

Annie Creek Habitat Overview Survey

For:

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July 2017

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Introduction:

This document is a physical survey, fish habitat assessment and restoration planning report of Annie Creek. The **Drinking Water and Watershed Protection Program** of the **Regional District of Nanaimo** has a water quality monitoring program with community volunteers from the Qualicum Bay, Bowser, Deep Bay and Fanny Bay Communities. Recent water quality sampling through this program had indicated high turbidity in Annie Creek. The stream assessment reported on here was an opportunity to involve the stewards in a training and data collection activity that would result in understanding of impacts on water quality and fish habitat. Restoration activities would be identified and offer future activities for the stewards.

Methods:

Annie Creek was surveyed on June 12th and 13th, 2017. We used the Urban Salmon Habitat Program (USHP) methodology¹ developed by a team led by George Reid, Sr. Fisheries Biologist for Ministry of Environment Vancouver Island. The Urban Salmon Habitat Program has played an important contribution as a science based tool used by Streamkeepers and stewardship organizations on Vancouver Island in monitoring and restoration planning.

The original data collection method used waterproof field data cards which had a listing of approximately 22 data aspects for each pool or riffle in a stream reach (Figure 2). The data was then transcribed to a macro enabled excel spreadsheet that arranged, summarized, averaged and then scored the results. Since 2014, we have converted the field data cards into electronic data schemas that are embedded into the geo-referenced pdf maps of Annie Creek provided by the Regional District GIS dept. This software was uploaded to an Apple iPad equipped with Avenza PDF Maps™.

Our objective was to collect a full data card at 10 habitat units (pools or riffles), however this goal was exceeded in all three reaches. Prior to the survey, the mainstem length of Annie Creek was subdivided into three reaches (Figure 1) and data was formatted into a separate spreadsheet for each.

Once collected, the data for each reach is entered the USHP excel program spreadsheet. At the end of the spreadsheet the habitat parameters are summarized and scored. The parameters used to score the stream are based on published standards for stream assessment methodology developed for the Watershed Restoration Program². The scores for each reach habitat item provide an indication of health that is comparable to other reaches or watersheds. It will help in identifying problems with the habitat of Annie Creek.

Water quality monitoring is being done on Annie Creek by the local stewards. During the survey, field assessment of water quality was done at the beginning of each reach. An Oxy-Guard

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.

² N.T. Johnston and P.A. Slaney, 1996, Fish Habitat Assessment Procedures, Watershed Restoration Technical Circular No. 8. Ministry of Environment, Lands and Parks and Ministry of Forests.

meter was used for analyzing water quality (Table 1). This device measures dissolved oxygen, oxygen saturation and temperature. A separate pH kit was used at these same locations.

Personnel:

Reach 1 and 2 surveys were led by David Clough, RPBio with Joe McCallum, RDN Special Projects Assistant and volunteers from the Nile Creek Enhancement Society. The Streamkeepers included Gord Lipke, Bob Ellis, Jack Gillies, and Chris Meade. Dave Davies, DFO Community Advisor also partook in the survey of reaches 1 and 2. Braden Judson, DRC Field Technician and Bev Allen (Streamkeeper) assisted with the survey and data collection on Reach 3 of Annie Creek. The survey benefitted from streamside property owners who donated their time, information and permitted survey crews access. The assistance by these volunteers is essential to the success of projects like this one.

Survey Area:

Annie Creek is located approximately 1.9km south of Qualicum Bay. It originates at 100m elevation from groundwater seeps and shallow wetlands on a plateau along the edge of Highway 19A West. The headwater ditched channels converge into tributary Fletcher Creek and Annie Creek. Annie Creek flows from west to east in a confined valley adjacent to rural residential property and through culverts at the Rail Line, Bradshaw Road, Highway 19A west and a bridge at Van Isle Road before entering the ocean.

Figure 1.) Survey Areas

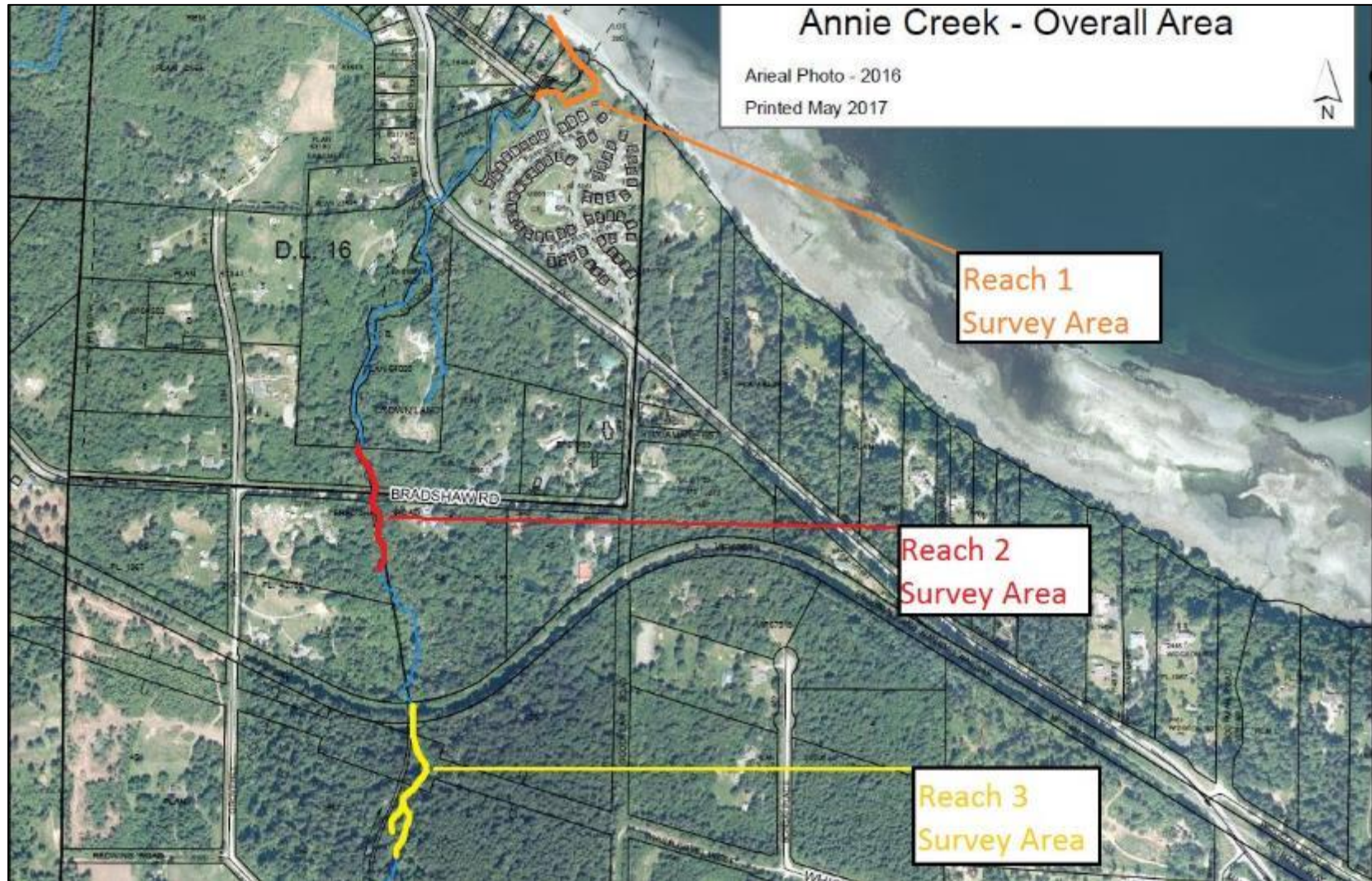




Figure 2.) USHP Data Card

Stream Name	<i>Fish C.</i>	<p>Habitat and Riparian Card Instructions</p> <ol style="list-style-type: none"> 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>. <p>Abbreviations and Definitions</p> <p>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</p> <p>¹ NOTE: Bank side is determined when facing downstream</p> <p> measure along stream length; note start and end for pools only  measure every 100 meters</p>
Reach / pg. #	<i>R2/pg1</i>	
Habitat Type (P/R)	<i>P</i>	
Start (m)	<i>10 m</i>	
End (m)	<i>20 m</i>	
Wetted Width	<i>2 m</i>	
Bankfull Width	<i>3 m</i>	
Average Depth	<i>0.5 m</i>	
% Bedrock	<i>20%</i>	
% Boulders	<i>20%</i>	
% Cobble	<i>30%</i>	
% Gravel	<i>20%</i>	
% Fines	<i>10%</i>	
Instream Cover (type/%)	<i>C-10% B-2%</i>	
% Crown Cover	<i>60%</i>	
Gradient	<i>2%</i>	
# LWD	<i>10</i>	
A/E/O	<i>E-10m A-20m</i>	
Off-Channel Habitat	<i>L/bank 20*2m</i>	
Land Use (L/R)	<i>N/R</i>	
Vegetation (L/R)	<i>CF/G</i>	
Vegetation Depth (L/R)	<i>30+/2</i>	
Riparian Slope (%)(L/R)	<i>10/15</i>	
Stability (L/R)	<i>M/L</i>	
Livestock Access (L/R)	<i>20m/0</i>	
Photos	<i>1,2,3</i>	
Comments	<i>1,2</i>	

Results:

All habitat parameters are scored with respect to their quality. Low quality habitat parameters receive higher numeric rating and high-quality parameters receive low numeric ratings:

Table 1: Habitat Rating and Results

Rating	Result
1	Good
3	Fair
5	Poor

The habitat and riparian survey results are presented for each reach below.

Reach 1:

Reach 1 starts at the tidewater that extends upstream past VanIsle Road to Hwy 19A culvert. It is approximately 400m along a low gradient 1% slope channel. Above the high-tide mark on the beach, Annie Creek begins with a reach of cobbles. This cobble and rock laden area contains perennial water and is valuable habitat for anadromous fish. This reach is also easily accessible from the ocean which helps maintain a stable fish population. We saw schools of Coho fry and several Cutthroat Trout in the relatively deep pools of this reach.

Instream Fish Habitat R1

Fish habitat within Reach 1 scored fair, with concerns associated with substrate composition, lack of perennial habitat and the absence of instream woody materials (Table 2). Despite these concerns this reach has sufficient pools and gravels for spawning and rearing of juvenile fish.

Table 2.) Reach 1 Habitat Data

Habitat Parameter	Value	Rating	Result
% Pool Area	100	1	Good
Large Woody Debris/Bankfull Channel Width	0.04	5	Poor
% Cover in Pools	80	1	Good
Average % Boulder Cover	0	5	Poor
Average % Fines	43	5	Poor
Average % Gravel	41	N / A	N / A
% of Reach Eroded	1	1	Good
Obstructions	0	0	Good
% of Reach Altered	19	5	Poor
% Wetted Area	69	5	Poor
Total Result:		3	Fair

The banks in lower Reach 1 consist of soft muddy materials that are slowly sloughing in and depositing sediments into the creek bed. Planting Red Osier Dogwood (*Cornus stolonifera*) would help stabilize the banks and reduce the rate of sedimentation. Conveniently, there is a Red Osier Dogwood sapling growing nearby that could be used to make stakes in the future. These soft banks contribute to the biggest habitat concern of this reach. The creek bed is buried

in soft sediments and organic materials. The water here was brown and dystrophic and flowing slowly between pools. Any potential spawning materials and gravels are covered by sediments and prevent fish from reproducing in many of these pools. Installing spawning gravels would be beneficial and likely highly used but the sources of sediments needs to be cut off. There are Yellow Flag Iris (*Iris pseudacorus*) growing into the channel and constricting flow and choking out native riparian vegetation. The channel here also has issues with being clogged by Willows (*Salix spp.*) growing over the channel and nearly stopping access.

The channel in the lower reach (i.e. Pool 4) has been altered by the installation of rip rap wall on the right bank and further upstream are more placed blast rocks that have fallen into the channel. We found a blue plastic pipe that discharges water into the creek. The rocks adjacent to this pipe were coated with algae, indicating that the water potentially carries excess nutrients (phosphates and nitrates) and should not be directed into the creek. There is also a small debris jam in the lower reach that obstructs the creek flow and potentially impairs juvenile fish passage. The woody materials here are small enough that this issue can be resolved by removing the wood by hand.

Water quality was measured at the Van Isle Road bridge and all parameters were normal (Table 8). The Reach 1 component of this survey ended here, approximately 235m upstream of the creek mouth at the beach.

Riparian Areas R1

The riparian community around Reach 1 of Annie Creek scored fair (Table 3). The plant community in lower Reach 1 is significantly limited by historic and ongoing residential encroachment. We found the lower survey riparian depth was only 3-5 m. A visual inspection indicated the upper half of the reach to the highway had a better riparian canopy. The newer upper areas appear to have a bylaw designated treed setback of 15-30 m past the lawns. The riparian canopy consists of Red Cedar (*Thuja plicata*), Douglas Fir (*Pseudotsuga menziesei*) and Broadleaf Maple Trees (*Acer macrophyllum*). The issues of depth of riparian vegetation can be easily addressed by planting. Future planting plans should include removal of invasives such as Reed Canary Grass (*Phalaris arundinacea*) and Yellow Flag Iris that is choking out other plant emergence.

Table 3.) Reach 1 Riparian Data

Riparian Parameter	Value	Rating	Result
Land Use	44	2	Good / Fair
Riparian Slope	24	1	Good
Bank Stability	60	3	Fair
% Crown Cover	57	3	Fair
% of Reach Accessed	131	5	Poor
Average Vegetation Depth	3	5	Poor
Total Result:		3	Fair

Reach 2:

The Reach 2 begins at Highway 19A and goes upstream through the culvert on 5% gradient to approximately 500m through Bradshaw Road culvert and ends at approximately 850m at the Railway Culvert.

Instream Fish Habitat R2

Our habitat survey covered 125m above and below the Bradshaw Road culvert. Over this survey area the steeper reach 2 has more rock substrate than the previous reach. Table 4 below shows the result is an overall Fair rating. Poor results were found in Boulder cover, Fines in substrates and lack of Large Woody Debris (LWD)

The survey area began at a pool formed behind a woody debris jam. The water could flow over the debris; however, in the summertime low-flow conditions at this site could obstruct flow. Upstream of this pool site there is a very long and rocky riffle along approximately 13m. There is natural groundwater seeping from the right bank into the creek along this riffle.

Table 4.) Reach 2 Habitat Data

Habitat Parameter	Value	Rating	Result
% Pool Area	40	3	Fair
Large Woody Debris/Bankfull Channel Width	0.45	5	Poor
% Cover in Pools	25	1	Good
Average % Boulder Cover	0	5	Poor
Average % Fines	32	5	Poor
Average % Gravel	28	N / A	N / A
% of Reach Eroded	50	5	Poor
Obstructions	0	0	Good
% of Reach Altered	0	1	Good
% Wetted Area	72	3	Fair
Total Result:		3	Fair

Annie Creek passes under Bradshaw Road through two 1.8m diameter and 21m long corrugated metal pipes (CMPs). These culverts appear undersized and are degrading. We observed that water can leak under the culverts and saturate adjacent bank materials. The right bank culvert is hung by approximately 50cm and the left bank culvert is not embedded into the creek bed. The pipes appear to be undersized based on the backwatering effect on them as well as the erosion on the right bank below the pipes. As this is a fish-bearing stream both culverts need to be sufficiently embedded into the creek substrates as to not impair the quality of fish spawning habitat. Not only are these culverts one of the largest factors impeding fish habitat within Annie Creek but also have the potential to negatively influence the structural stability of the Bradshaw Road crossing.

Upstream of the Bradshaw Road culverts the creek substrate is dominated by fine sediments that appear to be dropping out due to culvert backup. The riffles above the culverts are mild gradient (<6%) bedrock glides between small pools. While these small pools offer perennial fish habitat they lack adequate instream cover to protect fish. Boulders could be embedded into the

creek bed to offer cover for juvenile fish and to stabilize other creek-bed materials. Many of these riffles have caused serious erosion to the banks that is likely to blame for the sediment loading issues.

Riparian Areas R2

The riparian canopy depth and cover is good in this reach (Table 5). The large undeveloped areas since first pass logging are a great benefit to the stream water flow and temperature. A local property owner said that this Crown Land area was a protected natural area.

The eroded banks have undercut large Maple trees below Bradshaw Road. These trees are important riparian cover and help to condition the creek water temperature. They are going to fall into the creek and would deposit additional sediments downstream and potentially impair water flow.

Table 5.) Reach 2 Riparian Data

Riparian Parameter	Value	Rating	Result
Land Use	20	1	Good
Riparian Slope	28	1	Good
Bank Stability	74	4	Fair / Poor
% Crown Cover	78	1	Good
% of Reach Accessed	0	0	Good
Average Vegetation Depth	45	1	Good
Total Result:		1.5	Good

Reach 3:

Reach 3 extends from the E&N Railway tracks upstream in a confined valley approximately 700m to the entrance of Fletcher Creek. Reach 3 survey area was accessed upstream of the E & N railway tracks. The banks were very steep and deep. Access to this reach would be challenging with respect to getting equipment down for future restoration activities. Under the railway tracks is a concrete, 2.8m wide, 3.1m wide and 58 m long culvert.

Instream Fish Habitat R3

Fish habitat data scored poorly along Reach 3 (Table 6). Sedimentation was not as much of an issue in this reach as the previous two reaches but soft organic farm soil from runoff was seen in this reach. Our inspection of the upper reaches later observed both farms and roads with ditch lines open and exposed to sediments.

The substrates here were mostly cobbles and boulders with occasional bedrock glides. There were piles of cobbles and gravel bars that work to keep the water table below the creek bed. In many riffles and glides the substrates are quite permeable and would draw the water table too low to provide mid-summer fish habitat. Within this reach the channel width often exceeded the wetted width by 5 times or more. Just upstream of the Reach 3 survey end there is a steeply head-cut bank approximately 3m in height.

Table 6.) Reach 3 Habitat Data

Habitat Parameter	Value	Rating	Result
% Pool Area	26	5	Poor
Large Woody Debris/Bankfull Channel Width	0.67	5	Poor
% Cover in Pools	56	1	Good
Average % Boulder Cover	7	5	Poor
Average % Fines	19	3	Fair
Average % Gravel	25	N / A	N / A
% of Reach Eroded	39	5	Poor
Obstructions	0	0	Good
% of Reach Altered	0	1	Good
% Wetted Area	40	5	Poor
Total Result:		4	Fair / Poor

There is a large pile of fine sediments that will be drawn into the channel during the next high-water flush. Within the perennial pools of Reach 3 there is very little instream habitat. The pools are exposed and lacking boulder or wood cover. While access is limited, restoration activities using light-weight cover such as old Christmas Trees into these pools is recommended. Fish were observed in these pools all the way to the end of the Reach 3 survey, where the creek was dry. At the final pool in the Reach 3 survey a mature 6" Cutthroat Trout (*Oncorhynchus clarkii*) was observed taking refuge under the instream wood cover.

Around the mouth there is orange residue from iron leaching out from the culvert footings. Water quality at this station was normal and iron residue is likely the result of buried railway or forestry equipment. Monitoring water quality or working instream within Reach 3 would be difficult as access is a steep and narrow footpath.

Riparian Areas R3

Reach 3 riparian area scored Good to Fair (Table 7). The riparian width along Reach 3 typically exceeds 100m and is populated by a mix of second-growth Maples, Douglas Fir (*Pseudotsuga menziessi*), Western Red Cedar (*Thuja plicata*), and Western Hemlock (*Tsuga heterophylla*). Many of these trees exceed 60m in height and were historically protected from deforestation due to the steep gully banks. These mature trees cool and filter the creek water as well as stabilize the bank materials. Additionally, this treed riparian ecosystem supports an abundance of bird species. Numerous songbirds and woodpecker species were observed during the survey. This reach has noticeably cooler air temperature on sunny days and this sheltered understory ecosystem is home to Maidenhair Fern (*Adiantum pedatum*), Deer Fern (*Blechnum spicant*), Lady Fern (*Athyrium felix-femina*), Salmonberries (*Rubus spectabilis*), Stink Currant (*Ribes bracteosum*), Sword Fern (*Polystichum munitum*) and Cascara (*Rhamnus purshiana*) to name a few.

Table 7.) Reach 3 Riparian Data

Riparian Parameter	Value	Rating	Result
Land Use	22	1	Good
Riparian Slope	58	3	Fair
Bank Stability	60	3	Fair
% Crown Cover	76	1	Good
% of Reach Accessed	0	0	Good
Average Vegetation Depth	100	1	Good
Total Result:		2	Good / Fair

Other Drainages and Tributaries:

Adjacent to Grove Hill Road there is a very long and steep ditch line. This ditch channel flows for approximately 600m before entering an offshoot channel that directs all discharge water over the bank into the Annie Creek watershed. As Grove Hill Road is an unpaved, gravel road this is a huge sediment source for Annie Creek. Along Grove Hill Road there are several large, deforested properties that can also contribute sediments into this ditch and into Annie Creek. Installing roadside bio-swales along Grove Hill Road would filter road runoff and sediments before entering the ditch. This ditch also collects a large volume of water and fills Annie Creek to a flow capacity it wouldn't naturally experience. Not only does this ditch directly contribute sediments to the creek but accelerates downstream erosion rates.

Raw data collected during the survey is presented in the appendix.

Table 8) Water Quality

Reach	Location	pH	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Temperature (°C)	Time
1	Van. Isle Road Culvert	7.0	7.7	82	13.2	9:55 am
2	Pool 3, Below Bradshaw Road	7.0	9.0	97	13.6	1:30 pm
3	Riffle 1, Above Railway Culvert	7.0	8.8	92	15.0	10:00 am
	Pool 5, End of Reach 3 Survey	7.0	9.1	95	12.3	11:45 am

The measured water quality parameters do not indicate any significant issues in Annie Creek. The water chemistry of these surveyed reaches is hospitable to sustaining both fish and invertebrate life. Sensitive invertebrate species such as mayflies (*Ephemeroptera sp.*) and caddisflies (*Trichoptera sp.*) were observed in each reach; a good indicator that the creek is not significantly polluted or hypoxic. The gradient and cobble riffles along Annie Creek appear to adequately oxygenate the water.

Due to good overhead cover and much of the creek being within a steep gully the time of day appears to have negligible effect on water temperature. At the end of Reach 3 (Pool 5) there appears to be some groundwater influence as the water here was much cooler than in

downstream areas. The prominent overhead cover is one Annie Creek's greatest assets. pH levels were neutral and this result is typical for semi-urban streams on Vancouver Island.

Discussion

In Table 9 below are a list of restoration activities that were determined from the survey data and observations. We noticed the Annie Creek watershed has some significant attributes as well as some handicaps. The Erosion at Bradshaw Road is caused by the poorly placed and sized culverts. Replacing these pipes would be a significant improvement. The riparian reserve area of Crown Land above Bradshaw is significant. The impacts of upland farming and historic logging still result in many dry areas in this reach in summer. Controlling sediment from Grovehill Road and ditches would stop an impact that has been ongoing for years. The lower reaches of Annie Creek have water but they are infilled by these sediments. More trees need planting in Reach 1 which has a possible bylaw protected area where restoration access and permission will be easy. Addressing the pipe effluent into the creek at Reach 1 is also important as there are pollutants.

Table 9: Annie Creek: Habitat and Water Quality Improvement Opportunities

Reach	Impact	Recommended Remedial Action	Comments
1	1.1 Sloughing banks and erosion	Planting Red Osier Dogwood on Streambanks	Red Osier Dogwood growing nearby
1	1.2 Invasive Yellow Flag Iris and Reed Canary Grass constricts channel	Invasive plant removal, and plant native riparian shrubbery	Invasives threaten remaining Reach 1 riparian
1	1.3 Turbidity – Poor Water quality and covers spawning materials	Stabilize banks by planting, introduce spawning gravel beds	Sediment worst feature about Reach 1 water quality
1	1.4 Storm Pipe Outlet	Redirect or deactivate water source	Algae indicates nutrients
1	1.5 Log jam impairs hydrology and fish access	Remove debris jam	Small, can be removed by hand
2	2.1 Bradshaw Road Culverts undersized, hung, and rotting	Replace two culverts with one, properly sized and embedded culvert or bridge	A priority issue on Annie Creek. Contact highways.
2	2.2 Sediment Accumulation and Bank Erosion	Stabilize banks by planting. Erosion sites, undercut and put large riparian trees at risk of falling	Fine substrates impair fish spawning ability and Water Quality
3	3.1 Head-cut bank end of Reach 3	Stabilize bank by planting and potentially rock placement	Inaccessible site, sediment source
3	3.2 Lack of Instream Cover	Christmas Tree anchoring in pools	easy benefit to trout
Grove hill Road Ditch	Directs water and road runoff directly into Annie Creek.	Bio swales or line channel with rock. Would be optimal to pave road too	Huge sediment source and causes downstream erosion

Conclusion:

The objective of this survey and report was to teach stewards how to quantify the habitat and identify concerns surrounding the health of Annie Creek. The success of our effort will be measured by the actions taken on Annie Creek over the next few years.

Annie Creek has been altered by historic logging, some residential development, roadways and agricultural runoff. The habitat impacts are erosion, lack of LWD, lack of surface water in upper reaches and sedimentation.

Annie Creek has a large undeveloped Crown Land area in Reach 2 and 3 which has high wildlife values as it is an older second growth forest. Annie Creek still supports a high number of Coho observed in Reach 1. It also has Cutthroat to the end of summer water in the mid reach. The water quality of this creek also contributes to the overall water and substrate quality of Qualicum Bay. As sedimentation appears to be a large concern for Annie Creek, sediment deposition in the Qualicum bay subtidal zone likely affects many benthic species of fish and invertebrates. Long term fish values will always depend on there being a plentiful supply of water into deep pools with cover for the fish species of Annie Creek. These conditions exist, but currently they exist in separate areas, getting these to fit together is the next job. The activities in this report are scalable to capabilities of volunteers and property owners. We hope they remain interested in these activities and will undertake some, with support of partners like the RDN DWWP program.

Photo Page 1) Reach 1 Habitat



Photo 1) Reach 1, Pool 4 overhead bridge cover and shading



Photo 2) Pool 1 instream vegetation cover



Photo 3) Representative site at R1, Pool 5



Photo 4) Streamside sedges and native riparian vegetation

Photo Page 2) Reach 1 Restoration Opportunities



Photo 1) Invasive Reed Canary Grass choking creek at R1, Pool 2



Photo 2) Woody debris jam upstream of Reach 1, Pool 5



Photo 3) Reach 1, Pool 5 right bank storm pipe outlet



Photo 4) Invasive Yellow Flag Iris along Reach 1

Photo Page 3) Reach 2 Habitat



Photo 1) Reach 2, Riffle 1 habitat and cobble substrates



Photo 2) Reach 2, Pool 4 representative substrate composition and depth



Photo 3) Reach 2, Pool 1 instream wood cover and bank vegetation



Photo 4) End of Reach 2 undercut cover

Photo Page 4) Reach 2 Restoration Opportunities



Photo 1) Reach 2, Bradshaw Road culverts hung and rotten



Photo 2) Reach 2 bank erosion site



Photo 3) Bradshaw culvert impairing fish passage and hydrology



Photo 4) Reach 2, Riffle 4 too long, bound to dry in summer

Photo Page 5) Reach 3 Habitat



Photo 1) Reach 3, Pool 1 habitat with undercut cover



Photo 2) Large second growth riparian vegetation along Reach 3



Photo 3) Reach 3, Riffle 5 vegetation and wood instream cover



Photo 4) Reach 3, Pool 2 offers perennial fish habitat and cover

Photo Page 6) Reach 3 Restoration Opportunities



Photo 1) Reach 3 cement culvert under railway track



Photo 2) Sloughing bank and sediment source at Annie/Fletcher confluence



Photo 3) Reach 3, Riffle 5 is way too long and impairs fish passage



Photo 4) Railway culvert leaching iron residue into creek

Appendix 4) Summary Data and Results

Stream Name	Annie Creek				Watershed Code	920-488600	
Habitat Parameter	1	Ratings	2	Ratings	3	Ratings	Total
% Pool Area	112	1	40	3	26	5	12
Large Woody Debris/Bankfull Channel Width	0.04	5	0.45	5	0.67	5	18
% Cover in Pools	80	1	25	1	56	1	6
Average% Boulder Cover	0	5	0	5	7	5	18
Average % Fines	43	5	32	5	19	3	28
Average % Gravel	41	not rated	28	not rated	25	not rated	--
% of Reach Eroded	1	1	50	5	39	5	26
Obstructions	0	0	0	0	0	0	0
% of Reach Altered	19	5	0	1	0	1	22
% Wetted Area	69	5	72	3	40	5	16
Totals		30		30		36	174
Riparian Ratings							
Reach	1	Ave. Ratings	2	Ave. Ratings	3	Ave. Ratings	Total
Land Use	44	2	20	1	22	1	4
Riparian Slope	24	1	28	1	58	3	5
Bank Stability	60	3	74	4	60	3	9
		Ratings		Ratings		Ratings	--
% Crown Cover	57	3	78	1	76	1	8
% of Reach Accessed by Livestock	131	5	0	0	0	0	5
Average Vegetation Depth	3	5	45	3	100	1	12
Totals		19		10		8	44