Seasonal Creek Mapping and Restoration Project
District Lot 57 Galiano Island

By: Marcus Messner and Christian Caillé
Galiano Island Conservancy

Table of Contents

Introduction

Limitations

The creek mapping and restoration project has been developed by two undergraduate students. The project was developed by Marcus Messner, a German intern studying Forestry Engineering at Weihenstephan University in Germany and Christian Caille, studying Geography and Environmental Studies at the University of Victoria. These students are not experts, nor professionals in the creek ecology, mapping, or creek restoration. Additionally, this project was compiled during a 2 months span. This project is meant as a tool to further the efforts and restoration initiatives by returning the creek to a historic state. While this limitation is influential in the outcome of the project, the students have had bountiful guidance by advisers and colleges as well as conducted research on several aspects of the

project.

Purpose

The purpose of the creek restoration project has been to return the creek to a physical, chemical, and biological composition that closer represents its reference state. The reference state will ideally ensure a dynamic and functioning ecosystem. The project will produce a map of the existing creek, a map of the expected historic creek, recommended monitoring techniques and locations, and priority restoration initiatives. Prescribed restoration protocols for individual reaches of both the undistributed creek and the restored reference creek have not been determined, while the location of the reaches have been. This in turn provides additional opportunities for future projects.

Hydrological Site History

The District Lot (DL) 57, also called Learning Center, contains two seasonal creeks, one flowing on the North end of the property and the second flowing through the Southern region. The later of the two has been heavily disturbed and altered throughout a span of 40+ years. Portions of the creek have been ditched, culverted, and diverted for various purposes. As previously mentioned the project intends to restore the human alterations in order to return the creek to a historic reference state. Thus the current creek will have to be moved back to its previous locations, while biotic and abiotic conditions restored. In order to plan a restoration project, the current conditions need to be understood and studied, before restoration prescriptions are put forth.

Current Creek

Flora and Fauna of Creek

The current creek has been labeled used an alphabetical reach system, A, B,C, D. The DL 57 Baseline flora and fauna was compiled by Andrew Simon and Keith Erickson and has been referenced bellow

Figure #) Creek Reaches of DL 57 seasonal creek

Reach “A”

This polygon consists in a small, heavily disturbed, bowl-shaped area that includes a seasonal ditched stream and the access road to the cove. The polygon includes heavily disturbed road areas dominated by exotic grasses along with sparse canopy woodland portions with a mix of scattered arbutus (Arbutus menziesii), regenerating Douglas-fir (Pseudotsuga menziesii) poles, a small patch of mature Douglas-fir, a patch of Garry oak (Quercus garryana) as well as the odd alder (Alnus rubra) and bigleaf maple (Acer macrophyllum). Mature Scotch broom (Cytisus scoparius) was removed from a large portion of the polygon in the summer of 2012. The site at present is clear of mature broom plants, with the exception of a few patches on the steep slope near the cove. Broom regeneration will likely be prolific over the next several years and will require consistent annual removal to maintain control. Dominant vegetation on the road and disturbed areas includes exotic grasses such as common velvet grass (Holcus lanatus) and colonial bentgrass (Agrostis tenuis), as well as thistles (Cirsium spp.). A large portion of the polygon has thick, continuous groundcover of European periwinkle (Vinca sp.). The ditch also contains exotic grasses and periwinkle in a portion but exhibits a high percentage of common woodrush (Juncus effuses) and field mint (Mentha arvensis) as well as horsetail (Equisetum arvense) in some areas. The polygon includes a variety of site conditions ranging from very dry, rocky southwest-facing, shallow soiled micro-ridgelines to more moderately sloped, deeper soiled zonal areas to moisture receiving riparian sites along the ditch and seepage areas on the very steep back around the cove. The shrub dominated steep seepage bank is characterized by a mix of willow (Salix sp.) and Pacific ninebark (Physocarpus capilatus), bigleaf maple and oceanspray (Holodiscus discolor), with periwinkle along the ground. Another invasive species of note is evergreen blackberry (Rubus Rubus laciniatus), with several well established patches scattered throughout the polygon. Restoration recommendations for this polygon include invasive exotic control, specifically for Scotch broom, periwinkle, evergreen blackberry, along with spot planting of a diversity of native trees and shrubs where invasives have been removed. Also recommended is fencing natural regeneration subject to intense deer browse. Remediation of unused roads would also improve integrity of both the hydrology and ecology of the area. (Erikson and Simon, 2013)

Qualitative Observations

Description of Current Creek Reaches

A-Reach

- Creek starting (bottom line) – point #2 – rocky shrubs – covered creek – seepage point- no distinct depth/creek
- Top of rocky cliff- point #3- end of drainage – waterfall- invasive: Himalyan blackberry shrubs and periwinkle- noticeable creek erosion (small)- open creek
- Below bridge- logs- wooden culvert- brown sludge- #4- open to sun- noticeable bank undercut erosion (start of line)
- Above second bridge near outhouse – rocky area- shallow pools- #5 partial cover shade- grass and shrubs- invasive: yellow flag iris
- open area- stagnant water- open sun- rocky #6- below culvert
- open- start of culvert- grasses- rocky- shrubs-grasses #7
- culvert inflow-open – grasses/shrubs- sandy creek bed- #8

B-Reach

- cat-tail pond- stagnant pool- open- #9- 9.30mX3.30m
- blue flag- east of garden- cedar trees/grassy shrub- partial shade- creek distinguishable -vegetation and shrubs into partial forest
- wetland in ferns east of garden- open- surrounded by trees
- shallow wetland- partial open- near stump-
- wetland- log over creek- open- several braids

C-Reach

- open -culvert to northern wetland #15- flow bellow apple tree
- road split one to greenhouse- (possible culvert to restore natural flow from Cable house)
- #17 fork of seepage creek above Cable House- open- water pipe in creek

D- Reach

- Cable Bay house- water accumulation
- Two large cedar trees- possible flow between them

Reference Ecosystem

The Great Beaver Swamp was chosen as a reference ecosystem for the project as there is a seasonal creek that flows into the swamp. The area has also been previously logged approximately 40 years ago. While the creek is considered to have been disturbed and altered by human activities, it occupies a later successional stage as natural regrowth and restoration has occurred. Five points along the creek were selected as reference ecosystems as they represented similar conditions present at DL 57 creek. Percent cover of dominant species was collected at the points. Additionally, qualitative and quantitative data were collected at these points to further contribute to the prescribed restoration initiatives at the reaches.

Table 1- Beaver Swamp Reference Point #1

Species	**A1**	**A2**	**A3**	**B1**	**B2**	**C**	**D**

Red Alder	35						
Western Hemlock			T		T		
West Red Cedar					T		
Dewey Sedge						5	
Sword Fern						10	
Slough Sedge						30	
Horse Tail						T	
Fragile Fern						T	
Black raspberry						T	
American Brookline						T	

Table 2- Beaver Swamp Reference Point #2

Species	**A1**	**A2**	**A3**	**B1**	**B2**	**C**	**D**
Red Alder	30						
Western Hemlock		T		T			
Sword Fern						25	
Stinging Nettle						5	
Big leaf maple					10		
Skunk Cabbage							T
Dewey Sedge							T
Heart leaf spring beauty							T
Black raspberry							T
Cleaverse							T
Vanilla Leaf							T
American Brookline							T

Table 3- Beaver Swamp Reference Point #3

Species	A1	A2	A3	B1	B2	C	D
Red alder	35						
Western Hemlock			5				
Western Red Cedar			T				
Bigleaf Maple		T					
Douglas Fir		T		T			
Stinging Nettle					30		
Sword Fern					20		
Salal					T		
Slough Sedge					10		
American Brookline					T		
Vanilla Leaf					T		
Columbia Leaf					T		
Cleaverse					T		

Table 4- Beaver Swamp Reference Point #4

Species	A1	A2	A3	B1	B2	C	D
Red alder	40						
Western Hemlock				5			
Western Red Cedar				T			
Red huckleberry				T			
Stinging nettle					25		
Douglas Fir			5				
Vanilla Leaf							15
Slough Sedge							10
Cleaverse							T
Bedstraw							T

American Brookline							T
Salal							T
Dewey Sedge							T
Columbia Brome							T
Fragile Fern							T
Sword Fern						20	
Other grass sp.							10

Table 5- Beaver Swamp Reference Point #5

Species	**A1**	**A2**	**A3**	**B1**	**B2**	**C**	**D**
Red alder	25						
Western Hemlock				T			
Western Red Cedar		T					
Stinging Nettle					50		
Sword Fern					15		
Big Leaf Maple	5						
Salal					5		
Douglas Fir					T		
Slough Sedge					T		
Dewey Sedge					T		

Creek Restoration

Before establishing restoration prescriptions for the newly restored creek, an understanding on historic creek flow is required. Knowing the historic trajectory will allow for tailored restoration prescriptions. A Digital Elevation Model (DEM) analysis of flow accumulation was performed, as well as manual ground work using a theodolite to determine the appropriate creek location. Upon completion the creek was mapped using a GPS Tremble unit.

DEM Model

Using Arc GIS and existing data, a flow accumulation map was produced of DL 57. The map was produced in order to determine the true location of the reference creek. While the current creek is

noted in green as “Seasonal Creek” while the areas of high flow are in red. It is important to note that the existing creek is ditched, culverted, and has been drastically altered through human intervention. Additionally, the flow accumulation map is not intended to produce the true reference creek, merely a baseline for comparison purposes. This was concluded as the DEM is skewed due to human modification of the land, such as slope alteration, road infrastructure, land use modification, etc. These factors will influence how the DEM determines the slope, thus impacts for flow direction and accumulation. In order to ensure the proper orientation of the creek, we used the DEM as well as manual elevation profile.

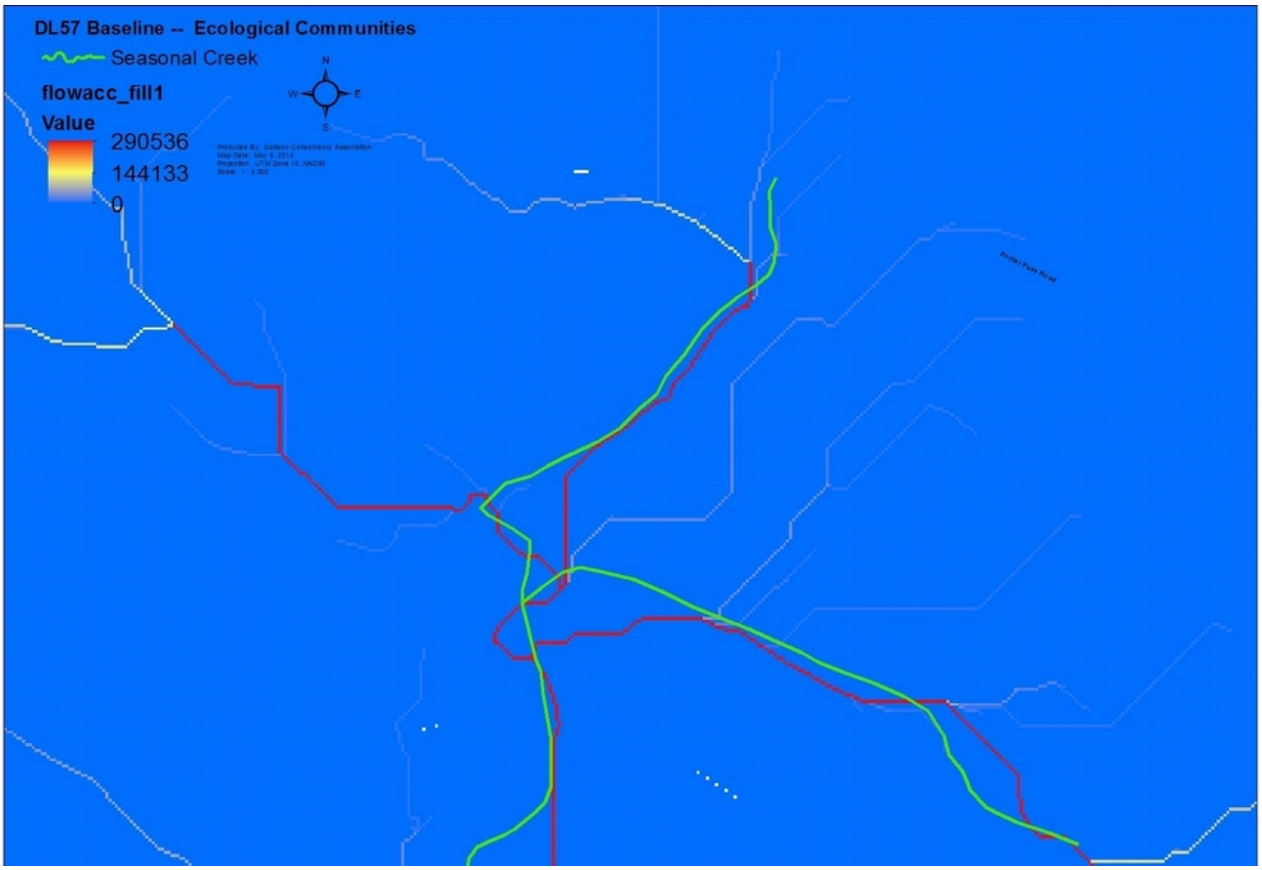

Figure #) DEM of flow accumulation of Southern seasonal creek at DL57

Creek Surveying

The human alteration of slope has influenced the outcome of the DEM. Therefore a manual method of surveying the landscape was used to determine the creek flow accumulation. A theodolite was positioned at a location which provided a clear vantage of the landscape. A fixed point was established, a tape measure was then used to ensure a fixed radius. Looking through the theodolite, the operator would communicate with the rod (meter stick) operator to determine the lowest slope height. When the lowest point was found on the landscape, a blue flag was put in place. The lowest point on the landscape will ensure the lowest low point as water will travel in the direction of least resistance. There are areas where the slope was approximated due to intense human modifications. In those cases, large tree stumps were used to determine slope.

Figure #) Manual surveying using theodolite and rod (determining lowest slope elevation). View from theodelite operator towards meter stick operator.

Figure #) View from meter stick operator towards theodolite and fixed tape measure point.

DEM and Manual Survey Map

Upon completion of the DEM and the manual survey, a map was produced to denote the area of interest between both methods. The area of most plausible creek restoration area is colored in yellow in relation to the DEM while the manual creek is in teal.

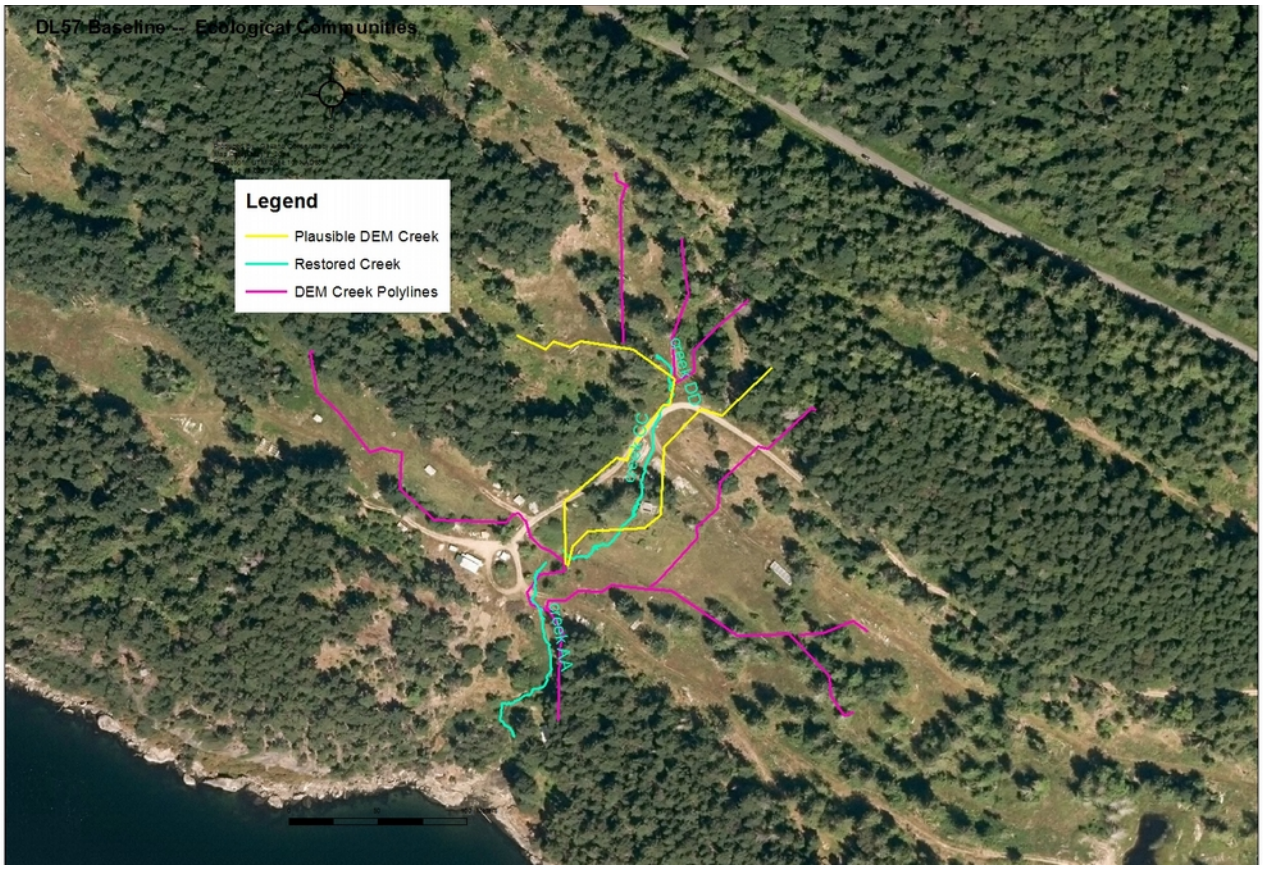

Figure #) DEM polylines and manual survey lines to infer creek location at DL 57.

Monitoring

Go With The Flow Hydrological Survey Baseline

An alkalinity assessment of the creek was conducted by “Go With the Flow Hydrological Survey” by University of Victoria students Kimberley Fitzsimmons, Yuhei Iida, and Chase Shields. These students presented a long term alkalinity monitoring methodology. The methodology was undertaken at various creek and wetland areas at DL57. The points surveyed by the students will not be replicated due to inadequate data points, while their methodology will be utilized. The purpose of their methodology was to determine the alkalinity of creek water. Alkalinity is an indicator of a solution’s, creek water, ability to neutralize acids. This characteristic is important in creek water chemistry as influxes of acid can be detrimental to flora and fauna in and around the creek ecosystem. Acids can be introduced through human means, as well as naturally occurring heavy metals and acid rain. Additionally, this methodology cannot be replicated year round due to the seasonal water flow of

the creek.

Methodology

Methodology adopted from "Go With the Flow Hydrological Survey" by University of Victoria students Kimberley Fitzsimmons, Yuhei Iida, and Chase Shields.

Material

- Digital Titration Kit
- Titration Cartridges
- Graduated Cylinder (minimum 25 mL)
- Color Indicator
- 125 mL Erlenmeyer Flask
- Sample Bottle
- Waste Bottle

Preparing the Sample

- Add 25 mL of sample water into the Erlenmeyer Flask
- Add 5 drops of color indicator to the Erlenmeyer Flask (the sample should turn green/blue)

Titrating the Sample

- Add the H_2SO_4 to the Erlenmeyer Flask containing the sample water while rotating the flask
- The titration is complete when the solution turns from blue to clear. If the solution turns pink too much H_2SO_4 solution has been added
- Record the count of three successful titration

Table #) Sample Alkalinity Titration Table

Sample Site Coordinates	Titration 1	Titration 2	Titration 3	Average Titration
Site 1				
Site 2				
Site....				

Long term Monitoring

The Stream Keepers Handbook: A Practical Guide to Stream and Wetland Care by the Salmonid Enhancement Program and DFO, recommends several long term monitoring protocols for streams and creeks. Such monitoring plans include: bankful and wetted channel measurements, stream discharge, stream velocity, creek slope, surveying habitat characteristics (primary, secondary, and tertiary). Additional surveys should include: water quality survey by collecting temperature, dissolved oxygen, pH, turbidity, and water quality index. These monitoring procedures should be undertaken at a consistent time interval using the same methodology. However, due to time, funding limitations, and seasonal variations, it is recommended that these measurements are collected at least twice a year for

three years prior to and after restoration. Sample tables can be found in the appendix, while methodology can be found in the Stream Keepers Handbook Module 2 Advanced Stream Habitat Survey and Module 3 Water Quality Survey.

Sample Site Monitoring Points

This project was conducted during the summer, therefore sampling sites may change depending on winter flow. Therefore these coordinates are mere recommendations on where to sample and may be subject to change. However, if sample sites are changed, these new sites should remain consistent for the duration of the monitoring plan.

Table #) Reach A Baseline Monitoring Sites

Site #	FID	Easting	Northing
Site 1	1	465179.757	5419762.951
Site 2	3	465204.647	5419789.919
Site 3	5	465197.37	5419833.261

Table #) Reach B Baseline Monitoring Sites

Site #	FID	Easting	Northing
Site 1	7	465202.446	5419857.447
Site 2	8	465287.558	5419831.238
Site 3	10	465346.931	5419790.694

Table #) Reach C Baseline Monitoring Sites

Site #	FID	Easting	Northing
Site 1	6	465191.316	5419851.36
Site 2	12	465187.001	5419872.25
Site 3	13	465252.792	5419934.531

Table #) Reach D Baseline Monitoring Sites

Site #	FID	Easting	Northing
Site 1	15	465265.730	5419948.180
Site 2	16	465275.652	5419989.455
Site 3	14	5420031.319	5420031.319

Prescribed Restoration Techniques

The Ministry of the Environment proposes a General Best Management Practices for any

project undertaken in, and around a stream. The restoration prescriptions should undertake a similar methodology. They highlight 133 best practice points under the headings: qualified professionals, monitoring, timing of works, deleterious substances, concrete works, isolation of work area, salvage of fish and wildlife, erosion and sediment control, vegetation management, site restoration, and temporary diversion.

Reaches

The creek reaches are labeled using an alphabetical system. The current reaches are labeled A, B, C, D, and the prescribed restoration creek reaches labeled AA, BB, CC, DD. Each reach should include the best management practices, however, we have chosen to select the best practices of highest priority for each individual reach in the interest of limitations.

Figure #) Restored creek reaches and notable points

AA-Reach

Figure #) AA Reach with notable points of interest and restoration areas

Vegetation Management (invasive species)

The majority of DL 57 has been invaded by several invasive species. While these various species are of concern, reach A is especially important due to the presence of periwinkle and yellow-flag iris. The later of the two is quite concerning due to its ability to drastically alter aquatic systems through dense rhyzomial matts. The displace native species and are poisonous to both wildlife and humans. Furthermore, periwinkle has an area of 1273m^2, and has overtaken the ground cover within the polygon above. Efforts have been innitiated to control it, however they have proven unsuccessful and require further attention. Additional invasive species occur near reach A, and should also be removed. These include: scotch broom, himalayan blackberry, evergreen blackberry, holly.

Erosion and sediment control:

Historically, the A reach of the creek was diverted in order to built a road by previous land owner. However, a portion of the creek has diverted bellow the bridges and sink holes and has begun eroding a bank. Efforts to stabilize this bank to prevent further erosion should be undertaken before restoration of reach AA occurs.

Temporary Diversion:

Near the conversion point of Reach B, C, lies a cattail pond, which acts as the starting point of reach A. This reach begins as a culvert under a road. The culvert will have to be repositioned in order to meet the accurate historic flow. Therefore, a temporary diversion strategy will be required to move and

construct a culvert at the Temporary_divers point on the map. The efforts will require further research to properly instal a culvert.

BB-Reach

Vegetation Management:

Vegetation management in reach BB is the primary focus. This envolves increasing biodiversity and creating a more dynamic ecosystem. Trees, shrubs, herbs, grasses, and primitive plants such as mosses and lichen form riparian or stream side vegetation. These plants tolerate occasional flooding. The riparian zone includes the immediate bank of the valley bottom or flood plain. The riparian area of influence may also include the adjacent lower slopes (see picture). Stream size and valley topography help define the width of the riparian zone. Riparian vegetation is a very important part of a stream ecosystem. Plants stabilize stream banks, reduce erosion etc. Trees provide shade, which helps control water temperatures. Logs fall into the stream, where they create diverse habitat and help dissipate erosion energy. Leaf litter provides an important source of food for stream organisms. Plants trap sediment and filter out pollutants before they reach the stream. They help the soil absorb precipitation and release it slowly during dry spells. The riparian area provides habitat and travel routes for birds and wildlife. (Streamkeepers, 1995)

Plan before you plant:

Stream banks need a good diversity of plant species to provide a variety of foods, cover types, and habitats for aquatic organisms, birds and wildlife. Both deciduous and coniferous species are

important. Deciduous trees like black cottonwood grow rapidly and begin to enhance a stream quickly. Coniferous trees like red cedar grow more slowly, but will enhance a stream long after the cottonwoods have disappeared. A mixture of coniferous and deciduous plants ensures a year-round supply of leaf litter for a diverse community of aquatic insects. Willow and cottonwood are common species along streams throughout the province. They are very easy to propagate from cuttings and grow very quickly. Nature will introduce new species over time, especially herbaceous plants, mosses, and other simple plants. (Streamkeepers, 1995)

Table #) Convenience native plants for restoration

Species	Conditions
Black Cottonwood (Populus trichocarpa)	Moist wet sites, forms extensive stands on island and floodplains along major rivers
Pacific Willow (Salix lucida)	River banks, flood plains, lakeshores and wet meadows, often standing in quiet shallow river backwaters
Western Redcedar (Thuja plicata)	Mostly wet soils- grows best in seepage and alluvial sites
Bigleaf Maple (Acer macrophyllum)	
Salmonberry (Rubus spectabilis)	Moist to wet places, often along stream edges and wet logged areas
Red – osier Dogwood (Cornus sericea)	Moist soil, typically in swamps and streamside forest and srub, also in open upland forests
Red alder (Alnus rubra)	Moist woods, streambanks, floodplains, slide tracks
Red elderberry (Sambucus racemosa)	Stream banks swampy thickets, moist clearings and open forests
Hazelnut.Sitka Alder (Alnus crispa)	Moist wet edges of meadows, along streams

(Pojar and Mackinnon, 1956)

CC-Reach

Site Restoration:

Site restoration within reach CC will be quite challenging and labor/funding intensive. This involves diverting the existing reach C from the West side of the road near towards the west side of the chicken coop and through the garden. Understanding of stream benthic composition, stream flora and fauna, stream physics, will be important research components. Additionally, planning for large machinery to excavate the creek, as well as diverting the current reach C will require further planning for disturbance from machinery.

Temporary Diversion

As mentioned in the site restoration heading, the creek will have to be diverted. That said, a temporary diversion strategy will be required to move construct a culvert at the Temporary_divers point on the map. This in turn will require further research to properly instal a culvert.

Deleterious Substances:

Throughout the years, DL 57 has had numerous occupants, who have used the property for various purposes. That said, there is an accumulation of inorganic and organic material piled and scattered throughout the restoration area. Areas of concern have been marked with a deleterious substances marker. The markers denote objects just as: large wood piles, metal fencing, garbage,

chicken coop structures. These substances should be removed and disposed of appropriately as they will likely interfere with the restoration initiatives. The effort required to remove these substances varies. For example, collecting scattered garbage will require less effort to demolish and dispose of the chicken coop. This should be taking into account for future restoration prescriptions.

DD-Reach

Site Restoration:

In the past, several individuals have settled on DL 57, and built wells and ditches for water use. Near the intersection of reach CC and DD lies the Cable house. The house had a dug well constructed and several ditches which were intended to help fill the well. In order to returning the historic condition of the creek, these wells and ditches will have to be filled in. This will allow the surface flow to return to the historic creek.

Additional Opportunities

There are several additional opportunities that are intended to supplement this project. They have been noted bellow in no specific order.

- Bank erosion prevention
- Culvert removal
- Culvert construction
- Stream relocation

- Baseline monitoring
- Invasive species removal
- Deleterious substance removal
- Planting locations
- Benthic composition (biotic and abiotic)

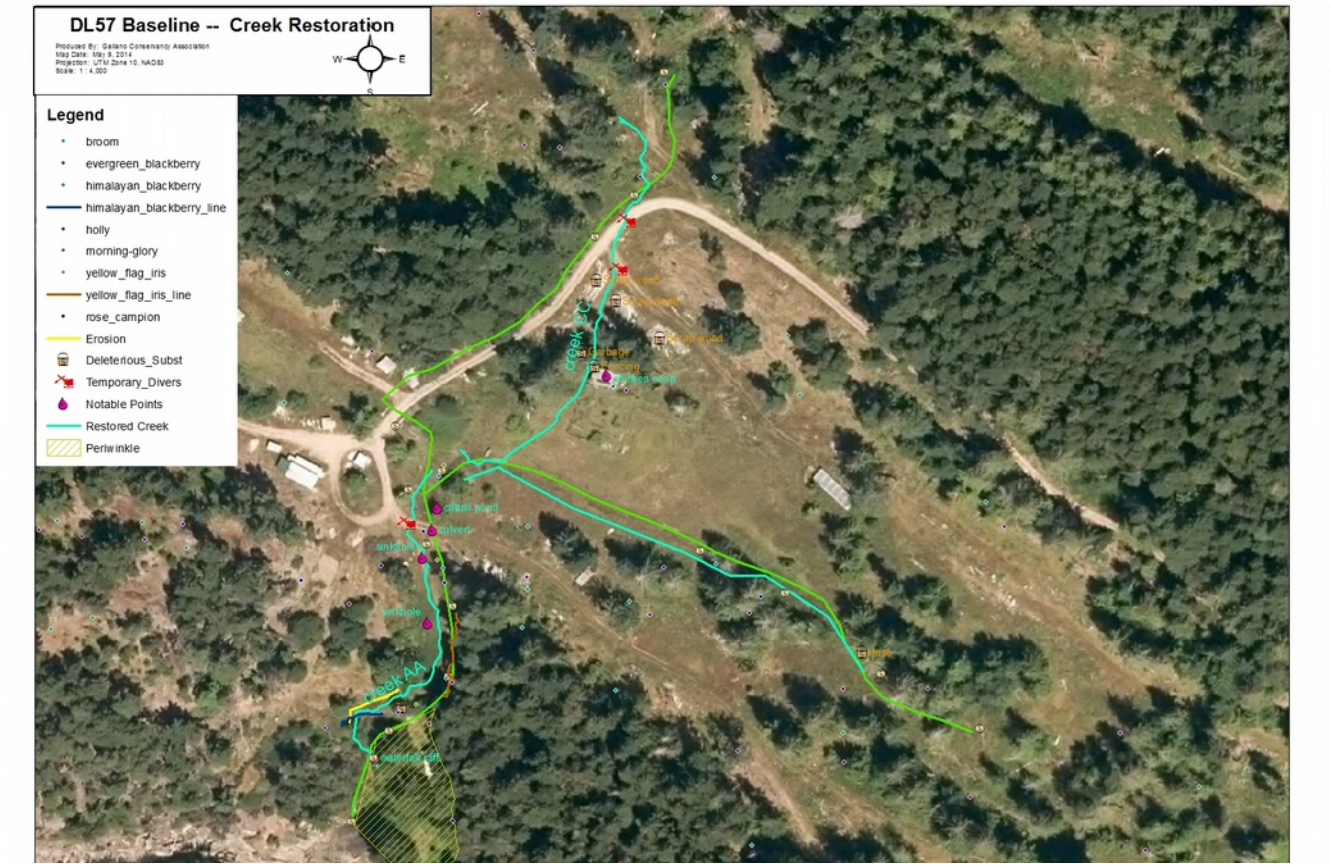

Figure #) Complete creek map with opportunities and notable areas.

Conclusion

The mapping and restoration project of the seasonal creeks on DL 57 serves as a tool to further restoration innitiatives on the property. As mentioned in the limitations, we are not professionals and may have made mistakes. Qualified professionals are expected to further continue researching the creek project. GIS Maps and data can be found in G: GIS>Projects>Stream Restoration>Creek Restora Final. Mxd. Photos and jped maps can be found in G:Galiano>Restoration>Learning Center>Amazing Creek Restoration.

Acknowledgments

We would like to thank our colleges Keith Erickson, Ken Millard, Terry Hoffman, Andrew Simon, UVic ES 470 Students (Kimberley Fitzsimmons, Yuhei Iida, and Chase Shields), Camille Mohn, Lisa Ott, and Quiran for contributions and advice.

Bibliography:

Taccogna, G. and Munro, K. 1995. The Streamkeepers Handbook: a practical guide to stream and wetland care. Salmonid enhacement program. Dept. Fisheries and Oceans.

Pojar, J and Mackinnon, K. 1956. Plants of Coastal British Columbia – including Washing, Oregon, and Alaska.

Mohn, C., Ott, L. and Quiran. 2014. Invasive Species Inventory DL 57 Galiano Island.

Simon, A. 2014. Baseline Ecological Inventory of DL 57 Galiano Island.

Appendix

In doc labeled Appendix_Creek_proj

yellow flag iris info http://www.invadingspecies.com/invaders/plants-aquatic/yellow-iris/

BC Gov Best practices - http://www.env.gov.bc.ca/wld/instreamworks/generalBMPs.htm

Vernal Pool restoration in agricultural land https://uwaterloo.ca/environment-resource-studies/sites/ca.environment-resource-studies/files/uploads/files/2009DeanHunterMorse490.pdf

Ecology encyclopedia-stream restoration http://ac.els-cdn.com.ezproxy.library.uvic.ca/B978008045405400077X/3-s2.0-B978008045405400077X-main.pdf?_tid=8e1a68a8-143d-11e4-bded-00000aacb361&acdnat=1406321714_21384d11e1fa2adb4978259977cb8c8b