Appendix B

Description of spatial structure and diversity of spring Chinook and steelhead populations within the Upper Columbia Basin

In December 2005, the ICBTRT produced draft status reports for populations of spring Chinook and steelhead within the Upper Columbia ESUs. In this appendix we reproduce portions of those draft status reports with little editing. The information contained in this appendix only includes information on the spatial structure and diversity of the populations. Information on abundance and productivity is found in Section 2 of the Plan.

The following information was used as a guide to assess the spatial structure and diversity of spring Chinook and steelhead populations in the Upper Columbia Basin (from ICBTRT 2005).

Goal	Mechanism	Factor	Metrics
A. Allow natural rates and levels of spatially-mediated processes.	1. Maintain natural distribution of spawning aggregates.	a. Number and spatial arrangement of spawning areas.	Number of MSAs, distribution of MSAs, and quantity of habitat outside MSAs.
		b. Spatial extent or range of population	Proportion of historical range occupied and presence/absence of spawners in MSAs.
		c. Increase or decrease gaps or continuities between spawning aggregates.	Change in occupancy of MSAs that affects connectivity within the population.
B. Maintain natural levels of variation.	1. Maintain natural patterns of phenotypic and genotypic expression.	a. Major life history strategies.	Distribution of major life history expression within a population.
		b. Phenotypic variation.	Reduction in variability of traits, shift in mean value of trait, loss of traits.
		c. Genetic variation.	Analysis addressing within and between population genetic variation.
	2. Maintain natural patterns of gene flow.	a. Spawner composition	(1) Proportion of hatchery origin natural spawners derived from a local (within population) brood stock program using best practices.
			(2) Proportion of hatchery origin natural spawners derived from a within MPG brood stock program, or within population (not best practices) program.
			(3) Proportion of natural spawners that are unnatural out-of-MPG strays.
			(4) Proportion of natural spawners that are unnatural out-of-ESU strays.
	3. Maintain occupancy in a natural variety of available habitat types.	a. Distribution of population across habitat types.	Change in occupancy across ecoregion types.
	4. Maintain integrity of natural systems.	a. Selective change in natural processes or impacts.	Ongoing anthropogenic activities inducing selective mortality or habitat change within or out of population boundary

Wenatchee Spring Chinook Population

The Wenatchee spring Chinook population is part of the Upper Columbia ESU that only has one extant *MPG* including 3 current populations—Wenatchee, Entiat, and Methow Rivers (Figure 1) (ICTRT 2004). The ICTRT classified the Wenatchee River spring Chinook population as "very large" in size based on historical habitat potential (ICTRT 2005). This classification requires a minimum abundance threshold of 2000 wild spawners with sufficient intrinsic productivity (>1.0 r/s) to exceed a 5 % extinction risk on the viability curve (ICTRT 2005). Additionally, the Wenatchee spring Chinook population was classified as a "type B" population (based on historic intrinsic potential) because it has dendritic tributary structure with multiple major spawning areas (Table 1) (ICTRT 2005).

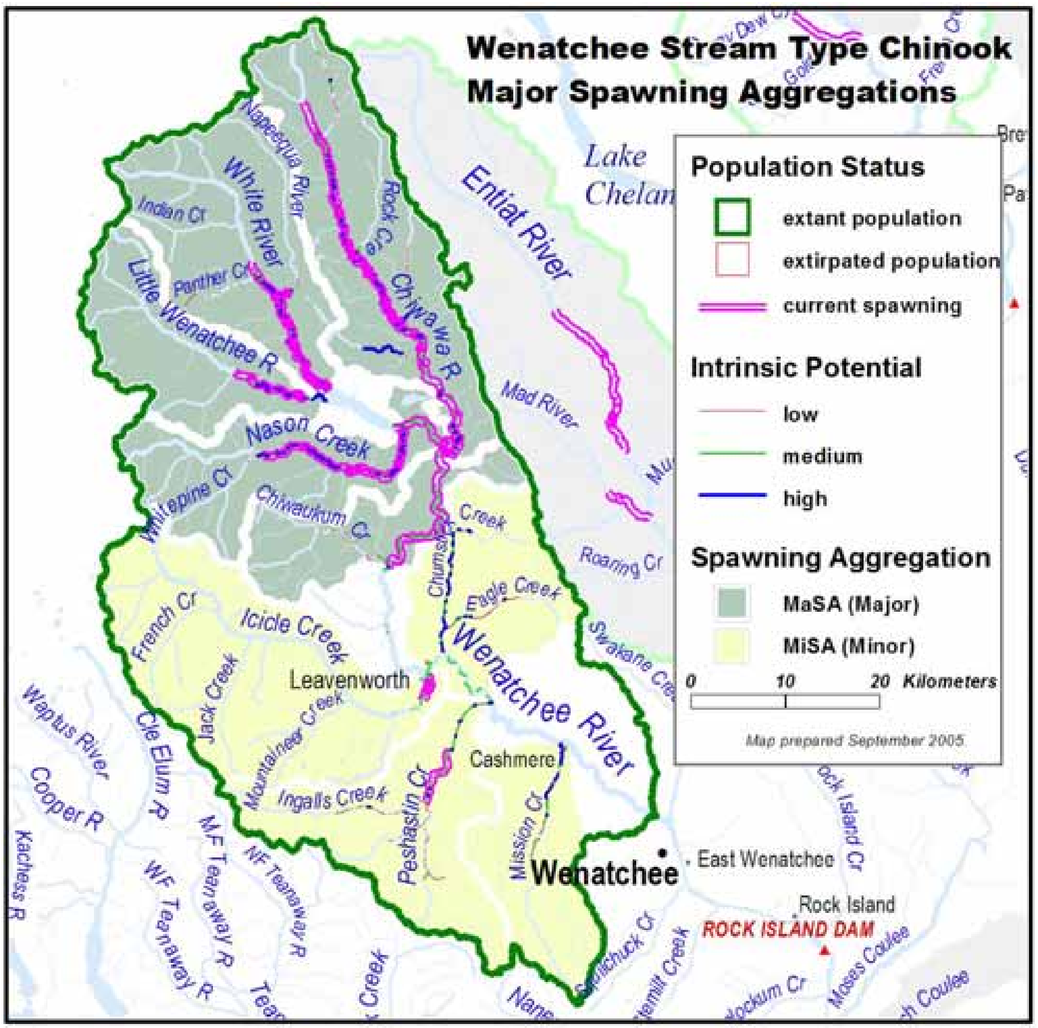

Figure 1. Wenatchee spring Chinook major and minor spawning aggregations.

Table 1. Wenatchee spring Chinook basin statistics

Drainage Area (km2)	3,440
Stream lengths km* (total)	1,733.2
Stream lengths km* (below natural barriers)	1,082.1
Branched stream area weighted by intrinsic potential (km2)	1.573
Branched stream area km2 (weighted and temp. limited)	1.527
Total stream area weighted by intrinsic potential (km2)	1.883
Total stream area weighted by intrinsic potential (km2) temp limited	1.798
Size / Complexity category	Very Large / B (dendritic structure)
Number of MaSAs	5
Number of MiSAs	4

*All stream segments greater than or equal to 3.8m bankfull width were included

**Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22^{o}C.

The ICTRT has identified five historical Major Spawning Areas (MaSAs) and four minor spawning areas (MiSAs) within the Wenatchee population (Figure 2). The five MaSAs are: Chiwawa, Nason Cr., Little Wenatchee R., White River and the upper Wenatchee mainstem (Tumwater Canyon to Lake Wenatchee). The minor spawning areas (MiSAs) estimated from the intrinsic potential analysis include Icicle, Chumstick, Peshastin, and Mission Creeks.

Currently, the primary spawning areas used by spring Chinook in the Wenatchee are the Chiwawa River, Nason Creek, White River, the Little Wenatchee River and the mainstem Wenatchee between Tumwater Canyon and Lake Wenatchee. Icicle Creek consistently has unlisted Carson stock spring Chinook spawning below the Leavenworth National Fish Hatchery and, between 2001 and 2004, Carson stock hatchery spring Chinook were planted in Peshastin Creek. Redds in these drainages would not contribute to VSP parameters because almost no wild Wenatchee origin fish are known to spawn in these MiSAs. During high abundance years, such as 2001, spring Chinook also spawn in Chiwaukum Creek.

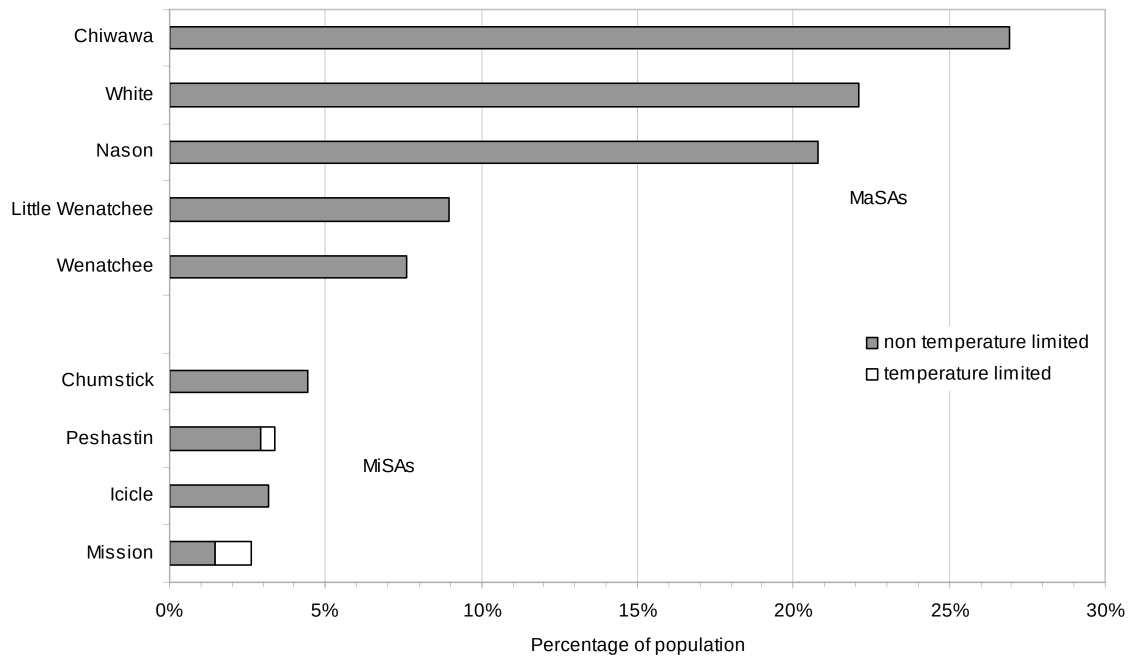

Figure 2. Percentage of historical spawning habitat (of the population) by major/minor spawning area. White portions are subject to temperature limitations.

Factors and Metrics

<u>A.1.a Number and spatial arrangement of spawning areas.</u> The Wenatchee spring Chinook population has five MaSAs (Chiwawa, Nason, White, and Little Wenatchee, and Upper Wenatchee mainstem) and they are all currently occupied (based on agency defined distribution) so it is at *very low risk*.

<u>A.l.b. Spatial extent or range of population</u>. The Wenatchee spring Chinook population has five MaSAs (Chiwawa, Nason, White, and Little Wenatchee, and Upper Wenatchee mainstem) and they are all occupied (based on agency defined distribution) so it is at *very low risk* (Figure 3). Additionally, based on redd counts in index areas from the most recent brood cycle (2000-2004) and during the last 3 brood cycles, the Wenatchee population would also be at very low risk. However, there were some years during the last 3 brood cycles that did not meet minimum occupancy requirements in the White, Little Wenatchee, and Upper Wenatchee mainstem MaSAs.

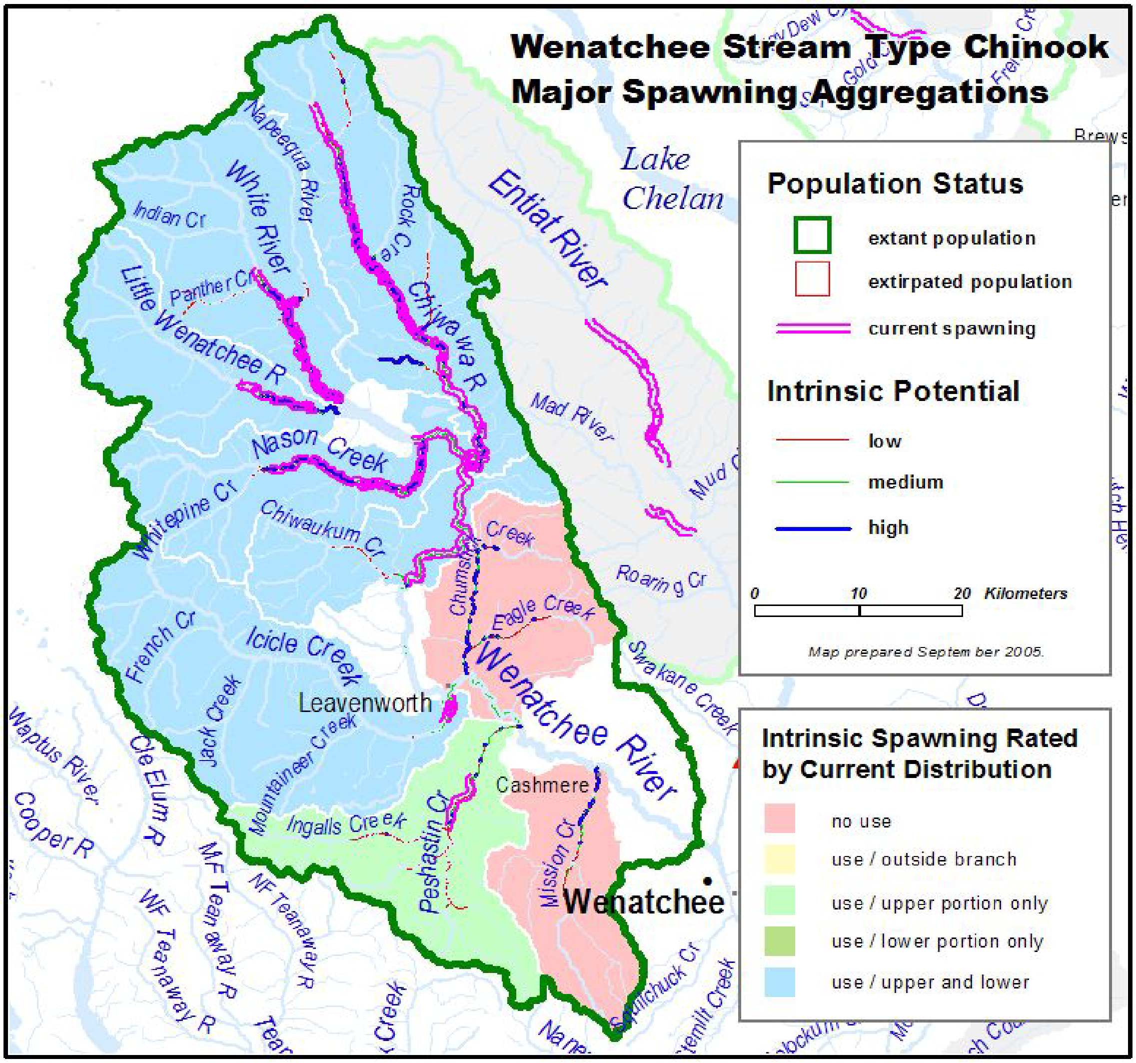

Figure 3. Wenatchee Spring Chinook current distribution.

A.1.c. Increase or decrease in gaps or continuities between spawning aggregates. There has been no increase or decrease in gaps between MaSAs for the Wenatchee spring Chinook population; however, the loss of multiple MiSAs at the lower end of the population boundary (below Tumwater Canyon) puts the population at *moderate risk*. It is assumed that habitat conditions, primarily flow and barriers prohibit the use of Mission and Chumstick Creeks as minor spawning areas. There is considerable uncertainty regarding the ability of these watersheds (Mission and Chumstick) to produce spring Chinook, even under pristine historical conditions. Additionally, there is uncertainty regarding passage of spring Chinook at the Boulder field in Icicle Creek. The opinion of local biologists is that the boulder field always was a barrier (even though road debris has made it artificially enhanced) and recent studies using marked hatchery fish from the LNFH, and historical information from the Wenatchi Tribe support that assumption (Cappellini 2001).

B.1.a. Major life history strategies. The Wenatchee spring Chinook population is *very low risk*, because no major life history strategies have been lost.

Studies of juvenile rearing and migration have identified three major juvenile life history patterns within the Wenatchee spring Chinook population: summer and overwinter rearing within natal spawning areas, fall presmolt migration and overwintering in the mainstem Wenatchee downstream of natal tributaries, and early summer emigration to downstream areas for summer rearing and overwintering. Limited PIT tagging information indicates that emigrating parr and presmolts use the mainstem reaches above and below Tumwater Dam for subsequent rearing.

B.1.b. Phenotypic variation. We do not have data available for this metric. Even if we determined that there was a change to one or more traits we do not know what the exact baseline is because changes likely occurred before there was biological monitoring. Therefore, we will assume that there has been some change and increase in variance for 2 or more traits placing the population at *moderate risk*.

B.1.c. Genetic variation. The Wenatchee spring Chinook population was determined to be at *high risk* for genetic variation due to a persistent homogenization from previous fish management efforts. Analyses based on allozymes collected in the 1980s suggest that there was some differentiation between subpopulations consistent with the level of differentiation expected in that time frame, particularly in the White River drainages. However, microsatellite samples collected in the late 1990s and early 2000s do not show this same differentiation, suggesting that recent management practices may have disrupted natural gene flow (ICTRT pop id draft, in prep).

The ICTRT genetic subgroup has reviewed the current status of all populations in the Interior basin. The subgroup concluded that the Wenatchee population has been homogenized with other UC populations due to past practices. Their conclusion was based on high similarity to all UC hatchery samples and ANOVA analysis indicating no apparent structure between populations, or with minor exceptions, within populations. Data examined include both allozyme and microsatellite data collected by WDFW and analyzed in Ford et al. (2000), and by the ICTRT genetics subgroup. It is possible that the true genetic risk metric for this population is lower. If additional data becomes available indicating differentiation between and within populations (either genetic data indicating levels of divergence consistent with the time since separation; or genetic information showing strong spatial structure), the risk level for this metric could improve to moderate or low risk.

B.2.a. Spawner composition.

(1) *Out-of-ESU strays*. The Wenatchee spring Chinook population is at *high risk* with respect to this metric due to the presence of non-local (outside the ESU origin) stocks on the spawning grounds, which include both LNFH and other stocks from hatcheries outside the Upper Columbia ESU. Tagging studies indicate that LNFH stray rates are generally low (<1%) (Pastor 2004). However, based on expanded carcass recoveries from spawning ground surveys (2001-2004), LNFH and other out-of-basin strays have comprised from 3-27% of the spawner composition above Tumwater Canyon (WDFW unpublished data). Its possible that 4 years of data is not sufficient to evaluate this metric and our risk assessment could change with the inclusion of a longer time series of data. It has been suggested that the mark rate and recovery rate for hatchery fish was insufficient to determine spawner composition prior to 2000 (Andrew

Murdoch, personal communication). Therefore, continuing a 100% external mark rate of hatchery fish and recovering high proportions of carcasses should be a priority.

(2) *Out of MPG strays*. The Upper Columbia ESU only has one extant MPG, so this metric is *not applicable* and no score will be given.

(3) *Out of population strays*. Out of population (but within MPG) origin strays comprised 0% and 1.8% of the naturally spawning population in 2001 and 2002, respectively (Tonseth 2003, 2004). Based on this short-term data set, the population was at *low risk* with respect to this metric. However, we recognize that two years is likely not sufficient to assess long-term risk and conclude that more years need to be added to the time series. Additionally, if the rearing and release practices discussed in the next metric are not addressed then all the hatchery fish on the spawning grounds will fall into this category and the population will be at high risk for this metric.

(4) *Within-population strays*. Since 1993, a total of 56% of the spawners in tributaries above Tumwater Canyon have been of local hatchery origin, specifically the Chiwawa supplementation program (WDFW unpublished data). Regardless of the duration (# of generations), this high proportion of hatchery fish on the spawning grounds places the population at *high risk* for this metric. Additionally, the Chiwawa River integrated hatchery program strays to other non-target MaSAs and commonly makes up greater than 10 % of the spawner composition in Nason Creek and the White and Little Wenatchee Rivers, based on comprehensive data collected in 2001 and 2002 (Tonseth 2003; Tonseth 2004).

<u>B.3.a. Distribution of population across habitat types</u>. The intrinsic potential distribution for Wenatchee spring Chinook covered four ecoregions; however, over 90% of the high to medium rated habitat was in two ecoregion types, Chiwaukum Hills and Lowlands and Wenatchee Chelan Highlands (Figure 4; Table 2). The loss of occupancy in all four MiSAs below Tumwater Canyon did not eliminate an ecoregion type or shift the distribution of ecoregion types by more than 1/3. Therefore, the population was at low risk for this metric.

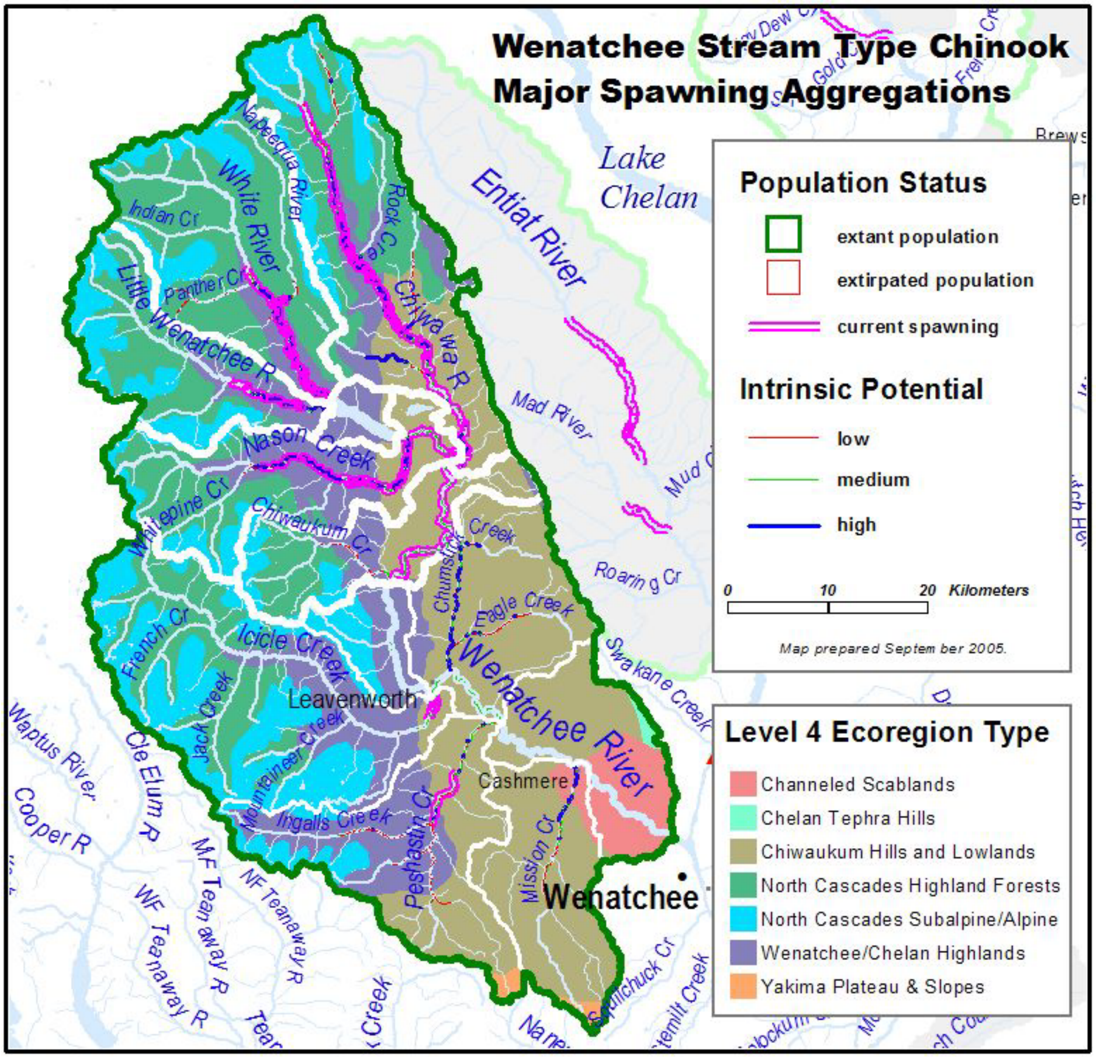

Figure 4. Wenatchee Spring Chinook population across various ecoregions.

Table 2. Wenatchee Spring Chinook – proportion of spawning area across various ecoregions

Ecoregion	% of historical spawning area in this ecoregion (non-temperature limited)	% of currently occupied spawning area in this ecoregion (non-temperature limited)	% of historical spawning area in this ecoregion (temp. limited)
Channeled Scablands	1.3%	0%	0.2%
Chiwaukum hills and lowlands	44.1%	44.8%	44.3%
North Cascades and Highland Forests	2.5%	3.1%	2.5%
Wenatchee / Chelan Highlands	52.1%	52.2%	53.0%

*Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22^{o}C.

B.4.a. Selective change in natural processes or selective impacts.

Hydropower system: Low risk, although it has slowed out migration for early and late out migrants, but in recent years flow augmentation has reduced the impact to the middle 95% of the run.

Harvest: Low risk in recent generations. Harvest rates affect <20% of the adults and selective gear reduces the impact of selectivity.

Hatcheries: Low risk, broodstock management of the Chiwawa supplementation program has been designed to be non-selective.

Habitat: Low risk, although low flow in Peshastin Creek from water withdrawals could prohibit run timing for late arriving adults, it’s a minor proportion of the population.

Based on low risk estimates across the four sectors, we conclude that the population is at *low risk* for this metric.

Spatial Structure and Diversity Summary

The Wenatchee spring Chinook population was determined to be at low risk for goal A (allowing natural rates and levels of spatially mediated processes) but at high risk for goal B (Maintaining natural levels of variation) resulting in an overall HIGH risk rating (Table 3). The metrics for genotypic and phenotypic variation were the determining factors for the high risk rating of Wenatchee spring Chinook. We concluded that there was evidence for a high degree of homogenization within the Wenatchee population as well as among the three extant Upper Columbia Spring Chinook populations. However, there was considerable uncertainty regarding whether or not the level of divergence in the Wenatchee was sufficient for a moderate risk rating. Therefore continued efforts to maintain natural levels of exchange within and among populations and further evaluation could lead to an improved risk rating. For B.1.b. (phenotypic variation), an analysis needs to be conducted that shows that the phenotypic traits of the current population are consistent with the assumed historical condition or with unaltered reference populations in a similar habitat, geologic, and hydrologic setting. Based on the scoring system, this metric must be addressed in order for the status of goal B to improve to low risk.

There were two metrics that were rated at high risk related to spawner composition that did not directly reduce the overall risk conclusion, but should be considered potential threats to both genotypic (B.1.3) and phenotypic variation (B.1.b). First, Chiwawa River hatchery fish (local origin stock; B.2.a.2) comprise a large portion of the fish on the spawning grounds over multiple generations. Additionally, this hatchery has not been operated to meet “best management practices,” because the rearing and release strategies (acclimation of Chiwawa fish on Wenatchee River water over the winter) have likely increased the probability of straying to non-target MaSAs. Second, the high proportion (3-27%) of LNFH fish (out-of-ESU stock) on the spawning grounds poses an additional risk to genotypic and phenotypic variation. However, due to the scoring system these high-risk ratings were averaged with other metrics and did not directly cause an increased risk rating.

Table 3. Spatial structure and diversity scoring table

Metric	Risk Assessment Scores				
	Metric	Factor	Mechanism	Goal	Population
A.1.a	VL (2)	VL (2)	Mean = 1.33 Low Risk	Low Risk	**High Risk**
A.1.b	VL (2)	VL (2)			
A.1.c	M (0)	M (0)			
B.1.a	VL (2)	VL (2)	High Risk	High Risk	
B.1.b	M (0)	M (0)			
B.1.c	H (1)	H (1)			
B.2.a(1)	H (-1)	High Risk (-1)	High Risk (-1)		
B.2.a(2)	NA				
B.2.a(3)	L (1)				
B.2.a(4)	H (-1)				
B.3.a	L (1)	L (1)	L (1)		
B.4.a	L (1)	L (1)	L (1)		

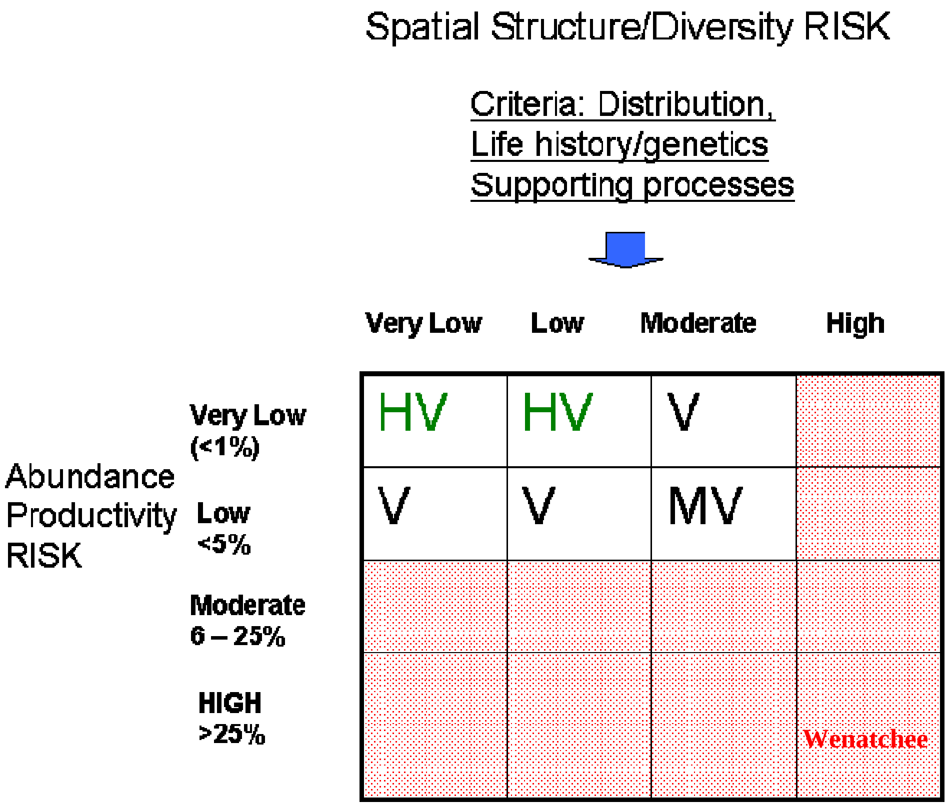

Figure 5. Abundance & productivity and spatial structure & diversity integration

Overall Risk Rating:

Spatial structure and diversity of Wenatchee spring Chinook was rated at high risk, primarily because of a high level of genetic homogenization within and among populations. Improvement of the spatial structure and diversity status to low risk would be required to allow the Wenatchee population to achieve a "highly viable" status (in addition to the improvements needed for abundance and productivity) (Figure 5). Based on the MPG guidelines, the Wenatchee population will need to achieve a highly viable status for recovery of the ESU (ICTRT 2005).

Wenatchee Summer Steelhead Population

The Wenatchee summer steelhead population is part of the Upper Columbia ESU that only has one extant *MPG* that includes 4 current populations: Wenatchee, Entiat, Methow, and Okanogan Rivers) plus Crab Creek (Figure 6) (ICTRT 2004). The ICTRT classified the Wenatchee River summer steelhead population as “Large” in size based on historical habitat potential (ICTRT 2005). This classification requires a minimum abundance threshold of 1500 wild spawners with sufficient intrinsic productivity (>1.0 r/s) to exceed a 5% extinction risk on the viability curve (ICTRT 2005). Additionally, the Wenatchee steelhead population was classified as a “type B” population (based on historic intrinsic potential) because of its dendritic structure tributary structure with multiple major spawning areas (Table 4) (ICTRT 2005).

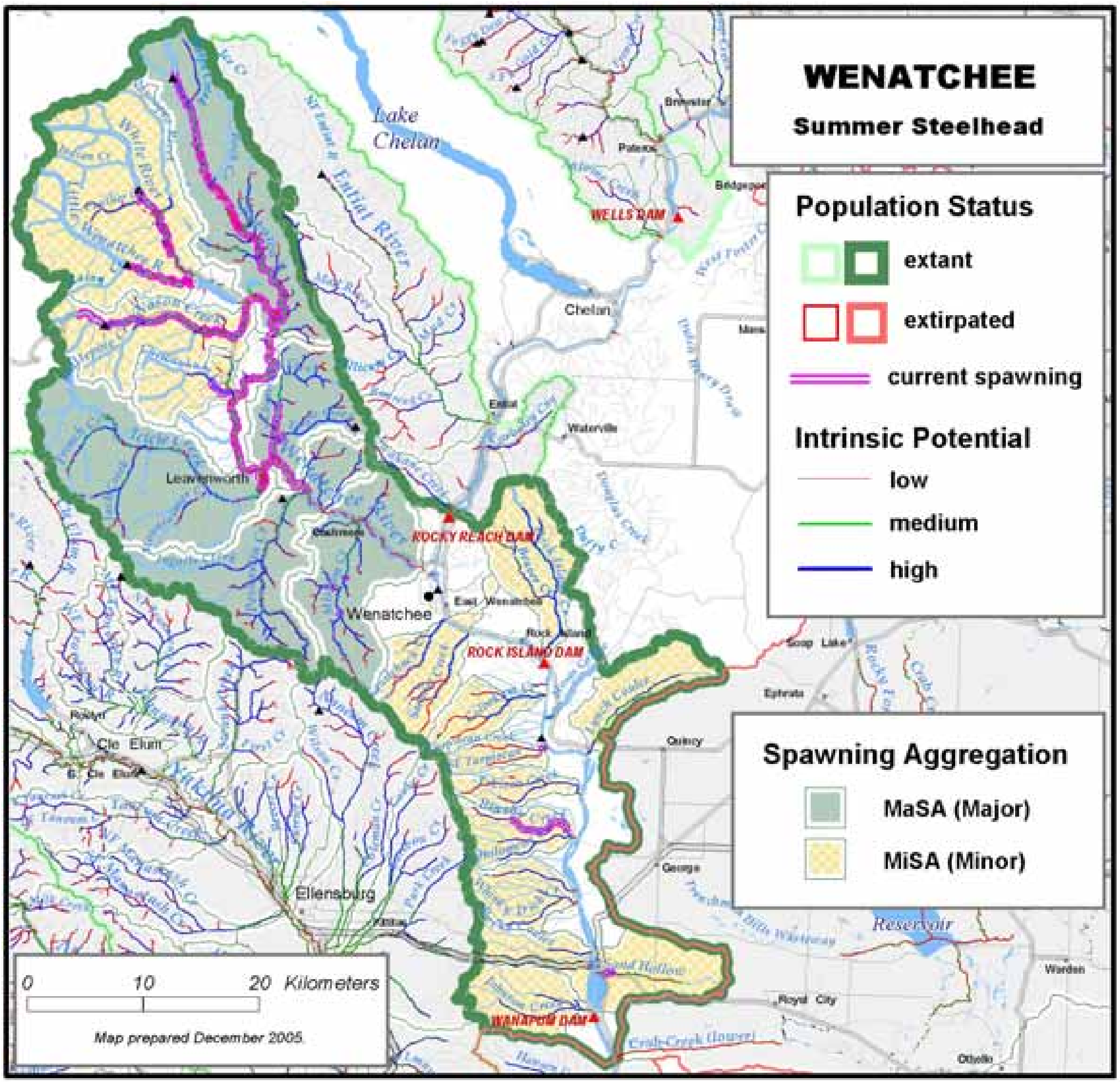

Figure 6. Wenatchee summer steelhead major and minor spawning aggregations

Table 4. Wenatchee summer steelhead basin statistics

Drainage Area (km2)	5,744
Stream lengths km* (total)	2,173
Stream lengths km* (below natural barriers)	1,497
Branched stream area weighted by intrinsic potential (km2)	4.209
Branched stream area km2 (weighted and temp. limited)	3.301
Total stream area weighted by intrinsic potential (km2)	6.396
Total stream area weighted by intrinsic potential (km2) temp limited	4.996
Size / Complexity category	Large / B (dendritic structure)
Number of MaSAs	5
Number of MiSAs	13

*All stream segments greater than or equal to 3.8m bankfull width were included

**Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22^{o}C.

Summer steelhead in the Wenatchee population formerly had a wide distribution, utilizing all major tributaries. Currently, the ICTRT defines the population to encompass mainstem Columbia River tributaries above Crab Creek, up to and including the Wenatchee River subbasin.

In the Columbia mainstem tributaries, USBR and WDFW has identified spawning in Sand Hollow, Quilomene, Brushy, and Trinidad Creeks (Lynch Coulee) (USBR, WDFW unpubished data). Additionally, during the extreme low flow year of 2005, spawners and/or carcasses were observed near or at the mouths of Tarpiscan, Johnson, and Squilchuck Creeks (WDFW unpublished data). Lynch Coulee does not receive flows from the irrigation system, but the springs are likely enhanced from the Columbia Basin Reclamation Project.

The major component of productivity is within the Wenatchee subbasin itself. Most current spawning identified by WDFW occurs in the Chiwawa River and its tributaries, Wenatchee mainstem above Tumwater Canyon, Nason Creek, and Peshastin Creek. Spawning has also been observed within the White and Little Wenatchee Rivers, as well as Icicle, Chiwaukum, Chumstick, and Mission Creeks.

The ICTRT has identified five intrinsic Major Spawning Areas (MaSAs) and 13 Minor Spawning Areas (MiSAs), within the Wenatchee population (Figure 7).

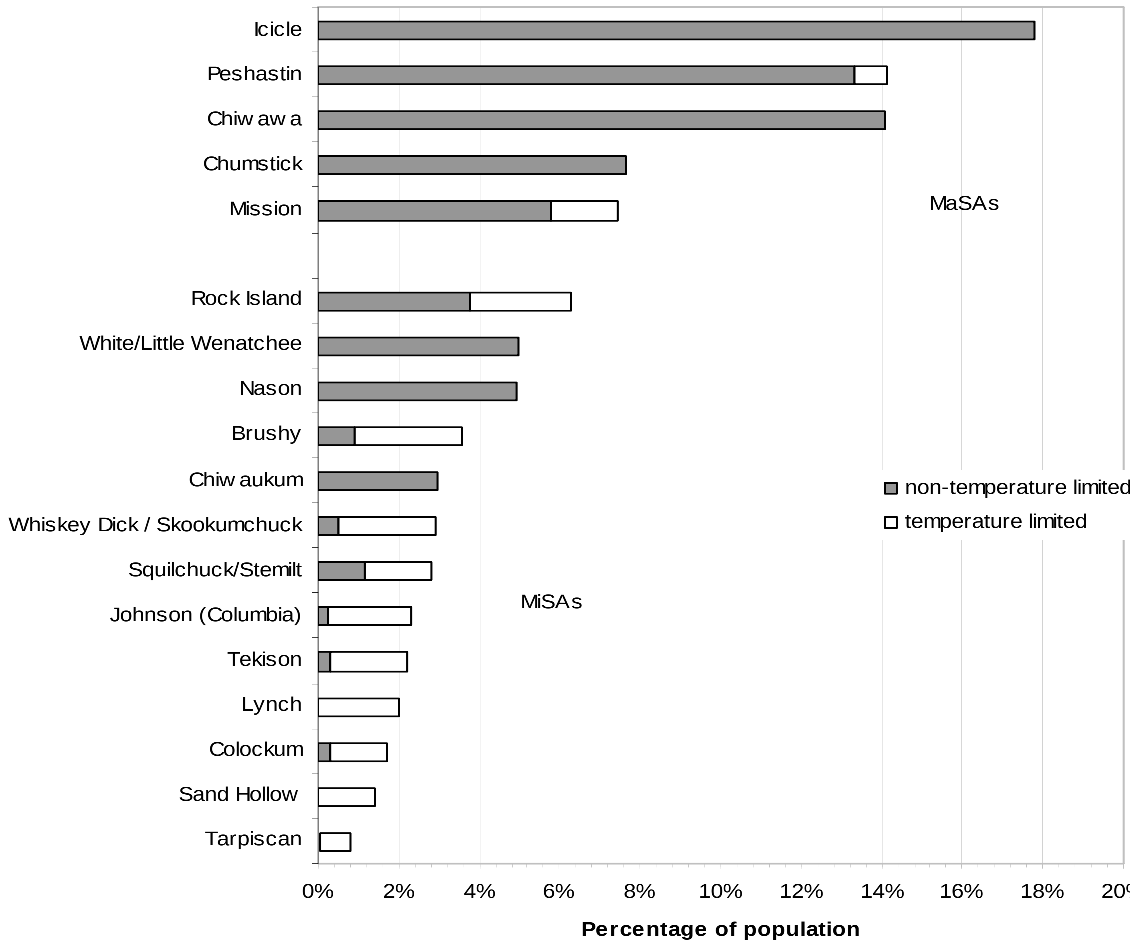

Figure 7. Percentage of historical spawning habitat (of the population) by major/minor spawning area. White portions are subject to temperature limitations.

Factors and Metrics

A.1.a Number and spatial arrangement of spawning areas. The Wenatchee Summer Steelhead population contains 5 MaSAs and 13 MiSAs. All of the MaSAs and many of the MiSAs are occupied based on agency distribution so the population is at *very low risk* for this metric (WDFW salmonscape). Additionally, more detailed recent (2001-2005) surveys have revealed the presence of multiple redds in the upper and lower halves of three of the MaSAs (Chiwawa, Peshastin, Mission) and several of the MiSAs including the Wenatchee mainstem, Quilomene Creek, Brushy Creek, Nason Creek and Trinidad Creek (Tonseth and Viola 2003; Murdoch et al. 2004; Tonseth 2004; WDFW unpublished data).

A.l.b. Spatial extent or range of population. Efforts to monitor the distribution and abundance of spawning steelhead have been expanded in recent years (2001-2004), but we still do not have comprehensive, long-term data sets to rate this metric for the entire Wenatchee watershed. Based on these recent data sets, four of the five MaSAs in the Wenatchee summer steelhead population are currently occupied, which puts the population at *moderate risk* for this metric (Figure 8). The Icicle Creek MaSA has consistently had redds in the lower 2 miles, but not within core branch spawning reaches identified by the intrinsic analysis. Most of these core reaches are located above the Leavenworth NFH, where Steelhead passage is currently blocked. However, the USFWS intends to provide passage (in the near future) during portions of the year that may allow for re-occupation of this MaSA (Jim Craig, personal communication). The presence of redds in the White/Little Wenatchee MaSA has been inconsistent in recent years, though this habitat is considered functional with few, if any, primary limiting factors. The Chumstick MaSA has been blocked by a culvert near the mouth during most years, although a few redds have been observed under certain flow conditions.

A.1.c. Increase or decrease in gaps or continuities between spawning aggregates. Unoccupied MaSAs have not increased the gaps between MaSAs by more than 10 km so the population is at *low risk* for this metric.

B.1.a. Major life history strategies. The Wenatchee summer steelhead population is *very low risk*, because no major life history strategies have been lost. There never was a winter run component and resident *O. mykiss* are known to occur at various locations in the subbasin (NPPC 2004).

B.1.b. Phenotypic variation. There are no data available for this metric. Even if we determined that there was a change to one or more traits we do not know what the exact baseline is because changes likely occurred before there was biological monitoring. Therefore, we will assume that there has been some change and increase in variance for 2 or more traits placing the population at *moderate risk*.

B.1.c. Genetic variation. The Wenatchee summer steelhead population was determined to be at *high risk* for genetic variation due to a persistent homogenization from previous and ongoing fish management efforts. The genetic signal shows little differentiation between populations with strong similarity to Wells Hatchery; however, all available data at least 20 years old. There is a possibility that the true genetic risk metric for this population should be lower. If additional data becomes available indicating differentiation between and within populations (either genetic data indicating levels of divergence consistent with the time since separation; robust straying data or genetic information showing strong spatial structure), this metric can be downgraded.

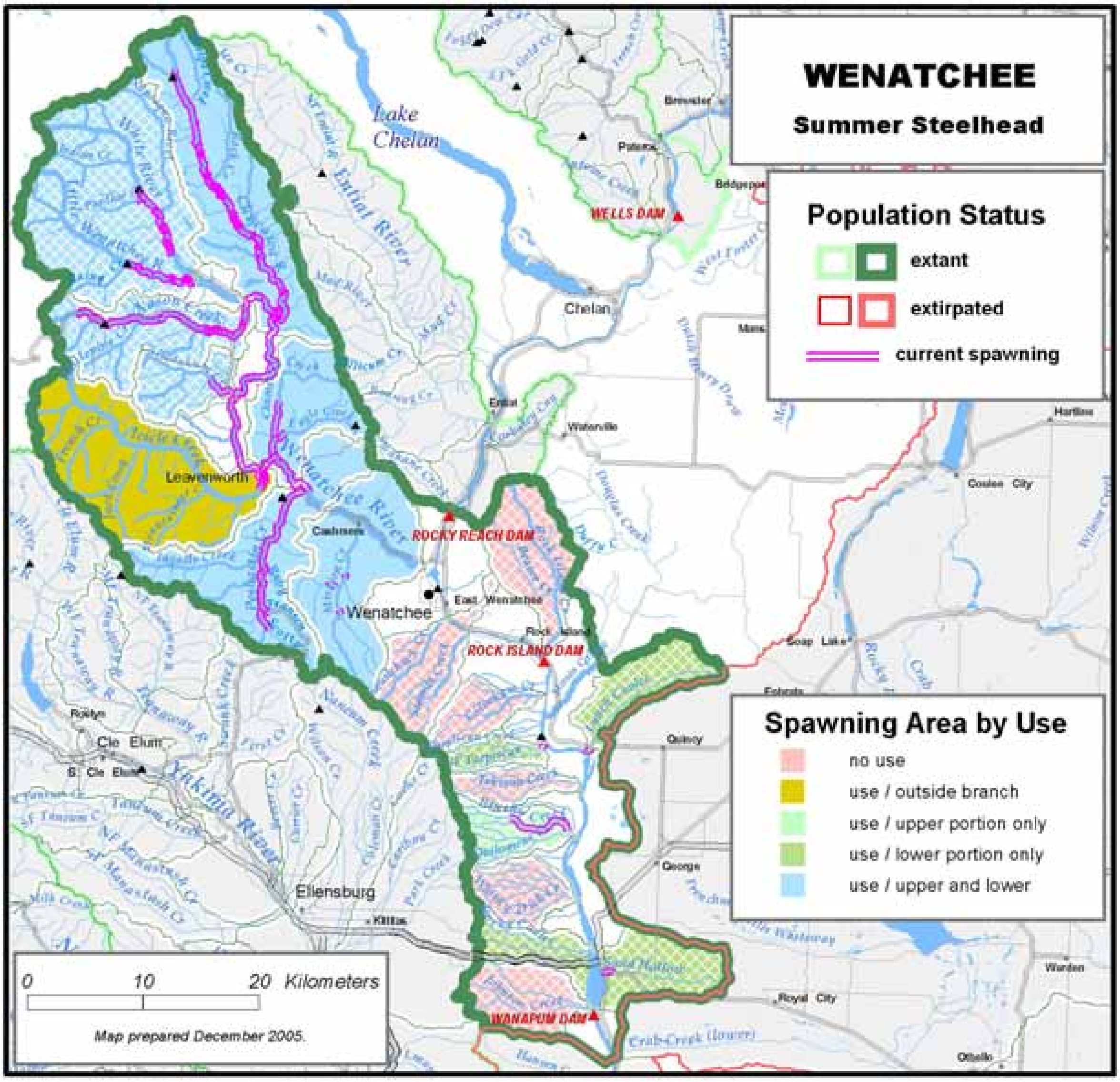

Figure 8. Wenatchee summer steelhead current distribution.

<u>B.2.a. Spawner composition.</u> We do not have estimates of spawner composition for the various MaSAs and MiSAs of the Wenatchee steelhead population because carcasses cannot be obtained in sufficient numbers from the spawning ground surveys. However, between 2001 and 2004 an average of 47% (range 30-69%) of the females passing Tumwater Dam were of wild origin (Tonseth 2004). This level of hatchery fish on the spawning grounds puts the population at *high risk* for this metric, regardless of the origin of the hatchery fish.

(1) Out-of-ESU strays. We have no data to evaluate the proportion of out of ESU hatchery strays on the spawning grounds of the Wenatchee population; therefore the default rating is *moderate risk*. However, there are no hatchery programs propagating non-local anadromous stock in the ESU and we have no reason to believe that the Wenatchee steelhead population is at an elevated risk level for this metric. Therefore, when considering future status reviews we may want to

consider an alternative measurement location, such as Priest Rapids Dam, to determine risk to the ESU, instead of to individual populations.

(2) *Out of MPG strays*. The Upper Columbia ESU only has one extant MPG, so this metric is not applicable and no score will be given.

(3) Out of population strays. We do not have estimates of spawner composition for the various MaSAs and MiSAs of the Wenatchee steelhead population because carcasses cannot be obtained in sufficient numbers from the spawning ground surveys. However, between 2001 and 2004 an average of 47% (range 30-69%) of the females passing Tumwater Dam were of wild origin (Tonseth 2004). The long term integrated program in the Wenatchee Basin collects fish at Dryden Dam (lower mainstem) and releases them at various locations throughout the upper basin, thereby mixing the progeny from various MaSAs and not encouraging local adaptation within the population. Additionally, because fish are not reared and acclimated in the Wenatchee basin, this program is not meeting best management strategies. Therefore, the population is at *high risk* for this metric.

(4) *Within-population strays*. This metric is *not applicable* for the Wenatchee because the local origin hatchery fish were considered not best management strategies for reasons identified earlier.

<u>B.3.a. Distribution of population across habitat types</u>. The distribution of intrinsic branches for Wenatchee summer steelhead covers 9 ecoregions, 5 of which were considered significant (> 10%) (Figure 9; Table 5). Currently occupied spawning areas for this population exist primarily within 2 ecoregions—Chiwaukum Hills & Lowlands and Wenatchee/Chelan Highlands and substantial shifts (> 67 %) have occurred in 2 of the 5 significant ecoregions putting the population at *moderate risk* for this metric.

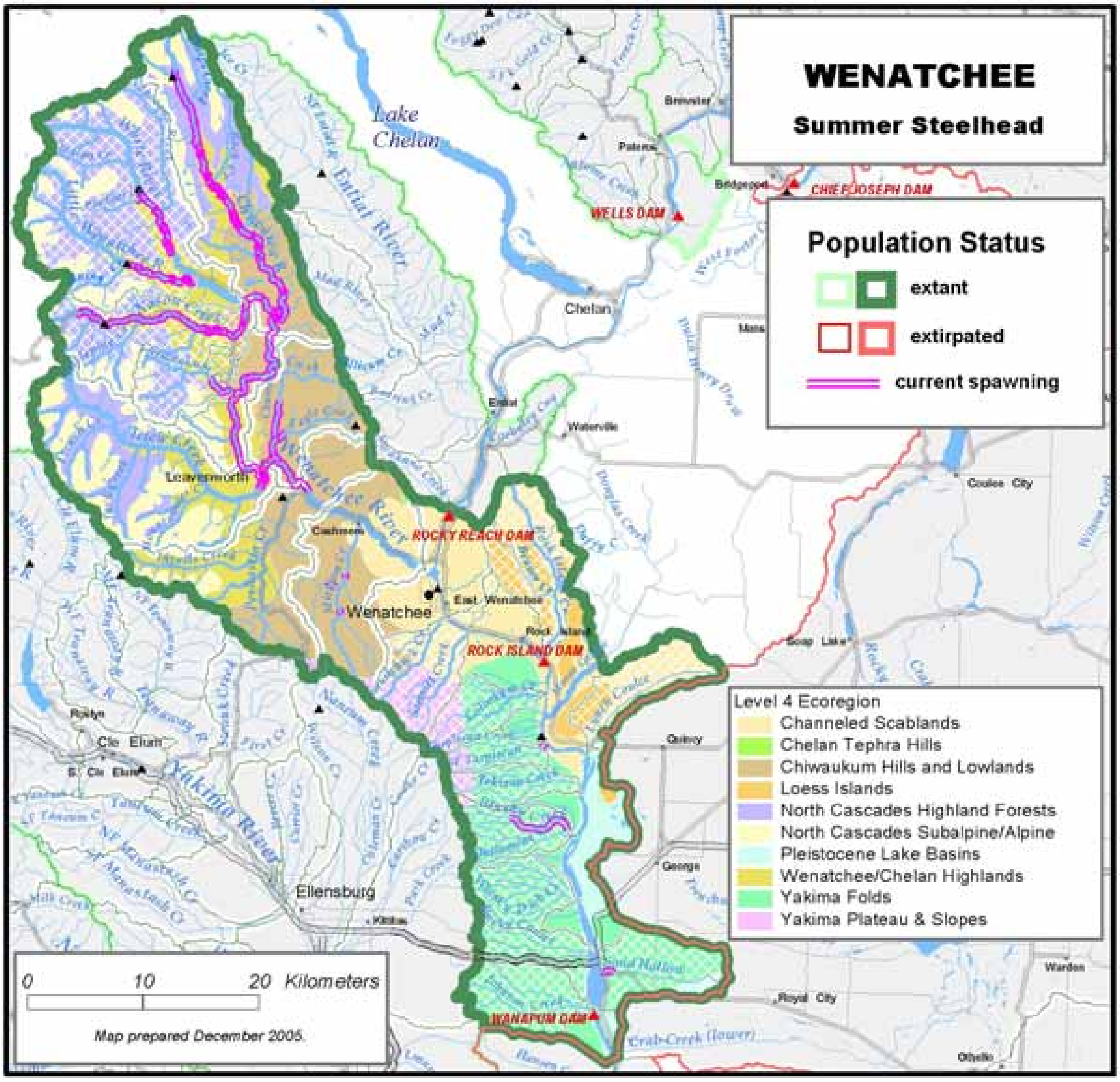

Figure 9. Wenatchee summer steelhead population across various ecoregions.

Table 5. Wenatchee summer steelhead – proportion of spawning area across various ecoregions

Ecoregion	% of historical spawning area in this ecoregion (non-temperature limited)	% of currently occupied spawning area in this ecoregion (non-temperature limited)
Channeled Scablands	11.8	0.1
Chiwaukum Hills and Lowlands	34.4	53.3
Loess Islands	0.2	0.0
North Cascades Highland Forests	14.2	3.6
North Cascades Subalpine/Alpine	0.2	0.0
Pleistocene Lake Basins	0.8	0.0
Wenatchee/Chelan Highlands	23.6	39.9
Yakima Folds	14.4	3.1
Yakima Plateau & Slopes	0.2	0.0

B.4.a. Selective change in natural processes or selective impacts.

Hydropower system: Low risk, although it has slowed out migration for early and late out migrants, but in recent years flow augmentation has reduced the impact to the middle 95% of the run.

Harvest: Low risk in recent generations. Harvest rates affect < 20% of the adults and selective gear reduces the impact of selectivity.

Hatcheries: Low risk, broodstock management of the Wenatchee supplementation program has been designed to be non-selective.

Habitat: Low risk, no known measurable effects.

Based on low risk estimates across the four sectors, we conclude that the population is at *low risk* for this metric.

Spatial Structure and Diversity Summary

The Wenatchee summer steelhead population was determined to be at low risk for goal A (allowing natural rates and levels of spatially mediated processes) but high risk for goal B (Maintaining natural levels of variation) resulting in an overall high risk rating (Table 6). The metric for genotypic variation was directly responsible for the high risk rating of Wenatchee summer steelhead. More recent samples are needed from steelhead from throughout the ESU to confirm this conclusion. For metric B.1.b. (phenotypic variation), an analysis needs to be conducted that shows that the phenotypic traits of the current population are consistent with the assumed historical condition or with unaltered reference populations in a similar habitat, geologic, and hydrologic setting. Based on the scoring system, these metrics must be addressed in order for the status of goal B to improve to low or very low risk.

There was one metric that was rated at high risk related to spawner composition that did not directly reduce the overall risk conclusion, but should be considered a potential threat to both genotypic (B.1.3) and phenotypic variation (B.1.b). We do not have estimates of spawner composition for the various MaSAs and MiSAs of the Wenatchee steelhead population because carcasses cannot be obtained in sufficient numbers from the spawning ground surveys. We assumed that most or all of the estimated 47% hatchery fish spawner composition was from the local origin program and assessed risk accordingly. However, due to the difficulty of obtaining carcasses, it might be more appropriate to make the risk rating at the mechanism level, rather than for each of the metrics. In the future, we may need to consider ESU level risks for this metric at sampling locations such as Priest Rapids Dam.

Table 6. Spatial structure and diversity scoring table

<table>
<tr><th rowspan="2">Metric</th><th colspan="5">Risk Assessment Scores</th></tr>
<tr><th>Metric</th><th>Factor</th><th>Mechanism</th><th>Goal</th><th>Population</th></tr>
<tr><td>A.1.a</td><td>VL (2)</td><td>VL (2)</td><td rowspan="3">Low Risk
Mean = 1</td><td rowspan="3">Low Risk</td><td rowspan="12">High Risk</td></tr>
<tr><td>A.1.b</td><td>M (0)</td><td>M (0)</td></tr>
<tr><td>A.1.c</td><td>L (1)</td><td>L (1)</td></tr>
<tr><td>B.1.a</td><td>VL (2)</td><td>VL (2)</td><td rowspan="3">High Risk</td><td rowspan="9">High Risk</td></tr>
<tr><td>B.1.b</td><td>M (0)</td><td>M (0)</td></tr>
<tr><td>B.1.c</td><td>H (-1)</td><td>H (-1)</td></tr>
<tr><td>B.2.a(1)</td><td>M(0)
(no data)</td><td rowspan="4">High Risk</td><td rowspan="4">High Risk</td></tr>
<tr><td>B.2.a(2)</td><td>NA</td></tr>
<tr><td>B.2.a(3)</td><td>H(-1)</td></tr>
<tr><td>B.2.a(4)</td><td>NA</td></tr>
<tr><td>B.3.a</td><td>M (0)</td><td>M (0)</td><td>M (0)</td></tr>
<tr><td>B.4.a</td><td>L (1)</td><td>L (1)</td><td>L (1)</td></tr>
</table>

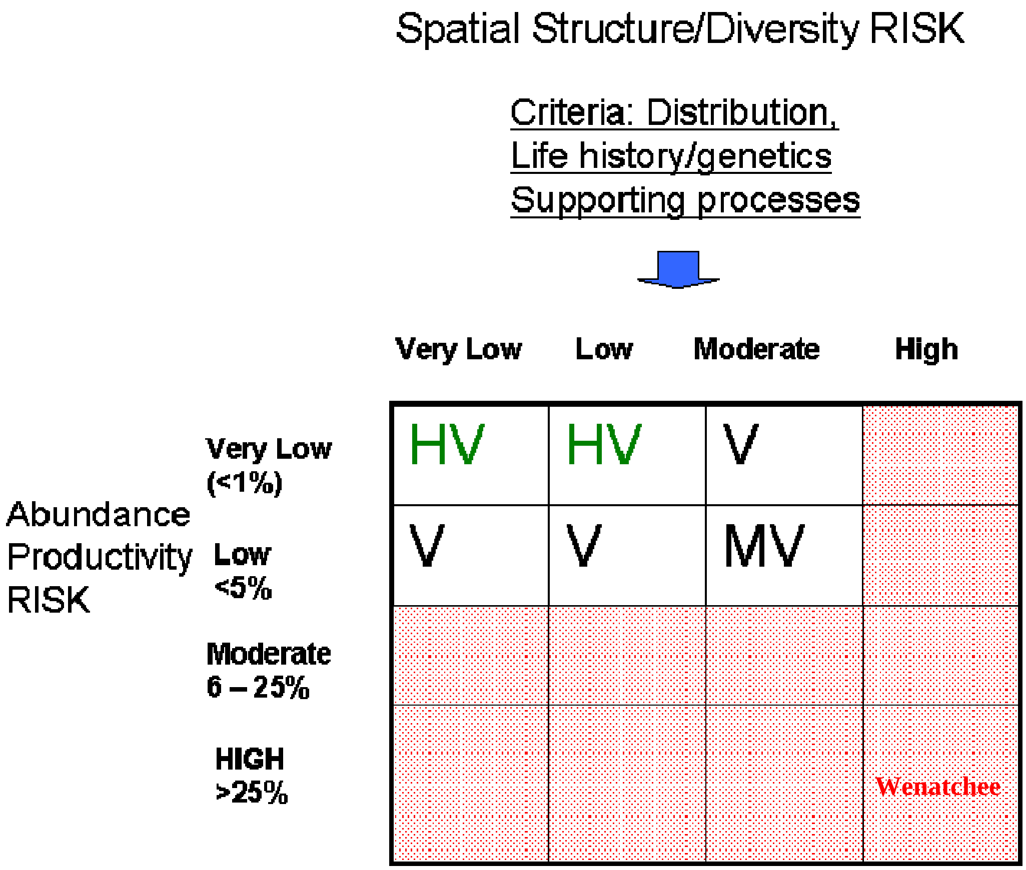

Figure 10. Abundance & productivity and spatial structure & diversity integration table

Overall Risk Rating:

The spatial structure and diversity of Wenatchee summer steelhead rated as high risk. Improvement of the spatial structure and diversity status to low risk would be required to allow the Wenatchee population to achieve a "highly viable" status (in addition to the improvements needed for abundance and productivity) (Figure 10). Based on the MPG guidelines, the Wenatchee population will need to achieve a highly viable status for recovery of the ESU (ICTRT 2005).

Entiat Spring Chinook Population

The Entiat spring Chinook population is part of the Upper Columbia ESU. This ESU contains only one extant MPG including 3 current populations—Wenatchee, Entiat, and Methow Rivers (Figure 11) (ICTRT 2004). The ICTRT classified the Entiat River spring Chinook population as "basic" in size based on historical habitat potential (ICTRT 2005) (Table 1b). This classification requires a minimum abundance threshold of 500 wild spawners with sufficient intrinsic productivity (greater than 1.0 r/s) to exceed a 5 % extinction risk on the viability curve (ICTRT 2005). Additionally, the Entiat spring Chinook population was classified as a "type A" population (based on historic intrinsic potential) because of its simple, linear tributary structure (Table 7) (ICTRT 2005).

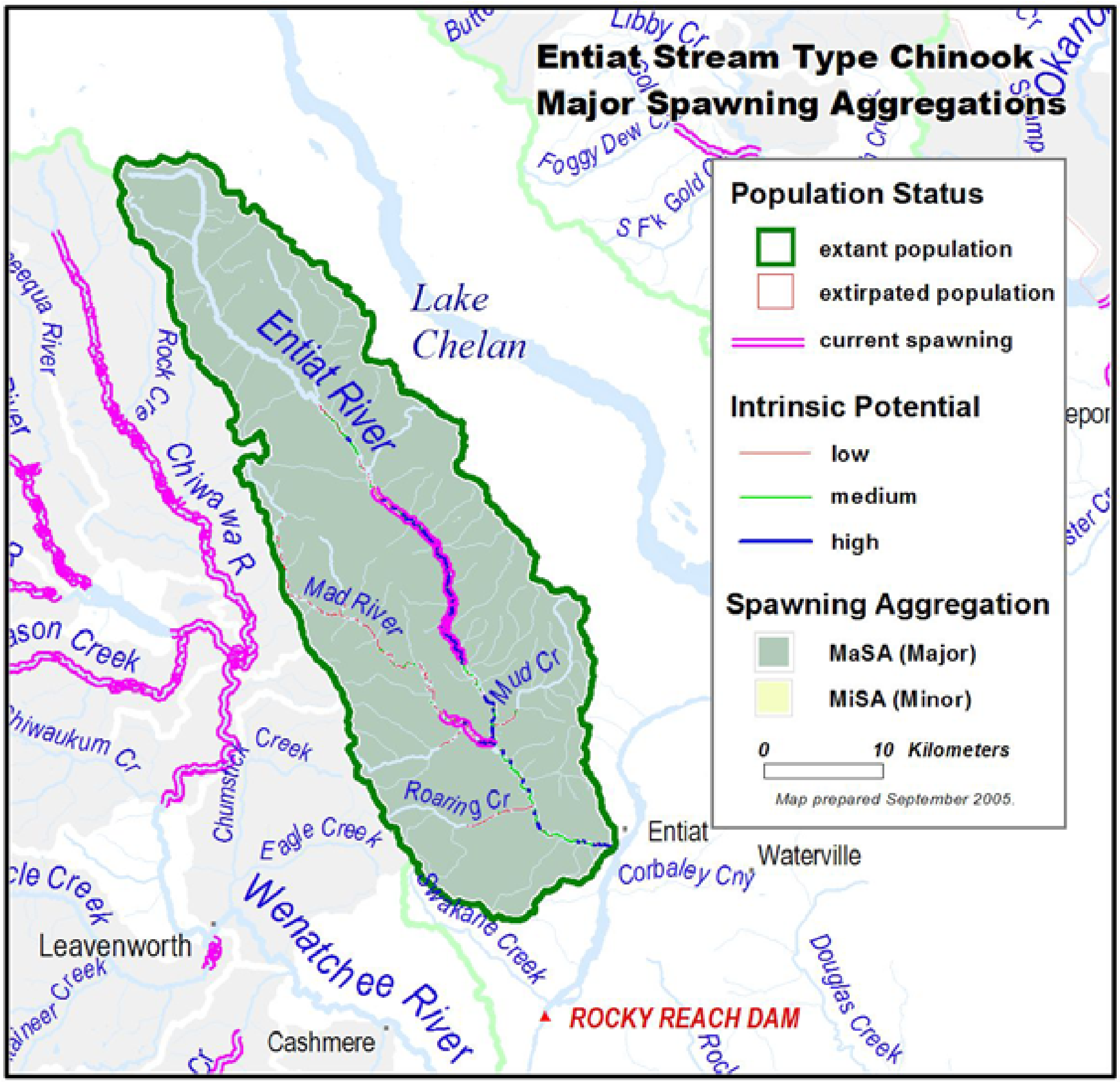

Figure 11. Entiat spring Chinook major and minor spawning aggregations.

Table 7. Entiat Spring Chinook Basin Statistics

Drainage Area (km2)	1,083
Stream lengths km* (total)	542.7
Stream lengths km* (below natural barriers)	245.4
Branched stream area weighted by intrinsic potential (km2)	0.422
Branched stream area km2 (weighted and temp. limited)	0.276
Total stream area weighted by intrinsic potential (km2)	0.537
Total stream area weighted by intrinsic potential (km2) temp limited	0.377
Size / Complexity category	Basic / A (simple linear)
Number of MaSAs	1
Number of MiSAs	0

*All stream segments greater than or equal to 3.8m bankfull width were included

**Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22^{o}C.

The ICTRT has identified one historical Major Spawning Area (MaSA)—the Entiat—and no minor spawning areas (MiSAs) within the Entiat population (Figure 12).

Currently, the primary spawning areas used by Spring Chinook in the Entiat population are the mainstem Entiat (above the Mad River), and below Entiat falls. The Entiat National Fish Hatchery has released unlisted Carson origin spring Chinook into the lower Entiat River annually since 1974. The program is intended to function as a segregated program to augment harvest, the broodstock for this program are not part of the Upper Columbia spring Chinook ESU. Spawning ground surveys in 2001-2005 substantiate that some Entiat National Fish Hatchery returns stray and spawn in upstream natural production areas.

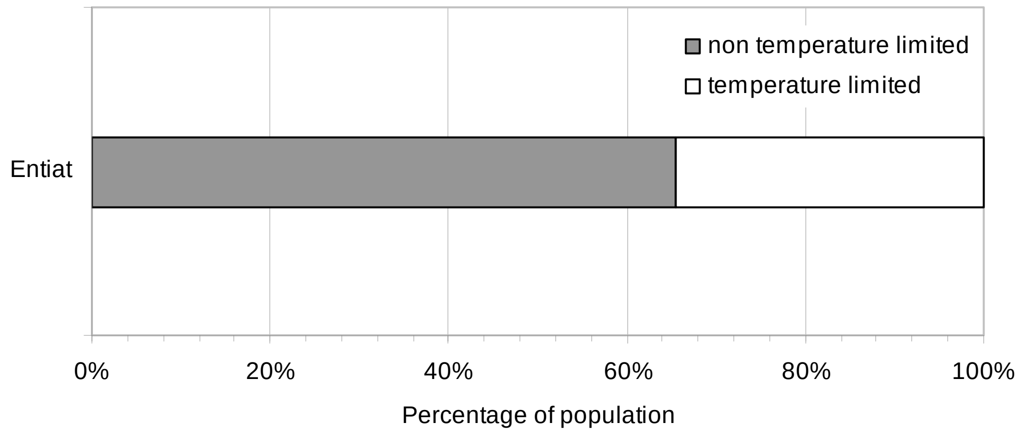

Figure 12. The Entiat River spring Chinook population has only one MaSA, and no MiSAs. Potential temperature limitations are shown in white.

Factors and Metrics

A.1.a Number and spatial arrangement of spawning areas. The Entiat Spring Chinook population has one MaSA (Entiat) and it is currently occupied. The single MaSA has been occupied during the previous 5 years (1999-2003) and 16 of the last 17 years (Hamstreet and Carie 2004). However, since the population has only one MaSA, it is classified as *high risk* for this metric, but that risk is inherent of this small population. The Mad River branch is part of the single MaSA, and its capacity is too low to offer any substantial risk moderation. The Entiat was always high risk due to historically simple spatial structure.

A.l.b. Spatial extent or range of population. The single MaSA has been occupied during the previous 5 years (1999-2003) and 14 of the last 15 years (Hamstreet and Carie 2004) so the population is at *low risk* for this metric (Figure 13).

A.1.c. Increase or decrease in gaps or continuities between spawning aggregates. The range of spawning distribution has been reduced due to the loss of the lower Entiat mainstem as spring Chinook spawning habitat. In recent years, no spring Chinook spawning has been detected below river mile 13, presumably because of the degraded condition of the habitat due to channelization and the high abundance of summer/fall Chinook in the lower Entiat (Hamstreet and Carie 2004). This reduction in range at the lower end of the spawning distribution increases the gap to adjacent populations by more than 10 km but less than 25 km. This situation does not fit precisely within one of the risk level categories in Table 8 of the ICTRT guidance document, but is most consistent with a *moderate risk* rating (ICTRT 2005).

B.1.a. Major life history strategies. The Entiat spring Chinook population is *very low risk*, because no major life history strategies have been lost.

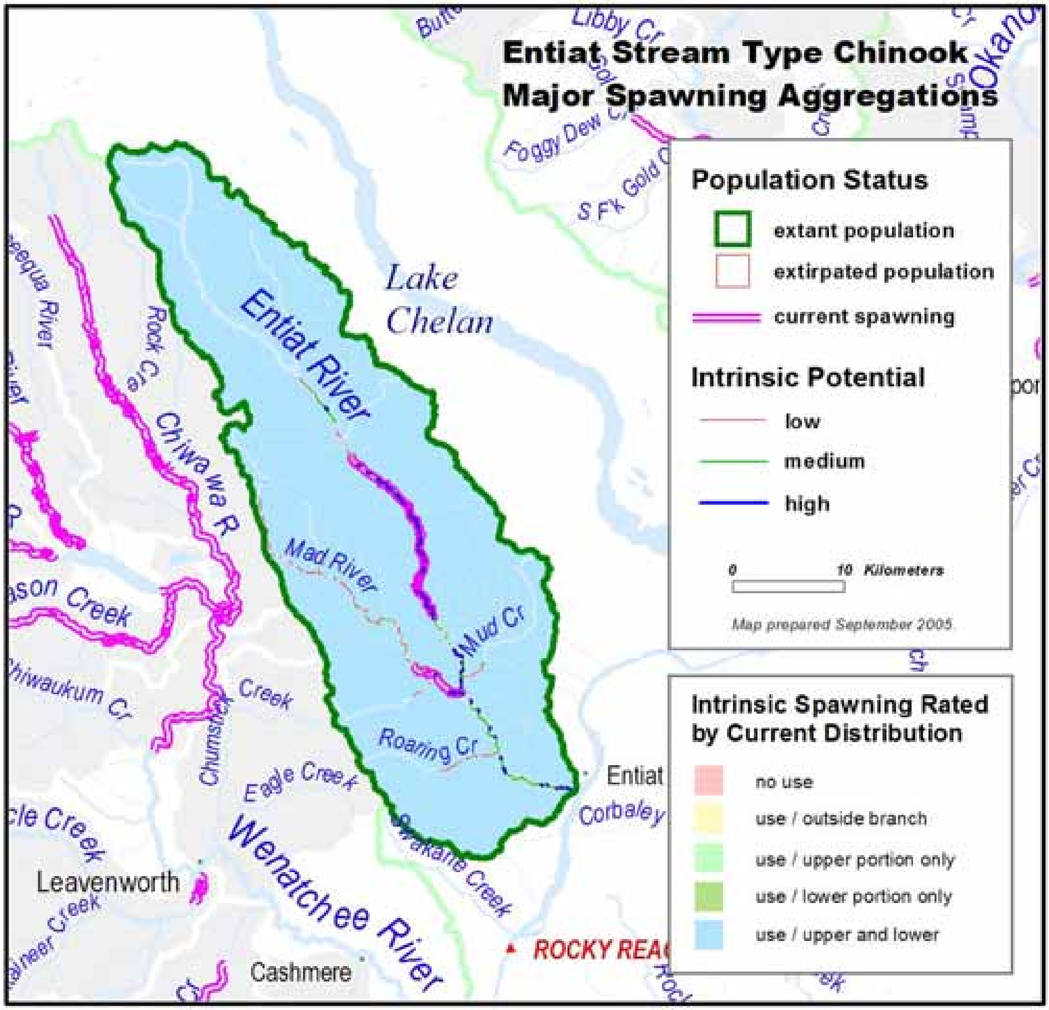

Figure 13. Current spawning distribution of the Entiat spring Chinook population

B.1.b. Phenotypic variation. There are no data available for this metric. Even if we determined that there was a change to one or more traits we do not know what the exact baseline is because changes likely occurred before there was biological monitoring. Therefore, we will assume that there has been some change and increase in variance for 2 or more traits placing the population at *moderate risk*.

B.1.c. Genetic variation. The Entiat spring Chinook population was determined to be at *high risk* for genetic variation due to a persistent homogenization from previous and ongoing fish management efforts. Microsatellite samples collected in the late 1990s and early 2000s do not show differentiation, suggesting that recent management practices may have disrupted natural gene flow (ICTRT pop id draft, in prep). The ICTRT genetic subgroup has reviewed the current status of all populations in the Interior basin. The subgroup concluded that the Entiat population has been homogenized with other UC populations due to past and ongoing hatchery practices. Their conclusion was based on high similarity to all UC hatchery samples and ANOVA analysis indicating no structure. It is possible that the true genetic risk metric for this population is lower.

If additional data becomes available indicating differentiation between and within populations (either genetic data indicating levels of divergence consistent with the time since separation; - or genetic information showing strong spatial structure), the risk level for this metric could improve to moderate or low risk.

B.2.a. Spawner composition.

(1)Out-of-ESU strays. Out-of-ESU hatchery fish averaged 32% (range 18-53%; 31% from ENFH) of the spawning population from 2000-2004 (USFWS unpublished data). Although 5 years of data may not be adequate to define the risk level with high certainty, the threat remains because the Entiat NFH propagates non-local stock and the broodstock must volunteer to the hatchery while all other spawners are allowed to migrate past the hatchery and spawn with the natural population. Therefore the Entiat spring Chinook population is *high risk* with respect to this metric.

(2) *Out of MPG strays*. The Upper Columbia ESU only has one extant MPG, so this metric is *not applicable* and no score will be given.

(3) *Out of population strays*. Out-of-population, but within ESU (and within MPG) hatchery fish averaged 11% (range 0-25%) of the spawning population from 2000-2004, with 3 of the 5 years less than 10% (USFWS unpublished data). Based on the average spawner composition for one generation the Entiat spring Chinook population is at *moderate risk* with respect to this metric.

(4) *Within-population strays*. There is no supplementation program for spring Chinook in the Entiat basin. Therefore, this metric is *not applicable* to the Entiat spring Chinook population.

B.3.a. Distribution of population across habitat types. The intrinsic potential distribution for Entiat spring Chinook covered two or three ecoregions, depending on whether a high temperature screen was applied to the historic intrinsic potential distribution (Figure 14; Table 8). If the temperature screen is applied the population is at low risk, if the temperature screen is not applied it is at moderate risk due to the loss of 1 ecoregion (see flow diagram on page 38 of ICTRT 2005). Due to the uncertainty of the historic suitability of the lower Entiat for spring Chinook, and because of the extensive use of the lower Entiat by summer Chinook (a separate ESU), we believe it is most appropriate to use the temperature screen and rate the Entiat population at *low risk* for this metric.

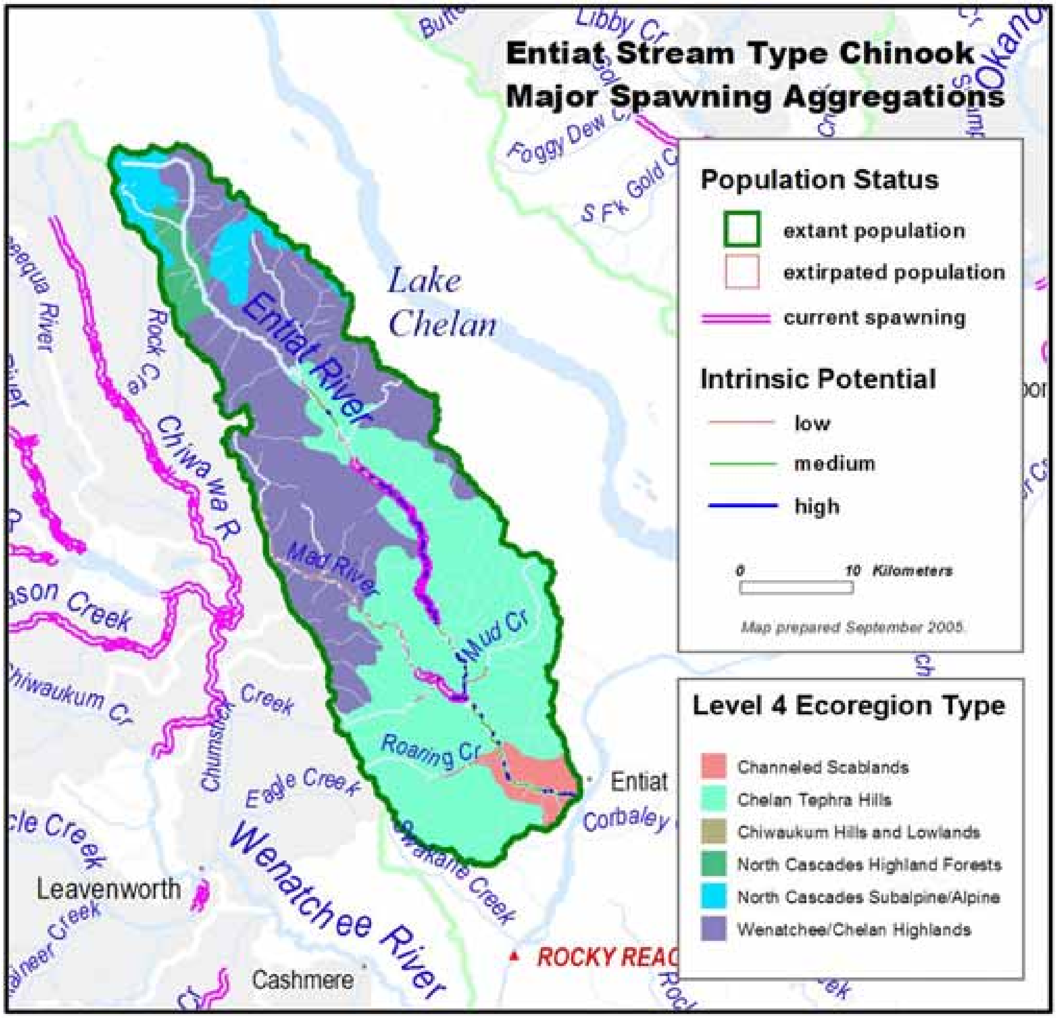

Figure 14. Distribution of the Entiat spring Chinook population across various ecoregion types.

Table 8. Entiat Spring Chinook – proportion of spawning area across various ecoregions

Ecoregion	% of historical branch spawning area in this ecoregion (non-temperature limited)	% of currently occupied spawning area in this ecoregion	% of historical branch spawning area in this ecoregion (temp. limited)
Channeled Scablands	20.7	0.0	0.0
Chelan Tephra Hills	78.8	99.0	99.1
Wenatchee/Chelan Highlands	0.6	1.0	0.9

*Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22°C.

B.4.a. Selective change in natural processes or selective impacts.

Hydropower system: Low risk. Although out migration has slowed for early and late out migrants, recent years flow augmentation has reduced the impact to the middle 95% of the run.

Harvest: Low risk in recent generations. Harvest rates affect < 20% of the adults and selective gear reduces the impact of selectivity.

Hatcheries: Not applicable.

Habitat: Low risk no known factors that would be selective.

Based on low risk estimates across the four sectors, we conclude that the population is at *low risk* for this metric.

Spatial Structure and Diversity Summary

The Entiat spring Chinook population was moderate risk for goal A (allowing natural rates and levels of spatially mediated processes) but high risk for goal B (Maintaining natural levels of variation) resulting in an overall high-risk rating (Table 9). The metric for genotypic variation (B.1.c) was directly responsible for the high-risk rating and it is likely that additional genetic analysis of natural origin Entiat spring Chinook would increase the certainty of this assessment. For B.1.b. (phenotypic variation), an analysis needs to be conducted that shows that the phenotypic traits of the current population are consistent with the assumed historical condition or with unaltered reference populations in a similar habitat, geologic, and hydrologic setting.

There was one metric that was rated at high risk related to spawner composition that did not directly reduce the overall risk conclusion, but should be considered a potential threat to both genotypic (B.1.3) and phenotypic variation (B.1.b). The spawner composition contained a very high proportion of out-of-ESU strays, primarily from the Entiat National Fish Hatchery.

Although reproductive success of ENFH strays is unknown, it is unlikely that genotypic variation consistent with moderate-low risk can be obtained with continued high proportions of these fish on the spawning grounds.

Table 9. Spatial structure and diversity scoring table

<table>
<tr><th rowspan="2">Metric</th><th colspan="5">Risk Assessment Scores</th></tr>
<tr><th>Metric</th><th>Factor</th><th>Mechanism</th><th>Goal</th><th>Population</th></tr>
<tr><td>A.1.a</td><td>H (-1)</td><td>H (-1)</td><td rowspan="3">Moderate Risk
(Mean = 0)</td><td rowspan="3">Moderate Risk</td><td rowspan="14">High Risk</td></tr>
<tr><td>A.1.b</td><td>L (1)</td><td>L (1)</td></tr>
<tr><td>A.1.c</td><td>M (0)</td><td>M (0)</td></tr>
<tr><td>B.1.a</td><td>VL (2)</td><td>VL (2)</td><td rowspan="3">High Risk
(-1)</td><td rowspan="11">High Risk</td></tr>
<tr><td>B.1.b</td><td>M (0)</td><td>M (0)</td></tr>
<tr><td>B.1.c</td><td>H (-1)</td><td>H (-1)</td></tr>
<tr><td>B.2.a(1)</td><td>H (-1)</td><td rowspan="4">High Risk
(-1)</td><td rowspan="4">High Risk
(-1)</td></tr>
<tr><td>B.2.a(2)</td><td>NA</td></tr>
<tr><td>B.2.a(3)</td><td>M (0)</td></tr>
<tr><td>B.2.a(4)</td><td>NA</td></tr>
<tr><td>B.3.a</td><td>L (1)</td><td>L (1)</td><td>L (1)</td></tr>
<tr><td>B.4.a</td><td>L (1)</td><td>L (1)</td><td>L (1)</td></tr>
</table>

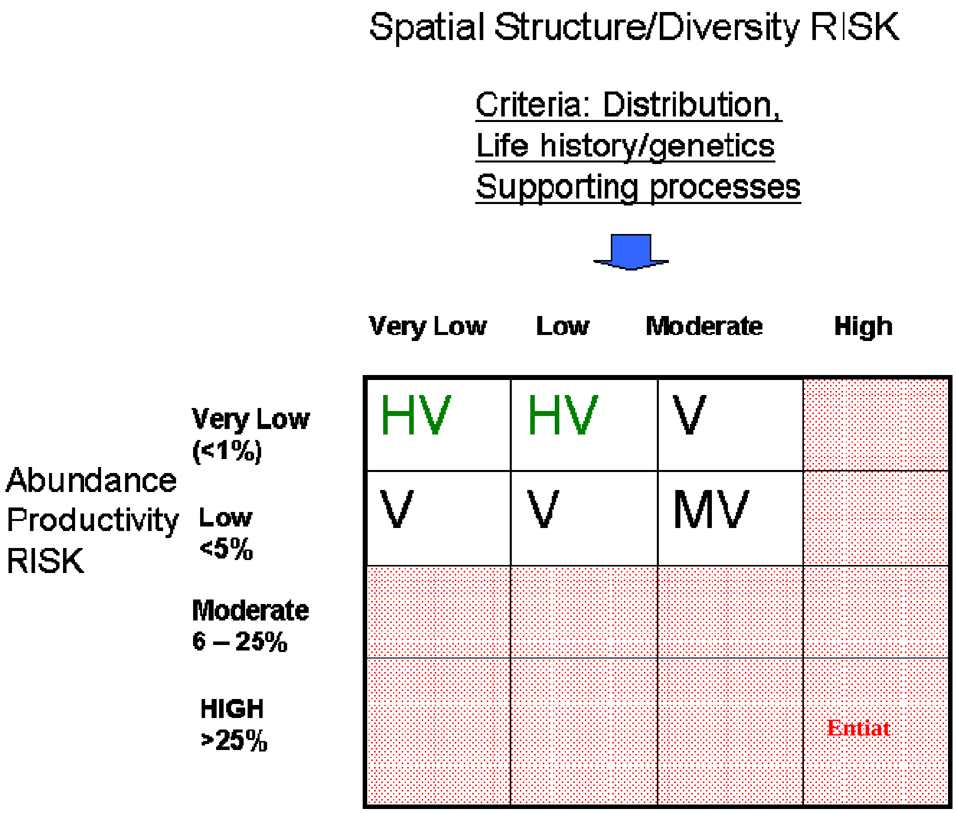

Figure 15. Abundance & productivity and spatial structure & diversity integration table.

Overall Risk Rating:

The spatial structure and diversity of the Entiat spring Chinook population is currently rated as high risk. Improvement of the spatial structure and diversity status to moderate risk would be required to allow the Entiat population to achieve a "viable" or "minimum viable" status (in addition to the improvements needed for abundance and productivity) (Figure 15). Due to the natural limitations of a basic, category A population, the Entiat could never achieve "highly viable" status. Based on the MPG and ESU guidelines, the Entiat population only needs to achieve "minimum viable" status for its contribution to recovery of the ESU.

Entiat Summer Steelhead Population

The Entiat summer steelhead population is part of the Upper Columbia ESU that only has one extant *MPG* that includes 4 current populations: Wenatchee, Entiat, Methow Rivers, and Okanogan) plus Crab Creek (Figure 16) (ICTRT 2004). The ICTRT classified the Entiat River summer steelhead population as "basic" in size based on historical habitat potential (ICTRT 2005). This classification requires a minimum abundance threshold of 500 wild spawners with sufficient intrinsic productivity (>1.0 r/s) to exceed a 5 % extinction risk on the viability curve (ICTRT 2005). Additionally, the Entiat steelhead population was classified as a "type A" population (based on historic intrinsic potential) because of its simple spatial structure (i.e., only 2 branches) (Table 10) (ICTRT 2005).

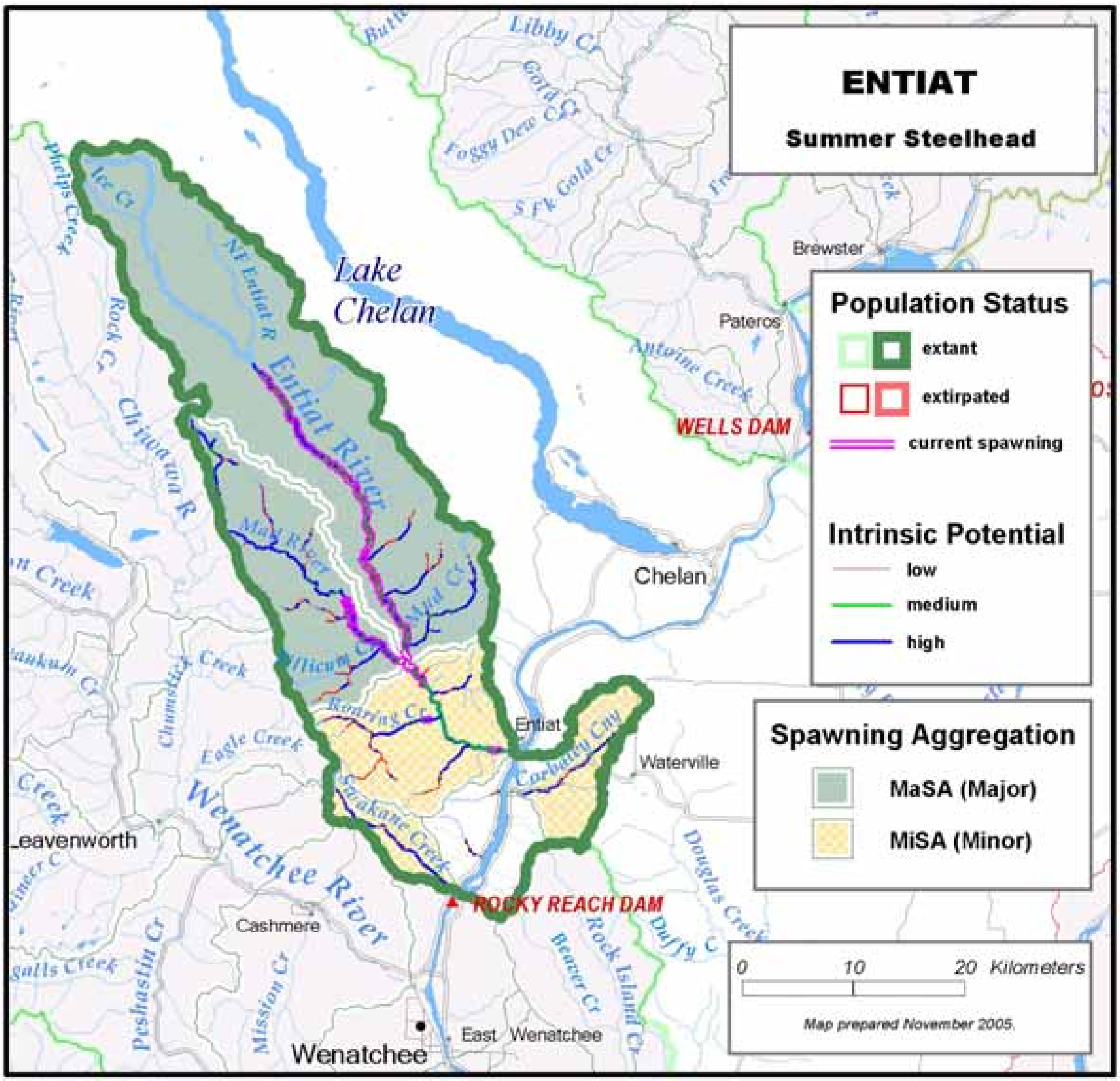

Figure 16. Entiat summer/winter steelhead major and minor spawning aggregates.

Table 10. Entiat summer/winter Steelhead Basin Statistics

Drainage Area (km2)	1.326
Stream lengths km* (total)	585
Stream lengths km* (below natural barriers)	288
Branched stream area weighted by intrinsic potential (km2)	1.196
Branched stream area km2 (weighted and temp. limited)	0.897
Total stream area weighted by intrinsic potential (km2)	1.456
Total stream area weighted by intrinsic potential (km2) temp limited	1.135
Size / Complexity category	Basic / A (simple linear)
Number of MaSAs	2
Number of MiSAs	3

*All stream segments greater than or equal to 3.8m bankfull width were included

**Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22^{o}C.

The ICTRT identified two historical Major Spawning Areas (MaSAs) and three minor spawning areas (MiSAs) within the Entiat population (Figure 17).

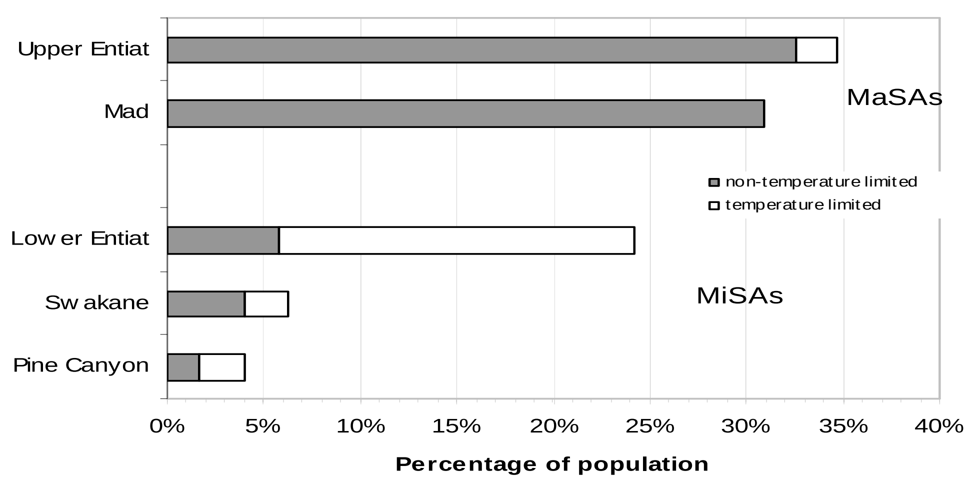

Figure 17. Percentage of historical spawning habitat by major/minor spawning area. Temperature limited portions of each MaSA/MiSA are shown in white. The Lower Entiat is considered to be a MiSA because it drops to less than 125,000 m^2 under temperature limitations.

Factors and Metrics

A.1.a Number and spatial arrangement of spawning areas. The ICTRT identified two major and three minor spawning areas for the Entiat summer steelhead population. The major spawning areas include the Upper Entiat (including Mud, Potato, and Stormy Creeks) and the Mad River (including Tillicum Creek) whereas the minor spawning areas include the Lower Entiat (including Roaring Creek), Swakane Creek, and Pine Canyon. Based on agency defined distribution, only the Upper Entiat MaSA and Lower Entiat MiSA would meet the ICTRT definition of occupied because the Mad only has spawners present in the lower portion of the intrinsic potential habitat (mouth to rkm 12). Assuming that the lower half of the Mad River MaSA and the Lower Entiat MiSA are over 75% of the capacity of a MaSA then the Entiat steelhead population is at *moderate risk* for this metric.

A.l.b. Spatial extent or range of population. Efforts to monitor the distribution and abundance of spawning steelhead have been initiated and expanded in recent years (2003-2005), but we still do not have comprehensive, long-term data sets to rate this metric for the Entiat population. Based on these recent data sets, one of the two MaSAs and one of the three MiSA in the Entiat were occupied putting the population at *moderate risk* for this metric (Figure 18). Only two official surveys have been conducted in the upper ½ of the Mad River MaSA and no redds have been detected in the relatively short stretch (~2 km) that was surveyed (Archibald et al? 2004, 2005). There has been little to no anthropogenic influence in this area so it is considered functional but unoccupied habitat and it may well have been occupied in areas or years that were not surveyed.

A.1.c. Increase or decrease in gaps or continuities between spawning aggregates. The Entiat steelhead population is at *moderate risk* for this metric because only 50% of the MaSAs are occupied, but unoccupied MaSAs have not increased gaps between MaSAs. Also, the absence of known spawning in Swakane Creek does not increase the gap between populations by more than 25 km.

B.1.a. Major life history strategies. The Entiat steelhead population is *very low risk*, because no major life history strategies have been lost (i.e. no winter run was ever present and resident *O. mykiss* are known to occur in the watershed).

B.1.b. Phenotypic variation. There are no data available for this metric. Even if we determined that there was a change to one or more traits we do not know what the exact baseline is because changes likely occurred before there was biological monitoring. Therefore, we will assume that there has been some change and increase in variance for 2 or more traits placing the population at *moderate risk*.

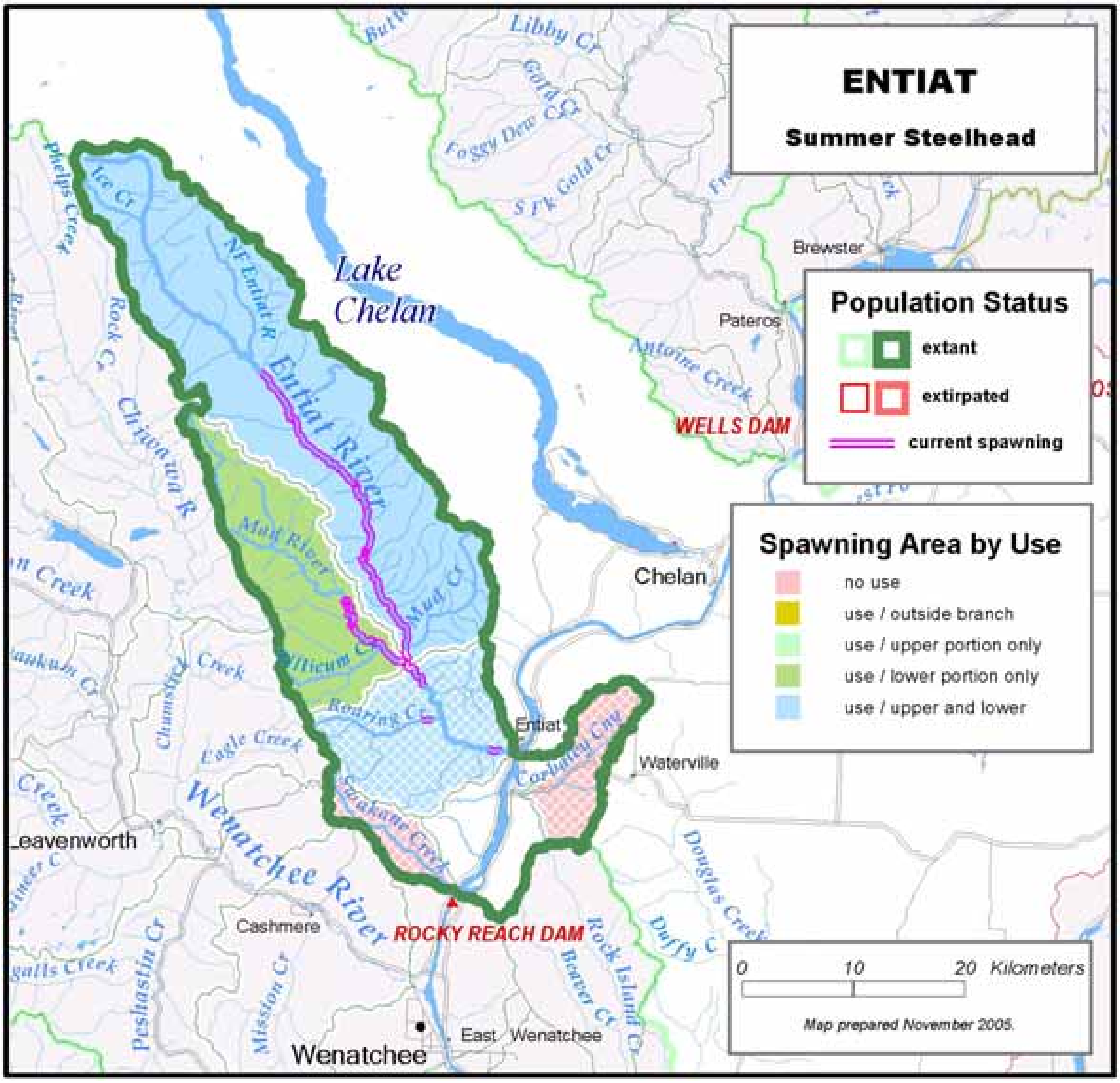

Figure 18. Entiat summer/winter Steelhead current spawning distribution.

<u>B.1.c. Genetic variation.</u> The Entiat summer steelhead population was determined to be at *high risk* for genetic variation due to a persistent homogenization from previous and ongoing fish management efforts. The genetic signal shows little differentiation between populations with strong similarity to Wells Hatchery; however, all available data are at least 20 years old. There is a possibility that the true genetic risk metric for this population should be lower, especially since there have been no targeted releases of hatchery steelhead in the basin for about 10 years. If additional data becomes available indicating differentiation between and within populations (either genetic data indicating levels of divergence consistent with the time since separation; robust straying data or genetic information showing strong spatial structure), this metric can be downgraded.

B.2.a. Spawner composition.

(1) *Out-of-ESU strays.* We have no data to evaluate the proportion of out of ESU hatchery strays on the spawning grounds of the Entiat population; therefore the default rating is *moderate risk*. However, there are no hatchery programs propagating non-local anadromous stock in the ESU and we have no reason to believe that the Entiat steelhead population is at an elevated risk level for this metric. Therefore, when considering future status reviews we may want to consider an alternative measurement location, such as Priest Rapids Dam, to determine risk to the ESU, instead of to individual populations.

(2) *Out of MPG strays*. The Upper Columbia ESU only has one extant MPG, so this metric is *not applicable* and no score will be given.

(3) *Out of population strays*. No data exists for the spawner composition of steelhead in the Entiat basin, but it is believed that a high proportion of fish spawning in the Entiat are of hatchery origin. Additionally, there is substantial risk of strays from the Wells hatchery program because of the inter-dam difference in adult counts between Rocky Reach and Wells Dam. Also, large numbers of Wenatchee River hatchery steelhead have been observed at the Wells trap, upstream of the Entiat (this program raises steelhead at Turtle Rock (Columbia River) and direct plants them in the Wenatchee basin with no acclimation). Therefore, because of these threats we conclude that the Entiat is at *high risk* for within ESU hatchery strays. However, data needs to be collected to verify if these threats are being realized on the spawning grounds of the Entiat population.

(4) *Within-population strays.* There is no supplementation program for steelhead in the Entiat basin. Therefore, this metric is *not applicable* to the Entiat steelhead population.

B.3.a. Distribution of population across habitat types. The distribution of intrinsic branches for Entiat summer steelhead covered 5 ecoregions, 3 of which were considered significant (>10%) (Figure 19; Table 11). Substantial shifts (> 67%) have occurred in 1 of the 3 ecoregions (Wenatchee/Chelan Highlands), based on no occupancy in the upper ½ of the Mad River MaSA. Therefore, the population is at *moderate risk* for this metric.

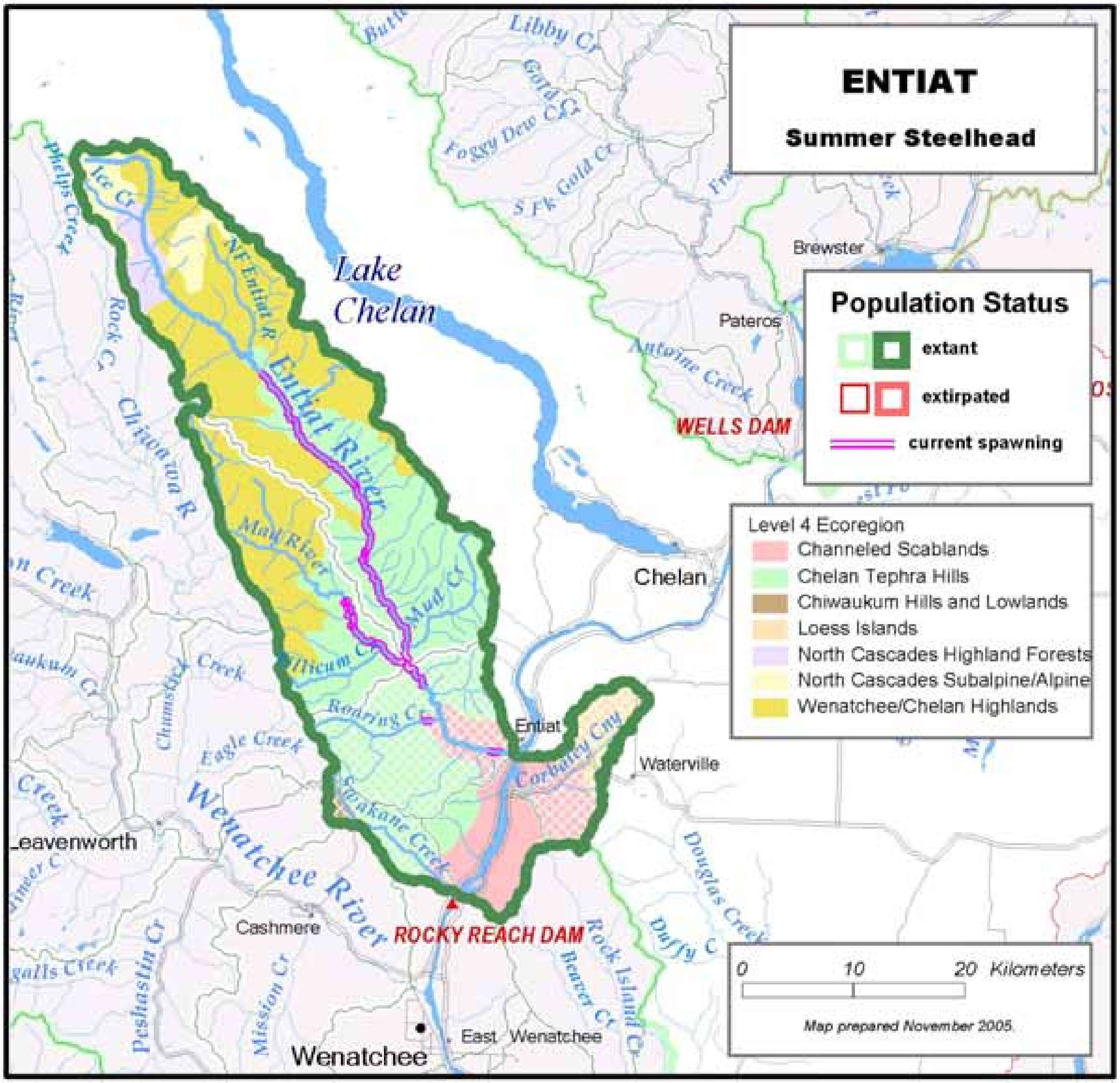

Figure 19. Entiat summer/winter steelhead population distribution across various ecoregions.

Table 11. Entiat Summer/Winter Steelhead – proportion of spawning area across various ecoregions

Ecoregion	% of historical spawning area in this ecoregion (non-temperature limited)	% of currently occupied spawning area in this ecoregion (non-temperature limited)
Channeled Scablands	17.7	6.4
Chelan Tephra Hills	66.2	93.3
Chiwaukum Hills And Lowlands	2.7	0.0
Loess Islands	1.0	0.0
Wenatchee/Chelan Highlands	12.4	0.3

B.4.a. Selective change in natural processes or selective impacts.

Hydropower system: Low risk, although it has slowed out migration for early and late out migrants, but in recent years flow augmentation has reduced the impact to the middle 95% of the run.

Harvest: Low risk in recent generations. Harvest rates affect < 20% of the adults and selective gear reduces the impact of selectivity.

Hatcheries: Low risk, broodstock management of the other Upper Columbia population supplementation programs has been designed to be non-selective.

Habitat: Low risk, no known measurable effects.

Based on low risk estimates across the four sectors, we conclude that the population is at *low risk* for this metric.

Spatial Structure and Diversity Summary

The Entiat steelhead population was determined to be at moderate risk for goal A (allowing natural rates and levels of spatially mediated processes) and high risk for goal B (maintaining natural levels of variation) resulting in an overall high risk rating (Table 12). For goal A, the lack of confirmed spawning in the upper ½ of the Mad River MaSA was causing the risk level to decrease from low to moderate for all 3 metrics. For goal B, the metric for genotypic variation was directly responsible for the moderate risk rating of Entiat summer steelhead. We concluded that there was not enough data available to determine if the level of divergence in the Wenatchee was sufficient for a low or high risk rating and therefore used a moderate risk rating. For B.1.b. (phenotypic variation), an analysis needs to be conducted that shows that the phenotypic traits of the current population are consistent with the assumed historical condition or with unaltered reference populations in a similar habitat, geologic, and hydrologic setting. Based on the scoring system, these metrics must be addressed in order for the status of goal B to improve to low risk.

Another metric that was rated at high risk was the proportion of out-of-population (but within ESU) spawners that were hatchery fish (B.2.a.2), because of the threat of strays from the Wells and Wenatchee hatchery programs.

Table 12. Spatial structure and diversity scoring table

<table>
<tr><th rowspan="2">Metric</th><th colspan="5">Risk Assessment Scores</th></tr>
<tr><th>Metric</th><th>Factor</th><th>Mechanism</th><th>Goal</th><th>Population</th></tr>
<tr><td>A.1.a</td><td>M (0)</td><td>M (0)</td><td rowspan="3">Moderate Risk
(Mean = 0)</td><td rowspan="3">Moderate Risk</td><td rowspan="13">High Risk</td></tr>
<tr><td>A.1.b</td><td>M (0)</td><td>M (0)</td></tr>
<tr><td>A.1.c</td><td>M (0)</td><td>M (0)</td></tr>
<tr><td>B.1.a</td><td>VL (2)</td><td>VL (2)</td><td rowspan="3">High Risk
(-1)</td><td rowspan="10">High Risk</td></tr>
<tr><td>B.1.b</td><td>M (0)</td><td>M (0)</td></tr>
<tr><td>B.1.c</td><td>H (-1)</td><td>H (-1)</td></tr>
<tr><td>B.2.a(1)</td><td>M (0)</td><td rowspan="4">High Risk
(-1)</td><td rowspan="4">High Risk (-1)</td></tr>
<tr><td>B.2.a(2)</td><td>NA</td></tr>
<tr><td>B.2.a(3)</td><td>H (-1)</td></tr>
<tr><td>B.2.a(4)</td><td>NA</td></tr>
<tr><td>B.3.a</td><td>M (0)</td><td>M (0)</td><td>Moderate Risk (0)</td></tr>
<tr><td>B.4.a</td><td>L (1)</td><td>L (1)</td><td>Low Risk (1)</td></tr>
</table>

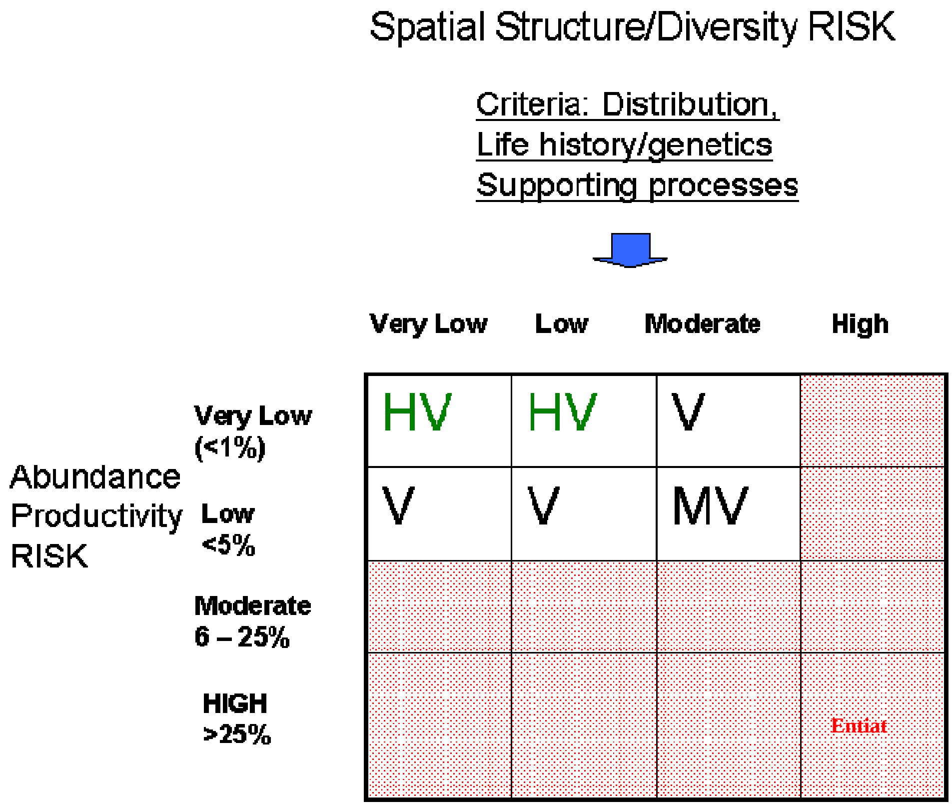

Figure 20. Abundance & productivity and spatial structure & diversity integration table.

Overall Risk Rating:

The spatial structure and diversity of the Entiat summer steelhead population is currently rated as high risk. Improvement of the spatial structure and diversity status to moderate risk would be necessary to allow the Entiat population to achieve a “minimum viable” status (in combination with low risk A&P) or “viable” status (with very low risk A&P) (Figure 20). Based on the MPG guidelines, the Entiat population will only need to achieve a minimum viable status for recovery of the ESU (ICTRT 2005).

Methow Spring Chinook Population

The Methow spring Chinook population is part of the Upper Columbia ESU. This ESU contains only one extant MPG including 3 current populations—Wenatchee, Entiat, and Methow Rivers (Figure 21) (ICTRT 2004). The ICTRT classified the Methow River spring Chinook population as "very large" in size based on historical habitat potential (ICTRT 2005). This classification requires a minimum abundance threshold of 2000 wild spawners with sufficient intrinsic productivity (>1.75 r/s) to exceed a 5 % extinction risk on the viability curve (ICTRT 2005). Additionally, the Methow spring Chinook population was classified as a "type B" population (based on historic intrinsic potential) because it has dendritic tributary structure with multiple major spawning areas (Table 13) (ICTRT 2005).

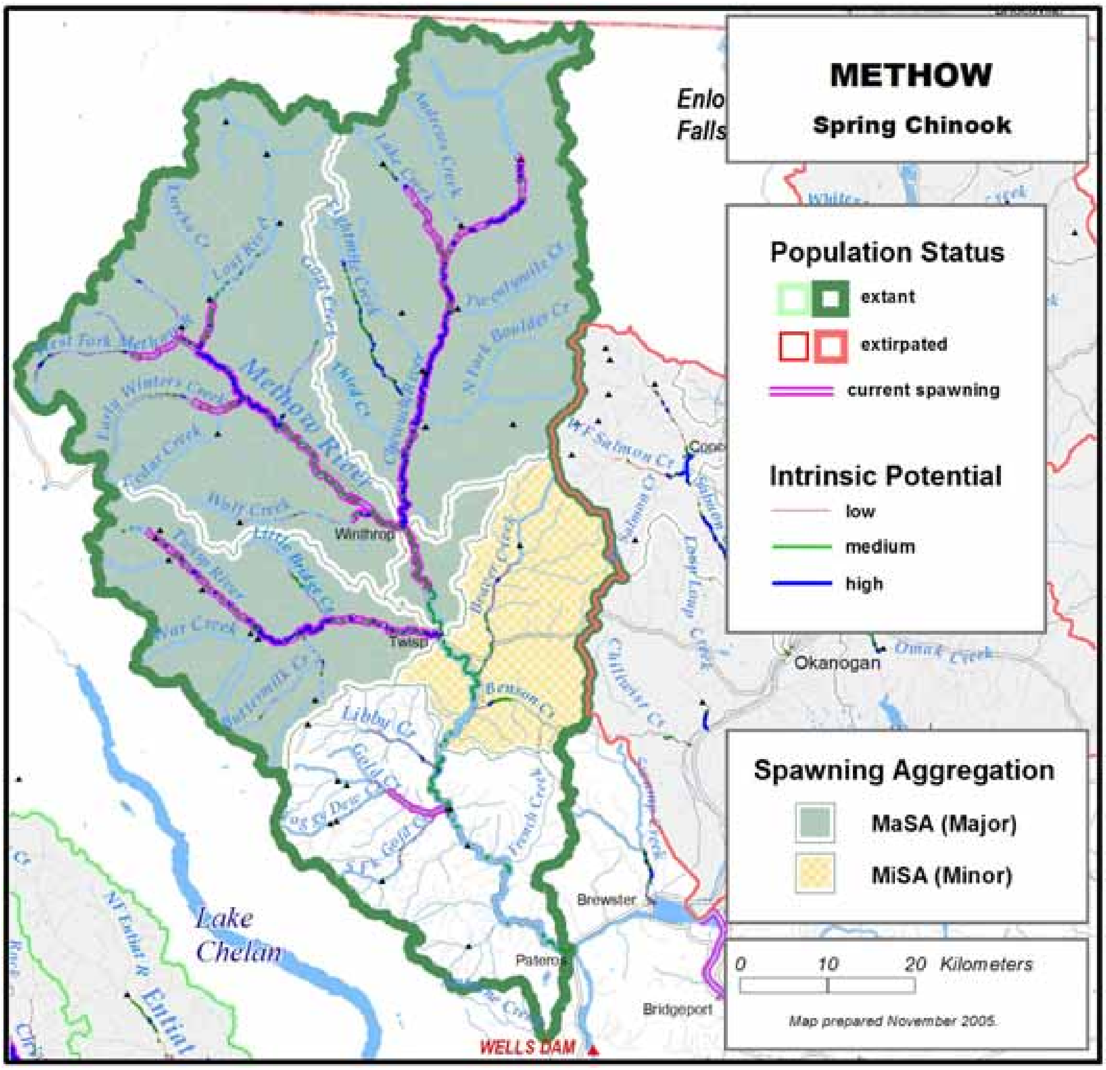

Figure 21. Methow spring Chinook major and minor spawning aggregations

Table 13. Methow spring Chinook basin statistics

Drainage Area (km2)	4,722
Stream lengths km* (total)	1,996.0
Stream lengths km* (below natural barriers)	889.0
Branched stream area weighted by intrinsic potential (km2)	1.497
Branched stream area km2 (weighted and temp. limited)	1.310
Total stream area weighted by intrinsic potential (km2)	2.036
Total stream area weighted by intrinsic potential (km2) temp limited	1.725
Size / Complexity category	Very Large / B (dendritic structure)
Number of MaSAs	4
Number of MiSAs	1

*All stream segments greater than or equal to 3.8m bankfull width were included

**Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22^{o}C.

The ICTRT has identified four historical Major Spawning Areas (MaSAs) and one minor spawning area (MiSA) within the Methow population (Figure 22). The four MaSAs are: Chewuch, Upper Methow, Middle Methow, and Twisp.

Currently, the primary spawning areas used by Spring Chinook in the Methow population are the mainstem Methow (above the Twisp confluence), Twisp, and Chewuch rivers. Additional spawning has been documented in Gold Creek, Wolf Creek, Robinson Creek, Lake Creek, and Early Winters Creek. Hatchery origin spring Chinook returns to natural spawning areas within the Methow basin originate from two separate programs. Winthrop National Fish Hatchery has planted spring Chinook in the Methow basin since 1941 (continuously since 1974). Beginning in 1998, broodstock for this program was shifted to a Methow “composite” stock. Since 1992, WDFW has operated the Methow Hatchery as a central facility to carry out release programs from acclimation facilities in three tributaries within the Methow River—the Methow, Chewuch and Twisp drainages. Broodstock for the Twisp program are collected from returns to the Twisp system. In recent years, a composite broodstock has been used for the Chewuch and Methow releases. The majority of returns from these programs spawn in their natal watersheds although there has been a relatively high rate of straying among areas within the Methow.

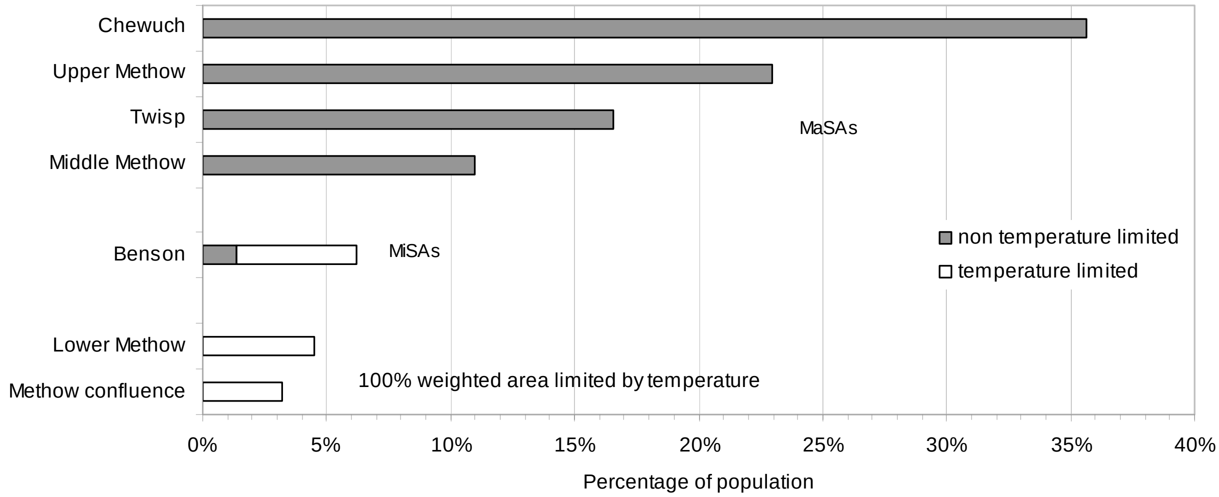

Figure 22. Percentage of historical spawning habitat (of the population) by major/minor spawning area. White portions are subject to temperature limitations. The Lower Methow and Methow confluence are 100% limited by temperature, therefore they are not included as MiSAs.

Factors and Metrics

A.1.a Number and spatial arrangement of spawning areas. The Methow Spring Chinook population has four MaSAs (Chewuch, Upper Methow, Middle Methow, and Twisp) and they are all currently occupied (based on agency defined distribution) so it is at *very low risk.*

A.l.b. Spatial extent or range of population. The Methow spring Chinook population has four MaSAs (Chewuch, Twisp, Upper Methow, and middle Methow mainstem), but only 3 of the 4 MaSAs meet the occupancy definition so it is at *low risk* (Figure 23). The MaSA that failed to meet minimum occupancy requirements was the middle Methow mainstem (between the Chewuch and Twisp confluences), which only had more than 4 redds in 3 of the last 5 years and 6 of the last 15 years (Humling and Snow 2005).

A.1.c. Increase or decrease in gaps or continuities between spawning aggregates. There has been no increase or decrease in gaps greater than 10 km between MaSAs for the Methow spring Chinook population so it is at *low risk* for this metric.

B.1.a. Major life history strategies. The Methow spring Chinook population is *very low risk*, because no major life history strategies have been lost.

B.1.b. Phenotypic variation. There are no data available for this metric. Even if we determined that there was a change to one or more traits we do not know what the exact baseline is because changes likely occurred before there was biological monitoring. Therefore, we will assume that there has been some change and increase in variance for 2 or more traits placing the population at *moderate risk*.

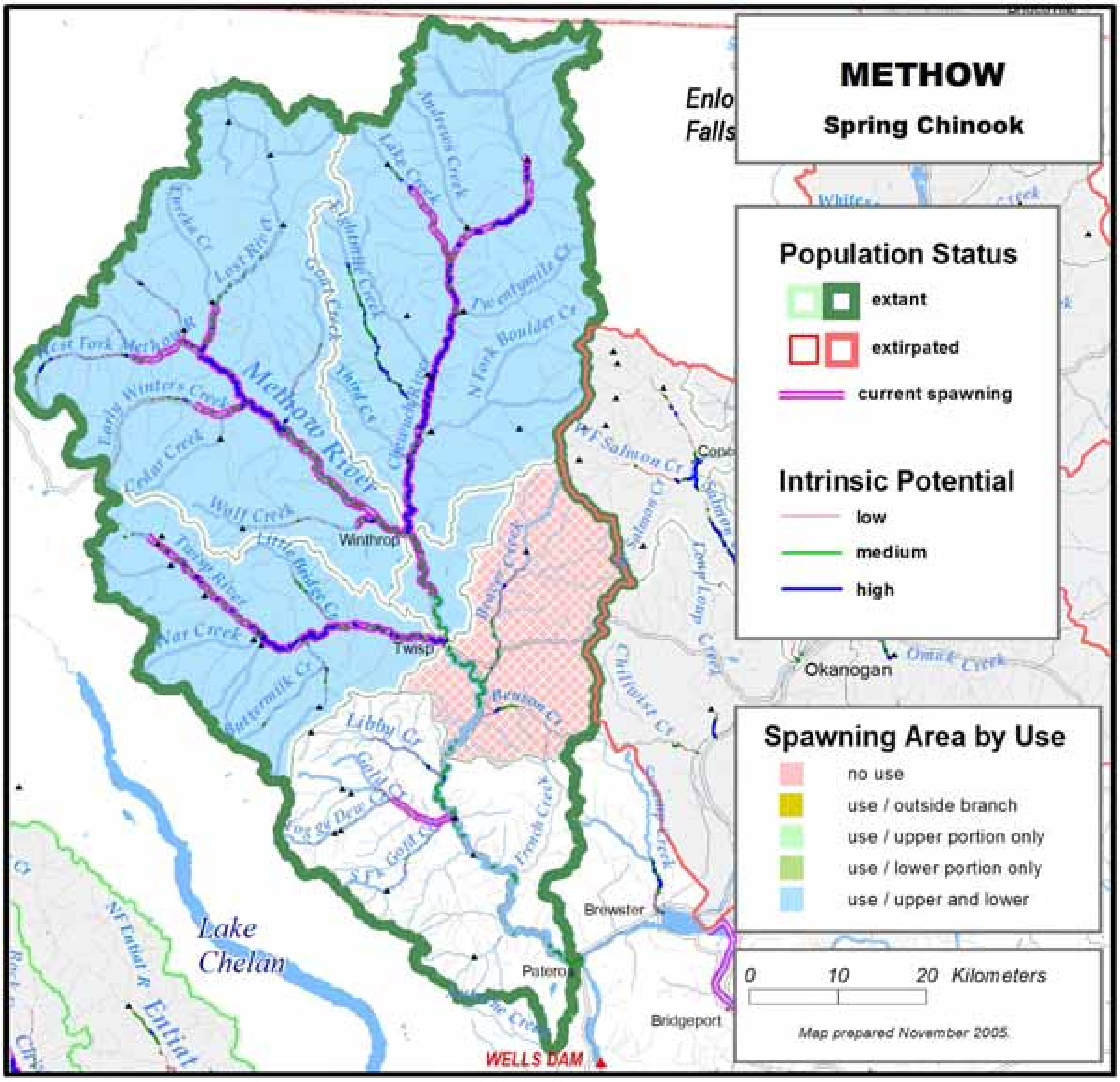

Figure 23. Methow spring Chinook current distribution

<u>B.1.c. Genetic variation.</u> The Methow spring Chinook population was determined to be at *high risk* for genetic variation due to a persistent homogenization from previous fish management efforts. Analyses based on allozymes collected in the 1980s suggest that there was some differentiation between subpopulations consistent with the level of differentiation expected in that time frame, particularly in the Twisp drainage. However, microsatellite samples collected in the late 1990s and early 2000s do not show this same differentiation, suggesting that recent management practices may have disrupted natural gene flow (ICTRT pop id draft, in prep). The ICTRT genetic subgroup has reviewed the current status of all populations in the Interior basin. The subgroup concluded that the Methow population has been homogenized with other UC populations due to past practices. Their conclusion was based on high similarity to all UC hatchery samples and ANOVA analysis indicating no structure. Additionally, the hatchery stocks

currently used in the upper Methow and Chewuch programs still contain a large percentage of Carson lineage, and hatchery fish comprise high proportions (40-98%) of fish on the spawning grounds (Humling and Snow 2004), so the threats to genetic variation have not been completely removed. It is possible that the true genetic risk metric for this population is lower. If additional data becomes available indicating differentiation between and within populations (either genetic data indicating levels of divergence consistent with the time since separation; robust straying data, or genetic information showing strong spatial structure), the risk level for this metric could improve to moderate or low risk.

B.2.a. Spawner composition.

(1) *Out-of-ESU strays*. In 2003, there was a 1% spawner composition (Humling and Snow 2004) of hatchery fish from outside the population, but the Methow State Hatchery and the Winthrop National Fish Hatchery are propagating a composite stock that has outside the ESU lineage, so the population is at *moderate risk* for this metric.

(2) *Out of MPG strays*. The Upper Columbia ESU only has one extant MPG, so this metric is *not applicable* and no score will be given.

(3) *Out of population strays*. Methow comp hatchery fish contain a high proportion of Carson stock in their lineage and cannot be considered "best management practices". These fish consistently comprise more than 90% of the spawner composition on the spawning grounds (Humling and Snow 2005); therefore, the population is at *high risk* with respect to this metric.

(4) *Within-population strays*. This metric is *not applicable* because of the high proportion of Carson lineage in the Methow comp stock that is being propagated for the supplementation program.

B.3.a. Distribution of population across habitat types. The intrinsic potential distribution for Methow Spring Chinook covered three ecoregions (Table 4). Current distribution also encompasses 3 ecoregions with no losses or substantial shifts in distribution among ecoregions (Figure 24; Table 14). Therefore, the population was at *low risk* for this metric.

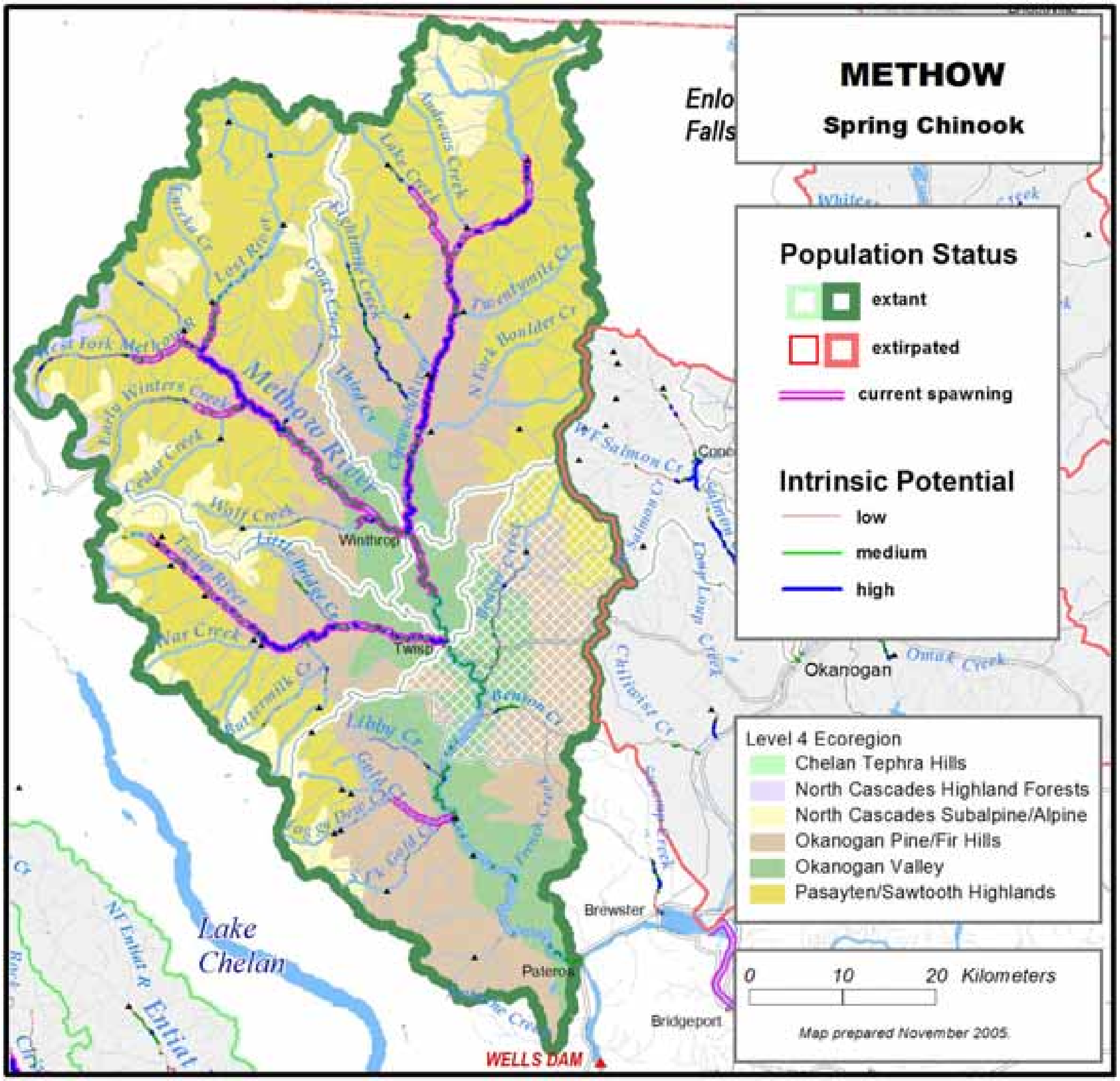

Figure 24. Methow spring Chinook population distribution across various ecoregions.

Table 14. Methow spring Chinook – proportion of spawning area across various ecoregions

Ecoregion	% of historical branch spawning area in this ecoregion (non-temperature limited)	% of historical branch spawning area in this ecoregion (temp. limited)	% of currently occupied spawning area in this ecoregion
Okanogan Pine/Fir Hills	44.0	50.3	50.4
Okanogan Valley	45.4	37.6	34.8
Pasayten/Sawtooth Highlands	10.6	12.1	14.8

*Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22^{o}C.

B.4.a. Selective change in natural processes or selective impacts.

Hydropower system: Low risk, although it has slowed out migration for early and late out migrants, but in recent years flow augmentation has reduced the impact to the middle 95% of the run.

Harvest: Low risk in recent generations. Harvest rates affect <20% of the adults and selective gear reduces the impact of selectivity.

Hatcheries: Low risk, broodstock management of the Methow-comp supplementation program has been designed to be non-selective.

Habitat: Low risk, although low flow and high temperatures in some areas could prohibit run timing for late arriving adults.

Based on low risk estimates across the four sectors, we conclude that the population is at *low risk* for this metric.

Spatial Structure and Diversity Summary

The Methow spring Chinook population was determined to be at low risk for goal A (allowing natural rates and levels of spatially mediated processes) but high risk for goal B (maintaining natural levels of variation) resulting in an overall high risk rating (Table 15). The metric for genotypic variation was directly responsible for the high risk rating of Methow spring Chinook. For B.1.b. (phenotypic variation) to improve from moderate to low risk, an analysis needs to be conducted that shows that the phenotypic traits of the current population are consistent with the assumed historical condition or with unaltered reference populations in a similar habitat, geologic, and hydrologic setting.

There was one metric that was rated at high risk related to spawner composition (B.2.a.3.) that did not directly reduce the overall risk conclusion, but should be considered a potential threat to both genotypic (B.1.3) and phenotypic variation (B.1.b). Met-comp hatchery fish contain a high proportion of Carson stock in their lineage and cannot be considered "within population" hatchery fish for the spawner composition metric. These fish consistently comprise more than 90% of the spawner composition on the spawning grounds (Humling and Snow 2005). However, due to the scoring system this high-risk rating was averaged in with other metrics and did not directly cause an increased risk rating.

Table 15. Spatial structure and diversity scoring table

Metric	Risk Assessment Scores				
	Metric	Factor	Mechanism	Goal	Population
A.1.a	VL (2)	VL (2)	Low Risk Mean = 1.25	Low Risk	**High Risk**
A.1.b	L (1)	L (1)			
A.1.c	L (1)	L (1)			
B.1.a	VL (2)	VL (2)	High Risk (-1)	High Risk	
B.1.b	M (0)	M (0)			
B.1.c	H(-1)	(H-1)			
B.2.a(1)	M (0)	High Risk (-1)	High Risk (-1)		
B.2.a(2)	NA				
B.2.a(3)	H (-1)				
B.2.a(4)	NA				
B.3.a	L (1)	L (1)	L (1)		
B.4.a	L (1)	L (1)	L (1)		

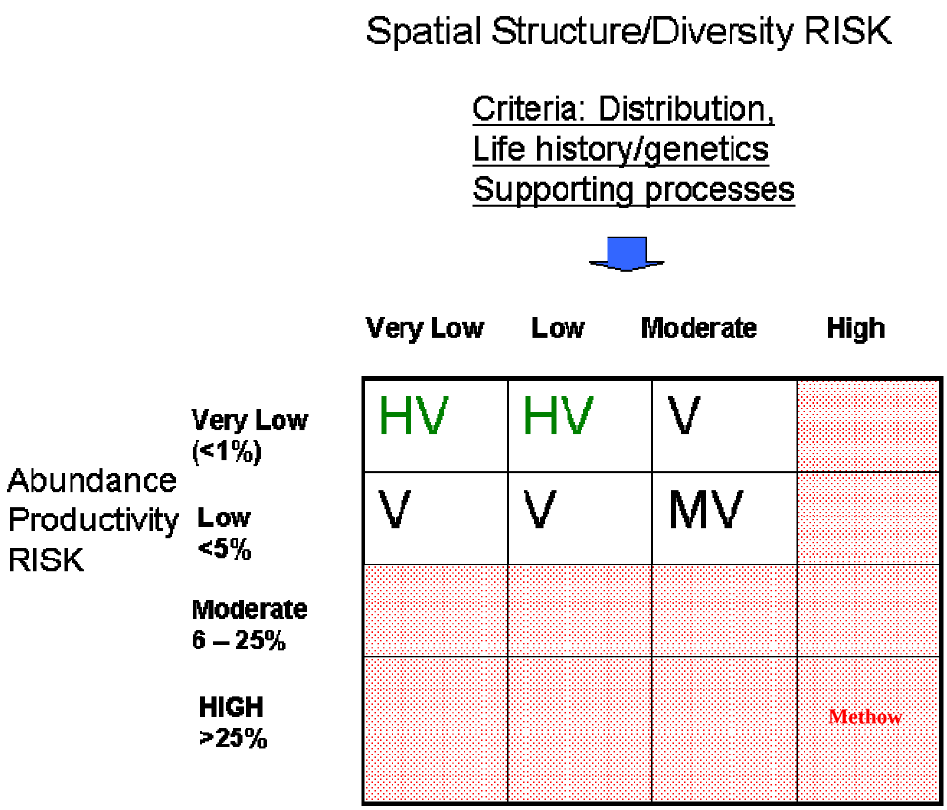

Figure 25. Abundance & productivity and spatial structure & diversity integration table.

Overall Risk Rating:

The spatial structure and diversity of the Methow spring Chinook population is currently rated as high risk. Improvement of the spatial structure and diversity status to low risk would be required to allow the Methow population to achieve a "highly viable" status (in addition to the improvements needed for abundance and productivity) (Figure 25). Based on the MPG guidelines, the Methow population will need to achieve a highly viable status for recovery of the ESU (ICTRT 2005).

Methow Summer Steelhead Population

The Methow summer steelhead population is part of the Upper Columbia ESU that only has one extant *MPG* that includes four current populations (Wenatchee, Entiat, Methow, and Okanogan Rivers) plus Crab Creek. (Figure 26) (ICTRT 2004). The size category of the Methow River summer steelhead population is "large" based on historical habitat potential (ICTRT 2005). This classification requires a minimum abundance threshold of 1,500 wild spawners with sufficient intrinsic productivity (>1.0 r/s) to exceed a 5 % extinction risk on the viability curve (ICTRT 2005). Additionally, the Methow summer steelhead population was classified as a type (B) population (based on historic intrinsic potential) because it has dendritic tributary structure with multiple major spawning areas (Table 16) (ICTRT 2005).

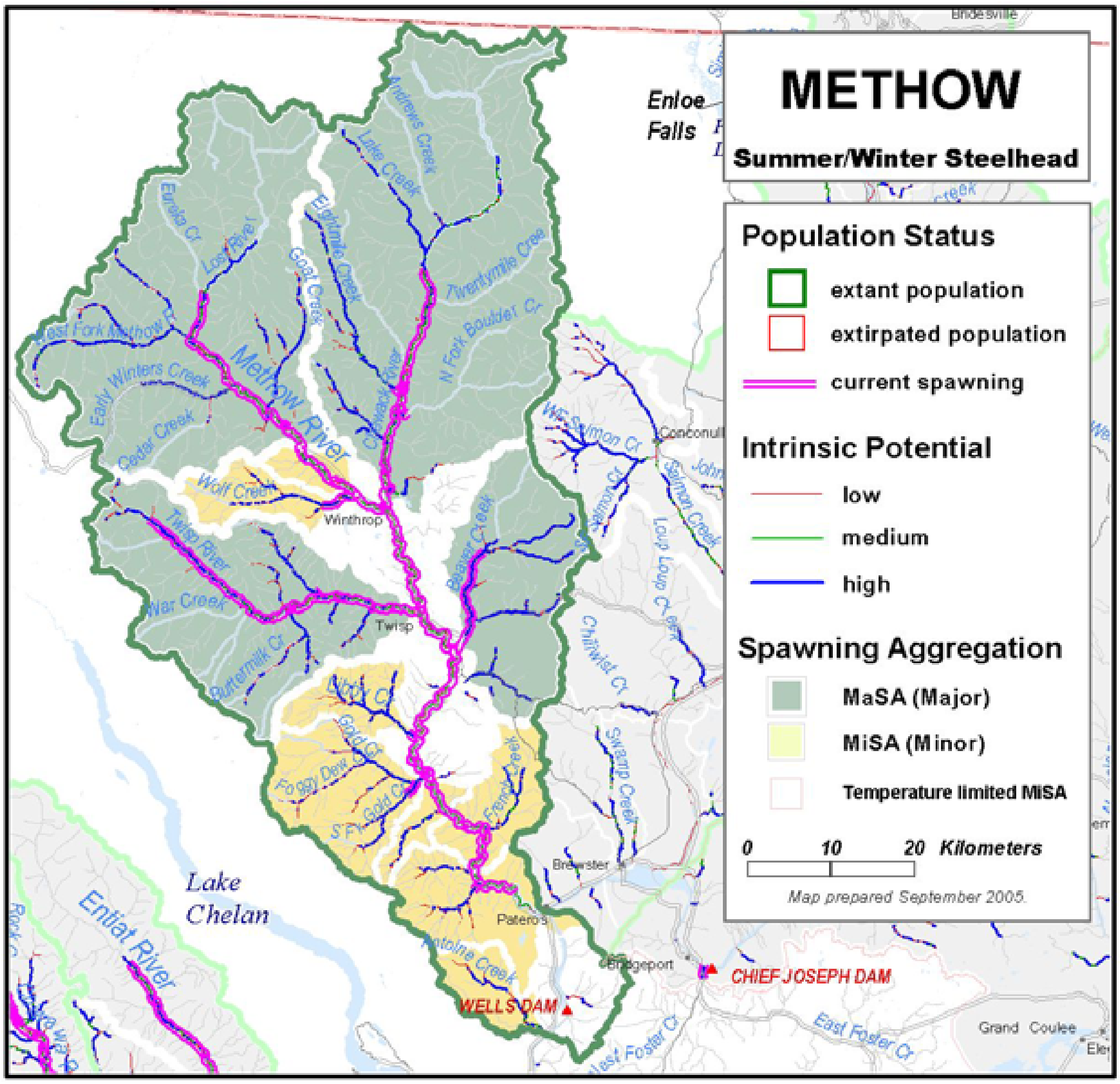

Figure 26. Major and minor spawning aggregations of the Methow summer/winter Steelhead population.

Table 16. Methow summer Steelhead basin statistics

Drainage Area (km2)	4,936
Stream lengths km* (total)	2,039
Stream lengths km* (below natural barriers)	918
Branched stream area weighted by intrinsic potential (km2)	3.491
Branched stream area km2 (weighted and temp. limited)	3.268
Total stream area weighted by intrinsic potential (km2)	5.694
Total stream area weighted by intrinsic potential (km2) temp limited	4.414
Size / Complexity category	Large / B (dendritic structure)
Number of MSAs	4
Number of mSAs	8

*All stream segments greater than or equal to 3.8m bankfull width were included

**Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22^{o}C.

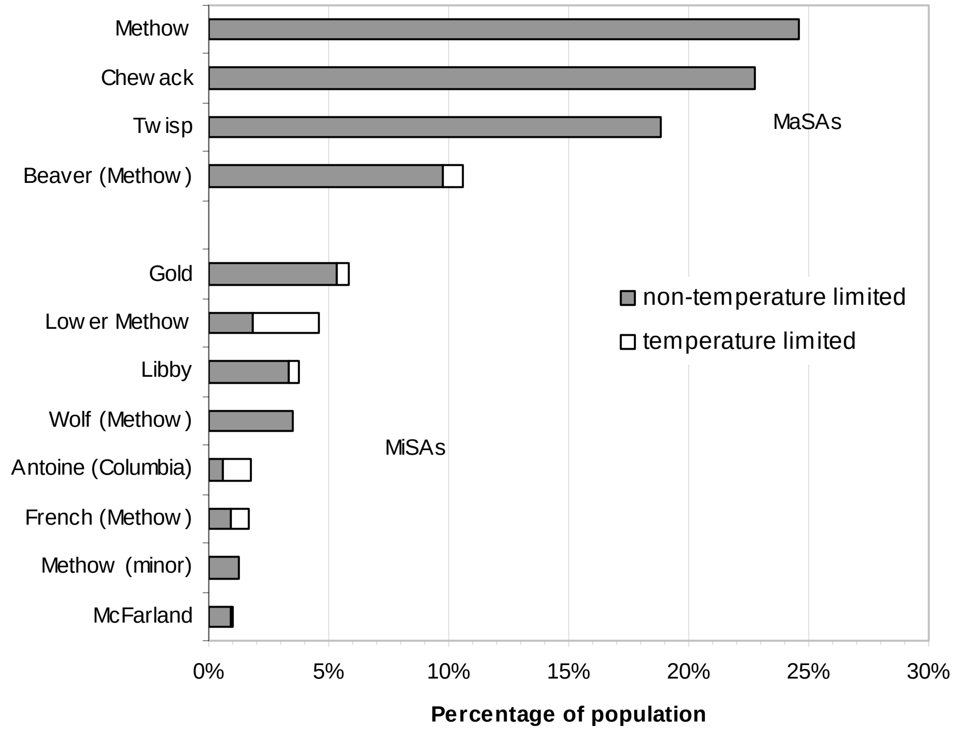

Figure 27. Percentage of historical spawning habitat by major/minor spawning areas in the Methow summer/winter Steelhead population. Temperature limited portions of the MiSA/MaSAs are shown in white.

Factors and Metrics

<u>A.1.a Number and spatial arrangement of spawning areas</u>. The ICTRT intrinsic potential analysis identified four major and eight minor spawning areas for the Methow summer steelhead population (Figure 27). Based on agency defined distribution, all of the MaSAs are occupied along with at least half of the MiSAs (Gold, Libby, Wolf Creeks, and the Lower Methow River putting the Methow steelhead population at *very low risk* for this metric.

<u>A.l.b. Spatial extent or range of population.</u> Based on agency defined distribution, all of the MaSAs are occupied along with at least half of the MiSAs (Gold, Libby,Wolf Creeks, and the Lower Methow River putting the Methow steelhead population at *low risk* for this metric (Figure 28).

Efforts to monitor the distribution and abundance of spawning steelhead have been initiated and expanded in recent years (2001-2005), but we still do not have comprehensive, long-term data to rate this metric for the Methow population. However, based on recent spawning ground surveys, all four MSA's were occupied in the upper and lower halves from 2001-2004, with the lowest average of 41 redds (2002-2004) occurring in Beaver Creek (Snow 2003; Humling and Snow 2004). These estimates do not separate out the hatchery fish and since natural origin fish were only approximately 10% of the population (based on fish trapped at Wells Dam), it's possible that there were few to no natural origin steelhead present in Beaver Creek in 2003.

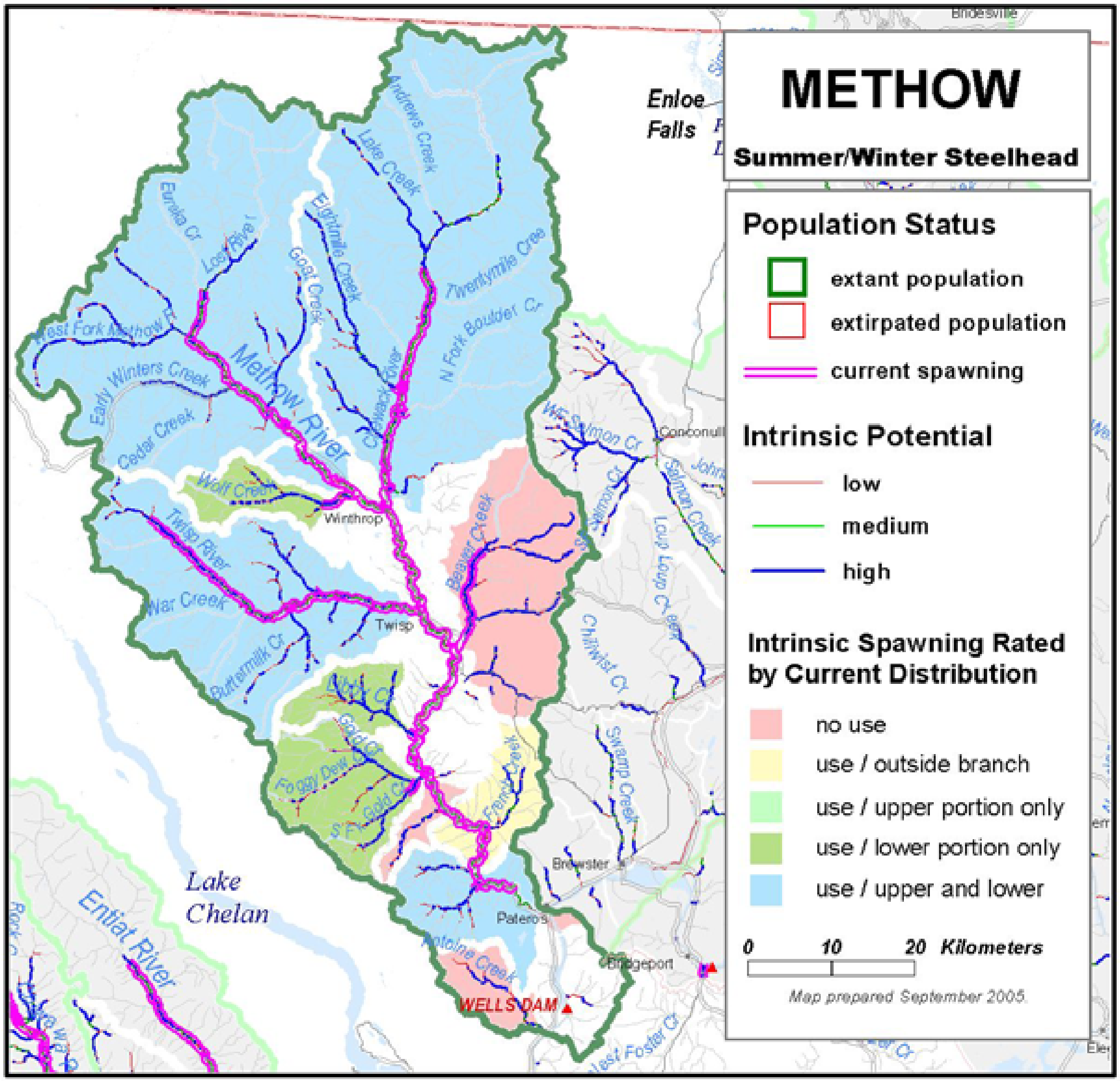

Figure 28. Current distribution of the Methow population.

<u>A.1.c. Increase or decrease in gaps or continuities between spawning aggregates.</u> The Methow steelhead population is at *low risk* for this metric because all of the MaSAs are occupied (no gaps) and unoccupied MiSAs have not increased gaps to adjacent populations by more than 25 km. However, several of the MiSAs appear to not be occupied, or have not been formally surveyed, based on recent redd surveys conducted by WDFW (Snow 2003; Humling and Snow 2004). Although two redds were located in Gold Creek in 2003, no redds were found there in 2002 or 2004 and no redds were found in Black Canyon Creek in 2004 (Snow 2003; Humling

and Snow 2004). We are not aware of any surveys in McFarland or French Creeks and they were not considered "potential" habitat based on agency-defined distribution. However, French Creek is included in a rotating panel design and will be surveyed once every 5 years starting in 2006 (Humling and Snow 2004).

B.1.a. Major life history strategies. The Methow steelhead population is *very low risk*, because no major life history strategies have been lost (i.e. no winter run was ever present and resident *O. mykiss* are known to occur in the watershed).

B.1.b. Phenotypic variation. There are no data available for this metric. Even if we determined that there was a change to one or more traits we do not know what the exact baseline is because changes likely occurred before there was biological monitoring. Therefore, we will assume that there has been some change and increase in variance for 2 or more traits placing the population at *moderate risk*.

B.1.c. Genetic variation. The Methow summer steelhead population was determined to be at *high risk* for genetic variation due to a persistent homogenization from previous and ongoing fish management efforts. The genetic signal shows little differentiation between populations with strong similarity to Wells Hatchery; however, all available data at least 20 years old. There is a possibility that the true genetic risk metric for this population should be lower. If additional data becomes available indicating differentiation between and within populations (either genetic data indicating levels of divergence consistent with the time since separation; robust straying data or genetic information showing strong spatial structure), this metric can be downgraded.

B.2.a. Spawner composition.

(1) *Out-of-ESU strays*. The Methow steelhead population is at *low risk* since there is no evidence of non-local (outside the ESU) hatchery fish passing Wells Dam.

(2) *Out of MPG strays*. The Upper Columbia ESU only has one extant MPG, so this metric is *not applicable* and no score will be given.

(3) *Out of population strays*. There are no estimates of spawner composition for the various MaSAs and MiSAs of the Methow steelhead population because carcasses cannot be obtained in sufficient numbers from the spawning ground surveys. However, in 2004 only 9.5 % of the steelhead passing Wells Dam were natural origin (Humling and Snow 2004). This is similar to the proportion of wild fish from previous years (Kirk Truscott, personal communication). This high proportion of hatchery origin spawners would result in *high risk*, regardless of whether or not the program was considered best management practices. However, the program was not considered best management practices because adult steelhead are trapped at Wells Dam (mainstem Columbia River) and they could have originated from any of the MaSAs within the Methow or from the Okanogan. Additionally, steelhead releases occur at various locations throughout the Methow and Okanogan, thereby mixing the progeny from various MaSAs of two independent populations and not encouraging local adaptation within the population or between the Methow and Okanogan population.

Although the Wells hatchery program does use wild fish, the NMFS BiOp restricts the broodstock to no more than 33% natural origin fish, regardless of the run size (NMFS 2002). This constraint limits the opportunity to meet production requirements with all wild fish during years of high abundance, a practice that would reduce the genetic risk of the hatchery program.

Finally, there has been high numbers of Wenatchee steelhead observed passing Wells Dam in recent years, presumably because they are reared on Columbia River water at the Turtle Rock facility before direct release with no acclimation in the Wenatchee (Kirk Truscott, personal communication). There is currently no information to determine if Wenatchee steelhead do show up on the spawning grounds of the Methow basin and efforts to monitor this risk need to be conducted. Therefore, given the extremely high proportion of hatchery fish passing Wells Dam, the mixing of Methow and Okanogan fish in the broodstock, the release of smolts into the Methow that could have originated from Okanogan parents, and the threat that the Wenatchee strays pose, suggest that the population is at *high risk* for this metric.

(4) *Within-population strays*. No score will be given for this metric because the Wells hatchery stock was rated for metric B.2.a.3 and therefore this metric is *not applicable*. The Wells hatchery program mixes Methow and Okanogan origin adults and therefore does not meet best management practices.

<u>B.3.a. Distribution of population across habitat types</u>. The distribution of intrinsic branches for Methow summer steelhead covered four ecoregions, three of which were considered significant (>10%) (Figure 29; Table 17). Substantial shifts (>67%) have occurred in 1 of the 3 ecoregions (Pasayten/Sawtooth Highlands). Therefore, the population is at *moderate risk* for this metric. The majority of the currently unoccupied habitat in the Pasayten/Sawtooth Highlands Ecoregion is in the upper Twisp, Upper Methow, and Upper Chewuch where the habitat is in pristine conditions and there are few to no anthropogenic effects limiting spatial structure in these areas.

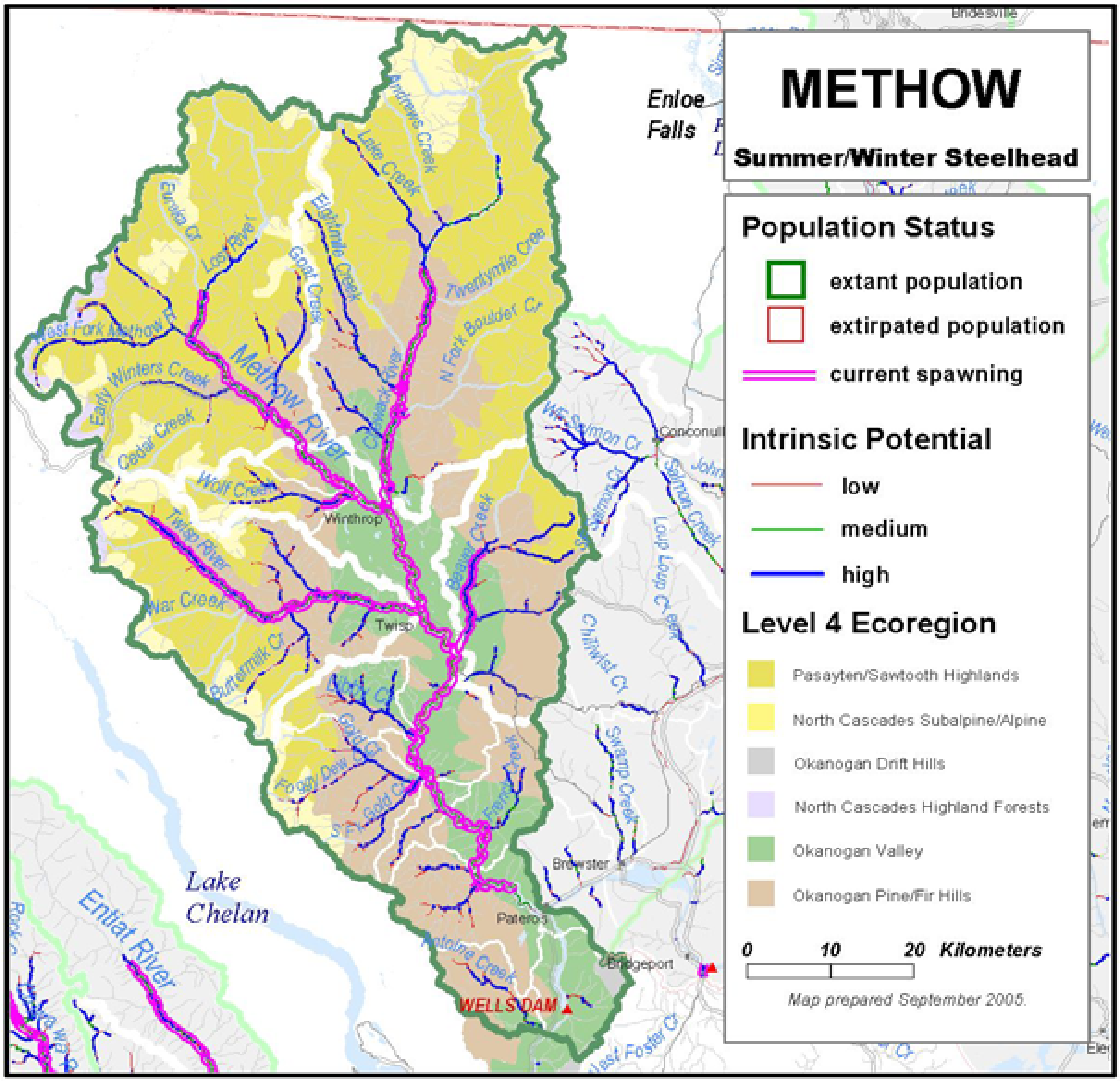

Figure 29. Distribution of the Methow steelhead population across various ecoregions.

Table 17. Methow summer Chinook – proportion of spawning area across various ecoregions

Ecoregion	% of historical spawning area in this ecoregion (non-temperature limited)	% of currently occupied spawning area in this ecoregion (non-temperature limited)
North Cascades Highland Forests	0.0	0.0
North Cascades Subalpine/Alpine	0.1	0.0
Okanogan Pine/Fir Hills	50.4	30.6
Okanogan Valley	20.3	64.9
Pasayten/Sawtooth Highlands	29.0	4.6

B.4.a. Selective change in natural processes or selective impacts.

Hydropower system: Low risk, although it has slowed out migration for early and late out migrants, but in recent years flow augmentation has reduced the impact to the middle 95% of the run.

Harvest: Low risk in recent generations. Harvest rates affect < 20% of the adults and selective gear reduces the impact of selectivity.

Hatcheries: Low risk, broodstock management of the Methow\Okanogan composite stock program has been designed to be non-selective.

Habitat: Low risk, no known measurable effects.

Based on low risk estimates across the four sectors, we conclude that the population is at *low risk* for this metric.

Spatial Structure and Diversity Summary

The Methow steelhead population was determined to be at low risk for goal A (allowing natural rates and levels of spatially mediated processes) and high risk for goal B (Maintaining natural levels of variation) resulting in an overall high risk rating (Table 18). For goal B, the metrics for genotypic variation was directly responsible for the high risk rating of Methow summer steelhead. For B.1.b. (phenotypic variation), an analysis needs to be conducted that shows that the phenotypic traits of the current population are consistent with the assumed historical condition or with unaltered reference populations in a similar habitat, geologic, and hydrologic setting. Based on the scoring system, these metrics must be addressed in order for the status of goal B to improve to low risk.

Another metric that was rated at high risk was the proportion of out-of-population (but within ESU) spawners that were hatchery fish (B.2.a.2). There were several factors that lead to a high risk rating, even though we did not have data that directly measured the origin of adults the spawning grounds. These risks included the extremely high proportion of hatchery fish passing Wells Dam (~90%), the mixing of Methow and Okanogan fish in the broodstock, the release of smolts into the Methow that could have originated from Okanogan parents, and the threat from the high number of Wenatchee origin steelhead passing Wells Dam. It is likely that genotypic and phenotypic variation have been influenced by past hatchery practices and that it will be difficult to achieve low risk levels for metrics B.1.b (phenotype) and B.1.c (genotype) given the continued threats outlined in metric B.2.a.2 (spawner composition).

Table 18. Spatial structure and diversity scoring table

Metric	Risk Assessment Scores				
	Metric	Factor	Mechanism	Goal	Population
A.1.a	VL (2)	VL (2)	Low Risk (Mean = 1.33)	Low Risk	**High Risk**
A.1.b	L (1)	L (1)			
A.1.c	L (1)	L (1)			
B.1.a	VL (2)	VL (2)	High Risk (-1)	High Risk	
B.1.b	M (0)	M (0)			
B.1.c	H(-1)	H(-1)			
B.2.a(1)	L (1)	High Risk (-1)	High Risk (-1)		
B.2.a(2)	NA				
B.2.a(3)	H(-1)				
B.2.a(4)	NA				
B.3.a	M (0)	M (0)	Moderate Risk (0)		
B.4.a	L (1)	L (1)	Low Risk (1)		

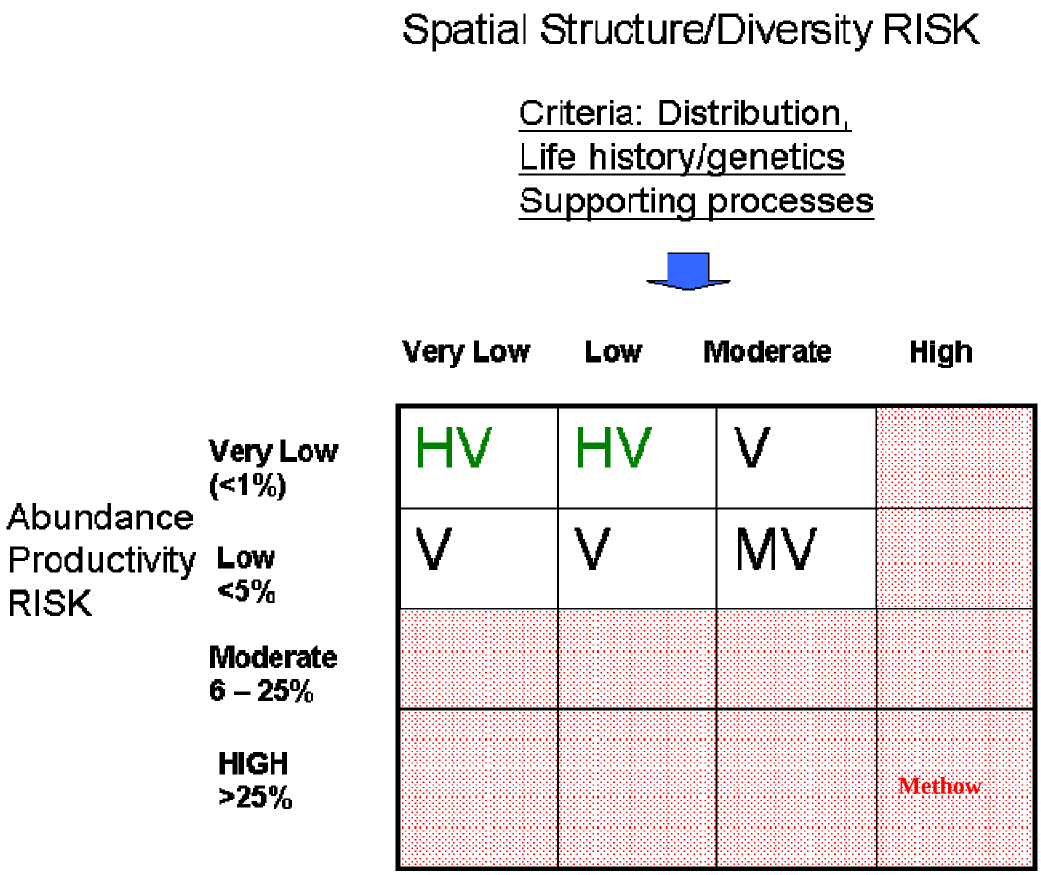

Figure 30. Abundance & productivity and spatial structure & diversity integration table.

Overall Risk Rating

The spatial structure and diversity of the Methow summer steelhead population is currently rated as high risk. Improvement of the spatial structure and diversity status to low risk will be necessary to allow the Methow population to achieve a “highly viable” status (in combination with very low risk A&P) (Figure 30). Based on the MPG guidelines, the Methow population will need to achieve a highly viable status for recovery of the ESU (ICTRT 2005).

Okanogan Summer Steelhead Population

The Okanogan Steelhead population is part of the Upper Columbia ESU that only has one extant *MPG* that includes four current populations (Wenatchee, Entiat, Methow, and Okanogan Rivers) plus Crab Creek (Figure 31) (ICTRT 2004).

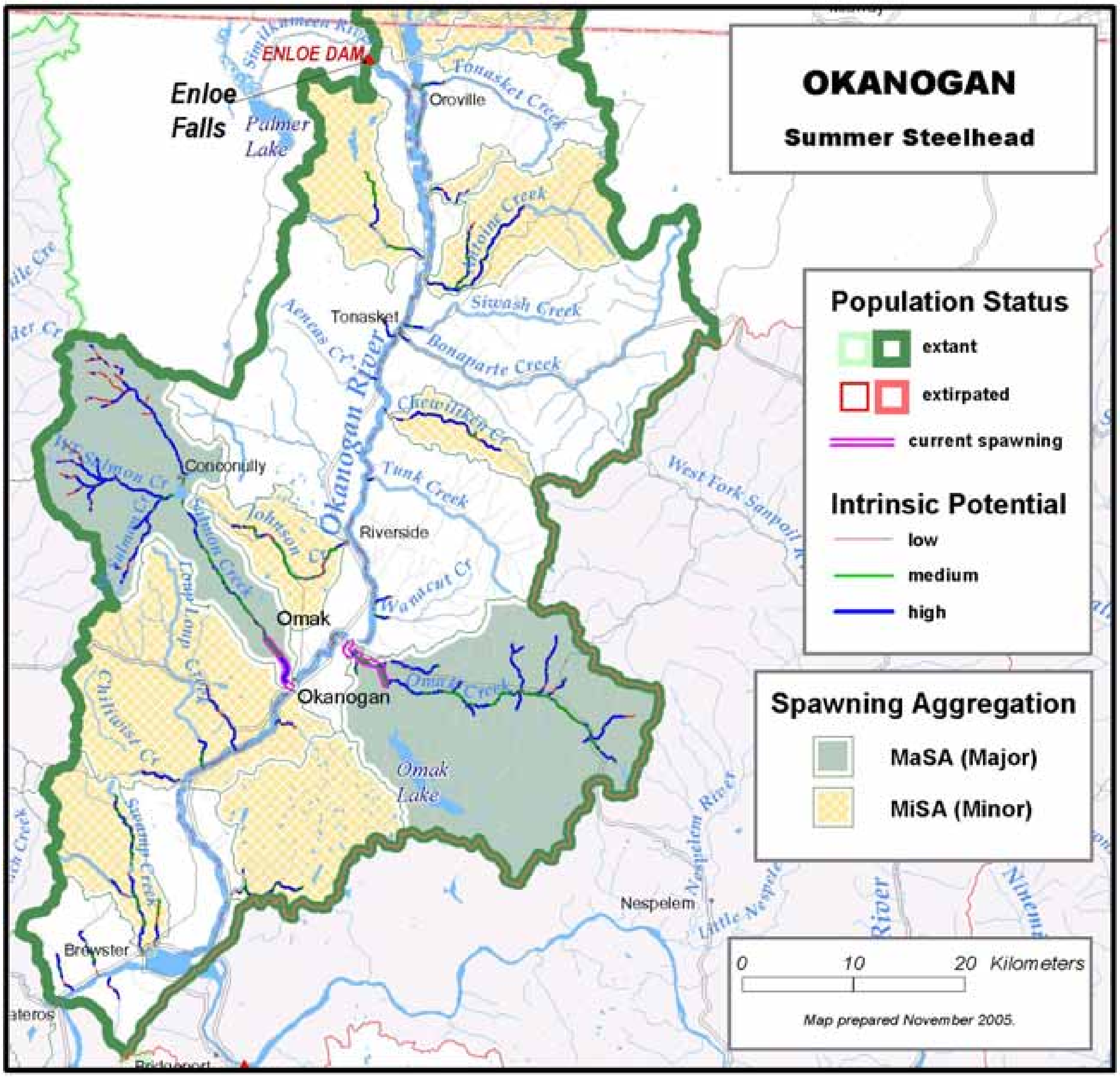

Figure 31. Okanogan summer Steelhead major and minor spawning aggregates.

The size category of the Okanogan River summer steelhead population is “intermediate” based on historical habitat potential (ICTRT 2005). This classification includes areas of intrinsic potential in Canada and requires a minimum abundance threshold of 1,000 wild spawners with sufficient intrinsic productivity (greater than 1.0 R/S) to exceed a 5 % extinction risk on the viability curve (ICTRT 2005). Data for fish distribution, abundance, and ecoregion classification were not available for Canada; therefore, we only conducted the status review for the U.S. portion of the population. The U.S. portion of the population only has enough habitat to be classified as "basic", and would require a minimum abundance threshold of 500 spawners and a productivity greater than 1.0 r/s to exceed 5% extinction risk on the viability curve. Additionally, the Okanogan summer steelhead population was classified as a type B population (based on historic intrinsic potential) because it has dendritic tributary structure with multiple major spawning areas (Table 19) (ICTRT 2005).

Table 19. Okanogan steelhead basin statistics

Drainage Area (km2)	5,725
Stream lengths km* (total)	913
Stream lengths km* (below natural barriers)	553
Branched stream area weighted by intrinsic potential (km2)	7.120
Branched stream area km2 (weighted and temp. limited)	6.409
Total stream area weighted by intrinsic potential (km2)	3.181
Total stream area weighted by intrinsic potential (km2) temp limited	0.882
Size / Complexity category	Intermediate / B (dendritic structure)
Number of MaSAs	10
Number of MiSAs	24

*All stream segments greater than or equal to 3.8m bankfull width were included

**Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22°C.

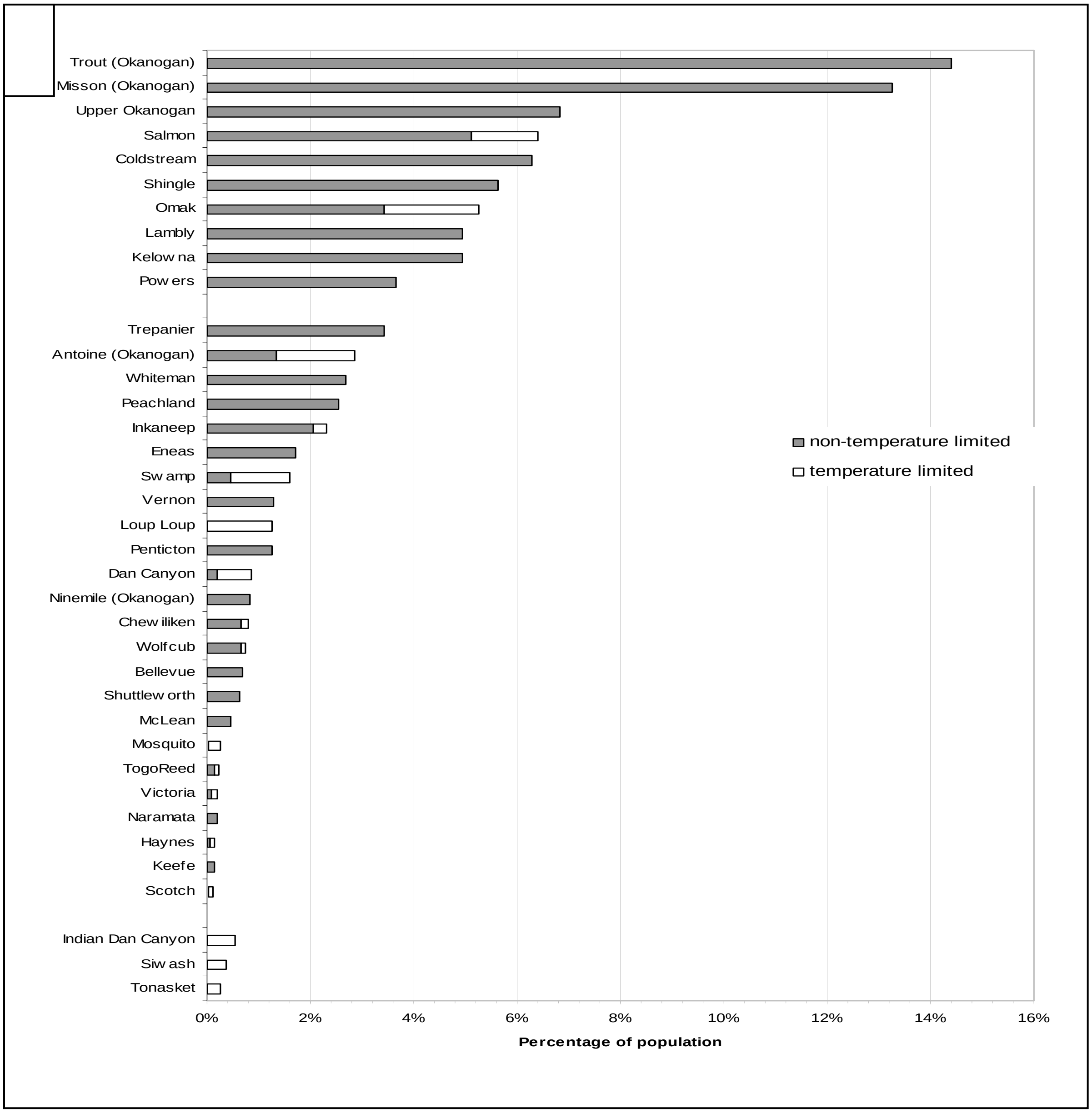

Figure 32. Percentage of historical spawning habitat in the Okanogan by major/minor spawning area. Temperature limited portions of major/minor spawning aggregates are shown in white. Three MiSAs were dropped due to temperature limitations: Indian Dan Canyon, Siwash, and Tonasket.

Factors and Metrics

<u>A.1.a Number and spatial arrangement of spawning areas</u>. The ICTRT identified 10 major and 24 minor spawning areas for the Okanogan summer steelhead population (Figure 32). However, only two major and five minor spawning areas are within the U.S. portion. Although recent redd surveys have identified spawning in the mainstem Okanogan and Similkameen Rivers (Arterburn

et al. 2005), extensive hatchery releases occur in these areas and it is uncertain if these areas can, or ever could, support viable components of the population due to high temperatures limiting juvenile survival. The intrinsic potential major spawning areas in the U.S. portion include Salmon Creek and Omak Creek, whereas the minor spawning areas include Ninemile, Whitestone, Bonaparte, Antoine, and Loup Loup Creeks (Figure 4). However, recent surveys have identified spawners in Ninemile, Bonneparte, Tunk and Tonasket Creeks, as well as the mainstem Okanogan and Similkameen Rivers (Arterburn et al. 2005). Based on agency defined distribution, only the lower portions of Salmon Creek and Omak Creek were occupied, therefore the population is at *high risk* for this metric.

A.l.b. Spatial extent or range of population. Efforts to monitor the distribution and abundance of spawning steelhead have been initiated and expanded in recent years (2004-2005), but we still do not have comprehensive, long-term data sets to rate this metric for the Okanogan population. Based on these recent but limited data sets, neither of the two U.S. MaSAs have multiple redds in the upper halves of their intrinsic potential habitat (above Haley Creek in the Omak Creek MaSA and above the forks in the Salmon Creek MaSA) so they do not meet minimum occupancy definition, putting the population at *high risk* for this metric (Figure 33). A rating of moderate risk could be achieved with occupancy of the upper ½ of either Omak Creek or Salmon Creek MaSAs.

A.1.c. Increase or decrease in gaps or continuities between spawning aggregates. The Okanogan steelhead population was at *high risk* for this metric because neither of the two U.S. MaSAs have multiple redds in the upper halves of their intrinsic potential habitat (above Haley Creek in the Omak Creek MaSA and above the forks in the Salmon Creek MaSA) so they do not meet minimum occupancy definition. Also, the absence of known spawning at the downstream MiSA (Loup Loup Creek), did not increase the gap between populations by more than 25 km. A rating of moderate risk could be achieved with occupancy of the upper ½ of either Omak Creek or Salmon Creek MaSAs.

B.1.a. Major life history strategies. The Okanogan steelhead population is *very low risk*, because no major life history strategies have been lost (i.e. no winter run was ever present and resident *O. mykiss* are known to occur in the watershed).

B.1.b. Phenotypic variation. There are no data available for this metric. Even if we determined that there was a change to one or more traits we do not know what the exact baseline is because changes likely occurred before there was biological monitoring. Therefore, we will assume that there has been some change and increase in variance for 2 or more traits placing the population at *moderate risk*.

B.1.c. Genetic variation. There are no genetic data for Okanogan steelhead. Throughout the rest of the Upper Columbia, the genetic signal shows little differentiation between populations, with a strong similarity to Wells Hatchery. Additionally, given the low escapement of natural origin fish and the high numbers of Wells origin smolts released in this basin there is sufficient evidence to assume the population is at *high risk* for this metric. There is a possibility that the true genetic risk metric for this population should be lower. If additional data becomes available indicating differentiation between and within populations (either genetic data indicating levels of divergence consistent with the time since separation or genetic information showing strong spatial structure), this metric could be assigned a moderate or low risk rating.

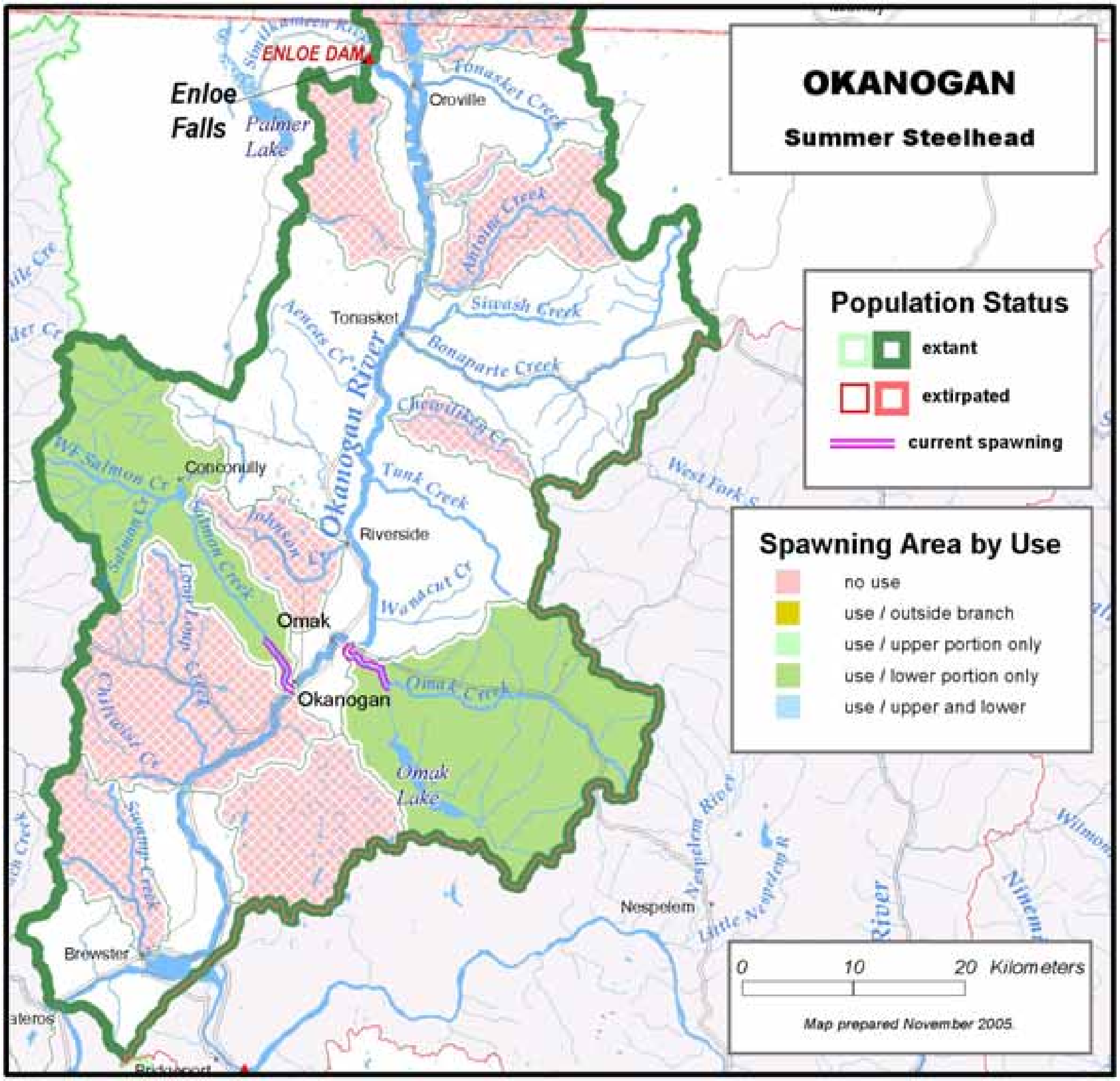

Figure 33. Okanogan summer steelhead current distribution.

<u>B.2.a. Spawner composition.</u>

(1) *Out-of-ESU strays*. The Okanogan steelhead population is at *low risk* since there is no evidence of non-local (outside the ESU) hatchery fish passing Wells Dam.

(2) *Out of MPG strays*. The Upper Columbia ESU only has one extant MPG, so this metric is *not applicable* and no score will be given.

(3) *Out of population strays*. We do not have estimates of spawner composition for the various MaSAs and MiSAs of the Okanogan steelhead population because carcasses cannot be obtained in sufficient numbers from the spawning ground surveys. However, in 2004 only 9.5 % of the steelhead passing Wells Dam were natural origin (Humling and Snow 2004). This is similar to

the proportion of wild fish from previous years (Kirk Truscott, personal communication). This high proportion of hatchery origin spawners would result in *high risk*, regardless of whether or not the program was considered best management practices. However, the program was not considered best management practices because adult steelhead are trapped at Wells Dam (mainstem Columbia River) and they could have originated from any of the MaSAs within the Methow or from the Okanogan. Additionally, steelhead releases occur at various locations throughout the Methow and Okanogan, thereby mixing the progeny from various MaSAs of two independent populations and not encouraging local adaptation within the population or between the Methow and Okanogan populations.

Although the Wells hatchery program does use wild fish, the NMFS BiOp restricts the broodstock to no more than 33% natural origin fish, regardless of the run size (NMFS 2002). This constraint limits the opportunity to meet production requirements with all wild fish during years of high abundance, a practice that would reduce the genetic risk of the hatchery program.

Finally, there has been high numbers of Wenatchee steelhead observed passing Wells Dam, presumably because they are reared on Columbia River water at the Turtle Rock facility before direct release with no acclimation in the Wenatchee (Kirk Truscott, personal communication). There is currently no way to determine if Wenatchee steelhead do show up on the spawning grounds of the Okanogan basin and efforts to monitor this risk need to be conducted. Therefore, given the extremely high proportion of hatchery fish passing Wells Dam, the mixing of Methow and Okanogan fish in the broodstock, the release of smolts into the Okanogan that could have originated from Methow parents, and the threat stray Wenatchee steelhead, suggest that the population is at *high risk* for this metric.

(4) *Within-population strays*. No score will be given for this metric because the Wells hatchery stock was rated for metric B.2.a.3 and therefore this metric is *not applicable*. The Wells hatchery program mixes Methow and Okanogan origin adults and therefore does not meet best management practices.

<u>B.3.a. Distribution of population across habitat types</u>. The distribution of intrinsic branches for Okanogan summer steelhead within the U.S. covered six ecoregions, three of which were considered significant (>10%) (Figure 34; Table 20). Substantial shifts (>67%) have occurred in 2 of the 3 ecoregions (Okanogan Pine/Fir Hills and Western Okanogan Semiarid Foothills). Therefore, the population is at *high risk* for this metric. Within the U.S., it appears that this metric would improve to moderate or low risk if the middle portion of Salmon Creek and the middle-upper portions of Omak Creek were occupied (Figure 34). Additionally, we could not analyze this metric for Canada (where 79% of the intrinsic potential habitat occurs) because ecoregion data does not exist and we are not aware of any distribution data for summer steelhead. Therefore, inclusion of Canadian watersheds into the occupied ecoregion analysis in the future could also change the results for this metric.

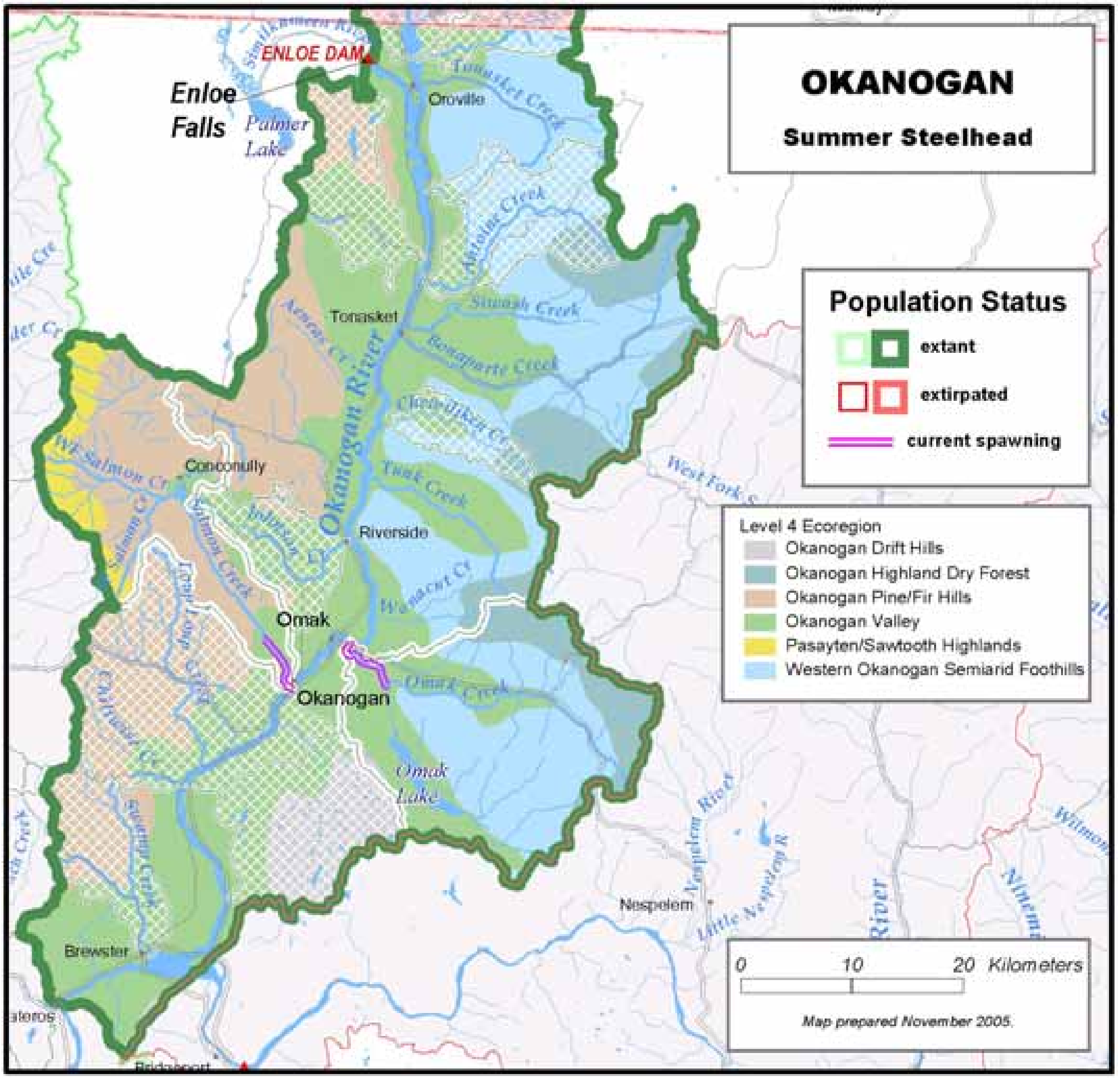

Figure 34. Okanogan Summer Steelhead distribution across various ecoregions.

Table 20. Okanogan steelhead – proportion of spawning area across various ecoregions. 79% of the population habitat falls within Canada, but ecoregion designations for this region are unknown. Therefore, the table takes into account only the US portions of the Okanogan steelhead population.

Ecoregion	% of historical spawning area in this ecoregion (non-temperature limited)	% of currently occupied spawning area in this ecoregion (non-temperature limited)
Okanogan Drift Hills	1.7	0.0
Okanogan Highland Dry Forest	1.2	0.0
Okanogan Pine/Fir Hills	27.3	0.0
Okanogan Valley	55.7	100.0
Pasayten/Sawtooth Highlands	0.6	0.0
Western Okanogan Semiarid Foothills	13.5	0.0

B.4.a. Selective change in natural processes or selective impacts.

Hydropower system: Low risk, although it has slowed out migration for early and late out migrants, but in recent years flow augmentation has reduced the impact to the middle 95% of the run.

Harvest: Low risk in recent generations. Harvest rates affect < 20% of the adults and selective gear reduces the impact of selectivity.

Hatcheries: Low risk, broodstock management of the Methow\Okanogan composite stock program has been designed to be non-selective.

Habitat: Low risk, no known measurable effects.

Based on low risk estimates across the four sectors, we conclude that the population is at *low risk* for this metric.

Spatial Structure and Diversity Summary

The Okanogan steelhead population was determined to be at high risk for goal A (allowing natural rates and levels of spatially mediated processes) and high risk for goal B (Maintaining natural levels of variation) resulting in an overall high risk rating (Table 21). For goal B, the metrics for genotypic and phenotypic variation were directly responsible for the high-risk rating. Although no genetic data existed for Okanogan steelhead, we assumed high risk based on the genetic results for the rest of the ESU and the very low escapement estimates for natural origin steelhead versus the high proportion of hatchery origin adults passing Wells Dam. For B.1.b. (phenotypic variation), an analysis needs to be conducted that shows that the phenotypic traits of the current population are consistent with the assumed historical condition or with unaltered reference populations in a similar habitat, geologic, and hydrologic setting. Based on the scoring system, these metrics must be addressed in order for the status of goal B to improve to low risk.

Another metric that was rated at high risk was the proportion of out-of-population (but within ESU) spawners that were hatchery fish (B.2.a.2). There were several factors that lead to a high risk rating, even though we did not have data that directly measured the origin of adults the spawning grounds. These risks included the extremely high proportion of hatchery fish passing Wells Dam (~90%), the mixing of Methow and Okanogan fish in the broodstock, the release of smolts into the Okanogan that could have originated from Methow parents, and the threat from the high number of Wenatchee origin steelhead passing Wells Dam. It is likely that genotypic and phenotypic variation have been influenced by past hatchery practices and that it will be difficult to achieve low risk levels for metrics B.1.b (phenotype) and B.1.c (genotype) given the continued threats outlined in metric B.2.a.2 (spawner composition).

Table 21. Spatial structure and diversity scoring table

<table>
<tr><th rowspan="2">Metric</th><th colspan="5">Risk Assessment Scores</th></tr>
<tr><th>Metric</th><th>Factor</th><th>Mechanism</th><th>Goal</th><th>Population</th></tr>
<tr><td>A.1.a</td><td>H (-1)</td><td>H (-1)</td><td rowspan="3">High Risk
(Mean = -1)</td><td rowspan="3">High Risk</td><td rowspan="12">High Risk</td></tr>
<tr><td>A.1.b</td><td>H (-1)</td><td>H (-1)</td></tr>
<tr><td>A.1.c</td><td>H (-1)</td><td>H (-1)</td></tr>
<tr><td>B.1.a</td><td>VL (2)</td><td>VL (2)</td><td rowspan="3">High Risk</td><td rowspan="9">High Risk</td></tr>
<tr><td>B.1.b</td><td>M (0)</td><td>M (0)</td></tr>
<tr><td>B.1.c</td><td>H (-1)</td><td>H (-1)</td></tr>
<tr><td>B.2.a(1)</td><td>L (1)</td><td rowspan="4">High Risk
(-1)</td><td rowspan="4">High Risk (-1)</td></tr>
<tr><td>B.2.a(2)</td><td>NA</td></tr>
<tr><td>B.2.a(3)</td><td>H (-1)</td></tr>
<tr><td>B.2.a(4)</td><td>NA</td></tr>
<tr><td>B.3.a</td><td>H (-1)</td><td>H (-1)</td><td>H (-1)</td></tr>
<tr><td>B.4.a</td><td>L (1)</td><td>L (1)</td><td>L (1)</td></tr>
</table>

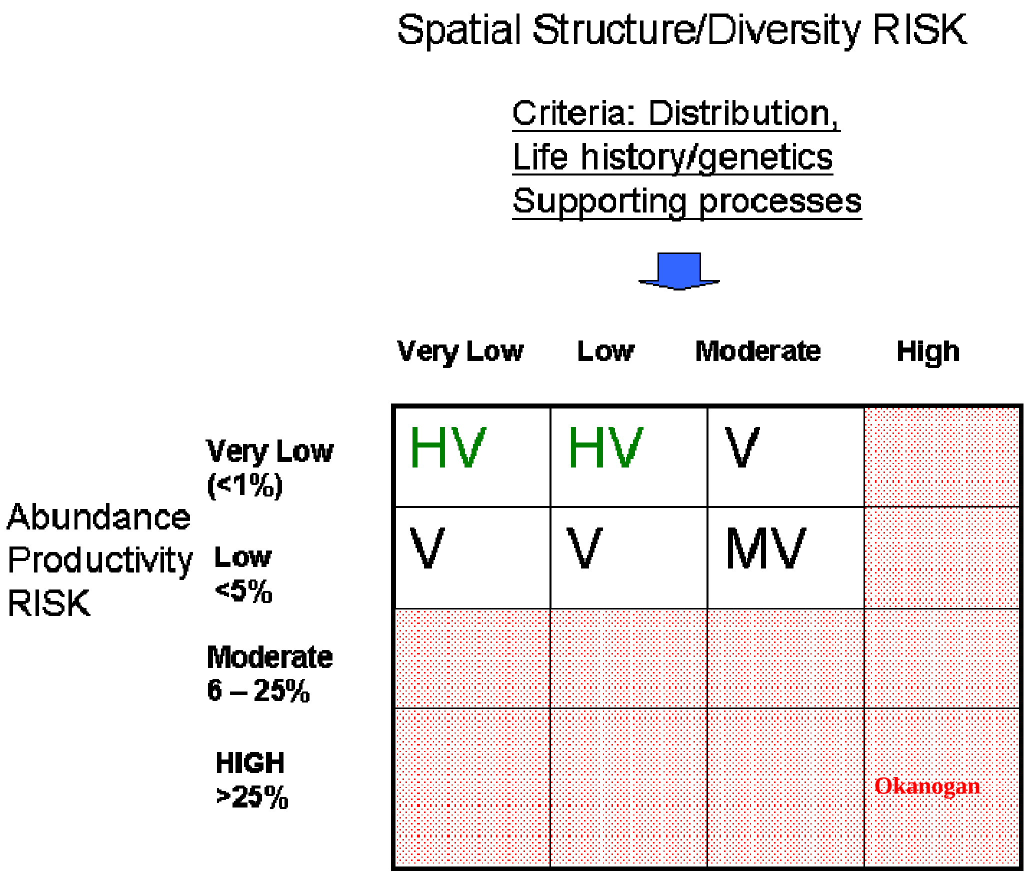

Figure 35. Abundance & productivity and spatial structure & diversity integration table.

Overall Risk Rating

The spatial structure and diversity of the Okanogan summer steelhead population is currently rated as high risk. Improvement of the spatial structure and diversity status to low risk will be necessary to allow the Okanogan population to achieve a "highly viable" status (in combination with very low risk A&P) (Figure 35). Based on the MPG guidelines, the Okanogan population will need to achieve a highly viable status for recovery of the ESU (ICTRT 2005).