12.0 LOWER COLUMBIA RIVER ESUs

12.1 LOWER COLUMBIA RIVER ESUs

The Lower Columbia River (LCR) evolutionarily significant units (ESUs) include the LCR Coho ESU, the LCR Chinook ESU, and the LCR Steelhead ESU. Table 12.1 lists the populations in each ESU by major population group.

Table 12.1 Lower Columbia River ESU populations by major population group.

LCR Chinook (yearlings)	LCR Steelhead (yearlings)	LCR Coho
Coastal fall run stratum Grays River Elochoman River Mill Creek Youngs Bay Big Creek Clatskanie River Scappoose River **Cascade fall run stratum** Coweeman River Lower Cowlitz River Upper Cowlitz River Toutle River Kalama River Lewis River/Salmon Creek Washougal River Clackamas River Sandy River **Cascade late fall run stratum** Lewis River Sandy River **Cascade spring run stratum** Upper Cowlitz River Cispus River Tilton River Toutle River Kalama River Lewis River Sandy River **Gorge fall run stratum** Lower Gorge Tributaries Upper Gorge Tributaries Big White Salmon River Hood River **Gorge spring run stratum** Big White Salmon River Hood River	**Cascade winter-run stratum** Lower Cowlitz River Coweeman River South Fork Toutle River North Fork Toutle River Upper Cowlitz River Cispus River Tilton River Kalama River North Fork Lewis River East Fork Lewis River Salmon Creek Clackamas River Sandy River **Cascade summer-run stratum** Kalama River North Fork Lewis River East Fork Lewis River Washougal River **Gorge winter-run stratum** Lower Gorge Tributaries Upper Gorge Tributaries Hood River **Gorge summer-run stratum** Wind River Hood River	**Coastal stratum** Grays River Elochoman River Mill Creek Youngs Bay Big Creek Clatskanie River Scappoose Creek **Cascade stratum** Coweeman River Lower Cowlitz River Upper Cowlitz River Cispus River Tilton River North Fork Toutle River South Fork Toutle River Kalama River North Fork Lewis River East Fork Lewis River Salmon Creek Washougal River Clackamas River Sandy River **Gorge stratum** Lower Gorge Tributaries Upper Gorge Tributaries Hood River Big White Salmon River

12.2 LCR CHINOOK

12.2.1 Grays Subbasin

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

Approximately 95% of the Grays Subbasin is forested, and commercial timber companies own 73% of the land. The bulk of the remaining lands are under state ownership. Much of the basin has been impacted by timber harvest and is primarily composed of young forest stands. Approximately 500 acres of the lower Grays River has been acquired by the Columbia Land Trust for protection of natural resources. Although the majority of the basin is commercial forest land, there is also substantial agricultural development in the lower mainstem river valley and along the lower reaches of mainstem tributaries. Forest harvest and agricultural development have left the subbasin with nearly 70% of vegetation in young forest or non-forested conditions. A major impact on native fish populations is the reduction in backwater habitat in the lower river within tidal influence, which is the result of agricultural development near the mouth. These changes have sharply reduced the habitat available to chum.

Grays Subbasin assessments have identified several key issues related to salmon habitat. First, forest harvest and related road-building on steep, unstable slopes have contributed to increased sedimentation of stream channels and elevated risk of peak flow increases. These conditions affect nearly all of the key habitat areas for fish populations in the subbasin, especially the critical mainstem spawning and rearing reaches. Furthermore, the potential for continued degradation is high due to the dominance of private timberland in the subbasin. New forest practices regulations regarding timber harvest on steep slopes will likely allow for some degree of passive restoration of impaired sediment delivery processes over time.

Another key issue is the severe channelization (and subsequent loss of backwater habitat) and riparian degradation that have negatively affected conditions for chum, coho, fall chinook, and, to some degree, winter steelhead in the lower mainstem. Channelization and riparian degradation are mostly related to extensive agricultural development. Population growth will result in the conversion of forestry and agricultural land uses to residential uses, with potential impacts to habitat conditions.

12.2.1.1 Grays River Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

The Grays River basin historically had a large population of chinook salmon. However, by 1944, as few as 34 adults were observed in the basin (WDF 1951). Large-scale hatchery introductions began in the late 1950s from a number of lower Columbia River hatcheries. By 1993, some 84 million fall-run chinook salmon had been released into the basin. The Grays River Hatchery fall-run chinook salmon program that began in 1962 was recently terminated. Carcass recoveries from natural spawning surveys indicated that approximately 35% of the fish were first-generation strays from the Grays River Hatchery (Harlan 1999). It is probable that the native Grays River population was overwhelmed by hatchery introductions and that a large proportion of the current natural spawners are first-generation, hatchery-origin fish. With the termination of in-basin releases of hatchery fish, it may be possible for the existing population to become more locally adapted, but only if suitable habitat conditions exist.

12.2.2 Elochoman River

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

The Elochoman/Skamokawa basin is almost entirely composed of private and state-owned lands, the bulk of which are commercial timberlands. Considerable logging occurred in the past without regard for riparian and instream habitat, resulting in sedimentation of salmonid spawning and rearing habitat (WDF 1990). Almost none of the forest cover is in late-seral stages, but as the forest matures, watershed conditions are recovering.

A broad agricultural valley extends up the mainstem Skamokawa, West Fork Skamokawa, and Wilson creeks. There are considerable agricultural impacts to fish habitat in these areas, which suffer from non-forested riparian zones and disconnected floodplains. Chum, fall chinook, and coho use these lower valley reaches and are therefore heavily impacted by agricultural land uses. The upper reaches of the mainstem and all major tributaries are impacted most heavily by forest harvest and the forest road network. Winter steelhead and coho occupy upper basin reaches, and are therefore affected most by forest practices. A similar land-use pattern can be found in the Elochoman basin, with the exception being that the agricultural valley is found primarily only along the mainstem. The species effects are also similar, with agricultural uses having the greatest impact on chum and fall chinook and forest practices having the greatest effect on winter steelhead and coho. The projected population change from 2000 to 2020 for unincorporated areas in WRIA 25 is 37% (LCFRB 2001). Current and expected growth will occur predominantly in the broad agricultural valleys along the major stream courses, resulting in land-use conversion from agricultural to residential uses. This pattern is already apparent in many areas. It will be important for land-use planning and critical areas policy to provide adequate protection of habitat and habitat-forming processes in sensitive areas.

A variety of human activities in the mainstem and estuary have decreased both the quantity and quality of habitat used by juvenile salmonids. These include floodplain development; loss of side channel habitat, wetlands and marshes; and alteration of flows due to upstream hydro operations and irrigation withdrawals. Effects are similar for Skamokawa and Elochoman populations to those of most other subbasin salmonid populations. Effects are likely to be more adverse for chum and fall chinook than steelhead and coho.

The lower Elochoman and the lower reaches of mainstem tributaries have been impacted by agriculture and rural residential development. Effective recovery measures will involve riparian and floodplain restoration. Winter steelhead make the greatest use of upper Elochoman reaches. These reaches are predominantly impacted by forest practices occurring in the upper basin.

Effective recovery of these reaches will involve basin-wide recovery of runoff and sediment supply function.

12.2.2.1 Elochoman River Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids*, prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Fall-run chinook salmon were historically present in the Elochoman River, but it is unclear whether a persistent spawning aggregation existed in Skamokawa Creek. Extensive hatchery releases into the Elochoman River prior to and following the construction of the Elochoman Hatchery probably resulted in functional loss of the original population. Much of the existing spawning habitat has been substantially degraded. Additionally, upstream passage in the Elochoman River is partially blocked by the hatchery weir. The majority of naturally spawning adults in Skamokawa Creek and Elochoman River are first-generation hatchery fish, 50% and 82%, respectively (Harlan 1999). Genetic analysis of fall-run chinook salmon from the Elochoman River indicates that they are most similar to fall-run chinook salmon from Abernathy Creek and the Kalama River. There has been little potential for the progeny of naturally spawning fish to adapt to local conditions.

12.2.3 Mill Creek

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II*, prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

The Mill/Abernathy/Germany basin is almost entirely private and state-owned lands, the bulk of which are commercial timberlands. Considerable logging occurred in the past without regard for riparian and instream habitat, resulting in sedimentation of salmonid spawning and rearing habitat (WDF 1990). Essentially none of the forest cover is in late-seral stages, but as the forest matures, watershed conditions are recovering. The impacts of forest practices on riparian areas and sediment supply have most affected winter steelhead and coho spawning and rearing habitat in the middle and upper basin reaches. Agricultural valleys extend up the mainstems of Abernathy and Germany creeks. The reaches within these broad valleys provide potentially productive habitat for all species, especially for chum and fall chinook, which make heavy use of lower mainstem reaches. Channel confinement and riparian degradation are the limiting factors with the greatest impacts in these areas. There is not extensive agricultural use in the Mill Creek basin, but rural residential development has been increasing in the lower basin over the last decade, which poses potential threats to fish habitat, primarily for fall chinook and chum that most often use lower basin reaches.

Table 12.2 Lower Columbia River Chinook (yearlings)

Data Sources

	①	②	CSTN	③	CSTN	④	CSTN	⑤	⑥	⑦
	Range of System Survival Rates GAP [D*]	Index of Potential to Increase Population: H/M/L (base period average annual redd count; recent average annual redd count) or % Interim Target	C S T N	Qualitative Assessment (CHART, NWFSC approach and other info) of Potential to Improve/Increase Habitat (H/M/L)	C S T N	Primary Candidate Anthropogenic Limiting Factors: **F**low, **C**hannel **M**orphology (bed, banks, sediment, LWD, sinuos., connectiv.), **T**emperature, **W**ater **Q**uality	C S T N	Ecological Improvement Potential	Improvement Potential Adjusted Based on Practical Constraints	Proposal to Fill Gap and Performance Measures/ Standards/ M&E
Coastal fall run stratum										
Grays River		VH (1500-10,000: 2400)		H		CM (all),		H	M	
Elochoman River		VH (5,000-10,000:154)		H		cm,t, passage		H	M	
Mill Creek		VH (5000-7500:248)		H		CM (all),		H	M	
Youngs Bay		? recent 0		M		CM, WQ		M	M-L	
Big Creek		? 180		M		passage, CM,		M	M-L	
Clatskanie River		? 186								
Scappoose River		? 100								
Cascade fall run stratum										
Coweeman River		VH (5000-7000:348)		H		cm,		H	M-L	
Lower Cowlitz River		VH (54000:463)		H		cm, wq, fl		H	M-L	
Upper Cowlitz River		VH extirpated		H		passage,		H	L	
Toutle River		VH 25000:1000-3700		H		passage, wq		H	H	
Kalama River		VH (2400:848)		H		cm, riparian,		M	M	
Lewis River/Salmon Creek		VH (18000-20000:230)		H		cm, riparian, passage, wq, fl		H	Salmon - L, Lewis - M	
Washougal River		VH (7500:903)		H		passage, cm, sediment, LWD,		H	M	
Clackamas River		VH recent 56		H		passage, wq, sed, fl, cm, lwd, temp		H	M	
Sandy River		VH recent 183		H		passage, wq, sed, fl, cm, lwd, temp		H	M	
Cascade late fall run stratum										
Lewis River		VH recent 6800-16000		H		cm, riparian, passage, wq, fl		H	M	
Sandy River		VH recent 504		H		passage, wq, sed, fl, cm, lwd, temp		H	M	
Cascade spring run stratum										
Upper Cowlitz River		225		H		passage		H	L	
Cispus River		extirpated		H		passage		H	M	
Tilton River		extirpated		H		passage		H	M	
Toutle River		extirpated hist 2900		H		passage, wq		H	H	
Kalama River		VH 4200:138		H		cm, riparian,		M	M	
Lewis River		VH 1700:320		H		cm, riparian, wq, fl, passage		H	M	
Sandy River		extirpated		H		passage, wq, sed, fl, cm, lwd, temp		H	M	
Gorge fall run stratum										
Lower Gorge Tributaries		VH (1400-2800:100)		H		cm		M	M	
Upper Gorge Tributaries		VH (2400:90)		H		cm, passage, loss of habitat inundation,		L	L	
Big White Salmon River		VH recent 98		H		cm, passage, loss of habitat inundation,		L	L	
Hood River		VH recent <50		H		fl, cm, wq, temp,		M	M	
Gorge spring run stratum										
Big White Salmon River		extirpated		H		cm, passage, loss of habitat inundation,		L	L	
Hood River		extirpated		H		fl, cm, wq, temp,		M	M	

*D = Delayed mortality due to transportation

C S T N = Council, States, TRTs, NWC

12.2.3.1 Mill Creek Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids*, prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

There is little information on the fall-run chinook salmon that historically inhabited the boundaries of this demographically independent population (DIP). Hatchery introductions, habitat degradation, and the straying of hatchery fish from outside DIP boundaries are likely to have overwhelmed native fall-run chinook salmon in this DIP. Presently, fall-run chinook salmon are observed spawning in Mill, Germany, and Abernathy creeks, but the majority of these fish are apparently hatchery-produced (Harlan 1999). Adults returning to Abernathy, Germany, and Mill creeks were more similar to fall-run chinook salmon in the mid-Columbia River tule genetic diversity unit (GDU), which includes fall-run fish from the Wind and White Salmon rivers and Spring Creek NFH (Marshall *et al.* 1995).

The Mill/Abernathy/Germany basin is almost entirely private and state-owned lands, the bulk of which are commercial timberlands. Considerable logging occurred in the past without regard for riparian and instream habitat, resulting in sedimentation of salmonid spawning and rearing habitat (WDF 1990). Essentially none of the forest cover is in late-seral stages, but as the forest matures, watershed conditions are recovering. The impacts of forest practices on riparian areas and sediment supply have most affected winter steelhead and coho spawning and rearing habitat in the middle and upper basin reaches. Agricultural valleys extend up the mainstems of Abernathy and Germany creeks. The reaches within these broad valleys provide potentially productive habitat for all species, especially for chum and fall chinook, which make heavy use of lower mainstem reaches. Channel confinement and riparian degradation are the limiting factors with the greatest impacts in these areas. There is not extensive agricultural use in the Mill Creek basin, but rural residential development has been increasing in the lower basin over the last decade, which poses potential threats to fish habitat, primarily for fall chinook and chum that most often use lower basin reaches.

Decades of human activity have significantly altered watershed processes and reduced both the quality and quantity of habitat needed to sustain viable populations of salmon and steelhead. Moreover, with the exception of fall chinook, stream habitat conditions within the Mill/Abernathy/Germany basin have the greatest impact on the health and viability of salmon and steelhead relative to the other limiting factors and threats discussed in this chapter.

Watershed process measures generally focus on the entire basin rather than being limited only to high-priority areas, because conditions in high-priority areas are often influenced by cumulative watershed effects. While reach-level habitat conditions often result from local factors, they are also affected or shaped by systemic watershed processes. Limiting factors such as temperature, high and low flows, sediment input, and large woody debris recruitment are often affected by or result from upstream conditions and degraded watershed processes. Access to key reaches may also be affected by barriers that occur downstream of a reach. Accordingly, restoration of a priority reach may require action outside the targeted reach. The reaches with the most current and potential production in the Mill Creek basin are in the lower mainstem (below the SF confluence and just upstream of the NF confluence), in lower SF Mill Creek, and in NF Mill

Creek. The Mill Creek basin is almost entirely forest land, with scattered rural residential development along the lower mainstem and lower SF Mill Creek. The primary impacts are related to basin-wide forest practices, and recovery measures should therefore focus primarily on forestry-related impacts.

The most productive reaches in Abernathy Creek are located in the lowest three to four miles of the mainstem and in Erick and Midway creeks. These reaches suffer from basin-wide forest practices and from localized riparian and floodplain impacts related to agriculture and rural residential development. Successful restoration of habitat will involve riparian forest recovery, floodplain reconnection, and restoration of functional runoff and sediment supply processes from the entire basin.

The lower and middle mainstem Germany reaches are used by all salmonid populations. These reaches are impacted by basin-wide forest practices and by local agriculture and rural residential development. The upper Germany Creek reaches are used most by winter steelhead. These reaches are impacted most by upper basin forest harvest and road conditions. Germany Creek reaches will require stream corridor (riparian areas and floodplains) restoration, as well as basin-wide recovery of functional runoff and sediment supply processes.

12.2.3.2 Youngs Bay Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Fall-run chinook salmon were historically present in most of the rivers within the boundaries of this DIP. Habitat degradation and over-harvesting substantially depressed or extirpated fall-run chinook salmon from many of these basins. Additionally, there have been substantial releases of both spring- and fall-run chinook salmon into this area. Many of these releases came from outside the Lower Columbia River ESU. Most notable are introductions of spring-run chinook salmon from the Upper Willamette River (UWR) ESU and fall-run chinook salmon from the Oregon coast (Rogue River). It is unlikely that there are any remaining distinct spawning aggregations of native chinook salmon in this DIP. Additionally, there has been little potential for local adaptation by any hatchery stocks introduced into this DIP.

12.2.3.3 Big Creek Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Fall-run chinook salmon are native to the basin. A hatchery was established in the basin in 1941 using locally returning fish as broodstock. Since 1941, eight different stocks of fall-run chinook salmon have been released from this hatchery, in addition to a number of spring-run chinook salmon (primarily from the Upper Willamette River ESU). Through 1993, 193 million fall-run chinook salmon had been released into the Big Creek basin. For several years, releases of Rogue River bright fall-run chinook salmon were made out of the Big Creek Hatchery. Releases were terminated because of concerns regarding the straying of these non-native fish into basins throughout the lower Columbia River. A weir placed in the river for the collection of spawners also blocks access to much of the basin. Passage provided above the weir has been intermittent during the course of hatchery operations. It is unlikely that much of the native Big Creek population is represented by the existing hatchery or naturally spawning populations. Furthermore, given existing conditions, it is unlikely that the naturally spawning fall-run chinook salmon in this basin are self-sustaining or independent. Genetically, the Big Creek Hatchery population most closely resembles fall-run chinook salmon from the Spring Creek NFH, which was founded by fish from the White Salmon River.

12.2.3.4 Clatskanie River Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Fall-run chinook salmon were historically present in the main streams in this DIP: Plympton Creek, Clatskanie River, and Beaver Creek. Naturally spawning fall-run chinook salmon still occur in these streams, but the majority of these fish appear to be first-generation hatchery strays (Theis and Melcher 1995). Genetic analysis of fall-run fish from these streams is not available, but based on the marked hatchery strays recovered and geographic proximity, it is likely that there would be a strong similarity to stocks released from the Big Creek Hatchery and other local facilities.

12.2.3.5 Scappoose Creek Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Fall-run chinook salmon were historically present in Scappoose Creek and many of the other smaller tributaries in this ESU. There is, however, little information on historical or current life-history traits or genetic characteristics. Spawner surveys have been done intermittently and give little indication of run size or trends in abundance. Hatchery introductions and strays have probably had a substantial influence on the native population. Furthermore, habitat degradation constrains natural productivity in the DIP and limits the development of a locally adapted population.

Western Cascade crest (Washington) tributaries include the Cowlitz, Kalama, Lewis, and Washougal rivers. These rivers all have headwaters at high elevations in the Cascade Mountains. River flows peak in December or January and sustain at least 50% of peak for six months or more. Basin sizes are much larger and able to sustain larger populations than those found in the coastal region. In many basins, naturally produced salmon (except for summer steelhead and spring-run chinook salmon and chum) are still found in appreciable numbers and make may up a significant portion of the spawning population. The lower reaches of these rivers are relatively low-gradient, but high-gradient sections are common in the middle and upper reaches. Dams currently block access to spring-run chinook and steelhead habitat on the Lewis, Cowlitz, and Sandy River basins.

12.2.3.6 Coweeman River Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Fall-run chinook salmon in the Coweeman River represent one of the few remaining populations in the ESU sustained through natural production. In 1951, it was estimated that there were 5,000 spawning fall-run chinook in the Coweeman River, with a total spawning escapement of 31,000 fall-run chinook salmon throughout the Cowlitz basin (WDF 1951). Recently, escapement into the Coweeman River has averaged 800 fish, but there has been minimal contribution to escapement by hatchery strays (ODFW 1998). Relatively few stray hatchery fish are recovered in the basin (based on CWT recoveries), and there have been limited introductions of hatchery fish into the Coweeman River. Genetic analysis indicates that Coweeman River fall-run chinook salmon are distinct from other populations sampled, including fall-run chinook salmon from the mainstem Cowlitz River.

A variety of human activities in the mainstem and estuary have decreased both the quantity and quality of habitat used by juvenile salmonids. These include floodplain development; loss of side channel habitat, wetlands and marshes; and alteration of flows due to upstream hydro operations and irrigation withdrawals. Effects are similar for Coweeman populations to those of most other subbasin salmonid populations.

Effects are likely to be greater for chum and fall chinook than spring chinook, steelhead, and coho. Decades of human activity have significantly altered watershed processes and reduced both the quality and quantity of habitat needed to sustain viable populations of salmon and steelhead. Moreover, with the exception of fall chinook, stream habitat conditions within the Coweeman River basin have the greatest impact on the health and viability of salmon and steelhead relative to the other limiting factors and threats discussed in this chapter. The most effective recovery measures will involve riparian and floodplain restoration. The middle mainstem reaches and Goble Creek are used most by winter steelhead, fall chinook, and coho. They are impacted mostly by forest practices and to a limited degree by agriculture and rural residential uses. These reaches have preservation as well as restoration value. The most effective recovery measures will include riparian restoration and recovery of basin-wide watershed processes.

The upper Coweeman reaches (including Mulholland and Baird creeks) contain potentially productive habitat for coho, winter steelhead, and fall chinook. These reaches have preservation as well as restoration value. They are heavily impacted by forest practices occurring throughout the upper Coweeman basin. Restoration of basin-wide runoff and sediment supply conditions will yield the greatest benefits to fish habitat.

12.2.4 Lower Cowlitz

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II*, prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

The lower Cowlitz basin is nearly entirely privately owned (94%), much of it by large industrial timberland owners. Forestry is the dominant land use. Commercial forest land makes up over 80% of the basin. The river valleys are mostly in agricultural or residential uses. The middle mainstem reaches below Mayfield Dam represent important spawning and rearing areas for several species. Below the Barrier Dam, the river flows south through a broad valley. Degraded riparian and floodplain function in these reaches is primarily a result of intensive agricultural development. The Toutle River, which enters the Cowlitz at RM 20, is a major lower tributary that drains the north and west sides of Mount St. Helens. The Toutle River was impacted severely by the 1980 eruption of Mount St. Helens and the resulting massive debris torrents and mudflows, which also impacted the Cowlitz mainstem downstream of the Toutle confluence. Following the eruption, the lower mainstem Cowlitz was dredged and dredge spoils were placed in the floodplain. Conditions in the lower mainstem limit the productivity of all species. These reaches have experienced intensive diking, agricultural development, urbanization, Mt. St. Helens sediments, and placement of dredge spoils. Restoring these conditions would provide great benefits, especially to fall chinook and chum, but feasibility issues may limit the potential for improvement. Flow regulation has decreased the risk of high temperatures, sedimentation, and flow extremes, but stranding of steelhead redds, lack of spawning gravel replenishment, lack of habitat forming flows, and lack of large woody debris transported from upstream are potential problems.

Tributary systems to the middle mainstem provide important habitat for winter steelhead, coho, and resident species, but many of these suffer from degraded habitat conditions.

The lower mainstem Cowlitz and lower tributaries (e.g., Ostrander Creek, Lower Salmon Creek, Delameter Creek) historically provided productive habitat for chum, coho, and fall chinook. These habitat, especially the mainstem, have been heavily impacted by mixed-use development. In addition to the influence of hydro-regulation from upstream dams, the primary impacts include channel manipulations, increased watershed imperviousness, and riparian degradation. Effective recovery measures would include riparian and floodplain restoration and land-use planning to protect and restore habitat and habitat-forming processes.

12.2.4.1 Lower Cowlitz River Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

The Cowlitz River basin has been and still is a major producer of fall-run chinook salmon. Since 1963, Mossyrock Dam has limited upstream access. Fall-run chinook salmon that historically migrated into the upper watershed (see "Upper Cowlitz River Fall-run Chinook Salmon") were incorporated into the Cowlitz (Salkum) Salmon Hatchery broodstock. A substantial number of spawners from the lower Cowlitz River fall-run chinook salmon have also been incorporated into the broodstock at the Cowlitz Salmon Hatchery. There may be some population structure in tributaries below the dam, although surveys indicate that hatchery strays occur at relatively high frequencies. Analysis of natural spawners in 1980 indicated that the majority of fish were hatchery strays (WDF *et al.* 1993). Additionally, an unknown proportion of spring-run fish may have been incorporated into the hatchery fall-run broodstock. Overall, however, the hatchery program has limited direct introgression (through hatchery transfers) from out-of-basin populations and may retain much of its historical diversity.

Decades of human activity have significantly altered watershed processes and reduced both the quality and quantity of habitat needed to sustain viable populations of salmon and steelhead. Moreover, with the exception of fall chinook, stream habitat conditions within the lower Cowlitz River basin have the greatest impact on the health and viability of salmon and steelhead relative to the other limiting factors. Subwatersheds, reaches, and habitat attributes have been prioritized for protection and/or restoration based on the plan's biological objectives, fish distribution, critical life history stages, current habitat conditions, and potential fish population performance.

While reach-level habitat conditions often result from local factors, they are also affected or shaped by systemic watershed processes. Limiting factors such as temperature, high and low flows, sediment input, and large woody debris recruitment are often affected by or result from upstream conditions and degraded watershed processes. Access to key reaches may also be affected by barriers that occur downstream of a reach. The lower mainstem Cowlitz and lower tributaries (e.g. Ostrander Creek, Lower Salmon Creek, Delameter Creek) historically provided productive habitat for chum, coho, and fall chinook. These habitat, especially the mainstem, have been heavily impacted by mixed-use development. In addition to the influence of hydro-regulation from upstream dams, the primary impacts include channel manipulations, increased watershed imperviousness, and riparian degradation. Effective recovery measures will include riparian and floodplain restoration and land-use planning that protects and restores habitat and habitat-forming processes.

12.2.4.12 Upper Cowlitz River Fall-run Chinook Salmon
(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

The Cowlitz River basin has been and still is a major producer of fall-run chinook salmon. Since 1963, upstream access has been limited by Mossyrock Dam (RKm 84). Fall-run chinook salmon that historically migrated into the upper watershed were incorporated into the Cowlitz (Salkum) Salmon Hatchery broodstock. Any population substructure that previously existed above the dam was effectively eliminated. There may be some population structure in tributaries below the dam, although hatchery-origin spawners are commonly found in the lower tributaries. Analysis of natural spawners in 1980 indicated that the majority of fish were hatchery strays (WDF *et al.* 1993). Additionally, an unknown proportion of spring-run fish may have been incorporated into the fall-run hatchery population. Overall, however, the hatchery program has limited direct introgression (through hatchery transfers) from out-of-basin populations and may retain much of its historical diversity. This population no longer occurs in its historical range, and the population itself no longer exists as a distinct entity but as a mixture of upper and lower Cowlitz populations. It is still reasonable to assume that the Cowlitz Salmon Hatchery stock, or the naturally spawning fall-run chinook salmon that migrate to the barrier dam, would be the best candidates for any reintroduction programs.

12.2.5 Upper Cowlitz River, Cispus River, and Tilton River

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

The upper Cowlitz is mostly National Forest in the Cispus and upper mainstem Cowlitz basins. The mainstem Cowlitz River valley (above Cowlitz Falls Dam), much of the Tilton Basin, and tributary basins to the reservoirs are in private lands. Forestry is the greatest land use in the middle and upper elevations, whereas mixed uses, including agriculture and residential development, dominate lower elevation river valleys. The three dams on the mainstem inundated a significant portion of the historical steelhead, chinook, and coho habitat. Fish are now transported around Mayfield Dam and released into the Tilton and upper Cowlitz (above Cowlitz Falls Dam). Downstream migrating smolts are captured and transported to below Mayfield Dam.

The areas with the greatest potential to support anadromous salmonids are the mainstem Cowlitz above Cowlitz Falls, the mainstem Cispus, and the mainstem Tilton and lower reaches of Tilton tributaries (WF, NF, SF). These areas provide the most abundant spawning and rearing habitat. They are all affected primarily by degraded watershed processes related to forest harvest and road building. Local impacts to floodplains and riparian areas are associated with channelization and development.

The Cispus supports winter steelhead, coho, and spring chinook. The most productive reaches are located in the alluvial section, from Greenhorn Creek to just upstream of the NF Cispus confluence. The basin is nearly entirely within the Gifford Pinchot National Forest. There is good preservation and restoration potential. The greatest emphasis should be placed on restoration and preservation of basin-wide watershed process conditions (runoff, sediment supply).

The Tilton system, which contains no Tier 1 or 2 reaches, is not expected to play a prominent role in recovery planning, but the basin was an important component of the historical upper Cowlitz populations and contains some potentially productive habitat that is currently degraded by watershed process impairments. Limiting factors, threats, and measures have therefore been specified for Tilton basin reaches. The primary impairments are related to intensive timber harvest and road building. There are also stream corridor impairments in and around the town of Morton, Washington.

Except for a few spring-run chinook salmon that have been passed above the Cowlitz Falls Dam, the historical spawning habitat for these three spring-run DIPs is no longer accessible. Downstream passage for chinook salmon smolts is limited. Furthermore, with the construction of Mayfield Dam in 1963, returning adults from the three DIPs were incorporated into a single spring-run broodstock at the Cowlitz (Salkum) Salmon Hatchery. The hatchery run has declined significantly since the construction of Mayfield Dam. A few spring-run chinook salmon are observed spawning naturally below the hatchery (average of 169 fish from 1980 to 1996). These are probably hatchery-origin fish. Furthermore, there is considerable potential for hybridization between fall-run and spring-run fish in the riverF and possibly also in the hatchery.

12.2.5.1 Upper Cowlitz River Spring-run Chinook Salmon, Cispus River Spring-run Chinook Salmon, and Tilton River Spring-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Except for a few spring-run chinook salmon that have been passed above the Cowlitz Falls Dam, the historical spawning habitat for these three spring-run DIPs is no longer accessible. Downstream passage for chinook salmon smolts is limited. Furthermore, with the construction of Mayfield Dam in 1963, returning adults from the three DIPs were incorporated into a single spring-run broodstock at the Cowlitz (Salkum) Salmon Hatchery. The hatchery run has declined significantly since the construction of Mayfield Dam. A few spring-run chinook salmon are observed spawning naturally below the hatchery (average of 169 fish from 1980 to 1996). These are probably hatchery-origin fish. Furthermore, there is considerable potential for hybridization between fall-run and spring-run fish in the river, as well as possibly in the hatchery. Spring-run chinook salmon are effectively no longer found within the historical population boundaries for the upper Cowlitz River, Cispus River, and Tilton River DIPs. The biological resources of the DIPs are still present, albeit in a homogenized form, in the Cowlitz Salmon Hatchery broodstocks and, to a lower extent, in the Kalama and Lewis River spring-run hatchery broodstocks. It is not known to what extent genetic variability has been lost or adaptive genetic complexes disrupted, but the Cowlitz Salmon Hatchery stock must be considered the “stock of choice” for any recovery efforts in the Cowlitz River basin.

Decades of human activity have significantly altered watershed processes and reduced both the quality and quantity of habitat needed to sustain viable populations of salmon and steelhead. Although upper Cowlitz populations are most affected by access and passage issues associated with the mainstem hydropower system, stream habitat conditions also have a large impact on the health and viability of salmon and steelhead. Subwatersheds, reaches, and habitat attributes have been prioritized for protection and/or restoration based on the plan’s biological objectives, fish distribution, critical life history stages, current habitat conditions, and potential fish population performance. Watershed process measures generally focus on the entire basin rather than being limited only to high-priority areas, because conditions in high priority-areas are often influenced by cumulative watershed effects.

The upper mainstem Cowlitz reaches with the greatest current or potential production are located between Siler Creek and Hall Creek. This alluvial reach contains historically productive spawning and rearing habitat for fall chinook, spring chinook, coho, and winter steelhead. The reaches with the greatest current productivity, and therefore the greatest preservation value, are located between Randle and Packwood. In general, recovery emphasis should be placed primarily on preservation, although many areas will also benefit from restoration measures. Effective restoration actions will involve addressing riparian and floodplain degradation related to mixed-use development (agriculture, residential) along the river corridor and basin-wide watershed process restoration.

The Cispus supports winter steelhead, coho, and spring chinook. The most productive reaches are located in the alluvial section from Greenhorn Creek to just upstream of the NF Cispus confluence. The basin is nearly entirely within the Gifford Pinchot National Forest. There is good preservation and restoration potential. The greatest emphasis should be placed on restoration and preservation of basin-wide watershed process conditions (runoff, sediment supply).

The Tilton system was an important component of the historical upper Cowlitz populations and contains some potentially productive habitat that is currently degraded by watershed process impairments. The primary impairments are related to intensive timber harvest and road building. There are also stream corridor impairments in and around the town of Morton, Washington.

12.2.6 Toutle

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

Forestry is the dominant land use, and commercial forestland makes up over 90% of the basin. Much of the upper basin around Mount St. Helens is within the Mount St. Helens National Volcanic Monument and is managed by the U.S. Forest Service. A significant proportion of the forests to the north and west of Mount St. Helens were decimated in the 1980 eruption. Intensive forest harvest and road building followed the eruption and contributed to widespread sediment and flow impairment. The majority of the forest is now in early seral or ‘other forest’ (bare soil, shrubs) vegetation conditions.

Of the three primary tributaries (North Fork, South Fork, Green River), the North Fork Toutle suffered the greatest eruption-related impacts, followed by the South Fork and then the Green River, which was mostly spared the devastating mud and debris flows. The North Fork historically provided productive habitat for steelhead and chinook, but productivity continues to remain limited due to the eruption effects and forestry impacts. The sediment loads in the North Fork remain very high, with a braided channel that is under frequent adjustment. The North Fork is further impacted by the Sediment Retention Structure (SRS). The SRS was created in an effort to retain sediments following the eruption, but it has become a persistent source of sediment to downstream reaches. The SRS is also a passage barrier, and fish are currently transported around the structure.

The South Fork, which also continues to suffer from high sediment loads, is recovering more rapidly than the North Fork. The South Fork has high restoration as well as preservation value for steelhead and chinook. The Green River also has high restoration and preservation value.

The lower mainstem is used by fall chinook and historically provided chum habitat. These reaches were heavily degraded by the dredging of eruption-related sediments and the placement of these sediments in the floodplain. Channels are currently disconnected from floodplains, and channel instability remains high.

Population centers in the basin consist primarily of small rural towns. Projected population incraese from 2000 to 2020 for unincorporated areas in WRIA 26 is 22%. Potentially productive habitat for fall chinook, chum, and coho exist in the lower few miles of the lower mainstem Toutle. These reaches were heavily impacted by mud and debris flows during the 1980 Mount

St. Helens eruption. Further degradation to channel, riparian, and floodplain conditions was caused by channel dredging and floodplain spoils placement in an effort to increase flow conveyance following the eruption. Effective recovery measures would entail reducing channel confinement and restoring riparian areas.

The upper SF Toutle provides important habitat for winter steelhead and fall chinook. These reaches have experienced rapid recovery since the 1980 eruption and subsequent heavy timber harvests. They have strong preservation value in addition to restoration value. The NF Toutle historically provided productive habitat for winter steelhead, spring chinook, and coho. Fall chinook may also have used these reaches to some degree. The reaches with the most potential are located just downstream of the Green River confluence and further upstream on the NF between Hoffstadt Creek and Castle Creek (reach NF Toutle 13). Volitional passage is currently blocked just upstream of the Green River confluence by the SRS, created to retain eruption-related sediments following the 1980 eruption. NF Toutle reaches were severely impacted by mud and debris flows during the 1980 eruption, followed by intensive road building and timber harvests. The recovery emphasis is for restoration of watershed processes throughout the NF basin including addressing the dense road network and heavy harvests. Emphasis should also be placed on addressing the continued supply of sediment from the SRS, which has become a persistent limiting factor for fish in downstream reaches.

12.2.6.1 Toutle River Spring-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

There are historical accounts of spring-run chinook salmon in the Toutle River, although it is unclear how large a population existed prior to European settlement. WDF (1951) estimated that the spawning escapement for the entire Cowlitz River basin was 10,400 spring-run chinook salmon, with 8,100 spawning in the Cispus River, 200 in the Tilton River, 1,700 in the upper Cowlitz River, and 400 in the upper Toutle River. SASSI (WDF *et al.* 1992) does not recognize a spring-run stock in the Toutle River basin, although there are reports of early returning fish in the Toutle River. More than 2 million spring-run chinook salmon from the Cowlitz Hatchery were planted in the Toutle River between 1974 and 1984. Whether the existing fish in the Toutle River represent the progeny of hatchery transplants, hatchery strays, or the descendants of native fish remains to be established.

12.2.6.2 Toutle River Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Fall-run chinook salmon were historically present throughout the Toutle River basin: North Forth Toutle River, Green River, and South Fork Toutle River. Furthermore, given the large size of the Toutle River basin (1,200 km_2), several DIPs may have existed (Myers *et al.* 2002). Population(s) in the Toutle River basin were nearly extirpated as a result of the Mount St. Helens eruption. Reestablishment of chinook salmon runs in the basin was achieved through natural recolonization and introductions of fish from hatcheries in the Cowlitz, Kalama, Grays, and Washougal rivers and Big Creek. SASSI (WDF *et al.* 1992) identifies two stocks in the Toutle River basin, the Green (Toutle) and South Fork Toutle fall chinook.

12.2.7 Kalama

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

Most of the basin is forested, and nearly the entire basin is managed for commercial timber production (96%). Only 1.3% is non-commercial forest, and 1.5% is cropland. Areas along the lower river have experienced industrial and residential development, resulting in channelization of the lower river. A portion of the upper basin is located within the Mount St. Helens National Volcanic Monument. National Monument land is managed primarily for natural resource protection and tourism.

The Kalama mainstem provides most of the available spawning and rearing habitat in the subbasin, except for a few tributaries that support steelhead and spring chinook. The mainstem has been severely impacted by logging and road building throughout the subbasin and to some extent by agricultural, rural residential development, and commercial development along the lower river.

The important reaches for steelhead and spring chinook are in the middle and upper mainstem and in the lower reaches of a few tributaries (NF Kalama, Gobar Creek, Wildhorse Creek, Little Kalama River). These habitat currently support healthy runs of steelhead. Further degradation of these reaches would jeopardize populations. Of particular importance are the mainstem canyon reaches, which are critical for parr rearing. The lower mainstem reaches are the most important for chum, fall chinook, and coho. These reaches suffer from impaired channel stability and habitat diversity, which are related to riparian and floodplain impacts from rural residential development, commercial development, agriculture, and transportation corridors. Sedimentation of these reaches is related to basin-wide forestry practices. Further degradation of these reaches would severely impact chum and fall chinook. Restoration would yield substantial benefits. Population density and development in the watershed are low. The year-2000 population was approximately 5,300 people (LCFRB 2001). The town of Kalama, located near the mouth, is the only urban area in the basin. The middle mainstem Kalama and major tributaries (i.e., Gobar Creek) contain productive habitat for steelhead and spring chinook. Coho, fall chinook, and chum do not typically ascend lower Kalama Falls to access these habitat. Forestry is the dominant land use surrounding these reaches. Stream-adjacent roadways impact riparian function. The most effective recovery measures will include preservation and restoration of riparian and upland forest and road conditions. The upper Kalama mainstem and tributaries (i.e., NF Kalama) are used primarily by summer steelhead. These reaches are heavily impacted by forest practices. The most effective recovery measures will include preservation and restoration of riparian and upland forest and road conditions.

12.2.7.1 Kalama River Spring-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids*, prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Presently, only a small spring-run population exists in the Kalama River, though anecdotal information suggests that the run may have been considerably larger (WDF 1951). Prior to 1950, there were limited reports of early returning fish in the Kalama River. Spring chinook were released from the Kalama Fall Hatchery beginning in 1959.

12.2.7.2 Kalama River Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

The Kalama River historically had and currently maintains a very large population of fall-run chinook salmon. Although an active hatchery program has been in the basin since 1895, there has been relatively little importation of fall-run chinook salmon into the basin. WDF *et al.* (1992) indicated that the Kalama River fall-run chinook exhibited distinctive biological and genetic characteristics.

12.2.8 Lower North Fork Lewis

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

The bulk of the land is forested, and a large percentage is managed as commercial forest. Agriculture and residential activities are found in valley bottom areas. Recreation uses and residential development have increased in recent years. Stand replacement fires, which burned large portions of the basin between 1902 and 1952, have had lasting effects on basin hydrology, sediment transport, soil conditions, and riparian function.

The Lower North Fork Lewis basin has experienced intensive watershed development along the mainstem Lewis, Cedar Creek, and the lower reaches of many tributaries. Timber harvests and road building have been widespread in the middle and upper elevation areas, which mostly lie within private commercial timberland.

The most important aquatic habitat areas in the basin are upper Cedar Creek, lower Cedar Creek, and the mainstem Lewis between tidal influence and Cedar Creek. Upper Cedar Creek is very important for steelhead spawning and rearing, but production is severely limited by lack of habitat diversity and flow, as well as sediment issues that are related to the high degree of timber harvest and road building that occurred in the upper basin during the 1980s and 1990s. Lower Cedar Creek is also important for steelhead, especially for parr rearing. These reaches are impacted by impaired sediment and flow processes stemming from upper basin logging and road building, but they also suffer from localized riparian impacts from agriculture and grazing. The mainstem Lewis between tidal influence and the Cedar Creek confluence has lost a significant amount of habitat due to artificial confinement. An estimated 50% of the historical floodplain has been disconnected from the river. Habitat diversity is severely limited in this straightened and simplified channel. Riparian function is impaired due to development within riparian areas. Historical fall chinook, chum, and coho production has been reduced as a result of habitat degradation in these reaches. Further degradation would pose great risks to the existing low levels of natural production. The most critical reaches in the middle mainstem Lewis lie between Ross Creek and Merwin Dam. These reaches are most important for chum, fall chinook, and coho, though they are also used by winter steelhead.

The middle mainstem basin is largely in private land ownership with some areas of state forestland. Hydropower operations, agriculture, and rural development have the greatest impacts. The recovery emphasis is for preservation as well as restoration. Effective recovery measures in the middle mainstem would involve managing regulated flows from the hydropower system, addressing agricultural and rural/suburban development impacts to floodplains and riparian areas, and ensuring that land-use planning effectively protects habitat and watershed processes. Cedar Creek reaches are most important for winter steelhead, though other species make limited use of them, as well. Lower Cedar Creek from the mouth to Pup Creek (Cedar Creek 1a) and the reach downstream of the Chelatchie Creek confluence (Cedar Creek 3) are the most critical. Forest practices on private commercial timberlands in the upper watershed have impacted sediment supply and hydrologic processes in Cedar Creek reaches. Agriculture and rural residential uses have impacted riparian areas and floodplains. Recovery measures would address agricultural impacts along stream corridors and forest practices in the upper basin.

12.2.9 Upper North Fork Lewis

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

The majority of this basin lies within the Gifford Pinchot National Forest. Approximately 70% of the basin is national forest or national monument land, 11% is state land, and the remainder is private, most of it in private industrial forestland ownership. Recreation uses and residential development have increased in recent years. The majority of the basin is heavily forested, except for an area of approximately 30 square miles in the north part of the upper basin that was denuded by the 1980 eruption of Mount St. Helens. Stand replacement fires, which burned large portions of the basin between 1902 and 1952, have had lasting effects on basin hydrology, sediment transport, soil conditions, and riparian function. The three mainstem reservoirs inundate nearly 40 miles of historically productive habitat and block all anadromous access to the upper basin. Currently, tributaries to the reservoirs and the upper mainstem and its tributaries provide habitat for bull trout and potential habitat for anadromous fish, although these streams have been impacted by years of timber harvest activities. Restoration of the reservoir reaches to historical conditions provides the greatest benefit to anadromous fish, but the feasibility of such an effort is low. With the anticipated reintroduction of anadromous fish, attention should be focused on the most potentially productive habitat to which the fish will have access. The most important area is the Lewis mainstem upstream of Swift Reservoir. These reaches provide abundant potential spawning and rearing habitat. They are impacted most by past upper-basin timber harvest and road building. The next most important areas are the Muddy River system (including Clearwater Creek) and the Clear Creek system (tributary to lower Muddy Creek). Protecting existing production potential and restoring habitat in these areas would provide important benefits to anadromous populations. These streams have been impacted by timber harvests and road building, as well as the mud and debris flows during the 1980 Mount St. Helens eruption. Most of the potentially productive habitat in the upper Lewis is in the upper mainstem above Swift Reservoir. The contributing basin is almost entirely within the Gifford Pinchot National Forest. The major impacts stem from the effects of forest practices on watershed processes. These reaches have high restoration and preservation value. The most effective recovery measures would be preservation of existing functional conditions and targeted restoration of road impacts and riparian areas. The Muddy Creek system includes the large tributaries Clear Creek and Clearwater Creek. This system, particularly the mainstem Muddy and Smith Creek, were heavily impacted by the 1980 Mount St. Helens eruption. Intensive post-eruption timber harvests and road building further impacted these streams. Historically, these reaches were most important for coho but also provided productive winter steelhead and spring chinook habitat. The recovery emphasis in the Pine Creek system is preservation, so no limiting factors and threats are specified. Pine Creek is believed to have historically provided habitat primarily for winter steelhead. This system was impacted by the 1980 Mount St. Helens eruption but has recovered rapidly. Although there has been considerable timber harvest and roading in this system, including some riparian timber harvests, stream conditions are currently good for winter steelhead.

12.2.10 East Fork Lewis

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

The bulk of the land is forested, and a large percentage is managed as commercial forest. Agricultural and residential activities are found in valley bottom areas. Recreation uses and residential development have increased in recent years. Most of the land is private (63%), though about 20% of the basin area lies within the Gifford Pinchot National Forest. Stand replacement fires, which burned large portions of the basin between 1902 and 1952, have had lasting effects on basin hydrology, sediment transport, soil conditions, and riparian function. The East Fork Lewis has a high degree of watershed process impairment (sediment, flow) in the lower half of the basin. This portion suffers from a variety of land uses, including agriculture, grazing, mining, rural residential development, and some timber harvest. The upper portion of the basin, much of which lies within the Gifford Pinchot National Forest, is more intact. Past fires and forest harvest have degraded watershed processes and riparian areas in many subwatersheds, though healthy conditions exist in headwater areas. The most important areas in the basin from an aquatic habitat perspective are the mainstem reaches and the lower mainstem tributaries. The upper mainstem is critical for summer steelhead production. These spawning and rearing reaches currently support substantial numbers of naturally produced steelhead, though much higher production could be achieved with recovery of impaired conditions. Upper-basin timber harvest and road building have the greatest impact here. The middle mainstem provides the best potential for winter steelhead. This stock would also benefit from restoration measures focused on recovering watershed process impairments related to forest harvest. The lower mainstem and lower mainstem tributaries represent important spawning and rearing sites for fall chinook, chum, and coho. These areas currently suffer from loss of key habitat, low habitat diversity, and channel instability. These conditions are partly due to recent avulsions of the mainstem into stream-adjacent gravel pits. This area also suffers from artificial confinement projects and degraded riparian zones.

The lower mainstem EF Lewis contains important spawning and rearing habitat for fall chinook, chum, and coho. This mixed-use area is heavily impacted by agriculture, rural residential development, and gravel mining. The recovery emphasis is for restoration and preservation measures. Effective restoration measures would involve riparian restoration, reductions in streambank erosion, reconnection of floodplains, and restoration of mining-related impairments and future avulsion risks. Land-use planning and growth management are critical to make sure that expanding development and land-use conversions do not continue to impair habitat conditions or habitat-forming processes.

The middle mainstem EF Lewis and Rock Creek are most important for winter steelhead, although summer steelhead also use these reaches to some degree. There are agricultural and rural residential uses along these reaches, but forestry impacts dominate. Emphasis should be placed on preserving functional sediment supply conditions in the Rock Creek basin. Summer steelhead use the greatest proportion of upper EF Lewis reaches. Winter steelhead may use some of these reaches, but they rarely make significant use of reaches above Sunset Falls. Nearly the entire upper basin is within the Gifford Pinchot National Forest, and forestry impacts dominate. Past wildfires have had a lasting impact on channels. The recovery emphasis is for restoration and preservation. Effective restoration measures would include riparian restoration and restoration of watershed processes related to forest practices (i.e., forest road and timber harvest impacts).

12.2.10.1 Lewis River Spring-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Historically, spring-run chinook salmon were found in the North Fork of the Lewis River. WDFG (1913) reported that the majority of the spring-run chinook salmon spawning occurred in tributaries to the Muddy Fork -- “The Muddy”-- of the Lewis River. Access to historical habitat was eliminated following the construction of Merwin Dam (RKm 31) in 1931. Few spring-run chinook salmon use the East Fork Lewis River. Despite attempts to maintain the run through hatchery supplementation, the native spring run dwindled and eventually was largely replaced by hatchery fish transferred from outside of the Lewis River basin. Introductions of spring-run chinook salmon from the Cowlitz, Kalama, Willamette, and Klickitat Rivers have been used to sustain the hatchery broodstock. Genetically, the Lewis River spring run most closely resembles populations from the Cowlitz and Kalama rivers (NMFS 1998a). There is also a close association between the Lewis River and the Sandy River spring runs. Over the past five years, total (hatchery and natural) escapements of spring-run chinook salmon to the Lewis River have averaged 2,444 fish (PFMC 1999).

12.2.11 Salmon Creek

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

Land use in the Salmon Creek/Lake River basin is predominately urban and rural development, with nearly the entire Burnt Bridge Creek watershed lying within the Vancouver metropolitan area. Historical wetlands and floodplains have been converted to residential, commercial, industrial, and agricultural uses. The upper reaches of the Salmon Creek basin have been impacted by forestry, agriculture, and rural residential development. Continued population growth is of primary concern in this basin. Major urban centers in the basin are Vancouver, Orchards, Salmon Creek, Battle Ground, and Ridgefield. The year-2000 population, estimated at 252,000 people, is expected to increase to 519,000 by year 2020 (LCFRB 2001). Population growth will result in the continued conversion of forestry and agricultural land uses to residential uses, with potential impacts on habitat conditions. It is important that growth management policy adequately protect critical habitat and the conditions that create and support it.

The lower mainstem Salmon Creek reaches with the greatest potential production are located in the vicinity of Salmon Creek County Park, near the I-5 crossing. These reaches historically provided productive habitat for fall chinook, chum, coho, and winter steelhead. This area is heavily impacted by urban and rural development in the expanding Vancouver metropolitan area. Effective recovery measures would involve land-use planning that adequately protects habitat-forming processes in sensitive areas (wetlands, floodplains, riparian corridors). Restoration of riparian areas along these and upstream reaches will also yield important benefits. A few potentially productive reaches for coho and winter steelhead are located on the mainstem between the Hwy 503 crossing and Salmon Falls. Rock Creek and other, smaller tributaries (e.g., Morgan Creek) also contain potentially productive habitat for coho. These reaches are heavily impacted by agricultural uses and rural residential development. As with the lower basin, the upper basin is expected to continue to develop rapidly. In light of the continued growth, there should be emphasis on land-use planning that provides adequate protections to sensitive areas. In addition, riparian and floodplain restoration that targets impacts related to grazing and rural development will yield important benefits to salmonid habitat.

12.2.11.1 Salmon Creek Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

The Lewis River contains two types of fall-run chinook salmon: an early-returning, or tule, fall run and a late-returning, or bright, fall run. The tule fall run returns primarily to the East Fork Lewis River in August and September and spawns from late September to November (Marshall et al. 1995). This DIP also includes tule chinook salmon that spawn in Salmon Creek and other minor tributaries upriver to, but not including, the Washougal River. Historical documentation of tule chinook salmon using these rivers is very limited, and it is possible that the run in the East Fork Lewis River was founded by hatchery introductions, although no hatchery program for these fish currently exists. Hatchery strays are uncommon in the East Fork Lewis River. Given the degraded condition of spawning habitat in Salmon Creek, spawning success is probably fairly low, and the majority of the returning adults are most likely of hatchery origin.

12.2.11.2 Lewis River Late Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

The Lewis River contains two types of fall-run chinook salmon: a tule fall run and a bright fall run. The bright fall run returns to the north and east forks of the Lewis River from August to October, and spawning extends from October to January, with reports of chinook salmon spawning as late as April (Marshall *et al.* 1995). A bright population, which is also genetically similar to the Lewis River brights, also exists in the Sandy River (Oregon). There has been limited hatchery propagation of fall-run chinook salmon in the Lewis River basin.

12.2.11.3 Clackamas River Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids*, prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Fall-run chinook salmon were native to the lower Willamette River and its principal tributary, the Clackamas River. A tule fall-run existed in the lower Clackamas River until the 1930s, when poor water quality conditions below Willamette Falls presented a barrier to returning fall-run chinook salmon (Parkhurst *et al*. 1950; Gleeson 1972). Dimick and Merryfield (1945) reported that these fish entered the Willamette River in September and October and spawned soon after entering the Clackamas River. Fall-run chinook salmon from lower Columbia River hatchery stocks were introduced into the Clackamas River from 1952 to 1981 to reestablish the run. Hatchery releases of fall chinook salmon into the Clackamas River last occurred in the 1980s, allowing the existing population at least five generations to adapt to local conditions. Presently, the run appears to be maintained through natural reproduction, according to ODFW(1998) , which estimated that few if any hatchery fish were spawning in the Clackamas River.

12.2.12 Washougal

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

Nearly all of the lands in upper portions of the Washougal subbasin (upper mainstem and upper reaches of the West Fork, Little Washougal, and Dougan Creek) are forested. Stream habitat in these areas is particularly important for summer steelhead spawning. However, watershed processes in the upper areas of the subbasin also affect salmon and steelhead habitat in the lower areas of the basin through influence on flows, water temperature, and sediment transport. Principal landowners in the upper subbasin are the U.S. Forest Service, the Washington Department of Natural Resources, and industrial forest companies. Landscape conditions in some of these areas are largely intact. Federal and state forest management plans and state forest practice regulations are expected to protect and restore watershed processes and habitat conditions in this area in the intermediate and long term (10 to 100 years). Additional active restoration efforts will help to achieve improved habitat conditions in the near term. The middle portion of the subbasin (middle mainstem and the lower reaches of the West Fork and Little Washougal) is a mixed-use area made up largely of rural residential development, small-scale or noncommercial agriculture, and non-industrial forestlands. These areas are important for summer and winter steelhead spawning and rearing, chum spawning, and chinook spawning and rearing. Watershed functions and habitat conditions have been altered by clearing of riparian zones, filling of wetland areas, isolation of side channel habitat, bank hardening, increased sediment inputs, and stormwater runoff. Degraded watershed processes in the middle subbasin impact habitat conditions in the lower subbasin. The lower area of the subbasin is characterized by industrial, urban, and suburban land uses. Watershed functions and habitat conditions have been significantly compromised by these high-intensity uses. Although some riparian areas in the lower reaches near the mouth have been protected through public ownership, destruction of riparian habitat, bank hardening, increased stormwater runoff, and channelization are major limiting factors. Lacamas Creek, the lowest tributary, has been dammed to provide water for industrial use. The reservoir and the creek's heavily altered upper watershed have resulted in increased temperatures and decreased water quality. The lower subbasin is particularly important for chum spawning. It is also important for steelhead and chinook rearing.

Active efforts to restore riparian habitat, side channels, and instream conditions will be required to compensate for development in the lower and middle portion of the subbasin that will likely preclude the full restoration of watershed processes.

Upper mainstem reaches are important summer and winter rearing areas for summer steelhead. The habitat conditions and watershed processes associated with these reaches are influenced primarily by actions on public and private timberland. While these lands have relatively intact landscape conditions, sediment supply processes are thought to be moderately impaired due to the prevalence of forest roads on unstable slopes. The potential for effective passive restoration is high through upgrading or obliterating roads and improving drainage systems. Policies to enable such actions are under development for private, state, and federal forest lands. Restoration of riparian function is also important. Preservation of existing functional conditions is the primary emphasis on these lands. Forest management policy currently being implemented by the USFS and WA DNR, as well as forest practice regulations for private lands, are expected to provide continuing protections of watershed processes. The West Fork Washougal is important for summer steelhead spawning and rearing. Winter steelhead also make limited use of these reaches. Most of the basin is in private or state forestland with a small amount of crop and pasture land in the lower portion of the basin. Portions of the headwaters (i.e., Hagen Creek basin) have intact forest conditions, while most other areas have been extensively harvested and heavily roaded. Effective habitat measures in the West Fork will involve watershed process restoration and preservation associated with forest practices, much of which is addressed in current forest practices policy and regulations. An additional habitat concern in the West Fork basin is a dam on Wildboy Creek, which blocks several miles of potentially productive habitat. The Little Washougal basin provides important habitat for winter steelhead adult holding, spawning, and rearing. Most other species (especially coho) also use these reaches. The basin is mixed-use and is mostly private and state forest land, with agricultural uses and rural residential development within the lower river valley. The City of Camas water withdrawals from Jones and

Boulder creeks create an increased risk of critically low summer flows. Effective habitat measures in the Little Washougal would involve riparian restoration, reestablishing connections between the stream channel and floodplains, growth management, water withdrawal management, and watershed process restoration and preservation on forest lands.

12.2.12.1 Washougal River Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

The Washougal River is 59 km long and drains a basin of 413 km^2. Salmon Falls (RKm 23) and Dougan Falls (RKm 34) may have been migration barriers to fall-run chinook salmon during low-water periods. Currently, the majority of the chinook salmon spawn in a 6-km reach below Salmon Falls. The average recent natural escapement to the Washougal (1992–1996) has been 3,638 fish (NMFS 1998a). Estimates of stray rates for fish released from the Washougal Hatchery are relatively high, with 27% of the recoveries in basins other than the Washougal. Among the adults surveyed spawning in the Washougal River, over 80% were from the Washougal Hatchery, suggesting that natural reproduction is relatively unsuccessful in the Washougal River basin.

Despite the potential influence of hatchery transfers, fall-run chinook salmon sampled from the Washougal River were genetically different from fish from other basins. WDFW biologists believe that conditions in the Washougal are unique enough to limit the success of these out-of-basin transfers. Furthermore, there is a general correlation between the geographic proximity of other basins and the genetic similarity among fish spawning in those basins.

12.2.12.2 Sandy River Spring-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

The Sandy River historically had a very large run of spring-run chinook salmon. Run size for the Sandy River basin may have been in excess of 12,000 fish (Mattson 1955). Access to the upper Sandy River basin was severely impacted by the construction of Marmot Dam (at RKm 43) in 1913. Water from the Sandy River was diverted at Marmot Dam into the Little Sandy and Bull Run Rivers, and there was little, if any, flow into the Sandy River below Marmot from July to September (Craig and Suomela 1940). Furthermore, the diversion was unscreened until 1951, so a large percentage of the progeny of naturally spawning fish above the dam was diverted and killed by the turbines of the Bull Run powerhouse prior to that time (ODFW 1990). Propagation activities were terminated in 1925, due to the low size of the run. The State of Oregon undertook artificial propagation activities with the collection of spring-run broodstock at the base of Marmot Dam from 1938 to 1955. Until the 1950s, introductions of Upper Willamette River spring-run chinook salmon were limited and intermittent. A hatchery was established on Cedar Creek, a tributary to the Sandy River, below Marmot Dam. Although releases of spring-run chinook salmon were made from the Cedar River site, there is some evidence that many returning spring-run fish were actually fall-run chinook salmon (Wallis 1966). Introductions of

Upper Willamette River spring-run chinook salmon increased considerably during the 1960s and 1970s. Recently, releases of hatchery fish in the upper Sandy River (above Marmot Dam) were terminated. Hatchery fish now being released are externally marked and will be intercepted at Marmot Dam when they return (ODFW 1998). ODFW plans to convert its Sandy River broodstock from Upper Willamette River–derived spring-run chinook salmon to naturally produced spring-run adults returning to the Sandy. ODFW estimated that the average escapement of naturally produced spring-run salmon over Marmot Dam was 2,600 fish (ODFW 1998).

Genetic analysis of naturally spawning fish from the Sandy River suggested that the Sandy River population was genetically intermediate between Upper Willamette River populations and Lower Columbia River spring-run populations. Furthermore, there was little genetic resemblance between the spring-run and late bright fall-run fish in the Sandy River basin. In other Lower Columbia River and coastal basins, there is a tendency for different run times in a basin to have evolved from a common source. The Sandy River basin would be a deviation from this pattern. Microsatellite DNA data indicated that the Sandy River spring run was genetically distinguishable from the Clackamas Hatchery spring-run broodstock, but the degree of differentiation was much less than between spring runs in the Sandy and Yakima rivers. Bentzen *et al.* (1998) concluded that although some interbreeding between the Upper Willamette River and Sandy River stocks had occurred, the Sandy River population still retained some of its original genetic characteristics.

12.2.12.3 Sandy River Early (Tule) Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Fall-run chinook salmon are native to the Sandy River. As in the Lewis River, there are two types of fall-run chinook salmon, early-returning (tule) fall run and late-returning (bright) fall run. It has been suggested that only the bright fish are native to the basin, and that the tule fall-run fish are descendants of hatchery releases from lower Columbia River hatcheries. Stocking of hatchery tules was discontinued in 1977, and many adults returning to the Sandy are thought to be hatchery strays (Kostow 1995).

12.2.12.4 Sandy River Late Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids*, prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Fall-run chinook salmon are native to the Sandy River. As in the Lewis River, there are two types of fall-run chinook salmon, early-returning (tule) fall run and late-returning (bright) fall run. The bright fall-run returns in September and October spawn throughout December and January (Howell *et al*. 1985). There are reports of a winter run in the Sandy River, although Kostow (1995) suggested that they have been extirpated. It is also possible that the winter-run chinook salmon observed are the tail-end of the bright fall-run fish. Bright fish in the Lewis River have been observed spawning as late as April. The run of bright fall-run fish may have historically been over 5,000 fish. In 1997, the escapement estimate was 1,125 adults (Whisler *et* *al.* 1998). There has been no artificial supplementation of the bright fall run. Genetic analysis indicates a strong association between Lewis and Sandy River bright fall-run chinook salmon, and these two populations cluster with other lower Columbia River populations.

12.2.12.5 Columbia River Gorge Tributaries Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

This region extends from east of the Washougal River (RKm 194.9) to the White Salmon River (RKm 270) and from east of the Sandy River (RKm 193.6) to the Hood River (RKm 272). Rivers in this region of the ESU are heavily influenced by the steeply sloped sides of the Columbia Gorge. Most streams are relatively short. Impassable falls limit accessible habitat to less than a half mile on most small creeks. Larger rivers contain falls or a series of cascades in their lower reaches, which may present migrational barriers during all or most of the year. Physiographically, this region marks a transition between the high-rainfall areas of the Cascades and the drier areas to the east. Stream flows can be intermittent, especially during the summer.

12.2.12.6 Lower Gorge Tributary Chinook Salmon Upper Gorge Tributary Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

There are a number of small creeks along the Columbia River upstream of the Sandy and Washougal rivers. Some spawning habitat in the lowermost portion (approximately 1–3 km) of these creeks and in the mainstem Columbia River was lost with the construction of Bonneville Dam and the filling of Bonneville Pool. Currently, these creeks contain little suitable spawning habitat for chinook salmon, and it is thought that the fall-run chinook salmon observed in these tributaries are hatchery fish released from Bonneville Pool Hatchery programs. Currently, aggregations of early and late fall-run chinook salmon and chum salmon spawn below Bonneville Dam in the vicinity of Ives Island (Van Der Naald *et al.* 2001). Although the original source of these spawning fish is unclear, the ability of salmon to use mainstem habitat is well established. The late fall-run chinook appear to be most closely related to the upriver fall-run chinook populations (Upper Columbia River Summer and Fall-run Chinook Salmon ESU), and are probably the progeny of hatchery strays (Marshall 1998; NMFS 1998a).

12.2.12.7 Wind River Spring-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids*, prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Spring-run chinook salmon were not historically found in the Wind River basin. Shipherd Falls (RKm 5) prevented chinook salmon from accessing the upper watershed (Parkhurst *et al.* 1950). Only steelhead were apparently able to ascend the falls. The falls were laddered in 1956, and both spring- and fall-run chinook salmon have been introduced into the upper watershed. The existing spring run is a composite of Upper Columbia and Snake River spring-run salmon that were intercepted at Bonneville Dam and propagated at the Carson National Fish Hatchery (NFH) in the upper Wind River (RKm 24). This spring-run stock is not considered part of the Lower Columbia River or any other ESU.

12.2.12.8 Big White Salmon River Spring-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

The Big White Salmon River (RKm 270) historically supported runs of both spring and fall chinook salmon prior to the construction of Condit Dam (RKm 4) in 1913 (Fulton 1968). Historically, anadromous fish may have been able to ascend the Big White Salmon River as far as Trout Lake (RKm 45.4) (WDF 1951). Spring-run chinook salmon in the Big White Salmon River were extirpated soon after the construction of Condit Dam, due to loss of accessibility to suitable habitat. A number of nonnative spring-run chinook salmon (Carson NFH) have been released from the Spring Creek and Little White Salmon NFHs.

12.2.12.9 Big White Salmon River Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

The Big White Salmon River (RKm 270) historically supported runs of both spring and fall chinook salmon prior to the construction of Condit Dam (RKm 4) in 1913 (Fulton 1968). Records indicate that fall-run chinook salmon in the Little White Salmon and Big White Salmon Rivers began spawning in early September, with peak egg takes in the later part of the month (21 September), with a total of 12,840,700 eggs collected in 1901 (Bowers 1902). Historically, anadromous fish may have been able to ascend the Big White Salmon River as far as Trout Lake (RKm 45.4) (WDF 1951). Fall-run fish from the Big White Salmon River were used to establish the nearby Spring Creek NFH broodstock in 1901 (Hymer *et al.* 1992). Although there have been a number of different hatchery stocks transferred to the Spring Creek hatchery, this stock is still most closely affiliated with other Lower Columbia River fall-run populations (NMFS 1999a).

The Spring Creek NFH stock of fall-run chinook salmon may still retain some historical genetic and life history characteristics. The life history characteristics of fall-run chinook salmon from the Spring Creek NFH do differ somewhat from other Lower Columbia River chinook salmon stocks. Furthermore, Spring Creek fall-run chinook salmon are genetically distinct from the cluster of Lower Columbia River populations. Existing late fall-run (bright) chinook salmon that spawn in this region appear to be the descendants of hatchery transfers from Upper Columbia River populations (Marshall *et al.* 1995).

12.2.12.10 Hood River Spring-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

There were once spring-run chinook salmon in the Hood River basin, but these runs have declined dramatically from historical levels and, despite supplementation efforts, remain at critically low levels. Spring-run chinook salmon in the Hood River are believed to have been extirpated (Kostow 1995; Kostow *et al.* 2000). Fish from a number of different hatcheries were released into the Hood River basin to reestablish a spring run. From 1985 to 1992, more than one million fish were released into the basin from the Carson NFH and the ODFW Lookingglass Hatchery (ODFW Stock #81, a Carson NFH derivative). Currently, fish from the Round Butte Hatchery (Deschutes River, Middle Columbia River Spring-run ESU) are being released into the Hood River basin as part of a reintroduction program. Fish from the Round Butte introductions and their descendants are not considered part of the Lower Columbia River ESU.

12.2.12.11 Hood River Fall-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Fall- and spring-run chinook salmon were native to the Hood River basin. Currently, a very small spawning aggregation of fall-run chinook salmon remains in the Hood River basin. Spawning occurs in the mainstem and the West Fork Hood River to Punchbowl Falls (RKm 6). There is very limited information on the biological or genetic characteristics of this population. Hatchery releases directly into the basin have been very limited, but the Hood River is located near a number of return facilities for large hatchery programs.

12.2.12.12 Clackamas River Spring-run Chinook Salmon

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids*, prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

The Clackamas River historically contained a spring run of chinook salmon, but relatively little information about that native run exists. ODF (1903) reports that, “The Clackamas River is, as has always been conceded, the greatest salmon breeding stream of water that our state affords...” Barin (1886) observed a run of chinook salmon that “commences in March or April, sometimes even in February.” Construction of the Cazadero Dam in 1904 (RKm 43) and River Mill Dam in 1911 (RKm 37) limited the spring run’s migratory access to the majority of historical spawning habitat. In 1917, the fish ladder at Cazadero Dam was destroyed by floodwaters, eliminating fish passage to the upper basin (Murtagh *et al.* 1992). Hatchery production of spring-run chinook salmon in the basin continued, using broodstock captured at the Cazadero and River Mill Dams (Willis *et al.* 1995). Transfers of Upper Willamette River hatchery stocks (primarily the McKenzie River Hatchery) began in 1913, and between 1913 and 1959 over 21.3 million eggs were transferred to the Clackamas River basin (Wallis 1961, 1962, 1963). Furthermore, a large proportion of the transfers occurred during the late 1920s and early 1930s to supplement the failure of the runs in the Clackamas River basin at that time (Leach 1932). In 1942, spring-run chinook salmon propagation programs in the Clackamas River basin were discontinued. By 1939, when passage for spring-run chinook salmon was restored over the Clackamas River dams, the spring-run population had declined considerably from its numbers at the turn of the century.

In a spawner survey conducted in August 1940, 300 adults were observed below Cazadero Dam and more than 500 below River Mill Dam (Parkhurst *et al.* 1950). However, unspecified conditions did not permit these fish to migrate above the dams. A further 500 to 700 spring-run chinook salmon were observed spawning in Eagle Creek (where the U.S. Bureau of Fisheries Station was sited) in September and October 1941 (Parkhurst *et al.* 1950).

The recolonization of the upper Clackamas River progressed very slowly. The average annual dam count (River Mill or North Fork Dam) from 1952 to 1959 was 461 (Murtagh *et al.* 1992). More importantly, 30% of the adult passage counts occurred in September and October. Artificial propagation activities were restarted at the Eagle Creek NFH in 1956, using eggs from a number of Upper Willamette River hatchery stocks. The program released approximately 600,000 smolts annually through 1985. In 1976, the ODFW Clackamas Hatchery (located below River Mill Dam) began releasing spring-run chinook salmon (Willamette River hatchery broodstocks were used, since it was believed that the returns from the local population were too small to meet the hatchery's needs [Murtagh *et al.* 1992]). Increases in adult returns over the North Fork Dam and increases in redd counts above the North Fork Reservoir corresponded to the initial return of adults to the hatchery in 1980 (Murtagh et al. 1992, Willis *et al.* 1995). Adult counts over North Fork Dam rose from 592 in 1979 to 2,122 in 1980 (Murtagh *et al.* 1992).

Spawner surveys conducted in 1998 estimated that 380 redds were present above the North Fork Dam (this corresponded to the cumulative total of 1,382 adults passing the dam one week prior to the redd count) (Lindsay et al. 1999). Recent changes in management policy by ODFW (ODFW 1998) should reduce the number of hatchery-derived adults spawning above the North Fork Dam. These changes include releasing hatchery fish farther downstream and mass marking all hatchery releases to allow the removal of hatchery fish ascending the North Fork Dam.

Genetic analysis by NMFS of naturally produced fish from the upper Clackamas River indicated that this stock was similar to hatchery stocks from the Upper Willamette River basin (Myers et al. 1998, see Appendix B). This finding agrees with an earlier comparison of naturally produced fish from the Collawash River (a tributary to the upper Clackamas River) and Upper Willamette River hatchery stocks (Schreck et al. 1986). Fish introduced from the Upper Willamette River have significantly introgressed into, if not overwhelmed, spring-run fish native to the Clackamas River basin, and obscured any genetic differences that existed prior to hatchery transfers. It was suggested by ODFW (1998) that spring-run fish returning to the Upper Willamette River basin historically may have strayed into the Clackamas River when conditions at Willamette Falls prevented upstream passage. Therefore, similarities between Clackamas River and Upper Willamette River spring-run fish may reflect an historical/evolutionary association between the two groups, rather than a recent artifact of human intervention. Recoveries of returning adults released from the Clackamas River have occurred at a number of sites outside of the Clackamas River. This may reflect the introgression of other Upper Willamette River spring-run hatchery stocks into the Clackamas Hatchery, the relative downriver location of the releases (relative to historical spawning sites), or other aspects of the propagation of these fish prior to release.

12.3 LCR STEELHEAD

12.3.1 Cowlitz River

12.3.1.1 Cowlitz River Basin Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Summer and winter steelhead are present in the Cowlitz River basin; however, only winter steelhead are believed to be native. The Cowlitz River contains two stocks of winter steelhead: an early-returning winter run that spawns in December and January, and a late returning winter run that spawns in April and May (Howell et al. 1985). The early-returning winter run is a hybrid of native Cowlitz River winter steelhead and Puget Sound Chambers Creek Hatchery stock, while the late-returning winter steelhead are reported to be representative of native fish (Busby et al. 1996). Genetic analysis substantiates the origins of these run times.

Summer steelhead in the Cowlitz River are derived from hatchery introductions of Skamania Hatchery summer steelhead. Furthermore, the Cowlitz River late-return winter steelhead are one of the most distinct in this ESU (Phelps et al. 1997). Both the early-returning winter steelhead and summer steelhead stocks are not considered part of the ESU (NMFS 1998a). Historically, there were runs of over 20,000 winter steelhead in the Cowlitz River (Hymer et al. 1992). The construction of Mossyrock and Mayfield Dams eliminated approximately 50% of the historical spawning habitat. Additionally, the eruption of Mount St. Helens dramatically altered habitat in the Toutle River basin. Naturally spawning populations exist in the lower mainstem Cowlitz, Coweeman, and Toutle River basins. Analysis of allozyme variation indicates that there are significant differences between late-run, native winter steelhead in the mainstem Cowlitz, Green (North Fork Toutle), and South Fork Toutle Rivers (Phelps et al. 1997, see Appendix B). The mainstem Cowlitz River population may represent the homogenized genetic resources of all winter-run populations from the upper and lower Cowlitz, Cispus, and Tilton basins. Furthermore, samples from the Green River (Cowlitz River basin) clustered with hatchery samples known to be strongly influenced by introductions of Chambers Creek (Puget Sound) winter-run steelhead, and may not be representative of the historical population.

Table 12.3. Lower Columbia River Steelhead (yearlings)

Data Sources

	①	②	③	④	⑤	⑥	⑦
	Range of System Survival Rates GAP [D*]	Index of Potential to Increase Population: H/M/L (base period average annual redd count; recent average annual redd count) or % Interim Target (C S T N)	Qualitative Assessment (CHART, NWFSC approach and other info) of Potential to Improve/Increase Habitat (H/M/L) (C S T N)	Primary Candidate Anthropogenic Limiting Factors: **F**low, **C**hannel **M**orphology (bed, banks, sediment, LWD, sinuos., connectiv.), **T**emperature, **W**ater **Q**uality (C S T N)	Ecological Improvement Potential	Improvement Potential Adjusted Based on Practical Constraints	Proposal to Fill Gap and Performance Measures/ Standards/ M&E
Cascade winter-run stratum							
Lower Cowlitz River		VH (1700brt:400edt)	H	cm, wq, fl	H	M-L	
Coweeman River		VH (2250brt-edt:233brt)	H	cm,	H	M-L	
South Fork Toutle River		VH (2600:498)	M 89% hab avail	cm-roads, rip,	M	M	
North Fork Toutle River		VH (3800:196)	H 63% hab avail.	roads-passage	M	M	
Upper Cowlitz River		VH (extirpated)	H	dam-passage,cm-floodplain/rip development, ag.	M	M	
Cispus River		extirpated	H	dam-passage,cm-floodplain/rip development, ag.	M	M	
Tilton River		extirpated	VH -outside forest	dam-passage,cm-floodplain/rip development, ag.	H	M - private	
Kalama River		M (1000-8000rec:726brt)	H	cm, riparian,	M	M	
North Fork Lewis River		vh (713brt:176)	H	cm, riparian, wq, fl, passage	H	M	
East Fork Lewis River		vh (4000:75)	H	cm, wq,	H	M	
Salmon Creek		500-8000:<100 rec pl	H	cm, riparian, passage, wq, fl	H	l	
Clackamas River		rec 410brt	H	passage, wq, sed, fl, cm, lwd	H	M	
Sandy River		rec 735brt	H	passage, wq, sed, fl, cm, lwd, temp	H	M	
Cascade summer-run stratum							
Kalama River		VH (3000:286brt)	H	cm, riparian,	M	M	
North Fork Lewis River		VH (4000:150rec)	H	cm, riparian, wq, fl, passage	H	M	
East Fork Lewis River		VH (422brt:180trt)	H	cm, wq,	H	M	
Washougal River		VH (1400edt:50brt)	H	passage, cm, sediment, LWD,	H	M	
Gorge winter-run stratum							
Lower Gorge Tributaries		793:140	H	cm	M	M	
Upper Gorge Tributaries		243:62	M	cm	M	M	
Hood River		rec 349	H	fl, cm, wq, temp,	M	M	
Gorge summer-run stratum							
Wind River		VH (2300:246)	M	cm	M	M	
Hood River		rec 152	H	fl, cm, wq, temp,	M	M	

*D = Delayed mortality due to transportation

C S T N = Council, States, TRTs, NWC

12.3.2 Upper Cowlitz River, Cispus River, and Tilton River

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

The upper Cowlitz is mostly National Forest in the Cispus and upper mainstem Cowlitz basins. The mainstem Cowlitz River valley (above Cowlitz Falls Dam), much of the Tilton Basin, and tributary basins to the reservoirs are in private lands. Forestry is the greatest land use in the middle and upper elevations, whereas mixed uses, including agriculture and residential development, dominate lower elevation river valleys. The three dams on the mainstem inundated a significant portion of the historical steelhead, chinook, and coho habitat. Fish are now transported around Mayfield Dam and released into the Tilton and upper Cowlitz (above Cowlitz Falls Dam). Downstream migrating smolts are captured and transported to below Mayfield Dam.

The areas with the greatest potential to support anadromous salmonids are the mainstem Cowlitz above Cowlitz Falls, the mainstem Cispus, and the mainstem Tilton and lower reaches of Tilton tributaries (WF, NF, SF). These areas provide the most abundant spawning and rearing habitat. They are all affected primarily by degraded watershed processes related to forest harvest and road building. Local impacts to floodplains and riparian areas are associated with channelization and development.

The Cispus supports winter steelhead, coho, and spring chinook. The most productive reaches are located in the alluvial section from Greenhorn Creek to just upstream of the NF Cispus confluence. The basin is nearly entirely within the Gifford Pinchot National Forest. There is good preservation and restoration potential. The greatest emphasis should be placed on restoration and preservation of basin-wide watershed process conditions (runoff, sediment supply).

The Tilton system, which contains no Tier 1 or 2 reaches, is not expected to play a prominent role in recovery planning. The basin, however, was an important component of the historical upper Cowlitz populations and contains some potentially productive habitat that is currently degraded by watershed process impairments. Limiting factors, threats, and measures have therefore been specified for Tilton basin reaches. The primary impairments are related to intensive timber harvest and road building. There are also stream corridor impairments in and around the town of Morton, WA.

Except for a few spring-run chinook salmon that have been passed above the Cowlitz Falls Dam, the historical spawning habitat for these three spring-run DIPs is no longer accessible. Downstream passage for chinook salmon smolts is limited. Furthermore, with the construction of Mayfield Dam in 1963, returning adults from the three DIPs were incorporated into a single spring-run broodstock at the Cowlitz (Salkum) Salmon Hatchery. The hatchery run has declined significantly since the construction of Mayfield Dam. A few spring-run chinook salmon are observed spawning naturally below the hatchery (average of 169 fish from 1980 to 1996). These are probably hatchery-origin fish. Furthermore, there is considerable potential for hybridization between fall-run and spring-run fish in the river, as well as possibly in the hatchery.

12.3.2.1 Upper Cowlitz River Winter Steelhead, Cispus River Winter Steelhead, and Tilton River Winter Steelhead, and

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Winter steelhead were historically found throughout the Cowlitz River basin. Construction of Mayfield Dam in 1968 eliminated access to spawning habitat in the Tilton, Cispus, and upper Cowlitz Rivers. Until 1981, returning steelhead were passed above the dam and into the Tilton River to enhance a sport fishery. Natural production by these fish was limited, and downstream passage facilities for naturally produced juveniles were inadequate. Reintroduction of adults (from the late-winter steelhead returning to the hatchery) above the dam into the three basins began again in 1994, with juveniles produced in the upper Cowlitz and Cispus Rivers being collected at the Cowlitz Falls Dam, and juveniles produced in the Tilton River being passed at Mayfield Dam.

With the construction of Mayfield Dam, many adults returning to the Cispus, Tilton, and upper Cowlitz Rivers were taken into the Cowlitz Trout Hatchery to establish the late-winter steelhead broodstock. The hatchery probably also collected adults returning to the lower

12.3.3 Lower Cowlitz

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

The lower Cowlitz basin is nearly entirely privately owned (94%); much of it by large industrial timberland owners. Forestry is the dominant land use. Commercial forestland makes up over 80% of the basin. The river valleys are mostly in agricultural or residential uses. The middle mainstem reaches below Mayfield Dam represent important spawning and rearing areas for several species. Below the Barrier Dam, the river flows south through a broad valley. Degraded riparian and floodplain function in these reaches is primarily a result of intensive agricultural development. The Toutle River, which enters the Cowlitz at RM 20, is a major lower tributary that drains the north and west sides of Mount St. Helens. The Toutle River was impacted severely by the 1980 eruption of Mount St. Helens and the resulting massive debris torrents and mudflows, which also impacted the Cowlitz mainstem downstream of the Toutle confluence. Following the eruption, the lower mainstem Cowlitz was dredged and dredge spoils were placed in the floodplain. Conditions in the lower mainstem limit the productivity of all species. These reaches have experienced intensive diking, agricultural development, urbanization, Mt. St. Helens sediments, and placement of dredge spoils. Restoring these conditions would provide great benefits, especially to fall chinook and chum; however, feasibility issues may limit the potential for improvement. Flow regulation has decreased the risk of high temperatures, sedimentation, and flow extremes; however, stranding of steelhead redds, lack of spawning gravel replenishment, lack of habitat forming flows, and lack of large woody debris transported from upstream are potential problems. Tributary systems to the middle mainstem provide important habitat for winter steelhead, coho, and resident species, but many of these suffer from degraded habitat conditions.

The lower mainstem Cowlitz and lower tributaries (e.g. Ostrander Creek, Lower Salmon Creek, Delameter Creek) historically provided productive habitat for chum, coho, and fall chinook. These habitat, especially the mainstem, have been heavily impacted by mixed-use development. In addition to the influence of hydro-regulation from upstream dams, the primary impacts include channel manipulations, increased watershed imperviousness, and riparian degradation. Effective recovery measures will include riparian and floodplain restoration and land-use planning that protects and restores habitat and habitat-forming processes.

12.3.3.1 Lower Cowlitz River Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Winter steelhead are native to the lower Cowlitz River and its tributaries. However, habitat degradation and changes in water quality due to Mayfield Dam have severely limited natural production. Wade (2000a) reported that 92% of the adults spawning in the lower Cowlitz River were of hatchery origin. The Cowlitz Trout Hatchery late-winter steelhead stock is an amalgamation of fish from populations that existed above and below Mayfield Dam. Two other nonnative steelhead broodstocks are also reared at the Cowlitz Trout Hatchery: the early returning winter steelhead stock (derived from Puget Sound and southwestern Washington sources) and the summer steelhead broodstock (derived from the Skamania Hatchery broodstock). Although some hybridization between these three stocks may have occurred, genetic analysis indicates that the late-winter steelhead stock is distinct from the other stocks.

12.3.4 Toutle

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

Forestry is the dominant land use and commercial forestland makes up over 90% of the basin. Much of the upper basin around Mount St. Helens is within the Mount St. Helens National Volcanic Monument and is managed by the U.S. Forest Service. A significant proportion of the forests to the north and west of Mount St. Helens were decimated in the 1980 eruption. Intensive forest harvest and road building followed the eruption and contributed to widespread sediment and flow impairment. The majority of the forest is now in early seral or ‘other forest’ (bare soil, shrubs) vegetation conditions.

Of the three primary tributaries (North Fork, South Fork, Green River), the North Fork Toutle suffered the greatest eruption-related impacts, followed by the South Fork and then the Green River, which was mostly spared the devastating mud and debris flows. The North Fork historically provided productive habitat for steelhead and chinook but productivity continues to remain limited due to eruption and forestry impacts. The sediment loads in the North Fork remain very high, with a braided channel that is under frequent adjustment. The North Fork is further impacted by the Sediment Retention Structure (SRS). The SRS was created in an effort to retain sediments following the eruption, but has become a persistent source of sediment to downstream reaches. The SRS is also a passage barrier and fish are currently transported around the structure.

The South Fork, which also continues to suffer from high sediment loads, is recovering more rapidly than the North Fork. The South Fork has high restoration as well as preservation value for steelhead and chinook. The Green River also has high restoration and preservation value.

The lower mainstem is used by fall chinook and historically provided chum habitat. These reaches were heavily degraded by the dredging of eruption-related sediments and the placement of these sediments in the floodplain. Channels are currently disconnected from floodplains and channel instability remains high.

Population centers in the basin consist primarily of small rural towns. Projected population change from 2000 to 2020 for unincorporated areas in WRIA 26 is 22%. Potentially productive habitat for fall chinook, chum, and coho exist in the lower few miles of the lower mainstem Toutle. These reaches were heavily impacted by mud and debris flows during the 1980 Mount St. Helens eruption. Further degradation to channel, riparian, and floodplain conditions was caused by channel dredging and floodplain spoils placement in an effort to increase flow conveyance following the eruption. Effective recovery measures will entail reducing channel confinement and restoring riparian areas.

The upper SF Toutle provides important habitat for winter steelhead and fall chinook. These reaches have experienced rapid recovery since the 1980 eruption and subsequent heavy timber harvests. They have strong preservation value in addition to restoration value. The NF Toutle historically provided productive habitat for winter steelhead, spring chinook, and coho. Fall chinook may also have used these reaches to some degree. The reaches with the most potential are located just downstream of the Green River confluence and further upstream on the NF between Hoffstadt Creek and Castle Creek (reach NF Toutle 13). Volitional passage is currently blocked just upstream of the Green River confluence by the SRS, created to retain eruption-related sediments following the 1980 eruption. NF Toutle reaches were severely impacted by mud and debris flows during the 1980 eruption, followed by intensive road building and timber harvests. The recovery emphasis is for restoration of watershed processes throughout the NF basin including addressing the dense road network and heavy harvests. Emphasis should also be placed on addressing the continued supply of sediment from the SRS, which has become a persistent limiting factor for fish in downstream reaches.

12.3.4.1 North Fork Toutle River (Green River) Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Winter steelhead are native to the North Fork Toutle River basin, but the eruption of Mount St. Helens in 1980 dramatically degraded spawning and rearing habitat in the North Fork Toutle River basin. Before the eruption, winter steelhead from the Cowlitz River (main stem), Elochoman River, and Chambers Creek Hatchery (Puget Sound) were released into the Toutle River basin. After the eruption, the steelhead population declined dramatically and founder effects may have substantially influenced population structure. In 1988, returning adults were collected and spawned as part of a supplementation program to recover winter-run steelhead in the North Fork Toutle River. Currently, the North Fork is managed for natural production, and the contribution of hatchery fish to spawner escapement is thought to be near 0% in the North Fork and 17% in the Green River (Wade 2000a). Genetic analysis of samples from the Green River (Toutle River basin) clustered with hatchery samples that were known to be strongly influenced by introductions of Chambers Creek (Puget Sound) winter-run steelhead, and may not be representative of the historical population. Cowlitz winter steelhead DIP (LCWL-SW) into the broodstock. Two other nonnative steelhead broodstocks are also reared at the Cowlitz Trout Hatchery: the early-returning winter steelhead stock (derived from Puget Sound and southwestern Washington sources) and the summer steelhead broodstock (derived from the Skamania Hatchery broodstock). Although some hybridization between these three stocks may have occurred, genetic analysis indicates that the late-winter steelhead stock is distinct from the other stocks.

12.3.4.2 South Fork Toutle River Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Winter steelhead are native to the South Fork Toutle River basin. The eruption of Mount St. Helens did not affect habitat in the South Fork to the same extent it did in the North Fork. Introductions of nonnative hatchery winter steelhead into the South Fork Toutle River have been limited. The South Fork Toutle River is managed for natural production, and hatchery strays are reported to comprise 17% of the natural spawning escapement (Wade 2000a). Genetic analysis of winter steelhead from the South Fork Toutle River indicates a strong association with other native steelhead populations in the Lower Columbia River (Phelps et al. 1997).

12.3.5 Mill Creek

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

The Mill/Abernathy/Germany Basin is almost entirely comprised of private and state owned lands, the bulk of which is commercial timberland. Considerable logging occurred in the past without regard for riparian and instream habitat, resulting in sedimentation of salmonid spawning and rearing habitat (WDF 1990). Essentially none of the forest cover is in late-seral stages, however, as the forest matures, watershed conditions are recovering. The impacts of forest practices on riparian areas and sediment supply have most affected winter steelhead and coho spawning and rearing habitat in the middle and upper basin reaches. Agricultural valleys extend up the mainstems of Abernathy and Germany creeks. The reaches within these broad valleys provide potentially productive habitat for all species, especially for chum and fall chinook, which make heavy use of lower mainstem reaches. Channel confinement and riparian degradation are the limiting factors with the greatest impacts in these areas. There is not extensive agricultural use in the Mill Creek basin, however, rural residential development has been increasing in the lower basin over the last decade, which poses potential threats to fish habitat, primarily for fall chinook and chum that make the most use of lower basin reaches.

12.3.5.1 Coweeman River Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Winter steelhead are native to the Coweeman River basin. This population is considered native by WDFW (WDF et al. 1993), despite the release of large numbers of out-of-basin winter steelhead released from the Coweeman Ponds (Myers et al. 1998). Wade (2000a) estimated that only 27% of the natural spawners were of hatchery origin.

12.3.6 Kalama

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II*, prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

Most of the basin is forested and nearly the entire basin is managed for commercial timber production (96%). Only 1.3% is non-commercial forest and 1.5% is cropland. Areas along the lower river have experienced industrial and residential development, resulting in channelization of the lower river. A portion of the upper basin is located within the Mount St. Helens National Volcanic Monument. National Monument land is managed primarily for natural resource protection and tourism.

The Kalama mainstem provides most of the available spawning and rearing habitat in the subbasin, except for a few tributaries that support steelhead and spring chinook. The mainstem has been severely impacted by logging and road building throughout the subbasin and to some extent by agricultural, rural residential development, and commercial development along the lower river.

The important reaches for steelhead and spring chinook are in the middle and upper mainstem and in the lower reaches of a few tributaries (NF Kalama, Gobar Creek, Wildhorse Creek, Little Kalama River). These habitat currently support healthy runs of steelhead. Further degradation of these reaches would jeopardize populations. Of particular importance are the mainstem canyon reaches, which are critical for parr rearing. The lower mainstem reaches are the most important for chum, fall chinook, and coho. These reaches suffer from impaired channel stability and habitat diversity, which are related to riparian and floodplain impacts from rural residential development, commercial development, agriculture, and transportation corridors. Sedimentation of these reaches is related to basin-wide forestry practices. Further degradation of these reaches would severely impact chum and fall chinook. Restoration would yield substantial benefits. Population density and development in the watershed are low. The year 2000 population was approximately 5,300 persons (LCFRB 2001). The town of Kalama, located near the mouth, is the only urban area in the basin. The middle mainstem Kalama and major tributaries (i.e., Gobar Creek) contain productive habitat for steelhead and spring chinook. Coho, fall chinook, and chum do not typically ascend lower Kalama Falls to access these habitat. Forestry is the dominant land use surrounding these reaches. Stream-adjacent roadways impact riparian function. The most effective recovery measures will include preservation and restoration of riparian and upland forest and road conditions. The upper Kalama mainstem and tributaries (i.e., NF Kalama) are used primarily by summer steelhead. These reaches are heavily impacted by forest practices. The most effective recovery measures will include preservation and restoration of riparian and upland forest and road conditions.

12.3.6.1 Kalama River Summer Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Summer steelhead are native to the Kalama River basin. Summer steelhead are found throughout the basin as far as the falls at RKm 56. Historically, they may have been the only salmonids able to ascend Kalama Falls (RKm 16). Modifications to Kalama Falls allowed winter steelhead to access the upper portion of the Kalama River and may have resulted in some hybridization between the two run types. Substantial numbers of nonnative summer steelhead have been released into the Kalama River basin, primarily from the Skamania Hatchery (out of ESU). Hatchery fish comprise 67% of escapement (Wade 2000b). In spite of the large proportion of hatchery-produced summer steelhead in the basin, native summer steelhead are genetically distinct from the Skamania summer steelhead that are released in the basin. Differences in spawning time and overall fitness between the two stocks may have reduced the extent of introgression.

12.3.6.2 Kalama River Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Winter steelhead are native to the Kalama River basin, but historically they may not have been able to migrate beyond Kalama Falls (RKm 16). Side-channel and tributary habitat is limited in the Kalama River basin, and the historical population may not have been very large. There have been a number of hatchery introductions from outside the basin (primarily Elochoman and Chambers Creek stocks). Approximately 31% of naturally spawning winter steelhead are of hatchery origin (Wade 2000b). Genetic analysis indicates that the existing native population is very distinct from the Lower Columbia River/Puget Sound hatchery stock mix.

12.3.7 Lower North Fork Lewis

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II*, prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

The bulk of the land is forested and a largepercentage is managed as commercial forest. Agriculture and residential activities are found in valley bottom areas. Recreation uses and residential development have increased in recent years. Stand replacement fires, which burned large portions of the basin between 1902 and 1952, have had lasting effects on basin hydrology, sediment transport, soil conditions, and riparian function. The largest of these was the Yacolt Burn in 1902. Subsequent fires followed in 1927 and 1929.

The Lower North Fork Lewis Basin has experienced intensive watershed development along the mainstem Lewis, Cedar Creek, and the lower reaches of many tributaries. Timber harvests and road building have been widespread in the middle and upper elevation areas, which mostly lie within private commercial timberland.

The most important aquatic habitat areas in the basin are upper Cedar Creek, lower Cedar Creek, and the mainstem Lewis between tidal influence and Cedar Creek. Upper Cedar Creek is very important for steelhead spawning and rearing, however, production is severely limited by habitat diversity, flow, and sediment issues that are related to the high degree of timber harvest and road building that occurred in the upper basin during the 1980s and 1990s. Lower Cedar Creek is also important for steelhead, in particular for parr rearing. These reaches are impacted by impaired sediment and flow processes stemming from upper basin logging/road building, but they also suffer from localized riparian impacts from agriculture and grazing. The mainstem Lewis between tidal influence and the Cedar Creek confluence has lost a significant amount of habitat due to artificial confinement. An estimated 50% of the historical floodplain has been disconnected from the river. Habitat diversity is severely limited in this straightened and simplified channel. Riparian function is impaired due to development within riparian areas. Historical fall chinook, chum, and coho production has been reduced as a result of habitat degradation in these reaches. Further degradation would pose great risks to the existing low levels of natural production. The most critical reaches in the middle mainstem Lewis lie between Ross Creek and Merwin Dam. These reaches are most important for chum, fall chinook, and coho. Winter steelhead also use these reaches.

The middle mainstem basin is largely in private land ownership with some areas of state forest land. Hydropower operations, agriculture, and rural development have the greatest impacts. The recovery emphasis is for preservation as well as restoration. Effective recovery measures in the middle mainstem will involve managing regulated flows from the hydropower system, addressing agricultural and rural/suburban development impacts to floodplains and riparian areas, and ensuring that land-use planning effectively protects habitat and watershed processes. Cedar Creek reaches are most important for winter steelhead, though other species make limited use of these habitat. Lower Cedar Creek (mouth to Pup Creek) (Cedar Creek 1a) and the reach downstream of the Chelatchie Creek confluence (Cedar Creek 3) are the most critical. Forest practices on private commercial timberlands in the upper watershed have impacted sediment supply and hydrologic processes in Cedar Creek reaches. Agriculture and rural residential uses have impacted riparian areas and floodplains. Recovery measures will need to address agricultural impacts along stream corridors and forest practices in the upper basin.

12.3.7.1 North Fork Lewis River Summer Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids*, prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Summer steelhead are native to the North Fork Lewis River. The construction of three mainstem dams -- Merwin Dam (RKm 31), Yale Dam (RKm 55), and Swift Dam (RKm 77) -- eliminated access to over 80% of historical spawning and rearing habitat. Despite attempts to maintain naturally spawning steelhead through a trap-and-haul program over Merwin Dam following its construction in 1931, the summer steelhead population dwindled (Parkhurst et al. 1950). Currently, some spawning takes place below the dams and possibly in a tributary, Cedar Creek, but naturally produced adults account for only 7% of total escapement in the North Fork Lewis River (Wade 2000b). Hatchery releases of nonnative summer steelhead, primarily from the Skamania Hatchery, have been common in the North Fork since 1979. Genetic analysis of North Fork Lewis River summer steelhead is not available, but given the limited amount of spawning habitat currently accessible it is unlikely that an independent self-sustaining population could exist.

12.3.7.2 North Fork Lewis River Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids*, prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Winter steelhead are native to the North Fork Lewis River, but construction of three mainstem dams -- Merwin (RKm 31), Yale (RKm 55), and Swift (RKm 77) -- eliminated access to over 80% of the historical spawning and rearing habitat. Despite attempts to maintain naturally spawning steelhead through a trap-and-haul program over Merwin Dam following its construction in 1931, the winter steelhead population dwindled (Parkhurst et al. 1950). Currently, some spawning takes place below the dams and in tributaries, Cedar and Fossil Creeks, but naturally produced adults accounted for only 6% of North Fork Lewis River total escapement in 1990 (Wade 2000b). Hatchery releases of nonnative winter steelhead, a mixture of Chambers Creek Hatchery (Puget Sound), Beaver Creek Hatchery (southwest Washington), and other hatchery populations have been common in the North Fork. Genetic analyses of North Fork Lewis River winter steelhead suggest a strong similarity to nonnative hatchery populations, rather than populations known to be endemic to the region (Phelps et al. 1997, Myers et al. 2002).

12.3.8 East Fork Lewis

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

The bulk of the land is forested and a largepercentage is managed as commercial forest. Agricultural and residential activities are found in valley bottom areas. Recreation uses and residential development have increased in recent years. Most of the land is private (63%), with about 20% of the basin area lying within the Gifford Pinchot National Forest. Stand replacement fires, which burned large portions of the basin between 1902 and 1952, have had lasting effects on basin hydrology, sediment transport, soil conditions, and riparian function. The largest of these fires was the Yacolt Burn in 1902. Subsequent fires followed in 1927 and 1929. The East Fork Lewis has a high degree of watershed process impairment (sediment, flow) in the lower half of the basin. This portion suffers from a variety of land uses including agriculture, grazing, mining, rural residential development, and some timber harvest. The upper portion of the basin, much of which lies within the Gifford Pinchot National Forest is more intact. Past fires and forest harvest have degraded watershed processes and riparian areas in many subwatersheds, however, healthy conditions exist in headwater areas. The most important areas in the basin from an aquatic habitat perspective are the mainstem reaches and the lower mainstem tributaries. The upper mainstem is critical for summer steelhead production. These spawning and rearing reaches currently support good numbers of naturally-produced steelhead, though much higher production could be achieved with recovery of impaired conditions. Upper basin timber harvest and road building have the greatest impact here. The middle mainstem provides the best potential for winter steelhead. This stock would also benefit from restoration measures focused on recovering watershed process impairments related to forest harvest. The lower mainstem and lower mainstem tributaries represent important spawning and rearing sites for fall chinook, chum, and coho. These areas currently suffer from loss of key habitat, low habitat diversity, and channel instability. These conditions are partly due to recent avulsions of the mainstem into stream-adjacent gravel pits. This area also suffers from artificial confinement projects and degraded riparian zones.

The lower mainstem EF Lewis contains important spawning and rearing habitat for fall chinook, chum, and coho. This mixed-use area is heavily impacted by agriculture, rural residential development, and gravel mining. The recovery emphasis is for restoration and preservation measures. Effective restoration measures would involve riparian restoration, reductions in streambank erosion, reconnection of floodplains, and restoration of mining related impairments and future avulsion risks. Land-use planning/growth management is critical to make sure that expanding development and land-use conversions do not continue to impair habitat conditions or habitat-forming processes.

The middle mainstem EF Lewis and Rock Creek are most important for winter steelhead, although summer steelhead also use these reaches to some degree. There are agricultural and rural residential uses along these reaches but forestry impacts dominate. The recovery emphasis is for restoration and preservation. Effective restoration measures would include riparian restoration and restoration of watershed processes related to forest practices (i.e., forest road and timber harvest impacts). Emphasis should be placed on preserving functional sediment supply conditions in the Rock Creek basin. Summer steelhead use the greatest proportion of upper EF Lewis reaches. Winter steelhead may use some of these reaches but they rarely make significant use of reaches above Sunset Falls. Nearly the entire upper basin is within the Gifford Pinchot National Forest and forestry impacts dominate. Past wildfires have had a lasting impact on channels. The recovery emphasis is for preservation and restoration. Effective restoration measures would include riparian restoration and watershed process restoration related to forest practices.

12.3.8.1 East Fork Lewis River Summer Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Summer steelhead are native to the East Fork Lewis River. In contrast to the North Fork Lewis River, accessible habitat for summer steelhead may have increased from historical levels with the “notching” of Sunset Falls (RKm 52.6) in 1982. Wade (2000b) reported that 12% of summer steelhead now spawn above Sunset Falls. Summer steelhead, primarily from the Skamania Hatchery, have been planted into the East Fork Lewis River since 1964 (WDF et al. 1993). However, genetic analysis indicates that East Fork summer steelhead are most similar to other endemic populations in this region, especially East Fork winter steelhead (Phelps et al. 1997, Myers et al. 2002). The level of genetic differentiation between hatchery and naturally produced summer steelhead is surprising given that 71% of escapement consists of hatchery fish (Wade 2000b). Phelps et al. (1997) suggest that temporal differences in spawn timing may contribute to reproductive isolation between these two groups.

12.3.8.2 East Fork Lewis River Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Winter steelhead are native to the East Fork Lewis River. Introductions of nonnative winter steelhead have occurred in the basin since 1954, and 100,000 fish are still planted throughout the Lewis River basin to enhance sport fisheries. Despite this level of intervention, naturally produced winter steelhead are distinct from hatchery populations and most similar to other endemic populations from this region. Hatchery fish contribute 51% of the total escapement to the East Fork Lewis River, and it is possible that differences in spawn timing provide some level of reproduction isolation (Phelps et al. 1997). WDF et al. (1993) estimate little contribution by hatchery fish to the naturally produced winter steelhead population.

12.3.9 Salmon Creek

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

Land use in the Salmon Creek/Lake River basin is predominately urban and rural development, with nearly the entire Burnt Bridge Creek watershed lying within the Vancouver metropolitan area. Historical wetlands and floodplains have been converted to residential, commercial, industrial, and agricultural uses. The upper reaches of the Salmon Creek basin have been impacted by forestry, agriculture, and rural residential development. Continued population growth is of primary concern in this basin. Major urban centers in the basin are Vancouver, Orchards, Salmon Creek, Battle Ground, and Ridgefield. The year 2000 population, estimated at 252,000 persons is expected to increase to 519,000 by year 2020 (LCFRB 2001). Population growth will result in the continued conversion of forestry and agricultural land uses to residential uses, with potential impacts to habitat conditions. It is important that growth management policy adequately protect critical habitat and the conditions that create and support them.

The lower mainstem Salmon Creek reaches with the greatest potential production are located in the vicinity of Salmon Creek County Park, near the I-5 crossing. These reaches historically provided productive habitat for fall chinook, chum, coho, and winter steelhead. This area is heavily impacted by urban and rural development in the expanding Vancouver metropolitan area. Effective recovery measures will involve land-use planning that adequately protects habitat-forming processes in sensitive areas (wetlands, floodplains, riparian corridors). Restoration of riparian areas along these and upstream reaches will also yield important benefits. A few potentially productive reaches for coho and winter steelhead are located on the mainstem between the Hwy 503 crossing and Salmon Falls. Rock Creek and other, smaller, tributaries (e.g., Morgan Creek) also contain potentially productive habitat for coho. These reaches are heavily impacted by agricultural uses and rural residential development. As with the lower basin, the upper basin is expected to continue to develop rapidly. In light of the continued growth, there needs to be emphasis on land-use planning that provides adequate protections to sensitive areas. In addition, riparian and floodplain restoration that targets impacts related to grazing and rural development will yield important benefits to salmonid habitat.

12.3.9.1 Salmon Creek Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Winter steelhead are native to Salmon Creek and nearby tributaries to the Columbia River. The basin is highly urbanized, and it is not known to what degree the naturally reproducing population is self-sustaining. Hatchery introductions began in this area in 1954 and are still common, and a large proportion of adults observed are likely hatchery strays. No genetic sampling has been undertaken in this area. The escapement goal for this area is 400 adults, although there have been no recent spawner surveys.

12.3.9.2 Clackamas River Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Winter steelhead are native to the Clackamas River basin. Although summer steelhead are present and naturally spawning in this system, they originated from releases of Skamania Hatchery summer steelhead stock (Murtagh et al. 1992, Chilcote 1997). Genetic analysis of winter-run steelhead from the Clackamas River suggest a close relationship to Skamania Hatchery summer steelhead; however, there is some suggestion that the juvenile sample analyzed contained a mixture of winter and summer steelhead (A. Marshall[1]). In the early 1960s over 2,000 wild winter steelhead were returning to the upper Clackamas River (Murtagh et al. 1992). Recent returns to the Clackamas River (enumerated at North Fork Dam) indicate that 278 of the 530 (52%) winter steelhead were of wild or native origin. Additionally, Chilcote (1997) estimated that competition between summer and winter steelhead significantly reduced the productivity of winter steelhead. Upstream migration was limited or blocked with the construction of the Cazadero Dam (later called the Faraday Diversion Dam, RKm 45) in 1904 and the River Mill Dam (RKm 37) in 1912. Ladders provided steelhead access to the upper watershed until 1917, when the ladder washed out (Murtagh et al. 1992). Passage was not restored until 1939. A number of hatchery programs release steelhead into the Clackamas River basin: Skamania Hatchery summer steelhead, Clackamas Hatchery winter steelhead (#20) derived from Big Creek Hatchery stock (southwest Washington ESU), Eagle Creek Nation Fish Hatchery Stock (Big Creek derivative), Clackamas Hatchery winter steelhead (#122) derived from late returning native spawners. It has been determined that only the Clackamas Hatchery stock (#122) is part of the Lower Columbia River ESU. The Big Creek Hatchery stock of winter steelhead return to the Clackamas River earlier (October to early March) than the native winter steelhead (February to June) (Murtagh et al. 1992). Furthermore, the peak spawning period for

Big Creek– derived fish is January to early March, compared with May and June for native Clackamas River winter steelhead.

12.3.10 Washougal

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

Nearly all of the lands in upper portions of the Washougal Subbasin (upper mainstem and upper reaches of the West Fork, Little Washougal, and Dougan Creek) are forested. Stream habitat in these areas is particularly important for summer steelhead spawning. However, watershed processes in the upper areas of subbasin also affect salmon and steelhead habitat in the lower areas of the basin through influence on flows, water temperature, and sediment transport. Principal landowners in the upper subbasin are the U.S. Forest Service, the Washington Department of Natural Resources, and industrial forest companies. Landscape conditions in some of these areas are largely intact. Federal and state forest management plans and state forest practice regulations are expected to protect and restore watershed processes and habitat conditions in this area in the intermediate and long-term (10–100 years). Additional active restoration efforts will help to achieve improved habitat conditions in the near-term. The middle portion of the subbasin (middle mainstem and the lower reaches of the West Fork and Little Washougal) is a mixed-use area comprised largely of rural residential development, small scale or noncommercial agriculture, and non-industrial forestlands. These areas are important for summer and winter steelhead spawning and rearing, chum spawning, and chinook spawning and rearing. Watershed functions and habitat conditions have been altered by clearing of riparian zones, filling of wetland areas, isolation of side channel habitat, bank hardening, increased sediment inputs, and stormwater runoff. Degraded watershed processes in the middle subbasin impact habitat conditions in the lower subbasin. The lower area of the subbasin is characterized by industrial, urban, and suburban land uses. Watershed functions and habitat conditions have been significantly compromised by these high intensity uses. Although some riparian areas in the lower reaches near the mouth have been protected through public ownership, destruction of riparian habitat, bank hardening, increased stormwater runoff, and channelization are major limiting factors. Lacamas Creek, the lowest tributary, has been dammed to provide water for industrial use. The reservoir and the creek's heavily altered upper watershed have resulted in increased temperatures and decreased water quality. The lower subbasin is particularly important for chum spawning. It is also important for steelhead and chinook rearing.

Active efforts to restore riparian habitat, side channels, and instream conditions will be required to compensate for development in the lower and middle portion of the subbasin that will likely preclude the full restoration of watershed processes.

Upper mainstem reaches are important summer and winter rearing areas for summer steelhead. The habitat conditions and watershed processes associated with these reaches are influenced primarily by actions on public and private timberland. While these lands have relatively intact landscape conditions, sediment supply processes are thought to be moderately impaired due to the prevalence of forest roads on unstable slopes. The potential for effective passive restoration is high through upgrading or obliterating roads and improving drainage systems. Policies to enable such actions are underway on private, state, and federal forest lands. Restoration of riparian function is also important. Preservation of existing functional conditions is the primary emphasis on these lands. Forest management policy currently being implemented by the USFS and WA DNR, as well as forest practice regulations for private lands, are expected to provide continuing protections of watershed processes. The West Fork Washougal is important for summer steelhead spawning and rearing. Winter steelhead also make limited use of these reaches. Most of the basin is in private or state forestland with a small amount of crop and pasture land in the lower portion of the basin. Portions of the headwaters (i.e., Hagen Creek basin) have intact forest conditions, while most other areas have been extensively harvested and heavily roaded. Effective habitat measures in the West Fork will involve watershed process restoration and preservation associated with forest practices, much of which is addressed in current forest practices policy and regulations. An additional habitat concern in the West Fork Basin is a dam on Wildboy Creek, which blocks several miles of potentially productive habitat. The Little Washougal Basin provides important habitat for winter steelhead adult holding, spawning, and rearing. Most other species (especially coho) also use these reaches. The basin is mixed use and is comprised mostly of private and state forest land with agricultural uses and rural residential development within the lower river valley. The City of Camas water withdrawals from Jones and Boulder creeks create an increased risk of critically low summer flows. Effective habitat measures in the Little Washougal will involve riparian restoration, reestablishing connections between the stream channel and floodplains, growth management, water withdrawal management, and watershed process restoration and preservation on forest lands.

12.3.10.1 Sandy River Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids*, prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Winter and summer steelhead are present in the Sandy River basin, although only winter steelhead are thought to be native (Kostow 1995). Historically, winter steelhead escapement may have been in excess of 20,000 fish (Mattson 1955). Loss of spawning habitat in the Bull Run and Little Sandy River basins, in combination with the effects of dams on the mainstem Sandy River, reduced the run to 4,400 in 1954. More recently, the estimated wild escapement of hatchery fish over Marmot Dam (RKm 43) was 851 in 1997, although distinguishing between wild and hatchery-derived winter steelhead was very difficult (Chilcote 1997). Winter steelhead have been propagated in the Sandy River basin since 1901 (Wallis 1963). Initially, returning adults were intercepted for use as broodstock. Beginning in 1960, Big Creek winter steelhead were introduced into the Sandy River (Wallis 1963). Hatchery fish constituted nearly 40% of the winter steelhead passing over Marmot Dam in 1997 (Chilcote 1997). ODFW predicted that changes in the release strategy for winter steelhead should limit the proportion of hatchery winter steelhead at Marmot Dam to 10% or less (Chilcote 1997). Releases of summer steelhead (Skamania Hatchery stock) began in 1976, and spawning escapement to the Sandy River currently averages 2,000 fish (Chilcote 1997), although there are plans to terminate the summer steelhead program in the Sandy River basin. Additionally, there are plans to remove several dams on the Bull Run, which may provide additional spawning and rearing habitat to a basin that once produced 5,000 adults (Mattson 1955). There are no genetic analyses available for Sandy

River winter steelhead. Differences in spawning time between Big Creek early winter steelhead and native late-winter steelhead may have minimized hybridization between the two groups. Prior to 1999, when hatchery fish were excluded from migrating above Marmot Dam, hatchery fish often contributed more than 50% of the spawning escapement above Marmot Dam.

12.3.10.2 Washougal River Summer Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Summer steelhead are native to the Washougal River basin. Two sets of falls, Salmon Falls (RKm 28) and Dougan Falls (RKm 34), present migration barriers to returning adult steelhead during low-water periods (Parkhurst et al. 1950, Hymer et al. 1992). In July 1935, a survey counted 539 summer steelhead in resting holes below Salmon Falls (Parkhurst et al. 1950). WDF (1951) provided no escapement estimates, but did estimate that the Washougal River basin contributed 55,000 kg to the fishery (prior to construction of the Skamania Hatchery). The summer and winter steelhead stocks currently released from the Skamania Hatchery are not considered part of the ESU due to the inclusion of out-of-ESU stocks into the hatchery program (NMFS 1998a). The Skamania Hatchery is located on the West Fork Washougal River. Wade (2000c) reports that hatchery fish comprise 87% of spawners in the West Fork, but only 1% in the mainstem Washougal River. Genetic analysis indicates that the naturally spawning summer steelhead are genetically distinct from the Skamania Hatchery summer steelhead, and similar to endemic steelhead from the Wind River.

12.3.10.3 Washougal River Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Summer steelhead are native to the Washougal River basin. Two sets of falls, Salmon Falls (RKm 28) and Dougan Falls (RKm 34), present a barrier to returning adult steelhead during low-water periods (Parkhurst et al. 1950, Hymer et al. 1992). Winter steelhead are distributed in the mainstem Washougal, the Little Washougal, and various tributaries within the Washougal subbasin. Generally, Dougan Falls (RM 21.6) is considered the upstream extent of winter steelhead distribution in the mainstem Washougal River. The SASSI spawner escapement goal was 841 wild winter steelhead for the mainstem Washougal River. Timing of adult migration most likely occurs from January through May, with peak movement in March (WDF et al. 1993). The summer and winter steelhead stocks currently released from the Skamania Hatchery are not considered part of the ESU due to the inclusion of out-of-ESU stocks into the hatchery program (NMFS 1998b). The Skamania Hatchery is located on the West Fork Washougal River. Approximately 110,000 hatchery winter steelhead smolts are released annually in the Washougal River (Wade 2000c). These smolts are Skamania Hatchery–origin steelhead, reared primarily at the Skamania Hatchery on the Washougal River, but also at the Vancouver and Beaver Creek facilities. Interbreeding between hatchery and wild steelhead is thought to be very low because of run-timing (WDF et al. 1993).

12.3.10.4 Lower Gorge Tributaries Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids*, prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Impassable waterfalls limit accessible habitat to less than a half mile on most small creeks in this region. Larger rivers contain falls or cascades in their lower reaches, which may present migrational barriers during all or most of the year. Furthermore this region marks a transition between the high-rainfall areas of the Cascades and the drier areas to the east. Spawning steelhead were observed in several small creeks that line the Columbia Gorge during surveys conducted during the 1930s and 1940s. None of these streams provides sufficient habitat for large spawning aggregations of fish, and it is unlikely that there were any independent populations. Relatively little information is available on the winter steelhead that occupy tributaries in the lower Columbia Gorge region. Numerous natural and artificial barriers in the lower parts of most tributaries limit spawning and rearing habitat in this area. There have been a number of hatchery introductions from the Skamania and Beaver Creek (southwest Washington ESU) hatcheries, although the current contribution of hatchery fish to escapement is thought to be less than 5% (Wade 2000).

12.3.11 Wind

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II,* prepared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

The Wind 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. Approximately 9.6% of the land is private, while almost all of the remainder lies within the Gifford Pinchot National Forest. Forestry land uses dominate the subbasin. Thepercentage 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 assessments illustrate the overwhelming importance of the lower mainstem and Panther Canyon reaches for summer steelhead parr rearing. While these reaches are affected by sediment and flow regime impairments originating in upstream subwatersheds, they have healthy local watershed conditions and are well-protected from riparian impacts due to the steepness of the canyons and lack of near-stream roadways. Recovery efforts should ensure that no further degradation of these important reaches occurs. The next most important area for summer steelhead in the subbasin is the middle Wind mainstem between Stabler and Panther Creek. These alluvial reaches provide potentially abundant spawning and rearing areas but are heavily impacted by a variety of habitat impairments. Past timber harvest, splash dam logging, stream-adjacent roadways, residential development, and flood control levees have served to create unstable conditions with low habitat diversity and high fine sediment loading.

The importance of the mainstem Wind for steelhead and resident fish underscores the importance of retaining or recovering subbasin-wide land cover conditions that affect these key downstream reaches. Due to a large amount of public land in the subbasin, many subwatersheds support functioning watershed process conditions that should be maintained. These actions, combined with vegetation recovery and road removal in impaired subwatersheds, will greatly benefit fish and wildlife populations.

12.3.11.1 Wind River Summer Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids*, prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Summer and winter steelhead are native to the Wind River basin. Shipherd Falls (RKm 3) presented a migratory barrier to chinook salmon, but not to steelhead (Hymer et al. 1992), although winter steelhead passage over the falls may have been intermittent at best. Additionally, a lumber-mill dam at RKm 22.5 on the mainstem Wind River blocked upstream passage until 1947. In 1956, Shipherd Falls was laddered and additional modifications were made to a number of other falls and cascades to provide greater access throughout the watershed. SASSI (WDF et al. 1993) originally identified three distinct stocks of summer steelhead in the Wind River basin; however, after recent revisions to the stock inventory, Wind River summer steelhead are considered to be one stock. Steelhead escapement in 1951 was estimated at 2,000 fish (WDF 1951). Both summer (Skamania Hatchery stock) and winter (Chambers Creek/Lower Columbia stock mixture) steelhead have been released in the Wind River watershed. Busby et al. (1996) reported that summer steelhead escapement to the Wind River averaged 600 fish, half of which were of hatchery origin. Genetic analysis of samples from the Wind River and two of its primary tributaries: Trout Creek and Panther Creek, indicates very different relationships among fish at the sample sites. Trout Creek samples were taken above a fish trap that excludes hatchery fish. The Trout Creek fish were most similar to steelhead from the Washougal River. On the other hand, samples from the mainstem Wind River and Panther Creek were similar to other samples that have been influenced by Skamania Hatchery introductions.

Overall, hatchery-produced adults account for 53% of the spawning escapement, although differences in spawning time may reduce the potential for interbreeding. Sport fishery regulations requiring the release of naturally produced steelhead have been in effect since 1981.

12.3.11.2 Wind River Winter Steelhead (Part of Upper Gorge Tributaries)

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Winter steelhead are native to the Wind River basin. Shipherd Falls (RKm 3) presented a migratory barrier to chinook salmon but not to steelhead (Hymer et al. 1992), although winter steelhead passage over the falls may have been intermittent at best. Additionally, a lumber-milldam at RKm 22.5 on the mainstem Wind River blocked upstream passage until 1947. In 1956, Shipherd Falls was laddered, and additional modifications were made to a number of other falls and cascades to provide greater access throughout the watershed. Very little is known about winter steelhead in the Wind River. Given the limited historical passage for winter steelhead over Shipherd Falls, this population was considered to be part of the upper gorge tributaries winter steelhead DIP. With the laddering of Shipherd Falls and the expansion of accessible habit, it may be possible to manage winter steelhead in this basin as a distinct population. Chambers Creek/Lower Columbia River winter steelhead have been released in the Wind River watershed, but direct introductions were terminated in the 1960s. Genetic analysis of winter steelhead from the Wind River has not been undertaken. The population is not monitored, although run-size estimates are less than 100 fish (Wade 2000d). Direct hatchery effects are thought to be minimal, given the absence of recent winter steelhead introductions. The effects of summer steelhead releases and straying winter steelhead from other hatchery programs into the Wind River are unknown.

The Wind 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. Approximately 9.6% of the land is private, while almost all of the remainder lies within the Gifford Pinchot National Forest. Forestry land uses dominate the subbasin. Thepercentage 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 lower mainstem and Little Wind River reaches provide habitat for fall Chinook, chum, coho, and winter steelhead, all of which do not typically ascend Shipherd Falls at river mile 2. These reaches are impacted by the Bonneville Dam impoundment, development activities around the towns of Carson and Home Valley, and basin-wide forest practices. Effective recovery measures here will include controlling excessive runoff and soil erosion from the Carson Golf Course, floodplain reconnection near the mouth of the Little Wind, and passive restoration of riparian areas. Emphasis should also be placed on addressing sediment supply conditions in the Little Wind Basin. Productive reaches in the middle and upper mainstem are located between Stabler and Paradise Creek. These reaches have been impacted by upper basin forest practices and by localized riparian and floodplain development. Although restoration opportunities exist in these reaches, the primary recovery emphasis is preservation. The lower (privately-owned) reaches are likely to witness increased development along the river valley bottom. It is imperative that land-use planning and critical areas protections are adequate to prevent impairment of habitat and habitat-forming processes. The Trout Creek system contains productive steelhead spawning habitat in the Trout Creek flats area and good rearing in the reach just upstream of Hemlock Lake. Trout Creek flats was heavily impacted by past forest practices and has undergone significant restoration in recent years. The primary recovery emphasis is for preservation. These reaches are almost entirely within the Gifford Pinchot National Forest and there is good potential for continued preservation and passive restoration of watershed processes. The lower Wind and Panther Creek canyons have good current production and have been identified in the technical assessment as having high preservation value. The Wind Canyon is located between Shipherd Falls and Trout Creek. Panther Creek Canyon extends from the mouth of Panther Creek to approximately Cedar Creek. Although these reaches are surrounded by private lands, they are relatively protected from riparian impacts due to steep, inaccessible canyons. Residential development encroaches into the riparian corridor of Panther Creek in a few places but the impacts are minor. These reaches are most important for steelhead parr rearing.

The recovery emphasis is for preservation and therefore no limiting factors or threats are identified for these areas. Upper Panther Creek also has high preservation value. These relatively functioning stream reaches support summer steelhead spawning and rearing and are completely within the Gifford Pinchot National Forest. There are good opportunities for passive restoration and preservation of watershed process conditions in the Panther Creek Basin.

12.3.11.3 Upper Gorge Tributaries Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Impassable waterfalls limit accessible habitat to less than a half mile on most small creeks in the upper Columbia Gorge. The upper gorge tributary DIP, extends from the historical location of the Bonneville Rapids to the eastern boundary of the ESU (Wind and Hood Rivers). Larger rivers contain falls or cascades in their lower reaches, which may present migrational barriers during all or most of the year. Furthermore, this region marks a transition between the high-rainfall areas of the western Cascades and the drier areas to the east. During surveys conducted in the 1930s and 1940s, spawning steelhead were observed in several small creeks that line the Columbia Gorge. None of these streams provides sufficient habitat for large spawning aggregations of fish, and it is unlikely that there were any independent populations. There is little information on naturally spawning aggregations in this area. It is likely that the large numbers of summer and winter steelhead released from hatcheries in this area contribute to natural reproduction.

Gorge tributary salmon and steelhead are affected by a variety of in-basin and out-of basin factors including stream, Columbia River mainstem, estuary, and ocean habitat conditions; harvest; hatcheries; and ecological relationships with other species. Analysis has demonstrated that recovery cannot be achieved by addressing only one limiting factor. Recovery will require action to reduce or eliminate all manageable factors or threats. The deterioration of habitat conditions in the Columbia River mainstem, estuary, and plume affect all anadromous salmonids within the Columbia Basin.

12.3.12 Hood River

(excerpted from *Lower Columbia Salmon And Steelhead Recovery and Subbasin Plan, Volume II, p*repared by Lower Columbia Fish Recovery Board for the Northwest Power and Conservation Council, May 28, 2004 Draft)

In the Hood River Subbasin, chronic human-caused habitat disturbances are believed to intensify and prolong the effects of frequent large scale natural disturbances leading to population declines in the focal species bull trout, spring chinook, fall chinook, and summer and winter steelhead. Key limiting factors for chinook and steelhead included flow, channel stability, habitat diversity, key habitat quantity, and sediment load. The scheduled removal of the Powerdale Hydroelectric Project and dam in 2010, and restoration of physical habitat connectivity for adult and juvenile life stages at other dams and diversions have the potential to substantially increase the survival of focal species in the Hood River.

The EDT model results for the Hood River Subbasin suggest that the environmental attributes that have had the greatest effect on the focal species chinook and steelhead are channel stability, flow, habitat diversity, sediment load, and key habitat quantity. Obstructions were most important overall to winter steelhead, and a lesser factor for spring chinook and summer steelhead. In general, the EDT model results are consistent with earlier assessment results with regard to limiting factors. The principal historic factors identified in earlier assessment work believed to inhibit the focal species' populations were associated with historic forest management, agriculture, transportation, and land development activities (HRWG, 1999; USFS, 1999 a&b). These include:

- Impairment of upstream juvenile and adult fish passage at dams, water diversions, and road crossings;
- Inadequate or absent fish screens at water diversions;
- Streamflow reduction at irrigation and hydropower diversions;
- Water quality degradation including temperature, pesticides, sediment, nutrients;
- Reduced riparian-floodplain function and instream habitat diversity;
- Increased peak flows

Factors limiting natural fish production focusing on steelhead and spring chinook were also identified in the recent HRPP Review which modeled subbasin habitat conditions. This review identified natural subbasin characteristics of turbidity, glacial fine sediment loads, rain on snow floods, cold rearing temperatures in the West Fork, and channel morphology as limiting natural production. Analysis of habitat data and UCM modeling showed that a lack of pool habitat, combined with low wood complexity, high fines, and high turbidity were key factors limiting freshwater capacity and survival. This analysis identified habitat restoration, water withdrawals, and fish screening and fish passage at diversions as priorities for restoration activities.

The single most important fisheries issue identified in the U.S. Forest Service watershed analysis for the Middle and East Forks of Hood River was the loss of large wood from streams, and the future large wood recruitment potential from the adjacent riparian areas (1996a).

12.3.12.1 Hood River Summer Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Summer steelhead are native to the Hood River basin (Kostow 1995). The combined escapement for both winter and summer steelhead (excluding known hatchery fish) averaged around 1,000 fish during the 1950s and 1960s (Howell et al. 1985). Summer steelhead alone are able to ascend Punchbowl Falls and access the West Fork Hood River, while winter steelhead are the dominant run in the Middle and East Forks (Kostow et al. 2000). Native summer steelhead escapement was 181 in 1997 and may have been as low as 80 in 1998 (Chilcote 1997). A local summer steelhead broodstock (ODFW #50) was established in 1998, using unmarked returning summer steelhead. Skamania Hatchery–derived summer steelhead (ODFW #24) were released in the basin for a number of years, and it is possible that unmarked (naturally produced) Skamania summer steelhead were incorporated into the broodstock (Kostow et al. 2000). From 1993 to 1998, unmarked summer steelhead accounted for only 16.1% of the summer steelhead passed over Powerdale Dam. Beginning in 1997, however, releases in the upper basin were terminated, and marked summer steelhead are prevented from migrating past Powerdale Dam (RKm 6.4). There is no genetic analysis available for Hood River summer steelhead.

12.3.12.2 Hood River Winter Steelhead

(excerpted from *Historical Population Structure of Willamette and Lower Columbia River Basin Pacific Salmonids,* prepared by James Myers (NWFSC), Craig Busack (WDFW), Dan Rawding (WDFW), and Ann Marshall (WDFW))

Winter steelhead are native to the Hood River basin (Kostow 1995). The combined escapement for both winter and summer steelhead (excluding known hatchery fish) averaged around 1,000 fish during the 1950s and 1960s (Howell et al. 1985). Winter steelhead are not found in the West Fork of the Hood River, but are the predominant run in the East and Middle Forks. Punchbowl Falls (RKm 0.6) prevents winter-run fish from ascending into the West Fork (Olsen et al. 1992). Hatchery winter steelhead (ODFW Big Creek Hatchery #13) have been released into the Hood River basin since 1962, but the program was terminated following the development of a local winter steelhead broodstock (ODFW #50) in 1991. The winter steelhead #50 broodstock was established using unmarked returning steelhead, and it is possible that some naturally produced Big Creek–origin fish were incorporated (as well as unmarked fish from other basins or hatcheries). Genetically, Hood River and Big Creek winter steelhead are quite distinct (Kostow et al. 2000).

12.4 LITERATURE CITED

To be completed.