Fish Passage Assessment of Highway 16 and CN Rail in the Bulkley Watershed

Tim Wilson & Ken Rabnett
Skeena Fisheries Commission
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SUMMARY

This Bulkley fish passage assessment is part of a larger regional effort to improve fish passage limited by highways and secondary roads throughout the Skeena Basin. The purpose of this report is to present background information and survey results for fish passage assessments conducted at stream crossings of Highway #16 and CN Rail in the Bulkley Watershed. In 2006, Skeena Fisheries Commission was retained by the Pacific Salmon Commission to conduct a Fish Passage and Culvert Inspection (FPCI) on all non-bridged Highway #16 and CN Rail stream crossings distinguished with fish presence throughout the Bulkley Watershed.

The primary objective of this project was to focus on increasing the abundance of fish stocks by opening freshwater habitat to salmon spawning and rearing. This project utilized the fish passage culvert inspection procedure that has been developed to evaluate one of the most easily addressed fish habitat constraints: access to existing habitat. The fish passage culvert inspection methodology is based on the BC Government fish passage protocol outlined in: *Fish Passage – Culvert Inspection Procedures*, Parker, 2000 (FPCI).

This project recorded 98 stream crossings traversed by Highway #16 and CN Rail over approximately 189 km. Of these 98 fish bearing stream crossings, 61 were passed with culverts. Rehabilitation priority ratings are based on the various types and degrees of barriers along with variable amounts of fish abundance and differing qualitative values of upstream fish habitat. Of the 13 streams crossings with full and partial barriers, 9 are rated high priority restoration sites and include: Toboggan Creek — Site 14, Station Creek — Site 78, Bulkley Oxbow 1 — Site 50, Moan Creek — Site 30, Johnny David Creek — Site 64, Glass Creek — Site 80, McDowell Creek — Site 37, Tyhee Creek — Site 36, and Coffin Creek — Site 77. Cesford Creek — Site 67 and Strawberry Creek — Site 5 are rated as moderate priority restoration sites. The assessment also found twelve stream crossings that require maintenance. The greatest part of the maintenance work is routine and cost effective.

When the FPCI were conducted in September and October 2006, the Bulkley Watershed was experiencing very low streamflow conditions. Many creeks were dry and had to be revisited in the spring, 2007. The majority of the full and partial barriers consist primarily of outfall drops and for the most part are linked to improperly designed and or installed culverts or erosion and down-cutting of the channel downstream of the culverts. We suspect that the erosion and down-cutting is due to extreme culvert velocities associated with spring freshet flows.

The task of restoring fish passage and upstream habitat at stream crossings involves establishing priorities based on measurable benefits. With limited resources, a focused approach providing the greatest short and long-term benefits to our fish and fish habitat resources is required. Station and Toboggan creeks are the highest priority culverts to rehabilitate in order to enable fish passage. Habitat and fish surveys are a high priority for abandoned channels on the upper Bulkley River floodplain. The amount of potential habitat gained and probable coho and steelhead production are significant.

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1.0 INTRODUCTION

The purpose of this report is to present background information and survey results for fish passage assessments conducted at stream crossed by Highway #16 and CN Rail in the Bulkley Watershed. In 2006, Skeena Fisheries Commission was retained by the Pacific Salmon Commission (PSC) to conduct a Fish Passage and Culvert Inspection (FPCI) on all non-bridged Highway #16 and CN Rail stream crossings distinguished with fish presence throughout the Bulkley Watershed. Highway #16 is approximately 189 km in length.

This Bulkley fish passage assessment is part of a larger regional effort to improve fish passage limited by highways and secondary roads throughout the Skeena Basin. Highway #16 Fish Passage Assessment in the middle Skeena – Terrace to Hazelton was funded by the PSC and completed in 2004 (Rabnett 2005). In 2005, the PSC Northern Fund supported the Highway #16 and CN Rail Fish Passage Assessment on the lower Skeena from Terrace to Prince Rupert (Rabnett 2006). This component, the Bulkley Watershed, will complete assessment of Highway #16 and the CN Rail right of way in the Skeena Watershed.

The connectivity of diverse fish habitats is fundamental to supporting fish abundance in all their life stages that are found in the Bulkley Watershed's freshwater habitats. Tributary streams, lakes, off-channels, back channels, ponds, and sloughs all provide critical habitat. Ensuring that these components remain connected for the free migration of spawning adults and rearing juvenile fish is a critical component in maintaining healthy populations.

The maintenance of healthy fish populations requires that streams crossed by roads and non-open bottom structures such as culverts permit the free migration of spawning adult fish and rearing juveniles to upstream habitat. The purpose of this project is to serve as an initial program phase to restore fish passage to diverse fish habitats disconnected in the past by culvert installations.

Many kilometres of critical habitat that used to support salmonids are inaccessible due to improperly designed and installed fish passage structures along the highway and rail grade. The majority of inaccessible habitat consists of short low gradient reaches of moderate to high value that are frequented by coho. Streams crossed with culverts at or downstream of viable fish habitat were assessed to determine the degree of obstruction posed, which led to the restoration feasibility, extent of restoration, and applicable priority. Restoring access to additional upstream habitat through culvert rehabilitation is one of the most timely and cost effective activities to benefit fish abundance and habitat productivity.

Deliverables from this project include this narrative report, an updated database of all fish bearing streams crossed by Highway #16 and CN Rail culverts and bridges in the Bulkley Watershed, and five 1:50,000 TRIM based maps showing the roads, streams, known fish presence, topography, and culvert locations.

1.1 OBJECTIVES

The primary goal of this project is to focus on increasing the abundance of fish stocks by reopening freshwater habitat to salmon spawning and rearing in a coordinated and planned manner for the benefit of fish habitat and water quality. Objectives include:

- Conducting stream crossing assessments and prioritizing obstructions;
- Developing conceptual restoration prescriptions for prioritized obstructed stream crossings;
- Increasing the abundance of fish stocks, particularly coho, chinook, and steelhead by restoring access to important fish habitat that is now disconnected;
- Developing partnerships that further habitat stewardship among DFO, BC Ministry of Environment (MoE), B.C. Ministry of Transportation, CN Rail, and Skeena Fisheries Commission.

1.2 FISH PASSAGE

The movement of fish through culverts can be restricted by many factors including culvert length and gradient, stream levels and velocities, and inlet and outlet configurations. Improper culvert design and installation can block fish passage to spawning and rearing areas such as small streams, lakes, and wetlands. In some cases depending on culvert location, large portions of sub-basins may be inaccessible due to full or partial obstruction at crossings.

When adult salmon enter freshwater, the maturing fish stop feeding and rely on energy reserves stored in body fat and protein to carry them through migration and spawning. The rate of sexual maturity is established by heredity and most often cannot adjust to delay (Powers and Orsborn 1985). Barriers that cause excessive delay and/or abnormal energy expenditures can result in pre-spawning mortality either during migration or in spawning areas.

The direction and length of migration varies with the fish species and life stage; consequently, the necessary timing, frequency, and duration for unimpeded access to required habitats also varies. On a finer scale, juvenile salmonids and resident freshwater species need to freely disperse to find optimal rearing conditions to ensure their survival, such as habitat with prime food sources, reduced competition, high quality and low velocity refuge habitat, and fewer predators.

Restoring fish passage increases the amount of available habitat within a stream system. If habitat abundance is the limiting factor, increased access to additional habitat will likely result in a rise in fish populations. However, the population response to habitat gain is also frequently dependent on numerous other factors, which may include the quality and quantity of new habitat, the nature and abundance of predators, and the presence of competitors.

When impassable culverts are replaced, restoring fish passage may change the transport of sediments, woody debris, and other materials to downstream reaches. This could change the slope or elevations of upstream or downstream channel reaches, as elevation differences are reconciled. These changes, which can lead to both positive and negative effects, can affect the aquatic environment by altering habitat preferences and characteristics affecting fish use and behavior. Consideration of potential changes, especially by flood stage stream flows and sediment transport events, is necessary in the Bulkley Watershed due to the topographical and climatic conditions that establish flow regimes.

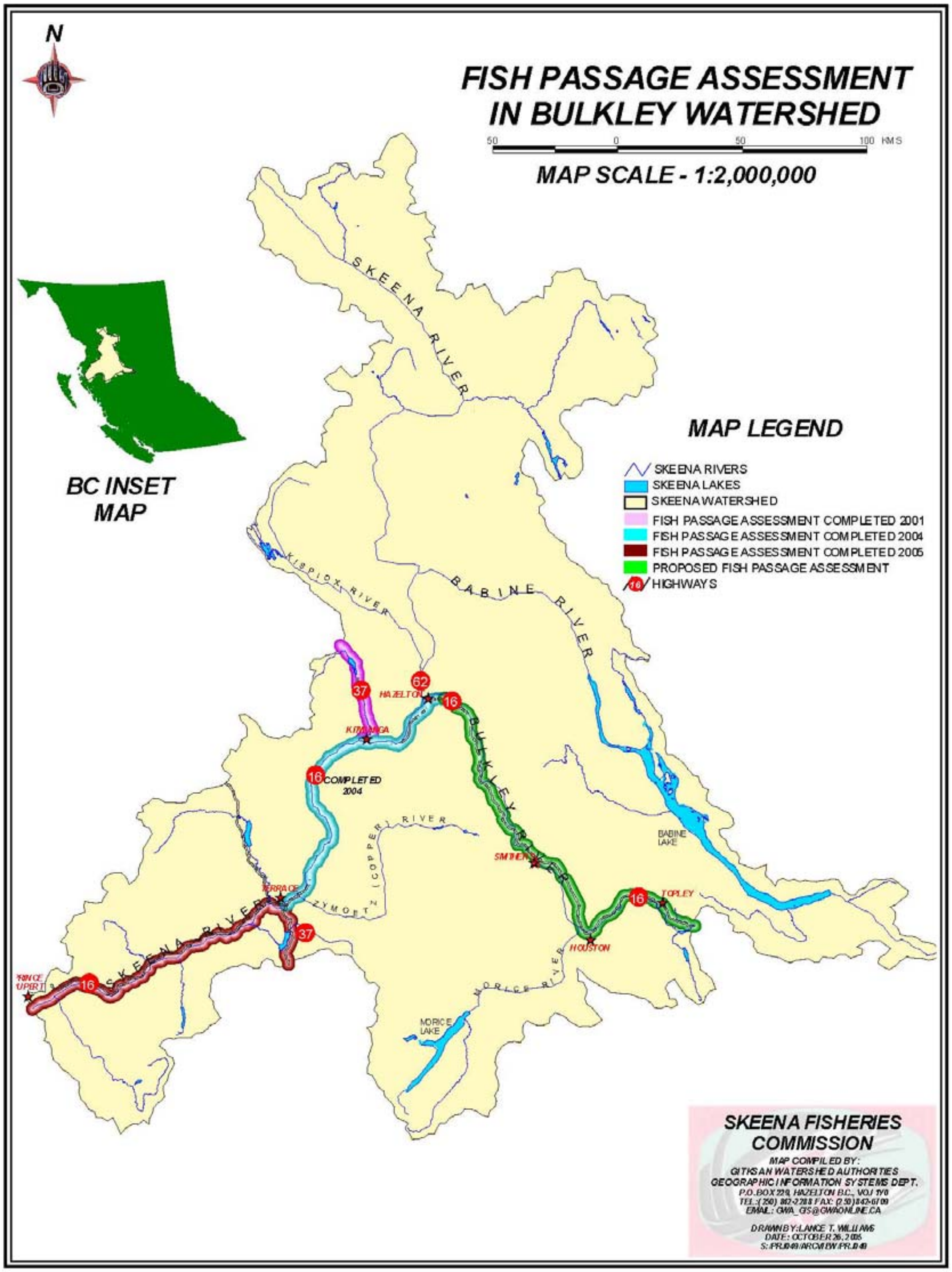


Figure 1. Bulkley fish passage assessment map

1.2.1 Obstructions to Fish Passage

The most frequent obstructions encountered in this survey were outfall drops at culvert outlets. The nature and extent of outfall drops impacting fish passage can vary significantly and includes stream and culvert factors such as:

- Culvert placement — longitudinally in relation to the stream hydraulics and depth of culvert in terms of embeddedness,
- Culvert size and velocity related to the amount of stream restriction. Culverts are hydraulically efficient conduits of water and can significantly increase stream velocity and typically provide shallower flows,
- Culvert gradient in relation to stream gradient, High culvert gradient frequently increases stream velocity due to efficient hydraulics,
- Culvert length. Due to potentially increased velocity, culvert length may be too long for juvenile and adult burst and prolonged swimming abilities,
- Outfall pool depth and size is important in that the outfall pool depth needs to be a minimum of 1.25 as deep as the height of the outfall drop,
- Damage to downstream channel morphology through erosion or down-cutting can result from excessive culvert velocities, which often ecaberates outfall drops,
- Height of outfall drop determines the severity of the obstruction at various flow levels,
- Stream hydrology — flow regime needs to be considered when developing fish passage solutions. Spring snowmelt flows can displace downstream backwater weirs, or alternatively, fill backwater pools with sediment.

Consideration of fish presence by species, life stage, and distribution along with their swimming speeds and jumping abilities are critical to evaluating barriers to fish passage. These biological factors coupled with the physical characteristics of the stream and culvert frequently poses complicated questions, and in turn, demands substantial judgements to support long-term fish passage solutions.

Knowledge of the fish species and life stage, the amount of culvert outfall drop, and the outfall drop pool depth is used to determine the severity of the obstruction. Various configurations of culvert placement, outfall pool depth, culvert water depth, and water velocity can significantly reduce fish jumping efforts. For adult salmon migration, average water velocity should not exceed 1.2 m/sec-1 and 0.9 m/sec-1 for culverts less than and greater than 24.5 m in length respectively. Water depth within the culvert needs to be a minimum of 0.23 m. Maximum jump height for the target species present are utilized to evaluate passage, however, our observations indicate that in many situations these jump heights are optimistic.

Figure 2. View upstream of Porphyry Creek culvert outlet
This 2.4 m outfall drop is a barrier to all fish.

1.2.2 Recent Fish Passage Projects

In the Bulkley watershed, DFO Habitat Management staff, BC Ministry of Environment (MoE) staff, and the BC Ministry of Transportation (MOT) meet annually to prioritize and plan fish passage improvement projects that utilize provincial funding. Several Highway #16 projects have been designed to restore fish passage at BC MOT culvert crossings. Works have been completed at Tamen Creek culvert on the Highway #16 that provided a tailwater control weir to improve trout and salmon passage. A steel plate arch was installed at the Highway #16 — Thompson Creek crossing that restored approximately 5 km of high value coho and steelhead spawning and rearing habitat.

Figures 3 & 4. Thompson Creek – Highway #16 crossing.
View on the left shows the Thompson Creek culvert outlets, which were replaced in 2004 with the steel plate arch on the right.

John Brown Creek, Barren Creek, and Johnny David Creek crossings at Highway #16 have all received efforts to facilitate backwatering the outlets; however, information is scarce on these efforts.

2.0 METHODS

2.1 Pre-field Planning

In order to generate a list of stream crossings to assess in the field portion of the project, an office-based overview was compiled and reviewed to identify all non-bridged stream crossings. Data used included Terrain Resource Inventory Maps (TRIM), a compilation of the existing fisheries information using the Fish Information Summary System (FISS), fish and fish habitat overview assessments and reconnaissance level 1:20,000 fish and fish habitat inventory mapping (Tamblyn and Jessop 2000, Triton 1998). Traditional fisheries knowledge and anecdotal material regarding important fish streams in the Bulkley Watershed were also rolled into the review. A GIS-based 1:20,000 map series was created for the field work and included the following sheets: 93M 004, 013, 014, 022, 023, and 93L 037, 040, 046, 047, 048, 049, 050, 056, 0578, 059, 065, 066, 074, 075, 084, 085, and 094.

2.2 Fieldwork

The fish passage culvert inspection methodology is based on the BC Government fish passage protocol outlined in Fish Passage–Culvert Inspection Procedures, (FPCI) (Parker 2000). Essentially, the FPCI fieldwork data collection includes: administrative categories such as stream name, location coordinates, and watershed code; measuring stream and culvert characteristics; noting the fish bearing qualities and quantities; evaluating barriers, and taking upstream and downstream photographs from the culvert inlet and outlet. Stream measurements were taken at distances of 25 m and 50 m so as to avoid the influence of the culvert on stream characteristics. Fieldwork was conducted from mid-September to late October. Due to dry conditions, many streams needed to be revisited in spring, 2007.

The objectives of this assessment were to:

- Identify all culvert and bridge crossing sites;
- Identify that the channel upstream and downstream are viable fish habitat and determine the quality and quantity of that habitat;
- Identify to what degree the culvert blocks or impedes fish passage.

The following procedures and field gear were used to collect stream and culvert characteristic data:

- Culvert length was measured with a Bushnell Yardage Pro laser range finder.
- Culvert and stream widths and depths were measured with a meter stick or tape.
- Stream velocities were measured with a Swoffer 2100 Current Meter.
- Stream and culvert gradients were measured with a Suunto clinometer.
- Location coordinates were recorded with a Garmin eTrex Summit.
- Photographs were taken with Olympus Stylus 730 and a HP Photosmart R707, 5.1 MP digital camera.
- Stream lengths were measured with a hip chain.

2.3 Post-Field

Following completion of the fieldwork, calculations were prepared for each barrier culvert site evaluating the type and degree of obstruction, stream length upstream of the barrier as well as overall length, and the Q100. These calculations were then scored using the criteria in the FPCI (Parker 2000) followed by the prioritization of assessed culverts. Three primary report sections were prepared to describe all stream crossings in text format, in a database, and on 1:50,000 scale maps.

2.4 Fish Passage Culvert Inspection Rating

Fish bearing streams receiving the fish passage culvert inspection were prioritized using the FPCI scoring matrix. The matrix considers fish species present, fish habitat values, barrier type, length of habitat upstream, proportion of stream habitat barred, and the presence of further upstream barriers. In short, prioritization is based on maximizing fish access to habitat segregated by a barrier culvert. The priorities do not take into account sediment movement or maintenance issues. The FPCI scoring matrix can be used to prioritize and to base restoration or rehabilitation efforts on funding availability or other considerations.

Fish species		Habitat value		Barrier		Length of new habitat		Stream barred %		Limiting to upstream barrier	
Multiple or significant	10	H	10	Full	10	≥1 km	10	>70%	10	Yes	5
Single	6	M	6	Partial	6	<1 km	6	51–70%	6	No	0
Other	3	L	3	Underter	3	<500 m	3	<50%	3		

Table 1. FPCI scoring matrix.

Fish species are classed as single, multiple, or significant, to note the degree of restorative benefits. Information in regard to fisheries values was generated through professional judgement by subjective analysis that included:

- Fish populations known to be conservation risks and their habitats and concerns.
- Fish species of Provincial significance–these include species that have been identified provincially as being particularly sensitive to forest harvesting activities (Haas 1998). In this fish passage assessment, these species refers to bull trout (BT), Dolly Varden (DV), and/or cutthroat trout (CT).
- Fish populations and habitat identified by First Nations as being traditionally or contemporarily important.

Habitat value is a subjective rating based on the known value of the stream habitat to be gained and is based on complexity, productivity, and limiting habitats. Different values for different habitat types are based on species preference and known distributions. The barrier factor is used to give higher priority for sites with more severe obstructions to fish. Barriers are based on outfall drop, culvert water velocity, culvert gradient, and culvert length.

Length of new habitat is the length of potentially restored stream, measured on the 1:20,000 scale maps to the next known barrier using gradient classes to differentiate the fisheries values of different habitat types. Stream barred percent is the length of new habitat divided by the total fish bearing stream length. Limiting to upstream barrier is scored if there is another culvert upstream of the site that has been assessed as a full, partial, or undetermined barrier (Parker 2000).

The relative numerical scores associated with each category are then summed. The ranking of high, moderate, or low is given based on the scoring classes listed below.

- High ranking score 39–55
- Moderate ranking score 26–38
- Low ranking score 15–25

Figure 5. Bulkley – Telkwa confluence.

3.0 LOWER BULKLEY RIVER

3.1 ENVIRONMENTAL SETTING

The Bulkley River is a major tributary to the Skeena River and flows into its left bank at Hazelton, BC, 285 km upstream of the mouth. The Lower Bulkley River includes the Bulkley River and its tributaries from the Bulkley–Skeena confluence 99 km upstream to the Telkwa River. The Lower Bulkley is bounded to the north and east mostly by the Babine drainage and to the west by the Zymoetz and Kitseguecla drainages. To the south, the upper Bulkley Watershed bounds the interest area.

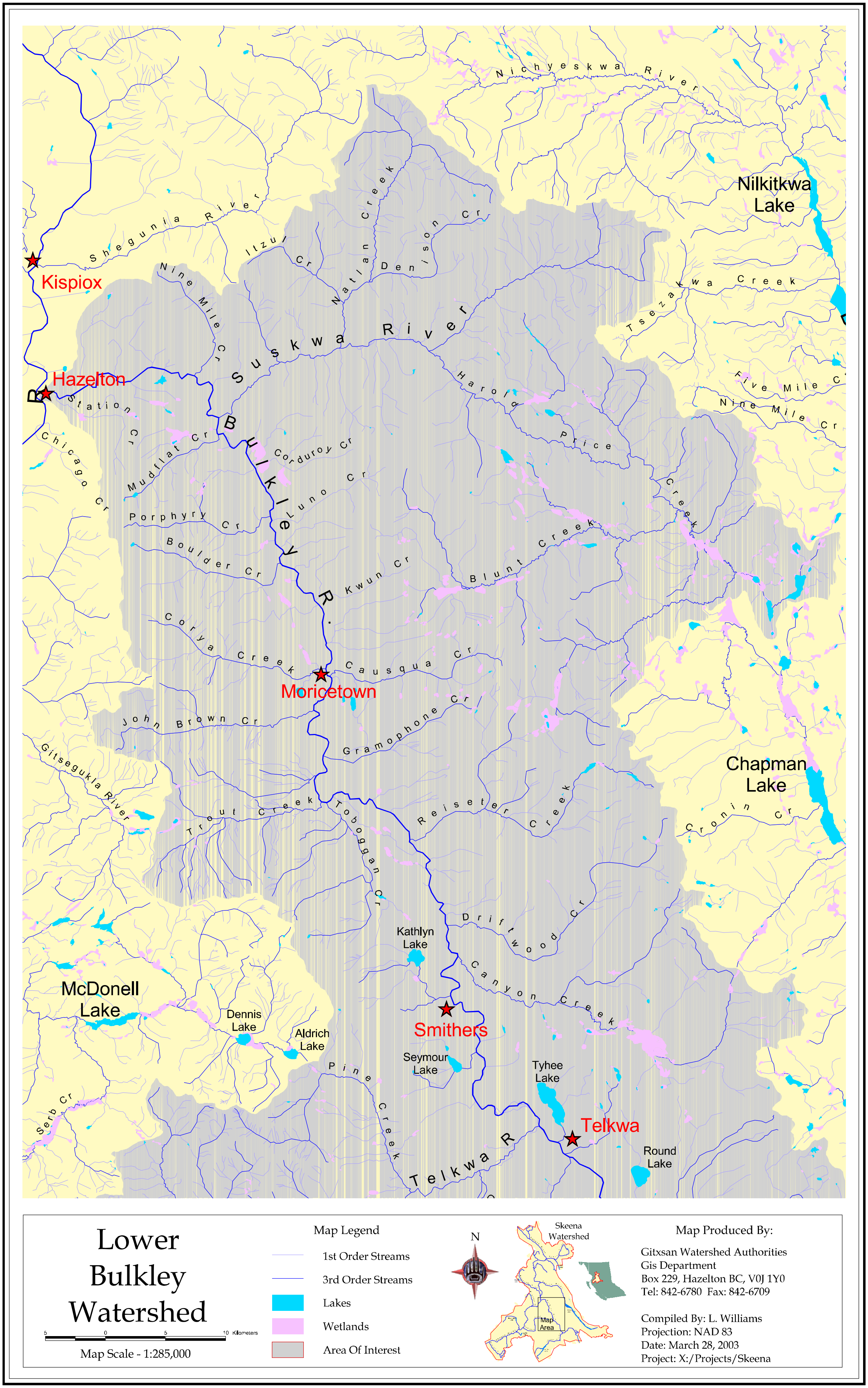
3.1.1 Hydrology

The lower Bulkley drainage is for the most part mountainous with high relief. The Bulkley River valley forms the physiographic boundary between the southern Skeena Mountains to the north and east, and the Hazelton Mountains to the south and west. Elevations range from 2,504 m at Brian Boru Peak in the Rocher Déboulé Range and 2,362 m at Netalzul Mountain in the Babine Range to 252 m at the Bulkley–Skeena confluence. Moricetown Canyon lies at approximately 366 m, while the Bulkley–Telkwa confluence lies at 500 m elevation. The Bulkley Valley is broad and rolling from Telkwa to Moricetown then relatively constricted from Moricetown northwestward to the Skeena confluence. Most tributary streams are relatively short. The only relatively large tributary is the Suskwa River, which cuts through and drains much of the Babine Range.

The one-in-ten-year, 7-day average low-flow estimates for the Bulkley River are 13.7 m^3/s at Quick, upstream of Telkwa, and 15 m^3/s at Smithers (Nijman 1986). The maximum daily discharge for the Bulkley River at Quick is 957 m^3/s. Overall, the hydrology is dominated by snowmelt. Mountains in the Hudson Bay Range, the Rocher Déboulé Range, and the Babine Range exert major hydrological influences; tributary streamflows have a moderately high response from water input due to the high gradients and the lack of water storage in lakes and wetlands of the major tributaries.

Peak discharges from the Bulkley River and the major tributaries typically occur in May and June due to snowmelt, then decrease until late September, when fall rains and early snowmelt increase stream flows until the end of October. Stream flows decline in late November and December when precipitation falls as snow, with minimum discharges recorded in January through March, prior to snowmelt.

The coastal/interior climate transition is reflected in the distribution of the major ecological zones. The wide valleys of the Skeena, Bulkley, and Suskwa allow warm, humid coastal weather systems to penetrate, thereby losing their warmth and moisture gradually. The climate is predominantly characterized by a mild, moist growing season, and light to moderate snowpacks. Depending on elevation, snowpacks typically last from six to eight months, and average annual precipitation varies from 500 to 1200 mm, increasing at higher elevations and with more coastal position. Precipitation is greatest in the fall and early winter and then generally uniform throughout the year. Summer convective storms are common but rarely deliver more than 20 mm of rainfall in a day. Weather stations operate in the Hazeltons, Smithers, Telkwa, and Suskwa Valley. At Smithers Airport, located in the


Nichyeskwa River
Nilkitkwa Lake
Sheguunia River
Kispiox
Itzul Cr
Natlan Creek
Denison Cr
Nine Mile Cr
Suskwa River
Tsezakwa Creek
Hazelton
Station Cr
Harold
Five Mile Cr
Nine Mile Cr
Chicago Cr
Mudflat Cr
Bulkley R.
Corduroy Cr
Price
Creek
Luno Cr
Porphyry Cr
Boulder Cr
Blunt Creek
Kwun Cr
Corya Creek
Causqua Cr
Moricetown
John Brown Cr
Gramophone Cr
Gitsegukla River
Chapman Lake
Trout Creek
Toboggan Cr
Reiseter Creek
Cronin Cr
Driftwood Cr
Kathlyn Lake
Canyon Creek
McDonell Lake
Dennis Lake
Aldrich Lake
Smithers
Seymour Lake
Tyhee Lake
Pine Creek
Serb Cr
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Box 229, Hazelton BC, V0J 1Y0
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valley bottom, mean annual precipitation is 522 mm, with 331 mm of rainfall and 191 mm water equivalent of snowfall.

There are seven hydrometric stations located in the lower Bulkley drainage, which have recorded flows on the mainstem, as well as several tributaries. Low and middle elevation tributaries tend to experience late summer and fall low water conditions. Snow melt at higher elevations extends the high flow season well into the late summer.

3.1.2 Stream Channels

Generally, most of the stream channels are lightly to moderately incised into the hillslopes, terraces, and valley bottoms. Valley bottom deposits are largely the result of glacial sediment supply that filled in the wider portions of the valley at the time of deglaciation. In the past 10,000 years, rivers have down-cut through most of the glacial fills creating the river benches that favour settlement. Generally the floodplain occupies only part of the valley floor. The floodplain expands when the river impinges upon and erodes the thick older glacial deposits. The few places where this is happens along the lower Bulkley River, contributes much of the fine sediment transported.

The tributaries flowing into the Bulkley River from the mouth upstream to Moricetown are for the most part short, high-energy, and steep-gradient streams that level out only in the last kilometer, or less, before entering the Bulkley mainstem. Sharp relief, with well-defined drainages, marks most of these tributaries and most streams possess stable channel conditions throughout much of their length; however, active fans often characterize the lower reaches. The Suskwa River is a large sub-watershed with significant tributaries of its own.

Moderate size streams flowing into the Bulkley River right bank include: Nine Mile Creek, Suskwa River, Corduroy Creek, Luno Creek, Sharpe Creek, Kwun Creek, Casqua Creek, Gramophone Creek, Reiseter Creek, Driftwood Creek, and Canyon Creek. Moderate size left bank Bulkley River tributaries include Mudflat Creek, Porphyry Creek, Boulder (East) Creek, Corya Creek, John Brown Creek, Trout Creek, and Toboggan Creek.

Figure 7. Station Creek culvert with a 1.5 m outfall drop.
This culvert passing under Highway 16 does not allow fish passage.

The majority of the lower reaches of Bulkley River tributary stream channels have been impacted to an unknown degree from landuse activities – principally transportation, agriculture, and urban developments (Mitchell 1997). Agricultural activities have caused the loss of riparian areas, which contributes to and is linked to runoff issues, reduced streambank stability, and streambank failures. Urban development has led to channelization and loss of riparian areas. The major linear developments occurring in the watershed are the Canadian National Railway and Highway 16, and to a lesser extent BC Hydro transmission lines.

Channelization and installation of culverts blocking or hindering fish passage are seen at numerous locations along the rail line and highway. An example of a perched culvert can be found at the Highway 16 crossing of Porphyry Creek. Both Waterfall and Station Creeks near New Hazelton have had a history of habitat alterations related to railroad and highway construction, and more recently to changes in New Hazelton's water supply and sewage disposal systems (Remington 1996). Coho salmon and steelhead passage up Station Creek is blocked by the poorly installed Highway 16 culvert about 1.6 km above the Bulkley River; a subsequent 5 km of potential coho rearing upstream is inaccessible (DFO 1991c).

3.1.2.1 Bulkley River

From the Skeena confluence upstream to the Telkwa River, the Bulkley mainstem is a single-thread, irregularly sinuous channel with an average gradient of 0.43%. Bedrock outcrops and sills control the channel gradient and location. Sediment production is relatively high due to bank undercutting and surface erosion of fine-textured materials. Bank failures are for the most part due to natural processes and events.

Reach 1 extends from the Skeena confluence 47 km upstream to immediately above Moricetown Canyon. From the Skeena confluence upstream to the Suskwa confluence, the Bulkley River flows through a deeply incised canyon that is approximately 18 km in length. The lower portion is known locally as Hagwilget Canyon and the upper portion as the Bulkley Canyon. The majority of the canyon cuts through bedrock, though the riverbanks are occasionally formed of bedded layers of gravels and sand. The canyons are characterized by swift water with occasional falls, rocks, and rapids.

Figure 8. Hagwilget Canyon upstream of bridge.

Hagwilget Canyon, at Hagwilget Village, was altered in 1959 by Department of Fisheries blasting in an unsuccessful attempt to reverse the abrupt decline of Bulkley River sockeye populations (Harding 1969). At the upstream end of this reach, Moricetown Canyon consists of a bedrock constriction and a short series of cascades that drop approximately 6 m over a 50 m length. Department of Fisheries engineers first blasted a fish pass out at the falls in 1929. More elaborate fishways were constructed prior to the 1951 fishing season.

Figure 9. Moricetown Canyon.

Reach 2 extends 52 km to the mouth of the Telkwa River. The channel is generally confined upstream as far as Canyon Creek, and then occupies a narrow floodplain ranging from 200-500 m in width. The floodplain is mostly composed of gravel and sand and is bordered by the valley sideslopes or river terraces, the latter which have been developed by agriculture and residential interests.

3.1.2.2 Suskwa River

The Suskwa River cuts southwesterly through the Babine Range. Major tributaries into the Suskwa River include Natlan Creek, Thirty-One Mile Creek, and Thirty-Three Mile Creek flowing into the right bank, while Skilokis Creek and Harold Price Creek flow into the left bank. The Suskwa River mainstem is approximately 38 km in length; the 19 km upstream of the Harold Price confluence are usually referred to as the upper Suskwa. Generally, the stream channel is incised into the valley bottom, which is either bedrock or glacial deposits that pose no obstructions to fish passage.

From the mouth upstream, Reach 1 is characterized as being occasionally confined, with an active floodplain and back channels and an average gradient of 1.0%. It extends from the mouth of the river upstream about 3.5 km. The irregularly sinuous wandering channel has occasional islands and frequent point and mid-channel bars. Reach 2 runs upstream to Fifteen Mile Creek and is primarily a canyon entrenched into bedrock. Reach 2 has major bank or valley wall slump zones and an average gradient of 1.0%, with no or discontinuous floodplain. Reach 3 passes from Fifteen Mile to Natlan Creek, and has an average gradient of 1.0%. This reach presents an irregularly sinuous channel that is frequently confined by valley bottom rock outcrops, discontinuous floodplain, and sporadic terraces with alluvial veneer.

Reach 4 with an average gradient of 0.6% is upstream of Natlan Creek and is composed of the 1 km long canyon that is confined by the valley walls. Reach 5 has a wandering gravel bed river configuration and is generally sinuous and largely unconfined, except occasionally by valley bottom benches. This reach is relatively active, having changed channel position since 1975 (Gottesfeld 1995). Reach 5 has an average gradient of 0.6%, is almost 7 km in length, and is bordered upstream by the Harold Price confluence. Reach 6 extends 1.6 km upstream and is occasionally confined between high gravelly terraces. The channel is straight and braided, with extensive gravel and boulder deposition. Reaches 7 to 12 in the upper Suskwa are considerably steeper with gradients ranging from 2.5 to 3.3%. The channel is generally confined or entrenched upstream to Thirty-Three Mile Creek. Upstream of Thirty-Three Mile Creek, the floodplain is developed as the valley opens up into the relatively broad Suskwa Pass.

3.1.2.3 Harold Price Creek

The Harold Price drainage is the portion of the Suskwa Watershed east of the Babine Range on the Nechako Plateau. The relatively high elevation of the watershed maintains a relatively large snow pack, which contributes 60% of the overall Suskwa Watershed streamflow. Blunt Creek, which flows to the east from where its valley cuts a low pass back through the Babine Range, is the major tributary to Harold Price Creek. Reach 1 of Harold Price Creek extends 5.8 km in an irregularly sinuous pattern with occasional islands and frequent point and mid-channel bars at an average gradient of 1.0%. The wandering channel is intermittently confined and unconfined; the active floodplain averages 100 m in width and contains active side and back channels.

Figure 10. Harold Price Creek clearcut to both banks.

Reach 2 extends 4.8 km in an irregular sinuous pattern, with an average gradient of 0.8%, no islands, and occasional gravel bars. The floodplain is discontinuous where present and is frequently confined by the valley walls. Reach 3 extends 6.2 km upstream to the Harold Price Falls. The reach is characterized by an irregular, sinuous, confined channel with an average gradient of 1.1%. Reach 4, 0.12 km in length, is the Harold Price Falls, which is entrenched into bedrock with a large deposit of gravel and woody debris. The falls were a three step series (5, 2, 2 m) until 1977, when the Salmon Enhancement Program funded blasting of the falls and the massive logjam immediately upstream. This blasting effectively flushed the upper Harold Price, although downstream reaches appear to have reached a new equilibrium (Weiland 1995).

Reach 5 extends 2.4 km to the mouth of Maish Creek in an irregular sinuous pattern with an average gradient of 1.0%. Glaciofluvial terraces and a discontinuous narrow floodplain generally confine the channel. Reach 6 extends 8.3 km upstream to the mouth of Blunt Creek in an irregular sinuous pattern with an average gradient of 0.5%. The channel is alternately confined, between low glaciofluvial and fluvial terraces, and unconfined with a few active back channels and sloughs that are a result of naturally occurring avulsions. Reach 7 extends 9.3 km to the mouth of Torkelson Creek with irregular meanders through a series of swamps and broad wetlands.

3.1.2.4 Natlan Creek

Natlan Creek is a large southward flowing tributary to the Suskwa River. Reach 1 extends upstream to the Denison Creek confluence. This reach presents a sinuous channel pattern that is occasionally confined or entrenched, with an average gradient of 1.7% and a discontinuous floodplain. Above Reach 1, Denison Creek, Natlan Creek, and Iltzul Creek are all confined or entrenched by valley walls, with moderate gradients that range from 3 to 10%. The channels are dominated by riffles with occasional pools and runs.

Since the late 1970s, the channel of Natlan Creek has been undergoing modification in the upper 7 km and from 2 km above Denison Creek downstream to the mouth (Gottesfeld 1995). There is evidence of moderate widening along with a moderate increase in coarse sediment within the channel. This exists alongside a significant increase in landslide activity. The stream bank failures involve floodplain deposits and bluffs of fluvio-glacial terraces overlying thick till deposits.

Along the north side of Iltzul Creek, the existing quiescent slumps have potential for large-scale mass wasting. The slumps are in thick till, as well as in an area of drainage concentration. If these slumps reactivate, there would be serious long-term consequences for downstream anadromous fish habitat (Gottesfeld 1995).

3.1.3 Water Quality

The monitoring station most relevant to the Lower Bulkley is at Quick, upstream of Telkwa. It shows the water as soft, with a near neutral pH and moderate colouration due to wetlands in the drainage; water quality is relatively good (Wilkes and Lloyd 1990). Upstream influences includes mining, linear development, urbanization, agriculture, and logging; these could potentially change or modify water quality of the lower Bulkley River.

Five urban settlements all discharge wastewaters into the Bulkley River: Telkwa, Houston, Smithers, Moricetown, New Hazelton, and Hagwilget. Two municipal solid waste landfills and two woodwaste landfills may also affect Bulkley River water quality. There are seven water withdrawal licenses from Telkwa downstream to Canyon Creek on the Bulkley mainstem: irrigation (4), domestic (1), waterworks (1), and industrial (1). Water withdrawal licenses on tributary streams are unknown.

The watershed generally has good water quality as shown by Site 0400204 located near Smithers; however, during flood events or streambank failures, water quality is compromised. Overall, describing water quality in the lower Bulkley drainage is complex due to the generally intensive land use in the mainstem valley bottom and wide-ranging forest development activities at middle to high elevations. Cumulative effects are unknown. How water quality is affected in relation to land use activities, particularly forest development, is not well understood. Major concerns include runoff changes in logged and roaded areas, temperature changes in streams, sedimentation, and effects to the physical stream structure.

Jumbo Creek, which drains a portion of the Denison Creek uplands, is an example of modified water quality in the drainage. Forest development activities in five cutblocks in the mid-1980s modified the water quality and flows in Jumbo Creek, which drains an area of 650 ha. The total logged area represents 167 ha, or 25.7%. This is well above the limit of 18% clearcut harvesting that begins to affect streamflow according to Bosch and Hewlett (1982).

The impacts of logging have affected snowmelt and rain-on-snow generated peak flows, summer low flows, and sediment generation. These dynamics in turn have accelerated erosion, caused channel changes, and produced aggradation (Rabnett 1997b). These effects were complicated by a logging-related avulsion originating from Xsa Anax Siin (unnamed on government maps) into Jumbo Creek, causing a debris torrent. Other effects include lowered water quality for domestic use and negative effects on juvenile coho, chinook, and steelhead juvenile rearing habitat.

3.1.4 Geography

Located within the watershed are a diverse assemblage of basins and ranges and a portion of the Nechako Plateau. This produces a diversity of vegetation, climate, and landscape. The lower Bulkley drainage is composed of three broad physiographic landforms characterized by isolated mountains highly dissected and separated by the prominent Bulkley, Harold Price, and Suskwa valleys.

The lower Bulkley drainage is for the most part mountainous with high relief. The Bulkley River valley forms the physiographic boundary between the southern Skeena Mountains to the north and east and the Hazelton Mountains to the south and west. The Babine Range lies within the southern Skeena Mountains. The Hazelton Mountains are composed of the Bulkley Range, which breaks down locally into the Rocher Déboulé Range and the Hudson Bay Range.

The Bulkley Valley and the upper Harold Price are located on the northwestern margin of the relatively low relief Nechako Plateau, where it fingers into the mountains. The Nechako Plateau, which is generally thought of as being below 1,500 m in elevation, passes by transition into the Skeena Mountains approximately between Moricetown and Evelyn, though the boundary is a gradual one. To the south and east, the topography consists of broad and rolling landforms, while to the north and west, the valley is relatively constricted from Moricetown to the Skeena confluence.

The Babine Range to the northeast and Hudson Bay and Rocher Déboulé Ranges to the southeast present striking views as they rise out of the Bulkley Valley. These mountains, along with Mount Thoen and Netalzul Mountain within the Suskwa drainage, possess substantial pocket glaciers mostly on their northeastward-facing cirque basins. The ice that covered and flowed down the Bulkley and Suskwa Valleys during the last glacial period forcefully glaciated the mountain slopes and basins, leaving a legacy of glacial erosion and depositional features.

Pleistocene ice overrode most of the drainage a number of times. Glaciers moving along the major valleys caused oversteepening of mountain slopes and contributed to the present-day U-shaped valley profiles, while the rounded summits are the result of ice moving across the mountain ridges. Above 1,500 m, alpine glacial activity significantly modified the high country. At the peak of the last glaciation, ice in the Bulkley Valley flowed coastward through a number of low passes. Ice in the Babine Lake area flowed to the east across the upper Fraser watershed.

Figure 11. Grassy Mountain slide, 2001.

Glacial and post-glacial deposits cover the lower gentle-to-moderate slopes and infill the broader sections of valley floor. Deposits formed before the last glaciation are found at depth in parts of the Bulkley Valley near Smithers. Thick blankets of glacial till from the last Ice Age cover the main valley and mountain valleys, and extend up the valley sidewalls, though bedrock is exposed along deeply incised streams and on steep-sided hillslopes. Thin soils, colluvium, and rock outcrops characterize the upper mountainsides. A morainal veneer is often found on many mid -slope positions, while upper areas are dominated by rock and colluvium.

The Nechako Plateau is an area of low relief, with large expanses of rolling country where glacial drift is widespread and the majority of bedrock is obscured. During the Fraser Glaciation, the plateau experienced complex patterns of glacier movement and sedimentation associated with multiple phases of ice flow (Stumpf 2001). During deglaciation, remnant ice disrupted drainage patterns, ponded proglacial lakes, and created eskers and meltwater channels. In many of the wider portions of the lower Bulkley valley, river terraces formed after deglaciation. They are generally composed of several meters of gravel and occasional pockets of organic terrain overlying thick deposits of till and other glacial sediment.

3.1.5 Forests

Other than the mountainous high country, the majority of the lower Bulkley drainage is covered with dense, coniferous forests. Smaller, but significant patches of deciduous forest occur over the low elevation valley bottoms and lower mountain slopes along the Bulkley Valley and on the north side of the Suskwa as far east as 28 Mile Creek. Within the watershed, principal forest types are represented by three bio-geoclimatic ecosystem classification (BEC) zones: the Interior Cedar Hemlock (ICH) zone, the Sub-boreal Spruce (SBS), and the Engelmann Spruce-Subalpine Fir (ESSF) zone.

The Interior Cedar Hemlock (ICH) zone occupies valley floors and mountain slopes with a transitional coast-interior climate, that is to say the more coastal climate portions of the lower Bulkley. The ICH zone characterizes the low-elevation coniferous and deciduous forests as far east as Moricetown in the Bulkley Valley and in the Suskwa drainage as far east as the lower Harold Price. Major tree species in this zone are western hemlock, spruce, pine, and subalpine fir with local stands of red cedar. Considerable deciduous and coniferous seral stands are present because of frequent aboriginal landscape burning over long periods of time.

The Sub-Boreal Spruce (SBS) zone characterizes the lowland coniferous forests of the central interior of B.C. These forests occupy the portions of the lower Bulkley watershed with a more continental climate. Subalpine fir and hybrid spruce are the major tree species; subalpine fir stands tend to dominate older, high elevation stands and moister sections of the zone. Due to a relatively intense natural and aboriginal fire history, lodgepole pine seral stands are extensive, particularly on stream terraces and south aspect slopes.

The ICH and SBS zones merge into the Engelmann Spruce-Subalpine Fir (ESSF) zone at higher elevations ranging from 900 to 1300 m, depending on local topography and microclimate. The ESSF zone possesses a shorter, cooler, and moister growing season, with continuous forests passing into subalpine parkland at its highest elevations. Subalpine fir is dominant, with lesser amounts of lodgepole pine and white spruce hybrids in drier or fire-influenced areas.

3.1.6 Geology

The bedrock of the lower Bulkley drainage is mostly of Mesozoic age. The Bulkley Valley is underlain by rocks of the Stikine Terrane almost entirely of Mesozoic age. The middle Jurassic rocks were deposited in a former island arc system. Volcanic activity produced great quantities of volcanic flow rocks such as basalt and andesite, as well as ash and mudflows. In the late Jurassic, these island arcs were pushed into and accreted with the North American continent. The Bowser Lake Group is a series of marine and non-marine sedimentary rocks that were formed during and after this accretion. Massive and rapid erosion caused the deposition of volcanic sand and mud. The Bulkley Valley area was located along the southern edge of the Bowser Basin and shoreline sediments prevail (Gottesfeld 1985).

In the early Cretaceous Period, tectonic uplift caused the area to be pushed up, initiating mountain building. The primarily volcanic Skeena Group of rocks formed between 120-100 ma. This group is a series of lava flows interspersed with sediments in a shallow sea and coastal plain river environment, which included large swampy areas where peat and plant life accumulated to form coal beds.

In the late Cretaceous from 100 to 65 ma, the area was uplifted with volcanic and plutonic activity creating the Bulkley and Babine Intrusives, which are chiefly composed of granitic and porphyritic rocks. These intrusions into the sedimentary and volcanic rock sequence occurred at relatively shallow depths. Alteration zones around the intrusions host metallic mineral deposits. These alteration zones are in close proximity and relationship to the three major faults that occur throughout the watershed.

3.2 FISH VALUES

Fisheries values are high within the lower Bulkley drainage. Coho, pink, sockeye, and chinook salmon, as well as steelhead characterize anadromous fish presence (FISS 2002). Freshwater resident fish presence includes cutthroat trout, Dolly Varden, rainbow trout (steelhead), mountain whitefish, bull trout, prickly sculpins, longnose dace, lamprey, and red-sided shiner (FISS 2002, WLAP 2002). In general, the most widely dispersed salmon species is coho, while Dolly Varden, rainbow trout, and mountain whitefish are widely distributed non-anadromous species.

3.2.1 Chinook Salmon

The lower Bulkley River is an important migration route for adult chinook passing through to the upper Bulkley and Morice systems, as well as to tributaries in the lower Bulkley drainage that sustain chinook spawning. There is no known chinook spawning in the lower Bulkley mainstem. Significant amounts of chinook are harvested at Moricetown Canyon in the aboriginal fishery. Bulkley River tributaries supporting chinook include the Suskwa system and John Brown Creek where they have been observed at 0.4 km; however, spawner abundance and spawning locations are unknown.

Adult chinook salmon begin their migration into the Skeena River usually in the third and fourth weeks of July, arriving at the Suskwa River throughout the month of August, with the peak of spawning usually from mid to late August. Suskwa River chinook spawners use the upper half of Reach 5, which is the wandering gravel bed downstream of the Harold Price confluence, and the lower 3 km of Harold Price Creek. These two spawning grounds dominate chinook production. Hancock *et al.* (1983) note chinook spawning grounds on Natlan Creek upstream to Denison Creek.

Suskwa River chinook escapement estimates have been recorded discontinuously since 1960, and since that time, escapement has been generally low. In 1960, Suskwa chinook population was estimated at 400. Escapements from 1961 to the present range from 10 to 250 (DFO 2005). Suskwa chinook spawner numbers have not recovered in the past two decades as many other Skeena chinook stocks have. Population levels are depressed and it is unknown if this stock has adequate escapement for sustainability. There is concern on the part of aboriginals, the public, and fish managers regarding the present and future status of Suskwa chinook. The present level of chinook escapement does not suggest a stable population level or long-term survival of this population.

3.2.2 Pink Salmon

Pink salmon are exclusively two years old at spawning time, meaning that odd and even-year stocks are genetically separate. Pink salmon arrive in the lower Bulkley drainage in mid to late August and small populations spawn in seven known tributaries.

3.2.2.1 Lower Bulkley Pink Salmon

Station Creek supports pink salmon spawning from the mouth upstream to a falls at 0.5 km. Wide fluctuations in escapement have ranged from highs of 3,500 in 1955, to 25 in many years. Spawning has been observed at 0.2 km in Boulder (East) Creek with abundance unknown. Casqua Creek supports pink spawners in the lower 0.2 km with five escapement records since 1950 that range from 0-1,000. Casqua Creek is subject to seasonal water fluctuations, which in the past have been exacerbated by industrial mining and logging activities.

John Brown Creek has no documented counts, but pink salmon were observed by Triton (1998c). Pink salmon have been observed on the fan at the mouth of Trout Creek, where spawning may or may not occur. Toboggan Creek supports spawners to 8.0 km, but most spawning occurs on the fan at the mouth. Since 1950, the escapement has varied from 0-20,000, though in most years, it ranges from 300-1,000 pinks. Kathlyn Creek supports a small population of pink salmon that apparently spawn 1.2 km upstream to Chicken Lake Creek confluence. Escapement has ranged from 0-2,500 in five enumerations recording spawners since 1950.

3.2.2.2 Suskwa Watershed Pink Salmon

Adult pink salmon usually migrate upstream on the Suskwa River arriving August 15, with the peak of spawning in mid-September. The principal spawning ground is the lower Suskwa mainstem in Reach 1 and 2, particularly from the mouth upstream 2.8 km. Other minor spawning areas include Reach 3 up to the canyon cascade east of Natlan Creek. Jantz *et al*. (1989) noted pink salmon presence in Harold Price Creek, though this may only occur in years of high abundance. Spawner escapement has been recorded discontinuously since 1967. Spawners have ranged from 0-5,000, with most years returning 100-500 pink salmon.

3.2.3 Coho Salmon

Coho life histories, particularly during the freshwater period prior to smolting, are not well known in the Bulkley Watershed. Coho juveniles and adults are relatively widely dispersed throughout the lower Bulkley drainage. Coho migrate into the Skeena River between late July and the end of September as recorded by the Tyee test fishery, with the annual peak of the migration in late August. Daily counts of coho through the Moricetown Canyon fishways during the late 1950s to the mid-1960s showed coho arriving in late July to early August, with peak abundance during mid-August.

Coho typically move to the outlet of various tributaries or pools to hold. Depending on water flow conditions, coho will wait for fall floods before moving into the tributaries from late September to late November to spawn. Coho are usually the last salmon to spawn in the fall, from the end of September through December.

3.2.3.1 Lower Bulkley Coho Salmon

Overall, the Bulkley River system coho has shown a serious decline since the 1970s, particularly in the Morice and upper Bulkley sub-basins. The extent of the decline in the lower Bulkley drainage is difficult to evaluate, as only Kathlyn and Toboggan Creeks have a near complete escapement data set from 1950. At this time, most of the coho production (74%) comes from Toboggan Creek, which has been augmented by the Toboggan Creek Hatchery since 1988.

Toboggan Creek is a somewhat singular sub-drainage in the lower Bulkley Watershed, in that it has a hatchery, operates a wild smolt trap, and enumerates returning adults. The hatchery, which has the capacity to rear 155,000 coho and chinook smolts on a yearly basis, augments chinook and coho stocks in various sub-basins of the watershed. An adult counting fence operating since 1988 provides accurate enumeration of coho adults. Beginning in 1995, hatchery smolts were marked with CWT and adipose fin clips prior to release, and wild smolts have been enumerated with fyke and rotary screw traps (SKR 1999). This coho index program lends itself to studies in freshwater survival, age distribution at smoltification, migration timing, and recruitments of coho juveniles.

Figure 12. Beach seining below Moricetown Canyon. Seining is part of the mark-recapture project.

Coho spawning enumerations in Toboggan Creek have been continuous since 1950, with fence counts since 1988. Since 1950, coho adult escapement has gradually increased with annual averages of 2,711. Spawning is scattered throughout the mainstem up to Toboggan Lake and into the tributaries that include Owen, Elliot, and Glacier Gulch Creeks.

Station Creek supports coho spawning from the mouth upstream 1.6 km to the Highway 16 crossing, which blocks fish passage since the culvert is a migration and velocity barrier (Mitchell 1998). Escapement ranges from 0-300 coho with an annual average from a discontinuous enumeration record of <250 fish. In 1993, coho were transplanted from Toboggan Creek to Station Creek, and since 1998, a counting fence facilitated enumeration and allowed easier transportation of a proportion of the returning adults above the impassable culvert (Houlden and Donas 2002b). There are anecdotal reports of coho spawning in the lower reach of the un-named creek west of Corduroy Creek, Corduroy Creek, and Luno Creek. Trout Creek sustains coho spawning 1.6 km upstream to the falls with a range of 0-300 spawners, although there have been no enumerations since 1970.

Reiseter Creek sustains coho, with discontinuous escapements records ranging from 0-400 spawners. Spawning is scattered throughout the lower 2.5 km, with seasonal water fluctuations presenting difficulties to coho entering the creek (Hancock *et al*. 1983). Driftwood Creek supports coho spawners with escapement ranging from 50-300, averaging 150 coho most years according to discontinuous enumerations. Hancock *et al*. (1983) noted that spawning locations extended upstream approximately 25 km in Driftwood Creek.

Canyon Creek supports coho spawning with escapements that range from 0-400 coho, though the enumerations are for the most part from the 1950s and 1960s. Hancock *et al*. (1983) reported two principal spawning locations located at 1.5–2.5 km and 6.5–7.5 km on the mainstem. Canyon Creek is subject to seasonal water fluctuations and beaver activity. In the late 1980s, Canyon Creek was stocked with coho fry from Toboggan brood stock.

Kathlyn Creek has a near continuous escapement record since 1950, which ranges from 10-500 coho. Since 1986, coho fry and smolts from Toboggan Creek wild broodstock have been transplanted into the Kathlyn Creek system, the majority of which were released into Kathlyn and Club Creeks (Toboggan Creek Hatchery 1999, DFO 2002). The principal coho spawning is located in Simpson, Kathlyn, and Chicken Creeks downstream of the lake and in Kathlyn and Club Creeks upstream of Lake Kathlyn in pockets of good gravel.

3.2.3.2 Suskwa Watershed Coho Salmon

Discontinuous records show aggregate coho escapements for the Suskwa sub-basin ranging from 25-2,500, with no records since 1992. Coho spawning is principally located in the upper half of the wandering gravel bed, Reach 5, in the Suskwa mainstem. Dispersed spawning occurs upstream to 10 km on Natlan Creek and possibly in the Suskwa mainstem 1.5 km upstream of the Harold Price confluence, though channel morphology in the latter reach has greatly changed over the last decade due to a combination of natural and logging-related events.

Figure 13. Beaver pond on lower Jumbo Creek.
This site is a highly productive coho nursery pond.

The primary spawning location in Harold Price Creek is the lower 2.5 km stretch of good gravel. Coho also spawn to a limited degree in unknown locations in the upper Harold Price, most likely in Blunt Creek and/or its tributaries. In 1999, the Suskwa Coho Synoptic Survey was established to provide information on coho salmon abundance and distribution in the Suskwa River Watershed (McCarthy 2000). This short-term program organized twenty-one sample sites that focused on side-channels and tributaries along 20 km of the Suskwa River and Harold Price Creek. One Suskwa River site, lower Jumbo Creek, had juvenile coho densities over 1.0 fish/m^2; the densities at all other sites had less than 0.5 fish/m^2. Sites sampled in Blunt Creek yielded coho juveniles in very low numbers.

3.2.4 Steelhead

Lower Bulkley River drainage steelhead are highly significant in a provincial and regional context. This is predominantly due to their being a food source and cultural symbol to the local First Nations, as well as to their angling popularity and their ecological role. The lower Bulkley drainage supports a summer-run steelhead population that enters the mouth of the Skeena in late June or July, arriving in the Bulkley system beginning in August and continuing into autumn.

Beere (1991b) reported that of the twenty-three summer-run steelhead radio-tagged in the lower Bulkley mainstem downstream of Moricetown Canyon, only five migrated upstream through the canyon. At least twelve of the twenty-three migrated downstream to the Suskwa–Bulkley confluence or entered the Suskwa River to overwinter. This is consistent with the findings of Lough (1980), who found that four of the six steelhead radio-tagged at the Suskwa–Bulkley confluence overwintered in the Bulkley mainstem as far as 12 km upstream.

Overall, the Tyee Test Fishery best estimates escapement to the Skeena Watershed. Total summer-run escapement estimates based on the Tyee index data are available starting in 1956. Overall, Skeena steelhead declined from about 1985 to 1992. Changes to steelhead populations in tributary watersheds in the Skeena are hard to identify. The most useful source of data is the Steelhead Harvest Analysis (Ministry of Water, Lands and Air Protection 1991). In general, the pattern of catch reported for the Bulkley River shows an increase in fishing effort and catch over the past thirty-five years, with the pattern of total catch, including released fish, resembling the Tyee Test Fishery estimates for summer-run steelhead. Recently, Mitchell (2001a) and SKR (2001) reported Bulkley–Morice steelhead population estimates based on the Wet'suwet'en Fisheries tagging program conducted downstream of Moricetown Canyon.

Few good data record steelhead escapements at individual streams. This is in large part because they spawn in spring at high water conditions when counts are usually not possible, and they are typically spread out at many sites within a stream.

3.2.4.1 Bulkley Watershed Steelhead

Steelhead adults have been observed at the mouth of Station Creek, though actual spawning locations are unknown (DFO 1991c). The lower 2 km, an unconfined reach of Gramophone Creek sustains steelhead spawners. Trout Creek has steelhead presence upstream to the falls and the reach above the falls was stocked with steelhead fry and parr (approximately 164, 000) intermittently since the mid-1980s (DFO 2002). Kathlyn Creek system has steelhead presence in Kathlyn Lake and spawning has been observed upstream of the Chicken Creek confluence.

Toboggan Creek supports steelhead spawning to 1.5 km above Toboggan Lake. Between 1995 and 2001, Toboggan Creek hatchery operated a counting fence to enumerate adults. Spawning is primarily scattered on the mainstem upstream of the counting fence, which is located at 2.5 km from the mouth.

3.2.4.2 Suskwa Watershed Steelhead

Suskwa steelhead are summer-run fish that enter the Suskwa system in late August or early September. Suskwa steelhead are noted for their large body size, deepness through the body, and in the past, their abundance. This made them the basis of an international sport fishery that continues into the present, though on a smaller scale (Chudyk 1978).

The 1979 radio telemetry project (Lough 1980) noted that all steelhead wintered at or below the canyon just upstream of Natlan Creek or relatively close to the Suskwa–Bulkley confluence. Steelhead spawning occurs the following March through May, coinciding with warming water temperatures and an increase in Suskwa River flows. In 1982, the average age of 27 steelhead spawners sampled was 4.2 years, while the repeat spawners averaged 8.6% for 1977, 1979, and 1982 (Schultze 1983). Results from the radio-tagging program (Lough 1980) indicated spawning is dispersed in side and main channels on the mainstem throughout the system below Harold Price Falls. Steelhead fry emerge between mid-August and mid-September and widely disperse throughout the system and in the smaller tributaries that offer suitable refuge.

In the mid-1970s, lack of angler success and conservation concerns in regard to Suskwa steelhead initiated a revitalization program under the auspices of the Salmon Enhancement Program (SEP). Through SEP, the BC Fish and Wildlife Branch (BCFW) developed a three-point program designed to increase the number of returning steelhead and thereby improve angler success (Chudyk 1978). The three-point program included an assessment of potential stocks and habitat within the watershed, the removal of Harold Price Falls as a fish barrier, and the colonization of steelhead in the upper Harold Price.

Modification of the one-step falls to a three-step falls allowing fish passage was successful; coho adults have been observed upstream of the falls. From 1979 to 1988, 257,000 marked steelhead fry were released above the falls, but returns were dismal. Up to the present time, adult steelhead do not appear to pass above the falls.

3.2.5 Indigenous Freshwater Fish

In comparison to salmon, information is scant in regard to resident freshwater fish in both the river and lake habitats of the lower Bulkley drainage. Freshwater species and documented populations inhabiting the lower Bulkley drainage include rainbow trout (*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarki clarki*), bull trout (*Salvelinus confluentis*), Dolly Varden char (*Salvelinus malma*), river lamprey (*Lampetra ayresi*), Pacific lamprey(*Lampetra tridentata*), mountain whitefish (*Prosopium williamsoni*), longnose dace (*Rhinichthys cataractae*), redside shiner (*Richardsonius balteatus*), and prickly sculpin (*Cottus asper*).

3.3 FISHERIES

3.3.1 Gitxsan and Wet'suwet'en Fisheries

The salmon stocks passing through and spawning in the lower Bulkley formed the principal food resource that enabled Gitxsan and Wet'suwet'en people to make the area their home. The Gitxsan and Wet'suwet'en salmon fishery at Hagwilget Canyon was likely one of the largest aboriginal fisheries on the Skeena system, along with the large fisheries at Kisgegas and Wud'at on the Babine River. Relative to its history, Hagwilget Canyon fishery currently functions on a small scale. In the past, the Moricetown Canyon fishery fulfilled the food, societal, and ceremonial (FSC) needs of the Wet'suwet'en; however, recent sockeye escapements in the Morice and upper Bulkley systems have been so low as to preclude sockeye fishing. The Bulkley and Suskwa Rivers possess a high-value, steelhead sport fishery conducted by shore and boat-based anglers.

3.3.1.1 Bulkley Watershed Fisheries

Gitxsan and Wet'suwet'en traditional salmon fisheries within the lower Bulkley drainage were concentrated at four principal locations on the Bulkley mainstem: Hagwilget Canyon downstream of Hagwilget Village, Hagwilget Canyon at the village, Bulkley mainstem upstream of the Suskwa confluence, and Moricetown Canyon.

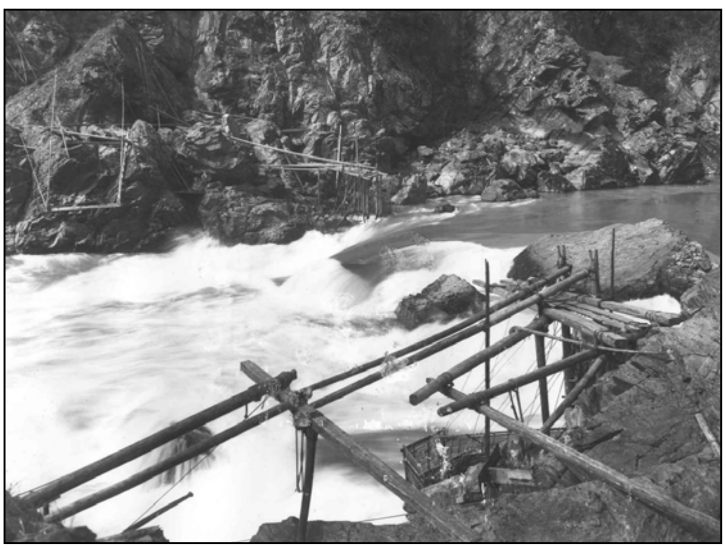


Figure 14. Hagwilget Canyon fishing platforms.
BC Archives.

The salmon fishery in Hagwilget Canyon downstream of Hagwilget Village was fished by Gitxsan, who utilized more than twenty sites on both the north and south bank (GWA 2003a). Gitxsan fished nine sites on the right bank in Hagwilget Canyon opposite Hagwilget Village, and the Wet'suwet'en fished twelve sites on the left bank (Gitksan and Wet'suwet'en Chiefs 1987). The majority of these canyon sites were not fished after the winter of 1958-59, when the Department of Fisheries blasted the rocks that helped to concentrate fish close to the canyons walls.

Figure 15. Part of a hlamgan trap in Hagwilget Canyon.
BC Archives.

An Naa Wildam Ax, also known as Dizkle, was a large village located on the Bulkley mainstem, 1.5 km upstream of the Suskwa confluence. This primarily Wet'suwet'en village fished eight nearby sites, as well as operating a weir. In Moricetown Canyon and below the canyon, Wet'suwet'en fished twenty-two known trap and gaff sites. Presently, the majority of FSC fishing at Moricetown Canyon is with dipnets.

According to current knowledge, dispersed fisheries operating on the Bulkley mainstem included nine camps between Boulder Creek and Moricetown Canyon and eleven camps upstream of the canyon to the Telkwa River confluence (Wet'suwet'en Fisheries 2003). These dispersed fisheries that mainly targeted coho and steelhead were often positioned at tributary mouths to easily exploit the fish resource. Dispersed fisheries away from the Bulkley mainstem included the fisheries at the outlets of Toboggan and lower Reiseter Lakes (Rabnett *et al.* 2001).

3.3.1.2 Suskwa Watershed Fisheries

Gitxsan primarily fished the Suskwa mainstem. Wet'suwet'en fished the upper and lower Harold Price. The largest fishery was located at An Djam Lan, also known as C'ee Ng'heen, which was adjacent to the Harold Price–Suskwa confluence. This fishery seasonally targeted chinook and coho utilizing a weir, and steelhead using nets under the ice. Downstream at the Natlan Creek confluence, and at Anx Milit, steelhead were fished in the early spring prior to ice break-up (GWA 2003a).

Dispersed seasonal fisheries in Harold Price Creek included steelhead fisheries in the canyon located at approximately 9.5 km, and downstream of the falls at 16.7 km. Ax Kegh Nee Tay, also known as Laydlii, which was located at the Blunt–Harold Price confluence, and Loots Wenii Cguunget Hozaay, located at the outlet of Touhy Lake, were sites to seasonally exploit freshwater fish.

Figure 16. Moricetown Canyon fishery, 1946. Fisheries Research Board of Canada.

3.3.2 Recreational Fisheries

The Bulkley and Suskwa Rivers support large-scale, seasonal recreational angling by local-area residents and non-resident visitors. The Bulkley mainstem is Class II waters September 1–October 31. Suskwa River and tributaries are Class II waters all year. The majority of recreational angling on the Bulkley mainstem is divided into two relatively distinct fisheries of equal proportions: the non-resident angling fishery and the area resident fishery (Morten and Parkin 1998). Hall and Gottesfeld (2001) reported that the majority of anglers fishing for coho at the Bulkley/Skeena confluence are local residents. The Bulkley River fishery is conducted from the river shore or by power and float craft. The Suskwa River sports fishery is almost exclusively shore-based.

The river sport fishery is primarily steelhead angling, though chinook may also be harvested. Pink and coho openings are held in years of abundance. The majority of steelhead angling effort occurs over approximately a ten-week period from early September through mid-November. Peak activity is commensurate with the period most anglers feel provides the best combination of steelhead availability – good weather and clear water – usually from mid-September to late October. Water clarity of the Bulkley River is usually good relative to other nearby steelhead rivers, but the Telkwa River, which provides the majority of turbidity from heavy rainfall or warm weather, can produce poor angling conditions downstream.

The use of boats – both power and drift boats – by local anglers, guides, and non-residents is a major feature of the steelhead fishery. Boat launches are located close to the Skeena confluence, adjacent to the Suskwa Forest Service Road (FSR) crossing of the Bulkley River, on the left bank downstream of Moricetown Canyon, at Trout Creek, and at Lunen Road immediately east of Smithers. Most of the fishing activity occurs in the most navigable water, from Trout Creek upstream to Telkwa River (Morten and Parkin 1998).

Most angling on the Suskwa River occurs on the lower 4 km section downstream of the canyon. Improved access by the Suskwa FSR Bridge crossing of the Bulkley River in 1967 provided greatly increased steelhead fishing opportunities. Presently, the status of Suskwa steelhead is unknown. Angling for steelhead typically occurs from mid-September to the end of October, though the timing is dependent on river clarity.

Seven angling guides are licensed to operate on the Bulkley River with a set quota of guided rod days that total 1,504 for the entire river. Although annual angling regulations specific to the Bulkley River may change, generally they include a bait ban and no fishing January 1 to June 15. Class II Waters apply from September 1 to October 31, with a mandatory steelhead stamp. Angling regulations specific to Suskwa River include a bait ban and Class II Waters year round; as well, a Steelhead Stamp is mandatory September 1-October 31 (Anonymous 2002). "Classified waters," mean that a special license must be purchased by anglers over and above the basic angling license.

3.3.3 Enhancement Activities

Enhancement activities in the Lower Bulkley Watershed consist of two major fish projects in Hagwilget and Moricetown Canyons and the Toboggan Creek Hatchery program. The present Moricetown Canyon fishways were constructed in 1951. Concerns regarding the low number of returning Nanika sockeye in 1955 led to the decision to remove obstructions in Hagwilget Canyon. The canyon rocks were blasted in 1958, effectively eliminating the aboriginal fishery in the canyon.

Toboggan Creek Hatchery, which has the capacity to rear 155,000 coho and chinook fry and smolts on a yearly basis, augments chinook and coho stocks in various sub-basins of the watershed. Most fry and smolt raised are released in the upper Bulkley drainage. The species summaries include details of juvenile releases. Minor enhancement programs such as incubating and rearing occur through community and school programs.

The Salmon Enhancement Program altered fish passage at the Harold Price Falls in attempt to introduce coho and steelhead to the upper Harold Price. Modification of the one-step falls to a three-step falls allowing fish passage was successful; coho adults have been observed upstream of the falls. From 1979 to 1988, 257,000 marked steelhead fry were released above the falls, but returns were dismal. Up to the present time, adult steelhead do not appear to pass above the falls.

3.4 LAND USE DEVELOPMENT ACTIVITIES

Land use in the lower Bulkley drainage is relatively intensive in comparison with other Skeena Watershed sub-basins. Over the last forty years, overall land use and development activities in the drainage have greatly increased. The principal land use activity is forestry, which is generally concentrated in the Suskwa and Harold Price drainages, and to a somewhat lesser extent in the Bulkley Valley. Urban development is concentrated in the Hazeltons, Moricetown, and the Smithers–Telkwa areas. Farms and rural residential settlement areas are scattered along Highway 16 east to Moricetown, and then concentrated along both sides of the Bulkley River eastward. Industrial land use occurs to a limited degree close to the urban areas.

Areas protected from development for their ecological, cultural heritage, and/or recreation values are scattered throughout the drainage. Small protected areas include Ross Lake (357 ha), Boulder Creek (48 ha), Netalzul Meadows and Falls (339 ha), Burnt Cabin Bog (646 ha), and Call Lake (62 ha). Babine Mountains and Driftwood Provincial Parks (approximately 39,000 ha) comprise the larger protected areas that are relatively high profile due to their diverse recreational activities, good road access, and proximity to Smithers.

The early part of the 20th century saw extensive mineral exploration in the Babine and Rocher Déboulé Ranges; presently there is little mineral exploration or development in the drainage. Linear development along the southern bank of the Bulkley River accommodates the CN Rail line, Highway 16, and the utilities infrastructure of BC Hydro and Telus. Transportation development has been the key to land use and resource development. Coal bed methane has recently been proposed for the Telkwa Coalfield. With few exceptions, none of the periodic natural resource development booms have lasted long enough or left sufficient of the extracted wealth in the region to create permanent, sustainable development.

3.4.1 Forest Resource Development

The lower Bulkley drainage is located within the Skeena–Stikine Forest District of the Ministry of Forests. Currently, the Ministry of Forests relies on land use management objectives defined in the Kispiox and Bulkley Land and Resources Management Plans (LRMPs). From the late 1960s to the present, the area and volume logged annually has increased from small-scale operations to large-scale industrial operations, especially within the southern and eastern portions of the drainage. These activities have largely led to the disappearance of the viable commercial forests in the Suskwa and Harold Price sub-basins as well as the mid-elevation slopes in the Bulkley Valley. The majority of forest development has been focused on the easily accessible, commercially viable timber.

The post-World War II demand for lumber contributed to the gradual logging of low and mid-elevation stands in the Bulkley Valley. In recent decades the trend to centralization of forest license holding and milling capacity has greatly increased the intensity of logging. Since the early 1970s, road building and logging activities within the Suskwa drainage spread eastward from the sawmill and chipping operations primarily located in the Hazeltons. In the late 1970s, forest development greatly increased in the upper Harold Price area, with timber flowing to sawmills in the Smithers area.

These logging activities have foreclosed on most forestry development options for the near and mid-term future. Overall, current forestry activities are limited for the most part to forest health-related logging and non-timber forest products.

In 1995 and 1996, the Watershed Restoration Program (WRP) was involved in assessing logging related disturbances in relation to fish, fish habitat, and upslope sediment-producing areas within the Suskwa Watershed. The effects of the thirty year history of disturbance were for the most part assessed; however implementation of watershed restoration activities have been limited. A large contribution of the WRP has been to increase awareness in the forest sector of the best management practices regarding water quality, fish, and fish habitat. Watershed health has benefited from the program principally through road deactivation.

3.4.2 Mineral Development

Euro-Canadian explorations for base and precious minerals have occurred since late in the nineteenth century. Early European efforts were focused mainly on high-grade silver and gold-rich veins, with most endeavours slowing down with the onset of the Depression of the 1930s. Silver-lead-zinc ore was discovered on Hudson Bay Mountain in 1905, and in 1908 similar ore was discovered on Nine Mile Mountain at Hazelton. Between 1910 and 1930, development was carried out from time to time on seventy-five groups of claims in these areas (Kindle 1940). Explorations in the mid-Babine Range led to claims on Thoen and Netalzul Mountains that were worked from 1916-1930. Claims in the southern Babine Range were active by 1916 and worked discontinuously until 1974, when the Cronin Mine closed.

The early 1960s saw a resurgence of exploration focused on porphyry-copper-molybdenum style deposits. To date, this style of mineral deposit, modeled on the Granisle and Bell mines of Babine Lake, has been the most promising economic deposit type.

There is known mineralization in the Babine, Hudson Bay, and Rocher Déboulé Ranges, reflecting alteration zones associated with the Bulkley and Babine Intrusives. The main types of mineral occurrences are polymetallic veins containing silver, lead, zinc, copper, gold, and tungsten, and a few large porphyry deposits. The majority of occurrences are located on Hagwilget Peak, Hudson Bay Mountain, and the southern Babine Mountains, followed by smaller amounts on Mount Thoen and Netalzul Mountain. Most of the watershed has been rated moderate to high mineral potential due to the Bulkley Intrusive rocks.

3.4.3 Oil and Gas Development

In December 2003, the B.C. Ministry of Energy, Mines and Petroleum Resources issued a call for proposals to develop coalbed gas resources near Telkwa, B.C. In January 2004, it announced that Outrider Energy would have first rights to explore and develop coalbed methane near Telkwa. No other company expressed interest in the development. There is currently no commercial coalbed methane production in British Columbia. If the Telkwa project were to go ahead, it will be the first in the province. A recent survey shows a broad cross section of local First Nations and residents oppose the development because it threatens the economy, lifestyle, and land. The proposed development undermines and threatens the integrity of the lower

Bulkley drainage, given the potentially devastating impacts of coal bed gas development impacts upon humans, water quality, fisheries, and community values.

3.4.4 Population and Settlement

The Bulkley and Suskwa valleys have been home to Gitxsan and Wet'suwet'en people for thousands of years and landscape utilization within the drainage was extensive and complex. Euro–Canadian settlers arrived following completion of the railroad in 1914, attracted by agricultural, mining, and various work opportunities. This population base remained relatively stable with low growth until the early 1970s, when the forest sector expanded, followed by the government sector in the late 1970s.

The current settlement pattern reflects the past, wherein the valley bottoms contained the easiest travel routes and the most productive agricultural land, as well as providing the best cultural and economic opportunities. Currently, approximately 13,860 people reside within the drainage, in the Hazeltons, Smithers, Telkwa, and surrounding rural areas (RDKS 2002, BC Stats 2003).

Historically and up to the recent past, many Hazelton area people derived their income from the fishing and forestry sectors; however, severe job losses in these sectors have curtailed this income. Presently, most residents derive their income from service sector employment in the Hazelton area. Old and New Hazelton serve as the health, education, and service centers for residents in the northern portion of the drainage. The population trend projects growth for aboriginal communities and a stable rural resident. Presently, housing vacancies exist in New Hazelton and South Hazelton due to the downturn in forestry activities. Recreation and tourism-based incomes are projected to grow over the next decade.

In the southern section of the drainage, Smithers (pop. 5,612) and Telkwa (pop. 1,200) are the main settlement areas. The Town of Smithers serves as the health, government, education, recreation, and service center for the regional area including Moricetown and Fort Babine. Forestry is clearly the most dominant activity in terms of employment and community income, followed by agriculture. Tourism, retail trade, government services, and transportation help to keep the economy relatively buoyant and stable. The agricultural land base, of which approximately 50,000 ha are used as farmland, is mostly suited to dairy farming and ranching, with a focus on beef production and forage crops. A significant amount of Crown rangeland supplements private land for grazing.

Population growth trends are projected to be stable, though closure of the major lumber mill or further downsizing of regional government services could have a moderate impact on the population. Agricultural interests and rural residents help to give stability to the economic base.

3.4.5 Transportation and Utilities

The existing transportation network in the watershed is based on the original Gitxsan and Wet'suwet'en trail network and reflects 120 years of steady development. Trails were initially widened for packhorses, and in some cases later improved for wagons, then further improved for vehicular traffic. The railroad line was completed in 1914, considerably increasing the population and economic activity. The geography of the watershed is sufficiently adverse that both transportation routes and settlement patterns must conform to its restrictive mountain and valley characteristics. Overall, the development pattern has been historically spurred by two motives: first, the development of a transportation network through the area to the sea; and second, the extraction of furs, fish, minerals, and forest products.

Highway 16 is the major road providing access into the lower Bulkley drainage. Forest resource road development throughout the watershed has tapered off and future trends point toward road maintenance responsibilities being off-loaded to industry or dropped altogether. Linear development within the drainage parallels the Bulkley River, the major river trunk system. Highway 16, CN Rail, BC Hydro, and Telus utilize a corridor that is located on the west and south side of the river, taking advantage of the geography and settlement patterns.

Over the last two decades, Highway 16 has assumed an increasingly important role for tourist travel, recreational vehicles, and commercial trucking operations. The largest factors include the trend towards recreational vehicle use, steady improvement of Highway 37, centralization of goods and services to regional focal points, and the growing popularity of coastal ferry traffic.

CN Rail serves the region and connects rail shipments to the rest of the country and to saltwater at Prince Rupert and Kitimat. The route is presently used for the movement of grain to Prince Rupert, for manufactured goods moving westward, and for locally produced wood products moving in both directions. In the mid-1980s, portions of the track were upgraded to a standard sufficient to permit the carrying of coal by unit train from northeast British Columbia. The sophisticated communications and movement control system was also recently upgraded. With these modifications, the rail line presently has the capacity to handle many more trains than it does.

The Suskwa drainage has a well-established road network, constructed to facilitate forest development activities. It connects to Highway 16 close to the river mouth. The Suskwa Forest Service Road (FSR) leaves Highway 16 east of New Hazelton and crosses out of the watershed at Natlan Pass close to 38 km. This provides linkage to the Babine Watershed and the Nichyeskwa Connector, which provides connection to the upper Babine River. From Highway 16 between Smithers and Telkwa, the Babine Lake Road through McKendrick Pass provides access to the upper Harold Price drainage via the Upper Fulton FSR. As in the Suskwa drainage, access into the upper Harold Price was constructed to facilitate forest development activities.

4.0 UPPER BULKLEY RIVER

ENVIRONMENTAL SETTING

The upper Bulkley River includes the Bulkley River and its tributaries upstream of the Bulkley–Telkwa confluence, and the Telkwa Watershed. The Bulkley River is a major tributary to the Skeena River and flows into its left bank at Hazelton, BC, 285 km upstream of its mouth.

4.1.1 Location

The upper Bulkley River is located in west-central British Columbia, and extends from the Telkwa–Bulkley confluence generally southeastward and upstream for 123 km to Bulkley Lake. The Telkwa–Bulkley confluence is approximately 99 km above the Bulkley–Skeena confluence, giving a total Bulkley River mainstem length of 222 km to Bulkley Lake. The drainage is bounded to the north by the Babine drainage, to the south and east by the Nechako drainage, and to the west by the Zymoetz and Morice drainages. Highway 16 and the CN Railroad parallel the upper Bulkley River and pass through the towns of Topley and Houston.

4.1.2 Hydrology

The upper Bulkley drainage is for the most part subdued, rolling country that lies on the Nechako Plateau, which is part of the Interior Plateau system. The Telkwa and Howson Ranges to the west afford the only areas of high relief. Elevations range from 2,523 m in the Telkwa Range and 2,796 in the Howson Range, to 500 m at the Bulkley–Telkwa confluence. The Morice–Bulkley confluence lies at 620 m, while Bulkley Lake lies at 776 m elevation, with the majority of upper Bulkley drainage land lying between 600 and 1,500 m elevation. The Telkwa River is a major streamflow contributor to the Bulkley River.

In the Telkwa Watershed, coastal climatic conditions and the comparatively high elevations influence overall precipitation with more than 1500 mm total annual precipitation. Winter snowfalls form heavy snowpacks in the mountains and significant glaciers. Coastal storms often move into the upper Telkwa watershed and produce runoff that can contribute most of the storm flows of the Bulkley River. Beaudry and Schwab (1990) estimated that more than 50% of the peak streamflow volume is generated in the upper third of the watershed. Baseline streamflow recording and assessments conducted in the Telkwa Watershed in relation to the Telkwa coal deposit have been reported by Klohn Leonoff (1985), MacLaren Plansearch (1985), and Agra (1998).

In contrast, the primarily continental climate of the Nechako Plateau is characterized by severe extremes of temperature and annual precipitation of 500-650 mm, with less than half of it falling as snow. In the Upper Bulkley watershed, snow depths range from 0.5-1.0 m at elevations below 900 m, with snow cover usually extending from mid-November to mid-April. Depending on elevation, average annual precipitation varies from 500 to 1200 mm, as there is a climatic gradient up the mountain slopes. Precipitation is greatest in the fall and early winter, and then tapers off to a low in April and May, before sharply increasing through the summer and into the fall. Summer convective storms are common but rarely deliver more than 10 mm of rainfall in a day.

Weather stations have operated or presently operate in Smithers, Quick, Houston, and Burns Lake. At Smithers Airport, located in the valley bottom, mean annual precipitation is 522 mm, with 331 mm of rainfall and 191 mm water equivalent of snowfall. Equity Silver Mine, located at 1,300 m, 35 km southeast of Houston, receives an average annual precipitation of 710 mm, consisting of 300 mm rain, and 410 mm of snow accounting for 70% of the precipitation.

Overall, the hydrology is dominated by snowmelt. The precipitation pattern usually results in a moderate stormflow discharge distribution, and other than in the Telkwa Watershed, accounts for the apparent lack of non-snowmelt events in the annual peak flow series. Mountains along the western margin of the watershed in the Hudson Bay, Telkwa, and Howson Ranges exert a major hydrological influence on the Telkwa River, capturing coastal rainstorms that can lead to floods.

Peak discharges from the Bulkley River and the major tributary, Telkwa River, typically occur in May and June due to snowmelt and then steadily decrease until late September, when fall rains and early snowmelt increase stream flows until early November. Stream flows decrease in late November and December when precipitation falls as snow, with minimum discharges recorded in January through March, prior to snowmelt.

Many of the smaller, low elevation tributaries to the Bulkley River peak earlier in the spring melt than the mainstem. The relatively low amount of precipitation causes the discharges of low and medium elevation tributaries to drop off sharply following spring freshet. There are fourteen hydrometric stations located in the upper Bulkley drainage recording flows on the mainstem, as well as high and low elevation tributary streams. The hydrometric station at Quick (08EE004), which is located approximately 13 km upstream of Telkwa, has one of the longest periods of record in the Skeena Basin.

One-in-ten-year, 7-day average low-flow estimates for the Bulkley River are 0.1 m^3/s near Houston, 13.7 m^3/s at Quick, and 15 m^3/s at Smithers (Nijman 1986). The maximum daily discharge for the Bulkley River at Quick is 957 m^3/s. On average, the Morice River flow accounts for 84% of the Bulkley streamflow at its confluence with the Bulkley and over 95% of flows at certain times.

Other than the Telkwa and Morice Rivers, and Buck and Maxan Creeks, the majority of tributaries into the Bulkley River are less than 30 km long and are characterized by summer/early autumn low flows. These low flows are typically similar to winter stream flows, and both are principally derived from groundwater, lakes, and unfrozen wetlands. In some years during low flow conditions, Maxan, Richfield, and Byman Creeks are partially dewatered and impassable to fish. An overall trend in declining discharge volumes has been noted for the upper Bulkley River (Remington 1996). The Bulkley River at Quick has a trend toward decreased September stream flows since 1930, which is discussed in Chapter 1.

McBean *et al.* (1992) suggested that climate change might potentially reduce late summer streamflow in the BC Interior Plateau region. If this is occurring, it exacerbates the historical low streamflow situation in the Bulkley River and its tributaries upstream of Morice River. Remington and Donas (2001) noted that it is difficult to separate hydrological variables due to climate change from land use activities that also affect the hydrological regime in the upper Bulkley River.

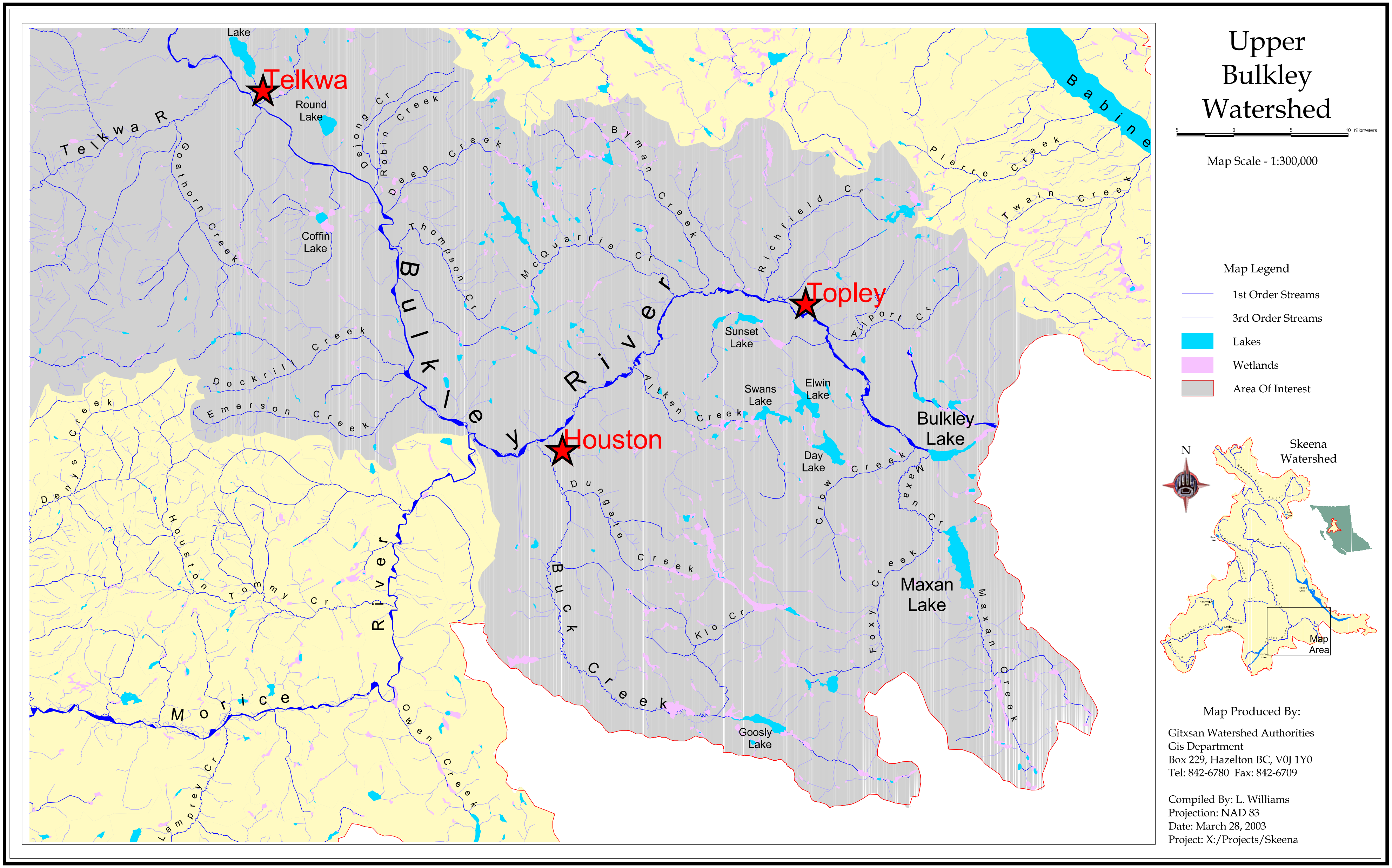
Sufficient water flows and levels are required to allow upstream migration of salmon spawners over beaver dams, shallow riffles, small cascades, and waterfalls. Generally, streams with low flows and low water levels are also subject to extremes in water temperature, especially when riparian vegetation has been removed. During the warm summer months, and frequently into the fall, low flows may lead to increased stream temperatures, which may stress or kill salmonids, reducing reproductive success. Conversely, low flows and low water levels may lead to freezing in the winter, which reduces available habitat and potentially kills juveniles (Tamblyn and Donas 2001).

4.1.3 Stream Channels

The upper Bulkley River heads in Bulkley Lake and flows generally northwestward for 57 km to the confluence with the much larger Morice River. Right bank tributaries from Bulkley Lake downstream include Ailport, Watson, Cesford, Richfield, Robert Hatch, Johnny David, Byman, McQuarrie, and Barren Creeks. Left bank tributaries flowing into the Bulkley downstream to the Morice River include Maxan, Crow, Aitken, McKilligan, and Buck Creeks. The two major tributaries upstream of the Morice River are Maxan Creek and Buck Creek, both draining relatively large sub-basins. The Bulkley River then flows northwestward 45 km to the Telkwa Confluence. Summary and detailed descriptions of reach habitat characteristics for various sub-basins are available in Tredger (1982), Bustard (1985), Agra (1996), MacKay *et al.* (1998), and. Tamblyn and Jessop (2000).

Generally, most of the stream channels are lightly to moderately incised into the hillslopes, terraces, and valley bottoms. Valley bottom deposits formed by glacial sediments that filled in the wider portions of the valleys have been partially excavated by the post-glacial streams, creating the floodplain and river benches that favor settlement and agriculture. The uppermost part of the Bulkley Valley has thick accumulations of deglaciation gravels, some of which formed in streams flowing eastward. The apparent drainage divide at that time, approximately 10,000 years ago, was west of Topley.

The majority of the Bulkley Valley lowlands have been impacted to unknown degrees by the effects of human land use: principally transportation, agriculture, and rural settlement. Agricultural impacts have resulted in the loss of riparian areas, which contributes to, and is linked with runoff issues and streambank failures. Urban development impacts include channelization and loss of riparian areas. The major linear developments in the watershed are the CN Rail line and Highway 16. Culverts that block or hinder fish passage occur at numerous locations along the rail line and highway.



Upper Bulkley Watershed
Map Scale - 1:300,000
5 0 5 10 Kilometers
Map Legend
1st Order Streams
3rd Order Streams
Lakes
Wetlands
Area Of Interest
N
Skeena Watershed
Map Area
Map Produced By:
Gitxsan Watershed Authorities
Gis Department
Box 229, Hazelton BC, V0J 1Y0
Tel: 842-6780 Fax: 842-6709
Compiled By: L. Williams
Projection: NAD 83
Date: March 28, 2003
Project: X:/Projects/Skeena
Telkwa
Topley
Houston
Bulkley River
Morice River
Telkwa R
Babine
Lake
Round Lake
Coffin Lake
Sunset Lake
Swans Lake
Elwin Lake
Day Lake
Bulkley Lake
Maxan Lake
Goosly Lake
Goathorn Creek
Dejong Cr
Robin Creek
Deep Creek
Byman Creek
Richfield Cr
Pierre Creek
Twain Creek
Thompson Cr
McQuarrie Cr
Allport Cr
Dockrill Creek
Emerson Creek
Aitken Creek
Dungate Creek
Buck Creek
Klo Cr
Crow Creek
Foxy Creek
Maxan Cr
Maxan Creek
Denys Creek
Houston Tommy Cr
Owen Creek
Lamprey Cr

4.1.3.1 Upper Bulkley River

The Bulkley Valley has the highest agriculture capability in the Skeena Watershed (Remington 1996). The Bulkley River upstream of Telkwa has some of the most intense land use in the Skeena Basin on both public and private land, predominantly in the form of agriculture, linear development, and forest development activities. The 123 km mainstem to Bulkley Lake is generally low gradient throughout.

Reach 3 of the Bulkley mainstem extends 45 km from the Telkwa River upstream to the Morice River. Reach 3 is a single thread, irregularly sinuous channel with an average gradient of 1.0%. The reach is characterized by gentle flows with intermittent rapids and occasional islands and bars. The river is for the most part lightly to moderately incised in the valley bottom with a discontinuous floodplain. Rightbank tributaries include Vallee, Thompson, Deep, Robin, McDowell, and Tyhee Creeks. Left bank tributaries include Emerson, Dockrill, and Helps Creeks, and the Telkwa River. Emerson and Dockrill Creeks drain the east slope of the Telkwa Range and are cold-water creeks. Tamblyn and Jessop (2000) conducted a comprehensive fish habitat, riparian, and channel assessment on the fourteen main tributaries that drain into Reach 3.

Reach 4 extends from the Morice River confluence (locally known as the Forks) upstream 9.1 km to the mouth of Buck Creek at an average gradient of 0.5%. Reach 4 is characterized as an irregularly sinuous gravel-bed channel with occasional islands and bar formations, and lateral downstream progression with periodic cut offs (MacKay *et al.* 1998). Buck Creek is the only significant tributary, on average supplying 19% of the upper Bulkley River flows. MacKay *et al.* (1998) noted that suspected cumulative impacts to Reach 4 include loss of riparian areas, confinement of the river channel between the valley wall and the railway/highway corridor, increased sediment delivery, and increased peak flows from Buck Creek and the upstream reaches of the Bulkley River.

Reach 5 extends upstream 19.8 km in length to North Bulkley. The channel is typified by regular to tortuous meanders, irregular island frequency, predominantly point and lateral bars, frequent oxbows, and an average gradient of 0.1% (MacKay *et al.* 1998). The floodplain varies from 0.5–1.0 km in width with channel lateral movement often constrained by the railway and highway fills. Channel structure is complex from avulsions, cutoffs, and side and back channels, as well as relatively large logjams. Reach 5 tributaries include McKilligan, Barren, and Aitken creeks.

Reach 6 extends 7.9 km in length to the mouth of Byman Creek with an average gradient of 0.4%, and receives tributary flows and sediment input from McQuarrie and Byman Creeks. The channel slightly meanders in a floodplain ranging from 0.2–0.9 km in width, which is constrained by the valley walls and the highway/railway corridor. MacKay *et al.* (1998) suggested that the periodic removal by CN Rail of the large logjams removes key elements of water and sediment storage and energy dissipation, decreases channel complexity, and directly contributes to the loss of fish habitat as the channel becomes more incised and disconnected from the floodplain.

Reach 7 extends 29.2 km to the mouth of Bulkley Lake and is described as an unconfined, regular to tortuous meandering stream with oxbows, and a very low gradient channel averaging 0.2%. The floodplain varies from 0-1.1 km in width, and channel lateral movement is often constrained by the extensive channelization associated with the CN Rail line, which has nine river crossings. From Forestdale upstream to Bulkley Lake, the substrate is composed of many gravel sections, while downstream the channel bed consists mostly of sand and fine sediments. Intact riparian areas are interspersed between heavily developed agricultural interests. Reach 7 receives the streamflows from Crow, Ailport, Cesford, Richfield, Robert Hatch, and Johnny David Creeks.

Figure 18. Upper Bulkley Falls.

Within Reach 7, Bulkley Falls is a narrow rock sill that crosses the Bulkley River at a right angle. It is located upstream of Watson Creek and 11.3 km downstream of the Bulkley Lake outlet. In response to CNR's proposal to blast Bulkley Falls, Dyson (1949) and Stokes (1955) surveyed the Falls and the upper Bulkley system. They concluded that the Bulkley Falls pose a partial obstruction to migrating fish. Chinook, which migrate into the system early in the summer when water levels are high, are able to ascend the falls in substantial numbers. The Falls are almost completely impassable to salmon during low water flows. Coho have not been observed above the Falls since 1972, which appears to be a function of streamflow levels at the Falls, as well as the presence of beaver dams on the system (Pendray 1990).

4.1.3.2 Telkwa River

The Telkwa River mainstem flows generally eastward 70 km to enter the Bulkley River left bank at Telkwa, BC. The river receives streamflow from 127 tributaries and is low gradient for most of its length, except a small steep gradient section of Reach 3 that is impassable to anadromous fish (Triton 1998d).

Other than Howson Creek, the tributaries flowing into the Telkwa River are for the most part short, moderately steep gradient streams that level out only in the last kilometer or less before entering the Telkwa mainstem. In general, most of these tributaries are of moderate relief with well-defined drainages. Channel stability conditions vary throughout, with unstable stream banks commonly contributing moderate to large amounts of sediment (Beaudry *et al.* 1991). Beaudry *et al*. (1991) noted that the large sediment loads carried by the Telkwa River during spring and fall runoff are dominated by natural erosion sources in all major tributaries to the river.

The sediment loads are principally caused by large active slump earthflows, gully erosion in alpine and subalpine areas, and streambank undercutting. The red soils from the Telkwa Formation give a distinctive colouration to floods from the Telkwa River that is recognizable at the Bulkley-Skeena confluence (Hazelton).

Pine Creek is the most important chronic suspended sediment source due to active earth flow movements in the lower canyon (Beaudry *et al.* 1991). Saimoto (1996a) reported that the Goathorn/Tenas, Cumming, and the Hubert/Coffin sub-basins were the most heavily impacted by forestry-related activities.

Reach 1 of Telkwa River extends 7.6 km upstream to the mouth of Goathorn Creek with a low gradient (<1%), and is a complex, wandering gravelbed reach with multiple channels. Goathorn Creek is a major sediment source to Telkwa River, which is evidenced by frequent channel shifts and widening, as well as dynamic sidechannel development (Bustard and Limnotek 1998).

Reach 2 of Telkwa River is a single-thread channel extending 16.6 km to the mouth of Howson Creek. The channel is characterized by moderate irregular meanders across the floodplain and is limited by the valley walls (Resource Analysis Branch 1977). Saimoto (1996a) noted many sections of unstable banks along the mainstem and tributaries, including Pine and Cumming Creeks.

Reach 3 of Telkwa River extends upstream 10.0 km to slightly above Sinclair Creek. The reach is typified by a single-thread channel with irregular meanders and is unconfined across a floodplain ranging from 0-1.0 km wide that contains extensive wetlands in the mid-section. Reach 3 tributaries include Jonas, Arnett, Winfield, and Sinclair Creeks.

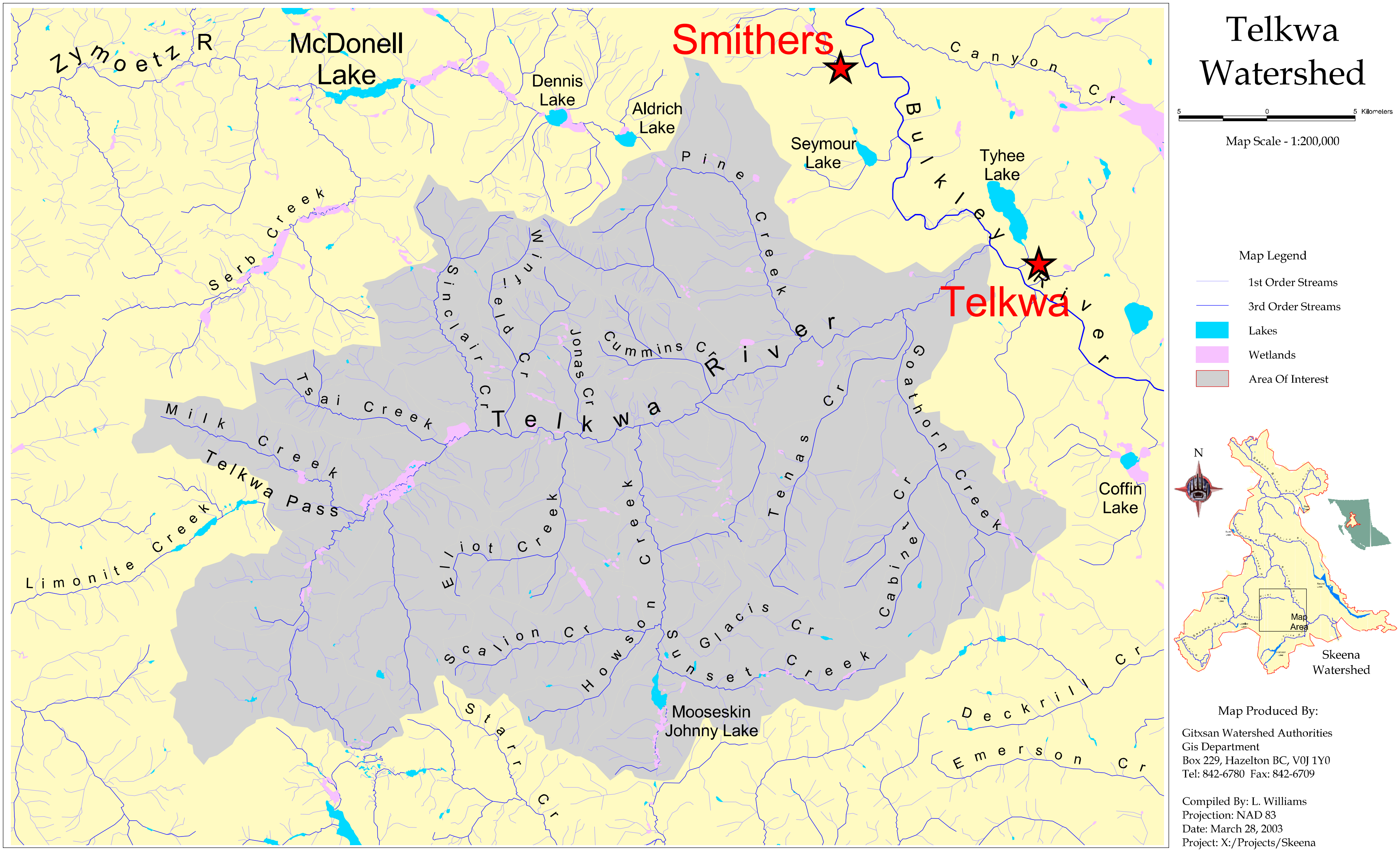
Reach 4 extends 14.5 km upstream in a slight to tortuous meandering pattern with an average gradient of 0.2%. The channel is unconfined across the floodplain, which averages 1.2 km in width and is for the most part a large interconnected wetland complex. Tributaries contributing streamflows include Tsai, Milk, and Elliott Creeks, all of which drain glacial areas. The upper Reaches 5-9 extend approximately 21 km upstream into the alpine.

4.1.4 Water Quality

Water quality reflects the physical, chemical, and biological attributes of water. Water quality is influenced by natural factors such as climate, season, mineralogy, and vegetation, as well as by the activities of humans. In order to remain healthy, fish populations and habitat depend not only on abundant and clean water, but also on functioning riparian and upland ecosystems.

Tamblyn and Donas (2001) indicated that the top water quality concerns in the Bulkley Watershed are water temperature, suspended sediment loads, nutrient levels, attached algae (periphyton), and pathogens. Anthropogenic factors that have modified water quality include mining, linear, urban/rural, agriculture, and forestry developments.

Telkwa Watershed



Map Produced By:

Gitxsan Watershed Authorities
Gis Department
Box 229, Hazelton BC, V0J 1Y0
Tel: 842-6780 Fax: 842-6709

Compiled By: L. Williams
Projection: NAD 83
Date: March 28, 2003
Project: X:/Projects/Skeena

4.1.4.1 Upper Bulkley

In comparison with other Skeena Watershed sub-basins, water quality in the upper Bulkley drainage has been extensively studied. A wide range of concerns and issues related to the nature and extent of developments are reported in Remington (1996) and Remington and Donas (2001).

Nijman (1986) set provisional water quality objectives and monitoring recommendations for the Bulkley River. The water quality objectives were set for characteristics that could be affected by human activity. Designated water uses included drinking water, aquatic life, wildlife, recreation, livestock, irrigation, and industrial use. In Reach 4 between Houston and the Morice River, drinking water was excluded, presumably due to discharge from the Houston sewage treatment plant.

The Bulkley River at Quick shows the water as soft (mean hardness=26.5 mg/L), with a near neutral pH (mean=7.3), and moderate coloration due to wetlands in the drainage (Wilkes and Lloyd 1990). Water sampling of Bulkley River waters at Telkwa in 2000 and 2001 was conducted by Dayton and Knight (2002), who recommended full treatment to alleviate water quality hazards to residents. In October 2001, Remington (2002) sampled Bulkley River at Telkwa and reported that fecal coliforms and *E. coli* concentrations were 1.6 and 1.6 CFU/100 mL (90^{th} percentile) respectively. No other physical or chemical parameters exceeded drinking water guidelines.

The impacts of agriculture on water quality in the upper Bulkley drainage principally stem from land clearing and various aspects of livestock operations, such as manure handling, feed yard runoff, and cattle access to riparian zones and streams for watering. Gaherty *et al.* (1996) noted that winter feedlots may contaminate water bodies due to manure runoff into nearby streams; high nutrient loads may result as documented by Remington and Donas (1999, 2001). However, Gaherty *et al.* (1996) assessed the contribution of grazing lands to water quality concerns to be inconsequential due to low cattle densities on rangelands and limited winter use.

Licensed water withdrawals in the upper Bulkley drainage for irrigation, domestic, stock watering, and water delivery is 0.527 m^3/s (Brocklehurst 1998). This is approximately 2.4 times the average 7-day, 10-year low flow of 0.216 m^3/s derived from the 1980–1993 Water Survey Canada April-September data (Remington 1996). Remington and Donas (2001) noted that water allocation is potentially double the currently available average supply during summertime low streamflows.

Various other water quality studies on Bulkley River and its tributaries include the following. Bustard (1996a) conducted dissolved oxygen and water temperature measurements during the winter at twenty-two locations. Remington (1997, 1998) reported on water quality and accumulated periphyton surveys in 1996 and 1997 in the Bulkley River and tributaries. Portman and Schley (2001) and Portman (2002) conducted water quality and fish sampling with the main objective of providing insight into the potential of impacts due to agricultural spring runoff. Remington (2002) conducted drinking water source quality monitoring in the Bulkley River Basin. Dayton and Knight (2002) conducted a water quality monitoring program for the Village of Telkwa. Finnegan (2002b) summarized water temperature data collected between 1994 and 1999 from four sites in the upper Bulkley drainage.

The Rivers Ecosystem project was initiated by MELP to develop a toolbox of impact assessment methods that could be used to measure changes in the aquatic ecosystem. In 1997, Dykens and Rysavy (1998) conducted water quality inventories for Buck and Klo Creeks that assessed water chemistry, substrate composition, chlorophyll a, and benthic invertebrates. This work was continued in 1998 and conducted by Agra (1999b), while in 1999, Buck Creek was dropped, and Ailport and Klo Creeks were assessed (Agra 2000b). Rysavy (2000a) and Bennett and Ohland (2002) assessed and calibrated a multimetric benthic invertebrate index of biological integrity for the upper Bulkley drainage.

In addition, water quantity and quality sampling of Maxan and Foxy Creeks were conducted from 1972–77 as part of the Maxan Lake multi-land use study, and was reported on by McNeil (1983) and Abelson (1977). Agra (2000a) re-installed staff gauges at historic Water Survey of Canada (WSC) stations on Richfield, Maxan, and Buck Creeks, as well as a new station on Buck Creek to gather data to generate discharge hydrographs. Agra (1999a) conducted streambed substrate composition studies and sampled interstitial dissolved oxygen in various upper Bulkley locations with control sites in Maxan and Buck Creeks.

Studies assessing and documenting the effects and impacts of land use on tributaries of the Bulkley River include the following. Mitchell (1997) assessed riparian and instream impacts to streams from Boulder Creek to Maxan Creek in the Bulkley headwaters. Tamblyn and Jessop (2000) conducted detailed fish habitat, riparian, and channel assessments on ten Bulkley River tributaries from Telkwa to Morice River. MacKay *et al.* (1998) conducted fish and fish habitat assessment work from the Morice River upstream to Richfield Creek. Agra (1996) conducted fish and fish assessment work in the Maxan Watershed reviewing impacts from logging. Croxall and Wilson (2001) summarized and prioritized potential future restoration efforts in the upper Bulkley Watershed east of Richfield Creek. These studies were conducted under the auspices of the provincial Watershed Restoration Program to document impacts to riparian, channel, and fish habitat, and provide restoration prescriptions.

Equity Sliver Mine is located on the divide between Foxy Creek, a tributary of Maxan Creek, and Buck Creek, operated from 1980–1994. Acid rock drainage was evident in 1981 and large-scale mitigation efforts to neutralize the acidity were put in place. Since that time, extensive environmental assessments have been conducted at the mine site and the receiving environments drained by Foxy and Buck Creeks. The majority of these studies have been summarized by Remington (1996), Nijman (1996), and Remington and Donas (2001). Bustard (1987–2002) has conducted fish population monitoring in Foxy and Buck Creeks on a continuous basis since 1987. Currently, Equity Silver Mines is constructing a high-density sludge treatment plant to neutralize the ARD, which is projected to be deleterious for the long-term, i.e. the next two hundred years or more (Stewart 2003).

Between 1972 and 1982, copper-sulphide concentrates from Noranda's Bell and Granisle mines were stored at two transfer stations located near Topley, quite close to the Bulkley River. Morin and Hutt (2000a, 2000b) conducted aquatic studies and concluded that water quality and aquatic life were receiving insignificant impacts despite the relatively large volumes of contaminated soils.

Remington and Donas (2001) summarized the upper Bulkley drainage as a "high risk" watershed because of the easily erodible soils and the P-rich soils in some sub-basins that contribute unusually high total and soluble phosphorous concentrations.

In addition, they noted that relatively small increases in nitrogen concentrations from rural residences and agriculture might have a big effect on algae growth. This is seen in thick accumulations of benthic algae at some monitored sites in the lower portion of the mainstem. Remington and Donas (2001) described these sites as being accompanied by a shift in community composition toward mesotrophic or eutrophic aquatic invertebrates.

4.1.4.2 Telkwa River

Suspended sediment levels in the Telkwa River can be high during and following spring snowmelt. The generally milky color of Telkwa River during the summer and early fall is caused by high elevation glacier melt. Beaudry *et al.* (1991) investigated sediment sources within the Telkwa system and concluded that land use activities produce erosion and subsequent sediment to the Telkwa River; however, no direct link could be made to logging activities and natural sediment sources dominated the sediment profile.

Water quality studies in the Telkwa drainage were conducted by Wilkes and Lloyd (1990) to gather baseline data for the Province. Telkwa River has soft water (mean=38.8 mg/L), a mean pH of 7.5, mean alkalinity of 42.0 mg $CaCO_3$/L, and low nutrients levels. Baseline water quality data collection and monitoring in relation to the proposed Telkwa coal mining developments were undertaken by MacLaren Plansearch (1985), and Klohn Leonoff (1985); these reports were summarized by Manalta Coal (1997).

In addition, Bustard (1984, 1985) and Bustard and Limnotek (1998) reported on aquatic inventory resources studies, which focused on periphyton and benthic invertebrates in the lower Telkwa River drainage. Water quality data collected for the Telkwa Coal project indicated that surface and groundwater attributes are highly variable and naturally high in iron, manganese, and dissolved aluminum. Remington (1996) provided a succinct discussion of Telkwa Coal baseline water quality.

4.1.4.3 Upper Bulkley Lakes

The majority of Bulkley tributaries have lakes in their headwaters. This is especially so for the upper portion of the drainage on the Nechako Plateau. Saimoto (1993) surveyed ten of these lakes with the focus on fish species composition and recruitment factors. These lakes included Sunset, Gilmore, Swans, Lars, Old Man, McBrierie, Elwin, Watson, Day, and Bulkley Lakes. Hatfield (1998) conducted secondary lake inventories that compiled general, limnological, and aquatic flora data.

Bulkley and Maxan Lakes are the two headwater lakes located in shallow valleys characteristic of the area. Maxan Lake, approximately 8 km^2 with a maximum depth of 15. 2 m, drains into Bulkley Lake via Maxan Creek. Bulkley Lake is approximately 4 km^2 in area with a maximum depth of 14 m and a mean depth of 7.2 m (Tredger and Caw 1974). Broman, Old Woman, and Conrad Lakes are connected by wetlands and ephemeral streams to Bulkley Lake (Agra 1996). The majority of streams in this upper portion of the drainage support extensive beaver activity.

Remington and Donas (2001) summarized the water quality analysis for Foxy and Maxan Creeks and the Bulkley River downstream of Bulkley Lake. They classified the trophic status of Bulkley Lake as eutrophic, with the total phosphorus concentration during spring overturn of 34 μg/L. The Water Quality Guidelines for total phosphorus is 10 μg/L during spring overturn of lake water (Remington and Donas 2001).

Figure 20. Bulkley Lake outlet.

The lake waters support dense phytoplankton, causing reduced transparency and anoxic hypolimnion waters during periods of thermal stratification due to the high level of organic productivity.

4.1.4.4 Mid Bulkley Lakes

Boyd *et al.* (1985) prepared water quality assessment and objectives for Tyhee and Round Lakes that focused on designated water uses including drinking, aquatic life, recreation, irrigation, and industrial use. Concerns with eutrophication due to nutrient contributions from agricultural and residential development prompted establishment of the Tyhee Lake Management Plan (Rysavy and Sharpe 1995). A management plan is currently in preparation for Round Lake.

4.1.5 Geography

The upper Bulkley drainage is divided between two physiographic areas, the Telkwa and Howson Ranges to the west and the Nechako Plateau to the north and east. The prominent Bulkley River valley dissects the drainage in a general southeast-northwest line cutting through the Nechako Plateau and low, isolated mountains.

The upper Bulkley drainage above Houston lies within the Nechako Plateau, which is characterized by rolling topography with elevations between 550 and 1,500 m. A blanket of glacial drift is widespread on the surface, and other than along ridges and knobs the majority of bedrock is obscured. Runka (1974) described the soils of the upper Bulkley as extensive fluvial and glacial lacustrine floodplain deposits of fine-grained sands and silts that are particularly sensitive to soil disturbance and highly erodible.

During the Fraser Glaciation, the plateau experienced complex patterns of ice movement, paleohydrology, and sedimentation. This was associated with multiple phases of ice flow moving southeastward from the higher mountain ice centers of the Hazelton and Skeena Mountains (Stumpf 2001). During deglaciation, remnant ice disrupted drainage patterns, ponded proglacial lakes, and created eskers and meltwater channels.

The Telkwa and Howson Ranges west of the Bulkley Valley between Houston and Smithers are the prominent mountain features providing streamflow into the upper Bulkley drainage. These ranges, particularly the Howson Range, possess substantial glaciers originating mostly on their northeastward-facing cirque basins that drain into the Telkwa River. These ranges were forcefully glaciated during the Fraser Glaciation causing oversteepening of the mountain slopes and contributing to the present-day U-shaped valley profiles. At the peak of the Fraser Glaciation, ice moved up the Telkwa Valley and through the mountains to the coast. The ice flow divide between westerly flowing ice and easterly flowing ice was over the Bulkley Valley between Smithers and Houston or the Babine Range to the east.

Most of the Telkwa River valley is filled with thick glacial deposits. Glacial till extends up the valley sidewalls, though the surface expression conforms generally to the underlying bedrock surface, with bedrock exposure along deeply incised streams and on steep-sided hillslopes. Thin soils, colluvium, and rock outcrops characterize the upper mountainsides.

4.1.6 Forests

The majority of land in the upper Bulkley drainage is covered with dense, coniferous forests, except the mountainous high country in the Telkwa and Howson Ranges. Smaller, but significant amounts of deciduous forests occur over the low elevation valley bottoms and lower slopes along the Bulkley and tributary valleys.

Within the watershed, principal forest types are represented by the two principal bio-geoclimatic ecosystem classification (BEC) zones: the Sub-boreal Spruce (SBS) and the Engelmann Spruce-Subalpine Fir (ESSF) zones. There is a small amount of the Coastal Western Hemlock (CWH) zone located in the upper Telkwa valley (Banner *et al.* 1993).

The SBS zone characterizes the lowland coniferous forests in the Telkwa and Bulkley valleys, as well as most of the Nechako Plateau. Subalpine fir and hybrid spruce are the major tree species; subalpine fir stands tend to dominate older, high elevation stands and moister sections of the zone. The CWH and SBS zones merge into the ESSF zone at higher elevations ranging from 900 to 1300 m, depending on local topography and climatic conditions. The ESSF zone possesses a shorter, cooler, and moister growing season, with continuous forests passing into subalpine parkland at its highest elevations. The CWH zone is located in the upper Telkwa valley to 1000 m elevation, in the valley bottoms and mid-mountain slopes; amabilis fir, alpine fir, and western hemlock are the most common species. The main ecological attributes signifying this sub-maritime, high elevation zone are a short, wet, cool growing season with considerable amounts of snow and comparatively low ecosystem productivity.

4.1.7 Geology

The geology of the upper Bulkley drainage is composed of three main assemblages of rocks, the Hazelton Group, the Skeena and Kasalka Groups and the Ootsa and Endako Groups. The mainly Jurassic age Hazelton Group are mostly volcanic rocks formed in an island arc environment. These rocks are exposed along the western margin of the watershed and in the cores of uplifted mountain masses. The Telkwa Formation and Nilkitkwa Formation are the thickest units in the Hazelton Group. They are composed of marine and terrestrial sediments and thick volcanic ash fall deposits that were formed 157-136 million years ago (Gottesfeld 1985).

The island arc rocks are overlaid by younger volcanic rocks such as the Skeena and Kasalka Groups formed 136-100 ma in a series of lava flows. These volcanic rocks are interspersed with Bowser Lake sedimentary strata to the north. The Bowser Lake sediments were formed in near shore marine and coastal plains that included large swampy areas where peat and plant life accumulated to form coal beds.

From 100 to 65 ma, uplifting, volcanic, and plutonic activity created the Bulkley Intrusives that are chiefly composed of porphyritic rocks with minor amounts of granitic rocks. These intrusions into the sedimentary and volcanic rocks occurred at depth, and provided the high heat levels to produce alteration zones of local mineral deposits including metallic ore bodies. Overall, metamorphism is light, aside from the contact effects near intrusive bodies.

A major period of uplift occurred when the Coast Mountains formed to the west. Subaerial volcanic rocks mainly composed of the Ootsa and Endako Groups erupted, producing the high interior plateau rocks. Over much of the Nechako Plateau, these flat-lying or gently dipping Tertiary lava flows cover the older volcanic strata and sedimentary rocks (Holland 1976). The plateau was disrupted by a series of major faults, which down-dropped blocks of rocks, causing the formation of major valleys such as those of the Bulkley River and Babine Lake. The dominant block faulting structure controls the location of the major mountain valley systems, as well as the many rock suites and mineral deposits. Numerous faults and contacts prevail with a strong regional pattern at 340^0.

4.2 FISH VALUES

Fisheries values are high within the upper Bulkley drainage. Coho, sockeye, pink, and chinook salmon, as well as steelhead and Pacific lamprey, are characteristic anadromous fish (FISS 2002). Sockeye historically used the Bulkley River for inward migration as adults, and for seaward migration as juveniles. In general, the most widely dispersed salmon species is coho, while Dolly Varden, rainbow trout, and mountain whitefish are present in most fish bearing waters. Cutthroat trout, Dolly Varden char, and bull trout are the three species of provincial concern.

Based on available historical records, it appears that low water and obstructions to fish passage in the upper Bulkley River above the Morice have been an ongoing issue. Typical comments from Fishery Officer Reports (Elliot and Gelley), the District Engineer (Dyson), and the District Biologist (Stokes) from 1949 to 1955 indicated that the large numbers of coho, chinook, and sockeye salmon runs that used to frequent the upper Bulkley River above Richfield Creek were declining considerably. Subsequently, and continuing into the 1970s, the many logjams and beaver dams above and below the falls were cleared in the winter by CNR crews, various DFO programs, and local ranchers.

4.2.1 Chinook Salmon

The upper Bulkley River is an important migration route for two chinook stocks: the spring run that passes through to the upper Bulkley above the Bulkley Falls and a summer run to the Morice River and the Bulkley River above and below the Morice confluence. Run timing appears to be split at the Moricetown Canyon fishways at about July 30 (Peacock *et al.* 1997). The upper Bulkley early run is genetically distinct from the larger and later run.

Estimates of upper Bulkley River chinook escapements have been recorded continuously since 1945. Escapement was comparatively low from the mid-1960s through to 1988; since then there has been a substantial recovery. There were record high escapements in 2000 and 2001 of 2,560 and 5,600 respectively. Counts since then showed 1,100 in 2002, 1,280 in 2003, and 620 in 2005, with no surveys in 2004. Chinook spawn in the mainstem, Buck Creek, Byman Creek, Richfield Creek, Maxan Creek, and Foxy Creek, with the latter four creeks being subject to seasonal fluctuations in water levels and flows. Chinook juveniles have been recorded in all six spawning streams.

Chinook spawn in August and September throughout the system. Chinook spawners utilize five sections of the mainstem upstream of Morice River through to Bulkley Lake. Principal spawning areas include the mainstem above and below Buck and McQuarrie Creeks, between Cesford and Watson Creeks, and the reaches upstream and downstream of Bulkley Falls DFO (1991e).

Buck Creek supports a small chinook population ranging from 12-100 spawners recorded since 1970 on a discontinuous basis. Spawning is scattered throughout the mainstem as far upstream as the falls at the top end of the second canyon (Reach 8, ~36 km). The cascade series in Reach 3 at 7.3 km is impassable in some years due to water conditions. Byman Creek has historical references to chinook spawning, and juveniles have been recorded in Reach 1 up to the highway crossing (DFO 1991e). Current escapement status is unknown.

Species	Stock	Run	Brood	Rel Year	Rel Stage	Rel Site	Total Rel
Chinook	Bulkley R Up	Spring	1985	1987	Smolt 1+	Bulkley R Up	21721
Chinook	Bulkley R Up	Spring	1986	1988	Smolt 1+	Bulkley R Up	91846
Chinook	Bulkley R Up	Spring	1986	1988	Smolt 1+	Bulkley R Up	10684
Chinook	Bulkley R Up	Spring	1986	1988	Smolt 1+	Bulkley R Up	10671
Chinook	Bulkley R Up	Spring	1986	1988	Smolt 1+	Bulkley R Up	10418
Chinook	Bulkley R Up	Spring	1987	1989	Smolt 1+	Bulkley R Up	10621
Chinook	Bulkley R Up	Spring	1987	1989	Smolt 1+	Bulkley R Up	10624
Chinook	Bulkley R Up	Spring	1987	1989	Smolt 1+	Bulkley R Up	82395
Chinook	Bulkley R Up	Spring	1987	1989	Smolt 1+	Bulkley R Up	10455
Chinook	Bulkley R Up	Spring	1988	1990	Smolt 1+	Bulkley R Up	34063
Chinook	Bulkley R Up	Spring	1988	1990	Smolt 1+	Bulkley R Up	34070
Chinook	Bulkley R Up	Spring	1988	1990	Smolt 1+	Bulkley R Up	34039
Chinook	Bulkley R Up	Spring	1989	1990	Smolt 0+	Bulkley R Up	35000
Chinook	Bulkley R Up	Spring	1989	1991	Smolt 1+	Bulkley R Up	24508
Chinook	Bulkley R Up	Spring	1989	1991	Smolt 1+	Bulkley R Up	24279
Chinook	Bulkley R Up	Spring	1990	1992	Smolt 1+	Bulkley R Up	25832
Chinook	Bulkley R Up	Spring	1990	1991	Smolt 0+	Bulkley R Up	8700
Chinook	Bulkley R Up	Spring	1990	1992	Smolt 1+	Bulkley R Up	26025
Chinook	Bulkley R Up	Spring	1991	1992	Fed Fall	Bulkley R Up	6908
Chinook	Bulkley R Up	Spring	1991	1993	Smolt 1+	Bulkley R Up	25962
Chinook	Bulkley R Up	Spring	1991	1993	Smolt 1+	Bulkley R Up	25878
Chinook	Bulkley R Up	Spring	1992	1994	Smolt 1+	Bulkley R Up	27686
Chinook	Bulkley R Up	Spring	1992	1994	Smolt 1+	Bulkley R Up	27876
Chinook	Bulkley R Up	Spring	1992	1994	Smolt 1+	Bulkley R Up	27471
Chinook	Bulkley R Up	Spring	1993	1994	Smolt 0+	Bulkley R Up	12347
Chinook	Bulkley R Up	Spring	1993	1995	Smolt 1+	Bulkley R Up	84829
Chinook	Bulkley R Up	Spring	1994	1995	Fed Fall	Bulkley R Up	22078
Chinook	Bulkley R Up	Spring	1994	1996	Smolt 1+	Bulkley R Up	88058
Chinook	Bulkley R Up	Spring	1995	1996	Fed Fall	Bulkley R Up	16720
Chinook	Bulkley R Up	Spring	1995	1997	Smolt 1+	Bulkley R Up	25055
Chinook	Bulkley R Up	Spring	1995	1997	Smolt 1+	Bulkley R Up	25028
Chinook	Bulkley R Up	Spring	1995	1997	Smolt 1+	Bulkley R Up	25006
Chinook	Bulkley R Up	Spring	1996	1997	Fed Fall	Bulkley R Up	12660
Chinook	Bulkley R Up	Spring	1996	1998	Smolt 1+	Bulkley R Up	27335
Chinook	Bulkley R Up	Spring	1996	1998	Smolt 1+	Bulkley R Up	27299
Chinook	Bulkley R Up	Spring	1996	1998	Smolt 1+	Bulkley R Up	27372
Chinook	Bulkley R Up	Spring	1997	1999	Smolt 1+	Bulkley R Up	29635
Chinook	Bulkley R Up	Spring	1997	1999	Smolt 1+	Bulkley R Up	29500
Chinook	Bulkley R Up	Spring	1997	1998	Fed Fall	Bulkley R Up	32350
Chinook	Bulkley R Up	Spring	1997	1999	Smolt 1+	Bulkley R Up	28738
Chinook	Bulkley R Up	Spring	1998	2000	Smolt 1+	Bulkley R Up	25172
Chinook	Bulkley R Up	Spring	1998	2000	Smolt 1+	Bulkley R Up	21728
Chinook	Bulkley R Up	Spring	1998	2000	Smolt 1+	Bulkley R Up	24959
Chinook	Bulkley R Up	Spring	1999	2001	Smolt 1+	Bulkley R Up	31083
Chinook	Bulkley R Up	Spring	1999	2001	Smolt 1+	Bulkley R Up	29100
Chinook	Bulkley R Up	Spring	1999	2001	Smolt 1+	Bulkley R Up	29881
Chinook	Bulkley R Up	Spring	2000	2002	Smolt 1+	Bulkley R Up	28847

Table 2. Juvenile chinook releases into the upper Bulkley River, 1987–2002.

Richfield Creek historically supported moderate numbers of chinook spawners, ranging from 0-100 in the lowest reach close to the Bulkley confluence (Hancock *et al.* 1983). There is no recorded escapement since 1964 and current escapement status is unknown. Maxan Creek and its major tributary, Foxy Creek, have both supported chinook spawners historically (Dyson 1949, Stokes 1956). There is one escapement record since 1950: 50 chinook in 1988. The preferred spawning location in Maxan Creek appears to be the boulder/gravel patches between the outlet of Maxan Lake and Foxy Creek confluence. In recent years, Maxan Creek has been subject to beaver activity, seasonal low flows, and drying.

From 1987 to 2002, considerable quantities of chinook smolts, and to a lesser extent fry, were outplanted into the upper Bulkley mainstem principally between McQuarrie and Richfield Creeks (O'Neill 2003). The upper Bulkley enhanced chinook stock serves as a coded wire tag indicator stock (Peacock *et al.* 1997). Chinook release information is shown in Table 5 above.

4.2.2 Pink Salmon

The movement of pink salmon in the upper Bulkley drainage is primarily through the mainstem upstream into the Morice system. Spawning has been documented in the Telkwa River and Buck Creek systems and in the upper mainstem to Bulkley Falls, though escapement data is scarce.

4.2.2.1 Bulkley Pink Salmon

Pink salmon spawning on the Bulkley mainstem between Telkwa and Morice River are confined to five small discrete locations (DFO 1991e). The upper River has historical references to scattered pink salmon spawning up to Bulkley Falls (Hancock *et al.* 1983, DFO 1930–1960). MacKay *et al.* (1998) noted that pink spawners are found to slightly above Buck Creek in the available riffles. Spawning was observed in Deep Creek in the lower km in 1999 (Tamblyn and Jessop 2000).

4.2.2.2 Telkwa Pink Salmon

In the Telkwa system, pink salmon spawn in the mainstem above and below Goathorn Creek confluence. Bustard (1984c) noted that gravel areas interspersed along the mainstem downstream of Goathorn Creek, particularly in active sidechannels, are utilized to a certain extent by spawners. Bustard noted that specific spawning sites would probably change from year to year given the frequency of channel changes and the range of flow conditions. In years of high escapement to the Bulkley River, the lower Telkwa River is likely heavily utilized by pink salmon spawners.

Pine Creek supports pink spawning in the lower 2 km. Pink salmon spawn in the lower 2.6 km of Howson Creek (DFO 1991e). Bustard (1984, 1998) reported spawning in lower Tenas Creek and 58 spawners (1983) in the lower 0.6 km of Goathorn Creek. Bustard (1984) suggested a crude estimate of between 500 and 1,000 for the lower Telkwa River in 1983.

4.2.2.3 Buck Creek

Pink salmon have been recorded spawning in the lower kilometer of Buck Creek and are suspected to be present up to the cascade in Reach 3 at 7.3 km (MacKay *et al.* 1998). The only escapement record is 1963 with 100 individuals.

4.2.3 Sockeye Salmon

Sockeye salmon used to spawn in Maxan Creek and most likely in Bulkley and Maxan lakes. Escapements were 50-600 until 1978. The stock or stocks then appear to have collapsed and records in the 1980s show few or no fish returning. In 2001, several sockeye were spotted at a coho counting weir in Houston that may have been heading upstream to Bulkley Lake. Maxan Creek does not have sufficient flow to allow sockeye passage in some summers. This was reportedly the case in 2001, a relatively wet year (Joseph 2001b) High water temperatures could also cause access problems. Bulkley Lake and Maxan Lake sockeye are at high risk of extirpation.

Figure 21. Buck Creek downstream of CN Rail

4.2.4 Coho Salmon

Juveniles and adult coho salmon are the most widely dispersed salmon species in the upper Bulkley drainage. Coho behavior and the variability in their life histories, particularly the freshwater period prior to smolting, are not well known in the upper Bulkley Watershed.

Coho fry emergence extends from April to July with an estimated 15–27% average egg to fry survival rate. Saimoto and Jessop (1997) suggested that based on the relatively early spawning time and suspected times of emergence, coho eggs and alevins are in the gravel for periods of six to seven months in the upper Bulkley drainage. Juveniles are widely distributed in accessible, slow stream waters and in various side and back channels. Many of the small tributaries flowing into the Bulkley River serve as auxiliary juvenile coho habitat as downstream migrants move into these streams.

In the upper Bulkley, overwintering studies show that winter water temperatures generally remain below 2^{0}C. This may result in poor growth conditions for rearing fish and may possibly compound other factors such as low discharge and oxygen depletion, which make winter survival difficult (Donas and Saimoto 1999).

4.2.4.1 Upper Bulkley Coho Salmon

From 1949 to 1970, coho spawner escapement was recorded in thirteen out of twenty-one years in the upper Bulkley mainstem. The dominant limiting factor appeared to be the low water levels. Historical escapement estimates for the upper Bulkley coho aggregate, including Maxan and Buck, ranged as high as 7,500 in the 1950s, though the annual average was 2,850 coho for the 1950s and 1960s. These visual escapement estimates are almost certainly underestimates of real abundance. No adult coho have been recorded in Maxan Creek since 1972, and juvenile sampling efforts from 1987–90 did not record coho presence (Pendray 1990).

The upper Bulkley coho aggregate is made up of populations spawning and rearing in the mainstem channels, and in Buck, Aitken, McQuarrie, Byman, Richfield, Ailport, and Maxan Creeks. Overall, the upper Bulkley sub-basin coho aggregate showed a serious decline from the mid-1960s to 1998, with an apparent increase beginning in 1998. Holtby *et al.* (1999) conservatively estimated the wild coho escapements to the upper Bulkley, and evaluated a decrease in returns of 11% per year from 1970 to 1998. Since 1998, escapements have increased through to 2005 with average annual returns of 1,358 coho from a range of 317 to 2,508.

Species	Stock	Run	Brood	Rel Stage	Rel Year	Rel Site	Total Release
Coho	Bulkley+Tobog	Summer	1987	Smolts	1989	Bulkley R Up	20628
Coho	Bulkley+Tobog	Summer	1987	Smolts	1989	Bulkley R Up	20564
Coho	Bulkley+Tobog	Summer	1987	Smolts	1989	Bulkley R Up	20624
Coho	Bulkley R Up	Summer	1989	Smolts	1991	Bulkley R Up	22978
Coho	Bulkley R Up	Summer	1989	Smolts	1991	Bulkley R Up	23212
Coho	Bulkley R Up	Summer	1989	Smolts	1991	Bulkley R Up	23201
Coho	Bulkley R Up	Summer	1989	Fed Spr	1990	Bulkley R Up	40000
Coho	Bulkley R Up	Summer	1992	Smolts	1994	Bulkley R Up	10969
Coho	Bulkley R Up	Summer	1992	Smolts	1994	Bulkley R Up	11327
Coho	Bulkley R Up	Summer	1992	Fed Fall	1993	Bulkley R Up	12500
Coho	Bulkley R Up	Summer	1992	Smolts	1994	Bulkley R Up	11667
Coho	Bulkley R Up	Summer	1993	Smolts	1995	Bulkley R Up	13336
Coho	Bulkley R Up	Summer	1993	Smolts	1995	Bulkley R Up	13077
Coho	Bulkley R Up	Summer	1993	Smolts	1995	Bulkley R Up	13524
Coho	Bulkley R Up	Summer	1993	Fed Fall	1994	Bulkley R Up	19432
Coho	Bulkley R Up	Summer	1994	Smolts	1996	Bulkley R Up	8850
Coho	Bulkley R Up	Summer	1994	Smolts	1996	Bulkley R Up	11242
Coho	Bulkley R Up	Summer	1994	Smolts	1996	Bulkley R Up	11123
Coho	Bulkley R Up	Summer	1994	Smolts	1996	Bulkley R Up	9925
Coho	Bulkley R Up	Summer	1995	Smolts	1997	Bulkley R Up	14660
Coho	Bulkley R Up	Summer	1995	Smolts	1997	Bulkley R Up	14979
Coho	Bulkley R Up	Summer	1995	Smolts	1997	Bulkley R Up	15140
Coho	Bulkley R Up	Summer	1996	Smolts	1998	Bulkley R Up	11419
Coho	Bulkley R Up	Summer	1996	Fed Fall	1997	Bulkley R Up	10367
Coho	Bulkley R Up	Summer	1996	Smolts	1998	Bulkley R Up	11834
Coho	Bulkley R Up	Summer	1996	Smolts	1998	Bulkley R Up	10908
Coho	Bulkley R Up	Summer	1997	Smolts	1999	Bulkley R Up	11655
Coho	Bulkley R Up	Summer	1997	Smolts	1999	Bulkley R Up	2354
Coho	Bulkley R Up	Summer	1997	Smolts	1999	Bulkley R Up	11557

Table 3. Coho releases into the upper Bulkley River, 1989–1999.

During the past few decades, the distribution of adult and juvenile coho has been limited to the lower half of the Bulkley River channel between Houston and Bulkley Lake, which is near Richfield Creek (Saimoto and Saimoto 2001). This is most likely due to low flows in late summer/fall and to a lesser extent, winter streamflows. Pendray (1990) noted that in years of relatively high summer streamflows, upper Bulkley tributaries appeared to be heavily utilized by juvenile coho, with rearing densities much higher than on the mainstem. Pendray (1990) reported that the best coho juvenile densities found in the mainstem were at the riprap sites, which provided artificial cover.

Since 1989, an annual average of 30,000 coho fry and smolts have been outplanted in the upper Bulkley mainstem (McQuarrie to Richfield) from upper Bulkley stock raised at Toboggan Hatchery (O'Neill 2003). Holtby *et al.* (1999) noted that it would be interesting to know if the synchrony of enhancement, which began with the 1989 smolt release, and the rapid decline in wild abundance thereafter was just a coincidence, and if so, what was the probable cause of the decline. Coho outplant release information for the upper Bulkley River from 1989 to 1999 is given in Table 6 above.

A counting weir on the upper Bulkley River located at Houston has been operated annually since 1989, except for 1991. The primary function of the fence operation has been to capture brood-stock for hatchery production. Holtby *et al.* (1999) reported that the total escapement in 1998 was 317, of which 139 coho were the progeny of wild spawners, a number that is slightly greater than brood year escapement. The proportion of hatchery coho in the escapement has been an issue of concern.

In most years since enhanced coho began returning, over 60% of the escapement has consisted of the hatchery stock. Donas (2001a) reported that from 1997–2001, the average proportion of hatchery coho counted at the fence has been 71%. Another issue of concern has been the coho that pool up below the fence and are reluctant to pass upstream through the fence. This has necessitated seining operations (Ewasiuk 1998, Glass 1999, Glass 2000, Donas 2001a). It is uncertain if the coho falling back downstream spawn elsewhere or regroup for later upstream movement.

Studies concerning the assessment of overwintering habitat and distribution of juvenile coho in the upper Bulkley drainage (above the Morice River) were conducted by Saimoto and Jessop (1997) and Donas and Saimoto (1999, 2001). Saimoto and Jessop reported on fish presence and densities at fifteen sample sites and found no juvenile coho above the McQuarrie Creek confluence. Overall coho densities in the mainstem were relatively low.

Donas and Saimoto (1999) summarized data collected in the initial year that focused on establishing indicators of overwintering habitat quality and determining influential overwintering physical and biological factors. Species richness and diversity were relatively low for all sample sites, with one species dominating catches at most sites. Water temperature, LWD, water depths, useable site areas, and oxygen concentrations were factors influencing overwintering habitat quality. Donas and Saimoto (2001) reported on analysis of data collected in the third year of the study and included a summary and comparison of data collected over the three years of the overwintering study.

4.2.4.2 Telkwa Watershed Coho Salmon

Adult coho destined for the Telkwa drainage generally ascend the Bulkley River in October, with spawning observed from October through December. Spawning in the Telkwa system usually peaks occurs in mid to late November (Manalta 1997). Coho escapement estimates have ranged from 100 in many years to 9,450 in 2001. The average annual escapement in most years is approximately 500 coho.

Bustard (1983b, 1985) reported on detailed coho spawning surveys conducted in 1982 and 1984 that focused on the lower Telkwa River area, particularly Goathorn, Tenas, and Pine Creeks. No juvenile or adult coho were found in the lower Telkwa River area, probably due to the severe icing conditions prevalent during the winter in the lower river. Bustard (1985) reported that surveys found the majority of coho spawning in the upper mainstem reaches (Reaches 2 and 3) of Telkwa River, as well as in lower Elliot Creek. Much of the mainstem spawning occurred from above Jonas Creek to 5 km above Milk Creek (30–47 km), with the heaviest use from above Jonas Creek to Sinclair Creek (30–34 km). The upper reaches of Telkwa River were also preferred by juveniles. This may be due to less severe icing conditions, the abundance of groundwater inflows, smaller bed material, and the generally excellent rearing areas available (Bustard and Limnotek 1998).

Two off-channel ponds, developed to create juvenile coho habitat are located on the Telkwa River floodplain at 10 km and 11 km on the Telkwa Forest Service Road (Bustard 1996b, Bustard 2000). The ponds were constructed in 1993 by the DFO as a pilot juvenile enhancement project, with additional improvements to increase water flows and to deal with beaver activities (Bustard 1997a). Success has been measured with mark and recapture, immigration, and emigration studies, which show large increases in pre-smolt production reflecting strong fry and yearling recruitment into the ponds (Bustard 2000).

4.2.4.3 Buck Creek

Buck Creek is thought to be one of the most potentially productive salmonid streams in the upper Bulkley system (MacKay *et al*. 1998). Buck Creek supports spawning and rearing coho with escapements that ranged from 75 to 600 up to the late 1970s. Since then, there has been one record: 50 coho in 1982. During the 1960s and 1970s, the annual average escapement was approximately 275 coho. DFO (1991e) reported that at certain water levels the Reach 3 cascades cause fish passage difficulties. Hancock *et al.* (1983) noted coho spawning areas in the lower reach, at approximately 3.5 km, above and below the Dungate Creek confluence on Buck Creek, and in the lower reach downstream of the falls on Dungate Creek.

Buck Creek enhanced coho stocks were outplanted in 1999, 2000, 2001, and 2002 with a mix of fed fry and smolts as shown in Table 7 below. These coho, along with juvenile chinook and rainbow trout/steelhead, were then sampled to assess emigration potential in 1999 and 2000, utilizing a rotary screw trap positioned off the first bridge on Buck Creek (SKR 2000, Donas 2001b).

The Buck Creek Release Pond was constructed in 1999 to improve performance of coho fry and smolt releases into Buck Creek (Donas 2001b). The intent was to assist in increasing the survival rate by improving the release technique. SKR (2000) reported that coho released vacated the release pond within a few days following their release. The release pond was destroyed in the Buck Creek 2002 spring flood (Tamblyn 2003).

Species	Stock	Run	Brood	Rel Year	Rel Stage	Rel Site	Total Rel
Coho	Bulkley R Up	Summer	1998	2000	Smolts	Buck Cr	14320
Coho	Bulkley R Up	Summer	1998	2000	Smolts	Buck Cr	13191
Coho	Bulkley R Up	Summer	1998	1999	Fed Fall	Buck Cr	40303
Coho	Bulkley R Up	Summer	1998	1999	Fed Fall	Buck Cr	40149
Coho	Bulkley R Up	Summer	1998	2000	Smolts	Buck Cr	14429
Coho	Bulkley R Up	Summer	1999	2000	Fed Spr	Buck Cr	24478
Coho	Bulkley R Up	Summer	1999	2001	Smolts	Buck Cr	11101
Coho	Bulkley R Up	Summer	1999	2000	Fed Spr	Buck Cr	21046
Coho	Bulkley R Up	Summer	1999	2000	Fed Spr	Buck Cr	20981
Coho	Bulkley R Up	Summer	1999	2000	Fed Spr	Buck Cr	6015
Coho	Bulkley R Up	Summer	1999	2001	Smolts	Buck Cr	11076
Coho	Bulkley R Up	Summer	1999	2001	Smolts	Buck Cr	11173
Coho	Bulkley R Up	Summer	2000	2001	Fed Spr	Buck Cr	10087
Coho	Bulkley R Up	Summer	2000	2001	Fed Spr	Buck Cr	10079
Coho	Bulkley R Up	Summer	2000	2001	Fed Spr	Buck Cr	10056
Coho	Bulkley R Up	Summer	2001	2002	Fed Fall	Buck Cr	42718
Coho	Bulkley R Up	Summer	2001	2002	Fed Fall	Buck Cr	5032

Table 4. Coho releases into Buck Creek from Toboggan Hatchery, 1999–2002.

4.2.5 Steelhead

Steelhead of the upper Bulkley River drainage are highly significant in a provincial and regional context. The upper Bulkley drainage supports a summer-run steelhead population that enters the mouth of the Skeena in late June to early August, arriving in the Bulkley system beginning in August and continuing into autumn (Lough 1981). In general, there is scant information concerning discrete stocks, life histories, and instream movements.

In general, the pattern of catch reported for the Bulkley River shows an increase in fishing effort and catch over the past thirty-five years, with the pattern of total catch, including released fish, resembling the Tyee Test Fishery estimates for summer-run steelhead (Anonymous 1998). Recently, Mitchell (2001a) and SKR (2001) reported on Bulkley–Morice steelhead population estimates that were based on the Wet'suwet'en Fisheries tagging program conducted downstream of Moricetown Canyon.

Mitchell (2001a) reported on the tagging-recapture using Petersen estimates, arriving at a result of 22,630 steelhead upstream of Moricetown Canyon. Few good data record steelhead escapements at individual streams. This is in large part because they spawn in spring at high water conditions when counts are usually not possible, and they are typically spread out at many sites within a stream.

4.2.5.1 Upper Bulkley Steelhead

The Bulkley mainstem is used as the migration corridor for the large Morice Watershed steelhead population. The sport steelhead fishery in the Bulkley River mainstem downstream of Morice River is known worldwide for providing high quality fishing and good fishable water conditions. Generally, information regarding steelhead adult escapement and distribution, overwintering habitat, and juvenile densities is scant.

In the upper Bulkley River (upstream of the Morice confluence), steelhead spawners have historically been, or are present in the mainstem, in Buck, McQuarrie, Byman, Richfield, and Ailport Creeks, and possibly in Johnny David and Robert Hatch Creeks (DFO 1991e, Mitchell 1997, Tredger 1982). Tredger (1982) conducted a reconnaissance level assessment in the Bulkley upstream of the Morice that focused on outlining the standing crop of steelhead juveniles and estimated carrying capacity. Tredger expressed difficulty in getting any confident estimates of steelhead juvenile populations due to problems differentiating steelhead from resident rainbow populations, particularly near headwater lakes. Tredger made rough estimates of basin-wide smolt outputs and adult escapements based on the standing crops of fry, which in turn were based on the output of carrying capacity from minnow trapping data; his data suggested 92,100 fry, 4,100-11,800 smolts, and 155-1,260 adults.

Steelhead spawn on the Bulkley mainstem between the Telkwa River and the Morice River near Hubert (DFO 1991e). Bustard and Limnotek's (1998) three years of sampling for steelhead juveniles in Hubert Creek indicated that the abundance and distribution are highly variable from year to year due to habitat conditions and presumably the number of fry recruiting upstream from the Bulkley River.

4.2.5.2 Telkwa Watershed Steelhead

Telkwa steelhead are summer-run fish that enter the Telkwa system in late August or early September (Spence 1989). Most summer-run steelhead apparently overwinter in the Bulkley River downstream of Telkwa River, though some steelhead have been observed overwintering in the Telkwa River (Read 1982).

The Bulkley River is one of the most heavily fished steelhead rivers in the Skeena system and the section in the vicinity of and downstream of the Telkwa River confluence is one of the most heavily fished reaches (O'Neill and Whately 1984). Although the Telkwa River receives limited steelhead angling, it is likely that Telkwa steelhead holding in the Bulkley mainstem form an important component of the steelhead fishery on the Bulkley River (Bustard and Limnotek 1998).

Movement into their natal stream is variable (March to May) prior to spawning, which is also dependent on temperature and water conditions. Estimates of steelhead abundance for the Telkwa system have not been conducted, though Bustard (1985) suggested steelhead spawning populations in the order of 52 in Goathorn Creek, 107 in Tenas Creek, and 347 steelhead in the lower Telkwa River. These estimates were established by assuming survival rates from parr to smolt and subsequently to returning adults.

Bustard and Limnotek (1998) summarized the fish and habitat assessments from the early 1980s and 1997, noting that lower Goathorn Creek, Tenas Creek, and the lower Telkwa River are important steelhead streams. In addition, their studies suggested that Tenas and lower Goathorn are the most productive steelhead tributaries in the Telkwa Watershed. The data also suggest that lower Goathorn and Tenas Creeks, along with the Telkwa River mainstem and sidechannels, are very important steelhead rearing areas with average steelhead fry densities ranging from 20 to 50 fry/100m^2.

4.2.6 Indigenous Freshwater Fish

In comparison to salmon, information is scant in regard to resident freshwater fish in both river and lake habitats of the upper Bulkley drainage. Freshwater resident fish presence is represented by cutthroat trout, lake trout, Dolly Varden, rainbow trout, mountain whitefish, bull trout, kokanee, burbot, prickly sculpins, longnose dace, largescale sucker, white sucker, longnose sucker, river lamprey, Pacific lamprey, lake chub, peamouth chub, northern pike minnow, prickly sculpin, and red-sided shiner (FISS 2002, WLAP 2002).

Fish inventories in the Telkwa system focused on or including freshwater resident fish have been reported by Triton (1998d), SKR (1998), Bustard (1985), and Bustard and Limnotek (1998). In the Bulkley sub-basin, Tamblyn and Jessop (2000) sampled streams from the Telkwa River upstream to the Morice confluence. Tredger (1982) noted freshwater fish presence in the course of his juvenile steelhead carrying capacity sampling. Saimoto (1993) and Hatfield (1998) surveyed many of the upper Bulkley drainage lakes and sampled for freshwater resident fish. Juvenile fish population studies that included resident fish in Foxy and Buck Creeks were reported by Bustard (1984b), Bustard 1987–2002) and Bustard (1993d) as part of the Equity ARD environmental monitoring.

4.3 FISHERIES VALUES

4.3.1 Wet'suwet'en Fisheries

The salmon stocks and anadromous lamprey passing through and spawning in the upper Bulkley formed the principal food resource that enabled Wet'suwet'en people to make the area their home. Both major aboriginal fisheries at Hagwilget and Moricetown Canyons have been altered by fisheries management prescriptions. In the recent past, the Moricetown Canyon fishery fulfilled the food, societal, and ceremonial (FSC) needs of the Wet'suwet'en; however, over the last several years sockeye escapements to the Morice system have been so low as to preclude sockeye fishing. The Bulkley River possesses a high-value, steelhead sport fishery conducted by shore and boat-based anglers.

4.3.1.1 Upper Bulkley Fisheries

Wet'suwet'en salmon fisheries within the upper Bulkley drainage were concentrated at seven principal areas that contained multiple fishing sites on the Bulkley mainstem. These sites include: the Telkwa River confluence, at 3 km northwest of Barrett, the Morice River confluence, at the mouth of Buck Creek, at Bulkley Falls, at the outlet of Bulkley Lake, and at the outlet of Maxan Lake (Gitksan and Wet'suwet'en Chiefs 1987).

Many other secondary fishery sites were operated on the Bulkley mainstem, usually close to tributary streams. Dispersed fisheries were operated that focused particularly on coho and resident freshwater species. Many of these dispersed sites are only recognizable in the present by cache pits or other cultural heritage evidence. Selected Wet'suwet'en fishery locations and types of fish harvested are shown below in Table 8 (Gitksan and Wet'suwet'en Chiefs 1987, Mills and Overstall 1996, Rabnett *et al.* 2001, Office of Wet'suwet'en 2001, Wet'suwet'en Fisheries 2002).

4.3.1.2 Telkwa Watershed Fisheries

Wet'suwet'en fished various sites on the Telkwa mainstem including Neetay at the Howson Creek confluence, Sggwelii Dziikw Taceek at the Elliot Creek confluence, Tasdleegh at the Jonas Creek confluence, and an unnamed site at the Goathorn Creek–Telkwa confluence. Dispersed traditional fisheries were operated in lower Goathorn Creek, Pine Creek, Howson Creek, and Mooseskin Johnny Lake.

Site Location	Traditional Site Name	Fish Species
Maxan Lake outlet	Tasdleegh	SK, CO, CH
Maxan-Foxy confluence	Tsaslachque	SK, CO, CH, trout
Bulkley Lake outlet	Nehl' dzee tez diee	SK, CO, CH.
Gilmore Lake		Trout
Sunset Lake	Alk'at	Trout
Elwin Lake	Deetts'eneegh	Trout
Fishpan Lake	Laytate Ceek	CO
Emerson Creek-Bulkley confluence	Decen Neeniinaa	SK, CO, PK, CH, ST
McQuarrie Lake outlet	Deeltsik	CO, ST, trout, char
Buck Creek–below falls		CO, ST, CH
Bob Creek-Buck confluence	Dzenk'et Hoz'aay	CO, ST, CH
Goosly Lake outlet	Neelhdzii Teezdlii Ceek	CO, CH, KO, RB
Klo Lake	Tsee zuulceek ben	Trout
Barrett Lake outlet	C'eli t'oots Ta'eet	CO
Round Lake outlet	Coostl'aat ben	CT, RB
Round Creek-Bulkley confluence		Trout
Coffin Creek-Bulkley confluence		Trout
Tyhee Lake outlet	Kyo kyut tezdlii	Trout and suckers
Bulkley River downstream of Quick	Ses biit kwe	SK, CO, CH, PK
Bulkley River, Upstream of Morice R. at Hwy.16 crossing.	Needz Kwe	SK, CO, PK, CH, ST.
Howson Creek-Telkwa confluence	Neetay	CO, ST, PK
Telkwa River-Jonas Flats	Tasdleegh	CO
Elliot Creek-Telkwa confluence	Sggwelii dziikw taceek	CO

Table 5. Selected Wet'suwet'en traditional fisheries locations and species.

4.3.2 Recreational Fisheries

The Bulkley River supports large-scale, seasonal recreational use. The majority of recreational angling on the Bulkley mainstem is divided into two relatively distinct fisheries of equal proportions: the non-resident angling fishery and the area resident fishery (Morten and Parkin 1998, Morten 1999). Anglers predominantly favour the stretch from the Telkwa River to the Morice confluence on the mainstem. This reach generally possesses stable water conditions in terms of flows and clarity except in the heaviest of rainstorms.

Pedestrian and vehicle access by anglers is generally achieved by crossing private land in most cases and Crown land in some instances. The Bulkley mainstem from (Telkwa to Morice) is navigable by powerboats and drift boats for its length, and access is available at regular intervals. The use of both power and drift boats by local anglers, guides, and non-residents are a major feature of the steelhead fishery. Morten and Parken (1998) reported that the use of powerboats as compared to drift boats is approximately 2:1; as well, their survey data confirmed that the primary method of access to the river is by boat rather than by foot.

The river sport fishery is primarily directed first to chinook until early August, and then to steelhead, with pink salmon openings held in years of abundance. Chinook angling primarily occurs around the vicinity of the Bulkley–Morice confluence, though angling effort is scattered throughout. Total chinook effort is comparatively small in relation to steelhead and participants are mostly BC residents. Tallman (1996) and Morten and Parken (1998) conducted creel surveys that focused on the Bulkley mainstem chinook and pink salmon sports fisheries and reported on effort, catch, and catch rates.

The majority of steelhead angling occurs over approximately a ten-week period from early September through mid-November. Peak activity is commensurate with the period that most anglers feel provides the best combination of steelhead availability, good weather and clear water, usually from mid-September to mid-October. Angler activity for steelhead is intense, and a public consensus planning process was established in late 1996 to deal with angler crowding, and to provide for long-term angling management on the Bulkley River. The Angling Use Plan for Bulkley River (Anonymous 1998) was signed off in 1998; however, the senior manager of the Ministry of Environment, Lands and Parks refused to implement it and many plan participants have sour feelings.

Seven angling guides are licensed to operate on the Bulkley River with a set quota of guided rod days that total 1,504 for the entire river. Although annual angling regulations specific to the Bulkley River may change, they generally include a bait ban and no fishing January 1 to June 15. There is no fishing upstream of the Bulkley-Morice confluence. There is no angling from boats between Morice River and the CN Rail bridge at Barrett, August 15 to December 31. The Bulkley mainstem is Class II Waters from September 1 to October 31, with a mandatory steelhead stamp and steelhead release between July 1 and December 31 (BC Fisheries 2005).

4.3.3 Enhancement Activities

Enhancement activities in the Upper Bulkley Watershed consist primarily of juvenile chinook and coho outplants and the construction and maintenance of the Telkwa River coho rearing ponds and the Buck Creek release pond. These projects have been discussed in the chinook and coho summaries. The enhancement projects that had large impacts to fish passage and abundance in the Upper Bulkley are the rock removal in Hagwilget Canyon and construction of the fishways at Moricetown Canyon.

4.4 LAND USE DEVELOPMENT ACTIVITIES

Land use in the upper Bulkley drainage is relatively intensive in comparison with other Skeena Watershed sub-basins. Over the last forty years, land use and development activities in the drainage have increased significantly. The current principal land use activity is forestry, which is generally concentrated in the Telkwa Valley and low to mid elevations in the Bulkley Valley. There is extensive agricultural development in the valley bottom. Urban development is concentrated in the Telkwa and Houston areas. Farms and rural residential settlement areas are scattered along Highway 16 east to Forestdale and generally parallel both sides of the Bulkley River. There is industrial land use to a limited degree in or close to the urban settings.

The early part of the 20th century saw extensive mineral exploration in the Telkwa Range; presently there is little mineral exploration or development in the drainage. Coal bed methane has recently been proposed for the Telkwa Coalfield. Linear development along the northerly bank of the Bulkley River accommodates the CN Rail line, Highway 16, and the BC Hydro and Telus utilities infrastructure. Transportation development has been the key to land use and resource development. Agriculture has provided a stable and sustainable community development base.

4.4.1 Wet'suwet'en Land Use

Wet'suwet'en land and resource use has occurred for approximately 6,000 years (Allbright 1987). Wet'suwet'en forest utilization within the upper Bulkley drainage was extensive and complex. Presently, cultural use features can be seen as complex series of ancestral and historical threads that form the fabric of the cultural landscape. In both the pre-contact and post-contact periods, trails formed the travel and communication network of the region. Trails were linked, facilitating travel, trade, social interaction, and access to spiritual and ceremonial sites, homeplaces, and resource gathering locales (Suskwa Research 2002).

Wet'suwet'en used fire as a tool to shape their environments and improve opportunities to harvest plant and animal resources. Evidence presented in a number of ecological studies (Williams *et al.* 2000; Haeussler 1987; Pojar 2002) noted that the landscape burning activities of the local First Nation established and contributed to the maintenance of extensive seral landscapes.

4.4.2 Forest Resource Development

Logging in the upper Bulkley drainage is an important land use and economic driver. The upper Bulkley drainage is located within the Ministry of Forests, Nadina and Skeena–Stikine Forest Districts. Currently, the Ministry of Forests provides land use management zoning, objectives, and strategies through the Lakes, the Morice, and the Bulkley Land and Resources Management Plans (LRMPs).

The community of Houston developed as a rail tie-cutting center in the early 1900s. The post-World War II demand for lumber contributed to the gradual logging of low and mid-elevation stands in the Bulkley Valley. The first planer and gang mills were brought into the area in the 1940s, and by 1958, there were eighty-four small sawmills operating in the area (Ministry of Sustainable Resource Management 2002). In the late 1960s, Bulkley Valley Industries (BVI) was formed to produce an integrated forest products complex including lumber, plywood, stud, and pulp mills, though this plan fell through.

Since then, the trend to centralization and the monopolistic status of forest license holding and milling capacity have laid the foundation for the current situation. The BVI mill was sold to Northwood and is currently owned by Canadian Forest Products. The mill is currently the largest sawmill in the world. In 1978, Houston Forest Products opened a second sawmill. From the late 1960s to the present, the area and volume logged has increased from small-scale operations to a large-scale, industrial road network and intensive clearcutting within most portions of the drainage (Hols 1999, Office of the Wet'suwet'en 2001).

The majority of forest development has been directed to the easily accessible, commercially viable timber. Major licensees log approximately 90% of the annual allowable cut, with the remainder cut by the Small Business and woodlot programs (Ministry of Sustainable Resource Management 2002). Presently, most forest harvesting and road building operations focus on timber affected by the Mountain Pine Beetle (MPB).

The strength and stability of the forest sector on the Nechako Plateau is supported by two principal factors: over 50% of forest stands is composed of pine, which allows for production of high quality timber; and the geography of the Plateau lends itself to relatively easy access to forest lands. In addition, timber supply is relatively plentiful in comparison to other Skeena sub-basins.

From 1995 to 2001, the Watershed Restoration Program (WRP) was involved in assessing and repairing logging-related disturbances to fish, fish habitat, and upslope sediment-producing areas. Within the Telkwa Watershed, Saimoto (1996a) and SKR (1998) reported on fisheries, fish habitat, and riparian zone assessments, while Silvicon (2001) reported on site works completed. Completed projects included bank stabilization, cut slope and landslide rehabilitation, and bridge abutment repairs. Bustard (1996b, 1997, 2000), under the auspices of the WRP, reported on juvenile coho population estimates associated with the Telkwa River coho ponds at km 10 and 11 on the Telkwa Forest Service Road.

In the Bulkley valley, WRP sponsored the Mid-Bulkley overview fish and fish habitat assessment conducted by MacKay *et al.* (1998), for the area from Morice River upstream to Richfield Creek. Agra (1996) conducted fish and fish assessment work in the Maxan Watershed, with Croxall and Wilson (2001) summarizing and updating restoration efforts in the upper Bulkley Watershed.

A large contribution of the WRP has been to increase awareness in the forest sector of the best management practices regarding water quality, fish, and fish habitat. Watershed health has benefited from the program principally through road deactivation, cutslope rehabilitation, fish passage improvement, and coho habitat enhancement.

4.4.3 Mineral Development

Euro–Canadian exploration for base and precious minerals has been active since the turn of the century. Early efforts were focused mainly on high-grade silver, copper, and gold-rich veins, as well as placer gold, with most endeavours slowing down with the onset of WWI, the Depression, and WWII. Silver-lead-zinc ore was discovered close to Goosly Lake, and similar ore was discovered on Grouse Mountain around 1912 (Hols 1999). Exploration and mineral development in the Telkwa Range centered on copper-silver prospects west of Mooseskin Johnny Lake and copper-silver-gold prospects in the headwaters of Goathorn Creek.

The Telkwa coal deposit was located early in the century and exploited on a sporadic basis from 1918 until the mid-1970s, operating as the McNeil Coal Mine until 1930, then as the Bulkley Valley Collieries. Manalta Coal Ltd. currently holds the coal reserves in the lower Telkwa River area. Proposed mining plans include conventional open pit methods with diesel powered mining equipment. The outstanding potential risk is the generation of acid rock drainage (ARD). Whether and how it might be mitigated is not clear. Aquatic baseline resource studies relevant to the Telkwa coal deposit are summarized by Bustard and Limnotek (1998).

The early 1960s saw a resurgence of exploration focused on porphyry, copper-zinc-silver style deposits. In 1961, copper and zinc values were found on the ridge east of Goosly Lake. After two decades of extensive proving of ore bodies, Equity Silver Mine operated from early 1980 to early 1994, producing primarily silver with additional gold and copper. The mine used open pit, surface mining methods, with a limited underground program. An onsite mill produced concentrate from the excavated ore.

In 1981, acidic drainage, commonly called acid rock drainage (ARD), was discovered. Interactions of the ARD and water quality were thoroughly reviewed by Remington (1996). Bustard has conducted fish population studies in Foxy and Buck Creeks from the mid-1980s up to 2002 (Bustard 1984b, Bustard 1993d, Bustard 1987-2002). Features remaining from the mine development include two open pits, one backfilled pit, a contiguous series of waste rock dumps, the mill site, and a tailings impoundment. Except for flooded surfaces, access routes, and the facilities for drainage collection and treatment, all disturbed surfaces have been capped with a compacted soil cover and re-vegetated. All the acid pH drainage and neutral pH drainage with high contaminant levels is collected and treated, predominantly with lime, prior to discharge.

4.4.4 Oil and Gas Development

In December 2003, the B.C. Ministry of Energy, Mines and Petroleum Resources issued a call for proposals to develop coalbed gas resources near Telkwa, B.C. In January 2004, it announced that Outrider Energy would have first rights to explore and develop coalbed methane near Telkwa. No other company expressed interest in the development. If the Telkwa project were to go ahead, it will be the first in the province. A recent survey shows a broad cross section of local First Nations and residents oppose the development because it threatens the economy, lifestyle, and land. The proposed development undermines and threatens the integrity of the lower Bulkley and Telkwa drainages, given the potentially devastating impacts of coal bed gas development impacts upon humans, water quality, fisheries, and community values.

4.4.5 Population and Settlement

The upper Bulkley valleys have been home to Wet'suwet'en people for thousands of years. Many Euro–Canadian settlers arrived following completion of the railroad in 1914, attracted by agricultural, mining, tie hacking, and various work opportunities. This population base remained relatively stable with low increments of growth until the early 1970s, when the forest sector expanded, followed by the government sector in the late 1970s, and the opening of Equity Silver Mine in 1980.

The current settlement pattern reflects the past in that the valley bottoms contained the easiest travel routes, the most productive land, and the best economic opportunities. Currently, approximately 5,750 people reside from Telkwa east to Topley, and in the surrounding rural areas within the drainage (RDBN 2002, BC STATS 2003). Generally, many people from the main settlement areas, the Town of Telkwa and the District of Houston, derive their income from the forestry sector. Both these towns are relatively small, resource-based communities, and the opening and closure of a major industry adjacent to them could have a significant impact upon the population and community stability.

Houston is a key supply and service center, with seven schools, a satellite NWCC campus, a municipal airport, and First Nation, Provincial, and Federal social services. In recent years, Houston has promoted itself as the “Steelhead Capital of B.C.,” and there is a growing tourism market in fishing and other types of outdoor recreation. Most of the rural population between Telkwa to Topley is located alongside or close to Highway 16, in low-density rural housing with an income base derived from agriculture.

Smithers in the west and Burns Lake to the east serve as the health, education, and other government social and resource service centers for the upper Bulkley area. The anticipated future growth rate is projected at a modest 1% per annum by the Bulkley Nechako Regional District and BC STATS (RDBN 2002, BC STATS 2003). The Houston/Topley/Granisle Rural Official Community Plan has planned for and designated residential and commercial use areas that are capable of providing on-site water and sewage disposals systems that will likely provide future growth opportunities.

In the Bulkley Valley, a large proportion of the bottomland is devoted to agriculture, which consists of forage and livestock production. The majority of agricultural land is included in the Agricultural Land Reserve (ALR), which was established as a provincial reserve on potential and existing farmland. A sizeable amount of Crown rangeland supplements private land for grazing. Overall, forestry is the largest land user and major contributor to the economic base; it contributes over 50% in terms of employment and community income. Two major lumber mills located in Houston directly employ approximately 600 people.

4.4.6 Transportation and Utilities

The existing transportation network in the Upper Bulkley watershed is based on the original Wet’suwet’en trail system improved over the past 120 years. Trails were initially widened for packhorses, and in some cases later improved for wagons, then further improved for vehicular traffic. The railroad line was completed in 1914, and subsequently the population and economic activity increased considerably. The geography of the watershed is sufficiently adverse that major transportation routes and settlement patterns are located within the valleys and avoid the mountain slopes. Overall, the infrastructure development pattern has been historically spurred by a single motive: the extraction of furs, minerals, and forest products.

Highway 16 is the major road providing access into the upper Bulkley drainage. Over the last two decades, Highway 16 has assumed an increasingly important role for residential, recreational vehicles, and for commercial trucking operations. This reflects the trend towards the centralization of goods and services to regional focal points, the increased use of Highway 37 North, and the growing use of recreational vehicles.

Granisle Highway heads north from Highway 16 at Topley, providing access to the west shore of Babine Lake. The east side of the lake is accessed via the private barge at Mitchell Bay operated by the forest industry. The North Road heads north from Houston to Mitchell Bay, and is primarily utilized by forest industry traffic. Other significant secondary roads are the Buck Creek Road accessing the upper Buck watershed and the Telkwa Forest Service Road that accesses the Telkwa valley as far west as Milk Creek. Forest resource road development throughout the upper Bulkley drainage is extensive with most drainages developed to various degrees.

Linear development within the drainage parallels the Bulkley River with Highway 16, CN Rail, BC Hydro, and Telus utilizing the corridor and taking advantage of the geography and settlement patterns. The natural gas pipeline stays south of the Bulkley River, crosses the Telkwa River, and then goes through Telkwa Pass into the Zymoetz Watershed.

CN Rail serves the region and connects rail shipments to the rest of the country and to saltwater at Prince Rupert and Kitimat. The route is presently used for the movement of grain and coal to Prince Rupert, for manufactured goods moving westward, and for locally produced wood products moving in both directions. In the mid-1980s, portions of the track were upgraded to a standard sufficient to permit the carrying of coal by unit train from northeast British Columbia. A sophisticated communications and movement control system was also recently upgraded. With these modifications, the rail line presently has the capacity to handle many more trains than it does.

5.0 HIGHWAY #16 AND CN RAIL FISH PASSAGE ASSESSMENT RESULTS

5.1 OVERALL FISH PASSAGE RESULTS

This Fish Passage Culvert Inspection project recorded 98 stream crossings traversed by Highway #16 and CN Rail. Of these 98 fish bearing stream crossings, 61 were passed with culverts. Full barriers are reported at 3 crossings on Highway #16: Porphyry, Station, and Mudflat creeks. Partial barriers are reported at 9 stream crossings with 10 crossings requiring maintenance.

Some first and second order streams crossed were determined to have no fish presence due to limiting stream gradients or suitable habitat. Beaver activity was observed at a relatively small number of crossing sites compared to other fish passage assessments in Skeena Basin. When the FPCI were conducted in September and October 2006, the Bulkley Watershed was experiencing very low streamflow conditions. Many creeks were dry and had to be revisited in the spring, 2007. The majority of the full and partial barriers consist primarily of outfall drops and for the most part are linked to improperly designed and or installed culverts or erosion and down-cutting of the channel downstream of the culverts. We suspect that the erosion and down-cutting is due to extreme culvert velocities associated with spring freshet flows.

Restoration priority ratings are based on the various types and degrees of barriers along with variable amounts of fish abundance and differing qualitative values of upstream fish habitat as determined by the procedure laid out by Parker (2000). Of these 13 streams crossings with full and partial barriers, nine are rated high priority restoration sites and include: Toboggan Creek — Site 14, Station Creek — Site 78, Bulkley Oxbow 1 — Site 50, Moan Creek — Site 30, Johnny David Creek — Site 64, Glass Creek — Site 80, McDowell Creek — Site 37, Tyhee Creek — Site 36, and Coffin Creek — Site 77. Cesford Creek — Site 67 and Strawberry Creek — Site 5 are rated as moderate priority restoration sites. These sites are summarized in Table 6 below. Overall data for all sites is presented in Appendix 1. Summarized data for all sites is shown in Table 7.

There is uncertainty in regard to historical fish presence in Mudflat Creek upstream of the Highway 16 crossing. Gazetted streams with no known fish presence or limiting habitat include: China, Atrill, Graphite, Cow, Beavery, and Powers creeks. Porphyry Creek is not included as priority restoration site due to the limited amount of high value habitat upstream of Highway #16.

5.2 RANKED PRIORITY FISH PASSAGE SITES

Bulkley Fish Passage — Ranked Priority Rehabilitation Sites					
Site No.	**Stream Name**	**Comment**	**Fish Species**	**Fish Passage Issue**	**Restoration Site Priority**
14	Toboggan Creek	Culvert controls access to high value spawning and rearing fish habitat in creek, lake and tributary systems	CO, ST, SK, DV, BT, RB, and CT	Culvert is undersized with a partial outfall drop barrier at all flows and extreme velocity at mid-high flows. Culvert discharges onto boulders at lower flows.	High. Recommend open bottom arch or bridge structure.
78	Station Creek	Culvert has caused fish access problems since it was installed in 1965. The culvert poses a full barrier to fish migration upstream and limits access to approximately 10 km of spawning and rearing habitat	CO, PK, CM, ST, RB, DV, BT, and CT	Culvert is 99 m long with extreme velocity and outfall drop issues. At high flows stream velocity is well above fish swim speeds.	High. Recommend a bridge structure. Ranked the highest priority in the Bulkley drainage.
50	Bulkley Oxbow 1	Culvert is the only access into and out of Bulkley Oxbow 1, a 800 m in length abandoned channel. Fish presence is inferred.	(CO,CH, ST)	Bulkley Oxbow 1 culvert needs to be lowered so it will function during low-mid flows	High. Recommend a habitat and fish presence survey.
30	“Moan Creek”	Culvert is immediately upstream (15 m) of Bulkley River and has 2.9 km of moderate to high fish habitat upstream.	CO, CH, RB, CT, DV, BT, (ST)	Culvert has a 57 cm outfall drop with a shallow plunge pool that limits juvenile and adult free passage.	High. Recommend lowering culvert or building robust backwater structures.
64	Johnny David Creek	Culvert is a partial barrier to adults and juveniles at various flow levels.	CH, CO, ST, CT, RB, DV	Culvert has 67 cm high outfall drop at low flows and plunge pool is too shallow to allow adequate jumping	High. Recommend three backwater structures downstream.
80	Glass Creek	Glass Creek is a short low gradient stream draining wetlands flowing into Toboggan Lake.	RB, DV	1200 mm culvert with a 20 cm outfall drop. The culvert is collapsing and needs to be replaced.	High. Recommend installing embedded culvert at correct elevation.
37	McDowell Creek	McDowell Creek has high quality habitat upstream of the highway, but dries annually with late summer low flows	CO, RB	Culvert outfall drop at low flows is considerable (~65 cm) decreasing to 10 cm at high flows.	High. Recommend outlet backwatering in two steps.
36	Tyhee Creek	Tyhee Creek has two culverts at highway crossing, extensive cleared land to creek edge, and is impacted by the secondary road 300 m upstream.	RB, CT, OS	Two-900 mm culverts with 28 cm outfall drop at high flow and 49 cm in low flow conditions.	High. Recommend replacing culverts with an 1800 mm open bottom structure.
77	Coffin Creek	Culvert outfall drop controls access to 4.1 km of generally moderate quality habitat.	CO, CT, DV, BT, RB, MW	Culvert has 46 cm outfall drop at low flows. The drop is negligible at high flows.	High. Recommend establishing two backwater structures downstream.
67	Cesford Creek	Cesford Creek has two culverts. The stream frequently dries in the late summer.	RB	Two multiplate elliptical culverts with 37 and 33 cm outfall drops at low flows and in-sufficient outlet pool depths.	Moderate. Recommend backwatering the outlet.
5	Strawberry Creek	Culvert drains hillsides and wetlands and frequently dries with summer low flows.	ST, DV, RB	Culvert has 30 cm outfall drop at low flows.	Moderate. Recommend installing a step to backwater culvert.

Table 6. Bulkley Fish Passage Ranked Priority Sites

5.3 Bulkley Fish Passage Site Summary

Map ID #	STREAM NAME	SITE	FISH PRESENCE	WATERSHED CODE	CROSSING TYPE	BARRIER	MAINTEN REQUIRED	COMMENTS
1	Mudflat Creek	93M023-CN1	CT, DV, RB	460-089199-000000	Bridge	No	Yes	Old culvert in creek needs to be removed.
2	Mudflat Creek	93M023-HW1	CT, DV, RB	460-089199-000000	Bridge	No	No	
3	Porphyry Creek	93M014-CN1	DV, RB	460-125600-000000	Bridge	No	No	
4	Porphyry Creek	93M014-HW1	DV, RB	460-125600-000000	Culvert	Full	No	Culvert is a full barrier.
5	Strawberry Creek	93M014-HW2	ST, DV, RB	Unknown	Culvert	Partial	No	Beaver guard on inlet. Culvert placement good. Downstream weir could mitigate the 30 cm outfall drop. Low prority.
6	Boulder Creek	93M014-HW3	PK, DV	460-142600-000000	Bridge	No	No	
7	Boulder Creek	93M014-CN2	PK, DV, BT	460-142600-000000	Bridge	No	No	
8	Corya Creek	93M004-CN1	DV, RB	460-185400-000000	Culvert	No	No	Inlet encased in concrete. 2 overflow pipes (2000 mm) on both sides of the main pipe (4000 mm). Culvert placement good.
9	Corya Creek	93M004-HW1	DV, RB	460-185400-000000	Culvert	No	No	Outlet of culvert (~3 m) is bent down creating higher velocity. Not a barrier for larger fish but may be a barrier (velocity) for juveniles at high flows. Large pool at outlet.
10	Unnamed	93M004-HW2	DV, RB	460-185400-116000	Culvert	No	No	Culvert good, not a barrier.
11	John Brown Creek	93M004-CN2	CH, CT, DV, BT	460-201500-000000	Bridge	No	No	
12	John Brown Creek	93M004-HW3	CH, CT, DV, BT	460-201500	Culvert	No	No	2-4600 mm pipes placed the same. Culverts are good, with possible barrier in high flows. Evidence of rock lines to establish backwater pools downstream of culvert.
13	Trout Creek	93L094-HW1	CO, PK, ST, CT	460-241300	Bridge	No	No	

5.3 Bulkley Fish Passage Site Summary

Map ID #	STREAM NAME	SITE	FISH PRESENCE	WATERSHED CODE	CROSSING TYPE	BARRIER	MAINTEN REQUIRED	COMMENTS
14	Toboggan Creek	93L094-HW2	CO, PK, ST, CT, DV, RB, MW	460-241300-000000	Culvert	Partial	Yes	Wood baffles placed throughout culvert. Lower 3 m at the outlet appears to have been pushed down possibly to reduce outfall drop. Recommend placing boulders around perimeter of pool to add depth and reduce the 60 cm (low water) outfall drop. Low water levels show boulders in outfall, recommend removing boulders from directly below outlet. At high water, velocity is extreme. Recommend a bridge or open bottom structure. High Priority
15	Owens Creek	93L094-CN1	CO, DV, CT, BT	460-242900-161000	Bridge	No	No	Observed a bull trout under bridge.
16	Elliot Creek	93L084-CN1	CO, DV, CT	460-242900-477000	Bridge	No	No	
17	Toboggan Creek	93L084-HW1	CO, PK, ST, Ct, DV, RB, MW	460-241300-000000	Bridge	No	No	
18	Toboggan Creek	93L084-CN2	CO, PK, ST, Ct, DV, RB, MW	460-241300-000000	Bridge	No	No	
19	Kathlyn Creek - upper	93L084-CN3	CT, DV	460-345400-267000	Culvert	No	No	2 pipes - 1500 mm. Good placement. Observed 1 trout in creek.
20	Simpson Creek	93L084-HW2	PK, CO, ST, CT, DV	460-345400-267002-7800	Culvert	No	No	Culvert good, thin layer of gravel and cobble on bottom of culvert.
21	Unnamed	93L084-CN6	Unknown	Unknown	Culvert	No	No	Culvert placement good. Not a barrier. Fry present above and below culvert.
22	Unnamed	93L084-CN5	Unknown	Unknown	Culvert	No	No	Culvert good. Fry present in stream.
23	Simpson Creek	93L084-CN4	PK, CO, ST, CT, DV, MW	460-345400-267002-7800	Culvert	No	No	2-1500 mm culverts spaced 19 m apart.
24	Kathlyn Creek - mid	93L085-HW1	PK, CO, ST, CT, DV, RB, MW, L	460-345400-267000	Culvert	No	Yes	Remove log from inlet
25	Kathlyn Creek - lower	93L075-HW1	PK, CO, ST, CT, DV, RB, MW, L	460-345400-267000	Culvert	No	No	Culvert good, inlet and outlet encased in concrete. Sediment traps at upstream end of culvert.
26	Chicken Lake Creek	93L075-CN1	PK, ST	460-345400-000000	Culvert	No	No	2-1600 mm culverts with fry present.
27	Bigelow (Dahlie) Creek	93L075-CN2	(DV, RB)	460-373800-332000	Culvert	No	No	2-1200 mm culverts that are good.

5.3 Bulkley Fish Passage Site Summary

Map ID #	STREAM NAME	SITE	FISH PRESENCE	WATERSHED CODE	CROSSING TYPE	BARRIER	MAINTEN REQUIRED	COMMENTS
28	Seymour Creek	93L075-CN3	CT, RB	460-373800-000000	Culvert	No	No	Dry stream, no flow. Looks to be ephemeral.
29	Bigelow (Dahlie) Creek	93L075-HW2	(DV, RB)	460-373800-332000	Culvert	No	No	2-1200 mm culverts good. Beaver guards installed on inlet of both culverts..
30	Moan Creek	93L066-CN1	CO, CH, RB, CT	460-548800-000000	Culvert	Partial	No	Recommend installing two weirs downstream that will mitigate the 50 cm outfall drop. High priority.
31	Unknown	93L056-CN2	Unknown	460-545700-000000	Bridge	No	No	
32	Unknown	93L056-CN1		460-545700-000000	Culvert	No	No	Culvert good, beaver guard installed on inlet, screen on outlet. Concrete pipe at inlet, round CMP 1000 mm at outlet. Fry present in pools above and below.
33	Dockrill Creek	93L046-CN1	PK, RB, DV	460-562100-000000	Bridge	No	No	
34	Unknown	93L046-CN2	Unknown	460-562900-000000	Bridge	No	No	
35	Emerson Creek	93L046-CN3	PK, RB, DV	460-568500-000000	Bridge	No	No	
36	Tyhee Creek	93L065-HW1	RB, CT, OS	460-430900-000000	Culvert	Partial	Yes	2 - 900 mm pipes. Dry stream. At high water the outfall drop is 35 and 23 cm. Bottom of culvert starting to rust through. High priority.
37	McDowell Creek	93L065-HW2	CO, RB	460-435300-000000	Culvert	Partial	Yes	Dry creek, re-visited in high flows. Culvert separated 6.5m from outlet. Separated section sunk ~ 18 cm. Fill scoured away from under separated section. Recommend fixing soon, dig outlet back and connect new section. High priority.
38	Lacroix Creek	93L066-HW1	CT, RB	460-472600-000000	Culvert	No	No	
39	Deep Creek	93L066-HW2	CO, CH, PK, ST, DV, RB, CT	460-496100-000000	Culvert	No	No	Culvert good, low flow. Deep pools, fry present above and below.
40	Thompson Creek	93L056-HW1	PK, CO, ST, DV, CT	460-517700-000000	Culvert	No	No	New open bottom arch. Man made rocklines built in stream through length of culvert. Culvert good, well built.
41	Thompson Creek trib	93L056-HW2	PK, CO, ST, DV, CT	460-517700-000000	Culvert	No	No	Culvert good, very little flow. Beaver guard on inlet.
42	Stock Creek	93L047-CN1	CT, RB	460-589500-000000	Culvert	No	No	2 - 300 mm pipes. Culverts good, dry creek. ~50 fish in outfall pool.

5.3 Bulkley Fish Passage Site Summary

Map ID #	STREAM NAME	SITE	FISH PRESENCE	WATERSHED CODE	CROSSING TYPE	BARRIER	MAINTEN REQUIRED	COMMENTS
43	Bulkley River	93L047-HW1	CH, CO, PK, SK, ST, BT, CT, L, MW	460-000000-000000	Bridge	No	No	
44	Bulkley River	93L047-CN2	CH, CO, PK, SK, ST, BT, CT, L, MW	460-000000-000000	Bridge	No	No	
45	Buck Creek	93L047-HW2	CO, PK, CH, ST, RB, DV, BT	460-636000-000000	Bridge	No	No	
46	Buck Creek	93L047-CN3	CO, PK, CH, ST, RB, DV, BT	460-636000-000000	Bridge	No	No	
47	Bulkley River	93L047-HW3	CH, CO, PK, SK, ST, BT, CT, L, MW	460-000000-000000	Bridge	No	No	No photos
48	Bulkley River	93L047-CN4	CH, CO, PK, SK, ST, BT, CT, L, MW	460-000000-000000	Bridge	No	No	
49	Raspberry Creek	93L048-HW4	Unknown	460-672800-000000	Culvert	No	Yes	30% embedded at the inlet, ~ 70% embedded at outlet. Recommend removing gravel from within culvert.
50	Bulkley Oxbow_1	93L048-CN1	Unknown	(CH, CO, ST)	Culvert	Full	No	Culvert placement 1.35 m above current, low water level. High priority to conduct a fish and habitat assessment.
51	Raspberry Creek	93L048-CN2	Unknown	460-672800-000000	Culvert	No	No	Dry creek. 1300mm overflow pipe ~5 m apart from main culvert. Heavily vegetated streambed suggests low water flows.
52	Barren Creek	93L048-HW1	CH, CO, RB	460-704700-000000	Culvert	No	Yes	Culvert ~ 50% embedded. Work has been recently completed apparently to remove access gravel from within the culvert and also up and downstream of culvert. Sediment traps installed in channel below culvert, recommend seeding excavated stream banks.
53	Barren Creek	93L048-CN3	CH, CO, RB	460-704700-000000	Culvert	No	No	2 - 1000 mm concrete culverts, placement good.
54	Bulkley Oxbow_2	93L048-CN4	Unknown	(CH, CO, ST)	Culvert	No	Yes	Clean debris from inlet. 2 - 1000 mm culverts. Logs and sticks plugging each pipe.
55	Unnamed	93L048-CN5	Unknown	Unknown	Culvert	No	No	

5.3 Bulkley Fish Passage Site Summary

Map ID #	STREAM NAME	SITE	FISH PRESENCE	WATERSHED CODE	CROSSING TYPE	BARRIER	MAINTEN REQUIRED	COMMENTS
56	McInnes Creek	93L048-HW2	Unknown	Unknown	Culvert	No	No	Dry creek.
57	Unknown	93L048-HW3	Unknown	460-741321-000000	Culvert	No	Yes	Fry present in outlet pool. Guard installed on inlet, some debris blocking lower half of inlet. Culvert placement good.
58	McQuarrie Creek	93L058-HW1	CH, CO, ST. RB	460-744900-000000	Culvert	No	No	Embedded 50%. Culvert placement good.
59	McQuarrie Creek	93L058-CN1	CH, CO, ST. RB	460-744900-000000	Bridge	No	No	
60	Perow Creek	93L058-HW2	Unknown	460--750400-022000	Culvert	No	Yes	Pull gravel from culvert. If round, culvert embedded 75%. Appears that gravel has been deposited in front of culvert as well as within culvert. With further deposition culvert may get plugged.
61	Perow Creek	93L058-CN2	Unknown	460--750400-022000	Culvert	No	No	Dry stream. Culvert good.
62	Byman Creek	93L058-CN3	CH, CO, RB, ST	460--750400-000000	Bridge	No	No	
63	Byman Creek	93L058-HW3	CH, CO, RB, ST	460--750400-000000	Culvert	No	No	Culvert good.
64	Johnny David Creek	93L059-HW1	CH, CO, ST, RB, CT, DV	460-750400-713000	Culvert	Partial	No	67 cm outfall drop with deep pool at low flow. Water level is low, norm to high flows pool depth will increase and outfall drop decrease. Fry present through lower section and upper section. Creek flowing through cow pasture on upper end. upper stream measurements taken at 100 and 125 m. Negligible outfall, but ~ 2.5m/s velocity with high flows. Recommend three downstream step weirs at 12 m, 22 m, and 34 m. High Priority.
65	Richfield Creek	93L059-HW2	CO, CH, ST	460-778200-000000	Culvert	No	No	2 - 4300mm pipes. Placement good both pipes.
66	Richfield Creek	93L059-CN1	CO, CH, ST	460-778200-000000	Bridge	No	No	
67	Cesford Creek	93L059-HW3	RB	460-800700-000000	Culvert	Partial	No	Stream below culvert could not be measured because stream flows under substrate. Outfall drop is 35 cm. Moderate priority.
68	Ailport Creek	93L049-HW1	CO, DV, RB	460-829700-000000	Culvert	No	No	Culvert good.

5.3 Bulkley Fish Passage Site Summary

Map ID #	STREAM NAME	SITE	FISH PRESENCE	WATERSHED CODE	CROSSING TYPE	BARRIER	MAINTEN REQUIRED	COMMENTS
69	Bulkley River	93L050-CN1	CO, CH, SK, ST, CT	460-000000-000000	Bridge	No	No	Forestdale south crossing
70	Crow Creek	93L040-CN1	Unknown	460-917900-000000	Bridge	No	No	
71	Bulkley River	93L040-CN2	SK, CH, CO, DV, RB, MW	460-000000-000000	Bridge	No	No	
72	Tamen Creek/Bulkley River	93L050-HW1	RB	460-000000-000000	Culvert	No	No	Culvert good
73	Bulkley River	93L040-CN3	SK, CH, CO, DV, RB, MW	460-000000-000000	Culvert	No	No	2 - 1000 mm pipes. Pipe 1/2 submerged on both ends, beaver pond up and down stream. Placement good, beaver guards on inlet of pipes.
74	Bulkley River	93L040-CN4	SK, CH, CO, DV, RB, MW	460-000000-000000	Culvert	No	No	Culvert 1/2 submerged at both ends. 2 other 1000 mm pipes draining same stream. Could be replaced with bigger pipe or bridge.
75	Waterfall Creek	93M023-HW2	CO, ST, CT, DV, RB	460-007300-394700	Culvert	No	No	Culvert good
76	Waterfall Creek	93M023-CN2	CO, ST, CT, DV, RB	460-007300-394700	Culvert	No	No	2 - 1000 mm pipes. Good placement. Beaver guard installed on inlet of both pipes.
77	Coffin Creek	93L066-CN2	CT, DV, RB, MW	460-472700-000000	Culvert	Partial	No	Dry creek. Culvert good. Large pool area around outlet. May have ~ 20 cm outfall drop with full pool. High Priority.
78	Station Creek	93M022-HW1	PK, ST, CO, CT, DV,	460-007300-000000	Culvert	Full	No	This crossing has received a detailed fisheries assessment; currently undergoing a detailed design and geotechnical studies. High priority.
79	Toboggan Creek	93L084-CN7	CO, PK, ST, CT, DV, RB, MW	460-241300-000000	Culvert	No	No	Concrete box culvert with two 2500 x 1500 mm boxes at Toboggan Lake outlet.
80	Glass Creek	93L084-CN8	RB, DV	460--242900-515009-600	Culvert	Partial	No	Support structure inside culvert under tracks. Beaver guard on inlet. Multi-channeled stream-swamp upstream. High priority.
81	Club Creek	93L084-HW3	CO, RB, DV	460-345400-267002-7800	Culvert	No	No	Culverts work good, beaver guard on inlet and outlet
82	Bulkley River	93L065-HW3	CH, CO, PK, SK, ST, BT, CT, L, MW	460-000000-000000	Bridge	No	No	

5.3 Bulkley Fish Passage Site Summary

Map ID #	STREAM NAME	SITE	FISH PRESENCE	WATERSHED CODE	CROSSING TYPE	BARRIER	MAINTEN REQUIRED	COMMENTS
83	Telkwa River	93L065-CN1	CO, PK, ST, DV, CT, MW	460-422700-000000	Bridge	No	No	
84	Hubert Creek	93L065-CN2	CO, ST, CT	460-437000-000000	Culvert	No	No	3 recently installed culverts; look good.
85	Bulkley River	93L046-CN4	CH, CO, PK, SK, ST, BT, CT, L, MW	460-000000-000000	Bridge	No	No	Barrett Crossing
86	Robin Creek	93L066-HW3	CH, CO, CT, RB	460-487900-000000	Culvert	No	No	Culvert works well
87	Lemieux Creek	93L066-HW4	CO, RB, CT, DV	460-487900-111000	Culvert	No	No	Culvert works well
88	Bulkley River	93L058-CN4	CH, CO, PK, SK, ST, BT, CT, L, MW	460-000000-000001	Bridge	No	No	Perow West Crossing
89	Bulkley River	93L059-CN2	CH, CO, PK, SK, ST, BT, CT, L, MW	460-000000-000000	Bridge	No	No	Perow East Crossing
90	Cesford Creek	93L059-CN3	RB	460-800700-000000	Culvert	No	No	Unable to access culvert
91	Bulkley River	93L049-CN1	CH, CO, PK, SK, ST, BT, CT, L, MW	460-000000-000001	Bridge	No	No	Ailport north crossing
92	Bulkley River	93L049-CN2	CH, CO, PK, SK, ST, BT, CT, L, MW	460-000000-000000	Bridge	No	No	Ailport central crossing
93	Bulkley River	93L049-CN3	CH, CO, PK, SK, ST, BT, CT, L, MW	460-000000-000000	Bridge	No	No	Ailport south crossing
94	Bulkley River	93L049-CN4	CH, CO, PK, SK, ST, BT, CT, L, MW	460-000000-000000	Bridge	No	No	Forestdale North Crossing
95	Bulkley River	93L050-HW2	CH, CO, PK, SK, ST, BT, CT, L, MW	460-000000-000000	Bridge	No	No	Concrete bridge
96	Mudflat Creek	93M023-HW2	DV, RB	460-089200-000000	Culvert	Yes	Yes	Bottom of culvert has rusted through allowing discharge to cause fillslope failure. 1.7 m outfall drop is a full barrier to all fish. Uncertain as to historical fish presence.

5.3 Bulkley Fish Passage Site Summary

Map ID #	STREAM NAME	SITE	FISH PRESENCE	WATERSHED CODE	CROSSING TYPE	BARRIER	MAINTEN REQUIRED	COMMENTS
97	Bunker Creek	93M023-HW3	DV, RB	460-089200-017300	Culvert	No	No	Culvert works well. Frequent beaver activity; beaver guard on inlet.
98	Trout Creek	93L094-CN2	CO, PK, ST, CT	460-241300-000000	Bridge	No	No	No photos

Table 7. Bulkley Fish Passage Assessment Summary Data

5.4 HIGH PRIORITY FISH PASSAGE SITES

5.4.1 Toboggan Creek Culvert

Site No. 14.

Toboggan Creek is a third order tributary draining an area of 112 km^2 into Bulkley River. The major tributaries drain mountainous and glacial areas before flowing across low gradient lowlands. The hydrology is controlled by spring snowmelt freshets that are frequently followed by a second minor peak in late fall. The Toboggan Creek Watershed is traversed by Highway #16 and CN Rail and has a long history of forestry and agriculture activities. Toboggan Lake and the mainstem downstream of the lake, traverse private property.

Toboggan Creek and its tributaries has high value spawning and rearing habitat that supports coho, steelhead, pink salmon, and occasionally chinook salmon, cutthroat trout, Rocky Mountain whitefish, Dolly Varden, and non-salmonids such as lamprey and sculpin. Toboggan Creek hosts a hatchery facility that augments Bulkley coho and chinook stocks in various sub-basins through the Bulkley Watershed. Adult and smolt fences directed towards coho stock assessment are maintained and along with the coded wire tag hatchery releases, assist with coho index stock estimates.

Highway #16 crosses Toboggan Creek approximately 115 m upstream from the Bulkley River. The creek passes through a 5000 mm elliptical multiplate culvert that is 33 m in length. The culvert is baffled to reduce stream velocity. The outfall drop varies with flow levels with ranges between 63 cm at low flows to approximately 20 cm at high flows. At low flows, the culvert discharges onto boulders that render fish jumps difficult. The lower 3 m of the culvert appears to have been pushed downward to lessen the outfall drop; however, this has resulted in an increase of velocity.

Culvert velocities range from an average of 1.38 m/s at low flows to 3.37 m/s at high flows. These average velocities are well above the recommended velocity of 0.9 m/s for a culvert of that length. Depending on flow levels, the culvert is a moderate outfall drop barrier and an excessive to extreme velocity barrier to adult and juvenile fish.

Toboggan Creek culvert rehabilitation is rated as a high priority fish passage restoration site due to its matrix score of 46 and the significant fisheries values. An open bottom arch or bridge structure is recommended to alleviate fish passage problems.

Figure 23. View upstream of Toboggan Creek culvert outlet. Photo shows low flow conditions September 21, 2006.

Figure 24. View of Toboggan Creek culvert downstream. Photo shows low flow conditions September 21, 2006.

Figure 25. View of Toboggan Creek culvert upstream. Photo shows low flow conditions September 21, 2006.

Figure 26. View of Toboggan Creek culvert inlet downstream. Photo shows low flow conditions September 21, 2006.

Figure 27. View of Toboggan Creek culvert outlet. Photo shows high flow conditions May 04, 2007.

Figure 28. View of Toboggan Creek culvert outlet. Photo shows high flow conditions May 04, 2007.

Figure 29. View of Toboggan Creek culvert inside. Photo shows high flow conditions May 04, 2007. Culvert water velocity averaged 3.37 m/s.

Date	09/21/06 05/04/07	Stream Name	**Toboggan Creek**
Road Name	Highway #16	Watershed Code	460-241300-000000
UTM/GPS Location	09 607725 6089354	Recorders Name	TW/JM TW/KR
1:20 000 Map Sheet	93L084	Field Number	93L094-HW2
Site Number	**14**		

Culvert Characteristics	
Culvert Diameter (mm)	5000 mm W x 3000 H
Culvert Length (m)	33 m
Culvert Slope (%)	4.0%
Culvert Material	Multiplate
Culvert Water Velocity	1.38 m/s low flow 3.37 m/s high flow
Culvert Shape	Elliptical
Culvert Wetted Width	3.49 m
High Water Mark	64 cm
Culvert Water Depth	28 cm
Culvert Outfall Drop	63 cm
Culvert Maintenance	No
Comment	Wood baffles throughout culvert. Last 3 m of culvert pushed down that have increased velocity

Stream Characteristics		
Pool Depth at Outfall	30-60 cm amidst boulders	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	8.70 m	7.35 m
Bankfull Width avg	11.6 m	9.7 m
Water Depth avg	34 cm	25.5 cm
Bankfull Depth (cm)	36 cm	59 cm
Stream Velocity avg	0.54 m/s	0.58 m/s
Stream Gradient (%)	4.0 %	1 %
Substrate	2S/20G/50C/25B/	5G/90C/5B
Fish Habitat Quality	High	Mod-High
Beaver Activity/Type	None observed	None observed
Barrier Evaluation:	Partial	
Barrier Type	Velocity, outfall drop, outfall pool depth at low to high water levels	
Prescription	Install open bottom structure	
Comment	Culvert overdue for rehabilitation	

Q100 Estimate	14.46
Stream Length Above Barrier	12 km of high value habitat
% Stream Partially Barred-	99 %

Fish species		**Habitat value**		**Barrier**		**Length of new habitat**		**Stream barred %**		**Score**
Multiple and Significant	10	H	10	Partial	6	≥1 km	10	>70%	10	**46**

Table 8. Toboggan Creek Culvert, Site 14

5.4.2 Station Creek Culvert
Site 78

Station Creek was surveyed in 2004 as part of the Middle Skeena fish passage assessment reported by Rabnett and Williams (2004) and was revisited in 2006. The Station Creek culvert is still the most important and highest fish passage restoration priority in the Bulkley Watershed. Station Creek culvert has been impassable to fish since its installation in 1965, as noted during assessments by Bustard (1986), Pendray (1990), Rabnett and Williams (2004), and SKR Consultants (2006). This fish passage issue is long overdue for fish passage restoration. Currently, it appears that there needs to be political will to move forward.

This third order watershed is approximately 12.5 km in length, draining 26.5 km^2 of mountain hillslopes, wetlands, and lowlands on the northern slope of Hagwilget Peak. Waterfall Creek, the major tributary, is approximately 7 km in length and drains two wetlands to the southeast of New Hazelton. Station Creek drains into Bulkley River 1.5 km upstream of the Skeena River confluence. Water Survey of Canada maintains stream gauge 08EE028 in upper Station Creek.

Station and Waterfall Creeks contain pink salmon (*O. gorbuscha*), coho salmon (*O. kisutch*), steelhead (*O. mykiss*), cutthroat trout (*O. clarkii*), and Dolly Varden char (*Salvelinus malma*) Mitchell (1998). The principal fisheries values in the system are currently located below the highway crossing in Station Creek, but Woloshyn (2004) notes that historically, coho spawners were reported as far upstream as the mid-reaches of Station and Waterfall Creeks in New Hazelton. There are high densities of cutthroat trout and Dolly Varden char in the upper sections of Waterfall Creek (Bustard 1986). Bustard indicated that this is due to the highly productive habitat (riffle, pool, cover, etc.) and stable flow regime in this system.

There are three principal barriers to fish access in the system: a rock chute at 0.5 km upstream of Bulkley River that prevents pink salmon movement above it; the highway culvert blocking coho and steelhead movement upstream; and a 20m waterfall on upper Waterfall Creek (Mitchell 1998).

Gitxsan Watershed Authorities (2004a) report that Xsan Xsagiibil was a fishing site located at the mouth of Station Creek (Xsi Gwin Sagiiblax). This site was directed to a spring steelhead and fall coho fisheries. Gitxsan Watershed Authorities strongly support fish passage restoration on this system.

Fishery stewardship groups attach significant importance to the fish and fish habitat values of Station Creek system. Since the early 1990s, a consensus-based stewardship program, involving local communities, interest groups, and the Department of Fisheries and Oceans, has operated a hatchery, enumerated returning adult salmon, and operated an adult coho trap that allows removal of brood stock, as well as the capture and transport of live adults to the creek upstream of the impassable Highway #16 culvert.

Station Creek is the highest priority culvert to rehabilitate on Highway #16 within the Bulkley Watershed. This culvert issue has been noted by DFO as a serious hindrance to fish passage since at least 1975. The culvert is undersized according to Ministry of Transportation guidelines. In the event of an extreme flood, washout of the culvert and/or the adjacent CN Rail line would severely damage fish habitat downstream from the highway.

Figure 30. Station Creek culvert inlet. View downstream to inlet.

Figure 31. Station Creek culvert inlet. View upstream from inlet.

Figure 32. Station Creek culvert outlet. View upstream of outlet.

Figure 33. Station Creek culvert outlet. View downstream from outlet.

Date	Sept 15 04, Nov 22 04	Stream Name	**Station Creek**
Road Name	Highway #16	Watershed Code	460-007300-000000
UTM/GPS Location	09 586630 6122416	Recorders Name	LW/KR
1:20 000 Map Sheet	93M022	Field Number	93M023-HW1
Site Number	**78**		

Culvert Characteristics	
Culvert Diameter (mm)	1500 mm
Culvert Length (m)	99 m
Culvert Slope (%)	1.8%
Culvert Material	Multi-Plate
Culvert Water Velocity	Average 3.93 m/s
Culvert Shape	Round
Culvert Wetted Width	120 cm
High Water Mark	150cm
Culvert Water Depth	33 cm
Culvert Outfall Drop	96 cm
Culvert Maintenance	No
Comment	

Stream Characteristics		
Pool Depth at Outfall	120 cm	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	3.95 m	5.7m
Bankfull Width avg	8.9 m	6.8 m
Water Depth avg	27.5 cm	30.5 cm
Bankfull Depth (cm)	43 cm	72.5 cm
Stream Velocity avg	0.58 m/s	0.80 m/s
Stream Gradient (%)	2.5 %	2.5 %
Substrate	Sand/cobble	Gravel/cobble
Fish Habitat Quality	High	High
Beaver Activity/Type	None observed	None observed
Barrier Evaluation:	Full	
Barrier Type	Outfall drop and velocity	
Prescription	Open bottom structure, backwater if necessary	
Comment	Culvert overdue for rehab	

Q100 Estimate	8.93 m/s
Stream Length Above Barrier	9000 m
% Stream Barred	80 %

Fish species		**Habitat value**		**Barrier**		**Length of new habitat**		**Stream barred %**		**Score**
Multiple and Significant	10	H	10	Full	10	≥1 km	10	>70%	10	**50**

Table 9. Station Creek — Site 78

5.4.3 Bulkley Oxbow 1
Site 50

Bulkley Oxbow 1 is an approximately 800 m in length abandoned channel that lies between Highway #16 and CN Rail. It is located 100 m east of the Raspberry Creek - CN Rail crossing. Coho and steelhead presence within the oxbow has been confirmed and chinook presence is inferred. The oxbow potentially represents high quality and productive overwintering habitat. The only culvert passing under the CN Rail grade is positioned at the eastern end of the oxbow. The 1700 mm culvert was 1.35 m in height above the Bulkley River during low flows. A habitat and juvenile presence/absence assessment needs to be conducted to determine the extent of productive habitat and the nature and stability of the flow regime. The results of these assessments will then determine if restoration work is appropriate.

Figure 34. Bulkley Oxbow 1 culvert inlet. View upstream.

Figure 35. Bulkley Oxbow 1 culvert outlet. View downstream of oxbow channel.

Figure 36. Bulkley Oxbow 1 culvert outlet. View upstream of culvert outlet.

5.4.4 Moan Creek Culvert

Site No. 30.

Moan Creek (local name) is a second order system draining an approximate 17.3 km^2 area. Moan Creek originates from a wetland complex located between the headwaters of Hubert and Coffin creeks. The lower 2.9 km are low gradient and support cutthroat trout, Dolly Varden, bull trout, and rainbow trout. Coho and chinook have been observed in the lower 500 m reach. Minimal information is apparent on the fish distribution in Moan Creek. Habitat quality values adjacent to the culvert are moderate to high.

The site was visited twice due to low flow conditions. The 2700 mm elliptical multiplate culvert is located 15 m from the Bulkley River, has an outfall drop of 57 cm and an outfall pool depth of 34 cm at low flow conditions. This is limiting to juvenile and adult fish. It is suspected that spring snowmelt freshets generate excessive culvert discharge with high flow velocities that have contributed to scouring downstream of the culvert. Installation of an open bottom structure is recommended. The site is rated a high restoration priority.

Figure 37. Moan Creek culvert outlet.
View upstream of culvert outlet.

Figure 38. Moan Creek culvert outlet.
View downstream from culvert outlet with Bulkley River in the background.

Figure 39. Moan Creek culvert inlet.
View downstream to culvert inlet

Figure 40. Moan Creek culvert inlet.
View upstream from culvert inlet

	10/26/06	Stream Name	**Moan Creek**
Road Name	CN Rail	Watershed Code	460-548800-000000
UTM/GPS Location	09 631022 6055956	Recorders Name	TW/JM
1:20 000 Map Sheet	93L066	Field Number	93L066-CN1
Site Number	**30**		

Culvert Characteristics	
Culvert Diameter (mm)	2700 x 1900 mm
Culvert Length (m)	16 m
Culvert Slope (%)	3.0%
Culvert Material	Multiplate
Culvert Water Velocity	0.42 m/s
Culvert Shape	Elliptical
Culvert Wetted Width	148 cm
High Water Mark	28 cm
Culvert Water Depth	30 cm
Culvert Outfall Drop	57 cm
Culvert Maintenance	None
Comment	Remove culvert outfall drop

Stream Characteristics		
Pool Depth at Outfall	34	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	N/A	1.65 m
Bankfull Width avg	N/A	3.45 m
Water Depth avg	N/A	15.8 cm
Bankfull Depth (cm)	N/A	18.0 cm
Stream Velocity avg	N/A	0.09 m/s
Stream Gradient (%)	2.3 %	3.0 %
Substrate	S10/G50/C35/B5	S5/G40/C50/B5
Fish Habitat Quality	High	Mod to high
Beaver Activity/Type	None observed	None observed
Barrier Evaluation:	Barrier at low to high flows	
Barrier Type	Outfall drop	
Prescription	Install open bottom structure	
Comment	Channel possibly backwatered by Bulkley R in high flows	

Q100 Estimate	6.6528
Stream Length Above Barrier	10.57 km
% Stream Barred	99%

Fish species		**Habitat value**		**Barrier**		**Length of new habitat**		**Stream barred %**		**Score**
Multiple and Significant	10	M-H	8	Partial	6	≥1 km	10	>70%	10	**44**

Table 10. Moan Creek Culvert Site 30

5.4.5 Johnny David Creek
Site 64

Johnny David Creek is a second order watershed draining an approximate 35.4 km^2 southward into Bulkley River. There are roughly 12 km of high value mainstem fish habitat. Fish presence is represented with coho, chinook, and steelhead salmon, cutthroat trout, rainbow trout, and Dolly Varden. Historic escapement records are scant.

Highway #16 crosses Johnny David Creek about one km upstream of the Bulkley River. The 2200 mm round multiplate culvert has an outfall drop of 67 cm, an outfall pool depth of 74 cm, and culvert water depth of 5 cm at low flow conditions. Not quite enough for adult spawners to enable jumping. There is evidence of prior backwatering efforts. At high flow conditions, the outfall drop is considerably reduced to ~5 cm; however, the stream velocity ranges around 2.5 m/s, which is excessive for enabling fish passage and maintaining backwater structures.

In addition, backwater steps could potentially infill with sediment transported in high flows. Overall, the Johnny David crossing is a partial barrier to adult and juvenile fish passage due to the outfall drop and high velocity at various flow regimes. Johnny David Creek culvert restoration is rated high priority with a matrix score of 46. Establishing a series of pools to step up to a deep outfall pool that acts to backwater the culvert is recommended.

Figure 41. Johnny David Creek culvert outlet.
View upstream of culvert outlet.

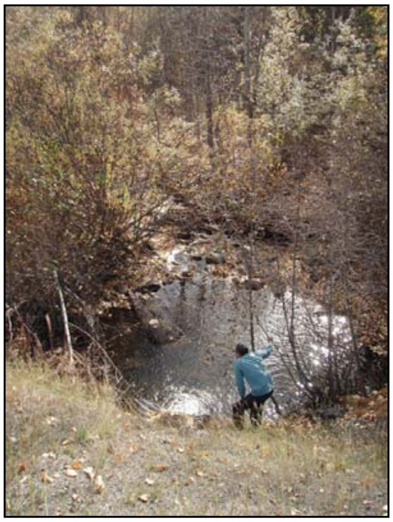


Figure 42. Johnny David Creek culvert outlet. View downstream from culvert outlet.

Figure 43. Johnny David Creek culvert inlet. View upstream from culvert inlet.

Figure 44. Johnny David Creek culvert inlet. View downstream to culvert inlet.

Date	10/04/06 05/04/07	Stream Name	**Johnny David Creek**
Road Name	Highway #16	Watershed Code	460-750400-713000
UTM/GPS Location	09 670214 6044759	Recorders Name	TW/PH TW/KR
1:20 000 Map Sheet	93L059	Field Number	93L059-HW1
Site Number	**64**		

Culvert Characteristics	
Culvert Diameter (mm)	2200 mm
Culvert Length (m)	28 m
Culvert Slope (%)	3.0 %
Culvert Material	Multiplate
Culvert Water Velocity	0.28 m/s
Culvert Shape	Round
Culvert Wetted Width	70 cm
High Water Mark	95 cm
Culvert Water Depth	5 cm
Culvert Outfall Drop	67 cm
Culvert Maintenance	None
Comment	Outfall drop height varies with discharge

Stream Characteristics		
Pool Depth at Outfall	74	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	2.5 m	3.7 m
Bankfull Width avg	4.0 m	5.45 m
Water Depth avg	52 cm	9.8 cm
Bankfull Depth (cm)	27 cm	46 cm
Stream Velocity avg	0.17 m/s	0.068 m/s
Stream Gradient (%)	3.0 %	2.7 %
Substrate	S5/G50/C45	Unknown
Fish Habitat Quality	High	High
Beaver Activity/Type	None observed	None observed
Barrier Evaluation:	Partial barrier at low to high flows	
Barrier Type	Velocity and outfall drop	
Prescription	Establish series of step pools	
Comment	Fry present throughout-above and below culvert	

Q100 Estimate	4.3456
Stream Length Above Barrier	11.1 km
% Stream Partially Barred	92%

Fish species		**Habitat value**		**Barrier**		**Length of new habitat**		**Stream barred %**		**Score**
Multiple and Significant	10	H	10	Partial	6	≥1 km	10	>70%	10	**46**

Table 11. Johnny David Creek Culvert Site 64

5.4.6 Glass Creek Culvert

Site 80

Glass Creek is a relatively small 9.8 km^2 second order watershed mostly draining wetlands into the eastern end of Toboggan Lake. Highway #16 and CN Rail both traverse the drainage. Fish presence and distribution isn't well known; however, rainbow trout and Dolly Varden presence has been confirmed.

The Glass Creek culvert crossing is located on the CN Rail grade downstream of a prominent wetland. The 1200 mm culvert has a 20 cm outfall drop which is a partial barrier to juvenile fish. The culvert is failing under the grade; it is currently supported inside the culvert with rail ties and will need to be replaced soon. A similar sized culvert installed at the proper elevation is recommended. The Glass Creek culvert crossing is rated high due to its matrix rating and the need to replace it.

Figure 45. Glass Creek culvert outlet. View upstream of culvert outlet.

Figure 46. Glass Creek culvert outlet. View downstream from culvert outlet.

Figure 47. Glass Creek culvert inlet. View upstream from culvert inlet.

Figure 48. Glass Creek culvert inlet. View downstream to culvert inlet.

Figure 49. Glass Creek culvert interior. View downstream from culvert inlet showing sag and support beams.

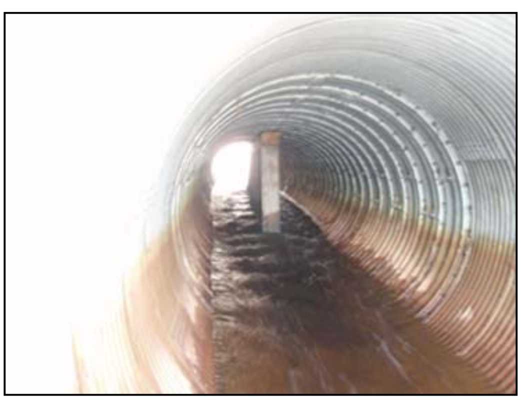


Figure 50. Glass Creek culvert interior. View upstream from culvert outlet showing support beams.

Date	05/03/07	Stream Name	**Glass Creek**
Road Name	CN Rail	Watershed Code	460-242900-515009-600
UTM/GPS Location	09 613516 6079933	Recorders Name	TW/KR
1:20 000 Map Sheet	93L084	Field Number	93084-CN8
Site Number	**80**		

Culvert Characteristics	
Culvert Diameter (mm)	1200 mm
Culvert Length (m)	21.6 m
Culvert Slope (%)	2.0 %
Culvert Material	CMP
Culvert Water Velocity	1.54 m/s
Culvert Shape	Round
Culvert Wetted Width	112 cm
High Water Mark	57 cm
Culvert Water Depth	23 cm
Culvert Outfall Drop	20 cm
Culvert Maintenance	Replace culvert
Comment	Culvert is sagging and will fail soon

Stream Characteristics		
Pool Depth at Outfall	76	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	1.80 m	N/A
Bankfull Width avg	3.70 m	N/A
Water Depth avg	45.8 cm	N/A
Bankfull Depth (cm)	26 cm	N/A
Stream Velocity avg	0.62 m/s	N/A
Stream Gradient (%)	1.3 %	N/A
Substrate	S10/G80/C10	Swampy
Fish Habitat Quality	High	Mod
Beaver Activity/Type	None observed	Light
Barrier Evaluation:	Barrier at low to high flows	
Barrier Type	Partial outfall drop	
Prescription	Replace culvert	
Comment	Embed culvert 20 %	

Q100 Estimate	XXXXXX
Stream Length Above Barrier	1.5 km
% Stream Barred	51%

Fish species		**Habitat value**		**Barrier**		**Length of new habitat**		**Stream barred %**		**Score**
Multiple and Significant	10	M-H	8	Partial	6	≥1 km	10	>70%	6	**40**

Table 12. Glass Creek Culvert Site 80

5.4.7 McDowell Creek Culvert

Site 37

McDowell Creek is a relatively small second order watershed draining 11.7 km^2 from McDowell Lake, located in the headwaters into Bulkley River. Fish distribution information is scant, but coho and rainbow trout presence is confirmed. Steelhead use is suspected, but has not been confirmed. The length of high value habitat is about 7 km. McDowell Creek frequently dries with late summer low flows, as was the case in 2006 and required a revisit in spring 2007. Riparian values in the majority of reaches have been compromised with agricultural clearing extending to the stream banks. The Highway #16 crossing is located approximately 480 m upstream from the mouth at Bulkley River.

McDowell Creek culvert is a 1200 mm round CMP positioned at a relatively steep slope (4%). The 30 m culvert is a two piece unit and the joint located 6.5 m upstream from the outlet has separated and sunk ~16 cm. This has allowed the fillslope to slowly fail and is starting to threaten the highway shoulder. The fillslope material is eroding into the pipe and then transported downstream. The outlet has a 65 cm outfall drop at low flows, which is modified to 10 cm at high flows such as spring snowmelt freshet. Culvert discharge velocity averages 3.20 m/s in high flows. This high velocity is excessive for enabling fish passage and for maintaining the position of backwater structures. Sediment could potentially infill weir or backwater structures.

The outlet situation needs assessment following culvert maintenance. It is likely that the outlet pool and channel downstream of the culvert have scoured and downcut; currently the stream gradient is 5%.The McDowell Creek culvert crossing is a partial barrier to adult and juvenile fish passage due to the outfall drop and high velocity at various flow regimes. McDowell Creek culvert restoration is rated moderate priority with 40.5 as the matrix score.

Figure 51. McDowell Creek culvert outlet. Photo shows late summer dry flows.

Figure 52. McDowell Creek culvert outlet in high flows. Note hillslope slump above culvert.

Figure 53. McDowell Creek culvert outlet.
View downstream of culvert outlet.

Figure 54. McDowell Creek culvert.
View upstream from culvert outlet to separated joint.

Figure 55. McDowell Creek culvert inlet.
View downstream to culvert inlet.

Figure 56. McDowell Creek culvert inlet.
Channel upstream of culvert inlet.

Date	28/09/06 05/07/07	Stream Name	**McDowell Creek**
Road Name	Highway #16	Watershed Code	460-435300-000000
UTM/GPS Location	09 628057 6060531	Recorders Name	TW/JM TW/KR
1:20 000 Map Sheet	93L065	Field Number	93L065-HW2
Site Number	**37**		
Culvert Characteristics			
Culvert Diameter (mm)	1200 mm		
Culvert Length (m)	30 m		
Culvert Slope (%)	4.0 %		
Culvert Material	CMP		
Culvert Water Velocity	3.21 m/s		
Culvert Shape	Round		
Culvert Wetted Width	100 cm		
High Water Mark	42 cm		
Culvert Water Depth	32 cm (low water)		
Culvert Outfall Drop	Low water-65 high water-10 cm		
Culvert Maintenance	Replace or repair outlet section		
Comment	Fillslope eroding into culvert		
Stream Characteristics			
Pool Depth at Outfall	Low-0 high-66.8 cm		
Measure	Below Culvert Average	Above Culvert Average	
Wetted Width avg	3.02 m	Multi-channeled above	
Bankfull Width avg	3.02 m	N/A	
Water Depth avg	34.6 cm	N/A	
Bankfull Depth (cm)	10 cm	N/A	
Stream Velocity avg	1.13 m/s	N/A	
Stream Gradient (%)	5 %	2.3 %	
Substrate	15S/85G	N/A	
Fish Habitat Quality	Moderate to low	Moderate to low	
Beaver Activity/Type	None observed	None observed	
Barrier Evaluation:	Barrier at various flows		
Barrier Type	Velocity barrier and outfall drop		
Prescription	Install open bottom structure or establish weirs		
Comment	Chronic passage problem		

Q100 Estimate	0.906
Stream Length Above Barrier	7.0 km
% Stream Barred	92%

Fish species		Habitat value		Barrier		Length of new habitat		Stream barred %		Score
Multiple and Significant	10	M-L	4.5	Partial	6	≥1 km	10	>70%	10	**40.5**

Table 13. McDowell Creek Culvert Site 37

5.4.8 Tyhee Creek
Site 36

Tyhee Creek drains a second order watershed that is approximately 35.5 km^2 and features Tyhee Lake. Tyhee Creek is 1.5 km in length from Tyhee Lake to the Bulkley River. Highway #16 crosses Tyhee Creek approximately 180 m upstream of Bulkley River. Tyhee Creek fish distribution information is relatively little; however, rainbow and cutthroat trout presence has been confirmed. Rainbow trout (Blackwater variety) are stocked annually in Tyhee Lake by BC Environment. Land use is primarily agricultural along with rural residences and a popular recreation park.

The Tyhee Creek culvert crossing under Highway #16 consists of two – 900 mm round culverts with outfalls drops at high water of 28 and 29 cm respectively. At low flows, the outfall drop is 49 cm. The creek frequently dries in the late summer and no flow was apparent in September and October, 2006. The site was revisited in May 2007, during spring freshet. Similar to other creeks in the upper Bulkley Basin, spring freshet flows through Highway #16 culverts are characterized by excessive velocities.

The culvert acts as a velocity barrier and outfall drop barrier at various flow levels. Tyhee Creek culvert restoration is rated high priority with a matrix score of 40.5. Establishing a series of pools is recommended to enable backwatering the culvert, or if the culvert is nearing it lifespan, replacement with an open bottom structure.

Figure 57. Tyhee Creek culvert outlets. Outlets in late September, 2006.

Figure 58. Tyhee Creek culvert outlets. View upstream of outlets in spring, 2007.

Figure 59. Tyhee Creek culvert outlets.
View downstream to outlets in high water, spring, 2007.

Figure 60. Tyhee Creek culvert inlet.
View upstream to inlet.

Figure 61. Tyhee Creek culvert inlet.
View downstream to inlet.

Date	28/09/06 07/05/07	Stream Name	**Tyhee Creek**
Road Name	Highway #16	Watershed Code	460-430900-000000
UTM/GPS Location	09 627204 6061450	Recorders Name	TW/JM TW/KR
1:20 000 Map Sheet	93L065	Field Number	93L065-HW1
Site Number	**36**		
Culvert Characteristics			
Culvert Diameter (mm)	900 x 2 mm		
Culvert Length (m)	50 m		
Culvert Slope (%)	2.5 %		
Culvert Material	CMP		
Culvert Water Velocity	2.53 m/s (high flow)		
Culvert Shape	Round		
Culvert Wetted Width	78/23 cm		
High Water Mark	66/60 cm		
Culvert Water Depth	29/24 cm		
Culvert Outfall Drop	29/29 cm		
Culvert Maintenance	Culvert bottom is rusting through		
Stream Characteristics			
Pool Depth at Outfall	51/50		
Measure	Below Culvert Average	Above Culvert Average	
Wetted Width avg	3.3 m	2.1 m	
Bankfull Width avg	5.7 m	2.7 m	
Water Depth avg	24.3 cm	54.8 cm	
Bankfull Depth (cm)	11 cm	29 cm	
Stream Velocity avg	0.9 m/s	0.79 m/s	
Stream Gradient (%)	6.0 %	1.5 %	
Substrate	S10/G60/C20/B10	S80/G10/C10	
Fish Habitat Quality	Moderate	Low	
Beaver Activity/Type	None observed	None observed	
Barrier Evaluation:	Barrier at low to high flows		
Barrier Type	Velocity and outfall drop		
Prescription	Install backwater steps or replace with open bottom structure		
Comment	Riparian values low in fields		
Q100 Estimate	2.25		
Stream Length Above Barrier	1.3 km		
% Stream Barred	87 %		

Fish species		**Habitat value**		**Barrier**		**Length of new habitat**		**Stream barred %**		**Score**
Multiple and Significant	10	H	4.5	Partial	6	≥1 km	10	>70%	10	**40.5**

Table 14. Tyhee Creek Culvert Site 36

5.4.9 Coffin Creek
Site 77

Coffin Creek is a relatively small third order stream draining 58 km2 of the Telkwa Range hillslopes into Bulkley River. The stream is about 17 km in length and originates in meltwater water and ground water sources. It flows into Coffin Lake, a mid-basin lake that is surrounded by wetland complexes. High value habitat consists is approximately 8 km in length. Fish presence is distinguished with coho, cutthroat trout, bull trout, Dolly Varden, rainbow trout, and mountain whitefish. Coho have been confirmed spawning 500 m upstream of the rail grade.

The culvert is located approximately 240 m upstream of the Bulkley River. The culvert that passes Coffin Creek beneath the CN Rail tracks a 4000 x 2000 elliptical multiplate 13.5 m in length. The creek was dry in late October, 2006, but was revisited in spring, 2007. The outfall drop was 51 cm in dry conditions. With high flows, the outfall drop is negligible; however, velocities averaged 2.5 m/s. This high velocity is excessive for enabling fish passage and for maintaining the position of backwater structures.

It is likely that the outlet pool and channel downstream of the culvert have scoured and downcut due to high discharge velocities. The Coffin Creek culvert crossing is a partial barrier to adult and juvenile fish passage due to the outfall drop and high velocity at various flow regimes. Coffin Creek culvert restoration is rated high priority with a matrix score of 40.5. Establishing a series of pools is recommended to enable backwatering the culvert, however, a maintenance agreement may have to be arranged with CN Rail due to potential sediment infilling of backwater pools.

Figure 66. Coffin Creek culvert outlet.
View upstream to outlet.

Figure 67. Coffin Creek culvert outlet.
View upstream of outlet in high flow conditions.

**Figure 68. Coffin Creek culvert outlet.
View downstream from outlet.**

**Figure 69. Coffin Creek culvert outlet.
View downstream of outlet in high flow conditions.**

**Figure 70. Coffin Creek culvert inlet.
View downstream from outlet.**

**Figure 71. Coffin Creek culvert inlet.
View upstream from inlet.**

Date	26/10/06 04/05/07	Stream Name	**Coffin Creek**
Road Name	CN Rail	Watershed Code	460-472700-000000
UTM/GPS Location	09 634345 6054617	Recorders Name	TW/JJ TW/KR
1:20 000 Map Sheet	93L066	Field Number	93066-CN2
Site Number	**77**		

Culvert Characteristics	
Culvert Diameter (mm)	2000 x 4000 mm
Culvert Length (m)	13.5 m
Culvert Slope (%)	3.0 %
Culvert Material	Multiplate
Culvert Water Velocity	2.79 m/s (high flow)
Culvert Shape	Elliptical
Culvert Wetted Width	N/A
High Water Mark	46 cm
Culvert Water Depth	N/A
Culvert Outfall Drop	51 cm
Culvert Maintenance	None
Comment	Culvert needs to be repositioned or backwatered

Stream Characteristics		
Pool Depth at Outfall	N/A	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	N/A	N/A
Bankfull Width avg	N/A	N/A
Water Depth avg	N/A	N/A
Bankfull Depth (cm)	N/A	N/A
Stream Velocity avg	N/A	N/A
Stream Gradient (%)	3.4 %	3.0 %
Substrate	Unknown	Unknown
Fish Habitat Quality	Low to Moderate	Low to Moderate
Beaver Activity/Type	None observed	None observed
Barrier Evaluation:	Barrier at low to high flows	
Barrier Type	Velocity and outfall drop-varies with flow	
Prescription	Reposition pipe or backwater	
Comment	Generally moderate habitat	

Q100 Estimate	N/A
Stream Length Above Barrier	7.76 km
% Stream Barred	97 %

Fish species		**Habitat value**		**Barrier**		**Length of new habitat**		**Stream barred %**		**Score**
Multiple and Significant	10	M	6	Partial	6	≥1 km	10	>70%	10	**42**

Table 16: Coffin Creek Culvert Site 77

5.5 MODERATE PRIORITY FISH PASSAGE SITES

5.5.1 Cesford Creek
Site 67

Cesford Creek is lake-headed and is a second order watershed draining approximately 34.8 km^2 into the Bulkley River. The high value habitat is 6.5 km in length. Rainbow trout presence in Cesford Creek is confirmed. The lower reach below the highway crossing has been cleared for agriculture. The highway crossing is approximately 540 m upstream of the Bulkley River.

The Highway #16 crossing consists of two elliptical multiplate culverts: a 2500 mm and a 1900 mm, which both have outfall drops at various flow levels. The stream frequently dries in late summer and was basically dry when surveyed in mid-September and late October, 2006. The site was not revisited. The crossing is rated low for restoration efforts. Establishing a downstream weir and excavating adequate outfall drop pools will likely facilitate fish passage.

Figure 62. Cesford Creek culvert outlet. View upstream to inlet.

Figure 63. Cesford creek culvert outlet. View downstream from outlet.

Figure 64. Cesford Creek culvert inlet. View upstream from inlet.

Figure 65. Cesford creek culvert inlet. View downstream to inlet.

Date	10/04/06	Stream Name	**Cesford Creek**
Road Name	Highway #16	Watershed Code	460-800700-000000
UTM/GPS Location	09 674389 6043444	Recorders Name	TW/PH
1:20 000 Map Sheet	93L059	Field Number	93L059-HW3
Site Number	**67**		

Culvert Characteristics	
Culvert Diameter (mm)	2500/1900 mm
Culvert Length (m)	25.0 m
Culvert Slope (%)	3 %
Culvert Material	Multiplate
Culvert Water Velocity	0.10 m/s (low flow)
Culvert Shape	Elliptical
Culvert Wetted Width	30 cm
High Water Mark	Unknown
Culvert Water Depth	2 cm
Culvert Outfall Drop	37/33 cm
Culvert Maintenance	None
Comment	Stream dry

Stream Characteristics		
Pool Depth at Outfall	42/20	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	N/A	1.3 m
Bankfull Width avg	7.70 m	5.55 m
Water Depth avg	N/A	10.6 cm
Bankfull Depth (cm)	74 cm	37 cm
Stream Velocity avg	N/A	0.2 m/s
Stream Gradient (%)	3.0 %	3 %
Substrate	S5/G15/C70/B10	S5/G20/C70/B5
Fish Habitat Quality	Low	Mod
Beaver Activity/Type	None observed	None Observed
Barrier Evaluation:	Barrier at low to high flows	
Barrier Type	Velocity and outfall drop	
Prescription	Backwater culvert if possible	
Comment		

Q100 Estimate	6.6528
Stream Length Above Barrier	5.9 km
% Stream Barred	92%

Fish species		**Habitat value**		**Barrier**		**Length of new habitat**		**Stream barred %**		**Score**
Single	6	L	3	Partial	6	≥1 km	10	>70%	10	**35**

Table 15. Cesford Creek Culvert Site 67

5.5.2 Strawberry Creek

Site 05

Strawberry Creek is a small second order low gradient stream draining Strawberry Flats and the adjacent hillslopes into the Bulkley River. The high value habitat is 1.7 km in length and supports steelhead, Dolly Varden, and rainbow trout. The Highway #16 culvert that passes Strawberry Creek is located 1 km upstream from Bulkley River. The 1500 mm culvert has an outfall drop of 30 cm at low flows, 24 cm at observed mid-flows, this is reduced at high flows to 5 cm, which is considered negligible. The Strawberry Creek culvert is rated a moderate restoration priority due to the fish values, habitat gained, and potential ease of modifications enabling fish passage.

Figure 72. Strawberry Creek culvert outlet. View upstream to outlet in high flows.

Figure 73. Strawberry Creek culvert inlet.

Figure 74. Strawberry Creek culvert outlet. View downstream from outlet.

Figure 75. Strawberry Creek culvert outlet. View downstream from culvert in high flows.

Date	20/09/06 25/10/06 04/05/07	Stream Name	**Strawberry Creek**
Road Name	Highway #16	Watershed Code	460-Unknown
UTM/GPS Location	09 539105 6170639	Recorders Name	TW/JM TW/KR
1:20 000 Map Sheet	93M014	Field Number	93M014-HW2
Site Number	**05**		

Culvert Characteristics	
Culvert Diameter (mm)	1500 mm
Culvert Length (m)	30 m
Culvert Slope (%)	2.0 %
Culvert Material	CMP
Culvert Water Velocity	0.85 m/s
Culvert Shape	Round
Culvert Wetted Width	64 cm
High Water Mark	60 cm
Culvert Water Depth	8 cm
Culvert Outfall Drop	30 cm (5-30 cm)
Culvert Maintenance	Clean debris from inlet
Comment	Backwater culvert

Stream Characteristics		
Pool Depth at Outfall	80	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	3.1 m	N/A-Beaver Pond
Bankfull Width avg	4.2 m	N/A
Water Depth avg	11.75 cm	N/A
Bankfull Depth (cm)	29 cm	N/A
Stream Velocity avg	0.32 m/s	N/A
Stream Gradient (%)	1.0 %	N/A
Substrate	S5/G30/C60/B5	N/A
Fish Habitat Quality	Moderate	Moderate
Beaver Activity/Type	None observed	Yes
Barrier Evaluation:	Partial barrier at low to high flows	
Barrier Type	Outfall drop	
Prescription	Backwater	
Comment	Steelhead reported up to highway crossing	

Q100 Estimate	2.7342
Stream Length Above Barrier	0.7 km
% Stream Barred	37%

Fish species		**Habitat value**		**Barrier**		**Length of new habitat**		**Stream barred %**		**Score**
Multiple and Significant	10	M	6	Partial	6	≥500 m	6	<50%	3	**31**

Table 17. Strawberry Creek Culvert Site 05

5.6 CULVERT MAINTENANCE SUMMARY

The majority of culvert maintenance consists of cleaning culvert inlets, particularly those with beaver guard screens.

Highway #16 culverts requiring maintenance are located at:

- Mudflat Creek – Site 96 (replace 3.5 m of culvert outlet),
- Toboggan Creek – Site 14 (remove boulders from outlet pool),
- Kathlyn Creek – Site 24 (remove debris from inlet),
- Tyhee Creek Site 36 (culvert outlet is rusting through),
- McDowell Creek – Site 37 (culvert outlet end has separated from main section),
- Raspberry Creek - Site 49 (culvert inlet is filled ~70% with sediment),
- Barren Creek – Site 52 (recommend seeding recently excavated stream banks),
- Unnamed - Site 57 (clean debris from culvert inlet),
- Perow Creek – Site 60 (clean sediment from inlet and body of culvert),
- Strawberry Creek – Site 05 (clean debris from inlet).

CN Rail culverts requiring maintenance are located at:

- Mudflat Creek – Site 1 (remove discarded culvert from creek),
- Bulkley Oxbow 2 – Site 54 (remove debris from culvert inlet).

6.0 DISCUSSION

This report presents Highway #16 and CN Rail fish passage issues in the Bulkley Watershed that need to be addressed with restorative or maintenance action. Our findings indicate the need for restoration or rehabilitation on eleven stream crossings. Of these culvert crossings, nine are rated as high priority and two are rated as moderate priorities. The assessment also found twelve stream crossings that require maintenance. The greatest part of the maintenance work is routine and cost effective.

The task of restoring fish passage and upstream habitat at stream crossings involves establishing priorities based on measurable benefits. With limited resources, a focused approach providing the greatest short and long-term benefits to our fish and fish habitat resources is required. Station and Toboggan creeks are the highest priority culverts to rehabilitate in order to enable fish passage. Habitat and fish surveys are a high priority for abandoned channels on the upper Bulkley River floodplain. The amount of potential habitat gained and probable coho and steelhead production are thought to be significant.

Support for moving forward with restoration efforts is being negotiated with the DFO and the B.C. Ministry of Transportation. Next steps include a meeting of partners and stakeholders to discuss and consider survey results and conceptual restoration plans, then to provide consensus for a work plan that outlines information gaps and assumptions in regard to:

- Fish species life histories and limiting habitat factors,
- Engineering assumptions and alternatives,
- Further site assessments needed,
- Restoration cost, liabilities, funding sources, and risks to investment if any.

Skeena Fisheries Commission recognizes that a considerable investment will be required to modify the four high priority culverts and install open bottom structures, but restoring fish passage will provide tangible long-term benefits to regional communities, the aboriginal, recreational, and commercial fisheries, as well as implementing international, federal, and provincial objectives that revolve around habitat integrity and abundant fish stocks.

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APPENDIX 1 PHOTOGRAPHS AND DATA TABLES

Photographs and Data Tables submitted under separate cover.

APPENDIX 2 FINANCIAL STATEMENT OF EXPENDITURES

Financial Statement submitted under separate cover.

APPENDIX 3 MAPS

Five 1:50,000 maps in pockets.