EDI ENVIRONMENTAL DYNAMICS INC.
Natural Resource Consultants

SWEDE JOHNSON CREEK FISH AND FISH HABITAT INVESTIGATION

PREPARED FOR:

GERALDINE POPE, RENEWABLE RESOURCES MANAGER

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1 INTRODUCTION

Arctic grayling (*Thymallus arcticus*) in the Swede Johnson Creek watershed were an important fishery for the Kluane First Nation (KFN) for many years. There are many local and historical accounts of adult grayling being captured in the creek downstream of the highway. According to local residents, this has changed dramatically since the highway upgrade in the late 1990s/early 2000s. Adult grayling are no longer present in the creek or the small waterbodies near the highway, although numerous juvenile grayling have been documented in the area more recently (2007). This apparent change continues to be a significant concern in the community; however, no clear rationale or explanation for the change has been identified.

This project details an investigation into the dynamics of the Arctic grayling population in the lower Swede Johnson Creek watershed and will attempt to provide an explanation for the recent changes. Possible explanations include beaver activity restricting migration, grayling overwintering dynamics, changes in water levels or other changes at the highway or pipeline crossing. Investigation of this problem included collection of the following information to ensure a detailed understanding of the watershed:

- Research of existing and historical information (including DFO habitat files);
- Extensive fish sampling throughout the lower portions of the watershed;
- Fish habitat assessment of the lower portion of the watershed; and
- Specific investigations into possible explanations as described above.

In addition, habitat or migration issues/limitations were documented and if appropriate restoration and/or enhancement plans were to be developed for future implementation.

2 METHODOLOGY

This project had two major components; the first was an investigation of past works completed around the lower Swede Johnson watershed and general history of the area; the second was an on-site field investigation of the fish and fish habitat present in the study area (Figure 1 and Figure 2).

2.1 OFFICE INVESTIGATION

The office investigation began with a search of the Fisheries and Oceans Canada (DFO) Yukon Stream Files, held in Whitehorse. These files hold records of work undertaken by DFO and other parties.

A review of the files at the Yukon Water Board also revealed a number of water licenses issued to Yukon Highways for work concerning the Swede Johnson crossing on the Alaska Highway. Copies of these water licenses were gathered and reviewed for possible changes to the lower Swede Johnson Watershed as a result of the work completed in the area. These water licenses also listed references pertaining to past environmental studies done as part of highway updating efforts. These references were sought out and reviewed.

Finally, Yukon Highways Transport Engineering Branch was approached to acquire any information, including photos, and engineered plans and drawings of the Swede Johnson highway crossing. This data helped to interpret changes made to the watershed in the creation and improvement of the highway. Applicable air photos were also collected to examine any changes in the watershed over time.

2.2 FIELD INVESTIGATION

The Swede Johnson Creek and surrounding area was visited twice over the spring/summer seasons. The spring visit was planned to closely follow spring melt, and therefore capture the high water season. The summer visit was planned for late August / early September, when the water levels are generally at a low. However, the summer of 2008 was remarkably wet, and water levels continued to be high through the summer and fall seasons. Both site visits were conducted by a biologist from EDI Environmental Dynamics Inc. together with field assistants from the Kluane First Nation (Janice Dubois, Simon Johnson and Sebastien Roy).

The spring site visit set out to catalogue fish presence and fish habitat up and downstream of the Swede Johnson crossing along the Alaska Highway. A number of representative sites along the creek were selected for fish habitat categorization. Each of these sites were investigated using the stream measurements, water quality data and qualitative channel and fish habitat observations as laid out in the standardized site cards developed in British Columbia. Methods for data collection followed standard procedures described by BC Environment (1999). Effort was also made to capture fish at all locations. Fish capture methods included minnow trapping, electro-fishing and angling.

The fall visit included investigation of the larger watershed. Nearby water bodies were visited to determine suitability for use as overwintering habitat and other fisheries values, and the entire length of Swede Johnson Creek from the highway downstream to the confluence with the Kluane River was investigated to determine presence or absence of any barriers to fish passage along the watercourse.

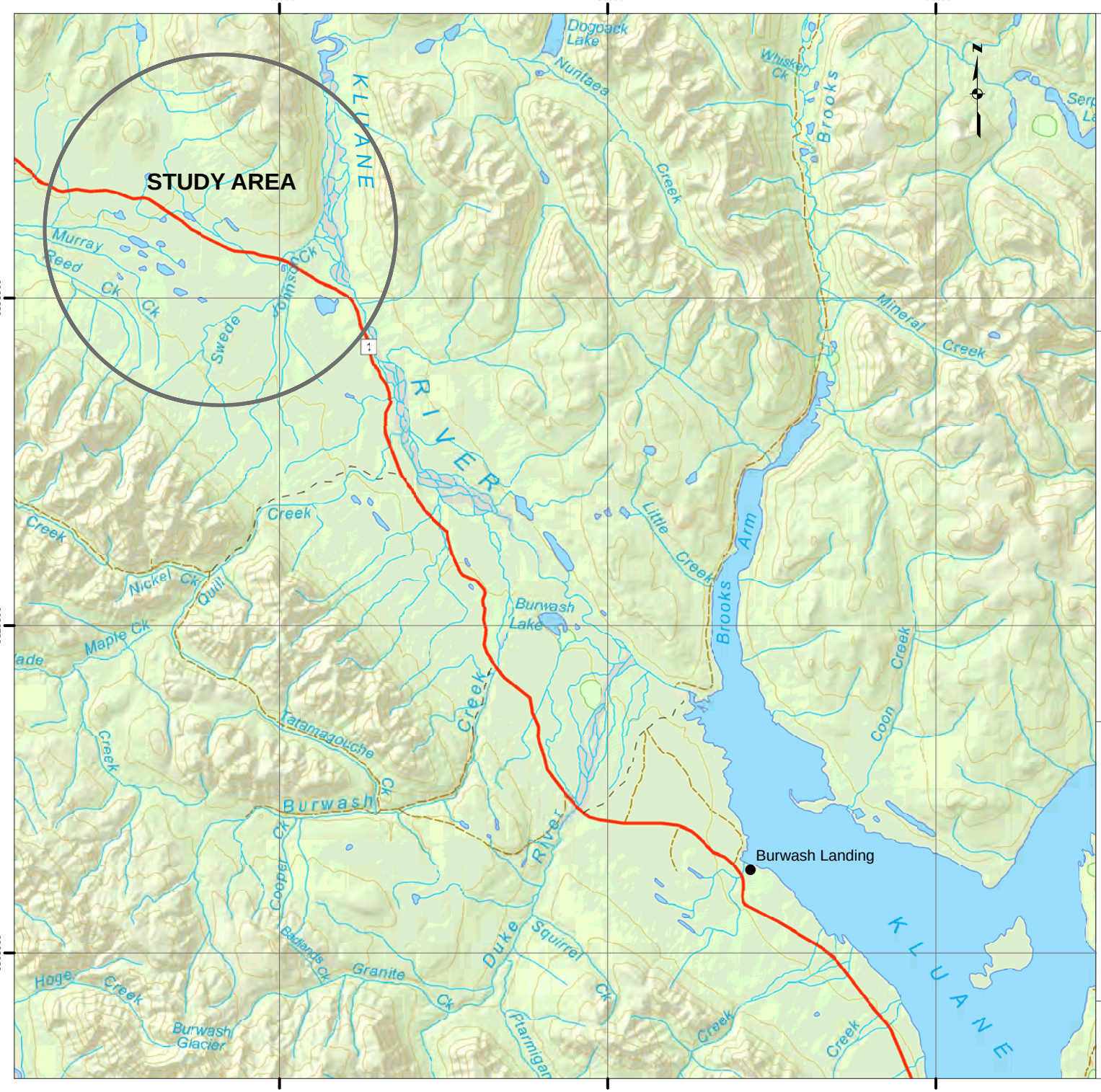

Figure 1. Overview Map of Swede Johnson Creek Study Location

Legend

- .....Yukon Community
- .....Major Road
- .....Unpaved Road
- .....Trail
- .....Contour
- .....Watercourse
- .....Waterbody
- .....River Gravel Bed
- .....Wetland

0 2.5 5 10 Km

Drawn By: M. Power
Checked By: L. Doetzel
Date: 17 December 2008
Projection: NAD 1983 UTM Zone 8
EDI Project #: 08-YC-0027

Digital Data Sources:

1:50,000 and 1:250,000 Topographic Spatial Data: Canvec and National Topographic Database (NTDB). Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved. Data obtained October 2008.

Digital Elevation Model of Yukon provided by Geomatics - Yukon Government; acquired Summer 2008

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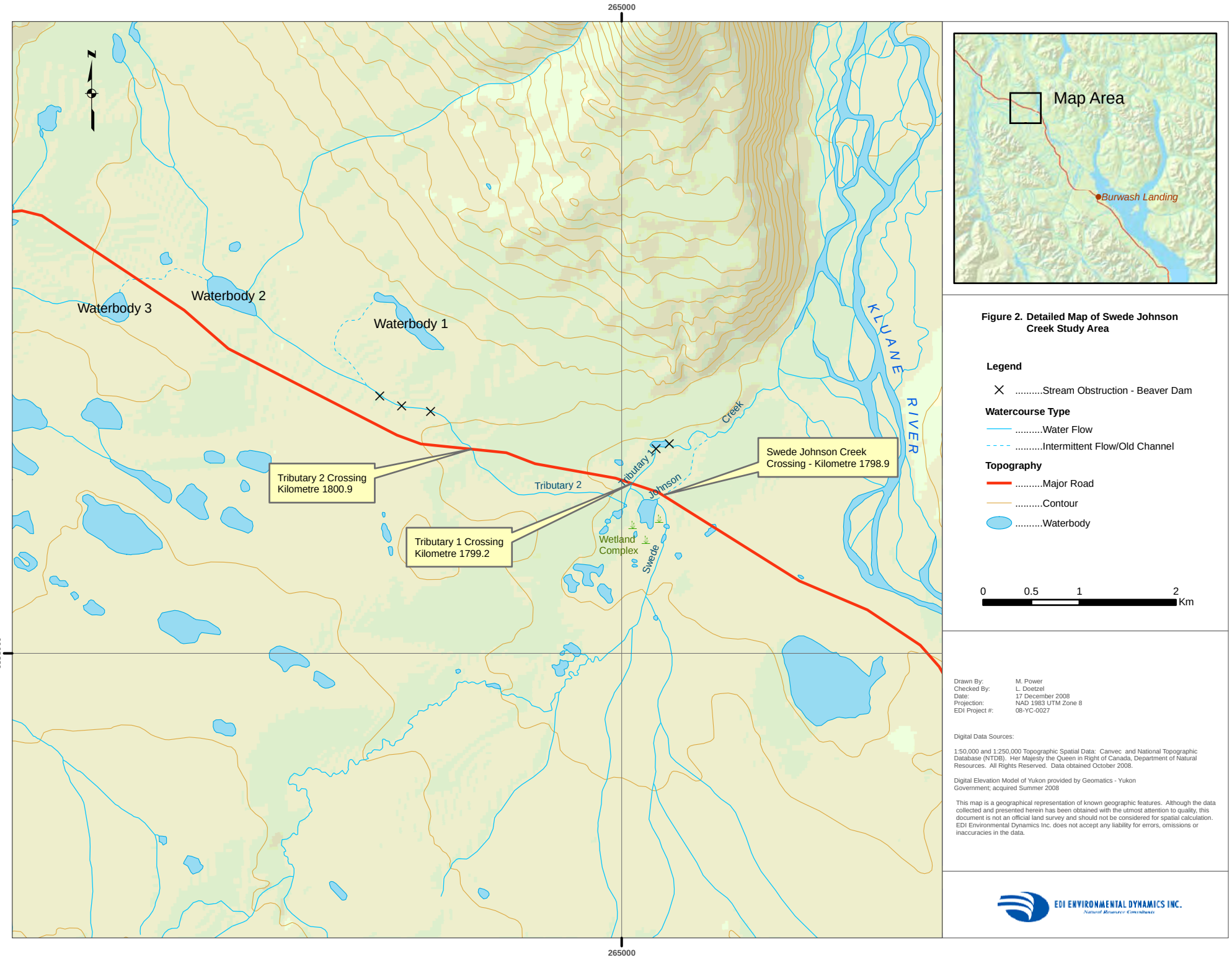
265000
6835000
265000
N
Waterbody 3
Waterbody 2
Waterbody 1
Tributary 2 Crossing
Kilometre 1800.9
Tributary 1 Crossing
Kilometre 1799.2
Swede Johnson Creek
Crossing - Kilometre 1798.9
Tributary 2
Tributary 1
Johnson
Creek
Wetland
Complex
Swede
KLUANE
RIVER
Map Area
Burwash Landing
Figure 2. Detailed Map of Swede Johnson Creek Study Area
Legend
.....Stream Obstruction - Beaver Dam
Watercourse Type
.....Water Flow
.....Intermittent Flow/Old Channel
Topography
.....Major Road
.....Contour
.....Waterbody
0
0.5
1
2
Km
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3 RESULTS

3.1 SITE HISTORY

Swede Johnson Creek at the highway crossing was, for years, an important fishery location for the Kluane First Nation. In a 1993 report on Environmental Impacts associated with the Shakwak highway improvement, Sentar Environmental Consultants determined that Swede Johnson Creek together with two nearby tributaries were valuable rearing and nursery habitat for Arctic grayling (Sentar 1993). However, since the 1990's, the fishery has experienced an apparent downturn, and in recent years no adult grayling have been documented in the creek at this location. Juvenile Arctic grayling (likely age 1+) were documented in the ponds upstream of the highway in the summer of 2007 and in 2002 or 2003 (Tobler Pers. Comm. 2008).

In addition to grayling, there are a number of other species found in the watershed: all species of fish captured in the area are listed in Table 1.

Table 1: Fish species reported in the Swede Johnson watershed.

Scientific Name	Common Name	Code
Couesius plumbeus	lake chub	LKC
Catostomus catostomus	longnose sucker	LSU
Oncorhynchus keta	chum salmon*	CM
Thymallus arcticus	Arctic grayling	GR
Cottus cognatus	slimy sculpin	CCG
Prosopium cylindraceum	round whitefish	RW

Data from Canada, Public Works 1997, NNRS 1997, Foothills 1981, Sentar 1993.
*chum salmon documentation is related to spawning grounds located in the Kluane River at the mouth of Swede Johnson Creek.

The Swede Johnson watershed near the highway is composed of three watercourses (as differentiated in Sentar 1993), Swede Johnson Creek, Tributary 1 and Tributary 2, and a wetland complex area. Review of NTS 1:50 000 maps detail that historically Tributary 1 flowed into Swede Johnson Creek downstream of the highway, below a small pond located on Tributary 1 (Figure 2). However, today, as well as seen in air photos dating back to 1975, the two watercourses are linked both upstream of the highway through the wetland complex, as well as at the downstream confluence. It is unknown when this change in flow pattern occurred.

Reconstruction/improvement of the Alaska Highway was completed in this 'segment' (13A: km 1797.4 through km 1804.4) from spring to fall of 2000. The stretch of highway surrounding Swede Johnson was given much consideration as it was recognized as an important traditional resource to the Kluane First Nation (Sentar 1993). Three multi-plate culverts were installed in the area in the summer and fall of 2000; one at the Swede Johnson crossing, one at each of the next two stream crossings north of Swede Johnson, both of which are tributaries of the Swede Johnson system; Tributary 1 and Tributary 2. Swede Johnson is

located at km 1798.9, Tributary 1 at km 1799.2, and Tributary 2 at km 1800.9 (Figure 2). The culvert in place at Tributary 1 prior to highway improvement was considered undersized (square-type with a width of 1.9 m), and was perched by 0.20 m (Sentar 1993). No problems were noted with the culvert at Tributary 2; however, the culvert was upgraded as a future preventative measure at the time of highway improvement (Sentar 1993).

The main fishing location historically visited by the KFN for Arctic grayling fishing was at the downstream outlet of the highway crossing at Tributary 1. There remains at this site traces of a past 'fish camp', with a fire ring, and bars set up for hanging fish (Photo 1). It should be noted that the original culvert at this crossing was perched by 0.20 m, potentially creating a barrier to fish passage and allowing for increased harvesting at the culvert outlet; however, adult grayling should be capable of overcoming a 20 cm obstruction. Parker (2000) lists the jumping ability of adult Arctic grayling to be 1.0 m provided there is a pool of 1.25 m. Another complicating factor, however is that the culvert was determined to be undersized; there may have been a velocity barrier associated with high flows moving through a small diameter culvert. If this culvert did present a barrier to fish passage, it potentially explains the high fisheries value of this location, and why that fishery was hurt with the replacement of the old culvert with a newer, larger model that presented no barriers to fish passage.

Photo 1. Remains of small 'fish camp' at Tributary 1 (Highway crossing km 1799.2)

In addition to the replacement of the three culverts, improvements to the highway required infilling of 750 m^2 surface area of the wetland (average depth approximately 1 m) along the west side of the highway (Photo 2). Because this infilling led to a loss in fish habitat, it was determined that this habitat must be

compensated for through creation of new habitat elsewhere. The loss of this habitat was compensated for through the creation of 1,200 m^2 of additional habitat within the wetland complex (average depth to be approximately 1 m), located on the northeast edge of the pond (Photo 3). This habitat compensation led to the net increase of 450 m^2 (1,200 m^2 - 750 m^2) of new fish habitat. It was anticipated that with existing groundwater levels and surface flow into the wetland there would not be any significant impact to overall water levels within the wetland complex associated with the creation of new habitat (Water License MS-99-141, Amendment).

Photo 2. Infill area along west side of highway north of the Swede Johnson crossing.

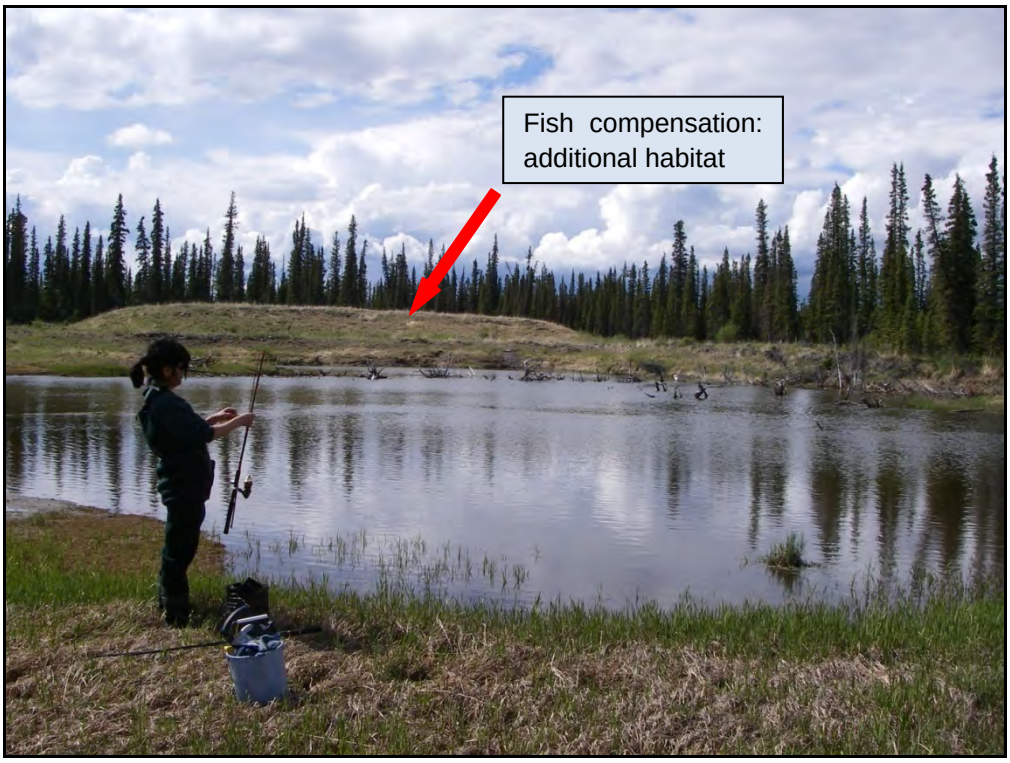

Photo 3. Wetland complex showing additional habitat dug out as compensation for infill area.

As part of the planning process for the highway improvements, photos were taken of the Swede Johnson culvert crossing in June 1999. These photos show a considerable amount of water moving through the Swede Johnson channel highway crossing. Following the highway improvement works on Segment 13A, Alaska Highway in 2000, water ceased to flow through the Swede Johnson Creek crossing culvert. Replacement of the undersized culvert at Tributary 1 likely allowed a larger volume of water to pass through, reducing possible backwatering upstream of that culvert. Also, the addition of 450 m^2 of habitat, dug to a variable depth averaging 1 m potentially temporarily lowered the water level in the wetland complex by a small measure. At the point where water flows from upper Swede Johnson Creek and separates, part flowing into the wetland complex, and part historically continuing through the culvert downstream toward the Kluane River, there is a small 'lip' over which water must flow to enter the culvert channel. It is possible that during highway construction the inlet channel to the Swede Johnson crossing was not dug deeply enough to allow water from upper Swede Johnson to divert and flow through this crossing. The entire flow from the upper Swede Johnson Creek now flows into the wetland complex, and this increased amount of water is not sufficient to allow water to overcome the height differential between the creek bed, and the culvert inlet bed. No signs of recent water flow through the Swede Johnson culvert were present.

3.2 FISH AND FISH HABITAT ASSESSMENT

Fish habitat and presence was investigated at a number of locations in the lower Swede Johnson watershed during the spring/summer of 2008.

3.2.1 SWEDE JOHNSON CREEK, UPSTREAM OF HIGHWAY CROSSING

Fish and fish habitat in Swede Johnson Creek, upstream of the highway and wetland complex was investigated as part of the June 2008 site visit. Along this reach the channel width ranged from 2.9 to 5.5 m. Water levels were very high at the time of assessment, and the wetted width ranged from 2.4 to 4.9; the watercourse was nearly at bank full levels (Photo 4). There were a number of pools noted, some as deep as 1.25 m, and average channel depth varied from 0.75 to 1.0 m. Morphology of the stream can be described as riffle/pool, and the bed material was composed of fines with smaller amounts of gravels and cobbles. The channel pattern was irregular meander, and while no islands were noted, there were a number of bars present along stream margins. This reach was coupled with surrounding topography, and frequently confined.

Instream cover was abundant; largely provided by large and small woody debris, with smaller amounts of overhanging banks, deep pools and instream vegetation. Evidence of permafrost melt was present throughout the area, and the resulting slumping of surrounding topography has lead to a large number of trees being uprooted and covering the watercourse (Photo 5). These trees have lead to many small log jams, and large amounts of instream cover.

Photo 4. Swede Johnson Creek upstream of highway and wetland complex.

Photo 5. Large amount of fallen trees surrounding the watercourse.

Potential for spawning habitat was good as there was appropriate gravel spawning habitat present throughout the area. However, at the time of investigation the water levels were exceedingly high and flow velocities very fast. Rearing habitat was moderate to good due to the presence of a number of deep pools containing slower moving water. Overwintering habitat was unlikely due to water depth. This creek likely freezes to substrate, or very close to substrate in the winter months.

Effort was made to sample fish in this reach through electrofishing. Approximately 200 m of this stream was electrofished before water depth and the amount of fallen trees prevented further effort. No fish were captured, however, one slimy sculpin was observed.

Table 2. Fish sampling effort in Swede Johnson Creek upstream of the highway and wetland complex.

Date	Catch Method and Effort	Fish Captured
18 September 2008	Electrofishing; 318 sec	No fish captured , 1 CCG observed

CCG – slimy sculpin

3.2.2 SWEDE JOHNSON CREEK, DOWNSTREAM OF HIGHWAY CROSSING

At the Swede Johnson Creek crossing no water was flowing through the culvert during either the spring or late summer investigation. The large amount of terrestrial vegetation including grasses and shrubs immediately upstream of the culvert provides evidence that water has not flowed through this channel in quite some time (Photo 6).

There are some small standing pools of water within the culvert, and some standing water downstream of the culvert. This water is likely due to precipitation and highway runoff. Approximately 100 m downstream of the highway all standing water disappears, leaving a dry, vegetated channel (Photo 7). This dry channel continues until approximately 200 m up from where Tributary 1 enters Swede Johnson Creek. At the confluence of Swede Johnson Creek and Tributary 1 there exists a small woody debris jam which creates a backwater area than extends into the dry Swede Johnson Creek channel (Photo 8 and Photo 9).

Photo 6. Dry channel bed in Swede Johnson Creek just upstream of culvert, looking downstream.

Photo 7. Swede Johnson Creek dry channel bed approximately 400 m downstream of highway crossing.

Photo 8. Swede Johnson Creek just up from confluence with Tributary 1.

Photo 9. Log jam present on Swede Johnson Creek, just downstream of confluence with Tributary 1.

3.2.3 SWEDE JOHNSON CREEK, DOWNSTREAM OF CONFLUENCE WITH TRIBUTARY 1

From the Swede Johnson-Tributary 1 confluence downstream to the Kluane River, the Swede Johnson Creek channel poses no barriers to fish migration. The channel width ranged from 5 to 11 m, and the wetted width in September ranged from 4.9 to 6.8 m. The stream channel widened with increasing proximity to the Kluane River. The morphology of the stream was riffle/pool, with a large number of pools present ranging in depth from 0.20 to 0.64 m. Water was clear and the bed material was composed of fines with some sections of gravel and cobble (Photo 10). Bars were present, both mid channel and along the margins throughout the length of the stream. The stream pattern was irregular meandering, and the stream channel partially coupled with surrounding topography (Photo 11).

The majority of cover was provided by large woody debris, with smaller amounts provided by small woody debris, undercut banks, and deep pools. Riparian vegetation on both left and right banks consisted of mature coniferous forest, with some marshy wetland areas.

Spawning habitat was moderate, with many areas of gravel bed material present, but slightly small in size. Rearing habitat was good with many available pools, slower velocity water along the margins, and abundant cover. Overwintering habitat was thought to be poor due to generally shallow water depth; it is more likely that fish populations move into the Kluane River, which provides overwintering habitat.

Photo 10. Bed substrate and cover material in lower reach of Swede Johnson Creek

Photo 11. Channel morphology of Swede Johnson Creek, lower reach.

In an effort to capture fish along this reach, minnow traps were set and approximately 450 m of the stream was electrofished. Though the habitat in this area was good for nearly all life stages and no obstructions were present to isolate this area from the Kluane River, no fish were captured through electrofishing and only one lake chub was found in the minnow traps (Table 3).

Table 3. Fish sampling effort in the lowest reach of Swede Johnson Creek.

Date	Catch Method and Effort	Fish Captured
17/18 September 2008	2 Minnow Traps; 42.83 hr (total)	1 LKC
18 September 2008	Electrofishing; 408 sec	No fish captured or observed

LKC – lake chub

3.2.4 TRIBUTARY 1

Tributary 1 was investigated at two locations, one upstream (Photo 12) and one downstream (Photo 13) of the highway crossing. Upstream of the highway the channel width ranged from 1.2 to 1.8 m, and the wetted width ranged from 1.10 to 1.97 m. Flooded conditions existed that prevented the channel and wetted width from being measured at the downstream location. Further investigation revealed that this flooding was due to downstream beaver activity. Bed material at the upstream site was composed of gravels with lesser amounts of fines. Where possible to ascertain bed type downstream of the crossing, it appeared to be composed of fines, with a lesser amount of gravels. Upstream of the highway the channel pattern was irregular meander, while downstream it straightened out somewhat to a sinuous pattern. At both sites the channel was occasionally confined.

Cover was present and abundant. Both upstream and downstream of the crossing small woody debris was the main source of cover. Smaller amounts of cover were provided by large woody debris (upstream), undercut banks and overhanging vegetation.

Spawning habitat potential at the upstream site was good, with moderate amounts of appropriate bed material, and moderate water flow. Rearing habitat potential at the upstream location was excellent; cover was abundant, some deeper pools were present, and there was access to the larger wetland pond. Due to shallow water depths overwintering habitat was classified as poor as many sections likely freeze to substrate. Habitat potential at the downstream location was difficult to ascertain due to the high water conditions.

Photo 12. View of Tributary 1 channel upstream of Alaska Highway crossing.

Photo 13. View of Tributary 1 channel downstream of Alaska Highway crossing.

Fish sampling in Tributary 1 was conducted mainly in June with a small additional amount conducted in September (Table 4). A large number of slimy sculpin and lake chub (Photo 14) were captured in the spring, however no Arctic grayling, juvenile or adults, were captured or observed at any time.

Table 4. Fish sampling effort in Tributary 1.

Date	Catch Method and Effort	Fish Captured
Upstream		
9/10 June 2008	9 Minnow Traps; 162.92 hr	4 CCG 51 LKC
9 June 2008	Electrofishing; 761 sec	12 LKC 1 CCG
Downstream		
9/10 June 2008	4 Minnow Traps; 75.58 hr	1 CCG
17/18 September 2008	1 Minnow Trap; 21:37	No Fish Captured

CCG – slimy sculpin LKC – lake chub

Approximately 500 m downstream from the Tributary 1 highway crossing (km 1799.2), a number of beaver dams have enlarged a pre-existing pond (Photo 15). This pond has beaver dams at both the inlet and outlet. While the upstream dam is not a complete barrier to fish passage (Photo 16), the downstream network of dams is very extensive, and can be considered an obstruction to fish passage (Photo 17).

Photo 14. Lake chub captured while electrofishing upstream of the Tributary 1 highway crossing.

Photo 15. View of beaver pond along Tributary 1.

Photo 16. Beaver dam upstream (at inlet) of the pond on Tributary 1.

Photo 17. One of the beaver dams which together creates an obstruction to fish passage at pond outlet.

Effort was made to catch fish in the pond in the early fall. Minnow traps were placed along the margins of the pond. One slimy sculpin (CCG) was captured (Table 5). Therefore, the pond is likely capable of providing overwintering habitat for sculpin.

Table 5. Fish sampling effort in beaver pond along Tributary 1.

Date	Catch Method and Effort	Fish Captured
17/18 September 2008	Minnow Trap 1, 22.46 hr	1 CCG
17/18 September 2008	Minnow Trap 2, 22.58 hr	No fish captured

CCG – slimy sculpin

3.2.5 WETLAND COMPLEX

Upstream of the Alaska Highway, Swede Johnson Creek flows into a wetland complex; this area includes a pond and a number of interconnected channels flowing through vegetated marsh. Initially, just past the Swede Johnson highway crossing, the creek runs into a small waterbody. Water exits this small pond and flows toward the highway before turning north to flow along the highway, ultimately emptying into Tributary 1 before flowing through the culvert at the km 1799.2 highway crossing (Figure 2). Within recent years (2007, P. Tobler Pers. Comm.) large numbers of juvenile grayling were seen rising in the small wetland ponds along the west side of the highway. However, at no time during either the late spring or early fall investigations were any grayling seen in this area, despite careful observation. Considerable effort was put into fish capture at this location, and it was sampled both in late spring and early fall (Table 6).

Table 6. Fish sampling effort in the wetland complex (pond and channels) upstream of the Alaska Highway.

Date	Catch Method and Effort	Fish Captured
11/12 June 2008	8 Minnow Traps; 133.83 hr (total)	8 CCG 1 LKC
11 June 2008	Angling; 30 min	No fish captured or observed
18/19 September 2008	10 Minnow Traps; 173.97 hr (total)	11 CCG 1LKC 1 LSU

CCG – slimy sculpin LKC – lake chub LSU – longnose sucker

3.2.6 TRIBUTARY 2

Tributary 2 flows south along the east side of the highway, crosses the Alaska Highway at km 1800.9, eventually flowing into Tributary 1, and then ultimately into Swede Johnson Creek (Figure 2). The stream was assessed approximately 250 m upstream of the highway crossing. The channel width ranged from 1.7 to 3.0 m. The wetted width varied from 1.6 to 2.65 m. The primary stream morphology was riffle/pool, and pool depths varied from 0.25 to 0.46 m. Bed material was composed of gravels with smaller amounts of cobbles and fines.

Cover was abundant, largely composed of small woody debris, with lesser amounts of undercut banks and overhanging vegetation. Riparian vegetation was composed largely of shrubs/willow and coniferous forest. Crown closure in some areas was quite high, largely due to the narrow channel width and abundance of willows in the riparian areas. Approximately 750 m upstream from the highway crossing the first in a series of beaver dams is present. These dams were thought to pose a significant barrier to all fish passage (Photo 18 and Photo 19).

The presence of these beaver dams prevents this stream from providing any valuable fish habitat upstream of the highway crossing. Downstream of the crossing, spawning habitat is poor due to a lack of suitable substrate; rearing habitat is very good due to an abundance of cover, with many small pools and moderate flow velocities; overwintering potential is poor due to general shallow depth of the watercourse.

Fish sampling effort at this site included minnow trapping and electrofishing, both conducted within 500 m of the upstream side of the highway crossing (east side of the highway) (Table 7). Sampling effort occurred in June during the on-site investigation. No fish were captured or observed throughout Tributary 2.

Photo 18. Beaver dam on Tributary 2 which both slows water flow and acts as a barrier to fish passage.

Photo 19. Backwater area on Tributary 2, upstream of largest of the beaver dams.

Table 7. Fish Sampling Effort in Tributary 2, upstream of the highway crossing.

Date	Catch Method and Effort	Fish Captured
10/11 June 2008	8 Minnow Traps; 155.17 hr (total)	No fish captured or observed
10 June 2008	Electrofishing; 309 sec	No fish captured or observed

3.2.7 UPSTREAM WATERBODIES

There are three small waterbodies in the area upstream of Tributary 2. For ease of explanation, these waterbodies were each given a numerical designation: 1, 2, and 3 (Figure 2). These waterbodies were investigated as potential overwintering locations for fish species present in the lower Swede Johnson watershed.

Waterbody 1 is small and narrow, and heavily vegetated (Photo 20). Though it appears from current mapping information that it is linked with Tributary 2 through an outlet approximately 1 km in length, this outlet is now entirely vegetated, and no open water channel is present (Photo 21). The historical channel can be seen as a break in the mature coniferous forest; however, the presence of small conifers in addition to grasses and shrubs throughout the area previously occupied by the water channel provides evidence that no water has been present for some time (Photo 22). This waterbody provides no fish habitat as there is no access, and the water depth is too shallow to permit overwintering.

Photo 20. View of Waterbody 1 from southeast point, looking northwest. Note heavily vegetated shorelines.

Photo 21. Location of mapped water body outlet, any watercourse previously present is now completely vegetated.

Photo 22. Location of mapped watercourse connecting Waterbody 1 and Tributary 2.

Waterbody 2 is the upstream source of Tributary 2 (Figure 2). This was the largest waterbody of the three investigated (Photo 24). The shorelines were marsh-like, and heavily vegetated with grass species. At the time of investigation there were a number of waterfowl present on the water surface (Photo 24). Water depth was likely deep enough to allow overwintering habitat; however, the series of beaver dams on Tributary 2 preclude any usage of Waterbody 2 by fish species within the Swede Johnson watershed at this time.

Some effort to capture fish through angling was made on 19 September 2008; Effort lasted 15 minutes, and no fish were captured, or observed.

Photo 23. Overview of Waterbody 2 and surrounding area.

Photo 24. Waterfowl present on the surface of Waterbody 2. Also, note wetland vegetation along shorelines.

Waterbody 3 is upstream from Waterbody 2, and is located on the opposite (west) side of the Alaska Highway. This is another small, shallow waterbody, heavily vegetated with grasses along the margins (Photo 25). The watercourse that links Waterbody 2 and Waterbody 3 is heavily vegetated, and unlikely to be used by fish species. The tall grass growth in the channel indicates that water does not flow continuously through the channel (Photo 26). Waterbody 3 provides overwintering opportunities for fish in the lower Swede Johnson watershed.

Photo 25. Overview of Waterbody 3.

Photo 26. Watercourse linking Waterbody 3 with Waterbody 2.

4 SUMMARY OF FINDINGS

Stream systems are dynamic, in constant transformation; through the last decade watercourses in the Swede Johnson watershed have undergone considerable change. A decrease in the apparent fisheries value of the Swede Johnson Creek watershed appeared to coincide with highway improvements to the area in the summer of 2000. There are a number of factors that appear to have altered this system. Highway improvements at km 1799.2 (Tributary 1 crossing) replaced a perched and undersized culvert with one that allowed a greater quantity of water to flow through, and presents no barriers/impediment to the passage of fish. This replacement likely reduced the number of adult grayling present in the pool at the outlet of the culvert, as fish were able to move upstream, thus decreasing its value as a good fishing spot.

The timing of the culvert replacement appears to coincide with the last season (late summer 2000) during which water flowed through the culvert at the Swede Johnson crossing (km 1798.2) and continued downstream to the confluence with Tributary 1. Photos taken in 1999, as part of construction planning, show a large amount of water moving through the culvert. Vegetation growth in the dry Swede Johnson channel also provides a rough estimate of a timeline of the last water flow through the area. A large number of established grasses are present on the creek bed. However, there is a notable lack of shrubs, willow or small coniferous trees; species which dominate the riparian vegetation surrounding the channel, but would require more time to establish in the dry creek bed. Vegetation type and abundance provides further evidence that water flowed through the channel as recently as 1999, but not in the time span between 2001 and this past summer season.

A possible explanation for the cessation of water flow in the Swede Johnson culvert is that the inlet channel for the crossing was not dug deep enough to allow water passage from upstream Swede Johnson Creek to be, in part, diverted into the culvert channel, causing the entire flow to move into the wetland complex. Local topography provides evidence of recent increased water levels in the wetland complex. There are a number of large coniferous trees in the centre of the wetland. Water levels in the wetland complex remained steady enough for these trees to grow to maturity, however, in recent years, water levels have increased slightly and these trees drowned and are now standing dead. Unfortunately these increased water levels are not sufficient to reintroduce flow through the Swede Johnson culvert.

Previous to the year 2000, fish were able to migrate from the Kluane River to the Alaska Highway through two channels; Swede Johnson Creek and/or Tributary 1. With the cessation of water flow through Swede Johnson Creek downstream of the highway crossing, grayling were left with only one option. In recent years, the amount of beaver activity in the Swede Johnson watershed has increased. There is a small pond along Tributary 1, downstream of the highway; beavers have constructed dams at both the inlet and outlet of this pond (Figure 2). The outlet dam, in particular, is a probable barrier to fish passage. Therefore, at the time of survey, it did not appear possible for adult grayling from the Kluane River to make it up to the highway.

Large numbers of juvenile Arctic grayling were noted in the wetland complex along the western margin of the highway in 2002 and/or 2003, and as recently as 2007 (P. Tobler, Pers. Comm. 2008). The population

located in the wetland ponds indicates that some adults were able to access the upper reaches of the Swede Johnson watershed in recent years, and successfully spawn; Sentar 1993 noted spawning habitat in Tributary 2, along with the presence of both fry and juvenile Arctic grayling, and spawning habitat was also documented in 2008 in Swede Johnson Creek upstream of the highway and wetland complex. This summer, despite extensive observation, no grayling were seen rising in the same location as the 2007 sightings (or in any other location in the watershed). The apparent absence of grayling could be explained by beaver activity and/or overwintering conditions. The downstream beaver activity likely prevents adults from entering this area and spawning. If the fish observed in 2007 were spawned nearby, it appears that they were able to overwinter in the area (in the winter of 2006/07). However, they either moved out of the area (i.e. downstream to the Kluane River) or did not successfully overwinter in 2007/08. Year to year variation in overwintering is possible given that the area has marginal overwintering habitat due to shallow water depth; during particularly harsh winters overwintering habitat may be lessened due to increased ice thickness or decreased dissolved oxygen (DO) concentrations. While other species were captured in the area near the highway, it is possible that they were able to overwinter, while grayling were not. The general trend is that non-salmonid species are more tolerant of low DO levels. For instance, Ostrand and Wilde (2001) found that some Cyprinid species can tolerate DO concentrations of 2.1 mg/L. As they appear to be able to overwinter in these ponds these fish species likely live out their entire life cycle within the watercourses near the highway.

In its current state, the Swede Johnson watershed near the highway does not appear to be accessible to Arctic grayling. However, as previously mentioned, stream habitat is dynamic. Should the beaver dams located on Tributary 1 be removed, either through natural or anthropogenic means, a migration route connecting the watershed with the Kluane River would be re-established. Additionally, should the inlet channel to the culvert at the Swede Johnson crossing be lowered to allow water flow, there would again be two migration routes linking the Kluane River with habitat upstream of the Alaska Highway. Reintroduction of water into this channel would re-establish a historical flow route, and should have minimal detrimental effect on water levels in the upstream wetland complex. As has been previously established, it appears that water levels in the wetland complex have increased in recent history, as evidence by downed trees located on the wetted margins.

5 CONCLUSIONS AND RECOMMENDATIONS

It appears that a variety of factors caused a section of Swede Johnson Creek downstream of the Alaska Highway to run dry in 2001; a condition that persists today. This lack of water flowing through Swede Johnson Creek, combined with increased beaver activity on Tributary 1, have led to an apparent absence of Arctic grayling in the upper portion of the Swede Johnson watershed.

Alterations to Swede Johnson Creek, immediately upstream of the culvert at km 1798.9, to lower the bottom culvert inlet creek would re-introduce water flow through the culvert, and the section of the creek immediately downstream of the highway. This alteration would increase Arctic grayling habitat for migration, rearing and nursery uses in the watershed, and re-open access to the upstream wetland area. Beaver or beaver dam management may also be necessary to maintain a migration route through Tributary 1 and/or Swede Johnson Creek. Alterations to improve and increase fish habitat within the Swede Johnson watershed cannot guarantee an increase in the value of the Arctic grayling fishery in this area to the Kluane First Nation. However, there exists the possibility that this area could again be used by high numbers of Arctic grayling.

Re-introducing water flow through the Swede Johnson crossing would slightly lower water levels in the upstream wetland complex. However, the levels should be consistent with historical levels (as witnessed by the dead conifers). The system maintains enough water flow to re-establish historic channels in the watershed.

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