

# **Departure Creek Habitat Assessment Report**

On behalf of:

**Departure Bay Neighbourhood Association, Nanaimo B.C.**

by

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## INTRODUCTION

The Departure Bay Neighbourhood Association (DBNA) requested an Urban Salmon Habitat Program Habitat Assessment to provide Habitat Restoration Prescriptions which could guide them on future recovery programs in the watershed. D.R. Clough Consulting was hired to help them in conducting the survey and to analyze the results. This is a report of the fish habitat survey conducted in July 2015 with the results and conclusions reported below.

The rationale for conducting this survey was the concern raised by the Departure Creek Stewards and the City of Nanaimo over the degradation of the Creek habitat by historic development on the watershed. The objective of this report was to conduct a fish habitat and riparian assessment of the mainstem and major tributary Keighley Creek.

This survey was conducted by;

- Brad Remillard, RPBio, Braden Judson, Fisheries Technician and Dave Clough, RPBio of D.R. Clough Consulting.
- Members of the Departure Bay Neighbourhood Association
- Members of the Snuneymuxwe First Nation

The project was funded by grants from the following;

- Pacific Salmon Foundation
- Fisheries and Oceans, Community Programs – Erica Blake, Community Advisor
- Regional District of Nanaimo (Community Watershed Program)

The project contacts were;

- Jean-Michel Hanssens, Streamkeeper Coordinator
- Allan Davidson, Departure Bay Neighbourhood Association
- Rob Lawrance, City of Nanaimo, Parks and Open Space Planner
- Perry Point, Fisheries Coordinator & Juan Moreno, Guardian, Snuneymuxwe First Nation

Community Association Members as well as Streamkeepers volunteered on this project included;

Jean- Michel Hanssens, Capri Brugge, Neil Hendrickson and Doug Boyle.

## **SURVEY OBJECTIVES**

The project objectives were to:

- Conduct a habitat assessment of Departure Bay Creek in the lower open water sections
- Concurrently train stream stewards on how to do a habitat assessment
- Assess the past (2000, USHP report) and habitat restoration activities in time for improvement or maintenance.
- Summarize the habitat survey data to Identify future-stream restoration projects in the watershed.

## **STUDY AREA AND BACKGROUND INFORMATION**

### **Departure Creek Watershed**

#### **History**

Departure Bay has been home to the Snuneymuxwe First Nation for over 3500 years. It historically featured a winter village and burial ground (inVision Planning, 2006). With the European settlement of Nanaimo in the late 1800's Departure Bay began to be developed with construction of a coal railway/pier system designed to deliver the coal from the Wellington mines to the ships in Departure Bay. Remnants of these piers can still be today during low tide even though coal production ceased in 1900. During the same time frame, upland farms were developed and the tidal marsh/estuary of Departure Creek disappeared (inVision Planning, 2006). Post World War one the waterfront area became recreational hotspot with historic photos showing a vibrant foreshore, featuring a swimming beach, and cabins. The existing development/infrastructure was constructed started in 1958 with Centennial Park and ended in 1969 with the parking lot and seawall construction along the foreshore. Departure Bay was recognized as an Improvement District from 1953 to the fall of 1975 (City Records). The northwest corner of Departure Bay and upland foreshore are within a designated archaeological site. Over the years a number of excavations areas have been discovered with a burial site adjacent Departure Creek, (inVision Planning, 2006). Golder Associated was contracted directly through the City of Nanaimo to conduct an archeological impact assessment of the lower Departure Creek written concurrently with this report.

Various incarnations of habitat stewards have been present in the watershed since the early 1990's. Previous urban stream surveys were funded by the Habitat Conservation Fund in 1993 (Toth) and was updated in 2000 through Project 2000 (ATC). Stream restoration work on Departure Creek was done in 1995 and 1996 by Trout Unlimited, Malaspina University College, and local groups. In 2000 the Nanaimo Area Land Trust conducted riparian planting and the Departure Bay Neighbourhood Association completed instream restoration work in 2008. The Harbour City River Stewards continued this work into 2014. Vancouver Island University has conducted water quality analysis in the watershed periodically since 2006. The Community Watershed Monitoring Network has conducted water quality analysis at three set locations during the first fall rain each year since 2012.

#### **Habitat Overview**

The Departure Creek is a small (3.2km<sup>2</sup>) second order tributary of located entirely within the City of Nanaimo (Figure 1). It originates from the Nanaimo Golf Club area running approximately 3km long before reaching Departure Bay. The watershed's main channel flows west to east which is fed by two main tributaries that flow from the north and south. Currently the tributaries (Joseph and Keighly Creeks) offer extremely limited fish access/habitat due to barrier culverts at their confluences. The mainstem

offers approximately 860m of salmon access before ending at natural barriers as the channel rises sharply over a series of two bedrock waterfalls within Woodstream Park.

The watershed is located in the Coastal Douglas Fir moist maritime (CDFmm) Biogeoclimatic zone (MWLAP 1998) at a median elevation of 70m, in the rain-shadow of Vancouver Island. The summers are warm and dry, and the winters are mild and wet, and are normally drier than most other BC coastal zones. The CDFmm is the rarest in the province at an estimated 250,000ha with only 1% of old growth forest remaining undisturbed. This climate creates a unique set of conditions, allowing for a diverse group of plants and animals found nowhere else in the country (Madrone 2008). Given the overall size and uniqueness of the CDFmm the plants and wildlife are critically endangered. Northwest Hydraulic Consultants Ltd calculated the average annual rainfall and mean annual discharge to be 1070mm and 0.066 m<sup>3</sup>/s respectively.

The Departure Creek watershed is severely developed; nearly half of the upper water is buried in storm water system, while the mid reach is located in a confined ravine and has remained in a relatively natural state with a functional 2<sup>nd</sup> growth riparian zone which is greater than 10m wide. The lowest 400m has been channelized and features a storm water flood diversion. The diversion which was first constructed in the mid 1960's is located off Bay Street adjacent the Elk Street intersection. The remaining Departure Creek crosses Bay Street then Elk through concrete culverts, it then parallels Bay Street running through the private residences (1482 to 1430 Bay Street) before reaching Centennial Park. Along Centennial Park it picks up an unnamed tributary which originates in the perimeter drainage of the play field. It then follows the perimeter of the City parking lot adjacent the foundation of the 7-11 gas station. It crosses Bay Street once again and is joined by the storm bypass outlet at a short channelized section before passing under Departure Bay Road through a 56m box culvert. The creek then enters the ocean on the north corner of Departure Bay featuring a 2.0 km long gravel and sand beach .

Figure 1 Departure Creek Watershed



## FISH HABITAT AND RIPARIAN ASSESSMENT METHODS

The habitat assessment was conducted using an assessment procedure developed by the Urban Salmonid Habitat Program (USHP). The survey methodology is described in detail in the *Vancouver Island Urban Salmonid Habitat Program (USHP) Assessment and Mapping Procedures Manual*<sup>1</sup>. This methodology was developed by the British Columbia Ministry of Environment staff on Vancouver Island and the results were integrated into a program that funded stewardship projects on streams. The program worked closely with stewardship groups all over Vancouver Island allowing for a comparative data base of similar streams.

The USHP survey of Departure Creek will result in analysis of habitat data using provincial stream habitat standards<sup>2</sup> and allow a detailed habitat comparison of other Vancouver Island Urban Streams.

Data was collected on up to 21 items per habitat unit on the waterproof paper field sheet (Figure 2). Habitat units were identified as pools (areas with residual depth) or riffles (emergent substrates at low flow and no residual depth). The habitat units were sampled and given a consecutive numbering system starting with Pool 1 and Riffle 1 at the beginning of the reach. The start of each pool habitat unit was marked with flagging tape. The flags were put on river right bank unless no attachment was available, then left bank was used. The distances were measured with a hip chain, 30 m tape and GPS access. Width and depth measurements were taken with a marked staff or retractable tape.

The data was recorded directly into embedded schema's via our ipad. Each pool and riffle was photographed with the location recorded. Representative habitat photographs of Reaches are provided in Appendix 1.

After the survey was completed the stream data was taken from the ipad and downloaded then entered into the USHP spreadsheet program (USHPv5). The internal macro enabled programming calculated the data then reviewed and scored the results of the most significant aspects such as: pool area, number of large woody debris (LWD)/bankfull channel width, percentage of in-stream cover, substrate (percentage of fines, gravels, cobbles, boulders, bedrock), percentage of reach eroded, altered and percentage of wetted area.

This survey was conducted on May 24 and 25<sup>th</sup>, 2016. The participants in the survey were organized by the Departure Bay Neighbourhood Association (DBNA). The team included the following people; Juan Moreno (SFN), Jean- Michel Hanssens, Capri Brugge, Doug Bogle, Neil Hendrickson (DBNA) ,Braden Judson, Fisheries Technician, Brad Remillard and Dave Clough, RPBio of D.R. Clough Consulting.



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<sup>1</sup> Michalski, T, G. Reid & G. Stewart, 2000. Ministry of Environment, Nanaimo B.C.

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



Figure 2 USHP Habitat and Riparian Data Card

Stream Name	<i>Fish C.</i>	<p><b>Habitat and Riparian Card Instructions</b></p> <ol style="list-style-type: none"> <li>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;</li> <li>2. Measure riparian parameters (black boxes) <u>every 100 meters</u>;</li> <li>3. Measure the start, finish &amp; wetted width for <u>pools only</u>; take data for all other shaded boxes along <u>entire stream length</u>.</li> </ol> <p><b>Abbreviations and Definitions</b></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 &gt;10cm in diameter and &gt;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,<sup>1</sup> 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><sup>1</sup> 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>	

## Departure Creek Habitat Survey Area-Reach Segments

The objective was to survey the lower salmon bearing reaches of Departure Creek. The survey areas were first reviewed with the GIS enabled map prepared from the city of Nanaimo. Then a pre survey inspection of the watershed was conducted with during a stream keeper training course with Dave Clough and Jean Michel Hanssens (March 2016) to identify the survey areas and restoration opportunities.

Departure Creek originates from a storm water discharge beneath a residence off of Shamrock Place upstream off the barrier culvert at Neyland Road. Tributaries Joseph and Keighley Creeks also enter in the vicinity Neyland Road with Joseph entering on the right bank upstream of Neyland and Keighley entering on the left bank below. The stream survey segments were finalized in the field as we determined the breaks based on the channel width, slope and barriers (Figure 3). It resulted in a nine mainstem reaches, with anadromous fish access ending at in Reach 5.

Departure Mainstem Reaches 1 and 2 were lumped together for the purpose of this report as they were both developed and altered segments. Reach 1 features a 50m long box culvert and a short 48m open water reach between Departure Bay Road and Bay Street. Reach 2 consists of the 290m long ditched residential reach running parallel Bay Street up to the diversion structure.

Reach 3 is a 289m long segment located upstream of the diversion and within Woodstream Park. It features the sediment sump for the diversion and a left bank floodplain area. It ends at a significant right.

Reach 4 starts above the tributary and is 148m long extending to the base of the bedrock section which forms the anadromous. This reach featured a higher rate of erosion and a few deciduous debris jams the erosion site was directly downstream of a storm water outfall. The bank slopes are also steeper than reach 3. This reach appears to be a significant sediment source for downstream reaches.

Reach 5 is dominated by bedrock it is 131m long and features a series of bedrock waterfalls resulting in the end of anadromous access. There is a braided channel at the uppermost extent of this reach with the river left bank appearing the most active, but it is likely that both are active during periods of high flow.

Reach 6 this headwater low gradient reach offers some of the most functional spawning, rearing habitat and riparian in the watershed (with the exception of one household). This reach covers 448m from the top of the waterfall barrier to the Joseph Creek confluence.

Reach 7 extends from the Joseph Creek confluence upstream to the Keighley Creek confluence off of Keighley Road. It crosses through the fish passable box culverts underneath Newton Street. This reach features steeper riparian slopes and higher rates of bank erosion. This is likely the impact of the storm water inputs.

Reach 8 this reach has been heavily impacted by residential development in the early 1973's. It has a limited riparian area with encroachments on nearly every property as well as a house foundation within 2m of the top of bank. The reach was 180m long and ended at the fish barrier culvert on Neyland Road.

Reach 9 is the end of the open water channel on the mainstem. It ranges from Neyland Road to the backyard of the residences off Shamrock Place. At this location the channel daylights from a series of storm drains. This reach was highly eroded given the amount of alterations to the riparian zone which ranged from vegetation removal to placement of fill. This reach was 101m long.

## **Joseph Creek**

Reach 1 is located below Neyland Road and is 27m long. Directly below the hung culvert the channel braids out before entering the floodplain of mainstem Departure Creek.

Reach 2 extends from Neyland Road upstream 575m. This reach featured a shallow unconfined channel with ditch like characteristics. This reach featured a substrate consisting of mostly vegetated fines.

## **Fish Population Sampling**

Fish populations were not sampled during the time of the assessment. A smolt trap was operated by the DBNA in reach 2 from April 15<sup>th</sup> to May 31<sup>st</sup>, 2016. They captured Coho smolts, Cutthroat trout, three Spine Stickleback and Prickly Sculpin (pers. comm., J-M Hanssens) . A brief electroshock survey was conducted on the morning of May 24, 2016. Juvenile Coho as well as Cutthroat Trout were captured in Reach 3. This was done in conjunction with smolt trap operation/educational display with Departure Bay Eco-School.

## **Water Quality**

Field measurements of water quality were conducted on the throughout the survey area. The sampling included the following parameters: temperature, pH, dissolved oxygen (DO), total conductivity and percent saturation.

Our field equipment was an OxyGard Dissolved Oxygen and Temperature Meter, as well as LaMotte Wide range pH kits (droppers), and a Hanna Conductivity, TDS and Temperature meter. No grab or sediment samples of water were taken.

## **Habitat Data Ranking Methods**

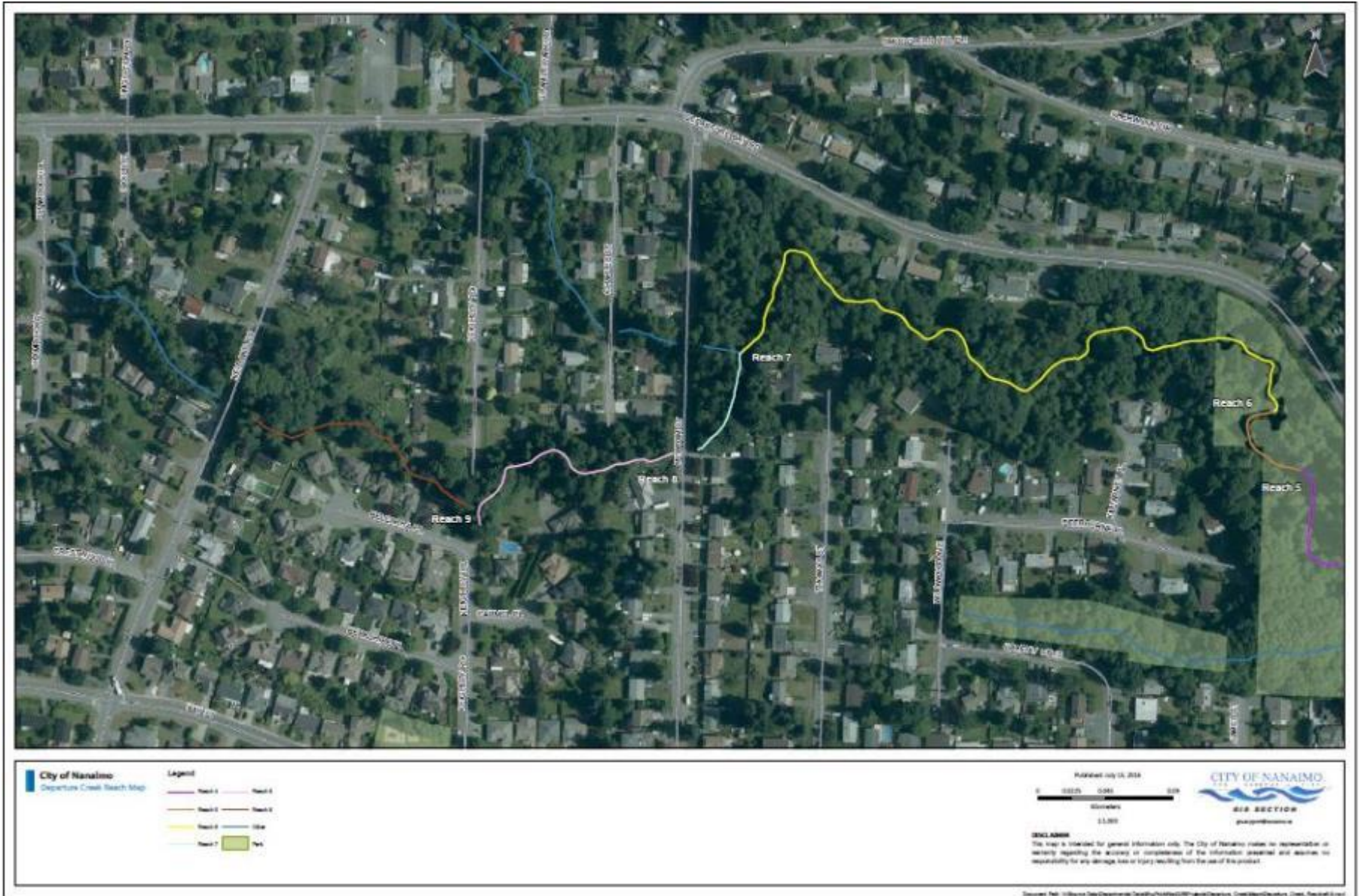
The field data for habitat and riparian values was entered in the USHP spreadsheet program. Both the physical habitat and the riparian parameters are scored using the ranking system outlined in the USHP manual (Michalski et al. 2000). The spreadsheet program automatically extracts data for a number of habitat parameters measured and enters these values into a separate summary table called the Sum and Ratings Table. The program also assigns numeric values to habitat parameters in this table. This ranking procedure assigns a number of one (good), three (fair), or five (poor) to each habitat and riparian characteristic. This allows a numeric summary and comparison of characteristics. The fish habitat parameter data in the Sum and Ratings Table is then compared to the biostandards for healthy streams (Johnston and Slaney 1996). Data sheets for Reaches 1 through 6, as well as the Sum and Ratings Table are provided in Appendix 2.

Figure 3 Departure Creek Reach Segments 1-6





Figure 4 Departure Creek Reach Segments 7-9



## **DEPARTURE CREEK HABITAT ASSESSMENT RESULTS**

The habitat and riparian data summary tables for Departure Creek are presented below. The USHP habitat survey measures were taken May 24 & 25, 2016. The weather prior to and during the survey was warm and dry. The water levels may not have been at extreme base flow which is what the USHP survey. The individual data tables for each reach are located in the Appendix 2 sections. The USHP uses a standardized summary for each reach of the Habitat, Water Quality and Riparian Assessments. The summary tables are shown in their sections of the report below.

There were nine reaches of Departure Creek assessed as noted above in the methodology area section. The total length sampled in the mainstem reaches of Creek was 1944m. Joseph Creek were estimated at 581m for a total of 2525m. The survey length was based on walking with a hip chain and GPS interpretation. The result was about 77% of the available fish habitat length being surveyed. The BC Environment RISC standards suggest 10-25% depending on the stream order and gradient. The Pacific Streamkeepers Handbook recommends 10 habitat units surveyed per reach (we surveyed at 100% with the exception of Joseph Creek). The summary habitat results are shown in Table 1 on the next page. A review of each reach is described below.

### **Departure Creek Reaches 1&2 Habitat Assessment Results**

This segment begins at the tidal culvert pool entering Departure Bay (0+000m) and extending upstream along Bay Street 388m to the diversion structure adjacent Elk Street. The water is diverted using an orifice plate to block high flow where it then travels through a box culvert running parallel Bay Street, it rejoins below the Bay Street lower culvert and upstream of the Departure Bay Road culvert. The reach had seven pools and 12 riffles. The smolt trap operated by the Departure Bay Neighbourhood Association is located on private property near station 0+245m.

The late May habitat survey results found the available wetted habitat offered was 681m<sup>2</sup>, of which only 20.7% of it was pools. This reach was very shallow with an average depth of 0.19m. The mean wetted width was 1.87m in a channel of 2.79m (USHP Reach 1 Data Sheet – Appendix 2).

This reach has been channelized and diverted from its original location. Historic maps and photos indicate the lower creek was once a large wetland behind beach dunes. The current channel has limited substrates from alteration and features a sand bottom trench. It has a wetted depth of up to 0.4m deep in some locations. This reach scored poorly in most categories including; % Pool Area, LWD/Bankfull Width, Boulder Cover, % Fines, Erosion, Wetted Area, Obstructions, % Off Channel Area and Riparian Depth.

Fine substrates are blanketing the lower reach. The input sources from erosion and road run off may exceed the capability of the stream to flush it out. It could be that the current diversion structure does not achieve suitable flushing (400% MAD) to remove the sandy substrates. Eliminating the sediment through erosion protection on public and private properties is also needed (many erosion areas listed in the lineal survey). Road runoff is also a contribution that must be addressed through changing input designs to include bioswales and to do regular maintenance of the existing catch basins and storm water bypass sump.

Other restoration opportunities include stabilizing the placement of spawning gravel/rock crests between Departure Bay Road and Bay Street. Additional small LWD (0.2-0.4m diameter) would be beneficial to add to wider areas with pools along the reach. The ditch like 70m long segment around the Centennial Park/7-

11 parking lot offers an excellent opportunity to create a more natural channel habitat and eliminate a big sediment source. There is a drainage from Centennial Park that is a potential 90m long off channel.

### Reach 1 and 2 Habitat Results

Habitat Parameter	R1/R2	Ratings	Result
% Pool Area	21	5	Poor
Large Woody Debris/Bankfull Channel Width	0	5	Poor
% Cover in Pools	22	1	Good
Average % Boulder Cover	2	5	Poor
Average % Fines	73	5	Poor
Average % Gravel	11	not rated	
% of Reach Eroded	17	5	Poor
Obstructions	2	2	Good
% of Reach Altered	4	1	Good
% Wetted Area	67	5	Poor
Dissolved Oxygen	9.6	1	Good
pH	7.6	1	Good
<b>Totals</b>		<b>36</b>	<b>Fair</b>

### Reach 1 and 2 Riparian Results

Riparian Ratings	R1/R2	Ratings	Result
Land Use	102	3	Fair
Riparian Slope	34	1	Good
Bank Stability	91	3	Fair
% Crown Cover	65	3	Fair
% of Reach Accessed	0	0	Good
Average Vegetation Depth	5	5	Poor
<b>Totals</b>		<b>14</b>	<b>Fair</b>

### Departure Creek Reach 3 Habitat Assessment Results

This reach begins at Woodstream Park on the upstream side of the diversion structure. The reach extends upstream to a confluence with the Holiday Crescent storm water tributary. The reach has a length of 289m. This reach is the first segment that is very likely not an altered route as it is in a confined gully with steep sidewalls of 15 to 50 m length. The creek runs in a 20 to 40m wide gully floor.

The average gradient is close to 2.0 % and it has a channel width of 4.34m. The wetted width average was 2.62m with a depth of 0.28m. There is a substantial left bank flood plain area in the mid reach. It is likely this portion of the creek has meandered throughout this area historically; however the existing trail network is acting as a dyke and has cut off this meander

Reach 3 offers the first suitable spawning substrates but the habitat rating of this reach scored poorly for; % Pool Area, LWD/Bankfull Width, Boulder Cover, % Fines, Alterations, Erosion, Wetted Area, % Off Channel Area and Riparian Depth.

This reach has been the subject of many restoration efforts including LWD placement, riparian planting, sediment removal and willow staking. The most recent LWD and pool crest placements (NHC 2012) are functioning as designed. Potential restoration works would include adding LWD to these structures and repair to the boulder riffle crests with additional spawning gravels. There is an opportunity for a ground water offchannel on the left bank in the floodplain area. Removing the pool sediment as it builds up in the diversion structure pool is required. Riparian areas require continued maintenance to past planting efforts along the trail corridors mostly due to disturbance.

### Reach 3 Habitat Results

Habitat Parameter	R3	Ratings	Result
% Pool Area	33	5	Poor
Large Woody Debris/Bankfull Channel Width	0.5	5	Poor
% Cover in Pools	11	3	Fair
Average % Boulder Cover	3	5	Poor
Average % Fines	27	5	Poor
Average % Gravel	63	not rated	
% of Reach Eroded	13	5	Poor
Obstructions	0	0	Good
% of Reach Altered	11	5	Poor
% Wetted Area	60	5	Poor
Dissolved Oxygen	N/A	N/A	
pH	N/A	N/A	
<b>Totals</b>		<b>38</b>	<b>Poor</b>

### Reach 3 Riparian Results

Riparian Ratings	R3	Ratings	Result
Land Use	87	1	Good
Riparian Slope	92	1	Good
Bank Stability	185	3	Fair
% Crown Cover	64	3	Fair
% of Reach Accessed	0	0	Good
Average Vegetation Depth	15	5	Poor
<b>Totals</b>		<b>14</b>	<b>Fair</b>

### Departure Creek Reach 4 Habitat Assessment Results

From the Holiday Crescent tributary upstream to the fish barrier is 147m long. This segment is the end of salmon habitat. It has an average channel width of 5.93m. The average gradient was 1.53% however this reach has step pool morphology with riffles at a 4-6% gradient. The average wetted width was only 2.34m with an average pool depth of 0.32m. Instream cover was moderate (12%) and resident trout were observed in the pools. This reach was second highest score in erosion (only below Reach 8) at 24%. It featured a recently eroding river left bank associated with blowdown and a debris jam mid reach below a storm water outfall from Departure Bay Road near Greenleaf Place.



Reach 4 failed to get good scores for % Pool Area, Boulder Cover, % Fines, Erosion, Wetted Area, % Off Channel Area and Riparian Depth.

Potential restoration activities in this reach should include removal and stabilization of the debris jam, repairs to the outfall of the stormwater culvert, bio stabilization of 15m long erosion site on the left bank. Addition of LWD and riparian planting would be beneficial.

#### Reach 4 Habitat Results

Habitat Parameter	R4	Ratings	Result
% Pool Area	31	5	Poor
Large Woody Debris/Bankfull Channel Width	1	3	Fair
% Cover in Pools	12	3	Fair
Average % Boulder Cover	1	5	Poor
Average % Fines	23	5	Poor
Average % Gravel	53	not rated	
% of Reach Eroded	24	5	Poor
Obstructions	0	0	Good
% of Reach Altered	0	1	Good
% Wetted Area	39	5	Poor
Dissolved Oxygen	10.2	1	Good
pH	7.7	1	Good
<b>Totals</b>		<b>34</b>	<b>Fair</b>

#### Reach 4 Riparian Results

Riparian Ratings	R4	Ratings	Result
Land Use	30	1	Good
Riparian Slope	48	2	Good
Bank Stability	113	4	Poor
% Crown Cover	69	3	Fair
% of Reach Accessed	0	0	Good
Average Vegetation Depth	24	5	Poor
<b>Totals</b>		<b>14</b>	<b>Fair</b>

#### Departure Creek Reach 5 Habitat Assessment Results

This stream segment is a 131m long "ravine" reach and its profile is controlled entirely by bedrock. Other than the first pass logging, it appears to be in its original state having been isolated from development by the steep banks. The anadromous barrier is located at station 0+875m where there is a series of two bedrock falls on 18-24% gradients. At the top end of this reach there is right bank blowout channel likely caused from an historic debris jam.

Restoration Potential: Given the bedrock dominance of this reach, restoration activities are best concentrated in other areas (reaches 1-4) or addressing sediment input areas (reach 8 and 9). Once the lower section of Departure is completely restored the right bank overflow could potentially be manipulated to create a bypass fishway, which is currently not a priority.

### Reach 5 Habitat Results

Habitat Parameter	R5	Ratings	Result
% Pool Area	44	3	Fair
Large Woody Debris/Bankfull Channel Width	0.2	5	Poor
% Cover in Pools	13	3	Fair
Average % Boulder Cover	10	3	Fair
Average % Fines	36	5	Poor
Average % Gravel	27	not rated	
% of Reach Eroded	0	1	Good
Obstructions	1	1	Good
% of Reach Altered	0	1	Good
% Wetted Area	67	5	Poor
Dissolved Oxygen	N/A	N/A	
pH	N/A	N/A	
<b>Totals</b>		<b>27</b>	<b>Fair</b>

### Reach 5 Riparian Results

Riparian Ratings	R5	Ratings	Result
Land Use	34	1	Good
Riparian Slope	22	1	Good
Bank Stability	47	1	Good
% Crown Cover	80	1	Good
% of Reach Accessed	0	0	Good
Average Vegetation Depth	30	3	Fair
<b>Totals</b>		<b>7</b>	<b>Good</b>

### Departure Creek Reach 6 Habitat Assessment Results

A long flat (average 2.17% gradient) headwater bench that goes from the top of the water fall upstream to the confluence with Joseph Creek. It extends 448m offering 343m<sup>2</sup> of pool area for resident Cutthroat Trout. This reach has a 3.69m wide channel with an average wetted width of 2.33m and a pool depth of 0.36m. It scored the highest % fines and % crown cover of all the reaches. This reach was historically logged and cleared, but has regenerated over the past 40-70 years with a closed canopy of 75 to 85%. The lowest section is within the new Woodstream Park boundary with the remainder is privately owned.

This reach failed in scoring for % Pool Area, Boulder Cover, Wetted Area, % Off Channel Area and Riparian Depth as there is not a 30m continuous riparian area.

Most property owners have developed their residences with care however a few households (off Departure Bay Road and Thomas Street) have encroached into the riparian areas. One better example is the larger property off Wildwood Ave with a park like setting complete with trails a multiple bridge network. This reach is the least impacted area in the watershed. It has perennial pools with resident Trout observed in the pools living year round. It could use additional conifer under planting as well as upland storm water protection. The pools are deficient in functional LWD but it may be difficult to make use of anything other than local materials due to the forested surroundings. Some local blow down could be hand placed.

### Reach 6 Habitat Results

Habitat Parameter	R6	Ratings	Result
% Pool Area	33	5	Poor
Large Woody Debris/Bankfull Channel Width	0.3	5	Poor
% Cover in Pools	5	5	Poor
Average % Boulder Cover	0	5	Poor
Average % Fines	11	3	Fair
Average % Gravel	74	not rated	
% of Reach Eroded	6	3	Fair
Obstructions	0	0	Good
% of Reach Altered	0	1	Good
% Wetted Area	63	5	Poor
Dissolved Oxygen	9.7	1	Good
pH	7.50	1	Good
<b>Totals</b>		<b>34</b>	<b>Fair</b>

### Reach 6 Riparian Results

Riparian Ratings	R6	Ratings	Result
Land Use	110	1	Good
Riparian Slope	174	2	Good
Bank Stability	326	4	Poor
% Crown Cover	73	1	Good
% of Reach Accessed	0	0	Good
Average Vegetation Depth	25	5	Poor
<b>Totals</b>		<b>13</b>	<b>Fair</b>

### Departure Creek Reach 7 Habitat Assessment Results

Above Joseph Creek confluence Reach 7 extends upstream past Newton Street to Keighley Creek. This reach was 260m long. There is a fish passable box culvert underneath Newton Street (Stream Station 1+024m). The channel increases in gradient to an average of 3.05% with an average channel width 3.19m.

This reach also features steeper riparian slopes and higher rates of bank erosion than Reach 6. This is likely the impact of the storm water inputs and removal of riparian vegetation and other alterations such as a failing concrete retaining wall along residential property upstream of Newton Street. This reach failed in scoring for % Pool Area, LWD/Bankfull Width/ Boulder Cover, Fines, Erosion, Wetted Area, % Off Channel Area and Riparian Depth.

### Reach 7 Habitat Results

Habitat Parameter	R7	Ratings	Result
% Pool Area	14	5	Poor
Large Woody Debris/Bankfull Channel Width	0.1	5	Poor
% Cover in Pools	9	3	Fair

Habitat Parameter	R7	Ratings	Result
Average % Boulder Cover	1	5	Poor
Average % Fines	22	5	Poor
Average % Gravel	22	not rated	
% of Reach Eroded	30	5	Poor
Obstructions	0	0	Good
% of Reach Altered	2	1	Good
% Wetted Area	68	5	Poor
Dissolved Oxygen	9.7	1	Good
pH	7.5	1	Good
<b>Totals</b>		<b>36</b>	<b>Fair</b>

### Reach 7 Riparian Results

Riparian Ratings	R7	Ratings	Result
Land Use	78	4	Poor
Riparian Slope	54	3	Fair
Bank Stability	118	3	Fair
% Crown Cover	80	1	Good
% of Reach Accessed	0	0	Good
Average Vegetation Depth	18	5	Poor
<b>Totals</b>		<b>16</b>	<b>Fair</b>

### Departure Creek Reach 8 Habitat Assessment Results

This extends from Keighley Creek upstream to Neyland Road. It is a reach that has been heavily impacted by 1970's era residential development. It has limited riparian area with encroachments on nearly every property as well as a house foundation within 2m of the top of bank. The reach was 180m long and ended at the fish barrier culvert on Neyland Road. It offers step pool habitat and is the steepest reach of the stream at 3.44%. It has an average width of 2.6m with an wetted width of 1.8m. Rearing pools were available but poor with a mean depth of only 0.24m. Reach 8 failed to score well in % Pool Area, LWD/Bankfull Width, Boulder Cover, % Fines, Alterations, Erosion, % Off Channel Area and Riparian Depth. This reach is an observed sediment source for downstream fish populations. Ensuring there is better watershed stewardship in peoples' back yards is important in this reach. A water quality friendly back yard program is needed to encourage riparian plants and reduce encroachment.

### Reach 8 Habitat Results

Habitat Parameter	R8	Ratings	Result
% Pool Area	14	5	Poor
Large Woody Debris/Bankfull Channel Width	0	5	Poor
% Cover in Pools	25	1	Good
Average % Boulder Cover	5	5	Poor
Average % Fines	39	5	Poor
Average % Gravel	15	not rated	
% of Reach Eroded	42	5	Poor

Habitat Parameter	R8	Ratings	Result
Obstructions	0	0	Good
% of Reach Altered	0	1	Good
% Wetted Area	70	5	Poor
Dissolved Oxygen	10.1	1	Good
pH	7.7	1	Good
<b>Totals</b>		<b>34</b>	<b>Fair</b>

### Reach 8 Riparian Results

Riparian Ratings	R8	Ratings	Result
Land Use	54	1	Good
Riparian Slope	32	0	Good
Bank Stability	73	4	Poor
% Crown Cover	76	1	Good
% of Reach Accessed	0	0	Good
Average Vegetation Depth	9	5	Poor
<b>Totals</b>		<b>11</b>	<b>Fair</b>

### Departure Creek Reach 9 Habitat Assessment Results

Reach 9 is the end of the open water channel on the mainstem. This 101m segment has been completely altered from its natural state. It begins at the Neyland Road culvert ending at the backyard of the residences off Shamrock Place. At this location the channel originates from a series of storm drains. This reach was had an average bankfull width of 2.01m with a wetted width of 1.58m. The average gradient was 2.75%.

This reach was highly eroded given the amount of alterations to the riparian zone which ranged from vegetation removal to placement of fill. As noted similar needs in reach 8 of backyard watershed stewardship to address encroachment and promote riparian areas is needed.

### Reach 9 Habitat Results

Habitat Parameter	R9	Ratings	Result
% Pool Area	25.2	5	Poor
Large Woody Debris/Bankfull Channel Width	0	5	Poor
% Cover in Pools	10	3	Fair
Average % Boulder Cover	0	5	Poor
Average % Fines	0	1	Good
Average % Gravel	100	not rated	
% of Reach Eroded	0	1	Good
Obstructions	0	0	Good
% of Reach Altered	38	5	Poor
% Wetted Area	77	3	Fair
Dissolved Oxygen	N/A	N/A	
pH	N/A	N/A	
<b>Totals</b>		<b>28</b>	<b>Fair</b>

## Reach 9 Riparian Results

Riparian Ratings	R9	Ratings	Result
Land Use	36	0	Good
Riparian Slope	24	1	Good
Bank Stability	60	2	Good
% Crown Cover	75	1	Good
% of Reach Accessed	0	0	Good
Average Vegetation Depth	6	5	Poor
<b>Totals</b>		<b>8</b>	<b>Good</b>

## Joseph Creek Habitat Assessment Results

Reach 1 is located below Neyland Road and is 27m long. Directly below the hung culvert the channel braids out before entering the floodplain of mainstem Departure Creek.

Reach 2 extends from Neyland Road upstream 575m. This reach featured a shallow unconfined channel with ditch like characteristics. This reach featured a substrate consisting of mostly vegetated fines.

Joseph Creek offers 27m of potential fish access/high water habitat before reaching the hung metal culvert on Newton Street. Above Newton there is not currently enough fish habitat to support spawning or rearing activities. As noted in the other headwater reaches, these source channels are important for water quality to be maintained to protect the downstream fish populations. Watershed stewardship with water quality protection is important in this reach. Addressing erosion locations, adding riparian plants, attenuating storm water from roads and residences with improved structures are important.

## **DEPARTURE CREEK FISH SAMPLING**

We did not fry sample in each reach during the May 2016 survey. There were fish observations during this survey. Coho fry were observed throughout the pools in reaches 3-5. Cutthroat trout were observed in reaches 2-7. The Departure Bay Neighbourhood Association operates a downstream smolt trap targeting Coho smolts in Reach 2. The trap was operated from April 15<sup>th</sup> to May 31<sup>st</sup>, 2016. In the 47 days of operation the trap captured 50 Coho smolts and one parr. A brief electroshock survey was conducted on the morning of May 24, 2016 Juvenile Coho as well as Cutthroat Trout were easily captured in Reach 3. This was done in conjunction with smolt trap operation/educational display with Departure Bay Eco-School.

## **DISCUSSION – FISH HABITAT AND RIPARIAN ASSESSMENT**

### **Survey Limitations**

There are limitations to the survey based on the design and effort discussed below.

*SAMPLING AREA* - The survey covered 100% of the available fish habitat in reaches 1-8 and nearly 77% of open channels within the watershed; this exceeded the minimum requirements (10%) (Johnston and Slaney 1996). In urban settings the higher value is the preferred as it provides not only overall health but specific knowledge about each habitat unit. This is important as it allows the stream stewards to identify each location for specific improvements or degradation. The headwater drainages (channels and ditches) were not surveyed and may indicate water quality influences. These upper reaches should be identified, surveyed and monitored for water quality.

A shoreline survey was not conducted. There may be eelgrass beds along the beach that were not surveyed as well as other features such as the foreshore developments such as hardened sea wall assessments.

*FISH SURVEYS* – Fry densities were not conducted during this survey. The upper reaches (7-9) could be minnow trapped during moderate flows in the fall or spring to determine the extent of fish access. The smolt trap will be an excellent indicator of the success of the instream restoration.

## Fish Habitat Status – A Comparison

Departure Creek is in moderate overall fish habitat condition based on the diagnostics provided by the USHP Assessment (Table 1). The Habitat Summary Results showed habitat categories for each of the nine stream reaches in Departure Creek were averaged. A poor rating scored a 5, a fair rating a 3, and a good rating a 1.

Table 1.) Departure Creek USHP Habitat Summary Ratings

Habitat Parameter	Value	Ratings	Result
Pool Area %	40	5	Poor
LWD/Channel Width	28	5	Poor
Pool Cover %	16	3	Fair
Boulder Cover %	28	5	Poor
Fine Materials %	57	5	Poor
Eroded Length %	20	5	Poor
Obstructions	40	5	Poor
Altered Length %	14	3	Fair
Wetted Area %	28	5	Poor
Offchannel Area	26	5	Poor
<b>Totals</b>	<b>0</b>	4.56	<b>Poor</b>

A summary of fish habitat of the Departure Creek USHP habitat assessment (Table 1) identifies areas where habitat scores that were Poor;

- Large Woody Debris
- Boulder Cover
- Fine Substrates
- Wetted Area
- Offchannel Area

The following discussion of each reach includes recommendations on addressing the deficiencies noted above.

## Past Stream Enhancement Departure Creek

There have been significant restoration and stewardship efforts by Nanaimo residents in the past 20 years. Various incarnations of habitat stewards have been present in the watershed since the early 1990's. Previous urban stream surveys were funded by the Habitat Conservation Fund in 1993 (Toth) and was updated in 2000 through project 2000 (ATC). Stream restoration work on Departure Creek was done in



1995 and 1996 by Trout Unlimited, Malaspina University College, and local groups. In 2000 the Nanaimo Area Land Trust conducted riparian planting and the Departure Bay Neighbourhood Association completed instream restoration work in 2008. The Harbour City River Stewards continued this work into 2014. Vancouver Island University has conducted water quality analysis in the watershed periodically since 2006. The Community Watershed Monitoring Network has conducted water quality analysis at three set locations during the first fall rain each year since 2012.

## **Discussion - Fish Habitat Condition and Recommendations 2016**

The 2016 assessment indicated the main structural components of the past habitat work have been effective in reaches 2-4. Given the property ownership (residential backyards) of reach 2 a complete channel rebuild with constructed pools, placed gravel substrates, LWD and planted riparian areas is not feasible. There is potential and good progress to naturalize the Centennial Park/7-11 parking lot. The habitat condition of each reach is discussed below; a summary of the recommended actions is listed on Table 4 at the end.

### **Reach 1/2 – Habitat Condition**

The channelized reach lacks instream cover logs/boulders. Any potential returning adult fish are exposed to predators and sunlight given the poor riparian condition. The existing LWD material needs to be inspected for anchoring and more material added where ever possible with willing property owners. This will provide bank protection, fish cover, increase scour and eliminate sedimentation which is ever present throughout this area.

The riffles and spawning areas between Departure Bay Road and Bay Street need to be stabilized and replenished with gravel appropriate for Chum. The pool tail outs are areas where spawning gravel should occur have completely infilled sediment, until the upland sediment sources have been stabilized it is not worth adding gravel upstream of Bay Street. Boulder cover in riffles is also lacking and could be added with sizes matching channel and flood depth.

The Centennial Park/7-11 parking lot off Bay Street is a 75m long ditch that offers an opportunity to naturalize the segment if the parking lot is deactivated. As noted, the proper function of any new design would have to consider the effect of the restricted flow upstream and the sediment inputs that could bury pools and riffles.

Offchannel habitat is critical for overwintering salmonids on these small urban watersheds. A short (75m) right bank ground water fed channel in the vicinity of the Centennial Park would be a reasonable project to undertake.

The riparian condition in this reach is in a poor state the most dominate tree is Red Alder and only has a mean depth of less than 5m. This area is also dominated by invasive plants including Japanese knotweed (*Fallopia japonica*) and Himalayan blackberry (*Rubus armeniacus*). The knotweed should be removed as soon as possible where the black berry can be slowly weeded out as riparian conditions improve. A watering regime for the first three years should be done with any plantings to ensure survival.

### **Reach 3 – Habitat Condition**

The Storm Water Bypass structure was first installed in the late 1960's and was rebuilt in the 1980's (Kevin Brydges, pers com). There is currently no water license on this structure. The structure is performing as

designed and the City of Nanaimo conducts regular maintenance of the sump but stewards routinely maintain the orifice plate for sedimentation and wood debris to ensure fish/flow makes it through the channel. It is suspected this structure does not meet fish flow/passage requirements and we recommend an engineering review to determine if improvements can be made to the flow regulation. The sediment sump at the bottom of reach three should be cleaned out annually to protect lower areas from further infilling. There is little LWD cover in this reach, and could be added with relatively good machine access and existing prescriptions from NHC.

Encroachment into the riparian areas in some locations could to be blocked with more guard logs and then planted. The invasive species continue with prevalent English Ivy The riparian area lacks coarse woody debris (CWD) for plant and wildlife ecology; that can be addressed by placing stumps and logs to protect the riparian areas (this was done in some areas previously).

A left bank off channel opportunity exists in the wet floodplain area below the Woodstream Park footbridge. There is potential to start this offchannel at the trail crossing and weave it through the existing riparian area with its confluence with the mainstem creek just upstream of the diversion structure. This could provide critical quiet water for refuge during storm events for juvenile salmonids as it is likely many get washed over the weir and go down the storm pipe to the ocean.

#### **Reach 4 – Habitat Condition**

This reach is similar to reach 3 with additional LWD and planting required. Addition of LWD would be beneficial near the trail corridor it could be done without damaging the existing regenerating riparian areas. A significant eroding bank was observed and there is a deciduous debris jam that is creating erosion. These areas could be worked on by stewards by hand over the course of a weekend. The eroding bank could be lived staked with willow and red osier dogwood cuttings.

#### **Reach 5 – Habitat Condition**

This relatively un-impacted reach has held up well during the development of the surrounding residential area. The bedrock substrates limit the restoration opportunities but remained stable during torrents. Riparian under planting of the deciduous forest would be good for overall watershed health. A long term objective would to assess the right bank overflow route at the barrier falls. Currently Coho populations do not access this reach. There is potential in this area where a bypass channel could be created which would allow access to reach 6 and 7.

#### **Reach 6 – Habitat Condition**

The majority of this reach is located on private property featuring a minimum of 10m of functional riparian width. There were three debris jams identified during the reach survey. These jams could be stabilized by repositioning the significant pieces and anchoring to the bank. Hand addition of windfall for additional cover in the pools is also possible.

#### **Reaches 7&8 – Habitat Condition**

Fisheries values decrease greatly in these two reaches; however the effects of the upland development are felt throughout the watershed. The riparian width is much less than 10m in most properties and has numerous alterations including a house within 2.0m from the top of bank. The properties between 2135-2145 Belacarra Place were built with their foundations nearly at the top of bank. One has the river bank

eroding beside the exposed foundation. The property on the opposite side of the river 3000 Keighley Road has the stream fenced to keep deer out but is collecting debris and holding back water resulting in some localized bank erosion. The best course is stewardship to work with the property owners and City to increase awareness and better practices. The Neyland Road culvert is currently the end of fish access as the culvert is a complete fish barrier.

### **Reaches 9 – Habitat Condition**

Located above the fish barrier culvert this reaches ditch like characteristics. Working with the property owner and limiting erosion/pollution would be first on the list.

### **Joseph Creek – Habitat Condition**

This tributary offers only 27m of access from Departure Creek before reaching the barrier culvert on Newton Street. This channel is seasonal contributing sediment, urban runoff and invasive species. It appeared the invasive species; Himalayan Balsam “ground zero” was identified in this reach next to the Departure Bay Baptist Church.

### **Marine Area**

The foreshore in Departure Bay was not surveyed. It is highly recommended to complete the picture as it is important to understand the marine conditions for juvenile salmonids leaving the creek. Eel grass, beach grass and riparian communities should be mapped and surveyed. The foreshore of Departure Bay is highly altered in the vicinity of the creek mouth and there lies the potential for a Green Shores accreditation for the first property owner to pull back the concrete/riprap/piles.

**Table 2 Departure Creek Restoration Planning Table 2016**

Location	Description	Rank	Comment
Reach 1/2	Riffle crests spawning gravel above Departure Bay Road		
	Naturalize Centennial Park/7-11 parking lot		
	Underplant riparian habitat		
	Construction of off channel adjacent play field		
	Invasive species removal		
Reach 3	Annual maintenance of sump at bypass structure. Request engineering review.		
	Add cover logs to existing pools.		
	Left bank ground water offchannel area directly above diversion		
	Restore the riparian area - access protection by placing wood guard logs, selective clearing of canopy for understory regeneration, plant polygons with imported soils and mulch .		
	Invasive species removal.		
Reach 4	Add LWD logs to existing pools		
	Live staking of erosion sites		
	.Cleanup and stabilization of LWD Jams		
	Riparian Restoration		
	Invasive species removal.		
Reach 5	Riparian under planting		
	Assess potential bypass channel around falls (long term).		
Reach 6	Addition of LWD by hand		
	Enhancement of riparian area with shrubs and conifers		
	Stabilization of debris jams		
	Invasive species removal		
Reach 7-9	Enhancement of riparian area with shrubs and conifers		
	Live staking of erosion sites		
	Landowner contact to improve downstream impacts		
Joseph Creek	Landowner contact to improve downstream impacts.		
	Planting of erosion area shade trees along exposed east side.		
	Invasive species removal including Himalayan balsam		
	Installation of sediment sumps at each publicly owned with equipment access		
Marine	Foreshore assessment needed – possible eelgrass, beach grass sites, green shores project on hardened sea wall		

## CONCLUSIONS

This report identifies the existing habitat status of Departure Creek. The standardized habitat information is useful for comparison of past and future changes. A copy of the Toth (1993) report was not located but the ATC, 2000 was used as a direct comparison. In general Departure Creek has remained stable or shown minor improvements since the past assessment. Each report also identifies the weakest habitat characteristics in the watershed. For example this watershed has scored poorly in LWD, fines, erosion and urbanization of the upper watershed in each survey. None of the weaknesses below Newton Street are insurmountable, and many, such as riparian characteristics would eventually repair themselves. With the invasive species removal and under planting with native plants this process can accelerate recovery from 50-70 years to 15-25 years.

Restoration prescriptions to address the habitat deficiencies are needed for the next steps. There may be some prescriptions available for use from the NHC (2012/2013) reports as well as opportunities to develop them with partners such as the City of Nanaimo, Fisheries and Oceans and the Snuneymuxwe First Nation. Landowner contact and stewardship promotion should not be overlooked as an important tool for recovery of the watershed.

The habitat assessment is one of the first steps in a recovery plan. There now needs to be a planning stage where the restoration options are prioritized by the community partners. Following that step, the prescriptions should be developed and budgets determined. The designs will then be used for funding and permit applications. Generally, if done in the fall/winter, there is time to meet the summer freshwater fish window (Aug 15-Sep 15).

Given the location and ease of access to the majority of the key areas there is already a long term water monitoring project in place. The streamkeepers are extremely active in this watershed looking for spawners, erosion, past restoration works and the function of the diversion structure. This report identifies many more restoration activities/sites, but the gap should not be 16 years between monitoring of the watershed health and restoration structures.

Biological monitoring is also recommended; the smolt trap should be operated for a minimum three years and spawning activity should be documented.

Departure Creek is a heavily altered watershed. For years most of the 1970's it was a nuisance to the developers of Nanaimo they would have preferred the entire channel be placed into the storm system similar to Joseph Creek. However, unlike most urban streams along the east coast of Vancouver Island this watershed is not limited by flow. According to property owners and City staff the flow levels during drought conditions this channel does not dry up entirely which is critical for salmonids. Past water quality reports have shown higher than typical conductivity indicating a ground water influence.

The current working group including the Departure Bay Neighbourhood Association, Snuneymuxwe First Nations, City of Nanaimo and Fisheries and Oceans Canada appear to contain the local knowledge of the watershed and expertise to work together and create change in the watershed.

Yours truly,



Brad Remillard, RPBio



David Clough RPBio

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## Reach 1 Photographs -



1.) Reach 1 - beach entrance



3.) R1 above culvert needs trees and gravel



2.) Departure Road culvert is fish friendly



4.) Bay St twin culverts are smaller but passable..



## Reach 2 Photographs -



1.) R2 - ditch line along side of 7-11 is poor.



3.) R2 - Cleared to grass along several homes



2.) Centennial park seepage channel. (Off channel)



4.) R2 - Elk St. runoff directed to Creek



## Reach 3 Photographs -



1.) Reach 3: Looking downstream at the diversion structure



2.) Reach 3: Looking downstream at Pool 8. Typical habitat in Reach 3

## Reach 4 Photographs -



1.) Reach 4; erroded riffle 5. Typical habitat of Reach 4



2.) Reach 4: Bank Erosion site at riffle 6



## Reach 5 Photographs -



1.) Reach 5: Looking upstream at riffle 1



2.) Reach 5: Looking upstream at first of two bedrock chutes which limit upstream salmon migration

## Reach 6 Photographs -



Reach 6: Pool 7 typical debris jam



2.) Reach 6: Pool 23 near confluence with Joseph Creek, (Note Lack of pool cover)



## Reach 7 Photographs -



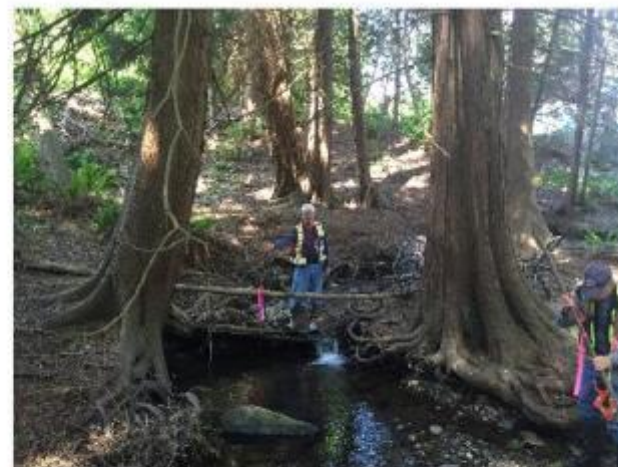
1.) R7 and Joseph Confluence below Newton.



3.) R7 - alterations above Newton St.



2.) Bank erosion below Newton st.



4.) R7 erosion below Keighly Ck

**Reach 8 Photographs -**



**1.) R8 - near Keighly Farm**



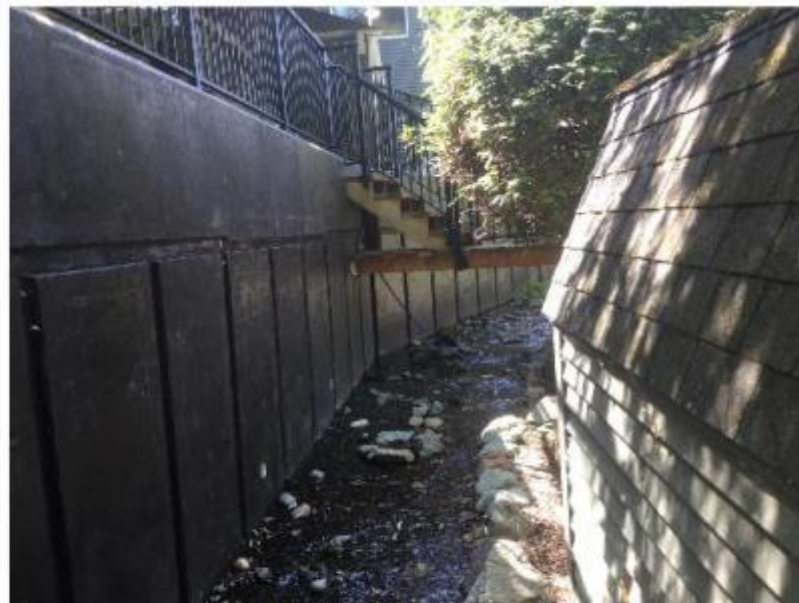
**2.) R8 - Storm Water erodes historic stable banks**



## Reach 9 Photographs -



1.) Reach 9: Looking downstream at riffle 2 eroding bank



2.) Reach 9: Looking upstream from riffle 4 where originates near Shamrock Place



## Joseph Creek Photographs -



Joseph Creek is an important perennial water source



Joseph Creek with Himalayan Balsam