Population Delineation and Characterization

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Wenatchee River Basin

Current and historic distribution (spatial structure), abundance, productivity, and diversity of each population

1. Spring chinook

Distribution

Historic

Mullan (1987) felt that because of the geology of the region upstream of the current Grand Coulee Dam site, that that spring chinook were not very abundant, with the possible exceptions of the San Poil and Spokane River basins. Fulton (1968) described the historic distribution of spring chinook in the Wenatchee River. He relied heavily on the fieldwork of French and Wahle (1965) for his information on distribution. He combines descriptions of spring chinook distributions in the Wenatchee River basin as: Most of main river; portions of Chiwawa, Little Wenatchee, and White rivers; and Nason, Icicle, and Peshastin creeks.

Current distribution

Spring chinook currently spawn and rear in the upper main Wenatchee River upstream from the mouth of the Chiwawa River, overlapping with summer chinook in that area (Peven 1994). The primary spawning grounds of spring chinook in the Wenatchee River, in order of importance, are: Chiwawa River, Nason Creek, Little Wenatchee, and White River (Icicle River is not included because it is believed that most of the spawning population from this stream consist of adult returns to the Leavenworth NFH (Peven 1994)).

Abundance

Historic

Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 588,000-spring chinook was the best estimate of pre-development run sizes. Spring chinook were relatively abundant in upper Columbia River tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

Spring chinook counting at Rock Island Dam began in 1935. Numbers (adults and jacks) in the period 1935-39 averaged just over 2,000 fish. Average counts fluctuated on a decadal average from the 1940s to 1990s from just over 3,200 (1940s) to over 14,400 (1980s), with recent counts (2000-2002) averaging almost 29,000. The long-term average of spring chinook passing Rock Island Dam is just over 8,900.

Current

In the Wenatchee River, redds counts have fluctuated widely since 1958, the earliest date for which systematic data were available. Spring chinook redd counts averaged 637, 564, 621 every ten years between 1958 and 1990. In the 1990s, the average dropped to 232, but has increased to over 1,100 since 2000. The long-term average is 560 over the period 1958-2002.

Ford et al. (2001) recommended an interim recovery level for spring chinook of the Wenatchee River at an eight-year geometric mean of 3,750 natural spawners per year.[1] LaVoy (1994) estimated the average number of fish per redd as 2.2. Applying that expansion to the estimated (unadjusted for harvest prior to the 1970s) redd counts, escapement has ranged between 70 to over 4,100, with a long-term average of over 1,200.

Productivity

Historic

Historic production of spring chinook is difficult to determine, although it was most likely not as high as sockeye or late-run chinook. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan 1987; Mullan et al. 1992), it is assumed that historic production of salmon was high, especially for summer/fall chinook and sockeye.

Current

Current productivity is affected by loss, or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Mullan et al. (1992) postulated that current production may not be greatly different than historic for spring chinook. Caveats to this postulate are that native coho are extinct, production comes at a higher cost in terms of smolt survival through the mainstem corridor, and that harvest is drastically reduced (e.g., over 80% in the lower Columbia River in the late 1930s, early 1940s). However, recent estimates of natural replacement rates for spring chinook suggest that they are not replacing themselves in most years until the broods of the late 1990s (A. Murdoch, personal communication).

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[1] Ford et al. (2001) based their recommendation on values that fell within the range of habitat capacity estimates, historical run sizes (adjusted for lower river harvest, which ranged between 25-64% prior to the 1970s), and simple population viability analysis (McElhaney et al. 2000)

There are still habitat areas in need of restoration (e.g., Peshastin and Mission creeks) within the Wenatchee Basin. By increasing known areas in need of restoration, it is reasonable to assume that production of spring chinook would increase.

Diversity

Because some areas within the Wenatchee Basin are in need of habitat improvements, diversity within the basin is believed to be lower than historic. While the Wenatchee population is still believed to be an *independent population* (see definition in Appendix _), increased habitat would most likely increase spatial and life history diversity.

Currently, genetic sampling suggests that the White River subpopulation may be distinct from other subpopulations within the Basin (Appendix _).

Summary

Spring Chinook[2]

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	High	Mod-high	Moderate	High
Current	Mod-high	Low-mod.	Low-mod.	Moderate

2. Summer Steelhead

Historic distribution

Steelhead historically used all major (and some minor) tributaries within the Upper Columbia Basin for spawning and rearing (Chapman et al. 1994 CPa). Fulton (1970) described steelhead using the Wenatchee River and eight of its tributaries: lower Mission, Peshastin, Icicle, Chiwaukum, Nason creeks, and the Chiwawa, Little Wenatchee, and White rivers.

Current distribution

Beginning in 2001, WDFW has been conducting spawning ground surveys for steelhead in the Wenatchee River (Murdoch et al. 2001). This effort is in conjunction with hatchery evaluations that are currently taking place within the Wenatchee River Basin for Chelan County Public Utility District (PUD) funded mitigation efforts. Current spawning distribution in the Wenatchee Basin, in order of importance appears to be: the Wenatchee River between the Chiwawa River and Lake Wenatchee, Nason, Chiwawa, and Icicle creeks. Other tributaries were not surveyed, such as the Little Wenatchee and White rivers, or Chiwaukum, Peshastin, or Mission creeks, but are most likely used by steelhead for possible spawning and rearing. In 2004, spawning surveys for steelhead are going to be expanded into these and other areas within the subbasin.

Abundance

[2] The values within the table are qualitative, based on the best information available. All species are considered within this qualitative approach (i.e., abundance of bull trout is relative to sockeye salmon).

Historic

Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 554,000 steelhead (for the entire Columbia Basin) was the best estimate of pre-development run sizes. Steelhead were relatively abundant in upper Columbia River tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

Steelhead counts began at Rock Island Dam in 1933, and annual counts averaged 2,800 between 1933 and 1939 (these numbers do not reflect large fisheries in the lower river that took place at that time, estimated by Mullan et al. (1992) as greater than 60%). Average decadal numbers changed little in the 1940s and 1950s (2,600 and 3,700, respectively). Large hatchery releases began in the 1960s, and the average counts increased to 6,700. In the 1970s, counts averaged 5,700 and 16,500 in 1980s (record count of about 32,000 in 1985). In the 1990s, counts decreased, following a similar trend as chinook, to 7,100, while, similar to chinook, they have increased substantially so far in the 2000s, with an average of over 18,000 (a high of 28,600 in 2001).

Current

In 2002, Murdoch and Viola (2003) found a total of 475 steelhead redds upstream of Tumwater Dam, with most of them found in the Wenatchee River. Ford et al. (2001) recommended interim recovery levels of about 2,500 naturally produced spawners for the Wenatchee River.

Productivity

Historic

Historic production of steelhead is difficult to determine, although it was most likely not as high as sockeye or late-run chinook. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan et al. 1992), it is assumed that historic production of steelhead was higher than current.

Current

Current productivity is affected by loss, or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Mullan et al. (1992) postulated that current production may not be greatly different than historic for steelhead. Caveats to this postulate are that native coho are extinct, production comes at a higher cost in terms of smolt survival through the mainstem corridor, and that harvest is drastically reduced. However, recent estimates of natural replacement rates for steelhead suggest that they are not replacing themselves in most years until the broods of the late 1990s (A. Murdoch, personal communication).

There are still habitat areas in need of restoration (e.g., Peshastin and Mission creeks) within the Wenatchee Basin. By increasing known areas in need of restoration, it is reasonable to assume that production of steelhead would increase.

Diversity

Because some areas within the Wenatchee Basin are in need of habitat improvements, diversity within the basin is believed to be lower than historic. While the Wenatchee population is still believed to be an *independent population* (see definition in Appendix _), increased habitat would most likely increase spatial and life history diversity.

Currently, genetic sampling has not found any differences among steelhead within the basin.

Summary

Steelhead (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	High	Mod-high	Moderate	High
Current	Mod-high	Low-mod.	Low	Moderate

3. Summer/fall chinook

Historic distribution

Summer/fall chinook historically used the mainstem of the Wenatchee River, from its mouth to Lake Wenatchee (Craig and Suomela 1941; Fish and Hanavan 1948).

Tumwater Dam (RM 32.7) and Dryden Dam (RM 17.6) on the Wenatchee River were partial obstacles to upstream passage of adults before 1957. Between 1957 and 1986, some observers considered fish passage facilities inadequate and new facilities were constructed in the late 1980s. Mullan et al. (1992) were skeptical that the dams were serious obstacles before the fishways were improved.

Current Distribution

Summer/fall chinook salmon currently spawn in the Wenatchee River between RM 1.0 and Lake Wenatchee (RM 54). Within that area the distribution of redds of summer/fall chinook has changed. Peven (1992) notes that, since the early 1960s, numbers of redds have decreased downstream from Dryden Dam (RM 17.5), while they have increased upstream from Tumwater Dam (RM 32.7). On a smaller scale, Peven (1992) reports that, since at least 1975, densities of redds (i.e., redds/mile) were highest near Leavenworth (RM 23.9-26.4) and in Tumwater Canyon (RM 26.4-35.6).

Abundance

Historic

Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 3.7 million summer chinook, (for the entire Columbia Basin) was the best estimate of pre-development run sizes. Summer/fall chinook were very abundant in upper Columbia River and tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

Historically, the late spring and summer components of the Columbia River chinook populations were the most abundant and heavily fished (Thompson 1951, Van Hyning 1968, Chapman 1986). Overfishing in the lower Columbia River rapidly depressed summer-run chinook. Spawning and rearing habitat extirpation and destruction accelerated the decline.

Decadal averages of summer/fall chinook escapements at Rock Island Dam from 1933 through 2002 show a rising trend. Harvest rates in the 1930s and 1940s were very high in the lower river fisheries, and no doubt had a large impact on the escapement at Rock Island (Mullan 1987). In 1951, when harvest rates in zones 1-6 (lower Columbia River) were reduced, numbers increased dramatically. Between the 1930s (starting in 1933) and 1960s (excluding 1968 and 1969)[3], total (adults and jacks) decadal average numbers of summer/fall chinook rose from just over 7,000 to almost 28,000. Numbers remained high in the 1970s until the mid-1980s, when they declined through the 1990s and have shown a sharp increase in the 2000s.

In the 1960s, dam counts became available at Rocky Reach Dam (1962) and Wells Dam (1967). These project counts of total summer/fall chinook show a different trend than

[3] Unfortunately, there were no counts at Rock Island Dam between 1968 and 1972.

Rock Island, which suggests the difference being the fish that spawn in the Wenatchee River were heavily affecting the trend at Rock Island Dam.

Current

Between the mid-1980s and through the 1990s, summer/fall chinook total numbers declined at Rock Island, Rocky Reach, and Wells dams. The magnitude of the decline increased the further upstream the counts were. This suggests that the run into the Wenatchee River remained high or increased, while runs ascending upstream of Rocky Reach, and Wells did not. The run of summer/fall chinook into the Wenatchee River has continued to increase since redd counts began in 1960.

The escapement into the Wenatchee River appears to be still primarily composed of naturally produced fish based on carcass sampling. The Eastbank Hatchery program releases fish in the lower Wenatchee River (near Dryden), primarily for the purpose of reseeding the lower river habitat.

Productivity

Historic

Historic production of late-run chinook is difficult to determine, it was thought to be very high. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan 1987; Mullan et al. 1992), it is assumed that historic production of late-run chinook was higher than current.

Current

Current productivity is affected by loss, or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Mullan et al. (1992) postulated that current production may not be greatly different than historic for late-run chinook. Caveats to this postulate are that production comes at a higher cost in terms of smolt survival through the mainstem corridor, and that harvest is drastically reduced.

While spawning habitat does not appear to be limiting summer/fall chinook in the Wenatchee Basin, potential changes to geo-fluvial processes may effect immediate rearing (or refuge) areas in the lower river. It is unknown what affect this has on production.

Diversity

Because some areas within the Wenatchee Basin are in need of habitat improvements, diversity within the basin may be lower than historic. While the Wenatchee population is still believed to be an *independent population* (see definition in Appendix _), increased habitat would most likely increase life history diversity.

Currently, genetic sampling has not found any differences among late-run chinook within the basin.

Summary

Summer/fall chinook (see footnote 2)

	Distribution	Abundance	Productivity	Diversity
Historic	High	Very high	Very high	High
Current	High	High	High	Mod.-high

4. Sockeye salmon

Historic Distribution
Historically, populations of sockeye salmon spawned in the Wenatchee Basin in the White and Little Wenatchee rivers (Mullan 1986). Some spawning may have occurred within and downstream of the lake, but evidence is inconclusive (Chapman et al. 1995).

Current Distribution
The principal spawning areas for Wenatchee Basin sockeye are approximately in the lower 4 miles of the Little Wenatchee River and the lower 5 miles in the White River (Peven 1992). Some fish spawn in the Napequa River (a tributary of the White River) too.

Abundance
Historic
Chapman (1996) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 2.6 million sockeye, (for the entire Columbia Basin) was the best estimate of pre-development run sizes. Sockeye were very abundant in upper Columbia River tributary streams (Yakima, Wenatchee, Okanogan, and Arrow Lakes) prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

By the beginning of the twentieth century, it appears that most of the sockeye entering the Columbia River were headed to the Arrow Lakes region in British Columbia (WDF 1938). In the mid-1930s, WDF counted fish ascending Tumwater Dam in the Wenatchee

River, and Zosel Dam in the Okanogan River. These counts suggested that 85-92% of the sockeye counted over Rock Island Dam in the same years where headed to spawning areas other than the Wenatchee and Okanogan basins.

Mullan (1986) quotes Rich (1940CPa, 1940CPb), who reviewed the sockeye fishery between 1892-1938, *the sockeye runs were greatly reduced as long ago as 1900, since which time there has been no marked change in the size of the catch.* Mullan (1986) suggests that the landings of sockeye may suggest otherwise, but that harvest rates in the lower river were undoubtedly high during that time; Rock Island Dam counts only accounted for 16% of the fish entering the Columbia River between 1933-1937, and in 1934 over 98% of the sockeye entering the river were harvested.

Mullan (1986) points out that commercial catches of sockeye after 1938 were still extreme, where escapement past the fisheries between 1938 and 1944 was mostly below 20%, and in 1941 was only 1%. In 1945, escapement increased and remained relatively high, between 25-50%. Since 1960, escapement has exceeded catch on a regular basis.

Current

Since 1938, the percentage of sockeye that has entered the Columbia River (minimum run) that have passed Rock Island Dam has varied from less than 1% (1941) to greater than 95% (1990s). The mean percentage of fish ascending the Columbia past Rock Island Dam has increased since 1938. Between 1938 and 1944, only 14.5% of the sockeye estimated to have entered the Columbia River were counted at Rock Island Dam (see above). The percentage has steadily grown since then, approaching 100% in most recent years.

Even though there appears to be problems associated with the spawning ground counts (see Appendix), they may be used as an index of abundance in the two systems. In the Wenatchee, it appears the run may be stable.

Decadal averages have shown a general increase in numbers of fish ascending Rock Island Dam.

Allen and Meekin (1980) report the escapement goal of 80,000 sockeye over Priest Rapids. Currently, the escapement goal at Priest Rapids is 65,000 (Devore and Hirose 1988). The Columbia River Technical Advisory Committee (TAC) changed the goal in 1984 from 80,000 fish (1933-1966 at Rock Island, and from 1967 to the present at Priest Rapids) to the current 65,000, which under most conditions equates to 75,000 sockeye over Bonneville Dam. LaVoy (1992) showed the escapement goal of the Wenatchee population as 23,000. Using the various dam counts, escapement has been met in most years since 1970, but if spawning ground counts are used, the Wenatchee system is not meeting escapement goals in most years.

Productivity

Historic

Historic production of sockeye is difficult to determine, it was thought to be very high. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan 1987; Mullan et al. 1992), it is assumed that historic production of sockeye was higher than current.

Current

Current productivity is affected by loss, or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Mullan et al. (1992) postulated that current production may not be greatly different than historic for sockeye in the Wenatchee Basin. Caveats to this postulate are that production comes at a higher cost in terms of smolt survival through the mainstem corridor, and that harvest is drastically reduced.

While spawning habitat does not appear to be limiting sockeye in the Wenatchee Basin, rearing in Lake Wenatchee is. Being a highly oligotrophic lake, production may never have been high in this particular subbasin, compared to other systems of the upper Columbia River region..

Diversity

Diversity of the Wenatchee independent population is believed to be robust, especially since the Grand Coulee Fish Maintenance Project, about 60 years ago, when mixed stocks were released within the basin.

Summary

Sockeye (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	High	Very high	Mod.-high	High
Current	High	High	Mod.-high	Mod.-high

5. Coho salmon

Coho salmon are considered extirpated in the Wenatchee River (Fish and Hanavan 1948, Mullan 1984). Mullan (1984) estimated that upstream of the Yakima River, the Methow River and Spokane River historically produced the most coho, with lesser runs into the Wenatchee and Entiat.

Recently, the Yakama Indian Nation has begun a more concerted effort to reintroduce coho into the Upper Columbia (Scribner et al. 2002). Preliminary results so far are promising. Current efforts to rebuild coho are primarily in the Wenatchee and Methow basins, where the YIN program is concentrated.

6. Pacific lamprey

Historic distribution

Historical distribution of Pacific lamprey in the Columbia and Snake Rivers was coincident wherever salmon occurred (Simpson and Wallace 1978). It is likely that Pacific lamprey occurred historically within the Wenatchee Basin. If we assume that Pacific lamprey and salmon used the same streams, one could conclude that Pacific lamprey occurred in the Wenatchee River, Chiwawa River, Nason Creek, Little Wenatchee River, White River, Icicle Creek, Peshastin Creek, and Mission Creek in the Wenatchee River basin.[4] In 1937, WDF (1938) collected several juvenile lamprey that were bypassed from irrigation ditches in Icicle and Peshastin creeks, and the lower mainstem Wenatchee River.

Current Distribution

Pacific lamprey still exist in the Wenatchee system, but the distribution is mostly unknown. BioAnalysts (2000) used anecdotal information to describe the extent of Pacific lamprey distribution Wenatchee River. However, they cautioned that the following description may be confounded by the presence of river lamprey. In most cases, observers they cited reported the occurrence of lamprey but did not identify the species. Thus, the descriptions below may apply to both species.

In the Wenatchee River basin, lamprey appear to occur primarily downstream from Tumwater Dam. Jackson et al. (1997) indicated that they have observed no Pacific lamprey ascending Tumwater Dam during the last decade. Because they monitored fish movement at Tumwater Dam between May through September, it is possible that they missed lamprey that migrate upstream to spawning areas during the spring (prior to May). Washington Department of Fish and Wildlife (WDFW) captured no lamprey in the lower Chiwawa River during the 1992-1999 trapping period or near the mouth of Lake Wenatchee (in BioAnalysts 2000). Hillman and Chapman (1989) surveyed the entire Wenatchee River during 1986 and 1987 and found no lamprey upstream from Tumwater Dam. The lack of lamprey in the upper Wenatchee is consistent with the work of Mullan et al. (1992), who found no lamprey in the mainstem or tributaries of the upper Wenatchee River basin.

Pacific lamprey have been observed in the lower Wenatchee River. Hillman (unpublished data) found many ammocoetes in the Wenatchee River near the town of Leavenworth and adult lamprey in the lower Wenatchee River (near RM 1.0). Kelly-Ringold (USFWS, personal communication, in BioAnalysts 2000) found an adult Pacific lamprey in the Wenatchee River near the golf course in Leavenworth). Lamprey are also seen in the smolt monitoring trap in the lower Wenatchee River every year near the town of Monitor (A. Murdoch WDFW, personal communication). Apparently lamprey spawn in the irrigation canal just upstream from Monitor. These observations indicate that

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[4] Currently, lamprey have not been observed upstream of Tumwater Canyon. We have no way to determine if they appeared there historically. This may suggest that hydraulic conditions within Tumwater Canyon are a migration barrier for lamprey and they may never have existed in the mainstem or tributaries upstream of the canyon. Another possibility is that Tumwater Dam may be limiting movement of lamprey upstream.

lamprey currently exist in the lower Wenatchee River (RM 0 to <27) and perhaps in the lower portions of Icicle, Peshastin, and Mission creeks.

Abundance
Historical abundance of Pacific lamprey is difficult to determine because of the lack of specific information. However, lamprey were (and continue to be) culturally significant to the Native American tribes in the Columbia Basin.

Current
There are currently no abundance information except perhaps dam count differences between Rock Island and Rocky Reach. However, comparing counts among different projects is problematic because of sampling inconsistencies, the behavior of lamprey in counting stations, and the ability of lamprey to bypass counting stations undetected (BioAnalysts 2000).

Productivity
There currently is no information on historic and current productivity on Pacific lamprey. However, it is reasonable to assume that current production is lower than historic.

Diversity
Within the Wenatchee Basin, it is not known whether Tumwater Dam is an impediment to migration. There is certainly more spawning and rearing habitat available upstream of the dam. If we assume that Tumwater is a migration blockage, then modifying that dam for passage would increase life history and spatial diversity of the Wenatchee Basin Pacific lamprey.

Pacific lamprey (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	?	?	Higher than present	?
Current	?	?	?	?

7. Bull trout
Historic
While detailed historic distribution is difficult to determine (Rieman et al. 1997), bull trout are believed to have been historically present in the Wenatchee River (Brown 1992; Mongillo 1993).

Current Distribution
All three ecotypes of bull trout currently exist in the Wenatchee River Core Area (WDFW 1998). The six "migratory[5]" bull trout sub populations in the Wenatchee River are found in the Chiwawa River (including Chikamin, Phelps, Rock, Alpine, Buck and

[5] "Migratory" bull trout are not defined within USFWS (2002). We assume they refer to ecotypes that exhibit some form of extended migration from either different "order" streams or between lakes and streams, and not those fish that inhabit a limited stream section (commonly known as "resident").

James creeks), White River (including Canyon and Panther creeks), Little Wenatchee River (below the falls), Nason Creek (including Mill Creek), Chiwaukum Creek, and Peshastin Creek (including Ingalls Creek). There may also be non-migratory subpopulations within some of these streams, as well as Icicle Creek.

In the Wenatchee subbasin, the adfluvial form matures primarily in Lake Wenatchee and ascends the White and Little Wenatchee rivers, and the Chiwawa River (Kelly-Ringold and DeLavergne 2003), where the young reside for one to three years. Fluvial bull trout populations spawn in the other streams identified above.

Abundance

Historic

There is currently no information available to assess what historic abundance of bull trout was in the Wenatchee River Basin.

Current

Recent comprehensive redd surveys, coupled with preliminary radio telemetry work suggest that remaining spawning populations within the Wenatchee River are not complete "genetic isolates" of one another, but rather co-mingle to some degree (Kaputa, Ed. 2002). It is possible that there are separate, local spawning aggregates, but more monitoring and DNA analysis is necessary to be able to empirically determine this. The chance of finding independent subpopulations within each subbasin would most likely found be in headwater areas upstream of barriers, which prevents immigration from downstream recruits, but not emigration to downstream areas during high water events occasionally.

Since non-migratory fish are difficult to enumerate, all estimates of current abundance should be considered underestimates of the true population size of bull trout within the Wenatchee Basin. This is based on the belief that "non-migratory" fish are most likely contributing to the "migratory" populations (like steelhead), and potentially vice versa, although there may not be very many non-migratory bull trout populations within the Wenatchee Basin (K. MacDonald, personal communication).

Redd surveys have been conducted by the USFWS, USFS, or WDFW in the various streams within the Wenatchee River Basin since the 1980s. The White and Little Wenatchee rivers have shown a fluctuating abundance of redds since 1983, averaging 34 redds.

Since 1989, the highest concentration of redds within the Wenatchee River Basin has been observed within the Chiwawa Basin, averaging over 300 redds per year, and showing a steady increase of abundance. Lesser numbers of redds have also been observed within the Peshastin and Nason creek drainages, and in the upper mainstem Wenatchee River. Overall, the Wenatchee River Basin has average over 250 redds since the surveys began in the Chiwawa River in 1989, and has shown a steady increase, although it should be noted that this trend may be a factor of increased effort in redd surveys in recent years (K. MacDonald, USFS, personal communication).

Hillman and Miller (2002) have observed between 76-900 bull trout in their snorkel surveys of the Chiwawa River between 1992 and 2002 (excluding 2000). They also state that because their surveys do not encompass areas outside of juvenile chinook salmon, or the entire lengths of all streams, so the estimates should be considered very conservative, since bull trout are known to extend beyond their survey boundaries.

Productivity

Historic

Historic productivity of bull trout within the Wenatchee Basin is not known. However, it is reasonable to assume that it was higher, based on habitat degradation and management practices (harvest).

Current

Current productivity appears to be improving based on redd counts and other factors (see above).

Diversity

Historic diversity was most likely higher than current based on some minor losses of connectivity and potential increases in temperature. If habitat restoration occurs, there will most likely be an increase in spatial and potentially life history diversity.

Summary

Bull trout (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	High	Moderate	Moderate	High
Current	Mod.-high	Low-moderate	Low-moderate	Mod.-high

8. Westslope cutthroat trout

Distribution

Historic

The primary historic distribution of westslope cutthroat trout (WSCT) occurred in the upper Columbia and Missouri River basins (USFWS 1999). WSCT were originally believed to occur in three river basins within Washington State; Methow, Chelan, and Pend Oreille, although only abundant in the Lake Chelan Basin (Williams 1998). From Williams (1998):

Apart from Lake Chelan and the Pend Oreille River where an abundance of relatively large cutthroat commanded the attention of pioneers, cutthroat trout in streams were *obscured by their headwater location and small body size . . . Accordingly, the ethnohistorical record is mostly silent on the presence or absence of cutthroat. The picture is further blurred by the early scattering of cutthroat from the first trout hatchery in Washington (Stehekin River Hatchery, 1903) by entities (Department of Fisheries and Game and county Fish Commissions) dissolved decades ago along with their planting records. The undocumented translocation of cutthroats by interested non-professional starting with pioneers is another confusing factor that challenges determination of historical distribution.*

Recent information, based on further genetic analyses (Trotter et al. 2001; Behnke 2002; Howell et al. 2003), indicates that the historic range of WSCT in Washington State is now believed to be broader. Historic distribution now includes the headwaters of the Wenatchee and Yakima River basins (Behnke 2002).

Overall, Behnke (1992) believed that the disjunct populations in Washington State probably were transported here through the catastrophic ice-age floods.

Current
Through stocking programs that began with Washington state's first trout hatchery in the Stehekin River valley in 1903 (that targeted WSCT), WSCT have been transplanted in almost all available stream and lake habitat (Williams 1998).

Williams (1998) documented that in the Wenatchee River Basin, WSCT sustain themselves in 82 streams (175 miles) and 83 alpine lakes (1,462 acres).

Abundance
Historic
There is currently no information available to assess what historic abundance of WSCT was in the Wenatchee River Basin. Numerical abundance has not been documented or estimated for WSCT. Westslope cutthroat were not thought to have been very abundant where they occurred in the headwater locations within the Methow, Entiat, and Wenatchee basins (Williams 1998; USFWS 1999; Behnke 2002).

Current
There are no known estimates of current abundance within the Wenatchee River Basin

Productivity
Historic
Historic productivity of bull trout within the Wenatchee Basin is not known. However, it is reasonable to assume that it was higher, based on habitat degradation and management practices (hatchery plants).

Current
There are no known estimates of current abundance within the Wenatchee River Basin.

Diversity

Historic diversity was most likely higher than current based on some minor losses of connectivity and potential increases in temperature. If habitat restoration occurs, there will most likely be an increase in spatial and potentially life history diversity.

Summary

Westslope cutthroat trout (see footnote 2).

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	Low-moderate	Low	Moderate	High
Current	Low-moderate	Low	Low-moderate	Mod.-high

Summary for Wenatchee Subbasin

	Distribution	**Abundance**	**Productivity**	**Diversity**
Spring chinook				
Historic	High	Mod-high	Moderate	High
Current	Mod-high	Low-mod.	Low-mod.	Moderate
Steelhead				
Historic	High	Mod-high	Moderate	High
Current	Mod-high	Low-mod.	Low	Moderate
Sum/fall chin				
Historic	High	Very high	Very high	High
Current	High	High	High	Mod.-high
Sockeye				
Historic	High	Very high	Mod.-high	High
Current	High	High	Mod.-high	Mod.-high
Bull trout				
Historic	High	Moderate	Moderate	High
Current	Mod.-high	Low-moderate	Low-moderate	Mod.-high
WSCT				
Historic	Low-moderate	Low	Moderate	High
Current	Low-moderate	Low	Low-moderate	Mod.-high

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Entiat River Basin

Current and historic distribution (spatial structure), abundance, productivity, and diversity of each population

1. Spring chinook

Distribution

Historic

Mullan (1987) felt that because of the geology of the region upstream of the current Grand Coulee Dam site, that that spring chinook were not very abundant, with the possible exceptions of the San Poil and Spokane River basins. Fulton (1968) described the historic distribution of spring chinook in the Entiat River. He relied heavily on the fieldwork of French and Wahle (1965) for his information on distribution. Fulton (1968) includes most of the mainstem Entiat as habitat for spring and summer chinook, noting that steep gradients of tributaries prevent salmon use.

Current distribution

Hamstreet and Carie (2003) describe the current spawning distribution for spring chinook as between river miles 16 and 28 in the Entiat River and 1.5 to 5 in the Mad River, its major tributary.

Abundance

Historic

Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 588,000-spring chinook was the best estimate of pre-development run sizes. Spring chinook were relatively abundant in upper Columbia River tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

Spring chinook counting at Rock Island Dam began in 1935. Numbers (adults and jacks) in the period 1935-39 averaged just over 2,000 fish. Average counts fluctuated on a decadal average from the 1940s to 1990s from just over 3,200 (1940s) to over 14,400

(1980s), with recent counts (2000-2002) averaging almost 29,000. The long-term average of spring chinook passing Rock Island Dam is just over 8,900.

Current

Redd counts in the Entiat River basin have been conducted since 1962. Decadal averages are 205, 143, 89, 33, and 81 between 1962 and 2002, with a long term average over the spanning years of 110.

For the Entiat River, Ford et al. (2001) recommended an interim recovery level of 500 spawners per year. The historic redd counts suggest an escapement ranging from 2 to 845, and has averaged 215 since 1962.

Productivity

Historic

Historic production of spring chinook is difficult to determine, although it was most likely not as high as sockeye or late-run chinook. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan 1987; Mullan et al. 1992), it is assumed that historic production of salmon was high, especially for summer/fall chinook and sockeye.

Current

Current productivity is affected by loss, or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Mullan et al. (1992) postulated that current production may not be greatly different than historic for spring chinook. Caveats to this postulate are that native coho are extinct, production comes at a higher cost in terms of smolt survival through the mainstem corridor, and that harvest is drastically reduced (e.g., over 80% in the lower Columbia River in the late 1930s, early 1940s). However, recent estimates of natural replacement rates for spring chinook suggest that they are not replacing themselves in most years until the broods of the late 1990s (A. Murdoch, personal communication).

There are still habitat areas in need of restoration within the Entiat Basin. By increasing known areas in need of restoration, it is reasonable to assume that production of spring chinook would increase.

Diversity

Because some areas within the Entiat Basin are in need of habitat improvements, diversity within the basin is believed to be lower than historic. While the Entiat population is still believed to be an *independent population* (see definition in Appendix _), increased habitat would most likely increase spatial and life history diversity.

Summary

Spring Chinook[6]

	Distribution	Abundance	Productivity	Diversity
Historic	High	Moderate	Moderate	Moderate
Current	Mod-high	Low-mod.	Low-mod.	Low-mod.

2. Summer Steelhead

Historic distribution
Steelhead historically used all major (and some minor) tributaries within the Upper Columbia Basin for spawning and rearing (Chapman et al. 1994). Fulton noted the mainstem Entiat and Mad Rivers as producing steelhead.

Current distribution
Current distribution in the Entiat is believed to be similar to historic, although some minor tributaries may not encourage certain life history phases because of habitat degradation from natural and human-caused reasons.

Abundance
Historic
Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 554,000 steelhead (for the entire Columbia Basin) was the best estimate of pre-development run sizes. Steelhead were relatively abundant in upper Columbia River tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

Steelhead counts began at Rock Island Dam in 1933, and annual counts averaged 2,800 between 1933 and 1939 (these numbers do not reflect large fisheries in the lower river that took place at that time, estimated by Mullan et al. (1992) as greater than 60%). Average decadal numbers changed little in the 1940s and 1950s (2,600 and 3,700, respectively). Large hatchery releases began in the 1960s, and the average counts

[6] The values within the table are qualitative, based on the best information available. All species are considered within this qualitative approach (i.e., abundance of bull trout is relative to sockeye salmon).

increased to 6,700. In the 1970s, counts averaged 5,700 and 16,500 in 1980s (record count of about 32,000 in 1985). In the 1990s, counts decreased, following a similar trend as chinook, to 7,100, while, similar to chinook, they have increased substantially so far in the 2000s, with an average of over 18,000 (a high of 28,600 in 2001).

Current

Beginning in 1997 (no survey was conducted in 1998), the USFS has been conducting limited spawning ground surveys for *O. mykiss* in the Mad River (Archibald 2003). The area covered has increased from the first 3 miles of the Mad River to up to 10 miles (currently the first 7 miles) of the Mad River. Roaring Creek has been surveyed too, but apparently not the mainstem Entiat River. The number of "definite" redds has ranged from 0 (1999) to 38 (2003), averaging 13.

Ford et al. (2001) recommended interim recovery levels of about 500 naturally produced spawners for the Entiat, using similar criteria that were used for spring chinook.

Productivity

Historic

Historic production of steelhead is difficult to determine, although it was most likely not as high as sockeye or late-run chinook. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan et al. 1992); it is assumed that historic production of steelhead was higher than current.

Current

Current productivity is affected by loss, or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Mullan et al. (1992) postulated that current production may not be greatly different than historic for steelhead. Caveats to this postulate are that native coho are extinct, production comes at a higher cost in terms of smolt survival through the mainstem corridor, and that harvest is drastically reduced. However, recent estimates of natural replacement rates for steelhead suggest that they are not replacing themselves in most years until the broods of the late 1990s (A. Murdoch, personal communication).

There are still habitat areas in need of restoration within the Entiat Basin. By increasing known areas in need of restoration, it is reasonable to assume that production of steelhead would increase.

Diversity

Because some areas within the Entiat Basin are in need of habitat improvements, diversity within the basin is believed to be lower than historic. While the Entiat population is still believed to be an *independent population* (see definition in Appendix _), increased habitat would most likely increase spatial and life history diversity.

Currently, genetic sampling has not found any differences among steelhead within the basin.

Summary

Steelhead (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	High	Low-moderate	Moderate	High
Current	Mod-high	Low	Low	Moderate

3. Summer/fall chinook

Historic distribution
Summer/fall chinook did not historically spawn in the Entiat River (Craig and Suomela 1941; Mullan 1987).

Current Distribution
Spawning of summer/fall chinook salmon in the Entiat River is a result of the Entiat National Fish Hatchery, which released chinook into the river between 1941 and 1976 (Mullan 1987). While late-run chinook may never have spawned naturally in the Entiat River, there does appear to be a self-sustaining population present currently. This population is small in relation to the Wenatchee or Similkameen River basins.

Abundance
Historic
Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 3.7 million summer chinook, (for the entire Columbia Basin) was the best estimate of pre-development run sizes. Summer/fall chinook were very abundant in upper Columbia River and tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

Historically, the late spring and summer components of the Columbia River chinook populations were the most abundant and heavily fished (Thompson 1951, Van Hyning 1968, Chapman 1986). Overfishing in the lower Columbia River rapidly depressed summer-run chinook. Spawning and rearing habitat extirpation and destruction accelerated the decline.

Decadal averages of summer/fall chinook escapements at Rock Island Dam from 1933 through 2002 show a rising trend. Harvest rates in the 1930s and 1940s were very high in the lower river fisheries, and no doubt had a large impact on the escapement at Rock Island (Mullan 1987). In 1951, when harvest rates in zones 1-6 (lower Columbia River) were reduced, numbers increased dramatically. Between the 1930s (starting in 1933) and 1960s (excluding 1968 and 1969)[7], total (adults and jacks) decadal average numbers of summer/fall chinook rose from just over 7,000 to almost 28,000. Numbers remained high in the 1970s until the mid-1980s, when they declined through the 1990s and have shown a sharp increase in the 2000s.

In the 1960s, dam counts became available at Rocky Reach Dam (1962) and Wells Dam (1967). These project counts of total summer/fall chinook show a different trend than Rock Island, which suggests the difference being the fish that spawn in the Wenatchee River were heavily affecting the trend at Rock Island Dam.

Current

Redd counts have been conducted in the Entiat River since 1957. Counts ranged from 0-55 between 1957 and 1991 (Peven 1992). Between 1994 and 2002, Hamstreet and Carie (2003) estimated the number of summer/fall chinook redds ranging between 15-218, averaging 75.

Productivity

Historic

Historic productivity of summer/fall chinook in the Entiat was non-existent.

Current

Current productivity is affected by loss, or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Spawning habitat may be limiting for summer/fall chinook in the Entiat Basin, but, other factors, such as the potential changes to geo-fluvial processes may affect immediate rearing (or refuge) areas in the lower river more. It is unknown what affect this has on production.

Diversity

Because some areas within the Entiat Basin are in need of habitat improvements, diversity within the basin may be lower than historic. Increased habitat would most likely increase life history diversity.

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[7] Unfortunately, there were no counts at Rock Island Dam between 1968 and 1972.

Currently, genetic sampling has not found any differences among late-run chinook within the basin.

Summary

Summer/fall chinook (see footnote 2)

	Distribution	Abundance	Productivity	Diversity
Historic	none	none	none	none
Current	moderate	Low	low	low

4. Coho salmon

Coho salmon are considered extirpated in the Entiat River (Fish and Hanavan 1948, Mullan 1984). Mullan (1984) estimated that upstream of the Yakima River, the Methow River and Spokane River historically produced the most coho, with lesser runs into the Wenatchee and Entiat.

Recently, the Yakama Indian Nation has begun a more concerted effort to reintroduce coho into the Upper Columbia (Scribner et al. 2002). Preliminary results so far are promising. Current efforts to rebuild coho are primarily in the Wenatchee and Methow basins, where the YIN program is concentrated.

5. Pacific lamprey

Historic distribution

Historical distribution of Pacific lamprey in the Columbia and Snake Rivers was coincident wherever salmon occurred (Simpson and Wallace 1978). It is likely that Pacific lamprey occurred historically within the Entiat Basin. If we assume that Pacific lamprey and salmon used the same streams, one could conclude that Pacific lamprey occurred in the mainstem Entiat and Mad Rivers.

Current Distribution

Pacific lamprey still exist in the Entiat system, but the distribution is mostly unknown. BioAnalysts (2000) used anecdotal information to describe the extent of Pacific lamprey distribution Entiat Basin. However, they cautioned that the following description may be confounded by the presence of river lamprey. In most cases, observers they cited reported the occurrence of lamprey but did not identify the species. Thus, the descriptions below may apply to both species. Juvenile lamprey have been found near RM 16, within the hatchery, and near the mouth (BioAnalysts 2000).

Abundance

Historical abundance of Pacific lamprey is difficult to determine because of the lack of specific information. However, lamprey were (and continue to be) culturally significant to the Native American tribes in the Columbia Basin.

Current
There are currently no abundance information except perhaps dam count differences between Rocky Reach and Wells. However, comparing counts among different projects is problematic because of sampling inconsistencies, the behavior of lamprey in counting stations, and the ability of lamprey to bypass counting stations undetected (BioAnalysts 2000).

Productivity
There currently is no information on historic and current productivity on Pacific lamprey. However, it is reasonable to assume that current production is lower than historic.

Diversity
Current distribution within the Entiat Basin may be impacted within smaller tributaries, but this is not known. Current diversity is most likely similar to historic.

Pacific lamprey (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	?	?	Higher than present	?
Current	?	?	?	?

6. Bull trout

Distribution

Historic
While detailed historic distribution is difficult to determine (Rieman et al. 1997), bull trout are believed to have been historically present in the Entiat River (Brown 1992; Mongillo 1993).

Current
The USFWS (2002) has identified two sub populations of bull trout in the Entiat River, one fluvial population in the mainstem Entiat and one in the Mad River, a tributary to the Entiat. Primary bull trout spawning and rearing areas are in the Mad River and the mainstem Entiat River from the Entiat Falls downstream to the National Forest boundary (USFWS 2002).

Abundance

Historic

There is currently no information available to assess what historic abundance of bull trout was in the Entiat River Basin.

Current

Bull trout redd surveys have been conducted by the USFS in the Entiat River Basin since 1989, primarily in the Mad River. Since 1989, the number of redds observed has averaged 24, and has increased, primarily since 1997. Archibald and Johnson (2002) attribute the increase in bull trout redds in the Mad River to the closure of bull trout fishing in 1992 and the closure to all fishing (from the mouth to Jimmy Creek) since 1995.

Productivity

Historic

Historic productivity of bull trout within the Entiat Basin is not known. However, it is reasonable to assume that it was higher, based on habitat degradation and management practices (harvest).

Current

Current productivity appears to be improving based on redd counts and other factors (see above).

Diversity

Historic diversity was most likely higher than current based on some habitat degradation and management practices. If habitat restoration occurs, there will most likely be an increase in spatial and potentially life history diversity.

Summary

Bull trout (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	High	Moderate	Moderate	High
Current	Mod.-high	Low-moderate	Low-moderate	Mod.-high

7. Westslope cutthroat trout

Distribution

Historic

The primary historic distribution of westslope cutthroat trout (WSCT) occurred in the upper Columbia and Missouri River basins (USFWS 1999). WSCT were originally believed to occur in three river basins within Washington State; Methow, Chelan, and Pend Oreille, although only abundant in the Lake Chelan Basin (Williams 1998). From Williams (1998):

Apart from Lake Chelan and the Pend Oreille River where an abundance of relatively large cutthroat commanded the attention of pioneers, cutthroat trout in streams were obscured by their headwater location and small body size . . . Accordingly, the *ethnohistorical record is mostly silent on the presence or absence of cutthroat. The picture is further blurred by the early scattering of cutthroat from the first trout hatchery in Washington (Stehekin River Hatchery, 1903) by entities (Department of Fisheries and Game and county Fish Commissions) dissolved decades ago along with their planting records. The undocumented translocation of cutthroats by interested non-professional starting with pioneers is another confusing factor that challenges determination of historical distribution.*

Recent information, based on further genetic analyses (Trotter et al. 2001; Behnke 2002; Howell et al. 2003), indicates that the historic range of WSCT in Washington State is now believed to be broader. Historic distribution now includes the headwaters of the Wenatchee and Yakima River basins (Behnke 2002).

Overall, Behnke (1992) believed that the disjunct populations in Washington State probably were transported here through the catastrophic ice-age floods.

Current

Through stocking programs that began with Washington state's first trout hatchery in the Stehekin River valley in 1903 (that targeted WSCT), WSCT have been transplanted in almost all available stream and lake habitat (Williams 1998).

In the Entiat, WSCT sustain themselves in 80 miles within 16 streams and 140 acres in 8 lakes (Williams 1998).

Abundance

Historic

There is currently no information available to assess what historic abundance of WSCT was in the Entiat River Basin. Numerical abundance has not been documented or estimated for WSCT. Westslope cutthroat were not thought to have been very abundant where they occurred in the headwater locations within the Methow, Entiat, and Wenatchee basins (Williams 1998; USFWS 1999; Behnke 2002).

Current

There are no known estimates of current abundance within the Entiat River Basin

Productivity

Historic

Historic productivity of bull trout within the Entiat Basin is not known. However, it is reasonable to assume that it was higher, based on habitat degradation and management practices (hatchery plants).

Current

There are no known estimates of current abundance within the Entiat River Basin.

Diversity

Historic diversity was most likely higher than current based on some habitat degradation. If habitat restoration occurs, there will most likely be an increase in spatial and potentially life history diversity.

Summary

Westslope cutthroat trout (see footnote 2).

	Distribution	Abundance	Productivity	Diversity
Historic	Low-moderate	Low	Moderate	High
Current	Low-moderate	Low	Low-moderate	Mod.-high

Summary for Entiat Subbasin

	Distribution	Abundance	Productivity	Diversity
Spring chinook				
Historic	High	Moderate	Moderate	Moderate
Current	Mod-high	Low-mod.	Low-mod.	Low-mod.
Steelhead				
Historic	High	Low-moderate	Moderate	High
Current	Mod-high	Low	Low	Moderate
Sum/fall chin.				
Historic	none	none	none	none
Current	moderate	Low	low	low
Bull trout				
Historic	High	Moderate	Moderate	High
Current	Mod.-high	Low-moderate	Low-moderate	Mod.-high
WSCT				
Historic	Low-moderate	Low	Moderate	High
Current	Low-moderate	Low	Low-moderate	Mod.-high

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Chelan Basin

1. Bull trout

Historic

While historic distribution is difficult to determine (Rieman et al. 1997), bull trout are known to have been historically present in Lake Chelan (Brown 1992; Mongillo 1993).

Current Distribution

Native bull trout are thought to be extirpated in Lake Chelan. None have been observed in Lake Chelan, its tributaries or in sport catch counts since the late 1950s (Brown 1984). Some remnant populations may still reside in tributaries of Lake Chelan, but verified captures of bull trout have not occurred from the lake in five decades (Brown 1984).

Abundance

Historic

Historic abundance is not known, but it was large enough to support a sport harvest until the late 1940s-early 1950s.

Current

Possibly extinct.

Productivity

Historic

Historic productivity of bull trout within the Chelan Basin is not known.

Current

No known production occurs at this time.

Diversity

Historic diversity was most likely high within the Basin, based on habitat features that would have allowed all three known ecotypes of bull trout (adfluvial, fluvial, and non-migratory).

Summary

Bull trout [8]

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	High	Moderate	Moderate	High
Current	Potentially none	Potentially none	Potentially none	Potentially none

[8] The values within the table are qualitative, based on the best information available. All species and historic values are considered within this qualitative approach.

2. Westslope cutthroat trout

Distribution

Historic

The primary historic distribution of westslope cutthroat trout (WSCT) occurred in the upper Columbia and Missouri River basins (USFWS 1999). WSCT were originally believed to occur in three river basins within Washington State; Methow, Chelan, and Pend Oreille, although only abundant in the Lake Chelan Basin (Williams 1998). From Williams (1998):

Apart from Lake Chelan and the Pend Oreille River where an abundance of relatively large cutthroat commanded the attention of pioneers, cutthroat trout in streams were obscured by their headwater location and small body size . . . Accordingly, the ethnohistorical record is mostly silent on the presence or absence of cutthroat. The picture is further blurred by the early scattering of cutthroat from the first trout hatchery in Washington (Stehekin River Hatchery, 1903) by entities (Department of Fisheries and Game and county Fish Commissions) dissolved decades ago along with their planting records. The undocumented translocation of cutthroats by interested non-professional starting with pioneers is another confusing factor that challenges determination of historical distribution.

Current

Spawning and rearing occurs in most suitable tributaries, including 25-Mile, Safety Harbor, Railroad, Prince, Fish, Four-mile creeks, and the Stehekin River drainage. Adfluvial forms use Lake Chelan as rearing.

Abundance

Historic

From anecdotal information on early catch rates of WSCT in newspapers and other sources, the current population of WSCT appears to be much reduced from historic times. High catch rates in the 19th century, hatchery practices in the early 20th century, and negative interactions with exogenous species have all lead to their decline.

Current

WSCT in the Chelan Basin are apparently at much reduced numbers than historic (Brown 1984).

Productivity

Historic

Historic productivity of WSCT within the Chelan Basin is not known. However, it is reasonable to assume that it was much higher, based primarily on management practices (hatchery programs and introduced species).

Current

There are no known estimates of current abundance within the Chelan Basin.

Diversity

Historic diversity was most likely higher than current based on some minor losses of connectivity and potential increases in temperature. If habitat restoration occurs, there will most likely be an increase in spatial and potentially life history diversity.

Summary

Westslope cutthroat trout (see footnote 2).

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	High	Moderate	Mod.-high	High
Current	Low-moderate	Low	Low-moderate	Mod.-high

Summary for Wenatchee Subbasin

	Distribution	**Abundance**	**Productivity**	**Diversity**
Bull trout				
Historic	High	Moderate	Moderate	High
Current	Potentially none	Potentially none	Potentially none	Potentially none
WSCT				
Historic	High	Moderate	Mod.-high	High
Current	Low-moderate	Low	Low-moderate	Mod.-high

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Methow River Basin

Current and historic distribution (spatial structure), abundance, productivity, and diversity of each population

1. Spring chinook

Distribution

Historic

Mullan (1987) felt that because of the geology of the region upstream of the current Grand Coulee Dam site, that that spring chinook were not very abundant, with the possible exceptions of the San Poil and Spokane River basins. Fulton (1968) described the historic distribution of spring chinook in the Methow River. He relied heavily on the fieldwork of French and Wahle (1965) for his information on distribution. Fulton (1968) shows chinook use of the Methow River basin as *Main stream* (Methow) *and large tributaries....Lower portion of main stream* (Twisp River) .... *Main stream* (Chewuch River) *to 52 km. above the mouth.* Fulton mentioned that the Chewuch River had the largest spring chinook run of any single stream above Rocky Reach Dam.

Current distribution

The primary spawning grounds in the Methow River currently are, in order of importance: the mainstem Methow, Twisp, Chewuch, and Lost rivers (Scribner et al. 1993).

Abundance

Historic

Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 588,000-spring chinook was the best estimate of pre-development run sizes. Spring chinook were relatively abundant in upper Columbia River tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

Spring chinook counting at Rock Island Dam began in 1935. Numbers (adults and jacks) in the period 1935-39 averaged just over 2,000 fish. Average counts fluctuated on a decadal average from the 1940s to 1990s from just over 3,200 (1940s) to over 14,400 (1980s), with recent counts (2000-2002) averaging almost 29,000. The long-term average of spring chinook passing Rock Island Dam is just over 8,900.

Current

Redd counts in the Methow River date back to 1958. Decadal averages are 494, 326, 306, 272, and 2,401 between 1958 and 2002, with a long term average of 454.

Ford et al. (2001) recommended an interim recovery level of 2,000 naturally produced spawners per year. Escapement has ranged from 0 to over 9,700 spawners, averaging 954.

These data suggest that while the populations have fluctuated greatly since the late 1950s and early 1960s, there is a great resilience demonstrated in the populations to rebound from low numbers.

Productivity

Historic

Historic production of spring chinook is difficult to determine, although it was most likely not as high as sockeye or late-run chinook. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan 1987; Mullan et al. 1992), it is assumed that historic production of salmon was high, especially for summer/fall chinook and sockeye.

Current

Current productivity is affected by loss, or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Mullan et al. (1992) postulated that current production may not be greatly different than historic for spring chinook. Caveats to this postulate are that native coho are extinct, production comes at a higher cost in terms of smolt survival through the mainstem corridor, and that harvest is drastically reduced (e.g., over 80% in the lower Columbia River in the late 1930s, early 1940s). However, recent estimates of natural replacement rates for spring chinook suggest that they are not replacing themselves in most years until the broods of the late 1990s (A. Murdoch, personal communication).

There are still habitat areas in need of restoration within the Methow Basin. By increasing known areas in need of restoration, it is reasonable to assume that production of spring chinook would increase.

Diversity

Because some areas within the Methow Basin are in need of habitat improvements, diversity within the basin is believed to be lower than historic. While the Methow population is still believed to be an *independent population* (see definition in Appendix _), increased habitat would most likely increase spatial and life history diversity.

Summary

Spring Chinook[9]

	Distribution	Abundance	Productivity	Diversity
Historic	High	Moderate	Moderate	High
Current	Mod-high	Low-mod.	Low-mod.	Moderate

2. Summer Steelhead

Historic distribution

Steelhead historically used all major (and some minor) tributaries within the Upper Columbia Basin for spawning and rearing (Chapman et al. 1994 CPa). Fulton noted the mainstem Entiat and Mad Rivers as producing steelhead.

Current distribution

In the Methow River, Jateff and Snow (2002) found, in order of importance appears to be: Twisp River, Winthrop National Fish Hatchery creek, mainstem Methow River, Chewuch River, and Beaver Creek. Other creeks that were surveyed and had fewer than 15 redds were, Methow Hatchery creek, Lost River, Buttermilk, Boulder, Eight-Mile, and Lake Creeks. War and Wolf creeks were surveyed but showed no redds.

Abundance

Historic

Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 554,000 steelhead (for the entire Columbia Basin) was the best estimate of pre-development run sizes. Steelhead were relatively abundant in upper Columbia River tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

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[9] The values within the table are qualitative, based on the best information available. All species are considered within this qualitative approach (i.e., abundance of bull trout is relative to sockeye salmon).

Steelhead counts began at Rock Island Dam in 1933, and annual counts averaged 2,800 between 1933 and 1939 (these numbers do not reflect large fisheries in the lower river that took place at that time, estimated by Mullan et al. (1992) as greater than 60%). Average decadal numbers changed little in the 1940s and 1950s (2,600 and 3,700, respectively). Large hatchery releases began in the 1960s, and the average counts increased to 6,700. In the 1970s, counts averaged 5,700 and 16,500 in 1980s (record count of about 32,000 in 1985). In the 1990s, counts decreased, following a similar trend as chinook, to 7,100, while, similar to chinook, they have increased substantially so far in the 2000s, with an average of over 18,000 (a high of 28,600 in 2001).

Current

Mullan et al. (1992) developed a spawner-recruit analysis that calculated the maximum sustainable yield (MSY) run size and escapement for the Methow Subbasin at 7,234 fish and 2,212 fish, respectively. Mullan et al. (1992) demonstrated that the wild population appeared to be barely supporting itself and that hatchery additions are supplementing the natural production of fish. They felt that despite the natural production being sustained at threshold population sizes, the biological fitness of the hatchery spawners has allowed the population to meet pre-development MSY escapement and smolt production in most years (Mullan et al. (1992). This does not mean that the hatchery fish are the "ecological equivalents of wild fish in all life history phases" (Chapman et al. 1994), although Mullan et al. (1992) found no difference in smolt to adult survival for hatchery versus wild steelhead. A portion of the hatchery-released steelhead remain in the freshwater for another winter (K. Williams, personal communication), increasing the fitness of returning adults (Chapman et al. 1994). In addition, the resident form contributes to anadromy, at varying degrees, inversely related with the steelhead productivity.

Jateff and Snow (2003) found 473 redds in the Methow Basin in 2002, most of which were found in the mainstem Methow River. Ford et al. (2001) recommended interim recovery levels of about 2,500 naturally produced spawners for the Methow River.

Productivity

Historic

Historic production of steelhead is difficult to determine, although it was most likely not as high as sockeye or late-run chinook. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan et al. 1992); it is assumed that historic production of steelhead was higher than current.

Current

Current productivity is affected by loss, or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Mullan et al. (1992) postulated that current production may not be greatly different than historic for steelhead. Caveats to this postulate are that native coho are extinct, production comes at a higher cost in terms of smolt survival through the mainstem corridor, and that harvest is drastically reduced. However, recent estimates of natural replacement rates for steelhead suggest that they are not replacing themselves in most years until the broods of the late 1990s (A. Murdoch, personal communication).

There are still habitat areas in need of restoration within the Methow Basin. By increasing known areas in need of restoration, it is reasonable to assume that production of steelhead would increase.

Diversity
Because some areas within the Methow Basin are in need of habitat improvements, diversity within the basin is believed to be lower than historic. While the Methow population is still believed to be an *independent population* (see definition in Appendix _), increased habitat would most likely increase spatial and life history diversity.

Currently, genetic sampling has not found any differences among steelhead within the basin.

Summary

Steelhead (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	High	Low-moderate	Moderate	High
Current	Mod-high	Low	Low	Moderate

3. Summer/fall chinook

Historic distribution
Summer/fall chinook may not have historically spawned in the Methow River (Craig and Suomela 1941; Mullan 1987).

Current Distribution
In the Methow River, summer/fall chinook salmon spawn between RM 2.0 and the Winthrop hatchery diversion dam (RM 51.6). Chinook redds are scattered throughout that area, with a redd found within almost every river mile (Hillman and Miller 1993). The overall distribution of redds of summer/fall chinook in the Methow River has changed little since 1987, when ground surveys began (Miller 2003). During that period, redds were most abundant between Carlton and Twisp (RM 27.2-39.6), and least abundant between Winthrop and the hatchery diversion dam (RM 49.8-51.6) (Hillman and Miller 1993).

Abundance
Historic

Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 3.7 million summer chinook, (for the entire Columbia Basin) was the best estimate of pre-development run sizes. Summer/fall chinook were very abundant in upper Columbia River and tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

Historically, the late spring and summer components of the Columbia River chinook populations were the most abundant and heavily fished (Thompson 1951, Van Hyning 1968, Chapman 1986). Overfishing in the lower Columbia River rapidly depressed summer-run chinook. Spawning and rearing habitat extirpation and destruction accelerated the decline.

Decadal averages of summer/fall chinook escapements at Rock Island Dam from 1933 through 2002 show a rising trend. Harvest rates in the 1930s and 1940s were very high in the lower river fisheries, and no doubt had a large impact on the escapement at Rock Island (Mullan 1987). In 1951, when harvest rates in zones 1-6 (lower Columbia River) were reduced, numbers increased dramatically. Between the 1930s (starting in 1933) and 1960s (excluding 1968 and 1969)[10], total (adults and jacks) decadal average numbers of summer/fall chinook rose from just over 7,000 to almost 28,000. Numbers remained high in the 1970s until the mid-1980s, when they declined through the 1990s and have shown a sharp increase in the 2000s.

In the 1960s, dam counts became available at Rocky Reach Dam (1962) and Wells Dam (1967). These project counts of total summer/fall chinook show a different trend than Rock Island, which suggests the difference being the fish that spawn in the Wenatchee River were heavily affecting the trend at Rock Island Dam.

Current

Redd counts in the Methow River show a precipitous decline from the mid-1960s through the early 1990s. Since the early 1990s, runs have increased sharply, partially due to the hatchery releases from the Eastbank Hatchery program (based on carcass sampling, e.g.,

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[10] Unfortunately, there were no counts at Rock Island Dam between 1968 and 1972.

Miller 2003), and in more recent years, high smolt-to-adult returns of hatchery and naturally produced fish.

Productivity
Historic
Historic productivity of summer/fall chinook in the Methow may have been non-existent.

Current
Current productivity is affected by loss, or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Potential changes to geo-fluvial processes may affect immediate rearing (or refuge) areas in the lower river more. It is unknown what affect this has on production.

Diversity
Because some areas within the Methow Basin are in need of habitat improvements, diversity within the basin may be lower than historic. Increased habitat would most likely increase life history diversity.

Currently, genetic sampling has not found any differences among late-run chinook within the basin.

Summary

Summer/fall chinook (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	None (?)	None (?)	None (?)	None (?)
Current	Moderate	Low	low	Low-mod.

4. Coho salmon
Coho salmon are considered extirpated in the Entiat River (Fish and Hanavan 1948, Mullan 1984). Mullan (1984) estimated that upstream of the Yakima River, the Methow River and Spokane River historically produced the most coho, with lesser runs into the Wenatchee and Entiat.

Recently, the Yakama Indian Nation has begun a more concerted effort to reintroduce coho into the Upper Columbia (Scribner et al. 2002). Preliminary results so far are promising. Current efforts to rebuild coho are primarily in the Wenatchee and Methow basins, where the YIN program is concentrated.

5. Pacific lamprey
Historic distribution

Historical distribution of Pacific lamprey in the Columbia and Snake Rivers was coincident wherever salmon occurred (Simpson and Wallace 1978). It is likely that Pacific lamprey occurred historically within the Methow Basin. If we assume that Pacific lamprey and salmon used the same streams, one could conclude that Pacific lamprey occurred throughout the Methow Basin.

Current Distribution
Pacific lamprey still exist in the Methow system, but the distribution is mostly unknown. BioAnalysts (2000) used anecdotal information to describe the extent of Pacific lamprey distribution Methow Basin. However, they cautioned that the following description may be confounded by the presence of river lamprey. In most cases, observers they cited reported the occurrence of lamprey but did not identify the species. Thus, the descriptions below may apply to both species. Lamprey occur in the mainstem Methow, Twisp, Chewuch , and Lost rivers, and Wolf and Early Winters creeks.

Abundance
Historical abundance of Pacific lamprey is difficult to determine because of the lack of specific information. However, lamprey were (and continue to be) culturally significant to the Native American tribes in the Columbia Basin.

Current
There is currently no abundance information except perhaps dam counts at Wells.

Productivity
There currently is no information on historic and current productivity on Pacific lamprey. However, it is reasonable to assume that current production is lower than historic.

Diversity
Current distribution within the Methow Basin may be impacted within smaller tributaries, but this is not known. Current diversity is most likely similar to historic.

Pacific lamprey (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	?	?	Higher than present	?
Current	?	?	?	?

6. Bull trout

Distribution

Historic
While detailed historic distribution is difficult to determine (Rieman et al. 1997), bull trout are believed to have been historically present in the Methow River (Brown 1992; Mongillo 1993).

Current

In the Methow River system, the USFWS (2002) has identified bull trout in Gold Creek, Twisp River, Chewuch River, Wolf Creek, Early Winters Creek, the Upper Methow River, Lost River, and Goat Creek. In the Upper Methow River, sub populations have been identified in the West Fork and Trout Creek (USFWS 2002).

Abundance

Historic

There is currently no information available to assess what historic abundance of bull trout was in the Methow River Basin.

Current

Redd surveys began in the Methow River Basin in the early 1990s. The Twisp River basin is the largest producer of bull trout, averaging two- to three times more redds than any other spawning area within the Methow Basin. The average number of redds within the basin has increased from less than 100 in the mid-1990s to greater than 150 since 1998.

Productivity

Historic

Historic productivity of bull trout within the Methow Basin is not known. However, it is reasonable to assume that it was higher, based on habitat degradation and management practices (harvest).

Current

Current productivity appears to be improving based on redd counts and other factors (see above).

Diversity

Historic diversity was most likely higher than current based on some habitat degradation and management practices. If habitat restoration occurs, there will most likely be an increase in spatial and potentially life history diversity.

Summary

Bull trout (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	High	Moderate	Moderate	High
Current	Mod.-high	Low-moderate	Low-moderate	Mod.-high

7. Westslope cutthroat trout

Distribution

Historic

The primary historic distribution of westslope cutthroat trout (WSCT) occurred in the upper Columbia and Missouri River basins (USFWS 1999). WSCT were originally believed to occur in three river basins within Washington State; Methow, Chelan, and Pend Oreille, although only abundant in the Lake Chelan Basin (Williams 1998). From Williams (1998):

Apart from Lake Chelan and the Pend Oreille River where an abundance of relatively large cutthroat commanded the attention of pioneers, cutthroat trout in streams were obscured by their headwater location and small body size . . . Accordingly, the ethnohistorical record is mostly silent on the presence or absence of cutthroat. The picture is further blurred by the early scattering of cutthroat from the first trout hatchery in Washington (Stehekin River Hatchery, 1903) by entities (Department of Fisheries and Game and county Fish Commissions) dissolved decades ago along with their planting records. The undocumented translocation of cutthroats by interested non-professional starting with pioneers is another confusing factor that challenges determination of historical distribution.

Recent information, based on further genetic analyses (Trotter et al. 2001; Behnke 2002; Howell et al. 2003), indicates that the historic range of WSCT in Washington State is now believed to be broader. Historic distribution now includes the headwaters of the Wenatchee and Yakima River basins (Behnke 2002).

Overall, Behnke (1992) believed that the disjunct populations in Washington State probably were transported here through the catastrophic ice-age floods.

Current

In the Methow Basin, Williams (1998) thought that WSCT are much more widely distributed now than they were historically, occupying some 60 streams (202 miles), and 43 alpine lakes (312 acres).

Abundance

Historic

There is currently no information available to assess what historic abundance of WSCT was in the Methow River Basin. Numerical abundance has not been documented or estimated for WSCT. Westslope cutthroat were not thought to have been very abundant where they occurred in the headwater locations within the Methow, Entiat, and Wenatchee basins (Williams 1998; USFWS 1999; Behnke 2002).

Current

There are no known estimates of current abundance within the Entiat River Basin

Productivity

Historic

Historic productivity of bull trout within the Methow Basin is not known. However, it is reasonable to assume that it was higher, based on habitat degradation and management practices (hatchery plants).

Current

There are no known estimates of current abundance within the Methow River Basin.

Diversity

Historic diversity was most likely higher than current based on some habitat degradation. If habitat restoration occurs, there will most likely be an increase in spatial and potentially life history diversity.

Summary

Westslope cutthroat trout (see footnote 2).

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	Low-moderate	Low	Moderate	High
Current	Low-moderate	Low	Low-moderate	Mod.-high

Summary for Methow Subbasin

	Distribution	**Abundance**	**Productivity**	**Diversity**
Spring chinook				
Historic	High	Moderate	Moderate	High
Current	Mod-high	Low-mod.	Low-mod.	Moderate
Steelhead				
Historic	High	Low-moderate	Moderate	High
Current	Mod-high	Low	Low	Moderate
Sum/fall chin.				
Historic	None (?)	None (?)	None (?)	None (?)
Current	Moderate	Low	low	Low-mod.
Bull trout				
Historic	High	Moderate	Moderate	High
Current	Mod.-high	Low-moderate	Low-moderate	Mod.-high
WSCT				
Historic	Low-moderate	Low	Moderate	High
Current	Low-moderate	Low	Low-moderate	Mod.-high

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Okanogan River Basin

Current and historic distribution (spatial structure), abundance, productivity, and diversity of each population

1. Spring chinook

Distribution

Historic

Fulton (1968) reports no use of the Okanogan River or it's tributaries by spring chinook. However, Craig and Suomela (1941) contain affidavits that indicate use of Salmon Creek by chinook salmon. Based on the time at which these fish were observed, they were spring chinook. In 1936, spring chinook were observed in the Okanogan River upstream from Lake Osoyoos by Canadian biologists (Gartrell 1936).[11] That observation for May estimated 100-300 adults present "on the spawning grounds." We know of no other recent years when use of the Okanogan River by spring chinook was noted.

It has been suggested that spring chinook (and steelhead) formerly used the Similkameen River upstream from falls that lay at the present site of Enloe Dam. Chapman et al. (1995) found no evidence that such use occurred. The underlying source for Fulton's (1968) inclusion of the Similkameen River upstream from the site of Enloe Dam as anadromous salmon habitat was WDF (1938). Perusal of that source does not support the Fulton observation. WDF (1938) describes existence of potential spawning habitat in the area upstream from Enloe Dam, but provides no documentation of historical use of the area by salmon or steelhead (*O. mykiss*). Cox and Russell (1942) state:

From testimony of a Mr. McGrath at Nighthawk, who had been in that country over 40 years, we learned that before any power dam was built (Enloe Dam)*, the 15' to 20' natural falls already mentioned prevented salmon ascending any farther. He had often fished the river at Nighthawk but had never heard of a salmon being seen or caught above the natural falls. He stated that the Indians came in to fish at these falls each summer.....Therefore, we conclude that this power dam did not interfere with any salmon runs....*

Accounts of the traditional story of coyote suggest that salmon never passed upstream of the falls, and the Native people of the Similkameen valley never sought to have fish passage there, further confirming that anadromous fish never passed the falls (Vedan 2002).

Current distribution

WDW et al.(1989) states: *Natural spring chinook production in the Okanogan and Similkameen subbasins is currently not feasible due to extensive habitat alterations in the*

[11] Gartrell (1936) contains the only reference that we found to spawning by spring-run salmon in the main Okanogan River. We regard this information cautiously.

accessible reaches. Failure of inclined-plane traps to capture spring chinook smolts during trapping of sockeye smolts in the lower Okanogan River (McGee and Truscott 1982; McGee et al. 1983) empirically supports that judgment. Bryant and Parkhurst (1950) and Fulton (1970) claim spring chinook used Omak Creek, although the affidavits in Craig and Suomela (1941) do not mention such use. Weitkamp and Neuner (1981) captured a handful of chinook juveniles in a floating trap in the Okanogan River in 1981 that were large enough to be spring chinook. The trap was downstream from the confluence of Salmon Creek, and could have resulted from spring chinook that spawned in Salmon Creek. None were captured in 1982-1983 (McGee and Truscott 1982; McGee et al. 1983).

In cooperation with the USFWS, the Colville Confederated Tribes are beginning a program to reintroduce spring chinook into Omak Creek.

Abundance

Historic

Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 588,000-spring chinook was the best estimate of pre-development run sizes. Spring chinook were relatively abundant in upper Columbia River tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

Spring chinook counting at Rock Island Dam began in 1935. Numbers (adults and jacks) in the period 1935-39 averaged just over 2,000 fish. Average counts fluctuated on a decadal average from the 1940s to 1990s from just over 3,200 (1940s) to over 14,400 (1980s), with recent counts (2000-2002) averaging almost 29,000. The long-term average of spring chinook passing Rock Island Dam is just over 8,900.

Current

Natural production abundance is currently not available for the Okanogan, but is probably extremely low.

Productivity

Historic
Historic productivity for spring chinook was most likely never high, comparatively because of natural habitat limitations within the Basin.

Current
Current productivity may start to increase if the CCT program works.

Diversity
Diversity was most likely never high in the Okanogan Basin because of natural habitat limitations.

Summary

Spring Chinook[12]

	Distribution	Abundance	Productivity	Diversity
Historic	Low	Low	Low	Low
Current	None	None	None	None

2. Summer Steelhead

Historic distribution
Steelhead historically used all major (and some minor) tributaries within the Upper Columbia Basin for spawning and rearing (Chapman et al. 1994). In the Okanogan Basin, Fulton (1970) named Omak and Salmon creeks as producing steelhead, and the upper Similkameen, but that is questioned based on uncertainty of fish being able to ascend Enloe Falls prior to the dam at that site (Chapman et al. 1994). Mullan et al. (1992) stated that steelhead never used the Okanogan in great numbers, and that Salmon Creek (blocked by a dam in 1916), Omak Creek and the Similkameen River (see discussion above concerning fish upstream of the falls) were the most probable steelhead producing streams in the basin.

Current distribution
The ICBTRT recently listed the Okanogan Basin steelhead as an independent population: "*The current status of steelhead endemic to the Okanogan is unknown. Currently, low numbers of natural steelhead return to this system, but may be offspring from hatchery returns. However, the Okanogan appears to have supported an independent population of steelhead historically. Although habitat conditions for rearing are highly degraded in the system, the Okanogan and its tributaries in the U.S. and Canada appear to have contained sufficient habitat to have supported an independent population of steelhead. In addition, the Okanogan is found in a substantially different habitat than other populations in this ESU, further supporting delineation of this population*" (ICBTRT 2003).

[12] The values within the table are qualitative, based on the best information available. All species are considered within this qualitative approach (i.e., abundance of bull trout is relative to sockeye salmon).

Steelhead are currently known to spawn naturally in Omak Creek and the Similkameen River. In 2001, redds were also observed in Bonaparte Creek and Tonasket Creek, although the success of spawning in these areas remains unknown (Fisher, Ed. 2002).

Abundance

Historic

Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 554,000 steelhead (for the entire Columbia Basin) was the best estimate of pre-development run sizes. Steelhead were relatively abundant in upper Columbia River tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

Steelhead counts began at Rock Island Dam in 1933, and annual counts averaged 2,800 between 1933 and 1939 (these numbers do not reflect large fisheries in the lower river that took place at that time, estimated by Mullan et al. (1992) as greater than 60%). Average decadal numbers changed little in the 1940s and 1950s (2,600 and 3,700, respectively). Large hatchery releases began in the 1960s, and the average counts increased to 6,700. In the 1970s, counts averaged 5,700 and 16,500 in 1980s (record count of about 32,000 in 1985). In the 1990s, counts decreased, following a similar trend as chinook, to 7,100, while, similar to chinook, they have increased substantially so far in the 2000s, with an average of over 18,000 (a high of 28,600 in 2001).

Although the historical record for steelhead in the Okanogan Watershed is not complete, Mullan et al. (1992) asserts that few steelhead historically used the Okanogan River. Salmon and Omak creeks had historically runs, but lack of flow currently restricts access in most years in Salmon Creek. Some evidence suggests that steelhead may also have historically used other tributaries in the Okanogan Basin (Chapman et al. 1994).

Current

No current information is available that documents steelhead abundance in the Okanogan Basin. Current habitat conditions in the Okanogan basin are generally poor to support most life history requirements of steelhead. An estimated half of the steelhead production may have been lost as a result of fish access restrictions to Salmon Creek by irrigation water withdrawals (Fisher, Ed. 2002).

Productivity

Historic

Historic production of steelhead is difficult to determine, although it was most likely never very high in the Okanogan Basin. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan et al. 1992) it is assumed that historic production of steelhead was higher than current.

Current

Current productivity is affected by loss, or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Many factors related to natural conditions that have been exacerbated by land use practices are limiting production of steelhead in the Okanogan Basin. By reducing the effects of these land use practices, it is reasonable to assume that production of steelhead would increase.

Diversity

Because of natural conditions that have been exacerbated by land use practices, diversity within the basin is believed to be lower than historic. While the Okanogan population is believed to be an *independent population* (see definition in Appendix _), increased habitat would most likely increase spatial and life history diversity.

Currently, genetic sampling has not found any differences among steelhead within the basin.

Summary

Steelhead (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	Low	Low	Low	Low-moderate
Current	Very low	Very low	Very low	Very low

3. Summer/fall chinook

Historic distribution

Summer/fall chinook historically used the mainstem of the Okanogan River, from its mouth into Canada, and the lower Similkameen River (Craig and Suomela 1941; Fish and Hanavan 1948).

Current Distribution

In the Okanogan Basin, summer/fall chinook salmon spawn in both the Okanogan and Similkameen rivers. In the Okanogan River, chinook usually spawn between RM 14.5 (just downstream of Malott) and Zosel Dam (RM 77.4). In the Similkameen River, chinook spawn between its mouth and Enloe Dam (RM 8.9). In both rivers, redds are highly clumped, and those distributions have not changed since 1987 when ground surveys were first conducted (Hillman and Miller 1993; Miller 2003). During that period, densities of redds in the Okanogan River were highest between Okanogan and Omak (RM 26.1-30.8), McLoughlin Falls and Tonasket (RM 48.9-56.8), and the Similkameen River confluence and Zosel Dam (RM 74.1-77.4); they were lowest between Tonasket and the Similkameen River confluence (RM 56.8-74.1) (Hillman and Miller 1993). In the Similkameen River during the same period, densities of redds were highest between the mouth and the county road bridge (RM 0-5). Unlike in other mid-Columbia streams, Hillman and Miller (1993) found that summer/fall chinook in the Okanogan Basin constructed most of their redds near islands, i.e., in braided segments.

Abundance

Historic

Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 3.7 million summer chinook, (for the entire Columbia Basin) was the best estimate of pre-development run sizes. Summer/fall chinook were very abundant in upper Columbia River and tributary streams prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

Historically, the late spring and summer components of the Columbia River chinook populations were the most abundant and heavily fished (Thompson 1951, Van Hyning 1968, Chapman 1986). Overfishing in the lower Columbia River rapidly depressed summer-run chinook. Spawning and rearing habitat extirpation and destruction accelerated the decline.

Decadal averages of summer/fall chinook escapements at Rock Island Dam from 1933 through 2002 show a rising trend. Harvest rates in the 1930s and 1940s were very high in the lower river fisheries, and no doubt had a large impact on the escapement at Rock

Island (Mullan 1987). In 1951, when harvest rates in zones 1-6 (lower Columbia River) were reduced, numbers increased dramatically. Between the 1930s (starting in 1933) and 1960s (excluding 1968 and 1969)[13], total (adults and jacks) decadal average numbers of summer/fall chinook rose from just over 7,000 to almost 28,000. Numbers remained high in the 1970s until the mid-1980s, when they declined through the 1990s and have shown a sharp increase in the 2000s.

In the 1960s, dam counts became available at Rocky Reach Dam (1962) and Wells Dam (1967). These project counts of total summer/fall chinook show a different trend than Rock Island, which suggests the difference being the fish that spawn in the Wenatchee River were heavily affecting the trend at Rock Island Dam.

Current

Redd counts in the Okanogan and Similkameen began in 1956, and similarly to the Methow, showed increasing escapement until the late 1960s, and then declined. However, dissimilar to the Methow, the number of fish spawning in the Okanogan and Similkameen remained at very low numbers until the rise in the 1990s, which is believed to be due to the hatchery releases from Eastbank Hatchery primarily. The Eastbank satellite pond is located on the Similkameen River, and most of the spawning fish return to the short section of the Similkameen that is open to anadromous fish. This creates a problem of fish over-imposing redds on top of each other (A. Murdoch, WDFW, personal communication).

Productivity

Historic

Historic production of late-run chinook is difficult to determine, it was thought to be very high. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan 1987; Mullan et al. 1992), it is assumed that historic production of late-run chinook was higher than current.

Current

Current productivity is affected by loss, or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Mullan et al. (1992) postulated that current production may not be greatly different than historic for late-run chinook. Caveats to this postulate are that production comes at a higher cost in terms of smolt survival through the mainstem corridor, and that harvest is drastically reduced.

The Okanogan River mainstem spawning habitat may be limited because of high siltation deposition, and other factors. The Similkameen River is limited by total spawning area, primarily because of the shear number of fish returning from the hatchery releases (especially since 2001).

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[13] Unfortunately, there were no counts at Rock Island Dam between 1968 and 1972.

Diversity
Because some areas within the Okanogan Basin are in need of habitat improvements, diversity within the basin may be lower than historic. While the Okanogan population is still believed to be an *independent population* (see definition in Appendix _), increased habitat would most likely increase life history diversity.

Currently, genetic sampling has not found any differences among late-run chinook within the basin.

Summary

Summer/fall chinook (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	High	Very high	Very high	High
Current	Mod.-high	High	High	Mod.-high

4. Sockeye salmon

Historic Distribution
Historically, populations of sockeye salmon spawned in the Okanogan Basin upstream of Lake Osoyoos, including tributaries of Lake Okanogan (Mullan 1986).

Current Distribution
In the Okanogan Basin, spawning occurs in the mainstem Okanogan River between the head of Lake Osoyoos (RM 90) to the outlet of Vaseux Lake (RM 106) (Peven 1992).

Abundance
Historic
Chapman (1986) stated that large runs of chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, he estimated that approximately 2.6 million sockeye, (for the entire Columbia Basin) was the best estimate of pre-development run sizes. Sockeye were very abundant in upper Columbia River tributary streams (Yakima, Wenatchee, Okanogan, and Arrow Lakes) prior to the extensive resource exploitation in the 1860s. By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1984, 1986, 1987; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Fish and Hanavan 1948; Bryant and Parkhurst 1950; Chapman et al. 1982), and private development of the subbasins, in

combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

By the beginning of the twentieth century, it appears that most of the sockeye entering the Columbia River were headed to the Arrow Lakes region in British Columbia (WDF 1938). In the mid-1930s, WDF counted fish ascending Tumwater Dam in the Wenatchee River, and Zosel Dam in the Okanogan River. These counts suggested that 85-92% of the sockeye counted over Rock Island Dam in the same years where headed to spawning areas other than the Wenatchee and Okanogan basins.

Mullan (1986) quotes Rich (1940CPa, 1940CPb), who reviewed the sockeye fishery between 1892-1938, *the sockeye runs were greatly reduced as long ago as 1900, since which time there has been no marked change in the size of the catch.* Mullan (1986) suggests that the landings of sockeye may suggest otherwise, but that harvest rates in the lower river were undoubtedly high during that time; Rock Island Dam counts only accounted for 16% of the fish entering the Columbia River between 1933-1937, and in 1934 over 98% of the sockeye entering the river were harvested.

Mullan (1986) points out that commercial catches of sockeye after 1938 were still extreme, where escapement past the fisheries between 1938 and 1944 was mostly below 20%, and in 1941 was only 1%. In 1945, escapement increased and remained relatively high, between 25-50%. Since 1960, escapement has exceeded catch on a regular basis.

Current

Since 1938, the percentage of sockeye that has entered the Columbia River (minimum run) that have passed Rock Island Dam has varied from less than 1% (1941) to greater than 95% (1990s). The mean percentage of fish ascending the Columbia past Rock Island Dam has increased since 1938. Between 1938 and 1944, only 14.5% of the sockeye estimated to have entered the Columbia River were counted at Rock Island Dam (see above). The percentage has steadily grown since then, approaching 100% in most recent years.

Allen and Meekin (1980) report the escapement goal of 80,000 sockeye over Priest Rapids to ensure 25,000 fish on the spawning grounds of the Okanogan. Currently, the escapement goal at Priest Rapids is 65,000 (Devore and Hirose 1988). The Columbia River Technical Advisory Committee (TAC) changed the goal in 1984 from 80,000 fish (1933-1966 at Rock Island, and from 1967 to the present at Priest Rapids) to the current 65,000, which under most conditions equates to 75,000 sockeye over Bonneville Dam. Improving pre-spawning mortality factors may increase the number of years that the Okanogan run would reach the escapement goal.

Decadal averages have shown a general increase in numbers of fish ascending Rock Island Dam.

Productivity

Historic

Historic production of sockeye is difficult to determine, it was thought to be very high. While it is known that in some years, there was drastic failure of certain year classes (primarily due to ocean conditions; see Mullan 1987; Mullan et al. 1992), it is assumed that historic production of sockeye was higher than current, especially considering that two major lakes (Okanogan and Skaha) have been lost to sockeye production.

Current

Current productivity is affected by loss, or degradation of habitat in spawning and rearing areas, increased downstream mortality through the mainstem Columbia River, ocean conditions, and other abiotic factors (drought, etc.).

Another limiting factor for Okanogan sockeye is that high water temperatures in the Okanogan River may delay entry into the river, further stressing fish. Increased water temperatures may also increase disease outbreaks, further causing direct or indirect mortality.

Lake Osoyoos, the only rearing lake currently used for juvenile rearing, is highly eutrophic, and land use practices, including urban development, increases the nutrient load into the lake. The net effect of this is that in summer, rearing area is reduced.

Diversity

Diversity of the Okanogan independent population is lower than historic, since some of the main rearing lakes are not in production anymore. While the Grand Coulee Fish Maintenance Project only released juveniles twice into Lake Osoyoos over 60 years ago, these fish were of mixed stock origin, further reducing the original genome of the population.

Summary

Sockeye (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	High	Very high	Mod.-high	High
Current	Low	Low-moderate	Low-moderate	Low

6. Pacific lamprey

Historic distribution

Historical distribution of Pacific lamprey in the Columbia and Snake Rivers was coincident wherever salmon occurred (Simpson and Wallace 1978). It is likely that Pacific lamprey occurred historically throughout the Wenatchee, Entiat, Methow, and Okanogan basins. In the Okanogan Basin, lamprey may have used the Okanogan River, Similkameen River, Salmon Creek, and Omak Creek.

Current Distribution
It appears that lamprey do not presently use the Okanogan system. Sampling by McGee et al. (1983) found no lamprey there. Hillman (unpublished data) electrofished portions of the Okanogan and Similkameen rivers and collected no adult lamprey or ammocoetes. Although no lamprey have been observed in the Okanogan system recently, suitable spawning and rearing habitat appear to be available.

Abundance
Historical abundance of Pacific lamprey is difficult to determine because of the lack of specific information. However, lamprey were (and continue to be) culturally significant to the Native American tribes in the Columbia Basin.

Current
There are currently no abundance information except perhaps dam count differences between over Wells. However, this is complicated because of the fish that enter the Methow River, which is downstream of the Okanogan.

Productivity
There currently is no information on historic and current productivity on Pacific lamprey. However, it is reasonable to assume that current production is lower than historic.

Diversity
Current diversity is though to be lower than historic, especially since lamprey have not been observed in the Okanogan in recent years.

Pacific lamprey (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	?	?	Higher than present	?
Current	?	?	?	?

7. Bull trout
Historic
Historically, Salmon Creek and Loup Loup Creek were known habitat for bull trout (Fisher, Ed. 2002).

Current Distribution
Bull trout are not known to presently exist in the Okanogan Basin, including Canadian waters. One of the factors believed to be responsible for the disappearance of bull trout from Salmon and Loup Loup creeks is the introductions of rainbow and brook trout (Fisher, Ed. 2002).

Abundance

Historic

There is currently no information available to assess what historic abundance of bull trout was in the Okanogan River Basin.

Current

There are no bull trout currently in the Okanogan Basin.

Productivity

Historic

Historic productivity of bull trout within the Okanogan Basin is not known. However, it is reasonable to assume that it was higher, based on habitat degradation and management practices (harvest).

Current

There are no bull trout currently in the Okanogan Basin.

Diversity

Historic diversity was most likely higher than current based on losses of connectivity and increases in temperature. If habitat restoration occurs, there may be an opportunity to establish populations in isolated places within the Basin.

Summary

Bull trout (see footnote 2)

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	Low	Low	Low	Low
Current	none	none	none	none

8. Westslope cutthroat trout

Distribution

Historic

Through stocking programs that began with Washington state's first trout hatchery in the Stehekin River valley in 1903 (that targeted WSCT), WSCT have been transplanted in almost all available stream and lake habitat, including the Okanogan River Basin (Williams 1998). WSCT may never have been in the Okanogan Basin (Fisher, Ed. 2002), however, this may never be known positively and the potential exists that some of the higher altitude streams may have had some fish present.

Current

Currently WSCT are found in the North Fork Salmon Creek, Sinlahekin headwaters, and in numerous alpine lakes (Williams 1998). They were most likely introduced into these waters (Fisher, Ed. 2002).

Abundance
Historic
There is currently no information available to assess what historic abundance of WSCT was in the Okanogan River Basin. Numerical abundance has not been documented or estimated for WSCT. Westslope cutthroat were not thought to have been very abundant where they naturally occurred in the headwater locations within the Methow, Entiat, and Wenatchee basins (Williams 1998; USFWS 1999; Behnke 2002).

Current
There are no known estimates of current abundance within the Okanogan River Basin

Productivity
Historic
Historic productivity of bull trout within the Okanogan Basin is not known (or if it existed). However, it is reasonable to assume that it was higher, based on habitat degradation and management practices (hatchery plants).

Current
There are no known estimates of current abundance within the Okanogan River Basin.

Diversity
If WSCT existed in the Okanogan, historic diversity was most likely higher than current based on reduction of habitat due primarily to land use practices and introduction of exogenous species. If habitat restoration occurs, there will most likely be an increase in spatial and potentially life history diversity.

Summary

Westslope cutthroat trout (see footnote 2).

	Distribution	**Abundance**	**Productivity**	**Diversity**
Historic	Low	Low	Low	Low
Current	Low	Low	Low	Low

Summary for Okanogan Subbasin

	Distribution	**Abundance**	**Productivity**	**Diversity**
Spring chinook				
Historic	Low	Low	Low	Low
Current	None	None	None	None
Steelhead				
Historic	Low	Low	Low	Low-moderate
Current	Very low	Very low	Very low	Very low

Sum/fall chin				
Historic	High	Very high	Very high	High
Current	Mod.-high	High	High	Mod.-high
Sockeye				
Historic	High	Very high	Mod.-high	High
Current	Low	Low-moderate	Low-moderate	Low
Bull trout				
Historic	Low	Low	Low	Low
Current	none	none	none	none
WSCT				
Historic	Low	Low	Low	Low
Current	Low	Low	Low	Low

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