Volume II, Chapter 16
Wind River Subbasin

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16.0 Wind River Subbasin

16.1 Subbasin Description

16.1.1 Topography & Geology

The Wind River subbasin covers about 143,504 acres (224 mi^2) in central Skamania County. The headwaters of the mainstem arise in the McClellan Meadows area in the southern Gifford Pinchot National Forest (GPNF). The major tributaries in the basin include the Little Wind River, Bear Creek, Panther Creek, Trout Creek, Trapper Creek, Dry Creek, Falls Creek, and Paradise Creek. Elevation in the basin ranges from 80 to 3,900 feet. The northwest portion of the basin is steep and the northeast portion is relatively flat and consists of high elevation meadows. Trout Creek, a major tributary to the west, has a broad alluvial bench (Trout Creek Flats) in the upper central portion of the basin. A broad alluvial valley extends along several miles of the middle mainstem before entering into a steep V-shaped canyon in the lower 20 miles of stream. The lower southeast portion of the basin, including the Panther Creek and Little Wind River basins, is quite steep. Shipherd Falls, actually a set of four 10-15 foot falls, is located at approximately RM 2 and historically blocked all anadromous fish except for steelhead, until it was laddered in the 1950s.

Basin geologic history consists of old and new volcanic activity combined with more recent glacial and alluvial processes. The older basalt flows date back 12 to 25 million years, while the newer ones emanating from Trout Creek Hill are as recent as 300,000 years ago. The older material, which makes up most of the basin, is the most susceptible to erosion due to weathering into finer material. Relatively recent glacial activity contributed glacial sediments and has shaped river valleys. Alluvial deposits from the massive Bretz Floods, which originated from eastern Washington during the late Pleistocene, have resulted in highly erodable soils in portions of the lower basin.

16.1.2 Climate

The climate is marine-influenced, consisting of cool, wet winters and warm, dry summers. Mean annual precipitation is 109 inches at Stabler. Most of the precipitation falls from November through April (WRCC 2003). 70% of the basin is in the rain-on-snow zone, with low elevation areas in the rain-dominated zone and the highest elevation areas in the snow-dominated zone.

16.1.3 Land Use/Land Cover

The subbasin is 93% forested. Non-forested lands include alpine meadows in the upper northeast basin and areas of development in lower elevation, privately-owned areas. Forest stands above 3,500 feet are generally in the Pacific silver fir plant association, while lower elevation areas tend to be in the Hemlock zone. Approximately 9.6% of the land is private, while almost all of the remainder lies within the GPNF. Forestry land uses dominate the subbasin. The percentage of the forest in late-successional forest stages has decreased from 83,500 acres to 31,800 acres since pre-settlement times. This change is attributed to timber harvest and forest fires (USFS 1996). The largest population centers are the towns of Carson and Stabler. Carson draws its water supply from Bear Creek, a Wind River tributary. The year 2000 population of the subbasin was estimated at 2,096 persons and is expected to increase to 3,077 by 2020 (Greenberg and Callahan 2002). Land ownership and land cover are illustrated in Figure 16-1 and Figure 16-2. Figure 16-3 displays the pattern of landownership for the basin. Figure 16-4 displays the pattern of land cover / land-use.

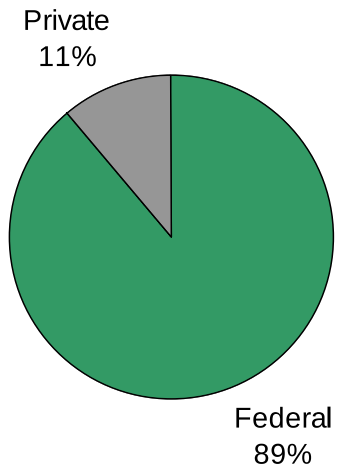


Figure 16-1. Wind River subbasin land ownership

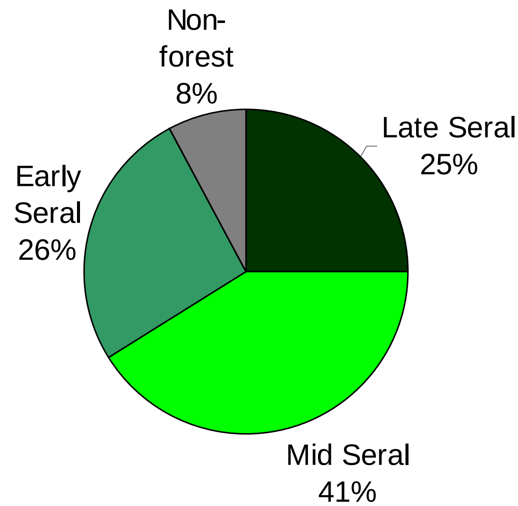


Figure 16-2. Wind River subbasin land cover

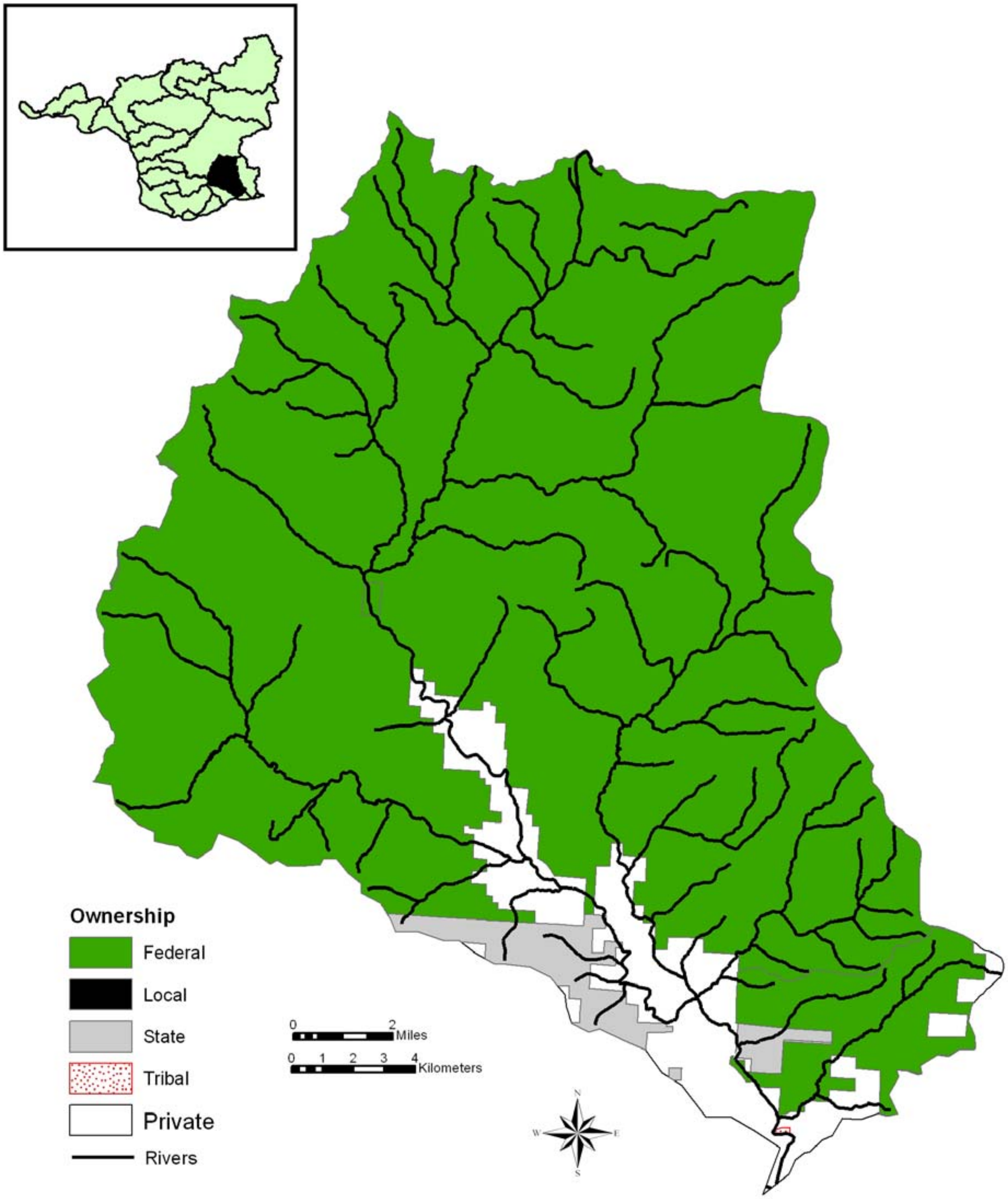


Figure 16-3. Landownership within the Wind basin. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

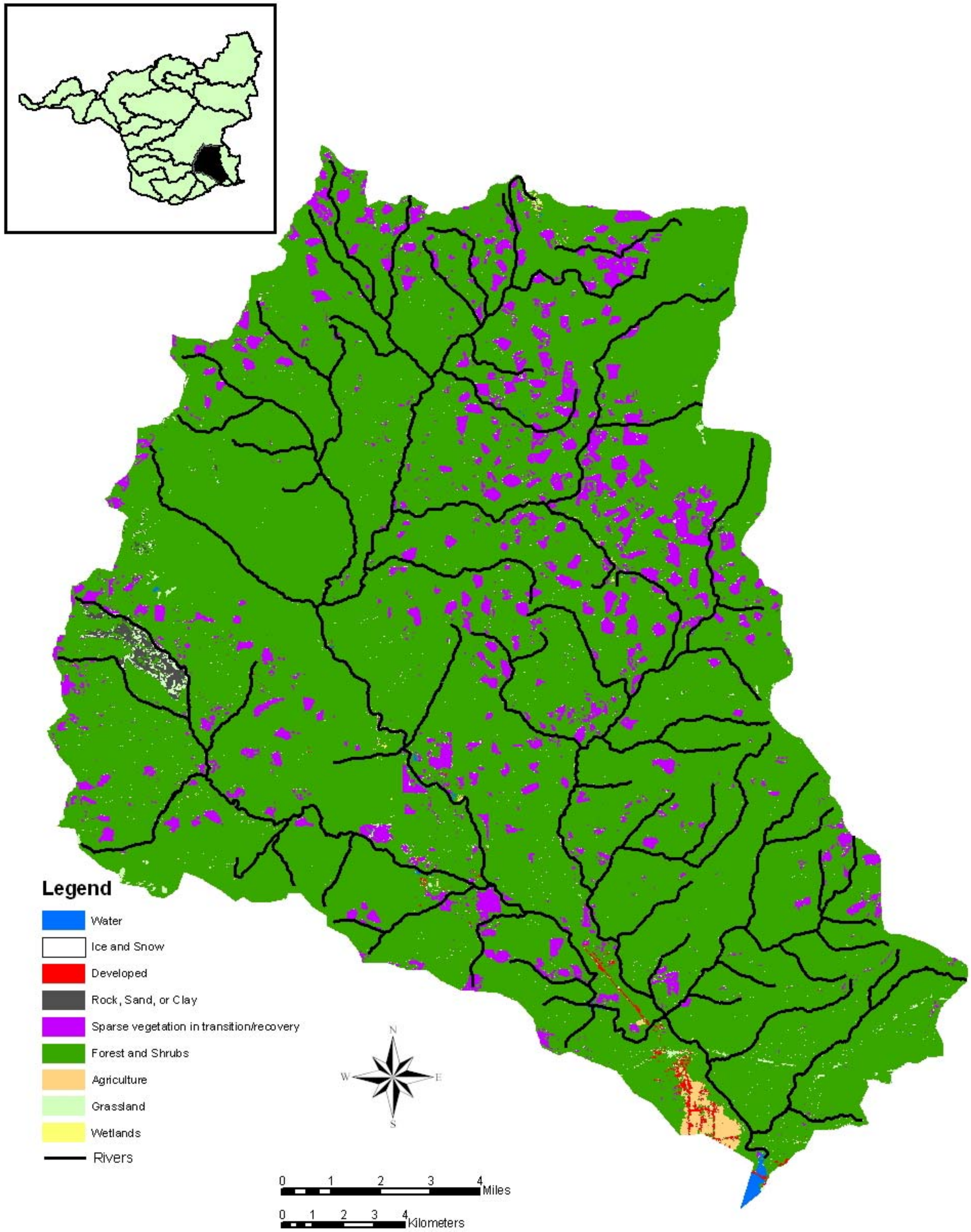
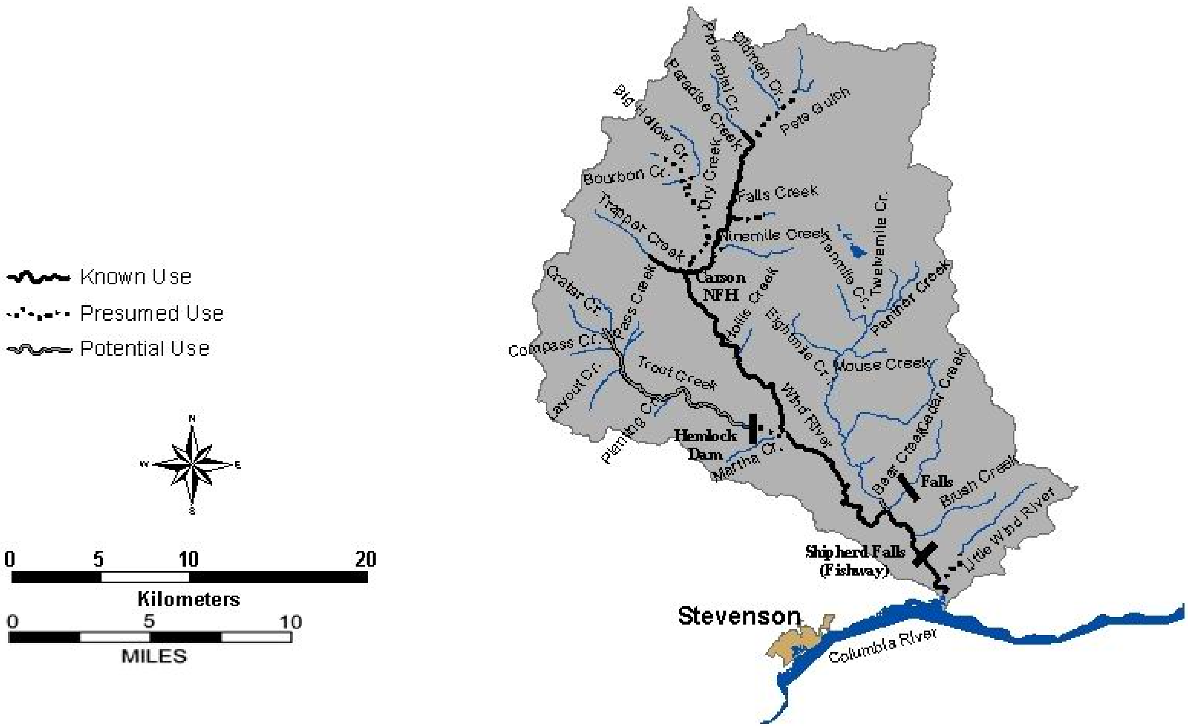


Figure 16-4. Land cover within the Wind basin. Data was obtained from the USGS National Land Cover Dataset (NLCD).

16.2 Focal Fish Species

16.2.1 Spring Chinook—Wind Subbasin

ESA: Not listed (non-native species)	SASSI: Healthy 2002

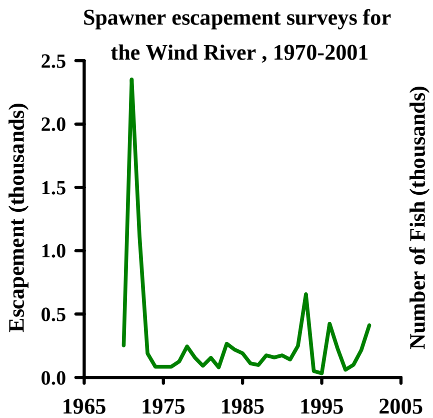


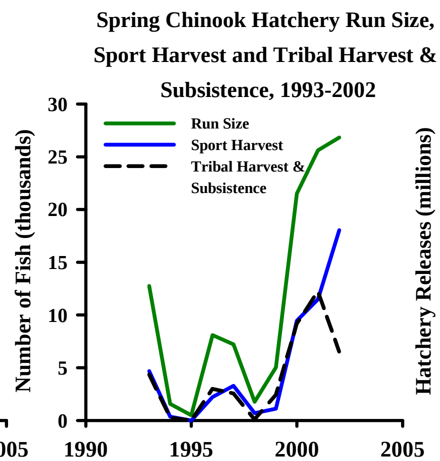
Distribution

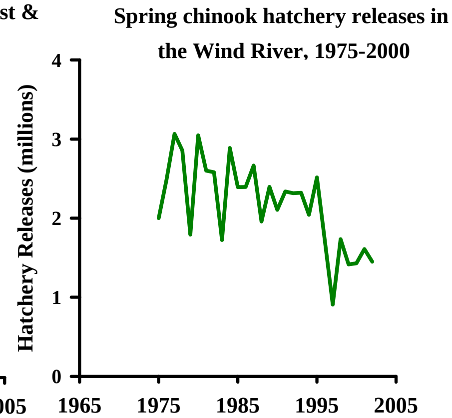
- Historically, spring chinook were not found in the Wind River basin
- A ladder was constructed at Shipherd Falls (RM 2) in the 1956 as part of a spring chinook introduction program, providing fish access to the upper watershed
- Currently, natural spawning occurs in limited numbers from the mouth of Paradise Creek (RM 25) downstream approximately 10 miles

Life History

- Spring chinook return to the Wind River from March through June; spring chinook counts peak at Bonneville Dam in late April
- Spawning in the Wind River occurs between early August and mid-September, with peak activity in late August
- Age ranges from 3-year old jacks to 6-year old adults, with 4- and 5-year olds usually the dominant age class (averages are 58.5% and 38.0%, respectively)
- Fry emerge between November and March, depending on time of egg deposition and water temperature; spring chinook fry spend one full year in fresh water, and emigrate in their second spring as age-2 smolts







Diversity

- Spring chinook did not historically return to the Wind River
- Spring chinook were introduced to the Wind River basin; brood stock is mixed upriver spring chinook stock
- Allozyme analysis of Carson National Fish Hatchery (NFH) spring chinook indicate they resemble upper Columbia River spring chinook stocks in the Wenatchee, Entiat, and Methow basins

Abundance

- Wind River spawning escapements from 1970-2002 ranged from 26 in 1995 to 1,936 in 1971
- The average fish per mile from 1970-84 was 21; fish per mile ranged from 4-112
- Spring chinook are not native to the Wind River basin; hatchery strays account for most spring chinook spawning in the Wind River

Productivity & Persistence

- National Marine Fisheries Service Status Assessment for the Wind River indicated a 0.01 risk of 90% decline in 25 years and a 0.03 risk of 90% decline in 50 years; the risk of extinction in 50 years was 0.0
- Smolt density model predicted natural production potential for the Wind River was 157,533 smolts
- Juvenile production from natural spawning is presumed to be low; population is not considered self-sustaining

Hatchery

- The state operated a salmon hatchery near the mouth of the Wind River from 1899-1938 to produce fall chinook
- Carson NFH was constructed in 1937 at Tyee Springs (RM 18); hatchery releases of spring chinook in the Wind River began in the 1930s; early attempts to introduce spring chinook to the Wind basin were unsuccessful
- Spring chinook releases into the Wind River 1972-1990 averaged 3,443,636
- Carson NFH brood stock was developed from spring chinook from the Snake River and mid- and upper Columbia River collected at Bonneville Dam in the 1970s

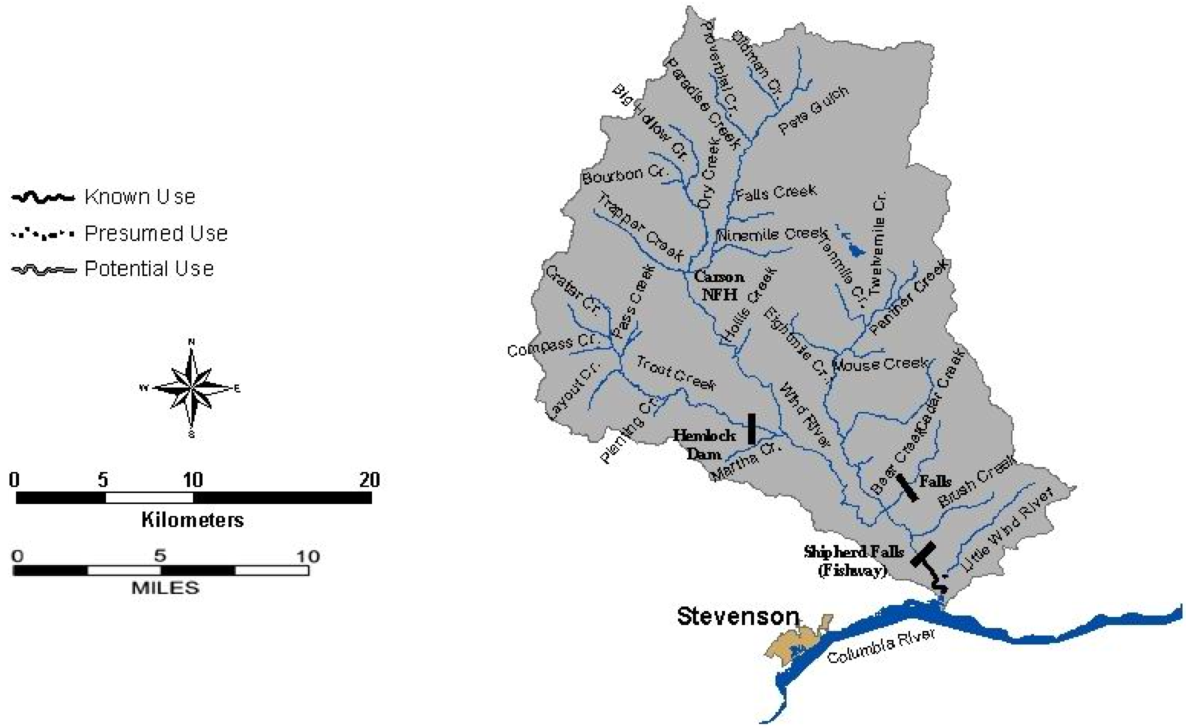
- The current Carson hatchery program releases 1.6 million spring chinook smolts annually into the Wind River

Harvest

- Spring chinook to harvested in ocean commercial and recreational fisheries from Oregon to Alaska, in addition to Columbia River commercial and sport fisheries
- CWT analysis indicated that upriver spring chinook are impacted less by ocean fisheries than other Columbia River chinook stocks; CWT recovery data suggest that Carson Hatchery spring chinook are recovered primarily as recreational harvest, incidental commercial harvest, and hatchery escapement
- From 1938-1973, about 55% of upriver spring chinook runs were harvested in directed Columbia River commercial and sport fisheries; from 1975-2000 (excluding 1977), no lower river fisheries have targeted upriver stocks and the combined Indian and non-Indian harvest rate was limited to 11% or less
- Beginning in 2001, selective fisheries and abundance based management agreement through *US vs. Oregon* has enabled an increase in Columbia harvest of hatchery spring chinook
- WDF and the Yakama Indian Nation negotiate an annual harvest plan for sharing the Little White Salmon Hatchery surplus between the sport fishery and the tribal commercial and subsistence fisheries in Drano Lake
- Sport harvest in the Wind River from 1993-2002 averaged 5,130; with a record 18,036 harvested in 2002
- Tribal harvest averaged 869 and tribal hatchery subsistence distributions averaged 3,189 from 1993-2002

16.2.2 Fall Chinook—Wind Subbasin

ESA: Threatened	**SASSI: Critical 2002**

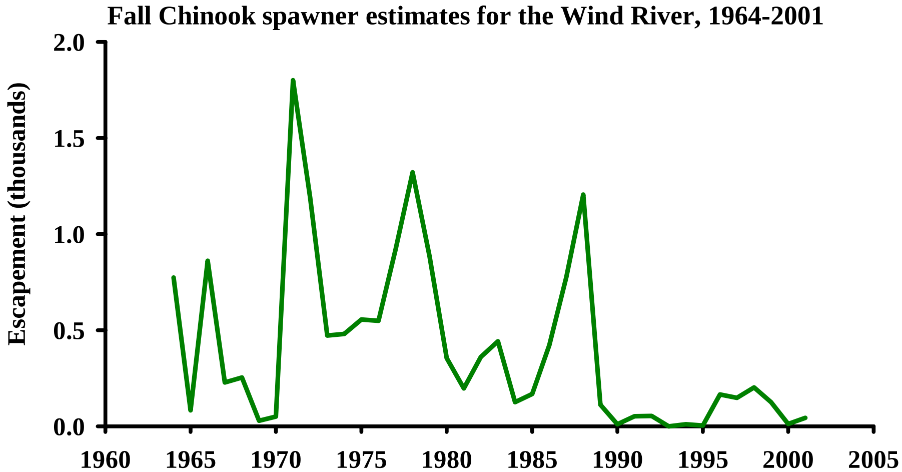


Distribution

- Historically, fall chinook were limited to the lower Wind River; a ladder was constructed at Shipherd Falls (RM 2) in 1956, providing fish access to the upper watershed
- Fall chinook have been observed up to the Carson NFH (RM 18), but the majority of spawning occurs in the lower two miles of the mainstem; spawning may also occur in the Little Wind River (RM 1)
- Completion of Bonneville Dam (1938) inundated the primary fall chinook spawning areas in the lower Wind River

Life History

- Bonneville Pool tule stock fall chinook upstream migration in the Columbia River occurs from August through September; peak counts at Bonneville Dam range from September 4-9
- Tule fall chinook enter the Wind River in September
- Spawning in the Wind River generally occurs in September
- Age ranges from 2-year old jacks to 4-year old adults, but age 3- and 4-year old spawners predominate
- Fry emerge from January through March, depending on time of egg deposition and water temperature; fall chinook fingerlings emigrate from the Wind River in spring



Diversity

- Considered a tule population in the lower Columbia River Evolutionarily Significant Unit (ESU)
- The Wind River fall chinook stock was designated based on spawning distribution, spawning timing, river entry timing, appearance, and age composition
- Hybridization between native Wind River tule fall chinook and Spring Creek NFH fall chinook is likely

Abundance

- In the late 1930s, fall chinook escapement to the Wind River basin was 200 fish
- WDFW (1951) estimated a 5-year average return of 1,500 fall chinook
- Wind River, spawning escapements from 1964-2001 ranged from 0 to 1,845 (average 416)

Productivity & Persistence

- NMFS Status Assessment for the Wind River fall chinook indicated a 0.52 risk of 90% decline in 25 years, 0.67 risk of 90% decline in 50 years, and 0.74 risk of extinction in 50 years
- Fall chinook smolt capacity was estimated at 206,608 for the Wind River basin
- Naturally produced fall chinook fry are observed each year in the lower Wind River smolt trap, documenting successful natural spawning

Hatchery

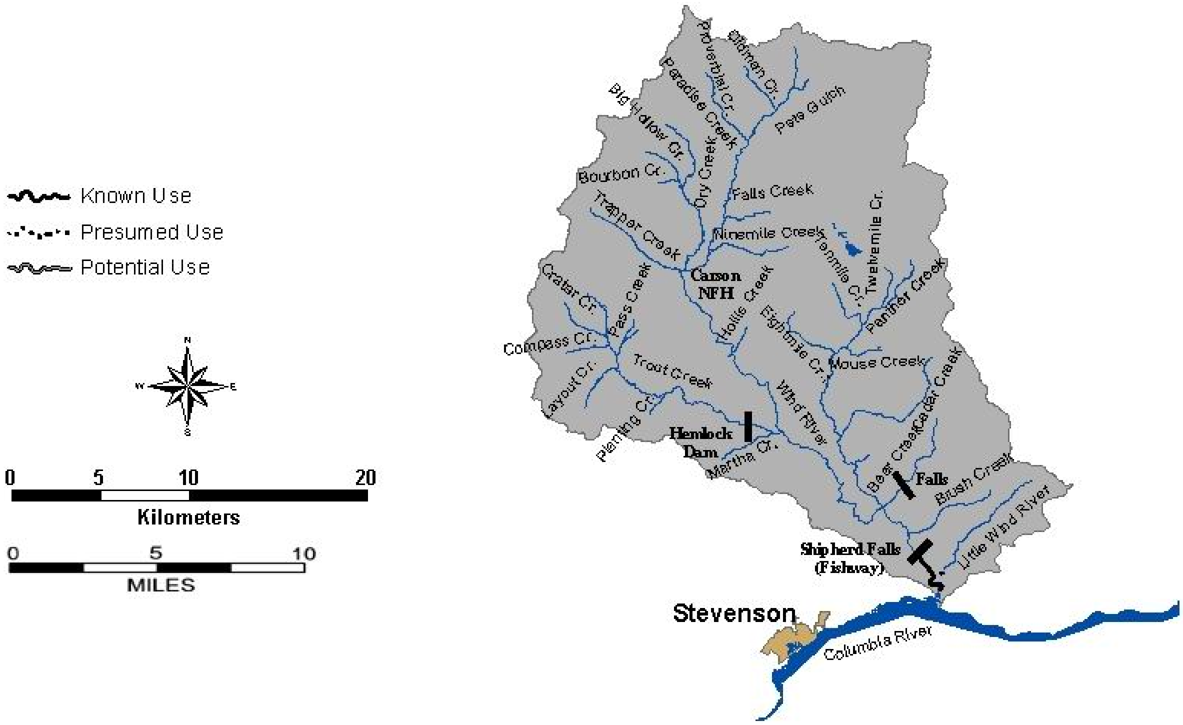
- The state operated a salmon hatchery near the mouth of the Wind River from 1899 until 1938 when the hatchery was flooded by Bonneville Dam Reservoir
- The state hatchery produced only fall chinook during 1899-1938, with egg take ranging from 1-4 million in most years, but as high as 10-20 million in some years; broodstock was taken directly from the Wind River
- Carson NFH was constructed in 1937 at Tyee Springs (RM 18); broodstock was developed primarily from Spring Creek NFH fall chinook stock
- Total fall chinook releases in the Wind River basin averaged 2 million from 1952-1976
- Fall chinook hatchery releases into the Wind River were discontinued after 1976

Harvest

- Fall chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, in addition to Columbia River commercial gill net and sport fisheries
- Columbia River commercial harvest occurs in August and September, but flesh quality is low once tule chinook move from salt water; the price is low compared to higher quality bright stock chinook
- Fall chinook destined for areas upstream of Bonneville Dam are harvested in August and September Treaty Indian commercial and subsistence fisheries
- Annual harvest dependent on management response to annual abundance in Pacific Salmon Commission (PSC) (US/Canada), Pacific Fisheries Management Council (PFMC) (US ocean), and Columbia River Compact forums
- Ocean and lower Columbia River harvest limited to 49% due to Endangered Species Act (ESA) limit on Coweeman tules
- Fall chinook originating upstream of Bonneville Dam are subject to Federal Court Agreements regarding Indian and non-Indian harvest sharing
- CWT data analysis of the 1971-1972 brood years from Spring Creek NFH indicates that the majority of Bonneville Pool Hatchery fall chinook stock harvest occurred in British Columbia (28%) and Washington (38%) ocean commercial and recreational fisheries
- Bonneville Pool tule stock fall chinook are important contributors to the Columbia River estuary (Buoy 10) sport fishery; in 1991, Bonneville Pool Hatchery fish comprised 25% of the Buoy 10 chinook catch
- Sport harvest in the Wind River averaged 9 fall chinook annually from 1977-1986

16.2.3 Mid-Columbia Bright Late Fall Chinook—Wind Subbasin

ESA: Threatened 1999 **SASSI: Healthy 2002**



Distribution

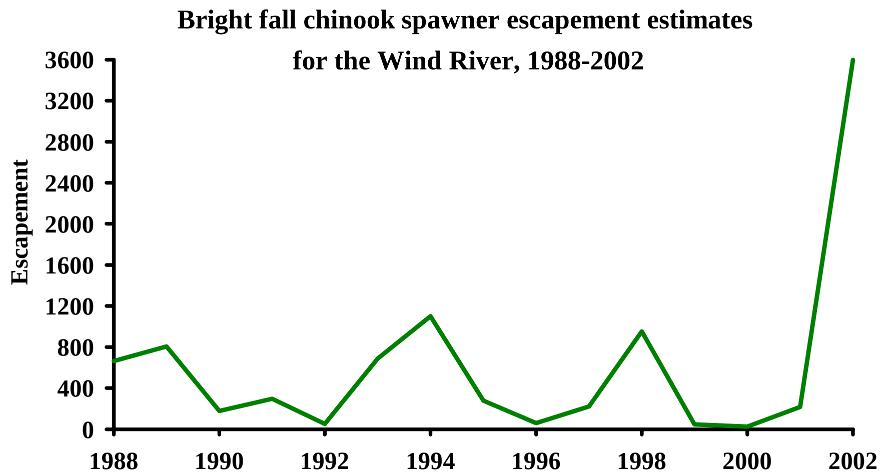
- Completion of Bonneville Dam (1938) inundated the primary spawning areas in the lower Wind River; a ladder was constructed at Shipherd Falls (RM 2) in 1956, providing fish access to the upper watershed
- Fall chinook have been observed up to the Carson NFH (RM 18), but the majority of spawning occurs in the lower two miles of the mainstem Wind River

Life History

- Mid Columbia bright fall chinook upstream migration in the Columbia River occurs from August to October; peak counts at Bonneville Dam range from September 4-9
- Mid Columbia bright fall chinook enter the Wind River in late September to October
- Spawning in the Wind River occurs from late October through November, later than the Wind River tule fall chinook stock
- Age ranges from 2-year old jacks to 6-year old adults, age 4 and 5-year old spawners predominate
- Fry emerge in the spring, depending on time of egg deposition and water temperature; fall chinook fingerlings emigrate from the Wind River in spring and early summer

Diversity

- Considered a late spawning upriver bright stock (URB), likely developed as a result of straying from URB fall chinook produced at nearby hatcheries
- The Wind River URB late fall chinook stock was designated based on spawning distribution, spawning timing, river entry timing, appearance, and age composition



Abundance

- Historically, URB late fall chinook were not found in the Wind River basin; presence in the basin is likely a result of straying from nearby hatcheries (Little White Salmon NFH and Bonneville Hatchery in Oregon)
- Presence of URB fall chinook in the Wind was discovered by WDFW in 1988 and was likely a result of displaced Bonneville Hatchery produced adults, which started with URB adults trapped at Bonneville Dam in 1977
- In the Wind River, URB spawning escapements from 1988-2001 ranged from 25-1,101 (average 397)

Productivity & Persistence

- Fall chinook smolt capacity was estimated at 206,608 for the Wind River basin
- Although the URB stock fall chinook likely originated from hatchery production, the run appears to be self-sustaining

Hatchery

- Hatchery production of URB fall chinook has not occurred in the Wind River; nearby hatcheries that release this stock include Little White Salmon NFH and the Bonneville Hatchery

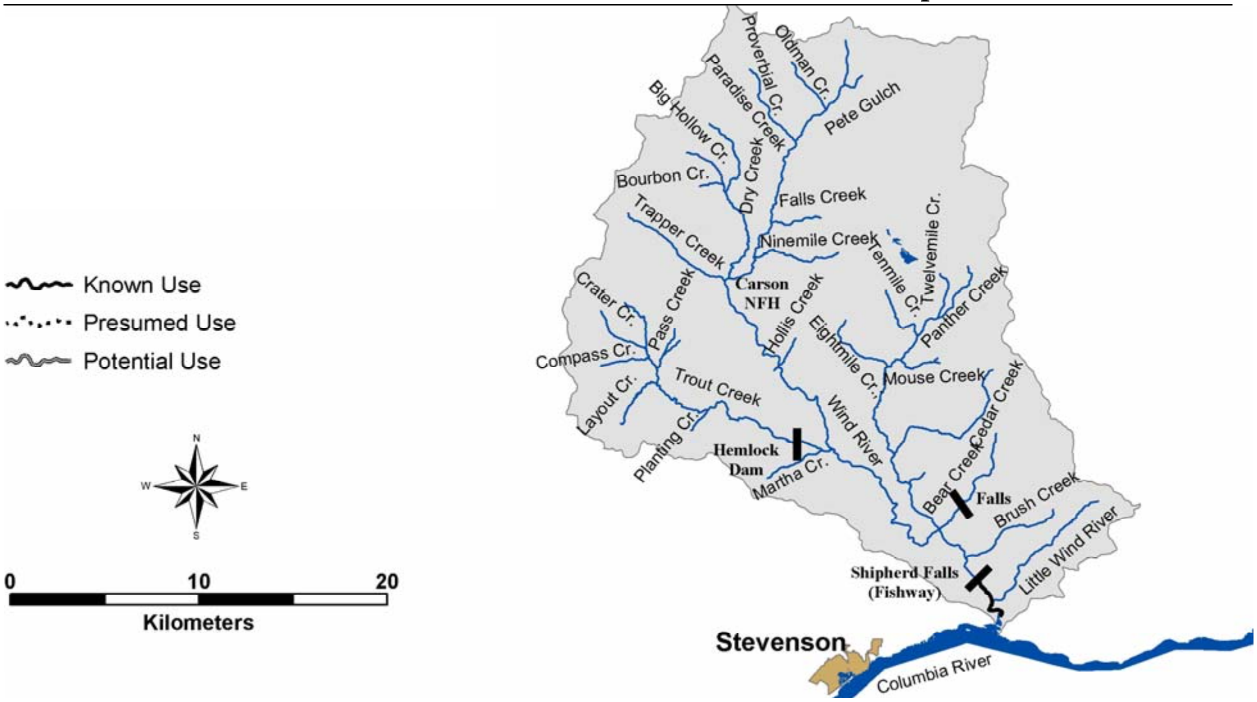
Harvest

- Fall chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, and in Columbia River commercial gill net and sport fisheries
- URB fall chinook migrate farther north in the ocean than lower Columbia chinook, with most ocean harvest occurring in Alaska and Canada
- URB fall chinook are also an important sport fish in the mainstem Columbia from the mouth upstream to the Hanford Reach, and an important commercial fish from August into early October
- Fall chinook destined for above Bonneville Dam are and extremely important fish for Treaty Indian commercial and subsistence fisheries during August and September
- CWT data analysis of the 1989-94 brood URB fall chinook from Priest Rapids Hatchery indicates that the majority of the URB fall chinook stock harvest occurred in Alaska (24%), British Columbia (23%), and Columbia River (42%) fisheries during the mid 1990s

- Current annual harvest dependent on management response to annual abundance in PSC (U.S./Canada), PFMC (U.S. ocean), and Columbia River Compact forums
- Columbia River harvest of URB fall chinook is limited to 31.29% (23.04% Indian/ 8.25% non-Indian) based on Snake River wild fall chinook ESA limits
- Fall chinook originating upstream of Bonneville Dam are subject to Federal Court Agreements regarding Indian and non-Indian harvest sharing

16.2.4 Chum—Wind Subbasin

ESA: Threatened 1999	SASSI: Depressed 1992



Distribution

- There appears to be potential chum spawning in the Wind River in the lower river below Shipherd Falls

Life History

- Adults enter the lower Columbia River from mid-October through November
- Peak spawning occurs in late November
- Dominant adult ages are 3 and 4
- Fry emerge in early spring; chum emigrate as age-0 smolts

Diversity

- No hatchery releases have occurred in the Wind River

Abundance

- Historical Wind River chum abundance data are not available
- Bonneville Dam count of chum ranged from 788-3,636 during 1938-1954
- Since 1971, chum counts at Bonneville Dam have ranged from 1-147

Productivity & Persistence

- Chum salmon natural production is low

Hatchery

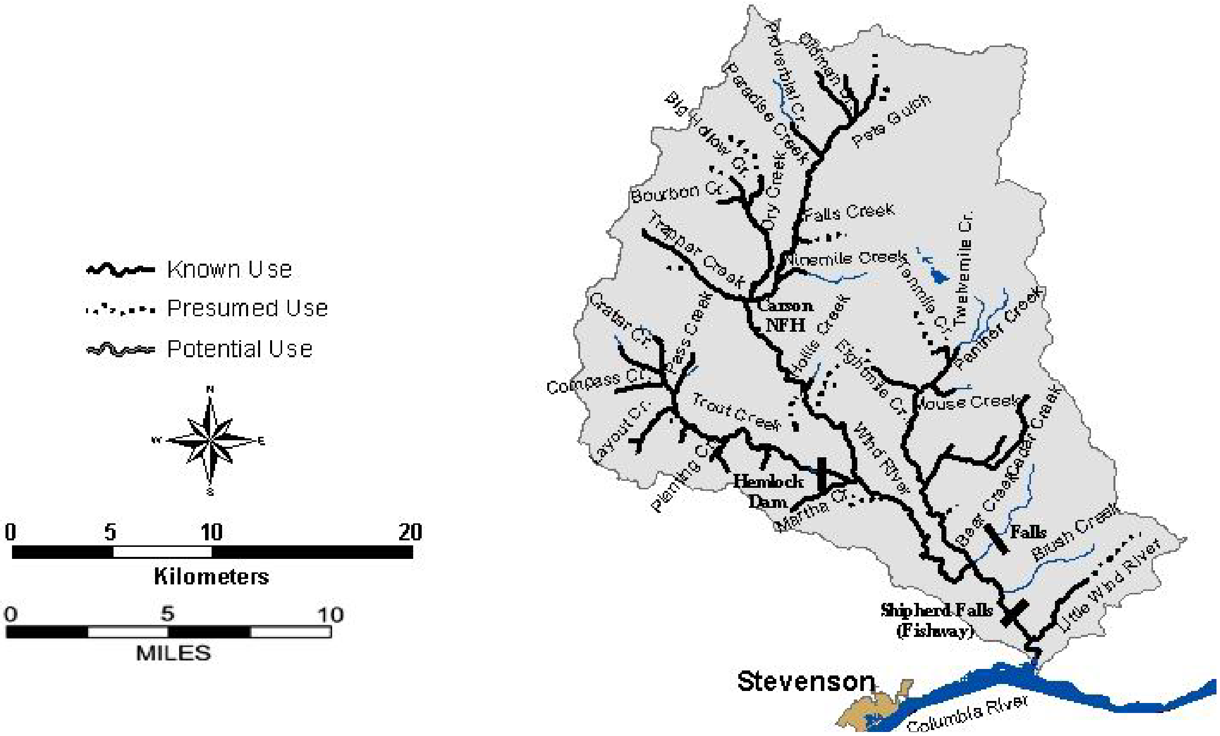
- Chum salmon have not been produced/released in the Wind River

Harvest

- Currently very limited chum harvest occurs in the ocean and Columbia River and is incidental to fisheries directed at other species
- Columbia River commercial fishery historically harvested chum salmon in large numbers (80,000-650,000 in years prior to 1943); from 1965-1992 landings averaged less than 2,000 chum, and since 1993 less than 100 chum
- In the 1990s November commercial fisheries were curtailed and retention of chum was prohibited in Columbia River sport fisheries
- The ESA limits incidental harvest of Columbia River chum to less then 5% of the annual return

16.2.5 Summer Steelhead—Wind Subbasin

ESA: Threatened 1998	SASSI: Depressed 2002

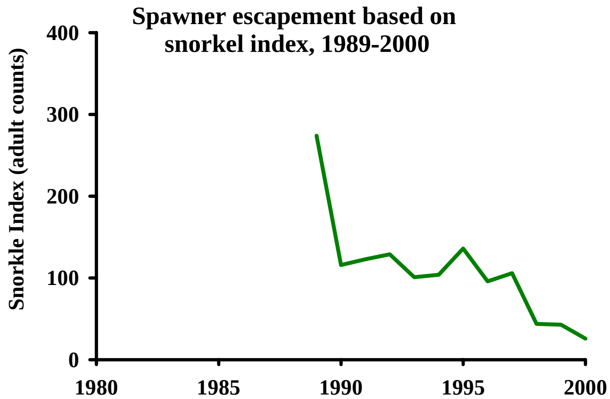


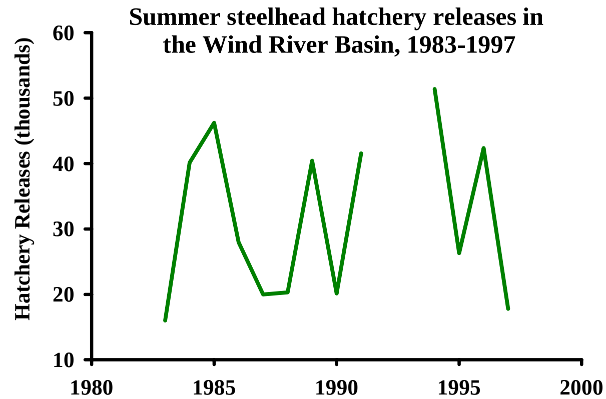
Distribution

- Summer steelhead are distributed throughout the Wind River basin, including the mainstem Wind River, the Little Wind River (RM 1.1), Panther Creek (RM 4.3), Bear Creek (RM 4.3), Trout Creek (RM 10.8), Trapper Creek (RM 18.9), Dry Creek (RM 19.1), and Paradise Creek (RM 25.1)
- High drop-offs and waterfalls exist throughout the basin; some have been modified to promote fish passage while others remain as impediments to upstream steelhead migration
- Shipherd Falls (40 ft cascade) located at RM 2.1 on the mainstem was laddered in 1956, allowing anadromous fish passage to the upper basin
- Construction of Bonneville Dam inundated the lower one mile of river, flooding spawning and rearing habitat

Life History

- Adult migration timing for Wind River summer steelhead is from May through November
- Spawning timing in the Wind River basin is generally from early March through May
- Limited age class data indicate that the dominant age class is 2.2 and 2.3 (58% and 26%, respectively)
- Wild steelhead fry emerge from April through July; juveniles generally rear in fresh water for two years; juvenile emigration occurs from April to May, with peak migration in early May





Diversity

- Wind River summer steelhead stock (including Panther and Trout Creek) was designated based on distinct spawning distribution and early run timing
- 1994 allozyme analyses clustered mainstem Wind River and Panther Creek summer steelhead with a number of lower Columbia summer and winter steelhead stocks, including Skamania Hatchery summer steelhead; Trout Creek summer steelhead were part of an outlier group that included SF Nooksack summer steelhead, Washougal steelhead, and Cowlitz native late winter steelhead

Abundance

- In 1936, steelhead were observed in the Wind River during escapement surveys
- Prior to 1950, wild summer steelhead run size was estimated to be between 2,500 and 5,000 fish
- Trout Creek escapement was estimated at over 100 wild summer steelhead in the 1980s but declined to less than 30 fish in the 1990s
- Snorkel index adult counts from 1989-2000 ranged from 26 to 274
- Escapement goal for the Wind River basin is 957 wild adult steelhead

Productivity & Persistence

- NMFS Status Assessment indicated a 0.0 risk of 90% decline in 25 years and a 0.91 risk of 90% decline in 50 years; the risk of extinction in 50 years was 0.0
- The smolt density model estimated potential summer steelhead smolt production for the Wind River basin was 62,273
- Wild steelhead smolt yield has been monitored in the Wind River basin since 1995; the trend indicates increasing smolt yield
- WDFW indicated that natural production in the watershed is primarily sustained by wild fish

Hatchery

- The Carson National Fish Hatchery operates in the basin but does not produce summer steelhead
- Skamania and Vancouver Hatchery stock were planted in the Wind River Basin; release data are displayed from 1983-1997

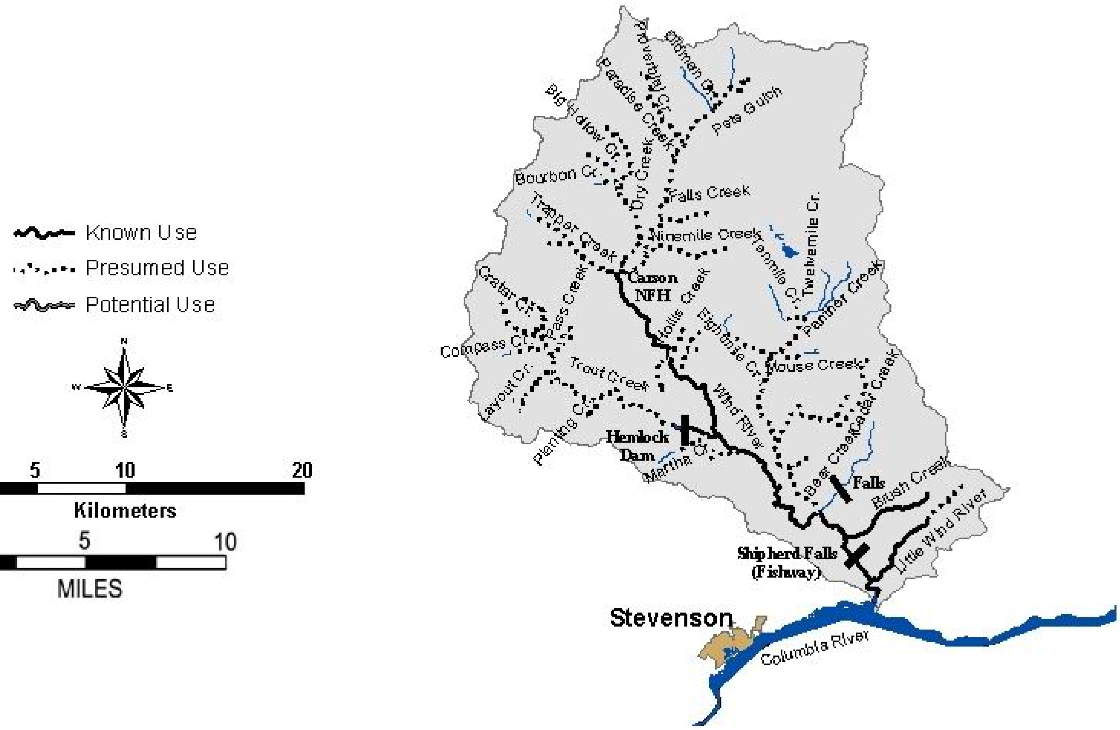
- Summer steelhead hatchery releases began in the basin in 1960; releases were suspended in the early 1980s for wild steelhead management then reinstated in the mid 1980s; releases of catchable rainbow trout were discontinued in 1994 and hatchery steelhead releases were discontinued in 1997
- Snorkel surveys from 1989-1998 indicated that hatchery summer steelhead comprised 41-60% of the spawning escapement
- Trout Creek trap counts conducted in 1992 indicate almost no migration of hatchery steelhead into this drainage; the hatchery fish that are captured are excluded from the drainage to preserve genetic diversity of the wild stock

Harvest

- No directed non-Indian commercial fisheries target Wind River summer steelhead; incidental mortality currently occurs during the Columbia River fall gill net fisheries
- Summer steelhead are harvested in the Columbia River Treaty Indian fall commercial and recreational fisheries in Zone 6
- Current steelhead harvest is primarily in the lower Wind and Cowlitz of hatchery steelhead from other Columbia basins which temporarily enter the Wind River before continuing their Columbia River migration
- Summer steelhead sport harvest in the Wind River from 1977-1982 averaged 1,373 and declined to an average annual harvest of 421 fish from 1983-1991; since 1981, regulations limit harvest to hatchery fish only
- ESA limits Wind wild summer steelhead fishery impact (Indian and non-Indian combined) to 17% per year

16.2.6 Winter Steelhead—Wind Subbasin

ESA: Threatened 1998	SASSI: Unknown 2002



Distribution

- Winter steelhead are distributed throughout the lower mainstem Wind River (~11 mi) and Trout Creek (RM 10.8)
- High drop-offs and waterfalls exist throughout the basin; some have been modified to promote fish passage while others remain as impediments to upstream steelhead migration
- Shipherd Falls (40 ft cascade) located at RM 2.1 on the mainstem was laddered in 1956, allowing anadromous fish passage to the upper basin
- Construction of Bonneville Dam inundated the lower one mile of river, flooding spawning and rearing habitat

Life History

- Adult migration timing for Wind River winter steelhead is from December through April
- Spawning timing on the Wind is generally from early March to early June
- Age composition data for Wind River winter steelhead are not available
- Wild steelhead fry emerge from March through May; juveniles generally rear in fresh water for two years; juvenile emigration occurs from April to May, with peak migration in early May

Diversity

- Wind River winter steelhead stock is designated based on distinct spawning distribution and run timing
- Wild stock interbreeding with Chambers Creek Hatchery brood stock may have occurred but is assumed to be minimal

Abundance

- In 1936, steelhead were observed in the Wind River during escapement surveys
- Trout Creek escapement was estimated at over 100 wild steelhead in the 1980s but has declined to less than 30 fish in the 1990s
- Wild winter steelhead escapement estimates for the Wind River are not available

Productivity & Persistence

- Wild steelhead smolt yield has been monitored in the Wind River basin since 1995; the trend indicates increasing smolt yield in recent years
- WDFW indicated that natural production in the watershed is primarily sustained by wild fish

Hatchery

- The Carson NFH operates in the basin but does not produce winter steelhead
- Hatchery releases of Chambers Creek and Skamania stock occurred in the Wind River Basin in the 1951, 1956, 1959, and 1963; releases ranged from 2,500 to 10,000 smolts
- Because of concern with wild steelhead interactions, releases of catchable-size rainbow trout were discontinued in 1994 and hatchery steelhead releases were discontinued in 1997
- No anadromous fish except unmarked (wild) steelhead are allowed past Hemlock Dam on Trout Creek

Harvest

- No directed commercial fisheries target Wind River winter steelhead; incidental mortality currently occurs during the lower Columbia River spring chinook tangle net fisheries
- Harvest occurs in the Columbia River Zone 6 winter commercial tangle net fishery and in tribal ceremonial and subsistence fisheries
- Winter steelhead sport harvest data in the Wind River are not available but approximately 25-50 wild winter steelhead are estimated to be harvested annually; since 1991, regulations limit harvest to hatchery fish only
- ESA limits fishery impact (Indian and non-Indian) of Wind River wild winter steelhead to 17% per year

16.3 Potentially Manageable Impacts

In Volume I of this Technical Foundation, we evaluated factors currently limiting Washington lower Columbia River salmon and steelhead populations based on a simple index of potentially manageable impacts. The index incorporated human-caused increases in fish mortality, changes in habitat capacity, and other natural factors of interest (e.g. predation) that might be managed to affect salmon productivity and numbers. The index was intended to inventory key factors and place them in perspective relative to each other, thereby providing general guidance for technical and policy level recovery decisions. In popular parlance, the factors for salmon declines have come to be known as the 4-H's: hydropower, habitat, harvest, and hatcheries. The index of potentially manageable mortality factors has been presented here to prioritize impacts within each subbasin.

- Loss of tributary habitat quantity and quality is an important relative impact on all species, while estuary habitat impacts appear to be of lesser importance.
- The impact of hydrosystem access and passage is one of the more important factors for chum and fall chinook. Hydrosystem effects on chum are substantial enough to minimize the relative importance of all other potentially manageable impact factors.
- Harvest has relatively high impacts on fall chinook, while harvest impacts to steelhead and coho salmon are moderate. The relative impact of harvest on chum is minor.
- Hatchery impacts are relatively moderate for coho and summer steelhead. Hatchery impacts on chum salmon, fall chinook, and winter steelhead are low.
- Impacts of predation are moderate for winter steelhead, summer steelhead, and coho, but are low for fall chinook and chum.

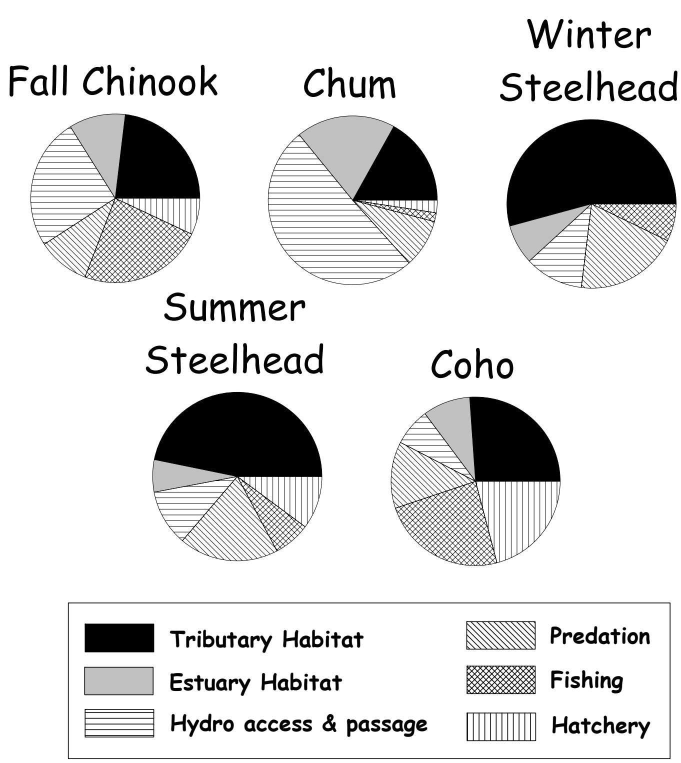


Figure 16-5. Relative index of potentially manageable mortality factors for each species in the Upper Gorge subbasin.

16.4 Hatchery Programs

Washington operated a salmon hatchery near the mouth of the Wind River from 1899 to 1938, when the hatchery was flooded by the Bonneville Dam reservoir. The hatchery produced fall chinook and broodstock was taken directly from the Wind River. Annual egg take was generally between 1 and 4 million; in some years, egg take was as high as 20 million.

The Carson National Fish Hatchery in the Wind River basin is at Tyee Springs (RM 18); the facility was constructed in 1937 and expanded in 1952–1955. Historically, the dominant species produced at the hatchery was tule fall chinook. Many other species of salmon and trout were also raised intermittently in large numbers from 1938 to 1981. In 1981, production switched to spring chinook exclusively, and this remains the only species produced. Current annual spring chinook release goals are 1.42 million yearlings (Figure 16-6). Skamania summer and winter steelhead were released in the basin until 1997; annual releases of summer steelhead ranged from 20,000 to 50,000 smolts while winter steelhead releases were generally fewer than 10,000 smolts. Steelhead releases were discontinued to promote wild steelhead management in the basin. The Wind River historically had a naturally spawning tule fall chinook population but only a small remnant of that population remains due to Bonneville reservoir inundating the spawning habitat in the lower river. In recent years, a self-sustaining population of mid-Columbia upriver bright late fall chinook, historically not found in this basin, has been observed in the lower river below Shipperd Falls. It most likely originated from hatchery strays, possibly from the two hatcheries in the area that produce this stock—the Little White Salmon (Willard) NFH and Bonneville Hatchery.

Genetics—The former tule fall chinook hatchery program at the Carson NFH used broodstock originating primarily from Spring Creek NFH stock, which was developed from the Big White Salmon River tule fall chinook stock. Fall chinook releases into the Wind River basin averaged 2 million from 1952 to 1976 but were discontinued in 1976. A small tule fall chinook population persists in the basin; the current population likely is a hybridization between native Wind River tule fall chinook and Spring Creek Hatchery tule fall chinook.

Spring chinook were not native to the Wind River. Historically, spring chinook eggs were transferred to Carson NFH from the Clackamas River and a Willamette River hatchery in Oregon, and from Camas Creek in Idaho. All of these stocking efforts failed because of adult passage problems at Shipperd Falls (RM 2); fish passage facilities were constructed at the falls in 1954. During the 1950s and 1960s, approximately 500 spring chinook captured annually at Bonneville Dam were transferred to the Carson NFH for broodstock collection. Genetic data indicates that the Carson NFH spring chinook stock was developed from a mixture of upper Columbia and Snake River spring chinook passing Bonneville Dam. Current broodstock collection comes from adults returning to the Carson NFH. CWT data indicates that Carson NFH spring chinook stray into the Little White Salmon NFH and are harvested in the Drano Lake fisheries, but because these stocks were developed from the same broodstock, there is little concern with genetic introgression. Carson NFH spring chinook straying into other lower Columbia basins is not considered a problem.

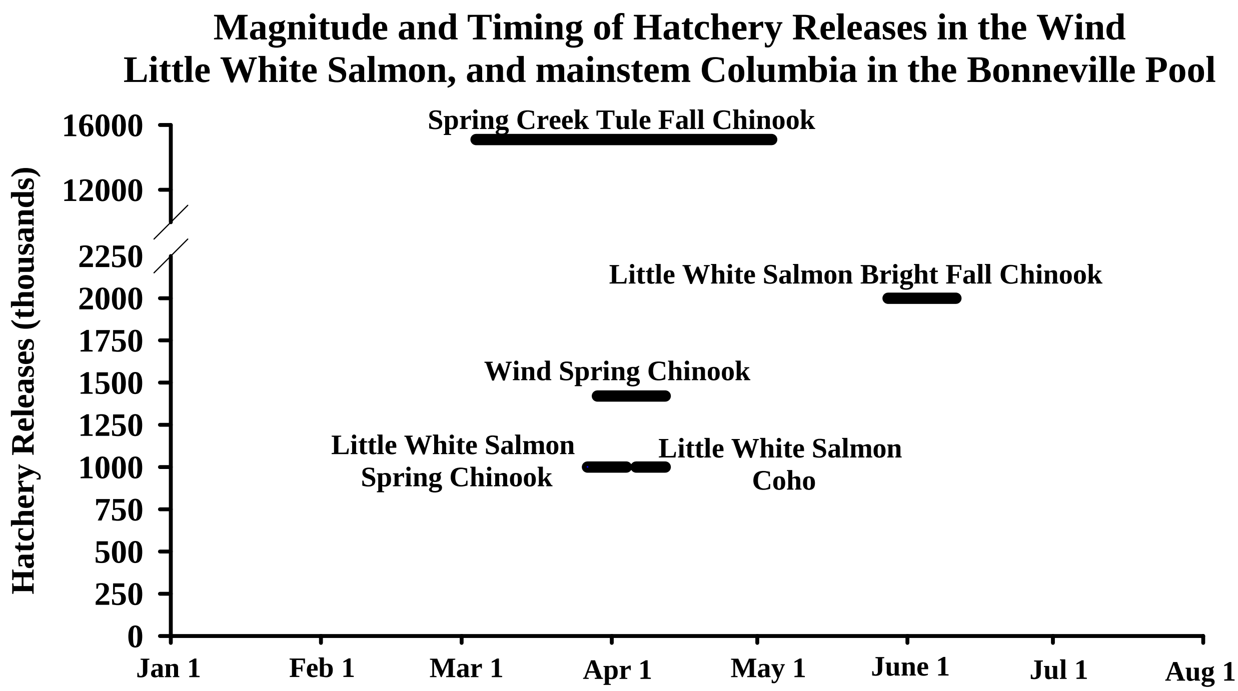


Figure 16-6. Magnitude and timing of hatchery releases in the Wind and Little White Salmon rivers and mainstem Columbia by species, based on 2003 brood production goals.

Summer steelhead releases into the Wind River basin came from Skamania and Vancouver Hatchery stocks. Allozyme analysis in 1994 clustered mainstem Wind River and Panther Creek summer steelhead with a number of lower Columbia River summer and winter steelhead stocks, including Skamania Hatchery summer steelhead. Trout Creek summer steelhead stocks were part of an outlier group that included South Fork Nooksack River summer steelhead, Washougal steelhead, and Cowlitz native late winter steelhead. Winter steelhead releases into the Wind River basin came from Chambers Creek and Skamania Hatchery stocks. Only unmarked summer and winter steelhead have been allowed to pass Hemlock Dam and access the upper watershed of Trout Creek, thereby preserving the genetic integrity of this stock. Both hatchery summer and winter hatchery steelhead stocking programs have been discontinued.

Interactions—Fall chinook hatchery releases were discontinued in 1976; the existing tule fall chinook population is sustained from wild production and strays from Spring Creek NFH. There are no wild/hatchery tule fall chinook interactions in the Wind River, other than from straying tule fall chinook from other basins.

Spring chinook are not native to the Wind River basin; the current population is sustained through hatchery production and any natural spawners are hatchery-origin fish (Figure 16-7). Therefore, there is no interaction between hatchery and wild spring chinook in the Wind River basin. However, hatchery spring chinook adults may interact with wild fall chinook, summer steelhead, and winter steelhead. Based on run timing, possible spring chinook effects are more likely on summer steelhead than the other species. In 2001 and 2002, the Carson NFH adult collection facility was closed to adult spring chinook on August 1; fish health personnel were concerned that this early closure would keep more spring chinook adults in the river and increase potential transmission of IHNV to steelhead. Juvenile outmigration trapping and PIT tag monitoring at Bonneville Dam indicate that Carson spring chinook exit the Wind River quickly after release and Carson spring chinook are not known to residualize. Therefore, although steelhead parr occupy the mainstem Wind River below the hatchery, competition between hatchery spring chinook and juvenile steelhead is thought to be minimal. Also, the size of steelhead parr (>80mm) that occupy the spring chinook migration corridor suggests that steelhead are not susceptible to predation by Carson spring chinook. Emigrant sampling conducted in the Wind River indicates that steelhead smolts and presmolts are not drawn out of the Wind River basin early by releases of hatchery spring chinook.

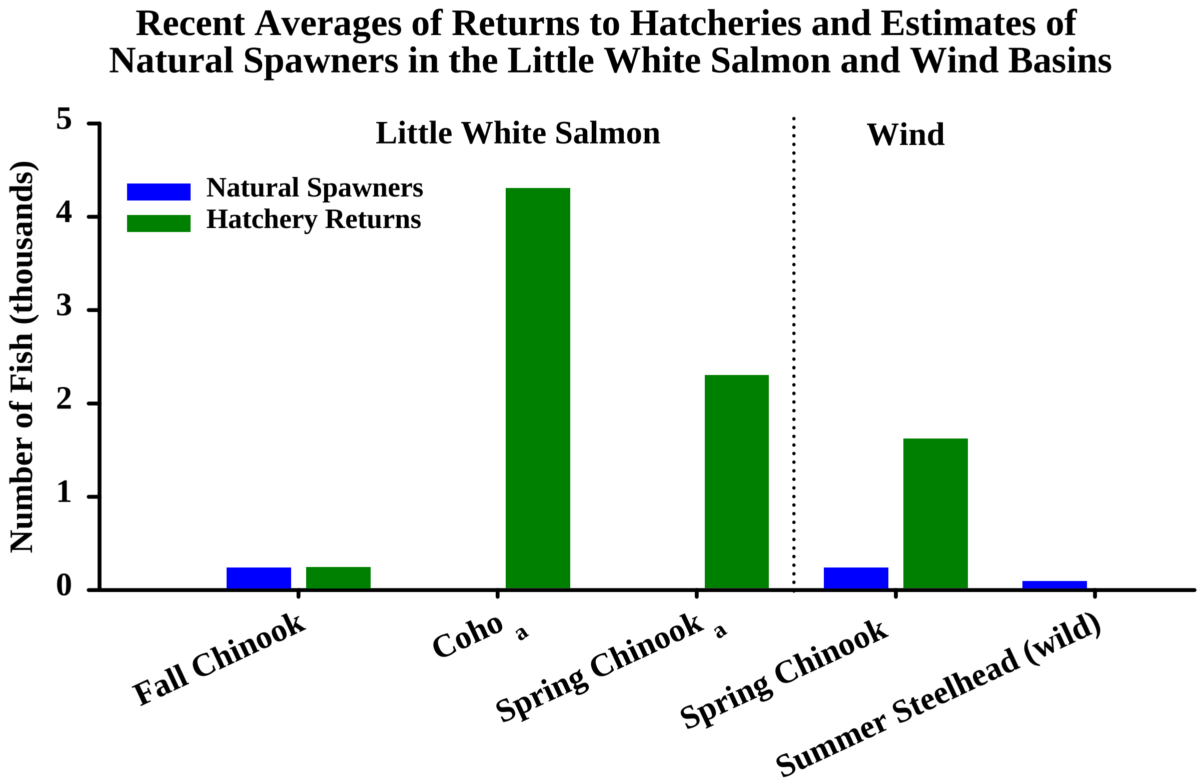


Figure 16-7. Recent year average hatchery returns and estimates of natural spawning escapement in the Wind and Little White Salmon River basins by species.

The years used to calculate averages varied by species, based on available data. The data used to calculate average hatchery returns and natural escapement for a particular species and basin were derived from the same years in all cases. All data were from the period 1992 to the present. Calculation of each average utilized a minimum of 5 years of data, except for Little White Salmon fall chinook, which represents the 1996–99 average.

[a] A natural stock for this species and basin has not been identified based on populations in WDFW's 2002 SASSI report; escapement data are not available.

Water Quality/Disease—The primary water source for the Carson NFH is Tyee Springs, approximately 3/8 mile from the hatchery; the springs produce 44 second-feet of 44°F, high-quality water. A feral brook trout population exists in Tyee Creek, which supplies the spring water to the Carson NFH. BKD is present in the brook trout population at low levels; periodic monitoring is conducted to determine the level of infection. The presence of this trout population in the hatchery water source has had no noticeable effect on the hatchery fish in recent years. The Wind River is a backup source of water for the hatchery and is used only as needed, primarily in September, after most natural spring chinook carcasses have drifted below the hatchery intake. Because there is evidence that using Wind River water in the hatchery may contribute to outbreaks of IHNV, BKD, and furunculosis in hatchery fish, the use of this water source is minimized.

The Lower Columbia River Fish Health Center (FHC) in Underwood, Washington, provides fish health care for the Carson NFH under guidance of the Fish and Wildlife Service Manual, the Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries, and the Co-Managers Salmonid Disease Control Policy. A pathologist from the FHC examines fish at various times during the hatchery operation. Adult certification examinations are performed at spawning; adult fish tissues are collected to ascertain viral, bacterial, and parasite infections and to provide a brood health profile for the progeny. Progeny from females with high levels of BKD are culled (if not needed to meet annual production goals) or segregated from progeny at lower risk. A ponding examination for viral infections is performed on newly hatched fish when approximately 50% of the fish are beyond the yolk-sac stage and begin feeding. Rearing fish are randomly examined monthly to determine general health. These monthly exams generally include a necropsy with detailed external and internal exams and tests for bacterial and viral infections are performed. Diagnostic exams are performed on rearing fish as needed, depending on unusual fish behavior or higher than normal mortality. Pre-release examinations are performed before fish are released or transferred from the hatchery and these focus on testing for listed pathogens. Numerous chemicals are used at various stages to prevent or treat infection. Erythromycin is injected into adults being held for broodstock collection; the number of injections ranges from 0-2, depending on the arrival time of fish to the hatchery compared to the actual egg take. Injections must be completed 30 days before spawning to be effective. Adults being held for broodstock also are treated with formalin three times per week to control external pathogens. All eggs received at the hatchery must be disinfected before they are allowed to come in contact with the hatchery's water or equipment. Salmonid eggs are hardened and disinfected with a 50-ppm iodine solution buffered in sodium bicarbonate. Formalin is also used to control fungus on eggs during incubation.

Mixed Harvest—The purpose of the spring chinook hatchery program at the Carson NFH is to mitigate for loss of spring chinook salmon as a result of hydroelectric and other development in the lower Columbia River basin and to contribute to terminal area tribal ceremonial and subsistence fisheries and non-tribal sport and commercial fisheries. Historically, exploitation rates of hatchery and wild spring chinook likely were similar. Upriver spring chinook are an important target species in Columbia River commercial and recreational fisheries, as well as in tributary recreational fisheries. Upriver spring chinook are impacted less by ocean fisheries than other Columbia River chinook stocks. CWT data suggests that Carson NFH spring chinook are recovered primarily as recreational harvest, with the remaining fish recovered as tribal harvest, incidental commercial harvest, and hatchery escapement. Carson NFH spring chinook contribute primarily to terminal area sport and tribal fisheries at the mouth of the Wind River; average terminal area harvest rate from 1989–98 was 44% for years when fisheries occurred. Selective fishery regulations in recent years in the Columbia River basin have targeted hatchery fish and maintained low harvest rates of wild spring chinook. Beginning with the 2000 brood, all Carson NFH spring chinook have been externally marked with an adipose fin-clip to allow for selective fisheries.

Passage—The adult collection facility at the Carson NFH consists of a fish ladder adjacent to the mainstem and two holding ponds. Returning adults enter the hatchery fish ladder volitionally; a barrier dam does not exist across the Wind River. Fish are maintained in holding ponds until broodstock collection. Prior to 2001, all returning adults were allowed into the hatchery through August or the end of the spawning run; this practice likely minimized potential interactions and disease transmission between hatchery spring chinook and wild steelhead. However, in 2001 and 2002, the hatchery ladder was closed to returning adults on August 1, allowing more spring chinook to remain in the Wind River.

Supplementation—Supplementation is not the goal of the current spring chinook hatchery program nor was it the goal of former fall chinook, summer steelhead, or winter steelhead hatchery programs on the Wind River.

16.5 Fish Habitat Conditions

16.5.1 Passage Obstructions

All anadromous fish except for steelhead were blocked by Shipherd Falls at RM 2 until a fish ladder was constructed there in the 1950s to allow spring chinook to return to the Carson National Fish Hatchery (RM 18). Upstream migration is regulated by a trap at the fish ladder. A significant portion of the riverine habitat downstream of Shipherd Falls was inundated by Bonneville Dam impoundment in 1938.

Hemlock Dam, at RM 2.1 on Trout Creek, is the other major migration barrier. This concrete dam replaced temporary splash dams in 1935 and was used to generate electricity for the USFS Ranger Station that is located nearby. The dam was eventually used only to provide irrigation water to the Wind River Tree Nursery. Since the nursery's 1997 closure, the dam provides a reservoir (Hemlock Lake) for recreation. A fish ladder built in 1936 at the dam has efficiency problems and the lake, which is rapidly filling with sediment, has problems with high temperatures. The dam is ranked as the highest priority for restoration in the Wind River Watershed Analysis—second iteration (2001), and dam removal options and benefits are currently being evaluated.

There are various culverts that restrict passage in Youngman and Oldman Creeks, although the impact on steelhead is believed to be minimal. Subsurface flow may be a problem in Martha Creek, Dry Creek, and portions of the Trout Creek Flats area. Passage in Tyee Creek is blocked by the water intake for the Carson Hatchery.

16.5.2 Stream Flow

Wind River flows are unregulated and thus driven primarily by watershed conditions and weather patterns. Flows in the Wind River mainstem range from an average monthly flow of 250 cubic feet per second (cfs) in the summer to over 2,000 cfs in winter months. Peak flows occur between November and March in response to rainfall or rain-on-snow events (Figure 16-8). The highest recorded flow was 45,700 cfs in January 1974, though the estimate of the February 1996 flood (gage was not operating) was 54,000 cfs (USFS 1996). Summer flows are maintained by snowmelt and groundwater recharge.

Figure 16-8. Wind River hydrograph (1934-1980). Peak flows are primarily related to winter and spring rain, with some high peaks occuring due to winter rain-on-snow. Flows fall below 300 cfs in late summer. USGS Gage #14128500; Wind River near Carson, WA.

Forest cover characteristics are believed to impact runoff conditions in the subbasin. Approximately 20% of the subbasin is in early-seral vegetation due to past fires and timber harvest. This condition, combined with moderately high road densities in a few watersheds (Lower Wind, Middle Wind, Trout Creek), has likely increased the potential for altered peak flow timing and magnitude. The 1996 and 2001 (second iteration) watershed analyses estimated risk of increased peak flows by calculating aggregate recovery percentage (ARP), which looks at the age of forest stands as a representation of hydrologic maturity. Watersheds with 100% ARP are fully hydrologically mature. Watersheds with low ARP levels would be at greater risk of increased peak flows associated with rain-on-snow events.

ARPs in 1995 ranged from 72% in Lower Falls Creek to 97% in Trapper Creek. 2001 levels ranged from 74% in Lower Falls and Eightmile Creek to 99% in Trapper Creek. Most sub-watersheds increased in ARP since 1995 due to tree growth, however, 5 out of 26 sub-watersheds decreased in ARP due to vegetation removal. In 2001, 5 of the 26 sub-watersheds had an ARP of less than 80%. A "relative risk" of increased peak flows was calculated for the 26 subwatersheds as part of the 1996 watershed analysis (USFS 1996). The analysis used road density, ARP, and percent of area in rain-on-snow zone to evaluate "relative risk". The Headwaters Wind, Ninemile, Compass/Crater, Upper Trout, Upper Panther, and Layout Creek subwatersheds ranked the highest for risk of increased peak flows. The remainder of the subbasin has a relatively low risk of increased peak flows.

Summer low flows may also be a problem in some stream reaches. Dry Creek, Martha Creek, and portions of the Trout Creek basin regularly go subsurface in late summer, possibly stranding fish. Water withdrawals from the subbasin are not believed to have a substantial impact on summer flow levels in the mainstem, though withdrawals do occur at the Carson Hatchery and at a few irrigation diversions. Withdrawal conditions in tributary streams warrant further investigation, especially in Trout Creek, where irrigation water rights may have an impact on the already very low summer flows. In the subbasin as a whole, the net streamflow depletion in the summer due to water withdrawals is approximately 3.9 cfs, representing up to 2.4% of the 90% exceedance flow in late summer (Greenberg and Callahan 2002).

16.5.3 Water Quality

The major water quality concerns in the subbasin are temperature and sediment. Bear Creek, Eight-mile Creek, and Trout Creek were listed on the State's 1996 303(d) list of impaired water bodies for exceedance of the 60.8ºF (16ºC) temperature standard (WDOE 1996). Only Bear Creek and Eight-mile Creek were included on the 1998 list (WDOE 1998). Water temperature monitoring has been conducted in the basin for many years. The USGS measured temperatures over 64.4ºF (18ºC) in the summer of 1977 in the Lower Wind River. In more recent years the USFS, USGS Columbia River Research Lab (CRRL), and UCD have conducted water quality monitoring using continuously recording thermographs. USFS and USGS monitoring has focused on the federally owned lands while the UCD monitoring has focused primarily on privately owned lands in the lower subbasin. USFS monitoring goes as far back as 1977 for some sites, whereas CRRL and UCD monitoring is limited to the past several years. A total of approximately 46 different locations have been monitored since 1977, all with various periods of record. At 32 of the sites, the temperature has exceeded 60.8ºF (16ºC) on at least one day during the sampling period. Fifteen of the sites have exceeded 64.4ºF (18ºC). Sites exceeding 68ºC (20ºC) include the mouth of Eight-mile Creek, the Wind River at the 3065 Road Bridge, and Trout Creek below Crater Creek, below Compass Creek, above Hemlock Lake, below Hemlock Dam, and at the mouth. The Trout Creek above Hemlock Lake station has been under the 60.8ºF (16ºC) standard for only one year since 1977 (USFS, CRRL, UCD published and unpublished data).

A Total Maximum Daily Load (TMDL) analysis was performed in the subbasin to identify problems and potential solutions related to high stream temperatures. High summer temperatures were attributed to loss of riparian cover, channel widening, and reduced summer base flows. Modeling indicated that an increase in stream shade would potentially be adequate to lower temperatures in the mainstem Wind River and Panther Creek. In Trout Creek, it was determined that a reduction in channel widening, combined with increased shading, would be the most effective strategy for lowering temperatures (WDOE 2002 Draft, as cited in Michaud 2002). The USFS developed a Water Quality Restoration Plan (WQRP) for the Wind River as part of requirements by the WDOE and EPA due to stream temperature problems. The analysis focused on stream shading, stream widening, and water withdrawals as sources for stream heating. GIS modeling of riparian shade revealed that the Middle Wind, Trout Creek, and the lower Wind had shade levels greater than 10% less than potential levels. The Lower Wind had shade levels approximately 50% less than the potential. Air photo analysis revealed that channel widening occurred on most of the surveyed stream reaches in the period dating from 1959 to 1979 and the period dating from 1989 to 1999. Most channels narrowed during the interim period. Channel widening was attributed to periods of large flood events. The analysis of the impact of water withdrawals indicated that Trout Creek and Bear Creek were the most susceptible to temperature increases due to water withdrawals (USFS 2001). Water withdrawals in Trout Creek are primarily for irrigation while withdrawals from Bear Creek are for the City of Carson's domestic water supply.

Turbidity is also regarded as a concern in the subbasin. Sampling of 16 sites at 4 different flow levels by the USFS in 1995 revealed that Lower Panther Creek, Trout Creek, and the Lower Wind River have the highest turbidity levels at high flow volumes. The Lower Wind

River had the highest turbidity levels at all flow volumes. It should be noted that investigators caution the use of such a limited data set (USFS 2001).

USGS and UCD have measured pH levels that are below standards, but low pH conditions are believed to be from natural sources (Michaud 2002).

16.5.4 Key Habitat

The USFS has conducted habitat surveys on many of the streams within public ownership. Pool quantity and quality are low in many of the surveyed streams. The 1996 watershed analysis reported that 93% of surveyed reaches did not meet desired condition for pool frequency. It should be noted, however, that investigators caution the use of pool frequency due to problems associated with observer bias. The use of a pool quality index that relates pool area to depth is recommended over pool frequency measures, and such an analysis was conducted. USFS stream surveys reveal that pool depths are low (surface area / volume > 68) in the Panther Creek tributaries Eight-mile, Cedar, and Mouse Creeks, as well as in the Headwaters Wind River and Upper Falls Creek. Width-to-depth ratios are high (>9) in the middle Wind River, Eight-mile Creek, and Cedar Creek, with only one stream segment, Upper Panther Creek, having "excellent" width-to-depth ratios (<6). Restoration efforts by the USFS have improved pool quality and quantity in several locations. In particular, reconnection of side channel / floodplain habitats restored 600 feet to Layout Creek and increased the channel length in the Mining Reach (middle Wind River) by 48%. In addition, bankfull pool volume in the Mining Reach was increased by 520% (USFS 2001).

16.5.5 Substrate & Sediment

There is not a lot of direct information on stream substrate conditions; however, as part of the USFS Watershed Analysis – second iteration (2001), McNeil Core Sediment samples were taken on 9 streams. Dry Creek the Upper Wind River had the highest percentages of fines and small sediment size classes. Both streams had greater then 34% of sediments less than 6.3 mm, with a high percentage (15% for Dry Creek and 16% for Upper Wind) of fines (<1.6 mm).

Observations indicate that Youngman and Dry Creeks have excessive in-stream sediment levels. Landslide activity appears to be contributing to instream sediment levels in Paradise Creek and Pete's Gulch. The Trout Creek basin has fine sediment aggradations due to basin morphology that includes steep headwater streams emptying into the broad alluvial valley known as Trout Creek Flats (WCC 1999). Sedimentation of channels is a problem in the lower and Little Wind Rivers due to landslide activity related to roads, utility corridors, timber harvest, a golf course, and naturally unstable soil conditions. Accumulation of sediment at the mouth of the Wind has long been a concern to local fishermen and to the Port of Skamania County who wish to preserve adequate water depths for commercial shipping traffic.

A number of watershed-scale sediment supply assessments have been conducted in the subbasin. Sediment supply conditions were evaluated as part of the IWA watershed process modeling, which is presented later in this chapter. Ten of the 25 IWA subwatersheds were rated as "moderately impaired" with respect to landscape conditions that influence sediment supply; the remaining subwatersheds were rated as "functional". High road densities, steep topography, and naturally unstable soils are the primary drivers of these sediment supply impairment ratings. The moderately impaired subwatersheds are scattered throughout the basin and include the Little

Wind, lower Trout Creek, headwaters Trout Creek, Trapper Creek, Paradise Creek, Falls Creek, and lower Panther Creek subwatersheds.

A similar investigation conducted as part of the USFS Watershed Analysis used road crossings per square mile, peak flow turbidity, mass wasting, surface erosion, and channel stability information to identify subwatersheds with the greatest threat of erosion and sedimentation. Twelve of the 26 USFS subwatersheds were identified as having a high risk of fine sediment impact on aquatic habitats. The percentage of land area with landslides, debris flows, and potentially unstable soils was calculated for the same 26 sub-watersheds. The sub-watersheds over 20% were Paradise Creek, Ninemile Creek, Layout Creek, Mouse Creek, Cedar Creek, North Fork Bear Creek, and East Fork Bear Creek (USFS 1996).

Approximately 20% of the forest cover in the subbasin is in early-seral stages, suggesting that portions of the basin may not have adequate vegetation to prevent excessive soil erosion, however, the presence of an extensive road network may be the factor contributing most to sediment production and delivery. The entire subbasin has an average road density of 2.2 mi/mi^2. This level has been reduced from 2.6 mi/mi^2 in 1995 due to road decommissioning efforts by the USFS (USFS 2001). Road densities greater than 3 mi/mi^2 are generally considered high, while those between 2 and 3 mi/mi^2 are considered moderate. Although the subbasin as a whole has only moderate road densities, several portions of the subbasin have high road densities. The 6^{th} field basins with the greatest road densities are the Lower Wind, Middle Wind, and Trout Creek basins. All of the 6^{th} field basins have seen an increase in the length of the drainage network due to roads. The increase has been greatest (up to 40%) in the Lower Wind, Middle Wind, and Trout Creek basins. The amount of stream crossings per mile is greatest in the Upper Wind, Middle Wind, Trout Creek, and Panther Creek basins (USFS 2001).

Several restoration projects by the USFS and Underwood Conservation District have attempted to restore bank stability and reduce sediment delivery rates to streams. Monitoring of a USFS restoration project in Layout Creek reveals a decrease of 73% of eroding banks in the reach (USFS 2001).

Sediment production from private forest roads is expected to decline over the next 15 years as roads are updated to meet the new forest practices standards, which include ditchline disconnect from streams and culvert upgrades. The frequency of mass wasting events should also decline due to the new regulations, which require geotechnical review and mitigation measures to minimize the impact of forest practices activities on unstable slopes.

16.5.6 Woody Debris

Pieces of LWD per mile have been collected as part of USFS stream surveys. In general, LWD conditions are very poor throughout the basin. This can be attributed to loss of recruitment due to past harvest of riparian areas and past stream clean-outs. Currently, 12 out of 20 regularly surveyed reaches contain less than 75 pieces of LWD per mile.

Restoration efforts conducted by the USFS and UCD have placed wood into streams in order to increase aquatic habitat complexity and to restore natural levels of bank stabilization. Monitoring of USFS restoration projects reveals that the number of LWD pieces has increased by 333% in Layout Creek and by 497% in the middle Wind River (Mining Reach) (USFS 2001).

16.5.7 Channel Stability

USFS surveys have revealed bank stability concerns in the Compass Creek, upper Trout Creek, middle Wind, Layout Creek, and upper Wind basins. High width-to-depth ratios can be an indicator of low channel stability causing excessive lateral bank erosion. High ratios (>9) have been measured in the middle Wind, Eight-mile Creek, and Cedar Creek. The middle Wind from RM 12-19 is a highly dynamic alluvial section that experiences rapid channel migration and avulsions during high flow events. Avulsions are often associated with the accumulation of large log jams that serve to re-direct the stream course through overflow / floodplain channels. The instability of this reach is believed to be partly due to excess sedimentation from upstream sources, loss of bank stability due to degradation of riparian forests, and the loss of stable in-stream large wood pieces. USFS and UCD restoration projects have increased bank stability through re-introduction of large wood assemblages and re-planting efforts. USFS efforts on the Mining Reach have increased bank stability by 58% (USFS 2001). Bank stability is also a concern in the Trout Creek basin. Accumulation of sediments from past logging operations resulted in lateral bank cutting as well as dramatic downcutting through aggraded substrates. Restoration efforts have alleviated some of these problems through large wood re-introduction and re-routing of the stream into stable channels with intact riparian forests.

The lower Wind River suffers from bank stability problems related to mass wasting. The most prominent feature is an eroded gully created by excessive runoff from the golf course in Carson. The gully, which is several hundred feet long, has contributed large amounts of sediment to the lower mile of the Wind River. There are other landslides along the lower Wind and the Little Wind River that are related to roads, timber harvest, utility corridors, and commercial development.

16.5.8 Riparian Function

The sub-watersheds with greater than 25% early-seral vegetation in riparian areas are the upper Wind, Eightmile Creek, Lower Trout, and the Little Wind River. Non-forest, seedling / sapling / pole, and small tree assemblages make up over 67% of riparian areas. The percent in the large tree category is under 33%, compared to the desired future condition of 75% (USFS 2001).

The mainstem Wind River between RM 12 and RM 19 contains rural residential development and past agricultural development that has resulted in cleared riparian forests. As a result, canopy cover and bank stability have been substantially reduced. The reduction of bank stability and LWD recruitment is partially responsible for dramatic channel shifts and rapid channel migration that has occurred in this reach.

Riparian function is expected to improve over time on private forestlands. This is due to the requirements under the Washington State Forest Practices Rules (Washington Administrative Code Chapter 222). Riparian protection has increased dramatically today compared to past regulations and practices.

16.5.9 Floodplain Function

Alluvial reaches with developed floodplains are located on the middle Wind River, upper Wind River, Dry Creek, Panther Creek, and Trout Creek. There is a lack of quantitative information on channel connectivity and function of these floodplains. Observations gathered as part of the 1999 Limiting Factors Analysis (WCC 1999) reveal a few areas of concern. On the middle Wind River, floodplain connectivity is reduced by the 30 Road, which closely abuts the river in several places. Diking associated with residential development, the Beaver Campground, and the Carson Fish Hatchery also limit floodplain function in this segment. In the Mining Reach, Forest Road 30 intercepts the floodplain from RM 21 to RM 25. On Trapper Creek, cabins are located within the historical floodplain on the lower mile of stream. Some filling of flood channels has occurred in order to protect property. Portions of Trout Creek withinTrout Creek Flats have downcut to the point where the stream can no longer access its floodplain. Similar problems exist on Layout Creek, where stream restoration efforts recently reconnected 600 feet of side-channel habitat (USFS 2001).

16.6 Fish/Habitat Assessments

The previous descriptions of fish habitat conditions can help identify general problems but do not provide sufficient detail to determine the magnitude of change needed to affect recovery or to prioritize specific habitat restoration activities. A systematic link between habitat conditions and salmonid population performance is needed to identify the net effect of habitat changes, specific stream sections where problems occur, and specific habitat conditions that account for the problems in each stream reach. In order to help identify the links between fish and habitat conditions, the Ecosystem Diagnosis and Treatment (EDT) model was applied to Wind River winter steelhead, summer steelhead, chum, and fall chinook. A thorough description of the EDT model, and its application to lower Columbia salmonid populations, can be found in Volume VI.

Three general categories of EDT output are discussed in this section: population analysis, reach analysis, and habitat factor analysis. Population analysis has the broadest scope of all model outputs. It is useful for evaluating the reasonableness of results, assessing broad trends in population performance, comparing among populations, and for comparing past, present, and desired conditions against recovery planning objectives. Reach analysis provides a greater level of detail. Reach analysis rates specific reaches according to how degradation or restoration within the reach affects overall population performance. This level of output is useful for identifying general categories of management (i.e. preservation and/or restoration), and for focusing recovery strategies in appropriate portions of a subbasin. The habitat factor analysis section provides the greatest level of detail. Reach specific habitat attributes are rated according to their relative degree of impact on population performance. This level of output is most useful for practitioners who will be developing and implementing specific recovery actions.

16.6.1 Population Analysis

Population assessments under different habitat conditions are useful for comparing fish trends and establishing recovery goals. Fish population levels under current and potential habitat conditions were inferred using the EDT Model based on habitat characteristics of each stream reach and a synthesis of habitat effects on fish life cycle processes.

Habitat-based assessments were completed in the Wind River subbasin for fall chinook, chum, coho, winter steelhead, and summer steelhead. Model results indicate declines in adult productivity for all species from historical levels (Table 16-1). Current productivity is only 17% and 19% of historical levels for winter steelhead and chum, respectively. Similarly, summer steelhead have experienced a decline in productivity to 25% of historical levels. The two species with the smallest estimated decline in adult productivity are fall chinook and coho. Fall chinook productivity has declined by 55% and coho productivity has declined by 47%.

As with productivity, adult abundance levels have also declined from historical levels for all five species (Figure 16-9). The decline in abundance has been most severe for chum and winter steelhead. Current chum abundance is estimated at only 3% of historical levels, while winter steelhead abundance is estimated at only 24% of historical levels. For fall chinook, coho and summer steelhead declines in adult abundance have been less severe, with current levels ranging from 32-44% of historical levels. Diversity (as measured by the diversity index) appears to have remained relatively steady for summer steelhead, with greater declines estimated for fall chinook, chum, and winter steelhead (Table 16-1). Coho diversity appears to have declined the most, with a current diversity level only 19% of the historical level (Table 16-1).

Modeled historical-to-current changes in smolt productivity and abundance show declines for all species (Table 16-1). The decrease in subbasin smolt productivity is greatest for winter steelhead and coho, with a decrease from historical levels of 88% for coho and 74% for winter steelhead. Smolt productivity appears to have declined the least for chum. However, this relatively higher productivity is merely an artifact of the way the EDT model calculates productivity. That is, the higher productivity of chum smolts is because Wind chum now have many less trajectories (life history pathways) that are viable (those that result in return spawners); but the few trajectories that remain have higher productivities than historical trajectories (many of which were only marginally viable).

Current smolt abundance is substantially less than the historical level for all species (Table 16-1), reflecting the significant loss of trajectories (which is also reflected in the life history diversity index). Historical-to-current change in fall chinook, coho, and chum smolt abundance shows an 81%, 90%, and a 94% decrease, respectively, from historical levels. Summer and winter steelhead smolt abundance appears to have declined somewhat less dramatically, with a modeled 40% and 56% decrease from past levels, respectively.

Model results indicate that restoration of properly functioning habitat conditions (PFC) would substantially increase adult abundance for all species (Table 16-1). Chum, fall chinook, and coho would benefit from an approximate 600%, 150%, and 100% increase, respectively, in adult abundance due to restoration of PFC. Restoration of PFC habitat conditions throughout the basin would also significantly improve adult productivity for all species (Table 16-1). Restoration of PFC conditions would have substantial effects on chum (229% increase), winter steelhead (122% increase) and fall chinook (104% increase). Somewhat lower effects would be seen for coho (64% increase) and summer steelhead (38% increase).

Table 16-1. Wind River— Population productivity, abundance, and diversity (of both smolts and adults) based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

Species	Adult Abundance			Adult Productivity			Diversity Index			Smolt Abundance			Smolt Productivity		
	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]	P	PFC	T[1]
Fall Chinook	954	2,418	2,584	4.85	9.92	10.78	0.62	0.98	0.99	158,081	755,887	835,275	568	1,234	1,316
Chum	361	2,582	10,886	1.67	5.50	9.02	0.45	1.00	1.00	227,457	1,715,208	3,829,348	720	1,000	1,083
Coho	418	898	946	2.88	4.75	5.40	0.11	0.56	0.56	1,384	12,730	14,062	35	244	288
Winter Steelhead	70	123	280	3.46	7.70	20.81	0.56	0.77	0.79	1,403	2,550	3,198	71	181	272
Summer Steelhead	1,230	1,437	3,814	4.37	6.04	17.73	0.88	0.95	1.00	24,673	28,658	41,020	84	117	185

[1] Estimate represents historical conditions in the subbasin and current conditions in the mainstem and estuary.

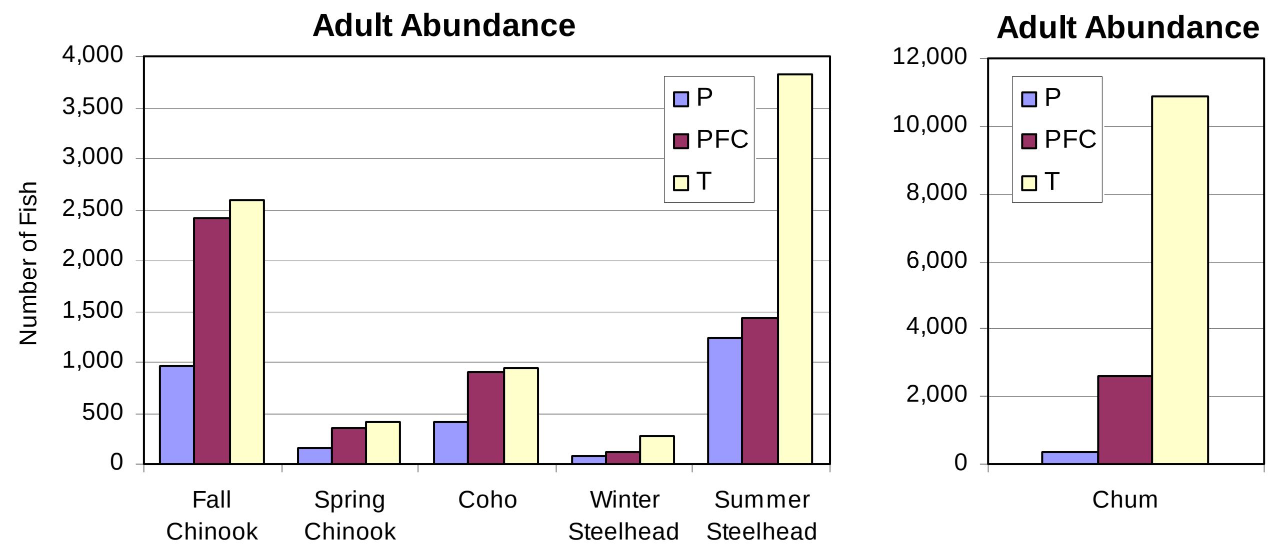


Figure 16-9. Adult abundance of Wind river fall chinook, spring chinook, chum, coho and winter and summer steelhead based on EDT analysis of current (P or patient), historical (T or template), and properly functioning (PFC) habitat conditions.

16.6.2 Restoration and Preservation Analysis

Habitat conditions and suitability for fish are better in some portions of a subbasin than in others. The reach analysis of the EDT model uses estimates of the difference in projected population performance between current/patient and historical/template habitat conditions to identify core and degraded fish production areas. Core production areas, where habitat degradation would have a large negative impact on the population, are assigned a high value for preservation. Likewise, currently degraded areas that provide significant potential for restoration are assigned a high value for restoration. Collectively, these values are used to prioritize the reaches within a given subbasin.

The Wind River subbasin includes approximately 60 reaches and has significant production potential for salmon and steelhead. Historically, Shipherd Falls could be passed by summer steelhead but the falls limited chum and fall chinook to the lower 3 miles of the river. Winter steelhead used the Lower Wind and the Little Wind River. The location of EDT reaches is displayed in Figure 16-10.

For Wind River fall chinook, chum, coho, and winter steelhead the high priority reaches (Wind 1, Wind 2, and Little Wind 1) are located in the lower river (Figure 16-11 - Figure 16-14). In this lower section of the river, reach Wind 1 consistantly provides the greatest restoration potential. However, restoring this reach would require substantial changes to the operation or configuration of Bonneville Dam. Significant improvements in fall chinook, chum, and coho habitat could be gained by restoration activities in reach Wind 2. Resoration activities in Little Wind 1 would benefit winter steelhead. Reach Wind 3 generally has both restoration and preservation value (see ladder diagrams below).

High priority reaches for summer steelhead in the Wind River appear most concentrated in the mid to lower sections of the subbasin (Figure 16-15). The high priority reaches in the mainstem include Wind 4a, 4b, and 6b, each with a preservation emphasis. Tributaries flowing into the mainstem Wind River also contain high priority reaches for summer steelhead. Reach Trout 1a and Panther 1a and 1b are all high priority for summer steelhead, again each with a preservation emphasis. Juvenile trapping has indicated that up to 70% of the Wind River steelhead smolt production is believed to originate in mainstem canyon reaches (Wind 4a-4b) (Rawding and Cochran 2000). Many age-1 parr move into these areas in May and rear for one year before out-migration. These canyon reaches, which are in relatively good condition, therefore have high preservation value. Some potential for restoration exists in the mainstem Wind between Trout Creek and Tyee Springs (Wind 5a and 5c), often referred to as the Wind Flats reach; the mainstem between Falls and Paradise Creeks (Wind 6d), often referred to as the mining reach; Panther Creek from the mouth to Eight-mile Creek (Panther 1a, 1b, and 1c); and Trout Creek between Hemlock Dam and Layout Creek (Trout 1c and 1d), referred to as Trout Flats.

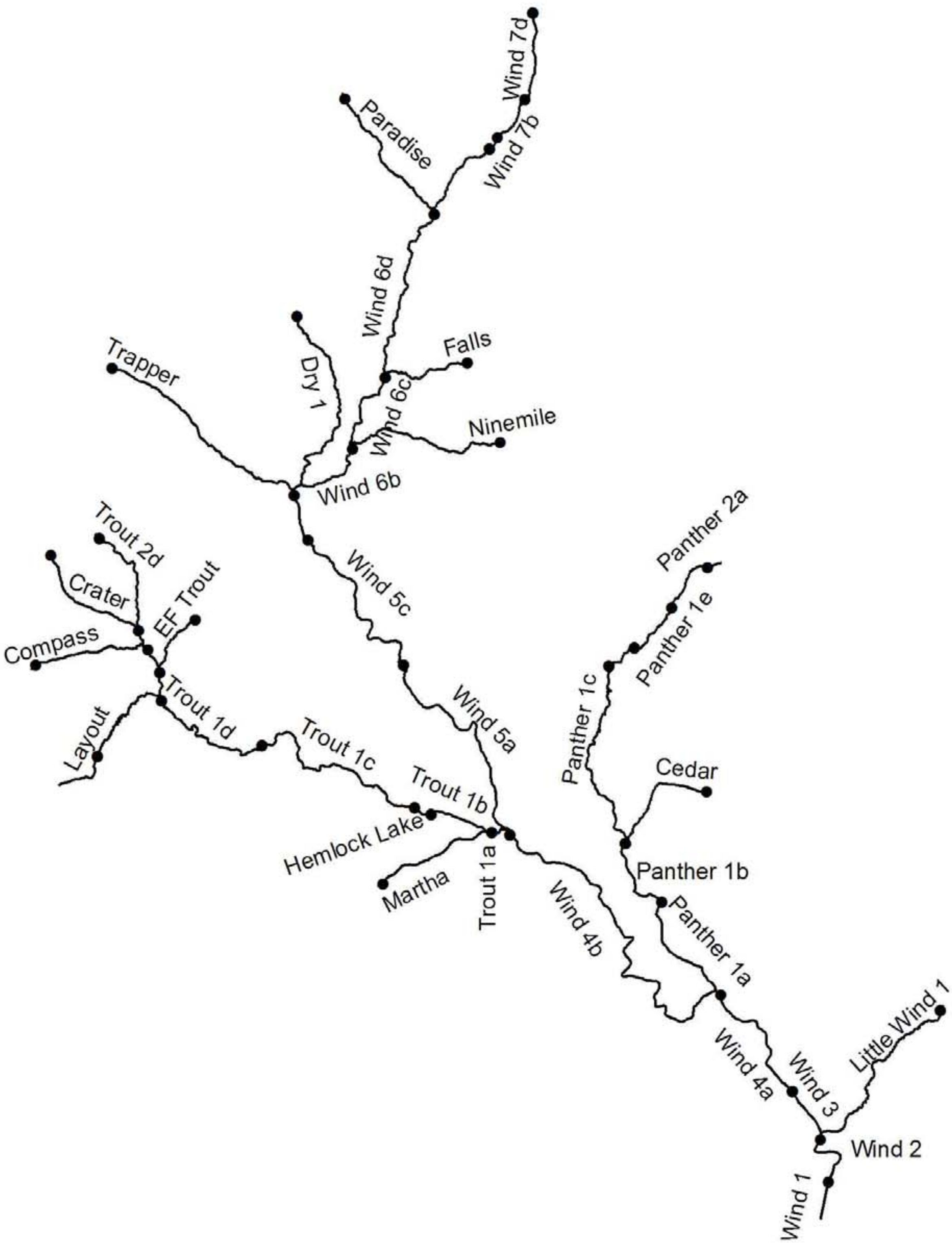


Figure 16-10. Wind River Basin EDT reaches. For readability, not all reaches are labeled.

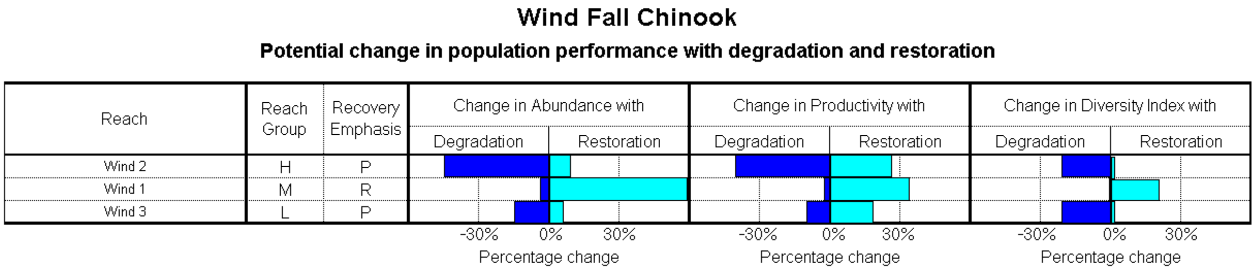


Figure 16-11. Wind River fall chinook ladder diagram. The rungs on the ladder represent the reaches and the three ladders contain a preservation value and restoration potential based on abundance, productivity, and diversity. The units in each rung are the percent change from the current population. For each reach, a reach group designation and recovery emphazsis designation is given. Percentage change values are expressed as the change per 1000 meters of stream length within the reach. See Volume VI for more information on EDT ladder diagrams.

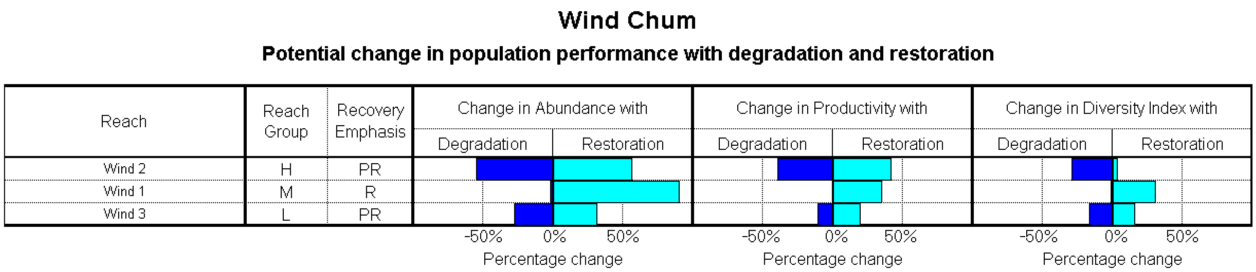


Figure 16-12. Wind River chum ladder diagram.

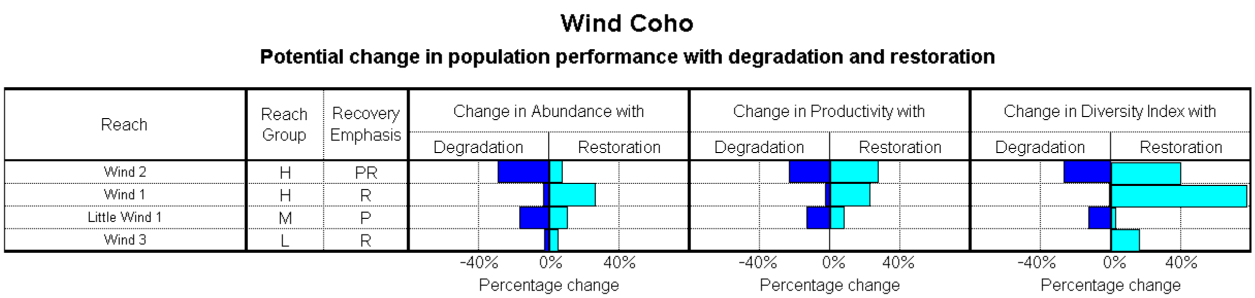


Figure 16-13. Wind River coho ladder diagram.

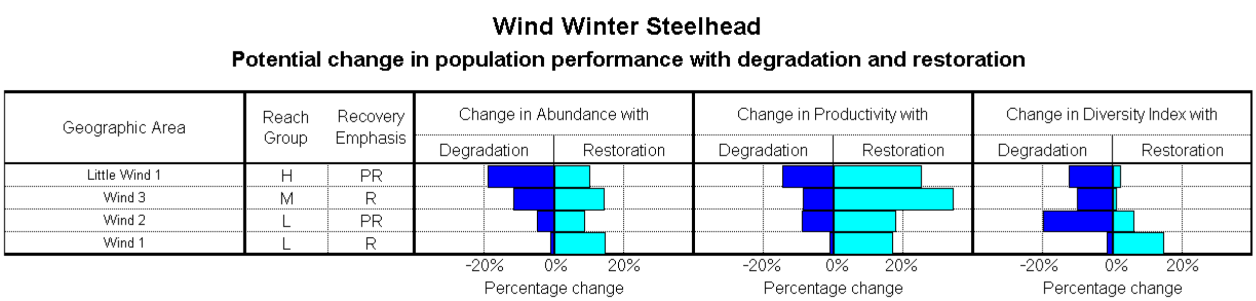


Figure 16-14. Wind River winter steelhead ladder diagram.

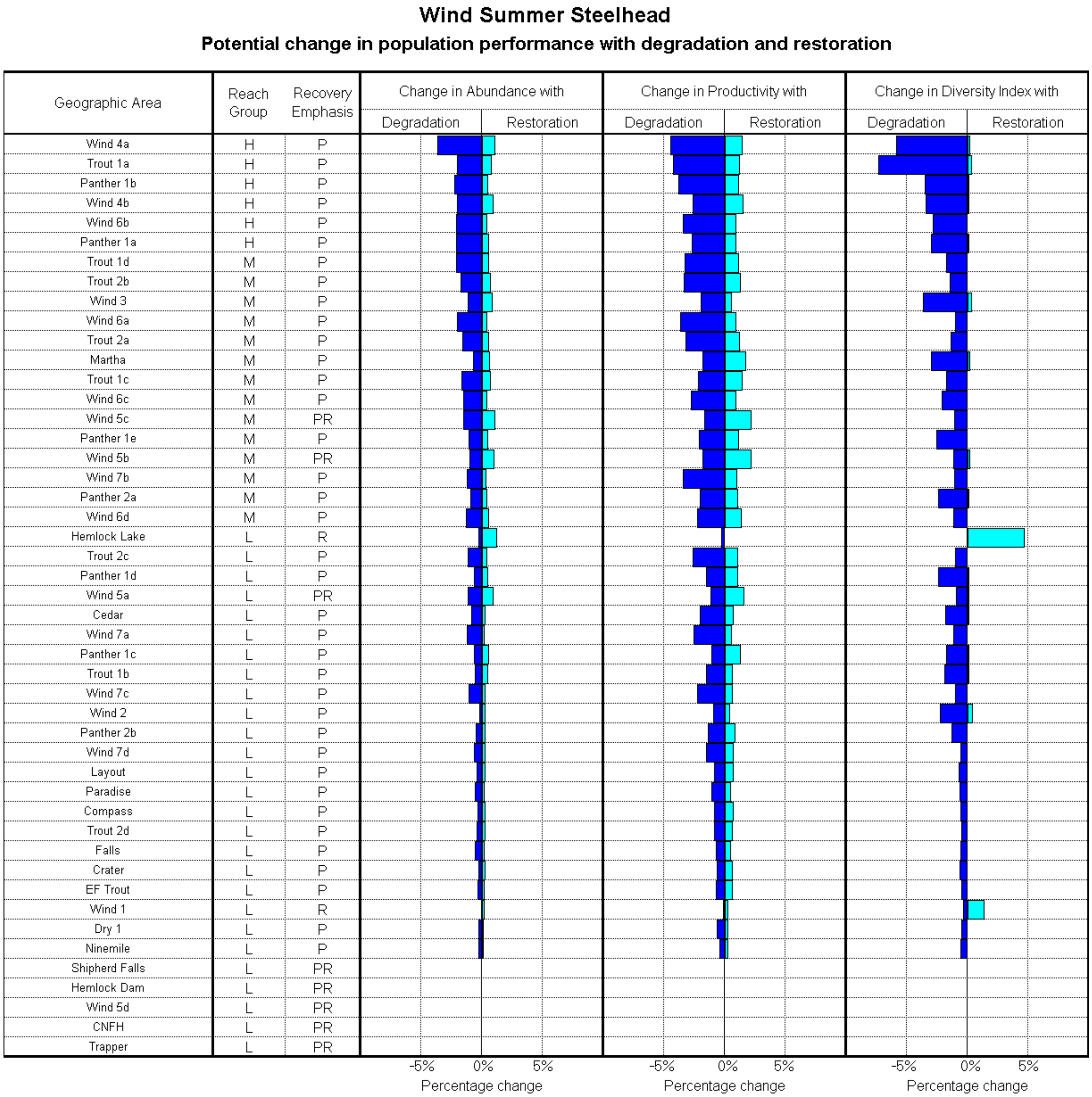


Figure 16-15. Wind River summer steelhead ladder diagram.

16.6.3 Habitat Factor Analysis

The Habitat Factor Analysis of EDT identifies the most important habitat factors affecting fish in each reach. Whereas the EDT reach analysis identifies reaches where changes are likely to significantly affect the fish, the Habitat Factor Analysis identifies specific stream reach conditions that may be modified to produce an effect. Like all EDT analyses, the reach analysis compares current/patient and historical/template habitat conditions. The figures generated by habitat factor analysis display the relative impact of habitat factors in specific reaches. The reaches are ordered according to their combined restoration and preservation rank. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to historical conditions.

The Habitat Factor Analysis of the Wind is most easily discussed in two areas within the subbasin. The first is the lower river, below Shipherd Falls, which provides habitat for winter steelhead, fall chinook, and historically, chum. The second area constitutes the remainder of the basin, which is accessed by wild summer steelhead.

For the lower river, Wind 1 suppresses the performance of fall chinook and chum due to loss of key habitat, habitat diversity, increased sediment, and increased temperatue (Figure 16-16 and Figure 16-17). All of these are related to Bonneville Pool inundation. For chum, reach Wind 2 has similar impacts. For winter steelhead, habitat diversity, temperature, and sediment are a problem in all of the Lower Wind and Little Wind reaches accessed (Figure 16-18). Sediment from upstream sources collects in reaches Wind 1 and Wind 2 as the velocity slows in these low gradient reaches. Sediment originates from upper basin hillslope sources, upstream channel erosion, and local mass wasting. Upper basin hillslope sources contribute sediment due to high road densities and early-seral stage forests. This is especially a problem in the Trout Creek and Middle Wind basins (USFS 2001). Sediment is also contributed during storm flows from upstream channel sources, mainly from the Wind Flats and Trout Creek alluvial channels. There is also considerable contribution of sediment from bank erosion in the Lower Wind itself. This area is underlain by Bretz Flood deposits that continue to deliver sediment through mass wasting events. Mass wasting from landslides and debris flows is exacerbated by roadways, denuded riparian vegetation, and concentrated runoff from the greater Carson urban area, in particular the Carson Golf Course.

Loss of key habitat is another major concern in the lower river. Riffle habitat has been lost by Bonneville Pool inundation and much of reach Wind 2 is in glide habitat. The prevalence of glides may be due in part to natural conditions but is also likely exacerbated by hydro-confinement from a rip-raped roadway along the east bank of reach Wind 2. Temperature is also a concern in the Lower Wind reaches. Wind 1 has elevated temperature due to the influx of Columbia River water, a condition that is unlikely to change. Temperature problems also exist in Wind 3 and on the Little Wind River, related primarily to loss of adequate riparian tree canopy cover. Habitat diversity is a concern in all of the Lower Wind reaches. This is related to confinement, denuded riparian vegetation, and lack of LWD.

For the remainder of the basin, summer steelhead abundance is degraded primarily by habitat conditions in a few general areas. These include the reaches Wind 4a and 4b (canyon), Wind 5a–5c (wind flats), reach Wind 6d (mining reach), reaches Trout 1c and 1d (Lower Trout), and Panther 1a, 1b, and 1c (Lower Panther) (Figure 16-19). These areas represent major steelhead spawning and rearing sites. The main impacts result from degraded key habitat, sediment, flow, habitat diversity, temperature, and channel stability. Key habitat has been altered due to a combination of interacting factors, and in some cases may reflect natural conditions. In general, in the Wind Flats, Mining reach, Lower Trout, and Lower Panther Creek reaches, key habitat in the form of pools and riffles has decreased. Filling of pools with sediment, increased gradient from confinement, and lack of LWD are mostly to blame for their degradation. Excess sedimentation has a high impact in the wind flats, Lower Trout, and Lower Panther reaches. Sediment is contributed from hillslope as well as in-channel sources. High road densities in the Trout Creek basin and early-seral stage vegetation in the Trout, upper Wind, and Panther basins contribute to sedimentation. Sources of in-channel sediment are high in the wind flats and reach Trout 1d, where past practices have reduced channel stability. Dramatic alterations to channel planforms, including avulsions and rapid meander migrations, have occurred in these reaches. Denuded riparian conditions, isolated floodplains, sediment aggradation, and large wood accumulations all contribute to this instability.

Flow condition is another degrading factor in the subbasin, with major effects once again in the highly degraded areas of Wind Flats, Lower Trout, and Lower Panther. Low hydrologic maturity of forests (early seral-stages) in the rain-on-snow zones in Upper Wind, Falls Creek, Trout, and Panther Creek basins (USFS 2001) are believed to contribute to these problems. High road densities and an increase in drainage density due to roads in Upper Wind, Trout, and Falls Creek basins are also likely contributors. Historically, large stand-replacement fires also would have affected snow accumulation, snowmelt, and water delivery to streams (USFS 1996), however, these events were infrequent (return intervals of hundreds of years) and channels and floodplains were in a better condition to accommodate flood flows.

Another habitat factor impacting steelhead is loss of habitat diversity. Habitat diversity is affected by hydro-confinement, degraded riparian conditions, lack of LWD, and direct channel manipulations. Direct impacts to stream channels have occurred only rarely in recent years, though many of the channels, especially the middle mainstem Wind (Wind Flats) and Lower Trout Creek, still suffer from past splash dam logging and past LWD removal inappropriately aimed at facilitating fish passage (USFS 1996). Channel straightening/confinement and floodplain isolation occur in the wind flats and mining reaches, where Hwy 30 parallels the river. Straightening increases gradient, which increases scour of the channel bed and facilitates transport of woody debris. Bank hardening projects (i.e. rip-rap) associated with Hwy 30 have further reduced LWD and streambank vegetation that is important for fish food and cover.

Riparian manipulations have contributed to stream temperature impairments. Stream temperature is especially high in portions of Trout Creek and the middle Wind (wind flats and mining reach). Temperature problems in the Wind basin are also related to an increase in channel width-to-depth ratios (USFS 2001), which result from bank erosion and sedimentation.

Impacts from changes in biological community are of lesser magnitude than changes in hydrologic and stream corridor characteristics. There are however, minor concerns of competition with hatchery spring chinook and brook trout in the middle wind and Trout Creek, respectively. There are also concerns regarding the impact of potential pathogens originating from the Carson Hatchery. The food resource has been increased in reach Wind 5c due to an increase in spring chinook salmon carcasses since historical times.

Wind Fall Chinook

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Wind 2	•	•	•						•	•					•	•
Wind 1	•	●	⬤	●	•				•	●	•			•	●	⬤
Wind 3	●	•								•					•	+

High Impact ⬤ Moderate Impact ● Low Impact • None Low Positive Impact + Moderate Positve Impact + High Positve Impact ✚

Figure 16-16. Wind River fall chinook habitat factor analysis diagram. Diagram displays the relative impact of habitat factors in specific reaches. The reaches are ordered according to their restoration and preservation rank, which factors in their potential benefit to overall population abundance, productivity, and diversity. The reach with the greatest potential benefit is listed at the top. The dots represent the relative degree to which overall population abundance would be affected if the habitat attributes were restored to template conditions. See Volume VI for more information on habitat factor analysis diagrams.

Wind Chum

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Wind 2	•	●		•					•	•	•				●	●
Wind 1	•	●	•	•	•				•	•	•			•	●	⬤
Wind 3	•	●		•					•	•					•	•

High Impact ⬤ Moderate Impact ● Low Impact • None Low Positive Impact + Moderate Positve Impact + High Positve Impact ✚

Figure 16-17. Wind River chum habitat factor analysis diagram.

Wind Winter Steelhead

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Little Wind 1	•	•	●	•		•			•	●	•			•		⬤
Wind 3	•	●	•	●		•			•	●				•	•	✚
Wind 2	•	●	•	•		•			•	•	•			•	•	•
Wind 1	•	●	●	●	•	•				•				●	•	⬤

High Impact ⬤ Moderate Impact ● Low Impact • None Low Positive Impact + Moderate Positve Impact + High Positve Impact ✚

Figure 16-18. Wind River winter steelhead habitat factor analysis diagram.

Wind Summer Steelhead

Reach Name	Channel stability	Habitat diversity	Temperature	Predation	Competition (other spp)	Competition (hatchery fish)	Withdrawals	Oxygen	Flow	Sediment	Food	Chemicals	Obstructions	Pathogens	Harassment / poaching	Key habitat quantity
Wind 4a	•	⬤	•	●		●			●	⬤				●		✚
Trout 1a	•	⬤	●	•		•			●	●	•			•		+
Panther 1b	•	●		•					●	⬤						+
Wind 4b	•	●	●	●		●			●	⬤				●		✚
Wind 6b	•	●	•	•					●	●	+			•		●
Panther 1a	•	⬤		•					●	●						+
Trout 1d	•	●	●	•		•			●	⬤	•			•		+
Trout 2b	•	●	•	•		●			●	⬤	●					✚
Wind 3	•	⬤	•	●		●			●		•			●		
Wind 6a	•	●	•	•		●			•	●	+			•	•	+
Trout 2a	•	●	•	•		●			●	⬤	●					✚
Martha	•		⬤	•		•			●	⬤	•			•		●
Trout 1c	•	●	●	•		•			●	●	•			•		●
Wind 6c	•	●		•					●	●						●
Wind 5c	●	⬤	•	●		●			●	●	+			●	•	●
Panther 1e	•	●				•			●	●	•					+
Wind 5b	●	⬤	•	•		●			●	●	•			●	•	●
Wind 7b	•		●	•					●	⬤						+
Panther 2a	•	●				•			●	●	•					+
Wind 6d	•	●	•	•		•			●	⬤	•					+
Hemlock Lake		⬤	●	•		•			+	⬤	•			•	•	⬤
Trout 2c	•	●		•		•			●	⬤	•					+
Panther 1d	•	●				•			●	●	•					●
Wind 5a	●	●	•	●		●			●	●	•			●	•	●
Cedar		●	•	•		•			●	●	•					+
Wind 7a	•		•	•					●	⬤						+
Panther 1c	•	⬤				•			●	●	•					●
Trout 1b	•	●	●	•		•			●	●	•			•		+
Wind 7c	•		•	•					●	⬤						+
Wind 2	•	●	•	•		•			•		•			•		
Panther 2b	•	●				•			●	●	•					+
Wind 7d	•		•	•					●	⬤						✚
Layout	•		●	•		•			●	●	•			•		+
Paradise		•				•			•	⬤	•					
Compass	•	•	•	•		•			●	⬤	•					•
Trout 2d	•	●				•			●	●	•					+
Falls	•	●							•	●						•
Crater			●	•		•			•	⬤	•			•		•
EF Trout			●	•		•			•	⬤				•		
Wind 1	•	•	•	•		•								•		
Dry 1		•	•			•			•	●	•					
Ninemile		•				•			•	•						+
Shipherd Falls																
Hemlock Dam																
Wind 5d																
CNFH																
Trapper																

High Impact ⬤ Moderate Impact ● Low Impact • None Low Positive Impact + Moderate Positve Impact + High Positve Impact ✚

Figure 16-19. Wind River summer steelhead habitat factor analysis diagram.

16.7 Integrated Watershed Assessment (IWA)

The Wind River watershed includes 25 subwatersheds, which make up the 144,000 acres in the basin. The majority of the basin is in public ownership (91%), most of it under federal management, with privately held lands in the southern portion of the basin and in the middle mainstem valley.

16.7.1 Results and Discussion

Due to a lack of available geospatial data, IWA results were calculated only for sediment conditions in the Wind River watershed. IWA results are calculated at the local level (i.e., within subwatershed, not considering upstream effects) and the watershed level (i.e., integrating the effects of the entire upstream drainage area as well as local effects). A summary of the results is shown in Table 16-2. A reference map showing the location of each subwatershed in the basin is presented in Figure 16-20. Maps of the distribution of local and watershed level IWA results are displayed in Figure 16-21.

Table 16-2. IWA results for the Wind River watershed

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
10101	ND	F	ND	ND	F	10102, 10103
10102	ND	M	ND	ND	F	10103
10103	ND	F	ND	ND	F	none
10104	ND	M	ND	ND	M	none
10201	ND	M	ND	ND	M	10202, 10203
10202	ND	F	ND	ND	F	10203
10203	ND	M	ND	ND	M	none
10301	ND	M	ND	ND	M	none
10302	ND	F	ND	ND	F	none
10401	ND	F	ND	ND	F	10101, 10102, 10103, 10104, 10201, 10202, 10203, 10301, 10302, 10402, 10403
10402	ND	F	ND	ND	F	10101, 10102, 10103, 10104, 10201, 10202, 10203, 10301, 10302, 10403
10403	ND	F	ND	ND	F	10101, 10102, 10103, 10104, 10201, 10202, 10203
10501	ND	M	ND	ND	M	10502, 10503, 10504
10502	ND	F	ND	ND	M	10503, 10504
10503	ND	F	ND	ND	M	10504
10504	ND	M	ND	ND	M	none
10601	ND	M	ND	ND	F	10602, 10603, 10604
10602	ND	F	ND	ND	F	10603, 10604
10603	ND	F	ND	ND	F	10604
10604	ND	F	ND	ND	F	none
10701	ND	F	ND	ND	F	10702
10702	ND	F	ND	ND	F	none
10801	ND	M	ND	ND	F	10101, 10102, 10103, 10104, 10201, 10202, 10203, 10301, 10302, 10401, 10402, 10403, 10501, 10502, 10503, 10504, 10601, 10602, 10603, 10604, 10701, 10702, 10802, 10803
10802	ND	F	ND	ND	M	10101, 10102, 10103, 10104, 10201, 10202, 10203, 10301, 10302, 10401, 10402, 10403, 10501, 10502, 10503, 10504
10803	ND	M	ND	ND	M	none

Notes:

[a] LCFRB subwatershed identification code abbreviation. All codes are 14 digits starting with 170701051#####.

[b] IWA results for watershed processes at the subwatershed level (i.e., not considering upstream effects). This information is used to identify areas that are potential sources of degraded conditions for watershed processes, abbreviated as follows:

F: Functional
M: Moderately impaired
I: Impaired
ND: Not evaluated due to a lack of data

[c] IWA results for watershed processes at the watershed level (i.e., considering upstream effects). These results integrate the contribution from all upstream subwatersheds to watershed processes and are used to identify the probable condition of these processes in subwatersheds where key reaches are present.

[d] Subwatersheds upstream from this subwatershed.

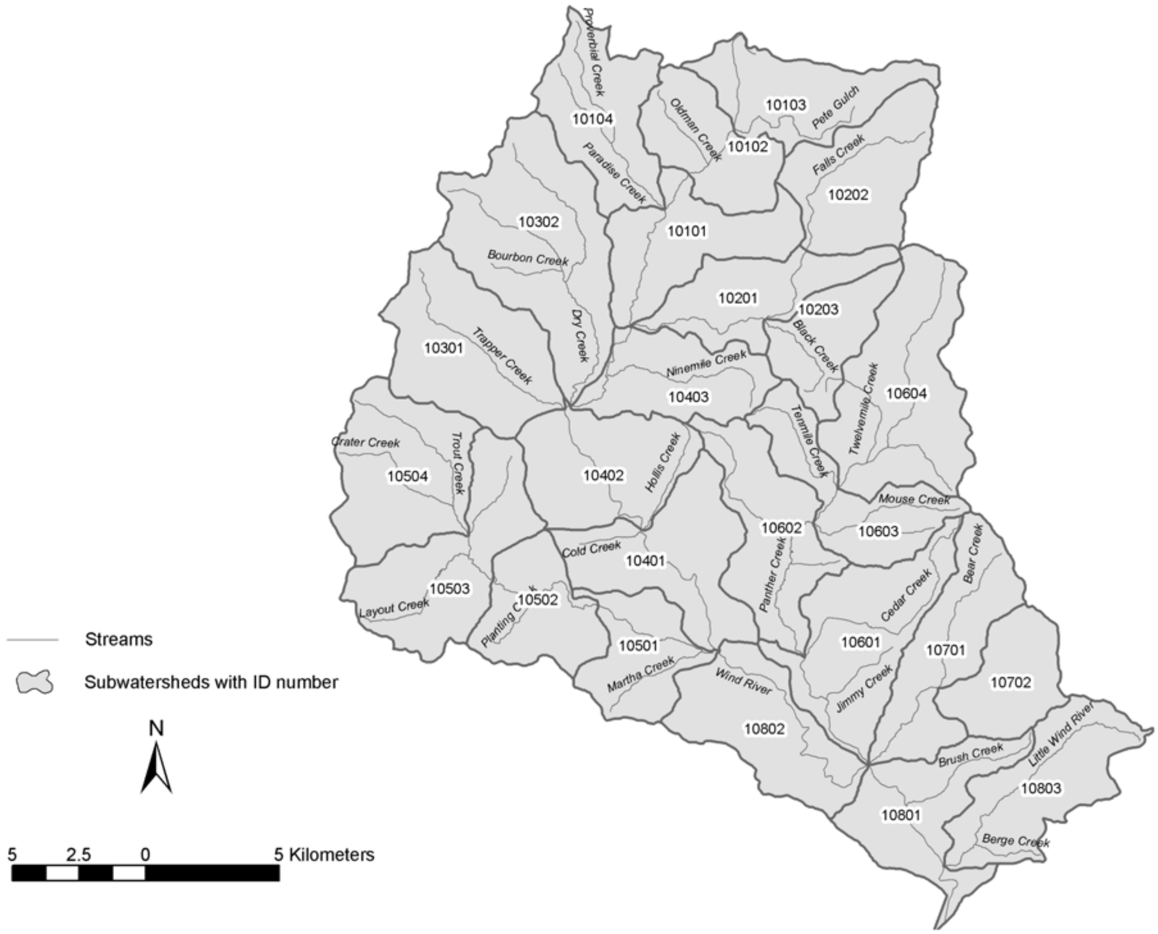


Figure 16-20. Map of the Wind River basin showing the location of the IWA subwatersheds

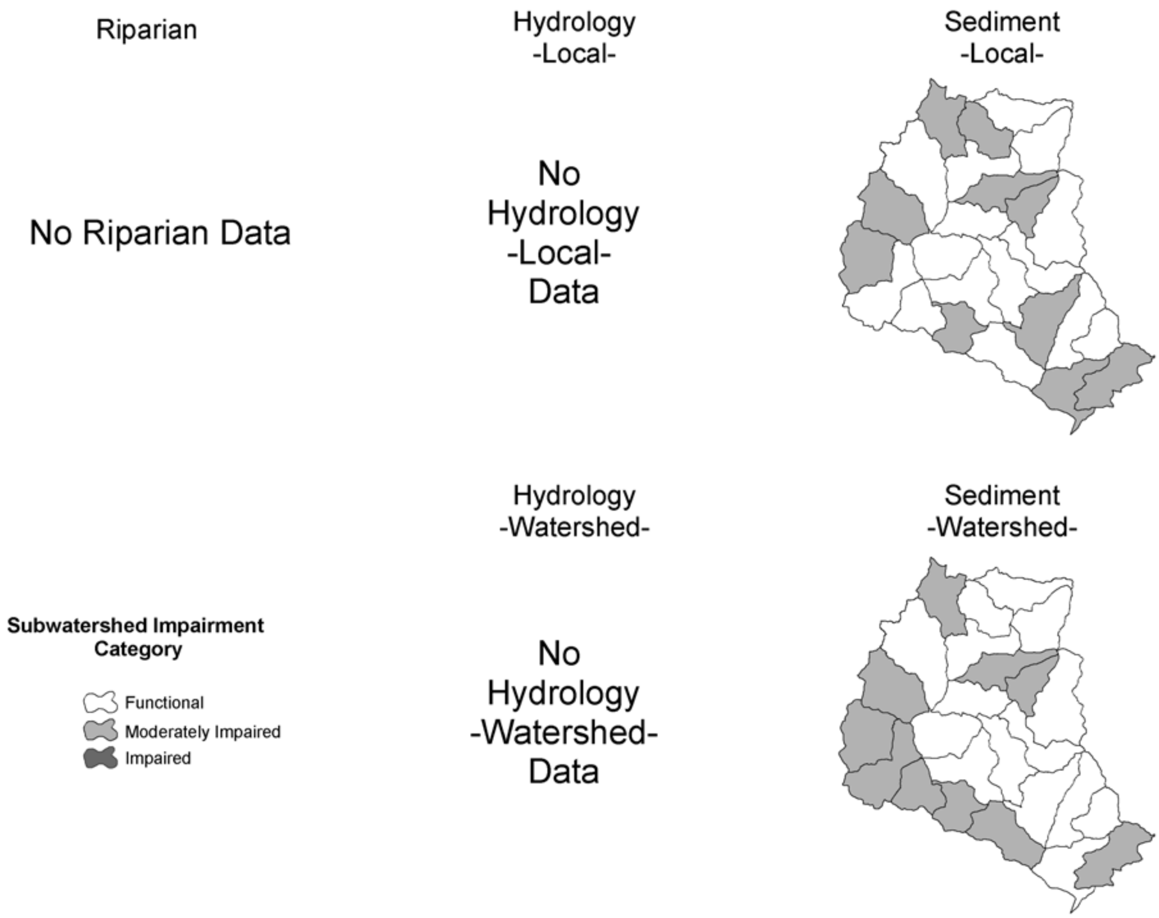


Figure 16-21. IWA subwatershed impairment ratings by category for the Wind River basin

16.7.1.1 Hydrology

IWA results were not developed for hydrologic and riparian conditions in the Wind River watershed due to the lack of GIS based data for forest cover. However, ratings for local hydrologic conditions can be derived from available sources of information. The 1996 watershed analysis conducted by the USFS indicates that 14% of the subbasin is in hydrologically immature forest cover (USFS 1996). The USFS watershed analysis divided the watershed into 26 subwatersheds, which are somewhat compatible with the 25 LCFRB recovery planning subwatersheds that comprise the Wind River drainage. Based on these results, all subwatersheds in the Wind River drainage appear to have hydrologically mature vegetation in excess of 50% of total area. In the IWA analysis, percent immature hydrologic vegetation and road density are used to rate likely hydrologic condition where impervious surface information is not available. Because of generally uniform coverage with hydrologically mature vegetation, road densities would be the determinants of hydrologic conditions in the IWA analysis.

Based on these derived ratings, hydrologic conditions in the upper Wind River are mixed. Local conditions are rated as moderately impaired in the upper mainstem (10102), lower Falls Creek (10201),and the middle mainstem (10401 and 10402). Conditions in remaining subwatersheds—including the upper mainstem key subwatershed 10101—are rated as locally functional. The upper Wind River is 97% publicly owned, with the vast majority of this area contained in national forest. This portion of the watershed has 48% of its area in the rain-on-snow zone, with much of the remainder in the snow-dominated zone. The high proportion of area in the rain-on-snow prone zone indicates a higher sensitivity to hydrologic impacts from poor forest cover and high road densities. Rain-on-snow area is particularly high (>70%) in the upper mainstem (10101 and 10102), Falls Creek (10201 and 10202), and the middle mainstem Wind River (10403). Road densities in excess of 3 mi/sq mi) are present in lower Falls Creek (10201) and the upper mainstem Wind (10102). This combination of factors suggests that these subwatersheds may be particularly prone to hydrologic impacts. This tendency is moderated somewhat by the presence of wetlands in the Wind River headwaters (10103) and Black Creek in the Falls Creek drainage (10203), covering approximately 3% and 6% of watershed area, respectively. These relatively extensive wetlands will serve to buffer hydrologic conditions in downstream subwatersheds.

Hydrologic conditions in Trout Creek and Panther Creek are similarly mixed in comparison to the upper Wind River. Based on ratings derived for these drainages from available data, local hydrologic conditions in the headwaters of Trout Creek (10504 and 10503) and Panther Creek (10604 and 10603) are moderately impaired. These ratings are attributed to the high road densities (3.0 to 4.7 mi/sq mi) present in these subwatersheds. Lower Trout Creek (10501) is also rated as moderately impaired, again due to high road densities (4.7 mi/sq mi). Remaining subwatersheds in these drainages are rated as functional. Over 90% of the land area in this portion of the watershed is in public lands, with significant portions of the Trout Creek drainage in the Wind River experimental forest. Trout Creek and Panther Creek have moderate to high proportion of total area in the rain-on-snow zone (ranging from 36-74%). These subwatersheds have the largest amount of rain-on-snow area, with upstream watersheds increasingly snow-dominated and downstream subwatersheds more rain-dominated.

Local level hydrologic conditions in the mainstem subwatersheds of the lower Wind River watershed and its tributaries are mixed. For example, the second upstream subwatershed of the lower middle Wind River (10802) is rated as functional while the lower mainstem (10801) is rated as moderately impaired. The Little Wind River (10803), which enters the lower Wind River approximately one mile above its mouth, is rated as moderately impaired. Approximately 3 miles upstream at RM 4 is the confluence of Bear Creek, with two subwatersheds (10701 and 10702) rated as hydrologically functional. Extensive private land holdings can be found in several of these subwatersheds, such as the Little Wind River (10803) and the lower mainstem (10801 and 10802) which average approximately 50% private lands. Private lands in this part of the watershed include rangelands, agriculture, residential development, and timber. Land uses on public and private lands in these subwatersheds are within the Columbia Gorge National Scenic Area and are subject to stricter land use and development regulations, thereby dampening the effects of land management in these areas.

When interpreting the hydrologic condition ratings for the mainstem subwatersheds (10802 and 10801), it is important to recognize that the local level hydrologic conditions do not reflect the influence of the upstream portions of the watershed. Watershed level conditions will consider both the local and the upstream effects, and may be quite different than the local conditions alone.

16.7.1.2 Sediment

As with hydrologic conditions, the local level sediment conditions in the upper Wind River are mixed. Functional sediment ratings are concentrated in the Wind River headwaters (10103), Upper Falls Creek (10202), Dry Creek (10302), the upper mainstem (10101), Ninemile Creek (10403), and the middle mainstem (10401 and 10402). Moderately impaired ratings for local level sediment conditions are found in Paradise Creek (10104), the upper Wind River (10102), Falls Creek (10201 and 10203), and Trapper Creek (10304). Watershed level ratings are identical to the local level conditions with one exception. The upper mainstem (10101) is rated functional and appears to benefit from functional conditions in the Wind River headwaters (10103). Natural erodability ratings in this part of the watershed range from low to moderate (5-30 on a scale of 0-126), with the more erodable subwatersheds including Dry Creek, Trapper Creek, Ninemile Creek and the middle mainstem subwatersheds of the Wind River. The functional watershed level ratings for the upper and middle mainstem (10101, 10401, 10402) are determined both by locally functional conditions and the buffering effect from upstream subwatersheds. The functional conditions in upstream subwatersheds appear to provide a buffering effect that balances the effect of moderately impaired subwatersheds at the watershed level.

Trapper Creek (10301 – moderately impaired) has relatively pristine forest cover and riparian conditions (USFS 1996). Road densities in this subwatershed are relatively low (<2.0 mi/sq mi), and the density of streamside roads is also moderately low (0.45 miles/stream mile). However, sediment conditions in this subwatershed are rated as moderately impaired due to the intersection of forest roads, steep slopes, and more erodable geology. While rain-on-snow zone density in Trapper Creek is moderate (43%), the combination of roads in sensitive areas with the potential for rapid runoff under rain-on-snow conditions may create significant sediment loading.

Lower Falls Creek (10201 - moderately impaired) has a low natural erodability rate (7 on the 0-126 scale), but has moderately impaired sediment conditions due to high rain-on-snow area (83%) and high streamside road densities (>2 miles/stream mile). Streamside roads are relatively large sources of sediment relative to overall unsurfaced road density.

Local level sediment conditions in Trout Creek subwatersheds are rated as moderately impaired at the headwaters and the mouth (10504 and 10501). The middle two watersheds in the Trout Creek drainage (10502 and 10503) are rated as functional for sediment conditions. In contrast, watershed level conditions in all four subwatersheds in this drainage are rated as moderately impaired. Based on this information, the moderately impaired conditions in the headwaters of Trout Large are strongly influencing downstream subwatersheds. Natural erodability rates for the Trout Creek drainage are moderate (13-31 on a scale of 0-126), with erodability ratings increasing on an upstream gradient. The watershed level effects of moderately impaired conditions in the headwaters suggests that the relatively high road densities in this subwatershed (>4 mi/sq mi) are concentrated in more erodable areas. Similarly, while erodability ratings at the lower end of Trout Creek (10501) are relatively low, the high road densities in this subwatershed (4.7 mi/sq mi) are concentrated in more erodable areas.

Sediment conditions in the Panther Creek drainage are functional at the local level in all subwatersheds except lower Panther Creek (10601). Watershed level conditions are functional in all subwatersheds, suggesting that the functional conditions in the headwaters and middle subwatersheds of the drainage provide a buffering effect on sediment conditions in the most downstream subwatersheds. Lower and middle Panther Creek (10601 and 10602) are important subwatersheds for summer steelhead. Natural erodability ratings in these areas are low to moderate (ranging from 18-30 on the 0-126 scale), suggesting that moderately impaired ratings are indicative of detrimental effects on instream habitat conditions.

Sediment conditions in the lower Wind River are strongly influenced by watershed level effects from upstream drainages. Sediment conditions in the lower middle Wind River (10802) and the lower Wind River (10801) are rated as functional and moderately impaired at the local level, respectively. These ratings reverse at the watershed level. The lower middle Wind (10802) is rated as moderately impaired at the watershed level due predominantly to the influence of watershed level degradation in the Trout Creek drainage. In contrast, the lower Wind River (10801) is rated as functional at the watershed level, due to the influence of generally functional sediment conditions in the Panther and Bear Creek drainages. The moderately impaired local level rating for the lower Wind River is borderline, suggesting that local level effects are relatively modest contributors of sediment relative to watershed level effects.

Sediment conditions in the Bear Creek drainage (10701 and 10702) are rated as functional at both local and watershed levels. Bear Creek has moderately low overall road densities (averaging 2.0 mi/sq mi). Streamside road densities are moderate, averaging 0.48 miles/stream mile, and rain-on-snow area ranges from 35% in lower Bear Creek (10701) to over 60% in upper Bear Creek (10702). Natural erodability rates are in the moderate range, averaging over 30 on the scale of 0-126. The functional rating for the headwaters of Bear Creek is borderline moderately impaired. This suggests that some roads may be located in particularly sensitive areas.

The moderately impaired rating for sediment conditions in the Little Wind River (10803) is driven by the relatively high level of natural erodability for this watershed (36 on the 0-126 scale) and moderately high road densities (3.1 mi/sq mi). In addition, the headwaters of this subwatershed are in the rain-on-snow zone. This subwatershed has significant area in private land ownership (41%); however, the proximity of this subwatershed to the Columbia Gorge National Scenic Area limits land uses and development on both public and private lands. Streamside road densities are high, exceeding 0.9 miles/stream mile.

16.7.1.3 Riparian

Riparian conditions are rated in the USFS watershed analysis based on various measures of the riparian zone seral stage in selected stream reaches (USFS 1996). Thresholds of concern for riparian vegetation are not defined in the watershed analysis and no definitive ratings are provided. While the data in the watershed analysis cannot be directly evaluated using IWA thresholds, a general rating of riparian condition can be qualitatively derived using arbitrary thresholds for the proportion of the riparian zone in large (successionally mature) trees. For the purpose of this qualitative analysis, riparian ratings are defined as follows:

- Functional: riparian zone >50% large trees
- Moderately Impaired: riparian zone between 20-50% large trees
- Impaired: riparian zone <20% large trees

Based on this information, riparian conditions appear to vary widely across the Wind River watershed, with a general trend towards moderately impaired to impaired conditions. Functional riparian conditions are found in the Little Wind River (10803), the Bear Creek drainage (10701 and 10702), lower and upper middle Panther Creek (10701 and 10703), Trapper

Creek (10301), and Dry Creek (10302). Riparian conditions are rated as impaired in the upper middle Wind River (10401 and 10401) and lower and middle Trout Creek (10501 and 10502). All remaining subwatersheds are rated as moderately impaired, with borderline impaired conditions present in lower middle Panther Creek (10602) and upper middle Trout Creek (10503).

16.7.2 Predicted Future Trends

16.7.2.1 Hydrology

Because of the high proportion of area under public ownership, relatively high levels of mature vegetation, low development expectations, and the extent of restoration actions being implemented on federal lands in the watershed, overall hydrologic conditions in the Wind River Watershed are predicted to trend stable over the next 20 years, with gradual improvement as vegetation matures. Road and road-crossing removal as well as riparian restoration are likely to provide substantial hydrologic benefits.

Most of the upper watershed lies within the GPNF, and can be characterized by fairly good mature vegetation cover. Because of the high proportion of area in public ownership, and the extent of restoration actions being implemented on federal lands in the watershed, hydrologic conditions in the upper Wind River are predicted to trend stable over the next 20 years, with gradual improvement as vegetation matures. High road densities (in excess of 3 mi/sq mi) in subwatersheds within the rain-on-snow zone, such as the upper mainstem (10102) and lower Falls Creek (102 10202), may impede hydrologic recovery in affected reaches.

Given the high percentage of public lands in the Trout Creek and Panther Creek drainages, hydrologic conditions are predicted to trend stable in these subwatersheds over the next 20 years with some gradual improvement as vegetation matures.

While the influence of watershed level conditions in the lower mainstem Wind River (10801 and 10802) have not been analyzed, the general trends predicted for the upstream areas of the watershed will strongly influence conditions in these mainstem reaches. In general, the extensive coverage of hydrologically mature vegetation and the emphasis on habitat restoration on public lands in the watershed would suggest that hydrologic conditions in the watershed as a whole will trend towards improvement. Hydrologic conditions are predicted to trend stable over the next 20 years, given the higher proportion of private lands in these watersheds, the likelihood of ongoing land management activities under existing regulatory constraints, and the existing road densities. Some gradual improvement will occur as areas with immature vegetation recover, but these positive influences may be outweighed by the effects of road conditions.

Other important portions of the Wind River watershed include Bear Creek and the Little Wind River drainages. Hydrologic conditions for the Bear Creek drainage are predicted to remain stable over the next 20 years, based on the currently functional rating and the high proportion of public lands in the drainage. Road densities in the Bear Creek drainage are relatively low (averaging 2.0 mi/sq mi), with a relatively high proportion of mature vegetation. The hydrologic conditions in the Little Wind River (10803) are predicted to remain moderately impaired due to high road densities, with some moderation due to existing land use restrictions. Road densities in this subwatershed just exceed the threshold for hydrologic effects, by 0.1 mi/sq mi (3.1 mi/sq mi total).

16.7.2.2 Sediment Supply

Sediment conditions in the upper Wind River, Trout Creek, and Panther Creek are predicted to trend stable or to gradually improve over the next 20 years due to federal management that places emphasis on habitat preservation and restoration. Forest road maintenance and removal projects, as well as continued vegetation recovery from past clear cutting, will reduce sediment generation and delivery to stream channels. In moderately impaired subwatersheds where roads are not targeted for restoration, degraded conditions are expected to persist.

Sediment conditions in the lower middle (10802) and lower mainstem (10801) Wind River are expected to trend stable. Vegetation recovery and road maintenance/removal projects will improve sediment conditions in some areas, but these improvements will be offset by continued heavy logging practices on private timberlands. Given these balancing factors, the predicted trend over the next 20 years is for sediment conditions in these drainages to remain in their current condition.

The Bear Creek subwatersheds (10701, 10702) are predicted to trend stable for sediment conditions over the next 20 years, due to the high proportion of area in federal lands (approximately 95%). However, the borderline sediment conditions in the headwaters and the high rain-on-snow area suggest the potential for episodic sediment loading.

Given the protections offered by the Columbia Gorge National Scenic Area, sediment conditions in the Little Wind River subwatershed (10803) are predicted to trend generally stable over the next 20 years due to the natural erodability of the drainage and moderately high unsurfaced road and streamside road densities.

16.7.2.3 Riparian Condition

Riparian protections are in place throughout the private and public lands in the basin. However, indiscriminate historical logging practices removed significant amounts of riparian vegetation over the last century, particularly along the middle and upper mainstem Wind River, the Wind River headwaters, Trout Creek and Panther Creek. In some areas (e.g. lower mainstem, middle mainstem), residential, agricultural, and transportation corridor impacts have denuded riparian vegetation. Although many riparian areas, especially those impacted by past timber harvests, are recovering, other areas continue to suffer from degraded conditions. In some places, riparian restoration efforts are restoring natural vegetation assemblages. Based on this information, riparian conditions are predicted to trend toward gradual recovery in most areas. This general trend must be considered against existing limitations. Some riparian areas suffer from residential development and/or streamside roads. High streamside road densities (exceeding 0.7 miles/stream mile) are present in all subwatersheds with impaired ratings for riparian conditions, with some subwatersheds including lower Trout Creek (10501) and the middle mainstem Wind River (10401) approaching 1.5 miles/stream mile. The potential for full recovery of riparian vegetation in these subwatersheds will be somewhat limited, unless road retirement projects are implemented with a goal of riparian restoration.

High streamside road densities are also present in subwatersheds rated moderately impaired for riparian condition. Lower Falls Creek (10201) has road densities exceeding 2 miles/stream mile, i.e., many stream reaches are effectively bracketed on both sides by roads. Streamside road densities in upper Wind River subwatersheds 10101 and 10102 are 0.74 and 1.31 miles/stream mile, respectively. Moderately impaired riparian conditions in these subwatersheds tend to indicate that there is some potential for additional recovery over time, again within the limits imposed by existing roads.

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