SNOQUALMIE WATERSHED AQUATIC HABITAT CONDITIONS REPORT: SUMMARY OF 1999-2001 DATA

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LIST OF ABBREVIATIONS AND ACRONYMS

ACOE........ Army Corps of Engineers
AFS .... American Fisheries Society
APD .... Agricultural Production District
C................ Celsius
cfs.............. cubic feet per second
DEM.......... Digital Elevation Model
DNRP........ Department of Natural Resources and Parks
DO............. dissolved oxygen
DOT .... Department of Transportation
ESA........... Endangered Species Act
FPD .... Forest Production District
GIS .... Geographic Information System
GLO .... General Land Office
GPS .... Global Positioning System
LB .... left bank
LIDAR ...... Light Detection and Ranging
LWD .... large woody debris
mm .... millimeters
NOAA....... National Oceanic and Atmospheric Administration
OHWM ..... ordinary high water mark
RB .... right bank
RM .... river mile
SARA........ Snoqualmie Aquatic Resources Assessment
USFS......... United States Forest Service
WDFW...... Washington Department of Fish and Wildlife
WDOE ...... Washington Department of Ecology
WFPB........ Washington Forest Practices Board
WLRD....... Water and Land Resources Division
WRIA........ Water Resources Inventory Area

INTRODUCTION

Scope and Purpose of Report

This report summarizes and interprets data collected in the field from 1999-2001 about habitat conditions for multiple species of salmonids and other aquatic biota in aquatic ecosystems of the Snoqualmie River Watershed, including the mainstem Snoqualmie River and several of its tributaries. This information was collected by King County Water and Land Resources Division (WLRD) staff and consultants. Previously existing information about habitat conditions for fish and other aquatic biota is also summarized from reports on existing conditions in the overall Snohomish River Basin (Water Resource Inventory Area 7 [WRIA 7]).

Until recently, there has been a paucity of data about some areas and issues in the Snoqualmie Watershed. Largely this was because the watershed was located outside of the King County surface water management service area and thus funding was low or nonexistent to do substantive inventory and analysis. In 2000, the King County Council approved the establishment of a Rural Drainage Program that extends surface water management services to the rural areas of the county including the Snoqualmie Watershed. This service area expansion provided additional emphasis and some funding for investigating baseline habitat conditions in the watershed and implementing habitat protection and restoration actions.

Information from this report will be used as part of a larger effort to assess what is currently known and what additional information is needed about the Snoqualmie Watershed in order for King County to proceed with long-term salmon conservation and recovery in the watershed and in WRIA 7 overall, as part of the regional, state, and federal efforts to recover salmon. The report is the first step in framing the questions that need to be answered in the Snoqualmie Watershed portion of the WRIA 7 strategic assessment and in building the Snoqualmie Aquatic Resources Assessment (SARA), which will be a comprehensive technical study program for the Snoqualmie Watershed. King County WLRD staff are currently developing a scope for SARA. The scope will likely include hydrologic mapping and modeling of catchment and subcatchment basins in King County's portion of WRIA 7, geologic interpretation of surficial geology maps, wetland assessment, and biologic assessment (i.e., Snoqualmie River valley floor habitat assessments and salmonid distribution mappings). Implementation of SARA is expected to take place in 2003 and 2004, concurrent with the overall WRIA 7 strategic assessment.

Summary of Previously Existing Information

This section summarizes information about land use, geomorphology, hydrology, water quality, fish populations, and aquatic and riparian habitat in the Snoqualmie Watershed. This information was published prior to the King County WLRD field studies that were conducted from 1999 to 2001.

Figure 1. Snoqualmie Watershed and Snohomish Basin WRIA

The Snoqualmie Watershed comprises 692 square miles and nearly half of the Snohomish River Basin (Figure 1). Approximately 75% of the Snoqualmie Watershed lies within the Forest Production District (FPD). This largely undeveloped headwaters area helps to protect water quality and to maintain hydrologic, sediment, and large woody debris (LWD) functions in waterbodies downstream from the FPD. Most of the Snoqualmie River floodplain downstream of Snoqualmie Falls is zoned for low density agricultural uses, specifically 70.4% for agriculture and 22.2% for rural residential land use.

Between 1980 and 2000, the population in the Snoqualmie Watershed nearly doubled, from just under 20,000 to approximately 40,000 residents. The Puget Sound Regional Council predicts that the population will further increase to over 70,000 residents by 2020 (King County WLRD, 2001).

The major tributaries of the Snoqualmie River begin high in the Cascade Mountains, but none of these streams is fed by glaciers. The Snoqualmie River flows over a relatively unconfined, alluvial floodplain that is divided into two segments by a major bedrock protrusion at Snoqualmie Falls (Pentec Environmental and NW GIS, 1999). As indicated in Figure 2, the river gradient is gentle below the Falls and much steeper above.

The bedrock ledge that forms Snoqualmie Falls resists erosion and traps most of the coarse sediment (bedload) transported from headwater source areas. Above the Falls, sediment deposition is prominent in the South Fork Snoqualmie River, the North Fork Snoqualmie River just above the confluence with the mainstem Snoqualmie, and the mainstem Snoqualmie below the confluence of the North Fork and Middle Fork. The Raging and Tolt Rivers and Tokul Creek supply most of the bedload sediment to the Snoqualmie River below the Falls. Deposition of bedload sediment is concentrated at and just downstream of the confluences of these waterbodies with the Snoqualmie (Booth et al., 1991; Anderson, 2002).

Hydrology and Water Quality

Because a large portion of the Snoqualmie Watershed drains high-elevation areas of the Cascade Mountains, snowmelt strongly influences the hydrology of the watershed. There are two distinct periods of high monthly flows: November, December, and January due to winter rainfall and increased meltwater from rain-on-snow events, and May and June due to snowmelt at high elevations (Figures 3-4). The lowest mean monthly flows occur in August at almost all gauges in the watershed because most of the snow has melted and there is usually little rainfall in western Washington during the summer months. Low elevation subwatersheds such as that of the Raging River do not benefit from a winter snow pack; thus their flows have no springtime increase (Figure 4). Mean monthly flows in low elevation basins increase from September through January as rainfall increases, and then decrease to the low point in August (Pentec Environmental and NW GIS, 1999).

Water quality problems have been identified in several waterbodies of the Snoqualmie Watershed. The mainstem Snoqualmie, South Fork Snoqualmie, and Raging Rivers were included on the Washington Department of Ecology's 1998 Section 303(d) List of Impaired Waterbodies because State of Washington water quality standards were violated for temperature in the mainstem and South Fork Snoqualmie, and for pH in the South Fork Snoqualmie and Raging Rivers (Washington Department of Ecology, 2000). Dissolved oxygen (DO) levels and fecal coliform bacteria counts have not met state water quality standards in the past in the mainstem Snoqualmie River; nutrient levels have been elevated as well. Low gradient reaches of Kimball and Patterson Creeks exhibit low DO levels that violate State of Washington water quality standards. High fecal coliform counts are a concern in Ames, Cherry, Kimball, and Patterson Creeks, and in the Raging River (City of Snoqualmie, 2001; Pentec Environmental and NW GIS, 1999; Fricke, 1995; Joy, 1994; Ehinger, 1993).

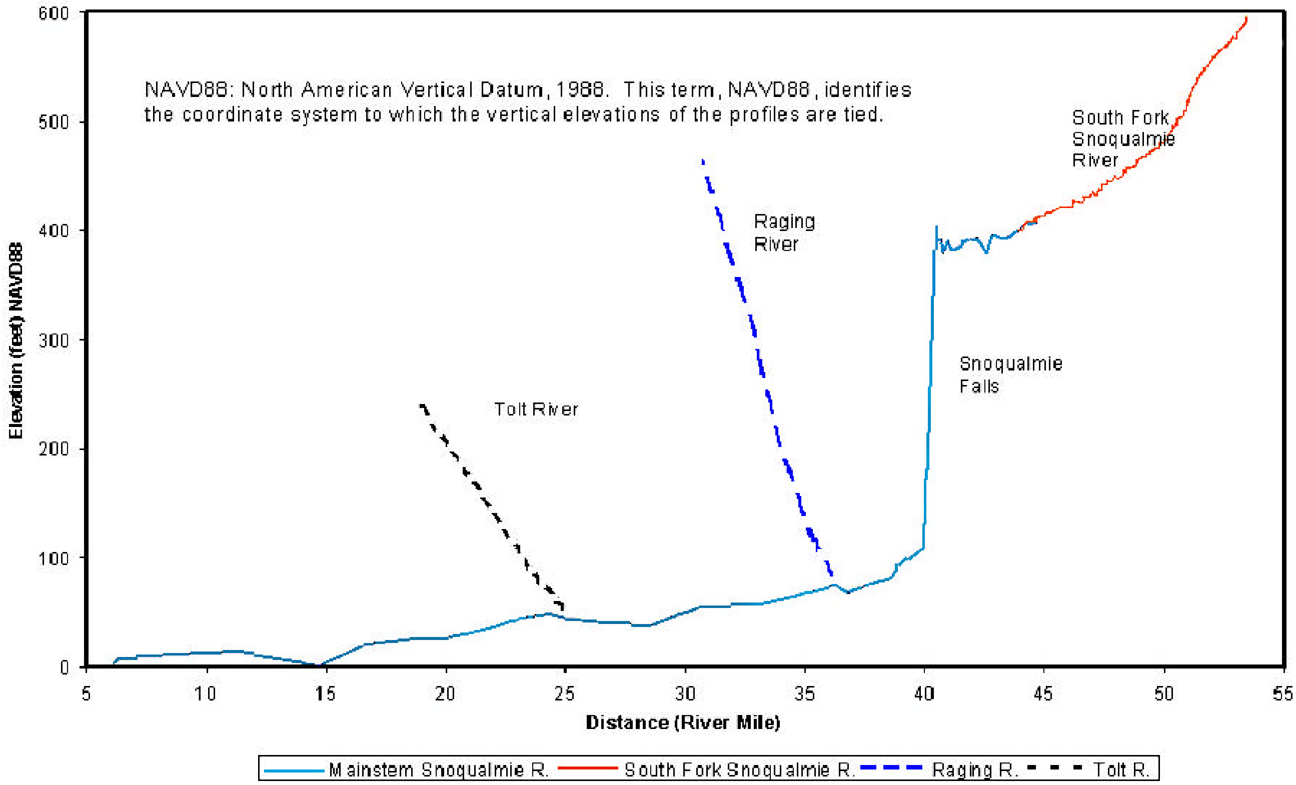

Figure 2. Longitudinal Profiles of Mainstem Snoqualmie River and Selected Tributaries

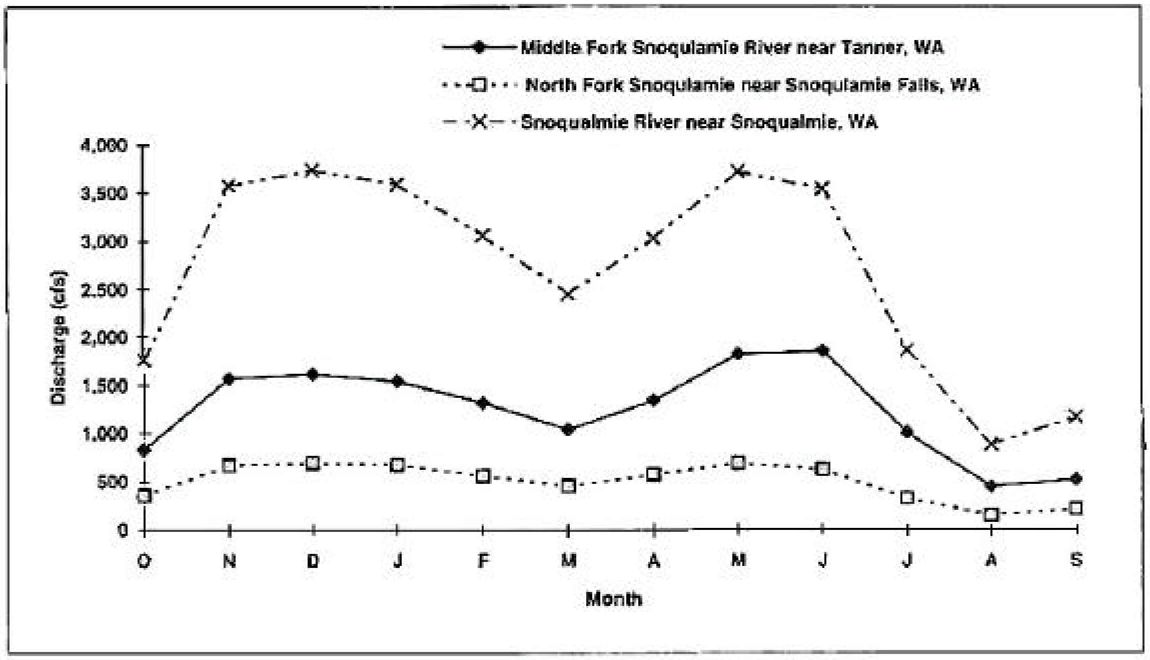

Figure 3. Mean Monthly Stream Discharge, Upper Snoqualmie River Watershed (Pentec Environmental, Inc. and NW GIS, 1999)

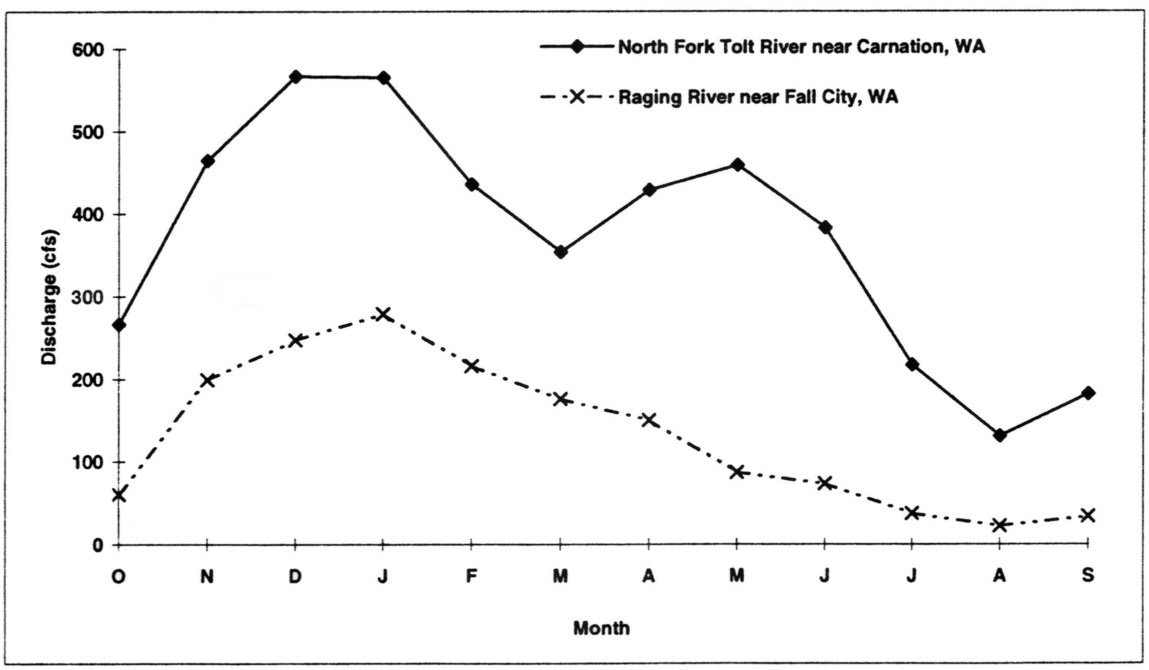

Figure 4. Mean Monthly Stream Discharge in the North Fork Tolt and Raging Rivers (Pentec Environmental, Inc. and NW GIS, 1999)

Groundwater is important in the Snoqualmie Watershed as a source of stream flow during the low flow months, as a potential large-scale source of human water supply for municipalities, and as the primary source of water for rural homes unconnected to regional water supply systems. Two large aquifer systems are located in the Snoqualmie Valley beneath the mainstem Snoqualmie River, one above and one below Snoqualmie Falls. Another aquifer is located beneath the Tolt River delta. Several seepage studies have been conducted to quantify how much groundwater discharge the Snoqualmie River receives directly from the valley aquifers during the dry season. Groundwater could be contributing as much as 22% of the total mean August flow to the Snoqualmie River at the City of Carnation, or 40% of the median seven-day low flow at Carnation (Pentec Environmental and NW GIS, 1999).

Fish Populations

The Snoqualmie Watershed contains some of the healthiest aquatic habitat remaining in King County and supports wild populations of chinook (*Oncorhynchus tshawytscha*), chum (*Oncorhynchus keta*), coho (*Oncorhynchus kisutch*), and pink salmon (*Oncorhynchus gorbuscha*), steelhead (*Oncorhynchus mykiss*), rainbow (*Oncorhynchus mykiss*), and cutthroat trout (*Oncorhynchus clarki*), and native char, i.e., Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) (King County WLRD, 2001). Salmonid spawning in the mainstem Snoqualmie River occurs in the gravel riffles below the confluence with the Tolt River (RM 24), at the confluence with the Raging River (RM 35), and in a section of channel below Tokul Creek (RM 38). These mainstem spawning areas are the same areas supplied with coarse sediment from the Tolt and Raging rivers and Tokul Creek. Chinook and steelhead spawning are concentrated in these areas and in the lower Raging and Tolt Rivers. Pink and chum salmon spawn in the lower Tolt River as well. Pink salmon have historically spawned in the Raging River; some still do. Most coho spawning and some steelhead spawning occurs in the tributary rivers and streams. Table 1 displays known spawning times and locations for anadromous species. Maps that show the distribution of each species within WRIA 7 are available from King County WLRD.

Anadromous fish do not travel above Snoqualmie Falls. However, resident populations of cutthroat, rainbow, and brook trout (*Salvelinus fontinalis*) can be found above the Falls. Native char were found historically as well (Pentec Environmental and NW GIS, 1999). See the section on bull trout surveys for more detail.

Table 1. Wild Salmonid Stocks in the Snoqualmie Watershed
(Washington Department of Fish and Wildlife and Western Washington Treaty Indian Tribes, 1994; Snohomish River Basin Work Group, 1998)

Species/Stock	Origin	Spawning Times	Spawning Habitat Locations
Chinook salmon/ Snohomish, fall	Native	late September to October	Snoqualmie River from Harris Creek to Snoqualmie Falls Tolt River from mouth to confluence with North and South Forks N. Fork Tolt River—Lower Reach S. Fork Tolt River—from mouth to reservoir Raging River—Lower
Chum salmon/ Snoqualmie	Native	mid-November to mid-January	Snoqualmie River from Harris Creek to Raging River Tolt River—Lower Reach Griffin Creek—Lower Reach Snoqualmie River, in side channel near Fall City
Coho salmon/ Snoqualmie	Mixed	late October to January	Snoqualmie River from mouth to Falls Cherry Creek Tolt River mainstem and lower reach of tributary at RM 5.5 N. and S. Forks Tolt River—lower reaches Tokul Creek—lower reach Raging River Harris Creek Stossel Creek—lower reach Griffin Creek from mouth to headwaters and in unnamed tributary at RM 5.0 Patterson Creek at RM 6.5 Lake Creek Canyon Creek in 1-mile reach Adair Creek—lower reach (Liz Ritzenthaler, Personal Communication, November 2001)
Pink salmon/ Snohomish, odd year	Native	mid-September to October	Snoqualmie River from mouth to Falls Tolt River—lower reach
Steelhead trout/ Tolt, summer	Unknown	February to April	Tolt River from mouth to reservoir North Fork Tolt River—Lower Reach
Steelhead trout/ Snoqualmie, winter	Native	March to mid-June	Snoqualmie River from RM 5 to Falls Cherry Creek—lower reach Raging River and Deep Creek Tokul Creek—lower reaches, Canyon Creek Tolt River—mainstem, N. and S. Forks

Aquatic and Riparian Habitat

Chinook salmon habitat requirements, habitat-forming processes, and factors affecting salmon populations are discussed in the *Initial Snohomish River Basin Chinook Salmon Conservation/Recovery Technical Work Plan* (*Initial Chinook Work Plan*), which was written by the WRIA 7 Technical Committee to provide a technical foundation for chinook salmon conservation and recovery for the Snohomish River Basin. In this document, the Technical Committee identified 34 categories of problems that may contribute to the decline of chinook salmon populations in WRIA 7. The following nine were considered to be the most important habitat problems (Snohomish Basin Salmonid Recovery Technical Committee, 1999):

- Loss of channel area and complexity resulting from bank protection and diking of the river and major tributaries, cutting off the channel from its floodplain.
- Dearth of in-channel large woody debris (LWD).
- High frequencies of redd scour resulting from flood flows.
- Increased sediment input to streams as a result of unnaturally high rates of slope failure and erosion.
- Poor quality riparian forests.
- Loss of wetlands resulting from draining for land conversion that eliminates habitat and reduces water retention.
- In-redd mortality resulting from siltation or water quality contamination.
- Urbanization (road construction, commercial and residential construction, additional bank hardening) that further reduces chinook salmon viability in the basin.
- Artificial barriers (dams, tide gates, diversions, culverts, pump stations) that prevent juveniles from reaching rearing habitat.

As a follow-up to the *Initial Chinook Work Plan,* the WRIA 7 Technical Committee developed a habitat evaluation matrix for chinook salmon (*Snohomish River Basin Chinook Salmon Habitat Evaluation Matrix).* This matrix assesses seven habitat conditions for the 62 subwatersheds of the Snohomish River Basin including the 25 subwatersheds of the Snoqualmie Watershed. Performance criteria from the scientific literature (NOAA, 1996; WFPB, 1997; Gersib et al., 1999; Spence et al., 1996; Bjornn and Reiser, 1991; WDFW and Western Washington Treaty Indian Tribes, 1997; Point No Point Treaty Council and WDFW, 1999) were applied to review existing information and to evaluate each subwatershed as “properly functioning,” “at risk,” or “not properly functioning” for each habitat condition. These habitat conditions are:

- artificial barriers/access to habitat.
- sediment regime.
- baseflow.
- peak flows.
- water quality.
- wetlands/riparian zone and shoreline vegetation/LWD.
- channel/shoreline complexity and floodplain connectivity.

The *Snohomish River Basin Chinook Salmon Habitat Evaluation Matrix* was intended to flag areas of concern. As such, it is not a complete and thorough analysis of all causes and effects that limit suitability of aquatic habitats for the natural production of chinook salmon in WRIA 7. Nor does it pinpoint the precise locations or areal extent of adverse habitat conditions within the watershed.

Table 2 summarizes the habitat conditions evaluations for the Snoqualmie Watershed (Snohomish Basin Salmonid Recovery Technical Committee, 2000). Not surprisingly, the most developed subwatersheds have the largest number of “at risk” and “not properly functioning” habitat conditions evaluations. Issues of concern include:

- degradation of the natural sediment and hydrologic regimes of the mainstem Snoqualmie and many anadromous salmonid-bearing tributaries (e.g., increased delivery of sediments, mass wasting events, reduced baseflows, and increased peak flows).
- water quality parameters that are in violation of state water quality standards.
- degraded or immature riparian vegetation.
- paucity of LWD.
- shoreline hardening causing loss of hydraulic connectivity between river or stream channels and their floodplains.

Since the publication of the *Snohomish River Basin Chinook Salmon Habitat Evaluation Matrix* in June 2000, salmon recovery planning efforts in WRIA 7 have broadened to include all salmonid species. The WRIA 7 Technical Committee has developed a multispecies habitat evaluation matrix (*Snohomish River Basin Salmonid Species Habitat Conditions Review*) for the 62 subwatersheds of the Snohomish River Basin, including the 25 subwatersheds of the Snoqualmie Watershed.

The *Snohomish River Basin Salmonid Species Habitat Conditions Review* (Snohomish Basin Salmonid Recovery Technical Committee, 2002) modifies and updates the chinook matrix report by assessing existing available information for all species of native salmon, trout, and char found in WRIA 7. Baseflow and peak flows are condensed into one habitat condition that is named “hydrology,” some other habitat conditions are renamed also. The six evaluated habitat conditions are:

- instream artificial barriers to habitat.
- sediment.
- hydrology.
- water quality.
- wetlands/riparian zone and shoreline vegetation/LWD.
- shoreline condition and floodplain connectivity.

Table 2. Chinook Salmon Habitat Conditions Evaluations for Snoqualmie Watershed
(Snohomish Basin Salmonid Recovery Technical Committee, 2000)

Subwatershed	Acres	Artificial Barriers / Access to Habitat	Sediment Regime	Baseflow	Peak Flows	Water Quality	Wetlands / Riparian Zone & Shoreline Vegetation / Large Woody Debris (LWD)	Channel / Shoreline Complexity and Floodplain Connectivity
Snoqualmie River Subwatersheds								
Ames Creek	4,941	Data Gap	NPF	NPF	NPF	AR	AR	NPF
Cherry Creek	17,536	NPF	AR	AR	AR	AR	NPF	NPF
Coal Creek – Lower	4,538	Data Gap	NPF	NPF	NPF	NPF	NPF	NPF
Coal Creek – Upper	9,733	Data Gap	NPF	NPF	NPF	AR	AR	AR
Griffin Creek	11,257	PF	AR	AR	AR	AR	AR	AR
Harris Creek	8,626	AR	NPF	NPF	NPF	AR	AR	AR
Patterson Creek	13,220	AR	NPF	AR	NPF	AR	NPF	AR
Pratt River	18,094	Data Gap	AR	PF	PF	Data Gap	PF	PF
Raging River	20,987	AR	AR	AR	AR	NPF	NPF	NPF
Snoqualmie River – Lower Middle Fork	24,006	AR	PF	AR	PF	AR	NPF	AR
Snoqualmie River – Upper Middle Fork	47,800	AR	AR	AR	AR	AR	NPF	PF
Snoqualmie River – Lower North Fork	23,313	Data Gap	AR	PF	AR	Data Gap	AR	AR
Snoqualmie River – Upper North Fork	39,633	Data Gap	AR	PF	PF	Data Gap	AR	AR
Snoqualmie River – Lower South Fork	15,079	Data Gap	NPF	NPF	NPF	AR	AR	AR
Snoqualmie River – Upper South Fork	40,334	Data Gap	NPF	PF	AR	NPF	AR	AR
Snoqualmie River – Mouth	12,814	AR	NPF	NPF	NPF	AR	NPF	NPF
Snoqualmie River – Mid-Mainstem	15,493	AR	NPF	NPF	NPF	AR	NPF	NPF
Snoqualmie River – Upper Mainstem	9,256	AR	NPF	NPF	NPF	AR	NPF	NPF
Tate Creek	3,028	Data Gap	AR	AR	AR	AR	NPF	AR
Taylor River	19,551	Data Gap	AR	PF	PF	Data Gap	Data Gap	PF
Tokul Creek	21,704	NPF	NPF	AR	AR	AR	PF	AR
Tolt River – Lower	10,606	PF	AR	PF	PF	PF	AR	AR
Tolt River – North Fork	32,596	PF	AR	PF	PF	PF	AR	AR
Tolt River – South Fork Above Dam	11,897	NPF	AR	AR	PF	AR	NPF	AR
Tolt River – South Fork Below Dam	8,190	PF	NPF	AR	AR	PF	AR	AR

Legend
PF – Properly Functioning
AR – At Risk
NPF – Not Properly Functioning

Some performance criteria in the chinook matrix report were also deleted or modified in the multispecies matrix report, based on an updated understanding of conditions in WRIA 7. Each subwatershed in the multispecies matrix report was characterized as “intact,” “moderately degraded,” or “degraded” for each habitat condition. The terminology was changed from that used in the chinook matrix report to avoid confusion with federal Endangered Species Act (ESA) regulatory language.

Table 3 summarizes the multispecies habitat conditions evaluations for the Snoqualmie Watershed. Where there is insufficient information to make an informed determination at this time, the multispecies matrix report identifies data gaps and areas of concern for future, more thorough evaluation and research. As was the case with the chinook habitat evaluation matrix, the multispecies matrix is not a complete and thorough analysis of all causes and effects regarding the suitability of aquatic habitats for the natural production of salmonids throughout the Snohomish River Basin, nor is it a formal Limiting Factors Analysis or a Biological Assessment under Section 7 of the federal ESA.

Table 3. Multiple Salmonid Species Habitat Conditions Evaluations for Snoqualmie Watershed (Snohomish Basin Salmonid Recovery Technical Committee, 2002)

Subwatershed	Acres	Instream Artificial Barriers to Habitat	Sediment	Hydrology	Water Quality	Wetlands / Riparian Zone & Shoreline Vegetation / Large Woody Debris (LWD)	Channel Stability and Floodplain Connectivity
Ames Creek	4,941	D	DG	I	DG	D	MD
Cherry Creek	17,536	D	DG	I	D	D	D
Coal Creek – Lower	4,538	DG	DG	MD	D	D	D
Coal Creek – Upper	9,733	DG	DG	MD	DG	D	DG
Griffin Creek	11,257	D	D	DG	I	MD	MD
Harris Creek	8,626	D	DG	I	DG	D	MD
Patterson Creek	13,220	D	D	I	D	D	DG
Pratt River	18,094	DG	DG	DG	DG	I	I
Raging River	20,987	D	MD	DG	DG	D	D
Snoqualmie River – Lower Middle Fork	24,006	MD	DG	DG	DG	D	MD
Snoqualmie River – Upper Middle Fork	47,800	DG	DG	DG	DG	I	I
Snoqualmie River – Lower North Fork	23,313	DG	DG	DG	DG	DG	MD
Snoqualmie River – Upper North Fork	39,633	DG	DG	DG	DG	DG	DG
Snoqualmie River – Lower South Fork	15,079	DG	DG	MD	D	D	MD
Snoqualmie River – Upper South Fork	40,334	DG	DG	DG	D	MD	MD
Snoqualmie River – Mouth	12,814	D	DG	I	D	D	D
Snoqualmie River – Mid-Mainstem	15,493	D	MD	MD	D	D	D
Snoqualmie River – Upper Mainstem	9,256	D	MD	MD	D	D	D
Tate Creek	3,028	DG	DG	DG	DG	D	DG
Taylor River	19,551	DG	DG	DG	DG	MD	I
Tokul Creek	21,704	D	MD	DG	I	I	I
Tolt River – Lower	10,606	I	MD	D	I	DG	D
Tolt River – North Fork	32,596	MD	DG	I	I	DG	I
Tolt River – South Fork Above Dam	11,897	MD	D	DG	DG	D	DG
Tolt River – South Fork Below Dam	8,190	I	D	D	I	MD	I

Legend

I – Intact
MD – Moderately Degraded
D – Degraded
DG – Data Gap