Chehalis River Basin
WRIAs 22 and 23
Fish Habitat Analysis Using the Instream Flow Incremental Methodology

March 2004
Open File Technical Report 04-11-006

Washington State
Department of Ecology and Department of Fish and Wildlife

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Fish Habitat Analysis Using the
Instream Flow Incremental Methodology

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SUMMARY

The Washington state departments of Ecology and Fish and Wildlife conducted an instream flow study in the Chehalis River Basin using the Instream Flow Incremental Methodology (IFIM). This study provides information about the relationship between streamflow and fish habitat, which can be used in developing instream flow requirements for fish. Four key variables of fish habitat were examined:

- depth
- velocity
- substrate
- cover

The Chehalis River basin study included six rivers: the Humptulips, Satsop, Chehalis, West Fork Hoquiam, Black, and Skookumchuck Rivers. The six river sites were chosen to represent a specific reach of each river. Field data were collected and entered into the computer model to simulate the distribution of water depths and velocities with respect to bottom substrate and overhead cover under a variety of flows. The simulated habitat parameters were then used to generate the quantity of available habitat at each modeled flow; this index is referred to as "weighted usable area" (WUA).

An IFIM study cannot by itself determine the instream flow required by fish populations. The WUA graphs only show whether an increase or decrease in streamflow will increase or decrease the quantity of fish habitat. The study's fish habitat versus streamflow results have to be interpreted by knowledgeable biologists and others to arrive at an instream flow regime that satisfies applicable laws.

Sometimes the IFIM model will predict (for a certain fish species and lifestage) that the maximum amount of available habitat occurs at a flow that is higher than what typically is found during the late summer low flow period. This does not mean the model is incorrect. The model determines whether more or less flow makes more or less fish habitat based on the channel shape (its width and depth) – not on the hydrology (the quantity of flow which changes daily).

Whether an increase in fish habitat truly results in an increase in the fish population depends upon many different factors that affect fish survival. These include fish harvest, ocean survival, water quality, food supply, adult and juvenile fish passage survival, and predation.

ACKNOWLEDGEMENTS

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Introduction

The statutory directives for setting instream flows are given in several laws. The following are short summaries of the key statutes related to instream flow setting.

The Department of Ecology (Ecology) is mandated by the Water Resources Act of 1971 (Chapter 90.54 RCW) to maintain base flows[1] "necessary to provide for preservation of wildlife, fish, scenic, aesthetic and other environmental values, and navigational values." The word "preserve" means to keep from harm, damage, or danger.

Ecology must also meet the antidegradation requirements of Washington's water quality standards (Chapter 173-201A WAC). This law says existing beneficial uses shall be maintained and protected and no further degradation shall be allowed. The minimum instream flow may not cause any further degradation of beneficial uses such as: fish; fish spawning, rearing and migration; wildlife; recreation; boating; sport fishing; and aesthetics.

Additionally, the minimum instream flow must protect fish, game, birds, and other wildlife, recreational and aesthetic values and water quality (Chapter 90.22 RCW).

Under the Watershed Planning law (Chapter 90.82 RCW) the minimum instream flows developed in a watershed plan must not conflict with any existing laws such as those listed and summarized above.

The Department of Fish and Wildlife (WDFW) is mandated to "preserve, protect, perpetuate, and manage the wildlife and food fish, game fish …" (Chapter 77.04.012 RCW); part of this mandate is to protect habitat, including streamflows.

Additionally, Governor Locke has directed the state agencies in his Statewide Strategy to Recover Salmon that the state's goal is to "Restore salmon, steelhead, and trout populations to healthy and harvestable levels".

In determining appropriate base, or instream, flows for fish habitat, Ecology and WDFW often use the Instream Flow Incremental Methodology (IFIM) to generate information to evaluate fish habitat values. Six sites were chosen for this IFIM study, each composed of 4 to 9 transects:

- Humptulips River at RM 23.8, at a public access site downstream of the Highway 101 bridge
- West Fork Hoquiam River at RM 10.3, just downstream from the confluence with Davis Creek
- Satsop River at RM 5
- Black River at RM 4.2, at the public access site near the HWY 12 bridge
- Skookumchuck River at RM 1.0, at Riverside Rotary Park in Centralia
- Upper Chehalis River at RM 110.9, about 5 miles south of Pe Ell

Depths and velocities were measured along the transects at two to three different flow levels.

[1] In statute, the term "base flow" is used synonymously with the terms "instream flow" and "minimum instream flow." "Streamflow" refers to the amount of water flowing in a stream.

Project Background

The Chehalis River basin is one of the largest basins the state of Washington, second only to the Columbia River basin. It is located in southwestern Washington and is comprised largely of the Chehalis River and the Hoquiam and Humptulips Rivers, each of which flows into Grays Harbor. The Chehalis River basin is bounded by the Olympic Mountains and Black Hills to the north, the rolling hills of the Deschutes River basin to the east, and the Cowlitz River basin and the Willapa Hills to the south.

Water Quality

Instream flows can affect water quality; however water quality was not addressed in this IFIM/RHABSIM report. The reader should refer to the Salmon and Steelhead Habitat Limiting Factors Report for the Chehalis Watersheds - Water Resource Inventory Areas (WRIAs) 22 and 23 for a summary of water quality issues in the basin.

There are numerous water quality problems in the Chehalis basin. There are many streams in the Chehalis basin on the 303 d list (a listing of possible water quality problems as identified for the Clean Water Act), mostly related to fecal coliform, temperature, and sediment measurements. The list is long and may be perused at: http://www.ecy.wa.gov/programs/wq/303d/1998/1998_by_wrias.html. For example, the Wynoochee River and Wildcat Creek are listed for temperature problems and the Chehalis River, Duck Lake, and Grays Harbor are listed for fecal coliform problems.

TMDL (Total Maximum Daily Load) studies are in process, including one for Grays Harbor.

Sediment in streams is still a major problem in some areas from historical practices involving road building and natural landslides. The Forest and Fish law now in effect for timber lands may contribute to improving water quality in future years.

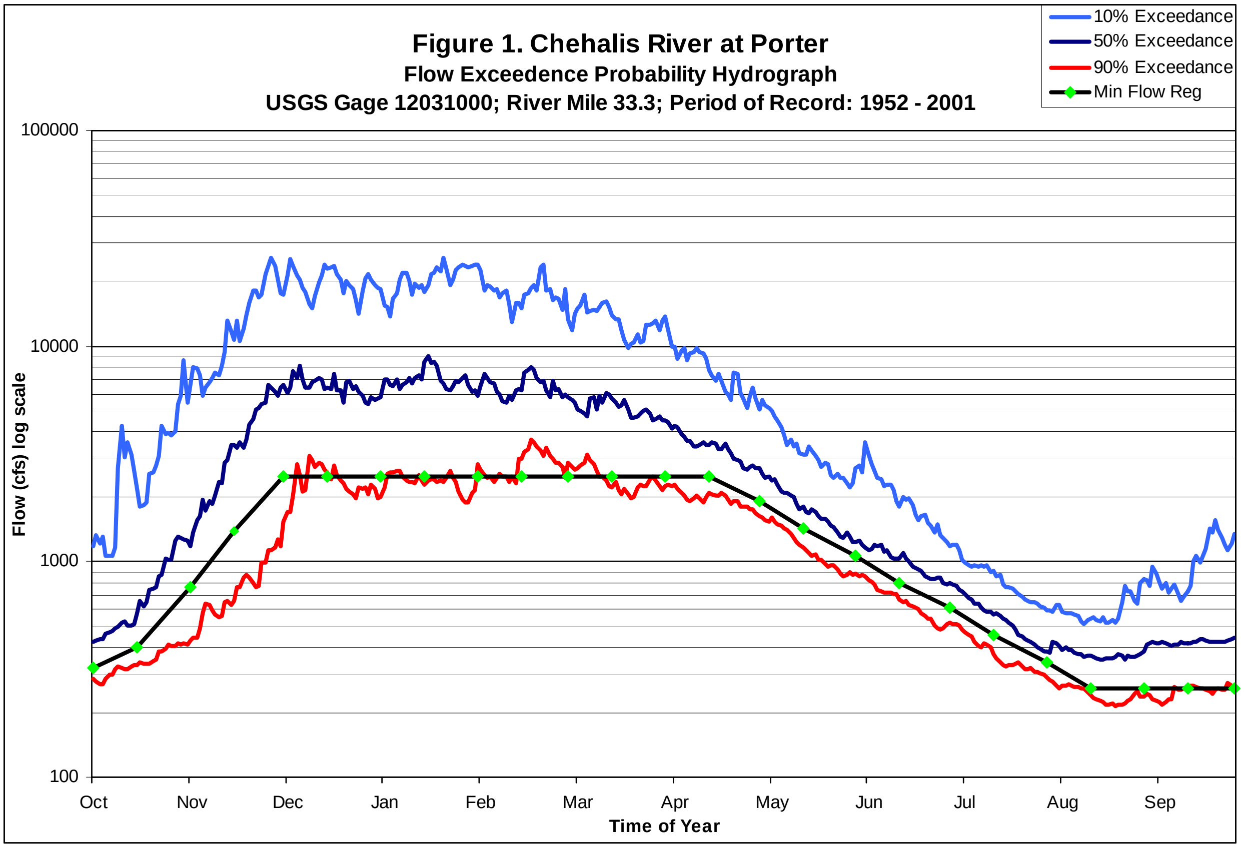
The agricultural lowlands in the extensive Chehalis floodplain are plagued by high water temperature problems partly due to a lack of riparian vegetation and summer low flows.

Hydrology

Although there is some snow melt from the Olympic Mountains, the Chehalis basin is primarily a rain-fed system with peak flows during the wet winters and low flows during the dry summers.

Specific hydrological data is available from the United States Geological Survey (USGS) which provides daily exceedance flow values for the streams throughout Washington. Exceedance flows are the flows expected to be exceeded a specific percentage of the time: e.g. the 50 percent exceedance flow would be exceeded 50 percent of the time. One-half of the streamflows measured in that stream on that specific day over many years of flow measuring would be higher than the 50 percent exceedance flow number.

Data from some of the USGS gage sites within the Chehalis River basin are graphed in Figures 1,11,15,19,23,27,and 31. In Figure 1, for example, the flow data for the Chehalis River at Porter gage is portrayed with 10, 50, and 90 percent exceedance flows. The 50 percent exceedance flow is the median flow. Its values are close to but usually lower than the average flow. The 90 percent exceedance flow is exceeded 90 percent of the time. This can be thought of as a 1-in-10-year low flow for a given date. The 10 percent exceedance flow is roughly the 1-in-10-year high flow for a given date. One can expect about 80 percent of the flow values to fall within the 10 to 90 percent exceedance range.



Exceedance flows are a useful tool for looking at the “normal” flow of a river. Although it might seem logical to represent the “normal” flow as a number such as the average monthly flow, such a number is often one that has never been measured as a daily flow. Averages are frequently skewed toward high numbers because of short-term rain events. It is more appropriate to describe the “normal” flow in a stream by using the 10 to 90 percent exceedance range.

These graphs show the range of flows expected throughout the year based on recorded data. Keep in mind that these hydrographs do not show the natural streamflow in the stream since the hydrographs show the streamflow after surface and groundwater diversions have removed stream flow.

River Description, Fish Distribution, and Lifestage Timing

(Note: We relied heavily on the Catalog of Washington Streams and Salmon Utilization (1976), Salmon and Steelhead Habitat Limiting Factors Report for the Chehalis Watersheds - Water Resource Inventory Areas (WRIAs) 22 and 23 (2001), Washington State Salmon And Steelhead Stock Inventory (1992 and 2002), StreamNet: Fish Data for the Northwest, and communications with local fish biologists for the details included in this section.)

Humptulips River

The Humptulips River drains 276 square miles and is formed by the confluence of its East and West forks at RM 28.1 with the West Fork considered part of the mainstem. This means the river mile (RM) numbering system continues up the West Fork Humptulips River. The upper two-thirds of the watershed is part of the Olympic National Forest and the majority of the lower watershed consists of private timberlands. Major tributaries of the Humptulips River include the Deep, Big, and Stevens Creeks, but there are numerous smaller tributaries available for spawning and rearing habitat. The IFIM site was at RM 23.8 (at a public access site downstream of the Highway 101 bridge).

The headwaters of the West Fork Humptulips are in the steep foothills of the Olympic Mountains beyond RM 60, but cascades below RM 46 create an impassable barrier to salmon, although steelhead are able to migrate past the cascades. Many tributaries also have impassable cascades or falls at or within the first mile of their confluence with the mainstem limiting the available salmon and steelhead spawning habitat. Fish passage facilities were constructed on O'Brien and Rainbow Creeks and the East Fork Humptulips to extend salmon and steelhead habitat.

Fall Chinook enter the river beginning in September and usually migrate to spawning areas in the mainstem and the East Fork Humptulips River and in the tributaries, Big Creek and Stevens Creek. However, some spawning occurs in smaller tributaries such as Donkey, Newbury, O'Brien, Brittain, Rainbow and Grouse Creeks. Spawning begins in October, peaks late October to early November, and ends early December. Egg incubation starts in October and continues through March. Fry begin to emerge in February, rear for around 90 days, then outmigrate from April to mid August. Fall Chinook stock status is classified as depressed (SASSI 2002) due to long term negative trends in escapement.

Chum begin entering the river in October and primarily spawn in the mainstem, the East Fork Humptulips, and the tributaries Stevens Creek and Big Creek. To a lesser extent they use O'Brien, Grouse, and Newberry Creeks. Spawning usually occurs between late October and mid-December, with peaks in mid-November. Egg incubation starts late-October and continues through March. Fry emergence begins mid-January with outmigration starting after as little as one week in late January and continuing through mid-June. Chum stock status is classified as healthy (SASSI 2002).

Adult coho migrate in from October to mid-January and spawn in over sixty tributaries throughout the Humptulips watershed. Most spawning occurs in Big, Hansen, Fairchild, Stevens, Ellwood, O'Brien, Donkey and Newberry Creeks and some even occurs in the lower mainstem and in the East and West Fork Humptulips. Spawning occurs between late October and mid-February with a peak in early December, but there is a significant late (thought to be wild) spawning component in January/February. Egg incubation starts in late October and continues through April with fry emergence beginning in February. Coho fry/juveniles rear for about 1 year, using low gradient wetlands and side channels, and then outmigrate from mid-February through mid-June of the following year. Coho stock status is classified as healthy (SASSI 2002).

Winter steelhead arrive between December and early June and usually spawn in the mainstem Humptulips River, and its East Fork and West Forks, as well as the tributaries Brittian, Stevens, Donkey, and Newbury Creeks. However, small numbers are found throughout the Humptulips watershed including past the cascades at RM 46 on up to RM 58. Spawning occurs between mid-February and mid-June with the peak in late April-early May. Egg incubation starts mid-February and continues through July with fry emergence beginning in April. Most steelhead fry/juveniles rear for 2 years (John Sneva, WDFW, personal communication) and then out-migrate between April through June. Winter steelhead stock status is classified as depressed (SASSI 2002) due to long term negative trends in escapement.

Summer steelhead arrival times overlap with winter steelhead and they migrate into the river between May and November. They usually migrate to the headwaters, but their spawning distribution is not well known. Summer steelhead hold over the winter and spawn between mid-February and April of the following year. Rearing and outmigration timings are also similar to winter steelhead. Summer steelhead stock status is classified as unknown (SASSI 2002).

Cutthroat in the Humptulips are part of the Chehalis coastal cutthroat stock. Cutthroat are present in virtually all perennial tributaries and mainstem reaches of the Chehalis system. River entry is from October through April. Spawning of anadromous cutthroat takes place January through mid-March and the resident cutthroat a bit later, February through mid-March. Although the status is unknown (SASSI 2000), the stock is believed to be relatively abundant and widely distributed.

West Fork Hoquiam River

The Hoquiam River watershed drains 98 square miles with 16 miles of mainstem and 68 miles of tributary presently accessible for salmon and steelhead production. The Hoquiam River is formed by the confluence of the West and East Fork at RM 2.4, and Middle Fork at RM 7.1, with the West Fork considered part of the mainstem. Commercial and residential uses dominate the lower five miles of the mainstem Hoquiam. The city of Hoquiam protects 7500 acres of forested land as a municipal watershed, but most of the watershed is managed for timber harvest. Major tributaries along the West Fork Hoquiam include Davis Creek and Polson Creek. The IFIM site was at RM 10.3, just downstream from the confluence of the West Fork with Davis Creek.

The West Fork Hoquiam is tidally influenced to RM 9.3. Downstream from this point silt and sand severely impact the spawning gravels and there is little spawning. However, these lower areas are important for migration and rearing. Dams on the West Fork Hoquiam at RM 10.7 and on Davis Creek at RM 0.2 are used to divert water for the city of Hoquiam. They are equipped with fish ladders, but still impact fish passage. Many improvements have been made to culverts along Highway 101, and fish passage, while still impacted, has improved.

Fall Chinook begin entering the Hoquiam River in September with the majority spawning in the East and West Forks Hoquiam. Some spawning also occurs in Davis Creek and the Middle Fork Hoquiam. Spawning usually occurs from mid-October through early December, with a peak in late October to early November. Egg incubation starts mid-October and continues thought March. Fry begin to emerge in February and then rear for around 90 days. Outmigration occurs from late April to mid-August. Hoquiam fall Chinook stock status is classified as depressed (SASSI 2002) due to a long term negative trend in escapement.

Fall chum in the Hoquiam River are considered part of the general Chehalis fall chum population. They begin entering the Hoquiam River in early October and are believed to have a spawning distribution similar to fall Chinook. Spawning occurs from late October through mid-December. Egg incubation starts late October and continues through March. Fry emergence begins mid-January with outmigration starting after as little as one week in late January and continuing through mid-June. Chehalis fall chum stock status is classified as healthy (SASSI 2002).

Coho begin entering the river in October and spawn in the East, Middle, and West Forks of the Hoquiam River. They also spawn in Berryman, Polson and Davis Creeks, but small numbers are found throughout the watershed. Spawning occurs late October though mid-February with a peak in early December, but there is a significant late (thought to be wild) spawning component in January/February. Egg incubation starts in late October and continues through April with fry emergence beginning in February. Coho fry/juveniles usually rear for a year, using low gradient wetlands and side channels, and then outmigrate from mid-February through mid-June of the following year. Coho stock status is classified as healthy (SASSI 2002).

Winter steelhead enter the river between December and early June and usually spawn in West Fork Hoquiam. Some spawning occurs in the Middle Fork Hoquiam River and in Polson and Davis Creeks, but small numbers are found throughout the watershed. Spawning occurs mid-February to mid-June with peaks in late April to early May. Egg incubation starts mid-February and continues through July with fry emergence beginning in April. Most steelhead fry/juveniles rear for 2 years (John Sneva, WDFW, personal communication) and then outmigrate between April and June. Stock status is classified as depressed (SASSI 2002) due to a short-term severe decline in escapements from 1998 to 2001.

Cutthroat in the Hoquiam are part of the Chehalis coastal cutthroat stock. Cutthroat are present in virtually all perennial tributaries and mainstem reaches of the Chehalis system. River entry is from October through April. Spawning of anadromous cutthroat takes place January through mid- March and the resident cutthroat a bit later - February through mid-March. Although the status is unknown (SASSI 2000), the stock is believed to be relatively abundant and widely distributed.

Satsop River
The Satsop River drains over 300 square miles, and is formed by the confluence of the East Fork (the continuation of the mainstem) and the Middle Fork at RM 11, and with the West Fork at RM 6.3. From this point, the Satsop River flows south through a flat agricultural and rural residential valley until it joins the Chehalis River at RM 20.2. The middle and upper watersheds are still predominantly managed for timber production. Major mainstem tributaries include the Bingham, Canyon, Dry Run, Dry Bed, and Decker Creeks. The IFIM site was at RM 5.

The Satsop drainage suffers from a number of problems. Reforestation within the upper watershed has been slow due to thin soils and steep slopes, and the reach between the West Fork and Middle Fork has poor water quality due to siltation. Low levels of large woody debris are a commonly cited problem. Within the lower watershed, loss of riparian zone has resulted in increased water temperatures, higher flood flows that cause redd scour, and lower summer flows that reduce the amount of summer rearing habitat.

Chehalis summer Chinook are unique to the Satsop River and are an early-timed run entering the river late August through September. They usually spawn in the East Fork Satsop River, but they are occasionally found in lower Decker Creek. Spawning begins early September, peaks in mid- to late September, and ends mid-October. Egg incubation occurs from September to March. Fry begin to emerge in January and rear for a period varying from 45 days to over a year. Outmigration occurs from mid-March to May of the current or following year. Summer Chinook stock status is classified as depressed (SASSI 2002) due to chronically low escapement values.

Fall Chinook have a later river entry and spawning time. They enter the river from September through October and usually spawn in the mainstem Satsop, the East and West Forks Satsop, and in Canyon River. They also spawn in Bingham, Decker and Black Creeks as well as two unnamed tributaries. Spawning begins in October, peaks in early November, and usually ends by mid- to early December. Egg incubation starts in October and continues into April. Fry begin to emerge in February and then usually rear for around 90 days. Outmigration occurs from April to mid August. Stock status is classified as healthy (SASSI 2002) because current numbers are within the normal variation range set in 1992. However, escapements have been in decline since 1996.

Fall Chum are part of the general Chehalis fall chum population. They enter the Satsop River from early October through late November and spawn in the Mainstem and East Fork Satsop River, but primarily use the side channels and sloughs. Chum also use the West Fork and Middle Fork Satsop as well as Decker, Dry Run, and Bingham Creeks. Spawning occurs from late October through mid-December. Egg incubation starts late October and continues through March. Fry emergence begins mid-January with outmigration beginning shortly thereafter in February and continuing through mid-June. Chehalis fall chum stock is classified as healthy status (SASSI 2002).

Coho typically enter the river early October through mid-January and spawn mainly in tributaries such as Bingham, Still, Canyon, Rabbit, Decker, Dry Run, Outlet, and Stillwater Creeks. Some spawning occurs in the mainstem and the East and West Forks of the Satsop River. Spawning starts late October and continues through February with peaks in early December, but there is a significant late (thought to be wild) spawning component in January/February. Egg incubation starts late October and continues through April with fry emergence beginning in February. Coho fry/juveniles rear for a year, using low gradient wetlands and side channels, and outmigrate from mid-February through mid-June of the following year. Coho stock status is classified as healthy (SASSI 2002), but recent year escapements have been below the long-term average.

Winter steelhead enter the river between December and early June and usually spawn in the mainstem Satsop, West Fork, Middle Fork, East Fork, and Canyon Rivers as well as Decker and Bingham Creeks. Some spawning occurs in Dry Run, Phillips, Black, and Rabbit Creeks. Spawning occurs mid-February through mid-June with peaks in late April to early May. Egg incubation starts mid-February and continues through July with fry emergence beginning in April. Most steelhead fry/juveniles rear for 2 years (John Sneva, WDFW, personal communication) and then outmigrate between April through June. Stock status is classified as depressed (SASSI 2002) due to chronic low population levels.

Black River

The Black River is an extremely low gradient system with 144 square miles with 25 miles of mainstem and 84 miles of tributaries. It flows southwest through 14 miles of mostly wetlands and bogs, then forms short riffles with long pools in the lower 9 miles, and enters the Chehalis at RM 47. Land use in the floodplain includes agricultural lands in the lower 9 miles, a mixture of residential, commercial, and agricultural land near the community of Littlerock (RM 17 to 20), and undeveloped wetlands. The uplands are extensively used for commercial timber harvest, low to high density residential developments, and recreation. Major tributaries include Mima, Beaver, Waddell, Salmon and Dempsey Creeks. The IFIM site was at RM 4.2 (at the public access site near the Highway 12 crossing).

Black River historically drained Black Lake, but the original system has been radically altered. In 1922 a flood control ditch was cut at the north end of Black Lake leading to Percival Creek. Deepening of the ditch in 1952 and 1976, along with erosion, made the Black Lake Ditch the primary outlet for Black Lake. In 1965 excavation spoils were left in the stream when a gas pipeline was constructed across the Black River, and vegetative dams and beaver dam debris have developed. This created an impassable barrier to fish and, except during high flows, reversed the wetland drainage such that the upper 1.5 miles of the Black River flows north into Black Lake. These flow changes have resulted in limited mainstem spawning gravels and have worsened the summer low flow conditions, limiting available rearing habitat.

Spring Chinook in the Black River are part of the Chehalis basin stock that spawn as low as RM 33 on the Chehalis River (near Porter Creek), but the vast majority (over 90%) are found in Skookumchuck, Newaukum, and upper Chehalis Rivers. Some enter the Black River between February and July and after holding in deep pools for a several months, spawn in the mainstem Black River. Spawning occurs from early September to mid-October with egg incubation starting in September and continuing through February. Fry begin to emerge in January. Chehalis spring Chinook do not usually rear all year (John Sneva, WDFW, personal communication), but instead outmigrate between July and August. Chehalis spring Chinook stock status is classified as healthy (SASSI 2002), but few are found in the Black River.

Fall Chinook migrating upstream of Porter Creek (Chehalis RM 33.3) are considered part of the upper Chehalis basin stock. They enter the Black River between October and November and spawn in the lower nine miles and from RM 16 to 17.3. They also spawn in the first mile of Waddell Creek. Spawning usually begins mid-October and ends early December. Egg incubation starts mid-October and continues into April. Fry begin to emerge in February, rear for around 90 days, and outmigrate from April to mid August. Chehalis fall Chinook stock status is classified as healthy (SASSI 2002) due to relatively stable escapement values.

Fall chum in the Black River are part of the Chehalis basin population that migrate upstream of Porter Creek (Chehalis RM 33.3). Historically, chum were quite abundant in the Black River, but since the 1970's have greatly diminished. Today they spawn in the lower 10 miles of the mainstem. Chum enter the river from early October to late November and spawn from late October to mid-December. Egg incubation starts late October and continues into mid-April. Fry emergence begins mid-January with outmigration beginning shortly thereafter in February and continuing through mid-June. Chehalis fall chum stock status is classified as healthy (SASSI 2002), but few are found in the Black River.

Coho in the Black River are part of the Chehalis basin population that migrate upstream of Porter Creek (Chehalis RM 33.3). They typically enter the river early October through late December and move quickly up to the headwaters to spawn throughout Black River tributaries, with especially productive areas in Waddell, Mima and Allen Creeks. Coho juveniles thrive in low gradient reaches through the wetlands above RM 9 except during the summer when low flows and high temperatures force rearing juveniles downstream. Spawning occurs from early November though February with a peak in early December, but there is a significant late (thought to be wild) spawning component in January/February. Egg incubation starts in November and continues through April with fry emergence beginning in February. Coho fry/juveniles rear for a year, using low gradient wetlands and side channels, and then outmigrate from mid-February through mid-June of the following year. Chehalis coho stock status is classified as healthy (SASSI 2002).

Winter steelhead in the Black River are part of the Chehalis basin population that spawn upstream of RM 25 starting with Cloquallum Creek. They enter the river between December and early June and usually spawn in the lower 7 miles of the mainstem and in Waddell and Beaver Creeks. They spawn from mid-February to mid-June. Egg incubation starts mid-February and continues through July with fry emergence beginning in April. Most steelhead fry/juveniles rear for 2 years (John Sneva, WDFW, personal communication) and then outmigrate between April through June. Chehalis winter steelhead stock status is classified as healthy (SASSI 2002). However, steelhead in the Black River are affected by the summer low flow conditions that limit available rearing habitat.

Cutthroat in the Black River are part of the Chehalis coastal cutthroat stock. Cutthroat are present in virtually all perennial tributaries and mainstem reaches of the Chehalis River system. River entry is from October through April. Spawning of anadromous cutthroat takes place January through mid-March and of the resident cutthroat a bit later, February through mid-

March. Although the status is unknown (SASSI 2000), the stock is believed to be relatively abundant and widely distributed.

Skookumchuck River

The lower Skookumchuck River drains 120 square miles with 22.1 miles of mainstem and over 125 miles of tributaries. It flows from Skookumchuck Dam (RM 22.1), which is an impassable barrier to salmon and steelhead, to the confluence with the Chehalis River at RM 67. An estimated 3.6 miles of habitat was lost to spring and fall Chinook when the Skookumchuck Dam was constructed. Land use is a mixture of residential, commercial and agriculture development in the valley and timber production in the uplands. Major tributaries include Hanaford, Salmon, Johnson and Thompson Creeks. The IFIM site was at RM 1.0 (at Riverside Rotary Park).

Near the town of Bucoda (RM 11), the landscape changes from low hills with moderate to steep gradients to a broad flat valley with low gradients. Rural residential developments and farms are located along the lower 9 miles of Hanford Creek and along the lower reaches of the Skookumchuck River. This has resulted in bank erosion, loss of riparian habitat, and reduced the quality of the spawning gravels. The Centralia Steam-Electric Power Plant pumps water from near RM 7.2, which contributes to low summer flows.

Spring Chinook are part of the Chehalis basin stock that spawn as low as RM 33 on the Chehalis River, but the vast majority (over 90%) are found in Skookumchuck, Newaukum, and upper Chehalis Rivers. They enter the Skookumchuck River mid-February through late July and after holding in deep pools for a several months, spawn in all suitable portions of the mainstem up to the dam. Spawning occurs from early September to mid-October with egg incubation starting in September and continuing through February. Fry begin to emerge in January. Chehalis spring Chinook do not usually rear all year (John Sneva, WDFW, personal communication), but instead outmigrate between July and August of the current year. Chehalis spring Chinook stock status is classified as healthy (SASSI 2002).

Fall Chinook in the Skookumchuck are part of the Chehalis basin stock. They enter the river between September and October and spawn in all suitable portions of the mainstem up to the dam. Spawning usually begins mid-October and ends early December. Egg incubation starts mid-October and continues into April. Fry begin to emerge in February, rear for around 90 days, and outmigrate between April and mid-August. Chehalis fall Chinook stock status is classified as healthy (SASSI 2002).

Coho in the Skookumchuck are part of the Chehalis basin stock. They typically enter the river early October through late December, and spawn in the mainstem and in many tributaries including Hanaford, Salmon, Johnson, and Thompson Creeks. Spawning occurs between early November and late February with a peak in early December, but there is a significant late (thought to be wild) spawning component in January/February. Egg incubation starts in November and continues through April with fry emergence beginning in February. Coho fry/juveniles rear for a year, using low gradient wetlands and side channels, and then outmigrate from mid-February through mid-June of the following year. Coho stock status is classified as healthy (SASSI 2002).

Winter steelhead in the Skookumchuck River are part of the Skookumchuck/Newaukum stock and enter the river between December and early June. They usually spawn in the mainstem from RM 6 to the Dam (RM 22.1), and in Hanaford and Thompson Creeks. Steelhead are also trucked to reaches upstream of the dam and spawn all along the mainstem up to the headwaters at RM 38. They spawn from mid-February to mid-June. Egg incubation starts mid-February and continues through July with fry emergence beginning in April. Most steelhead fry/juveniles rear for 2 years (John Sneva, WDFW, personal communication) and then outmigrate between April through June. Skookumchuck/Newaukum winter steelhead stock status is classified as healthy (SASSI 2002).

Cutthroat in the Skookumchuck River are part of the Chehalis coastal cutthroat stock. Cutthroat are present in virtually all perennial tributaries and mainstem reaches of the Chehalis system. River entry is from October through April. Spawning of anadromous cutthroat takes place January through mid-March and the resident cutthroat a bit later, February through mid-March. Although the status is unknown (SASSI 2000), the stock is believed to be relatively abundant and widely distributed.

Upper Chehalis River

The upper Chehalis River is formed by the confluence of the East and West Fork Chehalis at RM 118.9 with the East Fork considered part of the mainstem. The upper Chehalis River flows north through narrow steep-sided valleys but the landscape broadens near the town of Pe Ell at RM 106. Major tributaries include Stowe, Rock, and Crim Creeks, and the West Fork Chehalis River. Other tributaries important for fish production include Rodger, Thrash, Cinnabar, George, and Big Creeks. The IFIM site was about 5 miles south of Pe Ell, at river mile 110.9.

The mainstem has many reaches that are naturally confined with low gradients and where pools with long riffles are common. The larger tributaries have a moderate gradient but most of the smaller tributaries are steep and many have cascades near their mouths which limit salmon access. The upper watershed is used for timber production and fine sediment problems from logging and road construction have occurred in all major tributaries and the East Fork Chehalis. Sediment levels are low in the mainstem, but spawning gravels are still limiting due to historic splash-dam scour and stream-cleaning activities.

Spring Chinook are part of the Chehalis basin stock that spawn as low as RM 33 on the Chehalis River, but the vast majority (over 90%) are found in the Skookumchuck, Newaukum, and upper Chehalis Rivers. They enter the lower Chehalis River mid-February through July and after holding in deep pools for a several months, spawn in the mainstem up to RM 113.4. Spawning occurs from early September to mid-October with egg incubation starting in September and continuing through February. Fry begin to emerge in January. Chehalis spring Chinook do not usually rear all year (John Sneva, WDFW, personal communication), but instead outmigrate between July and August of the current year. Chehalis spring Chinook stock status is classified as healthy (SASSI 2002).

Fall Chinook in the upper Chehalis are part of the Chehalis basin stock. They enter the river between September and October and spawn in the mainstem up to RM 109. Spawning usually begins mid-October and ends early December. Egg incubation starts mid-October and continues into April. Fry begin to emerge in February, rear for around 90 days, and outmigrate from April to mid-August. Chehalis fall Chinook stock status is classified as healthy (SASSI 2002) due to relatively stable escapement values.

Coho in the upper Chehalis are part of the Chehalis basin stock. They typically enter the river October through December and spawn throughout all accessible portions of the upper Chehalis and its tributaries. Spawning occurs between November and February with a peak in early December, but there is a significant late (thought to be wild) spawning component in January/February. Egg incubation starts in November and continues through April with fry emergence beginning in February. Coho fry/juveniles rear for a year (and sometimes 2 years), using low gradient wetlands and side channels, and then outmigrate from mid-February through mid-June of the following year. Coho stock status is classified as healthy (SASSI 2002).

Winter steelhead in the upper Chehalis are part of the Chehalis basin population that spawn upstream of RM 25 starting with Cloquallum Creek. They enter the river between December and early June and have a distribution similar to coho except that they are not present in Roger Creek, but are able to migrate past the cascades on Mack Creek. They spawn from mid-February to mid-June. Egg incubation starts mid-February and continues through July with fry emergence beginning in April. Most steelhead fry/juveniles rear for 2 years (John Sneva, WDFW, personal communication) and then outmigrate between April through June. Winter steelhead stock status is classified as healthy (SASSI 2002).

Summer steelhead arrival times overlap with winter steelhead between May and November. They usually migrate to the headwaters, but their spawning distribution is not well known. Summer steelhead hold over the winter and spawn around the same time as winter steelhead, between mid-February and April of the following year. Rearing and outmigration timings are also similar to winter steelhead. Summer steelhead stock status is classified as unknown (SASSI 2002).

Cutthroat in the upper Chehalis River are part the Chehalis coastal cutthroat stock. Cutthroat are present in virtually all perennial tributaries and mainstem reaches of the Chehalis system. River entry is from October through April. Spawning of anadromous cutthroat takes place January through mid-March and the resident cutthroat a bit later, February through mid-March. Although the status is unknown (SASSI 2000), the stock is believed to be relatively abundant and widely distributed.

Study Methods

Overview of IFIM

The Instream Flow Incremental Methodology (IFIM) was selected as the best available method for predicting how the quantity of available fish habitat changes in response to incremental changes in streamflow. This methodology was developed by the U.S. Fish and Wildlife Service in the late 1970s (Bovee 1982). The IFIM involves putting site-specific streamflow and habitat data into a group of models collectively called PHABSIM (**P**hysical **HAB**itat **SIM**ulation). PHABSIM was and is the most commonly used hydraulic modeling program within IFIM to predict depths and velocities in streams.

In the 1990's, Thomas R. Payne and Associates (Arcata, CA) rewrote the PHABSIM program creating a version called RHABSIM (**R**iverine **HAB**itat **SIM**ulation). RHABSIM was chosen for the present study because it is a more user-friendly program, compatible with the Windows operating system. PHABSIM and RHABSIM produce similar depth and velocity predictions.

The IFIM is used nationwide and is accepted by most resource managers as the best available tool for determining the relationship between flows and fish habitat (Reiser, et al. 1989). However, the methodology only uses four variables in hydraulic simulation. At certain flows, such as extreme low flows, other variables such as fish passage, food supply (aquatic insects), competition between fish species, and predators (birds, larger fish, etc.) may be of overriding importance. In addition to the PHABSIM or RHABSIM models, IFIM may include water quality, sediment, channel stability, temperature, hydrology, and other variables that affect fish production. These additional variables are not analyzed in this report.

RHABSIM Process: in brief

The process of quantifying how the amount of available fish habitat changes in response to incremental changes in streamflow is as follows:

1. Collect data in the field: velocity, depth, substrate and cover measurements.
2. Enter data into hydraulic model and calibrate.
3. Enter data in habitat preference model.
4. Calculate Weighted Usable Area (WUA): Combine the predicted depths and velocities (from the hydraulic model) with the depths and velocities preferred by fish (from the habitat preference model). This provides what flows the fish prefer based on the depths and velocities they prefer: the WUA.

RHABSIM Process: in detail

The on-site data is collected and entered into HYDSIM (**HYD**raulic **SIM**ulation), a hydraulic computer model which deals with the movement and force of water. Several hydraulic modeling options are available in HYDSIM. Velocity can be calculated by regression and interpolation and extrapolation based on measured velocities at several flows. Alternatively, velocity at a single flow can be used to solve Manning's equation. These are discussed later in this report, in the section titled "Hydraulic Model."

HYDSIM uses multiple transects to predict depths and velocities in a river over a range of flows. It creates a cell for each measured point along the transect or cross-section. Each cell has an average water depth and water velocity associated with a type of substrate or cover for a particular flow. The cell's area is measured in square feet. Fish habitat is defined in the computer model by the variables of velocity, depth, substrate, and/or cover. These are important habitat variables that can be measured, quantified, and predicted.

After the HYDSIM model is calibrated (that is, adjusted to the situation being modeled) and run, its output is entered into another model (HABSIM, **HAB**itat **SIM**ulation) with data describing fish habitat preferences. These preferences vary by fish species and life stage (spawning and juvenile rearing).

The output of the HABSIM model is an index of fish habitat known as Weighted Useable Area (WUA). The preference factor for each variable in a cell is multiplied by the other variables to arrive at a composite, preference factor for that cell. For example, a velocity preference of 1.0 multiplied by a depth preference of 0.9, then multiplied by a substrate preference of 0.8 equals a composite factor of 0.72 for that cell:

velocity 1.0 x depth 0.9 x substrate 0.8 = 0.72, preference factor for that cell

This composite-preference factor is multiplied by the number of square feet of area in that cell.

A summation of all the transect cells' areas results in the total number of square feet of preferred habitat available at a specified flow. The final model result is a listing of units of square feet of habitat per 1,000 feet of stream. The WUA values are listed with their corresponding flows (given in cubic feet per second).

Study Site and Transect Selection

Preliminary study sites were selected for the IFIM/RHABSIM study with assistance staff from WDFW, who provided local knowledge of fish distribution and habitat characteristics. WDFW staff were a valuable resource in site selections for this study. Reaches were delineated on topographic maps.

Final site selections were made after on-site visits and access was secured with private property owners.

Six sites were chosen for this IFIM study, each composed of 4 to 9 transects:

1. Humptulips River at RM 23.8, at a public access site downstream of the Highway 101 bridge
2. West Fork Hoquiam River at RM 10.3, just downstream from the confluence with Davis Creek
3. Satsop River at RM 5
4. Black River at RM 4.2, at the public access site near the HWY 12 bridge
5. Skookumchuck River at RM 1.0, at Riverside Rotary Park in Centralia
6. Upper Chehalis River at RM 110.9, about 5 miles south of Pe Ell

Depths and velocities were measured at two to three different flow levels. Substrate was recorded at low flow. The river mile location and distances between transects are listed on the following page. Location maps for the six study sites are displayed in Figures 2-7.

Chehalis Basin IFIM Study Site Locations

Transect #	Location: Humptulips River at WDFW access site between Hwy 101 and Stevens Creek hatchery.
1	River Mile 23.8
2	271 feet upstream of #1
3	326 feet upstream of #2
4	567 feet upstream of #3
5	327 feet upstream of #4

Transect #	Location: West Fork Hoquiam River downstream of Davis Creek confluence.
1	River Mile 10.3
2	41 feet upstream of #1
3	53 feet upstream of #2
4	21 feet upstream of #3
5	15 feet upstream of #4
6	73 feet upstream of #5
7	37 feet upstream of #6
8	61 feet upstream of #7

Transect #	Location: Satsop River near Satsop
1	River Mile 5.0
2	100 feet upstream of #1
3	114 feet upstream of #2
4	172 feet upstream of #3
5	347 feet upstream of #4
6	494 feet upstream of #5

Transect #	Location: Black River at public access site below the Hwy 12 Bridge.
1	River Mile 4.2
2	360 feet upstream of #1
3	15 feet upstream of #2
4	80 feet upstream of #3

Transect #	Location: Skookumchuck River at Riverside Rotary Park.
1	River Mile 1.0
2	27 feet upstream of #1
3	41 feet upstream of #2
4	103 feet upstream of #3
5	48 feet upstream of #4
6	45 feet upstream of #5
7	36 feet upstream of #6
8	85 feet upstream of #7

Transect #	Location: Upper Chehalis River south of Pe Ell
1	River Mile 110.9
2	45.5 feet upstream of #1
3	55 feet upstream of #2
4	74 feet upstream of #3
5	104 feet upstream of #4
6	73 feet upstream of #5
7	61 feet upstream of #6
8	141 feet upstream of #7

Figure 2. Humptulips River IFIM site at RM 23.8.

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Figure 3. West Fork Hoquiam River IFIM site at RM 10.3.

Figure 4. Satsop River IFIM site at RM 5.

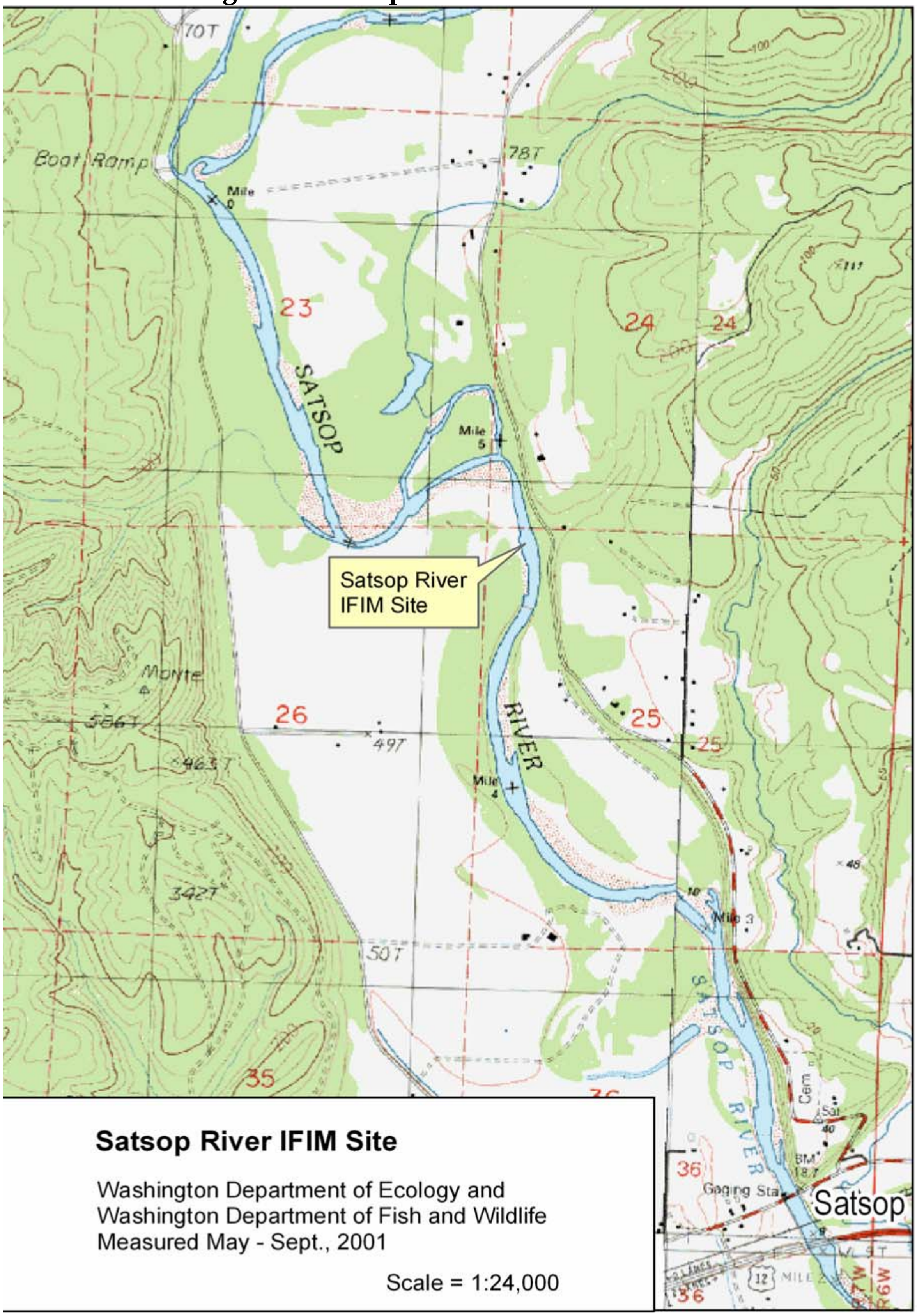


Figure 5. Black River IFIM site at RM 4.2.

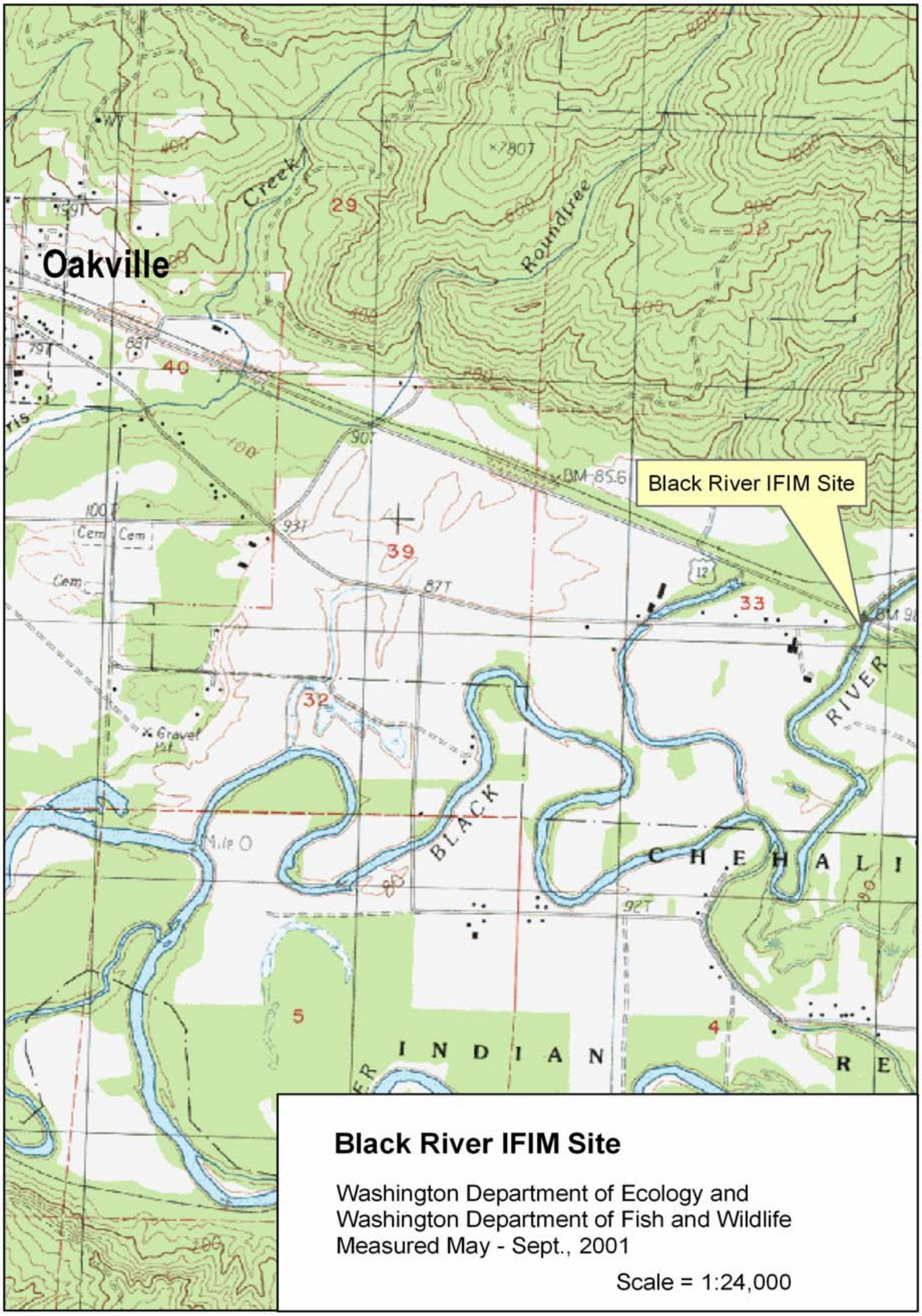


Figure 6. Skookumchuck River IFIM site at RM 1.0.

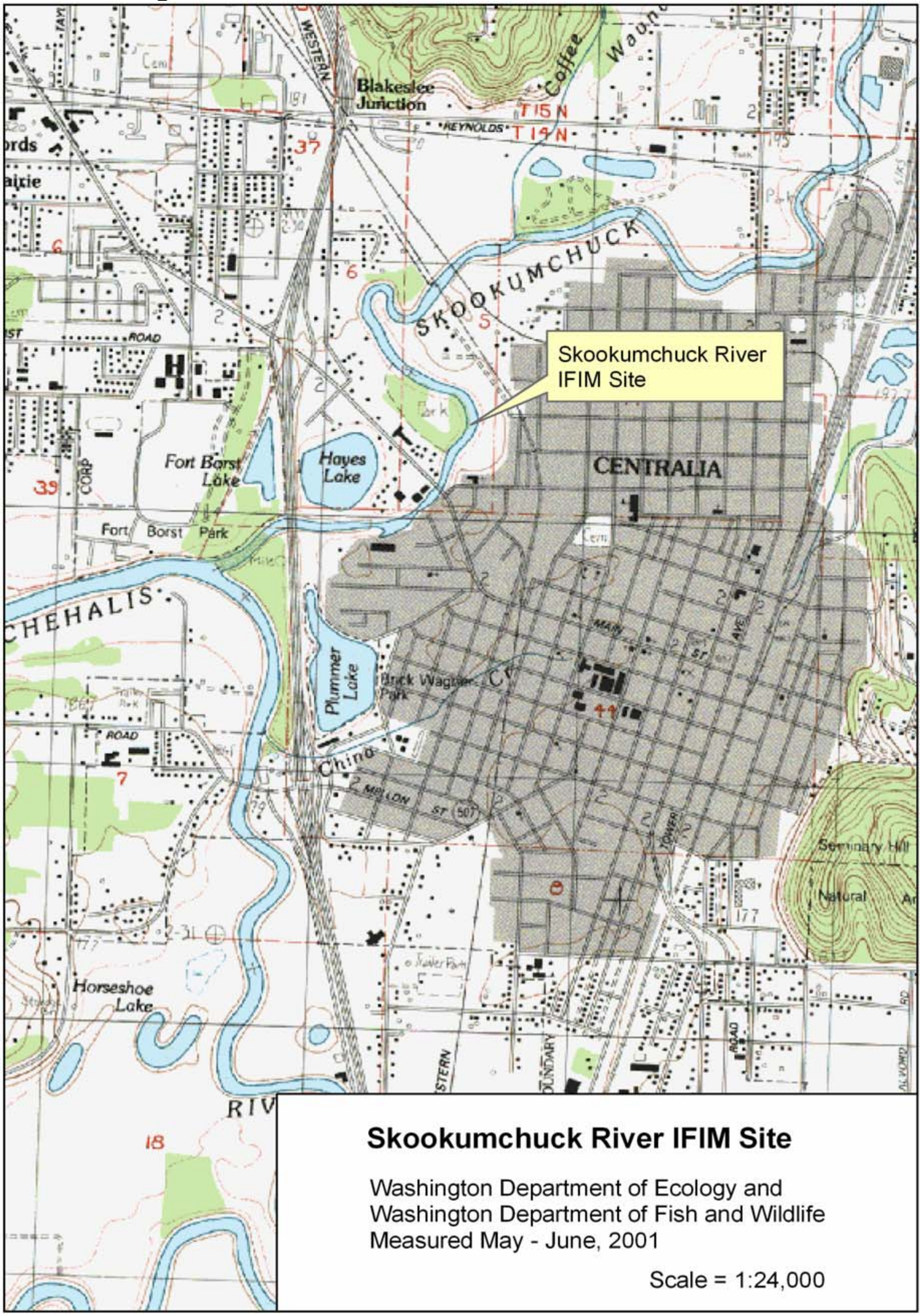
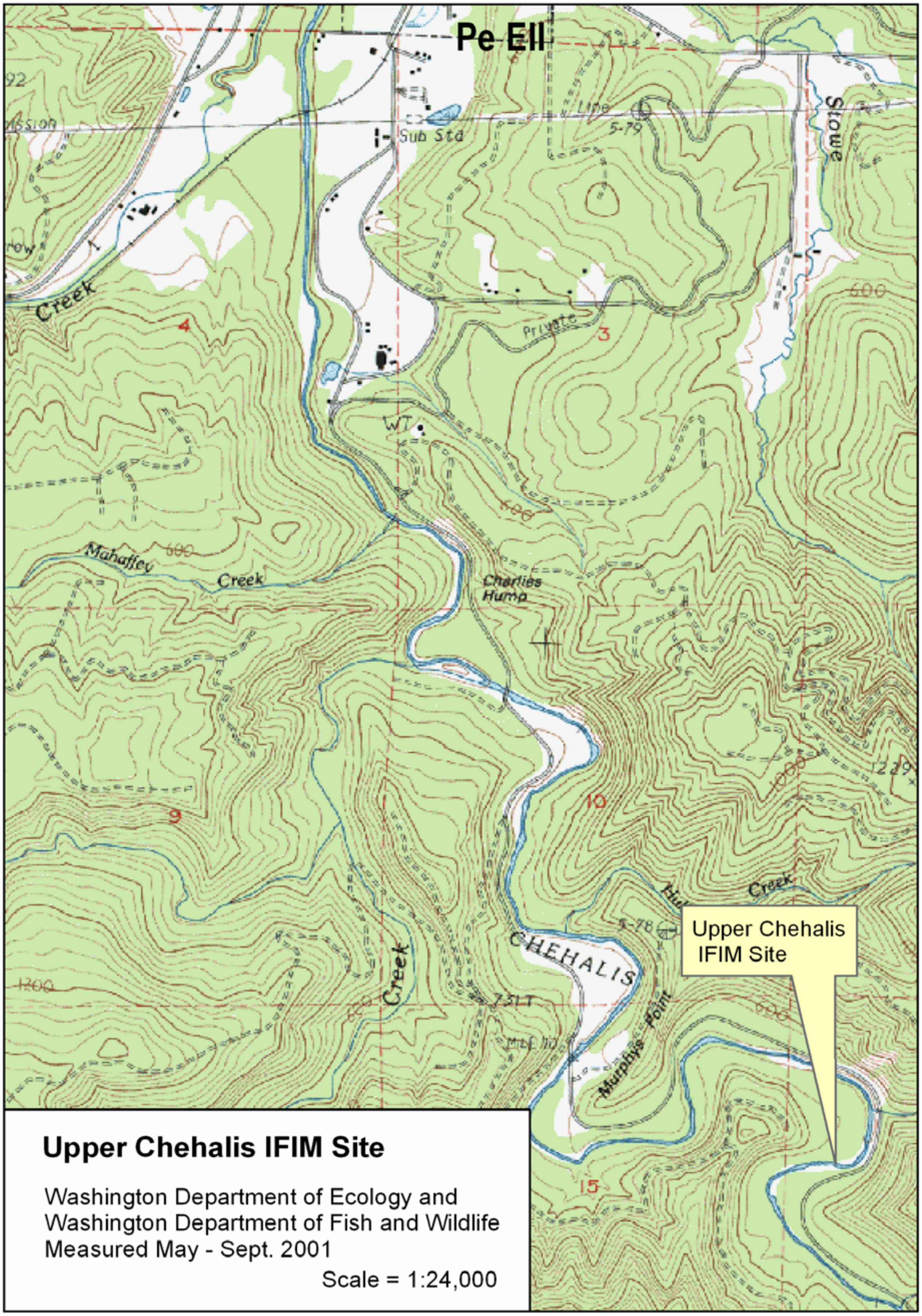


Figure 7. Upper Chehalis IFIM site at RM 110.9.



Field Procedures/Data Collection
IFIM measurements were taken in May, June and September of 2001 at the following sites and flows:

- Humptulips River at RM 23.8 near Stevens Creek Hatchery at 657, 313, and 255 cfs.
- West Fork Hoquiam River at RM 10.3 downstream of Davis Creek at 49, 20 and 12 cfs.
- Satsop River at RM 5.0 at 713, 360, and 280 cfs.
- Black River at RM 4.2 near the HWY 12 bridge at 149, 86 and 53 cfs.
- Skookumchuck River at RM 1.0 at Riverside Rotary Park in Centralia at 240 and 135 cfs.
- Upper Chehalis River at RM 110.9 about 5 miles south of Pe Ell at 140, 59, and 23 cfs.

A temporary gauge at each site was used to verify that streamflow rates at each transect remained steady during measurement. Transects were marked using survey hubs and flagging. Water velocity was measured using standard USGS methods with a calibrated Swoffer velocity meter mounted on a top-set wading rod. Depth and velocity were recorded at fixed locations along measuring tapes stretched across transects at each measured flow.

Water surface elevations and stream-bank profiles were surveyed with a survey level and stadia rod. These points were referenced to an arbitrary, fixed benchmark. Substrate composition and cover were assessed by visually estimating the percentage of the two main particle size classes and type of cover present (Appendix D).

Hydraulic Model

This section in brief: The field data is entered into the hydraulic model and calibrated, ensuring that the depths and velocities predicted by the model match the measured depths and velocities as closely as possible.

***This section in detail**:*

Calibration Philosophy
Calibration of the hydraulic model involved checking the velocities and depths predicted by the model against velocities and depths measured in the field. This included examining indicators of the model's accuracy such as the Velocity Adjustment Factor (VAF). Input data were changed or manipulated only when doing so would improve the model's ability to extrapolate without reducing the accuracy of predicted depths and velocities at the measured calibration flows.

Calibration of the RHABSIM Version 2 model was done cell by cell for each transect to decide whether the predicted cell velocities adequately represented measured velocities. Generally, if the predicted cell velocity at the calibration flow was within 0.2 feet per second (fps) or 20% of the measured cell velocity, the predicted velocity was considered adequate. Any change to a calibration velocity was usually limited to a change of 0.2 fps or 20% of the measured cell velocity. The 0.2 fps or 20% of the measured cell velocity was thought to be reasonable considering the normal range of velocity measurement error. All cell velocities were reviewed at the highest and lowest extrapolated flows so extreme cell velocities were not predicted.

Indicators of Model Accuracy
One indicator of the HYDSIM model's accuracy in predicting depths and velocities is the Velocity Adjustment Factor (VAF). See Appendix B for VAFs and other calibration details and data changes for each transect at each site.

The VAF for a three-velocity regression hydraulic model indicates whether the flow predicted from the velocity/discharge regressions matches the flow predicted from the stage/discharge regressions. The velocities predicted from the velocity/discharge regressions for a transect are all multiplied by the same VAF to achieve the flow predicted from the stage/discharge regression. Calculating and comparing the flows predicted from two different regressions gives an indication as to whether or not some of the model's assumptions are being met.

In VAF value ranges (Milhous, et al. 1989):

- 0.9 to 1.1 is considered good
- 0.85 to 0.9 and 1.1 to 1.15 is fair
- 0.8 to 0.85 and 1.15 to 1.20 is marginal
- less than 0.8 and more than 1.2 is poor

The standard extrapolation range is 0.4 times the low measured flow to 2.5 times the high measured flow. The extrapolation range of the model is usually limited when two or more transects have VAFs which fall below 0.8 or above 1.2.

In the case of the single velocity models, velocity simulations are based on Manning's N values calculated for individual cells across each transect. These Manning's N values are derived from a single set of depth and velocity measurements at each transect. The Manning's N values are used at each wetted cell throughout all simulated flows. A VAF based on the ratio between the calculated flow (using Manning's N) and the simulated flow is applied to all predicted velocities.

Since the model uses the same Manning's N value in a particular cell at all simulated flows, Manning's N values were adjusted as needed in order to more reasonably predict simulation velocities. Changes to actual calibration velocities were usually limited to cells at the channel edge where velocity simulation can be problematic.

Site Specific Calibration
For the Humptulips River study site a 3-velocity regression hydraulic model with 5 transects was created with RHABSIM with an extrapolation range of 100 to 1650 cfs. The water surface elevations were modeled using a log-log regression of the 3 measured flows.

For the West Fork Hoquiam study site a 3-velocity regression hydraulic model with 8 transects was created with RHABSIM with an extrapolation range of 10 to 122 cfs. The water surface elevations were modeled using a log-log regression of 3 measured flows.

For the Satsop River study site a 3-velocity regression hydraulic models with 6 transects was created with RHABSIM with an extrapolation range of 150 to 1750 cfs. The water surface

elevations were modeled using a log-log regression of 3 measured flows.
For the Black River four 1-flow models and a 2-velocity regression hydraulic model with 4 transects were created with RHABSIM with an extrapolation range of 33 to 375 cfs. The water surface elevations were modeled using 2 different log-log regressions with the 3 measured flows.

For the Skookumchuck River a 2-flow velocity regression hydraulic model with 8 transects was created with RHABSIM with an extrapolation range of 75 to 600 cfs. The water surface elevations were modeled using a log-log regression of 2 measured flows.

For the upper Chehalis River study site a 3-velocity regression hydraulic models with 8 transects was created with RHABSIM with an extrapolation range of 10 to 350 cfs. The water surface elevations were modeled using a log-log regression of 3 measured flows.

See Appendix A for the input files showing the distance along the transects with the corresponding bed elevations, velocities, substrate/cover, and water surface elevations.

See Appendix B for calibration details, velocity adjustment factors, and changes to data.

Transect Weighting
Transect weighting is the percentage of weight given to one transect's WUA results as compared to all the other transects. It shows which transects have the most effect on the final WUA results.

The table below lists the percent weighting each transect received relative to the whole site. Transect weighting is determined in one of two ways: either the model automatically determines weighting for each transect by using the distance between the transects, or transect weight is set to predetermined levels by specifying distances between transects and upstream weighting (referred to as composite weighting). Composite weighting is done when the transects are located far apart and the distances between the transects would create incorrect weighting, or the investigator wants to increase the weight of a particular type of fish habitat for that site. Transect weighting was done using the distances between the transects.

Transect Weighting for the Chehalis River Basin Study Sites

Transect Number	1	2	3	4	5	6	7	8
Humptulips River	15%	17%	25%	25%	18%			
West Fork Hoquiam River	12%	13%	11%	5%	7%	15%	19%	18%
Satsop River	7%	7%	9%	17%	28%	32%		
Black River	53%	28%	7%	12%				
Skookumchuck River	6%	8%	16%	17%	11%	9%	14%	19%
Upper Chehalis River	4%	8%	10%	14%	14%	10%	15%	22%

Habitat Use Model (HABSIM)
The HABSIM program combines the depths and velocities predicted from the HYDSIM hydraulic model with the depths, velocities, cover, and substrate preferences from the habitat-use curves. The HABSIM program calculates WUA for each flow modeled.

Habitat Preference Curves
Fish preference curves for the Chehalis basin sites were agreed to by Ecology (Brad Caldwell, Jim Pacheco) and WDFW (Hal Beecher, Terra Hegy, and Robert Vadas) in 2003. Existing agency preference curves were extensively reviewed, updated, and used in these models. These preference curves are listed in Appendix C. The Chinook spawning for rivers curve was used for the Humptulips and Satsop Rivers whereas the Chinook spawning for streams curves was used for the other four rivers in this study.

<u>Factors to Consider When Developing a Flow Regime</u>

No instream flow recommendations are made in this report. The process of determining instream flows for the Chehalis River basin will require a complex negotiation process, taking into account numerous factors. Instream flows need to be discussed in the context of the long-range water and fishery management objectives desired by the local watershed planning groups, state and federal natural resource agencies and affected Tribes.

Different fish species and life stages exist simultaneously in the river and each has a different flow requirement. Instream flows must include flows necessary for incubation of fish eggs, smolt out-migration, fish passage to spawning grounds, and prevention of stranding of fry and juveniles, for each species. Each fish species and life stage will need to be ranked, and competing life stages balanced against each other. Clearly, no single flow number will simultaneously provide optimum habitat for all fish species and life stages.

The WUA graphs show whether an increase or decrease in streamflow will increase or decrease fish habitat based on depth, velocity, substrate, and cover. Since only these four variables are considered, it is important to remember that other factors also impact the amount of useable fish habitat. The WUA graph may show that an increase in streamflow will result in increased fish habitat, but fish habitat may not actually be increased if other factors such as water quality or incubation flows are limiting the fish population.

It is important to note that sometimes WUA reaches its maximum at a flow that is greater than what typically occurs. It does not mean that the model is incorrect. The model shows how much water provides how much habitat in a given stream channel, regardless of hydrology. The model addresses hydraulics, which is a function of channel shape, but not hydrology.

In addition to WUA, an in recommendation requires the incorporation by best professional judgment of other variables that affect fish survival: expected incubation flows following spawning, expected scouring effects of high flows, flows needed for adult passage upstream and juvenile passage downstream, water temperatures, natural behavior to use upstream versus downstream reaches of rivers, and other forces.

Under the state's Water Resources Act of 1971 (Chapter 90.54 RCW), which guides Ecology in setting instream flows, an instream flow level must protect and preserve fish and all other environmental values. However, it is important to understand that instream flows set in rule cannot take away existing water rights. Instream flows have a priority date like any water right, and therefore only affect water rights that are junior to it. In this way, instream flows are limited in what they can accomplish in protecting instream values. No existing legal water users can be required by the state to put water in the stream to get the flow up to the instream flow, even if the existing legal diverters are drying up the stream.

Results

The study results are summarized in three types of graphs (Figures 8-30):

- ***fish habitat (WUA) versus flow graphs*** show the increase or decrease in the amount of fish habitat that results with an increase or decrease in streamflow
- ***percent of peak habitat versus flow tables*** show the percentage of increase or decrease in habitat with a loss or gain of streamflow from the highest possible amount of WUA
- ***wetted stream width versus flow graphs*** show the amount of stream width that is increased or decreased with an increase or decrease in flow.

These graphs and tables show whether there is a gain or loss in fish habitat or width for a given increase or decrease in flow.

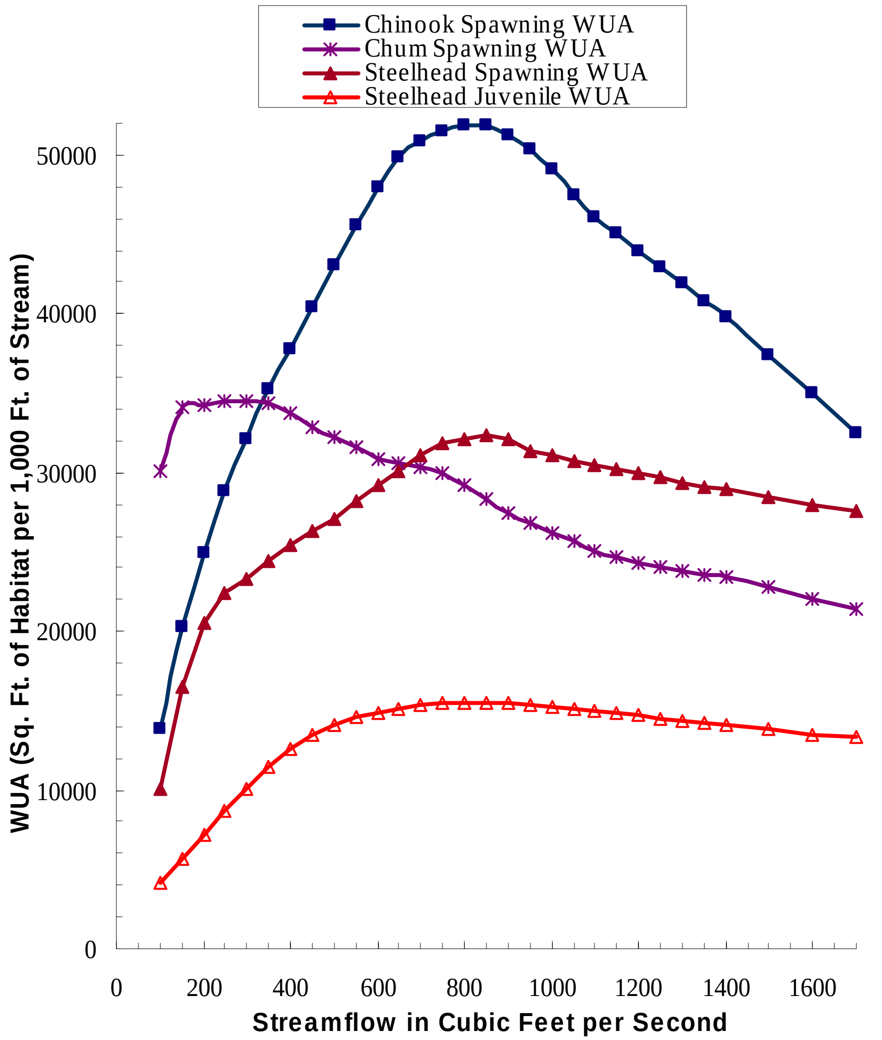
Tables 1-6 list the lifestage and timing of fish present at the IFIM sites.

Hydrographs

Flow exceedance probability hydrographs (Figures 11, 15, 19, 23, 27, and 31), based on data collected from USGS gauges, follow the study results. These hydrographs are presented so that the reader can compare this study's WUA results to the past streamflow (which includes past diversions).

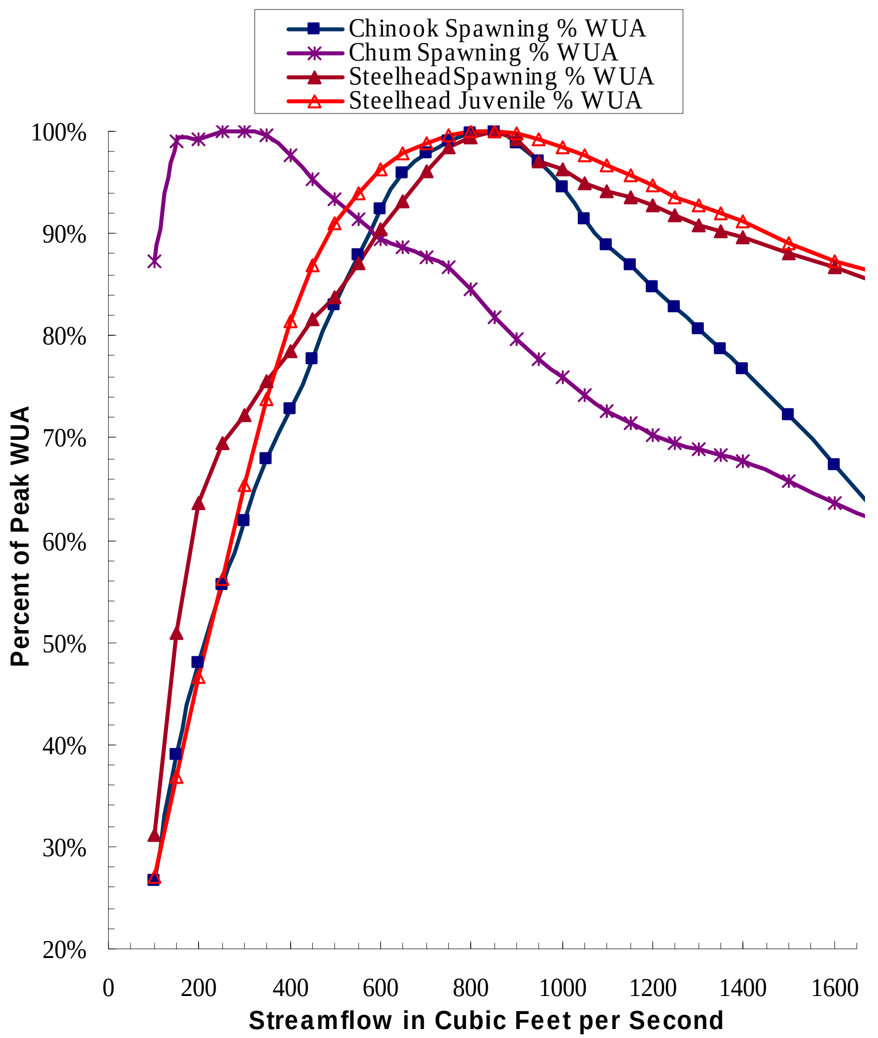
The hydrographs also include a line showing the existing instream flow set by regulation. The river mile location for the instream flow is the same as the river mile for the existing flow gage except at the Black and West Fork Hoquiam Rivers. WDFW and Ecology are presently gathering gage data at these two locations to be able to generate synthesized hydrographs that relate the streamflow to the instream flow and the IFIM fish habitat information.

Figure 8. Humptulips River at RM 23.8: Fish Habitat (WUA) vs Flow



Flow (cfs)	Chinook Spawning WUA	Chum Spawning WUA	Steelhead Spawning WUA	Steelhead Juvenile WUA
100	13859	30147	10072	4203
150	20266	34176	16451	5715
200	24907	34295	20541	7209
250	28834	**34526**	22442	8704
300	32158	**34534**	23339	10134
350	35224	**34379**	24420	11436
400	37825	33718	25372	12613
450	40363	32882	26360	13469
500	43074	32204	27101	14101
550	45589	31581	28153	14567
600	47960	30893	29219	14920
650	49812	30613	30127	15157
700	50804	30299	31068	15330
750	51450	29967	31798	**15438**
800	**51829**	29207	**32161**	**15486**
850	**51914**	28286	**32321**	**15497**
900	51280	27497	32064	**15474**
950	50367	26861	31343	15377
1000	49071	26214	31107	15263
1050	47454	25625	30692	15129
1100	46114	25053	30416	14979
1150	45120	24639	30227	14831
1200	43989	24295	29989	14671
1250	42929	24023	29690	14503
1300	41883	23799	29378	14367
1350	40849	23576	29148	14253
1400	39816	23412	28940	14138
1500	37451	22739	28484	13791
1600	34989	21972	28013	13515
1700	32462	21395	27528	13352

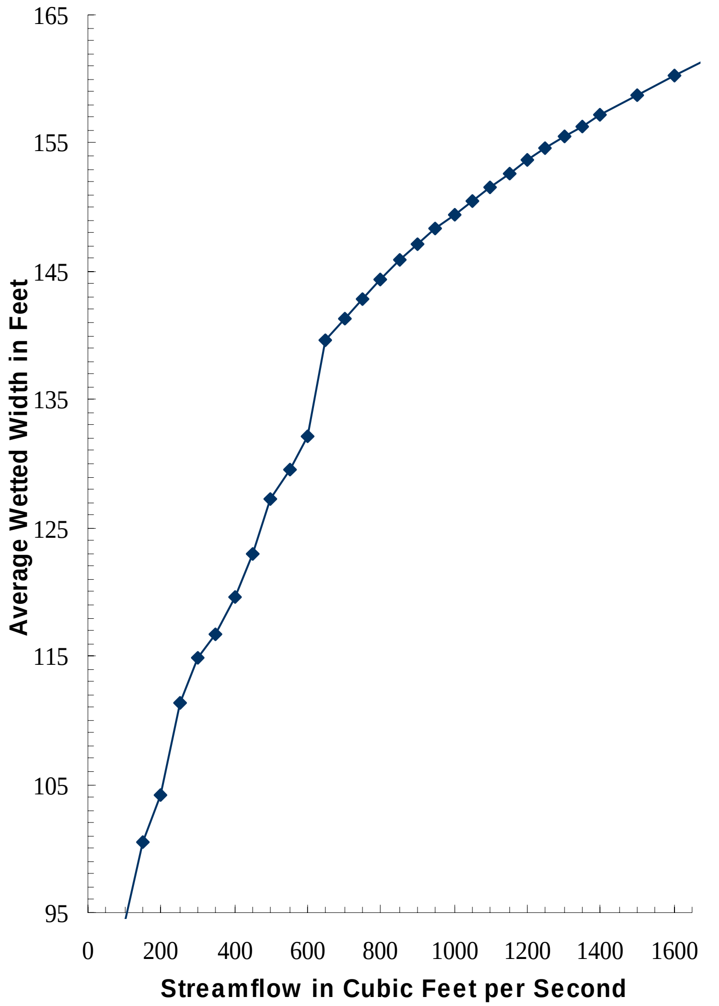
Figure 9. Humptulips River at RM 23.8: Percent of Peak WUA vs Flow



Flow (cfs)	Chinook Spawning % WUA	Chum Spawning % WUA	Steelhead Spawning % WUA	Steelhead Juvenile % WUA
100	27%	87%	31%	27%
150	39%	99%	51%	37%
200	48%	99%	64%	47%
250	56%	**100%**	69%	56%
300	62%	**100%**	72%	65%
350	68%	**100%**	76%	74%
400	73%	98%	78%	81%
450	78%	95%	82%	87%
500	83%	93%	84%	91%
550	88%	91%	87%	94%
600	92%	89%	90%	96%
650	96%	89%	93%	98%
700	98%	88%	96%	99%
750	99%	87%	98%	**100%**
800	**100%**	85%	**100%**	**100%**
850	**100%**	82%	**100%**	**100%**
900	99%	80%	99%	**100%**
950	97%	78%	97%	99%
1000	95%	76%	96%	98%
1050	91%	74%	95%	98%
1100	89%	73%	94%	97%
1150	87%	71%	94%	96%
1200	85%	70%	93%	95%
1250	83%	70%	92%	94%
1300	81%	69%	91%	93%
1350	79%	68%	90%	92%
1400	77%	68%	90%	91%
1500	72%	66%	88%	89%
1600	67%	64%	87%	87%
1700	63%	62%	85%	86%

Figure 10

Humptulips River at RM 23.8: Average Wetted Width



Flow (cfs)	Wetted Width (feet)
100	94.4
150	100.5
200	104.2
250	111.4
300	114.9
350	116.7
400	119.6
450	123.0
500	127.2
550	129.5
600	132.1
650	139.7
700	141.3
750	142.8
800	144.4
850	145.9
900	147.1
950	148.3
1000	149.4
1050	150.5
1100	151.5
1150	152.6
1200	153.7
1250	154.6
1300	155.5
1350	156.3
1400	157.1
1500	158.8
1600	160.3
1700	161.7

Table 1. Humptulips River: Lifestage and Timing of Fish Present at the IFIM Site

Species & Lifestage	Timing Begins	Timing Ends
Fall chinook		
Migration	September	October
Spawning	October	Early December
Intragravel	October	March
Juvenile	February	Mid-August
Outmigration	April	Mid-August
Chum Salmon		
Migration	October	November
Spawning	Late October	Mid-December
Intragravel	Late October	March
Outmigration	February	Mid-June
Steelhead		
Summer Migration	May	November
Winter Migration	December	Early June
Spawning	Mid-February	Mid-June
Intragravel	Mid-February	July
Juvenile	Year around	Year around
Outmigration	April	June
Coho		
Migration	October	December
Outmigration	Mid-February	Mid-June

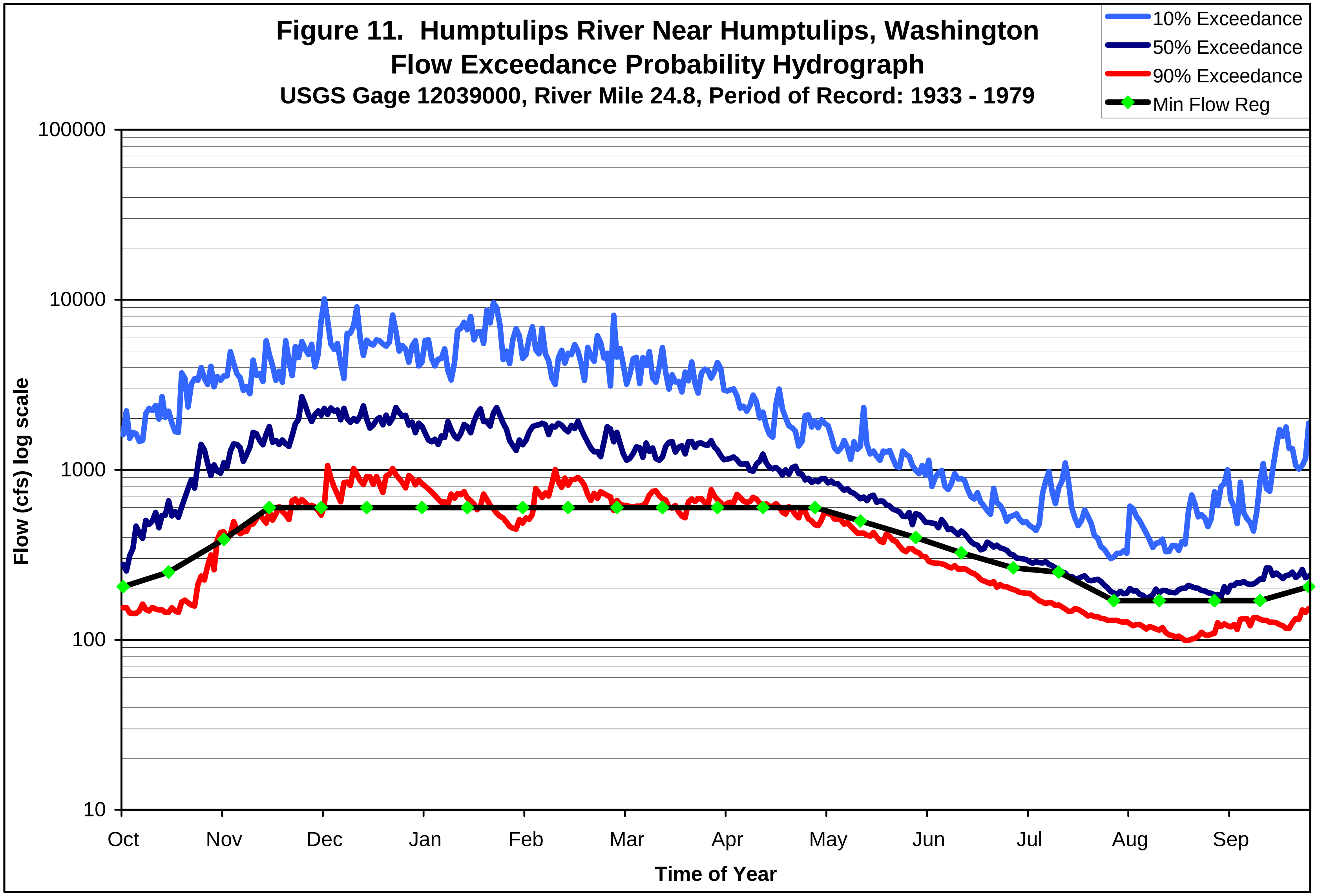
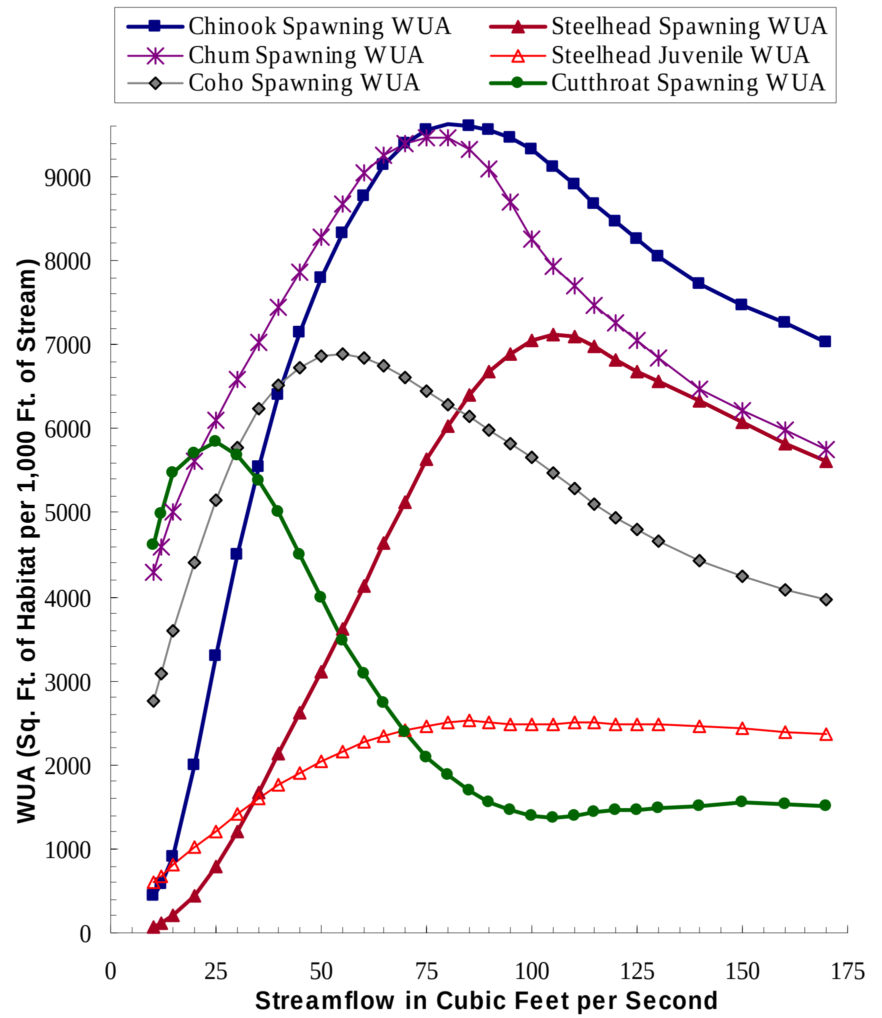


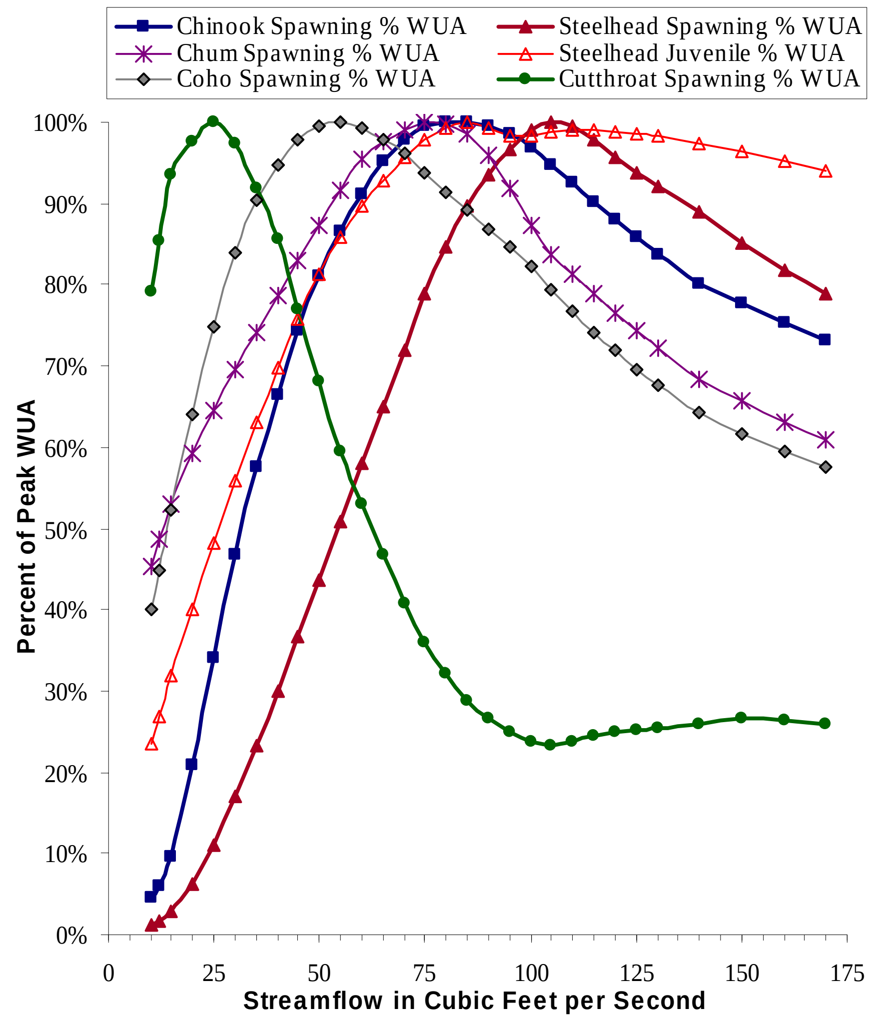
Figure 11. Humptulips River Near Humptulips, Washington
Flow Exceedance Probability Hydrograph
USGS Gage 12039000, River Mile 24.8, Period of Record: 1933 - 1979
10% Exceedance
50% Exceedance
90% Exceedance
Min Flow Reg
Flow (cfs) log scale
100000
10000
1000
100
10
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Time of Year

Figure 12. West Fork Hoquiam River at RM 10.3: Fish Habitat (WUA) vs Flow



Flow (cfs)	Chinook Spawning WUA	Chum Spawning WUA	Coho Spawning WUA	Steelhead Spawning WUA	Steelhead Juvenile WUA	Cutthroat Spawning WUA
10	430	4296	2757	80	595	4625
12	583	4599	3093	121	678	4983
15	915	5016	3599	200	802	5466
20	2003	5607	4405	448	1011	5699
25	3285	6099	5147	788	1213	**5841**
30	4505	6579	5782	1208	1408	5690
35	5546	7016	6233	1658	1590	5371
40	6390	7443	6523	2137	1757	4998
45	7145	7859	6732	2619	1910	4498
50	7791	8271	**6855**	3115	2049	3978
55	8330	8683	**6888**	3617	2164	3479
60	8774	9032	6839	4129	2262	3093
65	9147	9247	6747	4630	2342	2730
70	9398	9382	6616	5135	2413	2382
75	9559	**9470**	6456	5626	2470	2098
80	**9616**	**9453**	6294	6035	2503	1881
85	**9608**	9330	6138	6394	**2521**	1687
90	9564	9088	5978	6671	2504	1550
95	9468	8691	5827	6887	2481	1457
100	9318	8266	5660	7060	2478	1389
105	9118	7930	5475	**7127**	2490	1358
110	8902	7701	5283	**7099**	2498	1386
115	8679	7474	5109	6978	2496	1428
120	8473	7252	4948	6812	2491	1450
125	8265	7047	4795	6686	2486	1468
130	8056	6831	4656	6566	2478	1483
140	7713	6471	4429	6338	2456	1516
150	7470	6213	4245	6070	2433	1548
160	7251	5978	4092	5822	2397	1539
170	7034	5759	3960	5619	2369	1506

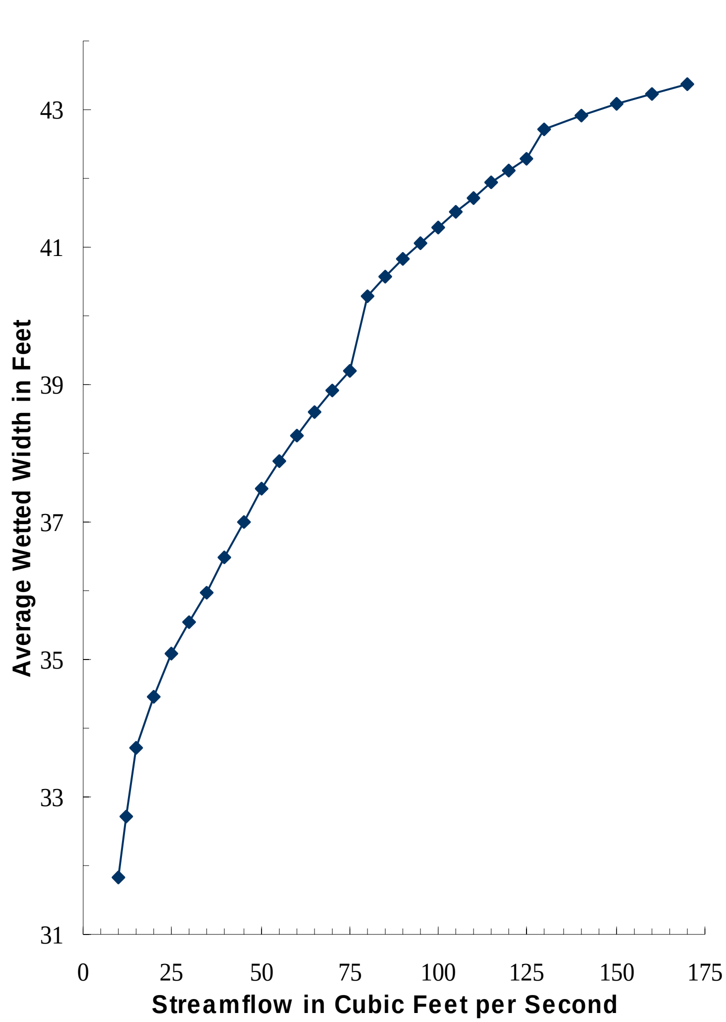
Figure 13. West Fork Hoquiam River at RM 10.3: Percent of Peak WUA vs Flow



Flow (cfs)	Chinook Spawning % WUA	Chum Spawning % WUA	Coho Spawning % WUA	Steelhead Spawning % WUA	Steelhead Juvenile % WUA	Cutthroat Spawning % WUA
10	4%	45%	40%	1%	24%	79%
12	6%	49%	45%	2%	27%	85%
15	10%	53%	52%	3%	32%	94%
20	21%	59%	64%	6%	40%	98%
25	34%	64%	75%	11%	48%	**100%**
30	47%	69%	84%	17%	56%	97%
35	58%	74%	90%	23%	63%	92%
40	66%	79%	95%	30%	70%	86%
45	74%	83%	98%	37%	76%	77%
50	81%	87%	**100%**	44%	81%	68%
55	87%	92%	**100%**	51%	86%	60%
60	91%	95%	99%	58%	90%	53%
65	95%	98%	98%	65%	93%	47%
70	98%	99%	96%	72%	96%	41%
75	99%	**100%**	94%	79%	98%	36%
80	**100%**	**100%**	91%	85%	99%	32%
85	**100%**	99%	89%	90%	**100%**	29%
90	99%	96%	87%	94%	99%	27%
95	98%	92%	85%	97%	98%	25%
100	97%	87%	82%	99%	98%	24%
105	95%	84%	79%	**100%**	99%	23%
110	93%	81%	77%	**100%**	99%	24%
115	90%	79%	74%	98%	99%	24%
120	88%	77%	72%	96%	99%	25%
125	86%	74%	70%	94%	99%	25%
130	84%	72%	68%	92%	98%	25%
140	80%	68%	64%	89%	97%	26%
150	78%	66%	62%	85%	97%	27%
160	75%	63%	59%	82%	95%	26%
170	73%	61%	57%	79%	94%	26%

Figure 14

WF Hoquiam River at RM 10.3: Average Wetted Width



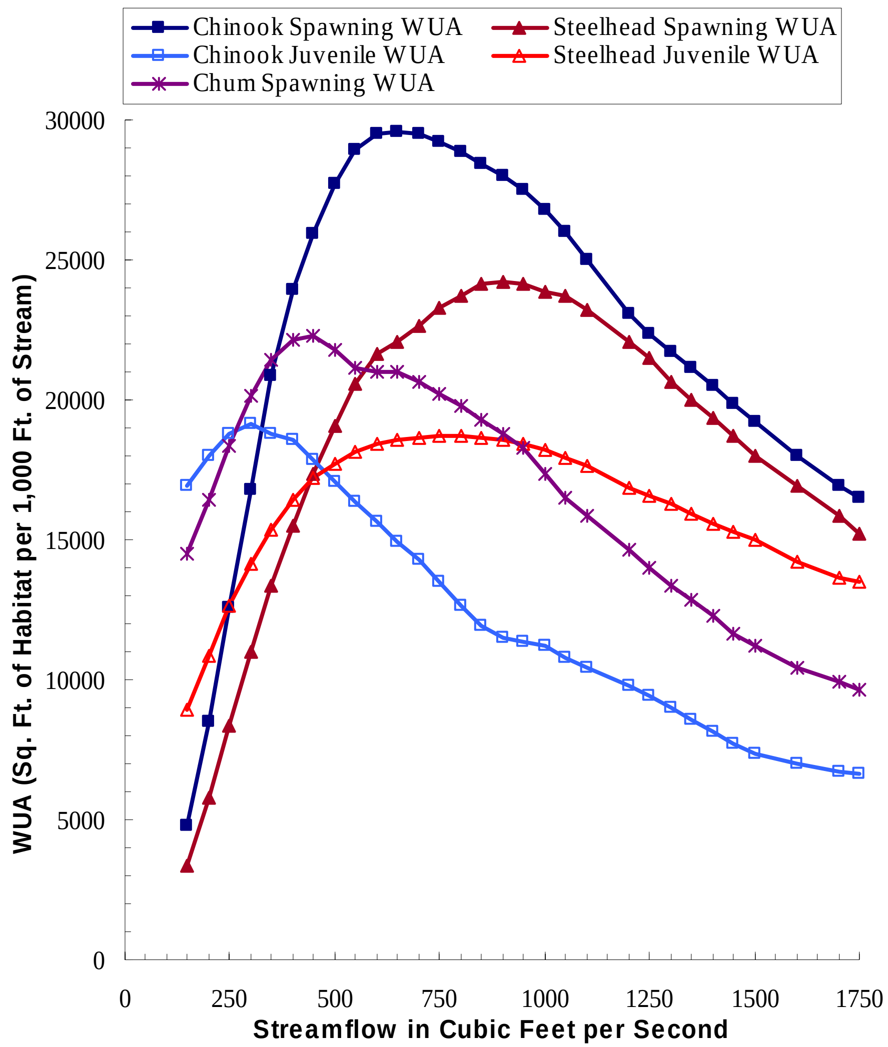
Flow (cfs)	Wetted Width (feet)
10	31.8
12	32.7
15	33.7
20	34.5
25	35.1
30	35.6
35	36.0
40	36.5
45	37.0
50	37.5
55	37.9
60	38.3
65	38.6
70	38.9
75	39.2
80	40.3
85	40.6
90	40.8
95	41.1
100	41.3
105	41.5
110	41.7
115	41.9
120	42.1
125	42.3
130	42.7
140	42.9
150	43.1
160	43.2
170	43.4

Table 2. WF Hoquiam River: Lifestage and Timing of Fish Present at the IFIM Site

Species & Lifestage	Timing Begins	Timing Ends
Fall chinook		
Migration	September	October
Spawning	Mid-October	Early December
Intragravel	Mid-October	March
Juvenile	February	Mid-August
Outmigration	Late April	Mid-August
Chum Salmon		
Migration	October	November
Spawning	Late October	Mid-December
Intragravel	Late October	March
Outmigration	Late January	Mid-June
Steelhead		
Migration	December	Early June
Spawning	Mid-February	Mid-June
Intragravel	Mid-February	July
Juvenile	Year around	Year around
Outmigration	April	June
Coho		
Migration	October	December
Outmigration	Mid-February	Mid-June

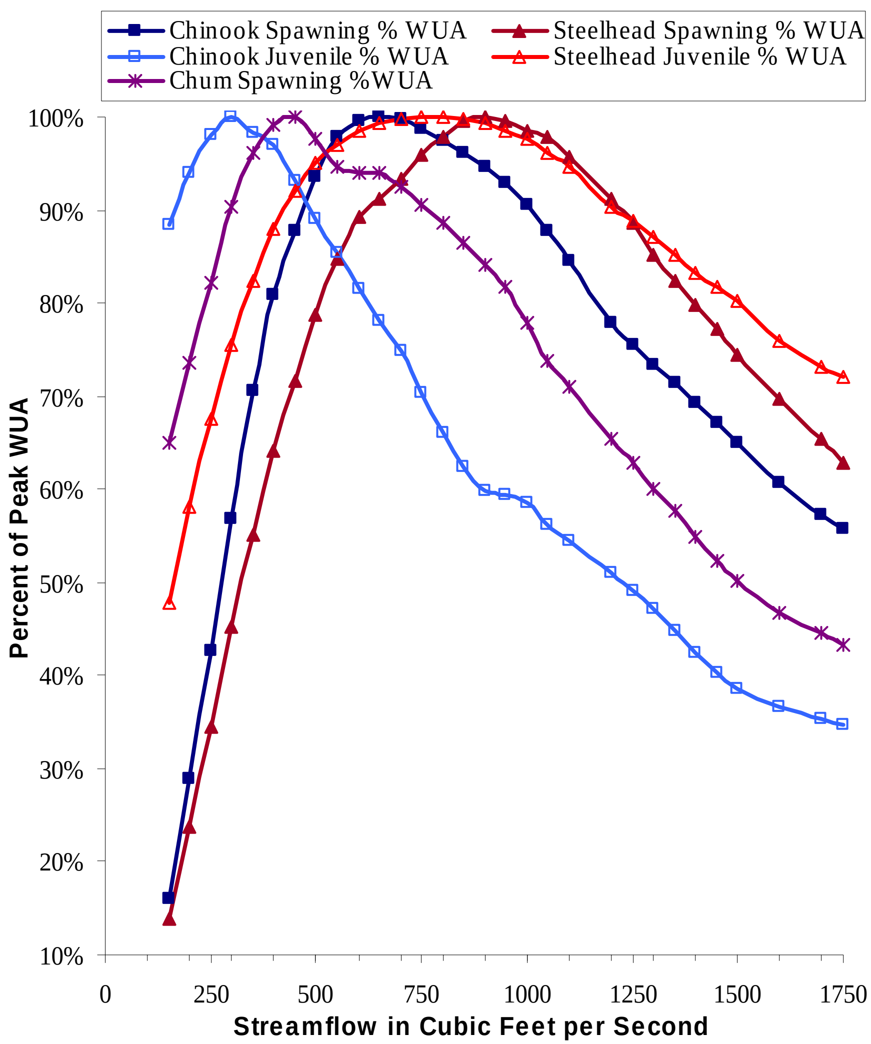
Figure 15 Hoquiam Hydrograph

Figure 16. Satsop River at RM 5.0: Fish Habitat (WUA) vs Flow



Flow (cfs)	Chinook Spawning WUA	Chinook Juvenile WUA	Chum Spawning WUA	Steelhead Spawning WUA	Steelhead Juvenile WUA
150	4754	16930	14507	3365	8945
200	8524	17984	16417	5770	10877
250	12605	18770	18364	8356	12636
300	16814	**19135**	20173	10984	14114
350	20844	18795	21453	13348	15389
400	23938	18546	22143	15523	16450
450	25952	17830	**22320**	17382	17220
500	27687	17036	21805	19076	17749
550	28934	16356	21120	20557	18137
600	**29469**	15611	20973	21644	18427
650	**29578**	14925	20970	22099	18553
700	**29534**	14310	20638	22636	**18632**
750	29219	13475	20209	23266	**18689**
800	28839	12648	19786	23741	**18681**
850	28452	11943	19304	**24160**	**18633**
900	28015	11466	18770	**24244**	18584
950	27471	11357	18259	**24123**	18415
1000	26804	11203	17387	23889	18232
1050	25969	10768	16468	23700	17961
1100	25005	10416	15829	23183	17675
1200	23052	9767	14609	22096	16872
1250	22328	9398	14009	21470	16587
1300	21707	9004	13382	20674	16295
1350	21129	8560	12851	19993	15925
1400	20505	8114	12260	19372	15569
1450	19849	7698	11678	18711	15267
1500	19216	7391	11182	18033	14995
1600	17975	7018	10434	16926	14179
1700	16949	6745	9941	15863	13678
1750	16469	6650	9668	15247	13489

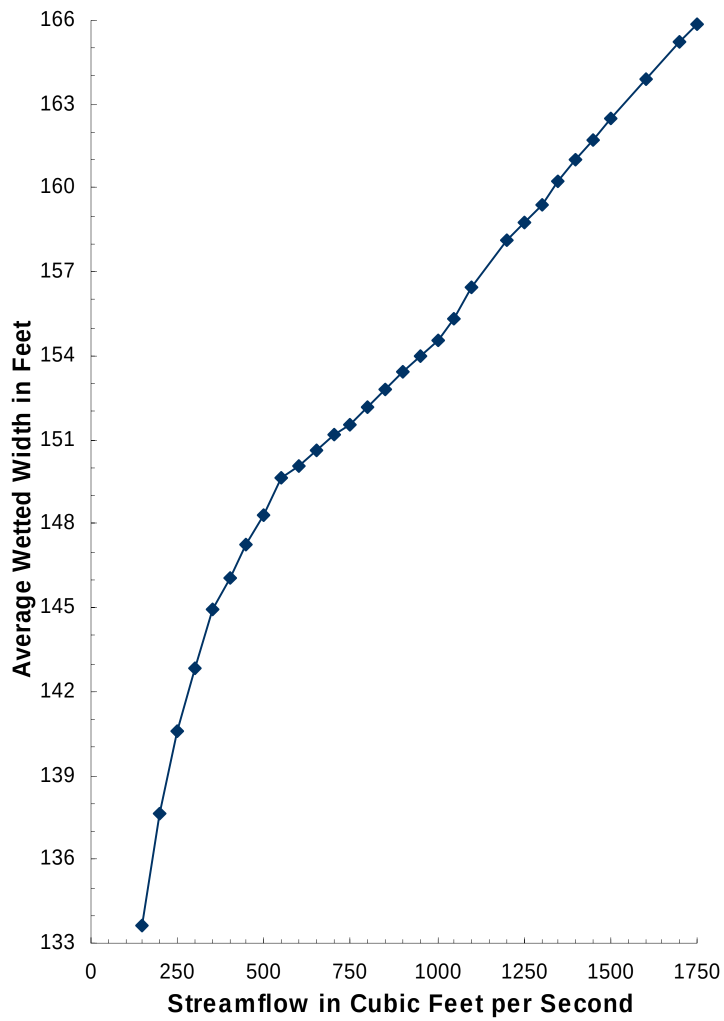
Figure 17. Satsop River at RM 5.0: Percent of Peak WUA vs Flow



Flow (cfs)	Chinook Spawning % WUA	Chinook Juvenile % WUA	Chum Spawning % WUA	Steelhead Spawning % WUA	Steelhead Juvenile % WUA
150	16%	88%	65%	14%	48%
200	29%	94%	74%	24%	58%
250	43%	98%	82%	34%	68%
300	57%	**100%**	90%	45%	76%
350	70%	98%	96%	55%	82%
400	81%	97%	99%	64%	88%
450	88%	93%	**100%**	72%	92%
500	94%	89%	98%	79%	95%
550	98%	85%	95%	85%	97%
600	**100%**	82%	94%	89%	99%
650	**100%**	78%	94%	91%	99%
700	**100%**	75%	92%	93%	**100%**
750	99%	70%	91%	96%	**100%**
800	98%	66%	89%	98%	**100%**
850	96%	62%	86%	**100%**	**100%**
900	95%	60%	84%	**100%**	99%
950	93%	59%	82%	**100%**	99%
1000	91%	59%	78%	99%	98%
1050	88%	56%	74%	98%	96%
1100	85%	54%	71%	96%	95%
1200	78%	51%	65%	91%	90%
1250	75%	49%	63%	89%	89%
1300	73%	47%	60%	85%	87%
1350	71%	45%	58%	82%	85%
1400	69%	42%	55%	80%	83%
1450	67%	40%	52%	77%	82%
1500	65%	39%	50%	74%	80%
1600	61%	37%	47%	70%	76%
1700	57%	35%	45%	65%	73%
1750	56%	35%	43%	63%	72%

Figure 18

Satsop River at RM 5.0: Average Wetted Width



Flow (cfs)	Wetted Width (feet)
150	133.6
200	137.6
250	140.6
300	142.8
350	144.9
400	146.1
450	147.3
500	148.3
550	149.6
600	150.1
650	150.6
700	151.2
750	151.6
800	152.1
850	152.8
900	153.4
950	154.0
1000	154.6
1050	155.3
1100	156.5
1200	158.1
1250	158.8
1300	159.4
1350	160.2
1400	161.0
1450	161.7
1500	162.5
1600	163.9
1700	165.2
1750	165.9

Table 3. Satsop River: Lifestage and Timing of Fish Present at the IFIM Site

Species & Lifestage	Timing Start	Timing Finish
Chinook		
Summer Migration	Late August	September
Fall Migration	October	Mid-November
Summer Spawning	September	Mid-October
Fall Spawning	October	Early December
Intragravel	September	Mid-April
Juvenile	February	Some rear all year
Outmigration	Mid-March	Mid-August
Chum Salmon		
Migration	October	November
Spawning	Late-October	Mid-December
Intragravel	Late- October	March
Outmigration	Late-January	Mid-June
Steelhead		
Migration	December	Early June
Spawning	Mid-February	Mid-June
Intragravel	Mid-February	July
Juvenile	Year around	Year around
Outmigration	April	June
Coho		
Migration	October	December
Outmigration	Mid-February	Mid-June

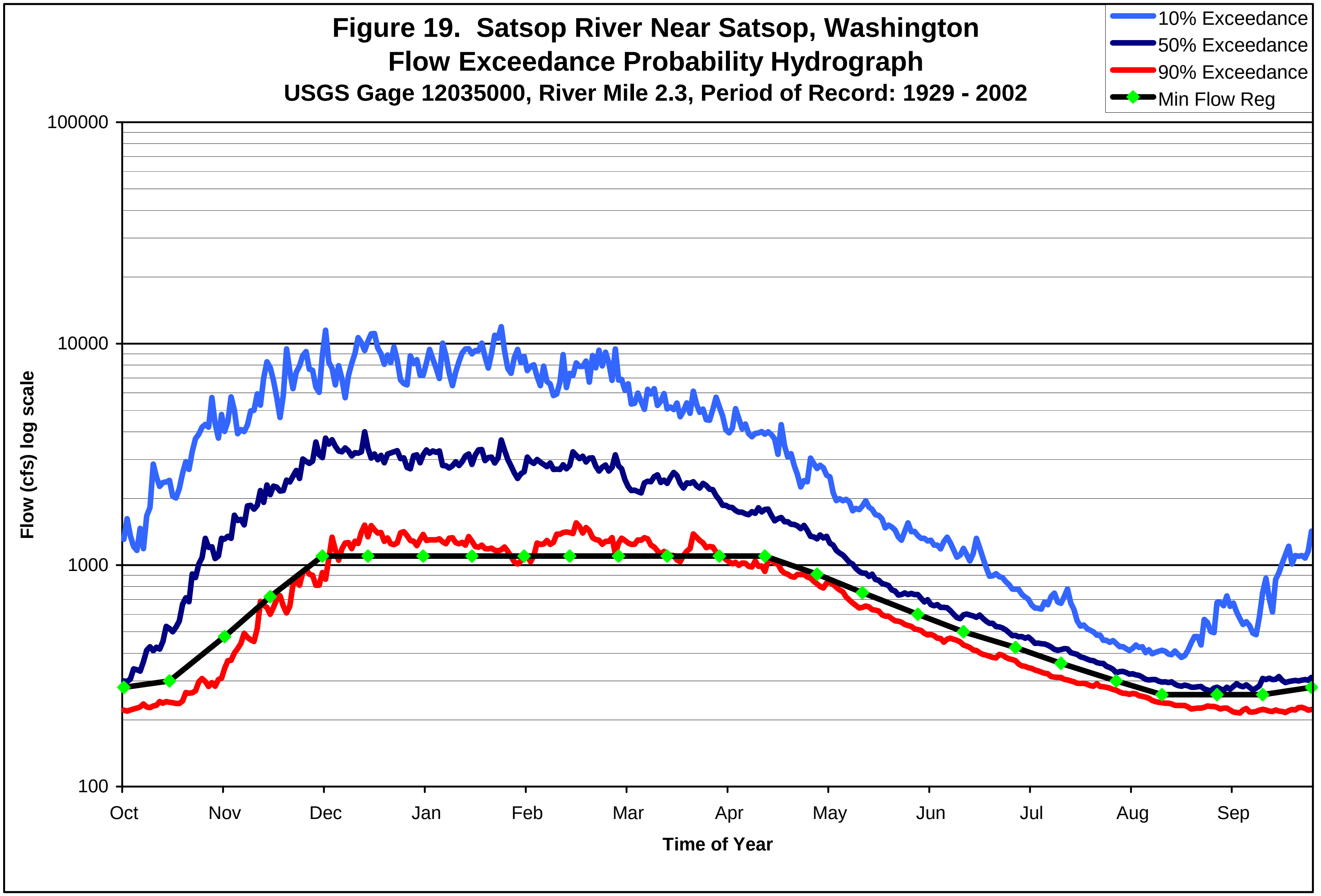
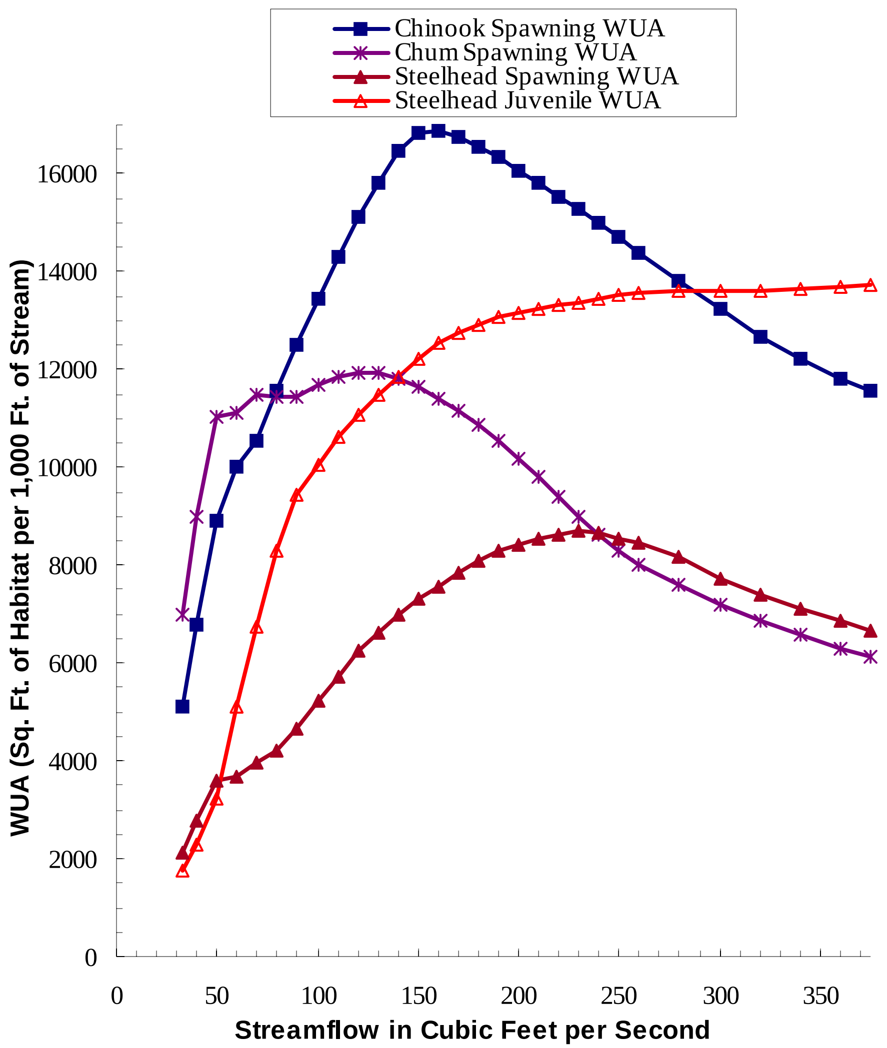


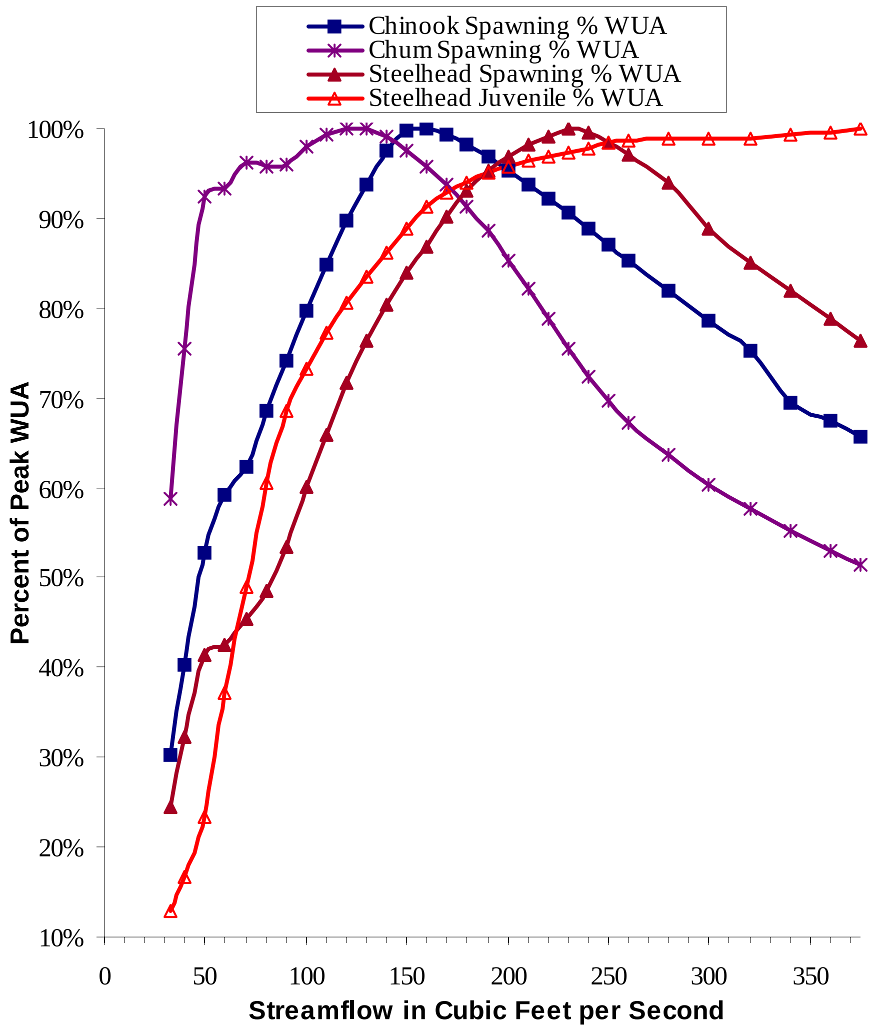
Figure 19. Satsop River Near Satsop, Washington
Flow Exceedance Probability Hydrograph
USGS Gage 12035000, River Mile 2.3, Period of Record: 1929 - 2002
10% Exceedance
50% Exceedance
90% Exceedance
Min Flow Reg
100000
10000
1000
100
Flow (cfs) log scale
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Time of Year

Figure 20. Black River at RM 4.2: Fish Habitat (WUA) vs Flow



Flow (cfs)	Chinook Spawning WUA	Chum Spawning WUA	Steelhead Spawning WUA	Steelhead Juvenile WUA
33	5101	6998	2129	1761
40	6798	9005	2799	2280
50	8918	11019	3592	3210
60	10004	11128	3691	5092
70	10527	11477	3958	6731
80	11558	11428	4219	8308
90	12518	11454	4641	9427
100	13435	11683	5217	10057
110	14308	11852	5738	10607
120	15121	**11920**	6238	11070
130	15829	**11921**	6636	11481
140	16468	11806	6996	11850
150	**16826**	11626	7298	12210
160	**16866**	11404	7552	12529
170	16745	11170	7850	12750
180	16552	10879	8098	12917
190	16342	10560	8285	13058
200	16078	10179	8425	13154
210	15806	9792	8532	13242
220	15546	9395	8619	13317
230	15273	8988	**8693**	13378
240	14985	8629	**8662**	13442
250	14691	8299	8558	13520
260	14397	8025	8439	13557
280	13826	7584	8167	13589
300	13258	7204	7716	13591
320	12678	6866	7399	13591
340	12200	6578	7125	13634
360	11819	6309	6855	**13679**
375	11573	6124	6646	**13736**

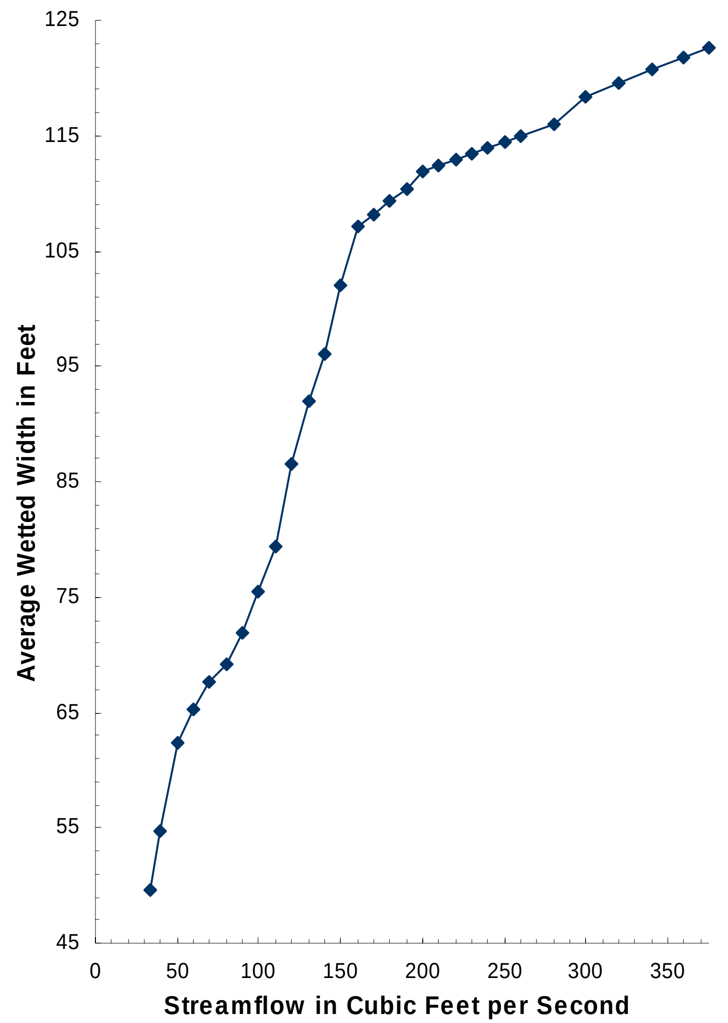
Figure 21. Black River at RM 4.2: Percent of Peak WUA vs Flow



Flow (cfs)	Chinook Spawning % WUA	Chum Spawning % WUA	Steelhead Spawning % WUA	Steelhead Juvenile % WUA
33	30%	59%	24%	13%
40	40%	76%	32%	17%
50	53%	92%	41%	23%
60	59%	93%	42%	37%
70	62%	96%	46%	49%
80	69%	96%	49%	60%
90	74%	96%	53%	69%
100	80%	98%	60%	73%
110	85%	99%	66%	77%
120	90%	**100%**	72%	81%
130	94%	**100%**	76%	84%
140	98%	99%	80%	86%
150	**100%**	98%	84%	89%
160	**100%**	96%	87%	91%
170	99%	94%	90%	93%
180	98%	91%	93%	94%
190	97%	89%	95%	95%
200	95%	85%	97%	96%
210	94%	82%	98%	96%
220	92%	79%	99%	97%
230	91%	75%	**100%**	97%
240	89%	72%	**100%**	98%
250	87%	70%	98%	98%
260	85%	67%	97%	99%
280	82%	64%	94%	99%
300	79%	60%	89%	99%
320	75%	58%	85%	99%
340	70%	55%	82%	99%
360	67%	53%	79%	**100%**
375	66%	51%	76%	**100%**

Figure 22

Black River at RM 4.2: Average Wetted Width



Flow (cfs)	Wetted Width (feet)
33	49.7
40	54.7
50	62.4
60	65.3
70	67.6
80	69.2
90	71.9
100	75.4
110	79.3
120	86.6
130	92.0
140	96.0
150	102.0
160	107.2
170	108.2
180	109.3
190	110.4
200	111.9
210	112.5
220	113.0
230	113.5
240	114.0
250	114.5
260	115.0
280	116.0
300	118.3
320	119.5
340	120.7
360	121.8
375	122.7

Table 4. Black River: Lifestage and Timing of Fish Present at the IFIM Site

Species & Lifestage	Timing Start	Timing Finish
Chinook		
Spring Migration	Mid-February	July
Fall Migration	October	November
Spring Spawning	September	Mid-October
Fall Spawning	Mid-October	Early December
Intragravel	September	Early April
Juvenile	January	Mid-August
Outmigration	April	Mid-August
Chum Salmon		
Migration	October	November
Spawning	Late-October	Mid-December
Intragravel	Late- October	Mid-April
Outmigration	Late-January	Mid-June
Steelhead		
Migration	December	Early June
Spawning	Mid-February	Mid-June
Intragravel	Mid-February	July
Juvenile	Year around	Year around
Outmigration	April	June
Coho		
Migration	October	December
Outmigration	Mid-February	Mid-June

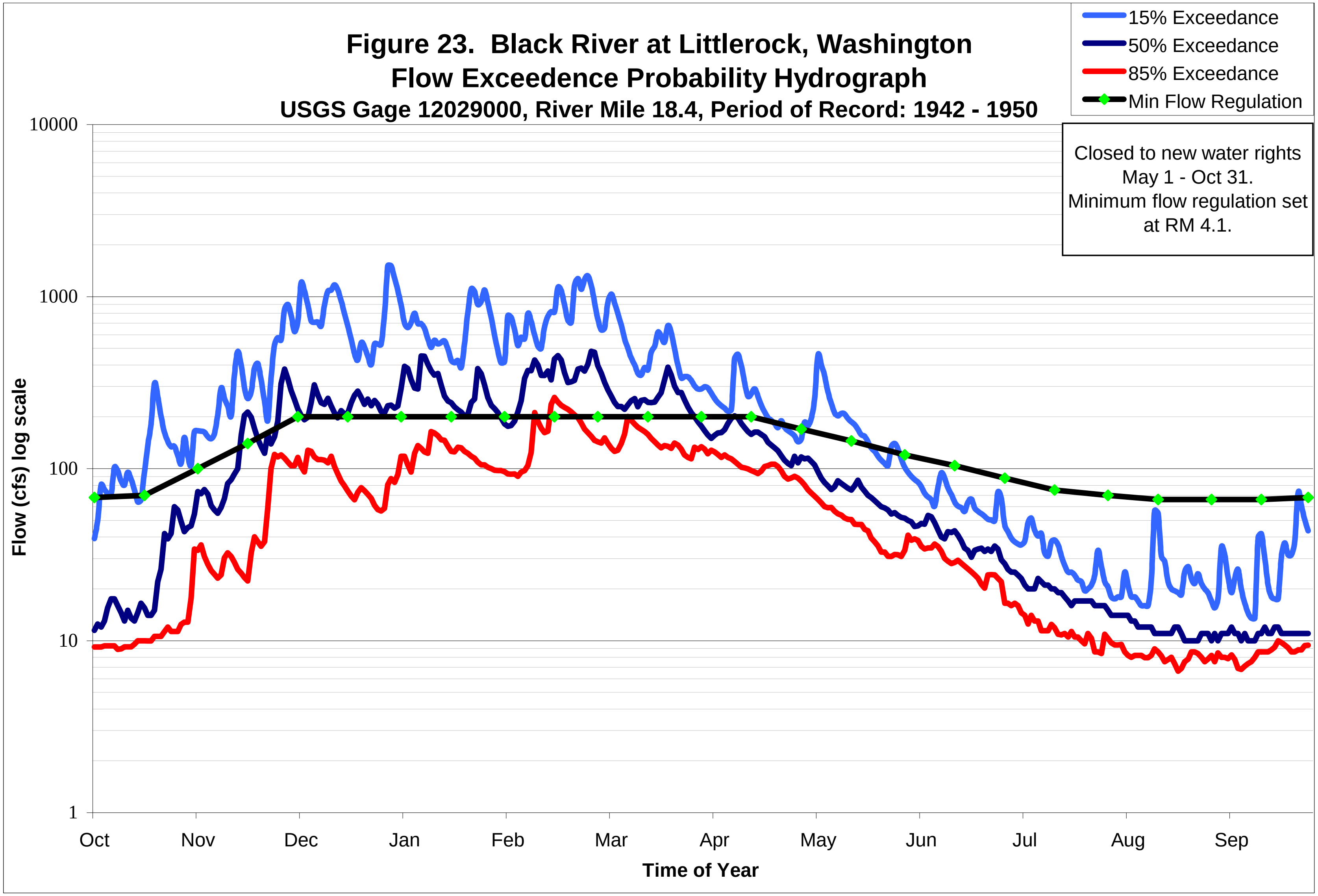
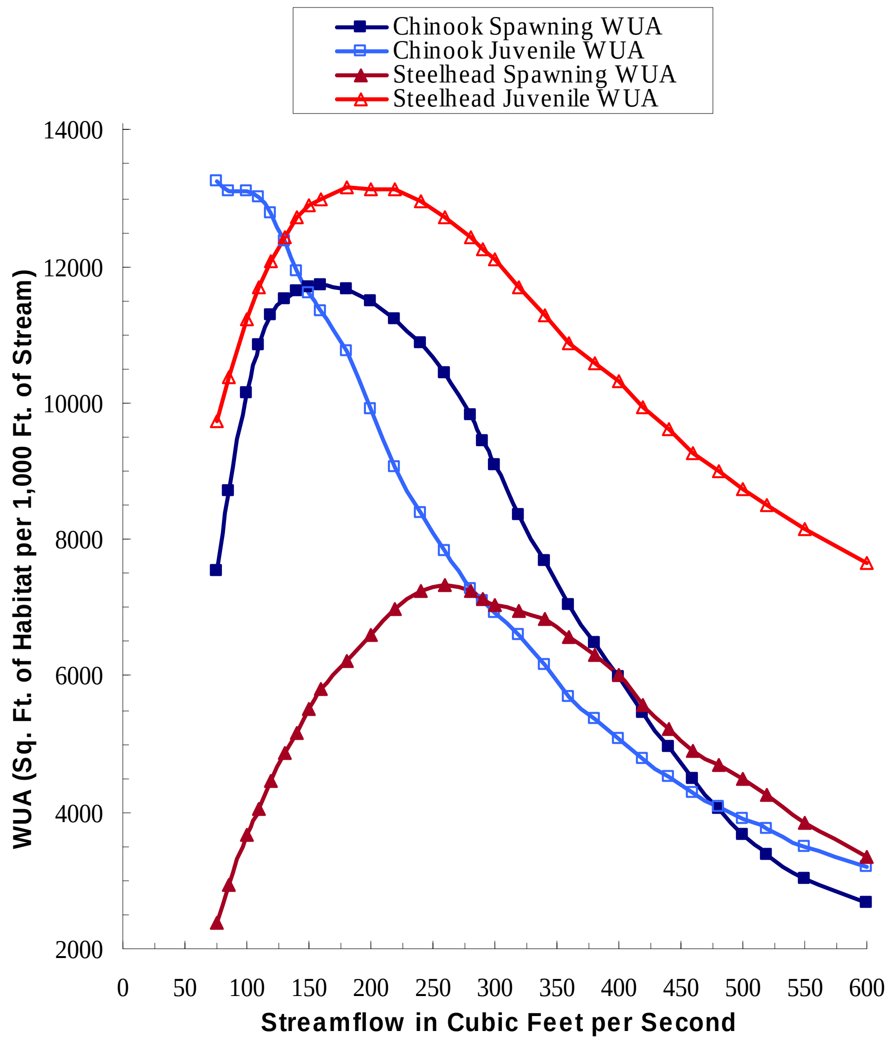


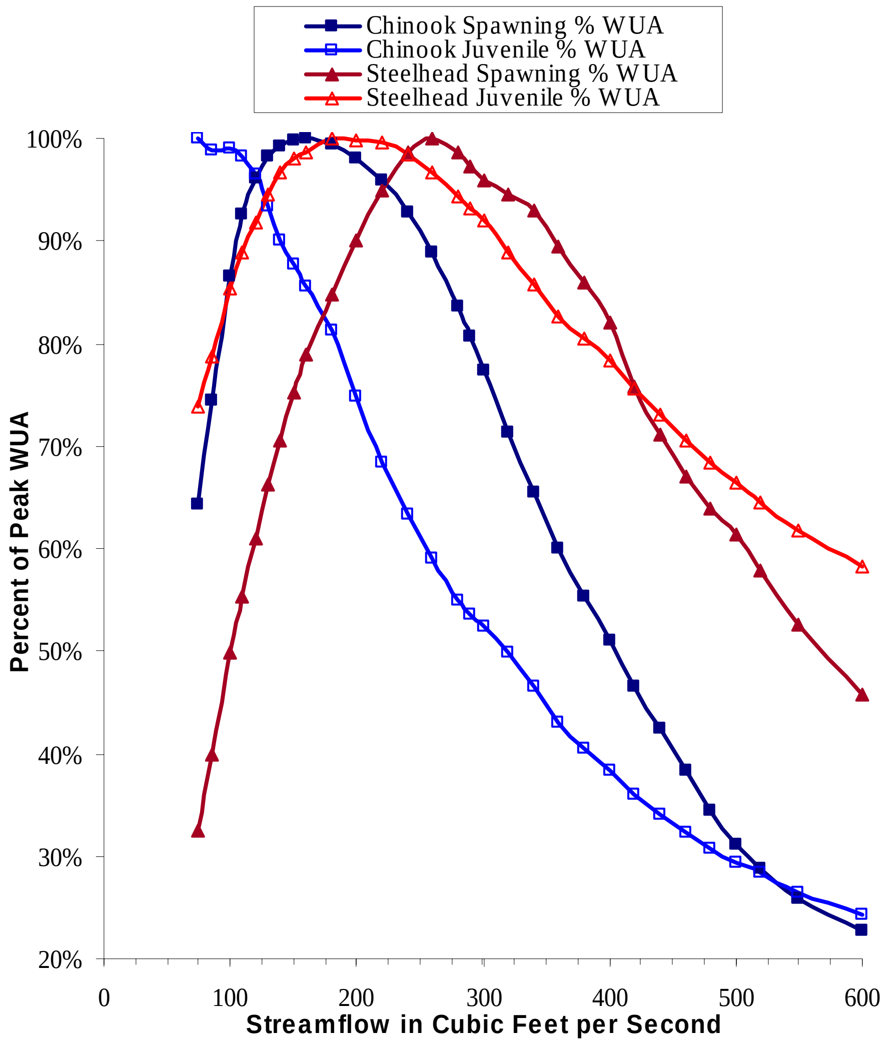
Figure 23. Black River at Littlerock, Washington
Flow Exceedence Probability Hydrograph
USGS Gage 12029000, River Mile 18.4, Period of Record: 1942 - 1950
15% Exceedance
50% Exceedance
85% Exceedance
Min Flow Regulation
Closed to new water rights May 1 - Oct 31. Minimum flow regulation set at RM 4.1.
Flow (cfs) log scale
10000
1000
100
10
1
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Time of Year

Figure 24. Skookumchuck River at RM 1.0: Fish Habitat (WUA) vs Flow



Flow (cfs)	Chinook Spawning WUA	Chinook Juvenile WUA	Steelhead Spawning WUA	Steelhead Juvenile WUA
75	7529	**13245**	2384	9722
85	8718	13099	2931	10371
100	10145	13107	3656	11240
110	10848	13012	4056	11697
120	11279	12784	4471	12092
130	11512	12374	4860	12441
140	11628	11924	5176	12716
150	**11701**	11606	5520	12893
160	**11726**	11338	5795	12995
180	11657	10761	6232	**13162**
200	11491	9908	6608	**13141**
220	11241	9062	6974	**13119**
240	10889	8385	7249	12968
260	10424	7830	**7343**	12729
280	9812	7273	7247	12419
290	9453	7089	7141	12263
300	9079	6932	7043	12106
320	8357	6603	6938	11704
340	7677	6172	6833	11282
360	7039	5699	6563	10884
380	6493	5372	6307	10599
400	5982	5078	6025	10314
420	5458	4775	5568	9952
440	4967	4505	5228	9607
460	4491	4277	4915	9278
480	4046	4075	4696	8994
500	3656	3895	4499	8733
520	3379	3752	4253	8490
550	3036	3497	3856	8139
600	2660	3213	3360	7656

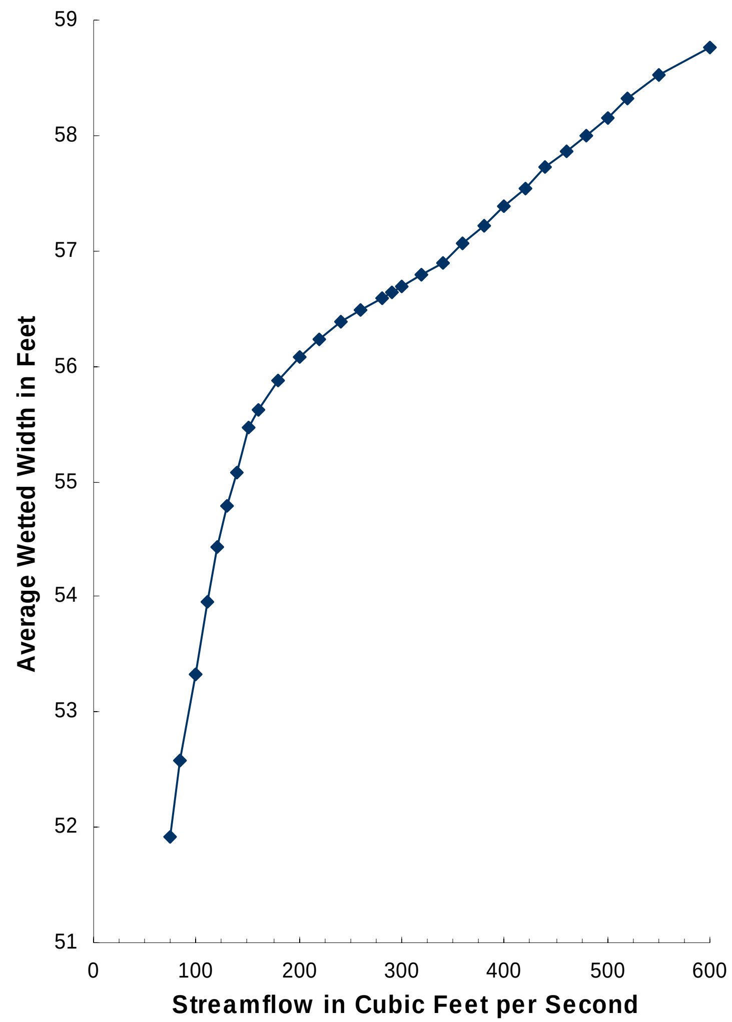
Figure 25. Skookumchuck River at RM 1.0: Percent of Peak WUA vs Flow



Flow (cfs)	Chinook Spawning % WUA	Chinook Juvenile % WUA	Steelhead Spawning % WUA	Steelhead Juvenile % WUA
75	64%	**100%**	32%	74%
85	74%	99%	40%	79%
100	87%	99%	50%	85%
110	93%	98%	55%	89%
120	96%	97%	61%	92%
130	98%	93%	66%	95%
140	99%	90%	70%	97%
150	**100%**	88%	75%	98%
160	**100%**	86%	79%	99%
180	99%	81%	85%	**100%**
200	98%	75%	90%	**100%**
220	96%	68%	95%	**100%**
240	93%	63%	99%	99%
260	89%	59%	**100%**	97%
280	84%	55%	99%	94%
290	81%	54%	97%	93%
300	77%	52%	96%	92%
320	71%	50%	94%	89%
340	65%	47%	93%	86%
360	60%	43%	89%	83%
380	55%	41%	86%	81%
400	51%	38%	82%	78%
420	47%	36%	76%	76%
440	42%	34%	71%	73%
460	38%	32%	67%	70%
480	35%	31%	64%	68%
500	31%	29%	61%	66%
520	29%	28%	58%	65%
550	26%	26%	53%	62%
600	23%	24%	46%	58%

Figure 26

Skookumchuck River at RM 1.0: Avg. Wetted Width



Flow (cfs)	Wetted Width (feet)
75	51.9
85	52.6
100	53.3
110	54.0
120	54.4
130	54.8
140	55.1
150	55.5
160	55.6
180	55.9
200	56.1
220	56.2
240	56.4
260	56.5
280	56.6
290	56.6
300	56.7
320	56.8
340	56.9
360	57.1
380	57.2
400	57.4
420	57.5
440	57.7
460	57.9
480	58.0
500	58.1
520	58.3
550	58.5
600	58.8

Table 5. Skookumchuck River: Lifestage and Timing of Fish Present at the IFIM Site

Species & Lifestage	Timing Start	Timing Finish
Chinook		
Spring Migration	Mid-February	July
Fall Migration	September	October
Spring Spawning	September	Mid-October
Fall Spwaning	Mid-October	Early December
Intragravel	September	Early April
Juvenile	January	Mid-August
Outmigration	April	Mid-August
Steelhead		
Migration	December	Early June
Spawning	Mid-February	Mid-June
Intragravel	Mid-February	July
Juvenile	Year around	Year around
Outmigration	April	June
Coho		
Migration	October	December
Outmigration	Mid-February	Mid-June

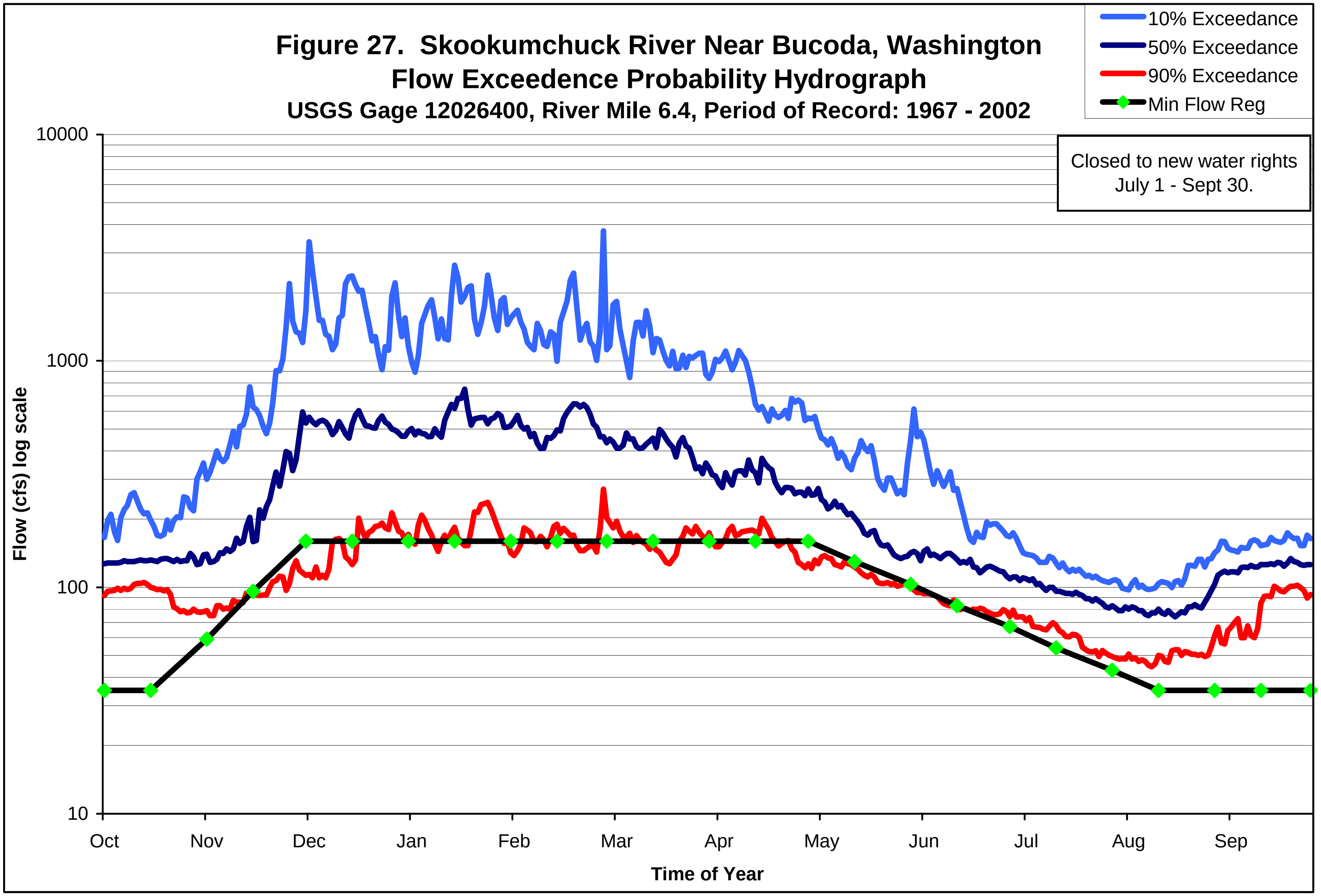
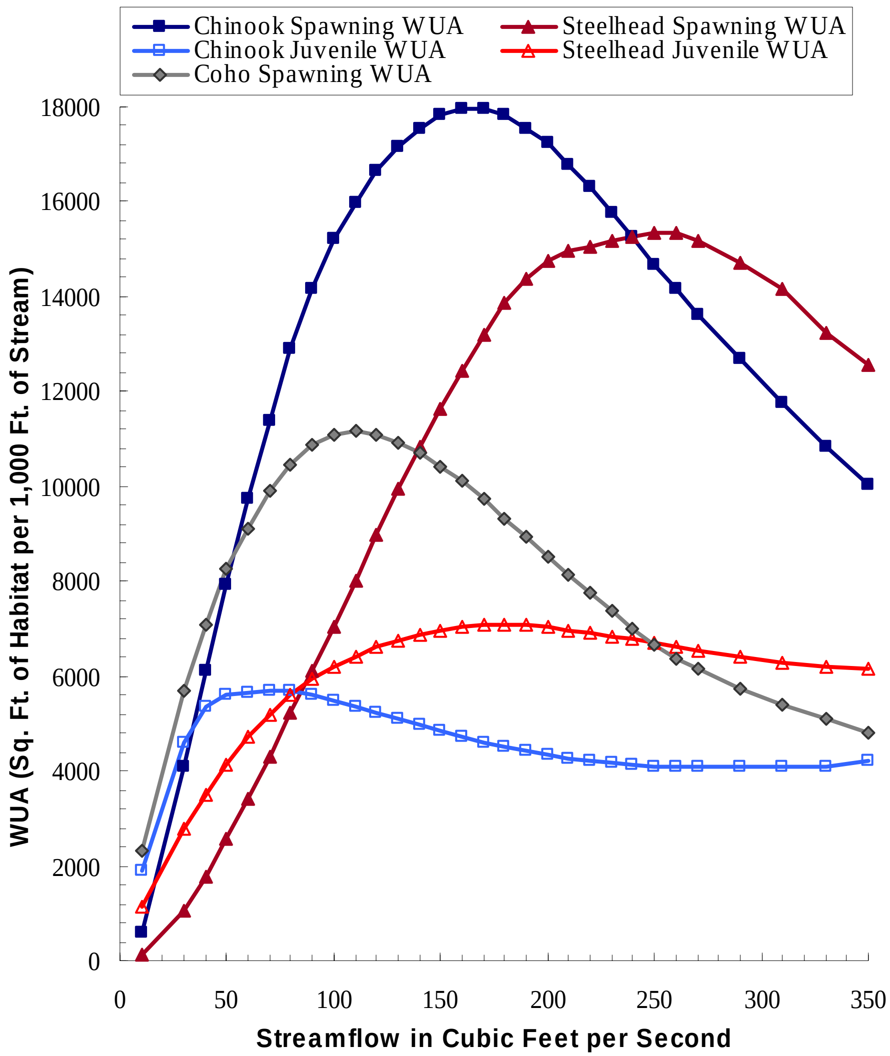


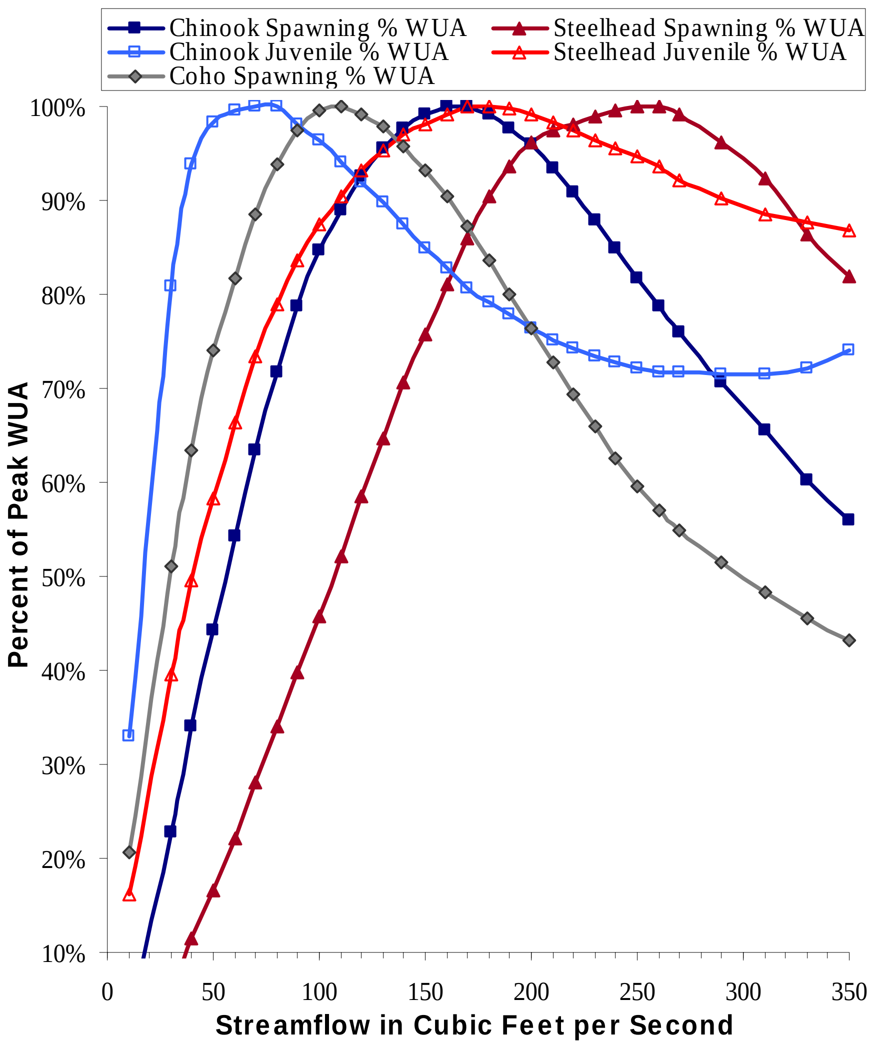
Figure 27. Skookumchuck River Near Bucoda, Washington
Flow Exceedence Probability Hydrograph
USGS Gage 12026400, River Mile 6.4, Period of Record: 1967 - 2002
10% Exceedance
50% Exceedance
90% Exceedance
Min Flow Reg
Closed to new water rights July 1 - Sept 30.
Flow (cfs) log scale
10000
1000
100
10
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Time of Year

Figure 28. Upper Chehalis River at RM 110.9: Fish Habitat (Weighted Usable Area) vs Flow



Flow (cfs)	Chinook Spawning WUA	Chinook Juvenile WUA	Coho Spawning WUA	Steelhead Spawning WUA	Steelhead Juvenile WUA
10	577	1878	2298	112	1146
30	4089	4603	5692	1060	2801
40	6119	5342	7080	1773	3512
50	7932	5593	8263	2556	4139
60	9730	**5667**	9126	3406	4711
70	11389	**5695**	9887	4306	5200
80	12886	**5693**	10472	5212	5596
90	14144	5590	10885	6108	5934
100	15217	5483	11101	7027	6196
110	15983	5356	**11158**	8006	6419
120	16638	5229	11074	8976	6603
130	17154	5111	10914	9930	6759
140	17546	4985	10694	10833	6881
150	17812	4835	10405	11623	6955
160	**17963**	4712	10099	12425	7028
170	**17957**	4595	9725	13192	**7084**
180	17816	4504	9325	13867	**7091**
190	17556	4430	8923	14359	**7070**
200	17224	4346	8521	14745	7028
210	16796	4271	8130	14946	6970
220	16314	4228	7741	15037	6907
230	15778	4184	7356	15181	6835
240	15246	4144	6985	**15264**	6769
250	14681	4105	6650	**15332**	6706
260	14145	4085	6367	**15332**	6632
270	13631	4080	6134	15190	6539
290	12675	4069	5734	14729	6395
310	11759	4076	5388	14163	6281
330	10823	4106	5082	13250	6213
350	10044	4215	4819	12554	6150

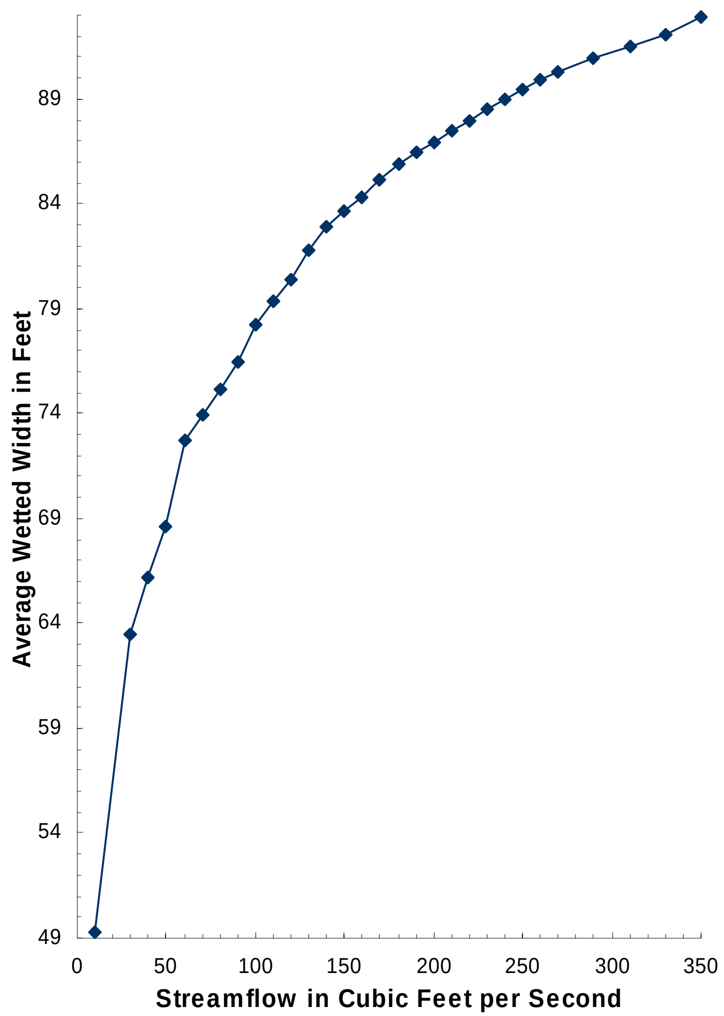
Figure 29. Upper Chehalis River at RM 110.9: Percent of Peak WUA vs Flow



Flow (cfs)	Chinook Spawning % WUA	Chinook Juvenile % WUA	Coho Spawning % WUA	Steelhead Spawning % WUA	Steelhead Juvenile % WUA
10	3%	33%	21%	1%	16%
30	23%	81%	51%	7%	40%
40	34%	94%	63%	12%	50%
50	44%	98%	74%	17%	58%
60	54%	**100%**	82%	22%	66%
70	63%	**100%**	89%	28%	73%
80	72%	**100%**	94%	34%	79%
90	79%	98%	98%	40%	84%
100	85%	96%	99%	46%	87%
110	89%	94%	**100%**	52%	91%
120	93%	92%	99%	59%	93%
130	95%	90%	98%	65%	95%
140	98%	88%	96%	71%	97%
150	99%	85%	93%	76%	98%
160	**100%**	83%	91%	81%	99%
170	**100%**	81%	87%	86%	**100%**
180	99%	79%	84%	90%	**100%**
190	98%	78%	80%	94%	**100%**
200	96%	76%	76%	96%	99%
210	94%	75%	73%	97%	98%
220	91%	74%	69%	98%	97%
230	88%	73%	66%	99%	96%
240	85%	73%	63%	**100%**	95%
250	82%	72%	60%	**100%**	95%
260	79%	72%	57%	**100%**	94%
270	76%	72%	55%	99%	92%
290	71%	71%	51%	96%	90%
310	65%	72%	48%	92%	89%
330	60%	72%	46%	86%	88%
350	56%	74%	43%	82%	87%

Figure 30

Upper Chehalis River at RM 110.9: Avg. Wetted Width



Flow (cfs)	Wetted Width (feet)
10	49.3
30	63.5
40	66.2
50	68.7
60	72.7
70	73.9
80	75.2
90	76.5
100	78.3
110	79.3
120	80.4
130	81.8
140	83.0
150	83.7
160	84.3
170	85.1
180	85.9
190	86.5
200	87.0
210	87.5
220	88.0
230	88.5
240	89.0
250	89.5
260	89.9
270	90.3
290	90.9
310	91.5
330	92.1
350	92.9

Table 6. Upper Chehalis River: Lifestage and Timing of Fish Present at the IFIM Site

Species & Lifestage	Timing Start	Timing Finish
Chinook		
Spring Migration	Mid-February	July
Fall Migration	September	October
Spring Spawning	September	Mid-October
Fall Spwaning	Mid-October	Early December
Intragravel	September	Early April
Juvenile	January	Mid-August
Outmigration	April	Mid-August
Coho Salmon		
Migration	October	December
Spawning	November	February
Intragravel	November	May
Juvenile	Year around	Year around
Outmigration	Mid-February	Mid-June
Steelhead		
Summer Migration	May	November
Winter Migration	December	Early June
Spawning	Mid-February	Mid-June
Intragravel	Mid-February	July
Juvenile	Year around	Year around
Outmigration	April	June

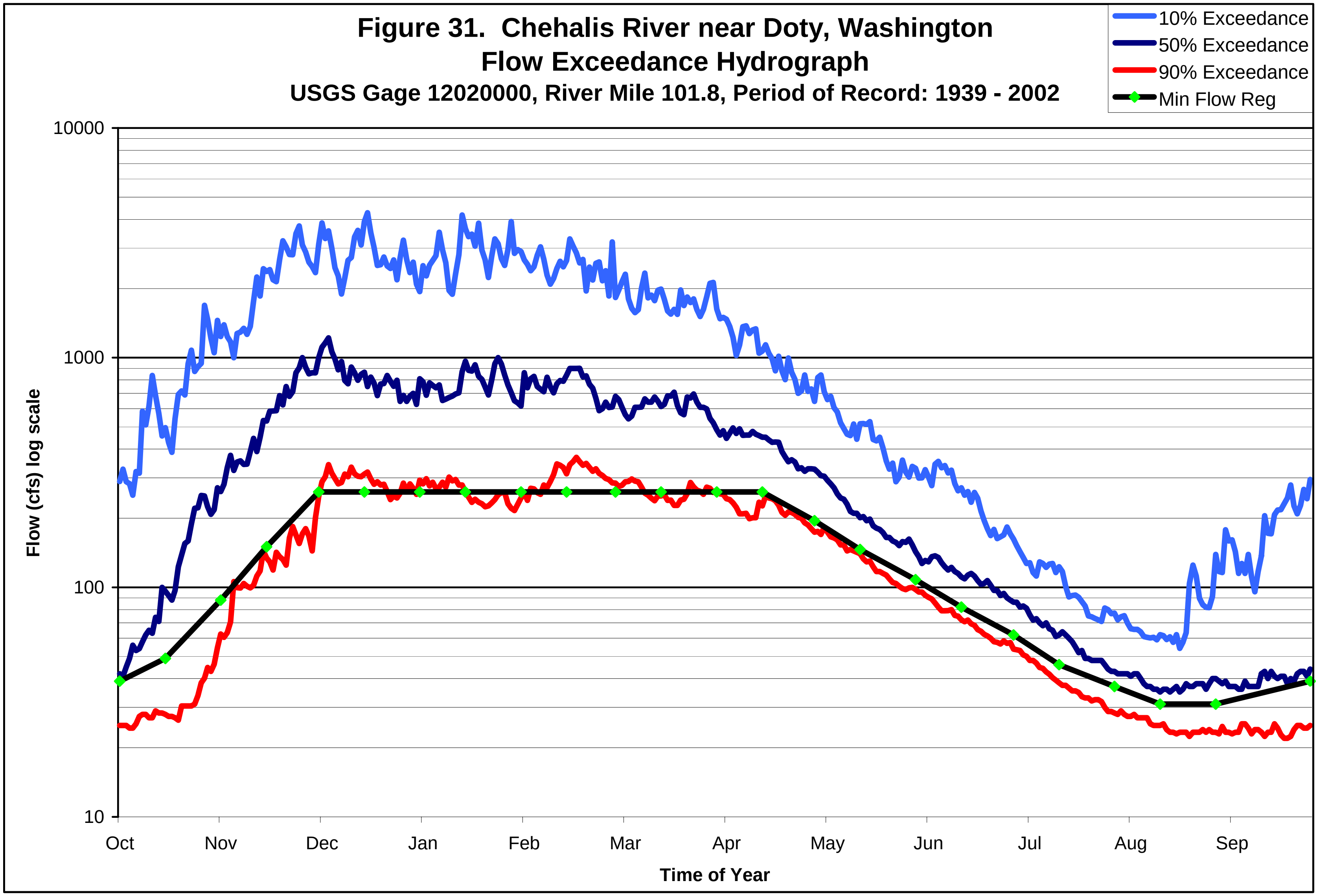


Figure 31. Chehalis River near Doty, Washington
Flow Exceedance Hydrograph
USGS Gage 12020000, River Mile 101.8, Period of Record: 1939 - 2002
10% Exceedance
50% Exceedance
90% Exceedance
Min Flow Reg
10000
1000
100
10
Flow (cfs) log scale
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Time of Year

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Appendix A

Computer Input Files for RHABSIM Models for Black, Humptulips, Satsop, Skookumchuck, West Fork Hoquiam and upper Chehalis Rivers.

Black River measured at RM 4.2 on 5/24/01 at 149 cfs,on 6/21/01 at 87 cfs, and on 9/12/2001 at 53 cfs by the Dept. of Ecology and WDFW.

SUMMARY DATA: CROSS-SECTION # 1 Black R.

X	Y	VEL 1	VEL 2	SUBSTRATE
-9.00	100.75			0.70
0.40	97.75			0.70
4.30	96.16			0.70
4.80	95.81			0.70
6.00	95.33			0.70
7.40	95.01			15.50
7.50	95.04			15.50
9.00	94.64			51.50
10.50	94.31	0.10		51.50
12.00	93.98	0.24	0.05	45.90
13.50	93.66	0.59	0.36	45.90
15.00	93.46	0.80	0.65	51.60
16.50	93.33	1.15	0.62	52.70
18.00	93.29	1.06	0.86	51.70
19.50	93.13	1.49	1.04	52.70
21.00	93.06	1.61	1.24	52.70
22.50	92.99	1.67	1.17	52.70
24.00	92.98	1.59	1.16	51.60
25.50	92.99	1.80	1.05	52.60
27.00	93.01	1.74	1.17	52.60
28.50	93.09	1.61	1.01	0.60
30.00	93.13	1.75	1.28	0.60
31.50	93.13	1.22	0.99	0.60
33.00	93.16	1.69	0.84	0.60
34.50	93.18	1.11	0.81	0.60
36.00	93.23	1.48	0.83	0.60
37.50	93.26	0.78	0.63	0.60
39.00	93.28	0.83	0.61	0.60
40.50	93.31	0.57	0.32	0.60
42.00	93.36	0.15	0.34	0.60
43.50	93.28	0.17	0.09	0.60
45.00	93.26	0.05		0.60
46.50	93.26	0.05		0.60
48.00	93.34	0.05		42.60
50.00	93.44	0.05		42.80
55.00	93.74	0.05		32.70
60.00	93.93	0.05		42.80
65.00	94.09	0.05		42.80
68.00	94.13	0.06	0.11	0.60
69.00	94.11	0.09	0.17	0.60
70.00	94.11	0.19	0.27	0.60
72.00	94.14	0.72	0.33	0.60
75.00	94.23	0.78	0.23	0.60
78.00	94.31	0.94	0.37	0.60
81.00	94.38	0.84	0.34	0.60
84.00	94.53	0.84	0.13	0.60
85.50	94.59	0.84	0.48	0.60
87.00	94.59	0.20	0.36	0.60
90.00	94.63	0.15	0.21	0.60
93.00	94.68			0.60
96.00	94.66		0.01	0.60
99.00	94.66		0.05	0.60
102.00	94.76	0.03	0.05	0.60
105.00	94.94	0.01		0.70
105.30	95.01			0.70
107.00	95.29			0.70
109.00	95.58			0.70
109.90	95.81			0.70
111.30	96.16			0.70
112.00	97.35			0.70
115.95	97.65			0.30
136.00	101.65			0.70

SUMMARY DATA: CROSS-SECTION # 2 Black R.

X	Y	VEL 1	VEL 2	SUBSTRATE
-3.00	100.26			0.70
0.70	99.26			0.70
1.00	97.26			0.30
3.50	96.41			0.70
4.00	96.36			0.30

4.20	95.96			0.30
5.00	95.51	0.88	0.11	0.20
6.50	95.36	1.08	0.85	42.80
8.00	95.07	0.76	0.60	42.80
9.50	94.91	0.80	0.66	42.50
11.00	94.59	0.65	0.67	42.50
12.50	94.21	1.70	1.14	0.60
14.00	93.92	1.91	1.09	0.60
15.50	93.66	1.91	1.17	0.60
17.00	93.07	2.25	1.26	0.60
18.50	93.07	2.15	1.74	0.60
20.00	92.96	2.24	1.97	0.60
21.50	93.12	2.34	2.03	45.50
23.00	93.46	2.39	2.20	54.50
24.50	93.72	2.37	2.15	54.50
26.00	93.74	2.56	2.09	54.50
27.50	93.79	2.64	1.95	54.50
29.00	93.97	2.60	1.84	54.50
30.50	94.09	2.46	1.77	45.70
32.00	94.27	2.29	1.71	45.80
33.50	94.42	2.21	1.44	34.80
35.00	94.67	1.90	0.68	32.50
36.50	94.89	1.62	0.23	24.80
38.00	95.04	1.58	0.03	24.50
39.50	95.07	0.87	0.70	24.50
41.00	95.26	1.39	0.88	41.50
42.50	95.49	1.03	0.52	41.50
44.00	95.98	0.05		42.50
44.30	95.96			42.50
45.00	96.06			0.70
45.50	96.16			0.70
47.00	96.21			0.70
48.50	96.21			0.70
50.00	96.26			0.70
51.50	96.31			0.70
52.00	96.36			0.70
55.00	96.46			0.70
65.00	96.61			0.70
75.00	96.86			0.70
85.00	97.16			0.70
95.00	97.26			0.70

SUMMARY DATA: CROSS-SECTION # 3 Black R.

X	Y	VEL 1	VEL 2	SUBSTRATE
-10.00	99.52			0.70
-2.00	99.52			11.90
0.40	97.52			0.30
1.90	96.39			0.30
2.00	96.62			0.30
2.30	95.99			0.30
2.80	95.64	0.27		32.60
3.50	95.34	0.66	0.27	43.70
4.50	95.42	0.68	0.44	0.50
5.50	95.07	0.71	0.35	0.50
6.50	94.71	0.92	0.48	34.70
7.50	94.57	0.90	0.51	43.60
8.50	94.44	1.03	0.62	43.60
9.50	94.26	1.01	0.67	43.70
10.50	94.12	1.14	1.03	43.70
11.50	93.92	1.32	0.91	43.70
12.50	93.79	1.46	0.90	43.70
13.50	93.66	1.78	1.01	43.70
14.50	93.56	1.86	1.02	43.70
15.50	93.44	1.83	1.22	43.70
16.50	93.34	1.84	1.54	43.70
17.50	93.21	1.79	1.53	54.60
18.50	93.12	1.96	1.57	54.60
19.50	93.54	2.11	1.51	45.80
20.50	93.31	2.36	1.66	54.60
21.50	93.56	2.19	1.88	45.70
22.50	93.46	2.18	1.90	45.70
23.50	93.36	2.11	1.75	54.50
24.50	93.27	2.21	1.62	45.60
25.50	93.34	2.27	1.54	45.60
26.50	93.39	2.13	1.28	45.70
27.50	93.42	1.98	1.18	43.70
28.50	93.57	1.99	1.24	45.70
29.50	93.82	1.97	1.31	43.80
30.50	93.97	1.87	1.14	43.60
31.50	94.16	1.68	1.11	43.60
32.50	94.34	1.44	1.07	43.60
33.50	94.39	1.48	1.04	43.50
34.50	94.49	1.45	0.92	43.50
35.50	94.59	1.47	0.89	45.80
36.50	94.72	0.87	0.16	43.70
37.50	94.87	0.68	0.63	43.70
38.50	95.04	0.72	0.75	34.50
39.50	95.26	0.52	0.19	0.60
40.50	95.54	0.10		22.50
41.00	95.62			54.50
41.50	95.94			22.50
42.00	95.92			0.70
43.00	95.94			0.70
45.00	96.09			0.70

47.00	96.19			0.70
49.00	96.24			0.70
50.00	96.22			0.70
51.00	96.29			0.70
53.00	96.34			0.70
56.00	96.34			0.70
58.50	96.34			0.70
58.60	96.39			0.70
60.00	96.47			0.70
70.00	96.62			0.70
80.00	96.82			0.70
90.00	97.12			0.70
100.00	97.42			0.70

SUMMARY DATA: CROSS-SECTION # 4 Black R

X	Y	VEL 1	VEL 2	SUBSTRATE
-15.00	101.92			0.70
-10.00	97.62			0.70
0.40	97.52			0.90
4.00	97.02			0.70
4.50	96.70			0.70
4.80	96.31			0.70
7.00	95.91			0.60
7.40	95.84			0.60
10.00	95.25		-0.05	0.60
13.00	95.10	-0.01	-0.10	0.60
16.00	94.95		0.17	0.60
19.00	94.75	0.93	0.19	0.60
22.00	95.00	1.46	0.89	32.60
25.00	95.43	1.25	1.36	34.70
28.00	95.53	1.63	1.56	43.60
31.00	95.50	1.71	1.58	43.60
34.00	95.37	1.65	1.64	43.60
37.00	95.33	1.44	1.69	43.70
40.00	95.33	1.67	1.63	45.70
43.00	95.30	1.56	1.70	45.60
46.00	95.28	1.85	1.80	53.50
49.00	95.30	1.72	1.76	34.60
52.00	95.18	1.78	1.80	34.70
55.00	95.10	1.79	1.36	45.80
58.00	95.10	1.52	1.27	45.50
61.00	95.00	1.26	0.54	54.60
64.00	94.77	0.97	0.71	45.60
67.00	94.85	1.07	0.74	45.70
70.00	95.10	1.05	0.60	43.90
73.00	95.28	0.95	0.74	45.70
76.00	95.17	0.89	1.03	45.50
79.00	95.20	1.19	0.38	54.70
82.00	95.08	1.02	0.34	53.70
85.00	95.12	1.07	0.80	54.50
88.00	95.32	1.00	0.08	53.70
91.00	95.55	1.11	0.29	45.50
94.00	95.78	1.01	0.05	34.70
97.00	96.13	0.08		46.80
100.00	96.28			0.70
103.00	96.23	0.27		0.70
105.30	96.31			0.70
106.00	96.35			0.70
109.00	96.50			0.70
110.70	96.70			0.70
114.00	96.72			0.70
121.50	96.82			0.70
127.00	97.07			0.70
132.00	97.12			0.70
137.00	96.72			0.70
142.00	96.52			0.70

Black River measured at RM 4.2 on 5/24/01 at 149 cfs,on 6/21/01 at 87 cfs, and on 9/12/2001 at 53 cfs by the Dept. of Ecology and WDFW.

High flow modeling

CAL	Stage	GivenFlow	CalcFlow
CROSS-SECTION # 1	Black R.		
1	96.16	149.00	141.35
2	95.81	86.00	78.36
CROSS-SECTION # 2	Black R.		
1	96.36	149.00	157.53
2	95.96	86.00	94.47
CROSS-SECTION # 3	Black R.		
1	96.39	149.00	144.49
2	95.99	86.00	85.51
CROSS-SECTION # 4	Black R.		
1	96.70	149.00	151.24
2	96.31	86.00	84.87

Low flow modeling

CAL	Stage	GivenFlow	CalcFlow
CROSS-SECTION # 1	Transect 1		
1	95.81	86.00	78.36
2	95.01	53.00	44.13
CROSS-SECTION # 2	Transect 2		
1	95.96	86.00	94.47
2	95.20	53.00	54.19
CROSS-SECTION # 3	Transect 3		
1	95.99	86.00	85.51
2	95.24	53.00	51.41
CROSS-SECTION # 4	Transect 4		
1	96.31	86.00	84.87
2	95.84	53.00	62.17

Humptulips River 2001 at WDFW access between Hwy 101 & Stevens Cr hatchery
657cfs (5/25),313cfs (6/22),255cfs (9/18) - Caldwell, Beecher, Vadas, Shedd

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SUMMARY DATA: CROSS-SECTION # 1 Trans 1
Number of Points = 52

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-20.00	100.16				0.70
0.40	98.31				0.70
3.00	96.32				0.20
5.00	95.14				0.70
5.10	94.83				0.70
5.50	94.73				0.60
6.50	94.50	-0.32			23.70
8.00	93.78	-0.10			0.50
9.00	93.40	0.08			0.50
10.00	92.95	0.43			0.50
12.00	92.68	0.94			35.70
14.00	92.70	1.42	0.57		34.70
21.00	92.73	2.22	1.84	1.12	43.60
25.00	92.28	2.76	1.95	1.94	45.60
27.00	92.16	3.66	2.75	2.24	45.50
30.00	92.10	4.43	2.73	2.93	45.50
36.00	92.09	4.58	3.28	3.39	46.60
42.00	92.10	4.63	3.49	3.49	64.70
48.00	92.10	4.92	3.82	3.52	65.70
52.00	92.35	4.93	3.67	3.52	56.70
57.00	92.40	4.75	3.89	3.71	56.60
63.00	92.50	4.42	3.82	3.23	46.60
70.00	92.65	3.90	2.83	2.33	54.60
77.00	93.00	3.26	2.12	1.12	46.60
84.00	93.64	2.32	1.03	0.67	45.50
88.90	94.08	1.71			45.70
91.00	94.08	1.71			45.70
98.00	94.55	1.36			34.90
105.00	94.23	1.85			34.50
112.00	94.43	1.15			46.70
119.00	94.53	0.61			45.60
126.00	94.78	0.20			45.50
133.00	94.73	0.05			34.60
140.00	94.81	0.05			53.50
143.70	94.83				45.50
147.00	94.81				46.60
154.00	94.80	0.05			35.60
161.00	94.78	0.10			35.60
168.00	94.75				46.60
175.00	97.74				35.70
186.10	94.58	0.01			53.60
189.00	94.13	0.01			53.60
190.10	94.00				52.70
196.00	93.75	0.01			51.90
202.30	93.89				35.60
203.00	94.13				35.60
204.60	94.30				34.70
207.00	94.43				34.90
210.20	94.83				0.80
211.40	95.30				0.10
213.00	98.30				0.70
233.00	100.16				0.70

SUMMARY DATA: CROSS-SECTION # 2 Trans 2
Number of Points = 47

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-0.50	100.12				0.70
0.50	98.12				0.30
2.00	95.62				0.80
2.60	95.41				0.80
3.00	95.28	0.10			0.80
4.00	94.88	0.51			0.80
5.00	94.50	0.83	0.31		0.80
6.00	93.95	1.03	0.71	0.33	35.70
7.00	93.45	1.07	0.77	0.63	35.70
9.00	93.05	1.25	0.92	0.94	54.50
12.00	92.70	1.55	1.13	1.23	56.50
15.00	92.31	1.76	1.37	1.43	65.60
20.00	91.75	1.94	1.65	1.59	45.70
25.00	91.86	2.46	2.04	1.91	43.70
30.00	92.10	3.02	2.03	1.94	45.80
35.00	92.35	2.78	2.25	1.93	45.50
40.00	92.40	2.99	2.39	1.99	45.50
45.00	92.45	2.90	2.32	2.20	54.60
50.00	92.55	2.93	2.23	2.33	45.70
55.00	92.56	2.81	2.75	2.22	45.70
60.00	92.80	2.89	2.50	2.34	54.70
65.00	93.00	2.89	2.19	2.00	56.80
70.00	93.10	2.64	2.00	1.78	45.50
75.00	93.30	2.67	1.97	1.68	46.50
80.00	93.35	2.45	1.87	1.63	56.50
85.00	93.60	2.37	1.65	1.53	56.50
90.00	93.95	2.28	1.33	1.07	46.50
95.00	94.10	2.07	1.08	0.52	45.50

100.00	94.25	1.77	0.75	0.40	45.50
105.00	94.17	1.99	0.89	0.47	46.50
110.00	94.25	1.75	0.91	0.40	53.50
115.00	94.35	1.76			56.50
120.00	94.53	1.74			46.80
125.00	94.80	1.29			46.70
130.00	94.98	0.80			65.50
135.00	94.98	0.85			54.50
140.00	95.13	0.69			53.50
145.00	95.23	0.09			63.50
150.00	95.28				64.50
153.20	95.38				64.50
153.30	95.45				56.80
165.00	95.71				56.80
180.00	96.24				54.70
193.00	99.77				54.70
219.50	95.41				0.80
225.00	96.91				0.70
228.00	99.91				0.70

SUMMARY DATA: CROSS-SECTION # 3 Trans 3
Number of Points = 47

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-1.50	100.36				0.70
0.50	99.37				0.70
2.00	98.37				11.90
4.00	96.78				11.90
7.00	96.24				11.90
7.60	94.62				0.50
8.00	94.59	0.37			0.50
12.00	94.04	0.41	0.28	0.36	12.90
16.00	93.45	0.53	0.68	0.74	22.90
20.00	93.05	0.64	0.70	0.76	22.90
25.00	92.70	0.76	0.65	0.74	24.50
30.00	92.23	0.97	0.86	0.85	34.70
35.00	92.00	1.11	1.01	1.08	24.80
40.00	92.00	1.17	0.98	1.15	23.80
45.00	92.20	1.48	1.06	1.16	34.60
50.00	92.35	1.39	1.16	1.08	43.50
55.00	92.35	1.47	1.00	1.12	43.50
60.00	92.30	1.57	1.14	1.18	43.50
65.00	92.30	1.63	1.23	1.23	45.80
70.00	92.30	1.72	1.11	1.12	45.60
75.00	92.30	1.63	1.29	1.19	45.50
80.00	92.35	1.74	1.22	1.27	45.60
85.00	92.45	1.77	1.15	1.19	45.60
90.00	92.60	1.90	1.17	1.07	45.70
95.00	92.70	1.73	1.26	1.12	45.70
100.00	92.80	1.73	1.24	1.04	34.60
105.00	92.90	1.72	1.00	0.95	45.70
110.00	93.00	1.48	1.02	0.96	54.60
115.00	93.00	1.47	1.03	0.88	45.70
120.00	93.20	1.28	0.95	0.83	43.70
125.00	93.40	1.22	0.91	0.83	34.60
130.00	93.40	1.16	0.86	0.70	43.60
135.00	93.30	1.04	0.79	0.62	35.50
140.00	93.40	1.09	0.72	0.62	43.60
145.00	93.60	0.95	0.70	0.47	45.70
150.00	93.60	0.82	0.61	0.39	43.70
155.00	93.50	0.88	0.57	0.37	43.60
160.00	93.40	0.79	0.51	0.40	43.60
165.00	93.10	0.91	0.44	0.39	34.70
170.00	92.79	0.67	0.47	0.31	23.70
175.00	93.00	0.52	0.27	0.23	92.70
180.00	94.62	0.15			99.90
181.80	95.52				99.90
182.00	96.44				99.90
183.00	97.25				99.90
185.30	98.48				99.90
193.00	100.00				11.50

SUMMARY DATA: CROSS-SECTION # 4 Trans 4
Number of Points = 50

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-1.30	102.49				0.70
6.70	99.99				11.90
20.00	99.38				31.80
30.00	99.43				14.50
40.00	98.87				45.60
60.00	98.33				54.50
75.00	97.94				53.70
85.00	97.89				43.50
100.00	97.63				43.50
110.00	97.13				43.50
120.00	96.10				43.60
123.60	95.59				43.80
125.00	95.44				43.80
128.50	94.75	0.05			43.80
130.00	94.57	0.14			43.80
132.50	94.40	0.21			63.50

135.00	93.90	0.37			63.50
137.50	93.50	0.52			47.80
140.00	92.70	0.62			54.50
142.50	92.35	0.85			57.90
145.00	92.20	0.99			46.80
147.50	91.90	1.29	0.45	0.20	56.50
150.00	91.60	1.43	0.51	0.20	56.60
152.50	91.40	1.63	0.68	0.27	32.50
155.00	91.20	1.75	0.86	0.39	32.50
157.50	91.00	2.09	0.87	0.53	23.50
160.00	90.80	2.23	1.16	0.64	23.90
162.50	90.50	2.29	1.15	0.83	22.90
165.00	90.30	2.35	1.34	1.13	22.90
167.50	90.07	2.28	1.40	1.31	22.90
170.00	89.80	2.35	1.38	1.43	22.90
172.50	89.50	2.51	1.65	1.44	54.50
175.00	89.00	2.76	1.75	1.53	54.50
177.50	88.80	2.78	1.83	1.70	54.50
180.00	88.40	2.77	1.98	1.68	54.50
182.50	88.06	2.87	1.58	1.75	65.50
185.00	87.87	2.79	1.80	1.54	67.60
187.50	87.70	2.31	1.18	1.40	76.70
190.00	87.60	1.96	0.74	1.07	79.70
192.50	87.80	1.13	0.46	0.50	98.60
195.00	88.47	0.44		0.26	99.90
197.50	89.87	0.21			99.90
200.00	89.90	-0.15			99.90
202.50	91.07	-0.55			99.90
205.00	92.62	-0.62			99.90
205.70	94.57				99.90
208.00	95.74				0.70
210.00	98.54				0.70
210.70	99.91				0.70
214.70	102.41				0.70

SUMMARY DATA: CROSS-SECTION # 5 Trans 5
Number of Points = 52

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
3.10	99.46				0.80
20.00	99.39				14.50
40.00	99.60				14.50
60.00	98.79				45.50
80.00	97.58				54.50
100.00	96.90				54.60
120.00	96.33				45.50
130.00	95.94				45.50
135.00	95.80				53.70
139.30	95.59				45.50
140.00	95.53				45.50
144.00	95.33				45.50
148.00	95.13	0.11			45.50
155.30	94.93	0.21			45.50
156.00	94.77	0.52			45.50
160.00	94.63	0.91			45.50
164.00	94.54	1.11			45.50
168.00	94.41	1.69	0.38	0.50	45.50
172.00	94.25	2.20	0.63	0.73	45.60
176.00	94.16	2.46	0.93	0.84	45.50
180.00	94.10	2.56	1.06	1.36	35.60
184.00	94.00	2.79	1.27	1.39	45.50
188.00	94.00	2.93	1.66	1.91	35.50
192.00	94.00	3.11	1.77	2.21	45.50
196.00	93.70	3.02	1.82	2.07	45.70
200.00	93.60	3.00	2.15	2.23	45.70
204.00	93.40	3.07	2.09	2.02	45.80
208.00	93.30	3.08	2.46	2.19	44.90
212.00	93.20	3.22	2.36	2.53	43.80
216.00	93.10	3.01	2.59	2.55	43.80
220.00	93.00	3.16	2.58	2.48	43.80
224.00	92.90	2.92	2.59	2.61	43.80
228.00	92.70	2.94	2.61	2.66	43.80
232.00	92.50	2.95	2.60	2.44	34.50
234.50	92.40	2.56	2.58	2.47	32.50
237.00	92.20	2.79	2.55	2.23	42.50
241.00	92.20	2.76	2.29	2.21	32.80
245.00	92.40	2.41	2.28	1.81	32.50
248.00	92.60	2.05	1.79	1.80	32.50
251.00	92.80	1.36	1.53	1.28	12.50
253.50	93.20	1.01	1.22	0.87	0.50
255.50	93.55	0.61	0.59	0.47	0.50
257.00	93.95	0.71	0.72	0.51	0.50
258.50	94.40	0.58	0.42	0.07	11.90
260.00	94.82	0.04			11.90
261.00	95.33				11.90
261.40	95.59				11.90
262.00	95.79				11.90
264.00	97.02				11.90
265.00	99.99				0.70
267.30	101.14				0.70
269.30	102.14				0.70

Humptulips River 2001 at WDFW access between Hwy 101 & Stevens Cr hatchery
657cfs (5/25),313cfs (6/22),255cfs (9/18) - Caldwell, Beecher, Vadas, Shedd

CROSS-SECTION # 1

CAL	Stage	GivenFlow	CalcFlow
1	94.83	655.00	683.76
2	94.08	312.00	329.98
3	93.90	255.00	264.65

CROSS-SECTION # 2

CAL	Stage	GivenFlow	CalcFlow
1	95.38	655.00	637.43
2	94.58	312.00	323.54
3	94.36	255.00	257.87

CROSS-SECTION # 3

CAL	Stage	GivenFlow	CalcFlow
1	95.52	655.00	568.35
2	94.74	312.00	296.56
3	94.54	255.00	258.54

CROSS-SECTION # 4

CAL	Stage	GivenFlow	CalcFlow
1	95.86	655.00	690.60
2	94.75	312.00	304.49
3	94.57	255.00	259.72

CROSS-SECTION # 5

CAL	Stage	GivenFlow	CalcFlow
1	95.59	655.00	557.77
2	94.82	312.00	288.49
3	94.66	255.00	253.36

Satsop R T18N R7W S24,25 - Caldwell, Shedd, Beecher, Vadas - 2001
calibration flows 713 (5/22), 360 (6/20), 280 (9/20/01)

SUMMARY DATA: CROSS-SECTION # 1 trans 0
Number of Points = 51

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
1.30	100.50				
3.30	99.00				0.30
10.00	95.76				99.90
15.00	94.79				99.90
15.90	94.36				11.90
18.70	93.67				11.90
20.00	93.67	-0.16			11.90
21.60	93.59				0.20
25.00	91.70	0.34	0.18	0.12	0.10
30.00	90.37	0.80	1.32	1.36	99.90
35.00	90.07	1.09	1.21	0.93	42.70
40.00	90.70	1.77	1.27	1.40	42.70
45.00	91.22	2.07	1.85	1.59	42.80
50.00	91.47	2.41	2.09	1.60	42.70
55.00	91.72	2.93	2.20	1.23	42.90
60.00	92.00	3.00	1.83	1.34	42.90
65.00	92.30	2.91	2.35	2.65	53.70
70.00	92.77	3.19	3.49	4.23	63.70
75.00	92.80	3.41	3.05	4.70	54.70
80.00	92.80	3.29	4.56	4.59	56.80
85.00	92.80	3.51	4.05	4.37	56.60
90.00	92.62	3.84	4.34	4.42	65.60
95.00	92.72	3.77	3.57	3.68	56.70
100.00	92.75	3.57	4.32	3.07	56.70
105.00	92.72	4.44	3.79	4.10	56.60
110.00	92.70	4.46	3.96	2.97	46.60
115.00	92.65	4.47	3.38	2.65	46.60
120.00	92.65	3.88	2.91	3.08	45.60
125.00	92.80	3.73	3.06	2.68	45.60
130.00	92.80	3.63	2.71	2.46	54.60
135.00	92.85	3.26	2.50	2.06	45.60
140.00	93.02	4.23	2.70	3.00	45.60
145.00	93.00	3.82	2.51	2.50	45.60
150.00	93.10	3.09	2.20	2.04	45.60
155.00	93.10	2.96	2.05	1.72	45.70
160.00	93.10	2.63	1.62	1.26	54.50
165.00	93.12	2.36	1.16	0.89	45.70
170.00	93.25	1.75	0.74	0.48	54.60
175.00	93.20	1.67	0.48	0.39	45.70
180.00	93.35	0.95	0.46	0.25	46.70
182.50	93.37	0.58	0.23	0.05	45.70
185.00	93.35	0.08	0.07	0.05	54.50
190.00	93.50				43.60
191.50	93.52				43.60
194.00	93.67				45.70
195.00	94.31				15.90
195.90	94.36				11.90
197.00	95.90				11.90
199.70	97.43				11.90
230.00	97.43				11.90
250.00	100.08				11.90

SUMMARY DATA: CROSS-SECTION # 2 trans 1
Number of Points = 56

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
0.40	100.98				11.90
2.00	97.15				11.90
5.00	96.33				11.90
8.00	95.66				11.90
12.00	95.09				19.50
15.00	94.74				99.90
15.90	94.33				99.90
17.50	94.33				99.90
20.00	94.33				99.90
22.90	93.73				99.90
23.50	93.58				0.40
24.00	93.36				0.40
27.00	92.80				0.40
30.00	92.48				0.40
36.00	92.53	0.04			0.40
42.00	92.85	0.02			0.40
48.00	93.40	0.58			34.60
50.00	93.58				34.70
54.00	93.80	0.04	0.20		34.90
60.00	94.10	1.14	0.30		34.80
63.00	94.30				34.70
66.00	94.25	1.70			34.70
72.00	94.10	2.33	1.33	0.82	35.60
78.00	94.10	3.13	1.40	1.12	53.70
84.00	93.85	3.79	2.37	1.81	46.80
90.00	93.80	3.99	2.71	2.27	46.70
96.00	93.74	3.96	2.82	2.80	56.50
102.00	93.55	3.89	2.44	2.26	46.70
108.00	93.44	2.70	2.55	2.38	45.60
114.00	93.11	3.97	3.04	2.57	46.90
120.00	92.86	3.69	2.71	2.16	54.60
125.00	92.78	3.86	2.32	2.00	45.60
130.00	92.77	3.55	2.45	2.62	43.80

136.00	92.78	3.22	2.60	2.38	45.60
142.00	92.77	3.69	2.42	2.34	45.70
148.00	92.90	3.57	2.72	2.43	45.70
154.00	93.00	3.46	2.59	2.22	45.60
160.00	93.15	3.46	2.69	1.80	54.70
166.00	93.34	3.36	2.80	2.71	45.60
172.00	93.21	3.53	2.96	2.32	45.60
178.00	93.08	3.55	2.54	2.17	46.70
184.00	93.14	3.37	2.64	2.35	46.70
190.00	93.12	3.01	1.99	2.03	46.70
196.00	93.03	2.65	2.20	2.17	46.80
202.00	93.25	2.84	2.17	1.71	45.70
208.00	93.38	2.69	2.20	1.78	45.70
213.00	93.54	2.14	1.69	1.53	43.70
216.00	93.50	1.91	1.31	1.15	43.70
218.00	93.65	1.26	1.08	0.78	43.60
220.50	93.95	0.58	0.45	0.44	23.80
222.00	94.15	0.15			22.90
222.20	94.38				0.60
223.00	95.38				11.90
223.85	95.72				11.90
230.00	97.72				11.90
232.00	99.72				11.90

SUMMARY DATA: CROSS-SECTION # 3 trans 2

Number of Points = 66

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-0.40	99.72				11.90
1.60	95.72				0.30
8.00	95.72				11.90
9.90	94.94				11.90
10.10	94.79	0.20			11.90
10.30	94.69	0.16	0.20		11.90
10.40	94.52				11.90
10.50	94.32	0.62	0.45	0.06	11.90
10.80	94.10	0.57	0.50	0.05	11.90
11.00	94.07	0.85	0.77		11.90
11.30	94.00	1.27	0.60	0.22	24.70
11.50	94.07	0.81	0.49	0.88	24.50
11.80	94.07	1.24	0.34	0.34	14.50
12.00	94.15	0.55	-0.05	0.17	11.90
12.30	94.40	0.30			11.90
12.30	94.65				11.90
12.50	94.84				54.50
12.60	94.94				54.50
16.00	95.78				54.50
22.00	95.33				54.50
30.00	95.46				54.50
50.00	95.67				54.50
65.00	95.34				54.50
79.00	95.13				54.50
80.40	94.75				52.60
81.00	94.73				52.60
85.00	94.73				52.60
88.00	94.70	0.10			52.50
91.00	94.68	0.38			52.50
94.00	94.63	0.68			52.70
97.00	94.60	0.93			52.70
97.90	94.51				52.80
100.00	94.44	1.15	0.33		52.80
105.00	94.30	1.74	0.58	0.40	62.80
110.00	93.87	1.87	0.85	0.57	62.80
115.00	93.80	1.72	0.79	0.86	72.80
120.00	93.32	1.86	1.19	1.06	62.80
125.00	93.17	2.22	1.44	1.26	62.70
130.00	92.87	2.27	1.25	1.27	62.70
135.00	92.73	2.36	1.74	1.40	62.70
140.00	92.66	2.46	1.52	1.23	62.70
145.00	92.50	2.64	1.75	1.67	45.50
150.00	92.40	2.48	1.57	1.45	53.70
155.00	92.34	2.25	1.67	1.50	43.70
160.00	92.42	2.39	1.80	1.44	43.70
165.00	92.42	2.31	1.83	1.54	43.60
170.00	92.44	2.27	1.63	1.27	34.70
175.00	92.50	2.33	1.63	1.43	34.70
180.00	92.34	2.52	1.68	1.52	43.70
185.00	92.22	2.65	1.78	1.53	43.70
190.00	92.09	2.83	1.86	1.52	45.70
195.00	92.14	2.87	2.03	1.62	54.70
200.00	92.13	3.00	1.82	1.61	54.60
205.00	92.07	3.12	2.04	1.71	46.60
210.00	91.92	2.51	1.86	1.37	45.70
215.00	92.04	2.58	1.55	1.28	43.70
220.00	92.37	2.11	1.54	1.28	34.60
225.00	93.02	2.23	1.31	1.23	34.60
228.00	93.72	0.32	0.10		23.70
229.00	94.14	0.04			11.90
229.50	94.50				11.90
230.00	94.90				11.90
231.00	95.23				51.50
233.00	95.87				51.50
237.10	96.58				61.50
242.00	100.58				11.90

SUMMARY DATA: CROSS-SECTION # 4 trans 3
Number of Points = 45

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-15.00	100.58				11.90
4.90	98.48				11.90
24.00	96.34				11.90
30.00	95.78				11.90
40.00	95.45				15.90
45.00	95.42				15.70
50.80	95.20				15.70
51.00	95.05				15.50
54.00	94.95				51.70
55.50	94.70				52.70
57.60	94.51				52.70
58.00	94.51				52.70
63.00	94.30		-0.05		62.70
69.00	93.85		0.05		62.70
75.00	93.81		0.05		42.70
81.00	93.85	0.08	0.05		42.70
87.00	93.85	0.27	0.10		52.70
93.00	93.37	0.36	0.22		52.70
99.00	92.94	0.56	0.36	0.20	62.70
105.00	92.80	0.75	0.46	0.37	42.60
111.00	92.76	0.88	0.54	0.44	42.60
117.00	92.70	1.13	0.69	0.52	42.60
123.00	92.44	1.29	0.78	0.68	42.60
129.00	92.04	1.39	0.88	0.77	42.60
135.00	91.72	1.36	1.03	0.82	42.60
141.00	91.34	1.78	1.09	0.98	52.60
147.00	90.82	1.70	1.25	0.85	52.60
152.00	89.93	1.72	1.29	0.84	52.70
158.00	88.91	1.13	0.37	0.50	56.80
164.00	89.41		0.10	0.09	52.60
170.00	90.50	0.21	0.07	0.07	52.80
176.00	90.21	0.62	0.49	0.69	62.70
182.00	90.61	2.23	1.44	1.19	62.80
188.00	90.65	1.89	1.19	1.25	62.80
194.00	90.70	2.10	1.28	1.29	62.70
200.00	90.77	2.07	1.28	1.09	62.70
206.00	90.90	1.71	1.13	0.88	62.70
212.00	91.00	1.32	0.84	0.89	62.60
218.00	91.05	1.06	0.77	0.42	0.60
224.00	92.40	0.13	0.01		0.20
228.40	94.55				11.90
230.00	95.30				11.90
232.00	96.77				11.90
235.70	97.77				11.90
244.00	100.28				11.90

SUMMARY DATA: CROSS-SECTION # 5 trans 4
Number of Points = 45

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
0.70	100.58				11.90
6.70	97.09				11.90
15.00	96.57				61.50
20.00	96.13				61.70
25.00	95.66				51.90
29.70	95.17				62.80
30.00	95.23				62.80
32.50	94.92	0.20			62.80
35.00	94.76	0.43			62.80
40.00	94.55	0.74			36.50
45.00	94.33	0.97			36.50
50.00	94.20	1.06	0.43	0.42	37.50
55.00	94.06	1.29	0.68	0.80	52.80
60.00	94.06	1.36	0.77	0.61	52.80
65.00	93.90	1.53	0.79	0.93	62.80
70.00	93.80	1.50	0.90	0.88	62.80
75.00	93.70	1.81	0.99	0.95	62.80
80.00	93.42	1.77	0.73	1.23	72.80
85.00	93.13	2.15	1.27	1.00	62.80
90.00	92.74	2.01	1.17	1.14	62.80
95.00	92.53	1.93	1.28	1.15	62.80
100.00	92.30	2.11	1.24	1.15	62.80
105.00	92.20	2.12	1.30	1.24	62.80
110.00	92.20	2.11	1.29	1.27	62.80
115.00	92.23	2.00	1.45	1.34	62.80
120.00	92.11	2.03	1.39	1.30	62.70
125.00	91.86	2.05	1.48	1.22	52.70
130.00	91.69	2.15	1.33	1.20	62.70
135.00	91.46	1.83	1.32	1.16	52.70
140.00	91.28	1.95	1.28	0.93	52.60
145.00	91.07	1.45	1.11	1.01	42.50
150.00	90.87	1.42	1.06	0.93	42.50
155.00	90.77	1.87	1.40	0.94	42.50
160.00	89.92	1.07	0.75	0.96	42.50
165.00	89.44	1.04	0.53	0.35	25.80
170.00	88.83	0.93	0.63	0.20	62.50
175.00	88.63	1.10	0.67	0.20	64.50
180.00	88.63	0.73	0.13	0.20	41.50
185.00	89.55	0.14			0.30
187.50	93.00	-0.10	-0.05	-0.02	0.30
188.50	94.60				0.30
189.30	95.89				0.30

190.30	96.23				0.30
194.30	96.54				11.90
199.30	100.54				11.90

SUMMARY DATA: CROSS-SECTION # 6 trans 5
Number of Points = 45

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
0.50	110.95				99.90
2.50	99.45				99.90
7.50	98.38				99.90
12.50	97.00				99.90
17.50	96.10				99.90
21.50	95.39				99.90
23.00	95.18				99.90
24.00	94.66				99.90
25.00	93.86	-0.10			99.90
27.50	93.51	-0.22			99.90
30.00	92.86	-0.10			99.90
32.50	91.76	0.09			99.90
35.00	90.96	0.11		0.11	99.90
37.50	89.66	0.06	0.03	0.09	99.90
40.00	86.66	0.61	0.07	0.28	89.50
42.50	87.06	1.04	0.41	0.73	99.50
45.00	86.61	1.55	0.64	0.96	54.60
47.50	86.71	2.06	1.35	1.08	56.80
50.00	86.71	1.93	1.19	1.18	54.50
52.50	87.01	2.26	1.18	1.03	45.70
55.00	87.37	2.00	1.29	0.96	45.80
60.00	88.50	2.05	1.12	1.02	43.50
65.00	89.91	1.85	1.13	1.04	42.70
70.00	89.21	1.52	1.06	0.99	42.60
75.00	89.61	1.67	1.01	0.94	23.50
80.00	89.20	1.63	0.97	0.89	23.70
85.00	88.91	1.48	0.96	0.71	23.90
90.00	88.56	1.43	0.85	0.47	23.90
95.00	88.06	1.07	0.67	0.47	24.70
100.00	88.31	1.11	0.85	0.31	24.80
105.00	88.40	0.61	0.53	0.28	24.80
110.00	88.86	0.36	0.18	0.23	24.50
115.00	89.41	0.04		0.14	24.50
120.00	90.06	-0.19			24.50
125.00	90.66	-0.36			24.50
130.00	91.66	-0.35			45.50
132.50	93.29	-0.67			45.50
135.00	94.57	-0.65			45.50
135.40	94.66				45.50
136.30	95.18				45.50
137.00	95.38				45.50
139.00	96.02				54.50
142.00	96.93				43.50
144.90	98.23				54.50
150.00	100.73				54.50

Satsop R T18N R7W S24,25 - Caldwell, Shedd, Beecher, Vadas - 2001
calibration flows 713 (5/22), 360 (6/20), 280 (9/20/01)

CROSS-SECTION # 1 trans 0

CAL	Stage	GivenFlow	CalcFlow
1	94.22	717.00	754.18
2	93.72	391.00	452.11
3	93.62	316.00	384.89

CROSS-SECTION # 2 trans 1

CAL	Stage	GivenFlow	CalcFlow
1	94.69	717.00	715.27
2	94.41	391.00	416.12
3	94.30	316.00	332.10

CROSS-SECTION # 3 trans 2

CAL	Stage	GivenFlow	CalcFlow
1	94.92	717.00	699.02
2	94.57	391.00	395.20
3	94.44	316.00	315.11

CROSS-SECTION # 4 trans 3

CAL	Stage	GivenFlow	CalcFlow
1	95.08	717.00	639.21
2	94.63	391.00	361.50
3	94.51	316.00	301.87

CROSS-SECTION # 5 trans 4

CAL	Stage	GivenFlow	CalcFlow
1	95.12	717.00	683.36
2	94.65	391.00	361.26
3	94.53	316.00	289.71

CROSS-SECTION # 6 trans 5

CAL	Stage	GivenFlow	CalcFlow
1	95.18	717.00	695.46
2	94.72	391.00	400.58
3	94.62	316.00	339.36

Skookumchuck River at Rotary Riverside Park, Centralia, nr RM 1; 240cfs (5/22/01
135cfs (6/20/01)-Caldwell, Shedd, Vadas, Beecher

SUMMARY DATA: CROSS-SECTION # 1 TRANS 0
Number of Points = 42

X	Y	VEL 1	VEL 2	SUBSTRATE
-2.00	99.74			11.90
0.60	98.04			88.90
3.00	96.74			88.90
5.00	95.93			88.90
5.30	95.36			0.10
6.00	94.54	0.25		87.80
7.00	94.44	0.52	0.26	87.80
8.00	94.34	0.39	0.14	87.80
10.00	93.81	0.87	0.63	78.80
12.00	93.59	3.67	3.31	76.80
14.00	94.44	2.74	2.16	76.50
16.00	94.41	0.25	0.10	73.90
18.00	94.71	4.74	3.34	86.80
20.00	94.76	2.91	2.24	86.70
22.00	94.59	3.36		86.60
24.00	94.39	2.91	2.17	76.90
26.00	94.16	2.33	1.47	73.90
28.00	94.59	4.08	2.81	76.80
30.00	94.16	4.35	3.30	74.70
32.00	94.01	2.84	2.61	74.80
34.00	93.94	4.20	3.33	74.90
36.00	93.74	3.87	2.92	74.80
38.00	93.76	3.81	3.06	74.80
40.00	93.66	3.85	2.76	73.80
42.00	93.44	3.73	2.98	73.80
44.00	93.34	3.63	2.41	74.80
46.00	93.41	2.80	2.20	74.80
48.00	93.66	3.40	2.48	74.50
50.00	93.66	3.15	2.59	73.80
52.00	93.66	2.73	1.69	73.70
54.00	93.79	2.46	1.26	74.80
56.00	93.86	2.54	1.89	74.70
58.00	93.84	1.89	1.79	0.40
60.00	94.09	2.69	1.48	0.40
62.00	94.34	0.38	0.11	0.30
64.00	94.99	1.06		0.30
64.30	95.36			0.30
64.70	95.36			0.30
65.00	95.95			51.50
67.00	98.18			0.50
68.70	99.00			0.50
95.00	99.00			11.90

SUMMARY DATA: CROSS-SECTION # 2 TRANS 1
Number of Points = 45

X	Y	VEL 1	VEL 2	SUBSTRATE
-5.00	102.05			11.90
0.90	99.05			0.20
2.00	98.40			88.90
5.00	97.20			88.90
7.20	96.01			87.70
8.00	96.30			87.70
8.80	95.30			87.70
9.00	96.25			0.10
9.50	95.21	0.29	0.11	75.70
10.00	95.29	1.11		76.80
11.00	95.09	1.51		86.70
12.00	94.74	0.42	0.08	86.80
13.00	94.41	1.31	0.61	78.80
14.00	94.34	1.46	1.05	76.90
16.00	93.29	1.42	0.92	78.90
18.00	92.94	2.08	1.14	73.90
20.00	92.31	1.76	1.26	76.80
22.00	91.94	2.12	1.34	76.90
24.00	91.74	2.03	1.40	76.90
26.00	91.41	2.08	1.50	76.80
28.00	91.84	2.12	1.58	78.90
30.00	91.44	1.91	1.40	78.80
32.00	91.31	1.89	1.38	76.80
34.00	91.61	1.81	1.27	78.90
36.00	91.79	1.67	1.05	76.70
38.00	91.91	1.78	1.10	75.50
40.00	92.39	1.50	1.14	83.80
42.00	92.76	1.57	0.95	73.90
44.00	92.86	1.62	1.06	73.80
46.00	93.19	1.61	1.09	72.80
48.00	93.44	1.42	1.03	72.80
50.00	93.61	1.58	0.92	72.80
52.00	93.94	0.98	0.31	0.40
54.00	94.09	1.71	1.01	0.40
56.00	94.19	1.52	0.99	0.40
58.00	94.34	1.39	0.83	0.40
60.00	94.69	0.85	0.51	72.70

61.00	94.74	1.02	0.62	72.70
62.00	94.84	0.50	0.30	63.50
63.00	95.09	1.10	0.46	42.70
63.50	95.16	0.55	0.20	42.70
63.90	95.49			0.20
65.00	97.18			11.90
66.40	97.82			0.40
70.00	98.82			11.90

SUMMARY DATA: CROSS-SECTION # 3 TRANS 2
Number of Points = 32

X	Y	VEL 1	VEL 2	SUBSTRATE
0.00	100.63			88.90
5.50	98.14			88.90
6.00	97.50			88.90
8.00	97.05			88.90
9.10	96.03			88.90
9.50	95.33			88.90
10.00	94.76	0.10	0.05	88.90
12.50	93.91	0.06	0.03	88.90
15.00	92.51	0.17	0.13	88.90
17.50	92.51	1.79	0.64	88.90
20.00	90.36	2.37	1.23	88.90
22.50	90.66	2.17	1.63	88.90
25.00	91.31	2.30	1.75	78.50
27.50	91.51	2.14	1.69	78.50
30.00	91.81	2.15	1.47	64.80
32.50	92.21	1.92	1.39	62.90
35.00	92.31	1.63	1.12	62.70
37.50	92.51	1.48	0.98	61.60
40.00	92.66	1.36	0.94	61.60
42.50	92.86	1.30	0.82	51.50
45.00	93.31	1.23	0.65	61.60
47.50	93.41	1.21	0.63	61.60
50.00	93.51	1.04	0.66	51.60
52.50	93.59	0.97	0.49	51.60
55.00	93.71	0.53	0.31	61.70
57.50	94.46	0.71	0.28	52.50
60.00	95.36	0.39		31.50
60.50	96.03			31.50
61.70	96.68			11.90
62.70	97.10			11.90
64.80	97.72			0.40
70.00	99.72			11.90

SUMMARY DATA: CROSS-SECTION # 4 TRANS 3
Number of Points = 31

X	Y	VEL 1	VEL 2	SUBSTRATE
0.00	102.05			88.90
2.00	100.05			88.90
5.70	96.72			88.90
8.10	96.05			88.90
8.90	95.36			86.50
10.00	94.29	0.76	0.35	86.80
12.50	93.86	2.37	1.44	88.90
15.00	91.98	2.84	1.89	88.90
17.50	90.54	3.42	2.18	88.90
20.00	89.88	2.79	2.29	88.90
22.50	88.89	2.45	1.76	88.90
25.00	88.68	1.45	0.98	82.90
27.50	88.74	1.18	0.68	82.80
30.00	88.36	0.85	0.50	84.60
32.50	89.28	0.76	0.37	58.50
35.00	89.89	0.41	0.15	57.50
37.50	90.28	0.26	0.13	56.50
40.00	90.79	0.23	0.13	54.50
42.50	91.18	0.29	0.13	52.50
45.00	91.44	0.19	0.10	42.50
47.50	91.48	0.28	0.10	0.20
50.00	92.11	0.09		0.20
52.50	92.91	0.08		62.50
55.00	94.04			0.40
57.50	95.43			0.40
57.70	95.54			0.40
59.00	96.33			11.90
59.70	96.40			0.40
65.00	98.45			11.90
70.00	99.40			11.90
100.00	99.40			11.90

SUMMARY DATA: CROSS-SECTION # 5 TRANS 4
Number of Points = 40

X	Y	VEL 1	VEL 2	SUBSTRATE
-3.00	102.03			11.90
0.00	99.03			11.90
2.30	97.88			0.40
5.00	97.38			87.50
9.00	96.16			88.90

11.00	96.02			88.90
11.50	95.34	0.43		88.90
12.50	94.64	1.06	0.47	88.90
14.00	94.84	3.72	2.30	88.90
15.50	93.99	2.62	2.45	88.90
17.00	92.89	4.30	2.68	88.90
18.50	92.56	4.12	3.71	88.90
24.50	92.11	4.18	2.63	87.50
26.00	92.31	3.39	2.52	78.60
27.50	92.29	3.07	2.38	87.60
29.00	92.44	3.51	2.03	68.60
30.50	92.36	2.97	1.58	76.70
32.00	92.56	1.90	0.90	67.60
33.50	92.41	1.40	0.51	67.60
35.00	92.71	0.92	0.37	67.60
36.50	92.89	0.71	0.39	46.60
38.00	92.96	0.67	0.27	57.50
39.50	93.06	1.07	0.37	56.50
41.00	93.16	0.95	0.30	56.50
42.50	93.36	1.65		56.70
44.00	93.51	0.88	0.30	56.50
45.50	93.54	0.69	0.20	56.50
47.00	93.79	0.44	0.10	56.50
48.50	94.01	0.36	0.10	56.50
50.00	93.96	0.23	0.10	65.70
51.50	94.16	-0.31		56.50
53.00	94.64	-0.31		54.70
54.50	95.01	-0.28		54.70
55.60	95.34			54.60
56.00	95.87			65.50
56.60	96.07			11.90
56.80	96.85			0.10
58.00	97.22			11.90
62.00	98.82			11.90
67.00	99.82			11.90

SUMMARY DATA: CROSS-SECTION # 6 TRANS 5
Number of Points = 44

X	Y	VEL 1	VEL 2	SUBSTRATE
1.00	101.92			88.90
2.00	97.32			0.10
4.00	96.80			51.50
6.00	96.27			88.90
7.00	96.22			88.90
8.00	96.47			88.90
9.00	95.64			88.90
9.50	95.59			88.90
11.00	95.28			88.90
13.00	94.97		0.23	78.60
15.00	94.49	0.08	0.52	67.60
17.00	94.46	0.61	0.74	76.70
19.00	94.22	1.40	0.90	76.50
21.00	94.11	2.57	2.60	67.70
23.00	94.04	2.24	2.20	67.70
25.00	93.94	4.38	3.14	76.70
27.00	93.92	4.45	2.75	76.50
29.00	94.26	5.61	3.53	76.50
31.00	94.32	4.69	3.90	76.50
33.00	94.31	4.28	4.49	76.50
35.00	94.77	6.41	5.87	67.70
37.00	94.36	5.60	4.09	67.70
39.00	94.62	4.15	3.46	67.70
41.00	94.29	4.72	2.97	67.70
43.00	94.59	5.05	4.84	56.50
45.00	94.71	4.59	4.24	56.50
47.00	94.87	3.69	3.43	56.50
49.00	94.96	3.54	3.18	56.60
51.00	95.27	3.22	1.60	65.60
53.00	95.11	4.34	2.68	67.50
55.00	95.24	2.45	2.65	56.50
57.00	95.32	2.12	1.26	67.50
59.00	95.39	2.38	1.20	67.50
61.00	95.26	2.81	1.35	65.60
63.00	95.32	3.58	2.36	65.80
65.00	95.04	1.68	2.20	65.80
67.00	95.16	4.24	2.51	65.70
69.00	95.22	3.30	2.83	64.70
71.00	95.37	1.50	0.76	45.50
72.20	95.89			43.70
73.00	96.79			0.30
73.50	96.72			53.60
76.00	97.53			11.90
81.00	100.05			11.90

SUMMARY DATA: CROSS-SECTION # 7 TRANS 6
Number of Points = 50

X	Y	VEL 1	VEL 2	SUBSTRATE
-1.00	100.93			11.90
0.00	98.81			11.90
0.90	98.73			0.30

1.20	96.74			0.30
1.50	96.54	-0.05		0.30
2.10	96.55			88.90
3.00	96.29	-0.05		88.90
5.00	95.89	0.10		76.50
7.00	95.64	0.30		76.50
9.00	95.19	0.89	0.26	87.60
10.50	95.59	0.92	0.69	78.60
12.50	94.74	1.77	1.13	76.50
14.50	94.87	2.49	1.28	76.50
16.50	94.64	2.34	1.38	76.50
18.50	94.59	2.56	1.80	76.50
20.50	94.54	2.34	1.96	76.50
22.50	94.37	2.36	1.97	76.70
24.50	94.62	2.96	2.06	67.70
26.50	94.54	3.27	2.30	67.60
28.50	94.79	3.33	2.40	76.50
30.50	94.57	2.92	2.33	76.50
32.50	94.67	3.39	2.30	67.70
34.50	94.87	3.20	2.29	67.70
36.50	95.12	3.18	2.14	67.70
38.50	95.59	2.92	1.88	65.70
40.50	95.32	3.08	1.86	67.70
42.50	95.34	2.95	1.97	67.50
44.50	95.29	2.73	2.03	65.60
46.50	95.52	2.99	2.07	67.60
48.50	95.64	3.03	2.15	65.70
50.50	95.59	2.43	1.77	56.60
52.50	95.67	2.87	1.44	56.70
54.50	95.79	2.55	1.88	56.70
56.50	95.84	2.78	1.60	56.50
58.50	95.87	2.04	1.46	56.50
60.50	96.07	2.31	1.84	56.50
61.50	96.14	2.79	1.50	46.50
63.50	96.14	2.87	1.63	64.60
65.50	96.14	2.06	1.27	56.50
67.50	96.34	2.06	1.52	45.60
69.50	96.47	2.04		46.70
71.50	96.42	0.36		45.40
73.40	96.87	1.23		32.70
73.70	97.07			13.50
73.80	96.55			12.50
74.00	96.54			11.90
76.00	97.84			11.90
80.00	98.49			11.90
84.30	99.57			11.90
104.00	102.05			11.90

SUMMARY DATA: CROSS-SECTION # 8 TRANS 7
Number of Points = 44

X	Y	VEL 1	VEL 2	SUBSTRATE
-5.50	101.55			11.90
-0.50	99.82			88.90
0.40	98.55			88.90
2.00	98.14			88.90
2.60	96.63			88.90
3.00	96.63			88.90
3.50	96.58	0.31		88.90
5.50	96.15	0.74		88.90
7.50	96.30	0.48	0.27	88.90
9.50	95.93	1.52	0.83	88.90
11.50	95.80	2.74	1.57	88.90
12.50	95.20	2.48	1.65	88.90
13.50	94.08	1.34	0.67	87.80
15.50	93.75	2.18	1.78	87.80
17.50	94.03	2.68	1.56	86.70
18.50	93.28	2.26	1.38	76.70
20.50	93.45	2.20	1.47	76.60
22.50	93.58	2.27	1.60	67.50
24.50	93.70	2.44	1.47	67.70
26.50	93.95	2.54	1.40	76.70
28.50	93.83	2.07	1.47	67.70
30.50	94.30	1.99	1.24	67.80
32.50	94.45	2.07	1.28	57.50
34.50	94.38	1.55	0.71	56.70
36.50	94.55	2.11	1.29	47.60
38.50	94.63	1.94	1.08	37.50
40.50	94.50	2.03	1.20	56.50
42.50	94.43	1.88	0.99	47.60
44.50	94.50	1.58	1.16	74.60
46.50	94.78	1.77	1.16	74.70
48.50	94.95	1.20	0.72	72.80
50.50	95.30	1.24	0.56	62.70
52.50	95.33	0.91	0.42	72.60
54.50	95.50	0.68	0.32	0.30
55.50	95.42	0.69	0.16	27.60
56.50	96.77	-0.10		0.30
58.00	96.43	0.18		0.30
60.00	96.58	0.06		0.30
60.20	96.63			11.90
60.90	96.93			11.90
61.00	97.68			0.30

62.00	97.94	0.30
64.90	98.27	11.90
95.00	98.27	11.90

Skookumchuck River at Rotary Riverside Park, Centralia, nr RM 1; 240cfs (5/22/01
135cfs (6/20/01)-Caldwell, Shedd, Vadas, Beecher

CROSS-SECTION # 1 TRANS 0

CAL	Stage	GivenFlow	CalcFlow
1	95.48	242.00	242.34
2	95.25	142.00	149.30

CROSS-SECTION # 2 TRANS 1

CAL	Stage	GivenFlow	CalcFlow
1	95.67	242.00	244.43
2	95.33	142.00	143.98

CROSS-SECTION # 3 TRANS 2

CAL	Stage	GivenFlow	CalcFlow
1	95.70	242.00	234.15
2	95.33	142.00	136.29

CROSS-SECTION # 4 TRANS 3

CAL	Stage	GivenFlow	CalcFlow
1	95.72	242.00	260.70
2	95.34	142.00	156.85

CROSS-SECTION # 5 TRANS 4

CAL	Stage	GivenFlow	CalcFlow
1	95.74	242.00	249.26
2	95.34	142.00	140.25

CROSS-SECTION # 6 TRANS 5

CAL	Stage	GivenFlow	CalcFlow
1	95.89	242.00	240.50
2	95.60	142.00	147.32

CROSS-SECTION # 7 TRANS 6

CAL	Stage	GivenFlow	CalcFlow
1	96.74	242.00	236.73
2	96.55	142.00	140.05

CROSS-SECTION # 8 TRANS 7

CAL	Stage	GivenFlow	CalcFlow
1	96.93	242.00	227.54
2	96.63	142.00	123.46

West Fork Hoquiam measured at River Mile 10.3 at 49, 20, and 12 cfs
by Dept. Ecology and WDFW.

SUMMARY DATA: CROSS-SECTION # 1 Transect 0
Number of Points = 40

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-70.00	98.16				0.70
-2.00	98.16				0.70
0.40	97.56				0.70
1.00	97.16				11.90
1.80	95.70				0.10
2.00	95.60	0.01			11.90
2.60	95.41	0.01			11.90
3.00	95.31	0.69		0.05	13.80
4.50	95.16	0.69	0.45	0.10	31.60
6.00	95.09	0.88	0.55	0.55	31.50
7.50	95.01	0.90	0.71	0.65	31.60
9.00	95.00	0.96	0.67	0.67	34.70
10.50	95.03	1.10	0.77	0.69	43.60
12.00	94.93	1.03	0.72	0.74	43.60
13.50	94.93	1.14	0.89	0.66	45.70
15.00	94.85	1.29	0.92	0.78	45.60
16.50	94.80	1.24	0.88	0.77	45.60
18.00	94.63	1.33	0.97	0.76	45.80
19.50	94.71	1.34	1.03	0.82	45.60
21.00	94.76	1.47	1.03	0.89	45.70
22.50	94.71	1.53	0.95	0.78	54.60
24.00	94.71	1.53	1.07	0.67	64.50
25.50	94.86	1.63	1.17	0.69	54.50
27.00	94.96	1.86	1.25	0.70	54.50
28.50	94.83	1.64	1.12	0.71	54.50
30.00	94.75	1.63	0.93	0.45	45.70
31.50	94.76	1.75	0.96	0.55	45.80
33.00	94.61	1.59	1.02	0.43	54.70
34.50	94.60	1.55	0.81	0.42	54.50
36.00	94.44	1.76	0.85	0.48	54.50
37.50	94.55	1.76	0.91	0.61	54.50
39.00	94.41	1.60	0.82	0.35	54.50
40.50	94.48	1.43	0.78	0.33	53.80
42.00	94.63	1.37	0.89	0.33	54.50
43.50	94.68	1.15	0.60	0.36	54.90
45.00	95.05	0.96	0.47	0.29	54.80
46.30	95.21	0.59	0.28	0.05	45.60
46.60	95.70				99.90
47.80	98.46				99.90
48.80	100.76				99.90

SUMMARY DATA: CROSS-SECTION # 2 Transect 1
Number of Points = 46

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-70.00	98.06				0.70
-5.00	98.06				0.70
0.40	97.56				0.70
2.00	97.16				0.70
3.00	96.66				0.70
4.00	96.56				0.70
5.00	96.31				0.70
6.00	96.36				0.70
7.00	96.21				0.70
9.00	95.96				31.50
13.30	95.68				23.70
14.00	95.58	0.05			23.70
15.00	95.48				32.50
16.00	95.43	0.10			42.50
17.00	95.29				42.70
18.00	95.17	0.11		0.05	42.70
19.00	95.00	0.17	0.07	0.11	42.70
20.00	94.80	0.27		0.23	42.70
21.00	94.59	0.38		0.22	42.60
22.00	94.47	0.35		0.26	42.60
23.00	94.32	0.30	0.15	0.32	42.60
24.00	94.20	0.21	0.17	0.08	42.60
25.00	94.17	0.30	0.11	0.17	42.60
26.00	94.04	0.24	0.23	0.16	52.70
27.00	93.92	0.10	0.06	0.03	52.70
28.00	93.85	0.36	0.04	0.07	52.70
29.00	93.65	0.28	0.01	0.05	52.70
30.00	93.55	0.59		0.11	52.70
31.00	93.52	0.75		0.21	52.70
32.00	93.62	1.00	0.16	0.19	52.70
33.00	93.59	1.32	0.15	0.23	52.70
34.00	93.49	1.18	0.23	0.14	52.80
35.00	93.45	1.50	0.53	0.20	52.80
36.00	93.45	1.39	0.70	0.57	52.80
37.00	93.47	2.10	1.08	0.83	52.80
38.00	93.57	2.19	1.30	1.05	52.80
39.00	93.62	2.48	1.65	0.99	99.90
40.00	93.62	2.58	1.57	1.03	99.90
41.00	93.77	2.26	1.27	0.88	99.90

42.00	93.82	1.78	0.88	0.62	99.90
43.00	94.10	1.65	0.84	0.63	99.90
44.00	94.49	1.09	0.77	0.49	99.90
45.00	95.00	1.66	0.73	0.47	99.90
45.60	95.68				99.90
46.00	100.76				99.90
46.50	97.66				99.90

SUMMARY DATA: CROSS-SECTION # 3 Transect 2
Number of Points = 41

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-70.00	97.86				0.70
-0.50	97.86				0.70
0.50	97.71				0.70
3.00	96.56				13.80
4.00	96.31				11.90
5.00	95.86				13.70
8.00	96.06				34.80
11.00	96.06				34.90
14.00	95.96				43.70
17.00	95.86				43.80
20.00	95.86				43.90
23.00	95.71				42.60
24.00	95.66				42.60
25.00	95.61	0.01			42.60
26.00	95.51	0.01			42.70
27.00	95.18	0.10	0.01	0.05	42.70
28.00	94.90	0.11	0.03	0.05	42.70
29.00	94.57	0.09	0.05	0.01	42.70
30.00	94.43	0.16	0.03	0.11	42.70
31.00	94.30	0.58	0.08	0.07	42.70
32.00	94.12	0.65	0.10	0.05	42.70
33.00	94.10	0.82	0.32	0.15	51.50
34.00	94.07	1.34	0.46	0.26	51.50
35.00	94.12	1.93	0.68	0.64	51.50
36.00	94.13	2.70	1.23	1.46	61.50
37.00	94.17	2.95	2.63	2.10	61.50
38.00	94.23	3.21	2.02	1.85	61.50
39.00	94.23	2.84	2.38	1.95	99.90
40.00	94.45	2.67	1.96	1.55	99.90
41.00	94.58	2.52	2.18	1.63	99.90
42.00	94.72	3.17	2.38	1.95	99.90
43.00	94.78	3.31	2.26	1.33	99.90
44.00	94.80	2.59	1.45	0.93	99.90
45.00	94.95	2.06	0.83		99.90
46.00	95.05	0.73	0.31		99.90
47.00	95.18	0.25	0.11	0.05	15.50
48.00	95.33	0.31	0.10		51.50
48.50	95.41	0.01			51.50
48.70	95.71				51.50
50.60	96.96				51.70
51.60	100.76				0.70

SUMMARY DATA: CROSS-SECTION # 4 Transect 3
Number of Points = 41

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-70.00	98.16				0.70
-5.00	98.16				0.70
0.40	97.76				0.70
4.00	96.66				0.70
6.00	96.46				31.80
8.00	96.36				34.90
12.00	95.97				34.70
13.50	95.87	0.05			13.50
15.00	95.77	0.55			43.80
16.50	95.67	0.79			13.50
17.50	95.62	0.86			34.50
19.00	95.57	0.99			34.50
20.50	95.50	1.16	0.31		34.50
22.00	95.47	1.13	0.35		34.50
23.50	95.42	1.51	0.54		43.60
25.00	95.38	1.64	0.54		43.60
26.50	95.39	1.82	0.87		45.50
28.00	95.37	1.93	0.97		45.50
29.50	95.30	1.98	1.05		45.50
31.00	95.35	2.30	1.28		45.50
32.50	95.50	2.45	1.29		45.50
34.00	95.33	2.12	0.85		45.50
35.50	95.24	2.22	1.09	0.76	54.50
37.00	95.04	2.49	2.05	1.71	54.50
38.00	95.00	2.44	2.03	1.26	54.60
39.00	94.92	2.63	1.91	1.60	54.60
40.00	94.72	2.59	1.88	1.58	54.60
41.00	94.59	2.74	1.86	1.70	54.60
42.00	94.52	2.56	1.90	1.58	41.50
43.00	94.65	2.50	1.89	1.57	41.50
44.00	94.52	2.40	1.68	1.37	51.50
45.00	94.70	2.41	1.62	1.35	51.50
46.00	94.90	2.21	1.35	1.20	51.50
47.00	95.05	2.04	1.22	0.57	99.90

48.00	95.35	1.69	0.98	0.45	99.90
49.00	95.62	1.23	0.40		99.90
50.00	95.90	0.50			13.50
50.20	95.97				13.50
52.00	97.26				41.50
53.50	100.76				41.50
54.10	99.16				41.50

SUMMARY DATA: CROSS-SECTION # 5 Transect 4
Number of Points = 36

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-50.00	98.16				0.70
0.40	98.16				0.70
3.00	96.56				0.30
4.00	96.26				0.30
5.00	96.16				31.70
6.90	96.01				13.50
8.50	95.94	0.05			13.50
10.00	95.91	0.05			13.50
11.50	95.84	0.44			13.50
13.00	95.71	0.58			13.50
14.50	95.62	0.67			34.50
16.00	95.46	0.76	0.21		43.70
17.50	95.33	0.59	0.26	0.05	43.70
19.00	95.11	0.55	0.28	0.05	43.70
20.50	94.99	0.88	0.36	0.11	43.70
22.00	94.88	0.87	0.34	0.16	43.70
23.50	94.75	0.98	0.47	0.24	43.70
25.00	94.58	1.04	0.52	0.25	43.70
26.50	94.56	1.12	0.63	0.32	45.60
28.00	94.45	1.10	0.59	0.33	45.60
29.50	94.37	1.06	0.59	0.35	45.60
31.00	94.33	1.27	0.63	0.41	45.60
32.50	94.25	1.21	0.66	0.40	45.60
34.00	94.17	1.39	0.68	0.41	45.60
35.50	94.12	1.36	0.67	0.46	45.60
37.00	94.16	1.26	0.68	0.46	45.60
38.50	94.13	1.28	0.72	0.48	99.90
40.00	94.29	1.12	0.65	0.45	99.90
41.50	94.40	1.11	0.57	0.41	99.90
43.00	94.54	0.91	0.52	0.39	99.90
44.50	94.82	0.86	0.44	0.28	99.90
46.00	95.16	0.72	0.23	0.19	99.90
47.50	95.86	0.07			14.50
48.00	96.01				14.50
49.00	98.16				14.50
50.00	100.76				0.70

SUMMARY DATA: CROSS-SECTION # 6 Transect 5
Number of Points = 43

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-60.00	98.67				0.70
-3.00	98.67				0.70
0.40	97.67				0.70
1.50	97.17				0.10
2.90	96.03				0.30
3.00	95.98				0.30
4.00	95.61				0.30
5.00	95.48				22.90
6.00	95.32				22.90
7.00	95.07	0.01			23.90
8.00	95.02	0.01			32.70
9.00	94.98	0.01			34.80
10.00	94.97	0.10	0.01	0.05	34.80
11.00	94.93	0.22	0.01	0.05	43.70
12.00	94.92	0.29	0.01	0.05	43.70
13.00	94.83	0.30	0.01	0.05	42.80
14.00	94.73	0.50	0.06	0.05	42.60
15.00	94.63	0.43	0.07	0.05	43.60
16.00	94.50	0.63	0.25	0.11	43.70
17.00	94.28	0.52	0.31	0.14	43.70
18.00	94.20	0.55	0.30	0.25	43.70
19.00	94.00	0.66	0.40	0.32	45.80
20.00	93.85	0.67	0.64	0.29	43.70
21.00	93.65	0.73	0.69	0.33	43.70
22.00	93.47	0.78	0.52	0.38	43.70
23.00	93.25	0.86	0.46	0.27	43.80
24.00	93.07	0.85	0.49	0.30	43.70
25.00	92.85	0.88	0.60	0.30	43.70
26.00	92.70	0.87	0.54	0.32	43.70
27.00	92.57	1.11	0.65	0.41	45.70
28.00	92.58	1.11	0.62	0.31	52.70
29.00	92.68	1.07	0.50	0.27	99.90
30.00	93.10	0.62	0.31	0.08	99.90
31.00	93.23	0.71	0.16	0.11	99.90
32.00	93.37	0.83	0.12	0.14	99.90
33.00	93.43	0.62	0.08	0.09	99.90
34.00	93.48	0.39	0.03	0.05	99.90
35.00	93.53	0.25	0.01	0.05	99.90
36.00	93.65	0.25			99.90

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
37.70	94.57	0.01			0.10
38.90	95.64	0.01			0.10
40.40	98.02				11.90
42.80	100.67				11.90

SUMMARY DATA: CROSS-SECTION # 7 Transect 6
Number of Points = 36

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-10.00	99.47				0.70
0.40	97.42				0.90
1.70	94.75	0.02			0.10
3.50	94.64	0.04			99.90
4.50	94.64	0.60		0.20	99.90
6.00	94.34	1.04	0.40	0.20	99.90
7.50	94.19	1.48	0.69	0.30	99.90
9.00	94.20	1.54	0.91	0.39	99.90
10.50	93.90	1.51	0.97	0.35	43.80
12.00	93.79	1.24	0.81	0.32	43.80
13.50	93.66	1.09	0.62	0.42	43.80
15.00	93.49	1.03	0.81	0.44	43.60
16.50	93.45	0.84	0.68	0.44	43.70
18.00	93.45	0.67	0.54	0.22	43.50
19.50	93.52	0.67	0.40	0.36	34.60
21.00	93.67	0.76	0.41	0.16	34.70
22.50	93.84	0.72	0.29	0.19	34.80
24.00	94.03	0.46	0.21	0.13	43.60
25.00	94.14	0.31		0.08	43.50
26.50	94.23	0.27	0.07		43.70
28.00	94.42	0.09	0.04		43.50
29.50	94.67	0.12	0.08	0.01	34.70
31.00	94.78	0.10	0.28	0.03	34.50
32.50	95.10	0.10	0.21	0.04	43.70
34.00	95.25	0.11	0.07		34.70
35.50	95.43	0.13	0.10		34.90
37.00	95.59				34.90
39.00	95.89				34.90
40.50	95.99				34.50
41.70	96.04				34.70
43.00	96.17				34.70
45.00	96.47				0.10
46.00	96.87				11.90
47.80	97.37				11.90
54.00	99.07				0.70
100.00	99.07				0.70

SUMMARY DATA: CROSS-SECTION # 8 Transect 8
Number of Points = 35

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-1.00	100.77				0.90
-0.20	95.74	0.24	0.20		0.10
1.00	95.12	0.49	0.35	0.23	23.60
2.50	94.98	0.90	0.28	0.18	23.60
4.00	94.90	1.29	0.80	0.60	23.70
5.50	95.72	0.91	0.86	0.71	0.40
7.00	94.97	0.26	0.43	0.15	34.80
8.50	95.10	0.78	0.92	0.58	34.80
11.50	94.83	1.66	1.28	1.16	34.70
13.00	94.72	2.28	1.37	1.15	34.90
14.50	94.82	1.51	1.31	0.99	34.50
16.00	95.02	2.12	1.45	1.43	34.50
17.50	95.32	2.17	1.58	1.31	43.70
19.00	95.32	2.54	1.39	1.02	34.60
20.50	95.28	2.20	1.29	0.94	34.60
22.00	95.35	2.17	1.32	0.80	34.50
23.50	95.42	1.75	1.07	0.56	34.60
25.00	95.50	1.73	0.95	0.38	34.60
26.50	95.55	1.62	0.64	0.35	43.60
28.00	95.67	1.77	0.64		35.70
29.50	95.65	1.43	0.48		43.70
31.00	95.65	1.32	0.44		34.60
32.50	95.74	1.09	0.34		35.70
34.00	95.76	1.08			35.50
35.50	95.67	1.58	0.62		0.50
37.00	95.83	1.54			34.60
38.50	95.98	0.63			34.70
39.60	96.20				34.50
42.00	96.37				43.70
45.00	96.37				34.50
46.00	96.62				43.50
49.00	97.07				11.90
51.10	98.47				0.70
75.00	98.47				0.70
100.00	98.47				0.70

West Fork Hoquiam measured at River Mile 10.3 at 49, 20, and 12 cfs by Dept. Ecology and WDFW.

CROSS-SECTION # 1 Transect 0

CAL	Stage	GivenFlow	CalcFlow
1	95.70	49.00	54.51
2	95.41	21.00	23.30
3	95.33	12.00	13.12

CROSS-SECTION # 2 Transect 1

CAL	Stage	GivenFlow	CalcFlow
1	95.68	49.00	52.91
2	95.40	21.00	20.00
3	95.33	12.00	15.01

CROSS-SECTION # 3 Transect 2

CAL	Stage	GivenFlow	CalcFlow
1	95.71	49.00	43.63
2	95.41	21.00	20.36
3	95.33	12.00	14.88

CROSS-SECTION # 4 Transect 3

CAL	Stage	GivenFlow	CalcFlow
1	95.97	49.00	53.62
2	95.67	21.00	21.90
3	95.52	12.00	12.16

CROSS-SECTION # 5 Transect 4

CAL	Stage	GivenFlow	CalcFlow
1	96.01	49.00	48.24
2	95.68	21.00	19.02
3	95.55	12.00	10.42

CROSS-SECTION # 6 Transect 5

CAL	Stage	GivenFlow	CalcFlow
1	96.03	49.00	43.48
2	95.68	21.00	18.56
3	95.54	12.00	10.33

CROSS-SECTION # 7 Transect 6

CAL	Stage	GivenFlow	CalcFlow
1	96.04	49.00	46.09
2	95.68	21.00	22.54
3	95.54	12.00	10.75

CROSS-SECTION # 8 Transect 8

CAL	Stage	GivenFlow	CalcFlow
1	96.20	49.00	49.68
2	95.86	21.00	20.15
3	95.74	12.00	12.34

Upper Chehalis River;Measured 5/23/01 at 140 cfs, 6/21/01 at 59 cfs,and on 9/10/2001 at 23 cfs at River Mile 110.9; calibrated 3/25/04

SUMMARY DATA: CROSS-SECTION # 1 Transect 1

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-7.00	100.61				0.50
2.00	96.61				95.90
6.00	96.71				99.90
10.30	95.86				0.10
13.00	95.66	0.67			99.90
16.00	95.61	0.08			99.90
19.00	95.76	0.42			99.90
22.00	94.90	1.51	0.95	0.42	95.90
25.00	94.77	0.34	0.06	0.17	99.90
28.00	94.59	1.55	1.85	1.18	96.50
31.00	94.55	2.20	1.03	0.59	57.70
34.00	94.69	2.14	0.83	1.29	64.80
37.00	94.70	1.79	1.92	2.70	96.50
40.00	95.30	3.71	4.63		99.90
43.00	95.40	5.12	3.67		99.90
46.00	94.85	3.47	1.99	0.92	97.80
49.00	94.84	4.61	2.52	1.20	97.80
52.00	94.59	3.12	2.02	2.03	96.90
55.00	94.04	2.41	2.04	0.62	96.90
58.00	95.76	2.16			99.90
61.00	95.00	2.58	1.00		97.80
64.00	94.85	2.04	0.55	0.64	96.80
67.00	95.42	2.57	1.32		99.90
70.00	94.70	1.78	0.93	0.85	99.90
73.00	95.10	2.60	1.75	1.00	99.90
76.00	95.41	2.89			99.90
79.00	95.20	2.12	0.69		99.90
82.00	94.80	1.38	0.37		99.90
85.00	94.84	0.51	0.10		99.90
88.00	95.00	0.28	0.07	0.12	99.90
91.00	94.70	0.20	0.51	0.08	99.90
94.00	94.94	1.07	0.36	0.07	99.90
97.00	95.15	1.07			99.90
100.00	95.00	0.27	0.12		99.90
103.00	95.20	0.10	0.10		99.90
106.00	95.86				99.90
107.00	99.81				88.90
113.30	100.41				81.50

SUMMARY DATA: CROSS-SECTION # 2 Transect 2

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-50.00	100.21				0.70
-40.00	97.21				99.90
-20.00	96.11				94.90
-16.00	96.71				99.90
0.50	96.81				36.90
4.00	97.01				57.80
7.00	96.71				56.50
8.00	96.41				37.50
10.00	96.03	0.58			76.70
12.00	95.67	2.40	0.33	0.20	76.70
14.00	95.49	2.41	1.46	0.72	76.60
16.00	95.34	2.00	1.46	1.21	67.50
18.00	95.37	2.33	1.34	0.94	78.50
20.00	95.02	2.71	1.37	1.27	78.50
22.00	94.79	2.64	1.97	1.39	68.50
24.00	94.54	2.79	1.69	0.87	76.80
26.00	94.42	2.99	2.07	1.11	76.80
28.00	94.22	2.93	1.32	0.75	86.50
30.00	94.56	3.09	1.37	0.67	96.80
32.00	95.04	1.77	0.51	0.20	96.90
34.00	95.24	2.36	1.50	0.84	99.90
36.00	94.71	3.30	2.16	1.17	96.70
38.00	94.71	2.21	0.67	0.70	87.50
40.00	94.51	1.34	0.71	0.23	89.50
42.00	94.62	1.69	0.70	0.37	99.90
44.00	95.34	1.14	1.18	0.56	99.90
46.00	95.51	1.58	1.48	0.40	99.90
48.00	95.09	1.75	0.84	0.20	99.90
50.00	95.37	1.12	0.28		99.90
52.00	95.62	2.26	0.88		99.90
54.00	95.77	1.13	0.38		99.90
56.00	95.77	3.13	1.99		99.90
58.00	95.56	1.81	0.13	0.10	99.90
60.00	96.00	2.61	0.89		99.90
62.00	96.05	0.61			99.90
64.00	96.25	0.10			99.90
66.00	96.30	0.10			99.90
68.00	96.15	0.21			99.90
70.00	96.05	0.14			99.90
70.60	96.35				99.90
71.00	97.71				89.50
74.00	100.41				88.90
81.80	101.21				88.90

SUMMARY DATA: CROSS-SECTION # 3 Transect 3

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-65.00	100.71				0.70
-45.00	98.71				0.70
-25.00	96.71				0.70
-10.00	96.61				75.50
1.20	97.41				75.50
5.00	97.51				75.50
10.00	97.41				64.70
15.00	97.11				75.60
20.00	96.81				74.60
21.20	96.59				75.70
22.00	96.54				75.60
23.50	96.54				67.60
25.00	96.54				76.70
26.50	96.34	0.19			76.50
28.00	96.34	0.43			74.70
29.50	96.08	0.40			76.50
31.50	95.84	0.80	0.14		75.60
33.50	95.66	0.93	0.41		75.70
35.50	95.71	1.10	0.56		75.80
37.50	95.58	1.19	0.44	0.13	78.50
39.50	95.56	1.25	0.56	0.21	72.80
41.50	95.16	1.28	0.60	0.26	72.80
43.50	95.04	1.54	0.66	0.30	72.80
45.50	94.63	1.66	0.69	0.26	72.80
47.50	94.68	1.64	0.86	0.24	72.80
49.50	94.49	1.69	0.78	0.20	72.80
51.50	94.54	2.19	1.22	0.52	72.90
53.50	94.16	2.03	0.97	0.27	76.80
55.50	94.06	2.34	1.15	0.57	76.90
57.50	93.74	2.03	1.25	0.65	78.50
59.50	93.73	2.50	1.50	0.65	78.50
61.50	93.36	2.10	1.36	0.72	78.50
63.50	93.18	2.26	1.18	0.55	78.80
65.50	93.31	1.75	1.20	0.75	78.50
67.50	93.14	0.46	0.20	0.19	87.50
69.50	93.41	0.10	0.05	0.05	87.50
71.00	94.43	0.10			88.90
72.50	95.21	0.05			88.90
74.50	95.48	0.05			88.90
76.00	94.61				88.90
78.00	95.41				88.90
79.50	96.33				88.90
80.00	96.59				88.90
81.50	97.51				88.90
84.00	100.51				88.90

SUMMARY DATA: CROSS-SECTION # 4 Transect 4

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-80.00	102.44				0.70
-75.00	99.94				86.50
-50.00	97.94				86.50
-25.00	96.74				86.50
0.40	97.94				75.80
5.00	97.94				47.90
10.00	97.44				47.70
15.00	97.14				47.80
18.20	96.64				84.70
20.00	96.54				48.50
21.50	96.34	0.01			67.70
23.00	96.24	0.05			67.50
25.00	96.29	0.10			37.60
27.00	96.10	0.44			46.50
29.00	95.94	0.61	0.17		36.50
31.00	95.93	0.74	0.19		36.70
33.00	96.15	1.01			47.50
35.00	95.88	0.45	0.18		36.70
37.00	95.89	0.71	0.21		37.70
39.00	95.81	1.13	0.30		63.60
41.00	95.65	1.15	0.17	0.10	64.80
43.00	95.77	1.29	0.42	0.20	47.70
45.00	95.66	1.60	0.66		67.60
47.00	95.60	1.71	0.97	0.20	56.50
49.00	95.63	1.83	1.04	0.27	65.70
51.00	95.21	1.95	1.65	0.30	56.50
53.00	95.00	2.65	1.42	0.53	56.70
55.00	94.91	2.65	1.64	0.58	65.60
57.00	94.85	2.43	1.64	0.66	76.50
59.00	94.75	2.71	2.04	1.02	65.70
61.00	94.70	2.76	2.02	1.05	65.70
63.00	94.50	3.38	1.92	1.06	65.50
65.00	94.31	3.08	2.04	1.50	57.70
67.00	94.40	2.62	2.35	1.16	57.70
69.00	94.56	1.84	1.15	1.44	57.70
70.50	94.38	2.00	0.86	0.73	58.50
72.00	94.71	1.30	0.54	0.51	84.60
73.00	95.56	0.27	0.21	0.11	36.70
73.50	95.46	0.19	0.04	0.08	26.70
74.00	95.45	0.05	0.01		12.80
75.00	95.90	0.01			11.90
76.00	96.29				31.50

76.80	96.64				11.90
78.30	101.74				11.90
80.00	102.64				0.70

SUMMARY DATA: CROSS-SECTION # 5 Transect 5

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-80.00	101.94				0.70
-76.00	100.94				0.70
-70.00	98.64				75.80
-49.00	99.14				81.90
-25.00	98.14				73.90
2.70	97.84				71.90
8.00	97.69				84.80
9.20	97.29				74.90
10.00	96.94	0.63	0.20		57.50
12.00	97.01	0.94			64.90
14.00	96.82	0.97	0.56		75.50
16.00	96.82	2.03	1.21		74.80
18.00	96.72	1.72	1.60	0.39	74.70
20.00	96.77	1.57	1.49	0.40	86.60
22.00	96.69	0.91	0.38	0.64	67.70
24.00	96.67	1.66	1.78	0.28	85.70
26.00	96.67	0.65	0.53		56.60
28.00	96.62	1.75	1.12	0.58	65.50
30.00	96.49	1.94	1.63	0.92	57.80
34.00	96.77	3.17	1.83	0.78	68.80
36.00	96.72	2.46	2.17	0.84	57.50
38.00	96.57	2.27	1.83	1.69	75.70
40.00	96.39	3.44	1.80	1.20	64.70
42.00	96.45	2.68	2.26	0.87	67.80
44.00	96.54	3.83	3.05	1.76	65.50
46.00	96.60	4.61	2.38	2.38	57.70
48.00	96.50	3.57	1.69	2.09	75.70
50.00	96.52	2.21	2.82	0.99	47.70
52.00	96.35	4.33	3.01	2.11	54.90
54.00	96.35	3.11	2.13	0.58	58.80
56.00	96.44	3.60	3.25	1.95	54.80
58.00	96.44	3.50	3.29	2.79	56.80
60.00	96.32	4.21	3.08	3.17	54.80
62.00	96.29	2.21	1.21		85.90
64.00	96.50	3.87	2.21	0.87	85.90
66.00	96.15	3.94	2.95	2.35	54.70
68.00	96.19	3.87	2.96	1.69	54.80
70.00	96.17	3.47	1.63	1.95	54.70
72.00	96.52	3.81	2.26	1.88	64.50
74.00	96.60	2.76	1.72	1.00	64.50
76.00	97.01	0.44			76.50
77.00	96.90	0.34	0.10		75.70
78.50	97.14	0.05			0.10
78.80	97.29				0.10
83.70	99.24				0.10
87.00	102.24				0.70

SUMMARY DATA: CROSS-SECTION # 6 Transect 6

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-43.00	102.64				0.70
-33.00	101.74				0.70
-23.00	99.74				11.90
0.50	99.19				86.70
3.00	98.84				86.70
7.00	98.34				57.50
9.60	97.95				58.80
11.00	97.74				48.70
11.40	97.65				47.70
12.00	97.70				68.60
16.00	97.39	0.14	0.05		48.50
20.00	97.36	0.37	0.05		0.40
24.00	97.22	0.96	0.47		58.60
28.00	96.74	1.04	0.57	0.39	46.50
32.00	96.72	1.24	0.83	0.54	46.50
36.00	96.67	1.68	0.90	0.57	58.50
40.00	96.59	1.97	1.03	0.68	56.60
44.00	96.79	1.97	1.31	0.80	46.70
48.00	96.76	1.96	1.35	0.79	45.70
52.00	96.96	2.34	1.46	1.11	54.60
56.00	96.89	2.20	1.32	0.82	53.60
60.00	97.16	2.19	1.28	1.15	45.70
64.00	97.24	1.88	1.42	0.85	45.70
68.00	97.16	2.23	1.21	0.77	46.80
72.00	97.16	1.87	1.28	0.65	45.60
76.00	97.11	1.82	1.19	0.52	45.70
80.00	97.17	2.07	1.14	0.91	45.70
84.00	97.09	1.98	0.96	0.40	46.70
88.00	97.24	1.53	1.45	0.50	47.60
92.00	97.11	1.64	0.98	0.91	36.70
96.00	97.24	1.76	1.36	0.26	46.60
100.00	97.34	1.96	0.77	0.23	74.60
104.00	97.27	1.30	0.87		47.70
108.00	97.36	1.12	0.41		56.50
112.00	97.53	0.12	0.10		53.60
116.00	97.65	0.90			0.60
120.00	97.50	0.09	0.05		0.60

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
124.00	97.52	0.98	0.25		0.60
128.00	97.31	1.00	0.25		0.60
132.00	97.39	0.41	0.05		0.60
136.00	97.31	0.15			0.60
139.40	97.95				0.70
140.00	98.04				0.70
142.00	99.54				0.70
145.00	99.64				0.70
151.60	100.74				0.70
161.00	102.64				0.70

SUMMARY DATA: CROSS-SECTION # 7 Transect 7

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-5.00	102.64				0.70
2.00	99.14				0.30
3.00	97.00				0.10
4.00	96.41				0.10
7.00	95.64	-0.07			99.90
10.00	95.48	-0.01		-0.05	99.90
13.00	95.01	-0.02		-0.05	99.90
16.00	94.91			-0.05	99.90
19.00	94.94	0.16			93.70
22.00	95.09	0.82	0.33	0.16	93.70
25.00	95.56	1.81	1.07	0.54	93.70
28.00	95.83	2.10	1.42	0.62	43.60
31.00	96.03	2.47	1.70	0.95	43.60
34.00	96.26	2.02	1.41	0.89	43.70
37.00	96.58	2.44	1.41	0.85	45.60
40.00	96.63	1.96	1.32	0.67	64.60
43.00	96.88	2.48	1.66	0.71	64.60
46.00	96.83	2.46	1.46	0.60	56.60
49.00	96.98	2.55	1.44	0.54	56.60
52.00	96.84	2.08	1.06	0.49	56.60
55.00	96.86	1.98	0.94	0.47	57.60
58.00	96.96	1.14	0.62	0.37	57.60
61.00	96.84	1.49	0.57	0.27	57.70
64.00	97.09	1.42	0.74	0.22	57.70
67.00	97.13	1.71	0.52	0.11	57.60
70.00	97.24	0.89	0.33	0.05	56.70
73.00	97.21	0.93	0.37	0.05	57.60
76.00	97.70	0.80			75.70
79.00	97.51	1.05	0.05	0.05	47.70
82.00	97.70	0.44			46.60
85.00	97.70	1.07			57.50
88.00	97.80	0.47			57.70
91.00	97.85	0.05			46.60
94.00	98.10				26.60
97.00	98.20				26.60
100.00	98.10				56.60
103.00	97.90	0.03			36.60
106.00	98.00				11.90
109.00	97.95				45.50
110.70	98.00				11.90
113.00	99.04				0.70
116.80	100.04				0.70
127.00	102.40				0.70

SUMMARY DATA: CROSS-SECTION # 8 Transect 8

X	Y	VEL 1	VEL 2	VEL 3	SUBSTRATE
-5.00	101.54				0.70
0.40	101.14				0.70
2.00	100.14				99.90
6.00	98.94				99.90
6.90	98.33				0.20
7.00	97.19				0.20
8.00	96.89				0.20
9.00	96.64	0.02			0.20
10.00	96.32	0.47	0.15		99.90
11.00	96.25	0.83	0.34	0.07	99.90
13.00	95.80	0.60	0.25	0.44	99.90
15.00	96.09	1.54	0.50	0.33	99.90
17.00	95.99	2.43	1.09	0.77	99.90
19.00	95.80	2.33	1.23	0.84	99.00
21.00	95.32	2.01	1.37	0.68	99.90
23.00	95.42	2.35	1.79	0.93	99.90
25.00	95.52	2.34	0.96	0.65	56.70
27.00	96.07	1.43	1.04	0.46	56.70
29.00	96.42	1.77	1.01	0.45	56.70
30.00	96.70	1.76	0.96	0.29	56.50
32.00	96.77	1.49	0.87	0.24	56.70
35.00	96.87	1.25	0.72	0.20	47.50
38.00	97.09	1.39	0.91	0.22	47.70
41.00	97.12	1.41	0.62	0.20	56.50
44.00	97.12	1.03	0.38		58.80
47.00	97.45	1.09	0.57	0.20	58.60
50.00	97.63	1.08	0.60	0.20	58.60
53.00	97.19	0.50	0.26		58.70
56.00	97.32	0.45	0.32		58.70
58.00	97.54	0.49	0.19	0.10	58.50
60.00	97.69	0.76	0.33		58.60
62.00	97.60	0.10		0.05	85.60
64.00	97.64	0.47	0.06	0.05	58.50

66.00	97.95	0.53	68.50
68.00	97.90	0.41	83.70
70.00	97.95		68.50
72.00	97.90	0.42	48.50
74.00	97.95		48.60
76.00	97.95	0.36	68.50
78.00	97.99		85.60
80.00	98.13	0.30	85.60
82.00	98.18		58.50
84.00	98.28		68.50
86.00	98.28	0.01	0.60
88.00	98.18	0.01	0.60
90.00	98.13	0.01	0.60
92.00	98.18		0.60
94.00	97.92		64.70
94.40	97.95		0.70
95.00	98.33		0.70
95.50	99.04		0.50
102.90	100.44		0.70
107.00	100.94		0.70
112.00	101.44		0.70

Upper Chehalis River;Measured 5/23/01 at 140 cfs, 6/21/01 at 59 cfs,and on 9/10/2001 at 23 cfs at River Mile 110.9; calibrated 3/25/04

CROSS-SECTION # 1 Transect 1

CAL	Stage	GivenFlow	CalcFlow
1	95.81	140.00	141.72
2	95.48	59.00	51.14
3	95.22	23.00	18.56

CROSS-SECTION # 2 Transect 2

CAL	Stage	GivenFlow	CalcFlow
1	96.35	140.00	139.89
2	96.05	59.00	57.34
3	95.76	23.00	23.11

CROSS-SECTION # 3 Transect 3

CAL	Stage	GivenFlow	CalcFlow
1	96.58	140.00	139.43
2	96.12	59.00	59.89
3	95.82	23.00	23.82

CROSS-SECTION # 4 Transect 4

CAL	Stage	GivenFlow	CalcFlow
1	96.60	140.00	128.85
2	96.16	59.00	58.85
3	95.84	23.00	24.75

CROSS-SECTION # 5 Transect 5

CAL	Stage	GivenFlow	CalcFlow
1	97.29	140.00	140.96
2	97.01	59.00	64.45
3	96.81	23.00	26.31

CROSS-SECTION # 6 Transect 6

CAL	Stage	GivenFlow	CalcFlow
1	97.95	140.00	148.66
2	97.65	59.00	58.01
3	97.47	23.00	24.05

CROSS-SECTION # 7 Transect 7

CAL	Stage	GivenFlow	CalcFlow
1	98.00	140.00	142.75
2	97.70	59.00	63.53
3	97.53	23.00	25.72

CROSS-SECTION # 8 Transect 8

CAL	Stage	GivenFlow	CalcFlow
1	98.33	140.00	129.05
2	97.95	59.00	55.34
3	97.68	23.00	23.52

Appendix B

Velocity Adjustment Factors, and Data Changes for Black, Humptulips, Satsop, Skookumchuck, West Fork Hoquiam Rivers and upper Chehalis Rivers.

Velocity Adjustment Factor Table:
Black River - n/a

Data changes for calibration:
Black River - None

Velocity Adjustment Factor table
Humptulips River 2001 at WDFW access between Hwy 101 & Stevens Cr hatchery
657cfs (5/25),313cfs (6/22),255cfs (9/18) - Caldwell, Beecher, Vadas, Shedd

For all Transects:
WSLs based on Log/Log Regression
Dual-Rating Method

VELs based on Regression calibration
Calibration Set Used: 1

Velocity Adjustment Factor table for XS # 1 Trans 1

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
93.30	102.00	116.77	0.9308	108.69
93.90	255.00	272.32	0.9866	268.67
94.07	312.00	328.85	0.9971	327.91
94.83	655.00	689.59	0.9892	682.13
96.18	1637.50	1949.93	0.8647	1686.20

Velocity Adjustment Factor table for XS # 2 Trans 2

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
93.69	102.00	117.61	0.9248	108.77
94.37	255.00	262.74	0.9968	261.90
94.56	312.00	315.55	1.0071	317.80
95.38	655.00	650.81	0.9945	647.21
96.78	1637.50	1809.85	0.8611	1558.42

Velocity Adjustment Factor table for XS # 3 Trans 3

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
93.86	102.00	117.42	0.9965	117.02
94.55	255.00	254.24	1.0023	254.83
94.73	312.00	301.68	1.0026	302.46
95.52	655.00	569.14	0.9978	567.87
96.84	1637.50	1267.02	0.9760	1236.66

Velocity Adjustment Factor table for XS # 4 Trans 4

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
93.86	102.00	125.57	0.8583	107.78
94.56	255.00	269.67	0.9694	261.41
94.75	312.00	322.65	0.9847	317.71
95.58	655.00	654.11	0.9950	650.82
96.96	1637.50	1802.39	0.8757	1578.44

Velocity Adjustment Factor table for XS # 5 Trans 5

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
93.99	102.00	119.63	0.9515	113.82
94.65	255.00	249.68	0.9958	248.63

94.83	312.00	294.52	1.0027	295.30
95.58	655.00	554.46	1.0024	555.80
96.82	1637.50	1317.19	0.9217	1214.07

Data Changes for calibration
Humptulips River 2001 at WDFW access between Hwy 101 & Stevens Cr hatchery
657cfs (5/25),313cfs (6/22),255cfs (9/18) - Caldwell, Beecher, Vadas, Shedd

Transect	Station	Vel	Change
1	12	2	.04 to 0
1	14	1	1.62 to 1.42
1	14	2	.37 to .57
1	77	1	.92 to 1.12
1	84	1	2.52 to 2.32
1	84	2	.83 to 1.03
1	84	3	.47 to .67
1	88.9	1	0 to 1.71
1	196	1	0 to .01
2	5	1	.93 to .83
2	95	3	.32 to .52
2	105	3	.27 to .47
2	110	3	.2 to .4
4	128	1	0 to .05
4	132.5	2	-.05 to 0
4	135	2	-.14 to 0
4	137.5	2	-.1 to 0
4	142.5	2	.05 to 0
4	145	2	.03 to 0
4	147.5	2	.35 to .45
4	147.5	3	0 to .2
4	150	1	1.53 to 1.43
4	150	3	0 to .2
4	152.5	3	.07 to .27
4	155	1	1.95 to 1.75
4	155	3	.19 to .39
4	160	3	.44 to .64
5	164	2	.09 to 0
5	168	3	1.89 to 1.69

Velocity Adjustment Factor table
Satsop R T18N R7W S24,25 - Caldwell, Shedd, Beecher, Vadas - 2001
calibration flows 713 (5/22), 360 (6/20), 280 (9/20/01)

For all Transects:
WSLs based on Log/Log Regression
Dual-Rating Method

VELs based on Regression calibration
Calibration Set Used: 1

Velocity Adjustment Factor table for XS # 1 trans 0

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
93.10	126.40	185.77	0.9642	179.11
93.60	316.00	381.31	1.0025	382.27
93.74	391.00	452.48	1.0076	455.93
94.21	717.00	755.43	0.9968	752.99
95.15	1792.50	1856.29	0.8657	1607.07

Velocity Adjustment Factor table for XS # 2 trans 1

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
93.94	126.40	149.09	0.9624	143.49
94.30	316.00	340.74	0.9859	335.94
94.40	391.00	413.77	0.9894	409.37
94.69	717.00	722.11	0.9954	718.77
95.23	1792.50	1729.29	0.9731	1682.71

Velocity Adjustment Factor table for XS # 3 trans 2

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
94.02	126.40	135.44	0.9684	131.15
94.44	316.00	318.55	0.9978	317.85
94.56	391.00	389.99	1.0012	390.46
94.92	717.00	702.88	0.9979	701.42
95.58	1792.50	1808.12	0.9401	1699.90

Velocity Adjustment Factor table for XS # 4 trans 3

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
94.01	126.40	136.27	0.9455	128.84
94.50	316.00	299.69	1.0003	299.77
94.64	391.00	363.49	1.0036	364.79
95.08	717.00	642.46	0.9929	637.87
95.91	1792.50	1688.21	0.8791	1484.16

Velocity Adjustment Factor table for XS # 5 trans 4

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
94.01	126.40	122.12	0.9068	110.75
94.52	316.00	286.97	1.0084	289.39
94.66	391.00	355.92	1.0165	361.78
95.12	717.00	681.06	1.0030	683.13
95.99	1792.50	2021.19	0.8832	1785.11

Velocity Adjustment Factor table for XS # 6 trans 5

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
94.10	126.40	145.44	1.0266	149.31
94.60	316.00	315.81	1.0638	335.95
94.74	391.00	385.55	1.0521	405.64
95.18	717.00	694.00	0.9996	693.76
96.01	1792.50	1765.44	0.8842	1561.02

Data Changes for calibration
Satsop R T18N R7W S24,25 - Caldwell, Shedd, Beecher, Vadas - 2001
calibration flows 713 (5/22), 360 (6/20), 280 (9/20/01)

Transect	Station	Vel	Change
0	185	1	.14 to .08
1	66	3	.03 to 0
1	78	1	3.53 to 3.13
1	78	2	1.2 to 1.4
1	78	3	.92 to 1.12
2	11	3	.035 to 0
2	11.75	3	.135 to .34
2	100	2	.13 to .33
2	100	3	.05 to 0
2	105	3	.2 to .4
2	228	3	.03 to .1

Transect	Station	Vel	Change
4	27.5	2	-.05 to 0
4	30	2	-.29 to 0
4	32.5	2	-.09 to 0
4	35	2	-.09 to 0
4	40	2	.05 to 0
4	45	2	.07 to 0
4	170	3	0 to .2
4	175	3	0 to .2
4	180	3	0 to .2
4	185	2	.05 to 0
4	185	3	-.04 to 0

Velocity Adjustment Factor table

Skookumchuck River at Rotary Riverside Park, Centralia, nr RM 1; 240cfs (5/22/01
135cfs (6/20/01)-Caldwell, Shedd, Vadas, Beecher

For all Transects:
WSLs based on Log/Log Regression
Dual-Rating Method

VELs based on Regression calibration
Calibration Set Used: 1

Velocity Adjustment Factor table for XS # 1 TRANS 0

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
95.01	75.00	89.79	0.9310	83.60
95.25	142.00	153.51	0.9726	149.30
95.48	242.00	242.39	0.9998	242.34
95.92	600.00	550.12	1.0052	552.98

Velocity Adjustment Factor table for XS # 2 TRANS 1

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
94.99	75.00	79.36	0.9627	76.40
95.33	142.00	144.23	0.9982	143.98
95.67	242.00	244.45	0.9999	244.43
96.39	600.00	654.53	0.9198	602.03

Velocity Adjustment Factor table for XS # 3 TRANS 2

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
94.97	75.00	75.98	0.9384	71.30
95.33	142.00	136.29	1.0000	136.29
95.70	242.00	234.15	1.0000	234.15
96.48	600.00	678.97	0.8668	588.54

Velocity Adjustment Factor table for XS # 4 TRANS 3

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
94.96	75.00	91.02	0.9378	85.36
95.34	142.00	158.09	0.9922	156.85
95.72	242.00	261.04	0.9987	260.70
96.54	600.00	678.38	0.9131	619.42

Velocity Adjustment Factor table for XS # 5 TRANS 4

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
94.95	75.00	82.38	0.8551	70.44
95.34	142.00	143.86	0.9749	140.25
95.74	242.00	249.19	1.0003	249.26
96.60	600.00	810.63	0.8189	663.80

Velocity Adjustment Factor table for XS # 6 TRANS 5

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
95.30	75.00	88.78	0.9227	81.92
95.60	142.00	147.40	0.9994	147.32
95.89	242.00	241.38	0.9963	240.50
96.50	600.00	613.21	0.9037	554.17

Velocity Adjustment Factor table for XS # 7 TRANS 6

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
96.33	75.00	77.33	0.9659	74.70
96.55	142.00	140.87	0.9942	140.05
96.74	242.00	236.74	1.0000	236.73
97.11	600.00	600.82	0.9634	578.81

Velocity Adjustment Factor table for XS # 8 TRANS 7

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
96.32	75.00	61.75	0.9615	59.37
96.63	142.00	123.86	0.9968	123.46
96.93	242.00	227.60	0.9997	227.54
97.52	600.00	683.05	0.9437	644.61

Data Changes for calibration

Skookumchuck River at Rotary Riverside Park, Centralia, nr RM 1; 240cfs (5/22/01
135cfs (6/20/01)-Caldwell, Shedd, Vadas, Beecher

Transect	Station	Vel	Change
2	17.5	2	.54 to .642
2	57.5	2	.18 to .28
3	32.5	2	-.37 to .37
3	35	2	-.08 to .15
3	37.5	2	-.13 to .13
3	40	2	-.13 to .13
3	42.5	2	-.13 to .13
3	45	2	-.06 to .1
3	47.5	2	-.04 to .1
4	17	2	2.48 to 2.68
4	39.5	2	.17 to .37
4	42.5	2	.11 to 0
4	44	2	.1 to .3
4	45.5	2	.01 to .2
4	47	2	.01 to .1
4	45	2	.07 to 0
4	48.5	2	.01 to .1
4	50	2	.01 to .1
5	27	1	4.65 to 4.45
5	29	1	5.81 to 5.61
5	51	2	1.40 to 1.60
5	67	1	4.44 to 4.24
5	67	2	2.31 to 3.51
6	52.5	2	1.44 to 1.64
6	61.5	2	1.30 to 1.50

Velocity Adjustment Factor table
West Fork Hoquiam measured at River Mile 10.3 at 49, 20, and 12 cfs
by Dept. Ecology and WDFW.

For all transects:
WSLs based on Log/Log Regression
Dual-Rating Method

VELs based on Regression calibration
Calibration Set Used: 1

Velocity Adjustment Factor table for XS # 1 Transect 0

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
95.27	10.00	10.67	1.0267	10.96
95.31	12.00	12.92	1.0194	13.17
95.44	21.00	23.07	1.0049	23.18
95.69	49.00	55.44	0.9844	54.58
96.16	170.00	213.14	0.9001	191.84

Velocity Adjustment Factor table for XS # 2 Transect 1

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
95.27	10.00	12.08	0.9403	11.36
95.31	12.00	14.08	0.9587	13.50
95.44	21.00	22.97	0.9992	22.95
95.67	49.00	51.44	0.9969	51.28
96.11	170.00	203.32	0.8209	166.90

Velocity Adjustment Factor table for XS # 3 Transect 2

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
95.26	10.00	12.66	0.9623	12.18
95.31	12.00	14.38	0.9783	14.07
95.45	21.00	21.66	1.0120	21.92
95.70	49.00	42.74	1.0027	42.86
96.19	170.00	142.30	0.8064	114.74

Velocity Adjustment Factor table for XS # 4 Transect 3

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
95.47	10.00	10.95	0.9149	10.02
95.52	12.00	13.02	0.9329	12.15
95.68	21.00	22.21	0.9868	21.92
95.97	49.00	53.46	1.0026	53.59
96.53	170.00	223.55	0.8907	199.11

Velocity Adjustment Factor table for XS # 5 Transect 4

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
95.49	10.00	8.63	0.9864	8.52
95.54	12.00	10.43	0.9962	10.39
95.70	21.00	18.86	1.0137	19.12
96.00	49.00	48.63	0.9905	48.16
96.58	170.00	217.86	0.8582	186.96

Velocity Adjustment Factor table for XS # 6 Transect 5

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
95.48	10.00	9.32	0.9254	8.63

95.53	12.00	10.94	0.9496	10.39
95.70	21.00	18.27	1.0062	18.38
96.02	49.00	42.57	1.0246	43.61
96.66	170.00	177.22	0.8749	155.04

Velocity Adjustment Factor table for XS # 7 Transect 6

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
95.48	10.00	9.86	0.9742	9.60
95.53	12.00	11.70	0.9862	11.54
95.70	21.00	20.21	1.0041	20.29
96.03	49.00	48.89	0.9752	47.68
96.68	170.00	203.93	0.8195	167.13

Velocity Adjustment Factor table for XS # 8 Transect 8

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
95.67	10.00	10.00	0.9990	9.99
95.72	12.00	12.21	0.9824	11.99
95.89	21.00	20.72	1.0134	21.00
96.19	49.00	49.27	0.9959	49.07
96.78	170.00	201.17	0.8477	170.54

Data Changes for calibration:
West Fork Hoquiam measured at River Mile 10.3 at 49, 20, and 12 cfs
by Dept. Ecology and WDFW.

Transect	Station	Vel	Change
0	2	1	0 to .01
0	2.6	1	0 to .01
0	37.5	1	1.96 to 1.76
0	37.5	3	.41 to .61
0	43.5	1	1.35 to 1.15
0	43.5	3	.16 to .36
0	45	1	1.16 to .96
0	45	3	.09 to .29
1	16	1	-.1 to .1
1	18	1	.01 to .11
1	18	3	-.05 to .05
1	19	1	-.07 to .17
1	19	2	-.02 to .07
1	19	3	-.11 to .11
1	20	1	-.27 to .27
1	20	3	-.33 to .23
1	21	1	-.38 to .38
1	21	3	-.42 to .23
1	22	1	-.15 to .35
1	22	2	-.02 to 0
1	22	3	-.46 to .26
1	23	2	-.15 to .15
1	23	3	-.32 to .32
1	24	1	.11 to .21
1	24	2	-.17 to .17
1	24	3	-.28 to .08
1	25	1	.1 to .3
1	25	2	-.11 to .11
1	25	3	-.37 to .17
1	26	1	.04 to .24
1	26	2	-.03 to .23
1	26	3	-.36 to .16
1	27	2	-.06 to .06
1	27	3	-.13 to .13
1	28	2	-.04 to .04

Transect	Station	Vel	Change
1	29	2	-.01 to .01
1	34	1	1.38 to 1.18
1	34	3	.34 to .14
1	35	1	1.7 to 1.5
1	35	3	.4 to .2
1	36	1	1.59 to 1.39
1	36	3	.77 to .57
1	38	1	2.39 to 2.19
1	38	3	1.25 to 1.05
1	39	1	2.68 to 2.48
1	39	3	1.19 to 1.09
1	40	1	2.78 to 2.48
1	40	3	1.23 to 1.03
2	25	1	0 to .01
2	26	1	0 to .01
2	27	1	-.1 to .1
2	27	2	-.01 to .01
2	27	3	-.05 to .05
2	28	1	-.11 to .11
2	28	2	-.03 to .03
2	28	3	-.05 to .05
2	29	2	0 to .05
2	29	3	-.07 to .01
2	30	2	-.03 to .03
2	30	3	-.11 to .11
2	32	2	0 to .1
2	32	3	-.05 to .05
2	33	3	.05 to .15
2	34	3	.06 to .26
2	35	1	2.13 to 1.93
2	35	3	.44 to .64
2	43	1	3.51 to 3.31
2	43	3	1.13 to 1.33
2	44	1	2.79 to 2.59
2	44	3	.73 to .93

Transect	Station	Vel	Change
2	45	1	2.46 to 2.06
2	45	2	.23 to .83
2	45	3	.09 to 0
2	46	2	.11 to .31
2	46	3	-.05 to 0
3	17.5	2	.05 to 0
3	19	2	.1 to 0
3	22	1	1.33 to 1.13
3	22	3	.05 to 0
3	23.5	3	.07 to 0
3	25	3	.07 to 0
3	26.5	3	.09 to 0
3	28	3	.1 to 0
3	29.5	3	.13 to 0
3	31	3	.1 to 0
3	32.5	1	2.65 to 2.45
3	32.5	3	.15 to 0
3	34	1	2.32 to 2.12
3	34	3	.2 to 0
3	35.5	1	2.42 to 2.22
3	47	1	2.24 to 2.04
3	49	1	1.43 to 1.23
3	49	2	.2 to .4
4	14.5	2	.05 to 0
4	17.5	1	.79 to .59
4	19	1	.75 to .55
4	35.5	1	1.56 to 1.36
4	40	1	1.32 to 1.12
5	4	2	.01 to 0
5	5	2	.01 to 0
5	6	2	.01 to 0
5	7	1	0 to .01
5	7	2	.05 to 0
5	8	1	0 to .01
5	8	2	-.01 to 0
5	9	1	0 to .01
5	9	2	-.01 to 0
5	10	2	-.01 to .01
5	10	3	-.05 to .05
5	11	3	-.05 to .05
5	12	3	-.05 to .05
5	28	1	1.31 to 1.11
5	29	1	1.27 to 1.07
5	30	1	.82 to .62
5	36	2	.01 to 0
5	37.7	1	0 to .01
5	37.7	2	-.01 to 0
5	38.9	1	0 to .01
6	4.5	3	0 to .2
6	6	1	1.24 to 1.04
6	6	2	.2 to .4
6	6	3	0 to .2
6	7.5	1	1.68 to 1.48
6	7.5	2	.49 to .69

Transect	Station	Vel	Change
6	7.5	3	0 to .3
6	9	1	1.74 to 1.54
6	9	3	.19 to .39
6	10.5	1	1.71 to 1.51
6	10.5	3	.55 to .35
6	12	2	1.01 to .81
6	12	3	.52 to .32
6	13.5	2	.82 to .62
6	13.5	3	.62 to .42
6	15	1	.83 to 1.03
6	15	3	.54 to .44
6	16.5	1	.64 to .84
6	16.5	3	.54 to .44
6	18	1	.47 to .67
6	18	3	.42 to .22
6	19.5	1	.47 to .67
6	19.5	3	.46 to .36
6	21	2	.21 to .41
6	22.5	1	.52 to .72
6	22.5	2	.09 to .29
6	22.5	3	.09 to .19
6	24	1	.26 to .46
6	24	2	.01 to .21
6	26.5	1	.07 to .27
6	26.5	2	-.07 to .07
6	28	2	-.14 to .04
6	29.5	2	-.13 to .08
6	29.5	3	-.01 to .01
6	31	2	-.28 to .28
6	31	3	-.03 to .03
6	32.5	2	-.21 to .21
6	32.5	3	-.04 to .04
6	34	2	-.27 to .27
6	35.5	1	-.03 to .13
6	35.5	2	-.2 to .1
6	37	1	-.01 to 0
7	Transect Deleted		
8	-0.2	2	.3 to .2
8	1	3	.33 to .23
8	2.5	3	.38 to .18
8	4	2	.6 to .8
8	4	3	1.0 to .6
8	5.5	2	.66 to .86
8	5.5	3	.91 to .71
8	7	1	.06 to .26
8	26.5	3	.25 to .35
8	28	3	.05 to 0
8	29.5	3	.05 to 0
8	31	2	.24 to .44
8	31	3	.05 to 0
8	34	2	.08 to 0
8	37	2	.1 to 0

Velocity Adjustment Factor table

Upper Chehalis River;Measured 5/23/01 at 140 cfs, 6/21/01 at 59 cfs,and on 9/10/2001 at 23 cfs at River Mile 110.9; calibrated 3/25/04

For all Transects:
WSLs based on Log/Log Regression
Dual-Rating Method

VELs based on Regression calibration
Calibration Set Used: 1

Velocity Adjustment Factor table for XS # 1 Transect 1

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
95.02	10.00	8.43	0.8483	7.15
95.22	23.00	18.24	1.0018	18.27
95.49	59.00	54.23	0.9729	52.76
95.80	140.00	137.96	1.0116	139.57
96.21	350.00	397.13	0.9859	391.51

Velocity Adjustment Factor table for XS # 2 Transect 2

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
95.55	10.00	10.46	0.9543	9.99
95.76	23.00	23.03	0.9940	22.89
96.05	59.00	57.67	1.0147	58.51
96.35	140.00	137.64	1.0054	138.39
96.73	350.00	369.25	0.9337	344.76

Velocity Adjustment Factor table for XS # 3 Transect 3

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
95.54	10.00	11.72	0.8998	10.55
95.80	23.00	24.34	0.9785	23.82
96.16	59.00	59.13	1.0127	59.88
96.56	140.00	141.66	0.9843	139.44
97.07	350.00	386.57	0.8841	341.77

Velocity Adjustment Factor table for XS # 4 Transect 4

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
95.57	10.00	12.76	0.9085	11.59
95.83	23.00	24.79	1.0005	24.80
96.19	59.00	56.49	1.0379	58.63
96.59	140.00	131.58	0.9810	129.08
97.10	350.00	354.62	0.8405	298.06

Velocity Adjustment Factor table for XS # 5 Transect 5

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
96.66	10.00	11.78	1.0378	12.22
96.81	23.00	26.43	1.0026	26.50
97.02	59.00	63.77	0.9971	63.58
97.28	140.00	141.97	0.9994	141.89
97.64	350.00	335.57	0.9905	332.39

Velocity Adjustment Factor table for XS # 6 Transect 6

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
97.30	10.00	9.91	1.0176	10.08
97.46	23.00	23.80	0.9843	23.42
97.68	59.00	61.04	0.9955	60.77
97.93	140.00	146.12	0.9972	145.72
98.27	350.00	393.04	0.9372	368.36

Velocity Adjustment Factor table for XS # 7 Transect 7
WSLs based on Log/Log Regression

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
97.36	10.00	13.66	0.8583	11.72
97.51	23.00	27.73	0.9313	25.83
97.73	59.00	63.64	0.9913	63.09
97.98	140.00	145.52	0.9838	143.15
98.31	350.00	378.66	0.9013	341.30

Velocity Adjustment Factor table for XS # 8 Transect 8

WSL	Calib. Flow	Calc Flow	VAF	Dual CalFlow
97.46	10.00	12.08	0.8771	10.60
97.67	23.00	23.73	0.9799	23.25
97.97	59.00	55.08	1.0264	56.54
98.32	140.00	130.11	0.9818	127.74
98.79	350.00	346.40	0.8752	303.17

Data changes for calibration:
Upper Chehalis River;Measured 5/23/01 at 140 cfs, 6/21/01 at 59 cfs,and on 9/10/2001 at 23 cfs at River Mile 110.9; calibrated 3/25/04

Transect	Station	Vel	Change
1	25	1	.24 to .34
1	28	1	1.29 to 1.55
1	28	3	.98 to 1.18
1	37	3	3.7 to 2.7
1	46	1	3.67 to 3.47
1	46	3	.72 to .92
1	49	1	5.21 to 4.61
1	49	3	.05 to 1.2
1	70	2	.53 to .93
1	88	1	.18 to .28
1	91	1	0 to .2
1	97	1	1.27 to 1.07
1	97	2	.08 to 0
1	103	1	-.1 to .1
2	12	1	2.6 to 2.4
2	12	2	.13 to .33
2	12	3	0 to .2
2	32	3	.04 to .2
2	48	3	.02 to .2
2	52	2	.68 to .88
2	54	2	.18 to .38
3	37.5	3	.03 to .13
3	67.5	2	-.06 to .2
3	69.5	1	-.1 to .1
3	69.5	2	-.01 to .05
3	69.5	3	-.05 to .05
3	71	1	-.02 to .1
3	72.5	1	-.01 to .05
3	74.5	1	-.01 to .05
4	29	2	.07 to .17
4	31	2	.09 to .19
4	35	2	.08 to .18
4	37	2	.01 to .21
4	39	2	.15 to .3
4	43	2	.32 to .42
4	43	3	0 to .2
4	45	2	.46 to .66
4	47	1	1.91 to 1.71
4	47	3	.05 to .2
4	49	1	2.03 to 1.83
4	49	3	.17 to .27
4	53	3	.33 to .83
4	55	3	.38 to .58
5	18	3	.19 to .39
5	26	2	.73 to .53
5	34	1	3.37 to 3.17
5	34	3	.58 to .78
5	42	3	.67 to .87
5	54	1	3.31 to 3.11
5	54	3	.38 to .58
5	62	3	.1 to 0
5	64	1	4.27 to 3.87
5	64	3	.47 to .87
6	108	2	.21 to .41
6	124	2	.05 to .25
6	128	1	1.2 to 1
6	128	2	.05 to .25
7	10	2	.12 to 0
8	10	2	.05 to .15
8	30	3	.19 to .29
8	35	3	.02 to .2
8	41	3	.02 to .2
8	47	3	.02 to .2
8	60	2	.13 to .33
8	72	2	.02 to 0

Appendix C

Fish Preference Curves

Species Name: chinook
Life Stage: spawning; Conditions: streams

VELOCITY	Value	DEPTH	Value	SUBSTRATE	Value	SUBSTRATE	Value
0	0	0	0	11.9	0	58.5	0
0.5	0	0.5	0	31.7	0	58.9	0
1	0.9	1.2	1	31.8	0.24	59.5	0
1.75	1	3	1	31.9	0.27	59.9	0
2.25	1	3.5	0.5	32.5	0	61.5	0
4	0	4.5	0.07	32.7	0	61.7	0
5	0	5	0	32.8	0.24	61.8	0.8
99	0	99	0	32.9	0.27	61.9	0.9
				33.9	0.3	62.5	0
				34.5	0.65	62.7	0
				34.9	0.37	62.8	0.8
				35.5	0.65	62.9	0.9
				35.9	0.37	63.5	0.65
				36.5	0.65	63.9	0.93
				36.9	0.37	64.5	1
				37.5	0.4	66.9	1
				37.9	0.32	67.5	0.75
				38.5	0	67.9	0.95
				38.9	0	68.5	0
				39.5	0	68.9	0
				39.9	0	69.5	0
				41.5	0	69.9	0
				41.7	0	71.5	0
				41.8	0.8	71.7	0
				41.9	0.9	71.8	0.4
				42.5	0	71.9	0.45
				42.7	0	72.5	0
				42.8	0.8	72.7	0
				42.9	0.9	72.8	0.4
				43.5	0.65	72.9	0.45
				43.9	0.93	73.5	0.4
				44.9	1	73.9	0.48
				46.9	1	74.5	0.75
				47.5	0.75	74.9	0.55
				47.9	0.95	75.5	0.75
				48.5	0	75.9	0.55
				48.9	0	76.5	0.75
				49.5	0	76.9	0.55
				49.9	0	77.9	0.5
				51.5	0	78.5	0
				51.7	0	78.9	0
				51.8	0.8	97.5	0
				51.9	0.9	97.9	0
				52.5	0	98.5	0
				52.7	0	99.9	0
				52.8	0.8		
				52.9	0.9		
				53.5	0.65		
				53.9	0.93		
				54.5	1		
				56.9	1		
				57.5	0.75		
				57.9	0.95		

Species Name: chinook
Life Stage: spawning; Conditions: rivers

VELOCITY	Value	DEPTH	Value	SUBSTRATE	Value	SUBSTRATE	Value
0	0	0	0	0	0	53.5	0.65
0.5	0	0.5	0	11.9	0	53.9	0.93
1	0.1	1.2	1	31.7	0	54.5	1
1.3	0.7	3.4	1	31.8	0.24	56.9	1
1.75	1	5	0	31.9	0.27	57.5	0.75
3	1	99	0	32.5	0	57.9	0.95
4	0			32.7	0	58.5	0
5	0			32.8	0.24	58.9	0
99	0			32.9	0.27	59.5	0
				33.9	0.3	59.9	0
				34.5	0.65	61.5	0
				34.9	0.37	61.7	0
				35.5	0.65	61.8	0.8
				35.9	0.37	61.9	0.9
				36.5	0.65	62.5	0
				36.9	0.37	62.7	0
				37.5	0.4	62.8	0.8
				37.9	0.32	62.9	0.9
				38.5	0	63.5	0.65
				38.9	0	63.9	0.93
				39.5	0	64.5	1
				39.9	0	66.9	1
				41.5	0	67.5	0.75
				41.7	0	67.9	0.95
				41.8	0.8	68.5	0
				41.9	0.9	68.9	0
				42.5	0	69.5	0
				42.7	0	69.9	0
				42.8	0.8	71.5	0
				42.9	0.9	71.7	0
				43.5	0.65	71.8	0.4
				43.9	0.93	71.9	0.45
				44.9	1	72.5	0
				46.9	1	72.7	0
				47.5	0.75	72.8	0.4
				47.9	0.95	72.9	0.45
				48.5	0	73.5	0.4
				48.9	0	73.9	0.48
				49.5	0	74.5	0.75
				49.9	0	74.9	0.55
				51.5	0	75.5	0.75
				51.7	0	75.9	0.55
				51.8	0.8	76.5	0.75
				51.9	0.9	76.9	0.55
				52.5	0	77.9	0.5
				52.7	0	78.5	0
				52.8	0.8	78.9	0
				52.9	0.9	99.9	0

Species Name: chinook
Life Stage: juvenile

VELOCITY	Value	DEPTH	Value	SUBSTRATE	Value	SUBSTRATE	Value
0	0.09	0	0	0.1	1	51.5	0.2
0.35	0.26	0.45	0	0.2	1	51.9	0.28
0.45	0.93	1.35	0.5	0.3	1	52.5	0.2
0.7	1	1.55	0.8	0.4	1	52.9	0.28
1.15	0.9	2.2	1	0.5	0.8	53.5	0.2
1.25	0.75	3.6	1	0.6	0.8	53.9	0.28
2.3	0.08	99	1	0.7	0.1	54.5	0.3
3.6	0			0.8	0.7	55.9	0.3
99	0			0.9	0.2	56.5	0.4
				11.9	0.1	56.9	0.32
				13.9	0.1	57.5	0.5
				14.5	0.2	57.9	0.34
				14.9	0.12	58.5	1
				15.5	0.2	58.9	1
				15.9	0.12	59.5	0.3
				16.5	0.3	59.9	0.3
				16.9	0.14	61.5	0.3
				17.5	0.4	61.9	0.46
				17.9	0.14	62.5	0.3
				18.5	1	62.9	0.46
				18.9	1	63.5	0.3
				19.5	0.2	63.9	0.46
				19.9	0.12	64.5	0.4
				21.5	0.1	64.9	0.48
				23.9	0.1	65.5	0.4
				24.5	0.2	65.9	0.48
				24.9	0.12	66.9	0.5
				25.5	0.2	67.5	0.6
				25.9	0.12	67.9	0.52
				26.5	0.3	68.5	1
				26.9	0.14	68.9	1
				27.5	0.4	69.5	0.4
				27.9	0.16	69.9	0.48
				28.5	1	71.5	0.4
				28.9	1	71.9	0.64
				29.5	0.2	72.5	0.4
				29.9	0.12	72.9	0.64
				31.5	0.1	73.5	0.4
				33.9	0.1	73.9	0.64
				34.5	0.2	74.5	0.5
				34.9	0.12	74.9	0.66
				35.5	0.2	75.5	0.5
				35.9	0.12	75.9	0.66
				36.5	0.3	76.5	0.6
				36.9	0.14	76.9	0.68
				37.5	0.4	77.9	0.7
				37.9	0.16	78.5	1
				38.5	1	78.9	1
				38.9	1	79.5	0.5
				39.5	0.2	79.9	0.66
				39.9	0.12	81.5	1
				41.5	0.2	89.9	1
				41.9	0.28	91.5	0.2
				42.5	0.2	91.9	0.28
				42.9	0.28	92.5	0.2
				43.5	0.2	92.9	0.28
				43.9	0.28	93.5	0.2
				44.9	0.3	93.9	0.28
				45.9	0.3	94.5	0.3
				46.5	0.4	95.9	0.3
				46.9	0.32	96	0.4
				47.5	0.5	96.9	0.32
				47.9	0.34	97.5	0.5
				48.5	1	97.9	0.34
				48.9	1	98.5	1
				49.5	0.3	98.9	1
				49.9	0.3	99.9	0.3

Species Name: fall chum
Life Stage: spawning

VELOCITY	Value	DEPTH	Value	SUBSTRATE	Value	SUBSTRATE	Value
0	0.4	0	0	0	0	53.9	0.93
0.1	0.45	0.3	0	11.9	0	54.5	1
0.2	0.6	0.6	0.55	31.7	0	56.9	1
1.6	0.8	1.2	1	31.8	0.24	57.5	0.75
2.1	1	1.5	1	31.9	0.27	57.9	0.95
2.8	1	1.75	0.63	32.5	0	58.5	0
3.1	0.45	3.9	0.1	32.7	0	58.9	0
4	0.1	5	0.05	32.8	0.24	59.5	0
5	0	99	0.05	32.9	0.27	59.9	0
99	0			33.9	0.3	61.5	0
				34.5	0.65	61.7	0
				34.9	0.37	61.8	0.8
				35.5	0.65	61.9	0.9
				35.9	0.37	62.5	0
				36.5	0.65	62.7	0
				36.9	0.37	62.8	0.8
				37.5	0.4	62.9	0.9
				37.9	0.32	63.5	0.65
				38.5	0	63.9	0.93
				38.9	0	64.5	1
				39.5	0	66.9	1
				39.9	0	67.5	0.75
				41.5	0	67.9	0.95
				41.7	0	68.5	0
				41.8	0.8	68.9	0
				41.9	0.9	69.5	0
				42.5	0	69.9	0
				42.7	0	71.5	0
				42.8	0.8	71.7	0
				42.9	0.9	71.8	0.4
				43.5	0.65	71.9	0.45
				43.9	0.93	72.5	0
				44.9	1	72.7	0
				46.9	1	72.8	0.4
				47.5	0.75	72.9	0.45
				47.9	0.95	73.5	0.4
				48.5	0	73.9	0.48
				48.9	0	74.5	0.75
				49.5	0	74.9	0.55
				49.9	0	75.5	0.75
				51.5	0	75.9	0.55
				51.7	0	76.5	0.75
				51.8	0.8	76.9	0.55
				51.9	0.9	77.9	0.5
				52.5	0	78.5	0
				52.7	0	78.9	0
				52.8	0.8	98.5	0
				52.9	0.9	99.9	0
				53.5	0.65		

Species Name: coho
Life Stage: spawning

VELOCITY	Value	DEPTH	Value	SUBSTRATE	Value	SUBSTRATE	Value
0	0.4	0	0	0	0	53.9	0.93
0.25	0.4	0.45	0	11.9	0	54.5	1
1.05	1	1.15	0.75	31.7	0	56.9	1
1.8	0.81	2.05	1	31.8	0.24	57.5	0.75
2.65	0.29	3.25	0.09	31.9	0.27	57.9	0.95
3.9	0	4	0.01	32.5	0	58.5	0
4	0	99	0.01	32.7	0	58.9	0
99	0			32.8	0.24	59.5	0
				32.9	0.27	59.9	0
				33.9	0.3	61.5	0
				34.5	0.65	61.7	0
				34.9	0.37	61.8	0.8
				35.5	0.65	61.9	0.9
				35.9	0.37	62.5	0
				36.5	0.65	62.7	0
				36.9	0.37	62.8	0.8
				37.5	0.4	62.9	0.9
				37.9	0.32	63.5	0.65
				38.5	0	63.9	0.93
				38.9	0	64.5	1
				39.5	0	66.9	1
				39.9	0	67.5	0.75
				41.5	0	67.9	0.95
				41.7	0	68.5	0
				41.8	0.8	68.9	0
				41.9	0.9	69.5	0
				42.5	0	69.9	0
				42.7	0	71.5	0
				42.8	0.8	71.7	0
				42.9	0.9	71.8	0.4
				43.5	0.65	71.9	0.45
				43.9	0.93	72.5	0
				44.9	1	72.7	0
				46.9	1	72.8	0.4
				47.5	0.75	72.9	0.45
				47.9	0.95	73.5	0.4
				48.5	0	73.9	0.48
				48.9	0	74.5	0.75
				49.5	0	74.9	0.55
				49.9	0	75.5	0.75
				51.5	0	75.9	0.55
				51.7	0	76.5	0.75
				51.8	0.8	76.9	0.55
				51.9	0.9	77.9	0.5
				52.5	0	78.5	0
				52.7	0	78.9	0
				52.8	0.8	98.5	0
				52.9	0.9	99.9	0
				53.5	0.65		

Species Name: steelhead
Life Stage: spawning

VELOCITY	Value	DEPTH	Value	SUBSTRATE	Value	SUBSTRATE	Value
0	0	0	0	0	0	54.5	1
0.55	0	0.65	0	11.9	0	56.9	1
2.5	1	1.25	1	31.7	0	57.5	0.65
3.25	1	1.55	1	31.8	0.4	57.9	0.93
3.45	0.62	2.4	0.5	31.9	0.45	58.5	0
5	0	5	0.5	32.5	0	58.9	0
99	0	99	0.5	32.7	0	59.5	0
				32.8	0.4	59.9	0
				32.9	0.45	61.5	0
				33.9	0.5	61.7	0
				34.5	0.75	61.8	0.8
				34.9	0.55	61.9	0.9
				35.5	0.75	62.5	0
				35.9	0.55	62.7	0
				36.5	0.75	62.8	0.8
				36.9	0.55	62.9	0.9
				37.5	0.4	63.5	0.75
				37.9	0.48	63.9	0.95
				38.5	0	64.5	1
				38.9	0	66.9	1
				39.5	0	67.5	0.65
				39.9	0	67.9	0.93
				41.5	0	68.5	0
				41.7	0	68.9	0
				41.8	0.8	69.5	0
				41.9	0.9	69.9	0
				42.5	0	71.5	0
				42.7	0	71.7	0
				42.8	0.8	71.8	0.24
				42.9	0.9	71.9	0.27
				43.5	0.75	72.5	0
				43.9	0.95	72.7	0
				44.9	1	72.8	0.24
				46.9	1	72.9	0.27
				47.5	0.65	73.5	0.4
				47.9	0.93	73.9	0.32
				48.5	0	74.5	0.65
				48.9	0	74.9	0.37
				49.5	0	75.5	0.65
				49.9	0	75.9	0.37
				51.5	0	76.5	0.65
				51.7	0	76.9	0.37
				51.8	0.8	77.9	0.3
				51.9	0.9	78.5	0
				52.5	0	78.9	0
				52.7	0	79.5	0
				52.8	0.8	79.9	0
				52.9	0.9	81.5	0
				53.5	0.75	99.9	0
				53.9	0.95		

Species Name: steelhead
Life Stage: juvenile

VELOCITY	Value	DEPTH	Value	SUBSTRATE	Value	SUBSTRATE	Value
0	0.23	0	0	0.1	1	51.5	0.2
0.25	0.3	0.25	0	0.2	1	51.9	0.28
0.9	0.8	1.8	0.39	0.3	1	52.5	0.2
1.35	1	2.65	1	0.4	1	52.9	0.28
1.55	1	2.95	1	0.5	0.8	53.5	0.2
2.6	0.8	4.5	0.64	0.6	0.8	53.9	0.28
2.95	0.39	6	0.64	0.7	0.1	54.5	0.3
3.65	0.22	99	0.64	0.8	0.7	55.9	0.3
5.5	0.16			0.9	0.2	56.5	0.4
6	0			11.9	0.1	56.9	0.32
99	0			13.9	0.1	57.5	0.5
				14.5	0.2	57.9	0.34
				14.9	0.12	58.5	1
				15.5	0.2	58.9	1
				15.9	0.12	59.5	0.3
				16.5	0.3	59.9	0.3
				16.9	0.14	61.5	0.3
				17.5	0.4	61.9	0.46
				17.9	0.14	62.5	0.3
				18.5	1	62.9	0.46
				18.9	1	63.5	0.3
				19.5	0.2	63.9	0.46
				19.9	0.12	64.5	0.4
				21.5	0.1	64.9	0.48
				23.9	0.1	65.5	0.4
				24.5	0.2	65.9	0.48
				24.9	0.12	66.9	0.5
				25.5	0.2	67.5	0.6
				25.9	0.12	67.9	0.52
				26.5	0.3	68.5	1
				26.9	0.14	68.9	1
				27.5	0.4	69.5	0.4
				27.9	0.16	69.9	0.48
				28.5	1	71.5	0.4
				28.9	1	71.9	0.64
				29.5	0.2	72.5	0.4
				29.9	0.12	72.9	0.64
				31.5	0.1	73.5	0.4
				33.9	0.1	73.9	0.64
				34.5	0.2	74.5	0.5
				34.9	0.12	74.9	0.66
				35.5	0.2	75.5	0.5
				35.9	0.12	75.9	0.66
				36.5	0.3	76.5	0.6
				36.9	0.14	76.9	0.68
				37.5	0.4	77.9	0.7
				37.9	0.16	78.5	1
				38.5	1	78.9	1
				38.9	1	79.5	0.5
				39.5	0.2	79.9	0.66
				39.9	0.12	81.5	1
				41.5	0.2	89.9	1
				41.9	0.28	91.5	0.2
				42.5	0.2	91.9	0.28
				42.9	0.28	92.5	0.2
				43.5	0.2	92.9	0.28
				43.9	0.28	93.5	0.2
				44.9	0.3	93.9	0.28
				45.9	0.3	94.5	0.3
				46.5	0.4	95.9	0.3
				46.9	0.32	96	0.4
				47.5	0.5	96.9	0.32
				47.9	0.34	97.5	0.5
				48.5	1	97.9	0.34
				48.9	1	98.5	1
				49.5	0.3	98.9	1
				49.9	0.3	99.9	0.3

Species Name: cutthroat
Life Stage: spawning

VELOCITY	Value	DEPTH	Value	SUBSTRATE	Value	SUBSTRATE	Value
0	0	0	0	11.9	0	54.9	0.82
0.15	0	0.15	0.04	31.7	0	55.9	0.8
0.4	0.3	0.35	0.9	31.8	0.64	56.5	0.65
0.55	0.9	0.45	1	31.9	0.72	56.9	0.77
0.95	1	0.75	1	32.5	0	57.5	0.4
1.15	1	0.95	0.1	32.7	0	57.9	0.72
1.5	0.8	1.3	0.07	32.8	0.64	58.5	0.4
2	0.26	5	0	32.9	0.72	58.9	0.72
3	0	99	0	33.9	0.8	59.5	0
5	0			34.5	0.9	59.9	0
99	0			34.9	0.82	61.5	0
				35.5	0.8	61.7	0
				35.9	0.8	61.8	0.4
				36.5	0.65	61.9	0.45
				36.9	0.77	62.5	0
				37.5	0.4	62.7	0
				37.9	0.72	62.8	0.4
				38.5	0.4	62.9	0.45
				38.9	0.72	63.5	0.65
				39.5	0	63.9	0.53
				39.9	0	64.5	0.6
				41.5	0	64.9	0.55
				41.7	0	65.5	0.65
				41.8	0.8	65.9	0.53
				41.9	0.9	66.9	0.5
				42.5	0	67.5	0.25
				42.7	0	67.9	0.45
				42.8	0.8	68.5	0.25
				42.9	0.9	68.9	0.45
				43.5	0.9	69.5	0
				43.9	0.98	69.9	0
				44.9	1	71.5	0
				45.5	0.9	72.9	0
				45.9	0.98	73.5	0.4
				46.5	0.75	73.9	0.08
				46.9	0.95	74.5	0.5
				47.5	0.5	74.9	0.1
				47.9	0.9	75.5	0.4
				48.5	0.5	75.9	0.08
				48.9	0.9	76.5	0.25
				49.5	0	76.9	0.05
				49.9	0	77.9	0
				51.5	0	82.9	0
				51.7	0	83.5	0.4
				51.8	0.64	83.9	0.08
				51.9	0.72	84.5	0.5
				52.5	0	84.9	0.1
				52.7	0	85.5	0.4
				52.8	0.64	85.9	0.08
				52.9	0.72	86.5	0.25
				53.5	0.8	86.9	0.05
				53.9	0.8	87.5	0
				54.5	0.9	99.9	0

Appendix D

Substrate and Cover Code

Cover/Substrate Preference Tables and Coding

Table 1 lists codes 00.1 through 00.9, which are cover codes, and 1 through 9, which are components of the substrate code. Adjacent to each code are the recommended preference factors used to determine preference value. Cover/Substrate codes use the format ab.c.

For substrate codes, "a" is the component code for dominant particle size (i.e. the substrate that covers greatest bottom surface, not necessarily the largest diameter particle; e.g., sand may be dominant over cobble), "b" is the component code for the subdominant particle size, and "c" is tenths of cell area covered by dominant (50% or greater) substrate type. For example, the code 46.8 indicates 80% medium gravel and 20% small cobble.

Cover codes use the same format as the composite substrate code (ab.c), but "a" & "b" are always 0 and "c" define the type of cover. For example, 00.1 is an undercut bank, 00.2 is overhanging vegetation, etc. Since PHABSIM and RHABSIM can only accept 1 Cover/Substrate code, best professional judgment is needed to determine if substrate or cover should used. In general, we use the code with the highest value. To insure this option, both categories must be noted during fieldwork.

Recommended Preference (RP) in substrate tables (2-4, & 8,-11) are calculated from generic preferences in **Table 1** according to the following equation:

RP = c * Pa + (1-c) * Pb

where RP is the Preference factor, Pa is the preference factor for substrate component "a" in Table 1, and Pb is the preference factor for substrate component "b" in Table 1. Exceptions are noted by an asterisk.

Many exceptions are listed for spawning substrate. For example, if the dominant substrate was silt, clay, or organic (component code 1), or sand (component code 2), the substrate was assigned a RP of 0.00, regardless of the suitability of the subdominant component. Moreover, if the subdominant substrate was silt, clay, or organic, or sand made up more than 20% of the substrate (i.e. c = 7, 6 or 5), the substrate was assigned a RP of 0.00, regardless of the quality of the dominant substrate, due to the smothering effect of fine substrates.

For salmonid spawning, the presence of bedrock (code 9) always resulted in a RP of

0.00, and in most cases, the presence of boulders (code 8) and for rainbow trout, large cobble (code 7) also resulted in an RP of 0.00 due to the inability of the fish to dig through, or move the substrate.
For salmonid juvenile rearing, boulders (component code 8) were found to be extremely valuable. Presence of boulder, whether dominant or subdominant, results in RP of 1.00.

Every code combination is not listed and not necessary. When there is a gap, PHABSIM and RHABSIM assume a straight line between entered codes. For example, Table 2 lists the codes 47.5 (RP 0.75) and 47.9 (RP 0.95). If a value for 47.7 were needed, PHABSIM or RHABSIM would derive a RP of 0.85. Another case is with redundant codes. A redundant code occurs when 100% of the substrate is of one type. If the substrate is 100% small gravel, any code between 33.5 - 33.9 could be used. By convention, redundant codes are only listed in the form ab.9.

TABLE 1. Generic Cover/Substrate Codes and Preference Value[2]

Code	type of cover Note: Cover Codes are not used for spawning					Rearing		Holding
						fry	juvenile	adult
00.1	undercut bank					1.00	1.00	1.00
00.2	overhanging vegetation[3]					1.00	1.00	1.00
00.3	rootwad (including partly undercut)					1.00	1.00	1.00
00.4	log jam/submerged brush pile					1.00	1.00	1.00
00.5	log(s) parallel to bank					0.30	0.80	0.80
00.6	aquatic vegetation					1.00	0.80	0.80
00.7	short (<1’) terrestrial grass					0.40	0.10	0.10
00.8	tall (>3’) dense grass[4]					0.70	0.70	0.10
00.9	vegetation beyond the bank-full waters edge					0.20	0.20	0.20
Code	type of substrate	Spawning				Rearing		Holding
		salmon	steelhead	resident trout	bull & dolly[5]	fry	juvenile	adult
1	silt, clay, or organic	0.00	0.00	0.00	0.00	0.10	0.10	0.10
2	sand	0.00	0.00	0.00	0.00	0.10	0.10	0.10
3	sm gravel (.1-.5")	0.30	0.50	0.80	1.00	0.10	0.10	0.10
4	med gravel (.5-1.5")	1.00	1.00	1.00	1.00	1.00	0.30	0.30
5	lrg gravel (1.5-3")	1.00	1.00	0.80	1.00	1.00	0.30	0.30
6	sm cobble (3-6")	1.00	1.00	0.50	0.70	1.00	0.50	0.30
7	lrg cobble (6-12")	0.50	0.30	0.00	0.70	1.00	0.70	0.30
8	boulder (>12")	0.00	0.00	0.00	0.00	1.00	1.00	1.00
9	bedrock	0.00	0.00	0.00	0.00	0.10	0.30	0.30

2 This table reflects average values for the listed species. Site specific preferences would supersede this table.

3 This includes low tree branches (<3 vertical ft) and bushes overhanging the bank-full water’s edge.

4 This category refers to stout, bushy grasses such as reed canary grass up to the bank-full water’s edge.

5 This category includes Bull Trout (Salvelinus confluentus) and Dolly Varden (S. malma).