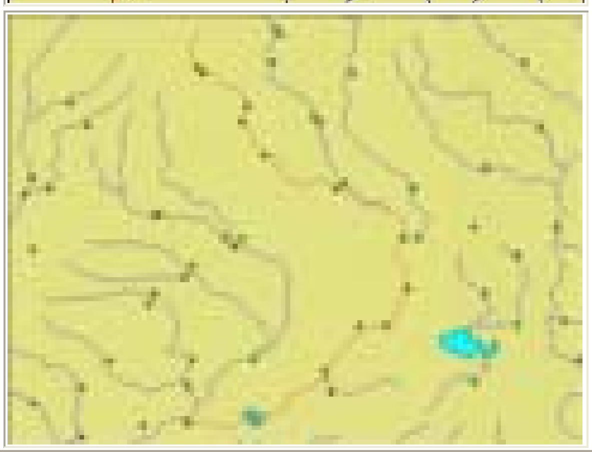
Oregon OWYHEE RIVER, MIDDLE FORK MOUTH TO IDAHO BORDER		• TEMPERATURE Sources of Impairment: 1.
Oregon OWYHEE RIVER, NORTH FORK MOUTH TO IDAHO BORDER		• TEMPERATURE Sources of Impairment: 1.

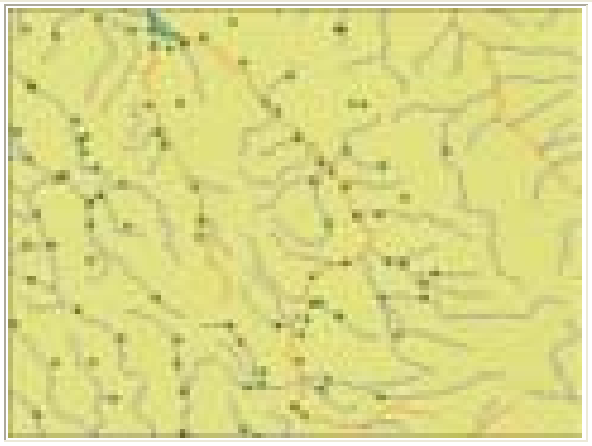
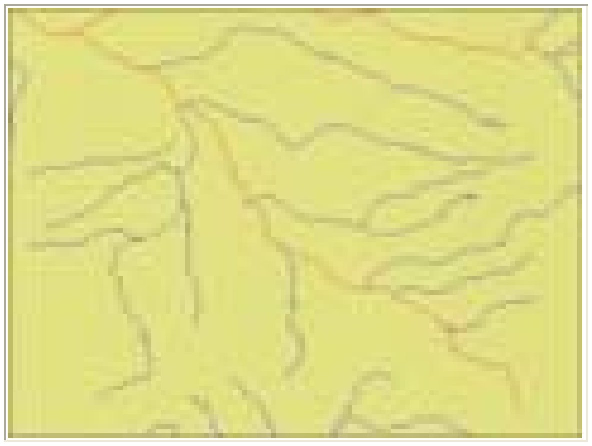
1. There were no potential sources of impairment reported to EPA by the state.

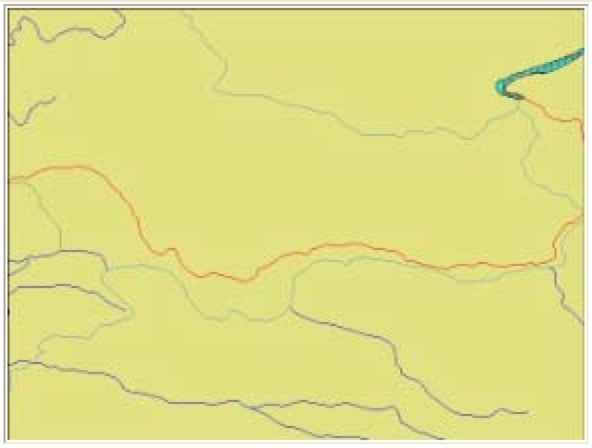
Appendix Table 4.3.5. Jordan HUC 17050108

(source: http://oaspub.epa.gov/pls/tmdl/waters_list.control?huc=17050108 .)

State/ Waterbody Name/ LOCATION	**Map of 303(d) Listed Waters (red line)** {Source: **http://oaspub.epa.gov/pls/tmdl** }	**State Identified Impairment(s)**
Idaho COW CREEK – HEADWATERS TO OREGON LINE		• FLOW ALTERATIONS • SEDIMENT • TEMPERATURE Sources of Impairment: 1.
Idaho JORDAN CREEK WILLIAMS CREEK TO OREGON LINE		• PESTICIDES • BACTERIA/ PATHOGENS • METALS - MERCURY • OIL/GASOLINE • SEDIMENT • TEMPERATURE Sources of Impairment: 1.
Idaho JORDAN CREEK HEADWATERS TO WILLIAMS CREEK		• PESTICIDES • BACTERIA • METALS - MERCURY • OIL/GASOLINE • SEDIMENT • TEMPERATURE Sources of Impairment: 1.

Idaho LOUISA CREEK HEADWATERS TO TRIANGLE RESERVOIR		• FLOW ALTERATIONS • SEDIMENT • TEMPERATURE Sources of Impairment: 1.
Idaho LOUSE CREEK HEADWATERS TO JORDAN CREEK		• METALS • PH • FLOW ALTERATIONS • SEDIMENT Sources of Impairment: 1.
Idaho MEADOW CREEK HEADWATERS TO ROCK CREEK		• FLOW ALTERATIONS • TEMPERATURE Sources of Impairment: 1.

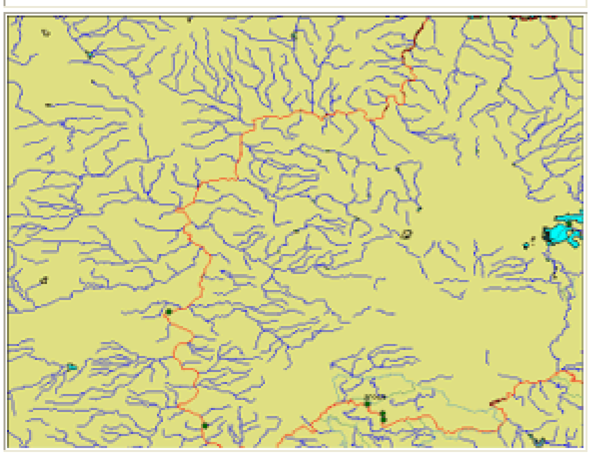
Idaho ROCK CREEK HEADWATERS TO TRIANGLE RESERVOIR		• FLOW ALTERATIONS • SEDIMENT • TEMPERATURE Sources of Impairment: 1.
Idaho SODA CREEK HEADWATERS TO COW CREEK		• SEDIMENT • TEMPERATURE Sources of Impairment: 1.
Oregon ANTELOPE RESERVOIR RESERVOIR		• FCA (MERCURY) • FISH CONSUMPTION ADVISORY Sources of Impairment: 1.

Oregon [JORDAN CREEK](#) MOUTH TO HEADWATERS		• FCA (MERCURY) • FISH CONSUMPTION ADVISORY Sources of Impairment: 1.

1. There were no potential sources of impairment reported to EPA by the state.

Appendix Table 4.3.6. Crooked Rattlesnake HUC 17050109

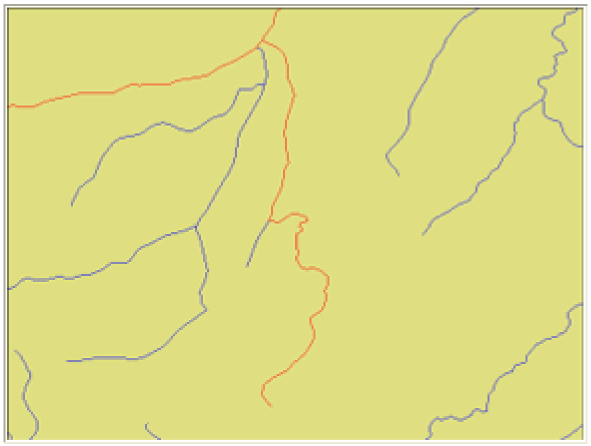
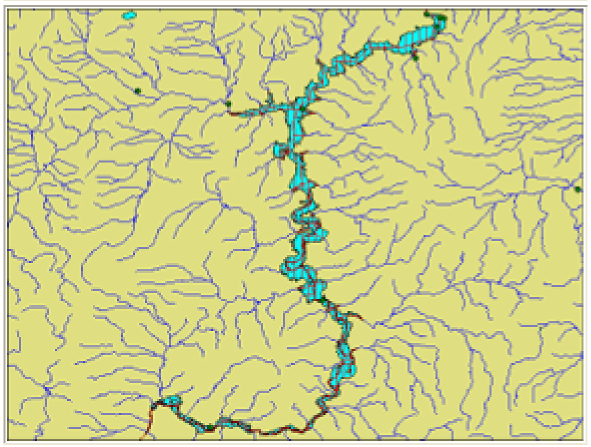
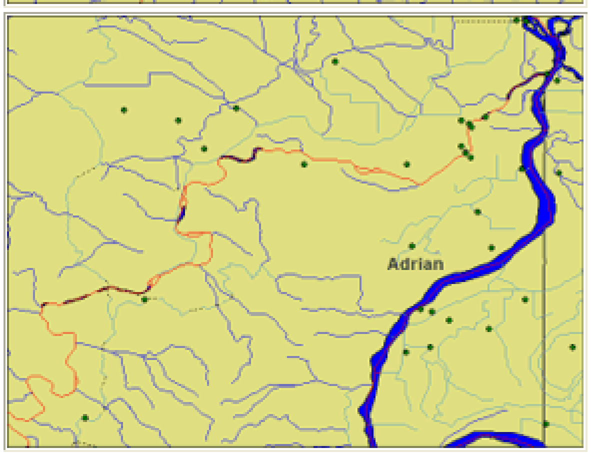
(source: http://oaspub.epa.gov/pls/tmdl/waters_list.control?huc=17050109 .)

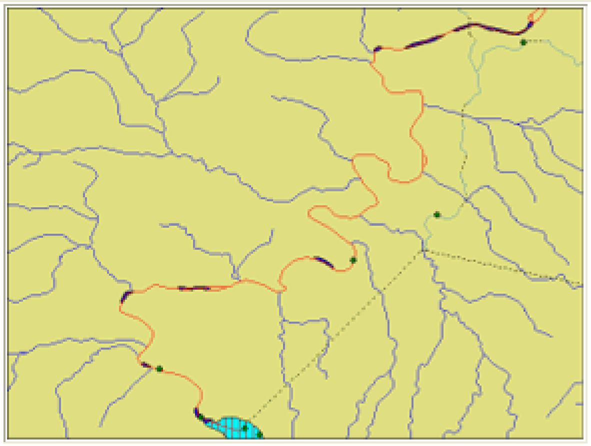
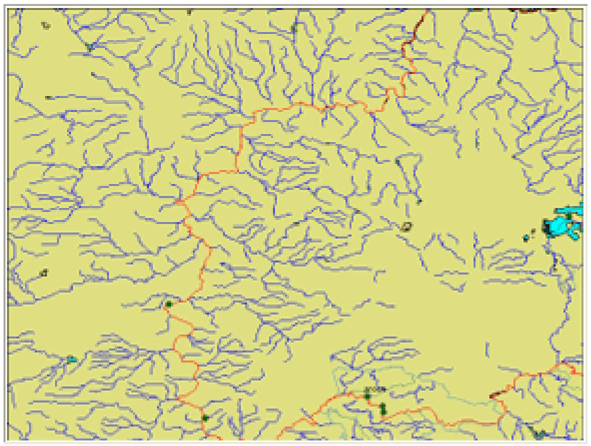
State/ Waterbody Name/ LOCATION	**Map of 303(d) Listed Waters (red line)** {Source: **http://oaspub.epa.gov/pls/tmdl** }	**State Identified Impairment(s)**
Oregon [OWYHEE RIVER](#) OWYHEE RESERVOIR TO ROME		• MERCURY • TEMPERATURE Sources of Impairment: 1.

1. There were no potential sources of impairment reported to EPA by the state.

Appendix Table 4.3.7. Lower Owyhee HUC 17050110

(source: http://oaspub.epa.gov/pls/tmdl/waters_list.control?huc=170501010 .)

State/ Waterbody Name/ LOCATION	**Map of 303(d) Listed Waters (red line)** {Source: http://oaspub.epa.gov/pls/tmdl }	**State Identified Impairment(s)**
Oregon ALDER CREEK (COTTONWOOD CREEK) MOUTH TO HEADWATERS		• TEMPERATURE Sources of Impairment: 1.
Oregon OWYHEE RESERVOIR RESERVOIR		• FCA(MERCURY) Sources of Impairment: 1.
Oregon OWYHEE RIVER MOUTH TO BLACK WILLOW CREEK		• DDT • DIELDRIN • BACTERIA • CHLOROPHYLL A Sources of Impairment: 1.

Oregon OWYHEE RIVER BLACK WILLOW CREEK TO OWYHEE RESERVOIR		• DISSOLVED OXYGEN Sources of Impairment: 1.
Oregon OWYHEE RIVER OWYHEE RESERVOIR TO ROME		• MERCURY • TEMPERATURE Sources of Impairment: 1.

1. There were no potential sources of impairment reported to EPA by the state.

Appendix 4.4. Objectives and strategies excerpted from federal, state, and inter-agency fish, wildlife and resource management plans relevant to the Owyhee Subbasin.

Appendix Table 4.4.1 Bureau of Land Management (BLM) – Resource Southeastern Oregon Management Plan

I. Objectives for Habitats/Species

Rangeland Vegetation

Objective 1: Restore, protect, and enhance the diversity and distribution of desirable vegetation communities including perennial native and desirable introduced plant species. Provide for their continued existence and normal function in nutrient, water, and energy cycles.

Objective 2: Manage big sagebrush cover in seedings and on native rangeland to meet the life history requirements of sagebrush-dependent wildlife.

Forest and Woodlands

Objective 1: Manage forests to maintain or restore ecosystems to a condition in which biodiversity is preserved and occurrences of fire, insects, and disease do not exceed levels normally expected in a healthy forest. Increase the dominance of ponderosa pine, Douglas fir, and western larch on appropriate sites in mature forests. Decrease the amount of Douglas fir, white fir, and grand fir where they were not historically maintained by the dominant fire regime. Manage forests for long-term, healthy habitat for animal and plant species. Provide for timber production where feasible and compatible with forest health.

Objective 2: Restore productivity and biodiversity in western juniper and quaking aspen woodland areas. Manage western juniper areas where encroachment or increased density is threatening other resource values. Retain old growth characteristics in historic western juniper sites not prone to frequent fire. Manage quaking aspen to maintain diversity of age classes and to allow for species reestablishment.

Water Resources and Riparian/Wetland Areas

Objective 1: Ensure that surface water and ground water influenced by BLM activities comply with or are making progress toward achieving State of Oregon water quality standards for beneficial uses as established per stream by the Oregon Department of Environmental Quality (ODEQ).

Objective 2: Restore, maintain, or improve riparian vegetation, habitat diversity, and associated watershed function to achieve healthy and productive riparian areas and wetlands.

Fish and Aquatic Habitat

Objective: Restore, maintain, or improve habitat to provide for diverse and self-sustaining communities of fishes and other aquatic organisms.

Wildlife and Wildlife Habitat

Objective 1: Maintain, restore, or enhance riparian areas and wetlands so they provide diverse and healthy habitat conditions for wildlife.

Objective 2: Manage upland habitats in forest, woodland, and rangeland vegetation types so that the forage, water, cover, structure, and security necessary for wildlife are available on the public land.

Special Status Animal Species

Objective 1: Manage public land to maintain, restore, or enhance populations and habitats of special status animal species. Priority for the application of management actions would be: (1) Federal endangered species, (2) Federal threatened species, (3) Federal proposed species, (4) Federal candidate species, (5) State listed species, (6) BLM sensitive species, (7) BLM assessment species, and (8) BLM tracking species. Manage in order to conserve or lead to the recovery of threatened or endangered species.

Objective 2: Facilitate the maintenance, restoration, and enhancement of bighorn sheep populations and habitat on public land. Pursue management in accordance with the 1997 "Oregon's Bighorn Sheep Management Plan" (OBSMP) in a manner consistent with the principles of multiple use management.

Rangeland/Grazing Use

Objective: Provide for a sustained level of livestock grazing consistent with other resource objectives and public land use allocations.

II. Strategies (Alternatives) from SE-OR-RMP for the above objectives

Rangeland Vegetation

Based on public and internal comment, the sagebrush desired range of future condition (DRFC's) was redefined by Appendix F (Wildlife Habitat Descriptions and Considerations), and Alternative E was changed to include management to control noxious weeds the same as all other alternatives.

Forest and Woodlands

- Changes from the preferred Alternative C to the Proposed RMP alternative:
  - This section was amended to include that all management tools be available (including harvest) on all acres to achieve forest health, although intensive commercial harvest would be unlikely in ACEC's, WSA's and NWSR's.
  - For the management of western juniper and quaking aspen, all tools, including chemical control, cutting, burning, and other means, would be available.

Special Status Plants

- Alternative D2:
  - Livestock grazing would be removed from selected Mulford's milkvetch sites.

Water Resources and Riparian/Wetland Areas

- Common to all alternatives:
  - Updated information on water quality management plans (WQMP's), total maximum daily loads (TMDL's), and water quality restoration plans (WQRP's) from the perspective of (BLM) policy of conducting WQRP's.
- Alternative D2:
  - Added narrative for Alternatives D2 and Proposed RMP for Objectives 1 and 2.
  - Livestock grazing would be removed from streams where PFC ratings are functioning at risk with downward trend, or not properly functioning, until appropriate livestock management actions can be implemented and a condition of functioning at risk with an upward trend is attained.
- Alternative E:
  - Was edited to reflect changes in alternative emphasis.
- Appendices:
  - Modified as follows: the Riparian Management Objective (RMO) section of Appendix D, Riparian/Wetland Areas, was edited for reference to the 1996 "Inland Native Fish Strategy" (INFISH) and tables were updated to reflect data gathered from 1996–1999; the Total Maximum Daily Load section was changed to the Water Quality Restoration Plan heading to reflect new U.S. Forest Service (USFS) and BLM policy and to incorporate TMDL's and WQMP into WQRP concepts. Appendix O, Best ManagementPractices, was edited to reflect comments and moved the

Wildlife Habitat andProtection section to Appendix F, Wildlife Habitat Descriptions and Considerations.

Fish and Aquatic Habitat

- Alternative D2:
  - Livestock would be removed from stream segments with Federally listed, proposed, or candidate species, and those with "strongholds" of Great Basin and inland redband trout and spotted frog.
  - Livestock would be removed from stream segments where PFC ratings are functioning at- risk with a downward trend, or not properly functioning until systems improve.

Wildlife and Wildlife Habitat

- Alternative D2:
  - Livestock grazing would be removed from selected habitat of sagebrush-dependant species, using sage grouse as an indicator species.
- Appendix F, Wildlife Habitat Descriptions and Considerations:
  - Changes were made to add wildlife DRFC, and to include additional information concerning management of sage grouse habitat.

Special Status Animal Species

- Updated special status fish component of riparian tables.
- Information was added for sage grouse management.
- Alternative D2:
  - Livestock grazing would be removed from selected habitat of sagebrush-dependant species, using sage grouse as an indicator species.

Appendix Table 4.4.2 Bureau of Land Management (BLM) – Owyhee Resource Area – Resource Management Plan

Purpose and Synopsis
The Owyhee Resource Management Plan (RMP) was prepared to provide the Bureau of Land Management, Lower Snake River District with a comprehensive framework for managing public lands administered by the Owyhee Resource Area. The purpose of the RMP is to ensure public land use is planned for and managed on the basis of multiple-use and sustained yield in accordance with the Federal Land Policy and Management Act of 1976 (FLPMA).

The Owyhee Resource Area, located in southwestern Idaho's Owyhee County, encompasses 1,779,492 acres. This total includes the following:

- 1,320,032 acres administered by BLM, Idaho

- 136,936 acres administered by the State of Idaho
- 319,777 acres of private lands
- 2,747 acres of water, primarily the Snake River

The area is bounded on the west by Oregon, on the south by Nevada, on the north by the Snake River and on the east by Castle Creek, Deep Creek, the Owyhee River, and the Duck Valley Indian Reservation. Most of the public lands are contiguous with only a few scattered or isolated parcels. The resource area contains the northern extent of the Owyhee Mountain Range and lies within what is often referred to as the Columbia Plateau. The Columbia Plateau is an elevated plateau with mountains which are separated by canyons draining to the Pacific Ocean via the Snake and Columbia Rivers. This broad regional landform and vegetative classification is known as the Intermountain Sagebrush Province/ Sagebrush Steppe Ecosystem.

Objectives, Management Actions and Allocations
Fishery Habitat
Objective:
FISH 1: Improve or maintain perennial stream/riparian areas to attain satisfactory conditions to support native fish.

Rationale: BLM Wildlife and Fisheries Management Manual Section 6500 directs BLM to maintain the continued effectiveness of habitat improvements and to maintain and enhance important resident fisheries resources. BLM Manual Section 6840 directs BLM to ensure that the crucial habitats of sensitive animals will be managed and conserved to minimize the need for listing as threatened or endangered under the Endangered Species Act. The Federal Water Pollution Control Act (Clean Water Act) of 1977, as amended, requires the restoration and maintenance of the chemical, physical, and biological integrity of the nation's waters.

Monitoring:
• Monitoring includes collection of rangeland health assessment, utilization, trend, climate, water quality and fish habitat data by various methods. See Appendix MONT-1 for details concerning procedures.

Management Actions and Allocations:
1. In pastures containing riparian areas categorized as unsatisfactory, non-functioning, or functional-atrisk, implement grazing practices that make progress towards achieving proper functioning condition and satisfactory riparian condition. These grazing practices will, at a minimum, comply with the Idaho Standards for Rangeland Health and Guidelines for Livestock Grazing Management, and BMPs and component practices approved in the Idaho Agricultural Pollution Abatement Plan or subsequent plans. See Table RIPN-1 and Map RIPN-1 for affected areas. Future inventory or monitoring may indicate additional pastures to which this management action will apply.

2. Improve or maintain herbaceous vegetation species to attain composition, density, canopy and ground cover, and vigor appropriate for the site. Adequate residual stubble height in an amount appropriate for the site, will be present throughout the grazing treatment and overwinter. This pertains to those key sedge and rush forage species which are excellent streambank stabilizers.

3. Improve or maintain woody riparian vegetation species to attain composition, density, canopy and ground cover, structure, and vigor appropriate for the site. Woody riparian vegetation utilization levels will be established to promote species reflective of the site potential.

4. Improve or maintain streambank and channel stability appropriate for the site by managing grazing to limit annual trampling impacts to 10% or less of linear bank length.

5. Implement a juniper abatement plan for appropriate sites on which juniper is invading.

6. Implement management practices addressing non-grazing impacts to riparian areas where needed and appropriate.

7. Provide a minimum of two growing seasons rest from livestock grazing following fires.

Objective:
FISH 2: Improve reservoir fisheries, when appropriate, in consultation with State agencies and adjacent landowners.

Rationale: BLM Wildlife and Fisheries Management Manual Section 6500 directs BLM to maintain the continued effectiveness of habitat improvements and to maintain and enhance important resident fisheries resources. BLM Manual Section 6840 directs BLM to ensure that the crucial habitats of sensitive animals will be managed and conserved to minimize the need for listing as threatened or endangered under the Endangered Species Act. The Federal Water Pollution Control Act (Clean Water Act) of 1977, as amended, requires the restoration and maintenance of the chemical, physical, and biological integrity of the nations water at a level of quality which provides protection for fish and wildlife.
Monitoring:
• Monitoring includes collection of rangeland health assessment, utilization, trend, climate, water quality and fish habitat data by various methods. See Appendix MONT-1 for details concerning procedures.

Management Actions and Allocations:
1. In pastures containing wetland areas categorized as unsatisfactory, non-functioning, or functional-atrisk, implement grazing practices that make progress towards achieving proper functioning condition and satisfactory riparian condition. These grazing practices will, at a minimum, comply with the Idaho Standards for Rangeland Health and Guidelines for Livestock Grazing Management, and BMPs and component practices approved in the Idaho Agricultural Pollution Abatement Plan or subsequent plans.
See Table RIPN-1 and Map RIPN-1 for affected areas. Future inventory or monitoring may indicate additional pastures to which this management action will apply.

2. Improve or maintain herbaceous vegetation species to attain composition, density, canopy and ground cover, and vigor appropriate for the site. Adequate residual stubble height in an amount appropriate for the site, will be present throughout the grazing treatment and overwinter. This pertains to those key sedge and rush forage species.

3. Improve or maintain woody riparian vegetation species to attain composition, density, canopy and ground cover, structure, and vigor appropriate for the site. Woody riparian vegetation utilization levels will be established to promote species reflective of the site potential.

4. Improve or maintain shoreline and soil surface stability appropriate for the site by managing grazing to limit annual trampling impacts to 10% or less of the linear shoreline length.

5. Implement a juniper abatement plan for appropriate sites on which juniper is invading.

6. Implement management practices addressing non-grazing impacts to riparian areas where needed and appropriate.

7. Provide a minimum of two growing seasons rest from livestock grazing following fires.

Wildlife Habitat
Objective:
WDLF 1: Maintain or enhance the condition, abundance structural stage and distribution of plant communities and special habitat features required to support a high diversity and desired populations of wildlife.

Rationale: Section 102.8 of The Federal Land Policy and Management Act states that it is policy of the United States that public lands be managed in a manner that will protect the quality of multiple resources and will provide food and habitat for fish and wildlife and domestic animals. The Public Rangelands Improvement Act (PRIA) directs improvement of rangeland conditions and provides for rangeland improvements including providing habitat for wildlife. The Memorandum of Understanding between the BLM and IDF&G states that the two agencies will work for the common purpose of maintaining, improving and managing wildlife resources on public lands.

Monitoring:
• Monitoring includes collection of utilization, trend, climate, rangeland health assessment, and other data to assess vegetation characteristics as they apply to wildlife species and wildlife habitat objectives.

• Additional monitoring includes use of appropriate techniques such as pellet group counts or breeding bird transects, lek counts, etc. which are applicable to specific types of wildlife. See Appendix MONT-1 for details concerning procedures for various methods.

• Periodically inspect/monitor authorized BLM activities including, but not limited to, range improvement projects, ROWs, OHMV use areas and woodcuts to insure compliance with wildlife stipulations and document observed habitat and animal disturbance.

Management Actions and Allocations:

- Ensure that all activity plans include objectives for maintaining or enhancing habitat for those wildlife species known or likely to occur within the planning area.

- Limit the adverse impacts of various land use activities, management actions and land tenure adjustments to wildlife populations and habitats through implementation of management actions identified in objectives FORS 2, WHRS 1, LVST 1, FIRE 1-4, LAND 1-6, LOCM 1, FLUM 1, MMAT 1, RECT 1 and HAZM 1.

- Protect and enhance habitat for a diversity of wildlife through implementation of management actions identified in objectives SOIL 1 and 2, WATR 1 and 2, VEGE 1, RIPN 1, FORS 1 and 2, FISH 1 and 2, RECT 3, WNES 1 and 2, HAZM 1 and ACEC 1.

- Adjust overall grazing management practices to ensure that adequate upland forage and cover remains to accommodate the needs of wildlife. Specifically:
  • limit utilization of key browse species, as measured in the fall, to a maximum of 30% within all deer winter habitat and 50% within all other habitats.
  • limit utilization of key upland herbaceous forage species to a maximum of 50% at the time of livestock removal from a pasture. More restrictive utilization standards may be imposed where necessary to accomplish specific wildlife or other resource objectives.

- Design and implement vegetation treatments to improve habitat where juniper or shrub density is contributing to unsatisfactory habitat conditions. All treatments will be designed to protect scarce, unique and highly productive wildlife habitat types, retain large interconnected blocks of more common habitat types and accommodate specific wildlife habitat requirements including migration corridors for big game. Reseed burns with a variety of shrubs, forbs and grasses. Rest all burns and seedings from livestock grazing for a minimum of two growing seasons following treatment.

- Ensure water availability for wildlife by providing unrestricted access to all livestock waters, requiring that where necessary, waters are left on following removal of livestock and constructing additional water developments where water is determined to be limiting. Ensure that water is available at intervals of no more than three miles apart in big game habitat.

- Retain all public land within crucial and other high quality wildlife habitats unless exchanging for land of equal or higher value and acquire additional high quality habitat through purchase or exchange with willing landowners. These include but are not limited to wetland/riparian habitats, crucial big game winter habitat and isolated tracts and shrublands adjacent to agricultural areas that provide important cover for upland game. Isolated tracts will be grazed only if needed to maintain or improve wildlife habitat.

- Minimize barriers to big game movement by constructing new fences and modifying existing fences to meet or exceed Boise District Fence Policy standards for the species present.
- Protect and enhance habitat for wildlife at all developed springs and selected undeveloped springs, wet meadows, reservoirs and stream riparian reaches by fencing to exclude livestock. Close all exclosures to livestock grazing for the life of this plan except where it is determined that controlled grazing is necessary to achieve a specific resource objective.

- Where feasible, enhance waterfowl nesting habitat by ensuring waterfowl benefits are incorporated into reservoirs with the potential to support nesting waterfowl. Enhancement may include fencing, construction of nesting islands and/or other structures and planting food and cover species.

- Develop cooperative wildlife habitat/farming development (Sikes Act) agreements designed to enhance habitat for upland game and other wildlife.

- Protect raptor nests and manage adjacent vegetation to ensure adequate habitat for prey species. Authorize no human caused disturbance within a 0.5 mile radius of any known golden eagle nest between February 1 and June 30 and other species' nests between March 15 and June 30. Disturbance is defined as any activity which could result in frequent flushing of adults or young, nest abandonment or significant loss of prey base.

- Ensure that all power poles on public land are designed to prevent raptor electrocution.

- Ensure that management to maintain or improve habitat for raptors and their prey species receives priority consideration within the Snake River Birds of Prey National Conservation Area as detailed in the SRBOPNCA Management Plan. See Map NCA-1.

- Install gates at entrances to caves and abandoned mine shafts where disturbance to bat populations is determined to be a problem.

Appendix Table 4.4.3 Bureau of Land Management (BLM) – Proposed Elko/Wells Resource Management Plans – Fire Management Amendment and Final Assessment

Subbasin	Habitat/Species	Objective	Strategies
Owyhee (Elko Nevada)	Low Sagebrush and Desert Shrub	• To maintain the native community, to provide for livestock and wildlife forage. Some of the areas are important for winter antelope habitat.	• Prevent annual vegetation or non-native plant incursion into this vegetation type resulting from disturbance of the existing community. • Maintain native vegetation composition.
	Aspen Areas	• Maintenance and restoration of the aspen stands.	• Maintain healthy aspen stands with appropriate stand age class diversity. • Maintain and improve riparian integrity.
	Seral Sagebrush Grasslands	• Maintain and improve native vegetation conditions, limit the spread of annual invasive species and noxious weeds, protect critical watersheds, provide wildlife and livestock forage and provide woodland products from higher elevations.	• Maintain and/or improve sagebrush/perennial grass diversity. • Prevent further encroachment of annual and non-native vegetation in the area.
	Mountain Mahogany/Juniper	• Management objectives are for woodland products and big game habitat.	• Maintain woodlands.
	Mixed Conifer	• Restore the health of the forest community.	• Healthy mosaic of uneven aged conifer stands with reduced fuel loadings.

Appendix Table 4.4.4 Objectives and strategies proposed for rainbow trout (hatchery) and redband trout (native) in various subbasins of the upriver-interior ecological Provinces of the Columbia and Snake Basins {source: Fisheries Management Plan 2001-2006; Idaho Department of Fish and Game}.

Drainage	Species	Objectives	Strategies
KOOTENAI RIVER DRAINAGE	Redband Trout and Hatchery Rainbow Trout	• Restore sport fish populations in the Kootenai River to self-sustaining levels capable of supporting an improved sport fishery.	• Implement and evaluate in-river flows designed to provide spawning and recruitment of white sturgeon and burbot (ling). Continue research to identify the flow needs of other native species (rainbow, cutthroat, bull trout and whitefish) and modify Libby Dam operations to restore ecosystem function. • Evaluate the experimental release of nutrients and the effects on the fish community with emphasis on rainbow trout, bull trout and mountain whitefish. • Assess catch, catch rates and harvest of trout and modify regulations if required to improve the fishery.
		• Minimize impacts to and enhance trout spawning and rearing habitat.	• Work with government agencies, the Kootenai Tribe, private developers, interested angling groups and local schools to make protection and enhancement of fisheries habitat a primary concern in land use decisions.
		• Improve the efficiency of hatchery put-and-take trout stocking programs.	• Evaluate rate of return, catch rate, and angler use on put-and-take trout fisheries through a routine data collection system. • Adjust rate, timing or location of trout stocking to improve rate of return to the creel. • Inform anglers of hatchery supported trout fishing opportunities through maps, brochures, media coverage and signing to improve

			return to the creel. • Discontinue put-and-take trout stocking in waters where a 40% or greater by number or 100% or greater by weight return to the creel cannot be met by the end of this planning period. Provide alternative fisheries to maintain angling opportunity. • Develop and utilize disease free, sterile stocks of rainbow and cutthroat trout to address concerns about potential impacts to wild trout.
		• Provide diverse angling opportunities in lowland lakes.	• Continue periodic surveys of fish populations to monitor population status and fish growth in relation to physical and biological conditions and fishing regulations. Manage some lakes for specific fish species in order to maximize angling opportunity. • Maintain maximum harvest opportunity for warmwater species and stocked trout in most lakes while providing quality or trophy management fisheries in a few lakes where biological and physical conditions, and public support provide the right set of conditions for special management. • Continue maintenance stocking of tiger muskies and channel catfish to maintain popular fisheries. Evaluate channel catfish harvest to determine if harvest restrictions are needed to maintain this hatchery-supported fishery. Establish bluegill sunfish in select waters to diversify panfish populations.
		• Improve fishing and boating access	• Develop or enhance fishing and boating access areas through easements, cooperative agreements or purchase. Utilize funds to

			build fishing docks for shoreline anglers.
		• Curtail illegal introductions of fish. Illegal introductions of exotic fishes threaten the stability of other established fisheries.	• Develop informational programs to educate anglers and the public to risks of random introductions of exotic species. Through planning, use enforcement efforts to curtail illegal introductions
PEND OREILLE RIVER DRAINAGE	Rainbow Trout	• Restore the trophy rainbow trout fishery of Pend Oreille Lake once kokanee populations are at a level to sustain additional predation.	• Modify fishing regulations to achieve trophy trout management goals established by the public. • Enhance the genetic makeup of Pend Oreille Lake rainbow trout by obtaining pure strain Gerrard rainbow trout from Kootenay Lake British Columbia. Work with Montana to avoid introductions of other stocks of rainbow trout in the Clark Fork River reservoirs above Pend Oreille Lake.
		• Improve the efficiency of hatchery put-and-take trout stocking programs.	• Evaluate rate of return, catch rate, and angler use on put-and-take trout fisheries through a routine data collection system. • Adjust rate, timing or location of trout stocking to improve rate of return to the creel. • Inform anglers of hatchery supported trout fishing opportunities through maps, brochures, media coverage and signing to improve return to the creel. • Discontinue put-and-take trout stocking in waters where a 40% or greater by number or 100% or greater by weight return to the creel cannot be met by the end of this planning period. Provide alternative fisheries to maintain angling opportunity. • Develop and utilize disease

			free, sterile stocks of rainbow and cutthroat trout to address concerns about potential impacts to wild trout.
SPOKANE RIVER DRAINAGE		• Minimize impacts of land use and development on fishery habitat in streams.	• Work with the Forest Service, other agencies, private developers and landowners and interested angling groups to make protection of fisheries habitat a primary concern in land use decisions. Incorporate evaluations of existing habitat in survey projects whenever possible. Develop a data base to demonstrate the magnitude of habitat loss and more effectively influence land use decisions. Work with the Forest Service, Department of Transportation, Silver Valley Natural Resource Trustees, Environmental Protection Agency, Department of Lands, Department of Environmental Quality and others to insure mitigation of habitat loss or restoration of habitat whenever possible. • Participate in the relicensing of the Avista owned Post Falls Dam to insure construction, inundation and operational impacts of the dam are properly mitigated.
		• Minimize impacts to lake fisheries due to lakeshore encroachment, pollution and nutrient loading.	• Work with county planners and Idaho Department of Lands to make protection of fish habitat and water quality a primary concern in land use decisions.
		• Improve the efficiency of hatchery put-and-take trout stocking programs.	• Evaluate rate of return, catch rate, and angler use on put-and-take trout fisheries through a routine data collection system. • Adjust rate, timing or location of trout stocking to improve rate of return to the

			creel. • Inform anglers of hatchery supported trout fishing opportunities through maps, brochures, media coverage and signing to improve return to the creel. • Discontinue put-and-take trout stocking in waters where a 40% or greater by number or 100% or greater by weight return to the creel cannot be met by the end of this planning period. Provide alternative fisheries to maintain angling opportunity. • Develop and utilize disease free, sterile stocks of rainbow and cutthroat trout to address concerns about potential impacts to wild trout.
		• Provide diverse angling opportunities in lowland lakes.	• Continue periodic surveys of fish populations to monitor population status and fish growth in relation to physical and biological conditions and fishing regulations. Manage some lakes for specific fish species in order to maximize angling opportunity. • Maintain maximum harvest opportunity for warmwater species and stocked trout in most lakes while providing quality or trophy management fisheries in a few lakes where biological and physical conditions, and public support provide the right set of conditions for special management. • Continue maintenance stocking of tiger muskies and channel catfish to maintain popular fisheries. Evaluate channel catfish harvest to determine if harvest restrictions are needed to maintain this hatchery supported fishery. Establish bluegill sunfish in select waters to diversify panfish populations.

		• Improve fishing and boating access.	• Develop or enhance fishing and boating access areas through easements, cooperative agreements or purchase. Utilize the funds to build fishing docks for shoreline anglers.
		• Curtail illegal introductions of fish. Illegal introductions of exotic fishes threaten the stability of other established fisheries.	• Develop informational programs to educate anglers and the public to risks of random introductions of exotic species. Through planning, use enforcement efforts to curtail illegal introductions.
PALOUSE RIVER DRAINAGE	Hatchery Rainbow Trout	• Improve fish habitat.	• Work with U.S. Forest Service, Department of Lands, University of Idaho, and private landowners to protect and improve habitat.
		• Increase fishing opportunities with small reservoirs.	• Work with public and private landowners to identify potential new small reservoir sites and initiate process for construction.
SNAKE RIVER AND MINOR TRIBUTARIES IDAHO/WASHINGTON BORDE-R TO HELLS CANYON DAM	Native Rainbow Trout, Hatchery Rainbow Trout	• Improve juvenile fish migration survival to lower Granite Dam.	• Establish long-term total dissolved gas monitoring stations below Hells Canyon Dam. Collect data on anadromous and resident fish populations, including mortality and gas bubble incidence during periods of high gas levels and correlate with anadromous adult returns. Coordinate all activities with Idaho Power Company. Develop and work to obtain flow regimes in the Snake River that maximize survival of migrating juvenile and adult anadromous fish. Continue to develop smolt timing and relative abundance indices to aid control of flow augmentation and water storage management. • Document impacts of fluctuating water levels on fall chinook survival, spawning

			success, and ecology. Work with Idaho Power Company and federal regulatory agencies to minimize flow fluctuations from Hells Canyon Dam to enhance fall chinook survival.
		• Enhance game fish production below Hells Canyon Dam.	• Document impacts of fluctuating water levels on game fish with emphasis on smallmouth bass and white sturgeon, survival, spawning success, and ecology. Work with Idaho Power Company and federal regulatory agencies to minimize flow fluctuations from Hells Canyon Dam to enhance resident game fish survival.
		• Manage mountain lakes within productivity and user preference constraints of individual lakes.	• Continue mountain lakes investigations in cooperation with USFS to collect biological, physical and chemical characteristics of each lake. Using acquired information, develop management plans.
CLEARWATER RIVER DRAINAGE	Native Rainbow Trout , Hatchery Rainbow Trout	• Maintain and improve fish habitat and water quality within the Clearwater drainage.	• Continue working with land management agencies (Forest Service, Bureau of Land Management, State Department of Lands) and private land owners to inform, educate and assist with land management planning for protecting fish habitat and water quality. Emphasize the need for riparian habitat protection and enhancement. Encourage containment of sediment production areas, including old mining sites. Oppose land use activities that degrade quality of natural production areas.
		• Maintain a diversity of fishing opportunity in the Clearwater River drainage to meet angler demand.	• Within the biological constraints of the fish resource, provide an array of lake and stream fishing opportunities including: a. High yield kokanee fisheries. b. Yield fisheries on

			catchable and fingerling released trout. c. Fishing (catch-and-release) for trophy-sized rainbow trout, cutthroat trout, and steelhead trout. d. Yield and trophy fisheries for smallmouth and largemouth bass. e. Yield fisheries for brook, cutthroat trout and rainbow trout in mountain lakes. f. Opportunities to harvest hatchery steelhead trout, and hatchery chinook salmon and coho salmon when run size permits.
		• Develop strategies including a funding source to construct a new reservoir in the Clearwater drainage.	• Construct Deer Creek Reservoir near Headquarters, Idaho. Funding secured in 2000 to begin planning, with completion in 2003.
		• Increase fishing access.	• As opportunities allow, acquire additional fishing access sites.
		• Maintain existing natural spawning populations of chinook salmon and steelhead trout.	• Continue Idaho Supplementation studies to evaluate supplementation strategies. • Work with the Nez Perce Tribe to develop hatchery fish release programs that preserve and protect genetic resources of naturally spawning chinook salmon and steelhead trout populations. Mark hatchery smolts released for harvest opportunities.
		• Support anadromous objectives with flood control releases and other available storage from Dworshak Reservoir.	• Work with Corps of Engineers and other action agencies to utilize flood control releases and other available storage (in Dworshak, Brownlee reservoirs) as necessary to achieve a flow objective of 100 kcfs at Lower Granite Dam during the spring

			migration period when migrants are present premised on shifts in flood control operations. Support managing existing flow augmentation volumes for summer migrants subordinate to flow augmentation operations during the spring migration period. Support use of Dworshak Reservoir flow later in the summer season to enhance juvenile fall chinook rearing and migration. Support use of Dworshak Reservoir flow to enhance adult steelhead return, when possible. Support flow modification to facilitate salmon and steelhead fishing in the North Fork and lower Clearwater when feasible. Evaluate effects of reservoir operation modifications on resident fisheries.
		• Work with private landowners to enhance fishing opportunities in private farm ponds.	• Continue consultation with private fishpond permittees to provide fisheries in farm ponds. Provide warm water fish for give-a-ways as lowland lake populations allow.
		• Manage mountain lakes within productivity and user preferences constraints of individual lakes.	• Continue mountain lake investigations in cooperation with USFS to collect biological, physical and chemical characteristics of each lake. Use acquired information to develop management plans.
SALMON RIVER DRAINAGE - MOUTH TO HORSE CREEK	Native Rainbow Trout , Hatchery Rainbow Trout	• Maintain maximum potential for fishery and recreational values in the Salmon River from mouth to Horse Creek.	• Work with land managers to ensure adequate riparian and water quality protection along the Salmon River corridor between Hammer and Vinegar creeks. Oppose land use activities that degrade quality of natural production and migration areas.

		• Maintain and improve habitat quality of tributary production areas.	• Oppose land use activities that further degrade the quality of natural production areas. Encourage implementation of grazing management plans, which eliminate negative grazing impacts to fishery productivity and survival.
		• Increase fishing access.	• Develop small outboard and float boat launch facilities where possible.
		• Manage mountain lakes within productivity and user preference constraints of individual lakes.	• Continue mountain lakes investigations in cooperation with USFS to collect biological, physical and chemical characteristics of each lake. Use acquired information to develop management plans.
LITTLE SALMON RIVER DRAINAGE	Native Rainbow Trout , Hatchery Rainbow Trout	• Improve water quality and fish habitat upstream of the barriers near Round Valley Creek.	• Work with the landowners to participate in state and federal programs to improve grazing, irrigation, and farming practices to improve riparian condition and water quality.
SOUTH FORK SALMON RIVER DRAINAGE	Native Redband Trout Hatchery Rainbow	• Maintain and improve habitat quality of mainstem and tributary production areas.	• Oppose land use activities that further degrade the quality of natural production areas. Participate in timber management proposals. Encourage implementation of grazing management plans, to eliminate negative grazing impacts to fishery productivity and survival. Participate in interagency mining oversight committees to review operating plans and work with regulatory agencies to require strict compliance with mining laws to protect water quality and fish populations. Develop monitoring programs for fish populations and fish habitat relative to land management activities, if needed. Continue to monitor and evaluate benefits from habitat improvement projects.
		• Provide information	• Continue to develop and distribute fisheries

		and education of fisheries management objectives for the drainage.	information and regulation signs to increase compliance and support.
SALMON RIVER DRAINAGE – HORSE CREEK TO NORTH FORK	Native Rainbow Trout	• Maintain and improve habitat quality of tributary production areas.	• Oppose land use activities that further degrade the quality of natural production areas. Participate in allotment management plan review. Encourage implementation of grazing management plans that eliminate negative grazing impacts to fishery productivity and survival. Participate in interagency mining oversight committees to review operating plans and work with regulatory agencies to require strict compliance with mining laws to protect water quality and fish populations. Develop monitoring programs for fish populations and fish habitat relative to mining activities, if needed. Implement rehabilitation measures for Panther Creek drainage.
		• Correct passage problems such as irrigation diversions, road culverts, and dewatered stream segments that restrict anadromous and resident fish access to spawning tributaries.	• Cooperate with Lemhi County and the USFS in identifying and constructing fish passage improvement structures for culverts. Identify and screen or repair irrigation diversions where needed. Work with the Upper Salmon River Model Watershed Project to reconnect tributary streams.
MIDDLE FORK SALMON RIVER DRAINAGE	Hatchery Rainbow Trout	• Preserve genetic integrity of wild native salmon, steelhead, and trout.	• anage hatchery supplemented Salmon River anadromous stocks to minimize straying into the Middle Fork Salmon River. • Designated wild anadromous fish sanctuary. No stocking of hatchery fish into the

			stream environment. • Continue to work with other state and federal agencies to improve juvenile downstream and adult upstream passage to and from the Middle Fork Salmon River.
		• Manage resident fisheries for low angler density fishing experiences and high catch rates and fish size.	• Maintain catch-and-release regulations for native trout in the mainstem Middle Fork Salmon River and its tributaries. • Maintain cutthroat trout harvest restrictions in the main Salmon River to protect Middle Fork Salmon River cutthroat trout that emigrate there to overwinter.
		• Maintain and improve habitat and water quality of key tributary fish production areas.	• Work with Forest Service and permittees to establish healthy riparian vegetation. • Work with the Forest Service to establish stream substrate objectives for sediment that would maintain high productivity of aquatic habitat. • Screen all identified irrigation diversions where needed. • Participate in interagency mining oversight committees to review operating plans and work with regulatory agencies to require strict compliance with mining laws to protect water quality and fish populations. Develop monitoring programs for fish populations and fish habitat relative to mining activities, if needed. • Participate in grazing allotment management plan reviews. Eliminate negative grazing impacts to fishery productivity and survival.
		• Maximize recruitment of native trout to the main river from tributaries.	• Continue restrictive regulations in tributaries. Continue monitoring juvenile densities by snorkeling once every three years.
		• Re-establish anadromous	• Continue to work with other state and federal agencies to

		runs to the numbers necessary to fully utilize available spawning and rearing habitat.	improve juvenile downstream and adult upstream passage to and from the Middle Fork Salmon River.
		• Develop methodologies for making accurate estimates of anadromous spawning escapement to the Middle Fork Salmon River.	• Work with other agencies to initiate research aimed at making chinook and steelhead escapement estimates to the Middle Fork Salmon River. Continue parr density monitoring once every three years and redd counts annually.
		• Increase ability of anglers to properly identify fish species.	• Provide fish identification signs and posters to increase recognition of bull trout. Encourage harvest of brook trout.
SALMON RIVER – NORTH FORK TO HEADWATERS	Hatchery Rainbow Trout	• Improve the quality of resident trout fishing in the mainstem Salmon River during the summer months.	• Continue protective fishing regulations on cutthroat trout, bull trout and rainbow trout.
		• Maintain and improve habitat quality of mainstem and tributary production areas.	• Work cooperatively with willing landowners through the Upper Salmon River Model Watershed Project, in priority areas, to maintain and enhance critical spawning and rearing areas for resident and anadromous fishes. Encourage land management activities on public and private properties that further improve the quality of natural production areas. Participate in grazing allotment management plan review. Encourage implementation of grazing management plans that eliminate negative grazing impacts to fishery productivity

			and survival. Participate in interagency mining oversight committees to review operating plans and work with regulatory agencies to require strict compliance with mining laws to protect water quality and fish populations. Develop monitoring programs for fish populations and fish habitat relative to mining activities, if needed. Continue to monitor and evaluate benefits from habitat projects.
		• Continue improving the return rate of stocked, catchable sized rainbow trout to the creel.	• Maintain high stocking frequency in heavily used areas between Hell Roaring Creek and Rough Creek bridge. Pursue the construction of a fishing pond in the Stanley vicinity to outplant catchable trout for better return to the creel.
		• Improve anadromous juvenile and adult fish passage in the Salmon River.	• Work with Federal Land Managers and private irrigators to alleviate passage problems in main river and tributaries due to irrigation diversions and dewatering. Screen and consolidate identified irrigation diversions by 2003.
LEMHI RIVER DRAINAGE	Native Rainbow Trout	• Improve angler access to the Lemhi River, trophy rainbow trout fishery.	• Negotiate with landowners to establish fishing by permission, easements or purchases.
		• Improve flows in lower river during peak irrigation season.	• Continue to participate and support efforts through the Upper Salmon River Model Watershed Program to transfer or purchase water rights to provide adequate flows through the seasonally dewatered portion of the river. Continue to investigate methods such as improved irrigation delivery systems, ditch consolidations, permanent head gates, and stream channel improvements, to provide

			safe passage through the lower river.
		• Maintain and improve habitat quality of the throughout the Lemhi River drainage.	• Continue to work cooperatively with willing landowners through the Upper Salmon River Model Watershed Project, in priority areas, to maintain and enhance critical spawning and rearing areas for resident and anadromous fishes. Pursue the reconnection of tributaries through improved irrigation delivery systems.
		• Improve the quality of cutthroat trout fishing in the mainstem Lemhi River. Maintain quality of trophy rainbow trout population.	• Maintain restrictive fishing regulations on all cutthroat trout and rainbow trout.
PAHSIMEROI RIVER DRAINAGE	Hatchery Rainbow Trout	• Maintain existing natural spawning populations of salmon and steelhead.	• Allow natural production to sustain existing, naturally producing populations. Limit outplanting of hatchery fish, other than direct hatchery releases, to support supplementation research and areas devoid of naturally producing salmon and steelhead.
		• Improve angler access to the Pahsimeroi River.	• Negotiate with landowners to establish fishing by permission, easements or purchases.
		• Minimize loss of juvenile salmon and steelhead to irrigation diversions on streams.	• Continue to upgrade existing screens, pursue consolidations, and install screens in remaining unscreened ditches.
		• Maintain and improve habitat quality of the throughout the Pahsimeroi	• Continue to work cooperatively with willing landowners through the Upper Salmon River Model Watershed Project, in priority areas, to maintain and

		River drainage.	enhance critical spawning and rearing areas for resident and anadromous fishes. Pursue the reconnection of tributaries through improved irrigation delivery systems.
		• Manage for quality resident trout fishing in the mainstem Pahsimeroi River.	• Maintain protective fishing regulations on all cutthroat trout and rainbow trout less than 14 inches in the mainstem river.
EAST FORK SALMON RIVER DRAINAGE	Native Rainbow Trout	• Maintain existing natural spawning populations of salmon and steelhead.	• Allow natural production to sustain existing, naturally produced populations. Limit outplanting of hatchery fish, other than direct hatchery releases, to support supplementation research and areas devoid of naturally producing populations of salmon and steelhead.
		• Maintain and improve fish habitat and water quality.	• Encourage land use activities that improve the quality of natural production areas. Participate in allotment management plan review. Work with landowners, the Shoshone-Bannock Tribes, and land management agencies to improve grazing practices, fence riparian areas, and take other actions to reduce erosion and eliminate negative grazing impacts to fishery productivity and survival. • Continue to work cooperatively with willing landowners through the Upper Salmon River Model Watershed Project, in priority areas, to maintain and enhance critical spawning and rearing areas for resident and anadromous fishes.
		• Improve the quality of resident trout fishing in the mainstem East Fork Salmon.	• Maintain restrictive fishing regulations for cutthroat trout in the mainstem river.

		• Improve anadromous juvenile and adult fish passage in the Salmon River.	• Work with landowners to alleviate passage problems due to irrigation diversions. Identify and screen irrigation diversions or repair screens by 2003.
YANKEE FORK SALMON RIVER DRAINAGE	Native Rainbow Trout, Hatchery Rainbow Trout	• Preservation of chinook and steelhead by harvest closures.	• Coordinate efforts with Shoshone-Bannock Tribes to protect existing chinook salmon spawners.
		• Maintain and improve fish habitat and water quality.	• Continue to actively pursue funding with the Shoshone-Bannock Tribes, U. S. Forest Service. J.R. Simplot Co., and others, to reestablish the dredged portion of the Yankee Fork mainstem to a natural state. • Reduce impacts of mining activity to fish populations and habitat by continuing to work with agencies such as the U.S. Forest Service and Department of Water Resources, mining companies, and private consultants to provide adequate protective measures in licensing and permitting agreements.
		• Improve resident fishery in the Yankee Fork system.	• Maintain harvest closures on cutthroat trout in the mainstem Yankee Fork.
SNAKE RIVER DRAINAGE FROM HELLS CANYON DAM to C.J. STRIKE RESERVOIR	Native Redband Trout	• Protect native bull trout and redband trout populations in the Snake River tributaries.	• Further define distribution and abundance of tributary populations of bull trout and redband trout. • Offer appropriate and accurate responses to proposed land management activities of private, state and federal entities.
WEISER RIVER DRAINAGE	Native Redband Trout, Hatchery Rainbow Trout	• Obtain stream resource maintenance flows to enhance the native fish populations.	• Quantify and apply for minimum stream flows where unallocated flows are available. • Work with Soil Conservation Service, Idaho Department of Health and Welfare, and

			landowners to utilize more efficient irrigation systems. • Evaluate the potential to enlarge Lost Valley Reservoir to provide summer flows in the Weiser River for eventual delivery to Weiser area irrigators or hydropower interests. Emphasis must include protection and mitigation of impacts to the Northern Idaho Ground Squirrel colony.
		• Improve methods to control flooding and erosion.	• Work with Soil Conservation Service, Idaho Department of Health and Welfare, and Idaho Department of Water Resources to have environmentally acceptable methods used for stream channel alterations and riparian vegetation restoration.
		• Preserve redband trout genetic integrity and population abundance.	• Limit hatchery trout to reservoirs and limited stream sections near major access points, such as campgrounds. Use sterile rainbow trout stocks. • Retain springtime fishing closures in the Adams County portions of the drainage to protect naturally spawning fish from harvest during this period of concentration and vulnerability.
		• Create local small fishing ponds in cooperation with local city or county governments.	• Utilize federal aide funds for "seed monies" to construct small local fishing ponds in the Weiser drainage.
PAYETTE RIVER DRAINAGE	Native Rainbow Trout	• Provide a diversity of fishing opportunities within the Payette River drainage.	• Zone the stream areas to concentrate hatchery catchable stocking in locations where the highest return-to-creel will occur. • Manage for wild trout where habitat and fish populations will sustain an acceptable fishery. • Manage for increased catch

			rates and size in selected stream reaches using quality trout regulations. • Stock appropriate strains of trout in natural production areas to better utilize the rearing capacity and provide larger and more desirable fish. • Stock adult steelhead directly downstream from Black Canyon Dam as these fish are available. Low river flow and ample notification of anglers must be accomplished to be successful. • Increase warm water angling opportunity by acquiring access or title to ponds in the Lower Payette River drainage. • Seek funding construction of new ponds near urban areas. • Improve land-use management through working with federal, state, and private land owners on proper land uses to increase soil stability in the drainage. • Monitor angler use of trophy trout waters. When use becomes moderate to heavy develop additional trophy trout waters.
		• Assess the potential for securing stream maintenance flows to protect fisheries on the North Fork Payette River, Lake Fork Creek, and other tributaries.	• Gather needed biological and economic information for the Idaho Water Resource Board to justify pursuing stream maintenance flows for fish and wildlife protection.
		• Maintain riparian and floodplain values for fish and public	• Work with Valley County to limit residential development in the floodplain. • Work with Valley County and landowners to provide public

		access.	access to the North Fork Payette River.
		• Maintain/enhance the large-size, mature nature of the lake trout population in Payette Lake.	• Maintain trophy regulations for lake trout to maximize numbers of large, mature fish. • Begin lake trout stocking program to replace old growth fish.
		• Provide a diversity of alpine lake fishing opportunities.	• Monitor existing trophy alpine lakes. • Investigate additional alpine lakes for different management opportunity.
BOISE RIVER DRAINAGE	Native Rainbow Trout, Hatchery Rainbow Trout	• Provide a diversity of fishing opportunities within the Boise River drainage.	• Zone the stream areas to concentrate hatchery catchable stocking in the locations where the highest return to the creel will occur. • Manage for wild trout where habitat and fish populations will sustain acceptable fisheries. • Manage for increase catch rates and fish size in selected stream reaches with quality and trophy trout regulations. • Develop ponds in the upper South Fork Boise River and Smoky Creek drainages for planting catchable rainbow trout.
		• Seek better land management practices that significantly improve fishery habitats.	• Provide sediment objectives/standards to land management agencies where sediment is the limiting factor in aquatic habitats. • Provide riparian vegetation objectives to land management agencies where grazing, development, or other activities have degraded riparian zones.
		• Monitor effects of land management activities, fishery regulations, and other fishery management	• Collect common data base information on habitat and fish populations throughout the Boise River drainage. • Examine changes and trends in common data base information and attempt to determine causes for any changes that are noted.

		activities on fish habitat and fish populations.	
		• Seek improved reservoir management and stream flows.	• Pursue development of a minimum pool in Arrowrock Reservoir. • Study water management at Lake Lowell to determine the relationship between fish production and water levels. • Monitor Arrowrock Dam valve replacement project. Maintain involvement in multi-agency fishery mitigation team. • Determine which water levels in Anderson Ranch Reservoir result in downstream losses of bull trout. Develop reservoir management plans to avoid or mitigate losses.
		• Create local small fishing ponds in cooperation with local city or county governments.	• Utilize federal aid funds for "seed monies" to construct small local ponds where there is demand and appropriate sites in the drainage.
		• Provide a diversity of alpine lake fishing opportunities.	• Investigate alpine lakes for opportunities to create trophy management.
OWYHEE RIVER DRAINAGE, BRUNEAU RIVER DRAINAGE, AND MINOR TRIBUTARIES SOUTH OF SNAKE RIVER	Native Redband Trout, Hatchery Rainbow Trout	• Manage stream and reservoir fisheries to preserve the genetic integrity of native desert redband trout.	• Stock other species of fish only in reservoirs that will not pose a threat to preserving redbands and use only sterile rainbow trout. • Restock streams with depleted populations where habitat conditions have been restored with redbands by collecting fish or eggs from adjacent areas that contain native redband trout.
		• Work cooperatively with state and federal land management agencies and grazing	• Establish riparian vegetation objectives in management plans that annually provide 80% of the potential, riparian vegetation mass to be in place prior to high flows occurring.

		permittees to improve riparian and aquatic habitats.	• Monitor stations on major tributaries of the Owyhee and Bruneau river systems to determine trends in riparian conditions, aquatic habitat, and fish production.
		• Increase reservoir fishing opportunities.	• Seek opportunities to construct new fishing reservoirs in cooperation with federal, state, and private landowners. • Seek cooperative agreements with private landowners to gain access to existing reservoirs. • Restock reservoirs with appropriate stocks of fish when drought conditions cause fish kills or de-watering. • Renovate reservoirs with rough fish populations that limit the fishery.
MAIN SNAKE RIVER - C.J. STRIKE RESERVOIR TO LAKE WALCOTT	Native Rainbow trout	• Improve water quality in the Snake River for fish spawning and rearing and for recreational uses.	• Work with regulatory and land management agencies, irrigation companies, municipalities, Watershed Advisory Groups (WAG's), and private owners to improve water quality in the Snake River. • Assist in the development of wetlands at the ends of irrigation drains and other nutrient rich water sources to filter sediments and nutrients from irrigation returns. Identify 319 grant funding opportunities and provide technical assistance to WAG.
		• Improve water quantity in the Snake River for fish spawning and rearing and for recreational uses.	• Work with regulatory agencies, Bureau of Reclamation and irrigation companies to improve water management in the Snake River to improve flows during white sturgeon spawning periods. • Work with Idaho Power Company and FERC to reduce or eliminate load following practices at Lower

			Salmon Falls Dam to improve fish rearing habitat down river to CJ Strike Reservoir. • Work with Idaho Dept. of Water Resources to define conditions under which water can be diverted for aquifer recharge while not impacting fish or riparian resources.
		• Return the trout fishery in Lower Salmon Falls Reservoir to the excellent fishery it has been in the past.	• Attempt to determine the reasons for the decline of this fishery and build the fishery back to its former level. Determine if the lack of fishery is water quality, water quantity or fish stocking related and manage accordingly.
		• Maintain existing and recover lost spring habitat along the Snake River in the Snake River aquifer area for Shoshone sculpin and redband trout spawning and rearing habitat.	• Continue strong efforts to preserve undeveloped natural springs with significant fishery values. • Work with Idaho Power Company and other private developers to reestablish natural spring habitat at Banbury Springs and other sites at the opportunity arises. • Work with Idaho Department of Parks and Recreation to develop a management plan for Box Canyon to maintain native habitat and fish species
		• Increase opportunity for warmwater and coldwater fishing in the Magic Valley area to meet increased demand.	• Acquire and develop fishing opportunities at the Clear Lakes Grade ponds.
		• Improve fishing in ponds along the Interstate in the Burley/Rupert area.	• Work with local officials and the public to develop a management plan to reduce common carp in the ponds. • Work with USFWS on controlling or managing fish eating birds at the ponds or develop a species or trout

			size stocking program to provide a fishery under current conditions.
BIG WOOD RIVER DRAINAGE	Native Rainbow Trout, Hatchery Rainbow Trout	• Maintain existing and improve degraded stream habitats in the Big and Little Wood river drainages.	• Work closely with county planning and zoning agencies and IDWR to prevent channel and riparian degradation and development in natural flood plains. • Work with land management agencies and livestock owners to implement grazing strategies, which will allow for the recovery of riparian systems along streams.
		• Reestablish stream connectivity between the upper Big Wood River and Magic Reservoir in good water years to take advantage of the surplus wild trout production in the river.	• Work with IDWR, water rights holders and interest members of the public to acquire sufficient water rights from willing sellers to maintain flows between Glendale Diversion and Stanton Crossing during average or better water years. If flows are acquired, implement best methods of diverting lost production in irrigation diversions into the river and Magic Reservoir.
		• Improve returns of hatchery fish and reduce impacts on wild trout populations in streams.	• Work with the USFS and the public to develop new fish out ponds and improve conditions on existing ponds in high use areas of the upper Big Wood River drainage.
		• Improve fish habitat and riparian ecosystem in the Little Wood River between Carey and Shoshone.	• Work with the Little Wood River Irrigation District on the development of an irrigation system which would provide flows in the river between Carey and Silver Creek in good water years.
		• Install fish ladders on irrigation and other barriers between the Dietrich	• Work with state and federal agencies, irrigation districts and landowners on developing wetlands on irrigation returns to improve water quality in irrigation

		Diversion and Shoshone to create connectivity between isolated fish populations in the Little Wood River.	returns. • Work with BLM and the public on reestablishing native riparian shrubs and trees along the Little Wood River between Silver Creek and Richfield to reduce water temperatures during summer months.
		• Improve reservoir fishing opportunity for both quality and harvest fisheries.	• Investigate the desirability and feasibility of reducing smartweed in Mormon Reservoir to improve boating access. • Continue to evaluate rainbow trout stocking program in Mormon Reservoir to determine effects of stocking timing and fish size on survival from bird predation. Also evaluate yellow perch population recovery. • Investigate economic and physical feasibility of increasing the height of the dam on Thorn Creek Reservoir. • Negotiate with the owners of Cow Creek Reservoir near Hill City on acquiring public access for fishing.
SALMON FALLS CREEK, GOOSE CREEK, ROCK CREEK, AND RAFT RIVER DRAINAGES	Native Rainbow Trout, Hatchery Rainbow Trout	• Improve water quality for fish habitat in lower reaches of streams in section.	• Work with regulatory agencies and landowners to reduce sediment and nutrient loads in streams flowing into the Snake River.
SNAKE RIVER-LAKE WALCOTT TO CONFLUENCE OF SOUTH FORK AND HENRYS FORK	Native Rainbow Trout, Hatchery Rainbow Trout	• Maintain quality trout fishery from Eagle Rock to American Falls Dam.	• Seek improved minimum flow. Biologically, a minimum flow of 20% (1,791 cfs) of the mean annual flow would be appropriate in this reach. However water managers currently reduce winter flow to as low as 300 cfs during low water years to maximize potential of reservoir refill.
		• Maintain boating access and an adequate minimum conservation	• Work with the Bureau of Reclamation, Department of Water Resources and Bonneville Power Administration to obtain a minimum conservation pool

		pool in American Falls Reservoir.	of 340,000 acre-feet (20% of full-pool). This level would keep at least one boat ramp accessible for anglers and maintain enough depth and surface area to reduce entrainment loss of trout and bass. This level would also minimize water quality impacts from sediment entrainment. This volume would also maintain some rocky habitat to encourage smallmouth bass to stay in the reservoir.
		• Increase catch rate to 0.3 trout/hour.	• Increase number of fish stocked by decreasing average size.
PORTNEUF RIVER DRAINAGE	Native Rainbow Trout, Hatchery Rainbow Trout	• Improve water quality and trout habitat in Portneuf River from Pocatello upriver to Lava Hot Springs, including Marsh Creek.	• eek participants in NRCS Continuous Signup Conservation Reserve Program. Participate in the Portneuf River Watershed Council.
		• Improve conditions for wild trout in the Portneuf River from Lava Hot Springs to Chesterfield Reservoir.	• Maintain existing riparian corridor fences on private land. Seek additional riparian fencing projects on the river and tributaries. Obtain renewed 10-year access and fence maintenance agreement with King Creek Grazing Association. • Reduce the number of hatchery trout stocked. • Seek funding for a full-time technician and seasonal aide to maintain riparian corridor fences, seek new fencing projects on private land in coordination with other natural resource agencies and solicit grants for fencing projects.
BLACKFOOT RIVER AND TRIBUTARIES	Native Rainbow Trout, Hatchery Rainbow	• Improve migration conditions in spawning tributaries in	• Repair potential migration barrier on Miner Creek below the highway bridge.

	Trout	the Blackfoot River from its mouth upriver to Blackfoot Reservoir.	
		• Stock rainbow trout in Blackfoot Reservoir of a size that has the best return to anglers.	• Conduct season-long creel survey to compare the relative return to anglers of a large number of small fingerlings (3-inches) and a small number of large catchables (9- to 10-inch). Use the results to update the stocking program for Blackfoot Reservoir.
		• Maintain sufficient oxygen and decrease anaerobic gasses so that trout can live through the winter under ice-cover in Dike Lake (a diked-off arm of Blackfoot Reservoir.	• Apply herbicide to reduce growth of aquatic macrophytes throughout the growing season.
HENRYS FORK SNAKE RIVER DRAINAGE	Native Rainbow Trout, Hatchery Rainbow Trout	• Maintain quality trout fishing in the Henrys Fork from the South Fork confluence upstream to Riverside Campground.	• Monitor trout populations in indicator reaches by electrofishing on a regularly scheduled basis, propose regulation changes as biologically or socially necessary • Maintain from the mouth to Del Rio its general harvest regulations for all trout with seasons and area closures as needed for protection of spawners. • Work for habitat and stream flow protection and/or enhancement.
		• Sustain high catch rates and a desirable size structure in the Henrys Fork on the catch-and-release section from	• Continue long-term monitoring of trout population and angling success through regularly scheduled sampling surveys. • Work for stream flow protection and enhancement, focusing on winter flow enhancements to optimize

		Riverside Campground upstream to Island Park Dam.	juvenile trout over-winter survival.
		• Manage the Henrys Fork above Island Park Reservoir for satisfactory and diverse angling opportunity, as desired by the public.	• Continue long-term monitoring of trout population and angling success through regularly scheduled sampling surveys, propose regulation changes as biologically or socially necessary. • Work for habitat and stream flow protection and enhancement. • Continue to manage Island Park Reservoir for optimum trout production goals to ensure strong escapements of spawning rainbow trout and kokanee upstream through the upper Henrys Fork to Moose Creek, Big Springs, and Henrys Lake Outlet.
		• Maintain maximum fishing opportunity necessary without detriment to ecologically sensitive species (trumpeter swans) throughout the Henrys Fork drainage.	• Monitor, through and in coordination with the Department wildlife bureau and the USFWS and its contractors, the spring nest distribution of trumpeter swans and potential impacts to swans by anglers, implementing emergency regulations (area closures, etc.) as needed.
		• Produce and maintain a quality, consumptive salmonid fishery in Island Park Reservoir.	• Continue stocking hatchery rainbow trout and kokanee at a size and on a schedule that provides high quality fishing with economic efficiency. • Work towards reservoir tributary habitat and stream flow protection and enhancement.
		• Evaluate management strategies to minimize negative	• Develop cooperative research projects with area universities to better understand chub population dynamics in Henrys Lake

		impacts of Utah chubs to the trout fishery	and develop potential management strategies.
TETON RIVER DRAINAGE	Native Rainbow Trout, Hatchery Rainbow Trout	• Increase consumptive trout fishing opportunity for bank anglers near population centers.	• Acquire or lease small, highly accessible ponds to provide an intensive hatchery supported fishery. Develop handicapped facilities where feasible. • Adjust rate and timing of stocking to provide 80% to 100% return to the creel. • Inform anglers of hatchery supported trout fishing opportunities through maps, brochures, media coverage, and signs.
		• Monitor incidence of fish disease and minimize its threat to wild trout populations.	• Continue to evaluate the effects of whirling disease on wild trout populations. • Educate private pond owners on the threat of whirling disease and strictly enforce fish transport regulations. • Educate the public on the threat of whirling disease and methods to control its spread. • Evaluate the effects of black spot disease on wild trout populations.
		• Monitor status of illegal fish releases and minimize their threat to wild trout populations.	• Monitor status of illegal brown trout and hatchery fish introductions. • Educate the public on the threat of illegal fish releases and strictly enforce regulations.
		• Minimize impacts of land use and development on fish habitat and water quality.	• Work with government agencies, private landowners and developers, and interested conservation groups to make protection and enhancement of fish habitat and water quality a primary concern in land use decisions. • Maintain cooperative fencing, pasture management, and livestock non-use projects with local landowners. • Ensure restoration of habitat or mitigation of habitat loss

			whenever possible.
		• Minimize loss of juvenile fish to irrigation diversions and tributary de-watering.	• Educate and negotiate with local irrigators for minimum stream flows when possible.
		• Obtain adult fish passage around or through barriers.	• Identify and obtain passage around irrigation diversions in cooperation with local irrigators. Continue to operate and maintain the South Fork Teton fish ladder. • Identify barriers and obtain passage through road culverts. • Negotiate with local irrigators for minimum stream flows when possible.
		• Improve angler compliance with special regulations.	• Develop informational programs to encourage compliance. Educate anglers on the need for regulations, the kinds and location of regulations, and alternative fishing opportunities. Continue to publish and distribute the Teton Valley fishing map. • Focus available enforcement to reduce poaching losses.
SOUTH FORK SNAKE RIVER DRAINAGE	Native Rainbow Trout, Hatchery Rainbow Trout	• Obtain adequate winter stream flows to reduce juvenile fish mortality.	• Work with Bureau of Reclamation to maintain at least 1500 cfs release from Palisades Dam during winter. Establish ramping rates to minimize water level fluctuations.
		• Monitor incidence of fish disease and minimize its threat to wild trout populations.	• Continue to monitor for presence of whirling disease. • Educate private pond owners on the threat of whirling disease and strictly enforce fish transport regulations. • Educate the public on the threat of whirling disease and methods to control its spread.
		• Minimize loss of juvenile fish to irrigation diversions and stream	• Operate and maintain the Palisades Creek and Burns Creek screens in cooperation with local irrigators.

		dewatering.	• Operate and maintain the Palisades Creek and Burns Creek screens in cooperation with local irrigators.
		• Minimize impacts of land use and development on fish habitat and water quality.	• Work with government agencies, private landowners, developers, and interested conservation groups to make protection and enhancement of fish habitat and water quality a primary concern in land use decisions. • Ensure restoration of habitat or mitigation of habitat loss whenever possible.
		• Improve angler compliance with special regulations.	• Develop informational programs to encourage compliance. Educate anglers on the need for regulations, the kinds and location of regulations, and alternative fishing opportunities. • Focus available enforcement to reduce poaching losses. •
SINKS DRAINAGES	Native Rainbow Trout, Hatchery Rainbow Trout	• Improve water quality conditions in Mud Lake by maintaining higher year-round pool levels to provide for stable game fish populations and improved year-round fishing opportunity.	• Work with irrigation storage space-holders and private fishing organizations to facilitate enhanced winter lake volumes.
		• Continue to provide for balanced quality and general harvest oriented stream fishing opportunity	• Continue wild trout management for Medicine Lodge Creek drainage to protect isolated cutthroat trout populations and maintain wild trout fishing opportunity. • Continue to manage Camas Creek drainage and Birch Creek under general regulations for consumptive fishing opportunity.

			• Evaluate the adequacy of current fishing regulations and management direction for the Big Lost River fishery below Mackay Reservoir to satisfy public angling desires.
BEAR RIVER AND TRIBUTARIES	Native Rainbow Trout, Hatchery Rainbow Trout	• Increase number of wild Bonneville cutthroat spawners and fry production in St. Charles Creek.	• Continue a graduate student project to investigate limiting factors for spawning and recruitment in St. Charles Creek. • Seek ways to divert less water from St. Charles Creek. • Reduce numbers of brook and rainbow trout in St. Charles Creek.
MALAD RIVER DRAINAGE	Native Rainbow Trout, Hatchery Rainbow Trout	• Maintain the trophy trout fishery at Daniels Reservoir but with protection of Bonneville cutthroat trout.	• Obtain Bonneville cutthroat trout eggs from Wyoming or adfluvial Bonneville cutthroat trout eggs from Utah for stocking into Daniels Reservoir. Stock half cutthroat trout and half sterile rainbow trout. Maintain sterile rainbow trout program. • Seek improved riparian and stream bed conditions on the Little Malad Spring.
		• Restore the quality of the Crowthers Reservoir rainbow trout fishery.	• Renovate Crowthers Reservoir to eliminate chubs, carp and goldfish that may have come downstream into this reservoir from Devil Creek Reservoir.
		• Improve the quality of the game fish fishery in Stone (Curlew Valley) Reservoir.	• Work with the local irrigation district to see if common carp can be eliminated in the reservoir. If necessary, considered using triploid grass carp to control vegetation.

Appendix Table 4.4.5 Oregon Department of Fish & Wildlife Trout Management Plan (source: Ray Perkins 2004)

Management Objectives

Objective 1. Influence land management decisions in ways that benefit fish habitat.

Assumptions and Rationale

1. Coordination of fish population and habitat inventories with allotment evaluations will provide current information for making better management decisions that benefit fish habitat.

2. Stream surveys need to be updated and monitoring established on many streams in the Owyhee basin.

3. Habitat management plans written for the Coyote Lake subbasin and McDermitt Creek need to be reviewed and updated.

Actions

1.1 Coordinate fish population and habitat inventories with grazing allotment evaluations. Integrate inventory findings and recommendations into evaluations.

1.2 Develop a priority list and use the ODFW Aquatic Inventory methodology, or other suitable method, to gather baseline habitat information on streams in the planning area.

   a. Work with the Burns, Vale, and Winnemucca BLM districts and NDOW to standardize habitat inventory methodologies.

   b. Combine resources and manpower with BLM and NDOW to accomplish habitat inventory needs.

   c. Identify opportunities for public involvement in habitat inventories through volunteers or classroom projects.

1.3 Provide up-to-date fish population and habitat information to land managers.

1.4 Evaluate inventory data with regard to land management and make recommendations to land managers. Request data be used in consideration of management decisions.

1.5 Cooperate with BLM and private land managers on measures to protect and enhance fish habitat. Identify opportunities for public involvement in fish habitat enhancement through volunteers or classroom projects.

1.6 Request Vale BLM review and update pertinent habitat management plans.

1.7 Recommend riparian protection and instream flow protection or restoration in review of other agencies' permit applications and plans.

Objective 2. Improve riparian habitat to provide food and cover for fish, maintain late season flows, prevent erosion, and ameliorate temperature extremes.

Assumptions and Rationale

1. Loss of riparian vegetation, such as reduction in seral stage, diversity, and quantity, affects fish habitat.

2. Restoration and maintenance of riparian vegetation in the subbasins would benefit fish populations.

Actions

2.1 Encourage land managers to institute grazing practices that benefit the riparian habitat and associated uplands, and restrict mining activities in the riparian zone to protect fish habitat.

2.2 Encourage land managers to consider the impacts on habitat when designing roads and making recreation plans, such as trails.

2.3 Coordinate with land management entities (public and private) to identify specific areas of concern and develop cooperative projects to improve riparian habitats.

2.4 Provide information to private landowners on the benefits of healthy riparian conditions and methods to achieve them.

2.5 Manage beaver populations in conjunction with grazing practices to benefit riparian and aquatic habitat.

   a. Monitor beaver populations and evaluate their adverse effects on fish habitat.

   b. Take appropriate action to control beaver where necessary.

2.6 Evaluate riparian habitat conditions at BLM reservoirs managed for fisheries. Make recommendations to BLM as required to improve riparian habitat conditions at BLM reservoirs.

Objective 3. Improve water quantity and water quality to meet the biological needs of fish by providing adequate instream flows, reducing fish losses at diversions, and reducing nonpoint source pollution.

Assumptions and Rationale

1. Improved supervision of water diversions would benefit fish by ensuring that water in excess of legal rights remained in the stream.

2. Obtaining instream water rights will protect fish habitat from further out-of-stream diversion.

3. ODFW will continue to apply for instream water rights.

4. Natural recovery of the riparian habitat will result in improvement of the structural components of instream habitat and water quality.

5. Quantitative water quality data has not been collected for most streams in the Owyhee basin.

Actions

3.1 Identify screen needs. If a problem exists, identify a solution and screen strategy.

   a. Draft a list of high priority screening needs in the planning area.

   b. Work with the screen task force to identify screen projects.

   c. Provide information to the Water Resources Department on diversions not in its data base.

   d. Identify opportunities where volunteers could help construct and maintain fish screens.

3.2 Identify opportunities to improve instream flows.

a. Set priorities for identifying streams/reaches where flows are most needed.

b. Work with the WRD to monitor instream flows, identify areas to focus water right permit reviews, and identify other areas to participate (e.g., basin planning) where fish habitat can benefit.

c. Explore cooperative opportunities with senior water right holders.

d. Identify opportunities where volunteers can help gather instream flow information.

3.3 Request on-the-ground water quality assessment studies from EPA, DEQ, or land management agencies, to evaluate the extent of nonpoint source pollution and trend.

3.4 Monitor mining activities; identify existing and potential problems (Denio Creek).

3.5 Coordinate with public and private land managers to identify specific areas of concern.

a. Request enforcement where violations occur.

b. Develop cooperative projects to improve water quality and water quantity.

ECOLOGICAL CONSIDERATIONS

1. Warmwater vs. coldwater interactions

Channel catfish and smallmouth bass in the river upstream of the reservoir may be limiting the distribution of redband trout in the main river.

The warmwater fish populations in the reservoir may be impacting the native amphibian fauna around the reservoir.

2. Fish issues that may conflict with amphibians issues.

Management for large brown trout in the river downstream of the dam may have impacts on the frog/salamander population within this reach of the river.

Management of trout in the upper basin stock ponds maybe impacting native populations of amphibians.

3. Introduced populations of fish in the upper river may impact the amphibians native this reach of the river.

Hatchery rainbow trout stocked into several mainstream stock ponds in the headwaters of Oregon tributaries might be impacting native populations of redband trout.

4. All management activities in the future that concern the reservoir maybe driven by the status of the introduced Lahontan tui chub.

Redband Trout Management Concerns

A combination of habitat alteration and natural conditions restrict the abundance and distribution of both tributary and mainstem populations of inland redband trout. These conditions also keep the populations in the mainstem very low. Removal of riparian vegetation has allowed water temperatures to increase. The stream banks where the riparian vegetation has been removed are less stable and flush more sediment into streams during high water events. Unscreened diversions allow fish to enter irrigation ditches where they perish.

The confinement of small numbers of individuals in short perennial stream reaches increases the susceptible of these populations to catastrophic events and genetic bottlenecks. Maintaining connectivity of the populations in the planning area with the populations in Idaho and Nevada is important. It maintains genetic variability and allows populations that are eliminated by catastrophic events to be repopulated.

Introduced hatchery trout that can interbreed with the native redband trout are still being planted in reservoirs in the planning area and upstream in Idaho and Nevada. Effects of stocked hatchery trout into waters with redbands are unknown.

The fishery directed on redband is small and incidental to stocked hatchery rainbow trout and warmwater fish. Stocking hatchery rainbow trout attracts more anglers into remote areas where native fish occur. The impact of an artificially inflated fishery can impact the small native populations.

Critical Uncertainties

What effects are the hatchery trout stocked into the planning area having on the native redband trout populations?

What effects are the nonnative trout stocked into the upper basin in Idaho and Nevada having on the native redband trout in the planning area?

What are the effects are introduced warmwater game fish having on native redband trout in the planning area?

In desert watersheds the issue of water rights is a major concern. The issue of increasing water storage upstream of Owyhee Reservoir is a concern because construction of additional dams would further segment this species and destroy spawning habitat. The result could mean the isolation and eventual extinction of the small populations in the planning area.

The populations of inland redband trout upstream of Owyhee Dam are acting as a meta-population. A meta-population is a series of populations that exchange individuals over time. If small populations are lost due, the habitat can be re-seeded from other nearby populations. This spreads the risk of extinction over several populations. Maintaining this interconnectivity within the Owyhee Basin is very important to long-term survival and genetic viability of this/these populations.

Appendix Table 4.4.6 Objectives and strategies proposed for rainbow trout (hatchery) and redband trout (native) in various subbasins of the upriver-interior ecological Provinces of the Columbia and Snake Basins {source: Resident Fish Multi-Year Implementation Plan, CBFWA Resident Fish Committee (1996)}.

Subbasin	Species	Objectives	Strategies	Preformance Measures
Mainstem Columbia / Lake Roosevelt	Rainbow trout (adfluvial stock)	• Provide a subsistence and recreational fishery • Manage the adfluvial rainbow trout populations as self-sustaining naturally reproducing populations. • Increase parr production consistent with habitat availability.	• Conduct stock assessments and population inventories (both adult and juvenile) to estimate population strength and population dynamics. • Continue to suspend stocking of fluvial rainbow trout in tributaries utilized by adfluvial rainbow trout. • Monitor the effectiveness of in-stream habitat improvements, passage improvements, and riparian enhancement efforts in increasing parr production. • Operate fish weirs on spawning tributaries to assess adult escapement and potential introgression of hatchery fish into the spawning population. • Conduct genetic evaluation of potentially distinct stocks of adfluvial rainbow trout. • Conduct evaluations of additional streams that may have potential for rainbow production. • Initiate watershed management activities to complement stream habitat improvements. • Operate Lake Roosevelt	• Increase in parr production over time. • Increased adult escapement and harvest numbers (12,000 fish harvest by year 2000 and 150,000 ultimately). • Average fish weight of 2 lb. • Evidence of adfluvial rainbow trout colonizing areas opened by passage improvement • Increased duration of flows in intermittent streams utilized by adfluvial fish.

			consistent with guidelines identified in NWPCC Fish and Wildlife Program. • Minimize entrainment through Grand Coulee Dam.	
Mainstem Columbia / Lake Roosevelt	Hatchery Rainbow trout	• Create and maintain a high quality sport and subsistence kokanee salmon and rainbow trout fishery as substitution for lost anadromous fish angling opportunity above Chief Joseph and Grand Coulee Dams • Maintain and enhance self sustaining wild kokanee salmon and rainbow trout populations where appropriate consistent with sound resource protection guideline. • Create and maintain a balanced ecosystem able to withstand unfavorable lake operations.	• Produce 1,000,000 yearling kokanee and 500,000 rainbow trout among the Spokane Tribal Hatchery, Sherman Creek Hatchery and the Lake Roosevelt Net Pen Program for release in June each year. • Acclimate and imprint 225,000 kokanee yearlings for net pen rearing at the Kettle Falls net pen site. • Trap and spawn adult wild rainbow trout broodstock at Phalon Lake to obtain 1 million eggs annually. • Weir tributaries to allow only wild fish pass above the weir to spawn • Operate Grand Coulee Dam consistent with guidelines identified in NWPCC Fish and Wildife Program. • Monitor the effect of lake elevation and water retention time on the kokanee and rainbow trout populations. • Conduct genetic evaluations to determine whether wild kokanee are a unique stock • Conduct stream and lake shoreline redd counts to determine extent of wild spawning. • Improve habitat by	• Weight of trout reared for release. • Annual harvest and escapement numbers.

			revegetating the Lake Roosevelt shoreline. • Education • Monitor and evaluate the effects of fish management actions • Model the effect of lake operations on the food chain. • Identify and implement methods to reduce kokanee and rainbow entrainment • Develop a fisheries management plan that recommends specific lake operations for improvements to the rainbow and kokanee fisheries.	
Mainstem tributary subbasins (including Colville Indian Reservation)	Rainbow trout (non-native stock)	• Provide successful subsistence fishery for the Colville Tribal members and non-member sport fishery on hatchery-reared rainbow trout in streams of the Colville Reservation. • Improve spawning and rearing conditions for rainbow trout in areas they currently occupy.	• Continue to stock rainbow trout into Colville Reservation waters (200,000 fingerlings, 300,000 subcatchable, and 81,000 catchable-sized fish annually). • Develop a "free-ranging" rainbow trout source of rainbow trout eggs as the basis for hatchery production for Colville Reservation waters (130,000 eggs per year by the year 2000) • Continue to obtain eggs from WDFW until local broodstock source is developed • Maintain current fishing regulations for rainbow trout on the Colville Reservation • Conduct stock assessments, population inventories, and angler surveys to estimate population	• Annual rainbow trout egg take of 130,000 from an on-reservoir (free-ranging) source by the year 2000 • Annual plants of 581,000 juvenile rainbow trout • CPUE greater than 0.8 fish/hr for sport anglers and 1.0 fish per hour for subsistence anglers • Fish condition factors greater than 5.5E-4.

			strength, population dynamics, and fishery quality over time (population trends) • Initiate marking program that allows monitoring of year class recruitment into the spawning population and into the creel over time. • Revise stocking and harvest rates as necessary to maintain brook trout population levels below maximum carrying capacity • Initiate watershed management from a holistic management approach to maintain or improve habitat for brook trout in areas they currently occupy. • Plant fish capable of survival and reproduction to increase natural production	• Average fish length greater than 13.5". • Minimal mortality during hatchery rearing due to diseases or parasitic infections. • Increase in natural production of rainbow trout adults by 15% by 2010.
Coeur d'Alene Subbasin (including Tribal Reservation Tributaries)	Rainbow Trout	• Provide alternate (limited) harvest fishery in closed or isolated systems • Develop additional rainbow trout fisheries to reduce pressure on native stocks • Mitigate in part for anadromous fish losses. • Additional biological/quantitative objectives will be developed in other areas of the subbasin. • Modify existing stocking program, where	• Monitor and evaluate to determine effectiveness of stocking to reduce pressure on wild stocks • Set regulations for enforcement • Develop additional ponds to maintain additional Rainbow trout fisheries. • Produce 25,000 rainbow trout to stock in pond system	• Attain biological objectives in section 10.8 of the Northwest Power Planning Council Program (under Coeur d'Alene Tribe). • Catch rates approaching .5 fish/hours • Removal rates approaching 60% of stocked fish.

		necessary, to minimize impacts to native stocks.		
Lower Pend Oreille Subbasin (below Albeni Falls Dam)	Native rainbow trout	• Identify historic stocks, population levels, habitat conditions, and geographic ranges as targets for restoration • Increase or protect population levels above minimum viable populations that maintain genetic diversity • Restore degraded habitat in historical use areas where feasible • When appropriate stock hatchery origin fish to recover or restore native stocks, also, use hatchery origin fish for recreational and subsistence opportunities. • Mitigate and compensate for resident and anadromous fish losses caused by construction and operation of federally regulated and federally operated hydropower projects	• Design studies that will identify stock status.	• Determination of non-game stock status in the subbasin.

Upper Pend Oreille Subbasin (upstream from Albeni Falls Dam)	Rainbow trout	• Mitigate and compensate for resident fish losses caused by the construction and operation of federally regulated and federally operated hydroprojects. • Improve sport fishing opportunity for rainbow trout. • Enhance and maintain self-sustaining rainbow trout populations in Lake Pend Oreille at a level that allows for maximum sustainable yield. • Additional biological/quantitative objectives will be developed in other areas of the subbasin.	• Conduct habitat assessments. • Determine areas within tributaries and upland sites for enhancement opportunities. • Conduct habitat improvements techniques involving: riparian planting, fencining, and instream structures. • Monitor and evaluate the effectiveness of habitat improvement projects. • Enforcement of illegal harvest. • Education • Develop and implement BRC's/IRC's and a mitigation plan. • Maintain higher winter lake levels to benefit a major prey item for Kamloops rainbow trout, thus improving lake trout population size and sport harvest opportunity	• A statistically significant increase in the rainbow trout sport fishery harvest (both number and size of fish)
Kootenai River	Resident Rainbow trout	• Mitigate and compensate for resident fish losses caused by construction and operation of federally regulated and federally operated hydropower projects. • Create viable populations in historic spawning and rearing areas. • Provide subsistence and	• Use habitat improvement techniques to restore habitat necessary to sustain natural reproduction and recruitment: revegetation, bank stabilization, cover installation, spawning substrate improvement, pool formation, and riparian fencing. (including Idaho tributaries to Kootenai River) • Correct fish passage problems: screens, fish ladders, jump pool construction, culvert	• Identification rainbow trout stocks and their status • Valid estimates of rainbow trout losses due to hydropower development. • Development and implementation of a mitigation plan. • Improved rainbow trout

		recreational fisheries based on sustainable harvest levels for kokanee salmon in Libby Reservoir, kokanee entrained through Libby Dam into the Kootenai River, and burbot in the Kootenai River.	replacement, baffles for velocity reduction and resting areas. • Dam operation modifications: implement Integrated Rule Curves, flow ramping rates, seasonal flow restrictions, minimum and maximum flow limits. • Harvest management: regulations and enforcement, education, and voluntary angler practices • Hatchery propagation: imprint planting, species reintroductions, and population enhancement (including exploration of the feasibility of instream egg incubation or conservation aquaculture to enhance kokanee in Idaho) • Research and monitoring: pre- and post-treatment sampling, cost effectiveness evaluations. (including annual trends in kokanee year class and growth, nutrification alteration effects, burbot tagging and recovery to identify habitats and movements) • Assess the feasibility of various technologies to control entrainment at Libby Dam. • Identify historic, and current stocks, population levels, habitat conditions, geographic range of rainbow trout and burbot as targets for protection	production, growth and survival • Protection, restoration, and reconnection of spawning and rearing habitat (miles by gradient and stream order). • Implement balanced dam operations • Production of thorough biological status report of aquatic biota and recommenda tion for nutrient/ productivity manipulation

			and/or restoration. • Evaluate Water quality in the Kootenai River for heavy metal and phenol pollutants • Develop a predictive model to estimate trophic responses to a range of hypothetical management options for the Kootenai River aquatic ecosystem.	
Lower Snake Subregion	Redband Native species	• Ensure that native population levels are above minimum viable population sizes which maintain adaptability and genetic diversity maximize probability of survival, and do not constrain consumptive and nonconsumptive uses of other species to protect sensitive populations. • Restore populations to near historic levels with sustainable harvest opportunities.	• Obtain stock assessment information of native fish populations incidental to work focused on other problems. • Restore anadromous fish habitat and abundance to near historic levels to provide nutrients, food resources, and habitat conditions suitable for sensitive resident species.	• Detailed habitat protection and restoration plans for <u>native</u> species in mainstem areas.
Subbasin Tributaries	Redband Native species	• Maintain and restore population productivity reduced by hydropower development and operations to healthy levels which provide opportunities for	• Identify and estimate the status of unique populations and groups of native fish species in subbasin tributaries. • Identify limiting factors (i.e., critical habitat per life stage, genetic introgression, etc.) affecting management objectives (i.e.,	• Distribution, abundance, size composition, genetic characteristic s, and habitat associations of native species in

		consumptive and nonconsumptive uses of native populations or other species whose use is constrained to protect sensitive populations in subbasin tributaries • Ensure population levels of native fish in subbasin tributaries are above minimum viable population sizes which maintain adaptability and genetic diversity, and maximize probability of survival	biological objectives) for native fish populations in subbasin tributaries • Implement selected measures based on distribution, status, and limiting factor assessments to improve habitat conditions, restore connectivity between isolated subpopulations, and meet biological objectives for native fish populations in subbasin tributaries • Improve and maintain stream flows in the subbasin to more resemble the natural hydrograph (including timing, volume, duration, temperature etc.) to benefit native resident fish. • Implement an irrigation diversions screening program with monitoring and evaluation, and screen maintenance provisions. • Provide enforcement emphasis to protect weak stocks from illegal harvest and harassment • Purchase land and water for the purpose of protecting and restoring native fish species. • Restore anadromous fish habitat and abundance to near historic levels to provide nutrients, food resources, and habitat conditions suitable to support sensitive resident species. • Monitor the status of native fish populations in	subbasin tributaries.

			subbasin tributaries to evaluate the effectiveness of restoration efforts and to determine when protection and restoration goals have been achieved.	
Subbasin Tributaries	Rainbow trout Hatchery	• Protect and enhance native wild stocks of anadromous and resident species as a higher priority than hatchery or introduced gamefish species in subbasin tributaries • Reduce or eliminate detrimental effects of existing hatchery or introduced gamefish species on native species where feasible in subbasin tributaries • Provide only those opportunities for consumptive and nonconsumptive uses of hatchery or introduced gamefish populations which do not produce substantial negative effects on native species in subbasin tributaries.	• Obtain stock assessment information appropriate to optimizing management of hatchery-reared and introduced species. • Implement stock specific measures including setting population escapement goals (e.g., redd densities, individual spawner densities) to ensure stocks are maintained and/or restored to healthy levels consistent with available habitat. • Develop ponds to maintain additional intensive and isolated fisher	• Angler effort, angler catch rate, and size-specific harvest of hatchery-reared and introduced gamefish. • Genetic assessment to monitor the status of westslope cuthroat trout populations relative to stocking programs based on localized broodstock.

Dworshak Reservoir and Tributraries	Rainbow trout Hatchery	• Increase opportunities for sustainable trout fisheries that are compatible with the continued persistence of native resident species and their restoration to near historic abundances (includes intensive fisheries within closed or isolated systems). • Develop additional hatchery trout fisheries to substitute, in part, for anadromous fisheries until anadromous fisheries impacted by federally licensed and federally operated hydroelectric facilities, are restored to near historic levels.	• Actively revegetate Dworshak Reservoir shoreline areas food production and rearing habitat for trout and smallmouth bass • Develop/Manage/Maintain in 14 fish ponds averaging 6 acres with production of 125-130 pounds per acre.	• Kokanee abundance/ density, catch/harvest rates, fishery yield, return to creel percentage, genetic profiles, population structure indeces, surface area of littoral vegetation. •
Upper Snake Subregion Mainstem / Hells Canyon Reservoirs	Redband Native species	• Protect native fish and their habitats in perpetuity. • Restore and maintain the health and diversity of native resident fish populations and their habitats. • Mitigate and	• Identify and estimate the status of populations and groups of populations of native fish species with unique genetic characteristics. • Identify factors limiting each population, critical habitats or conditions which limit life stages, and population sizes corresponding to management objectives	• Detailed habitat protection and restoration plans for native species in mainstem reservoirs. • Implementation of BRC's and IRC's

		compensate for resident and anadromous fish losses caused by the construction and operation of federally operated and federally regulated hydropower projects • Protect and maintain the health and diversity of watersheds. • Pursue opportunities for resident fisheries (consumptive and nonconsumptive) compatible with or isloated from native species protection and recovery programs.	(i.e. biological objectives) for native fish populations. • Select and implement measures based on distribution, status, and limiting factor assessments to improve habitat conditions, restore connectivity between isolated subpopulations, and meet biological objectives for native fish populations • Identify historic native fish population levels, habitat conditions, and geographic ranges as targets for restoration. • Monitor and evaluate results of efforts to restore fish populations, habitats and fisheries. • Continue to quantify and refine targets for protection, restoration, and fisheries. • Restore anadromous fisheries to near historic levels to provide nutrients and food resources to support sensitive resident species near historic levels • Develop and implement BRC's and IRC's • Improve streamflows to more resemble the natural hydrograph (including timing, volume, duration, temperature etc.) to benefit resident fish • Purchase land and water for the purpose of protecting and restoring native fish species . This inclueds all the	• Implementation of restoration plans • Identification of native stocks and their status. • Valid estimates of native fish losses due to hydropower development . • Improved flow regimes in the subbasin that benefit native resident fish.

			required analyses and permits • Implement an irrigation diversion screening program with monitoring, evaluation, and screen maintenance provisions. • Provide educational information to the public to promote conservation of native species. • Provide enforcement emphasis to protect stocks from illegal harvest and harassment. • Develop and implement subregional/subbasin mitigation plans based on loss assessments • Form a Watershed Councils when and where needed	
Upper Snake Subregion Mainstem / Hells Canyon Reservoirs	Hatchery -reared trout	• Protect and enhance native wild stocks of anadromous and resident species as a higher priority than hatchery-reared trout in mainstem reservoirs. • Enhance existing trout fisheries and pursue development of others that are compatible with the preservation and enhancement of native resident and anadromous species to substitute for lost anadromous fisheries. • Mitigate and	• Monitor and regulate fisheries and stocking programs to optimize benefits to anglers (e.g. catch rates, return to creel, etc.) and to ensure no negative impacts to native species. • Develop and maintain consumptive, noncomsumptive, and trophy fisheries in closed or isolated waters.	• Angler effort, angler catch rate, and catch rate of hatchery-reared trout.

		compensate for resident and anadromous fish losses caused by the construction and operation of federally operated and federally regulated hydropower projects.		
Subbasin Tributaries (downstream from Shoshone Falls)	Redband trout Native species	• Protect native fish and their habitats in perpetuity • Restore and maintain the health and diversity of native resident fish populations and their habitats • Mitigate and compensate for resident and anadromous fish losses caused by the construction and operation of federally operated and federally regulated hydropower projects • Protect and maintain the health and diversity of watersheds • Pursue opportunities for resident fisheries (consumptive and nonconsumptive) compatible with or isloated from native species	• Identify and estimate the status of populations and groups of populations of native fish species with unique genetic characteristics • Identify factors limiting each population, critical habitats or conditions which limit life stages, and population sizes corresponding to management objectives (i.e. biological objectives) for native fish populations • Select and implement measures based on distribution, status, and limiting factor assessments to improve habitat conditions, restore connectivity between isolated subpopulations, and meet biological objectives for native fish populations • Identify historic native fish population levels, habitat conditions, and geographic ranges as targets for restoration • Monitor and evaluate results of efforts to restore fish populations, habitats and fisheries. • Continue to quantify and	• Detailed habitat protection and restoration plans for native species • Implementation of BRC's and IRC's • Implementation of restoration plans • Identification of native stocks and their status (Distribution, abundance, size composition, genetic characteristics, and habitat associations, etc) • Valid estimates of native fish losses due to hydropower development • Improved flow regimes in the

		protection and recovery programs	refine targets for protection, restoration, and fisheries. • Restore anadromous fisheries to near historic levels to provide nutrients and food resources to support sensitive resident species near historic levels. • Develop and implement BRC's and IRC's. • Improve streamflows to more resemble the natural hydrograph (including timing, volume, duration, temperature etc.) to benefit resident fish. • Purchase land and water for the purpose of protecting and restoring native fish species . This includes all the required analyses and permits • Implement an irrigation diversion screening program with monitoring, evaluation, and screen maintenance provisions. • Provide educational information to the public to promote conservation of native species. • Provide enforcement emphasis to protect stocks from illegal harvest and harassment • Develop and implement subregional/subbasin mitigation plans based on loss assessments • Form a Watershed Councils when and where needed	subbasin that benefit native resident fish. • Recovery of weak stocks.
Subbasin Tributaries	Rainbow trout	• Protect and	• Monitor and regulate	• Angler effort,

(downstream from Shoshone Falls)	Hatchery-reared	enhance native wild stocks of anadromous and resident species as a higher priority than hatchery-reared or introduced gamefish species. • Enhance trout fisheries that are compatible with the preservation and enhancement of native resident and anadromous species to substitute, in part, for anadromous fisheries until anadromous fisheries impacted by federally licensed and federally operated hydroelectric facilities, are restored to near historic levels. • Mitigate and compensate for resident and anadromous fish losses caused by the construction and operation of federally operated and federally regulated hydropower projects.	fisheries and stocking programs to optimize benefits to anglers (e.g. catch rates, return to creel, etc.) and to ensure no negative impactsa to native species • Develop and maintain consumptive, noncomsumptive, and trophy fisheries in closed or isolated waters • Obtain stock assessment information appropriate to optimizing management of hatchery-reared and introduced species • Implement stock specific measures including setting population escapement goals (e.g., redd densities, individual spawner densities) to ensure stocks are maintained and/or restored to healthy levels consistent with available habitat.	angler catch rate, and size-specific harvest of hatchery-reared and introduced gamefish.
Brownlee Pool to Shoshone	Redband trout Native	• Protect native fish and their habitats in	• Identify and estimate the status of populations and groups of	• Detailed habitat protection

Falls (mainstem and reservoirs)	species	perpetuity. • Restore and maintain the health and diversity of native resident fish populations and their habitats • Mitigate and compensate for resident and anadromous fish losses caused by the construction and operation of federally operated and federally regulated hydropower projects. • Protect and maintain the health and diversity of watersheds.	populations of native fish species with unique genetic characteristics • Identify factors limiting each population, critical habitats or conditions which limit life stages, and population sizes corresponding to management objectives (i.e. biological objectives) for native fish populations • Select and implement measures based on distribution, status, and limiting factor assessments to improve habitat conditions, restore connectivity between isolated subpopulations, and meet biological objectives for native fish populations. • Identify historic native fish population levels, habitat conditions, and geographic ranges as targets for restoration • Monitor and evaluate results of efforts to restore fish populations, habitats and fisheries • Continue to quantify and refine targets for protection, restoration, and fisheries. • Restore anadromous fisheries to near historic levels to provide nutrients and food resources to support sensitive resident species near historic levels. • Develop and implement BRC's and IRC's • Improve streamflows to more resemble the	and restoration plans for native species • Implementation of BRC's and IRC's. • Implementation of restoration plans • Identification of native stocks and their status (Distribution, abundance, size composition, genetic characteristics, and habitat associations, etc). • Valid estimates of native fish losses due to hydropower development • Improved flow regimes in the subbasin that benefit native resident fish • Recovery of weak stocks.

			natural hydrograph (including timing, volume, duration, temperature etc.) to benefit resident fish. • Purchase land and water for the purpose of protecting and restoring native fish species . This includes all the required analyses and permits. • Implement an irrigation diversion screening program with monitoring, evaluation, and screen maintenance provisions • Provide educational information to the public to promote conservation of native species • Provide enforcement emphasis to protect stocks from illegal harvest and harassment • Develop and implement subregional/subbasin mitigation plans based on loss assessments • Form Watershed Councils when and where needed	
Brownlee Pool to Shoshone Falls (mainstem and reservoirs)	Hatchery-reared and introduced trout	• Mitigate and compensate for resident and anadromous fish losses caused by the construction and operation of federally regulated and federally operated hydropower projects. • Manage non-native resident fish stocks to ensure the health and	• Pursue opportunities for resident fisheries (consumptive, nonconsumptive, and trophy) compatible with or isolated from native species recovery and protection programs • Monitor and regulate fisheries and stocking programs to optimize benefits to anglers (e.g. catch rates, return to creel, etc.) and to ensure no negative impactsa to native species.	• Angler effort, angler catch rate, and catch rate of hatchery-reared trout

		diversity of native resident fish stocks, anadromous fish stocks, and wildlife stocks, and their habitats, then maximize consumptive and nonconsumptive use of non-native stocks when appropriate.		
Shoshone Falls to headwaters	Hatchery -reared and introduc ed trout	• Mitigate and compensate for resident and anadromous fish losses caused by the construction and operation of federally regulated and federally operated hydropower projects • Manage non-native resident fish stocks to ensure the health and diversity of native resident fish stocks, anadromous fish stocks, and wildlife stocks, and their habitats, then maximize consumptive and nonconsumptive use of non-native stocks when appropriate.	• Pursue opportunities for resident fisheries (consumptive, nonconsumptive, and trophy) compatible with or isolated from native species recovery and protection programs • Monitor and regulate fisheries and stocking programs to optimize benefits to anglers (e.g. catch rates, return to creel, etc.) and to ensure no negative impacts to native species.	• Angler effort, angler catch rate, and catch rate of hatchery-reared trout.
Owyhee Bruneau River Drainage	Redband trout Native species	• Manage stream and reservoir fisheries to preserve the	• Stock other strains and species of fish where they will not pose a threat to preserving	N/A

		genetic integrity of native desert redband trout and other native species • Work cooperatively with state and federal land management agencies and grazing permittees to improve riparian and aquatic habitats • Increase reservoir fishing opportunities • Maintain and improve bull and redband trout populations in the Owyhee River drainage.	native species • Restock streams with depleted populations where habitat conditions have been restored with redband trout by collecting fish or eggs from adjacent areas that contain native redband trout. • Develop a broodstock reservoir foir redband trout to annually produce fingerlings that could be used to stock reservoirs and streams in this area • Determine distribution and density of redband populations within the basin • Determine habitat condition of streams containing redband trout • Establish riparian vegetation objectives in management plan capable of protecting streambanks and riparian areas during high water. • Monitor station on major tributaries of the Owyhee River capable of protecting streambanks, riparian conditions, aquatic habitat, and fish production • Seek opportunities to construct new fishing reservoirs in cooperation with federal, state, and private landowners • Restock reservoirs with appropriate stocks of fish when drought conditions cause fish kills or dewatering. • Renovate existing	

			reservoirs that historically were stocked. • Establish/maintain catch-and-release regulation and encourage adoption of similar protective regulations by the Nevada Division of Wildlife. • Support effort by state and federal agencies to remove manmade migration barriers • Renovate reservoirs with undesirable fish populations when they limit the fishery	

Appendix 4.5. Monitoring Strategy for the Duck Valley Indian Reservation (Draft Report) by Tracy Hillman, BioAnalysts, Inc. May 1, 2004 – under Subcontract to Steven Vigg & Company for the Shoshone-Paiute Tribes.

MONITORING STRATEGY FOR THE DUCK VALLEY INDIAN RESERVATION

Draft Report

May 1, 2004

BioAnalysts, Inc.

Prepared by:
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Prepared for:
The Shoshone-Paiute Tribes
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Owyhee, Nevada

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introduction

The Shoshone-Paiute Tribes on the Duck Valley Indian Reservation (DVIR) have been actively involved in protecting and enhancing streams on the Reservation. Their goals include protecting and enhancing natural springs and headwater streams, removing stresses that degrade channel conditions (e.g., livestock grazing), monitoring water quality and quantity, and developing a database that includes information on habitat conditions, water quality, and fish composition, health, abundance, and genetic makeup. To this end, the Tribes have installed riparian exclosures and off-site water developments, planted riparian vegetation, repaired and improved road crossings, modified roads so they have little to no effect on streams, and identified a number of alternatives for restoring stream and riparian habitat along the Owyhee River. They have already implemented many of these actions; others will be implemented in the near future.

Although the Tribes understand the importance of protecting and enhancing aquatic resources on their lands, they also understand the value of monitoring their actions. There are several reasons for monitoring. First, monitoring informs the Tribes on the current status of their resources and how those resources change over time. Second, it allows the Tribes to assess the beneficial (or detrimental) effects of their management actions (strategies). That is, monitoring by the Tribes will assess cause-and-effect relationships. This information will allow the Tribes to determine cost/benefits of specific actions or strategies. Finally, monitoring will help inform the Tribes on factors that are important in limiting certain resources (e.g., redband trout) on the Reservation.

The Tribes recognize the value of having an integrated status/trend and effectiveness monitoring program. This plan outlines a program that will allow the Tribes to assess current conditions, changes in conditions over time, and the effects of management actions on conditions on the Reservation. Thus, this plan has three major parts. The first part (Section 4) describes landscape classification, which is needed to describe the ecological and geological setting on the Reservation. This section also identifies methods for describing channel and valley characteristics. The second part (Section 5) details the status/trend component of the monitoring plan, while the last major part (Section 6) describes effectiveness monitoring. Together, these three major parts make up the framework for monitoring on the DVIR. For completeness, this plan includes additional sections that deal with essential elements of a monitoring program (Section 3) and a description of measuring protocols (Section 7).

It is important to note that this document does not include a detailed Quality Assurance/Quality Control (QA/QC) Plan. Although the monitoring plan includes a description of sampling and experimental designs, indicators, and a general description of sampling protocols, it does not address in detail an evaluation of data, quality control,[1] or qualifications and training of personnel. These are important components of a valid monitoring program that will be developed after the monitoring plan is finalized.

[1] Quality control refers to specific actions required to provide information for the quality assurance program. Included are standardizations, calibration, replicates, and control and check samples suitable for statistical estimates of confidence of the data.

PROJECT AREA

This monitoring plan will be implemented within the Duck Valley Indian Reservation, which straddles Idaho and Nevada and encompasses an area of roughly 289,820 acres (117,290 ha) (Figure 1). The Reservation includes over 350 miles (563 km) of streams that drain into the Owyhee and Bruneau rivers. This area also contains three man-made lakes, three large wetlands areas, and over 200 natural springs. The Reservation forms part of the larger Snake River Basin/High Desert Ecoregion (Omernik 1987), although the southeastern corner of the Reservation falls within the Northern Basin and Range Ecoregion. The Reservation is entirely within the Intermountain Semi-Desert Province (Bailey 1994). Depending on location, average annual precipitation on the Reservation ranges from 10-30 inches (25-76 cm) and total solar radiation from 350-400 watts/m^2. Mean annual air temperatures on the Reservation range from 40-45˚F (4-7˚C). Geologies on the Reservation are complex and include alluvial, granitic, sedimentary, and volcanic districts. Geomorphic classes include both plateau and fluvial lands.

Streams on the Reservation are upstream from the Hells Canyon Complex, which has blocked anadromous fish migration into the Owyhee and Bruneau basins for over 40 years. Before hydropower development, the Owyhee and Bruneau basins supported diverse communities of anadromous and resident fish populations. Today these basins support native resident species, such as redband and bull trout, and hatchery-produced species like rainbow trout, cutthroat trout, brown trout, brook trout, catfish, crappie and other exotics. Genetically pure populations of redband trout still exist on the Reservation and are the focus of Tribal fisheries management goals. Bull trout may exist on the Reservation in the headwaters of the Jarbidge River.

The overall goal of the Tribes is to “protect, mitigate, and enhance fish and wildlife” by implementing management actions that protect and enhance natural resources on the Reservation. They intend to protect and restore all natural springs and native fish spawning areas on their lands. There are over 200 springs with few being protected from the effects of livestock use. These streams provide cold, clean water to the Owyhee River. The Tribes began protecting these springs in 1998. In addition, unimproved back-county roads increase fine sediment loads to streams supporting genetically-pure populations of redband trout. The Tribes have been working to improve these roads and have replaced or improved stream crossings. By implementing these actions, the Tribes will be able to provide high-quality water to downstream locations in the Owyhee, Bruneau, and Snake rivers.

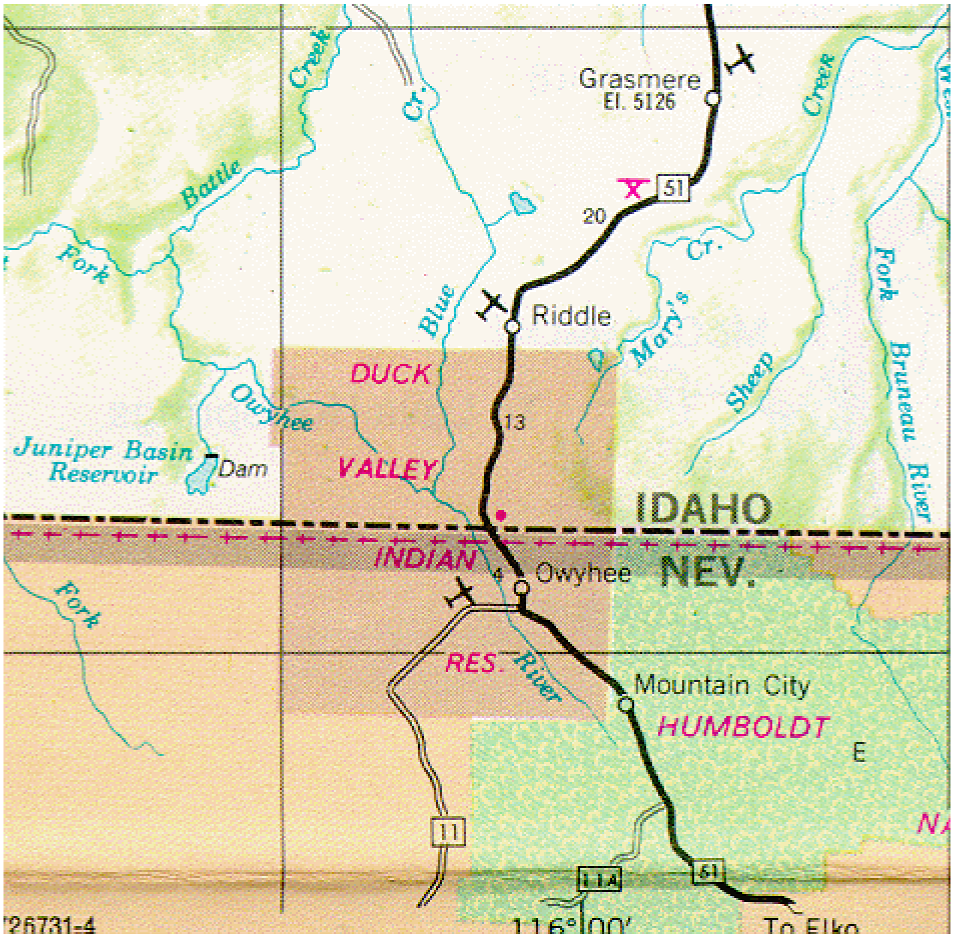

Figure 1. Location of the Duck Valley Indian Reservation along the Idaho/Nevada border.

Essential Elements of monitoring

Monitoring is a critical component of any management plan. Recently, several different entities have outlined appropriate strategies for monitoring aquatic resources. For example, the Independent Scientific Advisory Board (ISAB) of the Northwest Power and Conservation Council outlined a monitoring and evaluation plan for assessing recovery of tributary habitat (ISAB 2003). They describe a three-tiered monitoring program that includes trend or routine monitoring (Tier 1), statistical (status) monitoring (Tier 2), and experimental research (effectiveness) monitoring (Tier 3). Trend monitoring obtains repeated measurements, usually representing a single spatial unit over a period of time, with a view to quantifying changes over time. Changes must be distinguished from background noise. This type of monitoring does not establish cause-and-effect relationships and does not provide inductive inferences to larger areas or time periods. Statistical monitoring, on the other hand, provides statistical inferences that extend to larger areas and longer time periods than the sample. This type of monitoring requires probabilistic selection of study sites and repeated visits over time. Experimental research monitoring is often required to establish cause-and-effect relationships between management actions and population/habitat response. This requires the use of experimental designs incorporating "treatments" and "controls" assigned randomly to study sites.

According to the ISAB (2003), the value of monitoring is greatly enhanced if the different types of monitoring are integrated. For example, trend and statistical monitoring will help define the issues that should be addressed with more intensive, experimental research monitoring. The latter will identify which habitat attributes are most informative and will provide conclusive information about the efficacy of various restoration approaches. Implementing experimental research in the absence of trend and statistical monitoring would increase uncertainty about the generalization of results beyond the sampling locations. The ISAB (2003) identified the following essential elements of a valid monitoring program.

- Develop a trend monitoring program based on remotely-sensed data obtained from sources such as aerial photography or satellite imagery or both.

- Develop and implement a long-term statistical monitoring program to evaluate the status of fish populations and habitat. This requires probabilistic (statistical) site selection procedures and establishment of common (standard) protocols and data collection methods.

- Implement experimental research monitoring at selected locations to establish the underlying causes for the changes in habitat and population indicators.

Another strategy developed by the Bonneville Power Administration, the U.S. Army Corps of Engineers, the Bureau of Reclamation (collectively referred to as the Action Agencies), and NOAA Fisheries responds to the Federal Columbia River Power System (FCRPS) Biological Opinion issued by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Although the Action Agencies/NOAA Fisheries Draft Research, Monitoring, and Evaluation

(RME) Program was developed before the release of the ISAB (2003) report, it is in many respects consistent with ISAB recommendations. For example, the draft RME Program calls for the classification of all watersheds that have listed fish populations and receive restoration actions. Classification is hierarchical and captures physical/environmental differences spanning from the largest scale (regional setting) down to the channel segment. This component of the draft RME Program comports with Tier 1 Trend Monitoring in the ISAB (2003) plan. Status Monitoring (similar to Tier 2 Statistical Monitoring) and Action Effectiveness Research (similar to Tier 3 Experimental Research) are also included in the RME Program. The ISAB recently provided a favorable review of the RME Program.

About the time the Action Agencies/NOAA Fisheries released their draft program, the Washington Salmon Recovery Funding Board (SRFB) released a draft monitoring and evaluation strategy for habitat restoration and acquisition projects. The document identified implementation, effectiveness, and validation monitoring as key components of their program. The monitoring program is scaled to capture factors operating at different hierarchical levels. At the lowest level (Level 0), the program determines if the action was implemented (implementation monitoring). Level 1 monitoring determines if projects meet the specified engineering and design criteria. Level 2 and 3 monitoring assess the effectiveness of projects on habitat and fish abundance, respectively. Levels 1-3 constitute effectiveness monitoring. Finally, level 4 (validation) monitoring addresses how management and habitat restoration actions, and their cumulative effects, affect fish production within a watershed. This type of monitoring is the most complex and technically rigorous.

Although the three programs (ISAB, Action Agencies/NOAA Fisheries, and SRFB) describe monitoring in slightly different terms, they all address the same goal. That is, all three intend to assess the effectiveness of restoration projects and management actions on tributary habitat and fish populations. Consequently, the overall approaches among the three programs are similar, with the Action Agencies/NOAA Fisheries RME Program being the most intensive and extensive, in part because of the requirements of the FCRPS Biological Opinion. Indeed, the Action Agencies/NOAA Fisheries Program calls for monitoring all tributary actions with intensive, standardized protocols and data collection methods. For each tributary action, a list of specific indicators, ranging from water quality to watershed condition, are to be measured.

The monitoring strategy described in this document closely follows these regional programs. In fact, this plan relies heavily on the Upper Columbia Basin Monitoring Strategy (Hillman 2004), which integrates all the essential elements of the regional programs. A common theme found among all strategies is that an efficient monitoring program must include a valid statistical design, probabilistic sampling design, standardized data collection protocols, consistent data reporting methods, and selection of sensitive indicators (Currens et al. 2000; Bayley 2002).[2] What follows is a brief description of these elements (from Hillman 2004). The focus of this

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[2] An efficient monitoring plan reduces "error" to the maximum extent possible. One can think of error as unexplained variability, which can reduce monitoring efficiency through the use of invalid statistical designs, biased sampling designs, poorly selected indicators, biased measurement protocols, and non-standardized reporting methods.

section is on statistical design and sampling design. The other elements are described in other sections.

Statistical Design

“Statistical design” is the logical structure of a monitoring study. It does not necessarily mean that all studies require rigorous statistical analysis. Rather, it implies that all studies, regardless of the objectives, must be designed with a logical structure that reduces bias and the likelihood that rival hypotheses are correct.[3]

The validity of a monitoring design is influenced by the degree to which the investigator can exercise experimental control; that is, the extent to which rival variables or hypotheses can be controlled or dismissed. Experimental control is associated with randomization, manipulation of independent variables, sensitivity of dependent (indicator) variables to management activities (treatments), and sensitivity of instruments or observations to measure changes in indicator variables. There are two criteria for evaluating the validity of any effectiveness monitoring design: (1) does the study infer a cause-and-effect relationship (*internal validity*) and (2) to what extent can the results of the study be generalized to other populations or settings (*external validity*)? Ideally, when assessing cause-and-effect, the investigator should select a design strong in both internal and external validity. With some thought, one can see that it becomes difficult to design a study with both high internal and external validity.[4] Because the intent of effectiveness monitoring is to demonstrate a treatment effect, the study should err on the side of internal validity. Without internal validity the data are difficult to interpret because of the confounding effects of uncontrolled variables. Listed below are some common threats to validity.

- Sampling units that change naturally over time, but independently of the treatment, can reduce validity. For example, fine sediments within spawning gravels may decrease naturally over time independent of the treatment. Alternatively, changes in land-use activities upstream from the study area and unknown to the investigator may cause levels of fine sediments to change independent of the treatment.
- The use of unreliable or inconsistent sampling methods or measuring instruments can reduce validity. That is, an apparent change in an indicator variable may actually be nothing more than using an instrument that was not properly calibrated. Changes in indicator variables may also occur if the measuring instrument changes or disturbs the sampling site (e.g., core sampling).
- Measuring instruments that change the sampling unit before the treatment is applied can reduce validity. That is, if the collection of baseline data alters the site in such a way that the measured treatment effect is not what it would be in the population, the results of the study cannot be generalized to the population.

[3] Rival hypotheses are alternative explanations for the outcome of an experimental study. In effect, rival hypotheses state that observed changes are due to something other than the management action under investigation.
[4] Studies with high internal validity (laboratory studies) tend to have low external validity. In the same way, studies with high external validity (field studies) tend to have lower internal validity.

- Differential selection of sampling units can reduce validity, especially if treatment and control sites are substantially different before the study begins. This initial difference may at least partially explain differences after treatment.
- Biased selection of treatment sites can reduce validity. The error here is that the investigator selects sites to be treated in such a way that the treatment effects are likely to be higher or lower than for other units in the population. This issue is complicated by the fact that treatment areas are often selected precisely because they are thought to be problematic.
- Loss of sampling units during the study can reduce validity. This is most likely to occur when the investigator drops sites that shared characteristics such that their absence has a significant effect on the results.
- Multiple treatment effects can reduce validity. This occurs when sampling units get more than one treatment, or the effects of an earlier treatment are present when a later treatment is applied. Multiple treatment effects make it very difficult to identify the treatment primarily responsible for causing a response in the indicator variables.
- The threats above could interact or work in concert to reduce validity.

In most cases, there are simple design elements or requirements that reduce threats to internal and external validity. In general, the more complex the study, the more complex the requirements, but the minimum requirements include *randomization*, *replication*, *independence*, and *controls*.

Randomization—Randomization should be used whenever there is an arbitrary choice to be made of which units will be measured in the sampling frame, or of the units to which treatments will be assigned. The intent is that randomization will remove or reduce systematic errors (bias) of which the investigator has no knowledge. If randomization is not used, then there is the possibility of some unseen bias in selection or allocation. In some situations, complete randomization (both random selection of sampling units and random assignment of treatments) is not possible. Indeed, there will be instances where the investigator cannot randomly assign management activities to survey areas (e.g., removal of mine contaminants from a stream). In this case replication in time and space is needed to generalize inferences of cause-effect relationships.[5] Here, confidence in the inference comes from replication outside the given study area. The rule of thumb is simple: randomize whenever possible.

Replication—Replication is needed to estimate "experimental error," which is the basic unit of measurement for assessing statistical significance or for determining confidence limits. Replication is the means by which natural variability is accounted for in interpreting results. The only way to assess variability is to have more than one replicate for each treatment, including the controls. In the absence of replication, there is no way, without appealing to non-statistical arguments, to assess the importance of observed

[5] This does not mean that one cannot infer a cause-effect relationship in the study area. The point here is that without random assignment of management activities, it is questionable if results can be generalized to other sites outside the study area.

differences among experimental units. Depending on the objectives of the study, spatial and/or temporal replication may be necessary.

Independence—It is important that the investigator select replicates that are spatially and temporally independent. A lack of independence can confound the study and lead to "pseudoreplication" (Hurlbert 1984). The basic statistical problem of pseudoreplication is that replicates are not independent, and the first assumption of statistical inference is violated. The simplest and most common type of pseudoreplication occurs when the investigator only selects one replicate per treatment. It can be argued that case studies, where a single stream or watershed has been monitored for several years, suffer from pseudoreplication. Therefore, one might conclude that no inference is possible. However, the motive behind a single-replicate case study is different from that behind statistical inference. The primary purpose of a case study is to reveal information about biological or physical processes in the system. This information can then be used to formulate and test hypotheses using real statistical replicates. Indeed, case studies provide the background information necessary to identify appropriate management actions and to monitor their effectiveness.

Investigators need to be aware of spatial pseudoreplication and how to prevent it or deal with it. Spatial pseudoreplication can occur when sampling units are spaced close together. Sampling units close together are likely to be more similar than those spaced farther apart.[6] Spatially dependent sites are "subsamples" rather than replicates and should not be treated as independent replicates. Confounding also occurs when control sites are not independent of treatment sites. This is most likely to occur when control sites are placed downstream from treatments sites (although the reverse can also occur; see Underwood 1994). Understandably, there can be no detection of a management action if the treatment affects both the test and control sites similarly.

Similar, although less often recognized problems occur with temporal replication. In many monitoring studies it is common for sampling to be done once at each of several years or seasons. Any differences among samples may then be attributed to differences among years or seasons. This could be an incorrect inference because a single sample collected each year or season does not account for within year or season variability. Take for example the monitoring of fine sediments in spawning gravels in, say, Sheep Creek. An investigator measures fine sediments at five random locations (spatial replication) during six consecutive years during the second week of July. A simple statistical analysis of the data could indicate that mean percentages of fine sediments decreased significantly during the latter three years. The investigator may then conclude that fines differed among years.

[6] A common concern of selecting sampling units randomly is that there is a chance that some sampling units will be placed next to each other and therefore will lack independence. Although this is true, if the investigator has designed the study so that it accounts for the obvious sources of variation, then randomization is always worthwhile as a safeguard against the effects of unknown factors.

The conclusion may be incorrect because the study lacked adequate temporal replication. Had the investigator taken samples several times during each year (thereby accounting for within year variability), the investigator may have found no difference among years. A possible reason for the low values during the last three years is because the investigator collected samples before the stream had reached baseflow (i.e., there was a delay in the time that the stream reached baseflow during the last three years compared to the first three years). The higher flows during the second week of July in the last three years prevented the deposition of fines in spawning gravels. An alternative to collecting several samples within years or seasons is to collect the annual sample during a period when possible confounding factors are the same among years. In this case, the investigator could have collected the sample each year during baseflow. The results, however, would apply only to baseflow conditions.

The use of some instruments to monitor physical/environmental indicators may actually lead to pseudoreplication in monitoring designs. This can occur when a "destructive" sampling method is used to sample the same site repeatedly. To demonstrate this point one can look at fine-sediment samples collected repeatedly within the same year. In this example, the investigator designs a study to sample five, randomly-selected locations once every month from June through November (high flows or icing preclude sampling during other months). The investigator randomly selects the week in June to begin sampling, and then samples every fourth week thereafter (systematic sampling). To avoid systematic bias, the same well-trained worker using the same equipment (McNeil core sampler) collects all samples. After compiling and analyzing the data, the investigator may find that there is no significant difference in percent fines among replicates within the year. This conclusion is tenuous because the sampling method (core sampler) disturbed the five sampling locations, possibly reducing fines that would have been measured in following surveys. A more appropriate method would have been to randomly select five new sites (without replacement) during each survey period.

Although replication is an important component of monitoring and should be included whenever possible, it is also important to understand that using a single observation per treatment, or replicates that are not independent, is not necessarily wrong. Indeed, it may be unavoidable in some field studies. What is wrong is to ignore this in the analysis of the data. There are several analyses that can be used to analyze data that are spatially or temporally dependent (see Manly 2001). Because it is often difficult to distinguish between true statistical replicates and subsamples, even with clearly defined objectives, investigators should consult with a professional statistician during the development of monitoring studies.

Controls—Controls are a necessary component of effectiveness research because they provide observations under normal conditions without the effects of the management action or treatment. Thus, controls provide the standard by which the results are compared.[7] The exact nature of the controls will depend on the hypothesis being tested.

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[7] Lee (1993, pg 205) offers a quote from Tufte that adequately describes the importance of controls in study designs. Lee writes, "One day when I was a junior medical student, a very important Boston surgeon visited the school and delivered a great treatise on a large number of patients who had undergone successful operations for vascular

For example, if an investigator wishes to implement a rest-rotation grazing strategy along a stream with heavy grazing impacts, the investigator would monitor the appropriate physical/environmental indicators in both treatment (modified grazing strategy) and control (unmodified intensive grazing) sites. Because stream systems are quite variable, the study should use “contemporaneous controls.” That is, both control and treatment sites should be measured at the same time.

Temporal controls can be used to increase the “power” of the statistical design. In this case the treatment sites would be measured before and after the treatment is applied. Thus, the treatment sites serve as their own controls. However, unless there are also contemporaneous controls, all before-after comparisons must assume homogeneity over time, a dubious assumption that is invalid in most ecological studies (Green 1979). Examples where this assumption *is* valid include activities that improve fish passage at irrigation diversions or screen intake structures. These activities do not require contemporaneous controls. However, a temporal control is needed to describe the initial conditions. Therefore, a before-after comparison is appropriate. The important point is that if a control is not present, it is impossible to conclude anything definite about the effectiveness of the treatment.

It should be clear that the minimum requirements of valid monitoring include randomization, replication, independence, and controls. In some instances monitoring studies may lack one or more of these ingredients. Such studies are sometimes called “quasi-experiments.” Although these studies are often used in environmental science, they have inherent problems that need to be considered during data analysis. Investigators should consult Cook and Campbell (1979) for a detailed discussion of quasi-experimental studies.

Sampling Design

Once the investigator has selected a valid statistical design, the next step is to select “sampling” sites. *Sampling* is a process of selecting a number of units for a study in such a way that the units represent the larger group from which they were selected. The units selected comprise a *sample* and the larger group is referred to as a *population*.[8] All the possible sampling units available

reconstruction. At the end of the lecture, a young student at the back of the room timidly asked, ‘Do you have any controls?’ Well, the great surgeon drew himself up to his full height, hit the desk, and said, ‘Do you mean did I not operate on half of the patients?’ The hall grew very quiet then. The voice at the back of the room very hesitantly replied, ‘Yes, that’s what I had in mind.’ Then the visitor’s fist really came down as he thundered, ‘Of course not. That would have doomed half of them to their death.’ God, it was quiet then, and one could scarcely hear the small voice ask, ‘Which half?’ (Tufte 1974, p.4--attributed to Dr. E. Peacock, Jr., chairman of surgery, University of Arizona College of Medicine, in Medical World News, Sept. 1, 1974, p. 45.)”

[8] This definition makes it clear that a “*population*” is not limited to a group of organisms. In statistics, it is the total set of elements or units that are the target of our curiosity. For example, habitat parameters will be monitored at sites selected from the *population* of all possible stream sites in the watershed.

within the area (population) constitute the *sampling frame*.[9] The purpose of sampling is to gain information about a population. If the sample is well selected, results based on the sample can be generalized to the population.[10] Statistical theory assists in the process of drawing conclusions about the population using information from a sample of units.

Defining the population and the sample units may not always be straightforward, because the extent of the population may be unknown, and natural sample units may not exist. For example, a researcher may exclude livestock grazing from sensitive riparian areas in a watershed where grazing impacts are widespread. In this case the management action may affect aquatic habitat conditions well downstream from the area of grazing. Thus, the extent of the area (population) that might be affected by the management action may be unclear, and it may not be obvious which sections of streams to use as sampling units.

When the population and/or sample units cannot be defined unambiguously, the investigator must subjectively choose the potentially affected area and impose some type of sampling structure. For example, sampling units could be stream habitat types (e.g., pools, riffles, or glides), fixed lengths of stream (e.g., 150-m long stream reaches), or reach lengths that vary according to stream widths (e.g., see Simonson et al. 1994). Before selecting a sampling method, the investigator must define the population, size and number of sample units, and the sampling frame.

Selection of a sample is a crucial step in monitoring fish populations and physical/environmental conditions in streams. The "goodness" of the sample determines the general applicability of the results. Because monitoring studies usually require a large amount of time and money, non-representative results are wasteful. Therefore, it is important to select a method or combination of methods that increases the degree to which the selected sample represents the population. The five most commonly used sampling designs for monitoring fish populations and physical/environmental conditions are random sampling, stratified sampling, systematic sampling, cluster sampling, and multi-stage sampling. It is important to note that some monitoring programs include a combination of sampling designs. For example, the EMAP approach is a combination of random and systematic sampling. See Scheaffer et al. (1990) for a more detailed discussion of these sampling methods.

Measurement Error

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[9] The *sampling frame* is a "list" of all the available units or elements from which the sample can be selected. The sampling frame should have the property that every unit or element in the list has some chance of being selected in the sample. A sampling frame does not have to list all units or elements in the population.

[10] The error of extrapolating from a poor sampling design is nicely summarized by Mark Twain: "In the space of one hundred and seventy six years, the Lower Mississippi has shortened itself by two hundred and forty two miles. That is an average of a trifle over one mile and a third every year. Therefore, any calm person, who is not blind or idiotic, can see that in the Old Oolitic Silurian Period, just a million years ago next November, the Lower Mississippi was upwards of one million three hundred thousand miles long, and stuck out over the Gulf of Mexico like a fishing rod. There is something fascinating about science. One get such wholesale returns of conjecture out of such a trifling investment of fact."

Because most fish population and habitat variables are difficult to measure, and the errors in these measurements are often large, it is important to find ways to reduce measurement errors. Often, investigators ignore these errors and proceed as though the estimates reflect the true state of the resource. One should resist this temptation because it could lead to missing a treatment effect, resulting in a waste of money and effort. Investigators need to be aware of the types of errors and how they can be identified and minimized. This is important because total sample size and statistical power are related to variability. By reducing measurement error and bias, one effectively reduces variability, resulting in greater statistical power.

In general, "error" indicates the difference between an estimated value (from a sample) and its "true" or "expected" value. The two common types of error are *random error* and *systematic error*. Random error (a.k.a. chance error) refers to variation in a score or result that displays no systematic *bias*[11] when taking repeated samples. In other words, random error is the difference between the estimate of a population parameter that is determined from a random sample and the true population value, absent any systematic bias. One can easily detect the presence of random errors by simply repeating the measurement process several times under similar conditions. Different results, with no apparent pattern to the variation (no bias) indicate random error. Although random errors are not predictable, their properties are understood by statistical theory (i.e., they are subject to the laws of probability and can be estimated statistically). The standard deviation of repeated measurements of the same phenomenon gauges the average size of random errors.[12]

Random errors can occur during the collection and compilation of sample data. These errors may occur because of carelessness in recording field data or because of missing data. Recording errors can occur during the process of transferring information from the equipment to field data sheets. This often results from misplacing decimal points, transposing numbers, mixing up variables, or misinterpreting hand-written records. Although not always the fault of the investigator, missing data are an important source of error.

Systematic errors or bias, on the other hand, are not subject to the laws of probability and cannot be estimated or handled statistically without an independent estimate of the bias. Systematic errors are present when estimates consistently over or underestimate the true population value. An example would be a poorly calibrated thermometer that consistently underestimates the true water temperature. These errors are often introduced as a result of poorly calibrated data-recording instruments, miscoding, misfiling of forms, or some other error-generating process. They may also be introduced via interactions among different variables (e.g., turbidity is usually highest at high flows). Systematic error can be reduced or eliminated through quality control procedures implemented at the time data are collected or through careful checking of data before analysis. For convenience, systematic errors are divided into two general classes: those that

[11] *Bias* is a measure of the divergence of an estimate (statistic) from the population parameter in a particular direction. The greater the divergence the greater the bias. Nonrandom sampling often produces such bias.

[12] It is important not to confuse standard deviation with standard error. The *standard error of a sample average* gauges the average size of the fluctuation of means from sample to sample. The *sample standard deviation* gauges the average size of the fluctuations of the values within a sample. These two quantities provide different information.

occur because of inadequate procedures and those that occur during data processing. Each is considered in turn.

Biased Procedures—A biased procedure involves problems with the selection of the sample, the estimation of population parameters, the variables being measured, or the general operation of the survey. For example, selecting sample units based on access can increase systematic error because the habitat conditions near access points may not represent the overall conditions of the population. Changing sampling times and sites during the course of a study can introduce systematic error. Systematic errors can grow imperceptibly as equipment ages or observers change their perspectives (especially true of "visual" measurements). Failure to calibrate equipment introduces error, as does demanding more accuracy than can be expected of the instrument or taking measurements outside the range of values for which the instrument was designed.

Processing Errors—Systematic errors can occur during compiling and processing data. Errors can occur during the transfer of field records to computer spreadsheets. Investigators can also introduce large systematic errors by using faulty formulas (e.g., formulas for converting variables). Processing errors are the easiest to control.

The investigator must consider all these sources of error and identify ways to minimize measurement bias. Certainly some errors are inevitable, but a substantial reduction in systematic errors will benefit a monitoring study considerably. The following guidelines will help to reduce systematic errors.

(1) Measures based on counts (e.g., Redds, LWD, Pools)

- Make sure that new personnel are trained adequately by experienced workers.
- Reduce errors by taking counts during favorable conditions and by implementing a rigorous protocol.
- If an over or underestimate is assumed, attempt to assess its extent by taking counts of populations of known size.

(2) Measures based on visual estimates (e.g., snorkel surveys, bank stability)

- Make sure that all visual estimates are conducted according to rigorous protocols by experienced observers.
- Attempt to assess observer bias by using trained personnel to check observations of new workers.

(3) Measures based on instruments (e.g., dissolved oxygen, temperature)

- Calibrate instruments before first use and periodically thereafter.
- Personnel must be trained in the use of all measuring devices.
- Experienced workers should periodically check measurements taken by new personnel.
- Use the most reliable instruments.

(4) Re-measurement of indicators

- Use modern GPS technology, photographs, permanent station markers (e.g., orange plastic survey stakes or rebar[13]), and carefully marked maps and diagrams to relocate previous sampling units.
- Guard against the transfer of errors from previous measurements.
- Make sure that bias is not propagated through the use of previous measurements as guides to subsequent ones.

(5) Handling of data

- Record data directly into electronic form where possible.
- Back-up all data frequently
- Design manual data-recording forms and electronic data-entry interfaces to minimize data-entry errors.
- Use electronic data-screening programs to search for aberrant measurements.
- Frequently double-check the transfer of data from field data forms to computer spreadsheets.

Before leaving this discussion, it is important to describe briefly how one should handle outliers. Outliers are measurements that look aberrant (i.e., they appear to lie outside the range of the rest of the values). Because they stand apart from the others, it appears as if the investigator made some gross measurement error. It is tempting to discard them not only because they appear unreasonable, but because they also draw attention to possible deficiencies in the measurement process. Before discarding an apparent outlier, the investigator should look thoroughly at how they were generated. Quite often apparent outliers result from simple errors in data recording, such as a misplaced decimal point. On the other hand, they may be part of the natural variability of the system and therefore should not be ignored or discarded.[14] If one routinely throws out aberrant values, the resulting data set will give false impressions of the structure of the system. Therefore, as a general rule, investigators should not discard outliers unless it is known for certain that measurement errors attend the estimates.

The information contained in this section provides the framework for developing the plan for monitoring resources on the DVIR. The following sections describe in detail how the Tribes intend to monitor existing conditions, changes in conditions, and effects of their tributary habitat strategies on aquatic conditions.

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[13] Metal detectors can be used to relocate rebar.
[14] Another reason that outliers should be treated carefully is because they can invalidate standard statistical inference procedures. Outliers tend to affect assumptions of variability and normality.

Landscape classification

Both status/trend and effectiveness monitoring require landscape classification. The purpose of classification is to describe the "setting" in which monitoring occurs. This is necessary because biological and physical/environmental indicators may respond differently to tributary actions depending on landscape characteristics. An hierarchical classification system that captures a range of landscape characteristics should adequately describe the setting in which monitoring occurs. The idea advanced by hierarchical theory is that ecosystem processes and functions operating at different scales form a nested, interdependent system where one level influences other levels. Thus, an understanding of one level in a system is greatly informed by those levels above and below it.

A defensible classification system should include both ultimate and proximate control factors (Naiman et al. 1992). Ultimate controls include factors such as climate, geology, and vegetation that operate over large areas, are stable over long time periods, and act to shape the overall character and attainable conditions within a watershed or basin. Proximate controls are a function of ultimate factors and refer to local conditions of geology, landform, and biotic processes that operate over smaller areas and over shorter time periods. These factors include processes such as discharge, temperature, sediment input, and channel migration. Ultimate and proximate control characteristics help define flow (water and sediment) characteristics, which in turn help shape channel characteristics within broadly predictable ranges (Rosgen 1996).

This plan includes a classification system that incorporates the entire spectrum of processes influencing stream features and recognizes the tiered/nested nature of landscape and aquatic features. This system captures physical/environmental differences spanning from the largest scale (regional setting) down to the channel segment (Table 1). By recording these descriptive characteristics, the Tribes will be able to assess differential responses of indicator variables to proposed actions within different classes of streams and watersheds. The system is similar to the Action Agencies/NOAA Fisheries RME plan and the Upper Columbia Basin Monitoring Strategy (Hillman 2004). Importantly, the classification work described here fits well with Level 1 monitoring under the ISAB (2003) monitoring and evaluation plan. Classification variables and recommend methods for measuring each variable are defined below.

Table 1. List of classification (stratification) variables, their corresponding measurement protocols, and temporal sampling frequency. The variables are nested according to spatial scale and their general characteristics. Table is from Hillman (2004).

Spatial scale	General characteristics	Classification variable	Recommended protocols	Sampling frequency (years)
Regional setting	Ecoregion	Bailey classification	Bain and Stevenson (1999)	20
		Omernik classification	Bain and Stevenson (1999)	20
	Physiography	Province	Bain and Stevenson (1999)	20
	Geology	Geologic districts	Overton et al. (1997)	20
Drainage basin	Geomorphic features	Basin area	Bain and Stevenson (1999)	20
		Basin relief	Bain and Stevenson (1999)	20
		Drainage density	Bain and Stevenson (1999)	20
		Stream order	Gordon et al. (1992)	20
Valley segment	Valley characteristics	Valley bottom type	Cupp (1989); Naiman et al. (1992)	20
		Valley bottom width	Naiman et al. (1992)	20
		Valley bottom gradient	Naiman et al. (1992)	20
		Valley containment	Bisson and Montgomery (1996)	20
Channel segment	Channel characteristics	Elevation	Overton et al. (1997)	10
		Channel type (Rosgen)	Rosgen (1996)	10
		Bed-form type	Bisson and Montgomery (1996)	10
		Channel gradient	Overton et al. (1997)	10
	Riparian veg.	Primary vegetation type	Platts et al. (1983)	5

Classification work relies heavily on remote-sensed data and GIS. The majority of this work can be conducted in an office with GIS. It is important, however, to spend some time in the field verifying spatial data. This plan requires that at least 10% of the channel segments identified in a subbasin be verified in the field. These segments can be selected randomly. Additional verification may be needed for those segments that cannot be accurately delineated from remote-sensed data. Variables such as primary riparian vegetation type, channel type, and bed-form type will be verified during field surveys (described in Sections 5 and 6).

A large part of this work has already been conducted by White Horse Associates.[15] They described the regional and drainage basin characteristics for the entire Snake River Basin.

Regional Setting

[15] Mr. Sherm Jensen, White Horse Associates, 140 North Main, Box 123, Smithfield, UT 84335.

Ecoregions

Ecoregions are relatively uniform areas defined by generally coinciding boundaries of several key geographic variables. Ecoregions have been defined holistically using a set of physical and biotic factors (e.g., geology, climate, landform, soil, vegetation, and water). Of the systems available, this plan includes the two most commonly used ecoregion systems, Bailey (1978) and Omernik (1987). Bailey's approach uses macroclimate and prevailing plant formations to classify the continent into various levels of detail. Bailey's coarsest hierarchical classifications include domains, divisions, provinces, and sections. These regional classes are based on broad ecological climate zones and thermal and moisture limits for plant growth (Bailey 1998). Specifically, domains are groups of related climates, divisions are types of climate based on seasonality of precipitation or degree of dryness or cold, and provinces are based on macro features of vegetation. Provinces include characterizations of land-surface form, climate, vegetation, soils, and fauna. Sections are based on geomorphology, stratigraphy and lithology, soil taxa, potential natural vegetation, elevation, precipitation, temperature, growing season, surface water characteristics, and disturbance. Information from domains, divisions, and provinces can be used for modeling, sampling, strategic planning, and assessment. Information from sections can be used for strategic, multi-forest, statewide, and multi-agency analysis and assessment.

The system developed by Omernik (1987) is used to distinguish regional patterns of water quality in ecosystems as a result of land use. Omernik's system is suited for classifying aquatic ecoregions and monitoring water quality because of its ecological foundation, its level of resolution, and its use of physical, chemical, and biological information. Like Bailey's system, this system is hierarchical, dividing an area into finer regions in a series of levels. These levels are based on characterizations of land-surface form, potential natural vegetation, land use, and soils. Omernik's system has been extensively tested and found to correspond well to spatial patterns of water chemistry and fish distribution (Whittier et al. 1988).

Until there is a better understanding of the relationships between fish abundance/distribution and the two classes of ecoregions on the Reservation, the Tribes will use both classifications. Chapter 3 in Bain and Stevenson (1999) outlines protocols for describing ecoregions. Published maps of ecoregions are available to assist with classification work.[16] This work will be updated once every 20 years.

Physiographic Province

Physiographic province is the simplest division of a land area into hierarchical natural regions. In general, delineation of physiographic provinces is based on topography (mountains, plains, plateaus, and uplands) and, to a lesser extent, climate, which governs the processes that shape the landscape (weathering, erosion, and sedimentation). Specifically, provinces include descriptions

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[16] Bailey's digital-compressed ARC/INFO ecoregion maps are available at http://www.fs.fed.us/institute/ecolink.html. Omernik's digital level III ecoregion maps of the conterminous U.S. are available at http://www.epa.gov/OST/BASINS/gisdata.html (download BASINS core data) with documentation at http://www.epa.gov/envirofw/html/nsdi/nsditxt/useco.txt.

of climate, vegetation, surficial deposits and soils, water supply or resources, mineral resources, and additional information on features particular to a given area (Hunt 1967). Physiographic provinces and drainage basins have traditionally been used in aquatic research to identify fish distributions (Hughes et al. 1987; Whittier et al. 1988).

Chapter 3 in Bain and Stevenson (1999) outlines methods for describing physiographic provinces. Physiographic maps are available to aid classification work.[17] The Tribes will update physiographic provinces once every 20 years.

Geology

Geologic districts are areas of similar rock types or parent materials that are associated with distinctive structural features, plant assemblages, and similar hydrographic character. Geologic districts serve as ultimate controls that shape the overall character and attainable conditions within a watershed or basin. They are corollary to subsections identified in the U.S. Forest Service Land Systems Inventory (Wertz and Arnold 1972). Watershed and stream morphology are strongly influenced by geologic structure and composition (Frissell et al. 1986; Nawa et al. 1988). Structural features are the templates on which streams etch drainage patterns. The hydrologic character of landscapes is also influenced by the degree to which parent material has been weathered, the water-handling characteristics of the parent rock, and its weathering products. Like ecoregions, geologic districts do not change to other types in response to land uses.

Geologic districts can be identified following the methods described in Overton et al. (1997). Published geology maps aid in the classification of rock types. This work will be updated once every 20 years.

Drainage Basin

Geomorphic Features

This plan includes four important geomorphic features of drainage basins: basin area, basin relief, drainage density, and stream order. Basin area (a.k.a. drainage area or catchment area) is the total land area (km^2), measured in a horizontal plane, enclosed by a drainage divide, from which direct surface runoff from precipitation normally drains by gravity into a wetland, lake, or river. Basin relief (m) is the difference in elevation between the highest and lowest points in the basin. It controls the stream gradient and therefore affects flood patterns and the amount of sediment that can be transported. Hadley and Schumm (1961) demonstrated that sediment load increases exponentially with basin relief. Drainage density (km) is an index of the length of stream per unit area of basin and is calculated as the drainage area (km^2) divided by the total stream length (km). This ratio represents the amount of stream necessary to drain the basin. High drainage density may indicate high water yield and sediment transport, high flood peaks,

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[17] Detailed information about physiographic provinces of the U.S. can be found at http://www.salem.mass.edu/~lhanson/. Digital maps can be found at http://water.usgs.gov/GIS/.

steep hills, and low suitability for certain land uses (e.g., agriculture). The last geomorphic feature, stream order, is based on the premise that the order number is related to the size of the contributing area, to channel dimensions, and to stream discharge. Stream ordering follows the Strahler ordering system. In that system, all small, exterior streams are designated as first order. A second-order stream is formed by the junction of any two first-order streams; third-order by the junction of any two second-order streams. In this system only one stream segment has the highest order number.

Chapter 4 in Bain and Stevenson (1999) outlines standard methods for estimating basin area, basin relief, and drainage density. Gordon et al. (1992) describes the Strahler stream-ordering method. The Tribes will use USGS topographic maps (1:100,000 scale) and GIS to estimate these parameters. This work will be updated once every 20 years.

Valley Segment

Valley Characteristics

The plan incorporates four important features of the valley segment: valley bottom type, valley bottom width, valley bottom gradient, and valley confinement. Valley bottom types are distinguished by average channel gradient, valley form, and the geomorphic processes that shaped the valley (Cupp 1989a,b; Naiman et al. 1992). They correspond with distinctive hydrologic characteristics, especially the relationship between stream and alluvial ground water (Table 2). Valley bottom width is the ratio of the valley bottom[18] width (m) to active channel width (m). Valley gradient is the slope or the change in vertical elevation (m) per unit of horizontal valley distance (m). Valley gradient is typically measured in lengths of about 300 m (1,000 ft) or more. Valley confinement refers to the degree that the valley walls confine the lateral migration of the stream channel. The degree of confinement can be classified as strongly confined (valley floor width < 2 channel widths), moderately confined (valley floor width = 2-4 channel widths), or unconfined (valley floor width > 4 channel widths).

The latter three variables, valley bottom width, valley gradient, and confinement, are nested within valley bottom types. Therefore, these three variables will be described for each valley bottom type identified within the drainage basin (i.e., the valley bottom type defines the scale at which these variables are described).

The Tribes will follow methods of Naiman et al. (1992) to describe valley bottom types. Naiman et al. (1992) also describe methods for measuring valley bottom width and valley bottom gradient. Bisson and Montgomery (1996) outline methods for measuring valley confinement. GIS will aid in estimating these parameters. These variables will be updated once every 20 years.

[18] Valley bottom is defined as the essentially flat area adjacent to the stream channel.

Table 2. Examples of valley bottom types and valley geomorphic characteristics. Table is from Naiman et al. (1992).

Valley bottom type[a]	Valley bottom gradient[b]	Sideslope gradient[c]	Valley bottom width[d]	Channel patterns	Strahler stream order	Landform and geomorphic features
F1 Estuarine delta	≤0.5%	<5%	>5X	Unconstrained; highly sinuous; often braided	Any	Occur at mouth of streams on estuarine flats in and just above zone of tidal influence
F2 Alluviated lowlands	≤1%	>5%	>5X	Unconstrained; highly sinuous	Any	Wide floodplains typically formed by present or historic large rivers within flat to gently rolling lowland landforms; sloughs, oxbows, and abandoned channels commonly associated with mainstream rivers
F3 Wide mainstream valley	≤2%	<5%	>5X	Unconstrained; moderate to high sinuosity; braids common	Any	Wide valley floors bounded by mountain slopes; generally associated with mainstream rivers and the tributary streams flowing through the valley floor; sloughs and abandoned channels common.
F4 Wide mainstream valley	≤1-3%	≤10%	>3X	Variable; generally unconstrained	1-4	Generally occur where tributary streams enter low-gradient valley floors; ancient or active alluvial/colluvial fan deposition overlying floodplains of larger, low-gradient stream segments; stream may actively downcut through deep alluvial fan deposition.
F5 Gently sloping plateaux and terraces	≤2%	<10%	1-2X	Moderately constrained; low to moderate sinuosity	1-3	Drainage ways shallowly incised into flat to gently sloping landscape; narrow active floodplains; typically associated with small streams in lowlands, cryic uplands or volcanic flanks.
M1 Moderate sloping plateaux and terraces	2-5%	<10-30%	<2X	Constrained; infrequent meanders	1-4	Constrained, narrow floodplains bounded by moderate gradient sideslopes; typically found in lowlands and foothills, but may occur on broken mountain slopes and volcano flanks.
M2 Alluviated, moderate slope bound	≤2%	<5%, gradually increase to 30%	2-4X	Unconstrained; moderate to high sinuosity	1-4	Active floodplains and alluvial terraces bounded by moderate gradient hillslopes; typically found in lowlands and foothills, but may occur on broken mountain slopes and volcano flanks.
V1 V-shaped moderate-gradient bottom	2-6%	30-70%	<2X	Constrained	≥2	Deeply incised drainage ways with steep competent sideslopes; very common in uplifted mountainous topography; less commonly associated with marine or glacial outwash terraces in lowlands and foothills.
V2 V-shaped high-gradient bottom	6-11%	30-70%	<2X	Constrained	≥2	Same as above, but valley bottom longitudinal profile steep with pronounced stair-step characteristics.

Table 2. (continued)

Valley bottom type[a]	Valley bottom gradient[b]	Sideslope gradient[c]	Valley bottom width[d]	Channel patterns	Strahler stream order	Landform and geomorphic features
V3 V-shaped, bedrock canyon	3-11%	70%+	<2X	Highly constrained	≥2	Canyon-like stream corridors with frequent bedrock outcrops; frequently stair-stepped profile; generally associated with folded, faulted or volcanic landforms.
V4 Alluviated mountain valley	1-4%	Channel adjacent slopes <10%; increase to 30%+	2-4X	Unconstrained; high sinuosity with braids and side-channels common	2-5	Deeply incised drainage ways with relatively wide floodplains; distinguished as “alluvial flats” in otherwise steeply dissected mountainous terrain.
U1 U-shaped trough	<3%	<5%; gradually increases to 30%+	>4X	Unconstrained; moderate to high sinuosity; side channels and braids common	1-4	Drainage ways in mid to upper watersheds with history of glaciation, resulting in U-shaped profile; valley bottom typically composed of glacial drift deposits overlain with more recent alluvial material adjacent to channel.
U2 Incised U-shaped valley, moderate-gradient bottom	2-5%	Steep channel adjacent slopes, decreases to <30%, then increases to >30%	<2X	Moderately contrained by unconsolidated material; infrequent short flats with braids and meanders	2-5	Channel downcuts through deep valley bottom glacial till, colluvium, or coarse glacio-fluvial deposits; cross-sectional profile variable, but generally weakly U-shaped with active channel vertically incised into valley fill deposits; immediate side-slopes composed of unconsolidated and often unsorted coarse-grained deposits.
U3 Incised U-shaped valley, high-gradient bottom	6-11%	Steep channel adjacent slopes, decreases to <30%, then increases to >30%	<2X	Moderately constrained by unconsolidated material; infrequent short flats with braids and meanders	2-5	Channel downcuts through deep valley bottom glacial till, colluvium, or coarse glacio-fluvial deposits; cross-sectional profile variable, but generally weakly U-shaped with active channel vertically incised into valley fill deposits; immediate side-slopes composed of unconsolidated and often unsorted coarse-grained deposits.
U4 Active glacial out-wash valley	1-7%	Initially <5%, increasing to >60%	<4X	Unconstrained; highly sinuous and braided	1-3	Stream corridors directly below active alpine glaciers; channel braiding and shifting common; active channel nearly as wide as valley bottom.
H1 Moderate-gradient valley wall/head-water	3-6%	>30%	<2X	Constrained	1-2	Small drainage ways with channels slightly to moderately entrenched into mountain toe-slopes or head-water basins.
H2 High-gradient valley wall/head-water	6-11%	>30%	<2X	Constrained; stair-stepped	1-2	Small drainage ways with channels moderately entrenched into high gradient mountain slopes or headwater basins; bedrock exposures and outcrops common; localized alluvial/colluvial terrace deposition.

Table 2. (concluded)

Valley bottom type[a]	Valley bottom gradient[b]	Sideslope gradient[c]	Valley bottom width[d]	Channel patterns	Strahler stream order	Landform and geomorphic features
H3 Very high-gradient valley wall/head-water	11%+	>60%	<2X	Constrained; stair-stepped	1-2	Small drainage ways with channels moderately entrenched into high gradient mountain slopes or headwater basins; bedrock exposures and out-crops common; localized alluvial/colluvial terrace deposition.

[a]Valley bottom type names include alphanumeric mapping codes in italic (from Cupp 1989a, b).
[b]Valley bottom gradient is measured in length of about 300 m (1,000 ft).
[c]Sideslope gradient characterizes the hillslopes within 1,000 horizontal and about 100 m (300 ft) vertical distance from the active channel.
[d]Valley bottom width is a ratio of the valley bottom width to active channel width.

Channel Segment

Channel Characteristics

The plan includes four important characteristics of the channel segment: elevation, channel gradient, channel type, and bed-form type. These characteristics are nested within valley bottom types and therefore will be described for each valley bottom type identified within the drainage basin. Elevation (m) is the height of the stream channel above or below sea level. Channel gradient is the slope or the change in the vertical elevation of the channel per unit of horizontal distance. Channel gradient will be presented graphically as a stream profile.

Channel type follows the classification technique of Rosgen (1996) and is based on quantitative channel morphology indices.[19] These indices result in objective and consistent identification of stream types. The Rosgen technique consists of four different levels of classification. Level I describes the geomorphic characteristics that result from the integration of basin relief, landform, and valley morphology. Level II provides a more detailed morphological description of stream types. Level III describes the existing condition or "state" of the stream as it relates to its stability, response potential, and function. Level IV is the level at which measurements are taken to verify process relationships inferred from preceding analyses. Monitoring on the DVIR will include Level I (geomorphic characterization) classification (Figure 2; Table 3).

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19 Indices include entrenchment, gradient, width/depth ratio, sinuosity, and dominant channel material.

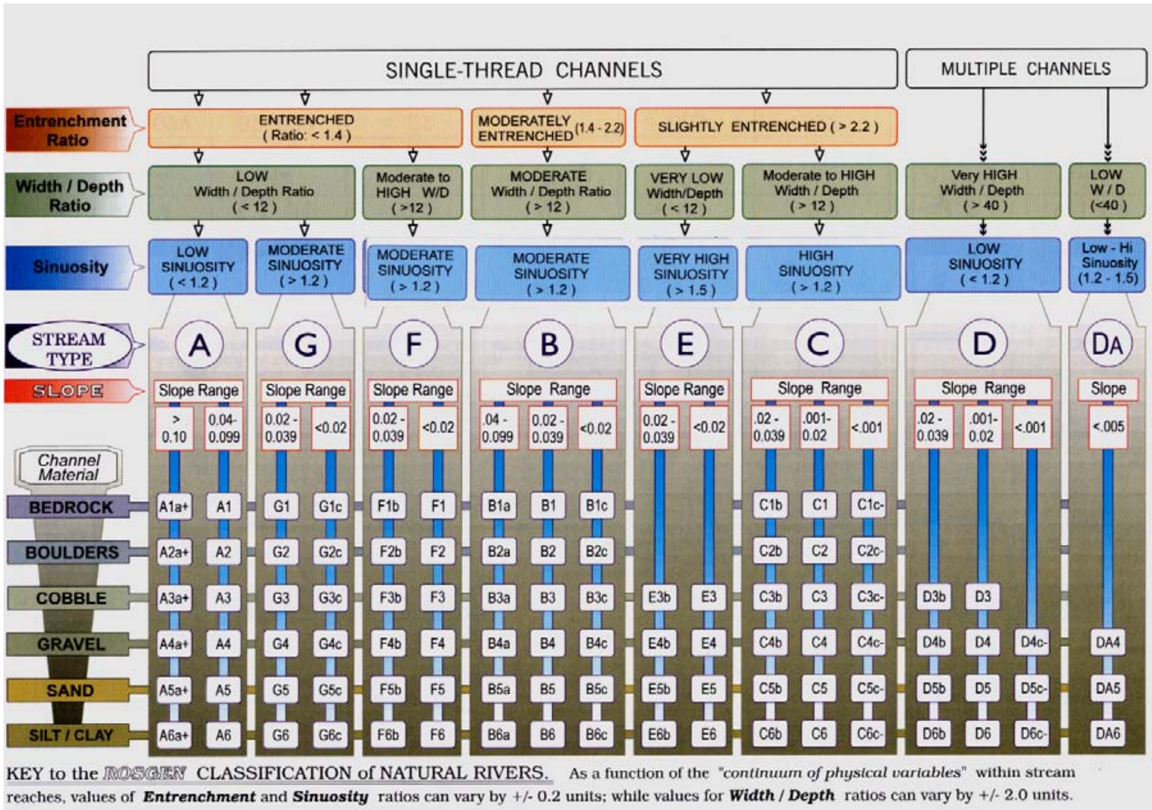

Figure 2. Classification key for identifying different channel types (from Rosgen 1996).

Table 3. General stream type descriptions and delineative criteria for Level I channel classification. Table is from Rosgen (1996).

Stream Type	General description	Entrenchment ratio	W/D ratio	Sinuosity	Slope %	Landform/ soils/features
Aa+	Very steep, deeply entrenched, debris transport, torrent streams.	<1.4	<12	1.0-1.1	>10	Very high relief. Erosional, bedrock or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with deep scour pools; waterfalls.
A	Steep, entrenched, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.	<1.4	<12	1.0-1.2	4-10	High relief. Erosional or depositional and bedrock forms. Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in associated step/pool bed morphology.
B	Moderately entrenched, moderate gradient, riffle-dominated channel, with infrequently spaced pools. Very stable plan and profile. Stable banks.	1.4-2.2	>12	>1.2	2-4	Moderate relief, colluvial deposition, and/or structural. Moderate entrenchment and W/D ratio. Narrow, gently sloping valleys. Rapids predominate with scour pools.
C	Low gradient, meandering, point-bar, riffle/pool, alluvial channels with broad, well defined floodplains.	>2.2	>12	>1.4	<2	Broad valleys with terraces, in association with floodplains, alluvial soils. Slightly entrenched with well-defined meandering channels. Riffle/pool bed morphology.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks.	n/a	>40	n/a	<4	Broad valleys with alluvium, steeper fans. Glacial debris and depositional features. Active lateral adjustment, with abundance of sediment supply. Covergence/divergence bed features, aggradational processes, high bedload and bank erosion.

Table 3. (concluded)

Stream Type	General description	Entrenchment ratio	W/D ratio	Sinuosity	Slope %	Landform/ soils/features
DA	Anastomosing (multiple channels) narrow and deep with extensive, well-vegetated floodplains and associated wetlands. Very gentle relief with highly variable sinuosities and width/depth rations. Very stable streambanks.	>2.2	Highly variable	Highly variable	<0.5	Broad, low-gradient valleys with fine alluvium and/or lacustrine soils. Anastomosed (multiple channel) geologic control creating fine deposition with well-vegetated bars that are laterally stable with broad wetland floodplains. Very low bedload, high wash load sediment.
E	Low gradient, meandering riffle/pool stream with low sidth/depth ratio and little deposition. Very efficient and stable. High meander width ratio.	>2.2	<12	>1.5	<2	Broad valley/meadows. Alluvial materials with floodplains. Highly sinuous with stable, well-vegetated banks. Riffle/pool morphology with very low width/depth ratios.
F	Entrenched meandering riffle/pool channel on low gradients with high width/depth ratio.	<1.4	>12	>1.4	<2	Entrenched in highly weathered material. Gentle gradients, with a high width/depth ratio. Meandering, laterally unstable with high bank erosion rates. Riffle/pool morphology.
G	Entrenched "gully" step/pool and low width/depth ratio on moderate gradients.	<1.4	<12	>1.2	2-4	Gullies, step/pool morphology with moderate slopes and low width/depth ratio. Narrow valleys, or deeply incised in alluvial or colluvial materials, i.e., fans or deltas. Unstable, with grade control problems and high bank erosion rates.

Bed-form type follows the classification proposed by Montgomery and Buffington (1993). This technique is comprehensive and is based on hierarchies of topographic and fluvial characteristics. This system provides a geomorphic, process-oriented method of identifying valley segments and stream reaches. It employs descriptors that are measurable and ecologically relevant. Montgomery and Buffington (1993) identified three valley segment types: colluvial, alluvial, and bedrock. They subdivided the valley types into one or more stream-reach types (bed-form types) depending on whether substrates are limited by the supply of sediment or by the fluvial transport of sediment (Table 4). For example, depending on sediment supply and transport, Montgomery and Buffington (1993) recognized six alluvial bed-form types: braided, regime, pool/riffle, plane-bed, step-pool or cascade. Both colluvial and bedrock valley types consist of only one bed-form type. Only colluvial bed-forms occur in colluvial valleys and only bedrock bed-forms occur in bedrock valleys.

Table 4. Characteristics of different bed-form types. Table is modified from Montgomery and Buffington (1993).

Valley types	Bed-form types	Predominant bed material	Dominant roughness elements	Typical slope (%)	Typical confinement	Pool spacing (channel widths)
Colluvial	Colluvial	Variable	Boulders, large woody debris	>20	Strongly confined	Variable
Bedrock	Bedrock	Bedrock	Streambed, banks	Variable	Strongly confined	Variable
Alluvial	Cascade	Boulder	Boulders, banks	8-30	Strongly confined	<1
	Step-pool	Cobble/boulder	Bedforms (steps, pools) boulders, large woody debris, banks	4-8	Moderately confined	1-4
	Plane-bed	Gravel/cobble	Boulders and cobbles, banks	1-4	Variable	None
	Pool-riffle	Gravel	Bedforms (bars, pools) boulders and cobbles, large woody debris, sinuosity, banks	0.1-2	Unconfined	5-7
	Regime	Sand	Sinuosity, bed-forms (dunes, ripples, bars), banks	<0.1	Unconfined	5-7
	Braided	Variable	Bedforms (bars, pools)	<3	Unconfined	Variable

Methods for measuring elevation and channel gradient are found in Overton et al. (1997). Bisson and Montgomery (1996) describe in detail the method for identifying channel bed-form types, while Rosgen (1996) describes methods for classifying channel types. All classification work will include Level I (geomorphic characterization) channel type classification. These variables will be updated once every 10 years.

Riparian Vegetation

Because riparian vegetation has an important influence on stream morphology and aquatic biota, this plan incorporates primary vegetation type as a characteristic of riparian vegetation. Primary vegetation type refers to the dominant vegetative cover along the stream. At a minimum, vegetation will be described as barren, grasses or forbs, shrubs, and trees. If remote sensing allows, the Tribes will conduct a more detailed classification of shrubs and trees. If possible, trees will be described as cottonwoods, fir, cedar, hemlock, pine, etc. Primary vegetation type will be described for a riparian width of at least 30 m along both sides of the stream. If resources are available, primary vegetation type will be described for the entire floodplain.

Remote sensing will be used to describe the primary vegetation type along streams within valley bottom types. Remote sensing may include aerial photos, LANDSAT ETM+, or both.

status/trend monitoring

One of the goals of the Shoshone-Paiute Tribes is to document current conditions of aquatic resources on the Reservation. Another goal is to assess changes in those conditions over time, especially following the implementation of tributary habitat strategies. Specifically, the Tribes are interested in the following questions:

1. What are the current conditions of aquatic habitats (springs and streams) and associated biota on the DVIR (status monitoring)?
2. Are these conditions improving over time on the Reservation (trend monitoring)?

The specific objectives addressed by status/tend monitoring on the Reservation are to:

1. Describe current water quality, stream connectivity, aquatic habitat quality, channel conditions, riparian conditions, stream flows, and watershed conditions on the DVIR.
2. Describe the current abundance and distribution of redband trout and bull trout on the DVIR.
3. Describe the presence and abundance of Columbia spotted frogs and yellow warblers in riparian habitats on the DVIR.
4. Assess changes in these physical/environmental and biological attributes over time on the DVIR.

Below, this plan describes the statistical design, sampling design, and indicators that will be measured to address the four status/trend objectives. Description of protocols that will be used to measure indicators is presented in Section 7.

Statistical Design

Because the intent of status/trend monitoring is simply to describe existing conditions and document changes in conditions over time, it does not require all the elements of valid statistical design found in effectiveness monitoring studies. For example, controls are not required in status/trend monitoring. However, status/trend monitoring does require temporal and spatial replication and probabilistic sampling.

An appropriate design for monitoring status and trend is the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP) design, which is a spatially-balanced, site-selection process developed for aquatic systems. The state of Oregon has successfully implemented an EMAP-based program for coastal coho salmon (Moore 2002). The monitoring program is also the foundation for status/trend monitoring in the Upper Columbia Basin Monitoring Strategy (Hillman 2004). The monitoring program is spatially explicit, unbiased, and has reasonably high power for detecting trends. The design is sufficiently flexible to use on the scale of the Reservation and can be used to estimate the relative condition of aquatic biota and freshwater habitat. In addition, the EMAP site-selection approach supports sampling at varying spatial extents.

Specifically, EMAP is a survey design that describes current status and detects trends in a suite of indicators. These two objectives have conflicting design criteria; status is ordinarily best assessed by including as many sample units as possible, while trend is best detected by repeatedly observing the same units over time (Overton et al. 1990; Roper et al. 2003). EMAP addresses this conflict by using rotating panels (Stevens 2002). Each panel consists of a collection of sites that will have the same revisit schedule over time. This plan includes six panels, with one panel defining sites visited every year and five panels defining sites visited on a five-year cycle (Table 5). Each panel will consist of 15 independent sites, thus, a total of 90 sites (15 sites x 6 panels) will be selected on the Reservation.

Table 5. Rotating panel design for status/trend monitoring on the DVIR. Shading indicates the years in which sites within each panel are sampled. For example, sites in panel 1 are visited every year, while sites in panel 2 are visited only in years 1, 6, 11, and 16, assuming a 20-year sampling frame. The number (15) within each shaded cell represents the number of independent sites within a panel.

Panel	Year																			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
2	15					15					15					15				
3		15					15					15					15			
4			15					15					15					15		
5				15					15					15					15	
6					15					15					15					15

Sampling Design

Because this plan follows EMAP, which requires spatially balanced samples, sites will be selected according to the generalized random tessellation stratified design (GRTS) (Stevens 1997; Stevens and Olsen 1999; Stevens and Urquhart 2000; Stevens 2002). Briefly, the GRTS design achieves a random, nearly regular sample point pattern via a random function that maps two-dimensional space onto a one-dimensional line (linear space). A systematic sample is selected in the linear space, and the sample points are mapped back into two-dimensional space. The GRTS design is used to select samples for all panels.

As noted above, this plan recommends a sample size of 15 sites per panel. This means that GRTS will select a total of 90 sites (6 panels x 15 sites per panel = 90 sites) on the reservation. Two panels of sites will be monitored each year (Table 5), resulting in a total of 30 sites sampled annually on the Reservation. Some of the sites may fall in areas that are physically inaccessible or cannot be accessed because of landowner denial. Therefore, GRTS will select an additional 90 sites (100% oversample), any one of which can replace an inaccessible site.

The sampling frame for the 90 sites (and the 90 oversample sites) will consist of all portions of first through fifth-order[20] streams on the Reservation (based on 1:100,000 scale USGS topographic maps) with reach gradients less than 12%[21]. The Tribes selected these stream segments because most salmonid spawning and rearing (especially redband trout) occurs in streams with gradients less than 12%. However, spawning and rearing are not evenly distributed among stream orders or among different gradient classes within stream orders. Therefore, this plan will divide each stream within the sampling frame into the following gradient classes: 0-2%, 2-4%, 4-8%, and 8-12%, which correspond roughly to dune-ripple/pool-riffle, plane-bed, step-pool, and cascade channel types, respectively (Montgomery and Buffington 1997; Roni et al. 1999). The first two classes represent response reaches, while the latter two represent transport reaches.

Although salmonids are more likely to spawn in stream segments with gradients less than 4% (Roni et al. 1999), it is unclear at this time how sites should be distributed among the four gradient classes. Therefore, this plan will model a variety of scenarios (Table 6). The first scenario will place 75% of the sites within gradient classes less than 4%, while the second will place 70% of the sites within these gradient classes. The third places 60% of the sites in classes with gradients less than 4%. The last examines the first three scenarios under the criteria that no more than 10% of the sites (9 sites) can fall within fifth-order streams. The purpose here is to limit the number of sites that fall within large streams (e.g., East Fork Owyhee River). The Tribes will evaluate the results of these scenarios to see which one most closely fits the objectives of status/trend monitoring on the Reservation. Importantly, estimates of subbasin-wide variables will not be biased by the choice of site-selection scenario (P. Larsen, personal communication, USEPA).

Table 6. Proportion of sample sites distributed among stream gradient classes on the DVIR.

Scenario	Gradient classes			
	0-2%	**2-4%**	**4-8%**	**8-12%**
1	0.45	0.30	0.15	0.10
2	0.45	0.25	0.20	0.10
3	0.30	0.30	0.20	0.20
4	Above scenarios but only 10% of the sites can fall within 5th order streams			

In order to estimate precision, 20% of the sites will be sampled by two independent crews each year for five years. This means that each year, six randomly selected sites will be surveyed by two different crews. Sampling by the two independent crews will be no more than two-days apart. This will minimize the effects of site changes on estimates of precision. These sites will also be used to compare fish sampling protocols (i.e., comparison of electrofishing and snorkel surveys).

[20] Stream order is based on Strahler (1952). This method of ordering streams is described in Gordon et al. (1992).
[21] Here, a reach is defined as a 300-m long stretch of stream. Therefore, all 300-m long reaches with a sustained gradient of >12% will be excluded from the sampling frame.

Data collected within the EMAP design will be analyzed according to the statistical protocols outlined in Stevens (2002). The Horvitz-Thompson or π-estimator is recommended for estimation of population status. Multi-phase regression analyses are recommended for estimating the distribution of trend statistics. These approaches are fully explained in Diaz-Ramos et al. (1996) and Stevens (2002).

Indicators

In this section, the plan identifies the suite of biological and physical/environmental indicator variables that will be measured on the DVIR. These indicators associate directly with the objectives of the status/trend monitoring program and are consistent with indicators identified in the Action Agencies/NOAA Fisheries RME Plan, the Upper Columbia Monitoring Strategy, and the WSRFB (2003) monitoring strategy. These indicators address various purposes, including assessment of fish production and survival, identifying limiting factors, assessing effects of various land uses, and evaluating habitat actions. The Tribes selected indicators that had the following characteristics:

- They are sensitive to land-use activities or stresses.
- They are consistent with other regional monitoring programs.
- They lend themselves to reliable measurement.
- The physical/environmental indicators relate quantitatively with fish production.

In addition, the indicators identified in this plan are consistent with most of the variables identified by the NMFS (1996) and USFWS (1998) as important attributes of "properly functioning condition." Indeed, NMFS and USFWS use these indicators to evaluate the effects of land-management activities for conferencing, consultations, and permits under the ESA.

Identified and described below are the biological and physical/environmental indicators that will be monitored by the Tribes on the DVIR.

Biological Indicators:

The biological variables that will be measured on the DVIR can be grouped into four general categories: fish, macroinvertebrates, amphibians, and birds. Each of these general categories consists of one or more indicator variables (Table 7). These biological indicators in concert will describe the characteristics of populations or sub-populations in aquatic and riparian habitats on the Reservation.

Table 7. Biological indicator variables to be monitored on the DVIR.

General characteristics	Specific indicators
Fish	Fish abundance
	Age/size structure
	Origin (hatchery or wild)
	Redd abundance
	Redd distribution
Macroinvertebrates	Abundance
	Composition
Amphibians	Occurrence
	Abundance
Birds	Occurrence
	Abundance

Fish

This plan includes five indicators associated with fish populations: abundance, age/size structure, origin, redd abundance, and redd distribution. Abundance describes the number of fish within specified stream reaches. The Tribes believe that fish abundance is an important biological indicator of population health. Indeed, numbers of mature adults within a stream or watershed is a function of all the factors that affect the life history of the population. Age/size structure describes the ages/sizes of fish within an area or population. Size describes the lengths and weights of fish within the population. Origin identifies the parentage (hatchery or wild) of individuals within the populations.

The Tribes will also census redband trout redds (nests) on the Reservation. Abundance describes the number of redds within a given area. Distribution indicates the spatial arrangement (e.g., random, even, or clumped) and geographic extent of redds within a stream or watershed.

Macroinvertebrates

This plan includes benthic macroinvertebrate abundance and diversity (composition) as important indicators of aquatic invertebrates in streams. Benthic macroinvertebrate assemblages in streams reflect overall biological integrity of the benthic community. Because benthic communities respond to a wide array of stressors in different ways, it is often possible to determine the type of stress that affects a macroinvertebrate community.

Amphibians

Amphibians are excellent indicators of environmental health, exhibiting marked declines in degraded habitat (deMaynadeir and Hunter 1995). Consequently, this plan includes the occurrence (presence) and abundance of Columbia spotted frogs as biological indicators that describe the health of riparian ecosystems on the Reservation. These organisms are thought to be common in wet habitats in the Owyhee and Bruneau basins. The Owyhee and Bruneau Subbasin plans identified the Columbia spotted frog as an important indicator species in those basins.

Birds

Occurrence (presence) and abundance of yellow warblers are also indicators of riparian ecosystem health. These birds occur within riparian areas, especially in willows and alders, throughout the Owyhee and Bruneau basins. These birds are quite sensitive to riparian disturbance. In a recent study, Earnst et al. (2004) found that when they compared yellow warblers to all other bird species, yellow warblers exhibited the most significant increase in abundance following cattle removal from high desert riparian habitats. The Owyhee and Bruneau Subbasin plans identified yellow warblers as an important riparian indicator species in those basins.

Physical/Environmental Indicators:

The physical/environmental variables that will be measured on the DVIR can be grouped into seven general categories: water quality, habitat access, habitat quality, channel condition, riparian condition, flow/hydrology, and watershed condition. Each of these categories consists of one or more indicator variables (Table 8). In sum, these categories and their associated indicators address watershed process and “input” variables (e.g., artificial physical barriers, road density, and other anthropogenic disturbances) as well as “outcome” variables (e.g., temperature, sediment, woody debris, pools, riparian habitat, etc.), as outlined in Hillman (2004).

Water Quality

Water Temperature:

This plan includes two temperature metrics that will serve as specific indicators of water temperature: maximum daily maximum temperature (MDMT) and maximum weekly maximum temperature (MWMT). MDMT is the single warmest daily maximum water temperature recorded during a given year or survey period. MWMT is the mean of daily maximum water temperatures measured over the warmest consecutive seven-day period. MDMT is measured to establish compliance with the short-term exposure to extreme temperature criteria, while MWMT is measured to establish compliance with mean temperature criteria.

Table 8. Physical/environmental indicator variables to be monitored on the DVIR. Table is modified from Hillman (2004).

General characteristics	Specific indicators
Water Quality	MWMT/MDMT
	Turbidity
	Conductivity
	pH
	Dissolved Oxygen
Habitat Access	Road crossings
	Diversion dams
Habitat Quality	Dominant substrate
	Embeddedness
	LWD (pieces/km)
	Pools per kilometer
	Residual pool depth
	Fish cover
	Off-channels habitats
Channel condition	Stream gradient
	Width/depth ratio
	Wetted width
	Bankfull width
	Bank stability
Riparian Condition	Structure
	Disturbance
	Canopy cover
Flows and Hydrology	Streamflow
Watershed Condition	Watershed road density
	Riparian-road index

Turbidity:

This plan includes turbidity as the one sediment-related specific indicator under water quality. Turbidity refers to the amount of light that is scattered or absorbed by a fluid. Suspended particles of fine sediments often increase turbidity of streams. However, other materials such as finely divided organic matter, colored organic compounds, plankton, and microorganisms can also increase turbidity of streams.

Conductivity, pH, and Dissolved Oxygen:

This plan includes three additional indicators associated with water quality: conductivity, pH, and dissolved oxygen (DO). Most of these indicators are commonly measured because of their sensitivity to land-use activities, municipal and industrial pollution, and their importance in aquatic ecosystems.

This plan included conductivity, pH, and DO because these parameters are often incorporated into water quality monitoring programs (e.g., OPSW 1999; Bilhimer et al. 2003). Conductivity (or specific conductance) refers to the ability of water to conduct an electric current. The conductivity of water is a function of water temperature and the concentration of dissolved ions. It is measured as micromhos/centimeter (µmhos/cm).[22]

pH is defined as the concentration of hydrogen ions in water (moles per liter). It is a measure of how acidic or basic water is—it is not a measure of acidity or alkalinity (acidity and alkalinity are measures of the capacity of water to neutralize bases and acids, respectively). The logarithmic pH scale ranges from 0 to 14. Pure water has a pH of 7, which is the neutral point. Water is acidic if the pH value is less than 7 and basic if the value is greater than 7.

DO concentration refers to the amount of oxygen dissolved in water. Its concentration is usually measured in mg per liter (mg/L). The capacity of water to hold oxygen in solution is inversely proportional to the water temperature. Increased water temperature lowers the concentration of DO at saturation. Respiration (both plants and animals) and biochemical oxygen demand (BOD) are the primary factors that reduce DO in water. Photosynthesis and dissolution of atmospheric oxygen in water are the major oxygen sources.

Habitat Access

Artificial Physical Barriers:

This plan includes two specific indicators associated with artificial physical barriers: road crossings (culverts) and dams (diversions). Roads and highways are common on the Reservation and where they intersect streams they may block fish passage. Culverts can block passage of fish particularly in an upstream direction (WDFW 2000). In several cases, surveys have shown a difference in fish populations upstream and downstream from existing culverts, leading to the conclusion that free passage is not possible (Clay 1995). Dams and diversions that lack fish passage facilities can also block fish passage. Unscreened diversions may divert migrating fish into ditches and canals. Entrained fish can end in irrigated fields.

Habitat Quality

Substrate:

[22] Conductivity may also be reported in millisiemens/meter, where 1 millisiemen/m equals 0.1 µmhos/cm.

This plan includes two specific indicators of substrate: dominant substrate (composition) and embeddedness. Dominant substrate refers to the most common particle size that makes up the composition of material along the streambed. This indicator describes the dominant material in spawning and rearing areas. Embeddedness is a measure of the degree to which fine sediments surround or bury larger particles. This measure is an indicator of the quality of over-wintering habitat for juvenile salmonids.

Large Woody Debris:

This plan includes the number of pieces of large woody debris (LWD) per stream kilometer as the one specific indicator of LWD in streams. LWD consists of large pieces of relatively stable woody material located within the bankfull channel and appearing to influence bankfull flows. LWD is also referred to as large organic debris (LOD) and coarse woody debris (CWD). LWD can occur as a single piece (log), an aggregate (two or more clumped pieces, each of which qualifies as a single piece), or as a rootwad.

The definition of LWD differs greatly among institutions. For example, NMFS (1996) defined LWD east of the Cascade Mountains as any log with a diameter greater than 30 cm (1 ft) and a length greater than 10.6 m (35 ft). Armantrout (1998) and BURPTAC (1999) defined LWD as any piece with a diameter >10 cm and a length > 1 m. Schuett-Hames et al. (1994) defined it as any piece with a diameter >10 cm and a length >2 m, while Overton et al. (1997) defined LWD as any piece with a diameter >10 cm and a length >3 m or two-thirds of the wetted stream width. Some Forest Service crews define LWD as any piece with a diameter >15 cm and a length >6 m. Because of the wide range of definitions, this plan recommends that LWD be placed within three size categories: >10-cm diameter x >1-m long; >15-cm diameter x >6-m long; and >30-cm diameter x >3-m long. By counting the number of pieces of LWD within each category, this plan will be consistent with many of the various organizations. This will also allow the Tribes to assess the association between different size categories of wood and fish production on the Reservation.

Pool Habitat:

This plan includes two specific indicators associated with pool habitat: number of pools per kilometer and residual pool depth. A pool is slow-water habitat with a gradient less than 1% that is normally deeper and wider than aquatic habitats upstream and downstream from it (Armantrout 1998). To be counted, a pool must span more than half the wetted width, include the thalweg, be longer than it is wide, and the maximum depth must be at least 1.5 times the crest depth. Plunge pools are included in this definition even though they may not be as long as they are wide. Residual pool depth refers to the maximum depth of a pool if there is little or no flow in the channel. It is calculated as the difference between the maximum pool depth and the maximum crest depth (Overton et al. 1997).

Fish Cover:

Fish cover consists of such things as algae, macrophytes, woody debris, overhanging vegetation, undercut banks, large substrate, and artificial structures that offer concealment cover for fish and macroinvertebrates. This information is used to assess habitat complexity, fish cover, and channel disturbance.

Off-Channel Habitat:

Off-channel habitat consists of side-channels, backwater areas, alcoves or sidepools, off-channel pools, off-channel ponds, and oxbows. A side channel is a secondary channel that contains a portion of the streamflow from the main or primary channel. Backwater areas are secondary channels in which the inlet becomes blocked but the outlet remains connected to the main channel. Alcoves are deep areas along the shoreline of wide and shallow stream segments. Off-channel pools occur in riparian areas adjacent to the stream channels and remain connected to the channel. Off-channel ponds are not part of the active channel but are supplied with water from over bank flooding or through a connection with the main channel. These ponds are usually located on flood terraces and are called wall-based channel ponds when they occur near the base of valley walls. Finally, oxbows are bends or meanders in a stream that become detached from the stream channel either from natural fluvial processes or anthropogenic disturbances.

Channel Condition

Stream gradient:

Stream gradient is the slope (change in vertical elevation per unit of horizontal distance) of the water surface within a site or reach. Although gradient is not usually affected by land-use activities, it is a major classification variable that indicates potential water velocities and stream power, which in turn control aquatic habitat and sediment transport within the reach. It is also an index of habitat complexity, as reflected in the diversity of water velocities and sediment sizes within the stream reach.

Width/Depth Ratio:

The width/depth ratio is an index of the cross-section shape of a stream channel at bankfull level. The ratio is a sensitive measure of the response of a channel to changes in bank conditions. Increases in width/depth ratios, for example, indicate increased bank erosion, channel widening, and infilling of pools. Because streams almost always are several times wider than they are deep, a small change in depth can greatly affect the width/depth ratio.

Wetted Width:

Wetted width is the width of the water surface measured perpendicular to the direction of flow. Wetted width is used to estimate water surface area, which is then used to calculate the density of fish (i.e., number of fish divided by the water surface area sampled)[23] within the reach.

Bankfull Width:

Bankfull width is the width of the channel (water surface) at the bankfull stage, where bankfull stage corresponds to the channel forming discharge that generally occurs within a return interval from 1.4 to 1.6 years and may be observed as the incipient elevation on the bank where flooding begins. There are several indicators that one can use to identify bankfull stage. The active floodplain is the best indicator of bankfull stage. It is the flat, depositional surface adjacent to many stream channels. These are most prominent along low-gradient, meandering reaches, but are often absent along steeper mountain streams. Where floodplains are absent or poorly defined, other useful indicators may serve as surrogates to identify bankfull stage (Harrelson et al. 1994). Those include:

- The height of depositional features (especially the top of the pointbar, which defines the lowest possible level for bankfull stage;
- A change in vegetation (especially the lower limit of perennial species);
- Slope or topographic breaks along the bank;
- A change in the particle size of bank material, such as the boundary between coarse cobble or gravel with fine-grained sand or silt;
- Undercuts in the bank, which usually reach an interior elevation slightly below bankfull stage; and
- Stain lines or the lower extent of lichens on boulders.

Streambank Condition:

This plan includes streambank stability as the one specific indicator of streambank condition. Streambank stability is an index of firmness or resistance to disintegration of a bank based on the percentage of the bank showing active erosion (alteration) and the presence of protective vegetation, woody material, or rock. A stable bank shows no evidence of breakdown, slumping, tension cracking or fracture, or erosion (Overton et al. 1997). Undercut banks are considered stable unless tension fractures show on the ground surface at the bank of the undercut.

Riparian Condition

Riparian structure:

Riparian structure describes the type and amount of various types of vegetation within the riparian zone. Information on riparian structure can be used to evaluate the health and

[23] By definition, the measure of the number of fish per unit area is called "crude density" (Smith and Smith 2001). However, not all of the water surface area provides suitable habitat for fish. Density measured in terms of the amount of area suitable as living space is "ecological density."

level of disturbance of the stream corridor. In addition, it provides an indication of the present and future potential for various types of organic inputs and shading.

Riparian disturbance:

Riparian disturbance refers to the presence and proximity of various types of human land-use activities within the riparian area. Activities include such things as walls, dikes, riprap, dams, buildings, pavement, roads and railroads, pipes, trash, parks, lawns, mining, agriculture, pastures, and logging. All these activities have an effect on the riparian vegetation, which in turn affects the quantity and quality of aquatic habitat for listed fish species.

Canopy cover:

Riparian canopy cover over a stream is important not only in its role in moderating stream temperatures through shading, but it also serves to control bank stability and provides inputs of coarse and fine particulate organic materials. Organics from riparian vegetation become food for stream organisms and structure to create and maintain complex channel habitat.

Flows and Hydrology

Streamflows:

This plan includes three specific indicators of streamflows: change in peak flow, change in base flow, and change in timing of flow. Peak flow is the highest or maximum streamflow recorded within a specified period of time. Base flow is the streamflow sustained in a stream channel and is not a result of direct runoff. Base flow is derived from natural storage (i.e., outflow from groundwater, large lakes, or swamps), or sources other than rainfall. Timing of flow refers to the time when peak and base flows occur and the rate of rises and falls in the hydrograph. These indicators are based on “annual” flow patterns.

Watershed Conditions

Road Density:

A road is any open way for the passage of vehicles or trains. This plan includes both road density and the riparian-road index (RRI) as indicators of roads within watersheds. Road density is an index of the total miles of roads within a watershed. It is calculated as the total length of all roads (km) within a watershed divided by the area of the watershed (km^2). The RRI is expressed as the total mileage of roads (km) within riparian areas divided by the total number of stream kilometers within the watershed (WFC 1998). For this index, riparian areas are defined as those falling within the federal buffers zones; that is, all areas within 300 ft (91 m) of either side of a fish-bearing stream, within 150 ft (46 m) of a permanent nonfish-bearing stream, or within the 100-year floodplain.

Ongoing Programs

The Tribal Environmental Protection Program (TEPP) is currently monitoring water quality on the DVIR for the purpose of establishing water quality standards for the Reservation, assessing overall water quality conditions, developing a 303(d) list, and writing a 305(b) report. In 2002, TEPP conducted an intensive sampling event on the East Fork Owyhee River to assess concentrations of toxicants released from tailings at the Rio Tinto Copper Mine. TEPP has sampled 28 locations on the Reservation (Figure 3) and measured metals[24] in the surface waters, in sediments, and in fish.

Under this plan, the Tribes will coordinate with TEPP to avoid redundant water quality sampling on the Reservation. This plan will rely on TEPP to monitor water quality in areas where monitoring efforts overlap. This plan, however, will monitor water quality on streams where no monitoring occurs under TEPP.

[24] Metals included aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

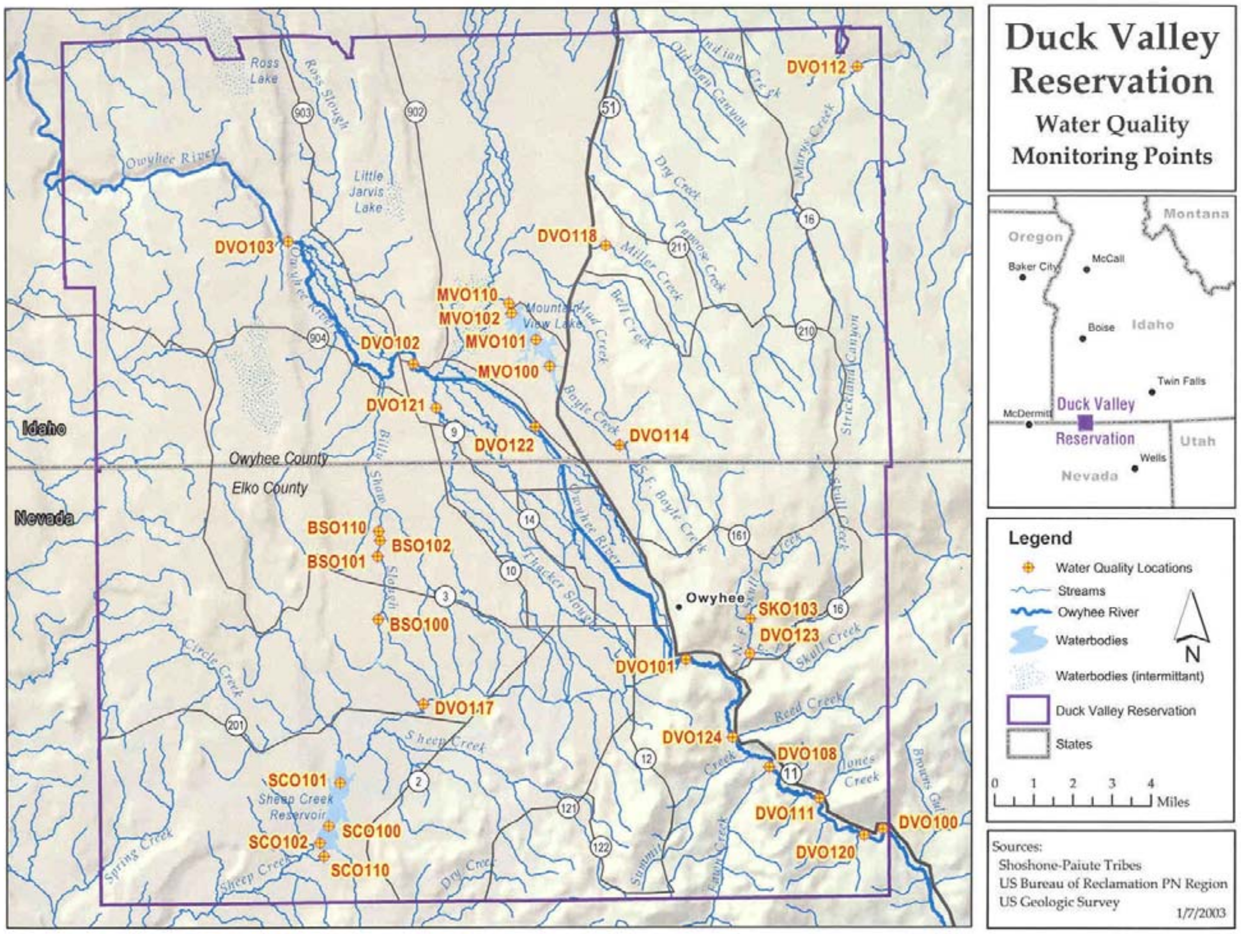

Figure 3. Water quality sites sampled by the Tribal Environmental Protection Program on the Duck Valley Indian Reservation.

Effectiveness monitoring

The Shoshone-Paiute Tribes are actively involved in restoring and improving aquatic habitat conditions on the Reservation. Their goal is to protect and enhance aquatic ecosystems on the Reservation. They have identified three classes of actions that should improve aquatic conditions on the Reservation:

- Protect and enhance springs and headwater springs
- Reclaim unimproved backcounty roads
- Restore habitat conditions within the East Fork Owyhee River

It is important to note that the sites sampled for effectiveness monitoring will be integrated with status/trend monitoring and ongoing monitoring activities of TEPP. Although this section identifies the number and general location of sites for monitoring the effectiveness of the three classes of actions, sites selected for status/trend and by TEPP may overlap with effectiveness monitoring sites. If that happens, then the sites selected under those programs will be used to help assess treatment effects. For example, if a status/trend monitoring site falls within the proposed treatment area on the East Fork Owyhee River, that site would then also serve as an effectiveness monitoring site, thereby reducing the number of additional effectiveness monitoring sites to be selected. The same is true for TEPP sites. If any TEPP sites fall within treatment or control areas, those sites will also be included as effectiveness monitoring sites.

What follows is a description of the objectives, statistical design, sampling design, and indicators that will be measured to assess effectiveness of each action implemented on the Reservation. Appendix A outlines plans for monitoring effectiveness of each of the classes of actions.

Spring Enhancement and Headwaters Protection

The goal of this action is to improve water quality, stream flows, and channel and riparian conditions on the Reservation by protecting headwaters and springs from livestock use. The specific objectives are to:

1. Improve water quality by excluding livestock from headwaters and springs.
2. Improve stream flow conditions and bank stability by excluding livestock from headwaters and springs.
3. Decrease fine sediment delivery to channels by excluding livestock from headwaters and springs.
4. Protect and restore riparian habitat conditions by excluding livestock from headwaters and springs.
5. Increase the abundance and distribution of salmonids (especially redband trout) by excluding livestock from headwaters and springs.
6. Increase the abundance and diversity of aquatic insects in streams by excluding livestock from headwaters and springs.

7. Increase the occurrence of yellow warblers and Columbia spotted frogs by excluding livestock from headwaters and springs.

The Tribes fenced headwaters, springs, and sensitive riparian areas and provided off-site stock watering areas in the Reed Creek, Jones Creek, Summit Creek, and in the East Fork Owyhee drainages. By implementing these strategies, the Tribes intend to test the following hypotheses:

1. The exclusion of livestock from headwaters and springs will significantly reduce stream temperatures and turbidity.
2. The exclusion of livestock from headwaters and springs will significantly increase stream flows and bank stability.
3. The exclusion of livestock from headwaters and springs will significantly decrease the accumulation of fine sediments in stream channels.
4. The exclusion of livestock from headwaters and springs will significantly improve riparian habitat conditions.
5. The exclusion of livestock from headwaters and springs will significantly increase that abundance and distribution of redband trout.
6. The exclusion of livestock from headwaters and springs will significantly increase the abundance and diversity of aquatic macroinvertebrates.
7. The exclusion of livestock from headwaters and springs will significantly increase the occurrence of yellow warblers and Columbia spotted frogs in riparian areas.

Statistical Design:

Because the Tribes began protecting springs and sensitive headwater streams from livestock before 2004, a BACI design is not possible. Instead, the effects of these actions will be assessed with a control-treatment design, which will compare biological and physical/environmental indicators in control areas (springs and headwater streams that were not treated) with treatment sites. Because the Tribes have treated different sites in different years, there should be a "gradient" of effects among treated sites. Thus, by collecting data from an unbiased sample of treated sites from each treatment year, the Tribes should be able to model with time and time x treatment interaction indicators. That is, the Tribes will collect data from a random sample of sites treated in year 2000, 2001, 2002, and 2003. Data will be compared among treatment years and with a random sample of sites that have not been treated (controls). The Tribes will monitor the same indicators using the same protocols for at least five years in both treatment and control areas.

Sampling Design:

This study does not allow the Tribes to randomly assign treatments to sites, because the sites have already been treated. However, the Tribes will randomly select treatment and control sites for monitoring. That is, from the array of sites already treated, the Tribes will randomly select three (3) sites from each treatment year for monitoring. They will also randomly select three (3) sites from the array of potential control sites.[25] Therefore, if there are four treatment years and one set of control sites, the total sample size for monitoring this action will be 15 randomly-selected sites.

Indicators:

Based on the objectives and hypotheses, the following biological and physical/environmental indicators will be measured at each of the 15 sampling sites.

Biological Conditions:
- Abundance and distribution of redband trout
- Abundance and diversity of aquatic macroinvertebrates
- Occurrence of yellow warblers
- Occurrence of Columbia spotted frogs

Water Quality:
- Temperature (MDMT and MWMT)
- Turbidity

Habitat Quality:
- Dominant substrate
- Embeddedness
- Number of pools
- Residual pool depth

Channel Condition:
- Width/depth ratio
- Wetted width
- Bankfull width
- Bank stability

Riparian Condition:
- Riparian structure
- Riparian disturbance
- Canopy cover

Flows and Hydrology:
- Stream flows

Section 7 describes methods that will be used to measure these indicators.

Although these indicators will be measured in only a random sample of treatment and control sites, all treated sites and sampled control sites will be documented with photographs. That is, all sites that receive a treatment (i.e., fencing) and monitored control sites will be photographed each year during base-flow conditions. Sites will be photographed from the same location each year (fixed photo points).

[25] Potential control sites will be matched as closely as possible with treatment sites based on the landscape classification variables described in Section 4.

Unimproved Backcounty Road Reclamation

The goal of this action is to reduce erosion and fine sediment recruitment to streams along backcountry roads and stream crossings on the Reservation. The specific objectives are to:

1. Improve water quality of streams by improving backcountry roads and streams crossings.
2. Improve stream habitat conditions (pools) by improving backcountry roads and streams crossings.
3. Decrease fine sediment delivery to channels by improving backcountry roads and streams crossings.
4. Increase the abundance of salmonids (especially redband trout) by improving backcountry roads and streams crossings.
5. Increase the abundance and diversity of aquatic insects in streams by improving backcountry roads and streams crossings.

The Tribes installed drainage dips (cross drains), sediment catchments, geo-web, and rock crossings (or culverts) where springs or small streams cross roads. They also in-sloped and contoured roads and re-vegetated along the streams. These actions were implemented in the Skull Creek, North Fork Skull Creek, Fawn Creek, and Summit Creek drainages. The Tribes will test the following hypotheses:

1. The improvement of backcountry roads and stream crossings will significantly reduce stream turbidity.
2. The improvement of backcountry roads and stream crossings will significantly increase numbers of pools and residual pool depths.
3. The improvement of backcountry roads and stream crossings will significantly decrease the accumulation of fine sediments in stream channels.
4. The improvement of backcountry roads and stream crossings will significantly increase that abundance of redband trout in the assessment area.
5. The improvement of backcountry roads and stream crossings will significantly increase the abundance and diversity of aquatic macroinvertebrates in the assessment area.

Statistical Design:

Because the Tribes implemented road improvements in 2002 and 2003, a BACI design is not possible. Therefore, the Tribes will assess the effectiveness of their road improvement projects by using a control-treatment design. For convenience, this action will be divided into two separate studies. The Skull Creek Road Project will serve as one study, while the South Red Cabin Road Project will be a separate study. The Skull Creek Road Project occurs within the Skull Creek drainage (including the North Fork); the South Red Cabin Road Project crosses both the Summit Creek and Fawn Creek drainages. Each project will have its own control-treatment design. The Tribes will monitor the same indicators using the same protocols for at least five years in both treatment and control areas.

Sampling Design:

Because sites have already been treated, the Tribes cannot randomly assign treatments to potential sites. In addition, because both projects include multiple treatments (i.e., implementation of numerous cross-drains/drainage dips, culverts, rock crossings, road contouring and grading, etc.), this plan will identify the cumulative effects of all treatments on biological and physical/environmental indicators. With the exception of culvert placements, this plan will not identify specific treatment effects for each individual treatment type.

For both projects, the Tribes will sample randomly selected treatment and control sites. For the Skull Creek Road Project, the Tribes will randomly select four (4) monitoring sites within the treatment area and four control (4) sites upstream from the treatment areas in the Skull Creek drainage.[26] For the South Red Cabin Road Project, the Tribes will randomly select four (4) sites within each of the treatment areas in the Summit and Fawn Creek drainages and four (4) control sites upstream from the treatment areas in the Summit and/or Fawn Creek drainages. Thus, the Tribes will sample 8 sites in the Skull Creek drainage and 12 sites in the Summit/Fawn Creek drainages.

All culverts placed in fish-bearing streams will be monitored for fish passage following the protocols identified in WDFW (2000).

Indicators:

Based on the objectives and hypotheses, the following biological and physical/environmental indicators will be measured at each of the 20 sampling sites.

Biological Conditions:
- Abundance of redband trout
- Abundance and diversity of aquatic macroinvertebrates

Habitat Access:
- Fish passage through culverts

Water Quality:
- Temperature (MDMT and MWMT)
- Turbidity

Habitat Quality:
- Dominant substrate
- Embeddedness
- Number of pools
- Residual pool depth

Channel Condition:
- Width/depth ratio
- Wetted width

[26] Potential control areas will be as similar as possible to treatment areas based on landscape classification variables described in Section 4.

- Bankfull width

Section 7 describes methods that will be used to measure these indicators.

This plan requires that all treatments implemented for the two projects be documented with photographs. Sites will be photographed from the same location each year (fixed photo points) during base-flow conditions.

Restoration of the East Fork Owyhee River

The goal of this action is to improve water quality, stream habitat, and channel and riparian conditions on the East Fork Owyhee River by implementing specific habitat restoration actions. The objectives of this project are to:

1. Improve water quality on the East Fork by implementing restoration and protection activities.
2. Improve habitat and channel conditions on the East Fork by implementing restoration and protection activities.
3. Decrease fine sediment delivery to the East Fork by implementing restoration and protection activities.
4. Improve riparian habitat conditions on the East Fork by implementing restoration and protection activities.
5. Increase the abundance of salmonids (especially redband trout) on the East Fork by implementing restoration and protection activities.
6. Increase the abundance and diversity of aquatic insects on the East Fork by implementing restoration and protection activities.
7. Increase the occurrence of yellow warblers and Columbia spotted frogs along the East Fork by implementing restoration and protection activities.

Along 3.5 miles of the East Fork Owyhee River, the Tribes will plant willows, re-slope and transplant shrubs on toe, excavate low-flow channel and floodplain, construct gravel bars, install riparian revetments and fabric-encapsulated soil lifts, and create new floodplains. By implementing these actions, the Tribes will test the following hypotheses:

1. The implementation of restoration actions will significantly reduce stream temperatures and turbidity on the East Fork Owyhee River.
2. The implementation of restoration actions will significantly reduce fine sediment concentrations in the East Fork Owyhee River.
3. The implementation of restoration actions will significantly increase habitat diversity on the East Fork Owyhee River.
4. The implementation of restoration actions will significantly improve channel conditions in the East Fork Owyhee River.
5. The implementation of restoration actions will significantly improve riparian habitat conditions along the East Fork Owyhee River.

6. The implementation of restoration actions will significantly increase the abundance of redband trout in the East Fork Owyhee River.
7. The implementation of restoration actions will significantly increase the abundance and diversity of aquatic macroinvertebrates in the East Fork Owyhee River.
8. The implementation of restoration actions will significantly increase the occurrence of yellow warblers and Columbia spotted frogs in riparian areas along the East Fork Owyhee River.

Statistical Design:

The Tribes will use a BACI design to assess treatment effects. Because the proposed treatment area (3.5-mile reach) will receive several treatments, this study will not assess the effects of each individual treatment. Rather, this study will assess the cumulative effects of the all treatments on biological and physical/environmental indicators. The Tribes will collect data on indicators in both the treatment area and control area at least once before the implementation of treatments. The control area will be upstream from the proposed treatment area and will be as similar as possible to the treatment area based on classification variables described in Section 4. Following the implementation of treatments, the Tribes will monitor the same indicators using the same protocols for at least five years in both the treatment and control areas.

Sampling Design:

The Tribes will randomly select sites for monitoring in both treatment and control areas. Three (3) sites will be selected randomly in both the treatment and control areas. Thus, for this project, the Tribes will monitor a total of six (6) sites on the East Fork Owyhee River.

Indicators:

Based on the objectives and hypotheses of this project, the following biological and physical/environmental indicators will be measured at each of the six (6) sites.

Biological Conditions:
- Abundance of salmonids (emphasis on redband trout)
- Abundance and diversity of aquatic macroinvertebrates
- Occurrence of yellow warblers
- Occurrence of Columbia spotted frogs

Water Quality:
- Temperature (MDMT and MWMT)
- Turbidity

Habitat Quality:
- Substrate composition
- Embeddedness
- Fequency of LWD
- Number of pools
- Residual pool depth
- Fish cover

- Off-channel habitat

Channel Condition:

- Width/depth ratio
- Wetted width
- Bankfull width
- Bank stability

Riparian Condition:

- Riparian structure
- Riparian disturbance
- Canopy cover

Section 7 describes methods that will be used to measure these indicators.

This plan requires that all treatments implemented in the 3.5-mile reach will be documented with photographs. Sites will be photographed from the same location each year (fixed photo points) during base-flow conditions.

Measuring protocols

The Tribes believe it is important to use the same measurement method for measuring a given indicator. The reason for this is to allow comparisons of biological and physical/environmental conditions within and among watersheds on the Reservation and across basins.[27] This section identifies methods that will be used to measure biological and physical/environmental indicators. The methods identified in this plan are consistent with those described in other programs (e.g., the Action Agencies/NOAA Fisheries RME Plan and the Upper Columbia Basin Monitoring Strategy) and are mostly consistent with EMAP and SRFB protocols.

Not surprisingly, there can be several different methods for measuring the same variable (Johnson et al. 2001). For example, channel substrate can be described using surface visual analysis, pebble counts, or substrate core samples (either McNeil core samples or freeze-core samples). These techniques range from the easiest and fastest to the most involved and informative. As a result, one can define two levels of sampling methods. Level 1 (extensive methods) involves fast and easy methods that can be completed at multiple sites, while Level 2 (intensive methods) includes methods that increase accuracy and precision but require more sampling time. This strategy, like other programs, uses primarily Level 2 methods, which minimize sampling error.

Before identifying measuring protocols, it is important to define a few terms. These terms are consistent with the Action Agencies/NOAA Fisheries RME Plan and the Upper Columbia Basin Monitoring Strategy (Hillman 2004).

Reach (effectiveness monitoring) – for effectiveness monitoring, a stream reach is defined as a relatively homogeneous stretch of a stream having similar regional, drainage basin, valley segment, and channel segment characteristics and a repetitious sequence of habitat types. Reaches are identified by using a list of classification (stratification) variables (from Table 1). Reaches may contain one or more sites. The starting point and ending point of reaches will be measured with Global Positioning System (GPS) and recorded as Universal Transverse Mercator (UTM).

Reach (status/trend monitoring) – for status/trend monitoring, a reach is a length of stream (20 times the mean bankfull width, but not less than 150-m long or longer than 500 m)[28] selected with a systematic randomized process (GRTS design). GRTS selects a point on the "blue-line" stream network represented on a 1:100,000 scale USGS map. This point is referred to as the "X-site." The X-site identifies the midpoint of the reach. That is, the sampling reach extends a

[27] Bonar and Hubert (2002) and Hayes et al. (2003) review the benefits, challenges, and the need for standardized sampling.

[28] This reach length differs from Simonson et al. (1994) and Reynolds et al. (2003), which use 40x the wetted width. The use of 20x the bankfull width is consistent with AREMP and PIBO protocols. This protocol also allows one to assess channel conditions even if the channel is dry. There are naturally dry channels within the project area.

distance of 10 times the average bankfull width upstream and downstream from the X-site, measured along the thalweg[29]. Biological and physical/environmental indicators are measured within the reach. The X-site and the upstream and downstream ends of the reach will be measured with GPS and recorded as UTM. For purposes of re-measurements, these points will also be photographed, marked with permanent markers (e.g., orange plastic survey stakes or rebar[30]), and carefully identified on maps and site diagrams. Reach lengths and boundaries will be "fixed" the first time they are surveyed and they will not change over time even if future conditions change.

Site (effectiveness monitoring) – a site is an area of the effectiveness monitoring stream reach that forms the smallest sampling unit with a defined boundary. Site length depends on the width of the stream channel. Sites will be 20 times the average bankfull width with a minimum length of 150 m and a maximum length of 500 m. Site lengths are measured along the thalweg. The upstream and downstream boundaries of the site will be measured with GPS and recorded as UTM. For purposes of re-measurements, these points will also be photographed, marked with permanent markers (e.g., orange plastic survey stakes or rebar), and carefully identified on maps and site diagrams. Site lengths and boundaries will be "fixed" the first time they are surveyed and they will not change over time even if future conditions change.

Transect – a transect is a straight line across a stream channel, perpendicular to the flow, along which habitat features such as width, depth, and substrate are measured at pre-determined intervals. Effectiveness monitoring sites and status/trend monitoring reaches will be divided into 11 evenly-spaced transects by dividing the site into 10 equidistant intervals with "transect 1" at the downstream end of the site or reach and "transect 11" at the upstream end of the site or reach.

Habitat Type – Habitat types, or channel geomorphic units, are discrete, relatively homogenous areas of a channel that differ in depth, velocity, and substrate characteristics from adjoining areas. The Tribes will identify the habitat type under each transect within a site or reach following the Level II classification system in Hawkins et al. (1993). That is, habitat will be classified as turbulent fast water, non-turbulent fast water, scour pool, or dammed pool (see definitions in Hawkins et al. 1993). By definition, for a habitat unit to be classified, it should be longer than it is wide. Plunge pools, a type of scour pool, are the exception, because they can be shorter than they are wide.

Biological Variables

[29] "Thalweg" is defined as the path of a stream that follows the deepest part of the channel (Armantrout 1998).
[30] Metal detectors can be used to relocate rebar.

As noted in Section 5, biological variables that will be measured on the DVIR can be grouped into four general categories: fish, macroinvertebrates, amphibians, and birds. Each of these general categories consists of one or more indicator variables (Table 9). These biological indicators in concert will describe the characteristics of biotic populations on the Reservation and will provide information necessary for assessing recovery of important Tribal resources.

Table 9. List of protocols and sampling frequency for biological indicator variables.

General characteristics	Specific indicators	Recommended protocol	Sampling frequency
Fish	Fish abundance	Thurow (1994); Reynolds (1996); Van Deventer and Platts (1989)	Annual
	Age/size structure	Borgerson (1992); Anderson and Neumann (1996)	Annual
	Origin (hatchery or wild)	Borgerson (1992)	Annual
	Redd abundance	Mosey and Murphy (2002)	Annual
	Redd distribution	Mosey and Murphy (2002)	Annual
Macroinvertebrates	Abundance	Peck et al. (2001)	Annual
	Composition	Peck et al. (2001)	Annual
Amphibians	Occurrence	USFS Protocol; Olson et al. (1997)	Annual
	Abundance	USFS Protocol; Olson et al. (1997)	Annual
Birds	Occurrence	Sutherland (1996)	Annual
	Abundance	Sutherland (1996)	Annual

Fish

Abundance:

Numbers of fish (with emphasis on salmonids) will be estimated within status/trend monitoring reaches and effectiveness monitoring sites using underwater observations (snorkeling) or electrofishing surveys. Snorkeling, which is a quick, nondestructive method that is not restricted by deep water and low conductivities,[31] is the "primary" sampling method in this plan. Snorkel surveys will follow the protocols identified in Thurow (1994). For each fish observed, snorkelers will estimate fish size to the nearest 2 cm and report numbers as fish/ha.

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[31] Hillman and Miller (2002) reported that snorkel estimates were more accurate than electrofishing estimates in the Chiwawa River, a Wenatchee River tributary, because low conductivity (35 μmhos) in the river reduced the efficiency of electrofishing. They noted that electrofishing estimates were at best 68% of snorkel estimates.

Electrofishing is the “secondary” method and will be used within a sub-sample of snorkel sites. This plan recommends that at least six randomly-selected sites (20% of the status/trend sites sampled annually) be sampled with both snorkeling and electrofishing.[32] The purpose for this is to establish a relationship between the methods and to collect fish for assessment of condition (length and weight) and age. Electrofishing will follow the protocols outlined in Reynolds (1996). For salmonids, fork length (anterior tip to the median caudal fin rays) will be measured to the nearest 1 mm and weighed to the nearest 1 g. For all other fish, total length (anterior tip to the longest “compressed” caudal fin rays) will be measured to the nearest 1 mm and weighed to the nearest 1 g. This plan recommends the removal-depletion method of electrofishing, with at least three complete passes. The maximum-likelihood formula (Van Deventer and Platts 1989) will estimate population numbers and 95% confidence intervals. Numbers of fish will be reported as fish/ha.

Age/Size Structure:

Age structure describes the ages of fish within the population, while size describes the lengths and weights of fish within the population. Size structure will be estimated with both snorkeling and electrofishing. Scales will be pulled and read to determine age structure and origin (wild or hatchery). Age analysis will be completed following methods described by Borgerson (1992).

Origin:

Origin identifies the parentage (hatchery or wild) of individuals within the population. Origin will be assessed by examining scales or fins, with hatchery fish tending to have deformed or eroded fins.

Redd Abundance and Distribution:

Abundance describes the number of redds (nests) of fish species within a given area. Total numbers (based on a complete census) will be estimated for redband trout. Distribution indicates the spatial arrangement (e.g., random, even, or clumped) and geographic extent of redds within the basin. Throughout the spawning period, the Tribes will conduct weekly redd surveys following the example of Mosey and Murphy (2002). Each week new redds will be counted, mapped, and marked.[33] Marking is needed to avoid recounting redds during subsequent surveys. Abundance of redds will be reported as the number of redds within a population. Abundance will also be reported as the number of redds per km within each population.

Macroinvertebrates

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[32] Sampling within a site will occur within the same day and sites will be blocked to fish prevent movement into and out of the site during and between sampling.

[33] Because of inclement weather and high streamflows, surveys for redband trout redds may not be made on regularly timed intervals. Adjusting surveys to fit environmental conditions may be necessary.

Abundance/Diversity:

This plan includes benthic macroinvertebrate abundance and diversity (composition) as important indicators of aquatic invertebrates in streams. Benthic macroinvertebrate assemblages in streams reflect overall biological integrity of the benthic community. The Tribes will follow the "targeted-riffle-sample" method described in Peck et al. (2001). This method requires at least eight independent kick-net[34] samples from riffles within sites or reaches. The eight samples are combined, sieved to remove debris and sediments, and then processed in a lab. Samples will be analyzed according to the River InVertebrate Prediction and Classification System (RIVPACS) (Hawkins et al. 2001).

Amphibians

Occurrence/Abundance:

Occurrence (presence) and abundance of amphibians (Columbia spotted frogs) are biological indicators that describe the health of a riparian ecosystem. The Tribes will follow the standard protocol developed by the Northern Nevada Spotted Frog Technical Team (NNSFTT) (Amy 2003) and used by the U.S. Forest Service on the Ruby Mountains/Jarbidge and Mountain City Ranger districts. The two-person survey protocol is not time constrained and follows the search pattern described in Olson et al. (1997). In accordance with this protocol, every attempt is made to capture all individuals for positive identification. These protocols are used to census spotted frogs in the Owyhee and Bruneau basins.

Birds

Occurrence/Abundance:

Another indicator of a healthy riparian ecosystem is the presence of yellow warblers. The Tribes will follow the protocols described in Sutherland (1996). Specifically, field workers will use "response to playback" to identify the presence and distribution of yellow warblers within monitoring sites. To minimize bias, playbacks will be broadcast for set durations at a standard volume under set conditions (e.g., certain periods of the day).

Physical/Environmental Variables

This section identifies the methods and instruments that will be used to measure physical/environmental indicators. Table 10 identifies indicator variables, example protocols for measuring indicators, and sampling frequency. Importantly, and for obvious reasons, all habitat

[34] The kick net is a D-frame sampler with a 30.5-cm wide base, a muslin bottom panel, a net with a mesh size of 500 µm, and a detachable bucket with a 500-µm mesh end (see Figure 11-1 in Peck et al. 2001).

sampling will follow fish sampling (snorkeling and electrofishing) within status/trend monitoring reaches and effectiveness monitoring sites.

Table 10. List of protocols and sampling frequency of physical/environmental indicator variables. Table is modified from Hillman (2004).

General characteristics	Specific indicators	Recommended protocols	Sampling frequency
Water Quality	MWMT/MDMT	Zaroban (2000)	Annual/Continuous (hourly)
	Turbidity	OPSW (1999)	Annual/Continuous (hourly)
	Conductivity	OPSW (1999)	Annual/Continuous (hourly)
	pH	OPSW (1999)	Continuous (hourly)
	Dissolved Oxygen	OPSW (1999)	Continuous (hourly)
Habitat Access	Road crossings	Parker (2000); WDFW (2000)	Annual
	Diversion dams	WDFW (2000)	Annual
Habitat Quality	Dominant substrate	Peck et al. (2001)	Annual
	Embeddedness	Peck et al. (2001)	Annual
	LWD (pieces/km)	BURPTAC (1999)	Annual
	Pools per kilometer	Hawkins et al. (1993); Overton et al. (1997)	Annual
	Residual pool depth	Overton et al. (1997)	Annual
	Fish cover	Peck et al. (2001)	Annual
	Off-channels habitats	WFPB (1995)	Annual
Channel condition	Stream gradient	Peck et al. (2001)	Annual
	Width/depth ratio	Peck et al. (2001)	Annual
	Wetted width	Peck et al. (2001)	Annual
	Bankfull width	Peck et al. (2001)	Annual
	Bank stability	Moore et al. (2002)	Annual
Riparian Condition	Structure	Peck et al. (2001)	Annual
	Disturbance	Peck et al. (2001)	Annual
	Canopy cover	Peck et al. (2001)	Annual
Flows and Hydrology	Streamflow	Peck et al. (2001)	Continuous
Watershed Condition	Watershed road density	WFC (1998); Reeves et al. (2001)	5 years
	Riparian-road index	WFC (1998)	5 years

Water Quality

Water Temperature:

This plan includes two temperature metrics that will serve as specific indicators of water temperature: maximum daily maximum temperature (MDMT) and maximum weekly maximum temperature (MWMT). Data loggers will be used to measure MWMT and MDMT. Zaroban (2000) describes pre-placement procedures (e.g., selecting loggers and calibration of loggers), placement procedures (e.g., launching loggers, site selection, logger placement, and locality documentation), and retrieval procedures. This manual also provides standard methods for conducting temperature-monitoring studies associated with land-management activities and for characterizing temperature regimes throughout a watershed.

Data loggers will record temperatures hourly to the nearest 0.1˚C throughout the year. Investigators will also measure water temperatures with a calibrated thermometer at each site or reach sampled for fish. These snap-shot measurements will be used to assess the reliability of fish sampling techniques.[35]

Turbidity:

This plan includes turbidity as the one sediment-related specific indicator under water quality. The Tribes will measure turbidity with monitoring instruments calibrated on the nephelometric turbidity method (NTUs). Chapter 11 in OPSW (1999) provides a standardized method for measuring turbidity, data quality guidelines, equipment, field measurement procedures, and methods to store and analyze turbidity data.

Monitoring instruments will measure turbidity hourly to the nearest 1 NTU throughout the year. The Tribes will also measure turbidity with a portable turbidimeter within each site or reach sampled for fish. Because both electrofishing and snorkeling are affected by turbidity, these snap-shot measurements will be used to assess the reliability of the fish sampling techniques.

Conductivity, pH, and Dissolved Oxygen:

This plan includes three addition indicators associated with water quality: conductivity, pH, and dissolved oxygen (DO). OPSW (1999) identifies standard methods for measuring conductivity (Chapter 9), pH (Chapter 8), and DO (Chapter 7).[36] OPSW (1999) also includes criteria for data quality guidelines, equipment, field-measurement procedures, and methods to store and analyze water quality data.

Water quality instruments will be used to monitor conductivity, pH, and DO. These indicators will be measured hourly throughout the year. Hydrolab® has a water quality instrument (DataSonde 4a)[37] that measures the water quality indicators identified in this plan (Table 11). Conductivity will be measured to the nearest 0.1 μmhos/cm, pH to the nearest 0.1 unit, and DO to the nearest 0.1 mg/L. Because conductivity affects electrofishing success, a portable conductivity meter will be used to measure conductivity within each site or reach sampled for fish.

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[35] Both electrofishing and snorkeling are affected by water temperature. Hillman et al. (1992) demonstrated that snorkel counts are less reliable at cold water temperatures.
[36] Although OPSW (1999) indicates that the Winkler Titration Method is the most accurate method for measuring DO concentration, this plan will use an electronic recording device with an accuracy of at least ±0.2 mg/L.
[37] Information on Hydrolab and the DataSonde 4a can be found at http://www.hydrolab.com. The use of trade names in this paper does not imply endorsement by the Shoshone-Paiute Tribes.

Table 11. Water quality indicators, range, accuracy, and resolution of the DataSonde 4a developed by Hydrolab.

Indicator	Range	Accuracy	Resolution
Temperature	-5˚ to 50˚C	±0.10˚C	0.01˚C
Turbidity	0 to 1000 NTU	±5% of range	0.1 to 1 NTU
Conductivity	0 to 100 mS/cm	±0.001 mS/cm	4 digits
pH	0 to 14 units	±0.2 units	0.01 units
Dissolved oxygen	0 to 50 mg/L	±0.2 mg/L	0.01 mg/L

Habitat Access:

Artificial Physical Barriers:

The plan includes two specific indicators associated with artificial physical barriers: road crossings (culverts) and dams. Remote sensing (aerial photos, LANDSAT ETM+, or both) will be used as a first cut to identify possible barriers. The Tribes will then conduct field surveys using the WDFW (2000) protocols to evaluate possible barriers. The WDFW (2000) manual provides guidance and methods on how to identify, inventory, and evaluate culverts and dams (diversions) that impede fish passage. WDFW (2000) also provides methods for estimating the potential habitat gained upstream from barriers, allowing prioritization of restoration projects. The manual by Parker (2000) focuses on culverts and assesses connectivity of fish habitats on a watershed scale. These manuals can be used to identify all fish passage barriers within monitoring reaches. Assessment of fish passage barriers will occur once annually during base-flow conditions.

Habitat Quality

Substrate:

This plan includes two specific indicators of substrate: dominant substrate (composition) and embeddedness. Peck et al. (2001) provides a method for describing substrate composition within each site or reach. Substrate composition will be assessed within the bankfull width (not wetted width) along the “channel bottom” in the site or reach, regardless if the channel is wet or dry. The Tribes will measure substrate at five equidistant points along each of the 11 “regular” transects, plus along an additional 10 transects placed mid-way between each of the 11 transects. The Tribes will visually estimate the size of a particle at each of the points along the 21 transects (total sample size of 105 particles). Classification of bed material by particle size will follow Table 12. For each sampling site or reach, the Tribes will report the dominant substrate size. Additionally, they will calculate reach-level means, standard deviations, and percentiles for substrate size classes (following methods in Kaufmann et al. 1999). Substrate will be characterized annually during base-flow conditions.

Table 12. Classification of stream substrate channel materials by particle size. Table is from Peck et al. (2001).

Class name	Size range (mm)	Description
Bedrock (smooth)	>4,000	Smooth surface rock larger than a car
Bedrock (rough)	>4,000	Rough surface rock larger than a car
Hardpan		Firm, consolidated fine substrate
Boulders	>250-4,000	Basketball to car size
Cobbles	>64-250	Tennis ball to basketball size
Gravel (coarse)	>16-64	Marble to tennis ball size
Gravel (fine)	>2-16	Ladybug to marble size
Sand	>0.06-2	Smaller than ladybug size, but visible as particles
Fines	<0.06	Silt, clay, muck (not gritty between fingers)

Peck et al. (2001) also provides methods for measuring embeddedness. As with substrate composition, embeddedness will be assessed within the bankfull width (not wetted width) along the "channel bottom," regardless if the channel is dry or wet. Embeddedness will be estimated at five equidistant points along the 11 "regular" transects (total sample size of 55). At each sampling point along a transect, all particles larger than sand within a 10-cm diameter circle will be examined for embeddedness. Embeddedness is the fraction of particle surface that is surrounded by sand or finer sediments. By definition, sand and fines are embedded 100%, while bedrock is embedded 0%. The Tribes will record the average percent (%) embeddedness of particles in the 10-cm circle. Embeddedness will be measured once annually during base-flow stream conditions.

Large Woody Debris:

Large woody debris (LWD) consists of large pieces of relatively stable woody material located within the bankfull channel and appearing to influence bankfull flows. The Tribes will simply count the number of LWD pieces within sites or reaches (wet or dry) in forested streams (e.g., see BURPTAC 1999). Pieces are counted throughout the entire reach or site, not just along transects. LWD will be divided into three size categories: >10 cm x >1 m; >15 cm x >6 m; and >30 cm x >3 m (diameter x length, respectively). The Tribes will record the count of LWD pieces within each size category. This indicator will be measured once annually during base-flow conditions.

Pool Habitat:

This plan includes two indicators associated with pool habitat: number of pools per km and residual pool depth. The Tribes will count the number of pools throughout a monitoring reach or site. To be counted, a pool must span more than half the wetted width, include the thalweg, be longer than it is wide, and the maximum depth must be at least 1.5 times the crest depth. Plunge pools are included in this definition even though they may not be as long as they are wide. Hawkins et al. (1993) and Overton et al. (1997) provide good descriptions of the various types of pools and how to identify them. Pools are counted throughout the entire reach or site, not just along transects.

Overton et al. (1997) describe methods for measuring residual pool depth. Residual pool depth is simply the difference between the maximum pool depth and the crest depth. Measurements differ, however, depending on the type of pool. For dammed pools, residual depth is the difference between maximum pool depth and maximum crest depth at the head of the pool. For scour pools, on the other hand, residual pool depth is the difference between maximum pool depth and maximum crest depth at the tail of the pool. Depths are measured to the nearest 0.01 m. For effectiveness monitoring, residual pool depth will be measured in all pools within treatment and control sites. For status/trend monitoring, residual pool depth will be measured in all pools within a reach. Both pool per km and residual pool depth will be measured once annually during base-flow conditions.

Fish Cover:

Fish cover is measured within the wetted width of a site or reach. Fish cover is not measured in dry side channels. It is visually estimated at 5 m upstream and 5 m downstream (10-m total length) at each of the 11 "regular" transects following procedures described in Peck et al. (2001). Cover types consist of filamentous algae, aquatic macrophytes (including wetland grasses), large woody debris, brush and small woody debris, in-channel live trees or roots, overhanging vegetation (within 1 m of the water surface but not in the water), undercut banks, boulders, and artificial structures (e.g., concrete, cars, tires, rip-rap, etc.). For each cover type, the Tribes will record areal cover as: 0 (zero cover), 1 (<10% cover), 2 (10-40% cover), 3 (40-75% cover), and 4 (>75% cover). Fish cover will be estimated annually during base-flow conditions.

Off-Channel Habitat:

Off-channel habitat consists of side-channels, backwater areas, alcoves or sidepools, off-channel pools, off-channel ponds, and oxbows. Following the definitions for each off-channel habitat type (see Section 5.3), the Tribes will enumerate the number of each type of off-channel habitat within a monitoring reach or site. Off-channel habitats will be enumerated throughout the entire site or reach, not just along transects. In addition, the Tribes will measure the lengths of side channels in the site or reach. They will record the number of off-channel habitat types and the lengths of side channels (measured to the nearest 0.5 m) within the site or reach. Sampling will occur once annually during base-flow conditions.

Channel Condition

Stream Gradient:

The water surface gradient or slope is an indication of potential water velocities and stream power. Water surface slope will be reported as a percentage[38] and will be measured according to the protocol described in Peck et al. (2001) with some modifications. Rather than measure percent slope directly with a clinometer or Abney level, as recommended in Peck et al. (2001), this plan calls for the measurement of water surface elevations with a hand level. That is, water surface elevation will be measured between each of the 21 transects (includes the 11 "regular" and 10 "additional" transects) using a hand level (5X magnifying level) and a telescoping leveling rod (graduated in cm). Beginning at the downstream-end of the reach or site, water surface elevation is measured by "backsighting" downstream between transects (results in 20 measurements per reach or site). The Tribes will record the elevation (measured to the nearest cm) and horizontal distance between transects points (measured to the nearest cm). Percent water surface slope is then calculated as the fall per unit distance (rise over run), times 100. Sampling will occur once annually during base-flow conditions.

Width/Depth Ratio:

The width/depth ratio is an index of the cross-section shape of a stream channel at bankfull level. The ratio is expressed as bankfull width (geomorphic term) divided by the mean cross-section bankfull depth. Peck et al. (2001) offer the recommended protocol for measuring bankfull widths and depths. This indicator will be measured at the 21 transects (includes the 11 "regular" and 10 "additional" transects) within each reach (for status/trend monitoring) or treatment and control sites (for effectiveness monitoring), regardless if the channel is wet or dry. Width and depth will be recorded to the nearest 0.1 m. Sampling will occur once annually during base-flow conditions.

Wetted Width:

Wetted width is the width of the water surface measured perpendicular to the direction of flow. Peck et al. (2001) describes the recommend method for measuring this indicator. Wetted width will be measured to the nearest 0.1 m at the 21 transects (11 "regular" and 10 "additional" transects) in each reach or treatment and control sites. Sampling will occur once annually during base-flow conditions.

Bankfull Width:

Bankfull width is the width of the channel (water surface) at bankfull stage. Peck et al. (2001) describe methods for measuring bankfull width. Bankfull width will be measured to the nearest 0.1 m at the 21 transects in each reach (for status/trend monitoring) or treatment and control sites (for effectiveness monitoring), regardless if the channel is wet or dry. Sampling will occur once annually during base-flow conditions.

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[38] Although this plan recommends reporting slope as a percentage, one can easily convert between percentage, decimal, and degrees with the following formulas: (1) Percent slope = slope (in decimal form) x 100; (2) Slope (in decimal form) = tan (slope in degrees); and (3) Slope (in degrees) = $\tan^{-1}$ (slope in decimal form).

Streambank Condition:

This plan includes streambank stability as the one specific indicator of streambank condition. Moore et al. (2002) describe the recommended method for assessing stream bank stability. The method estimates the percent (%) of the lineal distance that is actively eroding at the active channel height on both sides of the transect regardless if the channel is wet or dry. Active erosion is defined as recently eroding or collapsing banks and may have the following characteristics: exposed soils and inorganic material, evidence of tension cracks, active sloughing, or superficial vegetation that does not contribute to bank stability. Bank stability will be measured once annually during base-flow conditions at the 11 evenly-spaced transects within each reach (for status/trend monitoring) or treatment and control site (for effectiveness monitoring).

Riparian Condition

Structure:

Riparian structure identifies the type and amount of various kinds of riparian vegetation. Peck et al. (2001) offer methods for describing riparian structure. Riparian structure will be assessed within a 10 m x 10 m plot on both ends of each of the 11 transects, regardless if the channel is wet or dry. Within each riparian plot, the investigator will divide the vegetation into three layers: canopy layer (>5-m high), understory layer (0.5-5-m high), and the ground-cover layer (<0.5-m high). Areal cover will be estimated within each of the three vegetation layers. Aerial cover is recorded as "0" if no cover; "1" if <10% cover; "2" if 10-40%; "3" if 40-75%; or "4" if >75% cover. The type of vegetation will be described in both the canopy and understory layers. Vegetation types include deciduous, coniferous, broadleaf evergreen, mixed, and none. Kaufmann et al. (1999) describes methods for analyzing riparian structure data. This indicator will be measured once annually during base-flow conditions.

Disturbance:

Riparian disturbance will be measured as the presence and proximity of various types of human land-use activities in the riparian area. Peck et al. (2001) provide the recommended method for assessing this indicator. The presence/absence and proximity of 11 categories of human influences will be described within 5 m upstream and 5 m downstream from each of the 11 transects, regardless if the channel is wet or dry. Human influences include: (1) walls, dikes, revetments, riprap, and dams; (2) buildings; (3) pavement/cleared lot; (4) roads or railroads; (5) inlet or outlet pipes; (6) landfills or trash; (7) parks or maintained lawns; (8) row crops; (9) pastures, rangeland, hay fields, or evidence of livestock, (10) logging; and (11) mining. Proximity classes include: (1) present within the defined 10 m stream segment and located in the stream or on the stream bank; (2) present within the 10 x 10 m riparian plot but away from the bank; (3) present but outside the riparian plot; and (4) not present within or adjacent to the 10 m stream segment or the riparian plot area at the transect. Kaufmann et al. (1999) describes methods for analyzing riparian disturbance data. Riparian disturbance will be measured once annually during base-flow conditions.

Canopy Cover:

Peck et al. (2001) describe the recommended method for measuring canopy cover. Canopy cover will be measured at each of the 11 equally-spaced transects in wet or dry channels using a Convex Spherical Densiometer (model B). Six measurements are collected at each transect (four measurements in four directions at mid-channel and one at each bank). The mid-channel measurements estimate canopy cover over the channel, while the two bank measurements estimate cover within the riparian zone. The two bank measurements are particularly important in wide streams, where riparian canopy may not be detected at mid-channel. The investigator records the number of grid intersection points (0-17) that are covered by vegetation at the six points along each transect. Mean densiometer readings and standard deviations are calculated according to methods described in Kaufmann et al. (1999). Canopy cover will be measured once annually during base-flow conditions.

Flows and Hydrology

Streamflows:

Changes in streamflows will be assessed by collecting flow data at the downstream end of monitoring reaches and/or at the downstream end of the distribution of each population or subpopulation. The Tribes will use USGS or State flow data where available to assess changes in peak, base, and timing of flows. For those streams or springs with no USGS or State stream-gauge data, the Tribes will use the velocity-area method described in Peck et al. (2001) to estimate stream flows. Water velocities will be measured to the nearest 0.01 m/s with a calibrated water-velocity meter rather than the float method. Wetted width and depth will be measured to the nearest 0.1 m. Flows will be reported as m^3/s.[39]

Watershed Conditions

Road Density:

The plan includes road density and the riparian-road index (RRI) as indicators of roads within watersheds. Using remote sensing, the Tribes will measure the road density and riparian-road index within each watershed in which monitoring activities occur. Road density will be calculated with GIS as the total length (km) of roads within a watershed divided by the area (km^2) of the watershed. The riparian-road index will be calculated with GIS as the total kilometers of roads within riparian areas divided by the total number of stream kilometers within the watershed. WFC (1998) provides an example of

[39] The following formula can be used to convert cfs (cubic feet per second) to cms (cubic meters per second): cms = cfs x 0.02832.

calculating the riparian-road index in the Umpqua Basin. Both road density and the riparian-road index will be updated once every five years.

Equipment List

This section identifies the equipment that will be used to monitor biological and physical/environmental indicators on the Duck Valley Indian Reservation (Table 13). Some equipment will be used for more than one general indicator. Those items (e.g., chest waders and boots) are listed only once.

Table 13. List of equipment needed to monitor biological and physical/environmental indicators on the Duck Valley Indian Reservation.

General Indicator	Equipment	Quantity
Fish populations and redds	Backpack electrofisher with batteries	2
	Battery chargers	2
	Block nets	4
	Dip nets	4
	Rubber gloves	4
	Polarized sun glasses	4
	Buckets (5-gallon)	4
	Field-worthy scale (e.g., Ohaus Scale)	2
	Measuring board (mm)	2
	MS-222	2
	Lightweight breathable waders	4
	Wading boots with felt	4
	Dry/wet neoprene suits	4
	Diving gloves	4
	Diving hoods	4
	Masks and snorkels	4
	Dive slates	4
	Biodegradable flagging tapes	10
	First aid kits	2
	Write-in-the-rain notebooks	10
	Field data sheets	100
	USGS 7.5 minute topographic maps	4
	Soft pencils	10
Macroinvertebrates	Modified kick net (D-frame with 500 µm mesh)	2

	Stopwatch	2
	Plastic buckets (2-gallon)	2

Indicator	Equipment	Quantity
Macroinvertebrates (cont.)	Forceps	2
	Sieve with 500 µm mesh	2
	HDPE plastic sample jars (1 liter)	50
	Wash bottle (l liter)	2
	Spoons or scoops	2
	Funnel with large bore spout	2
	95% ethanol (2 gallons)	2
	Sample bottle labels	100
	Rubber gloves	4
	Waterproof labels	100
	Data forms	100
	Coolers	2
	Clear tape	4
	Soft lead pencils	10
	Pocket knifes	2
Amphibians	Aquatic net with 3 ft. aluminum handle	4
	3:1 concentration of bleach/water solution (5 L)	1
	Lightweight breathable waders/boots	4
	Data forms (write-in-the-rain logbooks)	8
	Soft lead pencils	10
Birds	Bird calls on CD	2
	CD electronic caller	2
	Waterproof compact binoculars	2
	Data forms	100
	Soft lead pencils	10
Water Quality	DataSonde 4a (or other continuous recorders)	
	Optic shuttle data transporter	2
	Submersible temperature loggers	
	Multi-parameter meters (turbidity/conductivity/DO/Temp)	2
Habitat Access, Quality, and Channel Condition	Digital camera	2
	Handheld GPS	2

	Rebar (2-foot lengths)	150
	Magnifying hand level (5x)	2

Indicator	Equipment	Quantity
Habitat Access, Quality, and Channel Condition	Telescoping fiberglass leveling rods (metric)	2
	Meter sticks	2
	Metal detectors (for finding rebar)	2
	Fiberglass measuring taps (50 m)	2
	Bearing compass	2
	Convex spherical densitometer (model B)	2
	Biodegradable flagging tapes	10
	Measuring rods (2-m wood or plastic rods marked in cm)	2
	Covered clipboards	2
	Blank write-in-the-rain sheets (for site diagrams)	100
	Data forms	100
	Soft lead pencils	20
	Ten-pocket field vests	4
Flows and Hydrology	Current velocity meters	2
	Stream staff gauges	
	Data forms	50
	Soft lead pencils	10

implementation schedule

The Shoshone-Paiute Tribes intend to begin status/trend and effectiveness monitoring in 2004 (Table 14). Before field work begins, however, the Tribes will classify the entire Reservation following methods described in Section 4. They will also work with EPA on selecting status/trend monitoring sites following protocols identified in Section 5. Once those sites are selected, the Tribes will work with the Tribal Environmental Protection Program (TEPP) to coordinate monitoring efforts. At the same time they will be selecting sites for effectiveness monitoring following methods outlined in Section 6. Sites selected for effectiveness monitoring will also be coordinated with status/trend monitoring and TEPP. This will be a one-time effort and will not be repeated annually.

Following classification work and the selection of sampling sites for both status/trend and effectiveness monitoring, the Tribes will begin collecting field data (Table 14). Most field sampling will occur in July and August during base-flow conditions. Spawning surveys will be conduced during the spring when redband trout spawn. Data compiling, analysis, and report writing will occur during autumn and early winter. Draft annual reports will be submitted for review by mid-February. Final annual reports will be completed by the end of March. Annual reports will document results of status/trend and effectiveness monitoring, coordination activities with TEPP, problems associated with the monitoring strategy, and changes or improvements to the strategy.

Table 14. Monitoring activities planned for 2004.

Program	Activity	Month 2004						
		Jun	Jul	Aug	Sep	Oct	Nov	Dec
Landscape Classification	GIS classification work	X	X					
Status/Trend Monitoring	Selection of sites	X	X					
	Coordination with TEPP	X	X					
	Data collection		X	X				
Effectiveness Monitoring	Selection of sites	X	X					
	Coordination with TEPP	X	X					
	Data collection		X	X				
Report Preparation	Data compiling/analysis				X	X	X	
	Report writing						X	X

Monitoring on the Reservation should continue for at least five years. Additional years may be needed to assess effects of actions on riparian habitat conditions. Status/trend monitoring should continue indefinitely.

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Appendix A—Effectiveness monitoring projects

This appendix identifies the three classes of management actions (strategies) that will be monitored for effectiveness on the Duck Valley Indian Reservation. For each action there is a brief description of the objectives, hypotheses, indicators, strategies, statistical/sampling designs, and existing monitoring efforts.

SPRING ENHANCEMENT AND HEADWATERS PROTECTION

Goal:

Improve water quality, stream flows, channel conditions, and riparian conditions on the DVIR by protecting headwaters and springs from livestock use.

Assessment Area:

Actions will be implemented in the following drainages:

- Reed Creek drainage
- East Fork Owyhee drainage
- Jones Creek drainage
- Summit Creek drainage

Objectives:

1. Improve water quality by excluding livestock from headwaters and springs.
2. Improve stream flow conditions and bank stability by excluding livestock from headwaters and springs.
3. Decrease fine sediment delivery to channels by excluding livestock from headwaters and springs.
4. Protect and restore riparian habitat conditions by excluding livestock from headwaters and springs.
5. Increase the abundance and distribution of salmonids (especially redband trout) by excluding livestock from headwaters and springs.
6. Increase the abundance and diversity of aquatic insects in streams by excluding livestock from headwaters and springs.
7. Increase the occurrence of yellow warblers and Columbia spotted frogs by excluding livestock from headwaters and springs.

Hypotheses:

1. The exclusion of livestock from headwaters and springs will significantly reduce stream temperatures and turbidity.
2. The exclusion of livestock from headwaters and springs will significantly increase stream flows and bank stability.
3. The exclusion of livestock from headwaters and springs will significantly decrease the delivery and accumulation of fine sediments in stream channels.
4. The exclusion of livestock from headwaters and springs will significantly improve riparian habitat conditions.
5. The exclusion of livestock from headwaters and springs will significantly increase that abundance and distribution of redband trout.
6. The exclusion of livestock from headwaters and springs will significantly increase the abundance and diversity of aquatic macroinvertebrates.
7. The exclusion of livestock from headwaters and springs will significantly increase the occurrence of yellow warblers and Columbia spotted frogs in riparian areas.

Focal Species:

1. Redband Trout
2. Aquatic macroinvertebrates (especially stoneflies, mayflies, and caddisflies)
3. Yellow warbler
4. Columbia spotted frog

Indicators:

Water Quality:

- Temperature (MDMT and MWMT)
- Turbidity

Habitat Quality:

- Dominant substrate
- Embeddedness
- Number of pools
- Residual pool depth

Channel Condition:

- Width/depth ratio
- Wetted width
- Bankfull width
- Bank stability

Riparian Condition:

- Riparian structure
- Riparian disturbance
- Canopy cover

Flows and Hydrology:

- Stream flows

Biological Conditions:

- Abundance and distribution of redband trout
- Abundance and diversity of aquatic macroinvertebrates
- Occurrence of yellow warblers
- Occurrence of Columbia spotted frogs

Management Actions (Strategies):

1. Fence headwaters, springs, and sensitive riparian areas.
2. Provide off-site stock watering.

Statistical/Sampling Design:

Because these actions were implemented before 2004, the effects of livestock exclusions on springs and headwaters will be assessed with a control-treatment design using random sampling. Gradient analysis may be used if the sampling design includes actions implemented within different years.

Ongoing Programs:

There are no current programs that monitor physical/environmental and biological conditions in this assessment area.

UNIMPROVED BACKCOUNTY ROAD RECLAMATION

Goal:

Reduce fine sediment recruitment and erosion within streams along backcountry roads and stream crossings on the DVIR.

Assessment Area:

Actions will be implemented in the following drainages:

- Skull Creek drainage
- North Fork Skull Creek drainage
- Fawn Creek drainage
- Summit Creek drainage

Objectives:

1. Improve water quality of streams by improving backcountry roads and streams crossings.
2. Improve stream habitat conditions (pools) by improving backcountry roads and streams crossings.
3. Decrease fine sediment delivery to channels by improving backcountry roads and streams crossings.
4. Increase the abundance of salmonids (especially redband trout) by improving backcountry roads and streams crossings.
5. Increase the abundance and diversity of aquatic insects in streams by improving backcountry roads and streams crossings.

Hypotheses:

1. The improvement of backcountry roads and stream crossings will significantly reduce stream turbidity.
2. The improvement of backcountry roads and stream crossings will significantly increase numbers of pools and residual pool depths.
3. The improvement of backcountry roads and stream crossings will significantly decrease the accumulation of fine sediments in stream channels.
4. The improvement of backcountry roads and stream crossings will significantly increase that abundance of redband trout in the assessment area.
5. The improvement of backcountry roads and stream crossings will significantly increase the abundance and diversity of aquatic macroinvertebrates in the assessment area.

Focal Species:

1. Redband Trout
2. Aquatic macroinvertebrates (especially stoneflies, mayflies, and caddisflies)

Indicators:

Water Quality:

- Temperature (MDMT and MWMT)
- Turbidity

Habitat Access:

- Fish passage through culverts

Habitat Quality:

- Dominant substrate
- Embeddedness
- Number of pools
- Residual pool depth

Channel Condition:

- Width/depth ratio
- Wetted width
- Bankfull width

Biological Conditions:

- Abundance of redband trout
- Abundance and diversity of aquatic macroinvertebrates

Management Actions (Strategies):

1. Install drainage dips (cross drains) and sediment catchments.
2. Install geo-web, rock crossings, or culverts where springs or small streams cross roads.
3. In-slope roads.
4. Re-vegetate.
5. Contour roads.

Statistical/Sampling Design:

Because actions were implemented in 2002 and 2003, the effects of road reclamation will be assessed with a control-treatment design using random sampling. All culverts placed in fish-bearing streams will be monitored for fish passage.

Ongoing Programs:

With the exception of Summit Creek, there are no current programs that monitor physical/environmental and biological conditions in this assessment area. There may be some monitoring within Summit Creek associated with spring enhancement actions. Monitoring in Summit Creek will be coordinated between the two actions.

RESTORATION OF THE EAST FORK OWYHEE RIVER

Goal:

Improve water quality, stream habitat, and channel and riparian conditions on the East Fork Owyhee River by implementing habitat restoration actions.

Assessment Area:

Actions will be implemented along a 3.5 mile stretch of the East Fork Owyhee River.

Objectives:

1. Improve water quality on the East Fork by implementing restoration and protection activities.
2. Improve habitat and channel conditions on the East Fork by implementing restoration and protection activities.
3. Decrease fine sediment delivery to the East Fork by implementing restoration and protection activities.
4. Improve riparian habitat conditions on the East Fork by implementing restoration and protection activities.
5. Increase the abundance of salmonids (especially redband trout) on the East Fork by implementing restoration and protection activities.
6. Increase the abundance and diversity of aquatic insects on the East Fork by implementing restoration and protection activities.
7. Increase the occurrence of yellow warblers and Columbia spotted frogs along the East Fork by implementing restoration and protection activities.

Hypotheses:

1. The implementation of restoration actions will significantly reduce stream temperatures and turbidity on the East Fork Owyhee River.
2. The implementation of restoration actions will significantly reduce fine sediment concentrations in the East Fork Owyhee River.
3. The implementation of restoration actions will significantly increase habitat diversity on the East Fork Owyhee River.
4. The implementation of restoration actions will significantly improve channel conditions in the East Fork Owyhee River.
5. The implementation of restoration actions will significantly improve riparian habitat conditions along the East Fork Owyhee River.
6. The implementation of restoration actions will significantly increase the abundance of redband trout in the East Fork Owyhee River.
7. The implementation of restoration actions will significantly increase the abundance and diversity of aquatic macroinvertebrates in the East Fork Owyhee River.
8. The implementation of restoration actions will significantly increase the occurrence of yellow warblers and Columbia spotted frogs in riparian areas along the East Fork Owyhee River.

Focal Species:

1. Redband Trout
2. Aquatic macroinvertebrates (especially stoneflies, mayflies, and caddisflies)
3. Yellow warbler

4. Columbia spotted frog

Indicators:

Water Quality:
- Temperature (MDMT and MWMT)
- Turbidity

Habitat Quality:
- Substrate composition
- Embeddedness
- Frequency of LWD
- Number of pools
- Residual pool depth
- Fish cover
- Off-channel habitat

Channel Condition:
- Width/depth ratio
- Wetted width
- Bankfull width
- Bank stability

Riparian Condition:
- Riparian structure
- Riparian disturbance
- Canopy cover

Biological Conditions:
- Abundance of salmonids (especially redband trout)
- Abundance and diversity of aquatic macroinvertebrates
- Occurrence of yellow warblers
- Occurrence of Columbia spotted frogs

Management Actions (Strategies):

1. Plant willows.
2. Re-slope and transplant shrubs.
3. Excavate low-flow channel and construct gravel bars.
4. Excavate floodplain.
5. Install fabric encapsulated soil lifts.
6. Install riparian revetments.
7. Create a new floodplain.

Statistical/Sampling Design:

1. Restoration actions implemented along the East Fork Owyhee River will be assessed with a before-after-control-impact design using stratified random sampling.

Ongoing Programs:

The Tribal Environmental Protection Program (TEPP) is currently monitoring water quality in the East Fork. This work will integrate with TEPP.

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