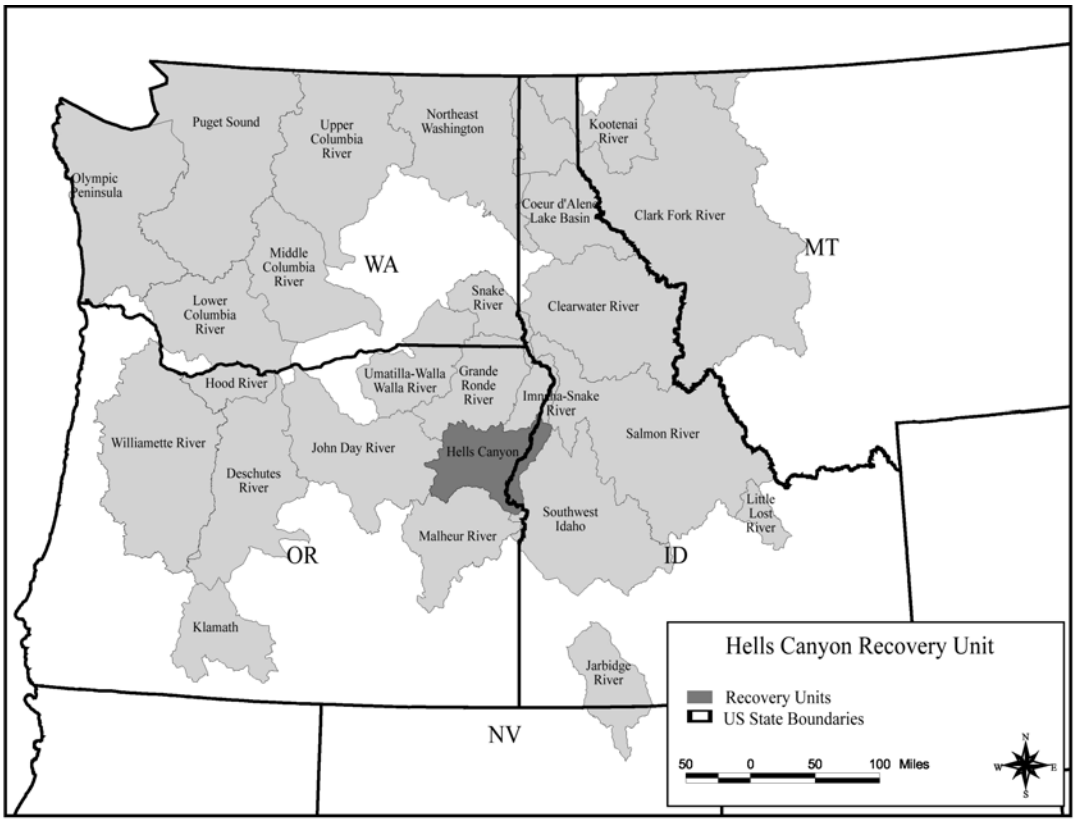
INTRODUCTION

Recovery Unit Designation

The Hells Canyon Complex Recovery Unit is 1 of 22 recovery units designated for bull trout in the Columbia River basin (Figure 1). The Hells Canyon Complex Recovery Unit includes basins in Idaho and Oregon, draining into the Snake River and its associated reservoirs from below the confluence of the Weiser River downstream to Hells Canyon Dam. This recovery unit contains three Snake River reservoirs, Hells Canyon, Oxbow, and Brownlee. Major watersheds are the Pine Creek, Powder River, and Burnt River drainages in Oregon, and the Indian Creek and Wildhorse River drainages in Idaho. Inclusion of bull trout in the Oregon tributaries (*i.e.,* Pine Creek and Powder River) in one recovery unit is based in part on a single gene conservation unit (*i.e.,* roughly the major drainages in Oregon inhabited by bull trout) recognized by the

Figure 1. Bull trout recovery units in the United States. The Hells Canyon Complex Recovery Unit is highlighted.



Oregon Department of Fish and Wildlife (Kostow 1995), which is supported by the genetic analysis conducted by Spruell and Allendorf (1997). Although the genetic composition of bull trout in the two tributaries in Idaho has not been extensively studied, the streams were included in the recovery unit due to their close proximity to the tributaries in Oregon containing bull trout, and the likelihood that bull trout from all tributaries were able to interact historically. Administratively, the Oregon Department of Fish and Wildlife established a working group to develop bull trout conservation strategies in Pine Creek, and the streams in Idaho were included in the Hells Canyon Key Watersheds in the Idaho Bull Trout Conservation Plan (Grunder 1999).

Geographic Description

The Hells Canyon Recovery Unit encompasses three 4th-field hydrologic units of the U.S. Geologic Survey. The Brownlee Reservoir hydrologic unit (hydrologic unit code (HUC)--1705201) includes the Snake River, Hells Canyon Complex of three reservoirs, and all tributaries in Idaho and Oregon from just downstream of the Weiser River confluence to Hells Canyon Dam, excluding the Burnt River and Powder River basins in Oregon. This hydrologic unit consists of 334,120 hectares (825,600 acres). The Burnt River hydrologic unit (HUC--1705202) includes the entire Burnt River basin, and consists of 282,319 hectares (697,600 acres). The Powder River hydrologic unit (HUC--1705203) includes the entire Powder River basin, and consists of 445,494 hectares (1,100,800 acres).

The Snake River flows in a generally south to north direction, and forms the boundary between Idaho and Oregon within the Hells Canyon Complex Recovery Unit. The recovery unit consists of 168 kilometers (104 miles) of the Snake River, of which most of the length is within the Hells Canyon Complex of reservoirs. Tributaries in which bull trout occur or may occur flow into the three Snake River reservoirs (Table 1). Elevations within the Hells Canyon Complex Recovery Unit range from about 2,133 to 2,438 meters (7,000 to 8,000 feet) in the Wallowa Mountains and Blue Mountains in Oregon (Buchanan *et al.* 1997) and from 2,255 meters (7,400 feet) in the Seven Devils Mountains in Idaho (Grunder 1999), to 122 meters (400 feet) at Hells Canyon Dam (Saul *et al.* 2001).

Table 1. Approximate river distances of major physical features within the Hells Canyon Complex Recovery Unit upstream of the Snake River confluence with the Columbia River.

Feature	River kilometer	River mile
Hells Canyon Dam	398	247.6
Pine Creek confluence	434	269.7
Indian Creek confluence	436	271.0
Oxbow Dam	439	272.8
Wildhorse River confluence	455	282.8
Brownlee Dam	459	285.3
Powder River confluence	476	295.8
Burnt River confluence	527	327.5
Brownlee Reservoir[1]	552	343.1
Weiser River confluence	566	351.6

[1] Upstream extent of Brownlee Reservoir.

The Hells Canyon Complex Recovery Unit is largely rural with much of the lands in Federal ownership. In the Pine Creek, Powder River, and Burnt River watersheds, combined, about half of the area is federally owned (Nowak 2001), whereas the remainder is private. The majority of lands in the Indian Creek and Wildhorse River watersheds of Idaho are federally owned (Grunder 1999). About 90 percent of the area in Indian Creek is administered by the Payette National Forest, and over half of the area in the Wildhorse River watershed is administered by the Payette National Forest and Bureau of Land Management. However, a substantial amount of private land occurs along Bear Creek, a tributary of Wildhorse River. Portions of the headwaters for Pine Creek (Norway Creek, Middle Fork Pine Creek, and West Fork Pine Creek) and the Powder River (Eagle Creek, East Fork Eagle Creek, and West Eagle Creek) occur in the Eagle Cap Wilderness Area (Nowak 2001). Reaches of the Powder River, North Powder River, and Eagle Creek, totaling 72 kilometers (44.7 miles), are designated as Wild and Scenic. Downstream portions of the recovery unit occur in the Hells Canyon Wilderness Area and Hells Canyon National Recreation Area.

The overall climate of the Hells Canyon Complex Recovery Unit is temperate continental, which consists of light precipitation, low relative humidity, rapid evaporation, abundant sunshine, and wide temperature and annual precipitation fluctuations (Nowak 2001). Mean temperatures at the lower elevations are typically 26.7 to 32.2 degrees Celsius (70 to 80 degrees Fahrenheit) in summer, and above -1.1 degrees Celsius (30 degrees Fahrenheit) during winter (Saul *et al.* 2001). Precipitation is highly seasonal with short, intense thunderstorms during summer and longer, milder storms delivering the majority of the annual precipitation during winter. Mean annual precipitation is 330 millimeters (13 inches) in the Hells Canyon area and 1,753 millimeters (69 inches) in the headwaters of Pine Creek. Some areas (*e.g.,* portions of the Powder River basin) are subject to rain-on-snow events, which reduce snow pack and may cause localized flooding.

Geology of the Hells Canyon Complex Recovery Unit consists primarily of granitic batholith formations and volcanic basalt (Saul *et al.* 2001; Nowak 2001). These and some metamorphic formations have produced soils low in clay with high erodible potential (*e.g.,* in the Powder River basin). The basalt deposits in Hells Canyon area are prone to landslides and mass wasting. Lava flows dammed the Snake River in Hells Canyon about 13 million years ago forming Lake Idaho. River flow breached the lava flow; and flows and the Bonneville flood increased downcutting in tributary canyons and distributed sediments. Vegetation within the recovery unit includes mixed conifer forests and Ponderosa pine (*Pinus ponderosa*) in forested areas, and shrub and grassland communities elsewhere.

Fish Species. Anadromous fishes (*e.g.,* chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*O. nerka*), steelhead (*O. mykiss*), and Pacific lamprey (*Lampetra tridentata*)) historically occurred in areas of the Hells Canyon Complex Recovery Unit (Saul *et al.* 2001; Stovall 2001). These species primarily migrated through the Snake River from the Pacific Ocean to spawning habitats located in tributaries either within the Hells Canyon Complex Recovery Unit or upstream (*e.g.,*the Powder River basin and the Payette River basin, respectively). Construction of impassable dams, first within the Snake River tributary basins (*e.g.,* Thief Valley Dam in the North Powder River, which was constructed in 1931) (Nowak 2001) and later in the Snake River (*i.e.,* the Hells Canyon Complex of three dams, which was

completed from 1959 through 1967) (Saul *et al.* 2001), eliminated natural runs of anadromous fishes in the recovery unit. The loss of these runs and associated nutrients derived from their carcasses is thought to have negatively affected resident fishes by reducing overall watershed productivity (Nowak 2001; Saul *et al.* 2001; Stovall 2001).

Forty-one fish species are known to have occurred, or may presently occur in the Hells Canyon Complex Recovery Unit (Table 2) (Chandler and Richter 2001; Nowak 2001; Saul *et al.* 2001). Thirty-two of these were documented in the Powder River basin (Nowak 2001). Because the remaining nine taxa were reported in the portion of the Snake River and select tributaries from C.J. Strike Dam downstream to Hells Canyon Dam (Saul *et al.* 2001), they may occur in the Hells Canyon Complex Recovery Unit. Of the 41 species, almost half (19) are native, with redband trout (*Oncorhynchus mykiss*), bull trout, and mountain whitefish (*Prosopium williamsoni*) representing the primary native salmonids. Introduced salmonids include brook trout (*S. fontinalis*), lake trout (*S. namaychush)*, and brown trout *(Salmo trutta*). Lake trout occur in a few high mountain lakes in the Powder River basin, and bull trout-brook trout hybrids have been collected in various locations (*e.g.,* Clear Creek in the Pine Creek basin of Oregon (Buchanan *et al.* 1997) and Indian Creek, which drains from Idaho into Hells Canyon Reservoir (Chandler and Richter 2001)). Most of the other introduced species are game fish (*e.g.,* black crappie (*Pomoxis nigromaculatus*), largemouth bass (*Micropterus salmoides*), channel catfish (*Ictalurus punctatus*), and bluegill (*Lepomis macrochirus*)) provide angling opportunities in the Hells Canyon Complex reservoirs, as well as ponds and lakes.

Table 2. Species, origin, and habitats of fishes known or likely to occur in the Hells Canyon Complex Recovery Unit. (after Chandler and Richter 2001; Nowak 2001; Saul *et al.* 2001)

Common name	Scientific name	Origin	Habitats[1]
Banded killifish[2]	*Fundulus diaphanus*	native	NR
Black crappie	*Pomoxis nigromaculatus*	introduced	SR, L, P, LG
Bluegill	*Lepomis macrochirus*	introduced	SR, L, P, LG
Bridgelip sucker	*Catostomus columbianus*	native	SR, WS
Brook Trout[3]	*Salvelinus fontinalis*	introduced	SR, WS
Brown trout	*Salmo trutta*	introduced	HCR
Bull trout[3]	*Salvelinus confluentus*	native	R, T
Bullhead, black[2]	*Ameiurus melas*	introduced	SR
Bullhead, brown	*Ameiurus nebulosus*	introduced	SR, L, P, LG
Bullhead, yellow[2]	*Ameriurus natalis*	introduced	NR
Channel catfish	*Ictalurus punctatus*	introduced	SR, L, P, LG

Table 2. Species, origin, and habitats of fishes known or likely to occur in the Hells Canyon Complex Recovery Unit. (after Chandler and Richter 2001; Nowak 2001; Saul *et al.* 2001)

Common name	Scientific name	Origin	Habitats[1]
Chiselmouth	*Acrocheilus alutaceus*	native	SR, T, WS
Common carp	*Cyprinus carpio*	introduced	SR, LG
Cutthroat trout[2]	*Oncorhynchus clarki*	native	NR
Dace[2]	*Rhinichthys spp.*	native	SR
Flathead minnow[2]	*Pimephales promelas*	introduced	SR, T
Flathead catfish	*Pylodictus olivaris*	introduced	SR, L, P, LG
Lake trout	*Salvelinus namaycush*	introduced	HL[4]
Largemouth bass	*Micropterus salmoides*	introduced	SR, L, P, LG
Largescale sucker	*Catostomus macrocheilus*	native	SR, T, WS
Longnose dace	*Rhinichthys cataractae*	native	SR, T, WS
Mottled sculpin	*Cottus bairdi*	native	T
Mountain sucker	*Catostomus platyrhychus*	native	WS
Mountain whitefish	*Prosopium williamsoni*	native	SR, T
Northern pikeminnow	*Ptychocheilus oregonensis*	native	SR, T
Oriental weatherfish[2]	*Misqurnus angullicaudatus*	introduced	D
Paiute sculpin	*Cottus beldingi*	native	T
Peamouth	*Mylocheilus caurinus*	native	SR, WS
Pumpkinseed	*Lepomis gibbosus*	introduced	SR, T, L, P, LG
Redband trout[5]	*Oncorhynchus mykiss*	native	SR, T, WS
Redside shiner	*Richardsonius balteatus*	native	SR, T, WS
Shorthead sculpin	*Cottus confusus*	native	T
Smallmouth bass	*Micropterus dolomieui*	introduced	SR, T, L, P, LG
Speckled dace	*Rhinichthys osculus*	native	SR, T, WS
Tadpole madtom[2]	*Noturus gyrinus*	introduced	SR
Torrent sculpin	*Cottus rhotheus*	native	SR, T
Tui chub [2]	*Gila bicolor*	introduced	NR
Warmouth	*Lepomis gulosus*	introduced	SR, T, L, P, LG
White crappie	*Pomoxis annularis*	introduced	SR, T, L, P, LG
White sturgeon	*Acipenser transmontanus*	native	SR, HCR
Yellow perch	*Perca flavescens*	introduced	SR, L, P, LG

[1] D-ditches, HCR-Hells Canyon Complex reservoirs, L-lakes, LG-low gradient streams, NR-not reported, P-ponds, SR-Snake River mainstem, T-Snake River tributaries, WS-widespread.

[2] May inhabit Snake River areas upstream of recovery unit.

[3] Includes bull trout-brook trout hybrids.

[4] Found in only a few high elevation lakes.

[5] Includes hatchery rainbow trout.

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 bull trout subpopulations in the Pine Creek watershed (Meadow Creek-Clear Creek, upper Pine Creek, East Pine Creek, and Elk Creek) and three in the Powder River basin (Powder River upstream of Mason Dam, North Powder River, and Big Muddy Creek) (U.S. Fish and Wildlife Service (USFWS) 1998). Subpopulations were not identified for bull trout inhabiting Snake River tributaries in Idaho in the listing rule. Subpopulations were isolated by impassable dams and unsuitable habitat. 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

Federal and State resource agencies and the Idaho Power Company have documented the occurrence of bull trout in portions of the Hells Canyon Complex Recovery Unit (*e.g.,* Buchanan *et al.* 1997; Grunder 1999; Chandler, J.A., *in litt.* 2000; Chandler *et al.* 2001). Distributional data for bull trout in the recovery unit comes primarily from presence-absence surveys and basin-wide surveys using techniques such as electrofishing, radio telemetry, spawning ground surveys, snorkeling, and traps. Comprehensive data on bull trout abundance through time in the recovery unit does not exist.

Hells Canyon Reservoir is the downstream reservoir in the Hells Canyon hydroelectric complex, lying between Hells Canyon Dam and Oxbow Dam (Table 1), and forms the lower- most portion of the Hells Canyon Complex Recovery Unit. Bull trout occur in Hells Canyon Reservoir (Chandler, *in litt.* 2000) and two tributaries to the reservoir, the Pine Creek basin in Oregon (Buchanan *et al.* 1997) and Indian Creek basin in Idaho (Grunder 1999). The confluence of Indian Creek is within the Oxbow Dam bypass, a 3.7 kilometer (2.3 mile) reach of original river channel between Oxbow Dam

and the point of water discharged from the Oxbow Dam Powerhouse (Idaho Power Company 1999). Oxbow Dam bypass is a relatively shallow backwater area maintained with a minimum flow of 2.8 cubic meters per second (100 cubic feet per second).

During 1993 through 1999, Idaho Power Company collected a total of 13 bull trout and 4 bull trout-brook trout hybrids upstream of Hells Canyon Dam in the reservoir and Indian Creek, using a downstream migrant weir near its confluence (Chandler, *in litt.* 2000). Two bull trout, one collected near Hells Canyon Dam and the other in Oxbow Dam bypass, were implanted with radio tags and subsequently located at least 8 kilometers (5 miles) upstream in Pine Creek during the spring and summer. Locations observed for one individual within Pine Creek included North Pine Creek and a tributary, Lake Fork Creek.

In the Pine Creek basin, bull trout occur in: upper Pine Creek, which includes West Fork Pine Creek, Middle Fork Pine Creek, and East Fork Pine Creek; Clear Creek; which includes upper Clear Creek, Trail Creek, and Meadow Creek; East Pine Creek; and Elk Creek, which includes the entire length of Elk Creek, Big Elk Creek, Aspen Creek, and Cabin Creek (Buchanan *et al.* 1997). Although bull trout were noted in a creel report from Lake Fork Creek in 1965, extensive sampling of the stream since 1990 collected brook trout, but did not detect bull trout (other than the bull trout observed there during the study by Idaho Power Company). The length distribution of bull trout surveyed from various streams in the Pine Creek basin during 1994 (Buchanan *et al.* 1997), and the limited pre- and post-spawning movements exhibited by radio-tagged fish (Chandler *et al.* 2001) suggest that most bull trout in the basin are resident fish. However, the movement of radio-tagged bull trout from Hells Canyon Reservoir to Pine Creek suggest that migratory fish persist in the basin.

Bull trout abundance was estimated for four streams in the Pine Creek basin by the U.S. Forest Service in 1994 (Table 3) (Buchanan *et al.* 1997). Maximum estimated abundance for bull trout was less than 400 individuals for each stream. Several index sites have been established in bull trout spawning and rearing habitat to conduct redd counts (Fedora and Walters, *in litt.* 2001). In the eight streams where survey sites exist, the actual number of redds observed ranged from 0 to 43 per site during 1998

through 2000, which is equivalent to 0 to 37.3 redds per kilometer (0 to 60.0 redds per mile) of stream length (Table 4).

Table 3. Bull trout population estimates for subwatersheds within the Pine Creek basin based on surveys conducted by U.S. Forest Service in 1994. (From Buchanan *et al.* 1997)

Subwatershed	Sample size	Minimum population estimate[1]	Maximum population estimate[2]
North Pine Creek	98	123	368
East Pine Creek	60	75	225
Clear Creek	98	123	368
Upper Pine Creek	92	115	345
Total for basin	348	435	1,305

[1] Number of fish times 1.25 (factor developed by Kim Jones, Oregon Department of Fish and Wildlife, based on available habitat and assumption that single pass technique captures 80 percent of population).
[2] Minimum estimate times 3.

Table 4. Densities of bull trout redds (number per mile) at index sites sampled in the Pine Creek and Powder River basins, Oregon, during 1998 through 2000 (number of definite redds observed). (Fedora and Walters, *in litt.* 2001)

Site	Stream length sampled (mile)	Year		
		1998	1999	2000
		Pine Creek basin		
0Pine Creek 1	1.20	9.2 (11)	5.8 (7)	5.0 (6)
Pine Creek 2	1.00	13.0 (13)	9.0 (9)	9.0 (9)
East Fork Pine Creek 1	1.20[1]	7.5 (9)	5.8 (7)	7.1 (5)
East Fork Pine Creek 2	0.80	43.7 (35)	18.7 (15)	na
Trail Creek	0.75	na	1.3 (1)	na

Table 4. Densities of bull trout redds (number per mile) at index sites sampled in the Pine Creek and Powder River basins, Oregon, during 1998 through 2000 (number of definite redds observed). (Fedora and Walters, *in litt.* 2001)

Site	Stream length sampled (mile)	Year		
		1998	1999	2000
Meadow Creek	0.75	57.3 (43)	1.3 (1)	25.3 (19)
Clear Creek	1.30	14.6 (19)	3.1 (4)	5.4 (7)
East Pine 1	0.65	60.0 (39)	7.7 (5)	1.5 (1)
East Pine 2[2]	0.50	na	na	10.0 (5)
Elk Creek 1	1.00	10.0 (10)	1.0 (1)	6.0 (6)
Elk Creek 2	0.50	6.0 (3)	0 (0)	na
Elk Creek 3	0.50	20.0 (10)	10.0 (5)	na
Elk Creek 4	0.40	0 (0)	0 (0)	na
Aspen Creek	0.70	15.7 (11)	5.7 (4)	4.3 (3)
Powder River basin				
Anthony Creek[2]	3.40	na	0.3 (1)	na
Lake Creek[2]	2.00	na	0.5 (1)	na
Wolf Creek[2]	2.00	na	1.5 (3)	na

[1] 0.7 mile surveyed in 2000.
[2] Reconnaissance or exploratory surveys.

In Indian Creek, bull trout have been repeatedly observed in the headwaters near Bluejacket Mine and the upstream headwaters, including Camp Creek, since 1979, (Grunder 1999; Nelson 2001). Although population estimates have not been made in

the Indian Creek basin, a U.S. Forest Service habitat survey crew observed 60 bull trout in Camp Creek (Nelson 2001). The U.S. Forest Service and Idaho Department of Fish and Game personnel estimated bull trout density in a reach of Indian Creek adjacent to Bluejacket Mine by electrofishing in 1998 (Grunder 1999). Bull trout density was 2.4 fish per 100 square meters (0.2 fish per 100 square feet). Based on 27 individuals, mean total length was 170 millimeters (range 103 to 219 millimeters; mean 7.0 inches, range 4.0 to 8.6 inches) suggesting that these were resident bull trout. However, bull trout were collected at a downstream migrant weir operated during fall 1998 and 1999 near the confluence of Indian Creek (Chandler and Richter 2001). One brook trout and 10 bull trout-brook trout hybrids (210 to 280 millimeters; 8.3 to 11.0 inches) were collected in 1998. One brook trout, three bull trout-brook trout hybrids, and two bull trout (220 and 270 millimeters; 8.7 and 10.6 inches) were collected in 1999, suggesting that migratory bull trout may occur in Indian Creek.

In Wildhorse River, bull trout occur in two tributaries, Bear Creek and Crooked River (Grunder 1999). Eleven bull trout were collected in upper Bear Creek during 1999, at sites above 1,600 meters (5,250 feet) in elevation (Williams and Veach 1999) and upstream of a physical barrier (R. Nelson, Payette National Forest, pers. comm. 2002). Brook trout and a bull trout-brook trout hybrid were also collected at these sites, and a hybrid was collected at a site 1,350 meters (4,430 feet) in elevation during 2000 (Williams 2001). Twenty-seven bull trout were collected at five of six sites sampled in Crooked River during 2000. Brook trout occurred at the majority of the sites and bull trout-brook trout hybrids were present at three sites. Neither bull trout nor bull trout-brook trout hybrids were captured at a downstream migrant trap operated near the confluence of Wildhorse River in 1998 (Chandler and Richter 2001).

In the Powder River basin, bull trout occur in tributaries of the Powder River upstream of Mason Dam (Silver Creek, Little Cracker Creek, and Lake Creek), tributaries of the Powder River between Mason Dam and the North Powder River confluence (Salmon Creek, Pine Creek, Rock Creek, and Big Muddy Creek), and the upper North Powder River and some tributaries (Anthony Creek, North Fork Anthony Creek, Indian Creek, and Wolf Creek) (Buchanan *et al.* 1997). For tributaries of the lower Powder River (*i.e.,* downstream of Thief Valley Dam), oral histories from residents indicate that bull trout occurred in Big Creek and were common in Eagle Creek during the 1940's and 1950's (Gildemeister 1992). However, we have no recent

reports of bull trout in Big Creek. There are creel reports from 1965 and angler reports during the mid-1980's of bull trout in Eagle Creek, but extensive surveys in 1991 and 1994 did not detect bull trout (Buchanan *et al.* 1997). The only report of bull trout in Brownlee Reservoir was a 305-millimeter (12 inch) individual captured by net during 1959 after the reservoir had filled (Buchanan *et al.* 1997).

Bull trout redd counts and density estimates have been performed in some tributaries of the Powder River basin, primarily as components of investigations of bull trout-brook trout interactions and spawning ground surveys. Bull trout densities were estimated in five tributaries of the upper Powder River and North Powder River in 1996 during an investigation of bull trout-brook trout distribution, abundance, and interactions (Bellerud *et al.* 1997). Mean densities of bull trout were 1.0 to 9.5 individuals per 100 meters (330 feet) of stream length (Table 5). In an 8.6-kilometer reach (5.3 miles) of Silver Creek, spawning surveys were conducted to investigate the use of redds counts as an estimate of adult bull trout abundance. Multiple redd counts were conducted annually in September and October 1996 through 1999 (Bellerude *et al.* 1997; Hemmingsen *et al.* 2001a, 2001b, 2001c). The total number of redds observed per year in the study was 7 to 36 redds (Figure 2). In 1999, snorkel and electrofishing surveys were conducted in Silver Creek to determine bull trout age structure, size-at-maturity, and adult abundance (Hemmingsen *et al.* 2001c). All bull trout 150 millimeters (5.9 inches) and greater in fork length were mature; about a third below this value to 130 millimeters (5.1 inches) were mature. A total of 885 bull trout with 150 millimeters (5.1 inches) fork length and greater were estimated to occur in Silver Creek. Redd counts were also conducted in three streams during reconnaissance-level surveys in 1998 (Table 4). All bull trout inhabiting the Powder River basin are thought to be resident fish.

Figure 2. Number of bull trout redds observed annually in Silver Creek, Powder River basin, Oregon. (After Hemmingsen *et al.* 2001c).

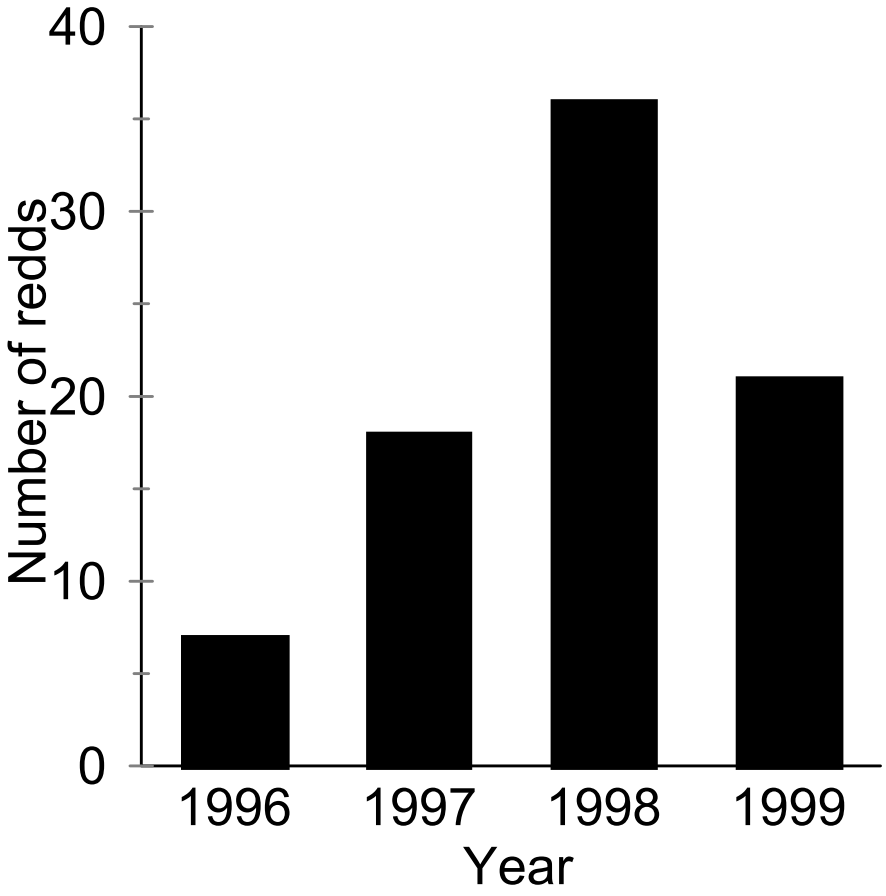


Table 5. Stream length (kilometers) and density (number per 100 meters) of bull trout (Bt) and brook trout (Bkt) collected in three zones within streams in the Powder River basin: bull trout zone (bull trout present, brook trout absence), bull trout-brook trout zone (both species present), and brook trout zone (bull trout absence, brook trout present). Density estimates were based on mean numbers of fish sampled at multiple 100-meter sites in each stream using single-pass electrofishing surveys. (After Bellerude *et al.* 1997; na–not available; English units for stream length (miles) and fish density (number per 100 feet) are given in parentheses)

	Bull trout zone		Bull trout-brook trout zone			Brook trout zone		Total stream length
Stream	Length	Density	Length	Bt density	Bkt density	Length	Density	
N. Fork Anthony Creek[1]	4.0 (2.5)	7.8 (2.4)	0.5 (0.3)	2.0 (0.6)	4.0 (1.2)	0.75 (0.5)	2.5 (0.8)	8.2 (5.1)
Indian Creek[2]	2.5 (1.6)	9.0 (2.7)	0.75 (0.5)	9.5 (2.9)	1.5 (0.5)	2.4 (1.5)	1.5 (0.5)	7.0 (4.3)
Lake Creek	2.5 (1.6)	4.7 (1.4)	na	na	na	1.0 (0.6)	1.5 (0.5)	7.5 (4.7)
Little Cracker Creek	0.5 (0.3)	1.0 (0.3)	0.5 (0.3)	2.0 (0.6)	3.0 (0.9)	na	na	3.0 (1.9)
upper N. Powder River[3]	1.0 (0.6)	5.3 (1.6)	1.5 (0.9)	1.0 (0.6)	34.7 (10.6)	7.5[4] (4.7)	34.3 (10.5)	upper reaches sampled

[1] Density of bull trout-brook trout hybrids were estimated at 1.0 fish per 100 meters (0.6 fish per 100 feet) in a 4.0-kilometer reach (0.6 mile). Two bull trout redds were observed in a 4.0-kilometer reach (2.5 miles) during spawning survey on September 25, 1996.
[2] No bull trout redds were observed in a 1.0-kilometer reach (0.6 mile) during spawning survey on September 26, 1996.
[3] Density of bull trout-brook trout hybrids was estimated at 1.8 fish per 100 meters (0.5 fish per 100 feet) in a 2.0-kilometer reach (1.2 miles).
[4] Brook trout zone may continue downstream.

REASONS FOR DECLINE

Habitat fragmentation and degradation are likely the most limiting factors for bull trout throughout the Hells Canyon Complex Recovery Unit. In the Snake River, large dams of the Hells Canyon Complex lack fish passage and have isolated bull trout among three basins, the Pine Creek and Indian Creek watersheds, Wildhorse River, and Powder River. Dams, irrigation diversions, and road crossings have formed impassable barriers to fish movement within the basins, further fragmenting habitats and isolating bull trout. Land management activities that degrade aquatic and riparian habitats by altering stream flows and riparian vegetation, such as water diversions, past and current mining operations, timber harvest and road construction, and improper grazing practices, have negatively affected bull trout in several areas of the recovery unit. Bull trout are also subject to negative interactions with nonnative brook trout in streams where the species occur together. The following factors contributing to the decline of bull trout in the coterminous United States are discussed relative to bull trout in the Hells Canyon Complex Recovery Unit.

Dams

The Hells Canyon Complex (*i.e.,* three dams and associated reservoirs) occupies a 154-kilometer (95.5-mile) reach of the Snake River. Construction of the three dams was completed over an 8-year period by Idaho Power Company. The complex provides power generation, flood control, and recreational opportunities for the region (Idaho Department of Environmental Quality and Oregon Department of Environmental Quality 2001; Saul *et al.* 2001). The dams are fish passage barriers and eliminated access by natural runs of anadromous fishes (*e.g.,* chinook salmon and steelhead) to the recovery unit, first in the upper portion of the recovery unit (including Powder River and Burnt River) with completion of Brownlee Dam in 1959, then the middle portion (including Wildhorse River) with completion of Oxbow Dam in 1961, and then in the lower portion (including Pine Creek and Indian Creek) with completion of Hells Canyon Dam in 1967. The loss of these runs and associated nutrients derived from their carcasses is thought to have negatively affected resident fishes through reducing overall watershed productivity (Nowak 2001; Saul *et al.* 2001; Stovall 2001). The

Hells Canyon Complex of dams also restrict movement of migratory bull trout within the Snake River and among tributaries, isolating tributaries and possibly contributing to the elimination of migratory bull trout in some streams (Grunder 1999).

Numerous dams exist in Snake River tributaries within the Hells Canyon Complex Recovery Unit. Because their primary function is storage and delivery of irrigation water, for example Unity Dam in the Burnt River is a U.S. Bureau of Reclamation facility operated by an irrigation district for irrigation water supply (U.S. Bureau of Reclamation 1998), they are discussed in the "Agricultural Practices" section of this chapter. However, dams for flood control and municipal water supply also occur in the Powder River basin.

Thief Valley Dam and Mason Dam were constructed by the U.S. Bureau of Reclamation on the Powder River in 1932 and 1968, respectively, for irrigation water supply and flood control (USBR 1998). Both dams are impassible fish barriers and are operated by irrigation districts. Thief Valley Dam restricted access of migratory fish to the lower 113 kilometers (70 miles) of the Powder River basin, where Eagle Creek is the primary tributary in which bull trout occurred (Nowak 2001). Mason Dam isolates bull trout in the upper Powder River (*i.e.,* Silver Creek, Little Cracker Creek, and Lake Creek) from bull trout in downstream tributaries of the Powder River above Thief Valley Dam (*i.e.,* Salmon Creek, Pine Creek, Rock Creek, and Big Muddy Creek), and the upper North Powder River.

Streams along the front of the Elkhorn Mountains provide a municipal water supply for Baker City, Oregon (U.S. Forest Service and Bureau of Land Management 1999). Diversions and water intake structures are located in several streams, including Salmon Creek, a stream inhabited by bull trout. These structures are upstream fish passage barriers. Another stream with bull trout, Rock Creek, has an impassible dam at a site where water is diverted for a hydroelectric project.

Forest Management Practices

Forested areas within the Hells Canyon Complex Recovery Unit have been subject to several management activities associated with timber harvest. These activities include timber harvesting and reforestation, road construction, fire suppression, and other practices. These practices can negatively affect bull trout habitats by increasing sedimentation rates, stream bank and channel instability, and water temperatures; decreasing recruitment of woody debris, canopy shading, and habitat complexity; and altering the hydrologic regime. High sedimentation rates may reduce pool depth and cause channels to become unstable and braid throughout bull trout habitats, and may reduce egg and larval survival in spawning and rearing habitat.

Roads exist throughout much of the public and private lands in the Hells Canyon Complex Recovery Unit and provide access for several activities, including timber harvest. The primary negative effects that can occur from road construction and timber harvest, combined, on bull trout habitats are increases in sedimentation, fish passage barriers, and habitat degradation (*e.g.,* reduced recruitment of woody debris, filling of pools, increased stream bank and channel instability, and decreased riparian canopy cover). Several habitat features important to bull trout (*e.g.,* levels of fine sediment, large woody debris, large pools, and channel conditions) recently were not adequately functioning for bull trout in tributary watersheds to the Powder River within the Wallowa-Whitman National Forest. Factors influencing these habitat features include high road densities, passage barriers, and degraded riparian areas (USFS 1999; USFS and BLM 1999). For example, extensive timber harvest on patented lands in the headwaters of Silver Creek (upper Powder River basin) has contributed high levels of sediment to occupied bull trout habitat downstream (Anderson 1995b; USFS 1999). Similar effects are likely in other streams in the basin. Mean road densities in the Pine Creek and Powder River basins are typically 0.8 to 2.7 kilometers per square kilometer (1.3 to 4.3 miles per square mile) (Fedora *et al.* 1998; USFS 1999; USFS and BLM 1999). Roads within the Hells Canyon Complex Recovery Unit make numerous stream crossings that can be barriers to bull trout passage. The effects on passage in this context are discussed under the section “Transportation Networks” in this recovery unit chapter.

The Indian Creek and Wildhorse River basins have been intensively managed for timber harvest and livestock grazing (Nelson 2001). In Indian Creek, timber harvest has occurred primarily in the mid and upper reaches of the basin where road densities are relatively high, whereas timber harvest in the Wildhorse River basin has occurred in the three primary tributaries, Bear Creek, Lick Creek, and Crooked River (Grunder 1999). Both basins exhibit habitat conditions that can be attributed to the effects of timber harvest and roads (*e.g.,* watershed disturbance, road density, and potential changes in hydrologic regime). Overall road densities within the two basins are 0.9 kilometer per square kilometer (1.4 mile per square mile) in the Indian Creek basin, and 3.1 kilometer per square kilometer (5.0 mile per square mile) in the lower Bear Creek and Lick Creek portions of the Wildhorse River basin (Nelson 1998, 2001).

Livestock Grazing

Improperly managed livestock grazing degrades bull trout habitat by removing riparian vegetation, destabilizing streambanks, increasing soil erosion, and altering water quality. These effects reduce overhead cover, increase summer water temperatures, and increase sediment in spawning and rearing habitats. A large portion of public and private land within the Hells Canyon Complex Recovery Unit is subject to livestock grazing (Anderson 1995a, b, c, d; Grunder 1999; Nowak 2001; Saul *et al.* 2001).

In the Powder River basin, the causes of most water quality problems are related to legacy (*i.e.,* activities conducted in the past but whose effects presently continue to affect habitats) effects of forestry, grazing, and mining (Nowak 2001). About 66 percent of the basin is considered rangelands with livestock and crop production occurring on the majority of this area. Of the remaining 33 percent of the Powder River basin, grazing is the primary use on about 80 percent of the area. Overgrazing in riparian areas has caused declines in riparian vegetation and increases in bank erosion that have negatively affected aquatic habitats. Habitats degraded from overgrazing are also present in the Pine Creek basin. For example, upland areas are recovering from overgrazing in the East Fork Pine Creek, and headcuts and gullies from continued use

of riparian areas in Boulder Creek have degraded habitats in the creek and downstream in Pine Creek (Anderson 1995a).

Livestock grazing occurs in both the Indian Creek and Wildhorse River basins (Nelson 2001). Some areas exhibit habitat degradation that may be influenced by livestock grazing. For example, damaged stream banks and riparian vegetation due to cattle have been noted near Lafferty Campground on the Crooked River (Wildhorse River basin) and most of its tributaries. Grazing in conjunction with timber harvest is thought to be responsible for degraded habitats (*i.e.,* unstable stream banks) in lower Bear Creek and Lick Creek.

Agricultural Practices

Irrigated agriculture and ranching are the primary agricultural activities within the Hells Canyon Complex Recovery Unit. Numerous water diversions, ditches, and reservoirs have been constructed to supply water for these activities (*e.g.,* production of hay and pasture). Many of these structures and their operation have negatively affected bull trout and bull trout habitats by creating impassible barriers to fish movement, entraining fish into unscreened ditches, and dewatering streams, which creates unsuitable habitat conditions (*e.g.,* elevated water temperatures, inadequate habitat quantity and quality). Passage barriers and habitat degradation due to agricultural practices are considered major factors adversely affecting bull trout in the recovery unit.

In the Pine Creek basin, there are 12 reservoirs (*i.e.,* those with capacity of at least 1,168 cubic meters (5 acre-feet) for irrigation storage) and 88 points of water diversion for irrigation throughout the basin, as reported by the U.S. Forest Service (USFS 1998) and the Powder Basin Watershed Council (PBWC 2000). Dams forming all the reservoirs lack upstream fish passage, and although some reservoirs are located upstream of the limits of bull trout distribution, others are barriers to fish movement. The delivery of water stored in reservoirs may be sufficiently raising water temperatures downstream so that bull trout distribution is affected (Anderson 1995c). Out of all points of water diversion in the basin, only 2 diversion points have fish

screens (USFS 1998). Unscreened diversions are present in bull trout spawning and rearing habitats in Meadow Creek and Aspen Creek, whereas a screen was recently installed on a diversion in Clear Creek. Irrigation diversions contribute to the complete dewatering of some stream reaches within the basin during low flow periods (Anderson 1995a).

In the Powder River basin, there are 46 reservoirs (*i.e.,* those with capacity of at least 12,336 cubic meters (10 acre-feet) for irrigation storage) and numerous ditches and points of water diversion for irrigation throughout the basin, as reported by Nowak (2001). The two largest reservoirs are Phillips Reservoir formed by Mason Dam and Thief Valley Reservoir, which have total storage capacities of 140.6 million cubic meters (114,000 acre-feet) and 16.4 million cubic meters (13,300 acre-feet), respectively, and are operated for irrigation storage and flood control (USBR 1998). These dams, and those forming the remaining reservoirs, lack upstream fish passage and have contributed to isolating bull trout and bull trout habitat. For example, Wolf Creek Reservoir and Pilcher Creek Reservoir both are formed by impassable barriers to fish movement within the Wolf Creek watershed, and are filled with water from the drainage as well as water diverted from other headwater streams (*e.g.,* Anthony Creek) that have bull trout (Anderson 1995c; USFS and BLM 1999). For ditches and points of diversion, some are active and others are no longer in use; there is presently no inventory of irrigation infrastructure, structures, and facilities for the basin (Nowak 2001). Most diversions likely contribute to degradation of habitats potentially available to bull trout and are unscreened, which may directly cause bull trout mortalities.

Reservoirs and irrigation diversions may have contributed to the decline, and perhaps extirpation, of bull trout in Eagle Creek, a tributary to the lower Powder River where bull trout were last observed in the mid 1980's. Dams have been constructed on five headwater lakes in the watershed to store irrigation water (Anderson 1995d). Although water delivery from the lakes locally augments stream flow, the water is diverted at at various unscreened locations, resulting in reaches that may be completely dewatered at times.

In the Indian Creek and Wildhorse River basins, there are no reservoirs and only a few water diversions. Water diversions for domestic use exist at springs in upper Indian Creek and Crooked River watersheds, and are not thought to negatively affect bull trout (Grunder 1999; Nelson 2001). In the lower Bear Creek-Lick Creek portion of Wildhorse River, a ditch on U.S. Forest Service land diverts water. A ranch apparently uses water delivered by the ditch and two individuals have applied for an easement, consisting of 1.12 cubic meters per second (3.05 cubic feet per second) of water (Nelson 2001). Although the diversion was not considered to affect bull trout because they have not been observed in the area and a substantial waterfall in Bear Creek near its confluence with the Crooked River isolates bull trout upstream (Nelson 2001), effects of the water diversion on bull trout that may potentially use the lower portion of Bear Creek is not known. Two diversions in the Crooked River watershed have potentially affected bull trout. One is on private land that dewaters a reach during late summer where bull trout have been observed downstream, and the other is unscreened and diverts an unknown quantity of water from a reach where bull trout occur.

Transportation Networks

A network of roads has been constructed in the Hells Canyon Complex Recovery Unit to provide transportation routes and access for such activities as timber harvest, mining, and water development facilities. Roads may degrade bull trout habitats in several ways, by increasing erosion and sedimentation, creating passage barriers, and reducing riparian vegetation (see Chapter 1). For example, a poorly located and eroding road in the headwaters of Meadow Creek, a tributary of Clear Creek in the Pine Creek basin, has been responsible for high levels of sediment in a reach that bull trout presently occupy (Fedora *et al.* 1998). Moreover, portions of a main access road following Clear Creek lies within the creek's riparian area and floodplain, potentially degrading habitats by restricting floodplain and riparian processes (*e.g.,* flow dynamics and riparian vegetation recruitment). With the relatively high densities of roads throughout the Hells Canyon Complex Recovery Unit, consisting of means of 0.8 to 3.1 kilometers per
square kilometer (1.3 to 5.0 miles per square mile) in each major basin, negative effects of roads on aquatic and riparian habitats are likely widespread in the recovery unit.

Improperly constructed stream crossings may act as barriers to bull trout movement either constantly or under certain conditions, which prevents bull trout access to suitable habitats and increases isolation of bull trout populations. Although a comprehensive survey and assessment of fish passage barriers at road crossings has not been conducted throughout the Hells Canyon Complex Recovery Unit, barriers may be relatively common. For instance, Fedora (1999) evaluated fish migration barriers on National Forest lands in the Pine Creek basin, and identified 6 within known occupied habitat, primarily in the Meadow Creek watershed, and 16 in other streams or reaches downstream of occupied habitat. Full or partial barriers to bull trout movement exist in the Indian Creek (Forest Road 105) and Wildhorse River (Forest Road 130 in upper Bear Creek) basins, and may be restricting the distribution of brook trout (Nelson 2001). Surveys of fish passage barriers at road crossings have been recommended for the Powder River basin (USFS 1999; USFS and BLM 1999). In the Oregon portion of the Hells Canyon Complex Recovery Unit, fish passage problems were noted at culverts on State- and County-owned roads in the Pine Creek (at least 18 culverts), Powder River (at least 86 culverts), and Burnt River (at least 38 culverts) basins (Mirati 1999).

Undersize culverts (*i.e.,* those that can not adequately pass a 100-year flow event) at road crossings may act as fish passage barriers, as well as degrade aquatic habitats downstream if they fail under high flows. Forty-six of 53 culverts surveyed in the Clear Creek watershed were considered undersize, suggesting that the entire Pine Creek basin may contain about 300 undersized culverts on National Forest roads if the Clear Creek watershed is representative of the entire Pine Creek basin (USFS 1998). The prevalence of undersize culverts throughout the Hells Canyon Complex Recovery Unit is not presently known.

Mining

Extensive mining activities (*e.g.,* placer, lode, and dredge operations) were historically conducted and continue in the Hells Canyon Complex Recovery Unit. Degradation of aquatic and riparian habitats important for bull trout caused by mining include removal of riparian vegetation, stream channelization, sedimentation, and input

of potentially toxic substances. Most mining activities in the recovery unit have occurred in the Pine Creek and Powder River basins.

In the Pine Creek basin, most mining activities have been concentrated in the Cornucopia Mining District, which is located in upper Pine Creek (USFS 1998). Placer mining was conducted along an 8-kilometer (5-mile) reach in which the stream channel and riparian areas have been highly disturbed (Fedora *et al.* 1998), greatly altering the natural channel form and reducing riparian vegetation. Tailings on the banks in Pine Creek and East Fork Pine Creek are considered hazardous waste by the Oregon Department of Environmental Quality, and it is unknown whether toxic materials are leaching from the tailing piles and affecting fishes currently residing in the area (PBWC 2000).

In the Powder River basin, there are reaches in nearly all streams in the upper Powder River drainage (*i.e.,* upstream of Mason Dam) that contain signs of past mining activities (USFS 1999). The most prominent area is a 9.4-kilometer (6-mile) reach of the upper Powder River near the community of Sumpter that was dredged, resulting in a 567-hectare (1,400-acre) expanse of tailings (Nowak 2001). The channels of this reach of the Powder River and Cracker Creek have been straightened, and meadow areas and riparian vegetation have been destroyed. Areas on tributaries farther upstream (*e.g.,* Cracker Creek, Little Cracker Creek, and Silver Creek) have been patented. In other areas of the Powder River basin, mining activities are ongoing in Salmon Creek and Wolf Creek (USFS and BLM 1999), and mining operations and their access roads are delivering sediments to portions of Eagle Creek (Anderson 1995d). Negative effects due to contaminants are presently unknown.

There are no active mines in the Indian Creek and Wildhorse River basins (Grunder 1999). However, three abandoned mines exist in the upper Indian Creek drainage, and it is not known whether they have affected or continue to affect bull trout and bull trout habitats. Substrate embeddedness was higher at an upstream versus a downstream site (41.3 versus 18.3 percent) in Indian Creek, which may be related to the granitic local geology of the upper site and the influence of historical mining (see references in Nelson 2001).

Residential Development and Urbanization

Although the Hells Canyon Complex Recovery Unit is largely rural, urban and residential areas typically exist at the lower elevations of the major basins. The five most populated communities in the recovery unit during 2000 were: Baker City (population of 9,880), North Powder (490), Haines (425), and Sumpter (175) in the Powder River basin, and Halfway (340) in the Pine Creek basin (Baker City, *in litt.* 2002). Effects of residential development and urbanization of the lower elevation portions of the basins may include stream channelization; loss of riparian vegetation and floodplain processes; and increases in nutrient and pesticide loading, sediment delivery, and water temperatures. The portions of the basins subject to these effects are currently, or were historically, used by bull trout as foraging, migrating, and overwintering habitat.

Residential development and urbanization is occurring in some portions of the recovery unit within or in relatively close proximity to spawning and rearing habitat. Examples in the Powder River basin include the community of Sumpter adjacent to Cracker Creek, a residence on Salmon Creek, and recreational residences on Anthony Creek. New residential housing has been constructed in Sumpter, and some development in Anthony Creek has occurred within riparian areas.

In the Indian Creek and Wildhorse River basins, there are two unincorporated communities, Cuprum near Indian Creek and Bear on Bear Creek in the Wildhorse River basin (Grunder 1999). There are also large private inholdings within the Payette National Forest in the headwaters and near the mouth of Crooked River, and along the corridor of Wildhorse River. Although residences and private lands are primarily downstream of most areas currently occupied by bull trout, there are potential negative effects to aquatic and riparian habitats from septic tank leaks, hazardous material spills, and fires. Summer home residents may increase the risk of inadvertent harvest of bull trout in headwater streams.

Fisheries Management

Brook trout have been widely introduced and are established in several areas throughout the Hells Canyon Complex Recovery Unit (Buchanan *et al.* 1997; Grunder 1999; Chandler and Richter 2001; Nelson 2001), which has contributed to the decline of bull trout. In the Pine Creek basin, brook trout were stocked in mountain lakes during the 1930's and have become established in the Clear Creek watershed, where bull trout-brook trout hybrids have been observed (Buchanan *et al.* 1997). Brook trout are widely distributed in the Powder River basin, and have been observed in several streams presently or historically occupied by bull trout. For example, brook trout occur with bull trout in reaches of such streams as North Fork Anthony Creek, Indian Creek, Little Cracker Creek, and upper North Powder River, and bull trout-brook trout hybrids have been observed in some of these reaches (Bellerud *et al.* 1997). Brook trout are also established in the Eagle Creek watershed, where bull trout have not been observed in several years. In the Idaho portions of the recovery unit, brook trout are widely distributed and locally abundant in the Indian Creek and Wildhorse River basins, and bull trout-brook trout hybrids have been observed in both basins (Grunder 1999; Chandler and Richter 2001; Nelson 2001).

Other fishes that may negatively interact with bull trout have been introduced in the Hells Canyon Complex Recovery Unit (see Table 2). Salmonids such as lake trout were introduced in some mountain lakes within the Powder River basin (Buchanan *et al.* 1997), however, they have not been observed elsewhere in the basin. Rainbow trout are currently planted in Phillips Lake and Cracker Creek. About 8,000 legal-sized and about 100,000 fingerling rainbow trout are annually planted. It is uncertain whether stocked rainbow trout negatively interact with bull trout, however, stocked fish may provide a source of prey to bull trout. Fish such as yellow perch and walleye were both introduced in Phillips Reservoir sometime in the 1980's, and the abundance of yellow perch may be negatively affecting other species. Effects of introduced fishes on the potential of bull trout ultimately using Phillips Reservoir is not known.

Some reaches of the Powder River have been treated with fish toxicants to remove nongame fishes (Buchanan *et al.* 1997). Chemicals were used in headwater tributaries and the main river from Sumpter downstream to Mason Dam, and from Mason Dam to Thief Valley Reservoir, during 1967 to control nongame fishes. Phillips

Reservoir was treated during this time as well as at other times. Eagle Creek was also treated to remove nongame fishes in 1967, and whitefish, rainbow trout, bull trout, and brook trout were noted throughout the upper watershed (Buchanan *et al.* 1997). The effects of this management practice on bull trout is not known.

Isolation and Habitat Fragmentation

The combined effects of the previously discussed factors contributing to the decline of bull trout (*e.g.,* dams, forestry management practices, livestock grazing, agricultural practices, transportation networks, mining, and residential development and urbanization) has led to the degradation and fragmentation of bull trout habitats in the Hells Canyon Complex Recovery Unit. Habitat fragmentation has resulted in isolated groups of bull trout that once had access to a greater diversity of resources than presently available (*e.g.,* amount and quality of habitat, prey abundance) and opportunities to interact among groups. Degradation of habitats has contributed to the isolation of bull trout and further reduced available resources.

The Hells Canyon Complex of three dams in the Snake River lacks two-way fish passage, which has isolated bull trout among the three reservoirs or their tributaries. Migratory bull trout occur in Hells Canyon Reservoir and likely use spawning and rearing habitat in the Pine Creek basin and may use the Indian Creek basin. Bull trout occur in tributaries of the remaining two reservoirs, Wildhorse River draining into Oxbow Reservoir and the Powder River draining into Brownlee Reservoir. Because of impassible barriers to fish movement within tributaries (*e.g.,* Thief Valley Dam and Mason Dam in the Powder River basin) and no observations of migratory bull trout within the reservoirs, bull trout in the recovery unit upstream of Oxbow Dam are thought to be resident fish. Hells Canyon Complex has also eliminated anadromous fish from the recovery unit, which has likely reduced the overall productivity of the watersheds upstream of Hells Canyon Dam.

Habitats within basins presently occupied by bull trout have been further fragmented by seasonal or complete barriers to fish movement caused by small dams, irrigation diversions, and road crossings. These habitats have also been degraded by

land management activities (*e.g.,* forestry practices, mining, livestock grazing, and transportation networks), which have reduced bull trout distribution. For instance, passage barriers and overall degradation of aquatic and riparian habitat conditions from land management activities in the Powder River basin is thought to have eliminated migratory fish, resulting in resident bull trout occurring primarily in the headwaters of the upper Powder River and North Powder River (USFS 1999; USFS and BLM 1999). Throughout the Hells Canyon Complex Recovery Unit, resident bull trout occur in several streams that are also inhabited by brook trout, which exacerbates the negative effects of habitat degradation on bull trout.

Poor water quality associated with habitat degradation has likely contributed to isolation and fragmentation of bull trout habitats in the Hells Canyon Complex Recovery Unit. Under the Federal Clean Water Act, states or the U.S. Environmental Protection Agency designate water bodies that are failing water quality standards (*i.e.,* not achieving their beneficial use) as water quality limited under section 303(d) and are required to develop management plans. These waters are reported every other year on the 303(d) list. In 1998, a total of 37 water bodies within the recovery unit appeared on the 303(d) lists for Idaho and Oregon combined (Appendix 1; IDEQ 1998; ODEQ 1998). The three reservoirs making up the Hells Canyon Complex were included primarily due to exceeding limits for water temperature, sediment, nutrients, and mercury. Water spilled from Brownlee Dam entrains air that has also resulted in supersaturated concentrations of total dissolved gases in Oxbow Reservoir and Hells Canyon Reservoir, which may cause gas bubble trauma in fishes, including bull trout. The effects of dissoved gas levels on bull trout and their distribution in the two reservoirs (*e.g.,* apparent absence in Oxbow Reservoir) is not known. Within Snake River tributaries originating in Oregon, 8, 13, and 13 waterbodies were listed in the Pine Creek, Powder River, and Burnt River basins, respectively. The most common pollutant for the three basins was water temperature. Although water quality limited stream segments occur throughout the basins, some include reaches coinciding with the current distribution of bull trout and have likely contributed to their decline.

ONGOING RECOVERY UNIT CONSERVATION MEASURES

Efforts to recover bull trout and other native species are ongoing in the Hells Canyon Complex Recovery Unit, with a high level of cooperation among natural resource management entities on various projects. For example, conducting spawning surveys within the recovery unit has been a cooperative effort between Federal and State agencies. Groups responsible for assessing the status of bull trout, identifying information needs, and developing conservation strategies exist in both the Idaho and Oregon portions of the recovery unit (*i.e.,* the Southwest Basin Native Fish Watershed Advisory Group in Idaho and the Pine Creek-Powder River Bull Trout Working Group in Oregon). The following discussion provides examples of completed and ongoing conservation activities conducted by these groups, their members, and others.

For proposed Federal activities occurring in the Hells Canyon Complex Recovery Unit, Federal agencies (*e.g.,* the Bureau of Land Management, Bureau of Reclamation, Federal Energy Regulatory Commission, U.S. Forest Service) are consulting with the U.S. Fish and Wildlife Service pursuant to section 7 of the Endangered Species Act. During consultations, potential effects of proposed activities on bull trout and their habitats are evaluated, and the activities may be modified to reduce or eliminate negative effects on bull trout. Federal activities often include conservation measures beneficial to bull trout, such as reducing sediment delivery to streams by closing, removing, or altering forest roads; changing grazing practices; providing fish passage by replacing improperly constructed culverts; and conducting fish and habitat surveys (*e.g.,* USFS 1999; Nelson 2001). For example, the Payette National Forest has been conducting surveys to determine the distribution of bull trout on Federal lands, which resulted in documenting bull trout in Bear Creek and Crooked River in 1998 (Nelson, *in litt.* 2002).

The Natural Resources Conservation Service and the Farm Services Agency administer several programs that provide technical and/or financial assistance to private landowners to address natural resource problems. Resource management systems are developed with landowners to address soil, water, air, plant, and animal resource concerns. Programs available to private landowners include the Conservation Reserve

Program, Environmental Quality Incentives Program, Wetland Reserve Program, and Wildlife Habitat Incentives Program. Resource management systems developed with landowners identify practices that will reduce soil erosion and sediment delivery to streams, restore riparian and wetland functions and values, reduce water consumption on irrigated agricultural lands, and reduce nutrient and pesticide pollution in water bodies. Typical practices employed include riparian forest buffers, fencing, use exclusion, irrigation water management, nutrient and pesticide management, prescribed grazing and livestock watering facilities. Within the Hells Canyon Complex Recovery Unit, the Natural Resources Conservation Service is involved with the Powder Basin Watershed Council in screening water diversions in the Pine Creek and Eagle Creek watersheds.

Ongoing studies are underway by Idaho Power Company in cooperation with the Bureau of Land Management, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, and U.S. Forest Service to investigate bull trout distribution, movement, and life history in Hells Canyon and Oxbow reservoirs and their tributaries (*i.e.,* Pine Creek, Indian Creek, and Wildhorse River). For example, radio telemetry has been used to investigate pre- and post-spawning movements, which also generated preliminary mortality rates, and weirs have been used to investigate downstream migration of bull trout in tributaries (Chandler and Richter 2001; Chandler *et al.* 2001).

The Idaho Department of Fish and Game has implemented ongoing conservation measures to benefit bull trout. Bull trout harvest has been prohibited State wide since 1996. Planting hatchery rainbow trout in the Indian Creek and Wildhorse River basins was discontinued in the 1980's due to potential effects on native redband trout, which has likely benefitted bull trout by eliminating the potential of disease transmission and reducing angler-related mortality to bull trout (Grunder 1999). Idaho Department of Fish and Game manages bull trout in the two basins according to a Five Year Fish Action Plan that emphasizes preservation of bull trout. The agency was also instrumental in the technical group that developed the Hells Canyon Group Key Watersheds Bull Trout Problem Assessment (Grunder 1999) for the Southwest Basin Native Fish Watershed Advisory Group under Idaho's bull trout conservation plan.

The Oregon Department of Fish and Wildlife has taken several actions to address the conservation and recovery of bull trout since 1990. More restrictive harvest regulations were implemented beginning in 1990; by 1994 the harvest of bull trout was prohibited throughout the State with the sole exception of Lake Billy Chinook in central Oregon. In addition to establishing the Pine Creek-Powder River Bull Trout Working Group to develop bull trout conservation strategies, the agency has discontinued stocking brook trout in areas of the recovery unit where they may affect bull trout, implemented angler outreach and education efforts about bull trout (*e.g.,* placing bull trout identification posters at campgrounds and trail heads), and surveyed culverts on State and County roads in the recovery unit for fish passage problems. A Fish Passage Task Force was recently created. The agency has applied for instream water rights in the Pine Creek and Powder River basins, but because the basins are over-allocated, the rights granted to date are junior to most existing rights. The agency is also conducting research to examine life history, genetics, habitat needs, and limiting factors for bull trout in cooperation with the U.S. Forest Service Pacific Northwest Research Station (see Bellerude *et al.* 1997; Hemmingsen *et al.* 2001a, 2001b, 2001c). The project was initiated in 1995 with funding from the Fish and Wildlife program of the Northwest Power Planning Council, and has included several areas within the Hells Canyon Complex Recovery Unit.

As part of the Pacific Northwest Electric Power Planning and Conservation Act of 1980, the Bonneville Power Administration has the responsibility to protect, mitigate and enhance fish and wildlife resources affected by operation of Federal hydroelectric projects in the Columbia River and its tributaries. The Northwest Power Planning Council develops and implements the Columbia River Basin Fish and Wildlife Program with the Bonneville Power Administration, U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and the Federal Energy Regulatory Commission. Coordination of the Northwest Power Planning Council's recommendations is done, in part, through the development of subbasin summaries that identify status of fish and wildlife resources, limiting factors, and recommended actions for the protection, mitigation, and enhancement of fish and wildlife resources. Draft subbasin summaries have been complete for the Powder River basin (Nowak 2001) and the Lower Middle Snake River

basin (Saul *et al.* 2001), which together encompasses the Hells Canyon Complex Recovery Unit.

Under sections 303 and 304 of the Federal Clean Water Act, states or the U.S. Environmental Protection Agency set water quality standards, which combine designated beneficial uses and criteria established to protect uses. States or the Environmental Protection Agency designate water bodies that are failing water quality standards as water quality limited under section 303(d) and are required to develop management plans. Management plans include Total Maximum Daily Loads with implementation plans that define site-specific actions and time lines for meeting water quality goals. The Idaho Department of Environmental Quality and Oregon Department of Environmental Quality released a draft Total Maximum Daily Load for multiple constituents in the Hells Canyon reach of the Snake River for public comment in December 2001 (IDEQ and ODEQ 2001).