Averill Creek Watershed
Habitat Assessment and Restoration Plan.

Prepared for

Somenos Marsh
WILDLIFE SOCIETY
Stewards of the S'amunu /Somenos Marsh Conservation Area

5-55 Station Road
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Introduction

The Somenos Marsh Wildlife Society (SMWS) are interested in the health and recovery of the Averill Creek Watershed. An Urban Salmon Habitat Assessment was conducted to measure the condition in representative reach areas throughout the watershed. This report identifies the habitat condition of the Averill Creek Watershed as well as restoration opportunities.

Methods

Personnel

The survey involved local SMWS volunteer stewards, land owners, staff and professionals. These people included;

- SMWS: Paul Gowland (board member), Adam Dewar (staff), and Gina Hoar (staff)- data collection on iPad, habitat and water quality measures, landowner contact, and coordination of the survey.
- SMWS: Society President; Paul Fletcher. Coordination of personnel and contract
- Land owners along the survey reaches were contacted by Adam Dewar and Gina Hoar of the SMWS prior to the survey. All whose properties we visited were welcoming of the effort. Names withheld for privacy.
- DR Clough Consulting Biologist; Dave Clough, RPBio. Lead on scientific collection and report.
- DR Clough Consulting Biologist; Brad Remillard, RPBio. Assistant lead on scientific collection.
- DR Clough Consulting Biological Technician; Chelsea Eaglestone-April. Data collection on iPad, habitat and water quality measures, data organization, and report writing.

Stream Survey Method

The Urban Salmon Habitat Program (USHP) survey[1] was utilized. This method of survey was initiated in 1997 by the Ministry of Environment in concert with Vancouver Island stewardship groups. The Urban Salmon survey methodology has now been used by the majority of stewardship groups on Vancouver Island and the lower mainland. The survey data collection objective was to undertake a minimum of 10 habitat units or 100m of representative segments of each reach of the watersheds. The Richards Creek survey was completed June 2nd, 2021, while the Averill Creek survey was completed June 3rd, 2021.

The USHP survey method involves habitat and riparian assessments as well as water quality assessment. The habitat and riparian data collection items and their definitions are shown in the USHP Field Survey Card (Figure 1). Fish habitat was measured using staffs, tapes, chains and clinometers. The sites were identified with flagging tape, a georeferenced place mark and a site photograph. The field data was recorded on an iPad © or iPhone © using the USHP field card in a customized file (pdf schema) written by D.R. Clough Consulting. We used the application Avenza PDF © and a GIS enabled PDF map. The data was then exported off the devices as *.csv and *.kml files for use in the USHP program and Google Earth ©.

Water quality was measured in the field at representative reach segments each day of survey from June 2nd-3rd, 2021. The Temperature, Oxygen, pH, Conductivity and Total Dissolved Solids were measured using field equipment (Oxygard Meter, Lamotte Wide Range pH kit, Lamotte TDS and Conductivity meter). Flow was estimated by stage height (0-100% bankfull). This data

[1] Michalski, T.A., G.E. Reid, G.E. Stewart, 1997. Urban Salmon Habitat Program ,Assessment And Mapping Procedures for Vancouver Island. Ministry of Environment, Lands and Parks, Fisheries Section. Nanaimo B.C.

was recorded on the iPad. The results were compared with Module 3 Water Quality Survey in "The Streamkeepers Handbook"[2].

The data points are collected for individual stream habitat units (pool or riffle). The data collection and assessment follows the B.C. Environment and DFO fish habitat assessment standards (Johnston & Slaney 1996[i]). The field data was transcribed into the USHP excel program which uses macros to collate and rate the data to published habitat standards[3]. The reach habitat parameters were summarized, rated and scored using the macro enabled excel program created by the USHP. Scoring is based on the Fish Habitat Assessment Procedures (Johnston & Slaney 1996). This method converts the results into numbers thus offering a scoring system that can compare reaches or other streams.

Fish Habitat Parameter	Score
Good	1
Fair	3
Poor	5

A Good result is scored as a 1, a Fair result scored as a 3 and a Poor result scored as a 5. The lower the score, the better the habitat as per the standards identified in methods. For the Ratings Result scoring, Ratings were calculated to a decimal point then rounded to whole numbers for this report.

[2] The Streamkeepers Handbook- A practical guide to stream and wetland care. 1995, SEP, DFO Vancouver B.C.
[3] Johnston ,N.T. & P.A. Slaney,1996. Fish Habitat Assessment Procedures. WRP Tech Circ.#8, MOELP & MOF

Fig. 1 USHP Survey Habitat and Riparian Data Card

Stream Name	*Fish C.*
Reach /pg. #	*R2/pg1*
Habitat Type (P/R)	*P*
Start (m)	*10 m*
End (m)	*20 m*
Wetted Width	*2 m*
Bankfull Width	*3 m*
Average Depth	*0.5 m*
% Bedrock	*20%*
% Boulders	*20%*
% Cobble	*30%*
% Gravel	*20%*
% Fines	*10%*
Instream Cover (type/%)	*C-10% B-2%*
% Crown Cover	*60%*
Gradient	*2%*
# LWD	*10*
A/E/O	*E-10m A-20m*
Off-Channel Habitat	*L/bank 20*2m*
Land Use (L/R)	*N/R*
Vegetation (L/R)	*CF/G*
Vegetation Depth (L/R)	*30+/2*
Riparian Slope (%)(L/R)	*10/15*
Stability (L/R)	*M/L*
Livestock Access (L/R)	*20m/0*
Photos	*1,2,3*
Comments	*1,2*

Habitat and Riparian Card Instructions

1. Measure <u>all</u> habitat parameters at the <u>beginning</u> of the reach and <u>every 200 meters</u>. Measure all parameters twice if the reach is less than 200 meters long;
2. Measure riparian parameters (black boxes) <u>every 100 meters</u>;
3. Measure the start, finish & wetted width for <u>pools only</u>; take data for all other shaded boxes along <u>entire stream length</u>.

Abbreviations and Definitions

A/E/O: Altered sites, Erosion sites, Obstructions

Bankfull Width: the horizontal distance from rooted terrestrial vegetation to rooted terrestrial vegetation.

Crown Cover: streamside vegetation at least 1 meter above water surface that provides shade over the habitat unit.

Gradient: slope of the stream, measured with a clinometer

Habitat Type: P=pool or R=riffle

Instream Cover: B=boulder C=undercut banks
LWD=large woody debris O=other
V=instream vegetation (includes algae)

Land Use: C=commercial I=industrial
EX=exposed L=lawns
FC=farms/cattle N=natural
FG=farms/grass R=roads or residential
GC=golf course

Livestock: note the length, in meters, of the site where any type of livestock have access to the stream.

LWD: deadwood >10cm in diameter and >2m. long and stable in the <u>wetted</u> channel

Obstructions: BD=beaver dam
CV=culvert X=log jam
D=dam EBB=other
F=falls

Off-Channel: includes ponds and lateral channels; note the bank side,[1] channel length and width

Riparian Slope: the slope of the bank above the high water mark to the far end of the riparian vegetation or break in slope; include distance if on floodplain

Stability: H=high; M=medium; L=low

Vegetation: Br=broadleaf forest Mix=mixed
Con=coniferous forest Sh=shrub
Gr=grasses

Wetted Width: the width of the water surface measured at right angles to the direction of flow

[1] NOTE: Bank side is determined when facing downstream

measure along stream length; note start and end for pools only

measure every 100 meters

Survey Area

The Somenos Watershed is a special ecological area connected by Somenos Creek to the lower Cowichan River. It offers an extensive array of lake, pond and stream habitat for fish and wildlife. The Somenos Watershed is comprised of Bings Creek as the largest stream followed by Richards and Averill Creeks representing the other significant streams (Figure 2). There are several other smaller unnamed streams that also enter Somenos Creek (i.e. Chesterman Park, Driving Range, Lakes Road). Quamichan Creek joins at its confluence with the Cowichan River.

Averill Creek enters Somenos Lake approximately 450m north of the entrance of Bings Creek on the lake's western edge. The majority of the watershed was historically logged and farmed and has been steadily becoming more urbanized over the last several decades.

The survey objective was to measure the representative habitat in the main salmon and trout segments of the watershed. Each of the survey reaches would have 10 or more habitat units surveyed or at least 100m of stream length. The degree of effort was determined by timing and budget to the single anticipated field day on June 3nd 2021. The field crew was separated into two groups; one surveyed the upper reaches, while the other surveyed the lower two reaches.

The reach segments are described below and shown in Figure 3. The stream channels were segregated by reaches. Reaches were identified as contiguous habitat types based on confinement, gradient and riparian characteristics (Table 1).

Table 1 – Survey Reach Description

Reach	Length (m)	Description
Reach 1;	443	Starts at Somenos Lake and ends at the Highway 1 culvert. Historically ditched and channelized. Now falls within Somenos Marsh property boundaries.
Reach 2:	378	Starts at the Highway 1 culvert and ends at a bedrock falls approximately 2.2m tall.
Reach 3;	469	Starts at the bedrock falls and ends at the Rafael confluence. This reach is much more urbanized and human accessible than the lower reaches.
Reach 4;	879	This reach starts at the confluence with Rafael and ends at the crossing of the railroad from east to west. The land use surrounding this reach is primarily agriculture with the exception of a large shopping center. The area is highly susceptible to further urbanization.
Reach 5;	986	This reach starts at the railroad crossing and ends at the Somenos rd. crossing. It is completely surrounded by pasture and other agricultural use. Riparian tree cover is limited throughout.
Reach 6;	1,396	This reach starts at the Somenos rd. crossing and ends at the Highway 19 crossing. The surrounding land used is a mix of residential and agriculture, with a large portion of the reach running through a golf course (Duncan Meadows).

Figure 2: Approximate Boundaries of the Averill Creek Watershed

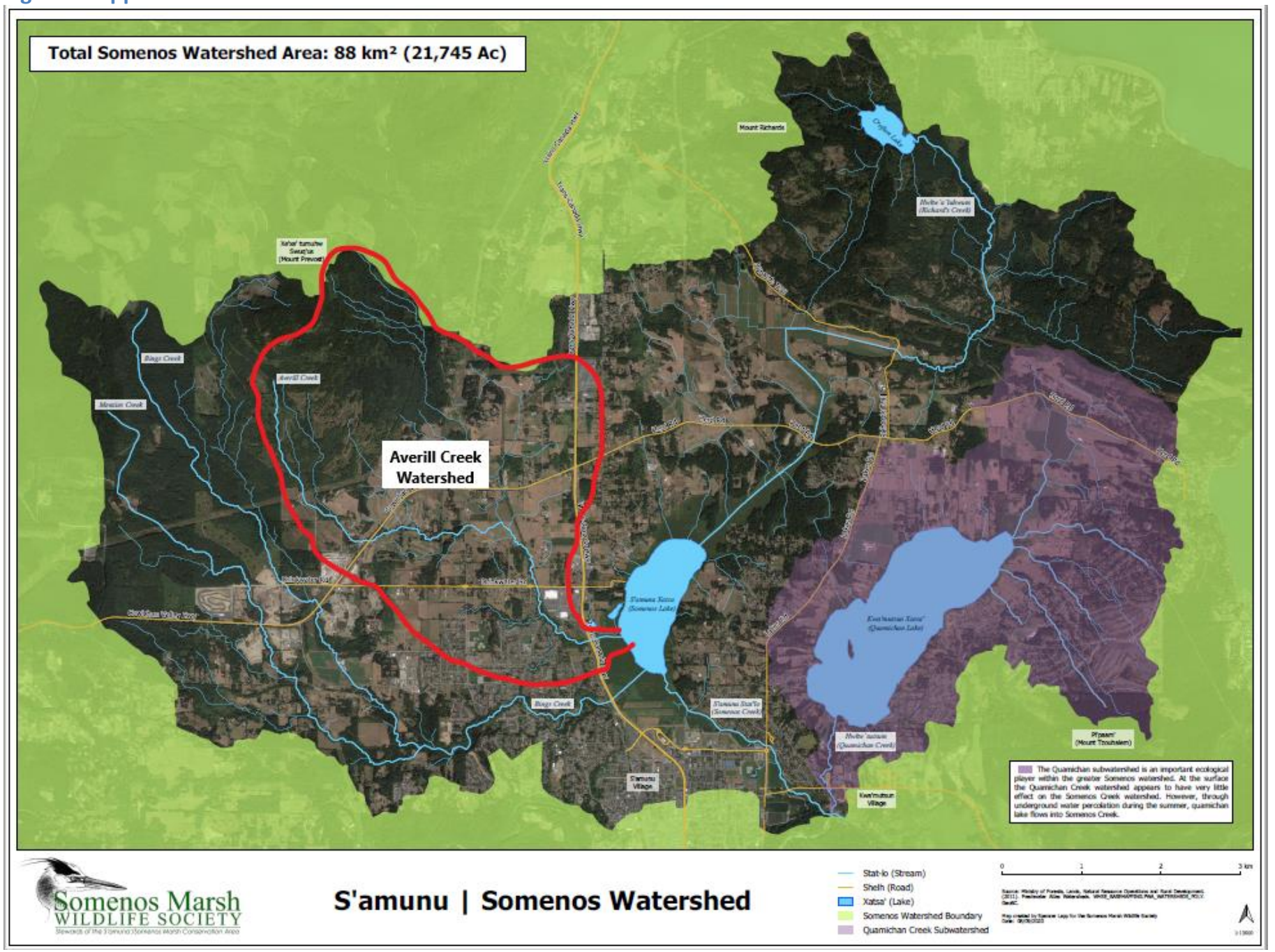
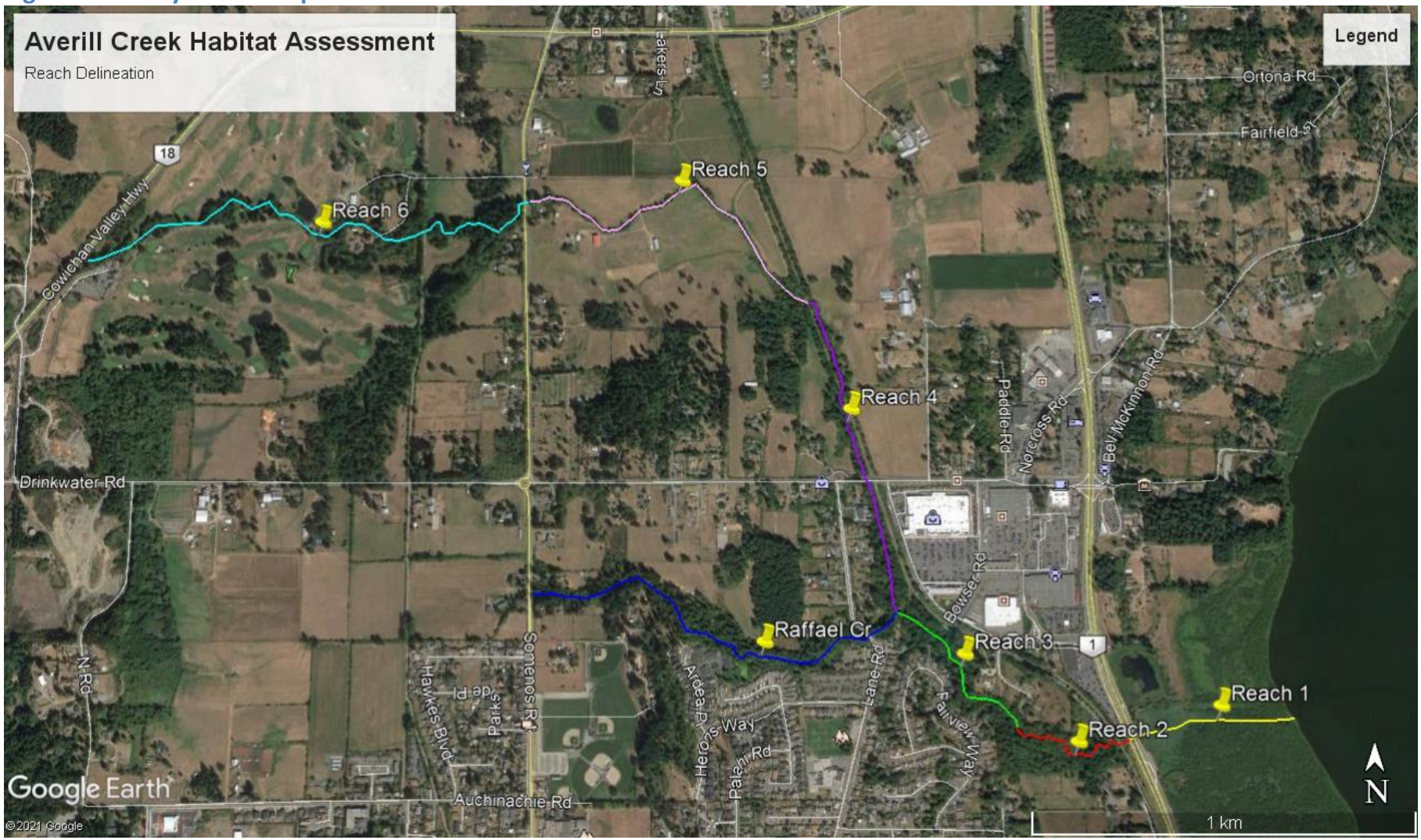


Figure 3. Survey Reach Map



Results and Discussion –Habitat Survey

The fish habitat and riparian data was summarized for each survey reach following the USHP format. The field survey date was June 3, 2021. Averill reaches R1-R6 were surveyed. Water quality sampling was conducted in Reach 1, 2, 3 and 4. The entire data set for each stream reach used in the USHP habitat assessment is in the appendices. The complete field survey data collection is also stored in a file provided to the SMWS. The files attached to this document include;

- Excel © table of compiled habitat data Averill data Reaches 1-6.
- Kmz file of survey locations and photo points.

The results of the USHP survey are presented below for each reach. The appendices show the habitat survey data recorded into the spreadsheet files for each reach.

Each reach had 10 habitat units (Pools or Riffles) surveyed if available. The spreadsheet data is shown in Appendix 1-9. This data was then scored according to the USHP methodology and presented Reach Habitat and Riparian scores and ratings in Tables 1-10 below. A reach map is shown in Figures 4 – 9.

A reach comparison table for the three largest tributaries in the Somenos watershed was summarized in Table 13.

The Watershed Restoration Summary Table and identifies the topics for each reach (Table 14);

- Riparian Habitat
- Spawning Habitat
- Rearing Habitat
- Obstructions
- Erosion
- Alterations
- Water Quality
- Education/Awareness

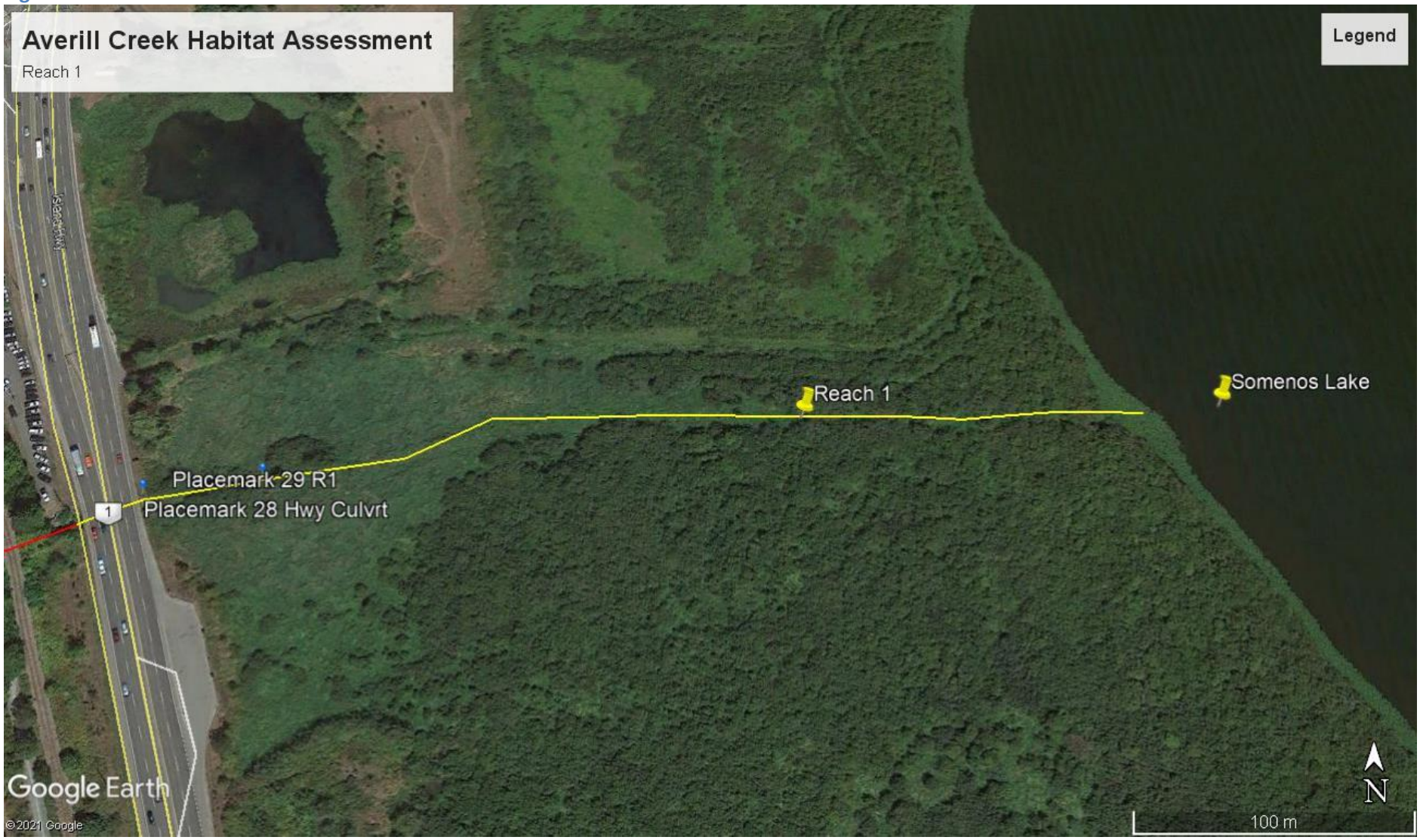
These items are described in the reach sections below and in the discussion.

Reach 1

Averill Reach 1 goes from Somenos Lake up to the Trans Canada Highway. This reach is in lake floodplain going past historic farm pastures delineated by cleared reed canary grass areas, old fence posts and irrigation ditches. The ditches appear to be diverting water away from Averill Creek into the old fields. The reach is estimated to be 443m long. This reach is salmon and trout accessible. The reach was surveyed June 3, 2021 with the channel at low summer flow. Our survey location was accessed from a northbound Highway 1 pullout.

Habitat was homogenous throughout the reach due to past channelization and farming, therefore only two points of data collection were found to be necessary to capture the 443m long reach.

Fig . 4 Averill R1



Reach 1 Habitat Photos

1.) Placemark 29- Reach 1, grass choked low gradient channel collects fines. 2.)Placemark 28- Reach 1, pool below highway is a sediment sump.

3.)Placemark 28- Reach 1, highway culvert barely above summer water level 4.)Placemark 29- Reach 1, shrub and canary grass dominated riparian

The reach was very low gradient (0.25% average) and runs through a wide floodplain (Somenos Marsh). The water temperature was 18.2C. The average channel width was 6.9m and the average wetted with was 4.5m. The mainstem has numerous disused irrigation ditches diverting mainstem water. The results are shown in the table below.

Table 1 - Reach 1 Habitat and Water Quality Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	100.00	1	Good
Large Woody Debris/Bankfull Channel Width	0.00	5	Poor
% Cover in Pools	55	1	Good
Average % Boulder Cover	0	5	Poor
Average % Fines	100.00	5	Poor
Average % Gravel	0.00	not rated	
% of Reach Eroded	0	1	Good
Obstructions	0	0	Good
% of Reach Altered	100	5	Poor
% Wetted Area	64.96	5	Poor
Dissolved Oxygen	65.00	1	Good
pH	7.30	1	Good
	Mean Score	3.0	Fair

The Riparian features of Reach 1 are shown in the table below taken from the USHP summary tables.

Table 2 - Reach 1 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	12	3	Fair
Riparian Slope	4	1	Good
Bank Stability	12	3	Fair
% Crown Cover	62.50	3	Fair
% of Reach Accessed	0	0	Good
Average Vegetation Depth	4	5	Poor
Mean Score		2.5	Fair

The entire length of Averill Creek Reach 1 was historically channelized into a straight ditch to accommodate drainage of hay pastures on either side. Farming has ceased in the area below Highway 1 which has re-naturalized, through still in early seral stages with limited shrub cover. It is low gradient and slow moving, causing settling of fine sediments which compose the majority of the stream bed.

The reach 1 survey showed a Fair overall result. There was a lack of diversity of habitat units.

The fish habitat characteristics that were good are;

- High percentage of pool area.
    - Extensive ditching has created homogenous pool habitat throughout the reach. Pool habitat is important for fish habitat, but it must be coupled with some habitat variance and instream cover.
- No permanent barriers manmade or natural.
    - No obstructions in the form of beaver dams, human structures, or debris jams were observed during the survey.
- High percentage of instream cover.
    - A large amount of overhanging shrubs and grasses offer great cover from predators and shade.
- Good water quality.
    - The water parameters measured in the USHP rendered a “good” scoring. Water quality parameters for dissolved oxygen barely fall within the “good” category for fish health. It should be considered this survey was completed in early June, it is not likely that dissolved oxygen would stay high enough to sustain fish life throughout the summer. Furthermore, conductivity and TDS were both measured to be very high, 247µS and 124ppm respectively. These are not measurements considered in the USHP calculation.
- Low percentage of erosion.
    - Low gradient, straight channel does not lend to erosive action.

The fish habitat characteristics that were poor are;

- Poor spawning habitat.
    - Due to lack of spawning gravel and high sediment levels. There is opportunity to create spawning habitat in this reach, very similar to those created in the lower reach of Bings Creek in summer 2021.
- Low percentage of instream cover.
    - Instream cover in the form of LWD and boulders are lacking. Overhanging vegetation is acting as an effective alternative in providing cover for fish, but thoughtful placement of LWD and boulders would offer erosive benefit and help create and maintain habitat diversity.
- Low percentage of wetted area.
    - An unnaturally wide channel has led to a lower percentage of wetted area and a shallower depth, not ideal for fish survival and habitat.
- High percentage of human alteration.
    - Reach has been repeatedly ditched leading to a serious lack of diversity in habitat, slow moving waters.
- Fines
    - Repeated ditching deeply into the channel has removed most natural substrates. Furthermore, erosion upstream has caused settling of sediments in this low gradient reach, exaggerating the issue.

Reach 2

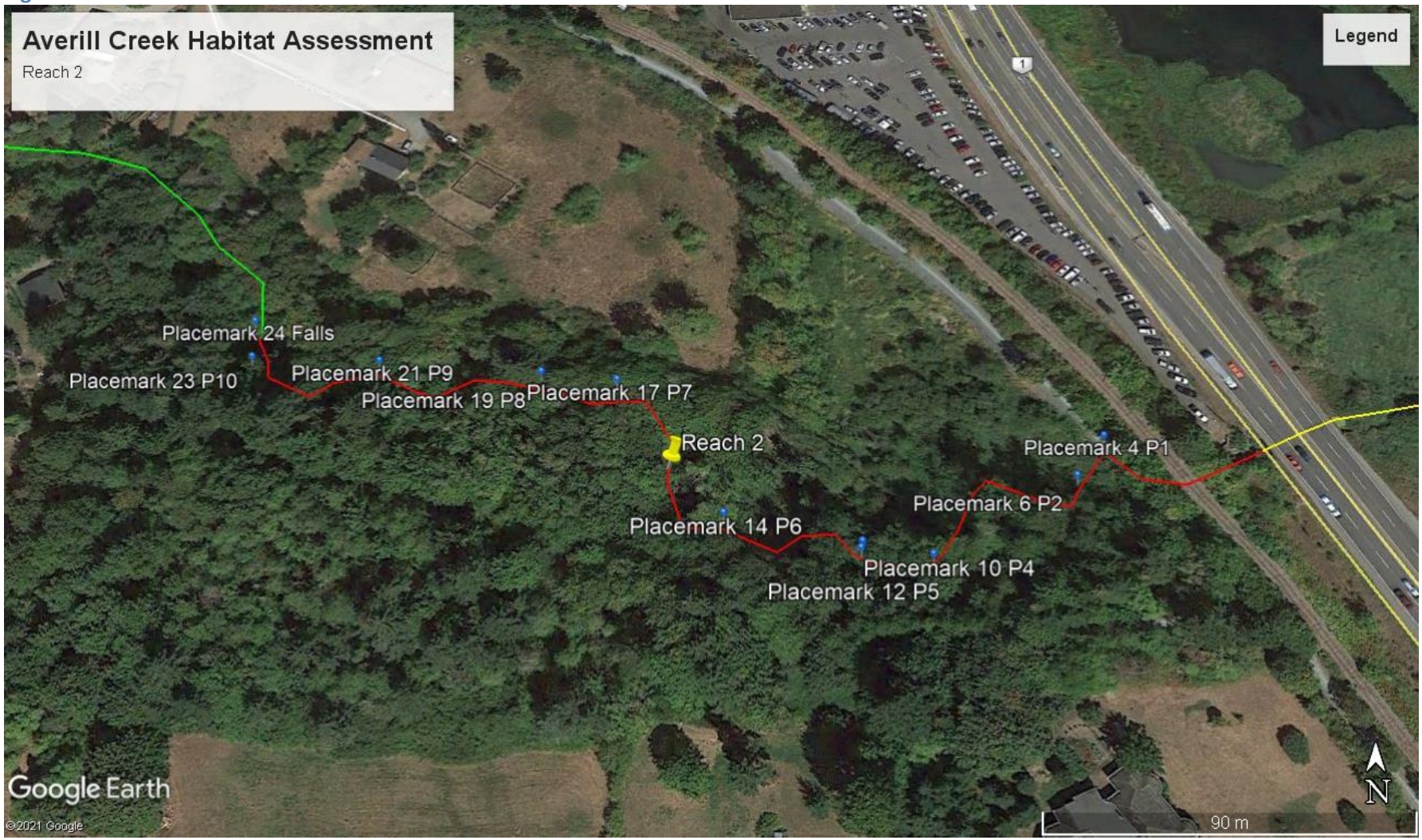
Averill Reach 2 is 378m long, beginning at the Highway 1 culvert it goes upstream under the highway, the E&N Rail into a treed riparian area of rural properties ending at a bedrock falls. This reach has Coho salmon and Cutthroat Trout juveniles observed in the perennial pools. The riparian area was historically logged but there is an adequate regeneration of trees in most of the length. The channel is altered by the highway and railway alignments that straighten the route but the majority follows the historic channel. During our survey we observed the impacts of higher than normal peak flows causing erosion, sedimentation, and degradation of instream habitat features.

The USHP survey on June 3, 2021 captured 10 pools and 8 riffles over 292m. We started our survey from the trail access near the highway and walked the channel to the falls and above. This reach had an average channel width of 6.5m and a wetted width of 3.4m. The reach is shallowly sloped with an average gradient of 1.2%. The water temperature was 17 C. The results are shown in the table below.

Table 3 - Reach 2 Habitat and Water Quality Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	77	1	Good
Large Woody Debris/Bankfull Channel Width	0.2	5	Poor
% Cover in Pools	6	5	Poor
Average % Boulder Cover	1	5	Poor
Average % Fines	46	5	Poor
Average % Gravel	45	not rated	
% of Reach Eroded	10	3	Fair
Obstructions	5	5	Poor
% of Reach Altered	2	1	Good
% Wetted Area	53	5	Poor
Dissolved Oxygen	67	1	Good
pH	7.30	1	Good
	Mean Score	3.4	Fair

Fig . 5 Averill R2



Reach 2 Habitat Photos

1.) Placemark 3- Reach 2 Culvert under Highway 1.

2.) Placemark 6- Reach 2, Pool 2. Heavy erosion along left bank

3.) Placemark 8- Reach 2, Riffle 2. Old spawning gravel crest.

4.) Placemark 15- Reach 2, Pool 6

The Riparian features of Reach 2 are shown in the table below taken from the USHP summary tables.

Table 4 - Reach 2 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	40	1	Good
Riparian Slope	46	1	Good
Bank Stability	140	4	Fair/Poor
% Crown Cover	68	3	Fair
% of Reach Accessed	9	3	Fair
Average Vegetation Depth	83	1	Good
Mean Score		2.2	Fair/Good

Reach 2 is altered by livestock fencing, diversion and transportation crossings. It scored an overall Fair result. Below are descriptions of good and poor habitat characteristics, specific sites for restoration activities are referred to in Table 13.

The fish habitat characteristics that were good are;

- Surrounding land use is primarily natural.
    - Riparian vegetation depth and health is generally quite good due to lack of human influence. This reach runs entirely within park and private land that has seen very little development.
- Water Quality was good.
    - Water quality parameters were slightly better than downstream and more likely to offer habitat through the summer due to lower susceptibility to change (crown cover, instream habitat diversity).
- High percentage of pool area.
    - Pools through this reach are more functional than the reach below. There is more diversity in habitat and substrate type.
- Low amount of human alteration
    - Largely naturalized and recovering well from historic logging.
- Spawning Habitat.
    - There are several areas of spawning habitat and a high percentage of instream gravel. Previous spawning gravel structures[4] have been installed on this reach. Salmon are observed using these sites. The sites could use maintenance (more gravel) and a handful of other sites for spawning gravel enhancement were identified (Table 13).

The fish habitat characteristics that were poor are;

- Lack of Instream Cover.

[4] *D.R. Clough 2014/2015 with District North Cowichan and Cowichan Community Land Trust. Reports on file.*

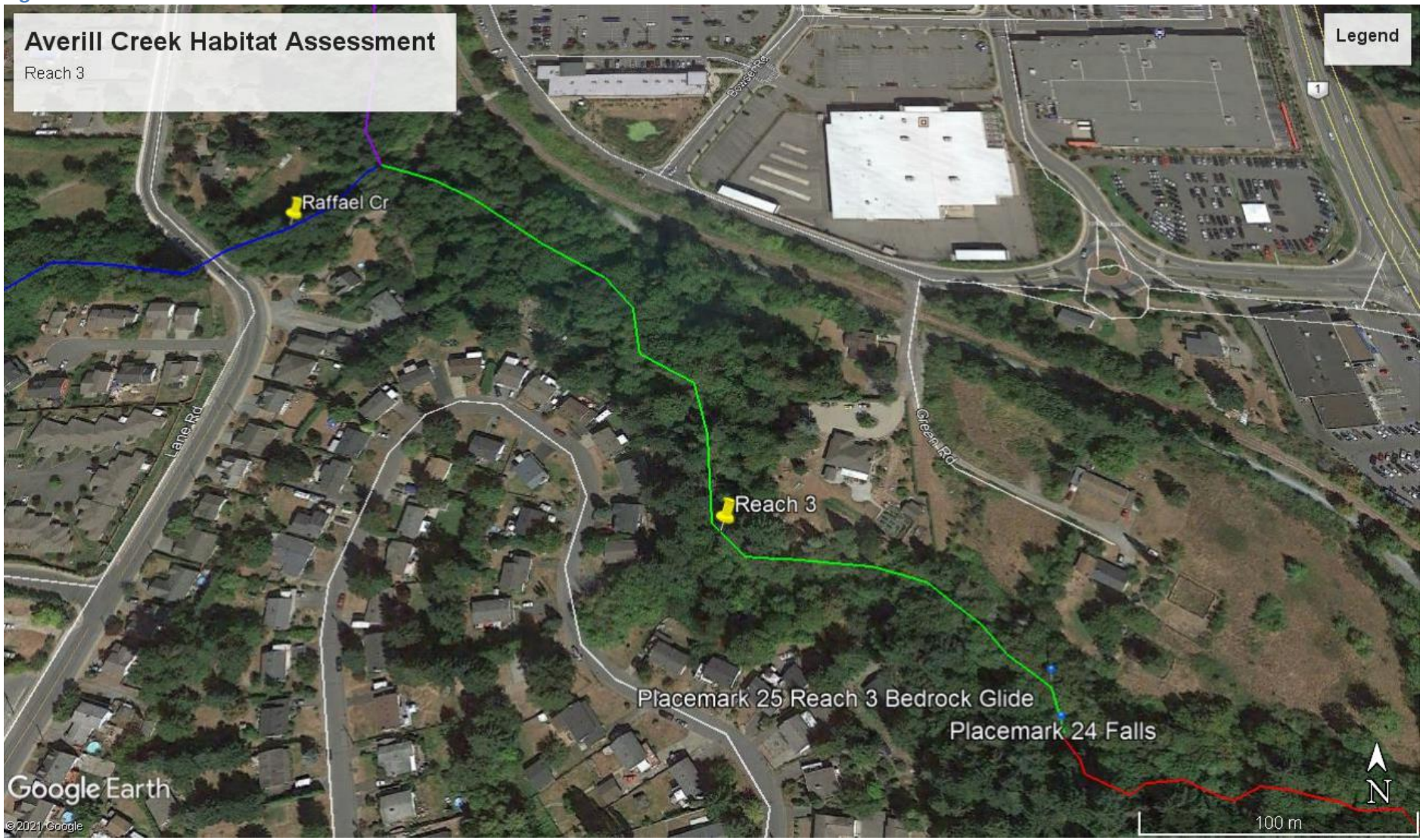
    - Higher peak flows and historic logging has removed much of this creek's instream cover in the form of LWD and boulders. The LWD and Brush cover installed in 2014/2015 remains in place and more could be added.
- Erosion
    - Bank erosion is occurring in the lower portions of this reach between placemarks 4-13. Strategic riparian planting and stabilization of these sites would be highly valuable.
- Alterations and obstructions
    - Channel altered and diverted for the purpose of farming. Old farm bridges collapsed into the channel in multiple locations.
- Low percentage of wetted area.
    - An unnaturally wide channel has led to a lower percentage of wetted area and a shallower depth, not ideal for fish survival and habitat.
- Fines
    - Gravel quality is diminished by sediment. The deposition of fines in the pools is a product of upland erosion and sedimentation. Addressing erosion upstream will help the lower reaches.

Reach 3

Averill Reach 3 is approximately 469m long, it starts from the bedrock falls and ends at the confluence with Raphael Creek. We walked the lower portion of the reach (approx. 100m) along a bedrock glide before encountering an aggressive dog. This reach was not thoroughly surveyed due to lack of access for the survey team. The result was a single habitat unit surveyed. The habitat unit surveyed was a bedrock glide and the bedrock composition remained consistent upstream. The confluence with Raphael was also inspected which was more similar to the upstream reach with evidence of farming impacts, primarily deposition of fines. The surveyed habitat had a channel width of 6.5m, a wetted width of 4.1m, and a gradient of 0%.

The results are shown in the table below.

Fig . 6 Averill R3



Reach 3 Habitat Photos

1.) Placemark 25- Bedrock glide lower.

2.) Placemark 25- Bedrock glide upper.

3.) Placemark 26- Bedrock pool upstream the surveyed glide.

4.) Placemark 32- R3 end; culverts at the confluence with Raphael Creek.

Table 5 - Reach 3 Habitat and Water Quality Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	0.00	5	Poor
Large Woody Debris/Bankfull Channel Width	0.03	5	Poor
% Cover in Pools	0	5	Poor
Average % Boulder Cover	0	5	Poor
Average % Fines	0.00	1	Good
Average % Gravel	10.00	not rated	
% of Reach Eroded	0	1	Good
Obstructions	0	0	Good
% of Reach Altered	0	1	Good
% Wetted Area	63	5	Poor
Dissolved Oxygen	86	1	Good
pH	7.20	1	Good
	Mean Score	2.7	Fair

The Riparian features of Reach 3 are shown in the table below taken from the USHP summary tables.

Table 6 - Reach 3 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	2	1	Good
Riparian Slope	2	1	Good
Bank Stability	6	3	Fair
% Crown Cover	75	1	Good
% of Reach Accessed	0	0	Good
Average Vegetation Depth	35	3	Fair
Mean Score	Mean Score	1.5	Fair/Good

This reach is the least altered segment in the entire stream. Reach 3 habitat results in an overall Fair score.

The fish habitat characteristics that were good are;

- High percentage of crown cover.
    - This reach is located adjacent a rural residential area that was historically logged and farmed. The regenerating second growth riparian area is now less encroached upon.
- Few obstructions or alterations.
    - Not any residual farm/logging alterations, much of this reach following its native route. The culverts are significant and require debris maintenance.
    - The main type of alteration in this reach was the bedrock falls with a small concrete weir/footing for a historic water line.
- Low percent of reach eroded.
    - High percentage of bedrock in the creek bed does not lend to erosion.
- Low percentage of fines
    - High percentage of bedrock does not offer very many opportunities for long term deposition of fines.

The Reach 3 fish habitat characteristics that were poor are;

- Low percentage of pool area.
    - Bedrock stream bed is not erodible with no scour pools.
- Instream cover by both large woody debris and boulders.
    - Instream habitat features must be well secured to protect from high velocity flows.
- Low percentage of wetted area.
    - The bedrock glide has no residual depth other than small rock pockets.

Reach 4

Averill Reach 4 is approximately 879m long and runs primarily through agricultural land. It goes from confluence of Raphael Creek upstream to the upper E&N rail crossing. The majority of the channel has moderate riparian coverage, but the land use results in erosion and deposition into the stream bed from upstream areas. There are portions of the upper reach with free access by cattle in farm pastures and cleared riparian to the creek edge.

The results are shown in the table below.

Table 7 - Reach 4 Habitat and Water Quality Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	87	1	Good
Large Woody Debris/Bankfull Channel Width	0.24	5	Poor
% Cover in Pools	6	3	Fair
Average % Boulder Cover	3	5	Poor
Average % Fines	49.50	5	Poor
Average % Gravel	35.50	not rated	
% of Reach Eroded	17	5	Poor
Obstructions	0	0	Good
% of Reach Altered	28	5	Poor
% Wetted Area	64	5	Poor
Dissolved Oxygen	60.00	1	Good
pH	6.00	3	Fair
	Mean Score	3.0	Fair

The Riparian features of Reach 3 are shown in the table below taken from the USHP summary tables.

Table 8 - Reach 4 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	60	3	Fair
Riparian Slope	48	2	Fair/Good
Bank Stability	70	4	Fair/Poor
% Crown Cover	61.00	3	Fair
% of Reach Accessed	91	5	Poor
Average Vegetation Depth	13	5	Poor
Mean Score	Mean Score	3.7	Fair/Poor

Reach 4 habitat results in an overall Fair score.

The fish habitat characteristics that were good are;

- High percentage of pool area.
    - Pools are necessary for fish habitat especially during low summer flows where they may provide habitat where no other wetter area exists. Unfortunately most were shallow and full of fines.

The Reach 4 fish habitat characteristics that were poor are;

- Poor vegetation depth
    - Much of the riparian is cleared to the creek bank for pasture in the upper reach. The lower reach has slightly better riparian depth, but is being encroached upon on both sides.
- Poor bank stability and erosion
    - The poor bank stability and heavy erosion is tied to the surrounding land use and the destruction of riparian for agricultural use.
- Instream cover by both large woody debris and boulders.
    - Human alterations and effects of surrounding land use have affected the availability of instream cover in the form of both boulders and LWD. These structures are critical to fish rearing and survival.
- Low percentage of wetted area.
    - The eroded sidewalls of the channel result in shallow dry and vegetated riffles.
- Fines
    - Gravel quality is diminished by sediment. The deposition of fines in the pools are a product of upland erosion and sedimentation. Addressing erosion will help the lower reaches.

Fig . 7 Averill R4

Reach 4 Habitat Photos

1.) Reach 4, Riffle 3.

2.) Reach 4, Pool 6

3.) Reach 4, Pool 7

4.) Reach 4, eroded banks from livestock access.

Reach 5

Reach 5 is the mainstem Averill upstream of the north fork, from above the E&N Rail to Somenos Road where there is a bedrock fish barrier. Similar to reach 4, reach 5 runs through agricultural lands, primarily livestock pastures. It is approximately 986m long. The surveyed (upper) portion of the reach was walked from Somenos Rd down 69m in which 4 riffles and 5 pools were surveyed. The survey was incomplete as access was denied by the land owner. This reach has a thin riparian and is heavily eroded throughout. There was evidence of livestock grazing on vegetation directly adjacent to the creek in the survey area.

The results are shown in the table below.

Table 9 - Reach 5 Habitat and Water Quality Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	59.	1	Good
Large Woody Debris/Bankfull Channel Width	0.06	5	Poor
% Cover in Pools	6	5	Poor
Average % Boulder Cover	4	5	Poor
Average % Fines	46	5	Poor
Average % Gravel	45	not rated	
% of Reach Eroded	99	5	Poor
Obstructions	0	0	Good
% of Reach Altered	4	1	Fair/Poor
% Wetted Area	49	5	Poor
Dissolved Oxygen	na		
pH	na		
	Mean Score	3.6	Fair/Poor

The riparian features of Reach 5 are shown in the table below taken from the USHP summary tables.

Table 10 - Reach 5 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	72	4	Fair/Poor
Riparian Slope	40	2	Fair/Good

Riparian Ratings	Result	Ratings	Result
Bank Stability	90	5	Poor
% Crown Cover	69	3	Fair
% of Reach Accessed	98	5	Poor
Average Vegetation Depth	5	5	Poor
Mean Score	Mean Score	4.0	Fair/Poor

Reach 5 habitat results in an overall Fair/Poor score.

The fish habitat characteristics that were good are;

- High percentage of pool area
    - Pool habitat was shallow and had poor cover.
- No obstructions in the survey area.
    - There were no obstructions observed but we were not permitted access to inspect the entire reach. Note this reach ends at a bedrock fish barrier at Somenos Road.

The Reach 5 fish habitat characteristics that were poor are;

- Lack of instream cover by both large woody debris and boulders.
    - Human alterations and effects of surrounding land use have affected the availability of instream cover in the form of both boulders and LWD. These structures are critical to fish rearing and survival.
- Low percentage of wetted area.
    - The wide channel is a result of disturbances and led to a lower percentage of wetted area and a shallower depth, not ideal for fish survival and habitat.
- Erosion and low bank stability
    - The reach has active erosion throughout due to an unfortunate mix of high winter flows, poorly vegetated riparian, and bank destabilization from livestock and past farm/logging development.
- Poor riparian depth
    - Agricultural land on either side of the creek encroaches to the very limits of the creek bank leaving very few trees.
- Fines
    - Gravel quality is diminished by the abundant sediment. Deposition of fines in pools is a product of erosion and sedimentation. Addressing erosion will help the reach.

Fig . 8 Averill R5

Reach 5 Habitat Photos

1.) Placemark 28- Reach 5, Riffle 2 well in creek.

2.) Placemark 29- Reach 5, Pool 3 erosion on river right.

3.) Placemark 32-Reach 5 end at Somenos rd. - Fish passage barrier.

4.) Placemark 33- Reach 5, Pool 5 heavy erosion river right.

Reach 6

Reach 6 is approximately 1,396m long, starting at the Somenos rd. culvert and ending at the double culvert (hung) under Highway 18. It runs primarily through rural residential areas with well-forested backyards in the lower reach and through a golf course in its upper reach. Specific measurements were not taken as this reach does not offer promising fish habitat as it resides between fish passage barriers and goes dry.

The reach was not flowing at the time of the survey, but the larger pools remained. As the survey was completed early in summer, the pools were likely to later dry up. Salamander tadpoles were utilizing the pools, but no fish were observed. Restoration efforts in this reach should be centered on aspects that effect downstream fish habitat and amphibian habitat restoration and enhancement. This is an ideal area to enhance for amphibians as this reach goes dry and therefore excludes bullfrogs. Bullfrogs require perennially wetted habitat for tadpole survival. Furthermore, the surrounding land use is largely rural residential and the riparian area has largely been left natural. Partnerships with land owners in this area could be highly successful.

Aspects to consider for downstream fish habitat:

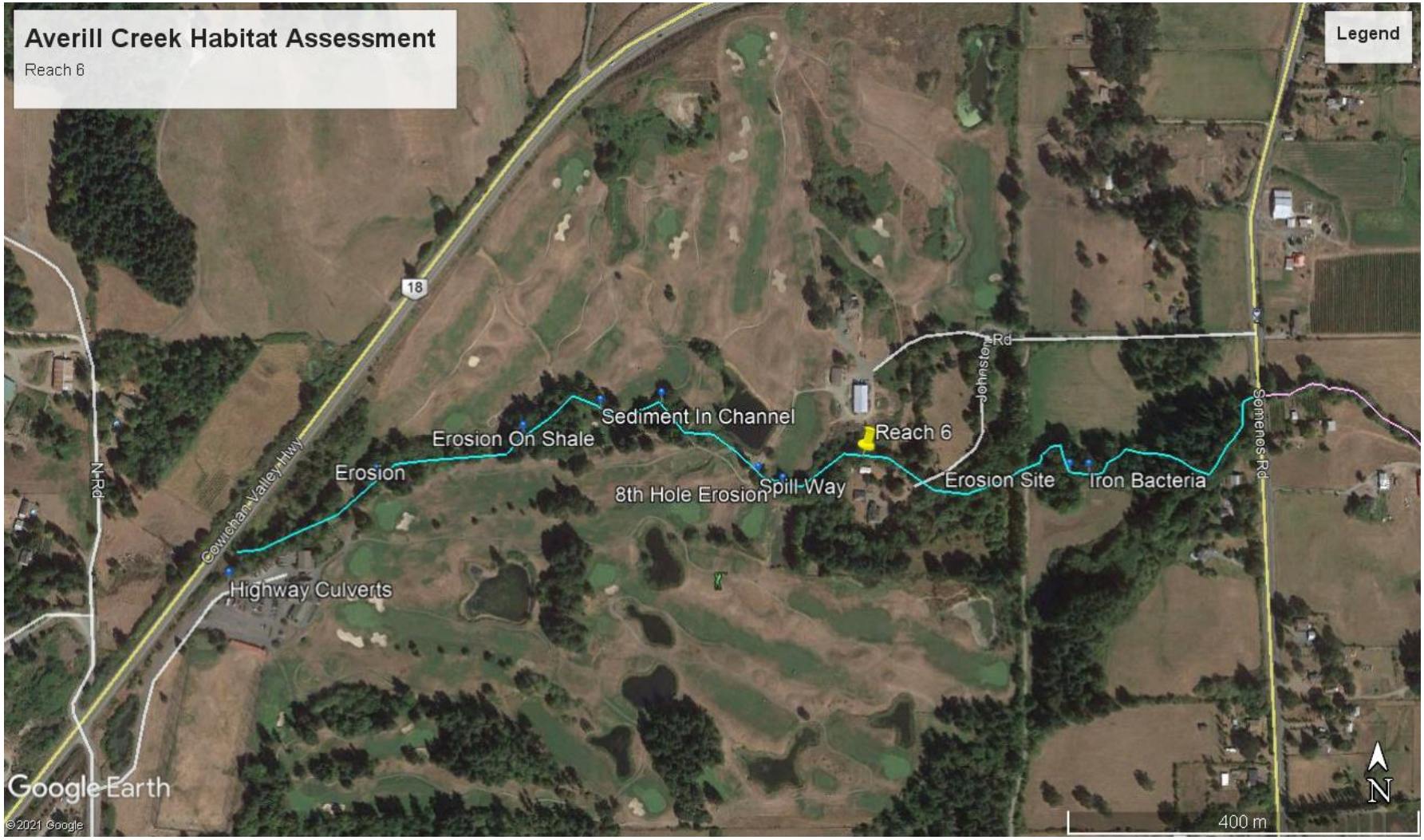
- Erosion
    - Erosion in this reach will deposit fines downstream, affecting fish spawning and invertebrate rearing habitat. Willow and Red Osier Dogwood staking would help stabilize areas of erosion. Other areas may need more detailed erosion protection prescriptions using the addition of rip rap and/or LWD (pond spill way and steep banks).

- Riparian planting
    - Overall riparian areas require infill planting, prioritize the southern aspect in gaps to shade the creek, reducing the temperature of water entering fish habitat.

Aspects to consider for amphibian habitat enhancement

- Placement of coarse woody debris (CWD)
    - CWD placement in the riparian area above the high water mark. CWD structures are necessary for amphibian survival and habitat, especially during the heat of summer when pools are dry (Appendix 9).

Fig . 9 Averill R6



Reach 6 Habitat Photos

1.) Lower Reach, dry channel

2.) Lower Reach, June pools

3.) Upper reach, bank erosion through golf course.

4.) Upper reach, irrigation pond of golf course.

Discussion

Survey Efficiency and Limitations

The level 2 habitat survey of Averill Creek covered six reaches 4,551m from Somenos Lake to the Highway 19 culverts. Our survey effort was weighted to the lower salmon bearing and perennial wetted habitat.

Table 11 – Averill Creek Survey Efficiency and Coverage

Reach	USHP Length (m)	Reach Length (m)	Percent Reach Surveyed
Reach 1	442	443	100
Reach 2	292	378	77
Reach 3	86	469	18
Reach 4	129	879	15
Reach 5	84	986	9
Reach 6	n/a	n/a	n/a
Total	1033	3155	43.8

Averill Creek Habitat Comparison

Reach Comparison

The interpretation of the USHP survey was compared in the reach summary tables presented in the Results above. The summary tables identified a numeric score for Good (1), Fair (3) and Poor (5). Converting the values into a numeric score permits reaches to be compared amongst each other or over time. The table below shows a review of the five Averill Creek reaches.

Table 12 – Averill Creek Reach Habitat and Riparian Summary

Reach	Habitat	Result	Riparian	Result
Reach 1	3.0	Fair	2.5	Fair
Reach 2	3.4	Fair	2.2	Fair/Good
Reach 3	2.7	Fair	1.5	Fair/Good
Reach 4	3.0	Fair	3.7	Fair/Poor
Reach 5	3.6	Fair/Poor	4.0	Fair/Poor
Mean Score	**3.1**	**Fair**	**2.8**	**Fair**

Based on overall reach scores in Table 12; the instream habitat results in Averill Creek scored 3.1 for a resulting overall value of Fair. This was a somewhat consistent habitat score for every reach.

Reach 5 scored the poorest at 3.6, largely due to the large amount of erosion, high percentage of fines, and degraded instream habitat from the surrounding land use.
The overall riparian mean score of 2.8 is fair. It was consistent throughout reaches, with the reaches 4 and 5 scoring poorest as these reaches are surrounded by agricultural land that has encroached on the riparian significantly. The riparian area of Averill Creek is recovering; the plant community is a regenerating mixed deciduous and conifer forest with a diverse shrub layer. It is improving with time.

Vancouver Island Habitat Comparison

The Table 13 comparison makes it clear that the Somenos watershed's three main tributaries (Bings, Richards, and Averill) are suffering from many of the same problems. Like most other Vancouver Island streams, these three creeks suffer from legacies of historic logging and dredging. These activities have removed the LWD, boulders, and large trees in the riparian which prevent erosion and offer excellent shading. They are fortunate to have a high percentage of pools, a product of deep dredging for flood mitigation and the Cowichan Valley's low gradient.

Table 13 - Fish Habitat Deficiency (x) Comparison of Creeks in the Somenos Watershed.

Watershed	Percent Pool Area (<55%)	Large Woody Debris (<2)	Percent In-stream Cover (<20%)	Percent Fines (>10%)	Percent Wetted Area (<90%)
Bings Creek (2020)		X	X	X	X
Richards Creek (2021)		X	X	X	X
Averill Creek (2021)		X	X	X	X

***An X entry represents a rating poorer than the proposed cutoff for acceptable habitat quality.**

Averill Watershed- Restoration Sites

The field survey in June resulted in many ideas for restoration. As we measured habitat, we were also considering the restoration plans for the site. We itemized the impacts and restoration options of each reach segment. After the habitat survey was completed the habitat data and daily observations were reviewed for the restoration plan. Table 14 below shows the summary of restoration plans for the Averill Watershed. The restoration categories we used were:

- Riparian Habitat
- Spawning Habitat
- Rearing Habitat
- Obstructions
- Erosion
- Alterations
- Water Quality
- Education/Awareness

Table 14 has a priority ranking for the restoration activity. The ranking of high, medium or low is based on a combination of factors; the ecological hazard and the benefit (cost, access, partnerships) of doing the activity. Table 14 shows the high priority restoration sites and activities.

Table 14 - Restoration Sites - Averill Creek

Reach	Issue	Location	Prescription	Priority
R1	Riparian Restoration Logged and farmed riparian area entire length. It was flattened and channelized for farming and the recovery is hampered by uniformity of the old pastures.	Both Banks. Entire reach.	Create plant mounds to both keep the roots slightly drier and lift the tree high enough that it won't be choked out by canary grass. Sitka Spruce is the ideal tree candidate for this site. In areas where riparian is primarily grass, red osier cuttings or other fast-growing, water-loving shrubs such as willow or salmonberry would be good candidates for immediate bank stabilization and shading of the creek. Plant at 1 meter spacing along the upper 140m of the reach. Removed sediments from the creek bed can contribute to the mounds.	**H**
R1	Fill old pasture perimeter ditches.	Placemark 30 is one location of several	Fill the perimeter ditches to conserve flow to Averill Creek, protect riparian areas from excessive flooding and loss of fish.	M
R1	Highway runoff management plan.	Placemark 28, bridge and adjacent shoulder.	Build impermeable curb over bridge leading to rain garden.	H
R1	Sump maintenance	Highway culvert outlet.	Remove fines and debris from sump area and downstream. Fines can be used for filling irrigation ditches or creating planting mounds.	M
R2	Railway culvert is undersized (2.5m) for flow and fish passage.	Placemark 3. Railway Culvert.	Long term plan should be replacement with bridge. Routine maintenance is required to remove debris blockages. It also has garbage and a beaver dam at the upstream end.	M
R2	Spawning Gravel. Deficient in stable spawning gravel. Previous sites damaged by log debris.	Placemark 5, 8, 13 and 17. (generally at pool tail-outs)	Placemark 5: 5m wide by 3m long spawning bed upstream of riffle 1. Use imported anchor rock for crest. Placemark 8: Maintenance at existing SG site. Reposition rocks and replenish gravel. Placemark 13: Maintenance at existing SG site. Reposition anchor rocks and replenish gravel. Placemark 17: Add gravel. No crest needed.	H

R2	Boulder Placement.	Placemark 11 and 13.	Boulders can be placed in clusters of 3 or singular, at least 1 meter from each bank and 1 meter apart. Use long flat rocks (35-45cm), to avoid creating a debris jam. Rock should not project more than 50% of its diameter at low flow. Non-uniform placement is preferred by fish.	M/H
R2	Cover habitat- Brush bundles and LWD.	Placemarks 4, 6, 11, 13.	Anchor LWD to banks using duck bills. Placement should be supervised by a professional to ensure placement that does not cause bank erosion. When placed correctly, LWD can offer both cover and scour (Increasing pool depth/ habitat quality). A short-term, more cost manageable option to provide pool cover is brush bundles. These are bundles of evergreen branches, tied together and anchored to the bank. Brush bundles offer shade and predator protection to fish (has been done here before).	M/H
R2	Erosion Stabilization.	Placemark 4, 5, 6, 9, and 10.	Red Osier dogwood or native willow cuttings can be planted in areas of erosion along the bank. This treatment should be coupled with any large rock placement to offer bank stabilization. When rock is used it is important that it be used in conjunction with cuttings to not only provide physical stabilization, but also, shade, organic input, and wildlife value.	H
R2	Improve falls fish passage.	End of Reach 2.	If the falls were made more passable increases habitat utilization to the Somenos Rd culverts for a total mainstem habitat availability of 3,155m. This number does not include the numerous off-channel habitats and tributaries that would offer a minimum 3,534m of anadromous accessible channels on just Rafael Creek and the tributary that enters at the top of reach 4. Consult experts for strategies and options to improve falls pass-ability.	H
R2	Riparian Restoration.	Southern aspect, various locations. Placemark 4,8, and 9 were flagged as particularly in need.	The reach has a relatively healthy riparian, but is dominated by deciduous trees. Planting conifers will offer diversity, increased bank stability and year-round shading. Water-loving conifer selections such as Western Red Cedar and Sitka Spruce would be the best selections for this site.	M
R2	Jam removal.	Placemark 10 (near trail)	Hand-remove SWD from the jam location (approx. 100 pieces). LWD can be cut or repositioned to improve their functionality as fish habitat and reduce their potential to catch debris.	M/H

R2	Wetland Restoration.	Placemark 7.	Removal or management of Reid Canary Grass would be necessary at this location. Planting of standard wetland species such as cedars, Sitka spruce, skunk cabbage, and sedges as well as adding CWD is suggested for this location. Planting of fast growing wetland plants to provide shading on the southern aspect will help control canary grass. The opportunity to create off-channel habitat at this location is relatively low as the wetland is much higher than the channel. There is, however, opportunity to enhance amphibian habitat by creating ephemeral or seasonal pools that go dry in the summer to exclude bullfrogs.	L/M
R2	Invasive Removal.	Placemark 7-12.	Himalayan Balsam can be removed from riparian areas and replanted with native species. Plant choice must be competitive, fast-growing, shade and water-tolerant, understory species. Suitable options could be salmonberry, red osier dogwood, skunk cabbage, and various species of fern.	M
R3	Debris cleanup.	Placemark 32.	Cleanout the buildup of debris and garbage on the upstream side of the footpath culverts.	M
R3	Riparian Restoration.	Southern aspect and areas of poor crown cover should be prioritized.	Conifers would be ideal for these sites, particularly water-loving ones such as Western Red Cedar and Sitka spruce.	L
R4	Boulder Placement.	Riffles and pools throughout.	Boulders placed in clusters of 3 or singular, at least 1 meter from each bank and 1 meter apart. Use long flat rocks (35-45cm), to avoid debris collection. Rock should not project more than 50% of its diameter at low flow. Non-uniform placement is preferred by fish.	M
R4	Pool Cover: LWD and Brush Bundles.	All pools, prioritizing those currently lacking cover. Surveyed pools would include pools 1, 4, and 7.	Anchor LWD to banks using duck bills. Placement should be supervised by a professional to ensure placement that does not cause bank erosion. When placed correctly, LWD can offer both cover and scour (Increasing pool depth/ habitat quality). A short-term, more cost manageable solution to lack of pool cover is brush bundles. These are bundles of evergreen branches, tied together and tied to the bank. Brush bundles offer shade and predator protection to fish.	M

R4	Erosion Control.	Riffle 1, 2, 3 and Pool 4.	Red Osier dogwood or native willow cuttings can be planted in areas of erosion along the bank. This treatment can be coupled with large rock placement to offer bank stabilization. When rock is used it is important that it be used in conjunction with cuttings to not only provide physical stabilization, but also, shade, organic input, and wildlife value.	M/H
R4	Riparian Restoration.	Throughout reach prioritizing south side, cooperative land owners and access. Can only be done in areas were livestock are excluded from riparian.	Conifers would be ideal for these sites, particularly water-loving ones such as Western Red Cedar and Sitka spruce. Strong partnerships with property owners would be essential for riparian restoration success.	M/H
R4	Cows access creek.	Along railway (west side).	Work with property owners to reduce or fence access.	H
R5	Boulder Placement.	Riffles and pools throughout.	Boulders placed in clusters of 3 or singular, at least 1 meter from each bank and 1 meter apart. Use long flat rocks (35-45cm), to avoid debris. Rock should not project more than 50% of its diameter at low flow. Non-uniform placement is preferred by fish.	M
R5	Pool Cover: LWD and Brush Bundles.	All pools, prioritizing those currently lacking cover.	Anchor LWD to banks using duck bills. Placement should be supervised by a professional to ensure placement that does not cause bank erosion. When placed correctly, LWD can offer both cover and scour (Increasing pool depth/ habitat quality). A short term, more cost manageable solution to lack of pool cover is brush bundles. These are bundles of evergreen branches, tied together and tied to the bank. Brush bundles offer shade and predator protection to fish.	M
R5	Erosion Control.	Right bank of surveyed area.	Red Osier dogwood or native willow cuttings can be planted in areas of erosion along the bank. This treatment can be coupled with large rock placement to offer bank stabilization. When rock is used it is important that it be used in conjunction with cuttings to not only provide physical stabilization, but also, shade, organic input, and wildlife value.	H

R5	Riparian Restoration.	Throughout reach prioritizing south side, cooperative land owners and access. Can only be done in areas were livestock are excluded from riparian.	Conifers would be ideal for these sites, particularly water-loving ones such as Western Red Cedar and Sitka spruce. In areas where invasive have taken hold, they should be removed in a method proven effective for that species. Fast-growing native trees should be planted on the southern boundary of the infestation to help suppress regrowth of shade intolerant species such as Himalayan blackberry. Ideal candidates for this use could be Red Alder or Pin Cherry, and in drier soils, Big Leaf Maple. Imported soil and mulch can help suppress regrowth.	H
R5	Goats grazing in riparian	Throughout surveyed area.	Work with property owners to reduce or fence access.	H
R5	Extensive erosion has exposed a well on river right bank.	Riffle 2	Inform land owner- water license is required for use of well. The well is currently not registered on iMap.	M/H
R6	Riparian Restoration	Throughout reach prioritizing south side, cooperative land owners and access.	Conifers would be ideal for these sites- particularly water-loving ones such as Western Red Cedar and Sitka spruce. In areas where invasive have taken hold, they should be removed in a method proven effective for that species. Fast-growing native trees should be planted on the southern boundary of the infestation to help suppress regrowth of shade intolerant species such as Himalayan blackberry. Ideal candidates for this use could be Red Alder or Pin Cherry, and in drier soils, Big Leaf Maple.	M
R6	Erosion Control	Erosion sites throughout Duncan Meadows. Placemarks labeled “Erosion”.	Red Osier dogwood or native willow cuttings can be planted in areas of erosion along the bank. This treatment can be coupled with large rock placement to offer bank stabilization. When rock is used it is important that it be used in conjunction with cuttings to not only provide physical stabilization, but also, shade, organic input, and wildlife value. The manager at Duncan Meadows was highly agreeable and could be a great partner for erosion stabilization projects. The spill way will require riprap placement to provide necessary stabilization. Erosion in this section is severe and stabilization would be highly valuable in reducing downstream fine deposition and improving success of spawning gravel restoration.	M
R6	CWD Placement	Riparian area above the high water mark.	CWD can be placed throughout the riparian. Wood used would ideally be unmerchantable due to risk of firewood scavenging. Unmerchantable or slightly rotting wood is best for amphibians due to hollows and access points. Please see CWD SOP in appendix 9 for placement advice.	M

R1 Restoration Photos

R1- Poor riparian depth and invasive canary grass

R1-Old farming irrigation ditch

R1- Highway runoff goes straight to creek

R1- Highway sump needs to be dredged

R2 Restoration photos

R2- Wetland on river left full of Canary Grass and Himalayan Balsam

R2 –Failing riffle crest from previous restoration.

R2 – Debris Jam at pool 5

R2 – Bedrock falls, 2.2m slide (anadromous barrier)

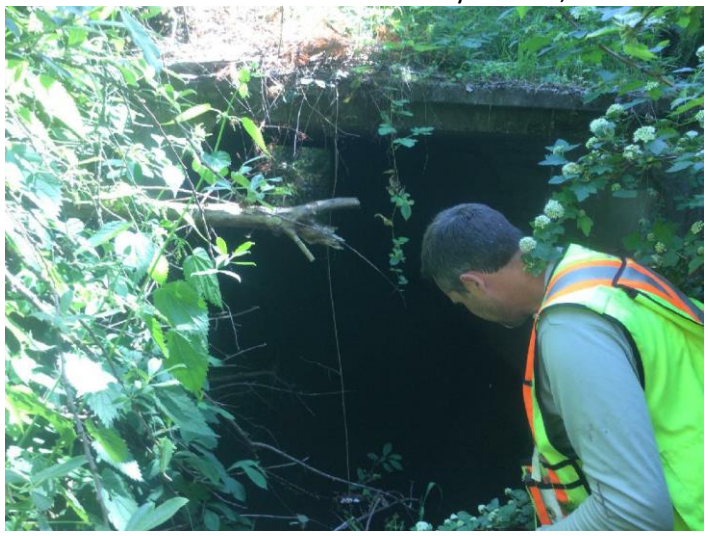
R3 Restoration photos

R3 – Double culvert at foot trail with debris and garbage

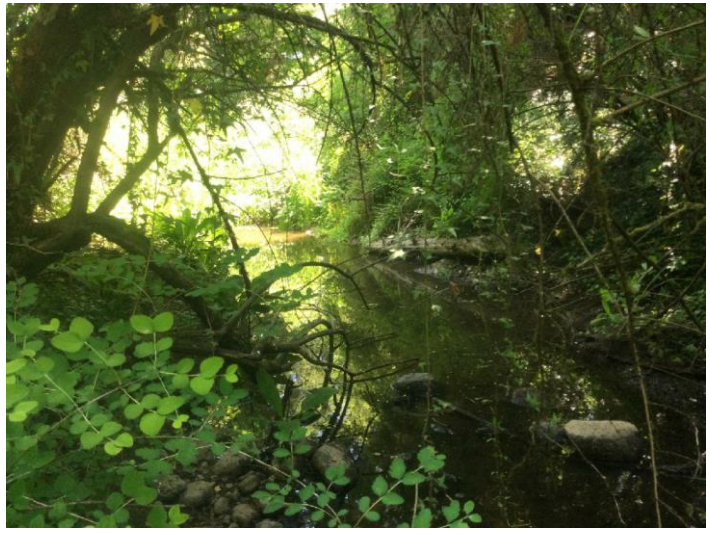
R4 Restoration photos

R3 –Pool 6 full of fines and heavily eroded, unstable banks

R3 – Cows in creek on east side of the railroad.



R3 – Drinkwater rd. concrete box culvert



R3 – Breaks in riparian near riffle 2.

R5 Restoration photos

R3 – Old farm well now in creek due to erosion.

R3 – Heavy bank erosion on river right.

R3 –Old concrete falling into the creek

R3 – Evidence of goats grazing on blackberry in riparian.

R6 Restoration photos

R3 – Blackberry infestation on southern aspect near Somenos rd.

R3 – Heavy bank erosion river right.

R3 –Large pool (salamander tadpoles present)

R3 – Golf course spill way is eroding (Duncan Meadows)

Restoration Prescriptions

The restoration projects identified involve riparian and instream works i.e. bank stabilization, planting, spawning gravel placement, and instream cover habitat placement.

Permits

Work instream that could result in disturbance to fish or their habitat is done under a water act permit. Generally riparian planting and surface garbage clean up does not require a permit. This permit is available online through Frontcounter B.C. http://www.frontcounterbc.gov.bc.ca. For fish habitat restoration the permits are submitted as *notifications* and signed off by Fisheries and Oceans, The District of North Cowichan or other government. The restoration design is taken from the data provided in the habitat survey (i.e. location, channel width).

Designs

Stream habitat restoration requires designs to plan the work and submit for permit. Table 13 identifies the restoration prescription. The table describes the type of restoration to be applied to the site. The designs for the sites are based on standard practices developed and published for stream restoration projects. The B.C. Watershed Restoration Program provides a standard reference for stream restoration techniques in "Fish Habitat Rehabilitation Procedures"[5]. This manual is often referred for acceptable restoration practices including rock log and gravel placements in streams.

The Pacific Streamkeepers Federation Streamkeepers Handbook is another very useful guide for restoration and monitoring examples such as;

- Module 3 – Water Quality Survey
- Module 6 – Stream Clean up
- Module 7 – Streamside Planting

High Priority Restoration Activities*

Table 15- High Priority Restoration Sites

Reach	High Priority Restoration Activity	Description
1	Highway runoff management plan	Redirect runoff away from the creek
1	Riparian Restoration	Planting water-tolerant tree species on mounds.
2	Spawning Gravel	Addition and maintenance of spawning sites.
2	Boulder Placement	Single boulders and clusters in both pools and riffles.
2	Cover habitat- Brush bundles and LWD	LWD must be well placed to prevent scour. Brush bundles can be put in pools wherever cover is lacking.
2	Erosion Stabilization	Red Osier and Willow staking. Possible placement of riprap.

[5] Slaney, P.A. and D. Zaldokas, 1997. Fish Habitat Rehabilitation Procedures, Watershed Restoration Program, MOELP, UBC , Vancouver BC.

2	Improve falls pass-ability	Consult a professional. Permitting required.
2	Jam removal	Pool 5. Reused LWD for pool cover.
4	Erosion Control	Red Osier and Willow staking. Possible placement of Riprap.
4	Riparian Restoration	Plant water tolerant plants, prioritizing southern aspect.
4	Cows access creek	Work with land owner.
5	Erosion Control	Red Osier and Willow staking. Possible placement of Riprap.
5	Riparian Restoration	Plant water tolerant plants, prioritizing southern aspect.
5	Goats grazing in riparian	Work with land owner.
5	Erosion Control	Red Osier and Willow staking. Possible placement of Riprap.

Conclusion

The Urban Salmon Habitat Survey of the Averill Creek watershed serves as a reference for both monitoring and restoring a watershed. The baseline survey of fish habitat with reference locations offers repeatable surveys critical to understanding the current and future stream health. The USHP survey also provides the data on the functional components used for recovery of the watershed. This information is the basis for restoration planning. The USHP provides specific data on the length width and character of the instream and riparian area.

The results of the habitat survey of Averill Creek indicate recovery from historic logging, but current land use activities are proving detrimental to recovery. The recovery is readily observable by the height and depth of trees along most of the waterway, particularly in areas that have been left to proceed with natural succession such as reach 2, 3, and lower reach 6. The current health of the watershed scored Fair in overall USHP ratings. Urbanization has more recently diverted, culverted and encroached the stream channel. Long term planning is essential for the protection of Averill Creek due to its vulnerability to further alteration as large portions of it run along borders of urban development. Agricultural practices have also had an impact on stream health and it was these areas of the creek that ran through agricultural land that scored lowest. Local government planning and zoning have the biggest role to play in how the land is developed, i.e. Cowichan Valley, North Cowichan Regional Districts and Cowichan Tribes.

Watershed based planning is key to protection of the waterways, fish and wildlife values. A good plan equally protects homes and infrastructure. Higher level guidance is available for communities from the B.C./DFO Develop With Care Guidebook and Waterbucket.ca. Establishing these principles in the OCP of local government is vital to protecting Averill Creek. The District of North Cowichan recently completed the Bonsall Creek Watershed Management Plan [6] in 2015. This study

[6] https://www.northcowichan.ca/EN/main/departments/planning-development/community-planning/bonsall-creek-watershed-management-plan.html

is a good template for the Somenos Watershed and should be endorsed to incorporate into the Official Community Plan (OCP).

The focus of restoration on Averill Creek should not start with the restoration prescription in table 13; it should start with forming partnerships with the local government and land owners. Restoration activities are most effective when preformed on a watershed level using a top-down approach. Restoration in the upper watershed will minimize confounding factors in the reaches below, increasing the chances of successful projects. The priority of activities in the restoration plan is not necessarily the order in which they should be done. Restoration is best done with willing land owners and partners. Bringing in the property owners and local residents as active participants is vital to long term success. The SMWS made a successful first step by contacting property owners about the survey. It is important to share the results and plans with them as a follow up. Thus any restoration on their property would be more likely approved by the land owner.

Over the last 30 years, there has been a transition of the boots on the ground restoration personnel from government only, to activities led by stewardship groups working in partnership with government and property owners. It has been the successful formula. The SMWS has put a lot of effort into the Somenos Watershed over the years. They have been undertaking water quality and fish monitoring, invasive species removal, native plant restoration, garbage removal, public awareness/education, watershed planning including mapping, landscape planning and committee and partnership building. They have broken out the Somenos Watershed into sub basins for assessment. This restoration plan offers a list of restoration prescriptions as well as important baseline habitat data on Somenos Watershed. We hope this report brings more successful projects for the Somenos Marsh Wildlife Society.

Submitted by

David R. Clough, RPBio

and

Chelsea Eaglestone-April, Biological Technician

Appendix 1 – Reach 1 Habitat Data

Stream Name	Averill Creek	Watershed Code	1234	Date	44350.00	Reach Name	Reach 1			Discharge Depth #1	1.00	Velocity		
Water Quality Information					Field Crew		PG, GH, DRC					T1	1.00	Site Length
Dissolved Oxygen	65.00	pH	7.30	Total Dissolved Solids	124.00	Temp C	18.60	Chainage at Beginning of Reach	0.00	Discharge Depth #2	1.00	T2	1.00	1.00
Velocity (m/s)	1.00	Average Depth (at flow site)	1.00	Wetted Width (at flow site)	1.00	Discharge (m3/s)	1.00	Chainage at End of Reach	442.00	Discharge Depth #3	1.00	T3	1.00	
Habitat Information (All Pool and Cross Section Data)														

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent					Percent Instream Cover				
												Bed	Bld	Cob	Grv	Fine	Bold	LWD	Cutbk	Veg	Other
Pool	417.00	442.00	25.00	7.50	187.50	187.50		1.00	0.00	8.50		0	0	0	0	100	0	0	0	100	0
Pool	0.00	417.00	417.00	1.40	583.80	583.80		0.10	0.50	5.20		0	0	0	0	100	0	0	0	10	0
Reach Totals and Averages		442.00	442.00	4.45	771.30	771.30	100.00	0.55	0.25	6.85	64.96	0	0	0	0	100	0	0	0	55	0

Habitat Type	Percent Crown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use		Vegetation Type		Riparian Slope		Stability		Vegetation Depth		Livestock Access		Photos	Comments
										Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left		
Pool	40.00	0	0	0	25	0	0	0	0	FG	FG	Gr	Sh	1	1	Med	Med	3	5	0	0		Sites 28 and
Pool	85.00	0	0	0	417	0	0	0	0	FG	FG	Gr	Sh	1	1	Med	Med	3	5	0	0		PM29
										0	0	0	0			0	0						
										0	0	0	0			0	0						
Reach Totals and Averages	62.50	0	0.00	0	100	0	0			6	6			2	2	6	6	3.00	5.00	0	0		

Appendix 2 – Reach 2 Habitat Data

Stream Name	Averill Creek	Watershed Code	1234	Date	44350.00	Reach Name	Reach 2			Discharge Depth #1	1.00	Velocity		
Water Quality Information					Field Crew		GH, PG, DRC					T1	1.00	Site Length
Dissolved Oxygen	67.00	pH	7.30	Total Dissolved Solids	123.00	Temp C	17.00	Chainage at Beginning of Reach	86.00	Discharge Depth #2	1.00	T2	1.00	1.00
Velocity (m/s)	1.00	Average Depth (at flow site)	1.00	Wetted Width (at flow site)	1.00	Discharge (m3/s)	1.00	Chainage at End of Reach	378.00	Discharge Depth #3	1.00	T3	1.00	
Habitat Information (All Pool and Cross Section Data)														

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent					Percent Instream Cover				
												Bed	Bld	Cob	Grv	Fine	Bold	LWD	Cutbk	Veg	Other
Pool	86.00	96.00	10.00	4.50	45.00	45.00		0.20	0.00	7.00		0	5	0	45	50	5	0	0	0	0
Riffle	96.00	97.00		5.30	0.00	5.30		0.00	1.00	6.10		0	0	0	50	50	0	0	0	0	0
Pool	97.00	139.00	42.00	4.10	172.20	172.20		0.50	0.00	5.60		0	0	0	40	60	0	0	0	0	0
Riffle	139.00	145.00		2.00	0.00	12.00		0.00	6.00	5.20		0	10	25	65	10	5	0	0	0	0
Pool	145.00	167.00	22.00	2.00	44.00	44.00		0.40	0.00	5.60		0	0	0	45	55	0	0	5	0	0
Pool	167.00	177.00	10.00	6.50	65.00	65.00		1.00	0.00	7.50		0	0	0	40	60	0	50	0	0	0
Riffle	177.00	179.00		0.90	0.00	1.80		0.05	0.00	6.00		0	0	0	40	60	0	0	0	0	0
Riffle	179.00	196.00		3.90	0.00	66.30		0.05	5.00	7.50		0	30	20	40	10	5	0	0	0	0
Pool	196.00	211.00	15.00	2.70	40.50	40.50		0.50	0.00	6.50		0	0	0	40	60	0	0	10	0	0
Pool	211.00	240.00	29.00	4.50	130.50	130.50		1.00	0.00	6.50		0	0	0	40	60	0	5	0	0	0
Riffle	240.00	258.00		2.00	0.00	36.00		0.30	1.00	7.00		40	10	10	40	0	0	0	0	0	10
Pool	258.00	271.00	13.00	4.10	53.30	53.30		0.20	0.00	7.50		0	0	0	40	60	0	0	0	0	0
Riffle	271.00	280.00		2.00	0.00	18.00		0.05	3.00	7.50		0	0	0	40	50	0	0	0	0	0
Pool	280.00	315.00	35.00	4.50	157.50	157.50		0.50	0.00	6.50		0	0	0	40	60	0	0	0	5	0
Riffle	315.00	329.00		4.50	0.00	63.00		0.05	3.00	6.50		0	0	0	40	60	0	0	0	0	0
Pool	329.00	351.00	22.00	4.50	99.00	99.00		0.30	0.00	6.50		10	0	0	40	50	0	0	0	0	0
Riffle	351.00	373.00		2.00	0.00	44.00		0.05	3.00	6.10		0	0	0	65	35	0	0	0	0	0
Pool	373.00	378.00	5.00	2.00	10.00	10.00		0.50	0.00	6.10		0	0	0	65	35	0	0	0	0	0
Reach Totals and Averages		292.00	203.00	3.44	817.00	1063.40	76.83	0.31	1.22	6.51	52.90	3	3	3	45	46	1	3	1	0	1

Habitat Type	Percent Crown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use		Vegetation Type		Riparian Slope		Stability		Vegetation Depth		Livestock Access		Photos	Comments
										Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left		
Pool	90.00	1	7	10	0	0	0	0	0	Nat	Nat	Mix	Sh	45	1	Low	Low	8	150	0	0		Obstruction
Riffle	80.00	0	0	1	0	0	0	0	0	Nat	Nat	Mix	Sh	30	1	Med	Low	50	150	0	0		
Pool	70.00	0	0	3	0	0	100	20	0	Nat	Nat	Sh	Br	15	1	Med	Low	50	150	0	0		
Riffle	70.00	0	0	0	5	0	0	0	0	R	Nat	Sh	Br	15	1	Med	Low	8	150	0	5		trail
Pool	85.00	0	0	5	0	0	0	0	0	Nat	Nat	Sh	Br	15	1	Low	Med	50	150	0	0		
Pool	70.00	5	37.5	10	0	0	0	0	0	Nat	Nat	Sh	Br	10	1	Med	Low	50	150	0	0		
Riffle	70.00	0	0	0	0	0	0	0	0	Nat	Nat	Br	Sh	10	1	Med	Med	100	150	0	0		
Riffle	70.00	0	0	0	1	0	0	0	0	Nat	Nat	Br	Br	10	1	Med	Med	40	150	0	5		
Pool	75.00	0	0	0	0	0	0	0	0	Nat	Nat	Br	Br	10	1	Med	Med	100	150	0	0		
Pool	75.00	2	13	0	0	0	0	0	0	Nat	Nat	Br	Br	10	5	Low	Low	50	150	0	0		
Riffle	60.00	0	0	0	0	0	0	0	0	Nat	Nat	Br	Br	10	5	Low	Low	50	40	0	0		
Pool	50.00	0	0	0	0	0	0	0	0	Nat	Nat	Br	Br	10	5	Low	Med	80	20	0	0		
Riffle	60.00	0	0	0	0	0	0	0	0	Nat	Nat	Br	Mix	20	5	Low	Low	80	20	0	0		
Pool	60.00	0	0	0	0	0	0	0	0	Nat	Nat	Br	Br	30	15	Low	Low	100	30	0	0		
Riffle	60.00	0	0	0	0	0	0	0	0	Nat	Nat	Mix	Br	50	10	Low	Low	100	40	0	0		
Pool	60.00	0	0	0	0	0	0	0	0	Nat	Nat	Mix	Br	50	10	Low	High	100	40	0	0		
Riffle	60.00	0	0	0	0	0	0	0	0	Nat	Nat	Br	Br	50	20	Low	High	100	40	0	0		
Pool	60.00	0	0	0	0	0	0	0	0	Nat	Nat	Br	Br	50	20	High	High	100	40	0	0		
Reach Totals and Averages	68.06	8	0.18	10	2	5	34			22	18			28	18	72	68	67.56	98.33	0	3		

Appendix 3 – Reach 3 Habitat Data

Stream Name	Averill Creek	Watershed Code	1234	Date	44350.00	Reach Name	Reach 3			Discharge Depth #1	1.00	Velocity			
Water Quality Information					Field Crew		GH, PG, DRC					T1	1.00	Site Length	
Dissolved Oxygen	86.00	pH	7.20	Total Dissolved Solids	114.00	Temp C	18.40	Chainage at Beginning of Reach	0.00	Discharge Depth #2	1.00	T2	1.00		1.00
Velocity (m/s)	1.00	Average Depth (at flow site)	1.00	Wetted Width (at flow site)	1.00	Discharge (m3/s)	1.00	Chainage at End of Reach	468.00	Discharge Depth #3	1.00	T3	1.00		

Habitat Information (All Pool and Cross Section Data)

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent					Percent Instream Cover					Percent Crown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use		Vegetation Type		Riparian Slope		Stability		V De
												Bed	Bld	Cob	Grv	Fine	Bold	LWD	Cutbk	Veg	Other									Right	Left	Right	Left	Right	Left	Right	Left	
Riffle	0.00	468.00		4.10	0.00	1918.80		0.40	0.00	6.50		90	0	0	10	0	0	0	0	0	0	75.00	2	13	0	0	0	0	0	0	Nat	Nat	Br	Br	10	10	Low	High	50
																															0	0	0	0			0	0	
																															0	0	0	0			0	0	
Reach Totals and Averages		468.00	0.00	4.10	0.00	1918.80	0.00	0.40	0.00	6.50	63.08	90	0	0	10	0	0	0	0	0	0	75.00	2	0.03	0	0	0	0			1	1			1	1	5	1	50.

Appendix 4 – Reach 4 Habitat Data

Stream Name	Averill Creek	Watershed Code	1234	Date	44350.00	Reach Name	Reach 4			Discharge Depth #1	1.00	Velocity			
Water Quality Information					Field Crew		CE, AD, BRR					T1	1.00	Site Length	
Dissolved Oxygen	60.00	pH	6.00	Total Dissolved Solids	59.00	Temp C	13.40	Chainage at Beginning of Reach	379.00	Discharge Depth #2	1.00	T2	1.00		1.00
Velocity (m/s)	1.00	Average Depth (at flow site)	1.00	Wetted Width (at flow site)	1.00	Discharge (m3/s)	1.00	Chainage at End of Reach	508.00	Discharge Depth #3	1.00	T3	1.00		

Habitat Information (All Pool and Cross Section Data)

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent					Percent Instream Cover					Percent Crown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use		Vegetation Type		Riparian Slope		Stability		V De
												Bed	Bld	Cob	Grv	Fine	Bold	LWD	Cutbk	Veg	Other									Right	Left	Right	Left	Right	Left	Right	Left	
Pool	379.00	411.00	32.00	3.70	118.40	118.40		0.40	0.50	3.70		0	0	10	80	10	0	0	0	0	0	10.00	0	0	0	32	0	0	0	0	FG	FG	Mix	Sh	45	45	High	High	15
Riffle	411.00	415.00		1.80	0.00	7.20		0.10	2.00	5.30		0	0	20	50	30	0	0	0	0	5	50.00	0	0	2	0	0	0	0	0	FG	FG	Mix	Sh	36	30	Low	Low	15
Pool	415.00	430.00	15.00	2.60	39.00	39.00		0.20	0.00	3.60		5	0	5	5	85	0	5	0	0	0	60.00	1	3.6	0	0	0	0	0	0	FG	FG	Mix	Mix	45	45	Low	Low	15
Riffle	430.00	437.00		4.40	0.00	30.80		0.10	0.50	6.30		0	0	20	60	20	10	0	0	0	0	80.00	0	0	6	0	0	0	0	0	FG	FG	Mix	Mix	45	45	Med	Low	15
Pool	437.00	446.00	9.00	2.90	26.10	26.10		0.10	0.50	5.30		0	10	10	40	40	5	0	0	0	0	70.00	0	0	9	0	0	0	0	0	RS	FG	Mix	Mix	45	45	Med	Low	15
Pool	446.00	457.00	11.00	3.30	36.30	36.30		0.30	0.50	6.10		0	10	20	20	50	10	0	0	0	0	70.00	2	12.2	0	0	0	0	0	0	RS	FG	Mix	Mix	45	60	Med	Low	15
Pool	473.00	482.00	9.00	5.10	45.90	45.90		0.30	0.50	5.70		0	10	20	20	50	0	5	0	0	0	70.00	1	5.7	0	0	0	0	0	0	RS	FG	Mix	Mix	45	60	Med	Low	15
Pool	482.00	508.00	26.00	6.00	156.00	156.00		0.30	0.50	6.30		0	0	0	0	100	5	0	0	0	0	70.00	0	0	0	0	0	0	0	0	RS	FG	Mix	Mix	45	60	Med	Low	15
Riffle	457.00	466.00		2.30	0.00	20.70		0.10	1.00	5.10		0	5	5	80	10	0	0	0	0	5	60.00	0	0	5	0	0	0	0	0	RS	FG	Sh	Sh	30	35	High	Med	8
Riffle	466.00	473.00		0.80	0.00	5.60		0.10	1.00	3.90		0	0	0	0	100	0	10	0	0	0	70.00	2	7.8	0	4	0	0	0	0	FG	FG	Sh	Sh	30	35	High	Med	15
																															0	0	0	0			0	0	
																															0	0	0	0			0	0	
Reach Totals and Averages		129.00	102.00	3.29	421.70	486.00	86.77	0.20	0.70	5.13	64.13	1	4	11	36	50	3	2	0	0	1	61.00	6	0.24	17	28	0	0			30	30			24	24	28	42	14

Appendix 5 – Reach 5 Habitat Data

Stream Name	Averill Creek	Watershed Code	1234	Date	44350.00	Reach Name	Reach 5			Discharge Depth #1		Velocity																									
Water Quality Information					Field Crew		CE, AD, BRR					T1		Site Length																								
Dissolved Oxygen	.	pH		Total Dissolved Solids		Temp C		Chainage at Beginning of Reach	895.00	Discharge Depth #2		T2																										
Velocity (m/s)	.	Average Depth (at flow site)		Wetted Width (at flow site)		Discharge (m3/s)		Chainage at End of Reach	979.00	Discharge Depth #3		T3																										

Habitat Information (All Pool and Cross Section Data)

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent					Percent Instream Cover					Percent Crown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use		Vegetation Type		Riparian Slope		Stability		V
												Bed	Bld	Cob	Grv	Fine	Bold	LWD	Cutbk	Veg	Other									Right	Left	Right	Left	Right	Left	Right	Left	
Pool	895.00	910.00	15.00	2.60	39.00	39.00		0.20	0.00	5.00		0	15	10	50	25	15	0	0	0	0	55.00	0	0	15	0	0	0	0	0	FC	FG	Br	Br	10	55	Low	Low	1
Riffle	910.00	914.00		1.80	0.00	7.20		0.10	1.00	3.50		0	0	0	80	20	0	0	0	0	0	50.00	0	0	4	0	0	0	0	0	FC	FG	Br	Br	60	45	Low	Low	8
Pool	914.00	928.00	14.00	2.40	33.60	33.60		0.40	0.00	3.50		0	0	5	10	85	0	0	5	0	0	80.00	0	0	14	0	0	0	0	0	FC	FG	Mix	Br	50	50	Low	Low	4
Riffle	928.00	931.00		0.80	0.00	2.40		0.10	2.00	5.30		0	0	0	80	20	0	0	0	0	0	65.00	0	0	3	0	0	0	0	0	FC	FG	Br	Br	45	20	Low	Low	8
Riffle	931.00	940.00		2.30	0.00	20.70		0.20	0.00	2.70		0	5	5	10	80	0	0	5	0	0	80.00	0	0	7	0	0	0	0	0	FC	FG	Br	Br	55	25	Low	Low	3
Riffle	940.00	958.00		2.10	0.00	37.80		0.10	3.00	3.70		0	0	0	70	30	0	5	0	0	0	80.00	1	3.7	18	3	0	0	0	0	FC	FG	Mix	Mix	55	35	Low	Low	1
Pool	958.00	964.00	6.00	1.70	10.20	10.20		0.10	0.00	4.30		0	0	10	30	60	10	0	0	0	0	75.00	0	0	6	0	0	0	0	0	FC	FG	Mix	Mix	50	30	Low	Low	2
Riffle	964.00	975.00		0.60	0.00	6.60		0.10	3.00	6.10		0	0	5	60	35	0	0	0	0	0	65.00	0	0	11	0	0	0	0	0	FC	FG	Mix	Mix	45	45	Low	Low	5
Pool	975.00	979.00	4.00	6.20	24.80	24.80		0.40	0.00	7.60		0	15	15	15	55	10	0	0	0	0	70.00	0	0	5	0	0	0	0	0	FC	FG	Mix	Mix	25	35	Low	Low	5
Reach Totals and Averages		84.00	39.00	2.28	107.60	182.30	59.02	0.19	1.00	4.63	49.16	0	4	6	45	46	4	1	1	0	0	68.89	1	0.06	99	4	0	0			45	27			23	17	45	45	4.

Appendix 6 – Reach 1-5 Habitat Summary

Stream Name	Averill Creek			Watershed Code	1234								
Habitat Parameter	**Reach 1**	**Ratings**	**Reach 2**	**Ratings**	**Reach 3**	**Ratings**	**Reach 4**	**Ratings**	**Reach 5**	**Ratings**		**Ratings**	**Total**
% Pool Area	100.00	1	76.83	1	0.00	5	86.77	1	59.02	1		1	**10**
Large Woody Debris/Bankfull Channel Width	0.00	5	0.18	5	0.03	5	0.24	5	0.06	5		1	**26**
% Cover in Pools	55	1	6	5	0	5	6	3	6	5		1	**20**
Average% Boulder Cover	0	5	1	5	0	5	3	5	4	5		1	**26**
Average % Fines	100.00	5	45.83	5	0.00	1	49.50	5	45.56	5		5	**26**
Average % Gravel	0.00	not rated	45.28	not rated	10.00	not rated	35.50	not rated	45.00	not rated		not rated	**--**
% of Reach Eroded	0	1	10	3	0	1	17	5	99	5		5	**20**
Obstructions	0	0	5	5	0	0	0	0	0	0			**5.4**
% of Reach Altered	100	5	2	1	0	1	28	5	4	1		5	**18**
% Wetted Area	64.96	5	52.90	5	63.08	5	64.13	5	49.16	5		1	**26**
Dissolved Oxygen	65.00	1	67.00	1	86.00	1	60.00	1	.	1	.	1	**6**
pH	7.30	1	7.30	1	7.20	1	6.00	3		5		5	**16**
Totals		**30**		**37**		**30**		**38**		**38**		**26**	**199.4**
Off-Channel Habitat as % of Reach	0	5	34	1	0	5	0	5	0	5		1	**22**
Reach Lengths	442	not rated	292	not rated	468	not rated	129	not rated	84	not rated		not rated	**1415**

Riparian Ratings													
Reach	**Reach 1**	**Ave. Ratings**	**Reach 2**	**Ave. Ratings**	**Reach 3**	**Ave. Ratings**	**Reach 4**	**Ave. Ratings**	**Reach 5**	**Ave. Ratings**		**Ave. Ratings**	**Total**
Land Use	12	3	40	1	2	1	60	3	72	4			**12**
Riparian Slope	4	1	46	1	2	1	48	2	40	2			**8**
Bank Stability	12	3	140	4	6	3	70	4	90	5			**18**
		Ratings		**Ratings**		**Ratings**		**Ratings**		**Ratings**		**Ratings**	**--**
% Crown Cover	62.50	3	68.06	3	75.00	1	61.00	3	68.89	3		1	**14**
% of Reach Accessed by Livestock	0	0	9	3	0	0	91	5	98	5			**13**
Average Vegetation Depth	4	5	83	1	35	3	13	5	5	5		1	**20**
Totals		**15**		**13**		**9**		**22**		**24**		**2**	**85**

Appendix 7 – Spawning Gravel Placement Methods

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Spawning Gravel Placement .
Written for Coho/Cutthroat low gradient streams with 1-5% gradient. If Chum are present they will use this material but will sort for the larger sizes. Pink salmon will choose the smaller material. But determine the rock sizes based on the stream hydrology, the fish will figure it out.

Spawning gravel will be a mix of washed round rock. There is enough dirt in most streams such that more is not needed, especially during the application process.

Do not use crush rock for the spawning substrates as the sharp edges cut the tails of the fish and are seldom a natural occurrence.

The gravel supply should be inspected prior to delivery. Most gravel suppliers will have a range of the appropriate sizes in screened piles. Identify the piles with the operator. Determine the amount required. Generally two or three piles will be loaded and mixed. In small loads, the mixing of gravels can be accomplished by loading all grades required in the dump truck.

Size
The objective is to accommodate the channel and the species, heavier material in steep reaches, lighter in low gradient reaches. Below is a general mix ratio, adjust for gradient and discharge and avoid using just one size gravel.

Size (inches)	Ratio	Comments
1/2	15%	
1’	20%	
2”	20%	
3”	20%	
4"	15%	
6 – 12”	10 %	(these larges are aeration/bug/anchor rocks)

Depth
Generally in small creeks (<5.0m) gravel is not functional or deeper than six inches, (due to average alluvial deposition rates in typical regenerating watersheds). Calculation of depth; Place the gravel at 2-6 inches depth (average 4 inch/0.1m for calculation)

Length
If the average channel base width is about 5.5m, gravel is placed in the same width. Generally spawning areas are channel length to width (i.e. a 5.5m by 5.5m area). Do not add excessively long runs of gravel, excess gravel will just wash out and fill in pools.

Placement
Look to augment a natural crest made of stable gravel, boulders, bedrock or logs, and generally located at a pool tail out. The best place to add gravel is the upstream side of the crest upstream into the pool. Note if the site has suffered alteration and has sediment, sticks or dirty gravel, it is best to remove this material first.

Many streams lack natural crests due to alteration to habitat from dredging, debris torrents or floods. Making a crest to hold gravel in place if one does not exist is possible and recommended.

Determine the crest material generally large rocks determined to be suitable for flood stability that will not blow out (i.e. manning formula). Angular rock is often used for its availability of uniform size and flat sides for anchoring against the bottom of the channel. Round rock looks more natural but are often harder to collect and anchor.

Digging a trench or machine punching to embed the crest rock to increase its anchoring/impermeability is recommended. The crests are generally perpendicular to flow but site location may call for angular installation.

Crests rocks are generally placed across the channel to above high water and/or well tucked in at outside corners to avoid erosion. The width of rock crest is determined by stream slope and height of rocks. Install the crest height to the gravel depth of 0.1-0.15 m. Low stream crests well embedded only require 2-3 cross rows of rock on a flat site, more on gradient. The crests must be sealed with hard packed fine sediments. A band of geotextile on the crest is often applied to assist in sealing.

Discussion
This is a brief summary for people who are interested in our experiences. There can be other ways and more detail. Note that monitoring/maintenance /replenishment is recommended. This is not always due to design imperfection but gravel starved salmon may "use up" all the gravel over time by pushing it over the crests while spawning. Attached photos below of typical SG Sites (adjustments necessary as they are sized for the specific stream)

David Clough, RPBio

Grandon Creek spawning crests with pools and cover logs added.

Swan Creek spawning gravel site

Swan Creek installing gravel/crests at low flow

Averill Creek – looking d/s note wide anchor crest apron to hold gravel in place.

Appendix 8 – Bank Erosion/LWD Placement example (French Creek)

Construction Environmental Management Plan

RE:

Coarse Woody Debris Addition

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250-390-2901

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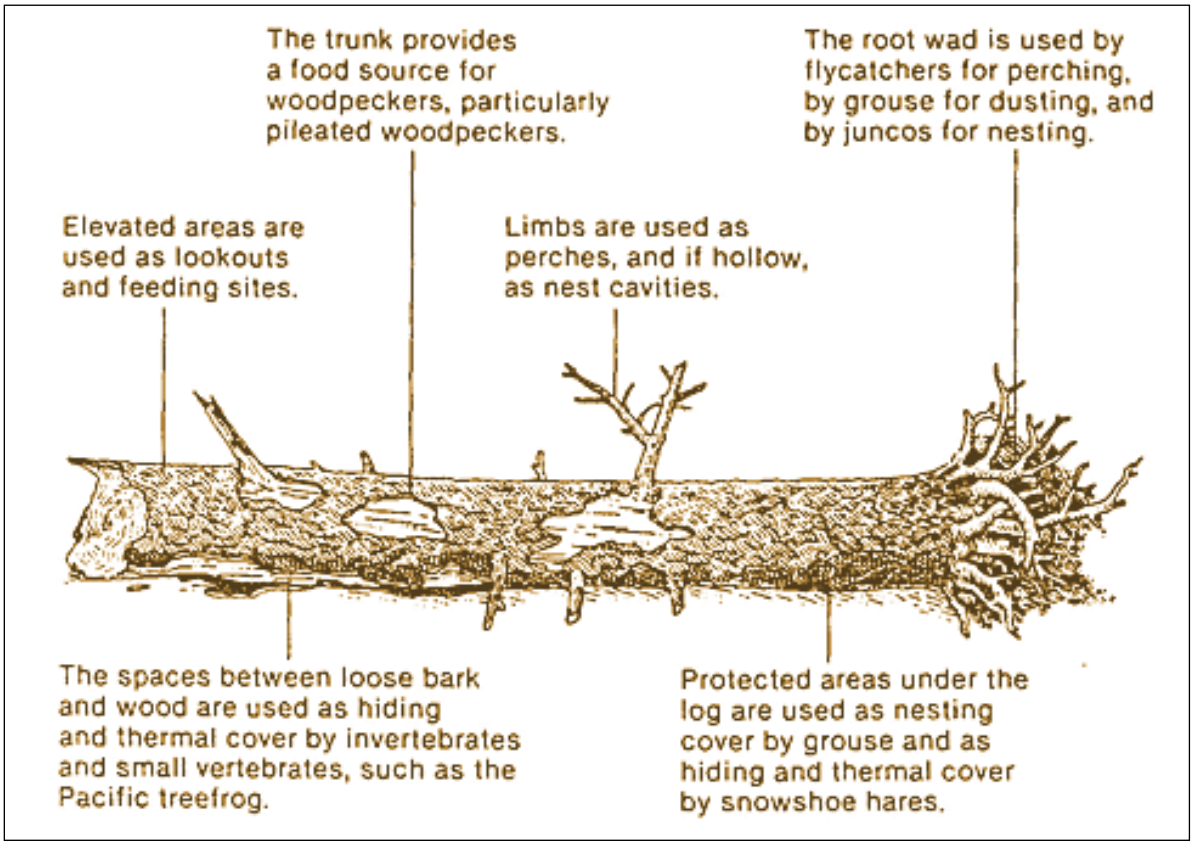
Introduction:

This is an addendum to provide detailed guidance on the utilization of Coarse Woody Debris (CWD) for wildlife habitat. The reason for this prescription is to compensate for the lack of wood on the forest floor that is important for wildlife habitat. The lack of CWD was identified from the environmental assessment[7]. The lack of CWD can be compensated following this plan.

Coarse Woody Debris Function

The function of coarse woody debris in coastal forests is very important for wildlife. The material is a food supply for invertebrates that are the base of the food chain for birds, amphibians and mammals. The wood is also an important home for cavity nesting and it acts as shade or moisture storage which creates a more diverse plant community on or adjacent these piles of wood. Coarse woody debris is a key ecological component of a healthy forest.

Fig. 1 Coarse Woody Debris Habitat Features[8]



[7] Tommy Road Water Environmental Assessment (D.R. Clough 2017).

[8] Ronald Bartels John D. Dell Richard L. Knight Gail Schaefer

Site Assessment

Determine the existing CWD density,

Table 1 – Site CWD Assessment

Survey Area	Existing CWD/ha	Species	Volume or Diameter/length

Assessment Comments:

i.e. Slope, soil conditions, fire hazard, nearby streams, wildlife dens, understory plant communities, danger trees.

Prescription

Survey Area	Additional CWD/ha	Species	Volume or Diameter/length

Based on access, material available, installation mechanisms and accessibility.

Discussion

Coarse Woody Debris Prescription

Danger Trees in the riparian areas are the best source of trees to use as CWD. Ensure the arborist knows the plan before work begins. Silviculture prescriptions may also identify trees that can be used such as felling off site species (i.e. Douglas fir in CWHvm1), thinning for conifer release and biodiversity clearing projects. Adjacent logging or clearing areas are the next likely available source of material. If importing CWD, it requires clean material with no invasive plants.

Work Area: Identify with flags, signage, mapping as required, ensure the locations are reviewed by all personnel.

Protected Areas: Identify and protect any stream crossings from equipment, protected plant communities, dens or other areas from site assessment

Other Areas: Streams, slopes, service corridors or future development areas may have different prescriptions.

CWD Materials:
Wood sources – species, diameter, lengths. All species native should be considered. Alders and other deciduous rot quickly to kick start diversity. Conifers must be used where longevity is needed.

Brush: Saplings and understory shrubbery may be cut for machine visibility of placements and for Silviculture prescriptions clearing for tree planting sites often done in concert with CWD placement.

Placement of Coarse Woody Debris

Placement of CWD will be sourced from danger tree falling and bucking or machinery placement.

1. Safety of personnel is paramount to any part of the operation. All persons and equipment operators must be certified and experienced in falling and handling the wood. None of the prescriptions override safe practices.
2. Consider the desired positioning and distribution of CWD prior to commencing falling, bucking or pruning activities. Direct falling such that they do not scar standing trees.
3. Buck minimally, for most sites 3-8m lengths or whole trees.
4. Roots attached and stumps are to be used as well.
5. Additional scarring and cavity creation is encouraged.
6. Top and Limb the logs only to allow some ease of handling.
7. Where possible, avoid visible cut ends by repositioning or covering with bark, moss, dirt or other logs.
8. Place CWD as barriers in roadsides or culvert/bridge sites to redirect wildlife (i.e. amphibians/reptiles) into riparian areas.
9. Avoid uniform positioning, with sporadic direction (make X, V, I and/or low piles) and maintain an even distribution.

10. Placement must avoid overloading one area and resulting in fire hazards, space the material at 3-5 m apart. Unless specifically creating special sites such as sensitive access barriers (i.e. a row of stumps on the riparian line to block public access).
11. Arrange CWD to create overlap and cover, but avoid positioning that eases firewood cutting or removal. Add some dirt or rocks to vulnerable placements to discourage chainsaws.

1.) Typical felled CWD

3.) CWD cavity cuts

2.) CWD Stump feature

4.) CWD Cavity covered.

References

Ronald Bartels John D. Dell Richard L. Knight Gail Schaefer, US Forest Service Bulletin 2006

Tommy Road Water Environmental Assessment (D.R. Clough 2017).

Surrey Parks, Recreation and Culture Department- Natural Areas: Coarse Woody Debris Management Strategy, Shawn Gurney Technician, Park Urban Forestry and Environmental Services, Edited by: Greg Ward, Manager Park Urban Forestry and Environmental Services City

Chief Forester's Guidance on Coarse Woody Debris Management
Chief Forester Guidance CWD management – May 2010