

Hayward Watershed Fish Habitat and Fish Passage Assessment

FWCP Project No. COA-F22-F-3524

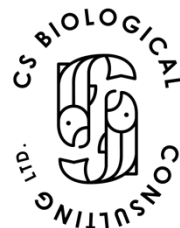
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Executive Summary

Skeena River salmon populations have significantly declined over the last century due to historical over-fishing, ongoing freshwater habitat alteration and more recently climate change issues affecting marine and freshwater environments. Past studies suggest that logging has resulted in the degradation of freshwater rearing and spawning habitat and is linked to declines in freshwater productivity for salmon populations. Habitat assessments in potentially impacted watersheds are needed to determine if restoration actions could potentially contribute to improving the productivity of degraded watersheds. The Hayward Creek watershed is a tributary to the Ecstall River and is a high value, medium-sized coastal river with populations of Coho (*Oncorhynchus kisutch*), Pink (*O. gorbuscha*), and a small number of Chinook Salmon (*O. tshawytscha*), as well as Dolly Varden (*Salvelinus malma*), Coastal Cutthroat Trout (*O. clarkii clarkia*) and potentially Steelhead Trout (*O. mykiss*). The Hayward Creek watershed was logged historically from the 1960s to 1990s. Impacts to freshwater habitat including siltation and logging debris were reported to be degrading spawning habitat during the earlier years of logging.

Hayward Creek watershed is associated the Falls River reservoir and Big Falls hydroelectric project, and it has been identified as a sub-basin requiring priority actions (FWCP 2017). Our study has been designed to address priority action FLS.RLR.RI.10.01 – to conduct a habitat assessment and an assessment of fish passage in the Hayward watershed (Priority Type 3) (FWCP 2017). This action aims to determine if anadromous fish access is or was historically possible via the Hayward Lake (Ecstall River system) through to Falls Reservoir.

To address this priority action, this study has three objectives:

1. Assess connectivity for anadromous salmon and resident species (trout and char) throughout the Hayward Creek Watershed, and connectivity between the Falls River reservoir and the upper Hayward River.
2. Conduct fish sampling and habitat assessment of the Hayward Creek watershed to assess condition of available fish habitat, fish distribution and identify potential forestry impacts.
3. Conduct drone surveys of riparian habitat in the Hayward Creek watershed to provide detailed aerial imagery and baseline information for future assessments and restoration planning.

The entire Hayward Creek watershed was assessed from the tidal extent up to Hayward Lake and throughout Little Beaver Creek, which drains into the Falls River reservoir. Stream habitats were assessed using Reconnaissance 1:20,000 Fish and Fish Habitat Inventory Standards (RIC 2001, 2008). Fish distribution was documented with electrofishing, angling, minnow trapping and gillnetting, and combined with historical information to identify potential barriers, available habitat quality and potential spawning habitat. Subjective assessments of spawning habitat and

logging impacts on critical fish habitats were collected while walking the entire stream by experienced observers.

The results of this study suggest that Hayward Creek watershed presently supports high value spawning, rearing and overwintering habitat for salmonid species. Hayward Creek supports high abundances of Coastal Cutthroat Trout and juvenile Coho Salmon. We also documented low abundances of Chinook Salmon (adult and juvenile) and Rainbow Trout (potentially anadromous Steelhead). Although reported in this watershed historically, we addressed knowledge gaps for these species by confirming their presence and identifying Chinook as stream-type Chinook rearing in Hayward Creek. Critical rearing habitats were identified throughout the Hayward Creek mainstem downstream from Hayward Lake to the tidal extent. We also documented adequate spawning habitat to support historic estimated escapements of Coho and Pink Salmon. No major impacts from historic logging were identified, however several minor disturbances are discussed. It should be noted that without long-term and repeated habitat assessments it is difficult to specifically identify most logging impacts that may have occurred over time and cannot be measured in a study such as this.

Hayward Lake supports resident populations of Coastal Cutthroat Trout and Dolly Varden and is connected to the Falls River reservoir by Little Beaver Creek during periods of higher flow. Fish habitat available in Little Beaver Creek is impacted by historic logging activities, with no evidence of riparian buffers present. Fish passage is likely restricted throughout Little Beaver Creek by significant inputs of non-functional woody debris (small and large) and eroding stream banks.

We also assessed connectivity throughout the watershed and identified that a falls complex in Lower Hayward Creek is passable for Coho and Chinook Salmon and that an impassable barrier is present at the outlet of Hayward Lake. This is the upstream limit for anadromous salmon passage in the watershed. The cascade/falls complex was created from a large natural rockslide, and we conclude that anadromous salmon cannot move into the Falls River reservoir through Hayward Creek from the Ecstall River.

In summary, the results of this study indicate that the Hayward Creek watershed contains relatively intact, high value fish habitat for anadromous and resident species of salmonids. Minor impacts from historic logging were noted, while large-scale restoration actions for the watershed have not been recommended. We recommend the following research priorities and future restoration actions:

- Anadromous salmon escapement has not been estimated in Hayward Creek since 1991 and stream counts to determine the abundance of Pink Salmon and Coho Salmon utilizing Hayward Creek are required. Pink Salmon were historically the most abundant salmon utilizing Hayward Creek; however, it is unclear if they continue to spawn in lower reaches. Fall surveys (redd or adult counts) are required to determine timing and abundance of anadromous salmon using Hayward Creek. This action is the recommended next step to understanding the Hayward Creek watershed and document

the suitability of spawning habitat in lower Hayward Creek that may have been impacted by fine sediment accumulation over time.

- Although less informative for determining current spawner abundance and critical habitat locations, capturing Pink Salmon fry in the spring could be used to determine species presence and out-migrating timing. Additionally, conducting fish surveys in the spring may also identify ocean-type Chinook out-migrating to the Skeena River estuary.
- Coastal Cutthroat Trout and Dolly Varden char populations throughout BC are Blue listed (special concern), however, knowledge of trout and char populations in the Lower Skeena remain limited. Further investigation to understand life-history strategies, population abundance and distribution throughout this region is recommended.
- Restoring connectivity between Little Beaver Creek and Falls River Reservoir for Coastal Cutthroat Trout and Dolly Varden Populations. Restoration actions should be aimed at a) addressing non-functional large woody and small woody debris likely restricting fish passage in the creek, and b) removal of the wooden bridge downstream of Hayward Lake, which is collapsing into Little Beaver Creek. Given that Little Beaver Creek only provides fish habitat in higher water, with little to no habitat available during low water summer flows, restoration actions to improve connectivity are likely of low priority.

This detailed habitat assessment and fisheries survey has provided updated baseline information on the fisheries values of Hayward Creek, identified potential restoration activities to address forestry impacts and additional research priority actions for the watershed.

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1. Introduction

The Skeena River is the second largest salmon producing river in British Columbia, however over-fishing, habitat alteration and climate change are contributing to declining salmon stocks (Walters et al. 2008; English et al. 2018; Price et al. 2019). For example, wild Sockeye Salmon populations in the Skeena River watershed have declined by 56%–99% in the last 100 years (Price et al. 2009), while Chinook Salmon have decreased 41% in the last 15-20 years (PSF 2016). Watershed logging often results in degradation of freshwater rearing and spawning habitat and is linked to declines in freshwater productivity for salmon populations (Wilson et al. 2022). Degradation from intensive historical logging has been documented in tributaries of the Ecstall River, a main coastal tributary of the Skeena River (Jyrkkanen Environmental Consulting 1997). Habitat assessments in potentially impacted watersheds are needed to determine if restoration actions could potentially contribute to the productivity of degraded watersheds.

The Hayward Creek watershed (WSC: 400-016500-14100) is a tributary to the Ecstall River and is a high value, medium sized coastal river containing Coho (*Oncorhynchus kisutch*), Pink (*O. gorbuscha*), and Chinook Salmon (*O. tshawytscha*), as well as Dolly Varden (*Salvelinus malma*), Coastal Cutthroat Trout (*O. clarkii clarkia*) and potentially Steelhead Trout (*O. mykiss*) (DFO 1991; Jyrkkanen Environmental Consulting 1997). The Hayward Creek watershed was heavily logged during periods from 1960 to the 1990s, with documented impacts to freshwater habitat such as silting and logging debris contributing to reduced quality and quantity of spawning habitat (DFO 1991; Jyrkkanen Environmental Consulting 1997). However, there has been no recent investigation and limited historic information on the fisheries values of the potentially impacted Hayward Creek Watershed. Given that Hayward Creek supports several salmonid species of conservation concern in BC, Coastal Cutthroat Trout and Chinook Salmon, a detailed habitat assessment is needed to document the condition and distribution of fish populations utilizing the watershed.

2. Goals and Objectives

The Fish and Wildlife Compensation Program (FWCP) is a partnership between BC Hydro, the Province of BC, Fisheries and Oceans Canada, First Nations and public stakeholders. This program aims to conserve and enhance fish and wildlife impacted by BC Hydro dams (FWCP 2017). The Falls River reservoir was created in 1930 by damming Big Falls Creek and is fed by three main tributaries: Big Falls Creek, Hayward Creek (Little Beaver Creek) and Carthew Creek (FWCP 2017). Hayward Lake, the headwaters of Hayward Creek, has two outlets with water flowing northeast via Hayward Creek to the Ecstall River, and south via Little Beaver Creek to the Falls River Reservoir. The Hayward River watershed and Falls River Hydroelectric project has been identified as a sub-basin requiring priority actions (FWCP 2017).

Our study has been designed to address priority action FLS.RLR.RI.10.01 – to conduct a habitat assessment and an assessment of fish passage in the Hayward watershed (Priority Type 3)

(FWCP 2017). This action aims to determine if anadromous fish access is or was historically possible via the Hayward Lake (Ecstall River system) through to Falls Reservoir.

This habitat assessment of the Hayward Creek watershed has the following objectives:

1. Assess connectivity for anadromous salmon and resident species (trout and char) from the Ecstall River to Hayward Lake, through Little Beaver Creek and into to the Falls River reservoir via the secondary outlet of Hayward Lake.
2. Conduct a habitat assessment and fisheries survey of the Hayward Creek watershed, including Little Beaver Creek, to a) assess condition of available fish habitat, b) determine fish distribution within the watershed, and c) identify potential forestry impacts.
3. Conduct drone surveys of riparian habitat in the Hayward Creek watershed to provide detailed aerial imagery and baseline information for future assessments and restoration planning,

This detailed habitat assessment and fisheries survey will provide baseline information on the fisheries values of Hayward Creek and identify potential restoration activities to address impacts from historical forestry activities.

3. Study Area

The Hayward Creek watershed is located 50 km southeast of Prince Rupert and flows into the east bank of the lower Ecstall River approximately 15km upstream of the Skeena River (Figure 1). Hayward Creek (WSC: 400-016500-14100) originates from Hayward Lake (00566LSKE) and flows northwest for 15km into the Ecstall River. The watershed has a typical U-shaped valley and is surrounded by steep mountains rising 1000 to 1200 meters above the creek (Bustard 1993; Jyrkkanen Environmental Consulting 1997; Triton Environmental Consultants 1998). Little Beaver Creek (WSC: 400-016500-24200-10300) is the second outflow of Hayward Lake, flowing southeast for approximately 1.5 km into the Falls River reservoir.

Based in the coast mountain range, the Hayward Creek watershed is in the Coastal Western Hemlock (CWF) biogeoclimatic zone and is composed of highly productive and structural complex coniferous forests. Within the valley bottom (CWH vm1 subzone (Jyrkkanen Environmental Consulting 1996)), Western Hemlock (*Tsuga heterophylla*), Western Red Cedar (*Thuja plicata*), Amabilis fir (*Abies amabilis*), and Sitka Spruce (*Picea sitchensis*), are the dominant trees, while the seral tree species include red alder (*Alnus rubra*) and black cotton wood (*Populus trichocarpa*) (Meidinger & Pojar 1991).

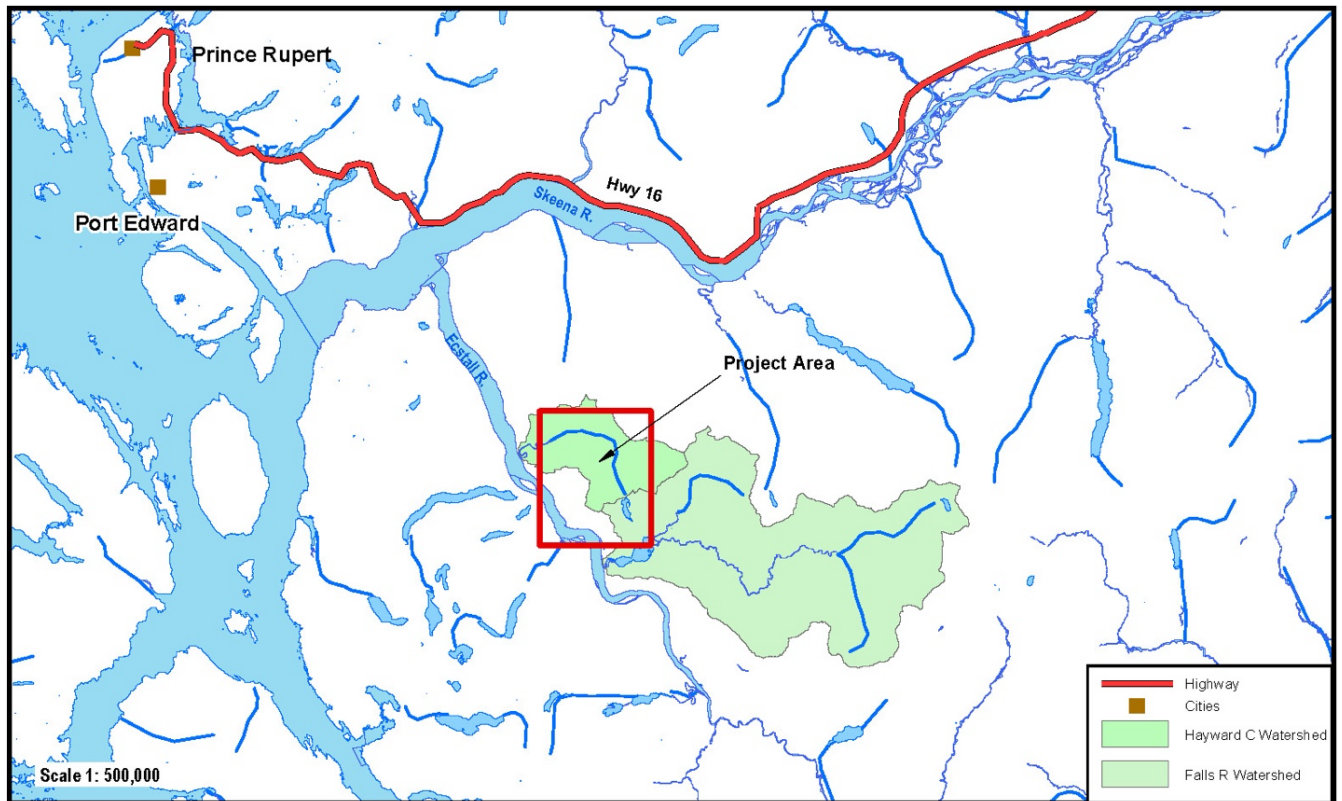


Figure 1. Study area map indicating the extents of Hayward Creek Watershed (project area) and Falls River Watershed.

3.1 Historical Fisheries Information

Fish distribution and fish habitat in Hayward Creek and Hayward Lake have been surveyed historically (Hancock et al. 1983; Norris & Grant 1985; DFO 1991; Bustard 1993; Triton Environmental Consultants 1998; FLNRORD 2005; Jordan & Addison 2018). Overall, there are documented populations of anadromous and resident salmonid species, and non-salmonid species utilizing the Hayward Creek watershed (Table 1). Anadromous species documented in the watershed include Coho Salmon, Pink Salmon, Chinook Salmon and potentially Steelhead Trout. Resident salmonid species include Coastal Cutthroat Trout and Dolly Varden. Non-salmonid species include Threespine Stickleback (*Gasterosteus aculeatus*), Prickly Sculpin (*Cottus asper*) and Lamprey (general). Table 1 provides a summary of fish presence and distribution previously documented within the Hayward Creek watershed.

Adult salmon spawner escapements on Hayward Creek were estimated periodically from 1949 until 1992 (Table 2) (DFO 2021). Historical salmon escapement estimates for Hayward Creek reports Pink Salmon as the most abundant salmon species utilizing the watershed (Table 2). Pink salmon spawning occurs from August to October with a peak spawning period observed from early to mid-September (DFO 2021). In general, the Pink Salmon population in the Ecstall River watershed is relatively small and saw a general decrease in the 1960s, with a population

rebound in the 1980s (Gottesfeld & Rabnett 2008). Since 1994 odd-year Pink Salmon have been dominant with record high returns (Gottesfeld & Rabnett 2008). Historical Coho Salmon escapement estimates in the Hayward Creek Watershed have been limited (Table 2), with spawning noted between September and late-October (DFO 2021).

Chinook Salmon and Steelhead Trout have also been reported to be utilizing the watershed (Jyrkkanen Environmental Consulting 1997; FLNRORD 2005), however, there have been no escapement estimates or formal documentation that is publicly available. Chinook salmon are known to spawn in the Ecstall River from mid-August to mid-November, with peak spawning in September (DFO 2021), and have been documented spawning in the lower reaches of Big Falls Creek (Gottesfeld & Rabnett 2008; Beblow 2012). A significant ocean-rearing life history (i.e. fry leave in their first summer to rear on the coast) has been documented for Chinook Salmon populations from the Ecstall watershed (Gottesfeld 2011). There have been no documentation of Sockeye or Chum Salmon utilizing the Hayward Creek watershed.

Table 1. A summary of historically documented fish species presence and known distribution in the Hayward Creek watershed.

Fish Species	Species Code	Distribution
Coho Salmon (<i>O. kisutch</i>)	CO	Adults observed spawning (Hancock et al. 1983; DFO 1991) and juveniles rearing in Hayward Creek (FLNRORD 2005; Jordan & Addison 2018). Very high densities of juvenile Coho Salmon noted in the headwater section downstream of Hayward Lake (DFO 1991; Bustard 1993; Triton Environmental Consultants 1998)
Pink Salmon (<i>O. gorbuscha</i>)	PK	Adults observed spawning to 5.4km upstream with no fish passage past the waterfall (Hancock et al. 1983; DFO 1991; FLNRORD 2005)
Chinook Salmon (<i>O. tshawytscha</i>)	CK	Unknown distribution. Chinook Salmon observation recorded in lower Hayward Creek with no source (FLNRORD 2005) and reported present in past studies (Bustard 1993; Jyrkkanen Environmental Consulting 1997). Found spawning in adjacent Big Falls River (Gottesfeld & Rabnett 2008).
Coastal Cutthroat Trout (<i>O. clarki</i>)	CT	Present throughout Hayward Creek (DFO 1991; Bustard 1993; Triton Environmental Consultants 1998; Jordan & Addison 2018) and Hayward Lake (Norris & Grant 1985; DFO 1991).
Dolly Varden (<i>Salvelinus malma</i>)	DV	Present throughout Hayward Creek (DFO 1991; Bustard 1993; Triton Environmental Consultants 1998) and Hayward Lake (Norris & Grant 1985; DFO 1991)
Rainbow Trout (<i>O. mykiss</i>)	RB	Unknown distribution. Rainbow Trout observation recorded in lower Hayward Creek with no source (FLNRORD 2005).
Prickly Sculpin (<i>Cottus asper</i>)	CAS	Documented in lower Hayward Creek (Jordan & Addison 2018)
Threespine Stickleback (<i>Gasterosteus aculeatus</i>)	TSB	Documented in Hayward Creek (Bustard 1993; Triton Environmental Consultants 1998; Jordan & Addison 2018) and Hayward Lake (Norris & Grant 1985).
Lamprey sp.	L	Unknown distribution. Lamprey observation recorded in mid-section of Hayward Creek with no source (FLNRORD 2005).

Table 1. Salmon escapement data for Hayward Creek from 1951 - 1991 summarized from the NuSeds database (DFO, 2021).

Species	10 Year Interval	10 Year Mean of Maximum Escapement Estimate	Maximum Escapement Year	Maximum Escapement Estimate
Coho	1951 - 1960	None Observed		
	1961 - 1970	113	1966	200
	1971 - 1980	None Observed		
	1981 - 1991	142	1984	200
Pink	1951 - 1960	1339	1951	5000
	1961 - 1970	904	1968	3500
	1971 - 1980	None Observed		
	1981 - 1991	497	1991	2500
Chinook	Not inspected			
Chum	Not inspected			
Sockeye	Not inspected			

3.2 Obstructions

A 4.0 m high falls is located at 5.4 km upstream of the Ecstall River and is documented to be passable to Coho Salmon under certain flow conditions and impassable to Pink Salmon (DFO 1991). There is reference that these falls have been blasted in the past to improve fish access (Jyrkkanen Environmental Consulting 1996, 1997). An impassable fish barrier is located at the outlet of Hayward Lake and is recorded as a 3 – 4 m falls with water percolating through slide material (DFO 1991; FLNRORD 2005). This barrier has also been reported as a 10m drop in vertical height over a 50m stream section (Bustard 1993).

3.3 Historical Resource Use

Logging in Hayward Creek has occurred since the 1960s, with logging on both sides of the mainstem river occurring at 4km upstream of the confluence of the Hayward with the Ecstall River. Extensive logging occurred further upstream in the watershed beginning in 1988 (DFO 1991), with riparian buffers left along most sections of the creek, with the exception of the south side of Hayward Lake (Triton Environmental Consultants 1998). Most of the road construction in the watershed occurred between 1985 and 1996 (Jyrkkanen Environmental Consulting 1996). During this time, several fisheries assessments were commissioned by International Forest Products (Bustard 1993; Jyrkkanen Environmental Consulting 1997) and the Watershed Restoration Program (Triton Environmental Consultants 1998) to document potential impacts of forestry.

Early impacts of logging within the watershed were first documented in 1971, with logging debris and subsequent silting reported to have significantly impacted the lower river, particularly the first 1.6km of Hayward Creek known to support Pink Salmon spawning (Hancock et al. 1983). Heavy rains in 1978 were also reported to have caused considerable streambed damage resulting in poor spawning habitat, rocky bottom and few gravel bars suitable for spawning (Hancock et al. 1983). It is important to note that these early impacts were documented as general remarks in a historic DFO escapement report, which have some inconsistencies resulting in difficult interpretation of details such as impact location or extent. For example, the lower 1.6 km of river was noted to be silty due to tides in 1968, but subsequently noted to be silty due to logging in 1971. In addition, it seems unlikely that Pink Salmon would spawn in the lower 1.6 km since it is a very low gradient section influenced by the turbid Ecstall River (mud and fine sediment deposition). It is possible that the 1971 notation refers to impacts observed at river kilometer 4 to 5.4, where Pink Salmon have been observed spawning (DFO, 1991), and the general area of early logging blocks in the Hayward Creek watershed.

Several potential impacts from logging in the 1990s were also documented. Deciduous riparian vegetation in old cut blocks within the lower reach (4km, Reach 1) remained evident, but appeared to be recovering in 1998 (Triton Environmental Consultants 1998). A portion of Reach 2 was logged on one side of the river without a riparian management zone, while certain high gradient tributaries were logged over in Reach 4 forming a possible sediment source (Jyrkkanen Environmental Consulting 1997). Lastly, the potential for erosion and sediment contribution from road networks and removal of short sections of riparian trees by logging in several locations of the upper watershed was documented (Reach 5 and 6) (Jyrkkanen Environmental Consulting 1997; Triton Environmental Consultants 1998).

A recent assessment also identified bank erosion and fine sediment distributed in lower Hayward Creek (Reach 2), including a high proportion of fines within spawning gravels (Jordan & Addison 2018). These findings suggested that further assessment in the upper watershed was required to determine the source of fine sediments and assess the upper watershed for potential logging impacts.

4. Methods

A reconnaissance flight was conducted on June 20th, 2021 to examine fish habitat from the air, document reach breaks, determine locations for river access and field logistics for a sampling program. Hayward Creek can be accessed by jet boat or helicopter, with jet boat access available within the tidal section up to 4.5km upstream from the Ecstall River confluence. Helicopter access is the primary method of access for the watershed, however, there are limited landing possibilities near the creek due to the steep nature of the valley and dense forests.

Fish and fish habitat surveys were conducted in 2021 from July 23 – July 26th by two field crews walking the stream. Based at a camp on the north-east side of Hayward Lake, field crews surveyed fish distribution and fish habitat in Hayward Creek and Little Beaver Creek on foot (with helicopter and boat support). Fish sampling of Hayward Lake was also conducted by boat (inflatable zodiac).

Reach break information on Hayward Creek was obtained from Bustard (1993) and corrected with GPS during the initial aerial survey prior to field studies. To create accurate river kilometers for the mainstem, TRIM2 stream centerline locations were first adjusted to stream location in geo-referenced World Imagery for ArcGIS (Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community - January 2022). Next, kilometer measurements were taken from the mouth of Hayward Creek upstream with an accuracy of +/-10m. Hayward Creek is divided into 6 reaches, with Reach 1 starting at the confluence of the Ecstall River, up to the end of the tidal section at 4.6km (Appendix A: Figure 1). Fish distribution and fish habitat in Hayward Creek were assessed by walking the entire length of stream from the tidal extent up to Hayward Lake. Fish sampling and habitat assessments were conducted in all non-tidal reaches (Reach 2 - 6), except for a short section (Reach 3: 6.6km to 7.6km) which was too deep to wade and was visually assessed with the helicopter.

Little Beaver Creek was assessed by walking from Hayward Lake for 650m downstream (9 U 453564 5984384). The remaining sections of Little Beaver Creek were surveyed from the air to visually assess for barriers and available fish habitat.

4.1 Stream Habitat Assessment

Stream habitats were assessed at sample sites located every 1 kilometer intervals using the Reconnaissance 1:20,000 Fish and Fish Habitat Inventory Standards (RIC 2001, 2008). This protocol involves characterizing fish habitat over a minimum distance of 100m of stream or 10 channel widths, whichever is determined to be greater. Physical attributes including stream channel and wetted width, residual pool depth and bankfull depth were measured with a measuring tape and measuring stick. Stream gradient was measured with a clinometer and water quality information (temperature, conductivity, and pH) was measured using handheld Hanna Combo Meter (HI 98129). Information on bed material, instream cover, riparian vegetation, bank characteristics, disturbance indicators and stream morphology were also collected according to Resource Inventory Committee Standards. At each site, the overall quality for fish spawning, rearing, overwintering, and migrating was described.

Additional information was collected throughout the entire length of Hayward Creek and Little Beaver Creek on barriers, available habitat, potential spawning habitat and logging impacts while walking the stream.

- Potential barriers to fish movement were described with measurements (length and height), GPS coordinates and photographs.
- Habitat notes and GPS coordinates were made while walking Hayward Creek to document suitable habitat (rearing, spawning, overwintering, holding), visual fish abundance and stream features such as beaver dams.
- Spawning gravel was documented with a size estimate (m^2), percentage of fine surface sediment, compaction and suitability for anadromous large-bodied salmon (e.g., Coho and Chinook Salmon) or resident small-bodied trout and char (e.g., Coastal Cutthroat Trout, Dolly Varden). Spawning gravel suitable for anadromous salmon was categorized as a dominant particle size of 16mm - 128mm at least 2.0 m^2 in area, while gravel suitable for resident trout was categorized as gravel of 8mm - 64mm at least 1.0 m^2 in area (Kondolf & Wolman 1993; Gerstein et al. 2005; Kondolf et al. 2008). Gravel patches were categorized as suitable for both anadromous salmon and resident trout when both conditions were met (gravel size 16 – 64mm and at least 2.0 m^2). Lastly, spawning gravels were categorized as “suitable gravels” when the levels of fine sediments ($< 3.35mm$) were $\leq 30\%$. This value is based on sources cited in Kondolf et al. (2008) as the reported maximum percentage of fine grains corresponding to 50 percent emergency of salmonids.
- Potential logging impacts were documented during foot and aerial surveys with coordinates, photos, and descriptions. Field crews documented indicators of channel disturbance described in Hogan et al. (1996) and MOF (1996). These include indicators for bed characteristics, channel pattern, stream banks and large woody debris.

4.2 Fish Sampling

Electrofishing was designated as the primary fish sampling method throughout Hayward Creek. However, during field sampling extremely low conductivity in Hayward Creek ($6 \mu s - 23 \mu s$) made it a less effective fish capture method, especially in upper reaches of the creek. Thus, fish in Hayward Creek were also sampled opportunistically by angling and minnow traps to further document fish distribution patterns. Fish captured were identified to species and fork lengths were recorded. DNA samples were also collected for Chinook Salmon (adult and juvenile).

Angling with a fly-fishing rod occurred at locations in Reach 2 to Reach 6 of Hayward Creek. This method was effective at catching fish the size of salmonid parr or greater but is ineffective at capturing fry and non-salmonid species such as Threespine Stickleback, Lamprey and sculpin. Salmonid fry and other species were visually documented when they could not be effectively sampled by electrofishing (conductivity too low). Angling using fish roe was also conducted in deep pools available in Reach 2 of Hayward Creek to search for adult Chinook that may have been holding or migrating during July.

In total, fish in Hayward Creek were sampled at 19 locations including 7 electrofishing sites, 10 angling locations and 2 minnow trap locations (Appendix B: Table 4). The fish community in

Little Beaver Creek fish was sampled three times by angling and once by minnow trap (Appendix B: Table 4).

4.3 Hayward Lake Fish Survey

Fish sampling on Hayward Lake was conducted to assess species assemblage using two standard gillnets (one floating and one sinking) and 6 minnow traps set overnight according to Resource Inventory Committee Standards (RIC 2001) (Appendix B: Table 4). Gillnets were set in approximately the same locations as the historic reconnaissance survey (Norris & Grant 1985) and minnow traps were set along the shore in proximity to lake outlets. Fish species were identified and measured to fork length (mm) and notes recorded on maturity and fish condition.

4.4 Aerial and Drone Habitat Survey

The entire Hayward Creek watershed from the confluence of the Ecstall River upstream to Hayward Lake, including Little Beaver Creek downstream to Big Falls Reservoir, was documented with aerial footage to capture current fish habitat values. In a continuous pass from the helicopter, the watershed was surveyed in 4K using a Sony a7siii video camera. Next, more stable, higher-quality drone footage of approximately 90% of the watershed was captured in 4K using both Mavic Air 2 and Mavic Mini 2 remotely piloted aircraft systems. The targeted elevation for the drone photography was 120 feet above the creek, though this varied due to limited take-off locations, 'line of sight' requirements, and the signal range limitations of operating within the narrow Hayward Creek drainage. This footage was sequenced together and overlaid with reach break information to provide companion documentation for this report.

Aerial footage will be hosted by the North Coast Skeena First Nations Stewardship Society and can be viewed and downloaded from the following links:

(helicopter footage) <https://vimeo.com/656775837/86f32c5237>

(high resolution drone footage) <https://vimeo.com/656856249/a24ed9255e>

5. Results

5.1 Stream Habitat Assessment

Hayward Creek is a low gradient (<1% – 2% slope) system flowing north from the outlet of Hayward Lake to the Ecstall River. Stream habitat is divided into 6 reaches, with the lowermost section of Hayward Creek subject to tidal influence up to 4.6km (Appendix A: Figure 1 -3). Overall, the mainstem river is a single channel with short side-channel sections and adjacent wetlands that are ponded behind beaver dams flowing through a narrow flood plain (0.5km across). The stream channel of the lower river is 15 – 30m wide and comprised largely of fine sediment (sands and silts) with pockets of gravel and cobbles (Appendix B: Table 1 -3). There

are several short sections where the gradient increases to support step-pool morphology. Upstream of Reach 5, the channel width ranges from less than 5m wide at the lake outlet to 15m wide. There are many small tributaries into Hayward Creek, many of which provide fish habitat for short distances before gradients increase up steep valley walls. Two tributaries (Tributary 31 and Tributary 32 (Bustard 1993)) in Reach 5 are major contributors to channel characteristics (water regime and bedload transport) for downstream habitat.

Fish habitat characteristics, fish habitat value, fish passage and potential logging impacts are summarized in this section for Hayward Creek (Reach 2 to Reach 6) and Little Beaver Creek. Stream habitat and fish sampling maps (1:10 000) (Appendix A), detailed site information (Appendix B), fish sampling details (Appendix C), photo documentation (Appendix D) and spatial information (Appendix E) from field surveys are provided in Appendices.

5.1.1 Reach 2

Location (river kilometer): 4.6km – 6.6km

Reach Break: 9U 446874 5990599, 9U 448251 5991762

Reach 2 starts 4.6km upstream from the Ecstall River (Appendix A: Figure 1) in the non-tidal section of Hayward Creek and has an average channel width of 20m (Appendix B: Table 1 and Table 2). This reach is a low gradient (1%) stream section containing abundant rearing habitat characterized by abundant in-stream cover (cobbles, boulders, LWD and instream vegetation). Off-channel habitat created by beavers provides abundant overwintering habitat for salmonids. There were few pools identified but available pools were large (ex. 45m long) and deep (1m-2.5m) and contained some functional LWD creating scour pools and providing good habitat for rearing and holding of salmonids. In total 1194 m² of spawning gravels was estimated for Reach 2, comprised of 844 m² of gravels potentially suitable for large-bodied salmonids and 350 m² suitable for small-bodied salmonids only (Table 3). Potential spawning gravels contained 10 – 30% fine sediment composition with low to medium compaction (Appendix B: Table 3). Channel morphology is riffle-pool with cobble (dominant) and fine (sub-dominant) bed material, alternating sections of long cobble riffles followed by riffle, run, pool complexes (RPC-w) with boulders (Appendix D: Photo 1 -7).

A series of bedrock cascades, the longest of which is 2m long is located at 5.2km and are passable, while a 4m vertical falls located 100m upstream may be passable for certain species (Coho and Chinook Salmon) in higher water on river right due to a narrow lower gradient section (Appendix D: Photo 9 -14). A side-channel starting at 5km on river left also provides fish passage at certain flows around the 4m falls by way of a cascade at the upstream end (16m long, 3m high), with resting pools in several locations along the cascade.

Several impacts from logging were noticed in this reach. A small bank failure was identified at 5.3km, in close proximity below the 4m falls (Figure 2). This bank failure is located where the river has steep banks and has been logged above (with a riparian buffer) on a steep slope suggesting it may be logging related. There were no signs of undercutting as it has been

stabilized by large woody debris and shrubs, however, this bank failure may provide some additional fine sediment deposition downstream. There was some evidence of blowdown, with large woody debris elevated across the river (non-functional) and one large log jam across a portion present from 5.6km – 6.6km (9 U 447538 5991230, (Appendix D: Photo 15)). A large cut block is located on the north slope of the river with a riparian buffer present at this location. Stream banks in Reach 2 were mainly undercut in shape and were heavily composed of fine sediments. Steep vertical banks were present for 200m adjacent to bedrock cascades and waterfall present at 5.4km. Banks in this reach remain stable with no evidence of eroding banks (aside from the bank failure at 5.3km).

Table 2. Summary of spawning gravel documented in Hayward Creek in Reach 2 to Reach 6 during foot surveys. Spawning gravel for anadromous large-bodied salmon (A) was categorized as gravel of 16 – 128mm, at least 2 m² in area, while gravel suitable for small-bodied resident salmonids (R) was categorized as gravel of 8 – 64mm at least 1m² in area. Gravel patches were categorized as suitable for both anadromous salmon and resident trout and char (AR) when both conditions were met (gravel size 16 – 64mm and at least 2.0m²). Suitable spawning gravel defined as ≤ 30% fine sediment based on decreased egg survival rates with higher amounts of fine sediment (Johnston & Slaney 1996; Kondolf et al. 2008).

Reach #	All spawning gravel (m2)				High quality spawning gravel (≤30% fines)			
	A	A, R	R	Total (m ²)	A	A, R	R	Total (m ²)
2	304	585	350	1239	259	585	350	1194
3	0	0	0	0	0	0	0	0
4	0	0	20	20	0	0	0	0
5	0	936.5	0	936.5	0	725		725
6	0	200	26	226	0	200	5	205
Total	304	1721	396	2421	259	1510	355	2124



Figure 2. Bank failure identified at 5.3km below logging on a steep slope on the north side of Hayward Creek.

5.1.2 Reach 3

Location (river kilometer): 6.6km – 7.6km

Reach Break: 9U 449162 5991646

Reach 3 is a deep, low gradient section that was too deep to conduct stream site measurements. The stream was noted to be approximately 15m – 18m wide, 100% glide morphology (flat water), low gradient (<1%), with densely shrubby undercut stream banks and abundant functional LWD. The bed material was comprised of fines, with some gravels present close to 7.6km. Abundant rearing and overwintering habitat was available with no spawning habitat. Instream cover consisted of abundant LWD, cutbanks, deep pools and instream vegetation (Appendix D: Photo 20 – 21). A high abundance of Coastal Cutthroat Trout fry and parr were visually seen from the stream banks. This stream reach was also surveyed from the air and no additional impacts from logging were seen.

5.1.3 Reach 4

Location (river kilometer): 7.6km – 9.0km

Reach Break: 9U 450404 5991343

Reach 4 starts at approximately 7.6km (Appendix A: Figure 2) where the gradient starts to pick up (2-3%) and transitions to riffle, run, pool channel morphology (RPc-w) (Appendix B: Table 1 and Table 2). Stream banks were vertical and overhanging with mature coniferous forest containing old growth. Abundant LWD, occasional boulder gardens with run, riffle pool morphology. Throughout the reach is a mixture of gravel and fines (dominant) with large cobbles and boulder (subdominant). At approximately 8km, the gradient increases to 6-8% and becomes boulder-cascade morphology (SPb-w) with intermittent holding pools (ex. 3.5m long, >1m deep) for approximately 300m – 500m long (Appendix D: Photo 22 – 28). Abundant overwintering (residual pools depth up to 1.5m residual pool depth) and rearing habitat is available in this reach. We visually observed abundant juvenile Coho Salmon, along with Coastal Cutthroat Trout (adult and juvenile) and Dolly Varden.

5.1.4 Reach 5

Location (river kilometer): 9.0km – 11.7km

Reach Break: 9U 451193 5989725

The Reach 5 stream section (Appendix A: Figure 2) ranges in channel width from 15m to 33m wide and is low gradient (0.5%) with fine substrates (dominant) and gravels (subdominant) and abundant LWD (Appendix B: Table 1 and Table 2). Abundant rearing and overwintering habitat is present with some patches of suitable spawning gravels scattered throughout. Gravels in Reach 5 contained 30 – 90% fine sediment composition with low to medium compaction (Appendix B: Table 3). A total of 725 m² judged to be suitable spawning habitat ($\leq$ 30% fines) for anadromous fish was identified in Reach 5 (Table 3). Stream banks were undercut and mainly composed of fines sediments and mixed coniferous and deciduous mature forest riparian vegetation (Appendix D: Photo 29 – 36).

Two large tributaries (WSC: 400-016500-14100-64000 and 400-016500-14100-64600 (Tributary 31 and Tributary 32 in Bustard 1993) occur within this reach and represent major contributors of gravel (large and small) and cobbles to Hayward Creek. Abundant and functional LWD was documented in these tributaries which also contain rearing, spawning, and overwinter habitat for salmonids until gradients become too steep. Abundant Coho Salmon fry, and Coastal Cutthroat Trout (adult and juvenile) were visually observed rearing in these tributaries. No disturbance indicators or evidence of erosion and bank instability were noted throughout Reach 5.

5.1.5 Reach 6

Location (river kilometer): 11.7km – 15.0km

Reach Break: 9U 451746 5987397

Reach 6 starts at 11.7km and is a meandering stream section ending at the start of the wetland and lake complex (Appendix A: Figure 2 and 3). Hayward Creek in this reach is low gradient (<1% - 1%) with slow moving water velocity through deep glides (slow moving deep runs) and pool morphology (limited riffle habitat) (Appendix B: Table 1 and Table 2). Fines are the dominant bed material, with dense shrub streambank vegetation and large old growth trees along the flood plain. Stream banks are undercut and there is abundant functional large woody debris present creating pools over 1m deep. Instream cover is abundant throughout this reach and is comprised of large-woody debris, deep pools, instream and overhanging vegetation (Appendix D: Photo 37 – 46).

There is abundant rearing and overwintering habitat available for juvenile salmonids with some scattered spawning habitat due to gravels recruiting from small tributaries. Gravels in Reach 6 contained 2 – 20% fine sediment composition with low compaction (Appendix B: Table 3). In total 200m² of suitable spawning gravels for large or small bodied salmonid species were found, and 5m² of additional gravels for small-bodied resident salmonid species (Table 3). Beaver dams are present throughout the length of reach but do not restrict fish movement. A short 200m section of boulder cascade (9 U 451743 5987401) occurs prior to Lower Hayward Lake. Abundant juvenile salmonids (Coho Salmon and Coastal Cutthroat Trout), along with adult Coastal Cutthroat Trout were visually documented throughout this reach, including upstream of the boulder cascade in ponds, wetlands, and tributaries. No disturbance indicators or evidence of erosion and bank instability were noted throughout Reach 6.

The upstream extent of Reach 6 is the upper extent of access of anadromous fish in the Hayward Creek watershed (Appendix D: Photos 61 – 65). The impassable barrier is a cascade (50m long, 10m high) containing a 3m high falls. Mature coniferous forest grows on and around the large slide materials with water percolating through large boulders.

5.1.6 Little Beaver Creek

Little Beaver Creek is the southeastern outlet of Hayward Lake (Appendix A: Figure 3), which has several old beaver dams and beaver houses located at the outflow. This secondary outlet discharges significantly less water than the main outlet on the northeast side of Hayward Lake and is controlled by beaver activity. The upper section of Little Beaver Creek can be categorized as cascade-pool morphology (CPb) (Appendix B: Table 1 and Table 2), while the lower section connecting to Big Falls Lake is slow moving glide habitat typical of lower gradient flood plains. Average channel width was 5.3m wide with dominant substrate composed of boulders and fine sediment (dominant), with cobble bed material (subdominant). Stream banks were vertical and sloping, heavily eroded with young coniferous forest as riparian vegetation (Appendix D: Photo 47 – 60).

Suitable fish habitat for rearing, overwintering and spawning is present for 100m downstream from Hayward Lake. Deep wetland pools contained adult and juvenile Coastal Cutthroat Trout and Threespine Stickleback. In addition, small, scattered patches of spawning gravels were present within 100m of Hayward Lake and are likely suitable for small resident trout (Appendix D: Photo 49 and 50). Some gravel patches appear to have been cleaned of algae recently indicating the presence of redds, potentially created by resident trout in the spring (May and June). Downstream of the lake outlet, low flows and stagnant water during sampling indicate that short sections of Little Beaver Creek dewater seasonally during low flow periods. Little Beaver Creek contained poor habitat for rearing, overwintering and spawning at the low water level present during July sampling in 2021. Little Beaver Creek provides connectivity from Hayward Lake to Big Falls Reservoir; however, fish passage may be limited seasonally by naturally occurring low flows and debris jams caused by logging debris.

Disturbance indicators identified during 650m of survey include eroding banks and beaver dams (B2 and O1), while abundant small and large woody debris from windfall are causing debris jams (Appendix D: Photo 52- 59). Although a small riparian buffer may have been left during clearcutting (Triton Environmental Consultants 1998), evidence of this riparian buffer is absent, with long sections completely logged to the banks and significant blowdown elevated across the channel. Due to the seasonal nature of Little Beaver Creek, stream bank erosion appears to be primarily caused by windfall. During sampling there was no flowing water with fine sediment, debris and orange algae covering bed material. Little Beaver Creek fish habitat has been impacted by logging and debris (non-functional small and large woody debris) were clogging the channel.

5.2 Fish Species Distribution

Juvenile Coho Salmon and Coastal Cutthroat Trout (juvenile and adult) were the most abundant fish species captured in Hayward Creek (Appendix c: Table 1). In total, 71 juvenile Coho Salmon were captured by electrofishing, angling and minnow trapping and ranged in size from 30mm - 115mm (fry and parr) (Figure 3). We caught 34 Coastal Cutthroat Trout in Hayward Creek ranging in size from 35 mm – 260 mm (Figure 3). Dolly Varden were caught in lower abundance (4 fish) and ranged in size from 96mm to 223mm. These three fish species were distributed across the entire Hayward Creek mainstem (Reach 2 to Reach 6) and were present upstream from the tidal influence to the upper barrier at the outlet of Hayward Lake (Figure 2). We also captured three Rainbow Trout parr (potentially Steelhead Trout) and four Chinook Salmon parr in the lower reaches of Hayward Creek (Reach 2 and 3) by electrofishing and angling. Individuals from both species were captured above and below the potential barrier complex (4m falls with passable side channel cascade) at 5.4km indicating fish passage is possible for these species. Additionally, one adult Chinook Salmon carcass was identified below the falls at 5.4km (Appendix D: Photo 10).

Non-salmonid species captured in Hayward Creek were Threespine Stickleback, Prickly Sculpin and Pacific Lamprey (Appendix B: Table 4). Prickly Sculpin were found at 4.5km and 5km and

are restricted in distribution to the lower river below the 4m waterfall. Pacific Lamprey were found in the upper reaches of the watershed and were associated with sandy substrate in Reach 5. Although only 4 Pacific Lamprey were captured and measured, they were present in higher abundances but were ineffectively sampled with the electro-fisher or angling. Threespine Stickleback were not present in high abundances throughout Hayward Creek but were captured in Reach 3 and 5.

Dolly Varden (adults), Cutthroat Trout (adults) and Threespine Stickleback were captured in Hayward Lake. In total, 39 cutthroat trout were captured by the floating (9 CT) and sinking (30 CT) gillnets, while 7 were captured by angling. Coastal Cutthroat Trout in Hayward Lake ranged in size from 119mm to 331mm, while Dolly Varden were 113 – 223mm in size.

Nine Coastal Cutthroat Trout (juvenile and adults) were also captured by angling and minnow trapping in Little Beaver Creek downstream of the southeastern lake outlet of Hayward Lake below a series of beaver dams. We also captured 7 Threespine Stickleback by minnow trapping at this location. No fish were visually seen downstream of the lake outlet where habitat was poor due to low flows and logging debris.

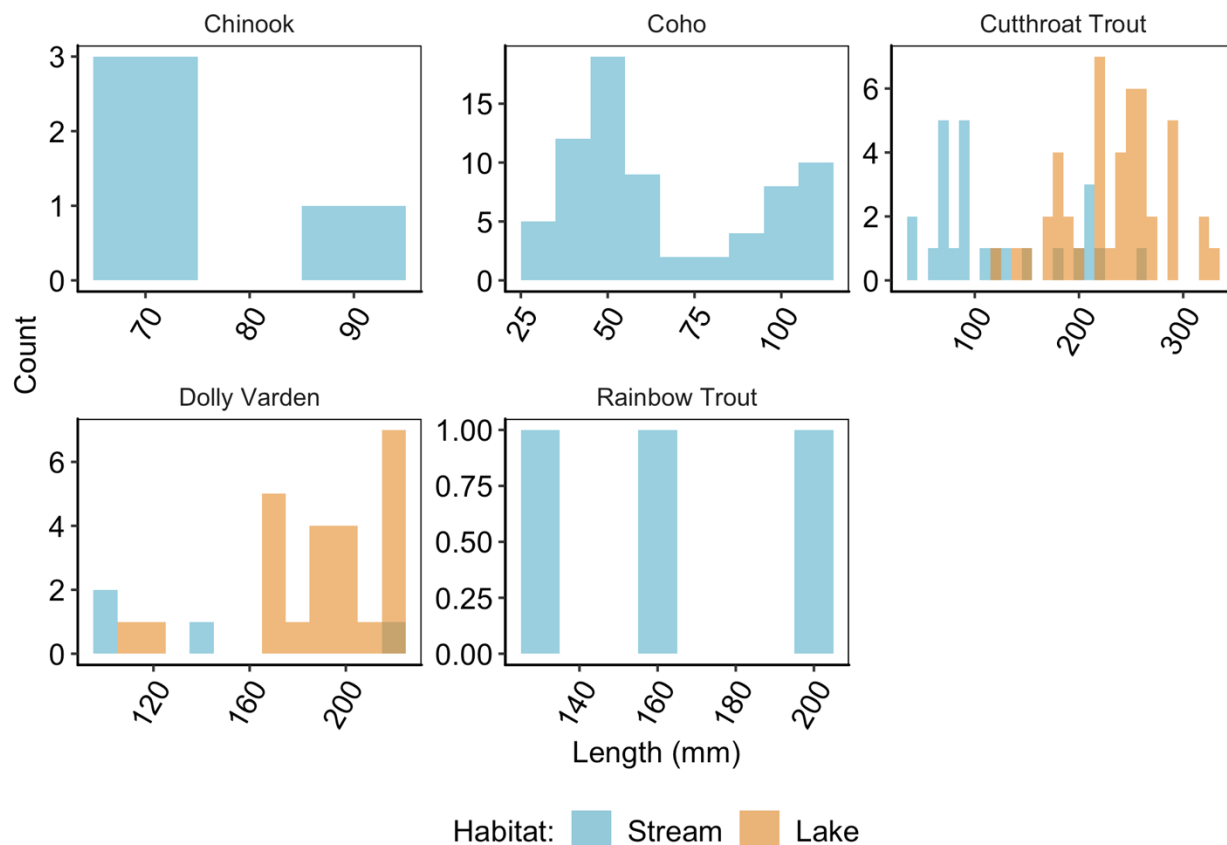


Figure 3. Fork length size distributions for salmonid species captured in Hayward Creek and Hayward Lake during July 2021 sampling by electrofishing, angling, minnow trapping and gillnetting (lake habitat only).

6. Discussion

We assessed fish habitat, fish distribution, habitat connectivity and documented potential impacts from historic logging activity in the Hayward Creek watershed. Our findings suggest that Hayward Creek has relatively intact high value fish habitat and supports abundant populations of Coastal Cutthroat Trout and juvenile Coho Salmon. Through instream and aerial surveys, this study provides updated fisheries knowledge on the Hayward Creek watershed and connectivity to Falls River Hydroelectric Project.

Fish Passage Assessment

Barrier assessment has identified two features on Hayward Creek that influence fish distribution throughout the watershed. First, a falls complex in lower Hayward Creek (Appendix D: Photos 11-14) limits the distribution of some fish species (e.g., Pink Salmon (DFO 1991; Bustard 1993)). Juvenile Coho Salmon, Chinook Salmon and Rainbow Trout (potentially anadromous Steelhead Trout) were found above this barrier indicating that the falls complex at this location (5.4km upstream) is passable for these fish species. The vertical height of the falls (4 m) is higher than the maximum jump height of adult resident salmonids (e.g. 1.5m for Coastal Cutthroat Trout) and anadromous salmon species (e.g. 2.4 m for Coho and Chinook Salmon, 1.5m for Pink Salmon) known to be present in Hayward Creek (Dane 1978; Bjornn & Reiser 1991; Levy & Slaney 1993). The passability of this barrier also depends on the depth of the plunge pool at the foot of the falls, which was too deep to measure during this survey (>1.5m deep). This falls was previously determined to be passable for certain species at high flow conditions (DFO 1991), likely due to the characteristics of the falls at river right with a less vertical drop containing small ledges. We also identified a side-channel starting at 5km that provides passage around the waterfall for certain species, with a chute measured to be 16m long by 3m high, with ledges and steps available throughout.

It is unclear if the falls complex in lower Hayward Creek has always been passable for anadromous salmon species. Early historical documents does not identify the current side-channel habitat that provides passage around the main falls and discusses the feasibility of engineering a side-channel to circumvent the falls (Hancock et al. 1983). In addition, there is reference that this falls had been blasted in the past to improve fish access (Jyrkkanen Environmental Consulting 1996, 1997). However, there is no mention of blasting activities in fisheries documentation of the watershed (DFO 1991).

The impassable barrier at the outlet of Hayward Lake was confirmed to be the upstream limit of fish passage for anadromous salmon in the watershed (Appendix D: Photos 61 – 65). The barrier is a cascade (50m long, 10m high) containing a 3m high falls. Mature coniferous forest grows on and around the large slide materials making it difficult to discern from satellite imagery or with aerial footage. It is important to note that two lake surveys (including Norris & Gran 1985) involving both gillnetting and minnow trapping have not identified any Coho Salmon juveniles in Hayward Lake. This barrier prevents the movement of anadromous salmon into the Big Falls

Watershed through the Hayward Creek (via Little Beaver Creek). However, there remains passage for resident Coastal Cutthroat Trout and Dolly Varden between the two watersheds from Hayward Lake to Big Falls Lake.

Fish Habitat Values

The Hayward Creek Watershed contains high value spawning and rearing habitat (including overwintering) for salmonid species. The majority of potential salmon spawning habitat was found in Reach 2 and Reach 5, although it contained a high composition of fine sediments (10 – 30%). Juvenile Coho Salmon (fry and parr) were abundant throughout the entire system, while small numbers of juvenile Chinook Salmon (parr) were found in low abundances both above and below the waterfall complex at 5.4km (Reach 2). This suggests that both salmon species are spawning and rearing above the falls. Juvenile Pink Salmon emerge from spawning gravels and out-migrate to the Skeena River estuary in early-spring (likely during March and April (Gottesfeld & Rabnett 2008; Sharpe et al. 2021)), thus were not captured in this study. However, it is likely that the falls complex in Reach 2 is a barrier to Pink Salmon, and Pink Salmon spawning is probably restricted to this lower section (DFO 1991).

We found high abundances of juvenile Coho Salmon, along with adult and juvenile Cutthroat Trout rearing throughout all reaches of Hayward Creek mainstem and several tributaries. Abundant instream cover (deep pools, undercut banks, large-woody debris and small-woody debris, boulders) and stable stream banks were documented. Fish populations were sampled to document size range and confirm species presence by angling, electrofishing, and minnow trapping. It should be noted that capture efficiency by electrofishing was low due to low water conductivity, which further decreased upstream closer to Hayward Lake. We caught and visually observed abundant groups of fish feeding and holding in healthy condition throughout Hayward Creek. Previous studies support the distribution of fish and high abundance of juvenile salmonids captured throughout the Hayward system due to unrestricted access and high quality rearing habitat (Bustard 1993; Triton Environmental Consultants 1998). Although fish density was not calculated in this study, the quality of rearing habitat appears to support high densities of juvenile Coho Salmon and Coastal Cutthroat Trout throughout Hayward Creek.

In this study, area estimates for suitable spawning gravels were subjective based on experienced observer judgements of suitable spawning habitat. Using a visual estimate of surface fine sediment composition to determine spawning gravel suitability, which is influenced by other factors including water depth, velocity, and water quality (temperature and dissolved oxygen) (Kondolf et al. 2008), is an oversimplification. However, it provides some context to the spawning gravel suitability in Hayward Creek. In lower Hayward Creek we estimated approximately 250 m² ($\leq 10\%$ fine sediments) to 800 m² ($\leq 30\%$ fine sediments) of potentially suitable spawning gravels accessible for Pink Salmon (Table 3 and Appendix B: Table 3). Assuming an area per redd required for pair of Pink Salmon is 0.5-1m² (Bjornn & Reiser 1991; Johnston & Slaney 1996), the lower section of Hayward Creek could support between 500 to 1600 adult spawners. This estimated number of spawners is similar to average historic escapement values of Pink Salmon for the watershed of 1339 spawners (1991 – 1960, Table 2)).

Similarly, approximately 350 m² ($\leq 10\%$ fine sediments) to 1800 m² ($\leq 30\%$ fine sediments) of accessible spawning gravels are available throughout the watershed for Coho Salmon above and below the falls (Table 3 and Appendix B: Table 3). Therefore, spawning gravels may support an estimated 250 to 1200 adult Coho Salmon spawners with an estimated area per redd of 3m² (Bjornn & Reiser 1991; Johnston & Slaney 1996). This value is far higher than an average escapement value of 113 spawner (1961 – 1970, Table 2)). Based on these exploratory estimates, it is likely that Coho and Pink Salmon using Hayward Creek are not limited by the extent of available spawning habitat. It is recommended that fall surveys counting adult salmon be conducted to determine abundance and document utilized spawning habitat in Hayward Creek. It should also be noted that historic spawner escapements are rough abundance estimates from 50 to 70 years ago, and likely only represent Coho Salmon counts within the lower section of Hayward Creek (Hancock et al. 1983). Given that we found high abundances of Coho Salmon fry and parr in the upper reaches, an observation also documented in Bustard (1993), Coho Salmon are spawning throughout the entire extent of Hayward Creek.

This study assessed available habitat throughout the mainstem of Hayward Creek and two major tributaries throughout the watershed. Two larger tributaries were identified in this study and in a previous assessment (Bustard 1993) as main contributors of coarse cobbles and gravel substrate to the mainstem. However, no habitat assessment was completed within most of the smaller tributaries. Historic assessment documented that stream habitat in tributaries was relative short, with suitable sections available for 100m to 300m upstream (Bustard 1993). Lower ends of tributaries may provide important spawning areas for Coho Salmon, Cutthroat Trout and Dolly Varden as they may contain gravel patches with lower percentages of fine sediment (higher energy systems).

Since there has been no adult spawning escapement estimates on Hayward Creek since 1991 (DFO 2021), the abundance status or trend of salmon populations in the Hayward Creek watershed is unknown. During a recent visit to Hayward Creek in mid-September, the reported peak spawning time period for Pink Salmon (DFO 2021), only a single adult Pink Salmon was recorded (Jordan & Addison 2018). Chinook Salmon and Steelhead Trout have also been reported to be utilizing the watershed (Jyrkkanen Environmental Consulting 1997; FLNRORD 2005), however, there have been no escapement estimates. We identified juvenile Rainbow Trout above and below the falls, which may indicate the presence of anadromous Steelhead Trout. We also found one adult Chinook Salmon carcass in lower Hayward Creek and a low abundance of Chinook Salmon parr (above and below the falls), confirming that Chinook Salmon utilize Hayward Creek. While a proportion of Chinook salmon in the Ecstall River drainage are reported to be ocean-type (Gottesfeld 2011), leaving freshwater as fry and rearing within the coastal environment, the Chinook Salmon parr captured in this study (72mm – 93mm fork length) were stream-type Chinook – utilizing freshwater habitat for rearing and overwintering. Chinook Salmon are known to strongly associate with higher gradient stream systems with loose cobbles with a lower percentage of sand (Gottesfeld 2011). The habitat characteristics of Hayward Creek, such as low gradient with higher composition of fine sediment substrates, suggests that it is more suitable to support higher abundances of other salmon species, such as Coho Salmon. Given that Hayward Creek was historically known to

support a relatively large population of Pink Salmon, it is recommended that additional surveys are conducted in the spring (fry capture) or fall (redd counts and/or adult counts) to understand the extent that Pink Salmon are currently utilizing Hayward Creek.

Coastal Cutthroat Trout and Dolly Varden were captured throughout Hayward Creek and Hayward Lake. We caught a similar catch composition but higher abundance of adult Dolly Varden and Coastal Cutthroat Trout during overnight gillnet sets in Hayward Lake compared to a previous study (Norris & Grant 1985). We also captured juvenile and adult Coastal Cutthroat Trout and Dolly Varden throughout the entire extent of Hayward Creek below the barrier at Hayward Lake. Cutthroat Trout and Dolly Varden populations in the Skeena Watershed are known to have both anadromous and stream resident life-histories (non-migratory) (Hagen et al. 2017). The maximum recorded size downstream of the barrier at Hayward Lake was 260 mm for Coastal Cutthroat Trout and 223mm for Dolly Varden, suggesting that these individuals may have either been stream-resident or anadromous (McPhail 2007). However, several life history patterns may be present within a single population (Slaney & Roberts 2005; Bond & Quinn 2013), and anadromous individuals are often present in coastal watersheds (Slaney & Roberts 2005; Griswold 2006). In general, knowledge on trout and char populations in the Skeena, including the Skeena Coastal Region is limited (Hagen et al. 2017, Kris Maier, pers comm. 2021). Due to land development pressures Coastal Cutthroat Trout are classified as Blue-listed (special concern) by the Province of BC Conservation Data Center, while the Skeena Coastal population unit for Dolly Varden and Coastal Cutthroat Trout is designated as Potential Risk (due to limited and/or declining numbers, range and/or habitat (Hagen et al. 2017)). Otoliths micro-chemistry from trout and char in Hayward Creek, from juveniles or adults, would be useful to advance our understanding of life-history strategies (anadromy and stream-resident) in the Skeena Coastal Region. Further investigation to understand life-history strategies, life history timing for anadromy, population abundance and distribution throughout this region are required.

Logging Impacts

Despite historic logging in the Hayward Creek watershed, minimal disturbance from logging was documented during this project on the mainstem river channel. Several impacts were documented in lower Hayward Creek (Reach 2) including a bank failure, evidence of blowdown (non-functional woody debris elevated across the stream bed) and a log jam. These disturbances were in proximity to large cut blocks logged after 1992 in this river section (BC Gov Air Photo 1992a). For example, the bank failure is located where the river has vertical banks but has been heavily logged above on the steep hillslope, suggesting it is likely logging or logging-road related (Figure 4). Additional impacts of logging have been identified historically in some fisheries studies of the Hayward Creek Watershed (DFO 1991; Jyrkkanen Environmental Consulting 1997; Jordan & Addison 2018). These impacts include sedimentation in lower Hayward Creek (DFO 1991; Jyrkkanen Environmental Consulting 1997; Jordan & Addison 2018) and channel degradation in Reach 4 (Jyrkkanen Environmental Consulting 1997). The following section discusses these potential impacts with the evidence collected in this study and past habitat assessments.

Increased fine sediment deposition due to logging in lower Hayward Creek (Reach 2) was described by DFO staff in 1971 (Hancock et al. 1983). This increase in sedimentation has been associated with logging disturbance leading to infilling pool habitat and degrading spawning gravels. However, the upstream extent of logging prior to 1986 was 4.5km from the Ecstall River confluence (Figure 4), which is the tidal boundary of the Hayward Creek mainstem (BC Gov Air Photo 1986). Thus, any additional sediment impacts described in 1971 would have occurred downstream of critical spawning locations, within the intertidal section (heavily influenced by fine tidal sediment regimes naturally). Starting in 1988, construction of roads and logging in the upper watershed began, resulting in logging throughout the entire extent of the Hayward Creek watershed (BC Gov Air Photo 1988). Fisheries surveys in the 1990s identified that fine sediment within Reach 2 may be logging related (Jyrkkanen Environmental Consulting 1997) or naturally occurring (Bustard 1993; Triton Environmental Consultants 1998). Results of our habitat assessment indicate that fine sediment is the dominant bed material and bank texture (above and below the bank failure at 5.3km, Figure 4), with sediment fingers and sandy bed material documented through all stream reaches downstream from the outlet of Hayward Lake. Previously discussed in Bustard (1993) and Triton Environmental Consultants (1998), the presence of fine sediment deposition throughout Hayward Creek, including Reach 2, is naturally occurring (Bustard 1993; Triton Environmental Consultants 1998). Additionally, a debris flow was identified at river kilometer 6.2km in 1993 prior to logging in the region (Figure 4), indicating that some channel instability is naturally present within the watershed (Bustard 1993). Overall, stream banks throughout Hayward Creek were undercut in shape and remain stable with no evidence of eroding. Stream banks in impacted stream channels are often characterised by bank erosion with an absence of undercuts banks (aggrading stream channel) or banks sloping and/or overhanging (degrading stream channel) (MOF 1996).

Although historic logging may have caused sedimentation events in the past (Hancock et al. 1983), there is no evidence to support major logging-related sediment sources currently impacting Hayward Creek. Because the watershed is naturally sandy, it is difficult to detect whether spawning gravels in lower Hayward Creek have been degraded by increased fine sediments in this survey, conducted 20 to 30 years after logging disturbance without a historic baseline. Disturbances may have contributed sands historically leading to higher sand composition in spawning gravels utilized by Pink Salmon. Similarly, natural instability of steep coastal systems makes it challenging to determine the cause and impact of the active bank failure located at 5.3km (Figure 4), located directly upstream of Pink Salmon spawning gravels. Approximately 10m long, the bank failure is small and is contributing large woody debris to the stream, adding stream habitat complexity at the slide location and downstream sections (Figure 4). Restoration actions to stabilize the slope at this location, such as installing modified brush layers (wattle fences) may be possible to reduce bank instability (Polster 2002). However, given the relatively small size of the debris slide, remote location of the watershed, and complexities with restoration techniques (Slaney & Zaldokas 1997), future restoration actions at this site are not recommended. It is however, recommended that lower Hayward Creek be surveyed to determine the abundance and extent of Pink Salmon spawning within Hayward Creek. This action is the recommended next step to understanding the Hayward Creek watershed and the

suitability of spawning habitat in lower Hayward Creek that may have been impacted by fine sediment accumulation over time.

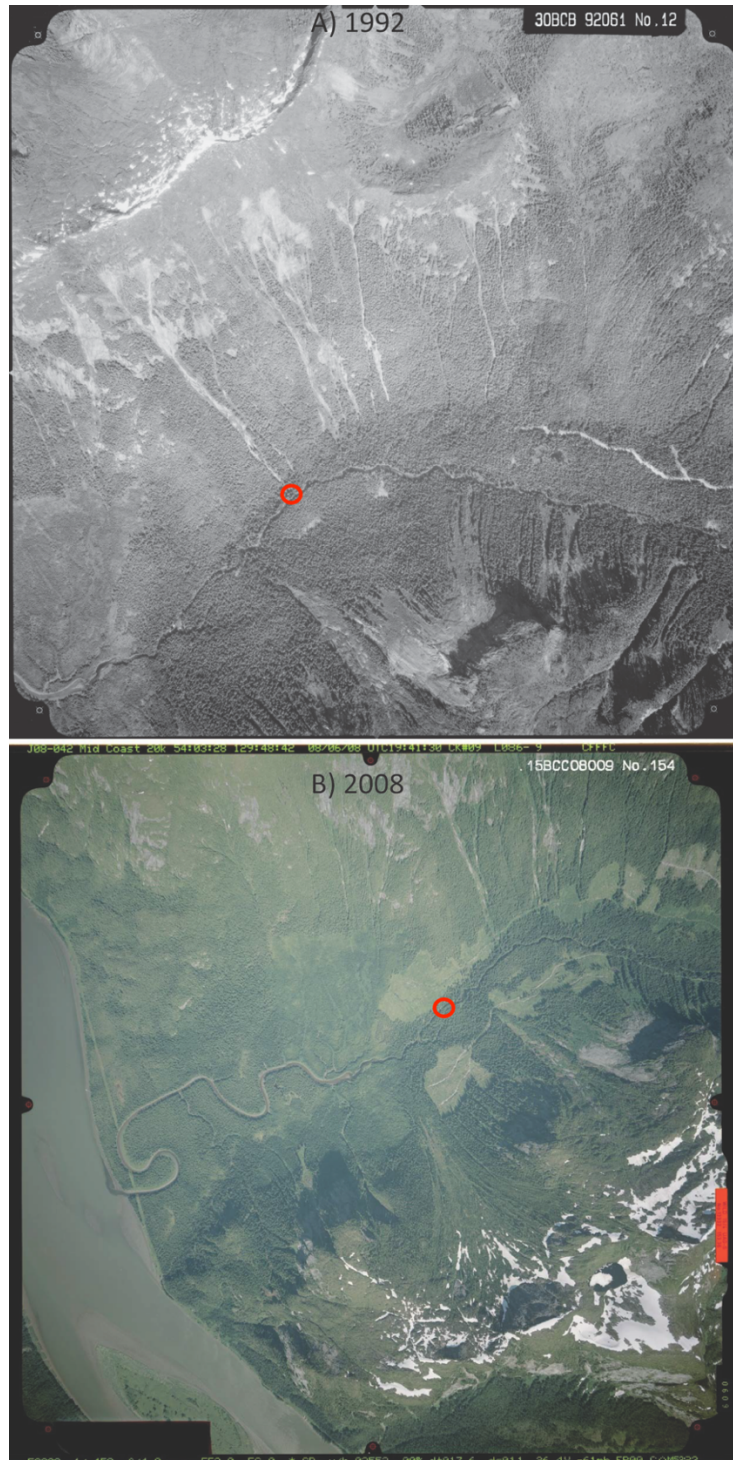


Figure 4. Air photos of lower Hayward Creek taken in A) 1992 (BC Gov Air Photo 1992a) prior to logging in Reach 2 and in B) 2008 (BC Gov Air Photo 2008), after logging of the entire watershed. Red circles denote approximate locations of bank failures and debris torrents identified in A) 1993 and B) current study.

The higher gradient stream section of upper Hayward Creek (Reach 4) was described as degrading by Jyrkkanen Environmental Consulting (1997). Habitat surveys and aerial footage indicate that there is no evidence of a degrading channel in this reach. Potential evidence for degradation to Reach 4 step-pool stream morphology may include 1) less continuous boulder lines or lines oriented more parallel to the banks, 2) step pool structure absent or 3) boulders with no moss covering (MOF 1996). However, we found perpendicular boulder line formations that can be seen from the air, significant step-pool structure present and abundant moss and in-stream vegetation on boulders throughout the upper section of the reach. In addition, habitat features in the lower section of Reach 4 (RPC-w morphology) also support this conclusion. We found abundant functional large woody debris, deep pools available (>0.5m deep), mainly diagonal bars, no bank erosion and a wide range of sediment size from cobble, gravel, fines and boulders (MOF 1996).

Logging has impacted stream habitat on Little Beaver Creek from the outlet of Hayward Lake downstream Big Falls Lake. Air photos indicate that extensive clear cut logging occurred downstream of Hayward Lake to Big Falls Lake from 1988 to 1992 (BC Gov Air Photo 1988, 1992b). Although a small riparian buffer was originally left, the majority of trees were blown-over by 1996 (BC Gov Air Photo 1996). Evidence of a riparian buffer was completely absent during our survey, and it appears that large old-growth stumps were logged within 10m of the stream bank. Fish passage from Hayward Lake and Big Falls is potentially impacted by debris (large-woody and small-woody debris) present in the streambed. Logging and blow down have also caused significant stream bank erosion and fine sediment has filled interstitial spaces between cobble and boulder bed material. Lastly, the wooden bridge crossing in upper Beaver Creek is collapsing, with half the bridge already blocking the stream channel. This structure will limit fish passage downstream of Hayward Lake when it collapses. Little Beaver Creek provides connectivity from Hayward Lake to Big Falls Lake for resident Cutthroat Trout and Dolly Varden populations. However, Little Beaver Creek only provides fish habitat in high water periods, with little to no habitat available during low water summer flows. Thus, restoration actions to improve connectivity in Little Beaver Creek are likely of low priority.

Overall, we identified impacts from logging in Little Beaver Creek and some disturbances in Reach 2 of the Hayward Creek mainstem. However, these impacts were minimal considering the extent of historic logging throughout the watershed. Forestry practices implemented during logging may have buffered larger impacts to the Hayward Creek watershed. For example, riparian protection is reported to have occurred starting in 1981 (Jyrkkanen Environmental Consulting 1997), with a detailed fisheries assessments occurring in 1993 to provide suitable recommendations for buffers around all fish bearing streams and larger tributaries above fish-bearing reaches (Bustard 1993). It was subsequently determined (in consultation with MOE) that riparian buffers were effective in protecting Hayward Creek from substantial impacts due to logging (Triton Environmental Consultants 1998). In addition, no landslides, major debris torrents or erosion of roads was documented in this study or in 1990s fisheries assessments during logging and road building activities (Bustard 1993; Jyrkkanen Environmental Consulting 1996, 1997; Triton Environmental Consultants 1998). Although we did not document any major impacts from logging the Hayward Creek watershed, extensive logging is known to influence

the hydrological-geomorphological processes of a watershed. These processes include increased water yield during certain times of year, altering natural hydrological pathways (loss of interception by tree canopies) soil compaction and overall slope stability (Hartman et al. 1996). Impacts are often complex and interconnected, lasting a few years to centuries and can be difficult to identify without baseline information (Hartman & Scrivener 1990; Hartman et al. 1996). Due to the widespread extent of logging throughout the Hayward Creek watershed, there may have been impacts to hydrology, sediment, and trophic level processes throughout the watershed. However, without historical baseline information on habitat and stream morphology, the results of this study indicate that the Hayward Creek watershed contains high value fish habitat with only minor disturbances evident. A high composition of fine sediment present in spawning gravels within lower Hayward Creek may be caused by historic sediment inputs related to historic logging activities or be naturally occurring. Available rearing and spawning habitat continues to support high abundances of juvenile Coho salmon and Coastal Cutthroat Trout. Future restoration efforts in the Lower Skeena should be focused on Ecstall River tributaries with greater documented impacts, such as Scotia Creek (Jyrkkanen Environmental Consulting 1997).

7. Recommendations

Our study addresses two knowledge gaps identified in the FWCP Falls River Action Plan: 1) assessing fish habitat throughout the Hayward Creek watershed and 2) assessing connectivity for anadromous fish from Hayward Creek into the Big Falls Reservoir.

The results of this study suggest the Hayward Creek watershed contains high value fish habitat that supports Coastal Cutthroat Trout and juvenile Coho Salmon in high abundances. We identified high quality rearing habitat throughout the Hayward Creek mainstem downstream from Hayward Lake to the tidal extent in the lower river. We also documented adequate spawning habitat to support estimated historic escapements of Coho and Pink Salmon. Only minor disturbances were identified throughout the Hayward Creek mainstem, with no major impacts from logging activities identified.

We also assessed connectivity throughout the watershed and identified a) a falls complex passable for Coho and Chinook Salmon but probably not Pink Salmon, and b) an impassable barrier at the outlet of Hayward Lake, which is the upstream limit for anadromous salmon passage in the watershed. The cascade/falls complex was created from a large natural slide and confirms that anadromous salmon cannot move into the Falls River Reservoir through Hayward Creek from the Ecstall River. Hayward Lake supports resident populations of Coastal Cutthroat Trout and Dolly Varden, which is connected to the Falls River reservoir by Little Beaver Creek during periods of higher water. Fish habitat available in Little Beaver Creek is impacted by historic logging activities, with no evidence of riparian buffers remaining. Passage is likely restricted throughout Little Beaver Creek by significant inputs of non-functional large and small woody debris and eroding stream banks.

In summary, the results of this study indicate that the Hayward Creek watershed contains relatively intact, high value fish habitat for anadromous and resident species of salmonids in most sections. Minor impacts from historic logging were noted, while large-scale restoration actions for the watershed have not been recommended. We recommend the following research priorities and future restoration actions:

- Anadromous salmon escapement has not been estimated in Hayward Creek since 1991 and stream counts to determine the abundance of Pink Salmon and Coho Salmon utilizing Hayward Creek are required. Pink Salmon were historically the most abundant salmon utilizing Hayward Creek, however, it is unclear if Pink Salmon continue to spawn in lower reaches. Fall surveys (redd or adult counts) are required to determine timing and abundance of anadromous salmon using Hayward Creek. This action is the recommended next step to understanding the Hayward Creek watershed and document the suitability of spawning habitat in lower Hayward Creek that may have been impacted by fine sediment accumulation over time.
- Although less informative for determining current spawner abundance and critical habitat locations, capturing Pink Salmon fry in the spring could be used to determine species presence and out-migrating timing. Additionally, conducting fish surveys in the spring may also identify ocean-type Chinook out-migrating to the Skeena River estuary.
- Coastal Cutthroat Trout and Dolly Varden char populations throughout BC are Blue listed (special concern), however, knowledge of trout and char populations in the Lower Skeena remain limited. Further investigation to understand life-history strategies, population abundance and distribution throughout this region is recommended.
- Restoring connectivity between Little Beaver Creek and Falls River Reservoir for Coastal Cutthroat Trout and Dolly Varden Populations. Restoration actions should be aimed at a) addressing non-functional large woody and small woody debris likely restricting fish passage in the creek, and b) removal of the wooden bridge downstream of Hayward Lake, which is collapsing into Little Beaver Creek. Given that Little Beaver Creek only provides fish habitat in higher water, with little to no habitat available during low water summer flows, restoration actions to improve connectivity are likely of low priority.

8. Acknowledgements

This research was financially supported by the Fish and Wildlife Compensation Program. We thank field technicians Cody Haggard, Jim Allen and Bryce O'Connor for their assistance and experience in the field. We also thank Jake Daly from Tiny Life Media for completing aerial surveys and Mac Jedrzejczyk from FINS Consulting Ltd. for fisheries mapping. We also thank Lana Miller and Peter Dekoning from the DFO Resource Restoration Unit for supporting this project and providing technical advice on restoration methods and procedures. Thank you to Julie Fournier from FWCP for coordinating and supporting this research project.

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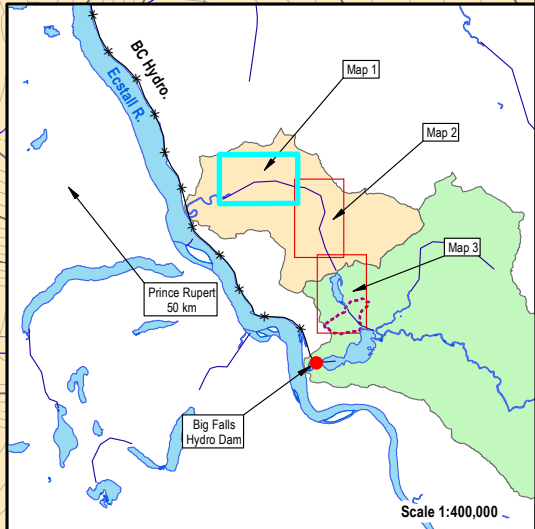
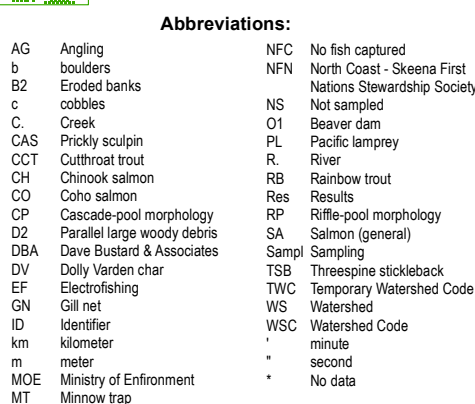
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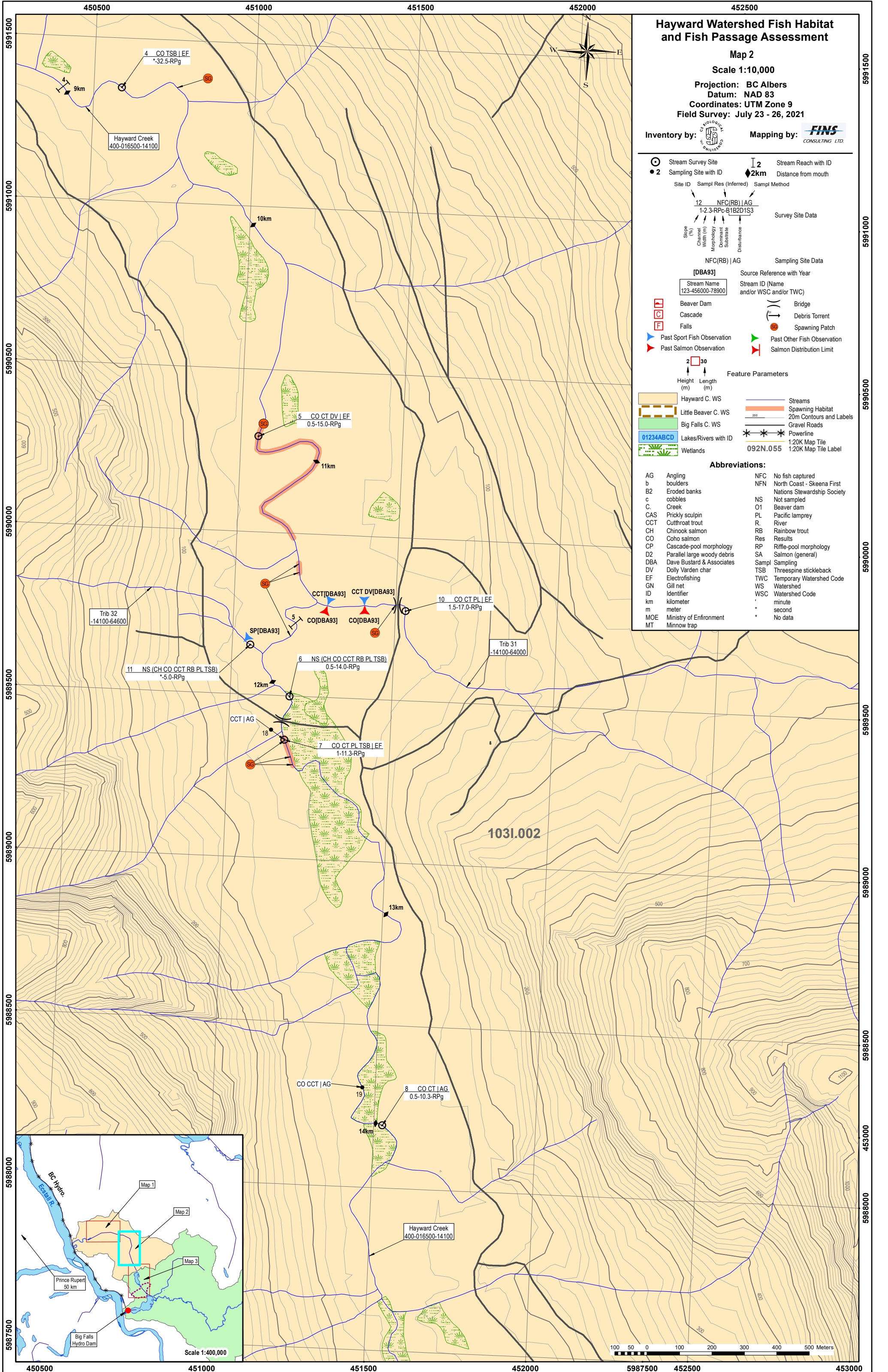
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Appendix A- Stream Habitat and Fish Sampling Maps (1:10 000)

Field Survey: July 23 - 26, 2021

FINS
CONSULTING LTD





Hayward Watershed Fish Habitat and Fish Passage Assessment

Map 2

Scale 1:10,000

Projection: BC Albers

Datum: NAD 83

Coordinates: UTM Zone 9

Field Survey: July 23 - 26, 2021

Inventory by:



Mapping by:



Legend

Stream Survey Site

- 2 Sampling Site with ID

Stream Reach with ID

- 2km Distance from mouth

Survey Site Data

Site ID: 12, 1-2, 3-RPc-B1B2D1S3

Sampling Site Data

NFC(RB) | AG

[DBA93]

Stream Name: 123-456000-78900

Source Reference with Year

Stream ID (Name and/or WSC and/or TWC)

Beaver Dam

Cascade

Falls

Past Sport Fish Observation

Past Salmon Observation

Bridge

Debris Torrent

Spawning Patch

Past Other Fish Observation

Salmon Distribution Limit

Feature Parameters

Height (m): 2, 30

Length (m): 30

Hayward C. WS

Little Beaver C. WS

Big Falls C. WS

Lakes/Rivers with ID: 01234ABCD

Wetlands

Streams

Spawning Habitat

20m Contours and Labels

Gravel Roads

Powerline

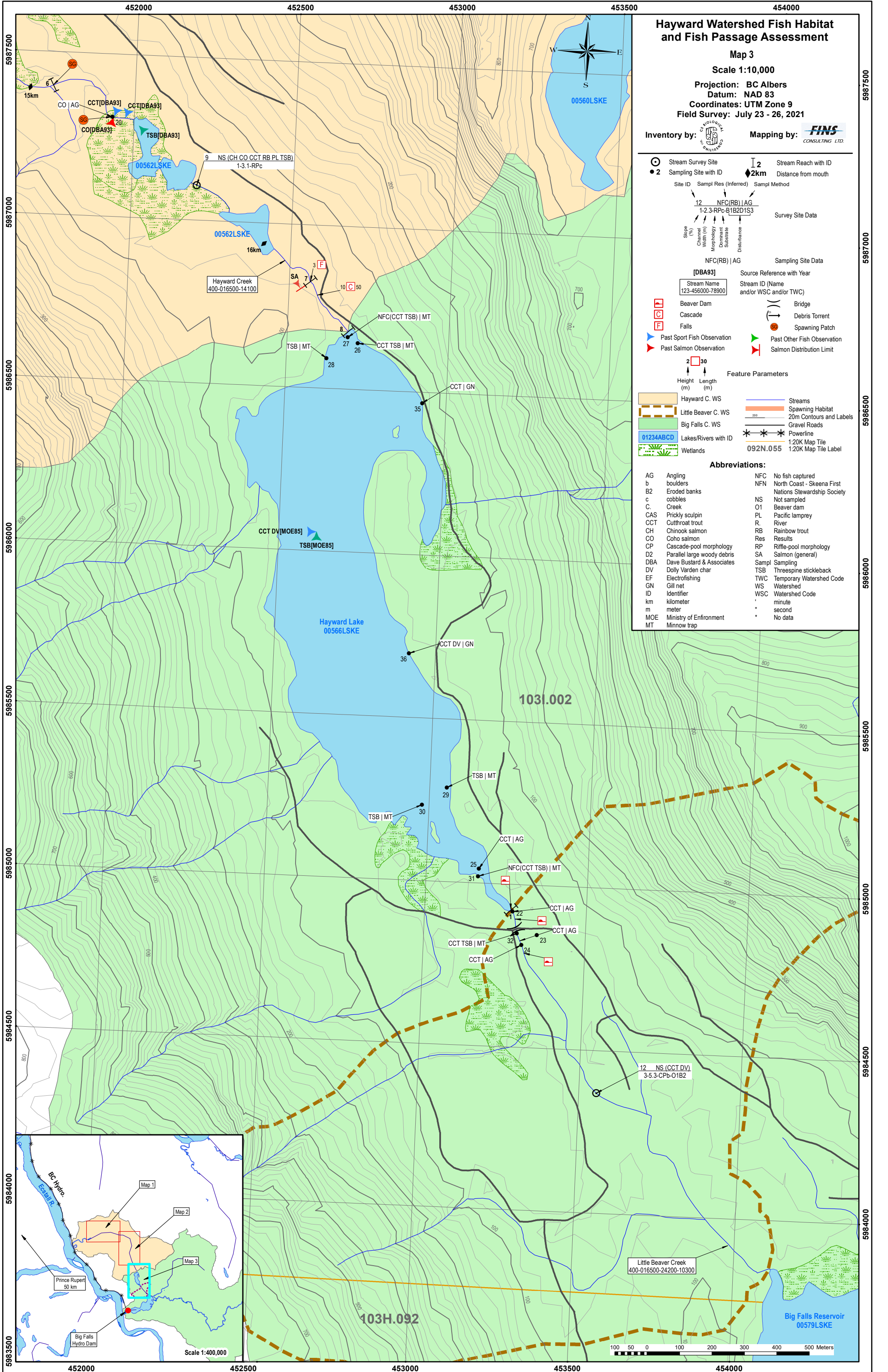
1:20K Map Tile

1:20K Map Tile Label

092N.055

Abbreviations:

AG	Angling	NFC	No fish captured
b	boulders	NFN	North Coast - Skeena First
B2	Eroded banks		Nations Stewardship Society
c	cobbles	NS	Not sampled
C.	Creek	O1	Beaver dam
CAS	Prickly sculpin	PL	Pacific lamprey
CCT	Cutthroat trout	R.	River
CH	Chinook salmon	RB	Rainbow trout
CO	Coho salmon	Res	Results
CP	Cascade-pool morphology	RP	Riffle-pool morphology
D2	Parallel large woody debris	SA	Salmon (general)
DBA	Dave Bustard & Associates	Sampl	Sampling
DV	Dolly Varden char	TSB	Threespine stickleback
EF	Electrofishing	TWC	Temporary Watershed Code
GN	Gill net	WS	Watershed
ID	Identifier	WSC	Watershed Code
km	kilometer	'	minute
m	meter	"	second
MOE	Ministry of Environment	*	No data
MT	Minnow trap		



Hayward Watershed Fish Habitat and Fish Passage Assessment

Map 3

Scale 1:10,000

Projection: BC Albers

Datum: NAD 83

Coordinates: UTM Zone 9

Field Survey: July 23 - 26, 2021

Inventory by:



Mapping by:



Legend

Stream Survey Site

- 2 Sampling Site with ID
- 2km Distance from mouth

Survey Site Data

Site ID Sampl Res (Inferred) Sampl Method

12 NFC(RB) IAG 1-2.3-RPc-B1B2D1S3

Slope (%) Channel Width (m) Morphology Dominant Substrate Distance

Sampling Site Data

NFC(RB) | AG

[DBA93]

Stream Name: 123-456000-78900

Stream ID (Name and/or WSC and/or TWC)

Beaver Dam Cascade Falls Past Sport Fish Observation Past Salmon Observation

Bridge Debris Torrent Spawning Patch Past Other Fish Observation Salmon Distribution Limit

Feature Parameters

Height (m) Length (m)

2 30

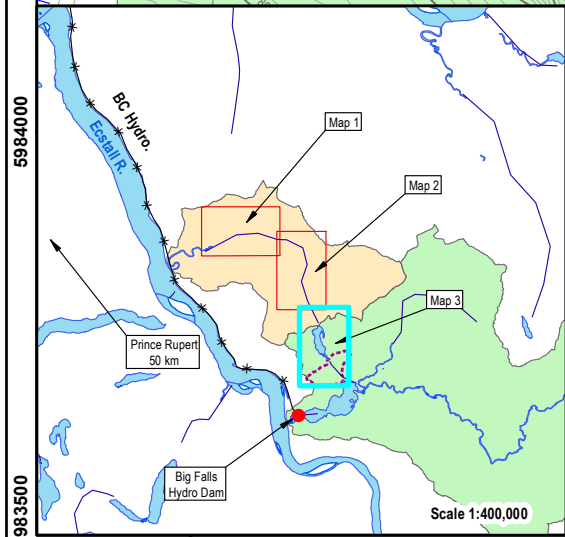
Hayward C. WS Little Beaver C. WS Big Falls C. WS Lakes/Rivers with ID Wetlands

Streams Spawning Habitat 20m Contours and Labels Gravel Roads Powerline 1:20K Map Tile 1:20K Map Tile Label

092N.055

Abbreviations:

AG	Angling	NFC	No fish captured
b	boulders	NFN	North Coast - Skeena First Nations Stewardship Society
B2	Eroded banks	NS	Not sampled
c	cobbles	O1	Beaver dam
C	Creek	PL	Pacific lamprey
CAS	Prickly sculpin	R	River
CCT	Cutthroat trout	RB	Rainbow trout
CH	Chinook salmon	Res	Results
CO	Coho salmon	RP	Riffle-pool morphology
CP	Cascade-pool morphology	SA	Salmon (general)
D2	Parallel large woody debris	Sampl	Sampling
DBA	Dave Bustard & Associates	TSB	Threespine stickleback
DV	Dolly Varden char	TWC	Temporary Watershed Code
EF	Electrofishing	WS	Watershed
GN	Gill net	WSC	Watershed Code
ID	Identifier	'	minute
km	kilometer	"	second
m	meter	*	No data
MOE	Ministry of Environment		
MT	Minnow trap		



Appendix B- Stream Habitat Assessment

Appendix B: Stream Habitat Assessment

Table 1. Detailed summary of site information, channel measurements, bed material, disturbance indicators and habitat comments for sites sampled on Hayward Creek and Little Beaver Creek (LBC) during July surveys in 2021*. Table continues onto subsequent page.

Site Information										Channel					Bed Material								
Sampling Site #	Reach	Site (km)	Easting	Northing	Site Length (m)	Date	Time	Crew	Fish Sampled (Y, N)	Fish sampling method	Avg. Channel Width (m)	Avg. Wetted Width (m)	Avg. Residual Pool Depth (m)	Gradient (%)	Avg. Bankfull Depth (m)	Stage	Dominant	Subdominant	D95 (cm)	D (cm)	Morphology	Disturbance	Comments
1	2	5	447045	5990674	200	23-Jul	12:00	CS, JA	Y	EF	19.9	18.5	0.8	1	0.7	M	C	B, F			RPC-w		Abundant rearing habitat, deep holding pools with cover (1 - 1.5m deep), functional LWD creating scour pools, instream veg thick in places (40% moss), some sand deposited along margins, clear tannic water. EF along right margin only, 40% riffle, 20% pool, 40% run, no habitat degradation, stable banks, small sediment wedges behind boulders.
2	2	6	447641	5991291	200	23-Jul	15:00	CS, JA	Y	EF, AG	20.8	18.5	0.7	1	0.7	M	C	F,B	23	15	RPC-w	D2	Abundant rearing habitat, no spawning habitat. Evidence of blow down (non-functional LWD), logged to the bank but banks appear stable, lots of boulders. Visually seen abundance CO and CT fry and parr. Long riffle sections, upstream of site at 6km becomes sand and boulder with deep pools (2.5m deep), small section of bedrock to falls (100m ds). Document 3 roughskinned newts in Hayward Creek.
3	4	8	449401	5991587	200	23-Jul	11:35	BO, CH	Y	EF	21.0	19.3	0.9	2	0.8	M	B	G	204		RPg-w		Deep Pool, riffle run bouldery habitat. Great overwintering and rearing habitat. Some good CH spawning gravel. Riffle run section, lots of large boulders and instream veg. Observed lots of juvenile salmon and adult/juvenile CT/DV.
4	5	9	450586	5991348	300	23-Jul	16:17	BO, CH	Y	EF	32.5	31.0	1.0		0.6	M	F	G			RPg-w		Good overwintering, abundant rearing habitat, marginal spawning habitat. Low gradient, sparse patches of spawning gravel, undercut banks. Abundant juvenile salmon and CT, abundant adult CT. Reach consistent throughout.
5	5	11	451054	5990294	150	24-Jul	10:40	BO, CH	Y	EF	15.0	13.0	0.7		0.7	M	F	G	84		RPg-w		Lots of small gravels, covered in aquatic vegetation. Too small at the exact site for salmon spawning. Boulders scattered throughout.
6	6	12.3	451184	5989498	150	24-Jul	15:36	BO, CH	N		14.0	14.0	1.2	0-1		M					RPg-w		At Reach 5/6 reach break fast transition after trib 32 to slow moving slough with deciduous overhanging vegetation. Beaver activity present with one full dam but no barriers to fish movement. Site card incomplete due to time constraint. This site was typical deep low gradient slough sections.
7	6	12.5	451174	5989365	150	24-Jul	11:52	CS, JA	Y	EF	11.3	11.2	1.8	1	2.1	M	F	G	5	3	RPg-w		Suitable spawning for CT and Coho, abundant rearing habitat, functional LWD creating deep pools >1m deep, some 3m deep. Site directly upstream of bridge (200m). Could not EF in deep pools (too low of conductivity). Visually saw lots of coho parr and CT adults in pools, angled in pools and caught CT 150mm. Long stretches of sand but small gravels abundant where tribs come in. Stable channel, low velocity. Instream grass and aquatic vegetation. Abundant coho fry not captured due to low conductivity. Pacific lamprey abundant (visually seen).

*Abbreviations for site card information can be found in Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Site Card Field Guide (RIC 2008).

Appendix B: Stream Habitat Assessment

Table 1 cont'd. Detailed summary of site information, channel measurements, bed material, disturbance indicators and habitat comments for sites sampled on Hayward Creek and Little Beaver Creek (LBC) during July surveys in 2021*.

Site Information										Channel					Bed Material						Comments		
Sampling Site #	Reach	Site (km)	Easting	Northing	Site Length (m)	Date	Time	Crew	Fish Sampled (Y, N)	Fish sampling method	Avg. Channel Width (m)	Avg. Wetted Width (m)	Avg. Residual Pool Depth (m)	Gradient (%)	Avg. Bankfull Depth (m)	Stage	Dominant	Subdominant	D95 (cm)	D (cm)		Morphology	Disturbance
8	6	14.3	451526	5988192	100	24-Jul	15:13	CS, JA	Y	AG	10.3	10.4	1.1	<1	1.3	M	F				RPg-w		LWD creating pools in long deep glides (difficult to sample, too deep to walk), all fines (no rocks), slow moving glides/pools (no riffle), vegetation is steep bush/sedge/ skunk cabbage. Electroshocking not effective due to low conductivity. Visually see lots of coho fry and parr but shocker not influencing. Large logs in the water from the flood plain (spruce/cedar/hemlock). Angled with fly rod for 2 minutes (coho fry and parr abundant). Fry too small to be captured by fly rod. CO and CT vert abundant (fry, parr and CT adults) across entire reach 6.
9	7	15.5	452201	5987108	30	25-Jul	17:33	BO, JA	N		3.1	3.1	0.5	1-2		M	C	G	190		RPC-w		Extremely complex boulder habitat with, wood (LWD, SWD), instream veg section between two lakes. Multiple inputs from above lake. Lakes referred to on this card are the two slough lakes below Hayward Lake
10	5	Trib 31	451531	5989776	170	24-Jul	13:28	BO, CH	Y	EF	17.0	16.0	0.5			M	G	G			RPg-w		Large and small gravels with lots of interstitial fines, not embedded. Large trees across river downstream near confluence with Hayward. Not barriers but provide cover and a break between suitable patches of spawning gravel. Site located just above bridge crossing. Upstream of site the channel split with abundant large gravels, undercut and woody debris, 100m upstream of site card gradient starts to pick up, coho fry visually seen.
11	5	Trib 32	451056	5989653	50	24-Jul	15:16	BO, CH	N		5.0	3.0	0.5		0.4	M	C	F,B		16	RPg-w		Site card located 30m upstream of Hayward Creek confluence. Walked upstream approx 100m until we found significant debris jam and high gradients. Possible barriers although not permanent (woody debris). Substrate changed from fines to cobbles and boulders. Approximately 50m upstream of confluence visually observed alot of fry.
12	LBC	1	453554	5984370	50	25-Jul	13:00	CS, JA	N		5.3	3.6	0.4	2	3.0	L	B, F	C	56		CPb	O1, B2	Beaver dam and eroding bank dist. indicators, and large woody debris and small woody debris from logging. Boulder step-pool morphology, no flow at this water level with disturbed habitat. Stream has been logged right to the creek on both sides causing significant blow down. Fine orange algae, LWD and SWD clogging creek and covering bed material, evidence of old scour in river channel (more energy historically). Eroding banks, limited fish visually seen (some fry in a pool), may dry up during low flows. Heavily impacted by logging, CT in headwaters, no riparian buffer. No D measurement, moss on everything. Rough Skinned newt found.

*Abbreviations for site card information can be found in Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Site Card Field Guide (RIC 2008).

Appendix B: Stream Habitat Assessment

Table 2. Detailed summary of water quality measurements, cover type, and stream bank information for sites sampled on Hayward Creek during July surveys in 2021*.

Location			Water Quality				Cover								LWD			Left Bank				Right Bank			
Sampling Site#	Reach	Site (km)	Temp °C	Cond (us/cm)	pH	Turbidity (T, M, L, C)	Total Cover %	SWD %	LWD %	Boulders %	Undercut Banks %	Deep Pools %	Overhang Veg %	Instream Veg %	LWD FNC (N, F, A)	Distribution (C, E)	Crown Closure	LB SHP (U, V, S, O)	TEXTURE (F, G, C, B, R, A)	RIP VEG (N, G, S, C, D, M, W)	STAGE (INIT, SHR, PS, YF, MF, NA)	RB SHP (U, V, S, O)	TEXTURE (F, G, C, B, R, A)	RIP VEG (N, G, S, C, D, M, W)	STAGE (INIT, SHR, PS, YF, MF, NA)
1	2	5	12.4	17.1	10.28	C	80	5	10	30	20	5	10	20	F	C	1	U	F,B	S	MF	V	F,B	S	MF
2	2	6	12.3			C	60	10	15	15	15	5	10	0	F		1	U	F	M	MF	S	F	M	MF
3	4	8	10.0	12.0	6.70	L		5	8	60	5	0	2	20	F	C	1	V,O	F,G	C	MF	V, O	F, G	C	MF
4	5	9	10.0	10.0	6.56	C		10	20	0	25	30	5	10	A	C	1	U	F	M	MF	U	F	M	MF
5	5	11	10.0	9.0	6.37	C		20	20		5	10	5	40	F	C	1	S	F	D	MF	U	F	M	MF
6	6	12.3				C		0	0	20			80				0	U,O	F	D	MF	U, O	F	D	MF
7	6	12.5	13.5	23.0	10.11	C	50	0	15	0	30	30	10	15	A	E	1	U	F	S	S, MF	S	F	S	S, MF
8	6	14.3	14.8	8.0	9.77	C		5	10	0	20	20	15	15				U	F	S	S, MF	S	F	S	S, MF
9	7	15.5	16.0			C		20	20	20	10	10	10	10	F		0	U	C,B	G	MF,	U	F,G	G	MF
10	5	Trib 31	9.5	6.0	6.19	C		20	20	0	0	0	20	40	F	E	1	U	F	M	MF	U	F	M	MF
11	5	Trib 32	9.0	9.0	5.87	C		20	35	0	15	15	10	5	A		1	U	F,G	M	MF	S	F, G	M	MF
12	LBC	1	12.1	21.0	7.45	T	90	30	20	30	5	0	15	0	F	E	2	V,S	F,B	C	YF	V	F,B	C	YF

*Abbreviations for site card information can be found in Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Site Card Field Guide (RIC 2008).

Appendix B: Stream Habitat Assessment

Table 3. Spawning gravel assessments conducted on Hayward Creek.

Patch #	River km (approx.)	Reach	Easting	Northing	Area (m ²)	Length (m)	width (m)	Depth (m)	Percent Fines	Species	Compaction	Notes
1	5	2	446846	5990590	250	25	10	0.4	30	A	medium	PK, CO, CH
2	5	2	446926	5990623	45	15	3	0.3		A	high	
3	5	2	447047	5990680	300	25	12	0.13	30	A,R	low	sandy gravel
4	5	2	447046	5990676	300	20	15	0.7	5	R	low	instream veg in places
5	5	2	447056	5990712	30	10	3	0.7	10	A,R	medium	nice spawning substrate
6	5	2	447084	5990751	9	3	3	0.7	10	A		3 x 1 x1 ptches (cleaned out veg in tail out)
7	5	2	447095	5990755	105	15	7	0.8	10	A,R	low	nice spawning substrate
8	5	2	447166	5990788	100	10	10	0.2	10	A,R	low	lots of potential for residents
9	5	2	447186	5990857	50	5	10	0.2	10	R	low	
10	6	2	447452	5991131	50	10	5	0.5	30	A,R	low	lots of sand
11	9	4	450122	5991434	20	10	2	0.7	90	R	low	
12	9	5	450757	5991353	600	30	20	0.5	30	A,R	high	10-20mm gravels
13	11	5	between 10.5km - 11.5km		32	8	4	0.87	60	A,R	low	abundant instream veg adjacent
14	11	5	between 10.5km - 11.5km		12	6	2	1.3	80	A,R	low	large rock causing turbulence
15	11	5	between 10.5km - 11.5km		20	10	2	1.2	90	A,R	low	strip of gravel
16	11	5	between 10.5km - 11.5km		15	6	2.5	0.8	90	A,R	medium	end of tail out
17	11	5	between 10.5km - 11.5km		8	2	4	2	70	A,R		divets below log jam
18	12	5	451196	5989906	12.5	2.5	5	0.1		A,R		
19	12	5	451198	5989880	100	5	20	0.2	40	A,R	low	
20	12	5	451179	5989683	12	4	3	0.57		A,R	medium	
21	12	5	451499	5989793	125	5	25	0.5	30	A,R	medium	
22	12	6	451174	5989363	100			0.2	20	A,R	low	comes from trib
23	12	6	451194	5989313	21	7	3					comes from trib
24	12	6	451202	5989289	3			0.3	15	R	low	comes from trib
25	15	6	451745	5987397	100	20	5	1	2	A,R	low	good quality
26	15	6	451931	5987307	2			0.5	5	R	low	looks like old CT redd

Appendix C – Fish Sampling

Appendix C: Fish Sampling

Table 1. Catch summary of fish sampling by electrofishing (EF), angling (AG), minnow traps (MT) and gill nets (GN) in Hayward Creek (HC), Little Beaver Creek (LBC) and Hayward Lake (HL). Abundance and fork length range (mean) are provided for each fish species by sampling event number.

Site#	EF	Site	km	Easting	Northing	EF second	Abundance and Fork Length - Salmonids **								Abundance and Fork Length - Non-salmonids**							
							CH	FL	CO	FL	CT	FL	DV	FL	RB	FL	CAS	FL	PL	FL	TSB	FL
1		HC	5	447045	5990674	1090	1	72-72 (72)	3	32-55 (43)	1	120-120 (120)					5	40-85 (62)				
2		HC	6	447641	5991291	685			11	40-75 (55)	1	95-95 (95)										
3		HC	8	449401	5991587	1224	1	93-93 (93)	9	48-107 (70)	7	68-91 (79)	2	98-138 (118)								
4		HC	9	450586	5991348	170			4	36-58 (45)											1	53-53 (53)
5		HC	11	451054	5990294	344			10	37-106 (54)	1	77-77 (77)	1	96-96 (96)								
7		HC	12.5	451174	5989365	1102			12	36-90 (58)	2	60-70 (65)							3	33-110 (68)	2	45-50 (48)
10		HC	Trib 31	451531	5989776	95			3	35-85 (53)	2	35-37 (36)							1	125-125 (125)		
Site#	AG		km	Easting	Northing	Time (min)	Abundance and Fork Length - Salmonids								Abundance and Fork Length - Non-salmonids							
							CH	FL	CO	FL	CT	FL	DV	FL	RB	FL	CAS	FL	PL	FL	TSB	FL
13		HC	4.5	446691	5990505	30	2	72-75 (73.5)	2	110-112 (111)	7	112-260 (187)										
14		HC	5	447041	5990661				7	30-115 (75)												
15		HC	5	447186	5990855	10									1	131-131 (131)						
16		HC	5	447339	5991073	45									1	198-198 (198)						
17		HC	6	447370	5991078										1	160-160 (160)						
18		HC	12.5	451174	5989365						1	150-150 (150)										
19		HC	14	451460	5988307				1	115-115 (115)	1	210-210 (210)										
8		HC	14.3	451526	5988192	2			3	101-110 (105)	2	92-220 (156)										
20		HC	15.3	451932	5987307	5			3	90-105 (99)			1	223-223 (223)								
21		HC	5	447388	5991074																	
22		LBC		453272	5984916						3	85-134 (106)										
23		LBC		453298	5984827						4	85-106 (98)										
24		LBC		453303	5984815						1	220-220 (220)										
25		HL		453162	5985043	41					7	119-249 (171)										
Site#	MT		km	Easting	Northing	Time (hr)	Abundance and Fork Length - Salmonids								Abundance and Fork Length - Non-salmonids							
							CH	FL	CO	FL	CT	FL	DV	FL	RB	FL	CAS	FL	PL	FL	TSB	FL
26		HL		452719	5986642	19.80															11	41-58 (47)
27		HL		452687	5986659	19.83																
28		HL		452625	5986593	19.82															34	33-56 (44)
29		HL		453053	5985289	16.53															20	31-59 (48)
30		HL		452978	5985233	16.33															1	49-49 (49)
31		HL		453161	5985021	15.35																
32		LBC		453288	5984849	2.70					1	85-85 (85)									7	32-70 (55)
33		HC	4.5	446546	5990444	7.02											1	114-114 (114)				
34		HC	4.5	446787	5990607	5.72			3	87-114 (99)												
Site#	GN		Easting	Northing	Time (hr)	Abundance and Fork Length - Salmonids								Abundance and Fork Length - Non-salmonids								
						CH	FL	CO	FL	CT	FL	DV	FL	RB	FL	CAS	FL	PL	FL	TSB	FL	
35	Floating	HL		452926	5986467	19.60					9	174-323 (258)										
36	Sinking	HL		452918	5985697	16.30					30	174-331 (245)	24	113-223 (191)								
						4	72-93 (78)	71	30-115 (66)	80	35-331 (186)	28	96-223 (184)	3	131-198 (163)	6	40-114 (71)	4	33-125 (82)	76	31-70 (47)	
						4	72-93 (78)	71	30-115 (66)	34	35-260 (119)	4	96-223 (139)	3	131-198 (163)	5	40-85 (62)	4	33-125 (82)	10	32-70 (54)	
						0		0		46	119-331 (236)	24	113-223 (191)	0		1	114-114 (114)	0		66	31-59 (46)	

* No Fish sampling occurred at sample site numbers 6, 9, 11, 12

** CH (Chinook), CO (Coho), CT (Cutthroat Trout), DV (Dolly Varden), RB (Rainbow Trout), CAS (Prickly Sculpin), PL (Pacific Lamprey), TSB (Threespine Stickleback)

Appendix C: Fish Sampling

Table 2. Fork length of fish sampled during each sampling event number in Hayward Creek (site km provided), Little Beaver Creek and Hayward Lake for fish capture methods: electrofishing (EF), angling (AG), minnow traps (MT) and gillnets (GN). Table continues on subsequent pages.

Reach	Site	Method	Samp. Event #	Species	FL (mm)	DNA #
2	5km			chinook	> 500	CH1
2	5km	EF	1	chinook	72	none
2	5km	EF	1	coho	55	
2	5km	EF	1	coho	32	
2	5km	EF	1	coho	43	
2	5km	EF	1	cutthroat trout	120	
2	5km	EF	1	prickly sculpin	70	
2	5km	EF	1	prickly sculpin	40	
2	5km	EF	1	prickly sculpin	85	
2	5km	EF	1	prickly sculpin	40	
2	5km	EF	1	prickly sculpin	75	
2	6km	EF	2	coho	50	
2	6km	EF	2	coho	75	
2	6km	EF	2	coho	60	
2	6km	EF	2	coho	57	
2	6km	EF	2	coho	60	
2	6km	EF	2	coho	70	
2	6km	EF	2	coho	50	
2	6km	EF	2	coho	53	
2	6km	EF	2	coho	40	
2	6km	EF	2	coho	42	
2	6km	EF	2	coho	52	
2	6km	EF	2	cutthroat trout	95	
3	8km	EF	3	chinook	93	
3	8km	EF	3	coho	49	
3	8km	EF	3	coho	99	
3	8km	EF	3	coho	48	
3	8km	EF	3	coho	107	
3	8km	EF	3	coho	98	
3	8km	EF	3	coho	59	
3	8km	EF	3	coho	63	
3	8km	EF	3	coho	53	
3	8km	EF	3	coho	53	
3	8km	EF	3	cutthroat trout	68	
3	8km	EF	3	cutthroat trout	73	
3	8km	EF	3	cutthroat trout	73	
3	8km	EF	3	cutthroat trout	74	

Appendix C: Fish Sampling

Table 2. Fork length of fish sampled during each sampling event number in Hayward Creek (site km provided), Little Beaver Creek and Hayward Lake for fish capture methods: electrofishing (EF), angling (AG), minnow traps (MT) and gillnets (GN). Table continues on subsequent pages.

Reach	Site	Method	Samp. Event #	Species	FL (mm)	DNA #
3	8km	EF	3	cutthroat trout	86	
3	8km	EF	3	cutthroat trout	87	
3	8km	EF	3	cutthroat trout	91	
3	8km	EF	3	dolly varden	138	
3	8km	EF	3	dolly varden	98	
3	9km	EF	4	coho	36	
3	9km	EF	4	coho	58	
3	9km	EF	4	coho	38	
3	9km	EF	4	coho	47	
3	9km	EF	4	threespine stickleback	53	
4	11km	EF	5	coho	52	
4	11km	EF	5	coho	46	
4	11km	EF	5	coho	59	
4	11km	EF	5	coho	52	
4	11km	EF	5	coho	57	
4	11km	EF	5	coho	46	
4	11km	EF	5	coho	38	
4	11km	EF	5	coho	50	
4	11km	EF	5	coho	106	
4	11km	EF	5	coho	37	
4	11km	EF	5	cutthroat trout	77	
4	11km	EF	5	dolly varden	96	
5	12.5km	EF	7	coho	87	
5	12.5km	EF	7	coho	45	
5	12.5km	EF	7	coho	41	
5	12.5km	EF	7	coho	65	
5	12.5km	EF	7	coho	55	
5	12.5km	EF	7	coho	52	
5	12.5km	EF	7	coho	45	
5	12.5km	EF	7	coho	49	
5	12.5km	EF	7	coho	46	
5	12.5km	EF	7	coho	36	
5	12.5km	EF	7	coho	90	
5	12.5km	EF	7	coho	82	
5	12.5km	EF	7	cutthroat trout	60	
5	12.5km	EF	7	cutthroat trout	70	
5	12.5km	EF	7	pacific lamprey	110	

Appendix C: Fish Sampling

Table 2. Fork length of fish sampled during each sampling event number in Hayward Creek (site km provided), Little Beaver Creek and Hayward Lake for fish capture methods: electrofishing (EF), angling (AG), minnow traps (MT) and gillnets (GN). Table continues on subsequent pages.

Reach	Site	Method	Samp. Event #	Species	FL (mm)	DNA #
5	12.5km	EF	7	pacific lamprey	33	
5	12.5km	EF	7	pacific lamprey	60	
5	12.5km	EF	7	threespine stickleback	50	
5	12.5km	EF	7	threespine stickleback	45	
	Trib 31	EF	10	coho	35	
	Trib 31	EF	10	coho	38	
	Trib 31	EF	10	coho	85	
	Trib 31	EF	10	cutthroat trout	35	
	Trib 31	EF	10	cutthroat trout	37	
	Trib 31	EF	10	pacific lamprey	125	
2	4.5km	AG	13	chinook	75	CH2
2	4.5km	AG	13	chinook	72	CH3
2	4.5km	AG	13	coho	112	
2	4.5km	AG	13	coho	110	
2	4.5km	AG	13	cutthroat trout	180	
2	4.5km	AG	13	cutthroat trout	260	
2	4.5km	AG	13	cutthroat trout	112	
2	4.5km	AG	13	cutthroat trout	130	
2	4.5km	AG	13	cutthroat trout	204	
2	4.5km	AG	13	cutthroat trout	210	
2	4.5km	AG	13	cutthroat trout	214	
2	5km	AG	14	coho	110	
2	5km	AG	14	coho	110	
2	5km	AG	14	coho	100	
2	5km	AG	14	coho	30	
2	5km	AG	14	coho	30	
2	5km	AG	14	coho	30	
2	5km	AG	14	coho	115	
2	5km	AG	15	rainbow trout	131	
2	5km	AG	16	rainbow trout	198	
2	6km	AG	17	rainbow trout	160	
5	12.5km	AG	18	cutthroat trout	150	
5	14km	AG	19	coho	115	
5	14.3km	AG	19	cutthroat trout	210	
5	14.3km	AG	8	coho	101	
5	14.3km	AG	8	coho	103	
5	14.3km	AG	8	coho	110	

Appendix C: Fish Sampling

Table 2. Fork length of fish sampled during each sampling event number in Hayward Creek (site km provided), Little Beaver Creek and Hayward Lake for fish capture methods: electrofishing (EF), angling (AG), minnow traps (MT) and gillnets (GN). Table continues on subsequent pages.

Reach	Site	Method	Samp. Event #	Species	FL (mm)	DNA #
5	14.3km	AG	8	cutthroat trout	92	
5	14.3km	AG	8	cutthroat trout	220	
5	15.3km	AG	20	coho	90	
5	15.3km	AG	20	coho	103	
5	15.3km	AG	20	coho	105	
Trib 3	5km (Side Channel)	AG	21	dolly varden	223	
1	Little Beaver Creek	AG	22	cutthroat trout	85	
1	Little Beaver Creek	AG	22	cutthroat trout	100	
1	Little Beaver Creek	AG	22	cutthroat trout	134	
1	Little Beaver Creek	AG	23	cutthroat trout	85	
1	Little Beaver Creek	AG	23	cutthroat trout	95	
1	Little Beaver Creek	AG	23	cutthroat trout	104	
1	Little Beaver Creek	AG	23	cutthroat trout	106	
1	Little Beaver Creek	AG	24	cutthroat trout	220	
	Hayward Lake	AG	25	cutthroat trout	119	
	Hayward Lake	AG	25	cutthroat trout	136	
	Hayward Lake	AG	25	cutthroat trout	155	
	Hayward Lake	AG	25	cutthroat trout	176	
	Hayward Lake	AG	25	cutthroat trout	177	
	Hayward Lake	AG	25	cutthroat trout	184	
	Hayward Lake	AG	25	cutthroat trout	249	
	Hayward Lake	MT	26	rough skinned newt	145	
	Hayward Lake	MT	26	threespine stickleback	58	
	Hayward Lake	MT	26	threespine stickleback	41	
	Hayward Lake	MT	26	threespine stickleback	46	
	Hayward Lake	MT	26	threespine stickleback	52	
	Hayward Lake	MT	26	threespine stickleback	46	
	Hayward Lake	MT	26	threespine stickleback	44	
	Hayward Lake	MT	26	threespine stickleback	41	
	Hayward Lake	MT	26	threespine stickleback	51	
	Hayward Lake	MT	26	threespine stickleback	47	
	Hayward Lake	MT	26	threespine stickleback	47	
	Hayward Lake	MT	26	threespine stickleback	47	
	Hayward Lake	MT	28	threespine stickleback	40	
	Hayward Lake	MT	28	threespine stickleback	47	
	Hayward Lake	MT	28	threespine stickleback	50	
	Hayward Lake	MT	28	threespine stickleback	50	

Appendix C: Fish Sampling

Table 2. Fork length of fish sampled during each sampling event number in Hayward Creek (site km provided), Little Beaver Creek and Hayward Lake for fish capture methods: electrofishing (EF), angling (AG), minnow traps (MT) and gillnets (GN). Table continues on subsequent pages.

Reach	Site	Method	Samp. Event #	Species	FL (mm)	DNA #
	Hayward Lake	MT	28	threespine stickleback	51	
	Hayward Lake	MT	28	threespine stickleback	39	
	Hayward Lake	MT	28	threespine stickleback	45	
	Hayward Lake	MT	28	threespine stickleback	46	
	Hayward Lake	MT	28	threespine stickleback	40	
	Hayward Lake	MT	28	threespine stickleback	33	
	Hayward Lake	MT	28	threespine stickleback	48	
	Hayward Lake	MT	28	threespine stickleback	44	
	Hayward Lake	MT	28	threespine stickleback	38	
	Hayward Lake	MT	28	threespine stickleback	49	
	Hayward Lake	MT	28	threespine stickleback	38	
	Hayward Lake	MT	28	threespine stickleback	56	
	Hayward Lake	MT	28	threespine stickleback	44	
	Hayward Lake	MT	28	threespine stickleback	44	
	Hayward Lake	MT	28	threespine stickleback	42	
	Hayward Lake	MT	28	threespine stickleback	47	
	Hayward Lake	MT	28	threespine stickleback	45	
	Hayward Lake	MT	28	threespine stickleback	47	
	Hayward Lake	MT	28	threespine stickleback	42	
	Hayward Lake	MT	28	threespine stickleback	39	
	Hayward Lake	MT	28	threespine stickleback	36	
	Hayward Lake	MT	28	threespine stickleback	48	
	Hayward Lake	MT	28	threespine stickleback	47	
	Hayward Lake	MT	28	threespine stickleback	40	
	Hayward Lake	MT	28	threespine stickleback	55	
	Hayward Lake	MT	28	threespine stickleback	43	
	Hayward Lake	MT	28	threespine stickleback	50	
	Hayward Lake	MT	28	threespine stickleback	43	
	Hayward Lake	MT	28	threespine stickleback	43	
	Hayward Lake	MT	28	threespine stickleback	41	
	Hayward Lake	MT	29	threespine stickleback	59	
	Hayward Lake	MT	29	threespine stickleback	46	
	Hayward Lake	MT	29	threespine stickleback	47	
	Hayward Lake	MT	29	threespine stickleback	49	
	Hayward Lake	MT	29	threespine stickleback	46	
	Hayward Lake	MT	29	threespine stickleback	58	
	Hayward Lake	MT	29	threespine stickleback	47	

Appendix C: Fish Sampling

Table 2. Fork length of fish sampled during each sampling event number in Hayward Creek (site km provided), Little Beaver Creek and Hayward Lake for fish capture methods: electrofishing (EF), angling (AG), minnow traps (MT) and gillnets (GN). Table continues on subsequent pages.

Reach	Site	Method	Samp. Event #	Species	FL (mm)	DNA #
	Hayward Lake	MT	29	threespine stickleback	47	
	Hayward Lake	MT	29	threespine stickleback	47	
	Hayward Lake	MT	29	threespine stickleback	50	
	Hayward Lake	MT	29	threespine stickleback	47	
	Hayward Lake	MT	29	threespine stickleback	31	
	Hayward Lake	MT	29	threespine stickleback	50	
	Hayward Lake	MT	29	threespine stickleback	51	
	Hayward Lake	MT	29	threespine stickleback	45	
	Hayward Lake	MT	29	threespine stickleback	47	
	Hayward Lake	MT	29	threespine stickleback	48	
	Hayward Lake	MT	29	threespine stickleback	53	
	Hayward Lake	MT	29	threespine stickleback	49	
	Hayward Lake	MT	29	threespine stickleback	49	
	Hayward Lake	MT	30	threespine stickleback	49	
1	Little Beaver Creek	MT	32	cutthroat trout	85	
1	Little Beaver Creek	MT	32	threespine stickleback	67	
1	Little Beaver Creek	MT	32	threespine stickleback	70	
1	Little Beaver Creek	MT	32	threespine stickleback	61	
1	Little Beaver Creek	MT	32	threespine stickleback	46	
1	Little Beaver Creek	MT	32	threespine stickleback	60	
1	Little Beaver Creek	MT	32	threespine stickleback	52	
1	Little Beaver Creek	MT	32	threespine stickleback	32	
2	4.5km	MT	33	prickly sculpin	114	
2	4.5km	MT	34	coho		
2	4.5km	MT	34	coho	87	
2	4.5km	MT	34	coho	114	
2	4.5km	MT	34	coho	96	
	Hayward Lake	GN	35	cutthroat trout	174	
	Hayward Lake	GN	35	cutthroat trout	218	
	Hayward Lake	GN	35	cutthroat trout	239	
	Hayward Lake	GN	35	cutthroat trout	255	
	Hayward Lake	GN	35	cutthroat trout	262	
	Hayward Lake	GN	35	cutthroat trout	265	
	Hayward Lake	GN	35	cutthroat trout	291	
	Hayward Lake	GN	35	cutthroat trout	293	
	Hayward Lake	GN	35	cutthroat trout	323	
	Hayward Lake	GN	36	cutthroat trout	174	

Appendix C: Fish Sampling

Table 2. Fork length of fish sampled during each sampling event number in Hayward Creek (site km provided), Little Beaver Creek and Hayward Lake for fish capture methods: electrofishing (EF), angling (AG), minnow traps (MT) and gillnets (GN). Table continues on subsequent pages.

Reach	Site	Method	Samp. Event #	Species	FL (mm)	DNA #
	Hayward Lake	GN	36	cutthroat trout	180	
	Hayward Lake	GN	36	cutthroat trout	194	
	Hayward Lake	GN	36	cutthroat trout	195	
	Hayward Lake	GN	36	cutthroat trout	198	
	Hayward Lake	GN	36	cutthroat trout	216	
	Hayward Lake	GN	36	cutthroat trout	218	
	Hayward Lake	GN	36	cutthroat trout	218	
	Hayward Lake	GN	36	cutthroat trout	220	
	Hayward Lake	GN	36	cutthroat trout	224	
	Hayward Lake	GN	36	cutthroat trout	225	
	Hayward Lake	GN	36	cutthroat trout	235	
	Hayward Lake	GN	36	cutthroat trout	242	
	Hayward Lake	GN	36	cutthroat trout	243	
	Hayward Lake	GN	36	cutthroat trout	244	
	Hayward Lake	GN	36	cutthroat trout	251	
	Hayward Lake	GN	36	cutthroat trout	253	
	Hayward Lake	GN	36	cutthroat trout	254	
	Hayward Lake	GN	36	cutthroat trout	254	
	Hayward Lake	GN	36	cutthroat trout	262	
	Hayward Lake	GN	36	cutthroat trout	263	
	Hayward Lake	GN	36	cutthroat trout	263	
	Hayward Lake	GN	36	cutthroat trout	265	
	Hayward Lake	GN	36	cutthroat trout	268	
	Hayward Lake	GN	36	cutthroat trout	275	
	Hayward Lake	GN	36	cutthroat trout	286	
	Hayward Lake	GN	36	cutthroat trout	289	
	Hayward Lake	GN	36	cutthroat trout	291	
	Hayward Lake	GN	36	cutthroat trout	320	
	Hayward Lake	GN	36	cutthroat trout	331	
	Hayward Lake	GN	36	dolly varden	218	
	Hayward Lake	GN	36	dolly varden	117	
	Hayward Lake	GN	36	dolly varden	113	
	Hayward Lake	GN	36	dolly varden	205	
	Hayward Lake	GN	36	dolly varden	218	
	Hayward Lake	GN	36	dolly varden	216	
	Hayward Lake	GN	36	dolly varden	218	
	Hayward Lake	GN	36	dolly varden	218	

Appendix C: Fish Sampling

Table 2. Fork length of fish sampled during each sampling event number in Hayward Creek (site km provided), Little Beaver Creek and Hayward Lake for fish capture methods: electrofishing (EF), angling (AG), minnow traps (MT) and gillnets (GN). Table continues on subsequent pages.

Reach	Site	Method	Samp. Event #	Species	FL (mm)	DNA #
	Hayward Lake	GN	36	dolly varden	201	
	Hayward Lake	GN	36	dolly varden	185	
	Hayward Lake	GN	36	dolly varden	174	
	Hayward Lake	GN	36	dolly varden	204	
	Hayward Lake	GN	36	dolly varden	221	
	Hayward Lake	GN	36	dolly varden	223	
	Hayward Lake	GN	36	dolly varden	189	
	Hayward Lake	GN	36	dolly varden	171	
	Hayward Lake	GN	36	dolly varden	206	
	Hayward Lake	GN	36	dolly varden	198	
	Hayward Lake	GN	36	dolly varden	175	
	Hayward Lake	GN	36	dolly varden	175	
	Hayward Lake	GN	36	dolly varden	170	
	Hayward Lake	GN	36	dolly varden	188	
	Hayward Lake	GN	36	dolly varden	194	
	Hayward Lake	GN	36	dolly varden	190	

Appendix D- Stream Photo Documentation

Reach 2



Photo 1. Viewing upstream (top photo) and downstream (bottom photo) at habitat present within Reach 2. Pool/run habitat 1-2m deep and some sections of high sediment content (50-70% fines). Overhanging vegetation, LWD, cobbles, and undercut banks present.

Appendix D: Stream Photo Documentation



Photo 2. Stream habitat representative of Reach 2, with long riffle sections, boulders, abundant instream cover and habitat complexity.



Photo 4. Representative illustration of habitat available in Reach 2 with riffle/run/pool complex and boulders, cobbles, instream vegetation and forest regeneration. Photo taken approximately at 5km, where logging occurred on both sides of the stream bank. Sediment is deposited throughout stream section behind boulders.

Appendix D: Stream Photo Documentation



Photo 5. Large woody debris creating large scour pool in Reach 2 of Hayward Creek.



Photo 6. Illustrating sediment deposited in behind boulders documented throughout Reach 2. Photo taken in stream section above the waterfall and debris flow on Reach 2.

Appendix D: Stream Photo Documentation



Photo 7. Examples of suitable spawning gravels present in Reach 2.

Appendix D: Stream Photo Documentation



Photo 8. Bank failure identified at 5.2km downstream of the waterfall on Hayward Creek, present on steep slope below large cutblock.



Photo 9. Photo facing upstream at a series of cascades with bedrock substrate downstream of the 4m falls present at 5.4km on Hayward Creek.

Appendix D: Stream Photo Documentation



Photo 10. Adult Chinook found on the bank directly below the 4m falls present at 5.4km on Hayward Creek. Carcass relatively fresh with sealice present and DNA sample collected.



Photo 11. Viewing upstream at the 4m waterfalls on Hayward Creek. Waterfall may be passable during certain flow conditions for some anadromous salmon species, however, a side channel also provides passage around this river section.

Appendix D: Stream Photo Documentation



Photo 12. Viewing upstream in side-channel starting at 5km, and providing passage around the falls.



Photo 13. Viewing upstream at cascade present (16m long, 3m high) at upstream end of side channel providing passage around the falls. Several small pools available to aid fish passage.

Appendix D: Stream Photo Documentation



Photo 14. Viewing downstream at cascade present (16m long, 3m high) at upstream end of side channel providing passage around the falls.

Appendix D: Stream Photo Documentation

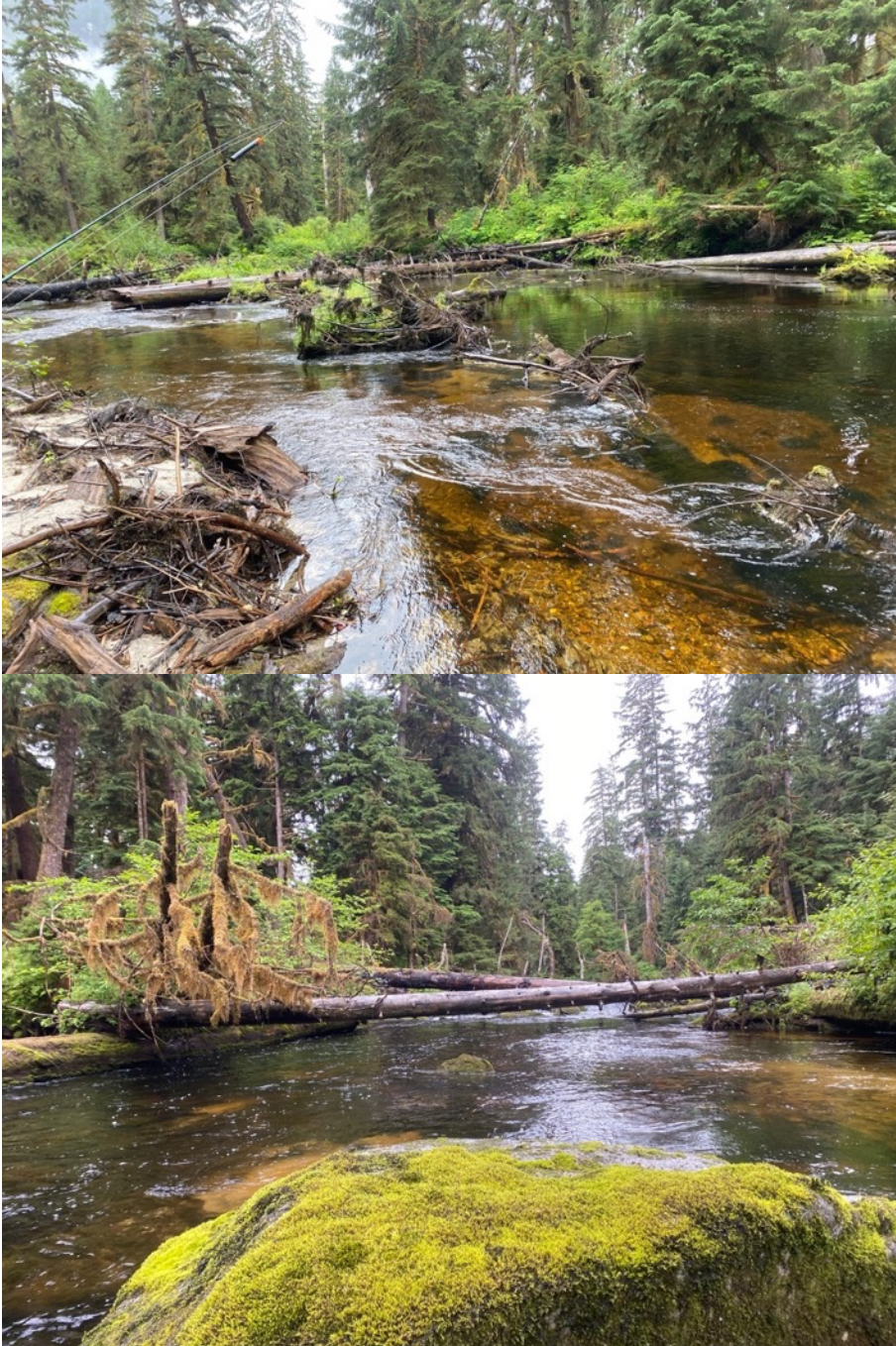


Photo 15. Non-functional LWD parallel to banks (evidence of blowdown) in stream section 5.6km to 6.6km, approximately located at 9 U 447538 5991230 with logging present on the north side of the river (with a riparian buffer present).

Appendix D: Stream Photo Documentation



Photo 16. Chinook Salmon parr captured in Reach 2 of Hayward Creek during July 2021 field surveys.



Photo 17. Rainbow Trout captured by angling in Reach 2 below the waterfalls on July 26th, 2021.

Appendix D: Stream Photo Documentation



Photo 18. Dolly Varden captured by angling in Reach 2 in the side-channel (starting at 5km) on July 26th, 2021.



Photo 19. Rough-skinned newt found in Reach 2 on sandy substrate in Hayward Creek on July 23, 2021.

Reach 3



Photo 20. Habitat characteristic of Reach 3 as a deep, low gradient stream section dominated by fine sediment. This section was too deep to wade but contains stable banks, deep pools, cutbanks, overwintering habitat, LWD and a high abundant of rearing salmonids was visually seen.



Photo 21. Habitat characteristic of Reach 3. Viewing deep low gradient stream section dominated by fine sediment.

Appendix D: Stream Photo Documentation

Reach 4



Photo 22. Chinook Salmon parr (top panel) and Coho Salmon parr (bottom panel) captured around 8km in Reach 4.

Appendix D: Stream Photo Documentation



Photo 23. Fine sediment present in Reach 4. Present with boulder and large cobble, abundant of instream vegetation in certain lower gradient sections.



Photo 24. Viewing habitat available in lower sections of Reach 4 with run, riffle pool morphology, boulders and cobble present over 2-3% gradient.

Appendix D: Stream Photo Documentation

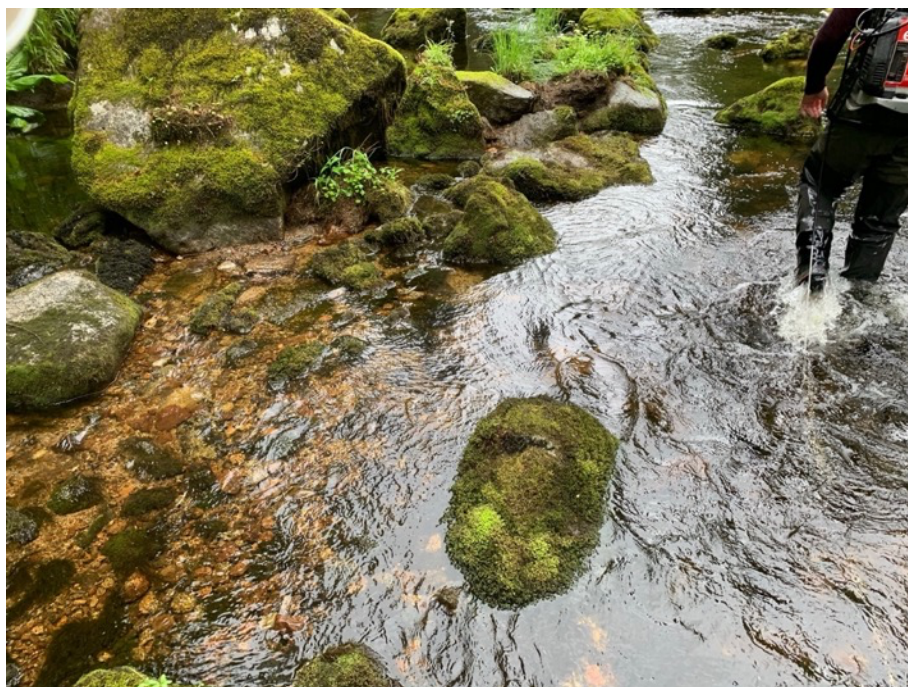


Photo 25. Viewing typical bed material present throughout Reach 4 with boulders, gravels and cobble.



Photo 26. Viewing upstream at higher gradient (6 -8 %) SPb channel morphology present in Reach 4.

Appendix D: Stream Photo Documentation



Photo 27. An example of deep pools present (>1m deep) in Reach 4.



Photo 28. Spawning gravels present in Reach 4.

Reach 5



Photo 29. Viewing upstream in Tributary 31 close to the Hayward Creek confluence. Abundant instream cover (LWD, SWD, undercut banks) and bed material is dominated by large gravel and fines (subdominant).

Appendix D: Stream Photo Documentation



Photo 30. Spawning gravels present on Tributary 31, a main tributary to Reach 5.

Appendix D: Stream Photo Documentation



Photo 31. Viewing upstream and habitat present in Tributary 31 with underhanging stream banks, instream vegetation and gravel bed material (dominant). Photo taken approximately 60m upstream of the bridge.



Photo 32. Viewing habitat present in Tributary 31 with LWD and riffle, run, pool complex and underhanging bank.

Appendix D: Stream Photo Documentation



Photo 33. Photo taken at location where gradient increases on Tributary 31.

Appendix D: Stream Photo Documentation



Photo 34. Viewing upstream in Tributary 32. Dominant bed material is cobble with fines (subdominant), overhanging vegetation, SWD and instream vegetation.



Photo 35. Viewing upstream on Tributary 32 from the confluence of Hayward Creek. Suitable spawning gravels present and abundant instream cover for juvenile fish (instream vegetation, undercut banks, overhanging vegetation).

Appendix D: Stream Photo Documentation



Photo 36. Viewing 1m falls present on Tributary 32 where gradients increase. Juveniles present to 150m upstream.

Reach 6



Photo 37: Coastal Cutthroat Trout captured in Reach 6 of Hayward Creek.



Photo 38. Viewing habitat characteristic of Reach 6, with deep glides and pools, functional LWD and suitable spawning gravels recruited from tributaries.

Appendix D: Stream Photo Documentation



Photo 39. Beaver dam present in Reach 6. Beaver dams in reach 6 do not restrict fish passage throughout this section.



Photo 40. Deep pool and glide complex available in Reach 6. Stable undercut banks, abundant LWD, fine substrate (dominant) and abundant instream vegetation present.

Appendix D: Stream Photo Documentation



Photo 41. Deep pool and glide complex available in Reach 6. Stable undercut banks, abundant LWD, fine substrate (dominant) and abundant instream vegetation present.



Photo 42. Deep pool and glide complex available in Reach 6. Stable undercut banks, abundant LWD, fine substrate (dominant) and abundant instream vegetation present.

Appendix D: Stream Photo Documentation



Photo 43. Deep pool and glide complex available in Reach 6. Stable undercut banks, abundant LWD, fine substrate (dominant) and abundant instream vegetation present.



Photo 44. Suitable spawning gravels present in Reach 6.

Appendix D: Stream Photo Documentation



Photo 45. Suitable spawning gravels present in Reach 6.



Photo 46. Short 200m section of boulder cascade (9 U 451743 5987401) occurs prior to Lower Hayward Lake.

Little Beaver Creek



Photo 47. Old beaver dam present at the outlet of Hayward Lake into Little Beaver Creek.



Photo 48. Coastal Cutthroat Trout captured in the upper section of Little Beaver Creek.

Appendix D: Stream Photo Documentation



Photo 49. Small gravel patches present in proximity to Hayward Lake suitable for small resident trout.



Photo 50. Small gravel patches present in proximity to Hayward Lake suitable for Threespine Stickleback or small resident trout.

Appendix D: Stream Photo Documentation



Photo 51. Threespine Stickleback captured in Little Beaver Creek downstream of Hayward Lake.



Photo 52. Eroding stream bank present in Little Beaver Creek which has been logged up to the edge (no riparian buffer remaining).

Appendix D: Stream Photo Documentation



Photo 53. Abundant non-functional LWD is present within little beaver creek caused by logging close to the stream bank and subsequent windfall.



Photo 54. Abundant non-functional LWD is present within little beaver creek caused by logging close to the stream bank and subsequent windfall.



Photo 55. Abundant SWD is present within little beaver creek caused by logging close to the stream bank and subsequent windfall. SWD and LWD in creek and clogging the creek and likely limiting fish passage. Red algae was present during sampling.



Photo 56. Low water levels present during sampling of Little Beaver Creek. Creek morphology is cascade-pool morphology with evidence of historic scour. Red algae was present during sampling.

Appendix D: Stream Photo Documentation



Photo 57. Abundant SWD is present within little beaver creek caused by logging close to the stream bank and subsequent windfall. SWD and LWD in creek and clogging the creek and likely limiting fish passage. Red algae was present during sampling.



Photo 58. Fine sediments and red algae clogging stream during low flow sampling in July.

Appendix D: Stream Photo Documentation



Photo 59. Abundant non-functional LWD is present within little beaver creek caused by logging close to the stream bank and subsequent windfall.



Photo 60. Documented bed material present in Little Beaver Creek downstream of Hayward Lake.

Appendix D: Stream Photo Documentation

Hayward Lake (including outlet)



Photo 61. Viewing old landslide downstream of Hayward Lake, where water is percolating through large-boulders. Mature forest has grown over boulders and represents the limit to anadromous fish passage in the Hayward Creek watershed.



Photo 62. Viewing old landslide downstream of Hayward Lake, where water is percolating through large boulders. Mature forest has grown over boulders and represents the limit to anadromous fish passage in the Hayward Creek watershed.



Photo 63. Viewing old landslide downstream of Hayward Lake, where water is percolating through large-boulders. Mature forest has grown over boulders and represents the limit to anadromous fish passage in the Hayward Creek watershed.



Photo 64. Viewing old landslide downstream of Hayward Lake, where water is percolating through large-boulders. Mature forest has grown over boulders and represents the limit to anadromous fish passage in the Hayward Creek watershed.



Photo 65. Viewing old landslide downstream of Hayward Lake, where water is percolating through large-boulders. Mature forest has grown over boulders and represents the limit to anadromous fish passage in the Hayward Creek watershed.

Appendix D: Stream Photo Documentation



Photo 66. Viewing lower Hayward Lakes below the cascade falls/complex at the outlet of Hayward Lake.



Photo 67. Viewing lower Hayward Lakes below the cascade falls/complex at the outlet of Hayward Lake.

Appendix D: Stream Photo Documentation



Photo 68. Coastal Cutthroat Trout captured by gillnet in Hayward Lake.

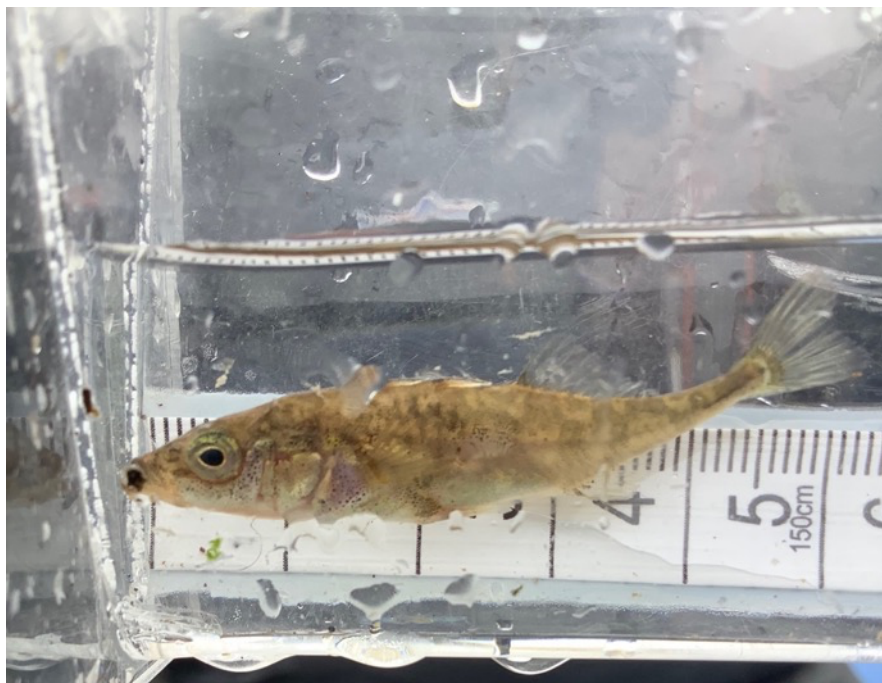


Photo 69. Threespine Stickleback captured by minnow trap in Hayward Lake.

Appendix D: Stream Photo Documentation



Photo 70. Coastal Cutthroat Trout captured by gillnet in Hayward Lake.



Photo 71. Southeast outlet of Hayward Lake during July 2021 sampling.



Photo 72. Photo of Hayward Lake facing north towards the outlet to Hayward Lake during July 2021 sampling.

Appendix E- Spatial Data Collected

Table 1. Spatial information illustrated in 1:10000 fish habitat and fish sampling maps presented in Appendix A. Data includes locations for river kilometers, reach breaks, site sampling, habitat features (cascades etc.) and spawning gravel locations. Table continues on subsequent pages.

Feature		Easting	Northing	Notes
River Kilometer	1km	444849	5989525	
River Kilometer	2km	444954	5990146	
River Kilometer	3km	445783	5990044	
River Kilometer	4km	446314	5990389	
River Kilometer	5km	447136	5990772	
River Kilometer	6km	447736	5991460	
River Kilometer	7km	448594	5991703	
River Kilometer	8km	449480	5991556	
River Kilometer	9km	450419	5991325	
River Kilometer	10km	451010	5990943	
River Kilometer	11km	451236	5990224	
River Kilometer	12km	451130	5989541	
River Kilometer	13km	451510	5988841	
River Kilometer	14km	451505	5988199	
River Kilometer	15km	451675	5987389	
River Kilometer	16km	452417	5986938	
Reach Break	1	446874	5990599	
Reach Break	2	448251	5991762	
Reach Break	3	449162	5991646	
Reach Break	4	450404	5991343	
Reach Break	5	451193	5989725	
Reach Break	6	451746	5987397	
Reach Break	7	452565	5986826	
Reach Break	8	452688	5986677	
Site Sampling #	1	447045	5990674	1-20-RPc, CH CO CT CAS EF
Site Sampling #	2	447641	5991291	1-21-RPc-D2, CO CT EF
Site Sampling #	3	449401	5991587	2-21-RPg, CO CT DV EF
Site Sampling #	4	450586	5991348	*-33-RPg, CO TSB EF
Site Sampling #	5	451054	5990294	0.5-15-RPg, CO CT DV EF
Site Sampling #	6	451184	5989498	0.5-14-RPg, NS (CH CO CCT RB PL TSB)
Site Sampling #	7	451174	5989365	1-11-RPg, CO CT PL TSB EF
Site Sampling #	8	451526	5988192	0.5-10-RPg, CO CT AG

Appendix E: Spatial Data Collected

Table 1. Spatial information illustrated in 1:10000 fish habitat and fish sampling maps presented in Appendix A. Data includes locations for river kilometers, reach breaks, site sampling, habitat features (cascades etc.) and spawning gravel locations. Table continues on subsequent pages.

Feature		Easting	Northing	Notes
Site Sampling #	9	452201	5987108	1-3-RPc, NS (CH CO CCT RB PL TSB)
Site Sampling #	10	451531	5989776	1.5-17-RPg, CO CT PL EF
Site Sampling #	11	451056	5989653	*-5-RPg, NS (CH CO CCT RB PL TSB)
Site Sampling #	12	453554	5984370	3-5-CPb-O1B2, NS (CCT DV TSB)
Site Sampling #	13	446691	5990505	CH CO CCT AG
Site Sampling #	14	447041	5990661	AG CO AG
Site Sampling #	15	447186	5990855	CO RB AG
Site Sampling #	16	447339	5991073	RB AG
Site Sampling #	17	447370	5991078	AG RB AG
Site Sampling #	18	451174	5989365	CCT AG
Site Sampling #	19	451460	5988307	CO CCT AG
Site Sampling #	20	451932	5987307	CO AG
Site Sampling #	21	447388	5991074	DV AG
Site Sampling #	22	453272	5984916	CCT AG
Site Sampling #	23	453298	5984827	CCT AG
Site Sampling #	24	453303	5984815	CCT AG
Site Sampling #	25	453162	5985043	AG CCT AG
Site Sampling #	26	452719	5986642	CCT TSB MT
Site Sampling #	27	452687	5986659	NFC (CCT TSB) MT
Site Sampling #	28	452625	5986593	TSB MT
Site Sampling #	29	453053	5985289	TSB MT
Site Sampling #	30	452978	5985233	TSB MT
Site Sampling #	31	453161	5985021	NFC(CCT TSB) MT
Site Sampling #	32	453288	5984849	CCT TSB MT
Site Sampling #	33	446546	5990444	CAS MT
Site Sampling #	34	446787	5990607	CO MT
Site Sampling #	35	452926	5986467	CCT GN
Site Sampling #	36	452918	5985697	CCT DV GN
Cascades		447262	5990968	2m long
Debris Torrent		447288	5991019	
Falls		447336	5991073	4m high
Beaver Dam		453267	5984922	
Beaver Dam		453280	5984893	
Bridge		453285	5984863	
Beaver Dam		453312	5984790	

Appendix E: Spatial Data Collected

Table 1. Spatial information illustrated in 1:10000 fish habitat and fish sampling maps presented in Appendix A. Data includes locations for river kilometers, reach breaks, site sampling, habitat features (cascades etc.) and spawning gravel locations. Table continues on subsequent pages.

Feature		Easting	Northing	Notes
Cascades		452588	5986785	10m high, 50m long
Falls		452565	5986826	3m high
Salmon, Upper Limit		452565	5986826	
Bridge		451164	5989423	
Cascades		447383	5991051	3m high, 16m long
Bridge		451506	5989794	
Spawning Gravel	1	446846	5990590	
Spawning Gravel	2	446926	5990623	
Spawning Gravel	3	447047	5990680	
Spawning Gravel	4	447046	5990676	
Spawning Gravel	5	447056	5990712	
Spawning Gravel	6	447084	5990751	
Spawning Gravel	7	447095	5990755	
Spawning Gravel	8	447166	5990788	
Spawning Gravel	9	447186	5990857	
Spawning Gravel	10	447452	5991131	
Spawning Gravel	11	450122	5991434	
Spawning Gravel	12	450757	5991353	
Spawning Gravel	13	451070	5990342	
Spawning Gravel	14	451070	5990342	
Spawning Gravel	15	451070	5990342	
Spawning Gravel	16	451070	5990342	
Spawning Gravel	17	451070	5990342	
Spawning Gravel	18	451196	5989906	
Spawning Gravel	19	451198	5989880	
Spawning Gravel	20	451179	5989683	
Spawning Gravel	21	451499	5989793	
Spawning Gravel	22	451174	5989363	
Spawning Gravel	23	451194	5989313	
Spawning Gravel	24	451202	5989289	
Spawning Gravel	25	451745	5987397	
Spawning Gravel	26	451931	5987307	