Chapter 5. Fish Habitat Assessment

This chapter summarizes available information on the fish populations, stock status, and habitat conditions in WRIA 31. The information available regarding fish populations and habitat conditions in the WRIA is sparse.

The goals of this document are to provide:

- An overview of fish populations in WRIA 31;
- A review of any published WRIA 31 habitat studies; and
- An examination of the characteristic fish use of each of the streams where data are available.

WRIA 31 contains stocks of fall up river bright (URB) chinook, coho, summer steelhead, resident rainbow trout, and other native and introduced fish species.

5.1 Background

WRIA 31 includes several tributaries to the Columbia River. The largest tributaries are (from west to east) Rock Creek, Chapman Creek, Wood Gulch Creek, Pine Creek, Alder Creek, Dead Canyon Creek, and Glade Creek.

WRIA 31 is underlain by Columbia River Basalts interbedded with sedimentary deposits (Section 2.3). In many areas, the bedrock is overlain by gravel sand, and silt deposited by glaciers or rivers. The eastern portion of the WRIA also has extensive wind blown sand and silt deposits (loess; Section 2.3). These deposits are fine grained and highly erodable. Most of the creeks originate on high plateaus and then run down long canyons before reaching the Columbia River.

Precipitation in the WRIA ranges on average from 8.2 to 16.2 inches per year (Section 2.5), decreasing from west to east. Most of the precipitation falls between October and May. Average maximum air temperature in Kennewick exceeds 90 degrees Fahrenheit in July and often reaches temperatures in excess of 100 degrees Fahrenheit. These precipitation and air temperature patterns have important influences on fish habitat.

Due to the low quantity of summer precipitation, natural stream flow is largely driven by groundwater inputs. Many of the streams in the area go dry or near dry in summer. The streams with negligible summer flow may have perennial pools fed by groundwater inputs that support fish. Summer flows in streams in the eastern portion of the WRIA may be influenced by runoff of irrigation water diverted from the Columbia River.

Water temperatures in most of the WRIA streams are higher than the Washington State criterion of 63.5 degrees Fahrenheit for streams containing salmon and trout. These temperatures are influenced by warm air temperatures and lack of flow. In some areas, water temperatures in pools may be cooled by groundwater inputs or subsurface flow.

The precipitation patterns also affect the type and condition of riparian vegetation along streams. Ponderosa Pine is found at higher elevations in many of the basins in the western portion of the WRIA. At lower elevations, riparian vegetation may include alder, black cottonwood, willow, Oregon white oak, and other shrubby vegetation. Black walnut, an introduced species, is also common.

5.2 Methods

This report is based on existing information contained in published reports supplemented by information provided by local residents and area biologists. Where possible, the text relies on actual published data. The published information was supplemented by a site reconnaissance survey and an interpretation of the information collected during surveys conducted by the General Land Office in the mid-1800s. Methods used are described below.

5.2.1 Existing Literature

The fish distribution maps (Figure 5-1) were obtained from the Streamnet database (www.streamnet.org). The Streamnet database draws its information on distribution largely from Washington Department of Fisheries, et al. (1993) but is updated with additional information. The database does not cite sources of information regarding distribution of fish. Natural fish passage barriers were identified through the review of literature, through direct observation, and through discussions with local residents.

Habitat condition data (published or otherwise publicly available) are virtually non-existent for this WRIA. Additionally, there has been no assessment of the effects of land management on fisheries habitat in the WRIA. The Washington State Conservation Commission Salmonid Habitat Limiting Factors, Final Report; WRIA 31 (Lautz 2000) provides some general descriptions of habitat conditions for some of the basins but provides little data and few citations to published information. This is largely due to the general lack of information regarding fish habitat in the area. The document draws largely on professional opinion of local biologists. These comments also extend to the Draft Klickitat Subbasin Summary (Berg et al. 2001), again due to the lack of available information.

5.2.2 Reconnaissance Survey

In order to supplement the available information, a reconnaissance survey was conducted of the Rock Creek, Chapman Creek, and Wood Gulch basins. Local residents assisted with this survey, providing access and accompanying the authors. Most of these basins are privately owned and the assistance of the local residents was invaluable. No specific data were collected during this reconnaissance survey; however, the survey did provide an opportunity to evaluate general conditions and watershed processes in the basins as well as an understanding of the history and management of the basins.

Table 5-1. Summary of Applicable Fisheries Reports

Author, Year	Title	Content Review
Bureau of Land Management (BLM). 1985.	Field exam of Rock Creek, Klickitat County. Memorandum to Wenatchee Area Manager. November 4, 1985.	Summary of fish survey data in Rock Creek
Bureau of Land Management (BLM). 1986.	Summary of Rock Creek Stream Survey, May 20, 1986 by Art Oakley, State Office Fishery Biologist	Summary of fish survey data in Rock Creek
Novotny, Jerry F., Thomas L. Macy, and James T. Gardenier, William R. Nelson, Curtis L. Burley. 1985a.	Pen Rearing And Imprinting Of Fall Chinook Salmon Annual Report 1984, Report to Bonneville Power Administration, Contract No. 1983BP13084, Project No. 198331300,	Report on net pen rearing experiment conducted at the mouth of Rock Creek.
Novotny, Jerry, Thomas L. Macy, James T. Gardenier - U.S. Fish and Wildlife Service. 1985b.	Pen Rearing and Imprinting of Fall Chinook Salmon, Final Report 1985b, Report to Bonneville Power Administration, Contract No. 1984BP13084, Project No. 198331300, 72 electronic pages (BPA Report DOE/BP-13084-2).	Report on net pen rearing experiment conducted at the mouth of Rock Creek.
Novotny, Jerry F, Thomas L. Macy, James T. Gardenier, and John W. Beeman. 1986.	Pen Rearing and Imprinting of Fall Chinook Salmon, 1986. Annual Report, 1986, Report to Bonneville Power Administration, Contract No. 1983BP13084, Project No. 198331300, 87 electronic pages (BPA Report DOE/BP-13084-3)	Report on net pen rearing experiment conducted at the mouth of Rock Creek.
Washington Department of Fisheries, Washington Department of Wildlife, Western Washington Treaty Indian Tribes. 1993.	1992 Washington State Salmon and Steelhead Stock Inventory. Washington Department of Fish and Wildlife. Olympia, WA.	Summary of information regarding the distribution and status of species in the WRIA
Beeman, John W. and Novotny, Jerry F. 1990.	Pen Rearing and Imprinting of Fall Chinook Salmon, Annual Report 1989 to Bonneville Power Administration, Portland, OR, Contract 83-AI-13084	Report on net pen rearing experiment conducted at the mouth of Rock Creek.
Paul Wagner. 2000.	Fish Survey of Dead Canyon Creek, completion report (note: *report not actually attained yet, will arrive in a few days; information currently cited as personal communication. This chapter will be updated when the report arrives.*)	Summary of electrofishing and snorkeling data collected in Dead Canyon Creek.
Berg, L, T. Bachman, W. Conley, F. Dobler, J. Matthews, and B. Sharp. 2001.	Draft Rock Creek Subbasin Summary. Prepared for the Northwest Power Planning Council.	Summary of available information plus descriptions of habitat and land use effects (little basin specific information cited).

Author, Year	Title	Content Review
Lautz, Kevin. 2000.	Salmon and steelhead habitat limiting factors, Water Resource Inventory Area 31. Washington State Conservation Commission.	Summary of available information plus descriptions of habitat and land use effects (little basin specific information cited).
Northwest Power and Conservation Council. 2004.	Lower Middle Mainstem Including Rock Creek Subbasin Plan. Draft.	Summary of available information plus discussion of presumed land use effects.

5.2.3 Review of Historical Records

In the mid-1800s, the General Land Office (GLO) contracted the survey of all townships, ranges, and sections in much of the western United States, including WRIA 31. The surveys were done in two parts. The boundaries of the townships were surveyed first. The interior section lines of the township were surveyed if the information collected by the boundary surveyors indicated there was value in conducting the interior surveys. All townships in WRIA 31 had both the township boundaries and the section lines surveyed.

The primary purpose of the surveys was to mark township and section lines on the landscape; hence the majority of the survey notes are focused on survey details. The surveyors also took detailed notes on available water, vegetation, and soils to help assess the potential for settlement of the surveyed areas. These notes included details on vegetation, location, size, and depth of streams, presence of dry channels, locations of ravines, locations of any existing homes, fields, and fences, and general information on the soil characteristics. Soil was rated as 1st, 2nd, or 3rd rate (no description of these terms has been found) and additional notes were made regarding the soil characteristics from time to time (e.g. soils are rocky). Since the surveys followed section lines, notes on streams are limited to locations where the channels cross those section lines. As a result, information on streams is scattered across a grid and is not continuous.

All measurements except stream depth were taken in units of chains or links. For the purposes of this document, those measurements were converted to inches and feet. One link = 7.92 inches and 1 chain = 100 links or 66 feet.

The quality of the notes varied between surveyors; however all of the survey notes reviewed for WRIA 31 were completed by Edwin Richardson, A. H. Simmons, or Edward Giddings. Each of these men took very detailed notes. No description of the methods used was found; hence, some interpretation of the notes was necessary. In particular, there is some uncertainty whether stream widths were wetted widths or channel widths and whether “ravines” had water in them.

The surveyors frequently noted stream widths of channels that they indicated were dry. Both also regularly noted even minor water in channels. Therefore, it is inferred that the reported widths are channel widths. The presence or absence of water, however, is sometimes more difficult to interpret. Where the channel was specifically described as dry or containing water, the interpretation is simple; but, in many instances, a channel

width was given with no description of the presence or absence of water. In these cases, no inferences were made regarding presence or absence.

Interpretation of the term "ravine" was also problematic. Both surveyors noted numerous ravines and typically gave their depths. In many locations, the presence of a wetted or dry channel was noted. Channels were described primarily in the lower portions of each basin. In the upper basins, ravines were often described but no channel was mentioned. It is unclear whether these ravines had channels in them. Since these ravines with no mention of a channel were typically found upstream of dry channels and the surveyors tended to be very complete in their description of water, we have assumed that they were also dry. This, however, cannot be confirmed or denied.

The survey notes are available on microfiche at the University of Washington. The notes for most of Rock Creek and the lower portions of the other major streams were gathered and reviewed. Specific locations, surveyors, and survey dates of the reviewed notes are detailed in Table 5-2. Most of Rock Creek and the upper portions of Wood Gulch were surveyed in late summer or early fall. These surveys represent conditions in the dry season. Lower Chapman Creek was surveyed in April and all other areas reviewed were surveyed in June. These spring and early summer surveys represent conditions during wetter periods of the year.

The amount of rainfall in the years that the surveys were conducted is unknown. No monitoring of climate was done in the area in 1867 and 1868. Garfin and Hughes (1996) have reconstructed a drought index for the period extending from 1840 through 2003 using tree ring analysis. The drought index is designed such that a value of 0.0 indicates an average year. The estimated drought indices for the years 1867 and 1868 were 0.912 and 2.009 respectively. Sixty-six (66) percent of the years between 1840 and 2003 were estimated to be drier than 1867 and 81 percent of those years were estimated to be drier than 1868. Hence, 1867 was just a little wetter than average and 1868 was a rather wet year. Based on this analysis, lower Chapman Creek, upper Wood Gulch, and the eastern portion of Rock Creek, including Squaw Creek, were all surveyed on unusually wet years. The rest of the townships were surveyed in years that were slightly wetter than average. Drought years are not represented in the notes.

Table 5-2. Locations, Primary Surveyor, and Survey Dates of General Land Office (GLO) Notes Reviewed

Township and Range	Location Description	Township Boundary or Section Lines	Surveyor	Date(s)
T3 R19	Lower Rock Creek to the pipeline crossing and portions of Chapman Creek	Section lines	Edwin Richardson (Richardson 1867)	November 19, 1867
		North and west boundaries	A. H. Simmons (Simmons 1867a)	September 7, 1867
T3 R20	Lower Chapman Creek to one mile east of Beeks Road and lower Old Lady Canyon to ½ mile north of the old 8 Road	Section lines	Edwin Richardson (Richardson 1868)	April 2, 1868
		North and west boundaries	Edward Giddings (Giddings 1867)	June 25, 1867
T3 R21	Lower 2+ miles of Wood Gulch	Section lines	Edward Giddings (Giddings 1867)	June 19-24, 1867
		West and north boundaries	Edward Giddings (Giddings 1867)	June 21-24, 1867
T4 R18	Rock Creek from 1 miles upstream of confluence with Squaw Creek to 1.5 miles downstream of confluence with Quartz Creek, and Luna Gulch to Oak Flat Road	Section lines	A.H. Simmons (Simmons 1867b)	September 24 – October 7, 1867
		North and west boundary	A. H. Simmons (Simmons 1867a)	November 14, 1867
T4 R19	Rock Creek from pipeline northwest roughly 2 river miles, the lower 2 miles of Squaw Creek, and portions of Squaw Creek and White Creek downhill from Newell Road. Upper Chapman Creek.	Section lines	Edwin Richardson (Richardson 1869)	September 29-October 2, 1868
		North and west boundaries	A.H. Simmons (Simmons 1867a)	September 6-7, 1867
T4 R20	Wood Gulch just upstream of the confluence with Big Horn Canyon	Section lines	Edwin Richardson (Richardson, 1869)	August 14-25, 1868
		West boundary	Edward Giddings (Giddings 1867)	June 24, 1867
T4 R21	Upper Pine Creek and portions of Wood Gulch	West and north boundaries	Edward Giddings (Giddings 1867)	June 21-24, 1867
T4 R22	Six Prong Creek	Section lines	Edward Giddings (Giddings 1867)	June13-17, 1867

Township and Range	Location Description	Township Boundary or Section Lines	Surveyor	Date(s)
	upstream from Peterson Road, lower 2 miles of Pine Creek	West boundary	Edward Giddings (Giddings 1867)	June 12, 1867
T4 R23	Lower Alder Creek to Peterson Road	Section lines	Edward Giddings (Giddings 1867)	June 6-11, 1867
		East and west boundaries	Edward Giddings (Giddings 1867)	June 4, 1867

5.3 Hatchery Operations

Currently, fish populations in WRIA 31 are not supplemented with hatchery fish. Supplementation has apparently been limited to an experimental program conducted in 1984 through 1986. Juvenile upriver bright fall chinook from the Spring Creek National Fish Hatchery were reared for one to two months in net pens at the mouth of Rock Creek (Novotny et al. 1985a; Novotny et al. 1985b; Novotny et al. 1986; Beeman, et al. 1990). Fish were tagged prior to release and returns of fish in ocean fisheries, in the Columbia River, and at the release site were documented in subsequent years. Overall, returns were low from these releases (Table 5-3).

Table 5-3. Tagged Fish Returns, 1984-1986

Year of Release	Number Released (not all were marked)	Number of Tagged Returns/4	Adjusted Total Returns (%)/4
1984	56,748/1	424	0.973
1985	232,962/2	1570	0.910
1986	620,204/3	N/A/5	

1/ Novotny et al. 1985a
2/ Novotny et al. 1985b
3/ Novotny et al. 1986
4/ Beeman et al. 1990
5/ At the time of the final report, only a few preliminary returns were reported.

5.4 Fish Distribution, Stock Status, and Population Trends

Three species of anadromous salmon, fall chinook (*Onchorynchus tschawytscha*), coho *(Onchorynchus kisutch)*, and summer steelhead (*Onchorynchus mykiss*), are found in WRIA 31. Summer steelhead has been identified as indigenous to the subbasin. The remaining anadromous use is believed to be a result of straying of other mid-Columbia stocks, or is incidental use associated with upriver migration of adults or downriver migration of juveniles (Berg et al. 2001). Pacific lamprey (*Entosphenus tridentatus*), suckers (*Catostomus spp)*, dace (*Rhinicchthys spp*), and other non-game fish species have also been observed in the basin (Berg et al. 2001; Paul Wagner, personal communication, July 21, 2004; Carl Dugger, personal communication July 2004).

5.4.1 Data Sources

Data sources regarding fish distribution in WRIA 31 are sparse. Data regarding stock status and/or population trends are non-existent. Fish species reported in the WRIA are based primarily on observations of local residents and fish biologists working in the area. The lower two miles of Dead Canyon Creek were surveyed using electroshocking and snorkeling methods in 2000 or 2001 in support of an Environmental Assessment (Paul Wagner, KWA, Inc., personal communication, July 20, 2004). Dace, 3-spine sticklebacks, and sculpin were found in that survey. Surveys were also done in upper Rock Creek (BLM 1985, 1986). Some limited redd surveys have reportedly been completed by the Yakama Nation in Rock Creek in 2002, 2003, and 2004. These surveys were done with single passes in each reach. Only the lower 3 miles of the mainstem were surveyed in all years (Northwest Power and Conservation Council 2004). Details of survey methods, survey locations, and survey results are not available. WDFW intends to conduct spawner surveys and electroshocking surveys in Glade and Alder Creeks, and possibly some other tributaries in the WRIA (Paul Hoffarth, personal communication, July 20, 2004). This work will most likely be conducted in 2005.

5.4.2 Steelhead

Distribution

The stock of summer steelhead present in WRIA 31 is considered part of the Mid-Columbia Evolutionarily Significant Unit (ESU) for steelhead, which has been listed as "threatened" under the Endangered Species Act (NMFS 1996). Summer steelhead are known to occur in Rock Creek up to a point 1/4 mile above the confluence with Quartz Creek (BLM 1985; BLM 1986); additional utilization may occur above this point. Steelhead have also been found in lower Quartz Creek (BLM 1985; BLM 1986) and are reportedly found in Squaw Creek up to the confluence with Harrison Creek (http://www.ecy.wa.gov/services/gis/maps/wria/sasi/sasipdf.htm). The source for the information regarding Squaw Creek is unknown.

The summer steelhead in Rock Creek are considered indigenous. The population is sustained through natural reproduction and there is no record of stocking in this basin.

The Yakama Nation conducted sporadic spawner surveys in 2002, 2003, and 2004. They indicated that the greatest density of spawners was observed in the lower five miles of Rock Creek, where 34 to 45 redds per mile were observed (Northwest Power and Conservation Council 2004). The surveys were not conducted across all potential habitat and were not repeated over the season in all areas, hence the reported number of redds is likely underestimated. The 1992 SASSI report (Washington Department of Fisheries et al. 1993) indicated that the status of the Rock Creek population is unknown.

In addition to Rock Creek, steelhead have also been mapped in the lower reach (approximately 0.3 miles) of Chapman Creek (http://www.streamnet.org) and Wood Gulch Creek (http://www.streamnet.org; Carl Dugger, personal Communication, July 2004) (Figure 5-1). Carl Dugger (WDFW) reported seeing juvenile of steelhead or rainbow trout in the lower Chapman Creek (Lautz 2000). Steelhead have erroneously been reported in Glade Creek as well, but these fish were apparently resident rainbows (Brett Barkdull, personal communication, July 22, 2002). Dead Canyon was surveyed for

fish and no salmonids were found (Paul Hoffarth, personal communication, July 20, 2004). Any steelhead in Chapman Creek, Wood Gulch Creek, and/or other streams are likely strays from other populations or fish making temporary use of the lower reaches during upstream migration (Berg et al. 2001).

Life History

Adults enter the Columbia from May to November and hold in the Columbia until fall and winter rains allow them to enter subbasin streams. The adults will hold in Rock Creek and its tributaries until they spawn in February through April (Berg et al. 2001; Figure 5-2).

Little watershed-specific information is available on juvenile life histories. Life stage timing can be inferred from those of nearby stocks. Fry are believed to emerge from April through mid-June, and will rear for up to two years (Berg et al. 2001). Smoltification and out-migration occur in April and May, peaking in early May.

In general, spawning may occur in any accessible area where suitable flow and substrate material are found. Rearing may be similarly widespread during portions of the year, but is largely restricted to pools fed by springs or groundwater upwelling areas in the mainstem and to the limited number of tributaries with flowing water during the summer and early fall. Known utilization includes the lower and middle portions of Rock Creek, lower Quartz Creek and Squaw Creek (Berg et al. 2001). Most Middle Columbia River steelhead spend 2 years in freshwater before migrating to the ocean (National Marine Fisheries Service 2003).

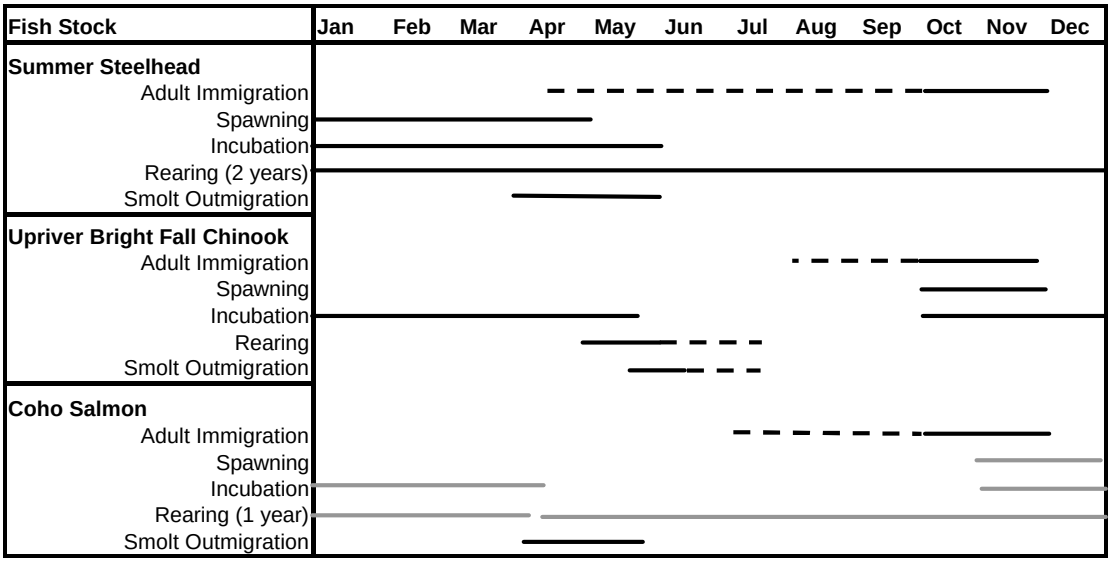

Figure 5-2. Depiction of the Timing of Key Life History Phases of Anadromous Fish Species Found in WRIA 31 (adapted from Berg et al. 2001; Lautz 2000). Solid black lines indicate life history stages found in WRIA 31. Dashed black lines indicate life history stages that may be found in Columbia River backwaters near the mouth of creeks, but are not likely occurring further upstream. Solid gray line indicates life stages that are not known to occur in the basin.

5.4.2 Chinook Salmon

Distribution

Fall chinook have been mapped by WDFW in Rock Creek up to the confluence with Luna Gulch (http://www.ecy.wa.gov/services/gis/maps/wria/number/wria31.htm). The source of this information is unknown. A map in the Middle Mainstem Subbasin Plan indicates that chinook have been observed in Rock Creek in the lower 3 miles only (Northwest Power and Conservation Council 2004). Fall chinook have also been mapped in the lower 0.3 miles of Chapman Creek (http://www.ecy.wa.gov/services/gis/maps/wria/number/wria31.htm). The source of this information is also unknown. Fall chinook found in this subbasin are believed to be stray upriver brights belonging to either the wild Hanford Reach stock or the Bonneville Pool Hatchery stock.

Life History

No specific life history information exists for fall chinook in WRIA 31. Life history information can be inferred from that of the Columbia River upriver bright (Hanford Reach) stock (WDFW 1990).

Upriver bright chinook adults begin entering the Columbia in August. Movement into Rock Creek for spawning may not occur until October or November when there are sufficient flows. Fry emerge from mid-March through Mid-May, and may utilize stream habitat through early- to mid-spring, but probably move out to Lake Umatilla before flows diminish and temperatures increase in June or July. Emigrating smolts occupy near-shore habitat in Lake Umatilla in late July and August (Lautz 2000).

5.4.3 Coho Salmon

Distribution

Coho have been mapped by WDFW in the lower 0.3 miles of Chapman Creek (http://www.ecy.wa.gov/services/gis/maps/wria/number/wria31.htm). The source of this information is unknown. A map in the Middle Mainstem Subbasin Plan also indicates that coho have been observed in the lower 3 miles of Rock Creek. The source of this information is also unknown. Juvenile coho were observed just upstream of the mouth in June 2004 by the authors of this report. This was a casual observation and not the result of a systematic survey. Coho found in this subbasin are believed to be stray fish from populations in other WRIAs (Berg et al. 2001).

Life History

No specific life history information exists for coho that utilize subbasin streams; the information below is inferred from that of Columbia River hatchery stocks (Lautz 2000).

Adults begin entering the Columbia in July and migrate past Bonneville Dam from July through November, with a peak in September. Adults will remain in the mainstem until there are sufficient flows brought about by fall rains, generally, in October or November. Spawning occurs shortly after stream entry, and continues until mid-December. Fry emerge in March and early April, and will rear in available stream habitat through the

following winter. The young fish smolt and emigrate out of the system likely in April through mid-May.

5.4.4 Resident Fish Populations

Resident rainbow trout have been found in many of the streams in the subbasin. Resident rainbow have been observed in the lower 2 miles of Glade Creek (Brett Barkdull, personal communication, 7/22/2004). These fish were observed in March and April of 1989 and 1990. Observed fish were 8 to 23 inches in length. The females were gravid (ready to spawn) at this time. These fish may have been rainbows that reared in the Columbia River and were returning to Glade Creek to spawn. Trout have also been reported in the Rock Creek basin, including the mainstem Rock Creek, Quartz Creek, Squaw Creek and Box Canyon. Other streams may have resident fish, but have not been surveyed at this point. Surveys conducted in the lower 2 miles of Dead Canyon Creek did not locate any rainbow trout.

Suckers, most likely bridge-lip suckers (*Catostomus macrocheilus*) and large-scale suckers (*C. columbianus*), were exploited by tribal members in Rock Creek. These fish are highly valued by Indians (Hunn 1990). These fish were caught in Rock Creek using traps set near the mouth of the creek or snagging with large treble hooks (Hunn 1990; R. Imrie personal communication). Both species are widespread in the Columbia River system and are found in slower moving portions of rivers, streams, and lakes (Dauble 1980; Wydowski, R.S. and R.R. Whitney. 1979). They move into the lower gradient sections of streams to spawn in late February and March (Hunn 1990). Preferred spawning areas are slow moving with sandy or muddy substrates (Wydowski, R.S. and R.R. Whitney. 1979)

Dace, 3-spine stickleback, and sculpins were found in Dead Canyon Creek during electrofishing and snorkeling surveys (Paul Wagner, personal communication, 7/20/2004). Other streams in the subbasin may also support these species.

Other species that may occur in the streams in the WRIA include crayfish, lamprey, and fresh water mussels as well as other warm water fish species. In the lower reaches of the streams that lie within the backwater of the Columbia River, a wide variety of fish species may be found. These include northern pikeminnow, smallmouth bass, walleye, carp, crappie, shad, catfish, sculpin, and other species inhabiting the Columbia River.

5.5 Habitat Conditions

5.5.1 Passage Barriers

There is little information available for the WRIA regarding passage barriers. Barriers can take the form of either natural or manmade features. Known barriers include the following:

Rock Creek. There is an impassable falls near the mouth of Wildcat Creek (Roscoe Imrie, personal communication, June 2004). Squaw Creek has a culvert that is not passable near the confluence with Spring Creek (Roscoe Imrie, personal communication, June 2004).

Chapman Creek. A bedrock chute is present at roughly RM 0.3. The chute is roughly 10 feet high and 20 feet long. There are no pools or resting locations partially up the chute and no substantial pools at the foot of the chute. At low flows, this chute is not passable. The potential for passage at higher flows is uncertain and has not been assessed.

Pine Creek. The culverts under Highway 14 are not functioning properly and flow from the stream moves through the road fill. This presents a barrier to upstream movement of fish. Pine Creek also has a natural waterfall, located roughly ½ to ¾ miles upstream of the lower East Road Bridge, which blocks upstream passage of fish (Jim Wright, personal communication, June 2004).

5.5.2 Rock Creek

There are no published data depicting habitat conditions in Rock Creek. The Draft Rock Creek Subbasin Summary (Berg et al. 2001) and the Limiting Factors Analysis (Lautz 2000) are based largely on the personal observations of local area biologists. The authors of this report completed a reconnaissance survey of the area in late June 2004. No data were collected in this survey, but it provided an opportunity for the authors to become familiar with the area. Local residents helped with this reconnaissance effort and provided useful insight into trends and conditions in the subbasin.

Lower Rock Creek Downstream of the Bickleton Bridge

Historical Conditions

Lower Rock Creek to the pipeline (T3 R19) was surveyed by the General Land Office (GLO) in November of 1867, the eastern portion of Rock Creek upstream of the pipeline (T4 R19) was surveyed in September of 1868, and the western portion of Rock Creek upstream of the pipeline (T4 R18) was surveyed in September of 1867. Portions upstream of these townships were surveyed but were not reviewed in this effort.

The surveys conducted in lower Rock Creek were conducted in November of an unusually wet year. Surveys in the western portion of the basin were conducted in late August and early September of an unusually wet year, and the surveys in the eastern portion of the basin were conducted in late summer of an average year. Therefore, conditions represented by the GLO surveys would tend to reflect average to wet conditions.

At the time the surveys were completed, there was only one settler in the basin. This settlement was located on the east bank of the creek, about ½ mile downstream of the current location of the Chamberlain-Goodnoe Bridge.

Specific information provided in the GLO notes includes the following:

Rock Creek from the mouth to the Chamberlain-Goodnoe Bridge (November 1867). The stretch of stream extending from a point roughly where the Rock Creek Park is currently located upstream to the Chamberlain-Goodnoe Road Bridge was surveyed at four points where section lines crossed the stream. These points were timbered with

cottonwood, oak, alder, balm[1], aspen, and willow. The bottom was wide in this area (627-990 feet wide). The channel itself was 26 to 33 feet wide. The only description of the presence or absence of water was at a location approximately 1 mile downstream of the bridge. Here, the notes indicated that the stream "*runs slowly*". No adjacent channels were mentioned. The notes indicate that, in summer and fall months when flows are low, the stream sinks into the sandy bottom about 1,320 feet downstream of the current location of the Rock Creek Park. At the mouth of the creek, the notes also indicate that there was a series of rocky bars present over which the creek flowed at high water.

Rock Creek from the Chamberlain-Goodnoe Bridge to Squaw Creek (September 1868). Between the Chamberlain-Goodnoe Bridge and the confluence with Squaw Creek, four points were surveyed, not counting the one at the bridge. At the point 1 mile upstream of the bridge, "some willow" was present. At the second survey point, the vegetation was cottonwood and willow. Another ½ mile upstream, cottonwood was present, and at the confluence with Squaw Creek, vegetation consisted of cottonwood, oak, alder, and willow. The channel width ranged from 23 to 40 feet wide. The widest point was located one-mile upstream of the bridge and the narrowest point was at the confluence with Squaw Creek. The width of the bottom ranged from 726 to 1,287 feet. The bottom was widest at the confluence with Squaw Creek. Water depth at the confluence of Squaw Creek was 18 inches deep. At a point roughly a mile downstream of Squaw Creek, a beaver dam was present and the water was 3 feet deep behind the dam. No information regarding the presence or absence of water was provided at the site between the beaver dam and Squaw Creek or at the lowest site. One 150-foot deep ravine was mentioned tributary to the stream.

Rock Creek from Squaw Creek to Luna Gulch (September 1868). The reach between Luna Gulch and Squaw Creek was surveyed at four points, not counting the point at the confluence with Squaw Creek. The first of these points was located just upstream of the confluence with Squaw Creek, the second was one mile upstream of the first point, and the last two were very close together and were located about one mile downstream of the confluence with Luna Gulch. Vegetation along this reach included oak, pine, cottonwood, and willow. The channel was 66 feet wide at the upper and lower locations and 20 feet wide at the point near the middle of the reach. The bottom was at least 330 feet wide just upstream with the confluence with Squaw Creek. At this location, there was an Indian corn field, roughly 330 feet by 660 feet, running up the bottom of the creek. At the mid-point in the reach, the bottom was 198 feet wide and a mile downstream of the confluence with Luna Gulch, the bottom was 1,234 to 1,452 feet wide. A second smaller Indian garden was also found near the Luna Gulch site. At the mid-point in the reach, water was 3 inches deep. No other notations regarding the presence of water or dry channels were made. Five tributaries were mentioned in the notes. These

[1] The GLO notes frequently refer to balm or balm gilead. Balm gilead (*Commiphora Opobalsamum*) is a species that grows in parts of Asia and Africa. In the United States, *Populus candicans (also known as P. balsamifera) and, P. Nigra*, have sometimes been referred to as balm gilead (Grieve 1931). *P. balsamifera* is the black cottonwood and is widespread in Washington (www.fw.fed.us/database/feis/plants/tree). *P. nigra* is the introduced Lombardy popular. Occasionally, *Abies balsamea* or the balsam fir and a variety of salvia have also been referred to as balm (Grieve 1931). The balsam fir is known only east of the Rocky Mountains. Therefore, the references to balm or balm gilead most likely refer to black cottonwood.

included a ravine near the confluence with Squaw Creek, a brook with a 2-foot channel just upstream of the confluence, a 75-foot deep ravine with a dry brook in the bottom that had a channel 3 feet wide, and two springs (unknown if flow reached Rock Creek).

Rock Creek from Luna Gulch to 1.5 miles downstream of Quartz Creek (September 1868). There were four points surveyed between the confluence with Luna Gulch and the northern edge of the township (roughly 1.5 miles downstream of the confluence with Quartz Creek). The lowest point, located roughly ¾ upstream of Luna Gulch, was described as a 99-foot ravine. The second point, located 1 mile upstream of the first point, was described as a ravine with a 1,023-foot wide bottom with a thicket of cottonwood. At the third point, roughly one mile upstream of the second point, the bottom was 1,122 feet wide and contained brushy cottonwood and willow. The channel at this point was 6.5 feet wide and had standing water present that was fed by a spring. The uppermost point was described as a ravine with a 726-foot bottom. Tributaries in this area included Luna Gulch, Badger Gulch, and a large unnamed ravine north of Badger Gulch. Notes regarding these tributaries are described below.

Luna Gulch (September 1867). Five points were surveyed along Luna Gulch. The point one mile upstream of the confluence with Rock Creek was described as a dry 9-foot channel with oak, cottonwood, and willow. A mile further upstream, the gulch was described as a ravine with a bed. The bottom was 130 feet wide and rocky. Upstream another mile, the gulch was described as a ravine with a 33 feet wide bottom. At the upper point, roughly 4 miles upstream of the confluence with Rock Creek, the gulch was described as a 150-foot ravine with pine, oak, and cottonwood. Five ravines were identified that were tributary to Luna Gulch. Two of these had springs in them. Oaks and pines were mentioned in the two ravines with springs and one more ravine. Additionally, 2 springs that were not located in ravines were mentioned that were tributary to Luna Gulch. Scattered oak was mentioned near one of them. Note, the ravine continues in the next township to the west. Those notes were not reviewed.

Badger Gulch (September 1867). Four points were surveyed along Badger Gulch. The lowest point was within ¼ mile of Rock Creek. This point was described only as the mouth of a ravine. A mile upstream of that point, the gulch was described as a ravine with a 99-foot bottom containing oak. A mile upstream of the second point was a location described as a ravine containing pine and oak. The uppermost point along Badger Gulch that was mentioned in the notes was described as a ravine containing a spring and some pine and oak. Note, the ravine continues in the next township to the west. Those notes were not reviewed.

Squaw Creek from confluence with Rock Creek confluence with Harrison Creek (September 1868). Five points were surveyed in this reach. Vegetation was mentioned at the lower three points. The vegetation described was variable, but included oak, cottonwood, oak, and willow. The width of the bottom was noted at three of the five sites surveyed and ranged in width from 181 to 759 feet. The upper point was located in a steep, rocky ravine. A tributary brook, which runs along present day Newell Road, is described in the notes at six locations. The channel of this tributary ranged in width from 2 to 6.6 feet. Scattered timber was located near the tributary about ½ mile upstream of Squaw Creek and at a point near the head of the channel. Other locations had no timber. The channel was dry at the head of the stream and at a point roughly ½ up the channel.

At a point roughly 1.5 miles upstream of Squaw Creek, the notes indicate the stream was "nearly dry". One other 40-foot high tributary ravine was also mentioned mid-way up the reach between Rock Creek and Harrison Creek.

Squaw Creek from Harrison Creek to ½ miles upstream of confluence with Glass Canyon (September 1868). Three points were surveyed in this reach. At a point roughly 1 mile upstream of the confluence with Harrison Creek, Squaw Creek ran through a canyon. Here the channel was 16 feet wide and water was 20 inches deep. The vegetation along the stream was alder, cottonwood, and aspen. Roughly 0.5 miles downstream of the confluence with Glass Canyon, the channel was 13 feet wide, rocky and dry. The notes indicate no timber was present here. Less than ¼ mile upstream of the confluence with Glass Canyon, Squaw Creek had standing water in the channel. This location had some oak and juniper.

Glass Canyon (September 1868). Four points were surveyed along Glass Canyon. The channel ranged from 3 to 6.6 feet wide at these points. No water was mentioned at any of the locations; however, the notes indicate the stream had water in it upstream and downstream of the point 2.5 miles upstream of the confluence with Squaw Creek. Pine, alder, and cottonwood were mentioned at the upper site and pine, oak, and aspen were mentioned at the second point, roughly 1.5 miles upstream of Squaw Creek. Five tributaries were mentioned in the notes. All had channels 1.3 to 3 feet wide. Three were specifically indicated as dry. No indication of the presence or absence of water was provided at the other two sites.

Current Conditions

In summer, Rock Creek is intermittent through most of the lower reaches downstream of the Bickleton Highway Bridge. Flows are negligible in summer (Section 3.1) and water is limited to a number of standing pools. This area contains large volumes of deep cobble and gravel. Subsurface flow augmented by springs likely maintains pools. The channel below the Bickleton Highway Bridge is wide and braided. This is a depositional area. Due to the volume of material deposited in the channel, the channel itself appears to be fairly unstable, apparently shifting often during high flow events. Major flood events in the past likely contributed to the high volume of gravel and cobble currently present in the valley bottom and have also disturbed the channel and riparian areas. The flood of 1964 apparently had large effects on the channel. Local residents have indicted that the flood of 1996 was locally a relatively smaller event.

In the lower reaches of Rock Creek, riparian forest stand development is limited by the lack of precipitation and runoff. Vegetation is generally limited to the area in the immediate vicinity of stream channels. Riparian quality is highly variable. A characterization of riparian conditions was developed through the review of aerial photographs. Measurements were estimated using a rough caliper of one mile. The portion of the stream length that has significant riparian vegetation downstream of the Bickleton Highway Bridge is summarized in Table 5-4.

Table 5-4. General Riparian Vegetation Characteristics along Rock Creek Downstream of the Bickleton Highway Bridge

Start Point	End Point	% Channel with Riparian Vegetation	Comments
Rock Creek Park near mouth	1.3 mile upstream of park	<20%	Riparian area not fenced and heavily grazed. Several abandoned cars, etc. in riparian area.
1.3 miles upstream of park	Goodnoe Hills Road Bridge	>75%	
Goodnoe Hills Road Bridge	1.5 miles above bridge	<30%	
1.5 miles above Goodnoe Hills Road Bridge	¼ mile upstream of confluence with Squaw Creek	>75%	Riparian area fenced. Grazing deferred to fall (Sep 15 - Oct 15).
¼ mile upstream of confluence with Squaw Creek	½ mile upstream of confluence with Squaw Creek	<10%	
½ mile upstream of confluence with Squaw Creek	½ mile downstream of Luna Gulch	>75%	
Start Point	**End Point**	**% Channel with Riparian Vegetation**	**Comments**
Luna Gulch from mouth	1 mile upstream of mouth of Luna Gulch	<20%	
1 mile upstream of mouth of Luna Gulch	Upstream from start in Luna Gulch	>75%	
Rock Creek from ½ miles upstream of confluence	Bickleton Highway Bridge	>70%	

The lower portion of Rock Creek up to a point slightly downstream of the gas pipeline crossing has generally poor vegetation. Upstream of this area, riparian areas have been fenced for approximately 3.5 miles. This fencing was built in 1972 and 1974. Grazing within the riparian area along this section of the creek has been deferred annually to fall (September 15 to October 15) since 1966 (Roscoe Imrie, personal communication, June 2004). In general, the riparian vegetation throughout most of this area is mature and provides good shade to the stream. Further upstream, the vegetation quality is variable. There are sections of stream with poor riparian vegetation. In these areas, willow and white alder are present. Oregon white oak and black cottonwood are also found in places. Some of the riparian vegetation along the lower sections of Rock Creek appears to have been affected by channel avulsions during major flow events. Willow is starting to become established in some areas along these portions of the stream.

Stream-adjacent roads exist along portions of lower Rock Creek. Generally, these roads occur either at the edge of the floodplain, or on a terrace immediately above the floodplain. Hence, the roads have minimal effects on floodplain connectivity and/or channel width (Lautz 2000; observations by authors in June 2000). In some locations, diking or bank reinforcement has occurred. These areas appear to be designed to minimize effects of winter flows on roads and affect only short segments of the channel. Some armored diking is also present at road crossings and near the boat ramps at the park near the mouth of the creek. Observed impacts of these features also appear to be minimal (Lautz 2000).

Comparison of Current and Historical Conditions

The GLO surveys only noted presence of vegetation and not density; hence, the change in vegetation between the years that the GLO surveys were completed and present can be assessed only in terms of presence or absence. All locations where vegetation was noted in the GLO notes have at least some vegetation today. One site located mid-way between the Chamberlain-Goodnoe Bridge and Squaw Creek was described as having "some willow" suggesting sparse vegetation. That site has sparse vegetation today as well. The site where the "Indian cornfield" was located (on Rock Creek, just upstream of the confluence with Squaw Creek) is not vegetated today. All sites where the GLO notes specifically indicated a lack of vegetation also have a lack of vegetation today. Therefore, in terms of presence and absence of vegetation, no differences were noted between today's conditions and the conditions of 1867 and 1868. There may be differences in density or width of riparian stands, but this could not be determined through the review of the GLO notes. Species present are generally similar with the exception of the black walnut that is currently widespread along some portions of Rock Creek and Squaw Creek.

Comparison of "bottom" widths reported in the GLO notes with recent aerial photographs suggests little change in "bottom" widths with the possible exception of the lowest two points in the reach downstream of the Chamberlain-Goodnoe Bridge. The bottom at these two points appears to be wider than that reported in the notes. Uncertainty exists because we do not know precisely how the early surveyors defined "bottom". Nevertheless, the current floodplain tends to be wide where the bottom was previously reported to be wide and tends to be narrow where it was narrow in the mid-1860s, with the exception already mentioned. The areas that appear to be avulsed today were also quite wide at the time the surveys were completed. Today, the area downstream of Luna Gulch is avulsed and covered with rock. The notes indicate that this area was wide and rocky in the mid-1860s, suggesting that the pattern of avulsion is not a recent occurrence.

Flow is also difficult to interpret. The surveyors usually indicated a channel width. In some cases, they noted the channel was dry; in others, they noted the presence of water or flow and, in many cases, the surveyors made no mention of the presence or absence of water. Where water was mentioned, the descriptions included measurements of water depth and/or descriptions of flow such as "standing water" or "runs slowly". This level of detail given at some locations might suggest that no water was present where it was not mentioned. On the other hand, the surveyors may have assumed the notes indicated water present unless otherwise indicated. Therefore, the lack of notation regarding water must be interpreted as simply unknown.

The notes do provide some indication of the flows in the basin. Sufficient notations were made to determine that Squaw Creek was spatially intermittent in a year that was slightly wetter than average. Today, Squaw Creek is also spatially intermittent. As it is today, Luna Gulch was documented as dry near its confluence with Rock Creek in a year that was substantially wetter than normal. Rock Creek was spatially intermittent between Badger Gulch and the confluence with Quartz Creek. No mention of either flow or a channel was made at any of the survey points in Badger Gulch. These last two observations are also similar to what is seen today.

There were only two notations on the presence or absence of water on the mainstem Rock Creek between Badger Gulch and the mouth. The first point was located about 1.5 miles downstream of Squaw Creek where a beaver dam had created a pool of water 3 feet deep, and the second point was a location about 1.5 miles upstream of the present day Rock Creek Park, where the notes indicate the creek "runs slowly". Hence, comparisons of historical and current flows are difficult and little can be concluded regarding similarities or differences.

Canyon Reaches Upstream of the Bickleton Highway Bridge

Historical Conditions

The historical records for only one reach in this portion of the Rock Creek basin were reviewed. This was the gulch north of Badger Gulch. There were three points surveyed on this gulch. All three points describe this tributary as a ravine. The notes mention the presence of pine and oak in the ravine at all sites. At the site a little less than one mile upstream of the confluence with Rock Creek, the ravine had a bottom that was 123 feet wide. At the point two miles upstream of the confluence, the bottom was 33 feet wide and a 2.6-foot brook was located in the bottom. No mention of the presence or absence of water was provided. The notes indicate the head of this gulch was located roughly 3 miles upstream of its confluence with Rock Creek. One tributary ravine, containing scattered oak and pine, was mentioned.

Current Conditions

Upstream of the Bickleton Highway Bridge, the channel becomes somewhat steeper, increasing to 2 to 4 percent (Berg et al. 2001). Channels are highly confined and substrate is characterized by a mix of cobbles and boulders. Riparian vegetation at lower elevations consists primarily of white alder, willows and water birch. As elevations increase, pine is occasionally seen in riparian stands. Although limited by the narrow floodplain area, existing riparian vegetation is of relatively good quality (Berg et al. 2001). The steep terrain limits accessibility. Quartz Creek is reported to be the only canyon that is accessible by horse (Roscoe Imrie, personal communication, June 2004). Historically, this canyon was used to move livestock. All other canyons are steep enough to exclude not only horses, but also cattle. Hence, there has been little disturbance of riparian areas or the stream channel in these canyons.

Headwaters and Upper Plateau

Headwater tributaries flow out of the mountains and across a relatively flat basalt plateau. Channels are moderately confined to unconfined and have gradients generally less than 3 percent. Land cover is primarily coniferous forest, although there are areas of rural

residential development. This area is above currently known anadromous fish use (Berg 2001).

Timber harvest in the headwater area is largely conducted through partial cuts. This approach to forest management leaves a somewhat sparse forest on the landscape (Figure 5-3). Historically, this area would have experienced high frequency, low intensity fires (Agee 1993). Fire return intervals were likely similar to those documented in the Warm Spring area. There, fire is estimated to have returned every 11 to 16 years (Weaver 1959).

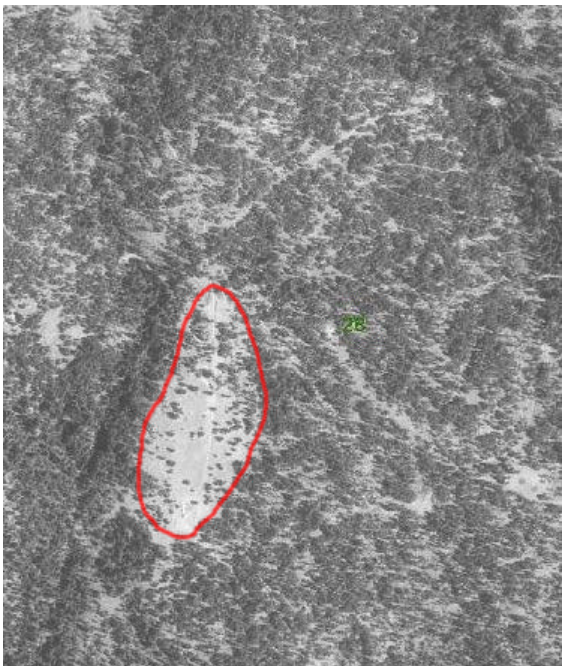

Figure 5-3. Aerial Photograph of Typical Forest within the Managed Timber Lands of the Rock Creek Basin. The area in red is naturally sparse.

Frequent low intensity fires reduce understory vegetation, including young trees, and create an open park like stand with clumps of trees, typically 35 to 55 meters on a side with open ground between them (West 1969). With fire exclusion, the density of trees in ponderosa pine stands has increased and the size has decreased due to competition. Higher densities of trees in ponderosa stands today have resulted in increased mortality due to insect and disease (Agee 1993). Fuels have also built up in the understory, increasing the probability of a stand replacing fire in the future. Relative to the historical, pre-fire suppression condition, the forests in upper Rock Creek are likely denser with smaller trees than they once were.

No assessment of effects of forest management on peak flows has been conducted in the Rock Creek subbasin; however, an assessment was completed in the Little Klickitat subbasin which lies adjacent to the Rock Creek subbasin in WRIA 30. Forest management is similar in both areas. The Little Klickitat assessment concluded that peak flows have been reduced relative to historical conditions due to the higher density of trees than were present prior to the initiation of fire suppression (Raines et al. 1999). A similar situation is likely present in Rock Creek.

The Bickleton fire in 1994 and the Bickleton/Cleveland Fire in 1998 removed vegetation in portions of the headwater area and may have had effects on sediment inputs and stream flow; however, no assessment of those potential effects was available. Young conifers are becoming re-established in the burn areas through a combination of natural seeding and planting. Oaks are also re-sprouting.

Historically, this area and some of the canyon areas were grazed by wild horses. Roughly a 100 head of horses were rounded up in 1956 and sold. Local residents have

commented that riparian vegetation has increased since these animals were removed from the area. Grazing has also been intense in some areas, such as upper Quartz Creek. In this area, grazing was discontinued roughly 10 years ago (Roscoe Imrie, personal communication, June 2004). Riparian areas have been planted along Quartz Creek and additional vegetation is starting to develop through natural seeding. Other intense grazing areas may occur, but were not observed during the reconnaissance survey and have not been documented in any reports.

Riparian areas within commercial timber areas that were visited during the reconnaissance survey appeared to be in relatively good shape in most areas. Grazing on commercial timber lands is fairly light and managed regularly. Within the region of rural development off Box Spring Road, some encroachment into riparian areas has occurred.

Roads

Roads can potentially affect fish habitat through three mechanisms: 1) encroachment on the channel or floodplain, 2) increase in peak flows, and 3) input of sediments to streams. Encroachment was discussed in the previous sections.

Three road crossing were observed that affect or have the potential to affect channel conditions. The first is an old abandoned road fill which washed out at some point and was not rebuilt. In this area, the channel is downcut substantially. Upstream of the road fill is a recently reconstructed road crossing with a new culvert in place. The old culvert apparently failed recently and caused some erosion of soils and the channel on the downstream side of the road. The third crossing was one that was recently reconstructed. At the time the crossing was observed, the work appeared to be incomplete. Bare soils were exposed within the channel that will tend to head cut if not treated. Other road crossings may also be in need of attention, but were not observed during the reconnaissance survey.

Peak Flows. The hydrologic effect of roads depends on several factors, including the location of roads on hillslopes, ground-water interception, connectivity of the road system to the stream network, and proportion of the watershed occupied by roads (Gucinski et al. 2001). In the Rock Creek subbasin, the road density is 1.5 miles of road per square mile of land (Table 5-5). Relative to most basins in eastern Washington, this is a very low density (Figure 5-4). Most of the roads in the subbasin are located on ridge tops or a considerable distance from the stream network. The reconnaissance conducted in summer of 2004 did not identify any areas where roads intercepted groundwater flow; however this may occur in some locations.

Subbasin	Road Density (mi/mi^2)
Quartz Creek	1.74
Upper Rock Creek	2.04
Middle Rock Creek	1.59
Luna Gulch	1.23
Upper Squaw Creek	1.51
Lower Squaw Creek	1.35
Lower Creek	1.44
Entire Rock Creek Basin	**1.53**

Table 5-5. Road Density in the Rock Creek Basin (based on the TIGER database; http://www.esri.com/data/download/census2000_tigerline/index.html).

Coe (2004) found that connectivity to the stream network is influenced by precipitation. The mean annual precipitation in Rock Creek is 16.2 inches (Chapter 2). At this precipitation, the data provided by Coe would indicate that, on average, less than 10

percent of the road system would be expected to be connected to the stream system. This level of connectivity is lower than that present in any study of road effects on hydrology.

The magnitude of effect of roads has been highly variable in studies conducted across the western United States. Effects have ranged from no effect to an increase in peak flows of up to 12 percent. The larger effects were found in smaller basins where both stream density and road density were high. Peak flows were found to increase significantly when road density exceeded 12 miles of road per square mile (Harr et al., 1975), which is substantially higher than the density found in Rock Creek. In general, the relative affect of roads decreases as the magnitude of the storm event increases. Hence, roads are more likely to affect average flows than the major peak events (Coe 2004). Given the magnitude of effects found in other studies, the low road density in the Rock Creek subbasin, and the configuration of the road system, significant effects on hydrology due to roads is unlikely in this subbasin.

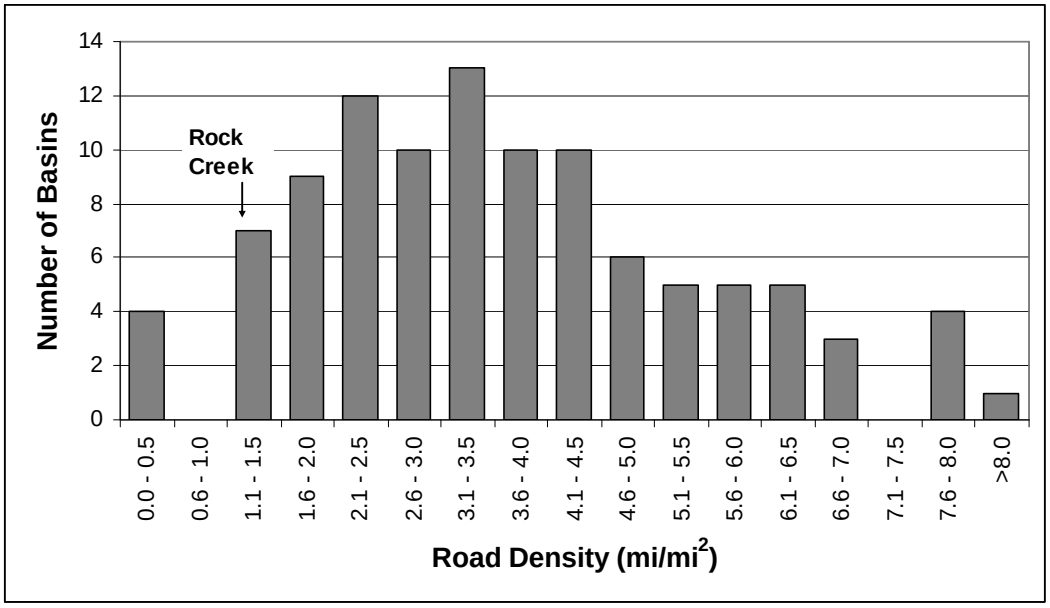

Figure 5-4. Road Density in Basins on the Eastside of Washington State. Data compiled from watershed analyses completed under the Washington Department of Natural Resources' Watershed Analysis Methodology. The road density in Rock Creek basin is 1.5 miles per square mile.

Sediment Inputs. Sediment delivered to streams from road systems is a function of the connectivity of the road system to the stream network, the surfacing of the roads, the configuration of the roads, road gradient, and traffic levels (Bilby et al. 1989; Megahan 1974; Megahan and Ketcheson 1996; Reid and Dunne 1984; Sullivan and Duncan 1980; Swift 1984; Vincent 1985). Road density is indirectly related to sediment inputs in that the potential to have significant affects increases with the number of roads present in a basin (Figure 5-5; Glass 1999). As can be seen in Figure 5-5, the quantity of sediment input from high density road systems can range widely. No cases of high sediment loads arising from low density road systems have been documented. At the road density found

in Rock Creek (1.5 mile per square mile), significant basin-scale inputs are unlikely. However, some roads may be locally affecting habitat through erosion of the road bed.

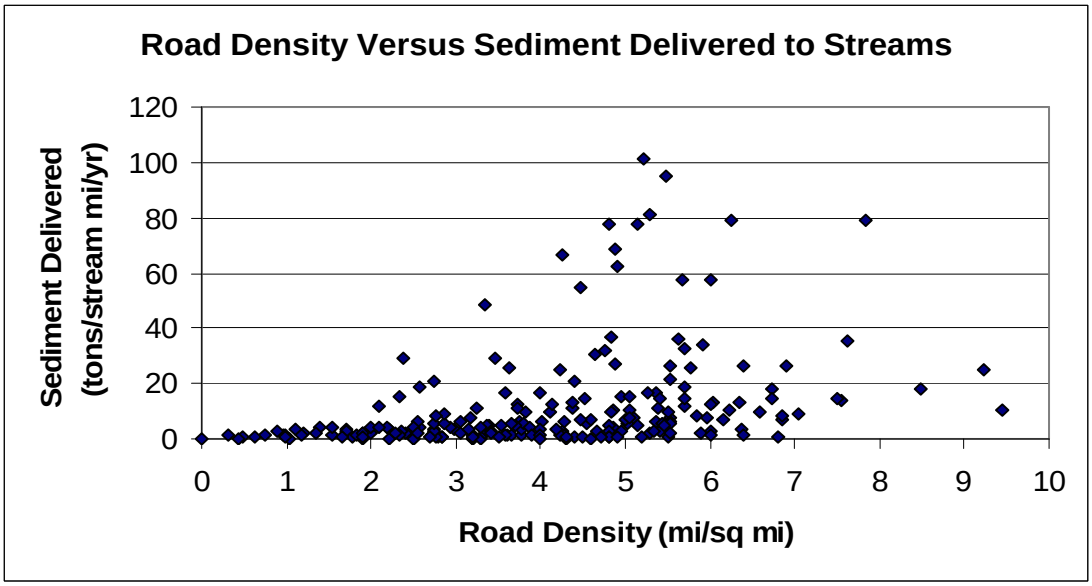

Figure 5-5. Sediment Delivered to Streams as a Function of Road Density. Based on sediment loads estimated using the WDNR watershed analysis methodology (Glass 1999).

Reduction of both the sediment and hydrological effects of roads is achieved through modification of the road system to reduce connectivity to streams. At present, forested roads are being upgraded per the requirements of WAC 222 with the objective of hydrologically disconnecting roads from the stream network. As this work is completed, the basin-scale effects of roads on sediment inputs and hydrology will be reduced.

5.5.3 Chapman Creek

Historical Conditions

The lower portion of Chapman Creek was surveyed by GLO in April of 1868, a year that was substantially wetter than normal. The middle portions of Chapman Creek were surveyed in November of 1867, a slightly wetter than average year. The survey of the headwater area was not reviewed.

The reach of Chapman Creek extending from the mouth to the location where Old Highway 8 turns to the northeast, away from the creek was 6.6 to 10 feet wide. An "Indian garden" was present at the mouth of the creek. This garden area was fenced and ditched on either side. The area between the ditches corresponds precisely to the area currently inundated by the Columbia River. At two points surveyed roughly 1.2 miles upstream of the mouth, the GLO notes only indicate the channel was 10 feet wide and "good grass" was present. Two additional points were surveyed in this reach. One was just downstream of the turn in present day Old Highway 8 and the second was about 1/3 mile further downstream. At both these locations, the channel was 6.6 feet wide and ran

through a 12-foot ditch. A homestead was present in this area and a fenced 90-acre field was located in the area. The field extended "down the creek about 20.00 chains [1,320 feet] and into the creek bottom on both sides of the creek about 60.00 chains [3,960 feet]" (numbers in brackets added). No mention of water presence/absence or water depth was made for any of the surveyed locations downstream of the location where Old Highway 8 turns northeast.

Old Highway 8 runs upstream near the channel of Chapman Creek for a little over a mile and then turns southwest. At this point, Chapman Creek had a bottom that was 1,122 feet wide, the channel was 10.5 feet wide, and the creek was 6 inches deep in June. Willow, sumac, alder, elder, and current were present in this bottom. Two to three miles further upstream, the channel was 4 feet wide in November and had some willow adjacent to it. Three springs were identified on a tributary that runs adjacent to Old Highway 8 where it runs to the northeast from Chapman Creek. A channel ranging from 2 to 3.3 feet wide was described in this tributary area.

In addition to the one settlement previously discussed, the notes indicate that the Indians had many horses and that the area was used for grazing those animals.

The survey notes provide little information regarding stream and riparian conditions in Chapman Creek. They tell us the stream had flow in spring. The surveyor made no specific comments regarding riparian vegetation. All comments on vegetation pertained to each one-mile section line. These comments indicate an abundance of grass and wildflowers.

Current Conditions

There are no published data depicting habitat conditions in Chapman Creek. The Limiting Factors Analysis (Lautz 2000) is based largely on the personal observations of local area biologists. The authors of this report completed a reconnaissance survey of the area in late June 2004. No data were collected in this survey, but it provided an opportunity for the authors to become familiar with the area. Local residents helped with this reconnaissance effort.

Much of the headwater area of the basin is dry in summer. This area has narrow buffers of riparian vegetation, primarily consisting of willows and other shrubby plants.

Between roughly river mile 5 to river mile 7, flows run under the substrate in summer (Jim Beeks, personal communication, June 2004). Downstream of river mile 5, flows were continuous in late June 2004. In general, the buffers are well vegetated with white oak, willow, alder, and walnut. Walnut in the area was introduced. Isolated areas exist where vegetation is sparse, at least partially due to heavy grazing. These areas, however, tend to extend over fairly short distances of the channel.

The area mapped as supporting anadromous fish populations (downstream of roughly river mile 0.5) is generally well vegetated. At Highway 97, box culverts were built under the highway. One was to provide for movement of cattle under the highway. The second carried the lower portion of Chapman Creek. Currently, all water in the stream appears to move through the culvert designed for cattle passage. Both culverts have deep

deposits of sediment. Downstream of the highway, vegetation is dense and the stream between the highway and the Columbia River could not be observed.

Much of the lower portion of the creek runs over deep soils. One section of stream located roughly 3 miles upstream of the mouth was observed that had cut down through the soils as much as 15 feet. In this area, the adjacent hill slopes were near vertical, although there was little rock present. This section of the creek is located near the section that ran through a 12 foot ditch in the mid-1880s. At the time the GLO survey was completed, the channel was 6.5 feet wide. Today, the stream in this area is highly sinuous with a broad bottom (>20 feet) and mature riparian vegetation. The channel in this area has abundant downed wood. There was evidence of some beaver activity recently in the area, though no evidence that the area was currently populated by beaver.

The lower 1/2 mile of the stream also runs in an area where the channel has eroded steeply into the underlying soils. The erosion of the bed appears to have occurred decades ago. There are mature walnut trees and other riparian vegetation in the bottom of the canyon and downed wood in the channel.

Stream-adjacent roads exist along portions of Chapman Creek. The majority of these are found in the headwaters of the basin along intermittent streams. Generally, these roads occur either at the edge of the floodplain or on a terrace immediately above the floodplain. Observed impacts of these roads on floodplain connectivity appear to be minimal (Lautz 2000).

5.5.4 Wood Gulch Creek

Historical Conditions

The GLO survey notes for the lower 10 miles of Wood Gulch were reviewed. The GLO survey for the area downstream of the confluence with Big Horn Canyon was completed in June of 1867, which was an average year in terms of moisture. The survey upstream of the confluence was completed in August of 1868, a wet year. The channel was dry at the mouth in late June of 1867.

The GLO notes indicate that flow sinks into the bottom roughly 660 feet upstream of the mouth. Approximately 0.2 miles upstream of the mouth, the channel was 3.3 feet wide and water was 6 inches deep. Vegetation along the stream included willow and currant. A mile further upstream, the channel was dry; however, the notes indicate that water was present “a few chains above and below” the point (a chain is 66 feet). Another mile upstream, the channel was 3 feet wide and water was 5 inches deep.

Big Horn Canyon is a major tributary to Wood Gulch. The confluence of the two streams is located approximately 5.3 miles upstream of the mouth of Wood Gulch. GLO surveys upstream of the canyon were completed in August.

Just upstream of the confluence with Big Horn Canyon, Wood Gulch was 20 feet wide and “full of sharp basalt rock”. The vegetation consisted of willow, alder, elder, sumac, and currant. Roughly 1.2 miles upstream of the confluence, Wood Gulch was 5 feet wide and had swift flow in August. Vegetation was a scattering of oak and willow. One mile upstream of this point, the flow was described as slow and three miles upstream of this

point, the notes indicate the stream barely runs. Vegetation upstream of the confluence with Big Horn Canyon included oak, pine, and willow.

Big Horn Canyon had a channel that was 26 feet wide and contained water that was 6 to 8 inches deep just upstream of the confluence with Wood Gulch. Two miles upstream of this point, the GLO notes indicate that the stream "barely runs" and four mile upstream of the confluence, the stream was dry. The latter two points were surveyed in August. Riparian vegetation along Big Horn Canyon was alder and cottonwood near the confluence with Wood Gulch. Farther upstream, vegetation included scattered oak and pine. At the upper most point where the stream was dry, pine was present in the bottom.

Overall, the notes suggest that by mid to late June of 1867 (an average year) Wood Gulch was dry at the mouth and spatially intermittent from the mouth to the confluence with Big Horn Canyon. Upstream of the confluence, water was reported consistently in August. Flows in Wood Gulch extended four miles upstream of the confluence with Big Horn Canyon and two to three miles upstream in Big Horn Canyon.

Current Conditions

There are no data available regarding habitat conditions in Wood Gulch Creek. Wood Gulch Creek runs through a steep, dry canyon. Elevation increases 500 to 800 feet from the stream channel to the top of the ridge above the canyon. The area is largely uninhabited with the exception of a couple of buildings in the headwaters and the transfer station located at the top of the ridge. The valley bottom and slopes appear to be extensively grazed. There is a fence separating the riparian area from upslope areas on at least one side of the creek. There are few roads in the basin. Most are jeep trails located far above the stream. Only a few jeep trails reach the valley bottom. The lower ½ mile of stream runs through Sundale.

In late June 2004, the channel was dry with the exception of a few pools. Three pools were observed in the lower 5 miles of the creek. Riparian vegetation is sparse and is most developed in the areas near pools (Figure 5-6). The lowest reach running through Sundale passes near a horse pasture. A hole dug in the ground indicated that water was available roughly 18 inches below the surface, suggesting some subsurface flow of water.

Figure 5-6. Lower Wood Gulch Creek. Note the cluster of trees in the circled area. These grow alongside one of the few pools present in late June 2004.

5.5.5 Pine Creek

There are no data available regarding Pine Creek except the water temperature data reported in Chapter 4. No reconnaissance of this area was conducted by the authors. The GLO survey notes for Pine Creek were not reviewed.

5.5.6 Alder Creek

Historical Conditions

The GLO survey notes were reviewed for the lower 2 miles of Alder Creek and portions of 6-Prong Creek (a tributary to Alder Creek). The surveys of this area were conducted in mid-June of 1867, a year with average moisture. At that time, Alder Creek was 50 feet wide and 14 inches deep at the mouth. The banks were covered by "balm gilead, willow, sumack, hackberry, and currant". A little over a mile upstream, the channel was 16.5 feet wide and water was 4 inches deep. The GLO notes indicate the bottom was filled with sharp basaltic rocks 1 to 20 feet in diameter. Riparian vegetation at this point included willow, sumac, alder, elder, and currant.

The survey notes for the lower seven miles of 6-Prong Creek were reviewed. The creek had 4 inches of water in it at all the survey points. The notes state: "this creek sinks and rises every 10 to 15 chains" [one chain is 66 feet]. Vegetation along the creek included willow, sumac, balm gilead, elder, and currant. Much of 6-Prong Creek ran through deep ravines ranging from 50 to 80 feet deep. The banks of the creek were described as perpendicular sand rising from 12 to 48 feet high.

Current Conditions

There are no data available regarding habitat conditions in Alder Creek with the exception of the water temperature data reported in Chapter 4. Reconnaissance of the creek was limited to the lower 5 miles of the creek and one of its tributaries, Six Prong Creek.

The lower portion of Alder Creek is perennial as a result of spring discharge (Section 3.1). The riparian area along the creek is narrow, but relatively dense. Despite the shading provided by the riparian canopy, the creek tends to be warm in summer with average temperatures exceeding the state standard for the seven-day average of the maximum temperatures. Pools and instream wood in this section of the stream are abundant.

Six Prong Creek is dominated with emergent wetland vegetation (Figures 5-7 and 5-8). Willows and other riparian trees are growing where slightly drier soils are available. The hill slope gradients are nearly vertical, up to 50 feet in height, and the hill slopes are comprised of highly erosive materials. Within these steep banks, the creek has a well developed floodplain and riparian vegetation. The condition of the present day channel is very similar to that which was described in the GLO notes in 1867.

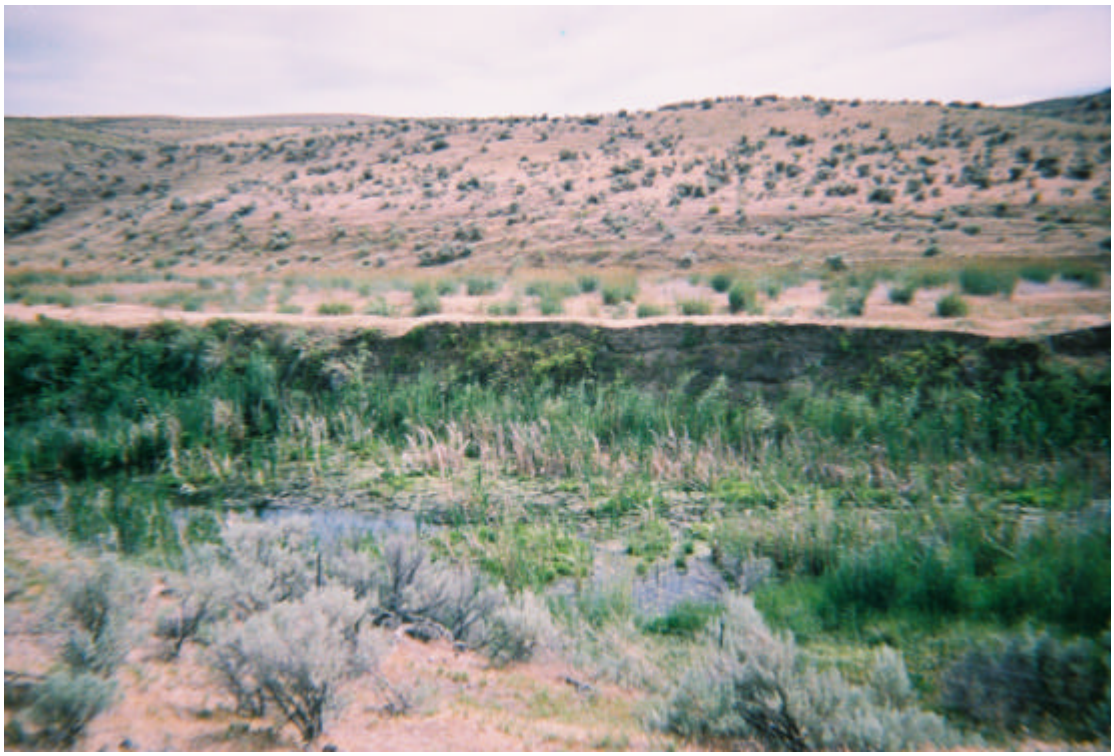

Figure 5-7. Lower Six Prong Creek

Figure 5-8. Six Prong Creek, Roughly ½ Way Up the Stream

5.5.7 Dead Canyon and Glade Creeks

No data are available regarding fish habitat in these two creeks with the exception of the stream temperature data reported in Chapter 4. Discussions with Brett Barkdull (personal communication, July 21, 2004) indicate that a number of pools are present in lower Glade Creek. No reconnaissance was completed in these basins. The GLO notes for this area were not reviewed.