Draft

Washougal River Subbasin Summary

May 17, 2002

Prepared for the
Northwest Power Planning Council

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DRAFT: This document has not yet been reviewed or approved by the Northwest Power Planning Council

Washougal River Subbasin Summary

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Subbasin Description

General Description

PART I. DESCRIPTION OF SUBBASIN

Drainage Area

The Washougal River is located in southwest Washington, originating in Skamania county and flowing southwesterly into Clark County, joining the Columbia River at River Mile (RM) I21 at the town of Camas. The Washougal and Salmon Creek watersheds to the west comprise WRIA 28. The drainage area encompasses approximately 240 square miles. This region lies in a geographical area known as the Willamette-Puget Trough, formed by the Cascade and Pacific Coast Mountain ranges (WDF, 1951).

Climate

The climate of the region is influenced by this geography, allowing moist air flowing up the Columbia River from the Pacific Ocean to moderate the seasonal extremes. Summers are cool and relatively dry and winters are wet but mild (WDF, 1951). The climate of Southwestern Washington is strongly influenced by its physical geography and position between the coastal Willapa Range to the west and the Cascade Range to the east. The Columbia River to the south and west, and Pacific Ocean (70 miles to the west) help moderate temperatures year-round. Maritime influences result in mild, cool, wet winters and moderately dry, warm summers. Orographic effects in the region are pronounced, with average annual precipitation varying from 41.3 inches (on average from 1961-1990) in Vancouver, situated in the Puget-Trough lowlands, to over 110 inches per year in the upper Cascade Range (Wildrick et al. 1998). Precipitation provides most of the surface and groundwater in WRIA 28 (Wildrick et al. 1998; WDF 1990). Over the period of record, annual precipitation has varied by a factor of about two and one-half times (24-64 inches) in WRIA 28. The average annual temperature in Clark County is 50° F, ranges from winter lows rarely below 32° F to summer highs rarely exceeding 80° F (Wildrich et al. 1998; (Wade, 2001).

Annual rainfall varies considerably throughout the subbasin, primarily a result of elevation differences. At the town of Camas, annual rainfall averages about 50 inches. Within the upper tributary regions annual rainfall averages 110 inches. Since there are no permanent snowpacks, reservoirs, or other impoundments on the river, streamflow is a direct result of rainfall and groundwater runoff. The 37-year average discharge is 873 cubic feet per second (cfs), with a peak record discharge of 40,400 cfs during the flood of December 1977.

Topography

The flashy nature of the river is due, in part, to the topography of the basin as well as natural perturbations of the environment. Large portions of the upper watershed were completely burned in a series of large forest fires in 1902, 1927, and again in 1929. The lighter forest regrowth, with reduced water storage capacity, contributes to the fluctuations in streamflows (WDF, 1951).

The Washougal River fish habitat has been degraded from the upper reaches downstream to its' mouth in Camas. The Yacolt Burn deforested large tracts of land in the upper reaches causing an increase in sediment transport, a reduction in hydrologic retention, and a general decline in habitat quality. Gravel extraction in the lower 20 miles of the river has caused a loss in suitable spawning substrate through this reach. Three dams were constructed by the Cotterell Power Company, which prevented fish passage during low flows. These dams contained fish ladders that were deemed inefficient (WDF 1990). The dams were eventually removed in 1947. Effluent from the kraft pulp mill located at the mouth of the Washougal River in Camas has been directly recognized as a contributor of fish mortality (WDF 1990; WDF 1951). Water quality remains a problem and the Washougal River is listed on the 303d list (WDOE 2000) along with several of its' tributaries.

Geology

Wildrich et al. (1998) also provides the best description of the geology of WRIA 28. According to Wildrich et al. (1998), "Swanston et al. (1993) completed the most recent geologic and hydrogeologic mapping of WRIA 28. They studied the much larger Portland Basin, a northwest-southeast trending structural basin about 20 miles wide and 45 miles long, filled with mostly continental sediments of the late Miocene, Pliocene, Pleistocene age. In this basin they mapped eight hydrogeologic units, grouped into three major subbasins. From youngest to oldest, these subbasins are the (1) unconsolidated sedimentary aquifer, (2) Troutdale gravel aquifer (sedimentary rocks, and (3) older rocks (including marine sediments, basalt, volcanic breccia, and volcaniclastic sediment). The older rocks that underlie the Columbia River floodplain and terraces at varying depths also form the western foothills of the Cascade Range. To the north and east of Washougal, the older rocks belong to several geologic formations, including the Skamania Volcanics and the Columbia River basalt group… West of Washougal, a thick sequence of sediments, deposited during the Miocene through the Pleistocene epochs, fills a structural basin formed during faulting and downwarping of the older rocks. These sediments belong to several geologic formations, including the Sandy River mudstone and the Troutdale Formation, both of Eocene age.

During the late Pleistocene time, large quantities of sediments were deposited over the Troutdale Formation. These sediments consist of basaltic boulders and cobbles with a gravel and sand matrix and were deposited throughout most of the study area north and east of Washougal during repeated catastrophic floods of the Columbia River. The flood deposits generally are coarsest near the present channel of the Columbia River, then grade into finer-grained facies of stratified san, silt, and clay to the Northwest (Swanton et al. 1993). Holocene age alluvium occurs along the floodplains of the Columbia River and its major tributaries. Columbia River alluvium consists largely of sand and silt, while alluvium of its major tributaries consists chiefly of cobbles and gravel." (Wade, 2001)

The towns of Camas and Washougal are located on the short confined floodplain at the mouth of the river. Treated municipal wastes from both towns are discharges into the Columbia rather than the Washougal River. Industrial development is limited, but growing. The major pollution concern is effluent from the Crown Zellerbach kraft pulp mill in Camas, which has long been recognized as a cause of fish mortality. Residential development is scattered along State Route 140, following the river upstream from Washougal. Rugged topography has limited agricultural development to the dike floodplain (WDF, 1950).

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Hydrology

Since there are no permanent snowpacks, reservoirs, or other major impoundments, stream flow is the direct result of rainfall and groundwater runoff (Wildrich et al. 1998;WDF 1990). Figure 2 illustrates mean monthly stream flows from long-term records for the Washougal River and Salmon Creek. Ground-water storage is recharged mainly by precipitation that percolates down to the water table, or by infiltration from streams or other water bodies. Barring long-term climatic change, ground water storage usually stays within a narrow range, and the average annual recharge rate may be assumed to be equivalent to the average discharge of ground water to streams, springs, or other surface water bodies (Wildrich et al. 1998). According to Wildrich et al. (1998) we can only estimate the historic rates of natural stream flow in WRIA 28 because stream flows were not measured prior to land clearing, cultivation, and development of water supplies.

In a watershed assessment of WRIA 28, Wildrich et al. (1998) provided an excellent description of the soil-water balance for the area. According to Wildrich et al. (1998) precipitation is more abundant during the fall and winter, and as soils become saturated, excess soil moisture tends to percolate beyond the reach of plant roots and recharges ground water. In some areas, water logging of soils results in overland flows of excess water to streams. During spring and summer, ground-water recharge practically ceases because the actual evapotranspiration rate (AET) usually exceeds the rate of precipitation.

This annual cycle is reflected in low streamflows during the summer and fall and higher flows during winter and spring. Soil-water balance estimates were developed for both Salmon Creek and the Vancouver area. Both of the estimated water balances indicate that, under normal conditions, very little ground-water recharge occurs from June through September because a soil-water deficit develops, leaving little water to percolate down to the water table. During this period, heads decline as ground water drains to streams. These seasonal imbalances in recharge lead to large seasonal swings in streamflow and ground water storage (Wildrich et al. 1998; Wade, 2001).

Soils

Land Uses

Agriculture is the dominant land use in the western and central parts of WRIA 28. The southwest portion of WRIA 28 is predominately urbanized, especially on the alluvial terraces and flood plain of the Columbia River. The City of Vancouver is the largest of urban center in WRIA 28. Silvaculture dominates land use on steeper ground to the east in the foothills of the Cascade Range (Wildrick et al. 1998). Manufacturing, especially in the technology sector, has increased in the urban centers of Camas and Vancouver following the rapid population growth observed since the 1960's (Wildrick et al. 1998). Industrial and commercial development extends along the

Columbia River from Vancouver to the flushing channel to Vancouver Lake and along the Camas Slough near the mouth of the Washougal River. Rapid urban and rural residential development has occurred along most of the streams within WRIA 28; especially along streams within the Lake River Subbasin, the lower 20 miles of the Washougal River, and the Little Washougal watershed (TAG).

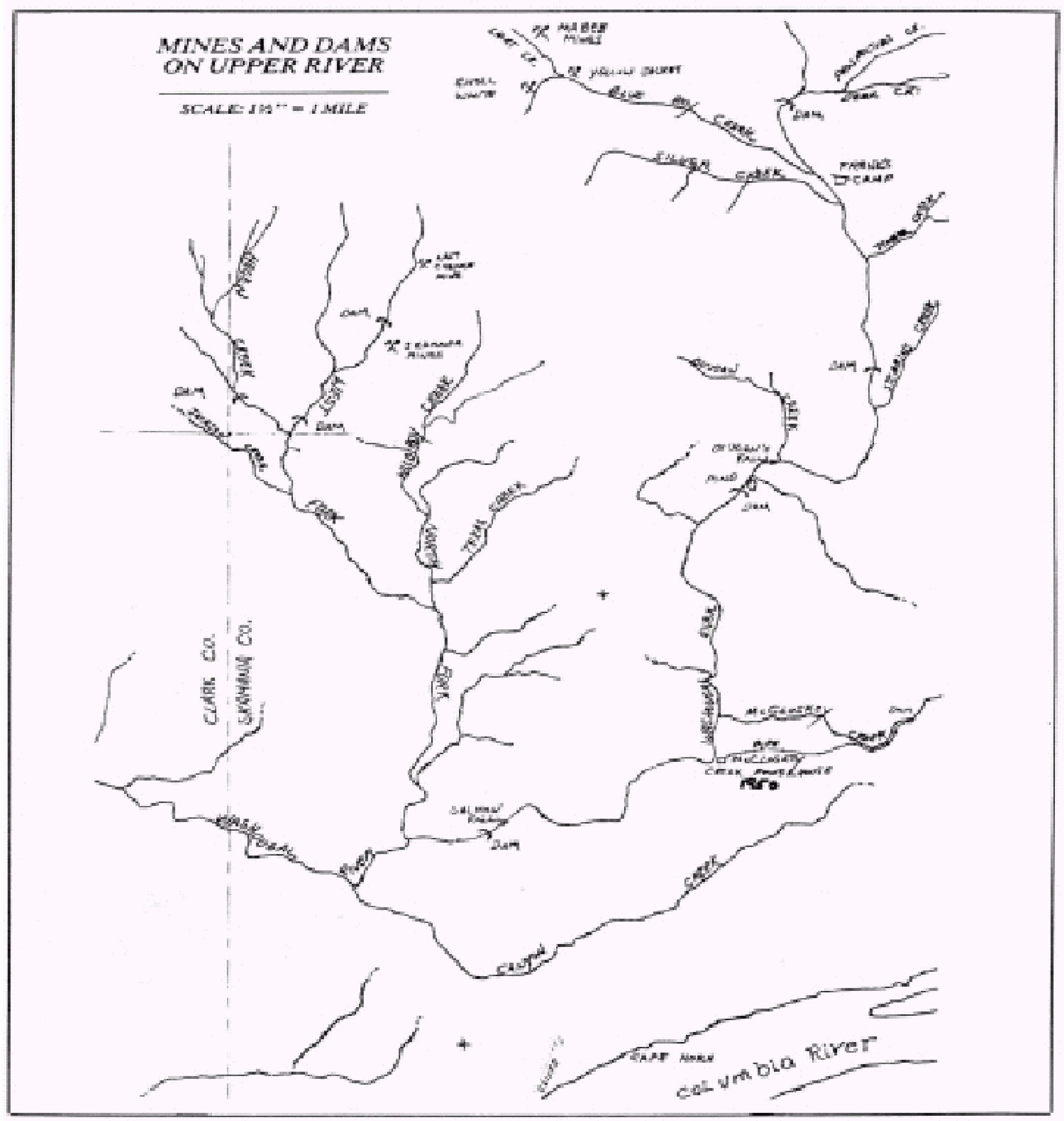
National wildlife refuges, state wildlife areas, and Clark County open space properties occupy large acreages of land along the Columbia River and around Vancouver Lake in WRIA 28. The geographical setting on the Columbia River floodplain has provided a unique opportunity to restore and enhance wetland areas. Historically, a prolific wetland area dominated the landscape at the convergence of the Columbia and Willamette Rivers. However, there has been a loss of these wetland habitats over the past 40 years due to urban, agricultural, and industrial development.

Land development and uses are limited in the southeastern portions of WRIA 28 due to regulatory limits on development within the Columbia River Gorge National Scenic Area (CRGNSA)(Public Law 99-663, the Columbia River George National Scenic Area Act). Yet, development is occurring within the urban centers of the Columbia Gorge and railroad and highway transportation corridors cut across all streams within the Bonneville Tributaries Subbasin near their confluence with the Columbia River.

Portions of the upper Washougal River and Bonneville Tributaries Subbasins are located within the USFS Gifford Pinchot National Forest. Many visitors visit this forest every year for a variety of recreational activities. State and private commercial forest lands cover a substantial amount of area in the upper Washougal River Subbasin.

Impoundments and Irrigation Projects

Dams are located in Figure 1. Each hatchery has a weir and intake structure to provide water for hatchery needs. Hatcheries are located in Figure 2.



From Parsons unknown date

Figure 1. Washougal River dams.

Historically, Salmon Falls at RM 14.5 was the first barrier encountered by migrating salmon and steelhead. Steelhead were the only species capable of consistently ascending the falls until a fishway was constructed in the 1950's (WDF 1990). Dugan Falls, at RM 21, is generally considered the upstream limit of salmon and winter steelhead migration, while summer steelhead move well into the headwaters (TAG, WDF 1990). However, according to Bill McMillan (2000: personal comm.) wild winter steelhead do ascend Dougan Falls in low numbers, and they represent a small, but genetically important part of Washougal River steelhead diversity (Wade, 2000).

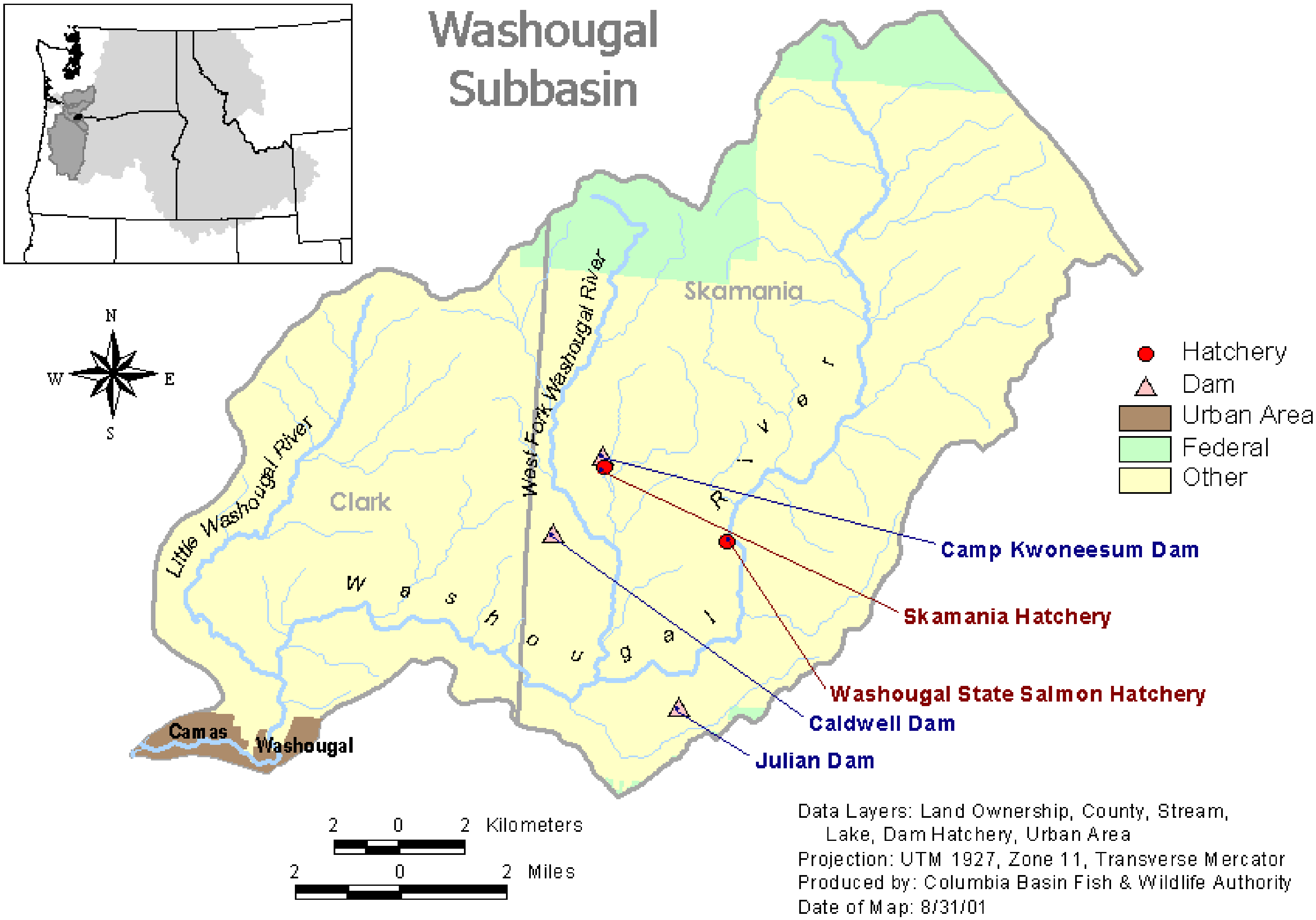


Figure 2. Washougal River hatcheries and dams.

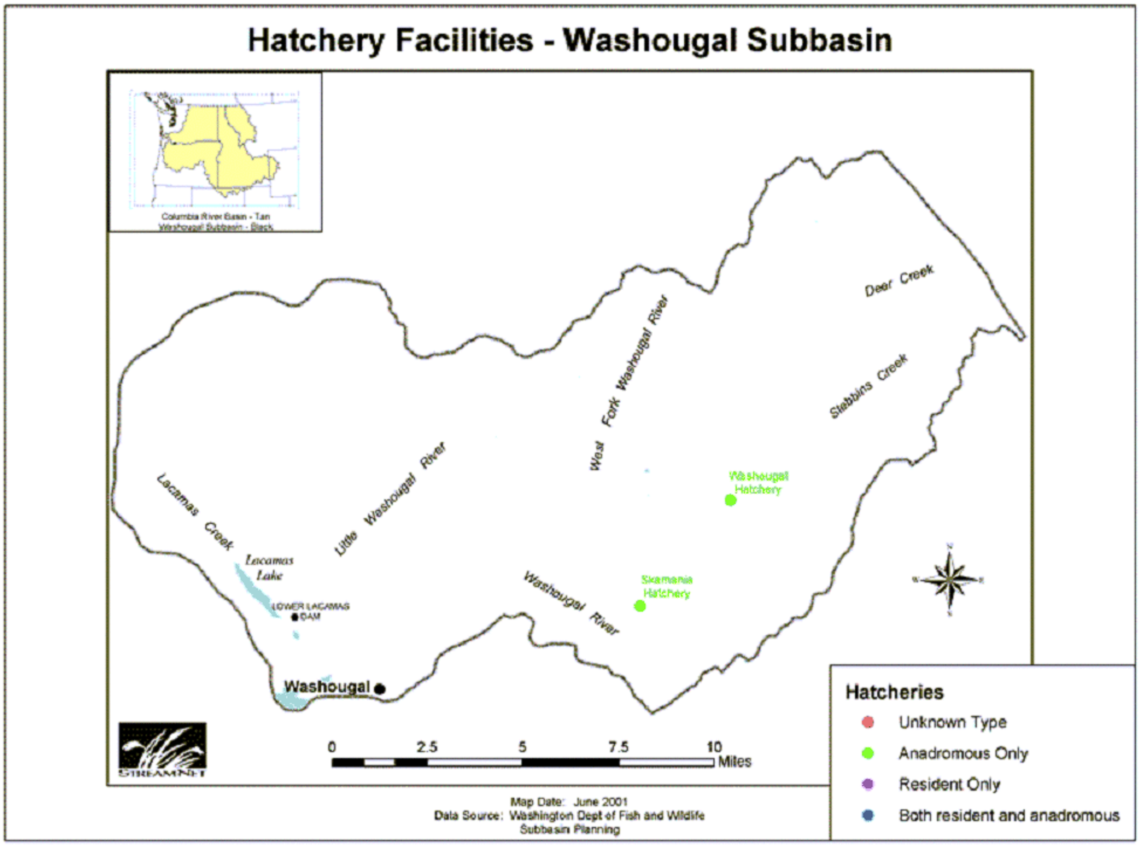


Figure 3. Washougal subbasin hatchery facilities

Falls and cascades also limit access to other parts of the watershed including:

- A natural falls on Lacamas Creek at approximately RM 0.9 blocks all upstream passage.
- A falls blocks anadromous passage approximately 600-feet upstream from the mouth of Cougar Creek.
- A bedrock chute at the mouth of Dugan Creek prevents larger fish from accessing the upper reaches.
- Falls block passage into Prospector/Deer Creek approximately 200 yards from the confluence with the Washougal (McMillan 1997: personal comm.).
- Sheetflow across bedrock near the mouth of Meander Creek may restrict passage at times into the upper reaches. TAG members suggest that LWD could reduce water velocities and help develop step pool habitat that would increase access.
- McMillan (1997: letter) also noted that large log jams in the lower reaches of both Bluebird and Silver Creeks have become cemented with gravel accumulating behind the jams. The condition of these jams needs assessment, as the jams potentially restrict passage, and block the movement of gravel to downstream reaches.

Artificial passage barriers also restrict access to various parts of the subbasin including:

- The weir at the Washougal Hatchery diverts summer steelhead into holding ponds until the flows increase, reducing the natural upstream movement of the fish. The hatchery intake dam also presents a potential barrier at low flows (TAG).
- A water intake structure for the Skamania Hatchery at the mouth of Vogel Creek blocks all passage into the stream system. Passage is blocked to reduce the chance that adult salmon will transmit diseases to the water supply for the hatchery.
- The City of Camas operates small dams on Jones Creek at RM 1.5 and on Boulder Creek at RM 1.5 that block passage to upstream habitat (Quinn 2000: letter). The quantity and quality of available habitat upstream of these structures is unknown. A natural 6-foot waterfall below the dam at RM 1.0 on Boulder Creek may already limit access to all species other than steelhead (Quinn 2000: letter). TAG members report that good habitat exists above the dam on Jones Creek.
- Fish screens on the intakes for Jones and Boulder Creek dams may also affect juvenile fish passage. According to Quinn (2000: letter) Steve Manlow of WDFW inspected the fish screens on both Jones and Boulder Creeks during a field visit. He said that the screening system was adequate, except that the screens had approximately1/4-inch openings instead of 1/8-inch openings required by Washington State Code and the NMFS Juvenile Fish Screen Criteria. The species potentially impacted by these screens include resident cutthroat and rainbow trout in the upper watershed. It is anticipated that the screen mesh size will be upgraded in the near future.
- Longview Fiber operates a 30- to 40-foot high dam on Wild boy Creek that is a complete passage barrier. Longview Fiber does not have any immediate use or plans for the Dam or reservoir, but Steve Hanson (2000: personal comm.) suggested that Longview Fiber has considered selling the property for summer homes. The dam blocks access to approximately 1.7 miles of good habitat for three species. The size of the dam and the amount of sediment perched behind the dam would make removal very expensive (Hanson 2000: personal comm.).

Protected Areas

Federal lands in WRIA 28 include several national wildlife refuges that border the Columbia River including: the Ridgefield National Wildlife Refuge, Steigerwald National Wildlife Refuge, Pierce Ranch National Wildlife Refuge, and Franz Lake National Wildlife Refuge. Also, small portions of the Gifford Pinchot National Forest extend into the upper reaches of the North Fork and mainstem Washougal Rivers.

The Washington Department of Fish and Wildlife and Clark County manage large acreages within the Columbia River lowlands, surrounding and to the north of Vancouver Lake. These properties are managed to provide fish and wildlife habitat, open space, and recreational opportunities for people within the area (Clark County 1994). The majority of public lands in WRIA 28 are held by Washington State Department of Natural Resources for commercial timber production (see Table 1 from Lunnetta et al. 1997). Most of the state owned land is located in the upper Washougal River Subbasin. Industrial timber companies also own and manage large properties in the upper Washougal River watershed.

Land development and uses are limited in the southeastern portions of WRIA 28 due to regulatory limits on development within the Columbia River Gorge National Scenic Area (CRGNSA)(Public Law 99-663, the Columbia River George National Scenic Area Act). Yet, development is occurring within the urban centers of the Columbia Gorge and railroad and highway transportation corridors cut across all streams within the Bonneville Tributaries Subbasin near their confluence with the Columbia River. Portions of the upper Washougal River and Bonneville Tributaries Subbasins are located within the USFS Gifford Pinchot National Forest. Many visitors visit this forest every year for a variety of recreational activities. State and private commercial forest lands cover a substantial amount of area in the upper Washougal River Subbasin.

Fish and Wildlife Resources

Fish and Wildlife Status

Fish

Washougal Winter Steelhead (Threatened, Lower Columbia ESU, 3/98)

Winter steelhead are distributed in the mainstem Washougal, the Little Washougal and various tributaries within the Washougal Subbasin (Figure 3). Generally, Dougan Falls (RM 21.6) is considered the upstream extent of winter steelhead distribution in the mainstem Washougal (WDF 1990). Winter steelhead also move well into the headwaters of the Little Washougal watershed.

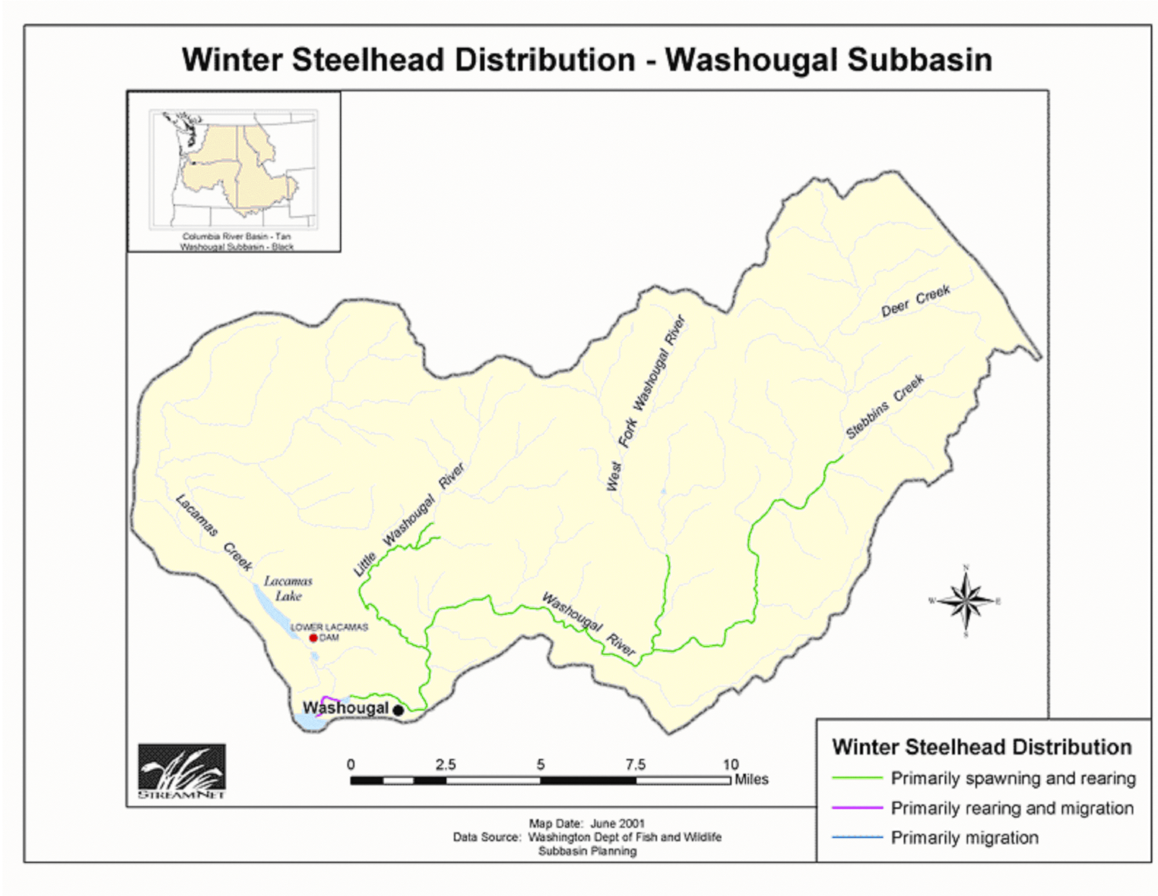


Figure 4. Washougal winter steelhead distribution.

Accurate run size and harvest estimates of wild winter steelhead do not exist (WDF et al.1990). The SASSI stock status of winter steelhead in the Washougal River was "unknown" in 1992 (WDF et al.1993). The LCSCI stock status update in 1998 listed the stock as "depressed" based on a short-term severe decline. The SASSI spawner escapement goal was 841 wild winter steelhead for the Washougal mainstem. This escapement goal for wild winter steelhead was lowered to 541 fish with the LCSCI update (see Table 1). Timing of adult migration most likely occurs January through May, with peak movement in March (WDF et al. 1990).

SASSI recognized a distinct stock of winter steelhead in the North Fork Washougal based on geographical isolation of the spawning population. North Fork Washougal winter steelhead spawn in the mainstem and its major tributaries.

The Skamania Hatchery is located on the lower end of the North Fork Washougal and has been stocking hatchery steelhead into the river system since 1957 (WDF et al. 1993). Approximately 110,000 hatchery winter steelhead smolts are released annually in the Washougal River. These smolts are Skamania origin steelhead, reared primarily at the Skamania Hatchery on the Washougal, but also at the Vancouver and Beaver Creek facilities (WDF et al. 1990). Interbreeding between hatchery and wild steelhead is thought to be very low because of the run timing (WDF et al. 1993)(Wade, 2001)

Table 1. Winter run steelhead peak live fish counts.

Begin Date	End Date	Year	Count Date	Times Surveyed	Miles Surveyed	Count Per Mile	Count	Sampling Method	Calculation Method	Count Comment	Reference
11/1/90	4/30/91	1990					114.0	Helicopter			1
11/1/91	4/30/92	1991					142.0	Helicopter			1
11/1/92	4/30/93	1992					118.0	Helicopter			1

References:

[1] Anonymous. Steelhead Resource Inventory electronic data files unpublished, 9999, (StreamNet Library)

Washougal Summer Steelhead (Threatened, Lower Columbia ESU, 3/98)

The Washougal River and its tributaries are the only stream systems within WRIA 28 that support runs of wild summer steelhead (Figure 4). Stream surveyors, in July 1935, counted lying in deep holes (Bryant 1949). Some 200 of these fish were found below Salmon Falls 539 steelhead within the Washougal River, the majority of which were unspawned fish (RM 14.5) and the others above. These fish were likely mostly summer steelhead waiting until the following spring to spawn. From this 1935 stream survey data, Bryant (1949) concluded that the largest run of fish entering the Washougal River at that time was steelhead.

According to Bill McMillan (1997: letter), "the North (West) Fork Washougal once had a good return of summer steelhead, prior to the construction of the Skamania Hatchery in 1956. In the summer of 1956, 153 native steelhead were trapped at Skamania Hatchery for brood stock, whereas 260 steelhead were scuba counted in the upper mainstem Washougal. This would indicate that 37% of Washougal native summer steelhead returned to the North Fork Washougal in 1956." McMillan (1997: letter) estimated that with late summer steelhead returns included, the North Fork could provide spawning habitat for a potential population of 200-350 wild summer steelhead. Wild summer steelhead in the mainstem Washougal River and tributaries are native and a distinct stock based on the geographical isolation of the spawning population. Similar to other wild summer steelhead stocks in the lower Columbia River area, run timing is generally from May through November and spawn-timing is generally from early March to early June. The Skamania Hatchery has been stocking hatchery steelhead into the river system since the late 1950's. There is concern about the genetic impact of potential interbreeding between wild and hatchery summer steelhead (WDF et al., 1993; Wade, 2001)

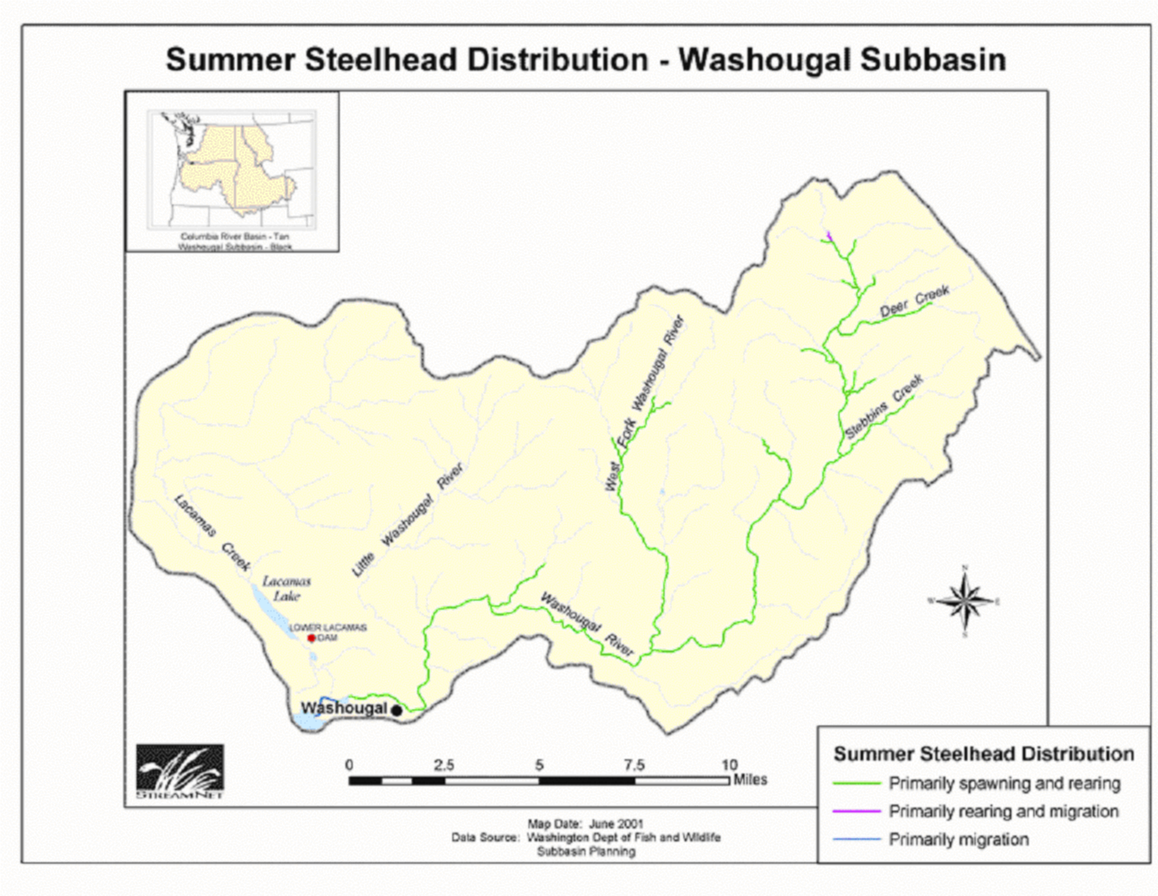


Figure 5. Washougal summer steelhead distribution.

Stock status has changed in recent years. Originally, the status of the stock was determined as "unknown" based on the 1992 SASSI Inventory (WDF et al. 1993). Limited spawner surveys and snorkel surveys of summering adults indicated low numbers of adult steelhead but not enough data was available at the time to assess the status of the stock. In a more recent study, the steelhead stock was determined to be "depressed" due to chronically low escapement measures taken between 1952 and 1997 (LCSCI 1998) (Table 2). Steelhead within the Lower Columbia River Evolutionary Significant Unit (ESU) are federally listed as "threatened" under the Endangered Species Act (NMFS 2001).

Table 2. Washougal summer steelhead stock status and escapement from Wade, (2001).

Table 2a: WRIA 28 Summer Steelhead Stock Status

Summer Steelhead Stock	Screening Criteria	SASSI Stock Status (1993)	LCSCI Stock Status (1997)	Status (ESA Listing)
Mainstem Washougal	Chronically low	Unknown	Depressed	Federal "Threatened"
North Fork Washougal	----	Unknown	Not recognized	Federal "Threatened"

Adapted from WDF et al.1993 and LCSCI 1998.

Table 2b: WRIA 28 Summer Steelhead Escapement Estimates

Summer Steelhead Stock	Wild Steelhead Escapement Goal	1991-1996 Average Wild Steelhead Escapement	Average % of Wild Escapement Goals	Average % of Hatchery Spawners
Mainstem Washougal	576 p	57 I	<40%	1%
North Fork Washougal	295 p	Not available	Not available	87%

p= Preliminary escapement goals for the Washougal River (to be field checked)
I = Index escapement goals and counts.
Adapted from Lower Columbia Steelhead Conservation Initiative 1998.

Washougal Fall Chinook (Threatened, Lower Columbia ESU, 3/99)

Fall chinook distribution within WRIA 28 is now limited to the Washougal River watershed and the lower reaches of Hardy and Hamilton Creeks. SASSI (WDF et al. 1993) only recognizes the Washougal River fall chinook stock. However, Bryant (1949) reported that a survey party in 1936 found 19 chinook salmon spawning within Salmon Creek, and WDF (1951) estimated fall chinook escapement within Salmon Creek at 100 fish in 1950, all of which spawned within the lower 5 miles.

According to WDF (1990), for management purposes, there are two stocks of fall chinook below Bonneville Dam in the Columbia River; lower river hatchery (LRH), lower river wild (LRW). Fall chinook returning to the Washougal are lower river hatchery fish. Native fall chinook have been reported in the Washougal (WDF 1951), but a distinct stock probably no longer exists (WDF 1990; WDF et al. 1993). Natural spawning does occur, but these fish are identified as hatchery strays (WDF 1990).

Brood stock for the Washougal Hatchery was usually obtained from local returning stocks; however, transfers of other stocks into the system were a common practice (WDF 1990).

Bryant (1949) compiled information on stream surveys conducted in the late 1930's. These surveys provided estimates of the amount of suitable spawning habitat and the number of spawning salmon pairs that this habitat could support. According to Bryant there was spawning area for approximately 5,000 pairs of salmon (all species) in the Washougal River below Salmon Falls (RM 14.5). In 1951, WDF estimated escapement of fall chinook within the Washougal River at 3,000 fish. Today, fall chinook within the

Lower Columbia River Evolutionary Significant Unit (ESU) are federally listed as "threatened" under the Endangered Species Act (NMFS 2001).

The Washougal River fall chinook stock was designated on the basis of spawning time and geographic distribution. Washougal River fall chinook spawn in the area from Salmon Falls (RM 14.5) downstream approximately 4.0 miles (Figure 5) (WDF et al. 1993; WDF 1973; WDF 1951). Natural escapement is estimated using spawning ground counts within selected index areas. Natural spawn escapements from 1967-1991 averaged 1,832 with a low return of 70 in 1969 and a peak return of 4,578 in 1989 (WDF et al. 1993). Since 1971, the annual natural escapement has averaged 2,157 fish. SASSI (WDF et al.

1993) listed the Washougal River fall chinook natural spawn stock status as healthy based on escapement trend.

Natural spawning occurs in the Washougal River slightly later (October to November) than other lower Columbia River tule fall chinook stocks. The Washougal River fall chinook natural spawners are a mixed stock of composite production (WDF et al. 1993).

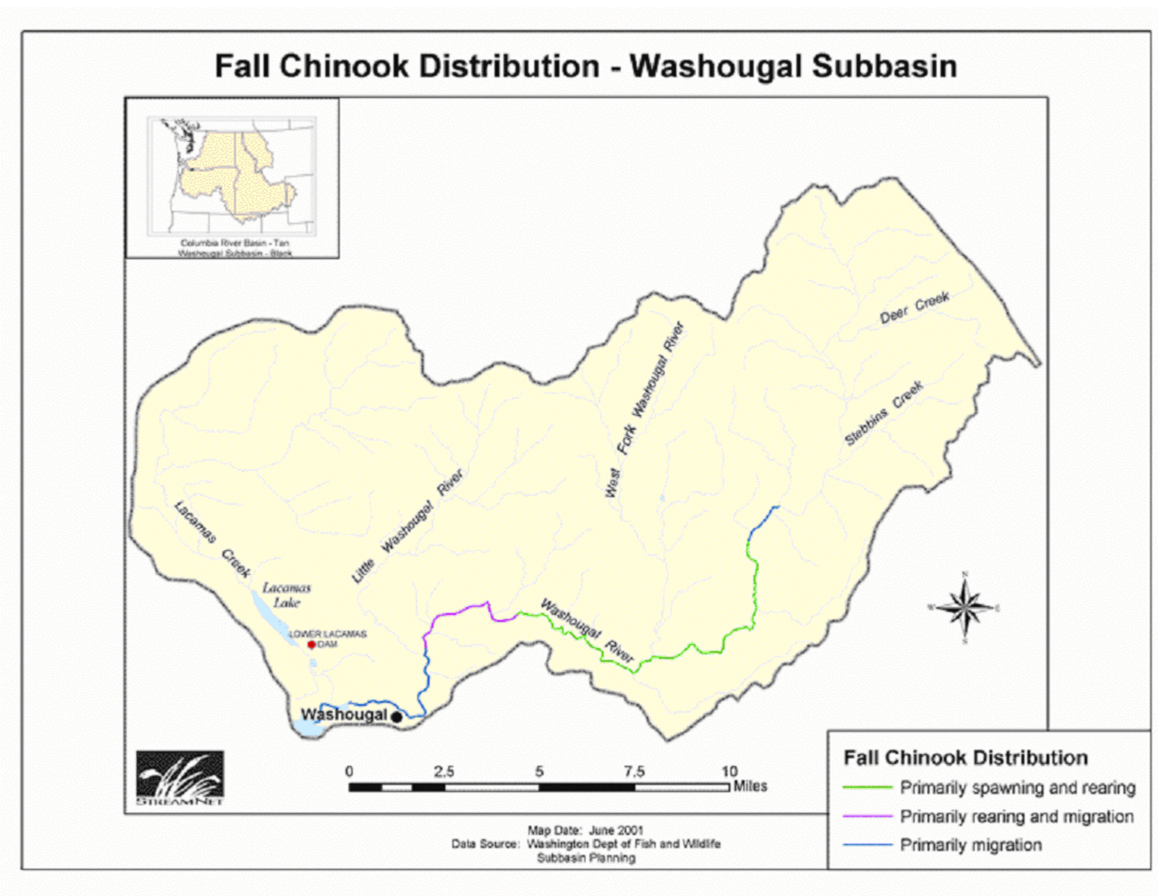


Figure 6. Washougal Fall Chinook Distribution.

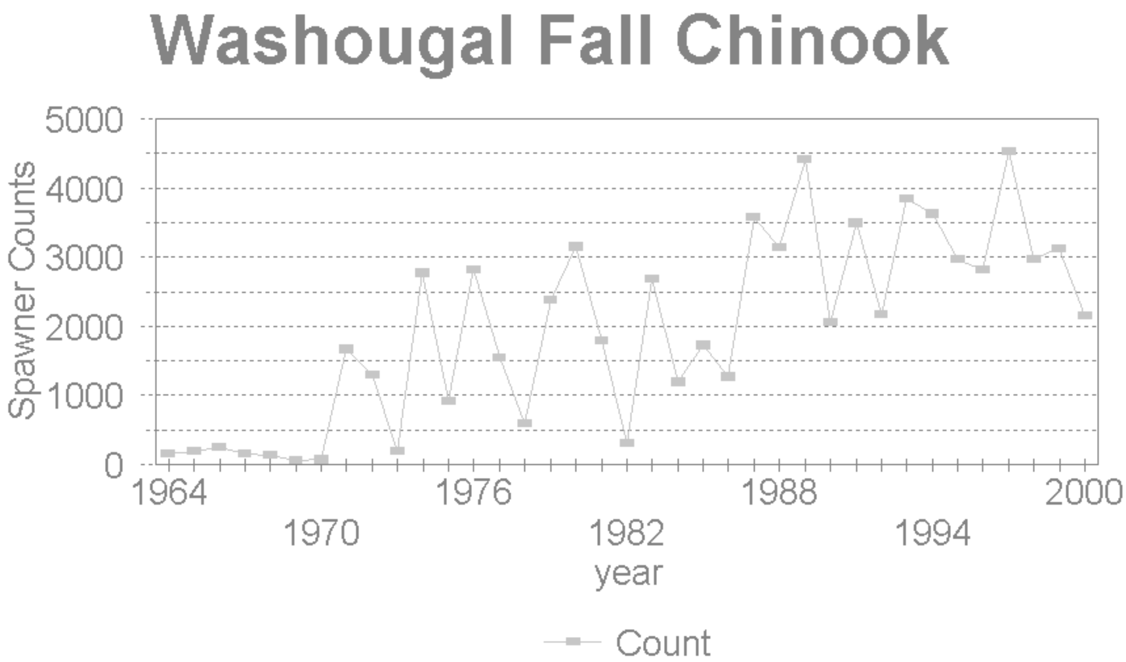


Figure 7. Washougal Fall Chinook wild escapement 1964-2000.

Washougal Coho (ESA candidate, Lower Columbia ESU, 7/95)

Known coho distribution extends through the mainstem Washougal River to Dougan Falls (RM 21.6), into the Little Washougal and North Fork Washougal, and into a number of smaller tributaries (Figure 7). Minimal amounts of data exist on the historical run size of coho in the Washougal. WDF (1951) estimated that 3,000 silver salmon (coho) annually enter the Washougal River to spawn. Bryant (1949) estimated that there was spawning area for approximately 5,000 pair of salmon below Salmon Falls (RM 17.5), and another 1,000 pairs between there and Dougan Falls. Before Salmon Falls was laddered in the late 1950's, coho spawned mainly in the tributaries below the falls including the Little Washougal, Winkler Creek and the North Fork Washougal (WDF et al. 1990).

Typically, coho begin entering the Washougal River in early September and continue through November. Holding is relatively short, with spawning commencing about mid-October and continuing through November. Incubation extends from late October through January with emergence occurring in late January and early February (WDF1990).

By the time fish surveys were first conducted in the Washougal, serious habitat damage had already occurred. Deforestation of the upper Washougal watershed due to the Yacolt Burn caused serious habitat degradation. Three small hydroelectric dams that formed low water barriers to fish migration until their removal in 1947 also degraded habitat. In 1958, the Washougal Hatchery was constructed and became a major producer of hatchery coho. Hatchery coho have been planted in the sub-basin since at least 1967. By 1973, the largest salmon run in the Washougal River was early stock hatchery coho. Minor mainstem coho spawning occurred and spawning was light to moderate in the tributaries (WDF 1973).

SASSI (WDF et al. 1993) listed the Washougal River coho stock status as "depressed" based on chronically low production. Natural spawning is presumed to be quite low and subsequent juvenile production is below stream potential.

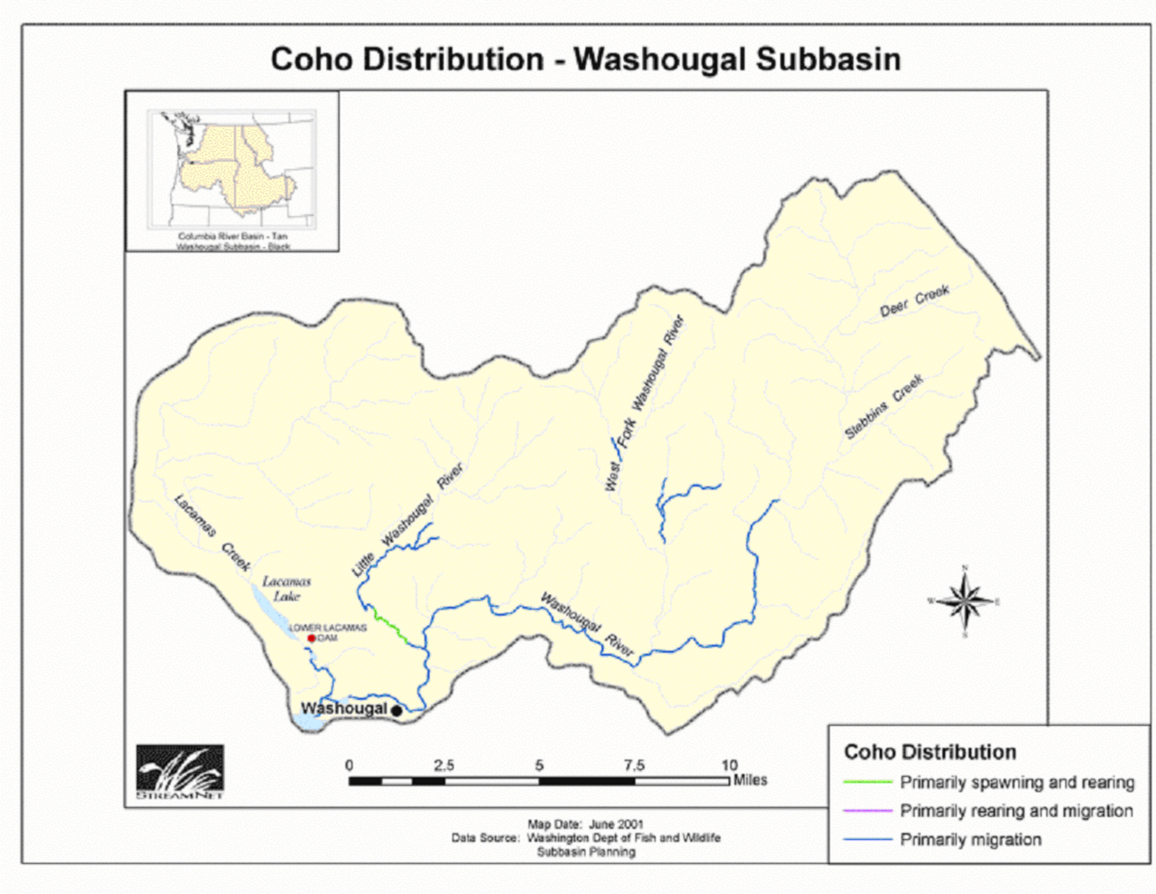


Figure 8. Washougal coho distribution.

Washougal Chum Salmon (Threatened, Lower Columbia ESU, 3/99)

There have been a few historical records of Chum salmon in the mainstem Washougal River (WDFW, 2001). However, previous surveys were conducted primarily for fall Chinook coded wire tag recoveries and upstream of typical Chum spawning areas. They were not conducted during chum spawning times nor at downriver spawning locations. In 1998, WDFW performed limited non-index spawning ground surveys and found one chum in the Washougal. In 2000, BPA funded PSMFC to conduct more intensive non-index surveys. One chum was found in Lacamas Creek a downstream tributary (RM 0.8) of the Washougal in 2000. Chum have "threatened" status under ESA (NMFS, 1996b). Efforts are being made to reestablish Chum numbers and populations (see Management Section).

Washougal Coastal Cutthroat Trout (ESA candidate)

According to Blakely et al. (2000), anadromous, fluvial, adfluvial and resident forms of cutthroat trout inhabit the Washougal watershed. Anadromous coastal cutthroat are found in the mainstem and most of its tributaries up to Dougan Falls, which is believed to be a barrier in most years to adult passage. Fluvial and resident coastal cutthroat are found throughout the watershed in the upper mainstem and tributaries including Lacamas Creek, the Little Washougal, the North Fork Washougal, Canyon Creek, Timber Creek, and Prospector Creek. Adfluvial fish are found in Lacamas Lake. Anadromous cutthroat enter the river from July through December and spawn from January through June. Fluvial, adfluvial and resident fish spawn from February through June. Washougal River cutthroat are considered a native stock of composite production (see Table 3).

The status of Washougal coastal cutthroat is "unknown" because there is insufficient quantitative information to identify a trend in abundance or survival. Anecdotal information from local residents, combined with generally poor habitat conditions suggest that this stock may be "depressed". It should be noted that hatchery-origin anadromous cutthroat in the Washougal River rebounded in 1995-1996. A hatchery anadromous cutthroat broodstock program was maintained at the Skamania hatchery, and used to release 29,000 cutthroat annually into the Washougal River (Blakley et al. 2000). However, cutthroat are no longer released in the Washougal River (Hymer 2000: personal comm.).

Table 3. WRIA 28 Coastal Cutthroat Stock Status Coastal Cutthroat Stock (from Wade 2001.)

Stock	Origin Production	Type Stock	Status
Salmon Creek	Native	Composite	Unknown
Washougal River	Native	Composite	Unknown
Bonneville Tributaries	Native	Wild	Unknown

Wildlife

Spotted owls, bald eagles, and Larch Mountain salamanders are all species of concern statewide and in the Washougal River watershed. Whereas the ecological needs and population status of owls and eagles have been well described, little is understood regarding Larch Mountain salamanders. Work being conducted in the watershed will increase our understanding of this species.

Mapping and inventorying wildlife habitats is key to protection of the Washougal River wildlife. Remote sensing and GIS technologies have been used elsewhere to map current conditions of critical habitat components. We need to do the same for WRIA #28 for the key species and then model habitat changes and their impacts on wildlife in the future.

Managing the Washougal River watershed at the landscape scale will aide in protecting all native species, including ETS species. Understanding individual species habitat requirements and interactions with other will improve long-term sustainability of wildlife diversity in the watershed.

Elk, deer, and goose populations in the watershed are-doing well and maintaining themselves through natural production and are not imperiled at this time. However, increased human development and changes in land management practices will affect species distribution and productivity. We must model for habitat changes, foresee problem areas, and initiate management strategies now to meet species objectives in the future.

A great number of bird species are associated with or require riparian habitats along the Columbia River and its tributaries. As a subset of this guild, the neotropical migrants (e.g., willow flycatcher, yellow warbler, yellow-breasted chat, red-eyed vireo, Vaux's swift) continually exhibit declining population trends in this region. Lewis's woodpeckers are closely associated with large cottonwood stands. Historically, they were common in cottonwood habitats of the Columbia River but declines were noted after 1965 and they are now considered absent from Columbia River riparian habitat. The yellow-billed cuckoo is a riparian obligate species that was once found along the Columbia River but has not been confirmed breeding in Washington for more than 20 years. Other species that are marsh obligates include the Virginia rail, sora rail, and marsh wren. Loss of riparian and riparian-marsh habitat for these birds resulted from the inundation and alteration of habitats in the Columbia River mainstem and tributaries.

Habitat Areas and Quality

Past natural and anthropogenic disturbances have had significant impacts on habitat conditions within the subbasin. The Yacolt Burn, forestry practices, splash and hydroelectric dams, road construction, mining, residential and industrial development, water withdrawals, and industrial pollution from paper mills have all altered habitat conditions within the subbasin. While some habitat conditions have improved over time, other habitat conditions have been much slower to recover from past impacts.

Many reaches of the mainstem Washougal and its tributaries still lack adequate structural LWD, spawning gravels, and quality pool habitat. Culverts and dams still block passage to critical and very limited tributary habitat. Stream adjacent roads continue to alter riparian function and stream hydrology, and contribute fine sediments to spawning gravels. Water withdrawals continue to limit available spawning and, especially, rearing habitat within the subbasin. Development continues to reduce critical floodplain and riparian functions. Recommendations for addressing the major habitat limiting factors in the subbasin include the following.

Access

Steep gradients and numerous falls limit access to critical tributary spawning and rearing habitat in the Washougal River Subbasin. Artificial passage barriers further limit the habitat available. Reopen as much tributary habitat as feasible, starting with the removal or alteration of some major passage barriers such as the dam on Wild Boy Creek.

Floodplain Connectivity

Floodplain connections have been lost along portions of the mainstem Washougal and its major tributaries. Floodplain development that eliminates critical salmonid habitat is still occurring within the urban areas of Washougal and Camas. Local jurisdictions need to update existing regulations to increase protection of the remaining floodplain habitat. Opportunities for restoration and enhancement of floodplain and side channel habitat occur on the mainstem Washougal River, along the lower reaches of the Little Washougal, in School House Creek, and in Slough Creek.

Streambed Sediment Conditions

Stormwater inputs, all-terrain vehicle (ATV) use, vegetation control in power line corridors, stream adjacent roads, farming and other land uses contribute excessive fine sediment to stream systems within the Washougal Subbasin. Road related problems are especially apparent in the upper Washougal basin. Recommendations include:

- Local jurisdictions need to review and update erosion and stormwater measures and shoreline regulations to assure protection of aquatic resources from urban and rural development.
- Continue to develop educational programs and incentives programs for landowners to alter various land use activities that negatively impact riparian corridors and increase fine sediment inputs.
- Fence cattle out of stream systems and restore riparian corridors to reduce erosion.
- Restrict ATV use to areas where impacts can be mitigated.

Channel Conditions

Almost throughout the subbasin, functioning LWD is scarce or absent. The lack of LWD, combined with the hydrologic impacts of the Yacolt Burn and subsequent logging, have left many of the stream channels in the Washougal scoured to bedrock and without adequate spawning gravels or pool habitat. The lack of LWD was considered one of most significant limiting factor in the Washougal Subbasin. Supplementation of LWD is needed in specific areas to provide short-term benefits; however, long-term LWD recruitment is needed to maintain the benefits.

Riparian Conditions

Riparian conditions are slowly improving within the Washougal River Subbasin, and unlike the more developed Lake River Subbasin, there are some fairly extensive areas with “good” riparian conditions in the Washougal River Subbasin. These areas are almost all located in the upper reaches of the mainstem Washougal and its tributaries on public or private industrial lands. Protection of these somewhat healthy riparian areas is critical to salmon recovery efforts in the subbasin. Restore degraded riparian habitat along the more developed lower reaches.

Water Quality

While some major water quality issues in the lower river have been largely resolved over the last few decades, various water quality problems continue to plague the watershed. Elevated water temperatures remain a serious concern in many areas of the Washougal River Subbasin. Poor riparian conditions, low streamflows, stormwater and road related issues, impoundments, recreational impacts, and a channel scoured to bedrock all contribute to elevated water temperatures. Only a concerted long-term effort to address these related problems will reduce water temperatures and increase water quality in the subbasin.

Water Quantity

Both elevated peak flows and low flows are considered limiting factors for salmonids in the Washougal River Subbasin. All but the upper reaches of the subbasin are hydrologically immature. Streams are subject to increased peak flows that can cause bed and bank scour and channel shifting to the detriment of egg and fry survival. Reduction of peak flows requires maintenance of mature forest cover in the subbasin and a reduction in stormwater impacts. Water withdrawals from Jones, Boulder, and Lacamas Lake reduce already low summer streamflow within the Little Washougal watershed and Lacamas Creek. The City of Camas and the Camas paper mill need to reduce the impacts of their water withdrawals on listed salmonids. Low summer flows, combined with high public use above Dugan Falls, also negatively impacts the adult population of summer steelhead through harassing and/or killing of holding fish. Reduce these impacts through increased public education and outreach, additional enforcement of existing regulations, and creation of sanctuaries for steelhead in critical holding areas within the upper Washougal River.

Biological Processes

Escapement for most anadromous fish is well below historic numbers and the lack of carcasses contributing nutrients to stream systems may be limiting production. Assess the potential for carcass placement projects within the subbasin to increase nutrient levels and potentially productivity. TAG members expressed concerns about warm-water predators in the lower river and the impact of hatchery fish on stocks of summer steelhead within the subbasin. Hatchery operations need to review and update their plans to protect native stocks of salmon and steelhead.

Priority Habitats In Need Of Protection

- The upper reaches of the Washougal River mainstem and its tributaries contain some of the best, most functional habitat within WRIA 28. Cool, clear water from these reaches buffers downstream impacts to water quality, and somewhat healthy riparian areas provide LWD recruitment to downstream reaches. Protect these streams that provide some of the best remaining habitat for summer steelhead stocks in the lower Columbia River.
- Most of the functional habitat within the Little Washougal River, and the North Fork Washougal also occurs within the headwaters. Protection and enhancement of these headwater reaches will benefit multiple stocks of salmon, steelhead, and coastal cutthroat trout.
- A substantial amount of the floodplain and side-channel habitat within the Washougal Subbasin has been lost or disconnected from the streams. Protection and enhancement of these habitats is critical for salmonids rearing within the subbasin.
- Urban and rural development within the Washougal Subbasin has also substantially increased impervious surfaces and reduced forest cover. Protection and enhancement of existing wetland habitat anywhere in the subbasin would provide

multiple benefits for salmonids, especially within the Little Washougal and Lacamas Creek watersheds.

Watershed Assessment

The Washougal River drains an area of approximately 240 square miles. It is located mostly in Clark County, but includes a small portion of Skamania County. The lower two miles of the Washougal River are within the Columbia River valley. The river then enters a narrow, shallow valley until it reaches Salmon Falls (RM 14.5). From Salmon Falls to the headwaters, the river flows almost entirely within a narrow, deep canyon (WDF 1990). Major tributaries include Lacamas Creek, the Little Washougal River, Canyon Creek, the North Fork Washougal River, and Dugan Creek.

The Cities of Camas and Washougal are the largest urban centers within the Washougal subbasin. Urban and rural residential development covers a substantial portion of the lowland areas within the Subbasin. Industrial uses have impacted this area since approximately 1884 when the Crown Zellerbach pulp mill was located at the mouth of the Washougal River (Van Arsdol 1986). Agriculture is practiced on the Columbia River flood plain, but forestry uses prevail outside of the lowland areas.

The topography of the Washougal subbasin is variable. The highest elevations are located at 3,200 feet in the headwaters of Bear Creek, a first order tributary of the Washougal River. The lowest elevations are found at the mouth of the Washougal River on the Columbia River floodplain at 20 feet MSL. Topography of this area is generally rugged, limiting development to the Columbia River floodplain. The Washougal River is a relatively low gradient tributary of the Columbia River. Slope increases at the confluence of the West Fork Washougal River at RM 14.5. Anadromous fish passage for some species was generally limited to the lower part of the river below Salmon Falls until a fishway was constructed at Salmon Falls, located at RM 14.5 (WDF 1990). Current salmon distribution continues up to RM 21 at Dougan Falls, with summer and sometimes winter steelhead moving beyond the falls into the headwaters

Rainfall and groundwater provide the available surface water in this subbasin. Discharges have averaged 873 cubic feet per second (cfs) over a 37-year period. Flows are highly variable due to topography, human induced alterations, and natural occurrences such as fire. A series of fires, termed the Yacolt burn, deforested 0.25 million acres in 1902, 1927, and 1929; reducing the hydrologic maturity of the watershed (WDF 1990; Van Arsdol 1986). As early as 1883, alterations to Lacamas River occurred by way of a tunnel connecting Lacamas Lake to the Columbia River at the present town of Camas (Van Arsdol 1986).

The Washougal River fish habitat has been degraded from the upper reaches downstream to its' mouth in Camas. The Yacolt Burn deforested large tracts of land in the upper reaches causing an increase in sediment transport, a reduction in hydrologic retention, and a general decline in habitat quality. Gravel extraction in the lower 20 miles of the river has caused a loss in suitable spawning substrate through this reach. Three dams were constructed by the Cotterell Power Company, which prevented fish passage during low flows. These dams contained fish ladders that were deemed inefficient (WDF 1990).

The dams were eventually removed in 1947. Effluent from the kraft pulp mill located at the mouth of the Washougal River in Camas has been directly recognized as a contributor of fish mortality (WDF 1990; WDF 1951). Water quality remains a problem and the Washougal River is listed on the 303d list (WDOE 2000) along with several of its' tributaries.

Limiting Factors

The Washougal River Subbasin includes the Washougal River and its tributaries including the Little Washougal, West Fork Washougal, Lacamas Creek, Cougar Creek, Jones Creek, Boulder Creek, Dugan Creek, and a number of other productive streams. The Washougal River watershed encompasses about 240 square miles and flows southwesterly approximately 33 miles to its confluence with the Columbia River at River Mile (RM) 121 at the city of Camas. The lower two miles of the river are located within the Columbia River valley. A narrow, shallow valley characterizes the next eleven miles, and the upper reaches flow through a narrow deep canyon extending into the Yacolt Burn area (Caldwell et al. 1999; WDF 1990).

Significant damage to salmon and steelhead habitat occurred in the early 1900's beginning with the Yacolt Burn, a series of huge forest fires that deforested the upper slopes of the watershed. Following the fires, loggers salvaged the remaining timber from already denuded slopes and built numerous splash dams to flush logs to mills on the lower river (WDF 1990; Parsons unknown date). The effect of these fires, logging, and splash damming on channel morphology is still apparent in the watershed (TAG; WDF 1990). Gravel mining impacted salmon runs by removing much of the spawning gravel in the lower 20 miles of the basin (WDF 1990). Three dams, sited on the lower river, partially blocked passage into much of the basin until they were removed in 1947. Fish also had to contend with toxic sulfite wastes released from the pulp mill that continued to pollute the river well into the 1960's (WDF et al. 1993; WDF 1990; WDF 1951; Bryant 1949).

The cities of Washougal and Camas, located near the mouth of the Washougal River, and the surrounding rural areas have experienced rapid growth over the last 20 years. The resulting urban and rural residential development has contributed to habitat problems within the basin (Caldwell et al. 1999; Wildrick et al. 1998; WDF 1990; WDF 1951). Two hatcheries are located in the Washougal basin. The Washougal Hatchery, located 16 miles east of Camas on the mainstem Washougal, is a major producer of coho and chinook (WDF 1990), whereas the Skamania Hatchery, located on the North Fork Washougal, raises both winter and summer steelhead (WDF 1990).

Access

Historically, Salmon Falls at RM 14.5 was the first barrier encountered by migrating salmon and steelhead. Steelhead are the only species capable of consistently ascending the falls until a fishway was constructed in the 1950's (WDF 1990). Dugan Falls, at RM 21 (see Figure 8), is generally considered the upstream limit of salmon and winter steelhead migration, while summer steelhead move well into the headwaters (TAG, WDF 1990. However, according to Bill McMillan (2000: personal comm.) wild winter steelhead do ascend Dougan Falls in low numbers, and they represent a small, but genetically important part of Washougal River steelhead diversity.

Falls and cascades also limit access to other parts of the watershed including:

- A natural falls on Lacamas Creek at approximately RM 0.9 blocks all upstream passage.
- A falls blocks anadromous passage approximately 600-feet upstream from the mouth of Cougar Creek.
- A bedrock chute at the mouth of Dugan Creek prevents larger fish from accessing the upper reaches.
- Falls block passage into Prospector/Deer Creek approximately 200 yards from the confluence with the Washougal (McMillan 1997: personal comm.).
- Sheetflow across bedrock near the mouth of Meander Creek may restrict passage at times into the upper reaches. TAG members suggest that LWD could reduce water velocities and help develop step pool habitat that would increase access.
- McMillan (1997: letter) also noted that large log jams in the lower reaches of both Bluebird and Silver Creeks have become cemented with gravel accumulating behind the jams. The condition of these jams needs assessment, as the jams potentially restrict passage, and block the movement of gravel to downstream reaches.

Artificial passage barriers also restrict access to various parts of the subbasin including:

- The weir at the Washougal Hatchery diverts summer steelhead into holding ponds until the flows increase, reducing the natural upstream movement of the fish. The hatchery intake dam also presents a potential barrier at low flows (TAG).
- A water intake structure for the Skamania Hatchery at the mouth of Vogel Creek blocks all passage into the stream system. Passage is blocked to reduce the chance that adult salmon will transmit diseases to the water supply for the hatchery.
- The City of Camas operates small dams on Jones Creek at RM 1.5 and on Boulder Creek at RM 1.5 that block passage to upstream habitat (Quinn 2000: letter). The quantity and quality of available habitat upstream of these structures is unknown. A natural 6-foot waterfall below the dam at RM 1.0 on Boulder Creek may already limit access to all species other than steelhead (Quinn 2000: letter). TAG members report that good habitat exists above the dam on Jones Creek.
- Fish screens on the intakes for Jones and Boulder Creek dams may also affect juvenile fish passage. According to Quinn (2000: letter) Steve Manlow of WDFW inspected the fish screens on both Jones and Boulder Creeks during a field visit. He said that the screening system was adequate, except that the screens had approximately1/4-inch openings instead of 1/8-inch openings required by Washington State Code and the NMFS Juvenile Fish Screen Criteria. The species potentially impacted by these screens include resident cutthroat and rainbow trout in the upper watershed. It is anticipated that the screen mesh size will be upgraded in the near future.
- Longview Fiber operates a 30- to 40-foot high dam on Wild boy Creek that is a complete passage barrier. Longview Fiber does not have any immediate use or plans for the Dam or reservoir, but Steve Hanson (2000: personal comm.) suggested that Longview Fiber has considered selling the property for summer homes. The

dam blocks access to approximately 1.7 miles of good habitat for three species (see Table 4). The size of the dam and the amount of sediment perched behind the dam would make removal very expensive (Hanson 2000: personal comm.).

Seven culverts were identified as partial or blocking barriers in the Washougal basin by the Clark County Culvert Inventory (Huntington, 1997) including:

- Dial Creek has a barrier above a natural falls that blocks anadromous passage (TAG; Huntington 1997).
- An Unnamed tributary to the Little Washougal at N.E. Blair Road has a partially blocking culvert; however, this stream was not identified as having anadromous fish.
- An Unnamed tributary to the Washougal that was not identified as having anadromous fish has a barrier in Section 32.
- Winters Creek has a partial to total barrier, but it is also above the anadromous zone.
- A partial and transient velocity barrier on Coyote Creek under the Washougal River Road (Section 32 tributary) that is in the process of being repaired or replaced.
- Jones Creek has a partial barrier (likely at least a juvenile barrier) under the Boulder Creek Road (Huntington 1997; TAG).
- Winkler Creek has a partial to total barrier that blocks access to approximately 0.78 miles of habitat at N.E. Borin Road; particularly at low and high flows. This culvert is slated for removal by Clark County.

There are also a number of small tributaries that could provide small amounts of rearing habitat for coho, steelhead, and cutthroat that have blockages near their confluences with the Little Washougal including: Jackson Creek, Cotter Creek, and Larson Creek at Stauffer Road, and other unnamed streams. A perched culvert on Timber Creek on state land near Miller Gate Crossing may also affect passage (TAG).

Floodplain connectivity

Various past land uses have reduced floodplain and associated wetlands habitat within the Washougal River watershed. Extensive splash damming, logging, and the loss of cover afterthe Yacolt Burn has left a channel that is scoured to bedrock and incised in many areas (WDF1990; WDF 1951). These alterations have disconnected the mainstem from historical sidechannel and floodplain habitat limiting available rearing and overwintering habitat within the watershed and likely affecting overwinter survival (TAG; Cowan 2000: letter; WDF et al. 1993).

Floodplain connectivity has been seriously reduced by various land use activities in the lower Washougal subbasin (TAG; WDF et al. 1993; WDF 1990). Most of the north side of the Camas Slough has been riprapped to protect the industrial sites. Floodplain connectivity and available habitat in the Camas Slough was also reduced with the filling of Lady Island to construct SR 14 and the railroad crossing (TAG). A large proportion of the lower Washougal from the mouth to Little Washougal at RM 5.6 has been diked and riprapped, with past and ongoing development occurring within the floodplain (TAG). Diking along the abandoned gravel pits adjacent to the lower river on the south bank has reduced connectivity to off channel habitats except during higher flows, with the possible result that fish are then stranded (TAG). A large reach along the east bank of Schmidt's property, near 32nd Street and K Street, has also been diked and disconnected from the river (TAG). TAG members suggested that the channel is also somewhat incised in this reach.

Public parks protect most of the Lower Lacamas Creek upstream from the 3rd Avenue from development impacts. The potential to improve floodplain and side-channel habitat exists along this protected, vegetated corridor. Between the confluence with the Little Washougal (RM 5.6) and Salmon Falls at RM 14.5, the Washougal River channel is generally a single thread system entrenched in bedrock, with some areas lined with riprap (TAG). The upper reaches flow through a narrow deep canyon with minimal floodplain development (Caldwell et al. 1999; WDF 1990). Stream adjacent roads run along most of the river to the headwaters, reducing the possibility of additional floodplain development (see Map A-11). Fires, past logging, splash damming, LWD removal, and ongoing land use activities have all contributed to a channel that has incised down to bedrock in many areas.

Development along the Little Washougal and its tributaries has also altered floodplain connections in the Little Washougal watershed. Riprap, dikes and filling to protect residential development and enhance agricultural lands have reduced floodplain connections and available habitat (McMillan 2000: personal comm.). Stream adjacent roads (Blair and the Stauffer Roads) and residential encroachment along Stauffer Road also tend to disconnect the stream from its floodplain. TAG members also noted severe channel incision in areas.

Like the upper mainstem Washougal, the West Fork Washougal is largely a single thread steam confined within a steep canyon (TAG). Two small creeks that do not appear on the 1:24,000 DNR hydrography layer (they are not typed as fish bearing streams) could provide important rearing and potentially spawning habitat. School House Creek is an unnamed and unnumbered tributary to the Washougal River that enters the Washougal near the WDFW boat launch above RM 13, just across the Skamania County line. This is a low-gradient, spring-fed stream with good water quality. Where the creek now crosses Washougal River Road and Malfait Tract Road there is a 100-foot long blocking culvert. The potential exists to restore some off-channel habitat and forested wetlands by diverting the creek to the west into another stream and through another passable culvert. This would open a substantial amount of rearing habitat that is presently very limited within the Washougal Subbasin. The stream could also potentially provide additional tributary spawning habitat for steelhead, coho, and cutthroat trout. Slough Creek, another unnamed, unnumbered tributary to the Washougal River, enters the Washougal above the Vernon Road Bridge (approximately RM 14). It is a spring fed sidechannel of the Washougal that provides good rearing and potentially spawning habitat for steelhead, coho, and cutthroat trout. The bridge crossing altered the existing stream channel, and three homes occupy the floodplain and reduce floodplain connectivity.

Bank Stability

Streambanks are generally stable along the Camas Slough and lower Washougal, since much of the area has been riprapped and/or diked. Further upstream streambanks are largely bedrock and stable as well. However, areas with localized erosion and instability occur. A hillside on the south side of the Washougal just downstream from the Vernon Road Bridge has been destabilized by a road cut across the hillside and by subsequent clearing and construction of an off road track (TAG; McMillan, Ed 2000; personal comm.). The unstable area is very large, with the potential to cause significant problems for the Washougal River drainage, even the potential to temporarily block the Washougal River (TAG; McMillan, Ed 2000: Personal comm.). This slide is part of an historic slide, as large as 1.5 miles across and ¾ of a mile deep (McMillan, Ed 2000: Personal comm.). Clark County is monitoring the progress of the slide and it appears that there may not be any way to stabilize the slope (TAG; McMillan, Ed 2000). The immediacy of the problem is unknown at this time.

Another unstable area noted with localized erosion was just below Salmon Falls. According to Bill McMillan (2000: letter), ever since the 1977 flood the island just downstream of the falls has continuously eroded away. The erosion has provided needed recruitment of gravel to the mid-Washougal. However, the entire side of the bluff continues to fall away where homes have cleared the vegetation from the edge of that bluff (McMillan 2000: personal comm.).

Overall bank stability was considered "fair to good" along the Little Washougal and most of its tributaries, with some localized erosion above natural rates (TAG). The most significant erosion along the Little Washougal occurs below Stauffer Road.

Other localized areas with bank erosion within the subbasin included:

- Both the Moto-Cross activities and cattle access to the stream reduces bank stability in Winkler Creek (TAG; McMillan 2000: personal comm.).
- A culvert at Millers Gate on Timber Creek focuses water into a downstream bank, increasing erosion (TAG).
- Fort James opens a gate at the east end of Oak Park Bridge on S.E. 6th Avenue that allows off-road vehicles access to the river to launch boats. Numerous trucks drive along the riparian zones in the lower river creating localized erosion, eliminating riparian vegetation and preventing reestablishment, and potentially leaking contaminants directly into the river.
- A culvert failure led to a debris flow on East Fork Dugan Creek (TAG; Johnson 2000: personal comm.). This failure actually contributed a huge load of scarce spawning gravel to downstream habitats.

Large Woody Debris

LWD was rated poor almost throughout the subbasin (TAG). Extensive splash damming occurred in the early part of the century on the Washougal system (McMillan, Bill 2000: personal comm.; Bryant 1949; Parsons unknown date)(see Figure 11). LWD was either actively removed from many of the channels and/or scoured from the channel when the stored logs were released. Fires in the early century combined with extensive logging after the fires reduced the recruitment of new LWD, and the subsequent logging of second growth forests has further reduced any LWD recruitment potential (McMillan, Bill 2000: Personal comm.; WDF 1990; Parsons unknown date).

Some of the upper portions of the Little Washougal, the West Fork Washougal and mainstem Washougal basin now contain "good" riparian habitat conditions where near-term recruitment potential is fairly high. Some of the best riparian habitat in the subbasin exists along the lower Lacamas Creek corridor. Yet, even in this system, few structural pieces of LWD remain in the channel. LWD is very scarce in the Little Washougal basin, including most tributaries. TAG members stated that LWD supplementation would likely provide substantial benefits in the Little Washougal watershed. LWD supplementation would also benefit a number of other creeks within the subbasin.

Pool Frequency

Information on pool habitat within the subbasin came almost exclusively from observations of the TAG. No comprehensive data on channel conditions exists for the Washougal and its tributaries. TAG members stated that pool habitat is limited in almost all streams within the subbasin, as structural LWD is also generally lacking. What pool habitat remains in the basin, after the active removal of LWD and the effects of splash damming, is largely controlled by bedrock.

The Camas Slough and the lowest reaches of the Washougal are tidally influenced backwaters of the Columbia. Above the tidal areas on the mainstem Washougal to the Little Washougal confluence the channel contains mainly glides and riffles, with only a few bedrock-formed pools. This lack of pool habitat continues through the middle and into the upper reaches of the mainstem Washougal (TAG). Low flows and extensive recreational use during the summer months further reduce the amount of pool refuge available for adult summer steelhead and juveniles salmonids attempting to rear in the river (McMillan 2000: personal comm.; WDF 1990).

Pool habitat within the Little Washougal and its tributaries is also very limited. This condition is also somewhat attributable to the lack of structural LWD in the stream channels (TAG). TAG members rated pool frequency as poor within the mainstem Little Washougal, Jones and Boulder Creeks, and the East Fork Little Washougal. Pools within the North Fork Washougal are also infrequent and largely bedrock formed. Of all the streams in the Washougal subbasin that the TAG was familiar with, only Wild Boy Creek has even "fair" pool frequency.

Side Channel Availability

Reductions in the amount of side channel habitat occurred within the lower Washougal River and the Camas Slough as a result of various land use activities including: gravel mining, the alteration of the Washougal River's entry into the Columbia due to the construction of Ladies Island dike and the State SR 14 Bridge across the Camas Slough in the mid 1960's, industrial development and diking, and the loss of stream adjacent wetlands and beaver ponds (TAG; McMillan 2000: personal comm.; WDF 1990; WDF 1973; WDF 1951). There is a definite need to restore side-channel and off-channel habitat in the lower river (TAG). Mainstem spawning areas are subject to disturbance from extremely high flows, and rearing habitat with refuge from these high flows is limited within the subbasin (TAG).

There is restoration potential for historic side channel habitat within the lower Washougal River at a number of sites including:

- At the abandoned gravel pits just above RM 1,
- Just upstream of 3rd Ave. on Lower Lacamas Creek,
- Below the bowling alley near the 3rd Ave. loop (RM 1.5),
- Near the 17th Street Bridge (RM 3),
- Along Hathaway Park at RM 3.5, and
- Along Schmidt's property upstream of the 17th Street Bridge (approximately RM 4). Further upstream between RM 5.6 and RM 14.5 the river channel is somewhat incised reducing connection to historic side channels (TAG). However, there were a number of areas noted between RM 13 and RM 14.5 where side-channel habitat still exists including:
- At Slough Creek and the Steel Bridge,
- Near the mouth of Schoolhouse Creek (RM 13.7),
- In an area of wetland complexes on the south side of the river across the river from Schoolhouse Creek,
- At Canyon Creek Road where a culvert blocks access to a wetland complex,
- Just below Salmon Falls.

The upper Washougal is largely a single thread stream that is entrenched down to bedrock, with little potential for development of additional side channel habitat. A large wetland complex located at the Salmon Hatchery (RM 20) has been converted so that the water now runs through the hatchery, eliminating historic access to potentially critical habitat. According to Bill McMillan (2000: personal comm.), "this series of wetlands, ponds, and the creek continue upstream nearly to Dougan Falls in that same extended flat the hatchery facility is built on". It may be possible to reconnect that wetland/creek system back into the Washougal, and provide additional side channel spawning and rearing habitat.

Side Channel availability is generally either unknown or poor for most tributaries within the Washougal Subbasin. TAG members noted that some side channel habitat exists on the Little Washougal River, but overall it is very limited. Tributaries to the Little Washougal (Boulder, Jones, and EF Jones Creeks) also have generally limited side channel habitat available (TAG).

Substrate Fines

Substrate fines are not considered a major problem within the mainstem Washougal (TAG). High flows regularly rework the sediments in this system. However, roads are likely contributing to the fine sediment load in many stream systems within the subbasin. Road densities are used as a surrogate measurement of substrate conditions in the LFA habitat rating standards, and >3 miles of road per square mile with some valley bottom roads falls in the "poor" category. With approximately 570 miles of roads, the road density within the Washougal River Subbasin is approximately 2.65 miles of road per square mile (from Lunetta et al. 1997). This density falls into the fair category for the entire subbasin using the habitat rating standards. However, when broken into smaller subbasins of

Watershed Administrative Units (WAUs) road densities fall into the "poor" category in both the Lacamas WAU and Little Washougal WAU (3.28 and 3.36 miles per square mile respectively) (Lunetta et al. 1997). While the upper Washougal WAU has a road density of only 1.38 miles of road per square mile.

Besides the potential overall inputs of fine sediment from high road densities, stream adjacent roads likely contribute to fine sediment loads within stream channels along almost the entire length of the mainstem Washougal, most of the lower Little Washougal, most of Dugan Creek, most of Canyon Creek, and along many other tributaries in the subbasin. Table 4 provides data on stream adjacent roads within the WAUs that make up the Washougal Subbasin. Almost 29 miles of roads fall within 200 feet of the anadromous portions of stream systems within the Little Washougal WAU, increasing the possibility that the delivery of fine sediments to the stream systems will be excessive. Many miles of stream adjacent roads also follow stream corridors within other areas of the subbasin. The number of stream crossings per square mile is also included in Table 4. The large number of stream crossings per square mile within the Little Washougal, Silverstar, and Upper Washougal WAUs may alter the movement of sediments through the stream systems within these areas and contribute additional fine sediment to stream channels.

Table 4. Washougal road densities, adjacent roads and stream crossings from Wade, 2001.

Table 4 : Road densities, stream adjacent roads, and stream crossing in the Washougal Subbasin

WAU Name	Road miles outside buffer	Road miles in buffer	Percentage of roads in buffer	Stream Crossings /Sq. Mile	Road Density
LACAMAS	217.3	17.6	7.5	3.5	3.3
LITTLE WASHOUGAL	211.9	29.0	12.0	6.1	3.4
SILVERSTAR	178.3	21.7	10.9	6.3	2.6
UPPER WASHOUGAL	104.0	15.8	13.2	6.5	1.4

Data from Lewis County GIS (2000)

TAG members noted that substrate fines accumulate in the lower end of the Little Washougal. Along with that contribution of fine sediments from roads, extensive residential upstream development is also likely contributing to the fine sediment load in the Little Washougal watershed (TAG). Access to three power line corridors in the Little Washougal watershed is not properly controlled inviting unauthorized ATV use and resulting in major erosion problems (TAG). Vegetation management along these corridors invites ATV use and increases the potential for erosion. Management of these power line corridors should be reviewed and updated to reflect the need to protect critical resources in the area.

An unimproved road and a series of trails parallel both Jones Creek and the East Fork Jones Creek. ATV use is permitted on some trails within this area, and some of these trails are unauthorized and have been closed to public use. However, the DNR does not have adequate resources to consistently patrol ATV use in this area, and the use of many unauthorized trails continues. Erosion from both authorized and unauthorized trails contributes excessive fine sediments to the streams in the area (TAG). Old logging practices scarified the hillsides and stream channels within the East Fork Jones Creek watershed, which also leads to excessive fine sediment inputs (TAG). The stream adjacent access road to the dam on Jones Creek needs assessment and repair to reduce fine sediment inputs (TAG).

In the Winkler Creek watershed, the Washougal Moto-Cross track is another area where ATV use contributes excessive fine sediments to stream systems (TAG; McMillan 2000: personal comm.). Along Winkler Creek a number of pastures need fencing to exclude livestock from the creek (TAG). TAG members noted that the stream adjacent road along Deer Creek was poorly constructed with a number of problems. These problems have been recently addressed, and hopefully the situation has been stabilized (TAG).

The Dugan Creek watershed contains a number of naturally occurring slides, some of which have been exacerbated by logging and roading on steep unstable ground (TAG). There is a large bedload in Dugan Creek, which Johnson (2000: personal comm.) largely attributes to the contribution from past forest practices. There is a major slide on East Fork Dugan that occurred as a result of a poorly constructed road (TAG; Johnson 2000: personal comm.). TAG members thought that the instability would continue in this area for some time to come. While the impacts from this slide are largely detrimental in the short-term, in the long-term the slide will replenish spawning gravels for downstream habitats. One problem that is mentioned as a major limiting factor in many previous reports on the Washougal River system is the lack of adequate spawning gravel. Various natural and anthropogenic disturbances have reduced the available spawning gravel in most of the Washougal River channel (TAG; McMillan 2000: personal comm.; Wildrich et al. 1998; WDF 1990; WDF 1973; WDF 1951; Parson unknown date).

Gravel mining in the lower river has depleted the spawning gravel supply in the slough and the lower river (TAG; WDF 1990; WDF 1973). The combined hydrologic impacts of the Yacolt Burn and subsequent logging practices, splash damming, and the removal of LWD from the river have left much of the lower 20 miles of the river with exposed bedrock outcroppings and large boulder sections. WDF (1973) noted that the natural chinook spawning production in the Washougal River was limited by a shortage of suitable spawning gravel. Even in the upper mainstem Washougal, spawning gravel is limited with large expanses of exposed bedrock in the channel (TAG). The lack of spawning gravels also occurs in various reaches of other tributaries within the subbasin where elevated peak flows and the lack of LWD has left channels scoured down to bedrock.

Dams on Lacamas Creek and Wild Boy Creek have also eliminated spawning gravel recruitment from upstream sources, and the streams lack adequately sized gravels for spawning (TAG). The 1996 floods may have benefited spawning gravel conditions within lower Lacamas Creek by flushing fine sediments from the spawning substrates (Hutton 2001: personal comm.). Logjams on Bluebird Creek and on Silver Creek may also be reducing gravel recruitment to downstream habitats; these jams need assessment (McMillan 1997: personal comm.).

Riparian Conditions

Riparian buffers were rated as good, poor, or unknown, depending upon the type of forest cover category within the 30-meter buffer. Buffers with late- and mid-seral stage forest cover were mapped as "good" riparian habitat and other lands and buffers with early-seral stage forest cover were rated as unknown because of its wide range of coniferous crown cover (from 10 to70% coniferous crown cover)(Lunetta et al. 1997; Lewis County GIS 2000).

Table 5 summarizes the number of miles in each category of riparian condition (Good, Unknown, and Poor) within each WAU of the Washougal Subbasin. Table 6 summarizes the percentage of good, unknown, and poor riparian habitat within each WAU. As Table 4 displays, the majority of riparian habitat within the Washougal Subbasin falls in the "Unknown" (or early seral stage) category (for an explanation how riparian conditions were determined see theRiparian Conditions section at the beginning of this chapter).

The Upper Washougal WAU contains the largest percentage of good riparian habitat in the subbasin, while the Lacamas WAU has the least percentage of good riparian habitat (see Table 6). However, only a small fraction of the lower Lacamas WAU contains anadromous habitat, and riparian habitat along lower Lacamas Creek was considered to be some of the best in the Washougal Subbasin (TAG) (see Table 5 and Table 6).

Table 5. Riparian conditions for WAU's within the Washougal River subbasin from Wade, 2001.

Riparian Conditions in each Category (in stream miles)				
WAU Name	**Good**	**Unknown**	**Poor**	**Total Miles**
Lacamas	7.8	34.0	34.9	76.7
Little Washougal	14.3	57.6	23.8	95.7
Silverstar	14.2	52.7	14.1	81.0
Upper Washougal	38.2	43.4	3.6	85.2
Subbasin Total	74.5	187.7	76.4	338.6

Lunetta et al. 1997; Lewis County GIS 2000

Table 6. Riparian conditions for WAU's within the Washougal River subbasin (percent) from Wade, 2001

Percentage of Stream Miles in each Category				
WAU Name	**Good**	**Unknown**	**Poor**	**Total**
Lacamas	10.2%	44.3%	45.5%	100%
Little Washougal	14.9%	60.2%	24.9%	100%
Silverstar	17.5%	65.1%	17.4%	100%
Upper Washougal	44.8%	50.9%	4.3%	100%
Subbasin Total (avg)	22.0%	55.4%	22.6%	100%

Lunetta et al. 1997; Lewis County GIS 2000

Riparian conditions are especially poor on the north side of the Camas Slough where industrial development has eliminated the riparian cover. Along the south banks of the slough there are a variety of deciduous trees, such as black cottonwood, that would likely be the dominant indigenous species. Residential development along the entire northwest side of the river has reduced riparian function in the lower river (TAG). Further upstream (RM 5.6 to RM 14.5) on the mainstem Washougal, riparian conditions are generally fair to good on the south bank, with poor conditions along the north bank where the road parallels the river. As a rule, riparian habitat conditions improve in the mainstem Washougal and in almost all of the tributaries towards the upper reaches. Two exceptions to this rule are the upper reaches of the West Fork and Dugan Creek, where the area is still recovering from the Yacolt Burn.

Alder and other deciduous trees dominate riparian areas along the Little Washougal watershed, where there is any buffer present. Many areas need riparian restoration, which could be accomplished since good riparian restoration potential exists within the basin (TAG). The Yacolt Burn reduced riparian cover and even soil productivity for many tributaries within the upper Little Washougal watershed. TAG members rated riparian conditions within Boulder, Jones, and East Fork Jones Creeks as poor.

Winkler Creek has clearly poor riparian conditions, and TAG members concurred with this data. TAG members also noted that most of the conifers have been removed from riparian buffers along Texas Creek. As stated, the Yacolt Burn had substantial impacts on the plant community and productivity of the upper reaches of the Washougal and its tributaries. Some of these areas have mostly recovered from the effects of the burn and logging activities afterwards. Other areas such as upper Dugan, Stebbens, Timber, and Prospector are still recovering from the fires and subsequent logging. These areas contain mostly deciduous riparian cover.

Water Quality

Some significant water quality problems occur in certain stream systems within the Washougal Subbasin. Lacamas Creek and many of its tributaries are listed as impaired streams on the 1998 303d list (WDOE 2000; WDOE 1996b). Upstream of Lacamas and Round Lakes state water quality standards have often been exceeded for temperature, pH, fecal coliform, and dissolved oxygen (DO). At the outlet from Round Lake into Lacamas Creek, sixty percent of the samples between 1991 and 1992 exceeded state water quality standards for DO, and 65% of the samples exceeded state standards for water temperature (WDOE 2000).

Lacamas Lake also has documented water quality problems. Lake eutrophication was recognized in the 1970's, and a Phase 1 Diagnostic and Restoration study was completed on Lacamas Lake in 1985. With the goal of improving water quality by reducing phosphorus loading, restoration efforts have included implementation of agricultural best management practices (BMPs) throughout the watershed (WDOE 1996b). As of June 1997, the Lacamas Lake Restoration Project had assisted 43 landowners with installation of 105 BMP's (Hutton 2000). Work continues on the cleanup efforts for this lake. Historically, there were significant water quality problems in the Camas Slough due to the discharges from the paper mill. Early reports on fisheries in the Washougal watershed all mention the harmful effects of sulfite discharges from the mill on fish populations (Bryant 1949; WDF 1951; WDF 1973; WDF 1990). Even as late as the 1960s, fish releases from the salmon hatchery had to be timed so that juvenile fish were passing the pulp mill on vacation weekends when the mill was closed (WDF 1990). Waste ponds were built in the 1970s on Lady's Island to treat mill wastes; however, toxins may still persist in the mud bottom of Camas Slough from the many years of effluent discharge from the Camas paper mill (McMillan 2000: personal comm.). A large cement plant, sited in the lower river, creates runoff that could also be impacting water quality (TAG).

There is somewhat conflicting information available on water quality parameters within the lower Washougal River. Even though there is little data available on water quality within the lower Washougal River, TAG members familiar with the lower Washougal believe that water temperatures are often elevated in the summer months (TAG). According to Dick Johnson (2000: personal comm.), hatchery complex manager on the Washougal River, below milepost 20 temperatures frequently exceed 20°C during the summer. However, water quality monitoring at RM 3.0 found that only one out of nine water samples taken exceeded state water quality standards for water temperature (WDOE 1996). According to WDF (1973), summer water temperatures in the basin tend to be high and reflect the low summer flows, lack of stream bank cover, and ponding of springs behind private dams.

Temperature data was collected on a number of streams within the upper Washougal between 1997-1999 by Clark Skamania Flyfishers and John Sowinski of Washington Trout. Temperature data was collected on West Fork Dugan Creek, East Fork Dugan Creek, Stebbins Creek, Timber Creek, Deer Creek, Prospector Creek, and on the mainstem upper Washougal River between Prospector and Meander Creeks. Table 7 summarizes the approximate high temperatures measured in these streams annually. Consistently high water temperatures were found in Stebbins and Prospector Creeks, and only Timber Creek and Deer Creek had water temperatures that were below 14°C (or considered "good" using LFA rating standards). Even within the upper Washougal mainstem, elevated water temperatures may present problems for juveniles rearing within the system. TAG members suggest that a combination of exposed bedrock, low flows, and poor riparian cover all contribute to the elevated water temperatures in the upper basin.

Table 7. Water temperatures form Upper Washougal basin from Wade, 2001.

Highest Measured Water (in degrees Celcius) from Wade, 2001.

Data Collection Point	**1997**	**1998**	**1999**
WF Dugan Creek	16.1	15.6	17.8
EF Dugan Creek	16.7	18.3	16.1
Stebbins Creek	17.8	18.9	17.2
Timber Creek	12.8	15.0	13.8
Prospector Creek	17.8	20.0	
Deer Creek			13.8
Upper Washougal	16.7	18.3	

Data from Sowinski 2000

Water temperature data collected at the Washougal Salmon Hatchery between 1987 and 1991 also documents high water temperatures in the upper Washougal basin. During this 5-year recording period, water temperatures at the hatchery frequently exceeded 17.8°C during July, August and September; in some cases for as long as 17 days in a row.

While water quality parameters are generally unknown on the North Fork Washougal, TAG members noted that historically there have been some water quality problems below the hatchery. Bill McMillan (2000: personal comm.) states that the Skamania and Washougal salmon hatcheries release potentially harmful waste effluent, antibiotics, and diseases into the Washougal.

Water quality conditions are unknown for many tributaries to the Washougal. However, TAG members provided qualitative information for some tributaries. TAG members noted that "push-up" dams have been built in the upper Winkler Creek drainage to provide livestock water, and that these tend to increase water temperatures and fine sediment inputs. There has also been extensive grading and clearing along the stream (TAG). Water quality is good within Boulder and East Fork Boulder Creeks. Elevated turbidity levels are considered a potential problem in the Little Washougal, and in both Jones Creek and Dugan Creeks (TAG).

Water Quantity

Seasonal streamflows in the subbasin follow the same general pattern as precipitation. Since there are no permanent snowpacks, major reservoirs, or other impoundments of the river, stream flow is a direct result of rainfall and groundwater inputs, and flows vary considerably between winter and summer months (see Figure 2 In Watershed Condition Chapter from Wildrick et al. 1998). The 37-year average discharge is 873 cfs, with a peak discharge of 40,400 cfs during the flood of December 1977. The flashy nature of the stream is due, in part, to the topography of the basin as well as natural and human alterations of the environment (mainly the Yacolt Burn that deforested most of the upper watershed)(WDF 1990).

With the existing streamflow data, it is difficult to separate out changes in streamflow due to alterations in land use and/or water withdrawals from natural long-term variations due to climate (Wildrick et al. 1998). However, land development that eliminates hydrologically mature forest cover and undisturbed soil can result in significant changes to stream hydrology and, in turn, to the physical stability of stream channels (Booth 2000; Richter et al. 1996; Chamberlin et al. 1991). The flow regime of developed basins commonly increases in magnitude, duration, and frequency of peak flow and decreases in summer baseflows (Morley, 2000). These changes in streamflow patterns can have major impacts on stream ecosystems (Booth 2000, Richter et al. 1996). Table 8 provides data on vegetation cover for each WAU within the subbasin (from Lunetta et al. 1997). It is apparent from Table 8 that well over 40% of the land cover in the Lacamas, Little Washougal, and Silverstar WAUs are now in either "non-forest" and/or "other" uses. These two categories describe areas without mature forest cover including urban areas, agriculture and rangelands, cleared forest, and areas with tree/scrub cover. Subsequently, streams within the subbasin likely experience increased magnitude, duration, and frequency of peak flows and decreased summer base flows (Morley 2000; Booth and Jackson 1997). In many of the urbanized areas of the subbasin, impervious surfaces and an increase in channel density from road ditches are also likely contributing to increased peak flows and potentially reduced summer flows (Booth 2000; Furniss et al. 1991).

WDF (1990) also states that extensive urbanization of the watershed has contributed to runoff fluctuations not conducive to stable flows. Map A-12 illustrates the potential peak flow concerns within each Watershed Administrative Unit (WAU) of WRIA 28 (Lewis County GIS 2000). The screening criteria used to identify WAUs within the subbasin with the potential for increased peak flows included WAUs with >3 miles of road per square mile and over 50% hydrologic immaturity based on land cover (hydrologically immature land cover was defined as early seral, non forest, and other forest, exclusive of snow-ice, sand bars, water). Functioning WAUs were considered hydrologically mature (>50% land cover in mature and/or late seral stage vegetation) and had road densities of less than 3.0 miles of road per square mile. Likely Impaired WAUs were either hydrologically immature or had road densities greater than 3.0 miles of road per square mile. Impaired WAUs were both hydrologically immature and had road densities >3.0. As Table 8 illustrates, only the upper Washougal WAU meets the criteria for a Functioning WAU by having hydrologically mature land cover (>60% mature and/or late seral stage cover) and road densities of <3.0 miles per square mile. All other WAUs were hydrologically immature, and the Lacamas and Little Washougal WAUs had road densities >3. Over 72% of the land cover in the Lacamas WAU falls in either the "non-forest" or "other" category.

Table 8. Forest seral stage/ land cover in the Washougal Subbasin (acres and percent total) from Wade, 2001.

WAU Name	Acres/ Percent	Seral Stage			Water	Non-Forest	Other	Total
		Late-Seral	Mid-Seral	Early Seral				
Lacamas	Acres	11	9103	1505	805	17511	12213	41148
	Percent	0.03	22.1	3.6	2.0	42.6	29.7	100.0
Little Washougal	Acres	28	10461	614	510	7917	10710	30241
	Percent	0.1	34.6	2.0	1.7	26.2	35.4	100.0
Silverstar	Acres	210	11473	637	0	6147	14221	32689
	Percent	0.6	35.1	2.0	0.0	18.8	43.5	100.0
Upper Washougal	Acres	1116	19886	1193	0.0	29.71	6525	31690
	Percent	3.5	62.7	3.8	0.0	9.4	20.6	100.0

From Lunetta et.al. 1997

TAG members stated that the Jones Creek watershed is another area with potential peak flow concerns. The watershed is hydrologically immature after the extensive logging that occurred under the old Forest Practice regulations (TAG). Residential development and impervious surface area has also increased substantially within the watershed (TAG).

Low flows are considered a limiting factor in many streams within the subbasin. An instream flow study was conducted for several creeks and rivers in WRIA 28. An Instream Flow Incremental Methodology (IFIM) study was completed for the Washougal River and toe width flows were calculated for the other streams (see Caldwell et al. 1999). The IFIM study was completed for the Washougal River at approximately river mile 3.5. Thirty-six years of streamflow data are available from a USGS gauge at river mile 9.2. December through April median flows on the Washougal are near 1000 cfs, dropping down to near 70 cfs by mid August. This hydrograph (Figure 14) indicates that optimal spawning flows for coho salmon are generally approached by mid October. Optimal chinook spawning flows of 425 cfs are approached by November 1. Optimal steelhead spawning flows of 375 cfs are generally maintained through May. By July 1 median streamflow has dropped to less than optimal flows of 250 cfs for chinook juvenile rearing and far less than optimal flows for steelhead juvenile rearing of 550 cfs. Rearing conditions approach optimal levels for Chinook rearing again in October (Loranger 2000: personal comm.).

Stream hydrograph data is also available for the Little Washougal River from a USGS gauging station on river mile 1.0 with a 6-year period of record. Median stream flows in the Little Washougal River range from 100 to 300 cfs in the winter, dropping to around 10 cfs in the summer months. By mid-November median stream flow increases to around 100 cfs, which is optimal for coho spawning (Loranger 2000: personal comm.). Optimal median flows for chinook spawning are not reached during the fall months. Flows are near optimal for steelhead spawning (160 cfs) through mid March. By the first of June and through October, median flows are below optimal for juvenile rearing. In four of those six months flows are less than 50 percent of optimal for juvenile rearing (Loranger 2000: personal comm.).

Water withdrawals for the City of Camas on both Boulder and Jones Creeks affect the hydrology of these streams, as well as the entire Little Washougal watershed (TAG). Withdrawals from Jones and Boulder Creeks are measured at the City of Camas Filtration Plant and totaled approximately 500 million gallons for 1999. Withdrawals from these streams are not metered individually. The City is planning to meter stream withdrawals and streamflows as part of it's watershed planning efforts aimed at providing adequate water for the City's needs while providing adequate flows to protect listed salmonids (Quinn 2000: letter). TAG members considered low flow problems a major limiting factor in both Boulder and Jones Creeks.

In the North Fork Washougal River optimal rearing flow for salmon and steelhead was approached by October 1, 1998. At this time the flows were considerably less than optimal for salmon spawning (Loranger 2000: letter).

Table 9. Flow and habitat relationships for the Washougal River from Wade, 2001.

Table 9 : Flow and Habitat Relationships for the Washougal River

Species	Instream flow which provides maximum spawning habitat	Instream flow which provides maximum juvenile habitat
Chinook Salmon	425 cfs	225 cfs
Steelhead	375 cfs	525 cfs
Coho Salmon	225 cfs	NA

Adapted from Caldwell et al. 1999

The dams on Round Lake alter the natural hydrology of Lacamas Creek and the lower Washougal. Diversions of water from Round Lake into the Mill Ditch and, at times, the release of large amounts of water have altered flows within Lacamas Creek, which used to be a major chum producer (TAG; McMillan 2000: personal comm.). Peter Aller, Facilities Manager at Fort James Camas Paper Mill (2000: personal comm.) stated, "withdrawal from the lake of approximately 35 million gallons per day occur in the winter, fall, and spring months between November and June". However, visual examination of the lake and dam site on October 15, 2000 found that water was already being diverted into the Mill Ditch and that the stop logs on the dam were in place. The only flow passing the dam into Lacamas Creek on October 15th was a minimal amount of water that escaped through the cracks between the stop logs. There are no minimum or maximum flow limitations placed on the operation of the dam according to Steve Young, Environmental Manager for Fort James Inc. (Young 2000: personal comm.). During the summer months lake levels are maintained for recreation, and consequently the creek almost completely dries up (TAG). During an October 15, 2000 site visit it appeared that the lake was at least 2 feet below ordinary high-water mark.

Other areas with low-flow concerns in the subbasin include:

- In the lower Washougal River and Camas Slough, past gravel mining disrupted and reduced subsurface flows to critical chum spawning areas (TAG).
- Low summer flows, combined with high public use above Dugan Falls, negatively impacts the adult population of summer steelhead through harassing and/or killing of holding fish (McMillan 2000: personal comm.; WDF 1990).

- A number of private water diversions (mostly unauthorized) also alter the hydrology of the basin and contribute to low flow problems in the subbasin (TAG; WDF 1973).
- Texas Creek dries up during the summer months (TAG).
- The dam on Wildboy Creek alters the hydrology downstream (TAG).
- Both Schoolhouse and Slough Creeks are spring fed systems that provide good rearing habitat for juveniles. Development threatens the water quantity and quality and habitat within these streams.
- Harvest activities are slated for this year in the Stebbens Creek watershed, increasing peak flow concerns (TAG).

Biological Processes

The Conservation Commission is using the number of stocks meeting escapement goals as a surrogate measurement of nutrient levels within stream systems. Escapement for most anadromous stocks in the Washougal River subbasin is likely well below historic averages (LCSCI 1998; WDF et al. 1993; WDF 1990), and the lack of carcasses contributing nutrients to the systems may be limiting production within the subbasin. Historical information on most stocks is lacking, and by the time early investigators conducted fish surveys serious habitat damage had already occurred (WDF 1990). In 1951, the Washington Department of Fisheries estimated minimum coho escapement at 3,000 fish, minimum fall chinook escapement at 3,000 fish, and minimum chum escapement at 1,000 fish.

SASSI (WDF et al. 1993) considered the Washougal River natural spawn fall chinook stock healthy based on escapement trend in 1992, with an average 1,832 fish returning each year between 1967 and 1991 (WDF et al. 1993). Coho stock status on the other hand was depressed based on chronically low production, and natural spawning was presumed to be quite low (WDF et al. 1993). Similarly, both winter and summer steelhead stocks were considered depressed in 1998 due to "chronically low escapements" for summer fish and a "short-term severe decline" for winter fish (LCSCI 1998). Returns of winter steelhead have been only 28% of the escapement goals for the Washougal, and returns of summer steelhead have been <40% of the escapement goals (LCSCI 1998).

Additionally, habitat alterations, non-native introductions, and hatchery practices influence competitive interactions and ecological processes in the Washougal River Subbasin. Higher water temperatures and sluggish flow in the lower Washougal and Camas Slough likely favors both native (pikeminnow) and non-native (bass) predators of salmonids (TAG). Brown trout (non-indigenous) are planted in Lacamas Lake and some make their way down into the Washougal Basin (TAG). Providing fish passage over Salmon Falls in 1956 allowed species/stocks of salmon/steelhead access between Salmon Falls and Dougan Falls; historically an area where passage was blocked. Access by these species potentially impacts summer run steelhead due to increased interspecies and intraspecies competition (McMillan 2000: personal comm.). Waste effluent, antibiotics, and potential disease from millions of hatchery fish from Skamania and Washougal River Salmon hatcheries likely affects native fish within the North Fork and mainstem of the Washougal Rivers (McMillan 2000: personal comm.). TAG members also suggested the need for a trap on the North Fork Washougal to separate out hatchery fish and reduce interactions between hatchery and wild fish on the spawning grounds.

Artificial Production

The Skamania Hatchery on the West fork Washougal opened in 1956 to producing steelhead and cutthroat trout. Two years later the Washougal hatchery opened on the mainstem producing fall Chinook and coho. Hatchery plants have allowed spawning ground interactions with wild fish on the spawning grounds diluting the genetic integrity of wild fish. Further discussion of artificial production is in the existing management section.

Existing and Past Efforts

Summary of Past Efforts

BPA funded projects are ongoing in the basin are listed in Table 10.

Table 10. Bonneville Power Authority funded projects ongoing in the Washougal Subbasin.

Project	Project Number	Start year	Project Focus 1	Project Focus 2	Primary Agency
Coded-Wire Tag Recovery	198201300	1982	Monitoring / Baseline	Adult Mainstem Passage	PACIFIC STATES MARINE FISH COM
Survey of Artificial Salmon Production Facilities	198405100	1984	Monitoring / Baseline	Baseline / Feasibility Efforts	US SMALL BUSINESS ADMIN.
Anadromous Fish Health Monitoring (Wdf)	198605400	1986	Research / Evaluation	Fish Health	WASHINGTON DEPT of FISHERIES
Ann Cd Wire Tag Prog-Missing Prod Washington Hatch	198906600	1989	Monitoring / Baseline	Program Outcome / Impacts	WASHINGTON DEPT of FISHERIES
Fish Passage Evaluations - Lower Columbia River	199204101	1992	Research / Evaluation	Adult Mainstem Passage	COE (PORTLAND DISTRICT)
Audit Columbia Basin Anadromous Hatcheries	199500200	1995	Monitoring / Baseline	Facility Design / Construction	MONTGOMERY WATSON
Evaluate Spawning of Fall Chinook And Chum Salmon Below the Four Lowermost Columbia River Mainstem Dams	199900301	1999	Monitoring / Baseline	Baseline / Feasibility Efforts	WASHINGTON DEPT of FISH AND WILDLIFE
Reintoroduction of Columbia River Chum Salmon into Duncan Creek	23040	2000	Research / Evaluation	Baseline / Feasibility Efforts	WASHINGTON DEPT of FISH AND WILDLIFE

Accomplishments by Year

1956 Skamania hatchery built.

1958 Washougal Hatchery built.

Present Subbasin Management

Existing Management

Management of the Washougal River subbasin is split between many Federal, State and local agencies. Both the U.S. Forest Service and Washington State Dept. of Natural Resources own and manage land in the upper Watershed. The cities of Camas and Washougal lie in the lower watershed and must develop appropriate development standards. Washington Department of Ecology monitors water quality and Washington Department of Fish and Wildlife and the National Marine Fisheries Service (NMFS) manage the fishery resource.

Federal Government

The National Marine Fisheries Service

The National Marine Fisheries Service (NMFS) administers the Endangered Species Act (ESA) for anadromous fish. NMFS reviews and comments on activities that affect fishery resources and develop recovery plans for listed species in the Subbasin. Under ESA, summer steelhead, Chinook salmon, chum salmon, and steelhead are listed as “threatened” by National Marine Fisheries Service and coho salmon are listed as a candidate species. Under the ESA’s 4(d) rule, “take” of listed species is prohibited and permits are required for handling. Biological Opinions, recovery plans, and habitat conservation plans for federally listed fish and aquatic species help target and identify appropriate watershed protection and restoration measures.

- Federal Caucus All-H Paper (2000). This document provides a framework for basin-wide salmon recovery and identifies strategies for harvest management, hatchery reform, habitat restoration, and hydropower system operations.
- FCRPS BiOp (2000). This is a biological opinion written by NMFS and the Fish and Wildlife Service regarding the operation of the federal hydropower system on the Columbia River, and fulfills consultation requirements with the US Army Corps of Engineers, the Bureau of Reclamation, and the Bonneville Power Administration under Section 7 of the ESA. This recent BiOp also concluded that off-site mitigation in tributaries is necessary to continue to operate the hydropower system.

The National Marine Fisheries Service also funds the operation of the Skamania Hatchery and the Washougal Salmon Hatchery on the Washougal River to mitigate for fish losses due to hydropower development.

United States Fish and Wildlife Service

Coastal cutthroat are proposed for a "threatened" listing, and since these are considered as non-anadromous fish they are in the process of being evaluated by the United States Fish and Wildlife Service.

United States Forest Service

Portions of the upper Washougal River and Bonneville Tributaries Subbasins are located within the USFS Gifford Pinchot National Forest. Fish bearing waters are managed under the North West Forest Plan.

Bonneville Power Authority

The Bonneville Power Authority wholesales hydroelectric power throughout the West. It also provides funding to deal with impacts of the Columbia River Hydrosystem on fish and wildlife (see table in Existing and Past Efforts section).

Yakama Indian Nation

The Yakama Nation receives coho fry from Washougal Hatchery planted into the Klickitat River as part of the Bolt Decision (U.S. v. Oregon).

State

Washington Department of Fish and Wildlife

The Washington Department of Fish and Wildlife manages fish and wildlife resources in the subbasin. Fall chinook salmon, chum salmon, and steelhead are listed as "threatened" and coho salmon are listed as a candidate species under the ESA. WDFW management attempts to protect these fish and provide harvest opportunity on hatchery fish through the Fish Management and Evaluation Plan.

The objectives of the Washington Department of Fish and Wildlife's (WDFW) Fish Management and Evaluation Plans (FMEP) are based on the WDFW Wild Salmonid Policy. In that policy, it states that harvest rates will be managed so that 1) spawner abundance levels abundantly utilize available habitat, 2) ensure that the number and distribution of locally adapted spawning populations will not decrease, 3) genetic diversity within populations is maintained or increased, 4) natural ecosystem processes are maintained or restored, and 5) sustainable surplus production above levels needed for abundant utilization of habitat, local adaptation, genetic diversity, and ecosystem processes will be managed to support fishing opportunities (WDFW 1997a). In addition, fisheries will be managed to insure adult size, timing, distribution of the migration and spawning populations, and age at maturity are the same between fished and unfished populations. By following this policy, fisheries' impacts to listed steelhead, chinook salmon, and chum salmon in the Lower Columbia River (LCR) Evolutionary Significant Unit (ESU) will be managed to promote the recovery of these species and not at rates that jeopardize their survival or recovery. The full text of the Fish Management and Evaluation Plan appears in Appendix B.

Artificial Production

WDFW has a long history of hatchery production on the Washougal River. All hatchery produced fish within the subbasin are marked with an adipose fin clip. Spawners are randomly selected, with one to one mating.

The Skamania Steelhead Hatchery began operation in 1956 producing summer and winter steelhead and sea-run cutthroat. Each hatchery has a hatchery specific hatchery genetic management plan (HGMP). Individual HGMP's are presented in Appendix A. Recent steelhead hatchery, sport and total steelhead returns are presented in Table 11 and Table 12. Hatchery returns are broken down by sex.

Table 11. Skamania summer steelhead hatchery, sport and total returns 1983-2000.

Brood year	Year of return	# planted 2 yrs. prior	number per pound	weight grams	Hatchery return	number of males	percent males	number of females	percent females	Hatchery return %	Sport return	Sport return %	Total return	Total return %
1980	1983	N/A	N/A	N/A	1302	N/A	N/A	N/A	N/A					
1981	1984	82436	"	"	2987	"	"	"	"	3.62%	1576	1.91%	4563	5.54%
1982	1985	148530	"	"	2286	589	36%	1033	64%	1.54%	3160	2.13%	5446	3.67%
1983	1986	134245	"	"	1608	820	42%	1125	58%	1.20%	1977	1.47%	3585	2.67%
1984	1987	104624	6.7	67.8	2398	637	24%	895	58%	2.29%	1219	1.17%	3617	3.46%
1985	1988	110801	7.1	63.9	1981	937	34%	1830	66%	1.79%	1435	1.30%	3416	3.08%
1986	1989	316663	5.6	81.1	3072	N/A	N/A	N/A	N/A	0.97%	2313	0.73%	5385	1.70%
1987	1990	238998	6.4	70.9	8244	872	46%	1036	54%	3.45%	5699	2.38%	13943	5.83%
1988	1991	100728	6.3	72.1	1671	639	47%	786	53%	1.66%	2039	2.02%	3710	3.68%
1989	1992	176194	5.4	84.1	4429	801	51%	766	49%	2.51%	1522	0.86%	5951	3.38%
1990	1993	100100	5.2	87.3	3044	1492	49%	1552	51%	3.04%	1620	1.62%	4664	4.66%
1991	1994	121000	6.5	69.8	1396	602	43%	780	56%	1.15%	657	0.54%	2053	1.70%
1992	1995	112152	5.9	76.9	932	422	45%	510	55%	0.83%	211	0.19%	1143	1.02%
1993	1996	105212	6.3	72.1	1733	753	43%	978	56%	1.65%	561	0.53%	2294	2.18%
1994	1997	124396	5.5	82.5	809	366	45%	443	55%	0.65%	172	0.14%	981	0.79%
1995	1998	85066	6.1	74.4	705	269	38%	436	62%	0.83%	66	0.08%	771	0.91%
1996	1999	120845	5.9	76.9	623	272	44%	341	55%	0.52%	166	0.14%	789	0.65%
1997	2000	124979	6.6	68.8	2276					1.82%				

Table 12. Skamania winter steelhead hatchery, sport and total returns 1981-2000.

Brood Year	Year of Return	# planted 18 months prior	number per pound	weight grams	Hatchery return	number of males	percent males	number of females	percent females	Hatchery return %	Sport return	Sport Return %	Total Return	Total Return %
1979	1981-82	N/A	N/A	N/A	73	N/A	N/A	N/A	N/A	N/A	1942	N/A	2015	N/A
1980	1982-83	"	"	"	296	"	"	"	"	"	1377	"	1673	"
1981	1983-84	94655	"	"	1018	"	"	"	"	1.08%	1927	2.04%	2945	3.11%
1982	1984-85	94380	"	"	217	"	"	"	"	0.23%	3195	3.39%	3412	3.62%
1983	1985-86	106029	"	"	606	78	50%	77	50%	0.57%	1901	1.79%	2507	2.36%
1984	1986-87	94168	7.0	64.9	392	303	79%	80	21%	0.42%	2101	2.23%	2493	2.65%
1985	1987-88	99482	5.0	90.8	48	N/A	N/A	N/A	N/A	0.05%	2005	2.02%	2053	2.06%
1986	1988-89	140824	5.6	81.1	623	137	36%	240	64%	0.44%	1576	1.12%	2199	1.56%
1987	1989-90	175298	6.1	74.4	577	274	66%	144	34%	0.33%	2577	1.47%	3154	1.80%
1988	1990-91	129129	6.1	74.4	568	300	55%	249	45%	0.44%	2064	1.60%	2632	2.04%
1989	1991-92	119501	5.2	87.3	624	484	70%	207	30%	0.52%	1193	1.00%	1817	1.52%
1990	1992-93	131256	4.7	96.6	166	252	75%	85	25%	0.13%	1570	1.20%	1736	1.32%
1991	1993-94	113000	6.4	70.9	170	95	56%	75	44%	0.15%	241	0.21%	411	0.36%
1992	1994-95	110315	6.1	74.9	227	N/A	N/A	N/A	N/A	0.21%	636	0.58%	863	0.78%
1993	1995-96	80173	5.9	77.5	492	353	72%	139	28%	0.61%	258	0.32%	750	0.94%
1994	1996-97	102361	5.5	82.7	199	134	67%	65	33%	0.19%	216	0.21%	415	0.41%
1995	1997-98	107606	6.4	70.9	135	94	70%	41	30%	0.13%	50	0.05%	185	0.17%
1996	1998-99	98328	5.6	81.1	693	470	68%	223	32%	0.70%	112	0.11%	805	0.82%
1997	1999-00	101652	5.5	82.5	254	191	75%	63	25%	0.25%	486	0.48%	740	0.73%

Skamania has a briefer history of sea-run cutthroat production beginning in 1984. Hatchery returns by sex and percent return are presented in Table 13.

Table 13. Skamania sea-run cutthroat returns 1985-2000.

BROOD YEAR	RETURN YEAR	NUMBER PER LB.	WEIGHT GRAMS	TOTAL TRAPPED	NUMBER OF MALES	PERCENT MALES	NUMBER OF FEMALES	PERCENT FEMALES	SMOLTS PLANTED	PERCENT RETURN TO HATCHERY
1984	85-86	4.9	92.7	50	N/A	N/A	N/A	N/A	16,690	0.30%
1985	86-87	4.8	94.6	120	"	"	"	"	21,358	0.56%
1986	87-88	4.0	113.5	N/A	180	44%	231	56%	32,318	
1987	88-89	3.9	116.4	250	N/A	N/A	N/A	N/A	24,332	1.03%
1988	89-90	4.8	94.6	193	94	49%	99	51%	36,486	0.53%
1989	90-91	4.2	108.1	841	576	69%	260	31%	43,906	1.92%
1990	91-92	4.8	94.6	511	251	59%	171	41%	29,000	1.76%
1991	92-93	4.1	110.7	91	32	54%	27	46%	30,000	0.30%
1992	93-94	4.6	98.7	80	58	72%	22	28%	39,000	0.21%
1993	94-95	3.9	116.4	88	61	69%	27	31%	10,856	0.81%
1994	95-96	4.3	105.6	490	289	59%	201	41%	29,820	1.64%
1995	96-97	3.5	129.7	309	185	60%	124	40%	34,106	1.21%
1996	97-98	3.8	119.5	664	482	73%	182	27%	30,945	2.15%
1997	98-99	3.0	151.3	959	624	65%	335	35%	15,732	6.10%
1998	99-00	3.4	133.5	793	459	65%	334	35%	12,584	6.30%

Fall chinook salmon have been produced at Washougal Hatchery since 1958. Returns are presented in Figure 9.

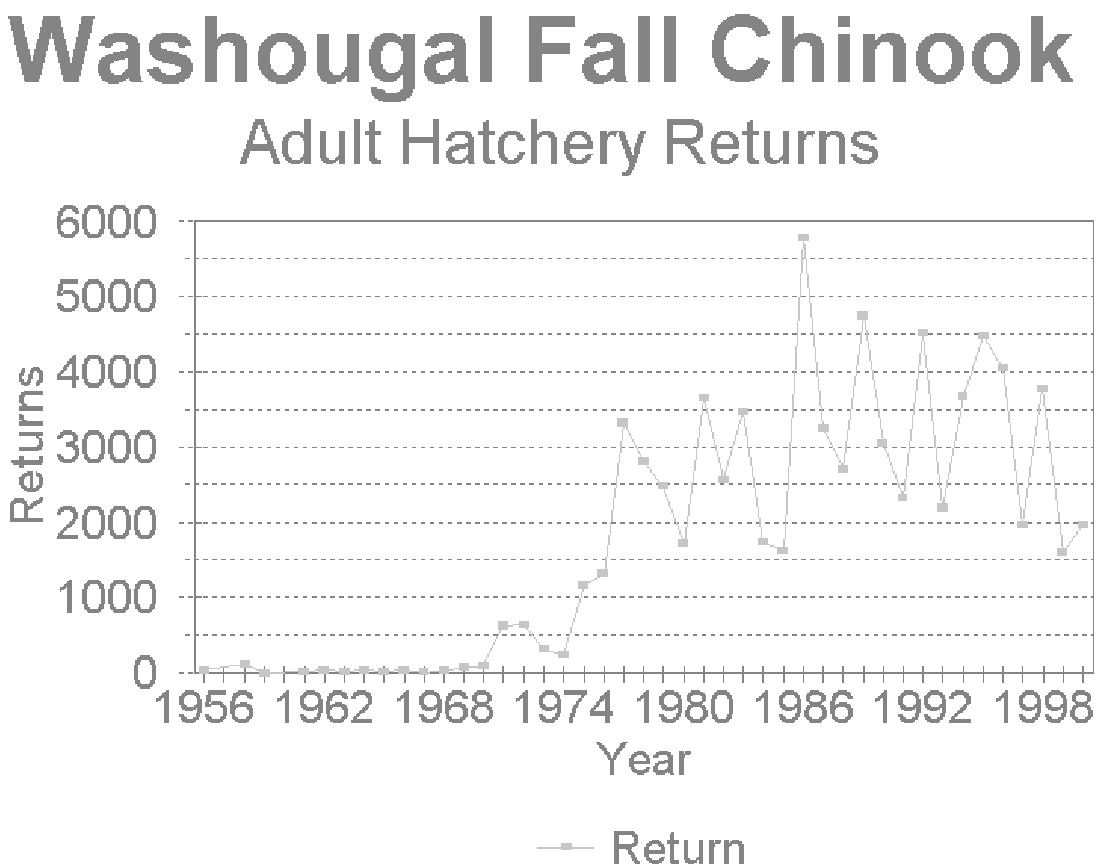


Figure 9. Washougal Fall Chinook adult hatchery escapement 1956-2000.

Washougal Hatchery has produced two stocks of coho over time. Early run coho (Type S) native to the Washougal basin were cultured from 1960 through 1988. Hatchery Adult returns are reported in Figure 10.

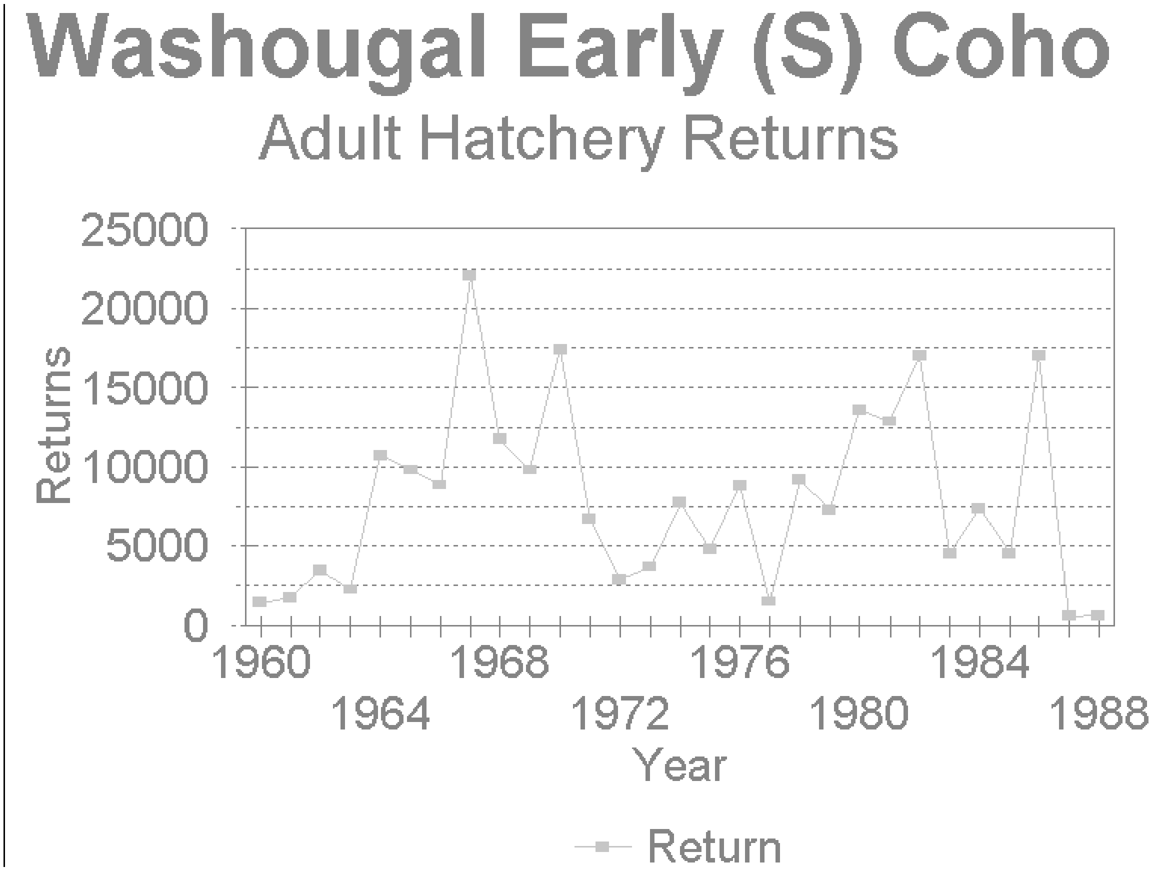


Figure 10. Washougal Early Coho adult hatchery escapement 1960-1988.

Two additional years of coho production occurred with 1999 and 2000 returns of 539 and 220 adults respectively.

In the late 1970's and early 1980's production shifted to late coho. Late coho (Type N) move northward form the mouth of the Columbia and are more readily caught in Washington waters providing greater benefits to Washington's commercial and recreational fisheries. Washougal late coho returns are presented in Figure 11.

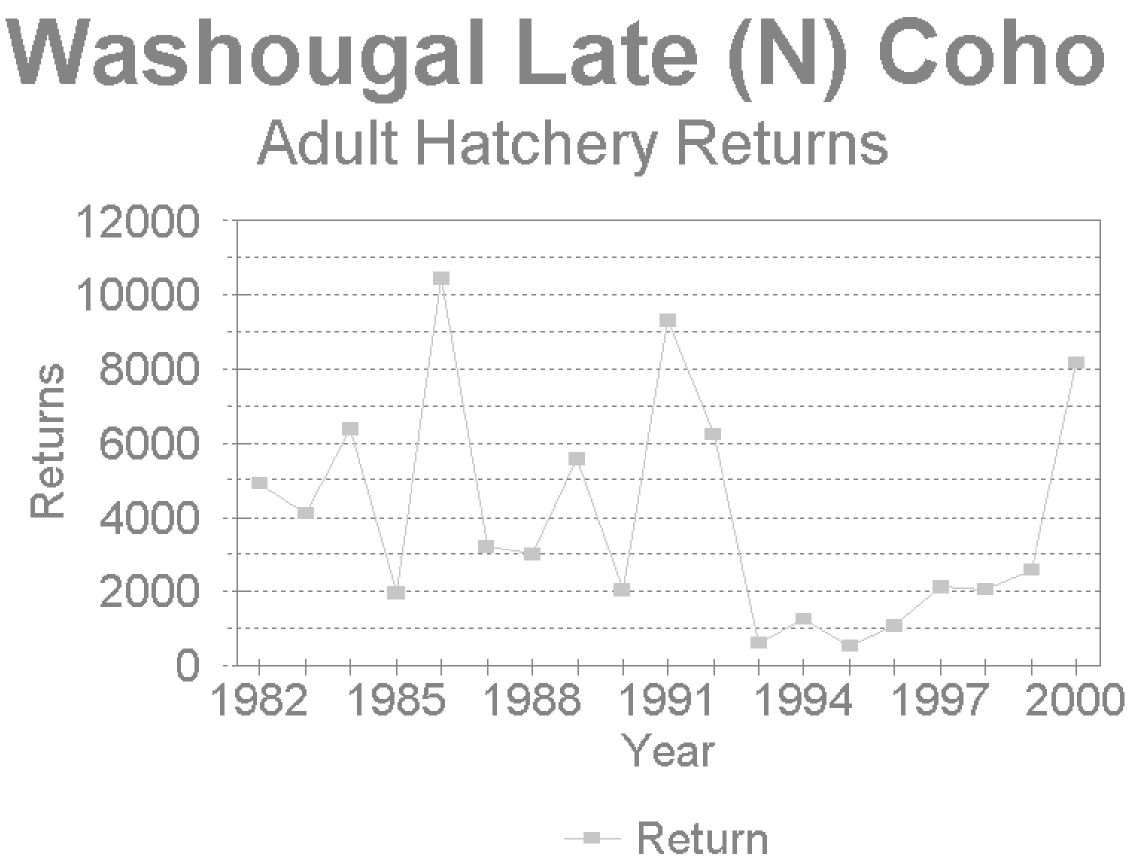


Figure 11. Washougal Late Coho adult hatchery escapement 1982-2000.

Other Activities

WDFW is participating in two Chum projects funded by Bonneville Power. Action 157 from the 2000 FCRPS Biological Opinion states, "BPA shall fund activities to improve and restore tributary and mainstem habitat for CR chum salmon . . .". The first evaluates chum and fall Chinook spawning areas below the four mainstem Columbia River dams, with a primary focus below Bonneville Dam. There is a second project to salvage chum from dewatered spawning areas in the Ives Island vicinity and north shore creeks and relocate adults to improved spawning channels in Duncan Creek. If flows are excessively low in all areas, Washougal Hatchery could be used as a refuge for eggs collected from stranded chum in low flow areas, incubated and fry fed for release back into their respective spawning areas.

The agency is presently conducting two habitat inventories within the subbasin. Ecosystem Diagnosis and Treatment (EDT) compares habitat today to that of the basin in a historically unmodified state. It creates a model to predict fish population outcomes based on habitat modifications. WDFW is also conducting a Salmon Steelhead Habitat Inventory Assessment Program (SSHIAP), which documents barriers to fish passage.
WDFW's habitat program issues hydraulic permits for construction or modifications to streams and wetlands. This provides habitat protection to riparian areas and actual watercourses within the watershed.

Washington SERF Board

The Salmon Recovery Funding Board's mission is to support salmon recovery by funding habitat protection and restoration projects, and related programs and activities that produce sustainable and measurable benefit for the fish and their habitat.

Joint Natural Resources Cabinet

In May 1997, Governor Gary Locke and thirteen agency heads signed a memorandum of agreement to establish a forum to serve as the " . . . formal and ongoing institutional framework to promote interagency communication, coordination, and policy direction on environmental and natural resource issues". This forum was named the Joint Natural Resources Cabinet (JNRC or Joint Cabinet) and is chaired by Curt Smitch, the Governor's Special Assistant for Natural Resources.

Government Council on Natural Resources

As a way to bring together a wider forum to assist with the review and development of the three-part effort to recover salmon, which includes the Statewide Salmon Recovery Strategy, state and federal budget proposals, and a comprehensive legislative package, the Government Council on Natural Resources (GCNR or Government Council) was developed. This group includes representation from JNRC, the Legislature, tribes, cities, counties, federal government, and ports.

Governors Salmon Recovery Office

To assist the Joint Cabinet and Government Council in accomplishing their mission, the Governor's Salmon Recovery Office was established by the Legislature through the Salmon Recovery Planning Act (Engrossed Substitute House Bill 2496). The Salmon office's role is to coordinate and produce a statewide salmon strategy, assist in the development of regional salmon recovery plans, and submit the strategy and plans to the federal government. The office will also provide the Biennial State of the Salmon report to the Legislature.

Department of Natural Resources

DNR through the Forest Practice Board has developed a Forestry Module. The Board has established the following Forestry Module goals: To provide compliance with the Endangered Species Act for aquatic and riparian- dependent species on state and private lands; To restore and maintain riparian habitat on state and private forest lands to support a harvestable supply of fish; To meet the requirements of the Clean Water Act for water quality on state and private forest lands; and To keep the timber industry economically viable in the state of Washington.

Washington Department of Ecology

The Department of Ecology impacts habitat in the subbasin in a variety of ways. Most importantly is the issuance of permits under the State Environmental Policy Act (SEPA) and the Shoreline management Act. DOE also participates in the development of county comprehensive plans for growth management and the development of DNR's Forestry Module.

DOE also issues municipal and industrial wastewater and storm water permits. It is involved in setting water allocations and instream flow.

Local Government

Clark County

Clark County has jurisdiction for most of the lower Washougal mainstem. The County has identified fish and wildlife critical areas and is in the process of bringing a series of ordinances into NMFS 4(d) compliance: the Fish and Wildlife Critical Areas Ordinance, the Stormwater Ordinance, Wetlands Ordinance etc. The County has established an Endangered Species Program, and has purchased some lands along the Washougal to incorporate into the County Parks for salmon protection.

The upper Washougal drainage lies within Skamania County. Skamania County has developed a critical areas ordinance and relies on WDFW's priority list for critical area identification.

Lower Columbia Fish Recovery Board

Established in 1998 by state law, the Lower Columbia Fish Recovery Board encompasses five counties in the Southwest Washington Region. The Board's mission is to recover steelhead and other species listed under the Endangered Species Act through the development and implementation of a comprehensive recovery plan. The 15-member board is responsible for implementing the habitat portion of an approved state and federal recovery plan. To accomplish this, the Board is authorized to establish habitat project criteria, prioritize and approve projects, acquire and distribute funds for projects, enter into contracts on behalf of project sponsor, and assess and monitor project outcomes. The Board holds regular monthly meetings on the first Friday of each month at different locations across the region.
Lower Columbia Fish Recovery Board approved projects are listed in Table 14.

Table 14. Lower Columbia Fish Recovery Board approved projects.

Project Name	*Sponsor*	*Amount*	*Purpose*
Coyote Creek Fish Passage	*Clark County Public Works*	*$21,445*	Fish Passage
Winkler Creek Fish Passage	*Clark County Public Works*	*$23,556*	DOT Design
Washougal River: Slough Creek Riparian	*Columbia Land Trust*	*$131,173*	Acquisition/Restoration
Washougal Assessment	*LCFRB*	*$50,000*	Assessment
Schoolhouse Creek	*Washington Trout*	*$367,325*	Acquisition/Restoration

The Lower Columbia Fish Recovery Board also has a list of goals and objectives, which are listed in the existing goals objectives and strategies section of this document.

City of Camas

Under Washington's Growth Management Act (GMA) the City of Camas is charged with identifying and protecting critical fish and wildlife habitat areas. Protection should be provided by the city developing appropriate ordinances and through application of the Shoreline Management Act to the development permitting process.

City of Washougal

Under Washington's Growth Management Act (GMA) the City of Washougal is charged with identifying and protecting critical fish and wildlife habitat areas. Protection should be provided by the city developing appropriate ordinances and through application of the Shoreline Management Act to the development permitting process.

Existing Goals, Objectives, and Strategies

Fisheries

In the State of Washington's Statewide Salmon Strategy, its goal is to "restore salmon, steelhead, and trout populations to healthy harvestable levels and improve the habitat on which fish rely on." The Washington Department of Fish and Wildlife has a mission statement of "Sound stewardship of fish and wildlife". The WDFW Wild Salmonid Policy goal is to "Protect, restore, and enhance the productivity, production, and diversity of wild salmonids and their ecosystems to sustain ceremonial, subsistence, commercial, and recreational fisheries; non-consumptive fish benefits; and other related cultural and ecological values." (WDFW 1997).

Objective 1 The Draft Endangered Species Act Implementation Plan for the Federal Columbia River Power System has a section on research monitoring and evaluation. It states," the primary objectives of the RM&E component of this Plan are: Track the status of fish populations and their environment relative to required performance standards; identify the physical and biological responses to management actions: and resolve critical uncertainties in the methods and data required for the evaluation of future population performance and needed survival improvements".

Strategy 1. Monitor effects of HGMP's It is imperative to be able to monitor the freshwater production of naturally spawning salmon, cutthroat and steelhead in the subbasin in order to understand the potential effects of hatchery stocking. Spawning and rearing areas should be identified and protected. Smolt production should be determined through the use of downstream migrant traps on major tributaries. Wild escapement should be documented through the use of redd surveys and carcass counts.

Strategy 2. Hatchery and wild interactions on spawning grounds need to be monitored. Spatial and temporal differences between hatchery and wild fish of the same species need to be documented. Spawning ground surveys should provide this information. Snorkel surveys could document interactions of hatchery residuals and wild juvenile fry.

Objective 2 Monitor the effect of Fish Management and Evaluation Plans (FMEP).

Strategy 1. The objectives of the Washington Department of Fish and Wildlife's (WDFW) Fish Management and Evaluation Plans (FMEP) are based on the WDFW Wild Salmonid Policy. In that policy, it states that harvest rates will be managed so that 1) spawner abundance levels abundantly utilize available habitat, 2) ensure that the number and distribution of locally adapted spawning populations will not decrease, 3) genetic diversity within populations is maintained or increased, 4) natural ecosystem processes are maintained or restored, and 5) sustainable surplus production above levels needed for abundant utilization of habitat, local adaptation, genetic diversity, and ecosystem processes will be managed to support fishing opportunities (WDFW 1997a). In addition, fisheries will be managed to insure adult size, timing, distribution of the migration and spawning populations, and age at maturity are the same between fished and unfished populations.

Strategy 2. Intensive efforts will be needed to determine the extent of the balance between harvest and escapement to fully seed the available habitat. Commercial and recreational fisheries will be monitored to prevent over harvest and insure comparable and temporal similarities between fished and unfished populations. Coded wire tags will identify the disposition of captured fish. Genetic sampling should be conducted to ascertain wild and hatchery genetic profiles and potential stray rates.

Wildlife

The Washington Department of Fish and Wildlife also has goals and objectives for wildlife. Some Washougal goals are:

Maintain the historic statewide diversity of native wildlife species. Determine the ecological needs and population status of wildlife species of concern.

Develop an inventory of the current habitats of wildlife populations. Protect and manage for recovery of all native wildlife classified as endangered, threatened or sensitive.

Manage game populations for sustainable natural production where feasible.

Objective 3 Develop management guidelines for game and nongame species that are endangered, threatened or sensitive (ETS) and identify, map, and update the Priority Habitats and Species (PHS) data.

Strategy 1. Maintaining diversity statewide can best be achieved by maintaining diversity in individual watersheds. The wildlife species in the Washougal are a diverse group of native, game and ETS species. Proper management of these species in the watershed will aide in maintaining diversity.

Objective 4 Conduct and support research to investigate the population status, habitat requirements and the natural ecology of wildlife species of concern and determine abundance, distribution and composition of game populations and incorporate into GIS database.

Strategy 1. Spotted owls, bald eagles, and Larch Mountain salamanders are all species of concern statewide and in the Washougal River watershed. Whereas the ecological needs and population status of owls and eagles have been well described, little is understood regarding Larch Mountain salamanders. Work being conducted in the watershed will increase our understanding of this species.

Strategy 2. Mapping and inventorying wildlife habitats is key to protection of the Washougal River wildlife. Remote sensing and GIS technologies have been used elsewhere to map current conditions of critical habitat components. We need to do the same for the Washougal subbasin for the key species and then model habitat changes and their impacts on wildlife in the future.

Objective 5 Develop and implement recovery and management plans for ETS species and develop management plans for game species in the Washougal subbasin.

Strategy 1. Managing the Washougal River watershed at the landscape scale will aid in protecting all native species, including ETS species. Understanding individual species habitat requirements and interactions with other will improve long-term sustainability of wildlife diversity in the watershed.

Objective 6 Identify and evaluate acquisition needs for important habitat of game species in WRIA #28.

Objective 7 Implement the interim regional habitat strategy as outlined in the goals and strategies the Lower Columbia Fish Recovery Board (Appendix F).

The Yakama Nation also has goals and objectives for fish and wildlife in their ceded areas and historical hunting and fishing areas (Bachman 2001 , personal communication). Some Washougal River goals area:

Utilize a Yakama Nation style supplementation program for fishery and natural production restoration.

Develop selective harvest techniques for returning adults.

Develop and understanding of estuary interactions of Washougal river anadromous fishery stocks.

Protect and restore ecosystem process and functions of spawning, rearing, and migratory habitat.

Protect and restore ecosystem process and functions to support native plant and wildlife.

Eliminate or control negative impacts of introduced plant, animals and fish.

Maintain water quality consistent with fish needs and human consumption.

The Lower Columbia Fish Recovery Board and its Technical Advisory Committee has developed goals and strategies that they will use to:

A. Identify and rank habitat restoration and protection needs; and
B. Evaluate and rank habitat project proposals.

It should be noted that this document is an ***interim*** habitat strategy.

Fish Recovery Goals of the Lower Columbia River Fish Recovery Board:

- Support Recovery of ESA listed stocks.
- Support biodiversity through recovery of native wild stocks.
- Restore or sustain geographic distribution of stocks.
- Maintain healthy stocks of a listed species.
- Support recovery of critical stocks of listed species.
- Habitat Protection and Restoration Goals:
- Restore access to habitat.
- Protect existing properly functioning habitat conditions.
- Restore degraded watershed processes needed to sustain properly functioning habitat conditions.
- Support of critical salmonid life-history stages.
- Secure near and long-term benefits.

The LCFRB has developed a process to evaluate Fish Stock Priorities, Habitat Protection and Restoration Priorities, and Evaluation and Ranking of Habitat Projects. This process should be utilized in decision making on habitat and restoration projects.

Nez Perce, Umatilla, Warm Springs, and Yakama Tribes in their Tribal Restoration Plan listed the following goals: "Restore anadromous fishes to the rivers and streams that support the historic cultural and economic practices of the tribes. Emphasize strategies that rely on natural production and healthy river systems to achieve this goal. Protect tribal sovereignty and treaty rights. Reclaim the anadromous fish resource and the environment on which it depends for future generations".

Research, Monitoring, and Evaluation Activities

Fisheries

Current fish research, monitoring, and evaluation activities are listed below:

- Activity 1 Collection of coded wire tags from hatchery returns and fish spawning in river.
  - Activity 1.1 WDFW staff at Washougal and Skamania Hatcheries collect and process coded wire tags from returning fish. Tags are read at the WDFW laboratory in Olympia.
  - Activity 1.2 PSMFC staff conduct spawning ground surveys, marking redd sites and collecting coded wire tags from returned spawners. Tags are read at the WDFW laboratory in Olympia.

- Activity 2 Creel checks and coded wire tags are recovered through sport check surveys. Tags are read at the WDFW laboratory in Olympia.

- Activity 3 SSHIAP (Salmon Steelhead Habitat Inventory Assessment Program) will provide data for the Washougal River basin area. This data will include:

  - Activity 3.1 Comprehensive fish barrier coverage.
  - Activity 3.2 Fish Distribution by species, life stages.
  - Activity 3.3 Habitat Typing by segment- breaks stream reaches into small/large trib, gradients, habitat type (wetlands, etc), and confinement.
  - Activity 3.4 Hydromodifications. SSHIAP will catalogue various hydromodifications in the drainage. Hydromodifications include anthropogenic structures that in some way prohibit natural alluvial processes. These can include rip rap banks, bulkheads, roads, and other features present in the active floodplain.
  - Activity 3.5   Other background information such as stream widths and flow will also be added. Habitat typing will be completed by mid November. Hydromodifications will be completed by Dec. 31, 2001. All of this information will be available in GIS format on the web sometime after Dec. 31.

Wildlife

1. Activity 1 Develop management guidelines for game and nongame species that are endangered, threatened or sensitive (ETS) and identify, map, and update the Priority Habitats and Species (PHS) data.

2. Activity 2 Conduct and support research to investigate the population status, habitat requirements and the natural ecology of wildlife species of concern and determine abundance, distribution and composition of game populations.

3. Activity 3 Develop and implement recovery and management plans for ETS species and develop management plans for game species in the Washougal subbasin.

4. Activity 4 Identify and evaluate acquisition needs for important habitat of game species in Washougal subbasin.

Statement of Fish and Wildlife Needs

Evaluate and monitor fisheries for meeting performance indicators identified in the NMFS Fisheries Management and Evaluation Plan (FMEP) for the Lower Columbia River.

Rationale: Limited monitoring of fish populations is presently occurring (see existing monitoring activities), but should be expanded to insure populations are not exceeding levels identified in the FMEP. This would allow harvest of surplus population while protecting wild populations.

Determine abundance, distribution, survival by life-stage, and status of fish and wildlife native to the watershed including steelhead, coastal cutthroat, fall chinook, coho salmon, crayfish, and others.

Rationale: Washougal River steelhead, chum and chinook salmon are part of the Lower Columbia River ESU and are currently listed under the ESA. Abundance and survival estimates will be needed to determine if habitat restoration programs are working and to determine if these fish can be removed from the Endangered Species list. Coastal cutthroat trout have been proposed for listing under ESA and coho salmon are considered a candidate for listing under ESA because of possible lowered status across their distributional range. Little is known about historical and current distribution and status of these fish in this watershed. Comparison of recent surveys with historical observations suggest that crayfish have disappeared from some of their former range. Crayfish are likely an important part of the food chain, and documenting their distribution and status is an important factor for assessment of health of the Washougal River ecosystem.

Determine genetic and life history types of native fish and wildlife and the strength of their current expression relative to historical and desired future conditions.

Rationale: Maintaining life history and genetic diversity allow fish to be productive under the current and a wide variety of future conditions. Determining these levels of diversity will help develop successful recovery strategies.

Determine the effectiveness of habitat restoration projects on achieving the desired physical change and measure the response of fish and wildlife populations to these changes.

Rationale: The State of Washington and the Lower Columbia Fish Recovery Board have spent thousands of dollars on habitat restoration in the Washougal River and requests have been made to continue this effort. Large-scale monitoring and site-specific monitoring projects are needed to evaluate the effectiveness of these actions to rebuild fish and wildlife populations.

Assess effect of operations and flow regime of Bonneville Dam on the Washougal River's fish and wildlife production capacity.

Rationale: The flow regime of Bonneville Dam has modified the natural flow regime of Washougal Slough and the lower Washougal River. The large natural Spring runoff of the Columbia River are diminished by the dam and flows are distributed over a greater time period. Water impounded behind the series of upstream dams has raised summer water temperatures. Fish production and wildlife may be negatively impacted by large-scale ecosystem functional changes including sedimentation, water temperature, turbidity, and predator access in the lower Washougal subbasin area.

Conduct routine surveys for chum salmon in the lower Washougal subbasin. Evaluate seeps and other potential spawning areas for chum production.

Rationale: Flow regimes at Bonneville Dam have caused dewatering of chum redds at Ives Island and potentially at seeps above the I-205 Bridge. Seeps and springs within the lower Washougal subbasin may prove to be alternative sites for successful chum spawning. The Washougal Hatchery could be used as an emergency refuge for chum eggs if Columbia River levels drop too low. Adults would be brought to Washougal Hatchery, spawned and the resulting fry replanted in their spawn areas of origin.

Protect and monitor headwater streams.

Rationale: Headwater streams are in public management through the Gifford Pinchot National Forest and Washington Department of Natural Resources. Both agencies should plan to protect fish and develop recreation areas which would allow protection of fish and habitat and enforcement of management policies.

Implement restoration actions identified in the watershed assessments that are consistent with recovery of fish and wildlife populations and their habitat.

Rationale: Restoration projects that are the outcome of watershed assessments and have gone through a review process have addressed factors that limit the recovery of fish and wildlife populations. These projects should have a high probability for success. The above or modified monitoring and evaluation programs should be funded as part of these restoration activities.

Investigate Camas municipal water diversion on instream flows.

Rationale: The City of Camas relies on Boulder and Jones Creek for its drinking water supply. The effect of such diversions on summer water flows should be investigated and minimized if at all possible.

Continue watershed coordination and local stewardship programs.

Rationale: The land and resource management decision needed to recover fish and wildlife populations and their habitat will impact local residents. Many of these people are knowledgeable about these resources and should be part of the decision process. The involvement of the Clark Skamania Flyfishers and the Camas Washougal Fish and Wildlife League is important to the outcome of management decisions and address local concerns about long-term community and economic sustainability.

Evaluate the needs and results of a nutrient enhancement project. If determined it is successful, design and implement a comprehensive nutrient introduction plan.

Rationale: Salmon carcasses play a major role in ecosystem health by directly and indirectly contributing to watershed and fish productivity. In some years, salmon carcasses from the Washougal and Skamania Fish Hatcheries could potentially be used as this nutrient source.

Implement aquatic macro invertebrate monitoring program.

Rationale: Aquatic macroinvertebrates serve as an effective measure of a stream's natural potential for productivity, habitat quality and water quality. Analysis of the macroinvertebrate communities can reveal conditions and trends in aquatic ecosystems. Few samples of aquatic macroinvertebrates have been collected in the Washougal River subbasin. Macroinvertebrates are a recommended means of monitoring the effects a nutrient enhancement program.

Implement needed hatchery repairs to bring Skamania and Washougal Hatcheries into compliance with "wild" fish protection measures.

Rationale: Skamania and Washougal Hatcheries intakes are not in compliance with current standards. Adult holding areas are not conducive for rapid sorting of fish and exclusion of wild steelhead. Traps, intakes and holding areas should be brought up to current standards. Traps should be reconfigured to allow for the easy removal and passage upstream of "wild" salmonids and prevent passage of hatchery escapees. Sixty percent of Washougal Hatchery's water supply has no pumped backup, which could cause catastrophic loss in the face of a power outage. The old 220-volt generator should be replaced with a modern 440-volt version.

Expand enforcement program for the entire Lower Columbia Basin.

Rationale: Successful fish and wildlife management programs require citizen compliance. While some users will intuitively act in the best interests of the resource, an effective enforcement and compliance regime is necessary to insure full cooperation with management goals.

Washougal Subbasin Recommendations

Projects and Budgets

No project proposals were submitted in the Washougal Subbasin.

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