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1 Management Plan Foundations

The Management Plan integrates key elements of the Yakima Subbasin Plan—the Assessment (Chapter 2) and the Inventory (Chapter 3)—with the Yakima Subbasin Fish and Wildlife Planning Board's Vision 2002 and its Guiding Principles (stated below). Vision 2020 describes in general terms the desired future conditions of fish and wildlife habitats and populations in the Yakima basin. The Guiding Principles set the direction for the Management Plan by taking into account local economic and social conditions and concerns, generally accepted biological assumptions, treaty rights, and other applicable laws and policies.

Crafted by the Yakima Subbasin Fish and Wildlife Planning Board as local policy input to the Subbasin Plan, the Vision and Guiding Principles are driving the selection of objectives and strategies for restoration of fish and wildlife habitat and populations that form the bulk of the Management Plan.

The purpose and scope of the Management Plan are somewhat narrower than they are for the Assessment and the Inventory. The Assessment and Inventory are designed and may be used to guide restoration and management actions by many parties under their own authorities in the course of ongoing efforts to protect and enhance the fish and wildlife populations and the aquatic and terrestrial ecosystems that exist within the Yakima Subbasin. While based on the Assessment and Inventory, the Management Plan is specifically designed to act as a draft amendment to NPCC's Columbia River Basin Fish and Wildlife Program. NPPC will review and approve the Yakima Subbasin Plan.

The Management Plan lays out the most effective ways NPCC and BPA can use funding resources to meet their obligations in the Yakima Subbasin to protect and mitigate for the resources affected by the construction and operation of the Federal Columbia River Power System (FCRPS). As such, the Management Plan is non-regulatory and uses BPA ratepayer funds to construct or improve existing infrastructure, acquire land or protective easements as a means of habitat protection, fund personnel to improve natural resource management, monitor and research the relationships between management actions and the health of the resource, and fund other actions that protect or restore the healthy natural resources negatively affected by the FCRPS.

1.1 Yakima Subbasin Vision and Guiding Principles

1.1.1 Vision 2020

Yakima River basin communities have restored the Yakima River basin sufficiently to support self-sustaining and harvestable populations of indigenous fish and wildlife while enhancing the existing customs, cultures, and economies in the basin. Decisions that continuously improve the river basin ecosystem are made in an open and cooperative process that respects different points of view and varied statutory responsibilities and benefits current and future generations.

1.1.2 Guiding Principles for the Yakima Subbasin Plan

1. The natural environment including its fish and wildlife resources is the common heritage of our diverse human community. The underlying premise of the YSPB's Mission and Vision is to prepare and implement a balanced plan of action that plays a key role in the long-term sustainability of this common cultural and biological heritage in the Yakima basin.
2. The quality of water and a near natural timing and quantity of water flow (normative hydrograph) are principle indicators of a healthy river ecosystem. These indicators must be improved and monitored to measure the progress of the subbasin plan.
3. The Yakima Subbasin Plan enhances the Yakama Nation's continued exercise of treaty reserved and aboriginal rights to religious, subsistence, commercial and recreational use of natural resources.
4. The Yakima Subbasin Plan is based on voluntary incentives.
5. The processes of plan preparation, implementation, and amendment are open and equitable.
6. The costs of plan actions are estimated in relation to benefits. Alternatives that achieve the highest benefit relative to costs are preferred. Costs of habitat/species restoration should be mitigated and distributed equitably.
7. The science and art of restoring ecosystems is still evolving; therefore, programs and actions must be monitored and evaluated for effectiveness and may be altered as necessary.
8. Balanced sustainable resource management recognizes these basic precepts: a) the physical and biological environments are functionally interdependent relative to productivity; b) at any level of function, productivity is finite; c) without actions to restore degraded functions, protect, avoid, and mitigate impacts to the physical and biological environment, the increasing demands of human population growth will reduce productivity to zero, with unacceptable costs to the cultures and economies of the Yakima basin.

1.1.3 Elements of a Management Plan

NPCC's *Technical Guide for Subbasin Planners* recommends that the Management Plan contain the following elements, biological objectives and strategies. The *Technical Guide* describes them as follows.

Biological objectives should:

- Be consistent with basin-level visions, objectives, and strategies adopted in the program.
- Be based on the subbasin assessment and resulting working hypothesis.
- Be consistent with legal rights and obligations of fish and wildlife agencies and tribes with jurisdiction over fish and wildlife in the subbasin, and agreed upon by co-managers in the subbasin. Where there are disagreements among co-managers that translate into differing biological objectives, the differences and the alternative biological objectives should be fully presented.

- Be complementary to programs of tribal, state, and federal land or water quality management agencies in the subbasin.
- Be consistent with the Endangered Species Act recovery goals and Clean Water Act requirements as fully as possible.
- Be quantitative and have measurable outcomes.

Strategies must:

- Explain the linkage of the strategies to the subbasin biological objectives, vision, and the subbasin assessment. Explain how and why the strategies presented were selected over other alternative strategies (e.g. passive restoration strategies v. intervention strategies).
- Describe a proposed sequence and prioritization of strategies.
- If necessary, describe additional steps required to compile more complete or detailed assessment (see Data Gap Strategy below)

Yakima subbasin planners also digested the Independent Scientific Review Panel's (ISRP) evaluation of the Clearwater Subbasin Plan and recognized the overriding desire for a strong and overt link between the Assessment and the biological objectives and strategies chosen. Given the size and complexity of the subbasin and the large amounts of existing data that were used in the preparation of the Assessment and Inventory, we were forced to use tables to link observed effects in the basin to working hypotheses (potential causes of the effect); hypotheses to objectives (to address the cause of the effect); objectives to strategies (to reverse the cause); or effect to strategies (to mitigate the effect if the cause could not be reversed). These tables also had to be constructed to prioritize strategies based on:

- The degree of impact on life histories of fish or wildlife;
- Ideally (which is not required in the Technical Guide) the effectiveness of the strategies given the ecological, social, and practical constraints specific to the Yakima Subbasin; and
- Consistency with the Vision and Guiding Principles established by the Yakima Subbasin Fish and Wildlife Planning Board.

Thus, in the Management Plan you will find tables that cover over 30 pages and 230 key findings, working hypotheses, objectives, and over 700 strategies. The tables are designed to condense the information in the assessment so that the logic path from Key Finding to Strategy can be discerned for the content of each row in the table.

The tables are more or less snapshots of our current understanding of subbasin conditions. Not only do the tables acknowledge uncertainties and lay out processes for improving our understanding of the basin, they also describe implementation actions that we feel confident will succeed in achieving the goals of the Subbasin Plan.

1.1.4 Adaptive Management of the Subbasin

The purpose of ongoing research and monitoring is to reduce uncertainty regarding subbasin function and to be able to move from uncertainty to action. As results of research and monitoring become known, or in some cases as projects are further refined, more specific action strategies are expected to be formulated at points in time which, however, will not precisely coincide with updates to the Yakima Subbasin Plan or Columbia Plateau provincial reviews. If adaptive management (i.e., a structured process to actively learn from ongoing management and research) is to work and improve our decision-making ability over time, unpredictable circumstances and outcomes will occur and must be acknowledged, and strategies, research, and monitoring programs must be allowed to change during a planning cycle. Agencies that use the Subbasin Plan as a guide for funding decisions need to recognize that the specific strategies within the Plan will soon be out of date and that newly developed strategies derived from and consistent with the Biological Objectives should still be considered legitimate components of the Subbasin Plan.

The tables incorporate current research and monitoring needs into the key findings.

2 Wildlife Key Findings Table

The Wildlife Key Findings are arranged in table format to demonstrate the connections between Key Findings, Hypotheses, Objectives, and Strategies. The conceptual framework used in the development of the linkage from findings to objectives was derived from consultation with the Nature Conservancy, and other science-based land management organizations.

The table was constructed using the focal habitat as the element for analysis. Each habitat element was defined by its key ecological attributes. Limiting factors were assessed by examining alterations of each habitat's key attributes. Impairment of some key attribute of a focal habitat denotes a stress that "limits" the habitat's ability to remain viable over the long term. "Key Findings" were captured as explicit stress factors that currently limit habitat viability. Hypotheses of the "sources" of the viability impairment factors were developed to test assumptions about management objectives. The table, therefore, starts with the elements of management interest (focal habitats), identifies the factors impairing element viability, makes statements about the probable human-induced sources of impairment (hypotheses), and proposes management objectives that direct focused action toward abating the limiting factors, and enhancing the long-term viability of the focal habitats.

2.1 FOCAL HABITAT: MONTANE CONIFEROUS WETLAND

Focal Species: Western Toad and Sandhill Crane

KEY ECOLOGICAL ATTRIBUTES

- **Intact montane wetland habitats are composed of characteristic native species and communities.**
- **Functional surface and ground water hydrologic regimes.**

LIMITING FACTORS (STRESS): Altered forest and herbaceous species composition can reduce habitat quality and ecological function.

Key Finding	Focal Species	Life Stage	Degree of Impact	Hypotheses Statements		Confidence H, M, L	Obj. #	Objectives	Strategies by Objective #
Native vegetative composition of known wetland communities has been altered from historic conditions	Western toad Sandhill crane	Breeding Rearing Breeding	H H	Alteration in community composition has occurred as a result of inappropriate grazing practices		H	1	Implement measures to improve vegetative condition of at least 50% of known degraded montane wetlands by year 2020.	1 Where feasible build and/or maintain fencing to allow for restoration for wetland sites. 1 Work with agencies, permit holders and landowners to modify or purchase grazing leases in identified areas.
				Alteration in community composition has occurred as a result of altered fire regimes		H			1 Work with the appropriate agencies and/or landowners to implement controlled burns in meadows suffering from tree encroachment.
				Alteration in community composition has occurred as a result of unauthorized off-road vehicles use		H			1 Increase signage, close and/or abandon roads leading to sensitive habitat areas, and increase enforcement
Montane coniferous wetland habitats remain unprotected in the watershed	Western toad Sandhill crane	Breeding Rearing Breeding	M M	Protection of this habitat will allow for restoration and will ensure that the vegetative composition will remain viable into the future		H	2	Implement measures to protect at least 20% of unprotected montane wetlands by 2020.	1,2 With willing landowners use purchase, lease or easement methods to protect montane wetlands.

LIMITING FACTOR (STRESS): Altered hydrology can reduce or eliminate habitat quality and ecological function of montane wetlands.

Key Finding	Focal Species	Life Stage	Degree of Impact	Hypotheses Statements		Confidence H, M, L	Obj. #	Objectives	Strategies by Objective #
Hydrologic conditions (esp. flow) of known montane wetlands have been altered from historic conditions.	Western toad Sandhill crane	Breeding Rearing Breeding Rearing	H H	Hydrologic conditions have been altered by road and culvert development.		H	3	Restore surface hydrologic function on at least 50% of montane wetland habitats with emphasis placed on those occurring in unregulated tributaries by 2020.	3,4. Relocate or modify roads negatively impacting publicly owned montane wetlands. 3 Implement hydrologic restoration measures within the wetlands. 3 Work with agencies and forestland owners on new road planning to avoid impacting these habitats.
				Hydrologic conditions have been altered by surface water channelization from off-road vehicle use.		H			3 Increase signage, close and/or abandon roads leading to sensitive habitat areas, and increase enforcement

LIMITING FACTOR (STRESS): Disturbance can reduce or eliminate habitat use by focal species.

Key Finding	Focal Species	Life Stage	Degree of Impact	Hypotheses Statements		Confidence H, M, L	Obj. #	Objectives	Strategies by Objective #
Suitable nesting habitat for sandhill cranes in the Yakima subbasin is unoccupied.	Sandhill crane	Breeding	H	Human presence during prenesting and nesting prevents Sandhill crane occupancy.		H	4	Reduce human disturbance during the Sandhill crane nesting season in the Satus, Toppenish, Ahtanum, and Naches watersheds by 2010.	4 Eliminate vehicular access and campsites on key habitats. 4 Initiate and continue cooperative road management planning and implementation with agencies and landowners.

KEY UNCERTAINTIES:

- **Identify and assess habitat conditions of montane wetlands important to focal species by 2006.**
- **Identify montane wetlands important to the hydrologic function of tributaries not influenced by regulating reservoirs.**

2.2 FOCAL HABITAT: PONDEROSA PINE/OAK WOODLANDS

Focal species Western Gray Squirrel, White-headed Woodpecker, Lewis's Woodpecker

KEY ECOLOGICAL ATTRIBUTES:

- **Ecologically functional Ponderosa pine/oak forest communities possess**
- **Large diameter trees (>20"dbh for pine)**
- **Frequent fire intervals**
- **Open stand structures**

LIMITING FACTORS:

Lack of large trees as key habitat elements for focal species

Key Finding	Focal Species	Life Stage	Degree of Impact	Hypotheses Statements		Confidence H, M, L	Obj. #	Objectives	Strategies by Objective #
Forest structures have been altered towards smaller diameter trees	White-headed woodpecker Western gray squirrel Lewis' woodpecker	All All Nesting, summer	H H M	Forest structures have been altered by harvest practices which have removed the largest trees		H	5	Restore large tree overstory with appropriate size, spacing and density of large overstory trees on focal habitat area by year 2105.	5 Adopt silvicultural practices that retain appropriate size, spacing and densities of large overstory trees to ecological standards (Stephenson 2004).
									5 Prioritize areas on landscape where habitat restoration is feasible and has high probability of success.
									5 Utilize management techniques that include development and retention of large tree overstory on all state lands.
									5 Protect existing stands of old pine through purchase, lease or easements on private land and through management agreements with agencies.
									5 Assist landowners with voluntary signup into cost share programs that help improve habitat condition. Establish such programs for this habitat type where necessary.
Habitat Connectivity has been lost across landscape	White-headed woodpecker Western gray squirrel Lewis'	All All Nesting, summer	H H M	Habitat connectivity has been lost across landscape due to harvest practices Dispersed human development reduces focal habitat connectivity		H	6	Connect functional core habitats across subbasin by 2105.	6 Prioritize areas on landscape for restoring connectivity
									6 Purchase easements or fee title from interested landowners in priority areas
									6 Provide economic and other incentives to interested landowners to manage their lands to benefit focal species

	woodpecker								6 Work with local governments and land owners to protect native plant communities
							7	Connect functional core habitats across subbasin by 2105	6, 7 Provide economic and other incentives to interested landowners to manage their lands to benefit focal species
									6, 7 Jurisdictions and agencies distribute educational information (seminars, printed, etc) to all landowners in focal habitats

LIMITING FACTORS: Altered fire regime

Key Finding	Focal Species	Life Stage	Degree of Impact	Hypotheses Statements		Confidence H, M, L	Obj. #	Objectives	Strategies by Objective #
Dense mixed species stands have replaced characteristic focal habitat	White-headed woodpecker Western gray squirrel Lewis' woodpecker	All All Nesting, foraging	H M M	Dense mixed stands have replaced focal habitats due to fire suppression		H	8	Restore natural fire regime that promotes characteristic focal habitat by 2020.	8 Prioritize areas where thinning and/or prescribed burning would help achieve habitat objectives.
									8 Conduct prescribed fires in prioritized areas.
									8 Assist landowners with voluntary signup into cost share programs that help improve habitat condition using thinnings and prescribed burning. Establish such programs for ponderosa pine/oak where necessary.
							9	Thin appropriate stands to restore appropriate stand density and species composition.	9 burning would help achieve habitat objectives. Prioritize areas where thinning and/or prescribed
									9 Conduct thinnings in prioritized areas.
									9 Assist landowners with voluntary signup into cost share programs that help improve habitat condition using thinnings. Establish such programs for ponderosa pine/oak where necessary.

KEY UNCERTAINTIES

Information on condition of habitat type on private land is not available.

2.3 FOCAL HABITAT: SHRUB STEPPE

Focal Species: Greater Sage-Grouse, Brewer's Sparrow, Mule Deer

KEY ECOLOGICAL ATTRIBUTES:

- **Connectivity of large blocks of intact shrub steppe habitats composed of characteristic native species and communities**
- **Intact native shrub steppe plant communities under natural disturbance regimes provide high ecological function and species diversity.**
- **Intact native shrub steppe plant communities are composed of characteristic native plant associations.**

LIMITING FACTOR: Increased Habitat Fragmentation

Key Finding	Focal Species	Life Stage	Degree of Impact	Hypotheses Statements		Confidence H, M, L	Obj. #	Objectives	Strategies by Objective #
Fragmentation of shrub steppe has led to isolated wildlife populations, species extirpations, and reduced viability [1]*Populations that winter in shrub steppe and summer in the Cascades.* [2] *Populations that live within shrub steppe year-round.*	Sage grouse Brewer's sparrow Mule deer (migratory pops.[1]) Mule deer (non-migratory pops.[2])	All Breeding, post-fledging Winter, spring All	H M M H	Fragmentation has occurred as a result of agricultural and urban development		H	10	Ensure habitat connectivity is accomplished on at least 50% of priority areas between large shrub steppe properties to prevent further isolation of focal species by 2020.	10 Purchase easements or fee title from interested landowners in priority areas
									10 Provide economic and other incentives to interested landowners to manage their lands to benefit focal species
									10 Work with local governments and land owners to protect native plant communities
Sage grouse population viability is threatened	Sage Grouse	All	H	Sage Grouse population viability (reproductive success and genetic diversity) is threatened by habitat fragmentation and isolation		M	11	Increase genetic diversity of the Yakima Training Center population by 2020.	11 Translocate individuals into the YTC population from healthy populations
									11 Periodically measure genetic diversity of population
							12	Establish reintroduced populations into formerly occupied areas where habitat has recovered from past land use by 2020.	12 Conduct/complete habitat suitability assessment in selected formerly occupied range
									11, 12 Translocate individuals from healthy populations into identified suitable habitat

LIMITING FACTOR: Altered Fire Regimes

Key Finding	Focal Species	Life Stage	Degree of Impact	Hypotheses Statements		Confidence H, M, L	Obj. #	Objectives	Strategies by Objective #
Sagebrush and other shrubs have been eliminated over large acreages of remaining shrub steppe	Sage grouse Brewer's sparrow Mule deer (migratory pops.) Mule deer (non-migratory pops.)	All Breeding & post-fledging Fall, Winter All	H H H M	Shrub loss has occurred largely as a result of human influenced increased fire return intervals		H	13	Restore natural fire regime return interval by reducing the annual rate of unplanned shrub steppe burning by at least 50% by 2020.	13 Map high risk ignition sites and priority areas for fire suppression and encourage land managers to work cooperatively to suppress all fires that occur in priority areas as soon as possible
									13 Create and maintain fire breaks in areas prone to frequent ignitions to prevent small fires from getting out of control
									13 Increase ability of rural fire districts to respond quickly to shrub steppe fires
Cheatgrass and other invasive species have been given a competitive advantage	Sage grouse Brewer's sparrow Mule deer (migratory pops.) Mule deer (non-migratory pops.)	Breeding, brood rearing Breeding, post-fledging Summer, Fall Spring, Summer		Cheatgrass and other invasives have become vectors for increased fire frequency.			14	Restore natural fire regime return interval by reducing the annual rate of unplanned shrub steppe burning by at least 50% by 2020.	13, 14 Map high risk ignition sites and priority areas for fire suppression and encourage land managers to work cooperatively to suppress all fires that occur in priority areas as soon as possible
									14 Create and maintain fire breaks in areas prone to frequent ignitions to prevent small fires from getting out of control
									14 Increase ability of rural fire districts to respond quickly to shrub steppe fires

LIMITING FACTOR: Inappropriate Grazing Practices

Key Finding	Focal Species	Life Stage	Degree of Impact	Hypotheses Statements		Confidence H, M, L	Obj. #	Objectives	Strategies by Objective #
Native plant diversity has been reduced	Sage grouse Brewer's sparrow Mule deer (migratory pops.) Mule deer (migratory pops.)	Breeding, brood rearing, summer Nesting, post-fledging Spring, summer	H H M H	Reduced plant diversity has been directly caused by inappropriate grazing,		H	15	Improve habitat condition for focal species in shrub steppe habitat that have grazing programs by 2020.	15 Promote the management recommendations made by Connelly et al. (2000) for livestock grazing in sage grouse habitats.
									15 Build partnerships with interested landowners;
									15 Sign up with voluntarily joint cost share programs;
									15 Adjust timing and location of grazing systems to increase residual bunchgrass cover in spring/summer

		All							15 Utilize strategic fencing on key locations

LIMITING FACTOR: Invasive alien species

Key Finding	Focal Species	Life Stage	Degree of Impact	Hypotheses Statements		Confidence H, M, L	Obj. #	Objectives	Strategies by Objective #
The viability of existing shrub steppe is threatened	Sage grouse Brewer's sparrow Mule deer (migratory pops.) Mule deer (non-migratory pops.)	Nesting, brood rearing, summer Nesting, post-fledging Fawning, summer Fawning, summer	H M M H	Shrub steppe viability is threatened by spread and presence of invasive alien species		H	16	Strive for a 25% reduction of invasive species abundance by 2020.	16 Prioritize areas for control and initiate control efforts. 16 Implement restoration techniques including use of herbicides, prescribed fire, seeding of native stock, strategic fencing, etc. 16 Coordinate with landowners to determine best management practices and means of reducing impacts to focal habitats.

LIMITING FACTORS: Loss of soil stability due to reduction of microbiotic crust cover.

Key Finding	Focal Species	Life Stage	Degree of Impact	Hypotheses Statements		Confidence H, M, L	Obj. #	Objectives	Strategies by Objective #
Microbiotic crust is reduced across the landscape	Sage grouse Brewer's sparrow Mule deer (migratory pops.) Mule deer (migratory pops.)	Breeding, brood rearing, summer Nesting, post-fledging Spring, summer All	H H M H	Microbiotic crust has been reduced due to trampling by livestock, vehicular traffic and destruction by fire			17	Protect areas with existing intact microbiotic crust	17 Use purchase, lease, or protect areas of intact crust cover through easements. 17 Utilize strategic fencing on key locations17 Protect from off-road vehicle use and new road construction
							18	Restore viable extent of microbiotic crust cover.	18 Include microbiotic crust recovery considerations in all shrub steppe restoration activities

KEY UNCERTAINTIES

- **Recovery rates for microbiotic crust are largely unknown and require research**
- **Shrub steppe restoration methods require research and should be developed under an adaptive management approach**
- **A prioritization plan for invasive species control has not been developed. A combination of remote sensing, field, and GIS techniques, followed by a risk assessment for priority areas needs to be completed**.

2.4 FOCAL HABITAT: INTERIOR RIPARIAN WETLANDS

Focal Species: Mallard, Yellow Warbler, and American Beaver

KEY ECOLOGICAL ATTRIBUTES:

- **Large intact floodplain landscapes composed of shifting, dynamic mosaics of:**
- **Uneven aged stands of cottonwood, willow and other woody riparian species,**
- **Side channels,**
- **Upland grass and shrub communities**
- **With direct connection between focal habitat and complex hydrologic processes.**

LIMITING FACTOR: Altered surface and ground water hydrology

Key Finding	Focal Species	Life Stage	Degree of Impact	Hypotheses Statements		Confidence H, M, L	Obj. #	Objectives	Strategies by Objective #
Riparian Wetland structure and composition has been lost or degraded	Beaver Mallard Yellow warbler	All All Breeding, summer	H H H	Riparian Wetland structure and composition has been lost or degraded as a result of human induced alterations in hydrology (e.g. roads, reservoirs, diversions, levees, pumps, drains, flood control)		H	19	Restore normative hydrologic conditions to all unregulated tributary habitats by 2020.	19 Maintain instream flow through various means including purchase of land and/or water rights from willing sellers in unregulated tributaries. 19 Explore out-of-subbasin solutions to habitat and irrigation needs in the Lower Yakima subbasin 19 Use fish-friendly water level control structures (grade control devices, spillways, etc.) to mimic normative conditions in restoration areas, especially areas in the Lower Yakima subbasin.
							20	Provide adequate hydrology to reconnected habitats in the regulated tributary and mainstem floodplain areas by 2020.	19, 20 Explore opportunities for alterations in hydrologic management in regulated tributary and mainstem reaches to address habitat as well as irrigation and other needs. 19, 20 Maintain instream flow through various means including purchase of land and/or water rights from willing sellers in unregulated tributaries 19, 20 Explore out-of-subbasin solutions to habitat and irrigation needs in the Lower Yakima subbasin 19, 20 Use fish-friendly water level control structures (grade control devices, spillways, etc.) to mimic normative conditions in restoration areas, especially areas in the Lower Yakima subbasin.

				Cottonwood regeneration has been impaired due to altered hydrology.		H	21	Establish new cottonwood stands in active riparian zones in all potential cottonwood restoration locations in Yakima subbasin by 2020.	20, 21 Complete assessments begun under the Yakima River Water Enhancement Plan to prioritize locations where cottonwood restoration is possible. 20, 21 Reconnect cottonwood restoration areas to the active floodplain.
									20, 21 When necessary, plant cottonwoods and other native riparian vegetation in prioritized locations.

LIMITING FACTOR: Habitat conversion and degradation of Riparian Wetland habitats									
Key Finding	**Focal Species**	**Life Stage**	**Degree of Impact**	**Hypotheses Statements**		**Confidence H, M, L**	**Obj. #**	**Objectives**	**Strategies by Objective #**
Extensive loss of Riparian Wetland habitat has occurred	Beaver Mallard Yellow warbler	All All Breeding, summer	H H H	Riparian Wetland habitats have been converted and degraded on a large scale to human use (e.g. urban, irrigated agriculture, pasture, gravel quarry).		H	22	Restore lost or degraded habitats to ecologically functional conditions in the Lower Yakima subbasin (from the south end of the Yakima Canyon to the Yakima River delta) by 2020.	19, 20, 21, 22, 23 Complete assessments begun under the Yakima River Water Enhancement Plan to prioritize areas with restoration potential.
						M		Restore ecologically functional floodplain riparian wetland to all possible areas of the upper Yakima subbasin (headwater to the south end of the Yakima Canyon) by 2020.	19, 20, 21, 22 Immediately implement protection and restoration activities in mainstem areas identified in Stanford and Snyder (2003), especially the Union Gap and Wapato reaches.
									19, 20, 21, 22 Immediately implement protection and restoration activities in tributary areas important to focal species - especially the Toppenish, Satus, Ahtanum and Naches watersheds.
							23		19, 20, 23 Reconnect side channels and plant native woody riparian vegetation where needed and possible in the upper Yakima subbasin.
							24	Restore non-wetland components of the floodplains, along with the wetlands, to meet the native habitat needs of the focal species.	19, 20, 21, 22, 23, 24 Work with cooperating landowners, tribes, and public agencies through purchase, easement, and land-use agreements to protect intact floodplain habitats and to secure lands for restoration.
									19, 20, 21, 22, 23, 24 Conduct management and monitoring activities on protection and restoration areas to ensure that the ecological functions and habitat benefits are maintained.

							25	Work with landowners on protection and restoration techniques on focal habitats	19, 20, 21, 22, 23, 24, 25 Interact with, assist, and distribute materials (e.g. seminars, printed) to landowners in focal habitats.

3 Aquatic Key Findings

Protection of existing highly productive habitats, and productive or threatened populations is a high priority for maintenance of the diversity, productivity and health of the Yakima Subbasin. The following Key findings are not prioritized, these Key Findings share a common Biological Objective – Maintenance and enhancement of these natural resource is of the highest priority in the Subbasin.

3.1 Protection Key Findings for Fish Focal Species

3.1.1 Protection Key Findings for Fall Chinook:

Protect Marion Drain Fall Chinook	**There has also been the relatively recent (early 20th century) development of a separate, self-sustaining population of fall chinook in the Marion Drain. Some researchers speculate that this is the remnant endemic Yakima fall chinook strain.** By any estimation, the abundance of Fall Chinook has been significantly reduced from historic levels.
	"[b]ased on existing electrophoretic and life history data, the genetic variability within the Marion Drain population represents a substantial portion of the genetic variability found in mid-Columbia summer and fall chinook. … the Marion Drain population may prove to be an important part of the effort to rebuild fall chinook in the Yakima Basin

3.1.2 Protection Key Findings for Steelhead:

Kelt life history	Survival of steelhead kelts (mature spawned out fish with the potential to spawn again) migrating out of the Yakima Basin and through the mainstem Columbia to the ocean is at or near zero.

3.1.3 Protection Key Findings for Bull Trout:

Harassment during spawning	Harassment such as poaching is high in Box Canyon and Gold Creek, resulting in decreased spawning success
Box Canyon Population	Box Canyon bull trout population is naturally limited by spawning habitat that

	limits viability due to low population size and low spatial diversity of spawning habitat.
Genetic diversity	Recent genetic analysis work done by Reiss (2003) has indicated a high level of genetic differentiation among 12 bull trout spawning populations in the Yakima River basin

3.2 Protection Key Findings for Assessment Units

3.2.1 Protection Key Findings for the Lower Yakima Assessment Unit:

Amon Creek	La Riviere (pers. com. 2004) noted that Amon Creek, which enters the Yakima in Richland, provides 6 cfs of cool spring fed water year round
Rearing Habitat	The reach of the Yakima River from Roza Dam to Sunnyside dam is an important rearing area for spring chinook juveniles. Juveniles from all three stocks are typically distributed throughout this reach in the late fall following emergence. Densities are highest well below the major spawning areas but above Sunnyside Dam
Critical Reach	Hockersmith et al. (1995) indicated that about 66 percent of Yakima steelhead overwinter in the mainstem Yakima in this Assessment Unit with the majority in the vicinity of the Satus creek confluence. This is the same area of the river which supports overwintering juvenile spring chinook, and this reach is the most important reaches for preservation or protection at the for all species in the subbasin according to the EDT model.

3.2.2 Protection Key Findings for the Mid Yakima Floodplain:

Critical Reach	However, much of this reach is still characterized by intact floodplains, cottonwood gallery forests, and extensive

	riparian wetlands

3.2.3 Protection Key Findings for Low Elevation Tributaries Assessment Unit:

Habitat and species diversity	These watersheds are extremely diverse for their size; and have vegetative types that include alkali flats, strub steppe, grassland, dry forest, mixed forest, high elevation forest. Steelhead populations in this AU would likely have high levels of genetic, life history and spatial diversity as well
Upper Satus Tribs	The upper portions of Dry, Logy and Kusshi creeks are generally in good to excellent conditions
Satus Floodplain	Most floodplains within the Satus basin have remained intact, in that little diking has taken place
Upper Toppenish	Channel conditions upstream of the mouth of Toppenish Canyon are very good Abundant high quality spawning gravel can be found throughout the uppermost portion of Toppenish Creek, as well as NF and SF Toppenish creeks Riparian condition is excellent in upper Toppenish Creek, as well as in NF and SF Toppenish Creeks,
Cowiche Creek	The moderate gradient of Cowiche Creek and its forks is associated with many pools, riffles, and glides. Large woody debris and overhanging/submerged vegetation is abundant in the mainstem and South Fork. Beaver dams are common on both the mainstem Cowiche Creek and the South Fork Cowiche Creek (CBSP 1990). There are enough gravel bars in Cowiche Creek and the South Fork for spawners to fully seed the available rearing habitat (CBSP 1990, WDFW 1998) In the upper portion of the watershed on WDFW and private timberlands the riparian condition is good to excellent in most places, with exceptions being located at road crossings or areas

	where the road is directly adjacent to the creek

3.2.4 Protection Key Habitat Findings for Mid Elevation Yakima Assessment Unit:

Productive mainstem habitat	The mainstem Yakima River between the Teanaway River and Keechelus Dam is the premier spring chinook spawning and rearing area in the Assessment Unit. Roughly 50 percent of all spawning spring chinook in the entire basin utilize this reach. Over 75 percent of the upper Yakima stock relies on this reach. The reach of the Yakima River from the confluence with the Teanaway River to Keechelus Dam is roughly 40 miles in length. Habitat quality is very good in this reach and is surpassed in the subbasin by perhaps only the American River. The large volumes of wood in the river, combined with a lack of natural confinement and perhaps a greater frequency of floods and disturbances, create a very complex river system.
Rainbow trout fishery	Rainbow trout are also found in large numbers in both the Yakima canyon and upper flats areas, and support an economically and recreationally significant trout fishery in those areas
Upper portions of upper Yakima tribs.	Large woody debris is abundant in the upper reaches of the South Fork of Manastash Creek (above ~RM 10 Buck Meadows), in the North Fork and South Fork of Taneum Creek (above RM 12.7), in the Fishhook Flats area of the North Fork of Taneum Creek (RM 3 NF Taneum), and above Big Creek Dam (RM 2.1) on Big Creek and contributes to habitat quality and complexity. Riparian conditions are unusually good on these creeks. Vegetation communities transition from dense alder/cottonwood stands that approach complete canopy

	closure in the valley to equally dense growths of alder/Douglas fir in the low-gradient upper reaches. The steep-sloped and rocky canyon sections of Manastash and Big Creek are fringed with dense growths of willow and alder.*

3.2.5 Protection Key Findings for High Elevation Yakima Assessment Unit:

NF Teanway Bull Trout	The fluvial bull trout population in the North Fork Teanaway River is believed to be at high risk of extinction (USFWS 2002) due to limiting habitat area and isolation from other populations
Bull Trout Population above reserviors	All of the existing storage reservoirs currently support populations of adfluvial bull trout, which spawn in the larger tributaries including the upper Cle Elum River, Box Canyon Creek, the Kachess River above the reservoir, and Gold Creek. The Box Canyon Creek bull trout population is naturally limited by spawning habitat.
Mainstem Teanaway Channel Characteristics	Well over half of the mainstem Teanaway is still anastomosing, even though the number of channels and interconnections is much lower than historically. Suitable spawning gravels and gradients for spring chinook, steelhead, and coho are present in most reaches of the mainstem and the lower portions of the forks, and are abundant in many areas. Despite extensive alterations, a fairly extensive wet meadow/wetland complex still exists in the lowermost several miles of the mainstem, and this area has been identified as a critical piece of habitat and a top priority for preservation
Upper Cle Elum River	The upper Cle Elum River was and is remarkably complex, containing a large, unconfined distributary fan near the lake, a confined canyon reach, a moderately steep (1.5 – 4% gradient) alluvial reach, and two

	lakes, one at the headwaters and one dividing two low gradient (0.5 – 1.0% gradient) lake outlet reaches with abundant, clean spawning gravel, and plentiful large woody debris The riparian corridor of the Cle Elum River upstream of the reservoir is in generally good condition
Box Canyon Bull Trout	The Box Canyon bull trout population is naturally limited by the availability of suitable spawning habitat (less than 50 redds estimated capacity) due to natural falls. Because of the small population size and lack of suitable habitat, the long-term viability of this population is low. Special care should be taken to ensure this population's viability and that the population remains connected to the population that spawns in to Kachess River mainstem.
	Harassment of bull trout, through fishing/poaching pressure is high in Box Canyon and Gold Creek, resulting in decreased spawning success.

3.2.6 Protection Key Habitat Findings for the Mid Elevation Naches-Tieton Assessment Unit:

Rimrock Bull Trout Populations	Historically the South Fork Tieton population exhibited a fluvial life history and the Indian Creek population had a resident life history, but after the construction of Rimrock Dam, both of these populations evolved into distinct adfluvial populations. Based on spawning surveys, the Rimrock populations represent the strongest stocks in the Yakima Core area
Little Naches Habitat	Upstream of Salmon Falls, habitat in the Little Naches is nearly pristine, with abundant spawning gravel, excellent riparian condition, adequate summer flows, and plentiful large woody debris and instream cover

3.2.7 Protection Key Habitat Findings for the High Elevation Naches Assessment Unit:

American River Habitat	Some of the best spring chinook spawning and rearing habitat in the entire Yakima Subbasin is found in the American River between RM 5 and 15.8 The American River, along with its tributaries, is noted for its pristine status The American River riparian corridor is pristine, consisting in most places of an overstory of old growth Douglas fir and an understory of willows and alder
American River Spring Chinook	American River spring chinook are one of the three genetically distinct Yakima stocks and are the least numerous stock in the basin.
Bull Trout Populations	The adfluvial bull trout population in Bumping Lake and the fluvial population in the American River are believed to be at high risk of extinction
Upper Bumping Habitat	The Bumping Lake tributaries are relatively pristine, occupying watersheds that are largely undeveloped. The upper Bumping River, along with these many other headwater and upper tributary reaches, is cold, small and often rather steep (gradient >4%). Some were probably negotiable by steelhead, although probably not spring chinook and coho. It is a relatively intact portion of the watershed.
American River Flow and Water Quality	. The hydrograph of the American River is considered to be essentially natural. Given the largely unaltered landscape of these areas, water quality is presumed to be essentially natural—that is, meeting the standards for class AA waters.

	Water quality is generally excellent in the American River

3.3 Explanation of Subbasin-Specific Aquatic Restoration Key Findings, Objectives and Strategies

Many of the strategies in this management plan are based on standard types of actions that would be very similar if they were implemented in other parts of the Pacific Northwest. Because of the uniqueness of the regulated flow regime and/or the geographic position and design of related infrastructure such as large diversion dams, drains and spillways there are several strategies that are unique to the Yakima Subbasin. The key findings that relate to unique basinwide features, however, do not mean that they are necessarily the most important findings. The discussion below are intended to clarify many of the strategies that were released to Subbasin planners, technical committees, public review groups and the general public in previous drafts. The bolded statements are frequently found in the tables that follow, and the paragraphs below are intended to provide an explanation of how we moved from the starting point of the Conceptual Foundation, to a logical development of Key Findings, Objectives and Strategies.

Develop flow/temperature benchmarks, fund and implement projects that move the hydrograph toward the benchmark.

This strategy is based on the concept that it is desirable to define a range or distribution of environmental attributes (such as the variation in water flow on an annual basis) that have a describable and definable relationship to conditions that existed in the basin when fish and wildlife populations were viable. The intent of these objectives is not necessarily to move towards pre-settlement conditions, but to have a means of defining current conditions relative to conditions that existed prior to Euro-american settlement (circa 1850) in order to assess the degree of change that has occurred since that time. Much of the rationale for this concept is based on the range of variability approach first put forward by Richter (1999) and the Patient/Template analysis employed in the EDT model. Conceptually, unless there is a known or hypothesized relationship between current conditions and the conditions that native species were adapted to, our ability to forecast the effects of management actions is very low.

Establishing these current and pre-1850 benchmarks would provide a set of scales that can be used to a) assess the relative impact of management actions such as restoration, preservation, or enhancement b) monitor changes in the watershed caused by changes in management according to scales that have some meaning specific to conditions within the Yakima subbasin, and c) to explicitly state the current understanding of changes in environmental attributes such as flow or temperature how those changes have affected fish, wildlife, plants, and plant communities. In some locations in the watershed, summer water temperatures are warmer for a longer period of time than under pre-settlement conditions, in other locations they are colder. Given the Conceptual Foundation and the importance of temperature to both the environment and life history of salmonids, either change in temperature regime could be expected to have (not necessarily negative or positive) consequences on productivity and survival of native salmonids in the subbasin. Basing objectives on absolute standards (i.e., water temperatures should not exceed 21^{o} C, ideal incubation temperatures for coho are 4^{o}C) are often not appropriate in the real world where variation from optimal conditions is the rule and adaptation to that variation is key to population performance. Taking a standard-based approach also does not lead to evaluation of the consequences of alteration of the temperature regime by altering temperatures to such an extent that they no longer lie within the normal range of pre-1850 or "naturally functioning" environment.

All references to benchmarks are either for characteristic flows or flow related attributes such as temperature. Currently, the flow models available for use within the subbasin are based on Riverware, which is a software program developed by the Bureau of Reclamation and is used to optimize management of the Yakima Irrigation Project and projects in other parts of the world. While there is the capability of using Riverware to model pre-1850 flows, the model is not configured to include the physical effects of the pre-settlement glacial lakes on the hydrology of the basin or (very productive) river reaches immediately downstream of the reservoirs, nor does it analyze changes to flows in tributaries that are not part of the Yakima Project. Therefore we do not currently have an agreed upon accurate description of pre-settlement flows in the mainstem, or any quantitative description of pre-1850 flows in the tributaries, to compare with present day flows and (notwithstanding the desire to have measurable objectives) are unable to portray the relationship of the current flow regime to the pre-1850 flow regime. The best that can be done at the current time is to attempt to put flows and flow related attributes into the pre-1850 "ballpark", and lay out strategies that will be needed to get there.

Reduce net water use; develop out of basin sources for new water; manage the system differently in good/excellent water years.

The strategies for conservation of water could be perceived as conflicting with recent documents that state that conservation of water will not solve the basin's water problems. While this is true from the standpoint of conservation's inability to make major improvements in the reliability of the water supply for agriculture and other uses, conservation of water can have major beneficial impacts in specific portions of the Yakima Subbasin, the difference in these two perspectives on the importance or role of water conservation is discussed below.

One of the documents that the Yakima Subbasin Plan draws on heavily is the Watershed Management Plan for the Yakima Basin (Yakima River Basin Watershed Planning Unit, Jan. 2003). The emphasis of the Watershed Plan is on improvement of reliability of the Yakima Project to supply irrigation water (to reduce the need for water rationing in water short years) and supply sufficient water for growing communities in the future. The Watershed Plan examines the issue of water conservation and for the most part finds that it could play a very small role in increase of reliability for 2 reasons: the relatively small storage capacity that exists in the basin and the amount of water reuse that occurs in the basin. This small storage capacity means that even if water is conserved, there is no place to store it in most years. The water reuse or the role of returns in maintaining flows means that even if water is conserved in the upper portions of the basin, the conserved water would still need to be released from storage to meet downstream demand, and again there is no benefit to conservation since water in storage must be released. If one were to look at this situation from the standpoint of increase in flow for fish habitat, the picture would be slightly different. Water conservation in the upper watershed would still make little sense given the current configuration of storage, diversion points, and water rights. But below Union Gap, conserved water could serve the purpose of increasing stream flow in the Wapato Reach, which has the most intact habitat and is the most dewatered reach in the mainstem.

If water were conserved (from either the Wapato Irrigation Project which serves the Yakama Reservation or the Sunnyside Valley Irrigation District which serves the east side of the River past Prosser) and allowed to pass over the Wapato and Sunnyside diversion dams, it would directly improve habitat conditions for the next approximately 18.5 miles of habitat in the mainstem Yakima. Water conservation in these areas serves a fish habitat purpose even if the water is withdrawn downstream (after other irrigation returns have caused flows to improve). This is especially true given the low temperatures of the water that passes over Wapato and Sunnyside dams in the summer months and could provide an even larger area of near normative thermal environments in this area of good to excellent habitat conditions. Reductions in water use/diversions below Union Gap (or shifting water use to earlier in the year) have the effect of reducing the peak flows required to be routed down the Naches during flip-flop, allowing the Naches to also achieve a more “normative” flow regime.

Similar rationale exists for many of the tributaries such as Ahtanum, Toppenish, Wenas, Manastash, Taneum, etc. which were not examined in the Watershed Plan. Where water conservation can be shown to be of direct benefit to fisheries by increasing flows in a limited reach, funding sources that are allocated to fish enhancement or restoration may be appropriate for water conservation, water purchase, or water rights transfers, even where such improvement in infrastructure also benefit consumptive water users such as agriculture by improving delivery efficiency or reducing pumping costs.

Develop out-of-basin sources for new water.

Primary among these projects is the proposed Black Rock Reservoir that is actively being studied at this time with funding from Congress and the State of Washington. Black Rock has been described in a variety of configurations, but the basic premise is that water is pumped from the Columbia during September when there is “excess” water in the Columbia (in most years) from the Corps spilling to gain flood control space for the winter and when hydropower is relatively cheap. The proposed reservoir itself is located in the Black Rock valley along SR 24 in Yakima County, and would be either .8 maf to 1.8 maf in capacity and could supply an annual amount of 0.5 maf for irrigation in the Yakima Basin or more in a water-short year. Recommended for study in the Watershed Management Plan, the project has received support from local governments (including the Yakama Nation), agricultural and irrigation organizations, local fish and wildlife biologists, the State legislature and Congress. There is, however, considerable opposition to the proposal from conservation organizations (due to potential effects on the Columbia River and also changes to the Yakima Subbasin) and others concerned about the project’s economic viability. It has not yet been determined whether the Black Rock project is economically and biologically viable, additional studies are currently in progress that examine the economic costs and the biological effects of the project on the Yakima Subbasin and the mainstem Columbia River.

If the Black Rock project were to be constructed, it could have a powerful effect on the flexibility of the Yakima Irrigation Project, and therefore on the intra-annual flow of the Yakima River. For instance, it could provide sufficient flows to eliminate the need for the flip-flop flow regime which would allow for more normative summer flows in the upper Yakima and Naches and a much more normative flow in the Naches during September and October.

Manage the system differently in good/excellent water years.

Change flip-flop management or manage differently in good water years.

Set TWSA (Total Water Supply Available) targets for reduction or elimination of flip-flop.

The flip-flop flow management regime results in high flows in the upper Yakima arm during the summer months of July and August; during these same months, flows in the Naches arm are greatly reduced. In September and October, flows are flip-flopped and flows in the upper Yakima drop to near normative levels, while those in the Naches are dramatically elevated. These strategies seek to reverse the effects of flip-flop, mainly the negative effects of the sustained high flows on the upper Yakima and the devastating effects of the September and October flows on the Naches.

During excellent water years it should be possible to manage the Naches side for greater flows during the early summer when black cottonwoods (vital for streambank stabilization and shade) begin releasing their seeds and then gradually lower flows in a manner that allows for black cottonwood seeds to establish themselves. In the fall, the flows required for flip-flop would then be lower than the early summer flows and black cottonwood seedlings would not be drowned. While this flow scenario may be somewhat rare due to the extremely the good water conditions required, even if it only happened on a 20-year or more cycle that would still approximate the normal recurrence interval for black cottonwood establishment. Management for this hydrology would have to begin in the spring and be based on the Total Water Supply Available calculation (the starting point for deciding water release and delivery schedules for the irrigation season), with some threshold for TWSA being set as a point to consider different operating rules for that year. The point of reducing flip- flop would not be to reverse the low flows in the upper Yakima during September and October as they provide spawning and incubation habitat that can be maintained throughout the winter. To go further and establish a flow regime without fall peaks in the Naches or unacceptable impact on upper Yakima spring Chinook would require either the development of a new source of out-of-subbasin water, new infrastructure that eliminated the use of the Naches as a conveyance for fall flows, or dramatic shifts in water use in terms of total consumption and seasonality, none of which may be practical for the continued functioning of the current agricultural economy of the Yakima subbasin.

Develop flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark.

Reconnect 100% of floodplain side channels in the X Assessment Unit.

Reconnect side channels as strategies to restore temperature regimes.

The first two objectives are usually and intentionally shown adjacent to each other in the table, as they are interrelated. Based on current habitat conditions in the lower river that are relatively similar to their pre-settlement state, various modeled pre-1850 summer low flows in the mainstem, and temperature models and direct measurements of the relationship between flow and temperature, it is highly likely that in many portions of the mainstem, and in the lower portions of major tributaries, summer temperatures were naturally at lethal or near lethal levels (for salmonids) for periods of time on an annual basis. Further it is likely that even under the most optimistic predictions, there will continue to be increased duration and severity of these periods of less-than-optimal temperatures in comparison to the pre-1850 environment. Obviously, in the pre-1850 environment, the subbasin was able to produce large amounts of salmon from these same geographic areas that had less than "optimal" temperatures. A major working hypothesis of the subbasin plan is that this was possible because of the massive storage capacity of the alluvial aquifers to feed the once numerous side channels and springs of the lower river for a significant proportion of the year. High water temperatures have an effect on the ecosystem and on the salmonid species as well. Higher water temperatures would increase autocthonous (nutrients and food energy produced in the aquatic environment) productivity of the environment, especially in July and August, before allocthonous (nutrients and food energy produced in the riparian/upland environments) inputs maximize in the fall. Side channels, springs, and other thermal refugia would have allowed salmonids to take advantage of the high productivity of increased temperatures, especially during those times of year where temperatures were elevated for only a portion of a day. Restoration of these side channels and in-channel temperature variability that would have been associated with large wood and natural channel forms, present the greatest opportunity for restoration of the productive capacity of the Subbasin.

Strategies for restoration of side channels need to include floodplain restoration to allow the channels to function naturally. In some cases, side channels were not part of the active floodplain, and removal of obstructions alone could reconnect them to a natural state. Large impacts have also occurred because of the construction of drain systems to establish farming in areas with naturally high water tables. Draining these areas has reduced the storage capacity of the alluvial aquifers. Restoration of local water tables and hyporheic zone function will not only have local benefits, but also benefits to the entire watershed as a result of increased natural retention capacity of the unregulated spring peak flow. In other areas (i.e., upstream of Wapato Dam and many bridges), aggradation of the channel has perched the mainstem channel above the floodplain (i.e., the main channel is no longer the low point in the floodplain), which either turns the surficial aquifer into "dead storage" or leaves it at a static head level throughout the year. The perched channel can also result in disconnection of side channels during low flow times of year (e.g., winter in the Union Gap reach) as illustrated below.

Figure 4-1. Spring Creek (a spring fed side channel of the Yakima River) unable to return to main channel because of sediment aggradation and bar formation at the creek mouth.

Increase anadromy in rainbow trout/steelhead specifically, and increase environmental attributes that favor anadromous fish.

Study the effect of altered temperatures on life histories and ecosystem in general.

The mechanisms that determine whether an individual or segment of a population will exhibit an anadromous or a resident life history is not well understood, but there is a general understanding of the genetic relationships to anadromy and environmental characteristics (e.g., productivity of the freshwater environment or access) that favor or inhibit anadromy. In the Yakima subbasin, the Satus and Toppenish populations of steelhead show a strong or completely anadromous life history, while upper Yakima rainbow trout show almost as strong a preference for a resident life history. We know that the upper Yakima was, at a minimum, partially blocked to steelhead passage for several (fish) generations and that rainbow trout were introduced into the upper watershed, but the level of genetic mixing with the native population was relatively low. The fundamental question is whether environmental conditions within the upper Yakima are so favorable to the resident life history that anadromy has been reduced or whether selection for resident fish by eliminating or reducing anadromy for several generations has reduced the ability of the population itself to adopt the anadromous life history form even when environmental conditions were changed. The relationship between these environmental conditions and life histories is a Key Uncertainty in the Subbasin Plan and the plan suggests that studies be undertaken to determine which of the above is true. Depending on the answer to that question, management activities would focus on restoration to restore environmental attributes such as habitats, temperature, and flow patterns; or on reinforcing anadromy through capture of adults and a captive broodstock program, initiation of an out crossing program to increase the prevalence of anadromous genes, or other strategies that focus on population attributes.

Lower temperatures in combination with other factors in the upper Yakima (constrictions by levees, high flows, relatively high velocities) also limit area that is usable by juvenile salmonids for growth (Todd Pearson, personal communication). In many locations, junctions of tributary streams with the mainstem Yakima present the greatest opportunity for increasing this currently limiting habitat type. Recent project submissions and the progress of organizations such as YTAHP in providing access to these types of habitats will increase the availability of these types of habitats dramatically in the next several years due to removal of passage obstructions in the lower end of many upper Yakima tributaries. Studies of the effect of these actions on upper Yakima salmonid populations including Steelhead, Rainbow Trout, and Spring Chinook to document habitat use and direction of change in growth rate and life history types (at the population level) should be undertaken.

3.4 Explanation of Key Findings Tables

1	2	3	4	5		6	7	8	9	10	11	12
Key Finding–Observed Effect or Phenomenon	**Cause/Working Hypothesis**	**Confidence Effect Is Actually Occurring.**	**Level of Confidence in Causal Relationship**	**Cont. of Cause to Key Finding or Effect**		**Focal Species Impact**	**Ecosystem Impact**	**Biological Objective (Reduce and/or Eliminate Negative Causes, Improve and/or Maintain Positive Causes)**	**Strategies to Reduce and/or Eliminate or to Improve and/or Maintain**	**Currently addressed?**	**Strategies to Mitigate Effect**	**Currently addressed?**
Availability of summer/early fall habitat lower in comparison with pre-1850 environment	Increases in summer flow will reduce temperatures to ranges— closer to pre-1850 times—that are below lethal levels for salmonids.	High	High	High				Develop temperature benchmarks, fund and implement projects that move the hydrograph toward the benchmark	Increase flow to depth threshold. Reconnect side channels Improve riparian zone	X		
Habitat and temperature diversity eliminated by loss of off-channel habitat	Obstructions associated with infrastructure have blocked habitat.	Med	High	High				Reconnect 100% of floodplain side channels in this assessment unit	Relocate infrastructure where possible to allow natural processes to operate.	X	Reconnect side channels by removal of obstructions without floodplain restoration.	

1) **Key Finding–Observed Effect or Phenomenon**. These are observations of habitat or population characteristics, usually stated in a manner that compares current conditions with the pre-1850 state of the habitat or population in the subbasin.

2) **Cause/Working Hypothesis**. A statement of the causal mechanism or working hypothesis for the observed effect. These statements are the known or hypothesized "cause" in a cause and effect relationship.

3) **Confidence Effect Is Actually Occurring.** This confidence level is based on comparison of the numerous data sources that were used in the assessment. Where all documents agree that an effect is occurring or in certain cases where an effect is documentable with a photograph (i.e., annual dewatering of a stream), the confidence is high. Where there is agreement among several documents or among the Aquatic Technical Advisory Committee without other documentation, confidence is medium. Where there is only a single source of information, confidence is low and should be confirmed prior to taking action to implement a strategy. The single sources come from either recently published materials (too new to be in documents older than 2 years) or come entirely as hypotheses generated by the EDT model. There are not any low ratings listed in this category as all Key findings that did not have a high confidence in their occurrence were categorized as Key Uncertainties and moved to the Research, Monitoring and Evaluation Plan for further study.

4) **Level of Confidence in Causal Relationship.** High level of confidence means that there is a well-accepted theoretical construct (i.e., a well-proven hypothesis or set of hypotheses that is broadly accepted in the scientific community) that has explanatory power for the cause and effect relationship, or the cause is established fact. Usually these are the types of theoretical constructs found in textbooks for biology, conservation biology and genetics, fisheries biology, ecology, hydrology, physics, etc. Medium confidence means that likely alternative hypotheses could be generated, but not likely given conditions in the Subbasin. There are not any low ratings listed in this category as all Key findings that did not have a sound theoretical base for a causal factor were categorized as Key Uncertainties and moved to the Research, Monitoring and Evaluation Plan for further study.

5) **Cont. of Cause to Key Finding or Effect.** Where a theoretical construct is composed of multiple causes that contribute to a finding or effect, is the given cause or hypothesis a major driver of the effect. For example, increased water temperatures could be related to flow, loss of riparian zone, change in channel shape, or discharge of warm water to the stream. High is the only or dominant cause, medium one of several potential causes; low is a small or unknown cause of the given effect. Where confidence is low, additional studies are generally recommended.

6) **Level of Impact to Focal Species.**. This column is left blank in the key findings for individual populations since these key findings are not measured across focal species. The level of impact is based on general tiers of effect based on EDT level 2 attributes mapped on GIS layers and whether the key finding effects a listed species. Tier 1 has a high degree of effect on focal species as a whole at a large scale, Tier 2 less effect or is only a reach scale effect, Tier 3 relatively low effect, and Tier 4 are site-specific effects. ESA effects a listed species.

7) **Level of Impact to Ecosystem or Watershed.** Certain Key Findings are not relatable to a specific life history of a focal species, examples are changes in flow, toxic pollutants, overall stream productivity, lowering of the groundwater table, etc. and are prioritized based on the total area of the stream channel affected by that key finding. For instance, the loss of historic sockeye populations has a very large effect on the ecosystem as a whole by reduction of carcasses and nutrient import to the watershed and the position of those populations in the upper watershed where they would have had an effect on the majority of fish habitat in the basin and also would have had a large effect on the terrestrial focal species and environment. These follow the same Tiering categories as above 1 = Subbasin wide effect, 2 = Subwatershed or multiple reach effect, 3= Reach effect 4= Site specific effect.

8) **Biological Objective (Reduce and/or Eliminate Negative Causes and Improve and/or Maintain Positive Causes)**. For a given cause, how can negative causes be reversed or positive causes be reinforced? Biological objectives should be measurable over a given time period. These objectives go beyond EDT or other environmental attribute data and attempt to address the cause of a given environmental attribute (i.e., the reason temperatures have been elevated or the riparian zone is degraded rather than simply the attribute itself, i.e. an objective that says "reduce lethal temperatures").

9) **Strategies to Reduce and/or Eliminate or to Improve and/or Maintain**. Strategies aimed at reducing or eliminating (or improving positive phenomenon) the causal factor for the given key finding. Most of these strategies will be common restoration techniques or practices, but some will be unique to the Yakima subbasin.

10) **Currently Addressed?** Based on the Inventory, this is a rating of whether a given strategy is already being implemented in the basin. This is not to imply the problem will be solved, but that the problem has been recognized in the past, and there is a well established experience base in the Subbasin with this type of action.

11) **Strategies to Mitigate Effect.** When a strategy to eliminate the cause will not be successfully implemented (because of social constraints, financial constraints, or impracticality) or where a temporal delay of several decades before the strategy would effectively reduce the cause of the Key Finding, these strategies are offered as alternatives. An unstated mitigation strategy for most effects, and what has been a standard mitigation practice across the Columbia Basin, is reliance on a hatchery to mitigate for loss of freshwater habitat.

12) **Currently Addressed?** Based on the Inventory, this is a rating of whether a given strategy is already being implemented in the basin. This is not to imply the problem will be solved, but that the problem has been recognized in the past, and there is a well established experience base in the Subbasin with this type of action.

Note: Short-term management strategies (i.e., over the next 5 years) are shaded in gray, while specific strategies are highlighted in **bold**.

3.4.1 Focal Species Populations- Restoration Key Findings, Objective and Strategies

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Conf. in Causal Rel.	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/or Eliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
Spring Chinook populations have been dramatically reduced from pre-1850 abundance levels	Habitat loss and alteration and changes in the biotic community have reduced habitat suitability, which in turn has reduced productivity, abundance, and spatial distribution of the species.	H	H	H			1	Restore Spring Chinook population abundance, productivity and spatial distribution to viable, harvestable and sustainable levels over the next 30 years.	**Coordinated management of populations and habitat improvements including**: Ongoing research, **Habitat restoration.** **Population management activities such as harvest management and hatchery supplementation**	X		
Range of Spring Chinook has been reduced.	Storage and diversion dams, culverts, and flow blockages have eliminated access to spawning habitat, and loss of side channels due to disconnection, filling, dewatering and conversion to other land uses has reduced rearing habitat.	H	H	H			2	Restore spring Chinook to their former range in the subbasin where possible, while reducing or eliminating undesirable effect on non-target taxa	**Continue Spring Chinook supplementation study by YKFP** **Continue removal of obstructions.** **Restore passage at mainstem storage dams** **Restore side channels**	X		
Increases in abundance of spring Chinook as a result of the supplementation of the population at the Cle Elum Supplementation and Research Facility have allowed in Subbasin Tribal and Sport harvest for the first time in over 40 years.	Supplementation can be used to increase natural production and harvest opportunities while keeping genetic and ecological impacts within specified biological limits. Use of a specialized hatchery and research environment in the Yakima Subbasin that is linked to habitat restoration and habitat research can provide a unique opportunity for understanding of integrated population and habitat strategies for improvement of productivity, abundance and spatial diversity of depressed populations.	H	M	H			3	Maintain and increase harvest opportunities for spring Chinook through supplementation and habitat restoration, while limiting negative effects of supplementation and harvest on other spring Chinook populations.. Construct, maintain and operate a specialized research environment to test the hypothesis.	**Continue Spring Chinook supplementation study by YKFP** **Continue removal of obstructions.** **Restore passage at mainstem dams** **Restore side channels.**	X		

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Conf. in Causal Rel.	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/or Eliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
Juveniles from all stocks redistribute themselves downstream the summer and fall after emergence, with highest densities in fall being found well below the major spawning areas	Natural expression of Spring Chinook life histories.	H	H	H			1	Concentrate habitat improvements, especially rearing habitat/side channel reconnection in middle and Lower alluvial floodplains.	**Concentrate habitat improvements, especially rearing habitat/side channel reconnection in middle and Lower alluvial floodplains.**	X		
One important life history difference between present-day and historical fall chinook populations is known: smolt outmigration timing. This truncation in the outmigration "window" has likely had a significant negative effect on the suitability of the entire lower Yakima River for natural production of fall chinook.	Changes to the thermal regime of the lower river have truncated the outmigration window, reducing or eliminating later migrating life history strategies.	H	H	H			1	Restore thermal regime and temperature spatial diversity in Lower Yakima River	**Reconnection of side channels** **Installation of in-channel LWD** **Restoration of natural flow regime**	X		
The first (1998) Yakima River fall chinook sport fishery in many years proved to be "low key" and not very successful. Since the river was opened by emergency regulation for the first time in decades, few anglers were prepared for the fishery even though an agency news release was published in several regional newspapers. The results were slightly better in 1999, and the fishery expanded dramatically in terms of fishing effort and harvest starting in 2000.	Hatchery reintroduction of Fall Chinook in the lower river has increased harvest opportunity.	H	H	H			3	Bring out-of-basin hatchery smolts into the basin to increase Tribal/sport harvest opportunities.	**Continue lower river hatchery releases primarily for harvest opportunities.**.	X		
Yakima Fall Chinook are not a distinct population from the Hanford Reach Fall Chinook, genetic introgression or damage to the Hanford Reach Fall Chinook or Lower Yakima Fall Chinook from Prosser hatchery releases is L due to the small proportion of this combined stock that is currently of hatchery origin.	Hanford Reach Fall Chinook are a composite stock that would have had a low fidelity to spawning sites. The Hanford Reach and Lower Yakima share the same surficial aquifer/hyporheic zone, and have similar temperature conditions during fall Chinook spawning.	H	H	H			3	Maintain or increase hatchery releases in context with Hanford Reach and Lower Yakima natural production and escapement.	**Continue YKFP Fall Chinook reintroduction.** **Restore habitat in the lower river in conjunction with reintroduction and life history studies**	X		
Fall Chinook populations have been dramatically reduced from pre-1850 abundance levels	Historic harvest, Habitat loss and alteration and changes in the biotic community have reduced habitat suitability, which in turn has reduced productivity, abundance, and spatial distribution of the species.	H	M	M			2	Maintain and increase harvest opportunity for fall Chinook by re-establishment of naturally reproducing population .	**Make an annual release of 1.8 million out-of-basin acclimated hatchery smolt releases from the Prosser Hatchery.**	X		

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Conf. in Causal Rel.	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/or Eliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
Marion Drain Fall Chinook represent an important component of the genetic and spatial diversity of the mid Columbia Fall Chinook ESU. The small population size puts this population at H risk of extinction.	This small population is genetically and spatially distinct from other populations, and uses unique habitats in the Yakima Subbasin.	H	H	H			2	Evaluate the feasibility of increasing the small (avg. of about 30-40/year), but sustainable fall Chinook population in the Marion Drain.	**Improve broodstock collect capabilities in Marion Drain.** **Evaluate the natural and hatchery smolt-smolt and adult-adult survival; the number of natural recruits per spawner.** **Collect more stock life history data- e.g. fry emergence timing, juvenile growth rate and body size, smolt timing exiting the drain and past CJMF and to McNary dam, spawner sex ratio, and fecundity to body size and age, spawner age composition, and redd distribution and abundance.** **Determine if DNA can be used as a real time tool to distinguish URB and Marion Drain adults in broodstock collect.**	X		
Steelhead populations have been dramatically reduced from pre-1850 abundance levels	Habitat loss and alteration and changes in the biotic community have reduced habitat suitability, which in turn has reduced productivity, abundance, and spatial distribution of the species.	H	H	H			1	To determine/increase the abundance, productivity, and genetic diversity (stability), of the species	**Monitor steelhead population abundance, distribution, and genetic diversity basinwide using radiotelemetry, trapping, tagging, and genetic sampling**	X	.	
The range of anadromous steelhead is significantly reduced from 1850. Fewer tributaries are utilized for spawning and rearing than were historically.	Storage and diversion dams, culverts, and flow blockages have eliminated access to spawning and rearing habitat, and loss of side channels due to disconnection, filling, dewatering and conversion to other land uses has reduced rearing habitat.	H	H	H			1	Restore Steelhead to their former range in the subbasin where possible, while reducing or eliminating undesirable effect on non-target taxa	Reintroduce steelhead populations to areas with suitable habitat after removal of obstructions. **Continue removal of obstructions.** **Restore passage at mainstem dams** **Restore side channels**	X		

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Conf. in Causal Rel.	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/or Eliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
Ahtanum, Cowiche, Manastash, Wilson/Naneum, Taneum Creeks, and others that currently have areas of suitable habitat which are unoccupied or have extremely low populations levels of anadromous fish, should be the focus of reintroduction efforts to establish steelhead populations.	These creeks have suitable but unoccupied habitats and have been or soon will be made accessible to steelhead through removal of obstructions and improvements in flow. Natural recolonization will be extremely slow given current population levels and stray rates.	H	H	H			2	Develop reintroduction program for these habitats, implement reintroduction in at least one watershed in the next 3 years.	Artificial supplementation of adults or juveniles from existing healthy and habitat-limited populations or from Kelt Reconditioning program.			
Capture, rehabilitation, and release of Kelts in the Yakima Basin increases survival, could act as a source of broodstock/genetic material for reintroduction efforts, and demonstrates kelt rehabilitation feasibility for application in other Columbia Basin Tribs..	Steelhead abundance and productivity have been reduced due to loss of iteroperous life history strategy resulting in severe reduction in repeat spawning. Kelt rehabilitation has been demonstrated to be successful in the Subbasin.	H	H	H			2	Increase the number of repeat spawning steelhead in Yakima subbasin. Set management parameters for the release or use of these kelts in restoration of population abundance and diversity.	**Collect spawned out steelhead kelts and** **1) recondition kelts and release in subbasin for natural spawning , and/or** 2) transport kelts below mainstem hydro dams to increase natural reconditioning in the ocean, and adult migration back to subbasin for repeat spawning	X		
Satus and Toppenish steelhead populations are healthy, could act as a source of broodstock/genetic material for reintroduction efforts. Production of steelhead within the Yakima Basin is heavily weighted towards Satus and Toppenish Creeks, increasing population levels in other creeks within this AU and in other AUs will decrease risk of extinction of steelhead in the Yakima Subbasin.	Data shows these populations are currently habitat limited , are healthy and have an extremely low probability of extinction. Habitat use by the steelhead stocks in the subbsin shows little overlap, so the potential for competitive effects on existing stocks is low. Appropriate use of these stocks for broodstock presents very low levels of risk to this populations.	H	H	H			2	Develop broodstock collection and use guidelines for these stocks, implement program	Collection of adults and involuntary spawning in new habitats Use of hatchery facilities and acclimation sites to reintroduce steelhead.			
Bull trout populations are fragmented by loss of passage at Tieton, Bumping, Kachess, Kachelleus, and Cle Elum dams, making these populations more vulnerable to extinction over the long term..Despite strong spawning site fidelity, temporal differences in spawn timing and other self-isolating behavior, evidence of gene flow among the populations with no barrier to migration implies that there is the possibility to reconnect populations if	Allowing genetic exchange between Bull Trout populations will increase population stability and diversity	H	H	H			1	Reconnect bull trout populations where possible, where not possible, manage existing populations for high levels of abundance to improve/maintain genetic diversity	Provide passage at storage dams **Maintain internal connection between populations in storage reservoirs.** **Protect and improve habitat for bull trout.**	X	Artificially transfer individuals to achieve or maintain levels of genetic diversity.	

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barriers are removed.												
Bull trout have reduced population viability due to competition and interbreeding with brook trout.	Reduction of potential for competition and interbreeding will increase population viability	H	H	H			2	Reduce or eliminate brook trout populations in the Subbasin.	Selectively remove Brook Trout Discontinue stocking of brook Trout within the Subbasin			
Extirpation of Sockeye from the Yakima Subbasin has negatively impacted the productivity of the watershed and ecosystem as a whole. Specifically, sockeye reintroduction will benefit bull trout. The feasibility of sockeye reintroduction should receive study, sockeye should be reintroduced wherever it is determined that passage, habitat, and potential productivity of the environment are sufficient to support viable populations over the long term	Reintroduction of Sockeye is possible and will positively impact the aquatic ecosystem and associated species. Habitat overlap/ presence of increased prey/restoration of passage at dams will benefit bull trout.	H	H	H			1	Develop theoretical construct for reintroduction of sockeye including passage and selection and development of broodstock.	Develop broodstock. **Continue passage study** Implement trail reintroductions.	X		
Population levels of Lamprey have been dramatically reduced from pre-1850 levels/.	Poor passage for anadromous forms though the mainstem and in the Subbasin have severed life history pathways and reduced population abundance, productivity and spatial diversity.	H	H	M			1	Study specific habitat relationships for lamprey. Implement habitat restoration actions under Subbasin Plan Improve passage	**Reconnect side channels** **Reduce/eliminate toxic loading to river.** Limit predation by non native fish	X		

3.4.2 Basinwide Watershed and Ecosystem Processes, Restoration Key Findings, Objectives and Strategies

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence. in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/orEliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence. in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/orEliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
E. Brannon quote:"…as poikilotherms, salmonids are completely dependent on temperature which affects metabolic rate, growth and other physiological characteristics of the species (Groot et. al. 1995). In retrospect, however, its role in life history and ultimately population structure has not been sufficiently regarded."	Increases or decreases in yearly average temperature can be expected to impact life history stages of salmonids in negative or positive ways. (Steelhead and spring chinook)	M	H	H		1	1	Develop year round and Subbasin wide temperature regime "benchmarks", fund and implement strategies that move the temperature regime towards benchmark levels	**Improve riparian zone conditions** **Restore normative channel form and process** **Move tributary and mainstem flow regimes to flow benchmarks.**	X		
Changes to the natural flow regime have resulted in 7 different flow regimes on the mainstem Yakima and Naches Rivers. Loss of these gradual changes has reduced the overall diversity of habitat and temperature spatial variability (the diversity of temperature regimes) at the subbasin scale.	Use of the mainstem for conveyance of irrigation water supply and delivery has resulted in changes to flow patterns in the mainstem. Gradual changes in the flow regime at natural knickpoints have been replaced by abrupt changes in the flow regime at diversion/delivery points.	H	H	H		1	1	Develop flow benchmarks, fund and implement strategies that move the flow regime towards benchmark levels.	**Reduce net water use** Develop out of basin sources for new water Manage the system differently in good/excellent water years Examine the possibility of "deconsolidation" of major diversion points.	X		
Riparian communities, and black cottonwood in particular, have been negatively affected by changes in the yearly hydrograph due to the cumulative effects of management of the water resources of the basin for irrigation, domestic, and industrial uses.	Black cottonwood is especially dependent on a normative hydrologic regime, each of the 5 different hydrographs in the mainstem, and in addition the hydrographs of numerous tributaries, prevent normal reproduction of Black Cottonwood, leading to stand senescence in most reaches, or changes in sex ratios and reproductive strategies.	H	H	H		1	1	Reestablish normal population and community dynamics (abundance, age class distribution, reproductive rate, sex ratios, dominance) of riparian plant populations and communities, especially Black Cottonwood.	Reestablish a normal hydrograph by: Reduce net water use, develop out of basin sources for new water, Manage the system differently in good/excellent water years **purchase/lease of water rights** **Establishment of a broodstock and restoration program for black cottonwood communities throughout the basin using native stocks and based on population inventories.**			

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence. in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/orEliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
Temp - the river is colder than pre settlement conditions above Wapato Dam/Union Gap, and warmer below. See also BW1 above. This has resulted in an especially steep environmental gradient for temperature at and below Parker, reducing habitat and temperature spatial variability at the Subbasin scale.	Increases in summer flow have resulted in significant decreases in summer temperatures in the Upper Yakima downstream to Wapato Dam at Union Gap. Decreases in flow in the Lower river have resulted in increased duration of temperatures at or above lethal limits. Model results show that changes in temperature would have been much more distributed along the length of the river in pre-1850 times.	H	H	H		1	1	Replicate basin wide temperature variability by Developing flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark	Reduce net water use, develop out of basin sources for new water, Manage the system differently in good/excellent water years **purchase/lease of water rights**			
Confinement of the river channel upstream and downstream of the Yakima Canyon has greatly increased the amount of "canyon habitat" (fast water with little or no side channels) in the Upper Yakima from above Ellensburg to the City of Yakima. This change favors the resident ecotype of rainbow trout and negatively effects all other anadromous populations.	Resident rainbow trout are able to exist in the mainstem upper Yakima Year round. This allows them to reach sexual maturity without going to sea or rearing in Lower productivity/Higher competition habitats in the tributaries.	H	H	H		ESA	2	Increase anadromy in Rainbow trout specifically, and increase environmental attributes that favor anadromous fish.	Reestablish a normal hydrograph by: Reduce net water use, develop out of basin sources for new water. Manage the system differently in good/excellent water years. **Purchase/lease of water rights** **Remove confinement where possible**			
Introduction of Sockeye and Coho will benefit Bull Trout populations and the ecosystem overall. .	Bull Trout are apex predators in the aquatic environment, and would directly prey on eggs, alevins and juveniles in rivers and lakes. Secondary productivity (increases in Cutthroat or macroinvertebrases) from carcasses would also benefit Bull Trout. Providing passage at the dams would also improve population connectivity and diversity. Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.	M	H	M		ESA	1	Reintroduce Sockeye to two reservoir systems by 2015, establish self-sustaining populations by 2030.	**Study feasibility** Implement initial studies using closely related Sockeye stocks**.** Explicitly manage Sockeye populations for escapement levels to benefit ecosystem.	X	**Fertilization of streams and lakes with artificial carcasses.** **Planting of hatchery carcasses in upstream areas.** Manage resident fish populations for escapement to maintain/increase prey base.	X

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence. in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/orEliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
The Coho reintroduction project should continue, coho should be reintroduced wherever it is determined that passage, habitat, and potential productivity of the environment are sufficient to support viable populations over the long term	Coho not only represent an opportunity to increase harvest, but the locations at which they spawn and their contribution to pre-1850 productivity of the Subbasin as whole was significant. Monitoring the success or failure of Coho reintroduction in the Yakima Subbasin will provide information that can be used for similar projects in other subbasins	H	H	H		1	1	Restore naturally reproducing coho populations wherever possible in the subbasin while minimizing or eliminating undesirable effects on non-target taxa	**Use existing coho reintroduction program being implemented by YKFP**	X		
Loss or reduction in this inflow from the Columbia could have had a major affect on the summer low flow temperatures of the lower Yakima River. These springs still exist, but have been modified and isolated from the river, and should be considered as a focal point for restoration of the lower Yakima.	Changes in the Columbia River hydrograph have had an effect on the temperature regime of the River below Wanawish dam	M	H	L		2	3	Restore annual temperature regime and temperature spatial diversity of the lower river	**Restore/reconnect historic side channels in lower river** **Create new side channels where hyporheic conditions allow.**	X		
Strong link between development, riparian zone loss (due to conversion to other uses or from changes in flow) and increases in temperature. Nearly all tributaries have elevated summer temperatures in their lower reaches where development pressure is greatest	Development pressure and changes in land use will continue to negatively effect the lower reaches of many tributaries	H	H	H		1	1	Restore riparian zones in developed and developing areas Develop site specific objectives for habitat and riparian conditions, fund and implement projects to move toward those objectives	**Riparian restoration** **Floodplain restoration** **Purchase of development rights/easements** **Work with local jurisdictions to develop objectives.**	X	**Restore existing degraded channels in developed areas to improve habitat**	

3.5 Key Findings by Assessment Unit

3.5.1 Lower Yakima–Restoration Key Findings, Objectives and Strategies

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Level of Impact to Focal Species	Level of Impact to Ecosystem or Watershed	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Summer/Early Fall Habitat availability Lower in comparison with pre-1850 environment This reach may be especially problematic for reintroduction of sockeye into the Yakima Subbasin Water temperatures in the Yakima River have increased significantly, so that returning fall-run adults must delay river entry, and juveniles must emigrate from the river sooner than occurred historically	Temperatures near and above lethal limits for salmonids for much longer duration than during pre-1850 times due to reduction in summer Low flow.	H	H	H		1	1	Develop temperature benchmarks, fund and implement projects that move the hydrograph toward the benchmark	Increase flow to depth thresholds/benchmarks **Reconnect Side Channels** **Improve riparian Zone**			
Loss of Habitat Diversity/Temperature Diversity by loss of off-channel habitat 10-35 percent of the juveniles from a given brood year migrate below Prosser Dam during the winter (Fast et al 1991), and begin their smolt outmigration from the lower river the following spring.	Obstructions associated with infrastructure have blocked habitat Conversion to Drain/Irrigation ditch has eliminated habitat Lowering/Alteration of GW table has eliminated habitat	M	H	H		1	1	Reconnect 100% of floodplain side channels in this Assessment Unit Restore physical and access characteristics of all ditches which were side channels	**Relocate infrastructure where possible to allow natural processes to operate.** **Compare to 1860s GLO maps, restore physical and riparian characteristics**		Reconnect side channels by removal of obstructions. Construct artificial channels where current conditions allow	
Lack of Habitat diversity (pools with cover)/Lack of Large Woody Debris	Lack of LWD Recruitment Due to interception/delay by diversion Dams Lack of LWD Recruitment Due to Change in upstream riparian Zone	H	H	H		2	2	Improve downstream LWD passage at diversion dams (pass during the flood) Restore viable P. pine populations to upstream riparian Zones over the next 20 years	Reconfigure/redesign Diversion Dams, Install racks/collection system with excavators. **Develop broodstock and reintroduction program**		**Artificially introduce LWD**	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Level of Impact to Focal Species	Level of Impact to Ecosystem or Watershed	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Massive In-channel Aquatic vegetation growth alters habitat, water quality, and ecosystem characteristics	Recent reductions in sediment load (increase in light), and ongoing nutrient inputs	H	H	H		2	1	Study problem to reduce limiting nutrients and characterize ecology of invasive aquatic vegetation.	Reduce spill, increase water efficiency to reduce field run off **Increase nutrient source control and management**		Introduction of pests.	
High Toxic Pollutant levels in sediments	Historic applications of DDT, routed to river bonded to sediments	H	H	H		2	2	Reduce fine sediment loading from Ag Zones	**Continue to implement TMDL for Toxics and sediment**	X		
Fine Sediment load is increased, related to toxics above Sediment loading throughout the lower Yakima produces a "quantity of fines in mainstem spawning areas [that] is sufficient in many areas to fully embed the substrate and is clearly sufficient to limit carrying capacity and productivity"(YSS 2001).	Construction of drains in fine sediments, field runoff (mostly solved at this point), early season spill to drains generates increased fine sediments.	M	H	H		3	2	Reduce fine sediment loading from artificial drain network	Continue to implement TMDL for Toxics and sediment Armor channels, install sediment traps/grade control, manage spill (especially in spring) **Implement on-farm irrigation and soil erosion BMPs to reduce input to the drain network**	X		
Reduction of sediment loading from from agricultural returns has been a major success story of water quality improvement in the State of Washington as a result of implementation of the TMDL and cooperation between DOE, local agricultural organizations, the irrigation districts, NRCS, and the conservation districts.	Concerted, cooperative efforts to improve water quality can be successful	H	H	H		1	1	Support/cooperate with Ecology, Conservation Districts and Irrigation Districts in improving water quality.	**Continue TMDL implementation** **Increase technical assistance support and monitoring of water quality**	X		
LOW FLOW reduces/eliminates habitat availability/quality/diversity including the ability of riparian communities to reproduce.	Alteration of hydrograph for irrigation (cumulative effect in this reach)	H	H	H		1	1	Develop flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark	Reduce net water use, develop out of basin sources for new water, Manage the system differently in good/excellent water years **Purchase/lease of water rights**			

Key Finding – Observed effect or phenomenon	**Cause/Working Hypothesis**	**Confidence that Effect is actually occurring**	**Level of Confidence in Causal Relationship**	Cont. of Cause to Key Finding or Effect		**Level of Impact to Focal Species**	**Level of Impact to Ecosystem or Watershed**	**Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)**	**Strategy to reduce/eliminate or improve/maintain**	**Currently addressed?**	**Strategy to mitigate effect**	**Currently addressed?**
Irrigation season daily or weekly flow fluctuations greater and more frequent than under presettlement conditions, potentially stranding juvenile salmonids, impacting macroinvertebrate life histories, and negatively effecting native plant species	Interaction of Prosser diversion/power generation, irrigation spill, returns from drains, etc.	M	H	H		3	2	Reduce flow fluctuations to mimic more natural flow conditions	Model tradeoffs **Reduce operational spill** Improve irrigation efficiency	X		
Ave annual flow at Kiona (has been reduced by an average of (a minimum) 1.65 maf (of an ave. of 3.4 maf) (IOP, 2002), reducing overall habitat availability/capacity year round. This reach has the second largest reduction in total annual flow of the mainstem reaches,	Net losses due to consumption (evapotranspiration, agriculture, rural/urban uses), deep groundwater, and export of KID water to downstream areas.	H	H	H		1	1	Develop flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark	Change flow management during wet years to more closely mimic pre-1850 hydrograph. **Pump exchange for KID water out of Columbia R**. Maximize natural retention of flow in basin by restore hydrologic/hyporheic connectivity upstream.		Artificial Off channel spawning area	
Sustained Low flows limit spatial and temporal habitat diversity	The sustained flow conditions that result from flip flop and modification of the hydrograph for irrigation limits habitat diversity - sustained areas of low velocity warm water in other areas - and do not allow a normal progression/variability of the habitat types throughout the year	H	H	H		1	1	Develop flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark.	Reduce net water use Develop out of basin sources for new water Manage the system differently in good/excellent water years purchase/lease of water rights			
Predation Risk to salmonids from native fish (northern pike minnow) is high Predation risk to salmonids from non-native fish (Smallmouth bass) is high Predation risk to salmonids from bird populations is High	Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation. Increased habitat for native predators in Col. Mainstem leads to increased pops in Lower tribs. Low flows, lack of cover, reduced suitable habitat area increase efficiency of predators	H	H	H		3	2	Increase abundance of salmonid populations to reduce proportion of predation due to native sp Reduce Habitat suitability, specifically reduce temperatures in early summer Reduce population levels in Mainstem Col Reduce populations of smallmouth bass in Lower Yakima River	**Implement Subbasin planning and other habitat and population restoration programs** Restore flow, **cover, and off channel habitats** Further control and actions on predator populations in Columbia mainstem reservoirs **Continue or expand bag limits on smallmouth in Lower Yakima, reverse management for smallmouth in mainstem reservoirs**.	X		

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Level of Impact to Focal Species	Level of Impact to Ecosystem or Watershed	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Predation Risk to salmonids is high at Prosser Diversion Dam	Configuration of the bypass outfall causes fish to be ejected into a pool with no cover.	H	H	H		3	2	Eliminate elevated predation	Redesign outfall or alter pool structure.			
Environmental conditions in the reach have changed since the early 1930s; this has resulted in Out migration for juvenile fall Chinook being shifted to earlier in the year, resulting in decreased production of fall Chinook.	With the change in hydrographs of both the Columbia and Yakima Rivers that occurred in the 1930s, temperature and flow conditions have reduced the amount of time of suitable habitat conditions for rearing.	H	H	H		2	2	Increase the suitable habitat conditions for rearing through the end of July.	Increase flows, Increase habitat diversity, especially off channel habitats			

3.5.2 Mid Yakima Floodplain – Restoration Key Findings, Objectives and Strategies

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Summer/Early Fall Habitat availability low or eliminated due to low flows and high temperatures (Wapato Reach) Water temperatures in the (Wapato reach of the) Yakima River within this Assessment Unit have increased significantly, such that returning fall-run adults must delay river entry, and juveniles must emigrate from the river sooner than occurred historically.	Temperatures near and above lethal limits for salmonids in mainstem (Wapato Reach and below)	H	H	H		1	1	Develop temperature benchmarks, fund and implement projects that move the hydrograph toward the benchmark	Increase flow to depth threshold **Reconnect Side Channels** Improve riparian Zone	X		

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Loss of Habitat Diversity/Temperature Diversity by loss of off-channel habitat	Obstructions associated with infrastructure have blocked habitat Side Channels have been Converted to Drain/Irrigation ditch Lowering/Alteration of GW table by drains has eliminated side channels Loss of riverine connection with water table due to sediment aggradation in Union Gap reach	M	H	H		1	1	Reconnect 100% of floodplain side channels in this Assessment Unit Restore physical and access characteristics of all ditches which were side channels Restore GW Table elevation by partial filling of drains.	**Relocate infrastructure where possible to allow natural processes to operate.** **Compare to 1860s GLO maps, restore physical and riparian characteristics** Install berm or flow constrictors in drains Raise drains to floodplain level when they get near the river	x	**Reconnect side channels by removal of obstructions**. Construct artificial channels where current conditions allow. Winter diversions to increase GW storage wetlands to allow GW recharge during good flow years	
Lack of Habitat diversity (pools with cover)/Lack of Large Woody Debris	Lack of LWD Recruitment Due to interception/delay by diversion Dams Lack of LWD Recruitment Due to 1) Change 2) Loss of riparian zone in this Assessment Unit and upstream	H	H	H		2	1	Improve downstream LWD passage at diversion dams (pass during the flood) 1) Restore viable P. pine populations to upstream riparian Zones over the next 20 years, restore sex ratio and density of Cottonwood over next 20 years 2) Restore riparian Zone to at least 40% of its pre-1850 extent in Union Gap and Selah Reaches	Reconfigure/redesign Diversion Dams, Install racks/collection system with excavators. **1) Develop broodstock and reintroduction program for these species, 2) Purchase of floodplain properties/easements in these areas, especially in concert with floodplain restoration/infrastructure reconfiguration.**		**Artificially introduce LWD**	
High Toxic Pollutant levels in sediments	Historic applications of DDT, routed to river bonded to sediments	H	H	M		2	1	Reduce fine sediment loading from Ag Zones	**Continue to implement TMDL for Toxics and sediment**			
Fine Sediment load is increased (Moxee Creek, Toppenish Drains, Marion Drain/ Mud Lake/Harrah drain), there have been recent large reductions in sediment load.	1) Construction of artificial drainage network (drains) in fine sediments which easily erode, 2) Field runoff (mostly solved at this point) 3) River/Creek Channel incision and bank erosion	H	H	M		2	1	Reduce fine sediment loading from artificial drain network Reduce or reverse processes leading to incision	Armor channels, install sediment traps/grade control, manage spill (especially in spring) Implement on-farm irrigation and soil erosion BMPs to reduce input to the drain network			

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Low Flow reduces/eliminates habitat availability/quality/diversity, including impacts to riparian plant community maintenance and establishment.	Alteration of hydrograph for irrigation (cumulative effect in this reach)	H	H	H		2	2	Manage flows to allow for Cottonwood establishment	Reduce net water use, develop out of basin sources for new water, Manage the system differently in good/excellent water years **purchase/lease of water rights**	X	**Concentrate habitat enhancement/restoration in Union Gap Reach (under existing hydrologic regime) where flow is not limiting habitat availability**	X
Irrigation season daily or weekly flow fluctuations greater and more frequent than under pre-1850 conditions, resulting in stranding, increased water temperatures, invasive plants	Difficulty in coordination of multiple users, and in managing the diversions to reduce fluctuations generated elsewhere, and at at Wapato Dam and Sunnyside Dam, make reductions in fluctuations extremely difficult. (IOP Graph at Parker)	H	H	H		2	2	Reduce flow fluctuations to mimic more natural flow conditions	Model tradeoffs Reduce operational spill Improve irrigation efficiency to lessen need for adjustments to diversion rates.			
False attraction flow Operational spill (to "creeks) and field runoff (to drains) attract salmonids to L quality or lethal habitat conditions (non viable populations, population sinks) or impede migration, or expose migrants to lethal or near-lethal conditions	Diversion points for these irrigation systems are well upstream, fish are homing on this upstream water	H	H	H		2	2	Reduce or eliminate operational spill to tribs during migration periods	Reregulation reservoirs On-farm efficiency increases		Construct permanent or seasonal obstructions to migration (only partial mitigation)	
The shape of the annual hydrograph has been severely modified. Upstream of Union Gap, the hydrograph has been "flattened" and the low flow period moved toward later in the year (Oct.), downstream the spring peak has been eliminated (on average) and the Low flow period greatly lengthened. These changes greatly affect riparian and aquatic ecosystem function, productivity and stability.	Cumulative effect of irrigation management in the basin	M	H	H		3	1	Move characteristics of annual hydrograph, especially the shape (rates of change) of the spring peak and decline,	Reduce net water use, develop out of basin sources for new water, Manage the system differently in good/excellent water years **purchase/lease of water rights**			

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Ave annual flow has been reduced by 1.2 maf (of an ave of 3.1 maf) from Parker to approximately Toppenish Creek/Marion Drain. This is the greatest reduction of overall quantity of flow in any of the mainstem reaches, and occurs in the reach with the most physically intact floodplain/riparian zone.	Cumulative effect of irrigation management in the basin, specifically in the Wapato reaches the presence of the major diversions of the Wapato Dam and Sunnyside Dam in the upstream end of this reach. This is the reason for this location at Parker being the "control point" for minimum instream flow in the mainstem.	H	H	H		1	1	Decrease the duration and magnitude of the low flow period.	Due to the extremely Low flows in this reach, it appears that conservation targeted to the Wapato Irrigation Project and the Roza and Sunnyside Irrigation districts would have major benefits to this reach. Reduce net water use, develop out of basin sources for new water, Manage the system differently in good/excellent water years purchase/lease of water rights		Deconsolidation of the irrigation diversions – example is the Satus area of the WIP. The existing Wapato or Sunnyside Dams would be replaced by 2 or more structures. This would allow significant flows to pass through the Wapato reach until they were diverted below, essentially eliminating this reach as having the Lest flows in the mainstem.	
Historic accounts and stumps in the floodplain indicate that riparian zone Ponderosa pine were found as low in the basin as Prosser. Current distribution of natural origin pine ends near the confluence of the Naches and Yakima Rivers (a reduction in range of over distance of over 50 miles)	Anthropogenic removal of P. pine for building material and firewood.	M	H	H		3	2	Restore natural distribution of Ponderosa pine over the next 20 years	**Develop broodstock and reintroduction program for these species**			
Sediment transport processes (available energy and supply), riparian zone function, and floodplain extent in the upper portion of this Assessment Unit reach has been severely altered	Selah Reach, mining of gravel has resulted in floodplain loss and loss of sediment supply Constriction and armoring of the channel have altered channel form and process Floodplain loss and constriction upstream increases sediment deposition downstream Diversion dams act to change the gradient of the River, causing sediments to be deposited upstream, and starvation of	H	H	H		3	2	Recover natural width/depth ratios in this reach. Restore floodplain and channel with additional emphasis on restoration of sediment supply to downstream reaches. Where possible, set back levees to increase natural channel form and process, with special emphasis on removal of constrictions. Reduce fine sediment loading	**Large-scale channel and floodplain reconstruction project.** **Multi-jurisdictional floodplain restoration and flood hazard reduction projects that recognize the interconnection of infrastructure to habitat function at the multiple reach scale.** Rebuild/refit diversion dams with floodgates sized to allow	X		

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
	downstream reaches.							and accumulation through levee setbacks. Increase floodplain acreage by 30% in the Selah Gap and Union Gap Reaches. Provide for increased bedload movement through Wapato Dam at and below 12000 cfs	bedload movement during dominant discharge events, leave gates open during non-irrigation season.			
Predation Risk to salmonids from native fish (northern pike minnow) is high Predation risk to salmonids from non-native fish (Smallmouth bass) is high Predation risk to salmonids from bird populations is High	Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation. Increased habitat for native predators in Col. Mainstem leads to increased pops in Lower tribs. Low flows, lack of cover, reduced suitable habitat area increase efficiency of predators	H	H	H		3	2	Increase abundance of salmonid populations to reduce proportion of predation due to native sp Reduce Habitat suitability, specifically reduce temperatures in early summer Reduce population levels in Mainstem Col Reduce populations of smallmouth bass in Lower Yakima River	Implement Subbasin planning and other habitat and population restoration programs Restore flow, cover, and off channel habitats Further control and actions on predator populations in mainstem Columbia reservoirs **Continue or expand bag limits on smallmouth in Lower Yakima, reverse management for smallmouth in mainstem reservoirs**.	X		
Environmental conditions in the reach have changed since the early 1930s; this has resulted in Out migration for juvenile fall Chinook being shifted to earlier in the year or the latter part of the run being truncated, resulting in decreased production of fall Chinook.	With the change in hydrographs of both the Columbia and Yakima Rivers that occurred in the 1930s, temperature and flow conditions have reduced the amount of time of suitable habitat conditions for rearing.	H	H	H		2	2	Increase the suitable habitat conditions for rearing through the end of July.	Increase flows, **Increase habitat diversity through reconnection of side channel** Install LWD	x		
Massive In-channel Aquatic vegetation growth alters habitat, water quality, and ecosystem characteristics	Recent reductions in sediment load (increase in light), and ongoing nutrient inputs	H	H	H		2	1	Study problem to reduce limiting nutrients and characterize ecology of invasive aquatic vegetation.	Reduce spill, increase water efficiency to reduce field run off		Introduction of pests.	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Marion Drain has severed the hydrologic connection between the Yakima River and Toppenish Creek, which is much deeper than the creek channel for much of its length (Yakima Nation in prep).	The Yakima River and Toppenish Creek shared a common floodplain and hyporheic zone, reducing springbroooks and flow in Toppenish Creek	H	H	H		1	1	Recover groundwater connection between the Yakima and Toppenish Creek and restore or create sidechannels and springbrooks.	Reduce efficiency of Marion Drain Raise groundwater table **Purchase of property and water rights on adjacent properties**		Seasonally reconnect or gate Marion Drain.	
Riparian vegetation in the reach of Toppenish Creek between the Unit II Pump Canal and State Route 22 has been heavily modified by grazing and irrigated agriculture (Toppenish Plan, Yakama Nation in prep).	Restoration of the riparian zone in this area will increase habitat availability and function.	H	H	H		1	2	Restore riparian zone to at least 50 feet in width.	Purchase of easement Work with landowners			
Temperatures in Marion Drain are about 6oC cooler in the summer and 5oC warmer in the winter than temperatures in the mainstem. This thermal moderation is attributable to the large proportion of groundwater in the drain. If the lower end of Marion drain could be made more accessable and have higher habitat quality, or these cool waters routed to Toppenish Creek, summer, fall and winter rearing habitat could be dramatically increased in this already valuable reach.	Good rearing habitat is severely limited in this reach, even seasonal access to these habitats would increase productivity for side channel dependent species such as spring Chinook.	H	H	M		1	2	Increase the areal and seasonal extent of this limiting habitat wherever possible in this reach.	Reconfiguration of the lower end of Marion Drain.			

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Sustained high flows in the Upper Yakima downstream to Union Gap, and Sustained low flows in lower Naches and from Union Gap downstream, limit spatial and temporal habitat diversity	The sustained flow conditions that result from flip flop and modification of the hydrograph for irrigation limits habitat diversity - sustained areas of H velocity cold water in the upper river, and sustained areas of L velocity warm water in other areas - and do not allow a normal progression/variability of the habitat types throughout the year	H	H	H		1	1	Develop flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark	Reduce net water use Develop out of basin sources for new water Manage the system differently in good/excellent water years **purchase/lease of water rights**	X		
Temperatures in the Yakima River in the Selah reach and the Selah Gap to Union Gap reach are moderate year-round. ….Gap-to-Gap reach is the lowermost portion of the mainstem Yakima thermally suitable for year-round rearing of salmonids.	This area is within the lower river area used by spring Chinook and other salmonids for rearing and presents the best opportunity to maximize this limiting habitat	H	H	H		1	1	Maximize habitat use and side channel forming processes in this reach to improve habitat at a basin scale.	**Continue YRBWEP floodplain/sidechannel restoration project** **Reconnect side channels and lower tribs where possible.** **Setback levees and improve total area of active floodplain** **Improve and restore plant communities**	X		
There is a previously unrecognized area of near normative temperatures downstream of Parker/Sunnyside Dam. This area should be a focus of habitat restoration under the existing flow conditions in the basin. Vaccaro temperature model and recent thermographs indicate that temperatures below Parker are suitable for rearing fish, a currently limited habitat in this AU and in the Basin overall.	Cold water from above Union Gap is spilled into this reach; this water gradually warms to and above normative temperatures as it moves downstream in this reach.	L	H	H		2	2	Implement off channel rearing project in this area, determine if response to increased habitat is favorable.	Increased temperature monitoring in this reach to determine suitable locations for habitat improvement. Construction of off channel habitat.			

3.5.3 Low Elevation Tributaries–Restoration Key Findings, Objectives and Strategies

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
SF Cowiche Creek is suitable habitat and should be the focus of a reintroduction effort for establishment of a steelhead population.	Steelhead have been eliminated by numerous passage obstacles on the mainstem Cowiche. Habitat above these obstructions is similar to habitat that supports healthy populations in Satus and Toppenish Creeks.	M	H	H		ESA	3	Begin phased reintroduction program into Cowiche creek that includes obstruction abatement and population reintroduction elements.	**Phased removal of obstructions at Snow Mountain Ranch, Alaska Steep pass fish way and other diversions.** **Reintroduction program for steelhead (ESA permitting**)	X		
Summer/Early Fall Habitat availability L or eliminated, (some areas of this AU had naturally L availability)	Temperatures near and above lethal limits for salmonids	H	H	H		1	1	Develop temperature benchmarks, fund and implement projects that move the hydrograph toward the benchmark	Increase flow to depth threshold **Water Rights Transfers, Purchases, Trusts**	X		
Loss of Habitat Diversity/Temperature Diversity by loss of off-channel habitat	Obstructions associated with infrastructure have blocked habitat Conversion to Drain/Irrigation ditch Lowering/Alteration of GW table by drains	M	H	H		2	1	Reconnect 100% of floodplain side channels in this Assessment Unit Restore physical and access characteristics of all ditches which were side channels Restore groundwater to pre-1850 levels where possible	Relocate infrastructure where possible to allow natural processes to operate Compare to 1860s GLO maps, restore physical and riparian characteristics. **Work with NRCS, Drainage Improvement Districts, Ag interests on management of drains to increase habitat availability, especially for federal funded reserve/wetland enhancement programs**	X	**Reconnect side channels by removal of obstructions**.	
Lack of Habitat diversity (pools with cover)/Lack of Large Woody Debris	Lack of LWD Recruitment Due to interception/delay by diversion Dams Lack of LWD Recruitment Due conversion of riparian zone to other uses/development Lack of LWD Recruitment Due to interception by bridges and culverts	H	H	H		2	2	Improve downstream LWD passage at diversion dams (pass during the flood) Restore riparian zones to the extent possible. Improve downstream LWD	Reconfigure/redesign Diversion Dams, Install racks/collection system with excavators. **Develop Nursery stock and riparian restoration program, especially in agricultural, rural and urban lands.** **Relocate roads located within the riparian zone in the**	X	**Artificially introduce LWD** Manage LWD debris accumulation.	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
								passage at bridges and culverts	**forested areas.** Reconfigure/redesign Bridges and culverts to pass LWD			
Low flows reduce habitat area and suitability, in some cases resulting in blockages to migration.	Diversions for irrigation have Lowered flows.	H	H	H		2	1	Set targets or Increase Low flow to less than one standard deviation from pre-1850 conditions below irrigation diversions (need better model to determine pre-1850 conditions)	**Reduce net water use, develop out of basin (i.e. interbasin transfer) sources for new water**, Manage the system differently in good/excellent water years **purchase/lease of water rights**	X		
Forestry activities have increased fine and coarse sediment load, and peak flows in Satus, Toppenish and Ahtanum Creeks	H road densities, poor reforestation success, and harvest on unstable slopes have contributed to increased sediment load and channel instability	H	H	M		3	2	Improve road management actions, all private landowners to have completed RMAP in 5 years, close Revegetation X miles of forest road over the next 15 years, improve road maintenance on remaining road system.	Provide tech assistance and coordination of efforts to private landowners in development of RMAPs. Work with public landowners on coordinated inventory and actions to reduce sediment loading.			
In areas where habitat conditions could be conducive to salmon productivity, flow fluctuation reduces productivity/increases mortality	Spill, irrigation returns cause flow fluctuations	H	H	M		3	2	Eliminate returns to these areas	Reregulation reservoirs On-farm efficiency increases			
Access Diversion Dams Block passage Seasonal push up dams block passage during irrigation season until they are removed. Permanent diversion dams without passage facilities.	Diversion dams are not passable or provide only limited passage. Most diversion dams in this AU are located on broad alluvial fans, making control of grade and sediment flow difficult. Over time, most diversions accumulate sediments upstream, and degrade/create impassable fallows downstream.	H	H	H		2	1	Improve passage and design of irrigation diversions to allow fish and sediments to pass through diversion points. .	Work Cooperatively with BPA /consultant engineers to design/locate irrigation diversions that will function over long time periods. **Replace/rebuild existing diversion dams based on prioritization from WDFW/YTAHP** Relocate or consolidate existing structures	X	Short-term passage fixes at existing dams.	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Productivity has been lost due to loss of access to habitat	Culverts block access to habitat	H	H	H		3	3	Repair/replace blocking culverts	Replace culverts in Ahtanum, Cowiche.			
Inadequate screening diverts and kills fish	Numerous smaller diversions remain unscreened and impinge and kill fish. Some larger diversion screens do not meet current standards.	H	H	H		3	3	Bring all diversions into compliance over the next 10 years, especially those in Lower tribs with good rearing access.	Move diversion off channel **Provide screens** **Consolidate diversions**			
Riparian Function has been reduced in the AU.	Due to change in annual hydrograph due to irrigation diversions and conveyance. Loss of riparian zone in this Assessment Unit and upstream due to conversion to other uses, development, and constrictions.	H	H	H		3	2	Develop tributary flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark. Restore riparian Zone to at least 80% of its pre-1850 extent.	Reduce net water use, develop out of basin sources for new water, Manage the system differently in good/excellent water years purchase/lease of water rights **Purchase of floodplain properties/easements in these areas, especially in concert with floodplain restoration/infrastructure reconfiguration.**	X	Planting of riparian vegetation, artificially introduce LWD	
Low flow reduces/eliminates habitat availability/quality/diversity	Alteration of hydrograph for irrigation	H	H	H		1	1	Develop flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark	**Reduce net water use**, develop out of basin sources for new water, Manage the system differently in good/excellent water years, **provide off channel water storage**	X		

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Increases in peak flows have increased bed erosion and instability	High road densities, lack of revegetation, and harvest on unstable slopes have contributed to increased peak flows, sediment load and channel instability	M	H	M		3	2	Improve road management actions, all private landowners to have completed RMAP in 5 years, close revegetate X miles of forest road over the next 15 years, improve road maintenance on remaining road system. Reduce clearcut/unvegetated areas, especially on south facing rain on snow zone.	**Provide tech assistance and coordination of efforts to private landowners in development of RMAPs. Work with public landowners on coordinated inventory and actions to reduce sediment loading.** Revegetation replanting of clearcuts and roads shift harvest to more partial retention of hydrologically mature stands.			
Current effects of the Hwy 97 on Satus Creek are most noticeable between Wilson-Charley Creek and the County Line bridge, where the stream has been deprived of a substantial part of its floodplain. This stream reach has the potential to provide high quality spawning and rearing habitat, but the constricting influence of the highway maintains the creek in a degraded condition	Road location damages channel form and process, reduces floodplain, interrupts LWD transport.	H	H	H		1	2	Improve road configuration during reconstruction activities for bridges or alignment.	Widen or extend bridges Relocate road to upland areas.			
Wenas Dam has eliminated habitat access to upper Wenas Creek, and dewatered Lower Wenas Creek	Dam constructed without passage	H	H	H		2	2	Study passage feasibility.	Trap and haul			

3.5.4 Mid Elevation Yakima – Key Findings, Objectives and Strategies

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence. in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/orEliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence. in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/orEliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
High summer temps prevent/alter summer use in Lower end of many tributaries.	Temperatures are near lethal range (in a few specific lower tribs) for an extended period during the year	H	H	M		1	1	Develop temperature benchmarks, fund and implement projects that move the hydrograph toward the benchmark	Increase flow to temperature thresholds **Improve riparian/shade conditions**			
Loss of side channels and springs has reduced habitat diversity and temperature spatial diversity.	Obstructions associated with infrastructure have blocked habitat Conversion to Drain/Irrigation ditch has eliminated side channels Gold mining and dredging (Swauk Cr.)has eliminated side channel	M	H	H		2	1	Reconnect 100% of floodplain side channels in this Assessment Unit Restore physical and access characteristics of all ditches which were side channels Reconfiguration of channel and floodplain in mined areas to natural width/depth ratio and floodplain connection	Relocate infrastructure where possible to allow natural processes to operate. Compare to 1860s GLO maps, restore access, physical and riparian characteristics Use heavy equipment to reshape mine spoils.		Reconnect side channels by removal of obstructions. Construct artificial channels where current conditions allow.	
High levels of toxics from gold mining and processing in Swauk Creek effects productivity of habitat	Mining processing with arsenic and mercury.	H	H	L				Assess means of removal/immobilization	Sampling of site and modeling of toxic mobility.			
Lack of Habitat diversity /Lack of Large Woody Debris limits productivity in this Assessment Unit.	Lack of LWD Recruitment Due to interception/delay by diversion Dams Lack of LWD Recruitment Due to loss/reduction of riparian zone in this Assessment Unit	H	H	M		2	3	Improve downstream LWD passage at diversion dams (pass during the flood) Restore riparian Zone to at least 40% of its pre-1850 extent in Mainstem Upper Yakima Reaches	Reconfigure/redesign Diversion Dams, Install racks/collection system with excavators. 1**) Develop broodstock and reintroduction program for Cottonwood, 2) Purchase of floodplain properties/easements in these areas, especially in concert with floodplain restoration/infrastructure reconfiguration**.		**Artificially introduce LWD**	
Turbidity is High within the Wilson System, effecting habitat suitability and productivity.	Conversion/Use for irrigation conveyance/rechannelization of portions of the Wilson system result in increased levels of turbidity, especially during high water use times of year.	M	H	M		3	2	Manage/convert the Wilson system to have more attributes similar to the natural system - riparian zone/bank stability, gravel bed and banks,	Convert irrigation system to pipes or separate conveyance Replant riparian zones Improve sediment transport through the system.			

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence. in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/orEliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
	Forestry activities in the upper watershed contribute fine sediment during floods and spring runoff. Stormwater runoff from greater Ellensburg and Kittitas area (other contaminants as well)							hydrology. Reduce clearcut/unvegetated areas, especially on south facing rain on snow zone. Minimize the effects of stormwater runoff on water quality and quantity in Wilson system	Revegetation replanting of clearcuts and roads shift harvest to more partial retention of hydrologically mature stands			
Sediment Load is High in Lumuma	Roads and their location adjacent to Lmuma Creek in the Yakima training center increase sediment loading to the Creek; to some degree this drainage would have H sediment loading under natural conditions.	H	H	L		2	3	Improve road maintenance on YTC.	Close relocate key roads Improve drainage structures and inslope/outslope roads to reduce energy and sediment routing.			
Low Flow reduces/eliminates habitat availability/quality/diversity in the lower reaches of many tributaries not associated with Yakima Project	Alteration of hydrograph for irrigation	H	H	H		1	1	Develop flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark	**Reduce nonconsumptive water use**, **Reduce net water use (water conservation or purchase),** develop out of basin sources for new water, Manage the system differently in good/excellent water years **purchase/lease of water rights**	X		
Increases in peak flows have increased bed scour and channel instability in Wilson/Naneum, Swauk, Cabin	Hydrologically immature stands of timber, especially on south facing slopes in the rain on snow zone, in combination with H road densities, lead to increases in peak flow.	M.	H	M.		3	2	Reduce clearcut/unvegetated areas, especially on south facing rain on snow zone.	Revegetation replanting of clearcuts and roads shift harvest to more partial retention of hydrologically mature stands.			
The range of anadromous fish has been greatly reduced in the tributaries of this AU, reducing habitat area, productivity and abundance.	Diversion dams are not passable or provide only limited passage. Most diversion dams in this AU are located on broad alluvial fans, making control of grade and sediment flow difficult. Over time, most diversions accumulate sediments upstream, and degrade/create impassable fallows downstream. Range has been reduced in the upper watersheds due to numerous blocking culverts associated with Forest roads.	H	H	L		3	2	Improve passage and design of irrigation diversions to allow fish and sediments to pass through diversion points Improve passage on forest roads. Repair and replace all blocking culverts over the next 20 years.	Work Cooperatively with BPA to design irrigation diversions that will function over long time periods. **Replace/rebuild existing diversion dams based on prioritization from WDFW/YTAHP** Culvert replacement.	X		

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence. in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/orEliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
Inadequate screening diverts and kills fish	Numerous smaller diversions remain unscreened and impinge and kill fish. Some larger diversion screens do not meet current standards. These effects are especially important in the Lower ends of tributaries where juveniles can rear out of the fast mainstem current.	H	H	H		3	2	Screen all diversions over the next 10 years, especially those in Lower tribs with good rearing access.	**Move diversion off channel** **Provide screens** **Consolidate diversions**	X		
Upper Yakima Mainstem is severely confined, resulting in loss of habitat and altered channel form and process (incision, bed scour)	Confinement by roads, railroads, levees, and gravel mining operations has reduced side channels, loss of large areas of floodplain, in turn resulting in increased energy and bed scour.	H	H	H		2	1	Recover floodplain wherever possible, especially in areas adjacent to historical side channels.	Relocate/reconfigure infrastructure to restore floodplain area and function. Reconnect gravel pits where possible.			
Riparian Function has been reduced in this AU	Due to loss/reduction of riparian zone in this Assessment Unit Due to changes in yearly hydrograph in Mainstem and Lower tribs	H	H	H		3	2	Restore riparian Zone to at least 40% of its pre-1850 extent in Mainstem Upper Yakima Reaches Develop flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark	**Purchase of floodplain properties/easements in these areas, especially in concert with floodplain restoration/infrastructure reconfiguration**. **Develop broodstock and reintroduction program for Cottonwoo** Change flow management regime Develop new water sources Restore hydrologic/hyporheic connectivity upstream Move irrigation conveyance out of tributaries	X	**Artificially introduce LWD**	
Flip Flop flow management negatively effects the entire suite of ecosystem functions in the Upper Yakima Mainstem	The early and mid irrigation season H flows associated with Flip flop cause dramatic changes in temperature, habitat, water surface elevation during the major part of the growing/rearing (salmonids) season, altering or severing life history pathways for multiple species.	M	H	M		1	1	Develop flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark	Reduce net water use, develop out of basin sources for new water, Manage the system differently in good/excellent water years purchase/lease of water rights			

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence. in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/orEliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
Winter low flow reduces/eliminates habitat availability/quality/diversity, Also encourages fish to spawn in the thalweg, increasing sensitivity to winter peak flows.	Low flow in late summer and fall limits spawning habitat for Spring Chinook in Upper Yakima mainstem.	H	H	H		1	1	Develop flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark to allow for cottonwood establishment	Reduce net water use, develop out of basin sources for new water, Manage the system differently in good/excellent water years purchase/lease of water rights		Develop artificial spawning channels	
Irrigation season daily or weekly flow fluctuations greater and more frequent than under presettlement conditions	Interaction of multiple storage dam releases with diversions at Easton and flip flop operation	H	H	H		3	2	Reduce flow fluctuations to mimic more natural flow conditions	Model tradeoffs Reduce operational spill Improve irrigation efficiency			
Sustained H flows in the Upper Yakima downstream to Union Gap, limit spatial and temporal habitat diversity	The sustained flow conditions that result from flip flop and modification of the hydrograph for irrigation limits habitat diversity - sustained areas of high velocity cold water in the upper river - do not allow a normal progression/variability of the habitat types throughout the year	H	H	H		1	2	Develop flow benchmarks, fund and implement projects that move the flow regime toward that benchmark.	Reduce net water use Develop out of basin sources for new water Manage the system differently in good/excellent water years purchase/lease of water rights **Reconnect side channels, lower tributaries to increase habitat availability**	X		
Restoration of anadromous forms of steelhead to this portion of the basin is a major objective of NOAA Fisheries restoration objectives for steelhead in the subbasin.	This area of the Subbasin was highly productive for anadromous Steelhead under pre-1850 conditions. Environmental attributes can be restored in this basin to improve steelhead productivity.	H	H	H		ESA	1	Develop flow benchmarks, fund and implement projects that move the flow regime toward that benchmark. Restore other habitat characteristics such as access, diversity, temp regime	Reduce net water use Develop out of basin sources for new water Manage the system differently in good/excellent water years purchase/lease of water rights **Continue restoration and removal of obstructions to spawning habitat , side channels and lower ends of tributaries**	X		
Non-native species - eastern brook trout - pose a danger to bull trout populations.	Brook trout are present is sufficient abundance in sympatry with Bull Trout to have genetic and competitive effects.	M	L	L		ESA	3	Eliminate brook trout from presently occupied or suitable bull trout habitat.	Selectively remove Brook Trout from Subbasin. Discontinue stocking of brook Trout within the Subbasin.		**Education of public regarding fish identification and fish regs.**	X

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence. in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/orEliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
Anadromous and migratory fish species do not currently have access to Umtanum Creek upstream of RM 4.8, where a large gabion structure intended to protect a pipeline crossing is a total barrier to fish passage at all but flood flows.	Anadromous and resident fish had access to this portion of their range in the pre-1850 environment, restoration of access to the good habitat and flow conditions in this watershed will increase productivity.	H	H	H		2	4	Provide full access to Umtanum Creek.	**Grade control structures** **Floodplain restoration** **Riparian restoration.**			

3.5.5 High Elevation Yakima–Key Findings, Objectives and Strategies

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence. in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/orEliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
Lack of fish passage facilities at Kachess, Kechellus, and Cle Elum dams has resulted in the extirpation Sockeye and other anadromous species above the Dams, and has disconnected resident fish populations including bull trout. Habitat in this AU was and is capable of supporting populations of spring chinook, steelhead/rainbow trout, bull trout, and sockeye salmon.	Storage dams built without fish passage facilities.	H	H	H		1	1	Restore passage at least one dam by 2005 to determine feasibility and develop more locally adapted broodstock.	**Various fish passage options such as ladders, trap and haul, and modification of outlets for downstream passage**.	X	Trap and Haul	
Low flow/Temperature conditions in the Teanaway limit migration rates and timing of migration. This is especially significant for the NF Teanaway bull trout populations.	The number and frequency of lethal temperature days and the length and severity of the Low flow season have been increased by water withdrawals, loss of riparian zone function, and channel instability.	H	H	H		2	2	Reduce number of lethal temperature days and Develop flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark	**Reduction of water use through conservation, purchase of water rights. Restoration of riparian zone and reduce chronic bed instability through revegetation and restoration of natural flow regime.**	X		

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence. in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/orEliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
Woody Debris recruitment and retention is low (Teanaway) resulting in lack of pools and other key habitats.	Loss of LWD recruitment and retention due to reduction in riparian zone area and function from change in flow regime forestry development and resultant channel instability	H	H	H		2	2	Develop flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark. Revegetation riparian areas that have been lost to development in the Lower 10 miles.	**Reduction of water use through conservation, purchase of water rights. Restoration of riparian zone and reduce chronic bed instability through revegetation and restoration of natural flow regime**.		**Install LWD until riparian zone recovers**.	
Forestry activities have increased fine and coarse sediment load to the Teanaway	H road densities, lack of revegetation, and harvest on unstable slopes have contributed to increased sediment load and channel instability	H	H	M		3	2	Improve road management actions, all private landowners to have completed RMAP in 5 years, close revegetate X miles of forest road over the next 15 years, improve road maintenance on remaining road system. Purchase of development rights property especially in rain on snow zones.	**Provide tech assistance and coordination of efforts to private landowners in development of RMAPs. Work with public landowners on coordinated inventory and actions to reduce sediment loading**.	X		
Increases in peak flows have increased bed scour and channel instability in the Teanaway	Elevation and orientation of the watershed make it naturally prone to H flow events. Forestry activities such as clearcuts can Further increase peak flows by reducing vegetation and accelerating runoff.	M.	H	H		3	2	Reduce clearcut/unvegetated areas, especially on south facing rain on snow zone.	Revegetation replanting of clearcuts and roads shift harvest to more partial retention of hydrologically mature stands.			
Historical splash dams on the Teanaway have increased bed instability and available coarse sediment	Effects of splash dams are still evident in bed stability.	L	H	L		2	2	Eliminate the effects of historical splash dams.	Encourage sediment deposition in areas scoured to bedrock through installation of key LWD.			
Road construction adjacent to streams has damaged fish habitat.	Loss of riparian zone area and function has reduced LWD loading, loss of floodplain has increased stream energy and destabilized channel.	H	H	H		3	2	Restore riparian zone and floodplain area and function which has been lost.	**Locate new roads away from streams Relocate/close existing roads and revegetate those locations**.		**Install LWD until riparian zone recovers.**	

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence. in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/orEliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
Habitat Diversity/Temperature Diversity has been reduced by loss of off-channel habitat	Obstructions associated with infrastructure have blocked habitat Lowering/Alteration of GW table has reduces side channels Channelization of the mainstem Teanaway has eliminated side channels and floodplain connection	M	H	H		2	1	Reconnect 100% of floodplain side channels in this Assessment Unit Maintain improve groundwater levels Restore channel form and process in the mainstem.	Relocate infrastructure where possible to allow natural processes to operate. Consolidate water system Maintain/improve Hyporheic connection Restore riparian zone Relocate gravel dikes and berms		Reconnect side channels by removal of obstructions.	
There are naturally reproducing populations of non-native brook trout throughout the High Elevation Yakima Assessment Unit (WDFW 1998). Notable brook trout concentrations exist in the Cle Elum and Waptus Lake drainages. Probable impacts to bull trout include predation on juveniles and competition for food and space. Brook trout may also pose a serious genetic threat to bull trout due to the potential for hybridization (WDW 1992; Rieman and McIntyre 1993). RV14	Brook trout are present is sufficient abundance in sympatry with Bull Trout to have genetic and competitive effects.	M	L	L		ESA	3	Eliminate brook trout from presently occupied or suitable bull trout habitat.	Selectively remove Brook Trout from Subbasin. Discontinue stocking of brook Trout within the Subbasin.		**Education of public regarding fish identification and fish regs.**	X
The current operation and management of the reservoirs is not conducive to beach spawning sockeye because of low water levels through the spawning and incubation season. If reintroduction is to be successful sufficient habitat must exist in the tributaries to support a viable population, therefore the most likely reservoir to begin reintroduction of sockeye to this Assessment Unit is Cle Elum, where a large tributary system with relatively good habitat conditions exists. RV10	Trial reintroduction of sockeye will have the greatest chance of success where habitat is sufficient to support large, naturally reproducing populaions	H	M	M		2	1	Use Cle Elum lake as a test bed for dam passage and sockeye reintroduction	**Continue BOR reintroduction and passage feasibility study** **Develop Sockeye broodstock and reintroduction techniques under YKFP**	X		

Key Finding–Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence. in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Species Impact	Ecosystem or Watershed Impact	Biological Objective (Reduce and/orEliminate Negative Causes and Improve and/or Maintain Positive Causes)	Strategies to Reduce and/or Eliminate or to Improve and/or Maintain	Currently Addressed?	Strategies to Mitigate Effect	Currently Addressed?
Management of reservoir water levels can create obstructions to access of tributaries for Bull Trout on Spawning Migrations	Low reservoir levels in late summer create highly unnatural channel conditions (wide and shallow, head cuts, etc) where tributaries flow across the dewatered floor of the reservoir	H	H	H		ESA	2	Allow unimpeded access of Bull Trout to spawning areas.	**Annual monitoring of channel conditions and construction of migration channels/paths.** Study methods for construction of permanent channels or paths Alteration of reservoir water level management.		**Trap and haul of spawning bull trout**.	

3.5.6 Mid Elevation Naches–Restoration Key Findings, Objectives and Strategies

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
LOW FLOW reduces/eliminates habitat availability/quality/diversity	Flip Flop and total quantity reduction due to diversion for irrigation, domestic use.	M	H	M		1	1	Develop flow benchmark, fund and implement projects that move the system towards that benchmark	Reduce net water use, develop out of basin sources for new water, Manage the system differently in good/excellent water years **purchase/lease of water rights**	X		
Loss of Habitat Diversity/Temperature Diversity by loss of off-channel habitat Bedload movement is apparent in some of the more narrowly confined reaches, and the right bank revetments have cut off historical side channels and springbrooks.	Obstructions associated with infrastructure have blocked habitat Conversion to Drain/Irrigation ditch (Buckskin Slough) Loss of riverine connection with water table due to sediment aggradation in Lower river.	M	H	H		2	1	Reconnect 100% of floodplain side channels in this Assessment Unit Restore physical and access characteristics of all ditches which were side channels Restore sediment transport	Relocate infrastructure where possible to allow natural processes to operate. Compare to 1860s GLO maps, restore physical and riparian characteristics **Improve sediment transport**		Reconnect side channels by removal of obstructions. Construct artificial channels where current conditions allow.	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
								throughout this reach	**capacity in Lower reach by modifying/replacing removing irrigation dams and constrictions caused by roads.**			
Lack of Habitat diversity (pools with cover)/Lack of Large Woody Debris Large woody debris is scarce, probably because of accelerated stream velocities and removal by private citizens, although some was recruited from upstream during the flood of 1996.	Lack of LWD Recruitment Due to interception/delay by diversion Dams Lack of LWD Recruitment Due to Change in upstream riparian Zone due to loss of large trees from riparian zone loss conversion/harvest of trees Lack of LWD Recruitment Due to Change in upstream riparian Zone due to loss of riparian function/restoration because of changes in annual hydrograph	H	H	H		2	2	Improve downstream LWD passage at diversion dams (pass during the flood) Restore viable P. pine populations to upstream Riparian Zones over the next 20 years Eliminate /reduce severity of flip/flop and flow management to allow natural reproduction of riparian communities	Reconfigure/redesign Diversion Dams, Install racks/collection system with excavators. **Develop broodstock and reintroduction program for Cottonwood and P.pine** Eliminate or reduce flip flop/Restore normative hydrograph to restore riparian function Reduce net water use Develop out of basin sources for new water.	X	Planting, artificially introduce LWD	X
Productivity has been lost due to loss of access to habitat	Culverts block access to habitat Diversion dams block access to Habitat Rimrock Dam Blocks Habitat (Rattlesnake Creek)During low flow or drought years the combination of low flow, diversions, and the porous nature of the alluvial fan can create passage problems for spring chinook and bull trout.	H	H	H		3	2	Repair/replace blocking culverts Improve fish passage at diversion dams, especially Lower Rattlesnake Cr.	**Replace culverts in Little Naches, Bumping, Nile Cr and other locations** **Move diversion off stream to pump** **Consolidate Diversions**	X		

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Lack of screening/poor screening at some diversions cause fish mortality	Old screens do not meet current standards; most of these screens are located on smaller diversions. Replacement of these screens will result in improved productivity.	M	H	M		3	3	Provide screening at all locations were it does not exist, upgrade existing screens to meet new criteria Consolidate diversions Move diversions off stream	**Continue with screening and passage improvements, monitoring program**	X		
Sediment transport processes have been altered in the Naches River Deposition of fine sediments has increased since the initiation of large-scale clearcutting in the upper watershed (CBSP 1990, WDFW 1998). The diversity of channel types has been greatly reduced, The river is usually confined on both sides either by basalt canyon walls or by riprapped dikes or road embankments Highway 410 parallels most of the left bank of the upper Naches and virtually all of the embankment is riprapped. In many places summer homes and residences on the right bank are protected by riprapped revetments as well. However, the 4.4 miles of the Little Naches below Salmon Falls was severely degraded by a series of floods in the late-1970s, and by an emergency campground restoration and protection project that removed bedload material, widened and channelized the riverbed, and eliminated riparian vegetation (CBSP 1990). This project was not successful and the lower 4.4 miles of the Little Naches now affords the	Constrictions effectively decrease upstream gradient during flood flows, increase velocity through the constriction, and increase erosion and incision downstream due to fast moving "hungry" water. In the Lower Naches levees; roads and railroads which act as levees, bridges, irrigation intakes, and the Yakima Waste Treatment Plant and associated bank armoring have constricted the floodplain and increased sediment transport in some locations, variation in width of the levees has resulted in constrictions that effectively reduce gradient, creating depositional zones in other locations. Channel characteristics are therefore an alternating series of unstable erosion and deposition zones separated by large areas more or less "natural" channel characteristics. In the Little Naches, the construction of the main FS road up the Little Naches has resulted in loss of floodplain and channel constriction for several miles in the Lower river; this contributes to channel instability in the same manner as above. The irrigation diversion dam at Powerhouse Road acts to change the gradient of the Naches River, causing sediments to be deposited upstream, and starvation of downstream reaches. Rimrock Dam has starved the Tieton and portions of the Naches of sediment since its	H	H	H		2	1	Reduce constrictions where possible by reconfiguration of levees and other infrastructure. Provide for increased bedload movement through the dam site at and below 7000 cfs. Restore bedload sediments to Tieton River or recognize permanent change in physical characteristics of Tieton and Naches rivers.	**Levee setback and reconfiguration, bridge replacement, road and highway relocation.** Rebuild/refit dam with floodgates sized to allow bedload movement during dominant discharge events, leave gates open during non-irrigation season. Consolidate diversions at upstream diversion points. Mine Gravel from Reservoir and deposit in Tieton below dam, Reconfigure Tieton and Naches (or allow) to naturally mine areas of available sediments.			

Key Finding – Observed effect or phenomenon	**Cause/Working Hypothesis**	**Confidence that Effect is actually occurring**	**Level of Confidence in Causal Relationship**	Cont. of Cause to Key Finding or Effect		**Focal Sp. Impact**	**Ecosystem Impact**	**Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)**	**Strategy to reduce/eliminate or improve/maintain**	**Currently addressed?**	**Strategy to mitigate effect**	**Currently addressed?**
poorest spawning and rearing habitat in the drainage.	construction.											
Riparian Function has been reduced in the AU.	Due to change in annual hydrograph in Tieton and Lower Naches River from flip-flop. Loss of riparian zone in this Assessment Unit and upstream due to conversion to other uses, constrictions.	H	H	H		1	1	Change Flip flop management or manage differently in good water years. Restore riparian Zone to at least 80% of its pre-settlement extent in Tieton and Lower Naches.	Reduce net water use, develop out of basin sources for new water, Manage the system differently in good/excellent water years **purchase/lease of water rights** **Purchase of floodplain properties/easements in these areas, especially in concert with floodplain restoration/infrastructure reconfiguration.**	X	**Planting of riparian vegetation, artificially introduce LWD**	X
Flip Flop flow management negatively affects the entire suite of ecosystem functions in the Tieton and Naches Reaches.	The late season high flows associated with Flip flop cause dramatic changes in temperature, habitat, water surface elevation during the latter part of the growing/rearing (salmonids) season, altering or severing life history pathways for multiple species.	M	H	H		1	1	Develop flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark	Reduce net water use, develop out of basin sources for new water, Manage the system differently in good/excellent water years purchase/lease of water rights			
Chinook have expanded range into the Little Naches due to the laddering of Little Naches Shallows.	The laddering of the fallows in the Little Naches has increased available habitat. Productivity of this habitat is currently low due to poor fitness of the population, naturally variable temperature and flow regimes (similar to Teanaway), and impacts from forestry management activities.	H	M	L		4	3	Improve abundance and productivity of chinook in Little Naches	**Improve habitat conditions through management of LWD, relocation of levees and other infrastructure**.			
Grazing impacts bull trout in SF Tieton	Grazing occurs during spawning and can impact spawning by repeated disturbance of spawning fish, and redds through trampling by cattle either resting, drinking from or crossing SF Tieton.	M	H	L		ESA	3	Reduce potential for grazing operations to impact bull trout spawning or redds.	**Fencing off stream** **off channel watering structures** **Crossing structures for cattle**.			
Irrigation season daily or weekly flow fluctuations greater and more frequent than under presettlement conditions	Interaction of Yakima/Tieton Diversion, Wapatox Diversion, and other irrigation diversions creates multiple fluctuations at multiple points in this AU.	M	H	H		3	2	Reduce flow fluctuations to mimic more natural flow conditions	Model tradeoffs Reduce operational spill Improve irrigation efficiency Consolidate Diversions to reduce number of diversion points.			

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Increases in peak flows have increased bed erosion and instability	Mainly forestry activities in Little Naches and other south facing drainages have increased melt during rain on snow events, road drainage network has decreased time of concentration resulting in increased frequency and magnitude of peak flows.	M	H	M		3	2	Reduce clear-cut/unvegetated areas, especially on south facing rain on snow zone.	Revegetation replanting of clear cuts and roads shift harvest to more partial retention of hydrologic ally mature stands.			
Sustained low flows and the rapid transition to high flows in the fall, limit spatial and temporal habitat diversity	The sustained flow conditions that result from flip flop and modification of the hydrograph for irrigation limits habitat diversity and do not allow a normal progression/variability of the habitat types throughout the year	H	H	H		1	1	Develop flow benchmarks, fund and implement projects that move the hydrograph toward the benchmark .	Reduce net water use Develop out of basin sources for new water Manage the system differently in good/excellent water years purchase/lease of water rights			
Productivity has been lost due to loss of access to habitat	Rimrock Dam Blocks Habitat	H	H	H		2	1	Restore passage at Tieton Dam.	Study feasibility in conjunction with other dams.		Trap and haul.	
Management of reservoir water levels can create obstructions to access of tributaries for Bull Trout on Spawning Migrations (Rimrock)	Low reservoir levels in late summer create highly unnatural channel conditions (wide and shallow, head cuts, etc) where tributaries flow across the dewatered floor of the reservoir	H	H	H		ESA	3	Allow unimpeded access of Bull Trout to spawning areas.	**Annual monitoring of channel conditions and construction of migration channels/paths.** Study methods for construction of permanent channels or paths Alteration of reservoir water level management.	X	Trap and haul of spawning bull trout.	
Bull trout population fragmented by loss of passage at Rimrock and Bumping dams, making these populations more vulnerable to extinction over the long term.	1) Lack of passage has cut off the former fluvial population that spawns in SF Tieton from other fluvial populations in the basin and reduced the population's habitat range. 2) Rimrock Res. Has increased connection of resident Indian Creek Population with SF Tieton Population	M	H	H		ESA	2	Provide for gene flow between fluvial populations, and manage to conserve genetic diversity and retention of genes in Rimrock populations to decrease risk of extinction	Maintenance of Rimrock Bull Trout populations well above normal viability thresholds (i.e. at limits of habitat).		Artificial gene flow by involuntary spawning, introduction of individuals from other populations.	
Bull Trout have reduced population viability due to competition and interbreeding with brook trout	Brook trout are present is sufficient abundance in sympatry with Bull Trout to have genetic and competitive effects.	M	L	L		ESA	3	Eliminate brook trout from presently occupied or suitable bull trout habitat.	Encourage brook trout harvest. Discontinue stocking of brook Trout within the Subbasin.		**Education of public regarding fish identification and fish regs.**	X

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Within the lower Naches, up to 450 cfs was historically diverted at Wapatox Dam and returned to the river at RM 9.7. The US Bureau of Reclamation has purchased the Wapatox is in the process of eliminating thewater power diversion. Assessing the benefits of the Wapatox purchase is not possible at this time It is certain that the restoration of flow to this reach will have a major beneficial effect on habitat forming processes in the Lower Naches.	The "bypass" reach was severely degraded by reductions in flow, recovery may take several decades.	H	H	H		1	1	Accelerate recovery rate in this reach and evaluate changes in habitat availability and channel form and process due to flow restoration.	**Continue ongoing monitoring by BOR** **Implement riparian restoration in this reach**.	X		
Due to the submerged and unscreened outlet of Rimrock lake, fish (principally Kokanee and Bull Trout) in the lake become entrained during the rapid drawdown of the lake in September and October.	Mechanical means of preventing entrainment is possible at this outlet.	H	M	L		2	3	Eliminate entrainment of Kokanee and bull trout	Install screening or modify inlet Change drawdown rate.	X		

3.5.7 High Elevation Naches–Restoration Key Findings, Objectives and Strategies

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Lack of fish passage facilities at Bumping Res. dam has resulted in the extirpation Sockeye and other anadromous species above the dam. Bull trout populations have been fragmented by loss of passage at Bumping Dam, making the Bumping Lake population more vulnerable to extinction over the long term	Storage dam built without fish passage facilities. Due to the low height of this dam it would be the easiest of the 4 reservoirs that were formerly natural lakes to restore passage to.	H	H	H		2	1	Restore passage at least one dam by 2005 to determine feasibility and develop more locally adapted broodstock.	**Various fish passage options such as ladders, trap and haul, and modification of outlets for downstream passage**.	X	Trap and Haul	

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
Blocking culverts on forest roads has reduced habitat availability.	Culverts on mainstem Deep Creek periodically fail during flood events, creating short term blockages	L	H	L		2	1	Replace/redesign culverts to withstand flood flows.	Installation of bridge or multiple culverts at existing location.			
Hells Crossing Bridge impedes LWD transport through this reach	Constriction, elevation of bridge deck above channel not sufficient to pass LWD	H	H	H		2	3	Restore LWD passage through bridge	Redesign/replace Hell's Crossing bridge		Manage LWD at bridge opening.	
Riparian zone has been damaged in this reach. There is bank damage associated with several campgrounds along the American River RV110	Dispersed recreational use and camping	H	H	H		3	1	Limit dispersed rec. in immediate riparian zone, relocate use to other areas.	**Public Education** **Road closure/blockage** **Revegetation**			

3.6 EDT Reference Condition Key Finding, Objective and Strategy

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
The conservative approach indicates that the restoration strategy is reasonable with the exception of the need for flow improvements in the Naches and lower Yakima using strategies that are more effective at flow improvement than the standard approaches of purchase or transfer of water rights or improvements in water use or conservation	The EDT model can be used as a coarse benchmark to evaluate an overall suite of restoration actions. The results of the Restoration reference condition scenario show an increase in abundance, diversity, productivity and capacity of the examined populations, but those populations that are dependent on the channel and floodplain habitats of the mainstem are still limited, and consequently large areas of productive habitat (over 50% for most species) are not used to their potential.	M	M	M		1	1	Restored the Yakima River basin sufficiently to support self-sustaining and harvestable populations of indigenous fish and wildlife while enhancing the existing customs, cultures, and economies in the basin.	**Implement the Subbasin Plan Elements and Strategies.** **Continue the Yakima Subbasin Fish and Wildlife Planning Board.** **Work toward cooperative water resource management over the long term with an emphasis on restoration of flows in the mainstem that support the life history needs of the Subbasins fish and**	X		

Key Finding – Observed effect or phenomenon	Cause/Working Hypothesis	Confidence that Effect is actually occurring	Level of Confidence in Causal Relationship	Cont. of Cause to Key Finding or Effect		Focal Sp. Impact	Ecosystem Impact	Biological Objective (Reduce/Eliminate Negative Causes, Improve/maintain positive causes)	Strategy to reduce/eliminate or improve/maintain	Currently addressed?	Strategy to mitigate effect	Currently addressed?
									wildlife populations.			

4 Research, Monitoring and Evaluation Plan for Resident and Anadromous Fisheries

4.1 Ambient Monitoring of Habitat and Populations.

Currently, the Yakima Klickitat Fisheries Project (YKFP) is the dominant habitat and fisheries management monitoring and research organization in the subbasin, and as it was established by the NPCC for this purpose, YKFP should continue in this role. The data structure of the monitoring programs already established by YKFP are compatible with the Pacific Northwest Ambient Monitoring Program (PNAMP) and are cited as a model in development of monitoring and analysis programs consistent with PNAMP. Management of the fisheries resource in the Yakima Subbasin is greatly aided by the information gathered and disseminated by YKFP, and the information and analysis resources provided by YKFP were invaluable in the preparation of this subbasin Plan and will continue to be invaluable into the future. The reader is referred to the YKFP monitoring plan in the Appendix for more detail on that YKFP program.

The data structure of the EDT model should continue to be used for collection and organization of habitat attributes, regardless of whether a specific attribute is currently a component of the EDT model. A lesson learned in the preparation of the Subbasin Plan was the utility of that structure in a GIS environment, and that a GIS environment has the potential to not only aid in understanding of the EDT model (or other similar environment/population models for that matter) but could be used to rapidly develop datasets for model inputs. Given the existing infrastructure associated with the EDT model (web based environment, the data structures at different scales, continuing validation efforts) that already exist, the Yakima Subbasin planners and YKFP both anticipate that the application of GIS to EDT over the next several years will fundamentally change how that model and associated data is used, developed, interpreted and displayed.

Fundamental data needs exist for actual habitat data to use in the model and as baselines to track improvement/effectiveness/change over time. The YTAHP Program is currently in the process of inventorying large sections of the subbasin upstream of Union Gap, especially those tributaries that have been heavily modified by irrigation infrastructure and withdrawal. This information will dramatically increase data accuracy and prioritization of restoration needs and actions, again regardless of whether EDT model runs are used to assist in making those decisions. Central Washington University is also working on more rapid data collection protocols (field, remote sensing, water quality data) that are compatible with the EDT model for those areas not covered by YTAHP such as the Mainstem and other tributaries. This work should continue. Finally, there are other programs, mainly on the Yakama Reservation that should put the habitat data gathered under those programs into a data structure consistent with the EDT model data structure.

Also needed is a consistent effort to define habitat use and capacity across species and life histories throughout the subbasin. Field-based information on fish use of habitat will not only make validation and refinement of the EDT model possible, but will also be of tremendous use in the supplementation and reintroduction programs that are currently ongoing and anticipated in this subbasin plan, and for setting harvest management and overall population targets. It is the combination of habitat data and fish use data that will be the cornerstone of evaluation of subbasin plan effectiveness.

4.2 Resolution of Key Uncertainties Identified in the Subbasin Plan

The following grouping of Key Uncertainties is not prioritized.

A) Physical Benchmarks. In development of the Subbasin Plan it became apparent that there was a consistent set of issues that are related to comparison of pre-1850s and current physical processes in the subbasin, mostly flow and flow related issues such as temperature and some other water quality parameters; sediment transport and geomorphology; peak flows and floods. YKFP has a synoptic view of the basin from the standpoint of fish habitat and life histories; no analogous group exists for the physical attributes of the subbasin. Because of the large influence of the Bureau of Reclamation’s Yakima Project on water flow and habitat conditions within the subbasin, Reclamation has become the default “keeper” and “developer” of physical models in the subbasin. Reclamation however, has specific interests and authorities in the basin that are legally defined, and the models that have been developed must (quite appropriately) directly relate to those legal authorities and management of the Project, or in the case of the Yakima River Basin Water Enhancement Project, reducing the Project’s effect on the aquatic resources of the Basin. This has lead to an emphasis on examining the physical effect of Project actions and components within a “Reclamation framework”, almost entirely dealing with the mainstem Yakima and Naches rivers. Again, this framework is appropriate and necessary for management of the Yakima Project, but the benchmarks set and more appropriate for efficient management of an irrigation delivery project than for management of a watershed and its aquatic resources.

Consequently, there is a lack of physical models that take a synoptic view of the basin and can relate processes in the tributaries (flow, temperature, sediment transport/channel form and process) to processes in the mainstem on a seasonal, annual, or decadal basis. There is a need for such models and data structures to establish physical benchmarks that can be used for management of the watershed, especially in the policy and management processes of setting objectives for crucial environmental attributes such as flow and/or temperature regimes in the tributaries and mainstem, and the development, prioritization, implementation and evaluation of restoration strategies that move environmental attributes toward those objectives.

Therefore, a Yakima Subbasin physical working group should be established that is charged with development of benchmarks (the pre-1850s physical attributes of the watershed versus current attributes) to measure against for flow, temperature, stream power, and sediment transport. Ideally the benchmarks will include the effects of the glacial lakes, as they existed in the pre-1850s environment and also the physical characteristics of tributaries and their influence on the mainstem. Over the long term, the benchmarks and should be usable basin wide and year-round. In order for this project to succeed, the working group would need to ensure that such baselines have broad applicability and acceptance across the subbasin, and, similar to YKFP some agency/group/entity to store and maintain the models for use by parties within and outside the basin. Specifically, benchmarks need to be developed that resolve the following Key Uncertainties identified in the Subbasin Plan:

- “Although some spring chinook redds are saved in the upper Yakima as a result of the flip-flop management, there has been little or no effort to understand or monitor the effects of this flow regime either on the upper Yakima or on the lower Naches River. …We strongly recommend that the flip-flop regime be examined carefully; a process made difficult by the lack of quantitative data.” (Snyder and Stanford, 2001).
- Examination of the rules in EDT makes clear that the degree of hydrologic alteration in the Naches River that is associated with flip flop was not included in the calibration of the general EDT model. Modeling based on EDT to determine the benefits of reduction of flip flop would probably not be reflective of the true effects.
- In water years with sufficient TWSA, flip flop should be reduced or eliminated to the extent possible to allow for periodic reestablishment of riparian communities and take advantage of short term opportunities to manage the system within a "normative" range.
- River Ware’s estimated "unregulated flows" do not take into account the necessary range of pre-1850 physical conditions in the watershed; specifically physical characteristics of the historical glacial lakes and the change in tributary flows to the mainstem due to irrigation diversions in the tributaries. Creation of a model that incorporates the physical changes in the watershed and known watershed processes should receive emphasis in the future.
- Presence of reservoirs in the system has dramatically reduced peak flows and net energy available for sediment transport. However, it is possible that the theoretical effects of regulation (i.e. the difference between pre-1850 and current peak flow characteristics) are quite different from the actual effects due to the small storage ability of reservoirs in the basin
- Very little information that compared the role and function of the pre-1850 lakes in creation of environmental attributes (such as flow and temperature) in river reaches directly downstream or at a subbasin scale.
- Much less attention has been paid to the winter temperature regime, but the physical relationships would still hold, and reduction of the number of winter and spring days above these thresholds would necessarily reduce winter temperatures. Based on changes to the flow regime and the above relationships,

    A) Temperatures in the Upper Yakima and the Union Gap reach are colder during all times of the year than under pre-1850 conditions due to dramatically increased summer flows and decreased winter and spring flows. Because these areas have had significant changes to floodplain and channel configuration (see below), changes to channel shape (narrower and deeper) may further contribute to cooling of the river in summer.

    B) Temperatures in the river below the Union Gap reach are warmer for a longer duration during the summer, and colder in the winter, due to reduced flows year round.

C) Temperatures in the Tieton and Naches are warmer in the summer, much colder in September and October during flip flop, and colder in the winter as well due to reduced flows.

There are at least 3 ongoing studies that could form the basis or starting point for the physical working group. The Yakima Storage Study (Black Rock) may provide a forum under which some of these models or benchmarks can be developed for the mainstem, as there is an emphasis in the storage study on not only using storage to increase the dependability of irrigation supplies, but to include the use of storage specifically as a strategy for restoration of fish and wildlife habitat. The study will probably look at physical flow/habitat quantity relationships, the effects of flip flop and the quantity, timing, and location of water delivery needed to modify or eliminate the effects of flip flop, flow/channel condition/temperature relationships, flood management and sediment transport energy, etc. The Bureau of Reclamation's Denver Technical Services Center has also begun scoping and study design to characterize the energy available for sediment transport in different reaches of the mainstem, and specifically to look at sediment transport and availability in the Union Gap reach to help design levee setback, gravel mine restoration, and floodplain restoration in that reach. The Department of Ecology is initiating a temperature TMDL in the Naches drainage that will also look at flow/channel condition/temperature relationships in that drainage (for summer time water quality exceedances) and develop a temperature model. Each of these studies will build mathematical models that could be designed for much wider applicability to the subbasin with marginal infusions of BPA funds. These models, once developed and generally made available with and outside of the subbasin, would have great utility in management of fish and wildlife habitat in the subbasin, and design and maintenance of capital facilities such as diversion dams, bridges, (setback) levees etc. within the context of normative subbasin stream energy, sediment availability, and thermal processes. Such models and benchmarks could also be specifically designed to resolve the following Key Uncertainties as well:

- The effect of recent increases in flow on temperatures in the Bypass Reach is not currently known, but the Naches is the subject of a TMDL study for temperature in 2004-2005. Modeled temperature profiles and temperature monitoring associated with the study should provide this information.
- Very little work has been done to study sediment in the tributaries
- A concerted effort to design appropriate irrigation diversion structures for high energy, high sediment, highly unstable environments should be undertaken to solve the subbasin, and Columbia Basin-wide problem.
- Current efforts are under way to study the tradeoffs involved in connection of gravel pits to the main river and should be completed in 2004.

B) Bull Trout Habitat Use. Bull trout and their management are not currently well integrated into either the YKFP or EDT data structures, and such integration will be highly valuable into the future, especially as feasibility studies for passage at the existing storage dams move forward. Mobrand Biometrics Incorporated, the developers of EDT, are currently in the process of development of a bull trout model for EDT and this model should be incorporated into the EDT model in the Yakima Subbasin. There is a considerable body of data regarding bull trout use and occurrence in the subbasin that has been developed is actively being developed by USFWS, WDFW, and YKFP through the species interaction studies, this data should be organized into the EDT data structure and model validation process. Completion of the bull trout habitat use studies and incorporation of their results into the EDT framework would resolve the bull trout Key uncertainties such as:

- Bull trout use/migrate throughout the Yakima system, including the mid and lower Yakima floodplains
- Historic abundance of bull trout is not well understood and should be regarded as a data gap.
- Bull trout could migrate throughout the Yakima System, including the mid and lower Yakima Floodplains.
- Adult bull trout may utilize this Assessment Unit as a migration and/or foraging corridor. The extent to which bull trout utilize this Assessment Unit is unknown and will need to be studied in the future.

C) Water Quality Effects on the Aquatic Environment

1) Lower River Eutrophication/Algal Bloom. The existing cooperative study by Ecology, USGS, South Yakima Conservation District and Benton Conservation District is seeking to study the causes of the lower river algal bloom, its effects on the environment (specifically including fish use of the environment) and means of control. There is a five year study plan that has been developed, but funding is not necessarily assured for full implementation of the study given the range of actions that could be looked at after the current characterization phase of the study (year 1) is completed. This is perhaps the most pressing research need in the subbasin, and is already receiving cooperation from the Yakama Nation, WDFW, NOAA Fisheries, Washington State Department of Agriculture, local government, and the Irrigation Districts in the lower river. This study should address the Key Uncertainty;

- Massive in-channel aquatic vegetation growth alters habitat, water quality, and ecosystem characteristics; means to control this growth should be studied.

2) Other Water quality Uncertainties. The TMDL processes from Ecology will resolve several key uncertainties, although probably not within the 3-year subbasin planning window. Ahtanum Creek will be studied soon for fecal coliform and temperature, and future studies in the Ahtanum by YTAHP and Ecology will address the following Key Uncertainty:

- Little is known about water quality in the lower reaches of Ahtanum Creek. Presumably water quality is degraded somewhat despite efforts to maintain minimum instream flows in the channel. Potential impacts include increased temperature, turbidity, and possibly chemical constituents related to agricultural runoff.

D) Ecosystem and Environment/Population Relationships

These types of uncertainties are within the overall mission and study design of the YKFP, and current studies are attempting to resolve these uncertainties:

- The EDT model hypothesizes that the food web in has been altered/reduced in the mainstem
- Colder temperatures could reduce ecosystem productivity.
- Growth of juvenile RBT is well below rates in similar Col. Basin systems. Reinforcing the hypothesis that the young of the year life stage is limiting rainbow/steelhead trout production in Upper Yakima.
- "Although some spring chinook redds are saved in the upper Yakima as a result of the flip-flop management, there has been little or no effort to understand or monitor the effects of this flow regime either on the upper Yakima or on the lower Naches River. …We strongly recommend that the flip-flop regime be examined carefully; a process made difficult by the lack of quantitative data." (Snyder and Stanford, 2001). (the biological questions associated with this issue)

Also within the mission of YKFP is resolution of the management issues determination of the negative and positive effects of fish use within the lower river tributaries. There is a considerable existing body of data regarding fish use of these areas, and an additional study would primarily be devoted to summarizing those prior efforts, YKFP is supportive of being the lead for such a study.

- Operational spill and field runoff routed to several natural drainages (Amon, Corral Canyon, Snipes, Spring Creeks) attract salmonids to low quality or lethal habitat conditions (non-viable populations, population sinks), impede migration, expose migrants or rearing fish to lethal or near-lethal conditions, or could provide some beneficial functions.

Of relatively low priority is the Key Uncertainty related to increased pathogens. This is because temperatures are at lethal or near-lethal levels for significant times of the year, which is the underlying driver of mortality or avoidance in those portions of the river:

- High temperatures have resulted in increased susceptibility of native salmonids to pathogens

E) Hatchery, Hatchery Supplementation, and Artificial Re-introduction Key Uncertainties.

These issues are also well within the mission and scope of YKFP, and directly relate to existing or future plans for management of all native fish stocks in the subbasin, and to YKFP's mission to act as a test bed for hatchery supplementation and its effect on non-target taxa and the ecosystem.

Hatchery Key Uncertainties. Current work on these subjects is concentrated in the upper Yakima, expansion of this work to the habitats in the lower Yakima is recommended. Increased study of the Naches system as a control for the upper Yakima work will also be starting soon:

- The EDT model hypothesizes that there are competitive interactions between hatchery fish released in this Assessment Unit (fall chinook and coho) and other portions of the basin (spring chinook and coho) that negatively impact the productivity of natural origin fish in this Assessment Unit.

- Hatchery fish compete with natural origin fish for space and food resources
- In 1995, the Yakama Nation began stocking hatchery coho salmon in the Ahtanum Creek system in an effort to reestablish self sustaining coho populations (YN 2003). Coho juveniles are known to be more aggressive than other anadromous or resident species, and there is the potential of competing with or preying on bull trout fry.
- There is a potential for hatchery fish to compete with natural origin fish for space and food resources, this is the focus of ongoing study related to the CESRF.

Hatchery Supplementation Practice and Effectiveness. Research and monitoring related to the uncertainties below have been ongoing at YKFP:

- Ongoing activities associated with the Cle Elum Supplementation and Research Facility provide information on the effectiveness of restoration, supplementation technology and effectiveness, and other population management strategies that can benefit fisheries and habitat management in the Yakima Subbasin and in the Columbia Basin as a whole. The stability of the population if supplementation were to cease is not well understood and much more study is needed.
- As a result of the location of an acclimation facility in the Teanaway River, spawner returns and redds in the Teanaway river have increased from near zero to 110 redds in 2002, and 31 in 2003. The long-term success of the introduced spring Chinook population in the Teanaway is also not well understood. The environmental conditions in the Teanaway, specifically the temperature regime, is significantly different from the mainstem Yakima, where the broodstock for the CESRF is collected.
- The purpose of the Yakima/Klickitat Production Project is to test the assumption that new artificial production can be used to increase harvest and natural production while maintaining genetic resources.
- Release of hatchery origin spring chinook have increase the number of returning spawners to this Assessment Unit. The long term prospect of continued high abundance if the hatchery supplementation were to cease is unknown.
- In 1997 the Cle Elum Supplementation and Research Facility (CESRF) began a program to determine if the abundance of spring chinook could be increased by artificial introductions (Fast and Pearson unpublished). It appears that introductions of spring chinook from the CESRF have increased the abundance of spawning fish and may lead to reestablishment of a spring chinook population or subpopulation in the Teanaway River.

Population reintroduction. The coho reintroduction plan is the only current reintroduction or population reestablishment effort in the Yakima Subbasin. The YKFP management plan for steelhead that is currently under development will include potential reintroduction programs for steelhead. Initial passage and reintroduction feasibility studies for sockeye and coho above the existing dams are being conducted by the Bureau of Reclamation. Development of broodstocks and implementation of reintroduction programs in the Yakima basin would be performed by YKFP and would be designed to answer the following uncertainties. Bull trout reintroduction or population establishment has not been studied for feasibility or desirability, and is not likely to be a major emphasis of study within the current planning horizon due to the current hiatus in recovery planning for bull trout while USFWS performs a status review under ESA.

- Ahtanum, Cowiche, Manastash, Wilson/Naneum, Taneum Creeks, and others that currently have areas of suitable habitat which are unoccupied or have extremely low populations levels of anadromous fish, and should be the focus of a reintroduction efforts to establish of steelhead populations.
- Sockeye Reintroduction - Though there are not currently any viable sockeye populations in the Yakima Basin, it can be expected that successful reintroduction would use one or both of these remaining populations as donor stock.
- Since management of the reservoirs would preclude beach spawning, natural populations of sockeye would be dependent upon available spawning habitat in the tributaries. Available habitat and productivity in these environments should be studied prior to commitment to sockeye reintroduction.
- Existing and anticipated future levels of abundance and straying indicate that natural colonization of suitable habitats (after removal of obstructions to passage) would be very slow or non-existent in this Assessment Unit. Supplementation into newly re-opened habitats could accelerate/greatly improve the success rate of population reestablishment.
- Existing and anticipated future levels of abundance and straying indicate that natural colonization of suitable habitats (after removal of obstructions to passage) would be very slow or non-existent in this Assessment Unit. Supplementation into newly re-opened habitats could accelerate/greatly improve the success rate of population reestablishment.
- An additional 9 miles upstream of Keechelus Dam and Kachess Dam are currently inaccessible but could support spring chinook spawning and rearing, but whether these areas formerly supported viable populations of chinook is uncertain.
- Recent information (WDFW 2003, the fish distribution maps) indicates that resident rainbow trout do not occur in the drainages upstream of the three reservoirs. Other information suggests that rainbow trout do occur in the upper Cle Elum drainage to and above Waptus Lake (J. Cummins, personal communication), so the upper distribution of steelhead and rainbow trout in these high elevation areas remains uncertain. Productivity of the Little Naches population is currently low, possibly due to poor fitness of the population, naturally variable temperature and flow regimes (similar to Teanaway), and impacts from forestry management activities
- In the 2002 Recovery Plan, the USFWS also mentions three areas in which to establish populations: Taneum Creek, Teanaway River (Middle Fork), and Tieton River (North Fork). Given the unknown historic distributions, these may in fact represent reestablishment of extant bull trout populations. Existing and anticipated future levels of abundance and straying indicate that natural colonization of suitable habitats (after removal of obstructions to passage) would be very slow or non-existent. Supplementation

into newly re-opened habitats could accelerate/greatly improve the success rate of population reestablishment.

F) Genetics. YKFP has components that are actively conducting research on genetic issues. These studies will address the following uncertainties:

- Ahtanum Creek steelhead might be a fifth population in the subbasin These indications of genetic differentiation among populations should be verified using larger sample sizes,
- Introduced kokanee in Rimrock Lake and other populations derived from Whatcom Lake stocks may present genetic risk to sockeye if they are reintroduced.

G) Fisheries Research. There are several Key Uncertainties regarding fairly fundamental questions of fisheries biology. For the most part, studies to resolve these uncertainties have not been proposed or funded. YKFP could perform studies such as:

- Pacific Lamprey abundance, use and distribution in the Yakima Subbasin
- Reduced rates of anadromy in upper River steelhead
- Effect of reduced/increased temperatures on life histories.

WDFW and USFWS would be appropriate agencies to resolve:

- Bull trout could be at high risk of extinction since only a few redds and individuals have been observed in the recent past. The possibility exists that the few fish that inhabit the mainstem Yakima are adfluvial fish that have passed through the high head dams from upstream populations and are currently stranded below these impassable dams (WDFW 2003).
- Lake trout are thought to be reproducing in Cle Elum Lake. While the abundance of lake trout in this lake is thought to be low, information regarding their current status is limited. Introductions into Kachess and Keechelus lakes are thought to have been unsuccessful; however, there are no data to confirm the present status in either lake (WDFW 1998). The potential for competition and predation on bull trout should be investigated, and if warranted, actions to reduce the impact implemented.

NOAA Fisheries, the Bureau of Reclamation, Washington Department of Fish and Wildlife and Yakama Nation Fisheries could study the following Key Uncertainty and its relationship to steelhead productivity in the Upper Yakima:

- To pass through or around Roza Dam, kelts and smolts must find the fish bypass system or sound to approximately 12 to 14 feet below the surface of the Roza pool to an opening that is 100 feet wide and less than 6 inches tall (when the subordination target below Roza Dam is 400 cfs, upstream flows are 1,800 to 2,000 cfs, and the Roza Power Plant is operating). The effects on downstream passage of this large flow differential, as well as the geometry and attraction of bypass systems and the dam opening on emigrating steelhead smolts and kelts are largely unknown.

Finally, given the strong connection to the BiOp and Section 7 and Section 10 requirements of the Endangered Species Act, the Council and NOAA Fisheries should implement the recommendation from the APRE and resolve the identified Out of Subbasin Key Uncertainty.

- The APRE recommends examination of the cumulative effect of hatchery releases on specific populations to resolve this uncertainty and provide a better information base for decisions regarding the scale of hatchery releases, especially BPA funded hatcheries, and their effect on natural origin fish in the mainstem, at a Columbia Basin Scale.

5 Plan and Strategy Implementation and Effectiveness Monitoring

The YSPB recommends that the Subbasin Plan and strategies be monitored using the Washington Salmon Recovery Funding Board protocols *Field Sampling Protocols for Effectiveness Monitoring of Habitat Restoration and Acquisition Projects* (http://www.iac.wa.gov/Documents/SRFB/Monitoring/Field_Sampling_Protocols.pdf).

Each project sponsor should be required to collect data on project effectiveness as a condition of receiving project implementation funding. Collection and analysis of this data should be performed by a central entity funded by BPA/NPCC for purposes of monitoring, coordination and reporting and answering questions such as:

- Are we (in the basin across all funding programs) doing the things that the plan calls for?
- Are the actions achieving the predicted results?
- Have conditions changed enough (i.e. Black Rock or drought or ESA) that the plan requires possible modification?

Due to the uncertainty of the future role, composition, and funding status of the YSPB, the YSPB recommended that three options for such an entity be included in the Subbasin Plan. These three options are:

a) Continue on with the YSPB in some capacity as contractor and overseer of a monitoring and coordination effort

b) Support the Yakima Basin Salmon Recovery Board and very much increase that entity' ability to inventory and perform analysis of habitat monitoring data. (This is within their existing statutory authority and mission, but would require their approval and consent to track Subbasin Plan implementation and effectiveness)

c) Contract with a consultant or government agency to do this monitoring. This could be combined with an agency or entity that would maintain the physical models and benchmark tools discussed in 1) A) above.

5.1 Endangered Species Act Compliance

In the Yakima subbasin, many of the larger issues regarding impacts to listed species that are concerns at the scale of the Columbia Basin are not concerns at the scale of the Yakima subbasin. Listed species are neither targeted for harvest or the subject of production hatcheries. The hatchery activity that is most closely associated with a listed salmonid species is the Yakima Klickitat Fisheries Project's Kelt Reconditioning Program, which is a research program piloting an innovative strategy to conserve an extremely valuable component of Steelhead life history–iteroparity or repeat spawning. Actions, research activities, or changes in management that are contemplated in this plan are in consistent with information the Yakima Subbasin Fish and Wildlife Planning Board has received from NOAA/Fisheries Technical Recovery Team to protect existing healthy populations of steelhead, improve the health of populations that have low productivity or are at low abundance, and to seek ways to increase the level of anadromy in the resident rainbow trout populations of the upper Yakima basin. In addition, recommendations from the draft Recovery Plan for the Middle Columbia Recovery Unit were incorporated into the Yakima Subbasin Plan where such recommendations were consistent with the plan's scope and the *Technical Guide for Subbasin Planners*. Like the Yakima Subbasin Plan, the FCRPS BiOP, and other fishery conservation management plans within the Columbia Basin, recovery plans should be based on the principles of adaptive management for those factors for decline that are not completely understood or for which strategies for conservation are not well defined. The ubbasin plan strengthens this approach by recognizing causes for decline that can be reversed or reducedcauses for decline that are at this point not completely understood.

5.2 Clean Water Act Compliance

Recent actions in the Yakima subbasin to reduce fine sediment and toxicant loading to the Yakima River have been very successful. Partially because of the success of these actions, increased water clarity has resulted in a dramatic increase of non-native aquatic plant biomass in the lower Yakima River. Addressing this issue from a research and action standpoint including research already initiated and efforts to reduce nutrient loading through improved nutrient and irrigation management have received strong support from all sectors of the local community and implementation of strategies uncovered through research is the best approach for the Yakima Subbasin Plan. The subbasin Plan is not a water quality plan that lays out a suggested sequence of TMDL actions by the state, EPA or tribal authorities, but does recognize the value of the TMDL process and the funding from the Columbia Basin Fish and Wildlife Program could be effectively used to improve habitat conditions and compliance with the Clean Water Act.