Lower Columbia Fish Recovery Board

Habitat Strategy

2006

J. Kalama River Subbasin

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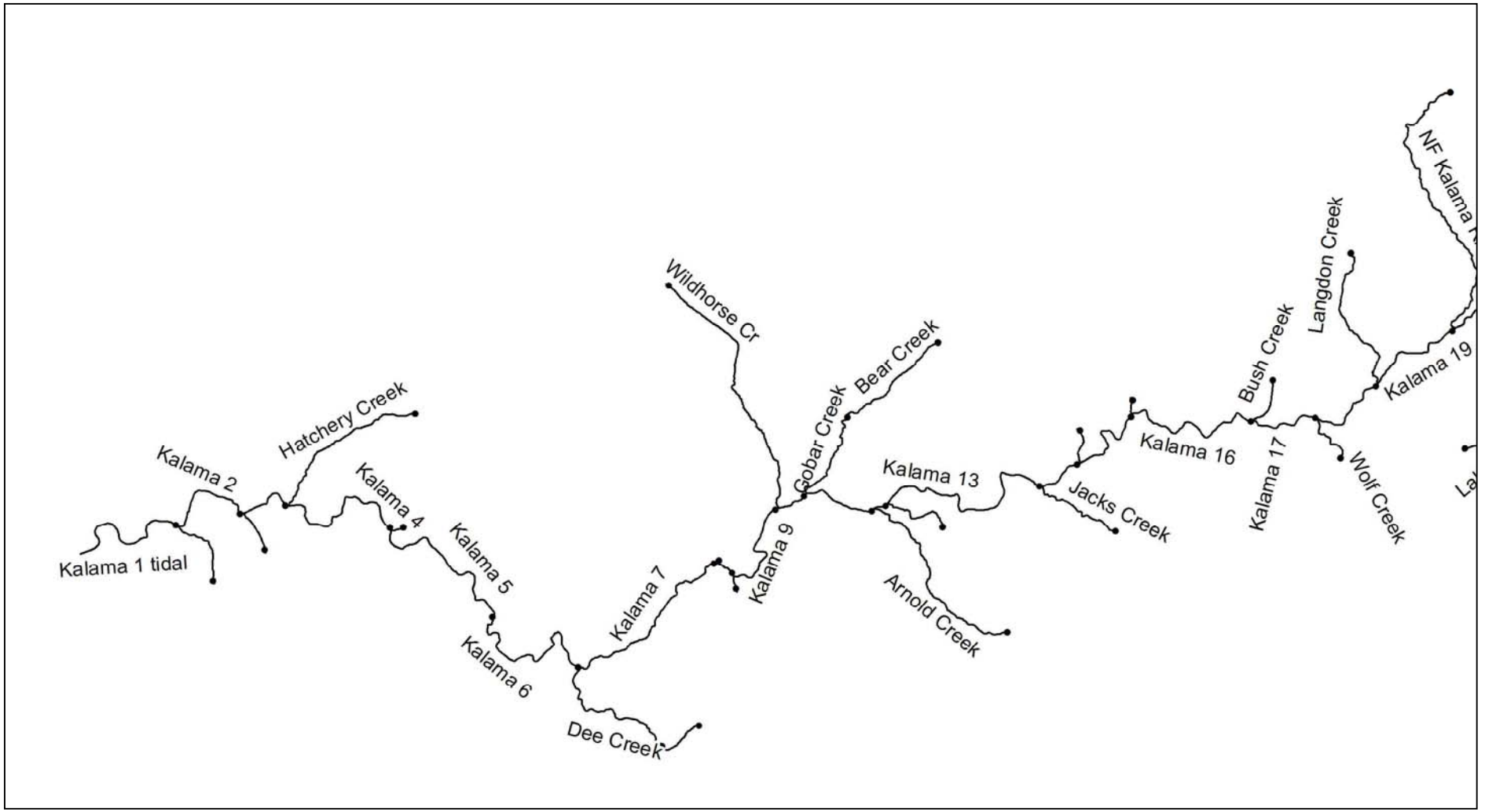
1.1 Subbasin Reach Priorities and Potential Restoration Activities Table

Stream Reaches	Species Presence and Reach Potential						Reach Tier	Restoration v. Preservation Value		Multi-Species Project Benefits Note: project benefits are derived from conditions of limiting factors and not from field observation of site-specific project needs								
	Winter Steelhead	Summer Steelhead	Fall chinook	Spring chinook	Coho	Chum		Restoration	Preservation	Access to blocked habitats	Stream channel habitat structure & bank stability	Off channel & side channel habitat	Floodplain function and channel migration processes	Riparian conditions & functions	Water quality	Instream flows	Regulated stream mngt for habitat functions	Watershed conditions & hillslope processes
Designation	*P*	*P*	*P*	*P*	*C*	*S*												
Kalama 2[1,2]	L	L	H	L	H	H	1	45%	55%	L	H	H[1,2]	H[1,2]	H[1,2]	M	H	L	H
Kalama 4	H	L	M	L	M	M	1	58%	42%	L	H	H	H	H	M	H	L	H
Kalama 5	H	L	M	L	L	H	1	45%	55%	L	H	H	H	H	L	H	L	H
Kalama 3	L	L	H	L	H	M	1	63%	37%	L	H	H	H	H	L	H	L	H
Kalama 6	H	H		H			1	36%	64%	L	H	H	H	H	M	H	L	H
Kalama 10	H	L		H			1	35%	65%	L	H	M	M	H	L	M	L	H
Kalama 8	H	L		H			1	35%	65%	L	H	H	M	H	M	H	L	H
Kalama 9	H	L		H			1	35%	65%	L	H	H	M	H	L	M	L	H
Kalama 11	L	L		H			1	45%	55%	L	H	M	M	H	L	M	L	H
Kalama 12	L	L		H			1	44%	56%	L	H	H	H	M	L	M	L	M
Kalama 17		H		M			1	43%	57%	L	H	H	H	H	L	H	L	H
Kalama 18		H		M			1	44%	56%	L	H	H	H	H	L	H	L	H
Kalama 15		L		H			1	42%	58%	L	H	H	H	M	L	M	L	H
Kalama 19		H		L			1	42%	58%	L	H	H	H	H	L	H	L	H
Kalama 20		H		L			1	44%	56%	L	H	M	M	M	L	H	L	H
Kalama 13	M	L		M			2	41%	59%	L	M	M	M	M	L	M	L	H
Kalama 16		M		M			2	40%	60%	L	H	H	M	M	L	M	L	H
Kalama 7	M	L		L			2	31%	69%	L	H	M	M	M	L	M	L	H
Gobar Cr	M	L					2	65%	35%	L	M	M	M	M	L	M	L	M
Kalama 14		L		M			2	36%	64%	L	H	M	M	M	L	M	L	H
Kalama 21		M		L			2	50%	50%	L	H	M	M	M	L	M	L	H
NF Kalama		M					2	57%	43%	L	M	M	M	M	L	M	L	H
Kalama 1 tidal[1,2,3,4,5]	L	L	L	L	M	L	3	63%	37%	L	H[4]	H[1,2,5]	H[1,2,3]	H[1,2,3]	L	H	L	H
Hatchery Cr			L		L	L	4	33%	67%	L	H	M	M	M	L	M	L	H
Knowlton Cr	L	L					4	67%	33%	L	L	L	L	L	L	L	L	L
Spencer Cr					L	L	4	36%	64%	L	M	M	M	M	L	M	L	M
Arnold Cr		L					4	39%	61%	L	L	L	L	L	L	L	L	M

Stream Reaches	Species Presence and Reach Potential						Reach Tier	Restoration v. Preservation Value		Multi-Species Project Benefits Note: project benefits are derived from conditions of limiting factors and not from field observation of site-specific project needs								
	Winter Steelhead	Summer Steelhead	Fall chinook	Spring chinook	Coho	Chum		Restoration	Preservation	Access to blocked habitats	Stream channel habitat structure & bank stability	Off channel & side channel habitat	Floodplain function and channel migration processes	Riparian conditions & functions	Water quality	Instream flows	Regulated stream mngt for habitat functions	Watershed conditions & hillslope processes
Designation	*P*	*P*	*P*	*P*	*C*	*S*												
Bear Cr		L					4	37%	63%	L	L	L	L	L	L	L	L	L
Bush Cr		L					4	49%	51%	L	L	L	L	L	L	L	L	M
Elk Cr		L					4	100%	0%	L	L	L	L	L	L	L	L	L
Indian Cr		L					4	0%	0%	L	L	L	L	L	L	L	L	L
Jacks Cr		L					4	42%	58%	L	L	L	L	L	L	L	L	M
Lakeview Peak Cr		L					4	52%	48%	L	M	M	L	M	L	M	L	M
Langdon Cr		L					4	50%	50%	L	M	L	L	M	L	M	L	M
Little Kalama R	L						4	73%	27%	L	M	M	M	M	L	M	L	M
Lost Cr		L					4	48%	52%	L	L	L	L	L	L	L	L	M
Summers Cr	L						4	59%	41%	L	M	L	L	M	L	L	L	M
Unnamed Cr (27.0087)		L					4	40%	60%	L	L	L	L	L	L	L	L	M
Wildhorse Cr[6]	L						4	78%	22%	L	M[6]	M	M	M	L	M	L	M
Wolf Cr		L					4	50%	50%	L	M	L	L	L	L	L	L	M
Cedar Cr					L		4	24%	76%	L	L	L	L	L	L	L	L	L
[1]Floodplain, riparian, and off-channel habitat restoration (south bank RM 2.2-2.5)																		
[2]Floodplain, riparian, and off-channel habitat restoration (north bank RM 2.0-2.4)																		
[3]Remove abandoned pipeline RM 2.1																		
[4]Address impairments to geomorphic processes at mouth																		
[5]Create/restore off-channel habitat RM 1.4-1.9																		
[6]Spawning gravel enhancement; gravel retention (Wildhorse Creek)																		

1.2 Subbasin Map



1.3 Kalama - Summary

The Kalama River is one of eleven major subbasins in the Washington portion of the Lower Columbia Region. This subbasin historically supported thousands of fall Chinook, winter steelhead, chum, and coho. Today, numbers of naturally spawning salmon and steelhead have plummeted to levels far below historical numbers. Chinook, chum, and steelhead have been listed as Threatened under the Endangered Species Act and coho is proposed for listing. The decline has occurred over decades and the reasons are many. Freshwater and estuary habitat quality has been reduced by agricultural and forestry practices. Key habitats have been altered or eliminated by modifications to stream channels, floodplains, and wetlands. Altered habitat conditions have increased predation. Competition and interbreeding with domesticated or nonlocal hatchery fish has reduced productivity. Hydropower construction and operation on the Columbia has altered flows, habitat, and migration conditions. Fish are harvested in fresh and saltwater fisheries.

Kalama River fall Chinook, spring Chinook, winter steelhead and summer steelhead will need to be restored to a high level of viability to meet regional recovery objectives. This means that the populations are productive, abundant, exhibit multiple life history strategies, and utilize significant portions of the subbasin. Coho will need to be restored to a medium level of viability and chum to a low level of viability to contribute to recovery.

In recent years, agencies, local governments, and other entities have addressed threats to salmon and steelhead, but much remains to be done. One thing is clear: no single threat is responsible for the decline in these populations. All threats and limiting factors must be reduced if recovery is to be achieved. An effective recovery plan must also reflect a realistic balance within physical, technical, social, cultural and economic constraints. The decisions that govern how this balance is attained will shape the region's future in terms of watershed health, economic vitality, and quality of life.

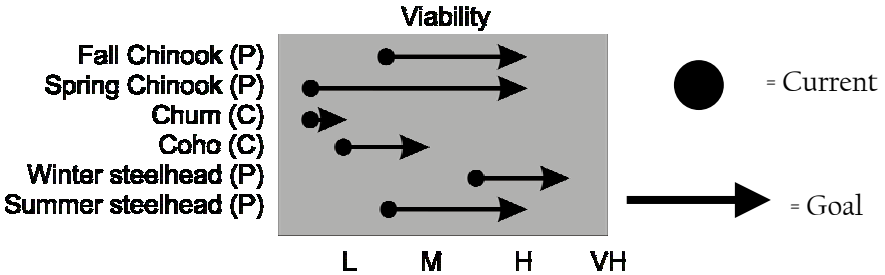
1.4 Key Priorities

Many actions, programs, and projects will make necessary contributions to recovery and mitigation in the subbasin. The following list identifies the most immediate priorities and are explained in more detail in the following pages.

1. Manage Forest Lands Restore Watershed Processes
2. Manage Growth and Development to Protect Watershed Processes and Habitat Conditions
3. Restore Passage at Culverts and Other Artificial Barriers
4. Align Hatchery Priorities with Conservation Objectives
5. Manage Fishery Impacts so they do not Impede Progress Toward Recovery
6. Reduce Out-of-Subbasin Impacts so that the Benefits of In-Basin Actions can be Realized

1.5 Population Priorities and Viability Goals

Species status in the Kalama subbasin relative to recovery priorities status (P=primary, C=contributing, S=stabilizing) and viability goals (Low, Medium, High, Very High)



1.6 Summary of the primary limiting factors affecting life stages of salmonid species

The Habitat Factor Analysis of EDT (Ecosystem Diagnosis and Treatment) identifies the most important habitat factors affecting fish in each reach. Whereas the EDT reach analysis identifies reaches where changes are likely to significantly affect the fish, the Habitat Factor Analysis identifies specific stream reach conditions that may be

modified to produce an effect. Like all EDT analyses, the habitat factor analysis compares current/patient and historical/template habitat conditions. For each reach, EDT generates what is referred to as a "consumer reports diagram", which identifies the degree to which individual habitat factors are acting to suppress population performance. The effect of each habitat factor is identified for each life stage that occurs in the reach and the relative importance of each life stage is indicated. The following table summarizes most critical life stages and the habitat factors affecting them are displayed for each species. Consumer reports for specific reaches and species can be found in Section 1.8.

Species and Lifestage		Primary factors	Secondary factors	Tertiary factors
Kalama Fall Chinook				
most critical	Egg incubation	channel stability, sediment	harassment	
second	Fry colonization	flow, habitat diversity	channel stability, predation, sediment, key habitat	
third	Spawning	habitat diversity, temperature	harassment, predation, sediment	
Kalama Spring Chinook				
most critical	Egg incubation	channel stability, sediment		
second	Fry colonization	habitat diversity, flow		
third	0-age summer rearing	habitat diversity	key habitat	
Kalama Chum				
most critical	Egg incubation	channel stability, sediment	Temperature,	flow
second	Prespawning holding	flow	habitat diversity, temperature	pathogens, harassment, key habitat
third	Fry colonization	habitat diversity, sediment	flow	food
Kalama Coho				
most critical	0-age winter rearing	habitat diversity	channel stability, flow	predation
second	0-age summer rearing	habitat diversity	temperature	channel stability, competition (hatchery), pathogens, predation
third	Egg incubation	channel stability, sediment	harassment, flow	
Kalama Summer Steelhead				
most critical	Egg incubation	sediment	channel stability	
second	0,1-age winter rearing	flow	habitat diversity	channel stability
third	1-age summer rearing	flow, habitat diversity		
Kalama Winter Steelhead				
most critical	Egg incubation	sediment, temperature	harassment, pathogens, channel stability	
second	1-age summer rearing	habitat diversity	competition (hatchery), flow, pathogens, temperature	predation
third	0,1-age winter rearing	habitat diversity	channel stability, flow	

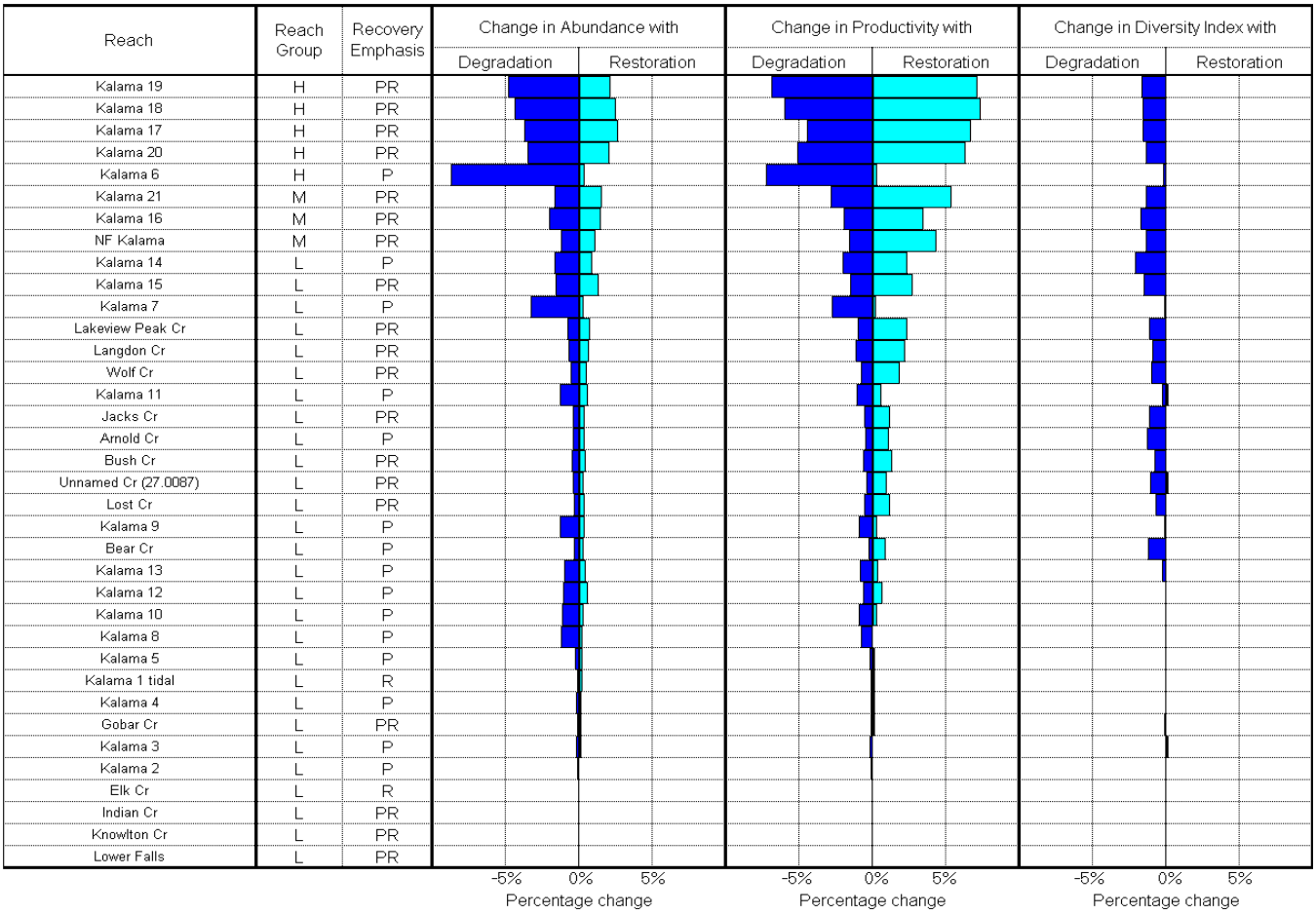
1.7 Key Reaches and EDT Analysis

The following are the EDT "Ladder" Diagrams for each species. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphasis designation is given (the longer the bar the greater the potential). The Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Appendix E, Chapter 6 of the Recovery Plan (LCFRB 2004) for more information on EDT ladder diagrams. Some low priority reaches are not included for display purposes.

Kalama Summer Steelhead

Potential change in population performance with degradation and restoration

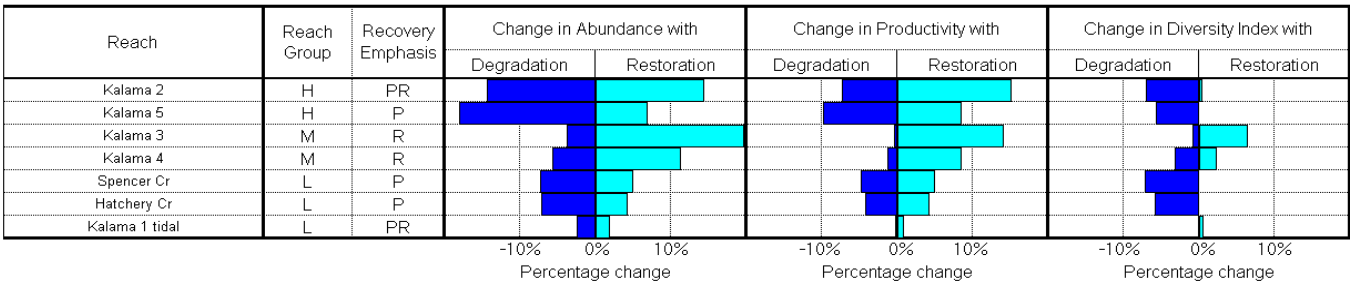
Reach	Reach Group	Recovery Emphasis
Kalama 19	H	PR
Kalama 18	H	PR
Kalama 17	H	PR
Kalama 20	H	PR
Kalama 6	H	P
Kalama 21	M	PR
Kalama 16	M	PR
NF Kalama	M	PR
Kalama 14	L	P
Kalama 15	L	PR
Kalama 7	L	P
Lakeview Peak Cr	L	PR
Langdon Cr	L	PR
Wolf Cr	L	PR
Kalama 11	L	P
Jacks Cr	L	PR
Arnold Cr	L	P
Bush Cr	L	PR
Unnamed Cr (27.0087)	L	PR
Lost Cr	L	PR
Kalama 9	L	P
Bear Cr	L	P
Kalama 13	L	P
Kalama 12	L	P
Kalama 10	L	P
Kalama 8	L	P
Kalama 5	L	P
Kalama 1 tidal	L	R
Kalama 4	L	P
Gobar Cr	L	PR
Kalama 3	L	P
Kalama 2	L	P
Elk Cr	L	R
Indian Cr	L	PR
Knowlton Cr	L	PR
Lower Falls	L	PR



Kalama Chum

Potential change in population performance with degradation and restoration

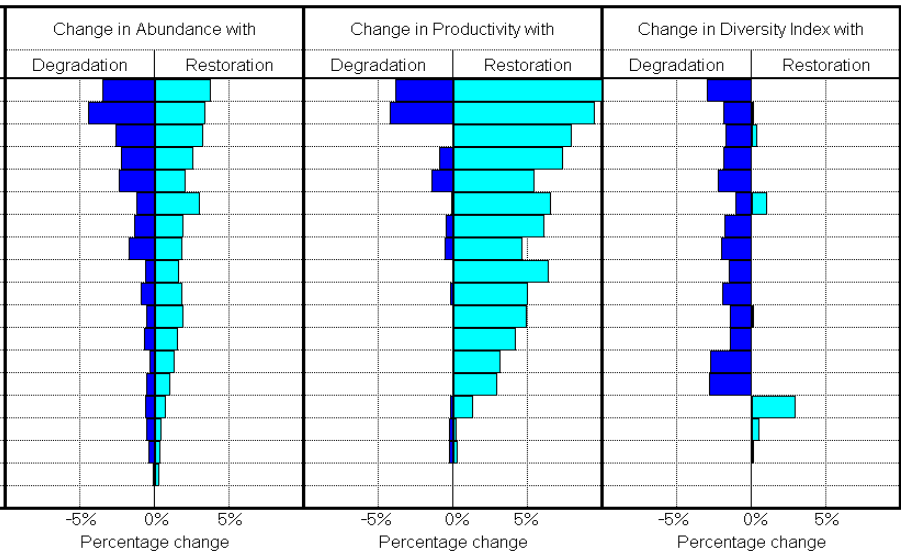
Reach	Reach Group	Recovery Emphasis
Kalama 2	H	PR
Kalama 5	H	P
Kalama 3	M	R
Kalama 4	M	R
Spencer Cr	L	P
Hatchery Cr	L	P
Kalama 1 tidal	L	PR



Kalama Winter Steelhead

Potential change in population performance with degradation and restoration

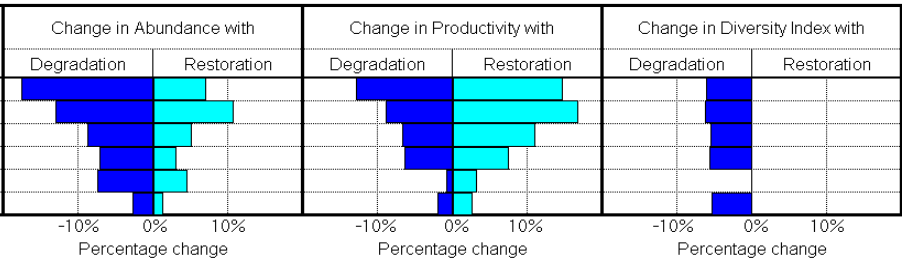
Reach	Reach Group	Recovery Emphasis
Kalama 8	H	PR
Kalama 9	H	PR
Kalama 5	H	R
Kalama 6	H	R
Kalama 10	H	PR
Kalama 4	H	R
Kalama 13	M	R
Kalama 7	M	PR
Gobar Cr	M	R
Kalama 11	L	R
Wildhorse Cr	L	R
Little Kalama R	L	R
Summers Cr	L	PR
Kalama 12	L	PR
Kalama 3	L	R
Kalama 2	L	PR
Kalama 1 tidal	L	PR
Knowlton Cr	L	R
Lower Falls	L	PR



Kalama Fall Chinook

Potential change in population performance with degradation and restoration

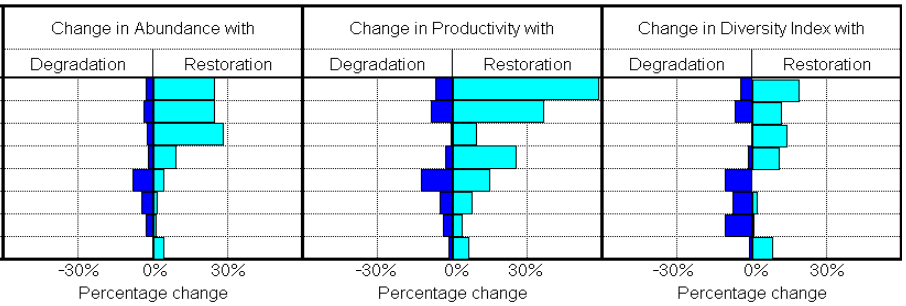
Reach	Reach Group	Recovery Emphasis
Kalama 2	H	P
Kalama 3	H	PR
Kalama 4	M	PR
Kalama 5	M	P
Kalama 1 tidal	L	PR
Hatchery Cr	L	P



Kalama Coho

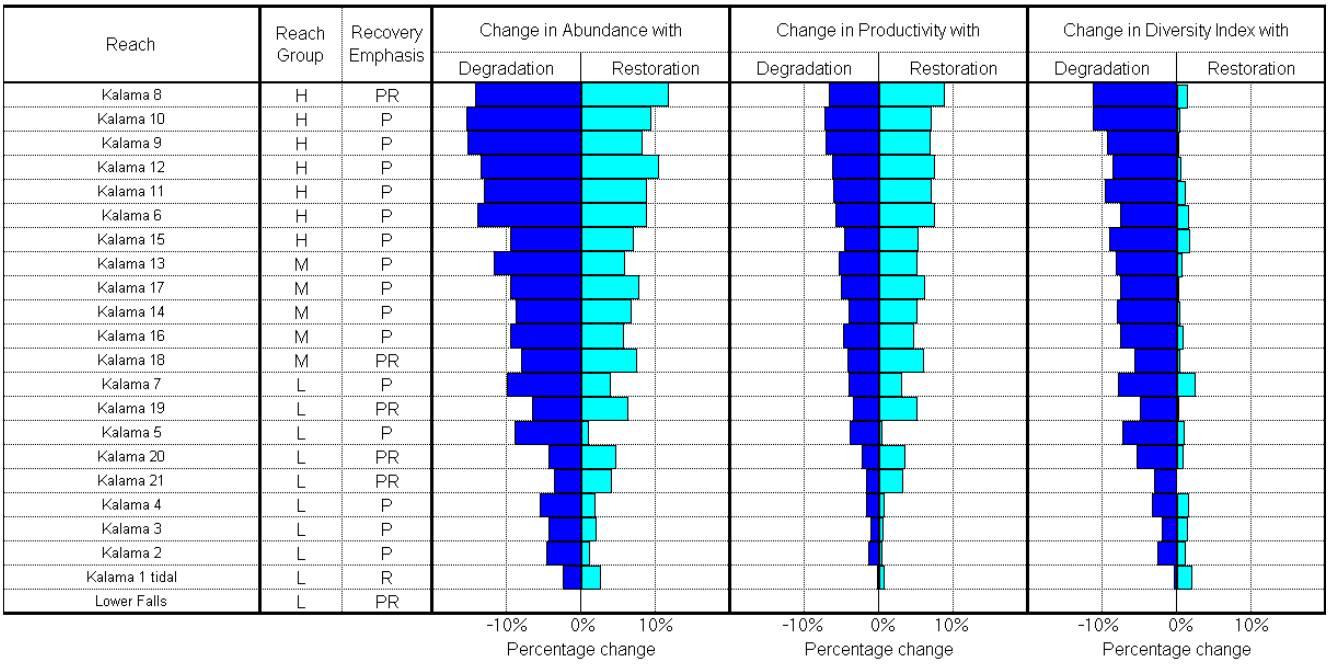
Potential change in population performance with degradation and restoration

Reach	Reach Group	Recovery Emphasis
Kalama 3	H	R
Kalama 2	H	R
Kalama 1 tidal	M	R
Kalama 4	M	R
Spencer Cr	L	P
Hatchery Cr	L	P
Cedar Cr	L	P
Kalama 5	L	R



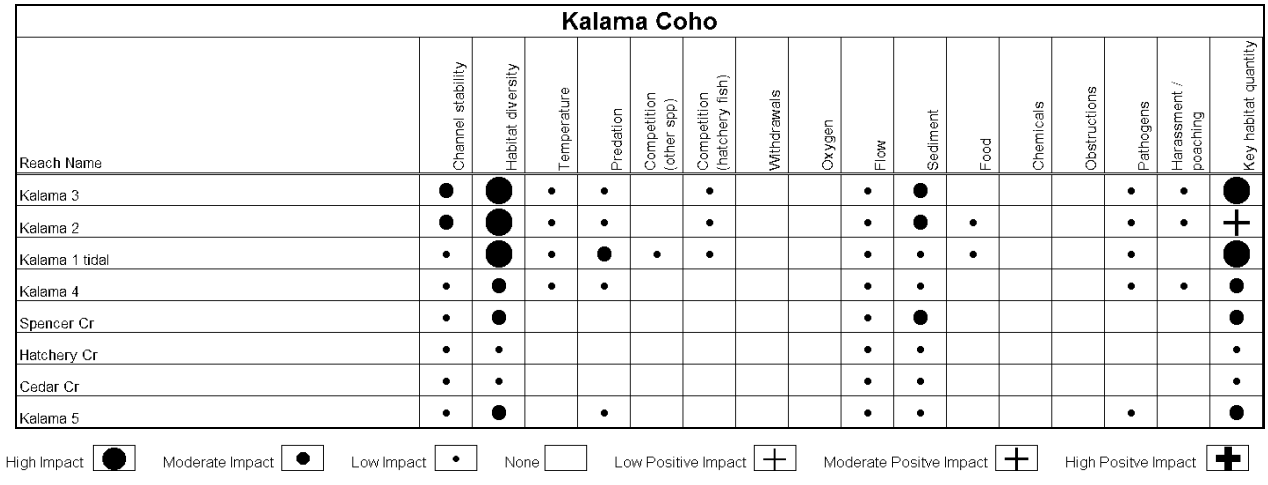
Kalama Spring Chinook

Potential change in population performance with degradation and restoration



1.8 Limiting Factors Analysis

The following are the EDT "consumer reports" or habitat factor analysis diagrams for each species. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions (the larger the dot the greater the potential). See Appendix E, Chapter 6 of the Recovery Plan (LCFRB 2004) for more information on habitat factor analysis diagrams. Some low priority reaches are not included for display purposes.



Kalama Summer Steelhead

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp.)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Kalama 19	●	⬤							⬤	⬤						●
Kalama 18	●	⬤							⬤	⬤						●
Kalama 17	●	⬤							⬤	⬤						●
Kalama 20	●	⬤							⬤	⬤						●
Kalama 6	•	●							•	•	•			•		+
Kalama 21	●	⬤							⬤	⬤						●
Kalama 16	●	⬤							●	⬤						●
NF Kalama	●	●	•			•			●	⬤	•					✚
Kalama 14	•	⬤							●	⬤						✚
Kalama 15	●	⬤							●	⬤						●
Kalama 7	•	●							•	•						
Lakeview Peak Cr	•	●	•						●	●	•					+
Langdon Cr	•	●	•						●	⬤	•					+
Wolf Cr	•	●	•						●	●	•					+
Kalama 11	•	●		•		•			●		•					
Jacks Cr	•	●	•						●	●	•					
Arnold Cr	•	●	•						●	●	•					
Bush Cr	•	●	•						●	⬤	•					+
Unnamed Cr (27.0087)	•	●	•						•	●	•					+
Lost Cr	•	●	•						●	●	•					+
Kalama 9	•	●		•		•			•	•				•		+
Bear Cr	•	●	•						•	●	•					
Kalama 13	•	●							•	•						
Kalama 12	•	●		•		•			•		•					
Kalama 10	•	●		•		•			•							
Kalama 8	•	●							•							
Kalama 5	•	•		•					•					•		•
Kalama 1 tidal		•		•					•	•						●
Kalama 4	•	•		•					•							
Gobar Cr		•		•					•							
Kalama 3		•														
Kalama 2		•														
Elk Cr		•							•							
Indian Cr																
Knowlton Cr																
Lower Falls																

High Impact ⬤ Moderate Impact ● Low Impact • None ▭ Low Positive Impact + Moderate Positve Impact + High Positve Impact ✚

Kalama Fall Chinook

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp.)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Kalama 2	●	●	●	•					•	⬤					•	•
Kalama 3	●	⬤	•	•					●	⬤				•	●	●
Kalama 4	●	●	•	•					•	●					•	+
Kalama 5	●	•	•	•					•	⬤					•	+
Kalama 1 tidal	•	●		•	•	•			•	•	•			•	•	●
Hatchery Cr	•	•		•					•	●						•

High Impact ⬤ Moderate Impact ● Low Impact • None ▭ Low Positive Impact + Moderate Positve Impact + High Positve Impact ✚

Kalama Winter Steelhead

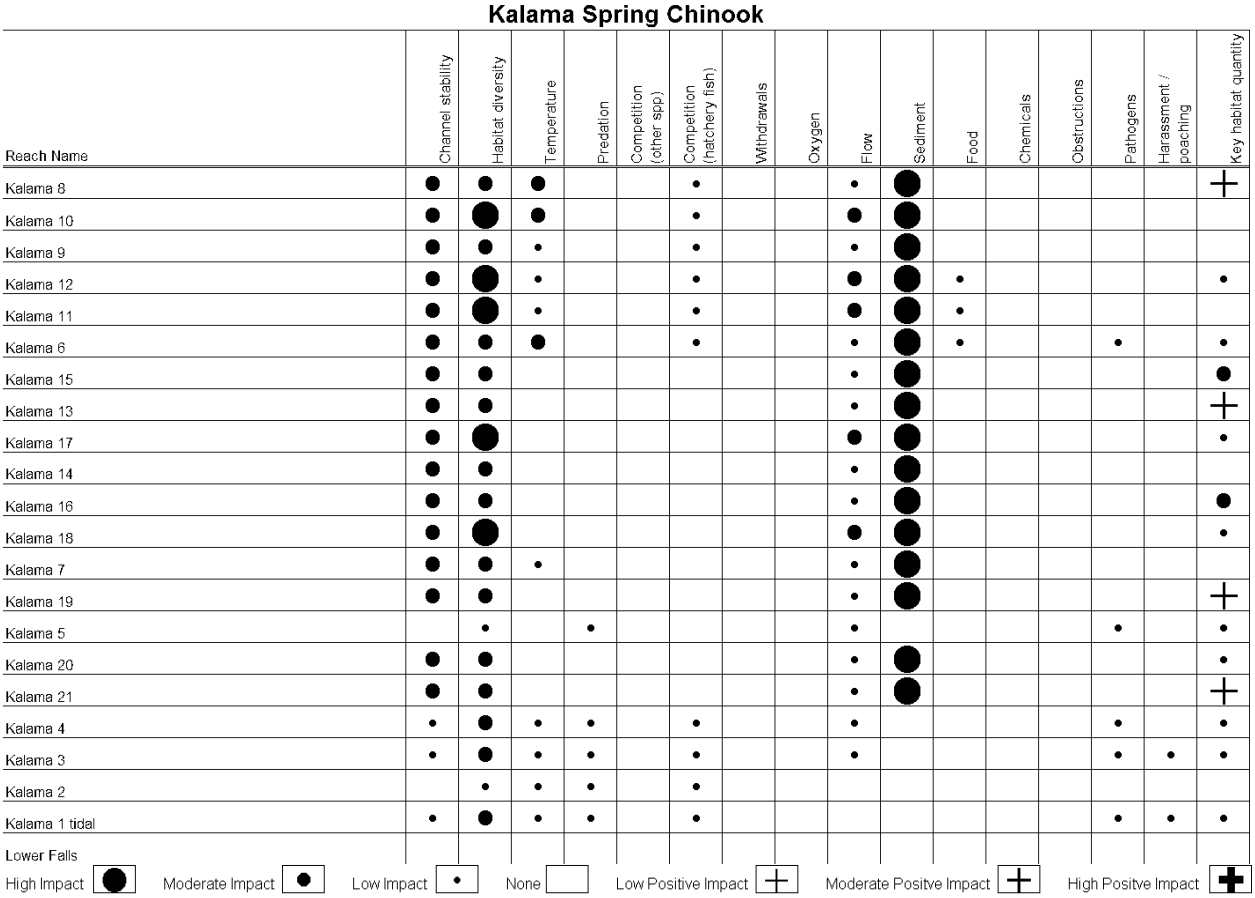
Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Kalama 8	•	●	●	•		•			●	●				•		+
Kalama 9	•	●	•	•		•			●	●				•		+
Kalama 5	•	●	●	●		•			●	●	+			●	•	✚
Kalama 6	•	●	●	•		•			●	●	•			•		+
Kalama 10	•	●	•	•		•			●	●				•		+
Kalama 4	•	●	●	●		•			●	●				•	•	✚
Kalama 13	•	●							●	●						✚
Kalama 7	•	●	•	•		•			●	●				•		+
Gobar Cr	•	●	•	•		•			●	●	•					•
Kalama 11	•	●	•	•		•			●	●	•			•		+
Wildhorse Cr	•	●	•						●	●	•					
Little Kalama R	•	●	•						●	●	•					
Summers Cr	•	●	•						●	●	•					+
Kalama 12	•	●		•					•	●	•					+
Kalama 3	•	●	•	•					•	•				•	•	●
Kalama 2		•	•	•					•							
Kalama 1 tidal		•		•					•	•						●
Knowlton Cr		•							•							
Lower Falls																

High Impact ● Moderate Impact • Low Impact · None ▭ Low Positive Impact + Moderate Positve Impact + High Positve Impact ✚

Kalama Chum

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Kalama 2	•	●		•					●	●	•				●	•
Kalama 5	•	●		•					•	●	+				•	+
Kalama 3	•	●		•					●	●					●	●
Kalama 4	•	●		•					•	●					●	+
Spencer Cr		●							•	●						•
Hatchery Cr	•	●							•	•	•					•
Kalama 1 tidal	•	•		•					•							•

High Impact ● Moderate Impact • Low Impact · None ▭ Low Positive Impact + Moderate Positve Impact + High Positve Impact ✚



1.9 Reach Tiers

Specific reaches and subwatersheds have been prioritized based on the plan's biological objectives, fish distribution, critical life history stages, current habitat conditions, and potential fish population performance. Reaches have been placed into Tiers (1-4), with Tier 1 reaches representing the areas where recovery measures would yield the greatest benefits towards accomplishing the biological objectives. Tier designations for each reach are identified in section 1.1. The following table provides the rules for designating reach tier priorities:

Designation	Rule
Reaches	
Tier 1:	All high priority reaches (based on EDT) for one or more primary populations.
Tier 2:	All reaches not included in Tier 1 and which are medium priority reaches for one or more primary species and/or all high priority reaches for one or more contributing populations.
Tier 3:	All reaches not included in Tiers 1 and 2 and which are medium priority reaches for contributing populations and/or high priority reaches for stabilizing populations.
Tier 4:	Reaches not included in Tiers 1, 2, and 3 and which are medium priority reaches for stabilizing populations and/or low priority reaches for all populations.
Subwatersheds	
Group A:	Includes one or more Tier 1 reaches.
Group B:	Includes one or more Tier 2 reaches, but no Tier 1 reaches.
Group C:	Includes one or more Tier 3 reaches, but no Tier 1 or 2 reaches.
Group D:	Includes only Tier 4 reaches.

1.10 Prioritized Measures

Measures are means to achieve the regional strategies that are applicable to the Kalama Subbasin and necessary to accomplish the biological objectives for focal fish species. Measures are based on the technical assessments for this subbasin as well as on the synthesis of priority areas, limiting factors, and threats presented earlier in this section. The following table summarizes the measures applicable to the subbasin in priority order. Each measure has a set of submeasures that define the measure in greater detail and add specificity to the particular circumstances occurring within the subbasin. The table for each measure and associated submeasures indicates the limiting factors that are addressed, the contributing threats that are addressed, the species that would be most affected, and a short discussion.

The measures themselves are prioritized based on the results of the technical assessment and in consideration of principles of ecosystem restoration (e.g. NRC 1992, Roni et al. 2002). These principles include the hypothesis that the most efficient way to achieve ecosystem recovery in the face of uncertainty is to focus on the following priorities and approaches:

1) Protect existing functional habitats and the processes that sustain them;
2) Allow no further degradation of habitat or supporting processes;
3) Re-connect isolated habitat;
4) Restore watershed processes (ecosystem function),
5) Restore habitat structure, and
6) Create new habitat where it is not recoverable.

These priorities have been adjusted for the specific circumstances occurring in the basin. For example, re-connecting isolated habitat could be adjusted to a lower priority if there is little impact to the population created from passage barriers.

#1 – Protect stream corridor structure and function

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect floodplain function and channel migration processes B. Protect riparian function C. Protect access to habitats D. Protect instream flows through management of water withdrawals E. Protect channel structure and stability F. Protect water quality G. Protect the natural stream flow regime	Potentially addresses many limiting factors	Potentially addresses many limiting factors	All Species	Reaches Kalama 2-6 provide important current and potential habitat for fall chinook, chum, coho, and winter steelhead. These reaches are located in mixed-use areas that have experienced increasing rural residential development within the stream corridor. Preventing further degradation of stream channel structure, riparian function, and floodplain function will be an important component of recovery.

#2 – Protect hillslope processes

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Manage forest practices to minimize impacts to sediment supply processes, runoff regime, and water quality B. Manage growth and development to minimize impacts to sediment supply processes, runoff regime, and water quality	• Excessive fine sediment • Excessive turbidity • Embedded substrates • Stream flow – altered magnitude, duration, or rate of change of flows • Water quality impairment	• Timber harvest – impacts to sediment supply, water quality, and runoff processes • Forest roads – impacts to sediment supply, water quality, and runoff processes • Development – impacts to sediment supply, water quality, and runoff processes	All species	Hillslope runoff and sediment delivery processes have been degraded throughout the basin due to past intensive timber harvest and road building. Hillslope processes in portions of the lower basin have been impacted by rural residential development and agriculture. Limiting additional degradation will be necessary to prevent further habitat impairment.

#3- Restore degraded hillslope processes on forest, agriculture, and developed lands

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Upgrade or remove problem forest roads B. Reforest heavily cut areas not recovering naturally C. Reduce effective stormwater runoff from developed areas	• Excessive fine sediment • Excessive turbidity • Embedded substrates • Stream flow – altered magnitude, duration, or rate of change of flows • Water quality impairment	• Timber harvest – impacts to sediment supply, water quality, and runoff processes • Forest roads – impacts to sediment supply, water quality, and runoff processes • Development – impacts to water quality and runoff processes	All species	Hillslope runoff and sediment delivery processes have been degraded throughout the basin as a result of past intensive timber harvest and road building. Rural residential development and agriculture have impacted hillslope processes in portions of the lower basin. Hillslope processes must be addressed for reach-level habitat recovery to occur.

#4 - Restore riparian conditions throughout the basin

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore the natural riparian plant community B. Eradicate invasive plant species from riparian areas	• Reduced stream canopy cover • Altered stream temperature regime • Reduced bank/soil stability • Reduced wood recruitment • Lack of stable instream woody debris • Exotic and/or invasive species	• Timber harvest – riparian harvests • Clearing of vegetation due to residential development	All species	Recovery of riparian vegetation is necessary throughout the basin in both forest and mixed-use areas. Much of this recovery is expected to occur passively on forest lands due to required protection of riparian buffers. Active measures, such as hardwood-to-conifer conversion, may be necessary in some areas. The increasing abundance of exotic and invasive species is of particular concern. Riparian restoration projects are relatively inexpensive and are often supported by landowners.

#5 – Restore access to habitat blocked by artificial barriers

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore access to isolated habitats blocked by culverts, dams, or other barriers	• Blockages to channel habitats • Blockages to off-channel habitats	• Dams, culverts, in-stream structures	All species	As many as 14 miles of potentially accessible habitat are blocked by culverts or other barriers (approximately 15 barriers total). The Kalama Hatchery on Hatchery (Fallert) Creek is a potential passage barrier. The blocked habitat is believed to be marginal in most cases. Passage restoration projects should focus on cases where it can be demonstrated that there is good potential benefit and reasonable project costs.

#6 - Restore floodplain function and channel migration processes in the mainstem and major tributaries

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Set back, breach, or remove artificial confinement structures	• Bed and bank erosion • Altered habitat unit composition • Restricted channel migration • Disrupted hyporheic processes • Reduced flood flow dampening • Altered nutrient exchange processes • Channel incision • Loss of off-channel and/or side-channel habitat • Blockages to off-channel habitats	• Floodplain filling • Channel straightening • Artificial confinement	Chum, fall chinook, coho	Significant degradation of floodplain function and channel migration processes have occurred over the years in the private, mixed-use lands along the lower mainstem. This area is primarily in agriculture/open-space and rural residential uses and is experiencing increasing development pressure as nearby population centers expand. There are feasibility issues with implementation due to private lands, existing infrastructure already in place, potential flood risk to property, and large expense. Floodplain degradation in other portions of the basin is mostly related to stream adjacent roads.

#7 - Restore channel structure and stability

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Place stable woody debris in streams to enhance cover, pool formation, bank stability, and sediment sorting B. Structurally modify channel morphology to create suitable habitat C. Restore natural rates of erosion and mass wasting within river corridors	• Lack of stable instream woody debris • Altered habitat unit composition • Reduced bank/soil stability • Excessive fine sediment • Excessive turbidity • Embedded substrates	• None (symptom-focused restoration strategy)	All species	Large wood installation projects could benefit habitat conditions in many areas although watershed processes contributing to wood deficiencies should be considered and addressed prior to placing wood in streams. Other structural enhancements to stream channels may be warranted in some places, especially in lowland alluvial reaches that have been simplified through channel straightening and confinement.

#8 – Provide for adequate instream flows during critical periods

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect instream flows through water rights closures and enforcement B. Restore instream flows through acquisition of existing water rights C. Restore instream flows through implementation of water conservation measures	• Stream flow – maintain or improve flows during low-flow Summer months	• Water withdrawals	All species	Instream flow management strategies for the Kalama Basin have been identified as part of Watershed Planning for WRIA 27 (LCFRB 2004). Strategies include water rights closures, setting of minimum flows, and drought management policies. This measure applies to instream flows associated with water withdrawals and diversions, generally a concern only during low flow periods. Hillslope processes also affect low flows but these issues are addressed in separate measures.

#9 – Restore degraded water quality

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Increase riparian shading B. Decrease channel width-to-depth ratios C. Reduce delivery of chemical contaminants to streams D. Address leaking septic systems	• Bacteria • Altered stream temperature regime • Chemical contaminants	• Timber harvest – riparian harvests • Leaking septic systems • Clearing of vegetation due to development • Chemical contaminants from developed lands	All species	The lower Kalama is listed on the draft 2002/2004 303(d) list as having temperature impairment. Hatchery Creek is listed as being a concern for temperature impairment. The lower Kalama is also listed as a concern for fecal coliform bacteria impairment potentially originating from leaking septic systems in areas of concentrated residential development. Bacteria contamination is more of a human health concern than a fish health concern. The remainder of the basin is believed to be in good condition with respect to water quality. Water temperatures are generally very cool in the middle and upper mainstem due to groundwater inputs throughout the canyon.

#10 – Create/restore off-channel and side-channel habitat

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore historical off-channel and side-channel habitats where they have been eliminated B. Create new channel or off-channel habitats (i.e. spawning channels)	• Loss of off-channel and/or side-channel habitat	• Floodplain filling • Channel straightening • Artificial confinement	chum coho	There has been significant loss of off-channel and side-channel habitats, especially along the lower mainstem that has been channelized. This has limited chum spawning habitat and coho overwintering habitat. Targeted restoration or creation of habitats would increase available habitat where full floodplain and CMZ restoration is not possible.