Richards Creek Watershed
Habitat Assessment and Restoration Plan.

Prepared for

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

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Introduction

The Somenos Marsh Wildlife Society (SMWS) are interested in the health and recovery of the Richards 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 Richards Creek Watershed as well as restoration opportunities.

Methods

Personnel

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 2, 2021, while the Averill Creek survey was completed June 3, 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 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 2-3, 2021. The Temperature, Oxygen, pH, Conductivity and Total Dissolved Solids were measured using field equipment (Oxygard Meter, Lamotte Wide Range pH kit, Lamotte

[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.

TDS and Conductivity meter). Flow was estimated by stage height (0-100% bankfull). This data 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 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.

Richards Creek is the most northern tributary, its lower reaches largely surrounded by agricultural land. The surrounding land use has heavily impacted the stream which has been thoroughly ditched in its lower reaches and has very little riparian cover. As a result, spawning and rearing habitat is extremely limited through these sections due to high summer temperatures, lack of gravels/cobbles/boulders, and therefore, lack of stream insects which provide a food source. The upper reaches provide much more promising habitat with less human alteration (ditching).

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 2nd 2021. The field crew was separated into two groups; one surveyed the lengthy lower reach, while the other surveyed reaches 2 and 3.

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;	4,975	Somenos Lake upstream to the Richard's Trail Culvert. Salmon accessible. Ditched and farmed historically to the Herd rd. bridge and currently between Herd rd. and Richard's Trail. Was ditched over its entire length
Reach 2:	255	Richard's Trail to 255m. Previously rerouted but recovered to a more natural state.
Reach 3;	880	Human alteration in the form of old farm bridges and weirs. Numerous log jams. Alterations and obstructions offset by good spawning and rearing habitat in some pockets.
Reach 4;	230	Majorly runs through a steep walled canyon, largely composed of boulders and bedrock, ending at a 2 m tall falls where fish migration ends.

Figure 2: Approximate Boundaries of the Richards Creek Watershed

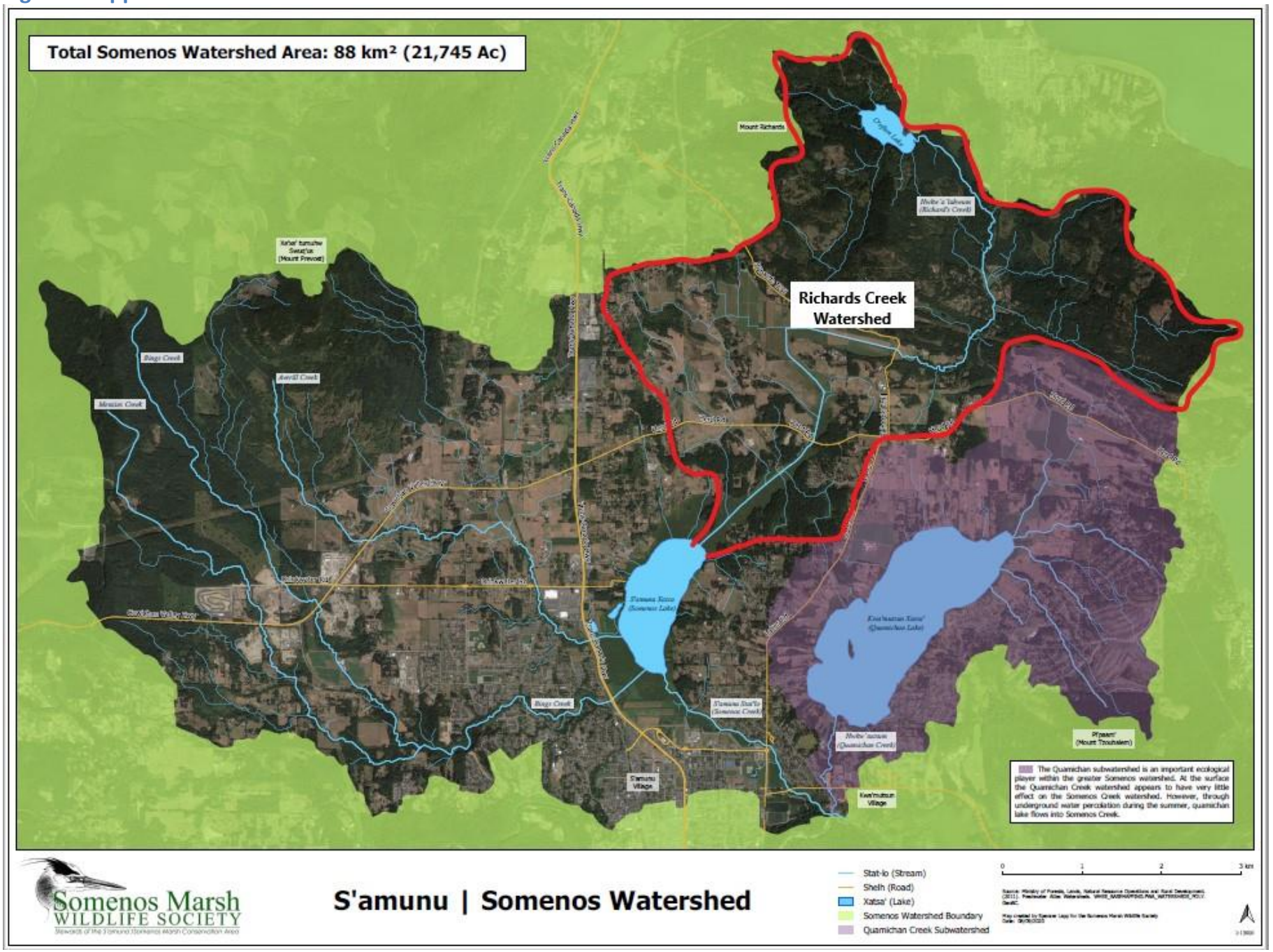

Figure 3. Survey Reach Map

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 2, 2021. Richards reaches R1-R3 were surveyed. Water quality sampling was conducted in Reach 1,2 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 Richards Reach 1-3.
- 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 1-4. This data was then scored according to the USHP methodology and presented Reach Habitat and Riparian scores and ratings in Tables 1-6 below. A reach map is shown in Figures 4 – 7.

A reach comparison table of the three primary tributaries of the Somenos Watershed is summarized in Table 9.

The Watershed Restoration Summary Table and identifies the topics for each reach (Table 10);

- 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

Richards Reach 1 starts from Somenos Lake and ends at the bridge at Richards Trail. It was broken into two reach segments based on past work; Reach 1A (below Herd rd. crossing) and 1B (above Herd rd. crossing). This reach is a combination of lake floodplain, historic farm pastures, and current farm pastures and fields. The reach is quite lengthy, estimated to be 4,975m long. This reach is salmon and trout accessible. The reach was surveyed June 2, 2021 with the channel at low summer flow. Our survey location was accessed from multiple properties with owner permission both along Richards Trail and Mays rd. S. We surveyed reach 1A first, then drove up to Richards Trail to access 1B.

Fig. 4 Richards R1

Reach 1 Habitat Photos

1.) Placemark 10- Floodplain Reach 1A, Richards Creek below Herd rd.

2.) Placemark 7- Reach 1A looking down at floodplain from McGregor Farm.

3.) Placemark 24- Reach 1B, just below Richards Trail looking upstream.

4.) Placemark 20- Reach 1B, shrub and grass dominated riparian

The USHP survey of Richards R1 on June 2, 2021 captured ten pools in 1050m (reach 1A) and 1425m (reach 1B). The reach is separated into reach 1A (below Herd Rd) and reach 1B (above Herd Rd). There are distinct differences in these reaches, as well as similarities. This report will be clear about where restoration prescriptions vary between the two sub-reaches. Reach 1A had an average channel width of 14.8m and a wetted width of 12.5m, while reach 1B had an average channel width of 5.5m and an average wetted width of 3.8m. The reach is heavily altered through ditching and farming. The area is naturally very flat, though there was some change in elevation it was never significant enough for our clinometers to measure, resulting in an average gradient of 0%. The water temperature was 19.9C. No fish were observed in the channel during the survey but there were numerous American Bullfrogs observed. 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	1	Good
Large Woody Debris/Bankfull Channel Width	0.00	5	Poor
% Cover in Pools	62	1	Good
Average % Boulder Cover	0	5	Poor
Average % Fines	99	5	Poor
Average % Gravel	0.50	not rated	
% of Reach Eroded	0	1	Good
Obstructions	0	0	Good
% of Reach Altered	100	5	Poor
% Wetted Area	81	3	Fair
Dissolved Oxygen	45	1	Poor
pH	6.20	3	Fair
	Mean Score	2.7	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	58	3	Fair
Riparian Slope	24	1	Good
Bank Stability	32	2	Fair
% Crown Cover	42	3	Fair

Riparian Ratings	Result	Ratings	Result
% of Reach Accessed	43	5	Poor
Average Vegetation Depth	95.5	1	Good
Mean Score		2	Fair

The entire length of Richards Creek Reach 1 was historically channelized into a straight ditch to accommodate drainage of hay pastures on either side. Farming has ceased in the lower 2km of the channel, until it meets Herd rd. This reach has not re-naturalized its path despite the low gradient floodplain on its river left. It is very deep and wide through this section of the reach. It is also low gradient and slow moving, leading to settling of fine sediments which compose the majority of the stream bed. Reach 1B above Herd rd. is still actively farmed. This area has less riparian depth, but a more confined channel with denser brush cover resulting in better riparian and instream cover.

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.
    - Deeply dredged channel resulting in depths between 0.9-1.6m deep at all survey locations.
- No permanent barriers manmade or natural.
    - Poor water quality may pose a temporary barrier to migration through the summer, but during the cooler seasons water quality will rise to meet parameters allowing for fish migration.
- High percentage of instream cover.
    - Cover is largely composed of aquatic vegetation to the point of being excessive and is likely contributing to lack of oxygenation/preventing mixing. The vegetation mat in the lower part of reach 1A could be a fish passage barrier when temperatures are high and annual vegetation is near maximum yearly growth.
- Wide riparian vegetation depth.
    - In reach 1A the riparian depth is wide, but mainly composed of shrubs, especially on the southern aspect. This low-lying vegetation does not sufficiently shade the channel. Reach 1B has a much narrower vegetation depth, but the width of the channel decreases and shrubs overhang a larger percentage of the channel allowing for more effective shading.

The fish habitat characteristics that were poor are;

- Poor spawning habitat.
    - Due to lack of spawning gravel and high sediment levels. This was not likely to be historic spawning habitat due to its low gradient and large floodplain.
- Water Quality was Poor
    - The oxygen level was 45% saturation in 19.9C temperature at the start of our survey near Somenos Lake. The temperature is high, especially for so early in the summer and is quite stressful on salmonids. Decomposition of organic material and sediment are depressing oxygen levels. Walking in the stream results in hydrogen sulfide gas

bubbles released in the grassy exposed areas (this represents high levels of decomposition).

- 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

Richards Reach 2 is 255m long, beginning at the Richards Trail crossing upstream to 255m. It follows a diversion through a farm field, though this one was not heavily ditched, has diversity in habitat, substrates, and treed riparian area.

The USHP survey on June 2, 2021 captured 8 pools and 4 riffles over 160m. We started our survey at the Richards Trail crossing and walked upstream between farm fields. This reach had an average channel width of 3.5m and a wetted width of 2.4m. The reach is low with an average gradient of 0.6%. 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	70	1	Good
Large Woody Debris/Bankfull Channel Width	0.08	5	Poor
% Cover in Pools	6	5	Poor
Average % Boulder Cover	1	5	Poor
Average % Fines	28	5	Poor
Average % Gravel	42	not rated	
% of Reach Eroded	49	5	Poor
Obstructions	5	5	Poor
% of Reach Altered	31	5	Poor
% Wetted Area	69	5	Poor
Dissolved Oxygen	91	1	Good
pH	7.00	1	Good
	Mean Score	3.9	Fair

Fig. 5 Richards R2

Reach 2 Habitat Photos

1.) Reach 2, Pool 1- Richards Trail box culvert full of coho fry.

2.) Reach 2, Riffle 3- Riffle under old farm bridge.

3.) Reach 2 Pool 6- Riparian area

4.) Reach 2, Riffle 2- Wide channel, shallow riffle

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	72	3	Fair
Riparian Slope	30	1	Good
Bank Stability	88	3	Fair
% Crown Cover	63	3	Fair
% of Reach Accessed	276	5	Poor
Average Vegetation Depth	2	5	Poor
Mean Score		3.4	Fair

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 9.

The fish habitat characteristics that were good are;

- High percentage of pool area.
    - Pools offer excellent fish habitat especially during low summer flows. This is even more important on a creek like Richards where the wetted area becomes very low.
- Water Quality was good.
    - Water quality parameters were good and can sustain a fish population. The temperature was 3 degree cooler than the reach downstream, but such a high temperature is still concerning so early in the summer. Beyond the parameters listed above, the conductivity and TDS were also measured. Conductivity was 196 µS/cm. This is a high reading, but lower than what could be expected given the surrounding land use as fertilizers used in agricultural practices can spike conductivity. The total dissolved solid count was 98, within acceptable parameters for aquatic life.

The fish habitat characteristics that were poor are;

- Poor spawning habitat.
    - There is a lack of spawning gravel and high sediment (28%) levels. This reach and reach 3 have the best potential for spawning habitat enhancement.
- Lack of Instream Cover.
    - 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 rearing and survival.
- Erosion
    - Poor vegetation depth and high peak flows have caused significant erosion throughout this reach, contributing to the high percentage of fines throughout this

reach and the reach below. Strategic riparian planting for 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.
- 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

Richards Reach 3 is very similar to the previous reach flowing through a treed area between farm fields. It is 880m long, ending where a tributary enters on river right bank. The entire reach was surveyed June 2, 2021. It consisted of eight pools and nine riffles over 220m. This reach had an average channel width of 5.1m and a wetted width of 3.0m. The reach is slightly steeper than the first two, averaging at approximately 0.9%.

The results are shown in the table below.

Table 5 - Reach 3 Habitat and Water Quality Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	37	5	Poor
Large Woody Debris/Bankfull Channel Width	0.21	5	Poor
% Cover in Pools	7	3	Fair
Average % Boulder Cover	4	5	Poor
Average % Fines	24	5	Poor
Average % Gravel	32	not rated	
% of Reach Eroded	8	3	Fair
Obstructions	0	0	Good
% of Reach Altered	3	1	Good
% Wetted Area	58	5	Poor
Dissolved Oxygen	.		
pH			
	Mean Score	3.6	Fair

Fig. 6 Richards R3

Reach 3 Habitat Photos

1.) Reach 3, Pool 7 .

2.) Reach 3, Riffle 8

3.) Reach 3, Pool 4 Debris Jam

4.) Reach 3, Riffle 10

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	54	2	Fair
Riparian Slope	64	2	Fair
Bank Stability	92	3	Fair
% Crown Cover	74.71	1	Good
% of Reach Accessed	3	1	Good
Average Vegetation Depth	43	3	Fair
Mean Score	Mean Score	1.9	Fair

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 upstream of intensive farming practices, but was historically logged. The regenerating second growth riparian area is less encroached upon than the lower reaches.
- Few obstructions or alterations.
    - Not as many alterations, much of this reach follows its native route. There are also fewer obstructions such as the disused farm bridges and fences as seen in the lower reaches. Unfortunately, there is one major alteration in the form of an abandoned concrete weir in the upper reach. It is full spanning, but is fish passable due to an eroded left bank.

The Reach 3 fish habitat characteristics that were poor are;

- Low percentage of pool area.
    - This reach has a steeper grade and longer riffles, resulting in less usable year-round habitat.
- 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.
    - 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 are a product of upland erosion and sedimentation. Addressing erosion upstream will help the lower reaches.

Reach 4

Richards Reach 4 is a confined bedrock and boulder reach. It primarily runs through a steeply sloped, well-forested ravine. It is approximately 230m long. The streambed is primarily composed of boulders. The entire reach was walked to inspect for alterations, erosion and obstructions. There is a fish barrier bedrock falls (2m) and cascade (25%) at the end of the reach.

Reach 4 was found to be protected from disturbance by being in a bedrock gully. No specific measurements were taken as this isn't a targeted area for restoration.

Headwaters

The headwaters of Richards Creek begin at Crofton Lake (Figure 2). This is an impounded lake used as a water supply. The headwaters are known to contain fish (iMap).

Fig. 7 Richards R4

Reach 4 Habitat Photos

1.) Reach 4, 2m tall falls.

2.) Reach 4, lower canyon

3.) Reach 4, Upper canyon

4.) Reach 4, River right tributary

Discussion

Survey Efficiency and Limitations

The level 2 habitat survey of Richards Creek covered 6,340m from Somenos Lake to the permanent barrier at the falls. We did not survey the estimated 2.9km of headwaters to the Crofton Lake outlet. The survey effort was biased to the reaches of highest salmon value. Unfortunately these salmon bearing reaches were also the locations of highest alteration.

Table 7 – Richards Creek Survey Efficiency and Coverage

Reach	USHP Length (m)	Reach Length (m)	Percent Reach Surveyed
Reach 1	4,975	4,975	100
Reach 2	170	255	67
Reach 3	240	880	27
Reach 4	n/a	n/a	n/a
Total	5,385	6,110	65

Richards 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 three Richards Creek reaches.

Table 8 – Richards Creek Reach Habitat and Riparian Summary

Reach	Habitat	Result	Riparian	Result
Reach 1	3.6	Fair/Poor	1.9	Fair/Good
Reach 2	3.9	Fair/Poor	3.4	Fair
Reach 3	2.7	Fair	2	Fair/Good
Mean Score	**3.4**	**Fair**	**2.4**	**Fair/Good**

Based on overall reach scores in Table 8; the instream habitat results in Richards Creek scored 3.1 for a resulting overall value of Fair. This was a somewhat consistent habitat score for every reach, the first two reaches scoring slightly lower. Reach 2 scored the lowest for instream habitat due to the large amount of erosion, low wetted area, lack of instream cover, and numerous obstructions and alterations.

The overall riparian mean score of 2.4 is Fair to Good. It was consistent throughout reaches, with reach 2 being slightly poorer due to the narrow riparian depth and accessibility to both livestock and humans. It was expected that reach 1 may score lower than it did, but the score was offset by the wide riparian (but low riparian height) in 1A and the narrow riparian depth, but high amount of crown cover in 1B.

Vancouver Island Habitat Comparison

The USHP survey of Richards Creek can be compared with the other two major tributaries of Somenos Watershed. Averill Creek assessment was completed in summer 2021 and the Bings Creek assessment was completed in summer 2020. Both were surveyed using the same methods. Table 9 below compares Richards Creek to Averill and Bings Creek.

Table 9 - 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.**

The Table 9 comparison makes it clear that the Somenos watershed's three main tributaries are suffering from many of the same problems. Like essentially all other Vancouver Island streams, these three creeks suffer from legacies of historic farming, 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.

Richards 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 10 below shows the summary of restoration plans for the Richards Watershed. The restoration categories we used were:

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

Table 10 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 9 shows the high priority restoration sites and activities highlighted in red.

Table 10 - Restoration Sites - Richards Creek

Reach	Issue	Location	Prescription	Priority
R1a	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.	Riparian throughout this reach is dominated by shrubs due to dredging. The creek needs fast growing deciduous trees such as pin cherries and alder to provide shade. They should, however, be planted alongside water and heat tolerant conifers such as Sitka spruce. Sitka spruce has been proven to do well in similar habitats in the watershed such as lower Bings Creek. Planting benches of imported substrate may be required to provide substrate and elevation above the flood plain. Long term: Potential for Trembling Aspen grove creation on river left floodplain, downstream of Herd rd. Upland: There is opportunity to enhance the Garry Oak ecosystem on river right bank from Placemark 4 (McGregor Farm) up to Herd Rd. Recommended planting here is primarily Garry Oak ecosystem plants. Microsite Opportunistic Planting: Deciduous or conifer planting (ie. Pines, Sitka Spruce, and Hemlock) on mounds and stumps throughout floodplain.	**H** **M** **H** **M**
R1a	Riparian lack of CWD	Both sides, higher up in the riparian to avoid washout. Best sites are lower McGregor farm and Mays rd. S.	Placement of coarse woody debris (CWD) in groupings at planting sites. Use 2-4m lengths or stumps of large diameter trees above high water mark.	**H**
R1a	Spawning Gravel/Boulders	Possibly at Herd Rd. bridge.	Limited opportunity.	**L**
R1a	Garbage cleanup	At Herd rd. bridge, Placemark 11, and the area between the two points.	Cleanup garbage along road edge, marijuana plant pots from the creek edge, and waste pile at Placemark 11.	**H**
R1a	Vegetation removal	Thickly vegetated areas of the channel from Placemark 4 to the lake.	Shading with planted trees in conjunction with dredging of mostly invasive aquatic annual vegetation plugging the creek flow will improve drainage. This will allow for better oxygenation and fish passage. Material may be useful for planting mounds.	**M**

R1a	Education/Partnerships	River left floodplain south of Herd rd. bridge	Wildlife viewing boardwalk	**M**
R1b	Fix bridge erosion	Herd rd. bridge	Mitigate runoff from road and address soft, erodible substrates under bridge with materials and/or planting.	**M**
R1b	Riparian Restoration	Any property owner open to expanding riparian.	Sitka Spruce and fast growing, water tolerant trees such as Red Alder or Pin Cherry planted on mounds. Prioritize banks on the southern aspect and areas without existing shrub cover.	**H**
R1b	Soil Conservation	Farms in floodplain	Educate farmers on the positive impacts of planting alternative crops overwinter to prevent soils loss and increased flooding potential. Consult an agriculture specialist.	**H**
R2	Stabilize erosion	Riffle 1, 2, 3, and pools 5 and 7.	Red Osier dogwood or native willow cuttings planted in the bank. This treatment can be coupled with large rock placement to offer immediate stabilization. It is important that cuttings are used in conjunction with rock to not only provide physical stabilization, but also, shade, organic input, and wildlife value.	**M**
R2	Spawning Gravel	Culvert under Richards Trail	Spawning gravel placement at both the entrance and exit of the concrete box culvert.	**H**
R2	Boulder placement	Riffles throughout the reach	Long and wide riffles should be prioritized. Boulders placed in clusters of 3, at least 1 meter from each bank and 1 meter apart. Non-uniform placement is preferred by fish.	**M/H**
R2	Pools cover habitat- LWD and brush covers	All pools; prioritize access and larger pool size (pools 3-6)	Anchor LWD to banks using duck bills. Placement should be supervised by a biologist 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/H**
R2	Riparian Restoration	Throughout reach	Prioritize areas protected from livestock grazing and banks on the southern aspect. Expanding the width of the riparian area is the goal and therefore needs land owner cooperation. Trees are already present and providing shade in this reach. Since shade is already being provided, water tolerant conifers such as Sitka Spruce and Western Red Cedar should be the focus of planting. Planting should	**M**

			be focused within the first 5 meters of riparian and infilling areas with strictly deciduous species.	
R3	Stabilize erosion	Riffle 1, 3, and pools 4-6	Red Osier dogwood or native willow cuttings planted in the bank. This treatment can be coupled with large rock placement to offer immediate stabilization. It is important that cuttings are used in conjunction with rock to not only provide physical stabilization, but also, shade, organic input, and wildlife value.	**M**
R3	Pool creation and cover habitat	Long riffles (8-10)	Addition of weirs and LWD structures to create scour. This will diversify habitat and offer survivable summer habitat when flows are very low.	**M**
R3	Invasive Removal	Waypoint: Ivy forest	Remove or exercise control measures to kill the ivy.	**M**
R3	Log Jam Removal	Waypoints: Debris Jam (2)	Remove SWD. LWD can be cut and rearranged in the creek for increased functionality as fish habitat or placed in the riparian area as CWD, offering amphibian habitat.	**M**
R3	Human obstruction removal	Waypoint: Old Weir	Remove unused concrete weir from the creek to allow improved fish passage.	**H**

R1 Restoration Photos

R1A- Herd Rd Bridge erosion.

R1A- Floodplain Riparian restoration area

R1B- Grass and shrub dominated riparian.

R1B- Intensive farming practices.

R2 Restoration photos

R2- Erosion, fencing collapsed in channel, canary grass riparian

R2 – Debris jam and grass riparian.

R2 – Box culvert at Richards Trail

R2 – Debris build up

R3 Restoration photos

R3 -Lower debris jam.

R3 – Ivy infestation on river right.

R3 –Abandoned concrete weir in the upper reach.

R3 – Upper debris jam.

Restoration Prescriptions

The restoration projects identified involve riparian and instream works i.e. bank stabilization, planting, spawning gravel placement, and instream cover 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 Front counter 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 10 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"[4]. 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 11) High Priority Restoration Sites

Reach	High Priority Restoration Activity	Description
1A	Riparian restoration	Garry Oak enhancement and shading
1A	CWD Placement	River left in Garry Oak areas.
1B	Soil conservation	Education and partnerships
1B	Riparian restoration	Expand riparian area
2	Spawning Gravel	Addition of gravel to enhance natural salmon populations.
2	Boulder placement	Placement of single or clusters of boulders to provide instream cover.
2	Pools cover habitat- LWD and brush covers	Well placed LWD to offer habitat and prevent erosion. Brush covers can be placed in any pool lacking cover.
3	Obstruction removal	Work with property owner to remove or mitigate concrete weir.

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

Conclusion

The Urban Salmon Habitat Survey of the Richards 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 Richards Creek indicate the upper reach is recovering from historic logging activities, while the lower two reaches have positive aspects, but are being heavily influenced by both historic and current agricultural activities. The current health of the watershed scored Fair in overall USHP ratings. The harmful historic impacts are receding; unfortunately newer impacts are depressing the recovery. Richards Creek is less vulnerable to urbanization than other tributaries of Somenos Lake (Bings and Averill), but is being severely impacted by both past and present agricultural practices. It is essential to educate and form partnerships with farmers to protect the watershed. A healthy river and strategic crop choice can benefit farmers greatly by mitigating flood risk, extending crop harvest season, and providing top soil conservation.

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 Richards Creek. The District of North Cowichan recently completed the Bonsall Creek Watershed Management Plan [5] in 2015. This study 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 Richards Creek should not start with these prescriptions; it should start with forming partnerships with the local government and land owners. 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.

There are many smaller projects identified in this survey. Garbage clean up, riparian planting and water quality monitoring are important projects that are scalable to any group size. They usually require only property owner permission, can be done at any time of the year and are lower cost. At the opposite scale are larger projects that require instream work permits and use heavy equipment. These projects incorporate stewards as well but require professional oversight to sign off on the permits and environmental aspects. An example may be bank restoration with excavator placed LWD and anchor rocks.

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

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

assessment. This restoration plan offers a list of restoration prescriptions as well as important baseline habitat data on Richards Watershed. We hope this report brings more successful projects for the Somenos Marsh Wildlife Society.

Submitted by

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and

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Appendix 1 – Reach 1 Habitat Data

Stream Name	Richards Creek	Watershed Code	1234	Date	44351.00	Reach Name	Reach 1			Discharge Depth #1	1.00	Velocity			
Water Quality Information					Field Crew		CE, AD, DRC					T1	1.00	Site Length	
Dissolved Oxygen	45.00	pH	6.20	Total Dissolved Solids	105.00	Temp C	19.90	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	4975.00	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 Bed	Bld	Cob	Grv	Fine
Pool	0.00	1070.00	1070.00	16.00	17120.00	17120.00		1.00	0.00	16.00		0	0	0	0	100
Pool	1070.00	1200.00	130.00	16.00	2080.00	2080.00		1.00	0.00	16.00		0	0	0	0	100
Pool	1200.00	1613.00	413.00	16.00	6608.00	6608.00		1.40	0.00	16.00		0	0	0	0	100
Pool	1613.00	1703.00	90.00	10.00	900.00	900.00		1.57	0.00	10.00		0	0	0	0	100
Pool	1703.00	1977.00	274.00	11.00	3014.00	3014.00		1.50	0.00	11.00		0	0	0	0	100
Pool	1977.00	3905.00	1928.00	6.00	11568.00	11568.00		1.20	0.00	20.00		0	0	5	5	90
Pool	3905.00	3977.00	72.00	4.80	345.60	345.60		0.90	0.00	4.80		0	0	0	0	100
Pool	3977.00	4070.00	93.00	3.00	279.00	279.00		0.90	0.00	7.00		0	0	0	0	100
Pool	4070.00	4328.00	258.00	2.90	748.20	748.20		1.00	0.00	3.50		0	0	0	0	100
Pool	4328.00	4975.00	647.00	4.50	2911.50	2911.50		1.00	0.00	6.50		0	0	0	0	100
Reach Totals and Averages		4975.00	4975.00	9.02	45574.30	45574.30	100.00	1.15	0.00	11.08	81.41	0	0	1	1	99

Habitat Type	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other	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)
Pool	0	0	0	100	0	20.00	0	0	0	1070	0	0	0	0
Pool	0	0	0	100	0	20.00	0	0	0	130	0	0	0	0
Pool	0	0	0	100	0	25.00	0	0	0	413	0	0	0	0
Pool	0	0	0	30	0	45.00	0	0	0	90	0	0	0	0
Pool	0	0	0	20	0	45.00	0	0	0	274	0	0	0	0
Pool	0	0	0	0	10	100.00	1	20	0	1928	0	0	0	0
Pool	0	0	0	80	0	95.00	0	0	0	72	0	0	0	0
Pool	0	0	0	80	0	25.00	0	0	0	93	0	0	0	0
Pool	0	0	0	80	0	25.00	0	0	0	258	0	0	0	0
Pool	0	0	0	20	0	20.00	0	0	0	647	0	0	0	0
Reach Totals and Averages	0	0	0	61	1	42.00	1	0.00	0	100	0	0		

Habitat Type	Land Use Right	Land Use Left	Vegetation Type Right	Vegetation Type Left	Riparian Slope Right	Riparian Slope Left	Stability Right	Stability Left	Vegetation Depth Right	Vegetation Depth Left	Livestock Access Right	Livestock Access Left	Photos	Comments
Pool	FG	FG	Mix	Sh	20	1	High	High	5	400				Active
Pool	FG	FG	Mix	Sh	20	1	High	High	40	430	130			
Pool	RS	Nat	Mix	Mix	23	15	High	High	100	600	413			
Pool	R	Nat	Mix	Sh	40	10	High	High	5	200				
Pool	R	Nat	Mix	Sh	40	15	High	High	5	100	274			
Pool	FG	FG	Sh	Sh	55	55	High	Low	0	0	20	20		cOVER IS
Pool	FG	FG	Gr	Gr	1	1	High	Med	5	1				
Pool	FG	FG	Gr	Gr	1	1	High	Med	5	1				
Pool	FG	FG	Gr	Gr	1	1	High	Med	5	1				
Pool	FG	FG	Gr	Gr	1	1	High	Med	5	2				
	0	0	0	0			0	0						
	0	0	0	0			0	0						
Reach Totals and Averages	34	24			12	12	10	22	####	####	17	0		

Appendix 2 – Reach 2 Habitat Data

Stream Name	Richards Creek	Watershed Code	1234	Date	44351.00	Reach Name	Reach 2			Discharge Depth #1	1.00	Velocity			
Water Quality Information					Field Crew		GH, PG, BRR					T1	1.00	Site Length	
Dissolved Oxygen	91.00	pH	7.00	Total Dissolved Solids	98.00	Temp C	17.00	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	170.00	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 Bed	Bld	Cob	Grv	Fine
Pool	0.00	4.00	4.00	2.90	11.60	11.60		0.15	0.00	3.90		100	0	0	0	0
Pool	4.00	12.00	8.00	2.20	17.60	17.60		0.20	0.50	3.50		70	10	0	5	15
Riffle	12.00	19.00		2.00	0.00	14.00		0.05	1.00	4.00		0	0	10	40	50
Pool	19.00	38.00	19.00	2.70	51.30	51.30		0.40	0.50	4.60		50	5	0	30	15
Pool	38.00	58.00	20.00	2.70	54.00	54.00		0.20	0.50	4.10		40	0	10	40	10
Pool	38.00	58.00	20.00	2.70	54.00	54.00		0.20	0.50	4.10		40	0	10	40	10
Riffle	58.00	75.00		2.20	0.00	37.40		0.05	1.00	4.30		0	0	10	90	0
Pool	75.00	101.00	26.00	3.20	83.20	83.20		0.30	0.00	3.40		0	5	5	80	10
Riffle	101.00	117.00		3.20	0.00	51.20		0.15	1.00	3.40		0	0	0	90	10
Pool	117.00	127.00	10.00	1.60	16.00	16.00		0.20	0.50	2.90		0	0	10	40	50
Riffle	127.00	145.00		2.20	0.00	39.60		0.30	1.00	2.20		0	0	0	100	0
Pool	145.00	160.00	15.00	1.60	24.00	24.00		0.30	0.50	2.40		0	0	0	0	100
Pool	160.00	170.00	10.00	2.10	21.00	21.00		0.40	0.50	2.60		0	0	0	0	100
Reach Totals and Averages		170.00	132.00	2.41	332.70	474.90	70.06	0.22	0.58	3.49	68.94	23	2	4	43	28

Habitat Type	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other	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)
Pool	0	0	0	0	10	60.00	0	0	0	4	0	0	0	0
Pool	0	0	5	0	0	10.00	0	0	0	0	0	0	0	0
Riffle	0	0	0	0	0	75.00	0	0	8	0	0	0	0	0
Pool	5	0	0	0	0	75.00	0	0	0	0	0	0	0	0
Pool	0	0	5	0	0	40.00	0	0	20	8	0	0	0	0
Pool	0	0	5	0	0	40.00	0	0	8	20	0	0	0	0
Riffle	0	0	0	0	0	80.00	0	0	10	0	0	0	0	0
Pool	5	0	0	0	0	90.00	0	0	20	8	0	0	0	0
Riffle	0	0	0	0	0	90.00	0	0	8	0	0	0	0	0
Pool	0	10	0	0	0	60.00	1	2.9	0	4	0	0	0	0
Riffle	0	0	0	0	10	60.00	0	0	0	8	0	0	0	0
Pool	0	10	0	0	0	60.00	1	2.4	10	0	5	0	0	0
Pool	0	0	10	0	0	75.00	2	5.2	0	0	0	0	0	0
Reach Totals and Averages	1	2	2	0	2	62.69	4	0.08	49	31	5	0		

Habitat Type	Land Use Right	Land Use Left	Vegetation Type Right	Vegetation Type Left	Riparian Slope Right	Riparian Slope Left	Stability Right	Stability Left	Vegetation Depth Right	Vegetation Depth Left	Livestock Access Right	Livestock Access Left	Photos	Comments
Pool	FG	FG	Mix	Mix	10	10	High	High	1	1	0	2		Cover is box
Pool	FG	FG	Mix	Mix	5	5	Med	Med	4	4	0	0		
Riffle	FG	FG	Gr	Mix	5	5	Low	Med	1	4	7	0		
Pool	FG	FG	Gr	Mix	5	5	Low	Low	1	4	19	0		
Pool	0	0	0	0			0	0	0	0	0	0		Bridge
Pool	FG	FG	Mix	Mix	62	60	Low	Med	1	4	20	0		Bridge
Riffle	FG	FG	Mix	Mix	5	5	Low	Low	2	4	17	0		
Pool	FG	FG	Mix	Mix	5	5	Low	Low	1	5	26	0		RipRap
Riffle	FG	FG	Mix	Mix	5	5	Med	Med	2	5	16	0		
Pool	FG	FG	Mix	Mix	5	5	Med	Low	2	4	10	0		old bridge
Riffle	FG	FG	Mix	Mix	5	5	High	Med	1	1	18	18		rip rap cover
Pool	FG	FG	Mix	Mix	5	5	Low	Low	1	4	15	0		Debris jam
Pool	FG	FG	Mix	Mix	5	5	Med	Med	1	1	10	10		
	0	0	0	0			0	0						
	0	0	0	0			0	0						
Reach Totals and Averages	36	36			16	14	44	44	1.38	3.15	93	18		

Appendix 3 – Reach 3 Habitat Data

Stream Name	Richards Creek	Watershed Code	1234	Date	44349.00	Reach Name	Reach 3			Discharge Depth #1		Velocity		
Water Quality Information					Field Crew		GH, PG, BRR					T1		Site Length
Dissolved Oxygen	.	pH		Total Dissolved Solids		Temp C		Chainage at Beginning of Reach	0.00	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	240.00	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
Riffle	0.00	5.00		1.10	0.00	5.50		0.05	2.00	5.50	
Pool	5.00	9.00	4.00	4.00	16.00	16.00		0.70	0.50	4.40	
Riffle	9.00	12.00		1.40	0.00	4.20		0.15	1.50	3.90	
Pool	12.00	24.00	12.00	3.00	36.00	36.00		0.30	0.35	3.50	
Riffle	24.00	27.00		3.00	0.00	9.00		0.15	1.00	3.70	
Pool	27.00	44.00	17.00	2.30	39.10	39.10		0.20	1.00	3.10	
Riffle	44.00	48.00		1.40	0.00	5.60		0.15	1.00	4.10	
Pool	48.00	58.00	10.00	5.00	50.00	50.00		0.20	0.35	5.60	
Riffle	58.00	75.00		3.80	0.00	64.60		0.20	2.00	4.90	
Pool	75.00	81.00	6.00	3.30	19.80	19.80		0.30	0.00	5.00	
Riffle	85.00	118.00		2.10	0.00	69.30		0.15	0.50	5.70	
Pool	81.00	85.00	4.00	3.40	13.60	13.60		0.60	0.00	4.00	
Riffle	118.00	147.00		1.30	0.00	37.70		0.05	1.00	6.30	
Pool	147.00	152.00	5.00	5.10	25.50	25.50		0.20	0.35	6.20	
Pool	152.00	168.00	16.00	4.00	64.00	64.00		0.20	0.50	6.80	
Riffle	168.00	220.00		3.80	0.00	197.60		0.05	1.50	5.70	
Riffle	220.00	240.00		2.70	0.00	54.00		0.20	1.00	8.30	
Reach Totals and Averages		240.00	74.00	2.98	264.00	711.50	37.10	0.23	0.86	5.10	58.48

Habitat Type	Substrate Percent Bed	Bld	Cob	Grv	Fine	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other	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)
Riffle	0	0	40	40	20	0	0	10	0	0	75.00	1	5.5	8	0	0	0	0	0
Pool	0	0	20	40	40	0	15	0	0	0	70.00	2	8.8	0	0	0	0	0	0
Riffle	0	0	40	40	20	0	0	0	0	0	75.00	0	0	0	0	0	0	0	0
Pool	0	10	10	30	50	0	0	5	0	0	75.00	0	0	0	0	0	0	0	0
Riffle	0	50	20	20	10	15	0	0	0	0	80.00	0	0	4	4	0	0	0	0
Pool	10	25	10	20	35	0	0	5	0	0	90.00	0	0	0	4	0	0	0	0
Riffle	0	0	0	10	0	0	0	0	0	0	80.00	0	0	0	0	0	0	0	0
Pool	0	0	0	40	60	0	0	0	0	0	80.00	3	16.8	0	0	0	0	0	0
Riffle	0	80	0	10	10	25	0	0	0	0	70.00	0	0	0	0	0	0	0	0
Pool	0	30	0	10	60	0	0	0	0	0	80.00	0	0	4	0	0	0	0	0
Riffle	0	80	0	10	10	0	0	0	0	0	70.00	0	0	0	0	0	0	0	0
Pool	50	0	0	30	20	0	0	15	0	0	60.00	1	4	4	0	0	0	0	0
Riffle	0	0	0	90	10	0	0	0	0	0	90.00	0	0	0	0	0	0	0	0
Pool	50	0	0	30	20	0	0	0	0	0	60.00	0	0	0	0	0	0	0	0
Pool	0	10	5	60	25	10	0	0	0	0	60.00	1	6.8	0	0	0	0	0	0
Riffle	0	30	20	40	10	10	0	0	0	0	80.00	0	0	0	0	0	0	0	0
Riffle	0	25	40	25	10	10	0	0	0	0	75.00	2	16.6	0	0	0	0	0	0
Reach Totals and Averages	6	20	12	32	24	4	1	2	0	0	74.71	10	0.21	8	3	0	0		

Habitat Type	Land Use Right	Land Use Left	Vegetation Type Right	Vegetation Type Left	Riparian Slope Right	Riparian Slope Left	Stability Right	Stability Left	Vegetation Depth Right	Vegetation Depth Left	Livestock Access Right	Livestock Access Left	Photos	Comments
Riffle	Nat	FG	Mix	Gr	1	45	Med	Med	10	20	0	0		
Pool	Nat	Nat	Mix	Mix	4	62	Med	Med	10	20	0	0		
Riffle	Nat	FG	Mix	Gr	1	45	Med	Med	15	10	0	0		
Pool	Nat	Nat	Mix	Mix	5	50	Med	Med	12	40	0	0		
Riffle	Nat	Nat	Mix	Mix	5	80	Low	High	10	20	0	0		old bridge
Pool	RS	Nat	Mix	Mix	10	50	Med	High	12	20	0	0		
Riffle	Nat	Nat	Mix	Mix	5	80	Low	High	20	15	0	0		
Pool	RS	Nat	Mix	Mix	10	50	Med	High	25	12	0	0		jam
Riffle	Nat	Nat	Mix	Mix	5	80	Low	High	25	15	0	0		
Pool	Nat	FG	Mix	Mix	1	10	High	Low	30	5	0	0		
Riffle	Nat	Nat	Mix	Mix	5	80	Low	High	100	5	0	0		
Pool	Nat	FG	Mix	Mix	1	10	High	Low	75	5	0	0		
Riffle	Nat	FG	Mix	Mix	1	10	High	High	30	5	0	0		
Pool	Nat	FG	Mix	Mix	1	10	High	Low	65	270	0	0		
Pool	Nat	Nat	Mix	Con	30	5	Med	Med	30	65	0	3		
Riffle	Nat	FG	Mix	Mix	1	5	Med	High	80	20	0	0		
Riffle	Nat	FG	Mix	Mix	1	10	High	Low	80	270	0	0		
	0	0	0	0			0	0						
	0	0	0	0			0	0						
Reach Totals and Averages	21	33			17	47	49	43	####	48.06	0	1		

Appendix 4 – Reach 1-3 Habitat Summary

Stream Name	Richards Creek			**Watershed Code**	1234							
Habitat Parameter	**Reach 1**	**Ratings**	**Reach 2**	**Ratings**	**Reach 3**	**Ratings**		**Ratings**		**Ratings**		**Ratings**	**Total**
% Pool Area	100.00	1	70.06	1	37.10	5		1		1		1	**10**
Large Woody Debris/Bankfull Channel Width	0.00	5	0.08	5	0.21	5		1		1		1	**18**
% Cover in Pools	62	1	6	5	7	3		1		1		1	**12**
Average% Boulder Cover	0	5	1	5	4	5		1		1		1	**18**
Average % Fines	99.00	5	28.46	5	24.12	5		5		5		5	**30**
Average % Gravel	0.50	not rated	42.69	not rated	32.06	not rated		not rated		not rated		not rated	**--**
% of Reach Eroded	0	1	49	5	8	3		5		5		5	**24**
Obstructions	0	0	5	5	0	0							**5**
% of Reach Altered	100	5	31	5	3	1		5		5		5	**26**
% Wetted Area	81.41	3	68.94	5	58.48	5		1		1		1	**16**
Dissolved Oxygen	45.00	1	91.00	1	.	1	88.00	1	.	1	.	1	**6**
pH	6.20	3	7.00	1		5	6.70	1		5		5	**20**
Totals		**30**		**43**		**38**		**22**		**26**		**26**	**185**

Riparian Ratings													
Reach	**Reach 1**	**Ave. Ratings**	**Reach 2**	**Ave. Ratings**	**Reach 3**	**Ave. Ratings**		**Ave. Ratings**		**Ave. Ratings**		**Ave. Ratings**	**Total**
Land Use	58	3	72	3	54	2							**7**
Riparian Slope	24	1	30	1	64	2							**4**
Bank Stability	32	2	88	3	92	3							**8**
		Ratings		**Ratings**		**Ratings**		**Ratings**		**Ratings**		**Ratings**	**--**
% Crown Cover	42.00	3	62.69	3	74.71	1		1		1		1	**10**
% of Reach Accessed by Livestock	43	5	276	5	3	1							**11**
Average Vegetation Depth	95.5	1	2	5	43	3		1		1		1	**12**
Totals		**15**		**20**		**11**		**2**		**2**		**2**	**52**

Appendix 5 – 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 6 – Bank Erosion/LWD Placement example (French Creek)