NATURE TRUST BRITISH COLUMBIA

Restoration Following the Re-Watering of Little Bear Slough

FINAL REPORT

Prepared For: Fish & Wildlife Compensation Program

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Executive Summary

Little Bear Slough (LBS) is located in the Squamish River Estuary on the traditional and contemporary territory of the Squamish Nation. Historically, LBS was connected to the Squamish Estuary; however, it has been isolated for over 50 years due to the installation of a railway spur line and two tidal flap gates. Plans are in place to re-water the slough via culverts in the railway spur line beginning in 2026.

This seed project has successfully enabled documentation of the current ecological condition of the Nature Trust of BC's (NTBC) Squamish Estuary Conservation Area, with particular attention paid to habitat features that support fish and wildlife. Surveys completed include: riparian vegetation inventory, water quality monitoring, wildlife trees surveys, and assessment of channel characteristics for fish habitat suitability. This data has been used to support restoration and project planning in the Squamish Estuary Conservation Area.

Priority restoration and enhancement activities have begun at NTBC's conservation area, including invasive species removal from riparian vegetation zones and re-planting of native shrubs. Further knowledge gaps and opportunities for habitat improvement have been identified, with recommendations for continued ecological monitoring with focus on current fish and wildlife presence and use within remnant channels, particularly pacific salmon. The implementation of enhancement and monitoring projects will be continued in 2025.

The project has completed work in line with several actions in the Cheakamus Watershed Action Plan including inventory and assessment of wetland and riparian areas as part of a restoration project (CMS.WAR.HB.26.01), as well as initial surveys to prepare for inform planning for restoration of cavities for large cavity users (CMS.UAD.HB.24.01).

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1.0 Introduction

1.1 Site Overview

Little Bear Slough is located within the Squamish River Estuary, west of the town of Squamish, within the traditional territory of the Skwxwú7mesh Úxwumixw (Squamish Nation). The slough is adjacent to the Nature Trust of BC's (NTBC) 5.6 ha conservation area composed of salt marsh and mature forest areas. The west side of the Squamish River Estuary is designated as the Skwelwil'em Squamish Wildlife Management Area (WMA), and serves as important habitat for fish, waterfowl, and migratory birds. Squamish Nation manages a section of the estuary referred to as Site A, although it should be noted that the entire estuary is within the Squamish Nation's traditional territory and has significant historical and cultural value to its people.

The Squamish Estuary Conservation Area, managed by the Nature Trust of BC, has a diverse range of ecosystem types. The north side of the conservation area is predominantly mature uplands forest, with coniferous trees including sitka spruce (*Picea sitchensis*) and western hemlock (*Tsuga heterophylla*). There is an understory of salmonberry *(Rubus spectabilis*), red elderberry (*Sambucus racemosa)*, and snowberry (*Symphoricarpos albus*) among other native shrubs and herbaceous plants, but is threatened by competition from invasive species, including English holly (*Ilex aquifolium*) and Himalayan blackberry (*Rubus armeniacus)*. On the southern

end of the conservation area, with increased tidal influence, there are sections of tidal marsh with plants species including Lyngbe's sedge (*Carex lyngbyei*) and black twinberry (*Lonicera involucrata*). We have also recorded the presence of a blue-listed species, Henderson's checker-mallow (S*idalcea hendersonii*).

There are multiple tidally influenced channels running throughout the Squamish Estuary Conservation Area. These channels are not connected to the Squamish River or Estuary at present and are mainly tidally influenced. Many of these channels are often dry, especially at low tides. Other water inputs to Little Bear Slough include stormwater drainage from the District of Squamish, groundwater, and rainwater runoff. The smaller channels within the conservation area present a potential connection point from the Squamish River Estuary to the Little Bear Slough through Squamish River Watershed Society's proposed rewatering project. The rewatering project aims to increase salmon rearing habitat by giving fish access to these channels directly from the estuary and providing increased freshwater inputs, creating a less saline environment that is more hospitable to a wider variety of life. Additionally, this would flush out stagnant channels, reducing concentration and buildup of pollutants (Dube et al., 2021).

1.2 History

The Squamish River Estuary has been a significant cultural site for the Skwxwú7mesh Úxwumixw (Squamish Nation) since time immemorial and has continued importance to the interests of the Squamish Nation. Plant medicines and traditional foods such as salmon, northern rice root (*Fritallaria camschatcensis*), and salmonberry *(Rubus spectabilis*) were important staples of the Squamish diet and culture (SRWS 2018, Joseph & Turner 2020). While knowledge and harvesting of traditional foods has been greatly reduced by colonization and all of its impacts, work continues to be done by the Squamish Nation to revitalize cultural practices, and the Squamish estuary as a source of food.

There has been significant disturbance of the Squamish River Estuary throughout the 19th and 20th century. Over half of the original estuary was infilled or drained to construct the District of Squamish townsite and extensive dike systems were put in place within the estuary to reduce flooding, among other projects (SRWS 2018). Little Bear Slough was once connected to the Squamish River via Cattermole Creek, but the Canadian National Railway Spur line was constructed in 1958 along the west side of the LBS Conservation Area, cutting off this section from the rest of the estuary (SRWS 2018). Currently there are no culverts in place along the spur line within the Squamish River Estuary, preventing flushing of the LBS and other channels, and limiting access to estuary channels for fish. Over time, due to the disconnection, the LBS Conservation Area has become increasingly forested, reducing estuary habitat.

In addition to these changes, Little Bear Slough has been further affected by the development of a flood control gate that was built in 1984 at the south end of Cattermole Creek. This flapgate

reduces tidal influence on LBS. To provide further drainage relief for the Squamish Townsite, stormwater drains have been constructed to drain water from Downtown Squamish into Little Bear slough (Dube et al., 2021). This has created conditions where stormwater runoff is one of the primary water inputs into Little Bear Slough.

2.0 Goals and Objectives

The Squamish River Watershed Society is leading the installation of culverts along the railway spur line which will restore LBS as critical salmonid rearing habitat beginning in 2026. The reconnection will re-establish the Nature Trust of BC's conservation area as critical estuary habitat, but to ensure a productive and diverse riparian ecosystem, significant knowledge gaps need to be filled. The goal of this seed project is to map and document the extent of the re-watering effects, including an in-depth vegetation inventory, water quality monitoring, wildlife trees surveys, and assessment of channel characteristics. The aim of these surveys is to be conducted both before the culvert installation to establish a baseline for ecosystem health indicators, and after the re-watering project to assess the effects of the re-watering on vegetation, as well as fish, and wildlife.

The primary investigation of this project includes comprehensive riparian vegetation surveys for the study site with close attention paid to the areas affected by the re-watering via culvert installation. The vegetation surveys inform decisions on which specific locations and species to prioritize for invasive species removal. They are also key for providing a picture of native species distribution to accurately replant the study area after disturbance. Invasive species removal work and construction of new culverts are both potential causes of disturbance and should be followed up with planting native species to prevent further encroachment of invasives.

The secondary intended outcome is to determine the effect of the re-watering project on fish and wildlife. This includes key variables that affect the suitability of the habitat for juvenile salmon and cavity nesters. Our aim in habitat monitoring is to determine significant changes in: water quality, channel characteristics, and wildlife trees. The collected data will provide a baseline understanding of the current condition of remnant channels as well as identifying potential gaps in habitat characteristics prior to re-watering. Once culvert installation takes place this information will be used to evaluate the effects of re-watering on habitat characteristics.

3.0 Study Area

3.1 Site Map

The Nature Trust of BC's Squamish Estuary Conservation Area, is located directly west of Squamish, and around 45 km North of Vancouver, BC. The conservation area is within the Coastal Western Hemlock (CWHdm) Biogeoclimatic (BEC) zone and is located on the historic floodplain of the Squamish River. Figures 2 and 3 show maps of land use and designation at the Squamish Estuary (Figure 2) and the Squamish Estuary Conservation Area (Figure 3). The planned monitoring activities focus on the entire conservation area, with some measurements specifically taking place in Little Bear Slough and related channels.

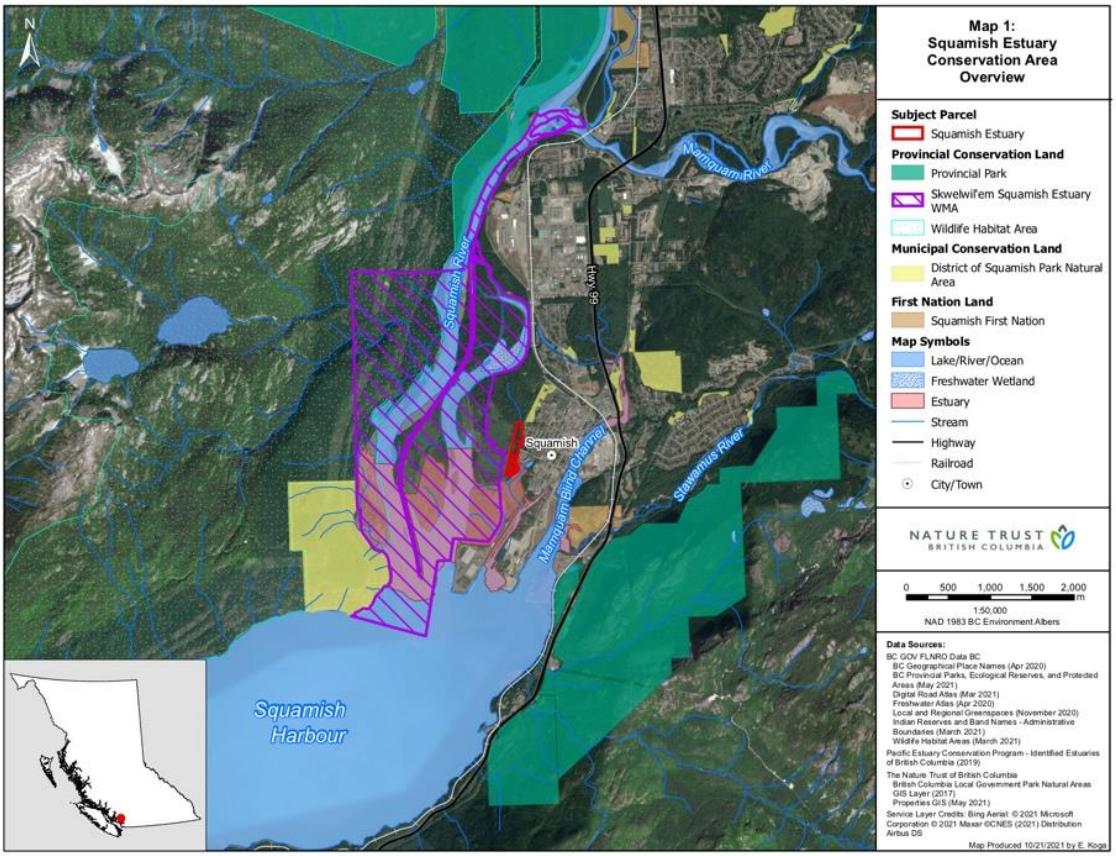

Figure 2. Land designation map of the Squamish Estuary. The study area is outlined in red.

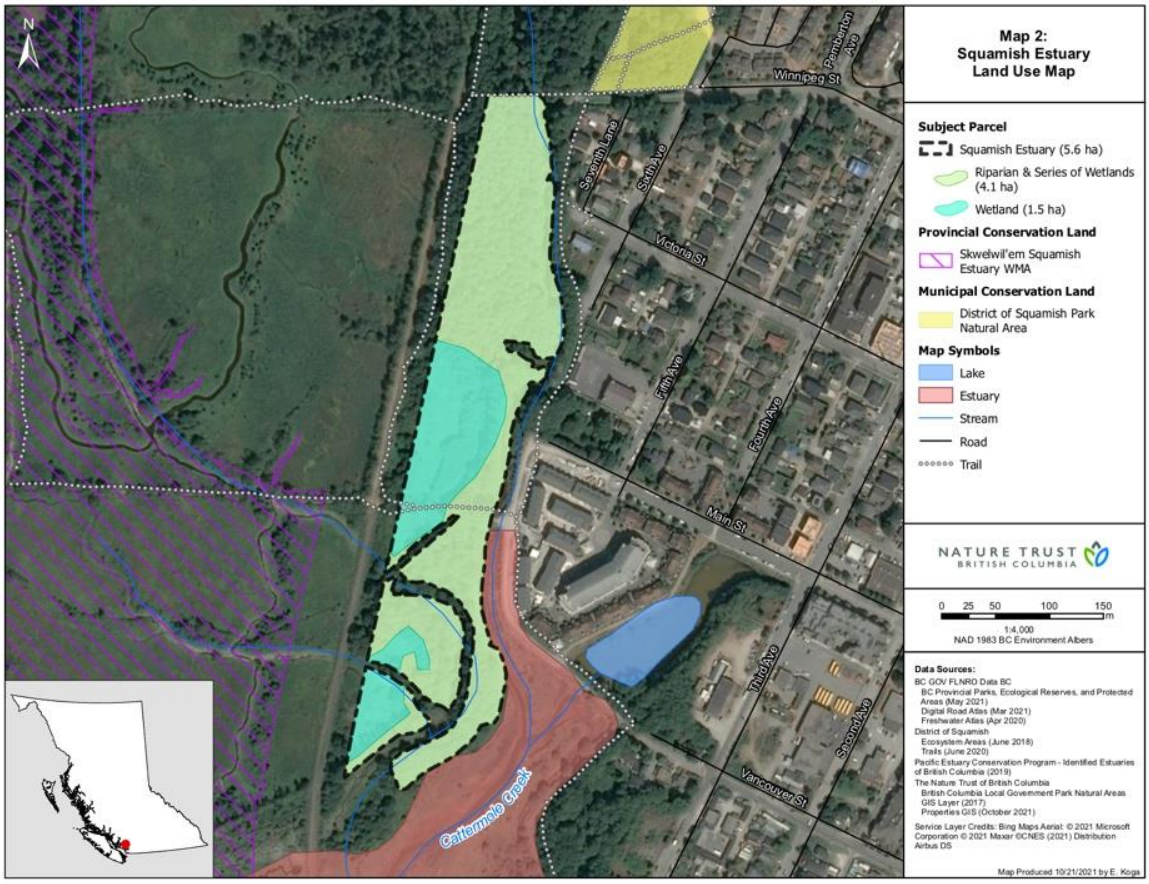

Figure 3. Land use map of the NTBC Squamish Estuary Conservation Area. The study area is outlined with a dotted black line.

4.0 Methods

Monitoring took place at NTBC's Squamish Estuary Conservation Area throughout the summer and fall of 2024 to establish baseline data with the goal of capturing baseline data before re-watering of channels occurs. One focus was to survey the current riparian vegetation surrounding

remnant channels to monitor for invasive species and gather an overview of the current conditions. Surveys were also done to establish habitat suitability for fish and wildlife including water quality monitoring, fish habitat suitability survey, and a wildlife tree assessment. Methods for these surveys are based on previous work done by BCIT students on Nature Trust lands (Chycoski et al., 2024)

Due to high density of invasive species found during riparian vegetation surveys, specifically English holly, invasive species removal was conducted in the summer and fall of 2024. The area of English holly removal was then re-planted with around 500 native plants in November of 2024. Although not funded by FWCP in 2024-2025, methods for holly removal and re-planting are also outlined below to provide background on proposed restoration activities and context for the project going forward.

4.1 Survey Maps

The potential re-watering points and main survey locations have been mapped for both the North and South sections of the conservation area to more effectively communicate methods used during monitoring.

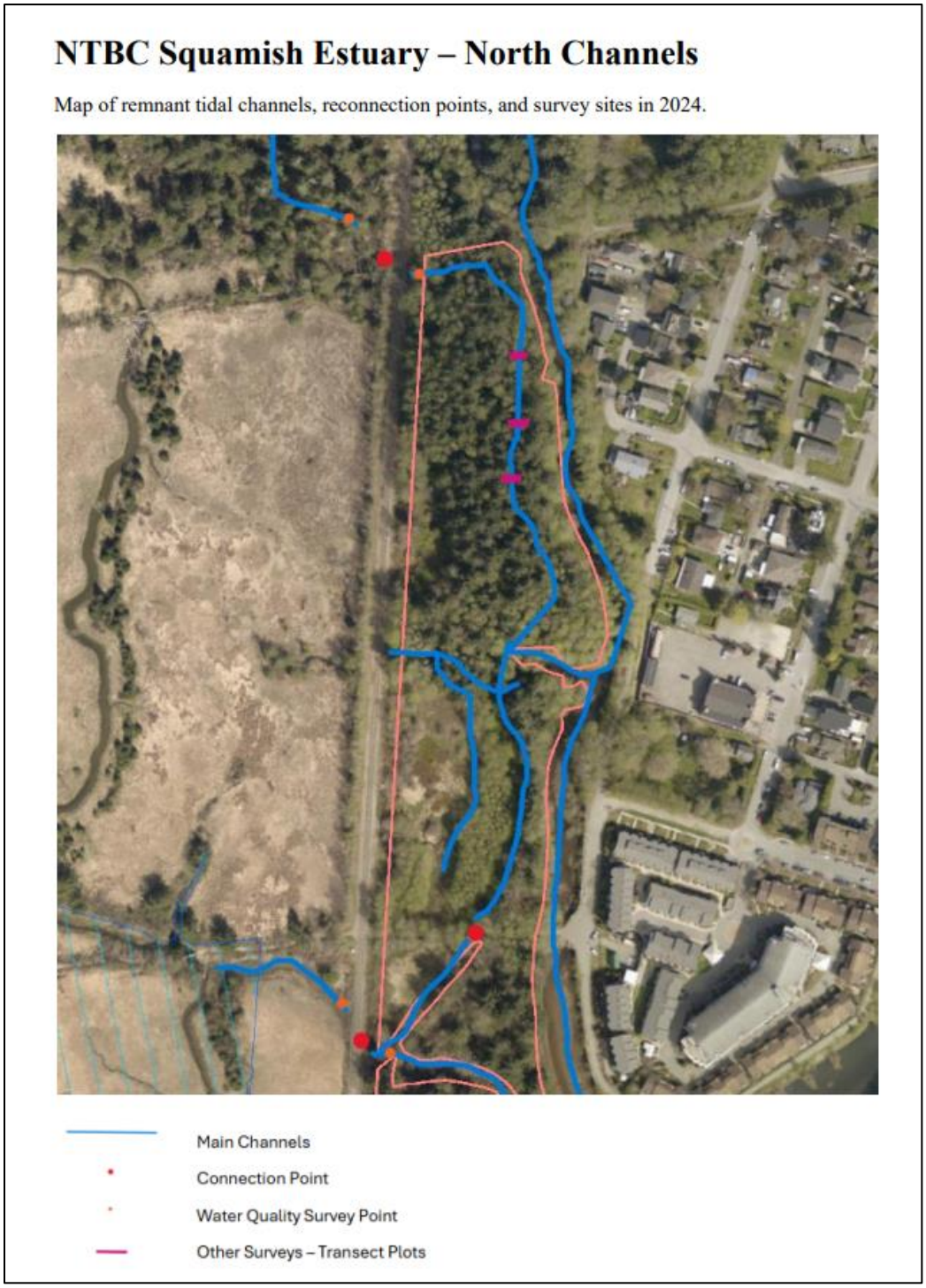

Figure 4. Map of current and remnant channels on the North side of the NTBC conservation area (red outline). Proposed connection points for re-watering remnant channels are shown along with survey locations.

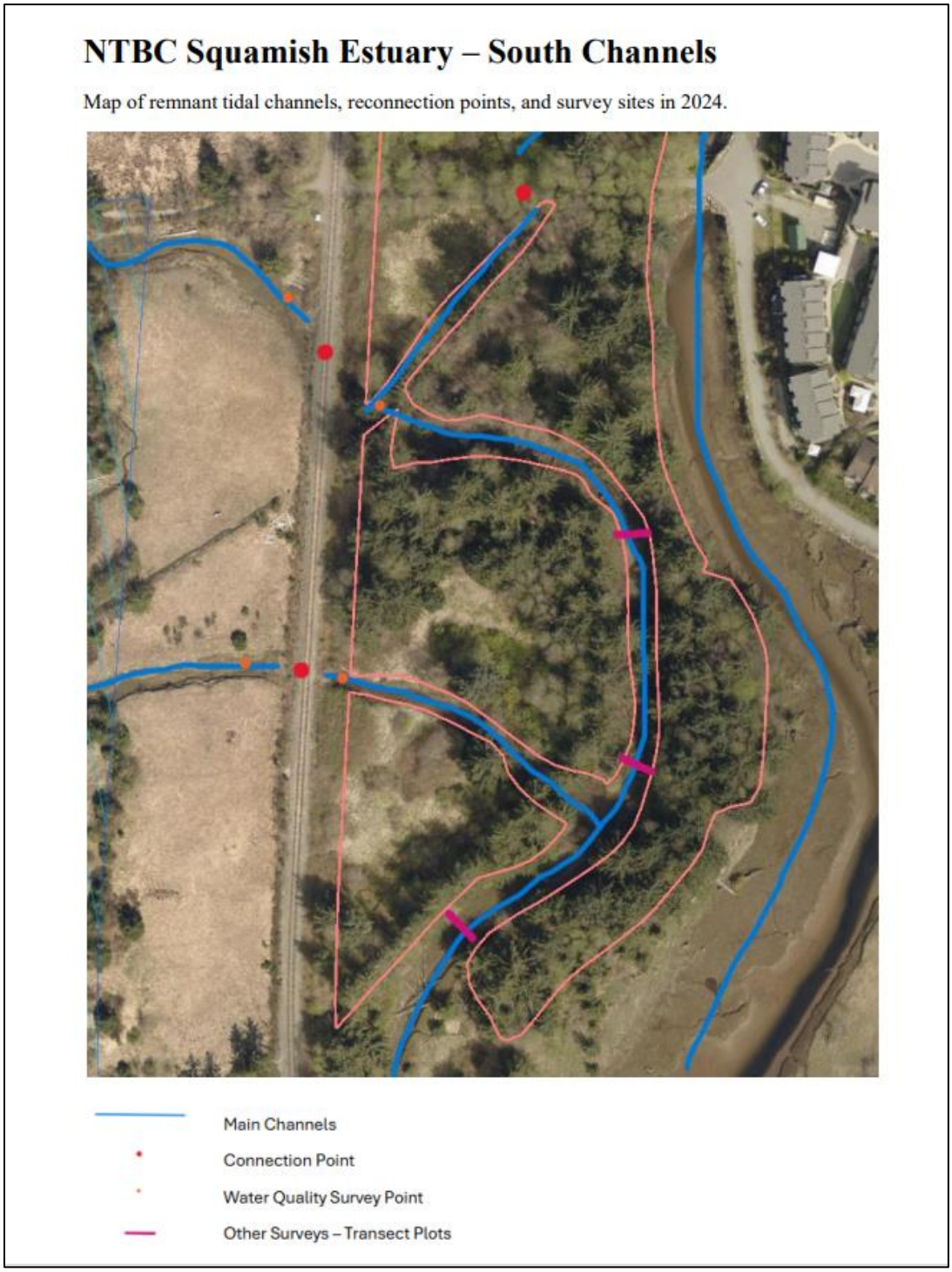

Figure 5. Map of current and remnant channels on the South side of the NTBC conservation area (red outline). Proposed connection points for re-watering remnant channels are shown along with survey locations.

4.2 Ecological Condition Surveys

Riparian Vegetation Survey

The vegetation along two 100 m transects was assessed to better understand the type of cover and understory along the stream bank. These transects follow remnant channels that have been cut off from the rest of the Squamish River Estuary by the CN rail line. The northern site was selected to represent the forested area within the conservation area, and the southern site to represent the more marsh-like areas closer to Howe Sound.

Within the 100 m transect, a plot was analyzed every 20 m for their vegetation, resulting in 4 plots total. To randomly determine which side of the bank the survey took place on, a coin was flipped. The plot sizes were 8 m long and 4 m wide plotted with flags, beginning at the first piece of vegetation along the middle of the transect line. The tree layer was assessed first, identifying the species, sub-layer, and percent cover. The same process occurred for the shrub, herb, and moss/lichen layer.

Any tree, shrub, or herb species that was not included in the identified vegetation could still be included in the percent canopy cover if overlaying branches were inside the flagged plots.

Fish Habitat Suitability

To determine the current fish habitat suitability of remnant channels within the Nature Trust conservation area, fish habitat inventory surveys were conducted. These surveys were based on the Resources Inventory Standards Committee methods for streams (RISC 2001).

Survey points have been established by students from the British Columbia Institute of Technology's Ecological Restoration Program. Survey points are 33 m apart beginning at 0 m of each reach (see Figures 4 and 5). The same 100 m transects from the riparian vegetation survey were followed.

The following parameters were measured: wetted width, water depth, and duff layer depth. Morphology, canopy cover, and stream bank characteristics were visually estimated.

As the surveys occurred prior to re-watering of the remnant channels certain features we were unable to collect data for due to lack of flowing and/or standing water. These features were residual pool depth and D95.

Wildlife Tree Survey

The presence and type of wildlife trees was assessed to determine how species are utilizing those spaces, to what extent, and observing their different features. Wildlife trees were defined as trees or stumps identified with characteristics suitable for wildlife use. The same two 100m transects were used as for the vegetation surveys, one northern transect and one southern transect. Any wildlife trees identified within 10 meters from the middle of the bank were included. Living wildlife trees were included when burrows were present beneath the roots, or nests or large cavities were present.

Measurements for each wildlife tree included: relevant species use, estimated height, estimated circumference at breast height, and surrounding habitat. Next, any habitat features including conks, amount of branching, fungi, or any other features that may be used by wildlife were recorded. The decay stage each wildlife tree was at was determined following British Columbia's wildlife tree classification system for conifers (2024), with 1 being most healthy and 9 being most dead or decayed.

Both sides of the remnant channels (east and west) were surveyed at an even distance from the middle of the bank (10 meters on each side), and coordinates for each wildlife tree were recorded.

Water Quality Monitoring

Water quality measurements were taken using a YSI multiparameter probe. Measurements were taken at the three suggested rewatering points on either side of the CN Rail for comparison of values pre- and post- re-watering. The parameters measured were dissolved oxygen, temperature, pH, conductivity, and salinity.

Surveys were completed by NTBC on September 9th and November 6th, 2024 at high tide. Measurements were taken at 6 locations on either side of the 3 main reconnection points (see Figures 4 and 5) and recorded in a table.

Table values marked as n/a were used when water levels were not high enough to sample, as remnant channels on the northern side of the conservation area are frequently dry.

4.3 Restoration and Enhancement

Invasive Species Removal

English holly removal began in July 2024. The removal process includes cutting the tree to the base and then coating the exposed surface with an herbicide solution to prevent re-growth. The initial work has targeted larger holly trees with this method as once established, holly spreads by suckering and will readily send out shoots if not prevented (Stokes et al. 2014). Once the plants had been cut or pulled, the plant material was removed from the site and disposed of following disposal standards at the Squamish Landfill. Smaller holly plants will be removed by hand with a weed wrench beginning in April 2025.

Native Plantings

Planting took place at the Squamish Estuary Conservation area on November 2, 2024. Native plants were selected based on results from the riparian vegetation surveys completed earlier in the summer. Plants were placed by the NTBC South Coast Conservation Field Crew in appropriate locations throughout the site. The focus was on filling in gaps left by English holly, within 20m of the channels proposed for re-watering in order to restore plant cover and diversity surrounding remnant channels. Planting was done over the course of 3 days with volunteers from St. Georges School. Planted areas were mapped and follow up monitoring will include plant survivorship surveys. Any data collected will be used to inform future plantings in the area.

5.0 Results and Outcomes

5.1 Fish Habitat Suitability

While fish habitat suitability surveys included many parameters, those identified as most important for juvenile salmon habitat have been summarized in the below tables:

Table 1. Summary of Fish Habitat Suitability of Habitat Features for North Transect

Habitat Feature	Value	Suitable for Juvenile Salmon (Y/N)
Pool depth	0 m	N – lack of water volume contributes to poor water quality and increases likelihood of fish traps
Small woody debris	>20% cover	Y – contributes to invertebrate abundance and thermal/predation cover

Large woody debris	<5% cover	N – Lack of woody debris may inhibit opportunities for thermal and predator cover.
Instream vegetation	<5% cover	N - Lack of instream vegetation may inhibit opportunities for thermal and predator cover along with feeding opportunities
Undercut banks	No cover	N - Juvenile Chinook salmon utilize undercut banks for prey and thermal cover

The North transect survey showed that the remnant channels currently provide poor habitat suitability for juvenile salmon due to several limiting factors. The most obvious limitation to suitable habitat is the very low or non-existent water levels. Currently this remnant channel provides little to no habitat for juvenile salmon and when wetted may result in fish traps if water levels remain low. Upon re-watering, the limiting factors on fish habitat suitability would include low levels of large woody debris and instream vegetation, as well as undercut banks. Options should be explored in preparation for re-watering regarding the possibility of dredging a channel thalweg, planting instream vegetation, and introduction of large woody debris.

Table 2. Summary of Fish Habitat Suitability of Habitat Features for South Transect

Habitat Feature	Value	Suitable for Juvenile Salmon (Y/N)
Pool depth	0.09m	N – lack of water volume contributes to poor water quality and increases likelihood of fish traps
Small woody debris	<5% cover	N – Lack of woody debris may inhibit opportunities for thermal and predator cover.
Large woody debris	>20% cover	Y – contributes to invertebrate abundance and thermal/predation cover
Instream vegetation	5-20% cover	Y - Instream vegetation provides habitat for invertebrate prey and opportunities for thermal and predatory cover
Undercut banks	<5% cover	Y - Juvenile Chinook salmon utilize undercut banks for prey and thermal cover

The data collected on the South Transect suggests that the remnant channels have mixed suitability for juvenile salmon habitat. There is presence of large woody debris exceeding 20% cover, moderate instream vegetation (5-20% cover), and the presence of some undercut banks that provide beneficial thermal cover, predator refuge, and feeding opportunities. The limiting factor for fish habitat suitability is the shallow pool depth of 0.09m and overall low water volume, which can result in lower water quality and increased risk of fish entrapment. Additionally, the low presence of small woody debris (<5% cover) may further reduce habitat complexity and available cover. The southern channels would benefit from increased fresh water

input and flow without as much requirement for additional work in comparison to the northern remnant channels to provide suitable habitat. Culvert installation would increase connectivity to other channels within the estuary for fish passage for both North and South channels.

5.2 Wildlife Trees

The results of the wildlife tree survey (Table 3) show distinct differences between the North and South Transects. The North Transect had a higher number of wildlife trees (12) compared to the South Transect (5), and these trees were generally larger, with a mean circumference of 113 cm compared to 88.4 cm in the South. The dominant decay stage in the North was stage 4 (dead with no fine twigs), suggesting that these trees are in a less advanced state of decay compared to the South Transect, where the dominant stage was stage 5 (dead with most branches absent).

The higher number of wildlife trees in the North Transect is likely due to the North side of the Conservation Area being more forested and having a generally higher density of trees within the survey area. It should also be noted that the South Transect has a higher quantity of large woody debris within the channel as seen in the fish habitat suitability survey that were not captured in the wildlife tree data.

Table 3. Wildlife Tree characteristics for North and South transects

Wildlife Tree Characteristics	North Transect	South Transect
Number of Wildlife Trees	12	5
Mean circumference (at chest height)	113cm	88.4cm
Dominant stage of decay	4 – dead with no fine twigs	5 – dead most branches absent
Surveyed habitat features	Loose bark (8), branching (10), broken top (3), cavity (1), stump (1)	Cavity (3), loose bark (3), branching (2), stump (1), broken top (1)
Evidence of fungal decay	Yes (3)	No

5.3 Riparian Vegetation

Riparian vegetation data was collected to show the species composition and relative percent cover of each species within riparian areas (within 8 m of channels). Native and introduced species were assessed and are summarized in below tables. Original data sheets separate species

by tree, shrub, and herb layers. Overall, plant communities differ between North and South transects, with some species like Sitka spruce and salmonberry common throughout.

Several non-native species were also recorded. Most were not very abundant (<5% cover) but two that stood out were English holly (average 45% cover in North Transect) and English Oak (average 20% cover in South Transect). Of these non-native species, English holly is considered an invasive species and is known to be destructive to native vegetation by changing soil composition, monopolizing water, and shading out other plants (Metro Vancouver, 2021).

North Transect

The riparian vegetation survey of the North transect reveals a diverse mix of native plant species, with Sitka spruce (30%) and red elderberry (25%) as the highest amount of cover. Other notable species include salmonberry (20%), red alder (15%), and a mix of understory plants such as western hemlock, sword fern, lady fern, and western lily of the valley, each covering about 10% of the surveyed plots. Less abundant species, such as snowberry (5%), alpine enchanter's nightshade (5%), and red huckleberry (<5%), contribute to overall plant diversity.

Several non-native species were recorded. English holly was very abundant (45%) while European mountain ash, English oak, laurel, herb robert, and English ivy were all observed in smaller quantities (<5%).

Table 4. Summary of 4 Riparian Vegetation Survey Plots - North Transect

Riparian Vegetation Survey - Native Species Present in North Plots	
Species	**Average % Cover (rounded to nearest 5)**
Sitka spruce	30
Red elderberry	25
Salmonberry	20
Red alder	15
Western hemlock	10
Sword fern	10
Lady fern	10
Western lily of the valley	10
Snowberry	5
Alpine enchanters nightshade	5
Red Huckleberry	<5

Riparian Vegetation Survey - Non-native species in North plots

Species	Average % Cover (rounded to nearest 5)
English Holly	**45**
European mountain ash	<5
English oak	<5
English laurel	<5
English Ivy	<5
Herb Robert	<5

South Transect

The riparian vegetation survey of the south conservation area shows a notably different plant community, with western lily of the valley (25%) and salmonberry (20%) being the most dominant species for herb and shrub layers respectively. There was changing species composition in the tree layer as we start to see species like Pacific crabapple (15%) and cascara buckthorn (10%) contributing to tree canopy diversity. Lyngbe's sedge (5%), Pacific silverweed, and marsh pea only occurred at the southernmost surveyed plot where there is the most tidal influence.

Table 5. Summary of 4 Riparian Vegetation Survey Plots - South Transect

Riparian Vegetation Survey – Native Species Present in South Plots	
Species	**Average % Cover (rounded to nearest 5)**
Western lily of the valley	25
Salmonberry	20
Pacific Crabapple	15
Sitka spruce	10
Cascara buckthorn	10
Nootka rose	10
Aster species	10
Lyngbe's sedge	5
Red alder	<5
Douglas fir	<5
Grass species	<5
Snowberry	<5
Cow parsnip	<5
Giant vetch	<5
Marsh pea	<5
Pacific silverweed	<5
Black twinberry	<5

Riparian Vegetation Survey - Non-native species in South plots	
Species	**Average % Cover (rounded to nearest 5)**
English Oak	20
English Holly	<5

5.4 Water Quality Monitoring

The water quality monitoring results show both differences between the North and South sampling locations, as well as variations between East (E) and West (W) readings. The most obvious contrast was between the North (W) channel and North (E) channel on the NTBC conservation area, where the North (E) channel had either very little water or no water (observations marked as n/a in tables 6 and 7). In comparison, the North (W) channel consistently had high enough water levels to sample.

Dissolved oxygen (DO) levels are significantly lower in the northern sites overall. The southern locations exhibit consistently higher DO levels, with South Connection 2 (W) reaching the highest value (96%).

Temperature readings are generally higher in the Sept. 9 dataset, as the conditions were warmer, with slightly higher temperatures in the South (W) channels as these channels have less vegetation cover. pH values have so far remained relatively stable across all locations, leaning towards somewhat more acidic in the North channels.

Salinity levels varied widely, with northern sites showing lower values compared to the southern sites, where South Connection 1 (W) recorded the highest salinity (11.82 ppt). Salinity readings were considerably higher in the South (E) channels compared to South (W) in September as the eastern channels are more tidally influenced, but this evened out in November, likely due to increased freshwater inputs due to heavier rainfall.

Table 6. Water Quality Measurements September 9, 2024 (Condensed)

Location	DO (%)	Temperature (°C)	pH	Salinity (ppt)
N. Connection 1 (W)	26.2	17.6	6.44	2.91
N. Connection 1 (E)	n/a	n/a	n/a	n/a
S. Connection 1 (W)	76.3	17.2	7.04	2.71

S. Connection 1 (E)	49.3	16.8	6.99	7.15
S. Connection 2 (W)	96	17.7	7.67	2.99
S. Connection 2 (E)	66.1	16.4	7.09	6.45

Table 7. Water Quality Measurements November 6, 2024 (Condensed)

Location	DO (%)	Temperature (°C)	pH	Salinity (ppt)
N. Connection 1 (W)	17.4	7	6.93	0.57
N. Connection 1 (E)	**7.8**	8.7	6.89	1.44
S. Connection 1 (W)	76.4	8	7.07	11.82
S. Connection 1 (E)	75.9	7.8	7.06	10.47
S. Connection 2 (W)	68.8	7.7	7.09	8.7
S. Connection 2 (E)	83.2	7.9	7.2	10.74

6.0 Discussion

Within the Squamish Estuary Conservation Area, there has been significant loss of side channel habitat from the construction of a railway spur line cutting off the conservation area from the Squamish River. The loss of habitat has impacted all pacific salmon species that use estuary channels as essential rearing habitat. These changes to the ecosystem and the proximity of the Little Bear Slough Conservation area to the District of Squamish Townsite has allowed for invasive species to become established surrounding the remnant channels and out-compete native plants.

Throughout the year, progress was made towards several of the main objectives. Baseline data was collected surrounding the ecological state of the remnant channels within NTBC's Squamish Estuary Conservation Area. Particular attention was paid to habitat characteristics for juvenile pacific salmon, including surveys of water quality, fish habitat suitability, and riparian vegetation. Data was also collected to describe the current abundance and characteristics of wildlife trees as key habitat components for birds and wildlife.

One of the main findings during the riparian vegetation surveys was the extent of English holly throughout the northern half of the Squamish Estuary Conservation Area. While the presence of this species was known, the extent had not yet been documented – an average of 45% cover over 4 separate plots. On the short term, holly removal work will continue take place within the capacity of the Nature Trust of BC with the goal of removing the holly before re-watering takes place to prevent further spread, give newly-planted vegetation time to establish, and avoid disturbance to channels once re-watered.

Longer term, it is likely that invasive species, and English holly in particular, will continue to persist within the Squamish Estuary due to re-introduction of seed by birds from the town of Squamish and re-growth of any remaining holly plants. NTBC will need to continually monitor invasive species encroachment. Establishing a thriving and diverse understory of native plants will help prevent further establishment of English holly long term in combination with continued management efforts.

The fish habitat and water quality suitability of the remnant channels for pacific salmon varied. Some of the habitat requirements for juvenile pacific salmon include: adequate water quality conditions, shelter from predation, thermal cover, and prey availability. Currently the northern remnant channels have little to no water (and therefore poor water quality when it is present) and limited large woody debris or in-channel vegetation, but are adequately shaded by riparian vegetation along the banks. Southern channels, while still quite shallow, have considerably improved water quality, high dissolved oxygen readings, and adequate pH levels. Temperatures were towards the high end at times but within adequate range for pacific salmon (under 18 degrees Celsius). Southern channels also had considerably more large woody debris and in-stream vegetation. Channels on both sides of NTBC's Squamish Estuary Conservation Area have potential to be restored for side channel habitat and would benefit greatly from increased connectivity and freshwater input from culvert installation, as well as further restoration work (e.g. introduce large woody debris, planting riparian vegetation).

One of the challenges faced this year included limited data collected for water quality. This was due to delays in chemical delivery for calibrating the YSI water quality monitor probes. It would be ideal to collect data several times throughout each season in 2025 to have a broader picture of water quality year-round, and delays are not anticipated this year. The other limiting factor to work done in 2024 was time and capacity of Nature Trust of BC staff and funding for the project. Securing additional funding in each subsequent year to cover the total project costs, including what has been approved by Fish and Wildlife Compensation Program funding, continues to be key to the project feasibility.

7.0 Recommendations

Overall, data collected throughout 2024 has contributed to knowledge on the current state of remnant channels within the Nature Trust of BC's Squamish Estuary Conservation Area. While abiotic habitat features and vegetation were well documented, further knowledge gaps were identified in relation to active use of habitat by fish and wildlife. Some of the specific questions identified are:

1. What is the current abundance and species breakdown of juvenile pacific salmon using Little Bear Slough and remnant channels?
2. What benthic invertebrates are currently present in remnant channels? What prey availability does this present for juvenile salmon?
3. What wildlife is currently using the NTBC Squamish Estuary conservation area? How would they be affected by the re-watering? Are there any ways that species at risk may be impacted by re-watering?

To fill in these gaps, there is opportunity for further surveys including fish trapping, benthic invertebrate assessment, camera traps for wildlife, and/or bird surveys. The feasibility and prioritization of these surveys should be assessed before the next field season and plans put into place for diversified monitoring.

It is also important for the Nature Trust of BC to put recommended restoration actions into motion based on our findings this year. Due to the high proportion of invasive species like English holly within the understory of riparian zones, it is recommended that removal of invasive species and replanting native plants be continued. Riparian vegetation provides cover and habitat complexity to shelter juvenile salmon from predators, and shade to decrease water temperature and improve water quality (Roni et al. 1999). Vegetation also improves bank stabilization and controls erosion (MOF 2019). Additionally, invasive species removal work will be more accessible and less disruptive to waterways if completed before re-watering takes place.

Included with this recommendation is the intent to go about this work in a good way. This includes continued and in-depth consultation with Squamish Nation as well as other collaborators. Relationships begun in this direction should be continued and prioritized. This may include actions such as:

- Including a significant portion of culturally significant plants within native plantings
- Co-developing plans for plantings and monitoring work.
- Contracting Squamish Nation technicians for work when funding is available (invasive species removal, monitoring, planting).

Thanks to the support of the Fish and Wildlife Compensation Program, the Nature Trust of BC had the opportunity to establish baseline data for the Squamish Estuary Conservation Area and further identify required restoration and enhancement as well as gaps in knowledge. Restoration

following the re-watering of Little Bear Slough is the very beginning stages of a project that will eventually be an integral part of restoring the Squamish Estuary.

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