Snohomish County Public Works Department
Surface Water Management Division

Wadable Stream Habitat Survey Preliminary Results for the year 2000

Project No. WA524

March 2001

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Introduction

In 2000, Snohomish County Public Works Surface Water Management (SWM) initiated a multi-year stream habitat inventory of fish-bearing streams in Snohomish County. This report summarizes preliminary analysis of the year 2000 data. Over the next several months, Snohomish County fish habitat analysis staff (FHAS) will generate a stream channel habitat assessment report, which will include analyses of habitat parameters in relation to watershed-scale data and performance criteria. Subsequent reports will be produced on an annual basis for the duration of this project.

Following the development of a habitat survey protocol by FHAS (Snohomish County SWM 2000), field crews gathered quantitative data on key habitat parameters (e.g. large woody debris frequency, % pool area) during summer low flow conditions. For efficient expenditure of public resources, FHAS confined the survey to parameters that are unambiguous in the field and are closely linked to watershed-scale processes and life history requirements of salmonids.

The goal of the physical habitat survey is to provide quantitative data to inform land management and salmon conservation planning. The primary objective is to document current conditions at the subbasin and reach scales for use in monitoring and adaptive management. A secondary objective is to provide quantitative habitat data to support stormwater, capital improvement projects and road maintenance programs.

Field surveys in 2000 were conducted in five randomly selected subbasins: Boulder Ridge, Canyon Creek, Higgins Ridge, Squire Creek and Quilceda Creek. Within these subbasins, field crews surveyed approximately 25 percent of fish-bearing streams within each channel type and re-surveyed 5-10 percent for quality control and to evaluate quality assurance. In future years, using a rotational panel design, FHAS will sample the remaining subbasins and resample previously sampled reaches for trend analysis and effectiveness monitoring.

Methods

Subbasin Grouping

Subbasins were grouped for analysis based on three variables: percent impervious surface, mean elevation and contributing watershed area. Each variable was separated into four continuous categories that were assigned letters A through D (Table 1). The name for each subbasin group was derived from these letters.

Table 1: Letters assigned to variable categories

Variables	A (Lowest)	B (Low-Medium)	C (Medium-High)	D (Highest)
Total Impervious Area (%)	1-7	8-12	13-24	>24
Mean Elevation (m)	0-198	198-381	381-686	>686
Contributing Area (hectares*)	0-4,047	4,047-10,117	10,117-28,329	>28,329

*1 hectare = 2.47 acres

For example, a subbasin with 6% impervious area, a mean elevation of 396 m and a contributing area of 6,070 hectares was placed in the ACB group while a subbasin with a similar mean elevation and contributing area but an impervious area of 20% was placed into group CCB. Once grouped, subbasins throughout the County were randomly selected for survey.

Stream Channel Classification and Delineation

The physical habitat survey uses the Rosgen method of stream classification to divide streams into reaches with similar morphologies (Rosgen 1996). The Rosgen method uses physical characteristics (i.e. stream channel gradient, sinuosity, entrenchment, and width to depth ratio) to classify stream reaches. This method is structured into multiple levels of classification starting with broad map and aerial photo measurements and progressing through detailed field verification and sub-classification. FHAS used data from a previous survey (Pess *et al*., 1999), office measurements and knowledge of stream systems throughout the county to perform a broad Level 1 Rosgen classification of Washington Department of Natural Resources (DNR) type 1, 2 and 3 streams (fish-bearing) in subbasins for survey in 2000. The Level 1 survey breaks streams into nine Rosgen channel types (Table 2).

Table 2: Level 1 characterization delineative criteria (adapted from Rosgen 1996)

Stream Type	Entrenchment Ratio (FPW/BFW)	Width to Depth Ratio (BFW/BFD)	Sinuosity $\left(\frac{\text{Stream Length}}{\text{Valley Length}}\right)$	% Gradient $\left(\frac{\text{Valley Gradient} \times 100}{\text{Sinuosity}}\right)$
Aa+	< 1.4	<12	1.0 – 1.1	>10
A	< 1.4	<12	1.0 – 1.2	4 – 10
B	1.4 to 2.2	>12	>1.2	2 – 3.9
C	>2.2	>12	>1.4	< 2
D	N/A	>40	N/A	< 4
DA	>2.2	Variable	Variable	< .5
E	>2.2	<12	>1.5	< 2
F	<1.4	>12	>1.4	< 2
G	<1.4	<12	>1.2	2 – 3.9

FPW = Flood prone width (channel width @ 2x max BFD)
BFW = Bankfull width

BFD = Bankfull depth

In the Stillaguamish River basin, values for channel gradient were derived primarily from Pess *et al.* (1999). In the Snohomish River basin, gradient was measured using United States Geological Survey 10 meter resolution Digital Elevation Model (DEM) and a Geographic Information System (GIS). Entrenchment and width to depth ratios were approximated using data from Pess *et al.* (1999), contour and shaded relief maps, and prior knowledge of stream channels. SWM GIS staff merged the stream classification layer with the County hydrography coverage. This coverage was used to calculate total lengths of each Rosgen channel type in each subbasin. Field observations made during the channel survey were used to verify and adjust Rosgen channel type delineations made in the office.

Habitat Parameters

The habitat survey protocol includes eight parameters: channel gradient; channel length; bankfull width; large woody debris (LWD); pools; streambank instability; surface fine sediment in spawning riffles; and secondary and off-channel habitat (Snohomish County SWM 2000). To meet County objectives, while maintaining consistency with regional approaches to data collection in streams, the protocol adopts and adapts techniques used to measure habitat parameters from other stream surveying methods (USFS 1999, Bauer and Burton 1993, Overton *et al*. 1997). A description of each parameter and the reported results are provided below:

Channel Gradient

Channel gradient is defined as the change in vertical elevation per unit of horizontal distance or rise/run. It was calculated for stream channel classification as described above and verified in the field using a hand level, stadia rod and hipchain. Channel gradient was measured at the beginning of each surveyed reach over a distance of at least one complete meander wavelength and included at least one pool-riffle sequence. Gradient was used to confirm channel type and reach breaks. The reported values are the ranges in channel gradient that, in part, define Rosgen channel types (see Table 2).

Surveyed Length and Total Stream Length

Total stream length for each channel type includes all DNR type 1, 2, and 3 stream types. In some cases, it was not possible to survey a particular channel type because it was inaccessible, only fractionally represented among the other stream types or was dry. The reported values represent the cumulative distance surveyed (approximately 25%) of each channel type.

Bankfull Width

Bankfull width is the width of a stream channel at the point where over-bank flow begins during a flood event. In entrenched channels bankfull width is indicated by: deposited bedload; stain lines; the lower limits of perennial vegetation; and a change in slope or particle size on the stream bank (USFS 1999). Bankfull width was measured at the first straight riffle with uniform banks along each reach. Survey crews measured and recorded additional bankfull width measurements if width changed significantly along the reach

(e.g., confluence with another tributary, change in confinement). Bankfull width thresholds were used to determine the minimum size of pools and woody debris to be sampled. Bankfull width is the weighted average of the bankfull widths measured within each channel type.

Secondary Channel and Off-channel Habitat

Secondary channels (e.g. side-channels, side-channel sloughs) are defined as channels separated from the main channel by a stable vegetated island and contain the smaller portion of total discharge. Field crews measured area of wet secondary channels connected to the main channel surface flow and surveyed pools, LWD, bank instability and surface fine sediment found within. Off-channel habitats, including marshes, ponds and oxbow lakes that may influence or be influenced by stream flow at different stages but were not directly part of the present stream surface flow, were noted in comments. Secondary channel area is reported as a percentage of the estimated total channel area.

Pools

A pool is a closed topographic depression within a stream channel, which is characterized by low water velocity, low gradient and fine substrate grain size. Pool dimensions were measured to determine habitat area for holding and rearing. Residual pool depth, wetted area and functional habitat area were measured for each pool meeting the bankfull width, residual depth and surface area criteria used by Johnston and Slaney (1996) (Table 3).

Table 3: Minimum pool dimensions (adapted from Johnston and Slaney 1996)

Bankfull Width (m)	Area (m^2)	Residual Pool Depth (m)
0 – 2.4	1.0	0.20
2.5 – 4.9	2.0	0.40
5.0 – 9.9	4.0	0.50
10.0 – 14.9	6.0	0.60
15.0 – 19.9	8.0	0.70
>20	10.0	0.80

Data are reported by channel type as percent pool surface area, pool frequency and average functional pool area (including standard deviation). Summary values include main channel and secondary channel pools.

LWD

LWD is defined as downed wood that intercepts bankfull flow and is large enough to influence the formation of habitat (USFS 1999). To be counted as LWD, the length of a piece of wood must be ≥7.6 m or greater than twice the bankfull width of the stream reach being surveyed, which ever is less. Additionally, the diameter of the wood must be ≥30 cm at a distance of 7.6 m from the base or twice bankfull width, which ever is less. LWD was placed into three categories (single pieces, stumps and jams) and characterized by rootwad presence/absence, wood type (conifer/deciduous) and decay class (Table 4).

Table 4: Decay class criteria (adapted from Schuett-Hames *et al.* 1994)

Class	Bark	Twigs	Texture	Shape	Wood Color
1	Intact	Present	Intact	Round	Original Color
2	Intact	Absent	Intact	Round	Original Color
3	Trace	Absent	Smooth	Round	Darkening
4	Absent	Absent	Abrasion	Round/Oval	Dark
5	Absent	Absent	Vesicular	Irregular	Dark

Data are reported as LWD frequency, percent conifer (decay classes 1-3) and average decay class value. Average decay class and standard deviation of the decay class values are calculated with two significant figures to capture the distribution of decay classes within a reach. This is acknowledged to be more precise than the data collected, but is thought to be reflective of the continuous wood decay process.

Streambank Instability

Streambank instability is indicated by the presence of the following conditions at or directly above the bankfull depth: breakdown; slumping (false bank); fracture; or vertical and eroding bank (Bauer and Burton 1993)(see Snohomish County SWM 2000 for definitions). Any bank that has less than 50% cover [e.g, perennial vegetation, roots, rocks (cobble size or larger), logs] or has been armored to control bank erosion was also considered unstable. Bank instability was measured with a hipchain along the right bank only. The hypothesis that right-bank instability is representative of overall bank conditions on a subbasin scale was tested as part of this survey. Data are reported as percent unstable bank by channel type.

Surface Fine Sediment

Surface fine sediment is defined as particles <6.3 mm. Measurements were taken in downstream riffles of adult holding pools (residual depth ≥ 0.5 m residual) within riffles with flow, depth and substrate within the range of suitable habitat for spawning by salmonids. Sampling transects were placed within 2 m up or downstream from the pool tailout/riffle crest within the most likely spawning location. Percent surface fines were measured at four equally spaced points using a 100-point grid along a transect perpendicular to flow (Rhodes and Purser 1998, Bauer and Burton 1993). Data are reported as average percent surface fines by channel type, and are weighted by the number of samples obtained in each reach. A weighted standard deviation is also reported.

Results

Preliminary physical habitat survey results are summarized by subbasin below. They include watershed group subbasin characteristics, salmonid fish use, the summary habitat parameters as described above, and subbasin maps depicting DNR hydrography and Rosgen channel types.

Snohomish County Public Works Surface Water Management
Fish Habitat Analysis Project - Year 2000 Wadable Stream Channel Survey Summary

Boulder Ridge Subbasin

WRIA: Stillaguamish (WRIA 5)
Tributary to: N.F. Stillaguamish R.

Watershed group: **ADC**
Total Impervious Area (TIA): **A**, low
Mean elevation: **D**, high
Contributing Area: **C**, medium-high

Total DNR stream types 1, 2, and 3 (km): 46

Salmonid Fish Use [1]

Species	spawning	rearing	migration
chinook*	X	X	X
coho	X	X	X
chum	X		X
pink	X		X
steelhead**	X	X	X
cutthroat	X	X	X
bull trout	X	X	X

*summer chinook
**winter steelhead

Rosgen channel type	Aa+	A	B	C
Channel gradient range (%)	> 10	4 - 10	2 - 4	< 2
Surveyed length (km)	0.7	1.3	3.8	1.6
Total channel length (km)	9.1	9.0	15.6	11.9
Mean bankfull width (m)	8.9	18.9	13.3	26.8
Secondary channel area (%)	8.6	0.0	0.2	9.1
Total pool surface area (%)	7.6	24.8	14.2	25.1
Pool frequency (pools/km)	18	12	7	9
Mean functional pool area (m^2)	13.8	137.2	157.4	135.6
Standard deviation of functional pool area	(10.3)	(94.5)	(173.3)	(105.5)
LWD frequency (pieces/km)	77	70	57	124
Conifer LWD (decay class 1-3 only) (%)	88	57	39	17
Mean of decay class	3.9	3.1	2.6	2.6
Standard deviation of decay class	(1.4)	(1.2)	(1.2)	(1.0)
Bank instability (%)	4	5	3	19
Surface fine sediment <6.3 mm (%)	ND	5	10	4
Standard deviation of surface fine sediment	ND	(2)	(4)	(5)

1 - compiled, in part, from the following sources; Pess *et al* . 1999, Stillaguamish Technical Advisory Group (STAG) 2000, StreamNet 2000, Williams *et al* . 1975, WDF *et al* . 1993.

ND. No data were collected. No suitably sized substrate for spawning by salmonids was observed as required by the protocol.

Snohomish County Public Works Surface Water Management
Fish Habitat Analysis Project - Year 2000 Wadable Stream Channel Survey Summary

Canyon Creek Subbasin

WRIA: Stillaguamish (WRIA 5)
Tributary to: S.F. Stillaguamish R.

Watershed group: **ADC**
Total Impervious Area (TIA): **A**, low
Mean elevation: **D**, high
Contributing Area: **C**, medium-high

Total DNR stream types 1, 2, and 3 (km): 83

Salmonid Fish Use [1]

Species	spawning	rearing	migration
chinook*	X	X	X
coho	X	X	X
chum			
pink	X		X
steelhead**	X	X	X
cutthroat	X	X	X
bull trout	X	X	X

*fall chinook
**summer and winter steelhead

Rosgen channel type	Aa+	A	B	C	F
Channel gradient range (%)	> 10	4 - 10	2 - 4	< 2	< 2
Surveyed length (km)	0.4	4.7	2.4	8.7	1.4
Total channel length (km)	17.4	13.7	8.3	31.6	4.2
Mean bankfull width (m)	4.8	9.6	29.5	21.4	20.7
Secondary channel area (%)	1.4	4.8	5.1	2.4	0.0
Total pool surface area (%)	11.1	12.6	15.5	18.5	44.1
Pool frequency (pools/km)	26	13	4	6	6
Mean functional pool area (m^2)	8.1	45.3	370.9	326.9	603.3
area	(2.1)	(147.1)	(305.4)	(642.8)	(561.7)
LWD frequency (pieces/km)	87	163	18	64	20
(%)	100	62	63	52	50
Mean of decay class	4.1	3.4	3.4	3.1	4.2
Standard deviation of decay class	(0.9)	(1.4)	(1.1)	(1.4)	(0.8)
Bank instability (%)	5	5	0	15	0
Surface fine sediment <6.3 (%)	4	15	5	12	33
Standard deviation of surface fine sediment	(0)	(10)	(5)	(0)	(10)

1 - compiled, in part, from the following sources; Pess *et al* . 1999, Stillaguamish Technical Advisory Group (STAG) 2000, StreamNet 2000, Williams *et al* . 1975, WDF *et al* . 1993.

Snohomish County Public Works Surface Water Management
Fish Habitat Analysis Project - Year 2000 Wadable Stream Channel Survey Summary

Higgins Ridge Subbasin

WRIA: Stillaguamish (WRIA 5)
Tributary to: N.F. Stillaguamish R.

Watershed group: **ACA**
Total Impervious Area (TIA): **A**, low
Mean elevation: **C**, medium-high
Contributing area: **A**, low

Total DNR stream types 1, 2, and 3 (km): 51

Salmonid Fish Use [1]

Species	spawning	rearing	migration
chinook*	X		X
coho	X	X	X
chum	X		X
pink	X		X
steelhead**	X	X	X
cutthroat	X	X	X
bull trout	X	X	X

*summer chinook
**winter steelhead

Rosgen channel type	Aa+	A	B	C
Channel gradient range (%)	> 10	4 - 10	2 - 4	< 2
Surveyed length (km)	1.2	3.3	1.3	3.8
Total channel length (km)	15.1	13.8	4.9	15.0
Mean bankfull width (m)	10.1	8.1	18.0	8.9
Secondary channel area (%)	0.0	5.1	0.7	3.3
Total pool surface area (%)	25.6	10.5	5.9	9.6
Pool frequency (pools/km)	26	11	4	7
Mean functional pool area (m2)	30.3	19.0	42.1	45.0
Standard deviation of functional pool area	(22.3)	(9.6)	(22.8)	(51.2)
LWD frequency (pieces/km)	156	112	108	51
Conifer LWD (decay class 1-3 only) (%)	22	67	28	21
Mean of decay class	3.0	3.5	3.5	3.5
Standard deviation of decay class	(1.3)	(1.2)	(1.6)	(1.1)
Bank instability (%)	14	3	6	13
Surface fine sediment <6.3 mm (%)	3	11	56	15
Standard deviation of surface fine sediment	(6)	(10)	(29)	(17)

1 - compiled, in part, from the following sources; Pess *et al* . 1999, Stillaguamish Technical Advisory Group (STAG) 2000, StreamNet 2000, Williams *et al* . 1975, WDF *et al* . 1993.

Snohomish County Public Works Surface Water Management
Fish Habitat Analysis Project - Year 2000 Wadable Stream Channel Survey Summary

Quilceda Creek Subbasin

WRIA: Snohomish (WRIA 7)
Tributary to: Ebey Slough, Snohomish Estuary

Watershed group: **DAC**
Total Impervious Area (TIA): **D**, high
Mean elevation: **A**, low
Contributing Area: **C**, medium-high

Total DNR stream types 1, 2, and 3 (km): 46

Salmonid Fish Use [1]

Species	spawning	rearing	migration
chinook*	X	X	X
coho	X	X	X
chum	X		X
pink			
steelhead**	X	X	X
cutthroat	X	X	X
bull trout	X	X	X

*fall chinook
**winter steelhead

Rosgen channel type	A	C	E	F	G
Channel gradient range (%)	4 - 10	< 2	< 2	< 2	2 - 4
Surveyed length (km)	0.1	6.0	2.4	5.2	0.8
Total channel length (km)	0.2	22.0	6.4	14.2	3.0
Mean bankfull width (m)	2.4	4.7	11.6	4.3	3.3
Secondary channel area (%)	0.0	0.6	0.0	1.7	0.0
Total pool surface area (%)	0.0	63.3	6.5	41.9	3.5
Pool frequency (pools/km)	0	11	2	12	9
Mean functional pool area (m^2)	0	102.4	247.3	79.7	2.6
Standard deviation of functional pool area	0	(260.3)	(143.6)	(199.7)	(1.9)
LWD frequency (pieces/km)	110	19	28	29	35
Conifer LWD (decay class 1-3 only) (%)	0	55	33	23	42
Mean of decay class	3.3	3.0	3.1	3.2	3.1
Standard deviation of decay class	(1.2)	(1.5)	(1.3)	(1.5)	(1.1)
Bank instability (%)	19	6	3	3	10
Surface fine sediment <6.3 mm (%)	ND	98	100	89	14
sediment	ND	(3)	(0)	(3)	(3)

1 - compiled, in part, from the following sources; Pentec Environmental, Inc. and NW GIS 1999, StreamNet 2000, Williams *et al* . 1975, WDF *et al* . 1993.
ND. No data were collected. No suitably sized substrate for spawning by salmonids was observed as required by the protocol.

Snohomish County Public Works Surface Water Management
Fish Habitat Analysis Project - Year 2000 Wadable Stream Channel Survey Summary

Squire Creek Subbasin

WRIA: Stillaguamish (WRIA 5)
Tributary to: N.F. Stillaguamish R.

Watershed group: **ADB**
Total Impervious Area (TIA): **A**, low
Mean elevation: **D**, high
Contributing area: **B**, low-medium

Total DNR stream types 1, 2, and 3 (km): 41

Salmonid Fish Use [1]

Species	spawning	rearing	migration
chinook*	X	X	X
coho	X	X	X
chum	X		X
pink	X		X
steelhead**	X	X	X
cutthroat	X	X	X
bull trout	X	X	X

*summer chinook
**winter steelhead

Rosgen channel type	Aa+	A	B	C
Channel gradient range (%)	> 10	4 - 10	2 - 4	< 2
Surveyed length (km)	0.6	1.6	0.7	3.5
Total channel length (km)	3.8	12.8	6.0	17.5
Mean bankfull width (m)	8.7	15.1	13.7	24.4
Secondary channel area (%)	8.9	23.0	4.0	5.5
Total pool surface area (%)	6.7	18.1	6.1	39.4
Pool frequency (pools/km)	21	15	9	9
Mean functional pool area (m^2)	6.1	88.7	38.4	428.7
Standard deviation of functional pool area	(3.0)	(54.8)	(22.3)	(591.9)
LWD frequency (pieces/km)	60	122	42	66
Conifer LWD (decay class 1-3 only) (%)	33	72	85	22
Mean of decay class	2.6	3.9	3.3	3.1
Standard deviation of decay class	(1.0)	(4.2)	(1.5)	(1.3)
Bank instability (%)	6	0	1	11
Surface fine sediment <6.3 mm (%)	2	4	9	6
Standard deviation of surface fine sediment	(0)	(6)	(0)	(4)

1 - compiled, in part, from the following sources; Pess *et al* . 1999, Stillaguamish Technical Advisory Group (STAG) 2000, StreamNet 2000, Williams *et al* . 1975, WDF *et al* . 1993.

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