

## Little Tahltan River Chinook Assessment - 2016



Prepared by:



Tahltan Fisheries

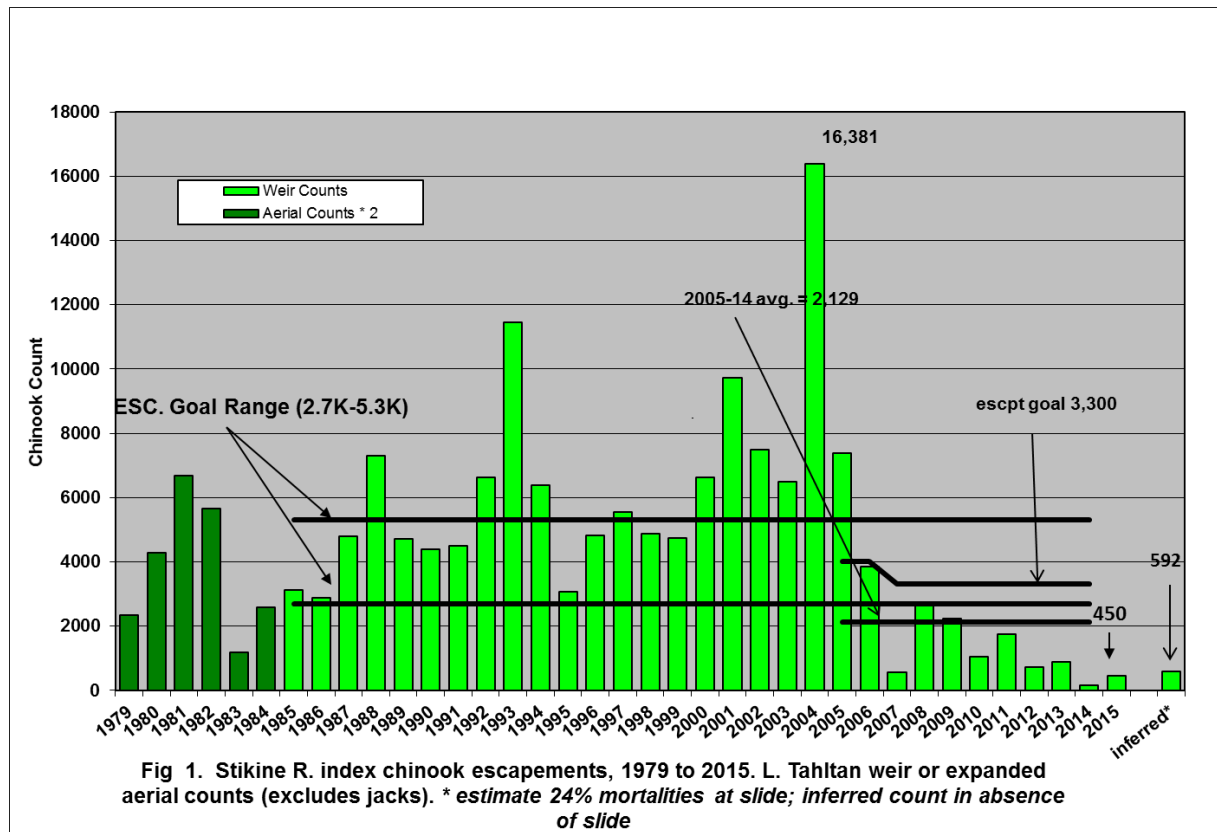
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## Introduction:

Historically, Little Tahltan River Chinook have been a major contributor to the overall Stikine production, but have declined in recent years, both in abundance and relative contribution to the total Stikine Chinook run. The L. Tahltan Chinook stock has failed to meet its escapement goal or target (of 3,300) in nine consecutive years. (See Figure 1 below, provided by DFO.) This abrupt decline started in 2007 and recovery has yet to occur. Although, the overall Stikine Chinook abundance has seen a similar declining trend, this stock has seen greater decrease in a disproportionate manner.



This report is a summary of the 2016 Reconnaissance Survey of the Little Tahltan Watershed, which was funded through the Northern Fund of the Pacific Salmon Commission. The overarching scope of this work is to look at physical habitat in the watershed and assess for factors that may relate to the decline of Chinook salmon escapement. The work in 2016 largely involved conducting an overflight of the watershed to photo-document the existing habitat, and installing a hydrometric station and gauging the main stem flows.

To note, the specific reasons for the decline in L. Tahltan Chinook abundance are not known at this time. There are likely to be multiple factors of influence which may include some of the following:

1. A decrease in marine survival (as related to the broader decline seen in many Chinook populations starting in 2007);
2. Flooding events that occurred during the spawning period of 2007;

3. Changes in the spatial distribution of Chinook spawners (as seen on the Nakina River, where there is not a live weir, only an upper carcass weir);
4. Influence of the L. Tahltan weir on fish behaviour or distribution;
5. Predation effects, in particular by grizzly bears;
6. The potential compounding effects of lower abundance on Chinook behaviour, distribution and predation.
7. Initiation of directed harvests on Stikine Chinook (beginning in 2005);
8. Age and size composition of Little Tahltan Chinook has changed over the last 30 years, shifting towards younger age-at-maturity and smaller size, with a higher proportion of jacks.
9. In late May 2014 a rockslide occurred at a site located approximately 800 metres upstream from the mouth of the Tahltan River. The rockslide introduced a seasonal, stage dependant migration barrier for Tahltan and Little Tahltan Chinook.

## Objectives:

The overall goal of this project was to improve understanding of the watershed processes that contribute to spawning and rearing habitat and assist with the planning function for potential future restoration efforts. From a broader perspective, the aim is to better understand any habitat based factors that may explain recent year declines in escapement to the system.

The objectives for this project mirror those developed at the bilateral meeting of the TTC in February of 2015. At that time the TTC recommended that a 2016 proposal to the NF regarding L. Tahltan Chinook should include the following field work or other tasks:

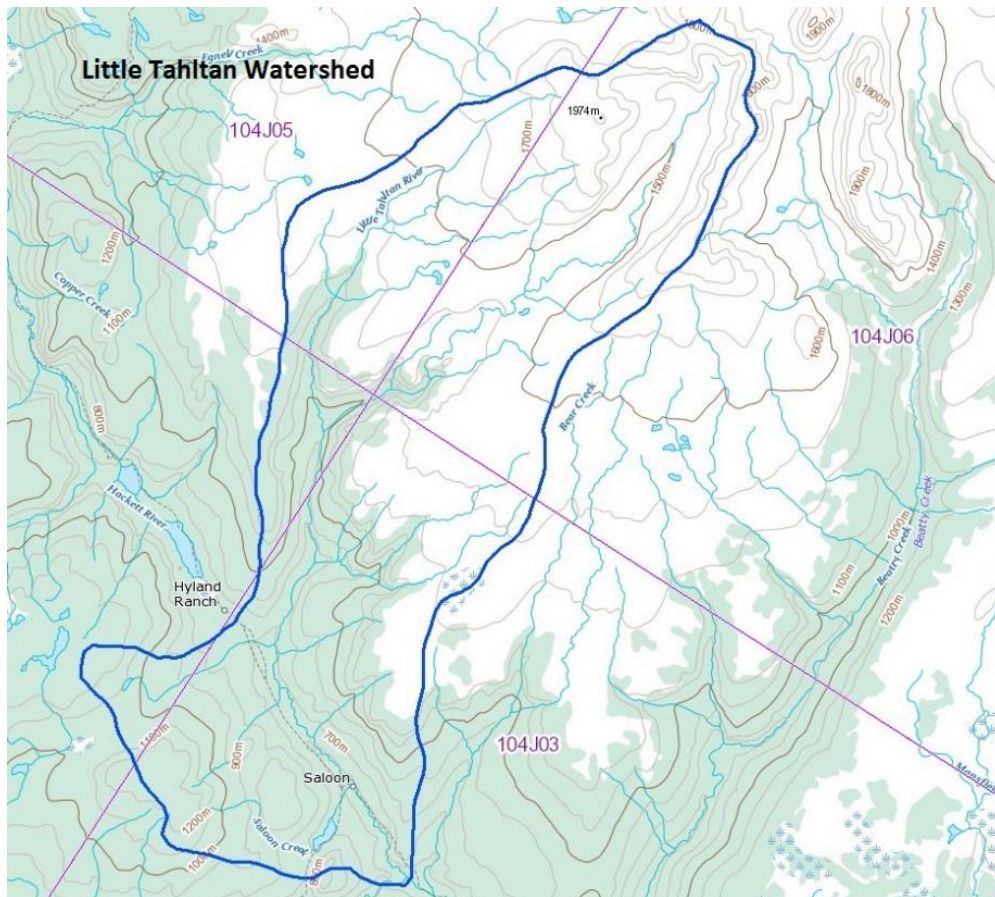
1. The installation of a hydrometric station to monitor temperatures and flows;
2. A reconnaissance field survey of the condition of spawning habitat, inclusive of probing for groundwater influence;
3. Review of the weir operations (from the perspective of ensuring fish are not being held back);
4. Further consideration of the feasibility of utilizing genetic sampling in the future to distinguish between Tahltan and L. Tahltan stocks;
5. Development of a plan for moving forward with the assessment of decline and/or restoration initiatives. Such would be in consultation with the TTC.

To note, the above objectives do not include assessment of all factors that may have contributed to a decline in abundance. The focus is upon investigating site specific environmental conditions in the L. Tahltan River, given that such is an aspect that is relatively easier to assess. Likewise, the potential influence of the weir, although not suspected as the main problem, is something that can be fairly easily modified or adjusted.

## Watershed Description:

The Little Tahltan watershed covers an area of approximately 306 km<sup>2</sup> divided roughly equally between forested and alpine areas (see Appendix 1). The watershed is located in the southern portion of the

Stikine Plateau Hydrologic Zone according to the Inventory of Streamflow in the Skeena Region (Ahmed and Jackson, 2013). The watershed is located in the lee of the Coast Range Mountains in an area of low annual precipitation. Ecosystems in the watershed reflect the dry climate with the lower slopes classified within the Boreal White and Black Spruce Biogeoclimatic Zone (BWBSdk), mid slopes are within the Spruce Willow Birch Zone (SWB) and the uppermost elevations of Meszah Peak fall within Boreal Alpine Zones (BAFAun). The area is mostly forested except for the Boreal Alpine zone.



**Figure 2: The Little Tahltan Watershed. The total watershed area is approximately 306 km<sup>2</sup>.**

Little Tahltan River is a left bank tributary of the Tahltan River that joins the main stem from the north approximately 25 kilometers upstream of the Tahltan / Stikine confluence. Little Tahltan is headwatered in the southern flank of Meszah Peak at an altitude of 2100 meters. Saloon Lake is the only significant lake in the watershed with a surface area of approximately 42 hectares a length of 1.4 kilometers. The headwater area has a number of small scour hole ponds within a large paleo-channel remnant that provide some low flow augmentation.

Much of the Little Tahltan watershed drainage system appears to be formed by glacial and subglacial mega flooding. Meszah Peak has many features that are currently recognized as glacial / subglacial outburst flooding landforms (Munro-Stasiuk, et al, 2009). Four major paleo-channel remnants can be seen emanating from the summit of Meszah Peak, the southernmost of which forms the headwater of Little Tahltan River (indicated by the blue arrow in Figure 3, below). At a smaller scale there are mega dunes and antidunes, scour holes and a network of coulees that are all hallmarks of mega-flood landforms. Given the monolithic nature of Meszah Peak (it is topographically isolated from neighbouring

mountains) and the size of the paleo-channels it can reasonably be assumed that the flooding and landform modification must have occurred while the basin was still largely ice covered and that Meszah Peak acted as a drain for Glacial Lake Stikine early in the deglaciation phase of the last glacial episode. The significance of this mega flood landscape evolution, in the fisheries context, is that the paleo-channel remnants provide excellent hydrologic fundamentals in terms of alluvial aquifers, groundwater storage, and surface pot-hole lake surface water storage. The implications of this suggest that the site may have better than average climate change resilience, better low flow character and resistance to stream warming.



**Figure 3: A Google image of the Little Tahltan headwaters and Meszah Peak. The dark green channels are paleochannels emanating from Meszah Peak from massive outburst flooding. The blue arrow indicates the flow path toward the Little Tahltan River.**

### Scope of Field Work:

The field work for this assessment was conducted from July 29-31, 2016 and included:

- Conducting an aerial reconnaissance of the watershed and assessing the fish habitats;
- Establishing a hydrometric station and conducting flow gauging;
- Some spot sampling of water characteristics and installing several temperature loggers;
- Assessing the current weir arrangement with respect to the effectiveness of passing (and not withholding) adult Chinook.

## Results:

### Hydrology:

#### Regional Data:

A look at the available regional hydrologic data is useful here to characterize Little Tahltan hydrology. The Tuya River Water Survey of Canada gauge (WSC Stn: 08CD001) is the closest and most geographically similar watershed to use for regional comparison. A summary of the two watersheds is included below:

Parameter	Tuya	Little Tahltan
<b>Watershed Area</b>	3550 km <sup>2</sup> (above the gauge)	306 km <sup>2</sup> (total)
<b>Percent Difference</b>	-	8.6% of Tuya
<b>Lake coverage</b>	30 km <sup>2</sup> (0.8% of watershed)	.42 km <sup>2</sup> (0.14 % of watershed)
<b>Spot Gauging (July 30, 2016)</b>	19.4 m <sup>3</sup> /s (WSC Stn 08CD001)	1.86 m <sup>3</sup> /s (measured)
<b>Spot gauging unit area runoff</b>	5.5 L/s/km <sup>2</sup>	6.1 L/s/km <sup>2</sup> (11% higher /Tuya)
<b>Average 7 day, 10 yr low flow</b>	17.18 m <sup>3</sup> /s	1.62 m <sup>3</sup> /s (Est.)

Table 1 shows the comparison of Tuya and Little Tahltan flows indicating that Little Tahltan watershed area is 8.6% of the size of Tuya with similar lake coverage. Spot gauging for both watersheds indicates that Little Tahltan has an instantaneous unit area runoff 11% higher than Tuya at the time of gauging. The average 10 year recurrence interval 7 day low flow (June to September) for Tuya is 17.18 m<sup>3</sup>/s and the estimated Little Tahltan (adjusted based on a ratio of watershed areas) is 1.62 m<sup>3</sup>/s. Based on the Little Tahltan spot gauging this places the Little Tahltan 2016 summer low flow was near to the 10 year recurrence interval low flow.

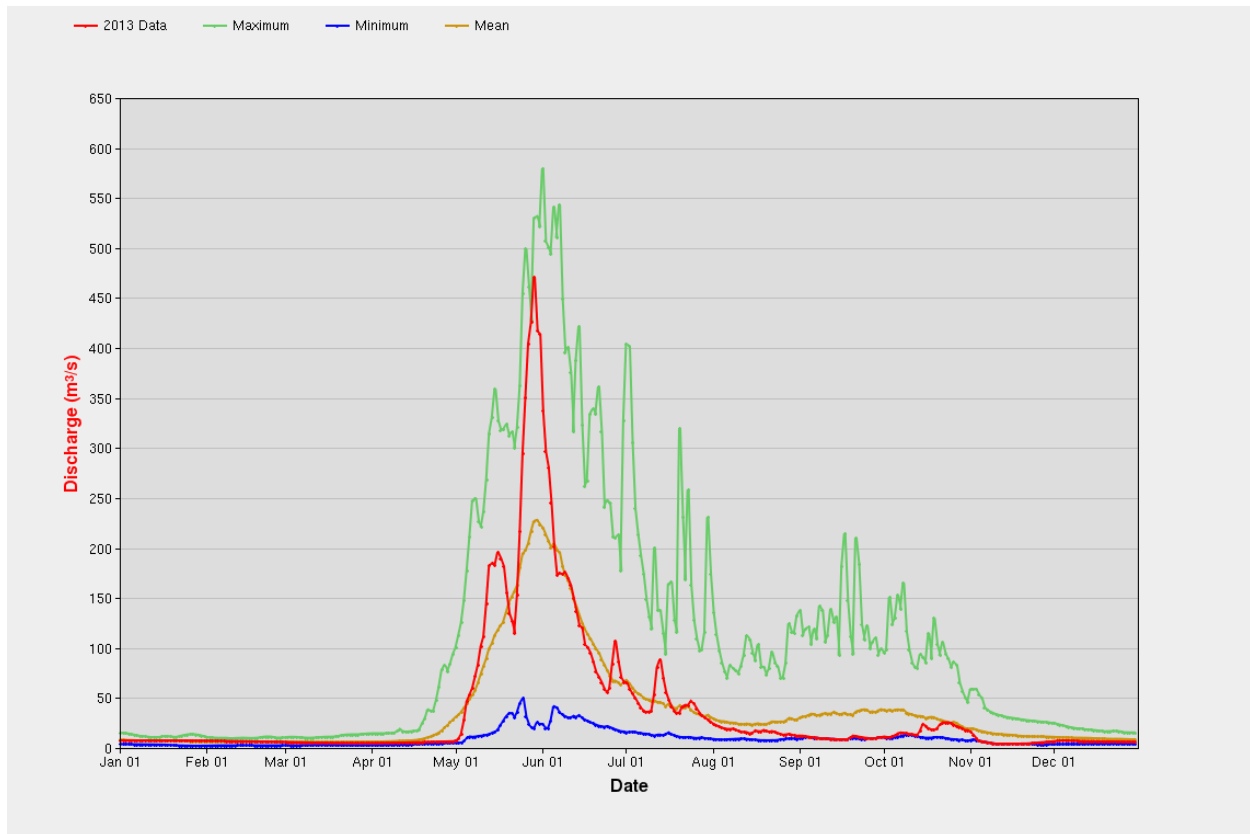
#### Site Data:

As a part of the scope of work a hydrometric station was installed approximately 250 meters upstream of the 2016 weir location. The station was instrumented with a Solinst pressure transducer and staff gauge and surveyed to a sturdy bench mark for hydrometric leveling. The flow was then gauged at a location between the weir and the hydrometric station. Survey notes and details are included in Appendix 2 and deployment records for all data loggers are in Appendix 3. Spot water quality data was also collected at the time of gauging. The data is included in Table 2 below.

Parameter	Value	Date
<b>Flow</b>	1.86 m <sup>3</sup> /s	July 30, 2016, 10:00
<b>pH</b>	8.95	July 29, 2016, 11:00
<b>Dissolved Oxygen % Saturation</b>	88 %	July 29, 2016, 11:00
<b>Dissolved Oxygen</b>	9.05 mg/L	July 29, 2016, 11:00
<b>Specific Conductivity</b>	68 µS	July 29, 2016, 11:00
<b>Temperature</b>	11.1 °C	July 29, 2016, 11:00



*Photo 1: The hydrometric station as installed on July 30, 2016.*



*Figure 4: Water Survey of Canada discharge data for Tuya River (WSC station 08CD001) is displayed to show the annual hydrograph pattern for Tuya River, the closest and most representative regional gauge.*

The gauging resulted in a flow estimate for Little Tahltan River on July 30, 2016, of 1.86 m<sup>3</sup>/s. Figure 4, below is a graph of Tuya River flows for the 52 year hydrometric record and the hydrograph for 2013 (the most recent 100% Quality Assured data). The plot shows a typical spring snowmelt driven hydrograph with a minor peak corresponding with fall storm precipitation. Their close proximity and geographical similarity make the comparison of Tuya and Little Tahltan data reasonably representative.

Some other spot measurements of water parameters were taken opportunistically and are displayed in Table 3 below. Despite relatively low water conditions, water depth at spawning sites appeared to be well within the bounds of known quantitative measures preferred by Chinook salmon (as per Keeley & Slaney, 1996). Water velocities seemed more than adequate, if anything on the higher end of known preference. Also, water temperatures taken with a long probe into the gravel provided some indication of groundwater influence and/or sub-surface flows that would help facilitate egg incubation. Spawning gravels appeared to be abundant and of appropriate size, however in some cases somewhat compacted.

<b>Date / Time</b>	<b>Water Temp</b>	<b>Gravel Temp</b>	<b>Depth (cm)</b>	<b>Velocity (m/s)</b>	<b>Comments</b>
<b>July 29, 2016 @ 11:00am</b>	10.8	10.7	35.5	0.94	Reach 2. Chinook spawning area in glide above crest of riffle.
<b>July 30, 2016 @ 1:30pm</b>	12.2	10.1	56.0	0.89	Reach 1. In thalweg just below water station.
<b>July 30, 2016 @ 1:53pm</b>	13.8	12.5	44.8	0.80	Reach 1. Further below water station
<b>July 30, 2016 @ 5:15pm</b>	-	-	50.0	0.77	Reach 1. In spawning area just above weir site.
<b>July 31, 2016 @ 10:55am</b>	-	-	30.0	1.17	Reach 1. In spawning area just above weir site.

In addition to the water station, 2 HOBO type temperature data loggers were placed approximately 100m above the weir in the vicinity of active Chinook spawners. Such were installed within a PVC tube, buried in the gravel and anchored with rebar.

#### Habitat Assessment:

Habitat assessments were undertaken by air on July 29<sup>th</sup> 2016 with an additional 2 days or reconnaissance by foot from the camp. The objectives of the recon were to:

- Observe Chinook spawning area habitats
- Conduct reconnaissance to photo-document the channel and assist with reach break delineations;
- Check for migration barriers and obstacles, and;
- Conduct ground truthing of spawning habitats.

#### Reach Breaks:

A summary of the reconnaissance reach break delineation for Little Tahltan is included in Table 4 below.

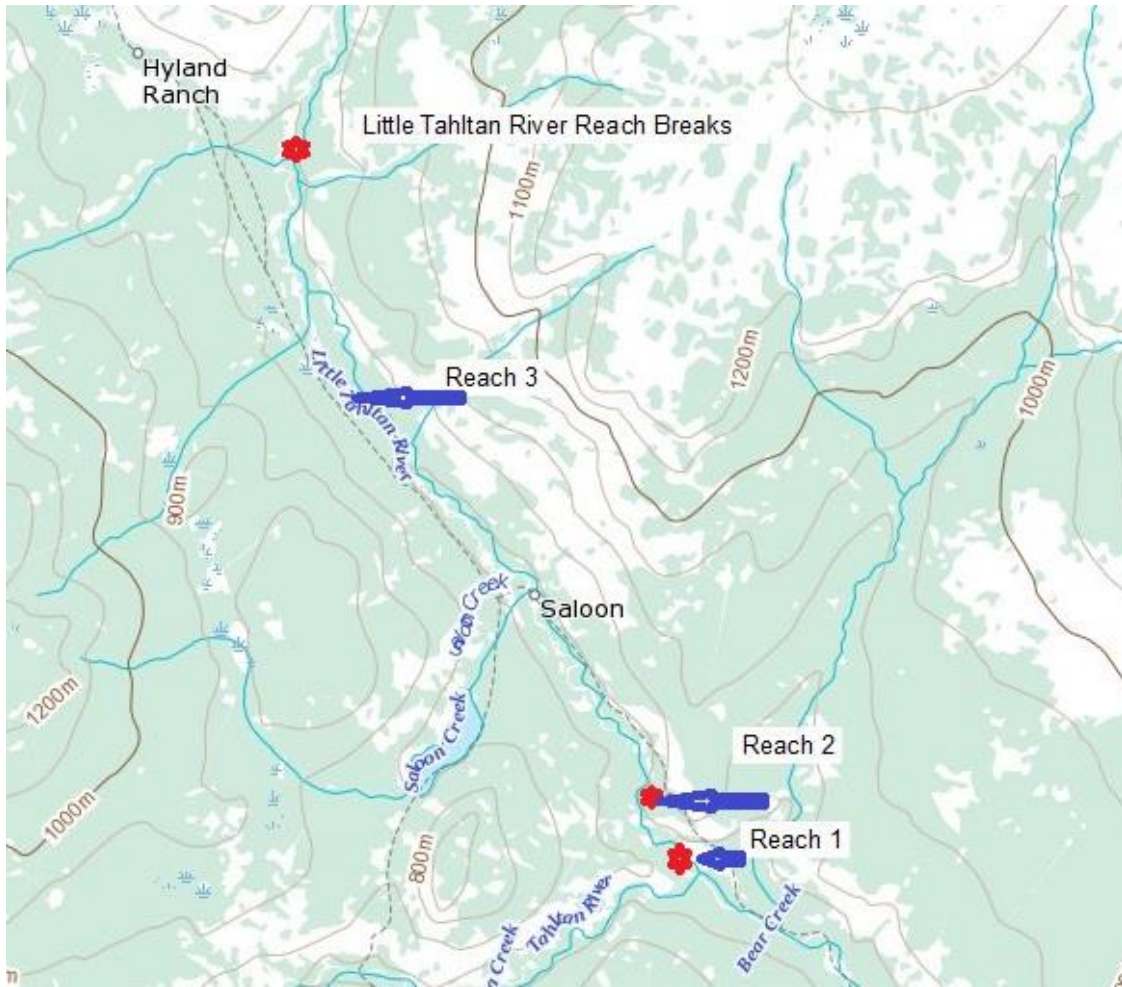


Figure 5: A map of the reach break delineation for the length of Little Tahltan River assessed during the field tour.

Table 4: Little Tahltan Reach Break Summary:					
Reach	Coordinates	Elevation	Reach Length	Gradient	Description
RB 1	363339mE, 6444532mN	516m	170m (Reach1)	3%	Alluvial Fan
RB 2	363232mE, 6444654mN	522m	1.7 km (Reach2)	1.5%	Confined Reach
RB 3	362173m E, 6445204m N	548m	10.8km (Reach3)	1.2%	Braided Reach
RB 4	354750mE, 6449773mN	670m			

### Reach Descriptions:

#### **Reach 1:**

Reach 1 is the lowermost 170 meter section starting at the Tahltan river confluence. The fan is limited in extent due to the tight valley sidewalls although there is some floodplain area on river right that may be inundated at higher flows. This reach is a single thread channel with a relatively coarse substrate mix of cobbles, gravels and sands and an immobile boulder lag deposit (See Photo 3 below). The river left bank is not inundated at any flows as the floodplain has been isolated by channel down-cutting. River right has some active floodplain area and evidence of recent overbank flows.



*Photo 2: Aerial view of Reach 1 on the alluvial fan.*



*Photo 3: Underwater shot of a Chinook at the gauging section in Reach 1 30 meters above the weir. The sediment mix of sands, gravels and cobbles with a boulder lag deposit is typical of the reach. Several Chinook pairs were observed spawning in reach 1 above the weir.*

**Reach 2:**

Reach 2 is a confined channel section from the apex of the alluvial fan upstream 1.7 kilometers to the start of Reach 3 where the valley opens up. Narrow bands of floodplain and bedrock confinement define this reach. The channel is single thread with pool-riffle and step-pool features. The sediment texture is similar to Reach 1 with a good mix of sands, gravels and boulders. A boulder lag deposit of immobile pieces (up to approximately 3 meters diameter) provides good scour hole holding habitat and depth variability.



*Photo 4: Reach 2 from the air. This reach is confined in a bedrock canyon.*

Several active Chinook redds were noted in reach 2 in pockets of spawn-able substrate. Towards the top of Reach 2 the channel is more confined by large alluvial deposits and bedrock outcrops. Photo 5 (below) was taken at the top of Reach 2 just above the bedrock canyon. This section has a number of active sediment sources, good channel complexity, undercuts and deep holding areas. The bedrock surface is likely shallow at this point creating strong groundwater upwelling and limits the depth of the local groundwater aquifer.



*Photo 5: The top end of Reach 2 where the channel is confined by alluvial deposits and bedrock outcrops. There is good channel complexity, bedload sources and deep holding water.*

### **Reach 3:**

Reach 3 is delineated based on its braided channel type, reduced slope and wide meander plain. This Reach is approximately 10.8 kilometers long with a combined meander plain and floodplain that ranges from about 200 meters in width at the bottom end to nearly 500 meters near the top of the Reach. The river in Reach 3 is “underfit” as it is nested in the alluvial channel of massive flows from the Meszah Peak paleo-channels. The overflight did not indicate any potential barriers or migration obstacles along the Little Tahltan River to the top end of Reach 3. There is no industrial development, roads or infrastructure within the watershed, the habitat is pristine.



*Photo 6: Looking upstream from the Bottom of Reach 3. The wide valley flat is a paleo-channel emanating from Meszah Peak.*

The recon overflight revealed that the braided reach has considerable off-channel habitat in abandoned channel scrolls, back channels and riparian wetlands (See photos 7 and 8 below.) Despite the fact that the photo was taken during extreme low flow there is still considerable wetted area and good holding pool structure and channel complexity. The lower half of Reach 3 had the greatest density of spawning activity at the time of the overflight. Photo 8 was taken in the lower half of Reach 3 and shows the braided channel morphology and extensive active gravel sources. The floodplain / meander plain showed areas of surface ponding and forested wetlands indicative of a high water table and groundwater discharge.



*Photo 7: Aerial photo at the middle of Reach 3. The photo shows a braided section of the channel with active sediment sources.*



*Photo 8: View of forested wetlands and side channels in the lower half of Reach 3. It is noteworthy that the picture was taken at a near 10 year recurrence interval low flow).*

### Weir Assessment:

As part of this project, a preliminary assessment of the potential Influence of the L. Tahltan weir on adult Chinook behaviour or distribution was to be considered. To note, some concerns regarding the possibility of fish being held back by the weir largely came about during the process of trying to establish a formal escapement goal for L. Tahltan Chinook.

As some background, in July of 2006 the Tahltan Fisheries Biologist conducted a brief (first time) site visit to the L. Tahltan weir. (This was prior to the drastic decline in L. Tahltan Chinook seen in 2007.) Opportunistic observations of the weir function at that time included some potential factors that could reduce the effectiveness of passing adult Chinook thru the weir. These included:

- Having all capture structures for sampling on the downstream side. This included a back out trap and trough below the weir. (See Photo 9 below);
- A lack of water depth and attraction flow thru the counting area on left bank;
- Highly apparent grizzly bear fishing activity in and around the weir structure;
- Some Chinook holding behind the weir area and at times returning downstream.

These concerns were expressed to a DFO staff member at the time, however this being prior to the Chinook decline, there seemed little reason to adjust weir structure or operations that had been utilized previously. Even afterwards, with the overall Chinook decline across a much broader region, the weir was not suspected as a contributing factor.



**Photo 9: Little Tahltan weir July, 2006.**



**Photo 10: Little Tahltan weir July, 2016.**

In 2016, after discussions at the TTC and between DFO and Tahltan Fisheries, multiple aspects of the weir configuration and operations were implemented. (See Photo 10 above.) These changes included:

- Installation of the sampling trap upstream of the fence, on the left bank;
- Movement of the weir placement upstream somewhat, into deeper water;
- Directing water to increase attracting flows;
- Setting up a lighting system to allow counting and sampling of fish during dark time periods;
- Installation of an electric fence around the weir perimeter to keep bears out, (which has been done for a number of previous years).

During the site visit in late July 2016, with the above adjustments made, both the weir configuration and operations appeared to move Chinook thru quite efficiently. As well, the weir staff was clearly diligent in efforts to move Chinook thru in an efficient manner. Chinook tended to move into the upstream trap relatively quickly, bear observations were minimal and outside of the weir perimeter. The 2016 weir count was 923 (large fish).

## Conclusions:

### Habitat Assessment:

The habitat assessments conducted are reconnaissance level overviews from a single overflight on July 29, 2016. Limited ground checking was conducted due to time, logistic and budget limitations but the results suggest that the main spawning area in Reach 3 has excellent hydrologic and groundwater fundamentals owing to the following factors:

- Reach 3 is an underfit river migrating across a large alluvial paleo-channel including extensive areas with very high potential for groundwater aquifer storage;
- The bottom of Reach 3 is bedrock controlled which further enhances groundwater storage across the floodplain by creating a subsurface “dam”;
- Reach 3 has a wide hydro-riparian zone with off-channel habitats and wetlands that were inundated and functional even at the very low flows observed at the time of the overflight.

The overflight did not reveal any migration barriers, jump obstacles or other passage issues so it is assumed that spawning access is not a problem. Habitat condition, in terms of channel form, instream cover, gravel recruitment and LWD inventory all seemed quite intact.

Ground observations in Reach 1 and 2 indicated an abundance of good quality spawning habitats which appeared to have ideal depths, more than adequate velocity and a plentiful amount of gravel substrate.

Overall, the 2016 reconnaissance assessment provided no preliminary indications of current habitat limitations to Chinook salmon productivity. (However, historical information on habitat condition is not available for comparison.) As follow-up to the 2016 field survey the installed temperature and pressure loggers will need to be downloaded and the river flows should be gauged again. Also, some further assessment of key upstream habitat parameters is also recommended, particularly in terms of spawning and rearing potential.

### Weir Assessment:

In retrospect, the past weir arrangement may have had some potential to reduce the effectiveness of passing Chinook in an expedient manner. Although not suspected as a main contributor to the L. Tahltan Chinook decline, it is something that can be fairly easily modified or adjusted.

Changes made to the weir structure and operations in 2016 appeared to provide effective passage of Chinook without any obvious signs of fish being held back, returning downstream, or being preyed upon. Preliminary discussions by the Transboundary Technical Committee identified a further potential adjustment to the weir for the 2017 season by installing a video camera. Such will not eliminate the need for a fence structure, however will allow constant, open passage thru the counting chamber. As well, fish will not need to be physically handled. The details of implementing this proposed change for 2017 will need to be further discussed between DFO and Tahltan Fisheries.

### Genetic sampling / analysis:

Also part of this project, it was suggested that further consideration of the feasibility of utilizing genetic sampling in the future to distinguish between Tahltan and L. Tahltan stocks. The Transboundary Technical Committee has had some preliminary discussions in this regard. It seems there needs to be some follow up in terms of the existing or potential analysis of historic genetic samples. Also, there may

be some potential to initiate a project to collect further genetic samples in the Tahltan River for stock delineation.

#### Summation:

Preliminary information from this initial assessment does not provide any indications that the current habitat conditions in L. Tahltan River should be affecting the productivity of Chinook salmon in the system. Some follow up work would be required to determine this with more certainty.

The historical weir structure and operations are not suspected as a main contributor to the decline in L. Tahltan Chinook, however it may have had some potential to reduce the efficiency of passing Chinook in an expedient manner.

A decrease in marine survival (as related to the broader decline seen in many Chinook populations starting in 2007) is likely to be one definitive factor affecting L. Tahltan Chinook productivity. Beyond that, it is probable that there may have been compounding factors of influence inclusive of some of those listed in the Introduction section of this report. In particular, the resulting effects of lower overall abundance on Chinook behaviour, spatial distribution and predation. In this regard, at lower densities, some of the L. Tahltan origin Chinook could be spawning in the Tahltan River where there may be reduced competition and less tendency for predation. Further study would be required to clarify the certainty and extent of such a hypothesis. In the meantime, it will be important to plan and implement management measures which serve to reduce the impacts upon the L. Tahltan stock along with the overall Stikine Chinook population. This may be in the form of fishery regulations, stock assessment activities or mitigation of the Tahltan River landslide.

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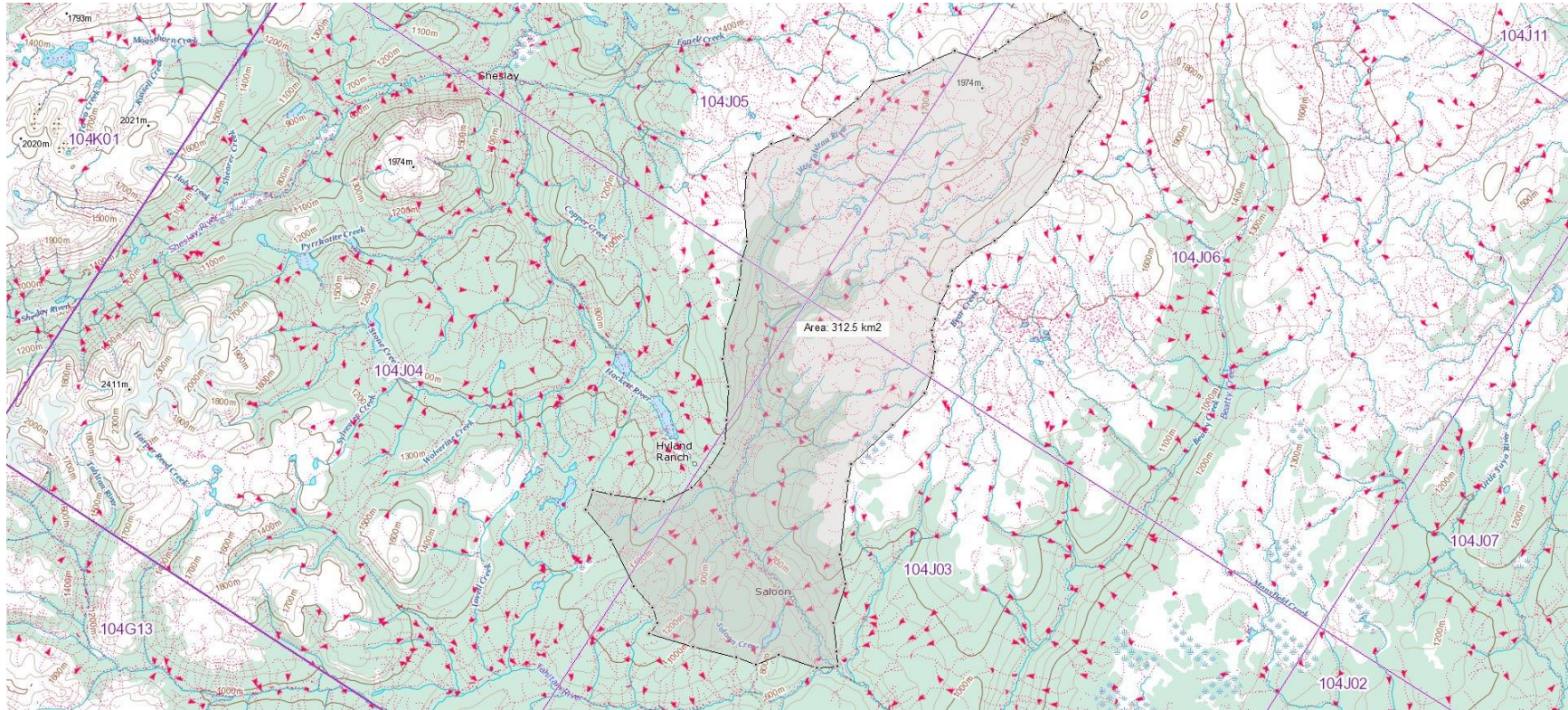
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## Appendix 1: Little Tahltan Watershed Flow Algorithm Delineation:



**Figure A1:** This map shows the delineation of the Little Tahltan Watershed using the Toporama flow path delineation algorithm. Using the algorithm achieves more accurate delineation in watersheds with subtle topographic features like Meszah Peak. More accurate delineation is useful for regional hydrologic assessment.

Appendix 2: Hydrometric Station Details.

Stream Name	Location	Date	Start Time	Finish time	Notes
Little Tahltan	Above the weir	July-30-16	09:50 AM	10:40 AM	Stage start- .355 m: Stage finish: .360 m
<b>Station</b>	<b>Depth (m)</b>	<b>Velocity (m/s)</b>	<b>Panel Width (m)</b>	<b>Panel (m<sup>3</sup>/s)</b>	<b>Weather, sunny, 16 deg. Celsius</b>
0.00	0.5				ToB, depth is tape height above Gd
1.45	1.18				Toe, depth is tape height above Gd
3.55	1.25				W/L, depth is tape height above W/L
4.50	0.15	0.01	0.3	0.00	Ineffective panel
5.50	0.25	0.11	1.00	0.03	
6.50	0.31	0.34	1.00	0.11	
7.50	0.31	0.43	1.00	0.13	
8.50	0.29	0.24	1.00	0.07	
9.50	0.22	0.29	1.00	0.06	
10.50	0.26	0.56	0.75	0.11	
11.00	0.29	0.24	0.50	0.03	
11.50	0.25	0.49	0.50	0.06	
12.00	0.25	0.71	0.50	0.09	
12.50	0.28	0.73	0.50	0.10	
13.00	0.24	0.79	0.50	0.09	
13.50	0.31	0.64	0.50	0.10	
14.00	0.34	0.49	0.50	0.08	
14.50	0.41	0.61	0.50	0.13	
15.00	0.34	0.50	0.50	0.09	
15.50	0.34	0.74	0.50	0.13	
16.00	0.34	0.68	0.50	0.12	
16.50	0.33	0.75	0.50	0.12	
17.00	0.20	0.55	0.50	0.06	
17.50	0.37	0.51	0.50	0.09	
18.00	0.39	0.34	0.50	0.07	
18.50	0.33	0.28	0.50	0.05	
19.0	0.25	0.33	0.50	0.04	
19.5	0.12	0.17	0.50	0.01	
20.0	1.25			0.00	W/L,
20.5	1.20			0.00	Toe, depth is tape height above Gd
20.8	0.45			0.00	ToB, depth is tape height above Gd



Total Discharge: 1.86 m<sup>3</sup>/s

Hydrometric Levels:

Bench Mark reference (BMR): On the gauge, horizontal rebar pin at the top of the stilling well.

Bench Mark (BM): Spike in a spruce tree river right approximately 10 meters south of the stilling well.

Elevations:

BM 0.00m

BMR 0.554m

Top of Staff gauge 0.558m

## Appendix 3: Data logger deployment records

Type	Serial #	Started	Rate	Units	Deployed	Location	Comments
Levellogger	2058996	July 28, 2016 @ 8:55am	1 hour	m & C	July 30, 2016	About 300m upstream from weir on right bank boulder	Cross river at transect site and take trail in forest on right bank side
Barologger	2058934	July 28, 2016 @ 8:59am	1 hour	kPa & C	July 30, 2016 @ 4pm	In tree on left bank behind weir site	
HOBO	10372204	July 28, 2016 @ 12:01pm	1 hour	C	July 30, 2016 @ 5:15pm	About 100m above weir / below large deadfall / in white PVC tube on bottom anchored with rebar	Placement in main current adjacent to group of Chinook spawners
HOBO	10354808	July 28, 2016 @ 11:53am	1 hour	C	July 31, 2016 @ 10:15am	About 200m above weir / above large deadfall / buried in gravel / anchored with rebar	Placement in main current just below a redd with active Chinook spawning pair