INTRODUCTION

Recovery Unit Designation

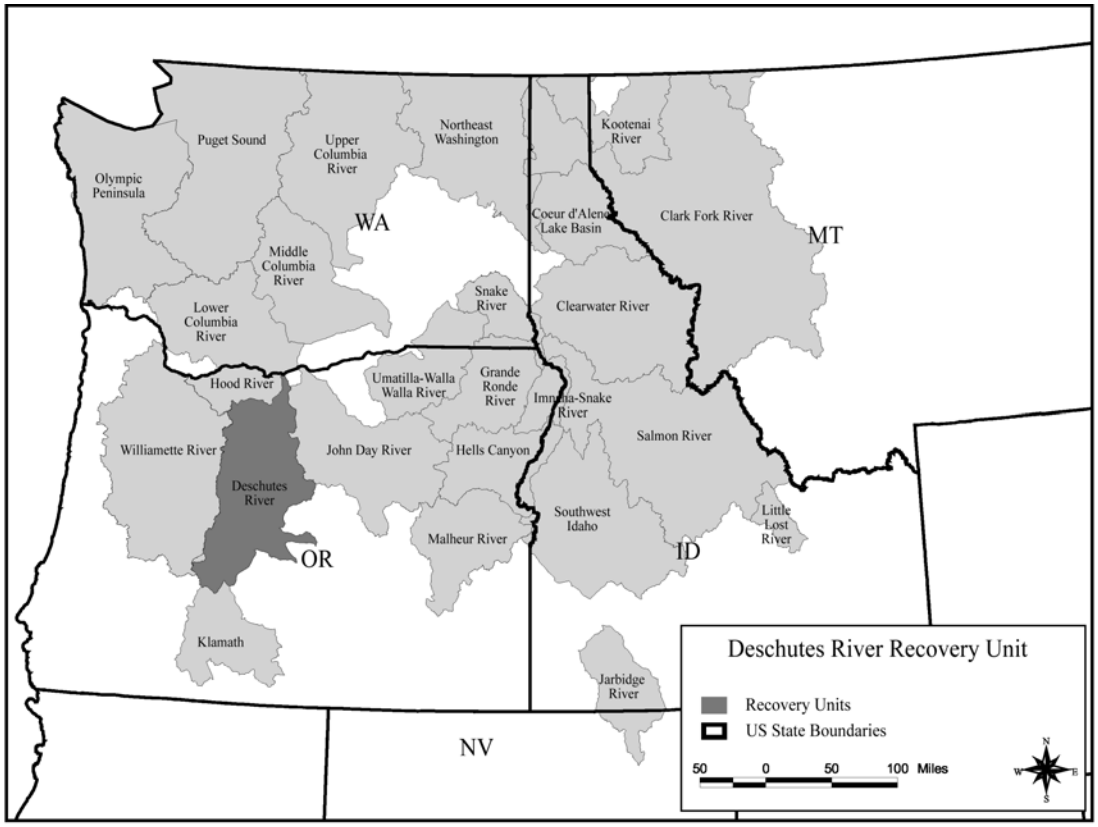
The Deschutes Recovery Unit is one of 22 recovery units designated for bull trout in the Columbia River Distinct Population Segment (Figure 1). Designation of the Deschutes Recovery Unit is based on its designation as a Gene Conservation Group by Oregon Department of Fish and Wildlife (Kostow 1995). The delineation of the Gene Conservation Group is based on the genetic analysis conducted by Spruell and Allendorf (1997).

Geographic Description

The Deschutes River originates at Little Lava Lake on the east slope of the Cascade Mountain range in Deschutes County, central Oregon. From this point it flows south through the Bureau of Reclamation's Crane Prairie and Wickiup Reservoirs, then generally north by northeast through Jefferson County. It then enters the Pelton/Round Butte Dam complex and its three reservoirs. The river continues flowing north by northeast through Wasco County, and forms the border between Wasco and Sherman counties to its confluence with the Columbia River, approximately 405 kilometers (252 miles) from its source. Elevation at Little Lava Lake is approximately 1,410 meters (4,700 feet), and elevation at the confluence with the Columbia River is approximately 23 meters (75 feet). The primary tributaries to the Deschutes River are the Little Deschutes River, Crooked River, Metolius River, Shitike Creek, Trout Creek, Warm Springs River, and the White River. The Deschutes River and its tributaries drain an area of approximately 26,939 square kilometers (10,400 square miles). Bend, Sisters, La Pine, Redmond, Prineville, and Madras are the major towns in the watershed.

Land ownership patterns and uses in the various subwatersheds making up the Deschutes River basin are as follows:

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



Little Deschutes River. Drains an area of approximately 2,642 square kilometers (1,020 square miles) comprised of about 30 percent private lands and 70 percent U.S. Forest Service and Bureau of Land Management lands. Land uses include agriculture such as animal production and animal feed production, forest products, and recreation.

Crooked River. Drains an area of approximately 11,137 square kilometers (4,300 square miles) comprised of about 50 percent U.S. Forest Service and Bureau of Land Management lands and 50 percent private lands. Land uses include grazing as a primary activity, as well as forest products, recreation, and irrigated agriculture.

Metolius River. Drains an area of approximately 816 square kilometers (315 square miles) comprised of 98 percent tribal and U.S. Forest Service lands; 28 percent

of these lands are designated wilderness. The remaining 2 percent is private property. Timber management and recreation are the primary activities.

Squaw Creek. Drains an area of about 606 square kilometers (234 square miles) from its origin at Broken Top Mountain's Bend Glacier at an elevation of over 2,700 meters (9,000 feet). Land ownership is about 82 percent Federal, 17 percent private, and less than 1 percent State. It is designated as a Wild and Scenic River, though the U.S. Forest Service has not as yet completed a Wild and Scenic Management Plan.

Shitike Creek. Drains an area of approximately 197 square kilometers (76 square miles) from its origin, Harvey Lake, at an elevation of 1,584 meters (5,280 feet) to its confluence with the Deschutes River at an elevation of 443 meters (1,476 feet). Shitike Creek flows entirely within the Confederated Tribes of the Warm Springs Reservation. The community of Warm Springs is located near the river's mouth. The majority of the drainage is managed for "conditional use," which is similar to the Federal wilderness designation.

Warm Springs River. Drains an area of approximately 1,362 square kilometers (526 square miles). The entire perennial flow is within the Confederated Tribes of the Warm Springs Reservation. Grazing, forest products, and recreation are the primary land uses.

Trout Creek. Drains an area of approximately 1,805 square kilometers (697 square miles) comprised of about 5 percent U.S. Forest Service land and the balance private lands. Agriculture, livestock production, forest products and recreation are the primary land uses.

White River. Drains an area of approximately 953 square kilometers (368 square miles); the headwaters and about half the length of the river are within the Mt. Hood National Forest. Agriculture and livestock production are the prevalent land management activities in the lower portion of the subwatershed.

Westside tributary headwaters are on the eastern slopes of the Cascade Mountain range where annual precipitation ranges up to 254 centimeters (100 inches),

much of it in the form of snow. Lower reaches of these tributaries, the mainstem Deschutes River, and eastside tributaries may only receive 23 to 36 centimeters (9 to 14 inches) of precipitation annually. Weather is generally cool to cold in the winter, and hot and dry in the summer, with the exception of the higher elevations of the Cascade Mountains (NPPC 2001; USFS and BLM 1999).

The Deschutes basin is in the southern portion of the Columbia basin physiographic province. Loess, volcanic ash, and pumice have been deposited over a basalt plateau in this region. Erosional forces have redeposited much of the loess and ash from upland areas to valley bottoms. Soils are comprised of silt, clay loams, stony loams, cobbly loams, and clay (Northwest Power Planning Council 2001; USFS and BLM 1999).

Some westside tributaries such as the Metolius have their sources in high Cascade Mountain lakes, glaciers, and springs, providing a relatively uniform and consistent range of flows. Others, such as Shitike Creek, have more typical dendritic drainage and thus more variable flows. Eastside tributaries have their sources in the Ochoco Mountain range, a lower and drier range than the Cascades.

Fish Species. A number of other native and exotic species of fish occupy the Deschutes basin. Native species include spring and fall chinook (*Oncorhynchus tshawytscha*), summer steelhead (*Oncorhynchus mykiss*), sockeye salmon (*Oncorhynchus nerka*), Pacific lamprey (*Lampetra tridentata*), mountain whitefish (*Prosopium williamsoni*), northern pikeminnow (*Ptychocheilus oregonensis*), bridgelip sucker (*Catostomus columbianus*), largescale sucker (*Catostomus marcocheilus*), torrent sculpin (*Cottus rhotheus*), and rainbow trout (*Oncorhynchus mykiss*). Exotic species include brown trout (*Oncorhynchus trutta*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), three-spine stickleback (*Gasterosteus aculeatus*), and brook trout (*Salvelinus fontinalis*).

The Deschutes River above the Pelton Round Butte dams once supported runs of native anadromous salmon such as sockeye, steelhead, and several races of chinook. The Confederated Tribes of the Warm Springs, Portland General Electric, and many State agencies, Federal agencies, and non-governmental organizations are

participating in an effort to reintroduce anadromous species above the dams. When successful, this action will help restore the historic species assemblage in the lower Deschutes Core Area.

DISTRIBUTION AND ABUNDANCE

Status of Bull Trout at the Time of Listing

In the final bull trout listing rule (FR 63:31647) the U.S. Fish and Wildlife Service identified three subpopulations of bull trout in the Deschutes River basin: 1) Odell Lake on the upper Deschutes River basin, 2) Metolius River-Lake Billy Chinook complex, and 3) lower Deschutes River. Historically bull trout were distributed throughout the Deschutes River basin from the headwaters and headwater lakes to the Columbia River (Newton and Pribyl 1994; Buchanan et al. 1997), allowing access to the Columbia River for juvenile rearing and adult foraging. The subpopulations are isolated by Pelton Round Butte Project dams on the Deschutes River, between river kilometers 161and 177 (River Mile 100 and 110), and Big Falls, a natural barrier at about River kilometer 212 (River Mile 132). Bull trout are thought to be extirpated in up to seven reaches or tributaries within the Deschutes River basin (Buchanan et al. 1997). At the time of listing bull trout had been extirpated from their historic habitats in the upper Deschutes above Big Falls, and bull trout in the Deschutes basin had been reduced to five populations. These are located in Shitike Creek, Warm Springs River, Whitewater River, Jefferson/Candle/Abbot river complex, and Canyon/Jack/Heising/mainstem Metolius river complex. 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.

The Odell Lake subpopulation is presently limited to Odell Lake, which contains the last extant native lake migratory (adfluvial) bull trout in Oregon (Ratliff and Howell 1992; Buchanan et al. 1997). Odell Lake was isolated from other bull trout populations in the upper Deschutes by a lava flow that dammed Odell Creek about 5,000 to 6,000 years ago. Because of its geographic isolation Odell Lake subbasin has been defined as a separate recovery unit, and will not be discussed further in this document.

Current Distribution and Abundance

Current bull trout distribution is limited to the lower Deschutes Core Area, which includes the five local populations in Shitike Creek, the Warm Springs River, and the three Metolius River population complexes. Bull trout currently inhabit most riverine habitats of the Metolius Subbasin. This includes First, Jack, Canyon, Roaring, Brush, Abbot, Candle, and Jefferson creeks, and Whitewater River. Some juvenile bull trout apparently expanded rearing habitat to Abbot Creek in 1994, as they were not observed in an earlier study (Ratliff and Fies 1989). The Metolius River, Lake Billy Chinook Reservoir, the Deschutes River above Lake Billy Chinook upstream to Big Falls, the Crooked River above Lake Billy Chinook upstream to Opal Springs Dam, and the lower Deschutes River below the Pelton Round Butte dams support bull trout. Subadult bull trout also use lower Squaw Creek, a tributary to the Deschutes River 4.8 kilometers (2.9 miles) above Lake Billy Chinook. The Crooked River upstream of the Opal Springs Dam may also be used by bull trout; operators at Opal Springs Dam have reported seeing large fish moving upstream over the dam crest during periods of high flow (McRostie, B. pers. comm. 2002).

The Metolius River-Lake Billy Chinook local population includes migratory bull trout that use the Metolius River and Lake Billy Chinook as seasonal foraging habitat and as a migration corridor (Buchanan et al. 1997). Bull trout spawn in Jack, Canyon, Roaring, Candle, and Jefferson creeks and in the Whitewater River. The local population has exhibited a positive trend in spawning numbers, based on numbers of redds observed, from 27 in 1987 to 330 in 1994 (Ratliff et al. 1996). The Shitike Creek and Warm Springs River have averaged about 232 and 202 spawners respectively between 1998 and 2001. Estimated population numbers for adult fish system-wide increased from 818 in 1993 to 1,895 in 1994 (Buchanan et al. 1997). Collectively the three Metolius basin populations have averaged 786 spawners between 1998 and 2000, though in 2000 there were an estimated 1,263 spawners.

Bull trout are found in the lower Deschutes River above Sherars Falls, Shitike Creek, and Warm Springs River. In 1998, Oregon Department of Fish and

Wildlife and the Confederated Tribes of the Warm Springs estimated the population of bull trout in a 1.8 kilometer (3 mile) river reach of the Deschutes near North Junction at seven fish per 0.6 kilometer (1 mile) greater than 20 centimeters (8 inches) long. One or two adult bull trout are caught in the Pelton fish trap each year. The trap is located at the base of the Reregulating Dam. In 24 years of operation of a steeppass trap at Sherars Falls, one bull trout was recently captured; in addition, two bull trout were captured in the tribal dipnet fishery at Sherar's Falls during 2001 (Pribyl, S. pers. comm. 2001). Anglers have recently reported higher incidental hooking of bull trout in the Deschutes River, which may indicate that the population is increasing. Subadult and adult fish are seasonally present in the lower Deschutes River (Newton and Pribyl 1994).

In the Metolius, most spawning occurrs between August 15 and October 1. However, spawning has been observed as early as July 13 and as late as mid-October (Ratliff et al. 1996). In Shitike Creek, spawning was observed from August 20 through early November, when water temperature averaged 6.2 degrees Celsius (43 degrees Fahrenheit) between River kilometer 30 to 45 (River Mile 18 to 27); this was the mean 7-day average from thermographs. In the Warm Springs River, temperatures averaged 6.6 degrees Celsius (44 degrees Fahrenheit) between River kilometer 52 to 59 (River Mile 31 to 35) during the late-August to early November spawning period (Brun 1999).

In the lower Deschutes River below the Pelton Round-Butte dams, bull trout spawn and rear in Shitike Creek and the Warm Springs River. Migratory bull trout are the primary life-history form present. In Shitike Creek the numbers of redds and juveniles appears to be stable. In the Warm Springs River there have been large fluctuations in redd counts and juvenile observations. During 1972 through 1988, low numbers of bull trout (0 to 27 fish) were recorded during surveys on the mainstem lower Deschutes River, and redd counts on Shitike Creek varied from 15 in 1990 to 6 in 1992 (Newton and Pribyl 1994). However, by 1998 redd counts had increased to 100; there were 115 and 76 redds counted in 1999 and 2000, respectively (Brun and Dodson 2000). In the Warm Springs River, 100 redds were counted in 1998, while 84 and 78 redds were counted in

1999 and 2000, respectively (Brun and Dodson 2000). Redd counts have averaged 101 redds in Shitike Creek, and 88 redds in the Warm Springs River from 1998 to 2001 (Brun and Dodson, in press). Juvenile bull trout densities in a 3.6 kilometer (2.2 miles) reach of the Warm Springs River were calculated at 0.005 per square meter (0.054 per square foot), while a density of 0.025 juvenile bull trout per square meter (0.27 per square foot) was calculated for the 1.1 kilometer (0.7 miles) surveyed in Shitike Creek (Brun 1999).

Deschutes basin bull trout exhibit both fluvial and adfluvial life histories. Fluvial bull trout migrate from their smaller natal stream to a larger river to rear, and then back to their natal stream to spawn. Adfluvial bull trout migrate from their smaller natal stream eventually entering a lake or reservoir to rear. After several years of growth, and with the onset of maturity, adfluvial bull trout retrace their earlier migration back to their natal stream to spawn.

In one recent study (Brun and Dodson 2000), radio-tagged adults began their migration in mid-May. They initially made short runs up and down stream runs into spawning streams. Later, one specimen moved upstream some 73 kilometers (44 miles) in Shitike Creek to reach spawning areas, and then moved quickly downstream after spawning. Other tagged fish showed similar behavior. In the Metolius, maturing bull trout moving from Lake Billy Chinook into the Metolius were captured from May through August. Peak upstream movement occurred between August 20 and September 15.

Juveniles moved downstream during both the spring and fall months. The majority were trapped during May and early June, while the remainder were captured during September. The mean fork-length of fish captured in Shitike Creek in the spring was 131 millimeters (5.2 inches), while fall migrants averaged 214 millimeters. Age two (120 to140 millimeters or 4.7 to 5.5 inches) fish accounted for 83 percent of spring catch, and the remaining were assumed to be age three (160 to 200 millimeters or 6.2 to 7.8 inches). One age four fish (399 millimeters (15.7 inches)) was also captured. No juvenile fish were captured in the Warm Springs River Humphrey trap (Brun 1999).

Other studies (Ratliff et al. 1996) reported that approximately 2,900 juveniles moves downstream from Jacks Creek in the Metolius between April 24 and October 13. Most were captured in May and June. Over 93 percent were found when the trap was checked in the morning, indicating that they were moving at night. Over half were age two.

REASONS FOR BULL TROUT DECLINE

Land and water management activities that currently depress bull trout populations and degrade habitat in this recovery unit include operation and maintenance of dams and other diversion structures, and the introduction of nonnative species. Impassable dams and diversion structures isolate and fragment bull trout local populations. Introduced brook trout threaten bull trout through hybridization, competition, and possible predation.

Dams

Lower Deschutes. The construction of the Pelton Round-Butte Hydroelectric Project created a barrier to the upstream movement of bull trout in the mainstem Deschutes River, and is also an obstacle to downstream movement. This project has had some effects to flows in the lower Deschutes River such as reducing dissolved oxygen levels immediately below this project. However, it is not known whether or not these effects alter how bull trout use the mainstem Deschutes River (Newton and Pribyl 1994).

In the Metolius River subbasin losses can occur when bull trout migrate from Lake Billy Chinook to Lake Simtustus through the turbines at Round Butte Dam. From there, bull trout may pass into the Reregulating Reservoir through Pelton Dam, and through the Reregulating Dam into the lower Deschutes River. Individuals may be killed or injured in the turbines, while survivors are unable to return to spawning areas because upstream passage facilities at the three dams are no longer operated. Until recently, bull trout may have had limited or reduced access to Suttle Lake, Blue Lake, and Link Creek due to barriers on Link Creek (Ratliff et al. 1996). A passage structure is planned for the barrier on Link Creek at the Suttle Lake Lodge.

In the Crooked River subbasin, Opal Springs Dam may mark the current upstream limit of bull trout on the Crooked River at about 1 kilometer (0.6 miles) upstream of Lake Billy Chinook, though anecdotal reports indicate that fish move upstream over the dam during high flows (McRostie, B., pers. comm. 2002).

Bowman Dam at river kilometer 113 (river mile 68) was completed in 1960 without fish passage; Ochoco Dam on Ochoco Creek also lacks passage (Stuart *et al.* 1996). Bowman and Ochoco Dams definitively mark the upstream limit of bull trout. Passage at these dams has not been identified as necessary for bull trout recovery.

Limiting factors in the Crooked River, should fish passage be realized, include operation of Prineville Reservoir. The reservoir causes periodic nitrogen supersaturation or gas bubble disease in fish, as well as turbidity, and a reversal of the flow regime in which high flows occur in summer to meet the irrigation demand and low flows occur during winter (Stuart et al. 1996). There are also high summer water temperatures due to reduced instream flows, as well as degraded riparian and watershed conditions.

Upper Deschutes. Dams were constructed at Crane Prairie in 1922, Crescent Lake in 1928, and Wickiup Reservoir in 1947 (Buchanan *et al.* 1997). These dams blocked fish passage, reduced instream flows and caused subsequent increases in water temperatures, altered streamflow regimes, and inundated spawning and juvenile rearing areas in the upper Deschutes subbasin (Buchanan et al. 1997). Colorado Street Bridge and North Canal Dam were constructed without fish passage (Fies et al. 1996a). The Bend hydroelectric dam was constructed with fish passage, but the wooden ladder deteriorated and was removed. Flow manipulations, which are described in the Wild and Scenic Plan/Geology Section (USFS) 1996), also affect water quality. The low instream flows associated with dam operations at Wickiup, Crane, Bowman, and Crescent dams impact bull trout by reducing habitat quantity and quality.

In conclusion, dams have been a major factor affecting bull trout in the lower and upper Deschutes River. They have interrupted or eliminated passage and population interconnections, as well as access to historic habitats. Some historic habitats have been lost to inundation, or have been significantly reduced in quantity and quality due to reduced instream flows. These factors contributed to the eventual extirpation of bull trout in the upper Deschutes. Dams have also altered water quality, though it is not known to what extent this affects bull trout

Forest Management Practices

Lower Deschutes. There has been some habitat degradation in the Metolius River subbasin from past logging and road-building. However, current management on public lands has corrected some of the problem areas (Ratliff et al. 1996). Proposed and ongoing timber harvests to address forest health issues have the potential to increase fine sediment input to bull trout spawning and rearing habitat. Recommendations to address high-risk areas have been proposed (Riehle *et al.* 1997), and road obliterations and drainage repair projects are being implemented. Other habitat limitations include low amounts of large woody material in the Metolius River (Fies et al. 1996b). Roads, skid trails, and general ground disturbance may be the leading causes of sedimentation in the basin and represent the greatest risk to bull trout habitat; potential for increasing sedimentation while thinning over-stocked stands of timber poses a continuing risk (Ratliff et al. 1996). The Warm Springs River and Shitike Creek have also experienced similar effects from forest management activities (Brun, C., pers. comm. 2002).

Upper Deschutes. Large wood was lost from the Deschutes River from Wickiup to Benham Falls from several factors, including wood removal and log drives (Oregon Department of Fish and Wildlife (ODFW) 1996). The Deschutes River above Crane Prairie Reservoir, Little Deschutes below Gilchrist, lower Crescent Creek, Fall River, Spring River, Tumalo Creek, and Squaw Creek below Sisters experienced similar impacts.

In conclusion, forest management has historically been a moderate factor affecting bull trout. However, forest practices have generally been improved in recent years, which has reduced effects to areas that support sensitive spawning and rearing habitats.

Livestock Grazing

Lower Deschutes. Habitat degradation from excessive grazing includes loss of riparian vegetation bordering the river, which reduces juvenile hiding and escape cover. This could impact aquatic and terrestrial insect production, increase water

temperature, as well as increase bank erosion and substrate sedimentation. These effects occur in some migratory corridors and overwintering areas (Newton and Pribyl 1995). There appears to be very little habitat degradation associated with grazing in the Metolius River basin. However, Canyon Creek and Lake Creek are somewhat affected by grazing from horses, while the Metolius River is affected by both horses and cattle (Ratliff et al. 1996).

In the Crooked River basin habitat degradation is severe and long-term. By 1860 over 350,000 people had entered the region using the Oregon Trail. By 1897 approximately 320,000 sheep, 40,000 cows, and 10,500 horses were in the area now occupied by Crook, Deschutes, and Jefferson counties. (Nehlsen 1995). However, since historic reports do not indicate that bull trout were present above the city of Prineville, grazing may have only affected bull trout using the lower reaches of the Crooked River for foraging or overwintering. Some grazing occurred in the Shitike Creek and Warm Springs River basins, which negatively affected bull trout.

Upper Deschutes. There are degraded riparian areas associated with grazing in the Little Deschutes River, lower Crescent Creek, Deschutes River from Wickiup Dam downstream to Benham Falls, Paulina Creek, Spring River, Tumalo Creek, and Squaw Creek. Some areas have not yet recovered from grazing that occurred over 100 years ago (ODFW 1996). Grazing practices may have been an additional factor in extirpating bull trout from the upper Deschutes River.

In conclusion, grazing effects to bull trout in the Metolius River appear to be low. However, effects to the Warm Springs River and Shitike Creek were probably more significant. The most notable habitat degradation from grazing appears to have

occurred in the Crooked River drainage. However, the apparently limited distribution of bull trout in the Crooked River reduced grazing effects to bull trout. In the upper Deschutes River, grazing may have had moderate effects to bull trout and contributed to their extirpation

Agricultural Practices

Lower Deschutes. Limiting factors include low flows from stream diversions, barriers created by diversion dams, high stream temperature, lack of instream cover, and sedimentation from agricultural practices (ODFW 1997). Effects to headwater spawning streams in the Metolius, Shitike, and Warm Springs river drainage were minimal due to the relatively protected status of these streams. However, there have been some chemical pond treatments for aquatic vegetation, as well as water diversions on Lake and Jack creeks (Ratliff et al. 1996). The suitability of Squaw Creek and the mainstem Deschutes River for foraging and rearing have been reduced due to irrigation withdrawals. Trout Creek is a perennial tributary of the lower Deschutes River; bull trout were documented there prior to 1990.

Habitat degradation in the Crooked River subbasin is so severe that it has been described as the most degraded river system in the State (Stuart et al. 1996). The most significant effects are the result of water quality problems, including flow reduction, temperature, sedimentation, and turbidity. Water temperatures in headwater streams often exceed 21 degrees Celsius (70 degrees Fahrenheit), and can reach 28 degrees Celsius (83 degrees Fahrenheit). There are numerous irrigation diversions and poor quality agricultural return water.

There are no screens on the Squaw Creek agricultural diversions. The Pelton Round Butte and Opal Springs hydroproject facilities are also unscreened. Some bull trout are entrained at Pelton Round Butte and mortalities have been reported. However, the overall level of entrainment appears to be low, and some bull trout survive turbine passage (Portland General Electric (PGE) 1999).

Upper Deschutes. Seasonally low water or complete dewatering resulting from agricultural irrigation diversions is the most significant factor limiting fish production in the upper Deschutes River subbasin (ODFW 1996). Water diversions reduced flows and increased water temperatures, which probably reduced the river's suitability for bull trout foraging and rearing. High stream temperatures of up to 27

degrees Celsius (80 degrees Fahrenheit) have been reported in the upper Deschutes River between North Canal's Steidle Dam at Bend and at Lower Bridge near Terrebonne. Temperatures in Crescent and Squaw creek are also excessively high.

Other affected areas include the Deschutes River from Wickiup Dam to Squaw Creek upstream of Lake Billy Chinook, the Little Deschutes River below the mouth of Crescent Creek, and Crescent, Paulina, Tumalo and Squaw creeks (Fies et al. 1996a). The high flows released during the summer irrigation season discourages establishment of vegetation on streambanks and facilitates bank erosion (USFS 1995). Degraded riparian areas include the Little Deschutes River, lower Crescent Creek, Deschutes River from Wickiup Dam downstream to Benham Falls, Paulina Creek, Spring River, Tumalo Creek, and Squaw Creek.

Four irrigation diversions on upper Deschutes either do not have screens or are equipped with ineffective louvers. These include the Lone Pine Irrigation District's and the Central Oregon Irrigation District's North Canal and Swalley Canal (Fies 1996a). However, all have proposed to install screening in the near future. There are also two hydroproject diversions without screening; these are the Bend Hydroelectric and Cline Falls. It is not known if these facilities are currently in operation. There are also no screens on the Tumalo Creek or Little Deschutes River diversions. The Crane Prairie and Wickiup Dam outlets are not screened.

In conclusion, in the lower Deschutes agricultural practices have been a minor factor affecting bull trout in the Metolius, but are somewhat more significant in Shitike Creek and the Warm Springs River. In the upper Deschutes these practices probably contributed bull trout extirpation, and would need to be addressed in any reintroduction plan. The effects of unscreened diversions on bull trout appearto have been minor. However, the recovery unit team has recommend that screening be pursued for these facilities to eliminate their effects.

Transportation Network

Railroad access to the Deschutes region was established by 1911. Road and railway networks create opportunities for toxic spills such as those that have occurred in the John Day River basin. Roads have also been constructed for residential areas and forest activities. In conclusion, the Deschutes River basin's transportation network has been a minor factor affecting bull trout in the Metolius River and Shitike Creek, but a more significant factor in the Warm Springs River drainage.

Mining

There is some mining in the upper Deschutes River. The Deschutes Recovery Unit Team concluded it does not appear to have been a factor causing decline, or would be a factor impeding recovery.

Residential Development

In the lower Deschutes River, residential development in the upper 6.7 kilometers (4 miles) of the Metolius River has reduced wood recruitment due to recreation, residences, roads, and resort development. Impacts include loss of riparian vegetation through land clearing, loss of streambank habitat, instream structures, as well as water surface area from construction of retaining walls and boat docks. Water quality degradation also occurs due to use of fertilizers, pesticides, and failed septic systems (Fies 1996a). The transition from agricultural use of water to its use for small farms and golf courses has changed the timing of withdrawal, return flows, and water quality. In the upper Deschutes basin development is heavy on the Little Deschutes River, while the Spring and Fall rivers have also been impacted by development. In conclusion, in the lower Deschutes River effects have been low in the Metolius and the Warm Springs river, but more significant in Shitike Creek. Effects in the upper Deschutes River have been moderate.

Fisheries Management

Fisheries management in the Deschutes River basin is highly influenced by the absence of fish passage at the Pelton Round-Butte Hydroelectric Project, as well as low stream flows and passage impediments on many tributaries due to irrigation diversions. The Confederated Tribes of the Warm Springs and Oregon Department of Fish and Wildlife co-manage fisheries throughout the Deschutes River basin.

Lower Deschutes. Bull trout harvest is illegal in the lower Deschutes River, and is mainly an historic issue (Newton and Pribyl 1995). Historically, anecdotal information suggests that European-Americans harvested large numbers of bull trout from the lower Deschutes. Protective bull trout angling regulations have been implemented since 1980, which culminated in the closure of the Metolius River tributaries below Lake Creek to angling in 1994. Some illegal harvest of bull trout may still occur in the lower Metolius River (Ratliff *et al.* 1996).

In addition to harvest by anglers, the Oregon Game Commission operated traps for bull trout on Lake, Jack, and Canyon creeks. Similarly, bull trout were trapped and killed using a weir at the U.S. Fish and Wildlife Service's fish hatchery on the Warm Springs River.

Brook trout inhabit Squaw Creek, the Warm Springs River, and Shitike Creek. Brook trout are a major threat to bull trout in the Warm Springs River due to competition for limited rearing habitat. In Mill Creek, which is a Warm Springs tributary, brook trout have displaced bull trout. Brook trout do not appear to be limiting bull trout abundance in Shitike Creek (Brun, C., pers. comm., 2002).

In the Metolius River basin introduced brook and brown trout may be limiting for some bull trout populations in the Metolius River basin due to their potential for interaction. Brook trout are found in Abbot, Brush, and Canyon creeks. Brown trout occur in Suttle Lake and may have been partially responsible for the demise of that bull trout population. Overharvest may be a factor in a mixed fishery with brown trout (Ratliff *et al.* 1996).

Upper Deschutes. Overfishing was a factor in the decline of bull trout in Crescent Lake and Wickiup Reservoir above the dams. Historical records indicate that European-Americans harvest large quantities of bull trout. Bull trout have been extirpated from the area; however, overfishing could be a factor affecting bull trout should they be reintroduced.

Brook trout and brown trout were introduced in the early 1900's. Brook trout are now widely distributed in the upper portion of the basin. Brown trout are found in the Deschutes River mainstem downstream of Crane Prairie Dam, in Wickiup Reservoir, East Lake, Crescent Lake, Spring River, Tumalo Creek, and the Fall River. They are also present in the Little Deschutes River basin, where they occur high in the system above Highway 58 (Fies *et al.* 1996a). Bull trout have been extirpated from the area; however, introduced species could be a factor affecting bull trout should they be reintroduced.

In conclusion, fisheries management was a moderate to major factor affecting bull trout in the lower Deschutes River. While harvest was historically a significant factor in bull trout decline, current fishing regulations have reduced this effect. Introduced species have been and continue to be a significant effect to bull trout due to interbreeding and competition. Though bull trout populations are less abundant than we would like, the fish are generally in good health. Fisheries management was also a moderate to major factor affecting bull trout in the upper Deschutes river. Harvest and introduced species both contributed significantly to bull trout decline and eventual extirpation. These factors must be addressed in any plan to reintroduce bull trout into the upper Deschutes River.

Isolation and Habitat Fragmentation

Lower Deschutes. Historic bull trout populations in the lower Deschutes River appear to have been robust and interconnected (Goetz 1989). Currently, the Pelton Round Butte dams prevent upstream gene flow from the populations in Shitike Creek and the Warm Springs River, and nearly eliminate downstream gene flow from the Metolius River. Until recently, bull trout may have had limited orreduced access to Suttle Lake, Blue Lake, and Link Creek due to barriers on Link

Creek and Lake Creek (Ratliff et al. 1996). However, the barrier on Lake Creek at Lake Creek Lodge no longer inhibits bull trout movement, while a passage structure is planned for the barrier on Link Creek at the Suttle Lake Lodge. In the Crooked River basin Opal Springs Dam was constructed without fish passage. Stream diversions for irrigation reduced or eliminated flows, and resulted in higher water temperatures and thermal barriers which further isolated or fragmented populations.

Upper Deschutes. Before they were extirpated, bull trout here were first isolated by several dams which were constructed without fish passage. These dams include the Bureau of Reclamation's Crane Prairie, Wickiup, and Crescent Lake dams, as well as several privately owned irrigation dams. The dams also isolated populations through their effects on water quality instream flow. Populations were further isolated as they were outcompeted for their historic habitats by brown trout and lake trout. Interbreeding with brook trout further increased fragmentation. Chemical treatment projects in historic habitats such as Big Lava Lake, Davis Lake, and the Fall River contributed to isolation and fragmentation (Fies 1996a) through the creation of water quality barriers.

In conclusion, isolation and fragmentation have had moderate effects to lower Deschutes bull trout. However, in the upper Deschutes these effects have been major. In general, bull trout populations in the Deschutes Recovery Unit are at greater risk ofextinction due to isolation and fragmentation. This is due to their isolation by dams, small population sizes associated with reduced habitat, and extirpation in large areas of their historic range. Each of the five remaining Deschutes Basin bull trout populations are below the effective population size of 1,000 spawners suggested by Reiman and Allendorf (2001). This does not mean that the existing populations are not viable. However, aggressive management and immediate attention to factors causing decline are even more important for small populations. Maximizing adult bull trout abundance in the local populations is essential for their long-term genetic health. Even in a recovered state, habitat for some populations may remain limited, resulting in small population size.

ONGOING RECOVERY UNIT CONSERVATION MEASURES

Efforts to recover native species are ongoing in the Deschutes Recovery Unit, with a high level of cooperation between fishery entities on various projects. Spawning surveys have been a cooperative effort for many years. The Deschutes, Crooked, Metolius, rivers and Squaw creek basins have active local watershed groups dedicated to finding workable solutions to restoring native fish runs. The following list is by no means complete, but is representative of ongoing efforts within the recovery unit.

Oregon Department of Fish and Wildlife has reduced or eliminated some stocking programs. Hatchery trout have not been stocked in the lower Deschutes River since 1978. Oregon Department of Fish and Wildlife adopted changes in angling regulations to prohibit take of bull trout, and modified regulations on other fisheries to reduce incidental take. The lower 170 kilometers (100 miles) of the Deschutes River is closed to the retention of bull trout by anglers. Anglers are required to use artificial flies and lures only. Sport angling in the lower Deschutes River tributaries is either closed or limited to catch and release with artificial flies and lures. That portion of the lower Deschutes River bordering the Warm Springs Reservation is closed to sport angling from January 1 to late April.

Oregon Department of Fish and Wildlife has developed and distributed bull trout identification posters, and undertaken educational and law enforcement efforts to enforce harvest restrictions. Oregon State Police annually assigns five cadets and one trooper to patrol the lower Deschutes. Their primary responsibility is education of river users and enforcement when needed. Oregon Department of Fish and Wildlife typically assigns up to four people to monitor sport and Tribal fishing pressure and catch. Both Bureau of Land Management and local sheriff deputies also patrol the river to conduct education and enforcement activities.

Oregon Department of Fish and Wildlife, the Confederated Tribes of the Warm Springs, Portland General Electric, and U.S. Forest Service staff work

cooperatively on spawning and habitat surveys, research, and habitat enhancement projects.

Oregon Department of Fish and Wildlife hired a bull trout coordinator in 1995 to complete Statewide bull trout status assessment, map bull trout distribution, and develop conservation strategies for bull trout. When bull trout were listed the effort shifted to recovery planning. Oregon Department of Fish and Wildlife initiated bull trout research projects in 1993. Research results have been published in a number of reports, which are available at http://www.dfw.state.or.us/. The Oregon Department of Fish and Wildlife coordinates with five irrigation districts to minimize adverse habitat effects associated with water unscreened water diversions. Habitat enhancement efforts, funded by a Federal Energy Regulatory Commission license holder and implemented by the Oregon Department of Fish and Wildlife, are also being implemented to restore stream function and fish habitat. Oregon Department of Fish and Wildlife has made changes to in-water work periods to better address bull trout needs and reduce effects.

Bonneville Power Administration has provided funding for anadromous and bull trout habitat restoration and research projects of the Oregon Department of Fish and Wildlife. This included a research project, No. 9405400, which performed genetic analysis of Oregon bull trout including samples from the Deschutes populations. This research established the genetic baseline for Oregon bull trout and confirmed Oregon Department of Fish and Wildlife's designation of Deschutes bull trout as a separate gene conservation group (Spruell and Allendorf 1997).

The Confederated Tribes of the Warm Springs has been actively involved in bull trout research and conservation efforts since 1998. This work has been focused mostly on the Warm Springs River and Shitike Creek. Both streams are on Tribal land and have bull trout populations. The Confederated Tribes of the Warm Springs has collected data on juvenile bull trout abundance, and has radio-tagged adult bull trout to track their seasonal migration. They plan to continue these activities in the future. The Bonneville Power

Administration has provided funding to the Confederated Tribes of the Warm Springs to determine bull trout life history, genetics, and abundance in the lower Deschutes. The project began in 1998 and is ongoing.

The U.S. Forest Service has performed stream bank stabilization and instream habitat construction projects (NPPC 2001). The Bureau of Land Management has reviewed its livestock allotment management plans and modified them to protect and enhance riparian and aquatic resources. Both the U.S. Forest Service and Bureau of Land Management have fenced some stream margins to exclude livestock. The Confederated Tribes of the Warm Springs has funded many restoration and enhancement projects on Tribal streams, including fencing, bank stabilization, and constructing instream structure. The Oregon Department of Fish and Wildlife has worked to restore portions of Trout Creek and to fence off riparian areas.

As part of the Pelton Round-Butte relicensing, Portland General Electric and the Confederated Tribes of the Warm Springs have conducted valuable predator/prey studies, and collected data on bull trout migration, spawning, and rearing. Portland General Electric and the Confederated Tribes of the Warm Springs have also studied the effects of the Pelton Round-Butte Project on water quality, algae, zooplankton, and kokanee. In the lower Deschutes River, research has been done on bull trout, as well as steelhead and redband trout. The major survey and experimental phase of Portland General Electric's fish health risk assessment was completed in 2001. Barring any changes it is likely that bull trout movement will have a low risk of introducing pathogens of concern. The 5-year period of monitoring and evaluation of pathogens which began in 2001 and ends in 2006 is a necessary requirement of passage of all these stocks. There will have to a reevaluation of passage after this five-year period.

RELATIONSHIP TO OTHER CONSERVATION/PLANNING/RECOVERY EFFORTS

On January 14, 1999, Governor Kitzhaber expanded the Oregon Plan for Salmon and Watersheds (Oregon 1997) to include all at-risk wild salmonids throughout the State through Executive Order 99-01. The goal of the Oregon Plan is to "restore populations and fisheries to productive and sustainable levels that will provide substantial environmental, cultural, and economic benefits." Components of this plan include: 1) coordination of efforts by all parties, 2) development of action plans with relevance and ownership at the local level, 3) monitoring progress, and 4) making appropriate corrective changes in the future. It is a cooperative effort of State, local, Federal, tribal and private organizations, and individuals.

The Oregon Department of Fish and Wildlife and the Oregon Water Resources Department have established priorities for restoration of streamflow as part of the Oregon Plan for Salmon and Watersheds, Measure IV.A.8. The Oregon Department of Fish and Wildlife has prioritized streamflow restoration needs by ranking biophysical factors, water use patterns, and the extent that water limits fish production in a particular area. The Oregon Water Resources Department watermasters will incorporate the priorities into their field work activities as a means to implement flow restoration measures. The needs priorities will be used by the Oregon Watershed Enhancement Board as one criterion in determining funding priorities for enhancement and restoration projects. Watershed councils and other entities may also use the needs priorities as one piece of information to determine high priority restoration projects. Bull trout occupied streams in the recovery unit are included in the highest priority designation for streamflow restoration (NPPC 2001).

Opportunities to convert existing out of stream flows to instream flows in Oregon are available through a variety of legislatively mandated programs administered by Oregon Water Resources Department, e.g., transfers of type and place of use (ORS 536.050(4), voluntary written agreement among water users to rotate their use of the supply to which they are collectively entitled

(ORS 540.150 and OAR 690-250-0080), allocation of "conserved water" to instream use (ORS 537.455 to 537.500), lease all or a portion of consumptive water rights to instream purposes (ORS 537.348, OAR 690-77-070 to 690-77-077, exchange of a water right for an instream purpose to use water from a different source, being stored water, surface or ground water (ORS 540.533 to 540.543), and substitute a ground water right for a primary surface water right (ORS 540.524). Oregon Water Trust provides purchase of water rights from willing landowners for conversion to instream water rights.

Through the Deschutes Basin Total Maximum Daily Load process a Water Quality Management Plan will be developed to address forest, agricultural, urban, and transportation sources of water quality impairment. The Water Quality Management Plan will include implementation plans from Federal land management agencies such as the U.S. Forest Service and Bureau of Land Management, State forestry and agriculture, cities, and counties. The upper mainstem Deschutes and little Deschutes should be completed in 2002, while the lower Crooked, upper Crooked, and Beaver South Fork will be finished in 2004. The lower Deschutes and Trout Creek are scheduled for completion in 2006. For more information, see under Deschutes basin at http://waterquality.deq.state.or.us/wq/TMDLs/TMDLs.htm).

The Agricultural Water Quality Management Program, established through the Senate Bill 1010 process (ORS 568.900 through 568.933), addresses water pollution associated with agricultural lands and activities. This program will address riparian conditions related to temperature and channel morphology in its plan and rules. Plans have been completed in the lower and middle Deschutes River. The upper Deschutes River plan is still in process, while the Crooked River plan will begin in the fall of 2002. For information on Senate Bill 1010 and water quality plans go to http://www.oda.state.or.us/Natural_Resources/wqal.htm.

The Deschutes Resources Conservancy is a community based nonprofit corporation dedicated to restoring streamflows and improving water quality in the Deschutes basin. The objective of the Deschutes Resources Conservancy is

to restore stream flows sufficiently to restore the natural hydrograph in all streams to the extent environmentally, socially, and economically practicable. The Deschutes Resources Conservancy has prioritized the following streams: Squaw Creek, Tumalo Creek, the Deschutes River between the city of Bend and Lake Billy Chinook, and Trout Creek. The Deschutes Resources Conservancy has established an Exchange Bank to facilitate water transfers. The Exchange can help promote stream restoration measures. Revenue earned through the Exchange will be invested in further conservation. The Deschutes Resources Conservancy and local irrigation districts have offered an Annual Water Leasing Program since 1998. In 2001, the Deschutes Resources Conservancy and the Irrigation District's leased 8,792 acre-feet of water instream for a flow of about 0.69 cubic meters per second (25 cubic feet per second) in sections of streams and rivers of the Deschutes basin that typically experience low flow conditions.

There are a number of watershed councils and Soil and Water Conservation Districts in the Deschutes River basin. They include the upper Deschutes, middle Deschutes, lower Deschutes, Squaw Creek, Trout/Willow Creek, and Crooked River Watershed Councils, and the Hood, Wasco, Sherman, Jefferson, Crook, and Deschutes Soil and Water Conservation Districts. Theses entities are involved in a variety of conservation efforts to improve water quality, quantity, stream habitat, and natural resource management.

The Oregon Water Trust works cooperatively with willing water right holders to acquire senior water rights and convert them to legally-protected instream water rights. They have worked with the Deschutes Resources Conservancy, Upper Deschutes Watershed Council, and other partners to restore flows to Squaw Creek, Trout Creek, and Buck Hollow Creek.

The Deschutes Basin Land Trust has begun a planning process called "Back to Home Waters." This initiative seeks to identify, prioritize, and pursue

voluntary efforts to protect and enhance critical habitat needed to reintroduce native fish to the upper Deschutes. It includes efforts within the Metolius, Squaw Creek, lower Crooked, Ochoco, and Mckay creeks. As noted above, various Deschutes basin watershed councils are also involved in conservation activities. In January 2002, the Land Trust acquired an option to purchase 502 hectares (1,240 acres) of forestland in the Metolius watershed. The property includes over 5 kilometers (3 miles) of Lake Creek, which is an important tributary to the Metolius River. The land is currently owned by Willamette Industries, and faces continued timber removal or perhaps sale to resort developers. Lake Creek is used seasonally by bull trout, and provides important water quality benefits by reducing warm summer water temperatures from Suttle Lake outflows.

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 that is implemented by the Bonneville Power Administration, U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and Federal Energy Regulatory Commission. Coordination of Bonneville Power Administration's responsibilities for protection, enhancement, and mitigation and incorporation of recommendations by Northwest Power Planning Council is in part done through the development of subbasin summaries, which identify status of fish and wildlife resources, limiting factors, and recommended actions at the subbasin level.

The draft Deschutes River Subbasin Summary (NPPC 2001) is consistent with bull trout recovery planning efforts to identify limiting factors. The draft subbasin summary identifies temperature, channel conditions, instream habitat diversity, flow, riparian, and passage as contributing to the decline of bull trout. The overall fisheries goal of the draft subbasin plan is to:

"Protect, maintain, and restore or enhance riparian watershed ecosystems to sustain an abundant, productive, and diverse community of fish and wildlife." According to the subbasin plan this goal will be achieved by assisting in developing recovery plans, supporting agencies to restore threatened and endangered fish populations, and by protecting riparian corridor habitats. The draft Deschutes subbasin summary on page 56 identifies loss of instream flows, riparian vegetation, increased sedimentation, other water quality effects as factors limiting bull trout. The Deschutes Recovery Unit Team will continue to utilize this planning process to identify and seek funding for projects to aid bull trout recovery.