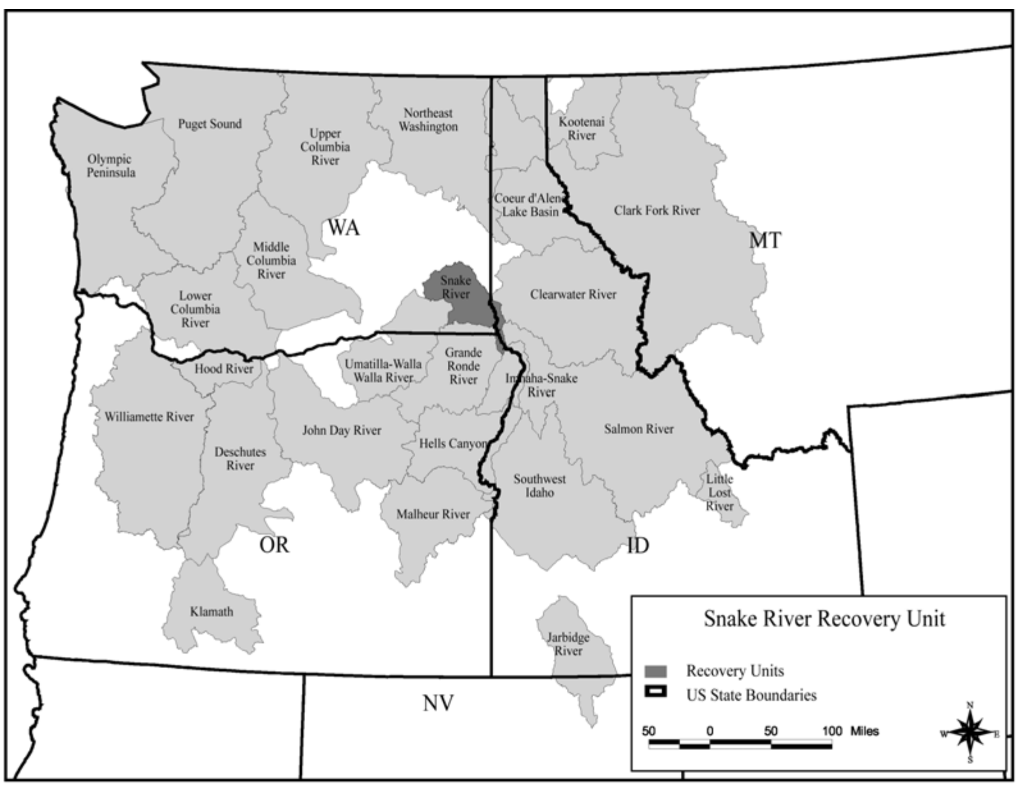
INTRODUCTION

Recovery Unit Designation

The Snake River Washington Recovery Unit is one of 22 recovery units designated for bull trout in the Columbia River basin (Figure 1). This recovery unit encompasses a portion of the Snake River basin between Lower Monumental Dam at river kilometer 68 (river mile 42) upstream to the Grande Ronde River at river kilometer 271 (river mile 168) and all tributaries within this reach. The Tucannon River and Asotin Creek are the only two tributaries to this stretch of the Snake River that are known to contain reproducing bull trout populations.

Figure 1. Bull trout recovery units in the United States. The Snake River Washington Recovery Unit is highlighted.



Two core areas are designated for the Snake River Washington Recovery Unit: the Asotin Creek Core Area and the Tucannon River Core Area (Figure 2). The Palouse River lies within the Snake River Washington Recovery Unit but does not currently contain a bull trout population. Couse Creek and Tenmile Creek enter the Snake River in this reach and are also included in the Snake River Washington Recovery Unit, but they are not believed to contain bull trout at this time. The Clearwater and Grande Ronde Rivers are large tributaries to the Snake River within this reach, but they have been placed in separate recovery units. Watershed boundaries of the Snake River Washington Recovery Unit overlap ceded lands of the Nez Perce Tribe; the Nez Perce and other Native American Tribes have treaty fishing rights here.

Figure 2. Snake River Washington Recovery Unit for bull trout.

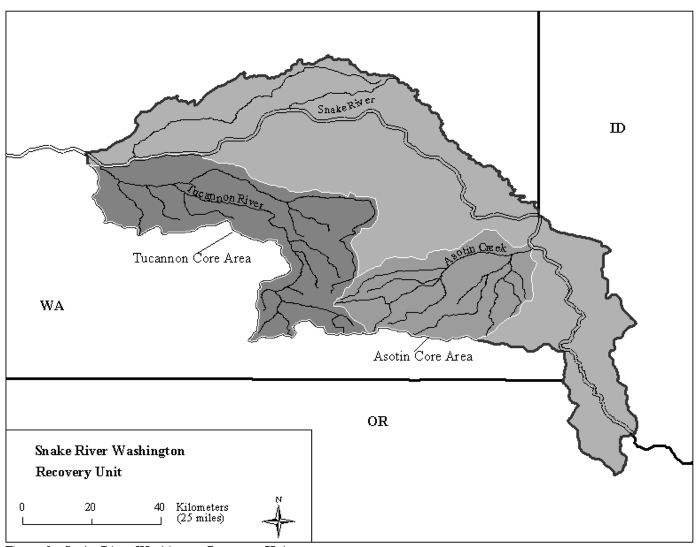


Figure 2. Snake River Washington Recovery Unit.

Geographic Description

Tucannon River Core Area. The Tucannon River watershed is located in southeastern Washington and is a tributary to the Snake River (Figure 3). Headwaters of the Tucannon River are in the northernmost part of the Blue Mountains. The Tucannon River watershed contains a total area of 129,996 hectares (321,228 acres), of which 30,351 hectares (75,000 acres) were classified by the Soil Conservation Service as forested area (Gephart and Nordheim 2001). Lands within the Umatilla National Forest total nearly 32,375 hectares (80,000 acres). There are 5,004 hectares (12,366 acres) of U.S. Forest Service lands in the Wenaha-Tucannon Wilderness area. The mean annual flow of the Tucannon River is 5 cubic meters per second (177 cubic feet per second) at its mouth. The minimum observed flow was 0.42 cubic meter per second (15 cubic feet per second), and the maximum was more than 226 cubic meters per second (7,980 cubic feet per second) in December 1964 (Gephart and Nordheim 2001).

Figure 3. Tucannon River Core Area with major drainages shown.

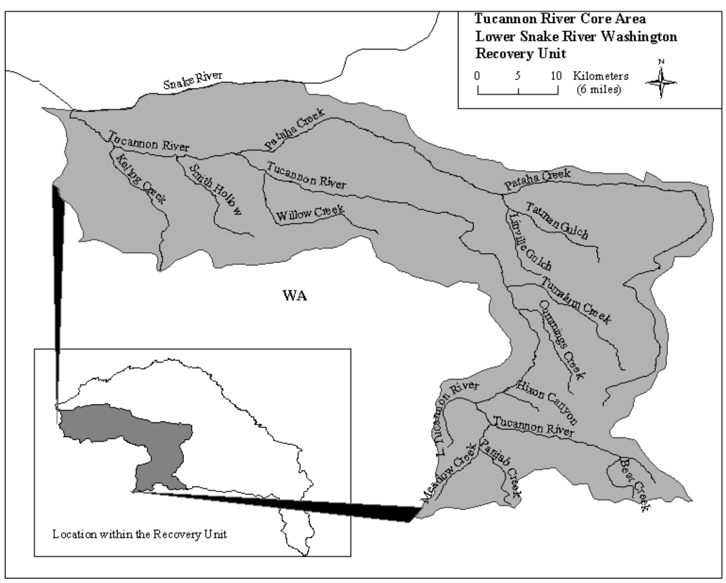


Figure 3. Tucannon River Core Area for Bull Trout within the Snake River Washington Recovery Unit.

The Blue Mountains in the headwaters of the Tucannon River watershed are composed of uplifted Columbia River flood basalt. These basalt flows are layered, with individual flows averaging 31 meters (100 feet) in thickness. Total thickness of the formation exceeds 900 meters (several thousand feet) (McKee 1972). The Tucannon River watershed is generally composed of V-shaped drainages having steep sides and narrow canyons. The steep terrain is the result of extensive folding and faulting associated with formation of the Blue Mountains. Geology of the basin consists of consolidated rock formed from Columbia River basalt that was overlain by volcanic ash from the eruption of Mount Mazama.

Columbia River basalts were formed from high-volume fissure eruptions of the Columbia Plateau, a flat featureless geologic province that existed before the Blue Mountains were uplifted. The surface of each basalt flow cooled as the underlying basalt was still flowing. Over time, the upper layer was broken by erosion to form a layer of rubble, while the underlying basalt had formed a more solid rock that is relatively impervious to water flow. As each successive lava eruption poured another layer of basalt over the previous flow, a series of alternating layers of rubble and solid rock were built up. The rubble layers form excellent aquifers and, when exposed by erosion, often create springs.

After the uplifting of a portion of the Columbia River flood basalt (formation of the Blue Mountains), water erosion began forming deep V-shaped drainages. When the heads of these drainages cut into the uplifted basalt, relatively sharp ridges were produced between adjacent drainages. Where the heads of the drainages have not met, flat uplands exist. The majority of the Tucannon River watershed has sharp ridge tops, and access is difficult in the upper portion. The southern edge of the watershed is relatively flat and more accessible.

The eruption of Mount Mazama in Oregon about 6,850 years ago deposited a layer of volcanic ash over much of the Blue Mountains. In general, erosion has removed most of the ash from the ridge tops and south-facing slopes, but it is still present on many of the north-facing slopes and flat upland areas.

Soils formed by the volcanic ash are moderately deep and medium textured and have high infiltration rates and water-holding capacity. These soils are highly sensitive to compaction and are easily eroded. Residual soils formed from the basalt flows are generally shallow and relatively fine textured with little water-holding capacity (Ehmer 1978).

Elevation of the basin varies from approximately 152 meters (500 feet) at the mouth of the Tucannon River to 1,947 meters (6,387 feet) at Oregon Butte, its highest point. The change in elevation results in climatic variations, with cooler, moist conditions occurring at the higher elevations. Rainfall varies from 25 centimeters (10 inches) at the mouth of the Tucannon River to more than 102 centimeters (40 inches) in the higher elevations. Ninety percent of the precipitation occurs between September 1 and May 30. Average annual air temperature for the entire basin is 17 degrees Celsius (63 degrees Fahrenheit). Mid-summer air temperatures range from 29 to 32 degrees Celsius (85 to 90 degrees Fahrenheit), and mid-winter temperatures range from 2 to 4 degrees Celsius (35 to 40 degrees Fahrenheit). Air temperature extremes range from –30 to 43 degrees Celsius (–22 to 110 degrees Fahrenheit) (SCS 1984).

The Pataha Creek watershed is located in western Garfield County and eastern Columbia County in southeast Washington. Pataha Creek is the largest tributary to the Tucannon River, draining 49,336 hectares (121,912 acres). The climate of the area is influenced primarily by continental weather patterns with moderating influence from marine air masses from the Pacific Ocean. The average annual precipitation ranges from 20 centimeters (8 inches) at lower elevations to over 114 centimeters (45 inches) in upper reaches of the watershed. Most of the precipitation occurs between September and June. Temperatures range from –30 degrees Celsius (–22 degrees Fahrenheit) in winter to 43 degrees Celsius (109 degrees Fahrenheit) in the summer. The frost-free growing season of the watershed averages 110 to 140 days (PCD 1998).

Topography of the watershed is primarily long slopes intersected by steep canyons. Most of the land having slopes of up to 45 percent, except for forested land, is under cultivation. The landforms are mainly flat to moderately sloping.

Elevations range from 274 meters (900 feet) above sea level at the confluence of Pataha Creek with the Tucannon River to 1,707 meters (5,600 feet) at the watershed's highest point (PCD 1998).

Asotin Creek Core Area. The Asotin Creek watershed is located in southeastern Washington and is a direct tributary of the Snake River (Figure 4). The name "Asotin" is derived from the Nez Perce description of "Hash Otin," meaning "Eel Creek" (ACMWP 1995). The Nez Perce name implies that Asotin Creek had a large run of Pacific lamprey (*Entosphenus tridentatus*). Pacific lamprey adults were observed in Asotin Creek prior to 1980 (ACMWP 1995). Pacific lamprey have a migratory life history similar to that of spring chinook salmon (*Oncorhynchus tshawytscha*), a species that also historically used Asotin Creek. Pacific lamprey are known to require clean substrate and cool water temperatures for spawning, requirements that probably indicate stream conditions present in Asotin Creek before land was disturbed in the 1900's.

The headwaters of the Asotin Creek are in the northeasternmost part of the Blue Mountains. The Asotin Creek watershed is generally composed of V-shaped drainages with steep-sided, mostly narrow, canyons. The steep terrain is the result of extensive folding and faulting associated with formation of the Blue Mountains. Geology of the basin consists of consolidated rock formed from Columbia River basalt, overlain by volcanic ash from the eruption of Mount Mazama. In general, erosion has removed much of the ash from the ridge tops and south-facing slopes, but this material is still present on many of the north-facing slopes. Soils formed by this volcanic ash are moderately deep and medium textured and have high infiltration rates and water-holding capacity. Soils composed of ash are also highly sensitive to compaction and are easily eroded.

Figure 4. Asotin Creek Core Area with major drainages shown.

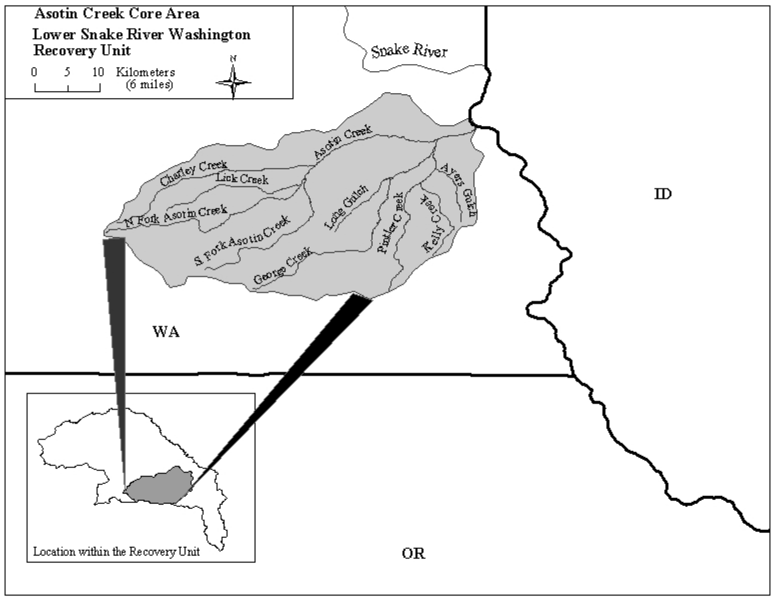


Figure 4. Asotin Creek Core Area for Bull Trout within the Snake River Washington Recovery Unit.

Residual soils formed from the basalt flows are generally shallow and relatively fine textured, with little water-holding capacity (Ehmer 1978).

While riparian zones within the Asotin Creek watershed were considered "moderately stable" in 1974 with regard to erosion and hydrology, more recent inventories indicate that riparian conditions in Asotin Creek vary widely by stream, location, and land use. The U.S. Forest Service (1992b) reported that grand fir (*Abies grandis*), ponderosa pine (*Pinus ponderosa*), and Douglas-fir (*Psuedotsuga menziesii*) comprise the dominant conifer overstory in riparian zones of the North Fork of Asotin Creek. Canopy cover in North Fork Asotin Creek averaged 39 percent in 1992. Grand fir and Douglas-fir are also the dominant species in the riparian zones of the South Fork of Asotin Creek and Cougar Creek. Logging operations took place adjacent to Cougar Creek more than 10 years ago. Some trees exceeding 4 meters (12 feet) in height are now regenerating along logged riparian areas (D. Groat, U.S. Forest Service, pers.

comm., 2002b). Alder (*Alnus* species) and, to a lesser extent, mallow ninebark (*Physocarpus malvaceus*) dominate the understory in areas where secondary vegetation is present. In other streams, such as Lick Creek, riparian zones are in poor condition along some reaches; clear-cuts were used to harvest timber immediately adjacent to the stream edge, and trees have not reestablished there. On State lands in the North Fork Asotin Creek drainage upstream from Dry Lick Creek, riparian zones are recovering from flood damage incurred in 1973 and subsequent salvage timber harvest (USFS 1992b). Streams in the upper watershed are generally reported to contain higher-quality riparian zones compared with lower reaches where more streamside activities occur (Kuttel 2002).

Elevation of the basin varies from approximately 232 meters (760 feet) at the mouth of Asotin Creek to 1,897 meters (6,223 feet) at Mount Misery. The change in elevation results in climatic variations, with cooler, moist conditions occurring at the higher elevations. Rainfall varies from 36 centimeters (14 inches) at the mouth of Asotin Creek to more than 140 centimeters (55 inches) in the higher elevations, with 90 percent of the precipitation occurring between September 1 and May 30. Average annual temperature for the entire basin is 17 degrees Celsius (63 degrees Fahrenheit), with mid-summer temperatures of 29 to 32 degrees Celsius (85 to 90 degrees Fahrenheit), mid-winter temperatures of 2 to 4 degrees Celsius (35 to 40 degree Fahrenheit), and temperature extremes from –32 to 40 degrees Celsius (–25 to 104 degrees Fahrenheit) (SCS 1982).

The Asotin Creek watershed contains a total area of 82,823 hectares (204,660 acres), of which 33,755 hectares (83,410 acres) were classified as forested area by the Soil Conservation Service in 1982; the remainder is classified as rangeland or cropland (SCS 1982). Lands within the Umatilla National Forest boundary total 29,499 hectares (65,480 acres). This total includes 947 hectares (2,340 acres) of State and private holdings. U.S. Forest Service lands total 25,552 hectares (63,140 acres). Forested lands comprise 40 percent of the land area in the watershed; non-irrigated cropland comprises 29 percent, and rangelands total approximately 30 percent of the watershed. Survey figures show 23,934 hectares

(59,141 acres) were used for crops, mainly wheat and barley. One percent is classified as "other," which includes rural farms and towns (SCS 1982).

The Asotin Creek watershed has approximately 579 kilometers (360 miles) of perennial and intermittent streams. The mainstem of Asotin Creek is approximately 55 kilometers (34 miles) long, with 42 kilometers (26 miles) designated as Class I (anadromous fish bearing), 8 kilometers (5 miles) designated as Class II (resident fish bearing), and 3 kilometers (2 miles) as Class III (perennial non-fish bearing) (USFS 1998b). Asotin Creek has about 7.2 kilometers (4.5 miles) of habitat that produces chinook salmon.

Mean annual flow at the mouth of Asotin Creek is about 2.2 cubic meters per second (76 cubic feet per second), with a bank-full width of 25 meters (83 feet). Maximum recorded flows were measured at 184 cubic meters per second (6,500 cubic feet per second) in 1964 at a U.S. Geological Survey gauge located at river kilometer 14.0 (river mile 8.7). The lowest recorded flow was 0.4 cubic meter per second (13 cubic feet per second) in 1963 (Stoval 2001).

DISTRIBUTION AND ABUNDANCE

Status of Bull Trout at the Time of Listing

In the final listing rule (63 FR 31647), the U.S. Fish and Wildlife Service identified four subpopulations of bull trout occurring within the Snake River Washington Recovery Unit. These subpopulations included one in the Tucannon River and one that was reported to exist in Pataha Creek, the largest tributary to the Tucannon River. The other two subpopulations initially identified were in North Fork Asotin Creek and Charley Creek, both tributaries to Asotin Creek (USFWS 1998). At the time of listing (June 1998), the Tucannon River subpopulation was suppressed by habitat degradation, but it was not at immediate risk of extinction because most spawning and rearing locations are within protected areas of the Wenaha-Tucannon Wilderness in the upper Tucannon River watershed. Although subpopulations were an appropriate unit upon which to base the 1998 listing decision, the recovery plan has revised the biological terminology to better reflect the current understanding of bull trout life history and conservation biology theory. Therefore, subpopulation terms will not be used in this chapter.

Current Distribution and Abundance

Both resident and migratory forms of bull trout occur in the Tucannon River basin (Martin *et al*. 1992; WDFW 1997). Migratory bull trout from the Tucannon River probably also use the mainstem Snake River on a seasonal basis (Kleist, *in litt*., 1993; Underwood *et al*. 1995; WDFW 1997). Each spring during salmon and steelhead (*O. mykiss*) collections, between 30 and 40 adult bull trout up to 65 centimeters (26 inches) long are captured and released upstream of a weir at the Tucannon River Fish Hatchery (G. Mendel, Washington Department of Fish and Wildlife, pers. comm., 2002c). Martin *et al*. (1992) reported capturing four adult bull trout larger than 61 centimeters (24 inches) at the Tucannon Hatchery anadromous fish trap in the spring of 1991. Although there is substantial evidence that some Tucannon River bull trout use the Snake River during a portion of their life cycle, studies have not been conducted to provide direct documentation.

Anecdotal accounts describe anglers catching large migratory bull trout from Asotin Creek in the early 1970's (Groat, pers. comm., 2002c). The reported size (50 centimeters [20 inches]) of these fish indicates that they probably used the mainstem Snake River to forage and overwinter.

Kleist (*in litt*. 1993) reported several observations of adult bull trout passing Lower Monumental and Little Goose Dams on the mainstem Snake River. The U.S. Army Corps of Engineers summarized occurrences of adult bull trout seen in fish ladders and captured in juvenile bypass sampling systems at Lower Monumental Dam and Ice Harbor Dam facilities (Baxter, *in litt*., 2002). Since 1993, fish facility personnel have documented a total of 37 bull trout at both projects. Length estimates for these fish ranged between 20 and 46 centimeters (8 to 18 inches). It is very possible that these fish are migratory fish returning to, or migrating from, the nearby Tucannon River, rather than fish migrating to streams significantly farther upstream. Fish passage personnel have not documented adult bull trout passing Lower Granite Dam (R. Baxter, U.S. Army Corps of Engineers, pers. comm., 2002). Juvenile bull trout have been captured in juvenile salmon bypass systems at Lower Granite Dam (Groat, pers. comm., 2002d). In the past, fish counters at Lower Granite Dam may not have documented passing bull trout because counting protocol instructed individuals to tally only "core" anadromous species (Baxter, pers. comm., 2002).

Table 1 lists the streams where spawning is known to occur in the Tucannon River and Asotin Creek Core Areas. Bull trout populations in the Tucannon River were rated as "healthy" in 1997 by the Washington Department of Fish and Wildlife (1997) based on a single population estimate conducted in 1992 by Martin *et al*. (1992) and by spawning surveys conducted by the U.S. Forest Service and Washington Department of Fish and Wildlife. Redd count data presented by the Washington Department of Fish and Wildlife (1997) is from a 12.1-kilometer (7.5-mile) reach between Panjab and Bear Creeks and not from all spawning locations in the Tucannon River watershed (Mendel, pers. comm., 2002b). Redd counts that were conducted intermittently between 1991 and 2000 ranged from 57 redds in 1991 to 222 redds in 1999. Counts averaged 123 redds for all years. While the peak count occurred in 1999 (222 redds), the number of stream miles surveyed that year was nearly double (49 kilometers compared with

Table 1. Streams in the Tucannon River Core Area (8) and Asotin Creek Core Area (2) where bull trout are known to spawn. Indentation of a stream name indicates that it is a tributary to the stream named directly above it.

RECOVERY UNIT	CORE AREA	KNOWN SPAWNING STREAMS
Snake River Washington	**Tucannon River**	1) upper Tucannon River (river kilometer 78 to 93)
		2) Bear Creek
		3) Sheep Creek
		4) Cold Creek
		5) Panjab Creek
		6) Meadow Creek
		7) Little Turkey Creek
		8) Turkey Creek
Snake River Washington	**Asotin Creek**	(1) North Fork Asotin Creek
		(2) Cougar Creek

26 kilometers [31 miles compared with 16 miles]) that of any other year (Gephart and Nordheim 2001). Significant differences in spawning survey protocol (*i.e.*, different survey locations, different survey distances, and the number of subsequent surveys per site) occurred from year to year, and such differences make drawing conclusions about spawning trends and adult abundance difficult.

In addition to the upper Tucannon River, bull trout currently spawn in seven other tributaries. These streams include the mainstem of Panjab Creek and several of its tributaries; Turkey Creek and Meadow Creek; and Little Turkey Creek, a tributary to Meadow Creek. Bull trout also spawn in Sheep, Cold, and Bear Creeks, all upper Tucannon River tributaries. In 1992, the U.S. Forest Service observed 142 juvenile bull trout during snorkeling surveys in a 17-

kilometer (11-mile) section of Cummings Creek (USFS 1992c). Spawning surveys have not been conducted in Cummings Creek.

Genetic work has not been initiated to substantiate genetic differences between fish in Panjab Creek or any of the other tributaries used by bull trout. Some spawning streams in the upper Tucannon River watershed are very close to one another. The Snake River Washington Recovery Unit Team concludes that this situation might promote free movement among spawning areas from one year to the next and, therefore, result in a single population of fish with a common genetic make-up using more than one stream for spawning and rearing.

The Snake River Washington Recovery Unit Team engaged in substantial discussion about Panjab Creek bull trout to determine whether one or more local populations exist in the Panjab Creek watershed. After reviewing the best available rangewide information on bull trout movement, population genetics, and spawning characteristics (Leary *et al*. 1992; James *et al.*, *in litt*., 1998; Spruell and Allendorf 1998; Dunham and Rieman 1999; Rieman and Dunham 2000; Spruell *et al*. 2000; Hvenegaard and Thera 2001; Rieman and Allendorf 2001; Baxter 2002), the Snake River Washington Recovery Unit Team designated Panjab Creek and each of its colonized tributaries as separate local populations. Until the necessary genetic work is completed, Panjab Creek, Turkey Creek, Meadow Creek, and Little Turkey Creek are considered separate local populations. It will be important to monitor spawning characteristics and conduct genetic research on each spawning population in the Tucannon River Core Area, especially in Panjab Creek. The Snake River Washington Recovery Unit Team emphasizes that genetic work is an important management need and research priority to verify the genetic characteristics and population structure of Tucannon River bull trout.

Bull trout currently inhabit portions of the upper mainstem of Asotin Creek, North Fork Asotin Creek, Cougar Creek, the Middle Branch and South Fork of North Fork Asotin Creek, and South Fork Asotin Creek. North Fork Asotin Creek and Cougar Creek are the only streams where spawning has been documented (Table 1). Juvenile and subadult bull trout rear in the mainstem of Asotin Creek from Charley Creek upstream to the confluence of North Fork and

South Fork Asotin Creeks (known as “the Forks”). Juveniles also rear in lower North Fork Asotin Creek and in the Middle Branch and the South Fork of North Fork Asotin Creek. Historically, bull trout may have also been present in the South Fork Asotin Creek drainage, but they were not found during 1992 snorkeling surveys by the U.S. Forest Service (USFS 1992i). Additional electrofishing surveys should be conducted to verify that bull trout are absent from this stream. The upper reaches of South Fork Asotin Creek still have some potential habitat to support bull trout.

The Washington Department of Fish and Wildlife (1997) reported that historically, migratory bull trout probably used Asotin Creek. The agency conducted redd count surveys in North Fork Asotin Creek in 1996, 1997, and 1999, Cougar Creek in 1999, and Charley Creek in 1998, 1999, and 2000. The Washington Department of Fish and Wildlife (1997) describes the status of Asotin Creek core population as “unknown.” Table 2 shows the years in which redd surveys were performed in the Tucannon River and Asotin Creek watersheds and the number of redds observed. Redd survey methods varied from year to year as both multiple pass surveys (preferred redd survey method where two surveys are conducted in the same stream reach separated by about two weeks time) and single pass surveys were used.

In 1991, Martin *et al*. (1992) conducted habitat surveys and population estimates for bull trout in portions of the Tucannon River and Asotin Creek. They estimated that a combined total of 4,853 young-of-the-year and juvenile bull trout were present within a 17-kilometer (11-mile) reach of the mainstem Tucannon River from the mouth of the Little Tucannon River upstream to Bear Creek. To obtain a population estimate, Martin *et al.* (1992) applied estimated bull trout densities across available habitat areas comprised of five different habitat types (scour pool, plunge pool, run, riffle, and cascade), though they sampled only a small percentage (5.6 percent) of each habitat type available and captured a total of only 56 bull trout in electrofishing samples. In addition, electrofishing sample sites were located in only four of the six habitat reaches, though bull trout densities were extrapolated into fish numbers for all six reaches.

Table 2. Bull trout redd counts in the Tucannon River and Asotin Creek Core Areas. Counts reflect multiple pass surveys in some years, but not all years (Gephart and Nordheim 2001; Mendel, pers. comm., 2002b; USFS, *in litt*., 2002).

	YEAR / REDD COUNT										
WATERSHED	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
kilometers surveyed	21	17	ns	14	19	26	30	28	49	29	6
Tucannon River											
Upper Tucannon	57	66	ns	127	115	167	74	104	135	95	68
Bear Creek	ns	ns	ns	4	ns	3	ns	4	26	49	ns
Sheep Creek	ns	ns	ns	ns	ns	ns	ns	ns	2	ns	ns
Cold Creek	ns	ns	ns	ns	ns	ns	ns	ns	2	ns	ns
Panjab Creek	ns	ns	ns	ns	7	9	4	0	15	ns	ns
Turkey Creek	ns	ns	ns	ns	ns	ns	ns	ns	8	ns	ns
Meadow Creek	ns	ns	ns	ns	2	4	0	0	25	7	ns
Little Turkey Creek	ns	ns	ns	ns	ns	ns	ns	ns	8	ns	ns
Asotin Creek											
NF Asotin Creek	ns	ns	ns	ns	ns	3	0	ns	59	ns	ns
Cougar Creek	ns	ns	ns	ns	ns	0	ns	ns	9	ns	ns
Charley Creek	ns	ns	ns	ns	ns	ns	ns	0	0	0	ns

ns = not surveyed

Martin *et al.* (1992) and Underwood *et al.* (1995) reported that bull trout abundance in Asotin Creek is very low. In a two year sampling period in which 16 sites (1,250 square meters [13,456 square feet]) were surveyed (electrofishing) for population estimates, Martin *et al.* (1992) captured only two bull trout and therefore were unable to estimate a population size. Three additional bull trout were sampled during efforts to determine relative abundance in other portions of the watershed. From these surveys, they concluded that the population status in Asotin Creek was probably at increased risk from genetic drift. In 1991, juvenile density was estimated at 0.4 fish per 100 square meters in North Fork Asotin Creek (WDFW 1997); more recent estimates are not available. The remainder of the data associated with the status of Asotin Creek bull trout consists of infrequent observations during U.S. Forest Service surveys; during 1993 ocular surveys, 21 bull trout were observed in the North Fork Asotin Creek and Charley Creek watersheds combined (WDFW 1997).

In March, 1998, biologists from the U.S. Geological Survey Western Fisheries Research Center caught a single 20-centimeter (8-inch) bull trout while backpack electrofishing the large plunge pool below Palouse River Falls (Rubin, *in litt*., 1998). This bull trout observation is the only one known by the recovery unit team for the Palouse River. Currently, we do not know whether bull trout are present in smaller tributaries within the Snake River Washington Recovery Unit (*e.g.*, Couse, Tenmile, Almota, Steptoe, and Canyon Creeks). More detailed surveys in these tributaries are necessary to verify presence or absence.

REASONS FOR DECLINE

Within the Snake River Washington Recovery Unit, historical and current land use activities have impacted bull trout local populations. Some of the historical activities, especially construction of low head dams in the early 1900's within the core areas, may have significantly reduced important fluvial populations. Lasting effects from some, but not all, of these early land and water developments still act to limit bull trout production in both the Tucannon River and Asotin Creek Core Areas. Threats from current activities are also present in both core areas of the Snake River Washington Recovery Unit. Below, we discuss the historical and current human-induced factors that limit bull trout.

Dams

The mainstem of the Snake River in Washington is probably used by bull trout as deep water habitat for overwintering and feeding. While some research and monitoring is now taking place, and more is planned, the percentage of populations that likely use the Snake River as a routine part of their life history is currently unknown. We do know that bull trout encounter mainstem dams on the lower and upper Snake River. How bull trout deal behaviorally with passage at dams is not known. Consequently, we do not know how the presence and operations of mainstem dams will affect recovery of bull trout in the Snake River Washington Recovery Unit. Therefore, we have not included the mainstem of the Snake River in either core area of the Snake River Washington Recovery Unit, but have recommended research on these issues to clarify the impact of mainstem dams on fluvial bull trout and to determine the significance of dams in relation to recovery.

Smaller dams within the Tucannon River and Asotin Creek watersheds may have had significant historical impacts on fluvial bull trout populations in both streams. Two of these dams are still present and may be affecting bull trout migrations. Historical accounts of these dams are discussed below.

Tucannon River Core Area. Construction of dams for power and irrigation occurred before 1909 in the Tucannon River watershed. At least two dams built across the Tucannon River channel had documented impacts on salmon and undoubtedly impacted bull trout as well.

Parkhurst (1950) compiled results of fish surveys performed on the Snake River and most of its tributaries from 1935 to 1937 for a special scientific fisheries report for the U.S. Fish and Wildlife Service. Three fish surveyors working for the U.S. Fish and Wildlife Service in 1935 described a dam at Starbuck on the Tucannon River at approximately river kilometer 8.9 (river mile 5.5). Starbuck Dam was built in 1907 by a local physician to produce electricity for the community of Starbuck on the Tucannon River. It replaced another dam that had been built for the operation of a gristmill. Starbuck Dam was 1.5 meters high (5.0 feet), 29 meters (95 feet) long, and diverted water through a penstock to a power plant about 1.6 kilometers (1.0 mile) downstream. A water right was recorded in 1909 for this dam at 5.7 cubic meters per second (200 cubic feet per second), which exceeded river discharge. Another diversion at Starbuck Dam simultaneously routed water out of the pond above the dam for irrigation. In February 1935, surveyors noted that nearly the entire river flow was diverted, and in summer months, the river channel for 1.6 kilometers (1.0 mile) was virtually dry between the dam and the power plant tailrace downstream. The main fish attraction flows were below the power plant where no fish ladder existed. On February 3, 1935, the penstock diversion at the dam measured 1.6 cubic meters per second (55.5 cubic feet per second), while the irrigation diversion withdrew 0.3 cubic meter per second (11 cubic feet per second). The penstock to the power plant was screened, but the irrigation diversion was not.

In 1992, the Washington Department of Fish and Wildlife built a new fish ladder at Starbuck Dam that is open only in October through December to allow fall chinook to pass. A notch was cut in the center of the structure to allow water to cascade through during the spring and summer. The current intent of the notch and ladder is to allow upstream passage of adult anadromous fish in the spring and summer, but to block the passage of nongame fish that are unable to overcome higher water velocity and jump through the notch. Bull trout are believed to be able to pass, but no efficiency information exists. There is some concern about whether juvenile or subadult bull trout can pass this structure.

Early descriptions of the dam indicate that it probably had significant impacts on fluvial bull trout that migrated up the Tucannon River in the spring to spawn and down the river in the fall after spawning. The screen widths of the apparatus used on the upstream end of the turbine penstock probably did not keep juvenile fish from passing through. If the mesh size was small enough to keep small fish from being entrained into the penstock, then juvenile fish may have been impinged on the screen during periods when all of the river flow was diverted into the penstock for power generation. In either case, significant mortality may have occurred.

Parkhurst (1950) gives detailed information on another dam, the De Ruwe Dam, which was located on the Tucannon River approximately 26 kilometers (16 miles) above the mouth. This dam was 1.5 meters (5.0 feet) high and was reported to block at least a portion of the chinook run above that point. The dam was originally constructed for power generation purposes between 1900 and 1910, but at the time of the survey in 1935, it only supplied water to an irrigation canal. A fish ladder was built on one end of the dam, but the surveyors reported that it was filled with mud and debris, overgrown with willows, and "entirely useless." They reported that, in summer months, splash boards were placed over the 3-meter (10-foot) spillway crest and that most of the river flow was diverted into an unscreened irrigation ditch.

For February 1935, Parkhurst (1950) accounted for 31 diversions withdrawing 3.6 cubic meters per second (128 cubic feet per second). Irrigation ditches, only three of which were screened, withdrew 2 cubic meters per second (72 cubic feet per second), and 1.6 cubic meters per second (56 cubic feet per second) were used to generate power (Parkhurst 1950). This volume of water is significant given that the season was winter.

In his narrative on the Tucannon River and Asotin Creek Dams, Parkhurst (1950) does not mention impacts to bull trout, or “Dolly Varden” as they were called at that time. He does, however, refer to significant impacts on salmon. Because chinook salmon, steelhead, and bull trout migrations into the Tucannon River overlap temporally today (Mendel, pers. comm., 2002d), impacts to fluvial bull trout may also have been high, especially since Starbuck Dam and De Ruwe Dam represented significant upstream and downstream migration barriers. Both dams operated in the same time period, and both were located well downstream of the upper watershed tributaries where bull trout currently spawn. The watershed area available to bull trout could have been reduced by as much as 90 percent for more than 40 years by the construction and operation of these two projects. And an even greater percentage of spawning habitat may have been eliminated because no tributaries enter the Tucannon River below this point.

Though the De Ruwe Dam no longer exists, the Starbuck Dam has been only partially removed. Potential continuing impacts to bull trout from the Starbuck Dam should be evaluated to determine the need for additional restoration measures.

Asotin Creek Core Area. The most significant impacts to bull trout in Asotin Creek associated with dam construction may have occurred historically when Headgate Dam and its water diversion works were constructed in the mainstem of Asotin Creek at river kilometer 14 (river mile 9) in 1906. The Washington Water Power Company of Spokane, Washington, is thought to have constructed the dam. The water diversion built at Headgate Dam replaced a crude ditch system that was dug in 1885 to carry water from Asotin Creek to Clarkston, Washington (ACMWP 1995). Below the dam, an additional water diversion ditch was built; this dam diverted more water from Asotin Creek to the City of Asotin, Washington. The exact volume of water that was diverted is not known, but it is believed to have been significant to supply enough water for domestic use in two rapidly growing towns. The dam itself was nearly 2 meters (6 feet) high and may or may not have included a fish ladder at the time of construction. One source reported that the dam included a ladder, but does not specifically relate the ladder to original construction. This report also describes the ladder as not adequately maintained (ACMWP 1995). Other accounts hold that no fish ladder was present at all until the early 1930's and that, even then, the ladder was poorly designed and not maintained (Mendel, pers. comm., 2002d).

In 1907, one year after original dam construction, a wooden penstock was constructed from Headgate Dam to a powerhouse containing a turbine and electrical generator more than 10 kilometers (6 miles) downstream. This power plant produced electricity for the towns of Asotin and Clarkston. Diversion of water into the penstock left the main Asotin Creek channel completely dry for more than 10 kilometers (6 miles) during the summer of most years and for even longer during dry years. Parkhurst (1950) noted that, for the 1935 survey, the penstock intake had been screened, but when the original screen was installed is unknown. For many years, bull trout, chinook salmon, and steelhead may have been unable to access the channel above the powerhouse. In high-water years, if enough water spilled over the dam in the spring, fish may have been able to jump or swim over the dam. Water velocities over the dam probably would have been excessive for smaller fish to be able to pass, but no information exists about passage conditions during spring runoff. Hydroelectric operations continued for 21 years at Headgate Dam until power generation ceased at the site in 1928; water continued to be diverted at two locations from the creek for domestic use in Asotin and Clarkston.

Before the early 1900's, spring chinook salmon were reported to be plentiful in Asotin Creek. In 1935, fish surveyors from the U.S. Bureau of Fisheries reported that 25 adult spring chinook salmon, and more than 250,000 juvenile steelhead, were trapped in a pool in the main Asotin Creek channel below the dam because the entire flow of the creek was diverted into the penstock and the municipal water diversions (ACMWP 1995). Although some water flow was returned to the main channel after 1928, fish passage across the dam was questionable. Water continued to be diverted from Headgate Dam to Clarkston Heights until 1964. By 1965, the small reservoir behind the dam was completely filled with rock and sediment. About the same time, the Washington Department of Game (now the Washington Department of Fish and Wildlife) and Asotin County worked to remove the top 46 centimeters (18 inches) of concrete from the center of the dam and to construct a "jumping pool" for fish below the dam (ACMWP 1995). The fish ladder at Headgate Dam was completely abandoned in 1970 after attempts to make it usable failed.

Today, fish passage at Headgate Dam is still a problem. More concrete has been removed from the center of the dam, but most of the dam is still intact. A significant volume of sediment and bedload material is still held behind the dam. Present fish passage (a V-notch in the dam) does not meet Washington State fish passage standards for adults and especially does not meet standards for juveniles (Mendel, pers. comm., 2002d).

After 1965, Headgate Dam became a popular site for anglers and day-use recreation because of the large, shallow pool above the dam. Early on, there were no facilities to accommodate the level of use the area received, resulting in serious impacts to the stream and streambanks. Adverse effects from this dam on bull trout populations probably occurred long ago from the severe decrease of in-stream flows and the resulting loss of any fluvial bull trout population that relied on the main creek channel to migrate. At the very minimum, at least four generations, and more realistically, 8 to 10 generations of adult bull trout, would have been unable to reach spawning areas in the upper watershed to reproduce.

The dam is now within Headgate State Park, a recreation area owned and operated by Asotin County. The pool above the dam, as well as the riparian area surrounding it, is still heavily used by recreationists throughout the spring, summer, and fall. The current fish passage limitations at Headgate Dam and the fact that the site is a high-use recreation area may limit future recovery efforts for bull trout in Asotin Creek, especially efforts to rebuild a fluvial bull trout population.

Parkhurst (1950) described the presence of another early dam (pre-1935) built by a former game commissioner at river kilometer 6 (river mile 4) on Asotin Creek. The dam was 0.6 meters (2 feet) high, apparently constructed to prevent bridgelip suckers (*Catastomus columbianus*) from migrating upstream in Asotin Creek. In 1935, fish surveyors felt that during low-flow periods, this dam would block salmon migration. It is unknown when the dam was built, how long it was in place, or how it was removed. The dam was not present in 1980 when the Washington Department of Game conducted habitat surveys in Asotin Creek (ACMWP 1995).

In 1948, the Washington Department of Game constructed two small earthen dams across the channel of Charley Creek approximately 6 kilometers (4 miles) above its confluence with Asotin Creek. The dams were built to create put-and-take rainbow trout (*O. mykiss*) ponds with a surface area of about 1.2 hectares (3.0 acres) and a maximum depth of about 5 meters (15 feet). The dams impeded upstream fish migration into Charley Creek for at least 16 years (WDFW 1997). In 1964, the dams and fishing ponds washed out during a large flood, sending sediment down Charley Creek and into Asotin Creek. For many years following, the stream channel in the area of the ponds was largely a steep, eroding gully with very little substrate or wood debris to produce water velocity breaks. Upstream fish movement from Asotin Creek is now possible even though the stream channel continues to head-cut where the ponds existed and overall passage conditions are poor. Despite numerous stabilization efforts at this site, it still produces elevated sediment loads that probably contribute to substrate embeddedness and channel widening issues in the mainstem of Asotin Creek.

Little information exists about whether Asotin Creek bull trout use the mainstem Snake River. Historical information from anglers who caught bull trout greater than 50 centimeters (20 inches) long from Asotin Creek suggests that large, fluvial bull trout were present in Asotin Creek and probably used the mainstem Snake River for foraging and overwintering to attain their size (Groat, pers. comm., 2002c). Other tributaries to the Snake River that enter both upstream and downstream of Asotin Creek are known to support fluvial bull trout, which have been observed using the mainstem of the Snake River. Construction of Lower Granite Dam on the lower Snake River, and of Hells Canyon Dam on the upper Snake River, probably did not confine Asotin Creek bull trout to an unproductive reach of the mainstem Snake River. Any Asotin Creek fish using the Snake River after Lower Granite Dam was completed and began operation in 1975 still had free access to 225 kilometers (140 miles) of the Snake River for foraging and overwintering. Information concerning the presence or status of fluvial bull trout from Asotin Creek, particularly on any use patterns of the mainstem Snake River, is not available.

Dam construction in the Snake River may have affected Asotin Creek bull trout to a lesser extent through conversion of river habitat to more reservoir-like habitat and through any negative impacts produced by changes in species composition and increased predator abundance. With regard to population size, the fluvial component of the Asotin Creek bull trout population may have been healthy, but inherently small, even before the smaller dams were built in Asotin Creek and migratory conditions in the lower reaches of this stream became impaired from habitat degradation. The Asotin Creek watershed is small, discharging only 2.1 cubic meters per second mean annual flow (74 cubic feet per second), while other Snake River tributaries discharge higher volumes of water and support modest numbers of fluvial fish (Stoval 2001). As human activities altered habitat in Asotin Creek, and lower stream reaches lost their ability to support rearing and migratory functions, fluvial bull trout would have been the first population component to disappear.

Some fluvial bull trout that currently use the Tucannon River and its tributaries are known to use the mainstem Snake River as foraging, migrating, and overwintering habitat. Also, fluvial bull trout in Asotin Creek and its tributaries historically used the mainstem Snake River as foraging, migrating, and overwintering habitat. For further information on the use of the mainstem Snake River by migratory bull trout, see Chapter 1.

Forest Management Practices

Timber harvest and associated activities such as road construction and skidding can increase sediment delivery to streams. This sediment delivery clogs substrate interstices and decreases stream channel stability and formation. Harvest in riparian areas decreases woody debris recruitment and negatively affects a stream's response to runoff patterns. Stream temperatures rise with decreases in the forest canopy and riparian zone shading. The timing and magnitude of runoff can also change, with more water delivered to streams in a shorter period causing increased stream energy and scour. Forest managers generally recognize these effects and design today's timber cuts to minimize such effects when possible. Although timber harvest comprises the third largest economic base in the Tucannon River watershed, most of the timber-related impacts that occur today in the Snake River Washington Recovery Unit are the result of historical timber harvest and road-building activities (legacy effects).

Tucannon River Core Area. The U.S. Forest Service manages the Umatilla National Forest, which contains 19,673 hectares (48,611 acres) of public land. Nearly 89 percent of all forested lands in the Tucannon River watershed are within the Umatilla National Forest boundary, including 4,856 hectares (12,000 acres) in the Wenaha-Tucannon Wilderness. An additional 2,002 hectares (4,948 acres) of forest lands owned by the Washington Department of Natural Resources are within the watershed. The Washington Department of Fish and Wildlife owns 5,276 hectares (13,037 acres) of mostly forested land outside the Umatilla National Forest.

In the Tucannon River watershed, the majority of current logging impacts are legacy effects from roads and harvest activities that occurred prior to the National Marine Fisheries Service listing of spring chinook salmon in 1992. Accounts of early logging on the Umatilla National Forest within the upper Tucannon River watershed state that the best saw logs had already been harvested by settlers and noncommercial loggers by 1905 (Kuttel 2002). Skidding operations were accomplished with horses, but stream and riparian damage occurred because logs were often moved downhill in stream channels and floodplains. Early harvest activities targeted only the most valuable trees. The bulk of commercial harvest began in the early 1950's. The U.S. Forest Service reported that approximately 30,352 hectares (75,000 acres) have been cut. Most of this land area has had harvest activity over the same areas more than once and by different harvest methods. Fifty to 75 percent of this acreage has been cut up to three times (USFS 1998a).

In the Tucannon River, the National Marine Fisheries Service and the U.S. Fish and Wildlife Service use the Equivalent Clearcut Acre Model as a management tool to assess watershed conditions. Within a watershed, this model determines an acceptable number of acres of forest stand in which the trees are predominantly less than 30 years old. This "threshold" percentage is determined by using total road-harvested acres and estimated forest recovery time and is intended to represent a harvest level under which a watershed can sustain acceptable erosion rates and ensure properly functioning fluvial processes. The threshold percentage determined by the National Marine Fisheries Service for the Tucannon River is 5.1 percent, with the Meadow Creek, the Little Tucannon River, and Cummins Creek drainages approaching 10 percent (USFS 1998a). For all timber sales, the U.S. Forest Service follows PACFISH (interim strategies for managing anadromous fish-producing watersheds in eastern Oregon and Washington, Idaho, and portions of California) (USDA and USDI 1995a) and INFISH (inland native fish interim strategy) (USDA and USDI 1995b) guidelines. By following these guidelines and excluding wetlands and riparian habitat conservation areas from harvest, the amount of harvestable land has been greatly reduced. From a total of 64,751 hectares (160,000 acres) of National Forest land outside the Wenaha-Tucannon Wilderness, only 16,997 hectares (42,000 acres) remain in which timber harvest can occur (USFS 1998a). The last logging operation that took place in what is now the Wenaha-Tucannon Wilderness occurred in 1978 along Panjab Creek above the Meadow Creek confluence. There is evidence of historical logging below the wilderness boundary, but no recent logging has occurred. All but the first 3 kilometers (2 miles) of Panjab Creek is in the wilderness.

The Tucannon River watershed has a total of 245 kilometers (152 miles) of roads within the Umatilla National Forest boundaries. There are 132 kilometers (82 miles) of road open year-round, while 113 kilometers (70 miles) are open only a portion of the year. Roads routinely run through riparian corridors along the river bottom because of the steep slopes of the canyon. Adverse legacy effects exist from some roads on National Forest land in the upper watershed because of original construction on very steep terrain. U.S. Forest Service Road 4712, built in the 1970's, is a main access road from Panjab Creek to the upper Tucannon River watershed above Sheep Creek. This road has a substantial, active landslide that delivers sediment directly into the Tucannon River from Panjab Creek. This reach of the mainstem Tucannon River is an important bull trout spawning location. U.S. Forest Service Road 4713, also built in the 1970's for a timber sale, is the primary access road into the Panjab Creek drainage. The road is slumping in several locations and delivers sediment to Panjab Creek, despite past cut-slope stabilization efforts by the U.S. Forest Service.

Asotin Creek Core Area. In a recent biological assessment, the U.S. Forest Service (1998b) described Federal activities on the Umatilla National Forest in the Asotin Creek watershed and their effects on bull trout local populations. In a description of the environmental baseline, the U.S. Forest Service described the status of bull trout in Asotin Creek with respect to population size, growth and survival, persistence, and genetic integrity. Both of the remaining local populations of bull trout in the Asotin Creek watershed exist in tributaries on U.S. Forest Service lands in the upper watershed. The apparent small size of the local populations is the primary concern for the U.S. Forest Service on forested lands in Asotin Creek.

The Umatilla National Forest encompasses 25,552 hectares (63,140 acres) in the Asotin Creek watershed. Only 40 percent of this area (10,221 hectares, or 25,256 acres) is forested. Nine percent of this amount is considered old-growth forest. Twenty-nine percent of the total Umatilla National Forest acreage is non-irrigated cropland, and 30 percent is rangeland. Both even-aged cuts (clear-cuts) and uneven-aged cuts (selective-cuts) are currently conducted in the basin.

In 1995, only about 162 hectares (400 acres) of old-growth timber remained, mostly in the North Fork Asotin Creek drainage and some in Charley Creek (F. Higgenbotham, U.S. Forest Service, pers. comm., 1995, cited in ACMWP 1995). Between 1970 and 1989, approximately 2,995 hectares (7,400 acres) of forest were clear-cut along tributaries to Asotin Creek, including Charley Creek, South Fork Asotin Creek, and two, 2-hectare (5-acre) cuts on both sides of Cougar Creek. The U.S. Forest Service indicated that these early cuts contributed to rises in water temperatures along adjacent streams because all riparian and upslope timber was harvested. Adequate riparian canopy has not regenerated along Cougar Creek where these two cuts occurred. Since 1970, selective-cuts in the Asotin Creek watershed accounted for 1,821 hectares (4,500 acres) of timber harvest. From 1990 to 1995, clear-cuts accounted for only 971 hectares (2,400 acres).

The U.S. Forest Service (1998b) used earlier studies by the Soil Conservation Service (1981) to report sediment delivery volume into Asotin Creek from land use activities in forests. More than 50 percent of the sediment delivered into Asotin Creek from timber-harvest activities came from existing roads. Some of the forested drainages in the Asotin Creek watershed have road densities as high as 2.6 to 5.0 kilometers of road per square kilometer (4.1 to 5.0 miles per square mile). Roads constructed in the 1970's and 1980's in Charley Creek, Cougar Creek, and South Fork Asotin Creek have been damaged by rain and snow runoff and exacerbated by inadequate drainage systems. Fill slopes on these roads are actively eroding and deliver sediment loads that eventually reach the mainstem of Asotin Creek.

After a 1974 flood, the Washington Department of Fish and Wildlife harvested considerable timber from their lands in the North Fork and South Fork of Asotin Creeks under a "salvage harvest." Although the harvest was designed to remove mostly dead or damaged timber, it also removed most of the live trees from riparian areas along sections of both tributaries (Mendel, pers. comm., 2002e). Legacy effects from this salvage operation in the North Fork and South Fork Asotin Creeks include active erosion, sediment delivery, and increased stream temperatures.

The U.S. Forest Service, as part of the Asotin Creek Technical Advisory Committee, listed the primary limiting factors to fish production as 1) high stream temperatures, even though stream temperatures are generally much cooler on National Forest lands than in privately held lands lower in the watershed; 2) low numbers of large pools; and (3) sediment deposition in spawning areas (ACMWP 1995). Even with these limiting factors, the U.S. Forest Service indicates that conditions on Umatilla National Forest lands in Asotin Creek are good to excellent for fish.

Below the National Forest boundary in Asotin Creek, the frequency of pool habitat and salmonid resting habitat is very limited (ACMWP 1995). Pool habitat in lower Asotin Creek is limited in part because sources of large woody debris (trees) have been eliminated by timber harvest on private property and because livestock have grazed riparian areas (ACMWP 1995).

Livestock Grazing

The most significant effect of livestock grazing in stream corridors is the removal or alteration of riparian vegetation and the physical destruction of streambanks. Other stream channel functions begin to break down when riparian vegetation is lost. Loss of bank vegetation significantly reduces bank stability and greatly increases erosion, bank retreat, and sediment delivery to streams during spring runoff. These effects combine to alter channel shape by increasing sediment buildup and reducing bed stability. Once the stream begins to lose hydraulic equilibrium, it begins to widen and channelize, resulting in loss of pool habitat and depth, in-stream fish cover, and habitat complexity. Grazing on pasture and rangeland is one of three predominant land uses within the Asotin Creek and Tucannon River watersheds. Historical and current grazing practices have caused riparian zone loss, channel widening and down-cutting, vertical cut banks, and excessive gully cuts in sections of both streams, especially Asotin Creek.

Tucannon River Core Area. Kuttel (2002) reports that since the late 1800’s, large herds of sheep and cattle were raised in the Blue Mountains and the upper Tucannon River watershed. The first community settled in the upper watershed in the 1860’s was a base camp for herders of cattle and sheep. In 1906, approximately 150 horses, 900 cattle, and 15,000 sheep grazed in the upper Tucannon River watershed. A map of the Wenaha National Forest dated 1908 documented several extensive cattle ranges and nine sheep ranges on forested land in the upper Tucannon River watershed (USFS 1998a). The National Forest boundaries have since been redrawn to encompass what is now the Umatilla National Forest. Grazed rangeland used for livestock production currently includes 36 percent of the Tucannon River watershed, covering 30,645 hectares (75,725 acres) (Gephart and Nordheim 2001).

The U.S. Forest Service (1998a) reported that some residents living in the watershed believe that current soil erosion problems on open hillsides, where no logging or road construction has occurred, are the result of extensive overgrazing by large sheep herds prior to 1950. Today, the Peola-Pomeroy allotment, which contains the Charley Creek-Pataha Unit, is the primary grazing allotment in the Tucannon River watershed.

Meadow Creek is an important bull trout spawning stream. The creek's lower end is part of the Upper Tucannon grazing allotment, which averages about 70 head of cattle (Kuttel 2002). The current impacts to Meadow Creek bull trout from livestock grazing in this allotment are unknown. Grazing is also a major land use in the Pataha Creek watershed; it is especially heavy in Pataha Creek below Columbia Center. The U.S. Forest Service (1992a revised) noted extensive grazing in one 4.0-kilometer (2.5-mile) section of Pataha Creek on National Forest land. Panjab Creek, another important bull trout spawning stream, was grazed before the Wenaha-Tucannon Wilderness was established. No livestock grazing has occurred in bull trout spawning areas since wilderness protection was implemented in Panjab Creek in the early 1950's.

In the Pataha Creek watershed, ranching comprises the second largest economic base (crop cultivation is the largest). Livestock grazing is a major land use; however, 60 of the 125 landowners who live in the watershed combine both grazing and cropland production on their property (PCD 1998). Rangeland occupies approximately 18,257 hectares (45,114 acres) of land in the Pataha Creek watershed, where grazing occurs largely on terrain either too steep or too dry to grow crops. The majority of grazed range is on the valley slopes above the river valley bottom; slope angles average 50 percent in these areas. In 1996, the condition of 69 percent of grazed lands in the watershed were rated from poor to fair, with soil loss from rill and sheet erosion on all rangeland estimated at 123 million kilograms (135,300 tons) per year (PCD 1998).

In 1991, the estimated annual sediment yield to the Snake River from grazed rangelands along the Tucannon River was 42.7 million kilograms (47,000 tons), or 15 percent of the total sediment load carried by the river that year (TRMWP 1997).

Asotin Creek Core Area. Effects of livestock grazing are listed as a primary limiting factor to aquatic habitat and salmonid production in Asotin Creek (USFS 1993a; ACMWP 1995; Kuttel 2002). Pastureland and associated riparian habitat along Asotin Creek are severely impacted by livestock in areas where animals are fenced in along the stream during the winter (NRCS 2001). These areas are described by the Natural Resources Conservation Service (NRCS 2001) as contributing negatively to the health of the watershed. The Natural Resources Conservation Service noted that, along the mainstem of Asotin Creek in 2000, only 16 percent of the channel had riparian canopy that met goals of at least 70 percent coverage. Riparian trees recently planted by the Asotin County Conservation District were not expected to provide shade for at least 15 years. In some locations, the stream has been used as a watering station for livestock for nearly a century. Although grazing practices and riparian fencing efforts have generally improved in the last seven years as a result of vigorous and proactive work by the Asotin County Conservation District, the damage in many stream reaches, particularly the mainstem below the National Forest boundary, will take years to repair. Damaged streambanks will continue to deliver sediment in many locations, and stream temperatures will remain high without shade from riparian cover. Except in headwater tributaries, these conditions are a common problem in Asotin Creek.

Denuded riparian zones are common in the mainstem of Asotin Creek, South Fork Asotin Creek, and Charley Creek. The lower 4.0 kilometers (2.5 miles) of Charley Creek are severely damaged as a result of cattle watering directly in the stream channel. The lack of riparian canopy cover greatly increases stream temperatures, especially in summer, in all of these streams. Poor riparian and streambank conditions exacerbated damage caused by large floods in 1964, 1974, and 1997, damage that further reduced riparian cover and significantly increased stream temperatures (Stoval 2001). In 1992, temperature monitoring data showed stream temperatures exceeded the Washington State standard from the confluence of the North Fork and South Fork Asotin Creeks at river kilometer 24 (river mile 15) all the way downstream to the mouth of Asotin Creek. High temperatures were believed to be caused by loss of riparian cover and corresponding lack of stream shade (Stovall 2001). A flood in February 1996 removed even more unstable vegetation that was already damaged from confined winter grazing adjacent to the stream.

In 1906, an estimated 30,000 sheep grazed in the Asotin Creek watershed. The U.S. Forest Service began regulating grazing on its lands and established the Asotin allotment in 1929 and the Peola-Pomeroy allotment in 1939 (Stoval 2001). Pasture and rangelands cover 43 percent (36,582 hectares, or 90,393 acres) of the entire Asotin Creek watershed. On Umatilla National Forest lands within Asotin Creek, 30 percent (7,666 hectares, or 18,942 acres) of a total of 25,552 hectares (63,140 acres) is open rangeland. Livestock winter mainly in the lower portions of the watershed from December through March and move upstream in the late spring and summer. Cattle herds continue to graze the lower slopes through the spring until National Forest lands are opened for grazing in June or July (Stoval 2001).

Currently, six private ranchers hold grazing permits on National Forest grazing allotments for a total of 4,500 animal unit months. Below the National Forest boundary on private rangelands adjacent to the stream, 30 percent of the streambank length is grazed year-around or between mid-summer and late winter. The other 70 percent of stream length is either fenced off permanently or grazed only during spring and early summer (ACMWP 1995). About 50 percent of the livestock using rangelands in the Asotin Creek watershed remain in the area year-round. Confined livestock feeding areas are present during winter months along the lower mainstem of Asotin Creek, Charley Creek, and South Fork Asotin Creek. Most of the livestock grazing in each watershed occurs in areas below the National Forest boundary line.

Agricultural Practices

Agriculture is an important part of the economic base for counties in both the Asotin Creek and Tucannon River watersheds. There are 142 farm and ranch operators who own or lease agricultural lands in the watershed (Stoval 2001). Of these farmers, 73 operate full time (ACMWP 1995). The size of agricultural land holdings ranges from 65 hectares (160 acres) to about 2,023 hectares (5,000 acres). The average land holding used for agriculture in the Asotin Creek watershed is 807 hectares (1,993 acres) (Stoval 2001). In the Tucannon River watershed, 83 full-time farm operators own or lease land parcels averaging of 567 hectares (1,400 acres) (TRMWP 1997). In 1997, average soil erosion rates in the Tucannon River watershed exceeded the soil productivity standards of the Natural Resources Conservation Service, and stream sedimentation exceeded tolerable levels for salmonid fish in some locations (TRMWP 1997).

Farming practices, especially those used in the early part of the century, produced high erosion rates and upland degradation (Gephart and Nordheim 2001). Most of the cropland in Asotin Creek and Tucannon River watersheds is classified as “highly erodible land” (ACMWP 1995; TRMWP 1997; Stovall 2001). More recently, farmers have adopted conservation practices such as direct seeding, strip cropping, and terracing to reduce erosion rates and sediment transport to streams. Despite these efforts, sediment delivery to streams from upland sources in both the Tucannon River and Asotin Creek watersheds is still a significant concern in protecting salmonid habitat (TRMWP 1997; Gephart and Nordheim 2001; Stovall 2001; Kuttel 2002).

Tucannon River Core Area. Agricultural practices on naturally erodible soil types, along with tilling and seeding immediately adjacent to and in the floodplain of the Tucannon River, have resulted in greatly increased coarse sediment loads and increased substrate embeddedness along the lower 32 kilometers (20 miles) of the river. The river’s width-to-depth ratio has increased significantly in the lower watershed. Along tilled areas of the streambanks, riparian vegetation has been removed to allow fields to drain more quickly and to reduce the propensity of flooding. Farming practices used from the early 1900’s to 1970 produced high erosion rates, sediment transport to streams, and overall degradation of habitat and water quality in some areas.

Crop systems in the Tucannon River watershed reflect the limited precipitation. Alfalfa, hay, and corn are raised in rotation on approximately 1,147 hectares (2,835 acres) of irrigated bottomlands along the Tucannon River (Gephart and Nordheim 2001). Despite upgraded soil conservation practices and increasing use of no-till crops, a Soil Conservation Service estimate in 1986 put total basin erosion rates at more than 964 million kilograms (1,060,000 tons) of soil per year (Gephart and Nordheim 2001). An estimated 162 million kilograms (177,600 tons) of sediment are deposited in streams within the watershed each year.

Pataha Creek is the largest tributary to the Tucannon River, with a mainstem stream length of more than 98 kilometers (60 miles). While Pataha Creek's mean annual flow has not been calculated, flow measurements ranged between 0.14 cubic meter per second (5 cubic feet per second) in September 1998 to 0.76 cubic meter per second (27 cubic feet per second) in March 1999. Agriculture is one of two primary land uses in this watershed. In Pataha Creek, from the Town of Dodge at river kilometer 16 (river mile 10) down to the stream's confluence with the Tucannon River, the channel is extensively incised as a result of ditching along farm fields and subsequent erosion. The stream has downcut through more than 6 meters (20 to 25 feet) of silt and clay to expose raw bedrock in many locations from the City of Pomeroy to the mouth of the creek. Erosion of cropland soil is exacerbated by the fact that nearly all livestock operators move cattle to cropland following harvest of fields to forage on leftover crop vegetation (PCD 1998). Cropland was identified as the major contributor of the more than 187 million kilograms (205,200 tons) of sediment lost each year through runoff in the mid 1980's. The Pataha Creek sediment load was identified as the primary cause of accelerated braiding in the lower reaches of the Tucannon River below the mouth of Pataha Creek (PCD 1998).

Elevated water temperatures in the lower Tucannon River are believed to be caused, in part, by reduced water volume from withdrawals for irrigation. Removal of water for irrigation is highest in dry years, when the Tucannon River is already low and needs to retain its flow volume to remain within tolerance levels for fish. Irrigation effects are most adverse in borderline water years when the snow pack is low and air temperatures are high. A cursory review of irrigation system data indicates that the overall efficiency of the irrigation system to use water that has been withdrawn is only 65 percent (TRMWP 1997). As of 1995, the Washington Department of Ecology had issued 68 surface water rights for the Tucannon River (Covert *et al.* 1995) for a total diversion of 1.7 cubic meters per second (60 cubic feet per second) to irrigate 464 hectares (1,147 acres) (TRMWP 1997). In 2000, only one additional water right application was pending, for 0.02 cubic meters per second (0.67 cubic feet per second). Since 1995, all other surface water right applications to the Washington Department of Ecology since 1995 have been denied.

Water removed from the Tucannon River during peak crop irrigation may cause a reduction in stream flow that could have adverse impacts on stream temperatures and bull trout migration. Impacts could be particularly severe during spring and fall migration periods in dry years with low snow pack runoff. In dry years, the base summer flows before any withdrawal are well below the volume allocated in combined irrigation permits. The compliance status for fish screen installation on all diversions is unknown. Similarly, it is not known whether diversions are screened in accordance with specifications of the U.S. Fish and Wildlife Service and National Marine Fisheries Service.

Asotin Creek Core Area. Crop production in the Asotin Creek watershed is the second largest land use in Asotin Creek, followed by livestock production. Approximately 26 percent (22,240 hectares, or 54,956 acres) of the watershed is comprised of cropland consisting of grasses, legumes, winter wheat, and spring barley (Stoval 2001). Nearly 6,645 hectares (16,420 acres) of cropland are enrolled in the Conservation Reserve Program. Summerfallow, an erosive till-crop method, occurred in one out of every three years up until 1997, when erosion estimates reached 8,985 kilograms per hectare per year (four tons per acre per year). Direct seeding has now replaced summerfallow practices (Stoval 2001). In discussing “major limiting factors,” the *Asotin Creek Subbasin Summary* (Stoval 2001) states that “Agriculture development has altered or destroyed vast amounts of native shrub steppe habitat, and fragmented riparian/floodplain habitat in the Asotin Creek subbasin. Agriculture operations have increased sediment loads and introduced herbicides and pesticides into streams.” In 1995, of the estimated 40 million kilograms (44,420 tons) of sediment delivered annually to Asotin Creek from all sources, the majority came from croplands (Stoval 2001), even though 30 percent of all agricultural lands in the watershed are enrolled in the Conservation Reserve Program. More than 50 percent of this sediment comes from agricultural and grazing practices in George and Pintler Creeks and from croplands adjacent to lower reaches of the mainstem of Asotin Creek (Stoval 2001). Loess soils predominate in this watershed and are highly susceptible to erosion with any kind of soil disturbance. Most of the sediment load delivered to Asotin Creek and its tributaries comes from upland agriculture below the National Forest boundary (Stoval 2001).

There are an unknown number of small irrigation diversions with unknown screen status on Asotin Creek. In 1950 during a fish survey for the U.S. Fish and Wildlife Service, Parkhurst (1950) counted all of the water diversions from Asotin Creek. By 1994, all of the 31 water diversions he identified were either abandoned or screened. It is not known whether all screens in the watershed meet U.S. Fish and Wildlife Service and National Marine Fisheries Service standards, and so they should be evaluated to verify that bull trout are not affected. Direct impacts to bull trout from water diversions are unknown.

Approximately 10 small pump diversions used to water lawns at private residences are believed to be present in the reach from George Creek to the mouth of Asotin Creek. There is no information on screening compliance (Kuttel 2002) or on impacts to bull trout from operations of the pumps.

<u>Transportation Networks</u>

Roads have been constructed in the Snake River Washington Recovery Unit to provide access for timber harvest, recreation, and urban development and for associated infrastructure, travel, and commerce. Sedimentation and stream channel changes are the primary negative effects of roads on streams (Furniss *et al.* 1991). Edwards and Burns (1986) linked levels of fine sediment in streams to road densities. Weaver and Fraley (1991) and Shepard *et al*. (1984) linked levels of fine sediment to ground-disturbing activities associated with road building. Roads constructed for timber harvest have been linked to significant increases in water yield and peak flows in forested basins (Troendle and King 1987). On steep or unstable slopes, poorly constructed or maintained roads can wash out and trigger large debris flows, which can fill streams with sediment and result in channel instability even decades after the road is abandoned (Cacek 1989).

Culverts are the most common migration barriers associated with road networks. Hydraulic characteristics within a culvert, and improper culvert placement, can impede or prevent fish passage. When Dunham and Rieman (1999) studied patch frequency and occurrence of bull trout in streams within the Boise River basin in Idaho, they found that the occurrence of bull trout was negatively related to road density in the stream basin. Road location and slope, construction methods, local geology, and hydraulic regimes may all affect the level of impact that roads have on bull trout habitat. Accessible roads along streams occupied by bull trout inevitably increase human access to the streams, access that may increase risk to local populations from angling mortality and introduction of nonnative salmonids (Furniss *et al*. 1991; Lee *et al.* 1997).

Tucannon River Core Area. The U.S. Forest Service reported that the Tucannon River watershed, excluding Pataha Creek, has 244 kilometers (152 miles) of road on National Forest lands (USFS 1998a). The *Tucannon River Watershed Biological Assessment of Ongoing Activities for Consultation on Bull Trout* (USFS 1998a) describes road density and road location on forest lands as "Functioning at Risk.." There are roads with riparian areas within occupied bull trout habitat on U.S. Forest Service lands in the upper watershed. As of 1994, the overall road density on forest lands in the Tucannon River watershed was slightly less than 1.2 kilometers per square kilometer (2.0 miles per square mile).

Within the Pataha Creek watershed, there are 341 kilometers (212 miles) of dirt, gravel, and paved County roads. An additional 240 kilometers of roads (149 miles) in the watershed are on the Umatilla National Forest. Many of the roads in this watershed run parallel to Pataha Creek and cross over many smaller tributaries. The road network in Pataha Creek watershed is largely a non-engineered system that is more than a century old. These roads receive runoff from adjacent lands and funnel sediment into Pataha Creek. Although some of the sediment delivered to Pataha Creek comes from poorly constructed and poorly maintained roads, it is important to note that much of the increased sediment delivered by the road system originates from upland land use activities. These activities create loose sediment, which is then deposited in road ditches and culverts that were not designed to transport elevated sediment inputs.

Water damage periodically occurs to roads in the floodplain. Subsequent road maintenance, especially on the main gravel road providing access up Pataha Creek, exacerbates sediment delivery because there are no sediment catch basins along the road and drainage ditches quickly fill with sediment (PCD 1998). In addition, some roads were built on excessively steep grades in the watershed and therefore deliver sediment during runoff and rainstorms. Many of these roads have steep, unprotected cut-and-embankment slopes that have moderate to severe tendencies to erode and therefore to move sediment into the stream system. Specific road maintenance activities that may have impacted historical populations of bull trout in Pataha Creek, and may impact any establishment of bull trout in this watershed, include undersized culverts incapable of handling high sediment loads, installation of flood control channel structures and riprap, ditch and roadway cleaning without sediment removal, grading of aggregate and unsurfaced roads, vegetation control, herbicide and dust-control chemicals, and winter road sanding. Road conditions along Pataha Creek not only affect stream conditions locally, but also impact channel conditions in the mainstem of the Tucannon River at its confluence with Pataha Creek.

Asotin Creek Core Area. Road development and maintenance activities have impacted riparian vegetation along Asotin Creek. Roads are located in the floodplain of most streams and have contributed to the loss of riparian canopies that maintain cool stream temperatures. The mainstem of Asotin Creek has been straightened in numerous places, diked, and even relocated in some reaches to protect the Asotin Creek Road. Asotin Creek Road is an improved-surface road (light paving) that provides the main access to the upper watershed. This road follows the creek bed for 24 kilometers (15 miles). In the upper watershed, between North Fork and South Fork Asotin Creeks, the Asotin Creek Road becomes a graveled, light-duty road maintained by the U.S. Forest Service. This road crosses the stream in numerous locations, requiring the use of culverts, each with variable impacts on fish passage. Many culverts in smaller tributaries need to be replaced to reduce the risk of road failure. A culvert under the Asotin County Road, which crosses Charley Creek, may be a fish passage barrier and needs to be investigated. A perched culvert at the Trent Ridge Road crossing and an associated in-channel pond may represent fish barriers on George Creek. Though George Creek was identified as a potential local population of bull trout by the Snake River Washington Recovery Unit Team, all barriers created by culverts should be addressed as up-front tasks before money is spent on habitat work in this watershed.

Most culverts in the watershed are sized to pass water produced by 25- to 50-year flood events. But many of these culverts are not adequately sized to pass both water and woody material during any large event. Road construction has resulted in loss of riparian vegetation along the mainstem of Asotin Creek, straightening of the stream channel, and significant loss of floodplain function. Most pool habitat has been lost, and not until recently has work been initiated to add log structures to create step pools and rebuild meanders in the stream channel.

Residential Development and Urbanization

Residential development within and adjacent to stream floodplains usually alters flow patterns and important floodplain functions. Stream channel alterations are common in developed areas because property owners attempt to protect property from high water. Urban development replaces important riparian corridors with concrete retaining walls or riprap to protect structures from natural flooding. In developed areas adjacent to a stream, the floodplain is often confined or restricted on one side, a situation that increases scour energy and erosion on the opposite side. Trees and vegetation cleared from streambanks result in significantly reduced bank stability as root masses die, decreased canopy shade, and reduction or elimination of large woody debris sources for the stream. Channel and riparian alterations are detrimental to fish habitat by reducing channel sinuosity, increasing erosive stream energy, and reducing habitat complexity.

Urban development increases demand for surface water for domestic and industrial purposes. Water from leaking septic tanks, drain fields, and storm runoff may seep into groundwater or flow directly into streams as surface flow, causing increased nutrient loads and negative changes in water chemistry and stream temperatures. Groundwater levels may be affected by construction of impermeable surfaces (parking lots, streets, and driveways) and withdrawals for drinking water. Groundwater percolation up into stream gravels is an important characteristic identified in some bull trout spawning areas (Heimer 1965; Shepard *et al*. 1984; Pratt and Huston 1993).

Tucannon River Core Area. As of 1997, the Tucannon River watershed had an estimated total population of 800 full-time residents, including 235 people who live in Starbuck, the principal community in the watershed. There are 83 permanent farm and ranch operators that own or lease agricultural lands in the watershed, and most of these operators own homes and large parcels of land up to 2,023 hectares (5,000 acres) in size (TRMWP 1997). Agriculture is the largest contributor to the economy, followed by forest products and recreation. A number of smaller homes are located mostly along the river corridor and are primarily used for recreational purposes rather than for full-time residences.

Although less than one percent of the land surface in the watershed is covered by urban development, expanding residential subdivisions, numerous individual homes, and the associated infrastructure are located primarily in floodplain areas of the mainstem Tucannon River. In addition, the road network is expanding to accommodate population growth in the watershed.

The Pataha Creek watershed comprises about 35 percent of the entire Tucannon River watershed land area. Private landownership is divided among 152 landowners. The City of Pomeroy is located along Pataha Creek, with City roads and infrastructure located in the floodplain. Within Pomeroy, significant portions of the streambank on both sides have been converted to vertical walls reinforced with concrete or riprap. The stream has been straightened, and there is no floodplain function in this reach. Large trees and other riparian vegetation are largely missing because of channel modification within the City limits and because of upstream land use activities that have caused severe head-cutting and erosion upstream of Pomeroy. In 1998, canopy cover in Pataha Creek ranged from 5 to 15 percent from Pomeroy downstream to its confluence with the Tucannon River (Kuttel 2002). Abandoned concrete slabs covered with mud and vegetation have blocked the stream channel downstream of the well site for Pomeroy.

Asotin Creek Core Area. The lower reaches of the mainstem of Asotin Creek are becoming increasingly urbanized (B. Johnson, Asotin County Conservation District, pers. comm., 2002). Residential development along the lower reaches of Asotin Creek was identified as a primary limiting factor in reestablishing a fluvial bull trout population in the creek and in expanding the downstream distribution of juvenile and subadult rearing habitat (Johnson, pers. comm., 2002; Mendel, pers. comm., 2002f). From the mouth of Asotin Creek upstream to George Creek, a distance of only 5 kilometers (3.1 miles), 55 homes are built in the floodplain, all within 94 meters (300 feet) of the creek channel. From George Creek to Headgate Park, a distance of 9.0 kilometers (5.6 miles), 11 more homes have been built in the floodplain. Above Headgate Park, at river kilometer 14.0 (river mile 8.7), 5 more homes are present in the floodplain within less than 2 kilometers (1 mile). Many of these residential lots contain a home with pasture and livestock feedlots.

Much of the stream channel along these residential areas is confined by riprap and dikes to protect property from floods. These flood control structures, bank protection measures, and heavy animal and human use of the streambanks have caused extensive damage to riparian cover, wood recruitment, pool habitat, and all stream attributes necessary for successful fish migration (ACMWP 1995; USFS 1998b). Stream temperatures during the summer from Headgate Park to the mouth of Asotin Creek are also elevated, at least in part as a result of the development, a factor that probably limits most mainstem use by salmonids in the late spring, summer, and fall.

Mining

Tucannon River Core Area. Mining historically occurred in isolated areas of the upper Tucannon River watershed. Mining development occurred between 1897 and 1998. At least four placer mines (Last Chance, Alice, Eureka, and Big Four) were operated during this period on Cummings Creek and the upper Tucannon River. The mines produced only small quantities of gold, silver, and copper ore. Most mining operations in the basin were abandoned around 1920 because they were not profitable (USFS 1998a). It is unknown whether these mines and their resulting waste materials affected water quality or habitat in the Tucannon River watershed. The U.S. Forest Service (1992b) did not identify any adverse conditions from two old mine sites on Cummings Creek.

Asotin Creek. No documentation of mining activities in the Asotin Creek watershed was found.

Fisheries Management

Historically, overharvest of bull trout throughout the Columbia River basin probably contributed to their decline. In the same period, reduction in spawning and rearing habitat in tributary systems lowered fish production. Harvest may have included both legal recreational angling and poaching. The bull trout's piscivorous nature created negative public perception that these fish consumed large numbers of more desirable salmonids. As a result, bull trout were held in low regard by anglers and were targeted for removal (Simpson and Wallace 1982; Bond 1992). State-sponsored eradication programs and bounties were offered for removing bull trout in Montana (Thomas 1992); however, there is no written record of these types of programs occurring in Washington (Mendel, pers. comm., 2002g)

In recognition of bull trout declines, State management agencies in Idaho, Montana, Washington, and Oregon suspended harvest of bull trout in the Columbia River basin except in a few limited locations. State fishing regulations allow for the harvest of other salmonid species in most waters. As bull trout populations become small, every adult fish becomes increasingly important to the propagation of future generations. In the Snake River Washington Recovery Unit, every bull trout mortality caused by incidental hooking is significant. This source of mortality will always be present in streams occupied by both bull trout and other fishable stocks of anadromous or resident salmonids. The Tucannon River is used by Snake River steelhead, spring chinook, and fall chinook salmon; of the anadromous species, a fishery exists only for steelhead.

Within the Snake River Washington Recovery Unit, overfishing has reduced bull trout populations in some southeast Washington streams, including the Tucannon River, as some anglers targeted bull trout when the fish were concentrated below stream barriers and vulnerable just prior to, or during, spawning (Mendel, pers. comm., 2002g). In addition, bull trout may have been historically considered an unfavorable species by anglers, as occurred in other areas (Thomas 1992), and been specifically targeted for removal. Current angler-related threats to bull trout in the Snake River Washington Recovery Unit could occur through misidentification and accidental harvest, intentional poaching, or hooking mortality.

The lower Snake River dams converted free-flowing (lotic) river habitats into slow-moving (lentic) reservoir habitat. With this change also came new fish species assemblages that were introduced to exploit the changed habitat. Seventeen nonnative fish species currently share resources with 18 native species in the lower Snake River reservoirs (Bartels *et al.* 2001). While attempts to study bull trout interactions, or diet overlap, with nonnative fishes in the Snake River have not been completed, it is likely that some level of competition and or predation occurs that does not favor bull trout. Well documented is the fact that the number of nonsalmonid fish predators has increased since the lower Snake River reservoirs were created (Karchesky and Bennett 1995).

Tucannon River Core Area. Recreation activities in the Tucannon River watershed are not all linked with fishing; however, fishing is a primary attraction for people visiting the river. Eight manmade lakes have been constructed adjacent to the Tucannon River from the mouth of Cummings Creek to Panjab Creek, a distance of 19 kilometers (12 miles). Six of these lakes withdraw water from the Tucannon River at a rate of 0.07 cubic meters per second (2.5 cubic feet per second) each; two of the lakes are filled using spring water. These small lakes were made specifically for recreation: camping and rainbow trout fishing.

Rainbow Lake was built prior to 1980 just above Cummings Creek. A dam is used to divert water from the Tucannon River into the Tucannon Fish Hatchery and Rainbow Lake. The dam is enough of a barrier that it required a fish ladder. Though upstream passage efficiency for the early ladder was not evaluated, passage may have been limited because excessive slope in the ladder created high water velocities and because the step pools were small and infrequent. The Washington Department of Fish and Wildlife believes that passage for bull trout was poor. In 1994, the ladder was rebuilt, but bull trout were killed in the new ladder when they became caught by the gills in weir pickets that had spacing designed for larger steelhead and salmon (Mendel, pers. comm., 2002h). While the picket spacing has since been reduced to avoid this problem, the passage efficiency for bull trout at this site is still unknown and should be evaluated.

Curl Lake is another of these adjacent lakes that is used for acclimating spring chinook salmon. In 1996, the original dam, which diverted water into Curl Lake, and a fish ladder associated with the dam washed out, causing severe bank damage. The stream channel had to be reconstructed and the dam and fish ladder replaced. Passage at the original dam was thought to be poor. The dam now has a boulder-type fish ladder that is believed to afford good bull trout passage, but that ladder has not been evaluated. The dam currently diverts a volume of 0.14 cubic meter per second (5 cubic feet per second) into Curl Lake during summer and fall. The diversion is screened, but further reduces river flows in crucial low-flow periods each year.

The series of manmade lakes are located fairly high in the watershed, just downstream of Panjab Creek where bull trout spawn in the mainstem of the Tucannon River. The lakes attract heavy recreation pressure of all types. All of the lakes are open for trout fishing. Impacts that threaten bull trout occur as a result of recreational use, including poaching, incidental harvest, trampling of the streambank, and riparian clearing.

Many other recreation activities take place in or around the main river channel and tributaries. Poaching and streambank degradation caused by activities associated with fishing and camping have been identified as concerns for Tucannon River bull trout. Fishing, camping, hunting, wildlife viewing, and hiking constitute almost 400,000 visitor days per year. Recreation use is very high on forested lands and is the dominant use of lands within the Wenaha-Tucannon Wilderness. Recreation is also the primary activity on 39,536 hectares (16,000 acres) owned by the Washington Department of Fish and Wildlife adjacent to the Tucannon River. Because of the relatively narrow and steep stream canyons, most human activity takes place in riparian zones. In the Tucannon River watershed, more than 81 kilometers (50 miles) of trail are maintained for nonmotorized use, and 10 kilometers (6 miles) of trail are maintained for off-road recreational vehicles. Most trailheads originate at various locations along the river bottom.

In addition to managing eight lakes, the Washington Department of Fish and Wildlife currently manages seven campgrounds, averaging approximately 0.4 hectares (1.0 acre) in size, on State-owned lands in the watershed. Recreational activities are concentrated in the riparian zone, and substantial impacts have occurred to riparian soils and vegetation and to the stream channel. Vegetation is severely trampled or cut down, damaged by anglers attempting to access the stream, or removed by campers looking for firewood and roasting sticks. The stream channel and banks are devoid of large woody debris pieces because they have been removed for firewood, especially near campgrounds. On occasion, the river has also been temporarily dammed by people building rock structures for wading pools. Until recently, most campgrounds were located immediately adjacent to the river. In response to the Federal listing of spring chinook salmon that use the Tucannon River system, about half of the campgrounds were moved to protect damaged riparian zones, but some of the campgrounds still remain open in sensitive streamside locations.

The U.S. Forest Service owns five campgrounds located in areas adjacent to the Tucannon River, and a sixth is being considered (Gephart and Nordheim 2001). Recreation will probably always be an approved use in the watershed. But with greater human use comes an increased probability that bull trout will be impacted either directly through poaching or indirectly through damage to important migration corridors or spawning habitat. Focused programs to increase enforcement of fishing regulations and prudent management of camping facilities may be the only options to protect bull trout from recreation impacts.

The Tucannon River and its tributaries receive substantial fishing pressure all year, pressure that probably impacts adult bull trout spawning escapements. In 1990, Washington Department of Fish and Wildlife angling regulations allowed harvest of two bull trout per day, none smaller than 51 centimeters (20 inches). In 1996, to protect adult spawners, regulations were changed to eliminate bull trout harvest in the mainstem of the river and in all tributaries above and including Panjab Creek. In 1998, the bull trout limit was reduced to one fish over 61 centimeters (24 inches) below Panjab Creek. Bull trout harvest was allowed in the Tucannon River below Panjab Creek up until 1999, when the Washington Department of Fish and Wildlife closed the fishery. Benefits to the harvest closure have not been evaluated scientifically; however, since 1999, both the number and size of bull trout caught and released by steelhead anglers during the winter and spring is reported to have increased (Mendel, pers. comm., 2002i).

Although the bull trout fishery is closed, incidental hooking mortality still occurs while fishermen target other salmonid species during open fishing seasons (Mendel, pers. comm., 2002j). Snake River steelhead, spring chinook salmon, and fall chinook salmon all spawn in the Tucannon River. Managed salmonid fisheries are allowed for steelhead, resident rainbow trout, and mountain whitefish (*Prosopium williamsoni*) only. From 1983 through 1999, the Washington Department of Fish and Wildlife stocked rainbow trout into the Tucannon River near the Tucannon River Fish Hatchery. In this 17-year period, the Washington Department of Fish and Wildlife stocked 283,813 catchable rainbow trout. Significantly fewer rainbow trout were stocked in the 1990's to minimize potential impacts on listed steelhead and salmon, and stocking in the Tucannon River ceased completely in 2000. Impacts on bull trout from past stocking practices are unknown, but predation and competition for food may have occurred. Anglers can also harvest brook trout (*Salvelinus fontinalis*) with no limit in Pataha Creek, a Tucannon River tributary.

Steelhead are a popular game fish sought by Tucannon River anglers. The steelhead fishing season on the Tucannon River runs from September 1 to April 15. Total annual steelhead harvest ranges between 400 and 600 fish annually, with anglers expending an estimated 6,000 to 7,000 hours of fishing effort in this period. Barbless hooks (single or treble) are required for steelhead fishing, but bait (roe, shrimp, and night crawlers) is allowed and frequently used. Hooking mortality of adult bull trout is known to occur in the Tucannon River during spring steelhead fishing periods, but catch rates and mortality estimates have not been quantified (Mendel, pers. comm., 2002g). Beginning in 2002, as part of weekly steelhead creel surveys, the Washington Department of Fish and Wildlife queries all anglers to determine whether they have caught and released bull trout while fishing for steelhead. This information will be used to derive catch rates for estimates of adult bull trout abundance and provide rough estimates for bycatch hooking mortality (Mendel, pers. comm., 2002i).

In 1949, the Washington Department of Game built the Tucannon River Fish Hatchery to produce rainbow trout. Under an agreement in 1986, the U.S. Army Corps of Engineers purchased the hatchery to raise steelhead and spring chinook salmon as part of the Tucannon River anadromous fish supplementation program. Because bull trout evolved with native stocks of steelhead and salmon in this watershed, the recovery unit team does not believe that supplementation of these native stocks adversely impacts bull trout or acts to hinder bull trout recovery. Fall chinook salmon spawn naturally in the lower Tucannon River in the late fall. Deposited eggs from these fish may provide a valuable food source for post-spawn bull trout returning to the mainstem of the Tucannon River or the Snake River in November and December. Salmon and steelhead juveniles may represent important prey items for bull trout as salmonid smolt outmigration overlaps temporally and spatially with upstream migration of spawning bull trout in the spring. The hatchery steelhead fishery does, however, result in some level of additional bull trout hooking mortality (Mendel, pers. comm., 2002g).

Brook trout may have contributed to the extirpation of bull trout from the Pataha Creek local population. Hybridization between bull trout and brook trout has not been identified in the Tucannon River, and samples have not been collected for genetic evaluation. While brook trout pose a problem in Pataha Creek, they have not been found in any other tributaries to the Tucannon River and occur as the only known population in southeastern Washington (Mendel, pers. comm., 2002a). Brook trout are restricted to upper reaches of Pataha Creek because of severe stream channel degradation, riparian vegetation loss, and seasonally excessive water temperatures in the lower 64 kilometers (45 miles) of this stream.

Movement of brook trout from Pataha Creek into the Tucannon River is largely impeded or blocked completely because of habitat degradation in lower Pataha Creek. Kuttel (2002) reported that substrate in the lower 19 kilometers (12 miles) of Pataha Creek was 100 percent embedded and that substrate in all reaches from Pomeroy upstream to the National Forest boundary at river kilometer 69 (river mile 43) was more than 50 percent embedded with fine sediment. Brook trout encroachment into the Tucannon River may occur in the future under the right flow conditions, but, to date, such encroachment has not been documented (USFS 1998a).

Asotin Creek Core Area. Rainbow trout were heavily planted in Asotin Creek to support a recreational fishery. From 1935 to 1980, more than 1.2 million rainbow trout were stocked in Asotin Creek. In 1935, a planting record described rainbow trout stocking in South Fork Asotin Creek, Charley Creek, Lick Creek, and George Creek. It states that the streams were "heavily fished" and had good road access (stocking record shown in Appendix M of ACMWP 1995). As of April 1994, the Washington Department of Fish and Wildlife implemented regulations requiring barbless hooks and artificial lures only in Asotin Creek, but still allowed an eight-fish limit for rainbow trout in North Fork Asotin Creek. Bull trout harvest was closed in North Fork Asotin Creek above the National Forest boundary, but was allowed in the lower 8 kilometers (5 miles) of the stream. Bull trout harvest has since been completely closed in North Fork Asotin Creek, which is one of only two remaining areas where bull trout spawn in the Asotin Creek Core Area. Impacts to bull trout from more than 40 years of rainbow trout stocking and heavy fishing pressure are unknown.

As discussed earlier, fishing ponds were constructed in Charley Creek, a tributary of Asotin Creek, to provide fishing opportunities as early as 1949. There are no records that document adverse interactions between bull trout and hatchery rainbow trout in Asotin Creek. However, there are still severe habitat and sediment problems associated with erosion and head-cutting in Charley Creek where the fishing ponds previously existed in the stream channel.

Isolation and Habitat Fragmentation

Bull trout spawn and rear in isolated portions of stream drainages in both core areas of the Snake River Washington Recovery Unit. The locations of manmade barriers and the passage problems they cause have been well described. Some barriers have been eliminated, but some still exist as partial barriers with continuing impacts. Destruction of riparian zones, leading to high water temperatures, is the most significant factor acting to reduce fish movement and habitat use in the middle to lower reaches of the Tucannon River and Asotin Creek. Elevated water temperatures limit bull trout distribution in some areas from July through October. Juvenile rearing and adult migration in lower stream reaches is prevented during this period. Other water quality parameters within lower reaches of the Tucannon River watershed are within Washington State standards most of the time and probably do not hinder expansion of local populations.

Asotin Creek and the Tucannon River are separated by the mainstem hydroelectric facilities at Little Goose and Lower Granite Dams. While genetic analyses have not been initiated to provide conclusive evidence, the physical distance that separates these streams makes interbreeding unlikely between these populations. Additional genetic information is needed to verify the separation of bull trout within the core areas of the Snake River Washington Recovery Unit.

Tucannon River Core Area. Within the Tucannon River watershed, several important streams that support bull trout spawning and rearing have impassable natural barriers that substantially reduce the stream area available to fish. Most of these barriers are sizable waterfalls that may eliminate opportunities to bring additional stream area into production. Waterfall barriers, from 3 to 8 meters (10 to 25 feet) high occur in Sheep Creek at river kilometer 0.8 (river mile 0.5), in Bear Creek at river kilometer 4.8 (river mile 3.0), and in Cold Creek at river kilometer 3.2 (river mile 2.0). All three streams support spawning bull trout below these barriers. Habitat in each of the streams is protected by various Federal and State land designations. About 202 hectares (500 acres) in the Sheep Creek drainage are designated as a botanical preserve (USFS 1992d). The Bear Creek and Cold Creek drainages lie entirely within the Wenaha-Tucannon Wilderness (USFS 1992e, 1992f).

The Washington Department of Fish and Wildlife identified one structure that may hinder migration and access of bull trout to upper spawning reaches of the Tucannon River (Mendel, pers. comm., 2002h). Located below Rainbow Lake, this barrier is a fish weir that is used to capture adult chinook salmon. Bull trout are allowed to pass during noncollection periods by way of a fish ladder around the facility that was built in 1997. During fish collection periods, bull trout are allowed to pass twice daily as the weir is checked for salmon (USFS

1998a). No other information is available on how frequently bull trout use the ladder or on the ladder's passage efficiency.

Meadow Creek is another tributary that supports spawning bull trout. A survey in 1992 by the U.S. Forest Service survey (USFS 1992f) describes a log jam 3.6 meters (11.8 feet) high at river kilometer 0.5 (river mile 0.3). This log jam broke up during high spring flows in 1996, how long the log jam was there prior to 1996 is unknown. It may have blocked upstream migration. Kuttel (2002) describes numerous debris dam barriers caused by buildup of dense Russian thistle (*Salsola iberica*) combined with fine sediment. These barriers are reported to be adequately large and dense to block steelhead migration into Meadow Creek and may also inhibit movement of bull trout during certain periods of the year. The Washington Department of Fish and Wildlife has indicated that a woody riparian buffer zone along Meadow Creek is needed to trap most of the tumbleweed to keep it from reaching the stream (Kuttel 2002). Three natural waterfalls, each 0.6 meters (2.0 feet) high and lacking plunge pools, may also hinder bull trout movement during low-flow periods in Meadow Creek.

Asotin Creek Core Area. No waterfalls, dams, culverts, or irrigation diversions are present in North Fork Asotin Creek or Cougar Creek (USFS 1992b, 1992h). The only spawning populations of bull trout in the Asotin Creek watershed are found in upper North Fork Asotin Creek and Cougar Creek, one of North Fork Asotin Creek's upper tributaries. Both local populations are believed to be isolated resident fish because seasonal water temperatures and poor habitat conditions exclude bull trout use of the mainstem Asotin Creek below the confluence of Charley Creek at river kilometer 21.7 (river mile 13.5). Isolation of these bull trout is exacerbated because fluvial bull trout that used the Snake River are thought to be absent or in very low abundance. Poor conditions in the stream channel and riparian zones, as well as high substrate embeddedness, also limit bull trout distribution below Charley Creek in the mainstem of Asotin Creek.

ONGOING RECOVERY UNIT CONSERVATION MEASURES

Soil erosion and sediment delivery to streams. On private lands, the Asotin County Conservation District, Pomeroy Conservation District, Columbia Conservation District, and Natural Resources Conservation Service are currently working to encourage dryland farmers to implement best management practices that reduce soil erosion and sediment delivery to streams in the Tucannon River and Asotin Creek watersheds. Since 1995, numerous projects have been implemented in both watersheds, including using no-till/direct-seed farming methods, installing terraces and sediment basins, using vegetated filter strips, and enrolling crop acreage into the Conservation Reserve Program (Kuttel 2002). In the Asotin Creek watershed, more than 8,458 hectares (20,900 acres) of cropland were enrolled in the Conservation Reserve Program, and 41 hectares (102 acres) were converted to Conservation Reserve Enhancement Program buffers to reduce sediment delivery to stream drainages. In the Tucannon River watershed, the Columbia Conservation District was instrumental in converting 567 hectares (1,400 acres) of tilled cropland to no-till/direct-seed farming in 1999 and 2000. The Pomeroy Conservation District helped to establish 3,592 hectares (8,876 acres) of no-till/direct-seed farming and 357 hectares (883 acres) of beneficial strip cropping to reduce erosion from croplands in Pataha Creek. The Washington Department of Fish and Wildlife installed a sediment basin below Hardtack Grade to reduce sediment delivery to the Tucannon River from lands that it manages for the Washington Department of Natural Resources (Kuttel 2002). Projects such as these will be instrumental in restoring and protecting bull trout habitat in the Tucannon River.

Riparian Buffers. With key funding from the Bonneville Power Administration and the Washington State Salmon Recovery Funding Board, the Asotin County Conservation District (Asotin Creek watershed) and Columbia Conservation District (Tucannon River watershed) are addressing riparian zone problems through the Conservation Reserve Program. This program is intended to restore riparian forest buffers on agricultural land adjacent to salmonid-bearing streams (Kuttel 2002). The Conservation Reserve Program is available through the Natural Resources Conservation Service to landowners who want to restore riparian buffers. Livestock is fenced out of the buffer area, and native vegetation is replanted. Landowners are compensated at 200 percent of the agricultural value of the land placed in the buffer over a 10- to 15-year rental agreement. Since 1995, the Asotin County Conservation District, in cooperation with landowners, has replanted 9,144 linear meters (30,000 linear feet) of riparian vegetation and installed 8,229 linear meters (27,000 linear feet) of riparian fencing. Since 1996, the Columbia Conservation District has planted 196,826 riparian trees and shrubs and installed 6,325 meters (20,753 feet) of riparian fence along the Tucannon River.

The Asotin County Conservation District is currently improving 33 kilometers (20 miles) of riparian buffers along Asotin Creek and its tributaries. In the Tucannon River watershed, the Columbia Conservation District was instrumental in establishing more than 68 hectares (169 acres) of riparian buffer along the Tucannon River and its tributaries (Kuttel 2002). The Columbia County Conservation District is currently improving 40 kilometers (25 miles) of these buffer zones. In Pataha Creek from 1996 to 2000, the Pomeroy Conservation District planted 49,900 riparian trees, installed 2,743 meters (9,000 feet) of riparian fencing, and established 36 hectares (88 acres) of riparian buffer zone along streams (Kuttel 2002). These efforts will help to abate water temperature problems in stream corridors used by migrating bull trout and help to improve stability of streambanks in both the Asotin Creek and Tucannon River watersheds.

Instream habitat. Since 1995, the Asotin County Conservation District has also placed 327 in-stream habitat structures to create plunge and scour pool habitat in Asotin Creek (NRCS 2001). From 1996 to 2001 in the Tucannon River, the Columbia Conservation District installed structures to create 84 large pools and 615 small- to medium-size pools for fish habitat. In the same years, the Columbia Conservation District also placed large woody debris and various structures to improve habitat complexity along 9,072 meters (29,764 feet).

Fisheries management. All waters in the Tucannon River and Asotin Creek watersheds are closed to the harvest of bull trout. Open fishing areas do overlap with areas used by bull trout, but selective gear rules are in place to protect bull trout from injury if they are hooked incidentally. The Washington

Department of Fish and Wildlife no longer stocks hatchery trout in the Tucannon River or Asotin Creek; this practice may help to reduce potential competition with bull trout. To help stream productivity, the Washington Department of Fish and Wildlife returns carcasses of hatchery steelhead and salmon back to the Tucannon River. This practice may benefit growth and survival of juvenile and subadult bull trout. Each spring, the Washington Department of Fish and Wildlife also counts adult fluvial bull trout at the anadromous fish trap at the Tucannon River Hatchery. This information provides an index of adult bull trout escapement in the Tucannon River watershed, and, as bull trout recovery tasks are implemented, the counts will be valuable to assess population responses of this bull trout life history form.

The U.S. Fish and Wildlife Service and the Washington Department of Fish and Wildlife will cooperatively conduct a study to evaluate bull trout movements in the Tucannon River and lower Snake River. The proposed project will meet the requirements of reasonable and prudent measures (10.A.3.1) in the U.S. Fish and Wildlife Service's Biological Opinion for the Federal Columbia River Power System (USFWS 2000). This study will determine the spatial distribution, migration timing, and movements of adult migratory bull trout in the lower Tucannon River and Snake River. This study will also collect empirical data to determine whether fishway design at the Snake River dams are suitable for passing bull trout through the projects, and, if so, what features could be replicated at other projects. The project will also collect data on the spatial and temporal distribution of bull trout in the mainstem lower Snake River reservoirs, estimate "fall back," and determine whether bull trout losses result when fish leave the Lower Monumental Dam pool.

The State of Washington produced a draft plan called *Extinction Is Not an Option: A Statewide Strategy to Recover Salmon* (State of Washington 1999). The plan was produced by the Washington Governor's Salmon Recovery Office and Joint Natural Resources Cabinet and served as the template for recovery unit designation in the Washington portion of the Columbia River distinct population segment. While this plan focuses primarily on salmon, many of the same factors affecting salmon also impact bull trout. Therefore, overall goals and strategies identified in this document for restoring healthy populations of salmon are consistent with actions needed for bull trout recovery. In addition, recovery unit teams incorporated information from the Washington State salmonid stock inventory for bull trout/Dolly Varden (WDFW 1997) and the management plan for bull trout/Dolly Varden (WDFW 2000), both prepared by the Washington Department of Fish and Wildlife.

The Washington State legislature established the Watershed Management Act (ESHB 2514) and the Salmon Recovery Planning Act (ESHB 2496) to assist in salmon recovery efforts. The Watershed Management Act provides funding and a planning framework for locally based watershed management addressing water quality and quantity. The Salmon Recovery Planning Act provides the direction for developing analyses of limiting factors for salmon habitat and creates a list of prioritized restoration projects at the watershed level. The Washington State Conservation Commission developed an analysis of salmonid-limiting factors, addressing habitat factors affecting Snake River salmon, steelhead, and bull trout (Kuttel 202). Results of this work were applied in the recovery planning process for the Columbia River distinct population segment. Though not specifically targeting limiting factors for bull trout, these documents have nonetheless played an important role in developing the Snake River Washington Recovery Unit chapter.