3 HABITAT RESTORATION GOALS AND OBJECTIVES

The restoration objective for the Tucannon River is to improve habitat conditions for ESA-listed species for all life history stages within the river. Improving habitat conditions will lead to an increase in the abundance of listed species returning to the river. Increasing abundance will lead to delisting of the species, which is the overall recovery goal for the system.

3.1 Limiting Factors

An Ecosystem Diagnosis and Treatment (EDT) analysis was performed that assessed habitat conditions in the Tucannon River for aquatic focal species (CDD 2004, Appendix B of TSP). This analysis allowed watershed planners and stakeholders to identify the primary limiting factors to aquatic focal species in discrete reaches throughout the river. These results are summarized in the SRSRP for summer steelhead and spring Chinook salmon (Tables 3-1 and 3-2); the SRSRP also provides priority habitat objectives for the Upper Tucannon River major spawning area (MSA). The lower Tucannon River (downstream of Pataha Creek) was not a priority MSA and was not considered for active restoration in the 2006 SRSRP; however, the Lower Tucannon is now considered a priority minor spawning area (MsA) and thus the status was changed to a priority restoration reach beginning in 2010 (SRSRB 2011a).

Table 3-1
Factors Limiting the Viability of the Tucannon River Steelhead Population (SRSRB 2006)

Geographic area priority			Attribute class priority for restoration																
Geographic area	Protection benefit	Restoration benefit	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Tucannon R, Pataha Cr to Marengo	○	◯	•		•		•		•		•		•		•	●		●
Tucannon R, Tumalum Cr to Panjab Cr	◯	◯	•		•		•		•	•	•		•			•		⬤
Pataha Cr, mouth to Pomeroy		○	●				●	•	●		⬤				⬤	•		●
Tucannon R, Marengo to Tumalum	○	○	•		•		•		•				•		•	●		●
Cummings Cr	∘	∘			•		•		•									●
Tucannon R, mouth to end of backwater		∘	•		•		•		•				●	●	⬤	●		●
Panjab Cr	∘	∘	•				•		•									●
Pataha Cr, Pomeroy to headwaters		∘	•		•		●		●		⬤				⬤			●
Tucannon R, Panjab Cr to headwaters	○	∘	•						•									•
Tucannon R, end of backwater to Pataha Cr		∘	•		•		•		•				•	•	●	•		●
Tumalum drainage		∘	●		•		•		•					•	•			●
Bihmaier Gulch Cr			•						•		⬤				•			⬤
Dry Pataha Cr			●				●		●		⬤				●			●
Hixon Cr			•		•		•			•					•			●
Iron Springs Cr			●				•		●						●			●
Kellog Cr			●		•		●		●				•	•	⬤	●		●
Little Tucannon River drainage			●		•		•		●									●
Pataha above Dry Pataha			●				●		●	•	●				⬤			●
Smith Hollow Cr			●		●		●	•	●				•	•	⬤	●		●

Key to strategic priority (corresponding Benefit Category letter also shown)

A	B	C	D & E
◯ / ⬤ High	○ / ● Medium	∘ / • Low	Indirect or General

Table 3-2

Factors Limiting the Viability of Tucannon River Spring Chinook (SRSRB 2006)

Geographic area priority			Attribute class priority for restoration															
Geographic area	Protection benefit	Restoration benefit	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Tucannon R, Pataha Cr to Marengo	◯	◯	•				•	•	●						•	●		●
Tucannon R, mouth to Starbucks Dam		○	•				•	•	•	•			•	•	⬤	⬤		●
Pataha above Pomeroy		○	•				●	•	⬤	•	●				⬤			●
Pataha below Pomeroy		○	•				●	•	⬤	•	●				⬤	●		●
Tucannon R, Starbucks Dam to Pataha Cr		○	•				•	•	●						●	⬤		●
Tucannon R, Marengo to Tumalum	∘	○	•		•		•	•	●	•			•		•	●		●
Tucannon R, Tumalum Cr to Panjab Cr	○	○	•				•	•	●	•						•		⬤
Pataha above Dry Pataha		∘	•				●	•	⬤	•	●			•	⬤			●
Tucannon above Panjab		∘							●	•								●
Panjab drainage			•		•		•		●	•					•			●

Key to strategic priority (corresponding Benefit Category letter also shown)

A		B		C		D & E	
◯ / ⬤	High	○ / ●	Medium	∘ / •	Low	(blank)	Indirect or General

3.2 Viable Salmonid Population

To inform habitat restoration actions, spring Chinook in Reaches 6 through 10 were identified as a species to focus on with the expectation that restoration actions targeted at improving habitat conditions for spring Chinook life stages will also improve conditions for steelhead and other species important to the Tucannon. Another approach to evaluate the health of Tucannon spring Chinook is to consider how the population is performing compared to the National Marine Fisheries Service (NMFS) standard of a Viable Salmon Population (VSP), a population biology concept. According to the NMFS (McElhany et al. 2000), a viable salmonid population is an "independent population of any Pacific salmonid (genus *Oncorhynchus*) that has a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year time frame." McElhany et al. (2000) identified four key population characteristic or parameters for evaluating population viability status:

- Abundance
- Population growth rate or entire life-cycle productivity
- Population spatial structure
- Diversity

The following sections present a brief introduction to each of the VSP parameters and how these apply to the Tucannon River habitat conditions and future restoration planning.

It must be emphasized that any change in risk associated with these population parameters is affected by a myriad of factors (including in-basin factors, conditions in the Snake and Columbia rivers, and ocean conditions), and consequently is a long-term proposition. Many of these factors (e.g., ocean conditions and marine survival rates) are largely outside of human control. Moreover, changes expected from the types of actions considered in this report are most likely to occur on a generational scale; the likelihood is low that there would be detectable changes in the near future. Also, there is uncertainty associated with the Tucannon supplemental hatchery program that may affect the spring Chinook salmon population in ways that may not be well understood.

3.2.1 Abundance

Population size is perhaps the most straightforward measure of the VSP parameters and is an important consideration in estimating extinction risk. All other factors being equal, a population at low abundance is intrinsically at greater risk of extinction than is a larger one. The primary drivers of this increased risk are the many processes that regulate population dynamics, particularly those that operate differently on a relatively small population such as Tucannon spring Chinook. Examples include environmental variation and catastrophes, demographic stochasticity (intrinsic random variability in population size), selected genetic processes (e.g., inbreeding depression), and deterministic density effects. Although the negative interaction between abundance and productivity may protect some small populations, there is obviously a point below which a population is unlikely to persist (McElhany et al. 2000).

Tucannon spring Chinook populations spawn almost exclusively in the mainstem Tucannon River with spawning occurring from just above the mouth of Sheep Creek (RM 52) downstream to King Grade (RM 21). Average annual spawning for the past decade (2000 to 2010) is 200 redds, with 53 percent of these being natural spawners and 47 percent hatchery-origin fish (SRSRB 2011c, Appendix B).

Between 1986 and 2010, the annual returns of natural-origin spring Chinook to the Tucannon River ranged from 0 to 1,500 adults; the high of about 1,500 returning adults occurred in 2010 and the low of 0 returning natural-origin spawners occurred in 1995 and 1999 (Chart 1, Gallinat and Ross 2011). The 10-year geometric mean abundance has varied between approximately 100 and 400 returning adults. The Interior Columbia Technical Recovery Team (ICTRT) estimated that the minimum abundance threshold of returning adults is 750 and the current average is 371 (SRSRB 2011c).

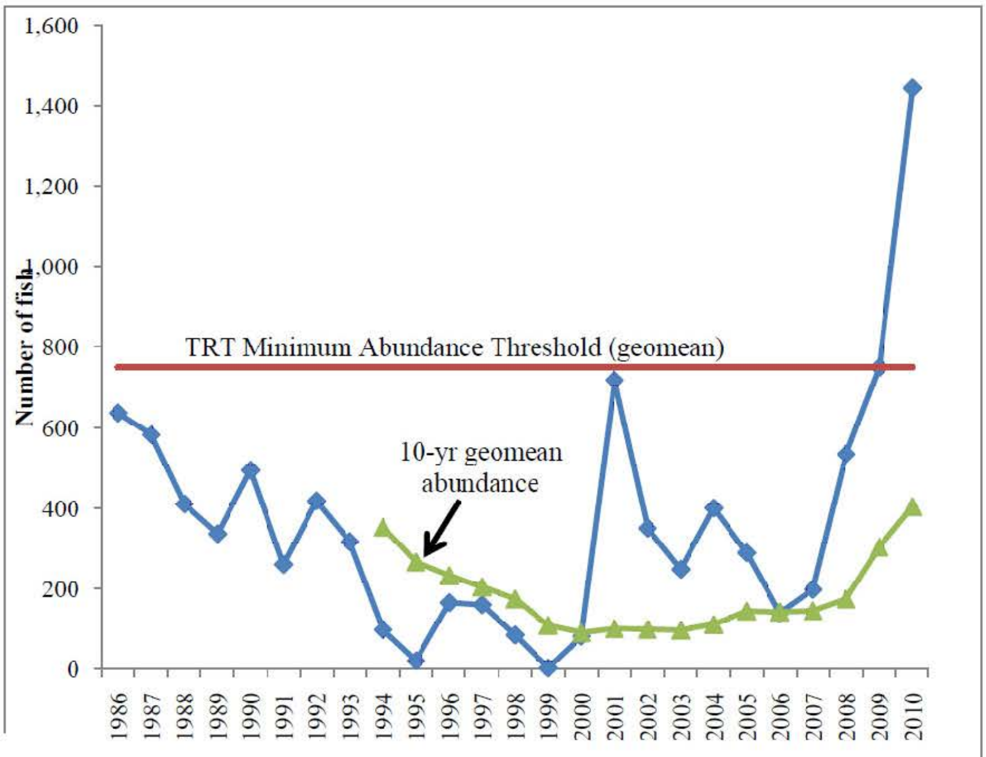

Chart 1

Estimated Abundance of Tucannon River Natural-Origin Spring/Summer Chinook Salmon Adults and 10-year Geomean between 1986 and 2010 (Gallinat and Ross 2011)

3.2.2 Life Cycle Productivity

Population growth rate (λ) or productivity over the entire life cycle is a key measure of population performance in a species' habitat. In simple terms, it describes the degree to which a population is replacing itself. A population growth rate of 1 ($\lambda = 1.0$) means that a population is exactly replacing itself (one spawner produces one spawner in the next generation), whereas a $\lambda = 0.71$, the λ value determined in the Tucannon for spring Chinook, means that the population is declining at a rate of 29 percent annually—a trend that is obviously not sustainable in the long term (Chart 2). This return to smolt (R/S) value does not account for the nearly 25 percent of returning adults that bypass the Tucannon River upon return, based on PIT-tag detections, and ascend the Snake River without returning back to the Tucannon River. Nevertheless, recruits per spawner are often less than 1 and documented R/S is nearly always less than 1 for spring Chinook (SRSRB 2011c). The Technical Review Team estimated that an R/S of 1.8 is needed for an extinction risk of less than 5 percent and an R/S of 2.1 is needed for an extinction risk of less than 1 percent (highly viable criteria) (SRSRB 2011c).

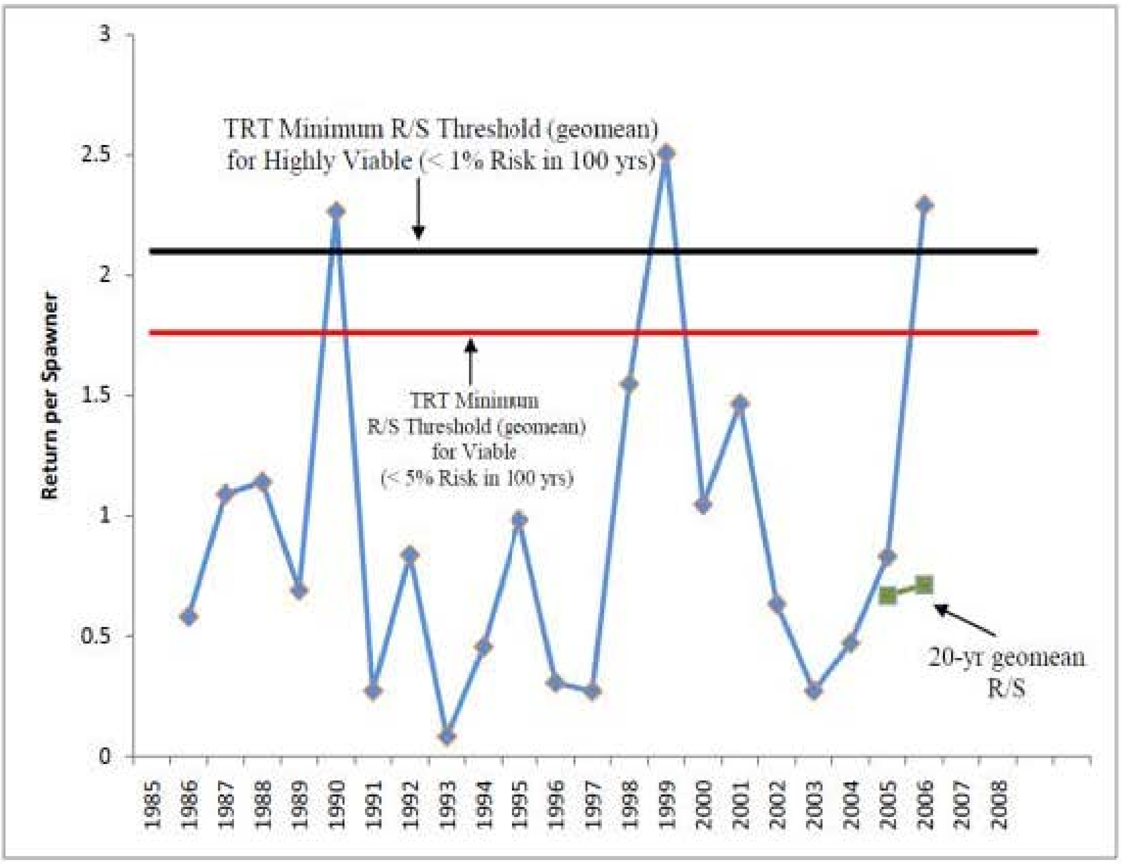

Chart 2

Estimated Productivity of Natural-Origin Spring/Summer Chinook Salmon Adults and 20-year Geomean from the Tucannon River

Note:
1986 to 2003 data from NOAA salmon population summary SPS database:
https://www.webapps.nwfsc.noaa.gov/apex/f?p=238:home:0
2003 to 2005 data from Gallinat and Ross (2010)

The causes for the low R/S are not precisely known and likely include multiple factors that are difficult to quantify, such as potential effects from habitat conditions and habitat capacity (Glen Mendel, WDFW, personal communication on 9/7/2011). Hatchery supplementation, the Columbia and Snake rivers, and ocean conditions are also factors of the R/S value.

3.2.3 Spatial Structure

Spatial structure, as the term suggests, refers to the geographic distribution of individuals in a population unit and the processes that generate that distribution. Distributed populations that interact genetically are often referred to as a metapopulation. Although the spatial distribution of a population, and thus its metapopulation structure, is influenced by many factors, none are perhaps as important as the quantity, quality, and distribution of habitat. One way to think about the importance or value of a broad geospatial distribution is to consider that in the presence of such a distribution, a population is less likely to go extinct from a localized catastrophic event or localized environmental perturbations (McElhany et al. 2000).

Spatial distribution (of spawning and summer rearing) of spring Chinook in the Tucannon River is primarily restricted to the area upstream of Marengo (RM 25) to the headwaters, yet historically it is presumed that spring Chinook spawned and reared at least down to Pataha Creek (RM 12.5) (Gallinat and Ross 2011). The spring Chinook salmon spawning and rearing distribution is reported in the 2006 Recovery Plan, which is currently being updated (SRSRB 2006). The information from the 2006 plan shown in Table 3-3 appears as Table B-3 in Appendix B of the draft 2011 SRSRP (SRSRB 2011c).

Table 3-3
Spring/Summer Chinook Redd Distribution in the Tucannon River

Section	River km (Rkm)	River mile (RM)	Percent of Total Redds	Average Redds	Redds per Rkm	Redds per RM
Mouth to Marengo (Lower)	0-20.1	0-13.6	0	0	0.0	0.0
Marengo	20.1-39.9	13.6-26.9	1.1	2	0.1	0.2
Hartsock	39.9-55.5	26.9-37.5	19.3	29	1.9	2.7
HMA	55.5-74.5	37.5-50.3	67.4	98	5.2	7.7
Wilderness	74.5-86.3	50.3-58.3	12.2	18	1.5	2.3
Upstream of Trap	> 59	> 39.9	60.7	87	-	-
Downstream of Trap	< 59	< 39.9	39.3	56	-	-

Note:
1985 to 2009 data from Gallinat and Ross (2009). Rkm and RM differ slightly; RM shown were developed for the current scope of work and have been compared to Rkm primarily based on landmarks (bridges, property boundaries) for consistency.

Per Table 3-3, it is noteworthy that approximately 88 percent of the spring Chinook spawning documented over the last 24 years occurs between RM 22.8 (King Grade) and RM 48.1 (near Cow Camp Bridge), recognizing that spawning near the headwaters may have occurred historically at a higher density than is currently occurring (Glen Mendel, personal communications, 9/7/2011).

The data provided in Table 3-3 have been further evaluated by delineating the spawning distribution into the geomorphic reaches identified in this report and in the *Geomorphic Assessment* (Anchor QEA 2011). This information was used in the project evaluation presented later in this report.

3.2.4 Life History Diversity

Biological diversity within and among populations of salmon is generally considered important for three reasons (McElhany et al. 2000):

- Diversity of life histories patterns is associated with a use of a wider array of habitats

- Diversity protects a species against short-term spatial and temporal changes in the environment
- Genetic diversity is the so-called raw material for adapting to long-term environmental change

The latter two reasons are often described as nature's way of hedging its bets—a mechanism for dealing with the inevitable fluctuations in environmental conditions—in the long and short term. With respect to diversity, more is better to minimize the risk of extinction.

Current life-history diversity of Tucannon River spring Chinook is presumed to reflect historic life-history diversity, with the majority of juveniles emerging from the gravel in spring, rearing for one summer and one winter, and then out-migrating as 1-year-old smolts in the spring. Of interest is the apparent lack of winter rearing habitat and channel complexity (e.g., side channels, back water, and pools) that support juvenile fish. Existing data demonstrate that the largest mortality occurs between egg and smolt, with the majority of the mortality occurring between egg and parr; it is alarming that, from brood year 1983 to brood year 2003, on average less than 6 percent of spring Chinook survived from egg to smolt (Gallinat and Ross 2010).

3.3 Restoration Expectations Related to Viable Salmonid Population Goals

3.3.1 Abundance

Population abundance is a key parameter used to assess the status of a stock and evaluate trends in stock improvement or decline. Abundance is also useful in identifying critical population dynamics that can be used to identify success in restoring a stock or levels at which extinction risk is high and the level of attention given to restoration be increased. Collectively proposed restoration actions in the Tucannon River are intended to improve abundance holistically; hence, no restoration action proposed in this report is targeting abundance specifically.

3.3.2 Life Cycle Productivity

As presented and referenced in this document, previous studies have identified degraded habitat conditions and juvenile carrying capacity as primary causes for the low R/S ratio currently observed in the Tucannon River. Therefore, proposed restoration actions are highly focused on addressing limitations to productivity. The largest mortality occurs between egg and smolt, with the majority of the mortality occurring between egg and parr (SRSRB 2006). In addition WDFW data indicate that smolt production generally increases with an increase in adult returns in the basin, although a carrying capacity issue may exist above approximately 200 female spawners (Gallinat and Ross 2010). Spawning and incubation for spring Chinook begins in August and continues through March, with fry developing to parr through June. This timeline represents a large range in hydrologic conditions and habitats used by Chinook; prioritizing specific time periods and associated habitats is necessary to target critical life-cycle periods affecting productivity (ISRP 2011a).

The life stage between egg and parr coincides with late summer low flow, winter storm flows, and the spring runoff period. Summer low flows are unpredictable, and other efforts in the basin are focused on improving water quality and quantity. Winter storm events are stochastic and vary greatly in the effect that they may have on growth and productivity. For example, several consecutive years of minor peak flows, where impacts to fish are also minor, may occur between larger, less frequent flood events that have the ability to scour redds, resulting in significant losses to the run. Spring runoff flows occur each year and are relatively predictable in their magnitude and their effect on the habitat types required by juvenile salmonids; these habitats are currently lacking in the system. Data from smolt trapping in the lower river indicates that parr are arriving in the lower basin throughout the spring runoff period, long before their genetic signal should be initiating movement downstream (Glen Mendel, personal communications, September 2011). It is speculated that this may be occurring either because they are being flushed downstream and are not able to find suitable refuge habitat, or because juvenile fish are actively seeking out habitats in the lower river because of the lack of refuge areas (carrying capacity) in the preferred rearing areas upstream.

Based on high egg-to-parr mortality and uncertainty related to much of the hydrologic cycle during the egg-to-parr timeline, improving habitat conditions for juveniles during the spring runoff period was determined to be of high priority and to provide the greatest certainty of success with respect to improving growth and productivity. Therefore, restoration actions that will provide hydraulic complexity; will improve or create side channels, alcoves, or hydraulic refuge and cover; or will improve low-lying floodplain connectivity will be considered to have high biological benefit when developing conceptual projects.

Installing necessary instream structure to provide adequate cover and complexity, while designing within the basin and reach-scale geomorphic context, will be critical to achieving both an immediate biological benefit and long-term restoration success. Hydraulic complexity and off-channel habitat projects will provide hydraulic refuge and rearing habitat for juvenile salmonids during moderate to high flows and will also provide more desirable habitat during lower flow conditions. LWD placements will provide refuge and cover and will be used to initiate a geomorphic response in many locations where natural channel development and floodplain connectivity can be achieved. Levee and riprap removal will remove stressors in the system, allowing for more natural geomorphic processes and promoting habitat recovery. For more details on specific restoration actions proposed for the Tucannon, see Appendix A: Conceptual Restoration Actions.

Collectively, these improvements can re-establish natural "processes of material and energy transfer across the watershed that enables the formation and maintenance of productive habitat," identified by the Independent Scientific Review Panel (ISRP) for the Tucannon (2011b). It is expected that these improvements will promote the re-establishment of natural processes, which will increase habitat diversity and total rearing area available for juveniles and will improve their survival and productivity. The habitat improvements should also increase spawning and emergence conditions over time through improved energy dissipation from increases in channel complexity, improved temperature conditions, and improved distribution of nutrients and fine sediment across the floodplain.

3.3.3 Spatial Structure

Improving the population spatial structure relates to improving habitat conditions throughout the river corridor such that habitat needs are met across the various life stages and hydrologic regimes, and the health of the population is not jeopardized by local environmental effects. While it is known that the majority of the spawning occurs upstream of Marengo and rearing densities decrease downstream of Cummings Creek, valuable existing and potential habitat exists throughout the basin. The restoration approach for the

Tucannon does not focus exclusively on one reach or segment of the study area, but values both areas of the river currently experiencing high fish use, as well as areas with high restoration potential should a "full build out" of restoration opportunity be realized. This approach is further described below and in Section 9 of this report.

In general terms, the restoration strategy for the Tucannon River is a holistic basin-scale approach that values both immediate and long-term biological benefits. Implementation of restoration projects will likely occur in high-use areas early to maximize growth and productivity in areas of current use. In addition, projects with high benefit and low cost will be highly recommended regardless of location to maximize the growth and productivity of the segment of the population currently using those areas. Projects implemented on the fringes of the current high-use areas will expand the linear extent of high-quality habitat throughout the river corridor, increasing the distribution and carrying capacity for fish using those areas. Projects removing stressors on habitat will allow for natural recovery of the system and better habitat continuity through the river in the long term.

This restoration strategy will improve the spatial distribution of the stock by improving existing high-use areas, implementing high-benefit/low cost projects in non high-use areas, expanding the size of high-use areas by implementing projects on the fringes of those areas, and removing stressors affecting natural processes for long-term improvement of quality habitat throughout the river corridor production; and improve the spatial distribution of the stock.

3.3.4 Life History Diversity

Because the majority of the population of spring Chinook are 1+ fish, and restoration actions will target improving habitat for juvenile fish, none of the proposed restoration actions will specifically target improving life history diversity within the target species.

4 REACH 10 CONCEPTUAL PROJECTS

Reach 10 is located from the mouth of Panjab Creek at RM 50.2 to the downstream end of Big Four Lake (RM 44.0; Figure 2). The reach is within the Umatilla National Forest and the Wenaha-Tucannon Wilderness area and includes both public (WDFW) and private holdings such as the Camp Wooten natural resources learning center. Reach 10 is an important reach for spring Chinook, steelhead, and bull trout. Spring Chinook spawn and rear in Reach 10, with a high density of juvenile rearing in the lower portion of Reach 10. Steelhead rearing and spawning also occurs in the reach. Reach 10 and the adjacent tributaries (especially Panjab Creek) are significant areas for bull trout spawning and rearing.

The valley is forested with conifers that increase in density upstream of Panjab Creek (RM 50.2). The reach contains several perennial tributaries that drain the headwater areas, as well as several spring sources; a majority of Reach 10 was identified as a gaining reach except for a small section between approximately RM 47.7 and 46 (HDR 2006). A majority of the subbasin areas between the Little Tucannon River (RM 48.0) and the downstream end of Reach 10 were affected by the 2005 School Fire; the most severely burned areas were the Hixon and Grub Canyon basins (USFS 2008).

Confinement in the reach is variable; confinement in the lower reach downstream of the Little Tucannon River is typically influenced by anthropogenic features and entrenchment, whereas confinement in the upper reach is associated with alluvial fans, debris flow deposits, and natural narrowing of the valley width. Channel pattern in Reach 10 transitions from a primarily single-thread channel near Panjab Creek into a more diverse channel network with some side channels and braided sections toward the lower end of the reach. Floodplain connectivity in Reach 10 is slightly impacted by infrastructure and strongly impacted by channel incision in many places.

Nine conceptual project areas were identified in Reach 10. The primary restoration strategy presented within Reach 10 focuses on addition of LWD, with a lesser number of projects that identify off-channel habitat opportunities. LWD addition is consistent with the limiting factors identified in the EDT analysis of key habitat quantity and increasing riparian function (Appendix J, CCD 2004). LWD will provide a greater quantity of holding areas by initiating