Distribution, Status, Life History, and Limiting Factors Of Redband Trout and Bull Trout Associated With the Hells Canyon Complex (E.3.1-7, Chapter 4)

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I. Introduction

During consultation for relicensing of the Hells Canyon Complex (HCC), the Applicant received from the Aquatic Resources Work Group a list of concerns regarding potential impacts associated with hydropower operation on native resident salmonids. In particular, bull trout and redband trout were identified as native resident salmonids of concern.

"In 1996, as part of the relicensing process for the Hells Canyon Complex, IPC began conducting studies to support its license application. This report presents results from studies designed to evaluate the distribution, status, life history, and limiting factors of redband and bull trout associated with the Hells Canyon Complex projects. Our specific study objectives were

1) *To determine the spatial and temporal distribution of redband and bull trout populations associated with the Hells Canyon Complex.*
2) *To assess the status of redband and bull trout populations associated with the Hells Canyon Complex and the Snake River below Hells Canyon Dam.*
3) *To describe the life history strategies present among redband and bull trout populations associated with the Hells Canyon Complex and the Snake River below Hells Canyon Dam.*
4) *To evaluate adult redband and bull trout upstream access to tributaries containing culverts in the Hells Canyon Complex and those within the fluctuation zone at Brownlee Reservoir and below Hells Canyon Dam." (Page 3, Paragraph 2)*

II. Conclusions

The Applicant did not list any study conclusions. They reported their findings in a discussion of the four identified issues affecting bull trout and redband trout associated with the Hells Canyon Complex: 1) distribution and status, 2) life history, 3) tributary access, and 4) limiting factors. The following response to sections of the discussion addresses each item as a conclusion.

A. Distribution and Status of Redband Trout

1. "We found self-sustaining native redband trout populations within all of the projects of the Hells Canyon Complex, in the Snake River, and in tributaries below Hells Canyon

Dam. Despite also finding an abundant and widely distributed hatchery rainbow trout component of the fishery, we found that redband trout were present throughout the Hells Canyon Complex reservoirs and in nearly every tributary that had adequate year-round flow." (Page 34, Paragraph 5)

Response: The BLM agrees with this finding.

2. "Within the project reservoirs and in the Snake River below Hells Canyon Dam, hatchery-produced trout were three to ten times more abundant than wild rainbow trout, yet wild rainbow trout dominated tributary streams throughout the study area." (Page 35, Paragraph 1)

Response: The BLM agrees with this finding. The mainstem of the Snake River has a large number of residualized hatchery steelhead (those that do not migrate to the ocean).

3. "Juvenile trout were the predominant life stage in all of the tributaries, while both juveniles and adults occupied reservoir habitats. Juveniles emigrating from tributaries served as the primary source of redband trout for the Hells Canyon Complex reservoirs and mainstem Snake River." (Page 35, Paragraph 1)

Response: The BLM agrees with this finding. This is reasonable, since there are no suitable spawning areas for redband trout in the reservoirs. When redband juveniles hatched and reared in tributaries become overcrowded they are forced to seek new habitat downstream in the reservoirs.

4. "Hybridization between hatchery rainbow trout and native redband trout has occurred within the complex but to a lesser extent than might be expected based on historic stocking levels. Because nearly all of the reservoir tributaries were found to have pure redband trout populations while Brownlee and Oxbow reservoirs contained a mixture of hatchery rainbows and native redband trout, hatchery fish have apparently been either physically or reproductively isolated from interbreeding with native redband trout in the tributaries (Leary 2001)." (Page 35, Paragraph 2)

Response: The BLM agrees with this finding. The state agencies should convert their rainbow trout stock to redband trout or sterile triploid rainbow trout. It was noted that this process has begun with some state hatchery programs.

5. "Leary (2001) reported that hatchery steelhead planted below Hells Canyon Dam were genetically similar to the average redband population from the Hells Canyon study area. This similarity may explain why wild redband trout from Sheep Creek did not contain genetic information from hatchery rainbow trout, even though residualized hatchery steelhead were present throughout the Snake River and in Sheep Creek." (Page 35, Paragraph 3)

Response: The BLM agrees with this finding. The steelhead stock is native to the Snake River, and they are an anadromous form of the redband trout.

6. *"....populations in Connor and Sutton creeks had characteristics closer to nonnative coastal strains of rainbow trout. Most populations examined had intermediate characteristics of redband trout and coastal rainbow trout. Redband trout collected above a barrier in McGraw Creek were characteristic of a small population isolated over a long time, a finding that suggested genetic drift from typical redband trout populations." (Page 35, Paragraph 4)*

Response: The BLM agrees with this finding.

B. Status and Distribution of Bull Trout

1. "We found that, within the Hells Canyon Complex, bull trout populations were restricted to the Indian Creek, Pine Creek, and Wildhorse River drainages. We also found them in the Oxbow Bypass Reach and Hells Canyon Reservoir, though their abundance at these locations appeared to be extremely low." (Page 36, Paragraph 2)

Response: The BLM agrees with this finding. The more important issue is whether the dams are causing these populations to be so low. Poor water quality in all of the reservoirs is well documented, and it is a matter of particular concern for native coldwater fish.

2. "All of the drainages that contained bull trout also had resident brook trout and hybridized individuals between bull trout and brook trout. Hybrids were particularly abundant in Indian Creek and the Wildhorse River, and a significant number were captured in Oxbow and Hells Canyon reservoirs." (Page 36, Paragraph 2)

Response: The BLM agrees with this finding.

3. "Bull trout below the Hells Canyon Complex did not show any signs of hybridization with brook trout. However, because brook trout have been stocked in lakes in the upper Granite Creek drainage, some hybridization may have occurred (although we did not evaluate the genetics of Granite Creek bull trout). All of the char that we sampled in the Snake River and Sheep Creek were genetically pure bull trout." (Page 36, Paragraph 3)

Response: The BLM agrees with this finding.

C. Life history of Redband Trout

1. "Our trapping, radio-telemetry, and genetics results showed that fluvial and resident redband trout populations have persisted within the Hells Canyon Complex and in the Snake River below Hells Canyon Dam." (Page 37, Paragraph 1)

Response: The BLM agrees with this finding.

2. "Redband trout home ranges were larger within reservoirs than they were in the Snake River: about half of the tagged fish used half or more of the length of the reservoirs. Larger reservoir home ranges may have been a result of reservoir trout actively

searching for food, while trout overwintering in the river probably relied mostly on invertebrate drift." (Page 37, Paragraph 2)

Response: The BLM agrees with this finding.

3. "We trapped juvenile and adult redband trout migrating downstream to Hells Canyon Complex reservoirs and the Snake River during fall when water temperatures began to drop below 8 to 10 °C. Adults and juveniles were observed moving downstream, but juvenile fish dominated the catch. Significant catches of juveniles at tributary traps indicated that a significant amount of spawning occurred within the tributaries." (Page 37, Paragraph 3)

Response: The BLM agrees with this finding.

4. "We also recorded the upstream return of adults with radio-telemetry monitoring. Radio-tagged adult redband trout made extensive movements into tributaries primarily during April and May."…. "Adult redband trout were probably moving to tributaries to spawn and likely remained there through the summer. Reservoir electrofishing results lent support to this hypothesis in that summer catch rates of wild trout were consistently lower than fall and winter catch rates." (Page 37, Paragraph 4)

Response: The BLM agrees with this finding. This finding only seems reasonable in that there is no place in the reservoirs for the redband trout to spawn and tributaries provide small gravel and riffles needed for spawning. The tributaries provide greater protection for the relatively smaller redband trout than would be available in large rivers and reservoirs. They would have greater vulnerability to predatory fish during spawning and early rearing in the larger bodies of water.

5. "Genetic results reinforced trapping and radio-telemetry data that pointed to the existence of a fluvial redband trout component within and below the Hells Canyon Complex. Genetics showed that gene flow among redband trout populations from different tributaries has occurred to a greater extent than genetic exchange between some populations within the same drainage (Leary 2001). Leary (2001) suggested that this genetic structure could be explained by the existence of two different life histories. Migratory fish, present in some or all of the drainages, would spawn and rear in the tributaries and then migrate to the Snake River. Adults returning to spawn might stray from their natal drainage and therefore generate gene flow among drainages." (Page 38, Paragraph 2)

Response: The BLM agrees with this finding.

6. "In general, reservoir habitats are unsuitable for successful salmonid spawning. Habitat requirements for spawning redband trout include a range of suitable water velocities and appropriate substrate sizes. Therefore, it should not be surprising to find that redband trout in Hells Canyon Complex reservoirs use tributary habitats for spawning and rearing but reservoir habitats during fall and winter for overwintering.

The specific features of suitable rearing habitat for emerging fry (including thermal regime, escape cover, and other features) may, in part, explain a natural selection toward tributary spawning. Fry survival from tributaries would likely be higher than survival in the mainstem where predators are more abundant and physical habitat conditions are less favorable. Substrate particle sizes suitable for smaller, nonanadromous salmonids could be subject to scour in larger river environments, which may further explain natural selection of smaller fluvial environments. Fluvial or adfluvial life stages are generally associated with larger individuals that migrate out of smaller tributary environments to benefit from greater forage potential in large river habitats and ultimately greater survival and fitness. And younger life stages are also known to migrate out of tributary habitats into mainstem environments, especially to overwinter." (Page 38, Paragraph 3)

Response: The BLM agrees with this finding. It should be noted that the young fish that do migrate into the reservoirs of the Hells Canyon Complex are subject to poor growing conditions due to poor water quality.

D. Life History of Bull Trout

1. "Indian Creek and Pine Creek appeared to contain at least a small fluvial bull trout population."... "Radio-tag monitoring provided the most convincing data suggesting a fluvial life history, since trap numbers for bull trout were extremely low. However, trapping information did indicate that bull trout were migrating from tributaries within the Hells Canyon Complex at about 250 to 300 mm TL. Below Hells Canyon Dam, outmigrants were much larger, at 350 to 450 mm TL." (Page 39, Paragraph 2)

Response: The BLM agrees with this finding. The difference in size is an indication of the poor quality habitat created by the reservoirs. It is probable that the fish migrating out of tributaries below Hells Canyon Dam are larger than those within the complex due to habitat quality differences. Bull trout below Hells Canyon Dam can forage on anadromous fish juveniles. Bull trout foraging in Hells Canyon Reservoir have few suitable forage species that they are adapted to feeding upon.

2. "Chandler, et al. (2001c) documented the presence of a resident bull trout population in the Pine Creek basin. They monitored pre- and post-spawn movements of bull trout in the Pine Creek basin from August 1998 to April 1999." (Page 39, Paragraph 3)

Response: The BLM agrees with this finding.

3." Radio-tagged bull trout below Hells Canyon Dam exhibited classic fluvial migrations during both years that we monitored movement. Fifty percent of the individuals that we monitored made spring migratory movements downstream to the Imnaha River after wintering in the mainstem Snake River." (Page 39, Paragraph 5)

Response: The BLM agrees with this finding. This behavior indicates that the bull trout that use habitat in the Imnaha River during the spring and summer are dependent on the quality of habitat in the Snake River during the fall and winter. They also were

documented to use the Snake River during the summer months if they do not migrate to the tributaries. It is probable that immature bull trout rear in the Snake River through the summer in cool water pockets.

4. "Tributary migrations in the Snake River generally occurred in late April through May. Movement up the Imnaha River was gradual through May, June, and July, a finding suggesting that increasing water temperatures may have influenced upstream movement through the summer. Additional observations of bull trout tagged in the Imnaha River in summer 2001 and monitored through the winter by USFS, ODFW, and IPC biologists (USFS, Wallowa-Whitman National Forest, unpublished data, 2002) provided further evidence for the existence of a fluvial population that spawns in the upper Imnaha River basin. These fish spawned between September and October 2001. After spawning, one of these bull trout moved out of the Imnaha River sometime in November or December and remained in the Snake River from January to April 2002." (Page 40, Paragraph 2)

Response: The BLM agrees with this finding.

E. Tributary Access

1. "Culvert surveys at 18 Hells Canyon Complex tributaries suggested that most were upstream barriers for adult rainbow and bull trout. The primary factors responsible for creating barriers were water depth and water velocity inside the culverts. Culvert size and the lack of downstream control points appeared to be responsible for inadequate depths, while culvert gradient was responsible for the extreme velocities." (Page 40, Paragraph 3)

Response: The BLM agrees with this finding. Responsibility for management of these culverts should be specified. The Applicant should make recommendations to replace or correct those culverts where fish passage is required.

2. "While nearly all of the streams that we surveyed had culvert barriers, 11 of the 18 streams were ephemeral or nearly ephemeral, flowing primarily in the spring and early summer."…. "In contrast, based on snorkel and bank observations, four of the seven perennial streams had rainbow trout populations." (Page 40, Paragraph 4)

Response: The BLM agrees with this finding. The culvert criteria are set for optimum fish passage. It is reasonable to assume that some culverts that do not meet the exact criteria would still pass fish. However, all culverts that do not meet criteria should be replaced or repaired to meet criteria.

F. Tributaries Without culverts

1. "Below Hells Canyon Dam, upstream passage seemed to be unaffected by low discharge in the Snake River. Instead, access to these tributaries was more likely a function of year-to-year variation in discharge within the tributary drainages and the unique geomorphological characteristics of the basins (Parkinson et al. 2002)." (Page 41, Paragraph 2)

Response: The BLM agrees with this finding. Observations of these tributaries indicate that they move substantial bedload that can affect fish access from year to year. A pulse of bedload material will frequently accumulate at the confluence of a tributary with the Snake River. The material may be so loose that water filters through it rather than flowing in a channel to the river. This prevents fish passage.

2. "Transect data at the reservoir tributaries showed that low reservoir elevations could create barriers within the lower reaches of some tributaries. We found it highly probable that Dennett Creek was inaccessible to adult trout at a low-pool elevation but that Sturgill Creek was accessible to all but the largest trout (greater than 457 mm TL). And, though travel distances were extensive, habitat conditions in Brownlee Creek were more than adequate to pass all sizes of adult trout. Water depth, water velocity, and resting habitat were the primary factors affecting access for adult trout in the lower reaches of the reservoir tributaries. Failure to meet these criteria was largely a result of an unconfined channel with sand and gravel substrates. Stream discharge might also have influenced the accessibility of these tributaries at low reservoir elevations. After many years of reservoir impoundment, channel substrates and overall channel gradient within the impounded reaches of reservoir tributaries might be affected by drainage basin size and a stream's ability to transport bed material." (Page 41, Paragraph 3)

Response: The BLM agrees with this finding. Basically the Applicant's study indicates that some streams are non-functional within the reservoir draw down zone. Sediment delivered to the reservoir aggrades and causes the channel to lose definition. In some cases the streams flow under unconsolidated bed material in the channel and emerge at the reservoir. Under these conditions fish cannot find a way to pass upstream.

4. "We rated two tributaries below Hells Canyon Dam as "high", one as "medium", and one as "low" for barrier probability. Tributary entrances downstream of Hells Canyon Dam generally had steeper gradients and higher velocities than upstream reservoir tributaries did. At several tributaries, these features appeared to be the result of natural substrate and debris flow events that had occurred relatively recently within the drainages. At the time of our survey, we also noted that the entire flow from several small (less than 5 cfs) tributaries did not reach the Snake River. This condition also may have been related to extreme flow events." (Page 41, Paragraph 4)

Response: The BLM agrees with this finding.

5. "Based on our tributary survey below Hells Canyon Dam, we concluded that annual precipitation, channel and drainage basin geomorphology, and extreme flow events within tributaries are probably key factors affecting habitat conditions at tributary entrances. Our observations also led us to conclude that fluctuations in discharge in the Snake River resulting from operation of the Hells Canyon Complex are unlikely to significantly affect tributary access for adult salmonids. Many of the tributaries below Hells Canyon Dam may have been historically inaccessible to trout and salmon during low-flow periods (i.e., late summer through winter) and after extreme flow events within tributaries that resulted in high gradient, shallow entrances. These streams would have been accessible only during spring runoff and possibly through early summer." (Page 41, Paragraph 5)

Response: The BLM agrees with this finding.

6. "The life history strategies of salmonids that occur in the Snake River downstream of Hells Canyon Dam may also provide some insight into the accessibility of small tributaries at various times during the year. For example, bull trout, a fall-spawning species, have been observed migrating to large tributaries like the Imnaha and Grande Ronde rivers to spawn, while fall-migrating chinook salmon spawn in the mainstem Snake River. Neither species has been collected in significant numbers in small (less than 5 cfs) tributaries downstream of Hells Canyon Dam, suggesting that small tributaries may have been inaccessible in late summer and fall. On the other hand, access in spring may be more reliable given the presence of spring-spawning steelhead, chinook salmon, and resident rainbow trout in many of these same tributaries." (Page 44, Paragraph 6)

Response: The BLM agrees with this finding.

7. "We consider our assessment of tributary passage a conservative one since we applied culvert passage criteria to natural stream channels to determine whether stream sections were passable. It is important to point out that culvert criteria could be exceeded in a natural stream channel while adequate conditions for adult trout passage were maintained. Therefore, we believe that many of the tributaries that we classified as having a "medium" probability of being a barrier were probably not barriers to all size classes of adult trout. Only the largest or smallest size classes may have been excluded, depending on which particular criteria were not met." (Page 42, Paragraph 2)

Response: The BLM agrees with this finding.

G. Limiting Factor for Redband Trout

1. "…several factors can be identified as potentially limiting redband trout populations. Such factors for redband trout associated with the Hells Canyon Complex include habitat degradation, habitat fragmentation, genetic introgression, competition and predation from nonnative species, and reduced tributary productivity." (Page 42, Paragraph 3)

Response: The BLM agrees with this finding. However, this is a generic statement that does not address the effects of the Hells Canyon Complex on redband trout. Water quality in the reservoirs may be a larger problem for redband growth and survival than tributary condition.

2. "In a large system such as the Snake River, diurnal fluctuations are not as large and as such would force fish to endure longer periods of suboptimal conditions. These prolonged exposures likely prompt fish to migrate and seek thermal refuge in tributary systems. Temperature conditions and low dissolved oxygen levels in the mainstem Snake River and even in the lower end of larger tributaries are likely critical in limiting the production potential of redband trout (Chandler 2001)." (Page 42, Paragraph 4)

Response: The BLM agrees with this finding.

3. *"Habitat alterations related to land-use practices within tributary basins could have negative effects on redband populations. For example, activities that increase sediment and decrease flow to a stream might lead to reduced spawning success and lower survival of redband trout fry from redds. Multiple land-use practices occur in most major drainages containing redband trout within the Hells Canyon Complex. Many of these activities could negatively impact prime spawning and juvenile rearing habitats. These tributaries may also be used extensively by adult redband trout as thermal refugia during summer. Protection and restoration of these habitats are probably essential to the continued persistence of the species on a local scale." (Page 43, Paragraph 1)*

Response: The BLM agrees with this finding. However, the effects of the Hells Canyon Complex on rearing and wintering fish may have an equal if not greater affect on limiting trout production.

4. "Redband trout demonstrate a complex of different life history forms. The species displays varying degrees of potamodromy (migration, spawning, and feeding entirely in freshwater), and anadromy is prevalent throughout much of its range (Behnke 1992, Currens 1996). Maintenance of various life history forms also appears to be critical to the persistence of some populations."…. "Within the Hells Canyon Complex, redband trout exhibit resident and fluvial life histories. Connectivity among drainages in the complex is necessary to maintain these life history forms. All major drainages in the complex appear to be accessible to the fluvial form, but a number of smaller tributaries may be periodically or permanently inaccessible because of culverts, fluctuating reservoir levels, and naturally low stream flows. Restoring connectivity to many of these smaller tributary populations when flows are adequate could help to ensure persistence of the two life histories and genetic diversity." (Page 43, Paragraph 2)

Response: The BLM agrees with this finding.

5. "Genetic hybridization between native redband trout and hatchery-planted coastal rainbow trout could also be a significant limiting factor among redband populations associated with the Hells Canyon Complex."…. "Even though genetic analyses showed that nearly all of the tributaries in the complex possessed pure redband trout, continued stocking of hatchery rainbow trout could threaten existing pure populations. This risk would become even greater if connectivity among smaller tributaries was improved. Limited access to these tributaries historically may have protected native redband trout from becoming hybridized with hatchery stocks. State fisheries managers have begun to reduce the risk of introgression in some areas by planting only sterile triploid rainbow trout into waters containing native cutthroat or redband trout. If the IDFG and ODFW adopt this management strategy in the Hells Canyon Complex, the risk of hybridization would be significantly reduced." (Page 43, Paragraph 3)

Response: The BLM agrees with this finding.

6. "Competition and predation from introduced nonnative fish species may also be a significant factor influencing native redband trout populations associated with the Hells

Canyon Complex. Introduced species such as rainbow trout, crappie, pumpkinseed, bluegill, yellow perch, smallmouth bass, and channel catfish compete with juvenile and adult redband trout for food and space. Predation by largemouth and smallmouth bass and channel catfish may also be a nonnative species may have on redband trout populations and attempting to compensate for their effects by establishing refuge areas may be critical for ensuring the persistence of some populations and life history forms." (Page 43, Paragraph 4)

Response: The BLM agrees with this finding. However, it is not stated how these refuges can be created.

7. "Reduced tributary productivity resulting from the loss of anadromous salmonids within tributaries in the Hells Canyon Complex may also be a limiting factor for redband trout populations. Marine-derived nutrients that had previously been imported to tributaries every year in the form of salmon carcasses are no longer present. Effects of this loss probably vary among drainages, depending on other sources of nutrients available through natural basin characteristics or human activities. The loss of nutrients may have directly affected the productivity of redband trout and other native salmonids, especially within the rearing areas." (Page 44, Paragraph 2)

Response: The BLM agrees with this finding. There may be opportunities to add nutrients to these streams artificially to compensate for the loss of anadromous fish marine-derived nutrients.

H. Limiting Factors for Bull Trout

1. "Water temperature, in particular, may be the most critical limiting factor for the species. Bull trout require a narrow range of cold temperatures for spawning and rearing."…."Therefore, land- and water-use practices that alter stream temperatures or other physical habitat conditions have reportedly had profound effects on bull trout populations (Bellerud et al. 1997, Buchanan et al. 1997). Within the Hells Canyon Complex, land-use activities in the Pine Creek basin, in particular, may negatively influence resident and migratory bull trout populations through habitat degradation. The effects of habitat alteration within Hells Canyon Complex tributaries may be especially important considering that bull trout in our studies appeared to use these areas as coldwater refugia during summer months when reservoir water quality conditions were degraded." (Page 44, Paragraph 3)

Response: The BLM agrees that tributary habitat quality is important to bull trout. The lands now in agriculture in Pine Valley may have been used in summer for refugia prior to European settlement, but it is likely that most bull trout moved further upstream to higher elevations where temperatures were cooler. The ambient air temperature on the valley floor would have heated streams above the temperature levels preferred by bull trout. Many of these upper stream reaches are in good condition today and do support bull trout. The largest problem in Pine Creek basin is the transfer of water between subwatersheds and loss of water to irrigation.

2. "Bull trout also display a complex suite of life history strategies, including resident, fluvial, and adfluvial populations."…." Maintenance of an appropriate number, size, and distribution of self-sustaining populations within a metapopulation is critical to bull trout conservation. Habitat loss and fragmentation have isolated many populations and subpopulations and ultimately led to the loss of certain life histories. Fragmentation caused by physical (such as dams and diversions) and/or habitat barriers (such as temperature, dissolved oxygen, and low stream flows) have reduced connectivity among populations in many drainages, resulting in reduced resilience to environmental change and less genetic variability. In the Hells Canyon Complex, reduced connectivity among populations from the Indian Creek, Pine Creek, and Wildhorse River basins has probably influenced the health of the fluvial life history component of each subpopulation and may have increased the risk of extinction among resident populations. Migrations corridors between these drainages are influenced by water quality conditions in the lower reaches of the tributaries and within the Hells Canyon Complex reservoirs (Chandler et al. 2001a). Measures that increase the connectivity among these tributary populations would undoubtedly reduce the risks to both life history components." (Page 44, Paragraph 4)

Response: The BLM agrees that measures to improve the connectivity are important to reducing the risk of extinction. The Hells Canyon Reservoir is a major cause of the disconnection between the five subpopulations. It is likely that if Hells Canyon Dam were to be removed, all of the populations would no longer be at-risk. Migratory forms of bull trout would access the watersheds and breed with existing populations.

3. "Below Hells Canyon Dam, populations from several large drainage basins, for the most part, remain connected and appear to persist despite severe habitat alterations within some of the lower portions of these drainages." (Page 45, Paragraph 1)

Response: The BLM agrees with this statement. The reason for the still viable population levels are three fold: (1) there are few dams on these small headwater tributaries, (2) most of the headwaters are in wilderness, and (3) anadromous fish still return to spawn in those streams. However, the HCC has eliminated salmon and steelhead needed for forage and marine-derived nutrients and eliminated riverine winter feeding area. It was noted previously that those bull trout found within the Hells Canyon Reservoir population were much smaller than those below the Hells Canyon Dam. This is probably related to available food resources and habitat quality.

4. "Hybridization between nonnative brook trout and bull trout may be the most serious risk for bull trout populations within the Hells Canyon Complex. Hybridization appeared to be prevalent in the Indian Creek and Wildhorse River basins. We also observed movement of hybrids to Pine Creek during our studies. The high level of genetic introgression that we observed could have a serious effect on the persistence of resident and fluvial populations in all of the drainages."...."Actions that reduce the level of hybridization by eliminating or reducing the number of brook trout could also reduce the risk to resident and fluvial populations (Thompson and Rahel 1996)." (Page 45, Paragraph 2)

Response: The BLM agrees with this finding.

5. "Competition between native bull trout and nonnative brook trout and predation by introduced centrarchids are also potential limiting factors for bull trout populations in the Hells Canyon Complex. Brook trout appear to be abundant enough in the headwaters of Indian Creek and the Wildhorse River to provide serious competition for food and space. Migratory bull trout that leave the tributaries and enter the complex reservoirs also face increased risk of predation because of the abundance of smallmouth bass. The overall effect of these factors on population dynamics is, at best, difficult to predict." (Page 45, Paragraph 3)

Response: The BLM agrees with this finding.

6. "Our bull trout population viability analysis for the Indian Creek and Pine Creek basins revealed that all five local populations are at risk of extinction due to low abundance, isolation, and limited suitable habitat (Pratt 2001."…. "Enhancing movement between populations within the complex was found to have the greatest chance of increasing population persistence, compared with any other management activity. Annual immigration rates of as little as 1 to 6 mature females into each subpopulation would significantly reduce the risk of stochastic extirpation." (Page 45, Paragraph 4)

Response: The BLM agrees with this finding. A plan should be developed to facilitate this interchange of bull trout between the five populations.

7. "The assessment also found that increasing the potential for population growth required increased egg deposition and access to more suitable habitat. Increased egg deposition could be achieved by increasing the average size, and thus fecundity, of spawning females. Increasing rearing space would require changes in land- and water-management practices and improvement of degraded habitats." (Page 45, Paragraph 4)

Response: The BLM agrees with this finding.

8. "The BayVAM assessment also concluded that high hybridization rates in Indian Creek have reduced the potential for the population to persist by reducing effective egg deposition. Competition with nonnative brook trout and hybrids for food and space have also reduced the effective rearing space available to bull trout in the basin." (Page 45, Paragraph 4)

Response: The BLM agrees with this finding.

9. "The loss of anadromous salmonids to tributaries within the Hells Canyon Complex and the resultant effects on nutrient cycling may also be a limiting factor for bull trout populations. Nutrient loss from tributaries has probably had the greatest impact in rearing areas where the forage base for bull trout may have been reduced. Loss of

anadromous fish in the Pine Creek, Indian Creek, and Wildhorse River basins has probably impaired bull trout by removing forage." (Page 45, Paragraph 5)

Response: The BLM agrees with this finding.

10. "Temperatures begin to become optimal for bull trout foraging relatively early in the spring. This period overlapped historically with pulses of juvenile anadromous fish migrating downstream to the ocean. Our radio-telemetry data showed that the activity level of bull trout that overwinter downstream of Hells Canyon Dam increases significantly during spring. Since bull trout evolved in the same geographical areas as anadromous fish, their life histories are probably closely linked. Energy reserves used during the relatively cold, dormant portion of the winter were likely replenished quickly, and substantial growth likely occurred during the late winter and early spring when anadromous fish moved out of the tributaries or emerged from mainstem habitats. This growth probably gave the bull trout enough energy to migrate back into the tributaries as temperatures began increasing during the spring and early summer, just as adult steelhead and spring/summer chinook salmon were moving into tributaries to spawn. Bull trout probably benefited further from spring/summer chinook salmon and steelhead spawning as they foraged on eggs and rearing juvenile anadromous fish in the tributaries. In turn, this forage further helped bull trout grow and increase their energy reserves for spawning activity in the early fall." (Page 46, Paragraph 1)

Response: The BLM agrees with this finding.

11. "The loss of anadromous fish in systems such as Pine Creek may have contributed more to losses of fluvial fish than lost connectivity within the tributaries and mainstem Snake River." (Page 46, Paragraph 2)

Response: This is speculation but it may be true. There has been no suitable replacement forage fish for bull trout to prey upon. The blockage of anadromous fish is a direct impact of the Hells Canyon Complex. PM&E measures should be developed to compensate for this situation.

III. Study Adequacy

A clear set of conclusions must be presented before the BLM can agree that this study is adequate. Based on normal scientific protocol for presentation of study results, this study is not adequate. The study does not present the author's conclusions.

IV. BLM Conclusions and Recommendations

Conclusions Redband Trout

A. Distribution and Status

1. Within the Hells Canyon Complex

Redband populations are both resident and fluvial within the Hells Canyon Complex. They are well distributed throughout the planning area. The redband trout appear to be smaller than their counterparts below Hells Canyon Dam. Wild redband trout are greatly outnumbered by hatchery rainbow trout stocked by ODFW and IDFG. Connor and Sutton creeks have rainbow/redband hybrids present. However, this is a relatively limited number considering the extensive stocking of hatchery rainbow trout that annually takes place.

2. Below the Hells Canyon Dam

The populations are both resident and fluvial below the Hells Canyon Dam. They are mixed with large numbers of residual hatchery steelhead that are also of redband genetic origin. The redband trout found in tributaries are pure strain with the exception of Sheep Creek where they have hybridized with cutthroat trout in the extreme headwaters. The population is widespread and abundant. The study also found that a few redband trout radio-tagged above the dams were found in the Snake River below Hells Canyon Dam. It is believed that they were entrained during periods when water was being spilled.

B. Life History

1. Within the Hells Canyon Complex

The redband trout within the Hells Canyon Complex exhibit two life history strategies. One strategy is to remain in the small tributaries and reproduce without migrating. The second strategy is to migrate into the reservoirs of the Hells Canyon Complex to rear. When redband trout rearing in the reservoirs become sexually mature, they return to their natal streams in the spring to spawn.

2. Below the Hells Canyon Complex

The redband trout below the Hells Canyon Dam exhibit two life history strategies. One strategy is to remain in the small tributaries and reproduce. The second strategy is to migrate into the Snake River to rear. When they become sexually mature they return to their natal streams in the spring to spawn.

C. Tributary Access

1. Within the Hells Canyon Complex

Redband trout migrate into a number of tributaries for spawning. Four tributaries are known to be accessible to redband trout at some flow stages. Of the 18 tributaries checked by biologist, 11 were ephemeral. Redband trout were present in 4 of the 7 with perennial flow. It was found that some tributaries have poor access because they lack the ability to move sediment that accumulates in the reservoir confluence zone. The low discharge from these tributaries is inadequate to clear the channels of sediment and they remain impassible.

2. Below the Hells Canyon Complex

Tributary access below Hells Canyon Dam is limited by steep slopes and limited flows. Access by redband trout to some tributaries below Hells Canyon Dam is affected by periodic blockages that occur when large quantities of bedload are discharged. Drought years that cause low flows may prevent redband trout from entering some small

tributaries. The study concluded that redband access to Snake River tributaries below Hells Canyon Dam is not affected by fluctuation of the Snake River level related to hydropower operations.

D. Limiting Factors

1. Within the hells Canyon Complex

The tributary habitat has been altered by anthropogenic activities to the point that many are nearly unsuitable for the production of redband trout. The reservoir environment provides low quality habitat and extensive competition by nonnative fish. The redband trout rearing in the reservoir have a lower than normal weight ratio that indicates they are either unable to feed efficiently or there is not enough food available. Water quality and temperature in the reservoirs are unfavorable to redband trout during the summer months. Hybridization is a known threat but has been relatively limited at this point in time. The population is generally abundant and not in jeopardy, but it shows signs of stress.

2. Below the hells Canyon Complex

The redband trout below the Hells Canyon Complex may be affected by water quality in the Snake River and habitat alteration in the tributaries. Overall, the population of redband trout below Hells Canyon Dam is relatively healthy and abundant.

Conclusions Bull Trout

A. Distribution and Status

1. Within the Hells Canyon Complex

The bull trout populations within the Hells Canyon Complex are likely to become extinct. Unless genetic interchange between the populations can occur on a regular basis, it is likely that they will become extinct within100 years.

2. Below the Hells Canyon Complex

The population of bull trout below Hells Canyon Dam appears to be relatively healthy based on the limited sampling conducted by the Applicant and others. They are distributed throughout and interconnected by the Snake, Imnaha, Salmon and Grande Ronde rivers. Their relative numbers are unknown.

B. Life History

1. Within the Hells Canyon Complex

The small sample size indicates that there are two life history patterns. The first is a resident tributary population that does not migrate. The second is the fluvial (migratory) pattern that migrates into the Hells Canyon Reservoir to rear, and then returns to the tributary streams of Pine or Indian creek to spawn or seek refuge during the spring and summer. There were so few fish sampled that it is uncertain whether the fluvial life history pattern is actually established.

2. Below the Hells Canyon Complex

The bull trout below Hells Canyon Dam spawn in the Imnaha, Grande Ronde or other large tributaries of the Snake River. They migrate upstream in the spring and remain until

they spawn in the fall. Following spawning, they return to the Snake River to spend the winter in a relatively dormant state. Some immature bull trout were found to stay in the Snake River during the summer months. They are thought to seek out cold water pockets in the Snake River to avoid the warm summer flows. However, the Applicant did not fully research the activities of bull trout that remain in the Snake River during warmer months.

C. Tributary Access

1. Within the Hells Canyon Complex

All of the tributaries where bull trout are now found are believed to be accessible to migrants. However, irrigation diversions on some tributaries are unscreened and may cause some mortality of downstream migrants. Based on what is known about migration timing it is possible that bull trout migrate into Pine Creek before irrigators install dams and migrate out after the irrigation dams are removed.

2. Below the Hells Canyon Complex

Access to tributaries below the Hells Canyon Dam is generally unimpaired. Bull trout are generally found in tributaries with higher flows. The Applicant did not check on migration access outside the narrow boundary of the Snake River project area. However, based on knowledge of bull trout distribution in the Grande Ronde and Imnaha rivers, access to most historic habitat is not significantly impaired by culverts or other anthropogenic barriers.

Recommendations

Redband Trout

1. Redband trout in the reservoirs should have any culverts that pose a barrier to their migration corrected.

2. Hatchery stocking of the reservoirs should use sterile triploid rainbow or redband trout to prevent hybridization.

3. The water quality of the reservoirs should be improved to provide longer periods of suitable rearing for the migratory form of the redband trout. This could improve their weight ratio to an acceptable level.

4. Hells Canyon Complex tributary habitat should be improved wherever possible to enhance spawning and rearing success of redband trout. This may include modified grazing systems to enhance riparian habitat.

Bull Trout

1. The bull trout in the Snake River below Hells Canyon Dam should continue to be studied to better define their relative abundance and life history patterns.
2. The Applicant's study provided good information, but it does not have enough data to make any definitive conclusions concerning bull trout habits and habitat needs within or below the Hells Canyon Complex.

3. The populations of bull trout within the Hells Canyon complex should continue to be monitored and measures taken to improve their genetic interchange. Physical movement of individuals between the five localized populations or introduction of bull trout from below the Hells Canyon Complex should be considered.

4. Efforts should be made to minimize the effects of brook trout hybridization. This may include a program of brook trout eradication in selected habitats.

5. Habitat improvement projects, if needed, should be instituted to ensure that the five local populations have optimum habitat conditions.

6. The possibility of expanding the range of the population by finding other suitable headwater snowmelt-fed tributaries in the Pine and Indian creek drainages should be considered.

7. The irrigation system of Pine Valley should be analyzed to determine what impacts it is having on fluvial and resident bull trout and what can be done to correct problems.

8. The addition of nutrients from salmon carcasses or synthetic stream fertilization (Canadian technique) should be considered to improve food resources for the five localized bull trout populations.

9. Bull trout studies should include a complete inventory of the Eagle Creek drainage wilderness to determine whether bull trout are still present.

10. The Applicant should consider including Eagle Creek in any plans to improve the connectivity of bull trout populations.