5 Inventory

5.1 Introduction, Purpose, and Scope

The inventory of the Wenatchee subbasin summarizes the fish and wildlife protection, restoration, and artificial production projects and programs. The Inventory also identifies management programs and projects that target fish and wildlife or otherwise provide substantial benefit to fish and wildlife. The inventory includes programs and projects extant or the past five years and where possible, activities that are scheduled to be implemented within the very near future.

The inventory of programs and projects helps demonstrate current management directions, existing and imminent protections, and current strategies. However, the Council's "Technical Guide for Subbasin Planners" (2002), states that the inventory will have its greatest value when it is reviewed in conjunction with the limiting factors resulting from the assessment. This analysis helps to identify gaps between ongoing management efforts and those efforts needed to realize the vision of the subbasin plan.

A comparison of past actions with limiting factors should help assess the efficacy of current actions, indicate the areas of project gaps and guide management decisions. Please refer to the electronic reference library (NPCC ftp site) included in this subbasin plan for an inventory of programmatic activities within this subbasin.

5.2 Lower and Middle Wenatchee River Assessment Units

The follow provides an Inventory of past and ongoing actions occurring within the Wenatchee Subbasin. For each Assessment Unit, a conclusion is provided that identifies additional needs for future assessment and implementation.

The following activities have or are taking place in this Assessment Unit:

- Riparian re-vegetation projects were completed between 1999-2001 by the Chelan County Conservation District.
- Trout Unlimited provided habitat enhancement work on Blackbird Island during the years 1997-2001.
- A Channel Migration Zone study was completed in 2004 evaluating the entire mainstem Wenatchee within this Assessment Unit. Recommendations for enhancements have been advanced.
- In-stream flow assessments are on-going and expected to be completed in 2005. Recommendation for implementation are expected to be available in 2005.
- Total Daily Maximum Load (TMDL) investigations are on-going. A Pollution Cleanup Management Plan and recommendations are expected to be available for implementation in 2006.
- Evaluations for fish passage problems have been on-going but are yet to be completed and projects identified and prioritized.
- Dryden irrigation water diversion was recently fitted with new fish screens.

Conclusions: Very little habitat restoration or enhancement work has occurred in this Assessment Unit especially considering its importance to all focal species considered in this subbasin plan. Recent and on-going investigations (will) provide a solid basis for future management actions. Additional efforts are required to address Limiting Factors identified in the Key Findings of this document, which should include:

- Improvements in riparian and floodplain habitat conditions, particularly associated with increases in side channel and off-channel enhancement and restoration.
- Increasing habitat diversity and complexity in the main stem and side channels.
- Improvements in base flow conditions, and expected decreases in water temperature.
- Future investigations should examine the relationship between flow and water temperature. This work should also focus on the potential for late summer warm water temperatures to limit salmonid productivity and to create a thermal barrier to fish passage in the lower reaches of the Wenatchee River.

5.3 Middle Wenatchee Assessment Unit

The following activities have or are taking place in this assessment unit:

- A Channel Migration Zone study was completed in 2004 evaluating the entire mainstem Wenatchee within this Assessment Unit. Recommendations for enhancements have been advanced.
- In-stream flow assessments are on-going and expected to be completed in 2005. Recommendation for implementation are expected to be available in 2005.
- Total Daily Maximum Load (TMDL) investigations are on-going. A Pollution Cleanup Management Plan and recommendations are expected to be available for implementation in 2006.
- Evaluations for fish passage problems have been on-going but are yet to be completed and projects identified and prioritized.

Conclusions:

Very little habitat restoration or enhancement work has occurred in this Assessment Unit especially considering its importance to all focal species considered in this subbasin plan. Additional efforts are required to address Limiting Factors identified in the Key Findings of this document, which should include:

- Key and functional floodplains and riparian areas should be identified for providing high environmental benefit and benefit to focal fish species.
- Tumwater Dam has altered (prevented) channel substrate transport within this section of the Wenatchee River. There have been no evaluations addressing this condition.
- Northern Pike minnow may be at elevated numbers immediately below Tumwater Dam. Investigations should occur to determine the benefit of a predator control program in this area.
- Investigations should evaluate the potential or extent that riprap (and associated turbulence at high flow) along Highway 2 below Tumwater dam may be injuring juveniles that pass through this area.

5.4 Mission Creek Assessment Unit

The following activities have or are taking place in this Assessment Unit:

- Riparian re-vegetation project was completed by the Chelan County Conservation District (CCCD) in portions of several stream reaches from 1999-2001.
- The CCCD and City of Cashmere completed a storm water project (water quality improvement) in the years 2001-2002.
- The Mission Creek Pilot Project (habitat enhancement) was completed by the Chelan County Conservation District and Washington Dept. Fish and Wildlife in 1996-97.
- The Brender Creek habitat improvement project was completed by Trout Unlimited, WDFW and CCCD in between years 1997-2001.

- Evaluations for fish passage problems have been on-going but are yet to be completed and projects identified and prioritized.
- Total Daily Maximum Load (TMDL) investigations are on-going. A Pollution Cleanup Management Plan and recommendations are expected to be available for implementation in 2006.
- In-stream work has yet to be implemented in this area but is envisioned in the near term.
- Specific efforts to control or eliminate brook trout populations within the Assessment Unit should be initiated.

Conclusion:

Recent habitat restoration or enhancement work has occurred primarily in the lower portions of this Assessment Unit. Most of the focus has been in enhancements to water quality needs, although some habitat enhancement projects have been implemented in needed areas. Additional efforts are required to address Limiting Factors identified in the Key Findings of this document, which should include:

- Sediment budget investigations should be initiated in the Mission Assessment Unit to identify priority treatments and establish baseline monitoring.
- Channel constriction and lost habitat diversity issues have not been well addressed.
- Evaluations to improve flow conditions have not been well addressed.
- Control or eradication of un-wanted species should be considered.
- Additional water storage and conservation measures are needed in this Assessment Unit.
- Additional riparian re-vegetation projects that focus on providing shade for this narrow and shallow stream are applicable for this Assessment Unit.

5.5 Peshastin Creek Assessment Unit

The following activities have or are taking place in this Assessment Unit:

- The USFWS has recently completed investigations and implementation of in-channel erosion control structures in lower Peshastin Creek.
- The local irrigation district is evaluating options to improve fish passage past an irrigation diversion in lower Peshastin Creek. This evaluation is pending due to lack of funding.
- Evaluations for other fish passage problems have been on-going but are yet to be completed and projects identified and prioritized.
- Total Daily Maximum Load (TMDL) investigations are on-going. A Pollution Cleanup Management Plan and recommendations are expected to be available for implementation in 2006.

- Evaluations for fish passage problems (culverts) have been on-going but are yet to be completed and projects identified and prioritized.
- Specific efforts to control or eliminate brook trout populations within the Assessment Unit should be initiated.

Conclusions:

Peshastin Creek Assessment Unit has a relatively high degree of potential to enhance salmonid resources. Aside from USFS activities associated with vegetation management, very little enhancement and restoration work has been implemented in this Assessment Unit, particularly in the lower portions. Additional efforts are required to address Limiting Factors identified in the Key Findings of this document, which should include:

- Sediment budget investigations should be initiated in the Peshastin Assessment Unit to identify priority treatments and establish baseline monitoring.
- Stream sinuosity and habitat diversity and improving riparian conditions are key elements to future salmonid enhancement efforts.
- In-channel structural diversity projects in the lower reaches should be evaluated and implemented where practical and where they have a reasonably good chance to persist during high flow events.
- Additional investigations and projects should be implemented to re-conform the channel shape, decrease sedimentation and decrease with to depth rations in appropriate locations.
- Evaluations addressing improving low flow conditions are needed.
- Priority work to improve passage conditions throughout the assessment unit is warranted.

5.6 Chumstick Creek Assessment Unit

The following activities have or are taking place in this Assessment Unit:

- Riparian re-vegetation project was completed by the Chelan County Conservation District (CCCD) in portions of several stream reaches from 1999-2001. Approximately 12 additional culverts have been identified for future replacement.
- Eleven culverts were recently replaced (2002-2003) by the CCCD, BPA, USFWS, and Washington State Salmon Recovery funds (SRFB) , opening approximately four river miles to fish passage.
- Total Daily Maximum Load (TMDL) investigations are on-going. A Pollution Cleanup Management Plan and recommendations are expected to be available for implementation in 2006.

Conclusions:

Culvert replacement and habitat restoration projects are appropriate and needed for this Assessment Unit. Considerable work remains in both areas. Water quality has long been an issue in the lower portions of this watershed. Long term management plans are expected in the near

future. A holistic evaluation of cost/benefit and sequence of projects is particularly important to this watershed due to its heavily altered environmental condition and relatively low potential for fish production. Additional efforts are required to address Limiting Factors identified in the Key Findings of this document, which should include:

- Sediment budget investigations should be initiated in the Chumstick Assessment Unit to identify priority treatments and establish baseline monitoring.
- Additional fish passage improvements are an important consideration in this assessment unit.
- Off-channel habitat, channel complexity and habitat diversity issues have not been well addressed.
- Road density and location in many areas throughout the watersheds should be evaluated and priority projects implemented.
- Low flows and the potential for future water storage is an important consideration.
- Re-establishing riparian vegetation would provide high benefit to in-channel conditions, and other ecological benefits.

5.7 Icicle Creek Assessment Unit

The following activities have or are taking place in this Assessment Unit:

- Riparian re-vegetation project was completed by the Chelan County Conservation District (CCCD) in portions of several stream reaches from 1999-2001.
- Evaluations concerning recreation camp sites and local road conditions within riparian areas are on-going by the USFS.
- The USFWS is currently investigating low flow and water temperature issues associated with the operation of the Leavenworth Nation Fish Hatchery. Results from these studies are expected to available in 2005.
- The USFWS is continuing the Icicle Creek Restoration Project (habitat improvements; 1999-present).
- Trout Unlimited is currently sponsoring investigations into improvements in lower Icicle riparian and in-stream conditions. Results from these investigations are expected to be available in 2005.
- Evaluations for fish passage problems have been on-going but are yet to be completed and projects identified and prioritized.

Conclusions:

Relatively few habitat improvements projects have been implemented in the lower Icicle Creek. Projects that have been implemented and on-going investigations are very appropriate to resource needs. USFS activities in the upper watersheds have focused on recreation and

transportation system. Additional efforts are required to address Limiting Factors identified in the Key Findings of this document, which should include:

- Recreation sites and road locations in riparian areas should continue to be evaluated and relocated as determined appropriate.
- Implementation of projects in the lower Icicle to improve in-channel habitat diversity and riparian characteristics that are identified as high priority from on-going assessments should begin in a timely manner.
- Key and functional floodplains and riparian areas in the lower Icicle should be identified for providing high environmental benefit and benefit to focal fish species.
- Continued evaluations and implementation of recommendation to improve water conservation would benefit flows.
- Specific efforts to control or eliminate brook trout populations within the Assessment Unit should be initiated.

5.8 Nason Creek Assessment Unit

The following activities have or are taking place in this Assessment Unit:

- Total Daily Maximum Load (TMDL) investigations are on-going. A Pollution Cleanup Management Plan and recommendations are expected to be available for implementation in 2006.
- A Channel Migration Zone study was completed in 2004 evaluating the lowest portion of Nason Creek. Recommendations for enhancements have been advanced.
- Evaluations for fish passage problems have been on-going but are yet to be completed and projects identified and prioritized.

Conclusions:

Very little habitat improvement or restoration work has occurred in the lower Nason Creek drainage. Historically, Nason Creek provided significant habitat for anadromous salmonids and currently has a very large potential for increasing productivity of all focal species. Lower Nason Creek is in poor condition and future emphasis should be re-directed to these areas. Aside from USFS activities associated with vegetation and road management, very little enhancement and restoration work has been implemented in this Assessment Unit, particularly in the lower portions. Additional efforts are required to address Limiting Factors identified in the Key Findings of this document, which should include:

- Sediment budget investigations should be initiated in the Nason Assessment Unit to identify priority treatments and establish baseline monitoring.
- The Channel Migration Zone study recently completed should continue throughout all of the mainstem reaches that contain anadromy.

- Investigations should occur that will identify specific and appropriate instream structures that will increase channel stability, habitat diversity and complexity and provide to increase distribution of substrates suitable for salmonid spawning.
- Investigations should occur that will identify specific actions to re-connect the mainstem river to lost side channel and off-channel habitats. Enhancement of riparian vegetation should be a component of this work.
- Key and functional floodplains and riparian areas should be identified for providing high environmental benefit and benefit to focal fish species.
- Specific efforts to control or eliminate brook trout populations within the Assessment Unit should be initiated.

5.9 Little Wenatchee River Assessment Unit

The following activities have or are taking place in this Assessment Unit:

- Evaluations for fish passage problems have been on-going but are yet to be completed and projects identified and prioritized.
- Evaluations concerning recreation camp sites and local road conditions within riparian areas are on-going by the USFS.

Conclusions:

Most of the Little Wenatchee River Assessment Unit is managed by the USFS. Relatively few habitat improvement activities have occurred on lands not management by the USFS. Activities associated with floodplain and in-channel characteristics have and should continue to focus primarily on protection of healthy natural resources and to benefit sustained productivity of salmonids. Additional efforts are required to address Limiting Factors identified in the Key Findings of this document, which should include:

- Specific efforts to control or eliminate brook trout populations within the Assessment Unit should be initiated.
- Identify and implement as appropriate all areas where road relocation will benefit riparian and in-channel conditions.
- Identify and initiate restoration of lost wetland complexes.
- Key and functional floodplains and riparian areas should be identified for providing high environmental benefit and benefit to focal fish species.
- Maintain existing roads in a manner that will to minimize interaction with basin hydrology.

5.10 White River Assessment Unit

The following activities have or are taking place in this Assessment Unit:

- The White River Floodplain Restoration Project (2000-2004), sponsored by the Eastern Washington Regional Fisheries Enhancement Group, SRFB and the Chelan Douglas

Land Trust will continue to protect approximately 70 acres of high quality floodplain habitat.

- Evaluations for fish passage problems have been on-going but are yet to be completed and projects identified and prioritized.
- Specific efforts to control or eliminate brook trout populations within the Assessment Unit should be initiated.
- Evaluations concerning recreation camp sites and local road conditions within riparian areas are on-going by the USFS.
- Key and functional floodplains and riparian areas should be identified for providing high environmental benefit and benefit to focal fish species.

Conclusions:

Most of the White River Assessment Unit is managed by the USFS. Relatively few habitat improvement activities have occurred on lands not in management by the USFS. Activities associated with floodplain and in-channel characteristics have and should continue to focus primarily on protection of healthy natural resources and to benefit sustained productivity of salmonids. Additional efforts are required to address Limiting Factors identified in the Key Findings of this document, which should include:

- Riparian areas in the lower river have been altered and habitat improvement projects would benefit floodplain function and focal species productivity.
- Evaluate the benefits/cost of replacing a bridge across the lower mainstem.
- Maintain existing roads in a manner that will to minimize interaction with basin hydrology.

5.11 Chiwawa River Assessment Unit

The following activities have or are taking place in this Assessment Unit:

- Evaluations for fish passage problems have been on-going but are yet to be completed and projects identified and prioritized.
- Specific efforts to control or eliminate brook trout populations within the Assessment Unit should be initiated.
- Evaluations concerning recreation camp sites and local road conditions within riparian areas are on-going by the USFS.

Conclusions:

Most of the Chiwawa River Assessment Unit is managed by the USFS. Relatively few habitat improvement activities have occurred on lands not in management by the USFS. Activities associated with floodplain and in-channel characteristics have and should continue to focus primarily on protection of healthy natural resources and to benefit sustained productivity of

salmonids. Additional efforts are required to address Limiting Factors identified in the Key Findings of this document, which should include:

- Identify key functioning floodplains and attributes to be considered to for protection of key attributes.
- Evaluations of interactions between use of well water and surface water should proceed.
- Maintain existing roads in a manner that will to minimize interaction with basin hydrology.

6 Synthesis and Interpretation

6.1 Introduction

The synthesis and interpretation brings findings from the subbasin plan together into a holistic view of the Wenatchee subbasin's biological and environmental resources. This information in turn provides a foundation for the development of scientific hypotheses concerning ecological behavior, and most importantly, ways that human intervention might prove beneficial.

This section contains a summary of environmental/population relationships for species and a discussion of the key findings. Contained within the key findings is a summary of the key limiting factors for focal species.

The section also includes hypothesis statements that suggest how focal species are expected to respond to improved environmental conditions.

The conclusion describes restoration priorities by a) species distribution, b) across landscapes, and c) in habitat activities.

6.2 Key Findings and Hypothesis Statements

Key findings are concise statements about environmental attributes found to have a relatively high importance to the focal species existence within each assessment unit. These statements describe habitat conditions that are functioning properly as well as those that have been altered or degraded to the point that they limit the ability for the focal species to thrive or exist. These degraded attributes are called limiting factors. For the purposes of this document, a limiting factor is defined as "*a habitat element that limits the productivity and/or life history diversity of a focal species.*"

Concluding the key findings for each assessment unit are hypothesis statements. These statements assume that over time, stakeholders within the subbasin will achieve the stated goals and desired future conditions. Given that, the hypothesis statements describe the *expected change (from the current condition) in productivity (from the current condition) and/or life history diversity of a specific life stage for the focal species population inhabiting the assessment unit.* Table 24 lists definitions of elements within the hypothesis statements.

Table 24. Definitions for hypothesis statements

Key Life Stages: (Adapted from the EDT framework. For simplicity, life stages are grouped into major categories.)	
Egg Incubation	Eggs in the gravel through emergence.
Fry Colonization	Emergence through the first 6-weeks as rearing territory is established.
Summer Rearing	Period throughout the late spring through October.
Winter Rearing	Period throughout winter, general dormancy of the focal species.
Juvenile Rearing	Includes both summer and winter rearing.
Pre-Spawning Adult	Adults migrating and holding until spawning.
Adult	Includes all time periods of adult life stages.
Degree of Effect (The expected change in productivity and/or life history diversity of a specific life stage for the focal species population using the Assessment Unit.)	
Low	Some improvement in productivity and/or life history diversity for this specific life stage is reasonable to assume but would be difficult to measure.
Moderate	Productivity and/or life history diversity for this specific life stage is expected to improve and changes should be measurable.
High	Productivity and/or life history diversity of a specific life stage has significantly improved and is clearly measurable.
Level of Certainty (The confidence that improvements in habitat condition will result in increases of productivity and/or life history diversity for the specific life stage of the focal species.)	
Low	The population/habitat relationship is not well understood, but it is reasonable to conclude some beneficial response will occur.
Moderate	The population/habitat relationship is reasonably well understood, and it is likely that a beneficial response will occur.
High	The population/habitat relationship is well documented through existing literature or direct observation and a beneficial response is expected.

6.3 Summary of Key Findings

6.3.1 Terrestrial/Wildlife

Key Findings: Terrestrial

The terrestrial assessment viewed the subbasin from a perspective of key and major vegetative communities. Three community types were chosen as focal habitat for this evaluation, ponderosa pine, shrubsteppe and riparian ecosystems. Within each of these focal habitats, representative species that are directly associated with these vegetative communities are identified and will be monitored.

Factors Affecting Ponderosa Pine Habitat

- Repeated timber harvest removed large diameter ponderosa pine and snags and left the understory. This has resulted in accelerated successional advancement and increased the Douglas fir component.
- Urban and residential development has contributed to loss and degradation of properly functioning ecosystems.
- Fire suppression/exclusion has contributed towards habitat degradation, particularly declines in characteristic herbaceous and shrub understory from increased density of small shade-tolerant trees. High risk of loss of remaining ponderosa pine overstories from stand-replacing fires due to high fuel loads in densely stocked understories.
- Historically, extensive grazing by domestic sheep may have altered understory composition, resulting in loss of forbs and a decrease in shrub densities.
- Overgrazing has resulted in lack of recruitment of sapling trees, particularly pines.
- Invasion of exotic plants has altered understory conditions and increased fuel loads.
- Fragmentation of remaining tracts has negatively impacted species with large area requirements.
- Hostile landscapes, particularly those in proximity to agricultural and residential areas, may have high density of nest parasites (brown-headed cowbird), exotic nest competitors (European starling), and domestic predators (cats), and may be subject to high levels of human disturbance.
- The timing (spring/summer versus fall) of restoration/silviculture practices such mowing, thinning, and burning of understory removal may be especially detrimental to single-clutch species.
- Spraying insects that are detrimental to forest health may have negative ramifications on lepidopterans (butterflies) and other non-target bird species.

Factors Affecting Shrubsteppe Habitat

- Permanent habitat conversions of shrubsteppe/grassland habitats (e.g., approximately 60 percent of shrubsteppe in Washington to other uses (e.g., agriculture, urbanization).

Significant acreage of shrubsteppe habitat continues to be converted to residential development between Wenatchee and Monitor (USFS 1999).

- Fragmentation of remaining tracts of moderate to good quality shrubsteppe habitat.
- Degradation of habitat from intensive grazing and invasion of exotic plant species, particularly annual grasses such as cheatgrass and woody vegetation such as Russian olive.
- Degradation and loss of properly functioning shrubsteppe/grassland ecosystems resulting from the encroachment of urban and residential development and conversion to agriculture. Best sites for healthy sagebrush communities (deep soils, relatively mesic conditions) are also best for agricultural productivity; thus, past losses and potential future losses are great. Most of the remaining shrubsteppe in Washington is in private ownership with little long term protection (57 percent).
- Loss of big sagebrush communities to brush control (may not be detrimental relative to interior grassland habitats).
- Conversion of CRP lands back to cropland.
- Loss and reduction of cryptogamic crusts, which help maintain the ecological integrity of shrubsteppe/grassland communities.
- High density of nest parasites (brown-headed cowbird) and domestic predators (cats) may be present in hostile/altered landscapes, particularly those in proximity to agricultural and residential areas subject to high levels of human disturbance.
- Agricultural practices that cause direct or indirect mortality and/or reduce wildlife productivity. There are a substantial number of obligate and semi-obligate avian/mammal species; thus, threats to the habitat jeopardize the persistence of these species.
- Fire management, either fire suppression (USFS 1999), which has resulted in succession of vegetation communities, or overuse of fire, both of which have lead to loss of shrubsteppe.
- Much of the low-elevation shrubsteppe vegetation is currently dominated by cheatgrass and other nonnative plants (USFS 1999). Invasion and seeding of crested wheatgrass and other introduced plant species reduces wildlife habitat quality and/or availability.

Factors Affecting Riparian Wetland Habitat

- Loss of habitat due to numerous factors including riverine recreational developments, inundation from impoundments, cutting and spraying of riparian vegetation for eased access to water courses, gravel mining, etc.
- Habitat alteration from 1) hydrological diversions and control of natural flooding regimes (e.g., dams) resulting in reduced stream flows and reduction of overall area of riparian habitat, loss of vertical stratification in riparian vegetation, and lack of recruitment of young cottonwoods, ash, willows, etc., and 2) stream bank stabilization which narrows stream channel, reduces the flood zone, and reduces extent of riparian vegetation.

- Habitat degradation from conversion of native riparian shrub and herbaceous vegetation to invasive exotics such as reed canary grass, purple loosestrife, perennial pepperweed, salt cedar, and indigo bush.
- Fragmentation and loss of large tracts necessary for area-sensitive species.
- Hostile landscapes, particularly those in proximity to agricultural and residential areas, may have high density of nest parasites (brown-headed cowbird), exotic nest competitors (European starling), and domestic predators (cats), and be subject to high levels of human disturbance.
- High energetic costs associated with high rates of competitive interactions with European starlings for cavities may reduce reproductive success of cavity-nesting species such as Lewis' woodpecker, downy woodpecker, and tree swallow, even when outcome of the competition is successful for these species.
- Recreational disturbances (e.g., ORVs), particularly during nesting season, and particularly in high-use recreation areas.

6.3.2 Aquatic/Fish

Summary of Environmental/Population Relationships of the Focal Species

Spring chinook

Adult migration and holding

Spring chinook enter the Wenatchee River from May through June and hold in larger pools until spawning begins in August. Channel confinement, the loss of riparian areas, and associated large wood used as cover have reduced the abundance of pools. Mortality, stress, or displacement to adults is likely greatest in Nason and Peshastin creeks.

Spawning and egg incubation

Spawning and incubation areas within the Chiwawa, White, and Little Wenatchee rivers remain in good condition. Spawning areas in Nason and Peshastin creek have been severely altered. The remaining spawning areas in the upper Wenatchee River, which is partially altered by domestic land use practices and a very small amount in Chiwaukum Creek, and Icicle Creek. Naturally spawning populations in Icicle Creek interact with fish reared in Leavenworth NFH.

Rearing

Rearing habitat for fry and parr is considered in good condition within the Chiwawa, White, and Little Wenatchee rivers. Rearing habitat in Nason and Peshastin creeks has been compromised by loss of riparian area and subsequent large wood recruitment, off channel habitat, channel stability, and general diversity. Tumwater Canyon is also known to be an important rearing area for spring chinook. Winter rearing habitat may be limiting to spring chinook juveniles because of natural temperature regimes in spawning tributaries and reductions in habitat diversity in the lower Wenatchee River.

Conclusion

Overall, spring chinook production in the Wenatchee River could increase if habitat problems within Nason and Peshastin creeks were corrected. This is a difficult task because of existing roads, railroads, and current land use practices. Preservation of quality habitat in the Little Wenatchee, White, and Chiwawa assessment units would ensure remaining high quality habitat areas remain in tact. Potentially, increases of off channel habitat and riparian areas in the lower Wenatchee River downstream of Leavenworth would increase potential rearing habitat and life history diversity. While creating or restoring more historic habitat in areas like Peshastin Creek may not increase overall spring chinook production by a significant degree, it would increase the spatial and potential genetic diversity of spring chinook in the Wenatchee River.

Late-run chinook

Adult migration and holding

Late-run chinook enter the Wenatchee River from June through October and hold (stage) until spawning begins in October in larger pools of the mainstem Wenatchee. Loss of abundance and pools likely affect late-run chinook the same way these conditions affect spring chinook (see the discussion above). Mortality, stress, or displacement to adults is likely greatest in the lower Wenatchee River.

Spawning and egg incubation

Late-run chinook of the Wenatchee subbasin spawn in the mainstem Wenatchee River. Spawning and incubation areas upstream of Leavenworth remains highly functional and are in good condition. In the lower Wenatchee increases in sediment deposition and higher flow rates (that may displace incubation gravels at a higher than normal rate) have possibly reduced incubation success in the lower river.

Rearing

Rearing habitat for fry has been compromised by loss of riparian area and subsequent LWD recruitment, off channel habitat, channel stability, and habitat diversity in the lower Wenatchee. It is reasonable to assume that given the level of detailed information from past surveys, that increases in off channel habitat in the lower river may elevate survival rates for post-emergent fry rearing in the lower river.

Conclusion

Late-run chinook production in the Wenatchee River could increase if habitat problems within lower river were improved. Preservation of quality habitat in the upper river would ensure remaining high quality habitat areas remain intact. Potentially, increases of off channel habitat and riparian areas in the lower Wenatchee River downstream of Leavenworth would increase potential rearing adult holding habitat and genetic, spatial, and life history diversity.

Sockeye salmon

Adult migration and holding

Sockeye enter the Wenatchee River from July through August and move rapidly upstream to Lake Wenatchee where they hold until spawning begins in September. Extreme high flows have been shown to be an impediment to sockeye migration in Tumwater Canyon. This is believed to

be a natural event but likely accentuated due to land management practices in the upper tributaries. Extreme low flows have shown to present migrational delays at Tumwater Dam. Collaborative efforts have improved passage at Tumwater Dam in recent years.

Spawning and egg incubation

Spawning areas within the White and Little Wenatchee rivers remains functional, where most geofluvial processes have not changed over time and spawning gravels and water flow are in good condition. Incubation of eggs is most likely not affected by human-caused factors in the White and Little Wenatchee rivers.

Rearing

Rearing habitat for fry and parr is considered to be a limiting factor in Lake Wenatchee. Since Lake Wenatchee is an oligotrophic lake, it is unlikely that increases in fry-smolt production can be obtained unless increases in nutrients are introduced into the lake. This could be accomplished by either an increase in spawning salmon upstream of the lake or by artificial means.

Conclusion

Overall, sockeye production in the Wenatchee River could increase if fry-parr survival improved. Preservation of quality habitat in the Little Wenatchee and White River basins would ensure that remaining high quality habitat areas remain intact.

Coho

Adult migration and holding

Coho salmon enter the Wenatchee River in early September through late November. Coho entering in September and October hold in larger pools prior to spawning, later entering fish may migrate quickly upstream to suitable spawning locations. Extreme high flows may be an impediment to coho migration in Tumwater Canyon. This is believed to be a natural event but is likely accentuated due to land management practices in the upper tributaries. In years with extreme low flow, coho entrance into the Wenatchee River or migration to spawning grounds may be delayed. Channel confinement, the loss of riparian areas and associated large wood used as cover have reduced the abundance of pools. Mortality, stress or displacement to adults is likely greatest in Nason and Peshastin Creeks.

Spawning and egg incubation

Spawning areas for coho salmon in Nason Creek have been compromised by loss of riparian area and subsequent large wood recruitment, off channel habitats, channel stability, and general diversity. Coho spawning areas in Peshastin Creek, Mission Creek, and Chumstick Creek have been severely altered likely resulting in reduced incubation success due to lack of suitable spawning gravel and sedimentation. Coho spawning habitat in the Little Wenatchee River remains in good condition. Coho spawning also occurs in the Wenatchee River and Icicle Creek where increases in sediment deposition, channel confinement and higher flow rates (that may displace incubation gravels a higher than normal rate) have most likely reduced incubation success. Largely unaltered coho spawning habitat exists in the Chiwawa and White Rivers.

Rearing

Rearing habitat for coho salmon in Nason Creek, Icicle Creek, and Peshastin Creek has been compromised by loss of off channel habitat, channel stability and habitat diversity. Winter rearing habitat may be limiting due to the lack of off channel habitat and large woody debris.

Conclusion

Natural coho production in the Wenatchee sub-basin could increase if habitat problems within Nason, Icicle, Peshastin, Mission, and Chumstick creeks were improved. Preservation of quality habitat areas in Chiwaukum, Little Wenatchee, White, and Chiwawa basins would ensure high quality areas remain intact. Increases of off-channel habitat in riparian areas in the lower Wenatchee River downstream of Leavenworth would increase rearing and adult holding habitat and life history diversity. Adult migration and holding

Steelhead

Adult migration and holding

Steelhead enter the Wenatchee River from August through May of the following year and hold until spawning begins in February in larger pools or deeper glides of the mainstem Wenatchee or spawning tributaries. Lost pool habitat has most likely impacted steelhead adults in Mission, Nason and Peshastin creeks.

Spawning and egg incubation

Spawning and incubation areas within the Chiwawa, White, and Little Wenatchee rivers remains functional. Spawning and incubation areas in Nason, Mission, and Peshastin creeks have been severely altered. The remaining spawning occurs throughout the mainstem Wenatchee River, but primarily in the upper Wenatchee River and a very small amount in Chiwaukum and Icicle creeks. Increases in sediment deposition channel confinement and higher flow rates (that may displace incubation gravels at a higher than normal rate) have most likely reduced incubation success.

Rearing

Rearing habitat for fry and parr is considered in good condition within Tumwater Canyon, and the Chiwawa, White, and Little Wenatchee rivers. Rearing habitat in Mission, Nason, and Peshastin creeks have been compromised by loss of riparian area and subsequent large wood recruitment, off channel habitat, channel stability, and habitat diversity. Winter rearing habitat may be limiting to steelhead juveniles because of natural temperature regimes in spawning tributaries and reductions in habitat diversity in the lower Wenatchee River.

Conclusion

Overall, steelhead production in the Wenatchee River could increase if habitat problems within Mission, Nason, and Peshastin creeks were improved. Preservation of quality habitat in the Little Wenatchee, White, and Chiwawa basins would ensure remaining high quality habitat areas remain in tact. Potentially, increases of off channel habitat and riparian areas in the lower Wenatchee River downstream of Leavenworth would increase potential rearing and adult holding habitat, and life history diversity. While creating or restoring more historic habitat in

areas like Mission or Peshastin creeks may not increase overall steelhead production by a significant degree, it would increase the spatial and potential genetic diversity.

Bull trout

Adult migration and holding

Bull trout may live their entire lives within the Wenatchee River or may migrate between the Wenatchee and mainstem Columbia Rivers. During their spawning migration (either from Lake Wenatchee or the Columbia River), abundance of pools, cover and high quality, cool water is important. Loss of riparian area and associated large wood that is used as cover, reduce the abundance of pools has most likely impacted bull trout adults in Nason and Peshastin creeks. Loss of connectivity to Icicle Creek and potentially Peshastin Creek is also likely to reduce productivity of this species. Illegal harvest and harassment may still negatively affect population growth, but to an unknown degree.

Spawning and egg incubation

Spawning and incubation areas within the Icicle, Chiwawa, White, Little Wenatchee rivers, and Chiwaukum Creek are in good condition. Spawning and incubation areas in lower Nason Creek and Peshastin Creek have been severely altered. Increases in sediment deposition channel confinement and higher flow rates (that may displace incubation gravels at a higher than normal rate), have most likely reduced incubation success.

Rearing

Rearing habitat for fry and parr is considered in good condition within Tumwater Canyon, and the Icicle, Chiwawa, White, and Little Wenatchee rivers and Chiwaukum Creek. Rearing habitat in Nason and Peshastin and lower Icicle creeks has been compromised by loss of riparian area and subsequent large wood recruitment, off channel habitat, channel stability, and general diversity.

Conclusion

Bull trout production in the Wenatchee subbasin could increase if habitat problems within Nason and Peshastin creeks were improved and if connectivity to Icicle and Peshastin creeks were re-established. Preservation of quality habitat in the Chiwaukum, Little Wenatchee, White, and Chiwawa basins would ensure remaining high quality habitat areas remain in tact. Potentially increases of off channel habitat and riparian areas in the lower Wenatchee River downstream of Leavenworth, would increase potential rearing and adult holding habitat and life history diversity. While creating or restoring more habitat in areas like Peshastin Creek may not increase overall bull trout production by a significant degree, it would increase the spatial and potential genetic diversity.

Westslope Cutthroat Trout

Life History

Westslope cutthroat trout (WSCT) generally exhibit three main life histories forms; fluvial, which migrate between smaller spawning stream and larger rearing streams; adfluvial, which migrate between spawning streams and a lake, and non-migratory, which generally spend their

entire lives in the stream they were born in. Much of the life history of WSCT in the Wenatchee River is unknown.

Adult migration and holding

WSCT may live their entire lives in the tributaries to the Wenatchee River or they may migrate to the mainstem and possibly to the Columbia River. When adults are migrating upstream to spawning areas, they associate with cover; debris, deep pools and undercut banks. The availability of and number of deep pools and cover is important to offset potential pre-spawning mortality. Adult cutthroat trout need deep, slow moving pools that do not fill with anchor ice in order to survive the winter. Intact riparian habitat will increase the likelihood of instream cover, and normative channel geo-fluvial processes will increase the occurrence of deeper pools.

Spawning and egg incubation

WSCT spawn between March and July, when water temperatures begin to warm. Spawning and rearing streams tend to be cold and nutrient poor. Stream conditions (e.g. frequency of flooding, extreme low temperatures) may affect egg survival. Flood can scour eggs from the gravel by increasing sediment deposition that reduces oxygen and percolation through the redd.

In the Wenatchee Basin, fall flooding has a high frequency of occurrence. This may negatively affect incubation and emergence success, especially in years of extreme flows. Road building activities in the upper watershed may increase siltation, as well as grazing and mining activities. Nason Creek, because of its location near a railroad and major highway has long term restoration needs that could most likely increase incubation success.

Rearing

After emergence, fry are usually found in shallow, slow backwater side channels or eddies, in association with fine woody debris. Juvenile cutthroat trout overwinter in the interstitial spaces of large stream substrate. Rearing habitat in Nason, and Peshastin Creek and the mid-mainstem Wenatchee and lower Chiwawa rivers have been compromised by the loss of channel stability, habitat diversity, obstructions, temperature and riparian conditions.

Conclusion

Westslope Cutthroat Trout production in the Wenatchee subbasin could increase if habitat problems within Nason and Peshastin creeks and the mid-Wenatchee and lower Chiwawa rivers were improved. Preservation of quality habitat in upper tributaries and small streams within the watershed would ensure remaining high quality habitat areas remain in tact. Potentially increases of off channel habitat and riparian areas in the lower Wenatchee River downstream of Leavenworth, would increase potential rearing and adult holding habitat and life history diversity. Creating or restoring more habitats in the Peshastin and Nason Assessment Units will increase overall westslope cutthroat trout production and will increase the spatial and potential genetic diversity.

Pacific Lamprey

Conclusion

Currently, there is not enough information concerning this species in the Wenatchee subbasin to draw conclusions.

6.4 Key Findings by Assessment Unit

6.4.1 Lower Wenatchee River Assessment Unit

Key Findings: Riparian Floodplain Condition and Function

Riparian and floodplain conditions have been substantially altered (70% measured) throughout the lower Wenatchee River. Developments have confined the river channel, separated much of the floodplain and side channels from the main channel, and degraded water retention, riparian shade, streambank stabilization, litter input, and recruitment of large wood. Carrying capacity and habitat diversity for juvenile rearing salmonids has been significantly reduced.

Confidence in conclusion:

- HIGH A channel migration zone study is currently under way that may suggest the degree of habitat lost due to degraded floodplain and riparian conditions. There is not enough information to indicate how much productivity would be enhanced as a result of these improvements in habitat attributes although it is reasonable to suggest it would be significant.

Key Findings: Stream Channel Conditions and Function

Habitat Diversity/Channel Stability

Habitat diversity has been significantly reduced throughout much of the lower mainstem Wenatchee River. Large pools in the mainstem provide key habitat for pre-spawning adults and juvenile salmonid rearing. Coupled with lost diversity and increased flows, channel stability is likely reduced, potentially disturbing redds and over-wintering juveniles.

Confidence in conclusion

- MODERATE It is not understood to what degree large woody debris would have contributed to in-channel conditions or how much large pool habitat was available in the historic reference condition.

Sediment

Sediment delivery to the channel has accelerated as a result of erosive processes throughout much of the Wenatchee subbasin. In lower gradient, depositional reaches, increased sediment production may be embedding cobble substrates and degraded substrates suitable for spawning and egg incubation.

Confidence in conclusion

- LOW The extent of sediment delivery to the lower Wenatchee River beyond the range of natural variation is not understood. Surveys on the mainstem have not been completed. No sediment budget has been developed for the Wenatchee River system.

In Derby Canyon channel modifications from rural development, riparian roading and riparian vegetation removal are apparent. Channel entrenchment is high in some areas as a result of these modifications and the predominant sandstone geology.

Key Findings: Water Quality

Elevated Water Temperature

The Wenatchee River is on the 303(d) list for high water temperature. Late summer water temperatures are believed to have increased moderately in low flow years from presumed historic conditions. Elevated temperatures could reduce key habitat quantity for focal species.

Confidence in conclusion

- MODERATE Temperature modeling has not been done to support this conclusion. Forward looking infrared (FLIR) information suggests some warming occurs.

Key Findings: Contaminants

Pollutants are known to enter the Wenatchee River as a result of agricultural, industrial, and urban activities. The extent to which these materials are toxic to focal species within the Wenatchee subbasin has not been determined. These materials may affect egg and fry development and have a cumulative affect on overall survival on fish that rear in the lower reaches.

Confidence in conclusion

- LOW Very little information has been collected to suggest bio-accumulation. No recorded history of fish kills as a result of contaminants exists. Potential cumulative affect is likely but unknown.

Key Findings: Water Quantity

Low Flow

Low flows (baseline flows) are presumed to have decreased moderately from historic reference condition. Lowered flows are a cumulative affect of overall watershed conditions in the tributary streams and exaggerated by irrigation withdrawal. Low flows limit habitat availability for all focal species using these waters.

Confidence in conclusion

- MODERATE Specific measurements concerning affects to hydrograph from degraded watershed conditions have not been made. Stream diversions and well withdrawals from shallow aquifers in the floodplain may cumulatively influence low stream flows, particularly during low water years.

Key Findings: Obstructions to Fish Passage

In the lower portions of Derby Canyon many culverts and residential ponds are known to restrict passage of resident fish, particularly steelhead trout.

Summary of Limiting Factors

- Key Habitat Quantity
- Habitat Diversity

- Channel Stability
- Sediment
- Low Flow
- Elevated Temperature
- Contaminants

Hypothesis Statements

Elevated Temperature

Improving low summer flow and riparian/floodplains conditions in the assessment unit and upper tributaries will decrease summer water temperatures, provide for additional key habitat, and improve habitat quality for the following focal species and life stages.

Table 25. Lower Wenatchee River hypothesis statements: elevated temperature

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Summer Rearing Pre-spawning Adults	Moderate Low	Moderate Moderate
Late-run Chinook	Summer Rearing Pre-spawning Adults	Moderate Moderate	Moderate Low
Coho	Summer Rearing	High	Moderate
Steelhead	Summer Rearing Pre-spawning Adults	Moderate Low	Moderate High
Bull Trout	Pre-spawning Adults	Low	Moderate

Low Flow

Increasing summer low flows will increase wetted channel area, increase key habitat quantity, and improve habitat quality for the following focal species and life stages.

Table 26. Lower Wenatchee River assessment unit hypothesis statements: low flow

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Summer Rearing Pre-spawning Adult	Low *(1)* Low	Moderate
Late-run Chinook	Summer Rearing Pre-spawning Adult	Low-Moderate Low	Moderate
Coho	Summer Rearing Pre-spawning Adult	Moderate High	Moderate
Steelhead	Summer Rearing	Low-Moderate	Moderate
Bull Trout	Pre-spawning Adult	Low	Moderate

(1) Spring chinook are probably limited more by elevated temperature at this time than by low flow conditions.

Riparian/Floodplain Condition

Improving and restoring riparian and floodplain habitats and functionality will contribute to decreased sediment delivery, decreased summer stream temperatures, increased in-channel structural diversity and recruitment of large wood, an increase of micro-refugia during extreme flow and temperature conditions, and increases in macro-invertebrate production. Cumulatively, these contributions will increase productivity of all focal species and life stages occupying these areas by increasing key habitat quality and quantity.

Habitat Diversity

Increasing in-channel structural diversity and complexity, large pool habitat, and the amount of side-channel habitats will increase habitat quantity and quality in the assessment unit over a wide range of flow conditions for the following focal species and life stages.

Table 27. Lower Wenatchee River hypothesis statements: habitat diversity

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Juvenile Rearing Pre-Spawning Adult	High Moderate	High High
Late-run Chinook	Egg Incubation Summer Rearing Adult	Moderate High Moderate	High High High
Coho	Juvenile Rearing Adult	High High	High High
Steelhead	Juvenile Rearing Adult	High Low-Moderate	High High
Bull Trout	Adult Migration	Low	High

Fine Sediment

Decreasing fine sediment delivery and excessive accumulation in the assessment unit will enhance macro-invertebrate productivity and increase focal species productivity for the following species and life stages.

Table 28. Lower Wenatchee River hypothesis statements: fine sediment

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Egg Incubation	Low	High
Late-run Chinook	Egg incubation	High	High
Coho	Egg Incubation	High	High
Steelhead	Egg Incubation	Low	High

(1) Spring chinook and steelhead typically spawn above this assessment unit.

Channel Stability

Increasing riparian and floodplain habitat and functionality, reducing channel confinement and increasing in-channel structural complexity will improve channel (bedload) stability and will increase productivity for the following focal species and life stages:

Table 29: Lower Wenatchee River hypothesis statements: channel stability

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Winter Rearing	Moderate	Moderate
Late-run Chinook	Egg incubation Winter Rearing	Moderate Moderate	Moderate Moderate
Coho	Egg Incubation (1) Winter Rearing	Moderate Moderate	Moderate Moderate
Steelhead	Winter Rearing	Moderate	Moderate

(1) With the successful introduction of Coho, it is assumed these fish will use these habitats for spawning and rearing.

Fish Passage

Providing full fish passage in the tributary streams of this Assessment Unit will enhance life history diversity and to a lesser degree will increase productivity for the following focal species and life stages:

Table 30: Lower Wenatchee River hypothesis statements: fish passage

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Coho	Adult Migration Juvenile Migration	Moderate Moderate	High Moderate

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Steelhead	Adult Migration Juvenile Migration*	Low Moderate	High Moderate

6.4.2 Middle Wenatchee River Assessment Unit

Key Findings: Riparian Floodplain Condition and Function

Riparian and floodplain conditions within the middle Wenatchee River have been altered over time, but remain relatively intact. Degraded riparian conditions contribute to reduced in-channel habitat diversity important for adult holding and juvenile rearing habitats.

Confidence in conclusion

- HIGH

Key Findings: Stream Channel Conditions and Function

Habitat Diversity/Channel Confinement

Channel confinement, primarily from the transportation system, and lost large wood recruitment have contributed to a reduction in pools and habitat diversity. Despite these intrusions, habitat diversity remains relatively good throughout much of this area.

Confidence in conclusion

- HIGH Stream surveys have been completed on many significant tributary streams to date.

Sediment

Bank hardening projects (riprap) to protect developed shorelines from erosion alter the natural processes of streambank erosion and lateral channel migration in the upper reaches (below Lake Wenatchee). These practices may be elevating sediment production in some locations (erosion-prone streambank terraces), although this relationship is not well documented.

The construction of Tumwater Dam (RM 31.0) in the early 1900s changed the character of the river upstream, creating the 0.5 mile long Lake Jolanda. This impoundment has altered the sediment transport regime of the river. Coarse sediments are trapped above the dam while fine sediments flush through. The deposition of fine sediments is localized, and not persistent throughout this area.

Confidence in conclusion

- MODERATE. Sediment condition and trend information is lacking for most of this area.

Key Findings: Water Quality

water quality has changed very little in the mainstem Wenatchee River since the historic reference condition. Slight increases in pollution and possible small decreases in dissolved oxygen are noted.

Elevated Temperature

The Middle Wenatchee River is listed on the 303d list for high water temperatures. Elevated temperatures are noted in some of the tributary streams as well. Increased water temperatures are likely the cumulative result of reduced riparian vegetation, floodplain function and channel conditions and reduced late-summer flows in the tributary streams.

Confidence in conclusion

- LOW-MODERATE Elevated temperatures may be a natural condition although it is reasonable to conclude that temperature is increased from lost riparian and floodplain function in the upper tributaries.

Key Findings: Water Quantity

None identified at this time.

Key Findings: Obstructions to Fish Passage

Tumwater Dam is known to have restricted fish migration, especially during lower flows. Structural modifications to fish passage facilities have recently been completed. It is assumed that Tumwater Dam no longer imposes a significant delay in fish passage, although this condition will be closely monitored.

Confidence in conclusion

- MODERATE Culverts under road crossings are known to limit fish passage (primarily steelhead) in Skinny and Beaver creeks.

Confidence in conclusion

- HIGH

Summary of Limiting Factors

- Riparian/Floodplain Function
- Habitat Diversity
- Sediment
- Obstructions

Hypothesis Statements

Riparian/Floodplain Condition

Improving and restoring riparian and floodplain habitats and functionality will contribute to decreased sediment delivery, decreased summer stream temperatures, an increased in-channel structural diversity and recruitment of large wood, an increase of micro-refugia during extreme flow and temperature conditions, and an increase in macro-invertebrate production. All of these contributions will increase productivity of all focal species and life stages occupying these areas by increasing key habitat quality and quantity.

Habitat Diversity

Increasing in-channel structural diversity and complexity will increase habitat quantity and quality in the assessment unit over a wide range of flow conditions for the following focal species and life stages.

Table 31: Middle Wenatchee River hypothesis statements: habitat diversity

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Egg Incubation Fry Colonization Juvenile Rearing Adult	Low High Moderate Moderate	High High High Moderate
Late-run Chinook	Egg Incubation Fry Colonization Juvenile Rearing Adult	Low High Moderate Moderate	High High High Moderate
Coho	Egg Incubation Fry Colonization Juvenile Rearing Adult	Low High Moderate Moderate	High High High Moderate
Steelhead	Egg Incubation Fry Colonization Juvenile Rearing Adult	Low High Moderate Moderate	High High High Moderate
Bull Trout	Juvenile Rearing Adult	Low Moderate	Moderate Moderate

Fish Passage

Providing full fish passage in the tributary streams of this assessment unit will enhance life history diversity and to a lesser degree will increase productivity for the following focal species and life stages.

Table 32: Middle Wenatchee River hypothesis statements: fish passage

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Coho	Juvenile Rearing Adult	Moderate Moderate	High High
Spring Chinook	Juvenile Rearing*	Moderate	Moderate
Steelhead	Juvenile Rearing* Adult	Moderate Moderate	High High
Bull Trout	Juvenile Rearing* Adult	Low Moderate	High Moderate

Delay of passage at Tumwater Dam may be detrimental to spawning and egg incubation success for all focal species passing through these waters. At this time there is not enough information to determine if lost productivity exists, but this situation should be monitored closely and timely and appropriate actions taken as needed:

Competition and Predation

Control or elimination of brook trout will improve productivity and potentially life history diversity for bull trout and cutthroat trout by reducing inter-breeding, competition and predation in the upper watersheds of this Assessment Unit.

6.4.3 Mission Creek Assessment Unit

Key Findings: Riparian Floodplain Condition and Function

Channel constriction from roads constructed within the floodplain throughout Mission Creek watershed has reduced the accessible floodplain. Riparian characteristics are highly altered in the lower watershed. In the upper watershed, riparian roads adjacent to stream channels are similar to those in most other significant drainages.

Confidence in conclusion

- HIGH

Key Findings: Stream Channel Conditions and Function

Habitat Diversity

Pool frequency and depth have been reduced as a result of channel simplification and lost production of LWD within the stream channel. In the lower watershed stream channels are highly confined by developments. Lost habitat diversity has severely limited habitat quality and quantity for all life stages of steelhead and juvenile rearing chinook salmon.

Confidence in conclusion

- HIGH Stream surveys have been completed in public lands.

Channel Stability

Developments have resulted in a predominance of entrenched and single channel characteristics within the watershed. In these areas, flow velocities are increased, resulting in increased bedload movement and possible disruption to incubating eggs, although these conditions have not been documented in this assessment unit. Low flows are pronounced in these simplified channels, substantially reducing habitat diversity and key habitat quantity.

Confidence in conclusion

- MODERATE-HIGH

Sediment

Various riparian and in-channel alterations throughout much of the watershed have resulted in increased sediment delivery into Mission Creek. Fine sediments have filled pools, embedded

cobble and gravel substrates, reducing cover for over-winter rearing juveniles, smothering incubating eggs and reducing available habitat for macro-invertebrate production.

Confidence in conclusion

- HIGH

Key Findings: Water Quality

Increased temperatures are the cumulative result of degraded riparian conditions and decreased summer flows throughout the Assessment Unit. Elevated temperature limits habitat availability and quality for juvenile salmonids and potentially increases the likelihood for.

Confidence in conclusion

- HIGH

Contaminants

Mission Creek does not meet state water quality standards for DDT; 4, 4-DDT; 4, 4-DDE and Gunthion, as well as dissolved oxygen, fecal coli form. Currently, only Mission Creek in the Wenatchee River subbasin is listed as impaired due to pesticides in fish tissues. It is likely that survival of incubating eggs and juvenile fish is reduced as a direct affect of these pollutants, or as an indirect or cumulative affect.

Confidence in conclusion

- MODERATE Affects of these toxic materials on salmonid fishes are not well documented in the Mission watershed.

Key Findings: Water Quantity

watershed hydrology is likely altered due to variety of management activities. High flows, coupled with channel confinement and reduced habitat diversity likely displaces and/or kills juvenile salmonids. High flows also increase bedload movement which likely disrupts or destroys salmonid redds. Low flows reduce key habitat availability and quality for all life stages and in many places throughout the watershed has eliminated usable habitat.

Confidence in conclusion

- HIGH It is assumed that management activities have advanced and exaggerated the hydrograph in the Mission Creek assessment unit.

Key Findings: Obstructions to Fish Passage

Fish Passage

Access to upper Mission Creek and its tributaries is limited due to de watering of lower Mission Creek, and numerous culverts and irrigation dams, many of which are impassable for juvenile fish and several also prevent adult passage.

Confidence in conclusion

- HIGH

Summary of Limiting Factors

- Riparian/Floodplain Function
- Habitat Diversity
- Channel Stability
- Sediment
- Contaminants
- Elevated Temperature
- Flow
- Obstructions

Hypothesis Statements

Elevated Temperature

Improving low summer flow and riparian/floodplains conditions in the Assessment Unit and tributaries will decrease summer water temperatures and will provide additional key habitat and improve habitat quality for the following focal species and life stages.

Table 33: Mission Creek hypothesis statements: elevated temperature

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Coho	Summer Rearing	High	High
Steelhead	Summer Rearing	High	High

(1) Chinook juveniles that presumably move into Mission Creek from the Wenatchee River will also benefit from decreased summer temperatures.

High Flow

By normalizing the hydrograph and moderating accentuated peak flow conditions within the Assessment Unit, habitat quantity and quality will improve for the following focal species and life stages.

Table 34: Mission Creek hypothesis statements: high flow

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Coho	Egg Incubation Fry Colonization Winter Rearing Adult	High (1) High High Moderate	High High High Moderate
Steelhead	Egg Incubation Fry Colonization Winter Rearing	High (1) High High	High High High

(1) Associated with in-channel conditions and assumes that redds are scoured out during high flow events.

(2) Chinook juveniles that presumably move into Mission Creek from the Wenatchee River will also benefit from a decrease in high flows.

Low Flow

Increasing summer low flows will increase wetted channel area and will increase key habitat quantity and improved habitat quality for the following focal species and life stages.

Table 35: Mission Creek hypothesis statements: low flow

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Coho	Summer Rearing Adult	High Moderate	High Moderate
Steelhead	Summer Rearing	High	High

Note: Chinook juveniles that presumably move into Mission Creek from the Wenatchee River will also benefit from an increase in base flows.

Riparian/Floodplain Condition

Improving and restoring riparian and floodplain habitats and functionality will contribute to decreased sediment delivery, decreased summer stream temperatures, an increased in-channel structural diversity and recruitment of large wood, an increase of micro-refugia during extreme flow and temperature conditions, and an increase in macro-invertebrate production. All of these contributions will increase productivity of all focal species and life stages occupying these areas by increasing key habitat quality and quantity

Habitat Diversity

Increasing in-channel structural diversity and complexity, increasing large pool habitat and increasing the amount of side-channel habitats will increase habitat quantity and quality in the assessment unit over a wide range of flow conditions for the following focal species and life stages.

Table 36: Mission Creek hypothesis statements: habitat diversity

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Coho	All Life Stages	High	High
Steelhead	All Life Stages	High	High

Channel Stability

Increasing riparian and floodplain habitat and functionality, reducing channel entrenchment and confinement and increasing in-channel structural complexity will improve channel (bedload) stability and will increase productivity for the following focal species and life stages.

Table 37: Mission Creek hypothesis statements: channel stability

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Coho	All Life Stages	High	High

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Steelhead	All Life Stages	High	High

Fish Passage

Providing full fish passage in the mainstem and tributary streams of this assessment unit will enhance life history diversity and will increase productivity for the following focal species and life stages.

Table 38: Mission Creek hypothesis statements: fish passage

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Juvenile Rearing	High	High
Coho	Adult Juvenile Rearing	Moderate High	High High
Steelhead	Adult Juvenile Rearing	Moderate High	High High

6.4.4 Peshastin Creek Assessment Unit

Key Findings: Riparian Floodplain Condition and Function

Riparian Floodplain Conditions

Floodplain, riparian areas and off-channel habitats have been significantly reduced as a result of State High way 97 which borders much of Peshastin Creek. Floodplain and riparian attributes within the lower nine miles have been significantly altered by residential, rural and agricultural use. Much of the area within Ingalls Creek is still in fair (lower reaches) to pristine (upper reaches) conditions.

Confidence in conclusion

- HIGH

Key Findings: Stream Channel Conditions and Function

Habitat Diversity

Stream reaches within the mainstem of the Peshastin have been significantly channelized and hardened which has reduced habitat complexity and accelerated erosive processes. Timber harvest and mining activities in most tributary streams have altered channel conditions resulting in reduced habitat diversity. Overall pool availability and quality is low in all areas except Ingalls Creek.

Confidence in conclusion

- HIGH

Channel Stability

The overall channel width of the lower 9.0 miles of Peshastin Creek is increasing, and the channel is becoming less entrenched in response to increases in sediment supply, decreases in riparian vegetation structure and function, and changes in the flow regime.

Confidence in conclusion

- HIGH

Sediment

Visual estimates indicate that substrates within a majority of segments are embedded. Exceptions include Ingalls Creek where embeddedness is not a problem and several tributaries where mining by dredging has scoured the channel down to bedrock in many reaches.

Confidence in conclusion

- MODERATE Empirical information concerning sediment in streams is lacking. Stream surveys on public lands supports this conclusion.

Key Findings: Water Quality

Elevated Temperature

Increased stream temperatures are likely a cumulative affect from a loss of riparian vegetation/shade, lower flows due to degraded channel conditions and floodplain storage throughout the mainstem and many of the tributary streams. Elevated temperature limits habitat availability and quality for focal species and potentially increases the likelihood for disease.

Confidence in conclusion

- MODERATE Insufficient data exists to determine if instream temperatures are significantly different than the historic range of temperatures. Increased stream temperatures are likely a cumulative affect from a loss of riparian vegetation and the disrupted hydrograph throughout mainstem and many of the tributary streams.

Key Findings: Water Quantity

High flows and reduced base flows within the Peshastin Creek watershed is a cumulative result of intensive upland and floodplain vegetation management, high road densities, degraded floodplain function (storage) and entrenched stream channels. High flows increase bedload movement which disrupts or destroys salmonid redds. Low flows have reduced key habitat availability and quality for all life stages,

Peshastin Creek at RM 2.4 is de watered by an irrigation diversion for approximately 100 feet below the diversion.

Confidence in conclusion

- MODERATE-HIGH There is a lack of information on flows for the Peshastin drainage. Conclusion is based upon general watershed and channel conditions.

Key Findings: Obstructions to Fish Passage

At RM 2.4, a water diversion dam presents a barrier to summer and fall migration (mid June through October) for adult and juvenile fish. There are many other water diversions and culverts that likely act to limit fish (especially juveniles) movement throughout the watershed.

Confidence in conclusion

- HIGH

Summary of Limiting Factors

- Riparian/Floodplain Function
- Habitat Diversity
- Channel Stability
- Sediment
- Elevated Temperature
- Flow
- Obstructions

Hypothesis Statements

Elevated Temperature

Improving low summer flow and riparian/floodplains conditions in the assessment unit and tributaries will decrease summer water temperatures and will provide additional key habitat and improve habitat quality for the following focal species and life stages.

Table 39: Peshastin Creek hypothesis statements: elevated temperature

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Summer Rearing Pre-spawning Adult	Low Low	Moderate High
Coho	Summer Rearing	Low	Moderate
Steelhead	Fry Colonization Summer Rearing	Low Low	High Moderate
Bull Trout	Summer Rearing Pre-spawning Adult	Low Moderate	Moderate Low*(1)*
Cutthroat Trout	Adults	None – Low	Low*(2)*

(1) Water temperatures cool significantly at night; it is not well understood if bull trout will use this time to move through day-time thermal barriers.

(2) Migration patterns of cutthroat trout are not understood and what effect elevated temperatures in this Assessment Unit might have on these patterns.

High Flow

By normalizing the hydrograph and moderating accentuated peak flow conditions within the assessment unit, habitat quantity and quality will improve for the following focal species and life stages.

Table 40: Peshastin Creek hypothesis statements: high flow

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Egg Incubation Fry Colonization Winter Rearing	High *(1)* High Moderate	Moderate High Moderate
Coho	Egg Incubation Fry Colonization Winter Rearing	High (1) High Moderate	Moderate High Moderate
Steelhead	Winter Rearing	Moderate	Moderate
Bull Trout	Winter Rearing Fry Colonization	Moderate Moderate	Moderate Moderate
Cutthroat Trout	Egg Incubation Fry Colonization	Low*(2)* Low	Moderate Moderate

(1) Associated with poor in-channel conditions, assumes that redds are scoured out during high flow events.

(2) Cutthroat trout currently exist in one tributary within the assessment unit which remains relatively intact hydrologically.

Riparian/Floodplain Condition

Improving and restoring riparian and floodplain habitats and functionality will contribute to decreased sediment delivery, decreased summer stream temperatures, an increased in-channel structural diversity and recruitment of large wood, an increase of micro-refugia during extreme flow and temperature conditions, and an increase in macro-invertebrate production. All of these contributions will increase productivity of all focal species and life stages occupying these areas by increasing key habitat quality and quantity.

Habitat Diversity

Increasing in-channel structural diversity and complexity, increasing large pool habitat and increasing the amount of side-channel habitats will increase habitat quantity and quality in the assessment unit over a wide range of flow conditions for the following focal species and life stages.

Table 41: Peshastin Creek hypothesis statements: habitat diversity

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Egg Incubation Fry Colonization Juvenile Rearing	Moderate High High	High High High

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
	Adult	Moderate	Moderate
Coho	All Life Stages	High	High
Steelhead	Egg Incubation Fry Colonization Juvenile Rearing Adult	Moderate High High Moderate	High High High Moderate
Bull Trout	Egg Incubation Fry Colonization Juvenile Rearing Adult	Low High Moderate Moderate	High High High Moderate
Cutthroat Trout	Egg Incubation Fry Colonization Juvenile Rearing Adult	Low High Moderate Moderate	High High High Moderate

Channel Stability

Increasing riparian and floodplain habitat and functionality, reducing channel entrenchment and confinement and increasing in-channel structural complexity will improve channel (bedload) stability and will increase productivity for the following focal species and life stages:

Table 42: Peshastin Creek hypothesis statements: channel stability

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Egg Incubation Winter Rearing	Moderate Moderate	Moderate Moderate
Coho	Egg Incubation Winter Rearing	Moderate Moderate	Moderate Moderate
Steelhead	Egg Incubation Winter Rearing	Moderate Moderate	Moderate Moderate
Bull Trout	Egg Incubation Winter Rearing	Moderate Moderate	Moderate Moderate
Cutthroat Trout	Egg Incubation Winter Rearing	Moderate Moderate	Moderate Moderate

Fish Passage

Providing full fish passage in the mainstem and tributary streams of this assessment unit will enhance life history diversity and will increase productivity for the following focal species and life stages

Table 43: Peshastin Creek hypothesis statements: fish passage

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Juvenile Rearing Pre-spawning Adult	Moderate High	High High
Coho	Juvenile Rearing Adult	High High	High High
Steelhead	Juvenile Rearing	Moderate	High
Bull Trout	Pre-spawning Adult	High	Moderate
Cutthroat Trout	Juvenile Rearing Pre-spawning Adult	Unknown Unknown	Unknown Unknown

Competition and Predation

Control or elimination of brook trout will improve productivity and potentially life history diversity for bull trout and cutthroat trout by reducing inter-breeding, competition and predation in the upper watersheds of this assessment unit.

6.4.5 Chumstick Creek Assessment Unit

Key Findings: Riparian Floodplain Condition and Function

Riparian / Floodplain Condition

A high way and railroad closely parallel Chumstick Creek, channelizing the creek, limiting the width of the riparian zone and restricting the use of its floodplain. Rural development has simplified many riparian characteristics. In disturbed areas where woody vegetation is lacking the invasive weed, reed canary grass (*Phalaris arundinacea*), is abundant.

Confidence in conclusion

- HIGH

Key Findings: Stream Channel Conditions and Function

Channel Stability

Many of the perennial channels in the Chumstick watershed have been modified, confined or hardened. In confined areas, bedload movement is likely augmented during high flows, although this condition is not well documented. Channel instability can disrupt egg incubation and winter rearing habitat.

Confidence in conclusion

- HIGH

Habitat Diversity

The transportation system and rural developments have simplified channel characteristics. Large woody debris throughout the watershed is lacking in quantity and quality.

Confidence in conclusion

- HIGH

Sediment

Erosion associated with riparian disturbance, channel confinement, culvert placement, road placement and past logging all contribute to excessive fine sediment and substrate embeddedness throughout much of the watershed.

Confidence in conclusion

- HIGH

Key Findings: Water Quality

Contaminants

Chumstick Creek is impaired for dissolved oxygen, fecal coli form, and pH criteria. Dissolved oxygen levels may be reduced as a function of elevated temperatures, increased nutrients and increased biological oxygen demand. Coli form counts are likely a cumulative affect of livestock and failing septic systems within the mainstem reaches. Changes in pH from the historic reference condition are unknown.

Confidence in conclusion

- MODERATE-HIGH Affects of these attributes to focal species is undetermined. Fish kills have not been reported.

Key Findings: Water Quantity

Flow

Watershed conditions have changed considerably resulting in accentuation and advancement of hydrologic responses. Coupled with simplified channel conditions, refugia for juvenile salmonids from high flow events is limited. Low flows are likely reduced from the historic reference condition because of lost watershed and floodplain function (water storage) and entrenched cannel conditions.

Confidence in conclusion

- HIGH

Key Findings: Obstructions to Fish Passage

The North Road county culvert at RM 0.3 is a full passage barrier to spring chinook and a partial passage barrier to steelhead, particularly juveniles.

This barrier substantially limits the ability for fish species to use the Chumstick watershed. There are numerous obstructions located throughout the watershed that are considered to be significant and/or partial barriers to adult and/or juvenile fish.

Confidence in conclusion

- HIGH It is not understood how much habitat above the existing culvert would be used by salmon if full passage existed, although it is assumed the use would be significant.

Summary of Limiting Factors

- Riparian/Floodplain Function
- Habitat Diversity
- Channel Stability
- Sediment
- Flow
- Obstructions

Hypothesis Statements

High Flow

By normalizing the hydrograph and moderating accentuated peak flow conditions within the assessment unit, habitat quantity and quality will improve for the following focal species and life stages.

Table 44: Chumstick Creek hypothesis statements: high flow

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Steelhead	Egg Incubation Fry Colonization Winter Rearing	High High Moderate	High High Moderate
Coho*(1)*	Egg Incubation Fry Colonization Winter Rearing	High High Moderate	High High Moderate

(1) Assumes that coho are established in this assessment unit.

Low Flow

Increasing summer low flows will increase wetted channel area and will increase key habitat quantity and improved habitat quality for the following focal species and life stages.

Table 45: Chumstick Creek hypothesis statements: low flow

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Steelhead	Summer Rearing	High	High
Coho	Summer Rearing	High	High

Riparian/Floodplain Condition

Improving and restoring riparian and floodplain habitats and functionality will contribute to decreased sediment delivery, decreased summer stream temperatures, an increased in-channel structural diversity and recruitment of large wood, an increase of micro-refugia during extreme flow and temperature conditions, and an increase in macro-invertebrate production. All of these contributions will increase productivity of all focal species and life stages occupying these areas by increasing key habitat quality and quantity.

Habitat Diversity

Increasing in-channel structural diversity and complexity, increasing large pool habitat and increasing the amount of side-channel habitats will increase habitat quantity and quality in the assessment unit over a wide range of flow conditions for the following focal species and life stages.

Table 46: Chumstick Creek hypothesis statements: habitat diversity

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Steelhead	All Life Stages	High	High
Coho	All Life Stages	High	High

Channel Stability

Increasing riparian and floodplain habitat and functionality, reducing channel entrenchment and confinement and increasing in-channel structural complexity will improve channel (bedload) stability and will increase productivity for the following focal species and life stages.

Table 47: Chumstick Creek hypothesis statements: channel stability

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Steelhead	Egg Incubation Winter Rearing	High Moderate	High Moderate
Coho	Egg Incubation Winter Rearing	High Moderate	High Moderate

Fine Sediment

Decreasing fine sediment delivery and excessive accumulation in the assessment unit will enhance macro-invertebrate productivity and increase focal species productivity for the following species and life stages.

Table 48: Chumstick Creek hypothesis statements: fine sediment

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Steelhead	Egg Incubation	High	High
Coho	Egg Incubation	High	High

Fish Passage

Providing full fish passage in the mainstem and tributary streams of this assessment unit will enhance life history diversity and will increase productivity for the following focal species and life stages.

Table 49. Chumstick Creek hypothesis statements: fish passage

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Steelhead	Juvenile Rearing Pre-spawning Adult	High High	High High
Coho	Juvenile Rearing Pre-spawning Adult	High High	High High

Competition and Predation

Control or elimination of brook trout will improve productivity and potentially life history diversity for bull trout and cutthroat trout by reducing inter-breeding, competition and predation in the upper watersheds of this assessment unit.

6.4.6 Icicle Creek Assessment Unit

Key Findings: Riparian Floodplain Condition and Function

The connectivity in upper and lower reaches between Icicle Creek and its off-channel, wetland, floodplain, and riparian areas has been reduced mainly due to development, road building, water diversions, construction of Leavenworth NFH, and flood damage control (dikes). Simplification of riparian and off-channel attributes has decreased habitat diversity in the lower river.

In the upper watershed some alterations in riparian vegetation are noted from localized recreation facilities (campgrounds) and past timber harvest. These conditions are considered minor at the watershed scale.

Confidence in conclusion

- HIGH

Key Findings: Stream Channel Conditions and Function

Sediment

All of the dominant land types in the Icicle Creek watershed have high sediment delivery hazards. In 1994 forest fires burned approximately 12% of the Icicle Creek watershed. These burned areas have and will continue to increase sedimentation in Icicle Creek.

Confidence in conclusion

- HIGH

Habitat Diversity

In the upper Icicle Creek watershed, habitat diversity is at or near pristine conditions. In the lower watershed, development of the hatchery facilities and rural/agricultural developments may have increased the channel width-to-depth ratio and reduced habitat diversity.

Confidence in conclusion

- HIGH

Key Findings: Water Quality

The majority of the water flowing into Icicle Creek comes from high elevation wilderness streams and areas that have had minimal disturbances from management activities. Currently there are no concerns related to chemical contamination or excessive nutrients in Icicle Creek.

Elevated Temperatures

Elevated water temperatures in the lower Icicle watershed are the result of decreased flow and reduction in riparian vegetation. water temperatures monitored near the USFS Boundary (RM 4.8) exceed Forest Plan standards.

Temperatures are reduced by inflow from several high mountain lakes including the Snow Lakes (enters through Snow Creek at RM 5.4). The lakes are managed as storage reservoirs to augment lower Icicle Creek water flows in order to meet water rights and to assure a source of cold water for Leavenworth NFH.

Confidence in conclusion

- LOW-MODERATE There is not enough data to determine if temperatures are significantly different than the historic range in upper Icicle Creek.

Key Findings: Water Quantity

Low Flows

Low flows in the lower reaches (RM 0.0 – 5.7) are the result of natural conditions compounded by public water supply needs, irrigation diversions, and fish hatchery diversions. During drought years, the stream can be de watered from the Leavenworth NFH diversion at RM 4.5 downstream through the canal to RM 2.6 (downstream from the spill way) where the hatchery returns flow into Icicle Creek.

Confidence in conclusion

- HIGH

Key Findings: Obstructions to Fish Passage

Hatchery operations of the dams and weirs in the historic channel of Icicle Creek block fish passage. A steep boulder field at RM 5.8 is thought to prevent essentially all fish from moving upstream although adult bull trout have recently been identified upstream of this partial or potential obstruction. Passage may occur at specific flows for different species, but this is not well documented. Conditions of the screens on water diversions along Icicle Creek is not well documented, although screens need to be updated on some of the larger diversions.

Confidence in conclusion

MODERATE The status or need for screens for most of the smaller diversions is not available. Historic passage above RM 5.8 is speculative for most species.

Summary of Limiting Factors

- Competition (Leavenworth NFH)
- Habitat diversity (lower watershed)
- Elevated temperature (lower watershed)
- Flow (lower watershed)
- Obstructions

Hypothesis Statements

Elevated Temperature

Improving low summer flow conditions in the lower 6 miles of the assessment unit will decrease summer water temperatures and will improve habitat quality for the following focal species and life stages.

Table 50: Icicle Creek hypothesis statements: elevated temperature

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Summer Rearing Pre-spawning Adult	Moderate Low	Moderate Moderate
Coho	Summer Rearing	Moderate	Moderate
Late-run Chinook	Pre-spawning Adult	Moderate	Moderate
Steelhead	Summer Rearing	Low	Moderate
Bull Trout	Pre-spawning Adult	Moderate	Moderate

Low Flow

Increasing summer low flows will increase key habitat quantity and improved habitat quality for the following focal species and life stages.

Table 51: Icicle Creek hypothesis statements: low flow

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Pre-spawning Adult Summer rearing	Moderate Moderate	Moderate Moderate
Coho	Summer Rearing	High	Moderate
Late-run Chinook	Pre-spawning Adult Summer rearing	Moderate Moderate	Moderate Moderate
Steelhead	Summer Rearing	Moderate	Moderate

Bull Trout	Pre-spawning Adult	Moderate	Moderate

Riparian/Floodplain Condition

Improving and restoring riparian and floodplain habitats and functionality in the lower portions (below river mile 6) will contribute to decreased sediment delivery, decreased summer stream temperatures, an increased in-channel structural diversity and recruitment of large wood, an increase of micro-refugia during extreme flow and temperature conditions, and an increase in macro-invertebrate production. All of these contributions will increase productivity of all focal species and life stages occupying these areas by increasing key habitat quality and quantity.

Habitat Diversity

Increasing in-channel structural diversity and complexity, increasing large pool habitat will increase habitat quantity and quality in the lower 6 miles of the assessment unit over a wide range of flow conditions for the following focal species and life stages.

Table 52: Icicle Creek hypothesis statements: habitat diversity

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Egg Incubation Fry Colonization Juvenile Rearing Adult	Low Moderate Moderate Moderate	Moderate Moderate Moderate Moderate
Coho	All Life Stages	High	High
Late-run Chinook	Egg Incubation Fry Colonization Summer Rearing Adult	Low Moderate Moderate Moderate	Moderate Moderate Moderate Moderate
Steelhead	Fry Colonization Juvenile Rearing Adult	Moderate Moderate Low	Moderate Moderate Moderate
Bull Trout	Pre-spawning Adult	Moderate	Moderate

Fish Passage

Eliminating man-made barriers to fish passage in the mainstem (lower 6 miles) of this assessment unit will enhance life history diversity and will increase productivity for the following focal species and life stages.

Table 53: Icicle Creek hypothesis statements: fish passage

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Juvenile Rearing Pre-spawning Adult	Low Low	Moderate Moderate
Coho	All life stages	High	Moderate

Late-run Chinook	Juvenile Rearing	Low	Moderate
Steelhead	Juvenile Rearing Pre-spawning Adult	Low Low	Moderate Moderate
Bull Trout	Pre-spawning Adult	Low	Moderate

Fish Passage

The upper Icicle watershed had a higher degree of connectivity for fish passage in the past than it does now. Road and irrigation developments may have imposed upon the channel and made passage over a natural obstruction more difficult. Allowing greater fish passage to the upper Icicle could increase productivity and life history and genetic diversity for spring chinook, steelhead, bull trout and cutthroat trout. There is a Moderate-High degree of uncertainty associated with this hypothesis statement.

Competition and Predation

Control or elimination of brook trout will improve productivity and potentially life history diversity for bull trout and cutthroat trout by reducing inter-breeding, competition and predation in the upper watersheds of this assessment unit.

6.4.7 Nason Creek Assessment Unit

Key Findings: Riparian Floodplain Condition and Function

In the lower 15 miles of Nason Creek, numerous activities have caused significant disturbances to the riparian areas and floodplains. The state high way, railroad, power lines, stream channel riprapping, recreational sites and residential developments all contribute to poor habitat conditions. All of the Nason tributaries are considered to have good conditions for off-channel habitat. Many of the tributaries have some wetland habitat in their floodplain, including Butcher, Mill, Roaring, and Coulter creeks.

Confidence in conclusion

- HIGH

Key Findings: Stream Channel Conditions and Function

Channel Stability

In low gradient reaches upstream of Whitepine Creek (RM 15.4) problems are noted with width-to-depth ratios, sediment, substrate embeddedness, bank erosion, reduced large woody debris. Below Whitepine Creek, eroding banks are symptomatic of a channel artificially confined within its floodplain and artificially increased water velocity.

Confidence in conclusion

- HIGH

Habitat diversity

Large wood, pool depth and frequency, and in-channel structural diversity are considered to be in fair to poor condition in the lower Nason Creek reaches. Some side channels and oxbows have been cut off from the main channel by the transportation system. Juvenile salmonid passage into oxbows, wetlands, side channels and other key habitat has been significantly reduced by isolation of these habitats from mainstem Nason Creek.

Confidence in conclusion

- HIGH

Sediment (Nason Creek mainstem)

Various riparian and in-channel alterations throughout much of the watershed have resulted in increased sediment delivery into the lower Nason Creek reaches. Fine sediments have embedded cobble and gravel substrates, reducing interstitial spaces used as cover for over-winter rearing juveniles, smothering incubating eggs and reducing available habitat for macro-invertebrate production.

Confidence in conclusion

- HIGH

Key Findings: Water Quality

Elevated Temperature (lower Nason mainstem)

Substantial channel alterations and reduced riparian vegetation are thought to be responsible for increasing stream temperatures in late summer and early autumn months.

Confidence in conclusion

- MODERATE Temperature modeling has not been done for this stream. Conclusion is based upon relationship between elevated temperatures and lack of stream shade.

Contaminants

Water quality in Nason assessment unit is considered to be relatively good, although exceptions are noted in the lower watershed. Fecal coli form was present in most Nason Creek water samples, but not at levels that exceeded state water quality standards.

Confidence in conclusion

- LOW-MODERATE Adequate water quality monitoring has not been completed. Conclusion is based upon proximity of high way, railroad and residential developments.

Key Findings: Water Quantity

High Flow

General watershed conditions have been altered due to timber harvest, road densities and road location. These factors have likely resulted in increased peak flows during precipitation and significant snow melting events. As a result bedload stability is reduced which likely increases mortality on incubating eggs and juvenile over-winter rearing.

Confidence in conclusion

- MODERATE Conclusion is based upon relationship between general hydrologic response to watershed and in-channel conditions.

Key Findings: Obstructions to Fish Passage

Juvenile passage into oxbows, wetlands, side channels and other key habitat has been significantly reduced by isolation of these habitats from mainstem Nason Creek. Numerous culverts associated with road crossings also disrupt stream flow, possibly creating high velocity barriers during high flow events.

Confidence in conclusion

- HIGH

Summary of Limiting Factors

- Riparian/Floodplain Condition
- Channel Stability
- Habitat Diversity
- Sediment
- Elevated Temperature
- Flow
- Obstructions
- Competition (Brook Trout)

Hypothesis Statements

Elevated Temperature

Improving riparian/floodplains conditions in the assessment unit and upper tributaries will decrease summer water temperatures and will provide additional key habitat and improve habitat quality for the following focal species and life stages.

Table 54: Nason Creek hypothesis statements: elevated temperature

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Adult Summer Rearing	Moderate Moderate	High High
Coho	Adult Summer Rearing	Moderate Moderate	High High
Steelhead	Summer Rearing	Moderate	High
Bull Trout	Pre-spawning Adult	Moderate	High
Cutthroat Trout	Summer Rearing	Low (1)	Low

(1) Potentially increase life history diversity for cutthroat trout.

Riparian/Floodplain Condition

Improving and restoring riparian and floodplain habitats and functionality primarily in the lower 15 miles of the mainstem will contribute to decreased sediment delivery, decreased summer stream temperatures, an increased in-channel structural diversity and recruitment of large wood, an increase of micro-refugia during extreme flow and temperature conditions, and an increase in macro-invertebrate production. All of these contributions will increase productivity of all focal species and life stages occupying these areas by increasing key habitat quality and quantity.

Habitat Diversity

Increasing in-channel structural diversity and complexity, increasing large pool habitat and increasing the amount of side-channel habitats in the lower 15 miles of Nason Creek will increase habitat quantity and quality over a wide range of flow conditions for the following focal species and life stages.

Table 55: Nason Creek hypothesis statements: habitat diversity

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	All Life Stages	High	High
Coho	All Life Stages	High	High
Steelhead	All Life Stages	High	High
Bull Trout	Juvenile Rearing Pre-spawning Adult	Low High	Low High
Cutthroat Trout	All Life Stages	Unknown	Unknown

Channel Stability

Increasing riparian and floodplain habitat and functionality, reducing channel entrenchment and confinement and increasing in-channel structural complexity (primarily in the lower 15 miles) will improve channel (bedload) stability and will increase productivity for the following focal species and life stages.

Table 56: Nason Creek hypothesis statements: channel stability

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Egg Incubation Winter Rearing	High Moderate	High Moderate
Coho	Egg Incubation Winter Rearing	High Moderate	High Moderate
Steelhead	Egg Incubation Winter Rearing	High Moderate	High Moderate
Bull Trout	Winter Rearing	Moderate	Moderate

Fine Sediment

Decreasing fine sediment delivery and excessive accumulation in the assessment unit (primarily in the lower 15 miles) will enhance macro-invertebrate productivity and increase focal species productivity for the following species and life stages.

Table 57: Nason Creek hypothesis statements: fine sediment

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Egg Incubation	High	High
Coho	Egg Incubation	High	High
Steelhead	Egg Incubation	High	High
Bull Trout *(1)*	Egg Incubation	Moderate	High

(1) Bull Trout spawning occurs in tributary streams that are in relatively good condition.

Fish Passage

Eliminating man-made barriers to fish passage in the mainstem and tributary streams of this assessment unit will enhance life history diversity and will increase productivity for the following focal species and life stages

Table 58: Nason Creek hypothesis statements: fish passage

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Juvenile Rearing Adult	High Moderate	High Moderate
Coho	Juvenile Rearing Adult	High Moderate	High Moderate
Steelhead	Juvenile Rearing Adult	High High	High High
Bull Trout	Juvenile Rearing Adult	High High	High High
Cutthroat Trout	Juvenile Rearing Adult	High Unknown	Moderate Unknown

Competition and Predation

Control or elimination of brook trout will improve productivity and potentially life history diversity for bull trout and cutthroat trout by reducing inter-breeding, competition and predation in the upper watersheds of this assessment unit.

6.4.8 Little Wenatchee River Assessment Unit

Key Findings: Riparian Floodplain Condition and Function

Riparian conditions in the Little Wenatchee assessment unit are in good condition with some alterations in localized areas (lower watershed). Affects to riparian resources are thought to be relatively minor at the watershed scale.

Confidence in conclusion

- HIGH

Key Findings: Stream Channel Conditions and Function

In-stream habitat conditions and diversity are at or near pristine conditions throughout most of the Little Wenatchee assessment unit.

Habitat Diversity

Some harvest has occurred in riparian areas, contributing to lowered contribution of LWD within the channel. Some changes to width-to-depth ratios and increased sedimentation rates in low gradient sections of the lower river reaches are also noted.

Confidence in conclusion

- HIGH

Rainy Creek

According to the 1991 USFS stream survey report for Rainy Creek, visual estimates showed a high percent of embeddedness below the (fish passage) barrier falls (RM 5.5). Extensive timber harvest and road placement may result in accelerated sediment delivery to the stream.

Confidence in conclusion

- MODERATE Empirical measurements have not been made.

Key Findings: Water Quality

Water quality for the Little Wenatchee River is essentially in pristine condition.

Temperature

Although temperatures exceed state and USFS forest plan standards during the summer months, temperatures are likely at or near pristine condition.

Confidence in conclusion

- HIGH

Key Findings: Water Quantity

Flow

Water flow conditions are likely at or near pristine conditions within the White River watershed. Timber harvest in the Rainy Creek drainage may have increased peak flows due to road density, but to a minor degree.

Confidence in conclusion

- HIGH

Key Findings: Obstructions to Fish Passage

Fish passage throughout this watershed is similar to pristine conditions.

Confidence in conclusion

- HIGH

Summary of Limiting Factors

- Competition (brook trout)

Hypothesis Statements

Riparian/Floodplain Condition

Maintaining and improving riparian and floodplain habitats and functionality will maintain favorable summer stream temperatures, in-channel structural diversity and recruitment of large

wood, adequate micro-refugia during extreme flow and temperature conditions and healthy macro-invertebrate production. All of these contributions will maintain productivity of all focal species and life stages occupying these areas by maintaining key habitat quality and quantity.

Competition and Predation

Control or elimination of brook trout will improve productivity and potentially life history diversity for bull trout and cutthroat trout by reducing inter-breeding, competition and predation in the upper watersheds of this assessment unit.

6.4.9 White River Assessment Unit

Key Findings: Riparian Floodplain Condition and Function

Riparian and floodplain conditions are in good to excellent condition. The White River still has abundant, good quality, side channel and oxbow habitat in the lower reaches.

In the lower White River (from the mouth upstream to the Napeequa River confluence at RM 11.0), historic logging and land clearing has altered riparian habitat. Localized sections of the White River have been riprapped and/or active bank erosion is evident in association with roads, bridges, dispersed recreation, or other development.

Confidence in conclusion

- HIGH

Key Findings: Stream Channel Conditions and Function

Throughout much the lower reaches of the White River (below Panther Creek) there is abundant, good quality, side channel habitat and also excellent oxbow habitat. The upper watershed remains hydrologically intact to the floodplain and is at or near pristine condition.

Habitat diversity

Channel conditions between Napeequa River and Panther Creek are altered as a result of past logging. Pool frequency in this area may be low for its channel type. Historic log drives and a large sediment pulse have contributed to this condition.

Confidence in conclusion

- MODERATE Empirical measurements have not been made.

Key Findings: Water Quality

Water quality

Water quality is considered to be at or near pristine conditions.

Confidence in conclusion

- HIGH

Key Findings: Water Quantity

Flow

Water quantity is considered to be at or near pristine conditions.

Confidence in conclusion

- HIGH

Key Findings: Obstructions to Fish Passage

Fish passage throughout this watershed is similar to pristine conditions.

Confidence in conclusion

- HIGH

Key Findings: Ecological Conditions

Summary of Limiting Factors

- Competition (brook trout)
- Riparian Floodplain Function
- Habitat Diversity

Hypothesis Statements

Riparian/Floodplain Condition

Maintaining and improving riparian and floodplain habitats and functionality will maintain favorable summer stream temperatures, in-channel structural diversity and recruitment of large wood, adequate micro-refugia during extreme flow and temperature conditions and healthy macro-invertebrate production. All of these contributions will maintain productivity of all focal species and life stages occupying these areas by maintaining key habitat quality and quantity.

Improving riparian, floodplain and in-channel conditions in the lower White River will increase key in-channel habitat quality and quantity for the following focal species and life stages.

Table 59: White River hypothesis statements: riparian/floodplain condition

Focal Species	Key Life Stages	Degree of Effect	Level of Certainty
Spring Chinook	Juvenile Rearing Pre-spawning Adult	Low Low	High High
Sockeye	Juvenile Rearing Pre-spawning Adult	Low Low	High High
Bull Trout	Juvenile Rearing Pre-spawning Adult	Low Low	High High
Cutthroat Trout	Juvenile Rearing Pre-spawning Adult	Low Low	High High

Competition and Predation

Control or elimination of brook trout will improve productivity and potentially life history diversity for bull trout and cutthroat trout by reducing inter-breeding, competition and predation in the upper watersheds of this assessment unit.

6.4.10 Chiwawa River Assessment Unit

Key Findings: Riparian Floodplain Condition and Function

Riparian and floodplain habitat conditions in the Chiwawa watershed are in good to excellent condition. Some riparian habitats have been altered in the lower reaches from road construction and rural development in the floodplain.

The Chiwawa River valley floor has an extensive high quality network of ponds, beaver canals, side channels, abandoned oxbows and other wetlands. Abundance, diversity, connectivity and quality of these wetlands are extremely high.

Confidence in conclusion

- HIGH

Key Findings: Stream Channel Conditions and Function

Streambank and in-channel conditions throughout the Chiwawa watershed are in good to excellent condition. Localized areas in the lower watershed have degraded stream banks. Overall, however, the degradation is considered relatively minor at the watershed scale.

Confidence in conclusion

- HIGH

Key Findings: Water Quality

water quality is considered to be at or near pristine condition.

Confidence in conclusion

- HIGH

Key Findings: Water Quantity

Flow

Soils are generally shallow in the Chiwawa watershed resulting in relatively low capacity for water storage and streams that rise rapidly in response to precipitation. Nevertheless, flow is well-sustained during the summer and fall months because of high altitude snow fields and glaciers.

An irrigation water diversion is located at RM 3.6. Although the diversion is for 33.3 cfs, the actual water diverted is approximately 12-16 cfs according to the Chiwawa watershed analysis (1996). This diversion is screened and can take up to 25% of the stream flow in late summer during low flow years. Potential affects to fish are thought to be low.

Confidence in conclusion

- MODERATE

Key Findings: Obstructions to Fish Passage

Fish movement throughout the Chiwawa watershed is essentially unhindered from the historic reference condition. Several culverts, though, have been identified within tributary streams that are known to limit bull trout movement. At RM 8.0 the Chelan Public Utility District operates a fish weir as part of their chinook salmon brood stock collection program. It is not yet understood if this weir significantly inhibits migration of bull trout into the Chiwawa River.

Confidence in conclusion

- HIGH

Key Findings: Ecological Conditions

Summary of Limiting Factors

- Competition (brook trout)

Hypothesis Statements

Riparian/Floodplain Condition

Maintaining and improving riparian and floodplain habitats and functionality will maintain favorable summer stream temperatures, in-channel structural diversity and recruitment of large wood, adequate micro-refugia during extreme flow and temperature conditions and healthy macro-invertebrate production. All of these contributions will maintain productivity of all focal species and life stages occupying these areas by maintaining key habitat quality and quantity.

Competition and Predation

Control or elimination of brook trout will improve productivity and potentially life history diversity for bull trout and cutthroat trout by reducing inter-breeding, competition and predation in the upper watersheds of this assessment unit.

6.4.11 Lake Wenatchee Assessment Unit

[No information to date]

6.5 Determination of Restoration Priorities

(*The following taken from the RTT Biological Strategy, 2003*.) The Wenatchee River is unique among subbasins in the upper Columbia region in that it supports the greatest diversity of populations and overall abundance of salmonids, yet is facing the greatest risk of habitat loss and degradation. There are core populations of sockeye salmon, steelhead, bull trout and both spring and late-run chinook salmon in the upper Wenatchee subbasin that are relatively strong, when compared to other populations in the Columbia basin. The current core population of coho salmon reintroduced to mid-Columbia tributaries is in the Wenatchee subbasin. The highest regional priority (Columbia Cascade Province) should be the protection of this salmonid community. The immediate strategy should be to protect the watersheds that contain these core

populations so that they are robust to normal environmental disturbances, and then to expand their range to adjacent watersheds.

Priority watersheds within the Wenatchee subbasin are White River, Chiwawa River, and the upper and middle mainstem Wenatchee River (including Lake Wenatchee). These watersheds are well connected and support a diverse assemblage of native species. Efforts should be made to connect Nason Creek, Middle Mainstem Wenatchee River, and Icicle Creek to these strongholds, which would enable a fuller expression of life history strategies and increase population resilience.

Recent research indicates that the mainstem Wenatchee River provides important habitat for many life stages of spring and late-run chinook salmon, coho salmon, steelhead, and bull trout. The mainstem at this time is most vulnerable to riparian and instream habitat degradation. All remaining intact habitat on the mainstem should be maintained, and floodplain function should be restored, particularly from the Mission Creek confluence downstream to the Columbia River confluence. This could primarily be done with passive restoration. Since this reach has the highest discharge in the subbasin, the extent of riparian vegetation needed to restore flood plain function would be larger than the tributaries. Benefits of this action would be numerous to anadromous and inland salmonids, as well as a myriad of wildlife species.

Priorities in Species Distribution

Threatened, endangered and unlisted salmonids are found in most, but not all watersheds in the upper Columbia region. In order to help guide protection and restoration programs, the Regional Technical Team (RTT) identified significant sub watersheds (HUC-6 level) for spring chinook salmon, summer chinook salmon, sockeye salmon, summer steelhead, bull trout, and westslope cutthroat trout. The RTT considered a sub watershed to be significant if any one of the following criteria was met:

The sub watershed was identified as a stronghold for the species in the Interior Columbia Basin Assessment (ICBEMP 1997).

The sub watershed provides the primary spawning and/or rearing habitat within the watershed.

The sub watershed represents the only known occupied habitat within a watershed and is fairly isolated from populations in other watersheds, and thus is significant from a distribution standpoint.

The sub watershed contributes to ward the genetic integrity of a species. One of the problems facing many native fish populations is genetic introgression. Relatively pure populations, which may be very important to the evolutionary legacy of a species, may be limited. Recently genetic information has become available for some populations in the upper Columbia region. Populations judged to be “pure,” “essentially pure,” or “good” based upon genetic analysis were considered to be significant.

The sub watershed is known or strongly suspected to support a stable, strong population of a species.

Appendix C contains maps of RTT identified significant sub watersheds for sockeye salmon, spring chinook salmon, summer chinook salmon, steelhead, and bull trout. The designation of

significant sub watershed does not necessarily depict the total distribution or life history stages of salmonids in the upper Columbia region. The status of some salmonid species is not fully known.

Priorities Across Varied Landscapes

The consensus of the RTT is that protection and restoration should focus first on maintaining the best remaining examples of biological integrity, connectivity, and diversity. This strategy will allow the populations to stabilize in abundance and productivity over the long term. It may be likely however, that current core populations have inadequate diversity and spatial distribution to ensure population resiliency.

To provide a framework to set priorities consistent with this strategy, the RTT classified each watershed (HUC-5 level) in the Wenatchee subbasin into four categories, based on the functionality of the aquatic ecosystems in those watersheds, and the capability of the ecosystem to protect against ecological catastrophe for endemic populations. The RTT adapted the classification system used by Quigley and Arbelbide (1997) for this report. In general, Category 1 watersheds should receive priority allocation of financial and/or management resources. Subsequent allocation of resources should be given to Categories 2 and 3, in that order, once refuge habitats (Category 1) for the target species are protected and secure. This does not mean however, that specific actions should not occur in Category 2 and 3 watersheds until all activities in Category 1 watersheds are completed. Any project within those watersheds that increase the range, life history diversity, or age cohorts of one or more species would contribute to the overall strategy of making them more robust to disturbances within and outside the region. As salmon recovery progresses, founder populations from core areas would colonize many watersheds that are suitable, yet unoccupied. Restoration of Category 4 watersheds should be considered in the regional recovery planning process, but immediate actions there would not be a priority.

Category 1

These watersheds represent systems that most closely resemble natural, fully functional aquatic ecosystems (Table 60). In general, they comprise large, often continuous blocks of high-quality habitat and sub watersheds supporting multiple populations. Connectivity among sub watersheds and through the mainstem river corridor is good, and more than two species of federally listed fish are known to occur. Exotic species may be present but are not dominant. Protecting the functioning ecosystems in these watersheds is a priority.

Category 2

These watersheds support important aquatic resources, often with sub watersheds classified as strongholds for one or more populations throughout. The most important difference between Category 1 and Category 2 is an increased level of fragmentation that has resulted from habitat disturbance or loss. These watersheds have a substantial number of sub watersheds where native populations have been lost or are at risk for a variety of reasons. At least one federally listed fish species can be found within the watershed. Connectivity among sub watersheds may still exist or could be restored within the watershed so that it is possible to maintain or rehabilitate life history patterns and dispersal. Restoring ecosystem functions and connectivity within these watersheds are priorities.

Category 3

These watersheds may still contain sub watersheds that support salmonids. In general, however, these watersheds have experienced substantial degradation and are strongly fragmented by extensive habitat loss, most notably through loss of connectivity with the mainstem corridor. At this time, there are limited opportunities for restoring full expression of life histories for multiple populations found within the watershed. The priority for funding in these watersheds should be to rectify the primary factor that is causing the habitat degradation.

Category 4

These watersheds contain both functional and non-functional habitats that historically supported populations of one or more federally listed species. Exotic species may now be dominant in one or more sub watersheds; native species are typically not present in sustainable numbers.

Table 60. Comparison of key indicators for watershed categories

Categories used to identify priority actions for protection and restoration of salmonid habitat in the upper Columbia region					
Category	**Significant Sub watersheds**	**Principle Actions**	**Habitat Fragmentation**	**Exotic Species**	**Listed Species**
1	Yes	Protection	Low	Low	Two or more
2	Yes	Protection / Restoration	Medium	Medium	One or more
3	Possible	Restoration	High	High	Possible
4	No	Restoration	High	High	Possible

Priorities in Habitat Activities

Habitat Protection

The highest priority for protecting biological productivity should be to allow unrestricted stream channel migration, complexity, and flood plain function. The principal means to meet this objective is to protect riparian habitat in Category 1 and 2 sub watersheds. Predetermined riparian protection measures (i.e., buffer strip widths) for each site may not be biologically effective. Riparian function depends on site-specific considerations including channel type, floodplain character, presence of wetlands or off-channel features, and the potential for channel migration. Obviously, some areas have more acute needs, because they may be within significant population areas, or may be at risk to habitat degradation, and should be given greater emphasis. These efforts will likely occur throughout the subbasins where properly functioning habitat remains.

Protection of existing stream flows in virtually all subbasins in the Wenatchee subbasin is important to maintaining biological productivity. Currently, the primary means to protect existing flows are regulatory in nature. Additionally, some streams may need increased flows to address chronic sources of mortality to salmonids; inadequate flows may be natural or human-caused. Diversion of water for out-of-stream uses (principally for irrigation and municipalities) is the most tangible impact to instream flow needs for fish. In addition, degradation of floodplain (and some upland) habitats exacerbates the peak and nadir of seasonal flows in all upper

Columbia subbasins; this strongly reduces the productivity and expression of diverse life histories in the region. The full effects of upland habitat degradation on peak flows in the Wenatchee subbasin are not understood and should be assessed. The means to increase flows are discussed in the section on habitat restoration.

Habitat Restoration

The highest priority for increasing biological productivity is to restore the complexity of the stream channel and floodplain. The RTT recommends a range of strategies for habitat restoration in the upper Columbia region, based on a fundamental emphasis of promoting habitat diversity, instream flows, and water quality throughout the watershed. Most of these efforts will likely be on the lower stream reaches and aggradation zones (typically areas of low stream gradient where deposition of substrate materials occurs). Restoration in these areas would benefit a broad range of species and populations.

The RTT Biological Strategy (2003) strongly recommends that structural manipulation of the stream channel (such as boulder or log placements) not be used unless (1) they are designed at the reach level or context and (2) those factors that are causing the habitat degradation cannot be corrected within a reasonable time. Remedial measures to rectify the effects of improper land use practices can have more benefits to biological productivity, may be economically more efficient, and be more permanent than measures that require active management of the stream channel. The simple alteration of physical features in the stream channel does not necessarily restore biological productivity when improper riparian or upland management practices continue to exert their effects on the aquatic ecosystem. Attempts to restore habitat are likely to fail if structures are placed in the stream channel without addressing those activities that are causing habitat degradation. For example, some short-term habitat benefits might be achieved by adding large woody debris to streams, but the benefits can only be temporary from an ecological perspective unless riparian management practices ensure the long term recruitment of LWD from the riparian zone.

In some isolated situations, restoration projects may be accomplished with both short-term and long term objectives. For example, LWD may be secured to stabilize erosive banks, allowing interim streambank protection and salmonid habitat, while passive restoration and re-vegetation will ensure proper functioning riparian conditions for the long term. We feel these projects are biologically effective when the initiation of the short-term strategy has been integrated with the long term strategy. Each active restoration project should be reviewed on a case-by-case basis.

Table 61. Categories of watersheds the Wenatchee subbasin

Categories of watersheds (HUC*-5 level) and number of significant sub watersheds (HUC-6 level) within those watersheds			
Subbasin	**Watershed**	**Category**	**Significant watersheds**
Wenatchee	Mainstem Upper Wenatchee	1	2
	Mainstem Middle Wenatchee	1	2
	Mainstem Lower Wenatchee	2	1
	White River	1	5
	Little Wenatchee River	1	5

Categories of watersheds (HUC*-5 level) and number of significant sub watersheds (HUC-6 level) within those watersheds			
Subbasin	**Watershed**	**Category**	**Significant watersheds**
	Lake Wenatchee	1	NA
	Nason Creek	2	3
	Chiwawa River	1	6
	Icicle Creek	2	4
	Chumstick Creek	3	0
	Peshastin Creek	2	3
	Mission Creek	3	3

(1) HUC – hydrologic unit code

(2) Definitions of watershed categories and Significant Sub watersheds are provided in text.

6.6 Reference Conditions

A reference condition is a benchmark from which habitat changes and/or population performance can be compared over time. The Technical Subcommittee used the Qualitative Habitat Assessment (QHA) process to define the Historic, Current and Existing Trend reference conditions. Reference conditions are described below, each are qualitative in nature but intended to provide context for identifying potential policy considerations over a relatively large time (year 2050) and geographic (subbasin) scale.

The Presumed Historic reference condition establishes the hypothetical "natural" environment. This description is based upon professional judgment, although it is important to note that there are many environments within the Wenatchee subbasin and Columbia Cascade Province that retain pristine habitat features that allow resource managers to confidently describe many historic environmental attributes. The presumed historic reference condition is described in the Qualitative Habitat Analysis in electronic appendix (see NPCC ftp site).

The Current reference condition describes existing conditions. Because habitats and populations respond to many variables, responses are described as an "average" over the past 10-years. Many of these habitat attributes were evaluated using existing information available to the Technical Subcommittee, although some attributes remain un-surveyed and are not documented. The Current reference condition is described in the Qualitative Habitat Analysis in electronic appendix (see NPCC ftp site).

There are two future reference conditions; the Optimal (or Desired Future Condition) and the Existing Trend. Each of these future conditions projects to the year 2050. The Optimal reference condition (with regards to fish and wildlife habitat and population attributes) anticipates that substantial resources are available for fish and wildlife habitat and propagation improvements over a sustained time period. The Optimal reference condition is synonymous with biological and environmental conditions stated in the Habitat and Biological Objectives, as identified in Section 7, Management Plan.

The Existing Trend reference condition anticipates a relatively constant pattern in urban/rural development and fish/wildlife funding levels (as compared to the last 10-years) to maintain and/or enhance fish and wildlife resources. The Technical Subcommittee examined general trend in land use. From these discussions, the following general statements can be derived:

Environmental conditions for focal species on lands under public management are generally improving, particularly for floodplain/riparian areas and in-channel (stream) management. Environmental conditions in the upper watersheds of Mission, Peshastin and Chumstick creeks are likely to improve significantly over existing conditions as large-scale natural disturbance regimes are being managed to mimic a more natural range of environmental variability. Improvements in road management will also contribute to improved environmental function and health.

Rural, agricultural and urban developments within the subbasin are expected to continue growing through time. Development will probably be most acute throughout the lower portions of the Wenatchee River, Mission Creek, Chumstick Creek. To a lesser degree development is also expected to occur in lower Icicle Creek, Nason Creek the Chiwawa River and areas surrounding Lake Wenatchee. These areas have key environmental attributes that long term viability of anadromous salmonid productivity will be dependent upon . Because these areas are some of the most sensitive within the subbasin (in terms of critical salmonid habitats) a relatively high potential exists that habitat conditions for these species may be degraded over time. As riparian and floodplain areas are developed, there is a tendency for land owners to protect investments. Typically this results in riparian simplification, bank hardening or armoring (dikes) and stream channel confinement. As habitat modifications occur, geo-fluvial processes and function will be disrupted. Habitat attributes most likely affected will include, but are not limited to lost riparian/floodplain vegetation and connectivity to the mainstem streams, lost side-and off-channel habitats, stream down-cutting (entrenchment) and channel destabilization, lost habitat diversity and lost carrying capacity for most focal species life stages.

Focal fish species responses have been estimated for each of the reference conditions. These estimates are qualitative and meant more to indicate trend rather than an absolute value. The reader should note the difficulty involved in separating out-of-basin effects from those within basin. This evaluation assumes effects within the Wenatchee subbasin.

The following discussion summarizes the key assumptions and estimated affects to focal species for each of the reference conditions.

6.6.1 Spring Chinook

Assumptions: Spring chinook were widely distributed throughout much of the subbasin. Distribution has been reduced somewhat, primarily in Peshastin Creek, and possibly in Chumstick and Mission creeks but to a lesser degree. Past developments have reduced habitat quality and quantity. Future developments will continue this trend, and key habitats may not be adequately protected under existing land use regulations. Integrated hatchery production should aid population abundance if implemented correctly. There are significant opportunities to maintain, improve and create additional habitat in the long term although much of this work would be relatively costly.

Table 62. Summary of estimated spring chinook population responses to reference conditions.

	Spatial Distribution	Population Abundance	Biological Productivity	Life History Diversity
Historic	High	Moderate-High	Moderate	High
Current	Moderate-High	Low-Moderate	Low-Moderate	Moderate
Existing Trend	Moderate	Moderate	Low-Moderate	Moderate
Optimal	High	Moderate-High	Moderate-High	Moderate-High

6.6.2 Late-run Chinook

Distribution of late-run chinook is contained within the mainstem of the Wenatchee River and lower Icicle Creek and remains similar to historic conditions. Changes in habitat conditions throughout the system have reduced habitat quality and quantity thereby reducing life history diversity, population abundance and productivity. Future trends are not expected to significantly improve existing biological parameters and potential degradation of conditions could occur above Tumwater Canyon with additional development and alteration of riparian areas. Future habitat enhancements could increase these parameters to a relatively high level.

Table 63. Summary of estimated late-run chinook population responses to reference conditions.

Late-run Chinook	Spatial Distribution	Population Abundance	Biological Productivity	Life History Diversity
Historic	Moderate	Very High	Very High	High
Current	Moderate	Moderate-High	High	Moderate-High
Existing Trend	Moderate	Moderate-High	High	Moderate-High
Optimal	Moderate	High	Very High	High

6.6.3 Sockeye

Biological parameters for sockeye have decreased since historic reference conditions primarily related to out-of-basin effects. Habitat degradation above Lake Wenatchee may have decreased abundance of egg and fry life stages. Degradation below Lake Wenatchee has reduced juvenile spatial distribution and life history diversity (Nason Creek). Maintaining key in-basin habitat conditions, implementing envisioned future habitat improvements and reduced mortality out-of-basin will likely increase all biological parameters.

Table 64. Summary of estimated sockeye population responses to reference conditions.

Sockeye Salmon	Spatial Distribution	Population Abundance	Biological Productivity	Life History Diversity
Historic	Moderate	High	Moderate-High	Moderate-High
Current	Moderate	Moderate	Moderate	Moderate
Existing Trend	Moderate	Moderate	Moderate	Moderate
Optimal	Moderate-High	Very High	Moderate-High	Moderate-High

6.6.4 Coho

Existing feasibility efforts to re-introduce coho appear promising but results are difficult to measure at this early point. Continuation of artificial production efforts will likely continue to increase all biological parameters, especially if brood stock selection techniques can develop a more genetically suitable stock for this subbasin. Improvements in habitat conditions in the mainstem Wenatchee River, in lower Nason, Mission and Chumstick creeks, and to a lesser degree Icicle Creek is needed to provide for increases in biological parameters and achievement of a long term self-sustainable population.

Table 65. Summary of estimated coho population responses to reference conditions.

Coho Salmon	Spatial Distribution	Population Abundance	Biological Productivity	Life History Diversity
Historic	Moderate-High	Unknown	Unknown	Moderate-High
Current	Low-Moderate	Low	Low-Moderate	Low
Existing Trend	Moderate	Moderate	Moderate	Moderate
Optimal	Moderate-High	Moderate-High	Moderate-High	Moderate-High

6.6.5 Steelhead

Assumptions: Steelhead were and continue to be widely distributed throughout much of the subbasin. Past developments have reduced habitat quality and quantity, thereby decreasing abundance and productivity. Future developments will continue this trend, and key habitats in the lower portions of most Assessment Units may not be adequately protected under existing land use regulations. Key habitats in the upper watersheds are likely to remain protected habitat conditions will continue to improve. There are significant opportunities to improve and create additional habitat in the long term. Much of this work would be relatively costly. Providing additional fish passage will increase each of the biological parameters.

Table 66. Summary of estimated steelhead trout population responses to reference conditions.

Steelhead Trout	Spatial Distribution	Population Abundance	Biological Productivity	Life History Diversity
Historic	High	High	Moderate-High	High
Current	Moderate-High	Low	Low	Moderate
Existing Trend	Moderate	Moderate-Low	Moderate-Low	Moderate
Optimal	High	Moderate-High	Moderate-High	High

6.6.6 Bull Trout

Biological parameters for bull trout have all been degraded from the Presumed Historic reference condition. Changes in habitat conditions, in-basin harvest and obstructions to fish passage have significantly reduced these parameters. Recent changes in many management practices have reversed this trend. Future management trends in the upper watersheds will likely allow an increase to all parameters, especially if passage is restored to higher elevation streams and competition with brook trout can be reduced or eliminated.

Table 67. Summary of estimated bull trout population responses to reference conditions.

Bull Trout	Spatial Distribution	Population Abundance	Biological Productivity	Life History Diversity
Historic	High	Moderate-High	Moderate	High
Current	Moderate-High	Low-Moderate	Low-Moderate	Moderate
Existing Trend	Moderate-High	Moderate	Moderate	Moderate-High
Optimal	High	Moderate-High	Moderate	High

6.6.7 Westslope Cutthroat Trout

Westslope cutthroat trout were introduced into areas that were not inhabited in the Presumed Historic reference condition, thereby increasing spatial and life history diversity. As a result abundance is assumed to also have increased. Cutthroat trout inhabit high elevation streams that are essentially pristine in condition. It is likely that these conditions will remain stable or improve (locally) somewhat over time. Productivity and abundance are likely to increase with improvements in water temperature, improvements in fish passage and implementation of a brook trout control or elimination program.

Table 68. Summary of estimated westslope cutthroat trout population responses to reference conditions.

Cutthroat Trout	Spatial Distribution	Population Abundance	Biological Productivity	Life History Diversity
Historic	Moderate	Low	Low-Moderate	Moderate
Current	Moderate-High	Low-Moderate	Low-Moderate	Moderate-High
Existing Trend	Moderate-High	Low-Moderate	Low-Moderate	Moderate-High
Optimal	Moderate-High	Moderate	Moderate	Moderate-High

6.6.8 Pacific Lamprey

Very little is known about Pacific Lamprey population abundance and distribution in the Wenatchee subbasin. Pacific Lamprey do require good water quality and relatively clean substrates to exist. There is essentially no information about habitat preference or suitability within the subbasin streams. The following summary is projected primarily from an academic understanding of this species.

Table 69. Summary of estimated Pacific lamprey population responses to reference conditions.

Cutthroat Trout	Spatial Distribution	Population Abundance	Biological Productivity	Life History Diversity
Historic	High	Higher than present	Higher than present	Higher than present
Current	Unknown	Unknown	Unknown	Unknown
Existing Trend	Unknown	Unknown	Unknown	Unknown
Optimal	High	High	High	High