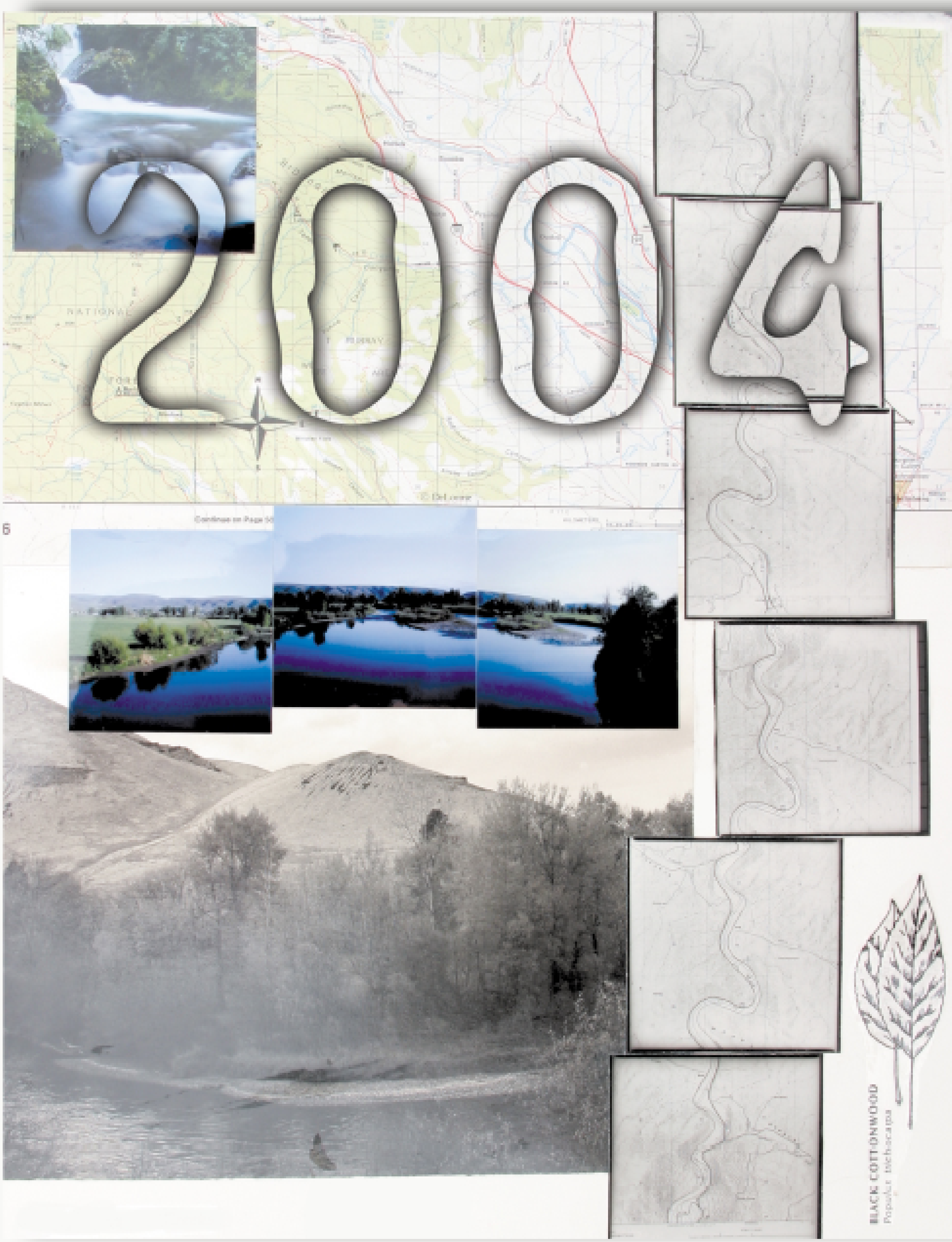
YAKIMA SUBBASIN PLAN



YAKIMA SUBBASIN
FISH AND WILDLIFE
PLANNING BOARD

SUPPLEMENT

NOVEMBER 26, 2004

Management Plan Supplement
Yakima Subbasin Plan
November 26, 2004

Prepared for the

Northwest Power and Conservation Council

Presented by the

Yakima Subbasin Fish and Wildlife Planning Board

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Disclaimer

The Northwest Power and Conservation Council intended the production of this subbasin plan to be a collaborative effort. Therefore, parties with information relevant to existing natural resources and conditions within the Yakima Subbasin were given an opportunity to participate in the production of this document. Consequently, the document was created using information collected from many sources. The parties participating in the development and submission of this Plan may not agree with all of the information submitted and with all of the key findings, strategies, and priorities. However, the parties have generally reached consensus that this plan, if implemented, will restore self-sustaining and harvestable populations of fish and wildlife while enhancing the existing customs, cultures, and economies within the Yakima Subbasin. Additionally, all parties reserve the right to further review and to provide additional information that they believe will improve this Plan. Both the Yakima Subbasin Fish and Wildlife Planning Board and the NPCC provided, and will continue to provide, opportunities for public input. The NPCC's subbasin planning process is iterative and designed within an adaptive management framework.

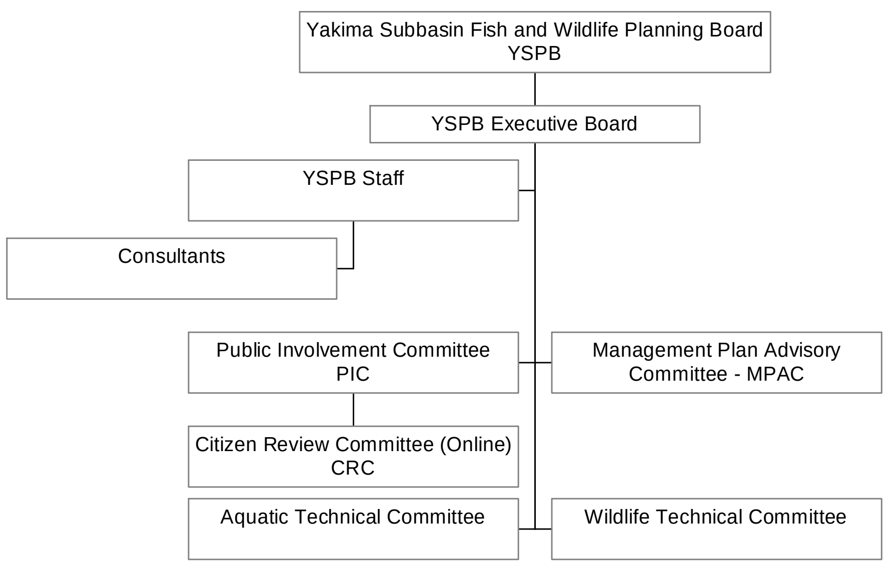
Management Plan Supplement	November 26, 2004
Final Plan	November 26, 2004
Final Draft	May 28, 2004
Public Review Draft	April 6, 2004

Acknowledgement

The Yakima Subbasin Fish and Wildlife Planning Board (YSPB) guided the planning process for the development of the 2004 *Yakima Subbasin Plan*. The Board is comprised of elected officials from local governments throughout the subbasin, and meets regularly to work with staff and the public. Throughout 2003 and 2004, the YSPB directed the development of the *Yakima Subbasin Plan* with the support of staff, consultants, and multiple committees. The general public assisted by reviewing the *Public Review Draft of the Yakima Subbasin* and providing significant input during the comment period, and at the onset and throughout this process.

The Board recognizes the considerable contributions made by citizens, interest groups, agencies, participating governments, and especially the staff and committees of the YSPB. The Yakima Subbasin staff and the committee members dedicated significant time, energy, and expertise to this planning effort. The Board acknowledges the dedication, cooperation, and commitment needed in order to develop a plan that reflects local priorities, meets the requirements outlined by federal statues, and is technically sound. The organizational structure of the YSPB is depicted below.

Organizational Structure of the Yakima Subbasin Fish and Wildlife Planning Board



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Purpose of Supplement

The Yakima Subbasin Fish and Wildlife Planning Board (YSPB) submitted the *Yakima Subbasin Plan* to the Northwest Power and Conservation Council (NPCC) on May 28, 2004. The contractually required purpose of the *Yakima Subbasin Plan* is to guide the selection of projects funded by the Bonneville Power Administration (BPA) for the protection, restoration, and enhancement of fish and wildlife affected by the federal hydropower system.

The Subbasin Plan consists of prioritized, non-regulatory strategies using BPA ratepayer funds that are currently spent annually for mitigation in the Columbia Basin. Strategies in the Plan are directed at protecting and restoring the functions of natural processes within the subbasin and supplementing depressed populations with hatchery production where habitat is under seeded, unseeded, and restored. These strategies include ways to restore and reconnect converted and fragmented habitat areas; protect existing critical habitat areas that are currently functioning at a high level; increase instream flows and return seasonal flows to a more natural flow regime; augment natural and artificial water storage; restore water temperatures in different parts of the basin to more natural levels; and restore sediment transport and sources of large woody debris The plan also identifies the need to fund personnel to improve management of natural resources, to monitor and research the relationships between management actions and the health of the resource, and other actions that protect or restore natural resource functions.

The Council performed both scientific and public review of the 59 Subbasin Plans that were submitted from across the entire Columbia Basin. Following this review process, the Council identified the need for further clarification of the *Yakima Subbasin Plan* (May 28, 2004 draft) before adoption into the Fish and Wildlife Program. The Council then granted another contract to the YSPB according to the specifications below.

Produce a short supplement to the existing management plan, not more than 20 pages in length that includes the following elements:

> **Subtask a. An explanation of the key factors limiting the biological potential of the selected focal species in the subbasin (referencing the existing assessment);**
>
> **Subtask b. A prioritization of which limiting factors should be addressed first (if possible, and again referencing the existing assessment);**
>
> **Subtask c. An identification of objectives and strategies, with an explanation demonstrating how particular strategies will address the limiting factors identified;**
>
> **Subtask d. Either a prioritization of strategies (related to the priority limiting factors) or a description of a "prioritization framework," that is, the criteria/considerations and procedures designed to develop and prioritize proposed actions in future project selection processes consistent with the assessment and related strategies; and**
>
> **Subtask e. A discussion of how artificial production is treated in the assessment; objectives and strategies, including a description of how artificial and natural production are related to the habitat objectives and strategies (the work described in this subtask may be subsumed within the work described subtask c.; it is identified here as a separate subtask for clarity only, not because it must be an independent element of the supplement).**

This document is intended to serve as the supplement described above. It will be delivered to the Council on November 26, 2004, after which the Council will undertake another public review and comment period before considering adoption of the Plan in early 2005.

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Management Plan Supplement

1 Vision for the Subbasin

The Yakima Subbasin Fish and Wildlife Planning Board (YSPB), consisting of elected representatives from the Yakama Nation and local governments in the Yakima River Basin, crafted the Vision and Guiding Principles as the local policy input to the *Yakima Subbasin Plan*. The Vision and the Guiding Principles acknowledges biological realities and existing legislation, and balances a wide spectrum of interests throughout this basin.

Vision for the Year 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 within 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.

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.

The Vision and eight principles, in conjunction with the scientific conceptual foundation, provide the framework to assess the key factors limiting the biological potential of populations. This framework provides the drivers for selection of the Plan's objectives and strategies for protection and restoration of fish and wildlife habitat and populations. The scientific conceptual foundation determines how information is interpreted, what problems are identified and, and as a consequence, it also determines the range of appropriate solutions to achieve desired management goals (Independent Scientific Group, 1996). (See the beginning of Chapter 2: Assessment for the conceptual foundation for the *Yakima Subbasin Plan*.)

In order to achieve the main objective of self-sustaining and harvestable populations, this supplement summarizes the limiting factors that need to be addressed first and then identifies the objectives and strategies that address these key limiting factors.

2 Key Limiting Factors in the Yakima Subbasin

The key factors that limit the biological potential of the focal species are grouped into three broad categories:

- Habitat limiting factors
- Population performance and response limiting factors
- Institutional efficiency limiting factors

Combined, the disruption of the Yakima Subbasin ecosystem functions and processes, out of subbasin impacts, and harvest of salmon have caused a significant decline of fish and wildlife abundance. Historically, 500,000-900,000 adult salmon and steelhead returned to the Yakima Subbasin annually. This total was comprised of spring, summer, and fall chinook, coho, sockeye, and steelhead. Summer chinook, sockeye, and native coho are extinct in the subbasin. Coho currently found in the subbasin are the result of reintroduction efforts by the Yakama Nation. The number of returning adults is greatly reduced from historic levels. Over the last ten years, returns of spring chinook have varied from a low of 650 to highs of 23,300. Fall chinook returns have ranged from about 1,000 to over 10,000, while coho runs have ranged from about 720 to 6,600 salmon. This significant decrease in abundance of these fish is mirrored on the terrestrial landscape. Though abundance data is limited for the terrestrial focal species, many important wildlife habitats have been significantly constricted and degraded thus limiting the population potential of wildlife that depend on these habitats. At the most general levels, the main habitat factors of focal species decline within this subbasin are the loss of key habitat quantity, quality, and diversity.

In addition to addressing habitat limiting factors, the inherent problems associated with low populations of fish also warrants attention. With all anadromous populations and bull trout dramatically reduced or extirpated, population performance and response is added as a limiting factor to describe and account for population parameters that limit or reduce a population's ability to respond to improvements in habitat quality, quantity, and diversity. Population response to increases in habitat are unlikely to meet the YSPB's mission and vision or NPCC goals in a desired time frame, and will not address goals for extirpated and reintroduced species (i.e., sockeye, summer chinook, and coho) without linked habitat restoration and population management strategies that include supplementation and reintroduction. (There are inherent problems associated with low wildlife populations but since the wildlife strategies are focused on focal habitats instead of populations, wildlife is not covered under the population performance limiting factor.)

Though continued research is needed on habitat and population performance, a significant body of scientific literature on the few basic things fish and wildlife need to sustain viable populations already exists. Of equal importance to achieving a desired abundance of indigenous fish and wildlife populations that are currently at critically low levels, is the successful implementation of key strategies. Once key strategies are developed, the ability to stop additional loss of habitat quantity, quality, and diversity and reverse species decline is in large measure a function of institutional effectiveness. Implementation of a number of important strategies requires greater coordination, integration, communication, and project development among those with the ability to improve the basin ecosystem. This is best done at the local level in cooperation with tribal, state, and federal governments. The YSPB Vision endorses an open and cooperative decision process to improve the basin ecosystem. A local dialogue to improve effectiveness has commenced within the salmon recovery planning process for this region. The YSPB is currently directing the development of the *Yakima Basin Regional Salmon Recovery Plan* as well as this Plan.

As mentioned before, the key limiting factors, biological objectives, and strategies are framed within the YSPB Vision, Guiding Principles, and scientific conceptual foundation. The main biological objective is to restore "…the Yakima River Basin sufficiently to support self-sustaining and harvestable populations…" by the year 2020. A list of well developed and vetted habitat restoration and protection and population management strategies will not meet the Plan's main objective unless implemented. Since most of the significant habitat limiting factors result from systemic dysfunction within this subbasin, isolated and localized actions alone will not be sufficient to solve fundamental habitat problems. A well-coordinated effort that pursues and achieves the longer term systemic solutions strategically throughout this basin, while also accomplishing near-term localized project actions is critical to achieve the YSPB's Vision. Systemic solutions should integrate habitat strategies with ongoing and new supplementation efforts to reach the Plan's goals. Much like the development of this Plan, the implementation of these integrated strategies will be most effective with local input.

2.1 Habitat Limiting Factors

2.1.1 Terrestrial Habitat Limiting Factors

Because of the large number of wildlife species and habitats in the subbasin, the subbasin wildlife assessment focuses on four focal habitats and their representative focal species. Focal habitats were selected based on the amount of decline that has occurred, the habitat's sensitivity to alteration or destruction, and on unique cultural and local concerns for this habitat in the subbasin. The purpose of the assessment was to discuss each habitat in a broad way, and from this discussion, emphasize the key ecological attributes of each habitat and identify the biggest problems occurring today that keep wildlife populations from reaching their full potential in our subbasin. These are the limiting factors for both the habitat and its representative focal species.

Three or more limiting factors were identified for each habitat. These are not the only limitations in the subbasin, but are the factors most limiting populations, and have the highest need of immediate funding to address restoration and protection. Some of the common limiting factors across habitats include altered fire regimes, inappropriate livestock grazing, and habitat fragmentation, conversion and loss. These issues are believed to have had the most detrimental effect on habitats and wildlife throughout the subbasin.

Within each habitat, the limiting factors were placed in order of priority for action and funding, although all limiting factors identified are considered to be of high importance (Table 1).

Table 1. Key limiting factors in prioritization order for each wildlife focal habitats

	FOCAL HABITAT			
	Montane Coniferous Wetlands	**Ponderosa Pine / Oregon White Oak**	**Shrub Steppe / Interior Grasslands**	**Interior Riparian Wetlands**
LIMITING FACTORS	High Road Density / Vehicle Use	Inappropriate Silviculture Practices	Habitat Fragmentation / Loss	Altered Surface and Ground Hydrology
	Inappropriate livestock grazing	Altered Fire Regime	Altered Fire Regimes	Habitat Fragmentation / Loss
	Anthropogenic Disturbance	Habitat Fragmentation / Loss	Presence of Invasive Alien Species	Loss of Healthy Cottonwood Forests
			Inappropriate Livestock Grazing	
			Loss of Microbiotic Crust Cover	

Montane Coniferous Wetlands

The historical extent of this focal habitat within the Yakima Subbasin is unknown. While it is possible that the amount of total acreage has not decreased, it is apparent that the quality of habitat has been significantly diminished. Even the wetlands that remain in high quality have become greatly fragmented. Documentation of wet meadows indicates decreasing size due to a variety of factors, such as an altered fire regime (resulting in conifer encroachment), roads, and livestock grazing. These factors have dewatered and converted wet meadows into dry openings. The effects of roads and road drainage, grazing and other disturbances have undoubtedly degraded and fragmented large areas. Disturbance has also diminished the quality of this habitat for breeding species which rely on this habitat for isolation and protection. Montane Coniferous Wetlands support a large number of unique, wetland-dependant plant and animal species and are important to the Native American community, as well as to the surrounding ecosystem.

Ponderosa Pine/Oregon White Oak

The Ponderosa Pine/Oregon White Oak focal habitat has experienced significant fragmentation and degradation in the Yakima Subbasin. Approximately 30% of ponderosa pine and oak stands have been converted to mixed conifer forests caused by encroachment as a result of fire suppression. Of the remaining pine/oak stands, 95% or more have been degraded from large-diameter, open stands to small diameter, denser stands. The biggest cause is land conversion due to heavy logging practices and fire suppression. Inappropriate logging has removed the majority of late seral, large diameter trees and snags. The loss of Old Growth Ponderosa Pine forests has been estimated as high as 99%. Fire suppression has additionally altered the natural fire regime, leading to denser forest stands composed of smaller diameter trees. This natural disturbance would normally keep tree recruitment low, selecting for larger trees and wider spacing. Oak woodlands have also been reduced in quantity and quality by land conversion and an altered fire regime.

Today, the absence of large trees and dead standing snags in pine and oak forests has limited the focal species that rely on these old-growth forest conditions. White-headed and Lewis' woodpeckers rely on the large diameter snags for nesting. Along with western gray squirrel, these birds rely on late seral pine and oak trees for forage.

Shrub Steppe/ Interior Grasslands

It has been estimated that only 40 percent remains of the roughly 10.4 million acres of shrub-steppe that once existed in Washington State prior to the 1850s. In the Yakima Subbasin, maps indicate there has been a ~25% reduction in shrub steppe habitat in the subbasin. Much of the remaining 75% is in the form of small, isolated parcels that are not useful to many shrub steppe dependent species. Much of what remains of intact shrub steppe and grassland is degraded. The most significant cause of loss of this habitat is the creation of the Yakima Basin Irrigation Projects, which led to large-scale conversion to agriculture. Other significant problems are invasive, alien plant species that compete with natives, and large scale wildfires. Sage grouse declines have largely resulted from habitat loss due to agriculture, degradation of habitat quality associated with livestock management (Dobler et al. 1996, Hays et al. 1998), and more recently, large-scale wildfires.

Interior Riparian

Since the early 1800s, 50-90% of Interior Riparian Wetlands habitat in Washington State has been lost or extensively modified. In the Yakima Subbasin, floodplain loss has been estimated at 77% in the Cle Elum Reach, 82% in the Union Gap Reach and 95% in the Upper Wapato Reach. The most profound alteration of riparian habitat occurred with the development of irrigated agriculture, similar to shrub steppe. This development has altered the river's historic hydrograph and, along with road and levee development and land conversion, has resulted in the river's separation from its historical floodplain. Large-scale habitat conversion and degradation has been the result of vegetation removal and increased weed presence. One of the most important features of Interior Riparian Wetlands is cottonwood forests, which has been reduced in extent and quality.

Riparian areas support a high diversity of fish and wildlife. They also have intrinsic values related to aesthetics, flood control, and water purification. Fish and wildlife are provided with breeding habitat, movement corridors and seasonal ranges. Beavers have historically played an important part in maintaining the hydrologic, forest and vegetation components. Land use practices, such as, roads, dams, and agriculture, remove important riparian vegetation while also affecting the structural and functional diversity of riparian habitat. The loss and fragmentation of large diameter cottonwood forests has significantly decreased habitat availability to birds and other wildlife dependant on this important tree species.

2.1.2 Aquatic Habitat Limiting Factors

Historically, the hydrologic cycle in the Yakima Subbasin was characterized by extensive and complex exchange of water between the surface, hyporheic (shallow groundwater made up of down-welling and up-welling surface water that are physically and biologically connected to the stream channel), and groundwater zones. Under pre-1850s conditions, vast alluvial floodplains were connected to complex webs of braids and distributary channels. These large hydrological buffers spread and diminished peak flows, promoting infiltration of cold water into the underlying gravels. Side channels and sloughs provided a large area of edge habitat and a variety of thermal and velocity regimes. For salmon and steelhead, these side channel complexes were critical to habitat carrying capacity, population productivity, and life history diversity by providing suitable habitat for all freshwater life stages. Estimates suggest this system supported 500,000 to 900,000 returning salmon and steelhead annually. Currently, less than 10 percent of historic numbers return annually while other species are extirpated from this system.

Altered flow regimes and floodplain conversion disrupt life histories of focal species with system-wide implications. The discontinuity between the current flow regime and life histories has system-wide implications. Another process with system-wide implications is large-scale alterations of the landscape, including the historic channel migration zone. Alterations to the natural flow regime and the landscape are not intrinsically negative. The implementation of key strategies to synchronize flow patterns and floodplain structure to better suit the life history of the focal species is possible without negatively impacting the existing customs, cultures, and economies within this basin. In order to do this, an understanding of the system and the key problems limiting biological potential is necessary.

As with wildlife, habitat quantity, quality, and diversity have been altered to negatively affect salmon, steelhead, and lamprey. For aquatic species, the limiting factors that should be addressed first are low flows; obstruction to fish migration and entrainment; diminished habitat quantity, quality, and diversity; high temperatures; altered sediment transport; and degraded channel stability.

The Ecosystem Diagnosis and Treatment (EDT) model provided the necessary framework to categorize, summarize, and prioritize which limiting factors should be addressed first. Level 3 EDT environmental parameters were selected to structure this supplement because the level 3 categories of limiting factors succinctly summarize the key habitat factors limiting the biological potential of selected focal species. At the level 3 scale, the EDT model defines sixteen environmental parameters that impede the biological performance and response potential of salmonids. Although EDT has not been run on sockeye, summer chinook, bull trout and lamprey, the level 3 attributes were used in conjunction with expert opinion to prioritize strategies as described below for these species.

Utilizing the results of the EDT model, local expert knowledge, the Assessment, and other tools and resources, the limiting factors were divided into three tiers based on severity of impact to focal species, number of focal species affected, and on geographic extent of the factors. Within each tier the limiting factors are also listed in general priority. Table 2 identifies effects and causes of the limitations. Tier 1 limiting factors have the most impact on aquatic species production potential within the subbasin and should be addressed first. Tier 2 and 3 limiting factors generally limit production to a lesser degree and are more site or species specific than tier 1. Addressing tier 2 and 3 factors without first addressing tier 1 factors is not expected to significantly increase population productivity or abundance of focal species. However, addressing tier 2 and 3 factors concurrently with tier 1 limiting factors will likely have cumulative benefits, especially for bull trout.

Limiting factors were used to group and prioritize subbasin strategies. Each strategy, with its associated objective and key finding (documented in chapter 2 subbasin assessment), was assigned to a limiting factor that the strategy, if implemented, would address (see strategy discussion below). Connecting the key findings, biological objectives and strategies to their limiting factors will guide strategic implementation of recovery actions. The majority of the strategies in the Management Plan address tier 1 limiting factors.

Flow is inextricably tied to three other tier 1 limiting factors: **key habitat quantity, habitat diversity, and temperature**. Regulation of outflows at irrigation storage reservoirs influences the magnitude of key habitat quantity (areal extent or range) of "wetted" channel, habitat diversity, and the range of water temperatures.

Historically, the annual flow regime in the subbasin was characterized by an unconstrained movement of flow through natural glacial lakes and down the basin where peak and flood flows created and nurtured a succession of vast alluvial floodplains laced with a complex web of connected and braided distributory channels. Pre 1850,this floodplain system was three times the current aerial extent, the annual peak and flood flows were sufficient to maintain large areas of the system in a condition of inundation or saturation (i.e., "wetted" or aquatic habitat). Within the floodplains occurred a dynamic exchange of water between the hyporheic zone and deeper groundwater zones. As a system, the floodplains functioned as large hydrological buffers that spread and diminished peak and flood flows, promoting infiltration of cold water and nutrients through the underlying gravels and side channels. The side channels and sloughs of the floodplains and at the intersections of tributaries with the mainstems provided extensive edge habitats and a variety of thermal and velocity regimes wherein diverse biological niches and activities occurred. Seasonal peak and flood flows carried and deposited coarse sediments to create islands, gravel bars, and pools and riffles; bank avulsions and failure deposited large woody debris and organic matter. The natural flow regime was seasonally sufficient to inundate the system side channels and saturate low elevation uplands to produce riparian corridors and cottonwood galleries that checked erosion and sedimentation, influenced water temperature, and tied the physical and biological properties of stream reaches together.

Obstructions within the basin continue to block access to miles of historic habitat. Reservoir dams have cut off available habitat in the upper watersheds and eliminated access to nursery lakes needed for sockeye production. More than 500 unscreened diversions continue to reduce production potential by entraining migrating fish, particularly in tributaries. Screening and passage projects are considered high priority actions to increase salmonid abundance and intrinsic population productivity.

Fine Sediment Loads have been increased throughout the basin due to forest, agricultural, and other development practices. Increased fine sediment loads have direct negative impacts on all focal species in the basin. The primary life stage that is impacted by this limiting factor is egg incubation. It should be noted that fine sediment loads are improving in some areas of the basin (e.g., the mainstem downstream of Granger). However, further improvements are needed throughout the subbasin.

The loss of floodplain area and functionality, anthropogenic confinement and degraded riparian zones have all synergistically reduced **channel stability**. In the mainstem Yakima and Naches rivers, this confinement has accelerated the rate of downcutting, which is followed downstream by sediment deposition. Abnormal scouring and deposition create hostile environments for incubation of salmonid eggs. Channel instabilities reduce population productivity for mainstem spawning species such as steelhead, coho, and spring, summer and fall chinook. Increasing channel stability is a key strategy for reintroduction or restoration of these species of anadromous salmonids.

Tier 2 and 3 Limiting Factors

Tier 2 and 3 limiting factors are lower in priority when compared to Tier 1 limiting factors. However, as stated previously benefits derived from addressing tier 1 limiting factors are unlikely to be as great if Tier 2 and 3 limiting factors are not addressed concurrently.

Predation has been identified as a limiting factor in "hot spots" in the basin and is generally a larger problem in the lower half of the basin where low flows and higher water temperatures favor predators. **Food** abundance and availability is a limiting factor in the upper watershed and is ultimately tied to a reduction in ocean derived nutrients caused by declining and extirpated anadromous populations. **Eutrophication** primarily impacts fall chinook in the lower mainstem where nutrient enrichment is causing a proliferation of aquatic macrophytes. **Harassment** in the upper watershed primarily affects spring chinook and bull trout. **Competition with other species** including hybridization with eastern brook trout is a significant problem for bull trout in parts of the Yakima Subbasin. For bull trout, harassment and competition with other species are Tier 1 priorities. **Pathogens**, **Oxygen [deficiency]**, and **Chemical [toxicity]** are limiting factors in the lower reaches of the Yakima River and tributary drains. These three limiting factors are addressed by strategies dealing with flow, sediment, and eutrophic conditions. **Competition with hatchery fish** has not been determined to be a major limiting factor within the subbasin. However, competition with hatchery-produced fish may be a limiting factor of significance in the Columbia River and its estuary.

Table 2. Explanation of tier 1 habitat limiting factors for aquatic focal species

Factor	Limitation	Effect of Limitation	Cause of limitation
Tier 1 Habitat Limiting Factors			
Flow	Basin-wide flows are altered to negatively affect salmonid life histories	The altered flow regime has the following results on all focal species: ▪ Reduced width of the wetted (inundated or saturated) area of the mainstem and tributary streams, thereby reducing the quantity and diversity of habitat ▪ Reduction of the extent and complexity of instream habitat/functions (e.g., bars, pools, riffles, LWD) created by fluvial processes ▪ Creation of low water passage barriers in the lower Yakima and lower tributaries ▪ Increased predation in low water reaches ▪ Creation of lethal temperature barriers in the lower and mid Yakima reaches ▪ Decreased temperatures affecting productivity in the upper Yakima below storage reservoirs ▪ Impediments to spawning and rearing of all focal species by flip-flop flow management in both the Yakima and Naches rivers	Capture and regulation of natural flow
Obstruction /entrainment (passage)	Basin-wide fish are blocked from passage, or entrained	Overall productivity is reduced basin-wide: ▪ Blocked passage for all focal species to productive spawning and rearing habitat ▪ Blocked passage constrains genetic diversity, especially in bull trout ▪ Entrainment increases mortality of outmigrating smolts of all focal species ▪ Storage dams inundated glacial lakes and extirpated sockeye	Reservoirs atop glacial lakes Diversion dams and canal headworks Frequent alterations of stream flow during spawning periods strands redds and fry Intermittent flow/access through culverts and gates

Factor	Limitation	Effect of Limitation	Cause of limitation
Key Habitat Quantity	Basin-wide, the wetted area of the stream channel is reduced, thereby also reducing the relative quantity of primary habitats utilized by focal species during life stages	Sufficient habitat area is required to support viable populations of focal species at all life stages. Primary habitats that have been reduced are: ▪ Side channels and sloughs, which provide a variety of thermal and velocity regimes ▪ Floodplains, which store runoff, release groundwater and attenuate flow ▪ Riparian corridor and wetlands ▪ Instream geomorphology (bars, pools, riffles, islands, LWD)	Capture and regulation of flows results in seasonal changes in the hydrograph that reduce the amount of flow and shrink key habitat Transportation corridors and other infrastructure that constricts and disconnect off-channel habitat
Habitat Diversity	With few exceptions basin-wide, the extent of habitat complexity within a stream reach has been reduced	Extent and complexity of habit affects the survival performance of focal species. While key habitat quantity represents area, habitat diversity addresses the number and proportions of important elements within that area, which allow fish to utilize the area fully and to survive and grow. Diversity of habitat reduced or eliminated: ▪ Side channels and slough and variety of thermal and velocity regimes; ▪ Floodway/flood/plain areas with side channels and springs and upwelling areas; ▪ Riparian/cottonwood zone and wetland areas ▪ Instream geomorphology (bars, pools, riffles, islands, LWD)	Capture and regulation of basin natural flow; Construction of transportation and other infrastructure that disconnect habitat elements or limit their function; Removal of LWD and diminished recruitment potential
Temperature	Basin-wide water temperatures are seasonally elevated or reduced to negatively affect the salmonids life histories	Seasonally elevated temperatures in the lower and mid Yakima (below Sunnyside Dam) are a negative influence on the spawning and migration cycles of all the focal species. In the Upper Yakima, seasonally lower temperatures below reservoirs have a similar effect on all focal species in that portion of the subbasin.	Conversion of natural lakes into reservoirs; Regulation/alteration of mainstem flow regimes under flip-flop flow management combined with irrigation diversions, and reduction in summer tributary flow by irrigation diversions; Reduction in canopy cover; Loss of hyporheic flow interactions; Decline of beaver dam storage and its influence on base flow

Factor	Limitation	Effect of Limitation	Cause of limitation
Sediment Load	Deposition of fines eliminates spawning areas, and reduces egg survival	Reduced number and distribution of redds and reduced egg survival. Fine sediment deposition is most extensive in the lower Yakima River, but also occurs in middle and lower reaches of tributaries.	Irrigation runoff to Yakima River and many tributaries; Drainage from unsurfaced roads into tributaries; Loss of riparian function; Alteration of physical conditions/processes (e.g., floodplain storage, coarse sediment transport and deposition) that provide channel stability
Channel Stability	Reduced channel stability is a causal factor in reduction of population productivity	Streambed, banks, and channel shape and location adversely impacted to reduced number of redds, reduced survival of eggs	Confinement of streams by roads, dikes and other infrastructure, causing increased flow velocity; Constrictions at stream crossings causing abrupt flow deceleration and bed load deposition; Loss of stabilizing stream bank vegetation
Tier 2 Limiting Factors • Predation • Food • Eutrophication • Harassment • Competition (with other species)		Tier 3 Limiting Factors • Pathogens • Oxygen • Chemicals • Competition (with hatchery fish)	

2.2 Population Performance and Response Limiting Factors

Alterations in the watersheds of the Columbia Basin and the mainstem of the Columbia River have reduced the quantity and quality of habitat capable of supporting natural populations of salmonids and lamprey. These changed environmental circumstances have reduced both the abundance and intrinsic population productivity of wild and natural populations. Other forms of development reduced the productivity of wild salmonid populations by altering habitat characteristics in which salmonids evolved and to which they were highly adapted. Rearing and migration habitats were changed in ways that imposed greater mortality rates on wild populations to the point that cumulative mortality rates ultimately exceeded intrinsic rates of reproduction and survival to adulthood. For example, development of extensive irrigation systems and the hydroelectric power system in the Columbia Basin imposed mortalities on juvenile salmonids that could not be compensated by average rates of fecundity, sex ratio, and egg-to-fry survival that evolved in wild populations during equilibrium conditions of high salmonid habitat quality.

The alterations in salmonid ecosystem quality caused changes in the population dynamics of wild populations. Declines in egg-to-smolt survival, survival during seaward migration, and cyclic patterns of ocean survival contributed to reduced average rates of population productivity. When it became clear that demographic trends in wild and naturally spawning populations were declining, many fishery managers recognized the value of artificial propagation as a necessary tool to increase average population survival rates to levels greater than the cumulative mortality rates operating on wild populations.

Even with improvements to habitat, low population numbers make it difficult to meet this subbasin's mission and vision, and will not address the goals for extirpated and reintroduced species without population management strategies that include supplementation and reintroduction. Natural populations that currently exist at reduced levels in the subbasin could take many years to recolonize the newly opened habitat, during which time they would continue to be at risk. Adult spawning escapement from natural production would also be limited in some years by the extensive development of the Columbia and Yakima Rivers. This reduction in natural spawning escapement would limit the population levels for those species in subsequent generations below their potential carrying capacity for the subbasin.

The successful recovery of extirpated stocks such as sockeye into newly opened habitats will require reintroduction of these species through artificial production rather than waiting on the evolutionary time scale for straying fish to reseed the subbasin. Reduced adult escapement and the loss of extirpated stocks has caused a great reduction in the marine derived nutrients returned to the upper watersheds of the Yakima Subbasin. This reduction in the nutrients continues to lower the productivity of the subbasin for all species. Finally, extirpations and limited escapements have reduced the potential for harvest of salmon and lamprey in the Yakima Subbasin. This is important, both culturally and economically, to the people who inhabit the watershed.

The strategies identified to address these limiting factors are expected to stabilize and increase populations, expedite colonization of newly opened and recovered habitat, provide a means to reintroduce extirpated species, and facilitate the ecological, cultural, and economic benefits associated with increased anadromous populations.

2.3 Institutional Efficiency Limiting Factors

Most of the projects within the last five years address passage, riparian, and water quality limiting factors. Many large-scale obstruction and entrainment problems have been addressed but many still remain that impede fish migration especially in the tributaries. Water quality, specifically in the lower river, has improved. As mentioned above, there is substantial supplementation work occurring in this basin.

Habitat restoration and preservation projects that can be localized to specific stretches of the system are more readily implemented. The Inventory gap analysis illustrates just this. Localized problems are easily identified and addressed whereas solving limiting factors rooted in systemic dysfunction is much more complicated and not so easily done. It is important to note here that systemic dysfunction for fish and wildlife might not be a dysfunction from other vantage points.

Disruptions to this subbasin's ecosystem processes have adversely impacted habitat, which in turn have affected population abundance, performance, and response. Ecosystem processes such as normative flow and floodplain formation have been altered through out the system. The gap analysis for the project Inventory shows little correlation between systemic limiting factors and projects to address them. Projects that are more likely to be implemented are localized problems like screening of a diversion. Projects that are more likely to be implemented are for localized problems like screening of a diversion. Projects that deal with obstructions and diversions are imperative but addressing two of the most important limiting factors, flow alteration and loss of floodplain extent and function need to be addressed. Employing integrated habitat and population management strategies through all scales of management and policy arenas is essential.

3 Objectives and Strategies

3.1 Biological Objectives

At the most general level, the biological objective for this Plan is to restore this watershed sufficiently to support self-sustaining and harvestable populations of indigenous fish and wildlife. The wildlife and fish strategy tables below contain more specific biological objectives based on individual Key Findings in the Assessment. Most of the wildlife and fish biological objectives relate to habitat-forming processes or environmental characteristics to improve population performance.

Both the aquatic (fish) and terrestrial (wildlife) technical committees could not come to consensus on abundance targets for each of the focal species. For wildlife, data availability on wildlife focal species is limited, while setting biological abundance targets for fish presented policy dilemmas. The YSPB in cooperation with NOAA Fisheries and USFWS will be setting steelhead and bull trout recovery numbers for the *Yakima Basin Regional Salmon Recovery Plan*. Those recovery bar numbers will differ from the self-sustaining or harvestable abundance targets.

3.2 Prioritized Management Strategies

3.2.1 Terrestrial Habitat Biological Objectives and Strategies

After identifying the key limiting factors for each focal habitat, wildlife subbasin planners compiled a list of objectives (goals) to address each limiting factor. Strategies were then created that would work to achieve success for each objective. The overall goal for the objectives and strategies is to provide habitat that will allow the wildlife focal species to reach their full potential. This will also result in a significant increase in population trends for many other wildlife species, especially those listed under the Endangered Species Act, and the quantity and quality of the unfragmented habitats on which they depend.

A strategy priority list was created for each focal habitat in table format. Strategies are divided into 2 or 3 priority groups. All strategies within a group are of equal priority. Within the table, each unique priority group was given unique shading. The highest priority group at the top of the tables was not shaded, the second priority group has a light shading, and the darkest shade was assigned to the lowest priority strategies. Each strategy was also given geographical areas where application is needed. Those geographical areas are placed into one of three tier rankings of implementation: immediate, implementable after key uncertainty (KU) addressed or with other contingency addressed, and long-term.

Immediate, refers to strategies that can be implemented immediately to address the associated biological objective once funding is available. These strategies may refer to projects that are currently in progress in the subbasin and require continued funding, or projects that do not have current funding, but are ready to be proposed and implemented.

Implementable after a key uncertainty or other contingency is addressed, refers to strategies of high priority, but may be contingent on other strategies, on resolution of key uncertainties, or other factors. These strategies can be implemented once the key uncertainty or contingency (ies) is addressed. Some key uncertainties may require very little time to address, such as identification of important areas, or prioritization of known areas.

Long-term refers to strategies that require significant institutional, legal, or policy changes, before implementation can occur. These strategies may be of equal importance to other strategies, but for some geographical areas, such as tribal or private land, may require several lengthy steps before implementation can occur.

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Table 3. Montane Coniferous Wetlands strategies (with their associated objectives and limiting factors) and their tier rankings. Focal species: western toad and greater sandhill crane.

Primary Strategies	Associated Objective (s)	Associated Limiting Factor	Tier Rankings[1] of Implementation Requirements by Geographical Areas		
			Immediate	Implementable with KU[2] addressed or with other contingency addressed	Long-term
Implement hydrologic restoration measures within the wetlands.	Restore surface hydrologic function on at least 50% of montane wetland habitats with emphasis placed on those occurring in unregulated tributaries by 2020.	High Road Density / Vehicle Use	Upper parts of (above ~2000 ft.): Satus, Toppenish, Ahtanum, Naches, Naneum, Teanaway, Manastash, Taneum, Cle Elum upper Yakima (Keechelus Reach) watersheds	Montane wetlands important to the hydrologic function of tributaries, not influenced by regulating reservoirs, have not all been formally identified and prioritized.	
With willing landowners use purchase, lease or easement methods to protect montane wetlands.	Implement measures to protect at least 50% of unprotected montane wetlands by 2020. Will also help address all other objectives.	Inappropriate livestock grazing	Upper parts of (above ~2000 ft.): Naches, Naneum, and Teanaway watersheds	Montane wetlands important to the hydrologic function of tributaries, not influenced by regulating reservoirs, have not all been formally identified and prioritized.	Upper parts of (above ~2000 ft.): Satus, Toppenish, Ahtanum
Work with agencies, permit holders and landowners to modify or purchase grazing leases in identified areas.	Implement measures to improve vegetative condition of at least 50% of known degraded montane wetlands by year 2020.	Inappropriate livestock grazing	Upper parts of (above ~2000 ft.): Naches, Naneum, Teanaway Manastash, Taneum, watersheds	Montane wetlands important to the hydrologic function of tributaries, not influenced by regulating reservoirs, have not all been formally identified and prioritized.	Upper parts of (above ~2000 ft.): Satus, Toppenish, Ahtanum
Work with the appropriate agencies and/or landowners to implement controlled burns and/or vegetation management measures in meadows suffering from tree encroachment.	Implement measures to improve vegetative condition of at least 50% of known degraded montane wetlands by year 2020.	Inappropriate livestock grazing	Upper parts of (above ~2000 ft.): Satus, Toppenish, Ahtanum and Naches, Naneum, Teanaway, Manastash, Taneum, and Cle Elum watersheds	Montane wetlands important to the hydrologic function of tributaries, not influenced by regulating reservoirs, have not all been formally identified and prioritized.	
Where feasible build and/or maintain fencing to allow for restoration for wetland sites.	Implement measures to improve vegetative condition of at least 50% of known degraded montane wetlands by year 2020.	Inappropriate livestock grazing	Upper parts of (above ~2000 ft.): Satus, Toppenish, Ahtanum and Naches, Naneum, Manastash, Taneum, and Teanaway, watersheds	Montane wetlands important to the hydrologic function of tributaries, not influenced by regulating reservoirs, have not all been formally identified and prioritized.	
Relocate or modify roads negatively impacting montane wetlands.	Restore surface hydrologic function on at least 50% of montane wetland habitats with emphasis placed on those occurring in unregulated tributaries by 2020.	High Road Density / Vehicle Use	Upper parts of (above ~2000 ft.): Satus, Toppenish, Ahtanum and Naches, Naneum, Teanaway, Manastash, Taneum, and Cle Elum upper Yakima (Keechelus Reach) watersheds	Montane wetlands important to the hydrologic function of tributaries, not influenced by regulating reservoirs, have not all been formally identified and prioritized.	
Work with agencies and forestland owners on new road planning to avoid impacting these habitats.	Restore surface hydrologic function on at least 50% of montane wetland habitats with emphasis placed on those occurring in unregulated tributaries by 2020.	High Road Density / Vehicle Use	Upper parts of (above ~2000 ft.): Satus, Toppenish, Ahtanum and Naches, Naneum, Teanaway, and Manastash watersheds	Montane wetlands important to the hydrologic function of tributaries, not influenced by regulating reservoirs, have not all been formally identified and prioritized.	

Eliminate vehicular access and campsites on key habitats.	Utilize current state seasonal disturbance restrictions (April 1 – August 10) in all potential breeding sites by 2010.	Anthropogenic Disturbance	Upper parts of (above ~2000 ft.): Naches, Naneum, Teanaway, Manastash, Taneum, and Cle Elum upper Yakima (Keechelus Reach) watersheds	Habitat conditions of montane wetlands important to focal species have not been formally identified	Upper parts of (above ~2000 ft.): Satus, Toppenish, Ahtanum
Initiate and continue cooperative road management planning and implementation with agencies and landowners.	Utilize current state seasonal disturbance restrictions (April 1 – August 10) in all potential breeding sites by 2010.	Anthropogenic Disturbance	Upper parts of (above ~2000 ft.): Satus, Toppenish, Ahtanum and Naches, Naneum, Teanaway, Manastash, Taneum, and Cle Elum upper Yakima (Keechelus Reach) watersheds	Habitat conditions of montane wetlands important to focal species have not been formally identified	
Increase signage, close and/or abandon roads leading to sensitive habitat areas, and increase enforcement.	Restore surface hydrologic function on at least 50% of montane wetland habitats with emphasis placed on those occurring in unregulated tributaries by 2020.	High Road Density / Vehicle Use	Upper parts of (above ~2000 ft.): Satus, Toppenish, Ahtanum and Naches, Naneum, Teanaway, Manastash, Taneum, and Cle Elum upper Yakima (Keechelus Reach) watersheds		

[1] Strategy Tier Definition: **Immediate** - High priority strategies, able to be implemented immediately and addresses significant limiting factors. Only factor required to implement to meet associated biological objective is funding,

Implementable with key uncertainty or with other contingency addressed - High priority strategies where implementation may be contingent on other primary strategies, on resolution of key uncertainties, or other factors. Can be implemented once contingency (ies) is addressed,

Long-term – High priority strategies that require significant institutional, legal, or policy changes.

[2] KU (Key Uncertainty): 1) Montane wetlands important to the hydrologic function of tributaries, not influenced by regulating reservoirs, have not been formally identified and prioritized,

2) Habitat conditions of montane wetlands important to focal species have not been formally identified, assessed or prioritized.

Table 4. Ponderosa Pine / Oregon White Oak strategies (with their associated objectives and limiting factors) and their tier rankings. Focal species: white-headed woodpecker, Lewis' woodpecker, and western gray squirrel.

Primary Strategies	Associated Objective (s)	Associated Limiting Factor	Tier Rankings[1] of Implementation Requirements by Geographical Areas (Assessment Units Used, figure XX)		
			Immediate	**Implementable with KU[2] addressed or with other contingency addressed**	**Long-term**
Protect key focal habitats through purchase, lease or easements on private land and through management agreements with agencies.	Restore large tree overstory with appropriate size, spacing and density of large overstory trees on focal habitat area by year 2105. Connect functional core habitats across Subbasin by 2105.	Inappropriate Silviculture Practices Habitat Fragmentation / Loss	Ahtanum, Naches, Tieton, Wenas, Mid-Elevation Yakima, Wilson System	See KU[2] #1.	
Provide economic and/or other incentives to promote focal habitat protection and restoration.	Restore large tree overstory with appropriate size, spacing and density of large overstory trees on focal habitat area by year 2105. Connect functional core habitats across Subbasin by 2105.	Inappropriate Silviculture Practices Habitat Fragmentation / Loss	Ahtanum, Toppenish, Naches, Tieton, Wenas, Mid-Elevation Yakima, Wilson System	See KU[2] #1.	

Establish standards for management and protection of this habitat type, particularly late seral stands or individual large diameter trees, (such as those within the Forest Practice Act).	Restore large tree overstory with appropriate size, spacing and density of large overstory trees on focal habitat area by year 2105. Connect functional core habitats across Subbasin by 2105.	Inappropriate Silviculture Practices Habitat Fragmentation / Loss	Entire Subbasin		
Improve planning processes on public lands (DNR, USFS) to assure management and protection of the habitat type.	Restore large tree overstory with appropriate size, spacing and density of large overstory trees on focal habitat area by year 2105. Connect functional core habitats across Subbasin by 2105.	Inappropriate Silviculture Practices Habitat Fragmentation / Loss	Entire Subbasin		
Conduct thinning and/or prescribed fires in identified areas.	Restore natural fire regime that promotes characteristic focal habitat by 2020.	Altered Fire Regime	Ahtanum, Toppenish, Naches, Tieton, Wenas, Mid-Elevation Yakima, Wilson System	See KU[2] #2.	
Where fire cannot be used, utilize alternative management techniques that include fuel reduction and selective thinning.	Thin appropriate stands to restore appropriate stand density and species composition.	Altered Fire Regime	Ahtanum, Toppenish, Naches, Tieton, Wenas, Mid-Elevation Yakima, Wilson System	See KU[2] #2.	
Assist jurisdictions and agencies to create and distribute information (seminars, printed, etc.) to all landowners about focal habitats.	Connect functional core habitats across Subbasin by 2105.	Habitat Fragmentation / Loss	Entire Subbasin		

[1] Strategy Tier Definition: **Immediate** - High priority strategies, able to be implemented immediately and addresses significant limiting factors. Only factor required to implement to meet associated biological objective is funding,

Implementable with key uncertainty or with other contingency addressed - High priority strategies where implementation may be contingent on other primary strategies, on resolution of key uncertainties, or other factors. Can be implemented once contingency (ies) is addressed,

Long-term – High priority strategies that require significant institutional, legal, or policy changes.

[2] KU (Key Uncertainty): 1) Information on condition of habitat type on private land is not available, assessments need to be done,

2) Specific areas within assessment units, where habitat restoration is feasible and has high probability of success must be identified and prioritized.

Table 5. Shrub Steppe / Interior Grasslands strategies (with their associated objectives and limiting factors) and their tier rankings. Focal species: greater sage-grouse, Brewer's sparrow, mule deer.

Primary Strategies	Associated Objective	Associated Limiting Factor	Tier Rankings[1] of Implementation Requirements by Geographical Areas (Management Units depicted in figure XX used.)		
			Immediate	Implementable with KU[2] addressed or with other contingency addressed	Long-term
Purchase easements or fee title from interested landowners to maintain and enhance landscape connectivity between large shrub steppe lands.	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. Protect areas with existing intact microbiotic crust.	Habitat Fragmentation / Loss Loss of Microbiotic Crust Cover	Rattlesnake Hills, Umtanum Ridge, Ahtanum Ridge, Toppenish Ridge and Colockum management units as identified in the Washington State Sage Grouse Recovery Plan (Stinson et al. 2004).		

Primary Strategies	Associated Objective	Associated Limiting Factor	Tier Rankings[1] of Implementation Requirements by Geographical Areas (Management Units depicted in figure XX used.)		
			Immediate	Implementable with KU[2] addressed or with other contingency addressed	Long-term
Provide economic and other incentives to interested landowners to maintain and enhance landscape connectivity between large shrub steppe lands.	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.	Habitat Fragmentation / Loss	Rattlesnake Hills, Umtanum Ridge, Ahtanum Ridge, Toppenish Ridge and Colockum management units.		
Implement restoration techniques including use of herbicide, mechanical methods, prescribed fire, planting of native herbaceous and woody species, strategic fencing, rest and rotation of grazing units, etc. to control existing and prevent future invasive species encroachment.	Strive for a 25% reduction of invasive species abundance by 2020. Protect areas with existing intact microbiotic crust.	Increased Presence of Invasive Alien Species	Rattlesnake Hills, Umtanum Ridge, Ahtanum Ridge, Colockum, and Toppenish Ridge management units.	Specific areas, within the management units, for control of invasive alien species need to be identified, mapped and then prioritized.	
Provide economic and other incentives to implement livestock management strategies such as those recommended by Connelly et al. (2000) to benefit focal species.	Improve habitat condition for focal species in shrub steppe habitat that have livestock grazing programs by 2020.	Inappropriate Livestock Grazing Loss of Microbiotic Crust Cover	Rattlesnake Hills, Umtanum Ridge, Ahtanum Ridge, Colockum, and Toppenish Ridge management units.		
Establish priority areas for fire suppression in cooperation with rural fire districts, state, tribal, and federal wildfire managers.	Restore natural fire regime return interval by reducing the annual rate of unplanned shrub steppe burning by at least 50% by 2020.	Altered Fire Regimes Loss of Microbiotic Crust Cover	Entire shrub steppe habitats within Yakima Subbasin.	Identify and map high-risk ignition sites.	
Create and maintain firebreaks in areas prone to frequent ignitions to prevent small fires from getting out of control.	Restore natural fire regime return interval by reducing the annual rate of unplanned shrub steppe burning by at least 50% by 2020.	Altered Fire Regimes Loss of Microbiotic Crust Cover	Rattlesnake Hills, Umtanum Ridge, Ahtanum Ridge, Colockum, and Toppenish Ridge management units.	Identify and map high-risk fire management zones.	
Increase ability of rural fire districts to respond quickly to shrub steppe fires in priority areas through provision of equipment, manpower, and other assistance.	Restore natural fire regime return interval by reducing the annual rate of unplanned shrub steppe burning by at least 50% by 2020.	Altered Fire Regimes Loss of Microbiotic Crust Cover			Rattlesnake Hills, Umtanum Ridge, Ahtanum Ridge, Colockum, and Toppenish Ridge management units.
Conduct/complete habitat suitability assessments for sage grouse.	Establish reintroduced populations into formerly occupied areas, where habitat has recovered from past land use, by 2020.	Habitat Fragmentation / Loss	Toppenish Ridge, Umtanum, Colockum, and Hanford management units.		
Translocate sage grouse individuals from healthy populations into areas where suitable habitat has been identified.	Establish reintroduced populations into formerly occupied areas, where habitat has recovered from past land use, by 2020.	Habitat Fragmentation / Loss	Toppenish Ridge, Umtanum, Hanford, and Colockum management units	Strategy could apply to other important shrub steppe species in subbasin. Other locations could apply.	

Primary Strategies	Associated Objective	Associated Limiting Factor	Tier Rankings[1] of Implementation Requirements by Geographical Areas (Management Units depicted in figure XX used.)		
			Immediate	Implementable with KU[2] addressed or with other contingency addressed	Long-term
Translocate sage grouse individuals into the YTC population from healthy populations.	Increase population and genetic diversity of the Yakima Training Center population by 2020.	Habitat Fragmentation / Loss	Toppenish Ridge, Umtanum, Hanford, and Colockum management units	Strategy could apply to other important shrub steppe species in subbasin. Other locations could apply.	
Periodically monitor population and genetic diversity of sage grouse population.	Increase population and genetic diversity of the Yakima Training Center population by 2020.	Habitat Fragmentation / Loss	Toppenish Ridge, Umtanum, Hanford, and Colockum management units	Strategy could apply to other important shrub steppe species in subbasin. Other locations could apply.	
Utilize strategic fencing on key locations.	Protect areas with existing intact microbiotic crust.	Loss of Microbiotic Crust Cover			Rattlesnake Hills, Umtanum Ridge, Ahtanum Ridge, Colockum, and Toppenish Ridge management units.
Protect from off-road vehicle use and new road construction.	Protect areas with existing intact microbiotic crust.	Loss of Microbiotic Crust Cover			Rattlesnake Hills, Umtanum Ridge, Ahtanum Ridge, Colockum, and Toppenish Ridge management units.

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Implementable with key uncertainty or with other contingency addressed - High priority strategies where implementation may be contingent on other primary strategies, on resolution of key uncertainties, or other factors. Can be implemented once contingency (ies) is addressed,

Long-term – High priority strategies that require significant institutional, legal, or policy changes.

[2] **KU (Key Uncertainties):** 1) Shrub steppe restoration methods require research and should be developed under an adaptive management approach,

2) Areas for control of invasive alien species need to be prioritized,

3) A prioritization plan for invasive species control has not been developed,

4) A combination of remote sensing, field, and GIS techniques, followed by a risk assessment for priority areas needs to be completed,

5) Recovery rates for microbiotic crust are largely unknown and require research,

6) High-risk ignition sites and priority areas for fire suppression need to be mapped.

Table 6. Interior Riparian Wetlands strategies (with their associated objectives and limiting factors) and their tier rankings. Focal species: mallard, yellow warbler, and American beaver.

Primary Strategies	Associated Objective (s)	Associated Limiting Factor	Tier Rankings[1] of Implementation Requirements by Geographical Areas		
			Immediate	Implementable with KU[2] addressed or with other contingency addressed	Long-term
Maintain and/or improve instream and groundwater hydrologic regime through various means including purchase of land and/or water rights from willing sellers in	Restore normative hydrologic conditions to all unregulated tributary habitats by 2020. Also addresses Objective #20.	Altered Surface and Ground Hydrology	Lower parts of (below ~2000 ft.): Toppenish, Satus, Ahtanum, Cowiche, Wilson/Naneum, Manastash, Teanaway, Swauk, Big	See KU[2] #1.	

unregulated tributaries.			Creek, Taneum watersheds		
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.	Restore non-wetland components of the floodplains, along with the wetlands, to meet the native habitat needs of the focal species. Also addresses Objectives #19, 20 and 21.	Habitat Conversion and Degradation	Lower parts of (below ~2000 ft.): Toppenish, Satus, Ahtanum, Naches, Cowiche, Wilson/Naneum, Manastash, Teanaway, Swauk, Big Creek, Taneum watersheds and Wapato, Union Gap, Naches mainstem reaches	See KU^2 #1.	
Implement protection and restoration activities in tributary areas important to focal species.	Restore lost or degraded habitats to ecologically functional conditions by 2020. Also addresses Objectives #19, 20 and 22.	Habitat Conversion and Degradation	Lower parts of (below ~2000 ft.): Toppenish, Satus, Ahtanum, Naches, Cowiche, Wilson/Naneum, Manastash, Teanaway, Swauk, Big Creek, Taneum watersheds	See KU^2 #1.	
Implement protection and restoration activities in the mainstem, such as those identified in Stanford and Snyder (2003).	Restore lost or degraded habitats to ecologically functional conditions by 2020. Also addresses Objectives #19, 20 and 22.	Habitat Conversion and Degradation	Wapato, Union Gap, Lower parts of (below ~2000 ft.): Naches, Easton / Cle Elum, Kittitas,	See KU^2 #1.	
Use fish-friendly water level control structures (grade control devices, spillways, etc.) to mimic normative conditions in restoration areas.	Provide adequate hydrology to reconnected habitats in the regulated tributary and mainstem floodplain areas by 2020. Also addresses Objective #19.	Altered Surface and Ground Hydrology	Lower parts of (below ~2000 ft.): All areas in lower Yakima Subbasin	See KU^2 #1.	
Conduct management and monitoring activities on protection and restoration areas to ensure that the ecological functions and habitat benefits are maintained.	Restore non-wetland components of the floodplains, along with the wetlands, to meet the native habitat needs of the focal species. Also addresses Objectives # 19, 2, and 21.	Habitat Conversion and Degradation	Lower parts of (below ~2000 ft.): Toppenish, Satus, Ahtanum, Naches, Cowiche, Wilson/Naneum, Manastash, Teanaway, Swauk, Big Creek, Taneum watersheds and Wapato, Union Gap, Naches mainstem reaches	See KU^2 #1.	
Where hydrology of riparian zones and wetlands is altered by irrigation conveyance or return, separate the irrigation system from the watercourse.	Restore normative hydrologic conditions to selected tributaries habitats by 2020. Also addresses Objectives #19 and 20.	Altered Surface and Ground Hydrology	Lower parts of (below ~2000 ft.): Toppenish, Satus, Cowiche, Wilson/Naneum, Manastash, Teanaway, Swauk, Big Creek, Taneum, Cherry watersheds	See KU^2 #1.	
Reconnect cottonwood restoration areas to the active floodplain.	Establish new cottonwood stands in active riparian zones in all potential cottonwood restoration locations in Yakima subbasin by 2020. Also addresses Objectives #19 and 20.	Loss of Healthy Cottonwood Forests	Lower parts of (below ~2000 ft.): Toppenish, Satus, Ahtanum, Naches, Cowiche, Wilson/Naneum, Manastash, Teanaway, Swauk, Big Creek, Taneum watersheds and Wapato, Union Gap, Naches mainstem reaches	See KU^2 #1.	

When necessary, plant cottonwoods and other native riparian vegetation in prioritized locations.	Establish new cottonwood stands in active riparian zones in all potential cottonwood restoration locations in Yakima subbasin by 2020. Also addresses Objectives #19 and 20.	Loss of Healthy Cottonwood Forests	Lower parts of (below ~2000 ft.): Toppenish, Satus, Ahtanum, Naches, Cowiche, Wilson/Naneum, Manastash, Teanaway, Swauk, Big Creek, Taneum watersheds and Wapato, Union Gap, Naches mainstem reaches	See KU[2] #1.	
Assist jurisdictions and agencies to create and distribute information (seminars, printed, etc.) to all landowners about focal habitats.	Work with landowners on protection and restoration techniques on focal habitats. Also addresses Objectives #19, 20, 21, 22 and 23.	Habitat Conversion and Degradation		See KU[2] #1.	Lower parts of (below ~2000 ft.): All Counties Subbasin wide

[1] **Strategy Tier Definition:** **Immediate** - High priority strategies, able to be implemented immediately and addresses significant limiting factors. Only factor required to implement to meet associated biological objective is funding,

Implementable with key uncertainty or with other contingency addressed - High priority strategies where implementation may be contingent on other primary strategies, on resolution of key uncertainties, or other factors. Can be implemented once contingency (ies) is addressed,

Long-term – High priority strategies that require significant institutional, legal, or policy changes.

[2] **KU (Key Uncertainties):** 1) As new information emerges, new priorities could be identified.

3.2.2 Aquatic Habitat, Artificial Production, and Institutional Efficiency Objectives and Strategies

At the subbasin scale, the areal extent and complexity of the lake and floodplain systems in conjunction with diverse tributary habitats determines salmon and steelhead productivity, genetic diversity, and sustainability. This provides suitable and closely connected habitats for all freshwater life stages. What remains of the subbasin's lake, tributary, and floodplain system today, although significantly reduced in extent and compromised in function, is essential to the survival of remaining salmonid and lamprey populations. An essential strategy for recovery of salmon within the subbasin is the protection, restoration, and reconnection of what remains of the floodplain system. A strategy is also needed to ensure that seasonal flows are sufficient to inundate, saturate, and renew the system so that it properly functions as salmonid habitat.

Implementing strategies that allow flows to be more normative will facilitate beneficial floodplain functions, will help moderate and move water temperatures to more normative conditions, and provide the best long term opportunities to meet self-sustaining fish production objectives in the Yakima Subbasin. Though obstruction and entrainment are not process related limiting factors, these impediments to migration warrant continued attention.

Most of the strategies in the tier 1 limiting factors go beyond isolated and localized limitations to biological potential. Key limiting factors that are imperative to address in order to meet the YSPB's vision and the NPCC's mitigation goals are systemic processes. To successfully implement strategies that address such factors, institutional efficiency strategies are included in the full Management Plan for both fish and wildlife. Population management strategies, more specifically artificial production strategies, can also be found in the Management Plan strategy tables for fish.

The Management Plan tables include key findings, cause/working hypothesis, biological objectives, and strategies and are organized by focal species, subbasin, and then Assessment Units (AUs)[1]. A specific strategy might be applicable to a number of focal species, the entire subbasin, and a number of AUs. For example, the strategy "purchase/lease of water rights to improve flow" appears seven times through out the 80 pages of tables. Redundancies in key findings, biological objectives, and strategies make the Management Plan tables both unwieldy and difficult to interpret without considerable time. Most of the strategies address habitat limiting factors and the rest address institutional efficiencies and population performance and response limiting factors.

The potpourri of key findings and strategies within the existing Management Plan breaks down into three board categories of limiting factors:

- Habitat limiting factors
- Population performance and response limiting factors
- Institutional limiting factors

[1] Appendix S contains an update Management Plan table with restoration key findings, objectives, and strategies. This updated table also includes columns with limiting factors, affected species, and assessment units, which were use to prioritize the strategies presented in this supplement. This table provides detailed information about key findings, objective, and strategies and the linkage with limiting factors.

The habitat limiting factors have been further organized and prioritized by tiers utilizing the EDT level 3 physical and biological parameters[2]. By reducing the redundancies and organizing the biological objectives and strategies by limiting factors, the 80 pages of tables are distilled to 10 pages.

The majority of the strategies address tier 1 limiting factors. The strategies that fall under tier 2 or 3 made it into the Management Plan because they are high priority strategies. Some of the strategies in tier 2 or 3 also show up in tier 1. A number of strategies that only show up in tier 2 or 3 are specific to bull trout and only cover geographic areas where this species occur[3].

There are no strategies related to pathogens and oxygen. Key uncertainties that address pathogens and oxygen are identified in the Plan. If these problems do exist, implementing flow strategies will alleviate them.

Most of the strategies listed below are followed by the Assessment Units (AUs) and the species that the strategies apply to. The strategies are implementable immediately or implementable after a key uncertainty and/or other contingency is addressed. Many of the strategies require long term commitment and stewardship to foster biologically and culturally desired population trends. Strategies in both columns are of equal importance.

One of the greatest utilities of the EDT model is site specificity. Appendix M: EDT Products and Interpretation and Appendix N: Multi-Population Ladder Diagram in consultation with local expert knowledge could guide site specific information about where to apply the following strategies.

Table 7. Institutional efficiency, vision, and values strategies

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 within 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.	
Implementable Strategies	Contingencies
Continue the Yakima Subbasin Fish and Wildlife Planning Board. Work with local jurisdictions to develop objectives for habitat protection and restoration. 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 Subbasin's fish and wildlife populations. Ongoing and long term involvement with the maintenance and development of water storage, distribution, and return systems, and the federal, state,	Implement the Subbasin Plan elements and strategies. (funding, commitment by local, tribal, state and federal agencies).

[2] The level 2 EDT physical and biological parameters helped inform the development of the Assessment. Level 2 attributes are a subset of level 3 parameters.

[3] If key factors limiting the biological potential of bull trout were prioritized, it would look something like this: 1) obstruction / entrainment, 2) flow, 3) competition with other species, 4) harassment, 5) food, and 6) key habitat, temperature, sediment load, and channel stability. This order differs from the prioritization when all focal species are considered.

tribal, local and private transportation systems to maintain and improve passage as those systems change over time.	
Geographic Locations – Subbasin wide.	

Table 8. Population performance and response strategies

Objectives – Restore existing populations to their former range, maintain genetic, and spatial diversity. Improve understanding of population dynamics and the negative and positive effects of artificial population management (production hatchery, supplementation programs, physical transfer of fish). Manage appropriate populations for harvest and all populations for sustainability over the long term. Reduce competitive effects with non-native and hatchery reared fish. Restore extirpated populations	
Implementable Strategies	Contingencies
Continue YKFP supplementation experiments and habitat restoration. Monitor population productivity, abundance, and life history and habitat restoration. Continue and enhance the YKFP programs for spring and fall chinook, coho reintroduction, kelt reconditioning. Study sockeye reintroduction, passage feasibility, and broodstock development. Determine the feasibility of summer chinook and Pacific lamprey reintroduction. Maintain bull trout harvest restrictions, discontinue brook trout planting in the Subbasin, and reduce brook trout populations.	Reintroduce steelhead and possibly bull trout to suitable but unoccupied habitats (ESA regulations, YKFP Master Plan, broodstock development). Reintroduce summer chinook and Pacific lamprey reintroduction (feasibility study, improve water temperature and quality in the lower river).
Geographic Locations – Subbasin wide. Consult the YKFP master plans.	

Table 9. Strategies to address flow

Objectives – Develop flow benchmarks that move the hydrograph to a more natural condition including: a decrease in the duration and magnitude of the low flow period, reestablish more natural spring peak flows, and reestablish more natural winter flows. Eliminate or reduce severity of flip/flop on ecological processes for both animal and vegetation life. Reduce flow fluctuations associated with irrigation diversions and operational spill. Manage flows to allow for cottonwood establishment. Study flow attributes that favor anadromy in O. mykiss specifically. Reduce clearcut impacts on local hydrographs.	
Implementable Strategies	Contingencies
Fund and implement projects that move the hydrograph toward an established benchmark (a more natural hydrograph including projects that will reduce net water use (e.g. conservation) and purchase and/or lease of water (for both mainstem and tributary habitats), increased storage natural and artificial. [AUs 1, 2, 3, 4, and 6] [Species - St, SpCh, FCh, Soc, PLa, and Co]	Eliminate or reduce flip/flop to restore a more normative hydrograph and riparian functions (legal). Manage mainstem flows differently in good/excellent water years to improve riparian conditions and other ecologic processes. (legal and design). [AUs – 4] [Species – St, Bt, SpCh, PLa, and Co] Manage mainstem flows differently in good/excellent

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 subbasin's fish and wildlife populations. [AUs 1, 2, 3, 4, and 6] [Species - St, SpCh, FCh, Soc, PLa, Co] 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. [AUs - All] [Species - All] Maximize natural retention of flow in basin by restoring hydrologic/hyporheic connectivity and increasing floodplain area where it has been artificially reduced. [AUs - All] [Species All] Restoration of flow in tributaries. [AUs – 3, 4, 5, 6, and 7] [Species - All] Model tradeoffs between improvements in distribution system efficiency, on-farm management, and management of diversions themselves to reduce flow fluctuations. [AUs - 1, 2, 3, and 4] [Species - St, SpCh, FCh, Soc, PLa, Co] Construct re-regulation reservoirs in irrigation distribution systems to reduce spill and rapid changes in diversion rates. [AUs - 1, 2, 3, and 4] [Species - St, SpCh, FCh, Soc, PLa, Co]	water years to improve riparian conditions and other ecologic processes. (legal and design). [AUs – 1, 2, 4, and 6] [Species - All] Eliminate or reduce irrigation operational spill to reduce downstream flow fluctuations (funding, design and legal). [AUs 1, 2, 3, and 4] [Species - All] Develop out of basin sources for new water For example Black Rock reservoir, KID pump exchange, etc. (funding, design, and legal). [AUs - All] [Species - All]
Geographic Locations – Subbasin wide. Consult Appendix M and N and local expertise.	

Table 10. Strategies to address obstructions and entrainment

Objectives – Replace/redesign diversion dams in tributaries to allow passage and prevent entrainment. Screen all unscreened diversion and upgrade inadequate screening. Reconnect side channel and springbrook habitats in the mainstem and tributary floodplains. Improve management of road/culvert systems to restore passage and prevent future failure. Provide passage at mainstem storage reservoirs to restore habitat diversity, productivity, species range, and extirpated species. Reduce/eliminate false attraction flows.	
Implementable Strategies	Contingencies
Continue long term restoration and removal of obstructions to spawning habitat, side channels and lower ends of tributaries. [AUs - All] [Sp – All] Replace/rebuild existing diversion dams based on prioritization from WDFW/YN/YTAHP. [AUs – 1, 2, 3, 4, and 6] [Species – All] Culvert and bridge replacement.(multiple sites). [AUs – All] [Species - All] Ongoing and long term involvement with the maintenance and development of water storage,	Resolution of specific problems (individual designs needed) Alteration of reservoir management or construction of channels to allow unimpeded migration of bull trout for spawning and rearing (design and feasibility studies). [AUs – 4, 5, 6, 7] [Species - Bt] Separation of the irrigation and natural channel network to improve normative flows. (design, funding, and legal). [AUs – 1, 2, 3, 4, and 6] [Species - All]

distribution, and return systems, and the Federal, State, Tribal, local and private transportation systems to maintain and improve passage as those systems change over time. [AUs - All] [Sp – All] Continue BOR reintroduction and passage feasibility study at mainstem storage dams. Work Cooperatively with BPA to design irrigation diversions that will remain stable and functioning over long time periods. Annual monitoring of migration conditions for bull trout in reservoirs. Improve efficiency of irrigation distribution systems and on farm use to reduce false attraction flows. [AUs - 1, 2, 3, and 4] [Sp - All]	
Geographic Locations – Subbasin wide on storage dams, irrigation diversion points, road and rail crossings. Consult maps in the Assessment, local expertise, and existing programs such as YTHAP.	

Table 11. Strategies to address key habitat quantity

Objectives – Improve, through protection and restoration, the wetted area of the stream channel and riparian zone function through restoration of normative flow regimes, reducing disturbance to the riparian zone, and direct revegetation to restore LWD and other habitat forming inputs to the system. Protect and restore off channel habitats wherever possible.	
Implementable Strategies	Contingencies
Restore and protect side channels and springbrooks. [AUs – 1, 2, 3, 4, and 6] [Species - All] 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 Subbasin's fish and wildlife populations. [AUs 1, 2, 3, 4, and 6] [Sp – All] 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. [AUs - All] [Species - All] Road closure and revegetation in forested areas to restore areas damaged by dispersed recreation. Public education to reduce dispersed recreational effects. [AUs – 3, 4, 5, 6, and 7] [Species - All] Installation of in-channel LWD. [AUs – All] [Species - All] Improve irrigation efficiencies, especially in tributaries, to restore instream flow. [AUs - 1, 2, 3, and 4] [Sp -	Reforestation of Black Cottonwood and Ponderosa Pine. (Local nursery stock development and revegetation plan). [AUs – 1, 2, 3, 4, and 6] [Species - All] Improvement of LWD passage at diversion dams (design, feasibility studies). [AUs – 1, 2, 3, 4, and 6] [Species - All] Separation of the irrigation and natural channel network to improve normative flows. (design, funding, and legal). [AUs – 1, 2, 3, 4, and 6] [Species - All] Manage mainstem flows differently in good/excellent water years to improve riparian conditions and other ecologic processes. (legal, and design). . [AUs – 1, 2, 4, and 6] [Species - All]

all] Restoration of flow in tributaries. [AUs – 3, 4, 5, 6, and 7] [Species - All	
Geographic Locations – Mainstem floodplains (especially Upper Yakima, Union Gap, Lower Naches, Wapato Reach/Toppenish Creek, and lower Yakima) for side channels and riparian restoration of cottonwood and ponderosa pine. Subbasin wide for flow improvements. Consult Appendix M and N and local expertise.	

Table 12. Strategies to address habitat diversity

Objectives – Improve habitat diversity by restoring flow to stream channels, side channels and springbrooks, restoring the surfacewater/groundwater interface. Reconnect side channels and restore floodplain, channel, and riparian zone processes to improve habitat diversity. Restore channel form and process by removal, relocation or alteration of levees, bridges, diversion dams. LWD installation to improve complexity.	
Implementable Strategies	Contingencies
Restore and protect side channels and springbrooks. [AUs – 1, 2, 3, 4, and 6] [Species - All] 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 Subbasin's fish and wildlife populations. [AUs 1, 2, 3, 4, and 6] [Species – All] 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. [AUs - All] [Species - All] Levee removal/reconfiguration. [AUs - 1, 2, 3, 4, and 6] [Species - All] Installation of in-channel LWD. [AUs - All] [Sp - All] Improve irrigation efficiencies, especially in tributaries, to restore flow. [AUs - 1, 2, 3, and 4] [Sp - all] Purchase/lease of water rights to improve flow. [AUs - 1, 2, 3, 4, and 6] [Species - All] Purchase of properties/easements to allow restoration or protect existing function. [AUs - All] [Species - All] Riparian restoration associated with all of the above strategies. [AUs - All] [Species - All] Restoration of flow in tributaries. [AUs – 3, 4, 5, 6, and 7] [Species - St, Bt, SpCh, Soc, PLa, Co]	Multiple reach/large scale floodplain restoration programs (design, funding, legal). [AUs – 1, 2, 3, 4, and 6] [Species - All] Restore hydrologic/hyporheic connectivity, manage drain systems to restore groundwater levels. (design, feasibility studies). [AUs – 1, 2, 3, 4, and 6] [Species - All] Separation of the irrigation and natural channel network to improve normative flows. (design, funding, and legal). [AUs – 1, 2, 3, 4, and 6] [Species - All] Manage mainstem flows differently in good/excellent water years to improve riparian conditions and other ecologic processes. (legal, and design). [AUs – 1, 2, 4, and 6] [Species - All] Water system consolidation to protect groundwater levels. (legal and design). [AUs – 1, 2, 3, 4, and 6] [Species - All]
Geographic Locations – Mainstem floodplains (especially the lower portions of Upper Yakima, Union Gap, Lower Naches, Wapato Reach/Toppenish Creek) for side channels. Upper Yakima, Union Gap and Selah reaches	

for large scale floodplain restoration, Wapato Reach/Toppenish Creek and Lower Yakima for groundwater/drain management and side channel restoration. Urbanizing areas for water system consolidation, especially in the upper Yakima. Purchase lease of water rights subbasin wide with the exception of the upper Yakima mainstem and the Selah and Union Gap reaches, which already have elevated flow levels for most of the year. Consult Appendix M and N and local expertise.

Table 13. Strategies to address temperature

Objectives – Restore the temperature regime and the extent of thermal refugia to normative ranges, timing, and extent.	
Implementable Strategies	Contingencies
Purchase/lease of water rights and other methods to improve flow. [AUs - 1, 2, 3, and 4] [Species - All] Riparian restoration associated with all of the below strategies. [AUs – All] [Species - All] Restore side channels and springbrooks. [AUs - All] [Species – All] 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 Subbasin's fish and wildlife populations. [AUs - All] [Species – All] Levee removal/reconfiguration. [AUs – 1, 2, 3, 4, and 6] [Species - St, Bt, SpCh, Soc, PLa, Co] Improve irrigation efficiencies, especially in tributaries, to restore flow. [AUs - 1, 2, 3, and 4] [Species - All] Installation of in-channel LWD. [AUs – All] [Species - All] Restoration of flow in tributaries. [AUs – 3, 4, 5, 6, and 7] [Species - All]	Multiple reach/large scale floodplain restoration programs (design, funding, legal). [AUs – 1, 2, 3, 4, and 6] [Species - All] Restore hydrologic/hyporheic connectivity, manage drain systems to restore groundwater levels. (design, feasibility studies). [AUs – 1, 2, 3, 4, and 6] [Species - All] Separation of the irrigation and natural channel network to improve normative flows. (Design, funding, and legal). [AUs – 1, 2, 3, 4, and 6] [Species - All] Manage mainstem flows differently in good/excellent water years to improve riparian conditions and other ecologic processes. (legal, and design). [AUs – 1, 2, 4, and 6] [Species - All] Water system consolidation to protect groundwater levels. (legal and design). [AUs – 1, 2, 3, 4, and 6] [Species - All]
Geographic Locations – Mainstem floodplains (especially the lower portions of Upper Yakima, Union Gap, Lower Naches, Wapato Reach/Toppenish Creek) for side channels. Upper Yakima, Union Gap and Selah reaches for large scale floodplain restoration, Wapato Reach/Toppenish Creek and Lower Yakima for groundwater/drain management and side channel restoration. Urbanizing areas for water system consolidation, especially in the upper Yakima. Purchase lease of water rights subbasin wide with the exception of the upper Yakima mainstem and the Selah and Union Gap reaches, which already have elevated flow levels for most of the year. Consult Appendix M and N and local expertise.	

Table 14. Strategies to address sediment load (fine)

Objectives – Continue to reduce fine sediment loading from artificial drain network. Reduce sediment input from altered natural stream systems. Support/cooperate with Ecology, Conservation Districts, and Irrigation Districts in improving water quality. Improve road management on public lands, in the forest setting, near streams, and on the Yakima Training Center (YTC). Reduce stormwater runoff. Reduce altered runoff from clear-cut and unvegetated areas, especially on south facing rain on snow zone.	
Implementable Strategies	Contingencies

Continue implementation of on-farm irrigation and soil erosion BMPs to reduce sediment input to the drain network, install sediment traps and grade controls, and manage spill. [AUs 1, 2, 3, 4] [Species - all] Improve road drainage structures, inslope and/or outslope roads to reduce energy and sediment routing. Close or relocate key roads. Provide tech assistance and coordination of efforts to private landowners in development of RMAPs. Continue to improve road maintenance on YTC. [AUs – 3, 4, 5, 6, and 7] [Species - St, Bt, SpCh, Soc, PLa, Co] Continue to implement TMDL for sediment loads.). [AUs – 1, 2, 3, and 4] [Species - St, Bt, SpCh, FCh, PLa, Co] Increase technical assistance support and monitoring of water quality. [AUs - 1, 2, 3, and 4] [Species - all] Revegetate clear-cuts. [AUs – 3, 4, 5, 6, and 7] [Species - St, Bt, SpCh, Soc, PLa, Co]	Reduce clear-cut type forest management. Support watershed health forest management (legal and technical knowledge). [AUs – 3, 4, 5, 6, and 7] [Species - St, Bt, SpCh, Soc, PLa, Co]
Geographic Locations – Consult Appendix M and N and local expertise.	

Table 15. Strategies to address channel stability

Objectives – Allow for natural sediment and bedload transport at all discharge levels. Reduce stream and river constriction where possible by reconfiguration of levees and other infrastructure. Restore riparian and floodplain functions. Improve road configuration during reconstruction activities for bridges and road alignment. Develop flow benchmarks and fund and implement projects that move the hydrograph toward the benchmark. Reduce clear-cut/unvegetated areas and artificially increased peak flow off from forest lands especially on south facing rain on snow zones. Eliminate the effects of splash dams.	
Implementable Strategies	Contingencies
Rebuild/refit dam to allow bed load movement during dominant discharge events. [AUs – All] [Species - All] Reduce constrictions with levee setback and reconfiguration, bridge replacement (relocate, widen, and/or extend) and road relocation. Locate new roads away from streams. [AUs – 1, 2, 3, 4, and 5] [Species - All] Improve sediment transport capacity by modifying, replacing, and/or removing irrigation dams. Consolidate diversions at upstream diversion points. [AUs – 1, 2, 3, 4 and 6] [Species - All] Restoration of riparian zone and reduce chronic bed instability through revegetation and restoration of natural flow regime. [AUs – All] [Species - All] Provide tech assistance and coordination of efforts to	Reduce clear-cut type forest management. Support watershed health forest management (legal and technical knowledge). [AUs – 3, 4, 5, 6, and 7] [Species - St, Bt, SpCh, Soc, PLa, Co] Mine Gravel from Reservoir and deposit in Tieton below dam (technical knowledge and funding). [AUs – 6] [Species - St, Bt, PLa, Co] Reconfigure Tieton and Naches (or allow) to naturally mine areas of available sediments (legal and design). [AUs – 6] [Species - St, Bt, PLa, Co] Develop out of basin sources for new water For example Black Rock reservoir, KID pump exchange, etc. (funding, design, and legal). [AUs – 1, 2, 3, 4, and 6] [Species - All]

private landowners in development of RMAPs. [AUs – 3, 4, 5, 6, and 7] [Species - All] Fund and implement projects that move the hydrograph toward an established benchmark (a more natural hydrograph including projects that will reduce net water use (e.g. conservation) and purchase and/or lease of water (for both mainstem and tributary habitats). [AUs 1, 2, 3, 4, and 6] [Sp – All] Revegetation replanting of clear-cut and roads. [AUs – 3, 4, 5, 6, and 7] [Species - St, Bt, SpCh, PLa, Co] To heal splash dam impacts encourage sediment deposition in areas scoured to bedrock through installation of key LWD. [AUs – 4] [Species - St, Bt, SpCh, PLa, Co] Restoration of flow in tributaries. [AUs – 3, 4, 5, 6, and 7] [Species - All]	
Geographic Locations – Subbasin wide. Consult Appendix M and N and local expertise..	

Table 16. Strategies to address predation

Objectives – Reduce elevated predation (fish and avian). Reduce predator populations. Reduce habitat suitability for predators. Reduce individual predation risk (increase salmonid populations).	
Implementable Strategies	Contingencies
Redesign bypass outfalls and/ or alter pool structure. [AUs – 1, 2, 3, and 4] [Species - All] Encourage population control actions within basin (e.g. expand bag limits on smallmouth bass). [AUs – 1, 2, 3, and 4] [Species - All] Continue population control actions on predator populations in Columbia mainstem reservoirs. Implement habitat restoration programs. [AUs – 1, 2, 3, and 4] [Species - All] Restore cover and off channel habitats. [AUs – 1, 2, 3, and 4] [Species - All] Fund and implement projects that move the hydrograph toward an established benchmark (a more natural hydrograph including projects that will reduce net water use (e.g. conservation) and purchase and/or lease of water (for both mainstem and tributary habitats). [AUs - 1, 2, 3, and 4] [Species - all] Implement population restoration programs. [AUs – 1, 2, 3, and 4] [Species - All]	Restore flow and move toward a more normative hydrograph (funding /expense, technical knowledge, and legal). [AUs – 1, 2, 3, and 4] [Species - All]

Geographic Locations – Subbasin wide. Consult the YKFP avian predation study. Consult Appendix M and N and local expertise.

Table 17. Strategies to address food

Objectives – Increase overall productivity in nutrient poor location in upper watersheds. Reintroduce sockeye, and other extirpated anadromous species, and establish self-sustaining populations by 2030.	
Implementable Strategies	Contingencies
Deliver needed nutrients (e.g. hatchery carcasses, analogs, etc.) to areas in the watershed that have seen a dramatic decrease in ocean-derived nutrients with the decline of anadromous fish. [AUs – 4, 5, 6, and 7] [Species - St, Bt, SpCh, Soc, PLa, Co] Continue BOR reintroduction and passage feasibility study at mainstem storage dams. Implement initial studies using closely related sockeye stocks. Continue coho population restoration efforts. [AUs – 4, 5, 6, and 7 [Species - St, Bt, SpCh, Soc, PLa, Co]	Re-introduce sockeye to the basin (technical knowledge). [AUs – 4, 5, 6, and 7] [Species - St, Bt, SpCh, Soc, PLa, Co] Explicitly manage sockeye and coho populations for escapement levels to benefit ecosystem (technical knowledge). [AUs – 4, 5, 6, and 7] [Species - St, Bt, SpCh, Soc, PLa, Co]
Geographic Locations – Subbasin wide. Consult Appendix M and N and local expertise.	

Table 18. Strategies to address eutrophication

Objectives – Reduce current levels of nutrient inputs entering the river system and move the hydrograph to a more natural condition.	
Implementable Strategies	Contingencies
Study problem to reduce nutrients and characterize ecology of invasive aquatic vegetation. [AUs - 1, 2, 3 and 4] [Species – St, SpCh, FCh, Soc, PLa] Increase nutrient source control and management. [AUs - 1, 2, 3, and 4] [Species – St, SpCh, FCh, Soc, PLa] Continue implementation of on-farm irrigation and soil erosion BMPs to reduce sediment input to the drain network, install sediment traps and grade controls, and manage spill. [AUs 1, 2, 3, 4] [Species - St, SpCh, FCh, Soc, Pl] Fund and implement projects that move the hydrograph toward an established benchmark (a more natural hydrograph including projects that will reduce net water use (e.g. conservation) and purchase and/or lease of water. [AUs - 1, 2, 3 and 4] [Species – St, SpCh, FCh, Soc, PLa]	Reduce irrigation spill (design , funding). [AUs - 1, 2, and 3] [Species – St, SpCh, FCh, Soc, PLa] Develop out of basin sources for new water For example Black Rock reservoir, KID pump exchange, etc. (funding /expense, technical knowledge, and legal). [AUs - 1, 2, and 3] [Species – St, SpCh, FCh, Soc, PLa]
Geographic Locations – Subbasin wide, especially lower river.	

Table 19. Strategies to address harassment

Objectives – Reduce potential for grazing operations to impact bull trout spawning habitat or redds.	
Implementable Strategies	Contingencies
Install fencing around key bull trout spawning habitat to reduce grazing impacts. [AUs – 3, 4, 5, 6, and 7] [Species – Bt] Construct off channel watering structures to reduce grazing impacts. [AUs – 3, 4, 5, 6, and 7] [Species – Bt] Construct crossing structures for cattle. [AUs – 3, 4, 5, 6, and 7] [Species – Bt]	
Geographic Locations – Consult bull trout experts with WDFW, USFWS, and USFS.	

Table 20. Strategies to address competition (with other species)

Objectives – Eliminate or reduce brook trout from presently occupied and suitable bull trout habitat.	
Implementable Strategies	Contingencies
Selective removal of Brook Trout by qualified agency/consultant personnel. [AUs – 3, 4, 5, 6, and 7] [Species – Bt]	Encourage brook trout harvest (extensive education of anglers). [AUs – 3, 4, 5, 6, and 7] [Species – Bt]
Geographic Locations – Consult bull trout experts with WDFW, USFWS, and USFS.	

Table 21. Strategies to address chemical

Objectives – Assess means of removal or immobilization of harmful chemicals entering/existing in water bodies. Reduce/eliminate toxic loading to river.	
Implementable Strategies	Contingencies
Sampling of site and modeling of toxic mobility. [AUs - 1, 2, 3 and 4] [Species – St, SpCh, FCh, Soc, PLa] Increase technical assistance, support and monitoring of water quality. [AUs - 1, 2, 3 and 4] [Species – St, SpCh, FCh, Soc, PLa] Continue to implement on-farm irrigation and soil erosion BMPs to reduce input of sediment and attached toxins. [AUs - 1, 2, 3 and 4] [Species – St, SpCh, FCh, Soc, PLa]	
Geographic Locations – Consult Appendix M and N and local expertise.	

Table 22. Strategies to address competition (with hatchery fish)

Objectives – Eliminate or reduce brook trout from presently occupied and suitable bull trout habitat.	
Implementable Strategies	Contingencies
Discontinue planting brook trout in the basin. [AUs –	

3, 4, 5, 6, and 7] [Species – Bt]	
Geographic Locations – Consult bull trout experts with WDFW, USFWS, and USFS.	

For more specific protection strategies for fish focal species, consult Table 6: Interior Riparian Wetlands strategies. The protection key findings are in the Management Plan under Section 3.1: Protection key findings for fish focal species and Section 3.2: Protection key findings for Assessment Units. Key uncertainties are through out the Assessment and summarized in the Management Plan chapter.

3.3 Population Management and Artificial Production

The vision of self-sustaining and harvestable populations has a greater chance of success if habitat restoration and preservation strategies are complemented with population management strategies. Some of the anticipated benefits of supplementation include increased natural production, increased marine derived nutrients, and increased harvest. Cultural and economic benefits in addition to legal requirements are met with supplementation. Supplementation has the greatest potential to increase natural production when the numbers of natural spawning fish is far below the carrying capacity. Thus, in some years supplementation may have large benefits to natural production, whereas in others the primary benefits will be in nutrient addition and harvest. Nutrient additions may increase the capacity of the environment to support a higher number of fish.

3.3.1 The Role of Supplementation and Its Relationship to Habitat Actions

In the 1990s researchers began to describe relationships between genetic ancestry, ecological fitness, and relative survival rates of hatchery and wild salmonid populations. A working hypothesis emerged from this body of research suggesting that conventional hatchery rearing protocols diminished the fitness and survival of fish reared in a hatchery and released into natural production areas. Further, researchers hypothesized that hatchery-reared fish that interbred with wild fish in natural production areas contributed to a reduced average population fitness in the wild population, thereby contributing to lower survival rates and reduced population productivity. This issue has substantially altered perceptions of preferred hatchery rearing regimes and prudent uses of hatchery-reared fish.

Based on these genetic considerations and demographic considerations described in Section 2.2, fishery co-managers and scientists in the Columbia Basin developed a concept of artificial propagation that was designed to provide wild and naturally-spawning populations with the very significant survival benefits of hatchery rearing, but in a manner that would also conserve or, at least, recognize the genetic benefits of maintaining the “wild” traits in those populations. The term, “supplementation,” was applied to this new concept to describe the intention of supplementing wild population abundance and productivity through the use of innovative artificial propagation methods.

Supplementation is envisioned as a means to enhance and sustain the abundance of wild and naturally-spawning populations at levels exceeding the cumulative mortality burden imposed on those populations by habitat degradation and by natural cycles in environmental conditions. A supplementation hatchery is properly operated as an adjunct to the natural production system in a watershed. By fully integrating the hatchery with a naturally-producing population, high survival rates for the component of the population in the hatchery can raise the average abundance of the total population (hatchery component + naturally-producing component) to a level that compensates for the high mortalities imposed by human development activities and fully seeds the natural environment.

The use of supplementation is appropriate where wild population abundance does not meet conservation and rebuilding goals prescribed by the fishery managers. These goals generally include maintaining the numerical abundance and spatial diversity of natural spawners as well as supporting some level of harvest. The goals of fishery managers in this watershed are in line with the YSPB's Vision for self-sustaining and harvestable populations. Supplementation also may be the preferred method for implementing mitigation actions required of human activities known to cause specific unavoidable mortalities to wild and natural salmonid populations, such as hydroelectric dam operations.

It is also important to recognize what supplementation cannot do. The use of supplementation will not, by itself, create a sustainable, naturally-producing population of salmonids in a watershed where the indigenous wild population has been diminished or extirpated. Habitat quality is the sole determinant of natural population productivity and sustainability. The use of supplementation can only "subsidize" population productivity to levels that compensate for poor habitat quality. If supplementation ceases without changing the underlying habitat conditions that required its use in the first place, the remaining, unsupplemented, naturally-producing population will be expected to resume the decline that was apparent before the application of supplementation. Only adequate habitat quality can ensure the long-term viability of unsupplemented, naturally-producing populations.

3.3.2 Population Management in the Yakima Subbasin and YKFP

The Yakima Klickitat Fisheries Project (YKFP) is a joint project of the Yakama Nation and the Washington State Department of Fish and Wildlife (WDFW) and is sponsored in large part by the Bonneville Power Administration (BPA) with oversight and guidance from the Northwest Power and Conservation Council (NPCC). It is by far the largest and most complex fisheries management project in the Yakima Subbasin in terms of data collection and management, physical facilities, habitat protection, restoration and management, and experimental design and research on the basin's fisheries resources. Using principles of adaptive management, the YKFP is attempting to evaluate all stocks historically present in the subbasin and apply a combination of habitat management and hatchery supplementation or reintroduction, to restore the Yakima Subbasin ecosystem with sustainable and harvestable populations of salmon, steelhead and other at-risk species.

The original impetus for the YKFP resulted from the landmark fishing disputes of the 1970s, the ensuing legal decisions in *United States versus Washington* and *United States versus Oregon*, and the region's realization that lost natural production needed to be mitigated in upriver areas where these losses primarily occurred. The YKFP was first identified in the NPCC's 1982 Fish and Wildlife Program (FWP) and supported in the *U.S. v Oregon* 1988 Columbia River Fish Management Plan (CRFMP). A draft Master Plan was presented to the NPCC in 1987 and the Preliminary Design Report was presented in 1990. In both circumstances, the NPCC instructed the Yakama Nation, WDFW and BPA to carry out planning functions that addressed uncertainties in regard to the adequacy of hatchery supplementation for meeting production objectives and limiting adverse ecological and genetic impacts. At the same time, the NPCC underscored the importance of using adaptive management principles to manage the direction of the Project. The 1994 FWP reiterated the importance of proceeding with the YKFP because of the added production and learning potential the project would provide. The YKFP is unique in having been designed to rigorously test the efficacy of hatchery supplementation. Given the current dire situation of many salmon and steelhead stocks, and the heavy reliance on artificial propagation as a recovery tool, YKFP monitoring results will have great region-wide significance.

The objectives of the YKFP are to: use Ecosystem Diagnosis and Treatment (EDT) and other modeling tools to facilitate planning for project activities, enhance existing stocks, re-introduce extirpated stocks, protect and restore habitat in the Yakima Subbasin, and operate using a scientifically rigorous process that will foster application of the knowledge gained about hatchery supplementation and habitat restoration throughout the Columbia River Basin. The following is a brief summary of current YKFP activities by species.

Spring Chinook

The Cle Elum Supplementation and Research Facility (CESRF) collected its first spring chinook brood stock in 1997, released its first fish in 1999, and adults have been returning since 2001. In these first few years of CESRF operation, the CESRF has demonstrably increased the number of spring chinook returning to lower Columbia mainstem and Yakima Basin fisheries and increased both the number and spatial distribution of fish returning to spawning grounds in the Upper Yakima Basin. Most demographic variables are similar between natural and hatchery origin fish. However, preliminary results indicate that hatchery origin fish are returning at smaller size-at-age and may be less successful at producing progeny in the wild than their wild/natural counterparts. Long-term fitness of the target population is being evaluated by a large-scale test of domestication. Semi-natural rearing and predator avoidance training have not resulted in significant increases in survival of hatchery fish, however growth manipulations in the hatchery may be reducing the number of precocious males produced by the CESRF and increasing the number of migrants. Ecological impacts to valued non-target taxa from supplementation activities have remained within containment objectives. Research estimates indicate that some fish and bird predators consume large numbers of juvenile salmonids in the Yakima Basin.

Fall Chinook

The YKFP is presently releasing over 2.0 million Upriver Bright fall chinook smolts annually from the Prosser and Marion Drain Hatcheries. These fish are a combination of in-basin production from brood stock collected in the vicinity of Prosser Dam plus out-of-basin Priest Rapids stock fish reared at Little White National Fish Hatchery and moved to Prosser Hatchery for final rearing and release. Marion Drain broodstock are collected from adult returns to a fishwheel in the drain. These fish contributed to the banner returns of fall chinook in recent years and enhanced fisheries from Alaska to Prosser Dam. The YKFP is exploring ways to improve the productivity of fish released from Prosser Hatchery and to improve in-basin natural production of fall chinook. For example, rearing conditions designed to accelerate smoltification of Yakima Basin fall chinook have resulted in smolt-to-smolt survival indices that exceeded those of conventionally reared fall chinook in four of the five years for which results are available.

Coho

The YKFP is presently releasing up to one million coho smolts annually from acclimation sites in the Naches and Upper Yakima Subbasins. These fish are also a combination of in-basin production from brood stock collected in the vicinity of Prosser Dam plus out-of-basin stock generally reared at Eagle Creek National Fish Hatchery and moved to the Yakima Subbasin for final rearing and release. Monitoring of these YKFP efforts to re-introduce a sustainable, naturally spawning coho population in the Yakima Basin have indicated that adult coho returns averaged nearly 3,000 fish from 1997-2003 (an order of magnitude greater than the prior 10-year average) including an estimated return of over 1,500 wild/natural coho to the Yakima River Basin in 2001. Coho re-introduction research has demonstrated that hatchery-reared coho can successfully reproduce in the wild. The project is working to further develop a locally adapted broodstock and to establish specific release sites and strategies that optimize natural reproduction and survival.

Steelhead

Because of their diverse life history (steelhead can migrate to sea after one to three years in freshwater) and since steelhead in the Yakima Subbasin are apparently uniquely adapted to one of several specific tributaries or reaches, it is difficult to design a steelhead supplementation program for the Yakima Subbasin using traditional fish culture practices. For these reasons, the YKFP has not incorporated steelhead into its supplementation activities. However, it is anticipated that the habitat actions undertaken pursuant to the YKFP are likely to benefit steelhead populations as well.

In lieu of a "traditional" supplementation program, the Yakama Nation, in cooperation with the Columbia River Inter-Tribal Fish Commission, is exploring the potential to increase the rate of repeat spawning in Yakima Subbasin steelhead populations. Repeat spawning (iteroparity) is a life history strategy expressed by some species from the family Salmonidae, including Columbia River steelhead. It is assumed that currently observed iteroparity rates for wild steelhead in the Columbia Basin are severely depressed due to development and operation of the hydropower system and various additional anthropogenic factors. Increasing the natural expression of historical repeat spawning rates using fish culturing means could be a viable technique to assist the recovery of depressed steelhead populations. Reconditioning is the process of culturing post-spawned fish (kelts) in a captive environment until they are able to reinitiate feeding, grow, and again develop mature gonads.

To test steelhead kelt reconditioning as a potential recovery tool, wild steelhead kelts from the Yakima River are captured during their emigration past Prosser Dam and through the Chandler canal and held in circular tanks at Prosser Hatchery. The reconditioning program has two components: a short- and a long-term program. In the short-term program, fish are held for one month or less, then trucked and released below Bonneville Dam to continue the reconditioning process on their own. In the long-term program, kelts are reconditioned for about 6-8 months at the Prosser Hatchery, and released in the vicinity of the hatchery in late November or early December concurrent with the return of the natural spawning run. This allows reconditioned kelts to naturally determine spawning location, timing, and mates. Survival to release has improved steadily since program inception for both long-term (from 20% to 62%) and short-term (from 70% to 90%) releases. Yakama Nation steelhead kelt reconditioning programs have increased the escapement of steelhead to spawning grounds in the Yakima Basin by 2.4% for the

2001-02 migration and by 7.3% for the 2002-03 migration. Preliminary results from PIT recapture data and radio telemetry efforts demonstrate success in locating spawning grounds and constructing redds. A study to investigate the relative reproductive success of artificially reconditioned kelt steelhead is now being implemented.

Sockeye

A study funded by the U.S. Bureau of Reclamation to evaluate the feasibility of developing passage for outmigrating smolts at Cle Elum Dam will begin in the spring of 2005. The study will initially use coho salmon smolts to evaluate the modifications in the reservoir outfall structure for juvenile passage. If successful, the research will repeat passage evaluations using sockeye salmon smolts. Evaluation of passage feasibility at other Yakima Subbasin storage reservoirs will also occur. Long-term planning for reintroduction of sockeye in the Yakima Subbasin is contingent upon the demonstrated success of juvenile sockeye salmon passage.

Lamprey

YKFP scientists are participating in regional fora to learn more about pacific lamprey restoration efforts occurring in other parts of the Columbia Basin. We expect these investigations to lead to formal efforts to study the feasibility of restoring pacific lamprey to the Yakima Subbasin in the short-term, and to planning, design, and implementation of restoration efforts in the long-term.

3.3.3 Management

With a project of this magnitude, there are many management decisions that are made that integrate and balance stewardship, utilization, legal, and scientific values. The Yakama Nation and WDFW are responsible for co-managing the fish resources in the Yakima Subbasin. Policy representatives of these two agencies interact regularly with technical representatives to forge sound management decisions that guide the YKFP. Management decisions are made within the frameworks of adaptive management and risk management.

As defined by the NPCC, adaptive management is the conscious decision in favor of *action* designed to increase understanding as opposed to *inaction* in the face of uncertainty. Adaptive management emphasizes experimental intervention into an ecosystem to provide insights into how it works and changes. The effects of management actions are monitored and evaluated, and programs, procedures, and facilities may all be modified in response to these findings. Using adaptive management, the scientific method is incorporated into Project planning and decision-making. It is particularly appropriate when attempting to mitigate for effects on otherwise declining natural resources in a complicated, large-scale ecosystem where complexities of the system are not fully understood.

YKFP management responsibilities generally include:
1. Project planning activities, including those pertaining to facility construction;
2. Operation and maintenance activities at all YKFP facilities;
3. Project research activities;
4. Design and development of a centralized database for Project use and dissemination to others;
5. Habitat restoration and acquisition projects intended to improve habitat conditions within the target ecosystem; and

6. Dissemination of accumulated project information through the Project Annual Review (PAR) conference, the project web site (ykfp.org), numerous technical reports and publications, and other means.

3.3.4 Research

NPCC and BPA are funding one of the most significant artificial production research and development efforts in the Columbia Basin. A primary responsibility of YKFP is to provide knowledge about hatchery supplementation to resource managers and scientists throughout the Columbia Basin, to determine if it may be used to mitigate effects of hydroelectric operations on anadromous fisheries. To achieve this objective, the YKFP created a Data and Information Center (Center) in 1999. The Center is located at Nelson Springs Office/Research facility. The Center's purpose is to gather, synthesize, catalogue, and disseminate data and information related to project research and production activties. The data and information management systems at the Center are designed to ensure compatibility with BPA and NPCC electronic data and reporting requirements.

The Project Annual Review (PAR) is also a vital part of the annual review and planning cycle that directs the research of the YKFP. The PAR is used to disseminate the results of research, monitoring and management activities that affect Yakima Subbasin stocks and guides direction of future activities. The YKFP produces regularly scheduled project reports which detail the ongoing monitoring and analysis of the various program elements, as well as peer-reviewed publications and documents that can only be produced by the large-scale experimental design that the YKFP personnel, facilities, and other resources provide.

One main purpose of the YKFP is to test the assumption that innovative, non-traditional artificial production methods can be used to increase natural production and harvest while maintaining the long-term genetic fitness of the fish population being supplemented and keeping adverse genetic and ecological interactions with non-target species or stocks within acceptable limits. By testing this hypothesis and developing new artificial production methods within specified biological parameters, significant benefits could be derived.

As most organizations with a research and development program can attest, research and development is expensive. Even though the cost associated with reaseach and development are high, so are the potential benefits. The applicability of research garnered from the YKFP has regional, national, and international significance. Although the YKFP is located in the Yakima Subbasin, neither its goals or findings are limited in scope or application to the Yakima Subbasin. As with most research results, they should be tailored to unique characteristics of a specific location.

3.3.5 Facilities and Equipment

Anadromous salmonids in the Yakima Subbasin can probably be monitored more thoroughly than in any other river in the Pacific Northwest. Full implementation of this project will increase monitoring power even further. All adults and jacks are enumerated via video monitoring at Prosser Dam in the lower Yakima, as well as Roza Dam on the middle Yakima, where the entire upper Yakima spring chinook run passes up a ladder and down a flume in an adult collection facility. Therefore, "intrusive" (hands-on) monitoring of all upper Yakima hatchery and wild adults can be conducted at Roza, allowing the detection of marked fish that cannot be identified on video. The right-bank ladder/denil/trap complex at Prosser Dam confers a similar capability. Stock-specific counts of migrating smolts can be made at the Chandler Juvenile Monitoring Facility (also located at Prosser Dam), which is equipped with two PIT-tag detectors.

The state-of-the-art hatchery at Cle Elum and associated acclimation sites have a capacity to produce 810,000 spring chinook smolts that can be segregated into experimental rearing treatments from the eyed egg stage through release. In 2000, the hatchery added an experimental spawning channel for evaluating differences in reproductive success and associated behaviors of hatchery and wild fish. The hatchery and Chandler juvenile monitoring facility also include facilities for juvenile behavior studies. The project has hatcheries at Prosser Dam and Marion Drain capable of rearing multiple treatment groups of fall chinook and coho. The Prosser Dam adult trap and the Prosser hatchery are currently being used to collect returning adults in an effort to develop locally adapted fall chinook and coho broodstocks.

3.3.6 Future Direction of YKFP

The current degree of fisheries management and population information, habitat condition, experimental design, and the existing management and technical framework provide a cost-effective and practical opportunity for the full development of stock-specific management plans for other species in the Yakima Subbasin. YKFP will continue the existing programs for spring chinook and the associated research.

YKFP will also concentrate on integrated reintroduction programs for species that have been extirpated in the Subbasin. YKFP would like to go beyond the feasibility stage with the coho reintroduction program, and attempt to rebuild coho stocks to sustainable and harvestable levels in areas of the watershed where the feasibility study determines these actions are appropriate. The same goes for the fall chinook program, which would concentrate more on reintroduction to their entire natural range within the Yakima Subbasin, which includes Wapato, Union Gap and Selah floodplains on the mainstem Yakima.

The Yakama Nation is in the process of developing a management plan for steelhead. The Yakama Nation will continue to work in cooperation with CRITFC to continue the steelhead kelt reconditioning program and evaluate short- and long-term reconditioning success, and proceed with reproductive success studies on reconditioned kelts.

Limited trials of experimental re-introduction of sockeye into the Yakima Subbasin occurred in the late 1980s and early 1990s with inconclusive results. Additional feasibility studies for the re-introduction of sockeye into the subbasin are under way. Currently the U.S. Bureau of Reclamation is funding an evaluation of reservoir outlet modifications on the potential for passage at Cle Elum Reservoir. Studies of the habitat capacity and potential life history paths (i.e. spawn timing, incubation, outmigration in relation to existing habitat conditions and flow/reservoir management) of sockeye are being designed. Given the historic abundance of this species, this program would represent a major opportunity for increasing productivity of the basin at the ecosystem scale while increasing the population diversity of sockeye in the Columbia Basin. Successful reintroduction of sockeye would also require improvements of water quality in the lower subbasin during the summer adult migration period.

Similarly, if conditions in the lower river for in-migration can be improved, summer chinook could be reintroduced to the Wapato, Union Gap, Selah and Lower Naches floodplains that were their former spawning and rearing habitats. Reintroduction of this chinook life history would fit within the purpose and capability of YKFP.

The distribution, ecology and life history of the existing stocks of Pacific lamprey in the Yakima Subbasin are not well understood at this time, and YKFP is cooperating with other agencies in the design of studies to characterize these aspects of lamprey ecology as well as potential use of restoration techniques for lamprey stocks.

A new model, the All H's Analyzer (AHA), is currently being developed to evaluate the roles of habitat, harvest, and hatcheries in the potential recovery of salmon. The Yakima Subbasin is one of the pilot watersheds that is being evaluated utilizing this model. It is anticipated that the model evaluation will be completed in time to be submitted as a comment on the Plan in January of 2005 and then inserted as a component of the final version of the *Yakima Subbasin Plan*.

3.4 Institutional Efficiency Strategies

As identified above, one of the most important limiting factors that needs to be addressed first is flow and the associated habitat quantity, quality, and diversity associated with a more normative flow regime. System wide habitat factors, like flow processes, that limit the biological potential of both fish and wildlife need to occur within a common analytical framework facilitated by institutional efficiencies. Addressing challenging limiting factors that are process driven and systemic requires institutional efficiencies. Through greater coordination, integration, and communication such efficiencies to successfully implement difficult and critical strategies will foster greater likelihood of achieving self-sustaining and harvestable abundance of fish and wildlife. Institutional strategies should also integrate ongoing and new supplementation strategies. Coordinating habitat restoration and protection actions in tandem or in sequence with supplementation strategies is advisable to achieve desired biological, cultural, and economic benefits.

In October 2005, the YSPB submitted their implementation recommendation of the *Yakima Basin Regional Salmon Recovery Plan* to the Governor's Salmon Recovery Office of Washington State. The YSPB is willing to facilitate improved institutional efficiency to implement both the subbasin and salmon recovery plans for this watershed. Constructive change in coordination, integration, and communication is necessary to implement many key strategies. More specifically, improved communication with resource managers, decision makers, stakeholders, and the public; coordinated management and sharing of environmental data and project information; effective communication and coordination with groups outside the Yakima Subbasin; and facilitation of large scale project development across agencies and interest groups.

The YSPB supports open and cooperative decision making that improves the river basin ecosystem. This regional Board also supports a non-regulatory approach to implement the *Yakima Subbasin Plan* with local input from fish and wildlife resource managers, conservation groups, stakeholders, and elected representatives in this subbasin.