U.S. FISH AND WILDLIFE SERVICE

BIOLOGICAL OPINION

for

Environmental Protection Agency's Proposed Approval of the Revised Washington Water Quality Standards for Designated Uses, Temperature, Dissolved Oxygen, and Other Revisions

USFWS Reference: 13410-2007-F-0298

Appendix C: Risk Assessment

APPENDIX C

RISK ASSESSMENT

Overview

To assess overall risk to bull trout from the potential effects of the changes to the Washington State water quality standards, a risk analysis integrating both spatial and non-spatial information was conducted. In this way we could evaluate where the effects could occur in relation to bull trout core areas and local populations within Washington, and what level of risk those potential effects presented to bull trout and their habitat given their life history needs and baseline conditions. This is a multi-scale analysis, focusing on the local population scale (i.e., smallest group of fish that is known to represent an interacting reproductive unit) and on the core area scale (i.e., the combination of one or more local populations and their associated foraging, migration, and overwintering habitat - FMO).

Core areas require both habitat and bull trout to function, and the number (replication) and characteristics of local populations inhabiting a core area provide a relative indication of the core area's likelihood to persist. Local populations represent the bull trout spawning and early juvenile rearing habitat for a core area and are generally depicted as area polygon (typically a subwatershed), while FMO habitat is all other habitat used by bull trout within the core area polygon. There are also important freshwater FMO habitats that are located outside of core areas. These FMO habitats are located within certain watersheds used solely by migratory (fluvial and anadromous) bull trout to complete their life history. These were evaluated separately in our analysis due to their potential use by bull trout populations from multiple core areas, and therefore, we have no clear way to evaluate their baseline population risk.

This risk analysis can be summarized into three basic steps:

<u>1) Analysis of Exposure</u> **–** Evaluate core area (i.e., local population/spawning and rearing habitats and FMO habitats) exposure risk to the application of WQS on stream reaches. See Tables 9 and 10 in the BO. This analysis was conducted using GIS to develop a list and table of populations and habitats which helped to determine which streams utilized by bull trout are adequately or inadequately covered by the proposed WQS.

The spatial analysis using GIS was conducted on all bull trout core areas in Washington State to help facilitate the risk analysis, and was used to identify the following information:

- The waterbodies/stream reaches that have water quality standards inadequate to meet life history needs of bull trout.

- The percentage of linear stream reaches within these core areas' local populations (i.e., spawning and rearing habitat) and foraging, migration, and overwintering (FMO) habitat to help estimate and compare relative levels of "exposure risk" (i.e., low, medium, high) to the application of inadequateWQS.

Exposure risk was used to narrow down the risk analysis and focus only on those bull trout core areas within Washington that could potentially be exposed to the effects of inadequate WQS.

2) Analysis of Baseline Population Risk – Evaluate baseline population risk (i.e., at local population scale and core area population scale) of moderate to high exposed core area and local populations.

As part of the risk analysis, population status parameters (i.e., adult spawner abundance and trend in abundance) of the local populations were evaluated to determine the "baseline population risk" ranking (i.e., low, medium, high). The analysis also evaluated similar population status parameters at the core area scale. This ranking helps with the understanding of the resiliency of a local population and of a core area population.

3) Overall Effects Risk – Integrate the two risk analysis above to reach conclusion about the overall effects risk to core area populations from the proposed water quality standards.

The overall risk analysis integrates the exposure risk and the baseline population risk to estimate an overall relative risk to specific local populations and their core areas to give an evaluation of potential effects associated with the changes to the water quality standards. From this analysis, it could be determined which local populations, FMO, potential local populations, and core areas may be at risk (High, Moderate, Low), and of those, which were at highest risk from the effects of the application of inadequate water quality standards to certain stream segments.

Assumptions

The following major assumptions were used in this bull trout risk analysis:

- Baseline habitat conditions were not incorporated into our analysis because they ultimately do not specifically influence the risk of application of proposed WQS criteria. For example, inadequate criteria applied to habitat having either baseline risk (i.e., low, moderate, or high) is ultimately a high risk to the species due to the nature of the proposed action. Conversely, application of adequate criteria is ultimately low or no risk to the species regardless of the baseline habitat conditions. However, if the regulatory tools to achieve the proposed criteria are inadequate, especially when baseline habitat conditions are poor, their evaluation would be important if addressing risk associated with implementation of the criteria.
- Marine waters and water quality parameters (e.g., contaminants, fecal coliform, pH) whose standards have not been revised are not evaluated as part of this assessment. For the purposes of this assessment, the current standards for these waters/parameters are assumed to have neutral effects to bull trout. However, any effects to population parameters from the current water quality conditions within marine waters are assumed to be reflected under baseline population risk, since these are inevitably related.
- The 13° spawning standard for anadromous salmon, compensates for inadequate temperature standards in bull trout FMO habitat stream reaches, but does not compensate for inadequate standards in spawning and rearing habitat. The 13 °C salmon spawning criteria was not used to adjust (i.e., reduce) a risk ranking for local populations (spawning

and rearing habitat) because it does not guarantee adequate spawning temperatures for bull trout during their actual spawn period.

- The 12 °C standard is not considered optimal spawning temperature. However, it is assumed that daily temperatures will decrease to <10° C by the normal spawn period (typically fall), which is required for initiation of spawning.
- The effects of global climate change will likely have an effect on WQS criteria and aquatic resources in the future. Although the manifestations of global climate change on bull trout related to water quality standards (especially water temperature) are reasonable to anticipate, the magnitude or location of effects cannot be specifically predicted. Therefore, this analysis may underestimate the long-term risk to some bull trout local populations and core areas.
- All FMO and spawning and rearing habitats for bull trout on Tribal or reservation lands are assumed to meet WQS set by the Tribes. In some cases, the Tribal standards are more stringent than the state standards.
- The DO criterion applies in a few spawning areas that are covered in the local population/spawning and rearing sections of this analysis

It should be noted that there are five core areas in Washington that are transboundary in nature. The Chilliwack core area spans Washington and part of British Columbia, with 2 of the 11 local populations largely within Washington and two that are transboundary. The Upper Skagit core area also spans Washington and part of British Columbia, with seven of 13 local populations largely within Washington and one that is transboundary. The Priest Lake core area spans Washington and Idaho, with only portions of two local populations lying within Washington. The Grande Ronde core area spans Washington and Oregon, with four local populations and a portion of its FMO habitat within Washington. The Umatilla-Walla Walla core area spans Washington and Oregon, with five local populations and a portion of its FMO habitat lying within Washington. We included the portions of habitat in British Columbia, Idaho and Oregon where necessary to complete our analysis (i.e., baseline population risk), since these habitats are functionally part of the respective core area populations.

1. Analysis of Exposure Risk

Exposure risk was estimated using the quantity (i.e., percent) and location of bull trout stream habitats within a core area's local populations (i.e., spawning and rearing habitats) and FMO areas. This determination addressed the amount of bull trout stream habitat that may be potentially exposed to the effects of maintaining inadequate WQS.

We also evaluated the quantity of habitat exposed within FMO areas outside of core areas. These FMO areas are typically used by individuals from multiple core areas, so the effects may impact individuals from multiple populations. Within the Coastal-Puget Sound population segment, these areas are solely used by the anadromous life history form, and within the Columbia River population segment used by the fluvial life history form.

Exposure risk for local populations and FMO habitats are summarized in Table 1.

The exposure risk for local populations was ranked based on the following criteria:

> *Low Risk*: Inadequate WQS for bull trout cover less than 10 percent of spawning and rearing habitat within the local population.
>
> *Moderate Risk*: Inadequate WQS for bull trout cover between 11 and 25 percent of spawning and rearing habitat within the local population.
>
> *High Risk*: Inadequate WQS for bull trout cover greater than 25 percent of spawning and rearing habitat within the local population.

The exposure risk for FMO habitat was ranked based on the following criteria:

> *Low Risk*: Inadequate WQS for bull trout cover less than 10 percent of the FMO habitat within the core area, and these covered areas do not include key stream segments necessary to support multiple life history forms nor connectivity between local populations.
>
> *Moderate Risk*: Inadequate WQS for bull trout cover between 11 and 25 percent of the FMO habitat within the core area and these covered areas do not include key stream segments which support connectivity between local populations, or covered areas are within key stream segments necessary to support multiple life history forms.
>
> *High Risk*: Inadequate WQS for bull trout cover greater than 25 percent of the FMO habitat within the core area, or these covered areas include key stream segments which support connectivity between local populations.

It should be noted that although some FMO habitat may be ranked at high exposure risk, this does not generally equate with the same level of risk to local populations (i.e., spawning and rearing habitat). Applying inadequate WQS in the FMO habitat are not necessarily expected to affect bull trout to the same degree as applying inadequate WQS in critical spawning and rearing habitat.

Bull trout FMO habitats are typically larger bodies of water that often have warmer water temperatures and are used seasonally by bull trout life stages that are less sensitive and use less restrictive habitats. Many of the FMO areas that are used year round by bull trout have cold water refugia (i.e., stratified cold water layers in reservoirs, springs, cold tributaries, etc) that are critical for the survival of bull trout during the period of summer high water temperatures. Although application of inadequate WQS may not completely preclude the use of these water bodies, it may cause areas with degraded baseline conditions to remain degraded and result in delays in migration and/or a reduction in the period of use of these FMO habitats by bull trout.

Table 1. Exposure risk rankings for local populations or FMO habitats, listed by bull trout population segments.

Core Area*	WRIA	Local Population or FMO	Exposure Risk
Coastal-Puget Sound Population Segment			
Nooksack	1	Lower SF Nooksack River LP	H
Stillaguamish	5	Stillaguamish FMO	M
Snohomish-Skykomish	7	SF Skykomish River LP	H
		Snohomish/Skykomish FMO	M
Puyallup	10	Puyallup FMO	L
		Clearwater PLP	M
Columbia River Population Segment			
Lewis	27	Lewis River FMO	L
Walla-Walla	32	Walla-Walla FMO	H
Asotin Creek	35	Charley Creek LP	M
		N Fk Asotin LP	L
		Asotin FMO	H
		Wormell Gulch PLP	H
Tucannon	35	Tucannon FMO	H
Grande Ronde	35	Grande Ronde FMO	H
Yakima	37,38,39	Ahtanum Creek LP	M
		Rattlesnake Creek LP	M
		Upper Yakima River LP	H
		Cle Elum River LP	L
		NF Teanaway River LP	M
		Yakima River Mainstem FMO	H
		Taneum Creek PLP	H
Wenatchee	45	Icicle Creek LP	H
		Chiwawa River LP	H
		Chiwaukum Creek LP	L
		Wenatchee FMO	H
Entiat	46	Entiat River LP	H
		Mad River LP	H
		Entiat FMO	H
Methow	48	Goat Creek LP	H
		Wolf Creek LP	H
		Chewack River LP	H
		Lost River LP	M
		Twisp River LP	M

Core Area*	WRIA	Local Population or FMO	Exposure Risk
		W Fk Methow River LP	L
		Methow FMO	H
Pend Oreille	62	Pend Oreille FMO	H
Foraging, Migration, and Overwintering Habitats Outside of Core Areas			
n/a	3	Samish River FMO	H
n/a	22, 23	Chehalis River FMO	H
n/a		Lower Green River FMO	M
n/a		Wishkah River FMO	M
n/a		Humptulips River FMO	L
n/a		Satsop River FMO	L
n/a	35	Lower Snake River FMO	H
n/a	many	Columbia River FMO	H

* Only core areas that have inadequate water quality standards are displayed.

Using a spatial analysis of where the various water quality standards for salmonids were applied in relationship to bull trout habitat, we were able to identify which of the core areas (n = 27) and freshwater FMO areas outside of core areas (n = 8) within or partially within Washington that have stream segments that are not adequately protected by the WQS (see Tables 8 and 9 of the BO).

In all, 14 core areas and FMO areas outside of core areas were brought forward in the analysis. The following core areas were brought forward because some portion of spawning or rearing, FMO, or potential local population habitats will not be adequately protected by the WQS, these include: Asotin Creek, and the Methow, Wenatchee, Entiat, Yakima, Pend Oreille, Grand Ronde, Walla Walla, Tucannon, Lewis, Puyallup, Stillaguamish, Snohomish/Skykomish, and the Nooksack Rivers. The following FMO areas outside of FMO were brought forward because some portion of them were not adequately covered by the WQS, these include: Samish, lower Green, Wishkah, Chehalis, Columbia, and Snake Rivers.

Thirteen core areas and three FMO areas, outside of core areas, were adequately covered by the proposed WQS and were therefore dropped from further analysis. These areas are: Chilliwack, Lower Skagit, Upper Skagit, Snohomish, Chester Morse, Skokomish, Dungeness, Elwha, Hoh, Queets, Quinault, Klickitat, and Priest Lake core areas and FMO in the lower Green, Humptulips, and Satsop Rivers.

Summary of Exposure Risk Rating

Local Populations Not Adequately Protected by the WQS

Eight core areas contained spawning and rearing stream segments with inadequate WQS (see Tables 8 and 10 of the BO). The core areas containing spawning and rearing habitat with inadequate temperature standards are listed below in descending order based on their total

number of stream miles having inadequate water temperature standards. Because of the importance and sensitivity of spawning and rearing habitat within local populations, there is no amount of stream habitat, with inadequate WQS, where a "no risk" ranking was considered warranted. Potential local populations are included at the end of the analysis in the Overall Effects Risk section (i.e. Puyallup). The following core areas and local populations brought forward include:

1) Methow – *Goat Creek LP, Wolf Creek LP, Chewack LP, Lost River LP, Twisp River LP*
2) Yakima – *Ahtanum Creek LP, Rattlesnake Creek LP, Upper Yakima River LP, N FK Teanaway LP*
3) Wenatchee – *Icicle LP, Chiwawa LP*
4) Entiat – *Entiat River LP, Mad River LP*
5) Nooksack – *Lower S Fk Nooksack LP*
6) Asotin Creek – *Charley Creek LP*
7) Snohomish/Skykomish – *S Fk Skykomish LP*
8) Pend Oreille – *FMO only*

The following local populations within these core areas rated out as being *Low Risk* of exposure to the WQS (i.e. less than 10 percent of the spawning and rearing area had inadequate protection):

> *Le Clerc Creek, North Fork Asotin, Cle Elum, Chiwaukum, Tucannon, and West Fork of the Methow*

They are not brought forward in the baseline population analysis. The rational for this is that these populations either had: 1) a very small proportion (<2 miles) of the lower reach of juvenile rearing area with inadequate temperature standards (LeClerc, N Fk Asotin, and Tucannon), 2) the entire spawning and rearing reach is on Federal land and will be adequately protected by the Northwest Forest Plan (Chiwaukum and W Fk Methow), or 3) there was very low use by juveniles (Cle Elum below the dam).

There are five core areas that are not covered in this local population analysis but are listed in the FMO exposure analysis below because they have some exposure risk in the migratory corridors. These include: the Walla Walla, Tucannon, Grand Ronde, Lewis, Stillaguamish, and Puyallup Rivers

FMO Habitat in Core Areas Not Adequately Protected by the WQS

The core areas containing FMO habitat with inadequate temperature standards are listed below in descending order based on the percent of available FMO habitat with inadequate temperature standards.

1) Grande Ronde – *Grand Ronde mainstem*
2) Pend Oreille – *Pend Oreille mainstem*
3) Asotin Creek – *Asotin mainstem, Pinter and George Creeks*
4) Yakima – *Ahtanum Cr, Naches R, Yakima R mainstem*

5) Walla Walla – *Walla Walla mainstem, Lower Touchet R. Mad, Mill, and Yellowhawk Creeks*
6) Entiat - *Entiat mainstem*
7) Tucannon – *Tucannon mainstem*
8) Wenatchee – *Wenatchee mainstem*
9) Methow – *Methow mainstem, Beaver Creek*
10) Stillaguamish – *Stilliguamish mainstem*
11) Snohomish/Skykomish – *Snohomish and Snoqualmie mainstems*

There were two core areas where less than 10 percent of the FMO was not adequately protected (*Lewis and Puyallup Rivers*). These areas were dropped from further analysis. Rationale for this decision included extremely low likelihood of bull trout use (Lewis River- populations are isolated above three dams) and small area of inadequate coverage (lower portion of the White River).

The Nooksack core area did not have any exposure risk in the FMO, but was brought forward in the analysis because of inadequate protection in the spawning and rearing areas.

FMO habitat outside of Core Areas not adequately protected by the WQS

Five FMO areas outside of core areas were listed in Table 9 of the BO and Table 1 (above) as containing FMO habitat stream segments with inadequate temperature standards. FMO areas outside of core areas containing habitat with inadequate temperature standards are listed below in descending order based on their total number of stream miles having inadequate standards.

1) Columbia River
2) Snake River
3) Chehalis River
4) Samish River
5) Wishkah River

Two of the FMO areas listed in Table 1 (Humptulips and Satsop) had low exposure (< 10 percent of FMO habitat was not adequately protected by the WQS) and were dropped from the analysis. Rationale for this decision included extremely low likelihood of bull trout use, small area of inadequate coverage, and/or insignificant level of effects because of adequate protection of cold water from salmon spawning criterion.

<u>Analysis of Baseline Population Risk</u>

Local Population Baseline Risk

This evaluation addressed the current condition of population status parameters at the local population scale, which are an indicator of the potential sensitivity of a local population to impacts from application of inadequate WQS. In those cases where population parameters were unknown, we ranked these as moderate risk by default. A moderate or intermediate risk ranking seemed reasonable to assume in these cases, although this could mischaracterize the true status of an unknown local population as either better or worse. Population data from the draft bull

trout recovery plans (USFWS 2002 and 2004) in conjunction with updated information from the core area templates (USFWS 2005) were used in ranking local populations.

Baseline population risk for local populations in the seven core areas listed above as a moderate to high exposure risk is summarized in Table 2. Baseline population risk was estimated only in those populations determined to have a moderate to high exposure by using the number of adult spawners and trend status within a local population. Local populations rated above with a "low exposure risk" were expected to receive minimal effects from the proposed action and were insignificant and discountable at a core area scale. These local populations with low exposure were dropped from further analysis (See the local population exposure analysis above).

Baseline population risk was ranked using the following criteria, which was based on the bull trout population guidance and information from Rieman and Allendorf (2001):

> *Low Risk*: Average, annual spawner abundance in the local population is greater than 100, and is stable or increasing (5-10 years data).
>
> *Moderate Risk*: Average, annual spawner abundance in the local population is greater than 100, and population trend is declining; or average, annual spawner abundance in the local population is between between 50 and 100 and is stable or increasing; or population parameters are currently unknown.
>
> *High Risk*: Average, annual spawner abundance in the local population is between between 50 and 100 and is declining; or average, annual spawner abundance in the local population is less than 50; or migratory form is or nearly absent.

Table 2. Baseline population risk rankings for local populations with moderate to high exposure risk.

Core Area	**Local Population**	**Baseline Population Risk**
Coastal-Puget Sound Population Segment		
Nooksack	Lower SF Nooksack River	M
Snohomish-Skykomish	SF Skykomish River	L
Columbia River Population Segment		
Yakima	Ahtanum Creek	H
	Rattlesnake Creek	H
	Upper Yakima River	H
	NF Teanaway River	H
Asotin Creek	Charley Creek	H
Wenatchee	Icicle Creek	H
	Chiwawa River	L
Entiat	Entiat River	H
	Mad River	H

Core Area	Local Population	Baseline Population Risk
Methow	Goat Creek	H
	Wolf Creek	H
	Chewack River	H
	Lost River	M
	Twisp River	M
Pend Oreille	Le Clerc (primarily FMO)	H

Summary of Local Population Baseline Population Risk

Based on the current population status, the following local populations rated out as *High Risk:* Ahtanum, Rattlesnake, Upper Yakima, N Fk Teanaway, Charlie, Icicle, Entiat, Mad, Wolf Creeks, Chewack and Le Clerc Creek. These populations are considered at high risk of extirpation, genetic drift, or inbreeding due to extremely low populations and/or isolation by impassable barriers.

The Lost, Twisp, and Lower SF Nooksack Rivers local populations were determined to be at *Moderate Risk* in accordance with the ranking factors above. These populations are at risk because of reduced populations or very low numbers of the migratory form.

Two local populations, the Chiwawa and South Fork Skykomish, were considered to be at *Low Risk* in accordance with the ranking factors above. They are considered low risk because they have adequate numbers, the population trends are stable, and the migratory form is present.

Core Area Baseline Population Risk

We used different parameter values to assess baseline population condition or risk at the core area scale. The ranking criteria reflect this, and are generally based on values described in the current bull trout literature and draft recovery plans (USFWS 2002 and 2004). Analysis of baseline population risk at this scale also includes: 1) assessment of an additional parameter, and 2) the number of local populations. Because we did not necessarily evaluate all local populations (i.e., only those with moderate to high exposure risk (from Table 1) within a core area in the earlier parts of our analysis, we could not simply "sum up" the baseline population risk rankings for local populations and equate that with the baseline population risk ranking for the core area, nor would that have been necessarily appropriate. Population data from the draft bull trout recovery plans (USFWS 2002 and 2004) in conjunction with updated information from the core area templates were used in ranking core areas. We only ranked baseline population risk for core areas with moderate or high exposure for the local populations or FMO habitat (see Table 3 below).

The baseline population risk for affected core areas was ranked using the following criteria, which was based on the bull trout population guidance and information from Rieman and McIntyre (1993), and Rieman and Allendorf (2001):

> *Low Risk*: Average, annual spawner abundance in the core area is estimated to be greater than 1000 and is stable or increasing (5-10 years data), and core area contains more than 5 local populations.
>
> *Moderate Risk*: Average, annual spawner abundance in the local population is estimated to be greater than 1,000 and is stable or increasing (5-10 years data), and core area contains less than five local populations; or average, annual spawner abundance in the core area is estimated to be at least 500 and is stable or increasing (5-10 years data); or population parameters are currently unknown.
>
> *High Risk*: Average, annual spawner abundance in the core area is estimated to be between 500 and 1,000 and is declining and has less than five local populations; or average, annual spawner abundance in the core area is less than 500.

Table 3. Baseline population risk rankings for local populations with moderate to high exposure risk in either the FMO or the spawning and rearing areas (SR), listed by WRIA.

Core Area	**Baseline Population Risk**
Coastal Puget Sound Population Segment	
Nooksack (SR)	M
Stillaguamish (FMO)	M
Snohomish/Skykomish (SR and FMO)	M
Columbia River Population Segment	
Walla-Walla (FMO)	M
Asotin (FMO)	M
Tucannon (FMO)	L
Grande Ronde (FMO)	L
Yakima (SR and FMO)	H
Wenatchee (SR and FMO)	M
Entiat (SR and FMO)	H
Methow (SR and FMO)	H
Pend Oreille (FMO)	H

<u>Summary of Core Area Baseline Population Risk</u>

Based on the current population status, the following four core areas were ranked and determined to be at *High Risk* in accordance with the core area scale ranking factors above. This relates to the fact that the core areas are likely not functioning appropriately and are at risk of extirpation, genetic drift, or inbreeding due to extremely low numbers and/or isolation by impassable barriers: Yakima, Entiat, Methow, and Pend Oreille.

Six core areas were determined to be at *Moderate Risk* in accordance with the ranking factors above and are still at risk in terms of extirpation, genetic drift, or inbreeding due to unstable trends, reduced numbers of local populations, or unknown status. These are: the Walla Walla, Asotin, Wenatchee, Nooksack, Stillaguamish, and Snohomish/Skykomish.

Two core areas, the Tucannon and Grande Ronde, were rated as *Low Risk* because they are functioning appropriately.

Overall Effects Risk

Overall potential risk for effects from the proposed action is presented at two scales, the local population and core area. Although the ranking results can be used independently to assess relative risk at the two scales, they should also be examined together to more fully assess the ultimate risk to a particular core area from the proposed water quality standards. FMO outside of core areas and potential local populations were also ranked.

Table 4. Potential individual risk combinations and resultant overall ranking.

Exposure Risk		**Population Risk**		**Overall Potential Risk**	
Ranking	Pt value	Ranking	Pt value	Ranking	Score
H	3	H	3	H	3
H	3	M	2	MH	2.5
H	3	L	1	M	2
M	2	L	1	L	1.5
M	2	M	2	M	2
M	2	H	3	MH	2.5

Local Population Scale Overall Effects Risk

The local population overall effects risk was ranked using a simple scoring system in the following matrix. A “high” ranking received a value of 3 points, a “moderate” ranking a value of 2 points, and a “low” ranking a value of 1 point (i.e. H=3, M=2, L=1). For each local population, its two resulting ranking values were summed together and then divided by two to determine its final score and its overall potential risk category. Since all local populations with low exposure risk were removed from further analysis by this point, the remaining local populations that were analyzed must either have a moderate or high exposure risk. This removal accordingly eliminated most of the potential “low” scores in the final rankings. We assumed that both exposure and population risk rankings were equally important to bull trout, and therefore, only a finite number of combinations are possible. The overall potential effects risk rankings for local populations with a moderate to high exposure risk are summarized below in Table 5.

Table 5. Overall potential risk rankings for local populations with moderate to high exposure risk. Rankings are in descending order, with high (H) exposure risk local populations listed first in each final ranking (Rank 3) category.

		Exposure Risk		Population Risk		Overall Potential Risk	
Core Area	**Local Population**	**rank 1**	**score 1**	**rank 2**	**score 2**	**rank 3**	**score 3**
Entiat	Entiat River	H	3	H	3	H	3.0
Entiat	Mad River	H	3	H	3	H	3.0
Methow	Goat Creek	H	3	H	3	H	3.0
Methow	Wolf Creek	H	3	H	3	H	3.0
Methow	Chewack River	H	3	H	3	H	3.0
Yakima	Ahtanum Creek	H	3	H	3	H	3.0
Yakima	Upper Yakima River	H	3	H	3	H	3.0
Wenatchee	Icicle Creek	H	3	H	3	H	3.0
Asotin	Charley Creek	M	2	H	3	MH	2.5
Yakima	Rattlesnake Creek	M	2	H	3	MH	2.5
Yakima	NF Teanaway River	M	2	H	3	MH	2.5
Nooksack	SF Nooksack River	H	3	M	2	MH	2.5
Methow	Lost River	M	2	M	2	M	2.0
Methow	Twisp River	M	2	M	2	M	2.0
Snohomish/ Skykomish	SF Skykomish River	H	3	L	1	M	2.0
Wenatchee	Chiwawa	H	3	L	1	M	2.0

Out of the 16 local populations analyzed to this point, eight scored in the high (H) risk category (all within the Columbia River population segment). Four local populations scored moderate-high (MH), one of which is on the west side of the Cascade Crest. Three of these local populations where ranked as having a high (H) baseline population risk. The remaining four local populations scored in the moderate (M) overall potential risk category. Because all of the low risk populations were dropped earlier, there are no low (L) ratings.

Core Area Scale Overall Effects Risk

To estimate the overall potential risk for core areas containing local population(s) or FMO habitat with moderate to high exposure risk, we integrated the corresponding exposure risk ranking (Table 1) with the baseline population risk for core areas (Table 5). However, since the exposure risk can be variable between local populations and FMO habitat within a core area, the results of this combined ranking should be evaluated with some degree of caution. As stated earlier, although the ranking results for local populations and FMO habitat can be used independently to assess relative risk at the two scales, they should also be examined together to more fully assess the ultimate risk to a particular core area from the proposed water quality standards. Generally, the core area exposure was the same as the FMO exposure because the conditions of the FMO generally reflect passage and connectivity of the core area. We looked at the ranking of the exposure was for the local populations, which generally was the same or lower than the FMO exposure. We used the FMO exposure to then rank the core area overall.

The overall potential risk rankings for the core areas with local populations or FMO habitats with a moderate to high exposure risk are summarized in Table 6.

Table 6. Overall potential risk rankings for core areas with at least one local population or FMO habitat at moderate to high exposure risk.

	FMO Exposure Risk		Core Area Population Risk		Overall Potential Risk	
Core Area	**rank 1**	**score 1**	**rank 2**	**score 2**	**rank 3**	**score 3**
Yakima	H	3	H	3	H	3.0
Pend Oreille	H	3	H	3	H	3.0
Methow	H	3	H	3	H	3.0
Entiat	H	3	H	3	H	3.0
Wenatchee	H	3	M	2	MH	2.5
Walla-Walla	H	3	M	2	MH	2.5
Asotin	H	3	M	2	MH	2.5
Stillaguamish	M	2	M	2	M	2.0
Snohomish/ Skykomish	M	2	M	2	M	2.0
Puyallup	M	2	M	2	M	2.0
Nooksack	M*	2	M	2	M	2.0

* No FMO, so rating was given based on risk to populations

The core areas determined to be at high (H) overall potential risk are: the Yakima, Methow, and Entiat. Three core areas, the Wenatchee, Walla-Walla, and Asotin were determined to be at a moderate-high (MH) overall potential risk. The remaining four core areas had either a moderate or low overall potential risk ranking.

Integration of the two risk rankings (Table 6) indicated that 58 percent (7of 12) of the affected core areas are at a moderate-high to high level of overall potential risk from the effects of the proposed action.

Summary of Overall Effects Risk

Integration of both the local population and core area overall effects risk is shown below in Table 7. This summary incorporates the final rankings for both local populations and core areas, where overall effects of the action rated out as either Moderate or High.

Table 7. Summary of Overall effects risk rankings for local population and core areas.

		Overall Local Population Effects Risk		Overall Core area Effects Risk	
Core Area	**Local Population**	**rank 3**	**score 3**	**rank 3**	**score 3**
Yakima				H	3.0
	Ahtanum	H	3.0		
	Rattlesnake	H	3.0		
	Upper Yakima	MH	2.5		
	NF Teanaway	MH	2.5		
Pend Oreille*	dropped			H	3.0
Methow				H	3.0
	Goat	H	3.0		
	Wolf	H	3.0		
	Chewack	H	3.0		
	Lost	M	2.0		
	Twisp	M	2.0		
Entiat				H	3.0
	Entiat	H	3.0		
	Mad	H	3.0		
Wenatchee				MH	2.5
	Icicle	H	3.0		
	Chiwawa	M	2.0		
Walla-Walla*				MH	2.5
Asotin	dropped			MH	2.5
	Charley	MH	2.5		
Nooksack				M	2.0
	Lower SF Nooksack	MH	2.5		
Stillaguamish*				M	2.0
Snohomish/ Skykomish				M	2.0
	SF Skykomish	M	2.0		
Tucannon*				M	2.0
Grande Ronde*				M	2.0

* Indicates the core area that only had FMO habitat exposed and no local population/spawning and rearing habitat.

Five of the 12 core areas were rated as Moderate or High for exposure in the FMO (> 10 percent of FMO habitat has inadequate WQS), but had Low or no exposure ratings for their corresponding local populations (Table 1). Core areas with no exposure risk in the spawning and rearing habitat include the Walla-Walla, Stillaguamish, Tucannon, and Grand Ronde. The Pend Oreille has a very low risk of exposure in the spawning and rearing habitat (< 1 mile at low end of Le Clerc Creek). However, the fact that this core area only has one spawning area and populations are extremely low, places this core area at an elevated risk from the perspective of

recovery. The overall risk to these five core areas from the proposed action is considered to be generally less than the other core areas because there is no risk to their associated local populations. This does not mean that adverse effects will not occur to bull trout or critical habitat in the FMO, but there is less overall effect at the core area scale because the spawning and rearing areas are protected.

Seven of the 12 core areas have exposure risk to both the FMO and local populations. These include: the Yakima, Methow, Entiat, Wenatchee, Asotin, Nooksack, and Snohomish-Skykomish. The overall risk rating was Moderate High to High for six (Yakima, Methow, Entiat, Wenatchee, Asotin, and the Nooksack) of the seven core areas (86 percent).

Integrating the results of the core area and local population overall potential effects risk rankings would indicate that the Yakima, Methow, Entiat, and Wenatchee core areas are at greatest risk from the proposed action. Although the Wenatchee and Methow core areas rated out as high risk, the risk is reduced by the early onset of the salmon spawning criterion (the 13 °C effectively applies year-round in the Methow) and the fact that most of the riparian areas are protected under the Northwest Forest Plan. It should also be noted that the local populations in the Methow and Entiat core areas were originally adequately protected by the char use designation but the FWS later modified the key habitat layers (to be consistent with the final Critical Habitat Rule). We were unaware of the new GIS layers until after the EPA maps were finalized.

The Asotin rated out as a Moderate-High risk in both the spawning and rearing areas and FMO habitats. The Noocksack is at Moderate risk because of the exposure to local population/ pawning and rearing habitat but there is no FMO exposure. Overall, the effects are similar in both areas because of poor population baseline conditions.

Overall Effects Risk for FMO Areas Outside of Core Areas

In the analysis of exposure risk, freshwater FMO habitats outside of core areas were identified as having moderate to high exposure (Table 1). However, these areas do not directly contain local populations, and therefore are not considered core areas. These areas do, however, support the completion of the life history cycle for individuals from multiple local populations and/or core areas. These FMO areas are the Samish, Lower Green, Wishkah, Humptulips, Satsop, Chehalis, Lower Snake, and Columbia Rivers. These areas' risk from inadequate WQS can be significant to the species, especially where there is significant exposure.

The overall risk to these FMO areas from inadequate WQS is considered to be generally less compared to the core areas ranked above in Tables 6 and 7 due to the more limited exposure to individuals from the populations (i.e., not all individuals utilize these areas, although specific life history strategies do). This does not mean that adverse effects from inadequate water quality standards will not occur to habitat in these FMO areas or that adverse effects will not occur to bull trout within these areas, but rather the adverse effects to a core population's more sensitive spawning and rearing habitats and more sensitive life stages will largely be avoided.

The overall potential risk rankings for these core areas are equated with their exposure risk ranking in Table 1. Four of the eight FMO areas (Samish River, Chehalis River, Lower Snake

River, and Columbia River) were determined to be at a high (H) overall potential effects risk. Two core areas, Lower Green River and Wishkah River, were determined to be at moderate (M) overall potential effects risk. The Humptulips River and Satsop River FMOs were determined to be at a low (L) overall potential effects risk ranking. The Samish, Chehalis, Lower Green, and Wishkah Rivers are used exclusively for foraging by anadromous bull trout, while the Lower Snake and Columbia Rivers are used at least six months of the year by migrating fluvial bull trout as key foraging and migration corridors in the Columbia River Basin.

Potential Local Population Overall Effects Risk

Potential local populations were identified in the Draft Bull Trout Recovery Plan as important for recovery. The plan states that: "A local population that does not currently exist, but that could exist, if spawning and rearing habitat or connectivity were restored in that area, and contribute to recovery in a known or suspected unoccupied area. Alternatively, a potential local population may be a population that is suspected to exist, but that has not yet been adequately documented (USFWS 2002; USFWS 2004)." In some cases, bull trout may have been observed in the potential local population area, but it is unknown whether they represent a spawning population due to the current lack of data demonstrating spawning and juvenile rearing, or due to the limited observations of individuals in the area. In other cases, these areas were identified as necessary for recovery because they were historically occupied by bull trout, but they are now either extirpated or presumed to be extirpated.

According to Rieman and McIntyre (1993), core areas with multiple local populations (ideally five or more) have a lower risk of local extirpation from stochastic events. They ultimately advise that it will be necessary to maintain multiple local populations within a core area to ensure conservation of bull trout populations. In some cases, habitats that could sustain local populations may require more intensive management and monitoring to ensure that their desirable characteristics are protected, enhanced, or restored (Rieman and McIntyre 1993).

Potential local populations were not included in the initial risk rankings because no population parameters (i.e., adult abundance and trend) are available to evaluate a baseline population condition. However, a coarse analysis of exposure risk was conducted which equates to the overall potential risk, especially where the proposed action will affect substantial amounts of potential habitat. We combined the two available risk categories (i.e., exposure risk and baseline habitat risk) to get a coarse estimate of the overall potential risk ranking for these potential local populations. These rankings are summarized below in Table 8. There were seven potential local populations at high risk of overall effects while three were at a moderate risk of overall effects.

Table 8. Exposure/overall potential risk rankings for potential local populations.

Core Area	Potential LP	Exposure/ Overall Potential Risk
Yakima	Taneum Creek	H
Pend Oreille	Mill Creek	H
Pend Oreille	Ruby Creek	H
Pend Oreille	Tacoma Creek	H
Pend Oreille	SF Tacoma Creek	H
Pend Orielle	Small/E Fk Small Cr	H
Asotin	Wormell Gulch	H
Puyallup	Clearwater River	M
Pend Oreille	Cedar Creek	M
Pend Oreille	Harvey Creek	M

The results of the potential local population risk rankings suggest that with respect to recovery, the Yakima and Pend Oreille core areas probably incur the greatest increment of additional risk to their overall potential core area risk ranking. It should be noted that the Pend Orielle core area is in an unusual situation. It currently contains only one known local population, Le Clerc Creek, which was ranked at low (L) overall potential risk due to low exposure in the spawning and rearing areas. The fact that it currently has only one local population, and the reliance on a significant number of potential local populations for recovery, elevated the ratings to moderate (M) and high (H) risk.