Focal Fish Species Characterization
APPENDIX I

This chapter describes the fish species selected to evaluate the health of the Deschutes Basin ecosystem and the effectiveness of management actions in the basin. These species were selected because they have special ecological, cultural or legal status. The chapter provides information on each focal species. In particular, it describes the status of each focal species population, as well as its historic and current distribution within the Deschutes Subbasin. It also discusses historic and current artificial production programs and harvest within the subbasin, and the relationship between artificial and naturally produced populations.

Focal Species Selection

The Deschutes River Basin supports more than thirty species of indigenous and introduced fish. Indigenous salmonids comprise six of the species and include Chinook salmon, summer steelhead, sockeye salmon, redband trout, bull trout and mountain whitefish. Five introduced salmonid species present in the subbasin include Coho salmon, brown trout, cutthroat trout, brook trout and lake trout.

Five of the thirty fish species in the Deschutes River Basin have been chosen as aquatic focal species for this subbasin plan: Chinook salmon (*Oncorhynchus tshawytscha*), steelhead/redband trout (*Oncorhynchus mykiss*), bull trout (*Salvelinus confluentus*), sockeye salmon (*Oncorhynchus nerka*) and Pacific Lamprey (*Lampetra tridentata*) (Table 1). The five species were selected by the Fish Technical Team, a group of fish and natural resource experts brought together to provide technical advice during the subbasin planning process. The team selected the focal species based on their significance and ability to characterize the health of the ecosystem and the effectiveness of management actions. The list of focal species was then adopted by the Deschutes Coordinating Committee for use in subbasin planning. Criteria used in selecting the focal species included a) designation as a federal threatened or endangered species, b) cultural significance, c) local significance, and d) ecological significance, or ability to serve as indicators of environmental health for other aquatic species. Generally these selected species also have population status, distribution and habitat use data available that will be of assistance in future decision making. Table 2 shows the various fish species found within the Deschutes River Basin.

Table 1. Deschutes River Basin Focal Species.

Species	Scientific name	Status	Distribution	Significance
Chinook Salmon	*Oncorhynchus tshawytscha*	Proposed for ESA listing – not warranted at this time	Lower 100 miles of Deschutes River, Warm Springs River system and Shitike Creek	High tribal cultural value, High non-tribal value
Summer Steelhead	*Oncorhynchus mykiss*	Steelhead ESA-Listed Threatened for Mid-Columbia ESU	Lower 100 miles of Deschutes River and tributaries	High Tribal cultural value, High non-Tribal value
Redband Trout		Redband Trout Proposed for ESA listing – not warranted at this time	Throughout the subbasin. Some populations fragmented	High Tribal cultural and non-Tribal value
Bull Trout	*Salvelinus confluentus*	ESA-Listed Threatened for Mid-Columbia ESU	Metolius River / Lake Billy Chinook habitat complex and lower Deschutes River, Warm Springs River, Shitike Creek	High Tribal cultural and non-Tribal value
Sockeye Salmon	*Oncorhynchus nerka*	Not listed	Major subbasin lakes and reservoirs and tributaries streams	High Tribal cultural and non-Tribal value
Pacific Lamprey	*Lampetra tridentata*	State Protected Species	Lower 100 miles of Deschutes River and Warm Springs River system and Shitike Creek	High Tribal cultural value

Table 2. Historical and Current Fish Species in the Deschutes River Basin.

Common Name	Scientific Name	Origin	Status	Abundance
Pacific lamprey	*Lampetra tridentata*	indigenous	present	Moderate
Summer steelhead	*Oncorhynchus mykiss*	indigenous	present	Moderate
Chinook salmon	*Oncorhynchus tshawytscha*	indigenous	present	Moderate
Coho salmon	*Oncorhynchus kisutch*	introduced	present	locally abundant
Kokanee	*Oncorhynchus nerka*	introduced	present	abundant
Atlantic salmon	*Salmo salar*	introduced	present	rare
Sockeye Salmon	*Oncorhynchus nerka*	indigenous	present	rare
Redband trout	*Oncorhynchus mykiss*	indigenous	present	Moderate to locally abundant
Bull trout	*Salvelinus confluentus*	indigenous	present	very rare
Mountain whitefish	*Prosopium williamsoni*	indigenous	present	very abundant
Brown trout	*Salmo trutta*	introduced	present	abundant
Brook trout	*Salvelinus fontinalis*	introduced	present	abundant
Cutthroat trout	*Oncorhynchus clarki lewisi*	introduced	present	moderate
Lake trout	*Salvelinus namaycush*	introduced	present	low
Largemouth bass	*Micropterus salmoides*	introduced	present	moderate
Smallmouth bass	*Micropterus dolomieui*	introduced	present	low
White crappie	*Pomoxis annularis*	introduced	present	low
Black crappie	*Pomoxis nigromaculatus*	introduced	present	low
Brown bullhead catfish	*Ictalurus nebulosus*	introduced	present	locally abundant
Carp	*Cyprinus carpio*	introduced	present	low
Bluegill	*Lepomis macrochirus*	introduced	present	moderate
Shorthead sculpin	*Cottus confusus*	indigenous	present	locally abundant
Reticulate sculpin	*Cottus perplexus*	indigenous	present	unknown
Redside Shiner	*Richardsonius balteatus*	indigenous	present	locally abundant
Speckled Dace	*Rhinichthyys osculus*	indigenous	present	locally abundant
Longnose dace	*Rhinichthys cataractae*	indigenous	present	low
Chiselmouth	*Acrocheilus alutaceus*	indigenous	present	moderate
Largescale sucker	*Catostomus macrocheilus*	indigenous	present	locally abundant
Bridgelip sucker	*Catostomus columbianus*	indigenous	present	moderate
Northern Pike Minnow	*Ptychocheilus oregonensis*	indigenous	present	moderate
Three-spine stickleback	*Gasterosteus aculeatus*	introduced	present	locally abundant
Tui chub	*Gila* (Siphateles) *bicolor*	introduced	present	very abundant
Blue chub	*Gila* (Gila) *coerulea*	introduced	present	locally abundant

Aquatic Focal Species Population Delineation and Characterization

Chinook Salmon

Columbia River Chinook salmon, including those that return to the lower Deschutes River, are separated into spring (before June), summer (June/July) and fall (after July) races by their passage at Bonneville Dam. In the Deschutes Basin, spring and fall Chinook, and probably summer Chinook, returned annually to spawn in the draining, though the summer run may have been lost after construction of the Pelton Round Butte Complex. Trap counts before construction of Pelton and Round Butte dams show that a number of Chinook were caught before September 1, excluding spring Chinook (Jonasson and Lindsay 1988). There were also two peaks in the run at Sherars Falls (RM 44), a July peak and a September peak. Jonasson and Lindsay (1988) suggested that, based on the timing of Chinook passing the falls and those trapped at the Pelton Fish Trap, the summer run spawned above the dam site at a higher rate than those that migrated in the fall. Jonasson and Lindsay (1988) concluded, however, that because of the presence of Pelton and Round Butte dams, there is no longer a mechanism to spatially separate summer and fall runs and that there is no longer a distinction between the two races (Nehlsen 1995).

Today, two races of Chinook salmon, spring Chinook and summer/fall Chinook, are believed to spawn and rear in the Deschutes subbasin. Both races are indigenous to the subbasin. Its possible that separate summer and fall races exist, however they are currently treated as one race. Managers based this decision on the fact that, while the existence of two peaks in run timing at Sherars Falls suggests that both summer and fall races return to the Deschutes River, there remains a lack of detectable reproductive isolation between the early and late segments of the run. Both segments of this run appear to spawn in the same areas and interbreeding between the two has been suspected for many years, suggesting that only one run exists. For this plan discussion the summer/fall Chinook will be considered as fall Chinook salmon.

Spring Chinook

Importance

Spring Chinook salmon are an indigenous anadromous species with great in-basin and out-of-basin values to the tribal and non-tribal citizenry. Historically, this was a more robust population with a much greater freshwater distribution. The population was able to migrate to and from the ocean when flow conditions were optimum in the Columbia and Deschutes river systems (i.e. high spring flows), which minimized problems associated with barriers, disease and predators. It was also able to access a number of Deschutes River tributaries for spawning and rearing that are no longer accessible (i.e., Metolius River system, Crooked River system, and Squaw Creek).

Spring Chinook are currently restricted to habitat areas below the Pelton Reregulating Dam (RM 100). Spawning and primary juvenile rearing habitat exists in Shitike Creek and the Warm Springs River system. Currently Portland General Electric and Warm

Springs Power Enterprises (co-FERC License applicants) are pursuing efforts to reintroduce anadromous fish upstream of Round Butte Dam. The intent of the plan is to restore sockeye and spring Chinook salmon, and summer steelhead to their historical range in the upper Deschutes River basin, including the Crooked River below Ochoco and Bowman dams.

Spring Chinook salmon in the basin are one of the focal species that will be used to evaluate the health of the Deschutes River ecosystem and compare the effectiveness of various proposed management actions. They were selected as a focal species based on their ecological value and their cultural and local significance.

- ***Species designation:*** Spring Chinook salmon are not an ESA-listed species in the Deschutes River subbasin or the Mid-Columbia ESU.

- ***Species recognition:*** An important food source for Native Americans for thousands of years. Historically fish were harvested at a number of sites within the subbasin, including the traditional Sherars Falls site on the lower Deschutes River (RM 43). Spring Chinook have also provided an important recreational fishery for other fishers. This fishery is also predominantly associated with the Deschutes River immediately downstream from Sherars Falls.

- ***Special ecological importance:*** An important food source for a variety of subbasin wildlife. Chinook salmon die shortly after spawning and thus contributed an important source of nutrients that have wide-reaching benefits to the biota of the subbasin, including aquatic insects, aquatic and semi-aquatic plants and, indirectly, terrestrial plant species.

- ***Tribal recognition:*** Important tribal cultural, subsistence and commercial value. Historically salmon was a primary food source for tribal members and the foundation of an important trade economy between various tribes. Today this species continues to have strong cultural and religious values for many Native Americans throughout the Pacific Northwest, including the Confederated Tribes of the Warm Springs Reservation of Oregon (Confederated Tribes). Fishing is still the preferred livelihood of some tribal members.

Population Data and Status

Considerable data have been collected on spring Chinook salmon populations in the lower Deschutes River subbasin during the past thirty years. These data have been collected independently and jointly by biologists and technicians with the Oregon Department of Fish and Wildlife and Confederated Tribes.

Abundance

Harvest and escapement information indicates that an average of 1,780 wild spring Chinook returned annually to the Deschutes River from 1977 through 2003. Annual returns have varied considerably during this time, ranging from 241 to 3,460 fish (Table 3) (French and Pribyl 2004). These estimates reflect harvest and escapement information collected for the Deschutes River and key tributaries since 1977. Biologists have estimated the total spring Chinook harvest each year since 1977 (except 1985 and 1986) by conducting statistical harvest surveys of the tribal subsistence and sport fisheries on the Deschutes River at Sherars Falls (RM 44). Spring Chinook escapement to spawning tributaries is based on Warm Springs National Fish Hatchery (Warm Springs Hatchery) counts. With the exception of a small number of wild spring Chinook that spawn downstream from the hatchery or in Shitike Creek, all others are captured or automatically counted at the hatchery.

Table 3. Run size of wild spring Chinook salmon (adults and jacks) in the Deschutes River, 1977-2002 run years (French and Pribyl 2004).

	Harvest		Brood Stock	Escapement	
Run Year	Tribal	Recreational	For RBHe/	to WSNFH	Total
1977	391	1,107	194	1,606a/	3,298
1978	173	512	115	2,660	3,460
1979	203	345	89	1,395	2,032
1980	113	337	60	1,002	1,512
1981	0	0	0	1,575	1,575
1982	201	502	0	1,454	2,157
1983	190	355	0	1,541	2,086
1984	0	0	0	1,290	1,290
1985	131	704	0	1,155	1,990
1986	22d/	122	0	1,711	1,855
1987	408	501	0	1,783	2,692
1988	241	629	0	1,647	2,517
1989	265	519	0	1,409	2,193
1990	297	775	0	1,867	2,939
1991	111	485	0	817	1,413
1992	142	563	0	1,065	1,770
1993	126	251	0	538	915
1994	0	0	0	435	435
1995	4	0	0	237	241
1996	57	2	0	1,287	1,346
1997	0	0	0	870	870
1998	45	0	0	271	316
1999	0	0	0	493	493
2000	326	14	0	2,705	3,045
2001	170	5	0	2,252	2,427
2002	184	3	0	1,440	1,627
2003	7	0	0	1,519	1,566

The Warm Springs River supports most spring Chinook spawning in the Deschutes River system. Since 1977, escapement above Warm Springs Hatchery (RM 11) has averaged 1,279 adults and ranged from 162 to 2,625 spring Chinook annually. Tribal fisheries staff has also counted spring Chinook redds in the Warm Springs River system since 1982. The average number of redds counted per year has been approximately

338 redds, with a range from 62 in 1995 to 751 redds in 2001 (Table 4) (French and Pribyl, 2004).

A small spring Chinook run also returns annually to Shitike Creek. Spawning ground counts show that an average of 49 adult spring Chinook escaped annually to Shitike Creek between 1982 and 1995 (ODFW 1997). Escapement is composed of wild spring Chinook. Redd counts for Shitike Creek from 1986 to 2002 are summarized in Table 4 (Gauvin. 2003). Of 17 spring Chinook carcasses sampled during redd counts in Shitike Creek from 1986 through 1995, no hatchery origin spring Chinook were found, (CTWS, unpublished data).

Table 4. Spring Chinook Salmon redd counts by index areas in the Warm Springs River Basin and Shitike Creek, 1986 – 2002 (Gauvin, 2003) (French and Pribyl, 2004).

	Warm Springs River Basin				
Year	**Beaver Creek 23.9 km**	**Mill Creek 10.1 km**	**Warm Springs River, 30.9 km**	**Total Redds**	**Shitike Creek 20.9 km**
1986	93	32	303	428	17
1987	101	23	360	484	13
1988	83	29	289	401	28
1989	100	27	288	415	17
1990	163	64	320	547	25
1991	65	10	171	246	22
1992	36	15	112	163	12
1993	27	11	109	147	11
1994	48	18	100	166	19
1995	16	3	46	65	9
1996	92	27	204	323	6
1997	76	28	258	466	33
1998	42	17	65	114	13
1999	30	7	89	126	11
2000	172	71	415	658	52
2001	141	120	491	752	82
2002	47	17	161	225	28
2003				262	

Capacity

A wild spring Chinook stock recruitment model developed by Bob Lindsay, an ODFW research biologist, in the 1980s suggests an optimum spawning escapement goal of 1,300 adult spring Chinook and a minimum of 1,000 adults upstream from the barrier dam at Warm Springs Hatchery. The model was originally developed based on wild spring Chinook returns to Warm Springs River. Additional data has been added as it has become available and the model now includes 23 complete brood years (Gauvin, 2003). Wild spring Chinook escapements of this suggested magnitude are believed to allow for pre-spawning mortality, sufficient natural selection to provide genetic variability, and maintenance of evolutionary potential (ODFW 1997).

The EDT Model estimated that current spring Chinook habitat in the Lower Deschutes Westside Assessment Unit has the capacity to return approximately 2,800 adult fish to the subbasin annually. With moderate habitat restoration (Preferred Alternative) the habitat capacity could increase the annual run to the subbasin to approximately 3,800 adult fish. If fish passage is restored at the Pelton Round Butte Project, Opal Springs Dam and small irrigation diversion dams on lower Crooked River (below Bowman Dam), Ochoco Creek (below Ochoco Dam) and Squaw Creek and there is moderate habitat improvement (Preferred Alternative) the subbasin's habitat has he capacity to return up to approximately 5,600 adult spring Chinook annually to the subbasin.

Portland General Electric has investigated spring Chinook salmon production potential upstream of the Pelton Round Butte Project as part of the FERC re-licensing process. As part of this investigation, a consultant for PGE developed a model, referred to as the PasRAS model, which evaluates the relative importance of different mortality and habitat factors that could affect re-introduced spring Chinook salmon (Ratliff 2003). Modeling results suggest that from 347 to less than 1,000 adult spring Chinook would be available annually to spawn upstream of the hydro project. These numbers are extremely tentative because of the uncertainty associated with the parameters for parr survival. The PasRAS model also indicated that downstream migrant collection efficacies at the hydro project needed to be better than those observed on the Columbia River in order to initially establish and maintain a sustainable spring Chinook run above the project (Oosterhout 1999).

Life History Diversity

Wild spring Chinook adults enter the Deschutes River in April and May. The run arrives at Sherars Falls in mid-April and peaks in early to mid-May. Most spring Chinook salmon pass above Sherars Falls by mid-June. Approximately 80% of the Deschutes River race of spring Chinook return to the river after 2 years in the ocean (age-4 at spawning). Roughly 5% return as 3-year old jacks (or jills) and 15% as age-5 adults (PGE 1999). The majority of wild spring Chinook spawners are believed to return to spawning grounds on the Warm Springs Reservation in Shitike Creek and the Warm Springs River system. Juvenile spring Chinook rear within these Deschutes tributaries, as well as in the Deschutes River.

Wild spring Chinook salmon spawning in the Warm Springs River occurs primarily above the hatchery. Only 3% of all spring Chinook redds counted in the Warm Springs River from 1982 through 1995 were downstream from the hatchery (CTWS unpublished data). The lack of spawning below the hatchery may be a response to summer water temperatures in the reach that approach the upper limit for Chinook spawning (Fritsch and Hillman 1995). Fish managers have no evidence that wild spring Chinook spawn in either the mainstem lower Deschutes River or tributaries other than the Warm Springs River or Shitike Creek (ODFW 1997).

Wild spring Chinook salmon begin arriving at Warm Springs Hatchery in late April or early May, once water temperatures exceed 50°F, and continue until late September. The run peaks at the hatchery by the first of June, with a second smaller peak in late August or early September. In most years, approximately 70% of the run arrives at the hatchery by June 1 and 90% by July 1 (Lindsay et al. 1989). Most of the fish that pass the hatchery are believed to hold in the Warm Springs River canyon within about seven miles upstream of the hatchery until August when they continue upstream to the spawning areas (ODFW 1997).

Sampling of fish passing through a trap on the Warm Springs River at the hatchery shows that wild spring Chinook returning to spawn in the upper Warm Springs River system average 4% age-3 (jacks), 78% age-4 and 18% age-5. There are very few age-6 spring Chinook observed in the population. The age distribution has been very consistent from year to year, ranging from 63% to 83% age-4 fish. Females comprise about 62% of the age-4 and age-5 fish returning to the Warm Springs River (ODFW 1997).

Spawning in the Warm Springs River system begins the last week in August, peaks by the second week in September, and is completed by the last week in September (Lindsay et al. 1989). The average fecundity of spring Chinook salmon returning to Warm Springs Hatchery (wild and hatchery populations) was 3,300 eggs per female for 1978 through 1985 (ODFW 1997).

Time of entry and locations and type of adult holding areas in Shitike Creek are unknown, although both are believed to be similar to those in the Warm Springs River. Spawning in Shitike Creek is believed to occur at about the same time as in the Warm Spring River.

Spring Chinook salmon in the Warm Springs River probably begin emerging from the gravel in February or March. Information on completion of emergence in the Warm Springs River is not available, but may be similar to the John Day River where emergence is completed by May. Juvenile spring Chinook migrate from the Warm Springs River in two peaks, a fall migration from September through December, and a spring migration from February through May (Lindsay et al. 1989). The fish migrating in the fall are age-0, range in size from 3.1 inches to 4.3 inches fork length, and do not have a smolt appearance. Most spring migrants are age-1 fish ranging in size from 3.5 inches to 5.1 inches fork length, and have the bright silver coloration characteristic of smolts (ODFW 1997).

Wild spring Chinook salmon that migrate from the Warm Springs River in the fall at age - 0 appear to rear over winter in the Deschutes or Columbia rivers before entering the ocean the following spring at age-1. During research conducted in the late 1970's, spring Chinook salmon marked in the fall as age-0 migrants from the Warm Springs River were recaptured in the Deschutes River the following spring. Wild spring Chinook salmon smolts generally migrate through the Columbia River in April and May at age-1 based on recoveries of marked smolts (Lindsay et al. 1989).

The Shitike Creek spring Chinook population is a small race of fish with the average adult size ranging from 8 to 10 pounds. The age distribution has been very consistent, ranging from 63% to 83% age-4 fish. Spring Chinook in Shitike Creek are believed to follow a similar life history strategy to those in the Warms Springs River system. Time of entry and locations and type of adult holding areas are unknown, but are believed to be similar to those in the Warm Springs River. Spawning in Shitike Creek is also believed to occur at about the same time as in the Warm Spring River.

The EDT Model estimated that the current spring Chinook population has approximately 95% genetic diversity. With moderate habitat restoration the diversity would increase to 96%. If spring Chinook access were restored to the Middle Deschutes and Lower Crooked River assessment units the genetic diversity of the total population would initially drop to 33%.

Productivity

In most years, the number of wild spring Chinook returning to the Deschutes River has exceeded 1,300 adults, the replacement level suggested by the stock-recruitment model to maintain the stock. However, poor returns were observed from the 1989, 1990, 1991, 1993, 1994, and 1995 brood years (ODFW 1997). The 1996 and 1997 brood year's — the last complete brood years — also returned recruits well above the replacement level, indicating a fairly healthy and productive stock (French and Pribyl 2003).

Tribal biologists have estimated the number of spring Chinook juveniles emigrating from the Warm Springs River since 1975. Those estimates are summarized from 1975 – 1994 in Table 5 (ODFW 1997).

Table 5. Estimated number of wild juvenile spring Chinook that migrated from the Warm Springs River, 1975-94 brood years (CTWS unpublished data) (ODFW 1997).

	Time of Migration		
Brood Year	**Fall**	**Spring**	**Total**
1975	25,795	43,250	69,045
1976	47,041	26,043	73,084
1977	25,125	25,204	50,329
1978	74,727	57,216	131,943
1979	24,930	25,628	50,558
1980	20,579	14,656	35,235
1981	29,238	14,647	43,885
1982	67,719	30,594	98,313
1983	89,396	31,101	120,497
1984	61,970	34,827	96,797
1985	35,991	38,333	74,326
1986	47,125	35,651	82,776
1987	59,195	27,508	86,703
1988	56,007	40,365	96,372
1989	42,720	33,154	75,874
1990	51,340	47,914	99,254
1991	14,576	14,056	28,632
1992	25,471	29,332	54,803
1993	14,196	13,842	28,038
1994	51,085	N/A	N/A

The EDT Model estimated that the current productivity of wild subbasin spring Chinook salmon is 5.4. With moderate habitat restoration productivity could increase to 6.0. The model also estimated if fish passage was restored at the Pelton Round Butte Project, Opal Springs Dam and small irrigation diversion dams on lower Crooked River (below

Bowman Dam), Ochoco Creek (below Ochoco Dam) and Squaw Creek and there is moderate habitat improvement (Preferred Alternative) the productivity of the subbasin's spring Chinook would be 4.6.

Carrying Capacity

The current smolt production capacity of the Warm Springs River system is estimated to be 132,000 smolts (ODFW 1977). The total number of fall and spring migrants (age-0 and age-1 spring Chinook) from the Warm Springs River ranged from 28,038 fish to 131,943 fish for the 1975 through 1993 broods (CTWS unpublished data). Survival of juvenile spring Chinook salmon in the Warm Springs River appears to be density dependent. Survival of 1975 through 1990 broods (Table 6), the last to be completed, from egg deposition to migration was highest at low egg densities, which has compensated for low spawner abundance (ODFW 1997).

Table 6. Abundance and survival estimates of wild spring Chinook salmon at various life stages in the Warm Springs River, 1975-95 brood years. Numbers represent fish surviving to spawn in the Warm Springs River and their recruitment back to the Deschutes River (ODFW 1997).

Brood Year	Females (redds)[a/]	Males	Millions of eggs	Migrants	Adult Returns	Survival (%) Egg to Migrants	Survival (%) Migrant to adult
1975	808	539 b/	2.669	69,045	1,891	2.6	2.7
1976	1,066	653 b/	3.521	73,084	1,547	2.1	2.1
1977	699	428 b/	2.309	50,329	1,691	2.2	3.4
1978	796	467	2.671	131,943	2,009	4.9	1.5
1979	359	220	1.309	50,558	2,077	3.0	4.1
1980	117	63	0.403	35,235	1,162	8.7	3.3
1981	157	114	0.539	43,885	1,807	8.1	4.1
1982	433	233	1.430	---	2,770	6.9	---
1983	438	304	1.447	120,497	2,743	8.3	2.3
1984	429	274	1.417	96,797	2,344	6.8	2.4
1985	398	254	1.315	74,326	2,274	5.7	3.1
1986	428	395	1.414	82,776	2,938	5.9	3.5
1987	484	447	1.599	86,703	1,372	5.4	1.6
1988	401	290	1.325	96,372	1,830	7.3	1.9
1989	415	277	1.133c/	75,874	564	6.7	0.7
1990	547	321	1.462c/	99,254	453	6.8	0.5
1991	246	210	0.632c/	28,632	---	---	---
1992	163	199	0.432c/	54,803	---	---	---
1993	147	106	0.399c/	28,038	---	---	---
1994	166	111	0.474c/	---	---	---	---
1995	65	94	0.173	---	---	---	---

a/ Number of redds includes those counted in Warm Springs River below Warm Springs Hatchery.

b/ Number of males based on average percentages of males (0.38) in 1977-1985 runs.

c/ Number of eggs based on average eggs per female for all fish spawned at Warm Springs Hatchery.

Population Trend and Risk Assessment

The Deschutes spring Chinook populations are small and, as such, are at greater risk from a number of factors, including environmental catastrophe, loss of genetic variability, environmental change, poor migration and ocean-rearing conditions and over-harvest. In addition, the population's freshwater spawning and rearing habitat is concentrated in several small geographic areas. The two populations have had a number of brood years that were too small to withstand in-subbasin tribal and/or recreational harvest and still meet the spawner escapement goals agreed upon by ODFW and the Confederated Tribes.

Survival of juvenile spring Chinook salmon in the Warm Springs River appears to be density dependent. Habitat problems, including low stream flow, associated with drought conditions, reduce the habitat's juvenile Chinook carrying capacity. Other human activities also threaten the fish population. For instance, Beaver Creek, one of the Warm Springs River tributaries important for spawning and juvenile rearing, closely borders US Highway 26. Traffic accidents on this stretch of highway have released hazardous chemicals into the stream with devastating impacts. There is an ongoing risk of similar incidents that could have a profound impact on this salmon population. Highway maintenance activities adjacent to the same reach have inadvertently introduced appreciable quantities of sand and crushed gravel into the stream as a result of winter road sanding operations.

The Shitike Creek salmon population remains very small. Redd counts in Shitike Creek indicate an estimated average spawning escapement of 49 adult spring Chinook annually from 1982 to 1995. This population may be at genetic risk from a very small gene pool. There is insufficient information on production potential and adult escapement to develop a stock recruitment model for this population (ODFW 1997). The Warm Springs Tribes and USFWS have been outplanting adult spring Chinook in Shitike Creek for the past three years. The effects of this program have yet to be determined.

Unique Population Units

Oregon's Wild Fish Population List recognizes natural production of spring Chinook from two separate subbasin populations, one in the Warm Springs River and one in Shitike Creek. Both stream systems are located on reservation lands. Currently, however, there is not enough information available to determine if the two groups have enough genetic differences to qualify as separate populations (ODFW 1997).

Estimate of Desired Future Condition for Long-term Sustainability

The Deschutes subbasin spring Chinook salmon populations should include a composite annual adult run to the river that provides tribal and non-tribal harvest opportunities, as well as adequate spawner escapement to perpetuate the populations. It is important that the annual wild spring Chinook spawner escapement in the Warm Springs River above Warm Springs Hatchery be maintained with a minimum of 1,000 fish.

Distribution

Current Distribution/Spatial Diversity

Spring Chinook in the Deschutes River subbasin are currently constrained to areas below the Pelton Round Butte Complex. Fish passage facilities were provided at Pelton and Round Butte dams, which were completed in 1958 and 1964, respectively. However, by the late 1960's it became apparent that the upriver runs could not be sustained naturally with these facilities, due primarily to inadequate downstream passage of juveniles through the project. By 1970 the remnant population(s) was limited to the lower Deschutes and Warm Springs rivers and Shitike Creek.

Historic Distribution

Spring Chinook salmon historically spawned in the mainstem Deschutes River below Big Falls (RM 132), Shitike and Squaw creeks, and the Warm Springs, Crooked and Metolius river systems. There may have also been spring Chinook spawning in other tributaries, but there are no data or observations to confirm use of these other streams.

In the Crooked River system, spring Chinook distribution once extended into the upper watershed. In 1826, Peter Skene Ogden remarked on a weir for taking salmon that the Indians had built the previous summer just below the confluence of the North Fork and Crooked River (Nehlsen 1995). A report by Frey (1942) states that Chinook used Ochoco Creek extensively before Ochoco Dam was built. It also cites reports of Chinook in the upper Crooked River 40 to 50 years before (1892-1902) and in Beaver Creek 30 to 40 years before (1902-1912) (Nehlsen 1995).

Historically, the Metolius basin was a major producer of spring Chinook, supporting runs of several hundred spawning adult fish annually. Counts of spawning salmon in the Metolius River and tributaries (Lake, Spring, and Jack creeks) and Squaw Creek, plus salmon trapped at the Oregon Fish Commission weir on the Metolius, totaled 765 fish in 1951 and 512 fish in 1953, the highest years recorded. These fish migrated as far as the headwaters, near where the springs surface, and into Lake Creek to spawn and rear (ODFW 1996).

The extent of historic spring Chinook production in Squaw Creek remains unclear as habitat alterations in the late 1800s and early 1900s restricted spring Chinook distribution to the lower channel. Records of spawning salmon and redds in Squaw Creek from 1951-1960 showed a high count of 30 in 1951 and 0 by 1960 (Nehlsen 1995).

Differences in Distribution Due to Human Disturbance

Completion of the Pelton Round Butte Complex resulted in the extirpation of the anadromous spring Chinook population in the Deschutes River above RM 100 by 1970. It also blocked migration to spawning and rearing habitat in the Metolius River, lower Crooked River and Squaw Creek.

Spring Chinook distribution in the Crooked River drainage likely declined in the early 1900s because of extensive water diversions and the development of power plants near the mouth that barred upstream migration during low flows. Opal Springs Dam, constructed in 1921on lower Crooked River, was a partial barrier to migratory fish. Large irrigation dams on Ochoco Creek (Ochoco Dam) and Crooked River (Bowman Dam), completed in 1921 and 1961 respectively, eliminated this run or the potential to re-establish a run upstream of those sites. Ochoco and Bowman dams were constructed with no fish passage facilities. In 1982, Opal Springs Dam was rebuilt as a larger dam, retrofitted to produce hydroelectric power, and as such became a complete passage barrier to migratory resident fish (ODFW 1998).

In the Squaw Creek drainage, spring Chinook distribution likely declined in the late 1800s. A canal constructed in 1895 left the stream dewatered near the town of Sisters, and by 1912 summer flow in the Sisters area was entirely diverted for irrigation (Nehlsen 1995). This limited spring Chinook access to habitat in lower Squaw Creek.
Spring Chinook in the Metolius drainage probably maintained access to historical habitat areas until construction of the Pelton Round Butte Complex. However, some spring Chinook habitat was lost because of log drives in the 1920s and through the removal of instream large woody debris.

Artificial Production

Artificial propagation of spring Chinook salmon within the subbasin began in 1947 with construction of the Oregon Fish Commission Metolius Hatchery on Spring Creek. Approximately 125,000 spring Chinook were reared annually at this facility (Wallis 1960). Today hatchery spring Chinook salmon smolts are reared and released from two hatcheries in the subbasin: Round Butte Fish Hatchery, operating since 1973, and Warm Springs Hatchery, operating since 1980 (ODFW 1997).

Current Hatchery Production

As the operator of the Pelton Round Butte Complex, Portland General Electric is obligated to return 1,200 adult Round Butte Hatchery-origin spring Chinook (600 females) annually to the Pelton Fish Trap at the base of the Pelton Reregulating Dam. The company constructed and funds operation of Round Butte Hatchery by ODFW to mitigate for lost production of wild spring Chinook salmon and summer steelhead above the project. The hatchery raises approximately 300,000 spring Chinook yearling smolts annually for release into the Deschutes River. The hatchery also releases approximately 230,000 yearling spring Chinook salmon smolts annually immediately below the Pelton Reregulating Dam to meet adult mitigation requirement. Approximately 65,000 to 70,000 additional yearling smolts are released at the same site each year as part of an ongoing study to evaluate innovative fish rearing cells in the former Pelton fish ladder (ODFW 1997).

Brood stock was collected from the wild run passing Sherars Falls during the low hatchery run years of 1977 through 1980. Since 1981, most hatchery brood stock has been collected from fish returning to the Pelton fish trap (ODFW 1997). Brood stock collected for the current program at Round Butte Hatchery includes approximately 300 adults and 30 jacks held to meet mitigation requirements mandated by the FERC license to PGE to operate the Pelton Round Butte Complex. An additional 200 adults and 50 jacks are held to provide brood stock for the increased ladder-rearing program funded by BPA. Brood stock has also been acquired from Warm Springs Hatchery on years when inadequate numbers of fish returned to the Pelton Fish Trap. Fish for brood stock are collected throughout the run, proportional to their abundance, to maintain diversity in the time of return. From 1985 to 1994, unmarked spring Chinook made up 5.1% to 39.4% of the brood stock held for spawning at Round Butte Hatchery. Since 1995, only adult spring Chinook originating from Round Butte Hatchery (verified from coded wire tags) are used in the hatchery brood stock (French 2003).

The spring Chinook salmon production program at Round Butte Hatchery currently consists of two different rearing techniques. Both techniques result in the release of full term smolts that rapidly migrate through the lower Deschutes River. This is believed to minimize interaction with wild fish. One technique involves rearing juvenile Chinook salmon at the hatchery until the spring of their second year (age-1+), and then trucking them 10 miles downstream for release immediately below Pelton Reregulating Dam. The second scenario involves rearing juvenile Chinook salmon at the hatchery until fall of the year following egg-take (Age-0+) and trucking them to Pelton ladder in November where they over winter in rearing cells until they are allowed to migrate volitionally the following April at age-1+ (ODFW 1997).

Rearing juvenile spring Chinook in the Pelton ladder has proven to be a unique and effective technique for increasing adult spring Chinook returns. Smolts reared in the ladder have shown higher smolt-to-adult return rates than smolts reared in the hatchery environment (Smith 1991). For example, average return rate for five brood years from 1977 to 1983 of spring Chinook (adults and jacks) reared in the ladder was 1.6%. Average return rate of spring Chinook (adults and jacks) reared in hatchery ponds during the same time period was 0.5% (Lindsay et al. 1989). Spring Chinook smolts rear well in the ladder, apparently benefiting from the semi-natural rearing conditions and volitional migration. Chinook in the Pelton Ladder are generally fed once per day, five days per week, compared to multiple daily feedings in the hatchery rearing ponds (ODFW 1997).

Warm Springs Hatchery was constructed on the Warm Springs River after the Warm Springs Tribes Tribal Council requested that the Bureau of Sport Fisheries and Wildlife (now the U.S. Fish and Wildlife Service) determine the feasibility of a permanent fish hatchery on the reservation. Warm Springs Hatchery was authorized by Federal Statute 184, on May 31, 1966 to stock Warm Springs reservation waters with salmon and trout. The U.S. Fish and Wildlife Service operates the hatchery on lands leased from the tribe (ODFW 1997).

Warm Springs Hatchery rears only spring Chinook salmon. Rearing other species at the facility was abandoned due to water temperature and fish health problems (USFWS 2003). The design capacity of the hatchery is 1.2 million smolts, but the current production goal is the release of up to approximately 750,000 juveniles (USFWS 2003). Approximately 10% of the brood voluntarily migrates from the hatchery in the fall as age-0 fish. The rest of the brood is released as age-1 smolts the following spring. The original brood stock for the hatchery was taken from wild spring Chinook returning to the Warm Springs River. The Hatchery and Genetics Management Plan identifies Warm Springs River spring Chinook as the stock of choice to be used at the facility. Actual current spring Chinook production varies according to brood stock availability. The annual brood stock collection goal is a maximum of 630 adult salmon (USFWS 2003).

Wild spring Chinook have been incorporated into the Warm Springs Hatchery brood stock 14 of 18 years of operation but have been used only one year in the last five due to insufficient wild spring Chinook escapement. Eggs from Round Butte Hatchery were obtained for production at Warm Springs Hatchery in 1981, 1983, 1994, and 1995 due to low returns of hatchery-reared adults to Warm Springs Hatchery (ODFW 1997).

An adult hatchery spring Chinook out-planting program was initiated in Shitike Creek in 2000. Hatchery–origin fish in excess of Warm Springs Hatchery or Tribal needs have been released annually into the stream below Peters Pasture (RM 23). Numbers of Chinook out-planted include 159 fish in 2000, 200 fish in 2001 and 80 fish in 2002. This program is scheduled to continue whenever there are adequate numbers of hatchery adults available at Warm Springs Hatchery (Gauvin 2003).

Historic Hatchery Production

An early hatchery supplementation program in the Deschutes subbasin was the incubation of eggs of unknown Columbia Basin stock from Carson National Fish Hatchery in hatch-boxes in the Warm Springs River in 1958. Records also show the release of juvenile hatchery fish into the subbasin in 1961 from an unknown stock of fish obtained from Carson National Fish Hatchery. Additional juvenile hatchery fish were released in the subbasin in 1961 and 1962 and have been released annually since 1964 (ODFW 1996). Hatchery jacks and adults have also been released in the Deschutes drainage. Hatchery-origin jacks were out-planted into the subbasin in 1970 and adults were out-planted into the subbasin in 1968 and 1970 (ODFW 1997).

Non-indigenous stocks introduced into the subbasin include the Santiam stock and unknown Columbia basin stocks of fish obtained from Carson and Eagle Creek national fish hatcheries. The contribution of these releases to the current genetic makeup of wild spring Chinook in the subbasin is unknown (ODFW 1997). Several releases of Deschutes River stock were made from McKenzie, Oak Springs, Wizard Falls, and Fall River hatcheries before completion of Round Butte Fish Hatchery.

Effect of Straying/Ecological Consequences

The effect of stray, out-of-basin origin spring Chinook into the Deschutes Subbasin is unknown. There have been stray spring Chinook adults observed in the subbasin, but numbers have apparently been low. In the past, hatchery-produced spring Chinook from other locations in the Columbia Basin have been released without distinguishing tags or external marks. This has made it impossible to determine the origin of some adult salmon captured at the Pelton and Warm Springs River fish traps or speculate on the incidence of straying (ODFW 1997).

A few stray hatchery spring Chinook are recovered annually in the Deschutes River sub-basin. They have included jacks and adults coded wire tagged and released as juvenile fish at sites located over a wide geographical area. Coded wire tags have been recovered from spring Chinook released as juveniles in subbasins located in Washington and Idaho, as well as coastal subbasins that include the Rogue River in Oregon and the Trinity River in California (ODFW 1997). Initially, some out-of-subbasin stray hatchery spring Chinook captured at the Pelton Fish Trap each year could potentially have been used for brood stock in the Round Butte Hatchery program if they were unmarked or marked with the same fin mark as Round Butte Hatchery origin returns. Hatchery brood stock identification measures have now been implemented to insure that stray fish are not incorporated into the hatchery brood stock. Only coded-wire tag verified Round Butte Hatchery origin adults have been used for the hatchery brood stock since 1995 (French. 2003). The consequences of the past use of potential out-of-basin strays in the Round Butte Hatchery brood stock are unknown.

Over the years, there have been a few out-of-subbasin hatchery stray spring Chinook observed at Warm Springs Hatchery based on coded wire tag recoveries. These fish could have been spawned with the Warm Springs stock. The results from using these out-of-subbasin stray hatchery fish for brood stock are unknown.

It does not appear that Round Butte Hatchery origin spring Chinook stray into the natural production area within the Warm Springs River system. Spring Chinook released directly from Round Butte Hatchery home to the Pelton Fish Trap with a great degree of affinity; only 2.5% of all coded wire tagged spring Chinook recovered at the Warm Springs Hatchery trap during return years 1990 through 1994 were Round Butte Hatchery origin (unpublished coded wire tag recovery data, Pacific States Marine Fisheries Commission tag recovery files). There is no evidence to suggest that significant numbers of hatchery origin spring Chinook currently spawn in the wild (ODFW 1997).

Further, carcasses from hatchery brood stock are available for outplanting into the Warm Springs River after spawning as a means of providing stream nutrient enrichment. All carcasses used for this purpose are screened for disease before outplanting. In addition, carcasses are eviscerated and heat-baked to prevent the possible transmission of disease (USFWS 2003).

Relationship between Natural and Artificially Produced Populations

ODFW, USFWS and the Warm Springs Tribes have conscientiously worked to maintain the characteristics of the hatchery produced spring Chinook as close to the wild population as possible. Hatchery-origin spring Chinook salmon returning to Pelton Fish Trap in numbers greater than those needed for brood stock at Round Butte Hatchery are provided to the Warm Springs Tribes for ceremonial and subsistence use (ODFW 1997).

In the Warm Springs system, only spring Chinook indigenous to the Warm Springs River are used for brood stock. Brood fish are currently collected throughout the run in proportion to their time of return, based on direction from the 2003 Warm Springs Hatchery and Genetic Management Plan. Approximately 70% of the fish are collected from late April through May, with a minimum of 90% collected by July 1. To reach full capacity at the hatchery, wild fish can be used for hatchery brood stock after 1,000 wild spring Chinook have been passed above the hatchery to spawn. To maintain genetic diversity in the hatchery stock, a minimum of 10% wild brood stock is incorporated into each hatchery brood if wild fish returns are sufficient to meet escapement goals above Warm Springs Hatchery.

Subbasin Harvest

Harvest of spring Chinook salmon has been ongoing for hundreds, if not, thousands of years. Systematic monitoring of tribal subsistence and sport harvest has only occurred during the past twenty five years. These data have been collected by ODFW and Confederated Tribes personnel.

Current harvest

Harvest of spring Chinook salmon at Sherars Falls has been monitored since 1977 with a statistical harvest survey. From 1977 through 1993, harvest of hatchery and wild spring Chinook averaged 1,002 and 737 fish, respectively. Harvest rates of wild and hatchery spring Chinook salmon are similar, averaging 32% for the wild stock and 36% for the hatchery stock (ODFW 1997). The spring Chinook season was closed in 1981, 1984, 1994 and 1997 for recreational and tribal fishers based on the low predicted return of wild spring Chinook. From 1995 to 2003, recreational angling for spring Chinook was closed or restricted to help insure adequate wild spring Chinook spawner escapement. Tribal fishing was also closed or restricted during this period (Table 7).

Table 7. Expanded statistical harvest estimates of spring Chinook (April 16 – June 15) at Sherars Falls, Deschutes River, by year. Trial includes dipnet, hook and line, and snagging (1987 snagging only). Does not include released fish (French and Pribyl, 2004).

			Sport				Tribal			
			Wild		Hatchery		Wild		Hatchery	
Year	Anglers/ Fishers	Hours	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack
1995 a/										
1995 b/	95	442					3	1	35	0
1996 c/	2,495	14,128	2	0	304	39				
1996 c/	296	1,431					57	0	130	6
1997 a/										
1997 b/										
1998 a/										
1998 d/	203	1,067					45	0	53	0
1999 a/										
1999 d/	30	252					0	0	8	11
2000e/	6160	36,558	8	6	2,454	348				
2000d/	463	2,428					299	27	491	72
2001e/	4998	24,493	0	5	1,550	941				
2001d/	323	1,498					169	1	352	31
2002e/	6254	20,590	3	0	2,101	207				
2002d/	254	1,228					179	5	703	12
2003e/	3,912	20,857	0	0	1,339	72				
2003f/							7	0	316	4

a/ Sport season closed.
b/ Tribal season Friday through Sunday during April.
c/ Sport season Wednesday, Saturday, Sunday April 1 to June 30. Tribal season varied.
d/ Tribal harvest allowed by tribal resolution.
e/ Wild release required by sport anglers, seven day per week sport season April 15 to June 15.
f/ Tribal harvest allowed by tribal resolution with mandatory release of wild fish.

Coded wire tag recoveries from wild spring Chinook tagged as juveniles in the Deschutes River from 1977-79 brood years, the only lower Deschutes River subbasin wild spring Chinook to be coded wire tagged, showed that 33% of total harvest for those brood years was in the ocean, 24% in the Columbia River, and 43% in the lower Deschutes River (ODFW 1997).

Historic Harvest Levels

There is little historic (i.e. pre-1977) subbasin harvest data available. Historically, there has been a tribal dip net and set net fishery at the Sherars Falls site for hundreds of years. There has also been an important non-Indian fishery at the same site for nearly one hundred years. In addition, a commercial fishery at the mouth of the Deschutes River occurred from approximately 1880 to 1900 with nets across the river, which "*practically blocked the ascent of all the fish*" (ODFW 1996). Historical accounts, stories and photos from the 1800s and early 1900s also describe salmon runs in the Crooked River system. Ogden's journals in the 1820s first documented salmon in the Crooked River when the explorer found an Indian barrier for taking salmon below the confluence of the North and South forks of the Crooked River (Ogden 1950; Buckley 1992). In addition, historical stories and photos from the early 1900s show huge catches of salmonids in the lower Crooked River.

Fall Chinook

Importance

Fall Chinook salmon are an anadromous species indigenous to the subbasin, with high in-basin and out-of-basin values to tribal and non-tribal fishers. Big Falls on the Deschutes River historically blocked all upstream migration of anadromous salmonids, including fall Chinook. However, it is not known whether fall Chinook distribution extended past Steelhead Falls, or even much above the site of the Pelton Round Butte Complex. Historical distribution for this mainstem Deschutes River spawner was truncated by the construction of the Round Butte Hydroelectric Complex at RM 100.

Fall Chinook were selected as a focal species based on an evaluation of their ecological, cultural and legal status. As discussed below, fall Chinook provide significant ecological and tribal value.

- ***Species designation:*** The Mid-Columbia ESU Chinook populations, including the Deschutes River population, were proposed for ESA listing, but it was determined that a listing was not warranted.

- ***Species recognition:*** Fall Chinook salmon in the Deschutes subbasin have provided an important food source for Native Americans over hundreds, if not thousands of years. Historically fish were harvested primarily at the traditional Sherars Falls site on the lower Deschutes River (RM 44). These Chinook salmon have also provided an important recreational fishery. This fishery is also predominantly centered on the Sherars Falls area of the Deschutes River.

- ***Special ecological importance to subbasin:*** These salmon not only provided an important protein source for Native Americans living in the subbasin, but they provided an important food source for a variety of wildlife. Fish, that were not consumed, contributed an important source of nutrients that had wide-reaching benefits to the biota of the subbasin, including aquatic insects, aquatic and semi-aquatic plants and, indirectly, some terrestrial plant species. Fall Chinook are the largest race of salmon utilizing the Deschutes River subbasin. They regularly till the river's gravel substrate during spawning. The regular loosening of the substrate helps to prevent cementing or embeddedness, which is beneficial to the production of macro invertebrates and other aquatic species.

- ***Tribal recognition:*** The fall race of Chinook salmon has strong cultural and religious values for many Native Americans throughout the Pacific Northwest, including the Confederated Tribes. These fish have long had important tribal cultural, subsistence and commercial value. Salmon are considered part of the spiritual and cultural identity of the Indian people. Historically the salmon were the center of an important trade economy between various tribes. They served as a primary food source for tribal members and continue to be an essential aspect of their nutrition. Fall Chinook were generally preferred for drying because their flesh contained less oil than the spring Chinook. Fishing is still the preferred livelihood of some tribal members.

Population Data and Status

Abundance

Fall Chinook abundance in the lower Deschutes River has increased in recent years. From 1977 to 2003, the run size of adult fall Chinook salmon into the lower Deschutes River averaged 7,146 fish and ranged from 2,813 to 20,811 fish annually (Table 8). From 1997 through 2003, the run size of fall Chinook (adult and jack) into the lower Deschutes River averaged 11,677 fish annually, ranging from 4,061 fish to 22,101 fish (French and Pribyl 2004).

The number of fall Chinook escaping to mainstem spawning grounds has also increased. The annual estimated spawning escapement of adult fall Chinook averaged 6,145 fish from 1977 to 2003, and ranged from a low of 2,205 fish in 1984 to a high of 20,678 in 1997 (Table 8). Annual spawning escapement of jacks averaged 3,937 fish from 1993 to 2003 (Table 8 and 9) (French and Pribyl, 2004). Annual spawning escapement of adult fall Chinook upstream from Sherars Falls averaged 2,438 fish for the period 1977 through 2003 and 2,597 fish for the period 1993 through 2003. Annual spawning escapement of adult fall Chinook from the mouth of the Deschutes River up to Sherars Falls averaged 3,708 fish for the period 1977 through 2003, and 7,237 fish for the period 1993 through 2003 (French and Pribyl 2004).

Capacity

The fall Chinook population appears capable of maintaining total production with an average spawning escapement of approximately 4,000 adults to the Deschutes River. In the years following implementation of the U.S./Canada Salmon Treaty, the number of fall Chinook returning to the river annually has increased markedly.

The EDT Model estimated that current fall Chinook habitat in the Lower Deschutes Westside Assessment Unit has the capacity to return approximately 16,277 adult fish to the subbasin annually. With moderate habitat restoration (Preferred Alternative) the habitat capacity could increase the annual run to the subbasin to approximately 17,826 adult fish.

Life History Diversity

Fall Chinook salmon spawn throughout the lower Deschutes River from the mouth to Pelton Reregulating Dam. The upper six miles of the lower Deschutes River (Dry Creek to Pelton Reregulating Dam) were heavily utilized for spawning in the 1970's and early 1980's. From 1972 through 1986, about 46% of all redds counted were counted in four sample areas above Dry Creek (RM 94.8). These four areas represent only 16% of the area surveyed for redds from the river mouth to the dam (Jonasson and Lindsay 1988). Huntington (1985) found approximately 55% of the suitable spawning gravel for Chinook salmon in the upper three miles of the river, from Shitike Creek to Pelton Reregulating Dam.

Managers have never documented spawning in any of the Deschutes River tributaries. Spawning of fall Chinook begins in late September, reaches a peak in November, and is completed in December. Researchers have observed carcasses of spawned out fall Chinook salmon from late September to late December with the peak number of carcasses noted during the last half of November. Ripe males and females have, however, been captured in the Pelton Fish Trap in early December (ODFW 1997). Emergence of fall Chinook fry from the gravel begins in January or February and is completed in April or May. They begin their ocean migration the same spring. Juvenile fall Chinook salmon begin their migration to the ocean from May to July at age-0. The downstream migration through the Columbia River occurs from April to August, with the median passage in June and July. A small percentage of the juvenile fall Chinook remains in the lower Deschutes River over winter and emigrate in the spring at age-1 (ODFW 1997).

The EDT Model estimated that the current fall Chinook population has approximately 53% life history diversity. With moderate habitat restoration the diversity would increase to 60%.

Productivity

The estimated adult fall Chinook salmon run to the Deschutes River from 1999 to 2003 averaged 9,942 fish and ranged from 3,981 to 12,590 fish (French and Pribyl, 2004). This may be some measure of stock productivity when in-river and ocean rearing conditions are favorable. The larger run sizes observed in recent years may also be related to improvements in Deschutes River juvenile rearing habitat. All production of fall Chinook salmon in the subbasin is from wild stock.

Information on survival rates for fall Chinook salmon in the lower Deschutes River subbasin is not available (ODFW 1997). Survival data will be available when fish that have recently been coded-wire-tagged by Tribal staff begin returning to the river as adults. This tagging of naturally-produced juveniles began in 2000 (Brun 2003).

Lower Deschutes River fall Chinook are susceptible to *Ceratomyxosis*, the disease caused by the myxosporidian parasite Ceratomyxa shasta (*C. shasta*). Juvenile fall Chinook salmon seined from the lower Deschutes River before May 4 in 1978 and June 8 in 1979 were not infected with *C. shasta*. Infection rates increased for groups of fish seined from the river until July 7 of 1978 (56% infected) and July 16 of 1979 (90% infected), and then steadily decreased to low infection rates in September of both years (Ratliff 1981). It is possible that most juvenile fall Chinook salmon avoid contracting *Ceratomyxosis* by migrating to the ocean before July when high numbers of infective units of *C. shasta* are present in the river. The ongoing juvenile fall Chinook tagging project has shown many fall Chinook juveniles are present in the river upstream of Sherars Falls during July. The cooler water temperatures above Sherars Falls may act to delay out-migration of juveniles, thus forcing these late migrants to migrate through the warmer water below Sherars Falls during June and July. By contrast the juveniles rearing in the river downstream from Sherars Falls appear to leave the river by early June, when water temperatures begin to rise (Brun 2002).

The EDT Model estimated that the current productivity of wild subbasin fall Chinook salmon is 6.0. With moderate habitat restoration productivity could increase to 7.1.

Table 8. Run size of adult fall Chinook salmon in the Deschutes River, by year (French and Pribyl 2003).

Year	Harvest	Escapement	Run
1977	1,861	5,631	7,492
1978	1,971	4,154	6,125
1979	1,592	3,291	4,883
1980	1,951	2,542	4,493
1981	1,837	3,183	5,020
1982	2,016	4,890	6,906
1983	1,496	3,669	5,165
1984	970	2,205	2,995
1985	807	2,645	3,452
1986	1,153	3,801	4,954
1987	2,057	4,097	6,154
1988	2,391	3,520	5,911
1989	1,730	4,770	6,500
1990	970	2,224	3,194
1991 a/	154	3,532	3,686
1992 b/	37	3,776	2,813
1993 b/	11	8,239	8,250
1994 b/	69	5,455	5,524
1995 b/	36	7,588	7,624
1996 b/	78	8,763	8,841
1997 b/	133	20,678	20,811
1998 c/	507	10,925	11,432
1999 c/	373	6,527	6,900
2000 d/	407	3,981	4,388
2001 b/	334	11,177	11,511
2002e/	975	3,940	13,244
2003e/	1078	12,590	13,668

a/ Sport and tribal Chinook season closed June 16 – September 30, 1991.
b/ Sport season closed. Tribal harvest limited differently by year.
c/ Sport season August 1 to October 31, Wednesdays, Saturdays, and Sundays only. Tribal harvest limited differently by year.
d/ Sport season August 1 to October 31. Tribal harvest limited by harvest cap of 1,300 adult fall Chinook.
e/ Sport season August 1 to October 31. Tribal harvest limited by harvest cap.

Table 9. Run size of jack fall Chinook salmon in the Deschutes River, by year.

Year	Harvest	Escapement	Run
1977	1,672	2,125	3,797
1978	1,597	2,708	4,305
1979	2,000	4,338	6,338
1980	1,507	1,904	3,411
1981	1,294	3,728	5,022
1982	1,506	3,360	4,866
1983	678	859	1,537
1984	987	1,237	2,224
1985	1,454	5,384	6,838
1986	1,428	5,872	7,300
1987	242	1,515	1,757
1988	245	1,859	2,104
1989	150	1,486	1,636
1990	140	727	867
1991 a/	59	1,746	1,805
1992 b/	4	2,483	2,486
1993 b/c/	0	NO ESTIMATE	
1994 b/	8	14,276	14,284
1995 b/	19	7,121	7,138
1996 b/	6	1,705	1,711
1997 b/	7	1,005	1,012
1998 d/	78	6,960	7,038
1999 d/	76	4,097	4,173
2000 e/	127	8,395	8,522
2001 b/	27	10,563	10,590
2002	75	1,169	3,707
2003 f/	78	3,264	3,342

a/ Sport and tribal Chinook season closed June 16 – September 30, 1991.
b/ Sport season closed. Tribal harvest limited differently by year.
c/ An insufficient number of tagged jack salmon were recovered during carcass surveys. No run size or escapement estimates for jack fall Chinook could be made.
d/ Sport season August 1 to October 31, Wednesdays, Saturdays, and Sundays only. Tribal harvest limited differently by year.
e/ Sport season August 1 to October 31. Tribal harvest limited by harvest cap of 1,300 adult
f/ Sport season August 1 to October 31. Tribal harvest limited by harvest cap.

Carrying Capacity

The Deschutes River fall Chinook salmon carrying capacity has not been determined. An accurate stock recruitment model, similar to that used to predict adult spring Chinook returns to the subbasin, does not exist for fall Chinook, but Tribal staff are in the process of developing a model (Brun, 2003). Managers feel that an average annual spawner escapement of 4,000 adults to the river, with a 2,000 escapement upstream of Sherars Falls, is the minimum spawner escapement needed to maintain this population (ODFW 1997).

Population Trend and Risk Assessment

Estimates of fall Chinook runs for the past twenty-five years indicate that this Chinook population has experienced some of its largest runs to the Deschutes River in the past ten years. This coincides with years of good ocean productivity (Tables 8 and 9) and may be directly associated with reduced ocean harvest following implementation of the U.S./Canada Salmon Treaty.

The risks to this population range from water quality to environmental catastrophe. Any reductions in river flow would likely result in increased water temperatures that would make these fish more vulnerable to parasites and disease. Elevated river temperatures prior to the smolt migration could produce appreciable losses from *Ceratomyxosis*. The major north – south rail line that closely borders the lower 86 miles of the Deschutes River also poses a threat. An accidental derailment and spill of hazardous material into the river could devastate all aquatic life from that point downstream. However, the population's complex life history patterns allow some built-in population protection from such a catastrophic scenario.

Unique Population Units

Deschutes River fall Chinook are managed as an upriver bright salmon race and are used as an indicator stock by the U.S./Canada Salmon Treaty. Schreck et al. (1986) classified populations of Columbia River Chinook salmon (wild and hatchery; spring, summer, and fall) into several broad groups of similar populations by cluster analysis of characteristics associated with body shape, meristics, biochemistry, and life history. Wild fall Chinook salmon from the Deschutes River were similar to eight hatchery and wild fall Chinook salmon populations that occur in the Columbia River basin from the Cowlitz River to the Hanford Reach, and were also similar to two hatchery spring Chinook salmon populations from the lower Columbia River. Deschutes River fall Chinook salmon were not genetically similar to summer Chinook salmon from the upper Columbia River or from the Salmon River. Details of the gene frequencies, meristic characters, and body shape characters of Deschutes River fall Chinook salmon can be found in Schreck et al. (1986).

Life History Characteristics of Unique Populations

It is uncertain if the lower Deschutes River fall Chinook run is composed of one or two populations. The adult run timing of this population(s) overlaps the accepted summer and fall Chinook run timing on the mainstem Columbia River. Evidence exists that two populations were historically present and may continue to exist. Galbreath (1966) reported several instances of Chinook tagged at Bonneville Dam during the summer Chinook migration (June 1 to July 31 at Bonneville Dam) being recovered later in the Deschutes River subbasin. Three of these tags were recovered in the Metolius River prior to the time anadromous runs were blocked by dams on the Deschutes River, suggesting that a portion of the Deschutes River Chinook population, potentially summer Chinook, spawned in the Metolius River and maintained spatial reproductive and hence racial separation. In the past 30 years, Deschutes River fishery managers have never been able to verify any temporal or spatial separation during spawning in the lower Deschutes River that could verify two distinct populations within the subbasin.

There has also been speculation about whether this is one population that spawns throughout the lower 100 miles of the Deschutes River or two populations; one spawning above Sherars Falls and one spawning below Sherars Falls. Beaty (1995) examined this question in detail but could not reach a definitive conclusion on the existence of two populations. Existing evidence supports both the one population concept and the two population concept (ODFW 1997).

The fall Chinook population(s) has two peaks in migration timing - one in June through August and one in late September and early October. Fish from the earlier migration peak tend to migrate further up the system and are captured at the Pelton Fish Trap at a higher rate than the later migrating group. During run years 1977 through 1986, about 28% of the fall Chinook that passed Sherars Falls did so before September 1. However, of the adults caught in the Pelton Fish Trap for those run years, 48% were caught by September 1 (Jonasson and Lindsay 1988).

This population's life history diversity is indicated by the number of age classes typically observed in the in-river fishery (Table 10). The average age class structure of lower Deschutes River fall Chinook during 1977 through 1986 brood years was 34% age-2 fish, 30% age-3 fish, 31% age-4, 5% age- 5, and less than 1% age-6 fish (Table 10). Approximately 96% of the returns during the same brood years had entered the ocean at age 0, and 4% had entered the ocean at age 1 (Jonasson and Lindsay 1988). Mean lengths of the four most common ages at return are shown in Table 10. In the lower Deschutes River subbasin, 21.3 inches is the length criterion to differentiate between fall Chinook jacks and adults for inventory purposes. Only 2% of age-2 fish are larger than 21.3 inches, and only 15% of age-3 fish are smaller than 21.3 inches (ODFW 1997). Data collected during Tribal fall Chinook salmon studies in 2001 and 2002 found the adult sex ratio of 51% male to 49% female, and 41% male to 59% female, respectively (Brun 2003). Information is not available regarding fecundity or adult length-weight relationship.

Table 10. Age-specific lengths of fall Chinook salmon sampled at Sherars Falls, 1978-83. (Jonasson and Lindsay, 1988).

Age [a/]	N	Mean Length (cm)	Length 95% CI [b/]	Length Range (cm)
2	866	43.9	0.3	20-59
3_1	644	61.7	0.9	34-88
3_2	39	55.3	1.9	48-80
4_1	852	85.5	0.5	61-108
4_2	41	78.8	2.7	61-92
5_1	153	93.0	1.1	74-109
5_2	46	95.5	2.8	78-133
6_1	3	94.0	11.4	90-99

a/ Age was determined by scale analysis.
b/ CI = confidence interval (+ or -).

Estimate of Desired Future Condition for Long-term Sustainability

Deschutes fishery managers have determined that a minimum spawner escapement of 4,000 adult fall Chinook is needed to sustain this population. A larger run to the mouth of the Deschutes River would provide for some in-river harvest and an adequate spawner escapement.

Distribution

Current and Historic Distribution

Fall Chinook salmon spawn and rear throughout the mainstem Deschutes River below Pelton Reregulating Dam. It remains unknown whether fall Chinook historically passed above Sherars Falls. Summer and fall flows in the lower Deschutes River may have historically limited distribution of fall Chinook salmon to 44 miles of river downstream from Sherars Falls before a fish ladder was built at the falls in the 1930's. However, it's possible that higher natural mainstem flow — which may have existed before development of extensive irrigation systems in Central Oregon in the late 1800s — was sufficient for fall Chinook passage at Sherars Falls throughout the summer and fall months. Construction of Pelton and Round Butte hydroelectric dams in 1958 and 1964, respectively, inundated spawning areas above river mile 100. Upstream passage was possible around the hydroelectric complex, but downstream passage facilities at the dams proved insufficient to sustain wild runs above the dams. The fall Chinook salmon run was extirpated above the Pelton Round Butte Complex by 1970.

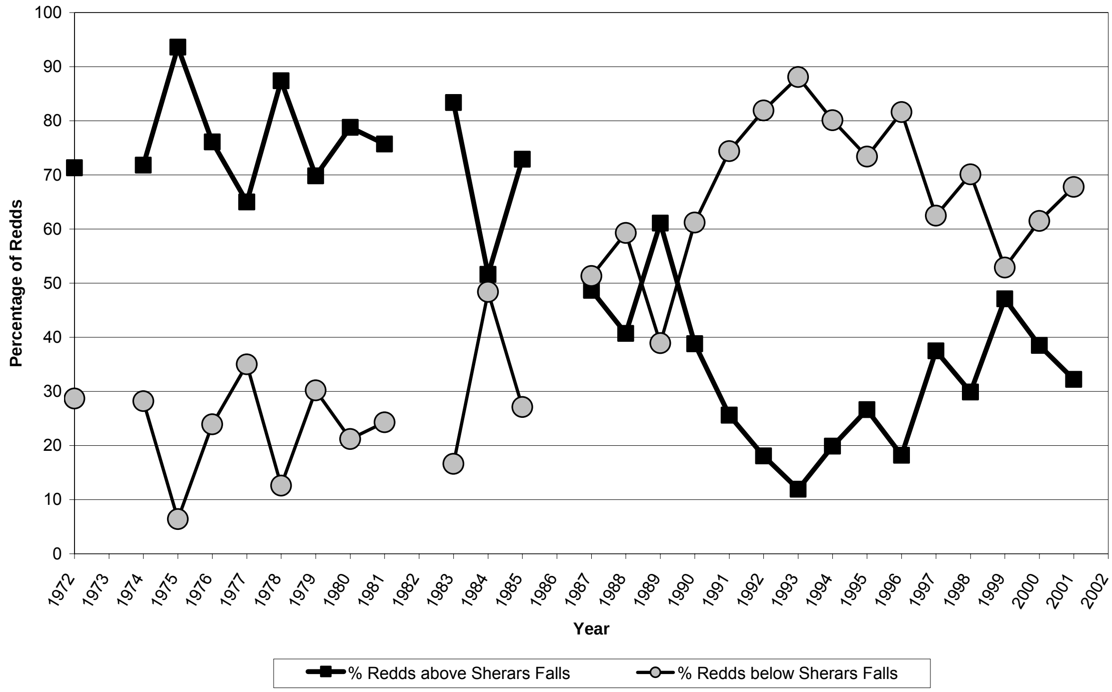
Differences in Distribution due to Human Disturbance

Construction of the Pelton Round Butte Complex may have eliminated several miles of historic spawning and rearing habitat. However, the bulk of the historic habitat remains available from the river mouth upstream to the Pelton Reregulating Dam.

Fall Chinook redd counts conducted from 1972 to 2002 suggest that a change in historic spawning distribution may have occurred and a higher percentage of spawning is now taking place downstream from Sherars Falls (Figure 1). From 1972 to 1987, an average of 76 percent of the fall Chinook redds found in the lower 100 miles of the Deschutes River were upstream from Sherars Falls. During years 1988 to 1995, an average of 30% of all redds counted were upstream from Sherars Falls (ODFW 1997). Radio telemetry data collected from adult Chinook tagged at Bonneville Dam appears to confirm the apparent shift in spawning distribution within the Deschutes River. Of the radio-tagged salmon spawning in the Deschutes River, 76% and 67% spawned downstream from Sherars Falls in 2001 and 2002, respectively (Brun 2002 and 2003).

Reasons for this shift in spawning distribution are unknown. Several factors may be responsible for causing the shift in fall Chinook spawning, including degradation of water quality, spawning gravel quality or quantity, increased egg-to-smolt survival below Sherars Falls associated with substantial riparian habitat recovery in this reach, adult passage problems associated with the Sherars Falls fish ladder, intensive water contact recreation above Sherars Falls, and over-harvest of the portion of the run destined to spawn above Sherars Falls (ODFW 1997).

Figure 1. Deschutes River Fall Chinook Salmon Spawning Distribution, 1972 – 2002 (French and Pribyl 2003).



Artificial Production

Introduction

Fall Chinook salmon culture was not listed as a condition on the Pelton Round Butte hydroelectric license. Fall Chinook hatchery production and/or juvenile releases have not occurred in the subbasin for more than twenty years, and no hatchery supplementation of this wild population is anticipated.

Historic Artificial Production

Fisheries managers out-planted Little White Salmon River Fish Hatchery fall Chinook salmon in the Warm Springs River without success in 1958, 1967, and 1968 (Table 11). There was also some experimental production of fall Chinook salmon at Round Butte Hatchery in the late 1970's. This project was discontinued because of poor returns, possibly due to *Ceratomyxosis* (Ratliff 1981).

Effect of Straying/Ecological Consequences

Few stray, out-of-subbasin origin fall Chinook had been observed in the Deschutes River until the past two years. However, managers now believe there is substantial interaction between wild Deschutes fall Chinook and other stray, hatchery origin summer or fall Chinook within the lower reaches of the Deschutes River. This conclusion is based on recent radio telemetry data and an ongoing Tribal fall Chinook study. The initial indications of no appreciable straying into the Deschutes River were masked by the difficulty of identifying stray fish. The lack of external markings for some Upper Columbia River Basin hatchery-origin fish makes it impossible to distinguish them as hatchery fish. Adult fall Chinook trapping at Sherars Falls during the past 25 years has not shown an appreciable number of fin-marked hatchery origin adults.

A Columbia Basin adult fall Chinook radio telemetry study has provided some insight into the straying of fish into the Deschutes River. Of the adult salmon radio tagged and released at Bonneville Dam, 47% and 54% of the adults tagged in 2001 and 2002, respectively, entered the Deschutes River but most did not remain to spawn. In 2001, 13% of these “dip-ins” migrated upstream to or above Sherars Falls (Brun 2002; Brun 2001). Tribal biologists recovering fall Chinook salmon carcasses following spawning estimate that only about one percent of the carcasses examined were fin-marked, out-of-subbasin stray salmon during 2001 and 2002. Coded wire tag recoveries from these fin-clipped carcasses originated predominantly from Klickitat River and Lyons Ferry fish hatcheries (Brun 2003). Nevertheless, it is difficult to thoroughly evaluate the extent of the interaction of stray fall Chinook since many Columbia Basin hatchery-origin fall Chinook can not be distinguished with any external mark or tag. The population co-exists with wild and hatchery-origin summer steelhead and spring Chinook salmon, but there are no known adverse effects from this association. It will be impossible to accurately estimate the number of stray hatchery salmon spawning in the river or estimate their effect on the Deschutes River population until all Columbia Basin hatchery-origin fall Chinook are distinctively marked.

Table 11. Releases of hatchery fall Chinook salmon in the lower Deschutes River subbasin (ODFW 1997).

Release Year	Hatchery and Stock	Number	Size	Location
1958	Spring Creek	300,000	Eggs	Warm Springs R.
1967	Little White Salmon	502,500	1,139/lb	Warm Springs R.
1968	Little White Salmon	1,000,000	856/lb	Warm Springs R.

Subbasin Harvest

Current Harvest

Harvest of fall Chinook salmon in the lower Deschutes River occurs primarily in a three-mile section from Sherars Falls downstream to the first railroad trestle (RM 41–44). This section of river is the only area of the lower Deschutes River where the use of bait is permitted by recreational anglers. A popular recreational fishery—and one of the last tribal dipnet subsistence fisheries for fall Chinook salmon in the region—typically occurs at Sherars Falls from early July to late October. Results from a statistical harvest survey of the recreational and tribal fisheries show that during years when recreational harvest of summer/fall Chinook was allowed, 88% of the recreational harvest of adult fall Chinook downstream from Sherars Falls took place in the Sherars Falls reach and the remaining 12% of the harvest occurred throughout the river as incidental captures in the recreational summer steelhead fishery. Managers have documented no target recreational fall Chinook fisheries outside of the Sherars Falls reach (ODFW 1997).

Recreational harvest averaged 320 adult fall Chinook and tribal harvest averaged 1,297 adult fall Chinook from 1977 to 1990, years when season length and harvest restrictions were not in place (Table 12). During the same time period, recreational harvest averaged 693 jack fall Chinook and tribal harvest averaged 372 jack fall Chinook (Table 11). Of the fall Chinook salmon that entered the lower Deschutes River from 1977 through 1990, 31% of the adults and 29% of the jacks were harvested in recreational and tribal fisheries (ODFW 1997).

From 1997 through 2003 recreational anglers could legally harvest fall Chinook during portions of five years. The average harvest during this period was 168 adults, with a range of 118 to 283 fish, and 66 jack salmon, with a range of 49 to 96 fish. Tribal fishers were able to fish each year during this seven-year period and they harvested an average of 404 adult salmon per year, with a range of 202 to 762 fish. At the same time their average jack harvest was 15 fish, with a range of 1 to 27 fish (French and Pribyl 2004).

Historic harvest

There are no estimates of annual harvest of fall Chinook salmon in the Deschutes River prior to 1977. However, the concentrated Tribal and sport fishery in the Sherars Falls reach has been ongoing for many years.

Table 12. Run size, harvest and escapement of wild fall Chinook salmon (adults and jacks) in the lower Deschutes River, 1977-2002 (French and Pribyl 2004).

Year	Harvest_ Tribal a/	Harvest_ Recreational	Escapement	Run Size
1977	2,280	1,253	7,756	11,289
1978	2,037	1,531	6,862	10,430
1979	1,991	1,601	7,629	11,221
1980	2,133	1,325	4,446	7,904
1981	1,786	1,345	6,911	10,042
1982	1,826	1,696	8,250	11,772
1983	1,549	625	4,528	6,702
1984	1,184	773	3,262	5,219
1985	1,449	812	8,029	10,290
1986	1,282	1,299	9,673	12,254
1987	1,676	621	5,612	7,911
1988	1,884	590	5,379	7,853
1989	1,446	419	6,199	8,064
1990	827	283	2,951	4,061
1991 b/	95	118	5,278	5,491
1992 c/	41	0	5,259	5,300
1993 d/	11	0	***NO ESTIMATE OF JACKS***	
1994 e/	77	0	19,731	19,808
1995 f/	53	0	14,709	14,762
1996 g/	90	0	10,468	10,552
1997 h/	210	0	21,683	21,823
1998 i/	359	188	17,885	18,470
1999 i/j/	256	183	10,624	11,073
2000 k/l/m/	382	214	12,376	12,910
2001 j/m/	360	0	21,740	22,101
2002	693	357	15,887	16,937
2003	2,937	1,174	15,854	19,965

a/ Combined dipnet and hook and line fisheries at Sherars Falls. Does not include left before 0700 sample in 1988 and 1989. Does not include tribal snagging harvest in 1987.

b/ Recreational and tribal fishery closed to Chinook salmon until October 1.

c/ Recreational fishery closed to salmon after June 16. Tribal fishery restricted to a 49 adult salmon harvest cap. Harvest windows: July 1 - 11, October 15 - 18, and October 30 - 31.

d/ Recreational fishery closed to salmon after June 18. Tribal fishery restricted to a 45 adult salmon harvest cap. Harvest windows: 6 AM Friday to 12 PM Sunday, July 9 to October 31.

e/ Recreational fishery closed to salmon after April 1. Tribal fishery not restricted June 16 to August 7. Tribal fishery closed August 7 to September 23. Tribal fishery restricted to 60 adult salmon harvest cap. Harvest windows: 6 AM Friday to 12 PM Sunday, September 23 to October 30.

f/ Recreational fishery closed to salmon after April 1. Tribal harvest allowed July 17 through July 29 and 6 AM to 9 PM Monday through Saturday, October 2 to December 31, 1995. Tribal harvest restricted to a 63 adult salmon harvest cap.

g/ Sport fishery closed 6/16 - 10/31. Tribal harvest up to 72 adults.

h/ Sport fishery closed. Tribal harvest up to 112 adults. Includes 69 hatchery origin adults (likely spring Chinook).

i/ Sport season 8/1 – 10/31 Wed., Sat. and Sun. only. Tribal harvest cap varies by year.

j/ Tribal fishers required to release wild steelhead.

k/ Sport season 8/1 to 10/31, 7 days per week.

l/ Tribal harvest cap of 1,300 adult fall Chinook.

m/ Tribal harvest cap of 300 adult fall Chinook, sport Chinook fishery closed 8-1-01, steelhead open.

Redband Trout

Redband trout are a hardy race of rainbow trout that is generally found in the more arid region east of the Cascade Mountains. Two distinct life forms of redband trout, resident redband trout and anadromous summer steelhead, are native to the Deschutes River subbasin. For this discussion, the subbasin's native resident redband trout will be referred to as redband trout, while hatchery rainbow trout will be referred to as rainbow trout.

Summer Steelhead

Historically, the Deschutes summer steelhead population was robust and widely distributed. Summer steelhead occurred throughout the mainstem Deschutes River below Steelhead Falls and in many of the larger tributaries, including the Crooked River and Squaw Creek systems (Nehlsen 1995). During high winter and early spring flows, they may have been able to negotiate Steelhead Falls, and migrated as far as Big Falls (RM 132.2). After construction of the Steelhead Falls fish ladder in 1922, fish could move upstream, regardless of flow conditions, to access some excellent gravel areas and cool spring-fed flows between Steelhead and Big falls (Nehlsen 1995).

Steelhead runs to the Crooked River drainage, the Deschutes River above RM 100, and Squaw Creek were eliminated by a series of large irrigation and hydroelectric dams on the Deschutes and Crooked rivers. In the Crooked River system, Ochoco Dam (Ochoco Creek) and Bowman Dam (Crooked River, RM 70) were completed in 1921 and 1961, respectively, with no fish passage facilities and blocked anadromous fish runs into Ochoco Creek and the upper Crooked River basin, respectively. Borovicka (1956) reported *"A concentration of steelhead in undetermined numbers was found below the dam of the Ochoco Lumber Co. on Ochoco Creek in the town of Prineville* (OSGC 1956). Borovicka (1956) also reported *that "Steelhead were observed jumping at the Stearns Dam above Prineville on the mainstem of Crooked River". "Steelhead are able to pass the Stearns Dam during flood stages of the Crooked River"* (OSGC 1956). Pelton and Round Butte dams were completed on the Deschutes River downstream of the confluence with the Crooked River in 1958 and 1964, respectively (ODFW 1996).

Today, summer steelhead return to spawn in the lower Deschutes River and several tributaries, including Buck Hollow, Bakeoven, Shitike, and Trout creeks and the Warm Springs and White rivers.

Importance

Summer steelhead are indigenous to the Deschutes River subbasin, with great in-basin and out-of-basin value to tribal and non-tribal fishers. Steelhead are one of the larger species of fish found in the subbasin and are an important component of the aquatic ecosystem. They were selected as a focal species based on an evaluation of their special ecological, cultural and legal status.

Demographically independent population delineation:
The Interior Columbia TRT identified 16 demographically independent populations in four major groupings and one unaffiliated area within the Mid-Columbia River Steelhead ESU shown on map on following page. The TRT based their delineation largely on the

basis of basin topography and habitat similarity, since data tended to be patchily distributed across the region. In particular, genetic studies in this ESU tended to be locally focused, with few overlapping loci to allow comparison across the broader geographic area, although some information was available within our groupings. Uncertainties about hatchery straying and interbreeding limited the TRT's ability to draw definitive conclusions from genetic data.

The Deschutes Subbasin falls within the Cascades Eastern Slope Tributaries grouping. Populations in this major grouping are united primarily by geographic proximity. The habitats they occupy are diverse, but the constituent rivers generally drain the eastern slope of the Cascades and the dry Columbia Plateau. There are two demographically independent steelhead populations, and one extirpated population in the Deschutes Subbasin.

Deschutes River Eastside Tributaries
Deschutes River Westside tributaries
Deschutes River above Pelton Dam

Deschutes River Eastside Tributaries (DREST-s). This population encompasses the mainstem Deschutes River from its mouth to the confluence of Trout Creek, and the tributaries entering the Deschutes from the east: Buck Hollow, Bakeoven, and Trout Creeks. Because of uncertainty concerning the relationship of mainstem spawners in the Deschutes Rivers and tributary populations, mainstem reaches were grouped with their respective tributary populations. The TRT separated the Deschutes River Eastside Tributaries population from other Cascade eastern slope populations by geographic distance (37 km to Fifteenmile Creek) and run timing (Deschutes steelhead are exclusively summer run fish), and from the Deschutes River Westside tributaries population on the basis of marked habitat differences, coupled with life-history differences. Eastside tributaries drain drier, lower-elevation areas than the Westside tributaries; consequently, flow patterns and water temperatures are quite different between the two areas. Steelhead in the two regions are temporally segregated, with eastside tributary fish spawning between January and April, and Westside tributary fish spawning between April and May (Olsen et al. 1992).

Deschutes River Westside Tributaries (DRWST-s). The TRT separated the Deschutes River Westside Tributaries population on the basis of habitat and life history characteristics. Included in this population are mainstem spawners from the mouth of Trout Creek upstream to Pelton Dam (current upstream barrier to anadromous fish), and the Warm Springs River and Shitike Creek. Recent work suggests that anadromous and resident females in this area are spatially isolated (Zimmerman and Reeves 2002), although males may not follow this pattern.

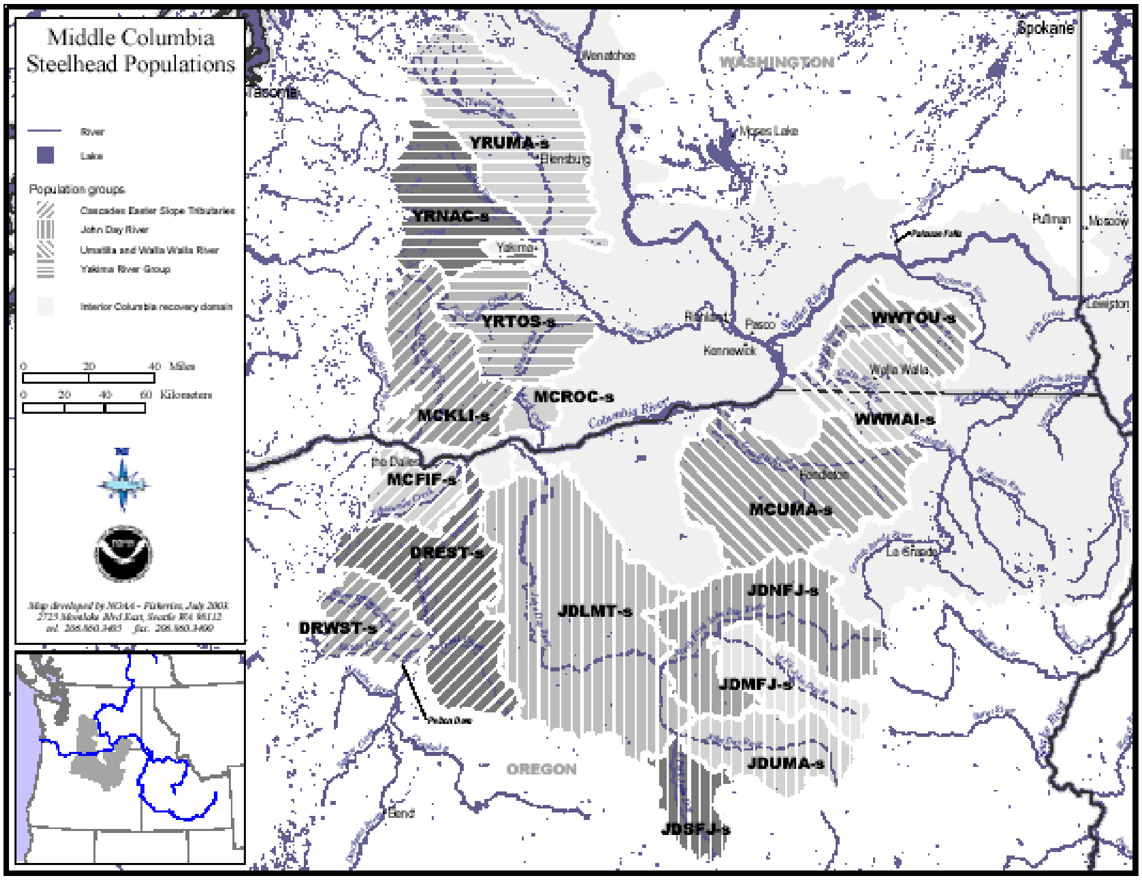


Figure VI-1. Mid-Columbia steelhead populations.

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Deschutes River above Pelton Dam. The population structure of steelhead in the area now blocked by Pelton Dam is ambiguous. The population may have included multiple life histories, including spring-run fish (Nehlsen 1995). Historically, steelhead were found upstream to Big Falls (RM 132), in Squaw Creek and the Crooked River, and possibly in the Metolius River, with Squaw Creek and the Crooked River being particularly productive. The current resident population in this area may include remnant, residualized steelhead. It is likely that this area supported at least one independent population; in fact, genetic samples from the Crooked River are quite distinct from those from other areas of the Deschutes (Currens 1997).

- Summer steelhead within this ESU were federally listed as threatened on March 25, 1999 (NMFS 1999). In 1999, NOAA Fisheries concluded that the Deschutes River hatchery steelhead stock was not considered part of the ESU since it was not essential for the recovery of the wild steelhead population (NMFS 1999a).

- ***Species recognition:*** Summer steelhead in the Deschutes subbasin have provided an important food source for Native Americans over hundreds, if not thousands, of years. Historically, fish were harvested in the Deschutes River and tributaries. Summer steelhead have also provided an important recreational fishery for other non-tribal fishers. This fishery is now confined to the Deschutes River downstream from the Pelton Reregulating Dam.

- ***Special ecological importance to subbasin:*** Summer steelhead serve as an important food source for a variety of wildlife. The fish also contribute an important source of nutrients that has had wide-reaching benefits to the biota of the subbasin, including aquatic and semi-aquatic plants and terrestrial plant species. Steelhead spawners routinely till portions of the gravel substrate, although in different areas than the Chinook salmon. This loosening of gravel is beneficial for the production of macroinvertebrates and other aquatic species. Historically, steelhead potentially had one of the widest distributions of any of the anadromous fish species found within the subbasin, possibly exceeded only by the Pacific lamprey.

- ***Tribal recognition:*** Native Americans throughout the Pacific Northwest, including the Confederated Tribes of the Warm Springs, maintain strong cultural and religious values for summer steelhead and Chinook salmon. These fish have long had important tribal subsistence, ceremonial and commercial value.

Population Data and Status

Abundance

The estimated number of wild summer steelhead migrating over Sherars Falls (Table 13) has ranged from a low of 482 fish in the 1994/95 run year to a high of 9,624 in the 1985/86 run year, averaging 5,0053 fish annually for the period of record (1977/78 – 2002/03). The 1985 high escapement estimate was likely inflated with unmarked stray hatchery-origin fish that were indistinguishable from wild fish (French and Pribyl 2003). Population estimates of wild and hatchery summer steelhead passing Sherars Falls in the lower Deschutes River reflect data collected annually since 1977 using Peterson mark-recapture estimation techniques. These estimates are made by tagging wild summer steelhead captured at the Sherars Falls adult salmon and steelhead trap (located in the fish ladder at Sherars Falls) and making later recovery of both tagged and untagged fish at Warms Springs Hatchery and at the Pelton Fish Trap. This technique yields an estimated number of wild and hatchery steelhead passing Sherars Falls (French and Pribyl 2002).

Capacity

The NOAA Fisheries interim spawner escapement objective for the subbasin is 6,300 wild steelhead. The ODFW Lower Deschutes Fish Management Plan (1997) concluded that a spawning escapement of 6,575 wild steelhead upstream from Sherars Falls would be adequate to sustain maximum natural production potential during years of good juvenile and adult survival conditions. During years of outstanding fresh water and ocean rearing conditions and high smolt-to-adult survival, spawning escapement could be considerably larger (ODFW 1997).

Table 13. Estimated number of steelhead migrating above Sherars Falls, by run year (French and Pribyl 2004).

Run Year	Wild	Round Butte Hatchery	Stray Hatchery	Total
1977-78	6,600	6,100	900	13,600
1978-79	2,800	3,200	300	6,300
1979-80	4,200	5,400	600	10,200
1980-81	4,100	5,500	500 a/	10,100
1981-82	6,900	3,800	1,200 a/	11,900
1982-83	6,567	3,524	1,249 a/	11,340
1983-84	8,228 b/	7,250	7,684 a/	23,162
1984-85	7,721 b/	7,563	3,824 a/	19,108
1985-86	9,624 b/	7,382	5,056 c/	22,062
1986-87	6,207 b/	9,064	9,803 c/	25,074
1987-88	5,367 b/	9,209	8,367	23,943
1988-89	3,546	3,849	2,909	10,304
1989-90	4,278	2,758	3,659	10,695
1990-91	3,653	1,990	2,852	8,495
1991-92	4,826	3,778	8,409	17,049
1992-93	904	2,539	4,261	7,704
1993-94	1,487	1,159	4,293	6,936
1994-95	482	1,781	4,391	6,654
1995-96	1,662	2,708	11,855	16,225
1996-97	3,458	5,932	23,618	33,008
1997-98	1,820	5,042	17,703	24,465
1998-99	3,800	3,527	11,110	18,437
1999-2000	4,790	2,628	13,785	21,203
2000-2001	8,985	4,380	15,072	28,437
2001-2002	8,749	9,373	25,263	31,784
2002-2003	9,363	8,880	15,203	23,004

a/ May include some AD CWT marked steelhead that originated from Warm Springs NFH although few of these ever returned to that facility.
b/ May include some unmarked hatchery steelhead out-planted as fry into the Warm spring River from Warm Springs NFH.
c/ May include adults from a release of 13,000 smolts from Round Butte Hatchery that were accidentally marked with the same fin clip as steelhead released from other Columbia basin hatcheries.

The Ecosystem Diagnosis and Treatment Model projected that the habitat capacity for summer steelhead in the three NOAA Fisheries designated population areas could produce up to 13,800 adult steelhead returning annually to the subbasin. This estimate was based on the assumption that fish passage was successfully restored at Pelton Round Butte and at small dams on lower Crooked River and Squaw Creek. This estimate included potential adult returns numbering up to 3,100, 5,200 and 5,500 for the Deschutes River Westside Tributaries, Deschutes River Eastside Tributaries and the

Middle Deschutes River Tributaries population areas, respectively. However, steelhead production in the Warm Springs River and Shitike Creek does not appear to have been as important historically as the Deschutes River Eastside Tributaries or the Crooked River system. It is also anticipated that these two prominent Westside tributaries will continue to produce low numbers of steelhead.

Portland General Electric has explored summer steelhead production potential upstream of the Pelton Round Butte Complex as part of the FERC relicensing process. During these investigations a PGE consultant, S.P. Cramer and Associates, Inc., developed a model that evaluated the relative importance of different mortality and habitat factors that could affect re-introduced anadromous fish species (Ratliff 2003). Cramer and Associates, Inc. modeled hypothetical asymptotic parr capacity in the accessible habitat upstream of the hydro project and estimated a capacity range between 40,000 and 160,000 fish, based on assumed stock-recruitment relationships and expected survival rates. When it was assumed there was no project-related juvenile or adult passage mortality or increased competition with resident trout, the estimated equilibrium spawner numbers ranged from 500 to 4,000 spawners per year (depending on the productivity of the re-introduced population (Cramer and Beamesderfer 2001).

Productivity

The summer steelhead population has the capability to respond to favorable management and environmental factors. However, the effects of thousands of stray steelhead spawning with the indigenous stock may ultimately have a negative impact on the population's productivity. Specific information on habitat carrying capacity for wild summer steelhead is not available for the lower Deschutes River subbasin. Specific information on wild juvenile summer steelhead populations in the mainstem lower Deschutes River or tributaries is also not available. It appears that steelhead productivity in several lower subbasin tributaries, including Trout, Buck Hollow, and Bakeoven may be increasing as a result of stream and watershed restoration measures implemented in recent years.

The EDT Model projected that the productivity of the Deschutes River Westside steelhead population to be 6.4. With moderate habitat restoration this productivity could increase to 9.0. The projected productivity of the Deschutes River Eastside Population was 1.6. With moderate habitat restoration this population's productivity could increase to 2.9. The potential productivity of the Middle Deschutes population could be 5.7, if fish were present. With restored fish passage and moderate habitat restoration population productivity could reach 8.2.

Life History Diversity

Adult summer steelhead generally return to the Deschutes River from June through October. Steelhead pass Sherars Falls from June through March with peak movement in September or early October. Wild female steelhead consistently out-number males in a run year (Table 14). Information on sex ratio by age at return, and length-weight ratio of wild summer steelhead is not available. Average fish length data for 1 and 2-salt adults is summarized in Table 15. Fecundity of wild summer steelhead, sampled in 1970 and 1971, ranged from 3,093 to 10,480 eggs per female with a mean of 5,341 eggs per female (Olsen et al. 1991). Average fecundity is 4,680 eggs per female for fish that have spent one year in the ocean (1-salt) and 5,930 eggs per female for fish that have spent two years in the ocean (2-salt) (ODFW 1997).

Wild summer steelhead spawn in the lower Deschutes River, Warm Springs River system, White River, Shitike Creek, Wapinitia Creek, Eagle Creek, Nena Creek, the Trout Creek system, the Bakeoven Creek system, the Buck Hollow Creek system and other small tributaries with adequate flow and a lack of barriers to fish migration. Spawning in White River is limited to the river below the impassable barrier at White River Falls (RM 2). A natural barrier also limits spawning opportunities in Nena Creek. The relative proportion of mainstem and tributary steelhead spawning is unknown. Based on limited spawning ground counts in the mainstem and tributaries, managers believe that mainstem spawning accounts for 30 to 60% of the natural production (ODFW 1997).

Spawning in the lower Deschutes River and west side tributaries usually begins in March and continues through May (Zimmerman and Reeves, 1999). Steelhead begin their spawning migration into the Warm Springs River in mid-February. The peak migration past Warm Springs Hatchery typically is in mid-April and is completed by late May. Spawning in the Warm Springs system generally occurs in the river upstream of the hatchery and in the tributaries, including Mill, Beaver, and Badger creeks. The life history characteristics of the Shitike Creek summer steelhead are believed to be similar to the Warm Springs fish. Summer steelhead appear to spawn and rear throughout the lower 40 km of the creek (USFWS 2003).

Spawning in east side tributaries occurs from January through mid-April. Spawning in east side tributaries may have evolved to an earlier time than west side tributaries or the mainstem Deschutes River because stream flow tends to decrease earlier in the more arid eastside watersheds (Olsen et al. 1991).

Table 14. Sex ratio of wild summer steelhead captured at Warm Springs Hatchery, 1977-94 run years (ODFW 1997).

Run Year	% Males	% Females
1977	35	65
1978	23	77
1979	38	62
1980	32	68
1981	34	66
1982	22	78
1983	40	60
1984	35	65
1985	36	64
1986	35	65
1987	25	75
1988	32	68
1989	38	62
1990	31	69
1991	45	55
1992	32	68
1993	47	53
1994	48	52

Table 15. Mean fork length (inches) of Round Butte Hatchery summer steelhead adults sampled at Sherars Falls, 1975-86 broods (ODFW 1997).

Brood Year	N	1-Salt Length	Range	N	2-Salt Length	Range
1975	426	23.6	17-29	473	27.4	20-31
1976	213	23.1	20-30	178	27.1	20-31
1977	859	23.5	20-29	530	26.2	20-31
1978	462	22.8	20-28	326	26.9	20-33
1979	255	22.7	19-28	182	26.5	22-31
1980	27	23.6	20-33	33	26.4	22-31
1981	332	23.5	19-28	187	27.3	22-31
1982	93	23.2	20-28	192	27.3	22-32
1983	280	23.4	20-31	457	27.7	20-32
1984	349	23.2	20-31	299	26.4	21-32
1985	119	22.8	20-34	465	27.2	21-31
1986	200	23.6	21-34	277	26.4	21-31

Steelhead fry emerge in spring or early summer depending on time of spawning and water temperature during egg incubation. Zimmer and Reeves (1999) documented summer steelhead emergence in late May through June. Juvenile summer steelhead emigrate from the tributaries in spring from age-0 to age-3. Steelhead fry from small or intermittent tributary streams experience greater growth then those in the mainstem Deschutes River and may experience a competitive advantage as they move from the tributary environments to the river (Zimmerman and Reeves, 1999). Many juveniles that migrate from the tributaries continue to rear in the mainstem lower Deschutes River before smolting. Scale patterns from wild adult steelhead indicate that smolts enter the ocean at age-1 to age-4 (Olsen et al. 1991). Specific information on time of emigration through the Columbia River is not available, but researchers believe that smolts leave the lower Deschutes River from March through June.

Lower Deschutes River origin wild summer steelhead typically return to the Deschutes after one or two years in the Pacific Ocean (termed 1-salt or 2-salt steelhead). Typical of other summer steelhead stocks, very few steelhead return to spawn a second time in the lower Deschutes River. Information on survival rates from egg-to-smolt and smolt-to-adult is not available for wild summer steelhead in the lower Deschutes River.

Zimmerman and Reeves (1999) concluded that summer steelhead and resident redband trout are reproductively isolated in the Deschutes River by a combination of spatial and temporal mechanisms. Although there was an overlap in the timing of spawning, only 9 to 15 percent of the total redband trout spawning occurred during while steelhead were spawning. Fifty percent of the steelhead spawning occurred 9 to 10 weeks earlier than the time when fifty percent of the redband spawning had occurred. Steelhead also selected spawning sites in deeper water with larger substrate than those selected by the redband trout.

The EDT Model projected the current and potential life history diversity of the three NOAA Fisheries designated steelhead populations. The model estimated that the current productivity of the Deschutes River Westside Tributaries population to be 89%. With moderate habitat restoration this population's diversity could reach 99%. The Deschutes River Eastside Tributaries population was estimated to have a life history diversity of 26%. With moderate habitat restoration this population's diversity could reach 57%. The life history diversity of the potential Middle Deschutes River population above Pelton Dam could reach 74%, if efficient fish passage is established at the Pelton Round Butte Complex.

Carrying Capacity

Specific information on habitat carrying capacity for wild summer steelhead is not available for the lower Deschutes River subbasin. Based on present habitat, an average fecundity of 5,130 eggs per female, and an assumed egg-to-smolt survival of 0.75%, the maximum steelhead production capacity of the lower Deschutes River subbasin is estimated to be 147,659 smolts, with an adult spawning population of 6,575 fish (ODFW 1997). These production estimates were developed during the preparation of the Columbia River Management Plan as directed by terms of the *U.S. v Oregon* court case. The data used to develop these estimates reflect the best information available at that time and are believed to be currently accurate. Both estimates of production capacity (smolts and adults) are based on the assumption that current habitat will sustain past escapement levels and juvenile rearing habitat will sustain the densities predicted from maximum escapement levels. The estimated adult return from a spawner escapement of 6,575 is 9,089 fish, assuming a 6% wild smolt-to-adult survival rate (ODFW 1997). The estimated return of 9,089 adults to the mouth of the Deschutes River would, theoretically, produce some level of harvestable wild summer steelhead.

Population Trend and Risk Assessment

Deschutes River summer steelhead within the Mid-Columbia ESU have been designated as a threatened species under the federal Endangered Species Act. Rationale for this listing includes the genetic risks posed to the wild population by thousands of stray, upper Columbia River Basin, hatchery-origin, steelhead. The incorporation of genetic material from large numbers of stray steelhead could have a long term effect on the subbasin steelhead production through reduced resilience to environmental extremes and diverse survival strategies. Out-of-basin strays also pose a threat to steelhead population health. About 5% of the hatchery stray steelhead have tested positive for whirling disease (Engleking 2002).

Summer steelhead escapement estimates have been made for fish passing upstream of Sherars Falls since the 1977-78 run year (Table 13) (French and Pribyl 2004). The average annual escapement of wild steelhead upstream from Sherars Falls for this period was 5,005 fish, with a range of 482 to 9,624 fish. However, these wild steelhead estimates could be inflated for some years when unmarked stray hatchery fish were unknowingly included in the wild fish escapement calculations. The estimated number of wild steelhead passing Sherars Falls during the last five run years has averaged 7,137 fish, with a range of 3,800 to 9,363 fish. These numbers may also be inflated by unmarked, stray hatchery included in the run size calculations (French and Pribyl 2004).

Only about 3% of the steelhead/redband spawning in the Deschutes occurs below the confluence of White River. Most spawning below Sherars is likely associated with several small tributaries and Buck Hollow Creek. Juvenile rearing occurs in the mainstem below Sherars Falls and may be more important because of the general upward trend in the condition of the riparian community.

The component of the Deschutes steelhead population spawning in the Warm Springs River system upstream of Warm Springs Hatchery may be at less genetic risk. The Warm Springs system is of particular value as a refuge for wild summer steelhead since hatchery marked or suspected hatchery origin summer steelhead are not allowed to pass the barrier dam at the hatchery (WSNFH Operational Plan 1992-1996). This effectively excludes all non-Deschutes River origin summer steelhead except stray wild summer steelhead or stray, unmarked, hatchery origin fish. The numbers of stray hatchery and wild summer steelhead arriving at the Warm Springs Hatchery are summarized in Table 14. Wild steelhead are passed upstream to spawn, while stray hatchery steelhead are donated to the Tribes. Table 15 shows redd counts from areas within Warm Springs River and tributaries since 1994.

Table 14. Summer steelhead adults arriving at Warm Springs Hatchery, 1977 to 2001 (Gauvin 2003).

Year	Wild*	Hatchery**	Total Steelhead
1977	136		136
1978	417		417
1979	378	16	394
1980	311	42	353
1981	397	46	443
1982	569	39	608
1983	255	35	290
1984	431	129	560
1985	577	89	666
1986	373	56	429
1987	822	692	1514
1988	522	699	1221
1989	385	204	589
1990	339	182	521
1991	165	129	294
1992	280	403	683
1993	79	109	188
1994	135	147	282
1995	95	101	196
1996	85	173	258
1997	243	349	592
1998	214	380	594
1999	96	80	176
2000	319	417	736
2001	503	319	822

* Fish are passed upstream to spawn naturally. ** Fish are donated to the Confederated Tribes.

Unique Population Units

Schreck et al. (1986) compared biochemical, morphological, meristic, and life history characteristics among steelhead stocks in the Columbia basin. Lower Deschutes River wild summer steelhead were found to be a component of one of three subgroups of stocks found east of the Cascade mountains; specifically, the group formed by stocks found in the Columbia Basin from Fifteenmile Creek in Oregon to the Entiat River in Washington.

Life History Characteristics of Unique Populations

Scale patterns from wild adult steelhead indicate a variety of life history patterns exemplified by smolts migrating to the ocean from age-1 to age-4 (Olsen et al. 1991). A total of eight life history patterns were identified on scales collected from a sample of lower Deschutes River origin wild adult summer steelhead (Olsen et al. 1991). Typical of other summer steelhead stocks, very few steelhead return to spawn a second time in the lower Deschutes River.

Table 15. Summer steelhead redd counts from index areas within the Warm Springs River system, 1994 – 2003 (Gauvin 2003).

INDEX AREAS	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
BEAVER CREEK:										
Reach D to Robinson Park	1	1	0	0	1	1	2	2	2	4
Robinson Park to Dahl Pine	0	6	0	3	23	4	5	6	0	17
Dahl Pine to Canyon	3	0	5	4	21	2	17	32	16	6
Old Bridge to Power line	1	0	0	0	0	3	1	3	0	0
Island Area	4	2	1	2	13	0	6	14	8	15
MILL CREEK:										
B-241 Road Bridge Area	-	-	-	-	-	-	5	-		
Old Mill to Strawberry Falls	2	0	0	0	2	3	1	2	1	4
Strawberry Falls to Potter's Pond	5	0	1	2	3	2	2	2	6	10
Potter's Pond to Boulder Creek	7	1	1	11	5	2	0	9	15	3
WARM SPRINGS RIVER:										
Bunchgrass to Schoolie	-	-	-	-	-	-	-	-		
Schoolie to He-He	-	-	-	-	-	-	-	-		
He-He to McKinley Arthur	-	-	-	-	6	3	-	-		
WSNFH to Culpus Bridge	-	-	-	-	-	-	-	-	-	
Total Redds	23	10	8	22	74	20	39	70	48	59

Estimate of Desired Future Condition for Long-term Sustainability

A spawning escapement of 6,575 wild adult summer steelhead is believed to be adequate to sustain maximum natural production potential with existing habitat conditions during years of good juvenile and adult survival conditions. During years of outstanding survival conditions and high smolt-to-adult survival, the spawning escapement could be even larger (ODFW 1997). A larger escapement capable of supporting some in-subbasin harvest would be desirable.

Distribution

Current Distribution

NOAA Fisheries Technical Recovery Team identified three subbasin steelhead populations, including the 1) Deschutes River Eastside Tributaries - this population encompasses the mainstem Deschutes River from its mouth to the confluence of Trout Creek, and the tributaries entering the Deschutes from the east: Buck Hollow, Bakeoven, and Trout Creeks, 2) Deschutes River Westside Tributaries - The Westside Deschutes River tributaries are separated from the eastside tributary population on the basis of habitat and life history characteristics. Included in this population are mainstem spawners from the mouth of Trout Creek upstream to Pelton Dam (current upstream barrier to anadromous fish), and the Warm Springs River and Shitike Creek, and 3) Middle Deschutes River Tributaries – this extirpated population utilized historic habitat upstream of the Pelton Round Butte Project (RM 100).
Summer steelhead occur throughout the mainstem lower Deschutes River and most tributaries below Pelton Reregulating Dam. Wild summer steelhead spawn in the lower Deschutes River, Warm Springs River system, White River, Shitike Creek, Skookum Creek, Wapinitia Creek, Eagle Creek, Nena Creek, the Trout Creek system, the Bakeoven Creek system, the Buck Hollow Creek system and other small tributaries with adequate flow and a lack of barriers to fish migration. Spawning in White River is limited to the lower two miles below White River Falls, an impassable barrier. Spawning opportunities in Nena Creek are also limited by a natural barrier.

The relative proportion of mainstem and tributary spawning is unknown. Based on limited spawning ground counts in the mainstem and tributaries, managers believe that mainstem spawning accounts for 30-60% of the natural production (ODFW 1987). The Warm Springs River system includes the mainstem and a number of moderate-sized tributaries, but does not appear to contribute a large portion of the tributary-spawned wild summer steelhead in the lower Deschutes River. Estimates of spawning activity suggest that Trout Creek may support 20-30% of the returning wild Deschutes summer steelhead. However, to have increased confidence in this percentage there needs to be an increased effort to better identify and understand the hatchery component in the basin (Haarberg and Nelson 2002).

Differences in Distribution due to Human Disturbance

Summer steelhead distribution was truncated first by the construction of Ochoco Dam on Ochoco Creek and then by the construction of the Pelton Round Butte Complex. Anadromous fish passage was not incorporated into the design of Ochoco Dam and failed at Pelton and Round Butte dams. Stream habitat deterioration associated with water withdrawals and stream channel alterations may have further reduced steelhead distribution in some tributary streams located downstream of the Pelton Round Butte Complex.

Artificial Production

A variety of brood stocks were used historically to augment natural steelhead production in the Deschutes River Subbasin. Willamette River and Big Creek stock winter steelhead were used for brood stock in 1958 and 1959, respectively. Skamania River and Siletz River summer steelhead were used as brood stock in 1965 and in 1965-66, respectively (Olsen et al. 1991). The Big Creek and Siletz River stocks were both susceptible to *Ceratomyxa shasta*. These fish likely did not survive and return as adults to have any genetic influence on the naturally reproducing population. Both the Willamette River and Skamania River stocks exhibit a higher degree of resistance to *C. shasta* and it is possible some adults could have survived from these releases to return to the lower Deschutes River. Potential effects of genetic exchange from these stocks to wild summer steelhead in the subbasin is unknown. Local brood stock for hatchery production before 1957 was collected from Squaw Creek, which lies above the Pelton Round Butte Complex. All brood stock from 1967 to present have been collected only from the lower Deschutes River.

Current Hatchery Production

Round Butte Hatchery, completed in 1972 to mitigate the effects of the Pelton Round Butte Complex, is the only hatchery releasing summer steelhead in the lower Deschutes River subbasin. The project operator is required, as a condition of the project's Federal Energy Regulatory Commission power license, to annually return 1,800 summer steelhead adults to the Pelton Fish Trap from Round Butte Hatchery smolt releases. Portland General Electric funded construction of the hatchery and continues to finance operation and maintenance. ODFW operates the hatchery. No non-indigenous summer steelhead stocks are being released into the subbasin.

Round Butte Hatchery annually releases approximately 162,000 age 1+ summer steelhead smolts. This level of smolt production is designed to meet the FERC License requirement to return 1,800 hatchery origin adults to the Pelton Fish Trap annually.

Brood stock for the summer steelhead program at Round Butte Hatchery were initially collected from hatchery origin and wild fish returning to the Pelton Fish Trap or from wild fish captured at the Sherars Falls adult trap (RM 44). Both wild and Round Butte Hatchery stock summer steelhead were held for brood stock prior to the 1984 brood year. Brood stock for the 1984 through 1987 brood years were selected only from Round Butte Hatchery origin steelhead because of concerns about unmarked, out-of-basin, stray fish introducing foreign strains of the *Infectious Hematopoietic Necrosis* virus (IHNV) into the hatchery steelhead program. From 1988 through 1992, managers collected wild steelhead for brood stock in addition to Round Butte Hatchery origin steelhead (ODFW 1997).

Wild brood stock used from 1988 to 1992 was incorporated into production through wild-by-wild pairing as opposed to a wild by hatchery pairing. Wild-by-wild offspring accounted for 27% to 34% of releases during those years. Wild brood stock collected in 1993, 1994, and 1995 was used in a wild by hatchery matrix pairing and resulted in wild genetic material being incorporated into the resulting egg take at a 32%, 61%, and 16%

rate, respectively (ODFW 1997). Only known Round Butte Hatchery origin adult steelhead have been used as hatchery brood stock since 1993.

Historic Hatchery Production

Squaw Creek was first stocked in 1952 with 27,817 steelhead, four to six inches in length. Hatchery records do not state the origin of the fish, but Nehlsen (1995) found the Oregon State Game Commission operated a trap at Camp Polk annually through 1956 for obtaining eggs from Squaw Creek steelhead. These fish were reared at Wizard Falls Fish Hatchery. Steelhead were also stocked in 1953, 1954, and 1955. Numbers ranged from 26,162 to 32,432 fish. They were released as 4-8 inch or 6-8 inch fish. Stocking was terminated after 1955 (Fies et al. 1998).

Before the 1972 opening of Round Butte Hatchery, Cedar Creek, Gnat Creek, Oak Springs, and Wizard Falls hatcheries reared Deschutes River origin summer steelhead for release into the lower Deschutes River (ODFW 1997). Warm Springs Hatchery reared and released summer steelhead in the subbasin in 1979 and 1981 (Table 18) (ODFW 1997). Steelhead production at the hatchery was discontinued in 1981 due to disease problems, as well as water temperature and physical facility limitations associated with the rearing of 2-year smolts. Future steelhead production at that facility is not planned (WSNFH Operation Plan 1992-1996).

Natural summer steelhead production was supplemented with fry and fingerlings from Round Butte and Warm Springs hatcheries periodically from 1974 to 1984. Fry and fingerling releases were intended to augment natural production rather than provide harvest opportunity. Shitike Creek and tributaries of the Warm Springs River were supplemented with summer steelhead fry or fingerlings from Warm Springs Hatchery, while fingerlings from Round Butte Hatchery were released in the lower Deschutes River (Table 19). The steelhead released off station in the Warm Springs River tributaries were not differentially marked to distinguish them from the production lot released directly from the hatchery. Generally, this supplementation did not appear to be successful since no large increase in unmarked returns was noted from these releases. No future supplementation of natural summer steelhead production is anticipated in the lower Deschutes River.

Table 18. Summer steelhead production releases from Warm Springs Hatchery, 1978 and 1980 broods (ODFW 1997).

Brood Year	Release Date	Number of Smolts	Location	Mark
1978	05/79	89,380	Warm Springs R.	AD+CWT
1980	04/81	4,486	Warm Springs R.	AD+CWT

Table 19. Releases of hatchery summer steelhead in the lower Deschutes River subbasin for supplementation of natural production, 1974 –1984 (ODFW 1997).

Release Year	Hatchery	Number	Size (fish/lb)	Location	Mark
1974	RBH	116,106	142	Deschutes mouth	--
1976	RBH	138,650	96.0	Deschutes mouth	--
1981	WSNFH	35,000	54.4	Warm Springs R.	AD+CWT
	WSNFH	20,000	54.4	Beaver Creek	AD+CWT
	WSNFH	28,000	54.4	Mill Creek	AD+CWT
	WSNFH	15,000	54.4	Badger Creek	AD+CWT
	WSNFH	27,332	781	Shitike Creek	--
1982	WSNFH	16,668	981	Beaver Creek	--
	WSNFH	15,000	981	Mill Creek	--
	WSNFH	35,000	981	Badger Creek	--
	WSNFH	3,000	981	Wilson Creek	--
	WSNFH	79,748	753	Shitike Creek	--
1983	WSNFH	5,000	440	Beaver Creek	--
	WSNFH	54,400	440	Badger Creek	--
	WSNFH	5,000	440	Wilson Creek	--
	WSNFH	5,000	440	Swamp Creek	--
	WSNFH	31,718	413	Shitike Creek	--
	RBH	150,006	26.6	Deschutes R.[a/]	ADRM
1984	WSNFH	80,481	993	Shitike Creek	--
	RBH	150,015	51.2	Deschutes R.[b/]	ADLM

a/ Released at Pine Tree (RM 39).
b/ Released at Macks Canyon (RM 25), Beavertail Campground (RM 31) and Pine Tree.

Effect of Straying/Ecological Consequences

While the percentage of stray hatchery summer steelhead passing Sherars Falls has increased over time (Table 20), the percentage of Round Butte Hatchery origin summer steelhead in the population has generally decreased (Table 21). The influx of out-of-basin stray steelhead started in the early 1980's and appears to be related to an increase in the number of hatchery origin steelhead smolts released in the upper Columbia basin and an increase in the number of steelhead smolts transported from upper Columbia River collection points for release below Bonneville Dam.

The annual estimated number of stray steelhead passing upstream from Sherars Falls to the Pelton Fish Trap averaged 7,841 (44%) fish for the 26-year period from 1978 to 2003, with a range of 300 (5%) to 25,263 (58%) fish (Table 22). For the first five years of this data string (1978 to 1983), the average number of stray steelhead passing Sherars Falls annually was 360 fish. From 1997/98 to 2002/03, an average of 16,087 stray steelhead passed Sherars Falls annually (French and Pribyl 2004).

The percentage of Round Butte Hatchery summer steelhead captured in the Pelton Fish Trap has decreased since 1983 (Table 22). The proportion of Round Butte Hatchery summer steelhead returning to the Pelton Fish Trap annually has ranged from a high of 96% in both 1973 and 1974 to a low of 35% in 1993. Conversely, returns of stray hatchery origin summer steelhead to the Pelton Fish Trap has ranged from a low of less than 1% in both 1971 and 1974 to a high of 53% in 1994 and 1995, generally increasing through time since 1983 (French and Pribyl 2004).

The large influx of out-of-subbasin stray summer steelhead may be contributing significant amounts of maladapted genetic material to the wild summer steelhead population in the lower Deschutes River subbasin. While Round Butte Hatchery origin summer steelhead contribute to this problem, their impact is much less numerically and genetically than the large number of out-of-subbasin stray hatchery steelhead also present in the spawning population. The cumulative effect of this genetic introgression may contribute to lowered productive capacity of the wild population as evidenced by low run strength of wild summer steelhead through time.

Table 20. Estimated number of steelhead that migrated past Sherars Falls, by run year (French and Pribyl 2004).

Run Year	Wild	Round Butte Hatchery	Stray Hatchery	Total Hatchery
1977-78	6,600	6,100	900	7,000
1978-79	2,800	3,200	300	3,500
1979-80	4,200	5,400	600	6,000
1980-81	4,100	5,500	500 a/	6,000
1981-82	6,900	3,800	1,200 a/	5,000
1982-83	6,567	3,524	1,249 a/	4,773
1983-84	8,228 b/	7,250	7,684 a/	15,443
1984-85	7,721 b/	7,563	3,824 a/	11,770
1985-86	9,624 b/	7,382	5,056 c/	12,106
1986-87	6,207 b/	9,064	9,803 c/	18,358
1987-88	5,367 b/	9,209	8,367	17,623
1988-89	3,546	3,849	2,909	6,336
1989-90	4,278	2,758	3,659	6,504
1990-91	3,653	1,990	2,852	4,786
1991-92	4,826	3,778	8,409	11,859
1992-93	904	2,539	4,261	6,008
1993-94	1,487	1,159	4,293	5,476
1994-95	482	1,781	4,391	6,126
1995-96	1,662	2,708	11,855	12,828
1996-97	3,458	5,932	23,618	28,416
1997-98	1,820	5,042	17,703	22,511
1998-99	3,800	3,527	11,110	15,120
1999-2000	4,790	2,628	13,785	15,219
2000-2001	8,985	4,380	15,072	19,310
2001-2002	8,749	9,373	25,263	31,784
2002-2003	9,363	8,880	15,203	23,004

Table 21. Estimated percent of Round Butte Fish Hatchery summer steelhead passing Sherars Falls (RM 43) (Data from French and Pribyl 2004).

Run Year	Round Butte Hatchery Steelhead	Total Steelhead	Percent
1977-78	6,100	13,600	45%
1978-79	3,200	6,300	51%
1979-80	5,400	10,200	53%
1980-81	5,500	10,100	54%
1981-82	3,800	11,900	32%
1982-83	3,524	11,340	31%
1983-84	7,250	23,162	31%
1984-85	7,563	19,108	40%
1985-86	7,382	22,062	33%
1986-87	9,064	25,074	36%
1987-88	9,209	23,943	38%
1988-89	3,849	10,304	37%
1989-90	2,758	10,695	26%
1990-91	1,990	8,495	23%
1991-92	3,778	17,049	22%
1992-93	2,539	7,704	33%
1993-94	1,159	6,936	17%
1994-95	1,781	6,654	27%
1995-96	2,708	16,225	17%
1996-97	5,932	33,008	18%
1997-98	5,042	24,465	21%
1998-99	3,527	18,437	19%
1999-2000	2,628	21,203	12%
2000-2001	4,380	28,437	15%
2001-2002	9,373	31,784	23%
2002-2003	8,880	23,004	39%

Table 22. Number and percent of wild, stray, and Round Butte Hatchery origin summer steelhead returning to the Pelton Fish Trap, by run year (French and Pribyl 2004).

	Wild Origin		Stray Hatchery		Round Butte Hatchery	
Run Year	Number	%	Number	percent	Number	percent
81-82	245	11.3	156	7.4	1,760	81.3
82-83	344	16.7	167	8.8	1,547	74.6
83-84	814	17.3	1,452	33.0	2,439	49.7
84-85	603	12.9	795	17.0	3,278	71.1
85-86	686	14.4	943	19.7	3,153	65.9
86-87	467	10.7	1,538	33.4	2,640	57.6
87-88	160	6.6	796	32.1	1,484	61.3
88-89	123	7.4	300	17.7	1,247	74.9
89-90	136	9.1	524	35.2	829	55.7
90-91	82	7.4	428	35.8	606	56.8
91-92	101	4.4	849	36.7	1,365	58.9
92-93	59	3.6	427	26.0	1,157	70.4
93-94	65	12.0	288	53.0	190	35.0
94-95	27	2.0	642	53.0	753	45.0
95-96	32	1.6	976	48.6	1,000	49.8
96-97	126	2.2	2,001	34.9	3,605	62.9
97-98	194	3.8	2,459	48.3	2,440	47.9
98-99	155	6.0	1,284	49.9	1,135	44.1
99-00	83	4.4	768	40.4	1,050	55.2
00-01	114	4.1	1,103	39.2	1,593	56.7
01-02	282	3.2	3,674	41.3	4,942	55.5
02-03	207	3.3	1,787	28.5	4,284	68.2

Relationship between Natural and Artificially Produced Populations

Most steelhead spawning in the subbasin occurs in the Deschutes River and tributaries upstream from Sherars Falls. If numbers of hatchery origin summer steelhead captured at the Pelton Fish Trap, Warm Springs Hatchery trap, and estimated in angler harvest upstream from Sherars Falls are subtracted from the estimated number of hatchery summer steelhead passing Sherars Falls, many hatchery fish, both Round Butte Hatchery origin and stray hatchery origin, remain unaccounted for. Steelhead spawning surveys on Buck Hollow and Bakeoven creeks indicate that many of these fish remain in the wild each year, potentially spawning with wild steelhead (Table 23). From 1984 to 1991, estimated hatchery origin summer steelhead adults migrating upstream from Sherars Falls exceeded estimated numbers of wild summer steelhead adults six of those ten years. From 1992 to 2003, the estimated number of hatchery origin summer steelhead adults escaping upstream from Sherars Falls exceeded the number of wild steelhead every year (see Table 13).

Table 23. Summer steelhead and redd counts, Bakeoven Creek and Buck Hollow Creek, by year (French and Pribyl 2002).

Year	Bakeoven Creek Steelhead				Buck Hollow Creek Steelhead			
	Redds	Wild	Hatch	Unkn	Redds	Wild	Hatch	Unkn
1990	24	2	1	0	85	3	0	0
1991	8	5	0	4	72	1	1	0
1992	9	0	0	0	34	0	0	0
1993	21	2	3	10	48	0	1	0
1994	13	0	0	0	8	0	0	0
1995	20	1	3	1	69	2	1	0
1996	35	2	8	6	65	0	0	0
1997	57	4	9	5	136	2	0	0
1998	68	3	2	4	179	0	0	2
1999	89	13	6	7	152	0	0	0
2000	83	14	17	11	110	0	0	1
2001	480	167	29	113	445	17	9	9
2002	214	55	10	170	221	42	20	41
2003	117	19	4	27	222	43	17	47

Subbasin Harvest

Tribal fishers have been harvesting summer steelhead in the Deschutes Subbasin for hundreds, if not, thousands of years. Non-tribal fishers have been harvesting these fish for decades. The only systematic monitoring of the steelhead harvest has occurred within the past thirty years. This monitoring has been done by personnel with ODFW and the Warm Springs Tribes and is generally associated with the lower 44 miles of river from the mouth to Sherars Falls.

Current Harvest

During the past ten years (1993 to 2002) the average catch of wild steelhead in the recreational fishery from the mouth upstream to, but not including the Sherars Falls area, averaged 3,268 fish, with a range of 1,192 to 6,525 fish. Recreational angling regulations stipulated that all wild fish had to be released unharmed. During the same period the catch of hatchery origin steelhead for the same river reach averaged 2,665 fish, with a range from 779 to 5,120 fish.

Most tribal summer steelhead harvest occurs in the dipnet/set net subsistence fishery concentrated at Sherars Falls. During the ten-year period from 1993 to 2003, tribal fishers at Sherars Falls had tribal regulations restricting the harvest of wild steelhead. The annual harvest of wild steelhead in this subsistence fishery averaged 31 fish, with a range from 0 to 135 per year (French and Pribyl 2004). Some limited hook and line harvest of wild summer steelhead by Tribal members does occur in areas upstream of Sherars Falls, primarily during the winter months. The number of wild summer steelhead harvested by tribal fishers in this fishery is not known.

Historic Harvest

Harvest or catch of the different components of summer steelhead runs in the lower Deschutes River has been estimated by statistical harvest estimation procedures since 1970. Both recreational anglers and tribal fishers catch wild summer steelhead. Only tribal fishers have been able to legally retain them since 1978. Tribal harvest of wild summer steelhead during the 1980s, years of unrestricted tribal dipnet effort, ranged from a low of 339 in 1988 to a high of 1,600 in 1984, and averaged 925 for the ten-year period. The recreational catch of summer steelhead in the Deschutes River July 1 to October 31 from the mouth to Sherars Falls, in years when all harvest samples were completed, is summarized in Table 24. Table 25 shows hatchery steelhead harvest data from upstream of Sherars Falls to the Pelton Reregulating Dam from 1984 to 1994.

Table 24. Estimated recreational catch of summer steelhead in the Deschutes River July 1 to October 31 from the mouth to Sherars Falls in years when all harvest samples were completed, 1973-95[c/].

Run	Wild a/		Round Butte Hatchery		Stray Hatchery		Total
Year	Number	Percent	Number	Percent	Number	Percent	Number
1973	5,080	69	1,974	27	315	4	7,369
1974	4,623	56	3,287	40	289	4	8,199
1975	4,226	75	1,156	20	279	5	5,671
1977	4,674	75	1,063	17	471	7	6,208
1980	5,674	71	1,610	20	723	9	8,007
1981	7,157	80	1,146	13	622	7	8,925
1982	5,929	78	973	13	713	9	7,645
1983	8,377	72	1,132	10	2,142	18	11,650
1987	11,662	81	765	5	1,913	14	14,340
1989	5,155	66	607	7	2,088	27	7,850
1990	2,037	57	220	5	1,319	38	3,576
1992b/	2,007	55	251	6	1,369	39	3,627
1993b/	2,139	59	180	4	1,303	37	3,622
1994b/	1,192	49	159	7	1,085	44	2,436
1995b/	1,641	44	259	7	1,833	49	3,733

a/ Includes fish caught and released under a regulation adopted in 1979.
b/ Recreational angling closed at Sherars Falls June 15 to October 31.
c/ Does not include estimated east bank mouth catch after 1979. Does include estimated catch at Kloan 1970, 1972-1975, 1977, and 1980.

Table 25. Estimated harvest of hatchery origin adult steelhead and spawning escapement above Sherars Falls, 1977 – 1994 (ODFW 1997).

	Estimated harvest of Hatchery steelhead		Estimated hatchery-origin spawners		Estimated Wild Spawners
Run Year	**Stray**	**RBH**	**Stray**	**RBH**	**Spawners**
1977	---	---	---	---	6600
1978	---	---	---	---	2800
1979	---	---	---	---	4200
1980	---	---	---	---	4100
1981	---	---	---	---	6900
1982	---	---	---	---	6600
1983	---	---	---	---	8200
1984	311	631	2628	3673	7700
1985	609	876	3532	3356	9600
1986	629	580	7088	5920	6200
1987	407	442	6681	7262	5400
1988	367	486	2067	2039	3500
1989	507	382	2506	1579	4300
1990	479	320	1898	1072	3700
1991	856	385	6792	2036	4900
1992	557	314	3216	1024	900
1993	693	195	3132	811	1500
1994	535	219	3205	823	500

Resident Redband Trout

Redband trout are a large group of inland native rainbow trout endemic to basins of the Pacific Northwest east of the Cascade Mountains. Their range includes the upper Columbia and Fraser Rivers, and the Klamath River southward to the McCloud River of northern California (Behnke 1992). Unlike rainbow trout, redband trout demonstrate a greater tolerance of high water temperatures, low dissolved oxygen levels, and extremes in stream flows that frequently occur in desert climates.

Redband trout were historically found in large numbers throughout suitable habitat areas in the Deschutes River and tributaries, including the entire Crooked River drainage. Today, redband trout are still found in many traditional habitat areas, but in some areas are much diminished in abundance, and fragmented and isolated into separate populations by habitat limitations, including low stream flow, high water temperatures, competition from other fish species and numerous manmade barriers.

Importance

Redband trout are indigenous to the Deschutes River subbasin. They are a valuable resource and are important to the tribal and non-tribal citizens. Anglers from throughout the country, as well as various foreign countries come to the subbasin to angle for the redband trout. Redband trout were selected as a focal species based on an evaluation of their special ecological, cultural and legal status.

- ***Species designation:*** The redband trout was proposed for ESA listing throughout its range, but a listing was determined not warranted at that time.

- ***Species recognition:*** Currens et al. (1990) examined the genetic characteristics of 22 populations of redband trout in the lower Deschutes River subbasin and found three distinct groups based on biochemical similarity. One group consisted of two introduced hatchery populations, the second group consisted of nine populations sampled in White River, and the third group consisted of wild populations in the lower Deschutes River and tributaries other than White River (including indigenous hatchery strains). Redband trout isolated above White River Falls are more similar to isolated populations of redband trout in the Fort Rock Basin, in both genetic and morphological characteristics, than they are to lower Deschutes River redband trout. These characteristics include fewer pyloric caeca, finer scales, and little or no variation at two specific alleles (Currens et al. 1990). A possible explanation is that the Fort Rock Basin was drained by the Deschutes River until lava flows separated the drainages in the late Pleistocene epoch (Allison 1979). Ancestral redband trout probably invaded White River and the Fort Rock Basin when they were connected to the Deschutes River. Subsequent isolation of White River and Fort Rock basins prevented these populations from acquiring genetic traits that evolved in the Deschutes River population during the last glacial period. Today, some populations in the White River system may represent remnants of the ancestral population and an evolutionary line originating from a primitive race of redband trout.

  Currens (1994) also found that redband trout from some tributaries of the North Fork Crooked River are in a group that is distinct from the remainder of the redband populations within the subbasin.

- ***Special ecological importance to subbasin:*** Redband trout were historically distributed throughout the Deschutes River subbasin. The population provided an important food source for the subbasin's first inhabitants, as well as a variety of wildlife species, including birds and mammals. These fish supplied an important source of nutrients for the aquatic, as well as the terrestrial ecosystem.

- ***Tribal recognition:*** Redband trout have long been an important food source for the Native Americans.

Population Data and Status

Abundance in the Lower Deschutes Subbasin

ODFW recognizes 46 wild populations of resident/fluvial redband trout in the basin up to Big Falls, with the strongest populations located in the lower mainstem. The lower mainstem, in fact, has the strongest population of resident redband trout in Oregon (Kostow 1995).

Surveys indicate that redband trout in the lower Deschutes River are most abundant in the 50-mile stretch of river between Maupin and the Pelton Reregulating Dam, and less abundant in the subbasin below Sherars Falls (Table 26) (ODFW 1997). There is little mainstem spawning habitat below Sherars Falls, so the population in this part of the river may rely on recruits from the river upstream (Aney et al.).

Abundance of lower Deschutes River redband trout, larger than 8 inches, was estimated in specific areas of the lower Deschutes River during the 1970's, 1980's and 1990's. Density of redband trout in the lower Deschutes River above Sherars Falls during this time ranged from 640 to 2,560 fish/mile (Tables 27 to 28). Densities in the 1980's, the time period with the most data, averaged 1,630 fish/mile in the North Junction area (RM 69.8 to 72.8) (Table 27) and 1,830 fish/mile in the Nena Creek area (RM 56.5 to 59.5) (Table 28) (Schroeder and Smith 1989).

Redband trout are abundant in the White River system, where all habitat above RM 2 is inaccessible to anadromous fish because of a series of impassable waterfalls. The abundance of redband trout age-1 and older in the White River system upstream from White River Falls was estimated in 1984 to range from 56 to 2,897 fish/mile (ODFW et al. 1985). In White River tributaries the density of redband trout greater than 6 inches ranged from 56 fish/mile (Little Badger Creek) to 445 fish/mile (Threemile Creek), whereas density of redband trout less than 6 inches ranged from 316 fish/mile (Clear and Frog creeks) to 2,897 fish/mile (Jordan Creek) (Table 29).

Redband trout are also known to be abundant in other lower Deschutes subbasin tributaries, such as Buck Hollow and Bakeoven creeks, however few studies have been completed to determine the extent of this production. Resident redband trout numbers are believed to be low in Trout Creek.

Table 26. Redband trout density (fish/mile) in four areas of the Deschutes River (ODFW 1997).

Location/	Size Group			
Year	8-10"	10-12"	> 12"	Total
Deschutes River Above Sherars Falls				
Warm Springs Bridge-Trout Creek (RM 88 – 97)				
1972	375	456	742	1,573
1973	a/	684	733	1,417b/
1974	739	261	530	1,530
1975	741	478	367	1,586
Above Warm Springs River (RM 84 –87)				
1978	407	720	1,050	2,177
1979	536	374	784	1,694
1996	275	519	323	1,117
Whiskey Dick (RM 80.0 – 84.0)				
1971	200	712	911	1,823
1972	401	733	1,040	2,174
1973	a/	741	686	1,427b/
1974	786	377	559	1,722
1978	412	473	1,240	2,125
1979	377	345	572	1,294
Deschutes River Below Sherars Falls				
Beavertail-Macks Canyon (RM 24- 31)				
1971	--	--	--	31
Pine Tree-Macks Canyon (RM 24 – 39)				
1972	--	--	--	55
Jones Canyon-Rattlesnake Canyon (RM 30.5 – 33.5)				
1986	140	163	217	520
1996	378	592	145	1,115

a/ No estimate because of insufficient recaptures.
b/ Total estimate for trout > 10" only.

Table 27. Redband trout density (fish/mile) in the Deschutes River at the North Junction study section (RM 69.8 – 72.8), by year (ODFW 1997).

	Size Group			
Year	8-10"	10-12"	> 12"	Total
1972	295	354	282	931
1973	164	1,138	462	1,764
1974	555	481	568	1,604
1975	1,179	723	533	2,435
1981	423	393	333	1,149
1983	343	857	853	2,053
1984	253	507	683	1,443
1985	a/	303	462	765[b/]
1986	559	357	1,224	2,140
1987	211	541	638	1,390
1988	a/	757	962	1,719
1995	335	822	497	1,654

a/ No estimate because of insufficient recaptures.
b/ Total estimate for trout > 10" only.

Table 28. Redband trout density (fish/mile) in the Deschutes River at the Nena Creek study section (RM 56.5 – 59.5), by year (ODFW 1997).

	Size Group			
Year	**8-10"**	**10-12"**	**> 12"**	**Total**
1973	a/	184	a/	--
1974	858	267	89	1,214
1975	1,311	167	56	1,534
1979	267	201	171	639
1981	911	596	338	1,845
1982	971	997	592	2,560
1983	927	1,005	486	2,418
1984	755	721	172	1,648
1985	a/	782	130	912b/
1986	409	555	489	1,453
1987	261	472	312	1,045
1988	567	651	491	1,709
1995	465	457	212	1,134

a/ No estimate because of insufficient recaptures.

b/ Total estimate for trout > 10" only.

Table 29. Redband trout population estimates and density (fish/mile) in the White River system 1984[a/] (ODFW et al. 1985).

Stream	Length (mile)	≤6 inches	Density (fish/mi)	<6 inches	Density (fish/mi)	%>6 inches
White River	41.0	11,413	278	27,979	682	29
Tygh Creek						
below falls	12.6	2,055	163	30,421	2,414	6
Above falls	5.4 b/	396 b/	73	7,261 b/	1,344	5
Jordan Creek						
below falls	0.9	300	333	2,607	2,897	10
Above falls	12.8	3,237	253	24,773	1,935	12
Badger Creek						
below falls	18.9	5,320	281	42,374	2,242	11
Above falls	3.1	1,289	416	2,807	905	31
Little Badger Cr.	5.7 b/	320 b/	56	11,645 b/	2,043	3
Threemile Creek	10.0 b/	4,447 b/	445	25,510 b/	2,551	15
Rock Creek						
below reservoir	3.3 b/	381 b/	115	5,997 b/	1,811	6
Above reservoir	6.0	763	127	14,487	2,414	5
Gate-South Fork	10.2 b/	584 b/	57	4,210 b/	397	12
Boulder-Forest c/	12.6	1,827	145	10,966	870	14
Clear-Frog c/,d/	16.4	1,145	70	5,183	316	18
Barlow Creek c/	6.4	68	108	5,599	875	11
Mineral c/-Iron-Bonney c/ -Buck c/	8.7	498 e/	57	3,901	448	11
Total						
Below barriers	146.7	28,979	196	176,372	1,202	
Above barriers	27.3	5,685	208	49,328	1,807	

a/ Population estimates expanded for stream by site-specific measurements of abundance.
b/ Adjusted stream length and abundance to account for stream sections with no summer flow or without resident populations.
c/ Brook trout present in the stream.
d/ Frog Creek had no redband trout above 4.6 miles.
e/ All in Iron Creek. Redband trout population estimates and density (fish/mile) in the White River system 1984 (from ODFW et al. 1985).

Abundance in the Crooked River Subbasin

Land and water management practices over the last 120 years have resulted in a decline in riparian condition, river channel morphology, water quality and quantity, and subsequent declines or extirpation of native fish populations. Most streams in the Crooked River basin are degraded, and fish habitat and production is substantially diminished from historical times. Redband trout occupy an estimated 75% of their historic range and are at a mere fraction of their historical abundance. Many streams, particularly in the southeast portion of the basin may have lost native redband trout due to habitat degradation, reduced flows and high water temperatures (Stuart, et al. 1996).

Currently, redband trout productivity in the Crooked River subbasin is severely limited by habitat degradation. The basin contains as many as 28 isolated redband trout populations (Stuart and Thiesfeld 1994). Many of these isolated populations are considered depressed (Figure 2). Generally, where habitat is in relatively good condition, with cool water temperatures, good riparian and instream conditions, redband populations in the Crooked River system exhibit a mixture of age classes and comprise the bulk of the fish populations. For example, headwater reaches of North Fork Crooked River tributaries such as Brush, Lookout, Peterson, Allen, and Porter creeks are primarily or exclusively redband trout. Tributaries with poorer riparian and instream conditions have a higher proportion of non-game fish, particularly dace and Bridgelip sucker (Stuart, et al. 1996).

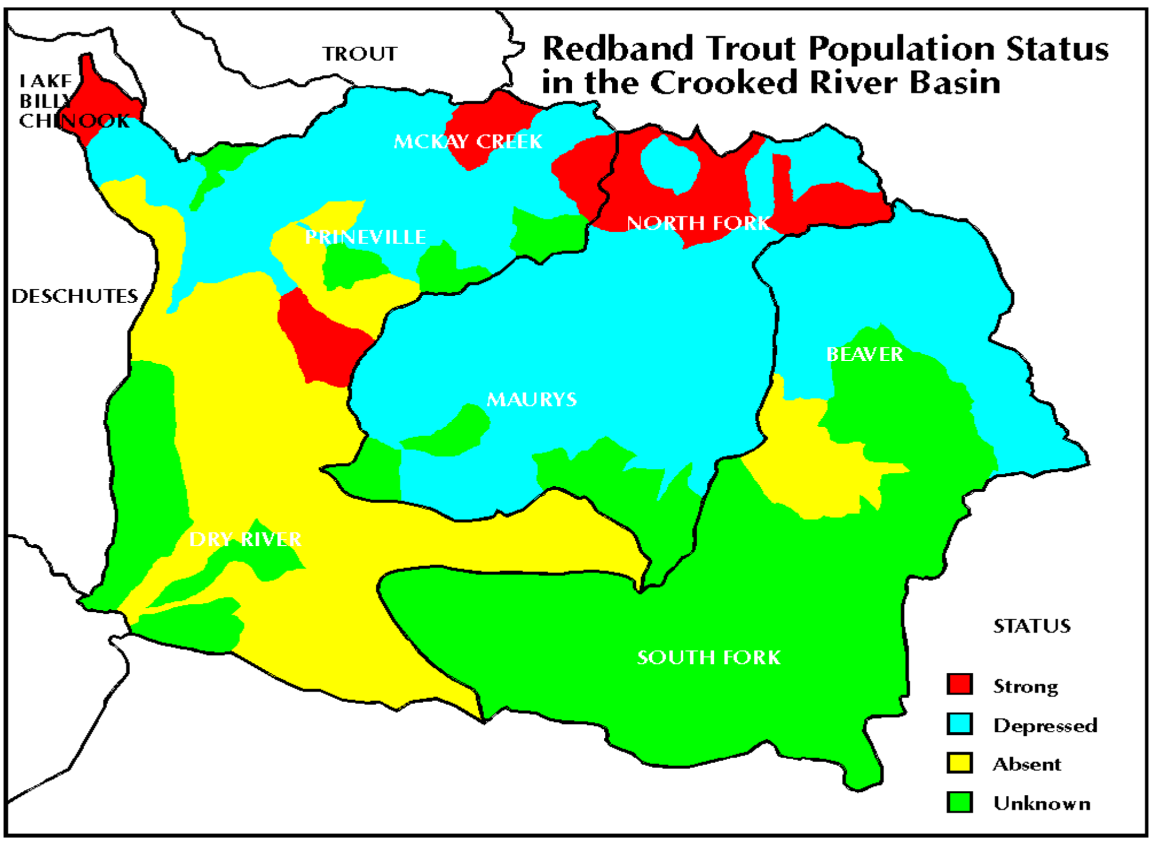


Figure 2. Status of redband trout populations in the Crooked River basin (Stuart et al. 1996).

Redband trout are the only native game fish remaining in the upper Crooked River subbasin, and reside primarily in the headwaters of smaller tributaries located on the USFS lands, including the following streams or stream segments: East Fork Mill Creek, Canyon Creek, Wolf Creek, Sugar Creek and Deep Creek and tributaries (Rife 2003). Headwater tributaries of Beaver, Ochoco, and McKay creeks, and the mainstem Crooked and North Fork Crooked River and Beaver Creek support low to moderately abundant populations of redband trout. Where habitat is in good condition, (i.e. cooler water, lower temperatures, and good riparian and instream conditions), populations exhibited diverse age classes with young of the year, juveniles, and mature fish up to 6 years old. Tributaries with degraded riparian conditions had lower densities of redband trout.

Most of the redband populations in the Crooked River system have been fragmented and isolated due to physical and water temperature barriers. Considerable effort has been expended studying populations of redband trout in the North Fork Crooked River. Streams in this basin vary in habitat quality from excellent to poor. Those streams with good habitat exhibit redband trout densities greater than $1/yd^2$, whereas those with poor habitat have redband trout densities less than $0.50/yd^2$. Electrofishing surveys in the upper Crooked River system found that redband trout comprise approximately 20% of the fish population in the Williams Prairie area, with dace accounting for the remainder (Ferry et al. 1979). Sampling downstream, the percentage of redband trout dropped and the percentage of non-game fish species increased. In the lower North Fork Crooked River, below the confluence with Deep Creek, redband trout comprise less than 1% of the population.

Redband trout were also found during physical and biological stream surveys in several South Fork Crooked River tributaries in 1979 (Carter 1979a; Carter 1979b), and in a fish presence survey on the South Fork Beaver, Grindstone, Trout, Camp, Freeman, Swamp and Dobson creeks in 1995 and on Swamp Creek in 1996. However, Stuart (1996) found that the South Fork Crooked River, and Beaver, Grindstone and Camp creeks, were either largely devoid of fish or were populated primarily with non-game fish species, such as dace and suckers, which are more tolerant to high summer water temperatures. Some of the tributaries in the Camp Creek drainage that arise in the Maury Mountains still have isolated redband trout populations, although at extremely low levels of abundance. Most of the west, south, and middle forks of Camp Creek appear to have no resident redband trout Stuart, et al. 1996).

The mainstem Crooked River redband population is also depressed, except for the tail water area downstream from Bowman Dam. In the Chimney Rock reach of the mainstem, fish surveys found high densities of trout ranging from 826 to 8,228 trout/mile (Table 30) in 1989 and 1994, respectively (Lichatowich 1998). Environmental conditions in this reach are influenced by the higher flows and lower temperatures of water released from Prineville Reservoir.

Table 30. Redband trout abundance (fish greater than 180 mm) in the lower Crooked River below Bowman Dam (Stuart et al. 1996).

Year	Reach	Fish/km
1989	RK 104-112	516
1993	RK 109-112	1431
1994	RK 109-112	5143
1995	RK 109-112	3811

Redband trout populations in Ochoco Creek and tributaries are also low. During redband trout density surveys conducted in 1991 and 1992, surveyors found 2.64 fish/m^2 in Canyon Creek, 2.66 fish/m^2 in Ochoco Creek, 0.31-0.77 fish/m^2 in Marks Creek and 0.34-0.69 fish/m^2 in Mill Creek (Stuart et al. 1996). Table 31 summarizes redband trout densities from a number of streams in the Crooked River drainage.

Table 31. Relative densities of redband trout, all age classes, in tributary stream of the Crooked River on Ochoco National Forest lands (Stuart et al. 1996).

Subbasin	Stream	Date	Fish/m^2
Ochoco	Canyon	8/92	2.64
	Ochoco	8/92	2.66
	Marks	8/92	0.31-0.77
	Mill	7/91	0.04-.069
North Fork Crooked River	Gray	7/94	0.068
	Lookout	8/91	0.81
	Brush	8/91	1.42
	E Fork Howard	7/91	0.54-0.68
	W Fork Howard	7/91	0.96
	Howard	7/91	0.77
	Porter	8/92	0.44
	North Fork CR.	7/90	0.01
Beaver	Dippingvat	8/92	1.01
	Roba	8/92	0.2

Abundance in the Upper Deschutes Subbasin

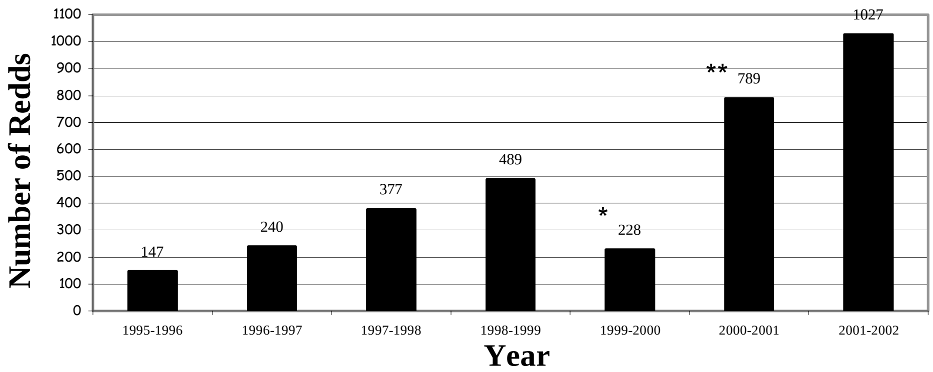
Principal redband trout production areas above Lake Billy Chinook include the mainstem Deschutes up to Steelhead Falls, Squaw Creek, Crooked River and Metolius River. The amount of genetic interchange between these areas has not been studied, but historically there were no physical barriers to stop movement of fish (Fies et al. 1996). For instance, redband trout in the Metolius River were likely once a part of the Deschutes River redband trout complex of populations (Fies et al. 1996).

The most productive redband trout habitat in the Deschutes mainstem between Bend and Lake Billy Chinook lies below Big Falls. During snorkeling and raft electrofishing surveys conducted from 1989 to 1991, biologists counted 1,261 redband trout in 0.42 miles surveyed between Big Falls and Lake Billy Chinook. In comparison, they counted only 68 redband trout in 0.88 miles surveyed between Big Falls and Bend. Redband trout population data gathered from 1989 to 1991 in the Deschutes River between Bend and Lake Billy Chinook is shown in more detail in Table 30. A general consensus is that fish populations have declined in this section of river in recent years, primarily due to low summer stream flow. By the early 1990s, redband trout essentially disappeared from near Tumalo (RM 158) to below Lower Bridge (RM 134.5) where spring flow begins to moderate temperature and river flow. Trout production is believed to have improved during the good water years of the late 1990s when sufficient river flows were maintained in this reach to sustain the population through the summer, though there is no actual inventory to support these assumptions. Currently, however, the redband trout population between Tumalo and Lower Bridge is believed to be at, or close to, zero as a result of low flows during the recent dry weather cycle (Marx 2003).

Table 30. Redband trout inventory from Bend to Lake Billy Chinook by snorkeling and electrofishing, 1989-91 (Fies et al. 1998).

River section	River mile	Method	Survey miles	Number of fish	Fish per mile	Size range
Bend to Big Falls	167-132	Snorkeling and electrofishing	0.88	68	77.3	3-13"
Big Falls to Lake Billy Chinook	132-120	Snorkel	0.42	1261	3002.0	2-16"

Redband trout production in the Metolius River system has increased in recent years. However, during the early 1990s, fish managers became concerned about the status of redband trout in the river. Surveys conducted during this time in several sections of the Metolius River suggested that the abundance of potential redband trout spawners was less than 500 fish. While it is not clear how these numbers compare to historical numbers or to the current habitat potential, densities of fish were very low — especially in the areas open to angling. This combination of factors suggested that wild Metolius redband trout were likely at significant risk and in a potential conservation crisis (Fies et al. 1996). This downward trend has been reversed in recent years, with a notable increase in the number of redband trout redds counted annually. Recent redband trout spawning surveys in the Metolius River system recorded a high of 1,027 redds, which is a record for the period of record (Figure 2). A slight dip in the numbers of redds observed in 1999 – 2000 may be attributable to less frequent sampling effort, as well as the effect of the 1996 Flood on juvenile redband that would have reached spawning age in 2000 (Marx 2003). The upward trend is believed to reflect the termination of hatchery rainbow trout releases and the implementation of more restrictive angling regulations.



* Redd counts are made every two weeks from mid-November through early May.

Figure 2. Redband Trout redd counts in Metolius River, 1994-95 to 2001-02* (Marx, 2003).

Above Bend, redband trout production in the Deschutes River varies by reach and is directly associated with winter flow conditions. An ODFW electrofishing inventory (1990-91) between Bend (RM 167) and Benham Falls (RM 180.9) found an apparent small redband population in the upper end of this section, and a larger population in the lower end. At the upper end of the section, only 30 trout were captured per mile with none exceeding 9 inches and most under 6 inches. At the lower end (RM 172), a partial (relatively low percent of population caught) ODFW inventory recorded between 235 and 310 redband trout per mile. Approximately 50% of the trout were larger than 6 inches and 11% were between 10 and 12 inches (Fies et al. 1998).

Redband trout numbers have increased dramatically in the subbasin upstream of Crane Prairie Reservoir since 1990. Record numbers of redband trout redds were observed during spawning surveys on Crane Prairie Reservoir tributaries in 2001 (Figure 3).

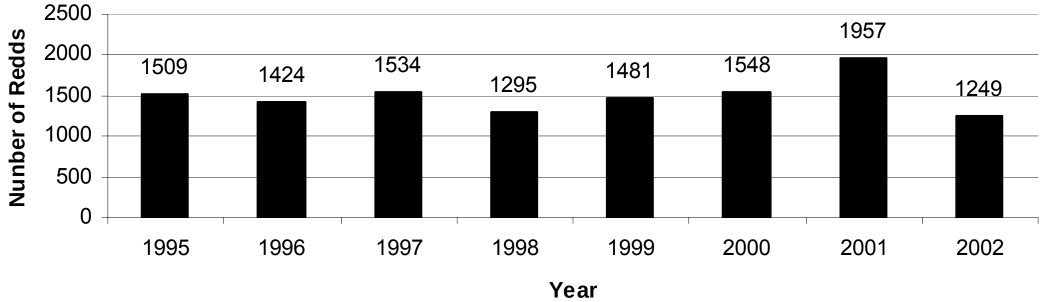


Figure 3. Redband trout redd counts in Crane Prairie Reservoir tributaries, 1995 – 2002 (Marx 2003).

A similar upward trend in redband redds has been seen on Odell Creek upstream of Davis Lake. Spawning surveys in 2001 recorded a record high 883 redds (Figure 4) (Marx 2003).

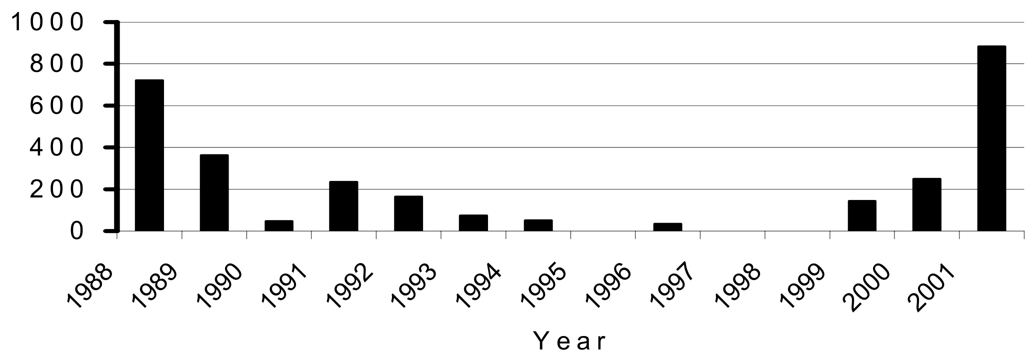


Figure 4. Redband Trout redd counts in Odell Creek, 1988 – 2001 (Marx 2003).

Fish inventories conducted throughout the Little Deschutes River basin using backpack electrofishers and snorkeling techniques show that, overall, the redband population is fair upstream of Gilchrist, but poor downstream. Redband trout were the dominant species historically, but habitat conditions have allowed brown and brook trout to out compete indigenous populations. During fish inventories in 1990 and 1992 at seven sites on the Little Deschutes River, only 10 redband trout were captured, with only 1 fish found above the town of La Pine. The redband ranged from 3 to 9 inches in length. Counts in 1992, however, were probably below normal as it was an extreme low water year and redband trout were less abundant than in more average water years (Fies et al. 1998).

Results from fish surveys conducted in 1992 along three reaches of Crescent Creek, all below Highway 58, show that the creek supports a small redband population. Redband trout were the most abundant trout species captured in Crescent Creek during the surveys. In the canyon reach below Highway 58, surveyors captured 9 redband and no brown trout in about 980 feet of stream. In the reach below Forest Road 61, they identified 26 redband, 94 whitefish, more than 50 sculpins, and 10 Tui chub in approximately one-half mile of stream. The reach furthest downstream, approximately 2.5 miles in length, was surveyed with a drift boat electrofisher. Through the entire reach, surveyors captured only 5 redband trout, 4 brown trout, and 41 whitefish (Fies et al. 1998).

Capacity

The lower Deschutes River Subbasin is capable of producing large populations of wild redband trout. Densities of redband trout greater than 8 inches in the 1980's averaged 1,630 fish/mile in the North Junction area and 1,830 fish/mile in the Nena Creek area of the lower Deschutes River. The capacity of most other subbasin streams is depressed by degraded habitat and competition.

While the Crooked River system once supported large numbers of redband trout, production potential is currently limited because of habitat conditions. Production potential will remain low until habitat deficiencies are improved.

The Deschutes River upstream of Crane Prairie Reservoir and the Metolius River systems appear capable of producing larger populations, as indicated by the previously discussed population trends. Below Crane Prairie, redband trout production is limited by available spawning habitat (i.e. limited gravel and limited free-flowing stream distance). Following extensive placement of spawning gravel (approximately 1,500 cubic yards) in the early 1990s, there was a notable rebound in the redband population. However, spawning habitat still limits these redband. There may also be adverse effects on this population from non-indigenous fish species in these waters, including brown bullhead catfish, largemouth bass and three-spine stickleback.

Productivity

Depressed redband trout populations are capable of rapid recovery if habitat conditions are favorable and other limiting factors are not oppressive. For example, the redband population in the Nena Creek reach of the lower Deschutes was depressed in 1979, with an estimated 639 fish per river mile greater than 8 inches in length. The low numbers of redband trout were the result of high harvest rates associated with an annual catchable-size hatchery rainbow trout stocking program. Redband trout production increased after rainbow trout stocking in the reach ended in 1979 and more restrictive bag limit and gear restrictions were implemented. In 1981, the population in this same reach had increased to an estimated 1,845 fish greater than 8 inches in length per mile (ODFW 1997). Similar results were seen in the Metolius River system. As discussed earlier, the population has rebounded in recent years, with a record number of redband trout redds observed during the most recent spawning surveys. This apparent rebound in redband numbers appears to be associated with changes in fish management practices.

Most reaches of the North Fork and mainstem Crooked River are in a degraded condition with low flows and high summer temperatures. They support densities of redband trout of less than 300 fish/km. The tailrace reach below Bowman Dam, however, supports very high densities of redband trout, indicating a tremendous capacity to produce native salmonids where flow conditions are sufficient throughout the year and water temperatures stay relatively cool, below 150C. Since 1989, abundance of redband trout in the 19 km of the lower Crooked River below Bowman Dam has shown a 10-fold increase from approximately 520 to 5200 fish/km. This population increase is likely attributable to increases in winter time flow from unallocated storage in Prineville Reservoir. Prior to 1989, flows during the drought cycle were frequently as low as 10 cfs to store water during the non irrigation season. Since 1989, the Bureau of Reclamation has released from 30 to 75 cfs through the winter storage season (Stuart, et al. 1996).

Surveys in the North Fork Crooked River and tributaries indicate that redband trout utilize intermittent streams when there is water, and that they readily re-colonize those habitats when water re-occurs. During drought years, an entire year's juvenile production may be lost in some streams (ODFW 1996).

Life History Diversity

In the lower Deschutes River, redband trout spawn during spring and early summer, with most spawning occurring from April to July. Zimmerman and Reeves (1999) observed redband spawning from mid-March through August. Most suitable trout spawning gravel in the lower Deschutes River is in the area from White River to Pelton Reregulating Dam (Huntington 1985).

Mean age and length of lower Deschutes River redband trout at first spawning is 3 or 4 years and 12 to 13 inches. Some males mature at age 2, and at about 8-10 inches in length. Average fecundity of redband trout in the lower Deschutes River is 1,300 to 1,500 eggs/female. Spawning redband trout compose about half of the population of fish over 10 inches. Approximately 60% of the spawning fish have spawned previously. Some redband trout skip one or more years between spawning (Schroeder and Smith 1989).

Growth of redband trout in the lower Deschutes River is dependent on the stage of maturity and size of the individual. Immature fish grow faster than mature fish. Growth slows after a fish matures as energy is used for development of gonads and regaining body condition following spawning. Growth slows as fish size increases. Average annual growth of redband trout at ages 1-6 is 4.4 inches, 4.3 inches, 3.1 inches, 1.7 inches, 1.4 inches, and 0.8 inch, respectively. Data from tagged fish showed that, of the redband trout greater than 2 years in age, many were 5 to 7 years old, with a few fish living as long as 10 years (Schroeder and Smith 1989).

Analysis of scales from redband trout in the White River system indicated a predominance of age-1 and age-2 fish in the watershed. Analysis of scales of redband trout over 12 inches from lower White River indicated first spawning at age-3 and age-4. Scale analysis suggested that growth continues after maturation, somewhat contrary to what is observed in the lower Deschutes River. Growth rate of redband trout in the lower mainstem White River was significantly greater than for redband trout elsewhere in White River. Redband trout that migrate out of tributary streams into the lower mainstem of White River from July to October showed an increase in growth for that period (Schroeder and Smith 1989).

Redband trout spawn in the Crooked River system from late April through early June. Fry emergence has been observed in early July to mid August. By September, most 0+ age fish range in length from 60 to 100 mm and averaged 76 mm in length. A few 0+ age fish were recorded as small as 41 mm. Mean lengths of 1+ age fish average 74-98 mm, and 2+ age fish average 124-147 mm in Crooked River tributaries. The oldest fish observed by scale analysis was 6 years old (280 mm); however, larger fish up to 355 to 455 mm have been observed in other sampling activities, and suggests fish may live occasionally older than 6 years of age (Stuart, et al. 1996).

In the Crooked River below Bowman Dam, size of redband trout by age class was determined by back calculating lengths from scale analysis. Age at annulus formation of redband trout scales collected in June 1994 were 119, 206, 237, and 300 mm, respectively, for age 1 to 4 trout (Borgerson 1994). Scale collections from April 1989, when trout densities were approximately 10% of 1994 densities, had back calculated lengths at annulus formation of 116, 193, 299, 379, 413, and 426 mm, respectively for age 1 to 6 trout. Both samples included larger fish with regenerated scales that made age determination impossible. Anglers have reported landing fish from Crooked River downstream of Bowman Dam up to 610 mm in length (Stuart et al. 1996). Figure 7 illustrates the average lengths of redband trout by age class sampled in Crooked River downstream from Bowman Dam.

Age composition of fish collected after an August, 1996 McKay Creek fish kill was 75%, 12%, 11%, and 2% of age 0+, 1+, 2+, and 3+ and older fish, respectively. However, in the two-day interval from the time of the kill to the survey, predators may have removed fish from the sample sites (Stuart, et al. 1996).

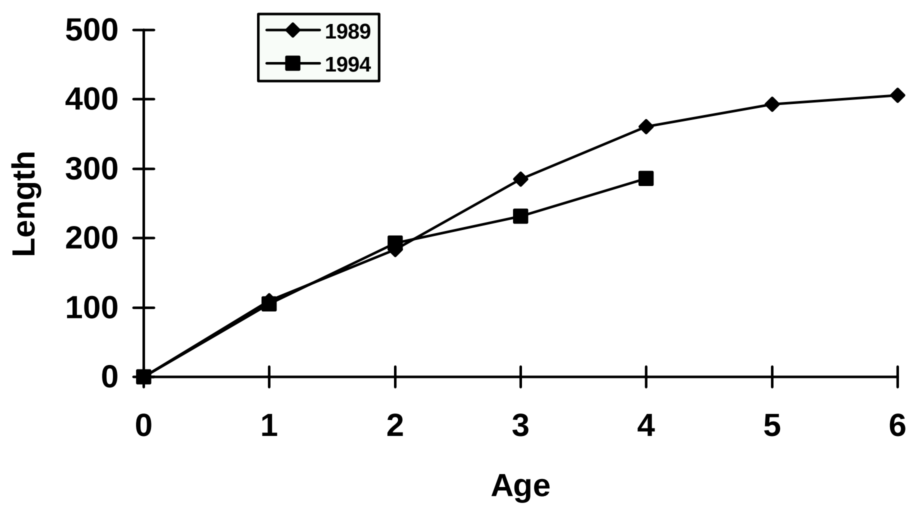


Figure 7. Back calculated length at annulus formation for rainbow trout captured in the Crooked River (RK 104-112) (Stuart, et al. 1996).

Carrying Capacity

There have been no estimates of potential redband trout carrying capacity in the Deschutes subbasin.

Population Trends and Risk Assessment

The redband trout populations in the lower Deschutes River and White River are robust. The biggest risk to these populations is a catastrophic environmental incident. The lower Deschutes population may be vulnerable to the effects of a hazardous substance spill that could result from a train derailment on the rail line closely bordering the lower 87 miles of the river. The White River population could be particularly vulnerable to catastrophic flooding associated with volcanic activity on Mount Hood. Historically this system has experienced pyroclastic flows and mud flows that originated on the slopes of Mount Hood and extended downstream to the river's confluence with the Deschutes River. Habitat deficiencies in some small tributaries, including low flow, temperature extremes and the lack of cover put trout populations at risk.

Natural mortality of trout in the lower Deschutes River, particularly associated with spawning, is high (45% to 69%) for fish greater than 31 centimeters (about 12.2 inches). This high natural mortality, and not harvest, is likely the limiting factor controlling recruitment of trout into size ranges over 41 centimeters (about 16.1 inches) (Schroeder and Smith 1989).

Lower Deschutes River redband trout are resistant to *Ceratomyxosis*, a fatal gut infection caused by *Ceratomyxa shasta,* a myxosporidian parasite. This disease was first detected in the lower Deschutes River immediately below the Pelton Reregulating Dam (river mile 100) in 1965. Its presence has been detected every time tests have been conducted since 1965 (ODFW 1997). Studies done by ODFW in 1984 indicate that redband trout in the White River system are also susceptible to infection by *C. shasta*.

Redband trout in the Crooked River basin are consistent with the metapopulation concept. Small fragmented and isolated populations reside in tributary streams, while vast reaches of the mainstem Crooked River, with the exception of the 19 km reach below Bowman Dam, are severely reduced in abundance. Historically the mainstem Crooked River was likely a "source" population. However, with severe habitat degradation and numerous partial and complete barriers on the mainstem and tributaries, many populations are fragmented and completely isolated from each other (Stuart et al. 1996). Fragmentation and isolation of populations may eliminate life history forms and reduce survival, growth and resilience. Populations with extremely low abundance, in streams with marginal habitats, and with little or no exchange of genetic material, have a high risk of extinction (Rieman and McIntyre 1993).

Today, only seven percent of the Crooked River Basin supports strong populations of redband trout. Little information on fish populations is available in the southern and eastern parts of the basin. However, based on current habitat conditions it can generally be assumed that fish populations in this part of the watershed are either depressed or absent. Of the known habitat occupied by redband trout, only 15 percent was identified as containing strong populations. Production appears to be strongly tied to environmental conditions. Surveys in the North Fork Crooked River and tributaries indicate that redband trout utilize intermittent streams when there is water, and that they readily re-colonize those habitats when water re-occurs. During drought years, an entire year's juvenile production may be lost in some streams (ODFW 1995).

Redband populations in the upper Deschutes subbasin are smaller than those in the lower subbasin and often fragmented. These populations may have been genetically impacted by past stocking of hatchery rainbow trout or are at genetic risk because of the small remaining population size. Environmental conditions associated with diminishing stream flows and degraded stream habitat have placed a number of populations at risk.

Metolius River redband trout have been examined to determine if there has been genetic introgression as a result of the past stocking of non-native hatchery rainbow trout. Study findings showed that Metolius redband trout had genetic and meristic characteristics of coastal or non-native hatchery rainbow trout populations. In addition, disease challenges revealed that Metolius redband trout were much more susceptible to *Ceratomyxa shasta* than redband trout from the Deschutes River, which have genetic resistance to the lethal disease. Based on these data it was concluded that genetic introgression has occurred with non-native hatchery rainbow trout. This introgression has made the Metolius River redband more susceptible to *Ceratomyxosis* when conditions for infection occur (Currens, et al. 1997).

Redband trout production is increasing in some areas because of changes in fish management and habitat enhancement. Redband trout populations in the Metolius River and Crane Prairie Reservoir tributaries both have shown indications from annual redd counts that these populations are on the increase. Record high redd numbers were observed in the Crane Prairie Reservoir tributaries in 2001 and in the Metolius River in 2001-2002.

Unique Population Units

Redband trout isolated above White River Falls are more similar to isolated populations of redband trout in the Fort Rock Basin of south-central Oregon, in both genetic and morphological characteristics, than they are to lower Deschutes River redband trout. These characteristics include fewer pyloric caeca, finer scales, and little or no variation at two specific alleles (Currens et al. 1990). A possible explanation is that the Deschutes River drained the Fort Rock Basin until lava flows separated the drainages in the late Pleistocene epoch (Allison 1979). Ancestral redband trout probably invaded White River and the Fort Rock Basin when they were connected to the Deschutes River. Subsequent isolation of White River and Fort Rock basins prevented these populations from acquiring genetic traits that evolved in the Deschutes River population during the last glacial period. Therefore, some populations in the White River system may represent remnants of the ancestral population and an evolutionary line originating from a primitive race of redband trout.

Preliminary information suggests that redband trout from tributaries of the North Fork Crooked River including Fox Canyon, Howard, and Lookout creeks have diverged from other inland redband trout groups and exhibit little introgression from non-native hatchery fish. However, populations in the lower Crooked River basin including the reach below Bowman Dam, Ochoco, Marks, and Canyon creeks, have the highest rate of hatchery introgression, ranging from 10 to 30% (Currens 1994). This percentage of introgression seems plausible due to the long term hatchery stocking and the multiple rotenone projects, particularly in the Ochoco Creek subbasin (Stuart, et al. 1996).

Estimate of Desired Future Condition for Long-term Sustainability

Recovery of depressed and fragmented redband trout populations to sustainable levels through habitat restoration would help insure the continued existence of the fish throughout the subbasin.

Distribution

Differences in Distribution due to Human Disturbance

Redband trout are still distributed throughout the Deschutes River subbasin. Some populations are now fragmented and isolated in headwater areas where habitat conditions are still conducive to trout survival. In the upper Crooked River drainage, redband trout have apparently been extirpated from a number of streams or stream reaches because of the cumulative effects of water withdrawal, riparian habitat degradation and/or elevated water temperatures. Habitat conditions in the mid and lower reaches of a number of streams effectively preclude trout survival and isolate remnant headwater populations. The presence of major and small impoundments in the subbasin without functional fish passage facilities have further fragmented redband populations.

With increasing settlement and development, redband trout populations have declined in distribution and abundance within the Crooked River basin. Presently, strong populations are found in 7% of the basin. This includes only two reaches of the mainstem Crooked River: the Wild and Scenic River section below Bowman Dam and the lower Crooked River upstream of Lake Billy Chinook. The remaining strong populations are located in headwater systems on the Ochoco National Forest. All strong populations are found on federally managed land. Many of the most productive fishery habitats were historically located in low gradient reaches of the mainstem of the Crooked River and its major tributaries. These areas were also the first places settled and developed in the basin and currently represent some of the most degraded habitats (Stuart et al. 1996).

Numerous chemical treatment projects using rotenone were conducted from the 1950's to the late 1980's to rid some flowing and standing water bodies of large populations of non-game fish species such as bridgelip and largescale sucker, and northern pike minnow. These species were thought to compete with trout for food and space, and in some cases prey on eggs or juvenile trout. Eradication of the non-game fish also resulted in the eradication of the remnant redband populations in some of these streams. Figure 8 illustrates the location of streams and stream reaches impacted by this management practice in the Crooked River Basin (Stuart, et al. 1996).

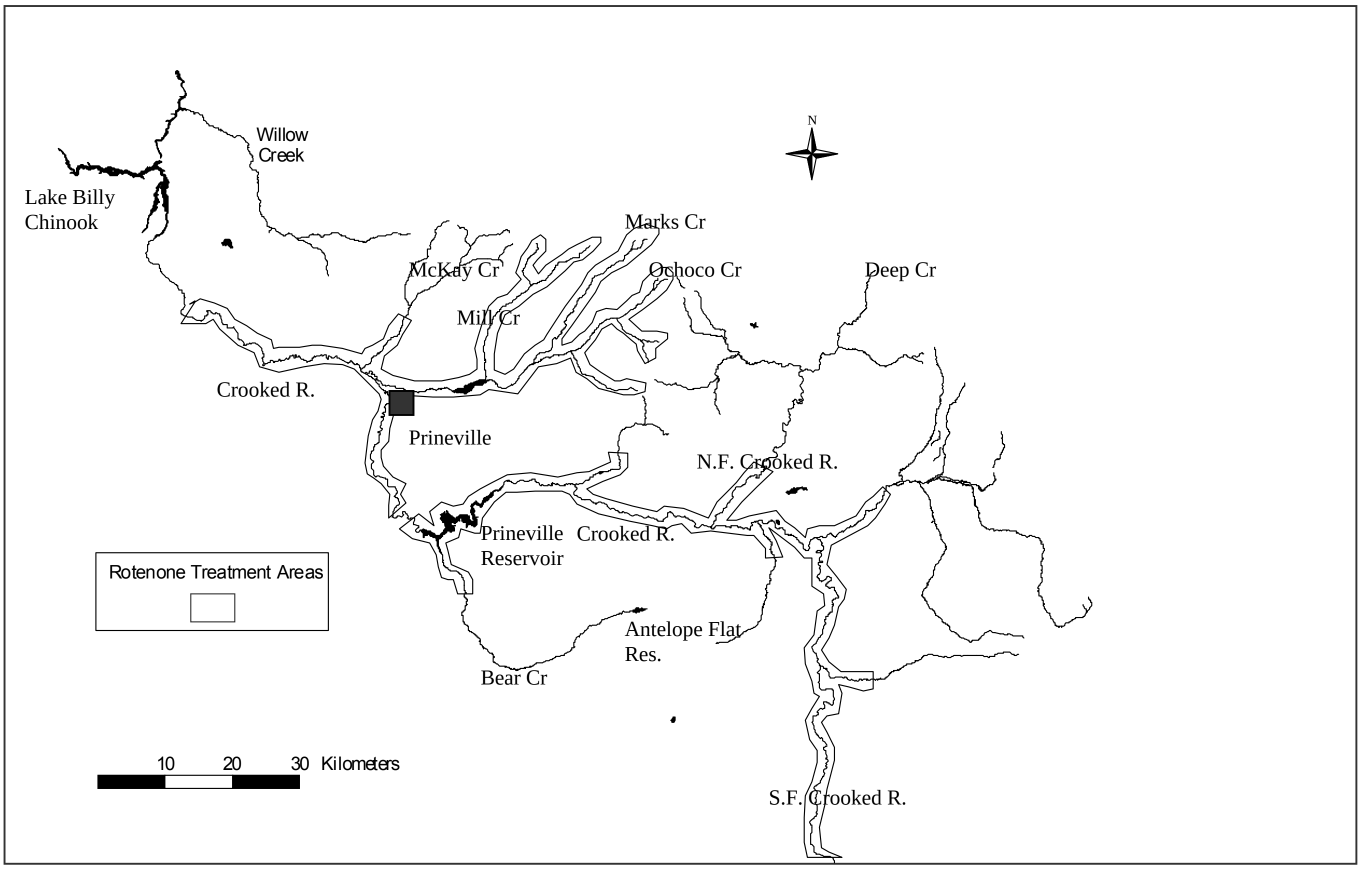


Figure 8. Map of past chemical treatment projects in the Crooked River Basin (Stuart et al. 1996).

Brown trout were introduced into Oregon in the early 1900's (ODFW 1969). The brown trout population in the upper Deschutes River and tributaries appears to be amazingly resilient in view of the adverse environmental conditions. The habitat in this portion of the Deschutes River, under its current condition, is more suited for brown trout than redband trout. It has a low gradient and few riffle areas. Competition from brown trout and whitefish may be holding the redband population in check and there is also a lack of winter holding habitat (Fies et al. 1998).

Artificial Production

Artificial propagation of rainbow in the subbasin began in 1916, with initial releases of hatchery trout into the Deschutes River near the City of Bend starting as early as 1911. Since that early beginning, hatchery rainbow trout from a number of fish hatcheries have been released in many subbasin waters. In recent years the release sites for hatchery trout in the subbasin have been essentially limited to lakes and reservoirs.

Current Hatchery Production

The release of hatchery rainbow trout into subbasin streams has been nearly halted within the past 25 years. Table 31 summarizes the status of hatchery rainbow trout stocking in subbasin streams.

A small Deschutes River redband trout brood stock (Stock 66) has been maintained at ODFW's Oak Springs Fish Hatchery for about 20 years. The original fish for this brood stock were collected from the lower Deschutes River. This stock's resistance to *Ceratomyxosis* was one of the primary rationales for developing the hatchery brood stock. Progeny of this stock have been used in a number of waters within the subbasin where *Ceratomyxosis* resistance was important for fish survival and contribution to recreational fisheries. Most recently, waters receiving Stock 66 Deschutes Redband Trout have included Haystack Reservoir, Crescent Lake, South Fork Crooked River and Fall River. Recent contributions of these fish to the sport fishery has been disappointing. ODFW plans to phase out this hatchery stock by 2006 or 2007 (Curtis 2003).

Table 31. Status of hatchery rainbow trout stocking in subbasin streams.

Stream	Currently being stocked with hatchery rainbow trout	Last year Hatchery rainbow trout were stocked
Lower Deschutes River		1978*
White River		1993
Badger Creek		1993
Warm Springs River		1997
Metolius River		1995
Middle Deschutes River – Lake Billy Chinook to Bend		1977
Upper Deschutes River – Bend to Benham Falls		1978
Upper Deschutes River – Benham Falls to Wickiup Dam	10,000 to 44,000 annually	
Fall River	7,500 annually	
Spring River		1954
Little Deschutes River		1978

Tumalo Creek	No stocking

* Occasional May release of 500 *C. shasta* susceptible rainbow trout in Maupin area for handicap anglers.

ODFW began to develop a Crooked River redband trout hatchery brood stock (Stock 153) at Oak Springs Fish Hatchery in 2003. The agency hopes this stock, which is also *Ceratomyxosis* resistant, will out-perform the Stock 66 fish in a number of upper subbasin waters. The first eggs for this new hatchery brood stock were collected from fish in Ochoco Creek (Crooked River tributary) upstream from Ochoco Reservoir. The brood stock will receive an annual infusion of 25% wild fish into each egg-take to help insure genetic diversity (Curtis 2003).

Historic Hatchery Production

There is a long history of trout production and stockings in the Deschutes River. This record is summarized below by subbasin.

Upper Deschutes Subbasin

- Concerns were raised in 1919 about fish populations in the upper Deschutes River being depleted. Citizens petitioned for a fish hatchery to be built and fish stocked in the river (reasons: stage of water seldom varies by 12 inches, a site can be obtained adjacent to the city, stock is depleted because Deschutes is a popular river and attracts many visitors, money collected from licenses has never been applied locally).

- Fish stocking in the Deschutes River may have begun as early as 1911, but records are not clear. The earliest records confirming fish stocking were found for 1916 (Oregon Sportsmen, January 1916). Fish were stocked above Benham Falls (RM 180.9), at Cline Falls (RM 144.7), and Bend. They were brook trout, rainbow trout, and steelhead. The brook trout were of East Coast origin, but the source of the rainbow and steelhead is unknown.

- Mathisen (1992) compiled early stocking history in the Deschutes River. He stated rainbow trout were planted in 1913 at several locations in the Deschutes River: 67,000 two miles above Bend (RM 169.6), 27,000 at Robinson Bridge (RM 179.6) and 33,000 at Spring River Bridge (or Harper Bridge, RM 191.6), 22 miles above town. They were brought in by the Game Commission rail car (called "Rainbow") probably from the Bonneville Hatchery.

- In 1915, Master Fish Warden announced plans to build a hatchery about three miles south of Bend on the John Sizemore meadows with an initial capacity of 500,000 eggs. By 1916 the hatchery building was supplemented by three outdoor ponds and 300,000 young trout were being raised for release in Deschutes, Jefferson, Crook, and Klamath counties.

- In 1919, the Old Bend Hatchery was replaced by the Tumalo Hatchery, which in turn was replaced by Fall River Hatchery in the mid-1920s.

- A few notes were found in the Oregon Sportsman and old hatchery records report about fish being stocked "at Bend" from 1929-1935, probably in the area above North Canal Dam. These fish were rainbow and brook trout. Hatchery records revealed 20,000 rainbow were stocked at Tetherow Bridge (RM 140.9) and 40,000 at Tumalo (RM 158.1) from 1931-1935. The origin of the fish is unknown. Fish stocking from 1931-35 also included 10,000 steelhead in the Deschutes River (Fies et al. 1998).

- Rainbow were stocked between Sheep Bridge (RM 236.5) and Twin Bridges in 1936, numbers and origin unknown (Fies et al. 1998).

- Hatchery fish stocking records for the Little Deschutes River date back to the 1930s when 60,000 rainbow were stocked at river mile 3.

- An unknown number of hatchery rainbow trout were released into Fall River in 1946. Rainbow were stocked in Spring River in 1947 and 1948 as fry or legal-size fish numbering from 9,900 to 20,043 fish (Fies et al. 1998). In 1945, about 52,000 fingerling rainbow, of unknown stock, were planted in the Little Deschutes River. Legal-size rainbow were first stocked in the Little Deschutes in 1948, origin unknown.

- Legal-size rainbow were stocked in 1950 in the Deschutes River between Wickiup Dam (RM 227) and Benham Falls. Stocking records show Crescent Creek was stocked only once, in 1950, with 4-6 inch rainbow trout, stock unknown (Fies et al. 1998).

- Stocking of hatchery-reared rainbow trout in the Deschutes from Benham Falls to Bend began in 1954 with the release of 11,000 to 58,000 legal-size rainbow trout from Oak Springs, Wizard Falls, and Klamath hatcheries. Rainbow were first stocked as legal-sized fish in Fall River beginning in 1957 and continue to the present. From 1957-1965, approximately 7,000 - 8,500 legal rainbow were stocked annually into Fall River. Numbers stocked over the years have ranged from 7,000 to 15,000 annually (Fies et al. 1998; Marx 2003). Legal-size rainbow trout were stocked in the Little Deschutes annually from 1954-1975 and 1977-1978, and ranged from 800-14,000 rainbow trout each year (Fies et al. 1998).

- Brown trout were tried with little success from 1965-1968. Rainbow trout releases did not resume until after 1968 when 2,000 - 41,000 fish were being released annually. The rainbow trout came from Klamath, Wizard Falls, Fall River, and Oak Springs hatcheries. This stocking ended in 1978 (Fies et al. 1998).

- From 1985-1993, conservation groups made annual releases of Deschutes River stock (Lot 66) rainbow fry at RM 190 and RM 205. Numbers released ranged from 369 in 1993 to 113,039 in 1989. Oak Springs Fish Hatchery provided eggs through the ODFW Salmon Trout Enhancement Program. The eggs were incubated in hatch boxes placed by the conservation groups in Spring and Fall rivers. Deschutes stock redband trout were selected for the egg incubation experiment because they are resistant to *Ceratomyxosis*, a lethal disease found throughout the Deschutes River below Wickiup Reservoir (Fies et al. 1998).

- In 1994, approximately 25,000 legal-size (3 per pound) rainbow trout (Fall River, lot 72) were stocked in the Deschutes from Wickiup Dam to Sunriver.

- Big Marsh Creek was stocked in 1968-69 with 4-500 legal-size rainbow trout, reared at Klamath hatchery (Fies et al. 1998).

- Tumalo Creek was first stocked in 1948 with 1,800 rainbow trout. The origin of the rainbow is unknown. This stream was stocked annually from 1949 through 1972. All of the rainbow trout releases were legal-size fish (Fies et al. 1998).

- Rainbow trout, steelhead, and brown trout have been released in the Deschutes River from Bend to Lake Billy Chinook. These have all been legal-size fish except for one release of fingerling rainbow in 1955. Numbers released ranged from 7 fish (16" brown trout in 1956) to 43,042 rainbow trout in 1960. Records of hatchery rainbow trout releases in the middle and lower Deschutes River were originally combined, so it is impossible to distinguish hatchery rainbow releases in this river reach prior to 1954 (Fies et al. 1998).

- Beginning in the 1920's hatchery rainbow trout were used to supplement the sport fishing demand on the Metolius River. Starting initially with fingerling releases, the program expanded with the construction of Wizard Falls Hatchery in 1947 (Fies. et al. 1998).

Crooked River Subbasin

- Very little fish stocking has occurred in the upper portion of the Crooked River basin. Fry and fingerling hatchery rainbow trout were planted in the mainstem Crooked River and in Tom Vaughn, Sherwood, Poison, Newsome, Maury, Lodgepole, Indian, Little Horse Heaven, Drake, Camp, Cottonwood, and Double Cabin creeks, and in Reams, Miller, and Double Cabin ponds. Most plantings occurred from 1947 to 1957 and were generally a single event in each stream although some streams received a total of 2-4 plantings in that time period (ODFW 1996).

- Both legal and fingerling hatchery rainbow trout have been released into the South Fork Crooked River since 1947, with legal releases of up to 10,000 catchable and 100,000 fingerling fish. Most fish have come from Oak Springs hatchery with a few releases from Wizard Falls, Fall River, or Klamath hatcheries (ODFW 1996).

Lower Deschutes Subbasin

- Approximately 60,000 Roaring River stock legal-sized, rainbow trout from Oak Springs and Wizard Falls hatcheries were released annually in the lower Deschutes River from the late 1940's to 1978. Trout were released near Warm Springs (RM 97 – 98.5), from Nena Creek to Wapinitia Creek (RM 55 – 59.5), and from Maupin to Oak Springs (RM 48 – 51.5). This stock was susceptible to *Ceratomyxosis* and likely did not survive to spawn in the lower Deschutes River. The Oregon Fish and Wildlife Commission discontinued stocking in 1978 after deciding to manage the lower 100 miles of the Deschutes River exclusively for wild trout.

- Indigenous White River redband trout populations were supplemented with hatchery rainbow trout from 1934 to 1993. Roaring River stock of hatchery rainbow trout was released into White River, Badger Creek, and the lakes and reservoirs of the White River system. These hatchery trout were reared at Oak Springs, Hood River, Wizard Falls, Fall River, Klamath, and Bonneville hatcheries. Deschutes River stock redband trout from Oak Springs Hatchery were released into the White River system from 1983 until 1991. Former stocking locations in the White River system were White River at Farmers Road (RM 17.5); Tygh Valley Bridge (RM 6.5); below the Highway 197 bridge (RM 5.0); and Badger Creek at Bonney Crossing (RM 7.0). These programs were discontinued in 1993 due to concerns for potential genetic impacts to the unique indigenous White River redband trout (ODFW 1997).

- Historic releases of rainbow trout made throughout the subbasin were generally comprised of non-indigenous stocks. These exotic fish stocks included rainbow trout that originated from Cape Cod, Massachusetts.

- In the past, Warm Springs River and Shitike Creek were stocked with Cape Cod (Roaring River Hatchery) domestic rainbow trout that were reared at Warm Springs Hatchery from eggs obtained from Roaring River Hatchery (ODFW 1997).

Effect of straying/ecological consequences

There is no indication that redband trout from other subbasins stray into the Deschutes subbasin. The past use of various domestic rainbow trout stocks in hatchery fish releases throughout the subbasin could have potentially posed similar or greater genetic risks to the indigenous redband populations as the straying of non-indigenous trout into the subbasin. These hatchery trout releases often encouraged elevated angling pressure and harvest of redband trout. Hatchery trout often competed with redband trout for food and habitat, which may have reduced redband numbers in some streams. Aside from competition, there are a number of confirmed examples where hatchery rainbow trout spawning with redband trout has resulted in some genetic intergression.

The fish disease, *Ceratomyxosis*, likely acted as a natural control that limited the potential adverse effects of the hatchery rainbow trout releases on some of the indigenous redband trout populations. In subbasin streams where *Ceratomyxosis* was prevalent, non-resistant hatchery rainbow trout were either harvested by anglers or predators, or died within weeks of being released. This natural population control of these hatchery rainbow trout meant these fish did not survive to compete with redband trout during the winter pinch period. It also meant that these hatchery trout did not survive to spawn with the redband trout. In streams where *Ceratomyxosis* is not found, such as White River above White River Falls, there has been documented genetic introgression from the hatchery trout. When hatchery trout survived to spawn with the redband trout in these streams, they also remained for months or years to compete with the redband trout.

Relationship between Natural and Artificially Produced Populations

Observed differences between populations in the White and lower Deschutes rivers are probably not attributable to the influence of hatchery rainbow trout that have been previously stocked in the White River system. However, there is evidence that genetic introgression between indigenous redband trout and hatchery populations may have occurred in the lower White River, lower Tygh Creek, Jordan Creek, and Rock Creek (Currens et al. 1990). Redband trout in Deep Creek (North Fork Crooked River tributary) also exhibited a moderate level of hatchery introgression from legal rainbow trout released from 1963 to 1990 (ODFW 1995).

Subbasin Harvest

Subbasin streams support a variety of redband trout fisheries, although most trout angling occurs in the numerous lakes and reservoirs. There have not been regular statistical sampling programs to document trout harvest from subbasin waters for approximately 30 years.

Current Harvest

The lower Deschutes River supports a popular redband trout fishery. The character of this fishery has changed over the years as angling regulations have become more restrictive and the stocking of hatchery rainbow trout has been discontinued. Angling regulations and management strategies have changed to protect juvenile steelhead and to potentially increase certain size groups of wild redband trout (ODFW 1997). The trout season on the lower Deschutes River is currently open year around from the river mouth up to the northern boundary of the Warm Springs Tribes reservation (RM 69). From river mile 69 upstream to Pelton Reregulating Dam, the trout season is open from the fourth Saturday in April until the end of October (no angling from Pelton Reregulating Dam downstream about 600 feet to the ODFW markers) (ODFW 1997).

Harvest data for trout are available for the lower Deschutes River downstream from Sherars Falls for 1989, 1990, and 1992 through 2002 for the period July through October. These data show that under the current regulations the majority of angler caught trout are subsequently released alive. The estimated percent of trout kept downstream from Sherars Falls during this period ranged from 2 to 7% and averaged 2.5% for the period of record. These low harvest rates indicate that most anglers currently do not fish for trout in the lower Deschutes River for consumption, but rather choose to release their catch regardless of existing regulations (ODFW 1997). There is no comprehensive creel census data available for the Deschutes River from Bend to Lake Billy Chinook (Fies et al. 1998).

While data specific to the lower Deschutes River does not exist, hooking mortality very likely equals or exceeds angler harvest under the existing regulations. Taylor and White (1992), in an analysis of 31 hooking mortality studies, report a mean hooking mortality of 7% for rainbow trout caught on flies and artificial lures.

It is believed that much of the past rainbow trout fishery in the White River system was supported by the stocking of hatchery fish in White River at Tygh Valley and Farmers Crossing and in Badger Creek at Bonney Crossing. Total harvest of hatchery or wild trout in the White River system has not been estimated (ODFW 1997).

There are no recent comprehensive catch estimates or angler-use estimates for the upper Deschutes River between Bend and Wickiup Dam. An extensive 1967 ODFW creel survey recorded 783 anglers catching 252 wild brown trout or about 0.32 fish per angler, but does not mention the redband catch. The survey covered the Deschutes

River from Wickiup to its confluence with Fall River. Random creel census collected in the Wickiup to Benham Falls section during the years 1970 - 1994 showed mean catch rates of 0.38 fish per hour and 0.84 fish per angler. Similar data collected for the Benham Falls to Bend section showed mean catch rates of 0.35 fish per hour and 0.63 fish per angler. However, the fish per angler catch rate has been declining since 1970 for both sections of the Deschutes (Table 32) (Fies et al. 1998).

Table 32. A comparison of fish per angler catch rates on two sections of the Deschutes River from Wickiup Dam to Bend (North Canal Dam) for the years 1970-94 (Fies et al. 1998).

	Fish Per Angler	
Years	**Wickiup Dam to Bend**	**Benham Falls to Bend**
1970-1980	1.24	0.78
1981-1990	0.61	0.54
1991-1994	0.47	0.39

Historic Harvest

Harvest of trout in the lower Deschutes River was estimated from random and statistical creel surveys in the 1950's, 60's, and 70's when the regulations were liberal and hatchery trout were stocked in the main stem. Historically, most of the trout angling in the lower Deschutes River occurred above Sherars Falls. Estimated harvest of trout from Sherars Falls to Pelton Reregulating Dam ranged from about 22,000 to 133,000 fish during years of creel surveys in the 1950's to the 1970's (ODFW 1997). Hatchery fish contributed significantly to the trout catch. Anglers harvested approximately 62% of the 61,000 hatchery fish stocked annually (Schroeder and Smith 1989).

Historical accounts also describe large trout harvests in the Deschutes River near Bend. In 1906, about 3,125 trout were caught in the Deschutes River near Bend on hook and line from four days of fishing by four anglers for a fish fry. In August 1915, about 2,000 people were fed with fish caught by six fishermen using hook and line (Mathisen 1985).

Bull Trout

Bull Trout are a resident species indigenous to the subbasin. Deschutes basin bull trout exhibit resident, fluvial (lower Deschutes) and adfluvial (upper Deschutes) life histories. Fluvial bull trout migrate from their smaller natal streams 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 (USFWS 2002).

Historically the Deschutes Basin supported a number of bull trout populations that included the lower Deschutes River population in the river and tributaries upstream to Big Falls, the upper Deschutes River population above Big Falls and tributaries, and the Odell Lake – Davis Lake population. Today, these populations are listed as threatened under the Endangered Species Act. The Odell Lake subpopulation contains the last extant native lake migratory (adfluvial) bull trout in Oregon (Ratliff and Howell 1992; Buchanan et al. 1997).

Bull trout in the basin are part of the Deschutes Recovery Unit, which encompasses the Deschutes River and its tributaries and contains two core bull trout habitat areas. The lower Deschutes Core Area and upper Deschutes Core Area are separated by Big Falls on the mainstem Deschutes River at RM 132. The lower Deschutes Core Area is generally described as the mainstem Deschutes River and its tributaries from Big Falls downstream to the Columbia River. The upper Deschutes core habitat is generally described as the upper Deschutes River, Little Deschutes River, and other tributaries upstream from Big Falls at about River Kilometer 212 (River Mile 132). The upper Deschutes core habitat does not currently support bull trout populations, but had bull trout historically (USFWS 2002).

Importance

Bull trout were selected as a focal species based on an evaluation of the legal, cultural and ecological status. They are federally listed as a threatened species under the Endangered Species Act and hold ecological value and local significance in the Deschutes basin.

- ***Species designation:*** The U.S. Fish and Wildlife Service issued a final rule listing the Columbia River population of bull trout (*Salvelinus confluentus*), including the Deschutes subbasin populations, as a threatened species under the Endangered Species Act on June 10, 1998 (63 FR 31647) (USFWS 2002). Bull trout are currently listed on the Oregon Sensitive Species List (OAR 635-100-040) as Critical.

- ***Species recognition:*** Historically the species was not highly regarded by tribal or non-tribal fishers or fishery managers. Until about 1960, bull trout were trapped and removed [killed] from the Metolius River at a salmon weir, because of perceived predation on spring Chinook eggs and juveniles. Bull trout captured at the Warm Springs Hatchery barrier dam were not counted before 1990, but were killed rather than passed upstream (ODFW 1997). Today, bull trout are recognized as indicators of high quality fish habitat and cold water. Their presence is associated with an intact aquatic ecosystem (Brun 2003).

- ***Special ecological importance to subbasin:*** Historically bull trout were an important component of the subbasin's aggregate fish population. The fish were an important predator that co-existed with other fish species and helped to keep the ecosystem in balance. Today bull trout are recognized as indicators of high quality fish habitat and cold water. Their presence is associated with an intact aquatic ecosystem (Brun 2003).

- ***Tribal recognition:*** Historically, the tribes utilized bull trout as food fish. Bull trout were generally perceived to be a predatory fish that adversely affected more desirable resident and anadromous fish species. This tribal image of the fish was fostered by the negative image they were given by ODFW and the USFWS. Today, the tribes view bull trout as being an important part of healthy, functioning ecosystems, which is consistent with their traditional beliefs (Brun 2003).

Population Data and Status

Abundance

The Metolius River system supports some of the largest bull trout populations in the Deschutes Basin. The system contains both resident and adfluvial bull trout populations. The populations have apparently responded to angling restrictions enacted to restore population numbers. Record high numbers of bull trout redds were recorded during the 2001 spawning survey (Figure 6), indicating an apparent upward population trend. A total of 643 redds was observed during the 2002 surveys (Table 33). This is 117 less redds than in 2001 (Figure 6), or a decrease of 15.4%. It is, however, still the second highest count on record. Based on a figure of 2.3 adult fish per redd this equates to 1,479 bull trout moving into the basin streams to spawn during the 2002 year. Those reaches surveyed in 2002 averaged 42.6 redds per mile compared to the 2001 average of 57.2 redds per mile and the 1986 average of 1.4 redds per mile (Wise 2003).

Several tributaries to the lower Deschutes River also support bull trout populations. The draft bull trout recovery plan estimates there are 1,500 to 3,000 adult bull trout in the recovery unit, which are distributed in the lower Deschutes Core Area (USFWS 2002). The lower Deschutes resident/fluvial bull trout populations reproduce in Shitike Creek and the Warm Springs River, though some adults spend a portion of the year in the Deschutes River. In 2001 Brun (2001) estimated there were approximately 260 and 470 bull trout spawners in the Warm Springs River and Shitike Creek, respectively. The Shitike Creek population may be comparable to the Metolius River populations in bull trout densities, but the Warm Springs River population is much smaller. Juvenile bull trout densities observed in Shitike Creek in 1999 were similar to juvenile densities in Metolius River tributaries. Metolius River tributary juvenile bull trout densities in 1999 were 1.34 fish/100m2 compared to 2.4 fish/100m2 in Shitike Creek (Brun 2003). In 1997, ODFW estimated bull trout numbers in a lower Deschutes River study reach at North Junction (RM 68.5 to 71.5). The number of bull trout greater than 25 cm in length was estimated to be 7 fish per mile (Newton and Nelson 1997). This estimate was made as part of redband trout population study that utilized the Petersen mark/recapture population estimate methodology.

Anecdotal information suggests that bull trout in the lower Deschutes River subbasin were more abundant historically than at present. A fish trap was used to pass upstream migrating salmonids over Pelton Reregulating Dam before 1968. Workers at that facility recalled annually passing up to several hundred large bull trout upstream for a number of years, indicating that bull trout were much more abundant historically (Ratliff et al. 1996).

Bull trout have not been reported from Odell Creek in recent years. The last official documentation was from a USFS survey in 1979 that recorded bull trout from 14 to 18 inches at a density of 0-5 fish per 100 feet of stream. Surveys were done by snorkeling.

USFS personnel conducted a spawning ground survey downstream of Odell Lake with the objective to document bull trout use, in 1994. Two surveys were completed in October but no redds or fish were found (Fies et al. 1998).

Capacity

There is potential to expand population abundance of all five populations within the Lower Deschutes Core Area (USFWS 2002), but there are no estimates available on the population potential. There are also no estimates of the population potential for the Odell Lake or Upper Deschutes Core Habitats.

Productivity

Recent upward trends in bull trout redd counts in both the Metolius populations and the lower Deschutes populations indicate that bull trout numbers are increasing in apparent response to restrictive angling regulations, habitat protection, and a more abundant forage base. Kokanee salmon populations in Lake Billy Chinook and the Metolius River provide a good prey species. Recent increases in salmon and steelhead numbers in the lower Deschutes River system would also increase prey availability.

Life History Diversity

In the Metolius River system, most bull trout spawning occurs 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°C (43°F) between RM 18 to 27; this was the mean 7-day average from thermographs. In the Warm Springs River, temperatures averaged 6.6°C (44°F) between RM 31 to 35 during the late-August to early November spawning period (Brun 1999).

Juvenile bull trout typically rear in the parent stream for two years and then migrate in the spring to larger waters for rearing to adulthood. Deschutes basin bull trout exhibit resident, fluvial and adfluvial life histories. At age-5, fluvial and adfluvial fish migrate back to their natal tributary to spawn (USFWS 2002). Bull trout are very piscivorous allowing them to reach up to 20 lbs in size depending on food availability.

Carrying Capacity

There is no estimate of the subbasin's bull trout carrying capacity.

Population Trend and Risk Assessment

Bull trout core areas with fewer than five local populations are at increased risk, core areas with between five and ten local populations are at intermediate risk, and core areas with more than ten interconnected local populations are at diminished risk. For the lower Deschutes Core Area, there are currently five known local populations. Based on the above guidance, bull trout in the Deschutes Recovery Unit is at an intermediate threat category (USFWS 2002).

Hybridization with brook trout is a concern for the Warm Springs River and Shitike Creek populations. Hybridization has not been documented in the lower Deschutes River subbasin but brook trout are present in high lakes in both systems and the potential does exist. Competition between juvenile brook trout and bull trout for available resources may exist where both are present even if hybridization does not occur (Brun and Dodson 2000).

Small populations risk extinction through excessive rates of inbreeding and chronic or catastrophic natural processes. It is unknown if lower Deschutes River subbasin bull trout populations are large enough to escape these risks (ODFW 1997). The limited quantitative measures of bull trout numbers in the lower Deschutes suggest there are several small populations. Tribal fishery managers have been closely monitoring bull trout populations in recent years at the weirs in Shitike Creek and the Warm Springs River, so any unusually population characteristics should be promptly noted.

The bull trout populations in the Metolius River system appear to have rebounded from extremely low levels as recently as the 1980s (Fies et al. 1996). The recent trend in Metolius River system bull trout redd counts also appears to indicate an upward population trend (Figure 6).

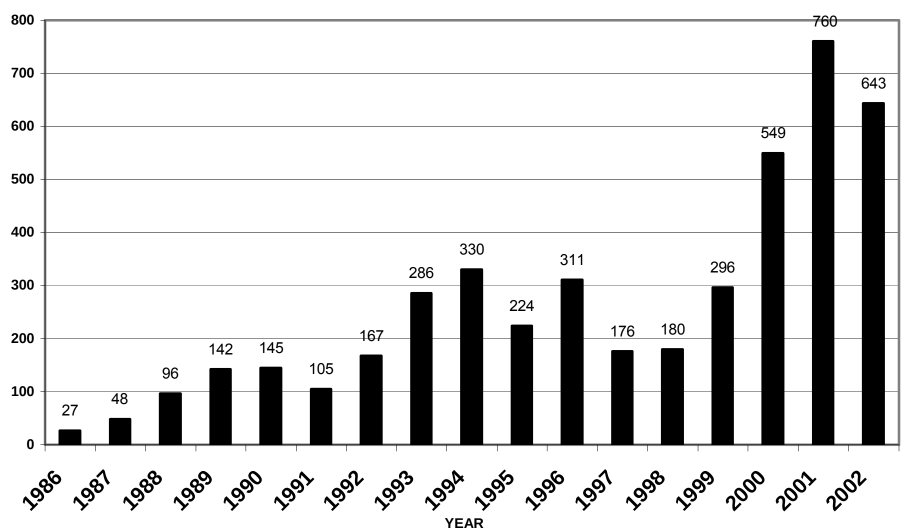


Figure 6. Bull Trout redd counts, Metolius River system, 1986 – 2002 (Wise 2003).

Bull trout spawning surveys in Shitike Creek and the Warm Springs River (Figure 7) indicate that the annual numbers of spawners appears to be stable in the Warm Springs River system and on an upward trend in Shitike Creek.

Table 33. Bull trout redd counts, Metolius River and tributaries spawning surveys, 1986– 2002 (Wise 2003).

Year	Jefferson	Candle	Canyon	Roaring	Jack	Heising	Metolius	Total
1986	6	6	8	4	3	0	0	27
1987	9	8	16	4	11	0	0	48
1988	27	8	9	22	30	0	0	96
1989	36	17	22	17	50	0	0	142
1990	29	16	35	13	49	3	0	145
1991	25	8	14	30	23	5	0	105
1992	28	13	40	28	53	5	0	167
1993	121	28	36	19	61	18	3	286
1994	81	30	104	17	50	31	17	330
1995	32	42	29	12	70	34	5	224
1996	75	71	56	14	55	35	5	311
1997	14	33	44	24	40	16	5	176
1998	29	48	33	9	39	15	7	180
1999	29	70	70	44	44	22	17	296
2000	116	85	92	90	87	57	22	549
2001	117	174	156	82	207	8	16	760
2002	134	91	130	104	164	13	7	643

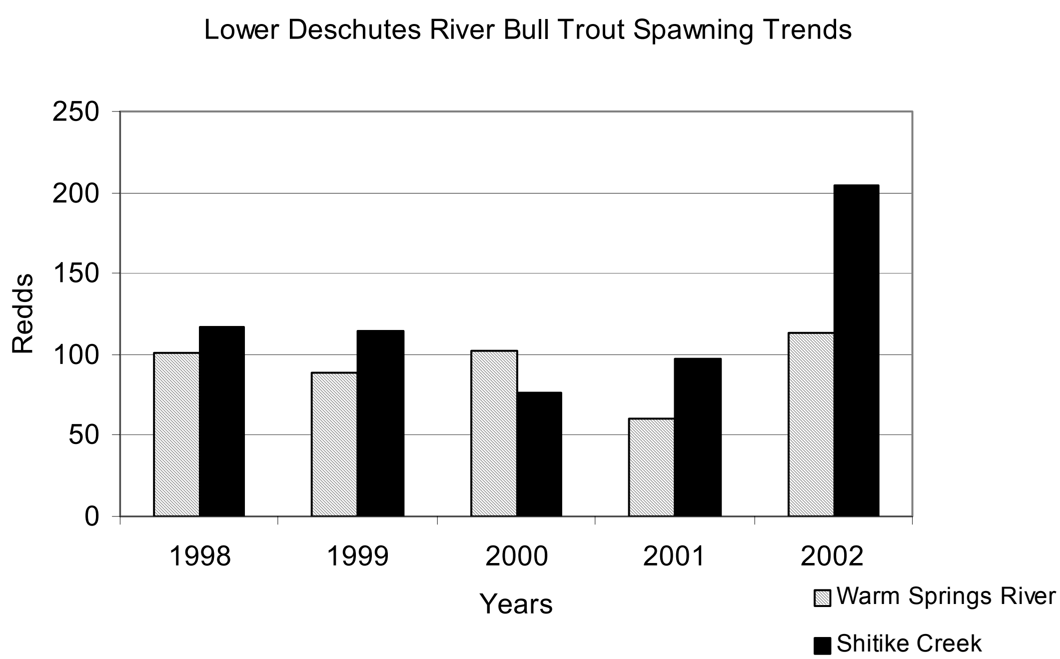


Figure 7. Bull trout redd counts from the Warm Springs River and Shitike Creek, 1998 – 2002 (Brun 2003).

Unique Population Units

Research conducted on the genetics of bull trout in Oregon established the genetic baseline for 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). Fluvial subpopulations in Shitike Creek and the Warm Springs River contribute bull trout into the lower Deschutes River. The Metolius River system populations were historically a component of the lower Deschutes populations. The Pelton Round Butte Complex isolated some of these populations. The Odell Lake population has been isolated from other subbasin populations for approximately 6,000 years.

Life history Characteristics of Unique Populations

The Warm Springs River and Shitike Creek bull trout populations are thought to be fluvial, but contain a resident component as well. The fluvial life history pattern is dominant in the lower Deschutes River habitat. The fluvial components of these populations spawn and rear in headwater reaches of the Warm Springs River and Shitike Creek. At age-2 and age-3, some juveniles migrate to the mainstem lower Deschutes River to rear. Brun (1999) found that the average size of juvenile bull trout migrants from Shitike Creek to be 131 mm and 183.9 mm in the spring and fall respectively. Some juveniles rear two to three years in the headwater stream reaches before emigrating to the Deschutes River.

Adults begin returning to the headwater spawning areas as age–4 fish (Brun and Dodson 2000). Adults migrate from the Deschutes into Shitike Creek and the Warm Springs River from April to June. Fish are generally in the habitat suitable for spawning by September. Spawning is generally complete by the end of October. The only known suitable spawning sites in the lower Deschutes subbasin are contained in the Warm Springs River system and Shitike Creek.

The Metolius River complex populations have a life history similar to the Shitike Creek and Warm Springs River populations. However, the Metolius populations contain at least an adfluvial component that spends a portion of its life rearing in Lake Billy Chinook.

Estimate of Desired Future Condition for Long-term Sustainability

The recovered abundance levels in the Deschutes Recovery Unit were determined by considering theoretical estimates of effective population size, historical census information, and the professional judgment of recovery team members. In general, effective population size is a theoretical concept that allows the recovery team to predict potential future losses of genetic variation within a population due to small population sizes and genetic drift. For the purpose of recovery planning, effective population size is the number of adult bull trout that successfully spawn annually. Based on standardized theoretical equations (Crow and Kimura 1970), guidelines have been established for maintaining minimum effective population sizes for conservation purposes (USFWS 2002).

Effective population sizes of greater than 50 adults are necessary to prevent inbreeding depression and a potential decrease in viability or reproductive fitness of a population (Franklin 1980). To minimize the loss of genetic variation due to genetic drift and to

maintain constant genetic variance within a population, an effective population size of at least 500 is recommended (Franklin 1980; Soule 1980; Lande 19) (USFWS 2002).
In a recovered condition, the lower Deschutes Core Area would have spawning and rearing populations in the Whitewater River, Jefferson/Candle/Abbot river complex, Canyon/Jack/Heising/mainstem Metolius river complex, Warm Springs River, and Shitike Creek. Core habitat in the upper Deschutes core habitat would also contain one or more local populations as yet to be identified (USFWS 2002). The Odell Lake habitat complex population should be increased to a minimum of 500 fish to avoid long term genetic risks.

There will be intact migratory corridors among all local populations in core areas providing opportunity for genetic exchange and diversity within the lower Deschutes Core Area. This will mean upstream and downstream passage must be addressed at the three dams associated with the Pelton Round Butte Complex and passage barriers at Opal Springs Dam, Link Creek, and upper Squaw Creek. Additional barriers may also be identified. If re-establishment is undertaken in the upper Deschutes core habitat, upstream and downstream passage at Wickiup, Crane Prairie, and several privately owned-hydropower and irrigation diversion dams must be addressed (USFWS 2002).

Distribution

Current Distribution

Bull trout in the Deschutes subbasin have been reduced to six populations. These are located in Odell Lake and tributary and outlet streams, Shitike Creek, Warm Springs River, Whitewater River, Jefferson/Candle/Abbot river complex, and Canyon/Jack/Heising/mainstem Metolius river complex (USFWS 2002). With the exception of the remnant Odell Lake population, the current bull trout distribution is limited to the lower Deschutes Core Area, which covers the lower Deschutes Basin below Big Falls and includes five local populations: one in Shitike Creek, one in the Warm Springs River, and three population complexes in the Metolius River (USFWS 2002).

Historic Distribution

Historically the Deschutes Basin supported a number of bull trout populations that included the lower Deschutes River population in the river and tributaries downstream from Big Falls, the upper Deschutes River population above Big Falls and tributaries, and the Odell Lake – Davis Lake population. 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 (USFWS 2002). Deschutes River bull trout populations in Shitike and Squaw creeks, and middle Deschutes, Warm Springs, Crooked and Metolius rivers likely were once part of a much larger fluvial metapopulation, which included fish that migrated to and from the Columbia River (USFWS 2002). These populations quite possibly exchanged genetic material with bull trout from the nearby Hood and Klickitat rivers.

Differences in Distribution due to Human Disturbance

Bull trout were extirpated from most of the basin above Steelhead Falls by the 1950’s (Ratliff et al. 1994). A variety of factors including construction of Crane Prairie (1922) and Wickiup (1947) dams, water withdrawal from irrigation developments, excessive harvest and introduction of brook trout likely contributed to the extinction of upriver subpopulations in the 1950's. Dam construction and water withdrawals in the Crooked River system eventually limited bull trout distribution to the river downstream from Opal Springs Dam. Construction of Pelton (1956) and Round Butte (1964) dams and termination of fish passage around these structures in 1968 greatly restricted or eliminated natural movement of upriver groups of bull trout into the lower Deschutes River.

Artificial Production

Bull trout have not been artificially produced in the subbasin and there are no records of any artificially produced bull trout being released anywhere in the subbasin.

Effect of Straying/Ecological Consequences

There are no documented instances of bull trout from other subbasins straying into the Deschutes subbasin. However, releases of other hatchery-reared salmonids within the subbasin may mimic or potentially be more harmful than the potential effects of straying. 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, a Warm Springs River tributary, brook trout have displaced bull trout. Brook trout do not appear to be limiting bull trout abundance in Shitike Creek (Brun 2002).

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. Over-harvest may be a factor in a mixed fishery with brown trout (Ratliff et al. 1996).

Subbasin Harvest

Current Harvest

In the past 20 years, size and bag limit regulations on the lower Deschutes River have likely precluded a target bull trout fishery and limited exploitation rates to very low levels. The taking of bull trout was banned by rule in the lower Deschutes River starting in 1994 (ODFW 1997).

Today, the only legal harvest of bull trout within the Deschutes Basin occurs in a very restrictive fishery within Lake Billy Chinook. Anglers are allowed to keep one bull trout over 24 inches in length per day. Protective bull trout angling regulations in the Metolius

River have been implemented since 1980, which culminated in the closure of the tributaries below Lake Creek to angling in 1994 (USFWS 2002).

The Warm Springs River and Shitike Creek are closed to tribal angling to protect spring Chinook salmon. The only exception is the occasional opening of the Warm Springs River from the mouth to the hatchery for spring Chinook when the salmon are abundant. Tribal angling is generally very light during these special seasons. Some tribal harvest of bull trout probably occurs from the lower Deschutes River, bordering the reservation, but numbers are believed to be minimal (Brun 2003).

Historic Harvest

There is little quantitative data available on in-basin bull trout harvest. A major Native American and pioneer fishery occurred on the Upper Deschutes River at Pringle Falls (Ratliff and Fies 1989). There are many historical photos of large bull trout or "Dolly Varden", as they were called, from both the Upper Deschutes River near Bend and from the Metolius River basin. The Deschutes River had excellent populations of bull trout and native redband trout. Pringle Falls created a natural fish trap, and bull trout migrating toward upstream spawning grounds in July and August (1903) were taken by spear or clubs at night while they were delayed and concentrated at falls. The bull trout weighed between 5 and 20 lbs, and ranged from 24-37 inches in length. Fish were salted and packed in barrels or smoked and packed for winter use. Bull trout were still being caught during spawning migrations at Pringle Falls in 1923 (Fies et al. 1998).

Historically, liberal bag limits and a lack of terminal tackle restrictions likely resulted in greater harvest and higher exploitation rates on bull trout in the mainstem lower Deschutes River than in recent times. It is possible that small target fisheries for bull trout existed and that harvest affected population levels (ODFW 1997).

Until about 1960, bull trout were trapped and removed from the Metolius River in conjunction with operation of a weir to collect salmon for hatchery brood, because of predation on spring Chinook eggs and juveniles (Fies et al. 1996).

Pacific Lamprey

Importance

Pacific Lamprey is an indigenous, anadromous species found in the Deschutes River subbasin. Historically, lampreys were widely distributed throughout the subbasin. This historic distribution may have surpassed the historic salmon and steelhead distribution since lampreys are adept at passing some natural barriers (i.e. Sherars Falls and Willamette Falls). Anecdotal historic observations indicate that lamprey were very abundant, at least periodically (Kostow 2002). Historical accounts also describe lamprey collections from the Crooked River (Kostow 2002). Masses of adult lampreys could typically be seen stuck to the windows of the Bonneville Dam fish ladder as recently as the 1980's. Today, Pacific lampreys have been extirpated above the Pelton Round Butte Complex.

- ***Species designation:*** Pacific lamprey were listed as a state sensitive species in 1993, and in 1997 they were given further legal protected status by the state of Oregon. They are not included on the federal threatened or endangered species lists. However, because of apparent declines in lamprey populations conservation groups in Oregon, Washington and California prepared a petition to give lamprey federal protection under the Endangered Species Act in January 2003. Budget limitations have forced the U. S. Fish and Wildlife Service to defer formal consideration of the lamprey petition until at least October 2003.

- ***Species recognition:*** There are a number of different lamprey species, including parasitic and non-parasitic species, anadromous species and those that live their complete lifecycle in fresh water. People have commonly viewed lampreys as a threat even where they are native and live in harmony with their ecosystem. Some people seem to find their parasitic behavior repulsive, a view that is perhaps also sustained by their sliminess and snake-like appearance (Kostow 2002). Historically lampreys have provided an important, local fishery, for subsistence, ceremonial and medicinal purposes, by the members of the Confederated Tribes of Warm Springs.

- ***Special ecological importance to subbasin:*** Historically this species likely had the widest distribution of any of the anadromous species within the subbasin. Barriers that effectively interrupted the migration of other fish can often be negotiated by this species. Historically pristine stream conditions throughout the subbasin likely supported lampreys. Some mammalian and avian predators may target lampreys during their migrations to and from the ocean. Most adult lampreys die shortly after spawning, feeding various scavenger species and contributing rich nutrients throughout their freshwater habitat (Kostow 2002).

- ***Tribal recognition:*** The species is culturally significant for Native Americans, including members of the Confederated Tribes. The lampreys have religious and ceremonial importance to tribal members. Lampreys are also an important component of the tribal subsistence fishery that occurs annually in the subbasin. Lampreys are fatty and highly nutritious. They are valued as a traditional source of food by some Native Americans (Kostow 2002). A Tribal subsistence fishery for adult lampreys has occurred in the Deschutes River at Sherars Falls for generations. Lampreys have also been used for medicinal purposes. The oils of the “eels” have been used as hair oil and were traditionally mixed with salmon and used as a cure for tuberculosis.

Population Data and Status

Pacific lamprey abundance in the Deschutes subbasin has not been estimated, but appears to be low. Pacific lamprey abundance throughout the Columbia River Basin has decreased significantly in recent years (ODFW 1997). In part, this reflects lamprey counts at Bonneville and The Dalles dams, which were lower in the 1990’s than pre-1970 counts (Kostow 2002). Counts at Columbia River dam fish ladders are one of the few indicators of lamprey numbers in the Mid-Columbia ESU. However, even these counts are suspect because of certain lamprey characteristics. Lampreys typically migrate at night, while most fish ladder counting occurs during daylight hours. Fish counting stations typically were designed for counting salmon and steelhead, and lampreys can often times pass without being seen. Their erratic swimming in the faster current of the fish ladders could also result in multiple counts of an individual lamprey that may become dislodged and drift back down stream (Kostow 2002).

Tribal biologists will begin to estimate adult lamprey escapement above Sherars Falls this year as part of a Bonneville Power Administration funded project (BPA Project 200201600).

Capacity

There is no information or estimates available that would indicate the potential lamprey capacity in the Deschutes Basin.

Productivity

Historic lamprey counts at Bonneville and The Dalles dams show the order of magnitude variations that can occur as lamprey numbers swung between tens of thousands and hundreds of thousands in just a few years (Kostow 2002). Because of their high fecundity rate, lamprey populations may be able to quickly rebound if freshwater and ocean survival conditions are favorable.

Carrying Capacity

The Deschutes River subbasin Pacific lamprey carrying capacity is unknown.

Population Trend and Risk Assessment

Abundance of Pacific lampreys in the subbasin appears to be low. Risks to the lamprey populations include the degradation of stream habitat including erratic or intermittent flow, decreased flows, increased water temperatures and poor riparian areas, predation in all life stages, artificial barriers and the lack of appropriate screening for lampreys. They are particularly vulnerable to pollution and erratic stream flows during their juvenile or ammocoete life stage because of the length of time they reside in the stream substrate. Migrating ammocoetes are especially vulnerable to predation during their in-river and ocean migration. Most movement appears to occur at night, but their size (up to 10cm) and the number of predators, especially in the Columbia River and impoundments, pose a serious risk.

Unique Population Units

There have been no unique populations of Pacific lampreys identified in the subbasin. Little is known about Pacific lampreys because taxonomy and field identification of the various species is so difficult. Generally species differentiation is based on adult characteristics, but lampreys are adults for a rather short period of their total lives (Kostow 2002). Until species identification and genetic characteristics of the species is better understood it will be difficult to determine if any unique populations exist.

Life History Characteristics of Unique Populations

Life history information for the Deschutes River subbasin lamprey population is generally lacking. Much of the information contained in this assessment is based on observations and data from other Columbia River Basin or Pacific Northwest lamprey populations.

Pacific lampreys are an anadromous, parasitic species. They are parasitic during that portion of their life cycle that occurs in the ocean. Adult lampreys return to the Deschutes River during the summer months. It is assumed that they over-winter in subbasin streams prior to spawning the following spring or early summer. Willamette River subbasin lampreys spawn from February through May (Kostow 2002). Colder water temperatures in the westside Deschutes River tributaries may result in a slightly later spawning time in the Deschutes River subbasin.

Lampreys do not feed once they enter freshwater. Adult lampreys may be attracted to pheromones (chemical stimuli) produced by juveniles (ammocoetes) living in the stream substrate, rather than relying on some homing instinct. During the over-winter period individuals survive on stored body fats, losing up to 20% of their weight and shrink in length. The size of adult Pacific lampreys can be highly variable depending when the measurements are taken. Measurements of adults reported in literature include 39.3 to 62.0 cm for migrating adults and 33.2 to 54.2 for spawning adults (Kostow 2002).

Spawning generally occurs just upstream of stream riffles and often near silty pools and banks. Lampreys' fecundity is thought to be highly variable, which might suggest a variety of life history patterns or age classes in a single spawning population. It has been estimated that the fecundity rate may vary from 15,500 to 240,000 eggs/female (Kostow 2002). Lampreys spawn in low gradient stream sections. They construct gravel nests in the stream substrate at the tail-outs of pools or in riffles. Most authorities believe that all lampreys die after spawning. However, there have been several reported observations of robust lamprey kelts migrating downstream and an indication of repeat spawning in one Olympic Peninsula population (Kostow 2002).

Lamprey eggs hatch within 2-3 weeks, depending upon water temperature. The juveniles emerge from the spawning gravel at approximately 1 cm in length. The ammocoetes burrow into the soft substrate downstream from the nest and may spend up to six or seven years in the substrate. They are filter feeders that feed on algae and diatoms. The ammocoetes will move gradually downstream, moving primarily at night, seeking coarser sand/silt substrates and deeper water as they grow. They appear to concentrate in the lower parts of basins before undergoing their metamorphism. When body transformation, or metamorphism, from the juvenile to adult stage is complete, they migrate to the ocean from November through June (Kostow 2002). In the Umatilla River this out-migration was observed to occur in the winter to early spring (Kostow 2002).

Pacific lampreys enter saltwater and become parasitic. They feed on a wide variety of fishes and whales. They appear to move quickly offshore into waters up to 70 meters deep. Some individuals have been caught in high seas fisheries. The length of their ocean stay is unknown, but some have speculated that it could range from 6 to 40 months (Kostow 2002).

Estimate of Desired Future Condition for Long-term Sustainability

It would be desirable to have a population of sufficient size to provide for subbasin harvest while insuring adequate spawner escapement to perpetuate the population.

Distribution

Current Distribution

Pacific lamprey distribution in the Deschutes subbasin is confined to the Deschutes River and select tributaries downstream of the Pelton Round Butte Complex. ODFW personnel have conducted numerous steelhead surveys on the tributaries entering the lower Deschutes River from the east. No adult or juvenile lampreys have been observed during these surveys. It is assumed that most, if not all, spawning occurs within the boundaries of the Warm Springs Reservation. This spawning is likely occurring only in the Shitike Creek and Warm Springs River systems. Tribal biologists are currently mapping the known larval distribution of lamprey within reservation waters (BPA Project 200201600) (Brun 2003).

Differences in Distribution due to Human Disturbance

Lamprey distribution within the subbasin has been greatly reduced as a result of the construction of impassable barriers, including the Pelton and Round Butte dams. Marked flow fluctuations and degraded stream habitat have further reduced the lamprey distribution. Subbasin harvest may have also contributed to the reduction in lamprey numbers and distribution.

Artificial Production

There have been no artificial lamprey production programs anywhere within the subbasin.

Effect of Straying/Ecological Consequences

Little is known about straying of lamprey in the Deschutes River subbasin, including the straying of lamprey from other subbasins into the Deschutes. Studies of the sea lamprey (*Petromyzon marinus*) in the Great Lakes have indicated that some lampreys have essentially no homing behavior. Instead, the adults may be attracted to streams with concentrations of ammocoetes, which were detected by some chemical stimuli (Kostow 2002). If these observations apply to Pacific lampreys, straying may be common if the chemical stimuli are an indiscriminate attractant for all lampreys.

Subbasin Harvest

Current Harvest

All lamprey harvest in the subbasin is associated with the Tribal salmonid subsistence fishery located at Sherars Falls. Tribal harvest of adult lampreys in recent years has been low, but there are no estimates of the numbers of lampreys harvested. The first sampling program designed to monitor tribal harvest of adult lamprey from the Deschutes River is scheduled to begin this year at Sherars Falls (BPA Project 200201600) (Brun 2003).

Historic harvest

There is no data to quantify past lamprey harvest in the subbasin. Anecdotal observations by ODFW workers in the Sherars Falls area have indicated that when lamprey were more numerous, Tribal fishers at times were able to fill several burlap sacks with adult lampreys after a few hours of fishing. During years when lampreys were abundant it is possible that several hundred lampreys could have been harvested daily at Sherars Falls.

Sockeye Salmon

This assessment considers both anadromous sockeye salmon, which were extirpated from the subbasin about 1940, and the landlocked sockeye or kokanee salmon, which is an important subbasin fish species today. Sockeye salmon were selected as a focal species because of their historic ecological value, tribal significance and potential for re-introduction if remedial fish passage issues at the Pelton Round Butte Complex are successful.

Importance

Sockeye salmon historically were an important anadromous fish species that occupied a portion of the Deschutes River subbasin. Spawning and early life history stages were confined to the Metolius River/Suttle Lake/Blue Lake habitat complex. Sockeye salmon in Suttle Lake were an indigenous species (Fies and Robart 1988; Fulton 1970; NOAA No. 618). Sockeye used Link Creek for spawning and Suttle Lake for rearing. The historic sockeye run was suppressed by the 1930's and apparently extirpated by 1940, due to passage problems on Lake Creek near the outlet of Suttle Lake (Fies et al. 1996). The sockeye population may have been comprised of several thousand spawners annually, if any comparisons can be drawn between the original sockeye salmon population and the current kokanee salmon population in Lake Billy Chinook/Metolius River habitat complex. Kokanee, the resident form of the species, provide a valuable fishery in ten subbasin lakes and reservoirs, including the former sockeye habitat in the Metolius/Suttle Lake complex.

- ***Species designation:*** *S*ockeye/kokanee salmon within the Mid-Columbia ESU are not listed on the state or federal sensitive species lists.
- ***Species recognition****:* Since sockeye salmon were indigenous to Suttle Lake and Link Creek, it is reasonable to believe a residual sockeye (kokanee) population existed as well. The 1940 lake survey of Suttle Lake (Newcomb 1941) reported that land-locked Blueback salmon were abundant. It is unknown if the indigenous form of kokanee are still present in Suttle Lake (Fies et al. 1996).
- ***Special ecological importance to subbasin:*** Historically the sockeye salmon were an important anadromous species in the subbasin, even though their distribution was limited to the Deschutes River and the Metolius River and tributaries. A variety of predators targeted these fish during their migrations to and from the ocean. Adult sockeye die shortly after spawning. Their carcasses were utilized by various scavenger species and they contributed rich nutrients throughout their freshwater and associated riparian habitat. Large spawning populations of kokanee salmon are now making similar contributions to the ecosystems in the upper portion of the subbasin. Kokanee migrating upstream from Lake Billy Chinook are utilizing former sockeye spawning habitat in the Metolius River system. Another large kokanee spawning migration occurs in the Deschutes River upstream of Wickiup Reservoir.

- ***Tribal recognition:*** Sockeye are highly regarded by members of the Confederated Tribes of the Warm Springs Reservation. The adult sockeye salmon were a high quality fish that was an important Tribal food source. They were captured as adults on the Deschutes River at Sherars Falls and in the Metolius River system on their spawning grounds.

Population Data and Status

Abundance

Counts of adult sockeye at the Pelton Fish Trap from 1955 to 1962 varied from 30 to 332 adults. However, most of these adults likely were hatchery returns from the Oregon Fish Commission's Metolius Hatchery on Spring Creek (Nehlsen 1994). The Metolius River hatchery program for sockeye salmon was discontinued and the return of native fish ranged from 7 to 35 from 1957-59 (Nehlsen 1995; Fies et al. 1996). The last sizable run of sockeye in the Metolius River was 227 adults reported in 1955 (Fies et al. 1996). Today, a few sockeye salmon are captured each year at the trap, but these fish are either out-of-basin strays or fish that have successfully out-migrated through the hydroelectric complex.

Capacity

The potential for re-introduction of sockeye salmon into historic habitat above the Pelton Round Butte Complex precipitated a 1996 through 2000 study designed to determine the dynamics of the current kokanee salmon population in Lake Billy Chinook. It was estimated that the number of spawning adult kokanee in the Metolius River basin ranged from 83,471 adults in 1996 to 569,201 adults in 2000. This study determined that kokanee eggs hatch in the Metolius River basin from early December through early February, with emergence occurring from January through April. Most fry migrate downstream in late March and early April. Estimated fry recruitment ranged from 1.9 million in 1999 to 2.5 million in 1998. Potential kokanee egg deposition in the Metolius River basin ranged from 39.75 million for brood year 1998 to 67.23 million for brood year 1997. Redd superimposition occurred at several monitored sites (regardless of adult run size) and may account for substantial egg mortality. Minimum egg to fry survival ranged from approximately 3.8 to 4.8 percent during this study (Thiede et al. 2002).

Portland General Electric had a consultant investigate the potential sockeye salmon production potential upstream of the Pelton Round Butte Complex as part of the FERC re-licensing process. The primary task of the model used to develop the potential run size estimates was to evaluate the relative importance of different mortality and habitat factors that could affect re-introduced sockeye salmon (Ratliff 2003). The estimated annual number of adult sockeye that would be available to spawn upstream of the hydro project was very speculative because there were so many assumptions required to make PasRAS model simulations. When the model parameter settings were assumed to be more consistent with the risks sockeye populations would face in the Deschutes River (i.e. downstream migrant collection efficacies of 0.6, with an initial population of 1,000 to 3,000 spawners) over 60% of the replications of scenarios involving collection mortalities ended in extinction within 50 years (Oosterhout 1999).

Productivity

Sockeye salmon and kokanee salmon populations can reproduce very successfully. Naturally reproducing populations in lakes and reservoirs have a propensity for over-populating if there is good spawning habitat available. Over-population often results in a population of small or stunted fish. An example of this problem is the Suttle Lake kokanee population. In the past anglers complained about the lake's small-size kokanee. A weir on Link Creek (Suttle Lake tributary) originally used to monitor fish migration and collect eggs for hatchery programs was used in the 1980's to block spawning runs of kokanee to reduce the kokanee recruitment into Suttle Lake and thereby increase the average fish size. Those efforts increased the average size (fork length in inches) of mature kokanee from 9.8 inches in 1984 to 14.3 inches in 1990 (Fies et al. 1996).

Life History Diversity

Sockeye salmon populations often exhibit a number of different life history patterns from each brood year's production. Most sockeye juveniles smolt and migrate to the ocean after 12 to 15 months rearing in a freshwater lake environment. A small percentage smolt and migrate after two years of lake rearing. Adult sockeye return to spawn after 1 to 3 years of ocean life (Wydoski and Whitney 1979).

Kokanee generally reach sexual maturity at three years of age, and then die in the fall after spawning (Fies et al. 1998). Large numbers of kokanee migrate from Lake Billy Chinook into the Metolius River for spawning. A similar migration of Wickiup Reservoir Kokanee occurs annually in the short segment of the Deschutes River below Crane Prairie Dam.

Carrying Capacity

There is no estimate of the subbasin's potential sockeye salmon population. The future of this population is strictly dependent upon solving adult and juvenile fish passage problems associated with the Pelton Round Butte Complex. The composite subbasin kokanee carrying capacity has not been estimated.

Population Trend and Risk Assessment

The indigenous Deschutes River subbasin sockeye salmon population was extirpated by 1940. Currently, the only adult sockeye salmon found in the subbasin are the few fish observed at the Pelton Reregulating Dam fish trap each year. However, these fish are assumed to be out-of-basin strays or adults returning from kokanee that successfully migrated downstream through the Pelton Round Butte Complex.

Unique Population Units

The Metolius River/Suttle Lake complex sockeye salmon population, extirpated by 1940, was historically the unique sockeye salmon population within the subbasin. This population was apparently extirpated by 1940.

Life History Characteristics of Unique Populations

Historically, sockeye salmon migrated up the Metolius River and into the Lake Creek-Suttle Lake habitat complex to spawn. Spawning was likely concentrated in Link Creek (connecting Suttle and Blue lakes), however some fish may have either spawned downstream from Suttle Lake or along the shores of Suttle Lake if there was suitable habitat with upwelling spring flow through the substrate. The fecundity of sockeye females ranges up to 4,000 eggs. Eggs generally hatch in 6 to 9 weeks, depending on water temperature. The young will remain in the substrate for another 2 to 3 weeks before emerging and moving into the lake environment (Wydoski and Whitney 1979).

Some juvenile sockeye likely moved upstream to rear in Blue Lake, while others dropped downstream into Suttle Lake to rear. After the juveniles underwent the physiological transformation into smolts they began their ocean migration. Adult salmon were probably predominantly age-3 when they returned to spawn. Sockeye, like other species of Pacific Salmon, die shortly after spawning.

Estimate of Desired Future Condition for Long-term Sustainability

Re-establishment of a self-sustaining sockeye salmon population in the Metolius River/Suttle Lake habitat complex habitat is the preferred management scenario. The population would be able to withstand annual in-river harvest and still maintain adequate spawner escapement to perpetuate the population.

Distribution

Current Distribution

Today, kokanee migrate from Lake Billy Chinook each fall to spawn in the Deschutes River above Lake Billy Chinook and in the first two miles of Squaw Creek (Fies et al. 1998). Kokanee from Lake Billy Chinook also spawn in the Metolius River and tributaries.

It is also not uncommon to see kokanee salmon in the Deschutes River downstream from Wickiup Dam. The outlet of Wickiup Reservoir is unscreened and allows fish to escape when water levels are drawn down. The outlet's depth is approximately 70 feet, which rules out the use of conventional fish screening. When the reservoir drops below 40,000 acre-feet of storage and fish become concentrated in the Deschutes River channel of the reservoir, the loss of fish through the outlet increases. These are primarily kokanee and coho, fish with strong emigrational tendencies (Fies et al. 1998).

Thousands of kokanee and coho salmon, and lesser numbers of brown trout, can be lost from Wickiup Reservoir annually. Evidence of kokanee loss from the reservoir to the river has been demonstrated by trapping the fish bypass at the Central Oregon Irrigation District canal near Bend. The trap was operated during the irrigation season in 1984, 1989, and 1990. The numbers of kokanee captured in the trap were 17,367, 58,625, and 38,665 respectively (Craven 1991). Kokanee comprised 92.5% of the fish trapped during the three years, (Fies et al. 1998).

There have occasionally been large numbers of juvenile kokanee that sound and pass through the hydroelectric turbines at Round Butte Dam. Some of these fish survive and are successful in negotiating the Pelton and Pelton Reregulating Dam turbines. It appears that a few of these fish survive to migrate to the ocean and eventually return to the Pelton Fish Trap as adult sockeye salmon.

Differences in Distribution due to Human Disturbance

The historic Deschutes River subbasin sockeye salmon population was extirpated by 1940. The loss of this population was directly attributed to manmade dams on Lake Creek near the outlet of Suttle Lake (Fies et al. 1996).

Artificial Production

Current Hatchery Production

The only releases of hatchery-reared sockeye salmon within the subbasin are the annual releases of kokanee salmon into several lakes and reservoirs (Table 34). Hatchery-reared kokanee salmon are released annually into East and Paulina lakes and Crane Prairie Reservoir. Other kokanee populations associated with subbasin lakes and reservoirs are self-sustaining.

Table 34. Deschutes River Subbasin lakes and reservoirs with Kokanee Salmon populations (Data from Fies et al. 1996 and 1998).

Water Body	Population Status	First Hatchery Release	Management Program
Lake Billy Chinook	Natural	Hatchery releases into Suttle Lake	Self-sustaining
Lake Simtustus	Fall-out from Lake Billy Chinook	Fish escape from Lake Billy Chinook	
Suttle Lake	Natural	Sockeye releases in 1940's and 50's	Self-sustaining since 1973
Wickiup Reservoir	Natural	Kokanee releases from 1958 - 86	Self-sustaining since 1987
Crane Prairie Reservoir	Hatchery Stocks	First Kokanee release in 1957.	Annual stocking since 1981.
Davis Lake	Low numbers from Odell Lake	No hatchery releases	Fish drop out of Odell Lake and Odell Creek
Odell Lake	Natural	First stocking 1950	Self-sustaining since 1983
Paulina Lake	Hatchery Stocks	First stocking 1973	Annual stocking
East Lake	Hatchery Stocks	First stocking 1993	Annual stocking
Elk Lake	Natural		Self-sustaining

The Paulina Lake kokanee program has provided an annual source of high quality eggs for the Oregon kokanee program since 1978. Other states such as Idaho and Washington have also used eggs from Paulina Lake kokanee. Table 35 summarizes the kokanee egg collections at Paulina Lake for the years 1991-95 (Fies et al. 1998).

Table 35. A summary of kokanee egg collections at Paulina Lake for the years 1991-95 (Fies et al. 1998).

Year	Number females	Number eggs	Eggs/female
1991	594	689,440	1,161
1992	1,333	1,423,000	1,068
1993	1,026	1,132,536	1,104
1994	1,045	1,295,000	1,239
1995	549	838,000	1,526

Historic Production

Wallis (1960) noted that blueback (sockeye - Washington and Bonneville stock) eggs were brought in for rearing at the Metolius River Fish Hatchery and released into the Metolius system as early as 1947 (Fies et al. 1996). Hatchery sockeye were planted in Suttle Lake in the late 1940's and 1950's in the hope of rebuilding the runs (Wallis 1960). The former Metolius Hatchery (opened in 1947) released sockeye into the Metolius River and Suttle Lake from 1948 to 1961. In the 1950's, a small artificial run of sockeye and kokanee utilized Suttle Lake and its tributaries. Marked sockeye salmon were released into Suttle Lake beginning with the 1953 brood. In 1958, approximately 10,000 blueback salmon (sockeye) eggs were placed in baskets in Link Creek to evaluate survival. Survival ranged from 62 to 91% (Fies et al. 1998). ODFW stocking records for Suttle Lake show kokanee were first released in 1954 and last released in 1973.

Hatchery releases of kokanee salmon into subbasin waters have originated from a number of in-subbasin and out-of-subbasin sources. For example, kokanee stocked in Wickiup Reservoir from 1958 to 1986 were the product of blending Montana, British Columbia, and Washington stocks (Fies et al. 1998). Current kokanee released into East and Paulina lakes are reared at the Wizard Falls Fish Hatchery from eggs collected annually at the outlet of Paulina Lake (Fies et al. 1998).

Effect of Straying/Ecological Consequences

The only known straying to have occurred in recent years has been out-of-basin stray sockeye captured in the Pelton Fish Trap. These fish have reached a dead-end and have no biological impact on the subbasin since the native sockeye salmon population was extirpated. There is no evidence that the small numbers of kokanee out-migrants leaving the subbasin are straying into other subbasins.

Relationship between Natural and Artificially Produced Populations

Introductions of sockeye and kokanee salmon into Suttle Lake in the 1940’s and 50 have established a landlocked kokanee salmon population in the Lake Billy Chinook/Metolius River habitat complex. This kokanee population has essentially occupied the historic sockeye salmon spawning and freshwater rearing habitat.

Subbasin Harvest

Current Harvest

The only sockeye salmon harvest occurring within the basin is minor incidental harvest of a few individuals annually in the subsistence tribal fishery at Sherars Falls.

Kokanee provide a valuable fishery in ten subbasin lakes and reservoirs, including the former sockeye habitat in the Metolius/Suttle Lake complex. The harvest of kokanee salmon in the subbasin lakes and reservoirs attracts many recreational anglers annually. An annual comprehensive estimate of total subbasin kokanee harvest is not available.

Historic Harvest

There are no quantitative estimates of historic sockeye salmon harvest within the subbasin. Historically most of the sockeye salmon harvest likely occurred in the Tribal subsistence fishery at Sherars Falls. There may have been some minor incidental sport harvest associated with the lower Deschutes River redband trout, steelhead and Chinook salmon fishery. However, adult sockeye salmon are not readily caught on hook and line in freshwater.

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