SECTION 46 – Table of Contents

46 Lake Rufus Woods Subbasin Assessment – Aquatic[1]

46.1 Species Characterization and Status

Aquatic species that are potentially present within the Lake Rufus Woods Subbasin are listed in Table 46.1. All native anadromous salmon and Pacific lamprey have been extirpated from the region. Seven species listed as native to Washington have ranges that occur within the Lake Rufus Woods Subbasin but have not been recorded as present. The status of these species is listed as “within range.” The remaining native species that have been observed above Grand Coulee are listed as “known upstream of Grand Coulee Dam.” Bull trout and Chinook salmon are not currently present in this area (CCT 2000).

46.1.1 Lake Rufus Woods

Entrainment through Grand Coulee Dam from Lake Roosevelt has likely influenced the fish assemblage currently present in Lake Rufus Woods. Results of a 42-month entrainment study at Grand Coulee Dam confirmed that entrainment of fish from Lake Roosevelt significantly influence the fish populations in both Lake Roosevelt and Lake Rufus Woods (LeCaire 1999). Between 1996 and 1999 the average entrainment through Grand Coulee Dam was estimated using single-beam hydroacoustics at nearly 403,000 fish annually, totaling over 1.6 million fish throughout the study. Catch composition of fish observed in Lake Rufus Woods (Council 2000) are listed as “known” and presented in Table 46.1. Many of the fish present in Table 46.1 were not intentionally introduced into Lake Rufus Woods, but established populations after being entrained from Lake Roosevelt.

46.1.2 Nespelem River

Fish present in the Nespelem River represent a largely nonnative assemblage of naturalized salmonid species that have persisted in altered habitat conditions (Hunner and Jones 1996). These species include brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta)*, and rainbow trout (*O. mykiss*) (Hunner and Jones 1996). Other species present include bridgelip sucker (*Catastomus columbianus*), sculpin (*Cottus sp*.), dace (*Rhinichthys sp*.) and mountain whitefish (*Prosopium williamsoni*) (Hunner and Jones 1996).

46.1.3 Lakes

Numerous lakes that support fisheries are located within the Lake Rufus Woods Subbasin. A majority of these lakes are located within the boundary of the Colville Reservation. Many of the lakes within the Subbasin support either naturalized or continuously stocked populations of rainbow trout and/or eastern brook trout, while Buffalo Lake is the only lake within the Subbasin that contains population of kokanee salmon. Largemouth bass fisheries are also present in some lakes within the Subbasin. Management of the lakes primarily consists of stocking and monitoring naturalized salmonids to support subsistence and recreational fishing opportunities and managing

[1] Portions of Section 46 were contained within the Lake Rufus Woods Subbasin Summary Report (2000) p. 2.

self-sustaining warmwater sport fishes where habitats are not conducive to salmonid management.

Table 46.1. List of Fish Species Occurring Within the Lake Rufus Woods Subbasin

Species	Common Name	Origin	Status
Acipenser transmontanus	white sturgeon	native	known[1]
Acrocheilus alutaceus	chiselmouth	native	known above Grand Coulee[3]
Catostomus catostomus	longnose sucker	native	known[2]
Catostomus columbianus	bridgelip sucker	native	known[2]
Catostomus macrocheilus	largescale sucker	native	known[2]
Catostomus platyrhynchus	mountain sucker	native	within range[5]
Coregonus clupeaformis	lake whitefish	introduced	known above Grand Coulee[3]
Cottus asper	prickly sculpin	native	known[6]
Cottus bairdi	mottled sculpin	native	not identified to spp.[2]
Cottus beldingi	piute sculpin	native	known above Grand Coulee[3]
Cottus cognatus	slimy sculpin	native	not identified to spp.[2]
Cottus confusus	shorthead sculpin	native	not identified to spp.[2]
Cottus rhotheus	torrent sculpin	native	not identified to spp.[2]
Couesius plumbeus	lake chub	native	within range[5]
Cyprinus carpio	common carp	introduced	known[2]
Esox lucius	northern pike	introduced	within range
Gasterosteus aculeatus	three-spine stickleback	native	within range[5]
Ictalurus melas	black bullhead	introduced	within range
Ictalurus nebulosus	brown bullhead	introduced	known[2]
Ictalurus punctatus	channel catfish	introduced	within range
Lampetra tridentata	Pacific lamprey	native	within range[5]- extirpated
Lepomis cyanellus	pumpkinseed	introduced	known[7]
Lepomis macrochirus	bluegill sunfish	introduced	within range
Lota lota	burbot	native	known[2]
Micropterus dolomieui	smallmouth bass	introduced	known[2]
Micropterus salmoides	largemouth bass	introduced	known[7]
Mylocheilus caurinus	peamouth	native	known[2]
Oncorhynchus clarki	cutthroat trout	native	known above Grand Coulee[6]
Oncorhynchus gorbuscha	pink salmon	native	within range[5] - extirpated
Oncorhynchus keta	chum salmon	native	within range[5]- extirpated
Oncorhynchus kisutch	coho salmon	native	within range[5] - extirpated
Oncorhynchus mykiss	rainbow trout	native	known[2]
Oncorhynchus nerka	sockeye salmon	native	within range[5] - extirpated
Oncorhynchus nerka	kokanee salmon	native	known[2]
Oncorhynchus tshawytscha	Chinook salmon	native	known[4] - extirpated

Species	Common Name	Origin	Status
Perca flavescens	yellow perch	introduced	known[2]
Percopsis transmontanus	sandroller	native	within range[5]
Pomoxis annularis	white crappie	introduced	known above Grand Coulee[3]
Pomoxis nigromaculatus	black crappie	introduced	known above Grand Coulee[3]
Prosopium williamsoni	mountain whitefish	native	known[2]
Ptychocheilus oregonensis	northern squawfish	native	known[2]
Rhinichthys cataractae	longnose dace	native	within range[5]
Rhinichthys falcatus	leopard dace	native	within range[5]
Rhinichthys osculus	speckled dace	native	within range[5]
Richardsonius balteatus	redside shiner	native	known[2]
Salmo trutta	brown trout	introduced	known[2]
Salvelinus confluentus	bull trout	native	known[3]
Salvelinus fontinalis	brook trout	introduced	known[2]
Salvelinus namaycush	lake trout	introduced	introduced range[5]
Stizostedion vitreum	walleye	introduced	known[2]
Tinca tinca	tench	introduced	known[2]

[1] Anders and Powell 1999
[2] D. Venditti pers. Comm. 1999
[3] Griffith and McDowell 1996
[4] Fish and Hanavan 1948
[5] Wydoski and Whitney 1979
[6] Powell et al. 2002
[7.] Arterburn 2003

46.2 Focal Species Selection

Five focal species were selected in the Lake Rufus Woods Subbasin. These species include Chinook salmon, kokanee salmon, brook trout, rainbow trout, and white sturgeon. The rationale for selection, historic and current status, and current management for each focal species is provided in Sections 46.3, 46.4, 46.5, and 46.6. Three other species, Pacific lamprey, burbot, and walleye were chosen as species of interest. Species of interest were chosen due to their historic, current, or the future possibility of being an important ecological, subsistence, or recreational fish species within the Lake Rufus Woods Subbasin. Although these species were not chosen by the technical team as focal species, strategies and objectives derived by the Lake Rufus Woods work team included these species.

46.3 Focal Species – Chinook Salmon

Chinook salmon were selected as a focal species for the Lake Rufus Woods Subbasin because of their cultural significance to the Colville Confederated Tribes (CCT), their potential recreational value as a sport fish, and to address concerns regarding native species conservation. Chinook salmon were also included as a focal species because of the possibility that they will be reintroduced into the Subbasin. Currently the CCT are evaluating the potential for the reintroduction of Chinook salmon in the Lake Rufus Woods Subbasin.

Chinook salmon are sometimes referred to as king, tyee, spring, and quinnat salmon. Chinook salmon are indigenous to the northern half of the Pacific Coast of North America (Meehan and Bjornn 1991), and are of great commercial and recreational importance within this area. Chinook salmon are most abundant in the large river systems, although they may be present in various sized rivers and streams. Although they have been stocked into many lakes and reservoirs throughout North America, they are usually not self-sustaining in these systems.

Chinook salmon display a great deal of variation in the timing of adult migration, juvenile migration, and spawning. One hundred eight stocks of Chinook salmon were identified in the State of Washington alone (Wydoski and Whitney 2003). Historically, Chinook salmon migrated to the headwaters of the Columbia River in Canada, but since the construction of Grand Coulee Dam and the subsequent construction of Chief Joseph Dam, their upstream terminus is river mile 545 (Wydoski and Whitney 2003).

46.3.1 Historic Status

Prior to hydroelectric development, Chinook salmon migrated up the Columbia River as far inland as British Columbia, with estimates of several million adults making annual migrations (Behnke 2002). The Lake Rufus Woods Subbasin is considered to be within the historic habitat area for Chinook salmon in the Upper Columbia River basin (Thurow et al. 2000).

Spring Chinook salmon are known to have existed in the areas above Chief Joseph Dam. As part of the Grand Coulee Fish Maintenance Project, it called for combining the gene pool for spring Chinook from the Wenatchee, Entiat, Methow, and upper Columbia River tributaries upstream of Grand Coulee Dam (Chapman et al. 1995). The "June Hogs" that historically existed within the upper Columbia River are thought to have been spring Chinook, based on the timing of the run. The peak of the spring Chinook run occurs at Rock Island Dam around mid-May and spring Chinook would likely arrive above Grand Coulee Dam after this time and be available for harvest at Kettle falls and other noted fisheries until spawning in July. Analysis of available genetic information indicates that spring Chinook and summer/fall Chinook differ substantially. Each group belongs to a different distinct evolutionary lineage within the Columbia River. Non-overlapping allele frequencies at many loci contributed to the distinction of these two groups (Chapman et al. 1995). Current listings (NMFS 1998) indicate fish from upriver areas above Chief Joseph and Grand Coulee dams are considered within the Upper Columbia Spring or Summer/Fall Chinook ESU. Chief Joseph Dam located at river kilometer (RK) 879 was built within a major historic fall Chinook spawning area identified in 1946 from RK 809-960 the present site of Grand Coulee Dam is RK 960 (Dauble et al. 2003; Fish and Hanavan 1948).

46.3.2 Current Status

The construction of Chief Joseph and Grand Coulee dams and their lack of fish passage facilities blocked migration of all anadromous salmon and steelhead and extirpated them from the Subbasin. Current trends in abundance and distribution of resident Chinook salmon above Chief Joseph Dam is unknown, but presumed to be extinct. Genetic variation and diversity historically present within Chinook salmon stocks above Chief Joseph and Grand Coulee dams are presumed to have been lost. Recent studies compared current habitat conditions upstream of Chief Joseph Dam with those found within the Hanford reach. Current habitat conditions were found to be the most similar of any Columbia River reach and therefore represent the best available habitat for restoring fall Chinook salmon in the Upper Columbia ESU. However, passage issues still need to be addressed at Chief Joseph Dam (Dauble et al. 2003).

The Nespelem River barrier falls at RM 1.5 along with water temperatures and other factors could limit the carrying capacity of this system for Chinook salmon production. Effective strategies such as controlling lake elevations for increasing Chinook salmon habitat above Chief Joseph Dam should be investigated to maximize recovery potential.

46.3.3 Current Management

Incidental take of any resident Chinook salmon within the Lake Rufus Woods Subbasin falls under the guidelines outlined for "trout" by Washington Department of Fish and Wildlife (WDFW) and the CCT (WDFW 2003). Regulations for Colville Tribal members are set by the CCT Fish and Wildlife Department and provide for no daily or possession limits for trout in all waters of the Lake Rufus Woods Subbasin located on the Colville Indian Reservation. Non-Tribal members are allowed only 2 trout per day by both the CCT and State of Washington with a possession limit of two times the daily bag limit. The Nespelem River and all other tributary streams located on the Colville Reservation are closed to non-Tribal member anglers.

The CCT are currently studying the feasibility of reintroducing fall Chinook salmon back into areas of the mainstem Columbia River above Chief Joseph Dam. Evaluating the current spawning habitat available and identifying potential limiting factors are their first priority in evaluating the potential for the reintroduction of fall Chinook salmon in the Lake Rufus Woods Subbasin. Battelle Memorial Institute (2001) was contracted by the CCT to evaluate the physical characteristics of potential fall Chinook salmon spawning habitat in upper Lake Rufus Woods from Grand Coulee Dam tailrace (rkm 956) downstream to Coyote Creek (rkm 928). The objectives of this study were to estimate the quantity and location of potential spawning habitat and to estimate redd capacity of the area based on spawning habitat characteristics and lake level.

Although velocity and depth are possibly limiting many study areas from meeting the current criteria for Fall Chinook spawning habitat, results indicate there is available habitat under the current conditions. Conservative estimates of redd capacity within the potential spawning habitat range from 79-1,599 redds, while less conservative methods estimate redd capacity between 207-6,951 redds. Although this study builds a foundation, further studies on other portions of Fall Chinook life cycle may be needed to evaluate the reintroduction of fall Chinook into the Lake Rufus Woods Subbasin. This study did not consider tributary areas that could be used by steelhead or spring Chinook when developing these estimates. Passage at Chief Joseph Dam may provide access to habitats beyond the current terminus for a wide variety of species. Further studies reviewing possible passage options at Chief Joseph Dam, species interactions, habitat use, survival of juveniles, and smolt out-migration would provide additional insight on the subject of Chinook reintroductions into the Lake Rufus Woods Subbasin.

46.3.4 Limiting Factors – Chinook Salmon

The lack of a fish passage program at Chief Joseph Dam is currently the primary factor eliminating Chinook salmon presence in the Lake Rufus Woods Subbasin. The CCT have evaluated the upper portions of Lake Rufus Woods and concluded that spawning habitat is available. The amount of Chinook salmon spawning habitat within the Subbasin was likely underestimated since the Nespelem River was not evaluated. Chinook salmon were not analyzed using the QHA model since they are not currently present within the Subbasin. Current strategies to improve tributary habitats may have benefits to Chinook salmon spawning and rearing habitat, although these habitats would not be utilized until fish passage is provided at Chief Joseph Dam.

46.4 Focal Species – Kokanee Salmon

Kokanee were selected as a focal species for this Subbasin because of their subsistence value, their recreational value as a sport fish, and their ecological significance among the aquatic habitat within the Subbasin.

The salmon *Oncorhynchus nerka* occurs in two forms: the anadromous sockeye salmon, and the nonanadromous or resident kokanee salmon. Kokanee are distributed from the Columbia River system in the South to northern Alaska (Meehan and Bjornn 1991). Kokanee are usually smaller than sockeye salmon, since adult rearing takes place in less productive lake environments rather than the productive Pacific Ocean.

Kokanee are fall spawners and spawn in either tributaries to nursery lakes or within suitable habitat along the shores of lakes. Substrate composition, cover, water quality, and water quantity are important habitat elements for spawning kokanee salmon (Meehan and Bjornn 1991). Planktonic crustaceans are the primary food source for juvenile and adult kokanee salmon (Meehan and Bjornn 1991).

Kokanee are a very popular game fish because of their excellent tasting flesh. Native stocks of kokanee salmon within the Columbia River system may be important for the conservation and the possible future reintroduction of sockeye salmon, since stocks of kokanee salmon may contain genetic material from stocks of extirpated sockeye salmon.

46.4.1 Historic Status

Prior to impoundment, the Columbia River provided a migration corridor for abundant stocks of sockeye salmon from as far upstream as British Columbia (Behnke 2002). Historically, the upper Columbia River likely supported large numbers of both life history types for *Oncorhynchus nerka*, resident or adfluvial kokanee and anadromous sockeye salmon (Fish and Hanavan 1948; Behnke 2002).

Passage for sockeye salmon was blocked with the construction and lack of fish passage facilities of both Chief Joseph and Grand Coulee dams, altering fish assemblages to resident and adfluvial forms. “Landlocked” or kokanee salmon currently persist in the Columbia River above Grand Coulee Dam. Stocking of kokanee salmon was initiated within the upper Columbia River to address declining fisheries. Kokanee stocks from various locations within Washington state and British Columbia have been used as broodstock sources for captive propagation (Spokane Tribal Hatchery HGMP). The primary hatchery stock of kokanee in this area that are released into Lake Roosevelt are derived from Lake Whatcom in western Washington. Kokanee derived from the Lake Whatcom stock were first introduced into the Subbasin in the 1930s and have been the primary source for the Lake Roosevelt Hatchery production program and are the parental origin of the self-sustaining Buffalo Lake population. The majority of naturalized kokanee salmon that occur in the Lake Rufus Woods spawn in the Nespelem River. An additional source of kokanee salmon found in Lake Rufus Woods are from entrainment through Grand Coulee Dam from Lake Roosevelt. Genetic analysis has identified the Nespelem River kokanee salmon stock as a similar stock to the San Poil River stock, located upstream of Grand Coulee Dam. Genetic analysis has identified the San Poil/Nespelem stock as divergent from other hatchery stocks used to supplement kokanee populations in Lake Roosevelt with limited success. The San Poil/Nespelem stock is phenotypically (obtain larger size than hatchery stocks) and genotypically different from hatchery stocks (John Arterburn, Fish Biologist, CCT, personal communication, 2003).

46.4.2 Current Status

Both naturalized and artificially propagated kokanee salmon are present in Lake Rufus Woods. The largest naturalized stocks originate from the lower Nespelem River, where the majority of kokanee spawning occurs. Although there are no current stocking programs for kokanee salmon in Lake Rufus Woods, a large number of kokanee entrain through Grand Coulee Dam into Lake Rufus Woods. Genetic analysis has indicated that the lower Nespelem stock of kokanee salmon are most similar to the San Poil River stock, located above Grand Coulee Dam (John Arterburn, Fish Biologist, CCT, personal communication, 2003). Although still in a developmental state, it is hypothesized that these two stocks of kokanee were sockeye salmon that changed their life history strategy with the completion of Grand Coulee and Chief Joseph dams. Although many hatchery origin stocks of kokanee salmon have been stocked into Lake Roosevelt, the lower Nespelem and San Poil River stocks are genetically and phenotypically different than the many hatchery origin stocks found in Lake Roosevelt.

Table 46.2. Percent of Total Catch, By Species, in Experimental Gill Nets Set in the Grand Coulee Dam Forebay

Species	Percent
Kokanee	53%
Rainbow trout	36%
Walleye	2%
Lake whitefish	4%
Chinook	1%
Yellow perch	<1%
Burbot	<1%

(*Source:* LeCaire 1999)

LeCaire (1999) summarized 1999 collection reports from the Rock Island Dam bypass facility, which captured 986 kokanee and 234 floy-tagged rainbow trout that were released behind Grand Coulee Dam in 1998 and 1999. Data suggest that fish entraining through Grand Coulee Dam may continue to entrain downstream (for example, Chief Joseph Dam), although estimates of total fish migrating to that point do not exist.

A self-sustaining population of kokanee salmon spawn in the Nespelem River (below the falls at RM 1.5) and migrate to rear in Lake Rufus Woods (LeCaire 1999). Preliminary genetic results suggest that this adfluvial population of kokanee salmon is a distinct stock. The Nespelem River kokanee are more similar to the Lake Roosevelt composite stock and North Arm Kootenay Lake stock than the main stock in Lake Rufus Woods and Lake Whatcom stock (LeCaire 1999).

Since 1995, adult kokanee returns have been monitored annually in the lower Nespelem River with adult returns ranging from 6 to 389 in 1997 and 1999, respectively (Table 46.3). Upstream migration into the Nespelem River begins as early as mid-July and spawning occurs between August and November (LeCaire 1999). However, behavior of juvenile fish is unknown. Redd capping attempts have been unsuccessful due to unusually high flows during the spring months (LeCaire 1999). It is hypothesized that juvenile fish migrate to the reservoir shortly after emergence in the spring (Council 2000).

Table 46.3. Lower Nespelem River Adult Kokanee Escapement 1995-1999

Year	Species	Number
1995	Kokanee	Est. 35-100
1996	Kokanee	18
1997	Kokanee	6
1998	Kokanee	70-100
1999	Kokanee	389

The Washington Department of Game (WDG) began stocking Lake Whatcom stock kokanee salmon into Buffalo Lake in 1946 and today this population is self-sustaining (Arterburn 2003). Buffalo Lake is the only lake on the Colville Reservation that contains kokanee salmon, while providing fishing opportunities for rainbow trout, brook trout, largemouth bass, and pumpkinseed sunfish. Buffalo Lake is one of the more popular fisheries on the Colville Reservation and angler usage in the 1970s was around 8,000 angler-days per year and average catch rate estimates were 2.5 fish per hour for an annual harvest of 20,000 trout between 7 and 13 inches in length, however the creel data could not be confirmed (Arterburn 2003). Rainbow trout and kokanee salmon have and continue to make up the majority of the game fish catch at Buffalo Lake. Although some limited natural recruitment of kokanee salmon occurs, the stream that enters this lakes southeast bay has insufficient fall flow to provide natural recruitment. Therefore, it is hypothesized that kokanee in Buffalo Lake utilize spring areas to spawn along the lake's shoreline.

46.4.3 Limiting Factors Kokanee Salmon

Kokanee are a lake species that utilize riverine habitat mostly for spawning, thus were included in the QHA approach to identify potential limiting factors to the life stage, spawning and incubation. Details of the QHA process are provided in Section 3.

Kokanee are currently present in nine of the 38 reaches within the Subbasin. The nine reaches were considered part of the historic distribution for comparison of past and present habitat conditions. The reaches include all of Lake Rufus Woods and the confluences of the Nespelem River and Coyote Creek with Lake Rufus Woods.

Based on QHA model, habitat attributes with the greatest deviation from reference conditions are shown in Table 46.4. Lower Coyote Creek received the top ranking for the largest change from historic conditions. This reach has an obstruction listed as the top alteration followed by a change in low flow conditions, habitat complexity, channel stability, fine sediments, and pollutants. The other top ranked reaches other than Lower Coyote Creek includes the entire reservoir, Lake Rufus Woods, and outlet of the Nespelem River. The attribute rankings of these reaches indicate that the flow regime and dissolved gas levels have experienced the greatest modification from reference conditions. In this area oxygen is not depleted, but total dissolved gas levels (TDG) are in excess of the 110 percent water quality standard during spill periods. The change in the hydrologic regime is attributed to operations of Chief Joseph and Grand Coulee dams.

Reaches ranked most similar to reference conditions, or highest for protection, are shown in Table 46.5. The top two reaches for protection included key kokanee spawning and rearing areas, the outlet of Coyote Creek and Nespelem River.

The tornado diagram (Table 46.6) and maps (Map LRW-1, Map LRW-2, located at the end of Section 46) presents the reach scores for both current habitat condition (ranging from zero to positive one, Map LRW-1) and protection (ranging from zero to negative one, Map LRW-2). Scores closest to negative one depict reaches that are most representative of reference habitat conditions. Scores closest to positive one depict reaches with habitat conditions least similar to reference conditions. Confidence scores range from zero to one and are associated with the ratings assigned by local biologists based on documentation or their expert opinion regarding reference and current habitat attributes for each reach.

Based upon the data collected during the QHA analysis it is important to understand that most model outputs are only as good as the data that is entered into them. Data that are lacking or inaccurate are likely to produce erroneous results. Within the Lake Rufus Woods Subbasin, lack of data makes interpreting QHA results highly subjective due to the distinct lack of confidence in the data used for this model. Confidence scores for protection ratings in the Lower Nespelem River was the only reach where sufficient confidence in the data existed to produce reliable results. Confidence results identified some data gaps existed for all other reaches; therefore anyone attempting to utilize the QHA assessment for making substantive decisions should do so with caution. In most cases current habitat conditions had better data and historic habitat ratings were largely considered speculative because this species was undocumented prior to completion of Chief Joseph Dam.

Spawning habitat is limited in the Subbasin to the confluences of the Nespelem River and Coyote Creek with Lake Rufus Woods. An estimated 90 percent of kokanee production for the entire Subbasin occurs in the Nespelem River reach (John Arterburn, Fish Biologist, CCT, personal communication, 2003). The QHA results show that these two reaches need protection, but also could benefit from some restoration. Small restoration projects may provide proportionally larger biological gains considering the ecological significance and contribution of the reaches. For example, the lower reach of Coyote Creek may benefit most by the removal of an obstruction whereas the lower Nespelem River may benefit from improvements to channel stability, protection of the riparian areas, and maintaining low flows along this reach.

Table 46.4. Ranking of reaches with the largest deviation from the reference habitat conditions for kokanee salmon in the Lake Rufus Woods Subbasin. A reach rank equal to 1 has the greatest deviation from reference condition in comparison to other reaches. Reach scores range from 0 to 1, with 1 having the greatest deviation from reference. Values associated with each habitat attribute range from 1 to 11, a value of 1 indicates a habitat attribute having the greatest deviation from reference compared to the other attributes within that reach. In some cases multiple habitat attributes have a value of 1 indicating all attributes equally deviate the most from the reference.

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
5	Lower Coyote Creek	1	0.2	8	2	2	2	8	2	8	7	8	2	1
8	Nespelem Bar	2	0.1	6	4	6	6	1	1	1	6	6	4	6
9	Buckley Bar	2	0.1	6	4	6	6	1	1	1	6	6	4	6
1	Chief Joe Dam	4	0.1	5	4	5	5	5	5	2	5	5	3	1
10	Upper Rufus Woods Reservoir	5	0.1	6	5	6	6	1	1	1	6	6	4	6
11	Coulee Dam Tailrace	6	0.1	5	5	5	5	1	1	1	5	5	4	5
13	Lower Nespelem River	7	0.1	6	1	5	6	3	6	6	1	4	6	6
2	Lower Rufus Woods Reservoir	8	0.1	4	3	4	4	4	4	1	4	4	2	4
4	Middle Rufus Woods Reservoir	8	0.1	4	3	4	4	4	4	1	4	4	2	4

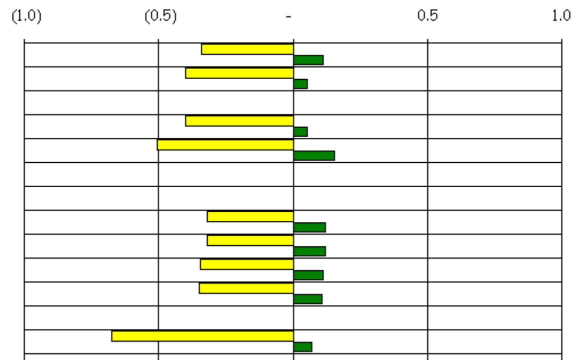
Table 46.5. Ranking of streams whose habitat is most similar to the reference condition for kokanee salmon in the Lake Rufus Woods Subbasin in comparison to other reaches. A reach rank equal to 1 reveals the reach with current conditions most similar to reference conditions in comparison to other reaches. Reach score ranges from 0 to -1, with -1 having the least deviation from reference. Values associated with each habitat attribute range from 1 to 11, a value of 1 indicates a habitat attribute being most similar to the reference compared to the other attributes within that reach. In some cases multiple habitat attributes have a value of 1 indicating all attributes are equally the most similar to the reference.

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
13	Lower Nespelem River	1	-0.67	11	8	9	5	4	1	1	5	10	1	7
5	Lower Coyote Creek	2	-0.51	10	3	7	3	1	7	1	6	9	3	10
2	Lower Rufus Woods Reservoir	3	-0.40	9	6	9	9	1	1	7	1	1	8	1
4	Middle Rufus Woods Reservoir	3	-0.40	9	6	9	9	1	1	7	1	1	8	1
11	Coulee Dam Tailrace	5	-0.35	9	1	9	9	5	5	5	1	1	8	1
10	Upper Rufus Woods Reservoir	6	-0.34	9	4	9	9	5	5	5	1	1	8	1
1	Chief Joe Dam	7	-0.34	8	5	8	8	1	1	6	1	1	7	8
8	Nespelem Bar	8	-0.32	9	4	9	9	4	4	4	1	1	8	1
9	Buckley Bar	8	-0.32	9	4	9	9	4	4	4	1	1	8	1

Table 46.6. Tornado diagram for kokanee salmon in the Lake Rufus Woods Subbasin. Degree of confidence for protection and current habitat conditions range from 0.0 to 1.0 with the greatest confidence equal to 1.0. Protection reach scores are presented on the left side and current habitat reach scores are presented on the right. Negative scores are in parentheses.

NP = Not present

Sequenc	Reach Name	Protection Confidence	Current Habitat Confidence
1	Chief Joe Dam	0.33	0.25
2	Lower Rufus Woods Reservior	0.33	0.25
3	Big Goose Lake	NP	
4	Middle Rufus Woods Reservior	0.33	0.25
5	Lower Coyote Creek	0.37	0.27
6	Middle Coyote Creek	NP	
7	Upper Coyote Creek	NP	
8	Nespelem Bar	0.33	0.25
9	Buckley Bar	0.33	0.25
10	Upper Rufus Woods Reservior	0.33	0.25
11	Coulee Dam Tailrace	0.33	0.25
12	Buffalo Lakes	NP	
13	Lower Nespelem River	0.47	0.32



46.4.4 Current Management

Current management of kokanee salmon in the Lake Rufus Woods Subbasin emphasizes protecting the lower Nespelem River spawning area, while enhancing and protecting other spawning locations throughout the Subbasin. Managers would like to develop an artificial production program that will supplement the lower Nespelem River, San Poil River, and Lake Roosevelt with genetically pure stocks that originate from unique naturalized stocks of kokanee salmon. Considerable data gaps exist for Lake Rufus Woods regarding entrainment, immigration from Lake Roosevelt and Banks Lake, juvenile habitat utilization, survival, possible impacts from fish passage at Chief Joe Dam, nonnative predation, competition, disease, and other influences that could impact kokanee residing in Lake Rufus Woods. Further studies examining these issues would be beneficial to the kokanee salmon populations within the Subbasin.

Current statewide and Colville Tribal regulations for non-Tribal members on kokanee for Lake Rufus Woods allow the harvest of two kokanee per day with no minimum size limits (WDFW 2003). All wild kokanee caught in Nespelem River Bay from July 15 to November 30 must be released immediately (WDFW 2003), (CCT 2004). Rivers on the Colville Reservation within the Lake Rufus Woods Subbasin are closed year-round to non-Tribal member fishing. Tribal members are allowed to fish in all areas of the Colville Reservation year-round with no bag or possession limits. Buffalo Lake provides angling opportunities for kokanee salmon for non-Tribal members from April 13 to October 31 and extended from January 1 to March 15 with the purchase of a special winter fishing season permit. The bag limit for Buffalo Lake kokanee is 15 for non-Tribal members.

46.5 Focal Species – Brook Trout

Brook trout were selected as a focal species for the Lake Rufus Woods Subbasin for their important recreational value, their subsistence value, and suitability to current habitat conditions. Brook trout are an introduced species and inhabit many of the higher elevation tributaries and lakes where other native game fishes are currently absent. The brook trout is indigenous to eastern North America and have been introduced throughout the other regions of the United States. In Washington state brook trout are most common in the northeast. Brook trout prefer cool, clear, headwater ponds and streams fed by springs (Wydoski and Whitney 2003). Brook trout are prevalent in streams on the Colville Reservation even with degraded habitat conditions, including warmwater temperatures exceeding 20 ºC and high levels of sedimentation (>60 percent) (CCT 2000). They provide one of the dominant fisheries in these settings within the Subbasin. Although brook trout are an important fish in the Lake Rufus Woods Subbasin, they are known to compete with native trout through direct competition and/or displacement (Wydoski and Whitney 2003).

46.5.1 Historic Status

Brook trout are not native and were introduced in the early 1900s with the establishment of the Owhi Lake population. Brook trout were observed by Tribal members as early as 1913 and were available in large numbers by 1930. Owhi Lake provided a readily available source of eggs, which were used in artificial propagation programs (Hunner et al. 2000). Historical stocking data indicate that brook trout were introduced to the Subbasin in the 1930s to augment depressed fisheries (Thiessen 1965; Halfmoon 1978). Early stocking efforts (1930-1989) included both lacustrine and fluvial habitats. Today, only lacustrine habitats are stocked and fisheries management efforts are solely conducted by the CCT. Brook Trout are preferred as a subsistence fish by many Colville Tribal members due to a taste and consistency that is closer to salmon than other trout (John Arterburn, Fish Biologist, CCT, personal communication, 2004).

46.5.2 Current Status

Brook trout are primarily managed within the lakes of the Subbasin where they are primarily stocked and are abundant enough to constitute a consumptive, nonnative sport fishery despite marginal water quality for other salmonids. Owhi, McGinnis, Buffalo, and Little Goose lakes have all been stocked with brook trout within the last two years. Stocking of brook trout is often on a put and take basis since most of the lakes are not conducive to natural reproduction. Natural reproduction does occur at Owhi Lake and fish from this lake are collected annually to support hatchery production used for enhancing recreational and subsistence fisheries.

Brook trout are able to survive a wider range of environmental conditions than other salmonids. Brook trout within the state of Washington are not known to exhibit various life history strategies, as other native salmonids do (Meehan 1991). Brook trout typically spawn in the fall between August and December when water temperatures drop below 10 ºC (50 ºF). Females vary greatly in their fecundity and eggs typically hatch within 144 days at water temperatures averaging 1.7 ºC (35 ºF) (Wydoski and Whitney 1979).

Although some local adaptations may have occurred in the last 100 years since brook trout were first stocked into Owhi Lake in the Lake Rufus Woods Subbasin, the genetic integrity of brook trout within the Subbasin is of minor importance since all populations are introduced. Fisheries investigations on Lake Rufus Woods indicate brook trout have likely not established viable populations (John Arterburn, Fish Biologist, CCT, personal communication, 2004).

46.5.3 Limiting Factors Brook Trout

Brook trout are an introduced species and are currently present in 20 of the 38 delineated reaches within the Subbasin. All 20 reaches were included for the historical distribution of brook trout in order to develop a baseline for comparing past and present habitat conditions. Current habitat conditions are severely altered from historic, and these conditions are likely to persist. Eastern brook trout are well suited to the current environmental conditions of most stream habitats in the Lake Rufus Woods Subbasin. Therefore, restoration and protection of habitats for other native species may result in more production of brook trout, especially in the Nespelem River and Coyote Creek watersheds.

For the highest ranked reaches listed in Table 46.7, the QHA output suggests the main habitat alterations have impacted the low flow regime, fine sediment loading, and habitat diversity. Approximately half of the top ten reaches with the greatest degree of deviation are located on the Little Nespelem River, while the other half are within the Nespelem River watershed. Fine sediment is listed as the top issue in the Little Nespelem, however historic levels of fine sediment loading remains uncertain (Arterburn, Fish Biologist, CCT, personal communication, 2003). The areas of degradation within the Nespelem River watershed (include the western tributaries and portions of the main channel) rank low flow and habitat complexity as the attributes with the greatest deviation from the reference condition.

The majority of the reaches receiving the highest rankings for protection is also within the Nespelem River watershed, but located primarily in the northern region and includes parts of the main channel (Table 46.8).

Table 46.7. Ranking of reaches with the largest deviation from the reference habitat conditions for brook trout in the Lake Rufus Woods Subbasin. A reach rank equal to 1 has the greatest deviation from reference condition in comparison to other reaches. Reach scores range from 0 to 1, with 1 having the greatest deviation from reference. Values associated with each habitat attribute range from 1 to 11, a value of 1 indicates a habitat attribute having the greatest deviation from reference compared to the other attributes within that reach. In some cases multiple habitat attributes have a value of 1 indicating all attributes equally deviate the most from the reference.

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
15	Little Nespelem Lower Meadow	1	0.3	8	2	2	1	8	2	10	10	5	6	7
18	Little Nespelem Upper Meadow	2	0.3	2	4	2	1	9	5	10	5	8	5	10
27	Whitelaw Creek	3	0.2	8	6	2	4	7	1	9	2	9	9	4
31	Pamenter Creek	4	0.2	5	6	1	4	8	1	9	1	9	9	6
17	Little Nespelem Canyon	5	0.2	8	6	8	3	7	1	8	1	4	5	8
28	Upper Mill Creek	6	0.2	8	6	4	1	7	1	8	4	8	8	3
29	Upper Nespelem River (Braids)	7	0.1	7	6	3	1	7	3	7	2	5	7	7
33	Middle Northstar Creek	8	0.1	4	5	5	2	8	1	9	2	9	9	7
14	Little Nespelem Falls	9	0.1	3	9	2	6	6	1	9	3	6	9	3
23	Nespelem River Lower Meadow	10	0.1	3	7	1	6	7	4	7	2	4	7	7
36	Middle Stepstone Creek	11	0.1	7	4	1	2	8	2	8	4	8	8	4
34	Upper Northstar Creek	12	0.1	7	4	1	4	7	1	9	1	9	9	4

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
24	Lower Mill Creek	13	0.1	6	5	1	2	7	2	7	2	7	7	7
25	Armstrong Creek	14	0.1	5	7	3	7	7	1	7	1	5	7	4
22	Nespelem River Developed Reach	15	0.1	1	6	6	11	8	2	8	2	5	2	8
32	Lower Northstar Creek	16	0.1	1	4	5	1	6	1	6	6	6	6	6
35	Lower Stepstone Creek	17	0.1	3	4	2	1	6	5	6	6	6	6	6
38	Nespelem River Headwaters	18	0.1	4	5	1	1	6	6	6	1	6	6	6
26	Middle Mill Creek	19	0.1	6	5	3	1	7	1	7	7	7	7	3
21	Nespelem Falls	20	0.1	2	5	1	11	5	5	5	2	4	5	5

Table 46.8. Ranking of streams whose habitat is most similar to the reference condition for brook trout in the Rufus Woods Subbasin in comparison to other reaches. A reach rank equal to 1 reveals the reach with current conditions most similar to reference conditions in comparison to other reaches. Reach score ranges from 0 to -1, with -1 having the least deviation from reference. Values associated with each habitat attribute range from 1 to 11, a value of 1 indicates a habitat attribute being most similar to the reference compared to the other attributes within that reach. In some cases multiple habitat attributes have a value of 1 indicating all attributes are equally the most similar to the reference.

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
38	Nespelem River Headwaters	1	-0.65	7	10	3	3	11	3	1	7	6	1	7
35	Lower Stepstone Creek	2	-0.65	8	10	3	5	11	7	1	3	6	1	8
32	Lower Northstar Creek	3	-0.65	9	10	3	4	11	7	1	4	6	1	7
26	Middle Mill Creek	4	-0.63	8	9	6	3	11	7	1	3	5	1	10
33	Middle Northstar Creek	5	-0.62	6	9	3	4	11	9	1	6	5	1	8
29	Upper Nespelem River (Braids)	6	-0.59	6	10	3	11	9	3	1	5	6	1	6
36	Middle Stepstone Creek	7	-0.59	7	9	4	3	10	8	1	6	5	1	11
34	Upper Northstar Creek	8	-0.58	6	7	4	3	9	9	1	9	5	1	7
17	Little Nespelem Canyon	9	-0.58	4	9	1	5	10	6	1	6	11	3	6
25	Armstrong Creek	10	-0.50	6	8	4	3	9	10	1	10	4	1	7
31	Pamenter Creek	11	-0.46	3	7	3	3	10	8	1	8	3	1	11
24	Lower Mill Creek	12	-0.41	9	5	5	3	9	7	1	7	9	1	4
27	Whitelaw Creek	13	-0.39	9	5	3	3	10	8	1	6	11	1	6

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
28	Upper Mill Creek	**14**	-0.39	9	6	3	3	9	7	1	3	9	1	8
22	Nespelem River Developed Reach	**15**	-0.37	5	11	2	9	5	3	1	3	5	10	5
21	Nespelem Falls	**16**	-0.36	6	10	4	9	6	1	1	3	4	6	10
23	Nespelem River Lower Meadow	**17**	-0.35	4	11	9	10	6	2	1	5	2	6	6
14	Little Nespelem Falls	**18**	-0.33	5	11	3	8	8	5	1	2	3	5	10
15	Little Nespelem Lower Meadow	**19**	-0.32	3	10	4	10	6	4	1	1	9	6	6
18	Little Nespelem Upper Meadow	**20**	-0.28	9	11	2	10	7	2	1	2	2	7	2

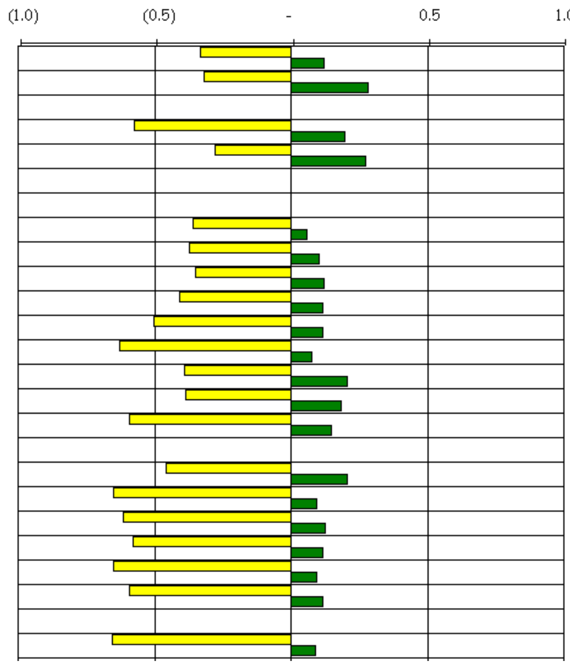
The tornado diagram (Table 46.9) and maps (Map LRW-3, Map LRW-4, located at the end of Section 46) presents the reach scores for both current habitat condition (ranging from zero to positive one, Map-3) and protection (ranging from zero to negative one, Map-4). Scores closest to negative one depict reaches that are most representative of reference habitat conditions. Scores closest to positive one depict reaches with habitat conditions least similar to reference conditions. Confidence scores range from zero to one and are associated with the ratings assigned by local biologists based on documentation or their expert opinion regarding reference and current habitat attributes for each reach.

Based upon the data collected during the QHA analysis, it is important to understand that most model outputs are only as good as the data that is entered into them. Data that is lacking or inaccurate is likely to produce erroneous results. Within the Lake Rufus Woods Subbasin a lack of data make interpreting QHA results highly subjective, due to the lack of confidence in the data used for this model. Confidence scores for protection ratings in the Little Nespelem lower meadow and Nespelem River lower meadow reaches were the only two reaches where sufficient confidence in the data existed to produce reliable results. Confidence results identified a complete lack of data about the habitat in the Nespelem Falls, Armstrong Creek, Whitelaw Creek, and Pamenter Creek reaches. Some data gaps existed for all other reaches; therefore anyone attempting to utilize the QHA assessment for making substantive decisions should do so with caution. In most cases current habitat conditions had better data and historic habitat ratings were largely considered speculative because this species was introduced.

Table 46.9. Tornado diagram for brook trout in the Lake Rufus Woods Subbasin. Degree of confidence for protection and current habitat conditions range from 0.0 to 1.0 with the greatest confidence equal to 1.0. Protection reach scores are presented on the left side and current habitat reach scores are presented on the right. Negative scores are in parentheses.

NP = Not present

Sequence	Reach Name	Protection Confidence	Current Habitat Confidence
14	Little Nespelem Falls	0.43	0.30
15	Little Nespelem Lower Meadow	0.47	0.32
16	Joe Moses Creek	NP	
17	Little Nespelem Canyon	0.33	0.25
18	Little Nespelem Upper Meadow	0.42	0.29
19	Owhi Lake	NP	
20	Owhi Creek	NP	
21	Nespelem Falls	0.25	0.21
22	Nespelem River Developed Reach	0.43	0.30
23	Nespelem River Lower Meadow	0.47	0.32
24	Lower Mill Creek	0.38	0.28
25	Armstrong Creek	0.20	0.18
26	Middle Mill Creek	0.38	0.28
27	Whitelaw Creek	0.25	0.21
28	Upper Mill Creek	0.38	0.28
29	Upper Nespelem River (Braids)	0.33	0.25
30	Smith Creek	NP	
31	Pamenter Creek	0.08	0.13
32	Lower Northstar Creek	0.37	0.27
33	Middle Northstar Creek	0.37	0.27
34	Upper Northstar Creek	0.40	0.28
35	Lower Stepstone Creek	0.37	0.27
36	Middle Stepstone Creek	0.37	0.27
37	Upper Stepstone Creek	NP	
38	Nespelem River Headwaters	0.37	0.27



Although the QHA points to opportunities to improve stream habitat for brook trout, lakes are the top priority for brook trout management in the Lake Rufus Woods Subbasin (John Arterburn, Fish Biologist, CCT, personal communication, 2003). Due to the existence of natural barriers, the Nespelem River watershed can be separated into three distinct zones. Zone one is the mouth upstream to the Nespelem Falls. This section should be managed for the preservation of spawning habitat for adfluvial and perhaps someday, anadromous fish. Zone two is from the Nespelem Falls section upstream to any of the natural headwater barriers. Zone two is primarily brook trout habitat. Zone two is more conducive to hatchery supplementation and harvest activities than restoration activities, due to the preponderance of eastern brook trout. Zone three is the headwater areas above the natural barriers. Areas in zone three are more conducive for habitat/watershed and native fish restoration efforts until such a time when the core native fish populations in this zone are re-established.

46.5.4 Current Management

Regulations for the take of brook trout within the basin are managed by the CCT for areas on the Colville Reservation and WDFW in areas outside of the reservation borders; Lake Rufus woods is co-managed. A daily bag limit of 2 trout is in effect for Lake Rufus Woods with a current possession limit of two times the daily bag (CCT 2003) (WDFW 2003). For non-Tribal members to fish the lakes on the Colville Reservation requires the purchase of a tribal fishing license. Eastern brook trout bag limits for open waters are 5 fish to be retained daily but only one may exceed 20 inches in length, and possession is two times daily bag limit. Owhi Lake is open to Tribal members only. Tribal members are allowed unrestricted harvest opportunities throughout the Lake Rufus Woods Subbasin, with the exception of white sturgeon (CCT 2004) (WDFW 2003).

46.6 Focal Species – Rainbow Trout

Rainbow trout were selected as a focal species due to their recreational importance as a sport fish, their subsistence value to Upper Columbia United Tribes, and their ecological significance within the watershed

Rainbow trout were historically distributed from northern Mexico to southeastern Alaska and inland in rivers that are free of natural obstructions from the Pacific Ocean (Behnke 1992). Rainbow trout exhibit both anadromous and non-anadromous life history strategies, with the anadromous form being referred to as steelhead. Three life history strategies are displayed by non-anadromous rainbow trout. Fluvial fish rear as adults in larger rivers and migrate to tributary streams to spawn, adfluvial fish rear as adults in lakes or reservoirs and migrate to tributaries to spawn, and resident fish spend their entire life cycle in tributary streams. The present distribution of rainbow trout and steelhead has been affected by both indiscriminate stocking practices and habitat alterations (Wydoski and Whitney 2003).

Rainbow trout are a cold-water salmonid that prefer water with temperatures below 70^{o} F and high amounts of dissolved oxygen (Wydoski and Whitney 2003). Rainbow trout typically mature between age 1 and age 5, depending on their growth rates (Wydoski and Whitney 2003). Rainbow trout spawn in the spring usually between February and June, depending on the temperature and location. Substrate composition, cover, water quality, and water quantity are important habitat elements for spawning rainbow trout (Bjornn and Reiser 1991). Juvenile rainbow trout typically prey on drifting organisms while residing in lotic systems and prey on a variety of planktonic, terrestrial, and bethic organisms when in lentic habitats. Adult rainbow trout are ominivorous and often feed on the most abundant prey resource at any given time. As rainbow trout grow in size, a proportion of their diet may be comprised of fish.

Rainbow trout have been transplanted to many temperate-zone waters in both the northern and southern hemispheres and have self-sustaining populations in many areas (Bjornn and Reiser 1991). Two subspecies of rainbow trout exist in the State of Washington, the coastal rainbow trout (*O. mykiss mykiss*) and the redband trout (*O.*

mykiss gairdneri). Redband rainbow trout are native to the IMP and currently at risk in many areas due to introgression from transplanted coastal rainbow trout stocks. The extirpated steelhead runs within the IMP were of the redband subspecies (Behnke 1992), therefore conservation of current redband populations may have benefits for recovering steelhead runs within the IMP in the future with the possibility of fish passage at Chief Joseph and Grand Coulee dams.

Coastal rainbow trout stocks have been widely propagated and planted indiscriminately throughout the North American continent. Today hatchery production of coastal stocks of rainbow trout continues. However, a few facilities are beginning to experiment with triploiding technology that makes these fish sterile, thus reducing genetic impacts on local native stocks. Triploid rainbow trout have increased growth rates once they reach maturity and often obtain larger sizes. Although there is a movement for native redband conservation in Washington state and Tribal waters, local redband brood stocks will take many years to develop and are unlikely to replace coastal stocks in the near future. The Colville Tribal hatchery is currently moving from utilizing coastal rainbow trout stocks to triploid rainbow trout, and hopes to move further into stocking native redbands. There is an attempt in the Subbasin to transform from reliance on coastal stocks to triploid rainbow trout to locally adapted redband trout, but this will take many years for the transition to be complete. A destination fishery is developing for triploid rainbow trout at Lake Rufus Woods due to the efforts of the CCT in conjunction with the Columbia River Fish Farm. The Tribes purchase triploid rainbow trout that can weigh between 3 and 8 pounds from the aquaculture operations for release into Lake Rufus Woods. The results have attracted the attention of many anglers due to stories of rainbow trout over 20 pounds. Lake Rufus Woods has produced the last two state record rainbow trout at 23 and 26 pounds.

46.6.1 Historic Status

Redband rainbow trout have been identified as the native rainbow trout stock that historically resided in the Lake Rufus Woods Subbasin. Although redband trout are still present in some locations within the Subbasin, the anadromous form known as steelhead has been completely eliminated.

Chapman (1996) stated that large runs of Chinook and sockeye, and lesser runs of coho, steelhead, and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 500,000 spring Chinook and 450,000 steelhead were the best estimate of pre-development run sizes. Spring Chinook and steelhead were relatively abundant in upper Columbia River tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid- and upper Columbia River spring and summer Chinook runs (McDonald 1895), and eventually steelhead (Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia River basin salmonids (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982).

Mullan et al. (1992) noted that the Spokane River upstream from the current Grand Coulee Dam site was a major producer of steelhead but noted:

> The inescapable conclusion is that headwater lacustrine environments produced negligible numbers of steelhead. This conclusion, combined with the inaccessibility or infertility of nearly all tributary systems above the San Poil River, helps explain why steelhead were confined to a relatively few tributary habitats.

Since the 1930s, and particularly since the 1960s, construction of mainstem Columbia River dams has also affected fish abundance. While the dams on the mainstem may not have caused the original demise of the fish runs, they are a factor in reducing the resilience of the fish runs to handle natural perturbations. Steelhead counts began at Rock Island Dam in 1933, and annual counts averaged 2,800 between 1933 and 1939. These numbers do not reflect large fisheries in the lower river at that time that were estimated at harvesting greater than 60 percent of all available fish (Mullan et al. 1992).

In summary, both harvest rate and numerical harvest of spring Chinook and steelhead appeared to have peaked in the last 15 years of the 1800s. Numbers of spring Chinook and steelhead in the upriver run in the late 1930s and 1940s were depressed by decades of over-fishing and habitat degradation. Runs increased in the 1950s, partly in response to somewhat reduced harvest rates and favorable ocean productivity.

46.6.2 Current Status

The popular rainbow trout fishery in the reservoir consists mainly of fish originating from the Trout Lodge and other hatcheries. The Trout Lodge stock is a triploid stock of mixed steelhead and rainbow trout origin that is used for food fish production at net pens located along Lake Rufus Woods. Large fish from these aquaculture operations are purchased by the CCT and released in Lake Rufus Woods to supplement subsistence and recreational opportunities (Council 2000). Trout Lodge stock also is known to escape from the Columbia River Fish Farms net pens in Lake Rufus Woods and enter the fishery. The Spokane stock rainbow trout from the Spokane Tribal Hatchery are likely fish released from the Lake Roosevelt net pens that have entrained out of Lake Roosevelt. In addition, the CCT stocks up to 100,000 sub-catchable Goldendale rainbow trout annually in Lake Rufus Woods from the Colville Tribal Hatchery. Rainbow trout are also released annually into Mill Creek and the Nespelem River from the Colville Tribal Hatchery to supplement subsistence fishing on Colville Reservation streams. In addition, Buffalo Lake receives annual stocking of rainbow trout from the Colville Tribal Hatchery.

46.6.3 Limiting Factors Rainbow Trout

According the QHA model, rainbow trout are currently present in 24 of the 38 reaches in the Subbasin. Only 14 reaches were identified as having rainbow trout historically present, and thus only 14 reaches were evaluated for the degree of change relative to the reference condition (Table 46.10). However, all 24 reaches were evaluated for a protection ranking (Table 46.11). In general, the main modifications to the habitat conditions resulted in a decrease in habitat diversity and riparian conditions, and the presence of more obstructions (see Table 49.2).

The reaches ranking highest for degradation or deviation from reference conditions included the Lake Rufus Woods and Little Nespelem River (Table 46.10). The top six ranked reaches were all in the reservoir and indicated habitat diversity as the most notable change from reference conditions. Riparian condition, low flow, oxygen, and an obstruction (refers to Chief Joseph and Grand Coulee dams) also received large marks in these reaches regarding the degree of change relative to historic conditions.

The top reaches ranked for protection include mostly the Nespelem River and some of its tributaries (Table 46.11). The reservoir reaches ranked 6-8, 10-12, and 14 (Table 46.11) showed temperature regimes have remained most similar to historic conditions compared to other habitat attributes.

Table 46.10. Ranking of reaches with the largest deviation from the reference habitat conditions for rainbow trout in the Lake Rufus Woods Subbasin. A reach rank equal to 1 has the greatest deviation from reference condition in comparison to other reaches. Reach scores range from 0 to 1, with 1 having the greatest deviation from reference. Values associated with each habitat attribute range from 1 to 11, a value of 1 indicates a habitat attribute having the greatest deviation from reference compared to the other attributes within that reach. In some cases multiple habitat attributes have a value of 1 indicating all attributes equally deviate the most from the reference.

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	Chief Joe Dam	1	0.3	5	7	1	4	8	8	3	8	8	5	1
8	Nespelem Bar	2	0.3	1	7	1	5	7	1	1	9	9	5	9
9	Buckley Bar	3	0.3	1	6	1	8	6	1	1	9	9	5	9
11	Coulee Dam Tailrace	4	0.3	4	8	1	4	4	2	2	8	8	4	8
4	Middle Rufus Woods Reservoir	5	0.2	4	6	1	2	7	7	2	7	7	4	7
10	Upper Rufus Woods Reservoir	6	0.2	4	7	1	8	4	2	2	8	8	4	8
6	Middle Coyote Creek	7	0.2	2	5	5	4	9	2	10	5	11	8	1
2	Lower Rufus Woods Reservoir	8	0.2	4	6	1	3	7	7	2	7	7	4	7
15	Little Nespelem Lower Meadow	9	0.2	9	2	3	1	8	3	10	10	3	3	3
18	Little Nespelem Upper Meadow	10	0.1	2	2	4	1	6	6	10	9	6	4	10
13	Lower Nespelem River	11	0.1	1	2	4	7	6	7	7	2	4	7	7
17	Little Nespelem Canyon	12	0.1	8	5	8	1	5	2	8	5	2	2	8
21	Nespelem Falls	13	0.1	2	5	1	11	5	5	5	2	4	5	5
7	Upper Coyote Creek	14	0.1	4	4	1	2	4	3	9	8	7	9	9
14	Little Nespelem Falls	15	0.0	6	6	6	6	3	1	6	4	5	6	1
5	Lower Coyote Creek	16	0.0	4	4	4	4	4	2	4	3	4	4	1

Table 46.11. Ranking of streams whose habitat is most similar to the reference condition for rainbow trout in the Lake Rufus Woods Subbasin in comparison to other reaches. A reach rank equal to 1 reveals the reach with current conditions most similar to reference conditions in comparison to other reaches. Reach score ranges from 0 to -1, with -1 having the least deviation from reference. Values associated with each habitat attribute range from 1 to 11, a value of 1 indicates a habitat attribute being most similar to the reference compared to the other attributes within that reach. In some cases multiple habitat attributes have a value of 1 indicating all attributes are equally the most similar to the reference.

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
26	Middle Mill Creek	1	-0.72	6	3	8	9	9	9	1	4	1	7	4
13	Lower Nespelem River	2	-0.70	11	8	4	8	10	1	1	5	7	6	1
29	Upper Nespelem River (Braids)	3	-0.69	3	8	3	11	10	3	1	8	3	7	1
23	Nespelem River Lower Meadow	4	-0.64	6	3	10	11	8	3	1	7	3	8	1
25	Armstrong Creek	5	-0.58	6	3	7	7	7	10	1	10	3	5	2
2	Lower Rufus Woods Reservoir	6	-0.57	10	5	10	9	6	1	6	1	1	8	1
10	Upper Rufus Woods Reservoir	7	-0.56	11	4	8	5	8	5	5	1	1	8	1
4	Middle Rufus Woods Reservoir	8	-0.56	9	5	9	9	6	1	6	1	1	8	1
6	Middle Coyote Creek	9	-0.55	4	3	5	10	9	11	1	5	2	5	5
11	Coulee Dam Tailrace	10	-0.55	11	1	7	7	7	5	5	1	1	7	1
9	Buckley Bar	11	-0.53	11	4	4	8	9	4	4	1	1	9	1
8	Nespelem Bar	12	-0.52	11	4	4	8	8	4	4	1	1	8	1
30	Smith Creek	13	-0.49	5	2	6	7	8	8	1	8	2	4	11
1	Chief Joe Dam	14	-0.48	9	4	9	8	5	1	5	1	1	7	9
24	Lower Mill Creek	15	-0.35	8	7	9	4	5	10	1	11	5	1	1
17	Little Nespelem Canyon	16	-0.34	5	7	5	4	7	9	1	10	10	3	1
7	Upper Coyote Creek	17	-0.33	6	6	9	4	8	11	1	10	5	1	1
27	Whitelaw Creek	18	-0.30	6	6	9	3	8	10	1	11	3	1	3

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
28	Upper Mill Creek	**19**	-0.29	5	5	8	3	5	10	1	11	3	1	8
22	Nespelem River Developed Reach	**20**	-0.12	7	7	7	7	1	3	4	5	6	7	1
18	Little Nespelem Upper Meadow	**21**	-0.10	7	7	7	7	2	3	3	5	5	7	1
15	Little Nespelem Lower Meadow	**22**	-0.09	7	7	7	7	1	3	3	3	6	7	1
14	Little Nespelem Falls	**23**	-0.09	7	7	7	7	1	2	2	5	6	7	2
5	Lower Coyote Creek	**24**	-0.07	6	6	6	6	1	5	2	4	3	6	6

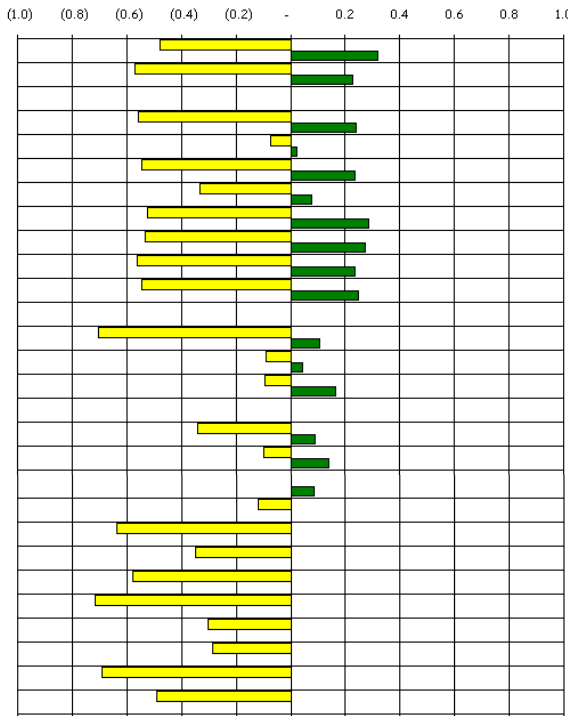
The tornado diagram (Table 46.12) and maps (Map LRW-5, Map LWR-6, located at the end of Section 46) presents the reach scores for both protection (ranging from zero to negative one, Map LRW-5) and current habitat condition (ranging from zero to positive one, Map LWR-6). Scores closest to negative one depict reaches that are most representative of reference habitat conditions. Scores closest to positive one depict reaches with habitat conditions least similar to reference conditions. Confidence scores range from zero to one and are associated with the ratings assigned by local biologists based on documentation or their expert opinion regarding reference and current habitat attributes for each reach.

Based upon the data collected during the QHA analysis it is important to understand that most model outputs are only as good as the data that are entered into them. Data that are lacking or inaccurate are likely to produce erroneous results. Within the Lake Rufus Woods Subbasin a lack of data makes interpreting QHA results highly subjective due to the distinct lack of confidence in the data used for this model. Confidence scores for protection ratings in the Lower Nespelem River and Little Nespelem lower meadow reaches were the only two reaches where sufficient confidence in the data existed to produce reliable results. Confidence results identified a complete lack of data about the habitat in the Nespelem Falls reach. Some data gaps existed for all other reaches; therefore anyone attempting to utilize the QHA assessment for making substantive decisions should do so with caution. In most cases current habitat conditions had better data and historic habitat ratings were largely considered speculative. This was most prominent in the information for reaches above Nespelem Falls, due to a lack of historical information.

Table 46.12. Tornado diagram for rainbow trout in the Lake Rufus Woods Subbasin. Degree of confidence for protection and current habitat conditions range from 0.0 to 1.0 with the greatest confidence equal to 1.0. Protection reach scores are presented on the left side and current habitat reach scores are presented on the right. Negative scores are in parentheses.

NP = Not present

Sequence	Reach Name	Protection Confidence	Current Habitat Condition Confidence
1	Chief Joe Dam	0.33	0.25
2	Lower Rufus Woods Reservior	0.33	0.25
3	Big Goose Lake	NP	
4	Middle Rufus Woods Reservior	0.33	0.25
5	Lower Coyote Creek	0.37	0.27
6	Middle Coyote Creek	0.37	0.27
7	Upper Coyote Creek	0.37	0.27
8	Nespelem Bar	0.33	0.25
9	Buckley Bar	0.33	0.25
10	Upper Rufus Woods Reservior	0.33	0.25
11	Coulee Dam Tailrace	0.33	0.25
12	Buffalo Lakes	NP	
13	Lower Nespelem River	0.47	0.32
14	Little Nespelem Falls	0.43	0.30
15	Little Nespelem Lower Meadow	0.47	0.32
16	Joe Moses Creek	NP	
17	Little Nespelem Canyon	0.33	0.25
18	Little Nespelem Upper Meadow	0.42	0.29
21	Nespelem Falls	0.25	0.21
22	Nespelem River Developed Reach	NP	
23	Nespelem River Lower Meadow	NP	
24	Lower Mill Creek	NP	
25	Armstrong Creek	NP	
26	Middle Mill Creek	NP	
27	Whitelaw Creek	NP	
28	Upper Mill Creek	NP	
29	Upper Nespelem River (Braids)	NP	
30	Smith Creek	NP	



No historic evidence of rainbow trout being present upstream of Nespelem Falls exists. However, there are populations maintained through stocking activities and an important recreational fishery currently exists in Lake Rufus Woods that would benefit from increased management activities. Lake Rufus Woods and other lake environments provide an opportunity for extensive subsistence and recreational harvest. The Colville Tribal hatchery has been the primary source of fish for these activities over the last decade. Aquaculture production of rainbow trout in Lake Rufus Woods has helped to establish a trophy fishery for rainbow trout at Lake Rufus Woods. The development of this fishery has been largely through the purchase of fish from these operations by the CCT and also from increased nutrient availability resulting from on-going aquaculture businesses.

Stream habitats and headwater habitats more specifically are largely restricted by biological constraints, such as low nutrient levels, although physical habitat is adequate. Habitats best suited for redband trout recovery are found in Northstar, Stepstone, and Mill creeks along with the mainstem Nespelem River above Smith Creek. If efforts to establish native fish are to be made then habitats below Smith creek are unlikely to support robust redband populations due to high summer water temperatures, substrates made up almost exclusively of fine sediments, little habitat diversity, and extremely low stream gradient.

Due to the existence of natural barriers, the Nespelem River watershed can be separated into three distinct zones. Zone one is the mouth of the Nespelem River upstream to Nespelem Falls. Zone one should be managed for the preservation of spawning habitat for adfluvial and perhaps someday, anadromous fish. Zone two is from the Nespelem Falls section upstream to any of the natural headwater barriers. Zone two is the primarily brook trout habitat. Zone two is more conducive to hatchery supplementation and harvest activities for rainbow trout than restoration activities, due to the preponderance of eastern brook trout. Zone three is the headwater area above the natural barriers. Zone three is the most conducive area for habitat/watershed and native redband trout restoration efforts at least until such a time that core native fish populations in this zone are re-established.

46.6.4 Current Management

Lake Rufus Woods is co-managed by WDFW and the CCT, and the daily bag is 2 fish with a possession limit of two times the daily bag. Lakes on the Colville Reservation are managed solely by the CCT, and for non-Tribal members to fish the lakes on the Colville Reservation requires the purchase of a tribal fishing license. Rainbow trout bag limits for Buffalo Lake is 5 fish daily but only one may exceed 20 inches in length and possession is two times the daily limit. Buffalo Lake provides angling opportunities for rainbow trout for non-Tribal members from April 13 to October 31. This season can be extended from January 1 to March 15 with the purchase of a special winter fishing season permit. Most Rainbow trout fisheries in the Rufus Woods Subbasin are the result of artificial production due to nonnative species interactions, habitat degradation, and other environmental constraints. Rainbow trout populations will continue to need hatchery supplementation in order to meet current and future management objectives and provide for subsistence and recreational fisheries in the Lake Rufus Woods Subbasin. The Lake Rufus Woods triploid fishery will require efforts to manage people and access as the popularity of this fishery continues to increase.

46.7 Focal Species – White Sturgeon

White sturgeon were once abundant in the Lake Rufus Woods Subbasin and provided subsistence and recreational opportunities. The white sturgeon was selected as a focal species for the Subbasin because of their cultural importance to the Upper Columbia United Tribes, and their potential ecological significance within the reservoir habitat. Information regarding this stock is limited, and potential impacts that passage at Chief Joseph Dam would have on white sturgeon are unknown. Since dams on both the upstream and downstream ends of the reservoir confine this population, it is highly unlikely that a self-sustaining population can persist. Limited scientific knowledge about this population makes specific actions difficult to address.

White sturgeon are found in marine waters and freshwater rivers along the Pacific Coast from California to Alaska (Wydoski and Whitney 2003). In the State of Washington, white sturgeon are found in the Columbia and Snake rivers, Grays Harbor, Willapa Bay, Puget Sound, and Lake Washington (Wydoski and Whitney 2003).

White sturgeon are the largest fish found in the freshwaters of North America, with specimens being reported to reach length of 20 ft and weights of 1, 800 pounds (Wydoski and Whitney 2003). Reproduction occurs at between 9 and 16 years of age and only a small percentage of adults may spawn in any given year. White sturgeon migrate great distances in unimpounded rivers and display both anadromous and resident life history forms.

White sturgeon in the Columbia River declined in numbers due numerous factors, including obstruction of migration by dams, altered stream flows, altered temperature regimes, reduced spawning habitats, and over-harvest (Wydoski and Whitney 2003).

46.7.1 Historic Status

Prior to hydroelectric development, white sturgeon within the Subbasin were likely anadromous and may have migrated considerable distances between subbasins within the Columbia River. In general, white sturgeon are not known to display variable life history strategies other than occasional, facultative anadromy. White sturgeon spawn in the spring and can be highly fecund, however survival from egg to adult is relatively low (Anders 2002). White sturgeon have not been stocked historically within the Lake Rufus Woods Subbasin.

46.7.2 Current Status

Relative abundance compared to other aquatic species is unknown but presumed to be low. Numbers of adult white sturgeon within the Lake Rufus Woods Subbasin are presumed to be minimal (Anders and Powell 1999). Recruitment is also presumed low or non-existent.

Theoretically, white sturgeon entrained through Grand Coulee Dam may represent gene flow to the population within the impounded Lake Rufus Woods. However, a recent genetic survey indicated white sturgeon from Lake Rufus Woods had only a single observed maternal lineage as compared to the significantly more variable Upper Columbia River (Anders and Powell 1999). With only seven fish sampled within the lake, genetic diversity remains largely unknown (Anders and Powell 1999). Any anadromous component to the life history of white sturgeon within the Lake Rufus Woods Subbasin was lost with the construction of Chief Joseph and Grand Coulee dams without fish passage.

Although data on white sturgeon in Lake Rufus Woods is sparse, more data has been collected for the Upper Columbia Subbasin. It is presumed that white sturgeon, like other fishes in Lake Roosevelt are entrained through Grand Coulee Dam, thus spending part of their life histories within the Lake Rufus Woods Subbasin. Since white sturgeon are a long-lived species, a fish entrained in Lake Rufus Woods could live a substantial portion of its life in the lake. Below is a summary on white sturgeon population above Grand Coulee Dam, just upstream of Lake Rufus Woods.

The current white sturgeon population estimate is 1,400 adults in the trans-boundary region of the Upper Columbia River basin (Upper Columbia White Sturgeon Recovery Plan 2002). Specific numbers for the Upper Columbia Subbasin are not known. Nonetheless, the population status is considerably less than the endangered status criteria of 2,500 adults determined by the World Conservation Union. Although most of the upper-mainstem populations appear unstable, their genetic similarity to the stable lower Columbia River population has excluded them from consideration for listing under the federal Endangered Species Act, unlike the Kootenai River population.

White sturgeon are found in Lake Roosevelt and the Columbia River upstream of the reservoir. Any anadromous component to the life history of white sturgeon within the Subbasin has been presumably lost. Genetic diversity of the samples collected is similar to the diversity observed elsewhere within the Columbia and Kootenai river basins (Anders and Powell 1999).

Recent data indicate that older fish dominate the population structure of white sturgeon in Lake Roosevelt. These data indicate that juvenile recruitment may be limiting this population. If this trend continues, the white sturgeon population in Lake Roosevelt may be in jeopardy. If recruitment does not improve, the Upper Columbia River basin population is projected to decline 50 percent within 10 years and 75 percent within 20 years (Upper Columbia White Sturgeon Recovery Plan 2002).

In 1998, a stock-indexing project (Devore et al. 2000) found that only 1.5 percent of the captured white sturgeon were juveniles (<110 cm Fork Length), suggesting poor recruitment. Furthermore, of the 204 fish captured, only three were captured in experimental gill nets (deployed for the purpose of catching juvenile sturgeon) and length at age assignments revealed an age structure of 12- to 96-year-old fish (Devore et al. 2000). The conclusion that there are severe recruitment limitations (Devore et al. 2000) supports conclusions of research conducted in the Canadian Reach of the Columbia River (R.L. & L. Environmental Services Ltd. 1996). Devore et al. (2000) found that the relative weight (Wr) of 91 percent of the white sturgeon collected from Lake Roosevelt was lower than other populations. (To date, this is the lowest recorded Wr value recorded for any Columbia River Basin white sturgeon population).

Distribution of white sturgeon within the Upper Columbia Subbasin is dependent upon water condition and suitable habitat (Devore et al. 2000). Trends in abundance will likely show declines since there appear to be little or no juvenile recruitment within the stock (Anders, 2002; Devore et al. 2000). Carrying capacity within the Lake Rufus Woods Subbasin is not known and needs to be further assessed. Current stocks are considered depressed but limiting factors are not completely known. Areas of successful spawning and recruitment are habitats to be identified, protected, and/or enhanced.

46.7.3 Current Management

White sturgeon are closed to harvest for all anglers in all portions of the Columbia River upstream of Chief Joseph Dam (WDFW 2003) (CCT 2004). At this time a sufficient carrying capacity and productivity of white sturgeon to support a sport fishery in Lake Rufus Woods is unknown and research is still needed to address these uncertainties. White sturgeon have not been introduced or stocked and no captive breeding programs currently exist in the Lake Rufus Woods Subbasin.

46.8 Species of Interest – Pacific Lamprey

Although currently extirpated from the Lake Rufus Woods Subbasin, Pacific lamprey were an important ecological and cultural species and provided a subsistence fishery within the Subbasin before the construction of Chief Joseph Dam. Pacific lamprey would most likely once again be an ecologically important fish to the Subbasin if fish passage is restored in the future. Although Pacific lamprey were not chosen by the technical team as a focal species in the Lake Rufus Woods Subbasin, they are included within the strategies and objectives formulated by the work team members, therefore they are of interest to the future direction of the Lake Rufus Woods Subbasin.

Pacific lamprey are found in streams from southern California to the Gulf of Alaska (Wydoski and Whitney 2003). In Washington state, Pacific lamprey are found in most large coastal and Puget Sound rivers and occurs long distances inland in the Columbia, Snake, and Yakima River systems (Wydoski and Whitney 2003).

Pacific lamprey are anadromous and rear as adults in the Pacific Ocean. Adults are parasitic, feeding on the body fluids of various species of fish. Adults reach lengths of 30 inches and a weight of about 1 pound (Wydoski and Whitney 2003). Unlike Pacific salmon, Pacific lamprey may be able to spawn more than once (Wydoski and Whitney 2003). The importance of Pacific lamprey predation in the Pacific Ocean has not been clearly evaluated (Wydoski and Whitney 2003), although biologists suspect there might be significant effects on some fish populations.

46.8.1 Historic Status

Pacific lamprey were historically present in the Lake Rufus Woods Subbasin prior to the construction of Chief Joseph Dam. The construction of the dams without fish passage facilities prevented migration upstream of Pacific lamprey and other anadromous species as well as extirpated them from the Subbasin.

46.8.2 Current Status

Currently, Pacific lamprey are not known to be present within the Subbasin.

46.8.3 Current Management

There is no current management for the species, since Pacific lamprey were extirpated from the Lake Rufus Woods Subbasin.

46.9 Species of Interest – Burbot

Burbot were selected as a species of interest for their ecological significance, their native species status, and their potential recreational importance as a sport fish. Although burbot are not as sought after by recreational anglers as the salmonids and walleye in the region, they are excellent table fare. More research needs to be conducted to truly understand the status of burbot in this Subbasin. Burbot were chosen not be analyzed by the QHA model in this assessment. The QHA model was developed for salmonid fishes and would not effectively identify limiting factors for populations of burbot in the Lake Rufus Woods Subbasin. Although data on the general population characteristics and distribution is not well understood, burbot are perceived as an important species in the Subbasin and warrant research to further understand how they interact with their environment in the Subbasin.

46.9.1 Historic Status

Distribution of burbot is circumpolar in the northern hemisphere. There is not a lot known about burbot in the Upper Columbia River, but they are found in Lake Roosevelt, Lake Rufus Woods and the Columbia River downstream from Chief Joseph Dam. Early systematic studies placed burbot into three distinct subspecies with only one of these subspecies found in North America, *Lota lota lacustris* (Hubbs and Schultz 1941). Current evidence suggests the sub-specific designation is unwarranted (Scott and Crossman 1973). Burbot are benthic feeders that reside in deep waters in lakes or rivers and are not considered migratory. Sexual maturity is reached between age 2 and age 4. Burbot spawn during the winter from mid-December to early April. Spawning habitat conditions include mostly shallow waters (0.3-1.5 m) and clean substrate (sand, gravel and stones) (Morrow 1980).

46.9.2 Current Status

Little is known regarding burbot biology within the Lake Rufus Woods Subbasin. Population status, abundance, and trends are unknown. Abundance appears to be fairly stable with comparison to other harvest and species composition data (WDFW catch data for Lake Roosevelt). Carrying capacity and current habitat condition for burbot remains relatively unknown within the Subbasin.

46.9.3 Current Management

Currently burbot have a daily catch limit of five per day. This was increased from previous regulations of two per day in an attempt to increase angler interest and harvest for burbot (WDFW 2003). No hatchery production or current captive breeding programs operate within the Lake Rufus Woods Subbasin. Current management direction is to maintain the harvest regulations that are in place.

46.10 Species of Interest – Walleye

Walleye were not included as a focal species for the subbasin planning process; however because of their potential ecological significance and popularity as a recreational fishery, entities within the Lake Rufus Woods Subbasin have included walleye as a “species of interest.”

46.10.1 Historic Status

Walleye are an introduced species that were first observed in Lake Roosevelt, upriver from Lake Rufus Woods during the early 1950s. Walleye may have occupied fluvial habitat and interacted with indigenous fish species downstream of Lake Roosevelt prior to impoundment by Chief Joseph Dam in 1961. The construction of Chief Joseph Dam and subsequent impoundment (Lake Rufus Woods) eliminated anadromous fish populations above Chief Joseph Dam and significantly reduced the viability of resident salmonid populations through habitat alterations and passage barriers, while at the same time increased habitat conducive to introduced species, including walleye. Although the altered habitat is likely more conducive to walleye populations than that provided during pre-impoundment, substantial water level fluctuations, short water retention times, and minimal plankton production result in a relatively unproductive aquatic ecosystem (Zook et al. 1982). Walleye recruitment is thought to be largely entrainment from Lake Roosevelt rather within reservoir production, although a thorough investigation of walleye life-history trajectory has not been conducted. Walleye have been and continue to be a focal target species for recreational angling in Lake Rufus Woods. Specific creel census data is lacking for Lake Rufus Woods. Because of its proximity to Lake Roosevelt and common species composition, it is likely that proportional fishery value (percent of total recreational catch) of the walleye fishery in Lake Rufus Woods during the 1980s and 1990s mimicked that observed in Lake Roosevelt, where a large proportion of the recreational catches were comprised of walleye. More recently, rainbow trout associated with the triploid net-penning operation within Lake Rufus Woods has gained in popularity. However, walleye continue to provide a substantial recreational opportunity.

46.10.2 Current Status

Walleye currently occupy habitat within Lake Rufus Woods and support an important recreational fishery. Recruitment is thought to be primarily entrainment from Lake Roosevelt.

46.10.3 Current Management

Walleye are managed to provide a recreational sport fishery. The current population supports an important recreational fishery, although systematic creel census information is lacking, the fishery is well-known throughout Washington state. The walleye fishery in Lake Rufus Woods is managed consistent with WDFW Statewide Rules for walleye.

46.11 Environmental Conditions

46.11.1 Environmental Conditions within the Subbasin

46.11.1.1 Lake Rufus Woods

Lake Rufus Woods is a reservoir created by the construction of Chief Joseph Dam. Since it was historically riverine habitat; it was evaluated by the QHA. In general, fisheries in Lake Rufus Woods are limited by available spawning habitats and reduced flow for most native resident fish. Although habitats still exist for Chinook salmon, they and all other anadromous fishes are limited by a lack of passage at Chief Joseph Dam. Nonnative fish stocks have benefited from inundation and complicate native fish management within Lake Rufus Woods, because of competition, predation, and introgression. Total dissolved gases can have a major influence on fish populations during some years, but effects are stochastic.

Environmental conditions within the Subbasin consists of the impounded portion of the Columbia River between Chief Joseph and Grand Coulee dams (reservoir habitat), several tributaries including the Nespelem River (riverine habitat), and several small lakes such as Owhi Lake (lake habitats). The majority of the aquatic habitat conditions found in Lake Rufus Woods are largely controlled by the operation of Grand Coulee and Chief Joseph dams. Chief Joseph Dam has very little storage capacity and functions as a re-regulating reservoir passing the water released from Grand Coulee Dam either by spilling or power generation. This situation creates highly variable water levels. Grand Coulee Dam operations (power production and spill) contribute to dissolved gas saturation that has been recorded to 138 percent in Lake Rufus Woods (USACE, 2000) and is listed on the 1998 final EPA 303(d) list for the State of Washington.

46.11.1.2 Nespelem River and Other Tributaries

The hydrology of the Nespelem River watershed is generally a product of snowmelt from forested mountains in the headwaters (Harkness et al. 1974). Between 86 and 91 percent of the annual surface water discharge at the mouth of the Nespelem River is from melting snow (Harkness et al. 1974). The historic conditions, with unaltered riparian areas and forested uplands, allowed vegetative ground protection that caused snow to melt off slowly throughout the summer months (Hunner and Jones 1996). This resulted in perennial stream flow and coldwater conditions necessary for native salmonid persistence. Further, sedimentation and embedded substrate were minimal due to channel morphology and hydraulics.

These natural conditions have been altered by activities including logging, road building, grazing, urbanization, water withdrawals, and agriculture. A decrease in canopy closure has reduced the amount of shade allowing more rapid snowmelt, resulting in unusually high spring flows and unusually low late summer flows. Hunner and Jones (1996) also documented a change in the hydrologic regime and reported 44 percent of the currently intermittent tributaries to the Nespelem River were historically perennial. Further, the lack of canopy closure, particularly in the riparian area, has resulted in warmwater conditions that often create metabolic demands that native salmonids cannot maintain with the given food supply. The lack of ground protecting vegetation allows for increased erosion that deposits fine sediments in streams, functionally reducing or eliminating native salmonid spawning habitat by increasing embedded substrate (LeCaire and Peone 1991). Additionally, increased embeddedness reduces invertebrate production, which is the primary food source for native tertiary consumers (fish).

46.11.1.3 Lakes

The lakes throughout this Subbasin are mostly found on the Colville Indian Reservation. Five lakes in the Subbasin have conditions suitable for maintaining subsistence and recreational fisheries and range from eutrophic to meso-oligotrophic (Hunner and Jones 1996). Big Goose, Buffalo, McGinnis, Owhi, and Rebecca lakes are closed basin lakes with little or no connectivity to the fluvial system. Lakes are maintained largely by stocking from the Colville Tribal Hatchery and through some natural production of nonnative warmwater species (Hunner and Jones 1996). Considerable additional information regarding these lakes is contained in the CCT Lakes Compendium (Arterburn 2003).

46.11.2 Out-of-Subbasin Effects and Assumptions

The Lake Rufus Woods Subbasin has been heavily affected by both impoundments on the Columbia River upstream and downstream. Grand Coulee Dam located on the upstream edge of Lake Rufus Woods has changed the hydrograph within the lake and halted the upstream migration of migratory fishes. Chief Joseph Dam, located on the downstream edge of Lake Rufus Woods, has also disconnected migratory fishes from downstream portions of the Columbia River. Large amounts of riparian and tributary habitat were lost with the inundation of Lake Rufus Woods. Nine dams on the mainstem Columbia River are present downstream of Chief Joseph Dam. All downstream dams have potentially detrimental effects on the Lake Rufus Woods Subbasin, when the potential for reintroducing migratory salmon, steelhead, and Pacific lamprey are considered. All other subbasins in the IMP possibly influence the Lake Rufus Woods Subbasin, since it is tied to each by waterways and is positioned on the downstream end of the province.

46.12 Limiting Factors and Conditions

46.12.1 Physical Habitat Alterations/Limiting Habitat Attributes

QHA was utilized to compare historic versus current physical stream conditions with respect to 11 habitat attributes. Details of the analysis method are provided in Section 3. QHA model does not determine which habitat attributes are most biologically limiting, but does identify which physical attributes have undergone the greatest deviation from reference conditions. These results, coupled with knowledge of local biologists and biological status of the focal species, can assist in identifying key limiting factors. This section provides QHA results on a subbasin level for Lake Rufus Woods Subbasin. Results specific to each focal species are discussed in each focal species section.

In the Lake Rufus Woods Subbasin both stream reaches and watersheds were delineated to analyze habitat conditions for brook trout, rainbow trout, and kokanee using the QHA model (Map LWR-7 located at the end of Section 46). Table 46.13 shows the reaches in Lake Rufus Woods Subbasin historically having habitat attributes less with less than optimal in the reference condition. Riparian condition (defined in Section 3) was the most common habitat attribute considered less than optimal in the reference condition.

Table 46.13. Reaches ranked as containing less than optimal habitat conditions in the reference condition.

Sequence	Reach Name	Habitat Attribute < Optimal
1	Chief Joseph Dam	Riparian Condition
2	Lower Rufus Woods Reservoir	Riparian Condition
4	Middle Rufus Woods Reservoir	Riparian Condition
5	Lower Coyote Creek	Riparian Condition, Low Flow, Low and High Temperature, Obstructions
6	Middle Coyote Creek	Habitat Diversity, Low Flow, Low and High Temperature
7	Upper Coyote Creek	High and Low Flow, High Temperature
8	Nespelem Bar	Riparian Condition, Channel Stability
9	Buckley Bar	Riparian Condition, Channel Stability
10	Upper Rufus Woods Reservoir	Riparian Condition
11	Coulee Dam Tailrace	Riparian Condition

Sequence	Reach Name	Habitat Attribute < Optimal
13	Lower Nespelem River	Riparian Condition, Channel Stability, Fine Sediment, High Temperature
14	Little Nespelem Falls	Riparian Condition, High Temperature
15	Little Nespelem Lower Meadow	Fine Sediment, High Temperature
16	Joe Moses Creek	Riparian Condition, Channel Stability, Habitat Diversity, Fine Sediment, Low Flow, Low and High Temperature, Obstructions
17	Little Nespelem Canyon	High Temperature
18	Little Nespelem Upper Meadow	Fine Sediment, Low Flow, Low and High Temperature
20	Owhi Creek	Riparian Condition, Channel Stability, Habitat Diversity, Fine Sediments, Low and High Flow, Low and High Temperature, Pollutants, Obstructions
21	Nespelem Falls	Riparian Condition, Fine Sediment, High Temperature, Obstructions
22	Nespelem River Developed Reach	Fine Sediment, High Temperature
23	Nespelem River Lower Meadow	Fine Sediment
24	Lower Mill Creek	Riparian Condition, Fine Sediment, Low Flow, Low Temperature
25	Armstrong Creek	Riparian Condition, Channel Stability, Habitat Diversity, Fine Sediments, Low Flow, Low and High Temperature
26	Middle Mill Creek	Riparian Condition, Habitat Diversity, Low Flow, Low Temperature
27	Whitelaw Creek	Fine Sediment, Low Flow, Low Temperature
28	Upper Mill Creek	Riparian Condition, Habitat Diversity, Low Flow, Low Temperature
29	Upper Nespelem River (Braids)	Riparian Condition, Channel Stability, Fine Sediment
30	Smith Creek	Fine Sediment, Low and High Flows, Low and High Temperature, Obstructions
31	Pamenter Creek	Fine Sediment, Low and High Flows, Low and High Temperature, Obstructions
32	Lower Northstar Creek	Low Flow, Low Temperature
33	Middle Northstar Creek	Low Flow, Low Temperature
34	Upper Northstar Creek	Low Flow, Low Temperature
35	Lower Stepstone Creek	Low Flow, Low Temperature
36	Middle Stepstone Creek	Low Flow, Low Temperature, Obstructions
37	Upper Stepstone Creek	Low Flow, Low Temperature
38	Nespelem River Headwaters	Low Flow, Low Temperature

The habitat attributes with the greatest deviation from reference conditions vary by species and are presented in Table 46.14. This table indicates the types of habitat attributes problematic for the focal species in the Subbasin as a whole. Some reaches had more than one habitat parameter that was ranked as being equally deviant from the reference, hence the number of reaches listed adds up to more than the total number of reaches ranked. Most reaches had more than one habitat attribute currently ranked less than the reference. Table 46.14 only lists those habitat parameters that had the greatest deviation from reference, not all the parameters that could be less than optimal.

Table 46.14. Habitat conditions with the greatest deviation from reference conditions for each focal species in Lake Rufus Woods Subbasin. Number in parentheses indicates number of reaches analyzed with respect to each focal species and the number of

reaches or watersheds with the particular habitat attribute exhibiting the largest deviation within that area.

Brook Trout (20)	Kokanee (9)	Rainbow (14)
Low Flow (10)	Oxygen (6)	Habitat Diversity (9)
Fine Sediment (7)	High and Low Flows (4)	Obstructions (3)
Habitat Diversity (7)	Obstructions (2)	Riparian Condition (3)
Low Temperature (5)	Channel Stability (1)	Low Flow (2)
Riparian Condition (2)	Low Temperature (1)	Fine Sediment (2)

The Nespelem River along with its northern and western tributaries represent the least degraded habitats in the Lake Rufus Woods Subbasin. The Lower Nespelem River above Nespelem Falls and the Little Nespelem River watershed represent highly degraded areas heavily impacted by development around the town of Nespelem, Washington. Outside of the town of Nespelem cattle grazing and agriculture practices are most likely causes for degraded habitats. Denuded riparian areas, water withdrawals, destabilized banks, and hot summer air temperatures all contribute to fine sediment, flow, and high summer water temperature issues. In the upper part of the watershed, sediment from high road densities and altered flow regimes from logging activities are the main contributors to fish habitat losses, although some intact areas still exist.

46.12.1.1 Lake Rufus Woods

High total dissolved atmospheric gasses in Lake Rufus Woods have caused it to be placed on the Washington 303(d) list. This high gas concentration is potentially a limiting factor to all fish populations in the reservoir. Research conducted by the U.S. Geological Survey (USGS), using gear types designed to sample species and habitats most likely to be affected by gas bubble disease (GBD), indicated that only one fish out of more than 5,000 examined exhibited signs of GBD in 1999, presented in Table 46.15 (Council 2000). However, 1999 was a relatively low water year and gas saturation levels were substantially lower than the previous three years. Therefore, it is unlikely that results based on data collected during 1999 revealed the impacts of gas supersaturation on the fish assemblage. For example, data collected by Chief Joseph Fish Farms and Columbia River Fish Farms suggests that fish in net pens exhibit higher mortalities when total dissolved gas (TDG) levels elevate to levels above 110 percent (USACE draft, in press). It is also worth noting that these increased TDG levels usually correspond with increasing water temperatures (15-24 $^{\circ}$C) making gas less soluble (USACE draft, in press). TDG levels are also affected by discharge at Grand Coulee Dam. Discharge through turbines and over the drum gates produce lower TDG levels than when water is discharged through the spill tubes.

Table 46.15. Prevalence of Gas Bubble Disease (GBD) in Five Common Fish Species Collected by electrofishing and beach seining in Lake Rufus Woods between April-July, 1999. Sucker spp. includes bridgelip, largescale, longnose, and unidentified suckers.

Species	Number Examined	Number With GBD

Rainbow trout	1028	0
Walleye	456	0
Northern pikeminnow	390	0
Redside shiner	688	0
Sucker spp.	2755	1

46.12.1.2 Nespelem River and Tributaries

One of the most important fish populations in the Subbasin, from a native fish recovery standpoint, is the adfluvial kokanee population that spawns in the lower Nespelem River. The habitat conditions existing in the 1.5-mile section of the Nespelem River below the barrier falls appear to be limiting the kokanee spawning production (Council 2000). The major limiting factors include silt deposition that increases embeddedness, elevated summer water temperatures that exceed 24 $^{\circ}$C and non-point source ammonia levels that have resulted in lethal parasitic infection by Columnaris (*Columnaris flexibacter*) (LeCaire 1999; Hunner and Jones 1996). High water temperatures documented during mid- to late summer may also affect juvenile survival (Figure 46.1). The bulk of the kokanee spawning activity takes place in one general area and the balance occurs in pockets behind boulders (Council 2000).

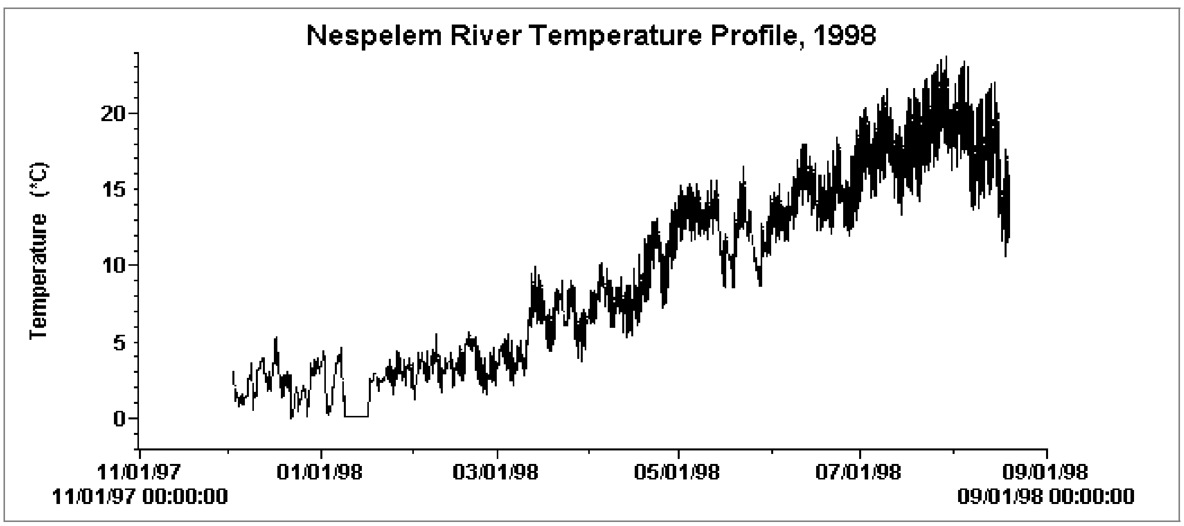


Figure 46.1. Nespelem River Water Temperature Profile

The unknown behavior of the juvenile age classes of native kokanee may be a limiting factor to the total population. If a large percentage of juvenile kokanee entrain through Chief Joseph Dam, then they will not be able to contribute to the next generation in the Nespelem River. Further, the lack of knowledge regarding juvenile behavior may be allowing for managers and dam operators to implement measures that are actually creating negative impacts to the population. Finally, predation from introduced species such as walleye may also be impacting the wild kokanee population. Eastern brook trout spawn mostly in the perennial headwater reaches of the Nespelem River watershed located upstream of Smith Creek, but little is known about the specific contribution of each tributary. Brown trout have developed a self-sustaining population but it is unknown where spawning occurs within the Nespelem River watershed. However, an adfluvial population has existed for many years at low abundance that returns to the lower 1.5 miles of the Nespelem River to spawn. These fish rear in Lake Rufus Woods.

46.12.1.3 Lakes

The lakes in the Subbasin that will support fish populations are managed to enhance subsistence and recreational fisheries. Lake management strategies are based on harvest objectives established using the best available information and knowledge. Annually lakes are monitored and stocking rates are adjusted using adaptive management to maximize recreational and subsistence harvest opportunities. Limiting factors have been assessed (Arterburn 2003). Habitat improvements that can be implemented could result in considerable increases to natural recruitment and result in more efficient use of resources.

Buffalo Lake is a large coldwater lake located in Okanogan County at T30N, R31E, Sections 26, 27, 34, and 35 in the Nespelem River drainage within the Lake Rufus Woods Subbasin. Several intermittent and one unnamed perennial streams that feed the lake are located along the northern and eastern shorelines along with several submerged springs. Elders in the area have mentioned that rainbow trout historically spawned in the “no name” perennial creek at the lake’s eastern shore. However, heavy grazing and upland timber harvest has devastated this drainage that has down-cut over 30 feet in some places. Buffalo is the only lake on the Colville Reservation that contains kokanee salmon while providing fishing opportunities for rainbow trout, largemouth bass, and pumpkinseed sunfish. Anglers introduced largemouth bass in the 1970s from nearby Rebecca Lake; this population is naturally reproducing in Buffalo Lake. All fish species are naturally reproducing in Buffalo Lake with the exception of rainbow trout that are stocked annually. All game fish species exhibit good condition, abundance, and growth characteristics, with the exception of the eastern brook trout, which has declined precipitously in recent years. Therefore, managers have discontinued hatchery plants since 2002. The data suggest that the decline of eastern brook trout has also resulted in an increase in largemouth bass abundance in recent years. Rainbow trout and kokanee salmon have and continue to make up the majority of the game fish catch at Buffalo Lake. Although some limited natural recruitment of kokanee salmon occurs, the stream that enters this lake’s southeast bay has insufficient flow to provide natural recruitment. No spawning activity takes place at this location because suitable substrate and depth are lacking due to poor upland land use practices (Arterburn 2003). It appears that kokanee salmon utilize abundant springs for shoreline spawning along the northeastern shore.

Owhi Lake is a medium-sized coldwater lake located in Okanogan County at T32, 31N, R31E, Section 27,34,3 in the Nespelem River drainage of the Lake Rufus Woods Subbasin. This lake was originally developed as an irrigation reservoir but today is managed as a recreational and substance fishery for Colville Tribal members. Owhi Lake is the brood source for all brook trout eggs used by the Colville Tribal Hatchery. It historically produced up to 10 million eggs commercially sold by the CCT before the 1947 cooperative agreement with the Washington Department of Game was signed. The intermittent inflow along the northeastern portion is through Owhi Creek. Several springs and a perennial unnamed tributary that flows from Little Owhi Lake enter the north end of Owhi Lake and provide excellent shoreline spawning habitat for brook trout. The outlet is through the Little Nespelem River. Supplemental stocking has occurred since the 1930s, but most of the fish are thought to be produced through natural reproduction. This will be verified over the next several years. Starting in 2002 all fish stocked will be differentially marked. Stocking records are unknown until 1951 but WDG did stock Owhi Lake prior to this date and anecdotal information suggests that this lake was originally stocked with brook trout in the late 1890s. Owhi Lake is the most popular Tribal member-only lake on the reservation and has a reputation for producing large brook trout. This fishery is most productive in the winter, early spring, and late fall because summer water temperatures force fish to be suspended off-shore (Arterburn 2003).

McGinnis Lake is a medium-sized coldwater lake located in Okanogan County at T29N, R31E, Sections 2,3,10A, 10B within the Upper Columbia Subbasin. The inflow is along the northeastern corner of the lake via an intermittent unnamed tributary. There is no outlet to the lake. Terrain surrounding the lake is rolling hills covered in sage and bunch grasses with basalt outcroppings and a few stands of aspen and yellow pine. Prior to 1953, the trout fishing at this lake was good, but by the mid-1950s fish production had been reduced and the WDG determined the lake was in need of rehabilitation. The rehabilitation efforts started in 1953 and were repeated in 1958 using 5 percent rotenone applied at 1-ppm by weight, but these efforts were ineffective for reducing the population of pumpkinseed sunfish. The CCT used toxaphene in 1965 and no pumpkinseed sunfish have been observed since. Today, McGinnis Lake is the only place on the Colville Reservation that non-Tribal members can fish exclusively for brook trout. Consequently, it is often a destination for local anglers targeting this species. Since population abundance, growth, and condition have been stable, the CCT plan no changes to current management strategies.

Big Goose Lake has marginal habitat specification for a warmwater lake. The main habitat constraint is dissolved oxygen. A recently installed windmill that circulates water should be able provide the slight increase in dissolved oxygen needed to prevent most fish kills. The lake is extremely shallow, so water is critical to the success of any fishery at this lake. No water withdrawals should occur from this lake, as ample water is available from other sources in this area. Fish stocked in 1949 and 1950 came from Pearrygin Lake located near the town of Winthrop. The 1974 stocking was from fish collected at Fish Lake in Pine Creek, 1981 stockings were from Bourgeau Lake on the Colville Reservation. In 2002, this lake was stocked with fish salvaged from Rebecca Lake when the lake level was lowered. After bass were stocked in 1974 and in 2002, game wardens reported that anglers were fishing and catching bass later that same year. However, a complete winter kill occurred in 1979. The lake was restocked in 1981 and plans to install an aeration system began. A partial winter kill in 1984 prompted the Colville Business Council to close Big Goose Lake in 1985 so that the population could be restocked and have time to be re-established. No records of stocking during this time are available. This lake supported medium-to-heavy fishing effort after an aerator system was installed in 1987. Many large fish were taken and fish appeared to have been reproducing naturally. However, the aeration system was not maintained and during low water years the lake died out. A new aeration system was installed in 2002, with hopes of recreating a quality largemouth bass fishery. Goose Lake has always been managed as a largemouth bass fishery and is one of only three lakes actively managed for largemouth bass on the entire Colville Reservation. Windmills were installed in 2002 and fish were restocked. Pumpkinseed sunfish were also stocked in 2002 to enhance the prey base. Natural recruitment and good survival from fish stocked in 2002 were observed in spring 2003 (Arterburn 2003).

Rebecca Lake is a small cool-water lake located in Okanogan County at T30N, R31E, Section-32 within the Lake Rufus Woods Subbasin. This lake was created when a small board dam was placed at the outlet of a permanent wetland raising the water level 4 feet. Prior to the dam installation, this lake was better suited to waterfowl habitat. Rebecca Lake has been a successful warmwater fishery for several years displaying a population structure of a traditional panfish option fishery. Small largemouth bass at high densities produce moderate numbers of large pumpkinseed sunfish. No population data has been collected but angler comments support this conclusion. In 2002, fish from this lake were electroshocked and transported to Big Goose Lake to start a new warmwater fishery. Legal issues may require the removal of the dam at Rebecca Lake and it is unclear if this lake will ever be refilled.

46.12.2 Description of Historic Factors Leading to Decline of Focal Species

The native fish assemblage within the boundaries of the Lake Rufus Woods Subbasin was supported by pristine habitat conditions and consisted of both resident and anadromous fish species. Anadromous fish transported marine nutrients into the Subbasin and were keystone species to the ecosystem (Willson and Halupka 1995; Mills et al. 1993; Cederholm et al. 1989; Kline et al. 1990). Construction of Chief Joseph Dam in 1958 blocked the upstream migration of adult salmon. Anadromous fish were extirpated from Lake Rufus Woods. The transformation of habitat conditions in the reservoir allowed for introduced nonnative species to establish self-sustaining populations within Lake Rufus Woods. This resulted in a shift in the fish community to nonnative species (Scholz et al. 1985). Therefore, discussions regarding native fish and/or native ecosystem recovery efforts must consider anadromous fish, as they are a significant part of the native ecosystem.