4 Assessment

4.1 Focal Species

A focal species will be used to evaluate the health of the ecosystem and the effectiveness of management actions. Focal habitat types are used as the basis for the wildlife assessment.

Terrestrial/Wildlife: Because terrestrial wildlife species often are wide ranging and typically have varied habitat needs, key focal habitats were used as bio-indicators and several different species that are obligated to these habitats were selected for this evaluation. The three focal habitats and representative species selected for this evaluation are listed in Table 11.

Table 11. Wildlife focal habitats and representative species in the Wenatchee subbasin

Focal habitats	Wildlife Species Represented
Ponderosa – Mixed hardwood	White-headed woodpecker, Pygmy nuthatch, Flammulated owl, Grey flycatchers
Shrubsteppe	Sharp-tailed grouse, Grasshopper sparrow, Brewer's sparrow, Mule deer
Riparian	Red-eyed vireo, Yellow-breasted chat, Beaver

Aquatic/Fish: Fish focal species were defined that a) have special cultural significance, b) fulfill a critical ecological function, c) serve as an indicator of environmental health, d) are locally significant or rare as determined by applicable state or federal resource management agencies and/or are federally listed species. Eight anadromous and resident fish species were chosen as focal species. Each of these species is considered to be culturally important, three of the species are listed under the ESA and each species uniquely represent different and important habitat characteristics. The eight species and their representative habitat types are listed in Table 12.

Table 12. Fish focal species and representative habitats in the Wenatchee subbasin

Focal Fish Species	Habitats Represented
Spring chinook	Mid elevation tributary streams, Stream order 2-3.
Late-run chinook	Mid and lower Wenatchee River mainstem
Sockeye	Lake Wenatchee, lower White and Little Wenatchee rivers.
Coho	Lower – mid elevation mainstem and tributaries, side channel and backwater environments.
Steelhead	Lower – mid elevation mainstem and tributaries
Pacific lamprey	Undefined habitat, culturally important species.
Bull trout	Mid upper elevation tributaries
Cutthroat trout	Upper elevation, higher gradient tributaries.

4.2 Terrestrial/Wildlife Assessment

Methodology

The wildlife assessment was developed from a variety of tools including subbasin summaries, the Interactive Biodiversity Information System (IBIS), WDFW Priority Habitats and Species (PHS) database, Washington GAP Analysis database, Partners in Flight (PIF) information, National Wetland Inventory maps, Ecoregion Conservation Assessment (ECA) analyses, and input from local state, federal, and tribal wildlife managers. Specific information about these data sources is located in Appendix A.

Although IBIS is a useful assessment tool, it should be noted that the historic habitat maps have a minimum polygon size of 247 acres (1 km^2) while current IBIS wildlife habitat maps have a minimum polygon size of 250 acres (Ashley and Stovall 2004). In either case, linear aquatic, riparian, wetland, subalpine, and alpine habitats are under-represented, as are small patchy habitats that occur at or near the canopy edge of forested habitats. It is also likely that micro habitats located in small patches or narrow corridors were not mapped at all.

Another limitation of IBIS data is that they do not reflect habitat quality nor do they associate habitat elements (key ecological correlates or KECs) with specific areas. As a result, a given habitat type may be accurately depicted on IBIS map products, but may be lacking quality and functionality. For example, IBIS data do not distinguish between shrubsteppe habitat dominated by introduced weed species and pristine shrubsteppe habitat.

Washington State GAP data were also used extensively throughout the wildlife assessment. The GAP-generated acreage figures may differ from IBIS acreage figures as an artifact of using two different data sources. The differences, however, are relatively small (less than 5%) and will not impact planning and/or management decisions.

The ECA spatial analysis is a relatively new terrestrial habitat assessment tool developed by The Nature Conservancy. The ECA has not been completed in all areas within the greater Columbia River Basin. Where possible, however, WDFW integrated ECA outputs into ecoprovince/ subbasin plans.

The major contribution of ECA is the spatial identification of priority areas where conservation strategies should be implemented. ECA products were reviewed and modified as needed by local wildlife area managers and subbasin planners.

Wildlife Focal Species and Representative Habitats

Focal Wildlife Species Selection and Rationale

The focal species selection process is described in Appendix A. Ecoprovince and subbasin planners identified focal species assemblages for each focal habitat type.

Nine bird species and two mammalian species were selected to represent three priority habitats in the subbasin (Table 13). Life requisite habitat attributes for each species assemblage were pooled to characterize a range of management conditions, to guide planners in development of future habitat management strategies, goals, and objectives.

General habitat requirements, limiting factors, distribution, population trends, and analyses of structural conditions, key ecological functions, and key ecological correlates for individual focal species are included in Appendix A.

Establishment of conditions favorable to focal species will benefit a wider group of species with similar habitat requirements.

Table 13. Focal species selection matrix for the Columbia Cascade Ecoprovince

Common Name	Focal Habitat[1]	Status[2]		Native Species	Priority Habitat Species	Partners in Flight	Game Species
		Federal	State				
Sage thrasher	SS	n/a	C	Yes	Yes	Yes	No
Brewer's sparrow		n/a	n/a	Yes	No	Yes	No
Grasshopper sparrow		n/a	n/a	Yes	No	Yes	No
Sharp-tailed grouse		SC	T	Yes	Yes	Yes	No
Sage grouse		C	T	Yes	Yes	No	No
Pygmy rabbit		E	E	Yes	Yes	No	No
Mule deer		n/a	n/a	Yes	Yes	No	Yes
Willow flycatcher	RW	SC	n/a	Yes	No	Yes	No
Lewis woodpecker		n/a	C	Yes	Yes	Yes	No
Red-eyed vireo		n/a	n/a	Yes	No	No	No
Yellow-breasted chat		n/a	n/a	Yes	No	No	No
American beaver		n/a	n/a	Yes	No	No	Yes
Pygmy nuthatch	PP	n/a	n/a	Yes	No	No	No
Gray flycatcher		n/a	n/a	Yes	No	No	No
White-headed woodpecker		n/a	C	Yes	Yes	Yes	No
Flammulated owl		n/a	C	Yes	Yes	Yes	No

1 SS = Shrubsteppe; RW = Riparian Wetlands; PP = Ponderosa pine;

2 C = Candidate; SC = Species of Concern; T = Threatened; E = Endangered

Ashley and Stovall 2004

Focal Representative Habitats

Focal representative habitats selected for the subbasin include ponderosa pine, shrubsteppe, and riparian wetlands. Neither the IBIS nor the Washington GAP analysis data recognize the historic presence of riparian wetlands. The current extent of this habitat type as reflected in these databases is suspect at best; however, riparian wetland habitat is a high priority habitat wherever it is found in the ecoprovince. Agriculture, a habitat of concern, is not included as a focal habitat type at the subbasin level. Focal wildlife habitat types are fully described in Appendix A.

Areas Currently Under Protection Status

An estimated 312,670 acres (37%) are permanently protected in the subbasin. These lands have permanent protection from conversion of natural land cover, and a mandated management plan is in operation to maintain a natural state within which disturbance events of natural type are allowed to proceed without interference or are mimicked through management (high protection). Approximately 0.18% (1,611 acres) of the subbasin has permanent protection from conversion of natural land cover, and a mandated management plan is in operation to maintain a primarily natural state (medium protection status). The majority (361,418 acres; 42%) of lands in the subbasin has permanent protection from conversion of natural land cover but is subjected to uses of either a broad, low intensity type or localized intense type (low protection status). Approximately 21% (177,614 acres) of the lands within the subbasin lack irrevocable easements or mandates to prevent conversion of natural habitat types to anthropogenic habitat types (no protection). Lands owned by WDFW fall within the medium and low protection status categories.

Additional habitat protection, primarily on privately owned lands, is provided through the Conservation Reserve Program (CRP) and the Conservation Reserve Enhancement Program (CREP). The CRP is intended to reduce soil erosion on upland habitats through establishment of perennial vegetation on former agriculture lands. Similarly, CREP conservation practices reduce stream sedimentation and provide protection for riparian/riverine habitats using buffer strips comprised of herbaceous and woody vegetation.

Both programs provide short-term (CRP-10 years; CREP-15 years), high protection of habitats enrolled in either program. Congress authorizes program funding /renewal, while the US Department of Agriculture (USDA) determines program criteria. Program enrollment eligibility and sign-up is decentralized to state and local Natural Resources Conservation Service (NRCS) offices.

Rare Plant Communities

The Wenatchee subbasin contains 22 rare plant communities Approximately 32% of the rare plant communities are associated with shrubsteppe habitat, and 68% with upland forest habitat.

Noxious Weeds

Changes in biodiversity have been closely associated with changes in land use. Grazing, agriculture, and accidents have introduced a variety of exotic plants, many of which are vigorous enough to earn the title noxious weed. Twenty-six species of noxious weeds occur in the subbasin. The primary weed species in the subbasin are cheatgrass, knapweeds, and Dalmatian toadflax (USFS 1999).

Vegetation Zones

Eight historic (potential) vegetation zones that occur within the subbasin. The three-tip sage, central arid steppe, and ponderosa pine vegetation zones are described in detail in Ashley and

Stovall (2004).These vegetation zones constitute focal habitat types. Douglas-fir, grand fir, mountain hemlock, subalpine fir, and alpine parkland are not focal habitat types, but these vegetation zones occur extensively throughout the subbasin.

Changes in Wildlife Habitat

Dramatic changes in wildlife habitat have occurred throughout the subbasin since pre-European settlement (c.1850). Quantitative changes in all subbasin wildlife habitat types are compared in Table 14 (Ashley and Stovall 2004).

Table 14. Historic and current wildlife habitat types in the Wenatchee subbasin

Status	Historic	Current	Change (%)	Habitat Type Description
Westside Lowlands Conifer-Hardwood Forest	11,618	1,411	-88	One or more of the following are dominant: Douglas fir, western hemlock, western red cedar, Sitka spruce, red alder.
Montane Mixed Conifer Forest	201,957	149,209	-25	Coniferous forest of mid to upper montane sites with persistent snowpack; several species of conifer; understory typically shrub-dominated.
Eastside (Interior) Mixed Conifer Forest	175,260	389,213	56	Coniferous forests and woodlands; Douglas fir commonly present, up to 8 other conifer species present; understory shrub and grass/forb layers typical; mid montane.
Lodgepole Pine Forest and Woodlands	117,417	4,287	-97	Lodgepole pine dominated woodlands and forests; understory various; mid to high elevations.
Ponderosa Pine Forest and Woodlands	208,137	51,912	-74	Ponderosa pine dominated woodland or savannah, often with Douglas fir, shrub, forb, or grass understory; lower elevation forest above steppe, shrubsteppe.
Upland Aspen Forest	742	0	-100	[No information to date]
Subalpine Parkland	65,754	36,044	-44	Coniferous forest of subalpine fir, Engelmann spruce and lodgepole pine.
Alpine Grasslands and Shrublands	21,506	108,886	81	This habitat is dominated by grassland, dwarf-shrubland (mostly evergreen microphyllous), or forbs.
Eastside (Interior) Grasslands	28,180	38,377	11	Dominated by short to medium height native bunchgrass understory with forbs, crust.
Shrubsteppe	9,146	24,248	64	Sagebrush and/or bitterbrush dominated; bunchgrass understory with forbs, cryptogram crust.
Agriculture, Pastures, and Mixed Environs	0	30,700	100	Cropland, orchards, vineyards, nurseries, pastures, and grasslands modified by heavy grazing; associated structures.
Urban and Mixed Environs	0	1,752	100	High, medium, and low (10-29% impervious ground) density development.
Open water—Lakes, Rivers, Streams	1,236	8,154	82	Lakes are typically adjacent to Herbaceous Wetlands, while rivers and streams typically adjoin Eastside Riparian Wetlands and Herbaceous Wetlands.
Herbaceous Wetlands	0	41	100	[No information to date]
Montane Coniferous Wetlands	0	8,937	100	Forest or woodland dominated by evergreen conifers; deciduous trees may be co-dominant; understory dominated by shrubs, forbs, or graminoids; mid to upper montane.

Status	Historic	Current	Change (%)	Habitat Type Description
Eastside (Interior) Riparian Wetlands	0	141	100	Shrublands, woodlands and forest; less commonly grasslands; often multi-layered canopy with shrubs, graminoids, forbs below.

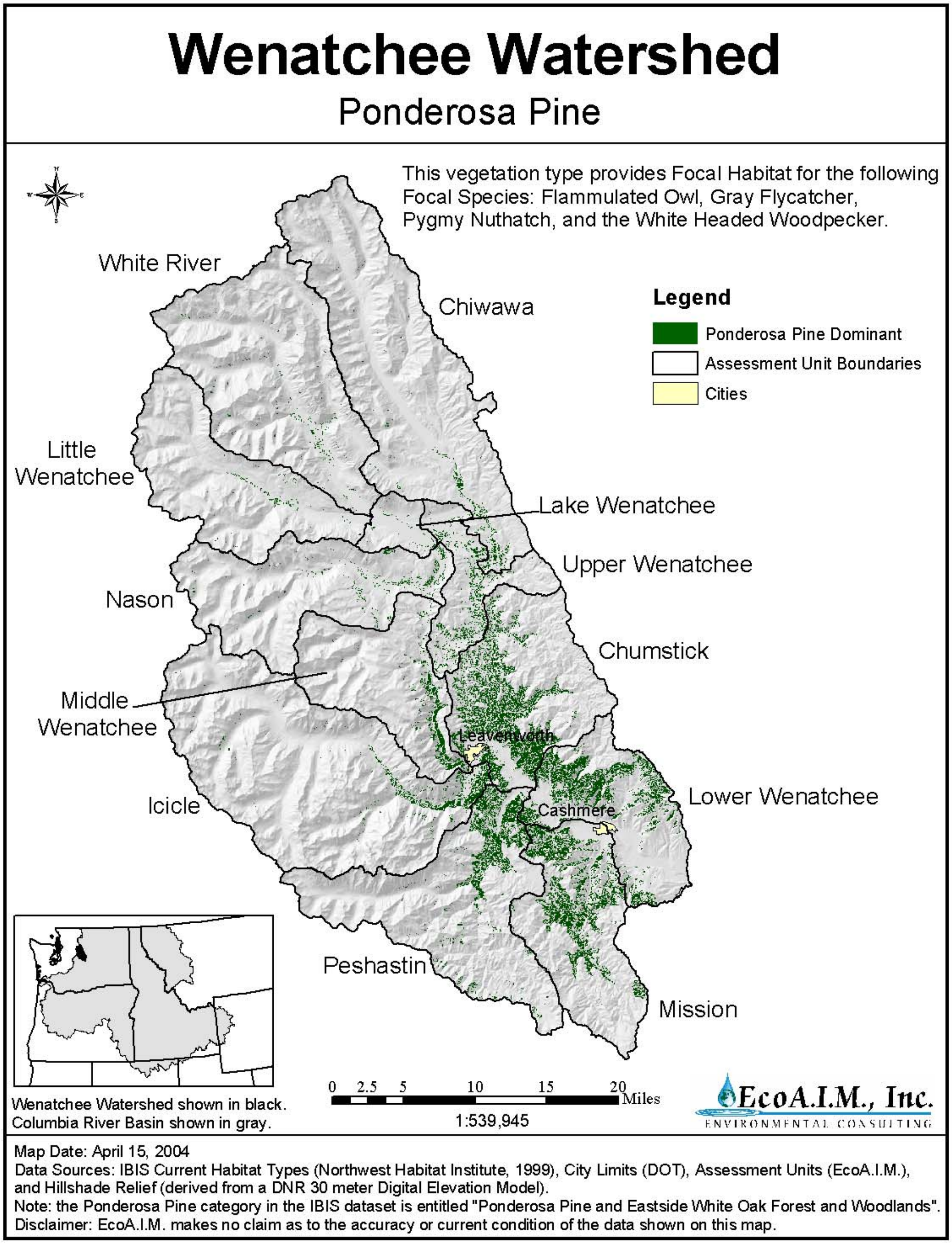

Figure 2. Ponderosa Pine distribution in the Wenatchee subbasin

4.3 Ponderosa Pine

Historically in the subbasin, old-growth ponderosa pine forests occupied areas between the shrubsteppe zone and moister forest types at higher elevations. Large, widely spaced, fire-resistant trees and an understory of forbs, grasses, and shrubs characterized these forests. Periodic low-intensity fires maintained this habitat type. With the settlement of the subbasin, most of the old pines were harvested for timber, and the frequent low-intensity fire regime has been aggressively suppressed. With the settlement of the subbasin, most of the old pines were harvested for timber, and frequent fires have been suppressed. As a result, much of the original forest has been replaced by dense second growth of Douglas-fir and ponderosa pine with little understory.

Extant ponderosa pine habitat within the subbasin currently covers a wide range of seral conditions. Forest management and fire suppression have led to the replacement of old-growth ponderosa pine forests by younger forests with a greater proportion of Douglas-fir than pine stands.

Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that gives the habitat a more closed, multi-layered canopy. . For example, this habitat includes stands previously maintained by natural fire in which grand fir can eventually become the canopy dominant. Large late-seral ponderosa pine and Douglas-fir are harvested in much of this habitat type. Under most management regimes, tree size decreases and tree density increases.

Introduced annuals, especially cheatgrass and invading shrubs under heavy grazing pressure, have replaced native herbaceous understory species. Four exotic knapweed species *(Centaurea* spp.*)* are spreading rapidly through the ponderosa pine zone and threatening to replace cheatgrass as the dominant increaser after grazing. Dense cheatgrass stands eventually change the fire regime of these stands often resulting in stand replacing, catastrophic fires. Bark beetles, primarily of the genus *Dendroctonus* and *Ips*, kill thousands of pines annually and are the major mortality factor in commercial saw timber stands.

Historically in the Wenatchee subbasin, 7% (3,577 acres) of the dry forest was in openings, 80% (40,876 acres) was low density park-like with 10-55% canopy closure, and 13% (6,642 acres) was high density with >55% canopy closure (USFS 1999). Currently, 7% (3,767 acres) remains in dry forest openings (nonforested, i.e., recent fire, clear cut), 41% (20,661 acres) is dry forest low density and lacking understory of more than 75% of the area, and 51% (25,907 acres) is high-density dry forest that is successionally advanced (USFS 1999).

In the North Cascades region, including sampled watersheds in the Lake Chelan and Wenatchee subbasins, ponderosa pine cover decreased from 16.5 to 13.2% (Peven 2003. This information was based on comparison of 337 randomly selected sub- watersheds in 43 of 164 watersheds using 1932-1966 aerial photos compared to 1981-1993 aerial photos. Other changes noted included decreased connectivity and decreased patch size (increased fragmentation). Douglas fir cover increased during the same interval.

Protection Status

The protection status of remaining ponderosa pine habitat in all watersheds fall primarily within the low to no protection status categories. As a result, this habitat type will likely suffer further degradation, disturbance, and/or loss in all ecoprovince subbasins.

Factors Affecting Ponderosa Pine Habitat

Factors affecting ponderosa pine habitat are explained in detail in section Appendix A and are summarized below:

- 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.
- Targeting insects that are detrimental to forest health for biocide application may have negative ramifications on lepidopterans and non-target avian species

Ponderosa Pine Community

4.3.1 White-headed Woodpecker

The white-headed woodpecker represents species that require/prefer large patches (greater than 350 acres) of open mature/old growth ponderosa pine stands with canopy closures between 10–50% and snags (a partially collapsed, dead tree) and stumps for nesting (nesting stumps and snags grater than 31 in. in diameter at breast height (DBH). Abundant white-headed woodpecker populations can be present on burned or cut forest with residual large diameter live and dead trees and understory vegetation that is usually very sparse. Openness however, is not as important as the presence of mature or veteran cone producing pines within a stand.

4.3.2 Pygmy Nuthatch

The pygmy nuthatch represents species that require heterogeneous stands of ponderosa pine with a mixture of well-spaced, old pines and vigorous trees of intermediate age and those species that depend on snags for nesting and roosting, high canopy density, and large diameter (greater than 18 in. DBH) trees characteristic of mature undisturbed forests. Connectivity between suitable habitats is important for species, such as pygmy nuthatch, whose movement and dispersal patterns are limited to their natal territories.

4.3.3 Flammulated Owls

Flammulated owls represent wildlife species that occupy ponderosa pine sites comprised of multiple-canopy, mature ponderosa pine stands or mixed ponderosa pine/Douglas-fir forest interspersed with grassy openings and dense thickets. Flammulated owls nest in habitat types with low to intermediate canopy closure, two layered canopies, tree density of 508 trees/acre (9-ft. spacing), basal area of 250 sq. ft./acre, and snags greater than 20 in. diameter at breast height (DBH) and 3-39 ft. tall. Food requirements are met by the presence of at least one snag greater than 12 in. DBH/10 acres and 8 trees/acre greater than 21 in. DBH.

4.3.4 Gray Flycatchers

Gray flycatchers represent wildlife species that occupy the pine/shrubsteppe interface (pine savannah) with a shrub/bunchgrass understory. Gray flycatchers require nest trees 18 in. DBH and a tree height of 52 ft. for their reproductive life requisites.

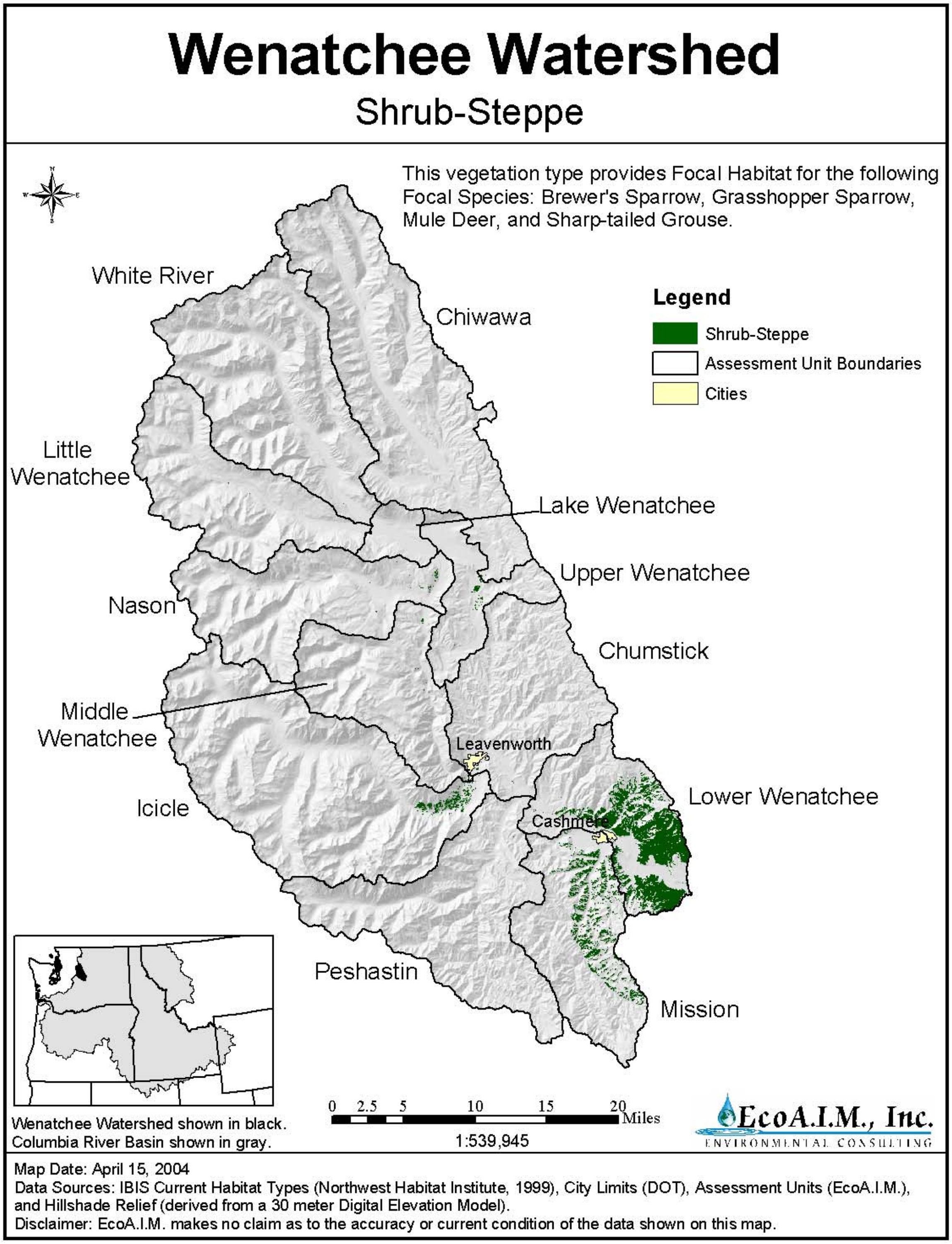

Figure 3. Shrubsteppe distribution in the Wenatchee subbasin

4.4 Shrubsteppe

The greatest changes in shrubsteppe habitat from historic conditions are the reduction of bunchgrass cover in the understory and an increase in sagebrush cover. Soil compaction is also a significant factor in heavily grazed lands affecting water percolation, runoff and soil nutrient content. A long history of grazing, fire, and invasion by exotic vegetation has altered the composition of the plant community within much of the extant shrubsteppe in this region, and it is difficult to find stands which are still in relatively natural condition.

Fire has relatively little effect on native vegetation in the three-tip sagebrush zone, since three-tip sagebrush and the dominant graminoids resprout after burning. Three-tip sagebrush does not appear to be much affected by grazing, but the perennial graminoids decrease and are eventually replaced by cheatgrass (*Bromus tectorum*), plantain *(Plantago* spp.), big bluegrass (*Poa secunda),* and/or gray rabbitbrush (*Chrysothamnus nauseosus).* In recent years, diffuse knapweed (*Centaurea diffusa)* has spread through this zone and threatens to replace other exotics as the chief increaser after grazing.

In areas of central arid steppe with a history of heavy grazing and fire suppression, true shrublands are common and may even be the predominant cover on non-agricultural land. Most of the native grasses and forbs are poorly adapted to heavy grazing and trampling by livestock. Grazing eventually leads to replacement of the bunchgrasses with cheatgrass, Nuttall's fescue (*Festuca microstachys*), eight flowered fescue (*F. octofiora),* and Indian wheat (*Plantago patagonica*). In recent years, several knapweeds (*Centaurea spp*.), have become increasingly widespread. Russian star thistle (*Centaurea repens)* is particularly widespread, especially along and near major watercourses.

Based on 1992 aerial photographs, 1994 post-burn photographs, and limited ground truthing, there was 25,882 acres of steppe communities in the Wenatchee watershed. Historically, the total number and distribution of steppe communities was likely greater than today (USFS 1999).

Protection Status

The protection status of remaining shrubsteppe habitats in all subbasins fall primarily within the low to no protection status categories. As a result, this habitat type will likely suffer further degradation, disturbance, and/or loss in all ecoprovince subbasins.

Factors Affecting Shrubsteppe Habitat

Factors affecting shrubsteppe habitat are explained in detail in Appendix A and are summarized below:

- Permanent habitat conversions of shrubsteppe/grassland habitats (e.g., approximately 60% of shrubsteppe in Washington (Dobler et al. 1996)) 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%)
- 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.

Shrubsteppe Community

4.4.1 Mule Deer

Mule deer were selected to represent species that require and prefer diverse, dense (30 to 60% shrub cover less than 5 ft. tall) shrubsteppe habitats comprised of bitterbrush, big sagebrush, rabbitbrush, and other shrub species with a palatable herbaceous understory exceeding 30% cover.

4.4.2 Brewer’s Sparrow

Brewer’s sparrow was selected to represent wildlife species that require sagebrush dominated sites. Brewer’s sparrow prefers a patchy distribution of sagebrush clumps, 10-30% cover, lower sagebrush height (between 20 and 28 in.), 1981), 10 to 20% native grass cover, less than 10% non-native herbaceous cover, and bare ground greater than 20%. It should be noted, however, that shrublands comprised of snowberry, hawthorne, chokecherry, serviceberry, bitterbrush, and rabbitbrush were also used by Brewer’s sparrows for nesting in southeast Washington. Specific, quantifiable habitat attribute information for this mixed shrub landscape could not be found.

4.4.3 Sharp-tailed Grouse

Sharp-tailed grouse was selected to represent species that require multi-structured fruit/bud/catkin producing deciduous trees and shrubs dispersed throughout the landscape (10 to 40% of the total area). Other habitat conditions include:

- Native bunchgrass greater than 40% cover
- Native forbs at least 30% cover
- Visual obstruction readings (VOR) at least 6 in. least 75% cover deciduous shrubs and trees
- Exotic vegetation/noxious weeds less than 5% cover
- Shrubsteppe habitat with native bunch grasses

4.4.4 Grasshopper Sparrow

Grasshopper sparrow was selected to represent species that require healthy steppe habitat dominated by native bunch grasses. Grasshopper sparrow require native bunchgrass cover greater than 15% and comprising greater than 60% of the total grass cover

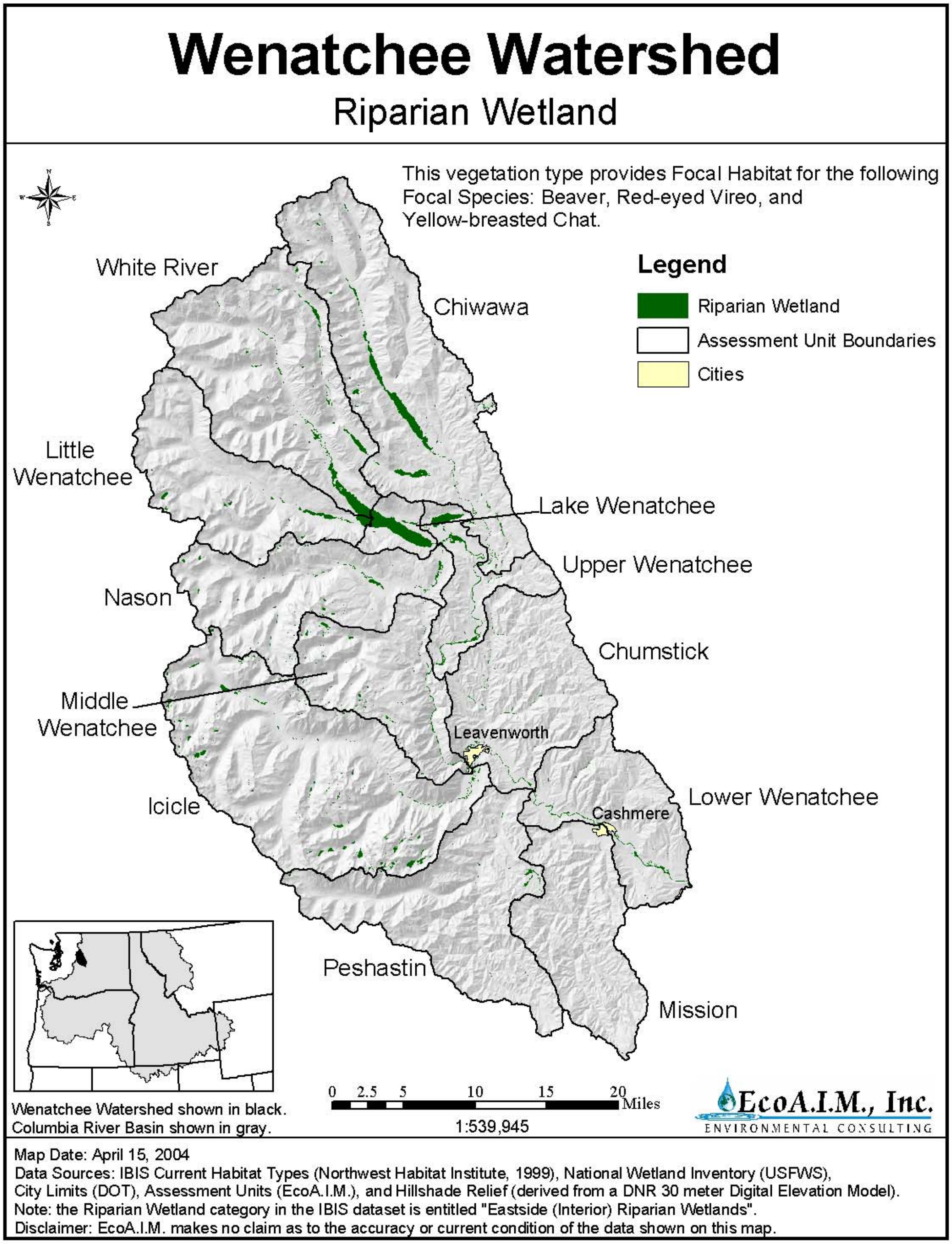

Figure 4. Riparian composition in the Wenatchee subbasin

4.5 Eastside (Interior) Riparian Wetlands

The eastside (interior) riparian wetlands habitat type refers only to riverine and adjacent wetland habitats in both the ecoprovince and individual subbasins. Historic (c.1850) and, to a lesser degree, current data concerning the extent and distribution of riparian wetland habitat are a significant data gap at both the ecoprovince and subbasin level. The lack of data is a major challenge as ecoprovince and subbasin planners attempt to quantify habitat changes from historic conditions and develop strategies that address limiting factors and management goals and objectives.

Due to the lack of historic riparian wetland data, the IBIS database cannot be relied upon for comparisons in the ecoprovince and individual subbasins between the historic and current extent of riparian wetlands. Riparian wetland habitat is being lost because of lack of permanent protection, and this habitat continues to be at risk.

Historically, riparian wetland habitat was characterized by a mosaic of plant communities occurring at irregular intervals along streams and dominated singularly or in some combination by grass-forbs, shrub thickets, and mature forests with tall deciduous trees. Beaver activity and natural flooding are two ecological processes that affected the quality and distribution of riparian wetlands.

Historically, riparian-stream habitat was higher than what currently exists (USFS 1999b). Construction of roads, fields and houses along the Wenatchee River has decreased the effectiveness and amount of riparian habitat. The change in extent of the riparian wetland habitat type from c.1850 to 1999 is not included because of inaccurate IBIS (2003) data and geographic information system (GIS) products. The current acreage, however, which consists of 32,050 acres of riparian habitat and 1,468 acres of wetlands, are believed to be similar to historic (USFS 1999b).

Protection Status

The vast majority of province riparian habitat is designated low or no protection status and is at risk for further degradation and/or conversion to other uses.

Factors Affecting Eastside (Interior) 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 s wallow, 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

Riparian Community

4.5.1 Red-eyed Vireo

Red-eyed vireo was selected to represent species that require greater than 60% canopy closure. For their food and reproductive requirements red-eyed vireo require mature deciduous trees greater than 160 ft. tall. Greater than 10% of the shrub layer should be young cottonwoods.

4.5.2 American Beaver

Beaver were selected to represent species that require 40-60% tree/shrub canopy closure and shrub height greater than 6.6 ft. Beavers also require trees less than 6 in. DBH.

4.5.3 Yellow-breasted Chat

Yellow-breasted chat were selected to represent species that require riparian habitat with a dense shrub layer 3-13 ft. tall, 30-80% shrub cover, scattered herbaceous openings, and less than 20% tree cover.

4.6 Agriculture

Agricultural habitat varies substantially in composition among the cover types it includes. Cultivated cropland includes at least 50 species of annual and perennial plants, and hundreds of varieties ranging from vegetables such as carrots, onions, and peas to annual grains such as wheat, oats, barley, and rye. Row crops of vegetables and herbs are characterized by bare soil, plants, and plant debris along bottomland areas of streams and rivers and areas having sufficient water for irrigation. Annual grains, such as barley, oats, and wheat are typically produced in almost continuous stands of vegetation on upland and rolling hill terrain without irrigation.

Improved pastures are used to produce perennial herbaceous plants for grass seed and hay. Alfalfa and several species of fescue and bluegrass, orchardgrass (*Dactylis glomerata*), and timothy (*Phleum pratensis*) are commonly seeded in improved pastures. Grass seed fields are single-species stands, whereas pastures maintained for haying are typically composed of several species.

The improved pasture cover type is one of the most common agricultural uses in and is produced with and without irrigation. Unimproved pastures are predominantly grassland sites often abandoned fields that have little or no active management such as irrigation, fertilization, or herbicide applications. These sites may or may not be grazed by livestock. Unimproved pastures include rangelands planted to exotic grasses that are found on private land, state wildlife areas, federal wildlife refuges, and CRP sites. Grasses commonly planted on CRP sites include crested wheatgrass (*Agropyron cristatum*), tall fescue (*F. arundinacea*), perennial bromes (*Bromus* spp.), and wheatgrasses.

Intensively grazed rangelands have been seeded to intermediate wheatgrass (*Elytrigia intermedia*), crested wheatgrass to boost forage production, or are dominated by increaser exotics such as Kentucky wheatgrass or tall oatgrass (*Arrhenatherum elatius*). Other unimproved pastures have been cleared and intensively farmed in the past, but are allowed to convert to other vegetation. These sites may be composed of uncut hay, litter from previous seasons, standing dead grass and herbaceous material, invasive exotic plants including tansy ragwort (*Senecio jacobea*), thistle (*Cirsium* spp.), Himalaya blackberry (*Rubus discolor*), and Scot's broom (*Cytisus scoparius*) with patches of native black hawthorn, snowberry, spirea (*Spirea* spp.), poison oak (*Toxicodendron diversilobum*), and various tree species, depending on seed source and environment.

Because agriculture is not a focal wildlife habitat type and there is little opportunity to effect change in agricultural land use at the landscape scale, ecoprovince and subbasin planners did not conduct a full-scale analysis of agricultural conditions. However, agricultural lands converted to CRP can significantly contribute to ward benefits to wildlife habitat and other species that utilize agricultural lands.

4.7 Summary of Factors Affecting Focal Habitats and Wildlife Species

Several factors have altered the historic vegetation of much of the subbasin and thus, to varying degrees, the species that occupy it. These factors include timber management, road development, fire, mining, and recreation associated disturbance.

Timber Management

Timber management activities, including extensive timber harvest in sections of the Wenatchee subbasin, have resulted in the wide-scale removal of large ponderosa pine trees and subsequently reduced populations of dependant species, as well as snag dependent species in some areas. Past timber harvest has created early to mid successional stand stages that affect forest-story function in the upper and lower layers, reduced forest interior habitat, created homogenous stands, and impacted the effectiveness of riparian functions in the subbasin. Early to mid successional stages across the landscape provide for homogenous stand structures that provide potential for increased pathogen and insect infestation. Logging has contributed to fragmentation of habitat, soil erosion, sediment delivery to creeks and streams, and changes to upland and riparian vegetative communities, including displacement of native plant communities with exotic species.

Grazing

In 1999, there was only one active grazing allotment in the subbasin, the Eagle/Blagg allotment. Problems identified with this allotment include high levels of erosion, noxious weeds, and conflict with bighorn sheep because of possible transmission of the disease Pasturella from domestic sheep to bighorns. Pasturella in bighorn sheep causes pneumonia and often proves fatal.

Road Development

The over-all road density in the subbasin is high in zones of human influence and riparian areas. Roads and motorized trails have significantly altered habitat for many species, particularly for the grizzly bear, gray wolf, mule deer, elk and lynx. Species proximity to roads and trails also impacts their behavior.

Fire

Fire is the dominant agent of change in this subbasin. Management attempts to influence ecosystem processes such as fire have had widespread and significant effects on the condition of wildlife habitat throughout the area, resulting in decreased habitat for some species and increased habitat for others. Fire suppression has created unnatural vegetation patterns. Forested stand conditions on north/northeast facing slopes have a higher number of smaller (pole-sized) stems per acre of Douglas-fir, lodgepole pine and *ceanothus*, causing the canopy to be more closed than would naturally have occurred. Fire suppression has lead to an increase in tree density in some areas as well as increased abundance of more shade tolerant trees such as grand fir (Andonaegui 2001).

Mining

Mining currently is a minor activity in the subbasin; however, patented mining claims exist in private inholdings throughout the subbasin.

4.8 Aquatic/Fish Assessment

4.8.1 Fish Focal Species and Representative Habitats

Eight fish focal species were selected. Four species of anadromous salmonids; spring chinook and late-run chinook *(Oncorhynchus tshawytscha),* sockeye *(Oncorhynchus nerka)*, and summer steelhead *(Oncorhynchus mykiss)* are present in the Wenatchee subbasin. Coho stocks (*Oncorhynchus kisutch*), historically abundant in the subbasin, became extripated in the early 1900's and have since been reintroduced through ongoing efforts by the Yakama Nation. Natural reproduction is occurring in the Wenatchee basin. Pacific lamprey *(Lampetera tridentate)*, also an anadromous species, is present in the Wenatchee subbasin, but very little information about this culturally and ecologically important species is available. Of the other resident fish that also occur throughout the subbasin, bull trout *(Salvelinus confluentus),* which is present in fluvial, adfluvial and resident life history forms and Westslope Cutthroat trout *(Oncorhynchus clarkia)* were selected.

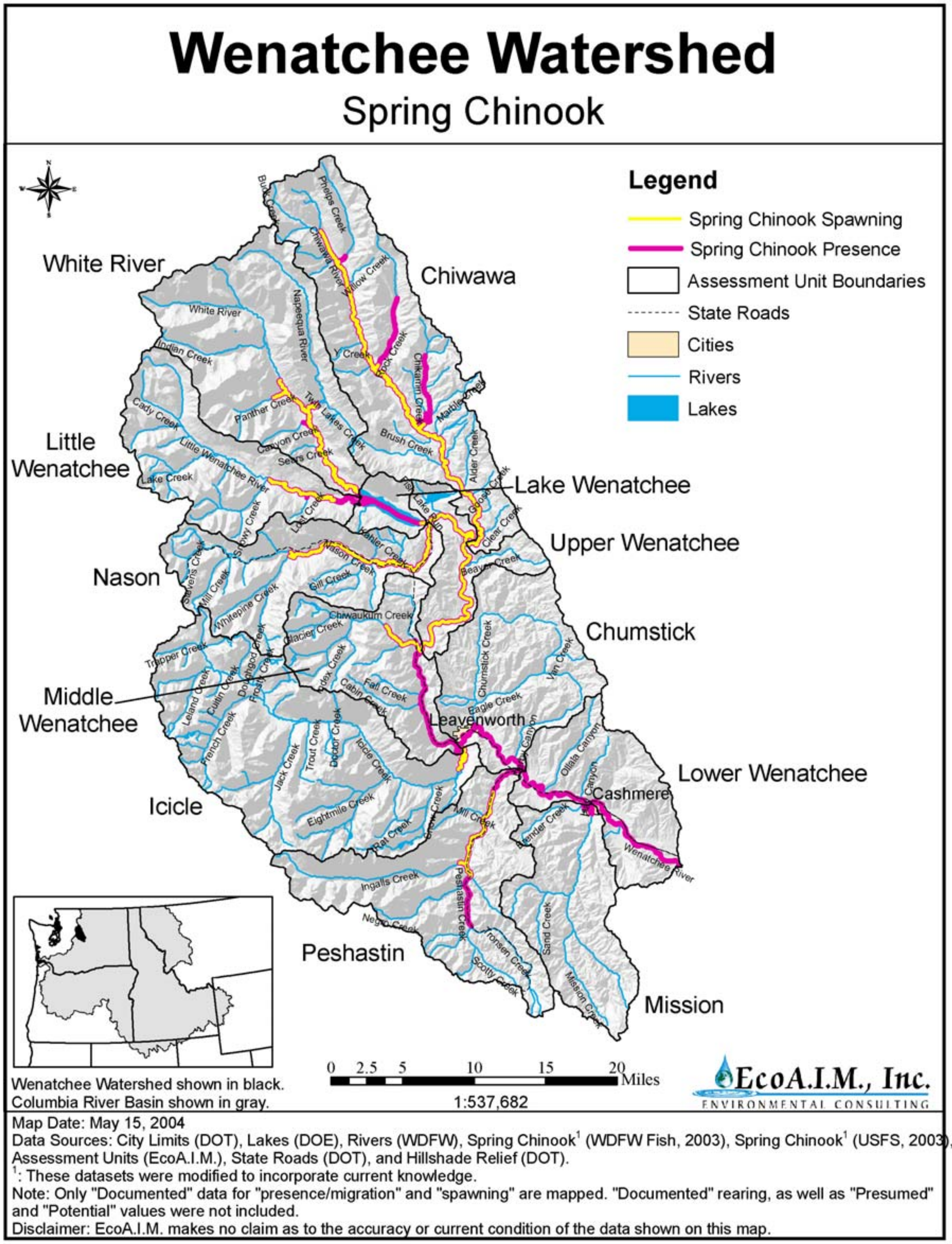

Figure 5. Spring chinook distribution in the Wenatchee subbasin

4.8.2 Spring Chinook (*Oncorhynchus tshawytscha*)

Rationale for Selection

Spring chinook salmon (stream type) are considered depressed throughout most of their current range and many stocks are at danger of extinction. All remaining populations and habitats are considered to be vital to the continued persistence of chinook salmon in the interior Columbia basin

The Wenatchee spring chinook is included by NOAA Fisheries into the upper Columbia ESU and are listed as endangered under the ESA. Spring chinook salmon utilize much of Wenatchee subbasin and are sensitive to many environmental conditions and changes. Spring chinook provide a good biological indicator of ecosystem health for the lower reaches of many tributaries of the Wenatchee River.

Key Life History Strategies: Relationship to Habitat

Time of entry and spawning

Adult spring chinook begin entering the Wenatchee River basin in May. Spawning begins in very late July through September, peaking in mid to late August (Chapman et al. 1995 CPa). The onset of spawning in a stream reach is temperature driven (usually when temperatures drop below 60.8°F). Temperature can be influenced by riparian conditions.

Prespawning

Adults hold in the deeper pools and under cover of the mainstem Wenatchee or natal tributaries. The availability and number of deep pools and cover is important to offset potential prespawning mortality. Intact riparian habitat will increase the likelihood of instream cover, and normative channel geofluvial processes will increase the occurrence of deeper pools.

Redd characteristics

Important habitat needs for redd building include the availability of clean gravel at the appropriate size, and proper water depth and velocity. Healy (1991) reports the range of depths of spawning as between approximately 1-23 ft. and velocities of between approximately 0.33-5 ft/s) for chinook salmon (this includes ocean-type chinook too). Preservation or restoration of naturally occurring geofluvial function insures that the proper spawning habitat is available.

Incubation and emergence

Healy (1991) reports that incubation and emergence success was related to oxygen levels and percolation through the gravel. When percolation was 0.001 ft/s, survival to hatching was 97%. However, emergence reduced to 13% when percolation was 0.002 ft/s. When oxygen fell below 13 parts per million (ppm), mortality of eggs increased from 3.9% at 13 ppm to about 38% at 5 ppm.

Stream conditions (e.g., frequency of flooding, extreme low temperatures) may affect egg survival too. Floods can scour eggs from the gravel increasing sediment deposition that can reduce oxygen and percolation through the redd. Healy states that siltation may be more lethal earlier in the incubation period than in later phases. Overall, Healy reports that egg survival from spawning to emergence ranged from 40-100% (these estimates include ocean-type chinook too) (Peven 2003).

In the Wenatchee subbasin, fall flooding has a high frequency of occurrence. This may negatively affect incubation and emergence success, especially in years of extreme flows (e.g., 1990 and 1995). Road building activities in the upper watersheds may also increase siltation, as well as grazing and mining activities. All three factors were once more prevalent than they are now in the subbasin, and conditions have improved in most watersheds. However, Nason Creek because of its location near a railroad and major high way has long term restoration needs that could most likely increase incubation success, although empirical information is needed to determine if this is a need first.

Fry

Spring chinook fry utilize near-shore areas, primarily eddies, within and behind large woody debris, undercut tree roots, or other cover (Hillman et al. 1989a; Healy 1991). Conservation and restoration of riparian areas of natal streams within the Wenatchee subbasin would increase the type of habitat that fry utilize.

Parr

Downstream movement of parr from natal streams is well documented. French and Wahle (1959) found that juvenile chinook migrated past Tumwater Dam on the Wenatchee River (RM 33) from spring through late fall. Since 1992, sampling by WDFW has found spring chinook emigrating from the Chiwawa River as pre-smolts from late summer through the fall. In general, movement from the Chiwawa River included some yearlings leaving as early as March, extending through May, followed by subyearlings leaving through the summer and fall (until trapping ceases because of inclement weather (Peven 2003).

Movement of juvenile chinook from the higher-order streams in the fall appears to be a response to the harsh conditions encountered in the upper tributaries. Bjornn (1971) related subyearling chinook movement in an Idaho stream indirectly to declining temperature in the stream as fish try to find suitable overwintering habitat. Hillman and Chapman (1989a) suggested that biotic factors, such as intraspecific interaction for available habitat with naturally- and hatchery-produced chinook, nocturnal sculpin predation, and interspecific interactions may accelerate movement of subyearlings from the mainstem Wenatchee River and into the Columbia River. This may or may not be true of the higher order streams that feed the upper reaches of the Wenatchee River, which produce most of the spring chinook in that basin. Hillman et al. (1989a) related subyearling chinook movement from an Idaho stream to declining temperatures, but acknowledged that it may consist of fish seeking higher-quality winter habitat, as suggested by Bjornn (Peven 2003).

Hillman and Chapman (1989a) found that Tumwater Canyon is where most fish rear over the winter before their smolt migration begins in the spring. During the daytime, juvenile chinook used instream and overhead cover extensively, although as they got larger (and stream flows reduced), they sought areas that were deeper and higher velocity (Hillman et al. 1989 CPa). Substrate preference also changed as the juvenile chinook got larger and hydraulic conditions changed from predominantly sand, large boulder, and bedrock to sand, sand-gravel, and cobble. As temperatures dropped below 50°F, salmon were observed primarily near boulder rip-rap, or concealed themselves in the substrate.

During night time hours during the warmer months, chinook moved inshore and rested all night in shallow, quiet water. In the colder months, chinook sought deeper water with larger substrate.

Conservation of high functioning habitat in natal tributaries and Tumwater Canyon, restoration of riparian and geofluvial processes in or near known and potential parr rearing areas will have the highest likelihood of increasing parr survival.

Smolt

Wenatchee River spring chinook smolts begin migrating in March from natal areas. Investigation of suspected or potential impediments to migration or injury or mortality should be identified and investigated. If areas are shown to unnaturally impede migration or injure or kill fish, then they should be fixed.

Population Characterization

Distribution

Historic

Mullan (1987) felt that because of the geology of the region upstream of the current Grand Coulee Dam site, that spring chinook were not very abundant, with the possible exceptions of the San Poil and Spokane River basins. Fulton (1968) described the historic distribution of spring chinook in the Wenatchee River. He relied heavily on the fieldwork of French and Wahle (1965) for his information on distribution. He combines descriptions of spring chinook distributions in the Wenatchee subbasin as: most of main river; portions of Chiwawa, Little Wenatchee, and White rivers; and Nason, Icicle, and Peshastin creeks (Peven 2003).

Current

Spring chinook currently spawn and rear in the upper main Wenatchee River upstream from the mouth of the Chiwawa River, overlapping with summer chinook in that area (Peven 1994). The primary spawning grounds of spring chinook in the Wenatchee River, in order of importance, are: Chiwawa River, Nason Creek, Little Wenatchee, and White River (Icicle River is not included because it is believed that most of the spawning population from this stream consist of adult returns to the Leavenworth NFH (Peven 2003)). Also see Figure 6.

Subwatersheds Significant for Spring Chinook in Wenatchee and Entiat Subbasins

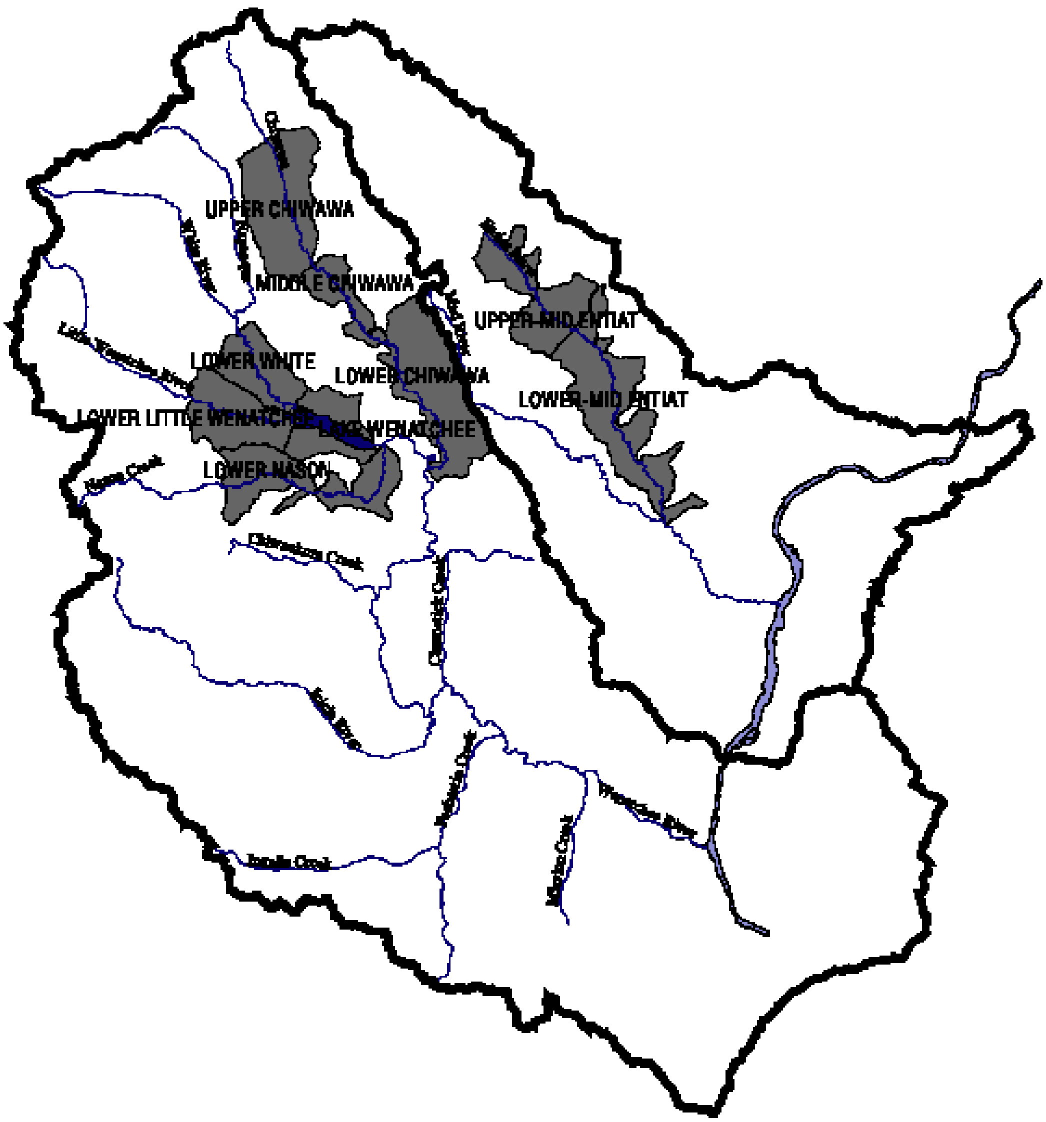

Figure 6. Significant spring chinook watersheds in Wenatchee and Entiat subbasins (RTT 2004)

Abundance

Historic

Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 588,000 spring chinook was the best estimate of predevelopment run sizes. Spring chinook were relatively abundant in upper Columbia River tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, unscreened irrigation intakes, poor logging and mining practices, overgrazing (Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of upper Columbia basin salmonids (Peven 2003).

Spring chinook counting at Rock Island Dam began in 1935. Numbers (adults and jacks) in the period 1935-39 averaged just over 2,000 fish. Average counts fluctuated on a decadal average from the 1940s to 1990s from just over 3,200 (1940s) to over 14,400 (1980s), with recent counts (2000-2002) averaging almost 29,000. The long term average of spring chinook passing Rock Island Dam is just over 8,900.

Current

In the Wenatchee River, redds counts have fluctuated widely since 1958, the earliest date for which systematic data were available. Spring chinook redd counts averaged 637, 564, and 621 every ten years between 1958 and 1990. In the 1990s, the average dropped to 232, but has increased to over 1,100 since 2000. The long term average is 560 over the period 1958-2002.

Ford et al. (2001) recommended an interim recovery level for spring chinook of the Wenatchee River at an eight-year geometric mean of 3,750 natural spawners per year. LaVoy (1994) estimated the average number of fish per redd as 2.2. Applying that expansion to the estimated (unadjusted for harvest prior to the 1970s) redd counts, escapement has ranged between 70 to over 4,100, with a long term average of over 1,200 (Peven 2003).

Productivity

Historic

Historic production of spring chinook is difficult to determine, although it was most likely not as high as sockeye or late-run chinook. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan et al. 1992), it is assumed that historic production of salmon was high, especially for late-run chinook and sockeye (Pevan 2003).

Current

Current productivity is affected by loss or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Mullan et al. (1992) postulated that current production may not be greatly different than historic for spring chinook. Caveats to this postulate are that native coho are extinct, production comes at a higher cost in terms of smolt survival through the mainstem corridor, and that harvest is drastically reduced (e.g., over 80% in the lower Columbia River in the late 1930s and early 1940s). However, recent estimates of natural replacement rates for spring chinook suggest that they are not replacing themselves in most years until the broods of the late 1990s (Peven 2003).

There are still habitat areas in need of restoration (e.g., Peshastin and Mission creeks) within the Wenatchee subbasin. By increasing known areas in need of restoration, it is reasonable to assume that production of spring chinook would increase.

Diversity

Because some areas within the Wenatchee subbasin are in need of habitat improvements, diversity within the subbasin is believed to be lower than historic. While the Wenatchee population is still believed to be an *independent population* increased habitat would most likely increase spatial and life history diversity.

Currently, genetic sampling suggests that the White River subpopulation may be distinct from other subpopulations within the subbasin (Appendix A).

Table 15. Summary of spring chinook population characterization

	Distribution	Abundance	Productivity	Diversity
Historic	High	Moderate-High	Moderate	High
Current	Moderate-High	Low-Moderate	Low-Moderate	Moderate

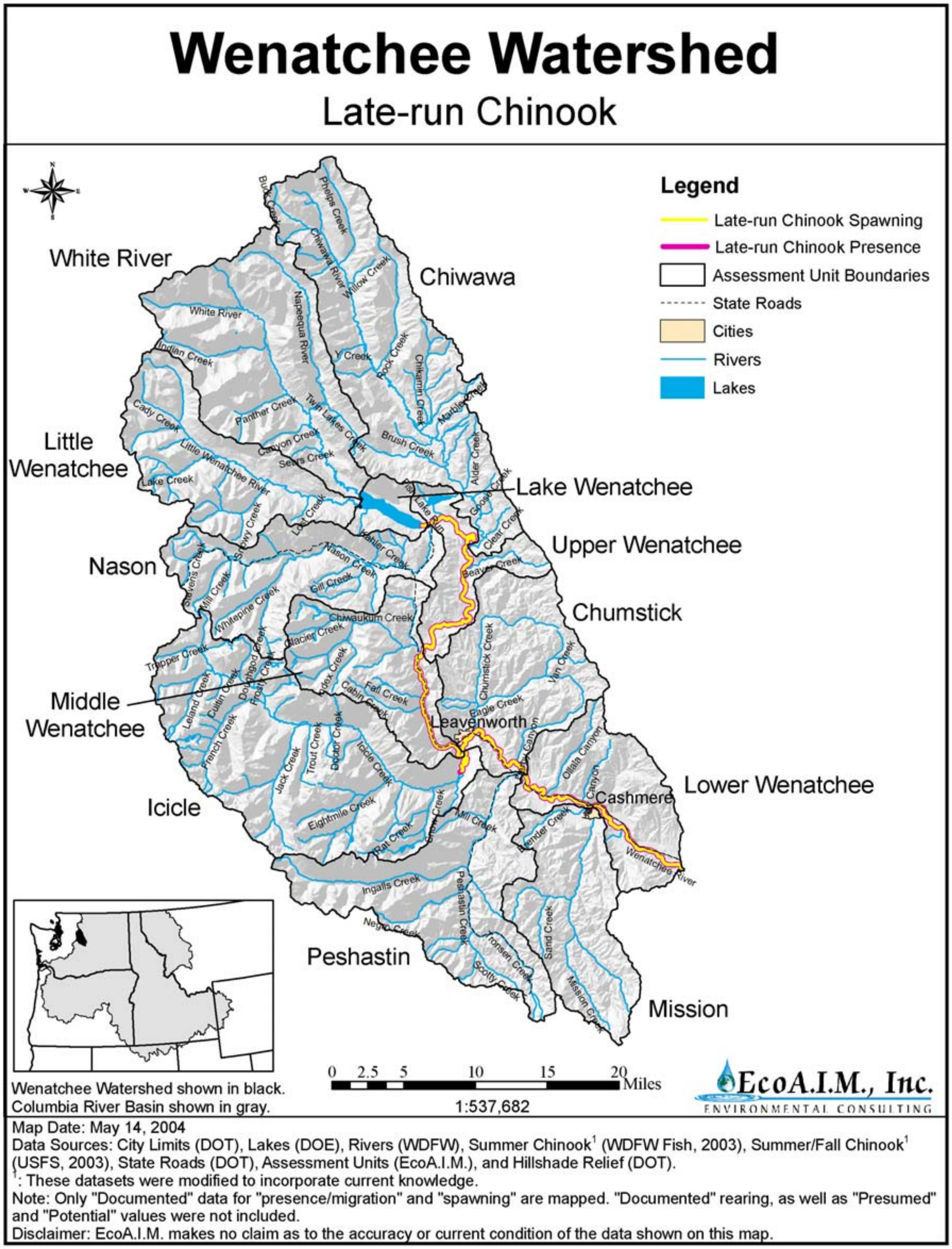

Figure 7. Late-run chinook distribution in the Wenatchee subbasin

4.8.3 Late-run Chinook (*Oncorhynchus tshawytscha*)

Rationale for Selection

NOAA Fisheries determined that the Wenatchee, Entiat, Methow and Okanogan late-run chinook are part of a larger population that includes late-run chinook in the upper Columbia (Chapman et al. 1994a). Late-run chinook provide a good biological indicator of ecosystem health to the mainstem Wenatchee River.

Key Life History Strategies: Relationship to Habitat

Time of entry and spawning

Adult late-run chinook begin entering the Wenatchee subbasin in June. Spawning begins in very late September through mid November, peaking in mid to late October. The onset of spawning in a stream reach is temperature driven (usually when temperatures drop below 60.8 °F). Temperatures in the mainstem Wenatchee are influenced by climate, Lake Wenatchee, and tributary flows.

Prespawning

Adults hold in the deeper pools and under cover of the mainstem Wenatchee. The availability of and number of deep pools and cover is important to offset potential prespawning mortality. Intact riparian habitat will increase the likelihood of instream cover, and normative channel geofluvial processes will increase or maintain the occurrence of deeper pools.

Redd characteristics

Important habitat needs for redd building include the availability of clean gravel at the appropriate size, and proper water depth and velocity. Healy (1991) reports the range of depths of spawning as between approximately 1-23 ft. and velocities of between 0.33-5 ft/s for chinook salmon (this includes spring chinook). Preservation or restoration of naturally occurring geofluvial function insures that the proper spawning habitat is available.

Incubation and emergence

Healy (1991) reports that incubation and emergence success was related to oxygen levels and percolation through the gravel. When percolation was 0.001 ft/s, survival to hatching was 97%. However, emergence reduced to 13% when percolation was 0.002 ft/s. When oxygen fell below 13 ppm, mortality of eggs increased from 3.9% at 13 ppm to about 38% at 5 ppm.

Stream conditions (e.g., frequency of flooding, extreme low temperatures) may affect egg survival too. Floods can scour eggs from the gravel by increasing sediment deposition that reduces oxygen and percolation through the redd. Healy (1991) cites Shaw and Maga (1943) as showing that siltation may be more lethal earlier in the incubation period than in later phases. Overall, Healy (1991) reports that spawning to emergence ranged from 40-100% (these estimates include spring chinook) (Peven 2003).

In the Wenatchee subbasin, fall flooding has a high frequency of occurrence. This may negatively affect incubation and emergence success, especially in years of extreme flows (e.g., 1990 and 1995). Road building activities in the upper watersheds may also increase siltation, as well as grazing and mining activities. All three factors were once more prevalent than they are now in the subbasin, and conditions have improved in most watersheds. Because of naturally occurring conditions and major events like fire, Peshastin, Mission, and Icicle creeks have had heavy sediment load events in the last 10-15 years. Most of the spawning area for Wenatchee late-run chinook occurs upstream of these tributaries.

Fry

Fry emerge mostly in April and May. Most subyearling late-run chinook leave the Wenatchee River within a few weeks after emergence. Beak (1980) found that weekly catches of chinook salmon fry declined sharply from over 700 in early June to about 25 in early July, then to zero by early August. This decline comports well with the observations of Hillman and Chapman (1989). Hillman and Chapman (1989) also demonstrated that the rate of emigration of subyearling chinook was highest in June, and then declined through the summer (Peven 2003).

Late-run chinook fry utilize near-shore areas, primarily eddies, within and behind large woody debris, undercut tree roots, or other cover (Hillman et al. 1989a; Healy 1991). They noted that in the spring this type of habitat was scarce in the Wenatchee River, but where it did occur, it was fully occupied. Conservation and restoration of riparian areas and increases in off-channel habitat in the lower Wenatchee subbasin may increase the type of habitat that late-run chinook fry utilize, although they may still emigrate through the system without utilizing these habitats (Peven 2003).

Population Characterization

Distribution

Historic

Late-run chinook historically used the mainstem of the Wenatchee River, from its mouth to Lake Wenatchee (Peven 2003).

Tumwater Dam (RM 32.7) and Dryden Dam (RM 17.6) on the Wenatchee River were partial obstacles to upstream passage of adults before 1957. Between 1957 and 1986, some observers considered fish passage facilities inadequate and new facilities were constructed in the late 1980s. Mullan et al. (1992) were skeptical that the dams were serious obstacles before the fish ways were improved (Peven 2003).

Current

Late-run chinook salmon currently spawn in the Wenatchee River between RM 1.0 and Lake Wenatchee (RM 54). Within that area the distribution of redds of late-run chinook has changed. Peven (1992) notes that, since the early 1960s, numbers of redds have decreased downstream from Dryden Dam (RM 17.5), while they have increased upstream from Tumwater Dam (RM 32.7). On a smaller scale, Peven (1992) reports that, since at least 1975, densities of redds (i.e., redds/mile) were highest near Leavenworth (RM 23.9-26.4) and in Tumwater Canyon (RM 26.4-35.6). Also see Figure 8.

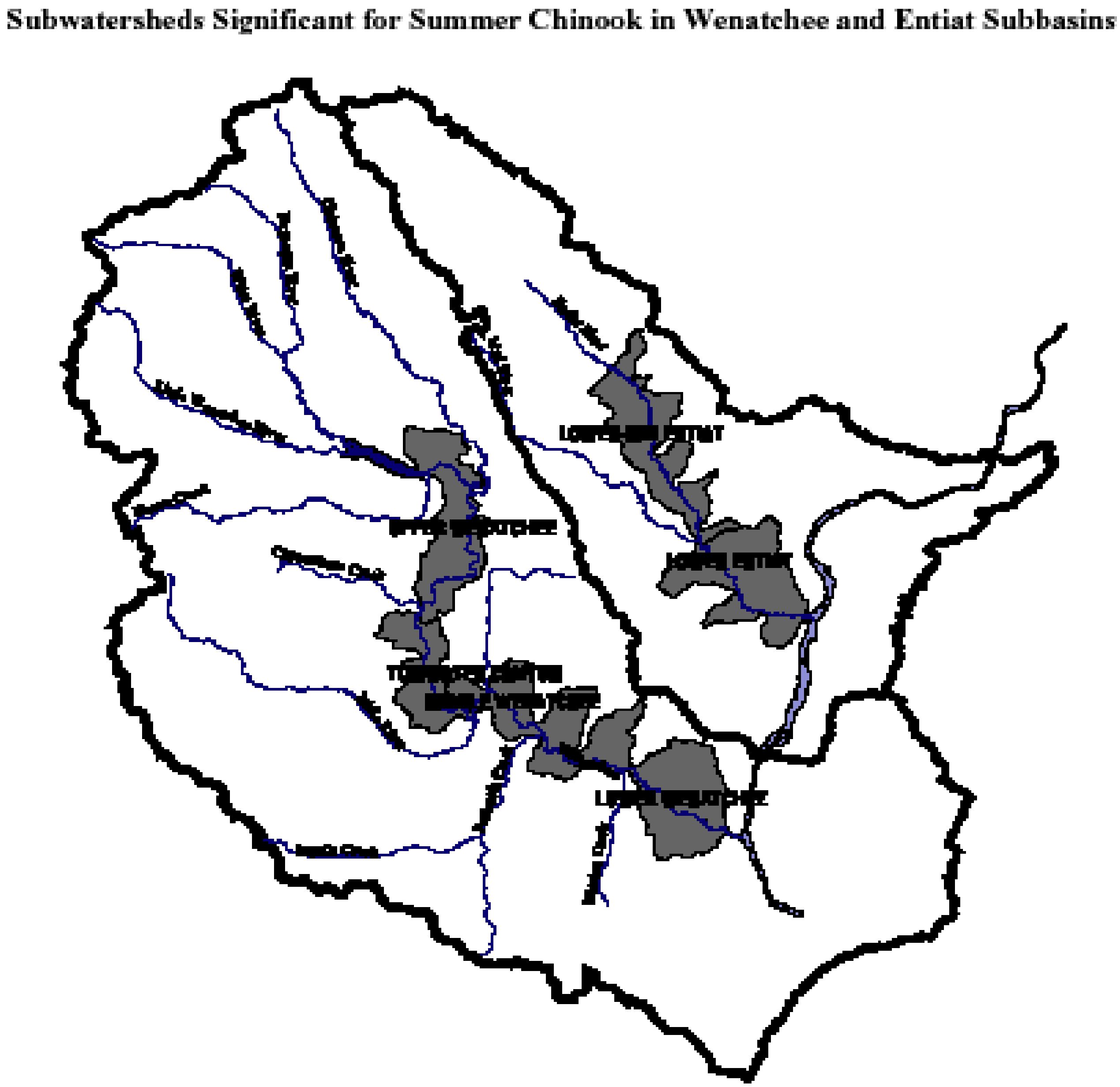

Figure 8. Significant summer chinook watersheds in Wenatchee and Entiat subbasins (RTT 2004)

Abundance

Historic

Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 3.7 million summer chinook, (for the entire Columbia Basin) was the best estimate of predevelopment run sizes. Late-run chinook were very abundant in upper Columbia River and tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Peven 2003; Mullan et al. 1992).

The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, unscreened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of upper Columbia basin salmonids (Peven 2003).

Historically, the late spring and summer components of the Columbia River chinook populations were the most abundant and heavily fished (Thompson 1951, Van Hyning 1968, Chapman 1986). Overfishing in the lower Columbia River rapidly depressed summer-run chinook. Spawning and rearing habitat extirpation and destruction accelerated the decline (Peven 2003).

Decadal averages of late-run chinook escapements at Rock Island Dam from 1933 through 2002 show a rising trend. Harvest rates in the 1930s and 1940s were very high in the lower river fisheries, and no doubt had a large impact on the escapement at Rock Island (Mullan 1987). In 1951, when harvest rates in zones 1-6 (lower Columbia River) were reduced, numbers increased dramatically. Between the 1930s (starting in 1933) and 1960s (excluding 1968 and 1969). (There were no counts at Rock Island Dam between 1968 and 1972.) total (adults and jacks) decadal average numbers of late-run chinook rose from just over 7,000 to almost 28,000. Numbers remained high in the 1970s until the mid 1980s, when they declined through the 1990s and have shown a sharp increase in the 2000s (Peven 2003).

In the 1960s, dam counts became available at Rocky Reach Dam (1962) and Wells Dam (1967). These project counts of total late-run chinook show a different trend than Rock Island, which suggests the difference being the fish that spawn in the Wenatchee River were heavily affecting the trend at Rock Island Dam.

Current

Between the mid 1980s and through the 1990s, late-run chinook total numbers declined at Rock Island, Rocky Reach, and Wells dams. The magnitude of the decline increased the further upstream the counts were. This suggests that the run into the Wenatchee River remained high or increased, while runs ascending upstream of Rocky Reach, and Wells did not. The run of late-run chinook into the Wenatchee River has continued to increase since redd counts began in 1960.

The escapement into the Wenatchee River appears to be still primarily composed of naturally produced fish based on carcass sampling. The Eastbank Hatchery program releases fish in the lower Wenatchee River (near Dryden), primarily for the purpose of reseeding the lower river habitat.

Productivity

Historic

Historic production of late-run chinook is difficult to determine, it was thought to be very high. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan et al. 1992), it is assumed that historic production of late-run chinook was higher than current.

Current

Current productivity is affected by loss or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Mullan et al. (1992) postulated that current production may not be greatly different than historic for late-run chinook. Caveats to this postulate are that production comes at a higher cost in terms of smolt survival through the mainstem corridor, and that harvest is drastically reduced (Peven 2003).

While spawning habitat does not appear to be limiting late-run chinook in the Wenatchee subbasin, potential changes to geofluvial processes may effect immediate rearing (or refuge) areas in the lower river. It is unknown what affect this has on production.

Diversity

Because some areas within the Wenatchee subbasin are in need of habitat improvements, diversity within the basin may be lower than historic. While the Wenatchee population is still believed to be an independent population increased habitat would most likely increase life history diversity.

Currently, genetic sampling has not found any differences among late-run chinook within the basin.

Table 16. Summary of late-run chinook population characterization

	Distribution	Abundance	Productivity	Diversity
Historic	Moderate	Very high	Very high	High
Current	Moderate	Moderate-High	High	Moderate-High

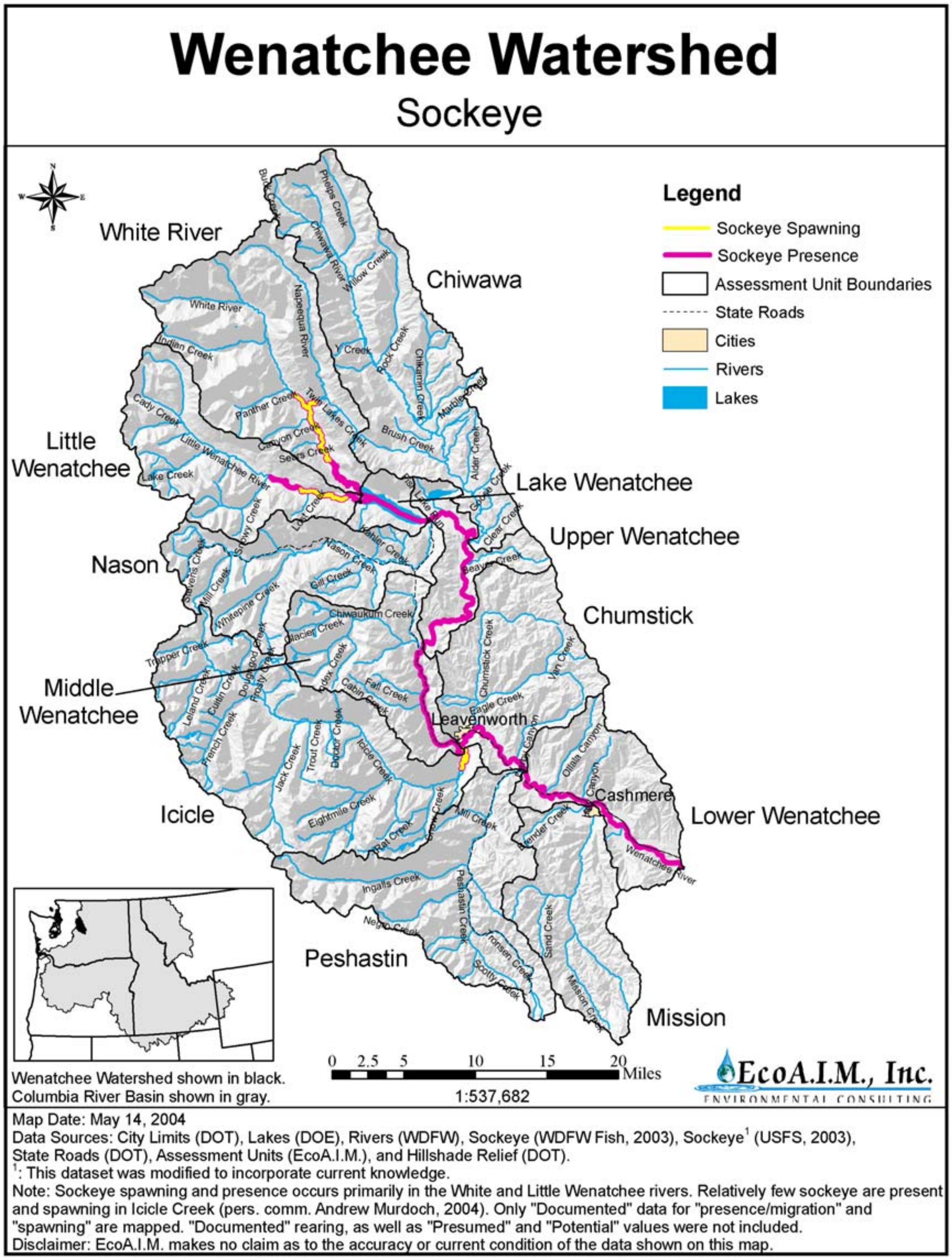

Figure 9. Sockeye distribution in the Wenatchee subbasin

4.8.4 Sockeye (*Oncorhynchus nerka*)

Rationale for Selection

The Wenatchee River supports one of only two remaining viable sockeye populations within the Columbia River, making the population of high local and regional interest. The primary spawning occurs in both White and Little Wenatchee rives, and rearing occurs primarily in Lake Wenatchee (Figure 9). Sockeye provide a good biological indicator of the ecosystem health for these spawning and rearing areas.

Key Life History Strategies: Relationship to Habitat

Time of entry and spawning

Adult sockeye begin entering the Wenatchee River basin in late June. Spawning takes place in September. The onset of spawning in a stream reach is temperature driven. Temperature may be influenced by riparian conditions. Conserving riparian areas in the White and Little Wenatchee rivers will help ensure that critical remaining spawning habitat stays intact.

Prespawning

Adults may hold in the deeper pools and under cover of the mainstem Wenatchee until arriving in Lake Wenatchee, where they hold prior to spawning. The availability of and number of deep pools and cover may be important to offset potential prespawning mortality, but most holding occurs in the lake. Preservation of the lake environment that ensures stratification (they appear to hold below the thermocline) is required at this stage.

Redd characteristics

Habitat needs for redd building include the availability of clean gravel at the appropriate size, and proper water depth and velocity. Depth of water does not seem to be critical for sockeye spawning (Chapman et al. 1995b). Sockeye appear to choose lower water velocity to spawn compared to other salmonids (Wydoski and Whitney 2003). Allen and Meekin (1980) found velocities over spawning areas ranging from 0.56 to 3.34 feet per second (fps), and average 1.52 fps. Conservation of remaining naturally geofluvial processes in the White and Little Wenatchee rivers, and restoration of areas that may have been affected by previous land use activities, will ensure quality spawning habitat remains (Peven 2003).

Incubation and emergence

Egg incubation usually lasts between 50-140 days, which is primarily dependent on temperature (in Chapman et al. 1995b). Emergence of sockeye occurs in the Wenatchee subbasin in March through April (Peven 2003).

Stream conditions (e.g., frequency of flooding, extreme low temperatures) may affect egg survival too. Floods can scour eggs from the gravel by increasing sediment deposition that reduces oxygen and percolation through the redd. Healy (1991) states that siltation may be more lethal earlier in the incubation period than in later phases. Chapman et al. (1995b) compiled information for sockeye throughout their range for various life stage survivals. Incubation survival generally ranged from 25-60%, although some measurements were at both extremes (0%; 100%). Allen and Meekin reported that incubation survival for Wenatchee sockeye was 0-

100%. Egg to fry survival ranged below 10% to slightly less than 50% for sockeye throughout their range (Peven 2003).

In the Wenatchee subbasin, fall flooding has a high frequency of occurrence. This may negatively affect incubation and emergence success, especially in years of extreme flows (e.g., 1990 and 1995). Road building activities in the upper watersheds may also increase siltation, as well as grazing and mining activities. All three factors were once more prevalent than they are now in the basin, and conditions have improved in most watersheds. Conservation of existing conditions (e.g., riparian, old growth forest, etc.) within the upper watersheds of the Little Wenatchee and White rivers will help ensure that floods will have less impact.

Fry

After fry emerge (primarily at night), they begin their movement towards Lake Wenatchee (Chapman et al. 1995 CPb). During daylight hours, fry hide under stones and within debris, and they begin moving again at dawn. Because of the relatively short distance that fry would have to migrate to Lake Wenatchee, it is reasonable to assume that they can reach the lake within one night under most conditions. Fry appear to arrive in Lake Wenatchee between March and May.

After fry enter a lake, they may either move immediately offshore, or remain in limnetic areas to rear until zooplankton production increases offshore (Chapman et al. 1995b). In Lake Wenatchee, Chapman et al. (1995b) reported that Allen and Meekin (1980) did not find fry in near-shore areas during their surveys in the 1970s, but felt that it was reasonable to assume that this behavior occurred because of the conditions fry encounter when they enter the lake (Peven 2003).

Since fry enter Lake Wenatchee at its western shore, where there is currently minimal development, conserving this area as potential sockeye rearing habitat may help overall sockeye production. Other near-shore habitat has been and is currently affected by land use activities. However, most of the other shoreline habitats do not have large limnetic areas because of a sharp drop off to deeper waters, so restoration of these areas may not increase production to a great degree, although there may still be certain areas (primarily along the north shore) that would benefit from restoration factors.

Parr

Sockeye juveniles have complex daily vertical migration patterns to balance risk of being preyed upon to finding food. Chapman et al. (1995b) cite Brett (1980) who concluded that the vertical migration doesn’t begin until the nursery lake stratifies. In general, juveniles seek cold, dark water (below the thermocline) in the day, rise towards the surface at dusk, feed, and then hold below the surface waiting for dawn when they feed again before migrating down again (Burgner 1991; Chapman et al. 1995b). Chapman et al. (1995b) noted that Lake Wenatchee does not typically develop a strong thermocline, and temperatures and dissolved oxygen conditions allow sockeye to use all depths throughout all photic regions within the lake (Peven 2003).

Lake Wenatchee is an oligotrophic lake; cold and well-oxygenated, but infertile. Historically, many septic systems may have leaked into the lake. The overall effect may have been increases in zooplankton, which may have had a positive affect on sockeye production. Recently, the formation of a waste water system may have reduced the production of sockeye, although this hypothesis is speculative.

Bull trout have evolved with sockeye. Historically, bull trout numbers were reduced from fishing pressure. Since they were listed as threatened in 1998, fishing pressure has been reduced. An increase of bull trout have been observed on the spawning grounds and has probably had an effect on the production of sockeye in the lake.

Maintaining the high quality functionality of Lake Wenatchee, while minimizing the impacts of current land use practices are the factors that may either maintain or increase sockeye productivity. Adding nutrients to Lake Wenatchee in a balanced manner would undoubtedly increase the production of sockeye.

Smolt

Wenatchee River sockeye smolts begin migrating from Lake Wenatchee in April. Investigation of suspected or potential impediments to migration or injury or mortality should be identified and investigated.

Population Characterization

Distribution

Historic

Historically, populations of sockeye salmon spawned in the Wenatchee subbasin in the White and Little Wenatchee rivers. Some spawning may have occurred within and downstream of the lake, but evidence is inconclusive (Chapman et al. 1995b).

Current

The principal spawning areas for Wenatchee subbasin sockeye are approximately in the lower 4 miles of the Little Wenatchee River and the lower 5 miles in the White River (Peven 1992). Some fish also spawn in the Napeequa River (a tributary of the White River) Also see Figure 10.

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Figure 10. Significant sockeye watersheds in Wenatchee and Entiat subbasins (RTT 2004)

Abundance

Historic

Chapman (1996) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead, and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 2.6 million sockeye, (for the entire Columbia basin) for predevelopment run sizes. Sockeye were very abundant in upper Columbia River tributary streams (Yakima, Wenatchee, Okanogan, and Arrow Lakes) prior to the extensive resource exploitation in the 1860s (Peven 2003).

By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, unscreened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of upper Columbia basin salmonids (Peven 2003).

By the beginning of the twentieth century, it appears that most of the sockeye entering the Columbia River were headed to the Arrow Lakes region in British Columbia (WDF 1938). In the mid 1930s, the Washington Department of Fisheries (WDF) counted fish ascending Tumwater Dam in the Wenatchee River, and Zosel Dam in the Okanogan River. These counts suggested that 85-92% of the sockeye counted over Rock Island Dam in the same years where headed to spawning areas other than the Wenatchee and Okanogan basins (Peven 2003).

Mullan (1986) quotes Rich (1940CPa, 1940CPb), who reviewed the sockeye fishery between 1892-1938, as stating that the sockeye runs were greatly reduced as long ago as 1900, since which time there has been no marked change in the size of the catch. Mullan (1986) suggests that the landings of sockeye may suggest otherwise, but that harvest rates in the lower river were undoubtedly high during that time; Rock Island Dam counts only accounted for 16% of the fish entering the Columbia River between 1933-1937, and in 1934 over 98% of the sockeye entering the river were harvested (Pevan 2003).

Mullan (1986) points out that commercial catches of sockeye after 1938 were still extreme, where escapement past the fisheries between 1938 and 1944 was mostly below 20%, and in 1941 was only 1%. In 1945, escapement increased and remained relatively high, between 25-50%. Since 1960, escapement has exceeded catch on a regular basis (Peven 2003).

Current

Since 1938, the percentage of sockeye that has entered the Columbia River (minimum run) that have passed Rock Island Dam has varied from less than 1% (1941) to greater than 95% (1990s). The mean percentage of fish ascending the Columbia past Rock Island Dam has increased since 1938. Between 1938 and 1944, only 14.5% of the sockeye estimated to have entered the Columbia River were counted at Rock Island Dam. The percentage has steadily grown since then, approaching 100% in most recent years.

Even though there appears to be problems associated with the spawning ground counts, they may be used as an index of abundance in the two systems. In the Wenatchee, it appears the run may be stable.

Decadal averages have shown a general increase in numbers of fish ascending Rock Island Dam.

Allen and Meekin (1980) report the escapement goal of 80,000 sockeye over Priest Rapids. Currently, the escapement goal at Priest Rapids is 65,000 (Devore and Hirose 1988). The Columbia River Technical Advisory Committee (TAC) changed the goal in 1984 from 80,000 fish (1933-1966 at Rock Island and from 1967 to the present at Priest Rapids) to the current

65,000, which under most conditions equates to 75,000 sockeye over Bonneville Dam. LaVoy (1992) showed the escapement goal of the Wenatchee population as 23,000. Using the various dam counts, escapement has been met in most years since 1970. If spawning ground counts are used, however, the Wenatchee system is not meeting escapement goals in most years (Peven 2003).

Productivity

Historic

Historic production of sockeye is difficult to determine, it was thought to be very high. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan et al. 1992), it is assumed that historic production of sockeye was higher than current (Peven 2003).

Current

Current productivity is affected by loss or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Mullan et al. (1992) postulated that current production may not be greatly different than historic for sockeye in the Wenatchee subbasin. Caveats to this postulate are that production comes at a higher cost in terms of smolt survival through the mainstem corridor and that harvest is drastically reduced (Peven 2003).

While spawning habitat does not appear to be limiting sockeye in the Wenatchee subbasin, rearing in Lake Wenatchee is. Being a highly oligotrophic lake, production may never have been high in this particular subbasin, compared to other systems of the upper Columbia River region.

Diversity

Diversity of the Wenatchee independent population is believed to be robust, especially since the Grand Coulee Fish Maintenance Project (GCFMP), about 60 years ago, when mixed stocks were released within the basin.

Summary

Table 17. Summary of sockeye population characterization

	Distribution	Abundance	Productivity	Diversity
Historic	Moderate	High	Moderate-High	Moderate-High
Current	Moderate	Moderate	Moderate	Moderate

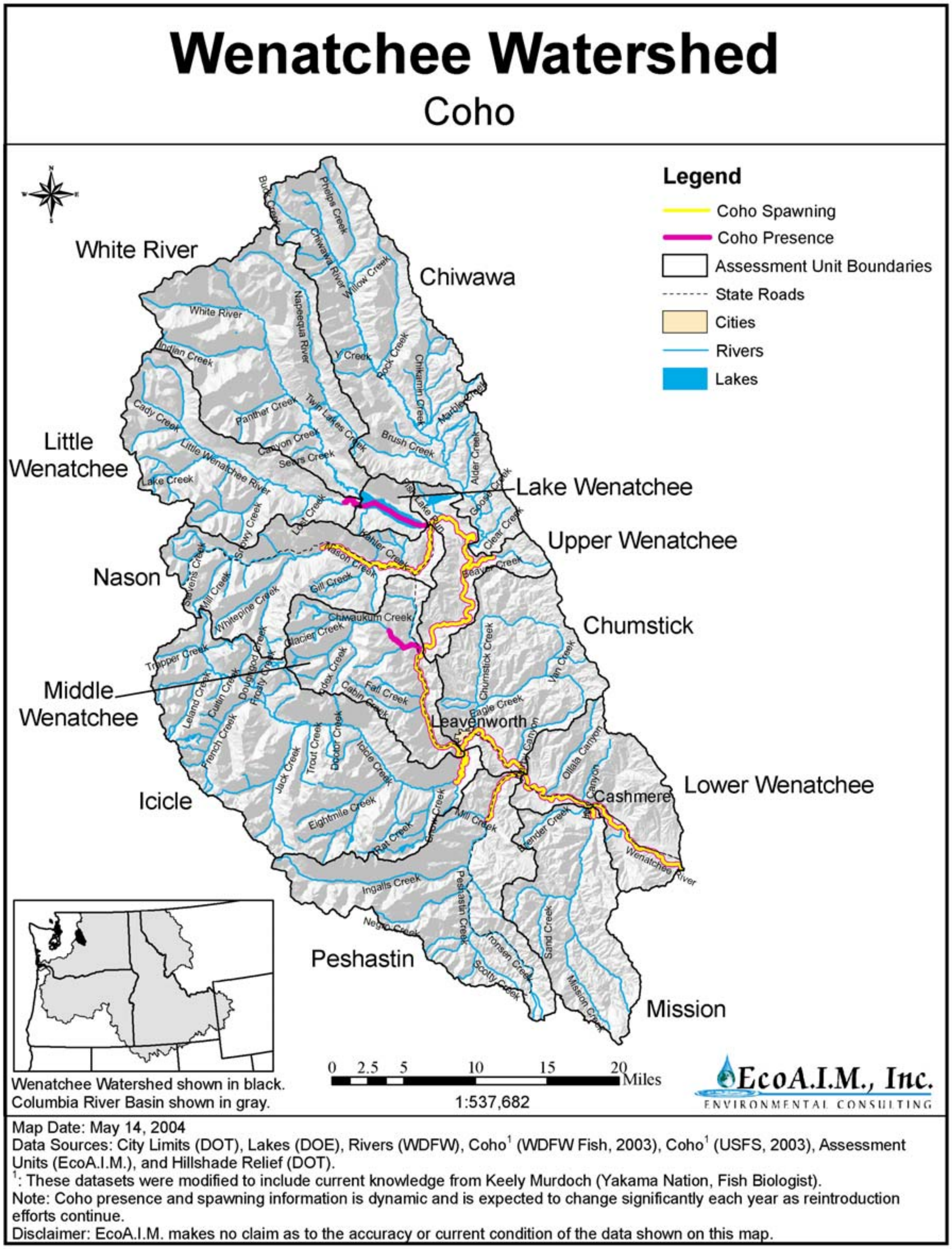

Figure 11. Coho distribution in the Wenatchee subbasin

4.8.5 Coho (*Oncorhynchus kisutch*)

Rationale for Selection

Coho salmon were once considered extinct in the mid Columbia region, but have since been reintroduced. Recent re-introduction efforts have resulted in natural reproduction occurring in the basin. Mullan (1984) estimated the historical run size at 38,000 to 51,000 adults to the Wenatchee, Entiat, and Methow rivers (Peven 2003).

Recently the Yakama Nation has begun a substantial and concerted effort to reintroduce coho into the upper Columbia, using the Wenatchee and Methow subbasins during the feasibility phase of this work. Coho salmon prefer and occupy different habitat types, selecting slower velocities and greater depths than the other focal species; Habitat complexity and off-channel habitats such as backwater pools, beaver ponds, and side channels are important for juvenile rearing making coho good biological indicators for these areas.

Key Life History Strategies: Relationship to Habitat

Time of entry and spawning

Coho salmon enter the Wenatchee River in early September through late November. Adults ascended the tributaries in the fall and spawning between mid-October and late December, although there is historical evidence of an earlier run of coho salmon (Mullan 1984). As cold Water temperatures at that time of year preclude spawning in some areas, it is likely that coho salmon spawn in areas where warmer ground water up-wells through the substrate.

Prespawning

Coho entering in September and October hold in larger pools prior to spawning, later entering fish may migrate quickly upstream to suitable spawning locations. The availability and number of deep pools and cover is important to off set potential prespawning mortality. Intact riparian habitat will increase the likelihood of in stream cover, and normative channel geofluvial processes will increase the occurrence of deeper pools.

Redd characteristics

Important habitat need for redd building include the availability of clean gravel at the appropriate size, and proper water depth and velocity. Burner (1951) reported the range of depths for coho spawning to be between 8 and 51 cm. Coho salmon spawn in velocities ranging from 0.30 to 0.75 m/s and may seek out sites of groundwater seepage (Sandercock 1991).

Incubation and emergence

The length of time required for eggs to incubate in the grave is largely dependent on temperature. Sandercock (1991) reported that the total heat requirement for coho incubation in the gravel (spawning to emergence) was 1036 (±138) degree (°C) days over zero. The percentage of eggs and alevins that survive to emergence depends on stream and streambed conditions. Fall and winter flooding, low flows, freezing of gravel, and heavy silt loads can significantly reduce survival.

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 flow. Road building activities in the upper watersheds may also increase siltation, as well as grazing and mining activities. All three factors were once more prevalent than they are now in the basin, and the conditions have improved in most watersheds. However, Nason Creek because of its location near a railroad and major highway has long term restoration needs that could most likely increase incubation success.

In the Wenatchee sub-basin, coho fry emerge from the gravel in April or May (K. Murdoch, personal communication).

Fry

Juvenile coho salmon generally distribute themselves downstream shortly after emergence and seek out suitable low gradient tributary and off channel habitats. They congregate in quiet backwaters, side channels, and shady small creeks with overhanging vegetation (Sandercock 1991). Conservation and restoration of riparian areas, and off channel habitat in natal streams within the Wenatchee Basin would increase the preferred type of habitat fry use.

Parr

Coho salmon prefer slower velocity rearing areas than chinook salmon or steelhead (Lister and Genoe 1970; Allee 1981; Taylor 1991) Recent work completed by the Yakama Nation supports these findings (Murdoch et. al. 2004). Juvenile coho tend to overwinter in riverine ponds and other off channel habitats. Overwinter survival is strongly correlated to the quantity of woody debris and habitat complexity (Quinn and Peterson 1996). Conservation of and restoration of high functioning habitat in natal tributaries along and restoration of riparian and geofluvial processes in or near known and potential parr rearing areas will have the highest likelihood of increasing parr survival.

Smolt

Naturally produced coho smolts in the Wenatchee Basin emigrate between March and May (Murdoch et. al. 2004). Investigation of suspected or potential impediments to migraton or injury or mortality should be identified and investigated. If areas are shown to unnaturally impede migration or injure or kill fish, they should be fixed.

Population Characterization

Distribution

Historic

Coho salmon were once considered extirpated in the upper Columbia River (Fish and Hanavan 1948; Mullan 1984), but have since been reintroduced. Mullan (1984) estimated that upstream of the Yakima River, the Methow River and Spokane River historically produced the most coho, with lesser runs into the Wenatchee and Entiat. There are conflicting reports of whether the Okanogan subbasin historically produced coho (Craig and Suomela 1941; Vedan 2002). Because the indigenous stock of coho salmon no longer occur in the upper Columbia River system, the Wenatchee subbasin coho are not addressed under the ESA or by the WDFW (1994) SASSI (Peven 2003).

Information regarding the historic distribution of coho salmon within the Wenatchee River basin is limited. Based on affidavits from 'old-time' residents, Nason Creek was likely an important spawning area, and nearly all the smaller creeks had a run of coho salmon (Mullan 1984). The fall run of salmon in the Wenatchee River Basin continued until about 1914-1915, after which it rapidly declined (Mullan 1984).

Current

Coho salmon currently spawn in the main stem Wenatchee River (Cashmere to Lake Wenatchee), Nason Creek, Beaver Creek, Icicle Creek, Peshastin Creek, Mission Creek, and possibly Chiwakum Creek. In 2004, coho are expected to return to the Little Wenatchee River to spawn. Coho salmon rear in their natal tributaries. A portion of juvenile coho likely migrate downstream duiring the fall, presumably for overwinter habitat.

Abundance

Historic

Historically 120,000-166,500 coho were attributed to the mid-and upper Columbia tributaries (Yakima, Wenatchee, Entiat, Methow, and Spokane Rivers: Mullan 1984). Mullan (1984) estimated that the Wenatchee River supported adult returns of approximately 6,000-7,000 coho.

There were two previous attempts in the twentieth century to rebuild coho populations though these two programs were not designed or intended to rebuild upriver runs. They were for harvest augmentation. Releases did not occur in the natural production habitat areas within the watershed.. Between the early 1940s and the mid 1970s, the USFWS raised and released coho as part of their mitigation responsibilities for the construction of Grand Coulee Dam (Mullan 1984). Chelan PUD also had a coho hatchery program until the early 1990s. While some natural production may have occurred from these releases, the programs overall were not designed to re-establish naturally spawning populations, and relied on lower river stocks that were not suited to the upper Columbia (Peven 2003). All coho releases under the Chelan PUD program (197-1993) were made from the Turtle Rock Fish Hatchery, located in the middle of the Columbia River above Rocky Reach Dam. The release location likely contributed to the inability to produce a naturally spawning coho run. This reach of the Columbia River does not provide suitable coho spawning and rearing habitat.

Current

The Yakama Nation, as the lead agency, has implemented a substantial reintroduction program designed to restore naturally reproducing coho salmon through the development a locally adapted stock, while releasing acclimated smolts in natural production areas.

Since the reintroduction of coho to the Wenatchee River in 1999, the abundance of adult returns has ranged between an estimated 350 to 4000 (Murdoch et. al. 2004). Many of these fish are taken into the hatchery for broodstock development purpose, the remainder have spawned naturally. The first generation of naturally produced coho smolts emigrated from the Wenatchee River basin in 2002 with an estimated population size of 17,000 (Murdoch et al. 2004). In 2003, approximately 36,700 naturally produced coho smolts emigrated from the Wenatchee River (T. Miller, WDFW, unpublished data).

Productivity

Historic

Historic production of coho salmon is difficult to determine, although it was most likely not as high as sockeye or late-run chinook.

Current

Current productivity is affected by loss, or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc). Habitats in need of restoration within the Wenatchee Basin include Nason, Icicle, Peshastin, Chumstick, and Mission Creeks. By increasing known areas in need of restoration, it is reasonable to assume that production of coho would increase.

Diversity

Because hatchery stocks were used to reintroduce coho salmon (and develop a local broodstock), spatial and life history diversity within the basin is likely lower than the historic populations of coho salmon. As increased natural production occurs, and naturally produced coho are incorporated into the broodstock, diversity will likely increase. Increased habitat would most likely increase spatial and life history diversity for coho salmon in mid-Columbia tributaries.

Table 18. Summary of coho salmon population characterization.

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	High	Mod-high	Moderate	High
Current	Low	Low	Low	Low

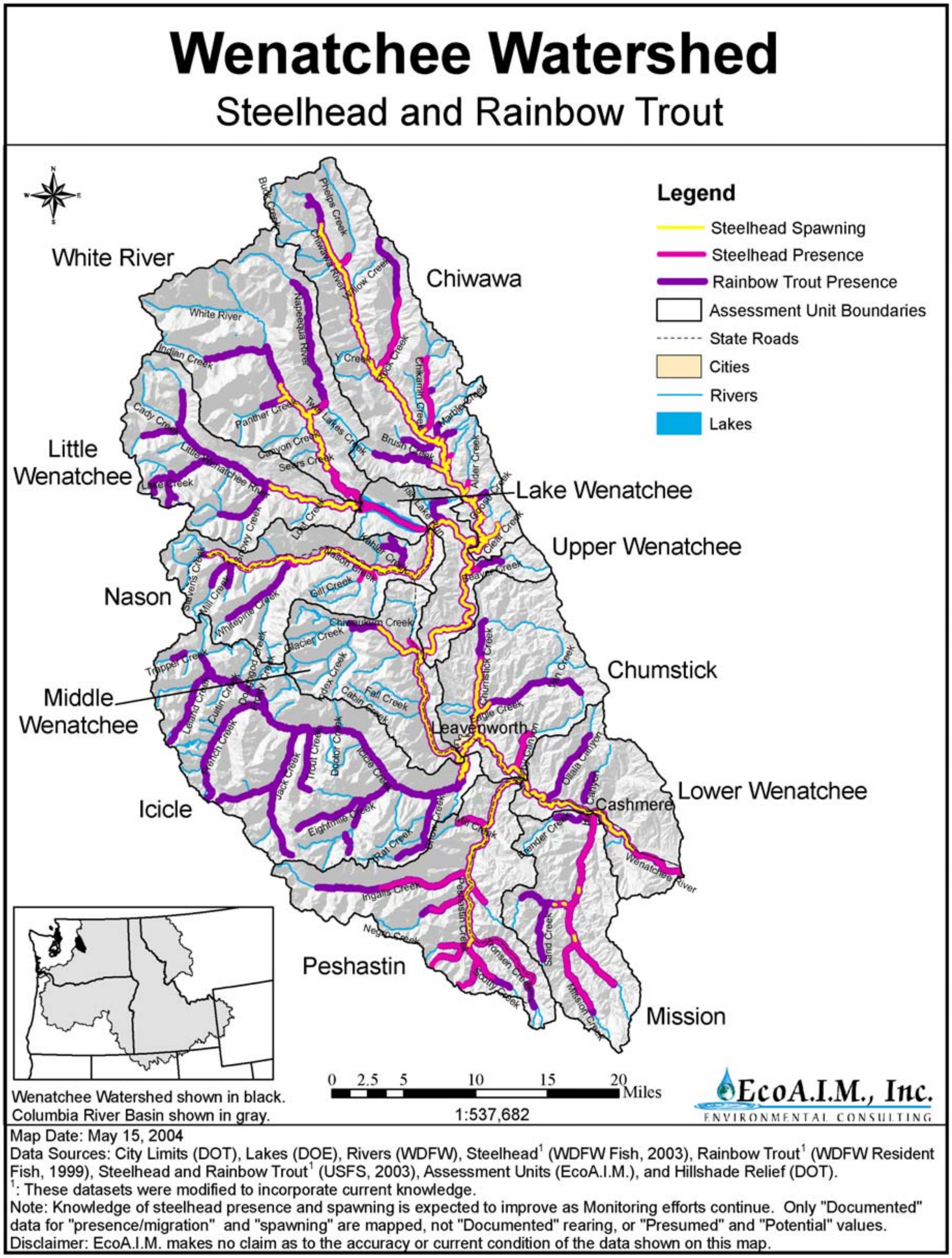

Figure 12. Steelhead and rainbow trout distribution in the Wenatchee subbasin

4.8.6 Steelhead Trout (*Oncorhynchus mykiss*)

Rationale for Selection

The Wenatchee steelhead is included by NOAA Fisheries into the upper Columbia ESU and is listed as an endangered under the ESA. Steelhead trout use all of the major tributaries of the Wenatchee subbasin except Icicle Creek due to existing barrier to passage (Figure 12). Steelhead juvenile spend two or more years in the Wenatchee mainstem and tributaries using many different habitat types making them a good biological indicator of ecosystem health.

Key Life History Strategies, Relationship to Habitat

Time of entry and spawning

Adult steelhead enter the Wenatchee River subbasin from August through the following April. Spawning begins in very late March and lasts through May, peaking in mid to late April (Murdoch and Viola 2003). Like other salmon species in the Wenatchee the onset of spawning in a stream reach is temperature driven. Other factors, such as habitat condition and stream flow may influence steelhead spawning success compared to other salmon species because of the time of year spawning occurs.

Prespawning

Adults using the Wenatchee subbasin hold in the deeper pools and under cover of the mainstem Wenatchee or natal tributaries. The availability of and number of deep pools and cover is important to offset potential prespawning mortality. Intact riparian habitat will increase the likelihood of instream cover, and normative channel geofluvial processes will increase the occurrence of deeper pools.

Redd characteristics

Important habitat needs for redd building include the availability of clean gravel at the appropriate size, and proper water depth and velocity. Wydoski and Whitney (2003) report that spawning is usually found at a mean depth of 0.7 to 1.34 ft and water velocities of 1.8 to 2.3 fps. Preservation or restoration of naturally occurring geofluvial function insures that the proper spawning habitat is available (Peven 2003).

Incubation and emergence

Incubation success is dependent on factors such as water flow through the redds and temperature. Eggs usually hatch in 4 to 7 weeks and fry emerge 2 to 3 weeks after that (Peven 2003).

Stream conditions (e.g., frequency of flooding, extreme low temperatures) may affect egg survival too. Floods can scour eggs from the gravel by increasing bedload movement. High flows associated with unstable stream banks increases sediment deposition that reduces oxygen and percolation through the redd. Healy (1991) cites Shaw and Maga (1943) as showing that siltation may be more lethal earlier in the incubation period than in later phases.

In the Wenatchee subbasin, fall flooding has a high frequency of occurrence. Road building activities in the upper watersheds may also increase siltation, as well as grazing and mining activities. All three factors were once more prevalent than they are now in the subbasin, and conditions have improved in most watersheds. However, Nason Creek because of its location near a railroad and major high way has long term restoration needs that could most likely increase incubation success, although empirical information is needed to determine if this is a need first.

Fry

In the Wenatchee River, Hillman and Chapman (1989) found most juvenile steelhead rearing in Tumwater Canyon. During daylight, age-0 (less than 1 year) steelhead used slower, shallower water than chinook, stationed individually over small boulder and cobble substrate (Hillman et al. 1989a). As they grew, they picked deeper and faster habitat over cobble and boulders. As with chinook juveniles, in winter, they concealed themselves in interstitial spaces among boulders near the stream bank, but did not cluster together. No interaction was observed between chinook and steelhead at anytime (Hillman et al. 1989a, 1989b).

During nighttime hours, steelhead moved downstream and closer to shore. At dawn, steelhead moved upstream. Most steelhead chose sand and boulder substrates, and during winter, chose deeper, larger substrate (Hillman et al. 1989b).

Hillman and Miller (2002) remarked that in ten years of surveying the Chiwawa River, age-0 steelhead most often used riffle and multiple channel habitats, but were also found associated with debris in pool and glide habitat.

Conservation and restoration of natural geofluvial processes and riparian areas of natal streams within the Wenatchee subbasin would increase the type of habitat that fry utilize.

Parr

Downstream movement of parr from natal streams occurs within the Wenatchee subbasin (Murdoch et al. 2001). French and Wahle (1959) found that juvenile steelhead migrated past Tumwater Dam on the Wenatchee River (RM 33) from spring through late fall. Since 1992, sampling by WDFW has found steelhead emigrating from the Chiwawa River as pre-smolts beginning in spring, but primarily in the fall. In general, movement from the Chiwawa River included some yearlings leaving as early as March, extending through May, followed by subyearlings leaving through the summer and fall (until trapping ceases because of inclement weather) (Peven 2003).

Movement of juvenile steelhead from the higher-order streams in the fall appears to be a response to the harsh conditions encountered in the upper tributaries. Hillman and Chapman (1989) suggested that biotic factors, such as intraspecific interaction for available habitat with naturally and hatchery produced chinook, nocturnal sculpin predation, and interspecific interactions may accelerate movement of chinook and steelhead juveniles from the mainstem Wenatchee River.

Hillman and Chapman (1989) found that most steelhead remained in Tumwater Canyon area to rear through all seasons. The amount of habitat diversity and complexity in this reach compared to other reaches was believed to be responsible for this behavior.

Conservation of high functioning habitat in natal tributaries and Tumwater Canyon, and restoration of riparian and geofluvial processes in or near known and potential parr rearing areas will have the highest likelihood of increasing parr survival.

Smolt

Wenatchee River steelhead smolts begin migrating in March from natal areas. Investigation of suspected or potential impediments to migration or injury or mortality should be identified and investigated.

Population Characterization

Distribution

Historic

Steelhead historically used all major (and some minor) tributaries within the upper Columbia basin for spawning and rearing (Chapman et al. 1994a). Fulton (1970) described steelhead using the Wenatchee River and eight of its tributaries: lower Mission, Peshastin, Icicle, Chiwaukum, Nason creeks, and the Chiwawa, Little Wenatchee, and White rivers (Peven 2003).

Current

Beginning in 2001, WDFW has been conducting spawning ground surveys for steelhead in the Wenatchee River. This effort is in conjunction with hatchery evaluations that are currently taking place within the Wenatchee River subbasin for Chelan County PUD funded mitigation efforts. Current spawning distribution in the Wenatchee subbasin, in order of importance appears to be: the Wenatchee River between the Chiwawa River and Lake Wenatchee, Nason, Chiwawa, and Icicle creeks. Other tributaries were not surveyed, such as the Little Wenatchee and White rivers, or Chiwaukum, Peshastin, or Mission creeks, but are most likely used by steelhead for possible spawning and rearing. In 2004, spawning surveys for steelhead are going to be expanded into these and other areas within the subbasin (Peven 2003). Also see Figure 13.

Subwatersheds Significant for Steelhead in Wenatchee and Entiat Subbasins

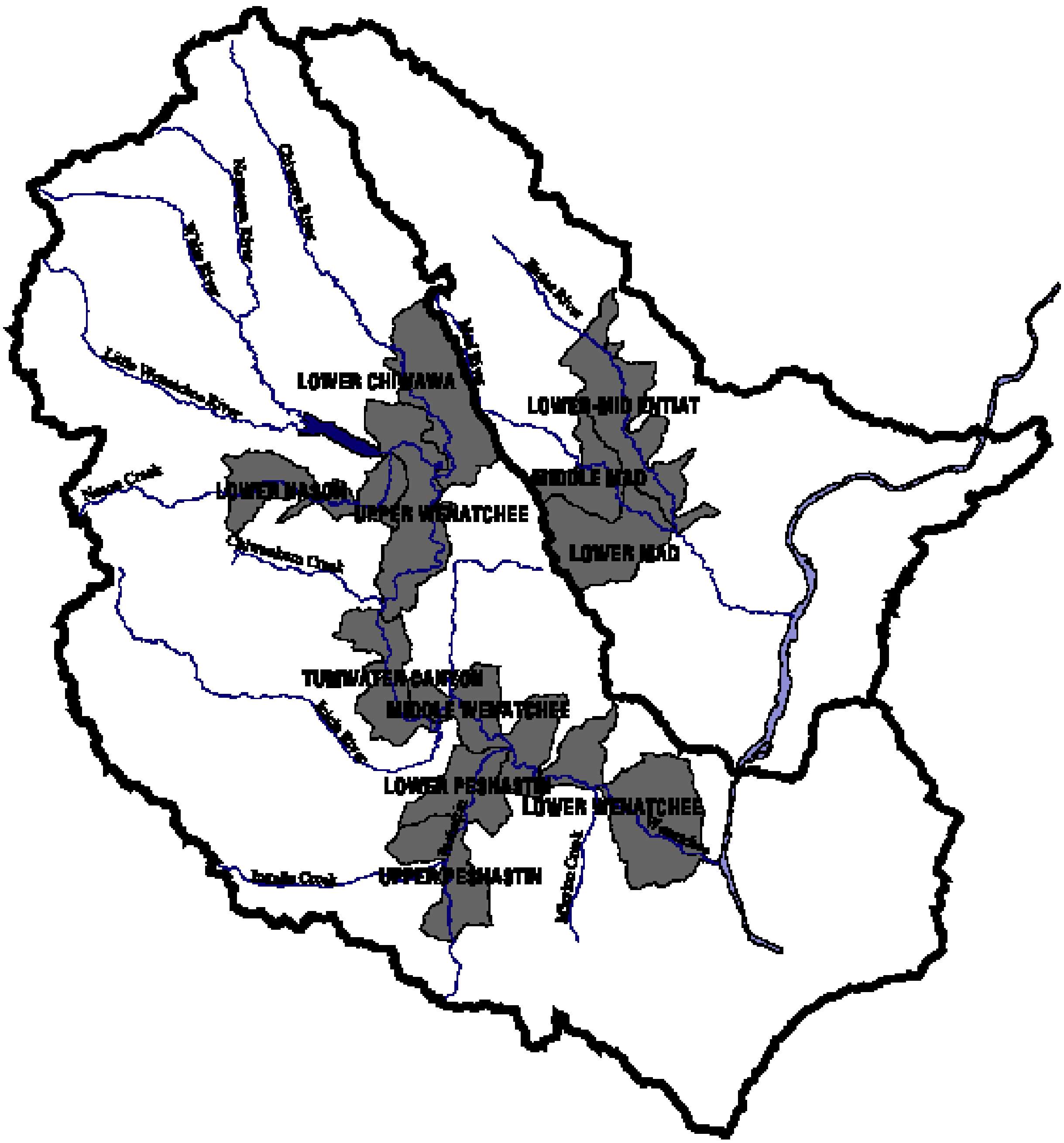

Figure 13. Significant steelhead watersheds in Wenatchee and Entiat subbasins (RTT 2004)

Abundance

Historic

Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead, and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 554,000 steelhead (for the entire Columbia basin) was the best estimate of predevelopment run sizes. Steelhead were relatively abundant in upper Columbia River tributary streams prior to the extensive resource exploitation in the 1860s.

By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, unscreened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of upper Columbia basin salmonids (Peven 2003).

Steelhead counts began at Rock Island Dam in 1933, and annual counts averaged 2,800 between 1933 and 1939 (these numbers do not reflect large fisheries in the lower river that took place at that time, estimated by Mullan et al. (1992) as greater than 60%). Average decadal numbers changed little in the 1940s and 1950s (2,600 and 3,700, respectively). Large hatchery releases began in the 1960s, and the average counts increased to 6,700. In the 1970s, counts averaged 5,700 and 16,500 in 1980s (record count of about 32,000 in 1985). In the 1990s, counts decreased, following a similar trend as chinook, to 7,100, while, similar to chinook, they have increased substantially so far in the 2000s, with an average of over 18,000 (a high of 28,600 in 2001).

Current

In 2002, Murdoch and Viola (2003) found a total of 475 steelhead redds upstream of Tumwater Dam, with most of them found in the Wenatchee River. Ford et al. (2001) recommended interim recovery levels of about 2,500 naturally produced spawners for the Wenatchee River (Peven 2003).

Productivity

Historic

Historic production of steelhead is difficult to determine, although it was most likely not as high as sockeye or late-run chinook. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan et al. 1992), it is assumed that historic production of steelhead was higher than current.

Current

Current productivity is affected by loss or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Mullan et al. (1992) postulated that current production may not be greatly different than historic for steelhead. Caveats to this postulate are that native coho are extinct, production comes at a higher cost in terms of smolt survival through the mainstem corridor, and that harvest is drastically reduced. However, recent estimates of natural replacement rates for steelhead suggest that they are not replacing themselves in most years until the broods of the late 1990s (Peven 2003).

There are still habitat areas in need of restoration (e.g., Peshastin and Mission creeks) within the Wenatchee subbasin. By increasing known areas in need of restoration, it is reasonable to assume that production of steelhead would increase.

Diversity

Because some areas within the Wenatchee subbasin are in need of habitat improvements, diversity within the subbasin is believed to be lower than historic. While the Wenatchee population is still believed to be an independent population, increased habitat would most likely increase spatial and life history diversity.

Currently, genetic sampling has not found any differences among steelhead within the subbasin.

Table 19. Summary of steelhead population characterization

	Distribution	Abundance	Productivity	Diversity
Historic	High	High	Moderate-High	High
Current	Moderate-High	Low	Low	Moderate

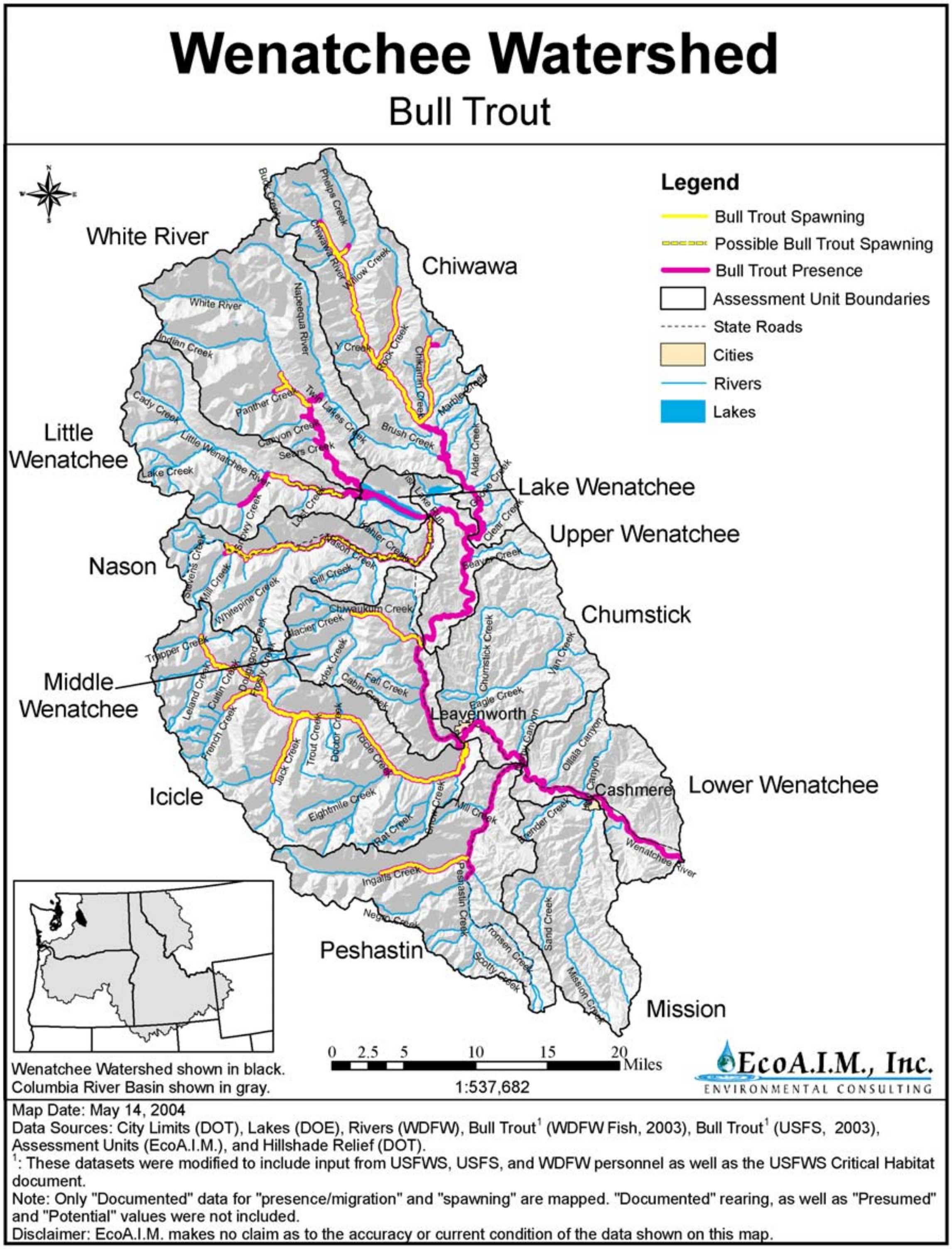

Figure 14. Bull trout distribution in the Wenatchee subbasin

4.8.7 Bull Trout (*Salvelinus confluentus*)

Rationale for Selection

Bull trout are sensitive to environmental changes, especially water temperature making them a good biological indicator of ecosystem health in the mid and upper elevations.

Key Life History Strategies, Relationship to Habitat

Spawning

Bull trout spawn in the Wenatchee River subbasin from August through October. The onset of spawning in a stream reach is temperature driven, apparently at the onset of dropping temperatures.

Prespawning

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 prespawning mortality. Intact riparian habitat will increase the likelihood of instream cover, and normative channel geofluvial processes will increase the occurrence of deeper pools.

Redd characteristics

Important habitat needs for redd building include the availability of clean gravel at the appropriate size, and proper water depth and velocity. Fraley and Shepard (1989) characterized selected spawning areas as having low compaction and low gradient, and potentially near upwelling influences and proximity to cover. In general, mean velocities over redds range from 0.13-2.0 fps, with water depth ranging from 0.71-2.0 ft. Brown (1992) noted that these metrics comported well with those found within the Wenatchee subbasin. Preservation or restoration of naturally occurring geofluvial function insures that the proper spawning habitat is available (Peven 2003).

Incubation and emergence

Optimum incubation for bull trout is lower than other salmonids (36-39 °F; Brown 1992). Because of the lower temperatures, bull trout development within the redd is usually longer than other salmonids. Emergence may take another three weeks after hatching.

Stream conditions (e.g., frequency of flooding, extreme low temperatures) may affect egg survival too. Floods can scour eggs from the gravel by increasing bedload movement. High flows associated with unstable stream banks increases sediment deposition that reduces oxygen and percolation through the redd. Healy (1991) cites Shaw and Maga (1943) as showing that siltation may be more lethal earlier in the incubation period than in later phases.

In the Wenatchee subbasin, fall flooding has a high frequency of occurrence. This may negatively affect incubation and emergence success, especially in years of extreme flows (e.g., 1990 and 1995). Road building activities in the upper watersheds may also increase siltation, as well as grazing and mining activities. All three factors were once more prevalent than they are now in the subbasin, and conditions have improved in most watersheds. However, Nason Creek because of its location near a railroad and major high way has long term restoration needs that could most likely increase incubation success, although empirical information is needed to determine if this is a need first.

Because bull trout development within the redd takes a long period of time, they may be more vulnerable to increases in sediments or degradation other water quality (Fraley and Shepard 1989).

Fry

Fry (< 100 mm) are usually found in shallow, slow back water side channels or eddies, in association with fine woody debris. Age-0 bull trout are consistently found near the substrate, usually over gravel-cobble areas.

Conservation and restoration of natural geofluvial processes and riparian areas of natal streams within the Wenatchee subbasin would increase the type of habitat that fry utilize.

Parr

Hillman and Miller (2002) state that most juvenile bull trout are consistently found in multiple channels, pool, and riffles, and a few in glides. Juveniles were found in association with the stream bottom over rubble and small boulder substrate or near woody debris.

Downstream movement of juveniles (> 4 in.) from natal streams occurs within the Wenatchee subbasin (Murdoch et al. 2001). Since 1992, sampling by WDFW has found bull trout emigrating from the Chiwawa River have two modes; one in spring, and the other in the fall.

Movement of juvenile bull trout from the higher order streams in the fall may be in response to the unsuitable conditions encountered in the upper tributaries. Murdoch et al. (2001) also speculated that movement in the fall may instead be correlated to the size and age at which bull trout become piscivorous. Most of the juveniles emigrating from the Chiwawa River are likely migrating to Lake Wenatchee (Peven 2003).

Conservation of high functioning habitat in natal tributaries, restoration of riparian and geofluvial processes in or near known and potential juvenile rearing areas will have the highest likelihood of increasing parr survival.

Another factor that is limiting bull trout production in the Wenatchee subbasin is competition with brook trout. Brook trout are found in most areas that bull trout are found (Hillman and Miller 2002).

Population Characterization

Distribution

Historic

While detailed historic distribution is difficult to determine (Rieman et al. 1997), bull trout are believed to have been historically present in the Wenatchee River (Brown 1992; Mongillo 1993).

Current

All three ecotypes of bull trout currently exist in the Wenatchee River Core Area (WDFW 1998). The six migratory (Migratory bull trout are not defined within USFWS (2002). We assume they refer to ecotypes that exhibit some form of extended migration from either different order streams or between lakes and streams, and not those fish that inhabit a limited stream section (commonly known as resident.) bull trout sub populations in the Wenatchee River are found in the Chiwawa River (including Chikamin, Phelps, Rock, Alpine, Buck and James creeks), White River (including Canyon and Panther creeks), Little Wenatchee River (below the falls), Nason Creek (including Mill Creek), Chiwaukum Creek, and Peshastin Creek (including Ingalls Creek). There may also be non-migratory subpopulations within some of these streams, as well as Icicle Creek.

In the Wenatchee subbasin, the adfluvial form matures primarily in Lake Wenatchee and ascends the White and Little Wenatchee rivers, and the Chiwawa River (Kelly-Ringold and DeLavergne 2003), where the young reside for one to three years. Fluvial bull trout populations spawn in the other streams identified above.

Abundance

Historic

There is currently no information available to assess what historic abundance of bull trout was in the Wenatchee River subbasin.

Current

Recent comprehensive redd surveys, coupled with preliminary radio telemetry work suggest that remaining spawning populations within the Wenatchee River are not complete genetic isolates of one another, but rather co-mingle to some degree . It is possible that there are separate, local spawning aggregates, but more monitoring and DNA analysis is necessary to be able to empirically determine this. The chance of finding independent subpopulations within each subbasin would most likely found be in head water areas upstream of barriers, which prevents immigration from downstream recruits, but not emigration to downstream areas during high water events occasionally (Peven 2003).

Since nonmigratory fish are difficult to count, all estimates of current abundance should be considered underestimates of the true population size of bull trout within the Wenatchee subbasin. This is based on the belief that nonmigratory fish are most likely contributing to the migratory populations (like steelhead), and potentially vice versa, although there may not be very many non-migratory bull trout populations within the Wenatchee subbasin (Peven 2003).

Redd surveys have been conducted by the USFWS, USFS, and WDFW in the various streams within the Wenatchee River subbasin since the 1980s. The White and Little Wenatchee rivers have shown a fluctuating abundance of redds since 1983, averaging 34 redds.

Since 1989, the highest concentration of redds within the Wenatchee River subbasin has been observed within the Chiwawa watershed, averaging over 300 redds per year, and showing a steady increase of abundance. Lesser numbers of redds have also been observed within the Peshastin and Nason creek drainages, and in the upper mainstem Wenatchee River. Overall, the Wenatchee River subbasin has average over 250 redds since the surveys began in the Chiwawa River in 1989, and has shown a steady increase, although it should be noted that this trend may be a factor of increased effort in redd surveys in recent years (Peven 2003).

Hillman and Miller (2002) have observed between 76-900 bull trout in their snorkel surveys of the Chiwawa River between 1992 and 2002 (excluding 2000). They also state that because their surveys do not encompass areas outside of juvenile chinook salmon, or the entire lengths of all streams, so the estimates should be considered very conservative, since bull trout are known to extend beyond their survey boundaries.

Productivity

Historic

Historic productivity of bull trout within the Wenatchee subbasin is not known. However, it is reasonable to assume that it was higher, based on habitat degradation and management practices (harvest).

Current

Current productivity appears to be improving based on redd counts and other factors (see above).

Diversity

Historic diversity was most likely higher than current based on some minor losses of connectivity and potential increases in temperature. If habitat restoration occurs, there will most likely be an increase in spatial and potentially life history diversity.

Table 20. Summary of bull trout population characterization

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	High	Moderate-High	Moderate	High
Current	Moderate-High	Low-Moderate	Low-Moderate	Moderate

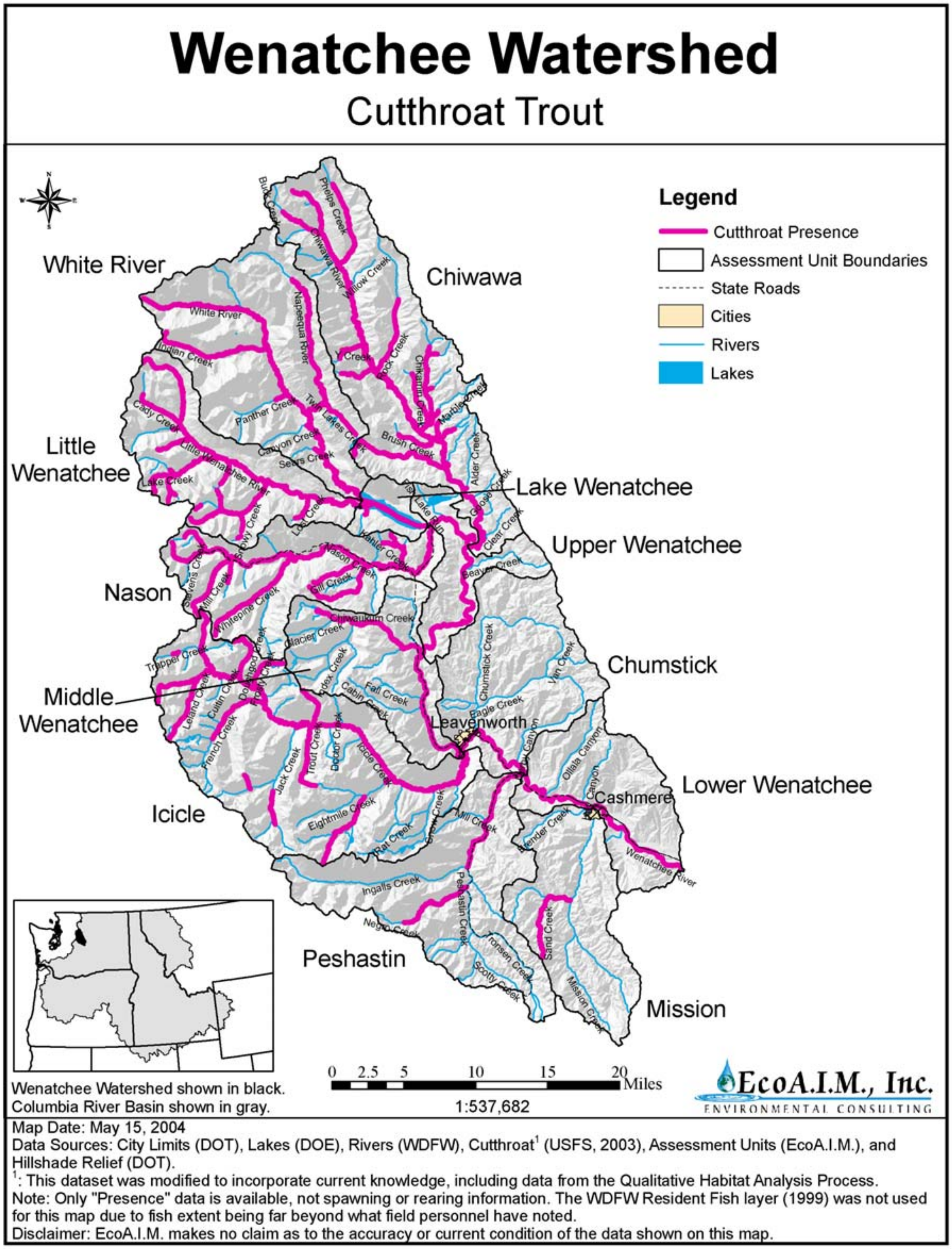

Figure 15. Cutthroat trout distribution in the Wenatchee subbasin

4.8.8 Cutthroat Trout (*Oncorhynchus clarki lewisi*)

Rationale for Selection

There are concerns about the status of this species due to genetic introgression (especially with introduced rainbow trout), depressed and fragmented populations or stocks, and loss of migratory life histories. The USFWS considers the westslope cutthroat trout a species of concern. The USFWS received a formal petition to list the westslope cutthroat trout as threatened pursuant to the ESA. A status review determined a listing of the species was not warranted at this time.

Cutthroat trout inhabit mid to high elevation streams, and may be the only salmonid species existing in various reaches. Cutthroat trout are sensitive to environmental changes, especially water temperature making them a good biological indicator of ecosystem health in the mid and upper elevations.

Key Life History Strategies, Relationship to Habitat

Spawning

Westslope cutthroat trout spawn between March and July, when water temperatures begin to warm. Spawning and rearing streams tend to be cold and nutrient poor.

Prespawning

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 prespawning 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 geofluvial processes will increase the occurrence of deeper pools.

Redd characteristics

Important habitat needs for redd building include the availability of clean gravel at the appropriate size, and proper water depth and velocity. USFWS (1999) state that westslope cutthroat trout redds are usually found in water that is about 0.7 ft deep with mean velocities of 1.0 to 1.3 fps.

Incubation and emergence

Eggs incubate for several weeks and emergence occurs several days after hatching (USFWS 1999).

Stream conditions (e.g., frequency of flooding) may affect egg survival too. Floods can scour eggs from the gravel by increasing bedload movement. High flows associated with unstable stream banks increases sediment deposition that reduces oxygen and percolation through the redd. Healy (1991) cites Shaw and Maga (1943) as showing that siltation may be more lethal earlier in the incubation period than in later phases.

In the Wenatchee subbasin, fall flooding has a high frequency of occurrence. This may negatively affect incubation and emergence success, especially in years of extreme flows (e.g., 1990 and 1995). These factors were once more prevalent than they are now in the subbasin, and conditions have improved in most watersheds. However, Nason Creek because of its location near a railroad and major high way has long term restoration needs that could most likely increase incubation success, although empirical information is needed to determine if this is a need first.

Fry

After emergence, fry are usually found in shallow, slow back water side channels or eddies, in association with fine woody debris.

Conservation and restoration of natural geofluvial processes and riparian areas of natal streams within the Wenatchee subbasin would increase the type of habitat that fry utilize.

Parr

Juvenile cutthroat trout overwinter in the interstitial spaces of large stream substrate.

Hillman and Miller (2002) state that most juvenile westslope cutthroat trout are consistently found in multiple channels and pools.

Downstream movement of juveniles from natal streams occurs within the Wenatchee subbasin. Since 1992, sampling by WDFW has found westslope cutthroat trout emigrating from the Chiwawa River (Peven 2003).

Movement of juvenile westslope cutthroat trout within streams is most likely related to changing habitat requirements as the fish grows, or winter refuge.

Conservation of high functioning habitat in natal tributaries, restoration of riparian and geofluvial processes in or near known and potential juvenile rearing areas will have the highest likelihood of increasing parr survival.

Another factor that is limiting westslope cutthroat trout production in the Wenatchee subbasin is competition with brook trout. Brook trout are found in many areas that westslope cutthroat trout are found (Hillman and Miller 2002).

Population Characterization

Distribution

Historic

The primary historic distribution of westslope cutthroat trout occurred in the upper Columbia and Missouri River basins (USFWS 1999). Westslope cutthroat trout were originally believed to occur in three river subbasins within Washington state: Methow, Chelan, and Pend Oreille, although only abundant in the Lake Chelan subbasin (Peven 2003).

Apart from Lake Chelan and the Pend Oreille River where an abundance of relatively large cutthroat commanded the attention of pioneers, cutthroat trout in streams were obscured by their head water location and small body size . . . Accordingly, the ethnohistorical record is mostly silent on the presence or absence of cutthroat. The picture is further blurred by the early scattering of cutthroat from the first trout hatchery in Washington (Stehekin River Hatchery, 1903) by entities (Department of Fisheries and Game and county Fish Commissions) dissolved decades ago along with their planting records. The undocumented translocation of cutthroats by interested non-professionals starting with pioneers is another confusing factor that challenges determination of historical distribution.

Recent information, based on further genetic analyses (Trotter et al. 2001; Behnke 2002; Howell et al. 2003), indicates that the historic range of westslope cutthroat trout in Washington state is now believed to be broader. Historic distribution now includes the head waters of the Wenatchee and Yakima River subbasins (Behnke 2002).

Overall, Behnke (1992) believed that the disjunct populations in Washington state probably were transported here through the catastrophic ice age floods.

Current

Through stocking programs that began with Washington state's first trout hatchery in the Stehekin River valley in 1903 (that targeted westslope cutthroat trout), westslope cutthroat trout have been transplanted in almost all available stream and lake habitat (Williams 1998).

Williams (1998) documented that in the Wenatchee River subbasin, westslope cutthroat trout sustain themselves in 82 streams (175 miles) and 83 alpine lakes (1,462 acres).

Abundance

Historic

There is currently no information available to assess what historic abundance of westslope cutthroat trout was in the Wenatchee River subbasin. Numerical abundance has not been documented or estimated for westslope cutthroat trout. Westslope cutthroat were not thought to have been very abundant where they occurred in the head water locations within the Methow, Entiat, and Wenatchee subbasins (Peven 2003).

Current

There are no known estimates of current abundance within the Wenatchee River subbasin

Productivity

Historic

Historic productivity of bull trout within the Wenatchee subbasin is not known. However, it is reasonable to assume that it was higher, based on habitat degradation and management practices (hatchery plants).

Current

There are no known estimates of current abundance within the Wenatchee River subbasin.

Diversity

Historic diversity was most likely higher than current based on some minor losses of connectivity and potential increases in temperature. If habitat restoration occurs, there will most likely be an increase in spatial and, potentially, life history diversity.

Table 21. Summary of westslope cutthroat trout population characterization

	Distribution	Abundance	Productivity	Diversity
Historic	Moderate	Low	Low-Moderate	Moderate
Current	Moderate-High	Low-Moderate	Low-Moderate	Moderate-High

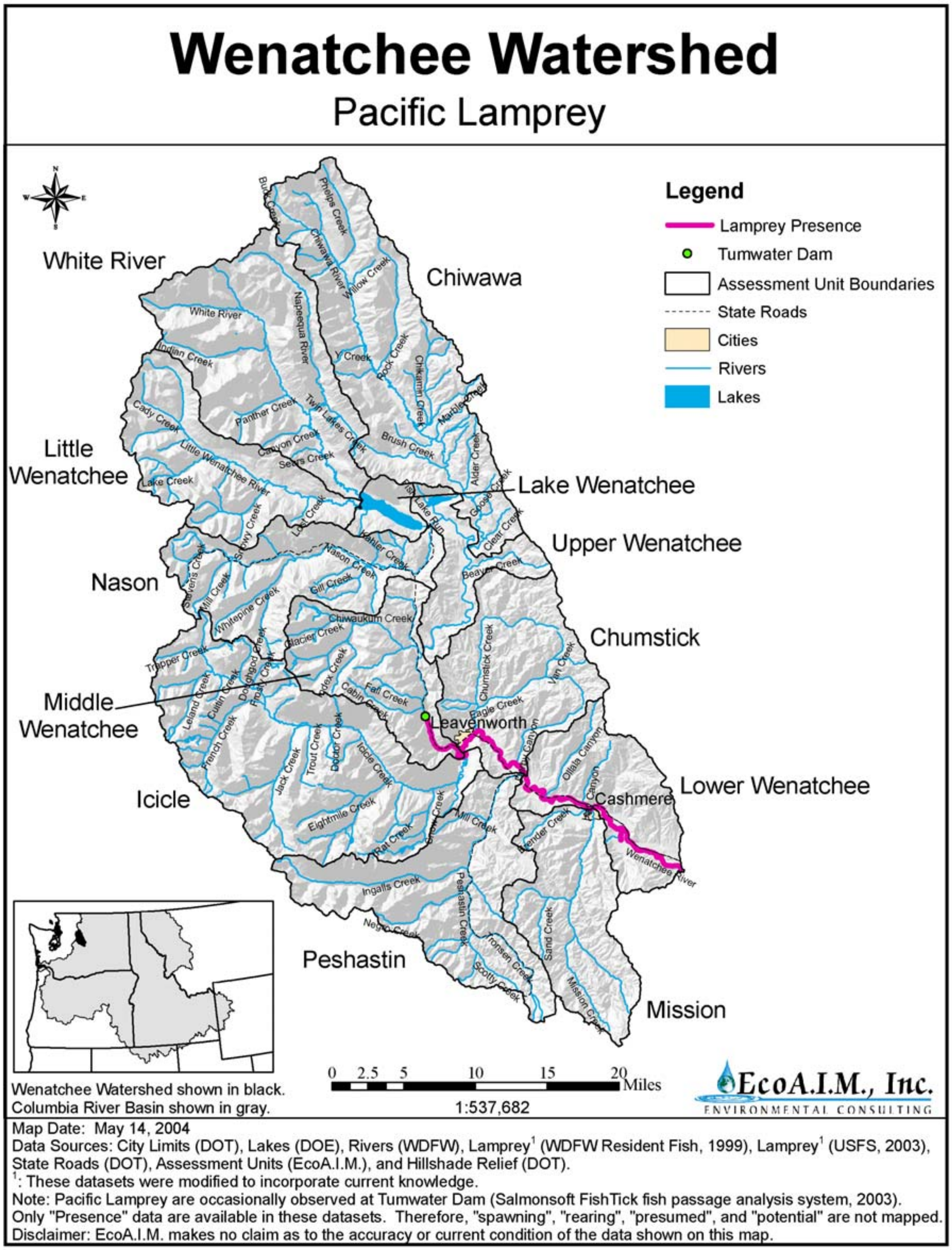

Figure 16. Presumed Pacific lamprey distribution in the Wenatchee subbasin

4.8.9 Pacific Lamprey (*Lampetra tridentate*)

Rationale for Selection

Very little is known about Pacific lamprey population or stocks in the upper Columbia and the Wenatchee River. Pacific lamprey is a culturally and commercially important species to the Yakama Nation and Confederated Tribes of the Colville Reservation.

Key Life History Strategies: Relationship to Habitat

[No information to date]

Population Characterization

Distribution

Historic

Historical distribution of Pacific lamprey in the Columbia and Snake rivers was coincident wherever salmon occurred (Simpson and Wallace 1978). It is likely that Pacific lamprey occurred historically within the Wenatchee subbasin. If it is assumed that Pacific lamprey and salmon used the same streams, it is possible to conclude that Pacific lamprey occurred in the Wenatchee River, Chiwawa River, Nason Creek, Little Wenatchee River, White River, Icicle Creek, Peshastin Creek, and Mission Creek in the Wenatchee River subbasin. (Currently, lamprey have not been observed upstream of Tumwater Canyon. There is no way to determine if they appeared there historically. This may suggest that hydraulic conditions within Tumwater Canyon are a migration barrier for lamprey and they may never have existed in the mainstem or tributaries upstream of the canyon. Another possibility is that Tumwater Dam may be limiting movement of lamprey upstream.) In 1937, WDF (1938) collected several juvenile lamprey that were bypassed from irrigation ditches in Icicle and Peshastin creeks and the lower mainstem Wenatchee River.

Current

Pacific lamprey still exist in the Wenatchee system, but the distribution is mostly unknown. BioAnalysts (2000) used anecdotal information to describe the extent of Pacific lamprey distribution Wenatchee River. However, they cautioned that the following description may be confounded by the presence of river lamprey. In most cases, observers they cited reported the occurrence of lamprey but did not identify the species. Thus, the descriptions below may apply to both species.

In the Wenatchee River subbasin, lamprey appear to occur primarily downstream from Tumwater Dam. Jackson et al. (1997) indicated that they have observed no Pacific lamprey ascending Tumwater Dam during the last decade. Because they monitored fish movement at Tumwater Dam between May through September, it is possible that they missed lamprey that migrate upstream to spawning areas during the spring (prior to May). WDFW captured no lamprey in the lower Chiwawa River during the 1992-1999 trapping period or near the mouth of Lake Wenatchee. Hillman and Chapman (1989) surveyed the entire Wenatchee River during 1986 and 1987 and found no lamprey upstream from Tumwater Dam. The lack of lamprey in the upper Wenatchee is consistent with the work of Mullan et al. (1992), who found no lamprey in the mainstem or tributaries of the upper Wenatchee River subbasin (Peven 2003).

Pacific lamprey have been observed in the lower Wenatchee River. Hillman (unpublished data) found many ammocoetes in the Wenatchee River near the town of Leavenworth and adult lamprey in the lower Wenatchee River (near RM 1.0). Kelly-Ringold (USFWS, personal communication in BioAnalysts 2000) found an adult Pacific lamprey in the Wenatchee River near the golf course in Leavenworth. Lamprey are also seen in the smolt monitoring trap in the lower Wenatchee River every year near the town of Monitor (Peven 2003). Apparently lamprey spawn in the irrigation canal just upstream from Monitor. These observations indicate that lamprey currently exist in the lower Wenatchee River (RM 0 to <27) and perhaps in the lower portions of Icicle, Peshastin, and Mission creeks.

Abundance

Historic

Historical abundance of Pacific lamprey is difficult to determine because of the lack of specific information. However, lamprey were (and continue to be) culturally significant to the Native American tribes in the Columbia basin.

Current

There are currently no abundance information except perhaps dam count differences between Rock Island and Rocky Reach. However, comparing counts among different projects is problematic because of sampling inconsistencies, the behavior of lamprey in counting stations, and the ability of lamprey to bypass counting stations undetected (Peven 2003).

Productivity

There currently is no information on historic and current productivity on Pacific lamprey. However, it is reasonable to assume that current production is lower than historic.

Diversity

Within the Wenatchee subbasin, it is not known whether Tumwater Dam is an impediment to migration. There is certainly more spawning and rearing habitat available upstream of the dam. If Tumwater is a migration blockage, then modifying that dam for passage would increase life history and spatial diversity of the Wenatchee subbasin Pacific lamprey.

Table 22. Summary of Pacific lamprey population characterization

	Distribution	Abundance	Productivity	Diversity
Historic	?	?	Higher than present	?
Current	?	?	?	?

4.8.10 Relationships of Salmonid Populations to the Ecosystem

Introduction

The biotic communities of aquatic systems in the upper Columbia basin are highly complex. Within communities, assemblages and species have varying levels of interaction with one another. Direct interactions may occur in the form of predator and prey, competitor, and disease or parasite host relationships. In addition, many indirect interactions may occur between species. For example, predation of one species upon another may enhance the ability of a third species to persist in the community by releasing it from predatory or competitive constraints. These interactions continually change in response to shifting environmental and biotic conditions. Human activities that change the environment, the frequency and intensity of disturbance, or species composition can shift the competitive balance among species, alter predatory interactions, and change disease susceptibility. All of these changes may result in community reorganization.

Community Structure

Few studies have examined the fish species assemblages within the upper Columbia basin. The available information indicates that about 41 species of fish occur within the upper Columbia basin (from the mouth of the Yakima River upstream to Chief Joseph Dam). This is an underestimate because several species of sculpins live there. Of the fish in the basin, 15 are cold-water species, 18 are cool- water species, and 8 are warm- water species. Most of the cold- water species are native to the area; only four were introduced (brown trout (*Salmo trutta*), brook trout (*Salvelinus fontinalis*), lake whitefish (*Coregonus clupeaformis—italics*), and Atlantic salmon (*S. salar*). Four of the 18 cool- water species are exotics (pumpkinseed (*Lepomis gibbosus*), walleye (*Stizostedion vitreum*), yellow perch (*Perca flavescens*), and smallmouth bass (Micropterus dolomieu)), while all warm- water species are exotics.

About half of the resident species in the upper basin are piscivorous or fish eating. Ten cold-water species, 7 cool- water species, and 5 warm- water species are known to eat fish. About 59% of these piscivores are exotics. Before the introduction of exotics, northern pikeminnow (*Ptychocheilus oregonensis*), sculpin (*Cottus spp*.), white sturgeon, bull trout (*Salvelinus confluentus*), rainbow trout (*O. mykiss*), cutthroat trout (*O. clarki*), and burbot (*Lota lota*) were the primary piscivores in the region. Presently, burbot are rare in the upper basin and probably have little effect on the abundance of juvenile salmonids in the region. The status of white sturgeon in the upper basin is mostly unknown, although their numbers appear to be quite low.

Introduced species such as walleye, smallmouth bass, and channel catfish (*Ictalurus punctatus*) are important predators of salmonids in the Columbia River. Channel catfish are rare and likely have little to no effect on abundance of salmonids. Other piscivores, such as largemouth bass (M. salmoides), black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), brown bullhead (*Ameiurus nebulosus*), yellow perch, and pumpkinseed are either rare or not known to prey heavily on juvenile anadromous fish.

What follows is a more detailed discussion of interactions between fish, birds, and mammals and spring chinook and summer steelhead in the upper Columbia basin.

Competition

Competition among organisms occurs when two or more individuals use the same resources and when availability of those resources is limited. That is, for competition to occur, demand for food or space must be greater than supply (implies high recruitment or that the habitat is fully seeded) and environmental stresses few and predictable. Two types of competition are generally recognized: (1) interference competition, where one organism directly prevents another from using a resource through aggressive behavior, and (2) exploitation competition, where one species affects another by using a resource more efficiently. Although competition is difficult to demonstrate, a few studies conducted within the upper Columbia basin indicate that competition may affect the production of chinook salmon and steelhead in the basin.

Chinook/steelhead

Perhaps the most likely form of interspecific competition would be between juvenile chinook and steelhead. Hillman et al. (1989) investigated the interaction between juvenile chinook and steelhead in the Wenatchee River between 1986 and 1989. They reported that chinook and steelhead used dissimilar daytime and nighttime habitat throughout the year. During the daytime in summer and autumn, juvenile chinook selected deeper and faster water than steelhead. Chinook readily selected stations associated with brush and woody debris for cover, while steelhead primarily occupied stations near cobble and boulder cover. During winter days, chinook and steelhead used similar habitat, but Hillman et al. did not find them together. At night during both summer and winter, Hillman et al. found that both species occupied similar water velocities, but subyearling chinook selected deeper water than steelhead. Within smaller streams, chinook were more often associated with pools and woody debris during the summer, while steelhead occurred more frequently in riffle habitat. Hillman et al. (1989) concluded that interaction between the two species would not strongly negatively affect production of either species, because disparate times of spawning tended to segregate the two species. This conclusion is consistent with the work of Everest and Chapman (1972) in Idaho streams.

Redside shiners

Under appropriate conditions, interspecific interaction may also occur between redside shiners and juvenile salmon and trout. Hillman (1991) studied the influence of water temperature on the spatial interaction between juvenile chinook and redside shiners in the field and laboratory. In the Wenatchee River during summer, Hillman (1991) noted that chinook and shiners clustered together and that shiners were aggressive to ward salmon. He reported that the shiners used the more energetically profitable positions, and that they remained closer than chinook to instream and overhead cover. In laboratory channels, shiners affected the distribution, activity, and production of chinook in warm (64-68°F) water, but not in cold (54-59°F) water (Hillman 1991). In contrast, chinook influenced the distribution, activity, and production of shiners in cold water, but not in warm water. Reeves et al. (1987) documented similar results when they studied the interactions between redside shiners and juvenile steelhead. Although Hillman (1991) conducted his fieldwork in the lower Wenatchee River, shiners are also present in the Entiat, Methow, and Okanogan rivers and are abundant in the mainstem Columbia River. At warmer temperatures, shiners likely negatively affect the production of chinook salmon and steelhead in the upper basin (BioAnalysts 2004).

Coho salmon

It is unknown if the re-introduction of coho salmon into the upper Columbia basin may affect the production of chinook and steelhead, although the results of extensive predation and competition studies associated with the YN’s current reintroduction efforts indicate that the reintroduction of coho is unlikely to negatively affect production of chinook and steelhead. One of the first studies in the upper basin that addressed effects of coho on chinook and steelhead production was conducted by Spauling et al. (1989) in the Wenatchee River. This work demonstrated that the introduction of coho into sites with naturally produced chinook and steelhead did not affect chinook or steelhead abundance or growth. However, because chinook and coho used similar habitat, the introduction of coho caused chinook to change habitat. After removing coho from the sites, chinook moved back into the habitat they used prior to the introduction of coho. Steelhead, on the other hand, remained spatially segregated from chinook and coho throughout the study. More recent studies conducted by Murdoch et al. (2004) found that juvenile coho, chinook, and steelhead used different microhabitats in Nason Creek, and at the densities tested, coho did not appear to displace juvenile chinook or steelhead from preferred microhabitats (BioAnalysts 2004).

Various salmonids

It is possible that juvenile chinook and steelhead interact with bull trout, brook trout, and cutthroat trout if they occur together. Hillman and Miller (2002) observed chinook, bull trout, and brook trout together in several tributaries of the Chiwawa River and in the Little Wenatchee River. In tributaries of the Chiwawa River, Hillman and Miller (2002) observed chinook and juvenile bull trout in the same habitat. They report seeing bull trout and chinook nipping each other in Big Meadow, Rock, and Chickamin creeks. Usually the aggressive interactions occurred in pools near undercut banks or in woody debris. In contrast, Martin et al. (1992) investigated the interaction between juvenile bull trout and spring chinook in the Tucannon River, Washington, and found that the two species have different habitat preferences. Juvenile spring chinook occurred more often in open, slow- water habitat without complex hiding cover. Bull trout, on the other hand, more frequently used riffle and cascade habitat. Bull trout numbers inversely correlated with amounts of woody debris and the two species did not compete for food because food was not limiting in the Tucannon River (Martin et al. 1992).

Although Hillman and Miller (2002) observed juvenile chinook and brook trout together in many tributaries of the Chiwawa River and in the Little Wenatchee River, they did not see aggressive interaction between the two species. Welsh (1994), on the other hand, studied the interaction between the two species in Idaho streams and found that when chinook were introduced into a stream with brook trout, the latter was displaced into marginal habitat. Over a six-year period, Welsh (1994) notes that brook trout vanished from his study sites. No studies address the interaction between chinook and cutthroat trout. Although chinook and steelhead may interact with bull trout, brook trout, and cutthroat trout, there is no evidence that they will negatively affect the production of chinook and steelhead in the upper Columbia basin (BioAnalysts 2004).

Predation

Fish, mammals, and birds are the primary natural predators of salmonids in the upper Columbia basin. Although the behavior of various salmonids precludes any single predator from focusing exclusively on them, predation by certain species can nonetheless be seasonally and locally important. Recent changes in predator and prey populations along with major changes in the environment, both related and unrelated to development in the mid Columbia basin, have reshaped the role of predation.

Although several fish species can consume salmonids in the upper basin, northern pikeminnow, walleyes, and smallmouth bass have the potential for significantly affecting the abundance of juvenile anadromous fish (BioAnalysts 2004). These are large, opportunistic predators that feed on a variety of prey and switch their feeding patterns when spatially or temporally segregated from a commonly consumed prey. Channel catfish also have the potential to significantly affect the abundance of juvenile salmonids, but because they are rare in the upper Columbia, they likely have a small effect on survival of juvenile salmonids there. Native species such as sculpins and white sturgeon also prey on juvenile anadromous fish. Below is a discussion on the importance of specific predators on the production of salmonids in the upper Columbia basin.

Sculpins

Sculpins are native and relatively common in the upper basin. Although sculpins are not considered a major predator of outmigrating anadromous fish, they do prey on small chinook and steelhead. In the Wenatchee River, Hillman (1989) noted that large concentrations (20 fish/11 sq. ft.) of juvenile chinook and steelhead occupied inshore, shallow, quiet- water positions on the streambed during the night. Hillman (1989) found that many sculpins moved into these areas at night and preyed heavily on chinook and steelhead fry. Predation on fry appeared to be limited to sculpins larger than 3.3 in. and ceased when prey reached a size larger than 2 in. The number of fry eaten per night appeared to be related to sculpin size, with the largest sculpins consuming the most fry per individual.

Because sculpins are abundant in upper Columbia River tributaries, they are likely an important agent of mortality of salmonid eggs and fry. As chinook and steelhead fry grow, they are released from this source of mortality. The fraction of the chinook and steelhead population removed by sculpins is unknown.

Various salmonids

Most adult salmonids within the upper basin are capable of preying on juvenile chinook and steelhead. Those likely to have some effect on the survival of chinook and steelhead include adult bull trout, rainbow/steelhead trout, cutthroat trout, brook trout, and brown trout. Because brown trout are rare in the region, they probably have little effect on the survival of other salmonids. The other salmonids often occur in the same areas as chinook and steelhead and are known to be important predators of chinook and steelhead (Mullan et al. 1992). Of these, bull trout and rainbow trout are probably the most important. These species occur together in most tributaries; hence the probability for interaction is high. The presence of both fluvial and adfluvial stocks of bull trout in the region further increases the likelihood for interaction there.

Bull trout are opportunistic feeders and will eat just about anything including squirrels, birds, ducklings, snakes, mice, frogs, fish, and insects, although adult migrant bull trout eat primarily fish. Because adult migrant bull trout occur throughout the upper basin, including the mainstem Columbia River, they likely prey on juvenile salmonids. In the upper Wenatchee subbasin, Hillman and Miller (2002) noted that juvenile chinook and steelhead were rare in areas where adult bull trout were present. Like northern pikeminnow, adult bull trout frequent the tailrace areas of upper Columbia dams. These areas provide concentrated prey items, which include juvenile chinook and steelhead. It is likely that adult bull trout prey heavily on migrant salmon and steelhead in these areas. Indeed, Stevenson et al. (2003) found bull trout staging near the Wells Hatchery outfall, apparently seeking opportunistic feeding opportunities. As the number of bull trout increase in the upper subbasin, the interaction between them and salmon and steelhead will increase (BioAnalysts 2004).

Rainbow/steelhead trout feed on chinook fry in the upper subbasin. In the Wenatchee River, for example, Hillman et al. (1989) observed both wild and hatchery rainbow/steelhead feeding on chinook fry. Predation was most intense during dawn to dusk. At that time, rainbow/steelhead occupied stations immediately adjacent to aggregations of chinook. Hillman et al. (1989) noted that within the prey cluster, the largest, light-colored chinook were closest to shelter and seldom eaten. Small, darker-colored chinook were farther from escape cover and usually eaten by predators. Hillman et al. (1989) suggest that predator-mediated interaction for shelter was strong and contributed to the rapid decline in chinook numbers in May. Although this work was done in the Wenatchee River, the results probably hold for other tributaries where the two species occur together.

Although adult salmonids prey on juvenile salmonids in the upper subbasin, the predation rate is unknown. Because of the abundance of both bull trout and rainbow/steelhead trout in the upper subbasin, it is reasonable to assume that large numbers of fry are consumed by these fish.

Birds

Currently, there is little information on the effects of bird predation on the abundance of juvenile salmon and trout in the upper subbasin. Fish eating birds that occur in the project area include great blue herons (*Ardea herodias*), gulls, osprey (*Pandion haliaetus*), common mergansers (*Mergus merganser*), American dippers (*Cinclus mexicanus*), cormorants (*Phalacrocorax spp*.), Caspian terns, belted kingfishers (*Ceryle alcyon*), common loons (*Gavia immer*), western grebes (Aechmophorus occidentalis), black-crowned night herons (*Nycticorax nycticorax*), and bald eagles (Haliaeetus leucocephalus). According to Wood (1987a, 1987b), the common merganser limited salmon production in nursery areas in British Columbia. He found during smolt migrations that mergansers foraged almost exclusively on juvenile salmonids (Wood 1987a). Maximum mortality rate declined as fish abundance increased (i.e., dispensatory mortality) and did not exceed 10% for any salmonid species. Wood (1987b) also estimated that young mergansers consumed almost one-half pound of subyearling chinook per day. Thus, a brood of ten ducklings could consume between four and five pounds of fish daily during the summer (BioAnalysts 2004).

Cormorants may take large numbers of juvenile salmon and trout in the upper subbasin. Roby et al. (1998) estimated that cormorants in the estuary consumed from 2.6 to 5.4 million smolts in 1997, roughly 24% of their diet, and most were hatchery fish. Although Caspian terns are not common in the project area, there is evidence that they consume fish from the project area. Bickford found both PIT-tags and radio tags at a Caspian Tern nesting area near Moses Lake. Tag codes indicated that consumed fish were from the upper Columbia region.

Mammals

No one has studied the influence of mammals on numbers of juvenile chinook in the upper Columbia basin. Observations by BioAnalysts indicate that river otters (*Lutra Canadensis*) occur throughout the region. BioAnalysts found evidence of otters fishing the Wenatchee, Chiwawa, Entiat, and Methow rivers, and Icicle Creek. Otters typically fished in pools with LWD. According to Hillman and Miller (2002), juvenile chinook are most abundant in these pool types, thus, the probability for an encounter is high. Dolloff (1993) examined over 8,000 otoliths in scats of two river otters during spring 1985 and found that at least 3,300 juvenile salmonids were eaten by them in the Kadashan River system, Alaska. He notes that the true number of fish eaten was much higher, as it is unlikely that searchers found all the scats deposited by the otters. Other predators, such as raccoon (Procyon lotor) and mink (Mustela vison) also occur in tributaries throughout the upper Columbia basin. Their effects on numbers of salmon and trout are unknown (BioAnalysts 2004).

Black bears (*Ursus americanus*) are relatively common in the upper Columbia basin and frequent streams used by spawning salmon during autumn. Studies have shown that salmon are one of the most important meat sources of bears and that the availability of salmon greatly influences habitat quality for bears at both the individual level and the population level. Observations by crews conducting chinook spawning surveys in the upper basin indicate that bears eat chinook, but it is unknown if the bears remove pre-spawned fish or are simply scavenging post-spawned fish. Regardless, there is no information on the roll that bears play in limiting survival and production of salmon and trout in the upper basin.

4.9 Aquatic Conditions

4.9.1 Introduction

The Wenatchee subbasin contains some of the most pristine habitat found throughout the Columbia River basin while also experiencing considerable habitat degradation in some drainages. The subbasin is very diverse in elevation and environmental conditions. For the purposes of this assessment, the Wenatchee subbasin has been dissected into 12 distinct Assessment Units, as illustrated in

In the upper Wenatchee subbasin, the Assessment Units include the Icicle Creek, Nason Creek, Little Wenatchee River, White River and Chiwawa River. These Assessment Units are all tributaries to the Wenatchee River and are characterized as being relatively high elevation, cool wet forest and relatively unaltered by human disturbances.

The Middle Wenatchee River (Tumwater Canyon to Lake Wenatchee) and Lake Wenatchee Assessment Units are also included in the upper Wenatchee subbasin. The Middle Wenatchee is primarily a steep, constrained canyon containing several smaller and highly variable tributary streams. Lake Wenatchee is a relatively large, oligtrophic (non-productive) lake that provides a unique environmental function within the Wenatchee subbasin.

The lower Wenatchee subbasin includes the mainstem of the lower Wenatchee River (mouth to Tumwater Canyon) and Mission, Peshastin and Chumstick creek assessment units. These Assessment Units are generally lower elevation, warmer dry forest types and grasslands that have been heavily altered by human disturbances.

The following describes the environmental and habitat conditions for each of the Assessment Units within the Wenatchee subbasin.

4.9.2 Assessment Methodology

The Qualitative Habitat Assessment (QHA) was developed for use by the NPCC subbasin planning process. The QHA is intended for use in stream environments at the subbasin scale. The QHA provides a structured, qualitative approach to analyzing the relationship between the focal species and habitat conditions. The assessment examines eleven environmental attributes considered important for biological productivity. Attributes are assessed for approximately 80 stream reaches within the Wenatchee subbasin.

The QHA relies on the expert knowledge of natural resource professionals and citizens with experience in a local area to describe physical conditions in the target stream. These individuals are also asked to describe how focal species may have used habitats in the past, and how fish distribution has likely changed as a result of changing habitat attributes. From this assessment, planners are able to develop hypotheses about the population and environmental relationships of the focal species. The ultimate result is a determination of the relative importance for restoration and/or protection management strategies at the watershed scale addressing specific habitat attributes.

The QHA is not viewed as a sophisticated analytical model. The QHA simply supplies a framework for reporting information and analyzing relationships between a species and its environment. It is up to local scientists, managers, and planners to interpret the results and make decisions based upon these relationships.

Rationale for Use

One of the primary objectives of the subbasin planning process is to provide a clear rationale for selecting management recommendations. Embedded in this discussion must be credible information (and assumptions) identifying key factors limiting biological productivity of focal species. The habitat characteristics used in the QHA methodology are similar to those attributes used by the federal regulatory agencies (NOAA Fisheries and USFWS) in evaluating federally funded project effects on habitat attributes important to ESA listed species. Therefore, QHA habitat attributes are intended to act as surrogates for those attributes used by the regulatory agencies to help ensure consistency and continuity between the subbasin plan and the biological assessments used by these agencies.

Currently, only the Ecosystem Diagnosis and Treatment (EDT) methodology has the power to describe biological productivity of the focal species as envisioned by the NPCC Technical Guide for Subbasin Planners. However, to adequately employ the EDT method requires a substantial commitment of time and resources necessary to develop the datasets and to run the EDT model. Due to significant constraints in budget and time, adequate resources were not available to the Wenatchee subbasin to appropriately develop a credible EDT model. Wenatchee subbasin planners chose to use the QHA because it is a simple means to organize and summarize a large amount of information and professional experience.

Development of the QHA

Subbasin planners chose to view the assessment as a tool for examining three fundament questions:

Where have significant habitat changes occurred since the historic reference condition?

What changes are thought to have most significantly affected the distribution /abundance of focal species (sub-populations within the watersheds)?

Where are the greatest opportunities to protect and / or enhance habitat attributes that will potentially provide the greatest benefits to fish populations within the subbasin?

Stream reaches and the QHA habitat rating values were described by the Habitat Technical Team and will continue to be reviewed (and modified as needed) by all interested community stakeholders. Current and historic habitat conditions were described by ranking eleven habitat attributes for each of the stream reaches. Additionally, current and historic focal species distribution was described by ranking focal species use for each of the stream reaches. The QHA values were compared to existing information to insure accuracy and consistency.

Shortcomings of the QHA

The QHA methodology has shortcomings to adequately describe environmental conditions and biological responses. One of the primary objectives of the QHA is simplicity, which is inherently contrary to the complexity of the environmental and population relationships that we are trying to describe. From the onset, it was obvious to subbasin planners that the existing definitions were inadequate and confusing. Definitions for attribute ratings were revisited on several occasions throughout the process.

There are two fundamental problems associated with the QHA approach. From a biological perspective, the habitat attribute ratings must be related to some defined quality, i.e. the attribute is good or poor compared to what species? In general, attribute ratings were related to the generic salmonid, however habitat needs are known to be very different for different species and for different life stages within a particular species.

Secondly, from a physical perspective, habitat attributes are difficult to compare between geographic areas because the inherent capacity of the habitats (geology, gradient, stream or floodplain width, etc.) are typically very different. Specifically, habitat attributes can be evaluated by their inherent capacity (in which all historic values are rated excellent) or habitat attributes are compared across a landscape (in which certain attributes for tributary steams rarely can rate high compared to mainstem reaches). In either case, simplification of the classification scheme undermines the complex and important relationships that we are striving to understand.

In spite of these problems with the QHA, the tool was useful to focus and organize the development of the assessment and provide subbasin planners with a clearer and holistic perspective of the subbasin and various Assessment Units.

Related Assessments

- U.S. Forest Service Biological Assessments (various years)
- U.S. Forest Service Watershed Assessments (various years)
- Channel Migration Zone Study (2003)
- Lake Wenatchee Storage Feasibility Study
- Regional Technical Team Biological Strategy (2004)
- Limiting Factors Analysis (2001)
- Wenatchee River Basin Watershed Assessment (August 2003)
- Subbasin Summary (October 2001)
- Aerial Surveys in the Wenatchee River Basin - Thermal Infrared and Color Videography (2003)
- USFWS Draft Bull Trout Recovery Plan, USFWS 2004: White Paper: Proposed Critical Habitat for the Mainstem Columbia River, Mid-Columbia HCP, etc.

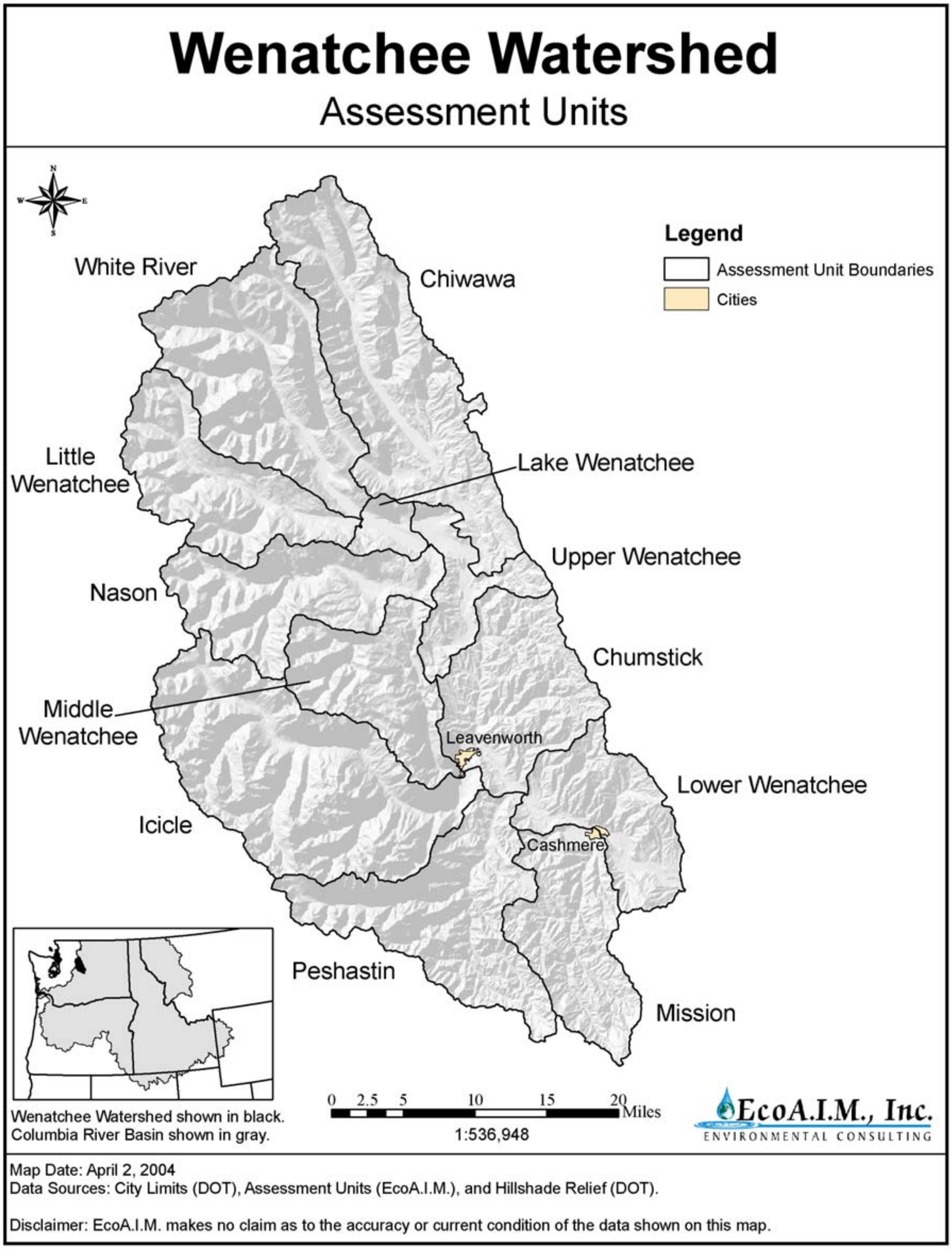

Figure 17. Assessment units in the Wenatchee subbasin

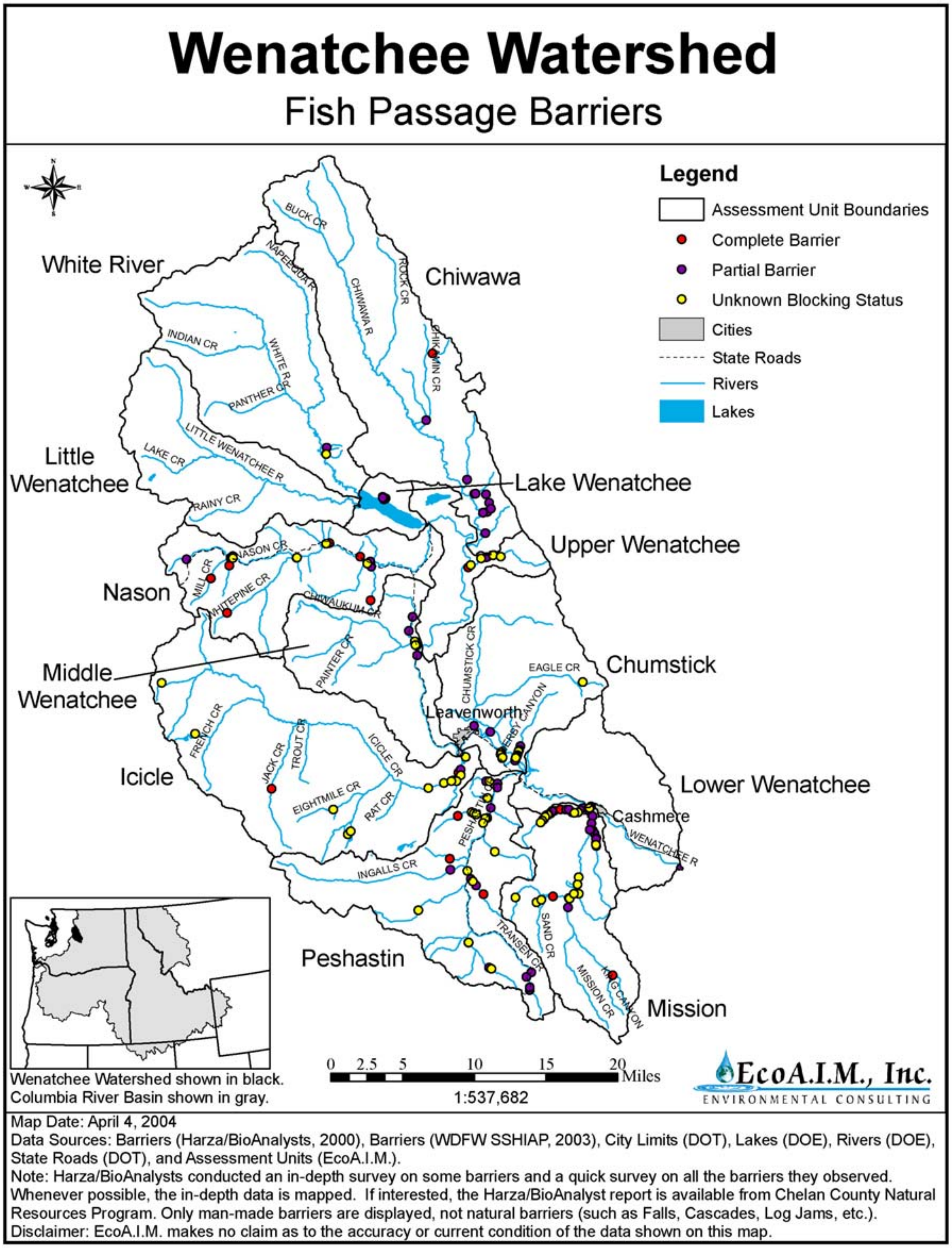

Figure 18. Fish passage barriers

4.9.3 Lower Wenatchee River Assessment Unit

Assessment Unit Description

The lower portion of the Wenatchee River begins at RM 25.6 (below Tumwater Canyon at RM 27) and flows southeasterly from the town of Leavenworth to the Columbia River. Mission, Peshastin, Chumstick and Icicle Creeks are the main tributary watersheds that join the lower mainstem (Icicle Creek will be described in the Upper Wenatchee Assessment Unit due to its ecological and geologic similarities to upper subbasin tributaries). Derby Creek, the only lesser tributary that contains anadromous fish, joins the lower Wenatchee at RM 19.0. Derby Creek contributes less than 0.1% of Wenatchee River flow (USFS 2003) The lower Wenatchee River area is within a rain shadow on the east side of the Cascades with mean annual precipitation ranging from 15 to 49 in. Most precipitation falls as snow in the winter (USFS 1999b, Andonaegui 2001).

The lower Wenatchee and the lower portions of its small tributaries including Derby, Hay, and Ollalla, have private development along the entire valley bottom with forest service ownership occurring in the upper elevations. Forest service lands are designated as matrix except for the Eagle Managed Late Successional Areas (MLSA) in the upper portion of the Chumstick and Derby creek sub watersheds (USFS 1999a).

The lower Wenatchee River flows through a floodplain formed by glacial melt waters and subsequent overbank floods. Included in the floodplain are alluvial fan sand terraces that are elevated by stream down cutting. The folded interbedded sedimentary rocks are controlling the shape of the land surface. Bedrock exposures are common. Resistant sandstone beds form predominant ridges while the stream network has downcut into weaker rock forming V-shaped valleys. The weakly cemented bedrock weathers rapidly to sand-sized grains (USFS 1999b, Andonaegui 2001).

Assessment Unit Condition

The lower Wenatchee River is rated Class A (excellent) by the State of Washington from Leavenworth to the confluence with the Columbia River. Some habitat and water quality problems have been identified and documented for this reach.

Settlement began in 1890 with the construction of the Great Northern Railroad along the Wenatchee valley bottom. This was followed by flood plain development, irrigation diversion structures, and bank armoring. Over a century of use has reduced in-stream large woody debris (LWD) and LWD recruitment, and reduced side channel/wetland habitat as well as the opportunity for development of side channel/wetland habitat. To varying degrees, the altered riparian and channel conditions have also reduced pool frequency, increased bank erosion, possibly increased channel entrenchment in localized stream reaches not naturally confined by glaciofluvial terraces, altered the sediment transport regime, and altered the natural flow regime. Stream diversions and well withdrawal from shallow aquifers in the floodplain probably have the greatest influence on low stream flows. Channel confinement, channelization, and riparian and upland land use impacts probably have the greatest influence on peak flow timing and duration. Actual identification and quantification of the causes and effects, however, are complex and problematic (USFS 1999b, Andonaegui 2001).

Depending on species needs, steelhead, spring and late-run chinook, bull trout and sockeye use the lower Wenatchee River for migration, rearing, spawning and over-wintering. The Wenatchee River provides essential connectivity for migratory bull trout traveling between Wenatchee River subbasin populations, and possibly other subbasin populations in the upper Columbia River ESU.

Riparian/Floodplain Condition and Function

Riparian Condition

As a result of riparian roads, riparian harvest, and private development and agriculture within riparian areas, Derby Creek and the lower Wenatchee River are in poor condition relative to riparian reserves.

The lower Wenatchee River riparian is in poor condition due to development of the floodplain and the presence of State Hwy. 2. The river still maintains some ponds and back water, but the presence of roads, railroads, towns, development, and agriculture have confined the lower portion and reduced the degree of accessibility.

Along its entire length 35% of the bank is confined by the railroad, 31% is entirely cleared, 19% is rip-rapped, and 16% is in a natural vegetated state. Fifty-seven percent of the bank area with little riparian vegetation is eroding, and 14% of the rip-rapped sections are eroding (USFS 1999b).

Stream Channel Conditions and Function

Channel Condition and High Flow

Channelization of some tributaries to the lower Wenatchee River and floodplain development in the mainstem corridor have degraded floodplain functions. Flood control measures in reaches not naturally confined by glaciofluvial terraces have contributed to the loss of functioning floodplain habitat. The altered riparian and channel conditions have also reduced instream LWD and recruitment, pool frequency, and side channel/wetland habitat and the opportunity for development of side channel/wetland habitat. Conditions have also increased bank erosion and possibly increased channel entrenchment instream reaches not naturally confined by glaciofluvial terraces, as well as altered the sediment transport regime the natural flow regime. Combined, these factors have likely had some of the largest impacts on the fishery resource on the mainstem Wenatchee River, limiting the use of alternate channels and access to the floodplain to disperse high flows (Andonaegui 2001).

Fine Sediment and Channel Stability

Sediment filling of pools is a problem in depositional reaches of the lower Wenatchee River, especially downstream of drainages with high sediment output. Sediment transport in the lower Wenatchee River is reduced by the back water influence of Rock Island Dam reservoir pool on the Columbia River (RM 453.4). As a result of the pooling effect caused by higher water levels upstream of Rock Island Dam, substrate in the first several hundred meter reach above the Columbia has formed a uniform stream bottom of gravel and sand, along with quiet surface water (Andonaegui 2001). In areas of the lower Wenatchee River where spawning material is available for steelhead and spring chinook, the level of fines is believed to exceed 20% (Andonaegui 2001).

Derby Creek substrate is in poor condition due to the abundance of sand in streams which may be related to the amount and location of native surface roads next to Derby Creek. Due to development and location of roads, Derby Creek is poor condition with pool-forming wood recruitment low and pool infilling occurring from high sediment loads and channel function impairment (USFS 2003).

Habitat Diversity

Off-channel habitats are severely lacking channel complexity and riparian condition has been negatively impacted over time from historic log drives and floodplain/streamside development resulting in reduced riparian and wetland connectivity. Off-channel habitats are further impacted by a loss of aquatic species connectivity through wetlands, reduced high flow refuge, reduced sinuosity and side channel development, increased bank erosion, reduced LWD and LWD recruitment, reduced pool frequency, and a reduction in channel roughness (USFS 1999b).

The lower Wenatchee refugia is in poor condition from development which has reduced channel complexity, off-channel habitat, and connectivity of minor tributaries. Private development restricts the river's access to its historic floodplain in many areas.

The majority of the entrenchment in the lower Wenatchee is a result of post-glacial down cutting through glacial fluvial deposits, however, where the river has been encroached upon State Hwy. 2 and other development, this may have contributed to localized channel entrenchment. Overall, human land use has not been the major influence in down cutting of the channel in the lower Wenatchee River. Likewise, although bank erosion has been exacerbated by land-use activities in some reaches of the lower Wenatchee River, increased sediment loading resulting directly from eroding banks is not significant at the lower Wenatchee River level (Andonaegui 2001).

Where glacial out wash and flood deposits have created terraces in the main valley, the mainstem channel morphology is shaped by fluvial downcutting through sedimentary rocks and terraces of the Chumstick formation. The stream substrates are fairly homogenous and riffle habitat predominate. The channel is naturally constrained by alluvial fans and bedrock in a few places. Scattered sandstone outcrops occur throughout. These bedrock shelves are the primary pool forming feature. Pool formation is also naturally associated with LWD, however LWD is lacking in this portion of the river, and may result in a lower pool frequency than would exist in a functioning system. The river is confined by orchards, roads, railroads, towns and bridges. Most old floodplain areas are no longer accessible or have been heavily altered by orchards. Off channel habitats are severely lacking. This is also likely the cause of the lack of woody debris. Velocities during high flows have likely increased, and wood that could be trapped into logjams is washed through the system.

Water Quality

Temperature

The lower Wenatchee River is on the WDOE 1998 303d listing for temperature. Point measurements at Peshastin and Monitor, Washington have exceeded desired values 7 times since 1991 for steelhead trout migration and rearing. During the same time period temperatures exceeded upper limits for spring chinook spawning and incubation at least 4 times at Peshastin and Monitor. High temperatures are usually observed in the months of July and August, potentially affecting bull trout migration, as well as the migration and rearing of steelhead trout (USFS 1999b).

Oxygen/Pollutants

The lower Wenatchee River is on the WDOE 303d list for pH and dissolved oxygen.

Water Quantity

Low Flow

The lower Wenatchee River is on the 303(d) listing for instream flow. Out-of-stream water use has resulted in reduced stream flow rates and modified season runoff patterns downstream of Tumwater Canyon. Additionally, road density and location has increased the drainage network (USFS 1999).

In years of low snowpack, water withdrawals for irrigation and domestic use impact salmonid spawning and rearing habitat downstream of Dryden Dam. While the percentage of flow diverted is small in June and July, it may be significant in August through mid October of average water years, and may leave lethal impacts to juvenile salmonids in the fall of a dry year. Minimum flows have been established for the mainstem Wenatchee River however, the Columbia River Inter-Tribal Fish Commission (CRITFC) has stated that the minimum flows are not adequate to realize the spawning potential of the existing habitat (Andonaegui 2001).

From the mouth upstream to Tumwater Canyon, including tributaries to this portion of the mainstem that are not addressed as separate 5th field HUC watersheds, there are 105 surface water rights permits or certificates worth a potential total diversion of 43.8 cfs. There are 204 surface water rights claims worth a potential total diversion of 411.6 cfs. There are 11pending applications for surface water rights permits, certificates, or claims worth a potential total diversion of 5.1 cfs. There are 145 ground water rights permits or certificates worth a potential total withdrawal of 10,520 gallons per minute (gpm). There are 771 ground water rights claims worth a potential total withdrawal of 15,120 gpm. There are 13 applications for ground water rights permits, certificates or claims pending worth a potential total of 444 gpm (Montgomery et al. 1995).

Obstructions to Fish Passage

The Dryden Dam (RM 17.0), an 8-foot high irrigation diversion dam, was constructed along with the Highline Canal to provide for the water supply to the Wenatchee Reclamation District. Dryden Dam currently has a fish ladder to facilitate passage. There remains speculation if this structure currently poses a migration delay to some salmonids (Andonaegui 2001).

Derby Creek has a barrier to nearly all fish passage near the mouth, and 3 small constructed ponds that block passage upstream. Therefore (USFS 2003; USFS 1999b).

Ecological Conditions

Steelhead have been observed as far as 3 mi. up Derby Creek , although their occurrence is attributed to strong swimming individuals passing known passage barriers (BioAnalysts 2004). The sub watershed stock in Derby Creek is in poor condition, and may be nonexistent except for occasional strong swimming strays.

Environmental/Population Relationships

The lower Wenatchee is a crucial migration corridor for spring chinook, bull trout, and steelhead. Although stream conditions may not be pristine and passage may be delayed it is not impassable. Bull trout spawning populations are among the highest in the mid Columbia basin. Declines in spring chinook spawning seems linked to a larger spatial phenomenon, mirroring patterns throughout the Wenatchee subbasin. Spring migrating steelhead adults are not exposed to late summer stream temperatures. Rearing habitat for steelhead and chinook may be affected in the lower tributaries and the lowermost mile of the Chiwawa, but substantial and spatially dispersed rearing areas in the upper watershed mitigate these losses. Brook trout may displace rearing steelhead in the lower watershed.

Areas of Special Interest

- Existing riparian habitat and channel migration floodplain function is critical to maintaining focal species productivity.
- Flood-prone areas of the lower Wenatchee River, particularly from the Mission Creek confluence (RM 10.4) downstream to the Columbia River confluence provide important side-channel and off-channel habitats for many species
- Floodplain stranded by developments where access can be reestablished, and important high-flow refugia habitat in side channels and wetlands that were cut off from the river because of High way 2 placement.

Limiting Factors

- Land development, state high way and railroad affects channel migration, woody debris recruitment, and gravel recruitment
- Riparian habitat and off-channel habitat have been significantly lost or degraded
- Late summer instream flows are often critically low throughout this reach
- Floodplain function has been impaired by development, causing extremes in the peaks and nadir of the hydrograph
- Stream temperatures often exceed regulatory standards, which is contributed to by riparian habitat loss and low instream flows.
- Late summer instream flow and temperature affects salmonid juveniles
- There is a high level of concern about impacts of land development on this stream reach

Data Gaps

- The relationship between stream flows and habitat quantity on the Wenatchee River from Tumwater Canyon downstream to the mouth is important to understand potential fish use under various flow scenarios.
- The relationship between stream flow and effects on temperature in the mainstem Wenatchee River.

- The effect of high water temperatures on anadromous salmonids and bull trout migration, spawning, incubation, and rearing in the mainstem Wenatchee River.
- Contaminants are a potential limiting factor, but it is unknown to what degree these effect fish health
- Bull trout distribution and seasonal use

Functional Relationship of Assessment Unit with Subbasin

The lower Wenatchee Assessment Unit is a Category 2 watershed (see Determination of Restoration Priorities in Section 6.5 of this document) and has two significant sub- watersheds. With the exception of cutthroat and bull trout, habitat condition in the mainstem Wenatchee have very high potential to affect salmonid fish production in the Wenatchee River subbasin as a whole. In addition to providing a migratory corridor, the mainstem provides essential rearing habitat for chinook, coho and steelhead juveniles (BioAnalysts 2004).

4.9.4 Middle Wenatchee Assessment Unit

Assessment Unit Description

Tumwater Canyon

This middle portion of mainstem channel from river mile (RM) 25.6 to 35.6 has gradient less than 2%. Debris flow deposits, particularly coarse sediments, in the narrow V-shaped valley create dramatic local morphological adjustments. When cobbles and boulders are input, the river increases gradient as it cuts through the deposits. As a result the river character changes sharply between long, deep pools and cascading, rapids type riffles. Large boulders form pocket pools and step pools. Alluvial fans form at the base of some of the debris flows creating lateral or elevational channel controls and also delivering LWD. The narrow valley floor has limited floodplain development. During flood flows, material from the fans is eroded a way and raw banks are exposed.

Chiwaukum Creek

The Chiwaukum drainage is a 4th order stream with 50 sq. mi. (32,779 acres) and located northwest of Leavenworth. Chiwaukum Creek flows into the Wenatchee River near the head of Tumwater Canyon and contributes approximately 20% to the Wenatchee Rivers flow (Andonaegui 2001). Elevation at the mouth is 1,666 ft. Chiwaukum Creek is a pool-riffle channel in its lowest segments, predominantly a step-pool system in the middle sections, and cascading in its head waters (Andonaegui 2001). The only tributary known to support anadromous salmonids in the Chiwaukum Creek drainage is Skinney Creek. Skinney Creek is 6,925 acres and flows into Chiwaukum Creek at RM 0.6. Average annual precipitation in Skinney Creek ranges from 35 in. near the mouth to 50 in. at higher elevations (Andonaegui 2001). The Chiwaukum watershed is mostly located within the boundaries of the Alpine Lakes Wilderness and is managed by the USFS. Most of Skinney Creek is owned by Longview Fibre Company.

Wenatchee River above Tumwater Canyon

In the upper mainstem from the mouth of Lake Wenatchee at RM 54 down to Tumwater Canyon at RM 35.6, glaciation has created a thick mantle of till covering lower ridges and valley walls. Valley floors have glacial out wash deposits and valley bottom till contributes greatly to the formation of wetlands. Glacial till is linked to ground water storage and remnant channel locations, and the most species richness in the watershed. The upper river is meandering and only moderately confined. Ponds, marshes and overflow channels may be frequent at localized points. Subsurface flow through the landtype is relatively high, with subsurface and instream flow in continuity adjacent to streams. Primary disturbances are fire, debris slides, and seasonal flooding (Andonaegui 2001). A combination of terraces and log drives in the early part of the last century likely rendered LWD low in this reach.

Assessment Unit Condition

Tumwater Canyon

River character has been modified over time by railroad construction dam construction, log drives, and high way construction. During railroad construction in the 1800s, the canyon bottom was narrowed and large boulders were removed, possibly resulting in channel degradation (Andonaegui 2001). Tumwater Dam at RM 31, built in the early 1900s, has altered channel bed grade and substrate content above and below the structure, creating Lake Jolanda. Log drives in the early 20th century removed LWD in the channel and blasted boulders from the channel to facilitate log drives.

Chiwaukum

Chiwaukum is largely unaltered by human land use. The campground situated at the mouth of Chiwaukum Creek lies in the alluvial fan, and the stream has been channelized restricting channel migration in this reach. Spawning and rearing production in the impacted reach has likely been reduced by the channel alterations. This area supports spring chinook and steelhead spawning and rearing along with limited late-run chinook rearing while also serving as a corridor to head water spawning and rearing habitat for bull trout. The Wenatchee Watershed Assessment describes Skinney Creek as severely impacted by the railroad, high way, farming, and timber harvest. Fish barrier culverts near the mouth impede fish passage into Skinney Creek (Andonaegui 2001).

Wenatchee River above Tumwater Canyon

Channel complexity and riparian condition has been altered over time from historic log drives and floodplain and streamside development. Results of this activity include reduced riparian and wetland connectivity, a loss of aquatic species connectivity through wetlands, reduced high flow refuge, reduced sinuosity and side channel development, increased bank erosion, reduced single pieces and complexes of LWD, reduced pool frequency, and a reduction in channel roughness. Anthropogenic factors affecting the upper Wenatchee subbasin include private home building and associated private land development; timber harvest on both private and federally owned lands, farming and associated land conversion, and the construction of state high ways, county roads, and logging roads.

Riparian/Floodplain Condition and Function

As a result of railroads, roads, harvest, and private development and agriculture within riparian areas, the middle and upper Wenatchee River riparian reserves are fair condition. Function and condition has been simplified by these uses (USFS 1999). Some loss of riparian vegetation associated with Tumwater campground at the mouth and dispersed camping sites located further upstream, has increased streambank erosion locally, however the channel itself has remained relatively stable. The location of Tumwater campground limits the natural migration of Chiwaukum Creek over its floodplain, and flood control measures have been taken to protect the campground (Andonaegui 2001).

Skinney Creek, the one tributary to Chiwaukum Creek known to support steelhead and rainbow trout anadromy and spring chinook rearing, was greatly altered by the railroad during the first part of the 19th century and subsequently, by State Hwy. 2. Passage into Skinney Creek is blocked by USFS road culverts at RM 0.25 and RM 1.5. In addition, high overall road density (3.4 mi./sq. mi.) in the watershed, with a substantial portion of the roads lying in riparian areas, and private land ownership in the stream bottom, with resulting agriculture and timber harvest, has combined to limit fish habitat by decreasing woody debris input, increasing sediment input, and potentially reducing migratory corridors.

Stream Channel Conditions and Function

Channel Condition and High Flow

Flow Substrate and channel conditions are fair in Tumwater Canyon. Major channel forming elements are still intact (USFS 1999a). Narrowing by the high way, and boulder and wood removal have likely caused channel degradation and higher flow velocities (Andonaegui 2001). Tumwater Dam has changed substrate composition locally above and below the dam.

Fine Sediment and Channel Stability

Observations of the Wenatchee River indicate that boulders and bedrock are the dominant substrate in much of Tumwater canyon and the upper reach. Historic log drives and stream cleaning to facilitate the drives may have altered the substrate. Substrate in the Wenatchee River is considered to be in fair condition. Fine sediment appears to be high in Skinney Creek, and may have been historically high due to the natural geomorphology of the area (USFS 1999a). Current levels, however, are probably related to the construction of the railroad and State Hwy. 2 during the early part of the 1900s, as well as combined with agriculture and timber harvest practices (Andonaegui 2001).

Habitat Diversity

Above Tumwater Dam, there is a lack of high quality cover and refugia, and a lack of diverse habitat types especially along the stream margins (USFS 1999a). The Wenatchee River is in fair condition for refugia due to development which has reduced channel complexity, off-channel habitat, and connectivity of minor tributaries (USFS 1999a). Access to acceptable refugia areas in Tumwater Canyon, Chiwawa River, White River, Chiwaukum and possibly Ingalls Creeks is available. Tumwater Canyon is thought to be in good condition with respect to pools, since in this bedrock-controlled canyon, the dominant mechanisms of pool formation (substrate and gradient) remain largely intact (USFS 1999a). The rest of the Wenatchee River below Lake

Wenatchee is in fair condition. This reach lacks LWD, an important pool-forming agent in these channel types. This section is also confined by roads, railroads, towns and agriculture, pressure that reduces pool frequency and quality.

Water Quality

Temperature

Chiwaukum Creek is on the WDOE 1998 303d list for temperature exceedences and has had 10 recorded excursions beyond state criteria (WDOE 1998). There are presently not enough data to determine if these temperatures are significantly different than temperatures in the historic range, however, or to what extent, if any, these temperatures negatively impact salmonid migration, spawning, incubation or rearing. Most of the drainage is contained in federally designated wilderness and the channel has not been greatly exposed to solar radiation as a result of land management practices (Andonaegui 2001).

Water Quantity

Low Flow

On Chiwaukum Creek the effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time. There are 3 surface water rights permits or certificates worth a potential total diversion of 0.5 cfs. There are 3 surface water rights claims worth a potential total diversion of 0.4 cfs. There are no pending applications for surface water rights, certificates, or claims. There is 1 ground water rights permit or certificate worth a potential total withdrawal of 50 gpm. There are 2 ground water rights claims worth a potential total withdrawal of 15 gpm. There are no applications for ground water rights permits, certificates or claims pending (Andonaegui 2001). Neither Chiwaukum nor Skinney creeks have been observed to de water in the lower 2.1 mi. (Andonaegui 2001).

Obstructions to Fish Passage

Tumwater Dam blocks the Wenatchee River and lays within the Tumwater Canyon. This dam does have a fish ladder and in the past has hindered migration at certain flows. Recent modifications to passage facilities may have relieved these passage problems.

There are multiple barriers throughout tributary streams with limited fish passage in this assessment unit. Major passage issues are listed below.

Chiwaukum Creek

From the mouth upstream to about RM 0.6, where the stream flows beside the Tumwater Campground. At low flows campers have been observed to build up small dams using the cobbles in the stream bed, to pool water. This may disrupt fish passage.

At low flows, the drop structure under the State Hwy. 2 crossing downstream of the Skinney Creek confluence at RM 0.6 may negatively impact juvenile salmon fish passage if the drop at low flow exceeds one foot in height. In the mid 1990s, a concrete drop structure was constructed at the bridge crossing to protect against bridge scour. This structure may be hindering passage. It is not certain, however, to what extent if at all, this location may be a partial barrier. In low flow years, spring chinook and migratory bull trout have been observed above the State Hwy. 2 crossing.

An old log diversion dam, two old pipes, and a water intake box, previously located at RM 0.7, were removed August 2001. The two pipes had continued to spill water back into Chiwaukum Creek. The status of this diversion is unknown.

At RM 4.3 there is a natural falls that is a barrier to spring chinook upstream passage. Bull trout have been observed above this falls up to another barrier at approximately RM 6.5 (Andonaegui 2001).

Ecological Conditions

Recent surveys in Chiwaukum Creek have found brook trout to be present. Numbers of brook trout pose a potential threat to the long term persistence of bull trout in this stream. (USFWS, 2003).Chiwaukum Creek drainage supports limited bull trout production. Anadromy on Chiwaukum Creek is naturally limited by an impassable falls at RM 4.3. Stream channel morphology limits anadromous salmonid use in the drainage to rearing in Chiwaukum and Skinney Creeks, except for some spawning in the lower 4.3 mi. of Chiwaukum Creek.

The presence of juvenile coho salmon in Chiwaukum Creek indicates that some adults originating from a reintroduction pilot project and returning in 2000 have successfully spawned either in Chiwaukum, or upstream of this tributary (USFWS 2003).

Environmental/Population Relationships

Steelhead, rainbow trout, Bull Trout and spring chinook are known to spawn and rear in Chiwaukum Creek up to a barrier falls at RM 4.3. Bull trout have been observed upstream of the RM 4.3 to the next falls at RM 6. In Skinney Creek, rainbow trout, steelhead and spring chinook rearing occurs but is restricted to the lower 0.25 mi. by an impassable culvert on USFS Road 7908. Bull trout are not present in Skinney Creek. Given its elevation and geomorphology, the habitat is more optimal for rainbow trout and steelhead than for bull trout (Andonaegui 2001).

Habitat in the watershed above Chikamin Creek (RM 13.7) is largely pristine. This portion of the watershed provides 90% of the chinook spawning, the majority of the bull trout spawning, a substantial portion of the chinook rearing, steelhead rearing, and bull trout rearing. This reach also contains the most genetically pure and possibly the strongest cutthroat populations (Andonaegui 2001; Haskins 1998).

The watershed is a crucial migration corridor for chinook, coho, sockeye, bull trout, and steelhead. Although stream conditions may not be pristine, passage in the mainstem is rarely hindered. Bull trout spawning populations are among the highest in the mid Columbia basin. The decline in spring chinook spawning seems linked to a larger spatial phenomenon, mirroring patterns throughout the Wenatchee subbasin. Spring-migrating steelhead adults are not exposed to late summer stream temperatures.

Areas of Special Interest

- The mainstem river provides key spawning and rearing habitat for chinook, coho and steelhead for this subbasin.
- The upper mainstem between Lake Wenatchee and the Chiwawa River confluence provides key habitat for most focal species (except cutthroat trout).

- Chiwaukum Creek provides a significant amount of cool water to the mainstem Wenatchee River flow, as well as key bull trout habitat.
- Beaver Creek provides steelhead/redband trout habitat and lends to structural diversity for this species

Limiting Factors

- The state high way negatively affects riparian function and LWD recruitment, which influences habitat diversity within the mainstem channel.
- Fish passage barriers exist in tributary streams.

Data Gaps

- The effect of high water temperatures on anadromous salmonids and bull trout migration, spawning, incubation, and rearing in the mainstem Wenatchee River
- It is not understood how roughness elements placed on the Tumwater Dam apron to protect State Hwy. 2 may affect smolt outmigration.
- Distribution and abundance of Bull Trout populations have not been determined.
- Effects of Tumwater Dam on sediment transport and habitat diversity.

Functional Relationship of Assessment Unit with Subbasin

The middle Wenatchee mainstem is a Category 1 (see Determination of Restoration Priorities in Section 6.5 of this document) watershed with two significant sub- watersheds, Tumwater Canyon and Chiwakum Creek (important cutthroat and bull trout habitat). With the exception of cutthroat and bull trout, habitat condition in the mainstem Wenatchee has the very high potential to affect salmonid fish production in the Wenatchee River subbasin as a whole. In addition to providing a migratory corridor, the mainstem provides essential rearing habitat for chinook, coho and steelhead juveniles (BioAnalysts 2004).

4.9.5 Mission Creek Assessment Unit

Assessment Unit Description

The 59,712 acre Mission Creek watershed in North Central Washington is located approximately 10 mi. west of the city of Wenatchee in Chelan County. Mission Creek is the main stream course in the watershed, flowing 9.4 mi. before emptying into the Wenatchee River (RM 10.4) at the town of Cashmere. This relatively narrow drainage trends in a north-south direction, with the eastern ridge defining the edge of the Columbia River Breaks. Elevations range from 795 ft. in Cashmere to 6,887 ft. near Mission Peak in the head waters. The average annual precipitation is 19 in. with the Mission Creek watershed, contributing 1% of the average annual flow of the Wenatchee River. (Andonaegui 2001).

Topography is characterized by steep slopes, dissected by perennial and intermittent stream channels. Unstable soils derive from the native Swauk and Chumstick sandstone formations. Soils are generally shallow and light textured, except for the alluvial plain in the lower watershed. The stream is deeply incised and has an average slope in excess of 100 ft. per mile in the lower reaches, and over 300 ft. per mile in the upper reaches. The USFS manages 78 % of the watershed, with the remaining 22% in privately ownership (Andonaegui 2001).

Assessment Unit Condition

Mission Creek is considered to be the most polluted water body in the Wenatchee River subbasin.

Cumulative disruption of both stream channel and upland habitat throughout the watershed, except in the Devils Gulch reach of Mission creek, has resulted in a declining population of spring chinook and steelhead since the mid 1880s (Rife 1999). Habitat conditions that limit access and reduce rearing habitat in the watershed include de watering, low flows, and high instream temperatures. (Andonaegui 2001). Diversion dams and culverts also create fish passage barriers that reduce access to spawning and rearing habitat. Floodplains have been separated from the stream channels and channels have been altered by forest roads, urban, agricultural, and residential development. Channelized streams have eliminated or reduced woody riparian vegetation to a narrow band of mostly shrubs and with some mature trees. Conditions in this controlled stream system are aggravated by high sediment loads and soil compaction associated with timber harvest and agricultural activities (NRCS 1996, Andonaegui 2001).

Anadromous fish expected in the creek include chinook, steelhead and lampreys. Adult anadromous fish may be able to travel up Mission and Brender creeks during spring and fall flows, although several irrigation diversions block passage during the irrigation season. High sediment loads, peak flows, and pre-spawning water temperatures as well as limited adult resting habitat are problems for anadromous fish. Juvenile chinook, rainbow trout, and steelhead do rear and over-winter in Mission and Brender creeks (BioAnalysts 2004).

Riparian/Floodplain Condition and Function

Riparian Condition

Mission Creek riparian and floodplain condition is poor. Although narrow valleys constrain some mid basin stream reaches, riparian habitat on private land has been mostly converted to orchards, pasture, or hay production. A narrow band of cottonwood and shrubs adjacent to the confined channel has been left. Conversion of riparian habitat to urban/rural/residential development, also simplifies the riparian zone and separates the channel from the floodplain (Andonaegui 2001; USFS 2003).

County Road 11 and USFS Road 7100, closely parallel the lower 17.0 mi. of the creek, reducing streamside vegetation and often restricting lateral channel migration. The riparian zone along the streambanks is narrow, quickly giving way upslope to dry ponderosa pine vegetation types. Timber harvest, road building, agricultural encroachment and urban development have greatly reduced the natural vegetation, especially large conifers that might have occurred near the stream side (Andonaegui 2001).

Historically, LWD from adjacent stands was more plentiful and the riparian zone vegetation, while dominated by brush in the immediate riparian zone, had a high component of large Ponderosa pine and Douglas fir. Due to historic logging and road building, there is a lack of LWD in the mainstem streams (USFS 2003).

Off channel habitat in Mission, Sand, Little Camas Creek, and East Fork Mission creeks is lacking due to the influence of the road system and channel degradation that has stranded the floodplain. Old oxbow sections and stranded river bends are evident within the floodplain. Devils Gulch has not been artificially constrained, yet does not contain much off channel habitat.

Stream Channel Conditions and Function

Channel Condition and High Flow

Stream channel condition is poor in Mission Creek. Below the USFS boundary at RM 8.0, land use practices have altered the natural stream channels. Within the confines of the town of Cashmere, stream channels are highly confined by light industrial/urban/suburban development. Upstream of the town of Cashmere, suburban/rural/agricultural development has altered the natural stream channel (Andonaegui 2001). Floods in the 1930s, coming after decades of extensive overgrazing, caused severe erosion. Consequently, numerous channel stabilization efforts took place through the 1950s to protect property along the creek and prevent further flood damage.

Fine Sediment and Channel Stability

Given the highly erosive soils found throughout the watershed, there is naturally a high rate of sediment delivery from tributaries and a resultant high level of fines (sand) in depositional reaches of Mission Creek. After stream channelization, berming in the floodplain, riparian habitat removal, drastic decreases in LWD recruitment, LWD cleanouts, and bank stabilization, however, the sediment transport regime has been altered and channel complexity has decreased. The result is channel incision in some reaches of lower Mission Creek with heavy sediment deposition in low gradient reaches (Andonaegui 2001).

Habitat Diversity

Channel constriction resulting from development within the floodplain of Mission Creek and its tributaries has resulted in bank erosion and down cutting or incision of the channel. Woody riparian vegetation is mostly limited to a single band of trees, shrubs or grasses, and at times is replaced by orchard or hayland. The banks, however, are generally stable at this time both within the town of Cashmere and in the upstream reaches located in agricultural areas. The exception is at a head cut between RM 7.0 and RM 10.0, which has initiated as a result of channel manipulations. Bank stabilization efforts and channel incision appears to be containing recent flow conditions pending a channel-changing event resulting from high flows and sediment pulses. Decreases in the natural sinuosity of the creeks, and increases of fine sediment, have reduced the number and frequency of pools as well.

In Brender Creek, the channel has been straightened and forced into several right angle turns below the concrete flume just downstream of Evergreen Road (RM 0.1). Sand depositions in this lower reach have altered the channel flow, which now runs under Sunset High way and is then runs through the old Mill site. There is a headcut and associated bank erosion near the 7200 block of Pioneer Street. Bank stabilization efforts, channel incision, a lack of LWD, and the lack of recent channel changing events, however, have resulted in overall stable banks.

The first 1500 ft. of Yaksum Creek upstream from the mouth is altered and entrenched. The remaining 1.6 mi. of lower Yaksum Creek have been converted to a roadside ditch with some piping. The dominant vegetative cover is Reeds canary grass.

Sand and East Fork Mission creeks stream banks are vegetated with brush vegetation. The degraded riparian zone and the artificial channel confinement by roads put streambank stability at risk for erosion given a high flow, channel changing event (Andonaegui 2001).

Water Quality

Temperature

Although stream temperatures in the Mission Creek watershed are expected to be warmer during the summer months as compared to watersheds at higher elevations in the watershed, channelization and vegetation removal increase stream temperatures. The CCCD monitored instream temperatures at four sites in Brender Creek from October 1999 to September 2000, including the site at the mouth of Brender Creek previously monitored in 1992 and 1993. During this period, instream temperatures exceeded properly functioning conditions for salmonids (50-57°F) at all four sites during the month of August. Given the alterations to Brender Creek including irrigation return flows, water diversions, and channelization impacts, elevated instream temperatures are expected. Temperatures have been the lowest in Sand Creek in the portion of the stream that is perennial. Devils Gulch is considered as a baseline condition for the upper watershed because it has minimal management compared to the rest of the watershed.

Oxygen/Pollutants

Water quality in Mission Creek is poor. The watershed is included on the WDOE 1998 303d list for low dissolved oxygen, high fecal coli form and pesticides counts. Traces of toxic insecticides have been detected in samples from Mission Creek at concentrations above the water quality criteria to protect both aquatic life and wildlife. The major pesticides occurring at the detectable levels in the agricultural (primarily orchards) and urban areas of the lower valley are the chlorinated insecticides DDT and endosulfan, and the organophosphorous insecticides, cholorpyriphos and azinphos-methyl. The WDOE has stated that there are no new sources of DDT, but contamination from historical uses is an ongoing problem. DDT was heavily used on orchards prior to its ban in 1972. It is still commonly found where there is soil erosion from the orchards. DDT is detected most frequently in June, probably from storm water runoff.

Water Quantity

Low Flow

Water quantity in Mission Creek is poor. The watershed is on the WDOE 1998 list for low instream flows. watershed-wide, most 1st order channels in the Mission drainage are intermittent, drying by early summer. The mainstem goes dry in late summer. This condition may be caused in part by surface water diversions and ground water withdrawals. Information on water diversion, water withdrawals and surface water/ground water interactions is complex and not fully understood in the watershed.

Historically, Brender Creek could go dry during the late summer months. However, currently there is year-round flow in during irrigation season because the Peshastin Irrigation District uses Brender Creek as an irrigation conduit. A 1996 NRCS “Inventory and Analysis Report” states there is evidently a year-round flow from the confluence of Brisky Canyon (RM 4.3) to the mouth (Andonaegui 2001).

Basin hydrology has been altered by stream straightening, berming, road building, home building, grazing, tree removal and soil compaction. Some of these activities have resulted in faster, more intense runoff during storm events and annual snowmelt. Mission Creek is included on the WDOE 303(d) list for instream flows. Base flows have also been reduced by the removal of beaver, the loss of LWD through channel cleanouts done by the Civilian Conservation Corp (CCC), the Soil Conservation Service (SCS, now the NRCS), and the USFS (1935 – 1937 and 1954 – 1959) and channelization from road-related channel confinement. Base flows are also interrupted at times in the late summer at irrigation diversions (Andonaegui 2001, USFS 2003).

Operational spills with water diverted from Icicle Creek are delivered into Mission Creek by the Icicle Irrigation District (IID) at about RM 1.2. The influence of the spill provides somewhat of a stabilizing flow for Mission Creek below RM 1.2, although at a very low flow. Likewise, spills into Brender Creek with water diverted from Peshastin Creek by the Peshastin Irrigation District system to irrigate agriculture lands along Brender Creek, seasonally influence creek flows. There is evidence of bank erosion, probably from the sudden flush of added flow (Andonaegui 2001).

Obstructions to Fish Passage

There are numerous fish passage obstructions throughout most of this Assessment Unit. Culverts are located in the mainstem and many tributaries and irrigation diversions are located in Mission and Brender creeks. Elevated water temperature and de watering also contribute to passage problems.

Ecological Conditions

Brook trout have been introduced into this watershed and compete with resident rainbow trout and steelhead juveniles for rearing habitat. Pollutants may affect food productivity in the mainstem, as might chemical contamination residues from past agricultural practices. Habitat has been simplified to the point where productivity is limited in the middle and lower watershed. Overall, ecological conditions are fair in the upper watershed, and poor in the lower portions of the watershed.

Environmental/Population Relationships

Mission Creek today supports very low salmonid production. (Mullen et al. 1992) Small numbers of steelhead have been observed spawning in Brender, Mission, and Sand creeks. Steelhead and rainbow trout are known to rear in Mission Creek from the mouth upstream to Devils Gulch (RM 10.3). The mid Columbia mainstem Conservation Plan (MCMCP) reported that juvenile steelhead and rainbow trout also over winter in lower Mission and Brender creeks where passage is not precluded by low flows or barriers. A small fall at the mouth of Yaksum Creek prevents passage of juveniles into Yaksum Creek to rear. Steelhead/rainbow juveniles also rear in E. Fork Mission Creek and Little Camas Creek.

Currently, no spring chinook spawning occurs in the Mission Creek watershed. Juveniles do use the lower portions of Mission and Brender creeks for rearing and most likely migrate from the Wenatchee River. Rearing is limited to the first 1.2 mi. of Mission and occurs in Brender Creek up to the concrete flume fish passage barrier located immediately downstream of Evergreen Road at RM 0.7.

There is no evidence of bull trout currently occurring in the watershed. Brook trout have been located in upper Mission Creek, lower King Canyon and East Fork Mission creeks (Andonaegui 2001).

Areas of Special Interest

- Devils Gulch is in a more natural condition with some off channel areas available for use (USFS, in preparation). Potential for increased steelhead production exists in this area.
- Revegetation projects have been initiated near the mouths of Mission, Brender and Yaksum creeks within the town of Cashmere.
- Adult steelhead and adult rainbow trout spawn in reaches on USFS land
- Juvenile chinook and steelhead overwinter in lower Mission Creek

Limiting Factors

- In-channel conditions have been significantly altered by channel straightening, channelization and simplification. Resulting channel has entrenched through alluvial materials.
- Low flows and associated high instream temperatures prevent or impede access to spawning grounds for spring chinook, reduce the available rearing habitat in these areas and constrain access to rearing habitat elsewhere in the watershed.
- Diversion dams and culverts create fish passage barriers from the lower end of the watershed and progressing upstream, significantly reducing access to spawning and rearing habitat
- Stream temperatures in the Mission Creek watershed tend to be naturally elevated during the summer months and exacerbated by management activities, water diversions and habitat degradation.
- Naturally intermittent flows are exacerbated by surface water diversions and ground water withdrawals occur in the watershed
- Most of the riparian habitat in the naturally narrowing valley has been converted to orchards, pasture or hay production with thin bands of cottonwood/shrubs adjacent to the confined channel (Andonaegui 2001).

Data Gaps

- In less impacted stream reaches there is not enough data to determine if instream temperatures are significantly different than temperatures in the historic reference condition or to what extent these temperatures might negatively impact salmonid migration, spawning, incubation or rearing.

- There is no conclusive information concerning bio-accumulation of toxic materials in aquatic organisms.
- The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are not fully known.
- It is not clear if sediment loads have been significantly altered in this system. A sediment budget (geomorphic potential) analysis should be completed for this watershed.

Functional Relationship of Assessment Unit with Subbasin

Mission Creek is a Category 3 watershed (see Determination of Restoration Priorities in Section 6.5 of this document); it still contains sub watersheds that support rainbow trout, steelhead and juvenile spring chinook rearing (Devils Gulch, Sand Creek, and lower Mission, respectively). In general, substantial degradation and fragmented habitat, including loss of connectivity from low flow, occurs in this watershed. Opportunities for restoring full expression of life histories for multiple populations found within the watershed are unlikely. Mission Creek does provide some high water refugia in late spring for juvenile salmonids, and small numbers of steelhead still uses the upper watershed.

4.9.6 Peshastin Creek Assessment Unit

Assessment Unit Description

Peshastin Creek originates near Swauk Pass and flows north, entering the Wenatchee downstream of the town of Peshastin at RM 20. Ingalls Creek, the largest tributary to Peshastin Creek, originates in the area around Mt. Stuart (USFS 1998). There are 14 tributaries entering Peshastin Creek and three lakes in the watershed with a total surface area of 26 acres. Although Peshastin Creek is one of the major watersheds in the Wenatchee subbasin as far as size (78,780 acres), it contributes only 4% of the summer low flow for the Wenatchee River.

Elevations in the watershed range from 9,470 ft. at Mt. Stuart to 967 ft. at the mouth. Annual precipitation levels decrease from the Cascades crest downstream to the Columbia River. Situated in the lower portion of the subbasin, Peshastin receives less precipitation than upper watersheds. Annual precipitation levels range from 80 in. in the upper elevations to 15 in. at the mouth.

The USFS manages 82% (64,600 acres) of the watershed, 29% (18,734 acres) of which is designated wilderness. The remaining 18% of the watershed (14,180 acres) is privately owned. Long View Fibre Company owns 10,000 acres.

The watershed has complex geology. Over half the landbase sits on Swauk Sandstone. Ingalls and Upper Blewett sub- watersheds are made of granite. Slopes are low to moderate gradient on much of the east side of the drainage to very steep on the west side. There is high natural surface erosion and related sedimentation level in the watershed. Valley morphology for Peshastin Creek varies from open and meandering to sharply incised and bedrock controlled. Tributary channels are dominated by steep slopes and V-shaped valleys (Andonaegui 2001).

Assessment Unit Condition

The loss of channel sinuosity, floodplain function and riparian habitat, including off channel habitat, within the channel migration zone of Peshastin Creek has had the greatest affect on salmonid production. Channel confinement resulting from the improvement of State High way 97 has reduced spring chinook, steelhead and Bull Trout spawning habitat, It has also reduced juvenile rearing habitat for all salmonid species, especially overwintering habitat for steelhead/rainbow trout. Floodplain and riparian habitat functions have also been simplified by residential and agricultural development, timber harvest and mining activity that has been active in various forms for over 100 years. Low LWD counts further reduce habitat quality.

In some years, dependent on spring runoff characteristics, reduced flow can act as a passage barrier to spawning spring chinook. During summer and fall, flows can become extremely low below the diversion, at times de watering the channel. This reduces the total amount of available rearing habitat and may lead to direct mortality of juveniles by stranding. Some tributary streams have been simplified by forest roads, mining ,and riparian harvest, which has also reduced LWD recruitment and increased sediment delivery (Berg and Lowman 2001).

Riparian/Floodplain Condition and Function

Riparian Condition

The location of State Hwy. 97 forced the abandonment of 34% of the mainstem floodplain, 194 acres out of 565 acres, from the mouth to below the Tronsen Creek confluence. During the high way construction, Peshastin creek was straightened and replaced with 19,317 ft. of new main-stem channel. Roads and mining activities along the mainstem of Peshastin, Negro, Tronsen, Scotty and Shazer creeks, further confine and entrench sections of stream channel, and consequently abandon the floodplain (USFS 1998).

From the mouth of Peshastin upstream to just below the Ingalls Creek confluence, conversion of riparian habitat to residential/urban, rural and agricultural use has heavily impacted riparian habitat. Overall, the riparian zone is reduced in size, continuity, and successional stages (Andonaegui 2001). All of these factors contribute to a lack of shade and woody debris, change in channel type, increases in temperature, lack of refugia, and a lack of connectivity (USFS 1998). From the Forest boundary downstream to the mouth, the creek has been converted from a channel that meanders (Rosgen C) into a constrained (Rosgen B) channel type.

Mill and Hansel creeks, tributaries to the lower Peshastin below Ingalls Creek, have been roaded and harvested. The lower mile of Hansel was harvested in 1975. No streamside buffer were left. Sometime after 1975, the USFS began harvesting in the head waters of Hansel Creek, which added additional regeneration units and increased roading. Additional entries were made between 1986 and 1992 in the head waters on USFS land. Harvested areas in the upper watershed are dominated by alder and other shrub species.

Upstream of Ingalls Creek, virtually all tributaries have experienced some alteration from road building, mining, timber harvest and recreational use. Ruby Creek has experienced past timber harvest practices which included tractor use that skidded logs downhill and out through tributaries.

Mining activities have reduced streamside vegetation and LWD recruitment. Other mining impacts include camps located inside riparian areas, removal of LWD and boulders for dredging access, and removal of streambank vegetation for access. Due to valley morphology in Negro Creek, mining camps are generally within 40 ft. of the creek. There is evidence of erosion from hydraulic mining scars, some of which has never re-vegetated. On the North Fork Shaser, depositional areas are visible where streamside vegetation has been cleared on both banks (Andonaegui 2001).

Stream Channel Conditions and Function

Channel Condition and High Flow

Channel type throughout much of the watershed is dominated by contained Rosgen A and B type channels, so off-channel habitat would naturally be limited in many of these perennial channels. These channels are often further contained by roads and road fill, or have been stranded from their limited floodplain due to channel down-cutting, either from channel confinement or suction dredge mining (USFS 1998). Although the ability to function under peak flow is not discussed the 1999 USFS assessment, channel simplification and confinement, combined with low wood counts and roading, likely prevents the Peshastin from attenuating peak flows.

Fine Sediment and Channel Stability

Stream survey reports describe streambank condition throughout the mainstem and many tributaries in the drainage as fair to poor. Bank integrity has been compromised by roads, mining, and riparian harvest. Streambank condition in Ingalls Creek is stable and in good condition. Overall, stream bank condition for this watershed is poor (USFS 1998).

McNeil Core samples have been collected from three sites in the watershed: below Ingalls Creek, Peshastin near Shaser Creek, and Tronsen, just above Peshastin Creek. All three of these sites had fine sediment percentages above the Forest Plan Standards. Ocular estimates of the surveyed streams indicate that a majority of segments are embedded. The exception is Ingalls Creek where the stream bed did not appear embedded. Peshastin Creek fine sediment is high, and channel bed stability is poor. High fine sediment content is likely influenced by high road densities and channel confinement, year-round suction dredge mining, and road sanding (USFS 1998). The lower reaches of Negro Creek receive pulses of sediment. At the time of the stream survey, however, embeddedness was not observed to be a problem in the lower 1.5 mi. of the stream.

The overall channel width of the lower 9.0 mi. of Peshastin Creek is increasing. The channel is becoming less entrenched, possibly in response to increases in sediment supply, decreases in riparian vegetation structure and function, and changes in the flow regime. Also, following the 1990 flood, the number of large boulders from Ingalls Creek to Negro Creek (RM 9.0 – 11.1) decreased in number, reducing channel roughness and step pool/cascades formation.

Due to historic timber harvest, mining and road building along most tributaries and Peshastin Creek, available data indicates that LWD recruitment has diminished. This has contributed to low pool frequency and poor quality in the mainstem and most tributaries. Ingalls is an exception with regard to LWD and is in good condition (Andonaegui 2001).

Habitat Diversity

Lower Peshastin Creek is of particular concern from the USFS boundary to the mouth. The normal meandering low gradient (Rosgen C type) channel in this reach has been completely modified and floodplains have been developed. Many important habitat attributes, such as large wood and cover, large pools and side channels have been significantly reduced in quality and quantity. Considering the amount of alteration in the watershed, channel condition and function is poor overall for the Peshastin watershed (USFS 1998).

Water Quality

Temperature

Peshastin Creek has been added to the current 303(d) list for failing to meet temperature and is considered to be poor by forest plan standards. In the lower reaches low flows, minimal vegetative cover, and high air temperatures contribute to high instream temperatures during late summer months (Andonaegui 2001). Temperatures above Negro Creek routinely reach the upper 60s and come close to 70°F. Between the Negro and Ingalls confluences, the temperature is decreased to the mid to lower 60s from the influence of the cooler water from Negro Creek. These reaches still exceed Forest Plan and WDOE quality standards. Directly below the Ingalls Creek confluence the stream does not exceed the one day maximum of 61°F, but does occasionally exceed the 7 day maximum temperature. It is suspected that temperatures farther downstream, in residential and agricultural portions of the creek also exceed the standard regularly. This is also true of the upper and head waters streams, including Tronsen, Shaser, North Fork Shaser, and Middle Fork Shaser. Temperatures in Negro and Ingalls creeks are considered good (USFS 1998).

The USFS does not think there is enough data to determine if instream temperatures are significantly different than temperatures in the historic range for Peshastin Creek upstream of RM 1.0 (Andonaegui 2001).

Oxygen/Pollution

Peshastin Creek did not meet dissolved oxygen standards 9 times, turbidity standards 2 times. Fecal coli form was exceeded once (CCCD 1998). The dissolved oxygen areas were throughout the watershed, while the fecal coli form was at the mouth, likely a result of the surrounding private land in the lower 8 miles. Relative to chemical contamination and nutrients Peshastin Creek is termed as functioning appropriately within USFS land and functioning at risk below the forest boundary (USFS 1998).

Water Quantity

Low Flow

Peshastin Creek is also included on the WDOE 1998 303(d) list for low instream flows. At RM 2.4, the Peshastin Irrigation District operates a water diversion dam on the eastside of the creek and a screened water diversion on the west side of the creek near the confluence of Mill Creek (RM 4.8). The channel downstream of the Peshastin Irrigation District diversion de waters approximately 100 foot section all the way to the mouth in drought years. The diversion canal intercepts several small tributaries to Peshastin Creek, two of which with the flow so completely intercepted that there is no exchange with Peshastin Creek. Although Peshastin is closed to new water diversions between June 15 and October 15, no provisions for minimum flow are in place for existing water uses (Andonaegui 2001).

There is a lack of information on flows for the Peshastin drainage. The USFS, however, considers flows in the areas above the irrigation diversions as fair. If the stream channel maintained a normalized (rather than highly modified) width to depth ration, it is likely low flow related issues would not be a significant problem. Late summer flows below the irrigation diversions during summer and early fall are considered poor due to drastic changes in flow. The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time (CCCD 1998). Due to lack of harvest activity and no flow diversions, Negro Creek and Ingalls Creek are termed as functioning appropriately (USFS 1998).

Obstructions to Fish Passage

At RM 2.4, the irrigation district operates a water diversion dam on the eastside of the creek. The diversion dam presents a barrier to summer and fall migration mid June through October partially blocking spring chinook salmon and migrating bull trout. The dam also precludes the movement of resident rainbows from the lower drainage into cooler waters of the upper watershed. During late summer, in years when the total water diversion exceeds instream low flows, the area directly downstream of the diversion is de watered for 100 ft., completely blocking all fish passage.

Numerous other passage obstructions, primarily culverts are located on in the tributary streams.

Ecological Conditions

Brook trout have been observed in Peshastin Creek as far upstream as RM 4.84. Reduced flows and elevated instream temperatures below a water diversion at RM 4.8 likely restricts upstream movement of migrating adult bull trout. Hatchery adult spring chinook have been released into Peshastin Creek in recent years.

Environmental/Population Relationships

Historically this WAtershed supported spring chinook, coho, bull trout, steelhead, redband trout and cutthroat trout. Steelhead were likely the more populous anadromous species spawning in this system. Before the historic stock of coho was extirpated from the region, however, they may also have been more abundant than spring chinook (MCMCP 1998). Current use is generally limited to steelhead, redband, cutthroat, and resident bull trout, although coho have been documented spawning in Peshatin Creek (C. Kamphaus, unpublished data). Current use is generally limited to steelhead, redband, cutthroat, and resident (delete and just say bull trout. We are finding sub adult bull trout rearing in Peshastin Creek via our screw trap study. Also we are uncertain as to the extent that fluvial bull trout are using Peshastin) bull trout. A barrier to summer and fall migration from mid June to October exists at RM 2.4. There a screened irrigation diversion hinders and often precludes upstream movement during mid to low flows (USFS 1998; Andonaegui 2001). Due to the timing of migration for steelhead (winter, spring), the irrigation diversion does not cause a known migration problem for steelhead in this drainage. The Bureau of Reclamation (BOR) is working with the irrigation district to design a new diversion that will not block fish passage at low flow (Kolk 2003).

Both Negro and Peshastin creeks used to maintain a population of spring chinook salmon. That population is currently very small due the many degraded conditions in lower Peshastin Creek. Steelhead use the Peshastin mainstem and associated tributaries including Negro Creek, where use would be expected mainly in the early spring. Juvenile steelhead rear in the drainage throughout the year in a variety of habitats including off-channel areas, pools, riffles, and inter-gravel spaces. Upper Negro Creek also contains westslope cutthroat trout, the only known population in the Assessment Unit.

Bull trout use Ingalls Creek and Peshastin Creek as a migration corridor from the Wenatchee River as well as for rearing .

Migratory bull trout have not been confirmed to spawn in Ingalls Creek in recent years. Outside of resident bull trout in Ingalls Creek, bull trout have been observed in the extreme lower portions of Peshastin Creek below the diversion (USFS 1998). In a recent screw trap study, USFWS have been collecting sub-adult bull trout at RM 6.25 within the mainstem of Peshastin Creek (K. Terrell May 18, 2004, personal communication to Bob Rose).

Areas of Special Interest

- The mainstem Peshastin, even though challenging, remains an important corridor for bull trout and possibly cutthroat trout rearing and migration. Ingalls Creek appears to be limited to a small population of resident bull trout.
- Peshastin Creek historically had spring chinook, although currently due to migrational barriers and temperature concerns the only known use is at the mouth for some rearing activity (USFS 1998).
- Steelhead and rainbow trout use Peshastin Creek for spawning, rearing, and as a migration corridor, although redd surveys indicate low numbers (WDFW 2003).
- Ingalls Creek is located almost entirely in wilderness and provides the one area of high water quality and fish habitat. Ingalls Creek produces the most water out of the drainage, and exceeds the flow from Peshastin Creek during most of the year.
- Negro Creek is in near pristine condition above RM 2.5 (USFS 1998) and contains the only know cutthroat population in the Peshastin watershed.

Limiting Factors

- The loss of channel sinuosity, floodplain function, and riparian habitat including off channel habitat within the channel migration zone of Peshastin Creek has had the greatest impact on salmonid production in the watershed.
- A water diversion dam presents a barrier from mid June through October partially blocking migrating spring chinook salmon, and migrating bull trout
- Low instream flows in lower Peshastin Creek impedes upstream migration, reduce rearing habitat, and likely contribute to elevated water temperature
- Elevated water temperatures exceed regulatory standards

- Loss of riparian habitat resulting from land development and state high way reduces quantity and quality of spawning and rearing habitat (Andonaegui 2001)

Data Gaps

- The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time
- Cumulative effects of current gold mining activities on sediment delivery, water quality, and channel conditions have not been evaluated
- The extent to which fine sediment is negatively impacting salmonid habitat and productivity in Peshastin Creek relative to historic conditions has not been evaluated (Andonaegui 2001)
- The abundance and distribution of bull trout within the Peshastin subbasin is uncertain (Upper Columbia RTT 2001)

Functional Relationship of Assessment Unit with Subbasin

Peshastin Creek is a Category 2 watershed (see Determination of Restoration Priorities in Section 6.5) based on fragmentation and habitat degradation, especially in the lower watershed (Upper Columbia RTT 2003). Peshastin has 3 significant sub-watersheds: lower Peshastin, upper Peshastin, and Ingalls. The subbasin provides spawning and rearing habitat for steelhead, although limited habitat for listed spring chinook juveniles, and resident-Deleate bull trout. Bull trout and spring chinook are at risk in this watershed. Coho spawning in lower Peshastin was noted in 2003. Connectivity among subwatersheds still exists, although it is interrupted in late summer.

4.9.7 Chumstick Creek Assessment Unit

Assessment Unit Description

The watershed is oriented in a north-south direction with tributaries entering from the north and east. Chumstick watershed can be broken into three smaller sub watersheds: mainstem Chumstick, Upper Chumstick-Little Chumstick, and Eagle Creek. Flowing south into the Wenatchee River at RM 23.5 at the east end of the town of Leavenworth, Chumstick Creek is a perennial, fish-bearing, 4th order stream (with some reaches that de water), typically flowing less than 10 cfs. It contributes 0.2% of the low flow to the Wenatchee River (USFS 2003, Andonaegui 2001).

The Chumstick drainage is 47,000 acres and located in the eastern Cascade rain shadow. Chumstick Creek and Eagle Creek (RM 1.9), a tributary to Chumstick Creek, are the only streams in the drainage known to support anadromous salmonids. Mean annual precipitation ranges from 20 in. in valley bottoms to 50 in. in the higher elevations (Andonaegui 2001). Most precipitation falls as snow in winter. The lower Wenatchee River, including Chumstick watershed, is almost wholly contained within the Swauk Sandstone Hills geologic subsection. This hilly subsection composed of folded interbedded sedimentary rocks has been modified by fluvial downcutting and mass wasting processes. Shrubsteppe and ponderosa pine dominate the lower elevations with Douglas-fir and grand fir occurring on the upper elevations (USFS 2003).

Along mainstem and major tributary valley bottoms, railroad berms, low-density housing, pastures, and agricultural development are common in the floodplain. Higher elevations are mostly in USFS ownership, although some lands are owned by the state and private landowners.

Assessment Unit Condition

The Chumstick once supported populations of summer steelhead, coho, and possibly spring chinook salmon. Land development and use occurring on both public and private land has created poor habitat condition for most stream attributes. Railroad logging began in Chumstick valley in 1910 when the Lamb-Davis Timber company finished laying 26 mi. of track from Leavenworth to Plain. In later years, the track was removed and used for the base of the high way. Many degraded habitat attributes can be linked to channel confinement resulting from road density and location, loss of floodplain connectivity, and alteration of disturbance regimes. Additionally, instream flows are very low, upstream access is blocked by multiple stream crossings and impoundments, water quality is degraded, and high fine sediments may limit spawning success and food production by macro invertebrate communities.

The Chumstick Creek drainage has been identified as one of the more problematic watersheds in the entire Wenatchee subbasin relative to land use impacts and management issues. Given restoration of fish passage, degraded habitat quality and low flow conditions will continue to limit salmonid production.

The Chumstick has most adult and all juvenile salmon passage blocked at RM 0.3 by a perched culvert under North Road. Telemetry results have shown one adult steelhead traveled 5.7 mi. up Chumstick Creek in 2000. Today, spring chinook juvenile use is limited to rearing in the first 0.3 mi. of Chumstick Creek downstream of the culvert. Brook trout have been planted throughout the drainage. Rainbow trout and steelhead are present in low numbers. Coho have been extirpated from the drainage (Andonaegui 2001).

Riparian/Floodplain Condition and Function

Riparian Condition

High way 209 and the Burlington Northern Railroad closely parallel Chumstick Creek, limiting the width of the riparian zone, and restricting channel access to the floodplain. High riparian road densities have a similar affect on tributaries. Due to the high densities of roads and restriction of the floodplain, riparian conditions in Chumstick Creek and tributaries are in poor condition (USFS 2003).

Habitat Diversity

Forty percent of the riparian vegetation along the mainstem Chumstick and Eagle creeks, in addition to other smaller tributaries, has been altered by agricultural and urban encroachment, historic railroad development, logging, and high riparian road densities, and fire suppression. Where disturbance has occurred, channels are often confined, surface erosion has increased, and channel degradation has resulted. In the disturbed areas where woody vegetation is lacking, soil is bare and an invasive weed, Reed canary grass, is abundant. High sediment levels and lack of channel roughness features such as large woody debris (LWD) are also linked to the degraded riparian habitat condition. Where woody vegetation occurs, shrubs are usually most common, with red osier dogwood the dominant woody plant. Willow, alder, snowberry, and wild rose can be found in more intact riparian areas. Cottonwood and hawthorn trees still occur on some sections of Chumstick Creek. Riparian condition is similarly poor for Eagle Creek (Andonaegui 2001).

Stream Channel Conditions and Function

Channel Condition and High Flow

As floodplain connectivity has been restricted, channel sinuosity has also decreased from the mouth to Little Chumstick Creek (RM 8.7). Coupled with high sediment rates, low LWD levels, and a flashy hydrology, Chumstick Creek may be at risk for becoming entrenched by developing a decreasing width-to-depth ratio (Andonaegui 2001).

Fine Sediment and Channel Stability

Streambank erosion associated with riparian disturbance and culvert placement has been recorded from the North Road culvert (RM 0.3) upstream to Little Chumstick Creek. Active erosion is highest from Eagle Creek (RM 1.9) to Sunitsch Canyon (Andonaegui 2001). A USFWS stream survey indicates that sand and finer substrates comprise 48-68% of the wetted channel substrate (riffles and pools). Sand and fines were the dominant substrate throughout the survey, from North Road to above Clark Canyon. Based on this data, Chumstick Creek has poor substrate (USFS 2003). Large percentages of fine sediment within the drainage can be linked to naturally erosive geology exacerbated by channel confinement, extensive native surface road network, erosion from burned areas, and possibly hill-slope erosion from historic and continued grazing (Andonaegui 2001, USFS 2003).

Instream LWD quantity throughout the watershed is lower than expected. Partially as a result of LWD deficiencies, sediment is not effectively stored in higher gradient streams, thus changing the way fine sediment is delivered to valley bottom channels (Karrer 2004. There is an acceptable amount of pool habitat in Chumstick Creek, however the depth in many pools Does not provide sufficient refuge for fish during low flow periods. Pool depth and frequency is poor in Eagle Creek (USFS 2003).

Water Quality

Temperature

The Chelan County Conservation District (CCCD) monitored water temperature at five stations in Chumstick Creek in 1999 and 2000. Most temperatures were below 57°F, although a single day high temperature of 58.5°F was recorded on August 8, 2000. Although single day measurements in summer months rarely exceed state single day standards, data does not conclusively prove state standards for temperature are met (USFS 2003).

Oxygen/Pollutants

Chumstick Creek is on the WDOE 303d list for dissolved oxygen, fecal coli form, and pH for criteria exceedences. The Wenatchee watershed ranking project documented dissolved oxygen, pH, and fecal coli form levels in violation of state water quality standards. The ranking project concluded that Chumstick was second to Mission Creek in contributing to current and future potential water quality degradation in the Wenatchee River watershed. Chumstick Creek is “functioning at an unacceptable risk” for water chemistry (USFS 2003).

Water Quantity

Low Flow

Chumstick Creek is also listed on the WDOE 303d list for instream flow for criteria exceedences. As is typical in drainages in the drier portion of the Wenatchee subbasin, stream flow is intermittent for the majority of 1st order tributaries in the drainage. Where perennial flow exists, stream flow is sometimes interrupted when the underlying water table drops low enough that surface flows go subsurface. Ground water withdrawals may influence intermittent flows on higher order mainstem channels.

Instream flow measurements showed that late summer discharge decreased going downstream, indicating Chumstick Creek has a possible loosing reach. This may be due to shallow aquifer well withdrawals throughout the valley. However, flows have been observed to go subsurface during dry summer months, sometimes reappearing when summer rains recharge the water table, then again going subsurface (Andonaegui 2001).

Given the amount of land development, high road densities, harvest, and fire suppression in relationship to Chumstick Creek peak and low flows, water quantity is in fair to poor condition in the watershed (USFS 2003). Ground water withdrawals from private wells may affect instream flows. watershed wide, there are 54 surface water rights permits or certificates worth potential total diversion of 8.2 cfs. There are 99 surface water rights claims worth a potential total diversion of 36.4 cfs. There are 103 ground water rights permits and certificates worth a potential total withdrawal of 2,194 gpm. There are 61ground water rights claims worth a potential total withdrawal of 1,215 gpm (Andonaegui 2001).

Obstructions to Fish Passage

The North Road county culvert at RM 0.3 is a full passage barrier to spring chinook juveniles and a partial passage barrier to steelhead (Andonaegui 2001). Twenty-three culverts were identified as potential migrational barriers to anadromous and resident fish species by the USFWS. Of the 23 culverts, eighteen were classified as too small to pass bank full flows and associated debris; nine exceed Washington State Administrative Code (WAC) gradient requirements and could cause low flow barriers. Many of the identified culverts are misaligned causing erosion and increased sediment loads in Chumstick Creek. Eleven of the 23 culverts have been replaced in the past three years. Funding for the remaining 12 culverts has been secured once passage at the North Road Culvert has been addressed. The culvert under North Road at RM 0.3 has received only partial funding and still awaits replacement.

Ecological Conditions

Ecological conditions are poor overall in the Chumstick Creek. In addition to state water quality listings, the Chumstick watershed no longer retains the complete fish community that was historically present. Coho reintroduced in the Wenatchee River do not use the Chumstick watershed at this time. Brook trout are present throughout most of the entire drainage (USFS 2003).

Environmental/Population Relationships

Juvenile fish access to Chumstick watershed is blocked by a perched culvert at RM 0.3, adult steelhead are occasionally able to pass this crossing. Steelhead and spring chinook juveniles would likely use more of lower mainstem Chumstick Creek for rearing and refuge if passage were restored.

Historically, steelhead and coho spawned and reared in lower Chumstick and lower Eagle creeks. Given its elevation and landtype, the Chumstick Creek drainage may have never supported spawning spring chinook and bull trout populations, even under historic conditions when water temperature, flows and substrate composition are assumed to have been in more favorable condition. Today, the North Road Culvert limits spring chinook use to the first 0.3 mi. of Chumstick Creek. Coho have been extirpated from the region and no documented bull trout use in any season exists for the drainage. Brook trout have been introduced throughout the entire drainage. Results of an ongoing radio telemetry study conducted on steelhead trout by the Douglas County PUD located adult steelhead trout in Chumstick Creek in 2000. The telemetry results tracked adult steelhead as far as 5.7 mi. upstream of the mouth of Chumstick Creek. Eagle Creek is the only tributary to Chumstick Creek that is known to support returning steelhead. The upper extent of known rainbow and steelhead trout anadromy in Eagle Creek is approximately RM 1.0 (Mullan et al. 1992, Andonaegui 2001). Rainbow and steelhead trout are present throughout the watershed.

Areas of Special Interest

- Currently spring chinook juvenile use the lower reach (the first 0.3 miles) although use is limited presumably because of the North Culvert.
- Some riparian and off-channel habitat remains in the Chumstick drainage, along with occasional beaver use.

Limiting Factors

- Channel migration is limited by state high way, the railroad, private land development, and forest roads (Andonaegui 2001, USFS 2003).
- Land development and high road density affects sediment delivery (Andonaegui 2001).
- The North Road county culvert at RM 0.3 is a full passage barrier to spring chinook and a partial passage barrier to steelhead (USFS 2003).
- Forty percent of the riparian vegetation along the mainstem Chumstick and Eagle creeks, in addition to other smaller tributaries, has been disturbed by agricultural and urban encroachment, historic railroad development, logging, and high riparian road densities.
- Given restoration of fish passage, degraded habitat quality and low flow conditions will continue to limit salmonid production.

Data Gaps

- There is insufficient data to determine if instream temperature, low dissolved oxygen and high total dissolved solids exceedences exist that affect salmonid use in Chumstick and Eagle creeks.
- The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time (Andonaegui 2001).

Functional Relationship of Assessment Unit with Subbasin

All habitat attributes, except pool frequency, are degraded in Chumstick Creek. In addition, Chumstick Creek experiences very low instream flows that go subsurface (2 cfs in August/September) which are exacerbated to an undetermined extent by private diversions and wells affecting surface flows. Differing reaches go dry in many years. Presently, fish passage into the drainage is blocked at RM 0.3 for all fish species except some adult steelhead trout. Given removal of fish passage barriers in the drainage, degraded habitat quality and low flow conditions will continue to limit salmonid production. The Chumstick is a low priority watershed Category 3 watershed (see Determination of Restoration Priorities in Section 6.5) and none of the three sub watersheds are considered significant.

4.9.8 Icicle Creek Assessment Unit

Assessment Unit Description

Icicle Creek originates high in a rugged portion of the Cascade Mountains and is a 5th order stream. Icicle Creek drains an area of 214 square mi. (136,960 acres) in North Central Washington. Icicle Creek main-stem flows east 31.8 river mi. (RM) before emptying into the Wenatchee River at RM 25.6) in the city of Leavenworth. There are 14 glaciers (420 acres) and 102 lakes (1,362 acres) in the watershed (Andonaegui 2001).

The watershed contains the largest tributary drainage in the Wenatchee River subbasin, providing 20% of the low season flows (Andonaegui 2001, CCCD 1996). Precipitation ranges from 120 in. at the crest of the Cascades to 20 in. at the mouth. Minimum and maximum flows recorded in Icicle Creek vary from 44 cfs to 11,600 cfs, as measured at the USGS gauging station located above Snow Creek at RM 5.4. The gauging station is upstream of all major diversions.

The main channel forming processes are glaciation and seasonal runoff. The watershed is characterized by steep valley head walls, cirques and cirque head walls which are typically bare rock or thinly soiled. The valley bottom is covered by a layer of glacial till with alluvial fans formed at the confluence of tributaries. The majority of stream channels (68%) are steep (>20% gradient) sediment/debris transport reaches with beds composed of cobble and boulder with bedrock stretches. Collapsed glacial till deposits have dammed tributary streams in the upper reaches of some west and southwest sub- watersheds (HUC 6), creating marshes, bogs, and some lakes. Historically, lower Icicle Creek below RM 3.8 was an unconfined, alluvial stream, with large areas of floodplain deposits (Andonaegui 2001)

Public ownership accounts for 87% (119,155 acres) of the watershed with 74% (88,175 acres) within the Alpine Lakes Wilderness (Andonaegui 2001, USFS 1995). Private ownership accounts for 13% with most of this land in the lower watershed below RM 6.0. East Icicle Creek and Icicle Creek roads roughly parallel the creek from the mouth to RM 17.5 at the USFS wilderness boundary (Andonaegui 2001).

Assessment Unit Condition

From the USFS wilderness boundary the head waters, aquatic habitat closely resembles historic conditions. Floodplain connectivity and riparian habitat below the wilderness boundary have been altered through the construction of roads, campground development, timber harvests, and private development. Habitat alterations increase dramatically below RM 2.8, primarily from stream side development and channel confinement. Bank stabilization, flood control, and loss of riparian habitat limit the streams ability to adjust to sediment, debris and high flows. This loss of function exacerbates bank destabilization in a naturally mobile stream section, which in turn contributes additional sediment to the stream channel. Decreased in-channel complexity from the loss of LWD degrades channel conditions in the lower 2.8 mi. (Andonaegui 2001; Berg and Lowman, 2001).

The watershed has a long history of human use beginning with sheep herding and mining in the late 1800s. More recent uses include water withdrawal, timber harvest, road building, fire suppression, campground development, private residences, and recreation. Logging has occurred on 5% of the total acreage. Road building provided access for development, recreation, and timber harvest. Over 11% of the vegetation along lower Icicle Creek has been removed from private property (USFWS 2002). Fires followed by landslides are natural disturbance events that occur at relatively frequent intervals (USFS 2004). For example, the 1994 forest fires burned 12% of the watershed in the lower part of the subbasin. In 1999, a landslide originating on a slope burned in 1994 reached Icicle just above Snow Creek.

Leavenworth National Fish Hatchery (LNFH) structures block anadromous migration beginning at RM 2.8. The LNFH intake diversion dam (RM 4.5) is a fish passage barrier at low flows. The Icicle/Peshastin Irrigation District diversion dam at RM 5.7 may also hinder upstream fish passage at low flows (Andonaegui 2001; Mullan et al. 1992; USFS 2004). The fish screens at the District and LNFH diversions do not meet current NMFS criteria and require updating. Changes in the historic channels flow regime have caused sediment accumulation and vegetation encroachment. As a result, the historic stream channel has evolved from riverine to wetland. These issues are being addressed and are slated for construction in 2006. Once completed the LNFH and Cascade irrigation withdrawal will be in compliance with NOAA-fisheries and USFWS under Section 7 of the ESA.

Brook trout, coastal rainbow trout, and lake trout are non-native species that have been introduced to the watershed. The Leavenworth NFH raises and releases hatchery fish in Icicle Creek (Andonaegui 2001, Berg and Lowman, 2001, USFWS 2002), and coho are acclimated in Icicle Creek by the Yakama Nation (Murdoch 2004). Salmon carcasses were distributed in the watershed by the USFWS in 2002 but not in 2003 (Cooper 2002; Cooper 2003).

Riparian/Floodplain Condition and Function

Lower Icicle Creek is an unconfined low gradient alluvial stream. The riparian vegetation in Icicle Creek from the mouth upstream to RM 2.8 is reduced in structures and function and is fragmented and poorly connected. Based upon analysis of aerial photographs in 1994, it was determined that 11.2% of the stream had riparian vegetation removed, principally from housing development. Homes and fields line 25% of the lower 2.8 mi. where riparian vegetation has been cleared and banks replanted with domestic grasses, trees, and shrubs. Few areas retain a narrow strip of streamside vegetation (Andonaegui 2001).

Campsites near streams throughout the watershed are thought to increase fines and bank erosion, as well as decrease riparian vegetation. Some campsites in the wilderness area are located close to stream and lake areas and have been denuded of vegetation. Loss of vegetation has contributed to erosion into these water bodies (Andonaegui 2001). Roads are a source of sediment below RM

5.7. An analysis by the US Department of Agriculture (USDA) in 1995, however, estimated that sediment from roads is at least an order of magnitude lower than the calculated background watershed sediment delivery rate (USFS 2004). Sediment from camping is relatively minimal when compared against natural delivery rates.

The riparian vegetation from RM 2.8 to 17.5, below the wilderness boundary and above the Leavenworth NFH, including the historic stream reach, is dominated by small trees 9 to 20.9 in. diameter at breast height. The quantity and quality of riparian vegetation has been reduced by campground development, road development, past timber harvests, private development, and forest fires (Andonaegui 2001, USFWS 2001). The extent of degradation to riparian habitat, however, may be more localized in nature rather than the overall degradation of the riparian habitat for the entire reach from RM 2.8 – 17.5 (Andonaegui 2001). Riparian condition above RM 5.7 is good with riparian reserves more than 80% intact. Riparian condition below RM 5.7 is poor (USFS 2004)

In areas where the Icicle Creek road is close to the stream, riparian harvest has occurred (Andonaegui 2001, USFS 1995). There are approximately 2.3 mi. of road in the watershed that are encroaching upon the stream. Outside of these areas the roads are far enough a way from the stream that direct impact is low (Andonaegui 2001).

Based on GIS mapping exercise of rip-rapped banks using GPS coordinates, 10% of the total bank length on both sides of the creek from RM 0.0 – 2.8 (3,4449 ft. [total?]) have been rip-rapped. The morphology of the historic channel reach between RM 2.8 and 3.8 has been altered considerably by the holding dams and weirs placed in the channel during construction of the Leavenworth NFH. Stream banks in the historic reach are stable (Andonaegui 2001). Upstream of RM 3.8, specific locations where riprap has been placed include the following locations provided by road mi.: 4.6 - 5.1; 9.9 – 10.1; 10.7 – 10.8; 13.6 – 14.1. The riprap placement corresponds to areas where the road is confining the stream channel. Some areas that are adjacent to streams are being degraded by heavy use with vehicles and people. This is causing localized increased bank erosion and denuding banks (Andonaegui 2001, USFS 1995). A dike has been constructed at RM 14.7 on Icicle Creek to protect the banks at the Ida Creek Campground (RM 14.7).

The majority of waters flowing into Icicle Creek originate in wilderness areas and areas that have had minimal management (Andonaegui 2001). Even in these reaches, estimates of substrate embeddedness are high at 31 ? 100% (Andonaegui 2001; USFWS 2001), the effect of naturally high sediment loads.

Delete Sediment in the substrate in upper Icicle is good condition, even though percentages are high Delete. Most important, upper reaches have extensive beaver dam development, which has slowed flow, raised water levels, and killed trees that have fallen into the channel. Sediment retention is expected under these conditions (USFS 2004). However, for stream reaches in the lower watershed affected by land management activities, the extent of increased sediment delivery coupled with channel, flow, floodplain and riparian impacts, sediment and channel stability is considered fair (USFS 2004).

Stream reaches in Icicle Creek upstream at RM 3.8 do not meet federal Forest Plan standards for LWD (Andonaegui 2001, USFWS 2001). For stream reaches within the Alpine Lakes Wilderness, observed LWD levels, which are below Forest Plan standards, are the result of natural influences. For stream reaches downstream of the wilderness boundary, residential and commercial development, road construction and timber harvest, both within the channel migration zone of Icicle Creek and within drainages potentially contributing LWD to Icicle Creek, have negatively affected LWD levels (Andonaegui 2001).

Stream Channel Conditions and Function

Channel Condition and High Flow

Peak flows are likely affected below RM 5.7. Heightened peak flows result from urbanization, flood control channels, bank hardening, roads, and urbanization (USFS 2004). Channel width-to-depth ratios in Icicle Creek downstream of RM 2.8 are increasing in response to increases in sediment supply and bank instability, decreases in riparian function and structure, and changes in flow regime. Increased width-to-depth ratios are causing the channel to become wider and shallower, thus altering the historic channel morphology considerably.

Peak flows likely have not been affected in the upper watershed as development is minor compared to the vast acreage that remains in a natural condition (USFS, 2004). Width-to-depth ratios for Icicle Creek upstream of the historic channel (RM 3.8) are probably similar to historic conditions based on stream measurement taken during USFS stream surveys, with the exception of areas where roads and bridges confine the stream channel and where riprap has been placed (Andonaegui 2001).

Jack Creek: In the mid 1970s, an avulsion occurred on the lower reach of Jack Creek, shortening the stream length (Andonaegui 2001; USFS 1995). During the 1990 flood event, the pre-flood channel was blocked by a large wood complex and a new channel again cut through the alluvial soils (Andonaegui 2001).

Fine Sediment and Channel Stability

The majority of waters flowing into Icicle Creek originate in wilderness areas and areas that have had minimal management (Andonaegui 2001). Even in these reaches, estimates of substrate embeddedness are high at 31 – 100% (Andonaegui 2001; USFWS 2001), the effect of naturally high sediment loads. Sediment in the substrate in upper Icicle is good condition, even though percentages are high. Most important, upper reaches have extensive beaver dam development, which has slowed flow, raised water levels, and killed trees that have fallen into the channel. Sediment retention is expected under these conditions (USFS 2004). However, for stream reaches in the lower watershed affected by land management activities, the extent of increased sediment delivery coupled with channel, flow, floodplain and riparian impacts, sediment and channel stability is considered fair (USFS 2004).

Habitat Diversity

Connectivity between Icicle Creek and its off-channel, wetland, floodplain, and riparian areas has been reduced due to development, road building, water diversions, and flood damage control (Andonaegui 2001). Below the Leavenworth NFH, the channel bed is less stable as Icicle Creek adjusts to natural and human impacts. Channel confinements confound this process. Reaches in upper Icicle Creek are in good condition except in areas where roads and bridges confine the stream channel and riprap has been placed. There are several side channels along East Leavenworth Road that are cut off from the stream. In several areas, riprap has been placed on stream banks and berms have been built to confine the stream and limit flood damage. Additionally, in several areas wetlands have been reduced either through draining and/or filling.

In the lower 2.8 mi. of Icicle Creek there are few back water areas and low energy off-channel areas. From RM 3.8 upstream, 1994 USFS stream survey data shows that 72% of upper Icicle Creek contains an adequate and diverse amount of off-channel habitat. Many side-channels, back water areas, ponds, wetlands, and oxbows occur (Andonaegui 2001).

Water Quality

Temperature/Oxygen/Pollutants

The WDOE 303d list has several water quality concerns for Icicle Creek, including temperature, pH, and dissolved oxygen. The USFS 1994 stream survey recorded instream temperatures as high as 64°F between RM 4.8 – 17.0 on Icicle Creek. This exceeds federal Forest Plan standards. There is presently not enough data, however, to determine if these temperatures are significantly different than temperatures in the historic range or to what extent, if any, these temperatures negatively impact salmonid migration, spawning, incubation or rearing (Andonaegui 2001; USFS 2004).

Turbidity

A landslide on a draw that descends from Icicle Ridge occurred in June 1999. The affected area was approximately 120 ft. wide and 300 ft. long with a depth of approximately 10-15 ft. (USFWS 2002).

Eightmile Creek: Timber harvest and fire have changed the vegetation and increased the exposed soils. Sediment that reaches the mainstem is transported to the alluvial fan at the mouth and into Icicle Creek. The Eightmile Road (USFS Road 7601) is a major contributor of sediment (USFS 1995).

Water Quantity

Low Flow

Icicle Creek Does not meet instream flow standards and has been included on the WDOE 303d list.

There are 23 surface water rights permits or certificates in the assessment unit that can divert a potential total of 205.4 cfs. There are 13 surface water rights claims worth a potential of 9.5 cfs. There are 5 pending applications for a surface water right permit, certificate, or claim worth 8.8 cfs. There are 5 ground water rights permits or certificates worth a potential total withdrawal of 5,178 gpm. There are 16 ground water rights claims worth a potential withdrawal of 369 gpm. There are 4 applications pending for ground water rights permits, certificates or claims worth a potential total of 135 gpm (Montgomery Water Group et al. 1995).

The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time. The status of the diversions and screens associated with the surface water rights are unknown at this time.

The Leavenworth NFH and the Cascade Orchards Irrigation District Company (privately owned, not an irrigation district) divert water at RM 4.5. The upstream-most water diversion occurs at

RM 5.7 on Icicle Creek by the Icicle/Peshastin Irrigation District (District) and the city of Leavenworth. Screens on all these diversions do not meet NMFS requirements.

Without releases of water (50 cfs) from Upper Snow Lake, the downstream reaches of Icicle Creek would go dry in some years (Andonaegui 2001, Mullan et al. 1992; USFWS, 2002). Low flows in the lower reach (RM 0.0 – 5.7) are the result of natural conditions compounded by public water supply needs, irrigation diversions, and the fish hatchery diversions.

Obstructions to Fish Passage

Fish passage in the upper portions of Icicle Creek remains similar to the historic reference condition. In the lower six miles of the mainstem Icicle Creek, the USFWS Leavenworth National Fish Hatchery and several irrigation diversions block fish passage. At RM 5.6, there is a natural boulder field, which creates a substantial velocity and gradient barrier.

This identifies the boulder field as the first potential natural fish passage barrier (partial barrier at some flows) on Icicle Creek (Andonaegui 2001).. LNFH is required to pass any un-spawned steelhead, that enters the holding ponds, above the hatchery.

Adult bull trout have also been observed below the LNFH spillway dam (Andonaegui 2001). In 2003, two fluvial bull trout were identified above the boulder field (Judy DeLaVergne, personal communication)

Ecological Conditions

Eastern brook trout, non-native rainbow trout, and lake trout have been introduced in the Icicle watershed (USFWS, 2002). The introduction of non-native species can impact native fish through competition, predation, and genetic hybridization.

Interactions between hatchery and wild salmonids is covered under Hatchery Management in the Wenatchee subbasin, in Section 4.

Environmental/Population Relationships

The majority of the fish habitat in the Icicle Creek between RM 24 and RM 30 and within associated tributaries is in highly functional condition. Spring chinook, steelhead and fluvial bull trout, however, are blocked at RM 2.8 at the Leavenworth NFH spill way and Dam 5 and headgate and weirs from hatchery operations in the historic channel between RM 2.8 and RM 3.8 (Andonaegui 2001, USFWS 2001). Historically, anadromous fish were able to access Icicle Creek to RM 24.0, where there is a natural falls prevents upstream passage (Andonaegui 2001; Mullan et al. 1992).

The spring chinook spawners observed annually below the spill way (RM 2.8) in Icicle Creek are likely mostly of hatchery origin (Andonaegui 2001; MCMCP 1998). From 1958 to 1999, 7.69% of all redds located in the Wenatchee subbasin by the Chelan County PUD were found in Icicle Creek. The natural characteristics of the stream are most suitable for spring chinook; steelhead, rainbow and bull trout rearing and spawning. Late-run chinook use of Icicle Creek is limited. Sockeye salmon do spawn downstream of RM 2.8, but use is limited to strays from the Lake Wenatchee population. There were 30 redds counted in 1997 and 9 in 1999 (Andonaegui 2001, USFWS 2001). Rainbow trout occur upstream of the spillway (RM 2.8), in the mainstem, and in various tributaries. Bull trout have also been located upstream of the spill way at RM 2.8 and in

Jack, Eightmile, and French creeks. The population abundance is uncertain, but are not considered strong due to the loss of connectivity to the rest of the Wenatchee River system at the Leavenworth NFH dam, and the influences of harvest and past fish stocking management. Adult bull trout have also been observed below the Leavenworth NFH spill way dam (Andonaegui 2001).

Areas of Special Interest

- functioning floodplain and riparian habitat downstream of the wilderness boundary (RM 17.5) with emphasis on protection downstream of RM 2.8 (Andonaegui 2001).

Limiting Factors

Andonaegui (2001) identified the following Limiting Factors:

- low instream flows in the Icicle
- channel function in lower Icicle Creek
- reduce sediment delivery from roads
- the Leavenworth NFH and the Cascade Orchards Irrigation District Company divert water at RM 4.5, where the screen needs updating
- waters of Icicle Creek are diverted by the Icicle/Peshastin Irrigation District and the Leavenworth at RM 5.7, where the screen needs updating
- Leavenworth at RM 5.7, where the screen needs updating Fish passage at LNFH. Dam 5 and the head gate are being retrofitted for fish ladders in 2005 for passage of steelhead and bull trout. Spring Chinook that enter the ladder will be moved to the holding ponds or be returned to the pool below Dam 5.

Data Gaps

- Salmonid passage at the boulder area (RM 5.6) upstream of the Leavenworth NFH (Andonaegui 2001; Upper Columbia RTT 2001)
- The interaction of water diversions, water withdrawals, and return flows on instream flows and temperatures, including its affects of fish habitat and use (Andonaegui 2001)
- The extent to which Icicle Creeks ability to dissipate energy and transport bedload has been affected by human-induced changes, including the location of the impacts (Andonaegui 2001)
- The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time
- Bull Trout and Cutthroat population abundance and distribution remains uncertain.

Functional Relationship of Assessment Unit within Subbasin

Icicle Creek is a Category 2 watershed (see Determination of Restoration Priorities in Section 6.5) and has 4 significant subwatersheds: lower, middle, and upper Icicle, and Jack creeks. Bull trout are located in upper Icicle and tributaries; they are currently- may be stranded from migratory bull trout by Leavenworth NFH structures during certain times of the year. Listed summer steelhead and hatchery spring chinook return to the lower Icicle. Westslope cutthroat are located in the upper watershed.

4.9.9 Nason Creek Assessment Unit

Assessment Unit Description

The head waters of Nason Creek lie in the eastern slopes of the Cascade Mountains in central Washington. Nason Creek flows east out of Lake Valhalla at 4,830 ft. for approximately 21 miles and then turns north for another 5 miles before emptying into the Wenatchee River at RM 53.6 just below Lake Wenatchee (RM 54.2; USFS, 1996; Rife and Haskins 1998, Andonaegui 2001). The watershed is bounded by Nason Ridge on the north, the crest of the Cascades on the west, the Chiwaukum mountains and McCue Ridge on the south, and Natapoc Mountain on the east (USFS, 1996). Nason Creek is a 3rd order stream, contributing approximately 18% of the low flow of the Wenatchee subbasin and draining 108 sq. mi. (Rife and Haskins 1998; Andonaegui 2001).

Elevations in the 69,000 acre watershed vary from 8000 ft. at Snowgrass Mountain to 1865 ft. at the mouth of Nason Creek. Precipitation and forest vegetation vary substantially along this elevational gradient (Andonaegui 2001). Annual precipitation ranges from 30 to 90 in.; 84% of the watershed receives 50-80 in. annually. Vegetation type ranges from sub-alpine to dry forest (USFS 1996).

The Nason Creek drainage was formed by glacial scour. It is dominated by steep bedrock or rocky slopes with accumulations of talus on the lower margins and a broad, U-shaped valley floor characterized by glacial till deposits (Rife and Haskins 1998; Andonaegui 2001). There are areas of excessive scouring occurring, a result of both natural events and human alterations (MCMCP 1998).

Assessment Unit Condition

Habitat in the Nason watershed has been altered by human activities including railroad development, road building, channel straightening, timber harvest, and private development. Every habitat feature measured by the USFS has been reduced to fair or poor condition somewhere in the watershed. The lower 15 mi. of the mainstem contain the most habitat features in poor condition. This reach contains all spring chinook spawning habitat in the watershed and is a key corridor for connectivity of sub watersheds. Habitat alteration is greatest in the lower watershed. The only channel reaches which are functioning appropriately for all reach metrics are Whitepine Creek above the wilderness boundary, Smith Brook, and Nason Creek above the wilderness boundary. Tributaries in the watershed form a continuum between these two extremes, with negative impacts decreasing as one moves towards the head waters (Rife and Haskins 1998).

Moderate to high subsurface water storage capacity, steep terrain, and deep, non-cohesive valley soils result in a naturally high mass wasting hazard in the watershed. Fire and debris slides are among the primary naturally occurring disturbance processes. Roads and timber harvest are believed to be the dominant human-related sources of sediment to the stream (USFS 1996;

Andonaegui 2001). Low instream flows are common in August and September, a natural condition related to snow accumulation and snow melt patterns (Andonaegui 2001).

(Feature each of the four+ components (not climate) as well as critical habitat attributes and other major related features (hatchery facilities, etc.). This is the primary place that EDT/QHA info. is presented.)

Riparian/Floodplain Condition and Function

The mainstem below Whitepine has experienced the greatest floodplain alteration and channel confinement. Much of the floodplain of the lower mainstem is privately owned, has experienced substantial development, and is likely to see further development in the future. Mill Creek watershed, the only known bull trout spawning in the Nason Creek watershed, has been substantially impacted by powerline access, a floodplain gravel pit, timber sales, roading, and a winter recreation facility that has been expanding operations in the watershed. Future development has the potential to further impair key bull trout habitat (USFS 1998).

The lower watershed is no longer resilient to disturbance, and typical disturbance events such as a 20 year high flow can have impacts beyond what would be expected in the historic condition (Rife and Haskins 1998). Channelization and constriction of Nason Creek for high way and railroad placement have led to changes in peak flow timing and duration and down cutting of the streambed in the lower reach (USFS 1996, Andonaegui 2001). Other impacts include meanders into oxbows, increasing flow velocities, and floodplain isolation (USFS 1996; Andonaegui 2001). Elevated instream temperatures in lower Nason Creek during summer months have been recorded.

Due to extensive floodplain development, much of it on private land, riparian reserves are poor condition in Nason Creek below Whitepine, and in Kahler, Gill, Roaring, and Coulter Creeks. Nason riparian condition above Whitepine is considered to be fair, due to streambank and floodplain alterations on private land, as well as floodplain and bank impacts of railroad, high way, and powerlines. There is potential for further development along some of the riparian area near Yodelin on private property (USFS 1998).

Stream Channel Conditions and Function

Fine Sediment and Channel Stability

A significant proportion of banks in low gradient reaches upstream of the Whitepine confluence (RM 14.6) have been riprapped. Bank vegetation and natural bank processes such as channel migration have largely been eliminated (USFS 1998; Andonaegui 2001). McNeil core sediment samples taken in the lower 5 mi. of Nason Creek exceeded USFS forest plan standards. Samples indicate that the sediment is out of balance and the channel bed is in poor condition (USFS 1998; USFWS 1998). Harvest-related landslides like the large 1990 slide across from Mill Creek, and other human-related sediment sources from development like the high way, may contribute sediment above historic levels from the Nason mouth to Stevens Creek. This reach is in poor condition with high amounts of fine sediment (Rife and Haskins 1998; Andonaegui 2001). The only Nason Creek tributary for which McNeil core information is available is Kahler Creek. Kahler is in poor condition with high amounts of fine sediment (Rife and Haskins 1998).

Stream surveys indicate that Mill, Stevens, Gill, Butcher, and reach 2 of Roaring creeks have elevated sediment levels and are in fair instead of good condition. Smith Brook has abundant fine sediment in any area with lower gradient but this seems to be a natural condition since there has been very little land management or roading within the drainage. Therefore the reach is considered to be natural and in good condition (USFS 1998).

The lower 15 mi. of Nason Creek has little LWD. The channel Does not appear to retain LWD as floods within the confined channel cannot dissipate energy (Rife and Haskins 1998). Recruitment of LWD from some tributaries into Nason Creek is limited by the railroad grade and culvert crossing near tributary confluences (Andonaegui 2001). Mill, Roaring, and Kahler creeks contain marginal LWD counts (Rife and Haskins 1998).

Habitat Diversity

Nason Creek below Smith Brook is in poor condition because of extensive loss of off-channel habitat. Nason Creek above Smith Brook is in fair condition for off-channel habitat because of some degradation (Rife and Haskins 1998). Although off-channel loss has been most severe in the lowest 15 mi. of Nason Creek, it has been significant in all areas of unconfined channel, including upper Nason Creek (USFS 1998; Andonaegui 2001). All of the Nason tributaries are in good condition for off-channel habitat (Rife and Haskins 1998).

Nason Creek floodplain connectivity above Whitepine is fair. Some channel confinement by high way, railroad, and floodplain development has reduced connectivity. Nason Creek below Whitepine is in poor condition resulting from these same factors. The rest of the watershed is considered to be in good condition (USFS 1998).

Water Quality

Temperature

WDOE 1998 303d lists includes Nason Creek from the mouth to Lake Valhalla. Elevated stream temperatures during summer in Nason Creek below Whitepine create poor fish habitat conditions. Nason Creek stream temperatures between Whitepine and Stevens are fair; any slight temperature increase here could have serious consequences downstream. Gill Creek temperatures are also considered fair. No temperature data is available for Kahler Creek, but summer temperature conditions are considered fair because of reduced riparian canopy. Mill Creek, Smith Brook and Whitepine creeks may be functioning appropriately for temperature (Rife and Haskins 1998). Elevated instream temperatures in upper Nason Creek are also a concern given the degraded condition of riparian habitat associated with high way riprap and riparian vegetation removal (Andonaegui 2001).

Oxygen and Turbidity

Hindes (1994) reported that 3 of 20 values of dissolved oxygen, and 1 of 20 of pH, turbidity, and water temperature failed to meet state water quality standards in Nason Creek at Nason Creek Campground. At an upper Nason site near Berne downstream of Henry Creek, 5 of 20 DO readings and one pH reading failed to meet state water quality standards. Fecal coli form was present in most water samples at both sites, but not at levels that exceeded state water quality standards. The watershed as a whole is functioning at risk for chemical contamination based on the 1994 Hindes report (Rife and Haskins 1998).

Water Quantity

Peak Flow

The WDOE 1998 303d list did not include water quantity concerns for Nason Creek. USFS 1998 evaluations noted that the combination of channel confinement, increased drainage network, road densities, and timber harvest has likely altered timing of flows within the watershed. Therefore Nason watershed is in poor condition related to peak/base flows (Rife and Haskins 1998).

Low Flow

There are 27 surface water rights permits or certificates worth a potential total diversion of 3.5 cfs. There are 35 surface water rights claims worth a potential total diversion of 6.8 cfs. There are 3 pending application for a surface water rights permits, certificates, or claims worth 0.9 cfs. There are 11 ground water rights permits or certificates worth a potential total withdrawal of 770 gpm. There are 22 ground water rights claims worth a potential total withdrawal of 270 gpm. There are 6 applications for ground water rights permits, certificates or claims pending worth a potential total of 2,555 gpm (Montgomery et al. 1995; Andonaegui 2001). The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time.

Obstructions to Fish Passage

Obstructions to fish passage are located throughout much of Nason Creek and its tributaries. Most of these are culverts. Important fish habitat is blocked due to the transportation system along much of Nason Creek.

Ecological Conditions

Brook trout were planted in some of the lakes within the watershed. Brook trout are known to out-compete and cross breed with bull trout, eliminating the genetically pure bull trout population (USFS, 1996). Stocking of non-native rainbow and brook trout may have displaced westslope cutthroat from some historical habitat. Planting native westslope cutthroat in high lakes has also likely expanded the range of the species. Brook trout may displace cutthroat from reaches with moderately elevated water temperatures and gradients below 7%. This displacement could fragment the population. (Rife and Haskins 1998). Cold water temperatures in the head water drainages may prevent genetically non-native rainbow from competitively displacing cutthroat in this habitat (Rife and Haskins 1998). The Yakama Nation is attempting to reintroduce coho into the Nason Creek watershed by out-planting hatchery reared pre-smolts (Peven 2003). Salmon carcasses were distributed in the watershed in 2002 and 2003 (Cooper 2002; Cooper 2003). Nason Creek above Smith Brook is important westslope cutthroat habitat (Rife and Haskins 1998).

Environmental/Population Relationships

The baseline condition of Nason watershed indicates significant environmental degradation. There is significant risk to chinook, steelhead, and bull trout habitat and populations in the watershed (Rife and Haskins 1998).

Late-run chinook do not occur in the watershed (Andonaegui 2001). Spring chinook, steelhead, bull trout, cutthroat and redband trout spawn and rear in Nason watershed (Rife and Haskins

1998, Andonaegui 2001). Whitefish, dace, and sculpin species are also present in the watershed (Rife and Haskins 1998).

The significance of the Nason Creek watershed lies in its potential contribution to Wenatchee subbasin spring chinook production and its connectivity to upper subbasin salmonid populations, particularly bull trout (Andonaegui 2001).

Key spring chinook and bull trout habitat are in poor condition in this watershed. All chinook spawning habitat lies in a reach in which every kind of habitat measurement has been reduced to fair or poor condition (Rife and Haskins 1998). All known bull trout spawning lies in a sub watershed in which many habitat conditions are poor. Little is known about steelhead spawning, but natural passage barriers confine it to the mainstem below Smith Brook and the lower ends of several tributaries. All of these channels have at least some habitat conditions reduced to fair condition. Chinook spawning appears to be confined to the mainstem below Whitepine Creek. All of this habitat has been degraded to some degree, reducing the chance to support a strong and significant chinook population. Chinook redd counts have fallen sharply since the 1950s, with an even more definite down ward trend than in neighboring watersheds. Bull trout redd counts in the watershed range from 1to 3 redds. No data is available on steelhead redds. (Rife and Haskins 1998). All spring chinook spawning and rearing habitat in the watershed is in Nason Creek below RM 16.8 where Gaynor Falls creates a natural barrier to upstream passage for chinook and sockeye (Andonaegui 2001).

Areas of Special Interest

- Remaining functioning floodplain and riparian habitat is the first priority in the Nason Creek watershed (Andonaegui 2001; Upper Columbia RTT 2002).
- Oxbows separated from the mainstem in the lower three mi. of Nason Creek.

Limiting Factors

- Channel migration is limited, and channel structure is simplified (Upper Columbia RTT 2002; Andonaegui 2001)
- Lost fish passage from the wetlands and oxbows to Nason Creek because of State Hwy. 2 placement from Whitepine Creek (RM 14.6) downstream to Kahler Creek at RM 5.1 (Upper Columbia RTT 2002; MCMCP 1998; Andonaegui 2001)
- Obstructions to Tributary and obstructions in the tributaries.Sediment delivery from roads and minimize road building (USFS 1996; Andonaegui 2001)
- Canopy loss on harvested upland habitat (Andonaegui 2001)
- Brook trout interactions (competition and predation).

Data Gaps

Andonaegui (2001) identified the following data gaps:

- The cumulative effects of timber harvest, development, and road densities on sediment delivery, LWD levels, and stream channel function.

- Opportunities to and benefits of restoring disconnected oxbows given the existing limitations presented by the existence of the railroad grade and state high ways 2 and 207.
- Population estimates and distribution of bull trout and cutthroat trout remains undermined.

Functional Relationship of Assessment Unit with Subbasin

Nason Creek is a Category 2 watershed (see Determination of Restoration Priorities in Section 6.5) and has 3 significant sub- watersheds: lower Nason, upper Nason, and head waters of Nason. Nason Creek is a Category 2 watershed based on fragmentation and habitat degradation, especially in the lower watershed (Upper Columbia RTT 2002). It provides spawning and rearing habitat for steelhead, and habitat for listed spring chinook and bull trout. Bull trout, summer steelhead and spring chinook are listed fish still able to access this watershed. Connectivity among sub watersheds still exists, although the amount of habitat available compared to historic conditions is limited.

4.9.10 Little Wenatchee River Assessment Unit

Assessment Unit Description

The Little Wenatchee River is a 4th order stream draining a 64,794 acre watershed. It is fed by four large tributaries: Rainy, Lake, Fish, and Cady creeks (Andonaegui 2001). The head waters of the Little Wenatchee River are at lower elevation than the White River, with more lakes and fewer glaciers. Elevation in the watershed varies from 1,868 ft at the lake inlet to 6,577 ft. at Longfellow Mountain. There are 13 lakes with a total area of 232 acres in the drainage (Andonaegui 2001, Raekes 2004). The Little Wenatchee River flows southwest 25 mi. and empties into Lake Wenatchee. The majority of precipitation falls during the winter months as snow, while localized high intensity thunderstorms during summer also accounting for some precipitation. Annual precipitation varies from 30 in. at the lake to 90 in. in the head waters of the Little Wenatchee River. Runoff peaks during late May and early June as snowmelt progresses. The Little Wenatchee River watershed contributed 15% of the annual flow to the Wenatchee River for the period October 1992 to September 1993 (Andonaegui 2001; CCCD 1996).

Of the total acreage in the drainage, 97% is publicly owned and 3% is in private ownership, all in the lower three mi.. Road densities are higher in the lower portions of the drainage from Lake Creek (RM 13.1) to the mouth (USFS 1998). In Rainy Creek and other managed sub watersheds of the Little Wenatchee, debris flow frequency appears to have been accelerated above background levels (Andonaegui 2001; USFS 1998).

The main channel forming processes in the Little Wenatchee watershed are glaciation and seasonal runoff. The watershed is characterized by steep valley head walls, cirques and cirque head walls which are typically bare rock or thinly soiled. The valley bottom is covered by a layer of glacial till with alluvial fans formed at the confluence of tributaries. This land type generally has a high subsurface water storage capacity and is commonly subject to inundation during high flow events. In sections where the stream is actively migrating across its floodplain, bank erosion is common and expected at meander bends. Stream migration naturally occurs in the lower river where the valley bottom is low gradient and wide, the substrate is glacial till, and channels have naturally high sinuosities (Rosgen C type channel) (Andonaegui 2001; USFS 1998). The lower

1.3 mi. of the river are heavily influenced by the back water effects from Lake Wenatchee and have remained relatively stable (Andonaegui 2001; USFS 1998). Most of the land in the watershed is designated wilderness.

Assessment Unit Condition

The Little Wenatchee River is among the healthiest watersheds in the Columbia basin. Several moderate habitat concerns, however, exist (Andonaegui 2001, USFS 1998). Most of the concerns occur in and below areas of extensive timber harvest ;Andonaegui 2001, USFS 1998). Most timber harvest in the Little Wenatchee River corridor has occurred from the mouth upstream to Cady Creek (RM 0.0 - 16.9) and the Rainy Creek drainage. Where harvest and roading have occurred, the potential for LWD input has decreased. Increased sediment delivery and disruption debris slide delivery is also expected. Moderate road densities of 2.4 mi./sq. mile and harvest activities may also contribute to high stream temperatures in the mainstem by increasing runoff and decreasing water storage potential (Andonaegui 2001).

Rainy Creek enters the mainstem at RM 8.4 above the falls (RM 7.8). It is the only tributary known to support bull trout, although there is a natural barrier on Rainy Creek at RM 5.5. There is also a barrier falls on the Little Wenatchee River that blocks anadromy. Rainy Creek is a high energy transport stream with steep gradients and a boulder/cobble bed alternating with bedrock. Over the millennia, a large fan has accumulated at the mouth of Rainy Creek. The channel pattern on the fan has gone from three wetted channels down to one entrenched channel. It is unclear what effect land management practices have had on debris slide regimes and channel form on the fan (Andonaegui 2001; USFS 1998). A bridge was constructed near the mouth, and USFS Road 6700 follows the creek up to its head waters crossing the stream three times.

Recreation including hiking, horse-riding, camping in developed campgrounds, and dispersed camping occurs throughout the Little Wenatchee watershed. Cross country ski and snowmobile routes are not groomed and use is limited to those looking for more primitive opportunities. There are no designated Off Road Vehicle opportunities in the watershed.

Coho are being reintroduced at the Two Rivers side channel (Peven 2003). Salmon carcasses were not distributed in 2002 or in 2003 (Cooper 2002; Cooper 2003). In general, roads, campgrounds, and private lands allow humans to access and potentially disturb fish, however the actual disturbance level is low.

Riparian/Floodplain Condition and Function

Riparian Condition

In the Little Wenatchee watershed, there are 29.3 mi. of road within 300 ft. of a stream (USFS 1998). Road densities in the lower Little Wenatchee sub watershed (RM 0.0 - 11.9) and the upper Little Wenatchee sub watershed (RM 16.9 to the head waters) are both 2.4 mi./sq. mile (Andonaegui 2001; USFS 1998). This road density is moderate in comparison to NOAA Fisheries habitat standards.

Some riparian harvest has occurred along the mainstem and contributes to lowered LWD levels. Harvest also possibly contributes to elevated instream temperatures measured at the mouth (Andonaegui 2001, USFS 1998). Before 1985, most timber harvest units on USFS lands left no riparian buffer on the upper reach from RM 16.9 to the head waters, the lower reach from RM

0.0 to RM 11.9 and in Rainy Creek (Andonaegui 2001, Driscoll et al. 1998). There are some clear-cuts directly adjacent to the creek where grazing and watering occurs near the head waters and tributary channel on the south side of Rainy Creek (Andonaegui 2001; Driscoll et al. 1998). On a watershed wide basis, the length of disturbed channel is minimal. USFS analysis considered effects on fish habitat relative to shade reduction and found effects to be discountable (Andonaegui 2001). Overall, the riparian corridor is in good condition.

Stream Channel Conditions and Function

Channel Condition and High Flow

The lower river has high width-to-depth ratios, a possible indicator of a high sediment load. Other indicators of high sediment load in the low gradient reaches include high apparent embeddedness in pool tail outs, apparent filling of some pools, and extensive bar development (MacDonald et al. 1998).

In the vicinity of the Riverside campground near a dispersed campsite at RM 7.8, both banks of the river have been riprapped for structure protection at the bridge and as a result of flood damage on the opposite side of the old campground . Riprap is not considered to have a measurable affect on the reach. Overall floodplain function within the watershed is in good condition (Andonaegui 2001; Driscoll et al. 1998).

Fine Sediment and Channel Stability

Analysis of historical aerial photographs in the USFS biological assessment concluded that depositional reaches of the Little Wenatchee River between RM 1.3 and 3.5 may be at risk for increasing width-to-depth ratios. There was evidence of pool filling and spawning gravel embeddedness upstream of the falls at RM (7.8) during the 1997 USFS stream survey (Andonaegui 2001; Driscoll et al. 1998).

In some surveyed reaches, however, there is not enough information to determine if fine sediment is a concern (Andonaegui 2001).

Habitat Diversity

During the 1970s, biologists were concerned that large LWD complexes created fish passage barriers in the lower few mi. of the river. They made several attempts to remove the complexes, although wood kept accumulating in the same locations (Andonaegui 2001; Mullan et al. 1992; USFS 1998). A stream survey conducted in 2000 concluded that LWD levels below RM 7.8 had good quantities of large wood present in the channel (Andonaegui 2001). All streams in the watershed appear to be within the range of natural conditions for pools . Pool depth and pool quality is considered appropriate for streams in the drainage (Andonaegui 2001; Driscoll et al. 1998).

Water Quality

Temperature/Oxygen/Pollutants

The Little Wenatchee River below Theseus Creek (RM 11.5) does not meet state and forest plan water quality standards during the summer months for temperature (Andonaegui 2001, Driscoll et al. 1998). water temperature exceeded 61°F for several weeks in August 1997 and exceeded 61°F in 4 of 5 recorded years (Andonaegui 2001; Driscoll et al. 1998). Because the water temperature exceeded criteria on numerous sampling occasions, the Little Wenatchee River is included on the WDOE 1998 303d list for water quality concerns. Other than sediment concerns, the Little Wenatchee is not listed for oxygen or pollution concerns.

There is insufficient data to determine if these temperatures are significantly different than temperatures in the historic range or to what extent they negatively impact salmonid migration, spawning, incubation or rearing. The USFS has initiated an analysis of instream temperatures on the river to evaluate the effects on salmonids (Andonaegui 2001).

On Rainy Creek multiple visual estimates of embeddedness below the natural falls barrier at RM 5.5 increased in volume by 35%. High and possibly accelerated rates of debris flows, extensive timber harvest, and road placement may result in accelerated sediment delivery to the stream (Andonaegui 2001; Driscoll et al. 1998). Road densities in Rainy Creek are 1.5 mi./sq. mile (Andonaegui 2001; USFS 1998). There are also some clearcuts adjacent to the creek where grazing and watering is allowed near head waters and mid slope at tributary channels on the south side of Rainy Creek. These were documented during USFS 1998 photo monitoring. Based on 1998 monitoring, the USFS determined that sediment impacts from soil disturbed by grazing may contribute slight but measurable amounts of fine sediment to the channel system. The USFS has also determined this is not significant on a reach basis (Andonaegui 2001; Driscoll et al. 1998).

Water Quantity

Low Flow

The WDOE 1998 303d list Does not include water quantity concerns for the Little Wenatchee River.

Annual flow records in watershed have not been recorded until recently. Some reviewers think the river flows may be altered from historic condition because of substantial road network and timber harvest below the wilderness boundary (approximately RM 9.5). (Andonaegui 2001; Driscoll et al. 1998).

There are no known areas of de watering, natural or human-induced, in the drainage (Andonaegui 2001).

There are 3 surface water rights permits or certificates worth a potential total diversion of 1.0 cfs. There are no surface water claims or applications. There are no ground water rights permits, certificates, claims or applications (Andonaegui 2001; Montgomery Water Group et al. 1995). The limited extent of potential water diversions described above Does not have the ability to change the flow regime of the mainstem or tributaries (Andonaegui 2001).

Obstructions to Fish Passage

There are no anthropogenic fish passage barriers in the Little Wenatchee watershed (USFS 1998).

Ecological Conditions

Brook trout and non-native rainbow trout have been introduced in the Little Wenatchee watershed and occur above the falls at RM 7.8. Brook trout occur throughout the mainstem to

Meander Meadow and in Rainy Creek. Potential hybridization of bull trout with introduced brook trout is a concern (Driscoll et al. 1998).

Cold water temperatures in the head water drainages may prevent non-native rainbow from competitively displacing cutthroat in this habitat. Twin Lakes serves as a strong genetic refuge for westslope cutthroat trout and is used for high lake stocking programs which could help assure persistence. Although rainbow stocking has ceased in streams, non-native rainbow are present and are still planted in some high lakes (Driscoll et al. 1998).

Environmental/Population Relationships

The Little Wenatchee watershed contains some of the best aquatic habitat and strongest native fish populations remaining in the upper Columbia River ESU (Berg and Lowman 2001; USFS 1998). The connectivity to the rest of the subbasin, including the large, un-dammed Lake Wenatchee, adds to the potential regional importance (Berg and Lowman 2001).

Spring chinook and steelhead trout spawn and rear in the river upstream to the falls (RM 7.8), with the primary spawning area for spring chinook between RM 2.7 and RM 7.8 (Andonaegui 2001, USFS 1998). Chelan PUD spring chinook redd counts from 1958 to 1999 showed the watershed contained 7% of the total number of redds counted in the Wenatchee subbasin for that period (Andonaegui 2001). Genetically "good" redband trout have been documented below Little Wenatchee falls. Above the barrier falls, native westslope cutthroat trout, introduced rainbow trout, and introduced brook trout are found (Driscoll et al. 1998). There has been extensive planting of rainbow and brook trout in most lakes and streams in the drainage. Brook trout have become well established in the lower river, Rainy Creek and other streams in the drainage (Andonaegui 2001; USFS 1998).

The lower 8 mi. of the river is one of two main spawning areas for the Lake Wenatchee sockeye run, the other being the lower White River (Andonaegui 2001; MCMCP 1998; USFS 1998). The lower Little Wenatchee River below the falls (RM 7.8) provides important spawning habitat for approximately 25% of the Lake Wenatchee sockeye salmon run. There is spawning and rearing of adfluvial bull trout in the river below the falls (Andonaegui 2001; USFS 1998).

Areas of Special Interest

- After the White River, the Little Wenatchee provides the remainder of sockeye spawning habitat in the subbasin.
- Bull trout and spring chinook successfully spawn and reproduce in the Little Wenatchee.

Limiting Factors

Competition and Predation by brook trout in the upper watersheds of the Assessment Unit

Data Gaps

In some surveyed reaches of the Little Wenatchee River, there is not enough information to determine if fine sediment is a concern (Andonaegui 2001).

Data gaps identified in the watershed Analysis (USFS 1998) include:

- Need better fish population and community composition data.

- Need complete fish distribution presence and absence information throughout watershed.
- Need data on nongame fish.
- Need to determine the where and why of Little Wenatchee River temperature concerns.
- Need better temperature and sediment data for Rainy Creek.
- Need more information on bull trout populations throughout watershed.
- According to the 1991 USFS stream survey report for Rainy Creek, visual estimates showed a high percent embeddedness below the barrier falls (RM 5.5). High and possibly accelerated rates of debris flows from a 1996 slide survey, extensive timber harvest, and road placement may result in accelerated sediment delivery to the stream (Andonaegui 2001; Driscoll et al. 1998). Road densities in Rainy Creek are 1.5 mi./sq. mile (Andonaegui 2001; USFS 1998). It is the opinion of the TAC, however, that in the past 10 years much could have changed and a more current review and analysis of sediment conditions in Rainy Creek is needed (Andonaegui 2001).

Functional Relationship of Assessment Unit with Subbasin

The Little Wenatchee River is a Category 1 priority watershed (see Determination of Restoration Priorities in Section 6.5) and 5 significant sub- watersheds. It provides spawning for spring chinook, and is one of two rivers in the subbasin in which sockeye spawn. The subbasin provides habitat for the listed spring chinook, bull trout, and for some steelhead.

4.9.11 White River Assessment Unit

Assessment Unit Description

The White River is a 5th order stream and relative to flow, one of the two primary tributaries (USFS 2004). (The Little Wenatchee River is the other tributary.) The drainage encompasses 99,956 acres and originates in alpine glaciers and perennial snow fields. Many White river head water sources are at higher elevation than the highest elevation in the Little Wenatchee drainage. Longfellow Mountain at 6,577 ft.. Elevation in the White River drainage varies from 1,868 ft at the lake surface to 8,575 ft at Clark Mountain (Andonaegui 2001; Raekes 2004). The White receives more precipitation, and sustains higher summer flows and cooler summer temperatures than the Little Wenatchee. Precipitation ranges from 30 in. at the mouth to more than 140 in. in the head waters (Andonaegui 2001).

The White River flows south-southeast for the majority of its length (26.7 river mi.). Two large tributaries, Napeequa (RM 11.0) and Panther (RM 13.1) creeks, support anadromous salmonids. Sears (RM 7.7) and Canyon (RM 10.0) creeks, two smaller tributaries to the mainstem, support bull trout only (Andonaegui 2001; Mullan et al. 1992).

Of the total acreage in the drainage, 78% is in public ownership and 22% in private ownership, all in the lower third of the river below Panther Creek (USFS 1998, Andonaegui 2001). Over half of the watershed is contained within wilderness (USFS 2004). The upper 15 mi. of the White River are located entirely within the Glacier Peak Wilderness (Andonaegui 2001).

Alpine glaciation carved out classic U-shaped valleys in the Napeequa and White Rivers. As a result of glaciation, the main drainages have a thick mantle of till on valley walls. Where glaciers overrode ridge tops, minor till may be present in thin lenses and pockets, but much of the landscape has been scoured to bedrock (USFS 1998; Raekes 2004). While upper slopes may be devoid, valley bottoms are filled with glacial till in the form of lateral moraines and glaciofluvial out wash. Glaciofluvial out wash is particularly noticeable on the mainstem below Panther Creek. Here large floodplains with high water tables and broad riparian zones dominate the landscape. Bank erosion is common at bends as the stream actively meanders across the floodplain (USFS 2004).

Assessment Unit Condition

The White River drainage is among the healthiest in the Columbia basin. Several habitat concerns, however, exist (USFS 1998; Andonaegui 2001). The mainstem below the wilderness boundary has had some alteration and consequently many habitat indicators exist in only fair condition. The most altered area is in the lower watershed below Panther Creek. Changes have resulted from floodplain development and impacts on riparian areas from historic cedar logging and roading. On private lands development of homes and vacation retreats is occurring (USFS 2004).

The mainstem below White River Falls is a key spawning and migration corridor for spring chinook salmon, sockeye, and bull trout. (USFS 2004). Four tributaries entering the White River below RM 13 support chinook salmon, steelhead or bull trout. The tributaries are Panther Creek (RM 13.1), Napeequa (RM 11.0), Canyon Creek (RM 10.0), and Sears Creek (RM 7.7). Only the Napeequa River has had some stream channel alteration in its lower two mi. where the drainage flows west through a widening valley into the very broad floodplain of the White River (Andonaegui 2001). Channel degradation from riprapping and vegetation removal is 4% of the streambank. The degradation is considered minor, and overall, the Napeequa River is in good condition.

The watershed above Panther Creek is functioning appropriately for all habitat indicators except LWD in Reach 1 of Indian Creek where historic cedar log drives originated. Despite historic floodplain conversion and development, high quality habitat and connectivity remains among White River, Panther and Napeequa populations. Increasing floodplain development in the privately owned lower valley continues to be of concern for off-channel habitat, refugia, streambank condition, floodplain connectivity, riparian reserves, LWD, and road density/location (USFS 2004).

Under the current program the Yakama Nation is not actively reintroducing coho into the White River Watershed, but as the program expands into the future, active reintroduction remains a possibility. (Murdoch 2004). Salmon carcasses were not distributed in the WAtershed by the USFWS in 2002 or 2003 (Cooper 2002; Cooper 2003).

Riparian/Floodplain Condition and Function

White River drainage has had minimal riparian harvest from the 1950s to the present on federal land. Turn of the century settlement and land clearing, however, has impacted the riparian reserve network up to Napeequa confluence. Riparian condition in the mainstem below Panther Creek is fair (USFS 2004). In the remainder of the watershed, woody debris recruitment, shade, aquatic habitat connectivity, and riparian vegetation appear to be in natural condition, and are in good condition (USFS 2004).

Disruption of the vegetative continuity along riparian areas is a result of site conversion on both private and public lands, grazing, and road building. Noxious weeds in riparian areas are also a concern and are found in most accessible riparian areas (USFS 2004).

Land development in the lower mainstem has reduced some floodplain function. The greatest future threat to salmonid production is additional floodplain development. Additional development could restrict lateral channel migration, connectivity with associated wetlands, side channel development, and LWD input. Off-channel habitat is fair in the watershed below Panther Creek and good for the remainder of the watershed, including Panther, Indian, and Napeequa tributaries (USFS 2004).

Although the Forest Service, WDFW, and Chelan-Douglas Land Trust have combined efforts in recent years to improve floodplain function in the lower mainstem, to date changes have been minor. Therefore floodplain function below Panther Creek is still in fair condition (USFS 2004).

Roads in riparian areas also contribute to loss of riparian habitat function downstream of RM 11.0 (Andonaegui 2001). Nearly half of the road mi. are located in this floodplain (Driscoll et al. 1998; Andonaegui 2001).

Concerns are related to access, recreational use, and resulting disturbance to sites including, but not limited to, snag falling, canopy openings, compaction, and reduction in amount of course woody debris (USFS 2004). In addition, concerns regarding the reduction of floodplain connectivity, reduced channel migration with a subsequent reduction in LWD input, and reduced shade related to Napeequa campground (RM 11.0) exist (Andonaegui 2001).

Stream Channel Conditions and Function

Channel Condition and High Flow

Both the White River and lower Napeequa River have sections of riprap and bank erosion associated with roads, bridges, dispersed recreation, and other development. Two notable locations include the streambanks on private land adjacent to the White River Bridge on the Little Wenatchee road, and riprap sections between Napeequa campground and the Napeequa River. During two record flood events in 1990 and 1995/96, two sections of FS 6400 below Panther Creek confluence were washed out and subsequently reconstructed. One segment was relocated further from the river, the other county road portion was reconstructed in place with riprap on the banks. The individual riprap sites restrict stream function. These hardened locations, however, are a fraction of the entire streambank length.

There are short sections of riprap and/or bank erosion associated with roads, bridges, dispersed recreation, or other development along the lower Napeequa River, the largest tributary to the White River. Bank disturbance totals 4% for the lower two miles. of Napeequa surveyed in 1996 (MacDonald et al. 1996). These individual sites are not considered to reduce the systems functionality overall. Overall streambanks are in good condition (Andonaegui 2001; Raekes 2004). With most of the riparian, floodplain, and channel condition in good or fair condition, high flows are not a concern in the watershed.

Fine Sediment and Channel Stability

There are no apparent concerns with fine sediments or human-induced channel incision in the river. The White and Napeequa rivers are glacial and transport glacial flour in the summer. Because both the White and Napeequa, upstream of the sediment sampling locations, flow through wilderness or largely unmanaged watersheds, fine sediment appears to be due to natural processes. Fine sediment levels are in good condition. All streams in the watershed are good condition in terms of pool depth and pool quality (USFS 1998; Andonaegui 2001; Raekes 2004).

Habitat Diversity

The White River still maintains high quality, complex habitat with refuge and rearing habitat for multiple life stages and life histories. The watershed is also well connected to adjacent high-quality habitats in Lake Wenatchee and the Chiwawa River that provide refuge during disturbance events. The floodplain condition is in good condition.

Water Quality

Temperature

Since 1995, the White River has been the coldest stream monitored in the Wenatchee subbasin (USFS 2004). Andonaegui (2001) indicated that there are no apparent concerns with waters temperatures.

Oxygen/Pollutants

The WDOE 1998 303d list did not include water quality concerns for the White River. The Forest Service (USFS 2004) rates the water quality in good condition.

Water Quantity

Low Flow

The WDOE 1998 303d list did not include any water quantity concerns for the White River. There are no known areas natural or human-induced de watering in the drainage (Andonaegui 2001). There are 9 surface water rights permits or certificates worth a potential total diversion of 0.9 cfs. There are 5 surface water rights claims worth a potential total diversion of 3.4 cfs. There is one pending application for a surface water rights permit, certificate, or claim worth 0.1 cfs. There is 1 ground water rights permit or certificate worth a potential total withdrawal of 350 gpm. There are 2 ground water rights claims worth a potential total withdrawal of 18 gpm. There is 1 application for a ground water rights permit, certificate or claim pending worth a potential total of 661 gpm (Montgomery Water Group et al. 1995; Andonaegui 2001). The limited extent of potential water diversions and withdrawals described above Does not have the ability to change the flow regime of the mainstem or tributaries (Andonaegui 2001).

Obstructions to Fish Passage

Although fish passage is good overall, there are three culverts that block passage. These barriers are located on the 6403 Road system at milepost 0.3 and 0.7 where 0.75 mi. of habitat for westslope cutthroat trout is blocked, and on the 6404 Road system at Sears Creek, where 1.5 mi. of habitat is blocked for juvenile and adult bull trout, and steelhead (USFS 2004).

Ecological Conditions

Connectivity among sub watersheds and through the mainstem river corridor is good. Three species of federally listed fish occur: spring chinook, bull trout, and summer steelhead. Brook trout are present but are not dominant (USFS 2004). Westslope cutthroat trout occur in the watershed. Much of the subbasin flow in late summer months comes from the Napeequa and White rivers.

Environmental/Population Relationships

Spring chinook and steelhead subpopulations are low for all indicators. Bull trout are in fair condition for subpopulation size. Westslope cutthroat and bull trout are good condition for three of four subpopulation indicators. Westslope cutthroat are in fair condition for life history diversity (USFS 2004).

Loss of floodplain function on the White is the greatest threat to salmonid production in the watershed. The connectivity between this watershed and other good aquatic habitat in the subbasin is good. The sockeye run, the majority of which spawns in the White, is one of the strongest remaining in the lower 48 states. The run is only one of two sockeye runs remaining in the Columbia basin. Spring chinook and bull trout also spawn and rear in the mainstem. Much of the reason for the high aquatic health is that depositional reaches near the mouth are structurally complex. Both meandering channels and broad, wetland-filled floodplains remain largely undeveloped and retain their function, despite some development and considerable private land ownership (Andonaegui 2001).

Areas of Special Interest

Stream channels, floodplain, and riparian function on the lower White River from the Panther Creek confluence downstream to the mouth are in fair to good condition and important habitat for the subbasin between RM 0.0 and 13.1 (MCMCP 1998; Andonaegui 2001; Upper Columbia RTT 2002).

Analysis has determined that the White River spring chinook are genetically distinct.

Limiting Factors

- Wetland complexes in lower watershed could have better connectivity to the stream channel (Upper Columbia RTT 2002; Andonaegui 2001).
- Competition and Predation by brook trout in the upper watersheds of this Assessment Unit.

Data Gaps

- Field habitat inventory and analyses are incomplete on private lands (Andonaegui 2001).
- Population abundance and distribution of Bull Trout and Cutthroat Trout is yet to be determined.

Functional Relationship of Assessment Unit with Subbasin

The White River is a Category 1 priority watershed (see Determination of Restoration Priorities in Section 6.5) and has 5 significant sub watersheds. It provides the most spawning for sockeye salmon spawning in the subbasin, as well as habitat for the listed spring chinook, bull trout, and possibly for some steelhead.

4.9.12 Chiwawa River Assessment Unit

Assessment Unit Description

The Chiwawa River originates from 5 glaciers on the southwestern slopes of the Entiat Mountains and flows southeasterly for 37 miles to its confluence with the Wenatchee River near the town of Plain. The Chiwawa River is a 5th order stream, contributing approximately 15% of the Wenatchee Rivers mean annual flow (Andonaegui 2001; Haskins 1998).

The watershed occupies 117,000 acres draining from north to south. Eleven percent of the watershed is privately owned with most of the private land occurring below RM 4.0. Of the 89% public ownership, approximately 31% is designated as wilderness (Andonaegui 2001). Elevation varies from 1,850 ft. at the mouth to 9,082 ft. at Mt. Maude. Annual precipitation in this watershed varies from 30-140 in. Most of the watershed is in public ownership, with private land use being more prevalent downstream of Chikamin Creek (Andonaegui 2001). Much of the upper Chiwawa watershed is nearly pristine because most human use has not altered ecological functions. Accordingly, the upper Chiwawa provides some of the best spring chinook and bull trout habitat in the Wenatchee subbasin.

The Chiwawa valley is U-shaped, with glacial till deposits on the lower side walls and steep bedrock slopes. The side walls have a dense network of parallel, incised first order streams and abundant precipitation in the form of snow. Debris flows are naturally frequent in this land-type, especially in conjunction with high precipitation, or rain-on-snow events. Because of the amount of bedrock, water storage capacity is limited; rain and snowmelt cause the stream to rise rapidly. Nevertheless, summer base-flows, with contributions from high altitude snow fields and glaciers, sustain salmon spawning throughout the late-summer and autumn months (Mullan et al. 1992).

Assessment Unit Condition

Overall, the Chiwawa watershed is in good condition. Development is minimal compared to most other watersheds in the Wenatchee subbasin and is constrained to the lower areas of the watershed. The lower Chiwawa River has several activities that can potentially influence watershed condition including: high road density, road location, private land development, forest practices, and a water diversion. Road concerns occur mainly in the lower mainstem and Meadow Creek. Road density is 3.8 mi/mi2 in the lower mainstem and is 3.7 mi/mi2 in Meadow Creek (USFS 1997).

Intensive logging has occurred in 15% of the watershed and typically has been carefully controlled (Mullan et al. 1992). Two 6th field watersheds in the lower Chiwawa have had 35% and 25% of their total acres harvested, respectively. Lands in these watersheds have either naturally regenerated or been planted with coniferous trees and do not measurably alter peak and base watershed flows (USFS 2004).

In the upper watershed, there is no indication that the frequency, size, or intensity of natural disturbance events has changed, other than alteration of the fire cycle through fire suppression.

Under the current program the Yakama Nation is not actively reintroducing coho into the Chiwawa River watershed, but as the program expands into the future, active reintroduction remains a strong possibility in the plan. (Murdoch 2004). Salmon carcasses were distributed in the watershed by the YN in 2000 and 2001 (K. Murdoch, YN, pers. comm.).

Riparian/Floodplain Condition and Function

Riparian Condition

Much of the Chiwawa River, especially the middle reach, meanders across a broad, unconfined, valley floor. Along the mainstem above Goose Creek, there is excellent floodplain connectivity. Below Goose Creek (RM 5.8), much of the channel is naturally confined by terraces created as climate changed after the last ice age. Glacial till provides excellent ground water storage in the valley, wetland habitat is abundant in impoundment stretches of the floodplain, summer baseflows are high relative to other geomorphic subsections on the forest, and ground water input helps moderate winter and summer water temperature extremes.

Even though alterations have taken place, the lower Chiwawa is considered fair for riparian condition. The riparian condition of Big Meadow, Brush, Clear, Deep, Goose, Elder, Alder, and Twin Creeks, is considered fair due to riparian roading and timber harvest. The proximity of roads and harvest units to stream channel reaches in these tributary drainages has resulted in some channel confinement, and possible increases in sediment delivery (USFS 2003). At the same time, these channels are lower in the watershed, located on comparatively mild topography where they receive less precipitation.

Shoreline habitat development with associated vegetation removal has occurred along segments of the mainstem from the mouth to RM 5.0, and near the confluence of Chikamin Creek at RM 13.8 (MCMCP 1998). Much of the shoreline development actually occurs on terraces above the reach of the floodplain for those developments occurring between RM 1.0 and RM 5.0 (USFS, pers. comm. date?). The channel is naturally less constricted from RM 0.0 to 1.0, and some simplification is observable. Overall, impacts to riparian characteristics and function are localized and not problematic on a watershed scale; (USFS 2003).

Probably the greatest human disturbance in the upper watershed is due to recreation facilities and campgrounds. At the watershed scale these occurrences are relatively minor. USFS management actions are being implemented to improve areas where issues have been identified.

Stream Channel Conditions and Function

Channel Condition and High Flow

Channel conditions for much of the upper Chiwawa are presumed to be near historic references since floodplain connectivity remains intact and channel condition has had only minor alteration. In the lower river, log drives occurred until the mid 1930s. Although channel conditions have repaired considerably since that time, some evidence of in-channel degradation remains. Most of the lower Chiwawa River is naturally contained by the landform and is therefore expected to contain less large wood than a channel at lower gradient flowing through loose gravel. Logging and roading activities have reduced levels of large wood within the following tributary streams: Brush, Clear, Deep, Goose, Elder, Alder, and Twin creeks (Haskins 1998).

Fine Sediment and Channel Stability

McNeil core sediment samples have been collected in mainstem Chiwawa from Grouse Creek to Rock Creek (RM 11.7 – 21.3) over the last decade. All of these reaches have fine sediment in excess of State Timber, Fish &Wildlife management recommendations. One reach fails to meet Wenatchee Forest Plan standards as well. Some of the sediment may result from recreation sites, although this has not been empirically demonstrated (USFS 2003). Sediment may also naturally occur above management recommendation levels. Because of uncertainty, sediment levels are considered fair instead of good.

Habitat Diversity

Chiwawa wetlands and off-channel habitat in the watershed are in good condition (USFS 2003). The valley floor has an extensive network of ponds, beaver canals, side channels, abandoned oxbows and other wetlands. Abundance, diversity, connectivity and quality of these wetlands is high (USFS 1997). The floodplain remains connected to the channel in the Chiwawa watershed (USFS 2003). In the upper Chiwawa, Forest Service Road 6200 parallels the Chiwawa and ends at private property on Phelps Creek at RM 30.7. The road minimally affects watershed condition and Does not constrain floodplain function. Road 6200 has simplified Rock and Chikamin Creek alluvial fans. Roads are also built on the private parcel near Phelps Creek to access a water diversion. Pool habitat is considered to be only fair in the lower main channel of Rock Creek and the lower Chiwawa.

Pool data has not been collected for Clear, Deep, Goose, Elder, Alder, and Twin creeks. The remainder of the watershed is in good condition for pool habitat (Haskins 1998).

Water Quality

Temperature

The Chiwawa River is a cold, low-conductive (35 µmhos) stream originating from snowfields and glaciers, which sustain flows through the late summer and fall (Mullan et al. 1992). In general, water quality is at or near pristine condition, however water temperatures at the mouth of Chiwawa River failed to meet USFS and State standards of 61 °F from 1992 to 1998. Stream temperatures typically reach the low to mid 60s°F, but have not exceeded 69°F (Andonaegui 2001). Cause for relatively high temperatures has not been determined although land use, channel type and channel bearing may play a role. Most tributary streams have little or no water temperature information on record (Haskins 1998).

Oxygen/Pollutants

Historic mining occurred in much of Chiwawa head waters; however no known chemical contamination has been documented. Some mine tailings in the Red Mountain and Trinity area remain unvegetated. There is no obvious contribution of fines from the mine tailing to streams (Haskins 1998). The WDOE 1998 303d list did not include any water quality concerns for the Chiwawa River

Water Quantity

Low Flow

Stream flow and total water yield or water quantity are considered to be at or near historic reference condition for most of the watershed. The WDOE 1998 303d list did not include any water quantity concerns for the Chiwawa River.

Two water diversions occur in the watershed. A six-foot wide Chiwawa Irrigation District canal diverts 12-16 cfs (limit 30cfs) from the Chiwawa River at RM 3.6. The diversion has little or no impact on fisheries (USFS 1997; CCCD 1998). It does, however, amount to approximately 25% of the average September flow in a drought year and approximately 13% of September flow in an average year (MCMCP 1998). The Trinity diversion Federal Energy Regulatory Commission (FERC) relicensing process is nearly complete and has been approved with specified mitigations. Withdrawals are not expected to harm spring chinook or bull trout using Phelps Creek (Lewis date?). There are 13 surface water rights permits, certificates, or claims located within the watershed filed with the WDOE (Andonaegui 2001).

Obstructions to Fish Passage

Fish passage throughout the Chiwawa watershed is considered to be good. A supplementation hatchery operated by Chelan County Public Utility District (PUD) is located at the mouth of the Chiwawa River. Fish passage is controlled with a weir at RM 8.0, but fish are able to migrate past it (Andonaegui 2001). Recent USFWS bull trout telemetry data suggests that the weir may discourage or delay some individual bull trout from migrating past the weir while it is operational (USFS 2003).

The Harza/BioAnalysts 2000 culvert survey identified other barriers on tributary streams. The results include: Clear Creek has one fish passage barrier culvert at RM 0.5. Deep Creek has six fish passage barrier culverts beginning at RM 0.4. Alder Creek has one fish passage barrier culvert located at RM 0.9. Goose Creek has two fish passage barrier culverts beginning at RM 0.4. Minnow Creek has one fish passage barrier culvert at RM 0.4.

Ecological Conditions

Ecological conditions are good overall in the Chiwawa River. The watershed is characterized by a diverse and strong fish community (Andonaegui 2001). The USFWS distributed salmon carcasses in the watershed in 2002, but not in 2003 (Cooper 2002; Cooper 2003). One of the greatest threats to bull trout populations in the upper watershed is from the introduction of brook trout, which could damage existing healthy bull trout through inter-breeding and competition. To date, no brook trout have been observed in the upper watershed. Brook trout are well established in the lower watershed in Schaefer Lake, Minnow Creek, and especially in Chikamin Creek. There are no barriers to hinder brook trout access to the upper watershed (Haskins 1998). Under the current program the Yakama Nation is not actively reintroducing coho into the Chiwawa River watershed, but as the program expands into the future, active reintroduction remains a strong possibility in the plan. (Murdoch 2004). Salmon carcasses were distributed in the watershed by the YN in 2000 and 2001 (K. Murdoch, YN, pers. comm.).

Hatchery out-plants occur in the Chiwawa watershed (Berg and Lowman 2001). Roads, campgrounds, and private lands in close proximity to salmonid holding and spawning areas may encourage disturbance of salmon and bull trout (USFS 2004). The amount of disturbance taking place, however, has not been quantified.

Environmental/Population Relationships

Habitat in the watershed above Chikamin Creek (RM 13.7) is largely pristine. This portion of the watershed provides 90% of the chinook spawning, the majority of the bull trout spawning, a substantial portion of the chinook rearing, steelhead rearing, and bull trout rearing. It also contains the most genetically pure and possibly the strongest cutthroat trout populations (Andonaegui 2001; Haskins 1998).

The lower watershed is a crucial migration corridor for the migratory life histories/stages of spring chinook, bull trout, and steelhead. Bull trout spawning populations are among the highest in the mid Columbia basin. The decline in spring chinook spawning appears linked to a larger spatial phenomenon, mirroring patterns throughout the Wenatchee subbasin. Spring-migrating steelhead adults are not exposed to late summer stream temperatures. Rearing habitat for steelhead and chinook may be affected in the lower tributaries and the lowermost mile of the Chiwawa, but substantial and spatially dispersed rearing areas in the upper watershed mitigate these losses. Brook trout may displace rearing steelhead in the lower watershed (Haskins 1998).

According to redd counts, the middle reach of the Chiwawa River between Chikamin (RM 13.7) and Phelps (RM 30.7) creeks supports the strongest spring chinook spawning population in the Wenatchee subbasin. The reach is one of only two watersheds in the Wenatchee subbasin that provided the bulk or 44.16% of spring chinook redds from 1958 to 1999. Nason Creek provided 28.23% during the same period.

By redd counts, Rock Creek (RM 21.3), tributary to the Chiwawa River, is the single most productive bull trout stream in the Wenatchee subbasin. Along with Rock Creek, the mainstem Chiwawa River and its tributaries help to serve as a stronghold for the bull trout population in the Wenatchee River watershed (Andonaegui 2001).

Areas of Special Interest

Functioning floodplain, good riparian and in-channel characteristics on the Chiwawa between Chikamin and Phelps Creek confluences supports the spring chinook population in the subbasin (Andonaegui 2001; MCMCP 199?, Upper Columbia RTT 2003).

Fish passage through the lower reach of the Chiwawa River is critical to sustaining spring chinook, steelhead, and bull trout populations in the Wenatchee subbasin (Andonaegui 2001, USFS 2003).

Habitat in the Chiwawa watershed upstream from Chikamin Creek (RM 13.7) is highly functional and pristine (Andonaegui 2001; USFS 2003).

Limiting Factors

- Brook trout competition and interbreeding threatens bull trout populations in the upper watershed (USFS 2003).

Data Gaps

- Interaction between surface diversions and well- water withdrawals with mainstem flows.

- Interactions between riparian development and stream temperature (Andonaegui 2001).
- It is unknown whether the debris flow regime has changed in the lower Chiwawa watershed (Haskins 1998).
- With the exception of Phelps Creek, tributary streams have little or no water temperature information on record (Haskins 1998).
- Population abundance and distribution of bull trout and cutthroat trout is undetermined.

Functional Relationship of Assessment Unit with Subbasin

The Chiwawa River is a Category 1 (see Determination of Restoration Priorities in Section 6.5) watershed for protection of natural resource values. This watershed provides a substantial amount of cool, clean water to the Wenatchee River and is a core spawning and rearing areas for spring chinook salmon and bull trout. The Chiwawa has 6 significant sub watersheds contributing key habitat for one or more native salmonid species (MacDonald et al. 2000).

4.9.13 Lake Wenatchee Assessment Unit

Assessment Unit Description

Lake Wenatchee is a large, steep-sided lake located approximately 15 mi. north of Leavenworth in the Wenatchee National Forest. It is fed principally by the Little Wenatchee River and the White River, and drains to the Wenatchee River. A large wetland is at the western end of the lake at the deltas of the Little Wenatchee and White rivers. A terminal glacial moraine at the east end of the lake is the natural dam that formed the lake. A diverse community of submerged aquatic vegetation along the shoreline extends to a depth of about 5.0 meters (WDOE 1997). The lake normally freezes over during the winter months and strong winds keep the lake mixed during much of the other seasons. General physical characteristics of the lake are listed in Table 23.

Table 23. General physical characteristics of Lake Wenatchee

Size	2,480 acres
Maximum Depth	244 ft.
Lake Volume	364,560 acre ft.
Drainage Area	273 2s. mi.
Altitude	1,875 ft.
Shoreline Length	13.3 mi.

WDOE 1997

Lake Wenatchee is an oligotrophic lake based on relatively high water clarity and low concentrations of phosphorous (Ecology 1997). Oligotrophic lakes are generally defined as being low-nutrient systems, with <10 mg/m3 phosphorus, <200 mg/m3 nitrogen, and <2 mg/m3 chlorophyll a. Average summertime secchi depth (water transparency) in Lake Wenatchee was estimated as 20 ft. and phosphorous concentrations were 4.8 ug/L (Ecology 1997). Although there are approximately 170 homes along the shoreline of Lake Wenatchee, septic systems are no longer used and all of the houses have been attached to a sewer system since around 1989.

Recreational uses on the lake include: swimming, fishing, motor boating, jet skiing, camping, hunting, picnicking, and camping.

Relatively little information exists on the water quality and limnology of Lake Wenatchee. water temperatures collected from depths of 10 ft. and lower indicated that the lake does not strongly stratify into a distinct warmer upper layer and a cooler lower layer with associated layers of high and low DO and pH (Table 6.3-2) (Sylvester and Ruggles 1957). The data for June through October, 1955 (shown in Table 6.3-2) suggest that temperature declines gradually between 10 ft. and 60–75 ft., and is notably lower at depths ranging from 150 to 175 ft.. However, coincident measurements of DO and pH suggest that deeper waters of the lake do not received sufficient organic matter to substantially depress values of either parameter. In many other temperate lakes, the upper layer of water is warmed through the summer as it absorbs solar radiation and this layer does not mix with the lower, darker layer of water, which generally exhibits a markedly cooler water temperature and depressed DO and pH in summer through fall months. However, Lake Wenatchee is subjected to high winds that apparently keep the waters mixed throughout the year resulting in similar water temperatures and levels of dissolved oxygen and pH in the upper approximately 100 ft. of the water column.

Other water quality parameters measured in Lake Wenatchee by Sylvester and Ruggles (1957) included total alkalinity, hardness, turbidity, conductivity and several metals. Their results from June 1955 through February 1957 provide a characterization of the lake as low alkalinity, very low hardness, very clear water with little turbidity and color, and low specific conductance. A single summertime chlorophyll a value of 1.7 ug/L measured in the lake (WDOE 1997) suggests phytoplankton algae levels are very low. All these features are characteristic of an oligotrophic lake, typically with low primary (algae) and secondary (zooplankton) productivity.

Little additional water quality data are available for Lake Wenatchee since the comprehensive surveys in the 1950. Some data were collected from August 1995 monthly through July 1996 at the Lake Wenatchee bridge (WRWSC 1998). These data were assumed to represent lake surface water conditions and indicate the following: 1) the surface lake waters remain very clear and of low turbidity; 2) nitrogenous nutrients (nitrate/nitrite and ammonia) were low enough to restrict algal growth; 3) total phosphorus was generally low, except for two mid winter measurements; 4) water pH remained near 7.0 (neutral), except for 1 reading of 8.87 in February 1996; 5) dissolved oxygen was measured to be above 9.0 mg/L, except for two low values in August and September 1995 (both were above 90% of air saturation); and 6) specific conductance ranged slightly higher than in the 1950s, possible indicating a slight increase in water hardness and alkalinity. Lake surveys of water transparency, total phosphorus and chlorophyll were conducted periodically from 1989 through 1997 (WDOE 1997). The results showed that water transparency is high (secchi depths >20 ft.) and chlorophyll and total phosphorus are very low. These available data, although somewhat sparse, suggest the lake waters remain oligotrophic with little evidence of effects from land use changes and development since the 1950s.