

Squamish Estuary Salmon Habitat Recovery Project
C1-PAC-02
YEAR END FINAL REPORT



Prepared for:
Coastal Restoration Fund

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Executive Summary

The scope of this 5-year project is to examine the Training Dike and identify restoration opportunities to improve salmonid and other fish access across the dike along with wildlife passage and habitat improvements. The installation of the nine culvert crossings between 1994 and 2007 have improved water flow across the Training Dike between the Squamish River and the Central Estuary. However, recent studies on juvenile Chinook outmigration have indicated the culverts are limiting access from the river to the estuary (InStream, 2017).

Monitoring and scientific studies have been undertaken along with the restoration efforts to determine the effectiveness of the works and provide a mechanism for adaptive management to improve the structures and sites for salmonid habitat. The results of the monitoring programs have indicated the culverts are being underutilized by salmonids. This lead to numerous meetings and discussions between DFO and SRWS and the project partners to discuss methods by which fish access, particularly salmonids, can be improved upon across the Training Dike. The recommendations included three main areas in which to concentrate: 1) replacement of culverts at key locations with either bridges, arch culverts, or similar structures that would allow improved fish passage through most tidal cycles; 2) realignment of the Spit to open up the southern portion of the estuary; and 3) install an intake structure across the CN Spur Line to once more allow water to flow from the Central Estuary east into the top end of the Cattermole Slough along the Bridge Pond.

Meetings were held in the spring and summer of 2017 between DFO and the SRWS and the Squamish Terminals, District of Squamish, Provincial Ministry (FLNROD), Squamish Nation, and representatives from the windsports and conservation groups. The result was strong support to allow upgrades along the Training Dike provided provisions were made to minimize impacts from increased sedimentation (that could impact the west berth of the Squamish Terminals), provide modelling of hydrologic flow with any culvert replacement or upgrades, consider impacts to vegetation colonization, and hold a meeting with the broader public. The latter recommendation resulted in a community-based meeting in January 2018 which included discussions around the potential impacts of any changes to the estuary.

In addition to the discussion around modifying culvert crossings at key locations to improve salmonid access between the river and the estuary were also dialogue around the potential realignment of the southern end of the Training Dike, often referred to as the Windsurfers Spit (henceforward referred to as “the Spit”). As a follow-up to these discussions applications were submitted to secure funding for physical works within the estuary that would include upgrading the culvert crossings and examining the potential to realign the Spit and restore the original flow of the Squamish River to pre-1972 dike construction conditions.

Contents

Executive Summary 2

1.0 Introduction and Project Description..... 4

2.0 Goals and Objectives 4

3.0 Study Area..... 6

4.0 Methods..... 6

5.0 Results and Outcomes..... 15

6.0 Discussion 17

7.0 Recommendations 17

8.0 Acknowledgement..... 17

9.0 References 18

10.0 Site Map..... 19

11.0 Photos 20

1.0 Introduction and Project Description

The Squamish Estuary has undergone significant modifications over the past 100 years including extensive logging, infilling to create the townsite that is now Squamish, and construction of major industrial sites (former FMC chlor-alkali facility, the former sawmill site, and the current Squamish Terminals). In the early 1970s BC Rail constructed a 5 km dike / road along the western edge of the estuary to confine the Squamish River to the west in order to infill the estuary to construct a coal port facility. While this industrial use was never realized, the dike / road remains to this day and is referred to as the Training Dike. It was only in the 1990s and 2000s that proper culvert crossings were installed across the Training Dike to allow regular flow between the Squamish River and the Central Estuary. Organizations such as the Squamish River Watershed Society, in partnership with Fisheries and Oceans Canada and Squamish Nation, have been engaged in the installation of the culverts as well as constructing tidal channel connections and off-channel habitat. Monitoring and scientific studies have been undertaken along with the restoration efforts to determine the effectiveness of the works and provide a mechanism for adaptive management to improve the structures and sites for salmonid habitat. The results of the monitoring programs have indicated the culverts are being underutilized by salmonids. This led to numerous meetings and discussions between DFO and SRWS and the project partners to discuss methods by which fish access, particularly salmonids, can be improved upon across the Training Dike. The recommendations included three main areas in which to concentrate: 1) replacement of culverts at key locations with either bridges, arch culvert that would allow improved fish passage through most tidal cycles; 2) realignment of the Spit to open up the southern portion of the estuary; and 3) install an intake structure across the CN Spur Line to once more allow water to flow from the Central Estuary east into the top end of the Cattermole Slough along the Bridge Pond.

2.0 Goals and Objectives

The project objectives for the 5-year program are as follows:

- Improve juvenile Chinook salmon access between the Squamish River and the estuary by upgrading passage structures through the Training Dyke (refer to Figures 1 and 2) by replacing key culverts with either bridges or larger sized culverts to allow increased flow and tidal exchange;
- Improve juvenile Chinook salmon access between the Squamish River and estuary by realignment of the lower portion of the Training Dike also known as the Spit, which will open the entire lower section of the Central Estuary to the Squamish River to migratory juvenile salmonids (Figures 3 and 4); and

- Improve juvenile Chinook salmon access between Cattermole Slough/Bridge Pond and the Central Estuary by installing a crossing structure(s) under the existing railway Spur Line that services the Squamish Terminals (Figure 5).

While this project targets Chinook salmon these same benefits will apply to all salmonid species that use the estuary for a portion of their life cycle.

Year 1:

- Milestone 1: Project Planning and Capacity Building: A key component of the first year of this project has been to engage the stakeholders and community partners. This project is a partnership between the Squamish River Watershed Society (SRWS), Fisheries and Oceans Canada (DFO), and Squamish Nation (SN). The stakeholders include District of Squamish (DOS), Squamish Terminals (ST), Ministry of Forests, Lands, and Natural Resource Operations (MFLNRO), Squamish Windsports Society (SWS), Nature Trust of BC (TNT), and local conservation groups. Several meetings were held in the summer of 2017 between the project partners, DOS, ST, and SWS to discuss the overarching goals of the project. A larger forum was held in January 2018 that was open to the public to provide an opportunity for the community to learn about the project and provide their input and insights. Overall there has been strong support for the project and a recognition of the impacts the Training Dike has on fish, wildlife, and plant habitat.
- Milestone 2: Engineering and Hydrologic Survey and Design: Complete engineering and hydrologic design to model the Squamish Training Dike for flow between the Squamish River and the Central Estuary at various tidal and flood events. Furthermore, an additional study to model sediment transport across the Training Dike will allow insights into whether larger openings, such as replacement of culverts with bridges, will affect sediment accumulation downstream at the Squamish Terminals. The engineering, flood study, and sediment transport study were commissioned by Kerr Wood Leidal who have now begun to develop the modelling for the Squamish Estuary. An aerial survey of the Training Dike was also completed to provide baseline comparison for any changes that will be made.
- Milestone 3: Construction Works: The first-year construction activities were mostly delayed until the next fiscal year to allow for time to generate detailed engineering design, develop hydrologic modelling, and complete sediment transport modelling that will all provide direction on the physical construction works. In the first-year construction was limited to purchase of equipment that will be used throughout the project including pit tags, seine nets, gee traps, tools and other equipment
- Milestone 4: Monitoring, Field Sampling, and Training: Several studies were initiated as part of Year 1 to establish base line data along the Squamish Training Dike and Central

Estuary. This included developing the methodology for trapping salmonids by the use of PIT tagging, seine netting, and Gee trapping; working with Tenderfoot Hatchery to set aside 1,000 Chinook (500 Cheakamus and 500 Mamquam); to collect 500 wild Chinook juveniles (>70mm in size) in early May. As well, concurrent with the fisheries monitoring, water quality monitoring was initiated to include collecting data on salinity/conductivity, dissolved oxygen, pH, temperature, light penetration, turbidity, barometric pressure, and tidal cycling at key locations along the Training Dike in association with the culvert crossings. This project has engaged the interest of the community and post-graduate students. Volunteers have been steadily showing interest in assisting with various aspects of the work and a Training Manual has been prepared for volunteers to assist with their ability to collect data with trained biologists (see attached Squamish Estuary Monitoring Training Manual). The fisheries and water quality monitoring crews have provided training for volunteer support including field methodology, sampling techniques, and data entry. As the project develops we hope these volunteers will continue to be involved in the project and ultimately assist with long-term post-construction monitoring beyond the length of the 5-year program as part of a Citizen Science initiative.

Aerial drone videography was also completed of the Training Dike, Spit, and Bridge Pond crossings along with extensive photo-point monitoring of each site. A video of the drone videography can be viewed at: <https://youtu.be/VQltwvZDSNk>.

3.0 Study Area

The Squamish Training Dike is a 5 km structure that extends from the confluence of the Mamquam River downstream to Howe Sound and confines the Squamish River to the western bank. Coordinates of the Training Dike are located at latitude 49.705816 and longitude -123.172332.

4.0 Methods

The first stage of this project was to consult with stakeholder and interest groups on the feasibility of implementing upgrades to the culvert crossings. To this end, initial meetings with DFO, DOS, Squamish Terminals, Squamish Nation, and the Windsports Society were held in the early summer. Some key concerns were identified including potential increases to sediment transport if the culverts are widened or enlarged, potential changes to flood storage or surge flows through wider openings, access for recreational usage (windsport activities), and potential impacts on vegetation growth. As a follow-up to the 2017 summer meeting discussions a facilitated stakeholder meeting was held in January 2018 to engage the broader community on this project and obtain their input. A summary report from the meeting is appended to the back of this report.

The next stage of the project was to commence various modelling studies to determine the transport of sediment along the Training Dike and how water flows at various tides and flood events react along the Training Dike that can then be applied to engineering designs to widen the openings at the various culvert crossings. An initial base-line aerial survey of the site was completed over a two-day period in September and a video of the Training Dike and Spit was captured. As well, Kerr Wood Leidal was hired to develop the two models: sediment transport and flood modelling. These engineering/hydrologic models were initiated as part of Year-1 but due to their complexity will not be complete until August of 2018.

Monitoring of the estuary was initiated to establish base-line data on fisheries usage, water quality parameters, and photo-point monitoring sites. InStream Fisheries was hired to oversee the fisheries monitoring program and have set up a series of PIT tag readers at key locations associated with the culvert crossings. As well, Lake Trail Environmental as hired to oversee the water quality monitoring. They have installed a series of data loggers at key locations throughout the Estuary and River to capture real-time data on salinity/conductivity, water temperature, and light penetration. As well, they have been sampling on a regular basis for dissolved oxygen levels, pH, and turbidity. The results from all these studies will be summarized by mid-summer.

Fisheries Monitoring:

Based on previous experience the recommendations for this project were to employ PIT tags and set up PIT readers on Culverts 3, 4, and possibly 2 if enough equipment could be procured.

Goal was to secure 1,000 juvenile Chinook from Tenderfoot Hatchery (500 Cheakamus and 500 Mamquam) as well as 500 wild Chinook juveniles (Squamish River above the Mamquam River with a minimum size of 70mm) in early May to place PIT tags. During year 1 the PIT tag readers were obtained along with the materials that would be required to install the readers along the culverts so that sampling could commence as close to early May as possible. Photo of pit tag reader located at Culvert 3:



Water Quality Monitoring:

Water quality monitoring equipment was purchased in year-1 in order that it could be deployed at key locations through the Squamish Estuary and Squamish River to provide baseline data on conditions in the river and Central estuary. The key factors being measured included dissolved oxygen (DO), pH, conductivity/salinity, water temperature, light penetration, tidal elevations, barometric pressure, and river flow elevations.

In order to achieve the project goals the following equipment has been installed alongside Culverts 2, 3, 4, Central Estuary, and along the Squamish River:

- Level loggers (3 deployed)
- Salinity Metres (5 deployed)
- Light/Temperature Metres (10 deployed)
- Hester Dendy Invertebrate Traps (8 deployed)
- Survey of each culvert (cross section and longitudinal survey)
- Staff gauges at Culverts 2 and 4

The program was to commence in early May in association with low tide events. Care was needed to ensure all data loggers were secured in place below the low-low tide mark and the dates selected for installation coincided with the low spring tide dates. Sampling was to take place bi-weekly starting in early May and continue until late September. The Hester Dendy invertebrate traps were to be deployed in low gradient tidal channels and will not be disturbed for at least 6 months to examine which invertebrates are colonizing in the channels.

Aerial Drone Videography and Photo-Point Monitoring:

In September initial drone videography was undertaken along the Training Dike at each of the upper 4 culvert crossings, along the Spit, and along the train tracks at the top end of the Bridge Pond. Video from the Spit can be found at <https://youtu.be/VQltwvZDSNk>.

Below are images from the top four culvert crossings (all imagery by Coastal Photo Studios):



Culvert 1 (river on right, Central estuary on left; south is to top of photo)



Culvert 1 (river on left, central estuary on right; north is top of photo)



Culvert 2 (river on right side and Central Estuary on left; south at top of photo)



Culverts 3 & 4 (facing south with estuary on left and river on right)



Culverts 3 & 4 (facing north with river on left and estuary on right)



Culverts 5 & 6 (facing south with river on right and estuary on left – note fully restored former Dredge spoils site)



Aerial overview of Spur Line (train tracks) with Bridge Pond on left and Central Estuary Site “A” on right with no culvert connection across tracks

5.0 Results and Outcomes

The proposal to upgrade and replace some of the culverts along the Training Dike was the result of previous studies that identified the culverts as being a key to limiting access between the Squamish River and the Central Estuary. The recommendations to replace the culverts with structures that would allow fish passage through most tidal cycles was the result of discussions with Fisheries and Oceans staff and Squamish Nation staff. Discussions were then held with the District of Squamish, who maintains the Training Dike, the Squamish Terminals, located at the south end of the Estuary, and the Ministry of Forests, Lands, and Natural Resource Operations who oversees the Skwelwil'em Wildlife Management Area. All the agency staff recognized the importance of improving fish access across the dike and were supporting of this initiative. Squamish Terminals

was concerned about potential increases to sediment buildup along their west berth as they were in the process of securing funding of their own to dredge out the sediment build up that had been accumulating.

As with many projects, the discussion with the stakeholder groups didn't just result in support or direction to continue to pursue funding for culvert upgrades but also included examining the potential to realign the southern end of the Training Dike known as the Windsurfers Spit to connect to the downtown via Third Avenue, just north of the Squamish Terminals. This realignment could potentially alleviate two major issues; access by the Windsports along the 5 km Training Dike which is in constant need of grading and maintenance by the District of Squamish, as well as providing a deflection berm to keep sediment from accumulating in the west berth of the Squamish Terminals.



Concept design by J. Martin on potential realignment of Windsurfers Spit

The results of the two river modelling studies by KWL will provide important insights to help determine which culvert(s) will be focused on for replacement. The areas being explored at this time are the uppermost culverts (#1 - #4) and each one has its merits. The final engineering design will be finalized in the summer of 2018 with the intention of commencing culvert replacement in December 2018.

Deliverables (appended to report):

- Communications Strategy (file name: communications elements3 – excel spreadsheet) providing key time lines, action items, roles and responsibilities, and key project activities)

- Central Squamish Estuary Restoration Project Community Meeting Minutes, January 26, 2018 (pdf file)
- Squamish Estuary Monitoring Training Manual (pdf document for volunteer support)
- Baseline Monitoring Report for the Squamish Estuary Restoration Project (pdf file “Central Estuary Monitoring Protocols”)
- Google Earth Map of Water Quality Monitoring Sites (file: Monitoring Stations_June 29 update.kmz)

6.0 Discussion

Three meetings were held between April 2017 and October 2017 between District of Squamish, Fisheries and Oceans Canada, Squamish Nation, Squamish Terminals, the Windsports Society, the Province, and other groups. In January 2018 a broader based meeting/workshop was held to provide information on the proposed estuary upgrades and hear from participants on the project benefits and challenges.

7.0 Recommendations

As a follow-up to the numerous meetings, site visits, monitoring studies, and internal discussions, the SRWS will continue to engage with the governing agencies to undertake physical works for 2018/2019 that would replace at least one or more culverts along the Training Dike to improve fish passage and examine the potential to realign the Windsurfers Spit. As well, the proposal included examining the installation of an intake structures across the CN Spur Line to re-water the upper Bridge Pond / Cattermole Slough by reconnecting the tidal channels with the Central Estuary.

8.0 Acknowledgement

We would like to thank Coastal Restoration Fund for the contribution of seed funding for this project as well as our partners, Fisheries and Oceans Canada and Squamish Nation.

We would also like to take this time to thank:

- Randall Lewis and Chris Lewis, Squamish Nation
- Dave Nanson, Al Johnson and other Fisheries and Oceans Canada for all of their assistance; and
- Brent Gurd and Eric Balke, Ministry of Forests, Lands, and Natural Resource Operations
- Mayor Patricia Heintzman, District of Squamish
- Kim Stegman, President Squamish Terminals
- DOS engineering department
- Squamish Windsports Society
- Squamish Environment Society, and

- Squamish Streamkeepers

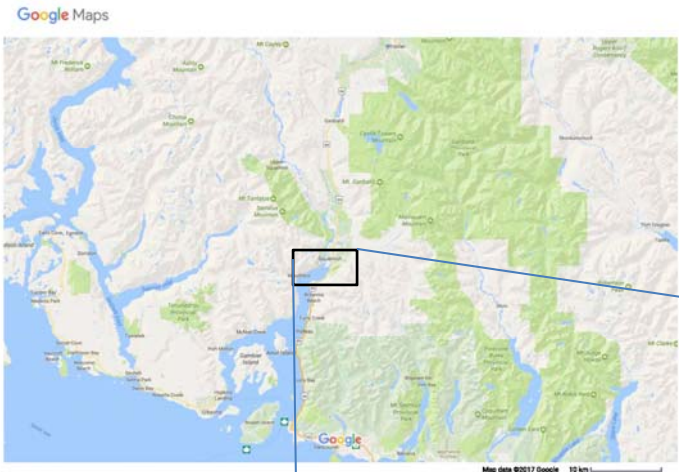
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10.0 Site Map

Google Maps

<https://www.google.ca/maps/@49.7172193,-123.1246481,10z>



1 of 1

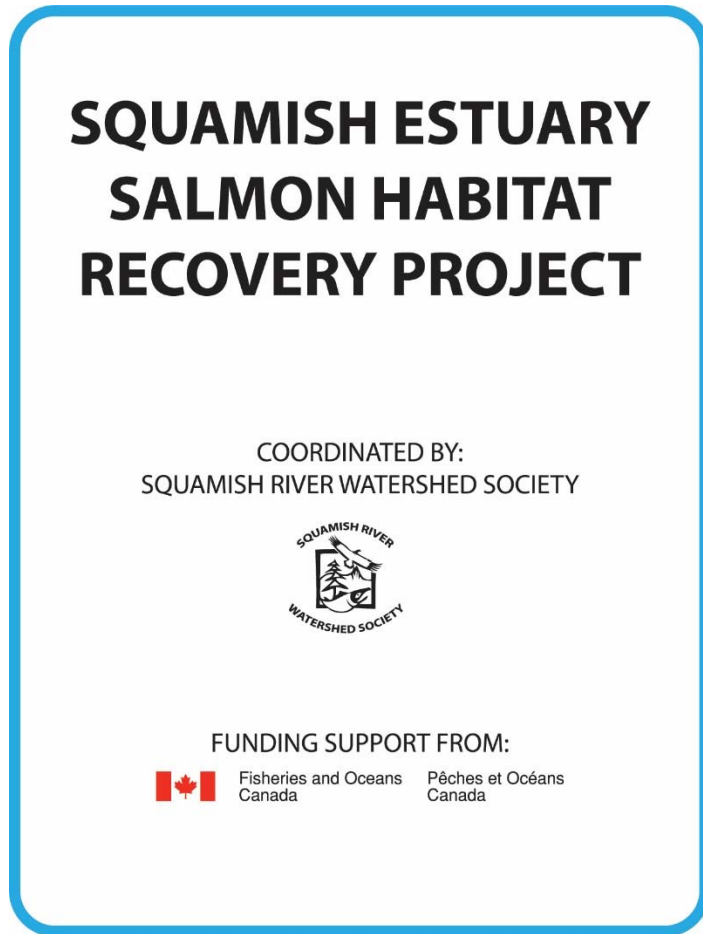


11.0 Photos

January 26, 2018 Community Meeting



Signage:



Sign will be installed on a kiosk at a prominent location along the Training Dike

May 15, 2018



Official announcement for CRF Funding by MP Pamela Goldsmith Jones
(Left to right: Dave Nanson, Kim Stegeman, Francesca Knight, Edith Tobe, Pamela Goldsmith-Jones, Mayor Patricia Heintzman, Randall Lewis)