SECTION 22 – Table of Contents

22 Spokane Subbasin Assessment – Aquatic

22.1 Species Characterization and Status[1]

Over 35 species of fish, including 20 native species, are found in the Spokane Subbasin (Table 22.1).

Table 22.1. Fish species currently present in the Spokane Subbasin

Species	Origin	Location	Status
White Sturgeon (*Acipenser transmontanus*)	N	L	D
Chiselmouth (*Acrocheilus alutaceus*)	N	L,R,T	C,S
Largescale sucker (*Catostomus catastomus*)	N	L,R,T	C,S
Bridgelip Sucker (*C. columbianus*)	N	L,R,T	C,S
Longnose sucker (*C. macrocheilus*)	N	L,R,T	C,S
Piute sculpin (*Cottus beldingi*)	N	L,R,T	U
Slimy sculpin (*C. cognatus*)	N	L,R,T	U
Torrent sculpin (*C. rhotheus*)	N	L,R,T	U
Burbot (*Lota lota*)	N	L	U
Peamouth (*Mylocheilus caurinus*)	N	L,R	C,S
Westslope cutthroat trout (*Oncorhynchus clarki lewisi*)	N	L,R,T	O,D
"Coastal" Rainbow trout (*O. mykiss*)	N	L,R,T	C
Redband trout (*O. mykiss gairdneri*)	N	R,T	O,D
Mountain whitefish (*P. williamsoni*)	N	L,R,T	U
Northern pike minnow (*Ptychocheilus oregoninsis*)	N	L,R	C,S
Longnose dace (*Rhinichthys cataractae*)	N	L,R,T	C,O,D
Speckled dace (*R. osculus*)	N	T	C
Redside shiner (*Richardsonius balteatus*)	N	L,R,T	C,S
Bull trout (*Salvelinus confluentus*)	N	L,R,T	O,D
Kokanee salmon (*Oncorhynchus nerka*)	N,E	L,R,T	C
Yellow bullhead (*Ameiurus natalis*)	E	L,R	U
Brown bullhead (*A. nebulosis*)	E	L,R	U
Lake whitefish (*Coregonus clupeaformis*)	E	L,R	C
Carp (*Cyprinus Carpio*)	E	L	U
Grass pickerel (*Esox americanus vermiculatus*)	E	R,T	O
Northern pike (*E. lucius*)	E	L	U
Tiger Musky (*E.lucius X E. masquinongy*)	E	L	C
Channel catfish (*Ictalurus punctatus*)	E	L,R	C
Green sunfish (*Lepomis cyanellus*)	E	L	A
Pumpkinseed (L. gibbosus)	E	L,T	O
Smallmouth bass (*Micropterus dolomieui*)	E	L,R	C,S
Largemouth bass (*M. salmoides*)	E	L,R	C
Yellow perch (*Perca flavescens*)	E	L,R	C
Crappie, black and white (*Pomoxis spp.*)	E	L,R	C,S
Brook trout (*Salvelinus fontinalis*)	E	R,T	C
Brown trout (*Salmo trutta*)	E	L,R,T	C
Tiger trout (*Salmo trutta X Salvelinus fontinalis*)	E	L	C
Walleye (*Sander vitreus*)	E	L	C
Tench (*Tinca tinca*)	E	L,R,T	O
E=Exotic, N=Native, L=Lake, R=River, T=Tributary, A=Abundant, C=Common, O=Occasional, U=Unknown, S=Stable, I=Increasing, D=Declining			

[1] Large portions of Section 22.1 were contributed to by the Spokane River Subbasin Summary Report (2000) pp. 4-9.

Many of the fish species hold important economic, aesthetic, cultural, recreational, and ecological value to the region. Based on these values, five species (redband trout, mountain whitefish, kokanee salmon, Chinook salmon, largemouth bass) were selected as focal species and are discussed in more detail in sections 22.2 to 22.7.

22.1.1 Anadromous Fishes

Historically, the Spokane River was famous as a recreational and subsistence fishery for both anadromous and resident salmonids (Stone 1883; Gilbert and Evermann 1895; Scholz et al. 1985). The STOI harvested various anadromous species such as Chinook salmon, sockeye salmon, coho salmon, and steelhead on the Columbia River (now part of Lake Roosevelt) up to Kettle Falls (Scholz et al. 1985). Along the Spokane River from the mouth up to Spokane Falls, Chinook salmon, sockeye salmon, and steelhead were the primary anadromous species the STOI harvested (Scholz et al. 1985). Salmon and steelhead were also harvested in Little Spokane River and its tributaries, Chamokane Creek below Tshimikain Falls and Hangman Creek at a fishing site about 10 miles upstream of the confluence with the Spokane River (Scholz et al. 1985). Sockeye salmon historically migrated up the east branch of the Little Spokane River to Chain Lakes, which consists of three small lakes with a total area of 100-surface acres (unpublished WDFW 1956). Additionally, the Coeur d’ Alene Tribe historically operated fish traps along the Spokane River from Spokane Falls upstream to the outlet at Coeur d' Alene Lake suggesting anadromous fish were capable of migrating past Spokane Falls (Coeur d’ Alene Tribal Elder, personal communication).

Prior to the construction of dams, the natural barriers preventing upstream migration of anadromous salmonids in the Spokane Subbasin were Spokane Falls (RM 74) on the mainstem and Tshimikain Falls on Chamokane Creek, a tributary to the mainstem. However, evidence suggests salmon or steelhead may have passed Spokane Falls in high flow years (Scholz, EWU, personal communication). In 1908, Nine Mile Dam (RM 58.1) was built blocking anadromous species upstream migration to Hangman Creek and middle reaches of the Spokane River. After the construction of Little Falls Dam (RM 29) in 1911, migratory fishes (anadromous and resident salmonids) were blocked from the upper reaches of the Spokane River and its tributaries including Chamokane Creek (RM 32.5), Little Spokane River (RM 56.3), and Hangman Creek (RM 72.4) (Scholz et al. 1985). Additionally, after the construction of Grand Coulee Dam (1939) on the Columbia River, anadromous stocks were blocked and extirpated from the remainder of the lower Spokane River system.

22.1.2 Spokane River

Historically, the fish assemblage below Spokane Falls in the Spokane River comprised of anadromous salmonids (Chinook salmon, steelhead, sockeye salmon) and resident fishes (largescale sucker, northern pikeminow, redside shiner, resident trout, mountain whitefish). Resident fishes were also prevalent above Spokane Falls (Gilbert and Evermann 1895). The native salmonid assemblage included bull trout, mountain whitefish, redband trout, and westslope cutthroat trout (Scholz et al. 1985). Behnke (1992) suggests areas historically accessible to steelhead, at least to Spokane Falls, likely had resident redband trout populations associated with them.

As previously mentioned, Nine Mile Dam (1908) and Little Falls Dam (1911) prevented anadromous and resident salmonid migration to the upper reaches of the Spokane River while Grand Coulee Dam prevented migration of anadromous stocks to the entire Subbasin. In addition to these man-made fish barriers, six other dams upstream of Little Falls Dam were constructed on the Spokane River with no fish passage facilities, creating a highly fragmented river with both free-flowing and reservoir habitat types. These dams are discussed in Section 21 Spokane Subbasin Overview.

As a result of species introductions and physical alterations to the environment over time, the overall fish assemblage in the Spokane River has shifted. Currently, nonnative species well adapted or more tolerant to warm water conditions such as largemouth bass, yellow perch, tench, brown trout, and others listed as exotic species in Table 22.1 are more abundant than native species in reservoir type habitats within the Spokane River. Data also suggest white sturgeon are present in the Spokane River based on one captured individual (Scholz, EWU and Peck, WDFW, personal communication).

Historical analysis suggests bull trout were present at low densities and current data suggests that they are undetectable in the Subbasin (Scholz, EWU, personal communication). Recent observations of bull trout below Little Falls Dam have been of individual fish most likely entrained down the Spokane River, most likely originating upstream from Coeur d' Alene Lake and its tributaries (Scholz, EWU, personal communication). Bull trout occur in the upstream Subbasin (Coeur d' Alene), but are at depressed levels (Scholz et al. 1985). Bull trout are also incidentally noted downstream in Lake Roosevelt, but are likely dropouts from tributaries.

Compared to the extremely low numbers of westslope cutthroat trout in the Spokane River below Post Falls Dam, westslope cutthroat trout are relatively abundant upstream of the dam in Idaho. Poor habitat quality due to unfavorable thermal conditions and flow regimes coupled with species competition has most likely limited the persistence of westlsope cutthroat trout in the mainstem Spokane River (C. Donley, Fisheries Biologist WDFW, personal communication, 2004).

Based on cutthroat trout supplementation history, the existing westslope cutthroat trout populations within the Spokane River between Post Falls and Spokane Falls are likely the remnant population of the native stock. There are no supplementation projects currently in operation for cutthroat trout in the upper Spokane River (C. Donley, Fisheries Biologist WDFW, personal communication, 2003). At this time there is no genetic data available for these cutthroat trout populations, however, genetic inventories are presently underway as a component of the Joint Stock Assessment Program (JSAP) (C. Donley, Fisheries Biologist WDFW, personal communication, 2003).

Information on other native and nonnative species present in the mainstem of the Spokane River (> 170 km in length) is limited. The most recent resident fish surveys available were conducted by WDFW in 2002 (Connor et al. 2003b) and 2003 (memo from McLellan, WDFW, 2004) and focused on the middle Spokane River, a 25.6 km (16 mi) reach between Nine Mile and Monroe Street dams (Connor et al. 2003b). The surveyed reach included both free-flowing and reservoir habitats. In the free-flowing section seven species were captured, which was less than half the number of species (15) captured in Nine Mile Reservoir (Table 22.2, Connor et al. 2003b). In the free-flowing section, all species identified were native, while almost half of the species in the reservoir were nonnative. All species present in the free-flowing section with the exception of longnose dace were present in the reservoir (Connor et al. 2003b).

Table 22.2. Fish species captured in free-flowing and reservoir habitat within the middle Spokane River during the 2002 WDFW survey

Species	Free-flowing	Reservoir
Longnose dace	X	
Rainbow Trout	X	X
Mountain Whitefish	X	X
Northern Pikeminnow	X	X
Redside Shiner	X	X
Bridgelip sucker	X	X
Largescale sucker	X	X
Brown Trout		X
Chinook Salmon		X
Chiselmouth		X
Black Crappie		X
Pumpkinseed		X
Largemouth bass		X
Brown bullhead		X
Yellow perch		X
Sculpin spp.		X

(***Source:*** Connor et al. 2003b)

In 2003 (April to July) WDFW surveyed one free-flowing section in the upper Spokane River above Spokane Falls between RM 92.7 to RM 96.1 and a second section in the middle Spokane River above Nine Mile Reservoir between RM 65.7 and RM 74 (memo from McLellan 2004). In the upper Spokane River, four salmonid species (brown trout, Chinook salmon, cutthroat trout, rainbow trout) were sampled along with northern pikeminow and largescale sucker. Largescale sucker (71.2 percent) and northern pikeminnow (17.6 percent) were the most common fish caught between April and May 2003 in the upper Spokane River. In the middle Spokane River, four salmonid species (brown trout, cutthroat trout, rainbow trout, mountain whitefish) were identified along with four cyprinidae (minnows), two catostomidae (suckers), and sculpin. In contrast to the upper Spokane River, bridgelip sucker (44.8 percent), mountain whitefish (29.7 percent), and rainbow trout (13.3 percent) were the most common species caught in the middle Spokane River between May and July 2003.

Current information on the fish assemblage in the Spokane Arm and for other lakes and reservoirs are discussed in sections 22.1.5 and 22.1.6, respectively.

22.1.3 Little Spokane River

Downstream dams on the Spokane and Columbia rivers have altered the historic fish community and dynamics in the Little Spokane River drainage. Information about historic distribution, abundance, and stock composition of native resident salmonids is limited (Council 2000). Native salmonids known and suspected to have inhabited the Little Spokane River drainage historically included Chinook salmon, steelhead, sockeye salmon, kokanee salmon, redband trout, westslope cutthroat trout, and mountain whitefish. The current fish assemblage (Table 22.3) in the Little Spokane River drainage consists of 33 species (Connor et al. 2003a, 2003b), both native and nonnative. Of the species listed in Table 22.3, kokanee, redband/rainbow trout, mountain whitefish, and largemouth bass are focal species and discussed within sections 22.2 to 22.7.

Table 22.3. Fish species identified in 2001 and 2002 WDFW resident fish surveys in the Little Spokane River drainage. Fish species are indicated as present in Little Spokane River, its tributaries, and/or lakes with an X.

Species	Little Spokane River	Tributaries	Lakes
Brown trout	X	X	X
Eastern brook trout	X	X	X
Kokanee Salmon	X	X	X
Rainbow Trout	X	X	X
Redband Trout		X	
Mountain Whitefish	X	X	X
Pygmy Whitefish	X		X
Grass pickerel	X	X	X
Carp	X		
Chiselmouth	X		X
Longnose dace	X	X	
Northern pikeminnow	X	X	X
Redside Shiner	X	X	X
Speckled dace	X	X	
Tench	X		X
Sucker spp. (3 spp.)	X	X	X
Black crappie	X		X
Bluegill	X		X
Green Sunfish		X	X
Largemouth Bass	X		X
Smallmouth Bass			X
Pumpkinseed	X		X
Yellow perch	X		X
Bullhead spp. (3 spp.)	X		X
Sculpin spp. (4 spp.)	X	X	

(*Source*: Connor et al. 2003a, 2003b)

22.1.4 Hangman Creek Watershed

In general, there is little documentation describing the historical distribution of salmonids or habitat conditions within the Hangman Creek watershed (Peters et al. 2003). Few fish surveys have been conducted over the last 105 years (Edelen and Allen 1998). Although Hangman Creek is not thought to have been a major producer of salmon such as the Little Spokane River and Spokane River (Scholz et al. 1985), historical records indicate

Chinook salmon migrated up Hangman Creek as far as Tekoa, Washington (Scholz et al. 1985).

Currently available information regarding the fish assemblage in the Hangman Creek drainage is isolated to the area within the boundaries of Idaho. In 2002, the Coeur d' Alene Tribe and Idaho Department of Environmental Quality (IDEQ) conducted fish surveys and water quality assessments (Peters et al. 2003). There were seven fish species observed in the 2002 survey including rainbow trout, cutthroat trout, rainbow/cutthroat hybrid, speckled dace, redside shiner, longnose sucker, and sculpin (Peters et al. 2003).

Presence of rainbow trout, cutthroat trout, and non-salmonids in the 2002 stream surveys (Peters et al. 2003) are indicated in Table 22.4. There were a total of 89 salmonids sampled, 52 rainbow, 36 cutthroat trout, and one hybrid (in lower Nehchen Creek). Cutthroat trout were most abundant (n=35) in Nehchen Creek and rainbow trout were most abundant in South Fork Hangman (n=19) (Peters et al. 2003).

Table 22.4. Creeks surveyed in 2002 and presence (indicated by X) of rainbow, cutthroat, and non-salmonids

Creek Name	Rainbow Trout	Cutthroat Trout	Non-Salmonids
North Fork Rock			X
Tensed			
Lolo			
Moctilime			X
Smith			X
Mineral			X
Rose			X
Hangman	X		X
Mission	X	X	
Sheep	X		X
Nehchen*	X	X	X
Indian	X		
Bunnel	X		
South Fork Hangman	X		X
*Formerly called Squaw Creek, one rainbow/cutthroat hybrid observed.			

(*Source*: Peters et al. 2003)

Distribution of salmonids appears to be in decline in the last ten years (Peters et al. 2003). In 2002, salmonids were detected in Mission, Sheep, Nehchen, Indian, Bunnel, Hangman, and South Fork Hangman creeks and densities of rainbow trout were low whereas ten years ago salmonids were also observed in Tensed, Smith, and Mineral creeks (Peters et al. 2003).

The 2002 survey conducted by Peters et al (2003) shows fish species composition in the upper Hangman Creek drainage varies depending on the surrounding land use practices (refer to Section 21, Figure 21.13 for map illustrating vegetation type and land use in the Spokane Subbasin). Salmonids tended to be present in conifer dominated areas or less impacted habitat areas in the upper reaches. No salmonids were found in stream reaches surrounded by agricultural land such as Lolo, Tensed, and Moctileme creeks. Distribution and abundance of trout are most likely limited in the upper Hangman Creek drainage as a result of degraded habitat conditions negatively impacting water quality conditions such as total suspended solids, low dissolved oxygen, and high temperatures (Peters et al. 2003). Water quality conditions are discussed in more detail in Section 22.8 Environmental Conditions and Section 22.9 Limiting Factors and Conditions.

22.1.5 Spokane Arm of Lake Roosevelt

The Spokane River contributes the second largest amount of discharge to Lake Roosevelt. The other major tributaries to Lake Roosevelt include Colville River, Kettle River, and San Poil River. The Spokane Arm, the lower reach of the Spokane River below Little Falls Dam, can be described as a low gradient channel where fine sediments accumulate and where numerous backwater habitats exist (Munn and Short 1997).

Historic fish assemblage in the Spokane Arm would most likely have been similar to the Upper Columbia River and Spokane River upstream to Spokane Falls. The current fish assemblage has been significantly altered as a consequence of Grand Coulee Dam. Grand Coulee Dam has resulted in the inundation of the Spokane Arm and eradication of anadromous salmonids and Pacific lamprey (since no fish passage facility exists). .

In general there are eight families of fish known to be present in the Spokane including Cyprinidae, Catostomidae, Ictaluridae, Salmonidae, Gadidae, Cottidae, Centrarchidae, and Percidae (Thatcher et al. 1992; STOI unpublished data). Acipenseridae are also known to be present in Lake Roosevelt, and are most likely present in the Spokane Arm as well (Lee et al. 2003). Fisheries surveys have been conducted on Lake Roosevelt from 1990 to the present via electrofishing and gill nets (Deanne Pavlik, personal communication). In 2000, 1,685 fish were captured throughout Lake Roosevelt. The majority of the fish assemblage collected was comprised of walleye (28 percent), largescale sucker (15 percent), rainbow trout (14 percent), lake whitefish (10 percent), smallmouth bass (8 percent), and longnose sucker (5 percent) (Lee et al. 2003).

As expected fish assemblage in the Spokane Arm is similar to Lake Roosevelt. Largescale sucker, lake whitefish, rainbow trout, kokanee, brown trout, smallmouth bass, yellow perch, and walleye have been collected every year from 1993-2001, and on average, represent the most abundant species found in the Spokane Arm (STOI unpublished data). The relative abundance of walleye captured between 1993 and 2001 peaked in 1998, then decreased (STOI unpublished data). Increases in walleye relative abundance in the Spokane Arm are expected due to the large number of walleye known to spawn there (Baldwin et al. 2003). Smallmouth bass have shown a general decrease in abundance between 1993 and 2001, with only a slight increase in relative abundance in recent years (STOI unpublished data). Rainbow trout relative abundance has increased slightly in recent years. The population is likely rebuilding following the 1997 high water year where large numbers of tagged rainbow trout were found to have entrained through Grand Coulee Dam (Lee et al. 2003; STOI unpublished data). Alternately, relative abundance of kokanee salmon, largescale sucker and brown trout did not show pronounced trends towards increasing or decreasing abundance between 1993-2001, but rather fluctuated between 3.4-20.3 percent, 1.0-15.8 percent, and 0.9-7.4 percent respectively (STOI unpublished data). Burbot are also present in the Spokane Arm. They have been consistently collected during fish surveys since 1994 with relative abundance ranging from 1.4 percent in 1996 and 2001 to 4.7 percent in 1998. The principal sport fish present in the Spokane Arm include walleye, rainbow trout, kokanee salmon, yellow perch, and smallmouth bass (McDowell and Griffith 1993, as cited in Munn and Short 1997). Black crappie, brown trout, mountain whitefish, and brook trout are present in lower numbers (STOI unpublished data).

In the early 1980s elevated levels of trace elements were found in fish in the lower region of Lake Roosevelt. Studies have confirmed elevated concentrations of arsenic, cadmium, copper, lead, zinc, and mercury in the sediments of Lake Roosevelt and elevated mercury levels in walleye, smallmouth bass, and rainbow trout (Munn and Short 1997). However mercury concentrations in fish tissue do not appear to correspond to spatial differences of mercury concentrations in surficial sediments (Munn and Short 1997). Consumption advisories have been issued for all fish in Lake Roosevelt, including the Spokane Arm.

Refer to Thatcher et al. (1992), Lee et al. (2003), Scofield et al. (2004), and the Upper Columbia Section 30 for further discussion regarding fish species in Lake Roosevelt, of which the Spokane Arm is part. Physical and chemical characteristics of the Spokane Arm are discussed in Section 22.8 Environmental Conditions under the subheading Spokane Arm.

22.1.6 Lakes and Reservoirs

Many of the lakes within the Subbasin are hydrologically isolated from the Spokane River and tributaries. Limited information exists about the historical fish assemblages of these natural lakes, it could be speculated that most of these bodies of water contained native cyprinid (minnows) and catostomid (sucker) populations (C. Donley, Fisheries Biologist WDFW, personal communication, 2003). Lakes hydrologically connected to the Spokane River drainage had species assemblages similar to the isolated lakes with the exception that native salmonids were also present given the fact a multitude of migratory native salmonid stocks were present historically in the Subbasin (Scholz et al. 1985). Lake habitats could have been critical rearing areas for migratory salmonid populations. WDFW historical records indicate that there was a run of sockeye salmon in the Little Spokane River that spawned and reared within Chain lakes (unpublished WFDW 1956). The remainder of lakes within the Little Spokane River drainage would have been available habitat to migratory fish, but there is no information indicating their presence.

Most of the lakes within the Subbasin have been hydrologically altered; water has been routed for hydropower production, irrigation or other uses, completely altering the hydrologic regime. The manipulation of these lake basins and the connection of isolated waters, in conjunction with historical fish stocking activities, have lead to the introduction of multiple nonnative fish species (Table 22.1). Most of the lakes within the Subbasin contain warmwater fish species. The most popular of which are largemouth bass, smallmouth bass, and bluegill sunfish.

There is one major reservoir on the Spokane River, Lake Spokane. Lake Spokane is impounded by Long Lake Dam and is managed by WDFW as a warmwater and coldwater fishery. WDFW has stocked the lake with nonnative salmonids such as rainbow trout, brown trout, and eastern brook trout since 1974 (Connor et al. 2003b). Sampling data from the past 20 years show yellow perch as the most abundant game fish (Osborne et al. 2003). Non-game native species such as northern pikeminnow, largescale sucker, and chiselmouth chub are also in high abundance (Osborne et al. 2003).

There are numerous small privately owned reservoirs, lakes and ponds established within the Spokane Subbasin. Some of these small bodies of water act as fish barriers and support multiple non-game fish species. WDFW does not actively manage these bodies of water, but does inherit fish species through entrainment into waters of the state of Washington. WDFW requires permitting in private waters to allow for fish stocking and is restricting the stocking of sexually viable trout and warmwater fish in hydrologically connected waters. As a result, these bodies of water could be a major impediment to native species enhancement, restoration and ultimately recovery.

There are three major inland lakes within the Spokane Indian Reservation that support fisheries. These are natural, eutrophic lakes that are not directly connected to larger streams or rivers. These lakes support salmonid fisheries that co-exist with warmwater species such as largemouth bass and pumpkinseed. Preference of Spokane Tribal members is to catch and consume salmonid species. Although the lakes suffer from high temperature and low dissolved oxygen, they are stocked with salmonids with the goal to provide an adequate consumptive fishery for tribal members.

The natural lakes and reservoirs in the Spokane Subbasin are important resources for sport fishing. Annual fish stocking within the Spokane Subbasin accounts for an average of 652,500 rainbow, cutthroat, brown, and brook trout (Peck, WDFW, personal communication). Sport fishing and the current management tactics within the Subbasin are critical parts of the local economy. The stocking creates popular sport fisheries with annual economic value estimated between 4 and 5 million dollars. Fish stocking efforts that create genetic problems or competition issues have been suspended, or are under review for modification.

Within the Spokane Subbasin there are eleven lakes that are actively managed by the WDFW (Table 22.5). Four management strategies are applied to these lakes: (1) Trout only opening day lowland lake, (2) Mixed species opening day lowland lakes, (3) Mixed species year-round lowland lakes, and (4) Warmwater Fisheries year-round lowland lakes. Additionally, there are lakes with special rules intended for resource protection. The rules for all WDFW lakes within the Spokane Subbasin are available in the annually published WDFW " Fishing Rules" pamphlet (Available 1/2004: http://wdfw.wa.gov/fish/regs/fishregs.htm).

Trout only opening day lowland lake lakes are managed as put-and-take fisheries. These lakes are stocked with high density trout populations, and are managed as harvest driven fisheries. Stocking densities are adjusted based on lake size and productivity, fish species, and size of fish available for stocking. Stocking densities range from 200 to 600 fish per surface acre. Rotenone is used to maintain the trout only single species management strategy; lakes in the program are treated every 7 to 10 years with rotenone.

Opening day mixed species lakes are waters stocked with trout to provide for moderate catch rate trout fisheries. Stocking densities vary from 75 to 200 fish per surface acre based on lake size and productivity, species composition of the lake and the size of fish available for stocking. These lakes are also managed to provide for moderate harvest of self-sustaining warmwater fish populations. Because of the presence of warmwater fish populations, these lakes provide a protracted fishery opportunity as opposed to the aforementioned trout only lakes.

Mixed species year-round lowland lakes are stocked with a limited amount of trout, 10 to 100 fish per surface acre. The objective is to provide for a trout fishery having modest catch rates of larger trout. Some of these lakes can produce trout of trophy proportions. These lakes are also managed to provide for harvest of self-sustaining warmwater fish populations. The warmwater fisheries in these lakes are targeted on panfish or large predator fish harvest depending on the lake type, productivity and the species that are most productive in the available habitat.

Warmwater only lakes are managed for harvest of self-sustaining warmwater fish species. There may be limited trout stocking to provide fishery potential during periods of time when warmwater fish are not available to the fishery. Stocking densities are on the order of less than 10 fish per surface acre.

Lakes managed using the above strategies are extremely popular with sport fisherman and are economically important to WDFW, the State of Washington and surrounding communities. Lowland lake fishing as a whole generates millions of angler days annually for the State of Washington, and opening day fisheries are billed as the largest single fishing season opener in the State of Washington. There are an estimated 300,000 anglers statewide that participate in just the opening day lowland lake fisheries.

Table 22.5. List of lakes in the Spokane Subbasin and associated management strategy

Lake Name	Management Strategy
Fish Lake*	Trout only opening day lowland lake
Liberty Lake*	Mixed species opening day lowland lakes
Newman Lake*	Warmwater Fisheries year-round lowland lakes
Horseshoe Lake (Spokane County)*	Mixed species year-round lowland lakes
Horseshoe Lake (Pend Oreille County)*	Mixed species opening day lowland lakes
Bear Lake*	Mixed species opening day lowland lakes
Eloika Lake*	Warmwater Fisheries year-round lowland lakes
Fan Lake*	Mixed species opening day lowland lakes
Diamond Lake*	Mixed species opening day lowland lakes
Chain Lake*	Mixed species opening day lowland lakes
Sacheen Lake*	Mixed species opening day lowland lakes

*Special rules apply for management of individual species. (Washington regulations available: https://fortress.wa.gov/dfw/erules/efishrules/index.jsp)

22.1.6.1 Little Falls Pool

The body of water between Little Falls Dam and Long Lake Dam is considered the Little Falls Pool. There are two major tributaries entering into the Spokane River within this reach: Chamokane Creek and Little Chamokane Creek. There are two large irrigation pump stations located within this reach to irrigate the Huteritarian lands to the south and the Little Falls Flats on the Spokane Indian Reservation.

The STOI does not actively manage the fisheries due to a combination of poor water quality and access. There are no general public or tribal boat ramps for this section of the river. The Avista Corporation conducted the first known fish sampling event using gill nets in the 1980s. The gill net results were similar to the fish assemblage collected in 2003 (Scholz, EWU, personal communication). Little Falls Pool has been electrofished twice by Eastern Washington University (EWU) in cooperation with the STOI although no reports were produced from the data collected. Scholz reported sampling northern pikeminnow, largemouth bass, kokanee, rainbow, and brown trout in 1992 (EWU data unpublished). In 2003, EWU and Tribal personnel conducted the latest fishery sampling effort of the littoral habitats. Several families of fish were identified including Catostomidae (suckers), Cyprinidae (minnows), Percidae (perch), and Centrarchidae (bass). There are no Tribal limits or regulations although the State of Washington combines it into its general regulations of the Spokane River. As the capabilities of the Spokane Tribal Department of Natural Resources grow, they are seeking to actively manage Little Falls Pool as a salmonid fishery.

22.2 Focal Species Selection

The focal species selected in the Spokane Subbasin are ecologically significant based on their utilization of the multitude of diverse habitats present in the Subbasin. Additionally, the focal species have cultural and recreational value. The selection criteria for the focal species are specifically discussed in Section 3. The focal species selected for the Spokane Subbasin include redband/rainbow trout, mountain whitefish, kokanee, largemouth bass, and Chinook salmon.

22.3 Focal Species – Redband/Rainbow Trout

22.3.1 Historic Status

Redband trout are a subspecies of rainbow trout with populations historically present in areas of the Columbia River basin, east of the Cascades. The genetic profile of native redband trout populations in the Spokane Subbasin has not been described entirely, and the historical distribution and abundance of native redband trout in the Spokane Subbasin is somewhat mysterious due to the complex distribution of both coastal and inland forms (Behnke 1992). Behnke (1992) suggests areas historically accessible to steelhead, at least to Spokane Falls, likely had resident redband trout populations associated with them.

22.3.2 Current Status

Currently, redband/rainbow trout are present, or suspected to exist throughout the Spokane Subbasin (Spokane Arm, Spokane River, Little Spokane River drainage, Hangman Creek drainage). However historical references are not available for comparison with current redband/rainbow trout distribution and abundance. The degree of introgression of coastal rainbow and resident redband trout is currently unknown for the entire Subbasin. In general, introgression is likely to be extensive throughout the Subbasin given the stocking practices in the twentieth century. WDFW stocked rainbow trout in the Spokane River and Little Spokane River for multiple years from 1933 to 2002 (tables 22.6 and 22.7) (Connor et al. 2003b). Stocking also occurs in the Spokane Arm with net pens and hatcheries.

Genetic testing to differentiate coastal rainbow trout from native redband trout has been conducted in the Little Spokane River drainage (WDFW) and is in the planning stages by fisheries managers for other drainages. WDFW has found four native redband populations in the Little Spokane Drainage (Table 22.7, Figure 22.1) (Connor et al. 2003b). The Coeur d'Alene Tribe has captured fish expressing phenotypic characteristics of redband trout in several streams in the upper reaches of the Hangman Creek watershed and intends to conduct DNA analysis to determine whether these fish originated from pure redband stock or are of a mixed origin (Figure 22.1) (Peters et al. 2003). Additionally, native rainbow trout, presumably redband trout, are also present in the Blue and Chamokane creeks (Figure 22.1, Scholz et al. 1988; Crossley, Fisheries Biologist, STOI, personal communication, 2004). In early May 2004, a collaborative effort among the Coeur d' Alene Tribe, WDFW, and Spokane County Conservation District (SCCD) will conduct a genetics study to determine the genetic profile of the rainbow trout population in Hangman Creek and its tributaries (Marshall Creek, California Creek, and Rock Creek) (BPA Project # 2001-032-00).

Many information gaps exist regarding redband/rainbow trout within the Spokane Subbasin. At this time, the carrying capacity and potential productivity for redband/rainbow trout populations are not known. Low flow, habitat degradation, and pollutants may be limiting the rainbow trout populations in the Spokane Subbasin (for more information on low flows in the Spokane and Little Spokane rivers refer to Section 22.8). A better understanding of where current populations are and their status, as well as where genetically distinct populations originated is needed to manage, conserve, and protect native redband trout.

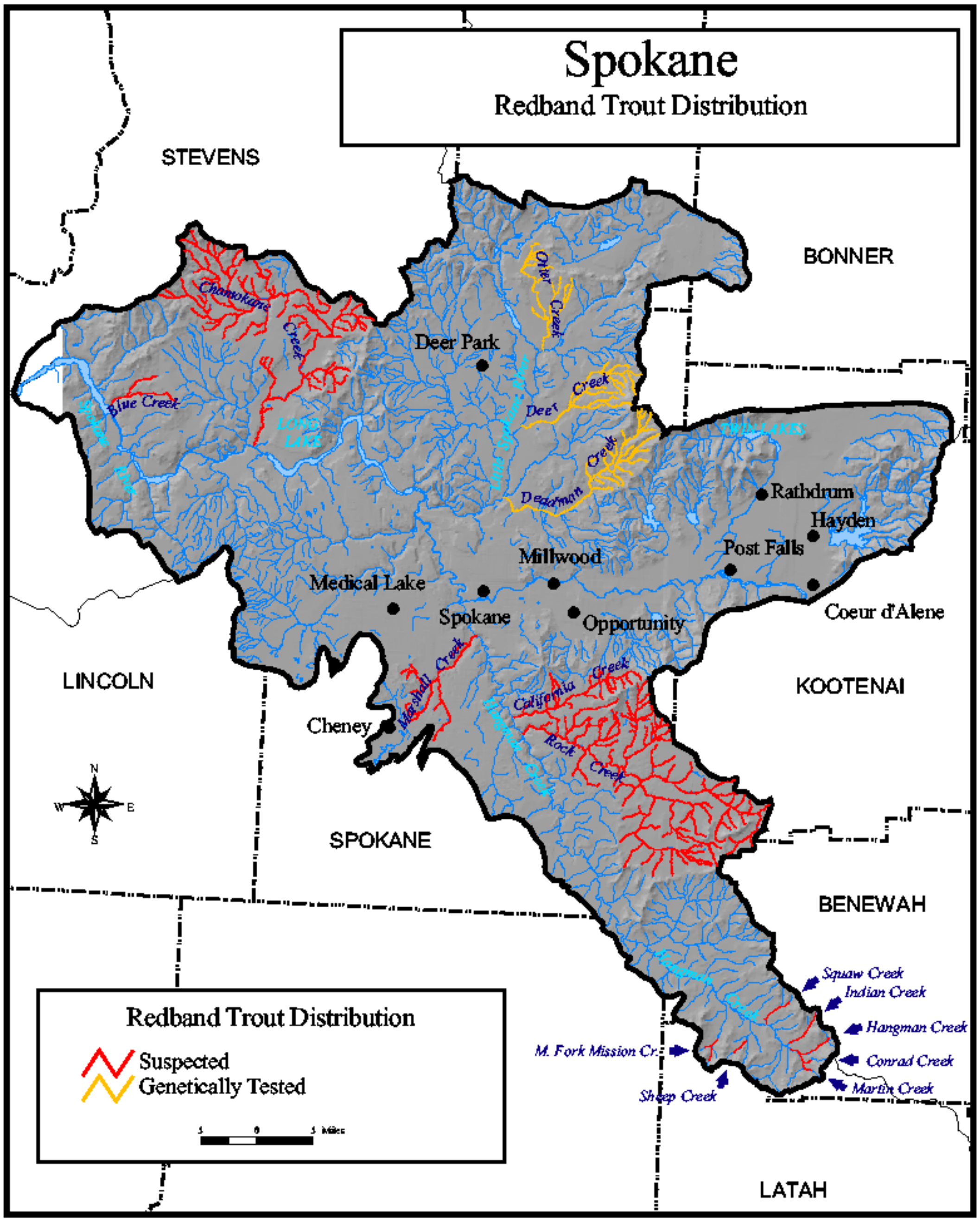


Figure 22.1. Genetically tested redband trout in Little Spokane River drainage and suspected redband trout in the Hangman Creek drainage, Chamokane Creek, and Blue Creek within the Spokane Subbasin. Other streams have not been genetically tested and/or are not suspected to have "pure" redband trout due to extensive stocking of "coastal" rainbow trout.

Table 22.6. Distribution of rainbow trout in the Spokane River indicating the genetic structure as redband, coastal, introgressed, or unknown

			Genetic Structure				
Water	**Dates Stocked**	**Genetics Tested**	**Redband**	**Coastal**	**Introgression (redband X coastal)**	**Mixed Stocks (Spokane-McCloud R. CA, Phalon Lake)**	**Unknown**
Spokane River							
Lower Spokane River (below Nine Mile Dam)	No data available						X
Middle Spokane River (Nine Mile Dam to Spokane Falls)	1934-2002	Y				X	
Upper Spokane River (above Spokane Falls)	No data available						X

(*Source*: Connor et al. 2003b)

Table 22.7. Distribution of rainbow trout in the Little Spokane River drainage indicating the genetic structure as redband, coastal, introgressed, or unknown

			Genetic Structure			
Water	**Dates Stocked**	**Genetics Tested**	**Redband**	**Coastal**	**Introgression (redband X coastal)**	**Unknown**
Little Spokane River	1933-2001					X
Tributaries of the Little Spokane River						
Bear Creek	1936-1939					X
Beaver Creek	1944-1947					X
Buck Creek	1941-1947	Y		X		
Dartford Creek						X
Deadman Creek	1934-1955	Y	X			
Deer Creek	1936	Y	X			
Dragoon Creek drainage	1934-1985	Y			X	
Dry Creek	1936					X
Little Deep Creek						X
Little Deer Creek		Y	X			
East Branch Little Spokane River	1938, 1939					
Mud Creek	1974, 1977, 1978					
Otter Creek	1936	Y	X			
Spring Creek	1951-1956					X
Spring Heel Creek	1940, 1947, 1948					
West Branch Little Spokane River	1939					X
Wethey Creek	1939-1944					X

Water	Dates Stocked	Genetics Tested	Genetic Structure			
			Redband	Coastal	Introgression (redband X coastal)	Unknown
Lakes in the Little Spokane River Drainage						
Chain Lakes	1940-1944					X
Diamond Lake	1933-2001					X
Trout Lake	1941-1972					X
Sacheen Lake	1939-2001					
Horseshoe Lake	1989-2001					X
Eloika Lake						X
Fan Lake	1941-2001					X

(*Source*: Connor et al. 2003a, Connor et al. 2003b, WDFW 2003 memo)

The remaining discussion on the current status of redband/rainbow trout is separated by three geographic locations: (1) Spokane River, (2) Little Spokane River, and (3) Hangman Creek. No data was available describing redband/rainbow trout populations specifically in the Spokane Arm. For information most relevant to this region, refer to Upper Columbia Subbasin Section 30.4 on rainbow/redband trout in Lake Roosevelt of which the Spokane Arm is part.

22.3.2.1 Spokane River

Between 1948 and 1987, the State of Washington stocked the Spokane River with more than one million rainbow trout (of presumably coastal genetic origin) to develop and maintain a resident salmonid fishery (Avista 2002). The State of Washington continued to stock 65,000-75,000 two- to three-inch rainbow trout into the lower Spokane River between 1995 and 1997 (Avista 2002). Since 1995, the Avista Corporation has also stocked eight- to ten-inch rainbow trout upstream and downstream of Monroe Street Dam with an estimated 2,000 and 5,000 fish, respectively (Avista 2002). As of 2002, all stocking of trout in the Spokane River has been reduced, by agreement between Avista and WDFW, to 2500 triploid fish annually. These fish are stocked in the impounded portions of the river (for example, Riverfront Park/Monroe Street Dam, Nine Mile Reservoir), and are mitigation for Avista hydropower operations. Current stocking strategies are intended to eliminate genetic introgression between hatchery rainbow and native redband trout. Additionally, the Spokane Arm is stocked with rainbow trout and kokanee through direct releases and via the Lake Roosevelt net pen program (Lee et al. 2003).

The following describes rainbow trout populations in the lower (Spokane Arm), middle (above Nine Mile Dam), upper (above Spokane Falls) reaches of the Spokane River.

STOI has collected several years of data on rainbow trout in Lake Roosevelt including the Spokane Arm. Between 1993 and 2001, a total of 924 rainbow trout were collected via electrofishing and gill netting in the Spokane Arm (STOI unpublished data). Relative abundance of rainbow trout was highest in 1994 (17.4 percent, n = 393), and lowest in 1997 (0.9 percent, n = 3; STOI unpublished data). Low numbers of rainbow trout collected in 1997 have been attributed to the very high flows observed in 1997 that contributed to large numbers of rainbow trout being entrained through Grand Coulee Dam (Cichosz et al. 1999). Between 1997 and 2000, the condition factor (K_{TL}) for hatchery and wild rainbow trout collected from Lake Roosevelt were similar to the condition factor of rainbow trout in other hatchery supplemented northwest lakes (Table 22.8) (McLellan 2000; Taylor 2000; Scholz et al. 1988).

Table 22.8. Comparison of rainbow trout condition factor (K) of fish collected in Lake Roosevelt (FDR) since 1997, and from other lakes and reservoirs in eastern Washington

	Hatchery		Wild	
Species and Location	**n**	**K_{TL}**	**n**	**K_{TL}**
FDR 1997	50	1.30 ± 0.24	31	1.16 ± 0.24
FDR 1998	154	1.39 ± 0.25	50	1.25 ± 0.30
FDR 1999	59	1.13 ± 0.27	20	1.00 ± 0.25
FDR 2000	132	1.13 ± 0.29	26	0.98 ± 0.24
Rock Lake, WA[1]	266	0.98 ± 0.2		
Sprague Lake, WA[2]	86	1.14 ± 0.16		
Deer Lake, WA[3]	--	1.07 ± ----		

(*Sources*: [1] McLellan 2000, [2] Taylor 2000, [3] Scholz et al. 1988a)

In 2002, WDFW conducted a fish survey on the middle Spokane River from Spokane Falls downstream to Nine Mile Dam (Connor et al. 2003b). Rainbow trout were the most abundant fish species in Nine Mile reservoir and in the free-flowing section of the middle Spokane River along with mountain whitefish. In the free-flowing section, rainbow trout represented about 12 percent of the total fish captured and about 89 percent of the rainbow trout were identified as wild (Connor et al. 2003b). In the reservoir, rainbow trout represented about 8 percent of the total fish captured and about 23 percent of the rainbow trout were identified as wild (Connor et al. 2003b). The age of wild rainbow trout in the free-flowing section ranged between 1 and 3 years, and in the reservoir ranged between 0 and 4 years (Connor et al. 2003b). In both habitat types growth based on relative weight (W_r) of rainbow trout was considered good although below the national standard of 100 (free-flowing $W_r = 88 \pm 11$, reservoir $W_r = 87 \pm 9$) (Connor et al. 2003b). The condition factor (free-flowing $K_{TL} = 0.96 \pm 0.11$, reservoir $K_{TL} = 0.95 \pm 0.09$) was comparable to other northwest rivers and reservoirs ($K_{TL} = 0.93 – 1.22$) (Connor et al. 2003b). No population estimates were provided in this study. Genetics data were also collected in the middle reach of the Spokane River. Results found rainbow trout represented multiple stocks of fish and could not be grouped solely within any of the previously tested rainbow stocks present in the Subbasin (Table 22.6) (Connor et al. 2003b). Additional genetic investigation will be conducted to determine the genetic contribution of each stock within the Subbasin to the middle Spokane River metapopulation.

Results from a 2003 WDFW fish survey conducted in the free-flowing middle and upper reaches in the Spokane River found rainbow comprised an aggregate total of 9 percent and 13 percent of the relative abundance, respectively during the sample period. Mean lengths in the middle reach were 333 mm ranging from 135 to 413 mm, and 400 mm in the upper reach ranging from 268 to 463 mm (WDFW, unpublished data).

In the Spokane River, water quality issues including but not limited to temperature, total dissolved gases (TDGs), turbidity, total suspended solids, and pollutants such as polychlorinated byphenyls (PCBs) or lead continue to impact fish species and habitat quality. In 1999, three fish species including rainbow trout contained higher than normal concentrations of lead between Upper Falls Dam and the Washington-Idaho state line. In 2001, a fish advisory was expanded to include PCBs of which elevated levels were found in rainbow trout, mountain whitefish, and largescale suckers between Nine Mile Dam and the Washington-Idaho state line (Washington Department of Health 2001). Although rainbow trout remain present in reaches with marginal conditions (temperature, pollutants, etc.), it is uncertain what impacts poor water quality conditions have had on the rainbow trout population. Research is still needed to unveil the current condition of rainbow trout and the potential limiting factors present in the Spokane Subbasin.

22.3.2.2 Little Spokane River

Currently redband/rainbow trout are present in the mainstem, several tributaries, and lakes within the Little Spokane River drainage (see Table 22.7) (Connor et al. 2003a, 2003b). Genetics were tested in 11 redband/rainbow trout populations representing 6 tributaries in the Little Spokane drainage suspected to be genetically "pure" redband trout. Results concluded 4 tributaries (Deadman, Deer, Little Deer, Otter) had native redband trout present (see Table 22.7, Figure 22.1). At least once between 1934 and 1955, three of the four tributaries (Deadman Creek, Deer Creek, and Otter Creek) having native redband trout were stocked with rainbow trout (see Table 22.7). Although not specifically stocked with rainbow trout, Little Deer Creek is connected to and a tributary of Deer Creek.

In 2001 and 2002, WDFW conducted fish surveys in a total of 12 creeks; Beaver Creek was surveyed in both years (Table 22.9). The relative abundance of rainbow trout ranged from less than 1 percent (Bear Creek) to 92 percent (Little Deer Creek). No rainbow trout were found in Heel or Spring Heel Creek. Mean total lengths ranged between 76 and 141 mm. When the relative abundance of rainbow trout exceeded 80 percent (Buck and Little Deer creeks), riffle habitat was most common (≥ 75 percent) and run habitat was least common (≤ 6 percent) (Table 22.9).

The Little Spokane River drainage, as in the rest of the Spokane Subbasin, has been impacted by anthropogenic activities such as timber harvest, agriculture, and urban development. It is assumed that these activities coupled with the introduction of nonnative fish species have negatively impacted the water quality and rainbow trout (Connor et al. 2003b), however data to quantify the degree of impact is limited.

Table 22.9. Tributaries to the Little Spokane River surveyed by WDFW in 2001 and 2002. Data on rainbow trout (total number, relative abundance to total sample, mean length) and habitat types (riffle, pool, run) are from Connor et al. (2003a, 2003b).

2001	# Reaches Surveyed	Total # RBT	% Relative Abundance	Mean Total Length (mm)	% Riffle	% Pool	% Run
Bear	11	17	<1	141	34	3	63
Beaver	3	21	4	93	27	10	63
Buck	15	743	84	107	75	21	4
Deer	14	2311	54	92	52	18	30
Dry	6	507	36	76	54	6	40
Otter Creek	14	452	17	89	31	12	57
West Branch Little Spokane***	8	25	3	119	34	18	48
Heel**	5	-	-	-	-	-	-
Spring Heel Creek***	1	-	-	-	-	-	-

* rainbow only collected below barrier falls
** no fish stocking records in creek (WDFW unpublished), but brook trout are present
*** rainbow have been planted by WDFW, but rainbow were not detected

2002	# Reaches Surveyed	Total # RBT	% Relative Abundance	Mean Total Length (mm)	% Riffle	% Pool	% Run
Beaver	11	7	<1	54	5	2	93
Dragoon	27	189	4	179	24	19	57
Little Deer	9	707	92	63	79	15	6
Spring	2	4	1.5	147	0	0	100
West Branch Dragoon	13	154	7	99	15	9	76

(*Source*: Connor et al. 2003a, 2003b)

22.3.2.3 Hangman Creek

In 2002, Peters et al. (2003) conducted a fish survey in upper Hangman Creek and its tributaries within the boundaries of Idaho (for additional information refer to Section 22.1.4). Rainbow trout, in low density, were found in Hangman, South Fork Hangman, Mission, Sheep, Nehchen, Indian, and Bunnel creeks. Many of the trout sampled in the upper Hangman watershed, particularly those sampled in the Indian Creek, expressed phenotypic characteristics consistent with those of native redband trout. In addition, one of this fish caught in Nehchen Creek expressed traits suggesting it was a rainbow/cutthroat hybrid (Peters et al. 2003). In general it appears salmonid (rainbow and cutthroat trout) distribution and abundance compared to ten years ago is in decline in the upper Hangman Creek drainage (Peters et al. 2003). No rainbow trout or cutthroat trout were found in heavily disturbed drainages surrounded by agriculture; rather all salmonids were in relatively intact, forested drainages. Water quality as a result of land use practices is most likely the principal limiting factor (refer to sections 21.2.5, 21.2.7, 22.1.4, 22.8, and 22.9 for information regarding water quality, land use practices, and limiting factors).

No information regarding redband/rainbow trout was available for the section of Hangman Creek within the boundaries of Washington state.

22.3.3 Limiting Factors Redband/Rainbow Trout

Historically rainbow trout were present in 49 of 63 delineated reaches and watersheds in the Subbasin. Five of these 49 areas no longer host rainbow trout (Table 22.10). However, rainbow trout have expanded their distribution to three new reaches (Table 22.11) and are currently distributed in 48 reaches.

Table 22.10. List of 5 reaches no longer hosting rainbow trout and respective rank for the amount of deviation present habitat conditions are from reference conditions, Rank 1 = most altered

Reach Name	Rank
State line to Mission Hangman Tributaries	2
Little Hangman	4
Moctileme	9
Rose	11
North Fork Rock	12

Table 22.11. Reaches where rainbow trout are currently present, but were not found historically along with the respective rank for protection. The ranking measures the degree of similarity present habitat conditions have to reference conditions, Rank 1 = most similar

Reach Name	Rank
Hauser/Post Falls	42
Rathdrum Ck	40
Hayden	3

To assess the degree of habitat alteration from reference conditions, all 49 historic areas were evaluated (Table 22.12). As shown in Table 22.9, some areas where rainbow trout were historically received rankings for large amounts of habitat alteration and degradation and no longer support rainbow trout. In general, the habitat attributes having changed the most included fine sediment, habitat diversity, and low flow regimes (Table 22.26). Within the Subbasin, Hangman watershed appears to have experienced the greatest degree of change to the habitat (for example, low flow, fine sediments, habitat diversity) relative to reference conditions (Table 22.12). The areas ranked the highest for protection are spread throughout the central region of the Subbasin (Table 22.123).

Table 22.12. Ranking of reaches with the largest deviation from the reference habitat conditions for rainbow trout in the Spokane Subbasin. A reach rank equal to 1 has the greatest deviation from reference condition in comparison to other reaches. Reach scores range from 0 to 1, with 1 having the greatest deviation from reference. Values associated with each habitat attribute range from 1 to 11, a value of 1 indicates a habitat attribute having the greatest deviation from reference compared to the other attributes within that reach. In some cases multiple habitat attributes have a value of 1 indicating all attributes equally deviate the most from the reference.

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
61	Mainstem Hangman - Upper	1	0.7	8	2	2	2	2	1	6	10	8	6	10
46	State line to Mission Hangman Tribs	2	0.6	7	2	2	2	5	1	5	11	9	7	10
49	Western Tributaries of Hangman Ck	2	0.6	7	2	2	2	5	1	5	11	9	7	10
44	Little Hangman	4	0.6	8	4	2	4	2	1	4	10	8	4	10
62	Mainstem Hangman - Middle	4	0.6	8	4	2	4	2	1	4	10	8	4	10
63	Mainstem Hangman - Lower	4	0.6	7	2	6	1	2	7	2	11	9	2	10
12	Rail Ck/Walkers Prairie	7	0.5	6	3	3	3	9	1	2	9	6	8	9
47	Mission to Indian Creek Hangman Tribs	8	0.5	7	3	3	1	3	1	6	11	8	8	10
8	Camas	9	0.5	6	1	1	1	9	1	1	9	6	6	9
45	Moctileme	9	0.5	4	2	3	1	4	4	4	11	9	4	10
43	Rose	11	0.5	4	2	3	1	4	4	4	10	9	4	10
42	North Fork Rock	12	0.5	5	2	2	1	5	2	5	10	9	5	10
41	Rock	13	0.4	4	2	2	1	4	4	9	10	8	4	10
7	Little Chamokane	14	0.4	5	2	2	1	9	2	5	9	7	8	9
3	Blue/Oyachen/Orzada	15	0.4	5	2	6	3	10	3	7	10	8	1	8
48	Hangman Headwaters	16	0.4	9	5	3	2	3	1	7	11	6	7	9

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
54	Mainstem Spokane R - Seven Mile to Nine Mile Falls Hydro	16	0.4	6	7	2	1	9	5	9	9	8	4	3
14	Frog/W.Dragoon	18	0.3	4	3	1	1	6	5	10	10	6	6	9
55	Mainstem Spokane R - Nine Mile Falls to Long Lake Dam	19	0.3	4	5	1	1	10	5	5	10	9	5	3
21	Peone/Deadman	20	0.3	2	2	2	1	7	2	9	9	7	2	9
6	Upper Chamokane	21	0.3	6	2	2	1	9	2	7	9	7	2	9
1	McCoy /Ente'	22	0.3	5	1	2	2	6	2	6	11	9	6	9
11	Lower Chamokane	22	0.3	6	3	2	1	9	5	7	10	8	3	10
25	Upper Little Spokane Tribs	24	0.3	5	3	2	1	7	3	9	9	8	9	6
52	Mainstem Spokane R- Upriver Dam to Monroe St Hydro	24	0.3	6	3	1	3	9	9	7	9	8	3	2
57	Spokane Arm of Lake Roosevelt, Little Falls Dam to confluence with Colombia	24	0.3	3	8	2	3	9	5	9	9	6	1	6
15	Dragoon	27	0.3	5	2	3	1	6	4	10	10	6	6	9
18	North Spokane	28	0.3	5	5	2	1	5	3	10	10	9	3	8
60	West Branch Little Spokane	29	0.3	4	5	1	1	8	6	8	8	3	7	8
59	Mainstem Little Spokane River - Lower	30	0.3	5	6	1	1	8	4	9	9	6	3	9
56	Mainstem Spokane R - Long Lake Dam to Little Falls Dam	31	0.3	4	6	1	3	9	6	9	9	8	5	2
24	West Branch Little Spokane Tribs	32	0.3	5	3	2	1	6	4	9	9	7	9	7
2	Sand Creek	33	0.3	5	2	2	1	9	2	6	9	8	6	9
58	Mainstem Little Spokane River - Upper	34	0.3	4	6	1	2	8	3	10	10	4	8	7
32	Upper Spring Creek	35	0.3	6	4	1	2	7	4	9	9	8	2	9
34	Middle Coulee	35	0.3	5	3	1	3	7	1	9	9	8	6	9

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
35	Upper Coulee	35	0.3	5	3	1	3	7	1	9	9	8	6	9
37	Middle Deep	35	0.3	5	3	1	3	7	1	9	9	8	6	9
38	Upper Deep	35	0.3	5	3	1	3	7	1	9	9	8	6	9
51	Mainstem Spokane R- Post Falls Dam to Upriver Dam	40	0.3	4	7	2	2	7	6	7	7	4	1	7
39	Marshall Creek	41	0.3	5	7	1	4	7	3	10	10	9	6	2
17	Mud/Wethey/Huston	42	0.2	4	1	3	1	4	4	9	9	4	4	9
30	Lower Spring Creek	42	0.2	5	6	1	2	6	4	9	9	8	2	9
31	Middle Spring Creek	42	0.2	5	6	1	2	6	4	9	9	8	2	9
40	California	45	0.2	4	5	1	1	8	1	9	9	7	5	9
53	Mainstem Spokane R - Monroe St to Seven Mi Bridge	46	0.2	4	7	3	1	8	5	8	8	6	2	8
22	Upper Deadman	47	0.2	4	5	1	1	5	3	8	8	7	8	8
23	Bear/Cottonwood/Pell	48	0.2	4	5	3	1	8	1	8	8	7	8	6
33	Lower Coulee	49	0.0	5	5	5	5	2	2	5	5	4	1	5
36	Lower Deep	49	0.0	5	5	5	5	2	2	5	5	4	1	5

Table 22.13. Ranking of streams whose habitat is most similar to the reference condition for rainbow trout in the Spokane Subbasin in comparison to other reaches. A reach rank equal to 1 reveals the reach with current conditions most similar to reference conditions in comparison to other reaches. Reach score ranges from 0 to -1, with -1 having the least deviation from reference. Values associated with each habitat attribute range from 1 to 11, a value of 1 indicates a habitat attribute being most similar to the reference compared to the other attributes within that reach. In some cases multiple habitat attributes have a value of 1 indicating all attributes are equally the most similar to the reference.

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
22	Upper Deadman	1	-0.66	11	3	8	8	3	7	1	5	8	1	5
53	Mainstem Spokane R - Monroe St to Seven Mi Bridge	1	-0.66	11	3	7	10	1	4	1	5	8	8	5
29	Hayden	3	-0.66	11	9	5	3	5	3	1	7	7	2	9
23	Bear/Cottonwood/Pell	4	-0.65	10	4	6	8	1	8	1	5	7	1	11
17	Mud/Wethey/Huston	5	-0.64	10	8	7	8	2	2	1	5	10	2	5
31	Middle Spring Creek	6	-0.64	8	2	11	8	2	6	1	4	7	8	4
40	California	6	-0.64	11	3	7	7	2	7	1	5	7	3	5
30	Lower Spring Creek	8	-0.61	7	2	11	7	2	5	1	4	6	7	10
39	Marshall Creek	8	-0.61	10	2	9	6	2	8	1	5	6	4	11
32	Upper Spring Creek	10	-0.60	10	5	11	8	2	5	1	3	7	8	3
34	Middle Coulee	10	-0.60	11	7	9	7	2	9	1	4	6	3	4
35	Upper Coulee	10	-0.60	11	7	9	7	2	9	1	4	6	3	4
37	Middle Deep	10	-0.60	11	7	9	7	2	9	1	4	6	3	4
38	Upper Deep	10	-0.60	11	7	9	7	2	9	1	4	6	3	4
56	Mainstem Spokane R - Long Lake Dam to Little Falls Dam	15	-0.58	9	3	9	8	1	3	1	5	7	6	11
59	Mainstem Little Spokane River - Lower	16	-0.58	9	3	10	10	2	6	1	4	8	7	4
18	North Spokane	17	-0.57	9	2	10	11	2	6	1	4	5	6	6
2	Sand Creek	18	-0.56	10	5	5	9	1	5	2	4	5	2	10
15	Dragoon	19	-0.56	10	9	6	11	2	5	1	4	8	2	6
25	Upper Little Spokane Tribs	20	-0.56	10	5	8	10	3	5	1	4	5	1	9

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
57	Spokane Arm of Lake Roosevelt, Little Falls Dam to confluence with Colombia	20	-0.56	9	6	9	6	1	1	3	4	5	6	11
58	Mainstem Little Spokane River - Upper	22	-0.55	8	4	10	7	2	6	1	5	8	2	11
1	McCoy /Ente'	23	-0.55	11	10	5	5	1	5	1	4	5	1	5
51	Mainstem Spokane R- Post Falls Dam to Upriver Dam	23	-0.55	8	1	6	6	1	5	1	4	8	8	11
24	West Branch Little Spokane Tribs	25	-0.55	9	6	8	10	3	5	1	4	6	1	11
21	Peone/Deadman	26	-0.54	11	5	5	10	2	5	1	3	9	5	3
11	Lower Chamokane	27	-0.53	10	5	9	11	1	4	2	3	5	5	5
6	Upper Chamokane	28	-0.53	10	4	4	10	1	4	2	3	9	4	4
14	Frog/W.Dragoon	28	-0.53	9	8	9	9	2	5	1	4	7	2	6
55	Mainstem Spokane R - Nine Mile Falls to Long Lake Dam	30	-0.53	10	2	8	8	1	2	2	6	7	2	11
52	Mainstem Spokane R- Upriver Dam to Monroe St Hydro	31	-0.53	10	3	7	6	1	5	1	4	8	9	11
48	Hangman Headwaters	32	-0.52	5	4	5	9	5	11	1	3	10	1	5
54	Mainstem Spokane R - Seven Mile to Nine Mile Falls Hydro	32	-0.52	8	3	9	10	1	5	1	4	6	6	11
3	Blue/Oyachen/Orzada	34	-0.52	10	9	4	5	1	5	2	3	5	11	5
60	West Branch Little Spokane	34	-0.52	9	6	7	7	1	4	1	5	10	3	11
7	Little Chamokane	36	-0.48	11	6	6	10	1	6	4	3	9	2	4
41	Rock	37	-0.46	11	7	7	10	4	4	1	2	9	4	2
47	Mission to Indian Creek Hangman Tribs	38	-0.39	6	7	7	10	7	10	3	2	5	1	4
8	Camas	39	-0.39	10	5	5	5	1	5	5	2	10	3	3
28	Rathdrum Creek	40	-0.37	5	3	5	7	8	9	1	2	9	3	11
12	Rail Ck/Walkers Prairie	41	-0.36	8	5	5	5	1	11	10	2	8	3	4
27	Hauser/Post Falls	42	-0.30	8	4	8	5	5	8	1	2	5	3	11
33	Lower Coulee	43	-0.28	8	8	8	8	3	7	1	5	6	4	1
36	Lower Deep	43	-0.28	8	8	8	8	3	7	1	5	6	4	1

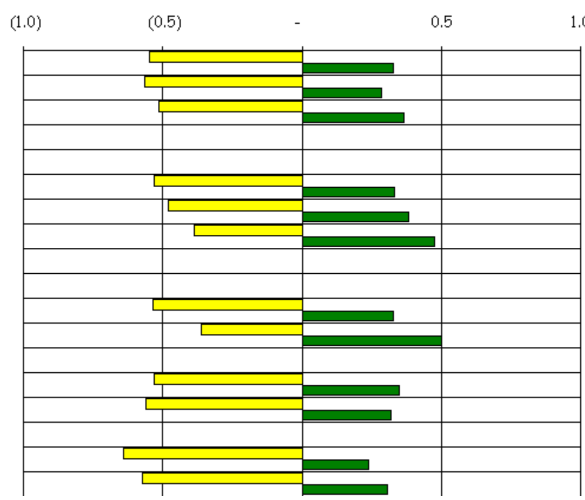
Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
49	Western Tributaries of Hangman Ck	**45**	-0.28	7	8	8	8	5	11	5	1	4	2	2
63	Mainstem Hangman - Lower	**46**	-0.23	6	3	7	10	7	11	3	1	7	3	1
61	Mainstem Hangman - Upper	**47**	-0.19	5	5	5	10	5	10	3	1	5	3	1
62	Mainstem Hangman - Middle	**48**	-0.15	7	7	7	7	5	7	3	2	6	3	1

The tornado diagram (Table 22.14) and maps (Map SK-1, Map SK-2, located at the end of Section 22) present the reach scores for both current habitat condition (ranging from zero to positive one, Map SK-1) and protection (ranging from zero to negative one, Map SK-2). The reach score ranges from negative one to zero with negative one indicative of a watershed having experienced the least amount of change. Scores closest to negative one depict reaches that are most representative of reference habitat conditions. Scores closest to positive one depict reaches with habitat conditions least similar to reference conditions. Confidence scores range from zero to one and are associated with the ratings assigned by local biologists based on documentation or their expert opinion regarding reference and current habitat attributes for each reach.

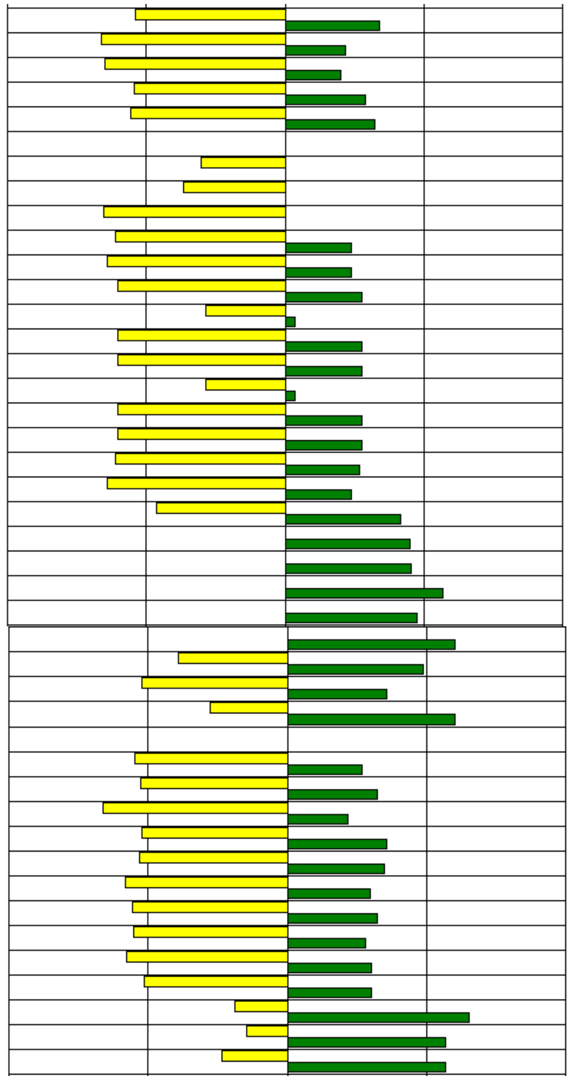
Table 22.14. Tornado diagram for rainbow trout in the Spokane Subbasin. Degree of confidence for protection and current habitat conditions range from 0.0 to 1.0 with the greatest confidence equal to 1.0. Protection reach scores are presented on the left side and current habitat reach scores are presented on the right. Negative scores are in parentheses.

NP = Not present

Sequence	Reach Name	Protection Confidence	Current Habitat Condition Confidence
1	McCoy /Ente'	0.88	0.78
2	Sand Ck	0.88	0.78
3	Blue/Oyachen/Orzada	0.88	0.78
4	South Slopes/Harker Canyon	NP	
5	South Slopes/Mill Canyon	NP	
6	Upper Chamokane	0.71	0.70
7	Little Chamokane	0.71	0.70
8	Camas	0.71	0.70
9	Included in #7	NP	
10	Included in #7	NP	
11	Lower Chamokane	0.88	0.78
12	Rail Ck/Walkers Prairie	0.71	0.70
13	TumTum/ North 1/2 only	NP	
14	Frog/W.Dragoon	0.88	0.78
15	Dragoon	0.88	0.78
16	Little Sandy Canyon	NP	
17	Mud/Wethey/Huston	0.71	0.70
18	North Spokane	0.88	0.78



21	Peone/Deadman	0.71	0.70
22	Upper Deadman	0.71	0.70
23	Bear/Cottonwood/Pell	0.88	0.78
24	West Branch Little Spokane Tribs	0.88	0.78
25	Upper Little Spokane Tribs	0.88	0.78
26	Thompson Creek	NP	
27	Hauser/Post Falls	NP	
28	Rathdrum Ck	NP	
29	Hayden	NP	
30	Lower Spring Creek	0.71	0.70
31	Middle Spring Creek	0.71	0.70
32	Upper Spring Creek	0.71	0.70
33	Lower Coulee	0.71	0.70
34	Middle Coulee	0.71	0.70
35	Upper Coulee	0.71	0.70
36	Lower Deep	0.71	0.70
37	Middle Deep	0.71	0.70
38	Upper Deep	0.71	0.70
39	Marshall Ck	0.71	0.70
40	California	0.71	0.70
41	Rock	0.71	0.70
42	N Fk Rock	0.71	0.70
43	Rose	0.71	0.70
44	Little Hangman	0.71	0.70
45	Moctileme	0.71	0.70
46	Stateline to Mission Hangman Tribs	0.88	0.78
47	Mission to Indian Creek Hangman Tribs	0.88	0.78
48	Hangman Headwaters	0.88	0.78
49	Western Tributaries of Hangman Ck	0.55	0.61
50	nstem Spokane R- C d'A Lake to Post Falls Dam	NP	
51	tem Spokane R- Post Falls Dam to Upriver Dam	0.71	0.70
52	n Spokane R- Upriver Dam to Monroe St Hydro	0.71	0.70
53	em Spokane R - Monroe St to Seven Mi Bridge	0.71	0.70
54	pokane R - Seven Mile to Ninemile Falls Hydro	0.71	0.70
55	n Spokane R - Ninemile Falls to Long Lake Dam	0.71	0.70
56	Spokane R - Long Lake Dam to Little Falls Dam	0.71	0.70
57	lt, Little Falls Dam to confluence with Colombia	0.71	0.70
58	Mainstem Little Spokane River - Upper	0.71	0.70
59	Mainstem Little Spokane River - Lower	0.71	0.70
60	West Branch Little Spokane	0.88	0.78
61	Mainstem Hangman - Upper	0.88	0.78
62	Mainstem Hangman - Middle	0.71	0.70
63	Mainstem Hangman - Lower	0.71	0.70



22.3.4 Current Management

Rainbow trout spawning and emergence was studied in the upper Spokane River between Upper Falls Dam and Post Falls Dam between 1995 and 1999 (Avista Corp 2000). The results of this study are being used to manipulate flows from Post Falls Dam to maintain flows at desirable levels during the rainbow trout incubation period (Avista Corp 2000). Rainbow trout year-class strengths vary annually and are associated with flows between spawning and post emergence (Bennett and Underwood 1988). A substantial proportion of spawning substrate is dewatered when mainstem flows drop below 6,000 cfs, resulting in decreased spawning success (Avista Corp 2000). Mean monthly flows from 1891 to 2001 indicate mainstem flows are below 6,000 cfs July through January (Figure 22.2). However, the key period for rainbow trout incubation is from late March until mid-June (Avista Corp 2000). There have been three primary spawning areas identified: Harvard Road, Starr Road Bar, and the Island Complex. Most redds were constructed at elevations that would be dewatered as flows drop between 4,000-6,000 cfs.

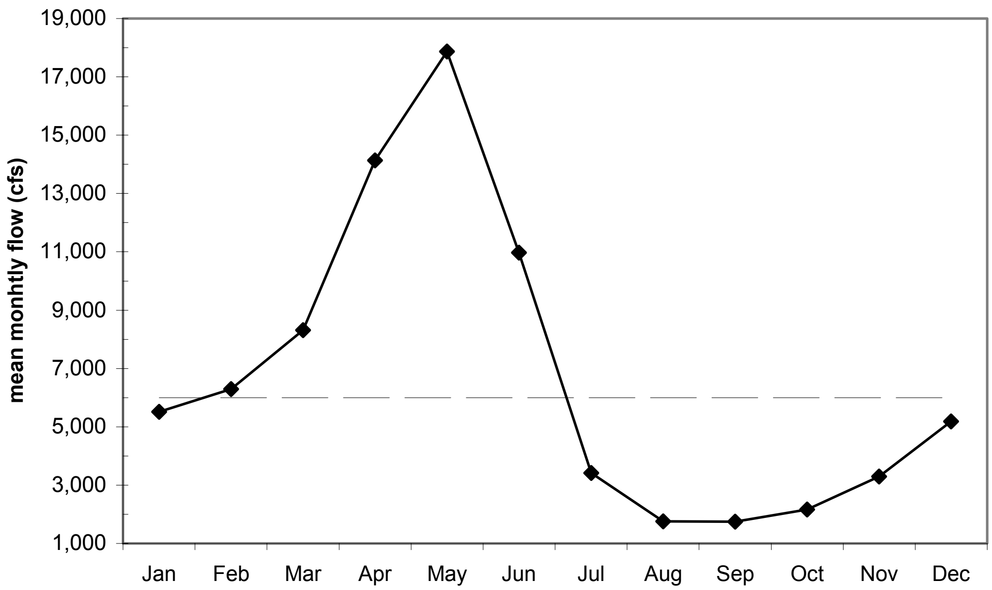


Figure 22.2 Mean monthly flow in the Spokane River 1891-2001.
(*Source:* USGS 12422500)

Current harvest regulations are intended to protect native rainbow trout in the Spokane River mainstem. Only catch and release is permitted in the Spokane River above Upper Falls Dam upstream to the Washington-Idaho state line. There is a restricted harvest in the Spokane River from Upper Falls Dam downstream to Riverfront Park, and from Monroe Street to Nine Mile Falls Dam allowing harvest of only hatchery origin fish (adipose clipped). In addition, WDFW enforces harvest regulations designated for tributaries and reservoirs to the Spokane River to protect wild salmonids from overharvest. In the river and tributaries, the minimum catch is 8 inches and daily limit is two trout. In lakes, ponds, and reservoirs there is no minimum size and the daily limit is 5 trout (refer to website for regulations: https://fortress.wa.gov/dfw/erules/efishrules/index.jsp).

22.4 Focal Species – Mountain Whitefish

22.4.1 Historic Status

Mountain whitefish are native to the Spokane Subbasin, and are broadly distributed in the Columbia River basin but absent from coastal drainages with the exception of the Puget Sound and the westside river drainages of the Olympic Mountains (McPhail and Troffe 2001). Mountain whitefish are present in both lotic and lentic environments. Some populations of whitefish complete their life cycle within or between a single lake or river system. Mountain whitefish life history traits and habitat requirements vary between lake and river environments. The variability in environmental conditions may affect behavior such as spawning time and locality. General knowledge and specific information regarding mountain whitefish migration patterns, straying, and gene flow among populations within the Spokane Subbasin is sparse.

22.4.2 Current Status

Current and past documentation and data on the abundance, distribution, life history strategy, genetic integrity, carrying capacity, and productivity of mountain whitefish in the Spokane Subbasin is limited. From 1938 to 1978, WDFW conducted creel surveys and found mountain whitefish present in Chain Lakes, Horseshoe Lake, and the Little Spokane River (Connor et al. 2003a). The most recent resident fish survey data available were conducted by the WDFW in 2001 and 2002 in the Little Spokane drainage and the middle Spokane River (Connor et al. 2003a, 2003b). Mountain whitefish were also sampled in Little Falls Pool in 1992 (Scholz, EWU, personal communication, unpublished data), in Chamokane Creek (Scholz et al .1988; Connor et al. 2004), in Lake Spokane (Johnson 2001), and in the Spokane Arm (STOI unpublished data). The following text describes mountain whitefish population abundance/structure for the Little Spokane River drainage, Spokane River, and Chamokane Creek.

Based on the WDFW 2001 and 2002 surveys, mountain whitefish are currently present in the Little Spokane River drainage encompassing Bear Creek, Dry Creek, Little Spokane River, Otter Creek, West Branch Little Spokane River, Wethey Creek, Horseshoe Lake, and Chain Lakes (Connor et al. 2003a, 2003b). No mountain whitefish were observed in Eloika, Fan, Sacheen, Diamond, or Trout lakes (Connor et al. 2003a). The relative abundance of mountain whitefish in the creeks and lakes in the Little Spokane River drainage were often less than three percent of the total fish captured in all reaches surveyed at one site (Connor et al. 2003a, 2003b). Temperature was suggested to be the limiting factor for mountain whitefish distribution since this species prefers conditions between 9 and 11 °C (Northcote and Ennis 1994). In the West Branch Little Spokane River, the mean annual temperature in 2001 was 17 °C, the mean temperature between May and September remained at 18.8 °C, and the maximum reached 28.65 °C (Connor et al. 2003a). These less favorable thermal conditions were likely the result of surface inflow from surrounding lakes (Connor et al. 2003a).

In 2002, WDFW also surveyed the middle Spokane River, which extends from Nine Mile Dam upstream to Spokane Falls including free-flowing and reservoir habitats (Connor et al. 2003b). In the free-flowing habitat, mountain whitefish represented about 12 percent of the fish surveyed with ages ranging between 2 and 4 years. In Nine Mile Reservoir mountain whitefish represented less than one percent of the relative abundance with ages ranging between 0 and 5 years. In 2002, the relative weight (W_r) of mountain whitefish in the reservoir was greater ($W_r = 92$) than in the free-flowing water ($W_r = 80$), but both habitat types were lower than the national standard ($W_r = 100$). Similarly, the condition factor (K_{TL}) of mountain whitefish in the reservoir was also greater ($K_{TL} = 0.93$) than in the free-flowing water ($K_{TL} = 0.80$), but overall comparable to condition factors of mountain whitefish in the Pend Oreille River reservoirs Box Canyon ($K_{TL} = 0.76$) and Boundary ($K_{TL} = 0.83$) (Connor et al. 2003b).

In 1987 an estimation of the mountain whitefish population was determined in Chamokane Creek (Scholz et al.1988) to be 719 individuals with a density of 55 per kilometer. In 2003, the density of mountain whitefish in the lower reach of Chamokane Creek was 3.08 fish/100m² (Connor et. al. 2004).

Mountain whitefish have been collected in the Spokane Arm every year since 1993, excluding 1996 and 1997 (STOI unpublished data). The highest relative abundance occurred in 2000. In the fall of 2000, a mature male and female mountain whitefish were collected below Little Falls Dam spillway by Eastern Washington University. These fish were spawned in the laboratory and progeny were archived for future morphological and larval development characterization (EWU unpublished data).

In general, population studies on mountain whitefish in the Subbasin remain limited. Based on the results from WDFW (Connor et al. 2003a, 2003b), the condition factor and relative weights of mountain whitefish are similar to other northwest streams and the national standard, respectively. Biologists do not have the data to know how water quality issues including but not limited to temperature, TDGs, turbidity, total suspended solids, and pollutants such as PCBs or lead in the Spokane River impact mountain whitefish. Water quality could prove to be a principal limiting factor and is a concern within the Spokane Subbasin. In 1999, three fish species including mountain whitefish contained higher than normal concentrations of lead between Upper Falls Dam and the Washington-Idaho state line. In 2001, a fish advisory was expanded to include PCBs of which elevated levels were found in rainbow trout, mountain whitefish, and largescale suckers between Nine Mile Dam and the Washington-Idaho state line (Washington Department of Health 2001). Studies on TDGs in river systems have concluded mountain whitefish are highly intolerant resulting in death of fish after 48 hours with TDGs at 128 percent saturation (Northcote and Ennis 1994). Concentrations of TDGs below dams between Post Falls and Little Falls are known to exceed state standards of 110 percent TDG saturation (Avista 2002), which could potentially limit mountain whitefish abundance or distribution. Research is still needed to unveil the current condition of mountain whitefish and the potential limiting factors present in the Spokane Subbasin.

22.4.4 Limiting Factors Mountain Whitefish

Historically, mountain whitefish were distributed in 39 of 63 delineated reaches and watersheds in the Spokane Subbasin. Habitat conditions from the past (reference) to present were compared for all 39 reaches and the results are presented in Section 22.9, Table 22.26. This table identifies the habitat attributes altered the most from reference conditions within a particular reach.

Currently, mountain whitefish are only present in 19 of 63 reaches and watersheds. Table 22.15 shows the areas where mountain whitefish are no longer present and the rank each reach received when comparing reference to current habitat conditions. The results show clearly the areas where the physical habitat is least similar to the reference and mountain whitefish are no longer present (Tables 22.15 and 22.16).

Table 22.15. List of the 20 reaches in the Spokane River where mountain whitefish are no longer present and the respective reach rank assessing the degree of habitat deviation from reference conditions, 1 = greatest habitat alteration

Reach Name	Reach Rank
Mainstem Hangman - Upper	1
State line to Mission Hangman Tributaries	2
Western Tributaries of Hangman Ck	2
Little Hangman	4
Mainstem Hangman - Middle	5
Mainstem Hangman - Lower	5
Mission to Indian Creek Hangman Tributaries	7
Moctileme	8
Rose	9
North Fork Rock	10
Rock	11
Blue/Oyachen/Orzada	12
Little Chamokane	13
Hangman Headwaters	13
Hauser/Post Falls	15
Frog/W.Dragoon	18
Sand Ck	29
Mainstem Spokane R- C d'A Lake to Post Falls Dam	32
California	36
Hayden	37

The Hangman watershed (southern tip of the Subbasin) received the top rankings for habitat conditions least representative to reference conditions. The key habitat attributes having undergone the most change appear to be fine sediment loading and high flow (Table 22.16).

Reaches ranked for protection (Table 22.17) signify the areas most representative of reference conditions. These areas were scattered around the Subbasin.

The tornado diagram (Table 22.18) and maps (Map SK-3, SK-4, located at the end of Section 22) presents the reach scores for both current habitat condition (ranging from zero to positive one, Map SK-3) and protection (ranging from zero to negative one, Map SK-4). Scores closest to negative one depict reaches most representative of reference habitat conditions. Scores closest to positive one depict reaches with habitat conditions least similar to reference conditions. Confidence scores range from zero to one and are associated with the ratings assigned by local biologists based on documentation or their expert opinion regarding reference and current habitat attributes for each reach.

Table 22.16. Ranking of reaches with the largest deviation from the reference habitat conditions for mountain whitefish in the Spokane Subbasin. A reach rank equal to 1 has the greatest deviation from reference condition in comparison to other reaches. Reach scores range from 0 to 1, with 1 having the greatest deviation from reference. Values associated with each habitat attribute range from 1 to 11, a value of 1 indicates a habitat attribute having the greatest deviation from reference compared to the other attributes within that reach. In some cases multiple habitat attributes have a value of 1 indicating all attributes equally deviate the most from the reference.

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
61	Mainstem Hangman - Upper	1	0.5	9	6	7	1	1	5	3	10	7	3	10
46	State line to Mission Hangman Tribs	2	0.5	9	5	7	1	2	4	2	11	8	6	10
49	Western Tributaries of Hangman Ck	2	0.5	9	5	7	1	2	4	2	11	8	6	10
44	Little Hangman	4	0.5	10	5	8	1	2	6	2	11	8	2	6
62	Mainstem Hangman - Middle	5	0.4	9	6	7	3	1	2	3	10	8	3	10
63	Mainstem Hangman - Lower	5	0.4	9	6	7	3	1	2	3	10	8	3	10
47	Mission to Indian Creek Hangman Tribs	7	0.4	10	4	5	1	2	3	5	11	8	7	9
45	Moctileme	8	0.4	9	2	7	1	3	6	3	11	8	3	10
43	Rose	9	0.4	8	2	7	1	3	6	3	10	8	3	10
42	North Fork Rock	10	0.4	9	5	7	1	2	6	2	10	8	2	10
41	Rock	11	0.3	9	4	6	1	2	5	7	10	7	2	10
3	Blue/Oyachen/Orzada	12	0.3	8	3	6	2	10	4	5	10	9	1	7
7	Little Chamokane	13	0.3	8	3	5	1	9	4	2	9	6	6	9
48	Hangman Headwaters	13	0.3	10	4	5	1	2	2	5	11	5	5	9
27	Hauser/Post Falls	15	0.3	9	3	3	1	7	1	11	10	6	7	5
54	Mainstem Spokane R - Seven Mile to Nine Mile Falls Hydro	16	0.3	7	6	4	1	9	5	9	9	7	3	2

55	Mainstem Spokane R - Nine Mile Falls to Long Lake Dam	**17**	0.3	6	6	3	1	10	8	4	10	9	4	2
14	Frog/W.Dragoon	**18**	0.3	9	2	3	1	4	4	10	10	7	4	8
21	Peone/Deadman	**19**	0.3	7	3	5	1	5	4	9	9	7	2	9
11	Lower Chamokane	**20**	0.3	7	3	4	1	7	5	5	10	7	2	10
57	Spokane Arm of Lake Roosevelt, Little Falls Dam to confluence with Colombia	**21**	0.3	6	4	4	2	9	9	7	9	8	2	1
15	Dragoon	**22**	0.2	9	2	3	1	3	3	10	10	7	3	8
52	Mainstem Spokane R- Upriver Dam to Monroe St Hydro	**23**	0.2	7	8	4	2	9	5	9	9	5	1	3
18	North Spokane	**24**	0.2	8	6	4	1	5	3	10	10	9	2	7
25	Upper Little Spokane Tribs	**25**	0.2	7	2	5	1	6	3	9	9	8	9	3
59	Mainstem Little Spokane River - Lower	**26**	0.2	7	5	3	1	7	4	9	9	5	2	9
56	Mainstem Spokane R - Long Lake Dam to Little Falls Dam	**27**	0.2	7	5	3	2	9	6	9	9	8	3	1
24	West Branch Little Spokane Tribs	**28**	0.2	7	2	3	1	4	4	9	9	7	9	6
2	Sand Ck	**29**	0.2	7	2	4	1	9	3	4	9	7	4	9
60	West Branch Little Spokane	**30**	0.2	5	4	3	1	8	6	8	8	2	7	8
58	Mainstem Little Spokane River - Upper	**31**	0.2	7	5	2	1	7	3	10	10	3	7	6
50	Mainstem Spokane R- C d'A Lake to Post Falls Dam	**32**	0.2	5	8	3	2	4	7	8	8	5	1	8
51	Mainstem Spokane R- Post Falls Dam to Upriver Dam	**33**	0.2	6	7	3	2	7	3	7	7	5	1	7
17	Mud/Wethey/Huston	**34**	0.2	8	2	5	1	3	7	9	9	5	3	9
30	Lower Spring Creek	**35**	0.2	7	6	3	1	5	4	9	9	7	1	9
40	California	**36**	0.2	6	5	3	1	6	2	9	9	6	3	9
29	Hayden	**37**	0.2	8	1	4	3	1	5	11	10	9	7	5
53	Mainstem Spokane R - Monroe St to Seven Mi Bridge	**38**	0.2	5	7	3	1	8	4	8	8	5	2	8
22	Upper Deadman	**39**	0.2	6	5	2	1	2	2	8	8	6	8	8

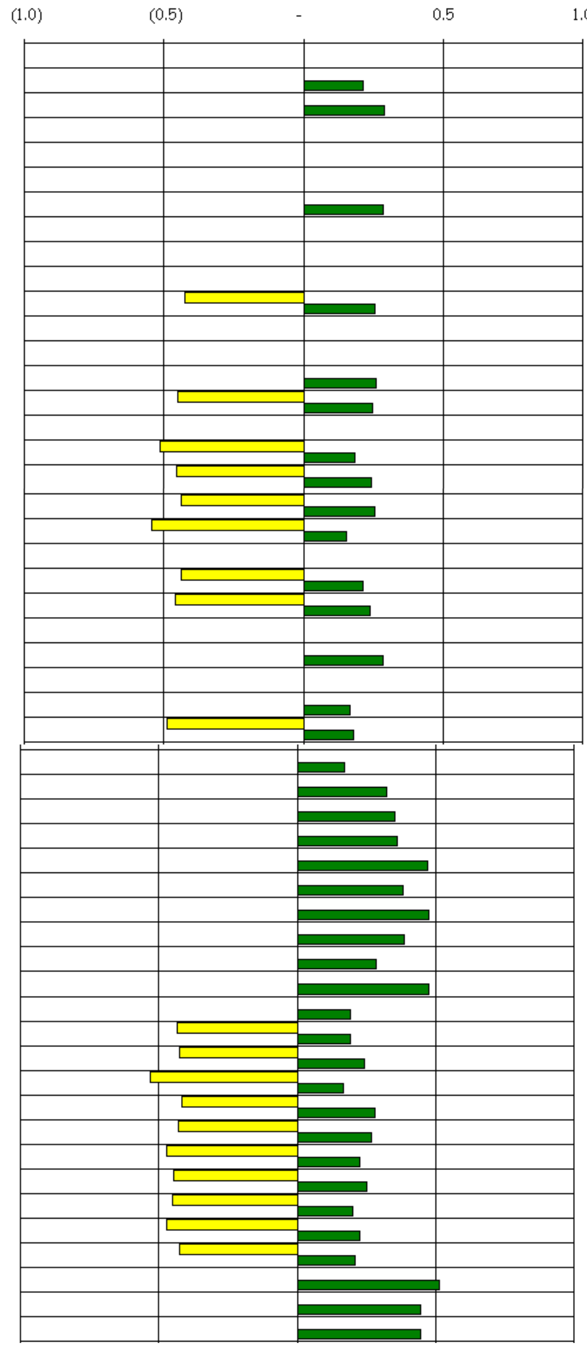
Table 22.17. Ranking of streams whose habitat is most similar to the reference condition for mountain whitefish in the Spokane Subbasin in comparison to other reaches. A reach rank equal to 1 reveals the reach with current conditions most similar to reference conditions in comparison to other reaches. Reach score ranges from 0 to -1, with -1 having the least deviation from reference. Values associated with each habitat attribute range from 1 to 11, a value of 1 indicates a habitat attribute being most similar to the reference compared to the other attributes within that reach. In some cases multiple habitat attributes have a value of 1 indicating all attributes are equally the most similar to the reference.

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
22	Upper Deadman	1	-0.54	11	5	10	6	3	7	1	9	8	1	4
53	Mainstem Spokane R - Monroe St to Seven Mi Bridge	2	-0.53	11	4	10	7	1	5	1	9	7	5	3
17	Mud/Wethey/Huston	3	-0.51	11	7	9	5	2	5	1	8	9	2	4
30	Lower Spring Creek	4	-0.49	10	3	11	4	2	7	1	8	6	4	8
56	Mainstem Spokane R - Long Lake Dam to Little Falls Dam	5	-0.47	10	4	9	5	1	5	1	8	7	3	11
59	Mainstem Little Spokane River - Lower	6	-0.47	10	4	10	9	2	6	1	7	8	5	3
25	Upper Little Spokane Tribs	7	-0.46	11	4	10	9	3	6	1	6	4	1	6
18	North Spokane	8	-0.46	11	3	10	9	2	7	1	7	6	4	4
15	Dragoon	9	-0.45	11	8	9	9	2	5	1	6	7	2	4
58	Mainstem Little Spokane River - Upper	10	-0.45	9	4	9	6	2	5	1	7	8	2	11
57	Spokane Arm of Lake Roosevelt, Little Falls Dam to confluence with Colombia	11	-0.45	10	7	9	4	1	3	2	8	6	4	11
21	Peone/Deadman	12	-0.44	11	5	9	9	2	6	1	6	8	4	3
24	West Branch Little Spokane Tribs	13	-0.44	10	5	9	8	3	4	1	7	5	1	11
51	Mainstem Spokane R- Post Falls Dam to Upriver Dam	14	-0.43	10	3	7	4	1	5	1	6	9	7	11
55	Mainstem Spokane R - Nine Mile Falls to Long Lake Dam	15	-0.43	10	4	9	8	1	5	2	7	6	2	11
11	Lower Chamokane	16	-0.43	11	6	10	9	1	5	2	8	6	3	3
60	West Branch Little Spokane	17	-0.43	9	5	8	7	1	4	1	6	9	3	11
52	Mainstem Spokane R- Upriver Dam to Monroe St Hydro	18	-0.42	10	3	9	4	1	5	1	6	7	7	11
54	Mainstem Spokane R - Seven Mile to Nine Mile Falls Hydro	19	-0.41	8	3	8	8	1	5	1	7	6	4	11

Table 22.18. Tornado diagram for mountain whitefish in the Spokane Subbasin. Degree of confidence for protection and current habitat conditions range from 0.0 to 1.0 with the greatest confidence equal to 1.0. Protection reach scores are presented on the left side and current habitat reach scores are presented on the right. Negative scores are in parentheses.

NP = Not present

Sequence	Reach Name	Protection Confidence	Current Habitat Condition Confidence
1	McCoy /Ente'	NP	
2	Sand Ck	0.88	0.78
3	Blue/Oyachen/Orzada	0.88	0.78
4	South Slopes/Harker Canyon	NP	
5	South Slopes/Mill Canyon	NP	
6	Upper Chamokane	NP	
7	Little Chamokane	0.71	0.70
8	Camas	NP	
9	Included in #7	NP	
10	Included in #7	NP	
11	Lower Chamokane	0.88	0.78
12	Rail Ck/Walkers Prairie	NP	
13	TumTum/ North 1/2 only	NP	
14	Frog/W.Dragoon	0.88	0.78
15	Dragoon	0.88	0.78
16	Little Sandy Canyon	NP	
17	Mud/Wethey/Huston	0.71	0.70
18	North Spokane	0.88	0.78
21	Peone/Deadman	0.71	0.70
22	Upper Deadman	0.71	0.70
23	Bear/Cottonwood/Pell	NP	
24	West Branch Little Spokane Tribs	0.88	0.78
25	Upper Little Spokane Tribs	0.88	0.78
26	Thompson Creek	NP	
27	Hauser/Post Falls	0.71	0.70
28	Rathdrum Ck	NP	
29	Hayden	0.71	0.70
30	Lower Spring Creek	0.71	0.70
40	California	0.71	0.70
41	Rock	0.71	0.70
42	N Fk Rock	0.71	0.70
43	Rose	0.71	0.70
44	Little Hangman	0.71	0.70
45	Moctileme	0.71	0.70
46	Stateline to Mission Hangman Tribs	0.88	0.78
47	Mission to Indian Creek Hangman Tribs	0.88	0.78
48	Hangman Headwaters	0.88	0.78
49	Western Tributaries of Hangman Ck	0.55	0.61
50	nstem Spokane R- C d'A Lake to Post Falls Dam	0.71	0.70
51	tem Spokane R- Post Falls Dam to Upriver Dam	0.71	0.70
52	n Spokane R- Upriver Dam to Monroe St Hydro	0.71	0.70
53	em Spokane R - Monroe St to Seven Mi Bridge	0.71	0.70
54	pokane R - Seven Mile to Ninemile Falls Hydro	0.71	0.70
55	n Spokane R - Ninemile Falls to Long Lake Dam	0.71	0.70
56	Spokane R - Long Lake Dam to Little Falls Dam	0.71	0.70
57	lt, Little Falls Dam to confluence with Colombia	0.71	0.70
58	Mainstem Little Spokane River - Upper	0.71	0.70
59	Mainstem Little Spokane River - Lower	0.71	0.70
60	West Branch Little Spokane	0.88	0.78
61	Mainstem Hangman - Upper	0.88	0.78
62	Mainstem Hangman - Middle	0.71	0.70
63	Mainstem Hangman - Lower	0.71	0.70



22.4.5 Current Management

Fisheries managers foresee mountain whitefish having a greater recreational importance in the future as a result of habitat loss and the continued degradation of the existing fishery resources. To avoid over-exploitation of this species and create a baseline for future management strategies, current information is needed regarding life history strategies, population size, abundance, capacity, and genetic integrity.

Currently, WDFW fish regulations for 2003/2004 categorize mountain whitefish as a game species with a daily catch limit of 15 fish with no minimum size limit. Some special rules do apply to areas of eastern Washington. For example, from SR 291 Bridge to the West Branch of the Little Spokane River, mountain whitefish are only harvested from December 1 to March 1 with no minimum size limit and a daily limit of 15 fish. Only one single hook (3/16 inch) or smaller measured point to shank (size #14) may be used (WDFW 2003/2004).

22.5 Focal Species – Kokanee Salmon

22.5.1 Historic Status

Prior to the construction of the dams on the Spokane River, specifically Little Falls Dam in 1911, local residents observed sockeye migration up the Little Spokane River (A. Scholz, EWU, personal communication, 2003). After the construction of Little Falls Dam, these sockeye were landlocked and are now referred to as kokanee. An initial genetic analysis suggests a genetically distinct kokanee stock resides in the Chain Lakes, located in the East Branch of the Little Spokane River drainage, as a result of long-term reproductive isolation and low number of effective breeders (WDFW 2002). Chain Lakes kokanee are most likely a remnant native sockeye stock.

22.5.2 Current Status

Currently, most of the kokanee stocked in the Spokane Subbasin are of coastal origin from Lake Whatcom, thus considered an exotic (see Table 22.1). However, residual native stocks persist and/or are suspected to persist throughout the Subbasin. For example, the kokanee population existing in the Chain Lakes section of the Little Spokane River drainage is likely a native stock (Scholz, EWU, personal communication, 2003). In 1999, the WDFW collected 25 kokanee and sent samples to the University of Montana for protein electrophoretic analyses. While the number of samples is not sufficient to provide statistically significant results, the data suggest the stock is distinct from other kokanee populations in the IMP. This naturally reproducing population is relatively small with an estimated population of 1,500 adult spawners in the early 1990s and observed spawning population over 1,000 adults in 2002 (A. Scholz, EWU, personal communication, 2003).

There are also several other indigenous stocks of kokanee that are entrained into the Spokane Arm, some of which reproduce in Lake Roosevelt tributaries. Refer to the aquatic assessment of the Upper Columbia Subbasin in Section 30.5 for more details regarding kokanee in Lake Roosevelt.

22.5.3 Limiting Factors Kokanee Salmon

Historically kokanee were present in 13 of 63 delineated reaches and watersheds in the Subbasin. The 13 reaches were evaluated for changes from reference to current habitat conditions (Table 22.19). The results show the western section of the Subbasin with habitat traits least representative of reference conditions. The habitat attributes having changed the most over time include pollutants, obstructions, fine sediments, and channel stability (Table 22.19).

Kokanee are currently present in 12 of 63 delineated areas in the Subbasin. However, the distribution of kokanee has changed over time. Kokanee are no longer found in six reaches included in the historic distribution. These areas encompassed the Little Chamokane, McCoy, Ente', and Sand creeks and lower reach of the Little Spokane River. There are five reaches on the mainstem of the Spokane River currently having kokanee where they were not present historically. Only the 12 reaches where kokanee are currently present were evaluated for protection (Table 22.20). The top three areas recognized to have habitat attributes most similar to reference conditions are located within the Little Spokane River watershed (Table 22.20).

The tornado diagram (Table 22.21) and maps (Map SK-5, Map SK-6, located at the end of Section 22) presents the reach scores for both current habitat condition (ranging from zero to positive one, Map SK-5) and protection (ranging from zero to negative one, Map SK-6). Scores closest to negative one depict reaches most representative of reference habitat conditions. Scores closest to positive one depict reaches with habitat conditions least similar to reference conditions. Confidence scores range from zero to one and are associated with the ratings assigned by local biologists based on documentation or their expert opinion regarding reference and current habitat attributes for each reach.

Table 22.19. Ranking of reaches with the largest deviation from the reference habitat conditions for kokanee in the Spokane Subbasin. Reach rank equal to 1 has the greatest deviation from reference condition in comparison to other reaches. Reach scores range from 0 to 1, with 1 having the greatest deviation from reference. Values associated with each habitat attribute range from 1 to 11, a value of 1 indicates a habitat attribute having the greatest deviation from reference compared to the other attributes within that reach. In some cases multiple habitat attributes have a value of 1 indicating all attributes equally deviate the most from the reference.

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
3	Blue/Oyachen/Orzada	1	0.3	9	2	7	3	9	3	5	9	8	1	5
7	Little Chamokane	2	0.3	9	4	3	2	9	4	4	9	8	4	1
55	Mainstem Spokane R - Nine Mile Falls to Long Lake Dam	2	0.3	8	2	5	1	8	2	4	8	7	6	8
57	Spokane Arm of Lake Roosevelt, Little Falls Dam to confluence with Colombia	4	0.3	8	2	5	2	8	8	6	8	7	2	1
1	McCoy /Ente'	5	0.3	10	1	4	2	4	2	4	10	9	4	4
11	Lower Chamokane	6	0.3	8	2	5	1	6	2	8	8	7	8	2
25	Upper Little Spokane Tribs	6	0.3	9	2	5	1	7	4	6	9	8	2	9
56	Mainstem Spokane R - Long Lake Dam to Little Falls Dam	8	0.3	8	5	3	2	8	5	8	8	7	3	1
24	West Branch Little Spokane Tribs	9	0.2	8	2	4	1	5	3	8	8	7	8	5
59	Mainstem Little Spokane River - Lower	10	0.2	8	5	3	1	6	3	8	8	7	2	8
2	Sand Ck	11	0.2	8	2	4	1	8	2	4	8	7	4	8
58	Mainstem Little Spokane River - Upper	12	0.2	9	4	2	1	6	2	9	9	6	6	4
18	North Spokane	13	0.2	7	5	7	7	3	1	7	7	6	1	3

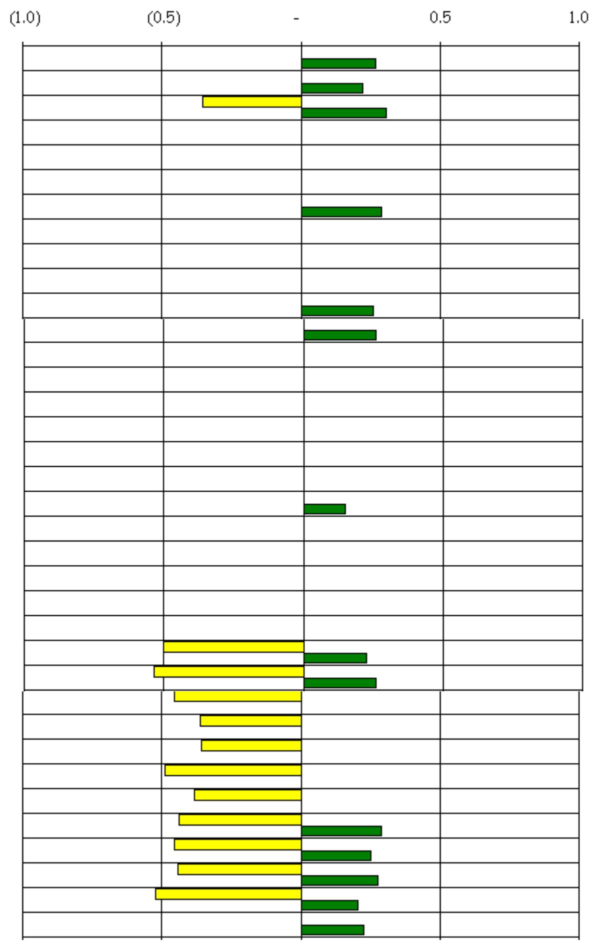
Table 22.20. Ranking of streams whose habitat is most similar to the reference condition for kokanee in the Spokane Subbasin in comparison to other reaches. A reach rank equal to 1 reveals the reach with current conditions most similar to reference conditions in comparison to other reaches. Reach score ranges from 0 to -1, with -1 having the least deviation from reference. Values associated with each habitat attribute range from 1 to 11, a value of 1 indicates a habitat attribute being most similar to the reference compared to the other attributes within that reach. In some cases multiple habitat attributes have a value of 1 indicating all attributes are equally the most similar to the reference.

Sequence	Reach Name	Reach Rank	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
25	Upper Little Spokane Tribs	1	-0.53	11	5	9	8	4	5	1	1	9	1	5
58	Mainstem Little Spokane River - Upper	2	-0.52	10	5	8	7	3	6	1	1	8	3	10
24	West Branch Little Spokane Tribs	3	-0.50	10	6	8	7	4	5	1	1	8	1	10
53	Mainstem Spokane R - Monroe St to Seven Mi Bridge	4	-0.49	9	7	9	9	1	4	1	5	8	5	1
50	Mainstem Spokane R- C d'A Lake to Post Falls Dam	5	-0.45	9	5	9	9	3	3	1	5	8	7	1
56	Mainstem Spokane R - Long Lake Dam to Little Falls Dam	5	-0.45	8	7	8	8	1	3	1	4	6	5	8
57	Spokane Arm of Lake Roosevelt, Little Falls Dam to confluence with Colombia	7	-0.44	8	7	8	8	1	1	3	4	5	6	8
55	Mainstem Spokane R - Nine Mile Falls to Long Lake Dam	8	-0.44	8	7	8	8	1	2	2	5	6	2	8
54	Mainstem Spokane R - Seven Mile to Nine Mile Falls Hydro	9	-0.38	8	6	8	8	1	3	1	4	7	4	8
51	Mainstem Spokane R- Post Falls Dam to Upriver Dam	10	-0.36	8	4	8	8	1	3	1	4	7	6	8
52	Mainstem Spokane R- Upriver Dam to Monroe St Hydro	11	-0.36	8	5	8	8	1	3	1	4	7	6	8
3	Blue/Oyachen/Orzada	12	-0.35	8	6	8	8	1	4	2	4	6	8	2

Table 22.21. Tornado diagram for rainbow trout in the Spokane Subbasin. Degree of confidence for protection and current habitat conditions range from 0.0 to 1.0 with the greatest confidence equal to 1.0. Protection reach scores are presented on the left side and current habitat reach scores are presented on the right. Negative scores are in parentheses.

NP = Not present

Sequence	Reach Name	Protection Confidence	Current Habitat Condition Confidence
1	McCoy/Ente'	0.88	0.78
2	Sand Ck	0.88	0.78
3	Blue/Oyachen/Orzada	0.88	0.78
4	South Slopes/Harker Canyon	NP	
5	South Slopes/Mill Canyon	NP	
6	Upper Chamokane	NP	
7	Little Chamokane	0.71	0.70
8	Camas	NP	
9	Included in #7	NP	
10	Included in #7	NP	
11	Lower Chamokane	0.88	0.78
11	Lower Chamokane	0.88	0.78
12	Rail Ck/Walkers Prairie	NP	
13	TumTum/ North 1/2 only	NP	
14	Frog/W.Dragoon	NP	
15	Dragoon	NP	
16	Little Sandy Canyon	NP	
17	Mud/Wethey/Huston	NP	
18	North Spokane	0.88	0.78
19	West Spokane - North side only	NP	
20	Downtown/East Spokane	NP	
21	Peone/Deadman	NP	
22	Upper Deadman	NP	
23	Bear/Cottonwood/Pell	NP	
24	West Branch Little Spokane Tribs	0.88	0.78
25	Upper Little Spokane Tribs	0.88	0.78
50	nstem Spokane R- C d'A Lake to Post Falls Dam	NP	
51	tem Spokane R- Post Falls Dam to Upriver Dam	NP	
52	n Spokane R- Upriver Dam to Monroe St Hydro	NP	
53	em Spokane R - Monroe St to Seven Mi Bridge	NP	
54	pokane R - Seven Mile to Ninemile Falls Hydro	NP	
55	n Spokane R - Ninemile Falls to Long Lake Dam	0.71	0.70
56	Spokane R - Long Lake Dam to Little Falls Dam	0.71	0.70
57	lt, Little Falls Dam to confluence with Colombia	0.71	0.70
58	Mainstem Little Spokane River - Upper	0.71	0.70
59	Mainstem Little Spokane River - Lower	0.71	0.70



22.5.4 Current Management

The WDFW is responsible for fishing regulations in the Little Spokane watershed. To ensure that a stock of a native species does not continue to decline, regulations prohibit all harvest of kokanee specifically within the Chain Lakes of the Little Spokane River.

Currently, there is a collaborative multi-agency artificial production program for Lake Roosevelt including the Spokane Arm. Lake Roosevelt fishery management agencies consisting of the WDFW, STOI, and Colville Confederated Tribes direct hatchery stocking in the Spokane Arm of Lake Roosevelt including annual releases of kokanee. Hatchery releases support a sport fishery as well as supplement kokanee returns up to Little Falls Dam where a terminal subsistence fishery for Spokane Tribal members exists as well as egg collection for artificial propagation occurs. Current brood stocks from Lake Roosevelt, Lake Whatcom, and Meadow Creek are utilized for artificial production.

22.6 Focal Species – Chinook Salmon

The restoration of Chinook salmon in Lake Roosevelt, which includes the Spokane Arm, is a management goal of the Indian Tribes in the IMP. Additionally, the historic range of Chinook salmon included the Spokane River and Little Spokane River drainages prior to hydropower development. Therefore, the restoration of Chinook salmon is pertinent to the Spokane Subbasin. For additional information about Chinook salmon in Lake Roosevelt refer to the Upper Columbia Subbasin Section on focal species.

22.6.1 Historical Status

Historically, Chinook salmon were prevalent in the Spokane River downstream of Spokane Falls (Douglas 1836; Stone 1883; Elliot 1914; Gangmark and Fulton 1957; Scholz et al. 1985). Chinook salmon spawned throughout the Spokane River prior to the construction of the dams. Historical evidence indicates the Coeur d' Alene Tribe harvested Chinook as far upstream in Hangman Creek as the current town of Tekoa, Washington (Scholz et al. 1985, Seltice 1990) and possibly as far as DeSmet, Idaho (Scholz et al. 1985).

22.6.2 Current Status

The only naturally reproducing population of Chinook salmon is a non-anadromous population that exists upstream in Coeur d' Alene Lake, the neighboring Subbasin. All Chinook observed within the Spokane Subbasin originated from the Coeur d' Alene Lake population. In the Spokane Subbasin, Chinook salmon have been observed as far downstream as the Spokane, Little Falls Dam, Little Falls Pool, and Chamokane Creek (Conner et al. 2004). Recent surveys in 2001 and 2002 have also observed individual Chinook salmon in Lake Spokane (Osborne et al. 2003) and Nine Mile Reservoir (Connor et al. 2003b), respectively.

22.6.3 Current Management

Currently, there are no efforts devoted to Chinook management within the Subbasin since they have been extirpated from the Spokane River and its tributaries. WDFW sport fishing regulations (2003/2004) group Chinook salmon with trout (Washington regulations available: https://fortress.wa.gov/dfw/erules/efishrules/index.jsp). There are no regulations on the Spokane Indian Reservation.

22.7 Focal Species – Largemouth Bass

22.7.1 Historic Status

Largemouth bass are not native to the Spokane Subbasin or western United States. In the late 1800s, warmwater fish were broadcast across the western United States. Largemouth bass were more than likely introduced multiple times in the Subbasin, however documentation for specific dates and places are unavailable. It is known largemouth bass were present in Lake Spokane prior to the introduction of smallmouth bass in the 1980s (Avista 2002).

22.7.2 Current Status

The current distribution of largemouth bass within the Subbasin includes the Spokane Arm of Lake Roosevelt (Lee et al. 2003), Lake Spokane (Osborne et al. 2003), Little Falls Pool (Scholz, personal communication, 2004), and the Little Spokane River drainage covering the Little Spokane River, Dry Creek, Diamond Lake, Eloika Lake, Fan Lake, Sacheen Lake, Little Spokane River, and Dry Creek (Connor et al. 2003b). In 1992, largemouth bass were sampled in Little Falls Pool (Scholz, EWU, personal communication, unpublished data). In 2000, largemouth bass were sampled in Benjamin and McCoy Lakes. Natural spawning is occurring in Benjamin Lake although only one size class was observed in McCoy Lake (Crossley 2000). Largemouth bass were not identified in any previous studies of the interior lakes of the Spokane Indian Reservation. Available documentation regarding largemouth bass population abundance and structure was limited to Lake Spokane. Populations in the Spokane Arm are very limited, and are likely fallouts from Lake Spokane (STOI unpublished data).

In 2001, Osborne et al. (2003) surveyed the warmwater fishery in Lake Spokane. Results show largemouth bass growth rates in Lake Spokane calculated using the overall mean (using direct proportion method) and weighted mean (using Lee's modification of the direct proportion method) were greater than the average growth rate in Washington (Table 22.22). Total length varied in size from 152 to 550 mm. Age ranged from 2 to 13 years with most of the population dominated by largemouth bass age 5 and older. The lack of young-of-the-year and age 1 largemouth bass observed during this survey suggests low recruitment or problem with the sample timing (Osborne et al. 2003).

Table 22.22. Back-calculated overall and weighted mean length at age (mm) of largemouth bass in Lake Spokane during June 2001 compared to the Washington state mean length at age. Overall mean based on direct proportion method, weighted mean based on Lee's modification of the direct proportion method.

Total Length (mm) at Age													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Overall Mean	85	221	315	369	403	428	450	469	482	493	498	538	550
Weighted Mean	103	227	316	369	404	425	450	477	488	501	506	537	550
WA State Mean	60	146	222	261	289	319	368	396	440	485	472	496	NA

(*Source*: Osborne et al. 2003)

The condition of largemouth bass based on relative weight varied greatly (W_r 52 – 144) and did not appear to be related to fish size. Approximately equal numbers of largemouth bass exhibited conditions above and below the national average (Osborne et al. 2003).

Due to a lack of trend data, the 2001 warmwater fisheries survey was unable to determine whether the largemouth bass population is in decline or has stabilized (Osborne et al. 2003). Even with the apparently low juvenile recruitment, the size structure in 2001 appears to be similar to documentation from the 1980s by Bennett and Hatch (1991, as cited in Osborne et al. 2003). Potential factors limiting largemouth bass recruitment include elevated predation pressures, lack of juvenile cover, winter induced-stressors, zooplankton entrainment, and unsuitable over-wintering habitat. All of these factors are related to annual drawdowns at Long Lake Dam. Lower water levels increases the density of predatory fish in Lake Spokane, reduces cover and shelter for juveniles, and elevates stress for juveniles that can result in mortality (Osborne et al. 2003).

22.7.3 Current Management

Lake Spokane is managed as a cold and warmwater fishery. Overall, surveys conducted by Osborne et al. (2003) conclude the warmwater fishery is doing well under current environmental conditions and management strategies. Osborne et al. (2003) also speculates any change in management strategy for largemouth bass may not have a large impact on the population, but could instead negatively affect the other gamefish populations.

Largemouth bass sport fishery is not considered a “trophy” fishery in Lake Spokane but does provide ample opportunity for tournament anglers and the general public. Since 2001, fishing regulations have been more conservative with a 305-432 mm (12-17 inch) slot limit and may influence the future structure of the population. It is likely current age structure of the largemouth bass population is reflective of the past regulations. Past statewide regulations in Washington allowed anglers to harvest five largemouth bass, but only three could be greater than 381 mm (15 inches) (Osborne et al. 2003).

Currently in the state of Washington, there is no minimum size limit with a daily limit of five bass less than 305 mm (12 inches) or no more than one bass greater than 432 mm (17 inches). In addition to the slot limit regulations, anglers must release all largemouth bass from May 1 to June 30 to limit harvest during the spawning season.

Additional information exists in the form of current regulations in the fishing regulations pamphlet (Available: https://fortress.wa.gov/dfw/erules/efishrules/index.jsp).

22.8 Environmental Conditions[2]

22.8.1 Environmental Conditions within the Subbasin

22.8.1.1 Historical Conditions – Spokane River

Historically, the Spokane River provided ideal salmonid production habitat. Habitats were characterized by cold, clean water, diverse habitat complexity, and unembedded substrates (Gilbert and Evermann 1895). The hydrograph of the Spokane River and tributaries were unaltered and passage between the Spokane River and tributaries were not impeded by hydroelectric development allowing for species movement and genetic exchange between different regions of the Subbasin. Habitat conditions were also well suited for an abundant and diverse community of aquatic invertebrates (Gilbert and Evermann 1895). Invertebrate communities supported juvenile anadromous salmonids and entire life histories of resident salmonids.

Aquatic habitats were, in part, the result of intact riparian and upland habitats. Mature coniferous forests, dense riparian communities, and rolling grasslands provided shade for rivers and streams. Prior to timbering of the Subbasin, snow melted off gradually throughout the spring and summer and extensive wetland and riparian habitats buffered inputs during peak runoff. Gradual melting of snow helped maintain cool water

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[2] Large portions of Section 22.8 were contributed to by the Spokane River Subbasin Summary Report (2000) pp. 9-13.

conditions during the warm summer months. Groundwater inputs (Spokane-Rathdrum Aquifer) to the Spokane River also contributed to maintain favorable thermal conditions for salmonids. Further, water from snowmelt and precipitation was filtered by stable soils, thus soil erosion and sediment from adjacent hill slopes was less extensive.

22.8.1.2 Current Conditions – Spokane River

Compared to historic conditions, Spokane River fish community has been significantly impacted by hydroelectric development and impaired water quality from various land use, pollutants from point and non-point sources, and other anthropogenic activities. The Spokane River is listed on Washington State's 1998 303(d) list for exceeding water quality standards regarding temperatures, metals in surface waters, PCBs, pH, metals in sediments, and total phosphorus. The upper reaches of the Spokane River are also included on Idaho's 1998 303(d) list for similar water quality impairments. These include impairments as a result of bacteria, dissolved oxygen, metals, nutrients, sediments, and temperature. The 2002/2004 Water Quality Assessment also added dissolved oxygen and TDGs to the list of parameters not meeting water quality standards in some reaches of the Spokane River, while other reaches in the Spokane River are now reportedly meeting temperature and pH water quality standards (Available January 2004: http://www.ecy.wa.gov/programs/wq/303d/2002/2002_list.html).

As discussed in Section 21.2, there are seven dams on the Spokane River and several other impoundments on the tributaries. The hydroelectric development on the Spokane River does not provide fish passage facilities thus preventing the historic migration patterns of fish species, genetic exchange, and disrupting metapopulation dynamics. The hydrodevelopment also modified some of the free-flowing river habitats into reservoir habitats providing less favorable habitat conditions for salmonids. Reservoir habitats or slackwater habitats modify river conditions resulting in slower flows, lower dissolved oxygen levels, warmer temperatures, and increased deposition of sediment.

The operations of Post Falls Dam and subsequent storage of water in Coeur d' Alene Lake has resulted in modifications of the Spokane River hydrograph as depicted in Figure 22.3. Figure 22.3 presents comparable high flow years from pre- (1890-1906) to post- (1965-1975) operation of Post Falls Dam. In the early 1900s before Post Falls Dam was constructed, Coeur d' Alene Lake's natural mean summer (July) lake elevation oscillated between 2121 and 2124 ft above mean sea level (amsl) (Figure 22.4) when Coeur d' Alene Lake "drained" throughout the summer. After operations began at Post Falls Dam (1906), summer lake levels increased to about 2126.5 ft amsl. In 1942, lake storage was further increased, which is reflected in today's summer lake level averaging 2128 ft amsl (Figure 22.4). Under current operations at Post Fall Dam, more water is stored during the summer to maintain higher than natural lake levels thus reducing available water downstream to the Spokane River (figures 22.3 and 22.4).

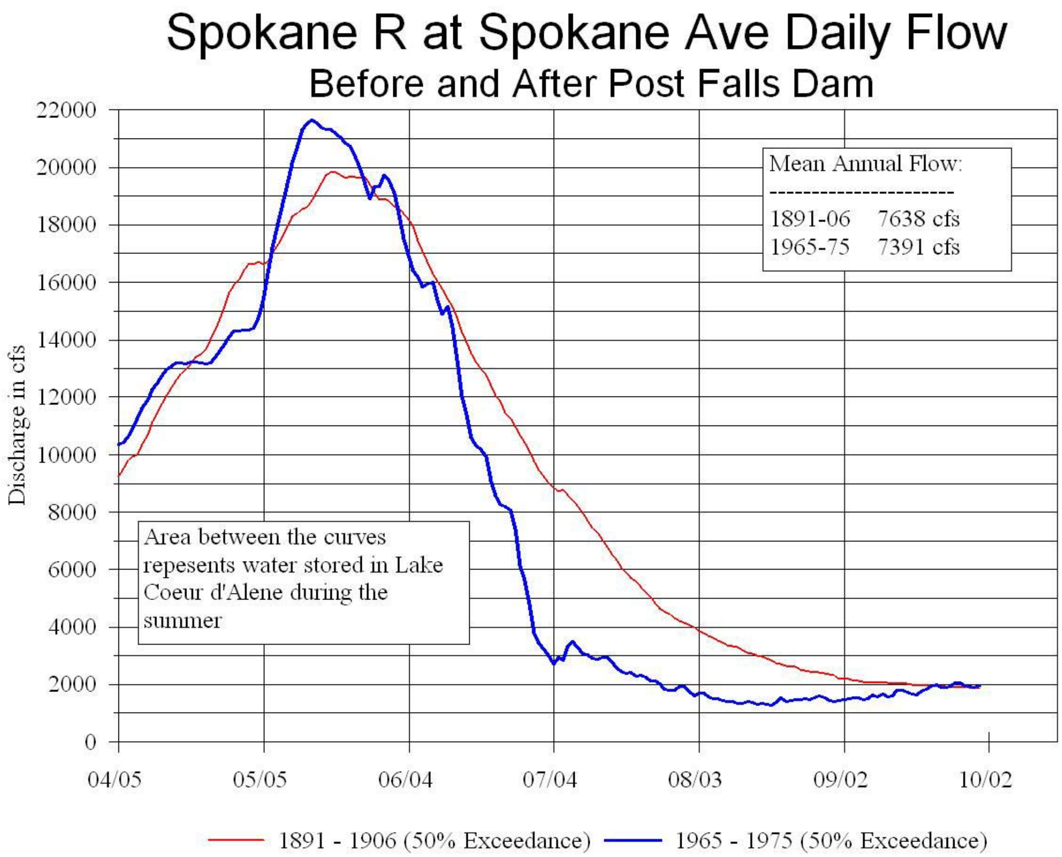

Figure 22.3. Graph shows 50 percent exceedance of average daily flow in the Spokane River of two comparable high flow years, pre- dam 1891-1906 and post- dam 1965-1975. (*Source*: WDOE using USGS data from gage station 12422500)

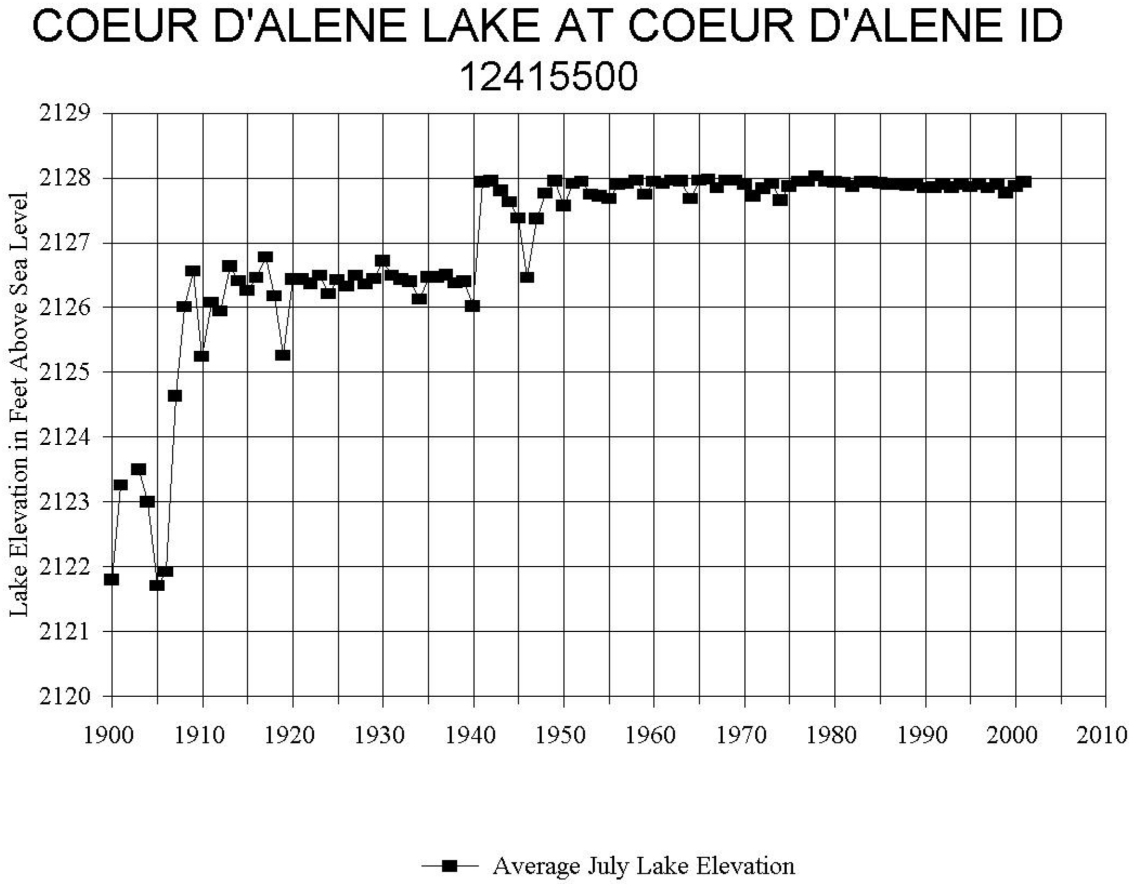

Figure 22.4. Coeur d' Alene Lake mean lake elevation in July from 1890-2003. Pre-Post Fall Dam is represented by years 1890-1906. The first managed summer lake levels (2126.5 ft) are represented by years 1907-1941. Current summer lake level management (2128 ft) is represented by years 1942-present. (*Source*: WDOE 2004)

Although the mean annual hydrograph for the Spokane River has not shown much change since the operation of Post Falls Dam in 1906 (Figure 22.5), noticeable seasonal alterations occur. Figure 22.6 depicts a declining trend in the 7-day low summer/fall flow data (1890-2003) that may reflect impacts from dam operations and/or increased water demands in the Spokane area during this time of year. However, the cause and effect relationship of dam operations and/or water demands to the seasonal flows of the Spokane River is not yet well understood or defined. The 7-day low flow between 1 June and 1 October has declined from a range pre-Post Falls Dam (1890-1906) between 1300 and 2600 cfs to a range post-Post Fall Dam (1942-2003, representative of current summer lake level management 2128 ft amsl) between 500 and 1800 cfs (Figure 22.6). Currently, snow melt and spring runoff are capable of recharging the aquifer and the Spokane River each year, thus the reduction in the 7-day low flow during the summer/fall (Figure 22.6) is not currently impacting or visible in the annual mean flow (Figure 22.5). However, the decreasing trend in the summer/fall 7-day low flows may affect fish survival during these time periods.

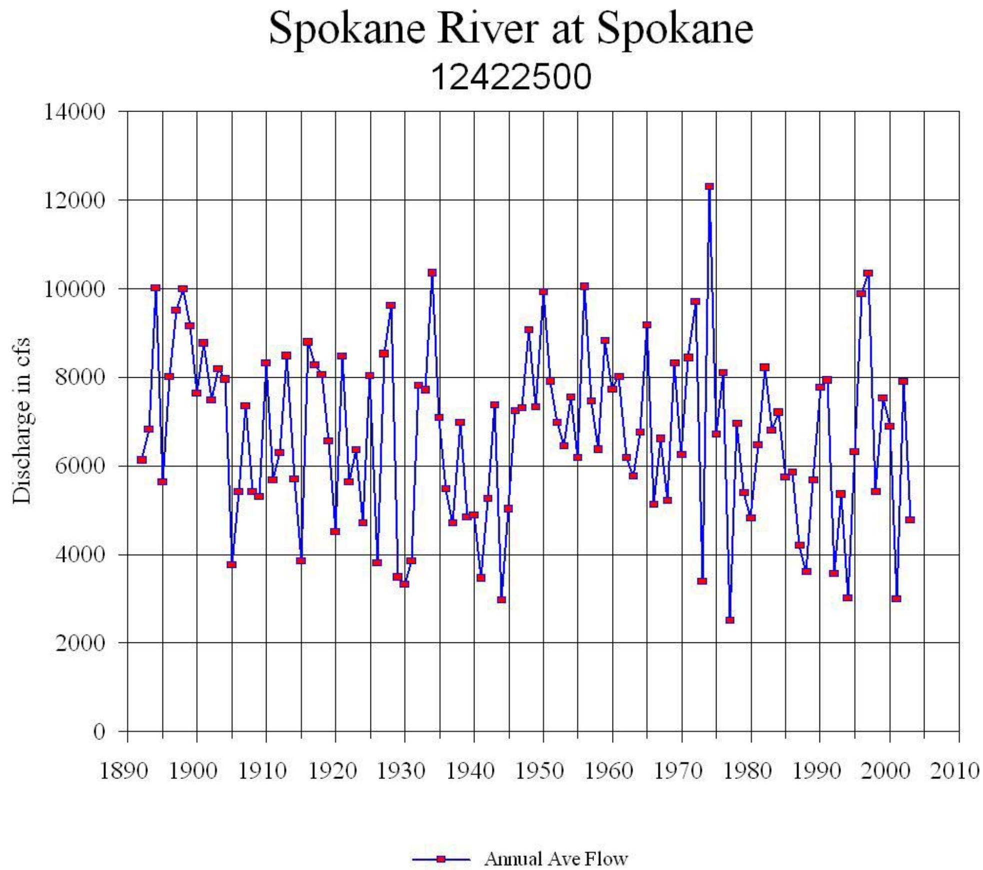

Figure 22.5. Annual mean flow in the Spokane River between 1890-2003 from USGS gage station 12422500 (*Source*: WDOE 2004)

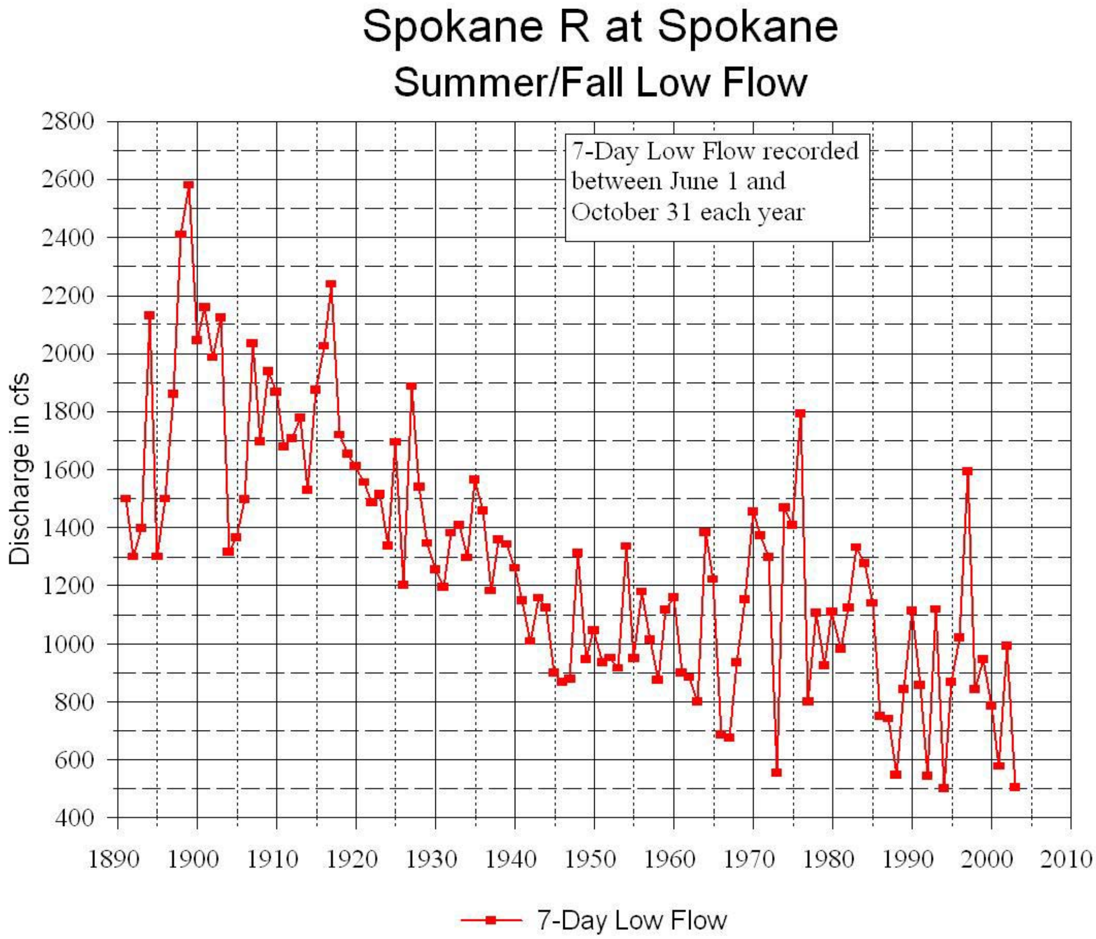

Figure 22.6. Spokane River summer/fall 7-day low flow data between June 1 and October 31 from 1890-2003. Post Falls Dam was present in 1906. Lake management for summer lake elevation was increased in 1942. (*Source*: WDOE 2004 using USGS data from gage station 12422500).

The Spokane River has also been impacted from upstream mining activities in the Coeur d' Alene Subbasin from the outlet of Coeur d' Alene Lake downstream to Lake Roosevelt. As early as the 1920s, mine-related contaminants from Coeur d' Alene Subbasin were observed in the Spokane River (Casner 1991, as cited in Parametrix 2003). In general, pollutants (various heavy metals and PCBs) have either leached into the river from the Coeur d' Alene Basin Mining Districts in Idaho (Johnson 2001, as cited in Osborne et al. 2003) or been directly discharged into the river by industrial sites and wastewater treatment plants in Spokane (Golding 2001, as cited in Osborne et al. 2003). The occurrence of heavy metals such as arsenic, cadmium, mercury, lead, and zinc can negatively affect fish populations at various life stages (Leland and Kuwabara 1985). Fish are most sensitive to effects of trace metals in embryo-larval and early juvenile stages (Leland and Kuwabara 1985), which are compounded by the limited amount of rearing habitat available. Toxic effects of heavy metals also impact invertebrate populations (Leland and Kuwabara 1985) and are likely a contributing factor in the reduction of invertebrate diversity in the mainstem of the Spokane River. Kadlec (2000, as cited in Johnson 2001) concluded the elevated metal concentrations in the Spokane River extending from the outlet of Coeur d' Alene Lake downstream to the Spokane Arm were negatively impacting phytoplankton productivity and macroinvertebrate communities, and most likely having a negative impact on the distribution and abundance of fish populations.

Other contaminants such as PCBs and polycyclic aromatic hydrocarbons (PAHs) have also been detected in resident fish species in the Spokane River (Johnson 2001). The highest PCB concentrations in fish tissue were found between Upriver Dam and Trentwood (RM 80.2 - 86.5), while moderate to low levels were observed upstream near Post Falls (RM 96.5) and downstream below Upriver Dam (RM 80.2) (Johnson 2001). The same trend was also found for PCB levels in the sediments. As part of a recent PCB study, sediment grab samples were collected in Little Falls Pool, between Little Falls Dam and Long Lake Dam, and from Little Falls Pool downstream to Porcupine Bay located in the Spokane Arm in 2003 (Jack et al. 2003). However, no PCB data have been analyzed from water, sediment, or fish samples from Little Falls Dam downstream to Long Lake Dam (Johnson 2001).

Impaired water quality conditions (increased levels of nutrients, temperature, pollutants) experienced in Coeur d' Alene Lake also influence downstream conditions in the Spokane River. Increased summer water temperatures create high metabolic demand for native salmonid species requiring cool water conditions. The reduced macroinvertebrate diversity and density in the mainstem of the Spokane further exacerbates the increased metabolic demands of salmonids. Facilities discharging biochemical oxygen demand and/or ammonia into the river in Idaho (City of Coeur d' Alene Advanced Wastewater Treatment Plant, Hayden Area Regional Sewer Board Publicly-owned Treatment Works, City of Post Falls Publicly-owned Treatment Works) and in the river in Washington (Liberty Lake Publicly-owned Treatment Works, Kaiser Aluminum Industrial Wastewater Treatment Plant, Inland Empire Paper Company Industrial Wastewater Treatment Plant, and City of Spokane Advanced Wastewater Treatment Plant) contribute to the degradation of water quality in the Spokane River and reservoirs. In addition, non-point source pollution sources such as agriculture and residential and commercial development in surrounding watersheds contribute to higher biological oxygen demands and increase nutrient loading into the Spokane River. Dissolved oxygen levels have also been low (<4 mg/L) downstream of Long Lake as a result of the high biological oxygen demands and phosphorus loading combined with stratification of Lake Spokane (CH2MHILL, 2000, 2001, 2002; Golder Associates 2003a).

The increased demands for water diversions and withdrawals have impacted long-term stream flows and trends within the Spokane Subbasin. In 1999, WDOE and WDFW agreed upon a minimum in-stream flow target of 2,000 cfs at Spokane Falls (Golder Associates, Inc. 2001). This minimum target was based on 50 percent of natural flows in the Spokane River prior to the operations of Post Falls Dam (1891-1906) (Golder Associates, Inc. 2001). The non-attainment of this target flow occurs almost every year. Potential factors leading to non-attainment of minimum target flows include water consumption, diversion, and impoundment (Post Falls Dam) as well as oscillating climatic periods such as the wet and dry Pacific Decadal Oscillation (PDO) periods (Golder Associates, Inc. 2001). Research of past climatic patterns suggest that 1891-1906 was within a wet PDO period, which may indicate the minimum in-stream flow target is not representative of oscillating climatic periods (Golder Associates, Inc. 2001). Low base flow conditions contribute to elevated water temperatures, decreased habitat complexity, decreased habitat area, and low dissolved oxygen levels.

In the Spokane River between Upper Falls and Post Falls Dam substrate remains relatively unembedded; however, the presence of Post Falls Dam has reduced the entrainment of larger gravel and cobble size substrates. Historically, and presently, Coeur d' Alene Lake has intercepted significant amounts of bedload originating within the upper Spokane River watershed (Corsi, IDFG, personal communication). These types of bedload movement impediments contribute to reduced entrainment of smaller gravel and cobble allowing for a relatively homogeneous substrate composition dominated by large cobble through boulder size substrate to remain. This large substrate limits the native salmonid spawning habitat, where currently there are only three major spawning sites for rainbow trout located between Post Falls and Upper Falls Dam (Avista Corp 2000).

22.8.1.3 Historic Conditions – Little Spokane River

The Little Spokane River was historically a cold and clear lotic system flowing through narrow and fertile valleys (Gilbert and Evermann 1895). The riparian corridor was covered mostly with "a network of brushes" with some trees along the banks (for example, cottonwood, maples, and alders), while the upland community on the high hills was "sparsely covered with pines" (Gilbert and Evermann 1895).

Gilbert and Evermann (1895) reported the fish community was abundant and supported eight to ten fish species. The Little Spokane River was also classified as having "excellent salmon and trout" habitat (Gilbert and Evermann 1895). Many cutthroat trout and whitefish were observed in 1894, and local Indians harvested an estimated 40,000-50,000 salmon in October 1, 1881 (Gilbert and Evermann 1895).

Even in 1894, anthropogenic activities were starting to impact the Little Spokane River. Destruction of the riparian zone via the removal of timber and brush on riverbanks and the cultivation of land in the flood plains had noticeably increased surface erosion (Gilbert and Evermann 1895).

22.8.1.4 Current Conditions – Little Spokane River

Relative to historic conditions, current aquatic habitat and water quality conditions in the Little Spokane River and its tributaries have been heavily degraded. Various anthropogenic activities in the surrounding watershed such as timber harvest, agriculture, and urban development have undoubtedly influenced the water quality. In addition, man-made barriers in the stream channel prevent passage for resident fishes. There are no dams on the mainstem of the Little Spokane River, but there are a variety of dams on the tributaries intended for irrigation, recreation, and water quality (Golder Associates Inc., 2001). Eight reaches on the Little Spokane River are on Washington State's 1998 303(d) list exceeding clean water standards for fecal coliform, dissolved oxygen, pH, PCBs, and temperature. Water availability for human consumption, as well as adequate stream levels and flows for fish is another critical issue within this watershed.

Flows in the upper reaches of the Little Spokane River are largely influenced by tributary input (Dragoon and Deadman creeks), while the lower reaches are largely influenced by groundwater discharge. Past studies in the Little Spokane River have shown a declining trend in mean annual flows between 1950 and 1990; however, more recent hydrologic data suggest an increasing trend between 1990 and 2000 (Figures 22.7) (USGS, 2003). The declining trend in streamflow from 1950 to 1990 was originally associated with lower than average annual precipitation coupled with increased demands for water withdrawals and diversions (Dames & Moore and Cosmopolitan Engineering Group 1995). However, data from the past decade (1990-2000) showing an increasing trend in streamflow may be indicative of the influence large-scale climatic oscillations, such as wet and dry Pacific Decadal Oscillation periods, have on hydrologic regimes (Golder Associates, Inc. 2001).

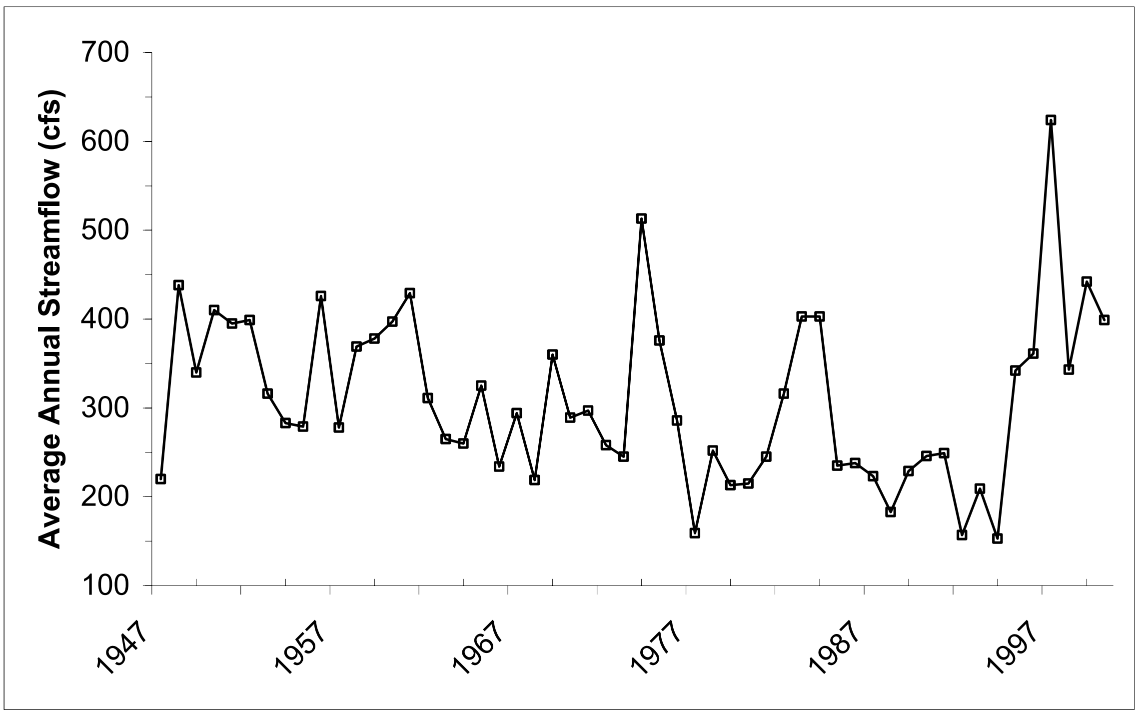

Figure 22.7. Mean annual flow (cfs) in Little Spokane River at Dartford 1947-2000. (*Source*: USGS, 2003)

In 1976, four stations were established to monitor minimum in-stream flows on the Little Spokane River (Chapter 173-555 WAC). These minimum in-stream flow targets were set at 20 percent of the exceedance level based on historical records (Table 22.23). Between 1948 and 1978, eight days/year, on the average, did not meet minimum flow targets; and the annual daily average of non-attainment of minimum base flows between 1970 and 1995 was 53 days (Dames & Moore and Cosmopolitan Engineering 1995). Periods of low streamflow below minimum in-stream flow targets most often occur during the summer. During the summer months in 2001 (a low water year) and in 2003, minimum in-stream flow targets were not met from July to October (Figure 22.8). Seven-day low flow between 1 July and 15 September 1945-2003 also shows an overall declining trend in flow with nineteen occurrences from 1965 to 2003 where flow was below the minimum in-stream summer target of 115 cfs (Figure 22.9). However, when analyzing flow at a different scale such as the mean monthly flow (1929-2001), flows remain above the minimum target levels (figures 22.8 and 22.10). It is important to note streamflow data presented only reflects one station (Dartford) and does not necessarily reflect water quality conditions of the entire Little Spokane River drainage.

Table 22.23. Minimum in-stream flow targets set in 1976 for four locations on the Little Spokane River presented in cubic feet per second

Month	Day	Elk	Chattaroy	Dartford	Confluence
January	1	40	86	150	400
	15	40	86	150	400
February	1	40	86	150	400
	15	43	104	170	420
March	1	46	122	190	435
	15	50	143	218	460
April	1	54	165	250	490
	15	52	143	218	460
May	1	49	124	192	440
	15	47	104	170	420
June	1	45	83	148	395
	15	43	69	130	385
July	1	41.5	57	115	375
	15	39.5	57	115	375
August	1	38	57	115	375
	15	38	57	115	375
September	1	38	57	115	375
	15	38	63	123	380
October	1	38	70	130	385
	15	39	77	140	390
November	1	40	86	150	400
	15	40	86	150	400
December	1	40	86	150	400
	15	40	86	150	400

(*Source*: Chapter 173-555 WAC)

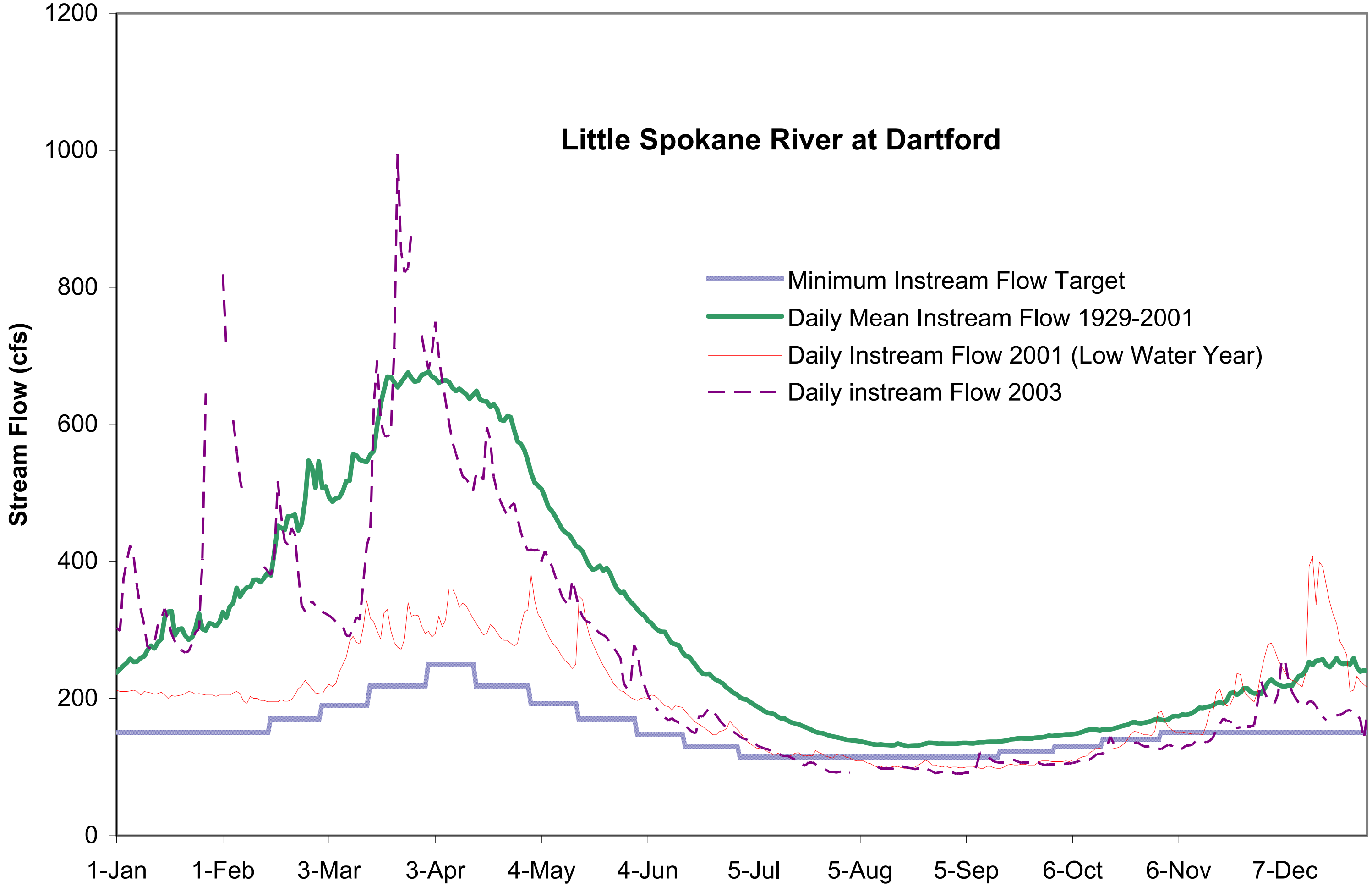

Figure 22.8. Minimum in-stream flow target, daily mean flow from 1929 to 2001, daily in-stream flow in 2001 during a low water year, and daily in-stream flow 2003 (*Source*: USGS)

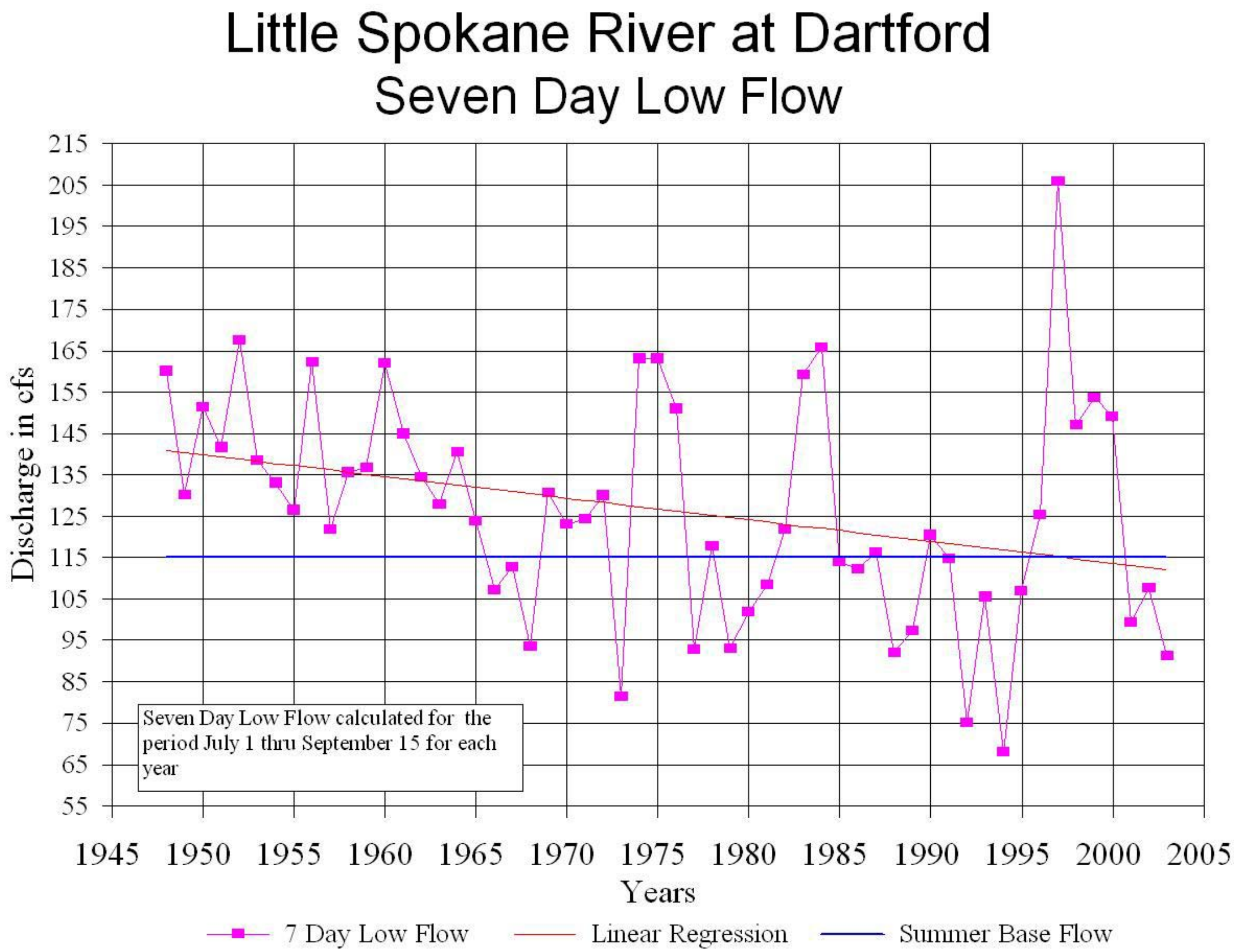

Figure 22.9. Seven-day low flow (cfs) calculated from 1 July to 15 September 1948 to 2003 (*Source:* USGS)

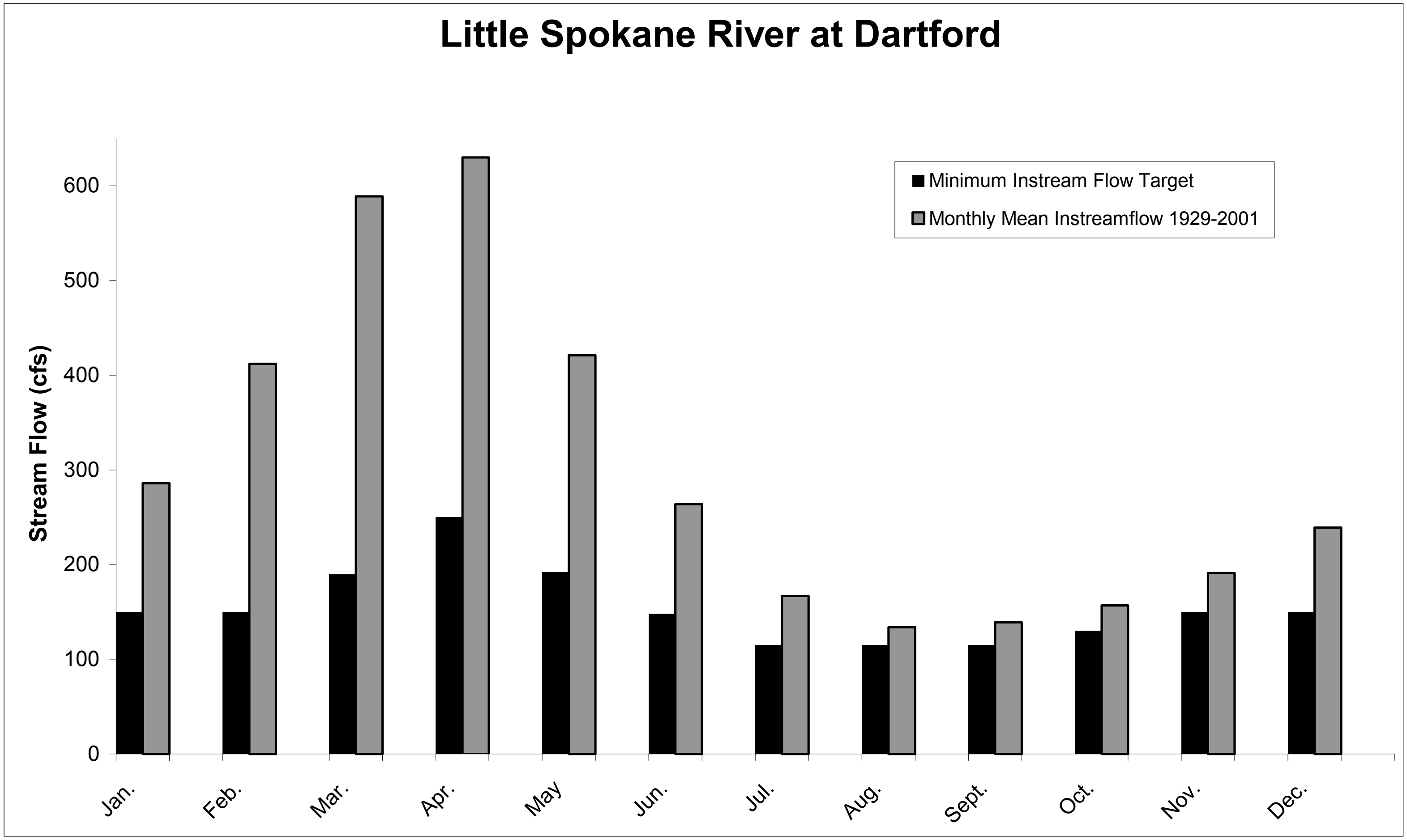

Figure 22.10. Minimum in-stream flow targets set in 1976 by WAC (Chp. 173-555) compared to monthly mean flows measured by the USGS (gage station 12431000) in the Little Spokane River at Dartford.

During the 1990s, annual in-stream flows in the Little Spokane River showed a declining trend despite WAC 173-555 seasonal closures of consumptive appropriation in the Little Spokane River Watershed (1980). Since 1997, mean annual flows appear to be increasing (see Figure 22.7), which was concurrent with a spike in the 7-day low flow from 1996 to 2000 (see Figure 22.9). The 7-day low flow data (July to September) also show flows declining below the minimum in-stream target flow of 115 cfs in 2001, 2002, and 2003 (see Figure 22.9). It is important to note that mean annual flow and summer/fall 7-day flow measurements provide different levels of information. The 7-day flow data may be more appropriate to use when evaluating whether flow conditions are adequate for local aquatic biota during critical life stages that occur under base flow conditions (July to September), whereas mean annual flows may not be able to detect the smaller seasonal changes.

In 1995, the initial Little Spokane watershed assessment conducted to evaluate surface and groundwater conditions came to the following conclusions: 1) streamflows did not meet minimum in-stream flow targets 42 percent of the time during the summer on average years (see Figure 22.8), 2) non-point source pollution was increasingly impacting the water quality within the watershed, and 3) continuous development and population growth (17 percent growth between 1990-2000) in the lower portion of the watershed increasing demands for water rights (Dames & Moore and Cosmopolitan Engineering Group 1995). As a result, an in-stream flow study was conducted in 2002 to review minimum in-stream flow targets and assess the requirements of aquatic biota (Golder Associates, Inc. 2001). This study concluded in general, minimum in-stream flow targets were reasonable for protecting fish habitat of target management species (Golder Associates, Inc. 2001).

22.8.1.5 Historic Conditions – Hangman Creek

In 1870s, prior to heavy settlement of the Hangman Creek watershed, the condition of the stream, riparian area, and floodplain are assumed to have been relatively pristine (Edelen and Allen 1998). Salmon were present in sufficient numbers to support a fishery for the Coeur d' Alene Tribe upstream near where the town of Tekoa, Washington is located (Scholz et al. 1985; Seltice 1990). However, the majority of salmon and trout were captured at the mouth of Hangman Creek, where it enters the Spokane River. Tribes would congregate at the mouth with weirs, spears, and nets to catch salmon and trout in the fall. One weir at the mouth of Hangman Creek was reported to catch 1000 salmon a day for a period of 30 days a year (Scholz et al. 1985).

In general, little is known about the historic conditions of Hangman Creek. Early records were not kept and anecdotal evidence is inconsistent. The Coeur d'Alene harvest of Chinook and steelhead in the area of what is now Tekoa, Washington (Scholz et al. 1985) suggests a clear, clean flowing stream. Stream conditions started to change in the 1880s and 1890s as an influx of settlers moved into the Hangman Creek. The gold mining in nearby communities had declined, so settlers were looking for suitable farmland. Hangman Creek provided fertile soils and opportune farming and ranching from the Palouse soils. As a result, settlers and Indians cleared the watershed of trees and tilled the fertile soils (Edelen and Allen 1998). In 1985, Gilbert and Evermann (1895) classified Hangman Creek as "an unimportant stream … found to be a small, rather filthy stream, not suitable for trout or other food-fishes, but well supplied with minnows and suckers of several species." These observations were made in Tekoa, Washington near the Idaho-Washington state line. The degraded state of Hangman Creek in 1894 was most likely the result of the strong influx of settlers and consequential land use activities, which was not described by Gilbert and Evermann (1895), such as timber harvest, agriculture, and a sugar beet processing plant near the town of Fairfield, Washington that discharged its pollutants directly into the stream (Leitz 1999). Other historical accounts of the flow in Hangman Creek vary from seasonally dry (original Public Land Survey Notes) to "almost as high in low water time as it was in high water time" (Cornelius Mooney circa 1920). The scant and contradictory evidence of the historic condition of Hangman Creek only highlights the lack of information as to its potential.

22.8.1.6 Current Conditions – Hangman Creek

Hangman Creek watershed has been significantly altered through past and present land uses including but not limited to agriculture, urban development, wetland/riparian destruction, forestry practices, and road construction. Agriculture constitutes 64 percent of Hangman Creek watershed land use and is most prevalent in the upper and middle reaches of Hangman Creek. The lower portion of Hangman Creek watershed is expected to endure 50 percent of the City of Spokane's urban growth in the next ten years (STRC 1997).

Agriculture, in the form of dryland farming and grazing, is prevalent throughout the watershed. Most croplands are plowed to the edge of the streams. Riparian zones have been severely impacted causing increased width-to-depth ratios from increased bank erosion. Channelization and vegetation removal (upland and riparian) combined with steep slopes, fine Palouse derived soils, coupled with exacerbated high runoff, have made the watershed more susceptible to streambed and upland agricultural erosion (Edelen and Allen 1998). Livestock have unrestricted access to riparian areas, tributaries, and the main channel in the watershed. Grazing impacts are not isolated to large operations in the watershed. Small "Hobby Farms" having too many head of livestock confined in a small area on stream systems also results in barren riparian meadows.

Forestry practices have also cleared much of the upper watershed creating higher peak flows and sediment loading, while decreasing summer low flows. High road densities (1.7-4.7 miles/square mile) in the lower portions and moderate road densities (0.7-1.7 miles/square mile) in the upper portions of the watershed also contribute significantly to sedimentation (refer to Section 21, Figure 21.14). The watershed within the state of Idaho has a road density of 3.9 miles/square mile (data on file, Coeur d' Alene Tribe Water Resources Program, 2003). Road density within Washington state portion of the watershed range between 0.1-4.7 miles/square mile with the highest road density in the city of Spokane (refer to Section 21, Figure 21.14).

Land use activities have reduced the quantity and quality of in-stream habitat complexity, such as natural meander patterns and large woody debris (LWD) recruitment. The cumulative effects of land use activities (agriculture, forestry) have changed the natural hydrograph, impaired downstream water quality, increased the sediment load, and degraded fish and wildlife habitat in Hangman Creek.

Hangman Creek is one of the largest contributors of bedload and suspended sediments into the Spokane River. Bedload and suspended sediments originating from Hangman Creek are transported to and deposited behind Nine Mile Dam and eventually settle out in Lake Spokane. Soletero et al. (1992) estimated Hangman Creek contributes 77 percent of the total annual sediment load to Lake Spokane. The annual suspended sediment load from Hangman Creek was estimated to be 52,000 tons in 1998 and 211,000 tons in 1999 (SCCD 2000). The increased sediment load has also more locally resulted in embedded substrate and unsuitable spawning habitat for salmonids. The principal source of suspended solids comes from non-point sources (roads, annual cropland, eroding streambanks) and consists mainly of alluvium and flood deposits that are highly erodible (SCCD 1994).

Aquatic habitats in Hangman Creek have been degraded physically and biologically with respect to the fisheries community requiring high environmental quality conditions. Hangman Creek flows are flashy, streambanks are unstable, and water quality is substandard. Results from an invertebrate inventory conducted throughout the Hangman Creek watershed found very few taxa requiring high environmental quality conditions (environmentally sensitive species) (Celto et al. 1998). These taxa were only found in two tributaries, Marshall and Rock creeks, and only found in one year (Celto et al. 1998). These biotic data reinforce the observations on degraded physical habitat conditions observed throughout the watershed.

In the lower and middle region of Hangman Creek, six reaches are on Washington State's 1998 303(d) list for exceeding EPA water standards for the following parameters: fecal coliform, pH, dissolved oxygen, and temperature. According to Washington State water criteria (WDOE), Hangman Creek also exceeds in parameters set for nutrients (nitrate, ammonia, nitrite, total phosphorus) and turbidity. The upper reaches of Hangman Creek are located in Idaho and are also listed on Idaho's 1998 303(d) list exceeding water quality criteria set for habitat alteration, sediment, nutrients, and pathogens. Low flows, high temperatures, and low dissolved oxygen concentrations also impair the upper reaches (Peters et al. 2003). Water quality at base flow and presence of trout in the upper reaches of Hangman Creek within the boundaries of Idaho are presented in Table 22.24.

Table 22.24. Summary of water quality at base-flow, compared to salmonid presence for the Hangman Creek watershed, 2002

Location	Intermittent Flow?	Max Daily Temp >20° C	DO < 7.0mg/L	TSS > 7mg/L	Are trout present?
Hangman Creek-State line	No	Yes	Yes	No	No
Hangman Creek-Nehchen Hump	No	Yes	?	Yes	No
Hangman Creek, Site 5	No	?	?	No	Yes
Hangman Creek, Site 6	No	No	No	No	Yes
Upper Hangman Creek, Site 7	No	No	No	No	?
Little Hangman Creek	No	Yes	Yes	No	No
Lower Moctileme Creek	No	Yes	No	No	No
Upper Moctileme Creek	No	No	No	Yes	No

Location	Intermittent Flow?	Max Daily Temp >20° C	DO < 7.0mg/L	TSS > 7mg/L	Are trout present?
Lower Mission Creek	No	Yes	?	No	No
EF Mission Creek	No	No	No	No	Yes
MF Mission Creek	No	No	No	No	Yes
WF Mission Creek	No	No	No	Yes	Yes
Lower Sheep Creek	No	Yes	Yes	No	No
Upper Sheep Creek	No	No	No	No	Yes
Upper Nehchen Creek	No	No	No	No	Yes
Lower Indian Creek	No	No	No	No	Yes
N.F. Indian Creek	No	No	No	No	Yes
Upper Indian Creek	No	No	No	No	Yes
E.F. Indian Creek	No	No	No	Yes	No
Upper S.F. Hangman Cr.	No	No	No	No	?
Martin Creek	No	No	No	No	?
Hill Creek	?	No	Yes	Yes	?
01SH013000 across from Hill	?	No	No	No	?
Bunnel Creek	No	No	No	No	Yes
Parrot Creek	No	No	No	No	?
Smith Creek	Yes	?	Yes	Yes	No
Lower Nehchen Creek	Yes	NA	NA	No	Yes
N.F Rock Creek	Yes	Yes	Yes	Yes	No
Mineral Creek	Yes	NA	NA	NA	No
Lolo Creek	Yes	NA	Yes	Yes	No
Tensed Creek	Yes	NA	NA	Yes	No
Upper Tensed Creek	Yes	NA	NA	No	No
Papoose Creek	Yes	NA	NA	?	?
Conrad Creek	Yes	NA	NA	No	Yes

(*Source*: taken from Table 18 in Peters et al. 2003)

22.8.1.7 Current Conditions – Chamokane Creek

No historical reference of Chamokane Creek was available regarding habitat condition or status on the presence, distribution, abundance, or condition of native salmonids. Studies in the late 1980s and early 1990s found the area in Chamokane Creek below Ford, WA to be highly productive, similar to blue ribbon trout streams (Scholz et al. 1988). A minimum in-stream flow of 24 cfs protects aquatic habitats from water withdrawals. The largest impacts to water quality included activities such as farming and logging with some grazing.

In 2002, STOI conducted a survey to investigate habitat conditions and fish presence in Chamokane Creek (Conner et al. 2003b). This survey included the area below Tshimikain Falls. Chamokane Creek has a low gradient (1.3 percent), substrate is represented predominately by cobble (40 percent) and gravel (40 percent), and habitat type is characterized as having 22 percent pool habitat, 49 percent riffle habitat, and 29 percent run habitat (Conner et al. 2003b). During the summer, mean temperatures in the lower portion of the creek remain below 20 °C (Conner et al. 2003b). In 2003, salmonids were observed throughout Chamokane Creek with an average density of 16.09 fish/100 m^2 from the mouth upstream to Ford, Washington (Conner et al. 2004). Chamokane Creek provides a unique fishery for tribal members and low densities could be related to high fishing pressure. Additional information regarding land use activities and their influence on water quality in the Chamokane Creek drainage is available in a Watershed Plan (STOI, personal communication, 2004).

22.8.1.8 Current Conditions – Lake Spokane Reservoir

For a historical description of the environmental conditions in Lake Spokane prior to impoundment, refer to historic conditions in the Spokane River.

The completion of Long Lake Dam in 1915 established the 39-km long reservoir known as Lake Spokane. The alteration in hydrology from a free-flowing river system ideal for native salmonids to a slow moving system has modified environmental conditions (velocity, temperature, dissolved oxygen, thermal stratification) and has allowed for the persistence of introduced nonnative warmwater species (for example, smallmouth bass, largemouth bass, yellow perch, black crappie). Currently, both warm- and cool-water fish species inhabit Lake Spokane, which is managed as a mixed species fishery.

Water quality impairment in Lake Spokane is a great concern since it impacts the recreational value of the fishery. The lake has a long history of water quality issues preceding the 1960s (Cunningham and Pine 1969; Soltero et al. 1975; Anderson and Soltero 1984; Jack and Roose 2002, as cited in Osborne et al. 2003). Before secondary treatment of wastewater, Lake Spokane was classified as eutrophic. After the commencement of secondary wastewater treatment in 1977, phosphorus loading was reduced declassifying Lake Spokane to a mesotrophic or meso-eutrophic depending on flushing rates and season. A chronology of events that have had the most significant impacts on water quality in Lake Spokane are listed below (Cusimano 2004):

> **Prior to 1958**: City of Spokane discharged raw sewage into the river
> **1958**: City of Spokane built the first facility for primary wastewater treatment.
> **1976-1978**: Raw sewage effluent was discharged into the Spokane River and resulted in toxic blue-green algal blooms and the entrapment of 126 metric tons of phosphate in Lake Spokane.
> **1977**: City of Spokane constructed an advanced wastewater treatment facility (secondary wastewater treatment with 85 percent phosphorus removal).
> **1979:** A Spokane River wasteload allocation study for all sources discharging phosphorus was a result of a decision by the Spokane Supreme Court.
> **1987**: Department of Ecology recommended 259 kg/day TMDL for Lake Spokane.

1989: A Memorandum of Agreement was endorsed for control measures to be implemented by the point-source dischargers. A Technical Advisory Committee was created to manage phosphorus concentrations.
1990: Regional phosphate bans.
1992: EPA approved 25 µg/L total phosphorus TMDL for Lake Spokane.

Past studies have found phosphorus loading and upstream sources (Little Spokane River, Hangman Creek, and the mainstem Spokane River drainages) to be linked to the low dissolved oxygen, algal blooms, increase of aquatic macrophytes, and poor quality conditions in Lake Spokane (Cunningham and Pine 1969; Soltero et al. 1992). A phosphorus budget developed by Soletero et al. (1992) found upstream sources from the Little Spokane River and Spokane River contribute about 94 percent of the total phosphorus loading into Lake Spokane while groundwater and sediments release contribute about 5 percent and less than 1 percent, respectively. Nuisance algal blooms and anoxic conditions in the hypolimnion are further exacerbated by inflow and lower flushing rates between June to October resulting in thermal stratification and a complex mixing regime. In 2003, WDOE conducted a study to evaluate the existing total phosphorus criterion and associated TMDL for Lake Spokane. Publication of the results was recently made available in 2004 (Cusimano 2004, Available: http://www.ecy.wa.gov/biblio/0403006.html).

22.8.1.9 Current Conditions – Spokane Arm
For a historical description of the environmental conditions in the Spokane Arm prior to the construction of Grand Coulee Dam, refer to historic conditions in the Spokane River.

The most current information about the Spokane Arm is presented in *The Lake Roosevelt Fisheries Evaluation Program 2000 Annual Report* (Lee et al. 2003). Lee et al. (2003) report significantly higher mean water temperatures in the Spokane Arm (13.5 ˚C) (outlet of the Spokane River) compared to Lake Roosevelt (11.4 ˚C). In 2000, Spokane Arm shoreline temperatures were significantly greater than pelagic temperatures between June and September, and both shoreline and pelagic temperatures were greater than 17 ˚C during this time (Lee et al. 2003). The annual mean level of dissolved oxygen (DO) in the Spokane Arm was 9.2 mg/L (Lee et al. 2003). The lowest DO concentrations were measured at a depth of 33 m (2.9 mg/L) while surface DO levels were at 8.9 mg/L and the overall mean DO concentration in the water column was at 6.6 mg/L (Lee et al. 2003). Water quality standards of Washington State and STOI require the Spokane Arm dissolved oxygen levels to remain at or be greater than 8 mg/L (Lee et al. 2003). Fish require a minimum of 5 mg/L (Lasee 1995, as cited in Lee et al. 2003). Although low DO concentrations were concurrent with higher summer water temperatures, Lee et al. (2003) suggest the decomposition of summer algal blooms were correlated to the low dissolved oxygen levels rather than warm water temperatures. In 2000, the mean TDG saturation was highest (112 percent) from late March to mid-May in the Spokane Arm (STOI unpublished data). During the sampling period (late March to mid-May), mean TDG saturation varied from 109 to 119 percent (late March, 109 percent; mid-April, 119 percent; early May 116 percent; mid-May 116 percent). The annual mean for TDG in the Spokane Arm was 105.2 percent. The maximum TDG levels at the tailrace of Little Falls Dam was between 125-134 percent from 1999-2001 (CH2MHILL, 1999, 2000, 2001). High TDG levels are the suspected cause of net pen fish kills within the Spokane Arm of

Lake Roosevelt in 1999 and previous years (Tim Peone, personal communication, 2004). The Spokane Tribe of Indians has not been able to successfully raise fish in net pens in Little Falls Pool.

For more information regarding current environmental conditions in Lake Roosevelt refer to discussions on the Upper Columbia Subbasin in Section 30.9.1 Environmental Conditions.

22.8.2 Out-of-Subbasin Effects and Assumptions

The function and structure of the Spokane Subbasin aquatic ecosystem have been altered from activities within and outside of the Spokane Subbasin. The historic hydrograph of the Spokane River and drainage has been altered by river regulation. Dams without fish passage facilities on the Columbia and on the mainstem of the Spokane River have extirpated anadromous salmonids from the Spokane Subbasin and restricted historic ranges of other native salmonids. The dams on the Columbia River have isolated fish populations and fragmented important habitat for the completion of different life stages (spawning, rearing, migration). Introduction of nonnative stocks and species has likely altered the genetic integrity of the few remaining native stocks of salmonids. Land activities upstream such as mining in the Coeur d' Alene Subbasin have contributed to pollution problems in the Spokane River. Point source and non-point source (introductions of PCBs, mercury, lead, zinc, and cadmium) have degraded water and sediment quality conditions in many parts of the watershed.

22.9 Limiting Factors and Conditions

The development of hydropower facilities and other barriers without fish passage facilities on the Spokane River and tributaries has been the principal factor limiting genetic exchange, distribution, and habitat connectivity for focal species and other native fish species. Barriers on the stream channel concurrent with land use activities have modified and degraded aquatic habitat conditions. Below is a description of factors specific to the Spokane River, Little Spokane River, Hangman Creek, and Lake Spokane resulting in less than optimal habitat conditions and are currently identified as limiting factors for focal species. No data regarding change in habitat conditions or identifying limiting factors was available for Chamokane Creek drainage or Little Falls Pool. Refer to Section 30.10 Limiting Factors and Conditions in Lake Roosevelt for additional information relevant to limiting factors and conditions in the Spokane Arm.

22.9.1 Physical Habitat Alterations/Limiting Habitat Attributes

QHA was utilized to compare historic versus current physical stream conditions with respect to 11 habitat attributes. Details of the analysis method are provided in Section 3. QHA model does not determine which habitat attributes are most biologically limiting, but does identify which physical attributes have undergone the greatest deviation from the reference stream/reach condition. These results, coupled with knowledge of local biologists and biological status and interactions of the focal species, can assist in identifying key limiting factors. This section provides QHA results on a subbasin level for the Spokane Subbasin. Results specific to each focal species are discussed in each focal species section.

As shown on Map SK-7 (located at the end of Section 22) waters in the Spokane Subbasin were divided into subwatersheds and reaches for QHA analysis. A few areas (shown in Map SK-1 in blue) were not analyzed with the QHA model because of a lack of fish-bearing streams. Using the QHA model, habitat conditions were analyzed where mountain whitefish, rainbow trout, and kokanee were distributed historically and currently. Table 22.25 provides a list of reaches with less than optimal (value = 4) reference conditions.

Table 22.25. Reaches were ranked as containing less than optimal habitat conditions in the reference condition

Sequence	Reach Name	Habitat Attribute < Optimal
2	Sand Creek	Obstructions
6	Upper Chamokane	Obstructions
7	Little Chamokane	Obstructions
8	Camas	Obstructions
11	Lower Chamokane	Obstructions
12	Rail Ck/Walkers Prairie	Obstructions
23	Bear/Cottonwood/Pell	Obstructions
24	West Branch Little Spokane Tribs	Obstructions
30	Lower Spring Creek	Obstructions
33	Lower Coulee	Riparian Condition, Fine Sediment, Low Flow
36	Lower Deep Creek	Riparian Condition, Fine Sediment, Low Flow
58	Mainstem Little Spokane River,Upper	Obstructions
60	West Branch Little Spokane	Obstructions
61	Mainstem Hangman - Upper	Fine Sediment
62	Mainstem Hangman - Middle	Fine Sediment, High Temperatures
63	Mainstem Hangman - Lower	Fine Sediment, High Temperatures

The habitat parameters with the greatest deviation from reference conditions vary by species and are presented in Table 22.26. This table should be interpreted as an indication of the types of habitat parameters problematic for the focal species in the Subbasin as a whole. Some reaches had more than one habitat parameter ranked as being equally deviant from the reference, hence the number of reaches listed adds up to more than the total number of reaches ranked. Most reaches had more than one habitat parameter currently ranked less than the reference. Table 22.26 only lists those habitat parameters having the greatest deviation from reference, not all parameters less than optimal. Fine sediment appears to be the most common problem throughout the watershed and for all species.

Table 22.26. Habitat conditions with the greatest deviation from reference conditions as presented in the QHA model output for each focal species in Spokane Subbasin. In parentheses are the number of reaches or watersheds with the particular habitat attribute exhibiting the largest deviation.

Mt. Whitefish (39)	Kokanee (13)	Redband/Rainbow (49)
Fine Sediment (30)	Fine Sediment (7)	Fine Sediment (26)
High Flow (5)	Obstructions (3)	Habitat Diversity (18)
Pollutants (4)	Pollutants (2)	Low Flow (15)
Obstructions (2)	Channel Stability (1)	Pollutants (5)
Low Flow (1)	Low Flow (1)	Channel Stability (3)
Channel Stability (1)		

For a more detailed analysis of limiting habitat attributes identified for each focal species (mountain whitefish, kokanee salmon, redband/rainbow trout), refer the sections on focal species where QHA results are discussed.

22.9.2 Description of Historic Factors Leading to Decline of Focal Species[3]

22.9.2.1 Spokane River

In the Spokane River above Spokane Falls, most of the habitat degradations are related to water quality conditions. Increased water temperature, low dissolved oxygen concentrations and toxic levels of arsenic, cadmium, mercury, lead and zinc all are parameters of the Spokane River watershed listed on the Washington State's 1998 303(d) list. These factors impact fish populations and invertebrate populations potentially creating a negative synergistic effect on the aquatic community.

Low base flows likely result from an amalgamation of factors such as poor land use practices in headwater areas, water demands and consumption from expanding urban areas in the Subbasin, and impoundment by Post Falls Dam. Land use over the last 100 years, water diversions, and dams have altered the spring freshet such that the current annual peak flow event occurs relatively rapidly rather than the natural condition of gradual run-off. This situation creates low, late summer base flows, limiting habitat area and complexity. Additionally, low base flows contribute to degraded water quality conditions such as increased water temperature and reduced dissolved oxygen (less than 8 mg/L).

Limiting factors in the Spokane River below Spokane Falls are generally related to dams and reservoir inundation. Warm water conditions and low dissolved oxygen levels from upstream are exacerbated by reservoirs. Past and present wastewater practices have contributed and continue to contribute nutrients to the system allowing aquatic vegetation to thrive in low velocity habitats. Accumulation of decaying aquatic vegetation creates biological oxygen demands, thus exacerbating the already low dissolved oxygen concentrations and has exhibited anaerobic conditions in some areas.

The turbine intakes are positioned low enough that the water discharged down the river has a lower temperature, and a lower dissolved oxygen because Long Lake stratifies and becomes anoxic in the hypolimnion. High levels of TDG are a major problem below

[3] Large portions of Section 22.9 were contributed to by the Spokane River Subbasin Summary Report (2000) pp. 13-15.

Long Lake Dam with levels reaching over 139 percent saturation (CH2MHILL 1999, 2000, 2001; Golder Associates 2003a) when the standard is 110 percent. A continual network of reservoirs prevents the dissolved gas from reaching equilibrium.

As a result of habitat modification (for example, temperature, flow regimes) nonnative species are in many regards better adapted for the available habitats. In addition, they provide important recreational fishing opportunities as well as cultural and economic benefits. As a result of these introductions, many of the nonnative game species have established self-sustaining populations and often out-compete and/or prey upon the native species.

22.9.2.2 Little Spokane River

Several reaches within the Little Spokane drainage are included on the Washington State 1998 303(d) list for violating water standards (temperature, pH, dissolved oxygen, fecal coliform, and PCBs). Approximately half of the drainage (over 400 miles) has substandard or impaired water quality throughout the year (Dames & Moore and Cosmopolitan Engineering Group 1995). Water quality appears to be good in only 16 percent (126 miles) of the watershed. The remaining 26 percent (205 miles) of the watershed has not yet been analyzed or data was insufficient (Dames & Moore and Cosmopolitan Engineering Group 1995).

22.9.2.3 Hangman Creek Watershed

As a result of past and current land practices, modifications and physical changes to the stream channel and floodplain, Hangman Creek drainage is described to have “flashy” flow conditions, unstable banks, and substandard water quality. Past and current land use activities continue to impact and degrade the aquatic habitat in the Hangman Creek drainage limiting the distribution, abundance, and presence of salmonids (for example, rainbow trout). Water quality is generally poor and state standards for fecal coliform, temperature, pH, and dissolved oxygen are often not in compliance (SCCD 1994, 1999, 2000; WDOE 1998). Other water quality issues that have been recently identified but not included in the 1998 303(d) lists consist of high sediment load, turbidity, ammonia, low flows, and total phosphorus. In the upper Hangman Creek drainage in Idaho, low flows, low dissolved oxygen, high levels of total suspended solids (chronic and acute), and high temperatures impair stream conditions and salmonid distribution (see Table 22.24). Of the streams supporting salmonids, Indian Creek is the only one where stream conditions are not impaired to the point of limiting salmonid distributions.

22.9.2.4 Little Falls Pool

Little Falls Dam is a “run of the river” dam that generally operates within the upper portions of the reservoir. The shift in fish assemblage and decline in native salmonid abundance is attributed to habitat alteration as a result of land use activities influencing upstream watersheds (for example, Hangman Creek and Little Spokane River) and regulation of flow from dam operations on the Spokane River. Two key water quality alterations impacting conditions in Little Falls Pool include TDG and dissolved oxygen levels. During the spring months, TDG saturation often exceeds the 110 percent water quality standard while dissolved oxygen levels fall below 4 mg/L during the summer and fall months (CH2MHILL 1999, 2000, 2001). High TDG occurs primarily in the spring months (CH2MHILL 1999, 2000, 2001).

22.9.2.5 Lake Spokane Reservoir

The construction of the Long Lake Dam prevents upstream migration of fish and has fragmented native salmonid populations. The transformation from a free flowing river to a lacustrine system has also changed with community dynamics allowing for nonnative fish species to out-compete and displace native species. Water conditions have also been altered allowing for a warmwater fishery previously inhabited by only coldwater fishes.

The fluctuation in reservoir water conditions during the winter can potentially limit the stability of warmwater species populations, such as the focal species largemouth bass. Potential factors limiting largemouth bass recruitment include elevated predation pressures, winter induced-stressors, zooplankton entrainment, and unsuitable over-wintering habitat. All of these factors are related to annual drawdowns. Lower water levels increases the proportional stock density of predatory fish in Lake Spokane, reduces cover and shelter for juveniles, and elevates stress for juveniles that can result in mortality (Osborne et al. 2003).

22.9.2.6 Spokane Arm of Lake Roosevelt

The construction of Chief Joseph and Grand Coulee dams have prevented the upstream migration of salmonids and other fish species into the Spokane Arm, resulting in a significant reduction of native salmonid species. Once abundant anadromous salmon and steelhead have been largely replaced by nonnative salmonids (brown trout, brook trout, coastal rainbow trout, etc). Pacific lamprey have been extirpated from the lower Spokane River, and white sturgeon numbers have declined significantly over the past 60 years. Additionally, native resident fish populations have declined in the Spokane Arm, impacted through habitat alteration and degradation, degraded water quality and by the introduction of nonnative, largely warmwater fish species. The transformation from a free-flowing environment to a more lacustrine system has negatively impacted water quality through increased water temperatures and TDG and decreased dissolved oxygen levels. The salmonid community structure of the lower Spokane River has shifted from a redband trout, bull trout, mountain whitefish, and westslope cutthroat trout assemblage to one comprised primarily of coastal rainbow trout, kokanee salmon, lake whitefish, brown trout, and brook trout (STOI unpublished data). Historically, native non-salmonid species assemblages were comprised of burbot and white sturgeon. Currently, non-salmonid species assemblage is primarily comprised of species such as smallmouth bass (nonnative), walleye (nonnative), and largescale suckers (STOI unpublished data). Native minnow (Cyprinidae) assemblages have been all but depleted from the Spokane Arm, likely a result of habitat degradation and predation by nonnative species.